UCS2018-0153
ATTACHMENT 2

WASTE & RECYCLING SERVICES

2018 Report on Waste to Energy

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1. INTRODUCTION

On 2015 December 7, as part of the Waste Diversion Target Update report (UCS2015-0835), Council directed Administration to report back in Q1 2018 on the potential application of waste-to-energy technology. In the interim, WRS provided a Waste to Energy Status Report to SPC on Utilities & Corporate Services in 2016 as part of the Waste Diversion Target Update (UCS2016-0470). On 2018 February 26, Council approved a Deferral Report (UCS2018-0147) allowing Waste & Recycling Services (WRS) to include this report on waste-to-energy as part of the Waste & Recycling Services Outlook report.

Waste & Recycling Services (WRS) is continually investigating, developing and implementing programs that enable the diversion and processing of materials otherwise destined for landfill to support The City's target of 70 per cent diversion from landfill by 2025. The intent of these programs is to enable the reuse, recycling and composting of solid waste materials in alignment with the waste management hierarchy (Figure 1).

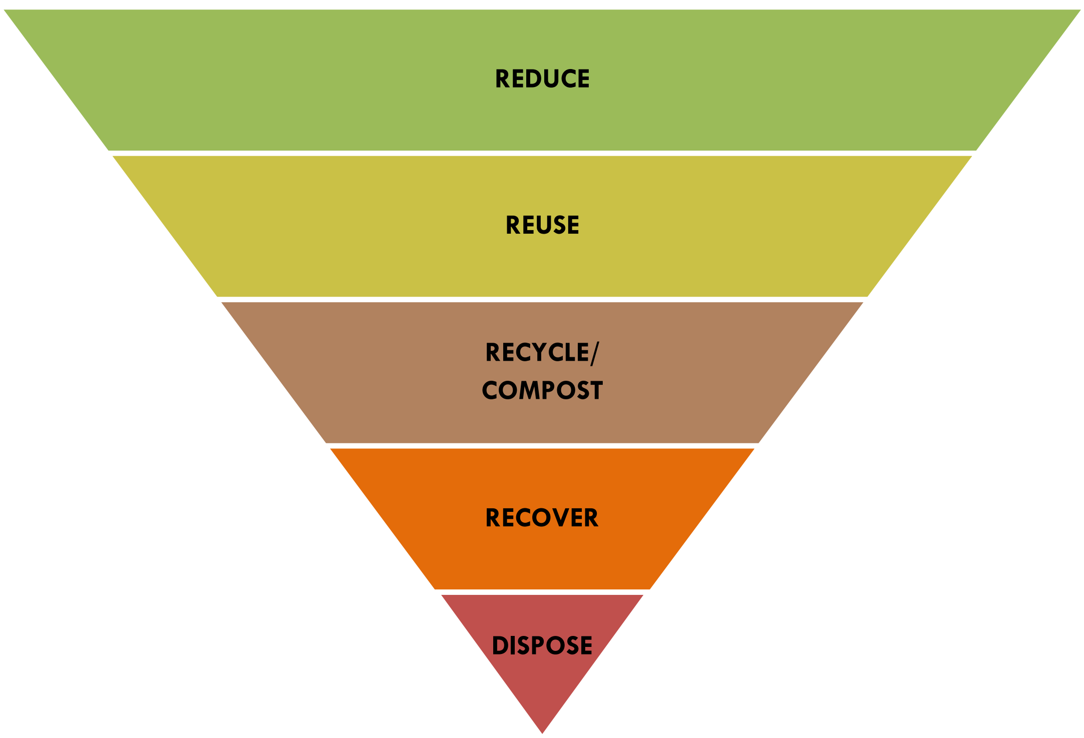

Figure 1: Waste Hierarchy

Reduction means consumption is decreased so that waste is not generated in the first place. Reuse and recycling activities return valuable commodities to the marketplace, avoiding the energy consumption and environmental impact of collecting virgin materials from renewable and non-renewable resources. When efforts to reduce, reuse, recycle and compost have been exhausted, Waste-to-energy (WTE) technology offers a final opportunity to recover energy from residual waste before waste is deposited in a landfill. The evolution of WTE has shifted somewhat from the traditional mass burn incineration of waste to alternative technologies that output synthetic gases, chemicals and liquid fuels.

WTE is not required to reach the 70 per cent by 2025 goal, as described in the UCS2016-0470 target update report. However, WTE technology was included in the 2007 strategy, and WRS is still considering WTE, bearing in mind multiple factors that influence the decision to implement and choose a WTE technology. With the recent introduction of new diversion policies and programs, we don't fully understand what residual waste will remain as a feedstock for WTE. We need to let our programs mature and understand our residual waste before we can assess the potential fit for WTE. Therefore, the earliest estimated timeframe for the introduction of WTE technologies for the treatment of waste by The City is beyond 2025. Considerations are described in the next section.

2. CONSIDERATIONS FOR INVESTING IN WTE

WTE facilities require a significant investment, and there are many factors to consider to ensure that The City of Calgary makes an informed decision. Common considerations that influence decisions to implement WTE include:

- Life of existing landfills
- Feedstock Assessment
- Tonnage projection
- Choice of technology
- Greenhouse gas emissions
- Capital and operating costs
- Timeframe and Project Schedule

Each of these considerations are discussed in more detail below.

Life of City of Calgary Waste Management Facilities

City of Calgary landfills are an asset that require protection to ensure their effective life lasts as long as possible. The most recent forecast is that City of Calgary WMFs have over 30 years of combined landfill disposal life left. Efforts to protect landfill space to date include diversion initiatives such as Blue and Green Carts, Community Recycling Depots and Throw and Go's, Bylaws requiring recycling and organics diversion, and disposal tipping fees at WMFs that encourage diversion of recyclable and organic materials. In jurisdictions where landfills have reached capacity or will reach capacity in the short-term, and where siting a new landfill is difficult, WTE becomes a more attractive option as costs for other traditional methods of disposal increase.

Feedstock Assessment

Making an appropriate technology choice for the implementation of WTE is heavily influenced by the composition and volume of feedstock for the facility. With the introduction of multiple diversion policies and programs over recent years, Calgary's waste composition is vastly different from our most recent composition studies, which were completed in 2014. WRS plans to begin another round of waste composition studies in late 2018, which will be completed in 2020. The results of those studies, combined with determinations of other suitability factors, will inform the assessment of the need and fit for WTE in Calgary.

Tonnage Projection

WTE facilities operated by third parties typically require guarantees on the volume of waste they will receive, as facilities run more efficiently when operated with as-designed waste volumes. Therefore, one of the considerations is the need for a steady and predictable volume of waste. As diversion programs mature, municipalities can see waste volumes drop below guaranteed volumes, making increasing diversion economically unattractive. In Calgary, waste disposed in landfill had been relatively static until 2014, when the economy, diversion and other external factors resulted in a steady decline to present day waste volumes (Figure 2). As new diversion programs mature we will have a more reliable projection of future waste volumes.

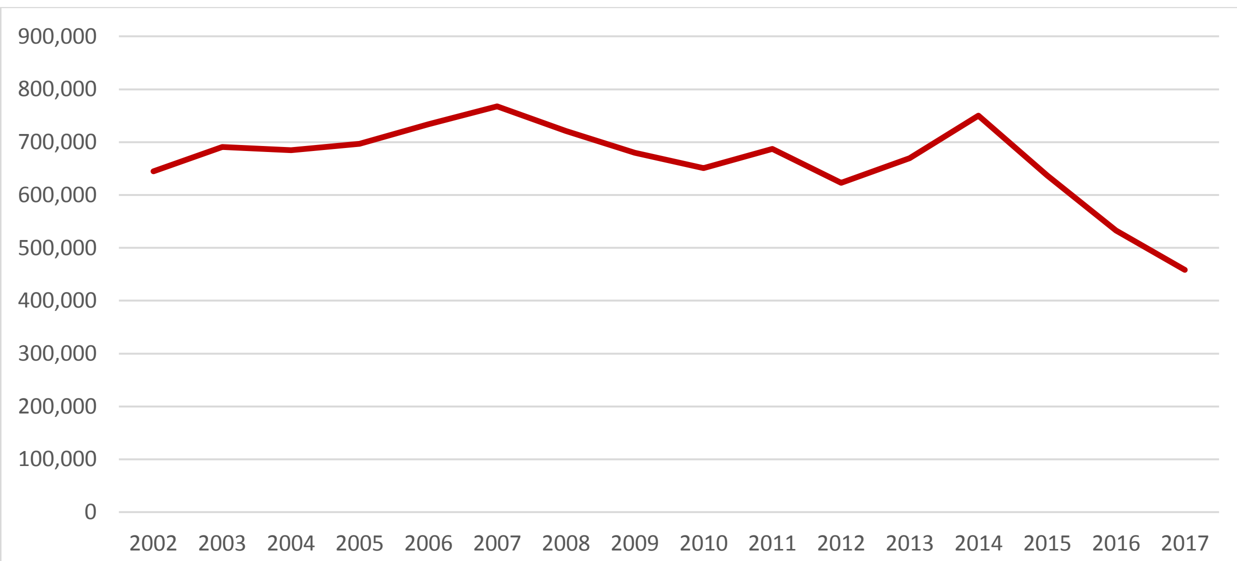

Figure 2: Historical Annual Waste to Calgary Landfills (Tonnes)

Choice of Technology

The table below provides detail related to common technologies used in the WTE industry and their state of use for municipal solid waste (MSW). Technologies are in varied states of reliability, commercialization and use in worldwide markets and as they continue to evolve, WRS will continue to monitor and evaluate their potential.

Table 1: Waste Conversion Technologies

Technology	State of Technology	Considerations
Mass Burn Incineration	Most common installation of WTE worldwide; however, new installations are rare.	Conventional combustion or mass burn incineration is the most common type of WTE used around the world to produce heat, power, or combined heat and power from MSW. In a direct combustion system, MSW is burned to generate heat, which is then used to boil water in a boiler to be used for heating/cooling applications, process applications, or driving steam turbines to generate electricity.
Gasification	Enerkem in Edmonton is the first example of a commercial gasification facility for MSW in Canada, but is not yet fully proven.	Gasification is an emerging WTE technology in which MSW is heated to high temperatures in a limited-oxygen environment. Gasification produces heat and combustible syngas (carbon monoxide, hydrogen and carbon dioxide), which can be burned directly in gas engines, used to produce methanol and hydrogen, or converted via the Fischer–Tropsch process into liquid hydrocarbons.
Pyrolysis	No pyrolysis facilities for a mixed MSW feedstock exist in North America with.	Pyrolysis is an emerging WTE technology in which MSW is heated to high temperatures in the absence of oxygen. Pyrolysis is a thermochemical decomposition of organic material and produces bio-oil, gases and heat as its principle products.
Plasma gasification	There are no commercial plasma gasification facilities for MSW in North America. Commercially implemented facilities exist in the UK, Japan, China and India.	Plasma gasification is less proven on a commercial scale and involves more complex technological processes. These systems utilize a plasma arc reactor in an enclosed chamber that contains plasma torches used to heat MSW to 3800 ^{o}C or higher. These high temperatures convert organic materials into synthetic gas and inorganic materials into a non-hazardous waste material (slag) that can be disposed of in landfill.
Anaerobic Digestion (AD)	AD is a standard technology in use in many jurisdictions across North America to manage biodegradable waste. The City	AD does not require high temperatures used in conventional and advanced thermal treatments. It is a biochemical process in which microorganisms break down the

	of Surrey’s new biofuel facility (using AD and composting) began operations in March 2018	biodegradable fraction of MSW in the absence of oxygen, resulting in the production of methane and carbon dioxide, otherwise known as biogas. The biogas produced during AD can be used directly for heating in combined heat and power gas engines, or it can be upgraded to pipeline-quality gas called biomethane or renewable natural gas. The City currently manages residential organics through the composting facility, which might make this technology a less valuable option.

Greenhouse Gas Emissions

One of the necessary considerations for implementation of WTE will be the impact that it will have on greenhouse gas emissions related to management of residual waste. These impacts will be dependent on waste composition, effectiveness of landfill gas capture from our landfills, and the WTE technology chosen.

Capital and Operating Costs

Research into Canadian WTE facilities estimates capital costs may range between $100 million and $500 million, depending on facility size and technology chosen. Operating costs are also reliant on size and technology, but could reach up to $15 million per year. Construction of a Mixed Waste Processing Facility (MWPF) is often required to deliver waste to the WTE facility in a useful format. A MWPF can add an additional $40 million to the project cost.

WRS is considerate of costs and of its current financial situation. WTE remains a higher cost approach to managing residual waste than landfill. In light of this and the fact that the composition and volume of our potential feedstock is unknown, now is not the appropriate time to choose WTE as an alternative to landfill. Given that WTE is not needed to reach 70 per cent by 2025 target, there are currently no plans for the construction of a WTE facility.

Timeframe and Project Schedule

For the City of Calgary, delivering a project of this magnitude could take approximately 10 years from the time of Council approval. Finding a suitable location for a WTE facility may be challenging considering stringent permitting requirements and potential stakeholder opposition to the operation of a conversion-based waste treatment facility. The choice of delivery model for the project (public/private or a public private partnership) could also affect the timeframe of delivery.

3. UPDATE ON THE CURRENT STATE IN CANADA

There are currently four large-scale (>100,000 tonnes annually) mass burn incineration facilities operating in Canada. The facilities are located in Quebec City, QC; Burnaby, BC; Brampton, ON; and the Regions of Durham/York, ON.

There is only one alternate thermal conversion technology functioning commercially in Canada. Enerkem is using gasification technology in Edmonton to produce methanol and ethanol from MSW. Enerkem continues to work on modifications that will allow their processes to operate in the most efficient manner possible. This is a leading technology and accordingly there are some growing pains. It is an opportunity for us to learn from our neighbours and apply those lessons to any future WTE initiatives.

Descriptions of the facilities listed above were provided in the Waste to Energy Status Update as part of the Waste Diversion Target Update in 2016 (UCS2016-0470). Surrey's $68 million biofuel facility began operations in March 2018. The new system is described as North America's first closed-loop organic waste management system. The facility converts curbside organic waste from homes into renewable energy using anaerobic digestion to power the city's fleet of waste collection trucks. Excess fuel will be transferred to the new district energy system that heats and cools Surrey City Centre.

WRS is unaware of any further WTE initiatives approved in Canada.

4. SUMMARY

Recent experiences in other municipalities suggest that WTE technology is still evolving. As with the Green Cart Program development, The City is in an advantageous position to learn from other municipalities and provide clear, cost-effective direction for future capital investment. We do not have a financial incentive to invest in WTE, and can meet our 70 per cent diversion by 2025 goal without investing in WTE; however, we are monitoring to ensure the choice of recovery and disposal options is appropriately managed.

The estimated cost to implement a WTE facility is between $100-500 million in capital investment, with operating costs that could reach up to $15 million per year, and would require a guaranteed volume of waste. To narrow this investment range and identify an appropriate technology and facility size, more certainty regarding feedstock composition and volume will be required. The waste composition studies will be completed in 2020 and will contribute to the evaluation of the business case for this type of technology.