Technical White Paper exploring end of life management of compostable and plastic coffee pods

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Introduction

This document provides a brief analysis of compostable and recyclable single serve coffee pods in relation to their processing in waste diversion facilities in Canada. This document covers three considerations:

1) Economic Feasibility
2) Environmental Impact
3) Technical Feasibility

1.0 Economic Feasibility

The economic feasibility of composting coffee pods is a function of site- and technology-specific factors. Compostable coffee pods are managed as a mixed organics load in aerobic and anaerobic digestion facilities, so attributing costs on a per material/product basis cannot be readily done. However, based on a review of salient literature and case studies, the inclusion of compostable coffee pod into a green bin program does not directly affect cost.

As an example, if the fixed cost per tonne of operating a household green bin program is $120/tonne, then including compostable coffee pods as a an accepted material will have no bearing on that cost. This is in direct contrast to the cost of managing end of life plastic coffee pods, which has a cost exceeding $2500/tonne when managed in the Blue Box system, a cost that exceeds that of managing all other Blue Box materials. Expressed alternatively, the cost of managing plastic coffee pods is 10x greater than the weighted average cost of all other Blue Box materials.

As will be noted in section 3, there are significant technical challenges to managing plastic coffee pods in conventional material recycling facilities. Most facilities do not have the technology to successfully sort plastic coffee pods, and if so, the cost is often prohibitive to processors. While there have been certain instances in which plastic coffee pods have been recovered in specific facilities, the success has been contingent on both specific sortation technologies, and households correctly separating out the coffee pod (removing coffee grounds, and separating aluminum from plastic).

While compostable coffee pods face similar challenges when being managed in a material recycling facility, they do have an economically viable EOL management option through composting or anaerobic digestion. Costs remain unchanged with the inclusion of compostable pods, as there is a fixed cost associated with managing a mixed load of organics.

An Economic Case Study (Plastics vs. Compostables)

In 2016, Agriculture and Agri-Food Canada estimated that more than 45,000T of coffee pods were sold in Canada. Assuming a recycling rate of 10%, an average processing cost of $2500 per tonne, and a landfill tipping fee of $100/tonne (Note: Tipping fees vary significantly across jurisdictions – the value used in this exercise represents a “mid-point” tipping fee for residential mixed waste landfills).

Using these assumptions, end of life waste management costs for plastic coffee pods are:

- Cost of Recycling: $11,250,000
- Cost of Landfilling: $4,050,000
- Total Cost of Waste Management: $15,300,000

Reversing this scenario, let's consider the end of life management costs for compostable coffee pods. Once again, assuming a diversion rate of 10% (Green Bin organics), landfill tipping costs of $100/tonne, and a composting cost of $150 a tonne (Note: costs associated with managing organics range significantly depending on jurisdiction, composting technology, and whether there is electrical generation from gas recovery from anaerobic digestion. The value chosen for this cost estimation represents a conservative assumption.)

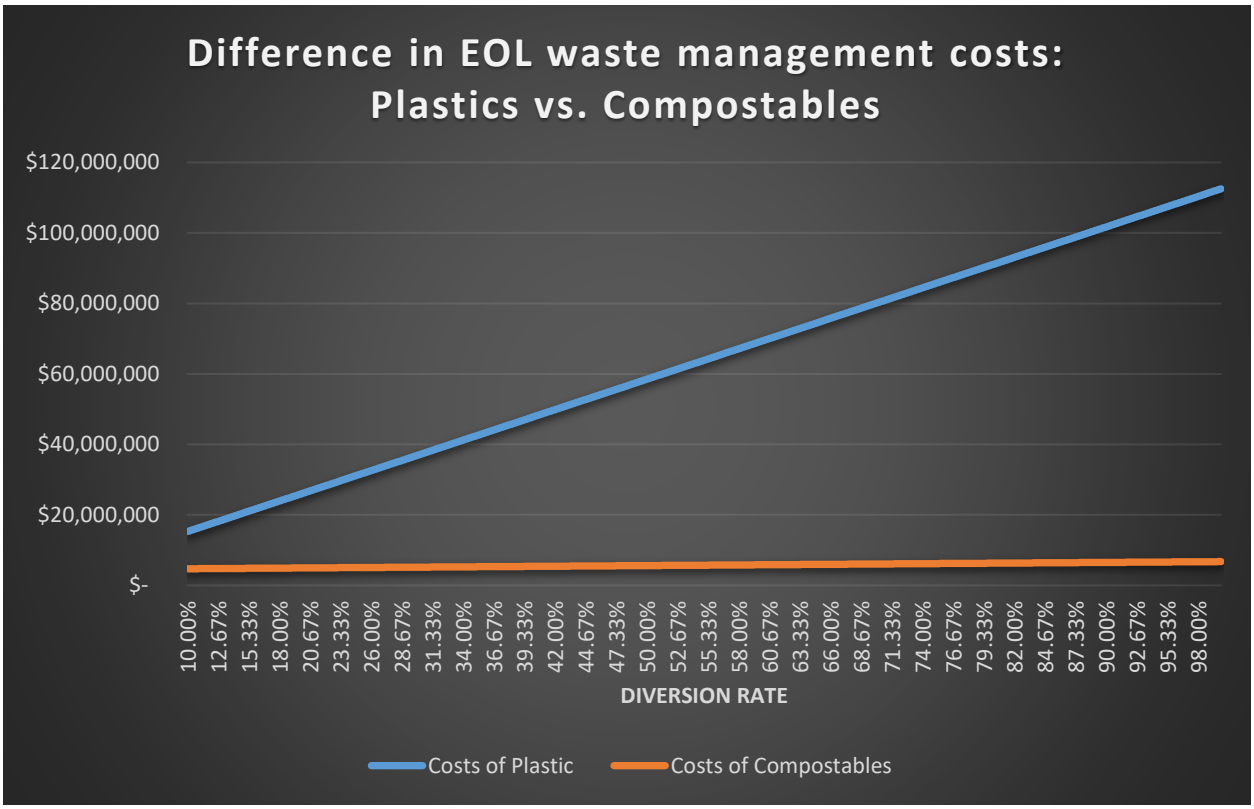
Using these assumptions, end of life waste management costs for compostable coffee pods are:

- Cost of Composting: $67,500
- Cost of Landfilling: $4,050,000
- Total Cost of Waste Management: $4,117,500

Comparing the modeled EOL costs of compostable and plastic coffee pods, the potential savings from compostables is in excess of $10,000,000. However, this disparity is even more pronounced when we consider a scenario when recycling rates/diversion rates increase.

Referring to Figure 1, we model the end of life management costs for both plastic and compostable coffee pods at different diversion rates.

Figure 1: EOL Management Costs for Plastic vs. Compostable Coffee Pods (At different diversion levels)



At a 25% Diversion Rate, the cost of plastics is $31,500,000 while the cost of compostables is $5,062,050. Extrapolating out even further, at a 75% diversion rate, the cost of plastics is $85,500,000, while the cost of compostables is $6,187,500. While it is unlikely that the coffee pods (of any variety) will achieve a 75% diversion rate, this scenario is meant to highlight the disparity in the cost of managing plastic coffee pods

when compared to compostables. In simpler terms, it is 16.6 times more expensive to recycle plastic coffee pods than it is to process compostables.

Readers must be cautioned from interpreting these numbers as fixed values – the costs of both recycling and composting change in response to new technologies, utility costs, labor costs and other cost drivers.

However, evaluating the merits of a particular packaging choice strictly along economic lines is shortsighted – to fully compare compostable and plastic coffee pods, we must consider environmental impacts as well.

2.0 Environmental Sustainability

It should be noted that quantifying emissions impacts of any packaging product, be they coffee pods, paper fibers, mixed plastics etc. is an inexact science. Emissions factors are a function of energy grid mixes, transport distances, processing technologies, end markets, and end use applications. As such, values found in the broader literature regarding the emissions impacts of waste management activity vary widely depending on source.

For the purposes of this white paper, the Life Cycle Analysis (LCA) database, Eco Invent, was used to calculate all emissions impacts. All modeling was done using the commercial LCA software Sima Pro. Our modeling assumes an Ontario Energy Grid mix, and assumes transportation distances that mirror Ontario's recycling markets.

Using these parameters, our modeling shows that recycling a plastic coffee pod in an Ontario material recycling facility is 0.45t CO2e/tonne. By comparison, calculating the emissions impacts of compostables is a function of the materials found in a commingled organics load. As an example, food and vegetable waste have significantly different coefficient values than fiber waste. As such, we will use the average emissions coefficient value for a mixed load of household organics, which works out to 0.81t CO2e/tonne.

On average, diverting one tonne of compostable coffee pods results in 180% more carbon abated than recycling one tonne of plastic coffee pods.

Using the same assumptions in the scenario modeled in section 2, the environmental impact of recycling 10% plastic coffee pods vs. diverting 10% of compostable coffee pods, the results are:

- Recycling 4500T of plastic coffee pods abates 2025tCO2e.
- Diverting 4500T of compostable coffee pods through anaerobic digestion abates 3645tCO2e.

Perhaps of greater interest, is the intersection of environmental and economic key performance indicators. York University developed a new metric by which to compare the economic and environmental viability of managing different packaging materials – how much money needs to be spent on recycling/composting in order to abate one tonne of carbon? ($/tonne CO2e).

Given that the cost of recycling plastic coffee pods is $2500/tonne, and the emissions savings from recycling one tonne is 0.45 tCO2e, the $/tonne CO2e is roughly $5500 – stated alternatively, recyclers need to spend $5500 to abate one tonne of carbon from recycling coffee pods. Compared to compostable coffee pods, the $/tonne is $185.19 (using an emissions coefficient of 0.81tCO2e and an average processing cost of $150/tonne).

Essentially, the environmental "return" for compostable coffee pods is almost 30x greater than plastic coffee pods.

Of note, the $/tonne CO2e for compostable coffee pods compares quite favorably to other packaging materials. Table 1 below summarizes the $/tonne CO2e for each of the materials found in Ontario's Blue Box system.

Table 1: Comparison of $/tCO2e for all Blue Box materials.

	$ Spent for every one tonne CO2 avoided
	$/tCO2e
Newsprint - CNA/OCNA	$60.64 $/tcO2e
Newsprint - Non-CNA/OCNA	$60.64 $/tcO2e
Magazines and Catalogues	$49.55 $/tcO2e
Telephone Books	$91.66 $/tcO2e
Other Printed Paper	$45.06 $/tcO2e
Paper	
Corrugated Cardboard	$155.98 $/tcO2e
Boxboard	$86.20 $/tcO2e
Gable Top Cartons	$500.55 $/tcO2e
Paper Laminates	$492.48 $/tcO2e
Aseptic Containers	$593.42 $/tcO2e
Paper Based Packaging	
PET Bottles	$552.65 $/tcO2e
HDPE Bottles	$540.88 $/tcO2e
Plastic Film	$1,394.43 $/tcO2e
Plastic Laminates	$1,386.46 $/tcO2e
Polystyrene	$908.42 $/tcO2e
Other Plastics	$903.97 $/tcO2e
Plastics	
Steel Food & Beverage Cans	$103.59 $/tcO2e
Steel Aerosols	$103.59 $/tcO2e
Steel Paint Cans	$103.59 $/tcO2e
Steel	
Aluminum Food & Beverage Cans	-$25.82 $/tcO2e
Other Aluminum Packaging	-$25.82 $/tcO2e
Aluminum	
Clear Glass	$315.42 $/tcO2e
Coloured Glass	$296.28 $/tcO2e
Glass	
	$139.93 $/tcO2e

3.0 Technical Feasibility

This section explores the technical feasibility of managing compostable coffee pods in aerobic and anaerobic digestion facilities.

One of the common concerns associated with managing compostable coffee pods in municipal green bin programs is their performance in composting systems. In a review of the available literature and pilot studies that have examined this issue, the findings show that compostable pods can be readily managed in existing composting systems.

In a review of 10 pilot studies in both Ontario and the United States, compostable pods broke down between a 2 and 5 week period, and in 9 out of 10 instances, met the MOECC Compost Quality Standards. In the one instance in which the compostable pods failed to break down sufficiently, it was noted that the material would be re-run through the system to break down the pods to required levels (a typical practice for other organics) and that the moisture levels in that system at the time of testing were below the 40% level during the curing stage now required under the Ontario Compost Quality Standards for Categories AA, A and B compost.

The conditions in which coffee pods can be broken down is highly dependent on the mix of materials entering the system, moisture content, retention time, temperature, as well as other factors. However, this issue is not unique to coffee pods – the compostability of all materials entering the facility is dependent on these factors as well. Facility managers are often tasked with constantly adjusting variables to ensure maximum efficacy of composting facilities.

It should be noted that these pilots were in collaboration with a number of large urban municipalities which operate a residential green bin/organics programs. The conditions and configurations of the composting systems found in these municipalities range a broad spectrum. As such, one can intuit that the experiences with compostable pods in these pilot programs can likely be transposed to other areas that offer residential organics services.

The results of these pilot studies demonstrate that compostable pods can be readily broken down with relatively minor changes to the composting process. In no instance did the pod remain intact after at least four weeks of processing.

When compared to plastic coffee pods (which cannot be composted, and must be recovered at a conventional material recycling facility), compostable pods provide municipalities with a more viable alternative for inclusion as part of a cities diversion program (via the Green Bin). The technical limitation associated with recycling plastic coffee pods is that there is that most processors have difficulty sorting this material. At present, capture rates of plastic coffee pods are estimated to be less than 5% - largely due to the fact that existing single and dual stream systems are not configured for composite plastic coffee pods. Further to that (and as discussed) in section 1.0, when it can be recovered, it is often done at an enormous cost that exceeds $2500/tonne.

4.0 Conclusions

While the debate surrounding single use packaging and coffee pods continues, the economic and environmental characteristics of compostable coffee pods points to a potentially promising technical solution. The purpose of this white paper is not to recommend any one packaging type over another – rather, it is intended to compare plastic vs. compostable coffee pods as a means to reduce consumer conflation of the two.

Not all coffee pods are created equal – as shown in sections 2 and 3, compostable coffee pods are 16.6x less expensive and represents an opportunity to abate almost twice as much carbon. As such, treating all

coffee pods as homogeneous, and characterizing their end of life management as problematic, ignores the fact that compostable coffee pods are distinctly different than their plastic counterpart.

While this white paper does not examine the viability of compostable pods displacing plastic coffee pods in the marketplace, it does suggest that economically and environmentally superior products exist in the marketplace.

Municipalities should consider compostable coffee pods for inclusion in their green bin program, as it represents an opportunity to divert more material, without incurring additional costs.

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