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our business

Report on the *Innovative Glass Works Plan*: The solution for recycling 100% of curbside collected glass in Québec

Summary

February 2019



In 2016, Éco Entreprises Québec launched and financed its *Innovative Glass Works Plan*, an initiative devised to modernize Québec sorting centres and support growth of markets to give glass a new life, with the goal of recycling 100% of glass collected from curbside bins.

The initiative was deployed in two phases:

- Improve the offering through a series of pilot projects to modernize sorting centres.
- Develop demand by diversifying trade opportunities for glass.

In order to share the conclusions of this endeavour in a broad and transparent manner, ÉEQ has published a detailed technical report on the overall project. This document is a summary of the detailed technical report.

Highlights

- ÉEQ invested \$12.2 million in the *Innovative Glass Works Plan*, including the implementation of major pilot projects.
- The project has shown that it is possible to recycle 100% of the glass collected via curbside recycling in Québec.
- The solutions are feasible, and we have the expertise and knowledge necessary to implement them.
- The deployment of measures to reach this goal requires global investments of approximately \$50 million to equip all sorting centres with glass processing machinery, develop the various glass markets, carry out a Québec-wide awareness campaign on glass recovery and recycling, as well as implement measures to monitor and control quantities sorted and recycled.

"The *Innovative Glass Works Plan* is the most innovative project in recent years in the Québec recyclable materials industry. It offers practical and feasible technical solutions that will require involvement on the part of all stakeholders."

Maryse Vermette, CEO of ÉEQ

Targeting a true and sustainable impact: the approach

For several years, ÉEQ has alerted all stakeholders involved in curbside recycling about the necessity of modernizing processes and equipment in order to improve sorting and the quality of resulting materials, for all recyclables.

In 2015, as part of its optimization efforts, ÉEQ mandated a multidisciplinary team to find solutions that would enable us to **recycle 100% of glass collected through curbside recycling, an amount equal to approximately 120,000 tons per year**, according to studies carried out by RECYC-QUÉBEC and ÉEQ.

They carried out analysis, interviews with value chain actors, as well as various market studies. This initiative, the only one of its kind in North America, has mobilized the recycling industry as never before to work towards a common goal.

Findings: Significant issues

1. The decision to invest in new recyclables sorting equipment rests mainly on the ability to generate more revenue, not on the performance improvement of the rate of recycling.
2. Very few investments were made in sorting centres to improve the quality of glass and give it resale value, except for a handful of exceptions.
3. The shut down of the major glass processor in 2013 highlighted the various quality concerns regarding glass in our sorting centres and the importance of developing and diversifying markets for glass.

An ambitious goal, concrete actions

In January, 2016, ÉEQ launched its *Innovative Glass Works Plan* (hereafter referred to as the "Plan"), which it funded entirely thanks to a budget of \$12.2 million that enabled it to achieve the following actions:

- Implementation of pilot projects to experiment with glass sorting and processing equipment in five Québec sorting centres (\$8 million).
- Providing a glass sorting and processing system to the future sorting centre in the west end of the City of Montreal, based on findings and lessons learned from the five pilot projects (\$2.5 million).
- Supported the development of glass markets (\$1.7 million).

Understanding how sorting centres work

Preliminary analyses have enabled us to get the big picture of the industry. There are 23 sorting centres for curbside recycling materials in Québec, whose role is to sort the various materials they receive, such as paper and cardboard, glass, plastic and metal packaging. ÉEQ took into account the various management models in order to develop pilot projects that match the real world, including status (private companies, not-for-profit organizations, and municipal bodies), quantities and location of the glass received yearly.

Finding sustainable solutions throughout Québec

The goal of combining equipment and systems is to increase the rate of purity of glass from 70% to 95% by the time it leaves sorting centres.

ÉEQ has chosen to work with experts for each step of the Plan's development and has benefited from the technical support of ten specialized organizations located not only in Québec, but also in other countries with relevant expertise.

Improving the offer: five pilot projects

An applied research and development project

In response to ÉEQ's call for tenders in January 2016, 18 sorting centres submitted a project. Five projects representing the diversity of sorting centres were selected. In addition to financing equipment, ÉEQ provided technical support as well as financial compensation for investments made and resources mobilized by the selected sorting centres.

Performance measurement program

In order to adequately measure the performance of the glass sorting process, ÉEQ developed and implemented a glass sampling and characterization that now serves as reference. Several key indicators were also monitored, five of which were monitored jointly with sorting centres and other partners.

Selection of technologies and equipment

One of the more innovative aspects of the Plan is the integration of glass sorting equipment into a single system using a never-before tested configuration. In order to determine the impact of changes in sorting centre operation parameters (seasonality, variance of incoming quantities, presence of snow and ice, etc.), the pilot projects were carried out over a 15-month period. The table below indicates the four key equipment items:

Equipment item	Description	Origin
Flip-Flow type screen	Screening and sizing separation	Australia
Imploder	Breaking glass into smaller pieces	United Kingdom
Zig Zag	Removal of lightweight materials	Germany
Air Lift Channel Feeder (ALCF)	Removal of lightweight materials	United Kingdom

Equipment manufacturer Machinex and their partner, Krysteline, were involved in the integration and installation tasks of all equipment, an unprecedented collaboration effort with ÉEQ and sorting centres, offering technical support for the entire testing phase.

Projects adapted to sorting centre capacities

The equipment items in the Plan were installed in the spring of 2017 in five sorting centres.

Small-capacity pilot project

Régie intermunicipale de traitement des matières résiduelles de la Gaspésie (Grande-Rivière) sorting centre: The glass processing system design is based on local use of glass, specifically for the construction of road infrastructures or pedestrian paths, or for horticulture applications.

Medium-capacity pilot projects

Récupération Frontenac (Thetford Mines) and EBI Environnement (Joliette) sorting centres: The glass processing system design in medium capacity sorting centres is based on the willingness to provide the required versatility to produce glass according to the market requirements. Thanks to the implemented equipment, therefore, medium-capacity sorting centres can choose to go with maximum production of small size glass, by changing equipment parameters.

Large-capacity pilot projects

Québec (Québec) and Tricentris (Terrebonne) sorting centres: Just as with medium-capacity pilot projects, the design of glass processing systems for large-capacity sorting centres is also based on a willingness to offer the required versatility to produce glass according to market requirements. Thanks to the ability to adjust equipment items, it is possible to adapt production to various size levels, in order to produce glass that meets recyclers' and processors' criteria.

Pilot project execution phases

Installation and running-in – March to August, 2017: The installation and running-in phase required some adjustments in order to synchronize the system's performance. Training was also provided for operators, specifically on equipment operation and maintenance, the sampling and characterization protocol, as well as workplace health and safety measures.

Testing – September 2017 to August 2018: 150 technical visits and over 4,000 support hours enabled the team to compile observations, identify issues, implement solutions, adjust equipment and improve training for field crews.

Transfer of operations to sorting centres – September 2018 to June 2019: After the completion of the testing phase, the five MRFs became owners of the ÉEQ equipment. Additionally, ÉEQ extended its financial support in order to address certain technical challenges created specifically by the presence of snow, ice and humidity in the systems.

Results that exceeded expectations

Purity level higher than 99%

The analysis of glass sample characterization results showed that it is possible to produce glass with a purity level reaching 99.85% for small size glass and 99.4% for large size glass. This rate exceeds the initial target of 95%, which allows for a diversified use of recycled material that meets the needs of recyclers and processors.

23,000-ton of glass processed over the course of the project

The quantities of glass processed over the course of the pilot projects from September 1, 2017 to August 31, 2018, were compiled, and the capacity of the equipment installed in the five sorting centres translated into a processing volume of approximately 23,000 ton of glass collected through curbside recycling in Québec.

Glass recycling rate of up to 100%

Four of the five sorting centres achieved a 100% rate of recycling for glass, giving it a second life across a variety of markets: sandblasting industry, filtration sand industry, mineral wool production, micronized glass for cement additives, road infrastructure work, local uses such as path paving and horticulture.

Regarding Tricentris (Terrebonne), the project manager had to ship a certain quantity of processed glass for alternative daily cover and other usages in a technical landfill site. That portion of glass was therefore not included in the financing participation of ÉEQ. This brought the recycling rate of the pilot projects to 73 %, but tryouts and showcases projects, carried out during the experimentation period, demonstrate that this rate will be increased with market development and maturity.

Growth of the average sale price of glass

We know that sorting centres pay between \$19 and \$28/t (per ton) to dispose of glass not processed. During the course of the pilot projects, the average sale price of glass varied between \$0/t and \$10/t. This represents a considerable economic gain and a true incentive to continue with the endeavour. The development of markets and increased competition for glass remain the key to achieving a higher average sale price.

Testing pilot projects: findings and recommendations

This section presents the findings after 15 months of testing, as well as implementation recommendations for the deployment of appropriate equipment in sorting centres throughout Québec to process and recycle 100% of the glass collected via curbside recycling.

<p>Recommendation regarding the Flip Flow type screen</p>	<p><i>A Flip Flow type screen is an essential piece of sorting centre equipment in order to separate glass into fractions, while removing unwanted materials.</i></p> <p>1. Flip Flow type screens made by Spaleck or Bivitec produced a higher performance rate and should be installed in sorting centres.</p>
<p>Recommendation regarding the Zig Zag</p>	<p><i>Designed to remove unwanted materials such as lightweight plastics and fibers, the Zig Zag is efficient in addition to being easy to operate and maintain.</i></p> <p>2. The Zig Zag by Trenso proved very efficient in eliminating unwanted materials and should be installed in sorting centres due to its performance.</p>
<p>Recommendations regarding the imploder</p>	<p><i>The imploder is a machine that breaks glass into smaller pieces; it is effective to produce small size glass.</i></p> <p>3. Glass implosion is appropriate for sorting centres operating in remote locations, as local markets require small size glass.</p> <p>4. However, it is imperative to ensure that the equipment supplier has any and all spare parts in North America and is able to supply these within a short time.</p>
<p>Recommendation regarding the ALCF</p>	<p><i>The Air Lift Channel Feeder (ALCF), used to clean small size glass, is not well adapted to handle the fluctuations in volumes received by sorting centres and causes numerous performance issues, including overflow.</i></p> <p>5. We recommend replacing the ALCF with a Zig Zag aspirator, which is more expensive, but clearly offers superior performance.</p>
<p>Recommendation regarding volume fluctuations for incoming glass</p>	<p><i>Fluctuations in volumes of incoming materials are a common occurrence for sorting centres and they pose several problems, such as blockage, overflow, breakage and poor performance of separation machinery.</i></p> <p>6. Glass processing systems must have equipment at the front of the line in order to absorb flow variations.</p>
<p>Recommendations regarding the servicing and</p>	<p><i>We noted a direct link between equipment maintenance and glass processing system performance.</i></p> <p>7. A preventative maintenance program for all sorting centre equipment must be implemented.</p>

<p>maintenance of equipment</p>	<p>8. At the front-end of the glass processing system, quality control equipment for incoming glass must be installed in order to restrict the presence of contaminants. 9. A sufficient supply of spare parts must be maintained by equipment suppliers, and they must be available on short notice.</p>
<p>Recommendations regarding unwanted materials</p>	<p><i>Processing glass during these pilot projects enabled us to specifically identify the unwanted materials that have an impact on the quality of produced glass.</i></p> <p>10. Local awareness campaigns on the exclusion of materials not suitable for disposal in curbside recycling bins must be deployed. 11. The implementation of awareness programs must be carried out by municipalities and RECYC-QUÉBEC. 12. Glass and shredded paper must be removed at the beginning of the processing line as much as possible. 13. Measures must be taken to avoid that biomedical waste, such as syringes, finds its way into recycling bins. 14. Specialized equipment for the removal of unwanted materials, such as drinking straws, crayons and toothbrushes, must be installed.</p>
<p>Recommendations regarding snow and winter conditions</p>	<p><i>Collecting recyclables during the winter is challenging because of humidity, temperature variations as well as snow and ice in sorting centres.</i></p> <p>15. Preventative measures to avoid the presence of snow in sorting centres must be deployed by municipalities with collectors. 16. In exceptional cases, temporary storage measures must be established.</p>
<p>Recommendations regarding after-sale service</p>	<p><i>The Plan's pilot projects have been a unique opportunity to implement equipment which had never before been combined and used in North America. Our findings have enabled us to define benchmarks to be integrated into contract negotiations.</i></p> <p>17. Before signing an equipment purchasing contract, make sure of the following:</p> <ul style="list-style-type: none"> • The equipment supplier is accountable for after-sales service • The proposed warranty terms and conditions are sufficient • They have formalized contractual agreements with their sub-contractors • The list of spare parts to be held in stock is indicated on the contract • The equipment supplier or their sub-contractor agrees to provide the spare parts rapidly (within 48 hours).

Developing demand: Glass markets

A proactive approach along each step of the marketing process

Sorting centres generally sell their glass to processors, whose role is to transform it so it meets the requirements of recyclers. Depending on the targeted market, specifications vary, particularly regarding glass size as well as the type and quantity of tolerated contaminants.

ÉEQ has created an action plan specifically designed for market development, with the main goal of lasting and viable diversification. A first step was implemented in 2016 in the form of a call for tenders for carrying out glass market research. With support from KPMG, this effort allowed for the emergence of a foundation project that could lead to the development of a new market for glass in Québec.

New measures, totaling \$1.7 million, were developed in June 2017 and implemented with the following objectives:

- Support the expenses of Québec processors and recyclers related to marketing their products.
- Create showcase projects to highlight glass ecomaterials.
- Promote the supervision of product quality through standards and certifications.
- Meet with various stakeholders, specifically investors, prime contractors and public institutions and raise awareness.

Results

Showcase projects

The municipal sector is a major actor in promoting concrete accomplishments regarding applications for recycled glass: as insulating backfill material for municipal pipes, as pedestrian path paving material and as filtering medium for public pools.

Standards and certifications

In order to promote the emergence of these innovations, ÉEQ supports quality control and standards development efforts in order to reassure prime contractors and industrial actors as to the quality and added value of products that integrate glass from curbside recycling. It was in this spirit that ÉEQ supported the Université de Sherbrooke in its efforts to get recycled glass powder recognized as an official cement additive in accordance with the CSA standard.

Investment development

ÉEQ has also implemented measures to increase and diversify the number of glass processors in Québec, by documenting potential investment sources of particular interest for them. The project will be completed in 2019.

Raising awareness with prime contractors

Most prime contractors do not know about the existence of the various glass-based products. This is why ÉEQ took part in over ten major events to promote valued-added ecomaterials that integrate recycled glass, met with the various stakeholders (municipalities, CSA certification committee, Association béton Québec, Bureau de normalisation du Québec, etc.).

Raising awareness with elected officials and government institutions

Because recycling and curbside recycling are public interest issues managed by various levels of government (provincial, RCM, municipalities), ÉEQ has raised awareness about its efforts with elected officials and public authorities.

Recommendations

Based on the results of research and testing related to the curbside collected glass market, we can make the following recommendations:

<p>Recommendation regarding the current market situation</p>	<p><i>In Québec, there are three companies able to process and recycle glass collected through curbside recycling, but they are not able to process the entire available volume for the time being.</i></p> <p>18. To achieve a 100% recycling rate for curbside collected glass, priority must be given to market diversification.</p>
<p>Recommendations regarding glass size according to market demand</p>	<p><i>Trials carried out with processors showed that it is easier to decontaminate large size glass.</i></p> <p>19. As per market demand, the production of large size glass must be promoted.</p> <p>20. Glass implosion must be reserved to small-capacity sorting centres in order to meet local market requirements.</p>
<p>Recommendation regarding the production of glass containers</p>	<p><i>Tests conducted with processors and equipment suppliers have shown that the development of a specific processing line is required in order to produce glass that meets the requirements of glass bottle and container producers. Therefore, there is no reason for preventing glass collected through curbside recycling from entering into the production of new glass bottles and containers, once the materials have been properly sorted and cleaned.</i></p> <p>21. In order to feed the glass bottle and container production market, investments must be made to allow the appropriate sorting of glass by colour, removal of unwanted materials such as rocks, ceramic and porcelain, so as to provide that industry with clear glass collected through curbside recycling.</p>
<p>Recommendations regarding the abrasives and filtration market</p>	<p><i>Based on a study carried out by ÉEQ, the abrasives market is nearing saturation. The filtration media market made from recycled glass aggregate may see considerable growth over the next years, as it has a competitive advantage over sand.</i></p> <p>22. Testing projects with filtering media must continue in order to show the added value of glass aggregate.</p> <p>23. Possible standardization efforts regarding products and quality control must be supported to facilitate marketing.</p> <p>24. Promotion of various water filtration applications must be carried out with target clientele.</p>
<p>Recommendation regarding the cement additive market</p>	<p><i>After several years of testing, glass powder is now recognized as a value-added cement additive. It was integrated into the CSA standard for cementitious compendium materials in December 2018.</i></p> <p>25. A quality control and development strategy for this new industrial sector must be devised jointly with all actors involved (cement manufacturers, concretors, ÉEQ, government ministries and public organizations, processors and recyclers, glass powder manufacturers, prime contractors).</p>
<p>Recommendation regarding the glass powder additive market</p>	<p><i>Micronized glass can be used in manufacturing a multitude of specialized products such as paints, varnishes, grouts, certain fireproof materials, polymers, etc.</i></p> <p>26. In order to feed the glass powder additive market, investments must be made to enable proper washing, drying and micronizing glass collected through curbside recycling.</p>
<p>Recommendation regarding the cellular glass market</p>	<p><i>Cellular glass is a pumice stone type product. It is lightweight but very resilient, used in residential and road construction. This market has been established in Europe for thirty years, and a project could emerge shortly here in Québec.</i></p> <p>27. In order to feed the cellular glass market, investments must be made to acquire glass heating equipment.</p> <p>28. A marketing and awareness strategy targeted to prime contractors must also be implemented.</p>

<p>Recommendations regarding remote region markets</p>	<p><i>The processing of glass in remote location sorting centres poses challenges of a different type: smaller glass deposit and difficult access to markets due to transportation costs. Several local recycling solutions are possible, specifically as granular material used in pavement structures.</i></p> <p>29. Small capacity, as well as medium capacity and geographically isolated sorting centres must be fitted with additional size reduction equipment, in order to meet local trade opportunity criteria, such as road infrastructures or pedestrian path paving.</p> <p>30. The use of glass in road infrastructures as an environmentally low-risk application under the Environment Quality Act must be recognized.</p>
<p>Recommendation regarding the glass in technical landfills</p>	<p><i>Glass deposited in recycling bins should never be sent to technical landfills. We must collectively put a stop to this practice.</i></p> <p>31. The use of glass as alternative material used in technical landfill sites (daily cover or other) must be progressively prohibited.</p>

Implementing a deployment strategy and an investment plan: The next step

In order to achieve the Plan's main goal, which is to recycle 100% of glass collected via curbside recycling in Québec, a total of approximately \$23 million in investments will be required to equip sorting centres. In addition to this investment, an amount of approximately \$27 million would be needed for diversification and market development, communications and awareness campaigns, as well as economic and environmental results measurements.

In sorting centres

ÉEQ has devised a strategy in order to set up all Québec sorting centres with glass processing equipment, representing investments of approximately \$23 million, including the update of pilot projects. The strategy is based on the following benchmarks:

- Sorting centre capacity: small, medium and large-capacity systems.
- Consolidation of glass tonnage (e.g. partnership between a specific operator's sorting centres): intermediary systems
- Sorting centre localization and, more specifically, remoteness of some of them: hybrid systems.

This strategy, which will be deployed over four years, may include consolidating glass deposits to carry out processing at certain sorting centres rather than in all of them. These consolidation proposals would be openly discussed with all the interested stakeholders, first and foremost among them, municipal administrations and the sorting centres involved.

For packaging and recycling

ÉEQ has identified the six market sectors with the biggest potential to achieve the goal of recycling the 120,000 tonnes of glass collected annually via curbside recycling, and has estimated that the investment amount required over a 24 to 30 month horizon for processors and recyclers would be approximately \$20 million.

This deployment strategy is meant to support the growth of the six market sectors through the acquisition of leading-edge equipment or targeted interventions. Several current and potential

processors and recyclers have shown an interest in one or the other of these six market segments through the acquisition of technology equipment:

Container production	Investment support for the development of processing of glass to be used for the production of bottles and containers.
Mineral wool	Investment support to increase production capacity of cullet to be used to make mineral wool.
Abrasives and filtration	Quality control measures and certification to be developed for filtration. Promote this type of filtering medium to prime contractors.
Cement additive	Increase production capacities through corporate financing programs. Ensure quality control regarding certification. Structure the industry with partners.
Micronized powder for additives	Develop glass washing capacity and increase micronization capacity through corporate financing programs.
Cellular glass	Invest in a specialized packaging line. Promote cellular glass to prime contractors.

Beyond the Report: A call to action

The *Innovative Glass Works Plan* shows that there is a solution within reach to recycle 100% of glass collected via curbside recycling.

It is now up to the various actors of the value chain and the government of Québec to support the deployment of the solution throughout the province.

ÉEQ wishes to take an active part in the implementation of that solution and offers its full cooperation to the various instances involved.

The complete version of this Report is available here: eeq.ca/verrelinnovation

About Éco Entreprises Québec

Éco Entreprises Québec (ÉEQ) is a private non-profit organization that represents the companies that place containers, packaging and printed matter on the market in Québec in their responsibility to finance the costs of effective and efficient municipal curbside recycling services. As an expert, ÉEQ optimizes the curbside recycling value chain and implements innovative approaches with a view to sustainable development and circular economy.

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