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Reducing methane emissions from Canada's municipal solid waste landfills

Discussion paper

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Purpose

The purpose of this discussion paper is to seek input on proposed objectives of regulations under the Canadian Environmental Protection Act, 1999, (CEPA) to reduce methane emissions from municipal solid waste landfills and on a number of key questions related to reducing landfill methane emissions. Information on the next steps in the consultation process and how to provide comments is provided at the end of the paper.

Introduction

The Intergovernmental Panel on Climate Change's (IPCC) *Special Report on Global Warming of 1.5* ºC indicates that achieving net-zero global greenhouse gas (GHG) emissions by 2050 is necessary to avoid the worst impacts of climate change. Recognizing that Canada and other countries around the world need to accelerate action to address climate change, the Government of Canada has committed to a 2030 emission reduction target of 40-45% below 2005 levels, and a net-zero emissions goal by 2050 (NZ2050). To meet our climate goals, action is required throughout the economy, including the waste sector.

Methane is a potent greenhouse gas with 86 times more global warming potential than carbon dioxide over a 20-year period, and a relatively short lifespan in the atmosphere. Methane is included in Schedule 1 - List of Toxic Substances of CEPA. In October 2021, Canada announced support for the Global Methane Pledge, which aims to reduce global methane emissions by 30% below 2020 levels by 2030.

Municipal solid waste landfills are responsible for about 23% of Canada's methane emissions[1]. The federal government recognizes that provinces, territories, municipalities and the private sector have made significant efforts over the years to address landfill methane emissions. However, the approach across Canada is uneven and emissions have not decreased for over a decade. Current policies are not expected to achieve significant additional emission reductions by 2030, requiring action by the federal government.

To achieve the targeted emission reductions by 2030, more landfills across Canada need to capture more of the methane they generate. Actions to reduce generation and increase diversion of biodegradable waste (the source of landfill methane) are also needed to achieve longer-term landfill methane emission reductions. In a circular economy, biodegradable wastes and waste emissions are processed to increase their value as they are transformed to raw material for products such as fertilizers, soil supplements, and renewable energy.

The Government of Canada's *Strengthened Climate Plan - A Healthy Environment and a Healthy Economy* committed to reducing waste sector emissions by:

- developing new federal regulations to increase the number of landfills that collect and treat their methane, and ensure that landfills already operating these systems make improvements to collect all they can; and

[1] ECCC, National Inventory Report (NIR): Greenhouse Gas Sources and Sinks in Canada: executive summary, 2021

- exploring opportunities to support waste and biosolids management infrastructure, such as composting, anaerobic digestion and landfill methane collection and use.

This discussion paper is focused on the first of these proposals – the development of new federal regulations aimed at reducing Canada's landfill methane emissions.

Canada's landfill methane emissions

The methane generated today is a result of decades of landfilling of biodegradable waste – food, yard and garden waste, paper, wood, natural fiber textiles and others – which makes up more than 60% of the waste currently landfilled in Canada.[2] Municipal solid waste (MSW) landfills receive waste from households, businesses, institutions, industry and construction and demolition sites. Most landfill methane is generated within the first 20 years, and most rapidly in the early years, following waste deposition but can continue for several decades following closure of a landfill.

Figure 1 shows projected national methane generation from 2020 to 2050 considering different waste disposal scenarios. The blue line in Figure 1 shows the methane generation resulting only from waste disposed up to 2020. By 2030, about half of methane generation at landfills will be due to degradation of biodegradable waste that was disposed before 2020. The only approach to reducing this portion of future emissions is to manage emissions at landfill sites.

Methane emissions from organic waste generated in the future can be avoided entirely by diverting biodegradable waste to beneficial management approaches such as composting, anaerobic digestion (AD), recycling (paper, wood, textiles) and thermochemical processing – all of which recover resources (energy, fuels and/or soil amendments) in addition to avoiding the creation of landfill methane. However, diversion alone cannot meet the required methane reductions to achieve Canada's 2030 target – landfill methane emissions must be controlled.

In Figure 1, the baseline scenario (yellow line) shows that, with growing population, methane generation will continue to grow as more biodegradable waste is added to landfills between now and 2030 and beyond. The light green line shows the impact on methane generation of reducing disposal of food, soiled paper, yard & garden and paper waste by 50% by 2030 from 2020 levels. The dark green line shows the impact of reducing disposal of all biodegradable waste by 50% by 2030 and 75% by 2040 (from 2020 levels). Even if current efforts by provinces, territories, municipalities and the private sector to increase diversion are accelerated, methane generation at landfills is not expected to be reduced significantly by 2030.

[2] ECCC, 2020. National Waste Characterization Study

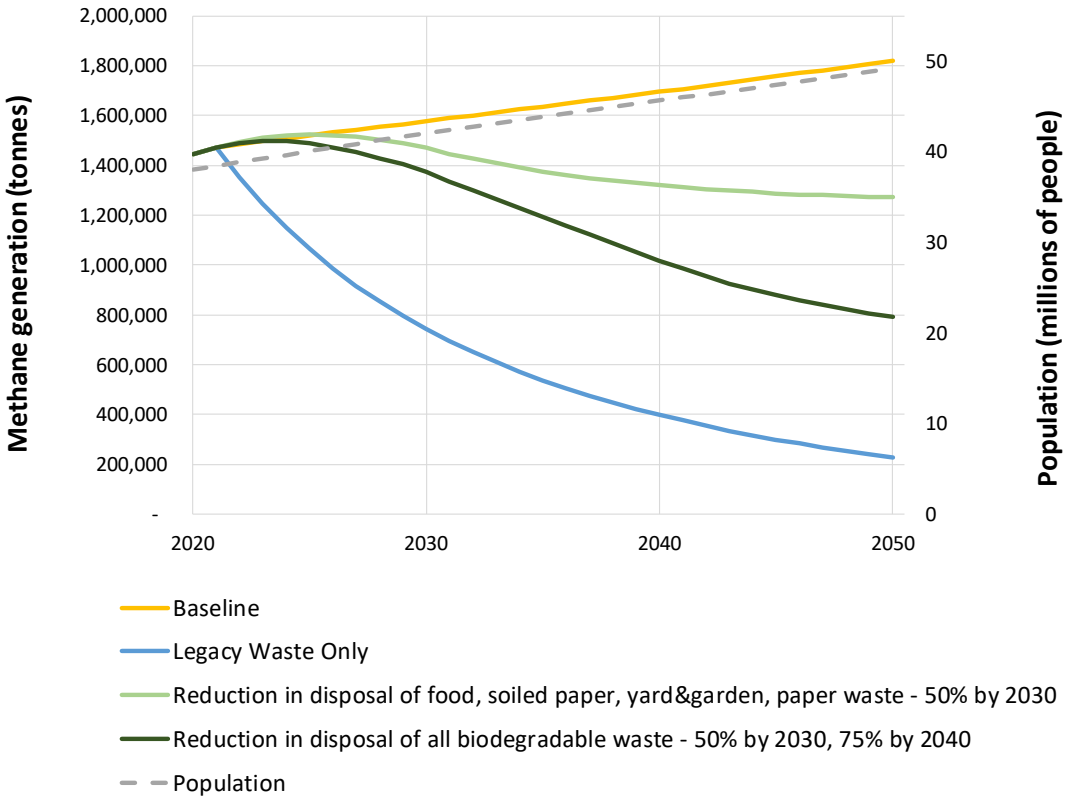

Figure 1. Projected landfill methane generation – 2020 to 2050

Emissions can be controlled through installation of infrastructure to recover landfill gas, which is then either flared or utilized to generate energy (both of which ultimately destroy methane by converting it to carbon dioxide through combustion). These approaches are well established and are technically feasible, commercially available and provide quantifiable reductions to landfill methane emissions. Traditional approaches to estimating emissions depend on a relatively simple model to represent a very complex number of influences. Newer approaches utilize optical methane sensors located on-site or mounted on unmanned aerial vehicles (UAVs or drones) or aircraft to measure methane concentrations in air. When combined with dispersion models, these atmospheric concentrations can be used to calculate emission rates. These methods require validation and development of standard study protocols to ensure the results are accurate and can be interpreted in the proper context. The emerging methods offer potential to quantify the methane emitted from landfills based on measured data rather than relying on modelled data and may offer new opportunities for landfill gas recovery system operators to determine how well systems are performing.

There are more than 3000 municipal solid waste landfills in Canada. A little over half are active and the rest are closed.[3] There are about 270 large landfills that either have a waste capacity of more than 100,000 tonnes of waste (open landfills) or have more than 450,000 tonnes of waste in place (closed landfills). These 270 landfills received almost 90% of the waste landfilled in 2019, and have accepted

[3] ECCC, 2021. Canadian landfill inventory. Unpublished.

over 70% of all the waste landfilled in Canada since 1941. These large landfills were responsible for over 85% (18 Mt of CO_2 eq) of Canada's annual landfill methane emissions in 2019. Municipalities own 233 of these large landfills, while the private sector owns 35.

Nationally, landfill methane emissions declined between the early 1990s and 2011 due to installation of landfill methane recovery and combustion infrastructure at very large landfills.[4] This was largely motivated by regulatory and permitting requirements in some provinces, landfill gas utilization incentives and the sale of emission credits. However, emissions from municipal solid waste landfills have not declined since 2011, even though further reduction is technically viable. In 2019, although there were 112 landfill gas recovery systems spread across nearly every province, only about one third of the methane generated in Canadian landfills was recovered.[5]

Currently, just over half of recovered landfill methane in Canada is utilized as a renewable energy source. The quantity of methane generated at an individual landfill and the economic viability of these projects are major limiting factors. Recent studies have highlighted the potential for recovery and upgrading landfill methane to supply renewable natural gas, as the demand for low-carbon fuels increases in response to the federal *Clean Fuel Standard* and other initiatives. [6] [7]

Further action is needed

The waste sector could reduce its emissions by at least a minimum of 12 Mt CO_2 eq per year by 2030 by increasing the number of landfills that recover methane and by increasing the quantity of methane recovered at landfills with existing landfill gas recovery systems. These actions are cost-effective, with an average estimated cost of less than $50 per tonne of CO_2 eq reduced.

While provinces and territories have made significant efforts to reduce generation and increase diversion of biodegradable waste from landfills, additional regulatory action is necessary to help reduce and eventually eliminate landfill methane emissions. Diverting this waste preserves landfill capacity and contributes to a circular economy that uses waste as an input to create new products and renewable energy. Under the waste hierarchy, waste management approaches that prioritize waste reduction, recycling and energy generation are preferred to landfilling. By 2030, increased diversion alone could reduce landfill methane emissions by 3 Mt CO_2 eq.

Existing regulatory approaches

The Government of Canada recognizes leadership demonstrated by provinces and territories, which have implemented various measures to control methane emissions from some landfills. For example, British Columbia, Alberta, Ontario and Quebec have regulations requiring larger landfills to capture and control or reduce methane emissions, and others include requirements for installing landfill gas recovery and flaring systems in operating permits.

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[4] ECCC, 2021. National Inventory Report : Greenhouse gas sources and sinks

[5] ECCC, 2021. Canadian landfill gas inventory. Unpublished.

[6] Deloitte, 2018. Renewable natural gas production in Québec: A key driver in the energy transition Assessment of technical and economic potential in Québec (2018–2030)

[7] Hallbar, 2017. Resource Supply Potential for Renewable Natural Gas in B.C.

Some provinces require landfills above a certain waste capacity or quantity to reduce methane emission by installing landfill gas recovery systems. Quebec and Ontario require landfills larger than 1.5 million cubic metres of waste capacity to install systems. British Columbia requires landfills with greater than 100,000 tonnes of waste or greater than 10,000 tonnes disposed per year to evaluate their annual methane generation and install landfill gas systems if they exceed 1,000 tonnes of methane per year. The lowest regulatory threshold in North America is in California, which requires landfills that generate landfill gas with a heat input capacity of more than 3.0 MMBtu/hr (~650 tonnes methane generation per year) to install landfill gas recovery systems.

Operational requirements or performance criteria for landfill gas recovery and flaring systems vary among jurisdictions. Some requirements apply at the system design stage and identify requirements for timely installation of collection infrastructure and considerations for design capacity of the system. Others are performance criteria to ensure the landfill gas recovery system is maximizing recovery (temperature, pressure, oxygen/nitrogen concentration in extraction wells; surface emission monitoring) and that methane flares are operating to maximum methane destruction efficiency (retention time and temperature within flare).

Some regulations in Canada (for example, Quebec) and the U.S. (federal and California) require surface emission monitoring programs at landfills with methane recovery systems. These programs monitor the concentration of methane at the surface of the landfill three to four times a year in addition to monthly monitoring of methane recovery systems. The U.S. rules identify action thresholds above which landfill owners must report exceedances and take corrective action within specified timelines to reduce surface emissions or system monitoring values to below the threshold.

In circumstances where provincial or territorial regulatory provisions can be determined to achieve equivalent environmental outcomes to federal regulations and meet certain enforcement-related requirements, the Minister of Environment and Climate Change Canada and a government of a province or territory can enter into an equivalency agreement under the *Canadian Environmental Protection Act, 1999*. With an equivalency agreement in place, an Order can be made by the Governor in Council indicating the federal regulations would not apply in that jurisdiction. The federal regulations would serve as a backstop in any jurisdiction without landfill methane regulations or an equivalency agreement.

Complementary measures

Various market-based measures that will create incentives for methane recovery are under development. The proposed *Clean Fuel Regulations* will increase demand for biogas from waste and landfills. As a low-carbon intensity fuel, biogas used to generate electricity or for heating and biogas-based renewable natural gas may be eligible to create credits under the Regulations.

Greenhouse gas offset credit markets also create a financial incentive for landfills with no regulatory requirements to recover and destroy methane. Offset protocols that enable generation of offset credits for landfill methane recovery and destruction or utilization exist in the Alberta and Quebec offset systems, and ECCC is developing a Landfill Methane Recovery and Destruction Protocol under the federal Greenhouse Gas Offset System. Protocols are also under development for use in British Columbia and Saskatchewan's offset systems. Landfill gas capture and destruction projects have also been generating offset credits on the voluntary offset market for many years. The extent to which these market-based approaches drive reduction of methane emissions at landfills will be further evaluated as these measures evolve.

Given that some regulated landfills may be too small to realize revenue potential from the sale of renewable natural gas or biogas-generated electricity, an important part of the path forward will include exploring additional opportunities to support landfill methane recovery and use infrastructure.

Proposed regulatory objectives and key questions

Reducing greenhouse gas emissions is a national priority. The Government of Canada is proposing new regulations under CEPA to significantly reduce methane emissions from municipal solid waste landfills by 2030, and is committed to engaging and working with provincial and territorial governments, Indigenous peoples, municipalities, industry, non-governmental organizations, and other Canadians to do so. There are many important aspects to consider, and this discussion paper presents an opportunity to inform the development of the approach. This will ensure that the Government of Canada considers the appropriate expertise, perspectives, and interests to develop the most effective and well-designed policy measures.

The following objectives are under consideration for a federal regulatory approach that will reduce landfill methane emissions:

Objective 1 - Increase the number of landfills that take action to reduce methane emissions

The primary objective is to increase the number of landfills that reduce methane emissions either through installation of landfill gas recovery systems or other approaches that directly mitigate emissions. Ideally, a regulatory approach that requires certain landfills to control methane emissions would allow landfill owners to develop mitigation approaches most suitable for their particular circumstances and could incentivize emerging technologies and approaches.

Reducing methane emissions is technically possible at most landfills in Canada. Based on specifications for landfill methane control equipment (for example enclosed flares) in use in Canada and elsewhere, there does not appear to be a technical limitation to flaring or oxidizing even very low levels of methane at landfills. Landfill gas venting and recovery systems have been installed at landfills of all sizes to manage odour issues and to reduce methane emissions. Additionally, there are emerging approaches – such as biocovers and biovents – that can treat very low levels of methane emissions.

A key consideration is how to require as many landfills as possible to reduce emissions.

- **What criteria should be used to identify which landfills should be subject to regulatory requirements to reduce their methane emissions?**
- **In Canada and the United States, the existing landfill methane regulations require the installation of landfill gas recovery systems where certain landfill size, methane generation or surface methane emission concentration thresholds are exceeded. Are there other approaches that could be considered to ensure that landfills reduce methane emissions?**
- **Current Canadian provincial landfill methane regulations do not apply to closed landfills. By contrast, closed landfills are regulated in the United States. What are the options for**

reducing methane emissions at closed landfills in Canada, where methane levels may be significant, but declining?

- **What are the main challenges that landfill owners would face to meet the federal regulation's objective of reducing methane emissions? How can existing provincial approaches be leveraged in the design and implementation of a federal regulation?**
- **Are challenges similar for large and small landfills? Are there opportunities to reduce methane emissions at smaller landfills in Canada? What type of incentives could encourage the development of innovative technologies (for example, biocovers) for smaller landfills?**

Objective 2 - Ensure that landfills maximize methane recovery

There remains significant potential to decrease methane emissions at landfills with existing recovery systems – through expansion or improved operating practices. There are documented approaches that maximize recovery of methane at landfills. Consideration will be given to requirements that ensure such approaches are implemented at landfills to maximize methane recovery. These could include requirements for installing and expanding infrastructure within a specific timeframe following waste disposal; monitoring and adjusting extraction systems; implementing leak detection and repair programs; or meeting performance standards such as a target collection efficiency of the recovery system.

- **What are the key opportunities and approaches for maximizing methane recovery at landfills with landfill gas recovery systems?**
- **What are the key technical challenges and limitations to implementing these approaches?**
- **Landfills that generate energy from landfill gas may need to operate recovery systems in a manner that does not maximize methane recovery. What are the opportunities to enable a landfill to generate energy from landfill gas and to optimize methane recovery?**
- **In Canada and the United States, some landfill methane regulations include requirements that maximize methane recovery by mandating installation of landfill gas recovery infrastructure within certain timeframes following waste disposal and for maintaining negative pressure in extraction wells. Other regulatory provisions set maximum allowable concentration thresholds for methane measured on the surface of the landfill. Should federal regulations include similar requirements to ensure methane recovery is optimized?**

Objective 3 - Achieve long-term emissions reductions through diversion of biodegradable waste

Encouraging or requiring the diversion of organic waste from landfills has been the focus of recent provincial, territorial and municipal efforts. These actions will secure long-term reductions of methane emissions from landfills, and need to be accelerated.

In parts of Europe, the drastic reduction in disposal of waste in landfills achieved in the early 2000's has resulted in very low levels of landfill methane emissions today. Alternative waste management practices such as anaerobic digestion, composting, mechanical-biological treatment and thermal treatment drastically reduced the disposal of waste and the generation of methane in some European countries.

Unless similar approaches are adopted in Canada, there will continue to be landfill methane that requires gas recovery systems.

ECCC is seeking input on whether the federal regulations should be designed to require or stimulate diversion from landfills.

- **Taking action to reduce methane emissions from landfills is essential to reducing emissions by 2030. Should federal regulations require landfill owners to reduce landfilling of biodegradable waste?**
- **What opportunities exist to incorporate biodegradable waste diversion into a landfill methane emission reduction plan?**

Objective 4 - Increase utilization of landfill methane to create low-carbon energy and fuels

Additional GHG reductions are achievable when recovered methane is used to displace the use of fossil fuels. Increasing the utilization of landfill gas is anticipated to be motivated by the proposed *Clean Fuel Regulations,* which will provide an additional source of revenue for biogas-derived energy, increasing the number of landfills where these projects are economically possible. Provincial and private sector commitments to increasing the proportion of renewable natural gas in the natural gas supply will also increase demand and support the development of projects.

Existing North American landfill methane regulations do not require utilization of recovered landfill gas. Under the EU landfill directive, landfills must prioritize utilization where feasible.

- **Are there options that should be considered within a federal landfill methane regulatory framework to require or encourage the utilization of recovered methane to produce low-carbon energy?**
- **How will a regulatory approach on landfill methane affect policy and other goals to increase the production of renewable natural gas?**

Next steps and sending comments

Interested parties are invited to submit comments on the content of this discussion paper that would help to inform the development of the proposed regulations. Please submit additional information and comments prior to April 13, 2022. Comments and information can be provided via an on-line form or can be submitted to the e-mail address provided below:

Environment and Climate Change Canada
Waste Reduction and Management Division
E-mail: ges-dechets-ghg-waste@ec.gc.ca

Next steps will include engagement with provincial and territorial governments, Indigenous peoples and stakeholders on the design of a regulatory framework for federal landfill methane reduction regulations.

ECCC also intends to form a technical working group to support the development of the regulatory framework. A call for membership in the technical working group will follow the close of the public comment period for this discussion paper.