USED OIL MANAGEMENT ASSOCIATION OF CANADA

Supply Chain Cost Analysis for Petroleum Product Packaging

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Acronyms

BEV	Battery electric vehicles
DIFM	Do-it-for-me
Dillon	Dillon Consulting Limited
DIY	Do-it-yourself
EHF	Environmental Handling Fees
EPR	Extended producer responsibility
ESG	Environmental, social, and governance
EV	Electric vehicles
GHG	Greenhouse gas
HEV	Hybrid electric vehicles
ICE	Internal combustion engine
NLCRC	National Lubricant Container Recycling Coalition
NORA	An Association of Responsible Recyclers
NUOMAAC	National Used Oil Material and Antifreeze Advisory Council
PHEV	Plug-in hybrid electric vehicles
PCR	Post-Consumer Recycled material
UOMA	Used Oil Management Associations

Executive Summary

Dillon Consulting Limited (Dillon) was retained by the Used Oil Management Associations (UOMAs) of Canada through the National Used Oil Material and Antifreeze Advisory Council to conduct a supply chain cost analysis study for petroleum product packaging. The purpose of the study is to provide valuable insights into the circular economy opportunities for the lubricating oil industry, specifically relating to packaging design and supply network improvements, building on a supply chain cost map that identifies the lubricating oil packaging life cycle components, and indicates the costs associated with each component.

Data for this study was gathered through desktop research, the information provided by the UOMAs and interviews with key informants from across the supply chain. Because of limitations around the data available on supply chain costs, the majority of the findings are qualitative in nature and based on in-depth interviews with key informants.

As an initial step of the study, the forward and reverse components of the supply chain for petroleum product packaging were mapped. Key supply chain actors were identified as packaging manufacturers, fillers/lubricating oil manufacturers, distributors, retailers, business users, installers, packaging recyclers and reconditioners. Key characteristics of the forward and reverse supply chains are reviewed, including the packaging type groupings and the supply chain models and market dynamics. The forward supply chain for lubrication oil was found to be highly dynamic and competitive and to be reactive to current market conditions and global trends. The reverse supply chain was characterized by a collection and processing market with little competition and a highly competitive commodity market for post-consumer recycled (PCR) content.

To analyze the costs in the lubricating oil packaging supply chain, findings from both desktop research and information from key informants during interviews were considered. Current supply chain cost trends, including commodity prices, vehicle fleet composition, labour, fuel and energy and capital costs, as well as regulatory changes, were considered. Supply chain cost mapping was then carried out to analyze and visualize the cost elements associated with all value chain components of the supply chain of a product. The supply chain cost components and main cost drivers for key supply chain actors were identified.

Finally, opportunities to increase circularity in the supply chain were identified and assessed for their potential for cost reduction and impacts on the environment. Five main opportunities emerged through this analysis as follows:

Opportunity #1: No packaging: increasing bulk deliveries to do-it-for me (DIFM) installers;
Opportunity #2: No packaging and refill: bulk to do-it-yourself (DIY);

Opportunity #3: Large packaging reuse (drums and kegs): reconditioning;
Opportunity #4: Optimization of reverse logistics;
Opportunity #5: Post-consumer recycled materials (PCR) cost increase mitigation.

Each of these opportunities was reviewed for the changes that would apply to the supply chain, assumptions regarding the market size, cost reduction assessment, environmental opportunity description, relation to incentives and fees and change management considerations.

Of these opportunities considered, Opportunity #1, bulk delivery to DIFM installers, and Opportunity #3, large packaging reuse, emerged as the most promising pathways to increase circularity in the supply chain. While these two scenarios already exist in the supply chain, they still have a good potential for cost reductions and environmental benefits and may benefit from continuing to be highlighted in discussions around circularity for lubricating oil packaging. The feasibility of Opportunity #2, offering refill solutions for DIY customers, was brought into question through an analogous case study considering refill stations for windshield washer fluid, which highlighted challenges for lubricating oil refill, including the diversity of products, limited customer traffic and potential hazards associated with lubricating oil. Opportunity #5, the PCR cost increase mitigation scenario, was found to be strongly related to regulatory changes for which the likelihood is high but the timing and specific supply chain impacts are uncertain. Opportunity #4, the feasibility of increased efficiencies in the reverse logistics supply chain, could be explored further by gathering additional data on the reverse supply chain through the incentive claims process.

1.0 Introduction

Dillon Consulting Limited (Dillon) was retained by the Used Oil Management Associations (UOMAs) of Canada through the National Used Oil Material and Antifreeze Advisory Council (NUOMAAC) to conduct a supply chain cost analysis study (the Study) for petroleum product packaging.

1.1 Background

NUOMAAC coordinates recycling efforts for used oil and antifreeze materials across Canada while advocating for consistent national standards. These joint initiatives encompass the recycling of diverse waste streams, such as used oil, oil filters, antifreeze, plastic containers, and aerosol cans. Notably, the nine UOMA programs in Canada have led to responsibly managed end-of-life petroleum packaging, including collection and recycling, for over two decades.

Manufacturers' and retailers' push for environmental, social, and governance goals has triggered significant transformations in consumer goods packaging, including petroleum packaging. Concurrently, international, federal, and state-level plastic and packaging regulations, including bans on single-use packaging and extended producer responsibility (EPR) laws, are pressuring lubricating oil producers to enhance packaging reduction and recycling efforts.

A recent National Survey and Study of the Lubricating Oil and Antifreeze Packaging Circular Economy was conducted by UOMA to better understand the trends in the use, reuse and recycling of plastic packaging in the automotive industry by gathering insights from key players (fillers, package manufacturers and recyclers). Study findings included:

- Among multiple potential solutions to decrease the volume of single-use packaging, participants mentioned that an expansion of incentive programs, including for plastic bulk containers, could be beneficial;
- Fillers (the central link in the supply chain) and packaging manufacturers are often located in the US, as are their head offices where the decision-making power rests, limiting opportunities for Canadian players to respond to Canada-specific regulatory pressures; and
- Further and more in-depth exploration of the integrated North American supply chain is needed to understand costs, design choices, supply networks, and recycling options.

1.2 Purpose

The study's purpose is to provide valuable insights into the circular economy opportunities for the lubricating oil industry, specifically relating to packaging design and supply network improvements. It builds on an assessment of the supply chain costs and potential cost impacts of circular improvements.

2.0 Methodology

This project was completed through six key tasks, covering primary and secondary research and analysis, as shown in the figure below. The sections below provide more information on these tasks.

2.1 Interview Process

Interviews were conducted with key informants from across the forward and reverse supply chains to gain insights into the operation of the supply chain. Analogous knowledge holders with experience implementing refill systems in the automotive sector were also interviewed to inform the case study on windshield washer refills. Interviews were the primary data source for this presentation.

Dillon and the UOMAs collaborated to identify key informants, who were then invited to participate in the study. Table 1 summarizes interview participants.

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Table 1: Key Informants for Interviews

Supply Chain Category	Number of Interviews	Companies Interviewed
Petroleum Packaging Manufacturer	2	Graham Packaging, Plastipak Packaging
Fillers/Petroleum Manufacturer	4	Petro Canada, Chevron, Valvoline, Shell
Petroleum Distributors/Fillers	0	
Petroleum Installers (DIFM)	1	Jiffy Lube
Petroleum Packaging Recyclers (collection and primary processing)	2	GFL, RPM (RPM also does resin production and reconditioning)
Petroleum Packaging Recyclers (resin production)	1	Merlin Plastics
Container Reconditioners	2	Envirocontainers, Mauser
Analogous Knowledge Holders (windshield washer refill case study)	2	Canadian Tire, EcoTank
Total	**14**	

Interview questions for supply chain companies focused on the following:

- Understanding their role in the supply chain, including client segments and product/packaging types;
- Understanding current practices to increase circularity in their companies and interest in circular economy solutions;
- Exploring cost drivers and decision-making processes; and
- Gathering insights into commercial and other business considerations for circular economy opportunities related to packaging.

A copy of the interview questions, targeting manufacturers and fillers, is provided in **Appendix A**.

2.2 Data Collection and Validation Process

Desktop research was done to understand the costs of the supply chain and trends related to supply chain costs. Data was also received from the UOMAs, including information on the supply of different container sizes and types and information on the weights of containers collected.

Data included information from, but not limited to:

1. Annual reports from the UOMA Provincial Programs;
2. Data on container sizes for the packaging under the scope of this project;
3. Tonnage of lubricating oil supplied and collected, and regions supplied to and collected from;
4. Information on the Lubricants Life Cycle Assessment and Carbon Footprinting by American Petroleum Institute (API);
5. National Survey and Study of the Lubricating Oil and Antifreeze Packaging Circular Economy, prepared by DesRosiers Automotive Consultants, that contains information from fillers, packaging manufacturers and recyclers on packaging used for small and medium bulk delivers of products;

6. Information from NORA on used oil collections and economics;
7. Information on economic and supply chain cost trends from Statistics Canada, the Continuous Improvement Fund and other sources; and
8. Data collected from interviews with players across the lubricating oil supply chain.

Price drivers for used oil were used to understand the economics of lubricating oil packaging, as that would feed into the drivers for packaging as well. The lubricating oil supply chain was used as the base to understand the cost drivers at each stage of the supply chain. Data collected on cost drivers at each stage of the supply chain were validated using the interviews conducted.

Dillon also created a survey to validate the cost data with respect to each supply chain player. This survey asked participants to allocate cost percentages between supply chain components affecting their company. The survey was sent to all interview participants; however, no responses were received.

2.3 Supply Chain Mapping and Characterization

Information from the desktop research and interviews was used to obtain an understanding of the nature and dynamics of the lubricating oil supply chain, which is necessary to understand the drivers for and potential impact of changes towards increased circularity.

The findings from the supply chain mapping and characterization are summarized in **Section 3.0.**

2.4 Costs and Opportunity Analysis

The data collected was analyzed to develop supply chain cost profiles for each step in the petroleum product packaging supply chain. This analysis covered components of both the forward and reverse supply chains, including packaging manufacturers, fillers, distributors, retailers, industrial clients, and packaging recyclers.

In addition to the cost analysis, the supply chain was also analyzed for potential opportunities to increase circularity. During this analysis, the potential for cost reduction and environmental benefits were considered, and five opportunities with the strongest potential for cost reductions across the supply chain were explored in more detail.

The findings from the cost analysis are summarized in **Section 4.0** and from the opportunity analysis are summarized in **Section 5.0**.

2.5 Project Reporting and Webinars

This report documents the project's findings. Additionally, project findings were presented to stakeholders, including the UOMAs, interview participants, and interested supply chain actors, through a

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webinar. A second webinar will also be held for representatives of the UOMAs, allowing the UOMAs to explore how they would build on the information gathered through this study.

2.6 Limitations

Limited data was available on supply chain costs, and where data was found, the granularity was not sufficient to get a detailed understanding of the impacts of various cost elements associated with the supply chain. Also, information on costs was based on financial information on listed companies in each part of the value chain. As information that is publicly available was for the entire product portfolio of the organization in question, assumptions had to be made to ascertain specific packaging-related costs. Because of this limitation, the majority of the findings are qualitative in nature and based on in-depth interviews with key informants. Interview findings were limited to what informants were willing to share, considering commercial sensitivity. Given this, only certain information ascertained through secondary research could be verified.

This project is limited to research to analyze the supply chain costs for lubricating oil packaging based on the methodology described in this section. Dillon has prepared this report for the sole benefit of the UOMAs. The material in the report reflects Dillon's best judgment in light of the information available at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions based on it, are the responsibilities of such third parties. Dillon accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

3.0 Supply Chain Mapping and Characterization

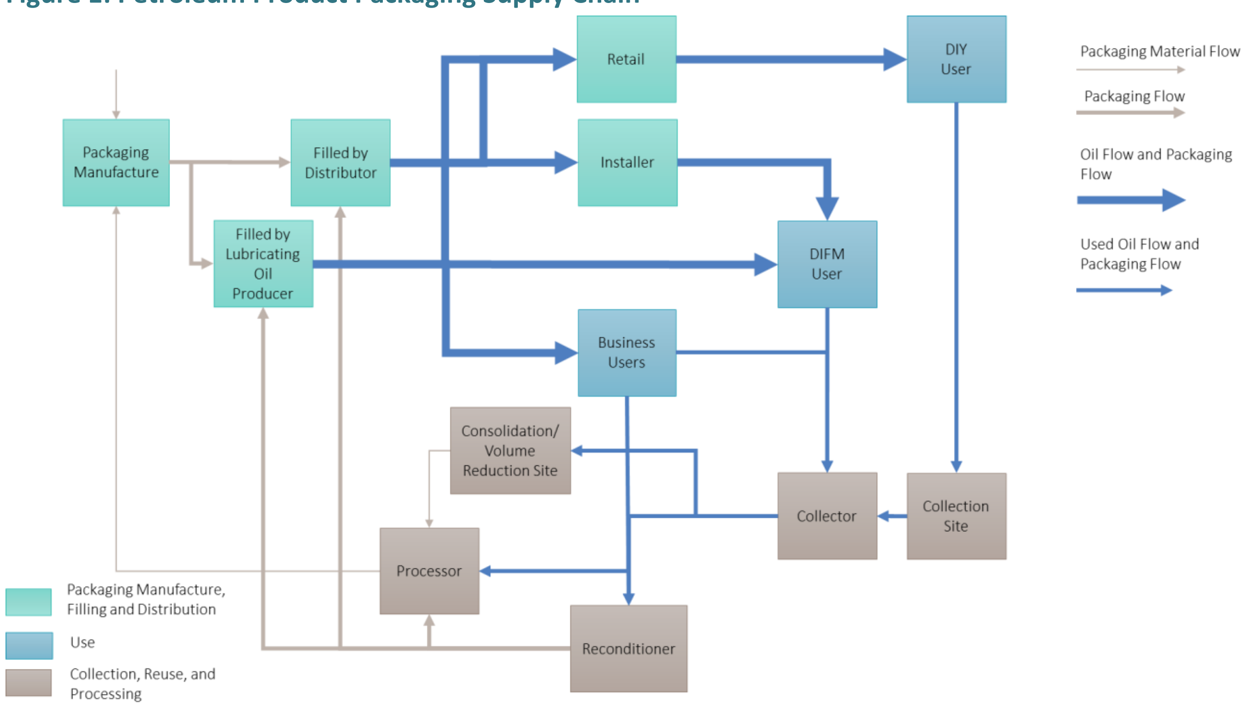
3.1 Supply Chain Overview

Figure 1 illustrates the supply chain for lubricating oil and its packaging. The supply chain is divided into three primary components as follows:

- Packaging manufacture, filling, and distribution;
- Use; and
- Collection, reuse and processing.

Of these components, the packaging manufacture, filling and distribution portion make up the forward supply chain, and collection, reuse, and processing make up the reverse supply chain. The forward and reverse supply chains are separated by the use phase when the lubricating oil and packaging are used by a customer, either an individual consumer or a business.

Figure 1: Petroleum Product Packaging Supply Chain



Key participants in the supply chain and a description of each are included in **Table 2**. Other participants in the supply chain include collection sites, where used lubricating oil packaging and oil is returned by consumers. It also includes collectors who transport the collected materials to processing or reconditioning sites.

Table 2: Key Supply Chain Participants

Key Supply Chain Participants	Description
Packaging Manufacturer	Those that produce lubricating oil packaging for fillers/manufacturers. In some cases, these companies also act as packaging recyclers.
Filler/Manufacturers	Fillers put lubricating oil into the packaging. They can be the manufacturers of lubricating oil or distributors that receive bulk deliveries from manufacturers. Fillers/manufacturers are typically the companies that make packaging decisions.
Distributors	Distributors receive packaged lubricating oil from a manufacturer and distribute it to retailers or consumers. Distributors may be part of a particular manufacturer's distribution network, or it may be independent.
Retailers	Retailers are those who receive lubricating oil packaging from distributors, which may be fillers or lubricating oil manufacturers, and then sell lubricating oil to customers, including businesses and individual consumers. The retail sector includes sales of lubricating oil to customers for do-it-yourself (DIY) oil top-ups or changes in both the automotive and non-automotive space (for example, lawn mowers and chainsaws). Retailers include large and small retail locations, as well as gas stations. Retailers also sell some lubricating oil to businesses for their use.
Business users	Business clients include industrial, commercial or agricultural businesses or installers that receive lubricating oil packaging from distributors and use it directly in their fleet or industrial equipment.
Installers	Installers, also known as the "Do-It-For-Me" (DIFM) sector, receive oil from distributors and deliver oil change services to a range of customers, including personal cars, small and medium-sized businesses, and fleets. They include quick lube shops, dealerships and independent auto service/tire shops.
Packaging Recyclers	Packaging recyclers are those that process used lubricating oil packaging so that it can be reused in new products or packaging. Many packaging recyclers also operate consolidation/transfer stations to reduce the volumes of materials before transportation.
Reconditioners	Reconditioners clean and recondition steel and plastic drums and IBCs for resale and reuse by cleaning, restoring, testing, and certifying these industrial containers.

The following sections discuss the key characteristics of the forward and reverse supply chains, including the customers, packaging type groupings, and the supply chain models and dynamics. The forward supply chain is discussed in **Section 3.2**, while the reverse supply chain is discussed in **Section 3.3**. Additional trends that affect costs in the entire supply chain are discussed in **Section 4.1.** The analysis and discussion of the supply chain is based on the 2020 National Survey and Study of the Lubricating Oil and Antifreeze Packaging Circular Economy, desktop research, data from the UOMAs and the information shared by key informants throughout the interviews.

3.2 Key Characteristics of the Forward Supply Chain

This section describes the key characteristics of the forward supply chain, encompassing the packaging manufacturing, filling, distribution, and customer use of the lubricating oil.

3.2.1 Applications

Lubricating oils are used in many applications, for automotive and non-automotive applications. An important one is the use of engine oil to lubricate internal combustion engines and applications that are expected to decline in the coming decade with the rise of electric vehicles. Other applications include gears, transmissions, compressors, turbines and hydraulic systems. Lubricating oil may be categorized as mineral, synthetic or bio-based, referring to differences in the virgin resource used and the manufacturing process. These many applications and differences in source and product performance and characteristics mean hundreds of different types of oil are supplied to the global market under a large variety of brands.

3.2.2 Packaging Type Grouping

There are various packaging types used to deliver lubricating oil to customers, as shown in **Table 3**.

Table 3: Packaging Types, Volume and Customer Segment

Packaging Types	Volume Range	Customer Segment
No packaging – bulk delivery	Various – up to Tanker Truck Capacity	Industrial and DIFM
Bag-in-box	~22 litres	DIFM
Drums	205 litres	Industrial
Kegs	60 litres	Industrial
Jugs	4-10 litres	Retail
Bottles	365 millilitres-1 litre	Retail

Plastic totes or IBC totes, with a volume of 1100 litres, are also used but were out of scope for this study.

3.2.3 Supply Chain Models

There are five primary supply chain models which exist in the forward supply chain for lubricating oil, including the following:

1. **Direct delivery:** When lubricating oil is delivered directly from the manufacturer to the customer through direct bulk delivery;
2. **Manufacturing & filling**: When the lubricating oil manufacturer procures packaging and fills the packaging for distribution to customers, downstream distribution partners or large-scale retailers;

3. **Decentralized filling by distributor:** When the manufacturer delivers lubricating oil in bulk to a filler or distributor, who may then package the lubricating oil for distribution to customers or downstream distribution partners or carry out bulk delivery to customers;
4. **Manufacturing, distribution and installation supply chain integration:** When the manufacturer is responsible for distribution and installation through a DIFM model direct to the customer; and
5. **Manufacturing, distribution and retail integration (gas stations):** When the manufacturer is responsible for filling, distribution and then sale to customers through their own retail locations, generally a gas station.

Most lubricating oil manufacturers use all of these in parallel and optimize which models are used at which time and in which geography based on market realities. An exception to this would be the manufacturing, distribution and installation supply chain integration which is less common. The chosen model also depends on the type of brand, their production locations and overall business model.

3.2.4 Supply Chain Market Dynamics and Trends

Lubricating oil supply chain

The lubricating oil market is highly diversified, dynamic, and competitive, with relatively low margins. The market is increasingly diversifying, driven by OEM product development, marketing, and consumer preferences. One recent driver of diversification is the increase in performance requirements to reduce greenhouse gas emissions from equipment use. The supply chains are highly dynamic due to the diversity in supply chain models. Supply chain players continuously adapt to market conditions and opportunities by switching between different models.

Lubricating oil packaging trends

Product packaging is designed for a global market, and decisions regarding the packaging supplied to the Canadian market are based on preferences in North America, particularly in the US.

In recent years, many companies are adopting environmental, social, and governance (ESG) and greenhouse gas (GHG) emissions reduction targets. To meet these targets, some manufacturers and fillers are reconsidering their packaging choices and looking for more sustainable solutions, including reducing the amount of packaging used by shifting to more bulk deliveries, decreasing the weight of packaging and substituting plastics. These pressures led, for example, to the adoption of bag-in-box technologies, which are light and reduce the amount of plastic used for packaging.

3.3 Key Characteristics of the Reverse Supply Chain

This section describes the key characteristics of the reverse supply chain, which encompasses the collection, reuse, processing, and packaging of lubricating oil.

3.3.1 Sources/Supply Customers

Once the customer has used lubricating oil, the containers, including any remaining oil, become available for collection. There are several collection points/sources that make up the reverse supply chain, including:

- Direct from generator:
  - Industrial/agricultural; and
  - DIFM installers.
- Municipal collection sites; and
- Other collection sites.

Generators are those that use lubricating oil for their business purposes and accumulate packaging for collection. Generators may also operate as collection sites and allow others to drop off materials for collection.

In some cases, collection sites may be paid a collection incentive through the UOMA program to accept materials dropped at their sites. These incentives are typically paid to municipal collection sites and private businesses/generators that accept drop-off of materials.

3.3.2 Packaging Type Groupings

In the reverse supply chain, packaging is typically grouped by material, as this will determine how it is processed. The packaging type groupings included:

- HDPE;
- Steel; and
- Other.

Another consideration for packaging type grouping in the reverse supply chain is whether the packaging is covered by an EPR program, as incentives are paid for the collection and processing of lubricating oil packaging. Across the UOMA programs, only packaging of 50L or less (and 30L or less in Alberta) is captured under the EPR programs. This means that there are no incentives for larger packaging types such as kegs, drums, and totes.

3.3.3 Supply Chain Models

The reverse supply chain is comprised of three primary models: independent collectors, small and large processors, and container reconditioners.

Independent Collectors

Some collection is carried out by independent contractors who collect materials from collection sites and transport them to a processor. These collectors are then paid an incentive based on the weight of materials delivered, which may be further determined based on the geographical zone in which materials are collected and delivered. These contractors tend to be smaller companies that operate in specific geographies based on existing relationships with generators and processors.

Small Processors

Smaller processors typically source materials locally, as their recycling capacities do not require extensive volumes. Processors may consolidate materials from more remote and low-density areas before transportation to their processing sites. Such sites may consist of something as simple as a parked trailer.

Larger Processors

Larger processors may operate across a province or across the country. Due to their capacity for recycling, they require large volumes of materials, and to ensure an adequate supply, they often also collect materials themselves both from collection sites and directly from business users.

Larger processors tend to have more sophisticated operations for consolidating materials and can deploy transfer stations with bailing or decentralized granulating to reduce transportation costs. These transfer stations exist as a function of scale.

Larger processors tend to utilize technologies to optimize collection, including improvements to routing.

Container Reconditioners

Some containers collected through the reverse supply chain will be processed by container reconditioners. These containers will be collected, and their capacity for reuse will be assessed. Where possible, containers will be reconditioned and certified for reuse, and where they are no longer fit for reuse, they will be sent for recycling. Reconditioning is common with larger containers, typically kegs and drums made from steel and plastic.

3.3.4 Supply Chain Market Dynamics and Trends

Recycling

The reverse recycling supply chain is characterized by two key market dynamics: a competitive commodity market for Post-Consumer Recycled material (PCR) and a little-competing collection and processing market.

The primary outcome of the reverse recycling supply chain is PCR content. This market is competitive and affected by the demand for PCR, which is driven by regulations requiring certain levels of PCR content in packaging, corporate ESG goals, and the commodity price for virgin plastics. Generating PCR content from petroleum product packaging requires more effort than for food or beverage packaging sources, as the removal of oil residue contaminating the packaging requires special measures for environmental compliance. Where the packaging cannot be adequately cleaned, there is a reduced market for the PCR content. The reverse supply chain also captures used oil, which is then refined into recycled oil, which is also a highly competitive commodity market.

With respect to collection and processing, there is little competition in the market. On the collection side, this is driven by the high costs of transporting the used packaging, with low margins for revenues. In urban centers, there is greater demand, as the increased density leads to greater volumes available for collection at lower costs. In rural/remote areas, competition is low to absent as the volumes available for collection are low, and the lack of density leads to high costs.

On the processing side, petroleum packaging requires a separate processing system from other types of packaging due to the oil residues found on the packaging, and there are very few processors established. Processors tend to have a regional focus, with small processors that operate out of one location and larger processors that may have multiple locations which carry out different activities. For example, they may do initial bailing or granulation in various locations prior to bringing materials to a central location for processing, thus reducing their transportation costs by enabling increased volumes to be transported in a single vehicle. Processors also trend towards integration of the processing supply chain, carrying out collection, primary processing and resin production.

An interviewee highlighted the expectation that the EPR programs would only be necessary until the reverse logistics infrastructure is created to then become redundant. This is not the case, at least not to the extent required by regulations: there is not sufficient demand for the product of the reverse supply chain to reliably cover the cost and generate a margin for businesses to invest in infrastructure and continue to serve customers on both ends of the supply chain (generators, plastics recyclers) across regions and material segments. Without the incentives, processors would likely start “cherry picking” to optimize their business model for sources that best align with the commodities markets and economies of scale: higher volume per trip, higher quality and higher oil content.

Therefore, the extended producer responsibility tools continue to be a key driver in the reverse logistics supply chain, compensating for any mismatch between what the “unregulated” market dynamics will achieve and the outcomes related to the policy intent (recovery targets, levels of service).

Reconditioning

There is also a trend in the reverse supply chain of decreasing packaging reuse, most notably for kegs and drums. Reconditioning activities have been around for a long time and are economically attractive compared to the use of new drums.

Historically, manufacturers have made voluntary efforts to enhance reuse through a deposit-return system. However, the administration of that system was considered burdensome and abandoned. A further reduction in reuse is partly caused by the lightweighting of this packaging, which reduces its durability and suitability for reuse. Some reported that drums are being lost to the recycling supply chain due to the convenience for users to have one collector for all packaging types and the economies of scale advantage to recyclers.

The success of this model is now largely reliant on the business development, customer services and logistical capabilities of reconditioners.

4.0 Cost Analysis

To analyze the costs in the lubricating oil packaging supply chain, findings from both desktop research and information from key informants during interviews were considered. In this section, current supply chain cost trends, including commodity prices, vehicle fleet composition, labour, fuel and energy and capital costs, as well as regulatory changes were considered and described in **Section 4.1**. A cost map of the supply chain was then created to visualize the cost elements associated with all value chain components and is summarized in **Section 4.2**.

4.1 Supply Chain Costs Trends

There are numerous factors which are influencing the costs of various supply chain components, including:

- Commodity prices for virgin and PCR HDPE;
- Wages;
- Fuel costs;
- Energy costs; and
- Interest rates and capital costs.

The following sections explore the trends related to these factors and their expected impacts on the petroleum product packaging supply chain.

4.1.1 Commodity Price for Virgin and PCR HDPE

The commodity price of virgin HDPE affects packaging manufacturing costs and is closely related to the price of oil.

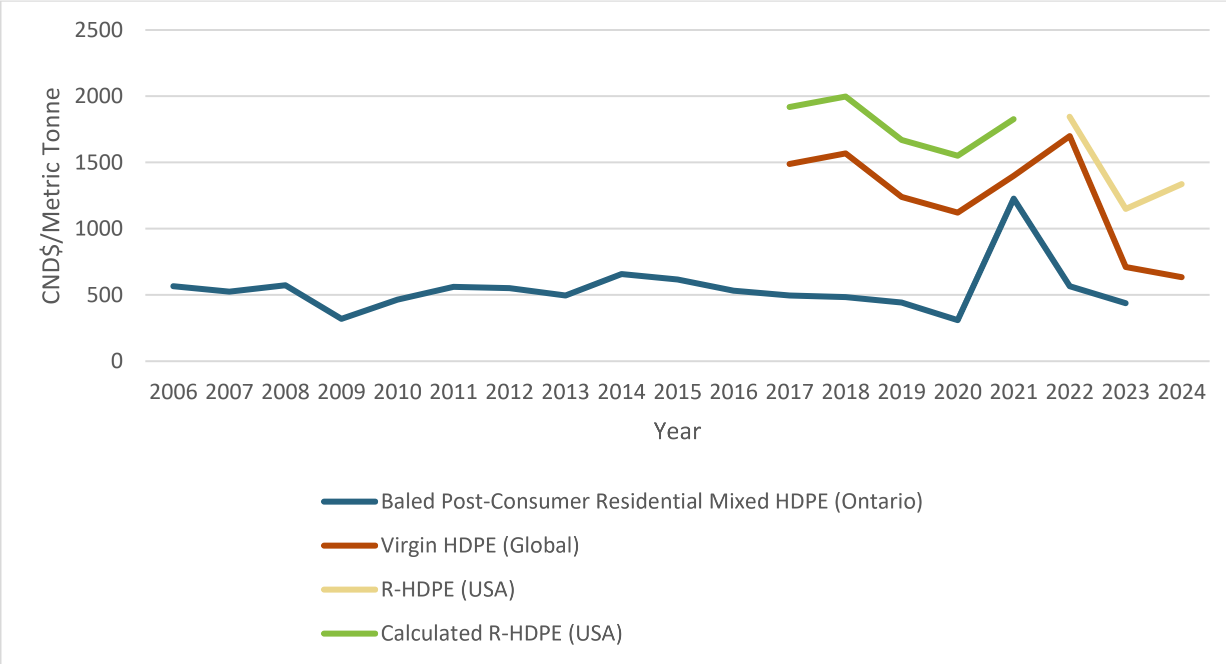
The commodity price for post-consumer (PCR) HDPE/recycled HDPE (R-HDPE) affects two aspects of the supply chain. First, it influences the profitability of the reverse logistics supply chain by increasing or decreasing revenues to HDPE packaging recyclers. Second, it can increase or decrease the cost of incorporating R-HDPE content into new packaging.

Figure 2 shows the changes in the yearly average price of the following data sets:

- baled post-consumer residential mixed HDPE between 2006 and 2023 in Ontario;
- virgin HDPE between 2017 and 2024 globally;
- R-HDPE prices in the USA between 2022 and 2024; and
- A calculated price for R-HDPE in the USA between 2017 and 2021.

It is important to note that the virgin HDPE price is a global price and the R-HDPE prices are for the United States and they may not reflect the actual values in Ontario or Canada.

Figure 2: Yearly Average Price HDPE[1,2,3,4,5,6]



The price baled post-consumer residential mixed HDPE can be used as a proxy to reflect the commodity price for PCR HDPE generally, although it should be noted that HDPE derived from lubricating oil packaging can have a lower value due to challenges associated with cleaning the oil from the HDPE. This price reflects the price of HDPE prior to processing to prepare it for reuse, and it is not the same as the commodity price for recycled HDPE. The price of baled post-consumer residential mixed HDPE fluctuates and there is no clear trend.

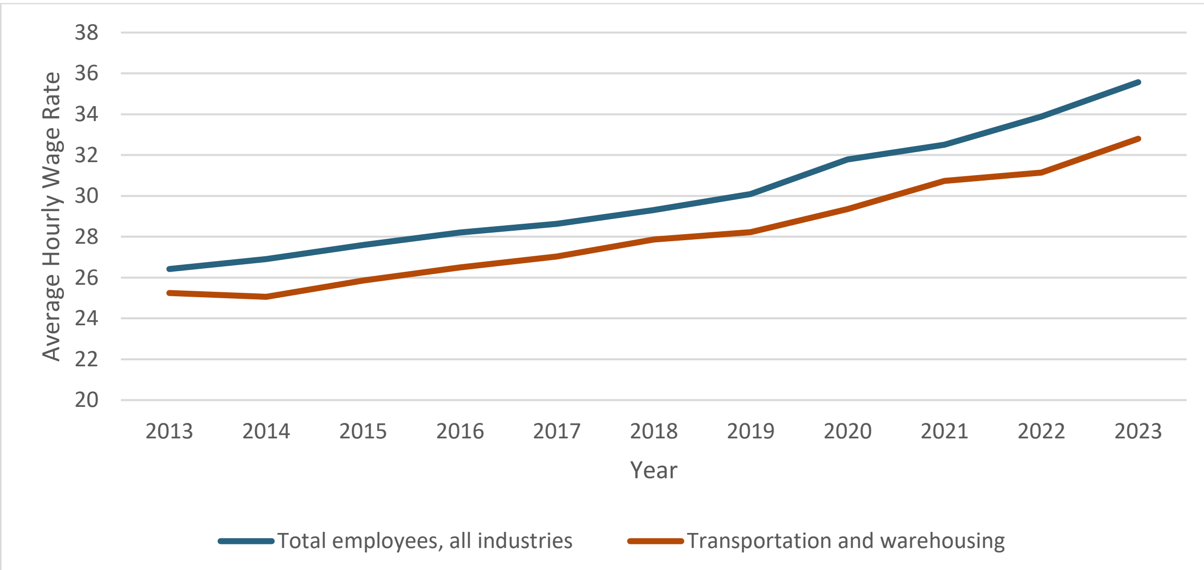
As shown in **Figure 2**, the price of R-HDPE is higher than the price for virgin HDPE. Depending on commodity prices, this difference may increase or decrease. Where there is a larger gap between the two prices, manufacturers will be more inclined to use virgin plastic, whereas, when the gap is smaller, they will be more inclined to incorporate R-HDPE into their packaging.

[1] Price Sheet – December 2023, Continuous Improvement Fund – thecif.ca
[2] Price of high-density polyethylene worldwide from 2017 to 2022 – statista.com
[3] HDPE price index – businessanalytiq.com
[4] Recycled High-density Polyethylene (R-HDPE) Price Trend and Forecast – procurementresource.com
[5] Recycled High-density Polyethylene (R-HDPE) Price Trend and Forecast, Sept 2022– chemanalyst.com
[6] Recycled High-density Polyethylene (R-HDPE) Price Trend and Forecast, March 2024– chemanalyst.com

4.1.2 Labour Costs

Figure 3 shows the average annual wage rate for all industries, as well as in the transportation and warehousing sector, between 2013 and 2023. Between 2013 and 2023, the average hourly wage for employees across all industries in Canada has increased by approximately 35%[7]. During the same time period, employees in the transportation and warehousing sector have seen an average hourly wage increase of approximately 30%[8]. It should be noted that these wages have not been adjusted to reflect the consumer price index and, therefore, their purchasing power in the market. Higher wages contribute to higher costs throughout the forward and reverse supply chains for lubricating oil packaging.

Figure 3: Canadian Average Hourly Wage Rate, 2013-2023[9]



4.1.3 Fuel Costs

Fuel costs are an important factor influencing the price of goods transported in the forward and reverse supply chains. Across Canada, fuel prices have been increasing in recent years.

Figure 4 shows the average diesel fuel prices in select Canadian cities between 2013 and 2023, with costs significantly increasing since a low in 2020. Between 2013 and 2023 there has been a 35% increase in the cost of diesel and between 2020 and 2023 there has been a 34% increase. Rising fuel prices impact the reverse supply chain, where revenues are low and transportation accounts for a significant portion of the costs incurred.

[7] Statistics Canada. Table 14-10-0064-01 Employee wages by industry, annual
[8] Statistics Canada. Table 14-10-0064-01 Employee wages by industry, annual
[9] Statistics Canada. Table 14-10-0064-01 Employee wages by industry, annual

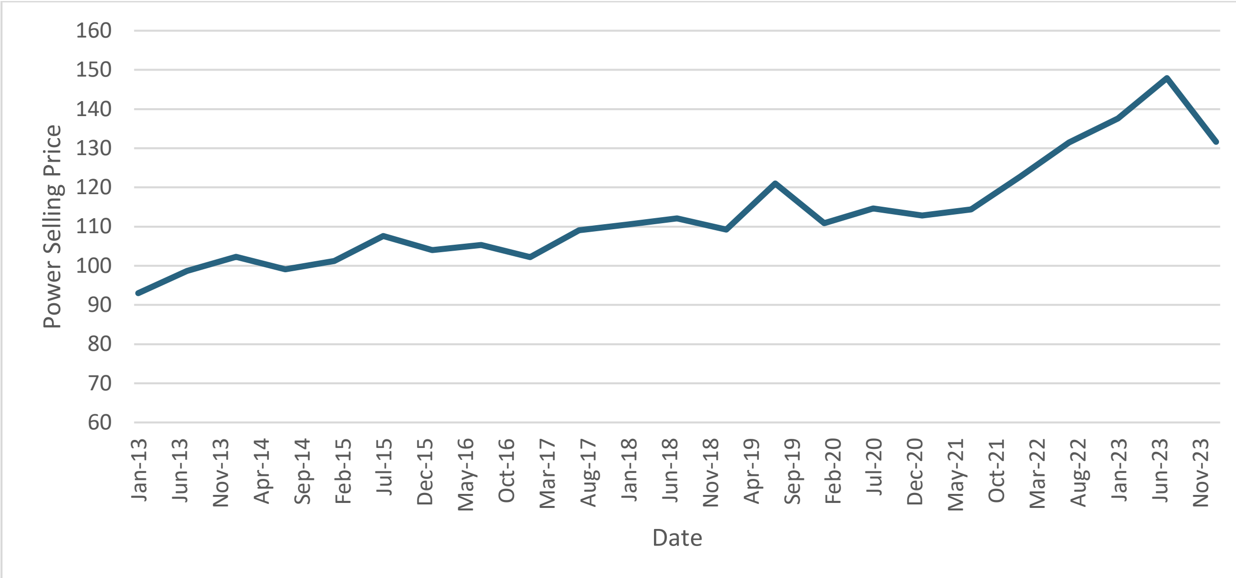
Figure 4: Diesel Prices in Select Canadian Cities, 2013-2023[10]

4.1.4 Energy Costs

Energy costs influence costs at all points in the forward and reverse supply chain but are particularly important for packaging manufacture and recycling, both of which are energy-intensive activities. **Figure 5** shows the Canadian national price index for electric power between 2013 and 2024. Energy costs have been trending upward over the past ten years, with a steeper increase between 2021 and 2023 before decreasing in 2024.

[10] Statistics Canada. Table 18-10-0001-01 Monthly average retail prices for gasoline and fuel oil, by geography

Figure 5: Electric Power Selling Price Index, Canada National Total[11]



4.1.5 Interest Rates and Capital Costs

In recent years, interest rates in Canada have increased from a low of 0.25% between March 2020 and March 2022, to the current level of 5%, which came into effect in July 2023[12]. This increase in interest rates limits capital investment by all companies across the supply chain, as the costs of borrowing for capital investments have increased.

4.1.6 Expansion of Regulatory Requirements for New Packaging and EPR

The USA is currently seeing a proliferation of EPR regulations, including those for lubricating oil packaging. This will likely have a minimal impact on Canadian supply chains, where EPR programs for lubricating oil are well established; however, it will drive up the availability of PCR HDPE derived from lubricating oil packaging.

In Canada and the USA, regulations are being considered and introduced, requiring manufacturers to incorporate PCR content into new packaging and demonstrate that products are recyclable. As these regulations become more prevalent and come into effect, the demand for PCR content is expected to increase. While PCR in industrial packaging, including lubricating oil packaging, is already prevalent through regulatory requirements in California, this increase in demand will primarily be seen for food-grade PCR HDPE. Currently, food-grade HDPE is used as a PCR source for lubricating oil packaging; however, the case for using industrial packaging as a PCR source will improve with increasing demand

[11] Statistics Canada. Table 18-10-0204-01 Electric power selling price index, monthly
[12] Canadian Interest Rate, Trading Economics – tradingeconomics.com

and pricing for food-grade PCR. This increases the future viability of collecting and processing PCR HDPE from lubricating oil packaging to be reused in lubricating oil packaging.

4.2 Supply Chain Cost Mapping for Petroleum Product Packaging

Supply chain cost mapping is a strategic process for analyzing and visualizing the cost elements associated with all value chain components of a product's supply chain. The objective is to gain a comprehensive understanding of the cost-related implications associated with the procurement, production, transportation, distribution, and recovery of products.

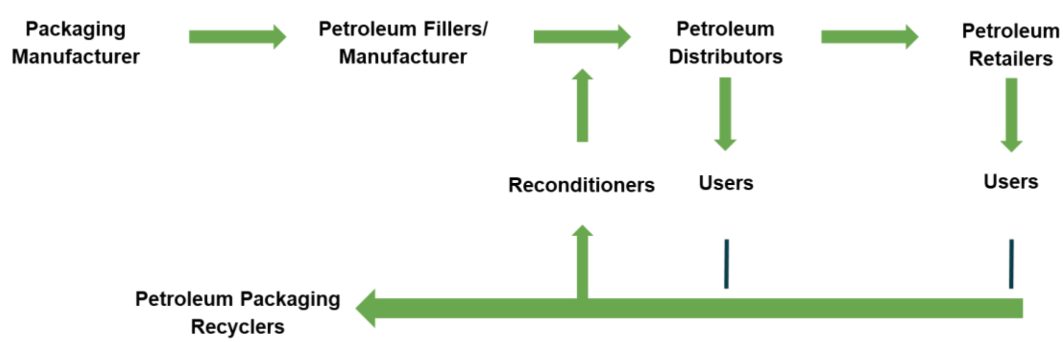
In the context of the current study on petroleum product packaging, the cost mapping enables an assessment of the opportunities for cost reduction of potential packaging design and supply improvements and generates insights that could help inform the use of the UOMA's tools.

For this purpose, the main priorities were to identify the main cost elements and assess their relative contribution to the overall cost of each value chain component. Cost elements were chosen by considering the various stages and components involved in the supply chain map for petroleum products. This encompassed both direct and indirect expenses related to packaging operations.

As per our preliminary findings, the supply chain cost components are represented in a range considering internal and external drivers, as depicted in the tables in the following paragraph. However, for visualization purposes, we have considered the lower range for each component, as highlighted in the pie charts that follow.

Figure 6 shows the key actors in a simplified supply chain for lubricating oil packaging. The supply chain components and their portion of the over costs for the keys actors are reviewed in **Section 4.2**.

Figure 6: Simplified Supply Chain Map for Petroleum Products



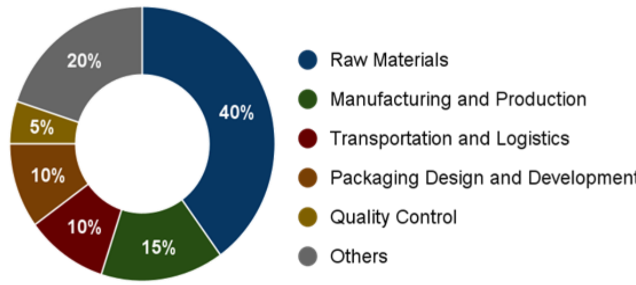
The key actors in the petroleum packaging supply chain are packaging manufacturers, fillers/ manufacturers, distributors, retailers, users, reconditioners and packaging recyclers. A description of each of these key actors is provided in **Table 2** in **Section 3.1**.

4.2.1 Packaging Manufacturer

For packaging manufacturers, the main cost drivers are:

- The costs of raw materials, which are influenced by the commodity price for virgin and PCR materials as well as regulatory changes including requirements for PCR content in packaging and EPR regulations requiring collection and recycling of packaging;
- Manufacturing and production costs, which are influenced by energy and labour costs; and
- Transportation costs, which are influenced by labour and fuel costs.

Raw Materials	**40-60%**
Manufacturing and Production	**15-25%**
Transportation and Logistics	**15-25%**
Packaging Design and Development	**10-15%**
Quality Control	**5-10%**



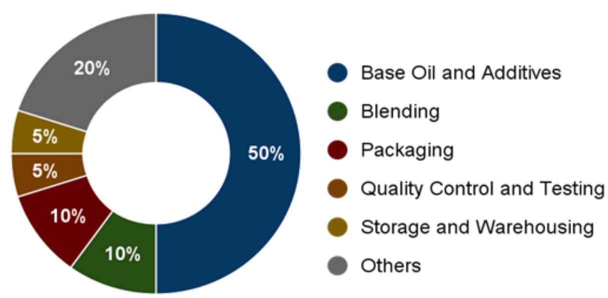
The "Others" includes all remaining supply chain cost components including Distribution, Warehousing, Administrative Cost, Technology and Marketing and Sales.

4.2.2 Fillers/Manufacturer

For fillers/manufacturers, the main cost drivers are:

- The costs of the base oil/additives that make up the lubricating oil product, which are influenced by commodity prices for oil;
- The blending/manufacturing process, which is influenced by labour and energy costs; and
- The cost of packaging is influenced by the cost of raw materials, including virgin and PCR materials.

Base Oil and Additives	**50-65%**
Blending/Manufacturing Process	**10-15%**
Packaging	**10-15%**
Quality Control and Testing	**5-10%**
Storage and Warehousing	**5-10%**



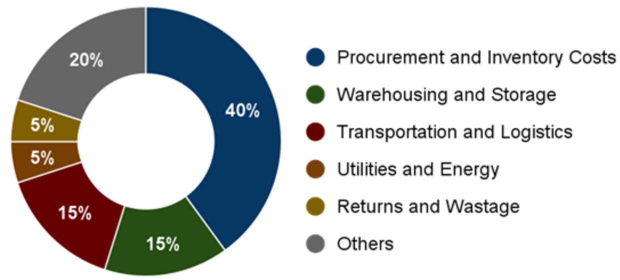
The "Others" includes all remaining supply chain cost components including Distribution, Logistics, Administrative Cost, Technology, Utilities & Energy and Marketing and Sales.

4.2.3 Distributors

For distributors, the main cost drivers are:

- The costs of their inventory and procurement, which are influenced by commodity prices for oil and packaging raw materials;
- Warehousing and storage costs, which are influenced by labour and energy costs; and
- Transportation costs, which are influenced by labour and fuel costs.

Procurement and Inventory Costs	**40-60%**
Warehousing and Storage	**15-25%**
Transportation and Logistics	**15-25%**
Utilities and Energy	**5-10%**
Returns and Wastages	**5-10%**



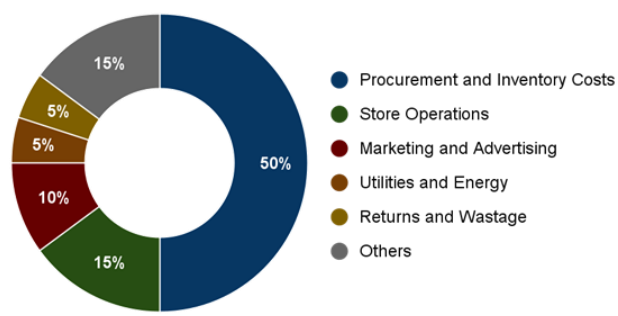
The "Others" includes all remaining supply chain cost components including Quality Control, Administrative Cost, Technology, Customer Services and Marketing and Sales.

4.2.4 Retailers

For retailers, the main cost drivers are:

- The cost of their inventory and procurement, which is influenced by commodity prices for oil and packaging raw materials; and
- Store operations costs, which are influenced by labour and energy costs.

Procurement and Inventory Costs	**50-60%**
Store Operations	**15-25%**
Marketing and Advertising	**10-15%**
Utilities and Energy	**5-10%**
Returns and Wastages	**5-10%**



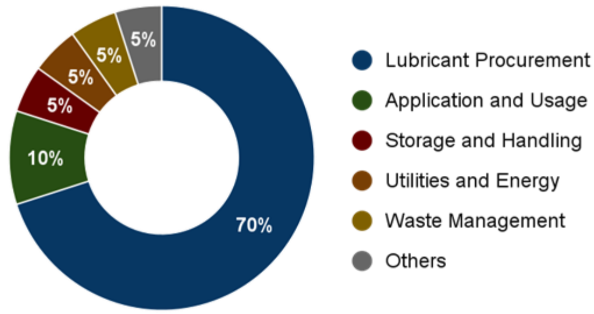
The "Others" includes all remaining supply chain cost components, including Quality Control, Administrative Costs, Technology, Customer Services, and Transportation.

4.2.5 Business Users

For industrial clients, the main costs drivers are:

- The cost of lubricant procurement, which is influenced by commodity prices for oil and packaging raw materials; and
- Their operating costs for application and usage, which are influenced by labour costs.

Lubricant Procurement	**70-80%**
Application and Usage	**10-15%**
Storage and Handling	**5-10%**
Utilities and Energy	**5-10%**
Waste Management	**5-10%**



The "Others" includes all remaining supply chain cost components including Monitoring & Maintenance, Environmental & Regulatory Compliance, Administrative and Labor Cost, Technology, and Systems.

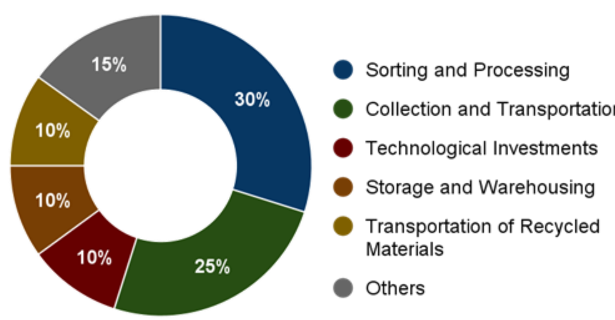
4.2.6 Packaging Recyclers

For the purpose of the cost analysis, we have considered a packaging recycler that collects used lubricating oil packaging from generators and transports those materials to their facilities for processing.

For packaging recyclers, the main cost drivers are:

- Sorting and processing costs, which are influenced by labour and energy costs, as well as insurance and environmental regulatory compliance costs; and
- Collection and transportation costs, which are influenced by labour and fuel costs.

Sorting and Processing	**30-40%**
Collection and Transportation	**25-35%**
Technological Investments	**10-15%**
Storage and Warehousing	**10-15%**
Transportation of Recycled Materials	**10-15%**



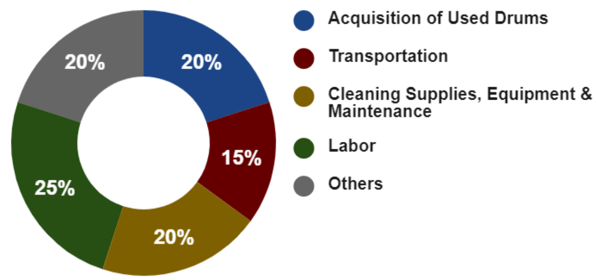
The "Others" includes all remaining supply chain cost components, including Labour, Quality Control, Environmental & regulatory compliance, Utilities & Energy, and Administrative costs.

4.2.7 Drum Reconditioners

For drum reconditioners, the main cost drivers are:

- Acquisition costs associated with the acquisition of used drums, which are influenced by the supply and demand of used drums;
- Transportation costs, which are influenced by vehicle and fuel costs;
- Cleaning Supplies, Equipment & Maintenance costs, which are influenced by costs of chemicals, tools and machinery maintenance needed to cleanse the drums to restore them to a re-usable condition; and
- Labor costs, which are influenced by the wages of skilled workers required to safely and effectively clean and restore the drums.

Acquisition of Used Drums	**20-30%**
Transportation and Logistics	**15-25%**
Cleaning Supplies, Equipment & Maintenance	**20-25%**
Labour	**25-35%**



The "Others" category includes all remaining supply chain cost components including Regulatory Compliance, Sales & Marketing.

5.0 Opportunity Analysis

The opportunity analysis for cost reduction in the petroleum packaging supply chain conducted as part of the study consists of three parts:
1. Development of the circular cost reduction scenarios;
2. Assessment and selection of the circular cost reduction scenarios; and
3. Insights for the UOMA.

5.1 Cost Reduction Scenario Analysis

During interviews, options for circularity were discussed, and several cost-reduction scenarios emerged for consideration.

Cost Reduction Scenarios
The main opportunities that emerged and were considered to both increase circularity and present a cost-saving opportunity were:
1. No packaging – bulk to DIFM;
2. No packaging (DIY top-ups)/Small packaging reuse (bottles);
3. Large packaging reuse (drums and kegs);
4. Optimization of reverse logistics (consolidation and transfer stations/decentralized processing); and
5. Increasing the production of PCR from lubricating oil packaging for closed-loop use (mitigating future cost increases).

The five cost reduction scenarios will be explored in greater detail in the sections below. To assess these opportunities and their impacts on the value chain steps identified in **Section 3.0** were considered. The opportunities for cost reductions and the environmental opportunity were also explored. With consideration to the impacts to UOMA the relation to collection/processing incentives and EHFs were also considered. Finally, any additional considerations for change management related to these opportunities were reviewed.

Other Options Mentioned in the Interviews
A few opportunities for increasing circularity that are being explored by interviewees came up during the interviews but were left out of this analysis as they would not reduce costs and/or have a high potential for improved environmental outcomes. These were:
- HDPE packaging innovation to increase recyclability (coatings, material innovation.)
  - The main advantage of improved recyclability is a higher quality and quantity of the resulting PCR produced from recovered packaging, resulting in increased revenue rather than a decrease in costs.
- Redesigning bag-in-box solutions to make them recyclable.

  - One available option in the market is the heavier stackable HDPE container. The shift back to this type of packaging is already ongoing as a result of recyclers charging generators to pick up this type of packaging.
    - While this shift back to HDPE would improve recyclability, the life cycle carbon impact is unclear.
  - Diverting the unrecyclable bag to advanced recycling facilities.
    - This option is not in the scope of the project.
- Increasing the PCR content in bottles based on existing sources of PCR.
  - This was not included as, while this is a great innovation, packaging containing PCR is currently more expensive and not sold at the scale that it can be produced. Realizing the potential of the current scale and sustaining that in a context that the PCR source may have to shift seems the bigger challenge.

5.1.1 Scenario 1: No Packaging – Bulk to DIFM

Under this scenario, no packaging would be used to deliver lubricating oil in the automotive space to do-it-for-me (DIFM) installers; instead, bulk refills would be provided into existing containers/tanks. In some cases, bulk deliveries to the DIFM sector are already in place, and therefore, implementation of this scenario would center around increasing the use of bulk deliveries rather than creating a new business model. The opportunity was selected for its potential to reduce the use of bag-in-box packaging, which has been identified as largely being sent to landfill at end-of-life. However, it also has the potential to decrease the use of new packaging of other types. Changes that would apply to different impacted segments are summarized in **Table 4**.

Table 4: Scenario 1 - Impacts and Changes

Impact category	Change
Packaging type/volume	Increase of lubricating oil delivered in bulk Reduction in lubricating oil delivered in bag-in-boxes
Value chain activities	Bulk trucks are filled at manufacturer sites delivered to installers who store the product in tanks or IBCs
Customer segment impacted	DIFM, with a focus on quick lube sector – commercial fleet and personal cars
Customer experience	Reduction of product diversity for client
Business impacts (other than cost/environment)	Longer term contracts, lower overhead costs

Assumptions regarding market size:

According to NORA, road transportation represents approximately 40% of the total lubricating oil market[13]. UOMAs reported that 240 million litres are being sold in Canada per year (excluding 2020) of which, according to the 2020 National Survey and Study of the Lubricating Oil and Antifreeze Packaging Circular Economy, the majority (approximately 83%) was performed at a DIFM location[14]. We further would assume that most DIFM locations are currently using either bottles or bag-in-boxes to accommodate a wide variety of oil types. In total we would thus be considering this scenario to potentially impact 33% of all lubricating oil.

Cost reduction assessment:

Table 5 shows the costs reduction assessment for the use of bulk deliveries to the DIFM sector including the supply chain and cost component impacted, a description of the impact and an assessment of the cost reduction.

Table 5: Scenario 1 - Cost Reduction Assessment

Main supply chain component impacted	Cost component impacted	Impact description	Overall cost reduction assessment
Lubricating oil manufacturers and fillers	Packaging	No packaging needed hence no packaging procurement or packaging filling operations required	Significant (the majority of the 10% assumed costs)
	Transportation and Logistics	Bulk transportation used to be cheaper but due to shrinking fleet sizes may neutral	Not significant
Lubricating oil manufacturers and installers	Administrative cost	Cost decrease due to long-term contracts and reduction in amount of interactions required	Minor
DIFM installers	Storage and Handling	We assume most DIFM sites have the ability to store in bulk without negatively	Not significant

[13] NORA, An Association of Responsible Recyclers, State of the Industry in North America, Presented by Scott D. Parker on Aug 23, 2023

[14] National Survey and Study of the Lubricating Oil and Antifreeze Packaging Circular Economy, DesRosiers Automotive Consultants Inc – interchangerecycling.com

Main supply chain component impacted	Cost component impacted	Impact description	Overall cost reduction assessment
Recyclers	Collection and processing	Reduction of costs relating to disposing of the bags from the bag-in-boxes. Potentially a reduction in overall volume, which may either result in a cost decrease (positive impact) or a scale decrease (negative impact).	Minor

Environmental opportunity description

- Reduction in volumes of packaging to be recovered;
- Reduction of unrecyclable bag in box;
- Reduction of the life cycle carbon footprint related to packaging; and
- Reduction in use of virgin materials and environmental impacts of manufacturing.

Relation to incentives and fees:

- Reduction of EHFs to be remitted on containers; and
- Reduction of tonnage and incentives (unless there is no marginal cost decrease).

Change management considerations:

- This scenario would benefit from OEM statements broadening the specifications of oils to use thus reducing the number of different types of lubricating oils that DIFM businesses need to keep in stock to satisfy customer needs.

5.1.2 Scenario 2: No Packaging and Refill – Bulk to DIY

Under this scenario, no packaging would be used to supply oil to the do-it-yourself (DIY) sector, and instead, retailers would provide facilities for customers to refill their vehicles directly or refill an existing container. These changes are anticipated to be implemented at fuelling stations, where there is a higher potential to manage the scope of change related to operations and permitting, although a diversity of retail locations could also be considered. Changes that would apply to different impacted segments are summarized in **Table 6**.

This opportunity was explored further through discussions with analogous knowledge holders who have experience implementing refills systems in the automotive space for windshield washer fluid. Insights from these discussions are summarized as a case study in **Appendix B.**

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Table 6: Scenario 2 - Impacts and Changes

Impacts	Change
Packaging type/volume	Increase of lubricating oil delivered in bulk Reduction in lubricating oil delivered in newly manufactured bottles
Value chain activities	Bulk trucks are filled at manufacturer sites and transported to retailers who store the product in tanks or IBCs. Retailer may have one or both of two models: 2 options: a) Consumer tops up the oil level in the car at the pump (no packaging required) b) Consumer brings a reusable (their own?) container to refill
Customer segments impacted	DIY owners who are performing own oil replacements for personal cars or light/medium duty trucks Consumers of lubricating oil for various non-automotive applications Business owners that purchase lubricating oils through retail setting
Customer experience	a) Client performs same operations as for fuel filling operations, at the same location. b) Client brings back container, and refills at refill station.
Business impacts (other than cost/environment)	Development of a new delivery model, including the development of refuelling/refill stations

Assumptions – Market Size:

The option is assessed based on the combination of the two models (top-up and refill) at fuelling stations, which has the higher potential (volume, scope of change related to operations and permitting). The DIY market share, according to the 2020 National Survey and Study of the Lubricating Oil and Antifreeze Packaging Circular Economy, is approximately 17% of the automotive lubricant market, impacting a total of approximately 7% of the entire lubricating oil market[15]. We assume that the refill/DIY top-up would be adopted by 60% of customers and will need to be deployed in parallel with the traditional bottled options.

7%
of the total lubricant market

14%
of the automotive lubricant market (2021)

Cost Reduction Assessment:

Table 7 shows the costs reduction assessment for the use of bulk deliveries and top-ups/refills for the DIY sector including the supply chain and cost component impacted, a description of the impact and an assessment of the cost reduction.

[15] National Survey and Study of the Lubricating Oil and Antifreeze Packaging Circular Economy, DesRosiers Automotive Consultants Inc – interchangerecycling.com

Table 7: Scenario 2 - Cost Reduction Assessment

Main supply chain component impacted	Cost component impacted	Impact description	Overall cost reduction assessment
Lubricating oil manufacturer and fillers	Packaging	No packaging needed hence no packaging procurement or packaging filling operations required	Significant (the majority of the 10% assumed costs)
	Transportation and Logistics	Bulk transportation used to be cheaper but due to shrinking fleet sizes may neutral	Not significant
Lubricating oil manufacturer and installers	Administrative cost	Cost decreases due to long term contracts and reduction in amount of interactions required	Minor
Retailers	Storage and Handling	Dispensing infrastructure to be developed. Once the system is operational, less staff handling needed. However pumping systems require regular maintenance	Initial cost increase, after that, neutral
	Customer Interface	Technological investments to develop a customer-centric interface to access refilling stations with POS setup	
Recyclers	Collection and Processing	Reduction of costs relating to disposing of the bags from the bag-in-boxes Potentially a reduction in overall volume, which may either result in a cost decrease (positive impact) of a scale decrease (negative impact)	Minor

Environmental Opportunity Description

- Reduction in volumes of packaging to be recovered; and
- Reduction in the use of virgin materials and environmental impacts of manufacturing.

Relation to Incentives and Fees:

- No EHF to be remitted on the container (though still required for the lubricating oil).

Change Management Considerations:

- To get to a 60% adoption rate requires client engagement and incentivization.
- Given the low volumes of DIY customers, the expected traffic may not be sufficient to justify the investment in refill stations;
- This scenario would benefit from OEM statements broadening the specifications of oils to use thus reducing the number of different types of lubricating oils that would need to be accommodated in top-up/refill systems; and
- Further change management considerations can be found in the analogous case study in **Appendix B**.

5.1.3 Scenario 3: Large Packaging Reuse (Drums and Kegs)

Under this scenario, more large drums and kegs would be recovered and reconditioned for continued use, rather than being recycled. This business model already exists, and therefore, implementation of this scenario would center around increasing the reuse of drums and kegs rather than creating a new business model. Changes that would apply to different impacted segments at summarized in **Table 8.**

Table 8: Scenario 3 - Impacts and Changes

Impacts	Change
Packaging type/volume	Reduction in lubricating oil delivered in newly manufactured drums and kegs
Value chain activities	Collector must sort drums/kegs for reuse vs recycling if collecting both simultaneously or must collect the drums and kegs separately. Reconditioner must prepare drums/kegs for reuse and obtain certification. Filler (mainly distributors acting as fillers) may need to rebrand drum/keg prior to filling.
Customer segment impacted	Industrial clients mainly Small portion of DIFM clients
Customer experience	Similar supply/return processes to status quo, small adjustment may be needed on returning the empty drum/keg if different collector is involved. Aesthetic experience of new product may be diminished
Business impacts (other than cost/environment)	Expansion of existing reuse businesses and associated reverse logistics

Assumptions – Market Size:

According to the 2020 National Survey and Study of the Lubricating Oil and Antifreeze Packaging Circular Economy, between 50 and 67% of fillers use drums, kegs and totes[16]. While this does not fully illustrate the market size, we can assume it is a common packaging type for commercial and industrial clients

[16] National Survey and Study of the Lubricating Oil and Antifreeze Packaging Circular Economy, DesRosiers Automotive Consultants Inc – interchangerecycling.com

whose demand is too small for bulk. The biggest impact of this scenario would be in the following industry segments:

- Manufacturing;
- Construction;
- Commercial fleet;
- Marine; and
- Mining.

Furthermore, we assume in this scenario an increase in the return rates of used drums and kegs, which will lead to larger volumes of drums and kegs available for reuse and allow for their use by larger market players.

Cost Reduction Assessment:
Table 9 shows the costs reduction assessment for the increase reuse of drums and kegs including the supply chain and cost component impacted, a description of the impact and an assessment of the cost reduction.

Table 9: Scenario 3 - Cost Reduction Assessment

Main supply chain component impacted	Cost component impacted	Impact description	Overall cost reduction assessment
Lubricating oil manufacturer and fillers	Packaging	Refurbished drums are cheaper than new ones	Minor
	Transportation and Logistics	Large packaging size may mean lower per litre costs of filling and transportation Packaging reuse benefits from inventory and reverse logistics tracking systems	Minor
Reconditioners	Collection and processing	Cost and revenue of refurbishing is better than for recycling, requiring lower incentives	Significant

Environmental Opportunity Description

- Reduction in volumes of packaging to be recovered; and
- Reduction in use of virgin materials and environmental impacts of manufacturing.

Relation to Incentives and Fees:

- Cost decrease for top-ups to end consumer, no EHF to be remitted on the container (though still required for the lubricating oil).

Change Management Considerations:

- Most often, reconditioners will directly pick up the drums from users. In some cases, however, they may share a part of the reverse logistics network with recyclers. For example, collectors may collect all lubricating oil packaging at the same time for user convenience and later separate the packaging that is obligated under EPR schemes from packaging that is not, and among the non-obligated drums, those that can be recycled from those that can be reconditioned. This dynamic should be considered in more detail to assess any potential impacts.
- The quality of kegs and drums put on the market needs to be considered in view of their viability for reuse.

5.1.4 Scenario 4: Optimization of Reverse Logistics

Under this scenario, used oil container reverse logistics would be improved, giving consideration to the potential to introduce consolidation sites to carry out initial treatment of collected containers and reduce their volume prior to transportation to the recycler. These consolidation sites may incorporate cutting and bailing of containers or the granulations of containers. Sites may be operated by individual companies or may be for shared use between several companies. Changes that would apply to different impacted segments are summarized in **Table 10.**

Table 10: Scenario 4 - Impacts and Changes

Impacts	Change
Packaging type/volume	All packaging and sectors
Value chain activities	Collectors transport materials to consolidation/volume reduction sites to reduce the amount of trips per volume Additional opportunities are presented by using smart logistics
Customer segment impacted	All sectors
Customer experience	Customer experience should remain the same
Business impacts (other than cost/environment)	Increased volumes during transportation and less overall driving distance for collectors

Assumptions – Market Size:

Interviewees highlighted that in some provinces, the absence of consolidation and volume reduction sites means transporting low density material which is suboptimal. In this scenario, we therefore assume that in strategic locations, investments into volume reduction sites are incentivized either for individual company or shared use.

Cost Reduction Assessment:

Table 11 shows the costs reduction assessment for the optimization of reverse logistics including the supply chain and cost component impacted, a description of the impact and an assessment of the cost reduction.

Table 11: Scenario 4 - Cost Reduction Assessment

Supply chain component impacted	Cost component impacted	Impact description	Overall cost assessment
Packaging Recyclers	Collection and Transportation	Collection represents at least 25% of the costs of the system (still to be validated). Improvements in reverse logistics can significantly reduce the costs associated with shipping items back to the recycler	Significant
	Sorting	Consolidation and volume reduction sites would reduce the amount of contamination transported over large distances	Minor

Environmental opportunity description

- Reduction of trips and associated GHG emissions; and
- Potential increase in material recovery from remote and hard-to-service areas.

Relation to incentives and fees:

- Reduction in incentives required to achieve required recovery rates and levels of service.

Change management considerations:

- Currently, reverse logistics are managed by individual businesses with little (or no) coordination between them. Achieving economies of scale to make this opportunity feasible may benefit from coordination and collaboration between companies.

5.1.5 Scenario 5: PCR Cost Increase Mitigation

Under this scenario, packaging manufacturers would increase the volume of PCR content in new oil containers and, in particular, increase the volume of PCR derived from used oil containers. This would drive the market to close the loop on oil container packaging and ensure viable supply chains are in place as the demand for PCR content increases due to regulatory changes. Changes that would apply to different impacted segments are summarized in **Table 12**.

Table 12: Scenario 5 - Impacts and Changes

Impacts	Change
Packaging type/volume	Primarily HDPE packaging of all volumes
Value chain activities	Packaging manufacturers increase the content of PCR from used oil containers in the production of new oil containers
Customer segment impacted	DIY, DIFM and industrial
Customer experience	Customers may see an increase in product price due to increased costs of producing packaging Customers perception of the sustainability of the industry could increase
Business impacts (other than cost/environment)	Packaging recyclers may see an increase in commodity values for their PCR materials

Assumptions – market impacts:

The option is assessed based on the use of PCR from used oil containers rather than other sources of PCR HDPE such as milk jugs. This scenario was brought forward by interviewees as they expect that upcoming PCR regulations will increase the demand for food grade PCR, increasing its price. It also assumes that there will be an increase in demand for PCR derived from used oil containers as demands for PCR increases for all types of grades HDPE.

Cost reduction assessment:

Table 13 shows the costs reduction assessment for the use of bulk deliveries to the DIFM sector including the supply chain and cost component impacted, a description of the impact and an assessment of the cost reduction.

Table 13: Scenario 5 - Cost Reduction Assessment

Supply chain component impacted	Cost component impacted	Impact description	Overall cost reduction assessment
Packaging Manufacturer	Raw Material Costs	Lubricating oil container-derived PCR is more expensive than the currently used PCR	Cost increase but smaller than expected without access to lubricating oil container-derived PCR
Lubricating oil manufacturers and fillers	Packaging	Increase in costs of packaging with PCR	

Environmental opportunity description

- Reduction in virgin plastic use; and
- Reduction in downcycling of used oil containers.

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Relation to incentives and fees:

- Amount of EHFs remitted remains the same; and
- Decrease in processing incentives may be possible as an increase in PCR demand would lead to an increase in the commodity value of the product of recycling.

Change management considerations:

- Change dependent on regulation being passed to increase demand for PCR; and
- Scale at which fillers would increase PCR content is expected to be less if regulatory requirements are not passed.

5.2 Opportunity Selection

The opportunities explored all have different potential for cost reduction and impacts on the environment. In this section the opportunities are compared to assess which have the most potential for consideration as circular innovations in the petroleum product packaging sector.

5.2.1 Assessment Summary

Table 14 summarizes the analysis of **Section 5.1** and was used to consider which opportunities have the most potential.

Table 14: Summary of Opportunity Analysis

	Option	Cost Reduction Assessment	Environmental Assessment	Other key considerations
1	**No packaging (bulk to DIFM)**	High potential: high market share, significant cost reduction opportunity	High potential	Unclear if the UOMA has a role to play in catalyzing this shift
2	**No packaging (DIY top-ups)/ Small packaging reuse (bottles)**	Medium potential: smaller market share than DIFM, but interesting cost saving potential.	Low potential	Significant change management needed. Opportunity for independent refill solution providers. Benefits from retail partnerships
3	**Increasing packaging reuse (drums and kegs)**	High potential: moderate market share, lower costs, and higher revenue	High potential	Refurbishing is not included in EPR, and large packaging sizes are not part of all UOMA programs

	Option	Cost Reduction Assessment	Environmental Assessment	Other key considerations
4	**Optimization of reverse logistics**	Medium potential: collection costs in some locations can be reduced through an upfront capital investment	Medium potential	Unclear how to realize the full potential of the change in such a way that multiple collectors/processors can benefit
5	**Increasing the production of PCR from lubricating oil packaging for closed-loop use**	Low short-term potential. High opportunity cost.	Medium potential	Topic is already front and center for the National Lubricant Container Recycling Coalition (NLCRC)

5.3 Insights for Incentive Setting

Under mature EPR frameworks, financial tools compensate for the mismatch between what unregulated market dynamics will achieve and the outcomes related to the policy intent such as recovery targets and levels of service. The main tools at the disposal of the UOMAs are the Environmental Handling Fees (EHFs) and incentives for collection and processing. Collection and processing incentives vary between the different UOMA programs but include the following:

- **Return incentives**, which are incentives paid to those that transport lubricating oil packaging from a generator/collection location to a registered processor;
- **Collection incentives**, which are incentives paid to collection sites that allow drop-off of materials from consumers; and
- **Processing incentives**, which are paid to those processing lubricating oil packaging, either through decontamination for reuse or recycling.

5.3.1 Environmental Handling Fees as a Tool

EHFs are levied to ensure that incentive fees can be paid out to service providers whose services enable regulatory obligations to be met. Additionally, under some EPR frameworks, steward fees are intended to influence upstream supply chain behaviour, such as the design, and marketing of lubricating oil manufacturers through eco-modulation (adjusting the fee rates to reflect the net cost impact on the system). Interviews show that the lubricating oil EHFs levied in Canada do not appear to be a significant driving factor for the decision-making of lubricating oil manufacturers. This is driven by several factors including:

- While brand owners are aware of the Canadian fees, their packaging choices are based on consumer needs across the globe and do not consider the specifics of the Canadian market. The Canadian context is important though to the extent that it may serve as a model or precedent for other jurisdictions such as the US;

- EHFs are collected and remitted by retailers and thus brand owners have little involvement in the process; and
- Consumers seem willing to pay the EHFs. Fees do not seem to have an impact on consumer behaviour or demand.

In view of this, the EHFs do not seem a very effective tool for driving supply chain change.

5.3.2 Incentives vs. Business Drivers

The incentives are intended to provide sufficient financial benefits to service providers to operate the reverse logistics network and enable stewards to meet their obligations under the EPR regulations. Incentives are needed for overall business viability for collection and processing. Currently, by setting different incentives per zone, the return incentives recognize that there is more financial impulse needed to get service providers to serve locations at a higher distance from major urban areas and with lower population density.

In a competitive market, the incentives could be set at a precise point where it exactly fills the gap in business drivers to come to a neutral or positive margin. The best indicator of business drivers for collection and processing is the normalized net cost: the difference between revenue and costs per unit collected or processed.

While it is worthwhile to unpack the elements making up this indicator to guide decision-making on setting the incentive, it should be noted that the reverse logistics supply chain is part of a regulated market that is only competitive to a limited degree. Remote locations, low volumes and environmental risks leave only a few players able to deliver the services required.

The main factors influencing the normalized net costs are listed below and demonstrate that these are strongly dependent on the business and supply chain models used by service providers.

Revenue

The main driver for the revenue of processing is a function of the pricing of PCR and the demand for it. While there are some minimum PCR content requirements, the demand for PCR is still mainly influenced by the difference between the PCR and virgin plastics prices. These commodity prices cannot be influenced by supply chain players; however, different supply chain models do result in variations in the impact of these prices on revenue:

- Long-term commercial arrangements dampening the effect of pricing peaks and lows;
- Process designs that result in varying product quality;
- Blending capacity to adapt the grading to changes in market demand;
- Complementary revenue streams, such as:
    - Revenue from other products collected alongside lubricating oil packaging, such as the used oil; and

- Revenue from other products processed alongside lubricating oil packaging, such as detergent packaging.

Costs per Unit

Section 4.0 presented cost elements of the supply chain. To add one more level of granularity, a distinction should be made between variable and fixed costs. As fixed costs are not a function of the amount collected and processed, these costs present the largest opportunity for per unit net cost reduction. That being said, variable costs often occur in step changes (maximizing the tonnage per trip or per shift for example) presenting further opportunities for marginal cost optimization. Finally, inflation and taxation impact all costs.

Insights

From the evaluation of the normalized net cost, the following insights emerge:

- Options to increase scale by expanding the material designation to other automotive fluids coming in HDPE packaging, such as windshield wiper fluids and diesel exhaust fluid are being considered in this context and are being discussed with Provincial governments;
- Multiple financial tools could be leveraged in parallel. For example, grants, loans or tax breaks could be deployed alongside incentives to lower fixed costs, though these require collaboration with various governmental organizations;
- Encouraging the development of a wide variety of revenue streams for processors could help lower the normalized net cost, both from a revenue and from a scale perspective. Processors consider some generators as their clients, developing long-term relationships that may diversify from lubricating oil and revolving around user convenience;
- The lack of competition is a strong barrier to overall cost reduction. However, the current volumes may be too low and market barriers too high to allow for multiple players to serve certain regions; and
- Data available from the UOMA, interviewees, or desktop research does not currently allow for modelling the normalized net cost per supply chain element. The UOMAs could, however, consider collecting data through their incentive claims process to obtain more clarity on opportunities, such as requesting claims to include details on source (type and location) alongside volume per trip, and categories of processed materials.

6.0 Conclusions

The study provided valuable insights into the lubricating oil supply chains, current trends and main cost drivers. The highly international, competitive and dynamic forward supply chain contrasts with a reverse supply chain with fewer players and limited competition.

From the research, interview and analysis process, five options emerged as being the most likely to present an opportunity for increased circularity and cost savings:

- Opportunity #1: No packaging: increasing bulk deliveries to DIFM installers;
- Opportunity #2: No packaging and refill: bulk to DIY;
- Opportunity #3: Large packaging reuse (drums and kegs): reconditioning;
- Opportunity #4: Optimization of reverse logistics;
- Opportunity #5: Post-consumer recycled materials (PCR) cost increase mitigation.

Of those, the two options that are already widely present in the supply chain, Opportunity #1, bulk delivery to DIFM installers and Opportunity #3, large packaging reuse, emerged as the most promising pathways. These two specific pathways are already being championed by various supply chain players; however, they may benefit from continuing to be highlighted in discussions around circularity for lubricating oil packaging.

One of the five options, Opportunity #5, is strongly related to regulatory intervention. The PCR cost increase scenario is anticipating the impacts of regulatory changes, of which the likelihood is high but the timing and specific supply chain impacts are uncertain. This topic is being closely followed by the NLCRC.

Learnings from the analogous case of windshield washer fluids raised a lot of questions on the feasibility of Opportunity #2, refill solutions for lubricating oil, for which volumes are lower, supply chains are simpler and more centralized, product diversity is low, and customer traffic is concentrated.

Drum and keg reconditioning is a mature business activity with established players. A more in-depth assessment of the current flows, as well as market constraints and opportunities, is recommended to better estimate the potential impact in terms of volumes and cost savings. Part of that will require an increased understanding of the interaction with the recycling supply chain and the role of independent distributors who were not available for interviews.

Interviews highlighted that there are opportunities for increased efficiencies in the reverse logistics supply chain. These could be considered to be focused on the status quo; however, it could be worthwhile to explore the feasibility of, for example, transfer stations/reduction sites that would span more materials, therefore improving the economics of such infrastructure investments and reducing the lack of efficiency of transporting empty lubricating oil containers over large distances.

Finally, the study identified three potential actions for the UOMA to consider in the shorter term. First, the lack of data on the reverse logistics supply chain is one that could be addressed through the incentive claims process, in alignment with best practices under other programs. This would lead to additional insights to identify specific opportunities for increased efficiency or cost reduction. Furthermore, the UOMA could explore the potential role of reconditioning under the used oil programs. Including them has the potential to improve the economics of the overall reverse logistics system. Finally, UOMA could advocate for other policy levers to be used to support a circular economy for lubricating oil packaging, including grants, loans or tax breaks.

Appendix A

Interview Questions

Key packaging types and customer segments

1. Could you please describe the different client segments for lubricating oil, as well as the different products and packaging types?

General attitude towards circular packaging/supply chain solutions

2. Is your company interested in increasing the circularity of lubricating oil packaging and its supply chain?
    a. If yes, in what context? (e.g. ESG, costs, supply chain reliability, compliance, etc.)
    b. If yes, are you targeting particular customer segments or packaging types? Why?

3. What improvements to increase packaging circularity is your company most interested in, or are you exploring/deploying? What is the impact your company is expecting from those improvements? What challenges are you facing?
4. In exploring or deploying those options, what part of your supply chain or of the product lifecycle do you consider? Do you consider all lifecycle components of your lubricating oil packaging, including stages from resin or packaging production to packaging end-of-life management?

Understanding filler packaging decision-making processes and cost drivers

5. What factors does your organizations take into account when designing or procuring packaging, or deciding on packaging innovations? (e.g. cost, technical performance, safety, aesthetics, consumer experience, supply reliability, environmental performance etc.)

6. Assuming costs represent an important factor for decision-making:
    a. What costs do you currently take into account in design or procurement choices? (e.g. packaging procurement, distribution, retail, also end-of-life management?)
        i. Are you able to share with us any prices or price ranges that you are currently seeing in the supply chain?
    b. Are there identifiable challenges or bottlenecks within the current lubricating oil packaging supply chain that significantly impact the costs directly or indirectly related to lubricating oil packaging?
    c. Can you pinpoint specific areas in the packaging supply chain and life cycle where you perceive opportunities for significant cost savings? (e.g. efficiency, cost-effectiveness improvements)
        i. If yes, what opportunities and where in the supply chain?

ii. Would you expect these cost savings to potentially be transferred through the supply chain and present a cost advantage to you?
iii. Are you aware of steward fees your organization is paying in Canada? If yes, is fee reduction a topic of interest?
iv. What incentives do you believe would be most effective in encouraging cost-saving practices within the lubricating oil packaging supply chain?
v. In terms of supply chain or packaging innovations, how receptive is your organization to exploring new approaches that could lead to cost savings?

Circular Plastic Design/Cost

7. [If not already organically discussed in question 4] How does your organization currently approach circular solutions in the context of packaging design and procurement?

8. [If answer to question 1 is yes – otherwise skip] To what extent are cost considerations influencing your efforts to increase the circularity of lubricating oil packaging and its supply chain?

9. What changes/incentives/actions would support the adoption of circular packaging and supply chain solutions?

Closing

8. Have we covered all the necessary aspects, or are there specific areas you feel we should delve deeper into during our discussions?

Appendix B

Case Study: Windshield Washer Refill Systems

Case Study: Windshield Washer Refill Systems

This case study is presented to highlight considerations for how a refill system could work in the automotive space. This case study was developed based on discussions with EcoTank, a Canadian company that is providing refill solutions for windshield washer fluid and Canadian Tire Corporation (CTC), one of the companies that has implemented the EcoTank windshield washer refills systems at their Canadian Tire Gas+ locations.

Overview of Windshield Washer Systems

The windshield washer fluid system explored through this case study uses dispensing machines at gas stations that consumers can access to refill their windshield washer fluid. **Figure A 1** shows one of the EcoTank dispensers installed at a Canadian Tire Gas+ gas bar. The dispensers are dual sided and have two hoses attached that are inserted by consumers directly into the windshield washer fluid tank in the vehicle to refill or top up the product. Consumers are then charged for the volume of windshield washer fluid dispensed.

Figure A 1: An EcoTank windshield washer fluid dispenser installed at a Canadian Tire Gas+ gas bar.

The dispensers require electrical connections and therefore an electrician for installation. The dispensers are installed through mounting them to concrete pads and in some locations the concrete pad onto which the dispensers are installed may need to be constructed or expanded.

CTC has played an important role in scaling up the implementation of the EcoTanks. They were an early champion of use of windshield washer refill systems which have now been adopted by gas station companies across Canada. Key considerations for CTC were the operationalization of the EcoTanks, including which at which gas bar they should be located and how many dispensers to locate at each gas bar that will see sufficient traffic to provide a return on investment. CTC has been able to secure funding for the expansion of the program through internal resources as well as through the Canadian Plastic Pact funding for Accelerator Projects to scale reuse/refill solutions in Ontario to tackle single-use plastic waste[17].

[17] Canada Plastic Pact, CPP Announces Accelerators to Scale Reuse and Refill Solutions in Ontario, April 23, 2024: https://plasticspact.ca/canada-plastics-pact-announces-accelerators-to-scale-reuse-and-refill-solutions-in-ontario/

There are several benefits to the refills systems, including that:

6. They are convenient for consumers;
7. They are convenient for companies that implement them; and
8. They have positive environmental impacts.

The convenience for consumers is driven by the ease of using the EcoTank systems and the ability to refill their windshield washer fluid at gas stations at the same time as refueling their vehicles. Consumers can choose to top up their vehicle directly or refill an existing container, although it is expected that most consumers would top-up their vehicle directly, with the exception of transport vehicles which are required to have a spare container of windshield washer fluid with them at all times. The system can also reduce spills when compared to a windshield washer fluid container as the hose can be inserted directly into the tank.

The convenience for companies is driven by several factors, first, EcoTank is responsible for the refill system and manages the monitoring the supply of windshield washer fluid, and refilling the tanks as needed. EcoTank also handles the payments for the windshield washer fluid, and they use a revenue sharing model with the companies that have installed their tanks. Convenience for companies also comes through having to manage less waste due to reduction in windshield washer fluid containers used by the customers, decreased theft of windshield washer fluid, reduced labour to stock windshield washer fluid, and reduced effort associated with remitting EHFs. Companies can also benefit through the promotion of the positive environmental impact of the refill systems.

Environmental benefits of the EcoTanks are driven by the reduction in single-use plastics, as consumers can top up their vehicle directly without the need for a container.

Key Considerations for Lubricating Oil Refill Systems

The potential for the implementation of refill systems differs between windshield washer fluid and lubricating oils in several ways, including the following:

- Windshield washer fluid is a product that is used up and then needs to be refilled or topped up, whereas lubricating oil needs to be changed in a vehicle (drained and then refilled). Although there is some market for top-ups to lubricating oil, this is limited to about 10% of the use of oil in the DIY space;
- There is little variation between different windshield washer fluid products, whereas there are many different types of lubricating oil, and consumers may have a preference for a specific brand, or their vehicle may have specific requirements for a type of lubricating oil. This limits the viability of a refill station as it would have to accommodate numerous product types;
- Although classed as a hazardous product, windshield washer fluid ends up in the environment during its use and poses fewer risks than lubricating oil if spilled. Lubricating oil is difficult to clean and can pose risks for slips and falls when spilt making it less appealing as a product for refill. Spill also negatively impact the customer experience for all user of a retail space, further limiting their appeal

for implementation in retail locations that cater to a large variety of consumers such as Canadian Tire stores. Given this risk, if implemented there will be a need to monitor the types of containers that customers are refilling, and there may be a need to develop a specific container for use at refill stations;

- With the adoption of more EVs and the trend towards more consumers using DIFM services for oil changes, the market for lubricating oil refills may be limited in the future which reduces the incentives for companies to invest in this space;
- Demographics influences the uptake of consumers using the refill stations. Windshield washer fluid is refilled by a broad range of customers, but consideration would have to be given to whether the DIY customer segment is interested in the environmental benefits of refill systems for lubricating oil; and
- Location of the refill stations is also an important consideration, and they should be placed in retail locations that serve DIY consumers. For example, CTC suggested that their PartSource stores would be better suited for lubricating refill options than their Canadian Tire retail stores as PartSource stores typically serve DIY customers.