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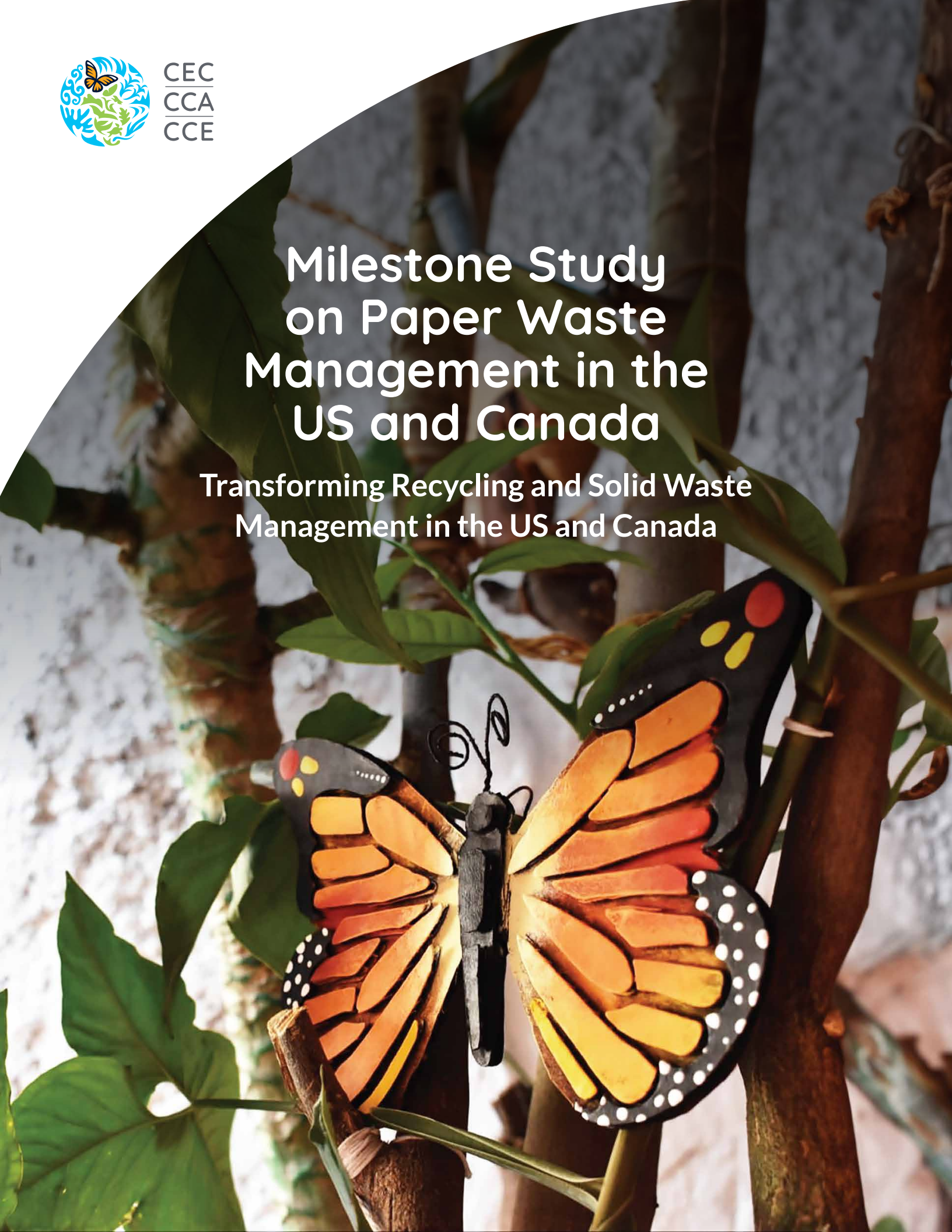
Milestone Study on Paper Waste Management in the US and Canada

Transforming Recycling and Solid Waste Management in the US and Canada



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For more information:
Commission for Environmental Cooperation
1001 Robert-Bourassa Boulevard, Suite 1620
Montreal (Quebec)
H3B 4L4 Canada
t 514.350.4300 f 514.350.4314
info@cec.org/www.cec.org

COMMISSION FOR ENVIRONMENTAL COOPERATION

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Glossary and List of Acronyms

ABCRC	Alberta Beverage Container Recycling Corporation (Canada)
AF&PA	American Forest & Paper Association
B2B	Business-to-business
BCMB	Beverage Container Management Board (Alberta)
BDL	Brewers Distributors Limited (British Columbia)
C&D	Construction & Demolition
CCME	Canadian Council of Ministers of the Environment
CEC	Commission for Environmental Cooperation
CEPA	Canadian Environmental Protection Act
CH_4	Methane
CO_2	Carbon dioxide
Containerboard	Type of paperboard used to make corrugated cardboard.
Corrugated container	Shipping containers made with kraft paper linerboard and corrugated medium.
DAO	Delegated Administrative Organization
Deinking	Ink is detached from the fiber surface through fiber-to-fiber rubbing and the use of detergents.
DEP	Department of Environmental Protection (US)
DRS	Deposit return system
DSNY	Department of Sanitation (New York)
EB	Electron beam
EPA	United States Environmental Protection Agency
EPR	Extended producer responsibility
HH	Household
HS	Harmonized system, a multipurpose international product nomenclature developed by the World Customs Organization that facilitates the identification of specific commodities.
ICI	Industrial, commercial, and institutional
Insulation cellulose	Production of paper wadding for the thermal and acoustic insulation of ceilings.
ISRI	Institute of Scrap Recycling Industries (US)
Kraft paper	Paper made from the sulfate (pulping process) pulp.
LDPE	Low density polyethylene, commonly used for carrier bags, bin liners and packaging films.
Lignin	Organic polymer found in the cell walls of wood. It is generally removed from wood pulp in the manufacture of paper, or it can give paper a brownish colour if not removed from cellulose.

Loss rate	The proportion of collected paper material that is lost during the sorting and/or pulping process and so is not recycled but is instead ultimately disposed of.
MP	Mixed paper (also termed mixed fiber), a mixture of various qualities of paper not limited to the type of fiber content, normally generated from residential, multi-material collection programs. "Mixed Paper" generally refers to lower quality fiber bales that have undergone relatively lower levels of sorting and typically contain high levels of contaminants, such as plastics.
Molded pulp	Packaging material made of paper and water. The products are molded for tray-type packaging, protection, or single-use products.
MRF	Materials recovery facility. This is a specialized facility that receives, separates and prepares recyclable materials for marketing to end-user manufacturers.
MSW	Municipal solid waste
MPIC	Municipal-Industry Project Committee (Ontario)
OCC	Old corrugated cardboard, used (post-consumer) shipping containers made with kraft paper linerboard and corrugated medium.
ONP	Old newsprint.
Paperboard	A thicker paper material used for the production of packaging containers such as folding cartons, paper cups, and coated boards.
P&E	Promotion and Education
PAYT	Pay-as-you-throw, systems in which households are charged variable rates based on the volume of waste set out for collection.
PCR	Post-consumer recycled
PET	Polyethylene terephthalate, a type of resin and a form of polyester. PET has some important characteristics such its strength, thermo-stability, gas barrier properties and transparency. It is also lightweight, shatter-resistant and recyclable.
POM	Placed on the market
PPP	Packaging and paper products
PPPC	Pulp and Paper Products Council (Canada)
PRO	Producer responsibility organization
Pulping	The process of separating cellulose fibers from wood, fiber crops, waste paper, or rags to create paper. This process involves removing compounds such as lignin or contaminants.
Pulp substitutes	Shaving or clippings from high-grade papers that come from converting operations at paper mills and print shops.
RCRA	Resource Conservation and Recovery Act (US)
RIC	Resin identification code
Single-stream recycling	Recyclables are collected in a single container (no source separation is required) such that paper is collected mixed with glass, metals, and multiple grades of plastic.
SOP	Sorted office paper, typically generated by offices, containing primarily white and colored groundwood-free paper, free of unbleached fiber. May include a small percentage of groundwood computer printout and facsimile paper.

SRPN	Sorted residential papers and news – sorted newsprint, mail, magazines, printing and writing papers, and other acceptable papers generated from residential programs (such as residential household and apartment collections and drop-off centers) sorted and processed at a recycling facility. Containerboard and brown grades (OCC, kraft bags, boxboard and kraft carrier board) will be considered as "outthrows".
UOP	Unsorted office paper – printed or unprinted paper typically generated in an office environment that may include a document destruction process. This grade may contain white, colored, coated and uncoated papers, manila, and pastel colored file folders.
UV	Ultraviolet
WCO	World Customs Organization

Abstract

This document is one of a set of three milestone studies prepared by Eunomia Research & Consulting on behalf of the Commission for Environmental Cooperation (CEC). These studies cover the markets and policy landscapes for post-consumer paper, plastic, and bioplastic waste from both residential and commercial sources in North America. Their purpose is to assess the current state of recycling in the paper, plastic, and bioplastic material markets as a contributor to a circular economy, identifying barriers to recycling and making recommendations for how to overcome these barriers and thereby increase circularity. This study focuses on Canada and the United States, and covers paper, specifically covering all discarded paper, prior to any decision on whether it is suitable for recycling. A similar study focused on Mexico will be available in the upcoming months.

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1 Introduction

1.1 Background to Study

The World Bank estimates that around 2 billion tonnes of municipal solid waste were generated globally in 2016, with Canada, Mexico and the United States generating 0.4–1.5 kg more waste per capita per day than the global average (Kaza, Yao, Bhada-Tata, & Van Woerden, 2018). North America has the highest per capita plastic and paper consumption in the world. The region represents 21% of total plastics consumption (Heller, Mazor, & Keoleian, 2020) and four times the global average in per capita paper consumption (Haggith et al., 2018).

According to the World Bank, while waste is generally managed in an environmentally sound manner in North America, globally the mismanagement of waste is polluting the oceans, clogging sewers, and causing flooding, transmitting diseases, and increasing respiratory problems, and, according to 2016 data, generating 1.6 billion tonnes of carbon dioxide.

Reducing waste and closing material loops will help minimize the environmental impacts along the value chain of resources and products, as well as presenting considerable economic opportunities. Circular economy strategies, including various recovery options, are estimated to unlock US$4.5 trillion of economic growth around the globe (Accenture, 2015). The World Business Council for Sustainable Development estimates that the global bioeconomy market could be worth up to US$7.7 trillion by 2030, with significant opportunities for circular solutions.

The transition to a circular economy and increased material recovery also offers solutions to mitigate climate change. The magnitude of avoided GHG-emissions benefits from material circularity is highly dependent on the type of material and the local circumstances for energy offsets. For example, the US Environmental Protection Agency (EPA) estimates that recycling of various paper products could result in 2.64-3.59 Mt CO_2e reduction per short ton of paper (ICF International, 2016), and a study of the Canadian plastic sector estimates that diverting 90% of the plastic waste now going to landfills could result in 1.8 Mt of CO_2e reduction by 2030 (Deloitte and Cheminfo Services Inc., 2019).

The Commission for Environmental Cooperation (CEC) was established in 1994 by the governments of Canada, the United Mexican States (Mexico), and the United States of America (United States) through the North American Agreement on Environmental Cooperation, a side agreement concluded in connection with the North American Free Trade Agreement (NAFTA). As of 2020, the CEC operates in accordance with the Environmental Cooperation Agreement, which entered into force at the same time as the new trade agreement known as CUSMA, T-MEC and USMCA in each of these three countries, respectively. The CEC brings together a wide range of stakeholders, including the general public, indigenous people, youth, nongovernmental organizations, academia, and the business sector, to seek solutions to protect North America's shared environment while supporting sustainable development for the benefit of present and future generations.

The CEC has commissioned this study as part of its Operational Plan 2021 Project "Transforming Recycling and Solid Waste Management in North America,"[1] with the goal of promoting circular economy and sustainable materials management approaches and bring economic and environmental benefits to the region. This project supports Canada, Mexico and the United States in their efforts to promote circular economy and sustainable materials management approaches to encourage eco-design and thus increase product and material reuse, recovery and recycling rates.

This publication represents one of a series of three milestone studies aiming to better understand the opportunities for the recycling sector and secondary material markets for paper, plastics, and bioplastics waste. The content focuses on the US and Canada, and a separate set of these studies focused on Mexico will be available in the upcoming months. Building on the results of these milestone studies and stakeholder input, the project will carry out pilot testing projects in a second phase to assess the feasibility of innovative technologies, policies, or practices for adoption at scale across North America.

1.2 Study Overview

This milestone study covers post-consumer paper waste from both residential and commercial sources, while the two other studies focus on plastic and bioplastic waste respectively. The present study specifically covers all discarded paper, prior to any decision on whether it is suitable for recycling, and provides, in terms as comprehensive as the available data allows, a picture of the state of paper circularity in North America and the barriers to further circularity.

The information this study presents is designed to support stakeholder collaboration and knowledge-sharing and provide policy makers with recommendations for improving paper circularity in the US and Canada. Information was gathered through secondary research analyzing existing relevant publications and databases, and primary research through consultation with key stakeholders in paper waste management in each country. This study considers the information and data available by December 2023.

This study encompasses:

- An overview of the value chain for paper and paper products and key actors within it;
- An overview of the paper waste market, including collection, sorting, and recycling infrastructure and capacity, and trade;
- Secondary markets for paper waste;
- Current and proposed policy and regulation related to paper waste;
- Best practice, emerging technologies, and policy options; and
- Recommendations to improve the circularity of paper in the US and Canada.

Where available, relevant market data and policy information is provided for individual federal states in the US and provinces/territories in Canada. There are 50 federal states in the US, while Canada is composed of 10 provinces and three territories.

[1] CEC Operational Plan 2021 Project "Recycling and Solid Waste Management in North America".

2 Value Chain Overview

This section provides an overview of the paper value chain in the US and Canada. Value chains refer to the full lifecycles of products, from material sourcing to treatment at end-of-life. In a circular economy, value chains create a loop in which waste products are recycled into materials that are used to manufacture new products, which in turn can be recycled. Materials are kept in circulation for as long as possible, and products and waste management systems are designed to facilitate this. Therefore, it is important to analyze the current paper value chain to understand every stage of paper's journey, identify potential areas for improvement, and develop strategies that will promote a more circular economy. When paper is disposed of in landfills or incinerated instead of being recycled, it generates biogenic carbon emissions. Enhancing the circularity of paper through recycling can mitigate these emissions. However, the scope of this study does not include calculating biogenic emissions.

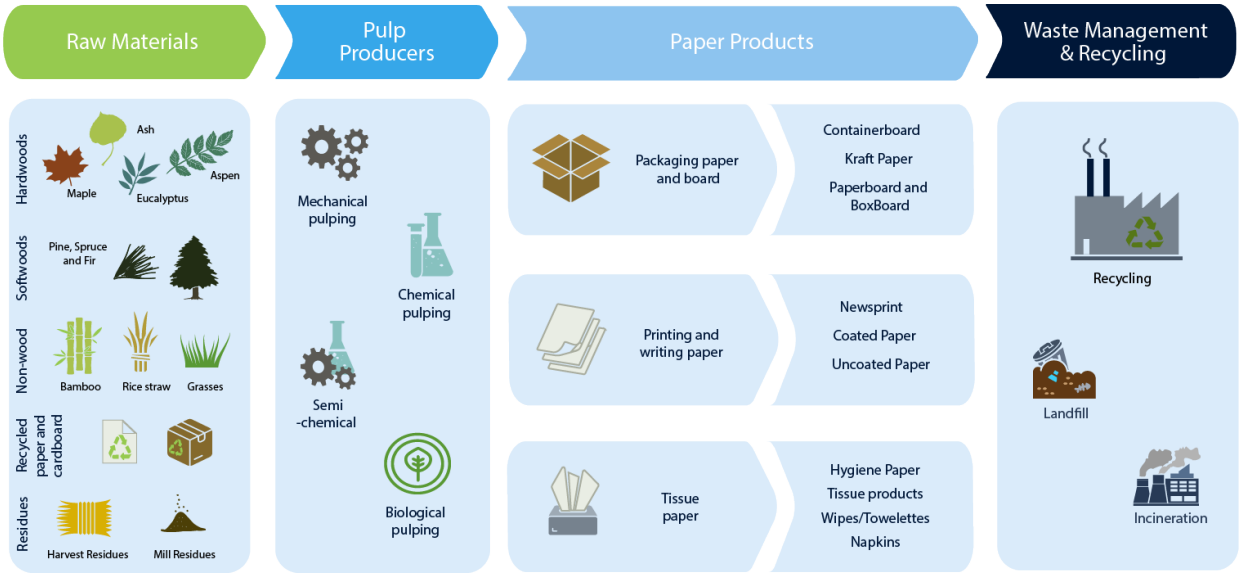
Figure 1 below illustrates the paper value chain. Virgin and secondary materials are pulped, using various pulping technologies, at a mill to a specific recipe that relates to the product being made at the mill. The pulp is used to create paper products, which are then used in a range of consumer products. During the manufacturing of consumer products, paper may be mixed with other materials, such as metals and laminants, to give them specific properties such as oxygen and moisture resistance or additional strength.

Once used, the consumer products are either collected for recycling or disposal or they are littered. For large generators, paper can be taken directly to the mill; an example would be cardboard from a major retailer. Alternatively, it can be collected through multi-material, dual-stream, or single-stream collection systems. Paper collected through dual-stream or single-stream systems must be sorted to specific bale specifications before being sold. This sorting is done at material recovery facilities (MRFs). No universal paper grade system exists (PaperIndex Academy, 2023), although the Institute of Scrap Recycling Industries (ISRI) provides waste paper grade guidelines that are followed in the US and Canada (ISRI, 2022).

As paper products pass through the stages of circularity—from manufacture to consumption, collection, sorting, and recycling—some of the fibers break down and they become shorter and weaker. The extent to which this happens can depend on exposure to moisture and organic material, resulting in decomposition. The recycling process itself can also reduce fiber length and strength. After multiple recycling cycles, shorter fibers result in lower quality products, and eventually fibers become so short they can no longer be used for paper production. This means that the same paper material can go through a limited number of recycling cycles. Once fiber can no longer be recycled, it is landfilled. While paper cannot be infinitely recycled, maximizing the amount that is recycled reduces the extraction of wood and non-wood feedstocks.

The diagram below provides an overview of the paper value chain, including raw materials, pulping processes, main paper and board types, application to manufactured goods, and waste management.

Figure 1. Overview of the paper value chain



2.1 Value Chain Summary

The paper value chain involves multiple actors, from those supplying raw materials and making primary paper products, through collecting and sorting those products at end-of-life, to recycling waste paper into new, secondary paper products.

Paper is more difficult to track through the value chain compared with other materials such as plastics. For example, PET plastic (polyethylene terephthalate) can be easily traced from its point of production, throughout the recycling system, and eventually into a new PET product. However, with paper products, the path is not as straightforward.

For example, if printed paper is collected for recycling and sorted into a mixed paper bale, it will be used as a secondary feedstock in paperboard and containerboard, while a cardboard box may be sorted and baled either into old, corrugated cardboard (OCC) to make new corrugated cardboard or with mixed paper as a feedstock for molded pulp production.

Paper mills typically blend different types of secondary feedstock in various 'recipes' to create particular recycled products. In addition, the specifications of the grades into which paper is sorted are left to the discretion of individual sorting facilities.

2.1.1 Paper components and production

Paper is produced by separating cellulose fibers from forestry products or other organic sources and chemically or mechanically treating these fibers to create a pulp, which is then made into paper products in a paper mill. This study covers all paper and cardboard, as well as the products made from these materials; it uses 'paper' as a catch-all term for paper products, including cardboard. Where information relates specifically to a paper material type, this is highlighted.

Based on the end use and application of paper products, for the purposes of this study we have divided paper into the following main categories:

- Newsprint
- Cardboard
- Mixed fibers

Newsprint production has been declining steadily since the 1990s, with a corresponding decline in demand for recycled newsprint. For this reason, newsprint is no longer recycled back into newsprint but is sorted into the category Sorted Residential Papers & News (SRPN) as feedstock for molded pulp and insulation production.

The term 'cardboard' is sometimes used interchangeably with 'paperboard', which comprises a single, thick layer of paper material. 'Cardboard' is also used as shorthand for 'corrugated cardboard' that comprises three layers of thick paper, two flat layers with a waved layer in the middle, a structure that gives it strength.

Barrier layers can be added to paper products to provide moisture and oxygen resistance. This helps protect the contents of packaging and, in the case of food and beverage packaging, extend its shelf life. Multi-material and laminated paper packaging products include:

- Aseptic and gable top food and beverage cartons, used primarily for liquids (juice, milk, soup) and made up of layers of paper, plastic, and aluminum foil.
- Coffee cups with a paper outer layer and a plastic lining.
- Snack food packaged in laminated bags with layers of paper, plastic, and/or aluminum foil.
- Takeaway containers with a plastic lining.
- Pet food bags comprising paper layers, plastic layers, and a metalized layer to keep food fresh.
- Laminated/multi-material containers and packaging.

Multi-material and laminated paper packaging products are more difficult to recycle than single-material paper packaging. For more information on the recyclability of paper products and multi-material packaging, please refer to subsection 6.1 on product design.

2.1.2 Paper categories and grades

Table 1 summarizes the value chain of the main paper categories, the grades into which they are sorted, and the most common recycling end markets.

Table 1. Value chain summary for common paper categories

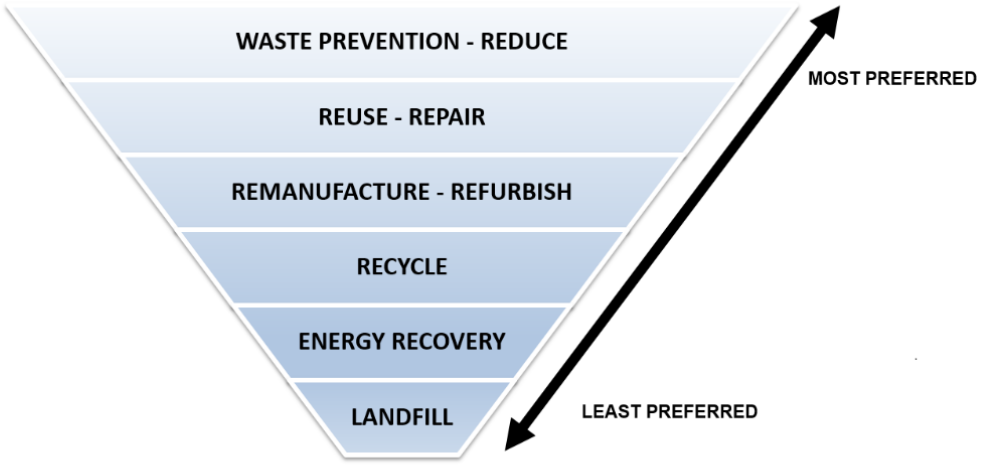
ISRI GRADE →	Recycled Content Use
(11) Old corrugated cardboard (OCC)	Containerboard
(12) Double sorted Old corrugated cardboard (DS OCC)	Containerboard

ISRI GRADE →	Recycled Content Use
(54) Mixed Paper	As a secondary feedstock to the production of: Boxboard, e.g., used for pizza boxes Paperboard, e.g., used for Pringles chip containers Paper trays Folding cartons Note: this information comes from a packaging producer that uses grade 54 at only one of its plants in Canada, representing 17% of the total recycled paper consumed annually. The rest is OCC 11, OCC 12, DLK, hardpack. Other mills have claimed that only a few mills can accommodate a small volume of MP 54 in the production of containerboard.
(56) Sorted Residential Papers and News	Molded pulp and cellulosic insulation As a secondary feedstock in the production of items similar to those listed for (54) Mixed Paper
Hardpack (no existing grade code)	Items similar to those listed for (54) Mixed Paper
(52) Aseptic Packaging and gable top containers	Tissues, Towels Printing paper Construction materials
(36) Unsorted office paper	Tissues, Towels Printing paper
(37) Sorted office Paper	Tissues, Towels Printing paper
(58) Sorted Clean News	Molded pulp and cellulosic insulation

2.1.3 End-of-life management

The waste hierarchy (Figure 2) outlines an order of preference for end-of-life management options in terms of their environmental impacts. Options that are best for the environment are at the top of the hierarchy, with less preferable options lower down, although the order can shift depending on specific circumstances. Recycling and composting are generally depicted on the same level, but for paper, recycling is considered more desirable than composting. In a circular economy, the objective is to establish closed-loop systems, reusing and recycling materials. Recycling paper aligns with this model, converting paper waste into new products, reducing the reliance on virgin materials, and minimizing waste generation. In all circumstances, preventing waste in the first place is the preferred option. Incineration without energy recovery and landfill are typically the least desirable options and are not considered consistent with a circular economy. The role of incineration with energy recovery (waste-to-energy) in the circular economy is debated, but it is preferred to landfill in the waste hierarchy.

Figure 2. The waste hierarchy



Source: (Government of Canada, n.d.)

Once sorted, waste paper collected for recycling is delivered to paper mills in bales. The process used to clean and pulp it varies for different paper grades and also depends on contaminant levels. Generally, sorted paper is shredded and cleaned. Some recycled paper may also need to be deinked or filtered several times to remove impurities, coatings, and inks (Doshi & Dyer, 2001). Various types of inks are used for printing on paper products, depending on the type of product and its requirements, and different deinking processes are needed to remove them. If a recycling process encounters a type of ink it is not designed to handle, the ink will contaminate the paper being recycled, i.e., a problem for circularity.

Paper and paper products not collected for recycling are sent to landfill or incineration along with garbage. Fiber that can no longer be recycled is also currently landfilled or incinerated.

A study to evaluate different low-grade[2] paper processing options conducted for Environment and Climate Change Canada (ECCC) found that, when comparing the greenhouse gas emissions associated with composting or anaerobically digesting paper versus landfilling in Canada, composting results in a greater net reduction of greenhouse gas emissions (ECCC, 2023). However, because composting and anaerobic digestion are not currently common end-of-life management methods for paper, these are not within the scope of this report.

2.2 Value Chain Actors

Table 2 lists the key actors in the paper value chain, the stage in the value chain at which they operate, and the roles they perform.

[2] Low-grade paper that could potentially be composted or anaerobically digested was defined as MRF fiber line residue; short fiber paper (fines) generated by paper and paperboard mills that cannot be recycled; non-recyclable used paper items (e.g., paper towels, napkins, facial tissue and soiled food packaging); recyclable paper that cannot be marketed due to the long distance to markets.

Table 2. Key actors in the paper value chain

Stage	Actor	Role
Raw material suppliers	Logging companies, paper mills	• Extracting and supplying raw materials (wood fibers, non-wood fibers)
Pulp and paper production	Integrated mills	• Producing pulp or paper
	Non-integrated mills	• Producing pulp or paper
	Secondary fiber mills	• Producing paper from recovered paper waste
Paper product manufacturing	Converters	• Manufacturing paper products
Waste generation	Consumers	• Segregation at source and disposing of paper waste
	Industrial, commercial, and institutional (ICI) sector	• Segregation at source and disposing of paper waste
	Government	• Policies, incentives, and taxes affecting waste generation and diversion • Mobilization, information dissemination, and general awareness of waste management and recycling
Collection and handling	Waste management company	• Private sector collection and handling of paper waste • Disseminating information on and raising awareness of waste and recycling
	Producer Responsibility Organisations (PROs)	• Assume the responsibilities of obligated producers regarding the financial and operational management of the collection and recycling of products via extended producer responsibility (EPR) programs, to ensure producers comply with legislative requirements
	Municipalities and regional government	• Providing collection services and managing waste in localities • Contracting private haulers • Managing logistics and coordinating recycling activities between the haulers, sorters, and recyclers • Administering hauling levies • Constructing, rehabilitating, acquiring, expanding, and managing waste management infrastructure • Providing training and building capacity through workshops, etc. • In some cases the owner of regional MRFs and/or disposal facilities
	Informal collectors	• Waste picking on streets • Purchasing scrapped products • Selling to recyclers

Stage	Actor	Role
		• Source segregation of waste • More common in US states or Canadian provinces with deposit return systems (DRS) involving a deposit for bottles
Sorting	Material Recovery Facility (MRF)	• A solid-waste management plant that processes recyclable material, separating it into single streams so that it can be recycled
	Waste collector/sorter	• Sorting collected paper waste •
Recycling	Paper recycler	• A paper mill that pulps sorted paper waste to create recycled paper products
Secondary market	Broker	• Providing quality recyled material in the market • Sourcing buyers or manufacturers of recycled paper products
	Buyer	• Purchasing recycled material • Identifying sellers of recyclables • Confirming quality of recyclables

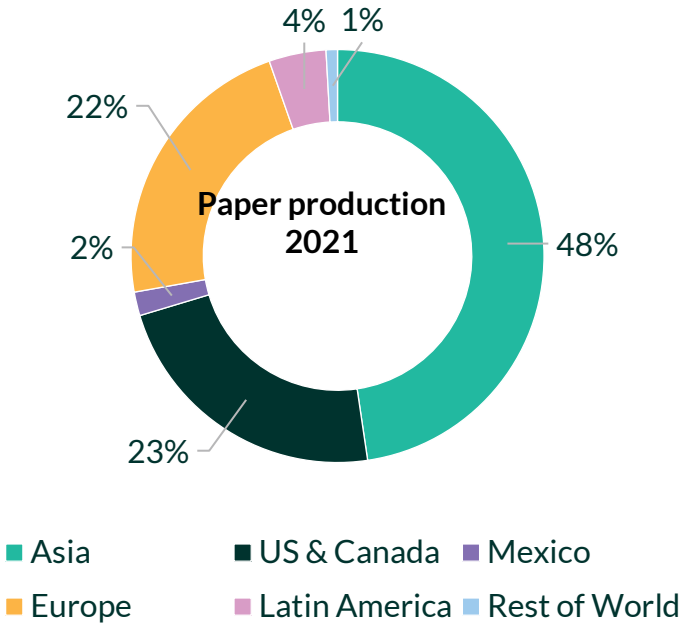
3 Market Overview

3.1 Material Flows

In the recycling and waste management of post-consumer paper in the US and Canada, materials flow through several phases: production, placed on the market (POM), consumption and waste generation, collection, sorting and baling, feedstock production and remanufacturing, disposal of waste paper, and trade of waste paper and finished goods. Each phase is described below.

- **Production –** The total tonnage of finished paper products produced in a country. The feedstock can be virgin or derived from recycled products. Figure 3 shows that the US and Canada were responsible for 23% of global paper production in 2021, producing approximately 77 million tonnes.

Figure 3. Global production of paper products (2021)



Source: Food and Agriculture Organization of the United Nations, 2021.

- **Placed on the market (POM**) – The total tonnage of paper products placed on the domestic market for consumption. This is the sum of domestic production and the net trade balance of finished paper products.
- **Waste generation** – Following the use of finished goods, paper waste is generated by various sectors, including single-family (SF) and multi-family (MF) residential (SF/MF), industrial, commercial and institutional (ICI), and construction and demolition (C&D). We have assumed that the waste generated is equal to the tonnage POM in the same year; this is because most paper products have a short use phase, while for those with longer lifetimes (e.g., books and magazines) the amount of material POM and collected as waste is likely to be relatively level from year to year.

- **Collection** – Recycling systems operated by government entities and private haulers commonly target waste paper for recycling. They gather it through various collection systems, including curbside collection (single, dual, and multi-stream) and drop-off centers.
- **Sorting and baling** – Once collected, waste paper can be immediately baled or transported to a processing facility, such as a Material Recovery Facility (MRF) or a paper processor. Here it is sorted, cleaned of physical contaminants, reduced in size, and baled so it can be transported to a mill.
- **Feedstock production and (re)manufacturing** – At a paper mill, sorted paper is pulped to produce the feedstock required to (re)manufacture paper products. Mechanical pulping is used to manufacture newsprint, printing papers, and specialty paper, while chemical pulping is used to make printing papers, sanitary and household papers, specialty paper, corrugated board base, boxboard, wrapping and packaging papers, and other paperboard products (Hong et al., 2011). The production of recycled paper also depends on the specific waste paper grade, as not all grades can be returned to all paper product types. Certain products, such as specialty papers, can only contain a small proportion of recycled paper, primarily high-grade sorted office paper, to limit discoloration and maintain demand for that product.
- **Disposal** – Waste paper lost from the recycling value chain is disposed of via incineration or landfill. Losses can occur where waste paper is not collected for recycling, or where it is collected but then removed from the value chain at the sorting stage.
- **Trade of waste paper** – Following the sorting and baling stage, a proportion of the sorted and baled waste paper is traded internationally due to its economic value. This trade can be traced using harmonized system (HS) codes, a multipurpose international product nomenclature developed by the World Customs Organization (WCO) that allows the identification of specific commodities.

The Sankey diagrams below (Figure 4 and Figure 8) illustrate material waste flows modelled for the US and Canada based on primary and secondary research conducted for this study. The waste flows begin when paper waste is generated and then move through the following nodes:

- collection;
- sorting;
- processing;
- recycled or disposal.

The diagrams include the flow of waste paper as trade, entering and leaving each country. We have assumed that paper being imported would likely go to a processer due to the cost of transporting it across borders, so in the diagrams these nodes are called “Imported for Recycling”. As there is no way to track whether exported material would go to a processor or be landfilled, this material has been labeled “Exported.” Material flows for each paper grade are difficult to establish, and therefore many previous material flow analyses consider the different paper grades as a single product (Hong et al., 2011). Consequently, while the material flows presented below for the US and Canada are as detailed as possible, paper has been aggregated as a single product where necessary.

The sources of data used to develop these material flows are acknowledged where appropriate below. Generally, data has been collected from multiple sources, including but not limited to international organizations (UN Comtrade, UN Food and Agriculture Organization), national

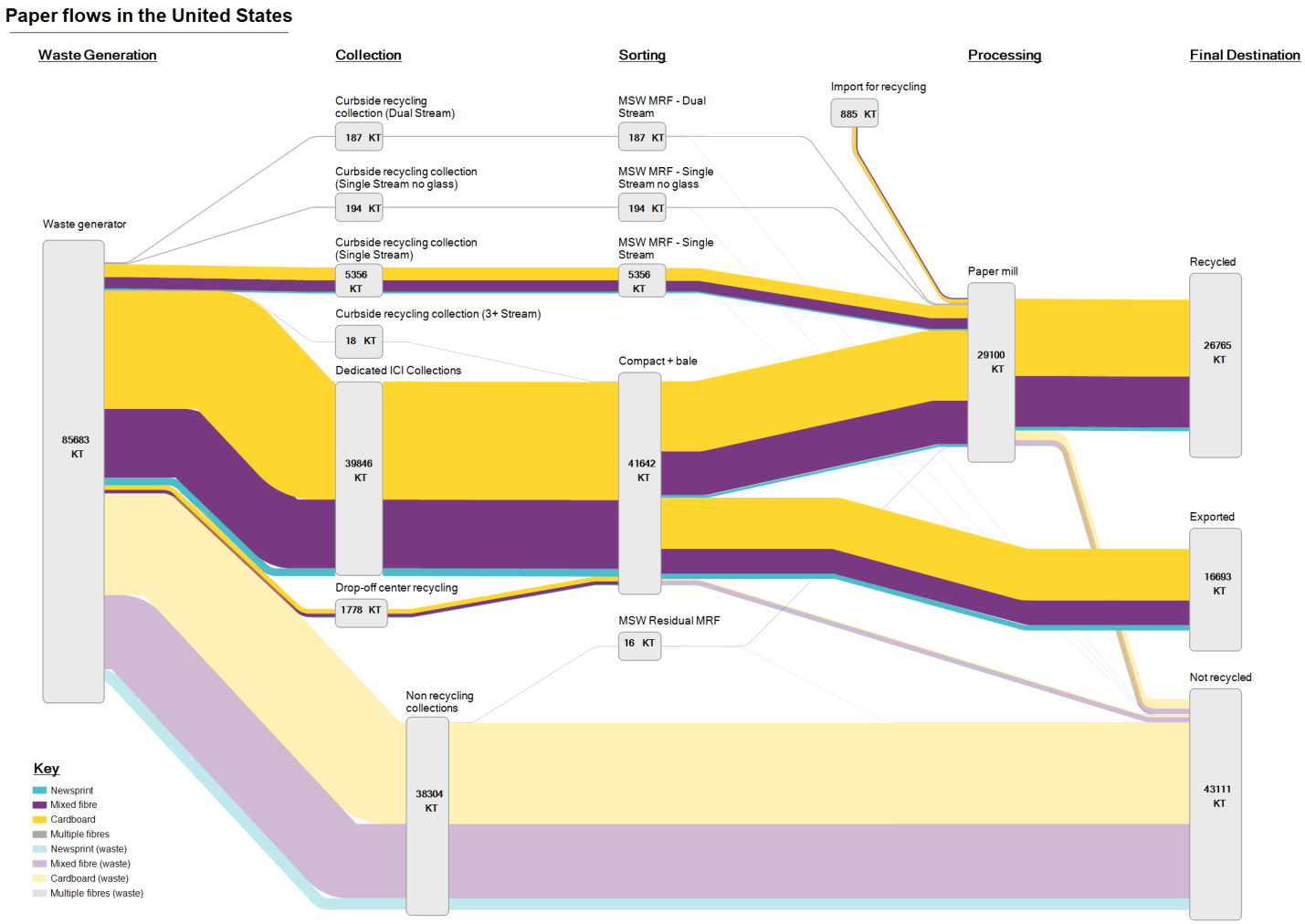
statistics databases (EPA, ECCC, Statistics Canada, National Institute of Statistics and Geography), national industry bodies (American Forest & Paper Association, Pulp and Paper Product Council, National Chamber of the Pulp and Paper Industry), and province- or state-level reports.

3.1.1 United States

Figure 4 provides an overview of the flow of waste paper in the US in 2021. In summary, based on our calculations:

- Approximately 85.7 million tonnes of paper were POM in 2021.
- Approximately 47.4 million tonnes of paper POM were collected for recycling in 2021: a collected-for-recycling rate of 55%.
    - This collected tonnage was dominated by dedicated dumpster/container collections in the ICI sector, which accounted for collecting 39.6 million tonnes.
    - In comparison, 7.5 million tonnes were collected from residential sources.
- Approximately 45.7 million tonnes were sorted for recycling, which amounted to a sorted-for-recycling rate of 53%.
    - 29.1 million tonnes of domestic paper waste (and 0.9 million tonnes imported for recycling) entered domestic paper mills for recycling.
- This recycled feedstock was used to manufacture paper products and, when processing losses were accounted for, 27.0 million tonnes of recycled paper were contained in US paper production.
    - As domestic paper production in the US in 2021 was 67.3 million tonnes, the recycled content in paper produced was 41% in 2021.

Figure 4. Paper waste flows in the United States (2021, in kilotonnes (kt))

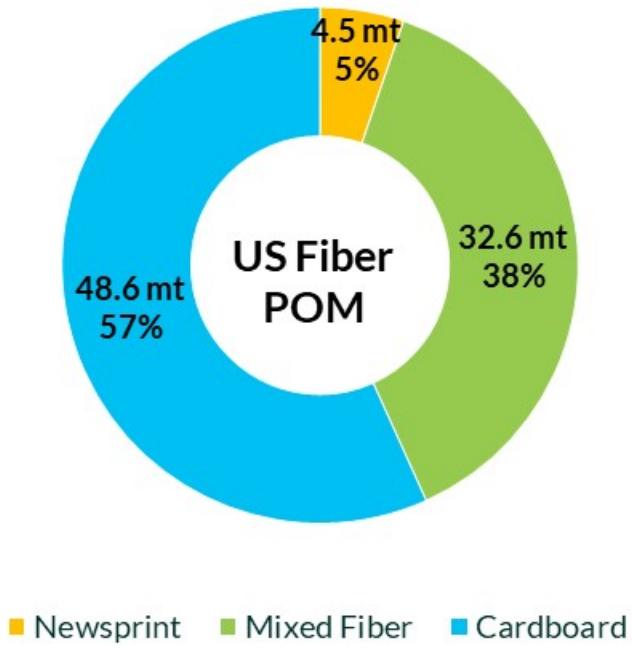


The following subsections provide more detailed analysis of paper flows in the US in 2021.

Paper Placed on the Market

In 2021, an estimated 85.7 million tonnes of paper products were POM in the US. This tonnage comprised domestic production, which equaled 67.3 million tonnes (79%) and the net imports of paper products, which totaled approximately 18.4 million tonnes (21%) (FAO, 2020). The majority of paper products POM were cardboard, comprising approximately 49 million tonnes (57%). The remaining tonnage POM consisted of mixed paper/fiber (38%) and newsprint (5%), as shown in Figure 5.

Figure 5. Paper products placed on the market (POM) in the US (2021)



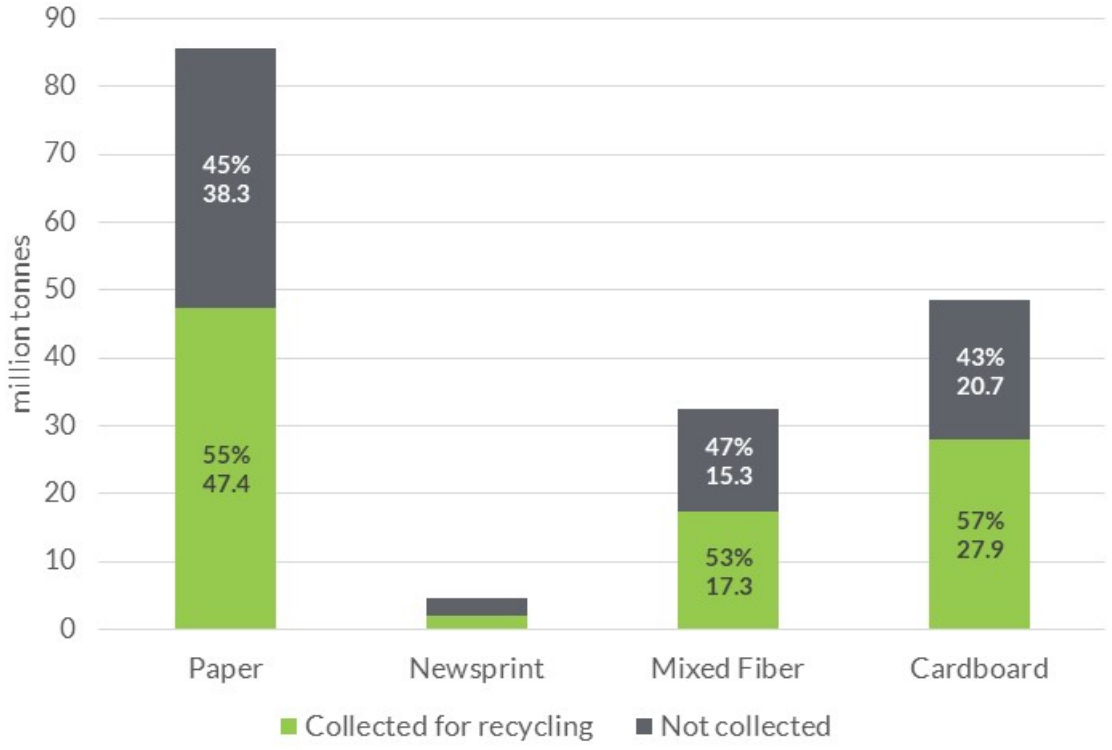
Source: American Forest & Paper Association (AF&PA) (2022) & Circular Ventures (2022).

Around 21.3 million tonnes (25%) of these paper products were consumed by the residential sector (The Recycling Partnership, 2020) and the remaining 64.4 million tonnes (75%) by the non-residential sector (ICI and construction & demolition).

Paper Collected for Recycling

To limit leakage from the recycling system and thus ensure high levels of circularity, it is important to maximize the tonnage of waste paper collected for recycling. The modelling for this report estimates that in 2021, approximately 47.4 million tonnes of waste paper were collected for recycling, with an overall collection rate of 55% (AF&PA, 2022). Cardboard had the highest collection rate (57%), with 27.9 million tonnes collected for recycling. Meanwhile, mixed paper had an estimated 53% collection for recycling rate (17.3 million tonnes collected), and newsprint the lowest rate at 47% (2.1 million tonnes collected), as shown in Figure 6.

Figure 6. Paper collected for recycling in the US, by paper grade (2021)



Note: 2.1 million tonnes of newsprint were collected in 2021: 47% of the 4.5 million tonnes POM.

Source: Eunomia Research & Consulting modelling based on AF&PA (2022) & Circular Ventures (2022).

Paper Sorting

The collection method, and its impact on sorting, is also an important factor controlling the circularity of paper products. Waste paper that is collected from residential sources via a curbside single-stream system must be sorted from other recyclable material at an MRF before it is baled.

Across the US, loss rates depend on the age of the MRF equipment, with lower loss rates in more modern MRFs. Previous research by Eunomia has found that paper sorting losses are 7% for mixed fibers and newsprint and 1% for cardboard when material is collected via a curbside single-stream system (King County Department of Natural Resources and Parks, 2020; Eunomia Research & Consulting, 2021). However, average loss rates across the US are likely to be higher. Based on a conservative estimate, 1.6 million tonnes of paper products were lost from the recycling chain in 2021; the total tonnage sorted for recycling was 45.7 million tonnes, which equates to a sorted-for-recycling rate of 53% (AF&PA, 2022).

Paper Reprocessing

Paper re-processors can draw on three sources: virgin feedstock, domestically sourced recycled feedstock, and internationally sourced recycled feedstock. Due to the global demand for sorted waste paper, not all of it goes to domestic re-processors and significant quantities are traded globally. In 2021, the US was a net exporter of waste paper, with net exports totaling 15.8 million

tonnes and amounting to US$3.4 billion in trade revenue. (The trade relationships between the US and Canada are more nuanced at the HS code level; please see subsection 3.5 for more detail.) The loss of post-consumer recycled feedstock to export means that either some virgin feedstock must be used in manufacture or finished goods must be imported to satisfy domestic demand for paper products. This limits the circularity of the paper recycling chain in the US. (For details on the export of paper from the US, see the Trade and Secondary Markets subsections of this report).

In total, when accounting for processing losses, 26.8 million tonnes of domestically recycled paper were used to produce the 67.3 million tonnes made in domestic paper mills, resulting in 40% minimum recycled content. Of this recycled material, the majority (62%) is used to make containerboard, with the remaining spread relatively equally across other paper products (AF&PA, 2022). For further detail on the products manufactured using this recycled content in the US, see section 4.1.

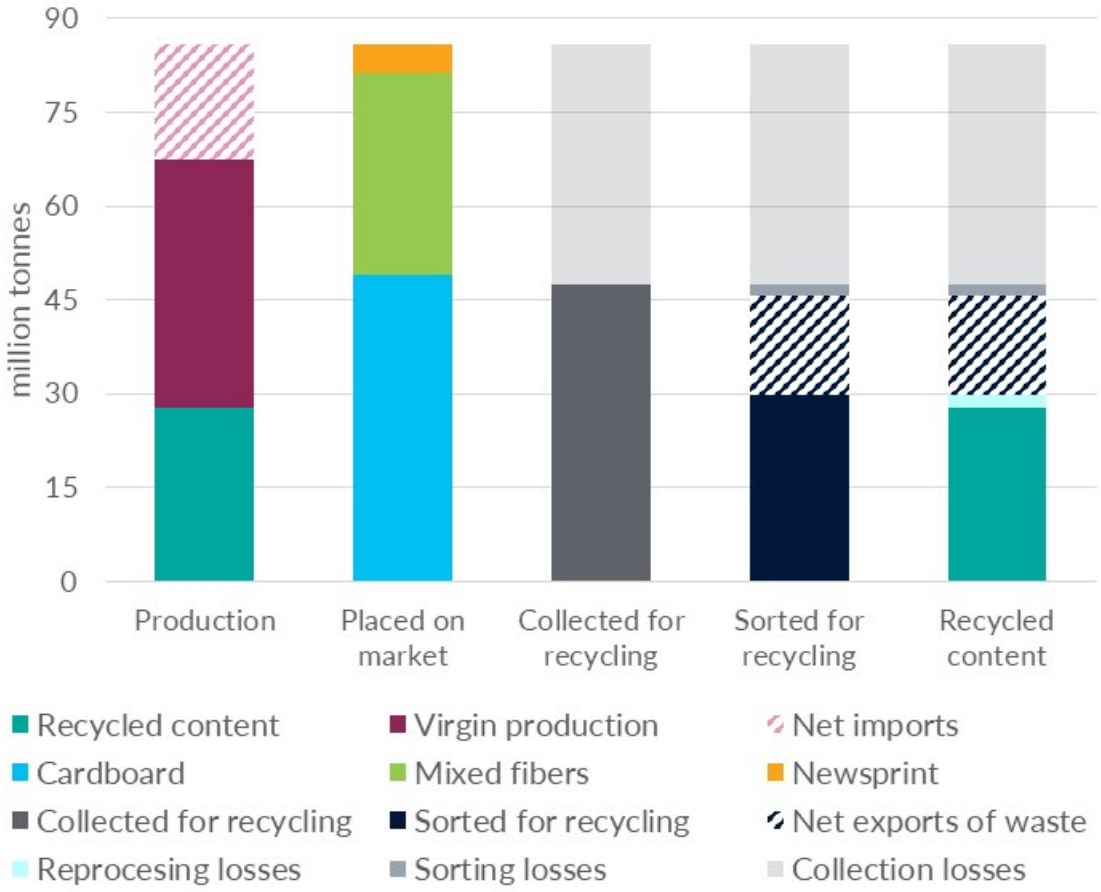
Given that 18.4 million tonnes of paper products were imported into the US, and their recycled content is not specified, the recycled content of all paper products POM in 2021 is unknown. However, it could range from 31% (if no recycled content was imported) to 53% (where 100% of the imported tonnage is recycled content).

Paper Losses

Error! Reference source not found. summarizes paper flows in the US in 2021 and highlights the s tages in the recycling value chain where paper is lost from the system. About 45% of paper—or 38.3 million tonnes—was not collected for recycling; this is the first limiting factor to domestic circularity. Accounting for balance of trade (i.e., when imports and exports are considered), approximately 15.8 million tonnes of sorted waste paper (about a third of the total sorted) are exported and thus do not enter domestic paper mills as recycled feedstock. Although this represents a loss from the domestic recycling system, the recycled feedstock can be used in paper production in other countries and therefore reduces overall demand for virgin feedstock in these countries.

In 2021, out of the 16.69 million tonnes of gross waste paper exports from the US, 13.48 million tonnes (28% of paper collected for recycling) were exported outside of North America.

Figure 7. Overall paper mass balance for the US (2021) (million tonnes)



Source: Eunomia Research & Consulting modelling based on AF&PA (2022), FOA (2020), The Recycling Partnership (2020), UN Comtrade (2023) and state EPR reports.

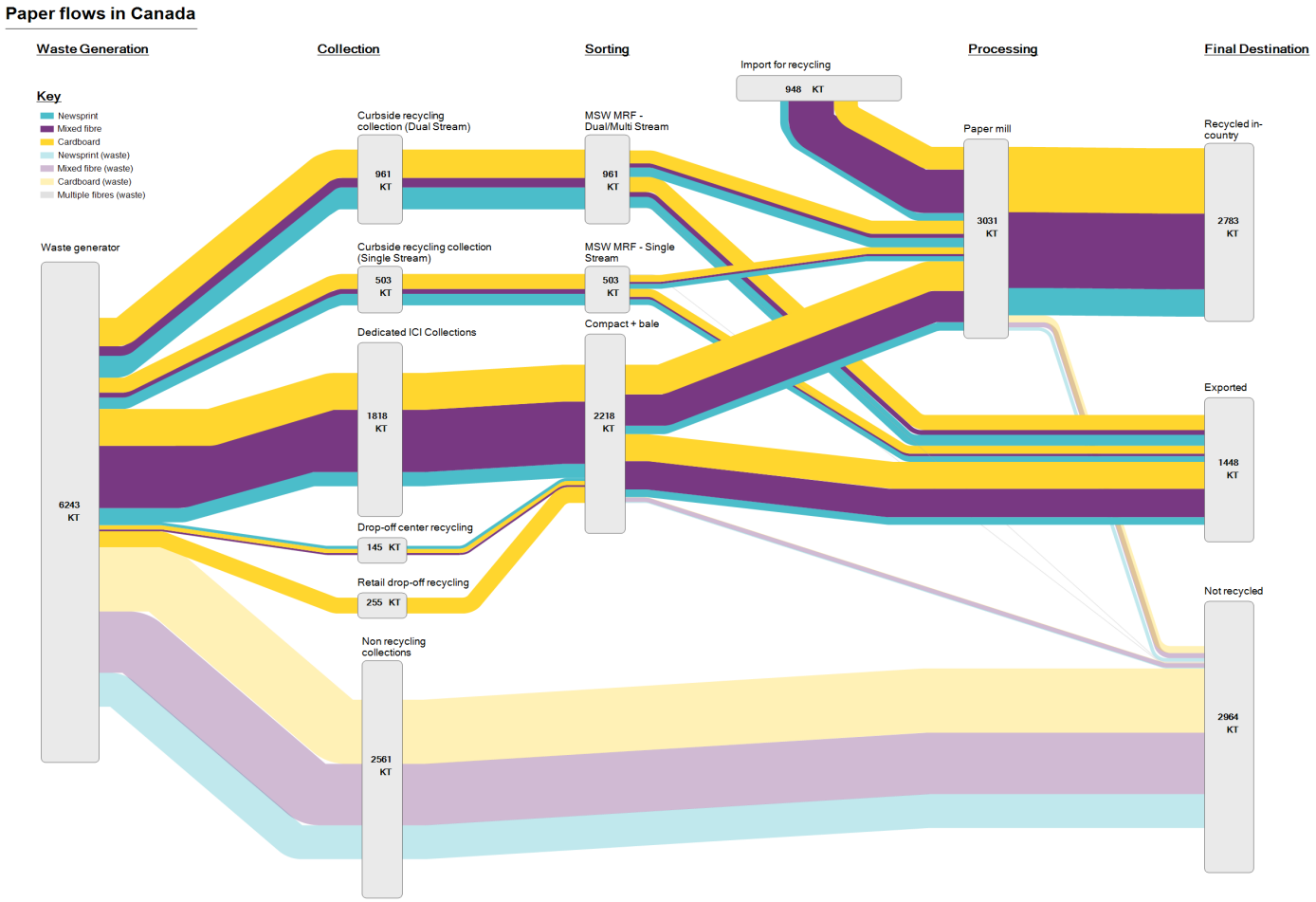
3.1.2 Canada

Figure 8 provides a summary of the flow of paper in Canada in 2020. In summary:

- Approximately 6.2 million tonnes of paper were POM.
- Approximately 3.7 million tonnes of paper POM were collected for recycling—a collected-for-recycling rate of 59%.
    - As in the US, collections in the ICI sector dominated this collected tonnage, accounting for 2.1 million tonnes—56% of all material collected.
    - The remaining 1.6 million tonnes were collected for recycling from residential sources, with 60% collected via dual-stream curbside collections.
- Approximately 3.5 million tonnes were sorted for recycling, which amounted to a sorted-for-recycling rate of 57%.
    - 3 million tonnes of paper waste (including ~950 tonnes of paper waste imported for recycling) entered domestic paper mills for recycling.

- This recycled feedstock was used to manufacture paper products so, when processing losses are accounted for, 2.8 million tonnes of recycled paper were used in Canadian paper production.
    - As domestic paper production in Canada was 8.3 million tonnes in 2020, the recycled content in paper produced was 33%.

Figure 8. Paper waste flows in Canada (2020) in kilotonnes (kt)



The following subsections provide more detailed analysis of paper flows in Canada in 2020.

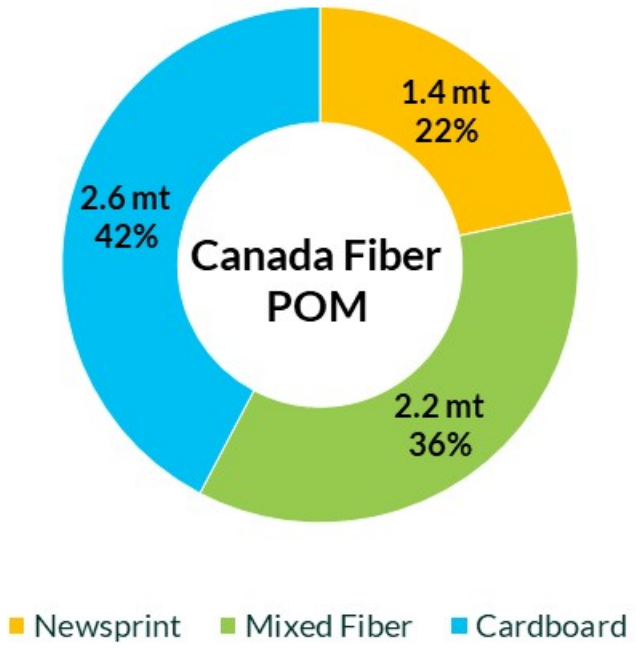
Paper Placed on the Market

In 2020, approximately 6.2 million tonnes of paper were POM in Canada and therefore generated as waste.[3] This tonnage was composed of domestic products (8.3 million tonnes) minus net exports of 2.1 million tonnes (FAO, 2020; Pulp and Paper Products Council, 2021). The trade balance of

[3] Statistics Canada has not published the tonnage of paper waste disposed of in Canada in 2020. As a result, the quantity disposed was estimated based on data available from previous years (2016, 2018). Looking at historical data, it was estimated that 2.7 million tonnes of paper was disposed in Canada in 2020. This figure also aligns with our bottom-up approach calculations, which used provincial stewardship reports and data, taken to calculate the tonnage of paper POM in Canada in 2020. Multiple methods were used to accurately estimate POM due to its significance in this work; POM is critical to calculate the collected for recycling and sorted for rates, as POM is as the denominator in these calculations. Further details can be found in the Technical Appendix.

finished paper products highlights that Canada produces more paper products than the domestic market demands and consumes. Of the 6.2 million tonnes POM, cardboard was the biggest proportion of paper waste generated, accounting for 2.6 million tonnes (42%). The remaining fraction consisted of mixed fibers (2.2 million tonnes, 36%) and newsprint (1.4 million tonnes, 22%), as shown in Figure 9.

Figure 9. Paper products placed on the market (POM in Canada (2020)



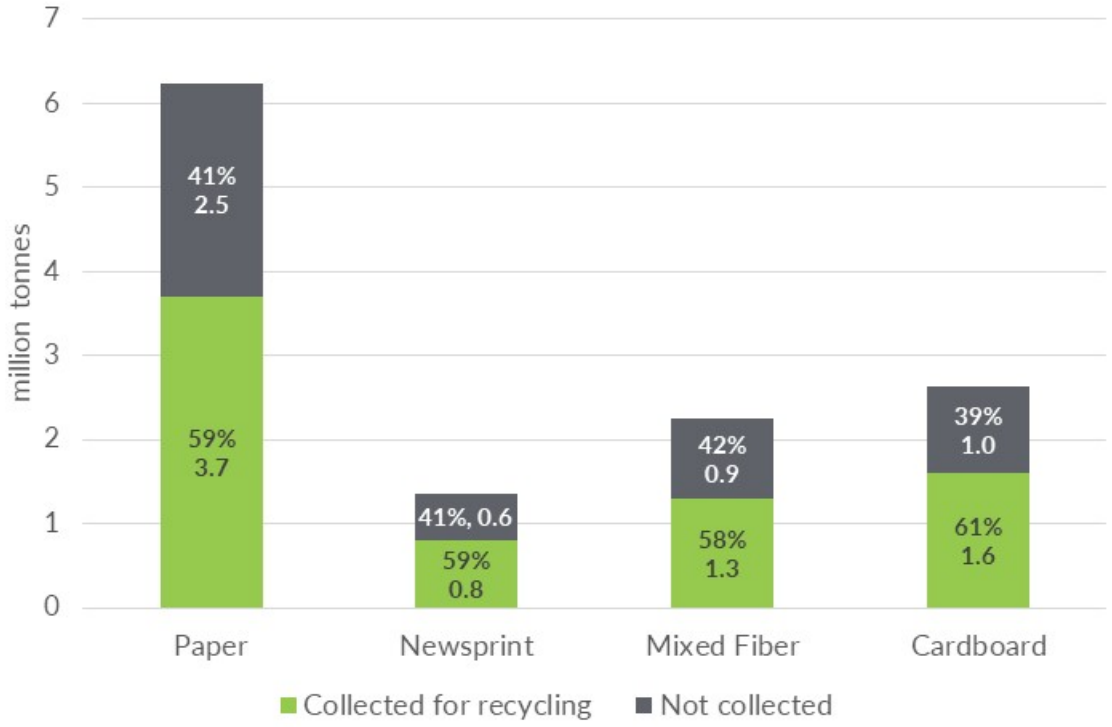
Source: Eunomia Research & Consulting modeling based on ECCC (2020), StatsCan (2023) and provinicial EPR reports.

These products were consumed by both the residential and non-residential (ICI and construction & demolition) sectors, with 2.6 million tonnes (42%) and 3.6 tonnes (58%) attributable to these sectors, respectively.

Paper Collected for Recycling

In 2020, approximately 3.7 million tonnes of waste paper were collected for recycling, which equates to a collection rate of 59%. Of the 3.7 million tonnes collected for recycling in 2020, cardboard was again the highest tonnage, with 1.6 million tonnes collected, which equates to a collection rate of 61%. The remaining collected tonnage consisted of mixed fibers (1.3 million tonnes, 56% collection rate) and newsprint (0.8 million tonnes, 60% collection rate). Based on these collected-for-recycling rates, 41% of waste paper was not collected for recycling and therefore lost from the recycling value chain, as shown in Figure 10.

Figure 10. Paper collected for recycling in Canada, by paper grade (2020)



Note: Paper refers to all fiber types.

Source: Eunomia Research & Consulting based on ECCC (2020), StatsCan (2023) and provincial EPR reports.

Paper Sorting

The collection method, and its impact on sorting, is also an important factor for the circularity of paper products. For residential sources, if recyclable materials are collected via a curbside single-stream system, then waste paper needs to be sorted from other recyclable material at an MRF prior to being baled. No paper sorting loss rates, regardless of the collection method employed, could be determined for Canadian MRFs; therefore, US paper sorting loss rates (7% for 'mixed fibers' and 'old newsprint' and 1% for OCC) were applied for material collected via curbside collection in Canada.

However, if waste paper is collected separately, then no further sorting may be necessary prior to baling and the quality of the material collected is likely to be higher. This mainly occurs in the ICI sector, where some large retailers have contracts directly with paper mills to recycle the fibers they generate on-site (business to business). In Canada, approximately 0.3 million tonnes of paper waste were collected in a manner that required no further sorting. A total of 3.5 million tonnes were sorted for recycling in 2020, which equates to a sorted-for-recycling rate of 57% (StatsCan, 2023).

Paper Reprocessing

Due to the global demand for sorted waste paper, not all of this material is sent to domestic re-processors and significant quantities are traded globally. In 2020, Canada was a net exporter of waste paper products: the country exported 1.4 million tonnes and imported 0.9 million tonnes, creating a net trade balance of -0.5 million tonnes. Its net export of sorted wastepaper also contributes to Canada's economy, with a trade surplus equal to US$37 million. Further detail on the trade of paper products is given in subsection 3.5.2.

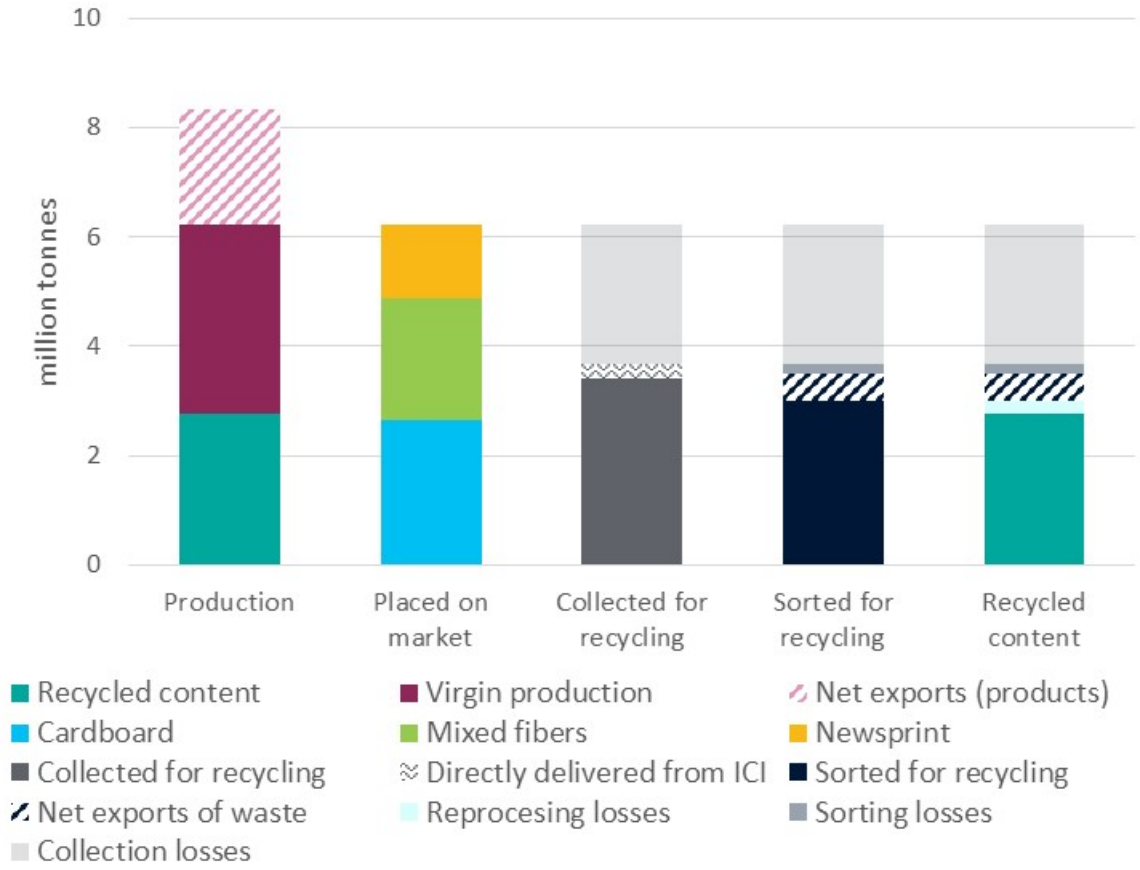
Paper reprocessors have three sources of feedstock: virgin feedstock, domestically sourced recycled feedstock, and internationally sourced recycled feedstock. The net export of sorted wastepaper leaks recyclable material from the domestic recycling value chain. Canadian paper mills used approximately 2.8 million tonnes of waste paper, generated both domestically and internationally, in 2020. Given that 8.3 million tonnes of paper products were produced in that same year, the recycled content was equal to 33%. Some virgin feedstock must be used to satisfy domestic demand for paper products; in 2020, 5.6 million tonnes of paper were made from virgin feedstock.

Paper Losses

Error! Reference source not found. summarizes the waste paper flow in Canada in 2020 and h ighlights the stages in the value chain where paper is lost from the system. Overall, Canada is a net exporter of paper products; of the 8.3 million tonnes of paper produced in the country, 2 million tonnes of paper products were exported to foreign markets. This export removes paper from the domestic system, as this material cannot be collected and sorted in Canada. Approximately 41% of paper POM was not later collected for recycling, meaning that another 2.5 million tonnes were lost from the recycling system. Furthermore, 23% of paper waste generated in Canada is sold to foreign markets and thus removed from the domestic recycling system.

In 2021, out of the 1.45 million tonnes of gross waste paper exports from Canada, 0.85 million tonnes were exported outside of North America.

Figure 11. Overall paper mass balance for Canada (2020) (million tonnes)



Source: Eunomia Research & Consulting modeling based on ECCC (2020), FOA (2020), PPPC (2022), UN Comtrade (2023) and provincial EPR reports.

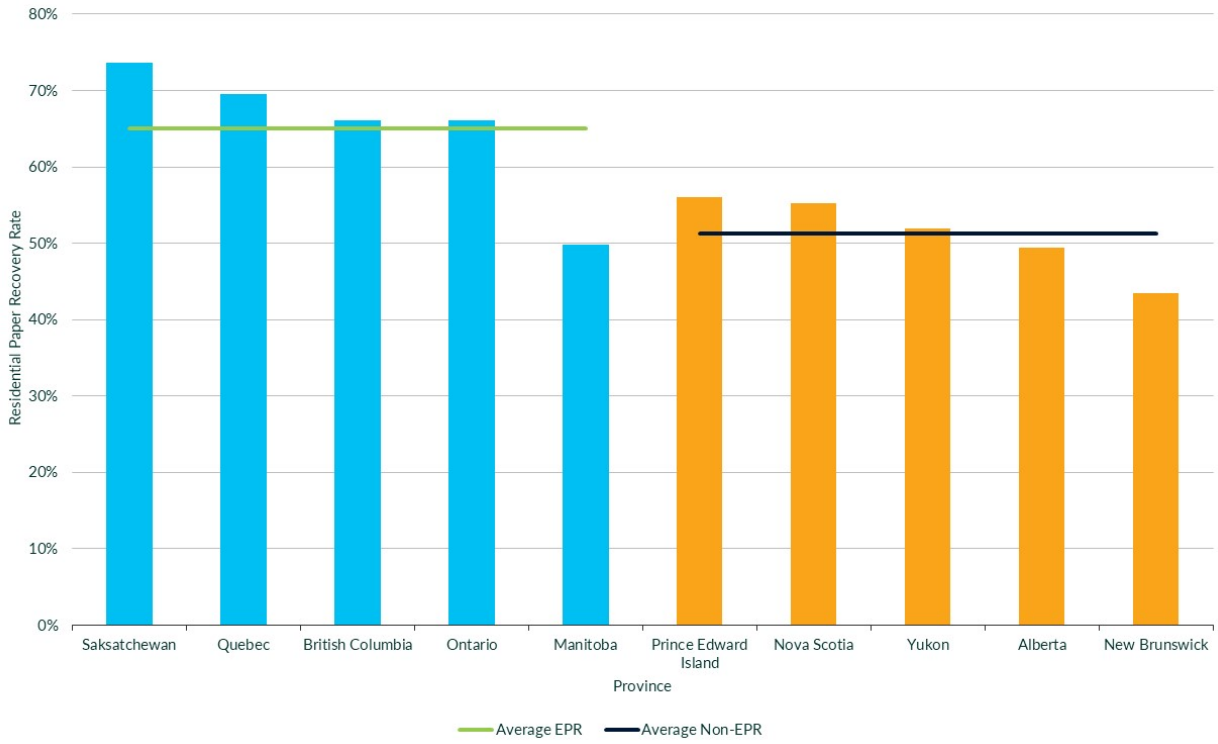
Impact of EPR and DRS on Paper Recycling

A number of Canadian provinces have passed EPR legislation that covers paper packaging. Figure 12 shows the performance of paper recycling in provinces that have enacted these EPR programs. Provinces with EPR tend to have a higher average residential paper recovery rate than those without.[4] While this demonstrates an increase in the paper diversion performance post-EPR, it cannot be inferred that EPR was the only contributing factor. Other considerations, such as the presence of other supporting policies and programs and the evolution in the approach used to measure performance by a given jurisdiction (i.e., measuring performance relative to tonnes reported by PRO members as opposed to actual tonnes generated), are also very likely at play. The provinces with EPR also appear to have slightly larger populations and thus may have more feedstock to justify recycling infrastructure. It is therefore difficult to draw a causal relationship between EPR and higher recycling rates.

[4] Provinces report recovery rates, which are the amount of material sorted for recycling (after being processed by MRFs).

The figure below shows the calculated residential recycling rate of paper for provinces in Canada. The ICI sector is not yet subject to EPR in Canada, so it has been omitted.

Figure 12. Average residential paper recovery rate in EPR and non-EPR provinces and territories in Canada (2021)



Source: Eunomia Research & Consulting calculations using ECCC (2020), StatsCan data (2023) and provinicial EPR and stewardship reports.

The impact of DRS on recycling rates specifically for cartons is uncertain; even within DRS systems, carton capture generally underperforms. There is large variability in the recycling rate for cartons across provinces, even those with similar collection systems. In British Colombia and Alberta, which both have a DRS for cartons, the recycling rate is 60% and 72% respectively (Carton Council, 2023). In some cases, this may be due to a lack of awareness among consumers that cartons are included in DRS; in British Columbia, for example, a survey showed awareness of this is much lower than for beverage containers of other materials (Encorp Pacific Canada, 2020).

3.2 Collection

This subsection offers an overview of recycling collection systems in the US and Canada. It describes the types of collection systems in each country, as well as access to recycling collection and the costs associated with these systems for municipalities. It also delves into some common challenges encountered during the collection of paper.

The collection of recyclable materials in the US and Canada can vary widely by geographic location, jurisdictional regulatory authority, existing infrastructure, and local population density. Across

both countries, waste often must be transported considerable distances from the point of use or disposal to treatment locations. Therefore, access to recycling programs is not uniform, with residents of multi-family buildings less likely to have curbside collection services and more likely to have no access to services at all. Ensuring convenient and widespread access is crucial to maximize the amount of paper captured in collection systems and improve paper recycling rates.

3.2.1 United States

In the United States, municipalities are generally responsible for collecting, recycling, and disposing of waste in their jurisdiction. This means they have the power to determine how waste is collected and processed and can use this to implement programs that encourage recycling and reduce the amount of waste going to landfill. Municipalities usually either directly carry out collection or contract haulers to provide collection services. Those that contract haulers can include contract terms that encourage practices that improve paper waste collection and recycling. For example, implementing dual-stream recycling, where paper is collected separately, improves the quality of the collected material by reducing contamination. This, in turn, leads to lower recycling costs. Municipalities in New York, New Jersey, Pennsylvania, and Florida have all reported positive results from switching from single-stream to dual-stream recycling (Wallace, 2021). They can also implement pay-as-you-throw programs, which charge residents based on the amount of waste they generate, encouraging them to reduce their overall waste and recycle more.

Paper recycling collection in the US is different for single-family households, multi-family households, residents in rural areas, and ICI properties. The types and extent of collection programs provided vary widely and are influenced by geographic factors, jurisdictional regulatory authority, existing infrastructure, and local population density. Below we describe the different collection types, access to collection, what materials are collected, and costs of collection.

Residential Curbside and Drop-off Collection

In curbside collection systems, sorted waste is picked up by municipalities or their haulers. In 2021, 86% of the US population with access to curbside recycling had a single-stream program (AF&PA, 2021). Single-stream recycling means that paper is collected mixed with other recyclable materials, such as glass, household metals, and plastic. 83% were served by a single-stream collection including glass, while 3% were served by a single stream collection excluding glass. 3% of the population with access to curbside recycling were served by a separate collection of two or more streams (AF&PA 2021). The remaining 11% were served by combination collection methods, which include mixed waste recycling (whereby trash and recyclables are collected together and separated at a recycling facility) and various hauler subscription service collection methods.

Municipalities manage curbside collection services themselves, contract collection out to private waste hauling companies, or require residents and businesses to contract directly with haulers. An estimated 54% of the population with curbside collection covering paper and board is serviced by their municipality and 28% by one or more municipally contracted haulers (AF&PA, 2021).[5] This

[5] The remaining 6% is subscription, where residents must set up their own service with a private hauler; 9% is not specified, and 3% have another system.

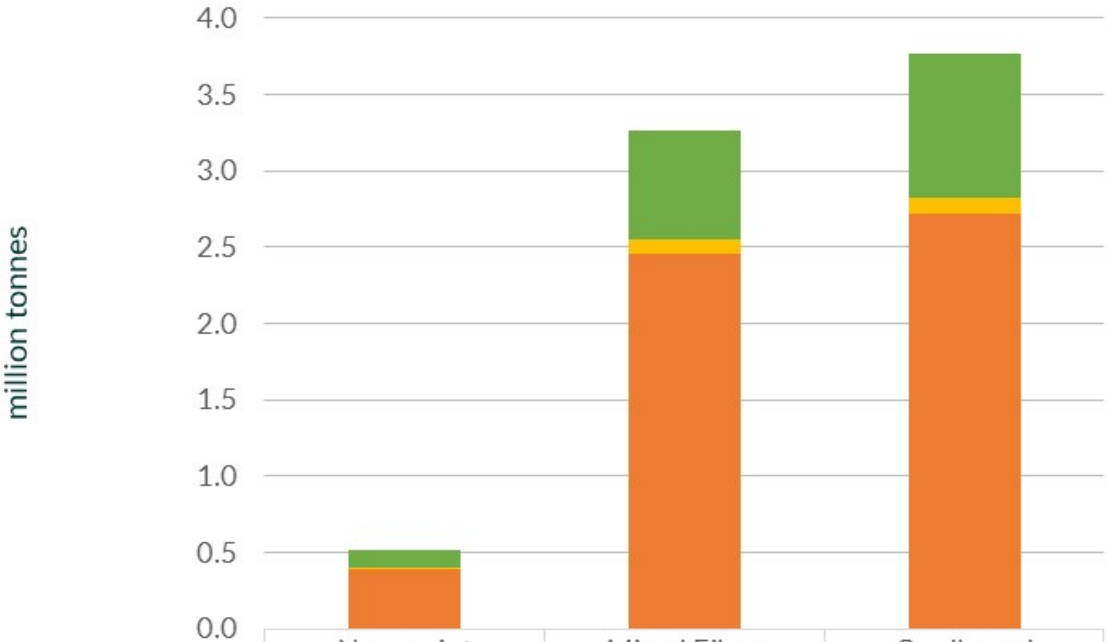
points to the important role municipal governments play in organizing and expanding the collection of recyclables within their jurisdictions to support the development of a circular economy.

Some jurisdictions offer drop-off programs for recyclables as an alternative or in conjunction with curbside services. These programs are more prevalent in rural areas, usually at the county level, where residents have the space to accumulate recyclables and drive them to drop-off locations. However, some urban and suburban areas also offer drop-off programs.

The lack of rural curbside collection reflects the challenges posed by low population densities spread out over wide areas, where smaller quantities of recyclables and dispersed routes make curbside collection economically unfeasible. Creating drop-off programs for recyclables is a more cost-effective and logistically simpler option. Certain factors, such as distance to a drop-off center and the availability of space on site to separate different materials, impact the capture rate for paper and card in these areas.

Figure 13 below shows the tonnage collected through residential single-stream recycling, multi-stream recycling, and drop-off centers, broken down by paper type. The majority of waste paper collected (5.6 million tonnes, or 74% of residential waste paper) is recovered through single-stream recycling systems. A further 0.2 million tonnes are collected via dual- or multi-stream recycling collections. The remaining 1.7 million tonnes are collected via the network of drop-off centers across the US.

Figure 13. Residential waste paper collected by system in the US (2021)



	Newsprint	Mixed Fiber	Cardboard
Depot Collection	0.1	0.7	0.9
2+ Streams	0.0	0.1	0.1
Single Stream	0.4	2.5	2.7

Source: Eunomia Research & Consulting Calculations, EPA Data, (Eunomia, 2021), (Stina Inc., 2020), (Sustainable Packaging Coalition, 2021)

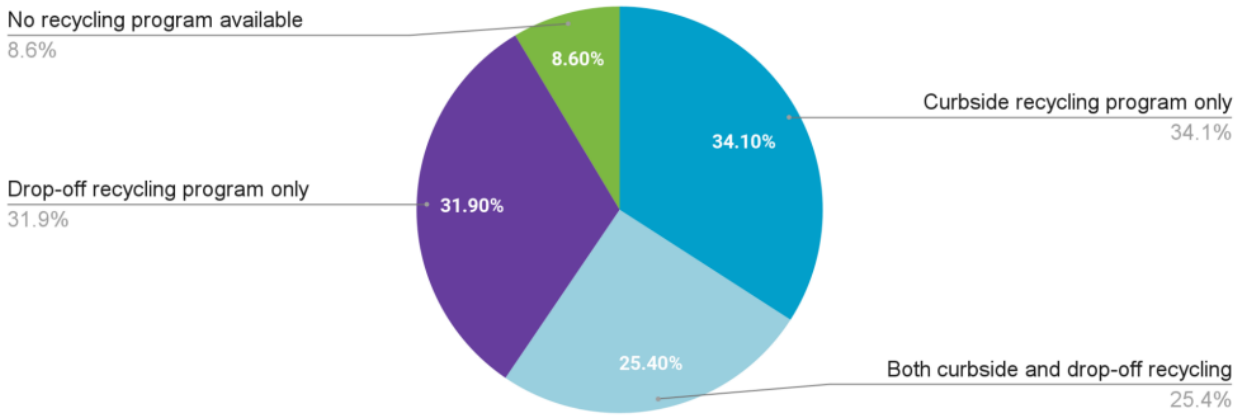
Collection for Industrial, Commercial, and Industrial Properties (ICI)

In the US, around 40 million tonnes of paper come from ICI sources, accounting for 84% of all paper collected in 2021. The percentage is even higher for cardboard: of the total 27.9 million tonnes collected, 24.1 million tonnes (87%) come from this sector. Local ordinances often do not require municipalities to collect commercial waste, so the ICI sector frequently contracts directly with haulers. Collection services vary based on the type and volume of paper waste generated, the type of business, and the location of the ICI generator. Haulers can offer separate paper or cardboard collection to accommodate the large volumes of office paper and corrugated cardboard that businesses generate. With its large volumes and lower contamination, separately collected commercial paper can be sent directly to mills for reprocessing, without being sorted at an MRF. ICI paper waste collection thus contributes significantly to collection rates across the country.

Access to Recycling Programs

Access to recycling programs in the US varies across municipalities. The Sustainable Packaging Coalition estimates that recycling programs are available to approximately 91% of the population. Figure 14 shows the breakdown, with 34% of the US population having access to recycling via curbside collection only, 32% via drop-off centers only, and 25% via both curbside and drop-off options; 9% have no access to recycling (Sustainable Packaging Coalition, 2021).

Figure 14. Recycling program access in the United States (2021)



Source: (Sustainable Packaging Coalition, 2021)

Access to recycling programs also differs by property type. Residents of multi-family buildings are less likely to have curbside collection services and more likely to have no access to services at all.[6] Table 3 illustrates the discrepancy in access to curbside recycling collection between residents of multi-family and single-family properties.

Table 3. Single-family versus multi-family property access in the US (2021)

	Recycling access for residents of multi-family properties	Recycling access for residents of single-family properties
Curbside recycling program only (including subscription curbside in areas where this is the method of single-family service provision)	19.1%	39.6%
Drop-off recycling program only	46.0%	26.3%
Both curbside and drop-off recycling programs	11.6%	30.7%
No recycling programs available	23.3%	3.4%

Source : (Sustainable Packaging Coalition, 2021)

The types of paper accepted by collection systems can vary across states and municipalities. Table 4 indicates the types of paper products that are commonly accepted in recycling programs and the products that may be accepted depending on the program, based on various factors, such as MRF requirements, commodity market prices, contracts, policy, and more. Note that the materials not commonly accepted are primarily ones at risk of being contaminated with food waste.

Table 4. Typical paper products accepted by residential recycling collection programs in the US

Materials Accepted	Materials Not Always Accepted
Cardboard	Pizza boxes
Office paper	Foodservice packaging
Folding Cartons/Boxes	Shredded paper
Junk Mail	Beverage cups
Newsprint/Inserts	Wax cardboard
Catalogs	Paper plates
Magazines	

[6] Notably, for this study by the Sustainable Packaging Coalition, multi-family residents who receive services via private commercial hauling services were not considered to have services available, because the number of residents with collection from their residence is impossible to estimate. Single-family housing typically refers to a detached dwelling in which one household resides. However, in recycling programs, "single family services" are often offered to residents in buildings with up to 2-8 residential units. Multi-family housing refers to buildings with more than one residential unit. For recycling program purposes, the definition of multi-family may vary from one community to another.

Aseptic cartons (available to 62% of the population) (Carton Council, n.d.)	

Source: Circular Venture, LLC

Finding specific data on paper recycling collection rates for each municipality in the United States is challenging due to inconsistent reporting requirements across states and municipalities. However, based on MRF tonnages and waste composition studies, where available, it is possible to calculate paper collection performance. This information is limited, as most states do not undertake composition studies or require their contracted MRFs to provide the relevant information.

Impact of EPR on Collection

As discussed further in the policy section below, four US states have passed EPR and more are likely to do so. EPR can impact collection by increasing service levels to cover underserved rural and multi-family residences. It can also require provision of collection services to the ICI sector, as is currently the case in California, Colorado, and Oregon.

Payment for Services by Generators

Single-family residents usually pay for recycling system costs (including collection and sorting costs) through utility rates, by contracting directly with a hauler, or through property taxes. Multi-family residents sometimes pay for these directly through utility fees charged by building managers, but more often indirectly as part of their rent payment. Some cities in the US have implemented pay-as-you-throw (PAYT) systems, in which households are charged variable rates based on the volume of garbage they set out for collection. PAYT systems can be structured so that: (a) a household pays a certain rate based on the number or size of carts they put out for collection; or (b) residents must dispose of their trash in official municipal trash bags or trash bag tags, which they purchase. In these systems, recycling is often provided at no cost, so residents are also encouraged to recycle rather than dispose of material.

In most cities and municipalities, ICI generators will contract directly with private haulers for the collection of trash and recycling. There will be variable rates based on the volume of waste and the frequency of collection.

Service Cost

Based on the Recycling Partnership State of Curbside Report, it is estimated that curbside residential mixed recycling collection costs US$72 per household per year. An estimated 69.8 million households are served with some type of automatic curbside recycling collection (The Recycling Partnership, 2020). Total annual curbside collection costs in the US are estimated to be US$5 billion, which roughly translates to US$463 per tonne. Once collected and delivered to an MRF, the material is sorted and baled. This adds an additional US$90 to US$130 per tonne in cost, over and above collection costs for residential paper recycled. Taking the average of US$463 per tonne cost for collection, plus US$90 per tonne for MRF processing, the estimated cost to collect, process, and bale recyclables from residential collection is US$553 per tonne. This is comparable to mixed recycling collection costs in Canada, which Recycle BC estimates to be C$475 per tonne (Recycle BC, 2021).

Table 5 breaks down the average cost of recycling in the US. These figures are mainly for single-stream collection and not specific to paper.

Table 5. Average costs of recycling collection in the US, adapted from The Recycling Partnership

Estimated total households served in the US per year	69.8 million
Average cost for collection per household per year	US$72
Total average cost for curbside collection per year	US$5 billion
Estimated tonnes collected curbside per year	10.8 million
Average cost for collection per tonne	US$463
Average cost for MRF processing per tonne	US$90
Average cost to collect, process, and bale curbside recycling material per tonne	US$553

Source: (The Recycling Partnership, 2020)

While collecting for recycling can be costly for municipalities, it is essential to highlight that landfilling or incinerating also incurs costs, in addition to the loss of value from not selling the recovered paper for recycling. One study estimated the cost of landfilling paper in the US in 2015 to be US$2.9–3.1 billion (Jon T. Powell, 2019). The commodity value of landfilled paper was further estimated to be around US$779 to US$826 million. Therefore, focusing solely on the upfront cost of recycling collection overlooks the cost of landfilling and the loss of a valuable resource.

3.2.2 Canada

The infrastructure for paper collection in Canada varies across provinces, territories, and municipalities. Provinces with higher population densities generally have a higher percentage of households with access to curbside collection. In almost all medium and large urban centers, curbside collection is the most common method for collecting a wide range of recyclables, including paper fibers. This is less common in small settlements and rural areas with more diffuse populations, where it would be more expensive. As a result, these areas are often serviced via drop-off centers or may not have access to recycling services at all.

It is worth noting the concept of the 'evolving tonne' in Canadian municipal waste collections, which describes the phenomenon of a decrease in the weight of material collected despite an increase in the overall amount of material collected. First noticed by municipalities in 2008/2009, this is due to the continued lightweighting of plastic packaging while the proportion of paper in material collected for recycling decreases. Paper is heavier than plastic, and while newsprint used to make up 80% of material collected in some cases, the figure is now closer to 20%. In addition, while newsprint previously formed the backbone of recycling programs due to its low collection costs and good revenues, the predominant paper type now collected is OCC; this is bulky and takes up a lot of room in collection trucks, thereby increasing recycling program costs. These changes in waste composition also pose a challenge for setting diversion goals by weight, which is the most commonly used metric for measuring waste diversion in Canada.

Curbside and Drop-Off Collection

Generally, municipalities or their contractors are responsible for collecting curbside recyclables, including a range of paper and paper products. Municipalities either directly deliver or contract for collection services. Overall, residential curbside collection is a mix of single-stream and dual-stream with some multi-stream, depending on the province. Ontario and British Columbia have a mix of all three, while Québec has single-stream and the Atlantic provinces have mostly dual-stream. Dual- and multi-stream systems generally benefit paper recycling: they keep the fiber components away from other materials, such as glass, which get crushed in the vehicle and contaminate the fiber stream, reducing its quality and available markets. The material quality benefit of dual- and multi-stream systems is often recognized in EPR programs, with the PRO paying more per household to municipalities with these services in recognition that while collection is usually more expensive, the downstream benefits (in terms of reducing sorting requirements and increasing material revenue) justify this.

Rural areas are less likely to have access to curbside garbage collection or recycling services and may rely on permanent or mobile drop-off centers.

In Alberta, 68% of households have a collection service provided or managed by their municipality, with the remaining 32% hiring their own hauler or relying on drop-off centers. In large municipalities, 79% of households have collection services provided or managed by their municipality. In medium municipalities, 73% have such services. But this number drops to 57% for small municipalities (Alberta Collaborative, 2019).

In British Columbia, 1,586,000 single-family and multi-family households were serviced by curbside collection (78%), and 442,000 HHs were serviced by drop-off locations only (22%) (Recycle BC, 2021).The vast majority of curbside collection programs are located in southern British Columbia. As outlined in its proposed Packaging and Paper Product Extended Producer Responsibility Plan 2023–2028, RecycleBC has established the following criteria in order to determine whether a municipality is eligible for curbside collection: the community has a minimum population of 5,000 residents and a curbside garbage collection program is in place and operated by the municipality (RecycleBC, 2022). Unincorporated areas are eligible to receive curbside collection provided they meet those criteria along with two additional conditions: the proposed service area has a minimum household density of 0.42 households/hectare and there is a maximum distance of 20 km between proposed Service Area Sections. Under the EPR program, municipalities that collect dual-stream or multi-stream are paid more to recognize the benefits to recycling of this service.

In New Brunswick, approximately 70% of households receive recycling collection service, which includes both curbside and drop-off only service.[7] Where curbside recycling collection services are not provided, some municipalities offer drop-off centers or mobile collection events that accept packaging and paper. According to one government official (Leblanc, 2023), the largest majority

[7] Circular Materials Atlantic, New Brunswick Stewardship Plan for Packaging and Paper (Draft for Consultation), 2022 – Table 3.1. A consultant for Circular Materials Atlantic indicated that comments received through the consultation process provided corrections to the baseline data in the draft plan, but that these corrections were not publicly available.

(about 95%) of single-family households in New Brunswick have access to curbside collection of recyclables now that the City of Saint John has initiated its program for recyclables.

Newfoundland and Labrador have the lowest population density of any Canadian province. Nonetheless, 82% of households in the province currently have access to curbside recycling programs, which cover residents of the eastern, western, and central regions. There are currently no formal recycling programs for five Newfoundland subregions or the four regions of Labrador (MMSB, 2022).

In Nova Scotia, 100% of the population with access to curbside garbage collection also has access to curbside recycling collection. Collection is dual-stream: paper is collected in one blue bag, and containers and film are collected in a second blue bag (Kenney, 2022).

In Ontario, under Regulation 391/21, producers of plastic and other packaging (including paper) must operate and pay for the collection and reuse, refurbishment, and recycling of blue box materials (Ontario, 2016).[8] Under Regulation 101/94 (Ontario, 2021), communities with a population over 5,000 must provide blue box services that are at least as convenient as waste disposal services. In other words, if a community over 5,000 provides curbside garbage collection, it must also provide curbside recyclables collection. If garbage is accepted at a waste disposal site, recyclables must be accepted at a drop-off center. According to the Resource Productivity & Recovery Authority's (RPRA) 2020 data, of the 250 municipalities and First Nation communities who submitted information on their recycling programs (representing about 96% of Ontario's total population), 5,175,266 households received curbside services and 198,290 households received drop-off center services, the latter representing about 3% of total households in Ontario (RPRA, 2020).

In Quebec, in 2004, 97% of the population were served by recycling collection; of that, 85% were served by curbside collection and 12% by a drop-off system, primarily offered to residents of multi-family buildings and rural areas (RECYC-QUÉBEC, 2006). As of 2022, according to RECYC-QUÉBEC, 99% of the population has access to recycling; of that, only about 1% of the population is served by drop-off only. This one percent is made up of small municipalities (1,500 inhabitants or less and in most cases less than 1,000 inhabitants, all located more than 100 km from Montréal or Quebec City). In most cases, these municipalities have remained in charge of service delivery (no grouping of services) (Lefrance, 2022). From 2023 to the end of 2024, Quebec is transitioning to "Partnership EPR," under which the designated PRO (Eco Entreprises Québec) will be responsible for overall system management while municipalities will continue to undertake collection, but following standard service agreements provided by the PRO. The PRO will own the collected materials and be responsible for all post-collection activities.

Saskatchewan is characterized by low population density and the fact that most of its population resides in non-urban centers. Currently, 84% of Saskatchewan households have recycling services

[8] Ontario's Blue Box Program collects recyclable materials such as paper, glass, plastic and aluminum from residences in over 240 municipalities and First Nation communities across the province.

for packaging and paper products through their municipality, via the province's stewardship program (Multi-Material Stewardship Western, 2022). Information on access to curbside collection versus drop-off centers was not available and is noted as a research gap.

On Prince Edward Island, all residents have access to monthly recycling collection. Households place their recyclables in transparent blue bags. Drop-off locations are also available to supplement the monthly collection service.

In Manitoba, 95% of the population has access to a recycling program (Multi-Material Stewardship Manitoba, 2021). Materials are collected through each municipality's recycling program.

In Yukon and the Northwest Territories, access to recycling is mainly only at drop-off centers, except in Whitehorse, Yukon where there is an opt-in private curbside recycling collection service 'Whitehorse Blue Bin Recycling'. There is no access to recycling in Nunavut.

Where households do not have access to convenient curbside services for recycling, more material will end up in the trash stream, especially where curbside trash collection is provided.

Collection from Single-family and Multi-family Properties

There is limited data available on access to and performance of recycling in multi-family buildings compared with single-family properties. Most multi-residential households (e.g., 80% in Ontario) (Office of the Auditor General of Ontario, 2021) receive municipal garbage and recycling collection, which is counted as residential waste in data, without a breakdown between single- and multi-family properties. However, as noted in a recent report from ECCC, there are recycling service gaps for multi-residential households in many jurisdictions, with multi-residential buildings generally categorized as part of the ICI sector (ECCC, 2023).

It is important to note, however, that access is often not the main barrier to recycling for residents of multi-family buildings. For example, 98% of all buildings sampled in Metro Vancouver[9] have access to recycling bins, but the recycling rate for multi-family buildings was 40% compared with over 60% for single-family buildings. A report commissioned by the Municipal Industry Program Committee of Waste Diversion Ontario points out several factors that affect recycling collection at multi-family buildings, such as the inconvenience of recycling compared to garbage disposal, insufficient bin capacity, lack of repercussions for improper recycling, the belief that maintenance fees cover waste management services, and inadequate education and outreach (KPMG, 2007). This is supported by academic studies, where there is general consensus that residents of multi-family buildings recycle less than residents of single-family buildings (DiGiacomo et al., 2018). While data for the whole of Canada is not available, the tables below present the collection rates for paper recycling, categorized by building type, for Ontario and Québec.

[9] Metro Vancouver is a federation of 21 municipalities, one electoral area, and one treaty First Nation that collaboratively plans for and delivers regional-scale services: https://metrovancouver.org/

The last four-season waste composition study carried out in Ontario found that collected rates were lower in multi-family buildings than in single-family homes, as presented in Table 6 (CIF, 2022):

Table 6. Collected rates in single-family and multi-family homes in Ontario, Canada (2020/2021)

Property Type	Recyclable paper collection rate	Recyclable paper packaging collection rate
Average single-family (non-weighted)	79%	79%
Average multi-family (non-weighted)	58%	55%

Source: (CIF/SO, 2021)

In Québec, multi-family buildings also exhibit lower performance than single-family buildings, but to a lesser degree, as presented in Table 7:

Table 7. Collected rates in single-family and multi-family homes in Québec, Canada (2015–2018)

Property Type	Printed paper collected rate	Paper packaging collected rate
Urban single-family	83.7%	68.88%
Rural single-family	79.6%	69.1%
Two-to-five-unit multi-family household	71.0%	62.4%
Multi-family	71.2%	54.8%

Source: (RECYC-QUÉBEC, 2021)

Collection for Industrial, Commercial, and Industrial Properties (ICI)

The main grade of paper generated by the ICI sector is OCC. Moreover, because certain ICI generators, such as office buildings and government offices, collect their paper waste streams separately, these also produce higher quality papers that have in effect already been sorted—for example, paper collected from office shredders. These types include office paper and sorted white ledger (i.e., stationery, printing papers, copy paper, and book pages, free from OCC).

Information on paper collection and recycling processes in the ICI sector is limited. This is because such activities generally fall outside the scope of EPR programs and are typically structured through individual business-to-business (B2B) commercial agreements.

Impact of EPR on Collection

As of March 2023, five provinces have EPR in place, while two (New Brunswick and Alberta) have enacted legislation and are in the process of setting up their respective programs, and three (Yukon Territory and Newfoundland and Labrador, and Nova Scotia) are currently consulting on its enactment. The introduction of EPR for packaging and paper products is expected to increase curbside collection services to more households. EPR generally requires services to be provided to areas generally underserved due to cost, such as rural areas, and properties that are more difficult to implement services within or would usually be served by haulers (e.g., multi-family). Producer

stewardship plans often set out how and where services will be provided. Plans are generally approved by government or the designated oversight agency. For example, in its 2019 stewardship plan, RecycleBC committed to providing curbside collection to a minimum of 973,400 curbside households and 421,600 multi-family households (RecycleBC, 2019).

Cost of Collection

The cost of paper recycling collection in Canada can vary significantly due to several factors, including the type of collection (drop-off center, curbside single-stream, curbside dual-stream), operational procedures (maintenance, training, fuel cost, etc.), capital investment (carts, building and infrastructure for drop-off centers, etc.), in-house or subcontracted collection, subcontract duration and quantity collected, and population density. As a result, the cost of collection varies significantly across provinces and territories and even within them. The tables below present the cost of collection per household for British Columbia and Ontario. These are the costs of collecting all designed recyclable material and have not been proportioned to show the likely costs for the paper stream. While collection costs for Quebec are discussed, no corresponding data table is given due to the available data being less detailed than that for British Columbia and Ontario.

The cost for collection in British Columbia (Table 8) includes the amortized cost of containers, carts, vehicles and equipment, maintenance and repairs, insurance fuel, and labor as well as education and publicity costs, customer service, and administration and management support.

Table 8. Annual costs of collection of all recyclable materials in British Columbia, Canada (2020)

Type of collection	Range	Weighted average*
Curbside collection	C$21 to 80 per household	C$46 per household
Multifamily collection	C$14 to 80 per household	C$29 per household
Depot collection (drop-off center)	C$161 to 2,803 per tonne	C$427 per tonne

Source: (Recycle BC, 2020)

Note: *the mean in which each item being averaged is multiplied by a number (weight) based on the item's relative importance (in this case, number of households) (RecycleBC, 2020).

The cost of recycling collection per household in Ontario varies widely, with prices reaching C$778 per household (RPRA, 2020); however, on average, the cost of collection is C$76 per household. The province has both dual- and single-stream systems. Table 9 shows the differences between the two. However, due to the high variability of data, no definitive conclusion can be drawn.

Table 9. Annual costs of collection in Ontario, Canada (2020)

Type of collection	Average collection cost per household
Dual stream	C$67 per household
Single stream	C$90 per household

Source: (RPRA, 2020)

In Quebec, the most recent publicly available data present a net cost of collection of C$167 per tonne (RECYC-QUÉBEC, 2016). A recent study undertaken in the context of the province's EPR modernization provided more details on the cost variation, based on factors such as type of collection, operational procedures, capital investment, population density, and others. The price for collection varies from approximately C$64 per resident to C$12 per resident. In Nova Scotia, the average collection cost in 2021 was C$28.71 per household, with prices ranging from C$0 to C$75.72 per household (Nova Scotia Environment and Energy, 2023).

3.2.3 Challenges for paper collection

Among the challenges for paper recycling in the US and Canada is the high cost of collection. This is linked to the cost of transporting, processing, and recycling paper, overall market demand, and the quality of paper bales—dynamics explored in the Market Overview section. It is important to note that changes in demand for recycled fiber, virgin fiber prices, global fuel prices, and labor costs will affect collection, with increased costs passed onto stakeholders in the value chain. Collection is the first stage of the value chain and costs further down are passed onto municipalities or haulers responsible for recycling.

Another challenge affecting paper circularity in the US and Canada is contamination, which can occur as consumers separate waste or during the collection phase. Any additional processing required to remove or reduce contamination increases the cost of recycling (WM, 2022). It also leads to higher yield losses, as contaminated paper may be landfilled (Bafail, 2020).

The type of collection system can also impact contamination rates and material quality through exposure to wet or damp conditions. In the US specifically, 86% of curbside recycling collection systems are single stream. An analysis of the impact of different programs shows that the average contamination rate is higher for single-stream collection systems than for dual- or multi-stream (Runsewe & Celik, 2021). Municipalities often prefer single stream for residential collection because it costs less and residents and businesses can easily co-mingle all recyclables in one bin (CRI, 2023). However, there is a trade-off between these lower costs/ increased participation rates and the higher contamination rates that increase processing costs. An alternative maybe to have modified single-stream programs that collect glass separately, as these have lower inbound glass contamination rates. Other collection practices, such as deposit and redemption systems, have also been shown to reduce contamination rates (Oregon DEQ, 2020) (WWF, 2022).

3.3 Sorting

Effective sorting of collected paper waste is crucial to achieve high recycling rates. Sorting aims to minimize the presence of contaminants such as plastics, metals, glass, and organic matter that can make paper unsuitable for recycling and to separate paper products and packaging into specific grades. Sorting is especially important for paper collected from residential single stream, where paper is mixed with other recyclables.

Paper is sorted and baled into various grades at MRFs. Common paper grades from residential collection include mixed paper and OCC. Common paper grades for the ICI sector include OCC, sorted office paper and sorted white ledger (ISRI, 2022).[10]

While sorting was originally done entirely manually, the use of automation has increased over time. Many MRFs employ a combination of manual sorting and mechanical technologies, using equipment such as optical sorters and robots. The different types, technologies, and capacities of sorting systems in the US and Canada are described below.

3.3.1 United States and Canada

Sorting Process and Equipment

In the US and Canada, sorting systems and technologies vary for each MRF. However, at a high level, the process is generally as follows:

1. At the MRF, trucks unload single- or dual-stream recyclables onto the tipping floor. The recyclables are then placed on a conveyor belt, which distributes the material for inspection and separation.
2. Through the combined work of automated machines and staff, different material types are sorted from the co-mingled recyclables. These sorting technologies, discussed in more detail below, recognize target items by shape, color, or specific material composition.
3. Once sorted and separated, the various paper grades are transported along conveyor belts to be baled.

The sorting of fibers at MRFs has been automated over time. Because larger facilities can achieve economies of scale, they are more likely to be able to invest in automated sorting equipment, including more specialized mechanical equipment. In general, then, the larger a facility, the more automated it will be. Because advanced sorting technologies are necessary both to remove contamination and to sort fibers according to specifications for recycling, opportunities for improving circularity are more likely to be found in larger MRFs. However, there are exceptions to this trend in the form of low-tech large facilities and technologically advanced smaller facilities.

Sorting technology consists of both separation and identification technologies. Separation technology is used to physically move different types of material away from each other. Identification technology can recognize different material types or their specific qualities, but it generally requires some separation technology to then move the material based on that classification. Sorting technologies can further be classified as either positive or negative. Positive sorting involves recognizing, selecting, and ejecting a target product (and only that product) from the rest of the stream, while negative sorting focuses on removing contamination from the stream.

[10] IRSI publishes a Scrap Specifications Circular annually, which provides guidelines for buying and selling a variety of processed scrap commodities, including paper. The grade numbers refer to the ISRI paper specifications.

Table 10 gives an overview of the types of sorting equipment and technologies used at MRFs. Subsection 6.2 presents a more detailed discussion of emerging technology and equipment.

Table 10. Sorting equipment at materials recovery facilities (MRFs)

Equipment	Type	Functions
Cardboard separator	Mechanical (steel discs)	Separation at the beginning of the sorting process of large OCC pieces
Dimensional separator	Mechanical (disc of ballistic)	Separation of 2D from 3D bodies in order to direct them to fiber line and container line, respectively.
Optical sorter	Optics (spectroscopy infrared)	Near infrared spectroscopy can be used to increase the purity of paper streams by removing non-paper products such as flexible films.
Specialized equipment	Mechanical sorters such as blowers, paper sensor AI robotic arms	Equipment that separates paper types and further removes non target material, replacing some manual picking

The level of mechanization influences the amount of material that will be baled for recycling and the degree of contamination. A recent report from ECCC found that many of Canada's smaller MRFs do not have advanced sorting equipment, leading to higher contamination rates in output bale; this impacts on the ability domestic mills to use collected material resulting in increased exports.

Some of the leading manufacturers of robotic sorting equipment in the US and Canadian markets include AMP Robotics, Bulk Handling Systems, Machinex, Pellenc, Waste Robotics, and ZenRobotics (Pyzyk, 2019). Technologies are integrated into US and Canadian systems via both retrofitting existing facilities and completely new builds. In some cases, technology retrofits can become more costly than starting from scratch with an entirely new system (Pyzyk, 2019).

Yield Losses

Material loss can occur at MRFs as well as at reprocessors, and loss rates vary for different packaging materials. The issues associated with losses are similar across the US and Canada.

Eunomia's 2021 report, *The 50 States of Recycling*, found that yield loss rates range from 3% to more than 20% across packaging types (Eunomia, 2021). Fiber losses are generally less than for other materials such as plastics. Sorting losses at MRFs can occur when material is missed by equipment or manual pickers, or when collected material is not of sufficient quality to be marketed (e.g., if it is too highly contaminated). Material can be missed by sorting equipment because of:

- Issues related to packaging design (e.g., black plastics cannot be detected by optical sorters).
- Packaging size (e.g., material can be too small to be detected).
- Residues of product on the packaging preventing it from being correctly sorted.

- Changes in the shape of a container preventing it from being correctly sorted (e.g., flattening of 3-D items reduces the ability of MRF equipment to effectively recognize and separate it into the correct stream).

Sorting losses differ by facility. They also depend on the scale of operation and process design within MRFs; the degree to which MRFs are operating effectively (within design parameters, with well-maintained sorting equipment, and at effective sorting speeds); and the fluctuation in prices for different grades of sorted material. Processing losses can also be due to moisture, dirt, labels, coatings, caps, and glues.

A 2015 study tested five MRFs in the US, one processing dual-stream recycling and four processing single-stream, to determine their loss rates by material type (RRS, 2015). The average loss rates for MRFs by paper type are shown in Table 11.

Table 11. Average materials recovery facility (MRF) loss rates by paper type in the US (2015)

Paper type	MRF Loss rates
Newsprint	7%
Mixed Fiber	7%
Cardboard	1%

Source: (RRS, 2015)

Cost of Sorting

As with yield losses, the issues associated with sorting costs are similar across the US and Canada.

According to a study by Northeast Recycling Council (NERC) and The Recycling Partnership, processing costs for MRFs average US$88 per tonne. For states in the Northeastern US, NERC calculated the average blended value of material, including the cost to dispose of residual waste in 2022, as US$76 per tonne (NERC, 2023). MRFs in the area therefore had an average deficit of US$14 per tonne. Facilities can mitigate this in various ways, including increasing tipping fees.

MRF profitability is crucial to ensure paper circularity; it enables facilities to invest in technology and improve processes to improve sorting and adapt to the emergence of new materials in the recycling stream. EPR regulation can benefit MRFs if PROs cover gross sorting and absorb all of the revenue volatility from the sale of material.

Sorting Outputs

As with yield losses and sorting costs, the issues associated with sorting outputs are similar across the US and Canada.

The ISRI paper specification set out the maximum acceptable level of contamination for each bale type. Based on the type and quality of bale, the guidelines provide a maximum percentage of prohibited material and contamination, which can range from 0.5% to 5% (ISRI, 2022). An assessment of MRFs in King County, Washington estimated that paper bales have an average

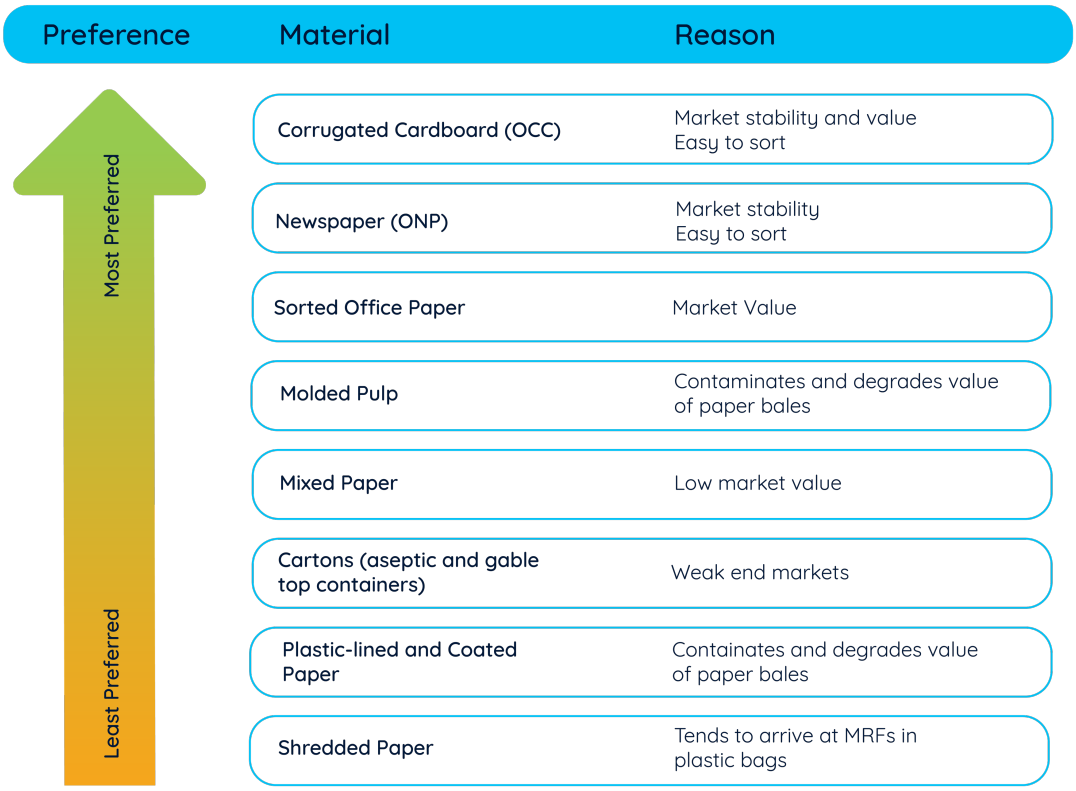
contamination rate of 3–5% (King County Department of Natural Resources and Parks, 2020). This may not be typical for other sorting systems, however, and contamination rates can be as high as 16% (Smalley, Markets for mixed paper, 2018). Table 12 outlines these challenges and describes the impact on the cost of sorting, processing, and recycling paper as well as the overall impact on paper circularity.

Table 12. Source of contamination for sorted paper and impacts on costs and circularity, US and Canada

Source of contamination	Impact on cost and circularity of paper
Glass	Glass can break during collection and the glass shards become embedded in paper. Glass particles can increase machinery wear, resulting in higher maintenance and recycling costs.
Plastic	Plastic can be picked up by 2D sorters and directed to the paper stream. A study of MRFs showed that around 34% of small PET containers and 8.5% of PET bottles are sorted into the mixed paper stream (RRS, 2015). Flexible plastic twists around sorting equipment, require manual removal by MRF employees, which is costly and slows down the sorting process (Damgacioglu, 2020). Furthermore, the light weight of flexible plastic makes it prone to being sorted into mixed paper bales (RRS, 2020).
Other non-target material	Flattened material such as polystyrene foam, plastic thermoforms, waste residue, aluminum cans, and aluminum foils can be picked up by disc sorters and contaminates paper bales (Damgacioglu, 2020).
Multi-layer and multi-laminate paper	Multi-layer and multi-laminate paper products can increase sorting costs and reduce efficiency in the recycling process. These products require additional processing before they can be pulped, as non-target materials such as plastic and aluminum, need to be separated from the paper.
Non-paper items	Non-paper items, like plastic bags and flexible film, are light and can be mistakenly sorted with paper. Plastic film is a contaminant; it lowers the quality and economic value of a paper bale.
Wet or frozen paper	Wet and freezing weather in northern climates can dampen or saturate paper collected for recycling. The sorting process relies on differences in weight to separate lighter materials such as cardboard and paper. However, when the paper is wet, moldy, or mushy, it cannot be effectively sorted. Moreover, wet paper sheets tend to stick together, jamming the sorting machinery, causing equipment downtime, requiring maintenance, and increasing costs. Wet paper is a problem because it will cause breakage and shortening of the fibers, making the paper harder to recycle or resulting in its being sent to landfill.
Shredded paper from residential collection	Shredded paper is valuable if captured separately, as it can be baled in higher grades and sold for a higher price. MRFs are not designed to separate shredded paper from residential collection; it falls through the screens early in the sorting process and often is sent to landfill along with other rejected materials. This means that MRFs can miss a valuable economic opportunity. By contrast, material from shredding companies or other commercial sources is processed separately and baled as high-grade paper.

Through their ASTRX project, the Sustainable Packaging Coalition and The Recycling Partnership surveyed MRFs in the US to classify paper material from the most to least preferred (ASTRX, 2019). The results are outlined in Figure 15.

Figure 15. Classification of paper material by materials recovery facilities (MRFs), from most to least preferred



Source: Adapted from ASTRX Review of Material Flow at MRFs and Reprocessors

The material categories detailed in Figure 15 correspond with the five most common paper grades into which recovered papers are sorted regionally. These grades, which are used globally, are:

- **Old Corrugated Cardboard (OCC),** commonly known as corrugated cardboard, can be recycled to produce shipping boxes and recycled paperboard for product packaging, such as cereal boxes and shoe boxes.
- **Mixed paper**, a broad category that includes varying proportions of the other four paper grades listed above, in addition to white and grey boards. Mills use a portion of mixed paper to produce containerboard, or as a raw material in products such as gypsum wallboard, chipboard, and roofing felt.
- **Sorted Residential Papers and News (SRPN),** primarily used by mills to produce insulation and molded pulp.
- **Sorted Office Paper (SOP)**, which can be recycled into tissue, toweling, and new writing/printing paper.

- **Pulp substitutes**, which are shaving or clippings from high-grade papers that come from converting operations at paper mills and print shops (ISRI, 2019).

These paper grades are used to track material imported and exported and provide the basis on which materials are valued; this is discussed further below.

Sorting Capacity

Limited data are available on total sorting capacity in the US and Canada. Table 13 provides a list of the 10 largest MRFs in the US and Canada, ranked according to shipped tonnages in 2020, out of a total number of more than 600.

Table 13. Ten largest MRFs in the US and Canada (2020)

Ranking	Plant Operator	MRF Location	Total Tonnage Shipped 2020
1	Sims Municipal Recycling	Brooklyn, New York, US	230,600
2	GFL Environmental	Toronto, Ontario, Canada	218,850*
3	Waste Management Inc.	Hodgkins, Illinois, US	215,445
4	Republic Services	North Las Vegas, Nevada, US	208,000*
5	Waste Management Inc.	Hopkins, Minnesota, US	184,102
6	Waste Management Inc.	Elkridge, Maryland, US	180,183
7	RWS of Southern California (Republic)	Anaheim, California, US	178,000*
8	S.W. Authority of Palm Beach County	West Palm Beach, Florida, US	169,400*
9	Waste Management Inc.	Pembroke Pines, Florida, US	167,666
10	Rumpke Recycling	Cincinnati, Ohio, US	163,404

Source: (*Recycling Today*, *2020*), Note: *Tonnages estimated by Recycling Today.

3.3.2 Challenges for paper sorting

The two main challenges that MRFs face in sorting paper are separating fibers into the desired grades and removing contamination. Paper mills create secondary paper products to recipes that specify the types of waste paper, and thus the types of fibers, that can be used as feedstock. For instance, a recipe for secondary cardboard will have a tolerance limit on the amount of fiber input from other paper products that can be used. Similarly, other secondary products will have varying tolerance limits for different types of fibers. Therefore, where there is a lack of technological capacity for sorting paper into distinct grades, this presents a barrier to circularity. Improving the ability of MRFs to sort fibers more extensively (for example, by enabling them to sort mixed paper into its constituent fiber components), would allow for higher quality paper recycling.

While contamination tolerance levels vary by paper grade, to create high-quality recycled paper products, recyclers need good quality fibers and low levels of contamination. When paper is

collected with other packaging materials, it often becomes contaminated (for example, with plastics or food waste, including grease or other residues from food items) and/or is exposed to moisture. Non-target materials (such as plastics) must be sorted at MRFs, but it is harder to remove contaminated paper. If contaminated bales are sent to paper mills for recycling during the pulping process, contaminated paper is separated out and may be sent to a landfill. Therefore, contamination leads to fiber loss and reduces paper circularity.

3.4 Recycling

Recycling is essential to building a circular economy. Once collected and sorted, most paper is reprocessed at a paper mill through a series of steps, including pulping, cleaning, and potentially deinking and bleaching.[11]

Paper mills can be categorized according to whether they produce pulp, paper products, or both:

- Non-integrated mills that only produce pulp, which they sell to other entities for product manufacturing;
- Non-integrated mills that only produce paper products and do not involve themselves in pulping operations, and thus are not directly involved in the recycling process of used fiber;
- Integrated mills that participate in both processes, pulping the fibers and creating paper products.

Integrated mills may sell their products to a converter for final product creation. A good example is the production of corrugated cardboard boxes. Converters assemble three sheets of containerboard (consisting of a wavy sheet of paper known as a flute, sandwiched between two flat sheets called liners) and apply starch and glue to form the final product.

3.4.1 United States

Recycling Capacity

To produce paper, mills utilize virgin pulp, recovered fiber, or a combination of both as their raw materials. In 2021, approximately 30 million tonnes of recovered paper were used by US paper mills (AF&PA, 2022).[12]

Paper Mills in the US

The American Forest & Paper Association estimates that 80% of paper mills use some recycled paper fiber (American Forest & Paper Association, 2021).
Table 14 shows the capacity of the largest ones.

[11] Other (less common) paper recycling applications include the production of insulation, molded pulp, and construction materials (e.g., roof board, ceiling tile). Refer to section 2.1.

[12] This 74.24MM tonnes calculated using the data provided by AF&PA in this May 23, 2022, news release.

Table 14. Largest paper companies' annual capacity – US

Company	Number of Paper Mills	Number of Converting Facilities	Recycling Plants	Tonnes of Used Fiber Recovered	Annual Paper Capacity (tonnes)
International Paper (International Paper, 2022)	24	163	18	4.5 million	12.5 million
International Paper is a leading global supplier of renewable fiber-based products and is the largest paper company operating in the US by revenue (International Paper, 2022). The company produces corrugated packaging products and pulp for tissue products. Industrial packaging represents 84% of the company's revenue and 14% is generated by cellulose fibers (International Paper 2022). The company is publicly held (NYSE: IP), employs approximately 52,000 people worldwide, and has 358 locations globally with manufacturing operations in North America, Latin America, North Africa, and Europe (International Paper, n.d.).					
West Rock	16	230	18	5.1 million	13.4 million
West Rock operates through four segments: Corrugated Packaging, Consumer Packaging, Global Paper, and Distribution. Corrugated Packaging consists of its integrated corrugated converting operations and is engaged in the sale of corrugated containers and other corrugated products (WestRock, 2022) . Consumer Packaging consists of its integrated converting operations and is engaged in the sale of consumer packaging products, such as folding cartons and interior partitions. Global Paper consists of its commercial paper operations and is engaged in the sale of containerboard and paperboard to external customers. Distribution is primarily engaged in distributing packaging products and assembling display products. The company supports customers around the world from locations spanning North America, South America, Europe, Asia, and Australia. Westrock is publicly held (NYSE: WRK), employs ~50,000 people worldwide, and operates more than 320 facilities globally (WestRock, n.d.).					
Graphic Packaging	8	54	19	0.68 million	3.4 million
Graphic Packaging is a global producer of beverage, foodservice, and other products and a leader in folding cartons and fiber-based products (GPI, 2021). Graphic Packaging is publicly held (NYSE: GPK), employs ~24,000 people worldwide, and has over 130 locations globally (GPI, 2021).					
DS Smith	2	9	1	4.4 million	5.62 million
DS Smith produces consumer and industrial packaging, consumer boxes, specialty and coated papers, and industrial packaging products. They opened their first dedicated fiber recycling facility in the US, in Reading, PA, where they now process 5.5- to 6-million tonnes of OCC per year (Barker, 2021).					
Georgia Pacific	6	9	6	1.8 million	2.5 million
Georgia-Pacific (GP) is one of the leading producers of tissue in the world. It also makes a wide variety of other products, including cardboard packaging, plywood and lumber, paper cups, office paper, and recycled paper fibers.					
Green Bay Packaging	5	24	0	N/A	N/A
Green Bay Packaging produces corrugated containers, folding cartons, coated label products, linerboard, paper slitting, and timber.					
New-Indy	4	1	1	0.748 million (est)	0.68 million

Company	Number of Paper Mills	Number of Converting Facilities	Recycling Plants	Tonnes of Used Fiber Recovered	Annual Paper Capacity (tonnes)
New-Indy is a joint venture by the Kraft Group, LLC and the Schwarz Partners, LP (New-Indy Containerboard, 2023). The company manufactures and supplies corrugated boxes, recycled containerboard, and virgin linerboard in the industrial packaging industry.					
Packaging Corporation of America	8	93	0	1.1 million	4.5 million
Packaging Corporation of America (PCA) manufactures containerboard and corrugated packaging products for protecting goods during shipment. The company also produces multi-color boxes and displays, as well as meat and wax-coated boxes for the agricultural industry (Bloomberg UK, n.d.).					
Pratt Industries	5	55	20	1.8 million	1.73 million
Pratt Industries manufactures containerboard, corrugated boxes and packaging, and specialty printing packaging.					
Greif	18	N/A	19	N/A	1.81 million
Greif Inc. is a manufacturer of recycled paperboard and containerboard.					
Sonoco	14	N/A	25	N/A	1.9 million
In September 2022, Sonoco announced its acquisition of Denmark-based Skjern Paper in a deal worth US$88 million (McNees, 2022).					

Source: Eunomia Research & Consulting and Circular Venture, LLC

3.4.2 Canada

Recycling Capacity

In 2021, approximately 2.7 million tonnes of recovered paper were used by Canadian paper mills (Pulp and Paper Products Council, 2021).

Paper Mills in Canada

The Trade Publication Pulp and Paper Canada provides information on all paper mills in Canada, whether they use recycled feedstock or not (Paper and Pulp Canada, n.d.). The available 2022 information, summarized in Table 15, suggests that there are 30 integrated mills that produce pulp and product and 29 mills non-integrated mills that produce pulp only (there are no paper mills located in Northwest Territories, Nunavut, Prince Edward Island, or Yukon). The publication does not identify the subset of these that use post-consumer fibers in their operations.

Table 15. Number of mills producing pulp-only and producing pulp and products in Canada (2022)

Province	Pulp-Only Mills	Pulp and Products Mills	Total
British Columbia	10	6	16
Alberta	6	2	8
Saskatchewan	1	N/A	1
Manitoba	N/A	1	1
Ontario	2	5	7
Québec	5	14	19
New Brunswick	4	N/A	4
Nova Scotia	1	1	2
Newfoundland and Labrador	N/A	1	1
Total	**29**	**30**	**59**

Source: (Pulp and Paper Canada, 2022)

Consultation with the Canadian Corrugated & Containerboard Association indicates that 11 Canadian mills produce containerboard (Kirkpatrick, 2023). Among these, nine use post-consumer fiber (OCC) as a key input; the two others use mostly virgin fiber but incorporate as much as 20% post-consumer fiber. An estimated total of 29 facilities in Canada use post-consumer fiber, as presented in Table 16. This is down from 34 facilities recycling post-consumer fiber in 2010, as identified in one source (Anonymous).

Table 16. Canadian facilities which use post-consumer fiber (2023)

Company Name	Material(s) Produced	Province	City
Atlantic Packaging Products Ltd.	Container board	Ontario	Scarborough
Atlantic Packaging Products Ltd.	Container board	Ontario	Whitby
Building Products of Canada[13]	Building materials (asphalt shingles and tar paper)	Alberta	Edmonton
Cascades Inc. CCP Cabano	Container board	Québec	Cabano
Cascades Inc. CCP Kingsley Falls	Container board	Québec	Kingsley Falls
Cascades Inc. CCP Trenton	Container board	Ontario	Trenton

[13] Building Products of Canada received 17% of the City of Edmonton's OCC and 5% of their paper in 2022.

Company Name	Material(s) Produced	Province	City
Cascades Inc. CCP Mississauga	Container board	Ontario	Mississauga
Cascades Inc. SPG Papier Kingsey Falls	Uncoated paperboard	Québec	Kingsley Falls
Cascades Inc. SPG Formapak Kingsey Falls	Molded pulp	Québec	Kingsley Falls
Cascades Inc. CTG Kingsey Falls	Tissue	Québec	Kingsley Falls
Cascades Inc. CTG Candiac	Tissue	Québec	Candiac
Cascades Inc. CTG Lachute	Paper hand 47 towel and tissue	Québec	Lachute
CKF	Molded pulp	Nova Scotia	Hantsport
CKF	Molded pulp	BC	Langley
Graphic Packaging	Coated paper Note: this mill uses mostly post-industrial feedstock	Québec	East Angus
Hartmann	Molded pulp	Ontario	Brantford
Igloo	Cellulose	Québec	Montreal
Kruger Inc.	Tissue	Québec	Crabtree
Kruger Inc.	Container board	Québec	Trois-Rivieres
Kruger Inc.	Container board	Québec	Montreal
MPI Papermills Inc.	Tissue	Québec	Portneuf
New Forest Paper (co-owned by Atlantic Packaging)	Container board	Ontario	Scarborough
Sonoco	Tube stock (cores and sono tubes)	Ontario	Brantford
Soprema	Cellulose	Québec	Ste-Julie
Strathcona Paper LP	Boxboard	Ontario	Napanee
Sustana	Pulp Sheets made of recycled fibers	Québec	Levis
Thermocell Industries	Cellulose	Nova Scotia	Debert
Ther-O-Comfort	Cellulose	Ontario	St-Thomas

Source: (NovAxia Inc, 2021) (ReMM, 2019)

3.4.3 Challenges for paper mills

Paper mills and recyclers face several challenges to increasing the use of recycled content and building a circular economy for paper.

The primary barrier identified by paper mills is technical capability, particularly for older facilities. Many mills were built before recycling became widespread and were designed to use virgin fiber as their feedstock. Retrofitting these to use 100% recycled content is expensive, with Circular economy consultancy Circular Ventures estimating conversion costs at between US$250– US$450 million per mill in the US and Canada. All mills are capable of incorporating some recycled content. They may choose not to do so because of fluctuations in the price of fiber, the availability of virgin raw material, demand for specific aesthetic characteristics (such as color and brightness) for end products, and requirements on the use of recycled content in food contact applications. These barriers are discussed below.

Ultimately, each individual paper mill must make decisions about what paper grades to accept. Not all mills are able and willing to pulp multi-material packaging that is primarily paper-based, such as food and beverage cartons and single-use paper cups. According to the Carton Council of Canada's web site (Carton Council Canada, 2023), four paper mills take this grade across the US and Canada (Sustana's facility in Lévis, Québec, Canada, Sustana's mill in Wisconsin and Great Lakes Tissue in Michigan. All three made the business decision to use recovered cartons, based on the cost to process them relative to the return. Parameters such as agitation time, pH levels, and water temperature need to be adapted to specific grades (Carton Council of Canada, 2020).

Moreover, fibers that contain high levels of ink, such as old magazines, are problematic for mills that are not equipped with a de-inking system. In the context of increasing scrutiny on plastics and the global momentum to reduce single-use plastics, many companies are evaluating the benefits of fiber-based packaging as an alternative. This is driving the development of new uses for fiber-based packaging in niches such as flexible packaging, for purposes including beverage containers, food packaging, and many more. Such alternative fiber-based packaging often comes with coatings that may or may not be compatible with the fiber recycling process. Recyclability testing has emerged as one way to determine whether these new types of packaging meet recyclability needs (Sustainable Packaging Coalition, 2023).

Another barrier to increasing the recycled content is integration. Some paper companies with mills own forest lands and prefer to use only their own supply of raw wood rather than purchase recycled fiber on the open market, which is subject to wide price fluctuations.

In some instances, for specific products and their packaging, consumer demand and preferences can represent a third barrier. Paper mills often respond to the needs and desires of the markets they serve. For example, high-end cosmetics or pharmaceutical products want a very bright, white box, limiting the ability to use recycled content, as this tends to skew the color of a final product towards brown. Similarly, high-end tissue products, such as those used in the home, often use virgin pulp because consumers prefer white napkins and paper towels. However, it should also be noted that, where consumer demand for paper-based packaging is increasing for environmental reasons

(driven, for example, by public awareness of problems associated with plastic packaging pollution), this is a motivating factor for paper circularity.

Another barrier is the availability of recycled content, particularly high-grade, white office paper. The digitalization of many activities has reduced the amount of white recycled office paper available, causing the price of recycled content to rise. This makes it more economical for mills to use virgin pulp as a feedstock for products such as high-end tissue.

Regulations pertaining to food contact present another barrier. In the United States, packaging that comes into contact with food must comply with the Food and Drug Administration's requirements. FDA regulation allows the use of pulp from reclaimed fiber, provided it is prepared by repulping paper and paperboard products with water to recover the fiber with minimal nonfibrous substances and the feedstock used does not contain harmful substances (Code of Federal Regulations, 2023). The Recycled Paperboard Technical Association (RPTA) has developed a comprehensive program to ensure compliance with FDA requirements for recycled paperboard and containerboard used in food-contact applications, including controlling sources of recovered fiber, using additives suitable for food contact, and implementing microbiological and chemical testing protocols, among other measures (RPTA, n.d.).

The AF&PA surveyed 86 paper mills in the US to highlight common non-fiber elements found on paper packaging that may generate challenges in the recycling process (AF&PA, 2021). These include adhesives, inks, dyes, tapes, labels, metals, plastics, barrier coatings, and foils. Note that the AF&PA defines an element as a "challenge" when it slows down the pulping process, plugs fiber screening systems, or contaminates the recycled fiber. Though paper mills employ a generally standardized paper production process, there are variations across mills regarding acceptable levels for contaminants (AF&PA, 2021) (Closing the loop, 2015). The study showed that hot melt adhesives, wet strength resins, and foils (laminated, stamped, and metalized) all reduce recyclability for all packaging types, with the exception of foils for kraft paper bags. Wet strength additives, which are used to improve the water resistance of packaging, can impede the successful separation of fibers. Given the rising trend of paper packaging replacing plastic in food and refrigeration contexts, packaging producers should be aware that the increasing prevalence of these types of packages on the market may have negative implications.

Water-soluble dyes, water-based inks, ultraviolet (UV) and electron beam (EB) inks, water-soluble adhesives, and clay and varnish coatings do not significantly disrupt the recycling process across all packaging types. They are thus preferable for incorporating in packaging product design. Other non-fiber elements were identified as disruptive for some types of paper packaging but not others.

The ECCC report, *The State of Paper Recycling Including Paper Waste Regulations in Canada*, presents the results of interviews with, and surveys of, stakeholders representing paper mills, MRFs, brokers, governments, industry associations and other related organizations, and equipment suppliers to identify the barriers to recycling (ECCC, 2023). For the ICI sector specifically, the report found that, in the absence of requirements to recycle with enforceable financial consequences, disposal is the most economical choice. This is because the cost of disposal for paper waste from the ICI sector is lower than the cost of recycling. It is thus challenging to create economies of scale in regions where

recycling programs are inconsistent, in terms of types of collection provided and materials accepted at MRFs.

Table 17 shows the types of contamination to paper packaging by non-fiber elements in paper mills in the US and Canada, and whether they are acceptable or challenging to process, drawing on the reports from the AF&PA and the ECCC. "Challenging" denotes paper packaging design features that present recycling challenges at paper mills, "acceptable" those that adversely impact the recycling process, and "NA" cases where the relevant element does not typically form part of the packaging (AF&PA, 2021).

Solutions for addressing the challenges highlighted in the AF&PA survey are discussed in Section 6.1 on product design.

Table 17. Contamination by non-fiber elements and whether they are acceptable or challenging to process in paper mills, US and Canada

Non-Fiber Items with the Potential to Impact	Paper Packaging						
	Corrugated packaging	Bleached paperboard cartons	Recycled /unbleached boxboard	Carrier stock cartons	Kraft paper bags	Multiwall shipping sacks	Molded fiber containers
Paper/ polymer tape, pressure sensitive labels	Acceptable	N/A	N/A	N/A	N/A	N/A	N/A
Water-based/UV and EB inks	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Water-soluble dyes	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Water soluble adhesives	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Hot melt adhesives	Challenging	Challenging	Challenging	Challenging	Challenging	Challenging	N/A
Clay and varnish coatings	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Wax coating	Challenging	N/A	N/A	N/A	N/A	N/A	N/A
Polymer barriers	Acceptable	Acceptable	Acceptable	Acceptable	Challenging	Acceptable	Acceptable
Bioplastic barriers	Challenging	Challenging	Acceptable	Acceptable	Challenging	Challenging	Acceptable
Metals	Challenging	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	N/A
Plastics	Challenging	Challenging	Acceptable	Acceptable	Acceptable	Challenging	N/A
Polymer windows	Acceptable	Challenging	Acceptable	Acceptable	Acceptable	Challenging	N/A
Non-tree fibers	Acceptable	Challenging	Acceptable	Acceptable	Acceptable	Challenging	Acceptable
Foils (laminated, stamped, and metallized)	Challenging	Challenging	Challenging	Challenging	Acceptable	Challenging	Challenging

Source: Adapted from (AF&PA, 2021).

3.5 Trade

Paper waste is an indispensable part of the circular economy, providing an essential substitute for wood and other plant-based fibers in the paper-making industry. As a result, this waste stream has significant economic value and is traded internationally. Using HS codes (six-digit codes that enable product types to be uniquely identified), it is possible to track this trade, both in terms of tonnage traded and the value of those transactions. Table 18 highlights the HS codes relating to waste paper products identified in the United Nations' Comtrade database.

Table 18. Harmonized System (HS) codes for paper waste

HS Code	HS Product Description	Assumed product type
470710	Paper or paperboard; waste and scrap, of unbleached kraft paper or paperboard or of corrugated paper or paperboard.	OCC
470720	Paper or paperboard; waste and scrap, of paper or paperboard made mainly of bleached chemical pulp, not colored in the mass	High grades
470730	Paper or paperboard; waste and scrap, of paper or paperboard made mainly of mechanical pulp (e.g., newsprint, journals and similar printed matter)	Sorted Residential Papers and News (SRPN)
470790	Paper or paperboard; waste and scrap, of paper or paperboard not elsewhere specified.	Mixed paper
470620	Pulp of fibers derived from recovered (waste and scrap) paper or paperboard	Pulp made from recycled fibers

Source: UN Comtrade.

Further details on the quantity and value of each product type imported and exported by the US and Canada are provided below.

3.5.1 United States

As explained above, the US was a net exporter of waste paper products in 2021, with a net trade balance of -15.8 million tonnes and + US$3.4 billion.

Table 19 highlights that the OCC grade made up most of the tonnages imported and exported, constituting 69.2% and 63.1% respectively. From a trade value perspective, OCC was also the biggest contributor to the US total exported value, accounting for 56.5%.

Table 19. Trade data for waste paper products in the US (2021) (in millions of tonnes, US$)

HS Code	Imports				Exports			
	Mt	%	Million US$	%	Mt	%	Million US$	%
OCC	0.61	69.2	96.1	64.4	10.53	63.0	1,992.7	56.5
High Grades	0.03	3.5	6.5	4.4	2.03	12.1	547.8	15.5
ONP	0.03	3.5	6.2	4.1	1.08	6.5	235.2	6.7
Mixed paper	0.20	23.0	36.2	24.3	2.70	16.2	526.8	14.9
Recycled pulp	0.01	0.8	4.2	2.8	0.36	2.2	227.0	6.4
Total	**0.88**		**149.2**		**16.69**		**3,529.6**	

Source: UN Comtrade, World Bank's World Integrated Trade Solution.

Table 19 also shows that the US was a net exporter for waste paper in 2021, both in terms of tonnage and value. This was likely due to limited recycling capacity in domestic mills in the US and favorable economic conditions in receiving countries, where labor and transportation costs are lower.

Using UN Comtrade and the World Bank's World Integrated Trade Solution, it is possible to identify the US's largest trade partners who import waste paper from the US, for each waste paper grade. Table 20 shows the US's largest export partners in 2021, by tonnes exported. India is the largest from an exporter's perspective, receiving 4.0 million tonnes in 2021. OCC (1.92 million tonnes, 48.4%) and mixed paper (1.56 million tonnes, 39.3%) make up the largest proportions of waste paper exported from the US. Mexico is the second-largest export destination for waste paper, importing 2.3 million tonnes in 2021. This was predominantly OCC (1.0 million tonnes) and high grade (0.9 million tonnes). Canada was the US's fifth-largest export market by tonnage exported, receiving 1.0 million tonnes.

Table 20. US's largest export trading partners, by waste paper grade (2021) (values in brackets indicate millions of tonnes traded and value in US$, ranked by tonnes exported to these countries)

Rank	OCC	High grades	ONP	Mixed paper	Recycled pulp
1	India (1.92m, US$373.3m)	Mexico (0.95m, US$235.6m)	Thailand (0.21m, US$57.8m)	India (1.56m, US$295.8m)	China (0.28m, US$179.5m)
2	Vietnam (1.79m, US$330.8m)	India (0.39m, US$109.4m)	Mexico (0.20m, US$40.0m)	Canada (0.25m, US$42.6m)	Canada (0.06m, US$37.4m)
3	Thailand (1.38m, US$274.0m)	Canada (0.14m, US$34.0m)	Rep. of Korea (0.14m, US$28.1m)	Thailand (0.17m, US$24.9m)	Italy (0.00m, US$2.3m)

Rank	OCC	High grades	ONP	Mixed paper	Recycled pulp
4	Mexico (1.00m, US$198.3m)	Rep. of Korea (0.12m, US$42.0m)	Canada (0.11m, US$26.8m)	Brazil (0.11m, US$30.9m)	Mexico (0.00m, US$2.0m)
5	Malaysia (0.69m, US$120.4m)	Colombia (0.08m, US$25.3m)	India (0.10m, US$18.9m)	Mexico (0.11m, US$29.9m)	UK (0.00m, US$1.7m)

In 2017, China's National Sword program restricted the import of recyclable waste (Vedantam, 2022) and placed a limit of 0.5% contamination on imported waste; this has greatly reduced the amount of paper it receives from the US. As a consequence, the value of mixed paper—a major product from single-stream MRFs—plummeted from US$73 per tonne in 2017 to US$7 per tonne in 2018 (US EPA, 2020). As shown in Table 20, China does not feature as one of the five largest export partners for OCC, high grades, ONP or mixed paper.

However, China has not banned imports of recycled pulp and is by far the largest destination of US-exported recycled pulp. The investments of the Chinese paper giant, Nine Dragons, in US paper mills suggest it plans to continue importing recycled pulp from the US. In 2018, Nine Dragons purchased mills in Biron, Wisconsin, and in Rumford and Old Town, both in Maine (Paben, 2023). These mills previously used virgin pulp to produce paper products and Nine Dragons made substantial investments to convert them to recycle post-consumer fiber, including OCC and mixed paper. Nine Dragons also bought a recycled pulp production mill in Fairmont, West Virginia. However, Chinese market demand for this material is currently weak due to the impact of COVID-19, inflation caused by the war in Ukraine, and the substantial decrease in product sale prices, despite relatively stable input costs and sales volumes. This has meant some paper mills that consume recycled content in the US have temporarily halted or reduced their production, including Nine Dragon's mill in Old Town, Maine (Paben, 2023).

In comparison to US exports, the origin of waste paper and pulp imported to the US is less complicated. Table 21 highlights the US's largest import partners in 2021, by tonnes exported. Where exporting trade partners are named but no values are given, this indicates that import tonnages round to less than 10,000 tonnes, and where no countries are named this indicates that there are no imports.

Table 21. US's largest import trading partners by waste paper grade (2021) (values in brackets indicate millions of tonnes traded and value in US$, ranked by tonnes exported from these countries to the US)

Rank	OCC	High grades	ONP	Mixed paper	Recycled pulp
1	Canada (0.60m, US$93.6m)	Canada (0.03m, US$6.4m)	Canada (0.03m, US$5.3m)	Canada (0.20m, US$35.8m)	Canada (0.01m, US$3.9m)
2	Mexico (0.01m, US$2.3m)	China	Mexico (0.00m, US$0.8m)	Mexico (0.00m, US$0.3m)	China

Rank	OCC	High grades	ONP	Mixed paper	Recycled pulp
3	China (0.00m, US$0.1m)	Mexico	China	China	UK
4	Cayman Islands	Rep. of Korea	Germany	Dominican Republic	–
5	Czech Republic	–	Rep. of Korea	Slovakia	–

In all waste paper and pulp grades, the US imported the greatest tonnage from Canada. Using Table 20 and Table 21, it is possible to examine the trade relationship between the US and other countries within North America (including Mexico, which is a major trade partner). The US is a net exporter of waste paper to Canada; in 2021, the US exported 1.0 million tonnes and imported 0.9 million tonnes. As a result, net exports in 2021 equaled to 0.1 million tonnes. Table 20 and Table 21 also show that the US was also a net exporter to Mexico, having exported 2.3 million tonnes of paper waste in 2021 and imported only 19.8 kilotonnes.

3.5.2 Canada

Like the US, Canada was a net exporter of waste paper in 2020, with a net trade balance of -0.5 million tonnes and CAD 37.0 million. Table 22 highlights that the OCC grade makes up the largest proportion of the tonnages imported and exported, constituting 37.7% and 60.3% respectively. The second most traded paper grade was mixed paper, although this has declined over the last three years, falling from 36% in 2019 to 28% in 2020 and 21.5% in 2021. This was likely a reflection of China's policies to significantly limit the volumes of waste paper it accepted from other countries.

Table 22. Trade data for waste paper products in Canada (2020) (in millions of tonnes, US$)

HS Code	Imports				Exports			
	Mt	%	Million US$	%	Mt	%	Million US$	%
OCC	0.36	37.7	66.4	34.9	0.87	60.3	130.5	57.3
High Grades	0.12	12.7	34.3	18.0	0.04	2.5	10.2	4.5
ONP	0.10	10.1	26.1	13.7	0.11	7.9	16.5	7.2
Mixed paper	0.24	25.6	42.8	22.4	0.40	27.9	61.4	27.0
Recycled pulp	0.13	13.9	21.0	11.0	0.02	1.4	9.0	4.0
Total	0.95	100%	190.6	100%	1.45	100%	227.5	100%

Source: UN Comtrade, World Bank WITS & Statistics Canada (2020?)

In comparison to the US, Canada imported comparable tonnages of each paper grade and so the country was not a net exporter of all waste paper grades. As shown in Table 22, Canada was a net

importer of high grades and pulp made from recycled fibers by tonnage and value. It imported these for use as feedstock in domestic paper mills.

Through Statistics Canada, it was possible to identify Canada's largest trade partners for each waste paper grade. From the perspective of imports, the dominant trading partner was the US, which accounted for at least 99% of all imports (or 0.94 million tonnes in 2020). It was a similar picture from a trade value perspective, with waste paper imports from the US accounting for at least 97% of the value.

In the exports market, the dominance of the US was not so apparent, with waste paper products exported to a wider range of countries. Although the US was Canada's predominant export trading partner in three of the five waste paper grades (OCC, high grades and mixed paper), Canada also exported waste to India and China—its largest export markets in the ONP and recycled pulp grades, respectively. Table 23 outlines Canada's largest export trading partners, ranked by tonnes exported in 2020, by grade.

Table 23. Canada's largest export trading partners by waste paper grade (2020) (values in brackets indicate millions of tonnes traded and value in US$, ranked by tonnes exported to these countries)

Rank	OCC	High grades	ONP	Mixed paper	Recycled pulp
1	United States (0.41, US$ 72.2 m)	United States (0.02, US$6.9m)	India (0.04, US$4.6m)	United States (0.13, US$26.8m)	China (0.01, US$5.76m)
2	India (0.21, US$ 16.7 m)	India (0.00, US$0.83m)	China (0.03, US$3.5m)	India (0.12, US$16.9m)	United States (0.01, US$2.85m)
3	China (0.10, US$ 18.4 m)	South Korea (0.00, US$0.96m)	United States (0.03, US$6.0m)	China (0.08, US$8.8m)	Viet Nam (0.00, US$0.10m)
4	Viet Nam (0.05, US$ 7.7 m)	Mexico (0.00, US$0.61m)	South Korea (0.01, US$1.3m)	Taiwan (0.04, US$4.5m)	Brazil (0.00, US$0.12m)
5	Taiwan (0.04, US$ 6.4 m)	Thailand (0.00, US$0.24m)	Mexico (0.00, US$0.6m)	Thailand (0.01, US$0.84m)	Denmark (0.00, US$0.10m)

Source: UN Comtrade, World Bank WITS & Statistics Canada.

Using Table 23, it is possible to examine the trade relationship between the US and Canada. It showed that Canada was a net importer of paper waste from the US in 2020; 0.94 million tonnes of paper waste were imported and 0.60 million tonnes exported. This is mainly because Canada has proportionally more developed waste processing infrastructure in place and therefore can manage larger quantities of waste relative to the US.

3.6 Market Overview Summary

There are several phases in the paper material flow from production to placement on the market (POM), consumption and waste generation, collection, sorting, feedstock production, and remanufacturing.

The collection of recyclable materials in the US and Canada varies widely by geographic location, jurisdictional regulatory authority, existing infrastructure, and local population density. Paper recycling collection is different for single-family households, multi-family households, residents in rural areas, and ICI properties. Distance to sorting facility, property type, policy, availability of end markets, and material value all influence what is collected from which generators. Ensuring convenient and widespread access is crucial to maximizing the amount of paper captured by collection systems and improving paper recycling rates.

Effective sorting of collected paper waste is crucial to achieve high recycling rates. Sorting aims to minimize the presence of contaminants such as plastics, metals, glass, and organic matter that can make paper unsuitable for recycling. Sorting is especially important for paper collected using residential single-stream systems, where it is mixed with other recyclables. Many material recovery facilities (MRFs) use a combination of manual sorting and mechanical technologies, such as optical sorters and robots, to sort and bale paper waste into various grades.

The most common paper grades for paper collected from residential sources are mixed paper and OCC. The most common bales for the ICI sectors are OCC, sorted office paper, and sorted white ledger. The US and Canada are home to large, vertically integrated MRFs with high sorting capacities. These high capacity MRFs also have technology and equipment that reduce the need for manual labor, and they are investing in equipment and integrating new technologies like AI to further improve sorting.

Once collected and sorted, recovered paper is recycled at a paper mill, where it undergoes several rounds of pulping and cleaning and sometimes also deinking and bleaching. The quality of the recycled paper products produced by paper mills depends on the quality of the fibers used and the level of contaminants in bales. Non-target materials and contaminants lower the quality of paper bales and their economic value. If paper bales contain an excessive amount of contamination and fail to meet the mill's standards, they may end up being sent to landfill. Contamination thus leads to fiber loss and reduces paper circularity.

4 Secondary Markets

In this context, secondary markets (also known as end markets) are those in which recovered and sorted paper (the secondary material) is sold on to reprocessors. Secondary markets are crucial to the recycling system: they provide demand for recycled material and give it economic value, thereby incentivizing the collection, sorting, and processing of recyclable waste.

There are four main secondary markets for post-consumer recycled fiber (ECCC, 2023):

- **Containerboard**: This secondary market mainly uses brown fibers to produce components for the manufacture of both corrugated and non-corrugated cardboard boxes. The former include both linerboard and corrugated medium, while the latter comprises paperboard for the food sector (such as cereal boxes), cosmetic and personal care (such as toothpaste boxes), and general product protection. Containerboard must meet strength criteria for performance in cardboard boxes, so any recycled fibers used in its production must be of a certain quality.
- **Tissue paper/printing paper**: This secondary market mainly uses white fibers to produce tissue paper, toilet paper, and other similar soft papers, as well as office printing paper. Sometimes brown fibers are used for toilet paper in the out-of-home sector (e.g., restaurants and hotels).
- **Molded pulp**: This secondary market mainly uses mechanical fibers (newsprint). Molded pulp is a packaging material made of paper and water, molded for tray-type packaging, protection, or single-use products.
- **Insulation cellulose**: This secondary market mainly uses mechanical fibers of very high purity to produce paper wadding, which is used to insulate ceilings thermally and acoustically.

4.1 US and Canada

In the US, 46 million tonnes of waste paper were sorted for recycling in 2021. Approximately 30 million tonnes (65%) of this were sent to US paper mills for reprocessing, with the remaining 16 million tonnes (35%) exported. However, the proportion exported varies for each grade of waste paper. Circular economy consultancy Circular Ventures estimates that, in 2021, 68% of sorted OCC bales were processed in US paper mills, while 57% of other grade bales were reprocessed domestically.

Of the 30 million tonnes reprocessed in domestic mills, containerboard is the largest secondary market for recovered paper in the US, with 18.5 million tonnes (62%) of recovered fiber being used to remanufacture it (AF&PA, 2022). When accounting for processing losses, approximately 17.2 million tonnes of recycled fiber are used to make 35.4 million tonnes of containerboard, giving containerboard an average recycled content of 49%. As Table 24, the recycled content used in other paper grades is lower, at 32% on average.

Table 24. Amount of virgin and recycled pulp in containerboard vs all other paper grades in the US (2022)

	Tonnes Manufactured in US	Tonnes Recycled Fiber used in US mills	Recycled Fiber (including processing loss)	Tonnes Virgin Pulp	Percent Recycled Content
Containerboard	35.3 million	18.5 million	16.8 million	18.5 million	48%
Boxboard	32.0 million	5.5 million	4.9 million	21.9 million	32%
Tissue		3.2 million	2.8 million		
Newsprint & other		2.6 million	2.4 million		
Total	**67.3 million**	**29.8 million**	**27.0 million**	**40.3 million**	**40%**

Source: AF&PA (2022) & Circular Ventures, LLC

In Canada, 3.5 million tonnes of waste paper were sorted for recycling in 2020. In comparison to the US, which exported around 35% of sorted waste paper, Canada exported only 15% (0.5 million tonnes). The greatest capacity for recycled paper reprocessing is for containerboard (see Table 25). A recent study conducted among 32 fiber recyclers in Québec, Ontario, the Maritimes,[14] and the northeastern United States found that nearly 90% of recycled fiber went into the production of containerboard (NovAxia Inc, 2021).[15] Furthermore, almost half of the surveyed recyclers reported producing containerboard, confirming that this is the largest end market for Canadian recyclers.

Table 25. Estimated capacity of post-consumer fiber end-markets in Québec, Ontario, Maritimes (Canada), and the northeastern US (2021)

End-markets	Total Capacity	
	MT	%
Containerboard	4,021,600	89.3%
Tissue & toweling/printing paper	314,000	7.0%
Molded Pulp	65,600	1.5%
Cellulose for insulation	87,100	1.9%
Building Products (roof cover)	12,000	0.3%
Total	4,500,300	100%

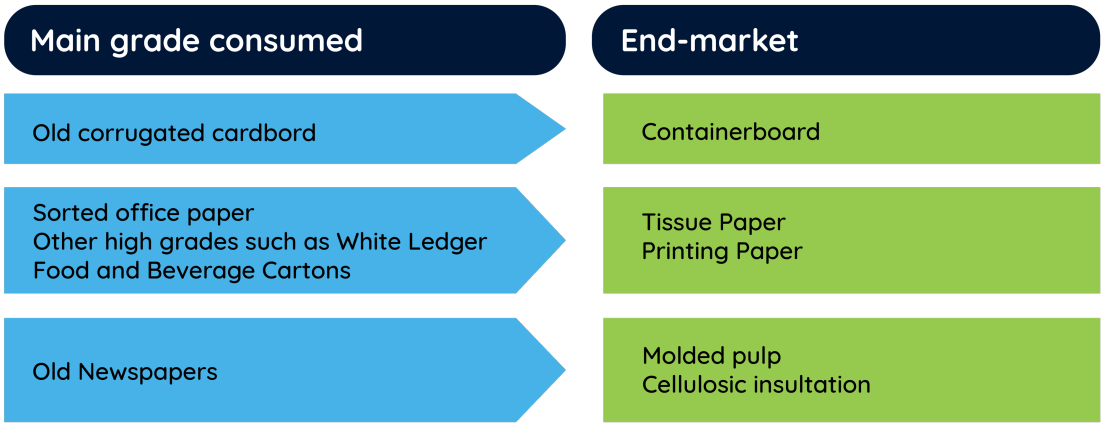
Source: (2021) (NovAxia Inc, 2021)

[14] Refers to New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland and Labrador.

[15] Refers to Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey and Pennsylvania.

Figure 16 presents the grades of paper used as feedstock and their main end markets in Canada. While mixed paper (which includes paperboard, sorted residential papers, and newsprints of both brown and white paper) is used to make containerboard, it is a minority feedstock, not a primary one. This is a crucial point to understand: no Canadian mills rely on mixed paper as their main feedstock. Therefore, the supply of mixed paper in Canada is currently higher than demand. For example, in Quebec, MRFs produced 280,000 metric tonnes of mixed paper in 2020, while the processing capacity of Québec-based recyclers for mixed paper was only 135,000 tonnes (NovAxia Inc., 2021).

Figure 16. End markets for waste paper grades in Canada



As noted in a recent report from ECCC, the end markets for OCC in Canada are mostly domestic due to abundant processing capacity, while markets for mixed paper are more international because many domestic facilities are unable to process large volumes of this grade (ECCC, 2023).

The ECCC report also states that, while some Canadian mills do have capacity to process more waste paper from domestic sources, they are limited in this because the recipes for end-products require very specific fiber mixes; these are typically procured from US and Canadian sources via long term contracts. In addition, Canadian mills often rely on US imports for contracted supplies of high-grade recycled fibers.

While paper mills can be upgraded to accept a wider variety of paper grades, this requires changing end-product recipes in addition to time and investment. In particular, major upgrades and investment would be required to allow mills to accept more mixed paper. However, some mills are expanding their capacity to handle mixed paper due to the lower cost of feedstock compared with OCC, with this happening more quickly in the US than in Canada.

The relatively high contamination of Canadian mixed paper bales has also led to this grade being exported to India (Canada's second-largest export market for waste paper—see Table 30), where low labor costs mean that mills can afford to manually sort it to remove contamination before it is recycled (ECCC, 2023).

With the exception of corrugated cardboard boxes, many fiber products consumed are not made from consumer fibers recycled in Canada. Instead, these products are typically:

1. Made from virgin fiber or post-industrial residue, such as printing rejects;
2. Made from rejects from the forestry industry; or
3. Imported into Canada (as virgin fibers or post-consumer recycled fibers).

Prices for recycled paper vary by paper grade and fluctuate over time depending on several factors, including global market dynamics, the interplay between virgin and recycled fiber markets, and emerging recycling capacity. Between 2018 and 2022, in the US and Canada, the sorted white ledger grade demanded the highest price, with an average revenue of US$241.15 per tonne. Conversely, the cheapest paper grade was mixed paper, with an average revenue of US$27.90 per tonne. However, it is worth noting that the revenue generated through selling a tonne of mixed paper has also been negative (loss making) during this same period. Table 26 provides simple summary statistics for each paper grade between 2018 and 2022.

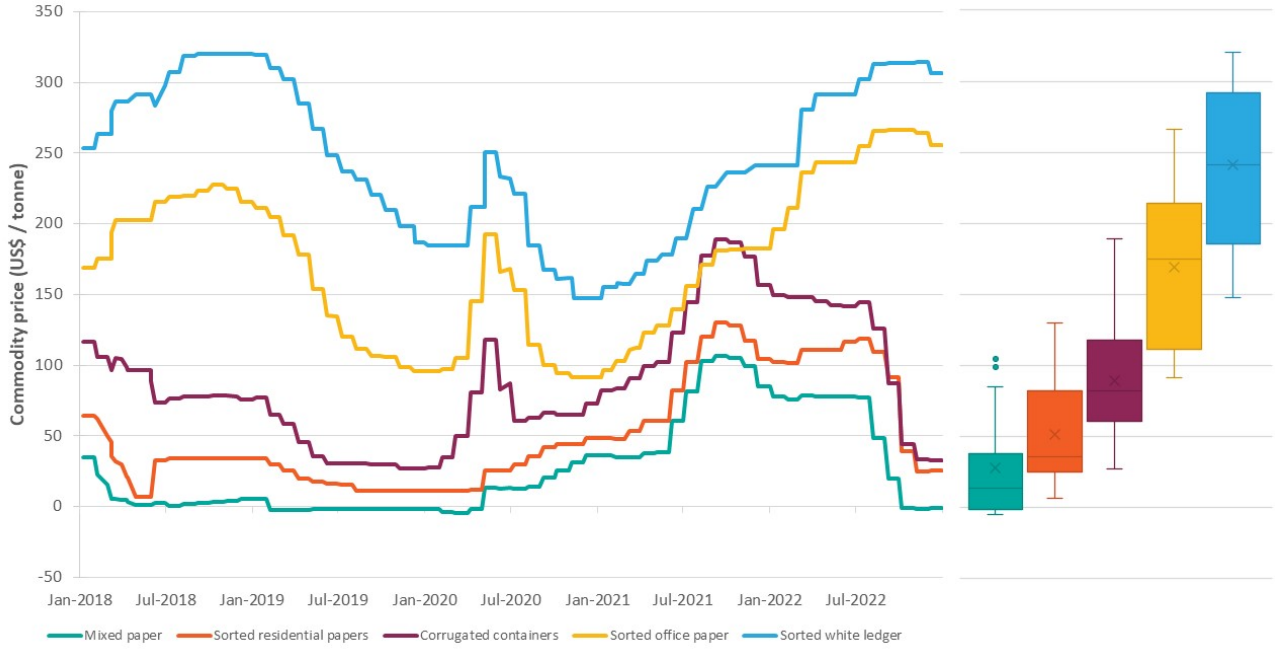
Table 26. Average paper grade US$ per tonne across the United States and Canada (2018–2022)

	Mixed paper	Sorted residential papers	Corrugated containers	Sorted office paper	Sorted white ledger
Minimum	-$4.83	$6.55	$27.22	$91.28	$147.43
Average	$27.90	$51.20	$89.26	$169.06	$241.15
Maximum	$106.79	$129.86	$189.11	$266.27	$320.36

Source: Recyclingmarkets.net

In the US and Canada, the prices for recycled papers have varied between 2018 and 2022. Figure 17 shows how the national average commodity price (in US$/tonne) has varied over the last five years.

Figure 17. Recycled paper prices in the United States and Canada (2018–2022)



Source: https://recyclingmarkets.net/secondarymaterials/index.html

Figure 17 shows that, between 2018 and 2022, the price of each paper grade roughly followed the same pattern of fluctuations. The sorted white ledger grade consistently brought the highest price in secondary markets, with an average price of US$241.14 per tonne, followed by sorted office paper at US$169.06 per tonne. These prices are due to a combination of high demand and low supply for these paper grades. Many producers want to maintain the premium look and high quality of their products, so they demand these grades to maximize recycled content but maintain quality. At the same time, the supply of these grades is decreasing as the digitalization of the economy limits the volumes of office paper available.

In comparison, mixed paper has always demanded the lowest price, with an average price of US$27.90 per tonne. In contrast to sorted white ledger and sorted office paper, this grade is abundant and demand for it is low, as the price reflects.

The time span in Figure 17 includes the onset of the COVID-19 pandemic, which increased the price of each paper grade. This was caused by a contraction in the total tonnage available as economic activity fell and waste collections were suspended. Using corrugated containers as an example, this material averaged about US$27.50 per tonne at the beginning of 2020, only to have pandemic-driven supply and demand trends drive the price to as high as US$188.50 per tonne in September 2021 (Resource Recycling, 2023). The lasting impacts of the pandemic are also visible in the price of each paper grade. Both sorted office paper and sorted white ledger have seen a consistent increase in price per tonne. This is also likely to be driven by changes in waste generation patterns; in this instance, the continued prevalence of working from home has reduced the supply of these paper grades and therefore increased the market price.

4.2 Secondary Markets Summary

Secondary markets play a crucial role in achieving circularity; they give economic value to material, thereby incentivizing the collection, sorting, and processing of recyclable waste. These markets can ensure the timely circulation of good quality recycled materials, which minimizes the need to extract natural resources.

Secondary markets for paper exist both domestically and internationally. In both the US and Canada, most of the sorted paper waste is reprocessed in domestic paper mills, with domestic reprocessing at 65% and 85% of total sorted paper waste, respectively. Although the export of waste paper does leak material from the domestic recycling chain, and therefore limits circularity in the US and Canada, exported waste paper can be used abroad and therefore reduces the global need for virgin pulp in paper and paper product production.

Certain grades in secondary markets are in greater demand, and this is influenced by available reprocessing capacity and the price of secondary materials. In the US and Canada, the demand for secondary materials is highest in the production of containerboard. In the US, 73% of domestically reprocessed secondary material is used to make containerboard. In Canada, almost 90% of this capacity is for containerboard and so secondary material is in high demand to maximize the efficient use of these plants. Conversely, in Canada, the demand for mixed paper is low, as many domestic facilities are unable to process large volumes of it, so the secondary market for this grade is largely international.

This picture is starting to change as mills across the US and Canada expand their capacity to reprocess mixed paper. This is driven by the price of secondary materials; the consistently lower cost of mixed paper feedstock, compared with that of OCC, is influencing preprocessors to change production habits. Increasing capacity to reprocess mixed paper domestically in the US and Canada will help to reduce the tonnage exported as well as the tonnage lost from the domestic recycling system. This will facilitate improvements in domestic secondary markets and further drive circularity in the paper sector.

5 Policy and Regulatory Frameworks

Government policies and regulations are put in place to mitigate the negative impact that the production and mismanagement of waste can have on the environment, human health, and the economy. Policy and regulation are key to changing waste and recycling practices in order to move waste up the waste hierarchy and increase material circularity, as part of the transition to a circular economy.

This section gives an overview of the different policies that affect paper waste management in the US and Canada. Comparable to the policy section in the Plastic Milestone Study, it concentrates on the impact of policy on paper recycling. More detail can be found in the Policy Appendix.

5.1 United States

In the US, legislation to regulate paper waste, as well as policies to address challenges and develop an integrated management approach to paper, are in place at the federal, state, and municipal levels of government.

5.1.1 Federal policy

Waste policy in the US has historically focused on regulating waste processing. The Resource Conservation and Recovery Act (RCRA) is the federal law that created the framework for proper management of hazardous and non-hazardous solid waste (40 C.F.R., 1976) (EPA, 2022). It was passed in 1976 and amended in 1980 and 1984. The RCRA prohibits open dumping and requires the use of engineered end-of-life management (National Chamber of Pulp and Paper Industries, 2022). The Act sets standards for the construction and operation of municipal solid waste landfills and incinerators. It also requires the development of comprehensive solid waste management plans at the state level. Each state is ultimately responsible for implementing the laws under the RCRA and can also implement more stringent requirements if they desire (Sicotte & Seamon, 2021).

Waste policy at the federal level mainly aims to regulate the discharge of pollutants and hazardous substances; there is no federal policy specifically regulating paper waste (Sicotte & Seamon, 2021). However, the environmental policies introduced apply to waste management in general, and therefore they affect paper waste management. Table 27 lists current federal policies that, while not specific to paper, impact paper recycling.

Table 27. US Federal laws impacting paper waste management

Policy	Date enacted	Description of policy	Impact on Paper
Infrastructure and Investment Act	2021	Provides new funding for infrastructure projects.	The Act directs the US Environmental Protection Agency (EPA) to provide grants to improve recycling, including US$275 million to invest in municipal recycling program and updates to improve waste management infrastructure, as well as US$75 million to enhance recycling education and outreach.
Pollution Prevention Act	1990	Encourages pollution prevention and source reduction. Requires the EPA to produce recommendations to develop pollution prevention and source reduction strategies.	Encourages minimizing waste through a waste hierarchy that privileges recycling. Requires treatment and proper disposal if waste reduction and recycling are not possible.
Comprehensive Procurement Guideline (CPG) Program	1995 (updated 2005)	EPA program requiring the federal procurement of products made with recovered materials and providing recommended practices for buying them.	Certain paper products are included under the CPG's list of designated products, meaning procuring agencies are required to buy such paper products with the highest levels of recycled content practicable.
Clean Air Act	1963 (Amended 1967, 1970, 1977, 1990)	Regulates the discharge of pollutants and hazardous substances from facilities.	Impacts municipal solid waste combustors and waste-to-energy facilities. Also applies to chemical recycling facilities that use pyrolysis.
Resource Conservation and Recovery Act (RCRA)	1976 (Amended 1980, 1984)	Framework for the management of hazardous and non-hazardous waste.	Prohibits open dumping and requires the use of engineered end-of-life management (landfilling or incineration).

Many of the environmental statutes that make up the bulk of federal waste policy were passed over 30 years ago. More recent bills have been introduced in Congress to improve regulation of waste management and recycling. In addition, the inclusion of certain paper products on EPA's CPG list (printing and writing paper, newsprint, ICI sanitary towels, paperboard and packaging, and tray liners) are driving recycled content requirements for federal procurements. However, no major legislation focusing on recycling and circularity has become law, and most policy regulating and managing waste has been left to individual states and municipalities.

5.1.2 State policy

States have control over waste management within the framework of federal law. Some states have implemented comprehensive laws to improve waste management and increase recycling, while others have taken little action, resulting in a fragmented system of recycling regulation across the country (MacBride, 2011). This section outlines the main policy levers that states use to improve the recycling of paper waste.

Disposal Bans and Mandatory Recycling Laws

Recycling disposal bans and recycling mandates aim to keep recyclable material, including paper, from being disposed in the landfill. Connecticut, Massachusetts, the District of Columbia, New Jersey, Pennsylvania, and Rhode Island have mandatory residential recycling laws for cardboard and mixed paper. Maine, Wisconsin, New York, and Vermont have residential disposal bans on recyclable materials that include mixed paper and carboard.

Fees/Taxes

Taxes or levies on landfilled material can be used to discourage landfilling in favor of waste management options that are higher up the waste management hierarchy. These are not specifically targeted at paper but, as they aim to increase the cost of disposal and as paper makes up much of the municipal waste stream, if structured correctly they can support recycling. Most US taxes and levies are not high enough to encourage recycling; they are used instead to generate revenue, in most cases to support the general fund. States with landfill tipping surcharges include Arizona, Arkansas, California, Colorado, Connecticut, Georgia, Hawaii, Illinois, Indiana, Iowa, Kansas, Kentucky, Maine, Minnesota, Mississippi, Missouri, Montana, Nebraska, Ohio, Oklahoma, Pennsylvania, South Dakota, Tennessee, Texas, Utah, Vermont, West Virginia, Wisconsin, and Wyoming (National Insitute of Statistics, Geography and Informatics, 2021).

Deposit Return Systems (DRS)

A DRS, also called a container deposit system or bottle bill, is a system that places a monetary deposit on a product, paid by the consumer at the time of purchase, which is refunded when the consumer returns the product to a designated location for reuse and/or recycling. DRS is a form of EPR in that producers in most cases are funding the system, although only in one state through a PRO (Oregon).

Ten states have DRS for beverage containers: California, Connecticut, Hawaii, Iowa, Massachusetts, Maine, Michigan, New York, Oregon, and Vermont. However, no state covers paper beverage containers (milk cartons, juice cartons, etc.), unlike similar programs in Canada. Bills would need to be amended to enable these programs to cover paper-based containers. Adding paper containers to existing DRS programs would increase the volume captured for recycling and provide quantities that could be marked for recycling.

Extended Producer Responsibility (EPR)

EPR makes producers physically and financially responsible for managing the waste generated from their materials. Producers pay fees into a PRO, which operates the program, based on the volume of material that they place on the market. EPR programs can cover paper packaging and products

but not necessarily newsprint and writing paper, so it will not cover all forms of paper waste. They can include collection and recycling targets to drive investment in the recycling system. Producer fees can also be modulated to incentivize the use of packaging designed for recycling.

Four states have passed EPR legislation that covers paper packaging: Oregon, Maine, Colorado, and California. As these bills passed in 2021 and 2022, the EPR programs have not yet been implemented and their impact cannot be evaluated. Table 28 summarizes and compares each of these four EPR programs. Full details of each program are presented in the Policy Appendix 9.4: US EPR Policies.

Table 28. Comparison of State EPR Policies in the US

	California	Colorado	Maine	Oregon
Materials included	All packaging and plastic food ware	Printed paper and packaging	All packaging	Printed paper and packaging, and plastic food ware
Producer authority in set-up of PRO	None	High	None	Low
Multiple PROs	Yes (after 8 years)	No	No	Yes (10 % market share requirement)
Recycling rate targets	65% for plastic	Set w/PRO plan	Set by DEP	25% by 2028, 50% by 2040, 70% by 2050 for plastics
Recycled content mandates	No (but set in other statute)	Set w/PRO plan	Set by DEP	No (eco-modulation factor)
Education and outreach	Yes	Yes	Yes	Yes
Reuse and/or refill mandate	Yes (part of source reduction mandate)	No (eco-modulation factor)	No (eco-modulation factor)	No

Source: Recycling Partnership

In 2023, Maryland lawmakers passed a bill mandating a needs assessment for the state and the formation of an advisory council to report findings and recommendations regarding EPR. It is likely that more states will adopt EPR covering packaging and paper products over the next five years.

Post-Consumer Recycled Content Requirements

Post-Consumer Recycled (PCR) content requirements aim to increase demand for recycled material by requiring products to have a minimum amount of recycled content. New Jersey is the only state that has PCR content requirements for paper products. Its PCR bill sets requirements for certain products, such as rigid plastic containers, glass containers, paper and plastic carryout bags,

and plastic trash bags (New Jersey, 2020). Starting in 2024, smaller paper carryout bags must have 20% recycled content, while larger ones will need 40%. The bill also establishes exemptions, such as for dairy products, infant formula, food for special dietary use, and refillable containers, and provides for waivers if the manufacturer cannot meet requirements. The bill directs the New Jersey Department of Environmental Protection to establish incentives and develop a recycling education program and gives it the authority to review and update requirements based on market conditions.

5.1.3 Local policy

Local governments hold significant authority over the management of waste within their municipality or county. They are often in charge of carrying out or contracting collection services, producing waste management plans that set goals, setting bans, and putting regulations in place that govern recycling and solid waste management.

Recycling Bylaws and Mandates

Through bylaws, local governments require single-family recycling services and will often set out which materials must be collected and the frequency of collection. In some cases, municipalities will also set requirements for haulers to provide recycling services to multi-family and commercial properties. The lack of policy requiring recycling from these generators impacts paper recycling rates.

Waste Management Plans

Local governments produce waste management plans that can set municipal collection and recycling goals. A growing number are passing zero waste plans, which do not mandate recycling but set out the long-term plans of the municipality. Zero waste refers to a solid waste management strategy that aims to establish circular material flow, so that no material is wasted or underused (Song, Li, & Zeng, 2015). Many US cities are either incorporating zero waste principles into their existing waste management plans or developing their own dedicated zero waste plans. These plans outline a series of policy changes aimed at reducing overall waste, enhancing recycling efforts, and establishing systems that promote repair, reuse, and refurbishment. Mixed paper and cardboard represented 23.1% of municipal waste generated in 2018 (EPA, 2020). Zero waste plans that aim to improve source separation and collection of paper can maximize recycling while reducing greenhouse gas emissions associated with landfilling or incineration.

Local Bans

Municipalities have the power to pass local landfill bans, or more general disposal bans, which aim to keep recyclables out of landfill or waste-to-energy facilities. They do this by prohibiting the disposal of recyclable products or packaging with municipal trash destined to landfill or waste-to-energy, and in this way aim to improve source separation to maximize the capture of recyclable material. Commonly, local landfill bans target recyclable waste, including paper. The responsibility for compliance with landfill and disposal bans can fall on a variety of stakeholders, including residents, businesses, landfill and waste-to-energy facility operators, and waste haulers. For bans to be effective, municipalities need to provide convenient and accessible recycling options for paper products. Moreover, appropriate penalties need to be in place to deter non-compliance, along with sufficient resources to ensure the ban is enforced.

A material ban aims to eliminate the use of a material for a specific application or item; they can be effective in reducing the overall amount of waste disposed. Another example is bans on single-use carrier bags. Municipalities have been banning or placing fees on single-use bags; this can be a prelude to banning paper bags and encouraging customers to bring their own bags or carry reusable bags. Other local material bans apply to single-use food service items such as paper plates and cups for food businesses. While more relevant for single-use plastic items, some states have enacted preemption laws that restrict local governments from passing ordinances to ban items or impose fees on residents.

5.2 Canada

In Canada, legislation to regulate paper waste, as well as policies to address challenges and develop an integrated management approach to paper, are in place at the federal, provincial, and municipal levels of government.

5.2.1 Federal policy

In Canada, the responsibility for managing and reducing waste is shared among federal, provincial, territorial, and municipal governments (ECCC, 2022). The Government of Canada has authority under the Canadian Environmental Protection Act (CEPA) of 1999 when there is potential for toxic pollution from waste into the air, land, or water (CCME, 2014). The Government is also responsible for waste management activities on federal land, as well as interprovincial and international movement of hazardous waste and hazardous recyclable materials. In December 2020, the Government of Canada recognized the waste sector's greenhouse gas emission reduction potential in Canada's strengthened climate plan—*A Healthy Environment and a Healthy Economy* (ECCC, 2020). The plan includes a commitment by the federal government to explore opportunities to increase landfill methane collection and use, support biodegradable waste diversion, and create resources from biodegradable waste. Food, paper and wood are the three largest biodegradable materials that are identified in landfills. Furthermore, the Government is supporting the implementation of EPR programs for packaging, including paper products, by delivering guidance to provinces and territories and providing funding for infrastructure and education initiatives. However, there is no material-specific federal legislation for the management of paper waste and no legal obligations on the management of paper at end-of-life.

The Canadian Council of Ministers of the Environment (CCME) does not set policy, but instead brings together members of federal, provincial, and territorial environment departments and provides a forum for cooperation on environmental issues, including waste management (House of Commons Canada, 2019). CCME releases comprehensive reports and action plans that support improving paper waste diversion and recycling across Canada. Together, these indicate the Government's intentions for increasing circularity in Canada; they are listed in Table 29.

Table 29. CCME publications relevant to paper recycling – Canada

Publication	Date	Summary
Aspirational Canada-wide Waste Reduction Goal	2018	The goal is to reduce the average amount of waste generated per person from 706 kg to 490 kg (30% reduction) by 2030 and to 350 kg (50% reduction) by 2040 (CCME, 2023). Progress will be measured through biennial waste management industry surveys conducted by Statistics Canada.
Canada-wide Action Plan on Extended Producer Responsibility	2009	The action plan provides recommendations and guidance to harmonize EPR across provinces and territories in Canada. It recommends common elements for all EPR programs, including producer responsibilities, stewardship plans, targets and reporting, funding, and design for environment considerations (CCME, 2009).
A Canada-wide Strategy for Sustainable Packaging	2009	Building on the Canada-wide Action Plan on Extended Producer Responsibility, this addresses the need for packaging strategies and proposes measures that would improve sustainable packaging choices and systems in Canada (CCME, 2009).

Another Government publication relevant to paper waste management is Canada's official greenhouse gas inventory (Government of Canada, 2020). This shows that disposing of municipal solid waste in landfill accounts for around 23% of Canada's annual emissions of methane, a powerful greenhouse gas. An estimated 64% of the waste disposed in landfills annually is biodegradable and therefore capable of producing methane, with food, paper, and wood the three largest contributors. Meanwhile, ECCC's National Waste Characterization Report estimates that paper waste accounts for approximately 11% of all waste disposed in Canada (ECCC, 2020).

5.2.2 Province and Territory policy

The regulation of paper waste and recycling is carried out by both provincial and territorial governments. A number of different policies are relevant for the recycling of paper, as discussed below.

Strategies, Acts and Regulations

Provincial governments develop strategies to address waste and wider sustainability issues. For example, the Strategy for a Waste-Free Ontario: Building the Circular Economy sets out the province's plan to help build a system that puts valuable materials destined for landfill back into the economy. The requirement for this strategy is set out in the Waste Free Ontario Act, 2016, which encompasses the Resource Recovery and Circular Economy Act and the Waste Diversion Transition Act. Regulations under Ontario's Resource Recovery and Circular Economy Act relevant to paper recycling include the Blue Box Regulations, which include EPR requirements for packaging and paper products.

Details of all provincial and territory regulations and strategies are included in the Appendix.

Deposit Return System

In Canada, nine provinces (Quebec, Newfoundland and Labrador, Prince Edward Island, Nova Scotia, New Brunswick, Ontario, Saskatchewan, Alberta, and British Columbia). and two territories (Yukon and the Northwest Territories) have a DRS. Of these, nine accept paper-based beverage containers—the exceptions being Ontario, whose DRS only applies to alcohol containers (Reloop, 2022), and Québec, whose system does not currently accept paper-based beverage containers but will start doing so in March 2025. For paper-based beverage containers, the highest performing DRS system is in Alberta, with return rates in 2021 of 70.5% for aseptic containers and 74.2% for gable-top containers. The only province and territory without a DRS in place are Manitoba and Nunavut, respectively.

These return rates are higher than those for the same material streams returned via other routes than a DRS. For example, Ontario reported a non-deposit recycling rate of 51.0% for gable-top containers and 24.4% for aseptic containers.[16] This difference shows that DRS does increase the return rate, minimizing leakages from the recycling value chain and therefore enabling a more circular system. Details of each province's and territory's DRS program are provided in the Policy Appendix 9.2: Canadian DRS systems, including the paper and carton beverage containers they cover, and the deposit redemption rates achieved (which serve as a proxy for collection rates).

Extended Producer Responsibility (EPR) and Product Stewardship (PS) Programs

EPR has become a crucial part of waste management policy in Canada. EPR policies assign producers some or all responsibility for the end-of-life management of a product and aim to improve collection and recycling rates.

In Canada, EPR policies are organized on a spectrum, based on the degree of responsibility assigned to producers:

- PS programs assign no direct responsibility to producers.
- Partial EPR programs are jointly financed and managed by consumers, government, and industry.
- Full EPR programs assign full financial and operational responsibility to producers for managing their products at the end-of-life (Arnold, 2019).

Product stewardship (PS) programs are government-designed programs to centralize a recycling system for a specific material or product. Many use eco-fees or advance disposal fees to finance their operations, with these added to the price of goods at the point-of-sale (Arnold, 2019). PS programs aim to improve resource recovery outcomes, but they do not directly incentivize environmental performance and circularity. The responsibility for managing materials does not fall directly on producers, who do not participate operationally in the program.

The CCME's Canada-wide Action Plan of 2009 set out the goal for provinces and territories to transition from a product stewardship model to an EPR model. To ease the transition to full EPR, some provinces have adopted partial EPR programs, where both governments and producers

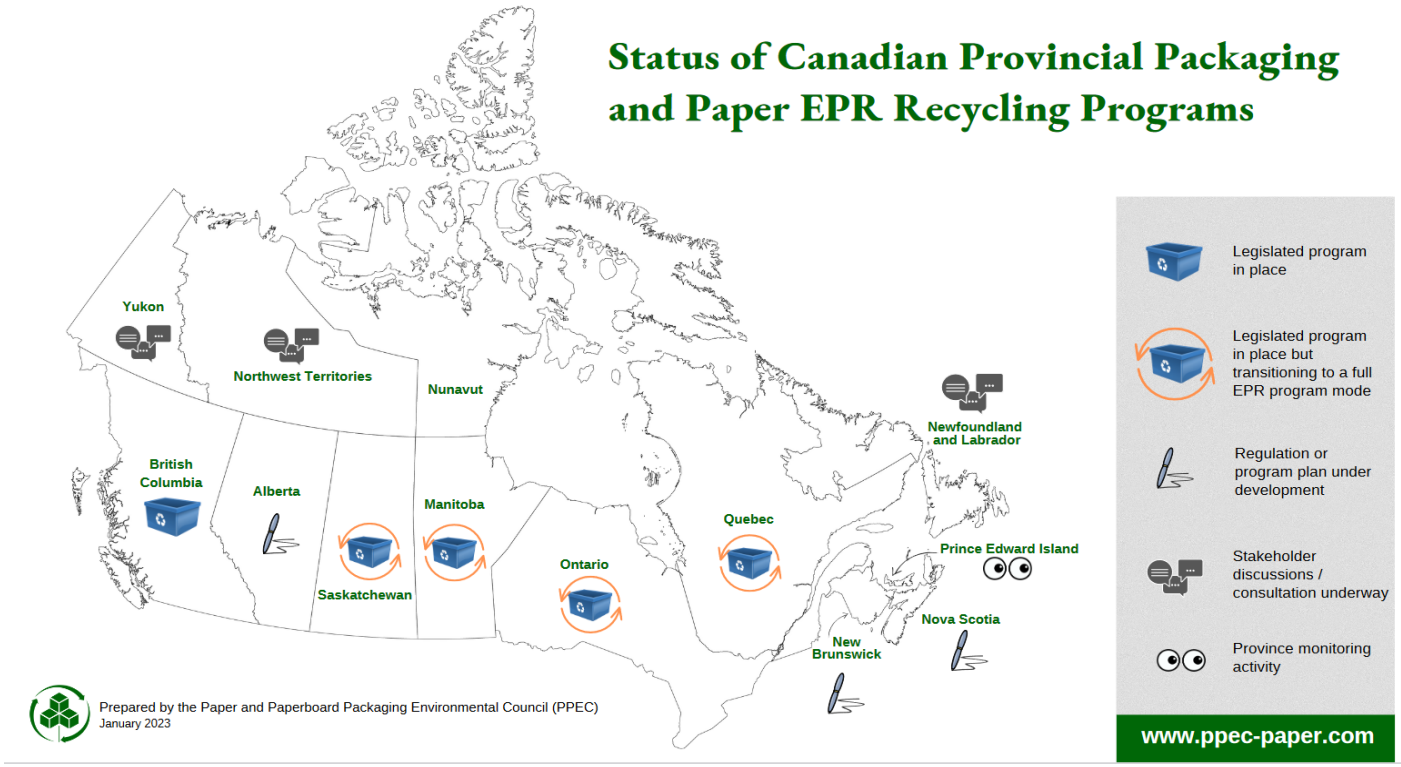
[16] Ontario has DRS covering only alcoholic beverage containers.

operate and finance waste management. The most common type is the municipal blue box program, in which municipalities are responsible for managing materials but producers are required to help finance the systems. Full EPR programs make producers operationally and financially responsible for managing the waste generated from their materials.

Three provinces currently have full EPR for residential paper waste: British Columbia, Ontario, and Québec.[17] New Brunswick has approved its plan for full EPR, with implementation planned for November 1st, 2023; Alberta is in the process of setting up its full EPR program to begin in 2025; and Manitoba is in the consultation process to shift to a 100% producer-funded EPR program by 2026. Yukon Territory and Newfoundland and Labrador are currently consulting on enacting EPR legislation. A total of 11 provinces and territories should have EPR for PPP by 2026 (Saunders, 2023). Nunavut and the Northwest Territories are not expected to adopt EPR by 2026.

Figure 18 summarizes the status of EPR programs for packaging and paper in each Canadian province. Table 33 in the Appendix provides further details on the status of legislated EPR programs for packaging and paper in Canada.

Figure 18. Provincial EPR in Canada



Source: PPEC

[17]Manitoba and Saskatchewan have partial EPR in 2023 but plan to transition to full EPR. Quebec has EPR fully funded by producers, but regional governments are still responsible for collection services.

Other Policies

Landfill fees and bans aim to influence the diversion of recyclable waste from landfill and privilege recovery across the value chain. Disposal bans are policy requirements that take place at the point of disposal. A disposal ban aims to prevent paper from being mistakenly placed in the residual waste stream, where it will be landfilled or incinerated. In British Columbia, Metro Vancouver has banned the disposal of recyclable paper, while the Thompson-Nicola Regional District has banned the disposal of cardboard. Enforcement varies from one region to the next, but often involves levies and contamination surcharges. In Metro Vancouver, fines are issued to waste haulers at the dump site. The collection company can also refuse to pick up loads of waste that contain banned materials to enforce compliance from generators. Nova Scotia has a similar disposal ban for recyclable waste that includes paper.

High landfill fees provide an economic incentive to privilege recycling over landfilling or incineration. Prince Edward Island (PEI) has a relatively high disposal fee (C$100–115), with a surcharge for mixed waste (C$230), and requires transparent bags to enforce adequate source separation. Québec has implemented a landfill levy of C$24/tonne and Manitoba a landfill levy of CAD 10/tonne, added to tipping fees, to increase the cost of landfilling.

5.2.3 Municipal policies

Municipalities have historically been responsible for financing and delivering waste collection services and setting requirements for recycling through bylaws. The transition to full EPR for PPP impacts the role of municipalities, with some continuing to deliver services that are paid for by producers while others may also give up operational responsibilities.

In British Columbia, various municipalities have enacted regional disposal bans covering paper. The regional district of Metro Vancouver has banned the disposal of recyclable paper at its solid waste facilities, while Thompson-Nicola regional district has banned the disposal of cardboard. Similar bans are in place in the districts of Nanaimo, Cowichan Valley, Central Okanagan, Capital, and Kitimat-Stikine. Their enforcement typically involves levies and contamination surcharges. In Metro Vancouver, fines are issued to waste haulers at disposal sites, while collection companies can also refuse to pick up waste loads containing banned materials, thereby placing the responsibility for compliance on those generating the waste.

In Alberta, the neighboring cities of Calgary and Lethbridge have both introduced mandatory requirements for businesses and organizations to source separate recyclable materials (including paper and cardboard) and organics for recycling and composting.

Municipalities are increasingly focusing on reducing single-use foodservice ware and cups. Since the Government of Canada has banned the manufacture, import, and sale of common single-use plastic items, municipalities have been encouraging the switch to reusable items. This is preferable to substituting plastic items for paper items, such as plastic cups for paper cups, since paper items that are used on the go are likely to be disposed and subsequently landfilled. Furthermore, some items like cups are lined with plastics, making them more difficult to recycle.

5.3 Policy and Regulatory Frameworks Summary

Policy still has a role to play in increasing the collection of paper material and supporting reliable end markets to improve paper recycling.

In the US and Canada, waste management responsibilities are shared by federal, state/ provincial/territorial, and municipal governments. In both countries, there is no material-specific federal policy for managing paper waste.

In the US, four states have passed EPR policies, with more likely to follow. These programs will include a range of paper-based packaging.

In Canada, provinces are implementing EPR programs that include a broad range of paper products. DRS programs in those provinces cover paper-based beverage containers, such as cartons and bag in a box. Municipalities are starting to put in place policies to reduce single-use items, including paper cups.

6 Best Practice – Product Design, Recovery and Recycling Technology, and Policy Options

The following sections outline best practices for improving paper circularity and reducing paper consumption. These include exploring product design options for improved reuse, repair, and recyclability, as well as outlining notable emerging technologies that would improve paper recycling rates. Finally, an analysis of policy options for improving paper circularity highlights best practices for policy measures such as EPR, DRS, and PCR content requirements.

Best practice examples are based on case studies from the US, Canada, and European countries, as these countries are at the forefront of product design, technological developments in recycling, and policy.

6.1 Product Design

Effective product design is crucial for minimizing paper waste and promoting paper circularity. Paper packaging has become more popular, as it is increasingly being used to reduce plastic packaging (Ellen MacArthur Foundation, 2020). Therefore, it is imperative that packaging producers be aware of the challenges associated with paper recycling and the product design principles that improve recyclability.

Incorporating paper fiber to reduce plastic in packaging can create other challenges. First, some paper packaging (such as multi-material and multilayer) still includes plastic elements to preserve barrier and moisture properties, which may create difficulties in the paper recycling process. Second, paper packaging that completely replaces plastic must retain high strength when wet, which can also make it difficult to pulp and therefore to recycle. High wet strength items do not yield significant quantities of usable fiber if they are recycled through the same pulping process as for newsprint, mixed paper, and OCC; instead, they must be pulped using chemical to break up the wet strength. A survey of US paper mills found that wet strength fiber is acceptable in small amounts, anywhere from less than 10% to less than 2% of paper bales (AF&PA, 2021).

Due to the diversity of paper recycling processes and equipment, and differences in the mix and quality of fiber supplies, the amount of contamination accepted at paper mills varies widely across facilities (AF&PA, 2021). The Institute of Scrap Recycling Industries (ISRI) provides detailed grade definitions of paper stock to be used as standards by its members when buying and selling paper (ISRI, 2020). Within these definitions, ISRI stipulates acceptable levels for outthrows and lists prohibitive materials (i.e., contaminants) for every paper grade. The guidelines should be used as a reference point for any paper producer during product design to improve the recyclability of their product or packaging (ISRI, 2020).

Nevertheless, considering the wide-ranging differences in what levels count as acceptable across mills, product design for paper packaging should consider minimizing the use of any non-fiber elements where technically and financially feasible or where acceptable alternatives exist. For example, in the case of cartons, Tetra Pak has begun trials in which the aluminum and/or plastic layer in cartons is replaced by a fiber-based alternative, making the cartons more attractive to

recyclers while reducing their carbon footprint (Braghiroli, 2022). Other examples include using inter-locking fiber-based tabs rather than tape.

Designing for recyclability should also consider consumer access to paper collection and recycling infrastructure, as well as address consumer confusion around the disposal of paper packaging (The Recycling Partnership, 2022). For example, paper packaging and single-use products with low recycling access rates in the US, defined as below 60% according to the Federal Trade Commission Green Guides (Federal Trade Commission, 2012), include food service packaging, paper cups, and paperboard with poly coating (AF&PA, 2021). Regarding confusion about correct disposal, only 4% of respondents in a 2019 US survey reported that they were not confused about recycling labels. This highlights the importance of providing descriptive labeling on packaging and single-use products so that consumers know how to dispose of them (How2Recycle, 2021). Labels can also re-direct consumers to an accessible website that provides information on how to recycle (How2Recycle, n.d.) and, potentially, on accessible recycling programs in their area, as was done with WestRock and Domino's scannable pizza boxes (WestRock, n.d.).

Product design can also specify the use of less virgin material through lightweighting. For example, lightweighting cardboard has been most successful in Western Europe, where box weights are optimized to about 80% of US weights (Hall, 2019). Lightweighting involves reducing the mass of a product; beyond this, how it is achieved depends on the particular product and its design specification. In general, lightweighting usually entails some reduction in functionality, for example, by reducing the strength of a product or the space available on it for branding.

Reuse systems for paper packaging are uncommon compared with plastic, metal, and glass packaging, mostly due to its lack of durability compared with these materials (see the Plastics Waste Management Milestone Study for examples of plastic reuse systems).

6.2 Recovery and Recycling Technology

Notable technological improvements in processing post-consumer paper waste include the use of optical sorters, ballistic separators, and robotics. These have helped to increase the quality of recovered paper while improving the efficiency of the sorting process, which enables the processing of larger volumes and higher quality fiber. Technological improvements are crucial to making circularity more technically and economically feasible.

This section provides an overview of recovery technology that will improve the sorting process. However, there are other ways technology can contribute to improving secondary markets for paper, such as advancements in recycling, pulping, and papermaking technology. These include improving fiber yields in the pulping process and modifying papermaking recipes to incorporate different recycling grades and higher amounts of recycled pulp to make functional products.

6.2.1 Optical sorters

Optical sorters are machines that identify and separate recyclable materials. They have succeeded at cleaning up fiber streams and helped to decrease reliance on manual labor at MRFs. Residential mixed paper usually includes high value paper mixed with lower value paper; optical sorters allow MRFs to separate residential mixed paper and pull out valuable material. Since China's Operation National Sword came into effect in 2018, more material recovery facilities (MRFs) are adding optical sorters to their fiber lines to improve sorting efficiency (Smalley, Sorting Success, 2021). Optical sorters have increased in efficiency and are now able to sort different types of material, such as plastics and fiber products, using a high-speed, short wave infra-red hyperspectral detection system. Modern optical sorters are also capable of detecting carton containers and metal and recognizing wood products, wood by grade (natural versus painted), and color.

The trend of adding optical sorters p[rocesssing lines to enhance the quality of sorted paper has tended to produce higher quantities of rejected paper grades. This points to the balance between maximizing the total amount of recovered paper and maintaining its quality. Adding an optical sorter at the end of the processing line has been identified as a potential solution to this by the Region of Peel MRF in Ontario, Canada. Between 2019 and 2022, the MRF retrofitted optical sorters on its fiber line as well as "last chance" optical sorters to recirculate recyclables, which are then sent to their respective lines at the beginning of the MRF process (Carton Council Canada, 2022).

6.2.2 Decontaminating paper packaging through autoclaving

Contamination from food can mean paper food packaging products are landfilled. Autoclaving can decontaminate these products by washing off food and removing polymer coatings using steam in a high-pressure environment. During the de-contamination process, paper fibers are separated from the contaminants and can be used in recycling. Georgia-Pacific has an autoclave in its MRF in Toledo, Oregon with a 63,500-tonne capacity (Juno, n.d.). The MRF accepts waste from residential streams as well as commercial streams, particularly waste from food service facilities such as airports, stadiums, and office buildings (AF&PA, 2022). After sanitization, paper is recovered and sent to paper mills for further recycling. Metals in the waste stream are separated using magnetic belts (for ferrous metals) and an eddy current separator (for non-ferrous metals) further down the processing line. The company claims that up to 90% of waste arriving at its plant is diverted from landfill and incineration to be recycled (Juno, n.d.).

However, it is important to note that autoclaving is an energy intensive process. While it may bring benefits in terms of paper circularity, it is currently unclear whether the environmental benefits outweigh the negative impacts associated with high energy use.

6.2.3 Achieving greater efficiencies

Efficient sorting and recycling processes can lead to the production of higher quality paper bales at lower costs. The level of cost efficiency depends on the volume of paper waste being processed and the size of the facility, as larger facilities can afford more advanced sorting equipment.

In 2021, the New-Indy paper mill in Ontario, California (US municipality as opposed to Canadian province), won a Leadership in Sustainability Award from the AF&PA due to its paper recovery efficiency project (AF&PA, 2021). The mill was able to improve its paper repulping by investing in additional screening and de-trashing equipment, which led to higher fiber recovery rates and allowed it to target mixed paper waste without reducing recycled fiber quality. Through this improved process, New-Indy reduced the amount of paper sent to landfill by 9,000 tonnes per year (New-Indy Ontario: Stock Preparation Efficiency Project, 2021).

6.3 Policy Options

This subsection explores policy options for improving paper waste collection and recycling and for stimulating secondary markets for paper. The measures discussed would help to stimulate market demand for recyclable materials, thereby enabling competitive prices compared to virgin materials. The policies explored in this section are:

1. EPR for residential materials, which includes services to multi-family buildings
2. EPR for ICI materials
3. DRS that include cartons
4. PCR Content requirements
5. Data collection and recycling rate calculation regulations or standards
6. Bans, taxes, and fees

In each policy subsection, where relevant, one or more case studies are explored to identify what factors have made the specific policy mechanism successful in improving collection and recycling rates for paper products. Where US and Canadian examples cannot be identified, European case studies or examples for other material streams (e.g., plastics) are explored.

EPR for Residential Materials Recycling

Section 5 summarized current EPR policy, under which producers pay a fee to cover the cost of recycling the packaging and products they place on the market. It is possible to modulate this fee to reflect how much it costs to manage particular products in the recycling system, net of material revenues. One such modulated fee system is found in British Columbia, Canada, and Table 30 presents the fees charged for a range of paper products in this province. These are based on Recycle BC's Four-Step Fee Methodology, which includes costs associated with collection, transportation, and processing and is revised annually.

Table 30. Modulated fees charged by Recycle BC for printer paper and paper packaging (2023) (CAD cents/kg)

Packaging Types	Modulated Fees
Newsprint	48
Magazines/Catalogues	19
Telephone Books	19
Other Printed Books	58

Packaging Types	Modulated Fees
Corrugated Cardboard	46
Boxboard	29
Gable top cartons	70
Paper laminates	55
Aseptic containers	76

Source: (CAD cents/kg).

In addition to fees being modulated based on the cost of managing and processing materials, they can also be modulated to support design for recyclability. This is the case for EPR in France, where producer fees are modulated based on the adoption of specific design features (Sachdeva, Araujo, & Hirschnitz-Garbers, 2021). Under France's EPR, in 2022, the fee was 16.43 Eurocents/kg for paper and cardboard and 24.91 Eurocents/kg for beverage cartons (CITEO 2021). Under France's law for a circular economy, fees can be further reduced if the product integrates environmental criteria (bonus) or increased if the product is polluting (malus). Fee modulation in France focuses on rewarding the increase of recycled content and the move to mono-material packaging.

EPR for ICI Waste

In Canada and the US, the majority of paper waste is generated by the ICI sector (ECCC, 2020). As some segments of the ICI sector have relatively low recycling rates with potential for improvement, any policy to improve paper recycling should target this sector in addition to residential paper generation.

Belgium has an EPR program to fund ICI packaging waste management, managed by the PRO Valipac, which reports tonnage data and recycling rates to the Belgian Authorities (IRPC). The program began in 1997 and helped raise the recycling rate for ICI packaging to 91.3% in 2022, with 100% of commercial paper and cardboard waste being recycled (Valipac, 2022). Producer fees are modulated according to material recyclability and packaging reusability (no fees are charged for reusables), encouraging producers to place more circular ICI packaging on the market. Valipac also gives bonuses to producers who incorporate at least 30% PCR content in ICI plastic packaging. The 50€ bonus is given for each tonne of recycled plastic used in the packaging (Valipac, 2021) Valipac also stimulates local recycling markets by offering a per-tonne bonus to recycling processors that operate in Belgium or the EU (Valipac, 2021).

PCR Content Mandates

Post-Consumer Recycled (PCR) content requirements can stimulate market demand for recycled paper and therefore encourage investment in more efficient, effective collection and waste management. Therefore, PCR content requirements are considered a policy directly targeting paper waste demand rather than supply. Although such requirements can incentivize innovation and spark investment in infrastructure for improved waste management and collection, they can also disrupt markets by requiring producers to use recyclable material that may not be readily

available. The policy is therefore best supplemented by supply-side policies that generate readily available, clean streams of waste, such as DRS and EPR (Eunomia Research & Consulting, 2023).

Data Collection and Recycling Rate Calculation

Currently, recycling rates are not calculated in a consistent way. To improve policy and set clearer goals, clearer and harmonized definitions and calculation rules are necessary. Furthermore, there is a need for aligned regulation around how to calculate rates across states and provinces. Federal laws on reporting, data collection, and recycling rate calculations can allow for the required harmonization across states and provinces.

There is global precedent for this, as the European Commission recently passed updated legislation on waste data collection, recycling rate calculations, and reporting requirements to allow for data harmonization across EU Member States. Alignment of definitions, data collection, and calculation methodologies would also be beneficial across the US and Canada.

Taxes and Fees

Fees and taxes on materials provide another form of disincentive, and they can target either producers and importers or consumers. Where fees are directly charged to consumers, there is a clear economic incentive for consumers to adjust their consumption habits, and a well-designed, fair fee policy will make it easy for consumers to change their behavior. Meanwhile, fees and taxes targeting producers and importers can also be passed on to consumers, with less visible incentive for behavior change in the mind of the consumer. In both cases, if fees and taxes on materials are not carefully designed, there is a risk that they may unfairly place the economic burden on consumers.

Disposal and tipping fees aim at increasing the cost of landfilling to encourage recycling. However, landfill taxes do not directly incentivize waste reduction or recycling. Disposal fees are generally calculated at the municipal level and allocated to households or haulers. They do not stimulate investment in waste management infrastructure on their own and are a more useful policy mechanism when they supplement programs that provide alternative material treatment options in the long term (e.g., DRS, EPR) (Recycle BC, 2021).

Disposal Bans and Material Bans

While bans are commonly used throughout the US and Canada, their effectiveness is limited. Disposal bans aim to divert recyclable materials that are currently landfilled or incinerated due to inadequate separation at source. However, they require penalties to deter non-compliance and resources to enable enforcement. Combining a disposal ban with an increase in landfill taxes or fees can improve compliance by adding a financial incentive to divert recyclable waste from landfill (D. Xevgenos, 2015).

Material bans aim to eliminate single-use or hard to recyclable materials. Bans on paper packaging are less common than bans on plastic packaging. For instance, in the US, New Jersey is the only state with a ban on single-use carryout bags that targets both plastic and paper bags (Smith, Greenstein, & McKeon, 2020). The lack of material bans for paper products can be attributed to several factors.

Firstly, plastic has been identified as a major source of pollution in the environment and its prolonged persistence in land and marine ecosystems is due to its significantly slower breakdown compared to paper. Secondly, some plastic resins are considered harder to recycle due to low demand or limited technical capacity to be recycled.

Improving Waste Collection and Recycling

In the US and Canada, urban and single-family residents have greater access to curbside recycling programs for paper packaging than rural households and multi-family dwellings, which are more likely to have access to drop-off recycling programs (Recycle BC, 2021). Improving collection of residential paper waste by expanding curbside recycling and recycling accessibility, mandating residential and commercial recycling, and introducing multi-stream collections can significantly improve recycling rates.

7 Findings and Recommendations

Based on analysis of the paper value chain, policy and regulatory landscapes, and best practices for improving paper circularity across the US and Canada, this section sets out the key barriers to circularity, including possible causes. To that end, this section provides recommendations in the form of suggestions for solutions and concrete actions for policy makers.

Barriers to circularity are grouped by the end-of-life stages of the paper value chain: collection, sorting, recycling, and exporting of waste paper. For some barriers there are multiple possible causes, with their own corresponding suggested solutions and policy recommendations; in such cases, the tables are structured using separate cells and color coding for clarity. The color coding is simply red for the left two columns that outline the challenges and barriers to circularity; green for the right two columns that outline the suggested solutions. At the top of each table, the US and Canadian flags are used to indicate which country the table applies to.

It should be noted that there is some repetition in the tables below. This is because barriers to circularity exist for multiple reasons, and policy actions can serve as solutions for overcoming more than one barrier. The most commonly featured policy recommendations include:

- Introducing multi-stream collection services in which paper is collected as a separate stream (or is at least kept separate from glass), as a way of overcoming barriers to circularity in both the collection and sorting stages, while also retaining more waste paper within domestic recycling markets.
- Leveraging extended producer responsibility (EPR) to promote circularity in a number of ways, including introducing collection requirements (e.g., for the industrial, commercial and institutional sector, and for multi-family buildings), modulating EPR product fees to incentivize the inclusion of recycled content and design for recycling, and using funds from EPR to finance investments collection/recycling infrastructure and education and outreach.
- Measures to increase recycled content in paper products, including recycled content targets, financial incentives for paper mills, and green public procurement guidelines.

7.1 Collection

Barrier to circularity	Possible cause(s)	Suggested solution(s)	Action(s) for policy makers
Low quality fibers: Collection practices impact the quality of post-consumer fibers, resulting in both a mixture of papers with different fiber lengths and levels of inking, and contamination from non-target materials, high moisture content, and other	**Collection practices:** There are three main causes of the loss of fiber quality: (i) Contamination by other recyclable materials in single stream recycling programs. Single-stream collection means that paper and fibers are	To mitigate the risk of contamination during collection, collection service providers to consider adopting multi-stream collections in which paper is collected separately from other materials. This would result in higher quality material that can attract a	Provide financial support, via grants, for pilot programs of multi-stream collections that collect paper separately from all other target materials. Alternatively, provide grant support for pilot programs of multi or dual-stream collections that at least keep glass (a

Barrier to circularity	Possible cause(s)	Suggested solution(s)	Action(s) for policy makers
contaminants such as food, as well as the presence of shredded paper, all of which lead to losses during the recycling process. Low quality fibers have fewer end markets and are a challenge to paper circularity.	mixed with other recyclables (glass, plastic). E.g., in the US, 74% (5.6 million tonnes) of all residential waste paper collected is collected through single-stream recycling. These other materials could be contaminants that must be sorted out for paper to be recycled, which requires investment in sorting infrastructure and still leads to losses if contaminants cannot fully be separated. In particular, fibers can become contaminated by glass, which can break during collection. (ii) Lack of separation of different types of post-consumer fibers in collection, leading to high quality fibers being collected commingled with low quality fibers as mixed paper, which has a lower market value than distinct fiber streams. (iii) An increased moisture content as a result of paper collected in uncovered bins being exposed to wet weather, with this at worst resulting in heavy contamination by water (and there being a risk that whole bins worth of material may be affected).	higher market price, thus potentially offsetting additional collection costs over time as this came to be reflected in materials contract prices. Multi-stream collection could be done using a covered bin to protect the paper from wet weather at the curb, reducing exposure to moisture and reducing the risk of water contamination. Even if multi-stream collection is not implemented, using a covered bin would still protect paper from wet weather in single-stream collection. An alternative approach would be to have a separate collection system for glass, the most problematic contaminant. DRS systems help reduce the volume of glass in the system and could allow for lower frequency glass collection or even drop off glass programs. These changes would further facilitate the sorting of paper into higher value streams at materials recovery facilities (MRFs).	problematic contaminant in fiber recycling) separately collected from fiber. Evidence for the success of these pilot programs could be gathered by tracking bale quality. Provide financial support, via grants, for collection services to use covered bins to protect fibers from wet weather, reducing moisture content. This would help improve fiber quality in multi, dual, and single-stream collection. In rural areas, support the establishment of depots that provide separate covered collection points for paper/fiber packaging. Pass deposit-refund systems (DRS)/bottle bills in jurisdictions in which these are not currently in place to reduce glass contamination. Include beverage cartons, including gable top/aseptic cartons, in new DRS/bottle bill proposals and support the expansion of existing DRS/bottle bills to cover such beverage cartons.
Inconsistent recycling requirements among different jurisdictions have resulted in consumer confusion regarding what items are recyclable. This inconsistency also poses challenges for creating uniform messaging or labeling	Lack of policy harmonizing collection practices.	Options for improving consistency in the collection of fibers include standardized landfill bans across regions, which would be particularly effective at driving the collection of industrial,	Investigate industry best practices to develop and implement country-wide labeling requirements for recyclability, including consistent color of containers/bins for recycling.

Barrier to circularity	Possible cause(s)	Suggested solution(s)	Action(s) for policy makers
to educate consumers about recycling practices.		commercial, and institutional (ICI) fibers (which account for 84% of fibers currently collected in the US market). Standardized multi-family recycling programs for residential buildings. Increase consumer understanding to improve consumer recycling behavior. Improvements to education programs are needed in both the residential and ICI sectors.	Harmonize/standardize materials that can be recycled in a region, jurisdiction and/or nationally to mitigate consumer confusion. Establish new, or improve existing, education programs for both the residential and ICI sectors. Implement consistent landfill bans for cardboard across jurisdictions and establish appropriate enforcement. Analyze best practices for waste diversion from the multi-family residential sector across each country. Provide financial support, via grants, to standardize these best practices across.
Insufficient material captured from residential sector, relative to industrial, commercial, and institutional (ICI) sector: Of the 85.7 million tonnes on paper placed on the US market, 47.4 million tonnes were collected for recycling. Of this, the vast majority were from ICI with 7.5 million tonnes from residential collections. While ICI operations will inherently generate greater tonnages of paper waste, there is potential to improve collection of residential paper waste for recycling. However, there remains a significant tonnage of ICI fibers that are not collected.	**Residential sector lacks the economic incentives present in ICI sector:** The majority of recycled paper in the US is from the ICI sector because the larger tonnages generated make it possible to achieve economies of scale. Paper waste is often collected separately, and If is uncontaminated old corrugated cardboard (OCC – i.e., used shipping containers made with kraft paper linerboard and corrugated medium) or office paper, it may not require sorting but be able to go straight to a mill. There are no financial	Increase the amount of residential paper waste collected for recycling.	Local governments to mandate separate recycling collection for paper. EPR could help to cover the costs of this, either through existing programs or through the introduction of new programs. Amend/introduce extended producer responsibility (EPR) with residential and ICI collection and recycling targets for paper. For jurisdictions that do not have EPR, begin consultation with large producers and waste management companies in the US on supporting EPR. Advocate for states to adopt EPR programs to cover the cost of

Barrier to circularity	Possible cause(s)	Suggested solution(s)	Action(s) for policy makers
	incentives for residents to separate recyclables (and therefore paper) from garbage, nor disincentives against not doing so. Furthermore, different jurisdictions accept different materials in collections, which can create consumer confusion about what products/packaging they can recycle.		residential collection and provide further investments to modernize and upgrade the collection/recycling infrastructure. Implement and enforce consistent landfill/disposal bans for paper products that can be recycled. Municipalities to consider introducing pay-as-you-throw for trash collections to incentivize recycling behavior. Run education and outreach programs on paper recycling to reduce consumer confusion, including providing clear instructions on how to recycle correctly. The Infrastructure and Investment Act (2021) has made available US$75 million to enhance recycling education and outreach. Examples of previous campaigns include those run by Ecomaine in the state of Maine, and on a larger scale the Recycle Across America campaign. Harmonize/standardize materials that can be recycled in a region or jurisdiction to mitigate consumer confusion.

Barrier to circularity	Possible cause(s)	Suggested solution(s)	Action(s) for policy makers
Low collection rates: Of the 6.2 million tonnes of paper placed on the Canadian market Statistics	**Collection practices for multi-family residences:** The multi-family residential sector is	Understand best practices for waste diversion from the multi-family residential sector across each country.	Pass municipal legislation that offers universal access to recycling (at either the curbside or depots) for both single-family and *multi-family

Barrier to circularity	Possible cause(s)	Suggested solution(s)	Action(s) for policy makers
Canada reports that 1.6 million tonnes were collected from residential sources and 2.1 was collected from industrial, commercial and institutional (ICI) sources (although this does not include all business-to-business transactions). On these figures, this leaves 2.5 million tonnes (41%) that were not collected for recycling, much of which is from the ICI sector. Furthermore, according to the 2020 National Waste Characterization Report (ECCC, 2020) , paper makes up approximately 11% of all residual municipal solid waste within Canadian disposal facilities. These figures demonstrate that there is considerable potential to improve fiber collection rates and significantly reduce the amount ending up in Canadian landfills.	managed differently across Canada. Some municipalities provide multi-family residential recycling services, whereas others leave management of multi-family residential recycling as optional, a decision for property owners. Private sector haulers can provide recycling services to multi-family residential buildings at an additional cost in this case. Even when recycling services are available at multi-family buildings, there are several barriers that building residents face to participate in the system, including lack of convenience (recycling bins are often in basements or outdoors), or lack of storage for recyclables within units, leading to low a participation rate.	Implement extended producer responsibility (EPR) with the requirement to collect recycling from multi-family buildings. Implement and enforce landfill/disposal bans for paper products. Scale up education and outreach to reduce consumer confusion over recycling.	households. **It should be noted that ECCC is currently running a study into multi-family residential recycling collections across Canada, which will evaluate regulations and best practice/guidelines. This study will be useful in the future formulation of collection policy in the multi-family residential sector.* Provide funding to improve recycling education and regular outreach to multi-family building residents. For provinces with full EPR, direct producer responsibility organizations (PROs) to set multi-family residential building service targets. For provinces and territories that do not have EPR or still have stewardship programs (Newfoundland and Labrador, Nova Scotia, Prince Edward Island, Manitoba), transition towards a full EPR model with residential collection and recycling targets. EPR can also provide for investment in collection/recycling infrastructure as well as education and outreach activities. Provinces and territories to implement consistent landfill bans for paper and fiber packaging and to enforce these for collections from multi-family buildings. Also, implement education and outreach campaigns to improve residents' sorting behavior, and establish appropriate enforcement. These measures can be combined with increases in tipping fees to further incentivize recycling.

Barrier to circularity	Possible cause(s)	Suggested solution(s)	Action(s) for policy makers
	Collection practices for the industrial, commercial, and institutional (ICI) sector: Only some Canadian provinces have disposal bans or recycling requirements for ICI paper. The nature of the disposal bans is inconsistent within these provinces because the details are determined at the regional and municipal levels. Extended producer responsibility (EPR) is also inconsistent across Canada, with no current implementation of EPR for ICI paper and paper products.	Investigate EPR for the ICI sector. Introduce recycling requirements for paper from the ICI sector.	Amend existing EPR programs and design all new EPR programs to include paper from the ICI sector. Either regulate haulers to require them to charge all their ICI customers for recycling services, regardless of whether they use them or not, thus driving participation (as if they pay for the service, they will be more likely to use it), or regulate businesses to require them to contract haulers for recycling collection in addition to their trash collection service. Increase disposal taxes/tipping fees to provide a cost driver to encourage recycling.
 			
Barrier to circularity	Possible cause(s)	Suggested solution(s)	Action(s) for policy makers
Collection service costs: Residential curbside collection is costly for municipalities. If recycling programs become too expensive, some municipalities may resort to disposal options. The cost of collection might deter municipalities from investing in, or expanding, recycling programs, leading to limited recycling infrastructure, and reduced overall recycling rates. In the absence of funding through extended producer responsibility (EPR), residents end up paying for municipal recycling programs through their taxes.	**Vulnerability to changes in the market:** Fluctuations in the cost of transportation, processing, demand, and quality of paper bales can have significant impacts on stakeholders throughout the value chain. The collection stage, being the first step in the value chain, is particularly vulnerable to changes in global paper prices, global fuel costs, and labor expenses. These fluctuations directly influence the cost and efficiency of collecting paper bales from various sources.	EPR would shift the financial and operational responsibility for recycling collections onto producers. Mandating a minimum percentage of recycled content in paper-based products increases demand for recycled fiber, thereby encouraging more efficient and consistent collection efforts. This increased demand, in turn, can help stabilize the price for recycled paper, making it more attractive for municipalities to pay for the collection of recyclables.	Begin consultation with large producers and waste management companies in the US about supporting EPR for both the residential and industrial, commercial, and institutional (ICI) sectors. Advocate for states to adopt EPR programs that have residential and ICI collection and recycling targets. EPR to provide investment in collection/recycling infrastructure and education and outreach activities. Government at both the national/federal and state/provincial/territorial level to update–or pass new legislation requiring paper packaging and products to have a certain percentage of recycled content (for example, recycled content of 30% is set for printing and writing paper,

Barrier to circularity	Possible cause(s)	Suggested solution(s)	Action(s) for policy makers
			and other paper products—with some higher and lower exceptions for certain products—in California's Public Contract Code). This percentage can increase with time to allow industry to gradually scale up recycled fiber use through modified paper production recipes. In jurisdictions with EPR, producer fees could be modulated to provide an incentive to those who integrate a given percentage of recycled fiber.

7.2 Sorting


Barrier to circularity	Possible cause(s)	Suggested solution(s)	Action(s) for policy makers
Mixed paper bales produced by materials recovery facilities (MRFs) have limited end markets: The most common type of paper bale produced from residential collection is (54) mixed paper. Mixed paper bales are produced when all paper types are collected together and then undergo relatively low levels of sorting. While mixed paper can be used to produce containerboard, it is only ever used as a minority feedstock. In Canada, because no mills currently rely on mixed paper as their main feedstock, the supply of mixed paper is higher than the demand.	**Collection practices:** Single-stream (mixed) recycling collection produces large amounts of mixed paper bales.	Implementing separate paper collection systems can greatly enhance the efficiency and effectiveness of MRFs in sorting paper. MRFs are better able to sort paper into bales of specific grades or types of paper (especially higher quality grades/types) when paper is collected separately from other materials, since the waste paper is more likely to be higher quality overall due to reduced contamination. Multi or dual-stream collection systems, in which glass is separated from paper/plastic, or with a separate collection stream specifically for paper and fiber, would be highly beneficial.	Provide financial support, via grants, for pilot programs of multi-stream collections that collect paper separately from all other target materials. Alternatively, provide grant support for pilot programs of multi or dual-stream collections that at least keep glass (a problematic contaminant in fiber recycling) separately collected from fiber. Evidence for the success of these pilot programs could be gathered by tracking bale quality. In rural areas, support the establishment of depots that provide separate covered collection points for paper/fiber packaging. Pass deposit-refund systems (DRS)/bottle bills in jurisdictions in which these are not currently in place to cover beverage containers, including cartons, including gable top/aseptic cartons and

Barrier to circularity	Possible cause(s)	Suggested solution(s)	Action(s) for policy makers
			support the expansion of existing DRS/bottle bills to cover beverage cartons to reduce number of such cartons in the collection stream.
	Mixed paper is considered a low-quality fiber because, alongside some higher quality paper, it contains soft paper with short fiber that has a poor yield when recycled. Equipment and technology at many paper mills are not designed to process low quality fibers.	Make it economically viable for mills to invest in machines and equipment to process mixed paper. This can be achieved by helping mills access investments for upgrades or by implementing recycled content targets that can create stable demand and prices for recycled fiber. Provide incentives for mills to change recipes to incorporate more recycled fiber.	Through funds from extended producer responsibility (EPR) or other funding structures (e.g., via Infrastructure Canada, and the Solid Waste Infrastructure for Recycling Grant Program or the Infrastructure and Investment Act in the US, to name a few), invest in sorting infrastructure. This can be done by upgrading existing MRFs for better paper sorting and removing plastic contamination. New MRFs to be built with advanced sorting capabilities from the start to promote efficient paper recycling. Tax breaks can also be given to mills on purchases of new technologies that allow them to use lower value and recycled fibers, including equipment to remove contaminants. Tax breaks could also be extended beyond paper related production to technology that allows companies to produce products with recycled fiber and accept other fiber materials (e.g., bio-hubs that process paper into products like biogas, biofuel and fertilizer). Incentivize mills to change their paper recipes to incorporate more recycled fiber through tax breaks and other financial incentives.

7.3 Recycling

Barrier to circularity	Possible cause(s)	Suggested solution(s)	Action(s) for policy makers
Value chain favors virgin fibers: Production systems are oriented towards the use of virgin fibers, and supply chains have been established based on the availability of paper products made from these fibers. This has resulted in a lack of demand for recycled fibers.	**Legacy of paper industry market dynamics:** Many mills were built prior to recycling becoming widespread and were therefore designed to use virgin fiber as their feedstock. Some paper mills are vertically integrated with forestry, and therefore use their own supply of raw materials rather than purchase recycled fiber on the open market. The value chain also favors the use of virgin fiber in manufacture through demand for specific aesthetic characteristics for end products, such as color and brightness, which are more difficult to achieve when paper recipes include recycled content. The perception is that consumers would be less willing to buy off-color products, and this places a limit on the market demand for recycled paper. Currently there are insufficient drivers and market signals to move away from the use of virgin fiber. With each round of recycling, the fiber length shortens, reducing the quality and structural integrity of the material. Recycled paper can be used to produce functional products for several recycling cycles.	Policy levers are needed to reorientate the market towards using recycled fibers, including supporting investments in infrastructure and recycled content targets.	Through funds from EPR, or other funding structures (e.g., via Infrastructure Canada, and the Solid Waste Infrastructure for Recycling Grant Program or the Infrastructure and Investment Act in the US), invest in recycling infrastructure. This can be done by providing financial incentives to open new 100% recycled content mills and/or retrofit existing mills to accept more recycled fibers. Government at both the national/federal and state/provincial/territorial level to update—or pass new—legislation requiring paper packaging and products to have a certain percentage of recycled content (for example, recycled content of 30% is set for printing and writing paper, and other paper products—with some higher and lower exceptions for certain products—in California's Public Contract Code). This percentage can increase with time to allow industry to gradually scale up recycled fiber use. In jurisdictions with EPR, producer fees can also be modulated to provide a bonus to those who integrate a given percentage of recycled fiber.
		Adopt nature-related financial disclosures to reflect that using recycled content has close to zero nature risk whereas virgin fiber has high nature risk (deforestation, monocultures, biodiversity loss) to incentivize manufacturers and producers to incorporate more recycled fiber,	Work with organizations such as the Taskforce on Nature-Related Financial Disclosures to begin public-private consultations to adopt voluntary nature-related financial disclosures. Encourage large paper manufacturers, recyclers, and producers to incorporate these disclosures into their sustainability and environmental, social and

Barrier to circularity	Possible cause(s)	Suggested solution(s)	Action(s) for policy makers
		thereby boosting demand. Nature related data primarily relates to species extinction risks and other biodiversity metrics, and ecosystem services, with the goal of nature-related financial disclosure being to shift investment and spending away from nature-negatives outcomes to nature-positive outcomes.	governance (ESG) reporting.
	Difficulty of changing paper recipes: Paper mills cannot automatically increase the amount of recycled fiber in their recipes, which include specific amounts of types of fibers. Accepting higher amounts of recovered fiber requires changes in processing and equipment. Furthermore, recipes for end-products are set and require very specific fibers, which are typically secured using long-term contracts.	Investment in equipment upgrades and new technologies to enable mills to change recipes and accept more mixed paper. Implementing recycled content targets can create stable demand and prices for recycled fiber, thereby incentivizing mills to invest in equipment to allow them to integrate more recycled fiber into their recipes.	Through tax breaks, funds from EPR, or other funding structures (e.g., via Infrastructure Canada, and the Solid Waste Infrastructure for Recycling Grant Program or the Infrastructure and Investment Act in the US, to name a few), invest in sorting infrastructure. This can be done by upgrading existing materials recovery facilities (MRFs) for better paper sorting and removing plastic contamination. New MRFs to be built with advanced sorting capabilities from the start to promote efficient paper recycling. Tax breaks can also be given to mills on purchases of new technologies that allow them to use lower value and recycled fibers, including equipment to remove contaminants. Tax breaks could also be extended beyond paper related production to technology that allows companies to produce products with recycled fiber and accept other fiber materials (e.g., bio-hubs that process paper into products like biogas, biofuel and fertilizer).

Barrier to circularity	Possible cause(s)	Suggested solution(s)	Action(s) for policy makers
			Incentivize mills to change their paper recipes to incorporate more recycled fiber through tax breaks and other financial incentives. Government at both the national/federal and state/provincial/territorial level to update—or pass new – legislation requiring paper packaging and products to have a certain percentage of recycled content (for example, recycled content of 30% is set for printing and writing paper, and other paper products—with some higher and lower exceptions for certain products—in California's Public Contract Code). This percentage can increase with time to allow industry to gradually scale up recycled fiber use. In jurisdictions with EPR, producer fees can also be modulated to provide a bonus to those who integrate a given percentage of recycled fiber.
Challenges of recycling molded pulp: Increased awareness of the problems associated with plastic pollution has resulted in a trend to reduce plastic packaging, which in turn has led to an increase in demand for paper packaging replacements, which are composed of molded pulp (i.e., packaging material made of paper and water). However, not all recyclers can recycle molded pulp and there is no mature recycling end market for it.	**Lack of access to technology, and issues with contamination:** The technology to recycle molded pulp is new and most converters do not have access to it. Molded pulp's ability to be recycled also depends on its contamination level. When it is contaminated with organic waste from food packaging it is especially difficult to recycle.	Support investments in research and development to develop scalable technology and infrastructure to recycle molded pulp. Establish recycled content targets that will stimulate innovation to recycle molded pulp.	Consider forming government-industry partnerships to provide funding for pilot projects to develop technologies to recycle molded pulp, with the aim that these technologies can be made available to all mills. Set recycled content targets for packaging, including molded pulp, to drive industry investment and action on finding ways to meet these targets, including developing and scaling new technologies. Government at both the national/federal and state /provincial/territorial level to update or pass new legislation requiring paper packaging and products to have a certain percentage of recycled

Barrier to circularity	Possible cause(s)	Suggested solution(s)	Action(s) for policy makers
			content (for example, recycled content of 30% is set for printing and writing paper, and other paper products—with some higher and lower exceptions for certain products—in California's Public Contract Code). This percentage can increase with time to allow industry to gradually scale up recycled fiber use. In jurisdictions with extended producer responsibility (EPR), producer fees can also be modulated to provide a bonus to those who integrate a given percentage of recycled fiber.
Challenges of recycling fiber-based packaging: There are challenges with recycling fiber-based packaging that currently limit the potential for switching from plastic to fiber-based packaging.	**Inclusion of non-fiber elements in fiber-based packaging:** Some fiber-based applications (such as multi-material and multilayer packaging) still include plastic elements to preserve barrier and moisture properties, and these may create difficulties in the paper recycling process, with wide-ranging differences in the abilities of different mills to handle these non-fiber elements.	Design for recycling. Possible design solutions include switching to mono-material packaging (e.g., replacing the aluminum and/or plastic layers in carton with fiber-based alternatives) or making non-fiber elements easily removable (and recyclable), to minimize loss of fiber (e.g., replacing tape with interlocking fiber-based tabs).	Incentivize design for recycling through extended producer responsibility (EPR) fee modulation. Provide financial incentive for design competitions from both industry and the academic communities.
	Challenge of pulping high wet strength fiber-based packaging: For paper packaging to perform comparably to plastics, the fiber must retain high strength when wet, which can make it difficult to pulp and therefore to recycle, leading to low yields of usable fibers. High wet strength paper packaging applications must therefore be pulped using	Implement pulping processes designed for high wet strength.	Through funds from EPR, or other funding structures (e.g., via Infrastructure Canada, and the Solid Waste Infrastructure for Recycling Grant Program or the Infrastructure and Investment Act in the US, to name a few), provide financial incentives for mills to invest in pulping technologies needed to treat high wet strength paper products. This includes both retrofitting old mills and ensuring that new mills are fitted with the required technologies.

Barrier to circularity	Possible cause(s)	Suggested solution(s)	Action(s) for policy makers
	processes specifically designed treat to them.		Fund life cycle assessments (LCAs) to understand the true cost of recycling coated paper packaging (such as alternative foodware). The challenge for mills, when it comes to polycoated paper packaging, is the time and energy required in the hydro-pulper to remove the paper fiber from the poly layer.
Lack of ability to handle recycled fibers at paper mills: A primary barrier to paper circularity is a lack of technical capability at paper mills. This is particularly true regarding older facilities, many of which were built prior to recycling becoming widespread and which were therefore designed to use virgin fiber as their feedstock.	**Costs of making the necessary technological upgrades:** These mills were built before sustainability and the circular economy was a mainstream concept. Technology upgrades and business model changes required to use recycled fiber require significant investment and can be challenging. While all mills are capable of incorporating some recycled content, retrofitting older facilities to use 100% recycled content is expensive, with conversion costs estimated at between US$250 and $450 million per mill. Some paper mills are also vertically integrated with forestry, and therefore use their own supply of raw materials from logging activities rather than purchase recycled fiber on the open market.	Investment in upgrading mills to integrate more recycled fiber in their recipes.	Through funds from extended producer responsibility (EPR), or other funding structures (e.g., via Infrastructure Canada, and the Solid Waste Infrastructure for Recycling Grant Program or the Infrastructure and Investment Act in the US, to name a few), invest in recycling infrastructure. This can be done by providing financial incentives to open new 100% recycled content mills and/or retrofit existing mills to accept more recycled fibers. Investments in paper mills to also focus on enhancing the ability to handle lower quality fibers and effectively remove contaminants. This can include adding cleaning equipment. Tax breaks could also be extended beyond paper related production to technology that allows companies to produce products with recycled fiber and accept other fiber materials (e.g., bio-hubs that process paper into products like biogas, biofuel and fertilizer).

Barrier to circularity	Possible cause(s)	Suggested solution(s)	Action(s) for policy makers
Lack of further sorting within paper mills: Mills generally lack the capability to further sort the paper bales delivered to them into the specific grades they require, and therefore if bales are grades of poor quality, they cannot be used.	**Costs of making the necessary technological upgrades:** Mills are generally not equipped with technologies needed to deliver additional sorting at this later stage in the value chain. Adding the necessary new equipment is prohibitively expensive and mills would incur further operational costs due to the extra time they would need to spend cleaning the fibers.	Improve sorting performance at materials recovery facilities (MRFs) to a level adequate to provide mills with the specific paper grades they need, and to reduce contamination.	Through funds from extended producer responsibility (EPR), or other funding structures (e.g., via Infrastructure Canada, and the Solid Waste Infrastructure for Recycling Grant Program or the Infrastructure and Investment Act in the US, to name a few), invest in sorting infrastructure. This can be done by upgrading existing MRFs for better paper sorting and removing plastic contamination. New MRFs to be built with advanced sorting capabilities from the start to promote efficient paper recycling.

7.4 Exports

Barrier to circularity	Possible cause(s)	Suggested solution(s)	Action(s) for policy makers
Loss of material to exports: A significant tonnage of waste paper and paper products are being exported outside of the US and Canada, meaning they are lost from domestic and regional markets and are therefore not contributing to circularity. In 2021, the US exported 13.48 MT of paper (28% of paper collected for recycling) outside of North America, and in 2020, Canada exported 0.85MT (23% of paper collected for recycling). There is a risk that	**Low domestic demand and competition from international markets:** Low labor costs in countries such as India, Vietnam, and Indonesia mean that mills can afford to manually sort paper to remove contamination prior to recycling. Therefore, international markets are able to out-compete domestic recyclers. There is limited domestic demand for some types of paper bales. In particular, mixed paper bales often contain higher levels of contamination and have lower quality fibers, making them less desirable to domestic recyclers.	Increase domestic demand for recycled fiber through policy, with the use of financial incentives to increase recycled fiber contents and disincentives the use of virgin fiber.	Government at both the national/federal and state/provincial/territorial level to update—or pass new—legislation requiring paper packaging and products to have a certain percentage of recycled content (for example, recycled content of 30% is set for printing and writing paper, and other paper products – with some higher and lower exceptions for certain products—in California's Public Contract Code). This percentage can increase with time to allow industry to gradually scale up recycled fiber use. In jurisdictions with extended producer responsibility (EPR), producer fees can also be modulated to provide a bonus to those who integrate a given percentage of recycled fiber. All levels of government to update their green public procurement guidelines to require the purchases of high recycled content paper packaging and products. Through funds from EPR, or other

Barrier to circularity	Possible cause(s)	Suggested solution(s)	Action(s) for policy makers
without addressing this, increasing the tonnages and quality of paper collected for recycling would simply result in a greater quantity being exported.			funding structures (e.g., via Infrastructure Canada, and the Solid Waste Infrastructure for Recycling Grant Program or the Infrastructure and Investment Act in the US, to name a few), invest in sorting infrastructure. This can be done by upgrading existing materials recovery facilities (MRFs) for better paper sorting and removing plastic contamination. New MRFs to be built with advanced sorting capabilities from the start to promote efficient paper recycling. Provide financial incentives to open 100% recycled content mills and/or retrofit existing mills to accept more recycled fiber. Invest in paper mills with a focus on enhancing their ability to handle lower quality fibers and effectively remove contaminants. This can also include adding cleaning equipment to remove more contaminants. Also, incentivize mills to change their paper recipes to incorporate more recycled fibers through tax breaks and other financial incentives. Tax breaks could also be extended beyond paper related production to technology that allows companies to produce products with recycled fiber and accept other fiber materials (e.g., bio-hubs that process paper into products like biogas, biofuel and fertilizer).
		Decrease contamination throughout the value chain (i.e., the stages of collection, sorting, and cleaning for recycling)	Provide financial support, via grants, for pilot programs of multi-stream collections that collect paper separately from all other target materials. Alternatively, provide grant support for pilot programs of multi or dual-stream collections that at least keep glass (a problematic contaminant in fiber recycling) separately collected from fiber. Evidence for the success of these pilot programs could be gathered by tracking bale quality. Collection services to use covered bins to protect fibers from wet

			
Barrier to circularity	**Possible cause(s)**	**Suggested solution(s)**	**Action(s) for policy makers**
			weather, reducing moisture content. This would help improve fiber quality in multi, dual, and single-stream collection. Expand existing deposit-refund systems (DRS)/bottle bills to cover beverage cartons and reduce the amount of gable top/aseptic cartons in the collection stream. In rural areas, support the establishment of depots that provide separate collection points for paper/fiber packaging. Pass DRS/bottle bills in jurisdictions in which these are not currently in place to cover beverage containers, including cartons, and support the expansion of existing DRS/bottle bills to cover beverage cartons to reduce number of gable top/aseptic cartons in the collection stream.
	Imbalance of packaging imports relative to domestic production: More packaging is imported from abroad than is manufactured domestically, with domestic manufacturing capacity limiting demand for recycled fiber.	Promote domestic paper manufacturing, especially by incentivizing building or retrofitting 100% recycled content paper mills. Invest in recycling infrastructure.	Through funds from EPR, or other funding structures (e.g., via Infrastructure Canada, and the Solid Waste Infrastructure for Recycling Grant Program or the Infrastructure and Investment Act in the US, to name a few), provide financial incentives to open 100% recycled content mills and/or retrofit existing mills to accept more recycled fiber. Invest in paper mills with a focus on enhancing their ability to handle lower quality fibers and effectively remove contaminants. This can also include adding cleaning equipment to remove more contaminants. Incentivize mills to change their paper recipes to incorporate more recycled fiber through tax breaks and other financial incentives.
		Implement recycled content requirements for paper packaging to boost demand and incentivize producers to increase domestic capacity to incorporate recycled fiber in their products.	Government at both the national/federal and state/provincial/territorial level to update—or pass new—legislation requiring paper packaging and products to have a certain percentage of recycled content (for example, recycled content of 30% is set for printing and writing paper, and other paper products—with

 			
Barrier to circularity	**Possible cause(s)**	**Suggested solution(s)**	**Action(s) for policy makers**
			some higher and lower exceptions for certain products—in California's Public Contract Code). This percentage can increase with time to allow industry to gradually scale-up recycled fiber use. In jurisdictions with EPR, producer fees can also be modulated to provide a bonus to those who integrate a given percentage of recycled fiber.

Appendix

8 Circular Economy Definitions

Currently, there is no standard, internationally recognized definition of the "circular economy." Below are several definitions that were used to provide guidance and reference for carrying out this study.

8.1 Domestic

The Government of Canada:

The circular economy is a different way of doing business. The way our economies extract, use, then dispose of resources is putting pressure on our natural systems, communities, and public health. This is a linear economy—it moves in a straight line from resource extraction to waste disposal. In a circular economy, nothing is wasted. The circular economy retains and recovers as much value as possible from resources by reusing, repairing, refurbishing, remanufacturing, repurposing, or recycling products and materials. It is about using valuable resources wisely, thinking about waste as a resource instead of a cost, and finding innovative ways to better the environment and the economy.

Source: https://www.canada.ca/en/services/environment/conservation/sustainability/circular-economy.html

The Government of the United States:

The term "circular economy'' means an economy that uses a systems-focused approach and involves industrial processes and economic activities that; are restorative or regenerative by design; enable resources used in such processes and activities to maintain their highest values for as long as possible; and aim for the elimination of waste through the superior design of materials, products, and systems (including business models).

Source: Save Our Seas 2.0 Act – United States law enacted on December 18, 2020

8.2 Reports/Studies

Closed Loop Partners Report (2020)

Put simply, the circular economy eliminates the concept of waste and makes the most of materials that are already in play, much like natural systems in which nutrients are continually cycled. Resource efficiency, and the resulting opportunities for savings and profit, is at its core.

Source: The Circular Shift: Four Key Drivers of Circularity in North America Report

McCarthy et al. (part of OECD Environment Working Papers series):

There is no single commonly accepted definition of the term "circular economy", but different definitions share the basic concept of decoupling of natural resource extraction and use from economic output, i.e., increased resource efficiency as outcome. One core view of the circular economy is that it can be defined relative to a traditional linear economic system, i.e., one that focuses on closing resource loops. A second, slightly broader, view of the circular economy stresses the importance of slower material flows, either within an economy with some degree of material circularity, or within one that is more linear. The third, and broadest, view of the circular economy is that it involves a more efficient use of natural resources, materials, and products within an existing linear system. This broad view of the circular economy affects potentially all economic activities, not only those with a high material-use profile, but is the one applied in most modeling assessments and in this review.

Source: McCarthy, A., Dellink, R. and Bibas, R., 2018. The macroeconomics of the circular economy transition: A critical review of modelling approaches.

Circle Economy – Circularity Gap Report (2018):

At the heart of the circular economy is the idea of moving away from linear value chains that we have had in place for more than 200 years. It means breaking with the 'take-make-waste' tradition and transitioning towards a circular approach that is much less heavily reliant on raw material extraction and much more focused on minimizing and eliminating waste. The broader benefit of this circular model is to separate things we do want from our economic system—such as equally distributed prosperity and a bright future for the next generations—from those we do not want, like wasteful use of scarce natural resources and adverse effects on our environment and society. A circular economy is thereby a decoupling strategy aimed at growing prosperity, while intelligently managing resources within the boundaries of our planet.

Source: https://www.circularity-gap.world/

8.3 Institutions and International Organizations

The European Commission:

The circular economy is a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible. In this way, the life cycle of products is extended.

In practice, it implies reducing waste to a minimum. When a product reaches the end of its life, its materials are kept within the economy wherever possible thanks to recycling. These can be productively used again and again, thereby creating further value.

This is a departure from the traditional, linear economic model, which is based on a take-make-consume-throw away pattern. This model relies on large quantities of cheap, easily accessible materials and energy.

Source: https://www.europarl.europa.eu/news/en/headlines/economy/20151201STO05603/circular-economy-definition-importance-and-benefits#:~:text=The%20circular%20economy%20is%20a,reducing%20waste%20to%20a%20minimum

Ellen MacArthur Foundation:

Systems solution framework that tackles global challenges like climate change, biodiversity loss, waste, and pollution. It is based on three principles, driven by design: eliminate waste and pollution, circulate products and materials (at their highest value), and regenerate nature. It is underpinned by a transition to renewable energy and materials. Transitioning to a circular economy entails decoupling economic activity from the consumption of finite resources. This represents a systemic shift that builds long-term resilience, generates business and economic opportunities, and provides environmental and societal benefits.

Source: https://ellenmacarthurfoundation.org/topics/circular-economy-introduction/glossary

International Resource Panel (IRP) & United Nations Environment Programme (UNEP):

The circular economy is one in which the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste is minimized. This is in contrast to a 'linear economy', which is based on the "extract, make and dispose" model of production and consumption.

Source: https://www.resourcepanel.org/glossary

United Nations:

Whilst there is no universally agreed definition of a circular economy, the 2019 United Nations Environment Assembly (UNEP), the UN's flagship environmental conference, described it as a model in which products and materials are "designed in such a way that they can be reused, remanufactured, recycled or recovered and thus maintained in the economy for as long as possible".

Source: https://news.un.org/en/story/2021/06/1093802

8.4 Events and Related Communications

Sitra/World Circular Economy Forum (WCEF):

The circular economy is not a new idea. Indigenous communities across North America and beyond have been practicing principles of circularity, including regeneration and reciprocity, since time immemorial.

Source: https://www.sitra.fi/en/publications/wcef2021-summary-report/

An economic model which does not focus on producing more and more goods, but in which consumption is based on using services—sharing, renting and recycling—instead of owning. Materials are not destroyed in the end but are used to make new products over and over again.

Source: https://www.sitra.fi/en/dictionary/the-circular-economy/

The circular economy is part of the glue that binds together the need to tackle climate change, the loss of biodiversity and the overconsumption of natural resources with an inclusive democracy, economic growth and increasing social well-being.

Source: https://www.sitra.fi/en/blogs/circular-economy-makes-business-sense-and-can-help-tackle-globalcrises/

Circular North America – Discussion Paper and Event Summary (May 2021)

The circular economy has come to the forefront as a solution for moving away from today's linear 'take-make-waste' society, addressing growing environmental and social challenges and risks while generating significant economic benefits. Defining the opportunities for North America requires an understanding of where things are today, what the end goal is, and how to get there—identifying relevant natural resource industry strengths while leveraging service-based sectors and the broader innovation ecosystem.

Source: https://www.canada.ca/content/dam/eccc/documents/pdf/circular-economy/north-americapaper/WCEF-Circular-North-America_Report_2021_EN.pdf and https://circulareconomyleaders.ca/circularnorth-america/

9 Policy Appendix

9.1 Canadian Policy at Provincial and Territorial Levels

Table 31. Paper waste management policies by province/territory

Province/Territory	Policy Summary
British Columbia	The Government of British Columbia regulates waste management through the Environmental Management Act. The Recycling Regulation, established in 2004 and amended in 2020, establishes an EPR program with the goals of reducing the overall volume of waste and diverting 75% away from landfills. The Recycling Regulation outlines products that are covered under EPR, including electronic and electrical products, packaging and paper products for residential, ICI waste, and some residual product categories such as pesticide containers, paint containers, and automotive antifreeze containers. Beverage containers are covered under the province's DRS. The non-for-profit waste management organization Recycle BC operates EPR in British Columbia for packaging and paper products (PPP). Recycle BC provides recycling services covering 99.3% of residents in urban, rural, remote, and First Nations communities and works with 181 collection partners to provide curbside collection, multi-family collection, and drop-off centers (Recycle BC, 2021). Additionally, British Columbia has a DRS that includes paper containers such as gable tops and aseptics, alongside all sealed and ready-to-drink containers made of plastic, including pouches, bag-in-box, and polystyrene cups. Encorp Pacific and Brewers Recycled Container Collection Council are the stewardship organizations that operate the DRS system for beverage containers (Encorp Pacific (Canada), 2021).
Alberta	The Alberta Environmental Protection and Enhancement Act (2000, updated 2020) requires recycling programs for beverage containers, In October 2022, the province passed an EPR law for packaging, which will be operational in 2025 (Alberta, 2022). The EPR program will cover single-use products and packaging, including flexible and rigid plastics, and printed paper such as newsprint, packaging, cardboard, printed paper, and magazines. Additionally, Alberta has DRS for all sealed containers, including PET, HDPE, other plastics, bag-in-box, and pouches, as well as paper aseptic containers, gable top, and Tetra Pak.
Saskatchewan	Saskatchewan's Environmental Management and Protection Act (2010, updated 2022) requires the recycling of packaging and paper products through a stewardship program for residential waste (Saskatchewan, 2010). Under the current system, producers are responsible for 75% of the cost of recycling while municipalities retain operational control and pay for the remaining 25% (Saskatchewan, 2023). The province is planning on transitioning its stewardship program for packaging and paper products towards a full EPR model where producers are responsible for 100% of costs. Additionally, the province has DRS for beverage containers, including plastic and multi-material containers as well as paper containers like gable top and aseptic.

Province/Territory	Policy Summary
Manitoba	In 2022, the province announced plans to implement a full EPR program for household packaging and printed paper, which will be managed by Multi-Material Stewardship Manitoba Inc. (MMSM). The program is set to be fully operational by 2025. Additionally, Manitoba has a deposit-refund system for certain sealed beverage containers, including plastic and glass bottles and aluminum cans.
Ontario	The Resource Recovery and Circular Economy Act of 2016 in Ontario requires the recycling of materials, including paper. The province is transitioning to a full EPR model for paper and plastic packaging and single-use foodservice items starting in 2023. Ontario also has a DRS for all alcoholic beverage containers, including bag-in-box containers, paper gable top, and Tetra Pak containers.
Québec	Pursuant to the Environmental Quality Act, the Government of Québec published its Residual Materials Management Policy, which aims to promote better residual materials management and consumption practices to create a zero-waste society in Québec (Quebec, 2023). It addresses three main challenges: ending resource waste, promoting the goals of the Québec Climate Change Action Plan and the Québec Energy Strategy, and making all stakeholders responsible for residual materials management. The policy aims to reduce the volume of residual materials sent to disposal sites and to recover and reuse resources by prioritizing source reduction, increasing fees for disposal, placing a landfill ban on organic material, implementing full EPR, promoting the recycling of residual materials generated by the ICI sectors, as well as improving knowledge of residual materials management and raising awareness to educate the public about the impacts of residual materials on the environment (Quebec, 2023). The Government of Québec is implementing EPR policies for packaging, printed paper, single-use products, electronics, paints and their containers, oils and antifreeze, and agricultural plastics (Gazette Officielle du Quebec, 2021). Producers will be required to meet performance targets for collection and recycling, and they may face penalties or be required to invest in system improvement if they do not meet these targets. The new system will be managed by an organization approved by RECYC-QUÉBEC (the Québec Society for Recovery and Recycling) and will be in effect by fall 2022 with full implementation by summer 2025 (Quebec, 2022). RECYC-QUÉBEC operates Québec's DRS for beverage containers. DRS in Québec has historically covered soft drinks under eight liters and beer containers but has not covered paper containers. However, beginning in 2023, Québec's DRS will cover all containers from 100 ml to 2 L ready-to-drink beverage containers, excluding bag-in-a-box containers. The deposit amount will rise to C$0.10 for most containers covered and C$0.25 for containers over 500 mL (Quebec, n.d.).
New Brunswick	Each region in New Brunswick has its own recycling services and material acceptance, governed by 12 regional commissions. New Brunswick is currently drafting legislation to implement an EPR system for residential packaging and printed paper. New Brunswick has a DRS for all sealed containers, including plastic bottles, cans, and plastic cups with foil lids, pouches, and bag-in-box, for beverages except for milk and containers under 5L, which also applies to paper aseptic and gable top containers.

Province/Territory	Policy Summary
Nova Scotia	Nova Scotia has province-wide landfill bans on all recyclable materials, including paper, newsprint, and cardboard (Nova Scotia, 2022). Nova Scotia has several stewardship programs in place for various materials, including milk packaging (which includes gable top cartons and Tetra Pak) and newsprint (Nova Scotia, n.d.). Milk producers voluntarily take responsibility for the end-of-life management of milk packaging through a stewardship agreement with Nova Scotia Environment (part of the Nova Scotia Department of Environment and Climate Change) and the Atlantic Dairy Council. The newsprint industry has an industry stewardship agreement with Nova Scotia Environment to address objectives of waste reduction, newsprint recovery, and public education for recycling.
Prince Edward Island	The provincial government established the Island Waste Management Corporation (IWMC) as a crown corporation under the Environmental Protection Act (1988, amended in 2019) to manage and oversee the provincial recycling program for packaging and paper materials. Businesses in Prince Edward Island are prohibited from selling or distributing single-use plastic bags and have a C$0.15 fee for paper bags (Prince Edward Island, 2022). The Waste Resource Management Regulations of 2019 prohibit the disposal of recyclable materials in landfills in the province.
Newfoundland and Labrador	The Environmental Protection Act (2004, amended 2019). outline the requirements governing the implementation and operation of waste diversion programs. Recycling programs for tires, beverage containers, and packaging and paper materials are government-operated and managed by the Multi-Materials Stewardship Board (MMSB), a crown agency responsible for developing, implementing, and overseeing waste diversion and recycling programs throughout the province. A DRS covers all sealed, ready-to-drink containers bag-in-box, gable top, and aseptic containers.
Yukon	The Government of Yukon subsidizes the recycling of non-designated materials such as packaging and paper in some municipalities, but these programs are not regulated territory wide. All recovered materials are shipped out of the territory for recycling. The Beverage Container Regulations authorize product stewardship programs across the territory, There is no requirement to recycle paper and cardboard packaging (non-beverage containers). The Government of Yukon has put in place a ban on businesses distributing single-use plastic bags, with the ban extending to single-use paper bags in 2023 (Yukon, 2021).
Northwest Territories	The Waste Reduction and Recovery Act (WRRA) (2004, amended 2017) provides the overall legislative framework for waste reduction, reuse, and recycling in the Northwest Territories (Northwest Territories, 2017). DRS in the Northwest Territories covers beverage containers, including bottles, cans, plastic cups, paperboard cartons, and packages made of metal, plastic, paper, glass, or any other material that contains or contained a beverage ready for consumption, including milk and liquid milk products (Northwest Terrotories, 2016). This excludes infant formula containers, containers with a capacity less than 30ml, and empty containers intended for retail sale without being filled. The Electronics Recycling Regulations authorize fees to be charged at point of sale to fund program recycling operations for electronics. The regulations prohibit the

Province/Territory	Policy Summary
	distribution or sale of new electronics in the territory without being registered as a distributor and no electronics can be distributed or sold without paying the surcharge to the environment fund (Northwest Territories, 2016). The single-use retail bag regulations prohibit the distribution or sale of single-use retail bags in the Northwest Territories (Northwest Territories). All paper, plastic and biodegradable bags sold in stores must be sold at a cost of C$0.25. This fee is passed onto the Environment Fund, which uses the revenue to cover program expenses and fund new waste reduction and recovery programs.
Nunavut	Nunavut does not have legislation or a defined waste management strategy.

9.2 Canadian DRS Programs

Table 32. Details of Canadian DRS programs

Province/Territory	Paper and Carton Beverages Covered by DRS	Redemption Rate for Covered Paper-Based Containers and All Containers Combined (incl. non-paper based)
British Columbia	Aseptic, gable top, bag-in-box	Gable Top: 59.6% Aseptic: 54% Bag-in-box: 47.8% All Beverage Containers: 80.3%
Alberta	Aseptic, gable top, bag-in-box	Tetra brik: 70.5% Gable Top: 74.2% Bag-in-box: 49.2% All Beverage Containers: 84%
Saskatchewan	Gable top and aseptic	N/A
Ontario	gable top, aseptic, bag-in-box (alcoholic beverages only)	Tetra/Bag-in-box: 24.9% All Beverage Containers: 73.7%
Québec	All paper beverage containers (RECYC-QUÉBEC, 2022)	Paper based containers will be covered by DRS starting in 2025, redemption rates not available at time of writing
New Brunswick	Aseptic, gable top, bag-in-box	Cartons: 46.3%* *This is data from 2018–2019 as more recent figures are not available at time of writing. All beverage containers: 69.5%
Nova Scotia	Aseptic, gable top	Gable top: 50% Tetra Pak: 43.5% All Beverage Containers: 82.3%
Prince Edward Island	Aseptic, gable top, bag-in-box	Cartons: 42.1% Pouches and aseptic: 62.2% All Beverage Containers: 84.6%
Newfoundland and Labrador	Aseptic, gable top, bag-in-box	Other: 37.4%*

Province/Territory	Paper and Carton Beverages Covered by DRS	Redemption Rate for Covered Paper-Based Containers and All Containers Combined (incl. non-paper based)
		*redemption rate for gable top, aseptic, bag-in-box as well as plastic pouches.
Yukon	Gable top, aseptic	N/A
Northwest Territories	Aseptic, gable top, bag-in-box	Gable Top/Aseptic: 40.8% Bag-in-box: 27.2% All Beverage Containers: 80.3%
Nunavut	No DRS	
Manitoba	No DRS for carton and paper containers	

Source: (Reloop, 2022)

9.3 Canadian Stewardship and EPR Policies

Table 33. Canadian Stewardship and EPR Policies

	Ontario	Québec	Manitoba	British Columbia	Saskatchewan	New Brunswick	Alberta
Year of program start	2003	2005	2010	2014	2016	TBD 2023 (6 months following plan approval)	Spring 2025
Producer Responsibility Organization (PRO)	Stewardship Ontario (SO)	Eco Entreprises, Québec (EEQ)	Multi-Material Stewardship Manitoba (MMSM)	Recycle BC	Multi-Material Stewardship Western (MMSW)	TBD	TBD
Service provider to the PRO	Circular Materials (CM)	none	Circular Materials (CM)	Circular Materials (CM)	Circular Materials (CM)	Circular Materials (CM)	TBD
Share of Industry Contribution	Current: 50% Future (2023 onwards): 100%	Current: 100% of eligible costs Future (2025 onwards): 100%	Current: 80% Future: 100%	100%	Current: 75% Future: 100% (TBC)	Full, based on defined service standards	Full
Responsibility for recycling service delivery	Current: local gov't Future: producers	Current: local gov't Future: local gov't resp. for collection; producers resp. for post-collection	Current: local gov't Future: producers	Producers	Local gov't	Collection: Local gov'ts will be given right of first refusal Post-Collection: producers	Producers
Targeted Materials	Current: packaging and printed paper Future: packaging;	Packaging; Printed paper; Single-use products	Packaging; printed paper	Packaging; Single-use products; Packaging-like	Packaging and aper	Paper (printed and unprinted) Packaging and Packaging-like Products	Single-use Products Packaging Paper Products

	Ontario	Québec	Manitoba	British Columbia	Saskatchewan	New Brunswick	Alberta
	paper product; packaging-like product			product; Paper			
Program Scope	Current: municipal Future: Residential (single-family (SF)+multi-family (MF)) Retirement & long-term care homes Public spaces Schools	Current: municipal Future: Municipal + ICI (phased implementation over 9 yrs)	Residential (SF & MF)	Residential (SF & MF) Streetscape	Residential (SF & MF)	Residential (SF & MF) Schools Public space	Residential (SF & MF)

9.4 US EPR Policies

This appendix subsection presents details of the EPR policies in place in the four US states whose EPR programs cover paper packaging (California, Colorado, Maine, and Oregon).

California (California, 2022)

California's EPR law covers single-use packaging and single-use food service ware. Exempted products include medical products and foods, packaging for products regulated by the Federal Insecticide, Fungicide, and Rodenticide Act, packaging containers for hazardous materials and flammable products, beverage containers subject to a bottle deposit, and packaging for long-term storage of a product.

Within 12 months of the effective date of the bill, producers of covered materials must form and join a PRO. A producer cannot sell, distribute, or import a covered material unless they are approved to participate in the plan of a PRO. However, a producer could comply individually without joining a PRO if they achieved a source reduction of at least 5% of covered materials through shifting to refill, reuse, or elimination and at least 8% source reduction of covered materials through optimization, concentration, right-sizing, bulking, shifting to non-plastic packaging, lightweighting, or increasing the number of consumer uses between 2013 and 2022.

The Department of Public Health and Environment and the PRO will contract an independent third-party to prepare a needs assessment, which will be updated every five years and funded by the PRO. An initial needs assessment for specific covered materials will also be completed before any PRO plan that includes such material is approved.

The PRO determines the fee structure and schedule for producers based on operating costs and the costs of implementing the plan, completing the needs assessment, mitigation requirements, and the California circular economy fee. The fees are calculated based on:

- The cost to develop and sustain end markets;
- The cost to collect, sort, avoid, or remove contamination, and to aggregate and transport materials into defined streams to support end markets for recycling; and
- Costs incurred by local jurisdictions or recycling service providers.

Fees will be modulated for covered materials that have adverse environmental or public health impacts. They will be modulated based on recycled content, source reduction, standardization of packaging that simplifies processing, marketing, sorting, recycling, and composting, presence of hazardous materials and toxic additives, clear and accurate labeling instructions that improve consumer behavior in sorting and disposing of products, and the acceleration of source reduction and investment in reuse/refill systems.

The program aims to ensure that covered products distributed in the state are recyclable or compostable by January 1, 2032, and subsequently meet the following recycling rates: 30% by January 1, 2028; 40% by January 1, 2030; and 65% by January 1, 2032. Additionally, the program aims to achieve a 25% source reduction by weight by January 1, 2032.

Colorado (Colorado, 2022)

Colorado's EPR program law is being established to increase recycling rates and improve access to recycling services. The program will be operated by a PRO overseen by the Colorado Department of Public Health and Environment with input from an advisory board of recycling stakeholders. Producers joining the PRO will fund the program through responsibility dues.

The PRO will develop a minimum recyclable list based on the availability of recycling services, recycling collection and processing infrastructure, and recycling end markets. There are exemptions to materials covered, such as packaging for long-term storage, beverage containers subject to a DRS, packaging used in industrial or manufacturing processes, and packaging of regulated products such as drugs and infant formula.

The PRO will hire an independent third party to conduct a needs assessment by September 1, 2023, to evaluate the state's current recycling services and identify needed improvements. The results of the needs assessment will be reported by April 1, 2024.

The funding mechanism for the EPR program will include costs for providing recycling services, conducting the needs assessment, education and outreach, and reimbursing administrative and implementation costs. Any surpluses generated by the program will be placed back into the program to fund improvements or reduce PRO dues. The PRO will calculate membership dues using an objective formula that considers factors such as the results of the needs assessment, regional recycling costs, population density, number and types of households served, collection method, revenue generated from collected materials, and contamination rates. Dues will be modulated to discourage practices that increase the costs of recycling or disrupt the recycling of other materials, and to discourage the use of materials not on the minimum recyclable list. The Executive Director of the department will develop the eco-modulation bonus schedule in consultation with the PRO.

The PRO will set minimum collection rates, recycling rates, and post-consumer recycled (PCR) content rates for covered materials. Targets will be set for January 1, 2030, and January 1, 2035, and the minimum rates will be increased thereafter.

Maine (Maine, 2021)

Maine's EPR law requires producers to be responsible for the end-of-life management of the packaging they produce. The materials covered by the law include paper and plastic packaging. Exemptions are given to packaging for long-term storage, beverage containers subject to a DRS, paint cans, federally regulated perishable foods, and small local producers/low-volume packaging producers.

Before the EPR program is implemented, a needs assessment must be carried out by the PRO. The assessment will evaluate funding needs for recycling, collection and transportation capacity and costs, market conditions and opportunities, and consumer education needs. The state will select a PRO via a competitive bid process and enter into a contract with the organization to coordinate the packaging stewardship program. Producers will be individually responsible for compliance.

Producers are required to pay a fee into a program fund that will reimburse local governments for the operation costs of collection, transportation, and sorting. These fees also cover the costs of administration and enforcement, investments in infrastructure, and improving recycling education.

Oregon (Oregon, 2021)

Oregon's EPR law covers packaging, paper, and food service ware. It excludes beverage containers subject to a DRS. The Department of Environmental Quality will conduct multiple needs assessments to evaluate the costs of collection expansion, multi-family services, and litter management. The needs assessment will also provide a process for local governments to request services and survey interest in expanding collection options and recycling drop-off centers in areas without these services. The first needs assessment must be complete by July 1, 2023, with additional assessments required at least once every four years.

Under the law, a PRO must provide for the collection and responsible recycling of a specified list of covered products not collected in municipal programs and fund or reimburse local governments for the costs of transportation, contamination reduction, education and outreach, recycling expansion and improvements, market development/end markets, and infrastructure improvements. Producer fees for PRO membership are adjusted based on environmental impacts such as PCR content, product-to-package ratio, material type, life cycle environmental impact, and recycling rate, with the aim of incentivizing producers to make changes to their production, use, and marketing of covered products. Recycling goals for plastics and plastic food service ware have been set at a minimum of 25% by 2028, 50% by 2040, and 70% by 2050.

10 Technical Appendix

10.1 Introduction

This appendix subsection details the data used to calculate the estimated tonnages of paper generated, collected, sorted and recycling in the United States and Canada.

Using available data, a methodology was developed to generate a material flow for paper products in the US and Canada. The methodology enables paper waste to be traced throughout the supply chain, from the production and consumption of paper products through to the collection, sorting and reprocessing of paper waste. At each stage of the process, the losses from the system are quantified. This section details the approach taken to calculate the tonnage of paper generated, disposed, and recycled.

The purpose of this analysis is to establish a baseline from which policy makers, service providers, operators, and investors can make informed strategic decisions on what measures are needed in the short-, medium-, and long-term to support a circular economy, replace virgin material consumption in production with secondary materials, and reduce greenhouse gas (GHG) emissions.

This content is organized as follows:

1. Data sources (Subsection 10.2) – This section has a table of the main data sources used for each of the paper types described in the study.
2. General methodology for data collection and quality assessment (Section 10.3) "...A high level description of how the material flow figures were derived."
3. Detailed data tables for the US and Canada (Section 10.4)– this section lists the detailed data tables which are used for the charts, statistics, and descriptions in the Material Flows section of the main body. The tables are the raw output from Eunomia's modelling to determine the flow of plastic material in the US and Canada.
4. Paper material flow methodology for the US and Canada (Section 10.5) – this section lays out the methodology for calculating the flow of paper material.

10.2 Data Sources

The below tables detail the data sources used to quantify the flows of paper in the US and Canada. A wide range of sources were used to develop the material flows, ranging from international databases provided by the United Nations (UN) to state- and provincial-level responses to freedom of information (FOI) requests. Some of the data used was also provided by subcontractors, such as Circular Ventures LLP and Ambiens, who provided the necessary detail and nuance in specific markets.

10.2.1 United States

Table 34 highlights the key data sources used to develop the material flow for paper in the US for 2021.

Table 34. Data sources for the US's paper material flow

Point of measurement	Data source	Year	Information provided
Domestic production	American Forest & Paper Association (AF&PA)	2022	Tonnes of paper and pulp products produced in the US in 2021.
	UN Food & Agricultural Organization (UN FAO)	2022	
Trade balance of finished goods	Circular Ventures LLP	2022	Trade balance of finished paper products for the US in 2021.
Placed on the market	Circular Ventures LLP	2022	The tonnage of paper products which enter the domestic market. These sources enabled to classify the tonnage into three paper grades; 'Cardboard', 'Mixed Fibre' and 'Newsprint'.
	American Forest & Paper Association (AF&PA)	2022	
	The Recycling Partnership	2020	
Collected for recycling	Reloop	2022	Tonnage of paper collected for recycling. This excludes the weight of dirt, moisture and product residues.
	Eunomia Research & Consulting	2021	
	State-level freedom of information (FOI) requests	Various	
Sorted for recycling	American Forest & Paper Association (AF&PA)	2022	Tonnage of paper that enters recycling facilities. It accounts for not just the collected tonnage but also the material lost during sorting processes.
	King County Department of Natural Resources and Parks	2020	
	Eunomia Research & Consulting	2021	
Secondary markets	American Forest & Paper Association (AF&PA)	2022	Proportion of secondary paper material that is used in the domestic production of paper products.
Trade of waste paper	UN Comtrade	2023	Tonnes and value (in US dollars) of waste paper grades traded internationally in 2021.

10.2.2 Canada

Table 35 highlights the key data sources used to develop the material flow for paper in Canada for 2020. Due to the availability of data on Statistics Canada (StatsCan), The year 2020 was used as the reference year.

Table 35. Data sources for Canada's paper material flow

Point of measurement	Data source	Year	Information provided
Domestic production	United Nations Food & Agricultural Organization	2022	Tonnes of paper and pulp products produced in 2020.
	Pulp & Paper Products Council	2022	
Trade balance of finished goods	Statistics Canada	2022	Trade balance of finished paper products for Canada in 2020.
	Pulp & Paper Products Council	2022	
Placed on the market	Statistics Canada	2020	The tonnage of paper products which enter the domestic market. These sources enabled to classify the tonnage into three paper grades; 'Cardboard', 'Mixed Fibre' and 'Newsprint'.
	Environment and Climate Change Canada (ECCC)	2020	
	Province-level freedom of information (FOI) requests	Various	
Collected for recycling	Carton Council	2023	Tonnage of paper collected for recycling. This excludes the weight of dirt, moisture and product residues.
	Provincial-level Extended Producer Responsibility reports	Various	
	Province-level freedom of information (FOI) requests	Various	
Sorted for recycling	Statistics Canada	2022	Tonnage of paper that enters recycling facilities. It accounts for not just the collected tonnage but also the material lost during sorting processes.
	Eunomia Research & Consulting	2021	
	Environment and Climate Change Canada (ECCC)	2020	
	King County Department of Natural Resources and Parks	2020	
Trade of waste paper	UN Comtrade	2023	Tonnes and value (in US dollars) of waste paper grades traded internationally in 2020. Both UN Comtrade and StatsCan provided trade data, enabling the data to be verified.
	Statistics Canada	2022	

10.3 General Methodology for Data Collection and Quality Assessments

Different approaches can be used to calculate the recycling rate of paper:

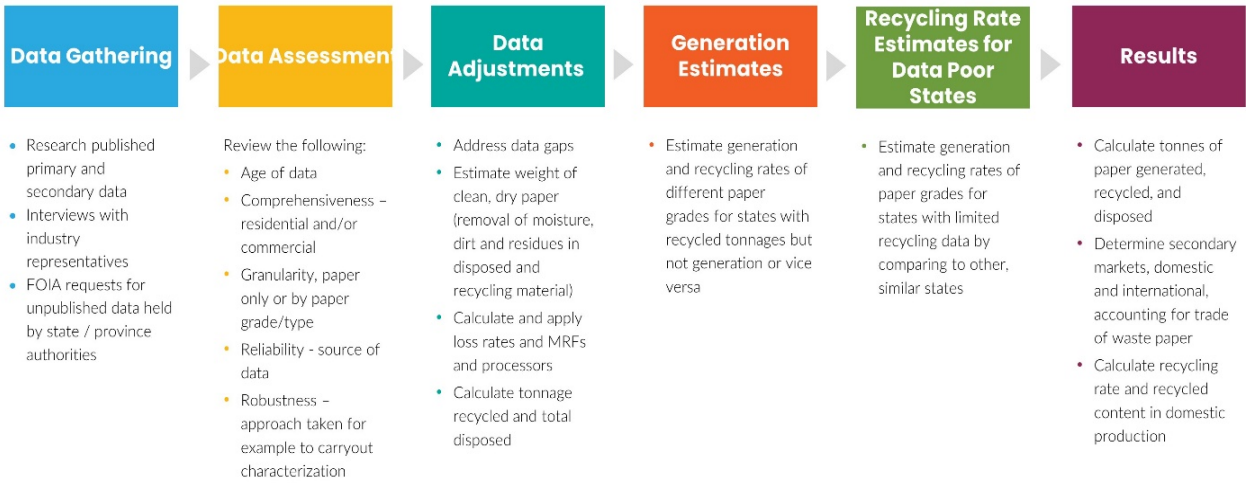
1. *Placed on the market:* Based on market data reported by packaging producers, ascertain the quantity of paper generated, along with consistent reporting of the paper recycled at the point of measuring when the material can be used in a new product: the output from the processor.
2. *Top down:* Using data provided by industry bodies throughout the paper industry in each country.
3. *Bottom up:* Using data on disposed of and recycled tonnage and waste characterizations, with assessment of material lost throughout the recycling process, to ascertain generation and recycling rates for different packaging materials.

Due to the lack of published and easily available information on data *placed on the market*, and to ensure a consistent approach across all packaging materials included in the study, the assessment approach used in this report is a combination of *approaches 2 and 3*, above. It was recognized that using this technique might not be ideal and depends on the availability, quality, and the systems for gathering the data within each geographical area. However, the necessity for absolute accuracy in the results bears reflection, due to the lack of any minimum requirement in reporting waste data: a starting point that can be improved as data systems develop.

10.3.1 Data processing

An overview of the process taken to gather, collate, and review data, as well as to calculate comparable weight and performance metrics, are summarized in Figure 19.

Figure 19. Overview of data gathering and analysis process



Step 1: Data gathering

The data gathering exercise aimed to collect all available data that could aid in an assessment of paper recycled and disposed, from publicly available data, published reports, and from FOI requests. Where possible, these data were collected at state or province levels, and aggregated in order to comprise a national estimate. Where state-level data were not available, tonnage and waste composition data were sourced from counties, cities, and municipalities.

Supplementary information was also gathered from industry reports, interviews with processors, and from data on Material Recovery Facilities (MRF), included in the "*2017–2018 MRF and Mixed Waste Facility database.*"

Step 2: Data assessment

The availability, quality and comprehensiveness of the data varied considerably across states/provinces/territories and between the two countries. The data collected were assessed for these issues and gaps were identified.

Step 3: Data adjustments

Based on the data gathered and assessed, adjustments were made to state-level data, which were then used to fill in data gaps and estimate 'clean, dry' quantities of paper materials.

> **Step 3.1 Address Data Gaps:** A series of supplemental assumptions were made for states where some data existed but where further assumptions were needed to identify paper materials in the waste.
>
> **Step 3.2: Estimate 'Clean, Dry' Weights:** Paper collected from waste streams contain moisture and product residues. These are adjusted across the different materials and waste streams, to enable an estimate of the quantity of paper itself to be derived. Removing moisture and contaminants, both from the disposed paper and the paper recycled, is important in deriving a real recycling rate.
>
> **Step 3.3: Calculate Tonnage Recycled and Total Disposed:** Where paper is sorted through Material Recovery Facilities, some of it ends up as residue. These losses are accounted for in the calculation of quantities generated (and considered in the overall quantity recycled).

Step 4: Calculate Generation Estimates

For those states/provinces/territories that had information on recycled tonnage but not on tonnages of paper disposed, or vice versa, a modeled estimate of the paper generated was applied, from which a recycling rate was estimated. See Section 3.5 for specific commentary on developing a generation/placed on the market estimate for Canada.

Step 5: Calculate Recycling Rate Estimates for Data Poor States/Provinces

Several states/provinces had no information on recycled tonnage or tonnages of paper disposed. For these states, the generation estimate was applied, as in Step 4, and a recycling rate estimated based on comparison with other similar states.

10.4 Detailed Data Tables

Table 36 provides a summary of the key statistics in the paper material flow for the US (Subsection 10.2.1) and Canada (Subsection 10.2.2).

Table 36. Data summary for paper material flow.

Million tonnes	US		Canada	
Year	*2021*		*2020*	
Domestic production	67.3		8.3	
Net trade of finished goods	18.4		-2.1	
Placed on the market (POM)	85.7		6.3	
Newsprint	4.5		1.4	
Mixed Fiber	32.6		2.2	
Cardboard	48.6		2.6	
Collected for recycling	47.4	55%	3.7	59%
Newsprint	2.1	47%	0.8	60%
Mixed Fiber	17.3	53%	1.3	56%
Cardboard	27.9	55%	1.6	61%
Sorted for recycling	45.8	53%	3.5	57%
Net trade of sorted paper waste	- 15.5		-0.5	
Recycled content used in domestic production	27.7		2.8	
% Recycled content	41%		33%	

10.5 Paper Material Flow Methodology

As highlighted above, data for the paper waste flows for the US and Canada were taken from a variety of sources. The high-level data processing steps taken were as follows:

1. Compile waste flow tonnages at best granularity possible (e.g., by paper grade);
2. Estimate material into separate commercial versus residential sectors; and
3. Calculate tonnages by applying Material Recovery Facility rates (see Step 1, above) and mechanical recycling-loss rates, to move along the recycling value in the necessary direction.

The following equations provide a summary of the calculations made at each stage of the material flow.

The tonnage of paper placed on the market (POM) is the sum of domestic production and the net balance of trade, where the net balance of trade is equal to the difference in tonnage between a country's imports and exports, as shown below:

$$Placed\ on\ the\ market = Domestic\ production + Net\ balance\ of\ trade$$
$$Net\ balance\ of\ trade = Import\ of\ paper\ products - Export\ of\ paper\ products^{18}$$

The calculation of tonnage placed on the market in the US is made simpler by the availability of publicly available data. Placed on the market (POM) data for Canada is less accessible and, as a result, an alternative approach has been used to 'back-calculate' a POM tonnage figure.

The POM tonnage is often reckoned as the sum of the paper-sorted tonnage and the paper-disposed tonnage. Statistics Canada have published the tonnage of paper waste prepared (sorted) for recycling in Canada in 2020, as 3.5 million tonnes. However, the bureau is yet to release statistics relating to the tonnage of waste disposed of in 2020; the most recent data are only available for 2018. As a result, the total tonnage of paper POM in 2020 has been estimated using historical data from 2016 and 2018, as shown in Table 37.

Table 37. Tonnage of paper prepared of recycling and disposed in Canada in 2016 and 2018 (million tonnes)

	2016	2018	2020
Tonnage prepared for recycling	3.58	3.52	3.50
Tonnage disposed	2.74	2.82	–
Tonnage placed on the market (POM)	6.32	6.34	–
Prepared for recycling (as a % of POM)	56.7%	55.5%	–

On average, 56.1% of paper POM is prepared for recycling based on historical data. As a result, if this percentage is maintained for 2020 data, it is estimated that the total tonnage POM in 2020 would be 6.24 million tonnes. It is important to accurately estimate the tonnage of paper products POM in the reference year, as both the collected for recycling rate and the sorted for recycling rate are calculated as a proportion of POM, as shown in the equations below:

$$Collected\ for\ recycling\ rate = \frac{Tonnes\ of\ paper\ collected\ for\ recycling}{Tonnes\ placed\ on\ the\ market}$$

$$Sorted\ for\ recycling\ rate = \frac{Tonnes\ of\ paper\ sorted\ for\ recycling}{Tonnes\ placed\ on\ the\ market}$$

[18] The net balance of trade can be calculated for both finished paper products and waste paper products.

The other important metric quantified throughout the material flows section is recycled content in domestic production, which is calculated using the below equation.

$$Recycled\ content = \frac{Tonnes\ of\ secondary\ material\ used\ as\ feedstock}{Tonnes\ of\ paper\ produced\ domestically}$$

The tonnage of secondary material used as feedstock in domestic production is equal to the sum of sorted paper waste generated domestically and the net balance of trade of waste paper. Using Harmonized System codes (six-digit codes that enable product types to be uniquely identified), it is possible to track this trade, both in terms of tonnage traded and the value of those transactions. Table 38 highlights the HS codes relating to waste paper products that can be identified in the United Nations' Comtrade database and on the World Bank's World Integrated Trade Solution platform.

Table 38. Harmonized System (HS) codes for paper waste

HS Code	HS product description	Assumed product type
470710	Paper or paperboard; waste and scrap, of unbleached kraft paper or paperboard or of corrugated paper or paperboard.	Old, corrugated cardboard (OCC)
470720	Paper or paperboard; waste and scrap, of paper or paperboard made mainly of bleached chemical pulp, not colored in the mass	High grades
470730	Paper or paperboard; waste and scrap, of paper or paperboard made mainly of mechanical pulp (e.g., newspapers, journals and similar printed matter)	Sorted Residential Papers and News (SRPN)
470790	Paper or paperboard; waste and scrap, of paper or paperboard not elsewhere specified.	Mixed paper
470620	Pulp of fibers derived from recovered (waste and scrap) paper or paperboard	Pulp made from recycled fibers

Data on imports and exports, by tonnage, value (in US$) and trading partner, are available for the US and Canada. As a result, it is possible to identify the largest trading partners of each country in the scope of this study, and therefore determine the flow of waste material within, and out of these countries. Using the imports and exports data enables the balance of trade of waste paper to be calculated for each country. This enables the quantification of secondary material used as feedstock in domestic production.

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