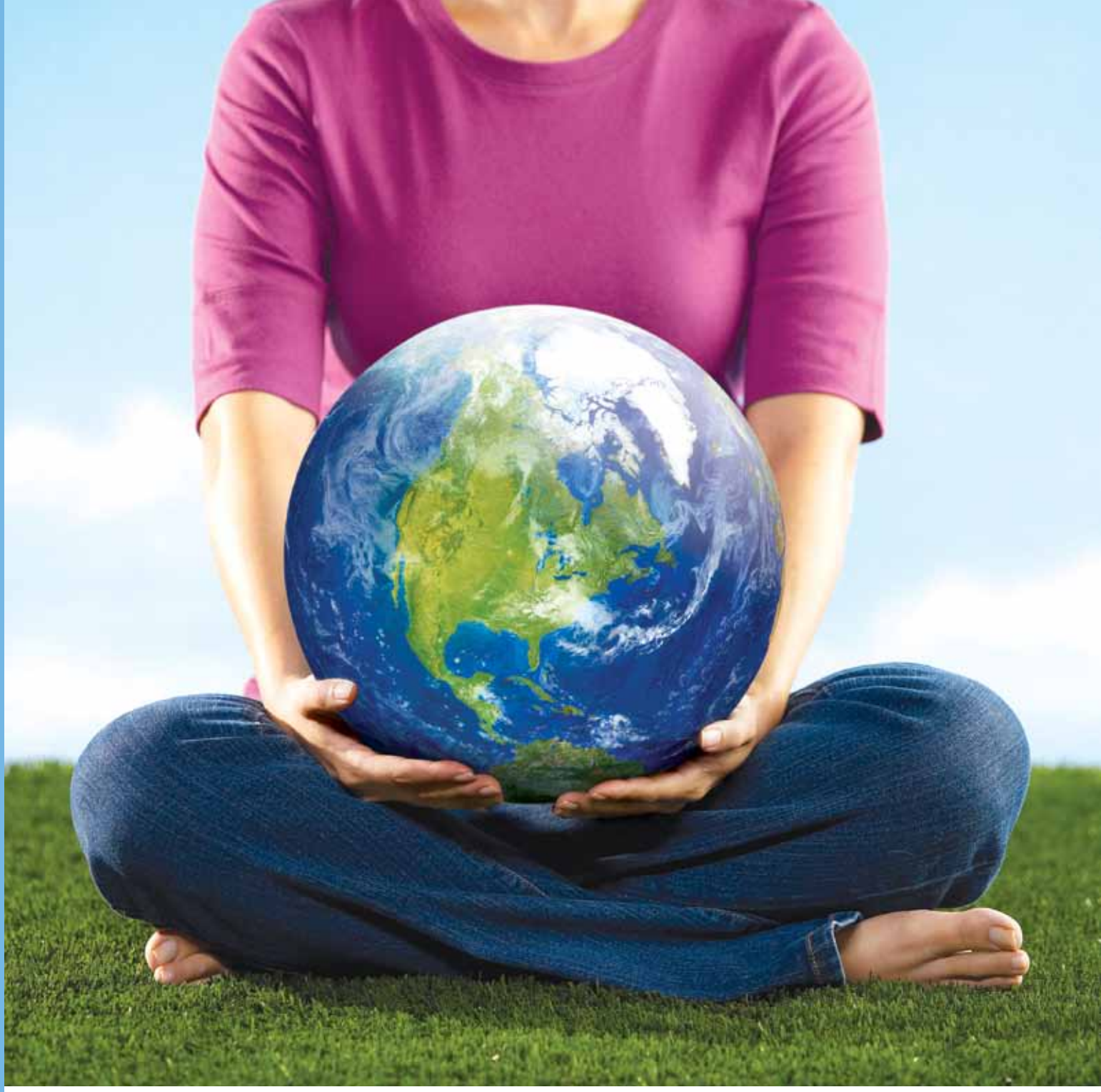

MEETING RESPONSIBILITIES: CREATING OPPORTUNITIES

Annual Greenhouse Gas Progress Report 2011

E C O
C E O
Environmental Commissioner of Ontario

Environmental Commissioner of Ontario

Commissaire à l'environnement de l'Ontario

Gord Miller, B.Sc., M.Sc.
Commissioner

Gord Miller, B.Sc., M.Sc.
Commissaire

May 2011

The Honourable Steve Peters
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 2011 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 2009-2010, and includes a review of its Climate Change Action Plan Annual Report 2009-2010 released in April 2011.

Sincerely,

Gord Miller
Environmental Commissioner of Ontario

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MEETING RESPONSIBILITIES

1.1 The ECO's Mandate

This report represents the Environmental Commissioner of Ontario's (ECO's) third Annual Greenhouse Gas Progress Report. Under the *Environmental Bill of Rights*, *1993*, the ECO is responsible for reporting annually to the Speaker of the Legislative Assembly of Ontario on the progress of activities in Ontario to reduce greenhouse gas (GHG) emissions. In fulfilling this mandate, the ECO is to review any annual report on GHG reductions or climate change published by the government in the year covered by the ECO report.

In previous years the government released its Climate Change Action Plan (CCAP) Annual Report at the end of the year, with the last report being issued in December 2009. Despite repeated commitments to report annually, the ECO notes with dismay that the government delayed the release of its CCAP Annual Report 2009–2010 until April 2011.

1.2 Setting the Context

Climate change policy is currently in a state of uncertainty. At the international level the global community has yet to agree on a treaty to succeed the Kyoto Protocol which expires in 2012. At the national level the federal government has chosen to harmonize its climate policy with that of the United States which, due to significant opposition from the Republican-controlled House of Representatives, remains in limbo. Provinces and states have attempted to fill the policy void through regional initiatives such as the Regional Greenhouse Gas Initiative and the Western Climate Initiative, but these are challenged by a lack of regulatory readiness on the part of participating jurisdictions and outright withdrawal of some states from these programs. A further discussion of these developments is contained in Appendix 1.

Despite this policy uncertainty, Ontario must remain firm in its commitment to reduce its contribution to global GHG emissions. Present climate change impacts (e.g, exacerbated droughts, floods, etc.) are predicted to worsen over the century if global GHG emissions continue to grow beyond 350 parts per million (ppm) – they are currently at 392 ppm.[1] A clear moral obligation is owed to future generations. Strong action must be taken today to address this challenge.

In the absence of sector targets, it is difficult to assess if the reductions being planned and achieved within a given sector are adequate or on track.

1.3 Sector Targets are Necessary to Track Progress

Ontario's total GHG emissions in 2009 were 165 megatonnes (Mt). This represents a decrease of 12 Mt (or 6.5 per cent) from Ontario's 1990 base year emissions of 177 Mt. The majority of this drop is due to decreased emissions in 2009 from electricity generation and reduced industrial activity due to the economic downturn.

The Ontario government has set three emissions reductions targets:

- 6 per cent below 1990 levels by 2014;
- 15 per cent below 1990 levels by 2020; and
- 80 per cent below 1990 levels by 2050.

These reduction targets represent overall totals. The contribution that each sector is expected to make to these total reduction targets is obscure because the government has not established sector-specific targets. If the mid-term 2020 target is met, it will likely result from larger proportionate reductions in some sectors compared to others. This is certainly true for the short-term 2014 target, where the bulk of reductions will come from phasing out the use of coal in the electricity sector.

In the absence of sector targets, it is difficult to assess if the reductions being planned and achieved within a given sector are adequate or on track. The current CCAP tools are not sufficient to meet mid- to longer-term targets. In order to achieve a cohesive plan, it would be wiser to break the plan down into sectoral targets so that progress in each area can be evaluated. With such targets in place the public, and the ECO, will be in a better position to determine what proportion each sector is anticipated to contribute and whether the individual initiatives within each sector are both sufficient and on track to achieve the three overall targets.

Sector targets would also benefit the government in terms of its monitoring and evaluation functions. Sector targets can confirm the efficacy and absolute benefit of existing sector initiatives, assist with the development of new ones ('policy learning'), while enhancing and confirming accountabilities for achieving results ('performance management').

By acting now to introduce a carbon price, the government will provide time for individuals, businesses and municipalities to adjust without imposing significant near-term economic impacts.

1.4 Decoupling Emissions from Growth

According to its CCAP Annual Report 2009–2010, the government has not altered its disappointing projection from last year that neither the 2014 nor the 2020 targets will be met. GHG emissions, which were 200 Mt in 2007 (the initial year of the CCAP) dropped to 190 Mt in 2008. The most recent federal National Inventory Report indicates that Ontario's emissions took a precipitous decline to 165 Mt in 2009. This volume is more than six per cent below the restated 1990 base year amount of 177 Mt, which at first glance makes it appear that the 2014 target has been met five years in advance. One has to be cautious of this interpretation, however, as these recent declines are, in large part, attributable to the economic recession. With economic growth predicted to resume in the years ahead, the challenge of meeting Ontario's first two targets will become more acute.

Meeting this challenge will require Ontario to further decouple its GHG emissions from provincial economic activity, as measured by gross domestic product (GDP). GHG emissions measured in terms of each dollar of economic output (i.e., emissions intensity) have decreased over the past two decades, which is encouraging. In 1990, Ontario emitted about 530 grams of CO_2 per dollar of GDP (g CO_2/$GDP). By comparison, the 2009 federal data indicates that the relationship between emissions and GDP had improved to 320 g CO_2/$GDP. In 2009, the Ontario economy contracted by 3.6 per cent[2] so one would expect a corresponding reduction in overall emissions, which is what the data shows.

The economic contraction of 2009, due largely to a substantial slowdown in the industrial sector, is in the process of reversing. The economy grew by an estimated 2.8 per cent in 2010 and is projected to grow by a further 2.4 per cent in 2011.[3] As industrial output rebounds overall emissions can be expected to grow, but even if one assumes that the emissions intensity of 320g CO_2/$GDP can be maintained, the challenge of meeting the 2014 target is considerable. The extrapolated economic growth, even at that low intensity, will add approximately 23 Mt to Ontario's tally. Eliminating the use of coal by the end of 2014 has the greatest potential for reductions, but even the net reductions associated with coal phase out (because of the expanded use of natural gas peaking plants) will only represent about 10 Mt, leaving about 13 Mt still on the table. The tools required to achieve a much larger reduction have yet to be identified by the government.

The problem associated with a shortage of tools to decarbonize the economy gets more acute as the timeline extends beyond 2014 to the 2020 target of 150 Mt. The challenge of an expanding economy necessitates even greater restructuring and innovation. The government's CCAP Annual Report 2009–2010 clearly indicates that emissions are projected to rise during the 2014–2020 period due in part to the shift back to natural gas during the lag when older nuclear facilities are retired and not yet replaced by new construction. At this time there is no plan, mechanism or tools in place that would allow the 2020 target to be met.

1.5 Pricing Carbon in the Economy

One of the stated goals of the government's CCAP is to pursue initiatives that will support the transition to a low-carbon economy. The ECO believes this will only happen if the cost associated with the release of GHGs into the atmosphere is reflected in the price of goods and services bought and sold in Ontario. The ECO remains agnostic on the instrument used to establish this carbon price – whether it is through a tradable permit system (i.e., cap-and-trade) or via a carbon fee or tax. While public acceptance of higher energy prices is often perceived as a political barrier to climate policies, both the general public and major industry associations support the implementation of a carbon price.[4 5]

The government has been working with other provinces and U.S. states through the Western Climate Initiative to establish a regional cap-and-trade program that is to launch in January 2012. In December 2009, Ontario laid the foundation to participate in a regional cap-and-trade system through two pieces of enabling legislation. Bill 185, the *Environmental Protection Amendment Act (Greenhouse Gas Emissions Trading)*, *2009* amended the *Environmental Protection Act* to allow GHG emissions trading, and Ontario Regulation 452/09 – Greenhouse Gas Emissions Reporting, made under the *Environmental Protection Act*, requires facilities emitting more than 25,000 tonnes of CO_2 equivalent (CO_2e) per year to begin reporting their emissions in 2011. In April 2011, however, the government indicated that it would not participate in the initial launch of the Western Climate Initiative cap-and-trade program because of economic competitiveness concerns and a lack of verified emissions data.

The ECO believes that policy delay in Ontario will likely result in higher overall costs to meet the 2020 target.[6] By acting now to introduce a carbon price, the government will provide time for individuals, businesses and municipalities to adjust without imposing significant near-term economic impacts. According to the National Round Table on the Environment and the Economy, a moderate carbon price of $30 would only reduce Ontario's GDP growth by 0.1 per cent per year between now and 2020.[7] Thus it is important that the government push forward with the development of a carbon pricing policy.

However, putting a price on carbon does raise concerns. Issues surrounding carbon leakage and so-called "trade-exposed industries" will need to be addressed and the ECO discusses potential options in Appendix 2 that should be considered in the interests of broadening Ontario's climate change policy agenda. The bottom line is that the ECO believes these issues are manageable going forward and that the time to act is now. The longer Ontario waits for other jurisdictions to move, the longer the transition to a low-carbon economy will be delayed and the higher will be the costs of this transition.

1.6 Transportation GHGs

The transportation sector contributes the largest volume of GHG emissions in Ontario (56.8 Mt or 34 per cent) with the bulk of emissions resulting from gasoline combustion for personal vehicle use. According to the government's CCAP Annual Report 2009–2010, several provincial and one federal initiative will result in only a 3.0 Mt reduction in transportation emissions by 2020. (The ECO notes that last year's projection was that transportation initiatives would result in an 8.1 Mt reduction.) Given the magnitude of the total reductions necessary, this projected reduction is unambitious and disappointing.

Over the past year, the government's climate change mitigation tool box actually shrank. Some programs, such as the Green Commercial Vehicle Program, the Ontario Bus Replacement Program, and certain tax measures designed to incent fuel-efficient vehicle purchases, quietly came to an end. Others remain in place but, as discussed in detail in Appendix 3, significantly more effort will be required to address this large, and growing, source of emissions. Not only does the government need to strengthen the tools that are currently in place, more tools must be added to the transportation GHG reduction toolkit, particularly with regard to land-use planning to curb urban sprawl and the expansion of public transportation options.

There appears to be only two choices: accept more traffic and greater congestion as inevitable; or do something about regulating the demand by putting in place the price signals that can help reduce congestion…Simply ignoring road pricing as a possible option for the transportation toolkit does not reflect leadership.

The manner by which current and future communities are developed implicitly "locks in" a particular future emissions curve. The trajectory of that curve depends upon the land-use planning choices that are made today. Increased intensification of already built-up areas and high-density development contributes to achieving a lower-emissions pathway. In the most densely populated region of the province, the Growth Plan for the Greater Golden Horseshoe, 2006 reflects a laudable vision for more mixed use, compact communities. However the targets set to achieve this goal are too weak and do not represent much more than business-as-usual development. As such, the ECO is concerned that the current targets are not sufficiently rigorous to combat the inexorable rise in GHG emissions created by future development.

Complementing stronger land-use intensification targets is the necessary expansion of attractive public transportations options. In the Greater Toronto and Hamilton Area (GTHA) – the area where most of Ontario's problem traffic is concentrated – the government has, through Metrolinx, made significant progress by developing a 25-year, $50-billion Regional Transit Plan (RTP). Implemented in conjunction with strong land-use planning policies, the RTP has the potential to reduce GHG emissions over the long term by decreasing vehicle kilometres travelled.[8] The key barrier to its full implementation, however, is a lack of adequate and secure funding. Metrolinx is exploring funding mechanisms to close the investment gap and is expected to provide recommendations by 2013. The ECO sees an urgent need for these recommendations to be completed sooner than 2013 in order to confirm Metrolinx funding sources and amounts.

Road pricing must be part of this dialogue. Traffic congestion imposes huge costs on the environment and public health, not to mention the economy. Simply put, there are too many single-passenger vehicle trips being made. Building more roads to accommodate more vehicles is not an option that works. With a projected 7 per cent increase in the number of passenger vehicles in the province by 2020 the problem will continue to grow unless we fundamentally shift the manner by which we move people and goods within the GTHA. There appears to be only two choices: accept more traffic and greater congestion as inevitable; or do something about regulating the demand by putting in place the price signals that can help reduce congestion. While there may be technical and public acceptance barriers, the ECO does not believe these to be insurmountable. A consultation process, followed by a time-limited pilot project, could help to analyze the strength of any perceived barriers and determine ways forward. Simply ignoring road pricing as a possible option for the transportation toolkit does not reflect leadership.

Given methane's significantly higher short-term global warming potential, the prevention of fugitive methane emissions from landfills should become a near-term policy priority.

Apart from the GTHA, other aspects of transportation require a re-think. In particular, traffic volumes and domestic air travel along the Quebec City – Windsor corridor have grown dramatically over the years, with GHGs increasing in lockstep. Previous studies have shown that significant emissions reductions would result from implementing a high-speed rail system. Yet another study was commissioned in February 2009, but two years later, no results are available. This is disappointing. The benefits and opportunities associated with high-speed rail have long been studied. It is now time to move forward.

1.7 Near-term Risk and Opportunities

It is common to discuss policy responses to climate change in the same long-term context that the impacts of global warming are presented by scientists, typically over a 100-year period. This creates the impression that we have a long response time and that there is no requirement to act immediately. However, there are good reasons to be concerned about what happens over the 'near term'. This presents a serious risk; however the ECO believes that several opportunities have considerable promise as near-term mitigation tools.

The risk over the near term arises from 'tipping-points' in atmospheric GHG concentrations. Once these concentration levels are exceeded, certain biogeochemical processes can be triggered and feedback cycles may be created that drive the planet to a severely altered climate state beyond human control. One example of a feedback cycle is the thawing of permafrost. Vast quantities of methane gas are trapped in northern permafrost and, as temperatures increase, more of this gas will be released. Given the short life span of methane, and its potency, any additions of GHGs or other positive radiative forcings are more dangerous now than they would be in 50 years.

One near-term opportunity, however, is provided by a constituent of the atmosphere that is not a GHG but is nonetheless an important source of positive radiative forcing. That material is the portion of tiny suspended soot particles in the atmosphere collectively termed black carbon aerosols. They are created and emitted by various kinds of combustion of organic fuels, not the least of which are diesel engines. The nature of the opportunity is described in Appendix 4. Also discussed in this appendix are two soil carbon mitigation opportunities.

1.8 Landfill Methane

Methane (CH_4) is a powerful GHG[9] and landfills are the largest source of this gas in Ontario. Landfills have historically contributed 3 to 4 per cent of the province's annual GHG emissions. Although the diversion of organic waste from landfills is the most effective way to reduce methane emissions from these sources,[10] most of this waste still ends up in landfills and, as a result, methane emissions from this source have grown between 1990 and 2008. Ontario set a target to achieve a 60 per cent solid waste diversion rate by 2008, but reported in 2009 that only 22 per cent was being diverted.[11] Up to one-third of these wastes consist of organic discards such as food scraps, paper, textiles and yard trimmings.

This low diversion rate is problematic, especially given that the Ministry of the Environment (MOE) may be underestimating landfill methane's contribution to Ontario's GHG inventory by several orders of magnitude. As discussed in Appendix 5, this is a function of current landfill gas emissions models that significantly *overestimate* landfill gas control system collection efficiencies, and thus grossly *underestimate* uncontrolled, fugitive methane releases into the atmosphere. Given methane's significantly higher short-term global warming potential, the prevention of fugitive methane emissions from landfills should become a near-term policy priority.

Complicating this picture of underestimated emissions is a regulatory framework for GHG emissions from landfills with conflicting priorities. In the space of just over two years, the Ontario government has: 1) stated a preference for using landfill methane for energy production;[12] 2) introduced regulatory amendments to require the installation of methane capture in smaller capacity landfills;[13] and, 3) introduced a policy proposal to divert organics away from landfills.[14]

These apparently divergent landfill policy directions beg the question: What is the government trying to accomplish? Is it the control of GHGs? Is it energy production? Is it the stabilization of landfills to limit their contaminating lifespans? Or, is it the diversion of organics away from landfills altogether? Are these goals and objectives compatible? To the extent that they require substantially different landfill design parameters and operating requirements, the ECO believes that they are *not* compatible.

Viable management options to reduce GHG releases from existing wastes-in-place are urgently required. There are well-established alternatives to landfilling for new organics – including composting, anaerobic digestion, and thermal conversion technologies (such as pyrolysis) – that do not create uncontrolled methane releases. But, there is no real alternative when it comes to existing wastes-in-place – these must be managed to reduce GHG releases.

Energy production in existing landfills requires major modifications to landfill management that may actually increase the escape of fugitive methane emissions. The promotion of this option also sends mixed signals to municipal owners and operators of landfills – with the unintended consequence of erecting marketplace barriers to more effective mitigation options such as diversion. The ECO believes that landfills should be managed so that they are as biologically inactive as possible to prevent the release of methane into the environment. Diversion will always produce greater GHG reduction benefits, regardless of the assumptions used.

The government must move quickly to develop a solid waste management strategy that clarifies how existing wastes-in-place will be treated while, on a go-forward basis, articulating the timing and commitments to ensure that all future organics are prohibited from landfills.

1.9 Governance and Transparency

The ECO's Annual Greenhouse Gas Progress Report 2008/2009 stressed the importance of transparency and requested details as to how the government's GHG emissions forecasting is undertaken, how emission reductions are tracked, to what sector or initiative they are attributed and how monitoring of CCAP results are verified. Our report stressed the need for transparency in the *governance process* that drives and enables these activities.[15]

Previously, the government indicated that the Climate Change Secretariat (CCS) played a lead role in this regard. The CCS was to co-ordinate government-wide efforts on climate change[16] and track progress – a role the ECO endorsed. The CCS reported progress in CCAP design and implementation to a Climate Change Action Committee (CCAC) chaired by the Minister of the Environment and made up of key deputy ministers whose policy decisions were influential to the achievement of the Action Plan's objectives and targets (i.e., transportation, natural resources, industry and northern development).

It is of concern to the ECO that the public, and other important environmental stakeholders, were left unaware of a significant change in the climate change governance structure until the release of the most recent climate report.

Further, the ECO understood that CCAC decisions and recommendations were channeled through the Secretary of the Cabinet to the Cabinet and Premier. These recommendations were to be informed by contributions from the Premier's Climate Change Advisory Panel – an entity also endorsed by the ECO. The ECO felt that the Panel could become more visible in its role as a champion for the identification of innovative low-carbon technologies and policies.[17]

The government's CCAP Annual Report 2009–2010 has revealed a new climate change governance model that apparently does not include either the CCS or the Climate Change Action Committee. The tracking and monitoring functions previously performed by the CCS have now been assumed by a newly formed Climate Change Results Table chaired by the Minister of the Environment. Rather than the deputy ministers, who have the technical expertise and continuity of purpose to identify and champion new initiatives, the members of this Table include ministers of departments that have a role in policy or programming for sectors such as transportation, energy, industry and innovative new technologies.[18] The Results Table is, in turn, co-ordinated by a team within Cabinet Office.

It is of concern to the ECO that the public, and other important environmental stakeholders, were left unaware of a significant change in the climate change governance structure until the release of the most recent climate report. It is therefore ironic to see this new governance model described under a heading entitled "Ensuring Transparency and Progress". The governance process and accountabilities to deliver program results are not discussed; nor is there any discussion or elaboration on how climate change considerations will be incorporated into ministry business plans and decision-making.

A final concern is one relating to process. The ECO's statutory requirement is to report to the Speaker of the Legislative Assembly on the progress of activities to reduce GHG emissions and review any annual report on GHG reductions published by the government. In previous years these reports were released in December. By shifting our reporting date to the spring, the ECO had tried to ensure that we had sufficient time to review and consider the government's results before we submitted our report to the Speaker. This year the government delayed the release of its annual report until April 2011. By failing to provide its annual report in a timely manner, the government has denied the legislature, the public and the ECO the opportunity to assess the government's progress and to evaluate the full transparency and thoroughness of its plan. The delivery of such information past the eleventh hour frustrates the ECO's ability to fulfill our duty to report to the Speaker and the public.

As the economy recovers from the recession and continues to grow, the government will need to pursue further tools to ensure that GHGs do not continue to grow with the economy.

1.10 Moving Forward

The government's climate change mitigation actions announced to date do not appear to match the commitments it has made in previous public documents. The government's CCAP calls for absolute reductions across the entire economy that will contribute to milestone targets at 2014, 2020 and 2050. However, beyond firm and measurable reductions in the electricity sector, the most recent report provides very little intelligence as to how other sectors will contribute to these reductions. Sector targets are needed to monitor the government's progress and assure the public that the government's plan is on track. The need for transparency and metrics is especially strong when one recognizes that the industrial and transportation sectors were responsible for 61 per cent of Ontario's 2009 GHG emissions.

As the economy recovers from the recession and continues to grow, the government will need to pursue further tools to ensure that GHGs do not continue to grow with the economy. The ECO has identified numerous studies[19] that support putting a price on carbon as a key tool in helping to decouple GHG emissions from GDP growth. Industry supports the pricing of carbon and is demanding that this happen sooner rather than later.

The ECO is also concerned about the apparent lack of engagement from key ministries and their deputy ministers in the assessment of climate mitigation risks and opportunities. For example, the uncritical acceptance of – and disjointed management policies relating to – landfill design and operation must be changed. Further, the significant near-term opportunities related to the reduction of black carbon aerosols and the longer-term management of agricultural soils for carbon sequestration must become key components of the government's climate change mitigation plan. These opportunities are nowhere to be seen in the government's most recent CCAP Annual Report or in any other ministry documents or research of which the ECO is aware. This is distressing when their significant near-term climate mitigation benefits, as described in this report, are so promising.

The ECO explores these examples of 'creating opportunities' in the appendices that follow.

1.11 Recommendations

1. The ECO recommends that the Ontario government establish sectoral GHG reduction targets that will allow the government, the public and the ECO to determine the efficacy of current and future Climate Change Action Plan initiatives towards achieving the government's overall 2014, 2020, and 2050 targets.
2. The ECO recommends that the Ontario government establish a price on carbon as soon as possible to hasten the transition to a low-carbon economy.
3. The ECO recommends that the Ontario government investigate and publicly report on the potential for soil carbon sequestration as a GHG mitigation strategy.
4. The ECO recommends that the Ontario government review its assumptions regarding landfill design and operational requirements and their contribution to the release of fugitive methane emissions and publicly report on the results of this review.

CREATING OPPORTUNITIES

Appendix 1
Jurisdictional Overview

1.1 International

The Kyoto Protocol is the only international agreement with legally binding GHG emission reduction targets for industrialized countries. The first commitment period, which began in 2008, expires in December 2012. While the international community made some progress at the most recent meetings in Cancun, Mexico on climate financing mechanisms and transparency in the reporting of national climate commitments and actions, it has still yet to reach an agreement with binding post-2012 GHG reduction targets for both developed and developing countries.

1.2 United States

In June 2009, the U.S. House of Representatives narrowly passed comprehensive energy and climate legislation that included an economy-wide cap-and-trade program. Ultimately, the initiative stalled in the Senate because of a lack of bipartisan support. Following the November 2010 midterm elections, in which the Republican Party retook some control of Congress, it is unlikely that such legislation will re-emerge soon.[20]

Federal climate policy development has continued however with the U.S. Environmental Protection Agency (EPA) using its authority to regulate GHGs as air pollutants under the *Clean Air Act* to legislate reductions from vehicles and new industrial facilities. New rules also require large emitters to collect and report their GHG emissions for the calendar year 2010 and beyond. This requirement will apply to approximately 10,000 facilities that are responsible for 85 per cent of the country's GHG emissions.[21] The EPA's authority to regulate GHG emissions is currently being challenged by Republicans within the House of Representatives, and so the success of this legislative avenue of climate policy remains uncertain.

1.3 Federal

Canada's reduction targets have undergone several revisions over the past few years. Under the 2002 Kyoto Protocol, Canada's commitment was to reduce GHGs by 6 per cent below 1990 levels by 2012. In 2007, the government subsequently 'recalibrated' its target by calling for reductions of 20 per cent below 2006 by 2020. Following its decision in 2009 to harmonize its climate policy with the U.S., the federal government once again changed both its target and baseline year – the commitment now is for a 17 per cent reduction over 2005 levels by 2020. In absolute terms, this now means that Canada's emissions will be about 5 per cent higher in 2020 than they would have been had the target set in 2007 been kept.[22]

Along with an aligned target, the federal government intends to harmonize its climate policies with the U.S. In this regard the government has indicated its intention to adopt a cap-and-trade system if the U.S. moves forward on this front.[23] The Canadian government has also stated its intention to align emission reduction activities and, in the transportation area, has recently done so with regard to light vehicle emissions standards.

1.4 Regional Carbon Markets

Given federal inaction, several Canadian provinces and American states have attempted to fill the void through regional climate policy networks. The Western Climate Initiative (WCI) is one such example of various jurisdictions working collectively to implement complementary GHG reduction policies. A central component of the WCI is the development of a cap-and-trade system that is scheduled to begin in January 2012. Three of the eleven original jurisdictions have indicated their readiness to begin at that time (California, British Columbia and Quebec), however participation is uncertain given the recent launch of a California court challenge[24] and a new provincial government in British Columbia. In April 2011, the Ontario government announced that it would delay participating in the WCI due to a number of outstanding policy issues. Particularly lacking is verified emissions data from regulated facilities upon which to base the provincial carbon budget and allowance allocations.

In April 2011, the Ontario government announced that it would delay participating in the WCI due to a number of outstanding policy issues.

The Regional Greenhouse Gas Initiative (RGGI) began as the first GHG cap-and-trade program in North America in 2005. Focused on the power sector, RGGI's goal is to reduce emissions 10 per cent by 2018. All RGGI emissions allowances have been auctioned by regulators with revenues earmarked to finance renewable energy and energy efficiency projects. Ten northeastern U.S. states are currently involved; however both New Jersey and New Hampshire have recently indicated their possible withdrawal. A third regional cap-and-trade program that was in development – the Midwestern Greenhouse Gas Reduction Accord – has been abandoned by the U.S. states involved.[25]


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Appendix 2
Pricing Carbon in the Economy

2.1 Introduction

The ECO believes that Ontario's transition to a low-carbon economy will only happen if the cost associated with GHG emissions is reflected in the price of goods and services. While Ontario's CCAP envisions the creation of green jobs and the transition to a low-carbon economy, nowhere is the role that carbon pricing can play in this regard explicitly articulated.[26] A key perceived barrier to the implementation of a carbon price is that increased costs will put Ontario's industry at a competitive disadvantage and thus have negative economic impacts.

2.2 Wanted: Price Discovery

While the Ontario government has made a number of statements and taken steps toward developing a provincial cap-and-trade system (e.g., passing cap-and-trade enabling legislation)[27], important pieces, such as an allowance registry and auction platform are not in place. Furthermore, the government has yet to put forward regulations regarding the generation of offset credits in the province, and has recently announced that it lacks the verified emissions data upon which to base its carbon budget and allocation of allowances.[28] This leaves a considerable degree of uncertainty as to when such a system will be up and running and what the final design will deliver in terms of GHG reductions.[29]

2.3 Going It Alone: Implications for Ontario

The Ontario government is sensitive to the potential impacts of cap-and-trade on industrial competitiveness and the challenges this presents to harmonizing climate change policy with the Canadian federal government and with its major trading partners. In the context of a hypothetical national cap-and-trade program with weaker federal government targets, Ontario's relatively more ambitious emission reductions could compensate for increased emissions in other provinces. This emissions leakage between Canadian provinces could negate some of the climate change benefits of Ontario's actions.

Under a policy of U.S.-Canada alignment based on harmonized emission reduction *targets*, key differences in the emissions profiles of the two countries could result in higher costs for Ontario. This is because, Ontario notwithstanding, Canadian GHG emissions are rising at a faster rate than they are in the U.S. and in sectors with high abatement costs (i.e., oil sands). Thus, while the U.S. should be able to meet its 2020 target through relatively inexpensive abatement in the electricity sector (i.e., fuel switching from coal to natural gas and energy efficiency), reaching Canada's target will require reductions across a wider range of sectors where abatement technologies are much more expensive (i.e., carbon capture and storage for oil sands upgrading).[30] Thus, a higher carbon price is required to reach the same GHG reduction target in Canada which could increase the compliance costs for Ontario industry relative to competitors in U.S. states.

A policy of alignment based on harmonized carbon *prices* between Canada and the U.S. would address several interrelated issues, including threats to the competitiveness of trade-exposed industries.[31] Linking systems based on price is a mixed blessing for Ontario. Lower carbon prices weaken the incentive to invest in the carbon-reducing technologies necessary to achieve Ontario's 2020 target.

It is in this context that the rationale for Ontario to act now to put in place a strong carbon price is compelling. The deployment of low-carbon technologies, facilitated through a strong carbon price signal, will stimulate employment and have minimal impacts on overall economic growth (see Table 1).[32] Furthermore, acting in advance of other provinces and respective federal governments should provide Ontario with more leverage in negotiating the design of a carbon pricing program that acknowledges its early actions.

The deployment of low-carbon technologies, facilitated through a strong carbon price signal, will stimulate employment and have minimal impacts on overall economic growth.

Table 1 Carbon Pricing/GDP Impacts

	Policy Scenario		Forecasted Average Annual GDP Growth, 2005–2020						
	Canadian carbon price in 2020	U.S. carbon price in 2020	BC	AB	SK	MN	ON	QC	AT
Reference case	$0/tonne	$0/tonne	2.3%	2.1%	2.3%	2.1%	2.3%	1.8%	1.7%
Transitional policy option if U.S. implements Waxman-Markey	$63/tonne	$33/tonne	2.2%	1.9%	2.2%	2.2%	2.2%	1.8%	1.6%
Transitional policy option if U.S. does not implement policy	$30/tonne	$0/tonne	2.2%	2.0%	2.2%	2.1%	2.2%	1.8%	1.6%

Source: National Round Table on the Environment and the Economy, 2011.

2.4 Managing Carbon Leakage

Industries that produce internationally traded commodities, such as cement, iron and steel, are emissions intensive. As such, their competitiveness can be reduced if a domestic carbon cost is added to their cost of production. Carbon leakage can, therefore, result either through a firm relocating to a jurisdiction with lower effective carbon costs or through substituting product from an unregulated jurisdiction.

The ECO believes that there are greater risks in waiting and that policy options are available to deal with the issues of competitiveness and carbon leakage over the near to medium term.

There are two basic options for mitigating the risk of carbon leakage within exposed sectors: leveling down carbon prices through the free allocation of permits or investment subsidies, or leveling up carbon costs through a border carbon adjustment (BCA) on imports. While free allocation has been favoured in cap-and-trade programs, it may not effectively deter leakage if a facility can economically reduce output and sell surplus allowances. It may also shift the burden of reductions to other sectors. As a result, it will be important to be selective about which sectors are deserving of free allowances[33] to avoid the scenario where such actions detract from industry's preparations for a longer-term transition to a low-carbon economy.

Reduced domestic output that results in greater imports from unregulated jurisdictions compromises the environmental effectiveness of a carbon pricing policy. In this situation a facility could generate windfall profits from allowance sales while doing little to reduce the emissions leakage that policymakers were seeking to avoid. A more effective solution from the perspective of economic and environmental efficiency is to level up the carbon costs on imported products through a BCA. Such an approach is particularly suitable for the cement sector where a homogenous product allows for a BCA benchmarked to the best-available-technology (e.g., dry kiln technology).[34] With respect to steel, the heterogeneity of product and process along with the significant economic value of internationally traded steel make the establishment of a BCA technically and politically challenging. Thus free allocations, with a gradual transition towards a BCA or preferably a global sectoral agreement, might be preferable.

2.5 Conclusions

Industry and the wider public need a clear price signal to guide current economic development in a manner that is less GHG intensive. The province cannot afford to wait until all uncertainty is minimized. The ECO believes that there are greater risks in waiting and that policy options are available to deal with the issues of competitiveness and carbon leakage over the near to medium term.

Appendix 3
Transportation

3.1 Climate Change Action Plan Initiatives

The government's CCAP Annual Report 2008–09 provided specific reduction estimates for five initiatives that focused on changing vehicle technologies and using cleaner fuels. Two other initiatives were focused on reducing the number of vehicle kilometres travelled (VKT) in the province. Several other transportation-related initiatives were included in the report, but no emissions reductions numbers were provided for these activities.[35] (This information is contained in Table 2.)

In the government's more recent CCAP Annual Report 2009–2010, the projected emissions reductions associated with transportation-related initiatives have not only been significantly reduced, they have also been presented as an aggregated total (see Table 3). The ECO can only assume that the reduced estimates are a function of revisions that have been made to provincial modeling, as well as a reflection of the economic downturn. Given the magnitude of reductions that are necessary in this sector, these new projections are underwhelming, to say the least.

Secondly, by presenting the projected transportation reductions as an aggregated total, it is virtually impossible to determine what contribution each initiative is projected to make toward the overall total. The ECO is disappointed that the government has chosen to present the data in this much less transparent manner. In the future, the ECO would urge the government to report both initiative and sector-specific totals.

Rather than adding any new tools to the transportation toolkit, this year's report indicates that the number of tools has actually been reduced. This is disappointing given the challenge that the province faces in reducing emissions from this sector.

Table 2 Transportation Initiatives and Emissions Projections as per the Climate Change Action Plan Annual Report 2008–09

Initiative	2014 Estimate (Mt)	2020 Estimate (Mt)
Conversion to Electric Buses	0.06	0.16
Ontario Bus Replacement Program & Public Transit Commitments	0.7	1.1
Fuel Efficiency Standard (GHG Emissions Standard) – Federal Initiative	2.24	5.45
Green Commercial Vehicle Program/ Anti-Idling Retrofits	0.02	0.02
Heavy Truck Speed Limiters	0.26	0.26
Places to Grow Act – Growth Plan for the Greater Golden Horseshoe	0.11	0.34
The Big Move	0.14	0.77
TOTAL	3.53	8.1

Rather than adding any new tools to the transportation toolkit, this year's report indicates that the number of tools has actually been reduced. This is disappointing given the challenge that the province faces in reducing emissions from this sector.

Table 3 Transportation Initiatives and Emissions Projections as per the Climate Change Action Plan Annual Report 2009–2010

Initiative	2014 Estimate (Mt)	2020 Estimate (Mt)
The Big Move and Growth Plan for the Greater Golden Horseshoe	N/A	N/A
Passenger vehicle efficiency regulations (GHG Emissions Standard) – Federal Initiative	N/A	N/A
Freight truck speed limiter regulation	N/A	N/A
Hybrid buses and Green Commercial Vehicle Program	N/A	N/A
TOTAL (as provided)	0.4	3.0

N/A – No data available

Public Transit Initiatives

Two initiatives identified within the CCAP Annual Report 2008–09 to reduce emissions from public transit were a $180.1-million electric bus conversion program and the Ontario Bus Replacement Program (OBRP), in conjunction with other transit funding. The OBRP was put in place in 2002 and allowed municipalities to purchase vehicles with lower GHG emissions. These programs were estimated to account for 0.16 Mt and 1.1 Mt of GHG emissions reductions by 2020 respectively. Along with reducing GHGs, the OBRP was expected to improve frequency and reliability, especially at peak hours.

The challenge, however, is that funding is being reduced and some initiatives may be delayed or cancelled. For example, the 2010 provincial budget cancelled the OBRP,[36] and now funds to replace aging buses will have to come from the same pot of money (the Gas Tax Fund) that already supports municipal transit. Within the most recent report, there is no mention of the OBRP, nor whether any emissions reductions calculations were conducted for this program.

The Growth Plan for the Greater Golden Horseshoe thus allows the majority of future growth to be located on previously undeveloped land which exacerbates urban sprawl.

Federal GHG Emissions Standards for Passenger Automobiles and Light Trucks

Since personal vehicles account for about 57 per cent of Ontario's transportation emissions,[37] strong fuel efficiency standards have the capacity to reduce GHG emissions substantially. In October 2010, the federal government finalized regulations which establish GHG emission standards for new passenger automobiles and light trucks for the 2011 to 2016 model years. At the same time, the federal government signaled its intention to develop more stringent standards for post-2016 models.[38] This initiative is estimated to result in a Canada-wide reduction of 2.5 Mt by 2012.[39] Within Ontario, the provincial government last year projected that this initiative would result in a 2.24 Mt reduction by 2014 and a 5.45 Mt reduction by 2020 – the second largest reductions of all initiatives proposed after phasing out coal use.[40] Given the manner by which projected reductions have been reported this year, it is impossible to determine if this initiative is still viewed as the second largest tool in the toolkit.

Green Commercial Vehicle Program/Anti-Idling Retrofits

Launched in November 2008, this $15-million program provided grants to support the purchase of low-GHG-emitting commercial vehicles (i.e., hybrid, electric, propane or natural gas fuelled). As well, grants were also provided to support the purchase of anti-idling technologies (such as accessory power units, cab heaters and cab coolers) for heavy-duty vehicles. Although the program was scheduled to run for four years, the Ministry of Transportation (MTO) has recently stopped accepting applications to the program[41] and all information regarding the program has been removed from MTO's website.

As well, the disbursements of grants under the alternative fuel vehicle element of the program were less than anticipated due, in large part, to the economic slow-down. Given both of these variables, and until the government releases verified numbers, the ECO assumes that actual reductions from this program will be less than had been estimated.

Heavy Truck Speed Limiters

Through changes made to the *Highway Traffic Act*, trucks operating in Ontario are required to operate electronic devices that limit maximum speeds to 105 km/hour. This change ensures that heavy trucks do not operate at higher – and less fuel-efficient – speeds. The government projects that the program will save 100 million litres of fuel per year, and 280,000 tonnes of GHGs.[42] The success of this program could be compromised by non-compliance rates which have been quite high in other jurisdictions with similar policies.[43] Preliminary data suggests that

the non-compliance rate in Ontario may be around 13.6 per cent, or about one in seven trucks.[44] While no results have yet been released regarding the GHG reductions associated with this initiative, the reductions will likely be lower than projected if the projected numbers assumed 100 per cent compliance – an issue previously raised by the ECO. The ECO expects that a GHG verification process would take account of the actual compliance rates.

Places to Grow Act, 2005 – Growth Plan for the Greater Golden Horseshoe

The Greater Golden Horseshoe – a region that extends roughly from Niagara Falls to Georgian Bay to Peterborough – is one of the fastest growing regions in North America. Home to approximately two-thirds of the province's population, it is projected that an additional 3.7 million people will settle in this region by 2031. To cope with the projected population and economic growth over the next few decades, the Ontario government enacted the *Places to Grow Act, 2005* to provide a legal and policy framework to facilitate the development and amendment of growth plans for different regions.

The Growth Plan for the Greater Golden Horseshoe (the Plan), the first issued under the Act, represents an overarching framework that prescribes where and how growth will occur in the region until 2031. With a broad vision to curb urban sprawl and its attendant effects (including rising GHG emissions), the Plan directs growth to built-up areas by establishing urban growth centres and intensification corridors.

The Plan includes an intensification target that 40 per cent of new population should be accommodated in built-up areas and 60 per cent accommodated in greenfield areas (undeveloped outer regions and farmland). The Plan thus allows the majority of future growth to be located on previously undeveloped land which exacerbates urban sprawl. The second target is a minimum-density one which establishes a lower threshold of 50 residents and jobs per hectare in greenfield areas. Thirdly, the Plan establishes specific density targets for the identified urban growth centres. Municipal plans were required to reflect compliance with the Plan by 2009, and by 2015, to comply with these intensification targets. While the Plan places a heavy emphasis on public transit, the density target for undeveloped greenfield areas is 50 residents and jobs combined per hectare. It has been calculated that this density would only support 30-minute wait times between buses, which is likely too infrequent to attract a large proportion of commuters.[45]

The government's recent CCAP Annual Report 2009–2010 is projecting significant growth in the number of passenger vehicles and detached homes between now and 2020. As the ECO believes the Plan's density targets are not sufficiently ambitious, we remain concerned that the Plan is locking-in a trajectory of emissions growth that is not sustainable.

The Big Move

In November 2008, Metrolinx passed The Big Move, its 25-year, $50-billion Regional Transit Plan (RTP). Focused on the Greater Toronto and Hamilton Area (GTHA) – an area plagued by traffic congestion – the RTP aims to ease congestion and commute times, and reduce harmful transportation-related emissions (including GHGs).[46]

According to some modelers, of all current provincial transportation policies The Big Move has the greatest potential to reduce GHG emissions over the long term (25 years) by both decreasing VKT and increasing transit use.[47] The key barrier to full implementation of The Big Move, however, is a lack of adequate and secure funding by all levels of government. Over the first 15 years, $30 billion in capital costs is required, with a subsequent $20 billion over the next 10. Three phases of funding were outlined, with the first phase fully funded by the 2008 provincial budget. The second phase, which began in 2009, was to rely significantly on $11.5 billion committed through the province's MoveOntario 2020 initiative. A further $6 billion was requested from the federal government to ensure completion of projects out to 2018.[48] The 2010 provincial budget, however, delayed at least $4 billion of these monies, thus putting the schedule for some projects in doubt and highlighting the critical need for dedicated long-term revenue sources.

With a view to expanding possible revenue sources, Metrolinx is exploring new and innovative funding mechanisms and is to report to the province, by 2013, with recommendations to close the 2016–2033 investment gap.[49] The ECO remains of the opinion that the delivery date for this report should be accelerated.[50] As well, the ECO sees an urgent need for the province to begin a public dialogue exploring potential revenue tools. This is precisely the type of dialogue that the province can initiate to better prepare itself for the implementation of proposals put forward by Metrolinx.

Of all current provincial transportation policies Metrolinx's The Big Move has the greatest potential to reduce GHG emissions over the long-term…The key barrier to full implementation of The Big Move, however, is a lack of adequate and secure funding.

3.2 Initiatives Under Consideration

According to the CCAP Annual Report 2008–09, several other transportation initiatives had been under consideration by the provincial government. Below is a discussion of some of these initiatives. Disappointingly, no mention was made of any of these initiatives in the government's April 2011 CCAP report.

High-Speed Rail

Over the past five decades, vehicle and air traffic volumes along the Quebec City – Windsor corridor have increased dramatically with GHG emissions increasing in lockstep. Recognizing the need to address these issues, the Ontario and Quebec governments announced in January 2008 a one-year study of the feasibility of developing a high-speed rail (HSR) system linking Toronto, Ottawa and Montreal.[51] The federal government subsequently became a joint partner and, in February 2009, the three governments commissioned a $3-million joint study to update previous studies on the feasibility of high-speed passenger rail in the 1,200 kilometre Quebec City – Windsor corridor.[52]

Despite MTO indications in November 2010 that the report would be publicly released in a "timely manner", no results are yet available.[53] While the lack of an updated study makes it difficult to draw any firm conclusions, a similar study in 1995 concluded that a HSR system would reduce transport-related CO_2 emissions in the corridor 24 per cent by 2025.[54] This result is, however, highly dependent upon the technology ultimately employed (diesel versus electric) and assumptions made around modal shift percentages.

While the costs associated with developing HSR may initially appear prohibitive, from an environmental perspective HSR is an obvious choice given that such trains require significantly less energy than either an airplane or automobile on a per passenger basis.[55] In light of the significant potential reductions in vehicle transportation fuel and GHG emissions (not to mention reduced public health costs, travel times, congestion and traffic accidents), the ECO agrees with the Martin Prosperity Institute that it is "hard to envision this region in 2021, without any 'high-order' transit or 'express service' linking the major regions."[56] Accordingly, the ECO strongly encourages the Ontario government to expedite the release of the study currently under way. Contained within this study, the ECO fully expects to see an analysis not only regarding the economic costs associated with such a project, but also a fully updated analysis of the environmental, health and safety benefits that would accrue from the development of a high-speed rail corridor.

GHG emissions reductions from a rigorously-designed Ontario Low Carbon Fuel Standard could be in the order of 1.2 Mt by 2020, climbing to 6.4 Mt by 2025.

Low-Carbon Fuel Standard

There are several technologically feasible low-carbon fuels which, if more widely employed in the province, would reduce transportation-related GHG emissions. One policy tool the Ontario government has been exploring to achieve this is a low-carbon fuel standard (LCFS). An LCFS requires fuel suppliers to reduce the average fuel carbon intensity to meet a defined GHG emissions benchmark. All emissions associated with the production of the fuel – extraction, refining, transportation, and consumption – are included. Those suppliers who reduce the carbon content of their fuels below the standard would receive credits that they could sell to other suppliers. Given that an LCFS caps average emissions intensity and allows suppliers to 'trade' credits, an LCFS operates in a fashion which is analogous to a cap-and-trade program, albeit within a single-sector.

A properly designed LCFS can significantly reduce life-cycle GHG emissions and encourage the production of lower-carbon alternatives such as advanced biofuels and electric and natural gas vehicles. According to independent analysis conducted for the ECO, GHG emissions reductions from a rigorously-designed Ontario LCFS could be in the order of 1.2 Mt by 2020, climbing to 6.4 Mt by 2025, based on a 2015 introduction date.[57] A properly designed system must consider who the regulated party is, how land use change is included, interaction with other policies, the baseline year, and what life-cycle GHG values to use for each fuel source. Ideally, an LCFS is accompanied by other complementary measures such as vehicle efficiency standards, strong investments in public transit and measures to restrict urban sprawl.[58]

Several jurisdictions, including California, British Columbia and the European Union, have implemented or are considering various forms of an LCFS. In May 2007, Ontario signed a Memorandum of Understanding with California to co-ordinate policy development on an LCFS that would require a 10 per cent reduction in carbon emissions from transportation fuels by 2020. While the government indicated in its CCAP Annual Report 2008–09 that it would provide additional detail on the proposed treatment of upstream fuels, no such information was contained within its most recent report.

Electrification of GO Trains

After a year-long study, the Metrolinx Board recommended in January 2011 to electrify portions of the GO Transit rail network with priority given to the two busiest routes – Lakeshore and Georgetown, beginning with the link between Union Station and Pearson International Airport. With regard to GHG emissions, the study concluded that "electrifying the entire network would deliver a 94% reduction in GO Transit's future GHG emissions."[59] This is a significant contribution, especially in light of other corresponding local air quality improvements that result from reduced diesel consumption. As such, the ECO encourages that electrification be implemented as soon as feasible.

3.3 Potential Tools for the Toolkit

Consumer Incentives

Environmental fiscal policies, such as taxes and financial incentives, can encourage the purchase of low-carbon vehicles. A feebate is a particular type of financial incentive that lowers the purchase price of more fuel-efficient vehicles and increases the purchase price of less fuel-efficient vehicles, relative to a specified benchmark. In general, feebate systems are designed to be revenue-neutral with the funds collected in fees roughly equal to the amount paid out in rebates.

Other incentive options include tax credits and rebates for more efficient vehicles (without the corresponding penalties on the less fuel-efficient vehicles). Non-financial incentives, such as access to high occupancy vehicle lanes or to preferred parking spaces, can also encourage the use of more efficient vehicles.

Until recently, Ontario had a feebate system in place comprised of three measures. The first was the Tax for Fuel Conservation (TFC) that applied to newly-purchased fuel-inefficient vehicles such as passenger vehicles using six or more litres, or sport utility vehicles using eight or more litres of fuel per 100 kilometres of highway driving.[60] A companion measure was the Tax Credit for Fuel Conservation (TCFC), which provided up to $100 to purchasers of new passenger cars that use less than 6 litres of gasoline or diesel fuel per 100 kilometres of highway driving. The final measure was in the form of a rebate that was available to either purchase new, or convert used, vehicles that operated on an alternative fuel. The rebates ranged from $750 for a propane vehicle, to $2,000 for a hybrid electric vehicle delivered after March 2006.[61]

As part of the harmonization of the provincial sales tax with the federal Goods and Services tax in 2010 each of these measures ended. This was a deliberate choice, not an inevitable consequence of harmonization, as the Ontario government instituted point-of-sale rebates for the provincial portion of the harmonized sales tax for several other product categories.[62] The government claimed that ending both the TFC and TCFC would "save businesses and consumers approximately $35 million per year."[63] While such financial savings may be important, the lack of a corresponding analysis of the GHG reductions that these programs could deliver concerns the ECO.

Other jurisdictions, for example, have had success using similar incentives. In France, a similar program introduced in 2008 resulted in a 3 per cent improvement in the fuel economy of new vehicles. As well, analysis conducted for the California Air Resource Board concluded that a moderate feebate system could lead to a 3 per cent decrease in GHG emissions per kilometre for new vehicle purchases in the period 2011 to 2025.[64]

Despite a promise to introduce a range of incentives to encourage people to shift toward greener vehicles[65] the only incentives now offered are with regard to electric vehicles. To assist with achieving its goal of having one out of every 20 vehicles in Ontario powered electrically by 2020, the government now offers rebates of $5,000 and $8,500 towards the purchase of plug-in hybrid and battery-electric vehicles. Further electric vehicle incentives include the privilege of accessing high occupancy vehicle lanes on provincial highways and access to public recharging facilities at GO stations and Ontario government parking lots.

With the recent introduction of the federal GHG emissions standards, the Ontario government should re-examine financial incentives for highly fuel-efficient gasoline and diesel vehicles. While performance-based standards, such as the federal GHG emissions requirements, force the adoption of newer technologies, they provide no incentive for vehicle manufacturers to exceed minimum requirements. By combining the synergies of the federal performance standard with a properly designed incentive policy to push continuous improvement, policymakers can enhance overall environmental effectiveness.[66] While Ontario's former feebate program (as embodied by the TFC and TCFC) lacked strong incentives to substantially alter consumer behavior[67] it can serve as a foundation upon which to improve future policies.[68]

Despite a promise to introduce a range of incentives to encourage people to shift toward greener vehicles the only incentives now offered are with regard to electric vehicles.

Road Pricing

Road pricing is an umbrella term referring to user fees charged for roads and road facilities. Various schemes exist and several pricing systems have been proposed or implemented in other jurisdictions. For many reasons, the ECO continues to believe that the government needs to seriously consider introducing similar road pricing systems in Ontario. Not only could revenues be generated for the expansion of public transit, a number of road pricing options have the dual effect of also reducing VKTs (and therefore GHG emissions) by serving as a disincentive to driving while reducing road congestion.

The GTHA's reliance on single-passenger vehicle trips is one of the highest among global cities[69] and is projected to increase with 1.4 million additional vehicles by 2031. In order to curb rising transportation emissions, Ontario must fundamentally shift the manner by which people and goods move around. There appears to be two broad choices: (1) accept increasing GHG emissions from passenger vehicles; or (2) implement price signals that will alter driver behaviour.

While technical and public acceptance hurdles may exist, the ECO does not believe these to be insurmountable. The ECO believes it is incumbent upon the government to begin funding research into possible alternatives. A consultation process should be held to analyze the strength of the perceived barriers and to determine possible ways forward. Lessons can be gleaned from other jurisdictions, and a pilot project that is relevant for the Ontario context can be implemented to determine viability. Simply ignoring road pricing's potential for GHG reductions does not reflect leadership.

Commuter Choice Incentives

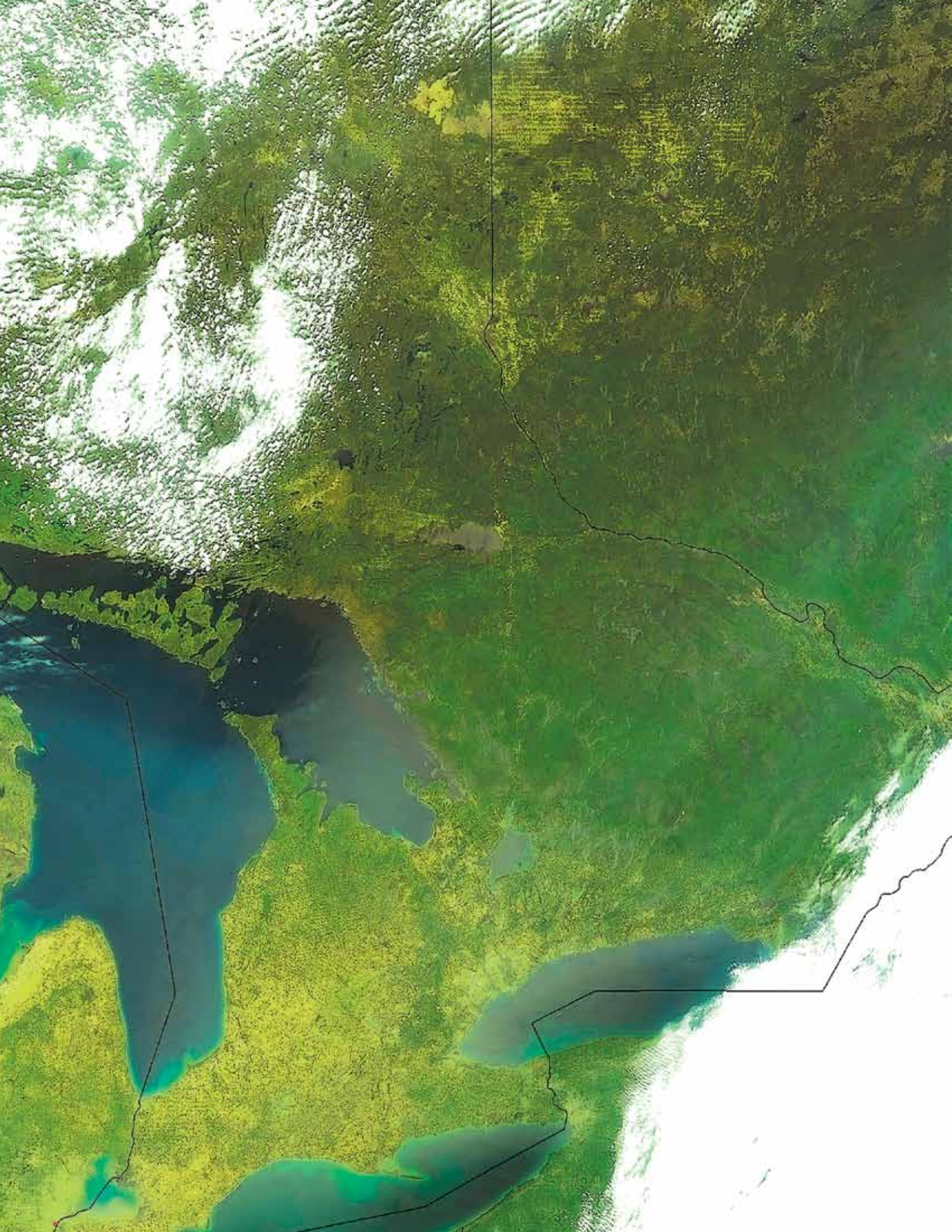
At present there are a number of programs in the province designed to provide commuters with alternatives to travelling in single-passenger vehicles. One such program is Smart Commute, an initiative in the GTHA that helps commuters explore alternative commuting options such as carpooling, cycling and transit. As well, the provincial government provides grants to municipalities through its Transportation Demand Management Municipal Grant Program. While these programs should be supported and expanded, the ECO would encourage the government to explore other transportation demand management tools and incentives to help reduce emissions from commuter transportation. For example, some jurisdictions have begun to explore options such as 'live-where-you-work mortgages' and 'pay-as-you-drive' insurance.[70]

The GTHA's reliance on single-passenger vehicle trips is one of the highest among global cities and is projected to increase with 1.4 million additional vehicles by 2031. Ontario must fundamentally shift the manner by which people and goods move around.

The former is based on the idea that if households spend less than average on travel costs, because residents live in a location where private vehicles are not required to commute to work, then they can afford mortgage payments that are higher than otherwise would be available under conventional mortgage lending practices. Given that homes in areas adequately serviced by public transit generally are more costly, such mortgages would assist with home purchases in these areas. Such mortgages have been estimated to reduce household VKT between 15 and 50 per cent.[71]

The second option is premised on the fact that the greater the amount of travel associated with a vehicle, the greater is the likelihood that it will be involved in a costly accident. Unlike conventional insurance which charges a flat-fee, a pay-as-you-drive approach would establish a clear link between distance driven and costs incurred and help to moderate travel demand and distance travelled. In the U.S., researchers have estimated that an additional insurance charge of US$0.07 per mile could result in an eight per cent reduction in VKT (along with a two per cent reduction in CO_2 emissions and a four per cent reduction in oil consumption).[72]

While pay-as-you-drive pricing would be implemented by individual insurance companies, regulatory barriers may exist. Accordingly, an analysis focusing on the Ontario context is required to determine what policy incentives or regulations can support its implementation. As such, the ECO is encouraged to note that pay-as-you-drive insurance has been recommended by the Western Climate Initiative as an initiative that is worthy of further evaluation due to the complementary role it may play to a cap-and-trade program.[73]



Appendix 4
Near-term Risk and Opportunities

Climate change is an upset in Earth's energy balance brought about by various perturbations. These can be natural, like major volcanic eruptions, or of human origin – which has predominantly been the case in recent decades. The mechanisms of perturbation can cause Earth to become cooler (termed negative radiative forcings) or warmer (positive radiative forcings). Climate change is described as being caused by global warming because the net effect when we balance out the various radiative forcings in the fossil fuel age is strongly positive.

The greatest positive forcing in the atmosphere is that caused by the propensity of water vapour to act as a GHG by absorbing infrared radiation and effectively trapping it and heating the planet. But water vapour will readily condense out of the atmosphere at 100 per cent humidity. The amount of water vapour (H_2O) is determined by temperature – not the other way around – so it cannot be the primary cause of global warming, only an amplifying feedback.

The dominant GHG is carbon dioxide (CO_2), a gas that traps infrared radiation and, due to human activities, has increased in concentration in the atmosphere from about 280 ppm before the industrial revolution to 392 ppm today. Unlike H_2O, it can accumulate in the atmosphere and persist for a very long time. Consequently, CO_2 is the greatest contributor to the global warming phenomenon. The comparative importance of other GHGs is expressed by their global warming potential (GWP). CO_2 has a GWP of 1 whereas methane (CH_4), by comparison, has a GWP commonly expressed as 25, meaning that methane is unit-for-unit 25 times as potent a GHG as CO_2 over a 100-year period in the atmosphere. Nitrous oxide has a GWP of 298 and some hydrofluorocarbons have GWPs of almost 15,000.[74] Fortunately, these gases are present in very small quantities in the atmosphere.

That 100-year time period, sometimes expressed as 'by 2100' (which, of course is now less than 90 years away) is the typical period of time over which climate change implications are discussed. While on the one hand this is a useful practice because it emphasizes the long-term effects of GHG accumulation and allows scientists to bridge some of the temporal uncertainty in their models, this long-term emphasis complicates present and near-term policy decisions.

4.1 The Tyranny of the Near Term

The next 40 years are a critical time for the planet with respect to GHG emissions. Presently the global economy is carbon-based and the content of the atmosphere is rapidly heading toward a perhaps imminent, but unknown, tipping point. Beyond this point feedback cycles will cause the rapid release of GHG emissions from biological and geological sources. Beyond that point control is lost. GHG abatement will become futile and we will suffer the full consequences of extreme weather, serious climate zone changes, ocean acidification and catastrophic sea level rise. But this doesn't have to happen. If the global economy be can de-carbonized, with Ontario contributing an 80 per cent reduction in GHG emissions by 2050, the present trends may well be reversed before these tipping points are reached.

That is why the next 40 years are critical. The near-term release of GHGs, or other substances with a significant GWP, presents a greater risk than releasing emissions later in the century, when our use of fossil fuels will likely have stopped. The ECO has raised this concern in our 2010 Annual Greenhouse Gas Progress Report[75] regarding the potential carbon impacts of burning forest biomass to produce electricity. There is no argument that such biomass energy could be considered 'carbon neutral' over the 100-year period after the trees grow back, but in the near-term, when the system is most vulnerable, all the forest carbon sequestered over the past century would be lingering in the atmosphere as CO_2 waiting to be taken up by the growing trees decades later.

In a related but different context, near-term GWP has other serious policy implications. Recall that methane, the second most important GHG, has a GWP of 25 over 100 years. That statistic masks the behaviour of methane over the near term. Methane oxidizes relatively quickly in the atmosphere compared to CO_2 and so its impact is greatest in the early years. The GWP of methane over 20 years is 72,[76] almost 3 times greater than over a 100-year timeframe, and so near-term methane releases are a far bigger threat. This has serious implications for policies related to natural gas extraction and handling as well as the management of landfill gas (see Appendix 5).

The focus on the near term does provide at least one policy opportunity with regard to climate change. Although the major GHGs are around for years, there are other atmospheric constituents that play a major role in climate change which have life expectancies measured in only days or weeks. These are aerosols, tiny particles of solids or liquids which are suspended in the

The reduction of black carbon [is] one of the only abatement strategies available to reduce near-term tipping-point risks – a policy opportunity that should not be ignored.

atmosphere and result from human activity, natural fires or volcanic eruptions. Their lifespans may be short, but because humans and nature continually discharge these materials there is a constant (but variable) supply suspended above us. Aerosols come in two types, reflective and black carbon. The former, which are commonly sulphate aerosols, have a negative radiative forcing because they reflect incoming solar radiation back into space. Black carbon aerosols, on the other hand, have a positive radiative forcing because they absorb solar radiation and radiate infrared back to Earth. The Intergovernmental Panel on Climate Change (IPCC) has estimated that the magnitude of each of these opposing forcings at the global scale are about equal, causing them to effectively neutralize each other in terms of global warming accounting.

Notwithstanding the reflective benefits of sulphate aerosols, we continue to limit the anthropogenic emissions of sulphates because they are a source of acid rain, smog and other health related impacts. Combustion emissions have been reduced through the use of low-sulphur fuels, but smelters and volcanoes remain significant sources worldwide.

4.2 A Black Carbon Aerosol Opportunity

Black carbon aerosols originate from the incomplete combustion of fossil fuels, biofuels and biomass. In the common vernacular, black carbon is called soot. Emissions of black carbon are controlled to a great extent in many advanced economies (much less so in the developing world) but there are still opportunities to reduce these emissions in Ontario. To the extent that emissions of black carbon aerosols are reduced, the zero sum game of aerosols would be turned to a net negative forcing (i.e., a cooling of the atmosphere) assuming the status quo for sulphates. However, more recent research indicates that aerosols may not be a zero sum game. At least one published journal article that analyzed black carbon's distribution in the atmosphere concluded that it is much more significant and is "the second strongest contributor to global warming."[77]

The GWP of black carbon over the 100-year term is conservatively estimated to be about 460. However, because of its short life span its GWP expressed over 20 years is 1,600[78] (see Table 4). Given its powerful influence on warming, black carbon deserves attention. More significantly, reductions in black carbon emissions will show reductions in radiative forcings in the very near term, a matter of weeks, unlike CO_2 which persists for many decades. This makes the reduction of black carbon one of the only abatement strategies available to reduce near-term tipping-point risks – a policy opportunity that should not be ignored.

A large proportion of black carbon, especially within Ontario, originates from diesel engine emissions…Significant reductions in these emissions can be justified solely on the basis of public and environmental health.

Table 4 Global Warming Potentials (GWP) Drawn from the IPCC 4th Assessment Report, 2007

	GWP20	GWP100	GWP500
Black carbon	**1600**	**460**	**140**
Methane	72	25	7.6
Nitrous oxide	289	298	153
Sulfur oxides	-140	-40	-12
Organic carbon	-240	-69	-21
Carbon dioxide	1	1	1

Note: The methodology used for black carbon was also used for organic carbon and sulfur oxides. Values for black carbon, organic carbon and sulfur oxides were not published by the IPCC and are not official estimates.
Source: The International Council on Clean Transportation, 2009.

A large proportion of black carbon, especially within Ontario, originates from diesel engine emissions[79] and technology is readily available to substantially abate this pollution. To its credit, Canada has fairly advanced emission control requirements for new diesel trucks, but these standards do not apply to older vehicles still on the road. Neither do they apply to off-road diesel equipment used in construction, stand-by diesel generators or provincially operated rail locomotives. Other opportunities for abatement include petrochemical flares and non-essential open burning of agricultural residues and other organic materials.

There are also important collateral benefits to reducing black carbon emissions. When black carbon particles precipitate from the atmosphere onto snow or ice they reduce the albedo (light reflectivity) of the white surface and promote melting. This promotes heat absorption in glacial and arctic regions and thus exacerbates global warming. But most importantly, black carbon forms a major part of the fine particulate matter in street level air pollution that carries toxins and carcinogens deep into our lungs. Significant reductions in these emissions can be justified solely on the basis of public and environmental health.

4.3 Soil Carbon Opportunities

Increasing Soil Organic Carbon

Increasing soil organic carbon levels is another approach to climate change mitigation. Every tonne of CO_2 captured in soil removes a tonne of CO_2 from the atmosphere.[80] Soils already hold more carbon than the atmosphere and above-ground biosphere combined,[81] even with a historic loss of soil carbon from modern agricultural practices. The capacity for further carbon sequestration is quite high[82] and so the ECO recommends that the Ontario government explore this mitigation opportunity.

The IPCC has conservatively estimated that improved agricultural practices could sequester anywhere from 0.18 to 2.79 tonnes of CO_2e per hectare per year (t CO_2e/ha/yr).[83] A more aggressive estimate from the Rodale Institute in the U.S. reported results of an 18-year, side-by-side comparison study of conventional versus organic agriculture that found a carbon-sequestration benefit of 3.6 t CO_2e/ha/yr for a manure-based organic system.[84] A recent survey of European soil studies found that the addition of compost to soil sequesters carbon at a rate of about 5 t CO_2e/ha/yr for every 10 dry tonnes of compost applied.[85] Other studies have found relatively high rates of sequestration for practices such as improved pasture management (5.5 t CO_2e/ha/yr)[86] and the growing of energy crops (6.2 t CO_2e/ha/yr).[87]

Table 5 Soil Carbon Sequestration and the 2020 Gap

Sector	Activity and/or Management Practice	Per cent Area Converted by 2020[88]	Documented Rate (tCO_2e/ha/yr)	Annual Carbon Storage by 2020 ($MtCO_{2e}$/yr)	Per cent of CCAP 30 Mt 2020 Gap
Cropland*	Assorted RMPs	40	2	2.9	9.6
	Organic Farming	10	3.6	1.3	4.3
	Compost Application	5	5	0.9	3
Pasture**	Assorted RMPs	25	5.5	1.0	3.4
Energy Crops	Switchgrass, *Miscanthus*, Poplar	10	6.2	2.7	9
TOTAL				8.8	29.3

RMP – Recommended Management Practice
CCAP – Climate Change Action Plan
*Total cropland in Ontario (ha) 3,600,000 (Stats Can 2006 Census)
**Total pastureland in Ontario (ha) 750,000 (Stats Can 2006 Census)

Using established technologies, Ontario could promote sequestration practices on pasture land and encourage the establishment of deep-rooted perennial energy crops such as switchgrass. Using reasonable assumptions for areas turned to these practices, 8.8 Mt of annual soil-carbon sequestration might be accomplished by 2020, (about 30 per cent of the currently estimated 30 Mt CCAP gap at 2020), using a mix of measures on cropland, pasture land, and land devoted to energy crops such as switchgrass or *Miscanthus* (see Table 5). Given that documented sequestration rates are from temperate climates, the Ontario government would need to develop its own protocols, based on both soil-sequestration modeling and local data.

The ECO does not wish to minimize or understate the technical, political and logistical challenges involved in reaching this target. Significant unresolved issues exist in the areas of measurement and permanence, for instance. The point of these projections is simply to highlight the opportunity that soil-carbon sequestration presents as a tool for climate change mitigation.

Using established technologies, Ontario could promote sequestering practices on pasture land and encourage the establishment of deep-rooted perennial energy crops.

The Special Case of Biochar

Biochar is the solid product of pyrolysis – the combustion of organic materials in the absence of oxygen. One common form of biochar is wood charcoal. Carbon in this form has the unique property of being extremely resistant to microbial degradation. Although more research is needed to confirm its stability in Ontario soils, scientific analysis has demonstrated that the bulk of biochar's carbon will remain sequestered in the soil for decades at a minimum, and possibly for millennia.[89] Biochar may also bring additional sequestration benefits. A recent study conducted on agricultural soils in Quebec indicated a substantial increase of mycorrhizal fungi[90] within biochar-amended plots. This suggests that biochar may work synergistically with soil microbes to create the conditions for further sequestration, additional to biochar's own carbon.

Biochar's potential is such that it could prove to be an excellent complement to the soil-carbon-boosting measures documented on page 47 of this report. If that turns out to be the case, the sequestration projections associated with those measures could be more easily achieved, or even exceeded.

The ECO is aware that the Ontario Ministry of Agriculture and Rural Affairs is investigating biochar's potential for Ontario soils. The ECO supports this work and has previously recommended that guidelines be developed for biochar production and use in Ontario.[91] If even a reasonable fraction of biochar's potential is proven to be real and practical to implement, it could make a key contribution to the province's 2020 GHG reduction target.

Appendix 5
Landfill Methane – A Conflicted Concept

5.1 Introduction

Managing existing organic waste in landfills, while also addressing the disposal of new organic waste, is a challenge. While organics already in landfills need to be managed to mitigate threats to groundwater and to minimize methane leakage, the government has indicated that the best long-term solution is organic waste diversion.[92] The ECO supports this philosophy.

The "divert organics" philosophy, however, is being undermined by policies and regulations currently in place. In our 2008/2009 Annual Report, we expressed concerns about the conflicting messages that these policies may be sending to municipalities with regard to organic waste.[93] These conflicting messages are a function of questionable modeling assumptions that underpin the design of landfill gas collection systems and the inherent incompatibility of landfill management priorities relating to energy production, groundwater protection and GHG emissions control.

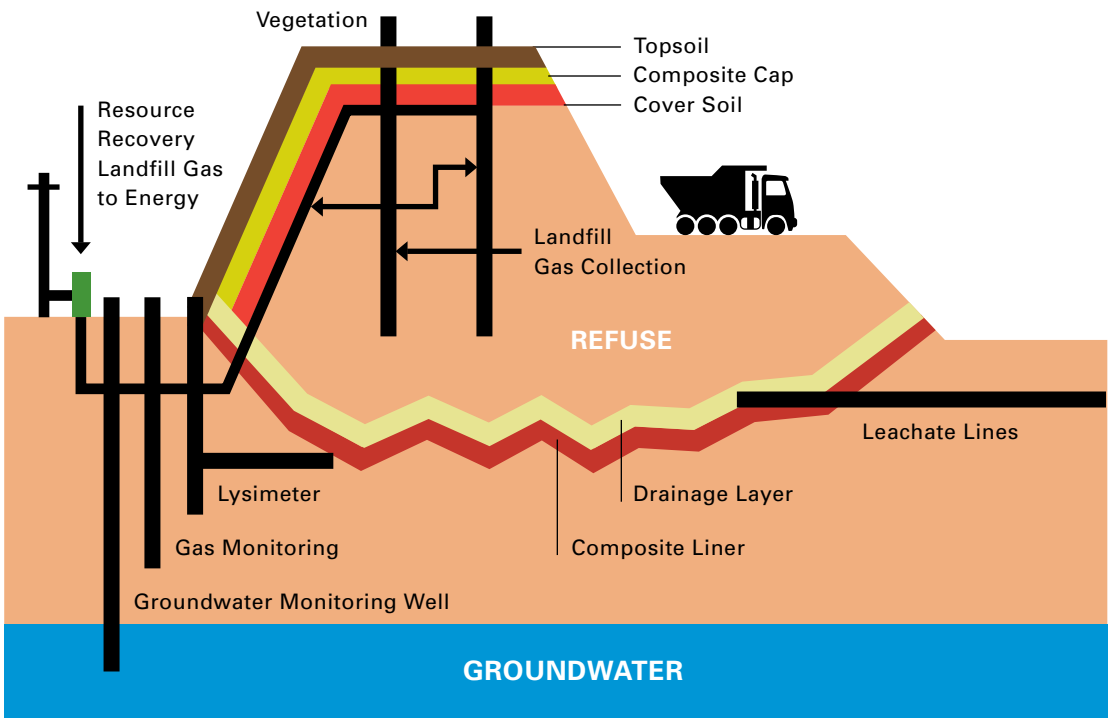
5.2 Questionable Design/Modeling Assumptions

The difficulty in obtaining reliable field measurements of uncontrolled methane releases (referred to as 'fugitives') makes an accurate inventory of GHG emissions from landfills difficult to achieve and has led to a proliferation of models to estimate GHG emissions.[94]

Current Emissions Models Are Inaccurate

Landfills (Figure 1) can extend over tens of hectares and, with their base extending approximately 20 metres into the ground, may be many tens of metres high.[95]

Figure 1 Typical Landfill Profile



Given their size, it is difficult to measure the fugitive emissions escaping from landfills. They leak into the atmosphere through cracks, tears and broken seams along the sides and top of the structure, and can escape through leachate collection trenches and piping from the bottom of the facility.[96]

Without actual fugitive emissions data, modeling is needed to predict fugitive releases from the facility. The variables in such a model must include a number of factor inputs, such as the quantities (and types) of wastes-in-place, operating parameters, moisture conditions, and related environmental conditions.

The value of these models in determining the landfill sector's contribution to Ontario's GHG inventory is questionable.

Like balancing a chequebook, a "mass balance analysis" attempts to estimate fugitive releases by accounting for all the material entering and leaving the landfill system. In addition to estimating the total gas potential in a landfill over its biologically-active lifespan, this requires knowledge of:

1. The annual gas generated based on decomposition rates;
2. Of that generated, the amount of landfill gas *captured* (via the gas collection system), *sequestered* (in the waste mass), and *oxidized* (in the overlying earthen cover) which then needs to be subtracted from the estimate of gas generated to determine *net* (fugitive) *releases*;[97] and,
3. The gas capture rate.

In essence, the challenge is to solve for the following equation:

Total Annual Gas Generated = Gas Captured/Assumed Capture Rate

Of the three parameters noted above, it is usual to have solid data only on the amount of gas captured. There are often reasonable *estimates* available for the total gas generated and decomposition rates, but only *theoretical* calculations of sequestration, oxidation and collection efficiency (the gas capture rate), and *no* reliable information at all on fugitive emissions.[98] As such, the value of these models in determining the landfill sector's contribution to Ontario's GHG inventory is questionable.

Collection Efficiencies Much Lower Than Assumed

The ECO noted in our 2008/2009 Annual Report that the efficiency of a landfill gas control system depends on many factors, including the placement of the collection pipes and the permeability of the containment materials around the landfill.[99] There is conflicting opinion in the literature regarding gas capture rates. The U.S. Environmental Protection Agency (U.S. EPA) has assumed that landfill gas collection efficiency is 75 per cent.[100] [101] This unconfirmed assumption has been incorporated directly into Ontario's GHG inventories.[102]

If, however, collection efficiencies are as low as 40 per cent…then a much larger volume of methane gas must be leaking from landfills as fugitive emissions.

The initial basis for the U.S. EPA's 75 per cent efficiency estimate[103] is based on what the EPA assumed are the best – *not the average* – gas collection efficiencies.[104] Some landfills perform optimally, while others may have less efficient or incomplete gas control systems. Technical reports from independent sources indicate that instantaneous gas collection efficiencies range between 34 and 50 per cent, averaging at approximately 40 per cent.[105]

Additionally, the 75 per cent figure is based on what optimal systems can achieve when the efficacy of a gas control system is at its highest. This is a period after the final cover is installed and continues while the cap is maintained. However, gas starts to be generated between five and twenty days after organic waste is buried.[106] In landfills, food scraps tend to decompose first, followed by paper products and textiles, creating gas and leachate. Further, in Ontario, the collection systems may not be installed or become operational for several years.[107]

The IPCC has determined that the best collection systems operated at the optimum times (when the landfill is sealed) may achieve efficiencies greater than 90 per cent. However, the IPCC also noted that not all landfills perform optimally and that "there are fugitive emissions from landfilled waste prior to and after the implementation of active gas extraction" such that "estimates of 'lifetime' recovery efficiencies may be a low as 20%".[108] [109]

Problems Estimating Total Gas Potential

The lifetime gas generation potential (LGGP) of a landfill is calculated by measuring the organic fraction of the municipal wastes contained therein. While the standard assumption has been that the LGGP of organic waste is 100 cubic metres per tonne (m^3/t),[110] there is considerable variation in that estimate. By isolating the degradable organic fraction for further analysis, researchers postulate that LGGP can vary by a factor of 300 per cent, ranging between 100 and 310 m^3 of total gas/t of waste.[111]

The issue is complicated further when trying to estimate the fraction that methane comprises of the total gas potential per tonne of waste. It has been noted that "[t]here is no method for determining methane potential that is without fault."[112] Ontario assumes that 50 per cent of total landfill gas is methane;[113] however, observed methane ratios in landfill gas are reported to range from 35 to 60 per cent.[114]

Calculation of an accurate methane gas potential figure requires reliable waste composition and sequestration data, both of which are often lacking. The IPCC's 1996 Guidelines state that, "[t]he degradable organic content (DOC) of the waste has a large impact on the potential methane generation value. Small variations in the DOC inputs can result in large variations in

the overall methane estimates."[115] The implication here is that variations in degradable organic content will generate large errors in the estimates of uncontrolled (fugitive) releases of methane from landfills – a situation exacerbated further by uncertainties regarding moisture levels and distribution in landfills.

Uncertainties Regarding Moisture Levels and Distribution

Liquids are not evenly distributed in landfills. Municipal solid waste is highly heterogeneous, heavily compacted, interspersed with daily cover, and often confined in plastic bags, all of which create preferred paths for water flow. Estimates are that liquids only reach 23 to 34 per cent of the waste mass.[116] This means that there is inadequate moisture for complete decomposition. In-coming wastes usually contain not much more than 20 per cent moisture.[117] However, complete biological conversion requires 60 to 80 per cent moisture. This level of moisture, essential for bacteria growth, metabolism, and nutrient transport, is necessary to optimize the generation of methane.[118]

Ordinarily, landfills might achieve average moisture levels of, perhaps, 35 per cent (none of which would be evenly distributed).[119] In Ontario, landfills that employ leachate recirculation to protect groundwater, as well as bioreactor landfills[120] can significantly increase moisture levels. More moisture translates into greater amounts of methane gas generated. If, however, collection efficiencies are as low as 40 per cent as suggested above, then a much larger volume of methane gas must be leaking from landfills as fugitive emissions. The ECO has cautioned that these uncontrolled releases of methane and other GHGs "could reduce, offset or even exceed the potential environmental gains from landfill gas capture and power generation."[121]

Table 6 compares the fugitive methane releases from a hypothetical landfill with a metered annual capture of 10,000 m^3 of methane. A capture rate of 75 per cent, as assumed by MOE, yields an annual uncontrolled methane leakage rate of 3,333 m^3. However, if the assumed collection efficiency drops to 40 per cent, then the fugitive methane leakage rate increases by 4.5 times to 15,000 m^3, all other factors being equal. If the lifetime collection efficiency is as low as the IPCC has suggested – 20 per cent – then the fugitive release rate increases by a factor of 12. While the ECO recognizes that these are estimates, they illustrate the uncertainty regarding the true impacts of landfilling organic wastes.

Table 6 Implications of Different Capture Rates for Fugitive Releases

Factors	Scenarios			
	A	B	C	Units
Methane Captured	10,000	10,000	10,000	m^3/yr
Methane Concentration Ratio	50%	50%	50%	
Capture Rate	75%	40%	20%	
Oxidation Rate	10%	10%	10%	
Sequestration Rate	0%	0%	0%	
NMOC*	0.5%	0.5%	0.5%	
Outputs				
Fugitive Methane	3.333	15,000	40,000	m^3/yr
Fugitive NMOCs	33.3	150.0	400.0	m^3/yr

* Non-methane organic compound
Source: Center for a Competitive Waste Industry, 2011.

So, we are left with what amounts to a *landfill operational/design conundrum*:

1. High moisture levels, only present some of the time in landfills, are a prerequisite for gas to be generated
2. An impermeable cover or cap is necessary to create the vacuum pressures needed for gas collection to work properly
3. The cap prevents the entry of precipitation, reducing moisture levels
4. When moisture levels drop, gas generation tapers off, leaving an undetermined but likely significant fraction of organic waste susceptible to future decomposition

Many of the key technical assumptions that underpin landfill gas control practices in Ontario have never been properly tested or verified in the field [calling] into question the methodologies and assumptions determining the waste sector's contribution to provincial GHG emissions.

5. Post-closure, when the cap is no longer being actively maintained, it will eventually degrade and crack
6. Cap failure allows moisture to re-enter the site, re-activating biological activity in the remaining organic waste and the generation of methane gas
7. This 'new' methane will appear as fugitive releases into the atmosphere.

Other Concerns

There is considerable disagreement regarding the extent to which methane generated in landfills is destroyed through oxidation in the overlying soil layer. The U.S. EPA assumes that 10 per cent of the methane generated in a landfill is oxidized in the soil layer that tops a closed cell.[122] However, oxidation rates drop if a composite cap[123] has been installed under the soil blanket. In that case, landfill gases concentrate along cracks and tears that can appear in the plastic sheeting. Such high flux emissions quickly overwhelm the capacity of the topsoil to oxidize the escaping methane.[124] Further, in Ontario, a correction for colder winter temperatures would likely need to be applied. However, the ECO is unaware of any field studies of oxidation in colder temperatures that have been cited in Canada's or Ontario's GHG inventory reports.[125]

There is also debate about the role of carbon sequestration in the remaining lignin not decomposed in landfill organic matter. While the U.S. EPA has suggested a 10 per cent sequestration rate based on one laboratory test,[126] more recent research contradicts this by showing that the actual sequestration rate ranges between 0.8 and 9.4 per cent.[127] As such, the uncertainty surrounding the roles of oxidation and sequestration of methane in landfills further obscures the actual fugitive methane releases from landfills. If we assume the lower oxidation rates noted above, then this means that even higher fugitive methane releases from landfills could be occurring than depicted in Table 6.

To summarize, many of the key technical assumptions that underpin landfill gas control practices in Ontario have never been properly tested or verified in the field. This calls into question the methodologies and assumptions determining the waste sector's contribution to provincial GHG emissions. For example, if collection efficiencies are 40 per cent on average instead of 75 per cent, as noted above, then the province is significantly underestimating fugitive releases from landfills.[128] It also calls into question the rationale for landfill energy production as an appropriate component of a climate change mitigation strategy.

Divergent landfill policy directions beg the question: What is the government trying to accomplish? Is it control of GHGs? Is it energy production? Is it the stabilization of landfills to limit their contaminating lifespans? Or, is it the diversion of organics away from landfills altogether? Are these goals and objectives compatible?

5.3 Conflicting Regulatory Requirements

Landfill Gas Collection and Control Regulation (Ontario Regulation 232/98 – Landfilling Sites, made under the *Environmental Protection Act*)

Amendments to Ontario's landfill regulations, promulgated in 2008, require landfill facilities above a prescribed capacity (1.5 million m^3) to install gas collection systems.[129] This affects 32 major public and private landfills in Ontario representing just over 300 million m^3 of permitted capacity.[130] The methane gas collected may be flared (burned) or extracted for energy production.[131]

Beginning June 1, 2010, eligible landfills were required to submit an annual written report with respect to the previous year's operation of the "landfill gas collection, venting or use facilities" that includes the following information:

- the total landfill gas volume collected at the site during the year;
- the percentage of the volume that was methane gas;
- the reduction in methane emissions from the landfill site associated with the burning or use of landfill gas during the year (expressed in tonnes of CO_2e and based on a GWP of 21 for methane gas[132]);
- a description of how sound scientific or engineering principles have been used to support these statements; and,
- all calculations and information that support the statements.[133]

It should be noted that, with the exception of "total landfill gas volume collected by the facilities at the site during the year", the other required information can only be estimated based on the same scientific or engineering principles that the ECO has called into question above.

Diversion Efforts - *Waste Diversion Act, 2002* Review

In 2009, MOE placed a policy proposal on the Environmental Registry (#010-8164) and the links to a minister's report entitled "From Waste to Worth: The Role of Waste Diversion in the Green Economy – Minister's Report on the *Waste Diversion Act, 2002* Review". The intent was to propose policy changes to Ontario's waste management framework that increase waste diversion while delivering "environmental and economic outcomes."[134] The minister's report set the context for Ontario's current diversion approach as follows: "The *WDA* promotes waste reduction, reuse and recycling, and *prohibits* programs from promoting the burning, *landfilling*,

or land application of *designated material*" (emphasis added).[135] "Branded organics", although not defined, are proposed in the report as a designated material that should be considered for inclusion in a long-term (five-year) schedule for diversion.[136] The report concluded by recognizing the challenges in "moving existing programs to the new framework"[137] and encouraged interested parties to provide feedback. A decision notice with regard to a review of the *Waste Diversion Act, 2002* had yet to be posted as of April 2011.

Climate Change Action Plan Targets

Given that the waste sector historically contributes between 3 to 4 per cent of Ontario's GHG emissions, in 2009 the government announced it would introduce a regulation to phase in new requirements for methane capture and energy production in landfills.[138]

According to the government's CCAP Annual Report 2009–2010, landfill methane gas collection for new, expanding or operating landfills is anticipated to achieve GHG reductions of 1.7 Mt CO_2e by 2014, and 2.1 Mt CO_2e by 2020.[139] These projected reductions, however, may be more than offset by unintended fugitive releases as discussed above.

Conflicting Priorities

These apparently divergent landfill policy directions beg the question: What is the government trying to accomplish? Is it control of GHGs? Is it energy production? Is it the stabilization of landfills to limit their contaminating lifespans? Or, is it the diversion of organics away from landfills altogether? Are these goals and objectives compatible? To the extent that they require substantially different landfill design parameters and operating requirements, the ECO believes that they are *not* compatible.

As described above, the models relied upon to measure fugitive methane releases do not accurately represent what is happening in landfills. Without detailed waste inventories, it is impossible to determine the total methane potential of landfilled organics. The end result is conflicting compliance issues. For example, the requirement for infiltration rates of greater than or equal to 150 millimetres of water per year in O. Reg. 232/98[140] may conflict with the *control* of methane because it produces *greater volumes* of methane, more of which may be escaping as fugitives. These high rates of permeability, along with the negative pressures generated by gas control systems, will work against each other. They offer additional pathways for fugitive methane leaks while also risking the draw down of air into the landfill that may either dry out the cells, kill the anaerobic bacteria that generate the methane and/or mix with the methane to create an explosive combination.[141]

The ECO concluded in our 2008/2009 Annual Report that the best way to deal with GHGs from landfills is to reduce or ideally eliminate, on a go-forward basis, the amount of organic matter that ends up in them. The ECO also noted that the only way to reconcile this policy objective with efforts devoted to the generation of landfill energy projects should be "within the context of an overall solid waste management strategy."[142] The strategy, yet to be developed, will need to balance the equally important goals of controlling groundwater contamination from leachate, controlling the release of methane into the atmosphere, and determining the most environmentally appropriate method to destroy the methane captured from existing wastes-in-place.

The ECO is also concerned about the mixed signals being sent to Ontario municipalities. The Ontario Power Authority's inclusion of landfill gas among the renewable energy sources eligible for 20-year guaranteed Feed-in Tariff contracts[143] is a case in point. On the one hand, Ontario's municipalities are responding to the dual concerns about landfill GHGs and threats to groundwater from leachate contamination by accelerating organics diversion efforts. But, the requirement to install gas capture systems in smaller capacity landfill sites, at considerable capital outlay, may prompt operators to seek an increased stream of organics to feed their gas collection systems to generate electricity and revenues to recoup these costs.

Despite the government's best intentions to mitigate the impacts of methane emissions from landfills, a renewed emphasis on landfill methane for energy production may make matters worse by increasing fugitive releases – with the unintended consequence of erecting marketplace barriers to landfill alternatives such as diversion.

5.4 What Needs to Happen

Management options for existing wastes-in-place are urgently required. While there are well-established alternatives to landfilling for new discards (including composting, anaerobic digestion, and thermal conversion technologies such as pyrolysis) that do not create uncontrolled methane releases, there is no real alternative to existing wastes-in-place which must be managed to mitigate environmental impacts.

Organics…diversion will always produce greater GHG reduction benefits than flaring or energy production at landfills, no matter what assumptions are used.

Diverting New Discards

Every municipality in Ontario successfully separates about one-third its residents' bottles, cans and newspapers for recycling. Implementing green bin programs for food scraps, pet wastes and soiled paper is the next logical step. Experience demonstrates that even higher levels of organics diversion are feasible.[144] Regardless of the efficiency of a gas control system, organics diversion is always more effective in preventing the release of methane. Diversion will always produce greater GHG reduction benefits than flaring or energy production at landfills, no matter what assumptions are used. The challenge of existing wastes-in-place, however, still remains.

Managing Existing Wastes-in-Place

Ontario's Climate Change Action Plan assumes uncritically that recovering the energy value in landfill gas is inherently preferable to flaring it, especially if the energy produced displaces electricity generated through the burning of fossil fuels. However, this encourages landfills to amend operating practices to increase the generation of methane to fuel their energy production facilities. This harkens back to the landfill gas design conundrum described earlier. The paradox is:

- the proportion of methane in landfill gas generated at landfill sites kept dry would be too low to economically operate the reciprocating engines that typically generate electricity (not enough methane); and,
- the operational changes needed to increase gas generation and methane concentration also serve to degrade gas collection efficiency while increasing fugitive emissions over both the short and long term.

With methane's high GWP, particularly over the short term, a small increase in fugitive emissions could overwhelm the benefits from lower CO_2e emissions associated with the displacement of electricity generated by fossil fuels.[145] Further, once the province phases out the use of coal in 2014, the contributions of electric power from landfill energy to the grid could be displacing other, cleaner sources of power.

Landfills that are properly operated should strive to minimize infiltration of liquids and maximize gas capture for flaring only. This will ensure that the wastes remain as close to biologically inactive as possible and prevent hazardous compounds from being released, thereby posing less of a threat to the environment.

The ECO believes that the promotion of landfill energy options over organic waste diversion compromises the achievement of Climate Change Action Plan GHG reduction targets.

The Next Steps

There are serious deficiencies in the mathematical models used by the government to calculate the generation of landfill gas over the course of a facility's biologically active lifetime. The ECO believes that the promotion of landfill energy options over organic waste diversion compromises the achievement of CCAP GHG reduction targets. This is particularly true in the near term when the methane gas generated by organic wastes in landfills brings the planet closer to a dangerous "tipping point" (see Appendix 4). Thus, MOE must move quickly to develop a solid waste management strategy that clarifies how existing wastes-in-place will be treated while, on a go-forward basis, articulates the timing and commitments to divert all future organics from landfills.[146] This strategy should be informed by an immediate revisiting of modeling assumptions behind projected GHG reductions from landfills facilitated through Ontario-specific field studies.

The ECO believes that the projected cumulative GHG reductions of 2.1 Mt at 2020 from landfill methane gas collection are, at best, optimistic and, at worst, may be completely negated due to an increase in fugitive methane releases. We have shown that gas collection systems for energy production require major modifications to how a landfill is managed to ensure a continuous supply of methane; modifications that increase the volume of methane that may escape as fugitive emissions.

With regard to future organics, diversion will always produce greater GHG reduction benefits. Existing wastes-in-place, on the other hand, must be managed to ensure that the wastes remain as biologically inactive as possible, with currently installed gas collection systems flaring the methane captured.[147]

Abbreviations

BCA	border carbon adjustment
CCAC	Climate Change Action Committee
CCAP	Climate Change Action Plan
CH_4	methane
CO_2	carbon dioxide
ECO	Environmental Commissioner of Ontario
EPA	Environmental Protection Agency
GDP	gross domestic product
GHG	greenhouse gas
GTHA	Greater Toronto and Hamilton Area
GWP	global warming potential
HSR	high-speed rail
IPCC	Intergovernmental Panel on Climate Change
LCFS	low-carbon fuel standard
LGGP	lifetime gas generation potential
MOE	Ministry of the Environment
Mt	megatonnes
MTO	Ministry of Transportation
OBRP	Ontario Bus Replacement Program
ppm	parts per million
RGGI	Regional Greenhouse Gas Initiative
RTP	Regional Transportation Plan
TCFC	Tax Credit for Fuel Conservation
TFC	Tax for Fuel Conservation
VKT	vehicle kilometres travelled
WCI	Western Climate Initiative

Image References

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Photo/Image By: User: Zakysant, on Wikimedia Commons
http://commons.wikimedia.org/wiki/File:Air-pollution.JPG

Endnotes

1 National Oceanic & Atmospheric Administration, Earth System Research Laboratory – Global Monitoring Division, *The NOAA Annual Greenhouse Gas Index*. Available at: http://www.esrl.noaa.gov/gmd/ccgg/trends/ (accessed April 28, 2011).

2 Government of Ontario, *Ontario Budget 2011: Turning the Corner to a Better Tomorrow, Ontario's Plan for Jobs and Growth* (Toronto, Queen's Printer for Ontario: *2011*), 156.

3 Ibid, 156.

4 Sustainable Prosperity, *Climate Compared: Public Opinion on Climate Change in the United States & Canada*, February 23, 2011. Available at: http://www.sustainableprosperity.ca/article911 (accessed April 28, 2011).

5 Sustainable Prosperity, *Canadian Business Preference on Carbon Pricing*, February 2, 2011. Available at: http://www.sustainableprosperity.ca/article758 (accessed April 28, 2011).

6 National Round Table on the Environment and the Economy, (NRTEE), *Parallel Paths: Canada-U.S. Climate Policy Choices,* 2011, 17. Available at: http://www.climateprosperity.ca/eng/studies/canada-us/report/canada-us-report-eng.pdf (accessed April 28, 2011).

7 Ibid, 148.

8 Pembina Institute, *Bridging the Gulf: Changing the way Ontarians commute will cut oil demand, protect the environment and save money*, August 2010, 7. Available at: http://www.pembina.org/pub/2063 (accessed April 23, 2011).

9 Forster, P., V. Ramaswamy, et. al., 2007, "Changes in Atmospheric Constituents and in Radiative Forcing," *Climate Change 2007: The Physical Science Basis. Contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge UK, Table 2.14, 212.

10 Government of Ontario, "Tackling Ontario's Waste," News Release, October 28, 2009. Available at: http://news.ontario.ca/ene/en/2009/10/tackling-ontarios-waste.html (accessed May 5, 2011).

11 Ontario Ministry of the Environment, 2009. *From Waste to Worth: The Role of Waste Diversion in the Green Economy*, October 2009, 2. Available at: http://www.downloads.ene.gov.on.ca/envision/env_reg/er/documents/2009/WDA%20Ministers%20Report.pdf

12 Government of Ontario, 2007. *Go Green: Ontario's Action Plan on Climate Change* (Toronto, Queen's Printer for Ontario: August 2007), 25.

13 Ministry of the Environment, *Landfill Gas Capture: A Guideline on the Regulatory and Approval Requirements for Landfill Gas Capture Facilities* (PIBS 6876e), September 2008. Available at: http://www.ene.gov.on.ca/environment/en/resources/STD01_076002.html.

14 Ontario Ministry of the Environment, 2009. *From Waste to Worth: The Role of Waste Diversion in the Green Economy*, October 2009.

15 Environmental Commissioner of Ontario, 2009. *Annual Greenhouse Gas Progress Report 2008/2009: Finding a Vision for Change*, 25.

[16] Government of Ontario, *Climate Change Action Plan Annual Report 2008–09* (Toronto, Queen's Printer for Ontario: 2009), 8.

[17] Environmental Commissioner of Ontario, 2009. *Annual Greenhouse Gas Progress Report 2008/2009: Finding a Vision for Change*, 27.

[18] Government of Ontario, 2011. *Climate Progress: Ontario's Plan for a Cleaner More Sustainable Future* (Toronto, Queen's Printer for Ontario: 2011), 37. Available at: http://www.ene.gov.on.ca/stdprodconsume/groups/lr/@ene/@resources/documents/resource/stdprod_085413.pdf.

[19] See e.g. Institute for Competitiveness & Prosperity, 2010. *Today's innovation, tomorrow's prosperity: Task Force on Competitiveness, Productivity and Economic Progress*, Ninth Annual Report, November 2010, 45–47; Pembina Institute and David Suzuki Foundation, 2009. *Climate Leadership, Economic Prosperity: Final report on an economic study of greenhouse gas targets and policies for Canada*, 2009; Bataille, C, et al. *Pricing Greenhouse Gas Emissions: The Impact on Canada's Competitiveness*, C.D. Howe Institute Commentary no. 280, February 2009.

[20] Fahrenthold, D. & Eilperin, J. "GOP win dims prospects for climate bill, but Obama eyes Plan B ahead of U.N. talks." *The Washington Post*, November 21, 2010, A05.

[21] Environmental Protection Agency, "EPA Finalizes the Nation's First Greenhouse Gas Reporting System," News Release, September 22, 2009.

[22] Environmental Commissioner of Ontario, *Sorting Out Canada's Shifting GHG Targets,* February 4, 2010 blog.

[23] Environment Canada, *A Climate Change Plan for the Purposes of the Kyoto Protocol Implementation Act* (Ottawa, Ontario: 2010), 4.

[24] Laura Mulrey, "California climate law faces legal challenge from the left." *Columbia Law School Climate Law Blog*. Posted March 31, 2011. Available at: http://blogs.law.columbia.edu/climatechange/2011/03/31/californias-climate-law-faces-legal-challenge-from-the-left/ (accessed April 28, 2011).

[25] Point Carbon, "Midwest US ditches carbon market, focuses on jobs," February 24, 2011.

[26] Pembina Institute, *Putting a price on carbon to reduce emissions from Ontario's industry and electricity sectors*, 2010, unpublished ECO report.

[27] Government of Ontario. *An Act to amend the Environmental Protection Act with respect to greenhouse gas emissions trading and other economic and financial instruments and market-based approaches*. December 15, 2009. Available at: http://www.ontla.on.ca/web/bills/bills_detail.do?locale=en&Intranet=&BillID=2195. (accessed April 28, 2011).

[28] Letter dated April 13, 2011 from John Mayes, Director, MOE Environmental Monitoring Reporting Branch and Jim Whitestone, Director, MOE Air Policy and Program Design Branch, entitled: *Filing direction for Greenhouse Gas Emissions Reports Clarification on the use of the 2009 and 2010 Guidelines*.

[29] Ontario Ministry of the Environment. "Ontario's developing cap-and-trade program for greenhouse gas emissions". Slide deck from MOE presentation – November 16, 2010. Available at: http://www.awma.on.ca/Documents/AWMA%20Breakfasts%20Seminars/AWMA%20Deck%20Nov%2016%202010.pdf (accessed April 28, 2011).

[30] National Round Table on the Environment and the Economy, (NRTEE), *Parallel Paths: Canada-U.S. Climate Policy Choices*, 2011, 34. Available at: http://www.climateprosperity.ca/eng/studies/canada-us/report/canada-us-report-eng.pdf.

[31] Ibid, 132.

[32] Ibid, 120.

[33] David Suzuki Foundation, the Pembina Institute and WWF-Canada. *Comments to the Government of Ontario on the Development of a Cap-and-Trade System for Reducing Greenhouse Gas Emissions in Ontario*, March 2, 2009, 6–7. Available at: http://www.pembina.org/pub/1797 (accessed April 28, 2011).

[34] Carbon Trust. "Tackling carbon leakage – sector-specific solutions for a world of unequal carbon prices," 51–54. Available at: http://www.ukerc.ac.uk/support/tiki-read_article.php?articleId=9 (accessed April 28, 2011).

[35] Government of Ontario, *Climate Change Action Plan Annual Report 2008–09* (Toronto, Queen's Printer for Ontario: 2009), 66–75.

[36] Government of Ontario, *2010 Ontario Budget: Open Ontario – Ontario's Plan for jobs and growth* (Toronto, Queen's Printer for Ontario: 2011), 53. Available at: http://www.fin.gov.on.ca/en/budget/ontariobudgets/2010/papers_all.html.

[37] Environment Canada, *National Inventory Report – Greenhouse Gas Sources and Sinks in Canada 1990–2009*, Part 3, 89.

[38] Environment Canada, "Canada Announces Final GHG Emission Regulations for New Light-Duty Vehicles," News Release, October 1, 2010. Available at: http://www.ec.gc.ca/default.asp?lang=En&n=714D9AAE-1&news=3C7732ED-B2B7-4E45-8A54-A495500E58DB.

[39] Environment Canada, *A Climate Change Plan for the Purposes of the Kyoto Protocol Implementation Act* (Ottawa, Ontario: 2010), 10.

[40] Government of Ontario, *Climate Change Action Plan Annual Report 2008–09* (Toronto, Queen's Printer for Ontario: 2009), 64.

[41] Deputy Minister of Transportation Carol Layton, Letter to Gordon Miller in response to ECO inquiry, November 5, 2010.

[42] Ontario Ministry of Transportation, "Mandatory Truck Speed Limiters", Available at: http://www.mto.gov.on.ca/english/trucks/trucklimits.shtml (accessed November 12, 2010).

[43] Transport Canada, *Summary Report – Assessment of a Heavy Truck Speed Limiter Requirement in Canada*. Available at: http://www.tc.gc.ca/eng/roadsafety/tp-tp14808-menu-370.htm (accessed November 12, 2010).

[44] CTV Southwestern Ontario News, "Speed limiters not always in effect on Ont. Highways", March 29, 2011. Available at: http://swo.ctv.ca/servlet/an/local/CTVNews/20110329/speed-limiters-one-110329/20110329/?hub=SWOHome (accessed April 28, 2011).

[45] IBI Group, *Transit Supportive Land Use Planning Guidelines,* prepared for Ontario Ministry of Transportation and Ministry of Municipal Affairs (1992), 18. Available at: www.mah.gov.on.ca/AssetFactory.aspx?did=1179 (accessed April 28, 2011).

[46] Metrolinx, *The Big Move – 3.0 Goals and Objectives*, Available at: http://www.metrolinx.com/thebigmove/en/goals/ (accessed April 28, 2011).

[47] Pembina Institute, *Bridging the Gulf: Changing the way Ontarians commute will cut oil demand, protect the environment and save money*, August 2010.

[48] Metrolinx, *The Big Move – 6.0 Investment Strategy*, 68–74. Available at: http://www.metrolinx.com/thebigmove/en/investment/ (accessed April 28, 2011).

[49] Ibid.

[50] Environmental Commissioner of Ontario, *Annual Greenhouse Gas Progress Report 2010: Broadening Ontario's Climate Change Policy Agenda* (Toronto, Ontario: 2010), 22.

[51] CBC News, "Governments revive plans for high-speed trains between Quebec, Ontario", January 10, 2008. Available at: http://www.cbc.ca/news/canada/story/2008/01/10/rail-study.html (accessed March 22, 2011).

[52] Ontario Ministry of Transportation, "Québec City-Windsor high-speed rail study – Contract awarded to update high-speed rail feasibility studies," News Release, February 23, 2009. Available at: http://www.newswire.ca/en/releases/archive/February2009/23/c3092.html

[53] Bob Nichols, email message to ECO staff, November 4, 2010.

[54] Québec-Ontario High Speed Rail Project Study (QOHSRTPS). Available at: http://bernardoanderson.com/tce.pdf.

[55] Paul Langan, "Getting on track," *Corporate Knights*, Issue 31, Spring 2010, 33.

[56] Martin Prosperity Institute, *Infrastructure and the Economy: Future directions for Ontario* Working Paper Series: Ontario in the Creative Age, Chris Kennedy, Bryan Karney, Eric Miller, and Marianne Hatzopoulou, February 2009, 10.

[57] Pembina Institute, *Reducing GHG Emissions from Ontario's Transportation Sector – Technical and Policy Report for ECO*, 2010, unpublished ECO report, 43.

[58] Natural Resources Defense Council and Environmental Defence, *A Comparison of California and British Columbia's Low Carbon Fuel Standards*, March 2010 (accessed April 28, 2011). Available at: http://www.climateactionnetwork.ca/webyep-system/program/download.php?FILENAME=53-31-at-PDF_File_Upload_1.pdf&ORG_FILENAME=BC_and_CA_fuel_standard_comparison_FINAL.pdf

[59] Metrolinx, *GO Electrification Study Draft Final Report*, December 2010, 63. Available at: http://www.gotransit.com/estudy/en/current_study/docs/ElectricificationStudy_FinalReport.pdf.

[60] Ministry of Revenue, "Tax for Fuel Conservation," August 2010. Available at: http://www.rev.gov.on.ca/en/guides/rst/513.html (accessed April 21, 2011).

[61] Ministry of Revenue, "Vehicles Powered by Alternative Fuels," Available at: http://www.rev.gov.on.ca/en/refund/vpaf/ (accessed April 21, 2011).

[62] Ministry of Revenue, "What's Taxable Under the HST and What's Not?," Available at: http://www.rev.gov.on.ca/en/taxchange/taxable.html (accessed April 28, 2011).

[63] Government of Ontario, "Ontario's Plan for More Jobs and Growth," News Release, November 16, 2009. Available at: http://news.ontario.ca/mof/en/2009/11/ontarios-tax-plan-for-jobs-and-growth-1.html.

[64] David Bunch and David Greene, *Potential Design, Implementation, and Benefits of a Feebate Program for New Passenger Vehicles in California: Interim Statement of Research Findings*, Prepared for California Air Resources Board, 2010. Available at: http://pubs.its.ucdavis.edu/download_pdf.php?id=1400 (accessed April 28, 2011).

[65] Government of Ontario, 2007. *Go Green: Ontario's Action Plan on Climate Change* (Toronto, Queen's Printer for Ontario: August 2007), 12.

[66] John German and Dan Meszler, "Best Practices for Feebate Program Design and Implementation", International Council on Clean Transportation April 2010.

[67] Environmental Commissioner of Ontario, *2005/2006 Annual Report: Neglecting Our Obligations* (Toronto, Ontario: 2005), 45. Available at: http://www.eco.on.ca/index.php?page=2005-06-annual-report&hl=en_US

[68] Environmental Commissioner of Ontario. *Annual Energy Conservation Progress Report, 2009 (Volume One): Rethinking Energy Conservation in Ontario*. (Toronto, Queen's Printer for Ontario), 33–35.

[69] CBC News, "Traffic jams cost Toronto $3.3B per year: OECD", November 10, 2009. Available at: http://www.cbc.ca/news/canada/toronto/story/2009/11/10/oecd-traffic.html.

[70] Pamela Blais, *Perverse Cities: Hidden Subsidies, Wonky Policy, and Urban Sprawl* (Vancouver: UBC Press, 2010).

[71] G. Dierkers et al, *CCAP Transportation Emissions Guidebook Part One.* Available at: http://www.ccap.org/safe/guidebook/guide_complete.html

[72] The Brookings Institution, *Pay-As-You-Drive Auto Insurance: A Simple Way to Reduce Driving-Related Harms and Increase Equity*, July 2008. Available at: http://www.brookings.edu/papers/2008/07_payd_bordoffnoel.aspx (accessed April 28, 2011).

[73] Western Climate Initiative, *Final Complementary Policies White Paper*, May 20, 2010, 32. Available at: http://www.raponline.org/docs/RAP_WCI_ComplementaryPolicies_FinalWhitePaper_2010_05_20.pdf

[74] Forster, P., V. Ramaswamy, et. al., 2007, "Changes in Atmospheric Constituents and in Radiative Forcing," *Climate Change 2007: The Physical Science Basis. Contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge UK, Table 2.14, 212.

[75] Environmental Commissioner of Ontario, *Annual Greenhouse Gas Progress Report 2010: Broadening Ontario's Climate Change Policy Agenda* (Toronto, Ontario: 2010), 17–19.

[76] Forster, P., V. Ramaswamy, et. al., 2007, "Changes in Atmospheric Constituents and in Radiative Forcing," *Climate Change 2007: The Physical Science Basis. Contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge UK, Table 2.14, 212.

[77] Ramanathan, V. and Carmichael, G. "Global and regional climate changes due to black carbon," *Nature Geoscience* 1, (2008): 221–227. Available at: http://www.nature.com/ngeo/journal/v1/n4/pdf/ngeo156.pdf (accessed April 21, 2011).

[78] International Council on Clean Transportation, *A policy-relevant summary of black carbon climate science and appropriate emissions control strategies*, June 2009.

[79] John Lash, "Black Carbon an Easy Target for Climate Change," *Policy Innovations,* February 9, 2009. Available at: http://www.policyinnovations.org/ideas/innovations/data/000084 (accessed April 21, 2011).

[80] Alan Sundermeier, Randall Reeder, and Rattan Lal, "Soil Carbon Sequestration – Fundamentals," Ohio State University, Extension Factsheet. Available at: http://ohioline.osu.edu/aex-fact/pdf/0510.pdf (accessed April 28, 2011).

[81] Rattan Lal, "Crop Residues and Soil Carbon," Carbon Management and Sequestration Center, The Ohio State University, Columbus, Ohio, 3.

[82] Ibid., p 3.

[83] Intergovernmental Panel on Climate Change Special Report, *Land Use, Land-Use Change and Forestry,* 2000. Available at: http://www.ipcc.ch/pdf/special-reports/spm/srl-en.pdf (accessed April 28, 2011).

[84] Paul Hepperly, et al., Jr., "Organic Farming Enhances Soil Carbon and Its Benefits", *Soil Carbon Management* (2007) CRC Press, edited by J.M. Kimble at al., 268.

[85] Johannes Biala, "Compost Use Mitigates Climate Change," *BioCycle* Magazine (January 2011): 42–44.

[86] M.B. Jones and Alison Donnelly, "Carbon Sequestration in temperate grassland ecosystems and the influence of management, climate, and elevated CO_2" *Tansley Review, New Phytologist* 164 (2004): 423–439.

[87] M.A. Liebig, et al., "Soil Carbon Storage by Switchgrass Grown for Bioenergy," *Bioenerg. Res.*, Vol. 1 (2008): 215–222.

[88] The percentage areas in the table are based on the following assumptions. Regarding RMPs on croplands almost half of Ontario's farmers have already adopted conservation tillage, so projecting 40 per cent taking up other carbon enhancing methods seems reasonable. Regarding organic farming, a study (R. MacRae, et al., 2006 "Ontario Goes Organic: How to Access Canada's Growing Billion Dollar Market for Organic Food," World Wildlife Fund and the Ontario Agriculture Centre of Canada. Toronto, ON.) suggests that 10 per cent was a reasonable target given the market for organic food in Ontario which currently far exceeds supply. Regarding compost application, 5 per cent is probably close to the maximum for compost production given the supply of organic residuals in Ontario. Regarding pasture, about 60 per cent of farmers with pasture report using rotational grazing, so projecting an increase in use of RMPs of 25 per cent over the next few years seems reasonable. Regarding energy crops, a recent study (Ontario Power Generation, 2011. "Assessment of the availability of agricultural biomass for heat and energy production in Ontario") estimates that the use of 10 per cent of Ontario's farmlands for energy crops would satisfy OPG's need for biomass for energy.

[89] See "Stability of Biochar in Soil", by Johannes Lehmann, in *Biochar for Environmental Management*. 2009. Lehmann and Joseph, eds. Lehmann suggests a half-life of two to three thousand years for biochar in soils.

[90] Barry Husk and Julie Major. 2010. "Commercial scale agricultural biochar field trial in Quebec, Canada over two years: effects of biochar on soil fertility, biology, and crop productivity and quality."

[91] Environmental Commissioner of Ontario, Annual Report 2009/2010; *Redefining Conservation*, 142.

[92] Environmental Commissioner of Ontario, Annual Report 2008/2009; *Building Resilience*, 166.

[93] Ibid, 83.

[94] D. Reinhart, et al, 2005. *First-Order Kinetic Gas Generation Model Parameters for Wet Landfills* (EPA-600/R-05/072) June 2005 @ Section 2.6, 2-2.

[95] Memorandum to Brian Guzzone, U.S. EPA, from Chad Leatherwood, Eastern Research Group, Inc., November 18, 2002, re: "*Review of Available Data and Industry Contacts Regarding Landfill Gas Collection Efficiency".*

[96] George Tchobanoglous, *Integrated Solid Waste Management* (McGraw Hill, 1993), 394; U.S. EPA Memorandum from Chad Leatherwood to Brian Guzzone, November 18, 2002, 1.

[97] S. Thompson and J. Sawyer, et al., *Review of Existing Landfill Methane Generation Model: Interim Report* (Prepared for Environment Canada, November 2005).

[98] Center for a Competitive Waste Industry, 2010. *Effective Mitigation of Methane Emissions from Ontario Landfills*, Unpublished ECO Report.

[99] Environmental Commissioner of Ontario, Annual Report 2008/2009; *Building Resilience*, 82.

[100] Memorandum to Brian Guzzone, U.S. EPA, from Chad Leatherwood, Eastern Research Group, Inc., November 18, 2002, re: *"Review of Available Data and Industry Contacts Regarding Landfill Gas Collection Efficiency"*.

[101] U.S. EPA, *Greenhouse Gas Emissions for Management of Selected Materials in Municipal Solid Waste* (EPA 530-R-98-013), September 1998, 106; *Turning a Liability into an Asset: A Landfill Gas-to-Energy Project Development Handbook* (EPA 430-B-96-004), September 1996, 2–8.

[102] ICF Consulting, *Determination of the Impact of Waste Management Activities on Greenhouse Gas Emissions: 2005 Update* (2005), 70; Conestoga-Rovers & Associates, 2007, *Assessment of Greenhouse Gas Generation and Potential Reductions for Select Landfills in Ontario*, prepared for Ontario Ministry of the Environment, June 2007, 2.

[103] Memorandum to Brian Guzzone, U.S. EPA, from Chad Leatherwood, Eastern Research Group, Inc., November 18, 2002, re: *"Review of Available Data and Industry Contacts Regarding Landfill Gas Collection Efficiency"*.

[104] U.S. EPA, *Anthropogenic Methane Emissions in the United States*, (EPA 430-R-003), 4–11; U.S. EPA, *"U.S. Methane Emissions 1990–2020: Inventories, Projections, and Opportunities for Reductions."* (EPA 430-R-99-013).

[105] S. Brown, "Putting the Landfill Energy Myth to Rest," *BioCycle* Magazine (May 2010): 33 [35%]; European Commission, *A Study on the Economic Valuation of Environmental Externalities from Landfill Disposal and Incineration of Waste – Final Appendix Report* (October 2000), 144 [40%]; Ofira Ayalon, *et al.*, *"Solid Waste Treatment as a High-Priority and Low Cost Alternative for Greenhouse Gas Mitigation,"* 27 Environmental Management 5 (May 2001), 699 [50%]; Riitta Pipatti and Margareta Wihersaari, *"Cost-Effectiveness of Alternative Strategies in Mitigating the Greenhouse Impact of Waste*

Management in Three Communities of Different Sizes," Mitigation and Adaptation Strategies for Global Change, 344 (1998) [40%]; Nickolas Themelis and Priscilla Ulloa, *"Methane generation in landfills,"* ScienceDirect-Renewable Energy (April 2006), 8 [34%].

106 S. Thompson and J. Sawyer, et al., *Review of Existing Landfill Methane Generation Model: Interim Report* (Prepared for Environment Canada, November 2005). 8.

107 Ontario has no mandated timeframes for the implementation of gas control systems in any of its regulations, policies or guidelines. These requirements are negotiated during the issuance of Certificates of Approval, on an individual, case-by-case basis.

108 J. Bogner, et al., "Waste Management", *Climate Change 2007: Mitigation, Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, 600.

109 Peter Anderson, "Some Essential Facts About Landfill Gas Emissions," *MSW Management* (February 2011). Anderson notes that the 20 per cent value is a "global average" only as it applies to developed countries "because most landfills in the underdeveloped world are shallow, frequently burned, open dumps [that] do not create…anaerobic conditions… Methane from garbage is, ironically, largely an unintended consequence of the liners used in the developed world to reduce groundwater contamination."

110 D. Reinhart, et al, 2005. *First-Order Kinetic Gas Generation Model Parameters for Wet Landfills* (EPA-600/R-05/072) June 2005, E-3, 1-1 and 4-1.

111 Ibid, 3-2.

112 Ibid, 3-2.

113 Based on this assumption, MOE further assumes that 125 m^3 of methane is generated per tonne of waste. Conestoga-Rovers & Associates, *Assessment of Greenhouse Gas Generation and Potential Reductions for Select Landfills in Ontario*, prepared for Ontario Ministry of the Environment, June 2007, 2.

114 U.S. Department of Energy, 1996. *Renewable Energy Annual*, at Chapter 10 (Growth of the Landfill Industry) Table 28.

115 S. Thompson and J. Sawyer, et al., *Review of Existing Landfill Methane Generation Model: Interim Report* (Prepared for Environment Canada, November 2005), 16.

116 Ibid, 11.

117 D. Reinhart, et al, 2005. *First-Order Kinetic Gas Generation Model Parameters for Wet Landfills* (EPA-600/R-05/072) June 2005, 2-2.

118 S. Thompson and J. Sawyer, et al., *Review of Existing Landfill Methane Generation Model: Interim Report* (Prepared for Environment Canada, November 2005), 11.

119 U.S. EPA considers it necessary to add outside liquids in order to reach 45 per cent moisture. 67 *Federal Register* 100 (May 23, 2002).

120 Bioreactor landfills use moisture to increase methane gas generation. See http://www.epa.gov/wastes/nonhaz/municipal/landfill/bioreactors.htm; Waste Management Inc., 2004. *The Bioreactor Landfill*, Waste Management Bioreactor Program, Cincinnati, Ohio.

[121] Environmental Commissioner of Ontario, Annual Report 2008/2009, *Building Resilience*, 82.

[122] George Tchobanoglous, *Integrated Solid Waste Management* (McGraw Hill, 1993), 106.

[123] A composite cap includes a layer of compacted clay placed over the waste, followed by a thick plastic membrane of high density polyethylene. The plastic and the clay layer work together to form a cap that helps reduce the amount of rain water entering the landfill and helps reduce odors from escaping the landfill. A layer of sand or gravel is installed directly on top of the HDPE membrane (See http://www.betterwhenbio.com/landfills.php).

[124] Center for a Competitive Waste Industry, 2010. *Effective Mitigation of Methane Emissions from Ontario Landfills*, Unpublished ECO Report.

[125] Ibid.

[126] P.M. Czepiel, et al., "Quantifying the effect of oxidation on landfill methane emissions," *Journal of Geophysical Research*, (July 20, 1996): 16,720.

[127] B. Bahor, et al., "Updated Analysis of Greenhouse Gas Emissions from Municipal Solid Waste Management Options Using a Carbon Balance," *Global Symposium* (2008), 17.

[128] Center for a Competitive Waste Industry, 2010. *Effective Mitigation of Methane Emissions from Ontario Landfills*, Unpublished ECO Report.

[129] Ontario Ministry of the Environment, *Landfill Gas Capture: A Guideline on the Regulatory and Approval Requirements for Landfill Gas Capture Facilities* (PIBS 6876e), September 2008. Available at: http://www.ene.gov.on.ca/environment/en/resources/STD01_076002.html

[130] Ontario Ministry of the Environment, *Landfill Inventory Management Ontario (LIMO)*. Available at: www.ene.gov.on.ca/en/land/limo/

[131] A survey of these smaller sites completed just after these announced changes to the regulation found that most had already completed studies for gas recovery. They were done not because of the new regulations but in direct response to the Ontario Power Authority's (OPA's) December 2006 Standard Offer Program for Renewable Energy which identified landfill gas as an eligible "renewable biomass generation facility" under the program. (Ontario Power Authority, 2006. Standard Offer Program Renewable Energy – Final Program Rules, November 2006. Available at: http://archive.powerauthority.on.ca/sop/Storage/32/2804_RESOP_Program_Rules_Version_2.0.pdf.

[132] Note that the MOE is still using a GWP factor of 21 for methane, even though the IPCC increased methane's multiplier to 25 in 2007 (See Intergovernmental Panel on Climate Change (IPCC), 2007. *Climate Change 2007: Synthesis Report – Summary for Policymakers*. An Assessment of the Intergovernmental Panel on Climate Change: http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf). As such, Ontario may be underestimating the real climate change forcing posed by methane from landfills and other sources.

[133] R.R.O. 1990, *Regulation 347: General – Waste Management* (as amended), subsection 11.4(1)–(4).

[134] MOE Policy Proposal Notice October, 28, 2009 (Environmental Registry #010-8164). Available at: http://www.ebr.gov.on.ca/ERS-WEB-External/displaynoticecontent.do?noticeId=MTA4MDIy&statusId=MTYyMjY5&language=en

[135] Ontario Ministry of the Environment, 2009. *From Waste to Worth: The Role of Waste Diversion in the Green Economy*, October 2009, 18.

[136] Ibid., 23.

[137] Ibid., 30.

[138] Ministry of the Environment, *Landfill Gas Capture: A Guideline on the Regulatory and Approval Requirements for Landfill Gas Capture Facilities* (PIBS 6876e), September 2008. Available at: http://www.ene.gov.on.ca/environment/en/resources/STD01_076002.html

[139] Government of Ontario. "Climate Progress: Ontario's Plan for a Cleaner more Sustainable Future." April, 2011, 51.

[140] Province of Ontario *Environmental Protection Act*. "O. Reg. 232/98 – Landfilling Sites". ss. 10(4)2; 10(5)2. Available at: http://www.canlii.org/en/on/laws/regu/o-reg-232-98/latest/o-reg-232-98.html (accessed April 28, 2011).

[141] Center for a Competitive Waste Industry, 2010. *Effective Mitigation of Methane Emissions from Ontario Landfills*, Unpublished ECO Report.

[142] Environmental Commissioner of Ontario, Annual Report 2008/2009, *Building Resilience*, 83.

[143] See OPA, *Feed-in Tariff Prices for Renewable Energy Projects in Ontario*, Ontario Power Authority, Aug 13, 2010. Available at: http://fit.powerauthority.on.ca/Storage/11128_FIT_Price_Schedule_August_13_2010.pdf.

[144] Center for a Competitive Waste Industry, *Beyond Recycling: Composting Food Scraps and Soiled Paper* (2010), 42.

[145] Adam Gendell, *Assessing the Greenhouse Gas Impacts of Biodegradation in Landfills*, Sustainable Packaging Coalition, 2011.

[146] Ontario Ministry of the Environment, 2009. *From Waste to Worth: The Role of Waste Diversion in the Green Economy*, October 2009, 23.

[147] Flaring is preferred to combustion in internal combustion engines or turbines because the former destroys 99 per cent of the methane collected while the latter may only destroy 94 per cent. Source: U.S. EPA, AP-42 (5^{th} Ed), Table 2.4-3. The noted control efficiencies for flares and reciprocating engines are for NMOCs, halogenated species and non-halogenated species, not for CH_4 or CO_2 specifically. In the absence of data on point, the typical control values for all three were averaged as an initial estimate pending the availability of better data.

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