Advanced Recycling Backgrounder

Introduction

Ontario currently generates nearly a tonne of waste per person each year, with valuable resources found in our waste being lost to landfill. Emerging technologies are increasingly allowing us to recover and recycle materials back into our economy rather than sending them to landfill. For example, maximizing the recovery of resources from plastic waste before disposal can decrease reliance on virgin resources used to produce new plastic products, support efforts to tackle the issue of plastics in our environment, reduce greenhouse gas emissions, and assist in managing landfill capacity.

Ontario is already taking action to recover resources from waste. The Blue Box program facilitates the recycling of paper and packaging materials, such as plastics, glass and aluminum. Typically, plastics collected through the Blue Box program are physically separated and then processed (e.g., washing, grinding) to create materials used to make recycled products; this process is called "mechanical recycling."

While mechanical recycling is an effective tool in the Ontario waste management framework, it has challenges, including recycling complex multi-layer plastics, and plastics contaminated with food residue. This results in significant amounts of plastic waste being sent to landfill from these recycling facilities. Ontario will continue to do its part to reduce and divert even more plastic through the transition of the current Blue Box program to a producer responsibility model.

Ontario has committed to increased diversion through the adoption of emerging forms of thermal and chemical waste processing technologies that can turn waste into valuable raw materials and replace the need for virgin resources and products. "Advanced recycling" technologies remain an untapped potential for Ontario. Advanced recycling is a process that should be recognized as a complement to mechanical recycling efforts. Recovering resources from waste, keeps them in Ontario's circular economy, and reduces the amount of waste that is sent to landfill.

Benefits of Recovering Value from Waste

Ontario is looking to recognize the benefits of advanced recycling by proposing regulatory changes to encourage innovation and allow for new ways to recover resources from waste,

including hard-to-recycle plastics, while maintaining appropriate environmental protections. Here's why:

Enabling Economic Recovery

Compared to traditional garbage disposal, waste recovery generates 30 per cent more jobs and 60 per cent more GDP. In Ontario, this supports 1,100 clean, green jobs and generates over $100 million in GDP and growing. A regulatory framework that supports timely assessments and permissions will support and encourage companies that use and develop advanced recycling technologies to invest in infrastructure and job creation in Ontario's waste management industry. This would support a green economic recovery, which is particularly important following the impacts of COVID-19.

Extending Landfill Capacity

It has been estimated that Ontario's current landfill capacity is expected to be exhausted in the next 10 to 28 years based on our current disposal rates. There is a growing need to divert waste from landfill. Recovering resources from waste currently lost to landfill through advanced recycling is one way to increase diversion rates.

Reducing Greenhouse Gas Emissions

Ontario has committed to reducing greenhouse gas emissions to 30 per cent below 2005 levels by 2030, with the waste sector accounting for 4.1 per cent of Ontario's greenhouse gases emissions.[1] In the traditional linear economy, materials move through a "make-use-dispose" process where they are manufactured from raw resources, used by consumers, and disposed to landfill. Encouraging a circular rather than linear economy, including through advanced recycling, supports lower greenhouse gas emissions through less dependence on new crude oil extraction to produce new feedstocks (e.g., resins for plastics manufacturing).

Thermal Treatment Technologies

Thermal treatment is an overarching term that describes any waste treatment technology that uses heat, sometimes in combination with pressure, to process waste. Traditionally, thermal treatment technologies have been used for the final disposal waste, like through incineration, or to produce energy-from-waste such as generating electricity or fuel. However, advanced recycling represents an evolution of thermal treatment technologies, allowing for the recovery

[1] In 2019, most recently published data available. Environment and Climate Change Canada, *National Inventory Report 1990-2019: Greenhouse Gas Sources and Sinks in Canada, 2021.*

of resources from waste via *waste breakdown* rather than *waste disposal*. While some jurisdictions treat advanced recycling as waste disposal (e.g., California) other jurisdictions treat it similar to a manufacturing process (e.g., Ohio, Illinois) recognizing that advanced recycling recovers materials from waste that can be used to create new plastics, chemicals, synthetic oil, fuels, and other materials for downstream manufacturing, commercial, or industrial processes. The following table summarizes common thermal treatment technologies used in traditional (disposal and energy generation) and advanced recycling waste management processes:

Thermal Treatment Technologies

Incineration

- Combusts wastes in the presence oxygen to generate energy-from-waste, or for disposal.
- The waste is typically converted to hot gases, which may be used to generate electricity and/or heat in a steam boiler and turbine system.
- Any non-combustible materials (e.g., metal, glass, stones) remain as a solid known as bottom ash, slag, or recovered metal.

Cement Kilns

- Traditionally use fossil fuels (e.g., coal, natural gas) to heat the kiln to produce cement.
- Other combustible materials, which may include plastic and other wastes, may be used as an alternative to reduce fossil fuel use.

Pyrolysis

- Represents the most used technology in advanced recycling facilities world-wide.
- Occurs in a low oxygen environment, heat and high pressure.
- Breaks down waste to produce a gas containing carbon monoxide, hydrogen, methane and other volatile organic compounds.
- Parts of this gas mixture may be condensed to form a pyrolysis oil that can be used to create new products (e.g., new plastics or fuels).

Gasification

- Produces synthesis gas (syngas), which contains mainly carbon monoxide, hydrogen and methane.
- May generate electricity by burning the syngas in a steam boiler and turbine system.
- Alternatively, syngas can be used as a carbon source to produce base chemicals such as methanol and ethanol or a fuel.

Bio-chemical Depolymerization

- Based on biochemical reactions occurring in the presence of water.
- The most common biochemical reactions involve waste polyesters.
- The output includes liquid polymers or monomers (i.e., building blocks of plastics), depending on the enzymes used to process the plastic, to be used to create new products.

Mechanical recycling will always play an important role in Ontario's waste management framework, but it can only take resource recovery so far. Advanced recycling has the potential to:

- Process more types of plastic, including complex multi-layer plastics.
- Make better use of contaminated plastic waste (e.g., food contaminated plastics).
- Convert wastes to fuel, reducing the reliance on virgin fossil fuel.
- Create monomers and polymers that can be used as feedstock in the chemical and plastics industry.

In summary, advanced recycling has the potential to recover resources from waste and reduce the amount of waste going to landfills in Ontario.

Advanced Recycling in Other Jurisdictions

A Growing Industry

Advanced recycling via thermal treatment technologies is a relatively new industry, with as few as 40 facilities identified worldwide that are operational or in the development stage.[2] Several jurisdictions, particularly European countries, have embraced thermal treatment technologies as a way of managing their waste and reducing demand for landfill capacity. Some governments have gone so far as to describe advanced recycling as enabling "infinite" recycling, underscoring its environmental and economic benefits.

The advanced recycling industry is growing in North America, with 14 U.S. states having passed supportive circular economy legislation.[3] In Canada, particularly in Ontario and Quebec, several advanced recycling facilities that feature pyrolysis, gasification, and depolymerization processes have been announced or are currently in operation. As advanced recycling is still evolving, there have been examples of facilities that did not move from pilot to operational status, or those that ceased operations. Reports indicate that some advanced recycling facilities have found that construction and operating costs were higher than anticipated, faced ongoing challenges related to contamination rates of the feedstock (e.g., takeout containers contaminated with food residue) that impact facility performance, or produced output material with a lower financial value than anticipated. This is an industry with room for innovation and the development of best practices, in which Ontario is well-positioned to lead.

[2] Closed Loop, Accelerating Circular Supply Chains for Plastics: A Landscape of Transformational Technologies that Stop Plastic Waste, Keep Materials in Play and Grow Markets

[3] As of August 2021: Arkansas, Arizona, Florida, Georgia, Illinois, Iowa, Louisiana, Ohio, Oklahoma, Pennsylvania, Tennessee, Texas, Wisconsin, and Virginia.

Approaches to Environmental Assessment

There is a growing appreciation by regulators that advanced recycling is not a form of final disposal, but rather a form of waste diversion and a means to extract recoverable materials or as a manufacturing process. As a result, approaches towards environmental assessments for advanced recycling vary between jurisdictions.

From an environmental protection lens, jurisdictions focus their evaluation on the overall environmental impact. Frequently, the assessment process is dictated by the amount of waste treated, with higher amounts requiring a more stringent environmental assessment process. An example of such an approach is the European Union (E.U.) that requires the completion of a prescribed environmental assessment for those facilities that process 100 tonnes of waste per day or more, with E.U. member countries authorized to set more stringent thresholds. For example, Germany has a lowered its threshold to 72 tonnes per day, whereas Spain has no threshold, thus requiring comprehensive environmental assessments for all advanced recycling facilities.

On the other end of the spectrum, there are jurisdictions that have enacted advanced recycling legislation that regulates the facilities as manufacturing facilities rather than waste management facilities. The U.S. states mentioned above feature legislation that does not require any environmental assessment for thermal technology facilities that produce fuels, chemicals and chemical feedstocks, or waxes and lubricants. Instead, these facilities can move directly to an environmental permitting process similar to other manufacturing facilities.

Drawing on the examples in other jurisdictions, Ontario is proposing a balanced approach to updating environmental assessment requirements for advanced recycling facilities.

Thermal Treatment in Ontario

The Current Legislative Framework

In Ontario all thermal treatment sites are currently subject to two primary pieces of legislation.

Environmental Assessment Act (EAA)

- Provides the authority to develop regulations for designating projects for a streamlined process.
- Under the EAA, various regulations and guidelines:
    - Sets requirements for the assessment of potential environmental impacts for establishing and expanding waste management facilities.

- Establishes thresholds and outlines the required level of assessment for sites that utilize thermal treatment technologies (e.g., comprehensive, screening process).

Environmental Protection Act (EPA)

- Governs the collection, transportation, and disposal or processing of waste (hazardous and non-hazardous).
- Establishes approval requirements for air emissions, waste management, and wastewater discharges.
- Under the EPA, various regulations and guidelines:
  - Define relevant terms, including thermal treatment and waste designations.
  - Set standards for waste management sites and systems.
  - Establish air standards and air emission limits.
  - Provide exemptions from approvals where appropriate.

Taken together, a proponent may operate a thermal treatment facility (e.g., an advanced recycling facility) only after demonstrating that the technology is protective of the environment and human health, and after obtaining the necessary approvals.

Evolving Thermal Treatment Technologies within the Current Framework

Thermal treatment technologies are evolving within a legislative framework that did not envision them. While the current framework broadly describes most thermal treatment technologies (i.e., incineration, gasification, pyrolysis and plasma arc treatment), it does not recognize many of the unique recovered materials characteristic of advanced recycling applications of such technologies.

The current framework does, in part, recognize some recovered outputs and prefers energy-from-waste to disposal alone (energy-from-waste facilities undergo a more streamlined environmental screening process than thermal disposal facilities that do not recover energy) but requires an updated regulatory approach to be fully realized.

One potential recoverable material that is worthy of special consideration is the creation of fuels. Advanced recycling allows for the recovery of a fuel that replace or supplement existing fossil fuel demand (e.g., fuels that can be introduced into a natural gas pipeline). An updated regulatory approach may be necessary, in order to distinctly address these recovered fuel products from advanced recycling processes. In advanced recycling, a fuel is not the generation of electricity.

Updating a Dated Regulatory Framework

Currently, Ontario's regulatory framework sets the level of environmental assessment required by a thermal treatment facility through factors such as the daily tonnes of waste treated, with only a limited consideration for the outputs. For example, energy-from-waste facilities only require an environmental screening process, whereas similarly sized non-energy-from waste thermal facility that processes more than 10 tonnes of waste per day must undergo a comprehensive environmental assessment. As advanced recycling represents an evolution of thermal treatment technology, it is reasonable that it would require an updated regulatory approach to address its unique characteristics and recognize that it is creating important environmental benefits through diversion from landfill. Building on this, we propose that an advanced recycler that produces a higher percentage of recovered materials should be able to access a streamlined EA process or not be subject to comprehensive EA requirements, whereas those who produce little recovered material should be subject to more scrutiny as they will also be producing waste for disposal.

Up to this point, tonnage has been a reasonable indicator for the scale and potential environment impact associated with a thermal treatment facility, and the resulting environmental assessment requirements. However, tonnage alone may not fully balance the environmental impacts of thermal treatment technologies in advanced recycling, with the generation of recovered materials and the resulting waste diversion; to address the latter, it is proposed that a resource recovery rate (i.e., the percentage of material recovered) be considered as an additional indicator.

Regarding fuels, an updated regulatory proposal that considers the generation of a fuel by an advanced recycler as a recovered material should have regulatory backstops. That is, it is important to ensure that any fuels produced from waste are marketable fuels, and not a form of disposal. Thus, Ontario will propose that for fuels created from advanced recycling to qualify as recovered materials they must:

- Meet specific standards (e.g., established by the distribution company, recognized standards association).
- Supplement or directly replace fuels that are currently in use (e.g., biogas that can be upgraded to replace natural gas).

Advanced recycling represents an evolution in how we use wastes to create fuel, expanding their application and maximizing their benefits. In many instances, fuel products created from advanced recycling have viable markets as fuel replacements, and more tangible environmental benefits in substantially replacing fuels made from virgin materials. In the past, most fuels created from waste were often of a lower quality or had only limited potential to displace the

use of fuels that had more negative environmental impacts. In defining recovered materials, the Ministry is seeking to better understand the quality and end-market for fuels created through advanced recycling.

To recognize the important role that advanced recycling can play in increasing the diversion of waste derived from municipal or industrial, commercial or institutional sources from landfills, Ontario is proposing to create a new environmental assessment pathway for advance recycling of waste that will consider tonnage and resource recovery rate by:

- Establishing a tonnage threshold that would result in very small facilities not being subject to the EA process (instead, like manufacturing facilities they would proceed directly to Environmental Compliance Approval review)
- Subjecting larger facilities that are above a set tonnage threshold to a streamlined environmental screening process.
- Creating an upper threshold as a backstop that would require very large projects to undergo a comprehensive environmental assessment in recognition of the broader potential environmental impacts from such a large facility.
- Recognizing the efficiency of facilities that meet a high resource recovery rate

The combination of thresholds and resource recovery rate will encourage innovation as advanced recycling facilities work to become more efficient to take advantage of the proposed streamlining of the environmental assessment process. The proposed resource recovery rate will incentivize advanced recyclers to be high performers to access the proposed streamlined environmental assessment process and it recognizes that these facilities are converting the majority of the waste into a recovered resource, and only sending a small amount to landfill (if any). We are proposing that if an advanced recycling site would produce energy (electricity) from waste which is wholly used on-site (i.e. of the energy generated by thermal treatment at the site that is used, not all of the energy is used to dispose of waste and all of the energy is used at the site), the environmental assessment requirements for advanced recycling would apply. Ontario expects that the changes to the environmental assessment framework for advanced recyclers further the goals of recovering the value from waste, extending our landfill capacity, and reducing the burden on high-performing businesses while continuing to safe-guard our environment.

Finally, it should be made clear that any facility that does not meet the classification of advanced recycling will remain under the current environmental assessment regulatory requirements.

A Proposed Path Forward

To maximize the benefits of recovering value from plastic waste and to support the growth of advanced recycling technologies, Ontario intends to update the environmental assessment requirements for advanced recycling facilities, while maintaining appropriate environmental protections.

Thus, the Government of Ontario is proposing to:

1. Clarify the regulatory terminology related to advanced recycling and recovered materials.
2. Change the environmental assessment requirements to distinguish between thermal treatment technologies utilized for i) disposal, ii) energy recovery, and iii) advanced recycling purposes, in part through acknowledging the recovered material outputs of advanced recycling facilities, while maintaining environmental approval requirements. This change would apply to both the establishment of a facility and significant process changes to a facility.
3. Change the environmental assessment requirements for thermal treatment sites that recover fuel. Production of a fuel deemed a recovered material will be decoupled from electricity production, and subject to the same environmental assessment requirements as other advanced recycling sites, with specific regulatory backstops and conditions.

The details for how these proposed changes would be executed are laid out in the “Plain Language Advanced Recycling Proposals” document that is also posted on the Environmental Registry.