Pollution Probe
CLEAN AIR. CLEAN WATER.

Report on Energy from Waste in Ontario's Cement Sector

Finding Worth in Waste

Prepared by Pollution Probe July 2014

ABOUT THIS REPORT

This report was prepared by Pollution Probe and provides a preliminary overview of the possible role of energy from waste in the cement sector in Ontario. In order to help the sector reduce its greenhouse gas emissions and help Ontario move towards a zero landfill future, this report recommends that cement manufacturers be permitted to use non-recyclable waste streams as a fuel alternative to coal and petroleum coke.

ABOUT POLLUTION PROBE

Pollution Probe is a national, not-for-profit, charitable organization that exists to improve the health and well-being of Canadians by advancing policy that achieves positive, tangible environmental change. Pollution Probe has a proven track record of working in successful partnership with industry and government to develop practical solutions for shared environmental challenges.

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Executive Summary

Pollution Probe applauds the Government of Ontario for embracing the vision of a zero landfill future for the province. To us, the attainment of this vision will serve as an indicator of responsible and efficient resource use, whereby the full value of goods is captured over their complete life cycle, with the realization of the lowest environmental impact and the highest economic and social benefits.

Pollution Probe believes that the introduction of the proposed *Waste Reduction Act, 2013* and *Waste Reduction Strategy, 2013* creates an opportunity for the Government of Ontario to seed the right conditions for medium- and near-term clean technology innovation, tangible environmental progress, and economic growth. To create these conditions, the Government of Ontario needs to nurture the development and stimulate the adoption of new approaches to material design and waste management emerging locally and across global jurisdictions. Individual producer responsibility is one provision of the proposed *Waste Reduction Act, 2013* and *Waste Reduction Strategy, 2013*, that is particularly conducive to innovation, as it encourages waste reduction at the source and promotes market-oriented, competitive solutions over a product's life cycle. Limiting the progressive nature of this provision, however, is the 3R waste management hierarchy (reduce, reuse and recycle) that the Government of Ontario has upheld in the proposed Act.

Pollution Probe is concerned that by dismissing energy recovery from waste as a component of accepted waste management options, the proposed *Waste Reduction Act, 2013* and *Waste Reduction Strategy, 2013*, may be failing to address Ontario's pressing landfill capacity issue in a timely manner, and may be missing out on realizing substantial emissions reductions in the waste management and manufacturing sectors. Energy from waste using today's best available technologies, and utilized in its proper place in Ontario's waste hierarchy (after the 3Rs, yet before landfilling), should be counted towards the province's waste diversion targets and should be deemed acceptable in industries that require a steady stream of hydrocarbon-based fuels to power their manufacturing processes (industries like cement, steel and lime manufacturing).

Given the rapidly growing number of jurisdictions in North America and abroad that are embracing energy from waste as a means to capture the full value of material resources, minimize landfilling, reduce greenhouse gas emissions in manufacturing and waste management, and spur technological innovations that enhance the sustainability of modes of production and consumption, Pollution Probe recommends that the Government of Ontario allow the province's cement sector to use refuse-derived fuel—waste streams that are non-recyclable yet have a high calorific value—as a fuel alternative to the non-renewable fossil fuels that currently power cement manufacturing. The central role that cement plays, and will long continue to play, in our society's infrastructure is such that we feel the sector should be given the latitude it needs to test and employ a variety of alternative fuels as it strives to reduce its environmental impact and maintain its economic viability.

Findings presented in this paper suggest that, environmentally, energy from waste using modern technologies will release fewer greenhouse gas emissions than landfilling; economically, energy from waste will generate power and revenue from materials that are currently unutilized, and will contribute to sustainable offshoot industries and jobs; socially, the pursuit of innovation in green technologies will help to make Ontario a hub of cutting-edge knowledge in the field of sustainable development, will encourage broader policy integration in the province and will allow the cement sector to develop and realize the innovative capacity it requires to remain viable in the long term.

By endorsing energy from waste in the cement sector, the Government of Ontario could further its mandate to eliminate coal as a source of energy in the province through the displacement of coal as a fuel in industrial processes. The cement sector is currently one of biggest users of coal and petroleum coke in the province, but with forward-thinking policy initiatives the province could help to eliminate the combustion of these fossil fuels altogether.

Introduction

Pollution Probe shares the Government of Ontario's vision of a zero landfill future. The landfilling of materials as waste indicates the suboptimal use of resources and reflects inefficiencies at certain points over the course of a product's design and use. With the proposed *Waste Reduction Act, 2013* and *Waste Reduction Strategy, 2013*, the Government of Ontario should pursue opportunities to decisively address Ontario's pressing landfill capacity issue, stimulate clean technology innovation, and reduce emissions associated with waste management and manufacturing. Simply dismissing non-recyclable materials as waste ignores the latent energy and value embedded in Ontario's current mix of residual by-products. By continuing to landfill such by-products we are essentially burying money at a time when we should be focussed on optimizing the value of all the resources we have at our disposal. In order to achieve the highest economic and social gains and the lowest environmental impacts of material resources over their life cycle, we must embrace the rapidly evolving innovations in material design, reuse and recycling, as well as residuals management.

New approaches to material design and waste management that foster sustainable development are rapidly emerging in domestic and international jurisdictions. If materials and products are designed with their entire life cycles in mind, extracting the full value of such materials and products at each stage of their use becomes cost-effective and efficient. If producers are held accountable for the recycling and diversion costs associated with their products, they will design products so as to be easy to disassemble, and with a minimal number of materials.

Drawing from a literature review and consultations with subject-matter experts, this report urges the Government of Ontario to consider energy from waste as an option for cement producers to help meet the province's waste reduction ambitions while ensuring stringent environmental protection and maintaining the priorities of waste reduction at the source, material reuse and recycling.

To this end, the report begins with a general overview of the role that the cement sector plays in Canada's economy and infrastructure, highlighting some fundamental practices, challenges, and trends in the sector. Chapter 2 broadly examines the regulatory framework of waste management in Ontario, summarizing the proposed *Waste Reduction Act, 2013* and *Waste Reduction Strategy, 2013*, with a focus on aspects of them that may serve as a hindrance to the attainment of their stated goals, and providing an introduction to the concept of a 4R waste management hierarchy. Chapter 3 looks at how energy from waste initiatives can have a minimal detrimental impact on the environment, overviewing the regulatory mechanisms in place at the provincial, federal, and international levels to ensure that environmental protection remains a top priority. The report then highlights some domestic and international case studies of energy from waste in practice, exploring the efficacy and evolution of waste management policies in recent decades. Chapter 5 takes a close look at the emerging role of energy from waste in Québec and British Columbia, and how the 4R hierarchy is administered and regulated in those provinces. Chapter 6 assesses the legal precedents for energy from waste in Ontario's cement sector, focussing on a case of central importance in regard to the distinction between waste materials and fuel. The report wraps up with a chapter that discusses the ramifications of all the information presented, and puts forth some recommendations which we feel will move Ontario closer to realizing its potential as a bastion of sustainable development.

In short, this report presents a summary of Pollution Probe’s investigations into how emerging opportunities in energy from waste are addressed in policy, regulations and legal precedent in Ontario, with a focus on applications in the cement sector. We hope that these investigations will serve to inform Ontario’s waste management policies and its ambition to reduce the use of fossil fuels in energy-intensive industries like those which produce cement, lime, iron and steel. Although this report endorses the establishment of a 4R waste management hierarchy in Ontario, it does not make specific recommendations on how best to design and implement such a hierarchy. It is the intention of Pollution Probe to develop such recommendations in due course, after we report on the detailed findings stemming from the low carbon fuel project currently underway at Lafarge Canada’s Bath, Ontario plant—a project in which Pollution Probe and Queen’s University are partners. This report is thus the first in a series of projects that will help to inform a robust and sustainable 4R approach in Ontario.

Pollution Probe believes that the time is now for the Government of Ontario to introduce forward-looking waste management regulations that will help transform our fossil fuel-reliant society to one in which the products we use are designed with the utmost resource efficiency in mind and where any residuals remaining after their use and recycling can power the creation of valuable goods and processes. We encourage the government to stay in tune with technological innovations that will enable such a transformation and to evaluate all available waste management options to minimize the risk of unintended consequences. As technologies related to material design, waste management, emissions mitigation, and alternative fuels evolve and new research becomes available, we look forward to continuing the dialogue started as part of this report.

Chapter 1: An Overview of the Cement Sector in Canada

Canada's cement sector is responsible for the production of what is estimated to be second only to water as the most consumed substance on the planet: concrete. There are currently 17 cement plants operating in five provinces which produce over 98% of the cement used in Canada.[1,2] Over 15 million tonnes of cement are produced in Canada each year, and over 4 million tonnes are exported, for a total contribution of over $3.2 billion to Canada's GDP.[3] The sector employs over 27,000 Canadians in its 17 plants, 45 distribution centres, and 1,100 production facilities nation-wide.[4]

Cement is a fine powder with hydraulic binding properties, primarily composed of limestone, but also includes sand/silica, clay, a source of iron, gypsum, and the minerals contained in the fuel used to heat the limestone (typically coal and/or petroleum coke).[5] When mixed with water, cement forms a paste and then hardens to bind the mineral aggregates present in concrete together. Concrete is a mixture of cement, aggregates, and water that hardens to form a versatile and robust building material.

The cement manufacturing process begins with the crushing, grinding, and mixing of the raw ingredients, which are fed into large rotary kilns and heated to average temperatures of 1,450°C to form clinker (lumps of sintered limestone and clay, roughly 1 cm in diameter). Residues from the fuels used to produce the clinker become incorporated into the clinker itself, comprising an integral component of the finished cement. This means that most modern day cement plants produce no solid waste as by-products of manufacturing. After the sintering process is completed, the clinker is then mixed with additives and ground once again to produce cement. The production of clinker is by far the most energy intensive phase of the cement manufacturing process, accounting for over 90% of the sector's energy use and almost all of its fuel use.[6]

More than 1.5 tonnes of raw ingredients are required to produce one tonne of Portland cement, the most common type of cement in the world.[7] Each tonne of cement produced leads to the production of roughly 0.8 tonnes of CO_2, roughly 40% of which stems from the combustion of fuels used to produce clinker, 10% of which stems from the transport of fuel and raw materials, with the remainder coming from the calcination of limestone in kilns (which leads to the liberation of CO_2 molecules from limestone molecules ($CaCO_3$) when lime (CaO) is produced).[8] These significant emission levels, along with the

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[1] Cement Association of Canada (CAC). 2008. The Canadian Cement Industry: 2008 Overview. Retrieved from: http://www.cement.ca/en/Cement-Industry/The-Canadian-Cement-Industry.html

[2] Cement Association of Canada (CAC). 2012. Economic Contribution: An Important Sector of Canada's Economy. Retrieved from: http://www.cement.ca/en/Economic-Contribution.html

[3] Ibid

[4] Ibid

[5] Asia-Pacific Partnership on Clean Development & Climate (APP). n.d. Energy Efficiency and Resource Saving Technologies in Cement Industry. Retrieved from: http://www.asiapacificpartnership.org/pdf/projects/cement/app_booklet_of_cement_technology.pdf

[6] Ibid

[7] Ibid

[8] Karstensen KH. 2007. A Literature Review on Co-processing of Alternative Fuels and Raw Materials and Hazardous Wastes in Cement Kilns. Prepared for SINTEF. Retrieved from: http://www.aitec-

widespread production and use of cement throughout the world mean that the cement sector is responsible for roughly 5% of global greenhouse gas emissions and 3.8% of Canada's emissions—numbers the sector is working in earnest to mitigate.[9,10]

There are three broad means by which the cement sector can reduce its CO_2 emissions: 1. Maximize the efficiency of manufacturing processes, including equipment, fuels, and materials; 2. Use alternative fuels (biomass and waste, as opposed to fossil fuels); and 3. Replace a portion of the clinker in the cement with alternative materials that do not require thermal processing (as in Portland limestone cement, which grinds Portland cement clinker with 6 to 15% raw limestone).[11] Cement kilns are able to make full use of both the calorific and the mineral content (contained in the ashes) of alternative fuels. In general, cement plant operators have found that cement quality and process stability are largely unaffected by the use of alternative fuels.[12] Typically, however, only alternative fuels with a low chlorine and metal content are utilized, so as not to compromise the quality of the cement.[13]

The typical residence time of combustion gases in cement kilns is five to ten seconds at a temperature higher than 1,000°C. By contrast, gas residence time in dedicated waste incinerators tends to be roughly two seconds. Residence time for solid materials in cement kilns varies from tens of minutes to an hour depending on the cement manufacturing process being utilized.[14] Under normal operating conditions in modern cement kilns—i.e., flame temperatures of up to 2,000°C, material temperatures of up to 1,450°C, and gas retention times of up to 10 seconds at temperatures between 1,200 and 2,000°C—all forms of organic compounds fed into the main burner with the fuels are reliably destroyed. No hydrocarbon by-products of incomplete combustion can be detected in the combustion gases of main burners while running at steady-state conditions.[15]

Creosote, a by-product of tar distillation produced by burning wood or coal, especially incompletely, is used to pressure-treat railway ties (and sometimes utility poles), often comprising up to 15% of their

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ambiente.org/Portals/2/docs/pubblici/Documenti/Raccolta%20bibliografica/Coprocessing%20literature%20review%202007.pdf

[9] Ibid

[10] Cement 2020. 2013. Lafarge Canada Inc., partners invests $8 million in innovative low carbon fuels at its Bath Cement Plant. Retrieved from: http://www.cement2020.org/content/lafarge-canada-inc-partners-invests-8-million-innovative-low-carbon-fuels-its-bath-cement

[11] Karstensen KH. 2007. A Literature Review on Co-processing of Alternative Fuels and Raw Materials and Hazardous Wastes in Cement Kilns. Prepared for SINTEF. Retrieved from: http://www.aitec-ambiente.org/Portals/2/docs/pubblici/Documenti/Raccolta%20bibliografica/Coprocessing%20literature%20review%202007.pdf

[12] Lafarge and Hyndman & Associates. 2011. Lafarge Biomass Demonstration Project Summary Report: A summary report to satisfy the reporting requirements for the Certificate of Approval to combust various sources of agricultural biomass in the Lafarge Bath plant cement kiln. Retrieved from: http://www.cement2020.org/publication/all/148

[13] Karstensen KH. 2007. A Literature Review on Co-processing of Alternative Fuels and Raw Materials and Hazardous Wastes in Cement Kilns. Prepared for SINTEF. Retrieved from: http://www.aitec-ambiente.org/Portals/2/docs/pubblici/Documenti/Raccolta%20bibliografica/Coprocessing%20literature%20review%202007.pdf

[14] Ibid

[15] Ibid

mass.[16] Because all combustible components of fuels used in cement kilns are consumed by the high temperatures and high retention times, creosote treated wood can be used as fuel in cement kilns without restrictions.[17] All of the spent creosote and pentachlorophenol (PCP) treated wood produced in Canada could theoretically be used to fuel the nation's cement kilns if approvals could be obtained.[18]

The vast majority (over 99%) of inorganic hazardous compounds and heavy metals present in fuel become incorporated into the finished cement, with the exceptions of mercury (61% incorporated into cement), thallium (90%), and selenium (95%).[19] These numbers do not vary significantly when alternate fuels are used to replace coal and petroleum coke, with comparable concentrations of heavy metals in emissions and the finished product. Coal can contain significant levels of heavy metals and halogens, the concentrations of which differ based on the type of coal and the area from which it was mined. Coal is often found to contain antimony, arsenic, barium, cadmium, chromium, lead, mercury, nickel, selenium, silver, thallium, vanadium, and zinc, as well as bromine, chlorine, fluorine, and iodine. The majority of coal, however, is composed of aromatic organic compounds (like most types of alternative fuels), which emit aromatic compounds like benzene and toluene when burned. The varying concentrations of organic compounds, heavy metals, and halogens in coal can complicate the results of emissions monitoring at cement plants.[20]

In some countries, the cement industry provides a public service by disposing of waste—even waste streams with little or no useful energy or mineral content. This may be done at the request of national governments or in response to local demand. Cement kilns can do this as they provide high temperatures and long residence times, as well as being carefully controlled to achieve high destruction efficiency. Such activities, however, are not part of the fuel or raw material substitution process as waste in these instances is incinerated as a form of disposal, without regard for its calorific or mineral content. Cement kilns have been used in this way for decades in many countries, such as Japan, Norway, and Switzerland, where there is little space for landfill sites. In Norway, polychlorinated biphenyls (PCBs) have been disposed of in cement kilns since the early 1990s. More recently, modern kilns have been used for waste disposal in some developing countries where the lack of existing waste disposal and incineration infrastructure means that kilns are the most economical option. Even where good waste disposal infrastructure exists, it often proves useful to increase local capacity through the use of cement kilns.[21]

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[16] Simpson Strong-Tie Company Inc. 2013. Preservative Treated Wood FAQs. Retrieved from: http://www.strongtie.com/productuse/ptwoodfaqs.html#

[17] Cooper PA. 1999. Future of Wood Preservation in Canada—Disposal Issues. Presented at the 20th Annual Canadian Wood Preservation Association Conference. Retrieved from: http://www.forestry.utoronto.ca/treated_wood/future.pdf

[18] Ibid

[19] Karstensen KH. 2007. A Literature Review on Co-processing of Alternative Fuels and Raw Materials and Hazardous Wastes in Cement Kilns. Prepared for SINTEF. Retrieved from: http://www.aitec-ambiente.org/Portals/2/docs/pubblici/Documenti/Raccolta%20bibliografica/Coprocessing%20literature%20review%202007.pdf

[20] Ibid

[21] Ibid

There are many sources of waste materials and by-products that can be used as alternative fuels, raw materials and cement constituents. Examples of by-products that are appropriate for use as alternative fuels in the cement sector include: bone meal and animal fat (which are banned from use in Ontario due to odour issues), plastics, wood products and residues, scrap tires (banned in Ontario due to concerns over toxic emissions), coal slurry, sewage sludge, carpeting, various types of cokes, refuse-derived fuels, packaging waste, agricultural and organic waste, and waste oil. Recovered materials that are appropriate for use as raw materials or cement constituents include: blast furnace or steel manufacturing slag, fly ash, and gypsum.[22]

Many countries have been burning forms of recycled waste as cement kiln fuel for over 30 years, with some governments actively promoting this approach. As of 2005, ten countries, all located in Europe, were already using a mix of over 20% alternative fuels in their cement manufacturing (Netherlands 83%, Switzerland 48%, Austria 46%, Germany 42%, Norway 35%, France 34%, Belgium 30%, Sweden 29%, Luxembourg 25%, Czech Republic 24%; the United States used 8%).[23]

Cement kilns typically operate continuously throughout the year—24 hours a day—with only minor interruptions for maintenance and repair. Smooth, consistent kiln operation is necessary for cement plants to meet production targets and the quality requirements of their products. To achieve these goals, all relevant process parameters are constantly monitored and recorded, including the analytical control of all raw materials, fuels, intermediate and finished products as well as emissions. With the requirements necessary to make a cement plant viable—i.e., large material flow, continuous operation and comprehensive process and product control—the cement manufacturing process is well suited for co-processing by-products, residues, and waste streams from industrial sources, both as raw materials and fuels substitutes and as mineral additions.[24]

Waste and hazardous waste management represent a challenge for many countries, but cement kiln co-processing can constitute an environmentally sound and affordable recovery option, as is evidenced in subsequent chapters. Cement kilns can destroy organic hazardous wastes in a safe manner when properly operated and can thus be mutually beneficial to industry, which generates such waste streams, and to the societies that want to dispose of such waste responsibly. The added benefit of non-renewable fossil fuel conservation is significant, since large quantities of fossil fuels can be omitted from the manufacture of cement when alternative fuels are employed.

Since the early 1970s, and particularly since the mid 1980s, alternative fuels derived mainly from industrial sources have been utilized in the cement industry for economic reasons. Since that time, it has been demonstrated both in daily operations and in numerous tests that the overall environmental performance of cement plants is not impaired by the use of alternative fuels.[25] To the contrary, it is normally the case that the use of alternative fuels significantly mitigates the negative environmental

[22] Ibid
[23] Ibid
[24] Ibid
[25] Ibid

impacts of cement operations—reducing greenhouse gas emissions from fuel use by up to 90% in relation to coal and petroleum coke.[26]

Since only moderate investments are required to successfully integrate alternative fuels into cement manufacturing, cement plants can acquire appropriate wastes at lower costs than would be required for landfilling or treatment in specialized incinerators. In addition, public investment required for the installation of new specialised incinerators or expanded landfill capacity would be significantly reduced. A comprehensive literature review conducted by Kare Helge Karstensen on behalf of SINTEF revealed that alternative fuels derived from waste streams usually reduce the production costs of cement manufacturing, thus strengthening the position of the industry, particularly in regard to imports from countries with less stringent environmental legislation.[27] Furthermore, the use of alternative fuels facilitates the industry's development and deployment of technologies to reduce atmospheric emissions.

[26] Lafarge Canada. April 2011. Biomass Use in the Cement Sector: A Fuel Users Perspective. Retrieved from: http://www.ofa.on.ca/uploads/userfiles/files/robert%20cumming.pdf

[27] Karstensen KH. 2007. A Literature Review on Co-processing of Alternative Fuels and Raw Materials and Hazardous Wastes in Cement Kilns. Prepared for SINTEF. Retrieved from: http://www.aitec-ambiente.org/Portals/2/docs/pubblici/Documenti/Raccolta%20bibliografica/Coprocessing%20literature%20review%202007.pdf

Chapter 2: The Need to Expand the Scope of Ontario's Proposed *Waste Reduction Act, 2013*

Summary of the Proposed *Waste Reduction Act, 2013*

In June 2013, the Government of Ontario proposed a new *Waste Reduction Act, 2013* and *Waste Reduction Strategy, 2013* for stakeholder consideration and feedback. These two documents aim to improve waste diversion efforts in the province by replacing the current *Waste Diversion Act, 2002* and to achieve the following results:

- Drive economic and environmental innovation by holding individual producers responsible for waste reduction outcomes;
- Transform Waste Diversion Ontario into a strong new compliance authority;
- Use all-in pricing to ensure consumer protection and incent improved product design;
- Increase support for municipal recycling programs such as Blue Box;
- Increase the recycling of a broader range of wastes; and
- Ensure existing programs are transitioned in a timely and smooth manner.[28]

An explanatory note accompanying the proposed *Waste Reduction Act, 2013*, Part I (General) states that "the purpose of the Act is to promote the reduction, reuse and recycling of waste derived from products, and contains definitions and other provisions of general application."[29] In the opening paragraphs of the proposed *Waste Reduction Strategy, 2013,* it is noted that a recycling transformation is needed in Ontario to "keep waste out of landfills for environmental reasons, but also because these materials have tremendous value and potential to generate new investment, new factories, new jobs, and new Ontario-made products. We do not want to truck these opportunities to a landfill—we need to kick start our recycling efforts."[30] High level rationales for the proposed *Waste Reduction Act, 2013* include:

- Recycling creates new jobs, fosters innovation, conserves resources and reduces environmental impacts;
- Progress on recycling is stalled;
- Action on waste management in the Industrial, Commercial and Institutional (IC&I) sector is needed;
- Challenges with the existing legislative framework are impeding progress;
- Lack of innovation and the need for strengthened consumer protection;
- The current approach has tax implications which are passed on to consumers;
- Costs to municipalities to fund recycling and disposal are increasing; and

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[28] Waste Reduction Strategy. June 2013. Government of Ontario. Retrieved from: http://www.downloads.ene.gov.on.ca/envision/env_reg/er/documents/2013/011-9262.pdf p. 20

[29] Legislative Assembly of Ontario. Bill 91, Waste Reduction Act, 2013. Retrieved from: http://www.ontla.on.ca/web/bills/bills_detail.do?locale=en&Intranet=&BillID=2818

[30] Waste Reduction Strategy. June 2013. Government of Ontario. Retrieved from: http://www.downloads.ene.gov.on.ca/envision/env_reg/er/documents/2013/011-9262.pdf p. 7

- Consensus is needed on the types of fundamental changes that are required.[31]

Furthermore, it is stated that "our vision is a province which moves towards zero waste, recognizing the inherent value of all materials while fostering economic and environmental innovation to increase access to convenient waste diversion approaches."[32] To achieve this vision, the Government of Ontario proposes to:

- Build on the success of Ontario's Blue Box program, designate paper and packaging supplied to the IC&I sector as the next waste to target;
- Develop recycling standards for end-of-life vehicles;
- Designate additional wastes over time;
- Develop a strategy to increase organics diversion;
- Ban designated wastes from disposal; and
- Quickly and smoothly transition existing waste diversion programs to the new individual producer responsibility framework.[33]

It is also noted that if the legislation is passed, the government plans to set recycling requirements, including waste reduction standards, service standards, and requirements for promoting public awareness for designated wastes in the future. However, the overall strategic objectives, within which these requirements would fall, are not specified in the proposed *Waste Reduction Act, 2013*. Specifying these objectives upfront is important to provide stakeholders with a sense of policy direction and waste management priorities in the province.

An example may be taken from Québec's *Residual Materials Management Policy*, which stipulates within the *Environment Quality Act* that the "goal of the Policy is to implement measures for the creation of a zero-waste society that seeks to maximize added value through sound residual materials management, thereby making it perpetual. It is accompanied by a 5-year action plan that sets intermediate goals for the period concerned," with the main goal of the Policy being "make end waste the only residual material sent for disposal in Québec."[34] To this end, the following objectives are specified in the Act:

"By the end of 2015:

- Reduce the quantity of residual materials sent for disposal to 700 kg per capita, 110 kg less per capita than in 2008;
- Recycle 70% of paper, cardboard, plastic, glass, and metal waste;
- Process 60% of organic putrescible waste;
- Recycle or reclaim 80% of concrete, brick, and asphalt waste;

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[31] Ibid, p. 7-12
[32] Ibid, p. 18
[33] Ibid, p. 18
[34] Ministère du Développement durable, de l'Environnement et des Parcs. Environment Quality Act Québec Residual Materials Management Policy. Retrieved from: http://www.mddefp.gouv.qc.ca/matieres/pgmr/presentation_en.pdf

- Sort at the source or send to a sorting center 70% of construction, renovation, and demolition waste from the building segment.

These goals represent a national average to which everyone must contribute. The first one, expressed in kilograms per capita, takes into account source reduction, reuse, recycling, and other forms of waste reclamation.

Each residual materials management plan must include measures compatible with achieving all goals in the area covered by the plan.

Other goals specific to materials or products–notably those under extended producer responsibility–are set by regulation or agreement."[35]

Defining guiding principles as part of the proposed *Waste Reduction Act, 2013* would provide insight into how waste management efforts are envisioned to unfold in Ontario, irrespective of the changes to the Act's goals, strategies and timelines.

The 4R Waste Management Hierarchy

Jurisdictions in Canada and globally have begun adopting modern and progressive waste management frameworks which include, often as a feature of central importance, the 4R waste management hierarchy. The fourth "R" stands for *recovery*, or treating waste that cannot be reused or recycled as a resource to produce electricity, heat, compost and/or fuel (see Figure 1). This concept can be illustrated as an inverted triangle which ranks the four waste management options from the most preferred to least preferred in terms of their environmental impact. The 4R hierarchy, when enshrined in legislation, not only highlights the most environmentally beneficial options, but strictly obliges waste management practitioners to adhere to its order when processing waste materials. The reduction of raw material inputs into production practices is thus given priority above all other options, and materials that cannot be eliminated from production should be reused wherever possible, rather than recycled or composted. When materials cannot be reduced, reused or recycled, however, disposal in landfills has long been the only remaining option for most North American jurisdictions. But even materials traditionally bound to amass in landfills in perpetuity have the potential to serve a valuable role in society, as most of these materials contain energy that can be captured through their

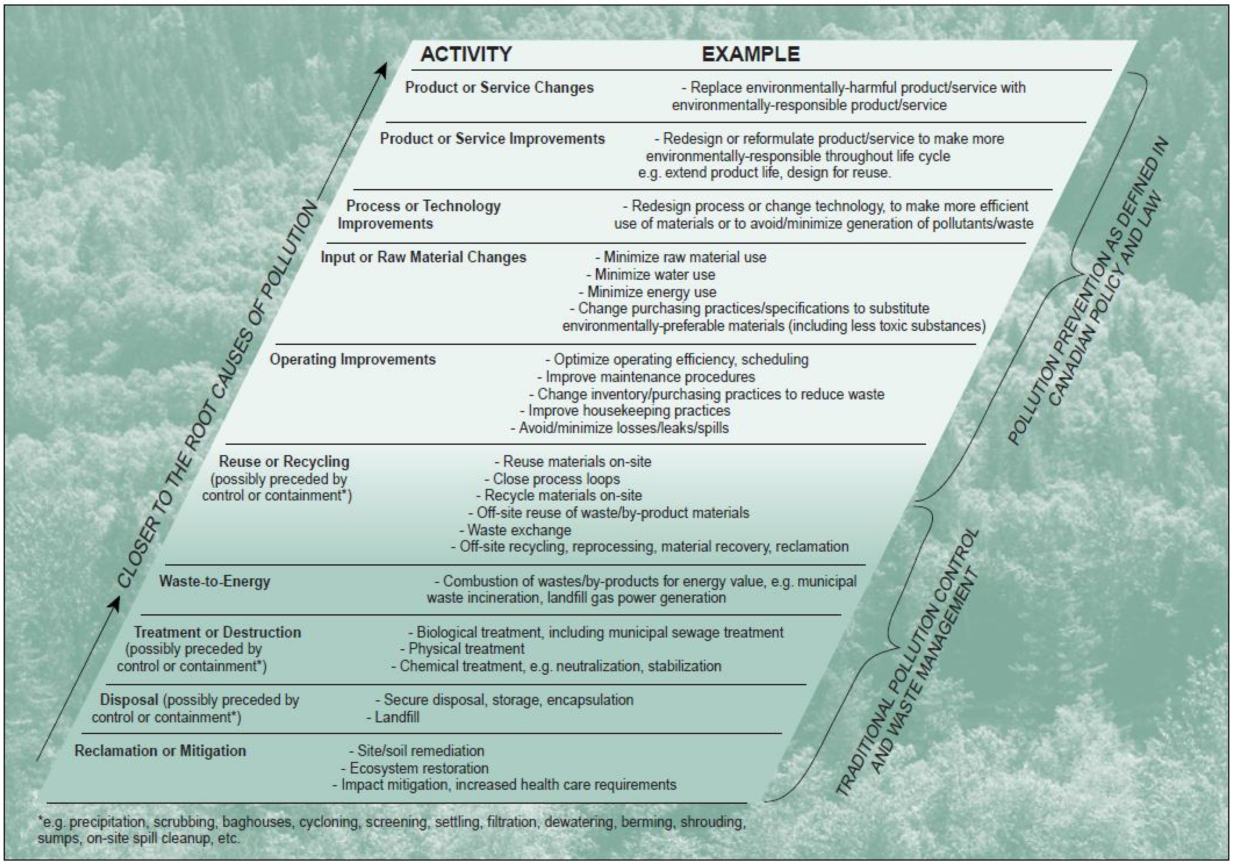
Figure 1: The 4R Waste Management Hierarchy

Source: Non-Hazardous Waste Management Hierarchy. United States Environmental Protection Agency (US EPA).

[35] Ibid.

combustion. There have been countless advancements in the combustion of waste in recent decades that now make this option a net benefit to the environment while maximizing the value of extracted material resources and minimizing the net energy involved in material processing and management. Furthermore, this prioritization is in line with Environment Canada's guidance on pollution prevention, or P2, which endorses energy from waste as a step prior to waste disposal (see Figure 2).[36]

Figure 2: The Environmental Protection Hierarchy



Source: Environment Canada. The Environmental Protection Hierarchy.

The 3R waste hierarchy practiced in Ontario prohibits energy recovery from waste from counting towards meeting waste reduction standards. Why would the province take this stance? In the past, experts have argued that "in Canada, the future for new energy-from-waste incinerators is not very promising. In the recent past, garbage incinerators lacked pollution control devices and were significant sources of atmospheric pollution. Thus, today, any form of waste incineration is suspect in the eyes of

[36] Environment Canada. July 2013. Pollution Prevention. Retrieved from: http://www.ec.gc.ca/p2/

the general population."[37] However, the same experts also noted that "on the other hand, incineration must not be dismissed; in specific circumstances it is still the most sensible waste management option." The prediction has proven to be accurate, as in the past decade energy from waste technology has evolved significantly, with pilot studies undertaken to monitor emissions profiles and life cycle assessments (LCAs) conducted to compare the environmental impacts of using waste for energy production, instead of non-renewable virgin resources.

The decision to prohibit energy from waste as an option to meet waste diversion targets in Ontario may be revisited in the future, when the province begins consultations on the development of a new organics diversion strategy. However, the development of an organics diversion strategy is currently earmarked as a "long term" policy item, and there is no guarantee that provisions enabling energy from waste will be integrated at the time it is introduced. This is concerning for two reasons. First, Ontario has little time to waste considering that one in five municipalities in the province already have insufficient landfill capacity for residential waste (with existing capacity filling up with increasing rapidity after the export of residential waste to Michigan ended in 2010), and that public opposition to new landfill development is now the norm.[38] Second, if energy from waste is a likely technology candidate to help address the organic waste diversion problem in Ontario, then it should not be prohibited as part of the overarching regulatory framework—the proposed *Waste Reduction Act, 2013*.

Moreover, additional impetus to broaden the 3R waste hierarchy to include energy from waste exists due to the recent introductions of other policies, which rely on energy from waste technology as an enabler. For example, during the July 2013 Renewable Fuels Discussion with Stakeholders, the Ontario Ministry of the Environment communicated that it proposes to "repeal the fuel tax exemption for biodiesel effective April 1, 2014," at which point it will "consult with stakeholders on a provincial mandate for greener diesel fuels," including diesel substitutes derived from organic feedstocks and waste, such as grease and animal fats. Ideally, the proposed *Waste Reduction Act, 2013* and *Waste Reduction Strategy, 2013* should complement these initiatives and be part of an integrated policy framework. Moreover, by endorsing energy from waste in the form of refuse-derived fuels, the government of Ontario could further its mandate on phasing out coal-fired electricity through offsetting industrial coal use.

One possible avenue to help expand the scope of the proposed *Waste Reduction Act, 2013* and *Waste Reduction Strategy, 2013* is by defining what Ontario means by "waste," "waste diversion" and "energy from waste" upfront in the regulations. In 2008, the Ontario Ministry of the Environment released a discussion paper titled "Toward a Zero Waste Future: Review of Ontario's Waste Diversion Act, 2002." The paper defined waste as a material from which no value can be recovered. It prioritized landfilling without energy recovery as a last resort (see Figure 3). Accordingly, the government advocated for a 4R waste hierarchy and a "cradle-to-cradle" approach to encourage industry to redesign products and

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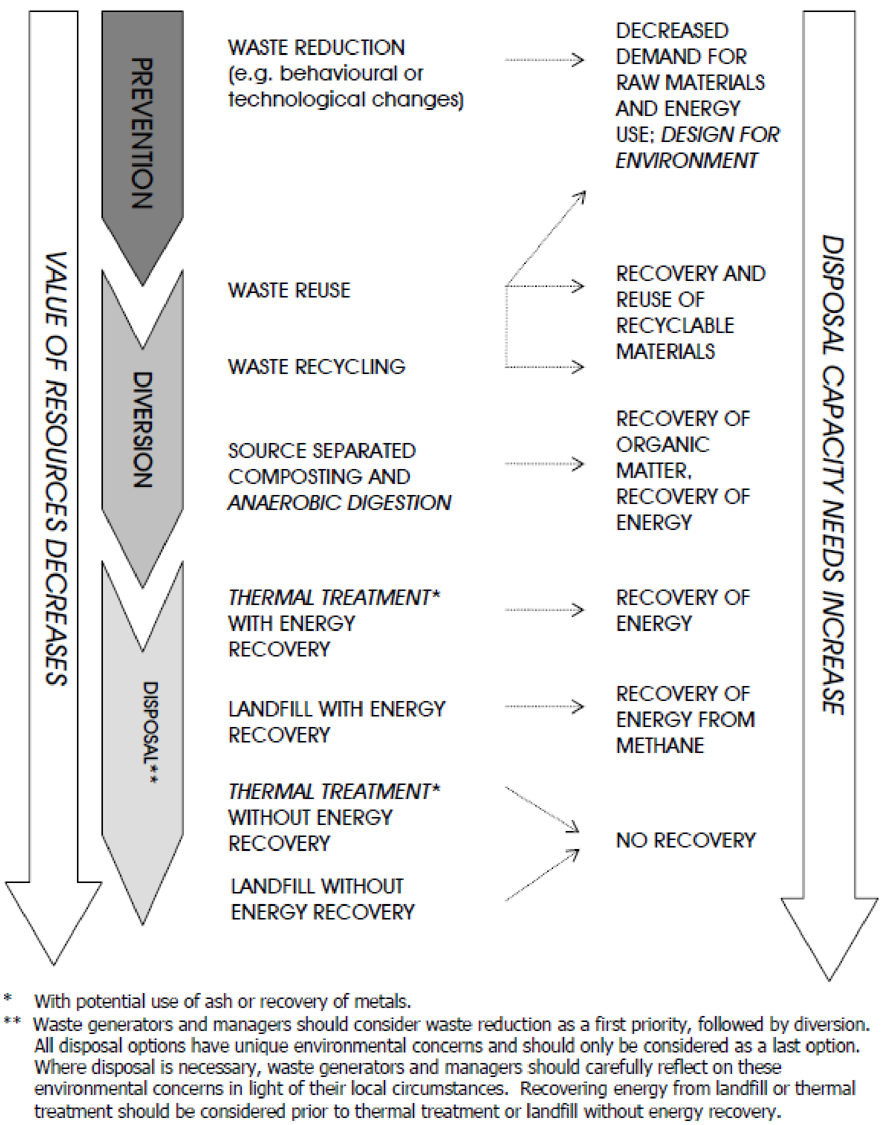
[37] Murray W. December 1995. Canada. Library of Parliament. Science and Technology Division. The Garbage Crisis: Traditional Solutions. Retrieved from: http://publications.gc.ca/Collection-R/LoPBdP/BP/bp407-e.htm

[38] Annual Report of the Office of the Auditor General of Ontario. Fall 2012. Chapter 4, Section 4.09. Non-hazardous Waste Disposal and Diversion. Retrieved from: http://www.auditor.on.ca/en/reports_en/en12/2012ar_en.pdf p. 384

processes to reduce waste at the source, as well as designing products for greater reuse. Furthermore, the intention was to stimulate the "development of innovative ways to make the wastes of one product the inputs of another, building more sustainable methods of production and supporting opportunities for industry to make a green transformation," recognizing that almost all materials currently designated as waste have some form of inherent value that can be recovered.[39]

Figure 3: Toward a Zero Waste Future – The Waste Value Chain



Source: Government of Ontario. Toward a Zero Waste Future: Review of Ontario's Waste Diversion Act, 2002.

[39] Government of Ontario. October 2008. Toward a Zero Waste Future: Review of Ontario's Waste Diversion Act, 2002. Retrieved from: http://greenmattersfredericton.ca/en/resourcesGeneral/wda-zeroWastePaper.pdf

Similarly, waste management legislation in Québec and British Columbia define "waste" as something from which no value can be derived, acknowledging that the recovery of energy from waste is a worthwhile pursuit to be explored prior to disposal at a landfill. British Columbia's *Integrated Solid Waste and Resource Management Plan* (ISWRMP)*, 2010* explains that "conventionally it has been assumed that the 5Rs hierarchy[40] approximates the sequence of processes in waste management and the goal of reducing, reusing or recycling waste to the maximum extent possible has been measured as the rate of 'diversion' of waste, preventing it from reaching the fifth step in the hierarchy—the disposal of residues. Modern reality is more complex. As a result, using the conventionally defined 'diversion rate' includes some source separated material utilized as fuel being considered 'recycled' while some material that is recycled after incineration is still considered 'disposed'."[41]

The current approach chosen by the Government of Ontario is to not provide the definition of waste as part of the proposed *Waste Reduction Act, 2013*, but to enable the Lieutenant Governor in Council to designate certain materials as waste, prescribe a person as a producer with respect to a product from which a designated waste is derived, and develop regulations and compensation formulas to govern the diversion of designated waste in the future.[42] It would be useful for Ontario to provide a more explicit definition of waste in the Act, in order to help stakeholders better understand the implications of the vision statement for the province, which refers to "zero waste" and to the "inherent value of all materials." This exercise may lead to an appreciation of the 4R waste hierarchy—the framework that is the most likely to move the province toward its "zero waste" aspiration by acknowledging energy recovery from waste as a valuable step in waste management.

[40] The 5R hierarchy sets out the relative value of different methods of waste management:

- **R**educe waste at source
- **R**euse where possible
- **R**ecycle products at the end of their useful life
- **R**ecover energy or materials from the waste stream
- Manage **R**esiduals in an environmentally sound manner

[41] Metro Vancouver. July 2010. Integrated Solid Waste and Resource Management: A Solid Waste Management Plan for the Greater Vancouver Regional District and Member Municipalities. Retrieved from: http://www.metrovancouver.org/about/publications/Publications/ISWRMP.pdf

[42] Legislative Assembly of Ontario. Bill 91, Waste Reduction Act, 2013. Retrieved from: http://www.ontla.on.ca/web/bills/bills_detail.do?locale=en&Intranet=&BillID=2818

Chapter 3: Energy from Waste and the Need for Environmental Protection

Among the major objections to the combustion of refuse-derived fuels to power industrial processes are the negative environmental impacts—primarily in the form of atmospheric emissions—associated with the use of such fuels. A good description of the nature of these concerns is provided by the Government of Nunavut, in the *Environmental Guideline for the Burning and Incineration of Solid Waste, 2010*:

"Many different types of pollutants can be released during burning and incineration. A few of these pollutants include acid gases, trace metals, fine particulates, volatile organic compounds and semi-volatile organic compounds. Acid gases such as hydrogen chloride and sulphur oxides result from burning waste that has high levels of chlorine and sulphur (i.e., plastics). Mercury, lead and cadmium are examples of trace metals found in both fly and bottom ash when batteries, used lubricating oil and other metal-containing wastes are burned. Fine particulates are the very small particles found in smoke created by incomplete combustion and can cause respiratory irritation in humans and wildlife.

Dioxins and furans are pollutants that have drawn much attention in recent years because they have been linked to certain types of cancers, liver problems, impairment of the immune, endocrine and reproductive systems and effects on the fetal nervous system. These pollutants persist in the environment for long periods of time, bio-accumulate in plants and animals, result predominantly from human activity and have been identified for 'virtual elimination' in Canada under the federal Toxic Substances Management Policy. The incineration of solid waste accounts for almost 25% of the dioxin and furan emissions in Canada each year. They are formed in trace amounts by de novo synthesis during the low temperature burning of waste containing organic compounds and chlorine (i.e. chlorinated plastic, PVC pipe, marine driftwood).

The most effective way to reduce or minimize the release of pollutants is to segregate the waste before burning and achieve sufficiently high temperature, holding time and turbulence in the burn chamber. Open burning produces more smoke and pollutants, including dioxins and furans, than does an incinerator capable of achieving complete combustion."[43]

In a 2007 report, the Canadian Institute for Environmental Law and Policy (CIELAP) overviewed the potentially positive and negative consequences of Ontario endorsing energy from waste as a form of waste diversion. The following excerpt from the report directly compares the effects of landfilling non-recyclable waste with the effects of combusting it.

[43] Government of Nunavut. October 2010. Environmental Guideline for the Burning and Incineration of Solid Waste. Retrieved from: http://env.gov.nu.ca/sites/default/files/guideline_-_burning_and_incineration_of_solid_waste_2012.pdf

"Main Advantages of Waste Incineration over Landfill

- If the public is confident about the safety of new incineration technologies there may be less opposition to locating an incineration plant near central residential areas than there would be to a landfill close by. This would lead to lower waste transportation costs.
- While incineration produces relatively inert ash that must be sent for landfill, the ash will take up only 10% of the volume that would have been required for the waste had no incineration taken place.
- Reduces reactivity by the near complete destruction of organic compounds.
- Allows for energy generation by heat recovery.
- The waste reduction is immediate and not dependent on long-term biological reactions.
- Air discharges can be controlled to meet environmental regulations.

Main Disadvantages of Incineration over Landfill

- Heavy metals can be released into the environment.
- Air pollutants NO_x, SO_2 are produced.
- Some materials should not be incinerated because they are more valuable for recycling, they are non-combustible or their by-products may give rise to harmful emissions.
- Incinerators have high capital costs and moderately high operating costs, relative to landfills.
- Supplementary fuel is often required.
- Incinerators do not produce biogas fuel that may be captured, as a landfill does. However, biogas capture from landfill is not necessarily economical."[44]

The cement sector is already well-positioned to realize the full spectrum of advantages listed in the CIELAP report. For example: the majority of cement plants are not located near residential areas; the ash created during the combustion of refuse-derived fuel is incorporated into the clinker (and subsequently, the cement) in its entirety, eliminating the need for any landfilling of by-products; all organic compounds are effectively destroyed in cement kilns, which achieve at least 99.99% destruction of hazardous compounds; the energy that would be generated through the combustion of refuse-derived fuels in cement kilns is currently generated through the combustion of coal and petroleum coke, and the use of refuse-derived fuels could thus eliminate or significantly reduce the use of these fossil fuels in the cement sector.

Dioxins and furans are groups of compounds which are classified as persistent organic pollutants due to their extremely high toxicity and the fact that they bioaccumulate in plants and animals. They are products of the combustion of chlorine-containing materials at low temperatures (between 200 and 400°C) and short residence times, usually with the help of a catalyst like copper.[45] Dioxins and furans were traditionally the pollutants of highest concern associated with the incineration of waste materials

[44] Canadian Institute for Environmental Law and Policy (CIELAP). March 2007. Ontario's Waste Management Challenge: Is Incineration an Option? Retrieved from: http://www.cielap.org/pdf/IncinerationOption.pdf
[45] Altarawneh M, Dlugogorski BZ, Kennedy EM, and Mackie JC. 2009. Mechanisms for formation, chlorination, dechlorination and destruction of polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDD/Fs). *Progress in Energy and Combustion Science,* 35: 245-274.

(in cement plants and waste incineration facilities), yet modern cement plants operate well below regulated limits for dioxin and furan emissions, and have systems in place to avoid the temperature window which promotes their creation. It is worth noting that the presence of lime (CaO), which is produced when CO_2 is liberated from limestone ($CaCO_3$) during clinker production, has been shown to suppress the formation of dioxins,[46] which means that the cement sector is ideally suited to use refuse-derived fuel, as the formation of the most dangerous airborne emissions are suppressed by cement's most prominent constituent.

Since the release of the CIELAP report, energy from waste technologies have advanced to the extent that some of the concerns profiled above as "disadvantages" may no longer be warranted. In terms of environmental impact, the release of heavy metals and air pollutants continues to fall in the cement sector due recent technological advancements. The application of fabric filters and/or electrostatic precipitators is proving to be increasingly effective at removing fine particulate matter from cement plant exhaust.[47] The resulting toxic material, known as fly ash, comprises roughly 4% of the volume of the original refuse-derived fuel,[48] and it is most often fed back into kilns for incorporation into the clinker. Gaseous contaminants can be removed either by mixing the flue gas with additives that react with exhaust gases, transforming them into benign compounds (a process known as absorption), and/or by passing exhaust gases through wet, wet-dry, or dry scrubbers (usually activated carbon filters—a process known as absorption).[49] Continuous emissions monitoring systems (CEMS) can verify that emissions from cement plants are within mandated levels, providing stakeholders with ongoing assurance that environmental standards are being upheld.[50]

From an economic perspective, evidence suggests that capital costs associated with energy from waste infrastructure can be lowered by utilizing the combustion infrastructure of existing manufacturing facilities like cement plants and steel mills. Utilizing existing combustion infrastructure would serve the double dividend of offsetting the use of fossil fuels that continue to power much of Ontario's industrial sector while avoiding the siting and construction of new waste incineration facilities. Most cement industry players are capable of adapting their existing facilities to incinerate waste as fuel, and have found that doing so would improve their emissions profiles and lower their fuel costs.[51] Cement plants in British Columbia, the United States, and the European Union have long been mitigating their use of fossil

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[46] Ibid

[47] Stantec Consulting Ltd. March 2011. Waste to Energy: A Technical Review of Municipal Solid Waste Thermal Treatment Practices. Retrieved from: http://www.env.gov.bc.ca/epd/mun-waste/reports/pdf/BCMOE-WTE-Emissions-final.pdf

[48] Environment Canada. March 2007. MSW Thermal Treatment in Canada 2006. Retrieved from: http://www.ec.gc.ca/gdd-mw/default.asp?lang=en&n=D54033E4-1

[49] Stantec Consulting Ltd. March 2011. Waste to Energy: A Technical Review of Municipal Solid Waste Thermal Treatment Practices. Retrieved from: http://www.env.gov.bc.ca/epd/mun-waste/reports/pdf/BCMOE-WTE-Emissions-final.pdf

[50] Ibid

[51] Lafarge and Hyndman & Associates. 2011. Lafarge Biomass Demonstration Project Summary Report: A summary report to satisfy the reporting requirements for the Certificate of Approval to combust various sources of agricultural biomass in the Lafarge Bath plant cement kiln. Retrieved from: http://www.cement2020.org/publication/all/148

fuels by using refuse-derived fuel as a component of their fuel mix, without detracting from the quality of the cement they produce. Cement plants are capable of processing a wide variety of combustible materials, not simply fossil fuels and refuse-derived fuels, so the sector is not expected to develop a dependence for a constant stream of municipal and IC&I waste, as is the case with dedicated waste incineration facilities. The production of non-recyclable materials of all forms should thus continue to be phased out in the short-term, and the use of renewable biomass as an energy-rich and low carbon fuel should be encouraged and incentivized.

Canada-Wide Guidance

In 2001, the Canadian Council of Ministers of the Environment (CCME) developed *Canada-Wide Standards for Dioxins and Furans,*[52] which need to be met by facilities that combust refuse-derived fuels as a step towards achieving virtual elimination for dioxins and furans. Accordingly, new or expanding facilities of any size need to utilise best available pollution prevention and control techniques to achieve a maximum concentration of dioxins and furans in exhaust gases as follows:[53]

- Municipal waste incineration 80pg I-TEQ/m^3
- Medical waste incineration 80pg I-TEQ/m^3
- Hazardous waste incineration 80pg I-TEQ/m^3
- Sewage sludge incineration 80pg I-TEQ/m^3

In addition, CCME *Canada-Wide Standards for Mercury Emissions*[54] state that new or expanding facilities of any size that combust refuse-derived fuels need to achieve a maximum concentration of mercury in exhaust gases as follows:[55]

- Municipal waste incineration 20 µg/Rm^3
- Medical waste incineration 20 µg/Rm^3
- Hazardous waste incineration 50 µg Rm^3
- Sewage sludge incineration 70 µg/Rm^3

Other guidance documents were developed by the CCME to aid municipal solid waste management decisions regarding energy from waste projects:

- *Guidance Document for the Beneficial Use of Municipal Biosolids, Municipal Sludge and Treated Septage, 2012* (Part 3 of the document provides considerations about the combustion of

[52] The Canadian Council of Ministers of the Environment (CCME). April 2001. Canada-Wide Standards for Dioxins and Furans. Retrieved from: http://www.ccme.ca/assets/pdf/d_and_f_standard_e.pdf
[53] Dioxin concentrations in exhaust gases are measured in picograms (pg, or 10^{-12} gram) of 2,3,7,8-tetrachlorinated dibenzo-p-dioxin toxic equivalent (I-TEQ) per cubic metre.
[54] The Canadian Council of Ministers of the Environment (CCME). June 2000. Canada-Wide Standards for Mercury Emissions. Retrieved from: http://www.ccme.ca/assets/pdf/mercury_emis_std_e1.pdf
[55] Mercury concentrations in exhaust gases are measured in micrograms (µg, or 10^{-6} gram) per reference cubic metre (Rm^3).

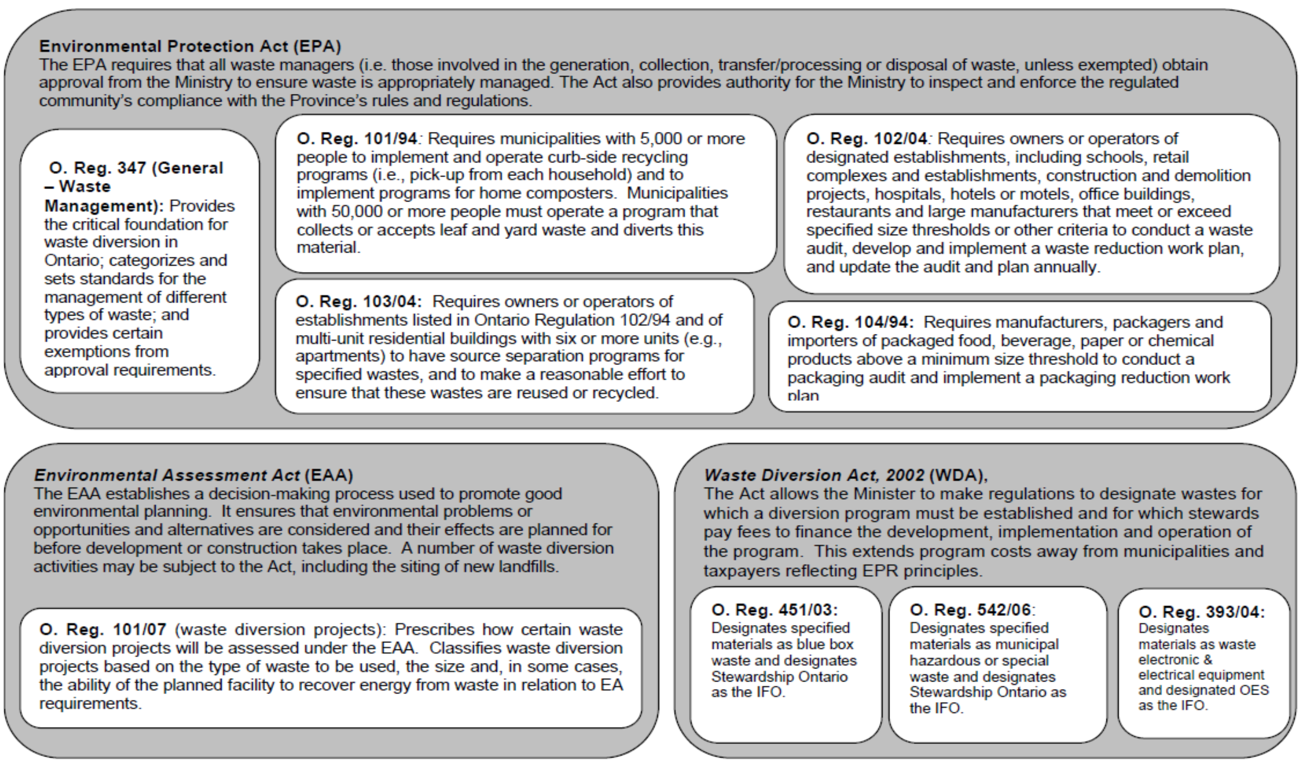
wastewater residuals to offset the use of fossil fuels for heat production or electrical power generation);

- *National Guidelines for Hazardous Waste Incineration Facilities: Design and Operating Criteria, 1992*; and
- *National Guidelines for Hazardous Waste Landfills, 2006*.

Ontario's Approach

In Ontario, the three main pieces of legislation that guide waste management efforts are the *Environmental Protection Act*, the *Environmental Assessment Act* and the *Waste Diversion Act, 2002* (see Figure 2). Currently, all municipal waste treatment facilities in the province must also comply with air emissions standards in accordance with Ontario Regulation 419/05 (Air Pollution – Local Air Quality), which among other things specify half-hour averaging standards for dioxins and furans, as well as mercury[44].

Figure 2: Ontario Waste Management: Legislative and Regulatory



Source: Toward a Zero Waste Future: Review of Ontario's Waste Diversion Act, 2002. Government of Ontario 2008

Should the province consider adopting a 4R waste hierarchy which would encourage energy from waste, the following regulations are of particular relevance: *Guideline A-7: Air Pollution Control, Design and Operation Guidelines for Municipal Waste Thermal Treatment Facilities*; *Guideline A-8: Guideline for the Implementation of Canada-wide Standards for Emissions of Mercury and of Dioxins and Furans and Monitoring and Reporting Requirements*; and *R.R.O. 1990, Regulation 347*. These are profiled in more detail below.

Ontario's Guideline A-7

Ontario's *Guideline A-7: Air Pollution Control, Design and Operation Guidelines for Municipal Waste Thermal Treatment Facilities* sets out minimum recommendations for pollution control systems and maximum allowable in-stack contaminant emission levels from municipal waste thermal treatment facilities in Ontario. The guideline also sets out recommendations for the acceptable design and operation parameters of thermal treatment facilities utilizing conventional incineration technology and other combustion equipment associated with municipal waste thermal treatment facilities. In addition, it covers pilot scale operations involving the thermal treatment of municipal waste not exceeding 50 tonnes per year. The emission levels in Guideline A-7 are set using the maximum achievable control technology (MACT) principle—a similar approach to that used in other jurisdictions, basing emission levels on those achieved by best performing facilities. Guideline A7 is planned to be updated on an ongoing basis, to reflect the most up-to-date technical advancements in the field of waste incineration.[56] Please see Appendix A for emission limits mandated through Guideline A-7.

Ontario's Guideline A-8

Ontario's *Guideline A-8: Guideline for the Implementation of Canada-wide Standards for Emissions of Mercury and of Dioxins and Furans and Monitoring and Reporting Requirements* establishes the formal adoption by Ontario of the Canada-wide Standards for dioxin and furan emissions from municipal waste, biomedical waste, sewage sludge and hazardous waste incineration systems, as well as steel manufacturing electric arc furnaces and iron sintering plants.[57]

[56] Ontario Ministry of the Environment. 2014. Guideline A-7: Air Pollution Control, Design and Operation Guidelines for Municipal Waste Thermal Treatment Facilities. Retrieved from: http://www.ontario.ca/environment-and-energy/guideline-7-air-pollution-control-design-and-operation-guidelines-municipal

[57] Ontario Ministry of the Environment. 2014. Guideline A-8: Guideline for the Implementation of Canada-wide Standards for Emissions of Mercury and of Dioxins and Furans and Monitoring and Reporting Requirements. Retrieved from: http://www.ontario.ca/environment-and-energy/guideline-8-guideline-implementation-canada-wide-standards-emissions-mercury

R.R.O. 1990, Regulation 347

R.R.O. 1990, Regulation 347 is the general waste management regulation for Ontario. Sections that are applicable to energy from waste projects include leachate quality criteria and requirements to use the US EPA's Toxicity Characteristic Leaching Procedure, Method 1311, as well as a discussion about which waste management options qualify as recycling or recovery, or are considered thermal treatment.[58]

Technical Guidance

In reviewing other literature pertaining to energy from waste environmental guidance, Pollution Probe notes one report in particular which stood out in terms of the level of detail and practicality of recommendations. The report, titled *Waste to Energy: A Technical Review of Municipal Solid Waste Thermal Treatment Practices*, was prepared by Stantec Consulting Ltd. and Ramboll Denmark A/S, at the request of British Columbia's Ministry of Environment to provide background on energy from waste technology and to be used as a supporting document for subsequent steps, including preparation of emission guidelines.[59] Below is an overview of the report, profiling its key findings.

Waste to Energy: A Technical Review of Municipal Solid Waste Thermal Treatment Practices (The Stantec Report)

The Stantec Report views the municipal solid waste stream as a bioenergy source produced in all communities that has the potential to be used as a fuel supply for the generation of heat or electricity, or for the generation of hot water or steam for community energy systems. It addresses the concept of what constitutes good performance, based on best practices in the energy from waste field, in order to provide guidance on potential stack emissions limits and the design and operation of energy from waste facilities. The report overviews the various emerging and currently available technologies to thermally treat municipal solid waste in an energy from waste context. The report includes a discussion of typical discharges from energy from waste facilities, including emissions to the atmosphere, liquid effluent, and solid residues, and the means by which such emissions can best be managed and mitigated. The report also profiles air emission control systems commonly applied to thermal treatment technology, including operational controls and air pollution control (APC) system equipment.

In addition, the report discusses the potential for refuse-derived fuels to be used as an industrial facility fuel supply for specific applications like cement manufacturing. Refuse-derived fuel is typically defined as processed municipal solid waste, but can also include waste generated through construction and

[58] Government of Ontario. 1990. R.R.O. 1990, Regulation 347. Retrieved from: http://www.e-laws.gov.on.ca/html/regs/english/elaws_regs_900347_e.htm

[59] Stantec Consulting Ltd. March 2011. Waste to Energy: A Technical Review of Municipal Solid Waste Thermal Treatment Practices. Retrieved from: http://www.env.gov.bc.ca/epd/mun-waste/reports/pdf/BCMOE-WTE-Emissions-final.pdf

demolition. Examples of the use of refuse-derived fuels and construction and demolition waste in power boilers and cement kilns as fuel substitutes is also discussed. The potential effect of the use of such fuels on emission profiles and rates from industrial facilities is examined. As part of the comparison of energy from waste technologies, the report includes a review of costs and energy efficiency for various thermal treatment and APC technologies.

The report also contains an overview of the European Energy Equation and its application to energy from waste projects. This equation gives priority to waste combusted in order to power manufacturing, as opposed to the combustion of waste simply to produce energy. Notably, the Province of British Columbia has followed the European approach to categorize waste incineration facilities as recovery facilities wherever specified energy recovery/efficiency results (calculated through the energy equation) can be demonstrated. Facilities that cannot meet these results are classified as waste disposal facilities.

An overview of emission and ambient monitoring systems is provided, along with a discussion of the regulatory environment and regulatory practices in various jurisdictions, including Canada, the United States and the European Union. The report goes on to review the regulatory emission limits for Criteria Air Contaminants (CACs) and Hazardous Air Pollutants (HAPs) for the energy from waste sector, looking not only at regulations, but at actual permitted limits from facilities currently in operation.

A section of the report examines ash and residue management in the energy from waste sector, discussing the composition of bottom ash, fly ash and APC residues from energy from waste facilities. The report discusses beneficial uses of these residues, including the recovery and recycling of metals and the use of bottom ash as a construction aggregate or as a feedstock for the cement industry. The report makes a series of technical recommendations on how to improve the performance and monitoring of energy from waste facilities, as well as current best practices on mitigating the environmental impact of residues and emissions. The report wraps up with the following conclusions (adapted for conciseness):

1. Mass burn incineration continues to be the most common method of thermal treatment in energy from waste facilities, and its use is anticipated to grow in the near future.
2. Other thermal treatment technologies such as gasification, plasma gasification and pyrolysis are technically more complex than mass burning, yet improved efficiencies are making these technologies more viable.
3. In order for energy from waste facilities to prove economically viable, they most often have to process waste at a rate of roughly 10 tonnes per hour (or 100,000 tonnes per year).
4. Modern energy from waste facilities are capable of achieving substantial emissions reductions through the use of emission control technology. Reductions in the contaminants of concern typically range from 90% up to 99.95% through the application of a typical modern-day APC system.
5. New energy from waste facilities will benefit from the development of infrastructure such as district heating that improves energy productivity by utilizing heat, in addition to electricity.

6. When using refuse-derived fuel as an alternative fuel in existing power generation facilities, the composition of the fuel should be similar to that of the primary fuel in regard to fuel value and general chemical composition (e.g., using cellulosic waste materials in wood-fired boilers).
7. Bottom ash, fly ash and APC residue from energy from waste facilities should be subjected to the Toxicity Characteristic Leaching Procedure (TCLP) test and the ash should then be handled according to its classification.
8. Bottom ash is normally not classified as hazardous waste and it is acceptable practice to deposit bottom ash in a permitted sanitary landfill or for the ash to be utilized for a beneficial use, such as intermediate cover, concrete or asphalt aggregate substitution or road base material. Fly ash and APC residue are more likely to contain leachable contaminants and to subsequently be classified as hazardous waste.
9. The energy from waste sector continues to evolve with the advent of new incineration and pollution control technology, and further advances in municipal waste diversion and separation technologies. The regulatory environment needs to evolve accordingly to keep pace with technological innovation.

Global Jurisdictions

In terms of the guidance available from global jurisdictions, the OECD's *Guidance Manual on Environmentally Sound Management of Waste*[60] puts forth a series of broad recommendations that are meant to help member nations implement the "environmentally sound and economically efficient management of waste, with the following objectives:

1. Sustainable use of natural resources, minimisation of waste and protection of human health and the environment from adverse effects that may result from waste;
2. Fair competition between enterprises throughout the OECD area through the implementation of core "performance elements" (CPEs) by waste management facilities, thus contributing to a level playing field of high environmental standards;
3. Through incentives and measures, diversion of waste streams to the extent possible from facilities operating with low-standards to facilities that manage waste in an environmentally sound and economically efficient manner."[61]

In 1999, OECD member countries decided to begin working towards international environmentally sound management (ESM) guidelines for waste recovery facilities. The OECD defines ESM as: "a scheme for ensuring that wastes and used and scrap materials are managed in a manner that will save natural

[60] Organization for Economic Co-operation and Development (OECD). 2004. Guidance Manual on Environmentally Sound Management of Waste. Retrieved from: http://www.oecd.org/env/waste/39559085.pdf
[61] Organization for Economic Co-operation and Development (OECD). October 2007. Recommendation of the Council on the Environmentally Sound Management of Waste. Retrieved from: http://acts.oecd.org/Instruments/ShowInstrumentView.aspx?InstrumentID=51#_ftn1

resources, and protect human health and the environment against adverse effects that may result from such wastes and materials."[62] The broad objectives of that work have been:

1. To provide facilities with common basic provisions for ESM in order to improve their environmental performance, if necessary;
2. To achieve a more level playing field among facilities within the OECD area, in order to help ensure that facilities which have invested in environmentally sound technologies maintain their competitiveness; and
3. To use the implementation of these "guidelines" as a way of helping countries to have greater confidence that their waste shipments within the OECD area were being sent to environmentally sound management facilities.[63]

A key purpose of the guidance manual is to help individual waste management facilities to continuously improve their environmental performance and to provide practical guidance on the implementation of these CPEs through examples of existing practices and the use of instruments or policies in relation to specific elements of ESM.[64]

[62] Organization for Economic Co-operation and Development (OECD). 2004. Guidance Manual on Environmentally Sound Management of Waste. Retrieved from: http://www.oecd.org/env/waste/39559085.pdf
[63] Ibid
[64] Ibid

Chapter 4: Energy from Waste in Practice

Notwithstanding substantial progress made by public and private waste management bodies in Canada, the country's waste diversion rates have plateaued in the last decade at roughly 25%.[65] Since 1998, waste diversion in the residential sector has increased by 70%, while waste disposal grew by 10%.[66] In the IC&I sector over the same timeline, the numbers were not as encouraging, with waste disposal increasing by 15% and diversion decreasing by 15%.[67] As the IC&I sector produces 65% of Canada's waste, these disposal and diversion rates must be decisively addressed by forthcoming waste management legislation.[68]

The more than 2,000 municipal government members of the Federation of Canadian Municipalities (FCM) agree that the current management of municipal solid waste reflects inefficient resource utilization and that waste needs to be viewed and managed as a resource rather than a burden.[69] The FCM stresses that our society must begin to emulate nature's zero waste model, in which the waste outputs from one system become the raw material inputs from which other systems are constructed.[70] The FCM strongly endorses the adoption of energy recovery from waste in the waste hierarchies of all levels of Canadian government.[71] According to the FCM, energy recovery from waste supports sustainable jobs across the country, reduces the environmental impact of landfilling, and also increases competitiveness in the downstream industries that produce and manage waste.[72] Similarly, the Association of Municipalities Ontario (AMO) contends that "more waste diversion means a longer life for landfill sites and better stewardship of limited resources."[73]

Many waste management experts are stressing the integral role that landfill bans can play in increasing diversion rates, citing the 1999 Nova Scotia ban on organics that resulted in the highest rate of waste diversion in the country.[74] Québec is also poised to enact landfill bans of its own, starting with paper

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[65] Federation of Canadian Municipalities. March 2004. Solid Waste as a Resource: Guide for Sustainable Communities. Retrieved from: http://www.fcm.ca/Documents/tools/GMF/Solid_waste_as_a_resource_en.pdf
[66] Golder Associates. November 2012. The State of Waste in Canada. Retrieved from: http://www.canwastesectorsymposium.ca/Portals/0/Paulper cent20vanper cent20derper cent20Werfper cent20andper cent20Michaelper cent20Cant.pdf
[67] Ibid
[68] Ibid
[69] Federation of Canadian Municipalities. March 2004. Solid Waste as a Resource: Guide for Sustainable Communities. Retrieved from: http://www.fcm.ca/Documents/tools/GMF/Solid_waste_as_a_resource_en.pdf
[70] Ibid
[71] Ibid
[72] Ibid
[73] Association of Municipalities Ontario. June 6, 2013. Key Role of Municipalities in Waste Diversion Recognized. Retrieved from: http://www.amo.on.ca/AMO-Content/Policy-Updates/2013/Key-Role-of-Municipalities-in-Waste-Diversion-Reco.aspx
[74] Golder Associates. November 2012. The State of Waste in Canada. Retrieved from: http://www.canwastesectorsymposium.ca/Portals/0/Paulper cent20vanper cent20derper cent20Werfper cent20andper cent20Michaelper cent20Cant.pdf

waste and cardboard and eventually transitioning to all organics.[75] Construction and demolition (C&D) debris is another prime candidate for a landfill ban, as can be evidenced by countries like the Netherlands, which diverts 95% of its C&D debris, earning revenue through added recycling and energy production, and mitigating the environmental impact of its disposal.[76] Internationally, the jurisdictions with the highest waste diversion rates have included the 4th R—recovery—in their waste management hierarchies. Ontario should consider taking similar measures, for the good of its economy, the environment, and its people.

The following case studies illustrate technological advancements in the recovery of energy from waste that have taken place in recent decades. When utilized in its proper place in a waste management hierarchy and with the application of best available technologies, the incineration of non-recyclable materials for energy recovery is now generally considered to be a more environmentally sustainable waste management option than landfilling.[77,78,79,80]

Municipal Solid Waste in Canada

There are currently seven municipal solid waste thermal treatment facilities operating in Canada that have a capacity greater than 25 tonnes per day. All of these facilities were built to address landfill capacity and/or greenhouse gas emissions issues. Five of these facilities, profiled below along with a sixth facility currently under construction, recover energy from the incineration of undesignated wastes. Overall, these case studies demonstrate the following:

- Energy from waste can complement recycling and composting programs, and can help to improve recycling rates;
- Energy from waste is increasingly seen as a viable and desirable method of managing waste by Canadian municipalities and waste management experts;
- Energy from waste can create new employment opportunities in host localities;
- Energy from waste using the best available technologies can result in lower greenhouse gas emissions than landfilling, irrespective of the offsets resulting from the displacement of fossil fuels in electricity production.

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75 Ibid
76 The Chartered Institution of Wastes Management. September 2005. Energy From Waste: Lessons from the Netherlands. Retrieved from: http://www.engr.usask.ca/classes/BLE/482/Miscper cent20Info/wasteper cent20toper cent20energy.pdf
77 Assamoi B, and Lawryshyn Y. 2012. The environmental comparison of landfilling vs. incineration of MSW accounting for waste diversion. *Waste Management,* 32: 1019-1030.
78 Cherubini F, Bargigli S, and Ulgiati S. 2009. Life cycle assessment (LCA) of waste management strategies: Landfilling, sorting plant and incineration. *Energy,* 34: 2116-2123.
79 Mendes MR, Aramaki T, and Hanaki K. 2004. Comparison of the environmental impact of incineration and landfilling in Sao Paulo City as determined by LCA. *Resources, Conservation and Recycling,* 41: 47-63.
80 Monni S. 2012. From landfilling to waste incineration: Implications on GHG emissions of different actors. *International Journal of Greenhouse Gas Control,* 8: 82-89.

Algonquin Power Energy-from-Waste Facility, Brampton, Ontario

This facility, opened in 1992, incinerates municipal solid waste from local residences as well as the IC&I sector.[81] It processes up to 174,000 tonnes of waste each year,[82] and directly employs 62 people.[83] It was built to eliminate the cost of transporting landfill waste to the US for disposal. The facility produces up to 9 MW of continuous power, producing electricity from steam and sending excess steam to a neighbouring recycled paper mill (owned by Norampac) via a closed-loop pipeline system.[84] The steam sent to Norampac displaces energy which would otherwise be produced from natural gas.[85]

Building on the Algonquin Power Facility's successful operation, the Region of Peel recently decided to invest in the Peel Region Energy Centre, a municipal solid waste incineration facility that will be able to process up to 300,000 tonnes of waste per year, allowing the region to divert up to 90% of its waste from landfills.[86] Greenhouse gas emissions associated with waste diversion and disposal in the region will be cut in half once the centre becomes fully operational in 2020.[87] The centre will co-generate heat and power, and will sort and separate metals, which will increase the proportion of waste recycled in the region.[88] It has the support of local communities, governments and industry stakeholders.[89]

Durham York Energy Centre, Clarington, Ontario

This facility, which is currently under construction, will be jointly owned by the regional municipalities of Durham and York, and will be built and operated by Covanta Energy.[90] The centre will become

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[81] Partners in Project Green. n.d. Algonquin Power – By-Product Synergies. Retrieved from: http://www.partnersinprojectgreen.com/files/CS_AlgonquinPower_WasteToEnergy.pdf

[82] Region of Peel. 2013. Algonquin Power Energy From Waste Facility. Retrieved from: http://www.peelregion.ca/pw/waste/garb-recy/algonquin-power.htm

[83] Environment Canada. March 2007. MSW Thermal Treatment in Canada 2006. Retrieved from: http://www.ec.gc.ca/gdd-mw/default.asp?lang=en&n=D54033E4-1

[84] Partners in Project Green. n.d. Algonquin Power – By-Product Synergies. Retrieved from: http://www.partnersinprojectgreen.com/files/CS_AlgonquinPower_WasteToEnergy.pdf

[85] Ibid

[86] Waste Management World. June 2013. Green Light for 300,000 TPA Waste to Energy Plant in Peel, Ontario. Retrieved from: http://www.waste-management-world.com/articles/2013/06/green-light-for-300-000-tpa-waste-to-energy-plant-in-peel-ontario.html

[87] Region of Peel. June 2013. Council Approves Plan to Build an Energy Recovery Centre. Retrieved from: http://www.peelregion.ca/news/archiveitem.asp?year=2013&month=5&day=27&file=2013527a.xml

[88] Waste Management World. June 2013. Green Light for 300,000 TPA Waste to Energy Plant in Peel, Ontario. Retrieved from: http://www.waste-management-world.com/articles/2013/06/green-light-for-300-000-tpa-waste-to-energy-plant-in-peel-ontario.html

[89] Region of Peel. June 2013. Council Approves Plan to Build an Energy Recovery Centre. Retrieved from: http://www.peelregion.ca/news/archiveitem.asp?year=2013&month=5&day=27&file=2013527a.xml

[90] Covanta Energy. 2013. Covanta and the Durham York Energy Centre. Retrieved from: http://www.covantaenergy.com/facilities/facility-by-location/durham-york.aspx

operational in the fall of 2014, and will reach full capacity in September 2016.[91] It will produce up to 20 MW of electricity, enough to power 11,000 to 15,000 homes annually.[92] It will process roughly 140,000 tonnes of municipal solid waste each year, in order to eliminate the need to ship the region's residential waste to Michigan.[93] In 2005, Durham and York Regions partnered in an environmental study to assess alternative methods of residential waste management. The study concluded that the incineration of waste was the most cost-effective, socially acceptable, and environmentally responsible method by which to manage residential waste in the two regions.[94] The facility will employ 40 people, full-time.[95]

L'incinérateur de la Ville de Québec, Limoilou, Québec

Opened in 1974, this facility is owned by the City of Québec, and operated by the energy firm Tiru Canada.[96] It processes about 283,000 tonnes of waste annually, producing steam for a local paper mill as well as electricity.[97] It processes waste from the residential and IC&I sectors in Québec City and neighbouring municipalities.[98] It is the only energy from waste facility in Canada to process sewage sludge, which comprises about 10% of its fuel.[99] It employs a full-time staff of 75 people.[100]

Metro Vancouver's Waste to Energy Facility, Burnaby, British Columbia

Opened in 1988, this facility is owned by Metro Vancouver and operated by Covanta Energy. It processes over 25% of the Vancouver region's waste, or roughly 285,000 tonnes of waste per year.[101] It co-generates steam and electricity, with the steam being sold to a neighbouring paper recycling facility and the electricity powering over 15,000 homes each year.[102] The facility directly employs 44 people.[103]

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91 Ontario Power Authority. 2013. Durham York Energy Centre (Clarington 01) (20.0 MW) – Municipality of Clarington. Retrieved from: https://cms.powerauthority.on.ca/efw/durham-york-energy-centre
92 Ibid
93 Ibid
94 Ibid
95 Covanta Energy. 2013. Covanta and the Durham York Energy Centre. Retrieved from: http://www.covantaenergy.com/facilities/facility-by-location/durham-york.aspx
96 City of Québec. 2013. Garbage Incinerator. Retrieved from: http://www.ville.quebec.qc.ca/citoyens/matieresresiduelles/ordures_menageres/incinerateur.aspx
97 Ibid
98 Ibid
99 Environment Canada. March 2007. MSW Thermal Treatment in Canada 2006. Retrieved from: http://www.ec.gc.ca/gdd-mw/default.asp?lang=en&n=D54033E4-1
100 Ibid
101 Metro Vancouver. August 2011. Waste-to-Energy Facility. Retrieved from: http://www.metrovancouver.org/about/publications/Publications/WasteEnergyFactsheet.pdf
102 Ibid
103 Environment Canada. March 2007. MSW Thermal Treatment in Canada 2006. Retrieved from: http://www.ec.gc.ca/gdd-mw/default.asp?lang=en&n=D54033E4-1

The Vancouver region is now planning to expand its existing energy from waste capacity by 370,000 tonnes per year (for a total annual capacity of 655,000 tonnes).[104] The plan is to complete the expansion by 2018, with the cost of the new plant(s) expected to be in the range of $500 million.[105] One of the corporations short-listed to add to the existing capacity is Lehigh Cement, who plans to process the waste into fuel for at its Delta, BC cement plant in order to offset emissions stemming from the combustion of coal and petroleum coke fuels.[106]

PEI Energy Systems Energy from Waste Facility, Charlottetown, PEI

Opened in 1983, this facility is owned and operated by Vereson Energy Infrastructure Incorporated.[107] The facility diverts about one third of PEI's waste from landfills, processing about 60,000 tonnes of waste each year.[108] It is a trigeneration plant, providing steam for a local hospital, electricity, as well as hot water, heating and cooling for roughly 125 public and private buildings in Charlottetown.[109] The plant incinerates three types of fuels: municipal solid waste (41%), wood waste (45%), and oil (17%, used as a peaking fuel in the winter).[110] It has a capacity of 1.2 MW of electricity and 33 MW of thermal energy.[111] The low costs of the locally-derived garbage and wood waste are what make the plant economically viable.[112] It employs a staff of 31 people.[113]

Wainwright Regional Waste-to-Energy Authority Combustor, Wainwright, Alberta

This facility, opened in 1995, incinerates residential and commercial municipal solid waste as well as medical waste, being the only energy from waste facility in the country to process medical waste.[114] It can incinerate up to 10,000 tonnes of waste per year, and directly employs a full-time staff of ten people.[115] It was built in response to rising costs of landfilling in the town and surrounding region, and

[104] The Surrey Leader. June 2013. Metro Vancouver short lists waste-to-energy bidders. Retrieved from: http://www.surreyleader.com/news/210310171.html
[105] Ibid
[106] Ibid
[107] The Guardian. March 2013. Feeling the Burn. Retrieved from: http://www.vereseninc.com/wp-content/uploads/2013/07/Feeling-the-Burn-Island-Weekend-March-16-2013.pdf
[108] University of Prince Edward Island. n.d. Heating and Cooling at UPEI. Retrieved from: http://sustainability.upei.ca/podcast/heating-and-cooling-upei
[109] Ibid
[110] Ibid
[111] Ibid
[112] The Guardian. March 2013. Feeling the Burn. Retrieved from: http://www.vereseninc.com/wp-content/uploads/2013/07/Feeling-the-Burn-Island-Weekend-March-16-2013.pdf
[113] Environment Canada. March 2007. MSW Thermal Treatment in Canada 2006. Retrieved from: http://www.ec.gc.ca/gdd-mw/default.asp?lang=en&n=D54033E4-1
[114] Ibid
[115] Ibid

serves over 10,000 people.[116] The facility generates steam which is sold to a neighbouring oil seed processing company.[117]

Industrial Applications in Canada

Industries throughout Canada are exploring energy from waste as part of their efforts to minimize operating costs, maximize the value of materials processed and associated by-products, and mitigate their environmental impacts. The following energy from waste initiatives utilize proven and economically viable technologies and the emissions stemming from their incineration of waste are well within jurisdictional compliance levels. Together, they make a strong case for the integration of energy from waste into Ontario's waste management hierarchy.

Canadian Forestry Sector Energy from Waste

Most modern pulp and paper mills in Canada now produce all or most of the energy they require on-site by combusting wood waste and black liquor, the by-products of their production processes. The combustion of black liquor—the liquid by-product of chemical pulping—in recovery boilers also allows mills to separate and reuse the pulping chemicals in the liquor, saving money and mitigating the environmental impact of the industry.[118] Many mills are even becoming net exporters of electricity to the grid, providing an additional, much-needed, source of income.[119] The energy produced by these mills is renewable, reliable, and easily dispatchable, allowing it to serve a complementary role with intermittent forms of renewable energy generation like wind and solar.[120] The federal government's $1 billion Pulp and Paper Green Transformation Program (PPGTP) of 2009 helped the industry add 200 MW of renewable waste-derived power to the nation's grid, enough energy to power roughly 140,000 homes each year.[121] PPGTP also provided the pulp and paper sector with the capital it needed to reduce its net emissions by 12% in spite of the fact that it has become a major energy producer.[122]

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[116] Cieslak JP, Ryan MT, and Brinckman GA. 1996. Design, installation and operation of the Wainwright regional waste-to-energy authority combustor. *Proceedings of the 17th Biennial Waste Processing Conference*. Retrieved from: http://www.seas.columbia.edu/earth/wtert/sofos/nawtec/1996-Biennial-Waste-Processing-Conference/1996-Waste-Processing-Conference-20.pdf
[117] Ibid
[118] Naqvi M, Yan J, and Dahlquist E. (2010). Black liquor gasification integrated in pulp and paper mills: A critical review. *Bioresource Technology*, 101: 8001-8015.
[119] Natural Resources Canada. September 2012. Pulp and Paper Green Transformation Program: Report on Results. Retrieved from: http://publications.gc.ca/collections/collection_2012/rncan-nrcan/Fo4-40-2012-eng.pdf
[120] Ibid
[121] Ibid
[122] Ibid

Edmonton Waste-to-Biofuels Facility

Construction is currently underway on the world's first industrial scale municipal waste-to-biofuels facility, which is expected to become operational in the summer of 2014.[123] The Edmonton facility will be owned and operated by Enerkem Alberta Biofuels, and will convert 100,000 tonnes of municipal solid waste into 38 million litres of biofuel (methanol and ethanol) on an annual basis.[124] These biofuels will help Alberta cut its greenhouse gas emissions, as they have been shown to yield less than 40% of the emissions that stem from the production and use of conventional gasoline.[125] The biofuels will eventually be used to power Edmonton's fleet of garbage trucks.[126] Edmonton currently diverts roughly 60% of its municipal solid waste from landfill through its recycling and composting programs, but this facility will allow that diversion rate to jump to 90%.[127] The facility will not process wastes that can be recycled or composted.[128] It will employ a permanent staff of over 30 people.[129]

Lafarge Canada's Biomass Demonstration Project, Bath, Ontario

As part of its Energy Farm Project and Cement 2020 Initiative, Lafarge, one of the world's largest cement producers, conducted a three day pilot project in 2010 to assess the feasibility of using biomass feedstocks[130] grown locally on marginal land to replace 15% (by volume, 10% by energy) of the coal-petroleum coke fuel mix used at their Bath, Ontario plant as a means to reduce CO_2e emissions.[131] Lafarge and its partners analyzed and published emissions, kiln efficiency, and cement quality data from the pilot project. Kiln efficiency and cement quality were not affected by the use of mixed biomass fuel, and toxic emissions of all types were found to be <1% of the maximum allowed under Ontario regulations (with the exceptions of $NO_{x,}$ SO_2, and PM, which were 35%, 5%, and 38% of allowable maximums respectively).[132] All heavy metal emissions were lower in the coal-coke-biomass mix than in the traditional coal-coke mix, and an equal proportion of heavy metals and contaminants were partitioned in the cement itself (>99% for all metals except copper (98%) and mercury (53%), which was expected).[133] While the project was considered a technical, social, and environmental success**,** it found

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[123] The City of Edmonton. 2013. Waste-to-Biofuels Facility: Turning Garbage into Fuel. Retrieved from: http://www.edmonton.ca/for_residents/garbage_recycling/biofuels-facility.aspx
[124] Ibid
[125] Ibid
[126] Ibid
[127] Ibid
[128] Ibid
[129] Ibid
[130] The biomass crops used in the Energy Farm Project were sorghum, maize, switchgrass, perl millet (which combined comprised 25% of the biomass fuel), and oat hulls (which comprised 75% of the biomass used).
[131] Lafarge and Hyndman & Associates. 2011. Lafarge Biomass Demonstration Project Summary Report: A summary report to satisfy the reporting requirements for the Certificate of Approval to combust various sources of agricultural biomass in the Lafarge Bath plant cement kiln. Retrieved from: http://www.cement2020.org/publication/all/148
[132] Ibid
[133] Ibid

that locally produced biomass currently cost roughly twice as much as coal, per unit of energy produced.[134]

Lafarge's Cement 2020 Initiative is an overarching initiative that aims to gradually phase out the use of coal as the primary fuel in cement manufacturing, replacing it with renewable, locally-sourced biomass.[135] The use of locally-sourced, low carbon biomass is envisioned as a way to reduce CO_2e emissions throughout the cement industry (making it more sustainable) and make use of underutilized materials while fostering local economic development.[136] Another major benefit associated with making the switch from coal to renewable biomass is that such a switch could prevent bio-based wastes from ending up in landfills, where they slowly decompose and release methane (a greenhouse gas roughly 23 times more potent than CO_2) into the atmosphere—unless that methane is captured using expensive and technically complex processes.[137] Results from the experimental biomass project at Lafarge's Bath Plant were so encouraging that the company feels it may be possible to completely eliminate the use of fossil fuels by 2020. The goal that Lafarge is currently working towards is to cut coal use at its Bath plant by 30% by 2016.[138]

In order to evaluate the social, economic and environmental impacts associated with burning alternative fuels, Lafarge Canada initiated the development of the Greener Fuel Protocol. The Protocol takes a holistic life cycle assessment approach to analysing the virtues of a given type of fuel, considering factors like the local availability of fuels, the resources required to produce biomass fuels, fuel handling challenges like water content, storage, and distribution, the impacts on landfill diversion rates in the case of recovered materials, the energy content of fuels, and emission levels associated with different fuels.[139] The intention of the Protocol is to develop a standardized methodology by which to assess the benefits and drawbacks of potential fuels. Lafarge plans to share the results of this initiative with other businesses, organizations and communities that are looking to reduce the negative impacts of their fuel use.[140] Several cement sector demonstration projects that will inform the development of a standardized fuel assessment methodology are currently underway across Canada, and include the use of fuels such as: purpose-grown biomass, crop and forestry residues, biochar, algae, post-recycling and post-composting residues, refuse-derived fuels, construction and demolition debris, old tires, shredded bank notes, asphalt shingles, and railway ties. The Protocol will ultimately help to identify the most sustainable options of the fuels tested, allowing the cement sector to focus its efforts on building the

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[134] Ibid

[135] Cement 2020. 2013. Project Statement. Retrieved from: http://www.cement2020.org/content/about

[136] Lafarge Canada, Inc. 2012. Application for an Environmental Compliance Approval: Low Carbon Fuel Demonstration Project – Lafarge Bath Plant. Retrieved from: http://www.cement2020.org/download/file/fid/149

[137] Yang N, Zhang H, Shao LM, Lu F, and He PJ. 2013. Greenhouse gas emissions during MSW landfilling in China: Influence of waste characteristics and LFG treatment measures. *Journal of Environmental Management,* 129: 510-521.

[138] Cement 2020. 2011. Lafarge biomass experiment a success. Retrieved from: http://www.cement2020.org/content/lafarge-biomass-experiment-success

[139] Cement 2020. April 2012. The Greener Fuel Protocol: Identifying fuels of the future. Retrieved from: http://www.cement2020.org/content/greener-fuel-protocol-0

[140] Ibid

capacity to develop and utilize the fuels that have the most beneficial social, economic and environmental impacts.[141]

St. Marys Cement Plant, St. Marys, Ontario

This plant held an alternative fuel demonstration from May 11th to 25th in 2011 to test the potential for alternative fuels to replace up to 30% of the typical coal-coke fuel mix used in cement manufacturing.[142] The alternative fuels used were shredded plastic bags, other plastic materials, paper fibre, and other woody materials from industrial and post-consumer sources.[143] Air quality monitoring and plant performance testing showed there was no significant difference in emissions stemming from the use of alternative fuels.[144] St. Marys Cement is now seeking environmental approval to substitute coal and coke for alternative, post-consumer, materials on a long term basis.[145]

The St. Marys plant has also partnered with Pond Biofuels, and now diverts a portion of the CO_2 produced on-site (0.83 tonnes of CO_2 is produced for every tonne of cement) into algae ponds.[146] The algae are gathered regularly, dried, and used as an alternative fuel in the plant or in the manufacture of biodiesel that could one day be used to power the plant's fleet of trucks.[147] Over the course of one year, a one half hectare algae farm can fix more CO_2 than 200 hectares of mature trees.[148] St. Marys Cement plans to scale up the size of its algae ponds in order to prove the economic viability of on-site algae production. The plant will increase its current algae production capacity by 1000% by 2014, and will divert 30% of the plant's CO_2 emissions to these expanded ponds.[149] This expanded algae facility will create 45 full-time jobs, and will lower plant costs.[150] The goal of St. Marys Cement is to eventually divert 100% of the CO_2 they produce to their algae ponds.[151]

[141] Ibid
[142] St. Marys Cement. September 2012. St. Marys Cement Alternative Fuel Project: Application for Long Term Approval. Retrieved from: http://www.stmaryscement.com/saintmaryscementinc/_Uploads/CurrentInfo/Stper cent20Marysper cent20Plantper cent20Displayper cent20Panelsper cent20forper cent20Septemberper cent2026per cent202012per cent20V4.pdf
[143] Ibid
[144] Ibid
[145] Ibid
[146] The Toronto Star. March 2010. CO_2-eating algae turns cement maker green. Retrieved from: http://www.thestar.com/business/2010/03/18/co2eating_algae_turns_cement_maker_green.html
[147] Ibid
[148] Ibid
[149] Aarts M. November 2012. St. Marys Cement Algae Innovation. Retrieved from: http://prezi.com/ox3rr7wzppez/st-marys-cement-algae-innovation/
[150] Ibid
[151] Ibid

Global Jurisdictions

The European Union's *Waste Framework Directive* of 2008 established Europe's waste hierarchy as follows:

1. Waste prevention;
2. Reuse;
3. Material recycling;
4. Other recycling (including energy from waste); and
5. Disposal/landfilling.[152]

This prioritization and accompanying regulations have resulted in some European countries adopting energy from waste technologies in earnest. Over the last two decades, hazardous emissions stemming from waste incineration have fallen anywhere from 500 to 1000% in most cases,[153, 154] while energy production efficiency has increased. In some cases, the incineration of waste has been shown to be complementary to other forms of diversion, rather than an impediment to them, as recycling rates in some jurisdictions continue to grow despite the implementation of a 4R waste hierarchy.[155]

Energy from Waste in Germany

Since the early 1990s, Germany has used alternative fuels (like used tires, carpeting, sewage sludge, meat and bone meal, and hazardous waste) in its cement manufacturing, making the cement industry one of the key players in the German waste management sector.[156] Because organic alternative fuels require pre-treatment before use in cement kilns, their incineration used to be prohibitively expensive, but a 2005 landfill ban on organics gave the incineration of organics in cement kilns an economic advantage.[157] The 2005 ban, in addition to rising oil costs and the Government of Germany's decision to issue CO_2 certificates to energy producers, led to a significant increase in Germany's waste incineration capacity over the last decade, and the country is now home to over 70 municipal waste incinerators.[158]

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152 Avfall Sverige. n.d. Towards a Greener Future with Swedish Waste-to-Energy: The World's Best Example. Retrieved from: http://www.avfallsverige.se/fileadmin/uploads/forbranning_eng.pdf

153 Canadian Council of Ministers of the Environment. 2010. Canada-Wide Standard for Mercury Emissions (Incineration & Base Metal Smelting): 2010 Progress Report. Retrieved from: http://www.ccme.ca/assets/pdf/mercury_incin_bms_2010_progress_rpt_e.pdf

154 Canadian Council of Ministers of the Environment. 2009. Canada-Wide Standards for Dioxins and Furans (Pulp and Paper Boilers Burning Salt Laden Wood, Waste Incineration, Iron Sintering Plants, Steel Manufacturing Electric Arc Furnaces and Conical Municipal Waste Combustion): Progress Report 2009. Retrieved from: http://www.ccme.ca/assets/pdf/df_2009_prgs_rpt_e.pdf

155 Netherlands Ministry of Housing, Spatial Planning and the Environment. August 2011. Developments in Waste Management: Lessons learned in the Netherlands. Retrieved from: http://www.slideshare.net/ONEIA/developments-in-dutch-waste-management-oneia

156 Fendel A, and Friege H. 2011. Competition of Different Methods for Recovering Energy from Waste Leading to Overcapacities. Retrieved from: http://www.iswa.org/uploads/tx_iswaknowledgebase/Friege.pdf

157 Ibid

158 Ibid

Like Sweden, Germany is also now incinerating waste from neighbouring countries, as the emissions stemming from waste transport, even over long distances, have been shown to be low compared to the emissions reductions stemming from the incineration of waste.[159]

Energy from Waste in Japan

Since 1965, the incineration of waste has been common in Japan, primarily due to lack of space for landfills.[160] Today, with over 300 energy from waste facilities operating in Japan, only a small fraction of the country's waste is landfilled, and all combustible waste is now incinerated in co-generation plants.[161] Japan offers producers a feed-in tariff rate of 22 cents (USD) for every kWh of electricity produced from waste combustion—the highest rate offered in the world.[162] It strongly backs the incineration of waste on the following grounds: it releases fewer greenhouse gas emissions than landfilling, it reduces landfilling rates by more than 90%, it allows for the treatment of a wide variety of wastes with the same general techniques, it is very adaptable, and it provides a dependable source of dispatchable power that complements intermittent renewable sources.[163] The negative aspects of energy from waste that the Government of Japan strives to rectify are its negative public image (the public is primarily concerned with toxic emissions like dioxins stemming from incineration plants, although in the case of dioxins emission levels fell by over 98% between 1997 and 2008, and emission levels of all other toxins have been reduced dramatically in recent decades), and the fact that incineration plants have higher start-up costs than landfills.[164]

Energy from Waste in the Netherlands

Waste incineration has been widely practiced for decades in the Netherlands, producing electricity, district heating and cooling, and steam for industrial purposes.[165] The Netherlands strives to minimize the amount of waste going to landfill due to: space limitations, the long-term maintenance requirements of landfills, the loss of valuable material resources, and the need to reduce greenhouse gas emissions stemming from landfilling.[166] The Netherlands has a strong record of individual producer responsibility (IPR), and about 80% of household waste is covered by an IPR framework, which greatly

159 Ibid
160 Japanese Business Alliance for Smart Energy Worldwide. November 2012. Presentation of Japanese technology of waste to energy. Retrieved from: http://www.mofa.go.jp/region/latin/fealac/pdfs/4-9_jase.pdf
161 Ibid
162 Ibid
163 Ibid
164 Ibid
165 Dutch Waste Management Association. 2013. Waste-to-Energy in the Netherlands. Retrieved from: http://www.wastematters.eu/about-dwma/activities/waste-to-energy/activities-in-the-netherlands.html
166 The Chartered Institution of Wastes Management. September 2005. Energy From Waste: Lessons from the Netherlands. Retrieved from: http://www.engr.usask.ca/classes/BLE/482/Miscper cent20Info/wasteper cent20toper cent20energy.pdf

helps municipalities cover the costs of waste management.[167] As a result of their recycling, composting, and waste incineration efforts, over 95% of Dutch municipal solid waste is now diverted from landfills, with 83% being recycled and 12% going towards energy from waste.[168] Despite the nation's long history of energy from waste, rates of recycling continue to grow, with household and commercial waste recycling expected to reach 60% by 2015, at which time industrial waste recycling will reach 85% and C&D waste recycling will reach 95%.[169] The Dutch waste hierarchy, known as Lansink's Ladder, consists of the following steps:

1. Prevention;
2. Design for prevention and for beneficial use;
3. Product recycling (re-use);
4. Material recycling;
5. Recovery for use as fuel;
6. Disposal by incineration;
7. Disposal to landfill.[170]

Energy from Waste in Sweden

In the 1970s, the Government of Sweden began investing heavily in waste incineration for energy recovery.[171] Since that time, emissions from its energy from waste facilities have fallen by 90 to 99%, despite the fact that its incineration capacity has tripled and its energy produced from waste has increased fivefold.[172] Today, only 4% of Swedish household waste ends up in landfills (America, by comparison, sends over 50% of its household waste to landfills), and just under 50% of household waste is recycled.[173] The remaining 2 million tonnes of waste are incinerated in co-generation facilities, providing electricity as well as heat and hot water to over a quarter of a million homes.[174]

Between 1990 and 2006 the Swedish waste sector cut its greenhouse gas emissions by 34%, and expects to further cut those emissions by 76% by 2020.[175] These cuts are largely attributable to increased landfill taxes and landfill bans on combustible waste in 2002 and organics in 2005 which served to significantly

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[167] Ibid
[168] Netherlands Ministry of Housing, Spatial Planning and the Environment. August 2011. Developments in Waste Management: Lessons learned in the Netherlands. Retrieved from: http://www.slideshare.net/ONEIA/developments-in-dutch-waste-management-oneia
[169] Ibid
[170] The Chartered Institution of Wastes Management. September 2005. Energy From Waste: Lessons from the Netherlands. Retrieved from: http://www.engr.usask.ca/classes/BLE/482/Miscper cent20Info/wasteper cent20toper cent20energy.pdf
[171] Avfall Sverige. n.d. Towards a Greener Future with Swedish Waste-to-Energy: The World's Best Example. Retrieved from: http://www.avfallsverige.se/fileadmin/uploads/forbranning_eng.pdf
[172] Ibid
[173] The Pachamama Alliance. November 2012. Models of Sustainability: Sweden Runs Out of Garbage. Retrieved from: http://www.pachamama.org/blog/models-of-sustainability-sweden-runs-out-of-garbage
[174] Avfall Sverige. n.d. Towards a Greener Future with Swedish Waste-to-Energy: The World's Best Example. Retrieved from: http://www.avfallsverige.se/fileadmin/uploads/forbranning_eng.pdf
[175] Ibid

curtail the release of methane from the country's landfill sites, as well as constantly improving technology.[176] The entire country's network of energy from waste incinerators, for example, now emits less than 1 gram of dioxins per year, down from about 100 grams in the mid-1980s.[177]

[176] Ibid
[177] Ibid

Chapter 5: The 4th R in Québec and British Columbia

Two jurisdictions in Canada—Québec and British Columbia—have established comprehensive waste management systems that integrate energy from waste into their policy frameworks. This chapter profiles Québec's *Residual Materials Management Policy* and British Columbia's *Solid Waste and Resource Management Plan*, citing key sections of these provincial policies.

Québec: The Residual Materials Management Policy

Administered by Ministry of Développement durable, de l'Environnement et des Parcs, Québec's *Residual Materials Management Policy* exemplifies a comprehensive approach to waste management through a lens of sustainable development, climate change mitigation and energy efficiency. The policy aims to create a zero-waste society "that maximizes added value through sound residual materials management, and its main goal is for end waste to be the only residual material sent for disposal in Québec."[178]

The policy is based on the 4R waste management hierarchy discussed earlier and gives priority to waste management methods that will have the least impact on the environment (i.e. source reduction, reuse, recycling (including by biological treatment or landspreading/composting), other forms of material reclamation, energy production, and disposal, in that order). Life cycle assessments are employed for decision-making regarding the best waste management options, making it possible to deviate from this order when an assessment demonstrates that such a deviation is justified from an environmental standpoint.[179] Notably, one of the main goals of the policy is to make end waste the only residual material sent for disposal in Québec. The policy defines end waste as "the waste that results after residual materials have been sorted, processed, and reclaimed and cannot be processed any further under existing technical and economic conditions to extract reclaimable content or reduce its polluting or hazardous character."[180]

In terms of scope, the policy "applies to all residual materials generated in Québec by households, industries, businesses, and institutions, including those produced by construction, renovation, and demolition activities and waste from primary industry that is transported outside of production sites to disposal sites or to residual materials reclamation facilities. These residual materials also include municipal and industrial sludge and out-of-service vehicles and their waste. The Policy does not apply, however, to hazardous materials (except for household and similar products), animal dung, uncollected logging residues, biomedical waste, mine tailings, soil containing contaminants in quantities or

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[178] Ministère du Développement durable, de l'Environnement et des Parcs. 2010. Environment Quality Act: Québec Residual Materials Management Policy. Retrieved from: http://www.mddefp.gouv.qc.ca/matieres/pgmr/presentation_en.pdf
[179] Ibid
[180] Ibid

concentrations exceeding the level set by regulation, and gaseous substances, except for those contained in another residual material or arising from the treatment of such a material."[181]

Another critical component of the policy is its intention to ban the landfilling of organic waste in the future once the necessary collection services and treatment facilities are available. "As paper, cardboard, and wood recycling is already well established, the government intends to begin by banning the disposal of these materials and follow up with other putrescible organic material, such as leaves, grass clippings, table scraps, and sludge."[182] Together with an increase in fees for the disposal of residual materials and a gradual ban on the disposal of organic materials, the policy aims to change how the IC&I and construction, renovation and demolition sectors manage their residual materials.[183]

Similar to Ontario's proposed individual producer responsibility approach to waste management, Québec's Residual Materials Management Policy "intends to make companies assume the entire cost of recovering and reclaiming containers, packaging, printed material, and written media."

British Columbia's Solid Waste and Resource Management Plan

Metro Vancouver and the Government of British Columbia promote the adoption of an "integrated resource recovery" approach, which attempts to generate synergies that enable the waste from one system to become resources for another. This echoes the previously mentioned conviction of the FCM that waste management policy should emulate the zero waste systems that arose in the natural world, in which waste materials from one part of an ecosystem serve as the building blocks for another part. Accordingly, the province sees the following benefits arising from energy from waste projects: preserving non-renewable resources, stretching the capacity of existing infrastructure, saving energy, generating revenue, protecting the environment, and reducing greenhouse gas emissions.[184]

In regard to energy from waste facilities, British Columbia's Ministry of Environment has set clear and stringent standards which are drawn from jurisdictions that have a long record of successfully implementing energy from waste into their waste management hierarchies.

BC's *Integrated Solid Waste and Resource Management Plan* (ISWRMP), a provincially mandated plan for the Vancouver region, lays out the most sustainable methods for dealing with the province's municipal solid waste, which it defines as: "refuse that originates from residential, commercial, institutional, demolition, land clearing or construction sources."[185] The overriding principle of the

[181] Ibid
[182] Ibid
[183] Ibid
[184] Metro Vancouver. July 2010. Integrated Solid Waste and Resource Management: A Solid Waste Management Plan for the Greater Vancouver Regional District and Member Municipalities. Retrieved from: http://www.metrovancouver.org/about/publications/Publications/ISWRMP.pdf
[185] Ibid

ISWRMP is the avoidance of waste through an aggressive waste reduction campaign and through the recovery of materials and energy from the waste that remains.[186]

The plan has four goals:

1. Minimize waste generation;
2. Maximize reuse, recycling, and material recovery;
3. Recover energy from the waste stream after material recycling; and
4. Dispose of all remaining waste in landfill, after material recycling and energy recovery.[187]

In order to realize the third goal, the ISWRMP mandates that municipalities utilize the following strategies: use energy from waste to provide electricity and district heating; recover energy from other solid waste management facilities (e.g. methane from landfill gas extracted in anaerobic digestion facilities); and utilize non-recyclable materials as fuel.[188] However, the Government of British Columbia expects municipalities to set minimum waste reduction targets of 70% (calculated only from reduce, reuse, and recycle initiatives) before utilizing the energy from waste option.[189] These strategies aim to ensure that energy from waste does not conflict with the reduce, reuse, and recycle steps in British Columbia's waste hierarchy, and will be used when landfilling is the only alternative.[190]

As part of an integrated policy approach, ISWRMP supports British Columbia's Air Action Plan, *Bioenergy Strategy*, and the *Landfill Gas Management Regulation*. Such integrated policy development is crucial to maximize the benefits and efficiency of policies at all levels of government that relate to waste management and environmental health. Please see Appendix B for an illustration of Metro Vancouver's ISWRMP policy integration with other municipal plans.

[186] Ibid
[187] Ibid
[188] Ibid
[189] Ibid
[190] Ibid

Chapter 6: Legal Precedents for the Use of Refuse-Derived Fuels in the Cement Sector

All of the information provided above begs the following questions: if certain “waste” streams have practical applications as fuels for industrial processes, are they really “waste” at all? If not, is “energy from waste” even an appropriate term? Are cement plants that make use of refuse-derived fuels involved in waste management, or are they simply using alternative fuels?

In a 2012 case that came before the Court of Appeal for Ontario, St. Marys Cement appealed a previous court ruling that held that using non-recyclable waste materials (post-composting residual plastic film, post-recycling paper bio-solids, and post-recycling residual materials) as fuel alternatives to petroleum coke constituted a change in land use under a municipality of Clarington zoning by-law.[191] St. Marys Cement contended that the by-law in place permitted them to manufacture cement using the proposed alternative fuels, while the Municipality of Clarington (in which the St. Marys plant is situated) disagreed.

Initially, the application judge interpreted the by-law in favour of Clarington, concluding that the use of alternative fuels would be an impermissible change in land use. The appeal judge, however, concluded that the use of alternative fuels would not constitute a change in land use, thereby approving the use of alternative fuels at the St. Marys plant in Clarington.

Over the course of the initial case and the appeal, Clarington argued that the use of recovered waste materials as fuel would mean that the site of the St. Marys plant would be used as a waste disposal area—a land use that was not permitted under existing zoning by-laws. Clarington thus felt that an amendment to the by-law was required if St. Marys Cement was to be allowed to use the proposed recovered materials as fuel.

The St. Marys plant is located on a 321 hectare piece of land zoned as an Extractive Industrial (M3) Zone. At the time of the appeal, the plant used petroleum coke—a by-product of crude oil refining—as its primary source of fuel. Most of the petcoke was transported to the plant via lake freighter, and the rest arrived by truck. St. Marys proposed to conduct a time-limited demonstration project in which the three alternative fuels would be substituted for up to 30% of the petcoke fuel. The alternative fuels were to be transported exclusively by truck and delivered on a just-in-time basis shortly before their use. The use of alternative fuels was intended to achieve the two-fold benefit of reducing the plant’s use of non-renewable fossil fuels while reducing operational costs. At the time of the appeal, St. Marys had applied for the necessary approvals to the Ministry of the Environment under s. 27 of the *Environmental Protection Act* (EPA), R.S.O. 1990, c. E. 19. Those approvals were pending the outcome of the appeal.

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[191] Court of Appeal for Ontario. December 17, 2012. *St. Marys Cement Inc. (Canada) v. Calrington (Municipality)*. Ordinal number 884. Retrieved from: http://caselaw.canada.globe24h.com/0/0/ontario/court-of-appeal-for-ontario/2012/12/17/st-mary-s-cement-inc-canada-v-clarington-municipality-2012-onca-884.shtml

It was brought to the attention of the appeal judge that similar alternative fuels were used by cement manufacturers in other jurisdictions including Quebec and British Columbia, as well as the United States and Europe. St. Marys Cement operates another cement plant in the town of St. Marys in south-western Ontario. That facility had proposed to use one of the same fuels proposed for use at the Clarington plant, pending approval by the Ministry of the Environment. The town of St. Marys had a similar by-law but, unlike Clarington, the town took the position that the use of alternative fuel did not constitute a change in land use, that fuel storage and handling was an accessory use, and that no additional planning permission was required. St. Marys Cement planned to seek regulatory approval for the long-term use of alternative fuels if the Clarington demonstration project showed that the fuels could be used without any significant change in emissions or environmental impact.

St. Marys Cement filed expert evidence on the application to the effect that the project would not create adverse neighbourhood effects. While the substitution of fuels would result in some increased truck traffic, the system of alternative fuel delivery was enclosed and, by design, the process would not create additional litter, odour or dust nuisances. Furthermore, the use of post-recycled and post-compost materials was proposed to have environmental benefits and their substitution for petcoke was expected to reduce the plant's greenhouse gas and sulphur emissions.

The application judge had decided that the proposed fuel substitution would bring the St. Marys Clarington plant outside of the expressly permitted use of the land as a cement manufacturing site, concluding:

"While I agree that SMCs [St. Marys Cement's] *use of the site for the manufacturing of cement will continue to be a permitted use under the Demonstration Project in my view, through the introduction of a fuel that falls within the EPA definition of waste, SMC is introducing a new and additional use on the site, because it will be disposing of industrial waste. As such, SMC will be operating a waste disposal area on the site."*[192]

The appeal judge, however, found that the application judge had erred in his conclusion that the use of recovered waste materials as fuel brought the Clarington plant within the definition of a waste disposal area, thus constituting a new and additional land use. The appeal judge found that the application judge did not apply the express language used in s. 2 of the by-law, which defines waste disposal areas. Although both judges found that the proposed alternative fuels fell within the general definition of waste under the EPA (the definition endorsed by the municipality of Clarington), which lays out a long list of designated wastes in s. 2 of the *General Waste Management* Regulation, R.R.O. 1990 Reg. 347 that includes post-recycling and post-composting materials, the appeal judge concluded that the use of waste materials as fuel did not in-and-of-itself make the Clarington plant a waste disposal area. Both parties in the case had agreed that the use of the cement plant site as a waste disposal area was not permitted. The term waste disposal area is defined by s. 2 of the zoning by-law as *"a place where*

[192] Ibid, paragraph 18.

garbage, refuse or domestic or industrial waste is dumped, destroyed, or stored in suitable containers."[193]

The appeal judge held that St. Marys Cement would not in fact be dumping, destroying or storing waste at its Clarington plant, and thus that the site of the plant would continue to be used exclusively for cement manufacturing. And if the Clarington plant site were to be used exclusively in the manufacture of cement and not as a waste disposal area, then no additional permits or by-law amendments were required. The municipality of Clarington argued that the use of alternative fuels by St. Marys Cement would constitute a second use of the land zoned for the Clarington plant involving waste processing. Extractive Industrial (M3) Zones, however, are explicitly entitled to host waste transfer stations and material recovery and recycling facilities for solid non-hazardous wastes. The appeal judge thus found that St. Marys' use of alternative fuels did not constitute a second use of the land.

The municipality of Clarington had contended that the alternative waste fuels proposed for use by St. Marys would be "destroyed" when combusted in the cement production process—rationale with which the application judge had agreed. The appeal judge, however, came to the following conclusion while deciding the case:

"SMCs use of the alternative fuel would not be considered destruction of waste, just as the use of petcoke fuel would not be characterized as the destruction of petcoke. In both cases, fuel is being used productively as part of the permitted use the manufacturing of cement.

SMC is proposing to use the materials as a resource for an existing and approved manufacturing process. The fact that the fuel materials are being diverted from the waste stream is not, on the facts of this case, determinative of the land use. In this context it is worth noting that petcoke is a by-product of petroleum production, and by definition, would itself be a waste product if it did not have a productive use. The use of one fuel as opposed to another does not alter the fact that the SMC plant is in essence a cement plant and not a waste disposal area."[194]

The appeal judge's decision was further informed by a precedent-setting case that came before the Court of Appeal of England in 2001, *R. (ex parte Lowther) v. Durham County Council and Lafarge Redland Aggregates Limited*, which he found to be analogous to *St. Marys Cement v. Clarington* although it was decided under a different regulatory framework. In the *Lowther* case, the court held that the use of alternative fuels did not constitute a change in land use, with the judge in that case concluding:

"I have been unable to identify any principle of planning law that decrees that, simply because waste is matter which has to be disposed of, a person who makes constructive use of the waste for the purpose of some activity other than disposal of the waste, but who incidentally disposes of the waste at the same

[193] Ibid, paragraph 22.
[194] Ibid, paragraphs 26 – 27.

time, must be deemed to be making two uses of the land, namely waste disposal and the ulterior activity."[195]

The judge went on to affirm that Lafarge's use of alternative fuels did not constitute waste disposal as the combustion of fuel for energy production was a process of such central importance to the manufacture of cement that it would be wrong to characterize it in any way as a separate process.

The appeal judge in the *St. Marys v. Clarington* case agreed with the reasoning of the judge in the *Lowther* case, holding that the burning of fuel is inherent to the production of cement, and the use of alternative fuel does not amount to a separate use of the land. He noted that there may be cases in which land truly has two uses, one of which would render the entire enterprise prohibited. Examples of this could include methane recapture from a landfill site or energy generation from a garbage incinerator. These situations could fall within the restricted definition of waste disposal area.

The appeal judge thus held that so long as the alternative fuels proposed for use by St. Marys Cement received approval from the Ontario Ministry of the Environment under section 27 of the EPA, St. Marys was free to make use of post-recycling materials at their Clarington plant.

[195] Ibid, paragraph 33.

Chapter 7: Discussion and Recommendations

Just as petcoke is not considered waste, but fuel, the post-composting residual plastic film, post-recycling paper bio-solids, and post-recycling residual materials that the St. Marys plant in Clarington proposed to use cannot be defined as waste, and even if they were, their combustion to power an integral industrial process could not be equated to their destruction.

If something has value as a fuel, and especially as in this case a fuel with a more environmentally-friendly emissions profile than petcoke, then how can it be considered waste? And how can its combustion be considered its destruction? Do vehicles destroy petroleum and diesel fuels? Is the purpose of vehicles to destroy fuel? Do campfires destroy wood and is that their purpose? No. Vehicles are intended to transport people and goods and require a combustible fuel in order to do so. Campfires are meant to provide heat and light and again require a combustible fuel. Cement plants are meant to make cement, and require combustible fuels in order to reach the high temperatures required to power the process. If materials currently designated as waste by Ontario legislation can be safely and effectively utilized as fuel, then this role for such materials must be acknowledged and explored. It was never the intention of Ontario legislation that designates materials as waste to do so in perpetuity, otherwise innovative practices and emerging technologies would never be able to take advantage of certain materials, and those materials would be fated to remain waste—a useless burden—to society forever.

A truly sustainable society must be one in which no materials are wasted, and no materials are even considered waste, but are rather cycled through natural and anthropogenic processes in perpetuity, changing states while maintaining utility and value. The value inherent in certain materials may be difficult to capture given our society's tendency to discard peripheral by-products as waste, but when we begin to embrace the fact that the by-products of one process can—and must, in the long run—serve as the building blocks for other processes, we can truly begin to manage our material resources sustainably. Waste is an arbitrary and subjective designation for materials whose management and re-purposing is not currently economically viable. If it is cheaper for society to designate undesirable or difficult to manage materials as waste and discard them without consideration for their potential functionality, then those materials will continue to be produced and used unsustainably. In a sustainable paradigm there can be no waste, there can only be materials awaiting to serve an alternative function, and to have their potential value realized.

If there are accessible streams of combustible materials currently designated as waste that have a less harmful emissions profile than coal and petcoke, then such materials should not be considered waste any more so than coal is. It would be exceedingly difficult to create a system of production and consumption that is a completely closed loop, requiring no additional inputs and creating no residual outputs. But as our society's technological expertise matures and our natural resources become increasingly scarce, we will have to shift our modes of production and consumption increasingly towards sustainability and comprehensive materials management. We cannot afford to squander our vast endowment of natural resources any longer, and we must therefore explore ways by which to extract all possible value from the resources already in circulation. Our tendency to discard massive amounts of useful materials as waste is but one of the many unsustainable and inefficient tendencies that are currently practiced and supported by legislation in Canada—one of the many societal tendencies that cannot be maintained indefinitely.

If the Government of Ontario is firmly committed to minimizing the production and disposal of waste, then it must allow room for industries to develop innovative means by which to minimize waste. The cement sector will always have a great demand for combustible fuels, and if certain waste streams possessing all the requisite properties of useful fuels are readily available and have less of an environmental impact than existing fuels, then to prohibit the use of such waste streams as fuel would be counter-productive. Those in opposition to the use of alternative waste fuels in the cement sector might argue that their use could promote the continued production of by-products that cannot be recycled or composted, in order to ensure that such fuels remain available to cement manufacturers. But perhaps it would be more appropriate for such opponents to advocate for the adoption of policies and practices that discourage the production of such non-recyclable by-products to begin with, rather than focusing their efforts on an industry that is trying to make use of materials that are currently in abundant supply, and which currently burden society.

It should be noted that the cement sector is already looking beyond the use of alternative waste fuels to a time when various forms of renewable biomass can serve as the industry's primary fuel (a shift that would reduce CO_2 emissions from fuel use in cement manufacturing by roughly 90%[196]). Currently, however, the costs associated with the use of biomass as fuel are prohibitive, so the sector needs to find a stream of combustible materials with a lower carbon footprint than petcoke and coal in the transition period between the era of fossil fuels and that of biomass fuels. Biomass fuels are highly likely to become more cost-competitive with petcoke and coal as carbon emission pricing schemes (carbon taxes) become the norm in Ontario, Canada, and throughout the world, and as the biomass resource industry (which has great potential in Ontario) gains momentum and develops the level of infrastructure required to become a dependable supplier of fuel to the cement industry. Renewable biomass that is locally sourced, does not conflict with food production, has minimal environmental impact, and promotes sustainable economic development in the province is the fuel of choice for the cement sector over the long-term. In the short and medium terms, however, the industry must wean itself off of petcoke and coal, and requires the approval of the use of alternative fuels in order to do so.

If the alternative fuels the cement sector hopes to utilize currently burden our society due to rapidly diminishing landfill capacities and unchecked greenhouse gas emissions stemming from the landfilling of non-recyclable wastes, then the heart of the problem does not lie in science or economics, but in the semantics of waste management and the political framework that upholds legislation even in the face of compelling evidence that makes such legislation obsolete. Legislation that allows no room for industries to innovate and experiment with methods that enhance their sustainability will end up serving as an

[196] Lafarge Canada. April 2011. Biomass Use in the Cement Sector: A Fuel Users Perspective. Retrieved from: http://www.ofa.on.ca/uploads/userfiles/files/robert%20cumming.pdf

obstacle to progress. Legislation in Ontario should be adaptable enough to keep pace with the innovative forces that exist in the province if the province is to remain a wellspring of technological innovation and sustainable development.

Energy from waste using today's best available technologies has been shown to release fewer greenhouse gas emissions than landfilling, and in the case of cement manufacturing it offsets the use of non-renewable fossil fuels. Energy from waste should thus be considered a viable means to address Ontario's landfill capacity issue while achieving higher rates of waste diversion and promoting economic development and innovation in the province's cement sector. Pollution Probe strongly encourages the Government of Ontario to consider this option while assessing the environmental, social, and economic impacts of its waste management regulations.

Appendix A: Ontario's *Guideline A-7*: In-Stack Emission Limits for Thermal Treatment Facilities

Table 1: In-Stack Emission Limits For Thermal Treatment Facilities Excluding Cement and Lime Kilns

TABLE 1		
Parameter	In-Stack Emission Limit	Verification of Compliance[1]
particulate matter (PM)	14 mg/Rm^3	Results from compliance source testing or calculated as the rolling arithmetic average of four (4) hours of data before dilution with any other gaseous stream, measured by a continuous emission monitoring system that provides data at least once every fifteen minutes
cadmium	7 µg/Rm^3	Results from compliance source testing
lead	60 µg/Rm^3	Results from compliance source testing
mercury	20 µg/Rm^3	Results from compliance source testing or calculated as the rolling arithmetic average of 24 hours of data measured by a continuous emission monitoring system that provides data at least once every 15 minutes
dioxins and furans	80 pg/Rm^3	Results from compliance source testing; results expressed as I-TEQ
hydrochloric acid (HCl)	18 ppmdv (27 mg/Rm^3) or an HCl removal efficiency of not less than 95%	Results from compliance source testing or calculated as the rolling arithmetic average of 24 hours of data measured by a continuous emission monitoring system that provides data at least once every 15 minutes
sulphur dioxide (SO_2)	21 ppmdv (56 mg/Rm^3)	Results from compliance source testing or calculated as the rolling arithmetic average of 24 hours of data measured by a continuous emission monitoring system that provides data at least once every 15 minutes
nitrogen oxides (NOx)	105 ppmdv (198 mg/ Rm^3)	Results from compliance source testing or calculated as the rolling arithmetic average of 24 hours of data measured by a continuous emission monitoring system that provides data at least once every 15 minutes
organic matter (undiluted, expressed as equivalent methane)	50 ppmdv (33 mg/ Rm^3)	Results from compliance source testing or calculated as the rolling arithmetic average of 10 minutes of data at the outlet of the piece of equipment where combustion of the gas stream resulting from thermal treatment of waste is completed but before dilution with any other gaseous stream takes place, measured by a continuous emission monitoring system that provides data at least once every minute
carbon monoxide	35 ppmdv (40 mg/Rm^3)	calculated as the rolling arithmetic average of four (4) hours of data at the outlet of the piece of equipment where combustion of the gas stream resulting from thermal treatment of waste is completed but before dilution with any other gaseous stream, measured by a continuous emission monitoring system that provides data at least once every fifteen minutes
opacity	10 percent	calculated as the rolling arithmetic average of six (6) minutes of data measured by a continuous emission monitoring system that provides data at least once every minute
	5 percent	calculated as the rolling arithmetic average of two (2) hours of data measured by a continuous emission monitoring system that provides data at least once every fifteen minutes

[1] Compliance source testing as set out in the facility's Certificate of Approval.

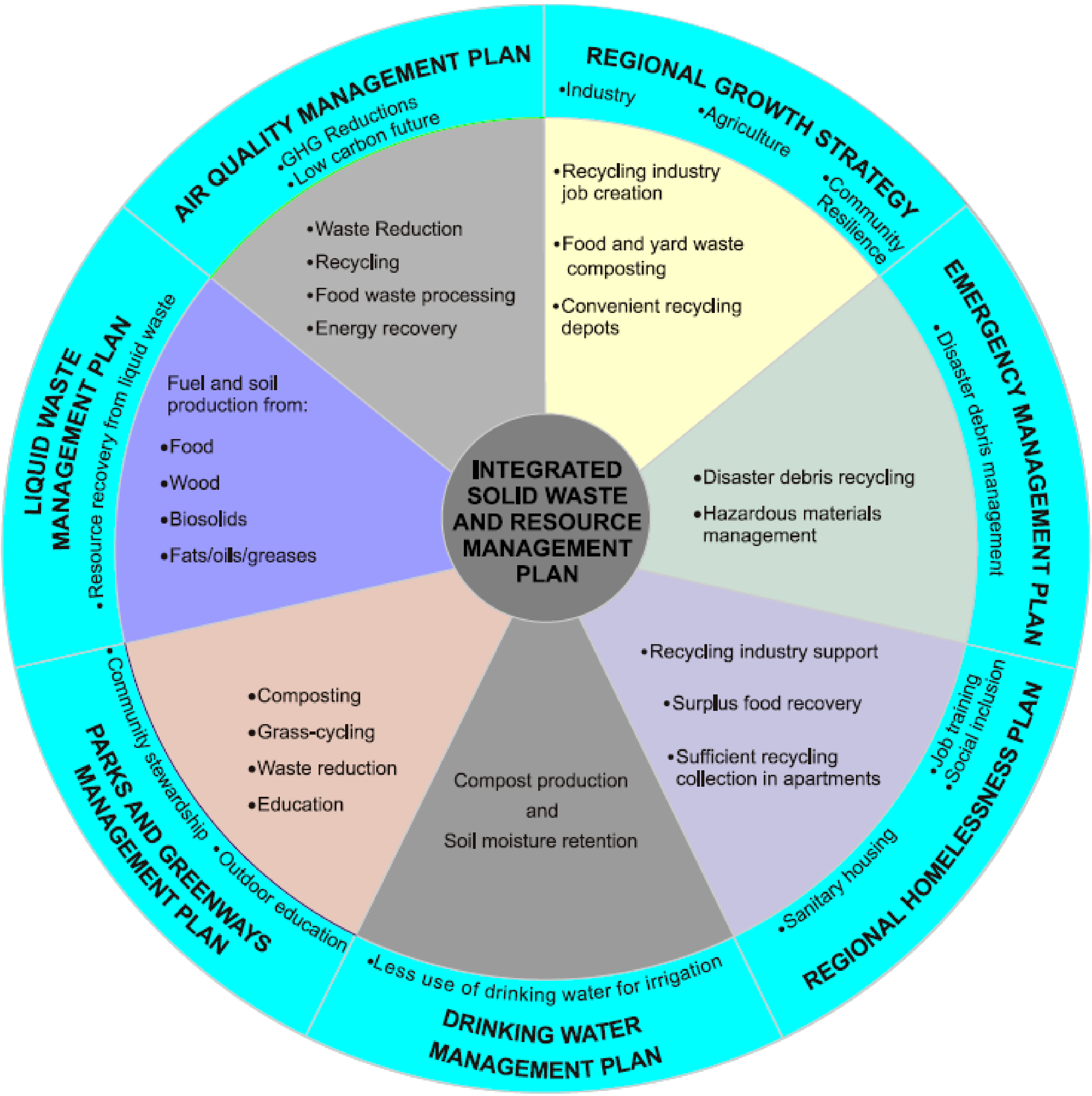
Table 2: In-Stack Emission Limits for Cement and Lime Kilns

TABLE 2		
Parameter	In-Stack Emission Limit	Verification of Compliance[2]
particulate matter (PM)	50 mg/Rm^3 or a site specific emission limit where a more stringent stack concentration limit is already in place for existing raw materials and conventional fuels (1)	Results from compliance source testing or calculated as the rolling arithmetic average of four (4) hours of data measured by a continuous emission monitoring system that provides data least once every fifteen minutes
cadmium (Cd)	7 µg/Rm^3 unless existing raw materials and conventional fuels result in higher concentration (2)	Results from compliance source testing
lead (Pb)	60 µg/Rm^3 unless existing raw materials and conventional fuels result in higher concentration (2)	Results from compliance source testing
mercury (Hg)	20 µg/Rm^3 unless existing raw materials and conventional fuels result in higher concentration (2)	Results from compliance source testing or calculated as the rolling arithmetic average of 24 hours of data measured by a continuous emission monitoring system that provides data at least once every 15 minutes
dioxins and furans	80 pg/Rm^3	Results from compliance source testing; results expressed as I-TEQ
hydrochloric acid (HCl)	18 ppmdv (27 mg/Rm^3) unless existing raw materials and conventional fuels result in higher concentration (3)	calculated as the rolling arithmetic average of 24 hours of data measured by a continuous emission monitoring system that provides data at least once every 15 minutes
sulphur dioxide (SO_2)	Site specific limit not to exceed the in-stack SO_2 concentration resulting from existing raw materials and conventional fuels. (4, 6)	calculated as the rolling arithmetic average of 24 hours of data measured by a continuous emission monitoring system that provides data at least once every 15 minutes
nitrogen oxides (NOx)	Site specific limit not to exceed the in-stack NOx concentration resulting from existing raw materials and fossil fuels (5, 6)	calculated as the rolling arithmetic average of 24 hours of data measured by a continuous emission monitoring system that provides data at least once every 15 minutes
organic matter	Section 50 (2) of Ontario Regulation 419/05	calculated as the rolling arithmetic average of 10 minutes of data measured by a continuous emission monitoring system that provides data at least once every minute
opacity	Section 46 of Ontario Regulation 419/05	calculated as the rolling arithmetic average of six (6) minutes of data measured by a continuous opacity monitor that provides data at least once every minute

[2] Compliance source testing as set out in the facility's Certificate of Approval. Owners and operators of cement and lime kilns can expect to be required, by conditions in Certificates of Approval, to maintain CEMS for SO_2, NO_x, THC, HCl and opacity.

Source: Ontario Ministry of the Environment. October 2010. Guideline A-7. Air Pollution Control, Design and Operation Guidelines for Municipal Waste Thermal Treatment Facilities.

Appendix B: Key Connections between Metro Vancouver's Integrated Solid Waste and Resource Management Plan and Other Metro Vancouver Plans



Source: Metro Vancouver. July 2010. Integrated Solid Waste and Resource Management: A Solid Waste Management Plan for the Greater Vancouver Regional District and Member Municipalities.