LOOKING FOR LEADERSHIP

THE COSTS OF CLIMATE INACTION

Annual Greenhouse Gas Progress Report 2014
Environmental Commissioner of Ontario

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Environmental
Commissioner
of Ontario

Commissaire a
l’environnement
de l”Ontario

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Commissioner

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Commissaire

July 2014

The Honourable Dave Levac
Speaker of the Legislative Assembly of Ontario

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

Dear Speaker:

In accordance with Section 58.2 of the *Environmental Bill of Rights, 1993*, I am pleased to present the Annual Greenhouse Gas Progress Report 2014 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 2013-2014.

Sincerely,

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THE CHANGING CONTEXT

There is an overwhelming scientific consensus that Earth's climate system is warming.

In its Fifth Assessment Report, the Intergovernmental Panel on Climate Change (IPCC) concluded that there is an overwhelming scientific consensus that Earth's climate system is warming and that human activities are mainly responsible for the change. In recognition of this growing need for urgency, the development of climate change policy, both within Canada and around the world, continues to advance. However, the policy landscape remains fragmented. Within the financial community, new risk valuation frameworks are being assessed, which will have implications for companies and investors. The reality of climate change, and the associated extreme weather events it brings, is presenting a fundamental challenge to the insurance industry's underlying business model. Anticipating and responding to these developments is central to good climate change governance and leadership.

This chapter summarizes the past year's global climate change developments as seen through three lenses: climate science, policy developments, and economic risk.

1.1 SCIENCE

In September 2013, Working Group I of the IPCC released its most up-to-date findings on the physical science underlying climate change. This is the IPCC's fifth major global assessment – the Fourth Assessment Report was released in 2007 – and the message is clear: not only is the global climate system warming, human

Human activities have increased the concentration of the three key greenhouse gases to levels that now substantially exceed those experienced at any time within the past 800,000 years.

activities are a key contributor. Recent scientific improvements have made the IPCC more confident – moving from 90 to 95 per cent certain – that human activities, such as deforestation and the burning of fossil fuels, have been the dominant cause of such warming since the 1950s. Although the focus of the IPCC report is on the global climate system, an understanding of its key findings is nevertheless important for policy discussion in Ontario. What follows is a summary of the IPCC's key findings.

Since the release of the 2007 IPCC report, the indisputable scientific evidence of climate change has continued to increase. In part, this is due to improved climate modelling, which is used in conjunction with on-the-ground observations, to assess the impact of humans on the climate system. In particular, long-term climate model simulations, which predicted an upward trend in global surface temperatures between 1951 and 2012, proved to be consistent with the trends that were actually observed.

Along with climate models, observational technologies (e.g., satellites) have improved, and longer time series have been used, particularly in studies that focus on changes to Earth's frozen areas. These refinements have helped to enhance both the identification and measurement of changes and trends over time. As well, former instrumentation biases (such as those relating to historical upper ocean temperature measurements) have been identified and reduced, thus providing scientists with greater confidence in the conclusions reached. Finally, not only have some of the former projections made by the IPCC been confirmed, many of the observed impacts are now happening more quickly than predicted.

Human activities have increased the concentration of carbon dioxide, methane and nitrous oxide (the three key greenhouse gases) to levels that now substantially exceed those experienced at any time within the past 800,000 years. The concentrations of these three gases in the atmosphere have also increased at unprecedented rates; according to ice core records, the rates now exceed those of the past 22,000 years.

Climate change models have predicted more extreme weather events as the global mean temperature rises.

Changing Global Temperature Patterns

Global weather systems fluctuate widely through the seasons and year to year due to the complex way Earth receives the sun's energy and distributes it through the oceans and the atmosphere. Over the short term, it is difficult to see a pattern in the weather, but over the longer term the impact on climate emerges from the data. For example, there has been a clear increase in global atmospheric temperatures when averaged over 10-year (decadal) time periods. Figure 1 shows this progressive warming. Over the last 30 years, the mean temperature in each succeeding decade has been warmer than the previous; within the Northern Hemisphere this is likely to have been the warmest period during the previous 1,400 years. Since 1880, global mean surface temperatures have risen a seemingly insignificant 0.85°C; however, when one considers that a 4°C increase is the difference between today's temperatures and those of the last ice age, it becomes clear that seemingly small changes have a profound impact.

One of the raging debates in the climate change file is whether or not the extreme weather events that are currently occurring can be attributed to climate change. Climate change models have predicted more extreme weather events as the global mean temperature rises. So, is the documented increase in mean global temperature related to the anomalous summer heat waves seen around the globe? Major scientific studies published in the past year have helped to shed light on this question.

Over a large geographic region, long-term climatic variables – like temperature – fall into a common statistical pattern called a bell curve (or, more technically, a normal distribution). For example, if all summer temperatures in the Northern Hemisphere over the period 1951–1980 are plotted, this produces the bell-curve pattern seen in the first illustration of Figure 2. The height of the curve (the y axis) is the frequency of occurrence of that temperature and the x axis indicates how far temperature varies from the mean (average) temperature. The difference between the mean

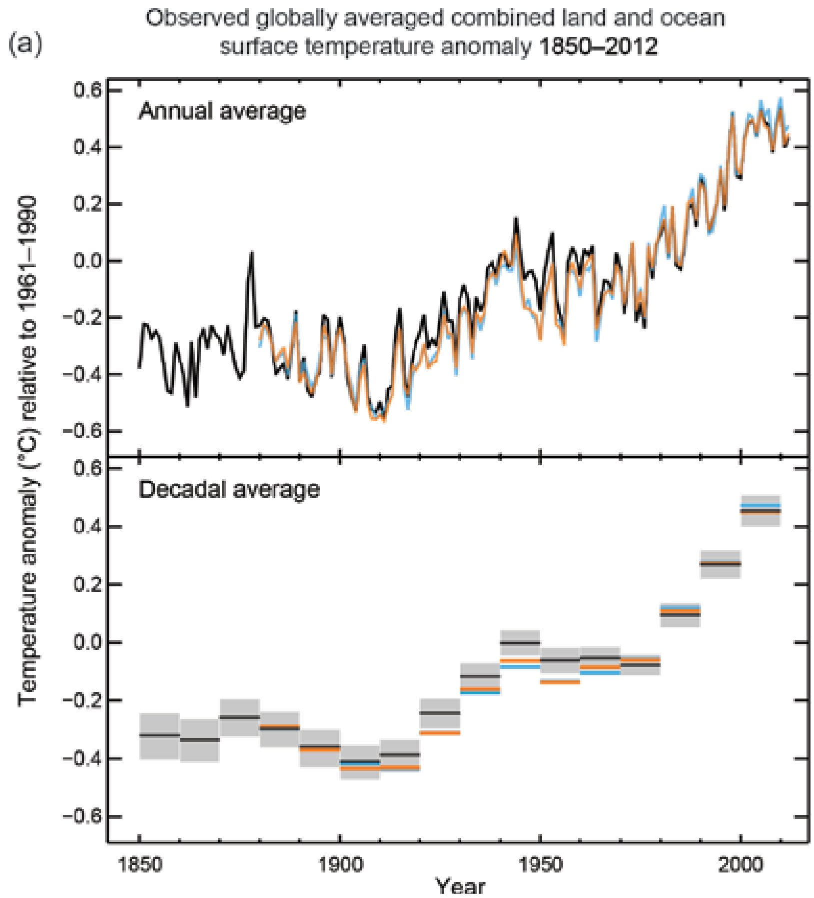
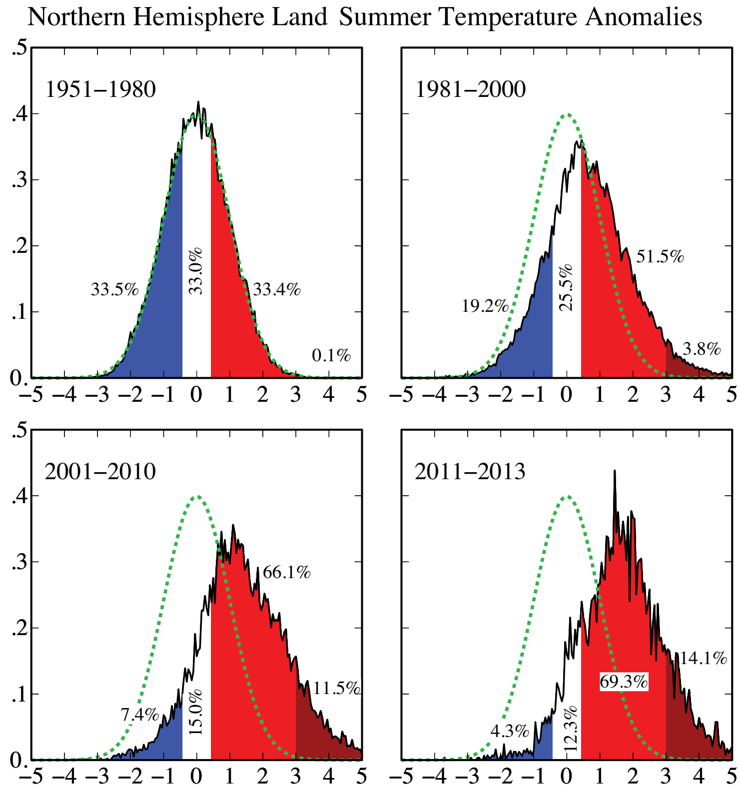


Figure 1:

Global average combined land and ocean surface temperature anomalies from 1850–2012. The three different colours represent information from three independently produced data sets. In each panel, average temperatures are compared with the average temperature experienced from 1961–1990. The top panel shows how annual average temperatures have deviated from the 1961–1990 average. The bottom panel shows how decadal average temperatures have deviated from the same 30-year average. The wider gray band represents the range of estimated uncertainty for one data set. (**Source**: IPCC, 2013: Summary for Policymakers, 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).

Figure 2:

Frequency distribution of summer temperature anomalies for land areas in the Northern Hemisphere. The green curve in all four boxes indicates the predicted baseline distribution of temperature anomalies based on 1951–1980 data. The horizontal axis represents units of standard deviation. The vertical axis represents the frequency of an occurrence in percent. (**Source**: James Hansen, Makiko Sato and Reto Ruedy, *Global Temperature Update Through 2013*. January 2014).



temperature and any given temperature is expressed in terms of a statistical unit called a standard deviation, represented by the Greek letter sigma.

Statisticians tell us that in any normal bell curve, like the one depicting temperatures in Figure 2, about two-thirds (68 per cent) of all data points are expected to fall within one standard deviation of either side of the mean. Most (or about 95 per cent) of all data points will fall within two standard deviations from either side of the mean. And almost all data points (about 99.7 per cent) can be expected to fall within three standard deviations from either side of the mean. So only a tiny percentage (0.3 per cent) of all data points will fall beyond three standard deviations from the mean. These are the extremely rare 3-sigma events.

A close look at the 1951–1980 graph shows that the tail of the figure on the right-hand side (i.e., the 'hot' side) extends just slightly past the three standard deviation point. This indicates that extremely hot days occurred only very rarely (0.1 per cent of

all temperature events) during the 1951–1980 climate record for the Northern Hemisphere. These days are, by definition, 3-sigma events.

The three other bell curves illustrated in Figure 2 show how the familiar 1951–1980 temperature pattern has shifted in subsequent decades. The lower right-hand figure illustrating the temperature distribution for the Northern Hemisphere for 2011–2013 makes the point. What were once very rare extreme heat-wave events are now occurring 14.1 per cent of the time. The entire curve has shifted significantly to a warmer distribution. Extreme weather events (in this case extreme temperature) have become much more common; exactly as predicted by climate change models. Furthermore, this tendency towards more frequent extreme heat is not restricted to just the Northern Hemisphere. According to recent research, this pattern has been replicated globally such that these 3-sigma events, which previously affected less than 1 per cent of Earth's surface, now affect 10 per cent of the global land area.

Global Temperature Trends – the Role of the Oceans

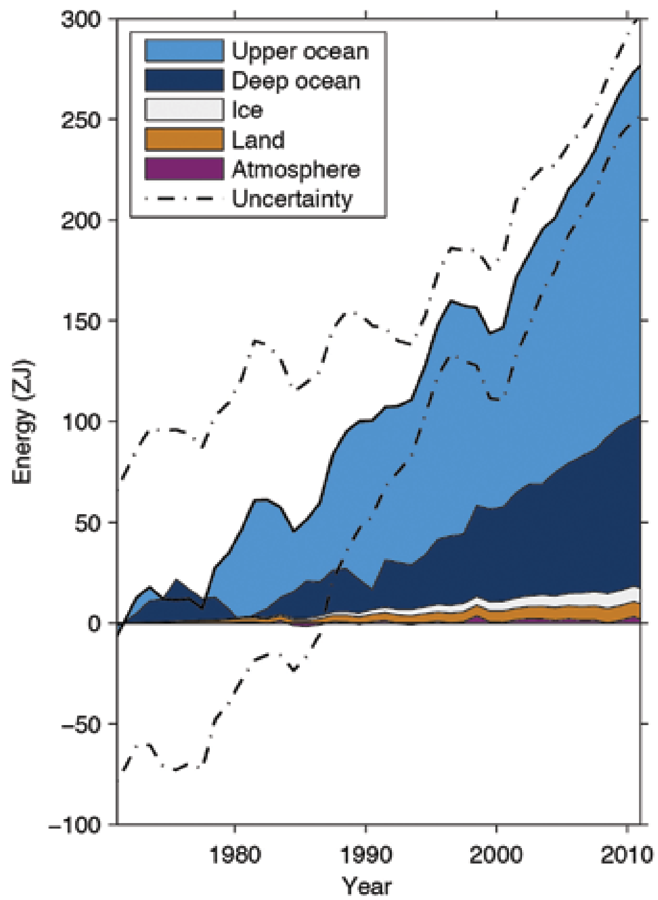
While the IPCC concluded that there has been a steady increase in average surface air temperatures over multiple decades, it also found that there exists substantial variability in the *rate* that such warming occurs on shorter time scales. In particular, although surface temperatures have continued to rise, the rate of warming has slowed since 1998. Looking at the climate system in its entirety, scientists have determined that the oceans have played a key role in moderating the rate of increase due to their absorption of much of the energy that is coming into Earth's climate system. As indicated in Figure 3, more than 90 per cent of solar energy (i.e., heat) that has accumulated in the entire climate system over the

Extreme weather events have become much more common; exactly as predicted by climate change models.

last 30 years has been stored in the oceans (in the form of higher ocean temperatures), with much of it being transferred to the deep ocean levels. Not only have increased amounts of heat been stored in the oceans, the rate at which this heat has been absorbed has accelerated over the past decade. Only a very small percentage of the energy coming into the climate system is accumulating in the atmosphere and serving to increase surface temperatures. Recent research indicates that while the deeper oceans have been very efficient at absorbing the excess heat, this is a short-term phenomenon. Once the oceans stop absorbing high levels of excess energy, rapid atmospheric warming is projected in the coming decades.

Figure 3:

Energy accumulation in each component of Earth's climate system expressed in zettajoules (10^{21}) between 1971–2010, relative to 1971. (**Source**: IPCC, 2013: Chapter 3, Observations: Oceans, 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).



Precipitation Events

Increased air temperatures have an impact on the amount of water vapour that is held in the atmosphere (given that warmer air can hold more water). As such, precipitation patterns are also affected by warmer temperatures. While these patterns show regional variation, the IPCC has concluded that for North America the frequency and intensity of heavy precipitation events has likely increased since 1950. Within Canada, one only needs to look at how Toronto and Calgary were deluged during the summer of 2013 to see examples of ferocious downpours (Figure 4). While it is challenging to attribute such single extreme events to climate change, these types of storms are consistent with the predictions that are being made for North America in a warmer world. For example, the Insurance Bureau of Canada estimates that extreme storms of a magnitude expected to happen every 40 years are now predicted to occur every six years.

Figure 4:

Flooding in Toronto and Calgary during the summer of 2013. (**Source for Toronto photo**: Canadian Press).

Toronto: July 8 2013

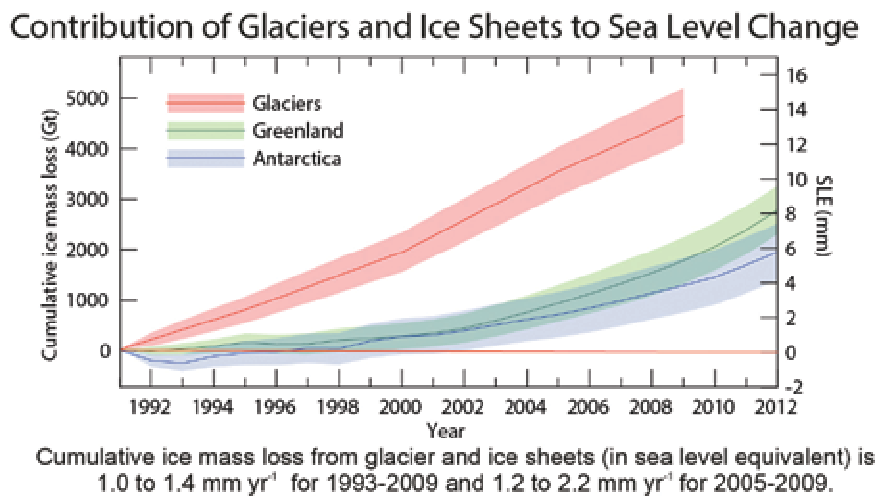
Calgary: June 21 2013

Diminishing Frozen Areas and the Impact on Sea Level Rise

In response to higher temperatures, there have also been significant changes to the frozen parts of Earth's surface – the global cryosphere – over the past 20 years. While the Greenland and Antarctic ice sheets, along with most of the world's glaciers, have experienced significant ice mass loss, the rate at which this has occurred has increased substantially over the past two decades. Between 1992 and 2001, for example, the average rate of ice loss from Greenland's ice sheets was 34 gigatonnes (Gt) per year; this increased dramatically to 215 Gt per year from 2002 to 2011 (Figure 5).

Figure 5:

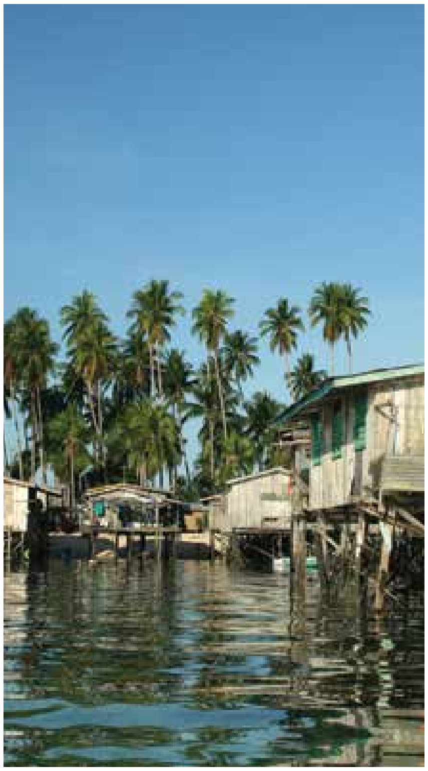
Contribution of glaciers and ice sheets to sea level change. Between 1993–2009, the average rate of ice mass loss from glaciers and ice sheets in sea level equivalent (SLE) was 1.0 to 1.4 mm per year. Between 2005–2009, the average loss rate was 1.2 to 2.2 mm per year. (**Source**: IPCC, 2013: Chapter 4, Observations: Cryosphere, 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).



Diminishing Arctic sea ice also indicates the seriousness of the problem.

Diminishing Arctic sea ice also indicates the seriousness of the problem. By September 2012, Arctic sea ice shrunk to its lowest summer areal coverage since satellite records began and was over 50 per cent less than the areal extent recorded in 1980. Sea ice plays a key role in reflecting the sun's radiation. As ice levels diminish, more energy from the sun is absorbed and a positive feedback loop is created, which leads to both increased warming and a further loss of ice.

The melting of snow and ice, combined with the expansion of the oceans due to warmer water temperatures, has contributed to a rise in sea levels of nearly 20 centimetres over the last century. While geological records, and more recently tide gauges and satellite measurements, indicate that sea levels have been rising over the past two thousand years, the rate of increase over the past century exceeds the rate experienced over this longer time period. Moreover, the average rate of increase has accelerated over the past 20 years; since 1993 the rate of change has been between 2.8 and 3.6 millimetres (mm) per year, a rate that exceeds the average rate of 1.7 mm per year measured over the course of the entire 20th century. While the satellite data collected is not comprehensive enough to be conclusive, they suggest an exponential, rather than a linear, increase is occurring.



The oceans will continue to absorb carbon dioxide well into the future and, by the end of this century, may reach levels of acidity not witnessed in more than 50 million years.

Ocean Acidification

Not only are the oceans warming and rising, they are also becoming more acidic due to their absorption of carbon dioxide, which dissolves in water to form carbonic acid. To date, the oceans have absorbed approximately 25 per cent of the carbon dioxide released by human activities since pre-industrial times. In one sense, this has been beneficial as it has served to significantly reduce the potential atmospheric greenhouse gas (GHG) levels and mitigate some of the impacts of climate change noted above. Projections indicate, however, that the oceans will continue to absorb carbon dioxide well into the future and, by the end of this century, may reach levels of acidity not witnessed in more than 50 million years. The resulting higher acidity level is having a detrimental impact on many marine organisms, especially those that build their shells and skeletons from calcium carbonate, such as corals, oysters, clams, mussels and some types of plankton. More acidic oceans will have an impact on the entire marine ecosystem, including the coral reefs that protect coastlines and support millions of people who depend upon them for their food supply.

Projections for the Future

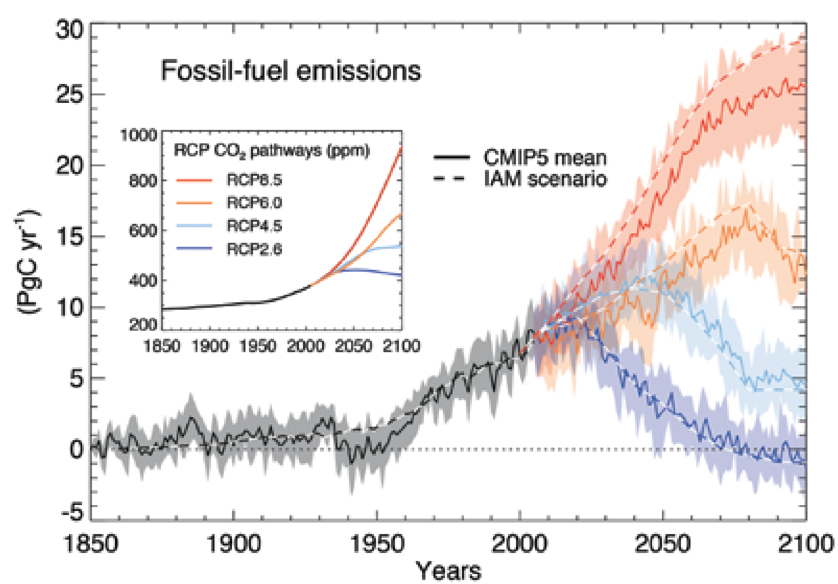
Not only did the IPCC outline the scientific consensus regarding climate change trends to date, it also presented projections for the future. Over the next few decades, climate change impacts will continue to increase due to the concentration of greenhouse gases that are already present in the atmosphere: a certain amount of temperature increase is already locked in due to historic emissions.

To project longer term impacts – from the middle to the end of the 21st century – the IPCC presented four scenarios based on future concentration levels of GHGs in the atmosphere. These are called the representative concentration pathways and are denoted as RCP 2.6, RCP 4.5, RCP 6.0 and RCP 8.5. Given that policy choices will directly influence the quantity of emissions that will be released going forward, the four scenarios range from a business-as-usual policy approach to one that assumes aggressive mitigation efforts. The inset box in Figure 6 shows the atmospheric carbon dioxide (CO_2) concentration trajectories associated with the four scenarios, while the large box indicates fossil-fuel emissions under each scenario. In both, the red curve reflects a business-as-usual future, whereas the dark blue curve represents the trajectory associated with aggressive mitigation efforts. The orange and light blue curves reflect intermediate levels of mitigation effort.

In conjunction with the projected emissions levels, the IPCC also provided estimates of the changes that would be associated with each of the four emissions pathways. Table 1 presents the four scenarios and the temperature and sea level impacts by 2100 that the IPCC forecasts based on different CO_2 concentration levels. Even under the most aggressive reduction scenario, warmer temperatures and higher ocean levels are projected for the end of the century.

Figure 6:

Future atmospheric carbon dioxide concentration levels and fossil-fuel emissions under four mitigation scenarios. The smaller inset box illustrates the four IPCC emissions scenarios. The larger box represents the level of fossil fuel emissions associated with each scenario. Future emissions are in petagrams of carbon (PgC), the equivalent of 1 gigatonne of carbon. (**Source**: IPCC, 2013: Technical Summary, 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).



Conclusion

The release of the IPCC's Fifth Assessment Report represents a watershed event in global climate science; the science underlying climate change has become much more compelling and certain, and the projections being made are dire indeed. In the face of these challenges, there is a great deal of climate change policy experimentation occurring in Canada and around the world. The next section of this report provides an overview of some of these policy developments.

Table 1
Emissions scenarios and projected impacts in 2100 relative to 1986–2005. (**Source:** IPCC, 2013: Summary for Policymakers, 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).

	Business as usual (RCP 8.5)	Some mitigation efforts (RCP 6.0)	Strong mitigation efforts (RCP 4.5)	Aggressive mitigation efforts (RCP 2.6)
Level of CO_2 concentration in the atmosphere in parts per million (ppm)	936 ppm	670 ppm	538 ppm	421 ppm
Likely increase in average surface temperature	2.6-4.8 °C	1.4-3.1 °C	1.1-2.6 °C	0.3-1.7 °C
Likely increase in global sea levels	45-82 cm	33-63 cm	32-63 cm	26-55 cm

1.2 POLICY DEVELOPMENTS

Recent climate change policy in Ontario has lacked the profile and ambition of the province's 2003 decision to eliminate coal-fired electricity. However, there have been many relevant developments in other jurisdictions over the past year, including carbon pricing. Many economists and prominent multilateral organizations, including

Box 1: The Western Climate Initiative (WCI)

The WCI was launched in February 2007 by a group of Canadian provinces and U.S. states with the goal of developing a multi-sector, market-based program to reduce greenhouse gas emissions. Ontario joined in 2008 and remains a member.

Unfortunately, the most ambitious new climate policy initiatives are taking place outside Ontario's borders.

the Organisation for Economic Co-operation and Development, the World Bank, and the International Monetary Fund, have increasingly supported putting a price on carbon.

North America

Unfortunately, the most ambitious new climate policy initiatives are taking place outside Ontario's borders. Quebec, a manufacturing province like Ontario, has implemented a Western Climate Initiative-compliant industrial cap-and-trade system, which limits emissions from companies covered by the system and allows them to trade permits to meet their reduction targets. The initial compliance period began January 1, 2013, and the first permit auction took place on December 3, 2013, with a floor price of $10.75 per permit (or tonne CO_2e[1]). The auction revenue will go toward funding initiatives within the province's climate change action plan, such as municipal climate change adaptation measures. Quebec's cap-and-trade system was linked to California's on January 1, 2014.

California is a long-time climate action leader among U.S. states, but it is not alone. The states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island and Vermont implemented the Regional Greenhouse Gas Initiative in 2003 to cap and reduce CO_2 emissions from the electricity sector. Following a 2012 program review, the cap was tightened by 45 per cent, and will subsequently decline by 2.5 per cent each year from 2015 to 2020.

Recently, President Obama ordered the U.S. Environmental Protection Agency (EPA) to regulate greenhouse gas emissions from the electricity sector. Under the *Clean Air Act*, the EPA is developing performance standards for new and existing facilities. The *Clean Air Act* allows for either a source (facility-level) or system-based (across a state, an electricity grid or other system) approach towards regulation; the latter opens the door for flexible policy instruments, such as emissions

[1]Carbon dioxide equivalent.

Box 2: The *Clean Air Act* (*CAA*)

The *Clean Air Act* was implemented in 1970, with major revisions in 1977 and 1990. It was originally designed to tackle air pollution, but U.S. Supreme Court rulings in the late 2000s affirmed the EPA's authority to tackle carbon dioxide emissions under the *CAA*.

trading. Many states will develop their own GHG reduction programs for existing electricity generating sources to avoid having federal standards imposed on them by the EPA; some states have been in contact with the Regional Greenhouse Gas Initiative program administrators to learn from their experience. The draft rule for existing electricity plants was recently released but the final rule and state implementation plans will not be finalized until 2015 and 2016, respectively. If the EPA defers to the states rather than issuing a strong federal rule, as many expect, there will be many divergent approaches to achieving electricity sector GHG reductions across the U.S.

Canada

At the federal level, Canada and the U.S. are aligned in pursuing a sector-by-sector regulatory approach. However, given the two countries' differing emissions profiles, the priority sectors (electricity in the U.S. versus oil and gas in Canada) are not the same. In 2012, the electricity sector in the U.S. represented about one-third of its total emissions, whereas Canada's electricity sector contributed only one-eighth of its total emissions.

Similar to U.S. developments, subnational fragmentation of climate policy continues in Canada with some provinces exploring their own industrial GHG reduction options. Those provinces with policies already in place are pursuing market-based approaches: from a carbon tax in British Columbia to an intensity-based regulation in Alberta that provides flexible compliance options, including paying into a technology fund. The range of actual and potential climate change policy approaches across the country increases uncertainty and complexity for companies, potentially creating economic trade barriers between provinces.

Rest of the World

Outside North America, there is a great deal of movement on climate change policy and carbon pricing. Emerging economies (such as China) are experimenting with new market-based carbon reduction policies. Carbon pricing systems are also being proposed or planned in many developing countries, including Brazil, India and Mexico. While other countries are moving ahead, Australia's

The Intergovernmental Panel on Climate Change, for the first time, released calculations regarding a global carbon budget.

Box 3: The Metrics of Measurement

Governments and the scientific community measure and report GHGs in national inventories using kilotonnes (Kt or thousand tonnes), megatonnes (Mt or million tonnes) and gigatonnes (Gt or billion tonnes).

change of national government in 2013 will likely translate into less ambitious GHG reduction targets for the country, and a move away from carbon pricing towards voluntary measures and subsidies.

The European Union still has the world's largest emissions trading system. The lessons learned from its prototype policy model have been incorporated into the design of subsequent emissions trading systems, including those of Quebec and California.

At this stage, there is a wide range in the level of action on climate change between various jurisdictions, even within the same country. In response to the complexity of approaches, combined with policy uncertainty, many companies are using an internal (or shadow) price on carbon as a risk management tool. This reflects a growing awareness of the increasing economic and financial risks that countries and corporations are facing in the context of a changing climate.

1.3 ECONOMIC RISK

The Concept of Unburnable Carbon

In 2009, the global community adopted a goal to limit global warming to 2° Celsius (C) compared to pre-industrial temperatures. The IPCC has reported that global temperatures have already risen by 0.85°C, so we are already approaching the half-way point towards the IPCC-designated 2°C equilibrium threshold. In its most recent assessment report the IPCC, for the first time, released calculations regarding a global carbon budget. Taking into consideration the emissions that have occurred to date, the IPCC has estimated how much additional carbon can be released if there is to be a reasonable chance of limiting the increase in warming to 2°C.

In order to have a 66 per cent chance of preventing a 2°C rise in average temperature (emissions scenario RCP 2.6, Table 1), total cumulative CO_2 emissions cannot exceed 2,900 Gt. Since the middle of the 19th century, just under 1,900 Gt have already been emitted; in other words, two-thirds of the global carbon budget has been used (released into the environment), leaving just over 1,000 Gt remaining. No comfort can or should be derived from this 1,000 Gt

About two-thirds of these reserves – representing 1,900 Gt CO_2 – must stay in the ground; they are 'unburnable' carbon.

value. At the current rate of annual global GHG emission releases (35.6 Gt CO_2 per year), this budget will be exhausted in less than 30 years (assuming that the annual rate of global emissions does not increase). This presents two interrelated and compelling challenges: 1) how does this remaining budget get spent; and 2) what can Ontario do to show leadership in accelerating the transition to a low-carbon economy?

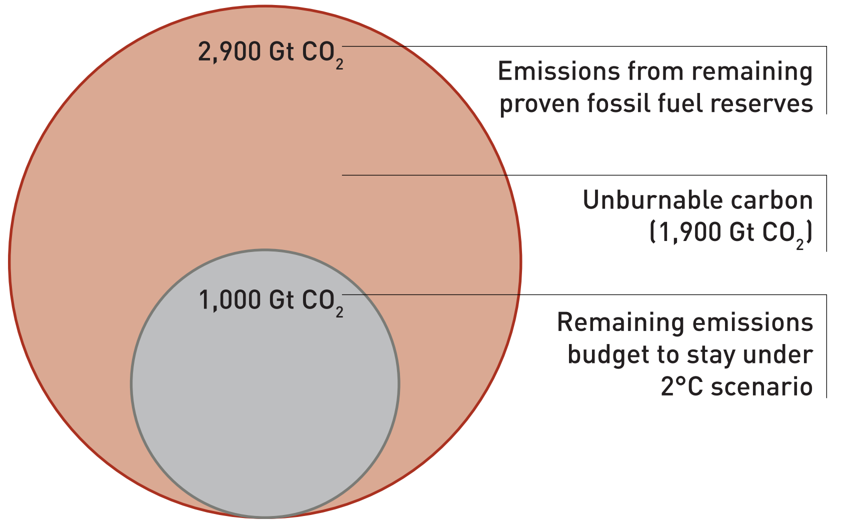
The challenge is compounded by the work of several scientists who have warned that the global community's target for limiting global warming to no more than 2°C is not aggressive enough. For example, James Hansen, a former NASA scientist and climate expert has argued that global warming should be restricted to 1°C. Due to the potential emissions from positive feedback cycles – such as the melting of permafrost and the corresponding release of methane into the atmosphere – CO_2 concentrations need to be reduced to 350 parts per million (ppm). In May 2013, the Mauna Loa Observatory in Hawaii reported that global CO_2 concentrations had exceeded 400 ppm for the first time in recorded history; which makes Hansen's position all the more compelling.

Further compounding the problem is the considerable disparity between what can be burned – while staying within the IPCC carbon budget – and what the global fossil fuel industry claims are its potential (proven plus probable) reserves of fossil fuels. The International Energy Agency's 2012 World Energy Outlook estimated that the remaining proven global reserves of fossil fuels contain 2,900 Gt CO_2. If the IPCC's 1,000 Gt CO_2 figure represents the budget limit that must be adhered to going forward in order to remain within the 2°C threshold rise, then about two-thirds of these reserves – representing 1,900 Gt CO_2 – must stay in the ground; they are 'unburnable' carbon (Figure 7).

This concept of unburnable carbon has been explored in considerable detail by several authoritative international organizations. Unburnable carbon raises the spectre of portfolio write-downs and stranded assets for fossil fuel-intensive industries, and raises an important financial risk for the industry's investors. Within Canada the S&P/TSX Composite Index is one of the most carbon-intensive stock indices in

Figure 7:

2°C emissions scenario and unburnable carbon (**Sources**: IPCC, 2013: Technical Summary, 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; IPCC, 2013: Summary for Policymakers, 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; International Energy Agency, 2012: *World Energy Outlook 2012*).



the world. In 2011, the TSX had over 400 companies listed in the oil and gas sector, representing a market capitalization of nearly $380 billion. Unburnable carbon is forcing the fossil fuel industry and its investors to re-examine business risk exposure through a new lens.

Changes in Insurance Risk – Confronting the New Reality

Similarly, another financial community – the insurance industry – is being forced to confront a comparable existential challenge driven by climate change: extreme weather events. The Insurance Bureau of Canada reports that precipitation-related extremes (including heavy downpours and flash floods) are happening *now* and are predicted to become more common and severe in the years ahead. In statistical terms, the occurrence of weather events is normally distributed – depicted by a bell-shaped curve (see discussion in Section 1.1 and Figure 2). The further a value is to either end of the curve, the less likely the event or value is to occur; they are considered rare. As the discussion in Section 1.1 on temperature changes in the Northern Hemisphere has shown, the mean has shifted to the right of the historical normal distribution and formerly rare events have now become more common. This shifting of the mean also applies to extreme weather events such as heavy downpours and flash floods. Traditionally, sewer and stormwater infrastructure has been designed and constructed to accommodate most precipitation events in the historical normal distribution. The extreme weather events, such as heavy downpours and flash

Ontario now has a stormwater infrastructure deficit estimated at $6.8 billion, simply due to its current state of disrepair.

floods that many parts of Ontario have experienced in recent years, are far more common than would be expected considering the historic distribution.

Adding to the problem is the current condition of our existing sewer and stormwater infrastructure. It was not designed to handle these new extremes, and much of it is more than 50 years in age and has not been properly maintained. Ontario now has a stormwater infrastructure deficit estimated at $6.8 billion, simply due to its current state of disrepair. The ECO believes the true infrastructure deficit is considerably larger due to the increasing incidence of extreme weather events that this infrastructure was never designed to accommodate. This worries the insurance industry in terms of losses from both property damage and liability exposure. Within Ontario, for example, the Finch Avenue flood (Figure 8) that occurred in Toronto in August 2005 resulted in insured losses of $600 million.

The Insurance Bureau of Canada reported that the insured costs of the flooding that occurred in Toronto in July 2013 were $940 million – the province's most expensive natural disaster to date. Meanwhile, the insured costs of the Calgary flood in the summer of 2013 are expected to top $1.7 billion. Year-end losses in 2013 due to catastrophic weather totaled $3.2 billion across Canada.

Figure 8:

Toronto's Finch Avenue, August 2005.

Flooding after heavy rain in 2005 split Finch Avenue in half (August 22, 2005)
Lucas Oleniuk / Toronto Star

Climate change is presenting a fundamental challenge to the insurance industry.

The Insurance Bureau of Canada noted that the majority of these costs are attributable to "the terrible effects of the new weather extremes", adding that:

> Canadian communities are seeing more severe weather, especially more intense rainfall. This overburdens our sewer and stormwater infrastructure, resulting in more sewer backups in homes and businesses.

The reference to new weather extremes makes it clear that historic weather and climate data can no longer be a guide for planning, investing and adapting to the extreme events that are occurring and will intensify. Climate change is presenting a fundamental challenge to the insurance industry, which could mean certain regions within Canada or asset categories are uninsurable as the risks are too high. Insurance premiums are already rising to cover the industry's rising weather-related losses. So, in light of this new normal, it is shortsighted that all three levels of government seem to be more focused on finding tax dollars to pay for last year's flood or ice storm instead of addressing the challenge of what to do about next year's extreme events that we know are coming. Decision makers need to move beyond a reactive stance, and instead forge a proactive plan to improve the resilience of our infrastructure. This challenge is discussed in greater depth in Section 4 of this report. In order to move forward with climate change planning, however, it is important to ensure that policy makers are equipped with the best data available.

2

ONTARIO’S GREENHOUSE GAS INVENTORY

Ontario does not publish its own GHG emissions inventory. Instead, it relies on the Ontario emissions inventory generated by Environment Canada and published annually in the National Inventory Report (NIR). The NIR is developed using IPCC protocols that, at the federal level, allow for international GHG emissions comparisons using a consistent methodology. The NIR is prepared and issued every year to meet both domestic needs and international reporting requirements. Since there is limited data sharing between many of the provinces and the federal government, as well as limited data availability on actual emissions in certain categories (e.g., off-road vehicles), the provincial breakdowns provided in the NIR may under or over report some emissions. Emissions for Ontario are allocated based on provincial activity (e.g., energy, waste, agriculture or population) data. Emission estimates are established based mainly on national emission factors, though some are provincially-based.

Ontario does not publish its own greenhouse gas emissions inventory.

British Columbia and Quebec

Two Canadian provinces prepare their own GHG inventories: British Columbia and Quebec. They provide an interesting contrast to Ontario because they each use a different approach.

British Columbia's *Greenhouse Gas Reduction Targets Act* (section 4(a)) requires that the government produce its own GHG inventory every two years. The government's 2010 inventory described it as a "sound, science-based, comparable and consistent reporting of GHG sources and sinks in British Columbia."

British Columbia's inventory relies on the NIR. As a result, there is a great deal of interaction between the province and Environment Canada to ensure the reconciliation of any areas where the provincial data does not match the NIR. For example, B.C.'s 2010 report noted:

> This report includes the following B.C.-specific emissions currently not reported at the provincial level in the NIR: emission sources and sinks reported under the "land use, land-use change and forestry" sector. As a result of including these categories, reported emissions in this B.C. Provincial GHG Report are 2.9 megatonnes CO_2e (4.7%) higher than the emissions reported for B.C. in the National Inventory Report.

The inventory is presented in a format that is arguably more accessible and readable than the NIR – in part because the provincial inventory is not required to provide the same level of technical detail. It is tailored for a B.C. audience and is much shorter since it covers a more limited scope of data (B.C. only) than the NIR. It also includes B.C.-specific commentary describing the emissions trends in various sectors (detail that the federal government is neither equipped nor required to provide in the NIR). As a result, it has become a trustworthy, heavily-referenced and useful report for industry, policy makers, environmental non-governmental organizations, the public and others.

Quebec takes a slightly different approach than both Environment Canada and B.C. For the industrial, agricultural and waste sectors, it primarily relies on data collected by provincial ministries. For transport and combustion-related statistics, it relies on Environment Canada and Statistics Canada data, respectively. Quebec's inventory does not cover emissions from land use, land-use change and forestry, unlike the B.C. inventory. Quebec's inventory numbers are very close to those reported for the province in the NIR, with some small differences in the waste and agricultural sectors. There is a significant difference, however, in the way key emissions categories are displayed. Quebec's inventory reports the energy/combustion emissions under the industrial and residential/commercial sectors, not as a separate category as in the NIR (as mandated by the IPCC).

Ontario's energy and GHG policies are creating rich datasets, and public sector organizations are generating more energy and GHG data each year.

Quebec uses its inventory data as a basis for supplementary materials, such as a concise reporting of its emissions in a *bilan* (or balance sheet), and as indicators in provincial sustainable development reports. The data is also fed into the province's statistical agency, the Institut de la statistique du Québec, where it can be accessed by researchers. The inventory is seen as an important tool for transparent communications with the public as well as being indispensable to the operation of the province's cap-and-trade system.

ECO Comment

Data Sharing – Improving the Accuracy of NIR Numbers for Ontario

The accuracy of Ontario's GHG inventory within the NIR could be improved by Ontario formalizing data sharing with Environment Canada, Statistics Canada and other federal agencies. The Ministry of the Environment (MOE) acknowledges that the NIR does not currently fully reflect the impact of Ontario's GHG reduction initiatives on emissions levels.

There should be enhanced data sharing with the federal government to improve the Ontario-specific inventory in the NIR. Improving Ontario's inventory in the NIR will also improve the Emissions Trends Report prepared by Environment Canada, which forecasts Canada's GHG emissions into the future, because it also relies on historical NIR numbers.

Ontario's energy and GHG policies are creating rich datasets, and public sector organizations are generating more energy and GHG data each year from: smart meters; mandated energy and GHG reporting from public sector buildings, landfills, industrial emitters and energy generators; the Drive Clean program; and more. Sharing this data with federal counterparts will increase the accuracy of the NIR, and not just for Ontario. With more data from Ontario, the NIR models could be more accurately calibrated for all provinces. For example, Drive Clean's dataset is unique in that it provides information on driving patterns (vehicle kilometers travelled).

Environment Canada could use the annual Drive Clean data to improve transport estimates for Ontario in the NIR, and to better calibrate its transport model.

The ECO would like to see Ontario share several datasets on an annual basis with the NIR team within Environment Canada, including:

- the industrial GHG emitters data collected by MOE;
- electricity generation data from the Ontario Power Authority (OPA) and the Independent Electricity System Operator (IESO);
- Drive Clean program data from MOE;
- data on farmer practices with regard to pesticide use from the Ontario Ministry of Agriculture and Food (OMAF); and
- landfill gas capture data from MOE.

Of course, there are confidentiality and regulatory issues to address before entering into data sharing agreements, but these can be managed. MOE can seek the consent of the entities whose data are collected to share the data with the federal government. The ECO believes that it would be in all reporting entities' best interests to allow this information sharing to ensure consistent, comparable and reliable data upon which to base government policy at all levels. Use of the data can be governed by conditions to address potential confidentiality concerns, such as allowing facility-level data only to be used for estimation purposes and published only on an aggregated basis.

The ECO believes that an enhanced GHG inventory is necessary for effectively managing Ontario's GHG emissions and achieving reductions, while ensuring both are more precisely reported.

An Ontario-Specific GHG Inventory: Connecting Data to Policy and Targets

Beyond improving the accuracy of the inventory in the NIR, MOE should produce a stand-alone GHG inventory for Ontario, similar to those of B.C. and Quebec. A more precise GHG inventory should be a priority for Ontario policy makers for several reasons. For example, as Ontario contemplates a cap-and-trade system, a more fine-grained inventory is needed to establish baseline emissions to guide important policy design, target setting and stringency decisions. Ontario already has the underlying industrial GHG data to accomplish some of the necessary policy design elements; however, the development of offset protocols in non-covered sectors (such as agriculture) would be hard to achieve without a more precise Ontario inventory. Furthermore, sophisticated policies that affect covered entities financially (such as a cap-and-trade system) rely on highly accurate and finer-scale data. The ECO believes that an enhanced GHG inventory is necessary for effectively managing Ontario's GHG emissions and achieving reductions, while ensuring both are more precisely reported. The province's reduction targets, achieved reductions and estimated reductions from specific policies (i.e., the results of GHG reduction efforts) all rely on precise data. Finally, more exact data would also help stimulate the development of a voluntary offset market in Ontario.

An Ontario-specific inventory, written in plain language and produced by the Ministry of the Environment, could become a valuable source of information for the business, policy and political communities, as well as the general public.

Beyond the benefit of improved precision, an Ontario-specific GHG inventory would improve policy making in several ways. First, and very much aligned with the push towards *Open Government*, the increased attention to its GHG inventory will lead to more transparent communications and decision making about Ontario's progress (or lack thereof) in reducing GHG emissions. It would provide the government with the opportunity to add more commentary on its emissions trends (which it already provides in its periodic climate change update reports).

An Ontario-specific inventory would provide MOE with more latitude to tailor GHG emissions reporting to the Ontario context. Specifically, Ontario could adjust its reporting methodology to take account of Ontario's climate policy priorities, and use this methodology to assess the government's progress against its own emissions targets. British Columbia has made this linkage. Its Climate Action Plan includes a net-zero deforestation policy; therefore, B.C.'s emissions inventory (and its reports on progress against targets) includes emissions from deforestation and afforestation, unlike the NIR.

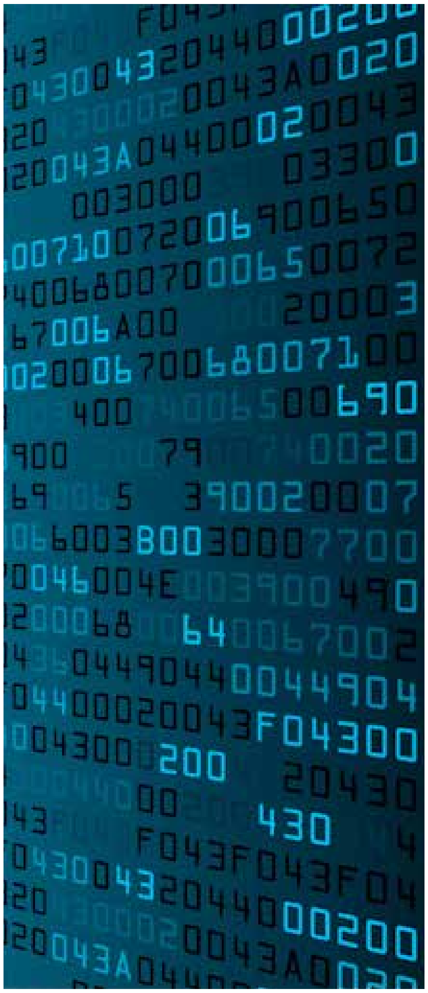
The waste sector's emissions numbers provide an example of how preparing its own inventory would provide Ontario with more flexibility and autonomy. MOE's best estimate of the methane gas capture rate from landfills is 55 per cent. However, Environment Canada is required by the IPCC methodology to use a 75 per cent landfill gas capture rate. Thus Environment Canada may be underestimating the waste sector's GHG emissions. If Ontario prepared its own GHG inventory, it would be free to use the methane capture rate it deemed most accurate.

Following the IPCC reporting guidelines, some sources of emissions are not counted in Ontario's NIR numbers, such as emissions from imported electricity. Ontario has the ability to influence these emissions through policy, and if it does, Ontario's reporting framework should ensure that it receives credit for its actions.

An Ontario-specific inventory, written in plain language and produced by MOE, could become a valuable source of information for the business, policy and political communities, as well as the general public. It offers the Ontario government the opportunity to deeply engage with the public about climate change and its associated policies and programs aimed at reducing provincial GHG emissions.

3

REVIEW OF ONTARIO’S PROGRESS ON GHG REDUCTION



3.1 ONTARIO'S LATEST GHG NUMBERS FROM THE NATIONAL INVENTORY REPORT

It has been seven years since the provincial government released Go Green: Ontario's Action Plan on Climate Change. As discussed in Section 1, the scientific understanding of climate change and the carbon policy landscape have both undergone significant change since that time. What has remained unchanged, however, are the GHG emissions reduction targets that were set by the provincial government back in 2007. The three provincial targets are to reduce Ontario's GHG emissions by:

- 6 per cent below 1990 levels by 2014 (to approximately 166 Mt);
- 15 per cent below 1990 levels by 2020 (to approximately 150 Mt); and
- 80 per cent below 1990 levels by 2050 (to approximately 35 Mt).

As required by the *Environmental Bill of Rights, 1993*, the Environmental Commissioner of Ontario reports annually on the progress of activities in the province to reduce GHG emissions. This section uses the most recent Environment Canada data to assess the Ontario government's progress toward meeting the targets established in 2007.

GHG emissions will exceed the target by 28 Mt in 2020.

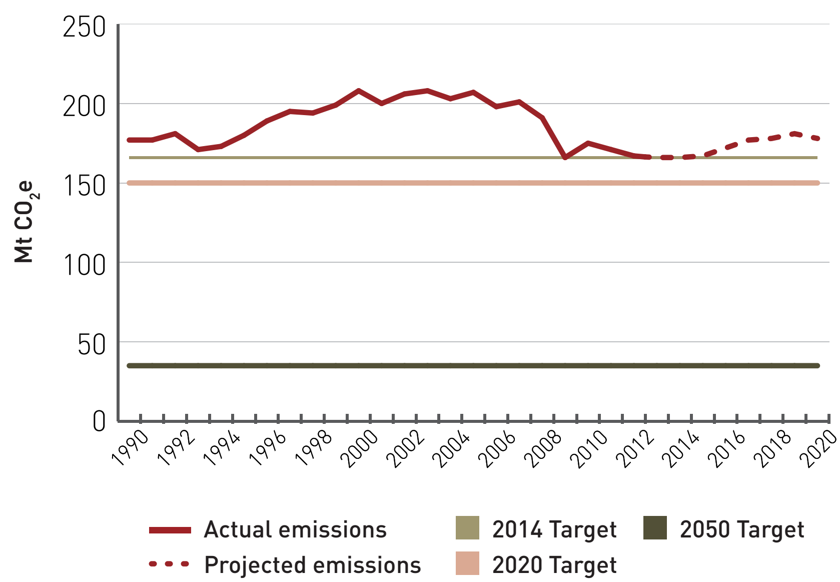
Overall Emissions in 2012

According to the 2014 NIR, Ontario's GHG emissions in 2012 were 167 Mt. This is the lowest annual level of emissions since the baseline year of 1990, when emissions were 177 Mt. As shown in Figure 9, the last several years have witnessed a significant decline from the peaks experienced between 2000 and 2005, when emissions from coal-fired electricity generation were at their highest.

The 2012 emissions total suggests that Ontario will meet its 2014 target. Unfortunately, the government's future projections indicate an upward trend in emissions after 2014. This means Ontario will exceed its own stated target for 2020. According to Climate Vision, the government's last climate change progress report (released in November 2012), GHG emissions will exceed the target by 28 Mt in 2020. This is a significant amount; it is almost twice the total emissions from the electricity sector in 2012.

Figure 9:

Ontario greenhouse gas emissions trends and targets (1990–2012) and projections to 2020. (**Sources**: Environment Canada. *National Inventory Report – Greenhouse Gas Sources and Sinks in Canada 1990–2012 (2014); Go Green: Ontario's Action Plan on Climate Change (2007); Climate Vision: Climate Change Progress Report Technical Appendix (2012)*).



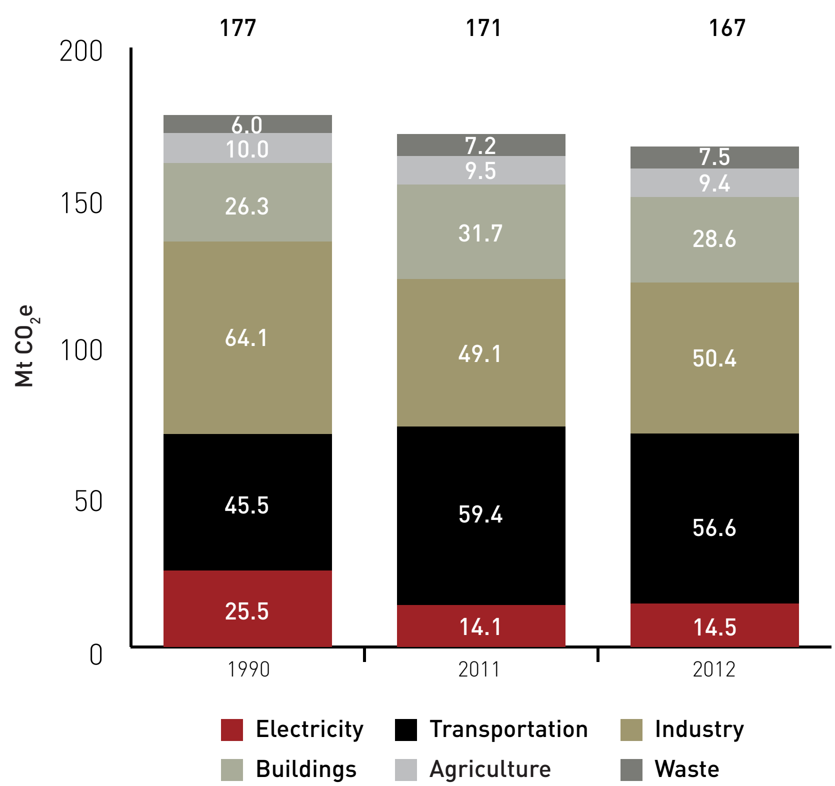
The transportation sector remains the largest contributor to the overall provincial inventory.

Sector Specific Emissions

Figure 10 shows Ontario's GHG emissions from each sector and how they have changed over time. The largest reductions since 1990 have been in the electricity and industry sectors. The electricity sector alone has seen a 43 per cent reduction in emissions over this time period, with the industrial sector contributing a further 21 per cent reduction. Partially offsetting these reductions, however, has been the 24 per cent increase in emissions from the transportation sector since 1990. The transportation sector remains the largest contributor to the overall provincial inventory, despite a 5 per cent dip in emissions from 2011 to 2012. A more detailed breakdown of sector emissions is provided in Appendix 1.

Figure 10:

Ontario greenhouse gas emissions by sector for 1990, 2011 and 2012. (**Source**: Environment Canada. *National Inventory Report – Greenhouse Gas Sources and Sinks in Canada 1990–2012 (2014)*).



3.2.1 TRANSPORTATION

As discussed in Section 1, the IPCC warns that a significant portion of fossil fuel reserves must be left undeveloped – termed *unburnable carbon* – in order to limit the future rise in global temperatures. While this imperative will affect all human activities, nowhere is the challenge of a carbon-constrained future greater than in the area of transportation. This sector and all of its modes – road, air, marine and intercity rail transport – depend almost entirely on fossil fuels as the primary energy input; globally, gasoline and diesel provide 95 per cent of the energy used for road transportation.

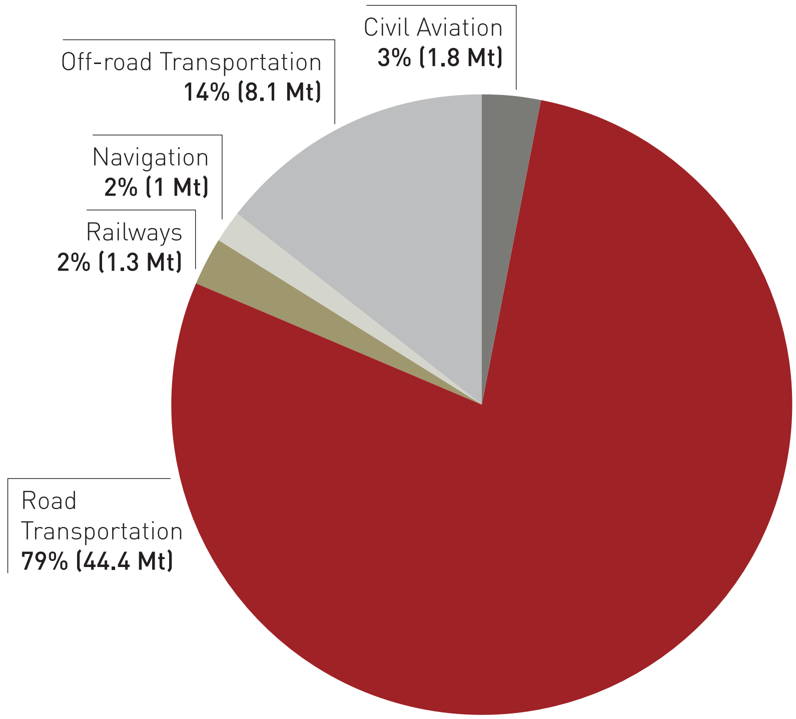
Ontario's Transportation GHGs

In Ontario, a similarly high level of dependency on fossil fuels for transportation means that the sector is responsible for the largest percentage of GHG emissions in the province. In 2012, 56.6 Mt – 34 per cent of the province's emissions – came from all forms of transportation. Since 1990, emissions from the sector have increased by 11.1 Mt. Between 1990 and 2005, much of this increase was driven by economic growth, with the low oil prices of the 1990s playing a contributing role. These factors supported a shift away from cars in favour of light trucks, such as sport utility vehicles, pickups and minivans. Since 2005, however, transportation emissions have remained relatively stable due to the increased fuel efficiency of cars and light trucks, despite an increase in the number of vehicles on the road and vehicle kilometres travelled.

Ontario's transportation GHG emissions predominantly come from on-road activities. As shown in Figure 11, road transportation accounts for almost 80 per cent of overall transportation-related emissions. The second largest category is off-road transportation, which includes: heavy equipment used in the construction, mining and logging industries; recreational vehicles, like snowmobiles and all-terrain vehicles; and residential equipment, such as lawnmowers and trimmers. This subcategory contributed 8.1 Mt to Ontario's GHG inventory in 2012.

Figure 11:

Ontario's transportation-related greenhouse gas emissions in 2012 totalled 56.6 Mt. (**Source**: Environment Canada, *National Inventory Report 1990–2012*, Part 3 Table A11-12: 1990–2012 GHG Emission Summary for Ontario).



Nowhere is the challenge of a carbon-constrained future greater than in the area of transportation.

Emissions from on-road transportation can be broken down between passenger and freight vehicles. As in previous years, passenger vehicles are still responsible for the majority of on-road transportation GHG emissions in the province; in 2012, these vehicles emitted 31.4 Mt. Freight transportation emissions have increased over the years; in 2012, they contributed the balance of on-road emissions, amounting to 13 Mt.

In its 2007 Climate Change Action Plan, the government indicated that a combined reduction across all sectors of 99 Mt of GHG emissions relative to business-as-usual would be required to meet the Plan's 2020 target. The province projected that transportation initiatives would make a significant contribution; efforts focused on passenger vehicles and transit were to contribute 13 Mt of the emissions reductions, and those targeting freight an additional 6 Mt. This means that 19 Mt of emissions reductions was projected to come from the transportation sector. However, according to Climate Vision: Climate Change Progress Report 2012, the government's most recent progress report, the expected contributions from transport have been scaled back dramatically; transportation will only contribute 3.9 Mt of the hoped-for reductions by 2020, rather than 19 Mt. The bulk of these reductions will result from current and proposed federal passenger automobile and light truck GHG emissions regulations, combined with higher prices for gasoline and refined petroleum products. While efforts to increase urban densities and enhance public transit are projected to play a role in mitigating transportation emissions, their contributions will be incremental and take many years, if not decades, to materialize.

According to Ontario government forecasts for the freight sector, provincial initiatives (such as the freight truck speed limiter regulation and the green commercial vehicle program) will produce almost negligible reductions. Furthermore, modelling indicates that Canada-wide freight emissions from heavy-duty trucks will increase by 2020, despite federal heavy-duty vehicle emissions regulations now in force for 2014 model year vehicles. Assuming that Ontario trends follow the same trajectory, this suggests that very little progress will be made in reducing absolute emissions from the freight subsector.

Fossil Fuel Dependency in Ontario's Transportation System

If the rate of personal vehicle ownership remains unchanged, projected population increases in Ontario would lead to an additional two million cars and light trucks coming onto Ontario roads by 2035. While a small portion of these new vehicles will use low carbon fuels (such as electricity), fossil fuels are expected to remain the predominant source of energy. Although Ontario has an ambitious target of having 1 in 20 vehicles on the road be electric by 2020 the prospects of achieving this electric vehicle target are poor – unless strong efforts are taken to encourage such a transition.

ECO Comment

In 2007, the government projected that transportation emissions would be reduced by 19 Mt through various policy initiatives and investments in transit. Revised projections now indicate that the reductions to be achieved will be less than one-fifth of what was originally envisioned. While revisions in forecasting may explain some of the difference, the ECO believes that it is incumbent upon the government to provide a clear explanation as to why the forecasted reductions in the transportation sector have been so severely downgraded.

Ontario needs strong, decisive efforts now to shift aggressively away from a carbon-based transportation system.

Climate change and the concept of unburnable carbon fundamentally challenge the future reliance on fossil fuels for transportation purposes. Since this sector is the single largest source of GHG emissions in Ontario, the ECO believes that the entire transportation sector, and the land use planning decisions that drive travel patterns, must increasingly be examined through the lens of a carbon-constrained future. Viewed in this manner, the key challenge going forward will be to transition Ontario's transportation system away from its current high dependency upon fossil fuels.

There are multiple levers that the provincial government can pull in order to help effect such a transition, including:

- Stronger incentives and directives for more compact and mixed urban development would help ensure that residents can access amenities without the use of a vehicle.
- Significantly higher investments in public transportation and active transportation options would provide low-emissions travel alternatives.
- Stronger efforts could be made to encourage the design, production and purchasing of light-weight, energy efficient vehicles.
- Enhanced efforts could be taken to encourage the uptake of alternative energy vehicles, such as those powered by electricity. Given that the province has transitioned towards a less carbon-intensive electricity grid, using electricity as an energy source for vehicles employs a readily available technology to lower the carbon footprint of the transportation sector.

All of these initiatives will take time and significant effort, and progress will be incremental. The science of climate change tells us, however, that time is no longer on our side. Ontario needs strong, decisive efforts now to shift aggressively away from a carbon-based transportation system. All options – including putting a price on carbon – must be on the table in order to achieve the much higher, but necessary, emissions reductions that were envisioned only seven years ago.

3.2.2 INDUSTRY

In 2012, industry in Ontario was responsible for 50.4 Mt of GHG emissions, or 30 per cent of the provincial total.[2]

Comparison of Provincial and Federal Industrial Emissions Data

Ontario's industrial emitters are required to report their GHG emissions to both the provincial and federal governments. However, the federal and provincial reporting requirements have different threshold limits for regulated facilities (i.e., 25,000 tonnes CO_2e for Ontario versus 50,000 tonnes CO_2e for Canada). Given the lower threshold for reporting to MOE, more facilities are captured and, therefore, the GHG emissions reported are slightly higher, as shown in Table 2 below.

Table 2
Total CO_2e emissions in Ontario (2010–2012) (**Source:** Ministry of the Environment, Greenhouse Gas Emissions Reporting by Facility; Environment Canada, Reported Facility Greenhouse Gas Data).

		Year			Per cent change	
Data Source		2010	2011	2012	2010–2011	2011–2012
Ministry of the Environment (emitters over 25,000 t CO_2e)	Total CO_2e from all sources in tonnes	59,571,948	52,692,245	52,891,143	-11.6	0.38
Environment Canada (emitters over 50,000 t CO_2e)	Total CO_2e from all sources in tonnes	56,288,678	49,037,728	49,909,069	-12	2

[2] The ECO calculates industrial emissions by adding together various categories of the National Inventory Report; this allocation process is the same as that used by the Ministry of the Environment. MOE adds the following categories together to determine total industrial emissions in Ontario: Fossil Fuel Production and Refining, Mining & Oil and Gas Extraction, Manufacturing Industries, Construction, and Agriculture & Forestry under Stationary Combustion Sources; Pipelines under Transport; Fugitive Sources; Mineral Products, Chemical Industry, Metal Production, Production and Consumption of Halocarbons, and Other & Undifferentiated Production under Industrial Processes; and Solvent & Other Product Use.

Industrial GHG Emissions Data Trends

MOE's facility-level data shows that carbon dioxide equivalent (CO_2e) emissions of industrial facilities in Ontario fell by 11.6 per cent between 2010 and 2011, then rose by less than 1 per cent in 2012, as shown in Table 2. A similar trend is found in the federal facility-level GHG data over the same time period.

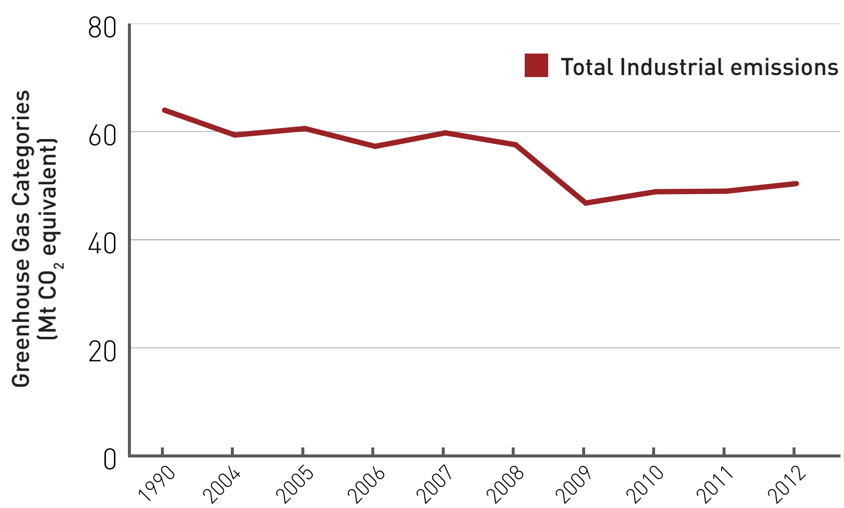
Although *overall* industrial emissions for reporting entities have fallen by just over 11 per cent between 2010 and 2012 (the years for which data is available), closer examination of MOE's dataset reveals that there is a large variation in emissions between individual facilities. For example, over the years 2010–2012, the highest emitters showed a change in emissions that ranged from an 83 per cent reduction to a 269 per cent increase. Given that this dataset has only been collected since 2010, it is not possible to draw any conclusions about overall longer term industrial sector data trends.

Starting in 2009, overall industrial GHG emissions began to slowly rebound, although they remain lower than 2005 levels.

According to the NIR, industrial GHG emissions from both process and energy combustion in Ontario have fallen on an absolute basis since 2005, with a few exceptions.[3] However, starting in 2009, overall industrial GHG emissions began to slowly rebound, although they remain lower than 2005 levels, as shown in Figure 12.

Figure 12:

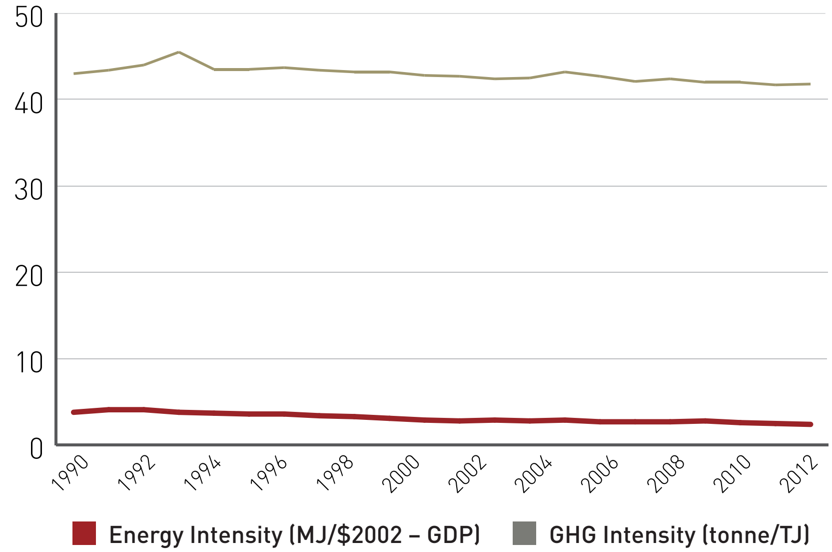
Total industrial GHG emissions in Ontario, 1990–2012 (both energy and industrial processes – see footnote 2 for all subcategories included). (**Source**: Environment Canada. April 2014. *National Inventory Report 2013*).



[3] Except in Mining & Oil and Gas Extraction, Agriculture & Forestry and Production and Consumption of Halocarbons.

Figure 13:

Industrial energy and GHG intensity (Ontario) (**Source:** Natural Resources Canada Office of Energy Efficiency. Comprehensive Energy Use Database Tables. Table 1: Secondary Energy Use and GHG Emissions by Energy Source). Note: Data on GHG emissions are presented excluding GHG emissions related to electricity production.



Aggregate energy and GHG intensity trends in Ontario's industrial sector also show gradual, but not large, declines over the same period, as shown in Figure 13. Most subsectors have seen declines in energy intensity,[4] but many have seen increases or stagnation in GHG intensity.[5]

Without more detailed data on industrial production, investments in energy efficiency and other information, it is difficult to pinpoint what is underlying the GHG emissions trends or to predict the future trajectory.

Stalled Industrial GHG Policy

Early in 2013, MOE released a discussion paper (its third in five years) on a GHG reduction program for industrial emitters. It outlined the principles and goals of such a program, as well as potential design elements and other factors. MOE held a series of in-person consultations with various stakeholders throughout 2013 on this latest paper, and received written comments through the Environmental Registry. As of the date of publication of this report, no proposed regulation has been released.

[4] Except in Smelting and Refining, Iron and Steel, Other Manufacturing, and Mining.

[5] Except in Smelting and Refining, Petroleum Refining, and Cement.

Ontario's industrial sector has witnessed only a slight decline in energy and GHG intensities; consequently, overall emissions have begun to trend upwards in recent years as industrial production recovers.

ECO Comment

Ontario's industrial sector has witnessed only a slight decline in energy and GHG intensities; consequently, overall emissions have begun to trend upwards in recent years as industrial production recovers. This suggests that a more concerted effort is required to put this sector's absolute emissions on a steady downward trajectory and to decouple GHG emissions from industrial production.

MOE has been contemplating a flexible emissions trading system for the past five years, since the first proposal was posted to the Environmental Registry in January 2009. Given the need to tackle industrial emissions without delay, the ECO is concerned that Ontario is moving too slowly on implementing an industrial carbon reduction program, especially as our neighbour, Quebec, rapidly moves ahead. Moreover, if the government is serious about emissions trading and providing industry with compliance options, the ECO would expect the development of GHG offset protocols to be underway; this does not seem to be the case.

While the government continues to delay putting a price on carbon, many large emitters are preparing for a carbon-constrained world by internally pricing carbon. Companies use a shadow carbon price, or a range of prices, for planning purposes, to help identify potential risks and opportunities arising from the costs of climate change and carbon policy.

The ECO is also concerned about weak transparency in MOE's 2013 stakeholder consultation process on its proposed GHG reduction program for industrial emitters. This process did not seem to meet industry needs for transparency and engagement on key questions of policy design and implementation, as described in a December 2013 letter to the Ministers of Environment, Energy and Economic Development and Trade from many industry associations. In order to move a policy of this significance ahead and tackle industries' competitiveness concerns, a transparent process trusted by all stakeholders is essential.

While the government continues to delay putting a price on carbon, many large emitters are preparing for a carbon-constrained world by internally pricing carbon.

3.2.3 BUILDINGS

The building sector remained the third largest GHG emitting sector in 2012, representing just over 17 per cent of Ontario's GHG emissions, and was exceeded only by transportation and industry. This sector, comprising residential, commercial and institutional buildings, had a similar ranking in 2011.

The past 20 years have witnessed a decoupling between the growth in Ontario's building stock and its related GHG emissions. Between 1990 and 2011, for example, total residential floor space increased by nearly 62 per cent, while GHG emissions from the housing sector increased by just under 18 per cent. While 58,300 new dwelling units were added to the provincial housing stock in 2012, GHG emissions associated with stationary combustion in the building category declined by 10 per cent between 2011 and 2012. Much of this drop in energy use can be attributed to weather differences; for example, the mean temperatures in the months of January, February and March 2011 were nearly 6°C colder than the same period in 2012 (a trend that may strongly reverse when 2013/14 data are available).

Improvements in codes and standards have contributed to the decoupling between increased floor space and GHG emissions in the residential sector. Another important factor is the type of residential unit being built. For example, in 2011 and 2012, 57 per cent of the total 118,900 dwelling units that were completed were apartments and condominiums (while the rest were single-family detached dwellings). Their smaller individual footprint and shared walls translate into a smaller energy and carbon footprint (while stricter building envelope requirements for large buildings would increase the energy advantages of multi-residential buildings even further).

A similar trend can be observed for commercial and institutional buildings. While commercial and institutional floor space grew by 45 per cent between 1990 and 2011, the associated GHG emissions increased by only 26 per cent. This building subsector has been adding an average of four million square metres of floor space annually over the six-year period from 2006 to 2011. While building

The ECO is encouraged by amendments to the 2012 Ontario Building Code that came into effect in January 2014, and include a stated objective to limit GHG emissions.

sector GHG emissions increased by about 10 per cent over the same period, it is noteworthy that, between 2011 and 2012, GHG emissions associated with stationary combustion in this building category declined by 7.7 per cent. Again, this is likely due to a milder winter in 2012 compared to 2011.

Given the demonstrated effectiveness of stronger codes and standards to date, the ECO is encouraged by amendments to the 2012 Ontario Building Code (OBC) that came into effect in January 2014, and include a stated objective to limit GHG emissions from buildings and to limit peak electricity demands. As peak electricity demand will continue to be met by gas-fired peaker plants for the foreseeable future, this is an important change in the OBC. The new energy efficiency requirements in the 2012 Code will see further improvements in overall efficiency of 15 per cent and 13 per cent for low-rise residential and larger buildings, respectively, compared to the 2006 Code, with these changes coming into force in January 2017. These developments in the Code should continue to enhance the floor space/GHG decoupling noted earlier.

The OBC changes coming into force in 2017 will essentially lock in energy efficiency requirements of the kind that the City of Toronto has already established through the Toronto Green Standards (TGS); the city requires demonstrated energy efficiencies in new buildings amounting to at least 15 per cent better than the OBC.

Clearly, many opportunities are still untapped to ratchet up energy efficiency provisions for new buildings in Ontario. Achieving similar improvements in the existing building stock in Ontario remains the greater challenge.

Over 70 per cent of Ontario's housing stock was built before 1990, the year that energy efficiency requirements were first introduced into the Ontario Building Code.

The Challenge of Existing Buildings

Over 70 per cent of Ontario's housing stock was built before 1990, the year that energy efficiency requirements were first introduced into the Ontario Building Code. Given that these dwelling units are typically less well insulated and often much draftier, they display much higher levels of energy consumption for space heating and cooling. Due both to the high up-front costs associated with conducting energy retrofits and the long pay-back periods, building owners are typically reluctant to make the necessary investments. This issue highlights the benefits that would accrue if energy audits were a mandatory requirement on resale of a home. The ECO has made this point before and believes this would level the playing field for the existing housing stock.

To help address the up-front costs of retrofits faced by homeowners, in October 2012 the Ministry of Municipal Affairs and Housing (MMAH) made regulatory changes to explicitly allow municipalities to use local improvement charges (LICs) to finance energy efficiency improvements on private property. In effect, an LIC is a loan made by a municipality to a homeowner or small commercial building owner that is recovered in yearly installments through the property tax system. This can be a very attractive offer to a building owner because the lien is attached to the property, not the property owner. Because municipalities are protected from default on the loan, they may be able to offer financing through the LIC at a lower interest rate.

As the ECO has previously observed, the impact on the homeowner in repaying the loan may be offset by lower energy bills and, depending on the choice of the retrofit actions, the net financial impact for the homeowner may be cash-flow positive from the start. Several municipalities are now working collaboratively to develop an energy retrofit pilot program based on LIC financing. The City of Toronto has already launched an LIC-based retrofit pilot program called HELP – the Home Energy Loan Program.

Several municipalities are now working collaboratively to develop an energy retrofit pilot program based on local improvement charges.

In December 2013, the Ministry of Energy released its updated Long-Term Energy Plan. To encourage energy conservation, the government indicated that starting in 2015 it will make additional financing tools available to consumers including on-bill financing for energy efficiency retrofits. Presumably, this will be accomplished through the co-operation of gas and electric utilities whereby homeowners pay back the costs of the retrofit through monthly installments on utility bills. A key difference from LIC financing is that, under an on-bill utility approach, the lien could be the existing homeowner's responsibility. It might need to be discharged upon sale of the home, which is an encumbrance that may dissuade a homeowner from undertaking any energy retrofit work. This barrier could be addressed by having the option of transferring the loan upon home sale, as is allowed in New York State's program.

ECO Comment

While on-bill financing is a welcome additional financial tool to target existing buildings, the existence of two alternatives may create confusion for building owners and municipalities as to which is best: the LIC approach or the on-bill financing option. In the ECO's view, there is a risk that this promise of future provincial action may prevent interested municipalities from following Toronto's lead and launching their own LIC-based programs. The Ontario government needs to engage the public in a more nuanced dialogue comparing the advantages and disadvantages of both financial mechanisms. In fact, the Clean Air Partnership and the Toronto Atmospheric Fund are seeking just such a dialogue with the Ministry of Energy to discuss

> how the on-bill financing and the LIC program can best work synergistically and in coordination to ensure a comprehensive energy efficiency retrofit program that is best able to reduce provincial energy demand, generation and costs; increase local economic development opportunities; and improve the resilience of Ontario's population to future energy cost increases.

The ECO believes that if these financial tools are marketed properly, either of them has the potential to reduce energy use and its associated carbon footprint in existing buildings.

Solar- and Plug-in Ready

A new or renovated building may last for well over 50 years. At the same time, technological innovations in such areas as on-site solar energy production (for electricity generation and space and water heating) and electric vehicles (EVs) are gaining momentum and could become mainstream technologies quite quickly if prices continue falling very rapidly. It makes sense, therefore, to prepare buildings in advance to take advantage of these innovations as they continue to enter the marketplace in greater numbers. In anticipation of these rapid developments, the federal and Ontario governments are assessing the technical implications of requiring that new houses be built solar ready to easily incorporate future connection of solar hot water systems or solar photovoltaic (PV) electricity panels. The ECO noted in our 2012 Energy Conservation Progress Report that there were concerns expressed regarding the structural implications associated with additional roof loadings of solar equipment. Neither the federal nor the Ontario government has indicated a date by which this issue might be resolved.

While a standard 120-volt outlet in a garage or carport will make it plug-in ready for electric vehicle charging, its main limitation is the time needed to deliver a full charge. For example, charging a 20 kW battery from zero to full charge on a 120-volt, 16-amp circuit takes over 10 hours. By comparison, charging the same battery on a 240-volt, 32-amp circuit can be completed in under three hours. All that would be required to make new buildings plug-in ready would be to ensure that the conduit installed between the panel and the outlet is large enough in diameter to accommodate the installation of heavier gauge wiring – a requirement that imposes little additional cost. While the majority of EV proponents are lobbying governments for the provision of such rapid recharging infrastructure in the public domain, there is a recognized need to ensure that rapid recharging is available at home for those purchasing EVs. Some jurisdictions are beginning to address this issue; for example, the City of Toronto's Green Standard requires that parking spaces in excess of the minimum stipulated in the zoning by-law incorporate empty raceways and conduits for future EV charging in mid- to high-rise residential and industrial, commercial and institutional developments.

ECO Comment

Accelerating the Market Uptake of Solar Energy and Electric Vehicles

Ontario possesses one of North America's most decarbonized electricity grids. As such, using cleaner electricity, rather than fossil fuels, to power our vehicles would help to reduce GHG and related emissions in the transportation sector.

The ECO encourages MMAH to resolve the roof loading issue promptly to support the introduction of solar energy in new – and existing – construction. While concerns about roof loadings are legitimate, newer solar cells are being introduced that are lighter in weight. With installed costs for both solar thermal and, especially, solar PV dropping rapidly, this warrants the elimination of this barrier to future retrofitting of solar applications.

Similarly, with regard to electric vehicles, the ECO would like to see MMAH amend the OBC so that the provision of larger diameter conduits (and the inclusion of sufficient electrical panel capacity) becomes standard practice in all new single family and multi-residential construction with parking spaces. Not only would this serve to accelerate the market penetration of EVs, it would take advantage of the fact that Ontario possesses one of North America's most decarbonized electricity grids. As such, using cleaner electricity, rather than fossil fuels, to power our vehicles would help to reduce GHG and related emissions in the transportation sector.

An Emerging Issue: The Global Warming Potential of Insulation

It is generally assumed that the more insulation in a building, the better, provided a reasonable cost-benefit has been calculated based on the building's heating (and cooling) degree-day requirements and the energy efficiency characteristics of its heating, ventilation and air conditioning equipment. Insulation works to reduce the amount of energy needed to heat and cool a building. In the case of fossil fuels used on site (in gas-, propane- or oil-fired furnaces or boilers), the reduction in fossil fuel use due

to higher insulation levels has a direct GHG mitigation benefit. And, depending on the contribution of fossil fuels to the electrical grid, a reduction in the use of electricity for space conditioning has a direct benefit on the building's carbon footprint as well.

However, not all insulating materials are created equal. For example, two common foam insulation materials – closed-cell spray polyurethane foam (SPF) and extruded polystyrene (XPS) – use hydrofluorocarbons (HFCs) as blowing agents in their manufacturing process. The global warming potential (GWP) of HFC blowing agents is extremely high: 1,030 for SPF applications and 1,430 for XPS applications (in contrast, the GWP of CO_2 is 1). By comparison, such insulation materials as fibreglass, mineral wool and cellulose do not require blowing agents in their manufacture.

The concern with these blowing agents is that they leak into the atmosphere over time and, in effect, are contributing to GHG emissions and climate change. For example, Canada's 2013 NIR notes that while approximately 10 per cent of HFCs (and perfluorocarbons) are released during production, "the remaining quantity … is trapped in the foam and is emitted slowly over a period of approximately 20 years." This is a rough estimate that does not attempt to account for differences between products. Another source suggested that if 50 per cent of the gas eventually makes its way into the atmosphere over the insulation's lifetime, this would essentially offset any benefit associated with the avoidance in emissions from the reduced consumption of fossil fuels to heat and cool the indoor environment. And, there is the added concern about the disposal of the material remaining at the end of the product's life in such a way to prevent these blowing agents from escaping and further exacerbating the problem.

Compared against the base year of 1990, the GHG emissions associated with electricity production declined by 43 per cent by 2012.

ECO Comment

The Right Insulation

It is encouraging to note that some designers are avoiding foam insulations that use HFC blowing agents. In the interests of avoiding the unintended consequences discussed above, the ECO would like to see MMAH address this issue as quickly as possible – in consultation with the federal government – in order to ensure that the use of insulation is aligned with the recent Code objective to limit the release of GHG emissions. This will likely require MMAH to develop appropriate net global warming indices for HFC blowing agents based on the best available research on leakage rates during production, use and disposal, and to incorporate this knowledge into the Code. MMAH has indicated it will open discussions with standards organizations and manufacturers to explore this issue further.

3.2.4 ELECTRICITY

The electricity sector's contribution to Ontario's total GHG emissions has dropped significantly since its peak in 2000. Compared against the base year of 1990, the GHG emissions associated with electricity production declined by 43 per cent by 2012. In 2012, emissions from electricity were 9 per cent of the province's total inventory, compared to just over 14 per cent in 1990 (and 21 per cent in 2000). The last coal-fired generating station (Thunder Bay) ceased using coal on April 15, 2014. As a result, the role of natural gas as a contributor to GHG emissions in the electricity sector now assumes greater significance.

The Growing Reliance on Natural Gas

According to Ontario's updated 2013 Long-Term Energy Plan (LTEP), nuclear provided about 60 per cent of the province's electricity production in 2013. The LTEP indicates that portions of the province's nuclear fleet will be withdrawn from service for refurbishment – over a period of 15 years – starting in 2016. According to the OPA, electricity sector CO_2 emissions will increase by nearly 60 per cent between 2020 and 2025 due to an increased reliance on natural gas during the refurbishment period.

Future GHG emissions from the burning of natural gas will be affected, in part, by the decisions made in renewing contracts with natural gas-fired non-utility generators.

Future GHG emissions from the burning of natural gas will be affected, in part, by the decisions made in renewing contracts with natural gas-fired non-utility generators (NUGs). NUGs are power plants not owned by Ontario Power Generation (OPG) that generate electricity for distribution to the grid. In some cases, these facilities also produce thermal or steam heat (i.e., combined heat and power facilities). In November 2010, the Ministry of Energy issued a directive instructing the OPA to negotiate new contracts with NUG operators as these contracts expire. At the time of the directive, 31 NUGs provided 1,200 MW of natural gas-fired generation, and 75 per cent of the contracts for those NUG operators were to expire by the end of 2018.

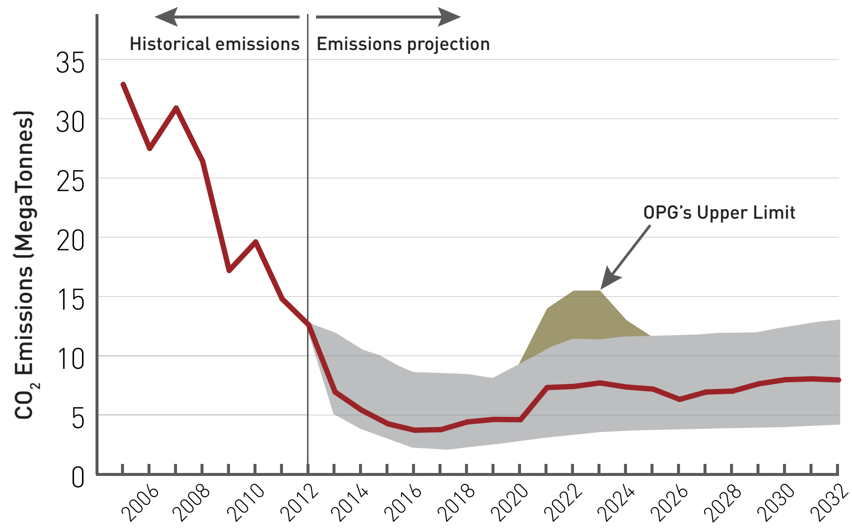
The ECO has noted previously that, under their current contracts, NUG operators can burn gas 24/7 if they want to and they typically do. Emissions could be lowered if the OPA uses discretion and structures its new contracts to stipulate that the NUGs be allowed to produce electricity only at peak times (this will be easier for NUGs that are not providers with a thermal load). The directive allows the OPA to do this, as well as to refuse contracts that are not in Ontario's best interest. The ECO urges that the OPA negotiate contracts with NUGs that would minimize the emission of GHGs while still accommodating the province's electricity needs.

Getting the Numbers Right

Assumptions about the degree to which GHG emissions are likely to increase due to an increased reliance on natural gas vary according to the agency conducting the analysis. As a result of using different assumptions, the OPA and OPG have produced projections with different worst-case emissions scenarios. Figure 14 includes information from the OPA and indicates that emissions from electricity generation (solid red line) will begin to trend upward as nuclear refurbishment begins later this decade. The OPA's projection, based on the LTEP, predicts that electricity sector GHG emissions, due to an increased reliance on natural gas, will peak at just above 8 Mt in 2031 (from a low of 3.7 Mt in 2016).

Figure 14:

Carbon dioxide emissions, forecasts and projected range of emissions to 2032. (**Sources**: Air Emissions Forecast 2013 LTEP: Module 5, Ontario Power Authority, January 2014; Information provided to the ECO by OPG, February 2014).



In Figure 14, the OPA provides a *range* of CO_2 emissions (the grey shaded area) in recognition of the uncertainty around potential changes in demand going forward and the sources that will be deployed to meet this demand (e.g., natural gas, renewables, imports, etc.). The OPA states that natural gas use is expected to increase to accommodate the nuclear refurbishments and meet the supply-demand balance.

Figure 14 also includes data taken from OPG and is based on a presentation given to the ECO in February 2014. OPG projects a much higher upper limit for GHGs associated with the use of natural gas between the years 2021 to 2024 with the potential upper limit of emissions peaking at just over 15 Mt by 2022 – 25 per cent higher than the upper limit of 12 Mt in the LTEP. OPG indicated that the data presented in Figure 14 is based on the 2010 LTEP, not the 2013 LTEP data used by the OPA, and noted that the "OPA evidently makes different assumptions on conservation, renewables and perhaps other assumptions such as in-service CCGT [combined-cycle gas turbine] emission rates and imports."

Box 4: Data Issues and Transparency at the Federal Level

In the 2013 NIR, it was reported that natural gas was responsible for 7.4 Mt of electricity sector GHG emissions in 2010 and 10.6 Mt of GHGs in 2011. However, a review of facility-level data from Environment Canada's Greenhouse Gas Reporting Program (GHGRP) indicated that the actual contribution of natural gas to electricity sector emissions in these two years were 11.5 Mt and 11.9 Mt respectively. The difference reflects how several NUGs are categorized and to which sector their emissions are allocated by Environment Canada. For example, the emissions from an industrial cogeneration facility in Central Ontario were allocated under the federal government's GHGRP to the electric utility sector. However, the emissions from the same industrial facility were allocated to the iron and steel sector in the 2013 NIR report. (The allocation of other NUG GHG emissions to industrial subcategories likely explains the balance of the difference noted above.) These variations in how GHG emissions are allocated across sectors makes it challenging to interpret emissions trends in the electricity sector and creates an additional barrier to transparency; another example of why the Ontario government should develop an Ontario-specific GHG inventory with all its assumptions and methodology clearly documented.

ECO Comment

The ECO is concerned about the differences between OPG's and the OPA's GHG emissions forecasting. It would be useful for the OPA to conduct (and regularly update) a sensitivity analysis showing how Ontario's electricity sector GHG emissions are expected to vary in response to different factors (e.g., cost competitiveness of natural gas versus imports, over/underachievement of conservation and/or renewables targets, changes in timing of refurbishments, etc.). If relatively minor changes in these factors lead to large increases in emissions, then this is something the Ministry of Energy should be tracking to ensure it can take corrective action, if needed, to prioritize actions that would prevent emissions from rising.

The ECO believes that the Ministry of Energy, with broad oversight for electricity planning in Ontario, should ensure that Ontario Power Generation and the Ontario Power Authority are working from the same set of assumptions when calculating future GHG emissions.

The ECO believes that the Ministry of Energy, with broad oversight for electricity planning in Ontario, should ensure that OPG and the OPA are working from the same set of assumptions when calculating future GHG emissions. This will enable the Ontario government to speak with one voice to the federal government with regard to the proposed federal regulation on gas generators (see Box 5, Proposed Federal GHG Standards for Gas-fired Turbines and Boilers). The federal regulation could potentially rule out converting any of Ontario's coal units to run on natural gas (or a mix of biomass and natural gas). This, in turn, could force Ontario to procure a costly new natural gas-fired unit instead. In the ECO's opinion, the emissions consequences could go either way – a new gas unit would emit less CO_2 than producing the same amount of electricity from a coal unit converted to 100 per cent natural gas, but this might not be the case if a mix of biomass and natural gas were used.

Box 5: Proposed Federal GHG Standards for Gas-fired Turbines and Boilers

Recognizing the growth in the use of natural gas to generate electricity across Canada, the federal government is developing standards for natural gas-fired turbines and boilers. This follows the publication of regulations under the *Canadian Environmental Protection Act, 1999* regarding the reduction of CO_2 emissions from coal-fired electricity generation. These regulations will come into force in July 2015. Although no draft of the standards for natural gas-fired turbines and boilers has yet been published, it is assumed that the Canadian regulations that are developed will harmonize with similar standards of performance proposed by the U.S. Environmental Protection Agency in January 2014. Once they are published, the ECO will assess the GHG implications of any new federal regulations for natural gas-fired electricity generating stations in a future report.

Carbon Neutrality of Biomass/Biofibre

Due to the phase out of coal use for electricity generation in Ontario, OPG is exploring alternative fuel sources and focusing on

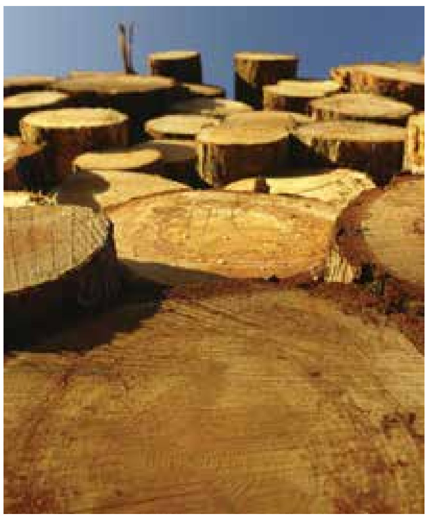
To the extent that large-scale pellet production is likely to exclude the use of forest residues the real issue shifts to a discussion of the carbon neutrality implications of using unmerchantable trees.

its Atikokan generating station located west of Thunder Bay. In 2008, OPG launched a pilot demonstration using biomass as a feedstock for electricity production, taking advantage of an incentive program the Ministry of Natural Resources (MNR) introduced that year. In a study commissioned by OPG in 2011, two assumptions were made regarding this biomass: 1) that "OPG would get most of the required biomass feedstock from logging residues"; and 2) that forestry companies regularly burn the majority of leftover residues from their harvesting operations. OPG maintained that its use of biomass was carbon neutral (it would have been burned either as slash or as wood pellet feedstocks).

However, the wood that was intended to be used – logging residue or slash – does not produce high quality pellets since it includes dirt, grit and a large proportion of bark (pellets made with bark content create higher amounts of ash, other air pollutants and related maintenance problems). OPG has indicated to the ECO that the majority of the feedstock for its Atikokan biomass facility will come from what MNR defines as unmerchantable or unmarketable low-grade timber volumes (e.g., birch and poplar) – not from forest residue or slash. To the extent that large-scale pellet production is likely to exclude the use of forest residues (for the operational issues noted above), the real issue shifts to a discussion of the carbon neutrality implications of using standing trees that would not otherwise have been harvested.

Under the same incentive program from MNR, wood used to manufacture pellets is exempt from stumpage fees. OPG maintains that, over many decades, the use of unmarketable trees is carbon neutral as the carbon released when the wood pellets are burned is eventually re-sequestered in new growth timber. However, if these timber volumes are not made into pellets as fuel for power generation, the wood would either be left standing or could be processed into other forest products. Almost all of these uses would sequester carbon over the medium to long term. Additional carbon would also be sequestered in the soil; if left undisturbed, the province's forest soils can store up to seven times as much carbon as the above-ground forest biomass. Once disturbed, forest soils can lose up to 50 per cent of their carbon content.

Industry and government must reassess their assumptions about the carbon neutrality of using forest products for electricity production.



ECO Comment

The ECO raised concerns about the use of forest biofibre for energy production in our 2008/2009 Annual Report. These concerns were reiterated in our 2010 Annual Greenhouse Gas Progress Report. As noted, OPG's position is that the life-cycle emissions of burning biomass are carbon neutral over a 100-year time period, a position that the ECO does not dispute. However, the ECO also noted that there is a substantial, short-to-medium-term surge of CO_2 from burning forest biofibre that is not sequestered for a considerable period of time and that this short-to-medium-term surge will be problematic in a 390 ppm world. As we are now living in a 400 ppm world, this conclusion carries a greater degree of urgency – industry and government must reassess their assumptions about the carbon neutrality of using forest products for electricity production.

While the ECO agrees that the use of forest biomass for power generation may approximate carbon neutrality over the long term, given the seriousness of the much shorter time scales we are facing (as discussed in Section 1), the use of forest biomass to generate electricity may incur a short-to-medium-term carbon debt – contributing to a tipping point – we simply cannot afford.

Many companies and leading organizations in the energy industry … predict that renewable forms of electricity generation are poised for exponential growth between now and 2025.

The Role of Renewables in Reducing GHG Emissions

Renewable power includes electricity derived from hydro, wind, solar PV (photovoltaic) cells and bioenergy. Many companies and leading organizations in the energy industry – including the International Energy Agency, the U.S. Department of Energy's National Renewable Energy Laboratory, Credit Suisse and British Petroleum – predict that renewable forms of electricity generation are poised for exponential growth between now and 2025. Credit Suisse projects over 100,000 MW of new renewable capacity additions in the United States alone, "with wind and solar market share more than doubling from 2012 to 2025 … *appreciably slowing the rate of demand growth for natural gas from the power sector* (emphasis added)." Ontario has been a North American leader in developing solar and wind generation, and may benefit from price or technology improvements as these technologies increase their market penetration across the continent over the next 10 years.

Box 6: Conservation Will Also Play a Key Role in Lowering Emissions

The LTEP projects that conservation – including improvements to codes and standards – will offset almost all of the growth in electricity demand in Ontario out to 2032. The LTEP provides figures indicating that if conservation actions were not pursued, Ontario electricity demand would increase from 144 TWh in 2011 to 181 TWh in 2032. When the impact of conservation initiatives is included, demand in 2032 is projected to rise to only 153 TWh. Since Ontario's peak demand is met by burning natural gas, this reduction in demand will correspondingly avoid GHG emissions.

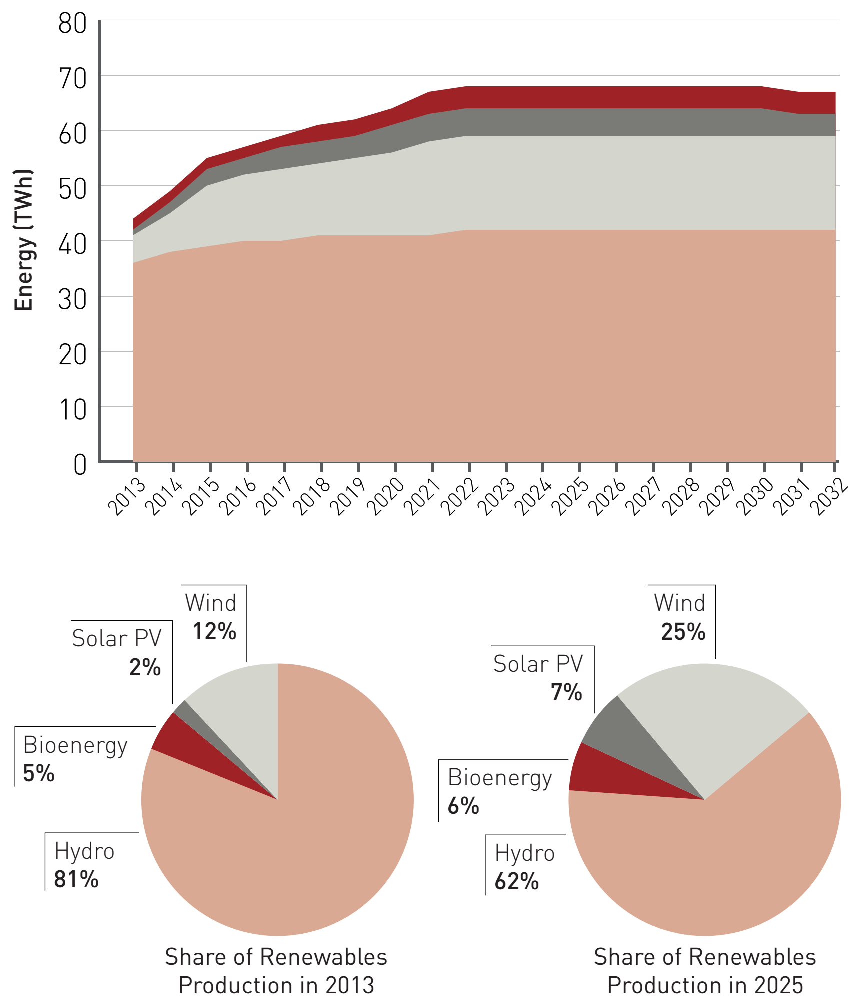
As of December 2013, renewable sources comprised 31.9 per cent (12,114 MW) of Ontario's total grid capacity of 38,000 MW with 3,725 MW of this capacity coming from non-hydro sources. By 2020, the LTEP projects that 10,700 MW of non-hydro renewables (26 per cent of total grid capacity) will be available on the grid.

The ECO fails to see the rationale behind the Long-Term Energy Plan forecast that electricity production from solar, wind and biomass will remain flat and actually decline from 2022 out to 2032.

The LTEP indicates that 3,479 MW of solar capacity will be grid-connected in Ontario by 2025. After the year 2022 the LTEP indicates that the contribution of non-hydro renewables – including solar – remains unchanged and actually drops by about 2 per cent after 2030 (see Figure 15). In the face of the predicted exponential growth of electricity production from wind and solar in the United States and elsewhere around the globe noted earlier, the ECO fails to see the rationale behind the LTEP forecast that electricity production from solar, wind and biomass will remain flat and actually decline from 2022 out to 2032.

Figure 15:

Ontario's forecasted renewables by resource category – 2013 to 2032 (**Source**: OPA (2014): Generation and Conservation Tabulations and Supply/Demand Balance 2013 LTEP: Module 3).



ECO Comment

With the termination of coal use at OPG's last coal-fired power station in April 2014, Ontario now has one of the least carbon-intensive electricity grids in North America. However, the potential for renewable forms of electricity to displace GHG emissions needs to be explored in greater detail by the OPA and by the Ministry of Energy. The discussion earlier in this section about the growing reliance on natural gas argues strongly for this reassessment. Given the speed with which wind and solar power, in particular, are changing the North American electricity landscape, the ECO believes that the current LTEP may be underestimating their potential to provide clean, non-emitting sources of electricity at competitive prices.

The ECO acknowledges that natural gas currently plays a key role as a dependable source of electricity supply that can be ramped up and down in electricity production to match changes in demand. Among renewables, only bioenergy or hydro dams (which are both accompanied by their own set of environmental and economic issues) can play a similar role. For this reason, there are limits to just how much we can reduce GHG emissions from the electricity sector at a reasonable cost. At some point, the law of diminishing returns kicks in, and Ontario may be able to achieve greater emissions reductions per dollar spent by focusing on other emitting sectors. This state of affairs could change. The costs of alternative technologies are expected to become more competitive, for example, due to the rapid advances being made in matching renewables with storage technology across North America.

This does not mean that nothing can be done today. The need for natural gas-fired electricity production can be reduced by smoothing out the peaks and valleys in electricity demand, for example, through load shifting. Given that Ontario's peak hours of solar radiation occur in hot weather, solar-generated electricity for space cooling would reduce the need for ramping up natural gas-fired generation.

There are also changes proposed in the design of Ontario's electricity market that could reduce operation of existing natural gas-fired peaking plants or reduce the need to build additional new peaker plants and, thereby, mitigate GHG emissions.

The Minister of Energy has transferred authority for the province's program to reduce peak electricity demand to the IESO. The IESO is consulting on proposed policy changes for market-based designs (e.g., a simple standard price per megawatt of demand that is reduced) that may attract more conservation and more frequent instances of shifting demand away from peak hours. The IESO is examining and consulting on the design of a market for generation capacity to be implemented in Ontario. The IESO's exploration of such a market to complement the spot electricity market could result in a serious commitment to demand-side resources and place conservation on an equal footing with supply-side options. Such market changes could also fill any capacity shortfall toward the end of the decade as nuclear refurbishments proceed and, to some degree, reduce the need for gas-fired generation to backfill nuclear generation.

While Ontario appears on track to a low-carbon electricity future, this future is not secure because the amount of natural gas-fired generation (and GHG emissions) could rise substantially if Ontario's electricity demand is greater than expected or supply from other sources is less than expected. If changes in Ontario's electricity supply-demand balance increase our need for natural gas-fired generation, this makes the acquisition of lower-emitting alternatives – either through conservation, demand management or renewables – all the more pressing. For this reason, the ECO supports the commitment in the LTEP to update Ontarians on changing supply and demand conditions through an annual Ontario Energy Report, as well as to review its targets for wind, solar, bioenergy and hydroelectricity annually as part of this report. The ECO expects that such reports will include a rolling forecast of GHG emissions (including a sensitivity analysis) over the planning horizon.

The ECO believes that the current Long-Term Energy Plan may be underestimating the potential of renewables to provide clean, non-emitting sources of electricity at competitive prices.

3.2.5 AGRICULTURE

Current agricultural practices result in a net release of GHGs into the atmosphere. In 2012, farming operations in Ontario were the source of 9.4 Mt of CO_2e, or roughly 6 per cent of the province's emissions. More than half of those emissions (5.2 Mt) came from agricultural soils, with the remainder primarily the result of enteric fermentation (gases produced by livestock) and manure management.

The main sources from soils are nitrous oxide (N_2O) emissions associated with the application of nitrogen fertilizer and manure to soils (3.1 Mt), as well as indirect emissions of N_2O resulting from fertilizer runoff and erosion processes (2.0 Mt). These figures have remained constant over the past two decades; the 1990 figure from soils, for example, was 5.1 Mt.[6]

Removing Carbon from the Atmosphere Requires Healthy Soils

In our 2011 Annual Greenhouse Gas Progress Report, the ECO estimated that Ontario's cropland and pastures could store or sequester nearly 9 Mt CO_2e per year by 2020 through the establishment of certain best management practices, such as cover crops and crop rotations, coupled with energy crop (e.g., biofuel) production. Therefore, the potential exists for these best management practices to offset nearly all of the agricultural sector's current annual GHG emissions. The ability to sequester carbon in Ontario's soils is a compelling opportunity.

Over the three-year period since that report was published, the latest science has continued to support the ECO's rather conservative estimates on soil-carbon sequestration potential and to provide new insights into the underlying mechanisms. Studies are linking high rates of soil-carbon sequestration directly with the quantity and diversity of beneficial soil microorganisms, which are also the factors that determine soil health and productivity.

For example, recent work by the U.S. Department of Agriculture's National Resources Conservation Service has demonstrated

[6] Emissions from fertilizer production are excluded from this discussion, but are captured in the National Inventory Report under the industrial sector.

The potential exists for these best management practices to offset nearly all of the agricultural sector's current annual GHG emissions.

Box 7: What is Soil Health?

The U.S. Department of Agriculture defines soil health as "the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans." The living components of this ecosystem are known as the soil food web and include bacteria, fungi, protozoa and many other beneficial microorganisms. The soil food web is the basis of soil health because it provides many of the ecosystem functions that sustain life in general, such as good soil structure, nutrient cycling, filtering of pollutants, water retention and disease suppression. Its diverse population of microorganisms is also actively involved in sequestering carbon, vital to microbes as both food and habitat.

that soil health is directly dependent on a diverse mix of beneficial microorganisms. According to this agency, following basic principles that support and enhance soil life (such as minimizing soil disturbance, maximizing soil cover, maximizing diversity with cover crops, and providing continuous live roots in the soil) can greatly increase agricultural productivity and reduce the need for synthetic inputs (e.g., nitrogen fertilizer), while at the same time sequestering substantial amounts of carbon.

Soil Health: Is it a Priority for the Ministry of Agriculture and Food?

The ECO is concerned that despite the growing evidence of the importance of soil health to climate change mitigation and adaptation, as well as to general agricultural productivity, OMAF has not yet made its promotion a high priority. OMAF's cornerstone environmental program, the Canada-Ontario Environmental Farm Plan, does not contain a single reference to soil microorganisms or soil health. All of the soil management issues discussed in the program workbook (such as compaction, erosion, soil structure and water infiltration) directly relate to the health of the soil microorganisms and their integrated web of life. Yet, the significant influence of these organisms on soil health (and carbon sequestration) is not discussed, explained or even mentioned.

The ministry has taken some steps; it has produced good practical handbooks on practices, such as no-till and soil management, and offers occasional workshops for farmers on soil health. It also sponsors research in this area, including a number of long-running field trials at the University of Guelph that have demonstrated the benefits of various best management practices to soil health and productivity. However, there is an absence of ministry data on whether or not these research and education efforts have led to an increased uptake of beneficial practices by farmers.

Without sound metrics and data on the uptake of various best management practices, the ministry cannot assess the effectiveness of its programs or determine where improvements might be needed. Similarly, the tools necessary to easily and reliably assess soil health are not yet available to farmers. However, this deficiency may soon be addressed. An adapted version of Cornell University's Soil Health Assessment Training Manual was tested at the University of Guelph trials (mentioned above), and the ministry has indicated that it is working toward its release in 2014.

OMAF has stated that it is the responsibility of MOE to lead the development of protocols necessary to accurately measure and validate the carbon storage potential of better soil and crop management practices. This is the vital first step in assigning a monetary value to soil-carbon sequestration, as well as related ecosystem services. OMAF says it remains ready and willing to provide the necessary support to MOE. This suggests that the government's biggest hurdle in the area of soil-carbon sequestration is one of governance and organization, and not necessarily financial in nature. Despite the obvious benefits such protocols would confer, none of the groundwork has started, in part, because the key ministries are waiting for each other to take the lead.

ECO Comment

The ECO believes that the government of Ontario needs to show stronger leadership in promoting soil-carbon sequestration opportunities. In particular, OMAF needs to address the general question of how to encourage, support and incent on-going

The ECO believes that the government of Ontario needs to show stronger leadership in promoting soil-carbon sequestration opportunities.

improvements in soil health. The development of effective policy and programs in this area would help to capitalize on the considerable carbon-sequestration potential of Ontario's soils, while also ensuring sustainable agricultural productivity.

Such efforts should include, at the very least:

- the development of effective and inexpensive methods for measuring soil health;
- the development of protocols for assigning reliable carbon-sequestration values to the various best management practices;
- the collection of data on the uptake by farmers of these practices;
- the implementation of mechanisms for compensating farmers for extra expenses and/or for risk mitigation; and
- the setting of realistic but ambitious targets for soil-carbon sequestration in Ontario.

A lack of prompt action on these issues could result in at least one missed opportunity. MOE has proposed a GHG emissions reduction plan for industry that would allow the use of offsets from emissions reductions in other sectors, potentially creating a financial incentive for these reductions. However, offsets will likely only be recognized in areas where emissions reduction protocols have been established.

Given the simplicity, low cost and significant co-benefits of soil-carbon sequestration compared to unproven and expensive technologies like carbon capture and storage, the ECO believes that it should be a much higher priority in Ontario's climate change action plan. The Ontario government must step up to the plate, show leadership and capitalize on this compelling opportunity.

3.2.6 WASTE

Emissions in the waste sector rose slightly in 2012 from 2011. Most of Ontario's 7.5 Mt of GHG emissions from this sector are methane generated in landfill sites. These methane emissions are primarily caused by the presence of organic waste. The current diversion rate of organic waste is relatively low, as shown in Table 3, meaning that most organic waste generated in the province is still ending up in landfills.

Table 3
Estimated Organic Diversion rates in Ontario (2011) (**Source:** Paul van der Werf, November 13, 2012. Ontario Organics Strategy Preliminary Report).

Sector	Subcategory	Diversion Rate
Residential	Leaf and Yard	82–89%
	Source Separated Organics	26–27%
	Overall	41–44%
Industrial, Commercial and Institutional		9–22%
Overall		22–39%

MOE recognizes the need to increase the province's organics diversion rate. In June 2013, the ministry posted a Draft Waste Reduction Strategy to the Environmental Registry (#011-9262), which indicates the government's intention to develop a strategy to increase the diversion rate for organics. In addition, the proposed *Waste Reduction Act*, which would have repealed the *Waste Diversion Act, 2002* and provided the institutional framework for waste management in the province, was given Second Reading on December 4, 2013, but with the prorogation of the legislature in May 2014, died on the order paper.

The current diversion rate of organic waste is relatively low, meaning that most organic waste generated in the province is still ending up in landfills.

In 2011, the province mandated that landfill owners install gas capture systems and report the estimated associated reductions in methane emissions to MOE. The data gathered through this process is currently not shared with Environment Canada on a formal, annual basis, where it could be used as a quality check by Environment Canada for its waste sector emissions estimates. At present, Environmental Canada obtains data on landfill gas through its own biennial survey on landfill gas capture and utilization.

Two factors would have an impact on the amount of GHGs reported in the NIR for the waste sector if they were reflected in Environment Canada's calculations of the sector's emissions: annual data sharing of the landfill gas capture data, and the methane capture rate, both of which were discussed in Section 2.

As recommended in 2012, the ECO believes that the Ministry of the Environment should implement a phased-in full ban on organics in landfills.

ECO Comment

The ECO looks forward to an increase in the organics diversion rate, especially in the industrial, commercial and institutional sectors. As recommended in 2012, the ECO believes that MOE should implement a phased-in full ban on organics in landfills. Completely removing organics from landfills will help reduce future waste sector methane emissions (although it will not help with legacy emissions from previously discarded organics). Landfill operators that have installed landfill gas capture systems to comply with MOE's landfill gas capture regulation can rely on already disposed organic waste that continues to create methane gas. Landfill gas capture systems are only partially effective, and fugitive methane emissions from landfills will still pose a problem, as the ECO has previously noted. A ban on organics in landfills does not preclude landfill operators from recouping their investment in landfill gas capture systems, and generating electricity for those with Feed-in Tariff (FIT) and non-standard offer contracts (Table 4), as they can rely on previously disposed organic waste to generate methane.

Table 4

Landfill gas FIT and non-standard offer contracts as of June 30, 2013 (**Source:** Ontario Power Authority. September 19, 2013. A Progress Report on Contracted Electricity Supply: 2013 Second Quarter; Ontario Power Authority. Active FIT Contracts as of June 30, 2013).

Contract Facility	Contract Capacity (MW)	Commercial Operation/Term Commencement Date	Contract Expiry Date	Type of Contract
Eastview Landfill Gas Energy Plant	1.7	Aug. 18, 2005	Q3 2025	Non-Standard Offer Program
Trail Road Landfill Generating Facility	6.0	Jan. 31, 2007	Q1 2027	Non-Standard Offer Program
Bensfort Road LFG Generation Project	1.6	May 11, 2013	N/A	FIT
Lafleche Landfill Gas Utilization	4.2	N/A	N/A	FIT
Merrick Landfill Project	1.6	N/A	N/A	FIT
WM Ottawa Landfill Gas to Energy	6.4	N/A	N/A	FIT
TOTAL	**21.5**			

Conclusion

A review of the Ontario government's progress in meeting the climate change challenge would not be complete without discussing the extent to which it is providing adaptation leadership. In the face of increasingly frequent and severe weather events, threats to infrastructure, particularly stormwater systems, are becoming more acute. These challenges are discussed in the final section of this report.

4

SINK, SWIM OR TREAD WATER? ADAPTING INFRASTRUCTURE TO EXTREME WEATHER EVENTS

Ontarians are learning that in a changing climate one of the few things they can expect is the unexpected. Destructive weather and associated flooding are becoming the new normal, and are challenging traditional approaches to stormwater management. Multiple levels of government have responsibilities for stormwater management in Ontario. While municipalities are finding themselves exposed on the front lines, the province also has a responsibility to provide oversight and meet its regulatory role in stormwater planning and management. This section examines the extent to which the provincial government is fulfilling its responsibility to provide leadership to municipalities in a changing and uncertain climate.

A New Normal: Extreme Storms in Ontario

Ontario has always experienced storms; however, the province has recently faced more intense and frequent extreme weather, as well as unprecedented damage costs.

During a storm in July 2013, parts of Toronto were inundated with up to 126 millimetres (mm) of rain in approximately two hours. This was almost *twice* the average monthly precipitation for July and more than the previous daily rainfall record of 121.4 mm set during Hurricane Hazel in 1954. Insured property damage from this event is estimated at $940 million, while the City of Toronto faces uninsured costs of approximately $60 million, making it the most expensive natural disaster in Ontario's history. During a similarly destructive Toronto storm in 2005, areas north of the city received up to 175 mm

of rain over several hours, exceeding the criteria for a 1-in-100 year storm (i.e., a storm with a 1 per cent chance of happening in any year). As a result, a major roadway was washed out at a cost of $600 million in insurance payments alone. Other municipalities, ranging from Sault Ste. Marie to Peterborough to Thunder Bay have also experienced multiple 100-year storms over the past 15 years.

Flooding from extreme weather has also hit small, northern communities. Many of these towns are surrounded by provincial Crown land and, therefore, do not benefit from the safeguards provided by conservation authorities (conservation authorities are watershed-based government agencies that, among other things, administer flood management programs). For example, in October 2012, the small town of Wawa was stranded when a catastrophic storm washed away parts of the Trans-Canada Highway, as well as roads, houses and businesses; this resulted in damages that could total $20 million.

Flooding also causes serious environmental damage. For example, the 2013 Toronto flood overwhelmed wastewater treatment plants and stormwater systems; up to a billion litres of sewage, as well as garbage and debris, were washed into Toronto's rivers and Lake Ontario. Municipal wastewater carries bacteria, nutrients, chemicals and other contaminants; this contributes to eutrophication, increases toxic loadings to the aquatic food web and presents risks to human health. Violent stormwater flows also cause shoreline and riverbank erosion.

Built-up urban areas are especially prone to flooding; highly developed watersheds lose most of their capacity to absorb precipitation and runoff before it reaches stormwater systems and flows into rivers. Trees and other vegetation slow rain as it falls and flows over the landscape, allowing water to permeate into the ground. In contrast, impermeable urban land cover, such as pavement and buildings, increases the volume and speed of runoff.

Experts predict that insurance rates will go up, that some types of liabilities, such as wet basements, will not be covered and that, in some locations, homes may not be insurable at all.

Industry and Municipal Responses to Changing Flood Patterns

The growing incidence of extreme and unstable weather events has been a wake-up call for a variety of players, both in the private and public sectors.

The insurance industry is introducing policy changes in response to the costs of extreme weather. While fire was once the leading cause of property insurance claims in Canada, the Insurance Bureau of Canada reports that in recent years, water and wind damage caused by severe weather has become the top concern. As a result, insurance companies and experts predict that insurance rates will go up, that some types of liabilities, such as wet basements, will not be covered and that, in some locations, homes may not be insurable at all.

Some larger municipalities are attempting to implement best management practices, such as green infrastructure, to better manage increased stormwater flow. They are also experimenting with innovative financial tools to fund stormwater infrastructure (see Box 8, Municipal Best Practices for Stormwater Management).

However, smaller municipalities often lack the capacity to independently design, test and implement new engineering or financing approaches. Both large and small communities are already struggling with the costs of replacing aging infrastructure. Most municipal water infrastructure in Ontario was built between the 1950s and 1970s and is now nearing the normal end of its life. As a result, Ontario municipalities face a deficit of $6.8 billion for the repair and replacement of stormwater infrastructure alone.

When municipalities do undertake the costly process of replacing aged stormwater infrastructure, they will require guidance about future climate projections and best management practices. Without this direction, communities run the risk of installing new – but ultimately inadequate – systems that cannot handle projected water flows.

Box 8: Municipal Best Practices for Stormwater Management

Conventional stormwater infrastructure typically involves conveyance and end-of-pipe tools, such as pipes, ditches and retention ponds. However, it is beyond the financial capacity of municipalities to install conventional stormwater systems that can handle 1-in-100 year storms. Therefore, some communities are looking to alternative means of managing stormwater.

Certain municipalities have used financial tools to create a more reliable funding base for the costs of maintaining and updating stormwater infrastructure. The cities of Kitchener and Waterloo collaboratively implemented a stormwater rate system to fund their stormwater management program. Land owners pay rates based on the amount of runoff expected from a property, using criteria such as property size and the amount of area covered by impervious surfaces. As a result of this user-pay approach, Kitchener and Waterloo are better able to recover stormwater management costs.

Some municipalities are also introducing green infrastructure – such as green roofs, permeable pavement and rain gardens – which use vegetation and ecological processes to retain and treat stormwater on-site.

Green infrastructure and stormwater financial tools can also be combined. For example, Kitchener and Waterloo home owners and businesses can apply for a credit to their stormwater rate if they implement source control measures that reduce runoff or improve water quality, such as rain barrels or green roofs. Similarly, the City of Mississauga is planning to implement a stormwater user rate system that will be complemented by low-impact development undertaken by the municipality. Mississauga has been recognized for its partnership with the Credit Valley Conservation Authority in using permeable surfaces and vegetation to retain and treat runoff on municipal properties, such as school yards and road allowances. By using multiple retention tools that include green infrastructure, existing stormwater systems are better able to manage stormwater – and hence, protect property – during extreme weather.

Recent unprecedented weather events have already disrupted the status quo. The insurance industry is responding to control its losses. Municipalities are realizing that some types of flood damage may no longer be insurable. Some large municipalities may be experimenting with new approaches, but most are simply overwhelmed. According to a feature article on infrastructure resiliency in a recent issue of *Water Canada*, "many municipalities feel they are in limbo when it comes to predicting what a changing climate demands of system design and capacity." Clearly there is a need for higher level co-ordination, guidance and leadership.

The Expert Panel stressed that there was no time to waste and "urged prompt and vigorous action..."

Ontario's Responsibility for Stormwater Management

The provincial government has a vital leadership and regulatory role to play in the design, management and delivery of municipal stormwater infrastructure. However, the involvement of multiple ministries (see Box 9, Responsibilities of Provincial Ministries Related to Stormwater Management) – as well as municipalities and conservation authorities – each with overlapping mandates and accountabilities, complicates the planning and implementation of stormwater infrastructure that can accommodate the stresses imposed by a changing climate. Moreover, there is no clear lead ministry responsible for addressing urban flooding.

In 2009, Ontario's Expert Panel on Climate Change Adaptation (the "Expert Panel"), released a report that emphasized the province's responsibility to provide leadership on climate change adaptation. The very first recommendation called for Ontario to "enhance provincial government capacity to take leadership" in managing climate change risks, as well as highlighting the province's responsibility to "increase efforts by communities to improve climate change resilience ...". The Expert Panel stressed that there was no time to waste and "urged prompt and vigorous action" to develop and implement a strategic plan.

Municipalities have also called for provincial direction. In January 2014, 19 mayors and three municipal chairs of the Greater Toronto Area not only requested disaster relief funding after the December 2013 ice storm, but also unanimously asked that the province show leadership with new and stronger programs to help municipalities adapt to climate change. Similarly, conservation authorities have requested the provincial government provide policy and funding support for green infrastructure, updated floodplain maps, emergency planning and infrastructure asset management.

The ECO has urged ministries – as far back as 2007 – to update the rules, policies and guidelines dealing with stormwater and flood prevention in light of climate change.

Box 9: Responsibilities of Provincial Ministries Related to Stormwater Management

Ministry of the Environment

- Developed the Stormwater Management Planning and Design Manual to provide guidance for planning, designing, operating and maintaining stormwater management infrastructure
- Issues Environmental Compliance Approvals for stormwater infrastructure

Ministry of Municipal Affairs and Housing

- Administers the Provincial Policy Statement, which provides direction to municipalities on land use planning, including restricting development from lands subject to flooding or erosion hazards
- Operates the Ontario Disaster Relief Assistance Program, which provides some compensation for property damaged or destroyed due to natural disasters

Ministry of Natural Resources

- Ministry assigned provincial lead for water-related natural hazards including flood hazards
- Monitors weather, rainfall and stream flows, provides advisories to conservation authorities and MNR district offices on flood potential
- Shares aspects of public safety and natural hazard prevention with municipalities
- Administers *Conservation Authorities Act*, delegating flood management responsibilities to conservation authorities where they have been established in the province
- Provides, through Emergency Management Ontario, support to municipalities during flooding when municipal resources are overwhelmed

Ministry of Transportation

- Provides design standards for provincial culverts, bridges and highway drainage systems

Ministry of Infrastructure

- Is responsible for administering infrastructure investment and managing sustainable growth

The Provincial Response So Far

The province itself has promised leadership on climate change adaptation, including guidance for stormwater management and planning. Commitments made in the province's Climate Ready Adaptation Strategy and Action Plan ("Climate Ready"), released in 2011 and covering the 2011 – 2014 period, were shared across several ministries, including MOE, the Ministry of Infrastructure (MOI), MNR and MMAH.

Minimal Guidance from the Ministry of Infrastructure

Climate Ready made two explicit commitments related to public infrastructure. First, it promised to build climate change adaptation into Ontario's 10-year infrastructure plan. Second, it committed to undertake vulnerability assessments of infrastructure.

On the first front, MOI did acknowledge in its 2011 infrastructure plan, Building Together, that "climate change will have a significant impact on stormwater systems…". The plan promised a roll-out of new requirements for performance measures and reporting for municipal water systems, including stormwater, under the *Water Opportunities Act, 2010*, but offered few details and no timelines. The ECO has not observed any roll-out of performance measures for municipal stormwater systems to provide such design guidance.

On the second front – climate change vulnerability assessments – MOI's progress has been even more tentative. Indeed, the ministry has missed a golden opportunity to make vulnerability assessments a core element of asset management planning at the municipal level. Over the years, the ministry has been emphasizing the need for asset management plans, after observing that fewer than 40 per cent of municipalities had these tools in place. In 2012, the ministry made asset management plans a pre-condition for municipalities to receive infrastructure funding support, and also published a 40-page how-to guide, setting out minimum expectations.

Unfortunately, MOI's guide does not make vulnerability assessments a mandatory component; nor does it explain the concept. The guide includes useful advice on financial planning, data collection and public engagement, but the looming issue of vulnerability to climate change is relegated to a single illustrative bullet point in a back page. MOI's guide leaves municipalities to puzzle through the linkages between infrastructure planning and climate change adaptation for themselves.

Nova Scotia, in contrast, has given its municipalities in-depth guidance, with its 2011 Municipal Climate Change Action Plan Guidebook. Nova Scotia's Guidebook walks municipalities through identifying vulnerabilities, hazards and key infrastructure, and helps prioritize actions. The Guidebook is similarly linked to a strong incentive, since municipalities must submit their climate change plans to qualify for funding support.

MOE: Retreating from Commitments?

MOE promised to develop guidance for stormwater management in response to climate change; this was Action 10 in the province's Climate Ready Action Plan. In 2010, the ministry had made similar and even more detailed commitments after a three-year internal review in response to an *EBR* application. The promised guidance is still in preparation, however, and the ECO has been told it will not be available for public comment before the end of 2014. In the face of increasingly severe weather patterns and calls for action stretching back to 2007, this delay is unacceptable.

More troubling still are indications of retreat from reforms MOE had viewed as necessary four years ago in its review of stormwater management. In 2010, the ministry felt that its 2003 Stormwater Management Planning and Design Manual needed to be updated to reflect the need for climate change adaptation. Rather than doing so, however, the ministry is drafting only supplementary and voluntary guidance on low impact development. As such, despite its commitment in 2010 to do so, there is no indication the ministry is working on an "MOE policy framework … to support resilient municipal stormwater management systems and adaptation to

Many of Ontario's floodplain maps date from the 1970s and 1980s, and do not reflect the twin realities of rapidly urbanizing landscapes and extreme weather events.

climate change ....". Nor does the ministry appear to be strengthening its "approvals process for municipal stormwater management ... to include source control best practices," despite highlighting this need as a key finding in 2010.

Updated Floodplain Mapping: An Orphaned Responsibility

The big lesson Ontario learned from Hurricane Hazel – not to build on floodplains – has helped enormously to prevent flood damage over the past five decades. In acknowledgment, Climate Ready noted the value of floodplain maps to identify flood-prone areas and to be used as a tool to steer development away from them. But many of Ontario's floodplain maps date from the 1970s and 1980s, and do not reflect the twin realities of rapidly urbanizing landscapes and extreme weather events. As upstream areas of watersheds are paved over, increased runoff can dramatically alter downstream flooding patterns – alterations that old maps fail to capture. Changing precipitation patterns are also not reflected in the old maps.

Ontario's conservation authorities have long been warning that many, if not most, of their floodplain maps are outdated – the estimates range from 50 to 80 per cent. On average, Ontario's floodplain maps are 22 years old, with many only available in hard copy format, rather than digitized. In 2013, Conservation Ontario estimated that the one-time cost to update all these maps to a standard that would be suitable for effective emergency management and planning would be $24 million.

That Ontario's floodplain maps urgently need updating is not in dispute – the need has been highlighted by the Expert Panel, the insurance industry and the ECO. A dispute does revolve, however, around who should take leadership and who should pay. Both the Expert Panel and the ECO have called on MNR to lead this exercise, in collaboration with conservation authorities. Conservation Ontario recommends sharing the cost among all levels of government, arguing that many municipalities simply do not have the resources to cover this work on their own. The perspective of the insurance industry is that a centralized database at the provincial or even

federal level would have value, and have called for independent, science-based mapping that would be less subject to political influence. The industry's concern is that, in the absence of a clear directive from a senior level of government, municipalities would find it politically challenging to forbid local short-term economic development on lands newly identified as flood prone.

For its part, MNR has resisted leading or funding the update of floodplain maps, and Climate Ready did not contain a commitment to do so. Ministry staff acknowledge there are gaps in mapping but believe that conservation authorities are adequately empowered for the task, that some are in fact producing updated maps, and that municipalities can find ways to fund the work. This position is contrary to concerns raised by conservation authorities and the insurance industry about outdated floodplain maps. MNR's position also fails to address the needs of small municipalities not associated with conservation authorities and who do not have the capacity to undertake updated floodplain mapping on their own.

Missed Opportunities in the Review of the Provincial Policy Statement

Climate Ready committed the government to integrating climate change adaptation policies into the Provincial Policy Statement (PPS) – the touchstone document relied on by land use planners for provincial guidance and direction.

Climate change is explicitly acknowledged as an issue in the new PPS released in February 2014 by MMAH. A handful of scattered language changes now advise that planning authorities: "shall consider" impacts from climate change, "shall ... support climate change adaptation," and "should promote" green infrastructure. MMAH also added new direction on planning for stormwater management, but inexplicably omitted any reference to climate change in that section.

In the absence of new standards, targets, training and clearer direction from the Ministry of Municipal Affairs and Housing and other ministries, most communities will stick with familiar, business-as-usual approaches, especially if short-term costs are lower.

Requiring that municipalities "consider" climate change is an important first step. Unfortunately, it will not be nearly sufficient to make climate change adaptation a transcending theme for future land use planning, as was called for by the Expert Panel in 2009. The only other guidance that MMAH provides to municipalities on planning for climate change appears to be a four-page Infosheet produced five years ago. In the absence of new standards, targets, training and clearer direction from MMAH and other ministries, most communities will stick with familiar, business-as-usual approaches, especially if short-term costs are lower.

Stronger climate change direction could and should have been integrated into the 2014 PPS, especially considering that the document's next review is likely five to ten years in the future. For example, MMAH had the opportunity to:

- Require municipalities to identify infrastructure and lands vulnerable to climate change, just as the PPS 2014 now requires municipalities to identify growth and development areas and natural heritage systems;
- Not permit development in flood-fringe areas, especially in light of the fact that most floodplain maps do not reflect projected changes in precipitation patterns;
- Require that planning for stormwater management reflects changing precipitation patterns as already observed in many Ontario locations and as predicted by climate change models; and
- Roll out more detailed planning tools, guidance, outreach and training on climate change adaptation, as well as relevant performance measures and ongoing review, as the ministry had promised in Climate Ready.

On stormwater management and climate change, Ontario ministries have unfortunately not yet stepped up to their responsibilities.

ECO Comment

Ontarians count on the provincial government to provide leadership and direction when consistent, province-wide vision and regulation is needed, especially when public safety is at risk. Such provincial oversight has been offered – and even imposed – in the past. After Hurricane Hazel in 1954, the province directed conservation authorities to map floodplains and later the province, in conjunction with conservation authorities, developed regulations that could restrict development in these areas. Similarly, the Ontario government has provided direction over the last decade to protect the public and overhaul drinking water safety through the *Safe Drinking Water Act, 2002* and *Clean Water Act, 2006*.

The province's role to lead and set an overarching vision is also well established in land use planning through the *Planning Act* and the Provincial Policy Statement. The result has been more coherent and consistent public policy, and arguably, wiser stewardship of Ontario's public resources than municipalities would have achieved in isolation.

On stormwater management and climate change, Ontario ministries have unfortunately not yet stepped up to their responsibilities. In a number of areas, they have in fact stepped back from their own recent commitments. The ECO urges the province to clarify that strategic leadership and inter-ministerial co-operation is expected on this file. Necessary actions include:

- Ensuring that public infrastructure is assessed for its vulnerability to climate change;
- Updating the policy and approvals framework for municipal stormwater management in light of a changing climate;
- Creating a funding structure and an independent science-based process for updating floodplain maps; and
- Providing municipalities with the necessary tools, guidance and training to respond to a changing climate.

There are very real public safety and environmental implications if the Ontario government fails to act. There are also huge economic implications; without supporting and regulating climate change adaptation at the provincial level, the future costs of responding to extreme weather will be much higher. The province can choose to either support proactive planning now or pay disaster relief again and again. Extreme weather has become an inescapable new normal and provincial leadership is crucial if Ontario and its communities are to adapt. Treading water is no longer an option.

Ontario's greenhouse gas emissions 1990–2012 (**Source:** Environment Canada. National Inventory Report – Greenhouse Gas Sources and Sinks in Canada 1990–2012 (2014)).

Sources	Emissions (Mt CO_2e)		Change from 1990 to 2012		Sector contributions to 2012 total
	1990	2012	Mt CO_2e	%	%
Electricity	**25.5**	**14.5**	**-11 Mt**	**-43%**	**9%**
Transportation	**45.5**	**56.6**	**11.1 Mt**	**+24%**	**34%**
Road (passenger)	26.9	31.4			
Road (freight)	8.0	13.0			
Off-road (gasoline and diesel vehicles)	5.6	8.1			
Domestic Aviation	2.3	1.8			
Domestic Marine	0.9	1.0			
Rail	1.8	1.3			
Industry	**64.1**	**50.4**	**13.7 Mt**	**-21%**	**30%**
Fossil Fuel Refining	6.2	5.9			
Manufacturing	21.8	15.8			
Mineral Production (cement, lime, mineral products)	4.0	3.7			
Chemical Industry	11.0	0.2			
Metal Production (iron and steel)	10.9	10.1			
Fugitive Sources	1.2	1.5			
Other[1]	9.0	13.4			
Buildings	**26.3**	**28.6**	**2.3 Mt**	**+9%**	**17%**
Commercial and Institutional	9.1	10.8			
Residential	17.2	17.8			
Agriculture	**10.0**	**9.4**	**0.6 Mt**	**-6%**	**6%**
Enteric Fermentation	3.3	2.7			
Manure Management	1.6	1.5			
Agricultural Soils	5.1	5.2			
Waste	**6.0**	**7.5**	**1.5 Mt**	**+25%**	**4%**
Solid Waste Disposal on Land	5.5	6.9			
Wastewater Handling	0.2	0.3			
Waste Incineration	0.3	0.3			
TOTAL	**177**	**167**	**- 10 Mt**	**-6%**	**100%**

[1] 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.

Erratum

NOTE: Appendix 1 has been updated to make factual corrections.

The change in CO_2e emissions from 1990 to 2012 for Industry should be -13.7 Mt instead of 13.7 Mt.

The change in CO_2e emissions from 1990 to 2012 for Agriculture should be -0.6 Mt instead of 0.6 Mt.

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