WHITE PAPER | SEPTEMBER 2021

Rethinking plastic packaging recycling

Solutions towards increased circularity in Quebec and Canada

GROUPE D'ACTION PLASTIQUES CIRCULAIRES

CIRCULAR PLASTICS TASKFORCE

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Thank you to our
financial partners

Phase I of the CPT-led project was made possible with the support of Environment and Climate Change Canada (ECCC), which was a major partner in funding this project. The CPT would like to sincerely thank them for their support which played a key role in the success of this first and important step. We also wish to acknowledge the contribution of Eco Entreprises Québec, which also financially supported this first phase, and thank them for their continued and appreciated support throughout the deployment of the work.

Environment and Climate Change Canada | Environnement et Changement climatique Canada

Éco Entreprises Québec — Recycling is our business

Thank you to our
project management team

In order to carry out all planned activities, the CPT was fortunate to be able to rely on a project coordination team led by the Center for Technology Transfer in Industrial Ecology (CTTEI) of the Sorel-Tracy CÉGEP, in collaboration with Stratzer and LGP Real Estate Strategies. Thank you to these exceptional team members who have put their skills and expertise towards serving the advancement of a circular plastics economy in Quebec.

cttéi — EXPERT EN LA MATIÈRE | STRATZER | LGP REAL ESTATE STRATEGIES

Thank you to our
advisory committee

Throughout our project, we were able to benefit from the expertise of exceptional partners who played an essential role in the success of this first phase. We therefore wish to warmly thank them for their support and their invaluable contribution to our project.

Center for Intersectoral Studies and Research on the Circular Economy (CERIEC) | Conseil des entreprises en technologies environnementales du Québec (CETEQ) | Quebec Business Council on the Environment (CPEQ) | Éco Entreprises Québec (ÉEQ) | Fédération québécoise des municipalités (FQM) | InnovLOG | Ministère de l'Économie et de l'Innovation | Ministère de l'Environnement et de la Lutte contre les changements climatiques | Réseau Environnement | RECYC-QUÉBEC | Retail Council of Canada (RCC)

Thank you to our
associate partners

CPT's strength lies in its ability to mobilize the entire plastics recycling value chain. Thank you to our many associate partners who support our approach through their association with our project and their active participation in our initiatives.

The Circular Plastics Taskforce (CPT)

Founding members, objectives and vision

The Circular Plastics Taskforce (CPT) was created from the collaboration between Cascades, Danone Canada, Dyne-a-Pak, Keurig Dr Pepper Canada, TC Transcontinental, and the Chemistry Industry Association of Canada (CIAC) which joined forces to help build a circular plastics economy in Quebec and Canada. A committed financial partner and advisor since the beginning, Éco Entreprises Québec joined the Steering Committee in 2021.

The CPT relies on a better alignment between market needs and recycling players to offer concrete solutions aimed at optimizing the management of plastics throughout the value chain. In doing so, the CPT wishes to support, at the local and national level, the strengthening of existing and emerging markets and help increase the performance of the industry so that it can produce quality recycled materials. The founding members of the CPT share a common vision, in which all plastic packaging marketed in Quebec and Canada should be collected, sorted, then recycled in line with market needs (volumes, grades, quality), thus creating a circular economy for plastics.

Structure of Phases I-II-III

The CPT thus gave birth to a project on the development of a circular approach to plastic recycling in Quebec and Canada, structured in three distinct phases. Phase I aims to carry out an exhaustive mapping of the plastics recycling value chain in Quebec to identify the main issues, propose innovative solutions and carry out simulation tests intended to validate their potential. These solutions will be put to the test during Phase II, through pilot projects deployed in sorting centers with recyclers. Once the model has been tested, the initiative can be reproduced outside Quebec during Phase III of the project.

Thanks to the support of its partners, the CPT recently concluded the work and activities included in Phase I of the project, which resulted in the drafting of a technical report submitted to the main financial partner of this phase, Environment and Climate Change Canada (ECCC). The main findings and recommendations emerging from this first phase are summarized in this White Paper. Phase II of the project will be launched in the fall of 2021.

Cascades · DANONE · dyne-a-pak · Keurig Dr Pepper Canada · tc TRANSCONTINENTAL · CHEMISTRY INDUSTRY ASSOCIATION OF CANADA · Éco Entreprises Québec

Preamble

In recent years, the management of plastic waste has become a growing source of concern for the population. In 2018, the closure of Asian markets to recyclable materials from overseas increased the pressure on the North American recycling industry, particularly due to a major drop in the value of certain materials, as well as the need for market diversification and increased quality requirements. This “crisis” revealed the heterogeneous and fragile nature of the recycling industry, in Canada as elsewhere, and highlighted the urgency of mobilizing the forces involved to modernize the industry and improve its performance.

Plastics are omnipresent in today’s economy and are used across multiple industries, from packaging to construction, automotive and healthcare. Packaging, for food and other applications, also represents a significant portion of plastic waste produced in Canada and its end-of-life management is largely based on curbside recycling programs. While some resins, such as PET bottles and HDPE, are widely recycled, others such as polystyrene or polypropylene are under-recycled.

Since it aims to optimize the use of resources and keep them in circulation, the circular economy must be the cornerstone of a redefined management of plastics. Having a recognized value and a very real end market, these materials have a concrete potential to be reintroduced into the economic cycle in the form of new resins and new goods. The economic opportunity is sizeable, the possibilities for innovation are immense and the environmental benefits are numerous.

Across Canada, initiatives are multiplying, and players are mobilizing, giving way to a real movement towards a circular plastics economy. The various levels of government are currently working on diverse strategies and policies to guide this change. In Quebec, Minister Benoit Charrette initiated in 2019 the project to modernize the curbside collection system and expand the deposit program, by promoting the implementation of a model based on Extended Producer Responsibility (EPR). At the federal level, the government has adopted a Zero Plastic Waste Strategy aimed at eliminating the loss of plastics in the environment, by keeping them in circulation in a circular economy, through an integrated management approach and various regulatory tools. The Canadian government is also behind the Ocean Plastics Charter, an international tool signed to date by 27 countries and 75 companies and organizations.

Companies are not left out, putting forward new commitments aimed at improving the recyclability of their packaging and integrating a greater proportion of recycled content into it by focusing on eco-design principles, particularly within the Ellen MacArthur Foundation’s New Plastic Economy initiative. In Canada, groups of leaders are also forming to support the advancement of the circular economy. Officially launched in February 2020, the Circular Plastics Taskforce, or CPT, is part of this movement.

Phase I of the Project Led by the CPT

The founding members of the CPT share a common willingness to support an increased use of post-consumer recycled plastic and, for many, are committed to integrating it directly into their products and packaging. Even more, they nurture the ambition to be able to locally source, in Quebec and Canada, quality resins from a truly circular economy.

As part of this project, the CPT has thus chosen to favor a reverse engineering approach, according to which the processes of the plastics recycling value chain are redesigned to better meet the needs of end users for these materials. Through the work of Phase I of the project, the CPT has therefore sought to identify the challenges encountered by the various links in the value chain, which constitute obstacles to the production of recycled plastic resins that correspond to market needs. Promising solutions have also been identified and validated on a small scale to confirm their potential, again with a view of closing the gap between the materials produced by the value chain and actual market requirements.

Governance Structure

The CPT has a solid governance structure to ensure the success of its projects. This structure is based on various committees and categories of partners:

Steering Committee:
The steering committee is made up of the founding members of CPT and Éco Entreprises Québec. Its role as the principal of the project is to ensure sound governance, full implementation and alignment with the objectives and vision pursued.

Advisory Committee:
This committee is made up of partners whose expertise and field of activities are linked to the objectives of the project and can therefore be valuable in its successful completion. These partners share the CPT's vision, are informed of the project's progression in a prioritized manner and are consulted on the directions and strategies to be put in place to ensure its success.

Project Manager:
The management of Phase I of the project was entrusted to CTTEI, whose mandate was to coordinate all the activities planned as part of this phase, in addition to receiving funding and managing the budget and cash flow.

Financial Partners:
These partners financially support the project and share its vision. They are informed of the progress of the work on a regular basis and have the opportunity to participate in various activities and contribute to the project through their expertise and their network.

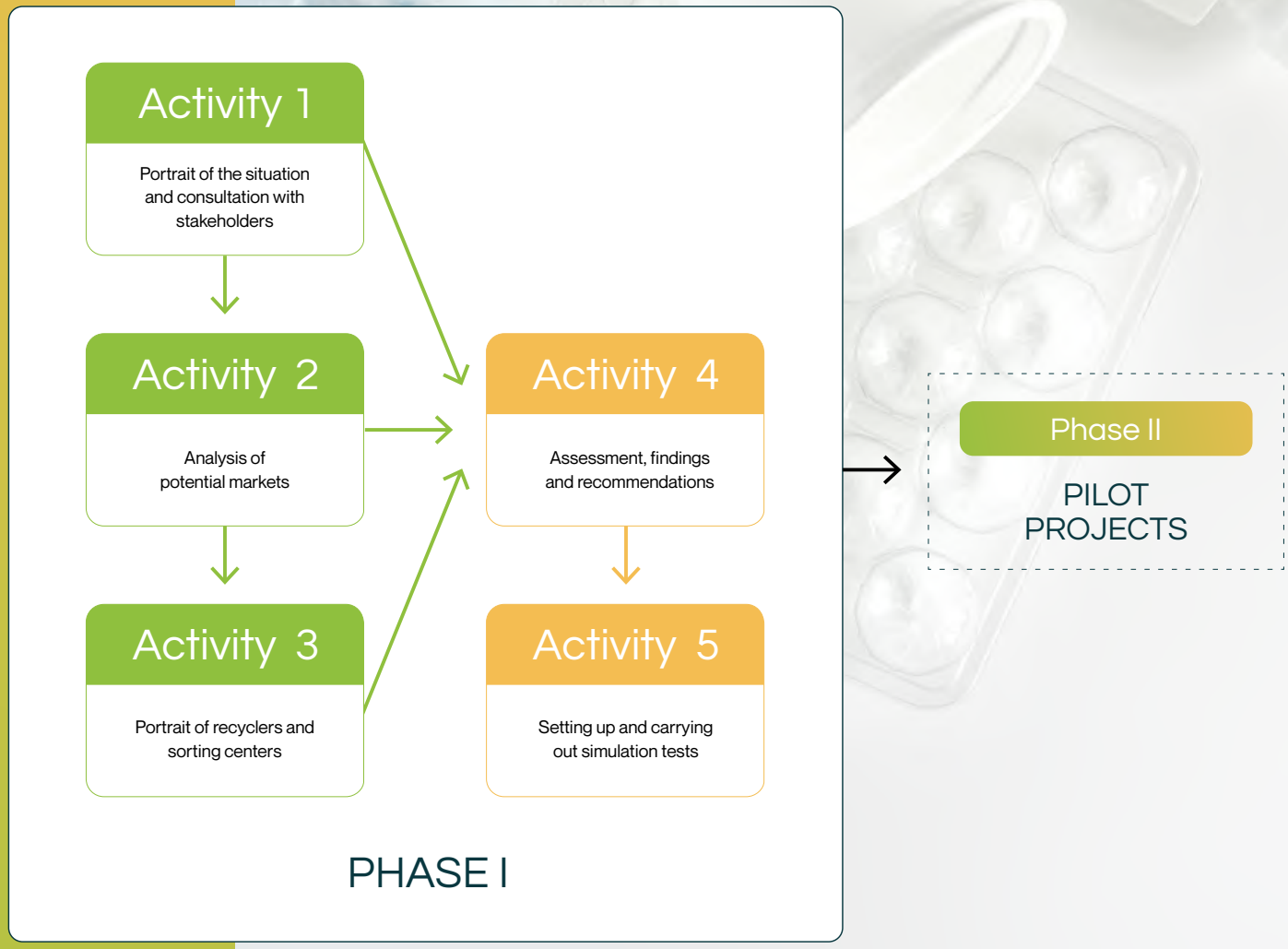
Associate Partners:
These partners share the vision and objectives of the project and expressed interest to be associated with it. They are informed of the progress made in a prioritized manner and can collaborate in certain activities and share their expertise for the benefit of the project.

** For the complete list of our advisory and associate partners, please visit www.gapc.ca/en

Phase I Methodology

In order to achieve its objective, the CPT has built a replicable methodology to map the plastics value chain, determine the needs of different markets for recycled plastics, identify the challenges encountered by the different links in the chain and establish improvement hypotheses to facilitate networking within the value chain. More than 130 interviews with members of the plastic value chain in Quebec were carried out between April and December 2020.

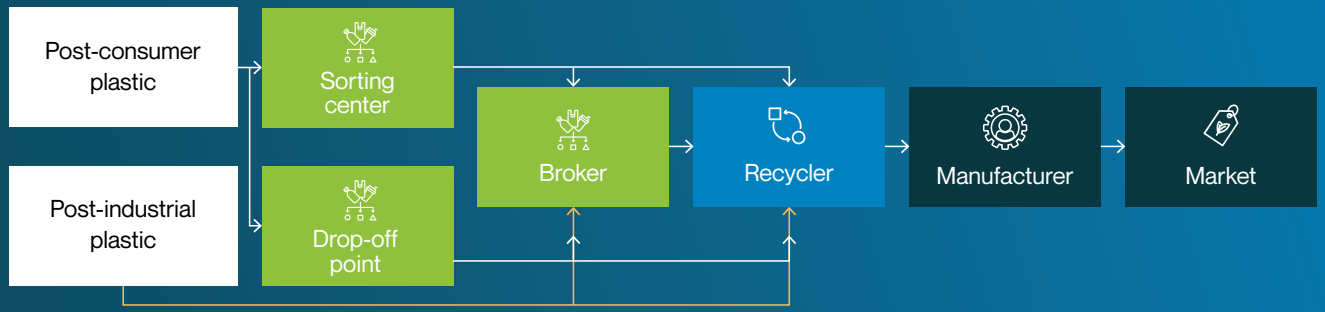
The figure on the right shows the five activities that were carried out during Phase I. The results of these five activities will be presented in the following sections.



Portrait of the Plastics Situation in Québec

To fully understand the situation of plastics generated and recovered in Quebec, we must focus our attention towards post-consumer plastics from curbside recycling, as well as those from post-industrial and post-commercial sources. It is also essential to understand the structure of the value chain, which includes several links as illustrated in the figure below.

Structure of the plastics recycling value chain



Curbside collection serves the residential sector and certain industrial, commercial & institutional (ICI) sectors. 35% of post-consumer plastics, or 80,000 tons per year, are collected by Quebec households and pass through Quebec's 23 sorting centers. Several types of plastics are recovered by curbside recycling and are present in varying quantities, as indicated in the table below.

Feedstock from curbside collection in Quebec – Characterization of residual materials in the municipal sector 2015-2018

Types of plastics	Generation (tons)	Recovery rate	Proportion of plastic in curbside recycling
Mixed PET #1	41,776	63%	4.1%
Mixed HDPE #2	19,238	68%	2.0%
Bags and films #2 and #4	35,501	26%	1.5%
Containers and packaging #6	15,297	22%	0.5 %
Other rigid plastics	53,054*	38%	3.1%
Other flexible plastics	62,737	12%	1.1%
Total	227,602	35%	12.3%

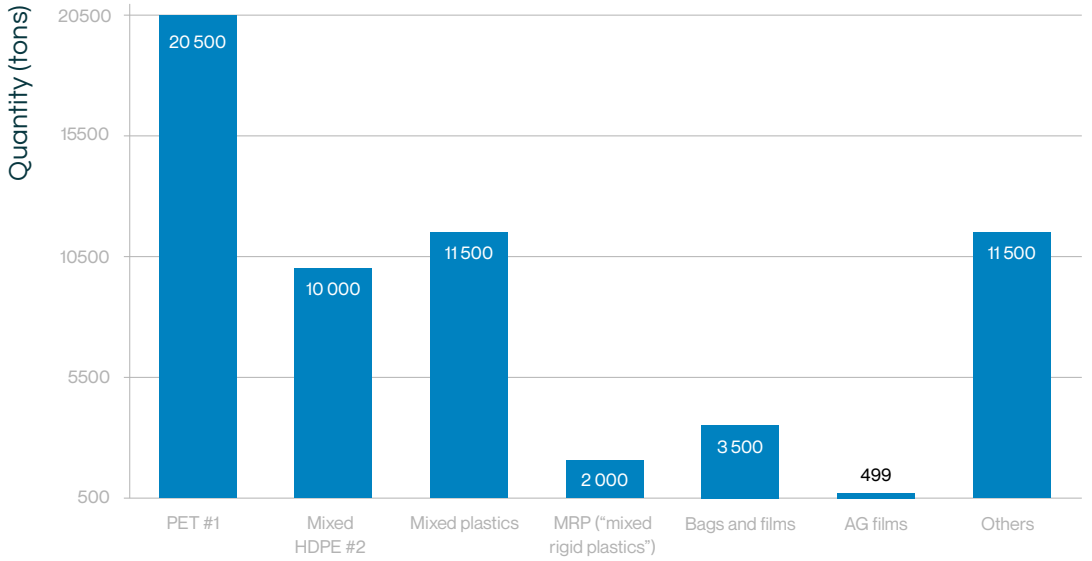
Source: ÉEQ and RECYC-QUÉBEC (2021)

* Including approximately 25% of PP.

Sorting centers separate post-consumer plastics using various processes: manual sorting, optical sorters, suction systems, ballistics, etc. Once sorted, these plastics are usually found in five types of bales: PET (#1), mixed HDPE (#2), mixed plastics (which may contain a mixture of the different plastics #1 to #7), mixed rigid plastics (or MRP) and bags and films. These bales are then sold directly to the recyclers or through brokers. The figures on the right show the breakdown of sales by bale type, as well as the variability of selling prices in Quebec between 2018 and 2020. It should be noted that the prices of recycled resins have risen sharply since the start of 2021, driven by growing demand from companies for post-consumer recycled resin.

Based on surveys of recyclers and an extrapolation of their revenues, the total post-industrial and post-commercial feedstock is estimated at 35,500 tons. These plastics are generated by companies and go directly to recyclers (74% or 26,200 tons) or with the help of brokers (26% or 9,300 tons), without going through sorting centers. The information gathered has made it possible to establish, among other things, that about one third of this feedstock is made up of post-commercial plastics (i.e. pallet packaging, expanded polystyrene, etc.), and that post-industrial plastics recovered in larger quantities include PVC, PP, LDPE, ABS and PS. Like post-consumer plastics, post-commercial and post-industrial plastics are sold to recyclers to be turned into ready-to-use recycled materials by the market.

Breakdown of sales from Quebec sorting centers by type of bales in 2018



Source: RECYC-QUÉBEC (2020)

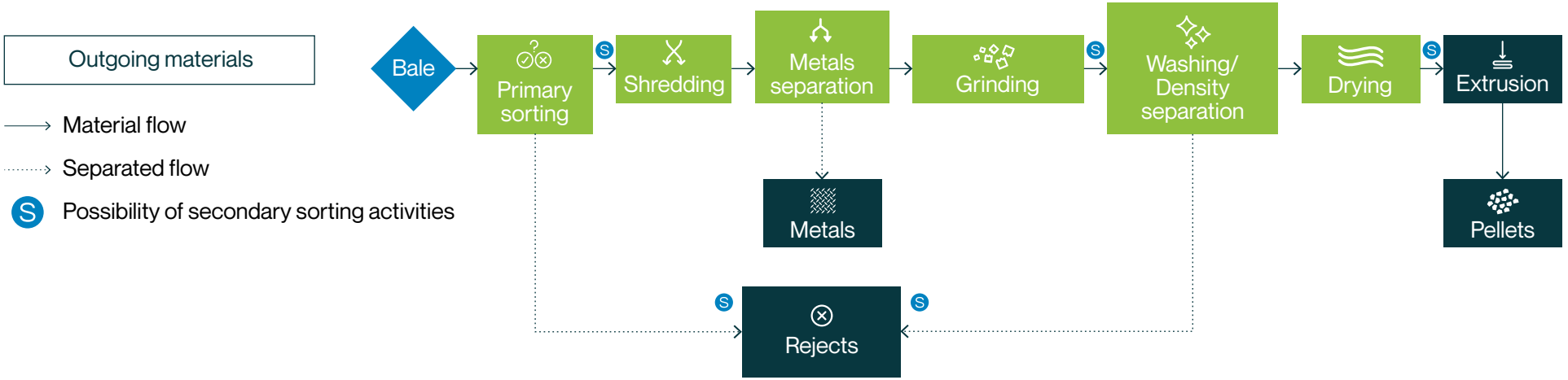
Price index for plastic bales sold in Quebec between 2018 and 2021

Bale types	Average selling price per year ($/ton)			
	2018	**2019**	**2020**	**2021**
PET #(1)	389	334	170	259
Mixed HDPE (#2)	479	419	288	1007
Mixed plastics	124	156	165	651
MRP ("mixed rigid plastics")	84	84	89	197
Bags and films	-23	-14	-45	-25

Source: RECYC-QUÉBEC (2021)

In Quebec, there are 34 recyclers, with 83% processing both post-industrial or post-commercial feedstock, while few of them specialize in materials from curbside collection. They use a range of recycling processes and technologies, which can be grouped into two broad categories: mechanical recycling and chemical (or molecular) recycling. Mechanical recycling is the form most used for plastics in Quebec and around the world. As shown in the figure below, it allows, using a series of steps, to generate products such as crushed flakes or extruded plastic pellets.

Standard recycling process:



Despite its capacity to process a large amount of material, mechanical recycling poses its share of challenges. The management of rejects, caused by contamination that has not been removed upstream, entails significant operating costs which increase the operating and disposal costs of recyclers. In addition, during the separation stage, mechanical recycling is not always able to remove all these contaminants, which thus continue their way through the process and affect the quality of the products generated. This situation limits the ability of the flakes and/or pellets produced to meet the specific needs of potential markets. These issues are not, however, insurmountable: for example, most manufacturers combine virgin and recycled resins in order to overcome these quality challenges.

For its part, chemical (or molecular) recycling consists of a set of technologies and processes that switch plastics from their basic solid state to another chemically different phase (liquid or gas), which allows them to be purified by different filtration processes. There are three families of technologies: recycling by dissolution (or purification), by depolymerization and by conversion. Depending on the technological family used, it is possible to return to the basic units of the formation of plastics (polymers, monomers, oligomers), and thus aim to obtain a recycled resin comparable to virgin resin. In fact, unlike mechanical recycling, chemical recycling makes it possible to remove contaminants intrinsic to the products, for example various additives such as dyes. Although chemical recycling generally requires more energy than mechanical recycling, its ability to produce a recycled resin in a structure similar to virgin resin makes it possible to consider reaching more stringent quality standards in certain markets. These technologies are therefore very promising to make it possible to complete the range of recycling capacities, but to this day remain at the development / experimentation stage and require significant capital investments. Quebec has several emerging players, including Pyrowave, Polystyvert, Loop Industries and Ernerkem, who aim to reach the commercialization stage of their technologies in the years to come.

Portrait of the Markets

The comparative analysis of the value chain of virgin and recycled resins made it possible to identify certain key elements that distinguish them. The value chain for virgin resin, on the one hand, is based on a known and controlled supply, the quality of which is predictable and the price relatively stable. The initial investments required to produce virgin resin are however imposing and the price of the final product fluctuates according to the price of fossil fuels.

On the other hand, the quality of the recycled resin is much more uneven due to the fluctuations and heterogeneity that characterize the supply. Initial investments are less than those required to produce virgin resin and the value of recycled resin is more stable. On the other hand, when the price of fossil fuels is on the decline, the competitiveness of recycled resin can suffer. This was the case in recent years, when the low price of virgin resin was seen by many as an obstacle to the use of recycled resin, the price of which was much higher. Long-term agreements between buyers and recyclers can, however, be part of the solution by bringing greater stability to the market.

The demand for recycled plastic resins nonetheless remains strong in Quebec as elsewhere, and several manufacturers already use these materials in their products. Many companies are making firm commitments in their use of recycled content, helping to fuel this demand. However, many of them are forced to source from outside Canada to meet their requirements in terms of volumes, grades and quality. Certain regulatory projects are also being studied to establish minimum thresholds for recycled content in products and packaging, which will likely put additional pressure on the value chain so that it can meet growing demand.

Final outlets for recycled plastics

In Canada, the three main end-markets for recycled plastics are the packaging ($5.5B), construction ($1.6B) and automotive ($4.3B) sectors, as shown in the following figure. In order to obtain food grade, recycled resins intended for food packaging are subject to a strict approval process imposed by Health Canada and the Food and Drug Administration (FDA). Due to the high requirements, these resins are available in the market in a smaller quantity and at a higher price. Due to their quality, these resins are coveted and are sometimes used for purposes other than food, which contributes to increasing their scarcity. The resins used for this purpose are mainly PET, PP, PS, HDPE and LDPE. Non-food packaging includes various types of containers and bags for industrial and commercial use, as well as bags and films manufactured primarily from LDPE, LLDPE and HDPE.

The construction sector, for its part, uses PS and PP to notably produce insulating materials, heating sub-tiles for bathrooms or backfill blocks for roads. The automotive sector uses recycled resins (PP, PET, PE, ABS) in the production of carpets, running boards and various electronic parts.

01

PACKAGING

The manufacturing of plastic packaging, films and sheets domintates with a $5.5 billion market.

02

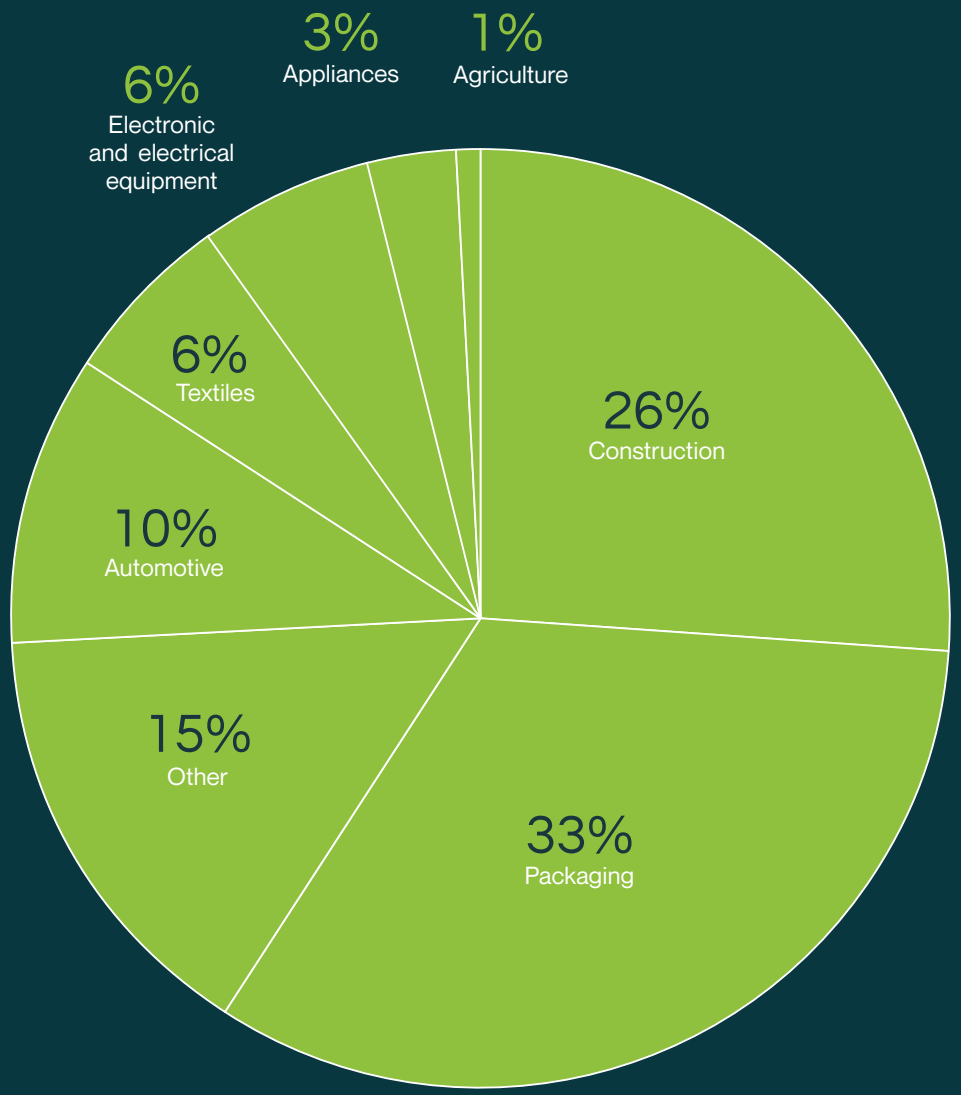
CONSTRUCTION

The manufacturing of pipes, conduits and profiles dominates with a $1.6 billion market.

03

AUTOMOTIVE

The manufacturing of various auto parts dominates with a market of $4.3 billion.



Adapted from: Environment and Climate Change Canada (2019). *Economic Study of the Canadian Plastic Industry, Markets and Waste*

The Quebec market for recycled plastic resins is distinguished by its own reality and challenges, which is important to focus on to better understand its dynamics. Firstly, most manufacturers and recyclers have little flexibility in the resins used, since they respond to precise specifications. In this regard, aesthetic requirements (color, odor, transparency) sometimes prove to be a barrier to the use of recycled resin. Most of them produce intermediate products and therefore operate in a very competitive environment where there is increased pressure on prices, in addition to having to face competition from virgin resins. Moreover, the use of recycled resins with varying properties often requires adjustments to production parameters, thus affecting the efficiency and profitability of operations. These manufacturers must also deal with an at times unstable supply, in an environment where collaboration between the different players may prove to be lacking.

However, we are witnessing a growing mobilization of actors in the value chain to face these challenges. Several innovative business models are tending to emerge, which constitute as many potential solutions: in particular, closed-loop processes, vertical integration and joint venture have given rise to several successful projects. For example, major automobile manufacturers have set up closed-loop models to be able to recover materials from end-of-life vehicles and reintroduce them into new cars. The construction and packaging sectors have created several associations within, relying on closer networking among the players in the value chain to better meet their needs.

Preliminary Findings

The portraits of the plastics situation in Quebec and the potential markets for recycled plastic made it possible to highlight the challenges experienced at the various stages of the value chain and to raise five main preliminary findings.

01

There is a strong demand for recycled plastics, but it is not aligned with supply.

Due to the increase in voluntary commitments from companies and new legislation mandating the inclusion of recycled content, the demand for recycled resins is growing. However, the post-consumer resin currently available on the market often does not meet the performance criteria of potential users, which confirms our initial assumption. Indeed, current markets, such as automotive, packaging (food and non-food) and construction, have very high specifications, which can often only be attained by virgin resin.

02

This misalignment is exacerbated by a lack of communication between members of the value chain.

The absence or lack of specifications on the composition of plastic bales and the gaps in market feedback are issues that have been raised by sorting centers. Indeed, the needs of the recyclers are often not sufficiently well defined and communicated, which leads to a great variability in the quality of the plastic bales produced by the various sorting centers. It is also common practice for sorting centers to sell bales of plastics to the highest bidder to the detriment of establishing long-term supply agreements with local recyclers. Downstream, they must be able to react to these fluctuations in volumes and quality and to offer an acceptable product on the market.

03

Ensuring that every plastic is captured in the right bale on a consistent basis is a challenge that must consider the various types of plastic.

To promote a high recovery rate for all containers and packaging in an economical manner, a single-stream collection model for recyclable materials has been recommended in Quebec since 2006. This model can contribute to a high contamination rate of incoming materials in sorting centers, the latter having to manage inputs without any control over volumes or quality. In addition, plastic containers and packaging are constantly evolving with the appearance of new formats, colors or additives, which complicates sorting. In order to validate the efficiency of their operations or to judge their acceptability on the market, some sorting centers carry out quality control on the composition of the bales produced. This quality control is carried out on an ad hoc basis by visual audit (observation of materials on conveyors or in bales).

04

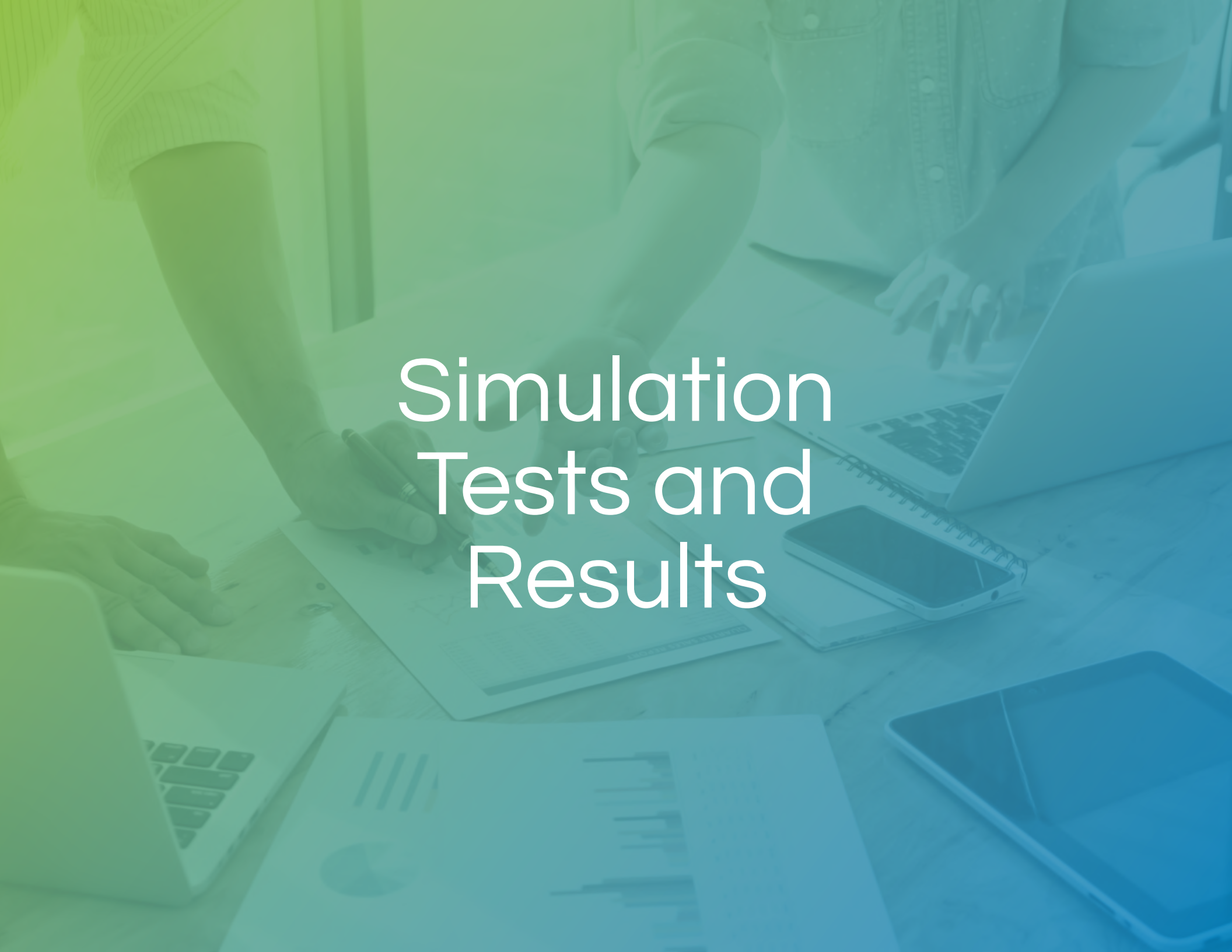
The current situation differs depending on the plastics, their shapes, sizes and properties. There is no such thing as a one-size-fits-all solution.

Plastics represent only a small proportion of the materials processed and sold by sorting centers, and more than half of this is associated with bales of PET and HDPE. Mixed plastics and bags and film bales account for only 1.5% and 0.4% of the total, respectively. A positive sort of the most abundant and highest-value resins is therefore prioritized to produce specific bales, while mixed plastics and flexible plastics must be secondarily sorted by recyclers. With a small quantity of materials distributed in 23 sorting centers, it is not profitable to carry out a dedicated sorting and to produce specific bales for plastics such as thermoformed PET, PP or flexible plastics.

05

The high rejection rate associated with bales from sorting centers is a major issue for recyclers.

Plastic recyclers must deal with a high proportion of rejects. These losses result from the high presence of unwanted materials in plastic bales from sorting centers and can represent 30% to 40% of the packaging process inputs for mixed plastic bales. The management of these rejects entails significant secondary sorting and disposal costs, which affect the viability of the recyclers' business model.



Simulation Tests and Results

The analysis of the data collected during the project made it possible to identify certain observations revolving around the need to restructure the post-consumer plastics value chain, and the importance of working on the development of new markets and innovative business models for the integration of recycled plastics in products and packaging. In order to test solutions to respond to some of the findings and obstacles identified, simulation tests were carried out as part of Phase I of the project.

The tests were designed to respond to three major obstacles to the recyclability of plastics that emerged throughout the study, namely:

01

Contamination of bales

02

Lack of collaboration among the various players in the value chain

03

Insufficient plastic volume and lack of consistency in supply

The following pages summarize the objectives, methodology, results and findings of the five simulation tests carried out during Phase I. Following the preliminary results and depending on the equipment required, a color code (green, yellow, red) was created to represent the level of reproductibility of testing elsewhere in Canada.

Simulation Test # 1

Real-time quality control of bales from sorting centers

Goal

Evaluate the applicability of different visual recognition technologies deployed in sorting centers or commercially available for the real-time characterization of baled materials.

Methodology

Technologies under review

Allowing mechanized sorting equipment to recognize different types of plastics.

- NIR (Near Infrared)
- Object recognition

Selected test sites & analyzed feedstock

Using one or more of the technologies under review.

- Sani-Éco sorting center (container line: HDPE, mixed plastics, aluminum, metals)
- Groupe Bouffard sorting center (curbside bulk collection)
- Innofibre (samples from Groupe Bouffard & Société VIA)
- Private research center (sample from Sani-Éco)

Sorting categories

Identified through a review of the characteristics of the equipment.

- #1 to #6
- Film (PE)
- PLA & Degradable
- Cardboard
- Multilayer
- Metals & Glass

Results

- NIR technology provides a good approximation of the proportions of detectable material in a feedstock
- Both NIR and object recognition demonstrate very high detection rates for detectable material
- A direct conversion of area measurements (NIR) or the number of pictures (objects) to masses or volumes is not yet possible
- Detection systems only work with material categories with known and predefined attributes. As a result, a significant portion of the feedstock may not be detected, particularly when they are highly contaminated

Conclusion

By using an optical sorter located in the sorting operations, it was foreseeable that the recognition data would not be correlated with the quality of the materials found exiting the bales. However, the results demonstrate the potential of the technology and further work will be required to continue its evaluation.

Simulation Test # 2

Development of specifications for the sorting center by the value chain

Goal

Using the reverse engineering approach, define market needs and review the operations of other players in the value chain in order to meet them.

Methodology

Steps in the process

01 Set specifications for the composition of bales

02 Modify sorting operations in co-development with a sorting center and a recycler

03 Manually sample and characterize plastic bales

04 Obtain market feedback on products made from bales that meet new specifications

Stakeholders involved

Mixed plastics:

- Conteneurs Verts
- Haycore

Plastic films:

- Société VIA
- Transcontinental Recycling Montréal
- Modix Plastique

Results

Material	Target	Composition during the test	
		Normal sorting	Improved sorting
PE and PP	Max.	90.3%	92.9%
PET, PVC ET	12%	5.5%	4.1%
PS			
Contaminants		4.1%	3.0%

Findings

- Changes in sorting operations have not resulted in significant improvements in the quality of the bales.
- It is estimated that the actual proportion of PE and PP is lower than the high proportion seen in this test (62% rather than 90%); this is probably related to the specifics of the sampling and the selected sorting center.
- Changes in the sorting of mixed plastics affected the quality of HDPE bales (from 93.3% to 85.9%).
- More mixed plastics and HDPE were generated as a result of the changes and the rate of rejects produced dropped by 45%.

Material	Target	Composition during the test	
		Normal sorting	Improved sorting
LDPE and HDPE	Max.	70.9%	77.0%
PET, PP, PVC flexibles	2% to 5%	7.1%	5.7%
Critical contaminants	0%	11.0%	7.9%
Other contaminants	Min.	11.0%	9.4%

* Great variability in composition from one sorting center to another.

Findings

- A sorter assigned to quality control has reduced contamination by 6%.
- Despite this reduction, the critical contaminants are still present at 7.9%; therefore, the targeted specifications are not met.
- The high levels of critical contaminants threaten the quality of the recycled resin produced.

Conclusion

Simple and inexpensive modifications to both types of sorting have resulted in improvements. Additional tests are thus justified while ensuring that all operations are considered so as not to induce indirect negative impacts on other bales.

Simulation Test # 3

Goal

Evaluate opportunities to recover and process packaging waste.

Methodology

Steps in the process

01 Identify recyclers that can work in synergy

02 Establish specifications for rejects to be upgraded

03 Carry out processing tests for rejects

04 Validate the conformity of recovered plastics

Stakeholders involved

Four partner recyclers in order to allow a logic of material flow:

- Société VIA (mixed plastic bales)
- Conteneurs Verts (secondary sorting)
- CED-LO (PE/PP washing)
- 7PS (molding of rejects)

Results

- The mass balance of the plastics packaged in this test shows that, out of a total of 23.5 tons of residual material, 64.5% was recovered and 35.5% was rejected through the various sorting stages.
- 28% were specifically rejected at the secondary sorting stage at Conteneurs Verts:
  - 7.2% black plastic – non-detectable material identified as primary contaminant, not separable by optical sorting
  - 4.2% of non-recovered PET, among plastic contaminants
  - 0.5% of aluminum not recovered due to lack of equipment
  - 16.2% of material that is difficult to recycle (fibers, soil and others)
- Distinct separation of PET, black plastics and aluminum would allow their resale for recovery.
- This obstacle raises important questions on the profitability of secondary sorting operations: costs appear far too high compared to the value of materials that could be marketed.
- A successful laboratory test conducted in the 7PS thermokinetic mixer demonstrates the potential of recycling these materials to produce composite molded products.
- Subsequent testing will be required to demonstrate the potential for energy recovery and chemical recycling of rejects.

Conclusion

Current mechanical technologies exist to recycle these rejects and should be further explored. However, the heavy contamination of the bales means that the recycling of mixed plastics in Quebec is difficult to render profitable under current secondary sorting conditions. Better quality control and price adjustment mechanisms based on quality are paths to consider.

Simulation Test # 4

Deodorization of recycled resins

Goal

Evaluate the effectiveness of selected deodorization technologies to remove odorous volatile compounds from targeted recycled resins.

Methodology

Steps in the process

01 Using LDPE, compare different specialized technologies for the extraction of odor-producing volatile organic compounds

02 Validate the deodorization results in the laboratory with an analysis of the compounds by GC-MS

03 Validate the results at packaging manufacturers

Deodorization technologies

- Extraction by supercritical CO_2
- Degassing by hot air purge (Erema Refresher)

Partners involved

- Cascades Plastics and Transcontinental Recycling Montréal (packaging manufacturers)
- CTTEI and Erema (deodorization experts)
- TransBIOtech and Coalia (analysis and processing of deodorized resins)

Reproducibility potential in Canada

Results

- The tests confirmed the removal of certain odorous molecules from the resins.
- Extraction by supercritical CO_2 made it possible to remove certain very odorous acids but led to the creation of alkanes in the resins. Optimization of the extraction parameters should be done to prevent this phenomenon.
- Erema's Refresher deodorization removed most of the odorous compounds, but acetic, propanoic and butanoic acids, characterized by a strong gasoline and rancid smell, were still present.

Conclusion

Deodorization technologies seem promising, but it would be necessary to optimize the extraction parameters to ensure complete elimination of odors.

Simulation Test # 5

Use of an optimization model for the packaging of thermoformed PET

Goal

Test a transport optimization model by linking the various players involved in the thermoformed PET value chain.

Methodology

Steps in the process

01 Identify potential players involved

02 Establish material flow scenarios to be tested

03 Feed data to the InnovLog model and make it work

04 Determine the optimal scenario

Scenario 1

Mixed plastics and PET recyclers perform a secondary sort of thermoformed PET and sell it on the market

Scenario 2

Mixed plastics recyclers perform an initial secondary sorting of thermoformed PET and PET recyclers perform a subsequent secondary sorting of thermoformed PET

Results

- The model selects the optimal recyclers and buyers to generate maps of the material flows for each scenario.
- In both cases, there are flows of bales from the sorting centers to mixed plastics and PET recyclers – the difference is that in scenario 1, the output from the mixed plastics recycler is marketed, whereas in scenario 2, it is sent to the PET recycler.
- Scenario 2 allows for the recovery of bottle PET in addition to thermoformed PET from the mixed plastics recycler, additional contribution of approximately 800 tons recovered annually.

Conclusion

The trial made it possible to briefly test the InnovLog optimization model, without however determining a scenario to be adopted for the management of thermoformed PET. Its use makes it possible to optimize specific flows and identify new processing infrastructures, which can be achieved by integrating new data into the model.

Recommendations

Based on all the work carried out in Phase I of the project as well as the findings, the CPT concludes that there are concrete opportunities for optimization in each of the links in the plastics recycling value chain and in the chain as a whole. At the end of this first pivotal stage, the CPT is therefore issuing a series of recommendations formulating many paths of solutions to be explored in order to meet the challenges currently faced by sorting centers, recyclers and market players and to progress towards building a real circular economy for plastics in Quebec and Canada. It is these recommendations that will inform the planning of Phase II of the CPT-led project, during which these solutions will be tested in industrial pilot projects that will generate concrete learnings and benefits for the value chain.

Recommendations

Value chain

01
Specify market needs to recyclers and sorting centers and establish clear quality standards for bales;

02
Establish long-term agreements between members of the value chain to stabilize local markets (supply, outlets, quality, etc.), increase the competitiveness of recycled resin in the long term and encourage investments;

03
Set up financial incentives for the production of quality plastic bales (price scale according to the level of contamination, government programs, etc.);

04
Work, in collaboration with Health Canada, to simplify the process for obtaining food grade for post-consumer plastics from curbside collection;

05
Monitor emerging practices in terms of traceability and support the implementation of a rigorous and harmonized system, particularly in order to be able to certify recycled content;

06
Set up incentives promoting the increased use of recycled resins (eco-modulation of EPR rates, tax exemptions, procurement policies, etc.);

07
Promote greater synergy within the value chain and the means of exchange and communication between industry players;

08
Test the technical and economic feasibility of the secondary sorting of post-consumer plastic bales in order to model the best practices to be put in place (configuration, location, logistics, etc.);

09
Communicate the limits of current collection, sorting and recycling processes to manufacturers and brand owners in order to promote good eco-design and recyclability practices.

Sorting centers

10
Evaluate, considering geographic, economic and market conditions, the types of plastic bales to be produced by the different sorting centers;

11
Establish real-time quality control of outbound bales, to ensure continued achievement of the quality criteria required by buyers.

Recyclers

12
Explore synergies between recyclers to facilitate greater recovery of packaging rejects in an industrial symbiosis logic;

13
Invest in the development of alternative outlets (chemical recycling, manufacturing of composite materials, energy recovery, etc.) to avoid the landfilling of plastics difficult to recycle as well as the rejects from recyclers.

Markets

14
Implement best practices in eco-design and recyclability among brand owners and packaging manufacturers;

15
Increase the rate of recycled content in products placed on the market;

16
Develop innovative business models between market players and other players in the value chain (closed loops, vertical integration, joint ventures, etc.).

17
Test new sorting technologies (artificial intelligence, optical sorting, robotics, etc.) and improve existing processes to optimize plastic capture and operational performance, while considering the diversity of physical characteristics of the incoming plastic packaging (format, density, colors, etc.).

18
Promote the use of an intermediate resin grade to ensure the use of recycled food grade resins for uses requiring it and dissociate the notion that the recycled food grade is the only guarantee of quality.

Conclusion

In alignment with its vision of creating a circular economy for all plastic packaging marketed in Quebec and Canada, the CPT is completing Phase I of its project aimed at optimizing the management of plastics throughout the recycling value chain.

Phase I: mobilize industry players

The objective of Phase I was to conduct a detailed mapping of the plastics recycling value chain in Quebec, to determine market needs, identify key challenges and establish optimization hypotheses to achieve the required specifications, following a reverse engineering approach.

The work carried out paints a picture of an improvable situation for the entire plastics recycling value chain in Quebec. The findings of this first phase show that challenges and issues are indeed encountered at all levels and for all stakeholders.

Among the findings of Phase I, the work demonstrated the relevance of mobilizing industry players and the great potential of a better alignment between the market and the other players in the value chain. Thus, there is a growing demand for recycled plastics, but it is not aligned with supply. Value chain optimization will therefore be essential, notably to maximize the capture of different types of plastics in the appropriate bale. Finally, it will be important to focus on the important issue of rejects for recyclers and the significant costs associated with them.

The circular economy of plastics: a systemic issue

Beyond the 18 recommendations proposed in this White Paper, the CPT would like to emphasize that there are also some more holistic systemic issues that are a shared collective responsibility. Although these issues are beyond the scope of the CPT, the group would like to highlight complementary areas for reflection in the development of innovative and efficient solutions, including:

- Recycled content: It will be important to promote and enhance the use of recycled resins through greater corporate commitment and government incentives, as well as to increase the availability of this resin (volume/quality) to support the development of vibrant local markets.

- Consumers and education: It is crucial to ensure that consumers are adequately educated about proper recycling behaviors and to this end, significant communication efforts must be made. The involvement of governments, municipalities and producers/brand owners is essential to encourage the adoption of better recycling practices and to enable consumers to be a positive part of the solution.

- Industrial, commercial and institutional (ICI) sectors: ICIs account for a significant portion of the potential post-consumer plastics feedstock, but the information available to quantify and qualify this feedstock is currently largely inadequate. Therefore, it would be essential to increase our understanding of the materials generated by ICIs so that they can be adequately integrated into the circular practices to be implemented and the results of these practices can be effectively communicated.

- Eco-design: As the generators of post-consumer packaging passing through curbside collection, brand owners have an important role to play in the wide spread adoption of best practices in eco-design and recyclability. Implementing these improvement processes will reduce the amount of resources used and ensure that the plastics that contribute to the transportation and preservation of products and food are sorted and recycled more efficiently.

A look at Phase II

The second phase of the project will begin in the fall of 2021. Throughout this phase, the CPT will support the deployment of several pilot projects in sorting centers and at recyclers to concretely improve, in the short term, the quality of outgoing materials and the recycling rate of all post-consumer plastic packaging. By demonstrating and deploying solutions for all plastics likely to find outlets, it will then be possible to encourage citizens to increase the proportion of containers and packaging they put in the recycling bin in line with the objectives that will be announced as part of the modernization of the extended producer responsibility of containers and packaging. The CPT wishes to position itself as a catalyst for change towards the implementation of a circular economy for plastics.

WHITE PAPER

GROUPE D'ACTION PLASTIQUES CIRCULAIRES

CIRCULAR PLASTICS TASKFORCE

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