FACT SHEET

THE INNOVATIVE GLASS WORKS PLAN

INNOVATIVE GLASS WORKS: A DURABLE SOLUTION FOR ALL GLASS COLLECTED THROUGH CURBSIDE RECYCLING IN QUÉBEC

In Québec, businesses that put containers, packaging and printed matter on the market have the responsibility to finance the municipal curbside recycling system. Éco Entreprises Québec (ÉEQ) is the private, non-profit organization that represents those businesses. Each year, over $150 million are collected from businesses and since 2005, over $1 billion have been redistributed to municipalities, making it possible to recover 5 million tons of recyclable materials and to prevent 2 million tons of GHG emissions. Due to their central role in curbside recycling, they are committed and mobilized to make the value chain of curbside recycling the most efficient possible.

GLASS REYCLING: A NORTH AMERICAN STRUGGLE

In Québec and elsewhere across North America, glass recycling comes with certain challenges: most sorting centres are not able to produce a glass quality that meets the expectations of conditioners and recyclers, limiting the variety of uses for this material that citizens put in their recycling bin. Until recently, only a portion of the glass collected through curbside recycling was able to find a second life with high added value. A solution had to be found.

ÉEQ, supported by a team of experts, has rigorously studied different solutions to improve curbside recycling. Meetings with Québec curbside recycling stakeholders have allowed to pinpoint their needs and to make an inventory of the available technologies all over the world. After this diagnostic, ÉEQ then selected innovative, tried and tested technologies used to initiate the modernization of sorting centres in 2017 with pilot projects.

A true first in North America, ÉEQ's approach aims at equiping sorting centres with technologies to produce a high quality recycled glass that meets the expectations of conditioners and recyclers. ÉEQ also supports the commercialisation of innovative eco-materials made from glass collected through curbside recycling.

Éco Entreprises Québec

DEMONSTRATING QUÉBEC'S LEADERSHIP IN TERMS OF CURBSIDE RECYCLING

THE INNOVATIVE GLASS WORKS PLAN AIMS TO MODERNISE SORTING CENTRES WITH NEW EQUIPMENT AND STIMULATING THE DEVELOPMENT OF END MARKETS FOR GLASS.

THE INNOVATIVE GLASS WORKS PLAN $6.7M

MACHINEX

Krysteline Technologies

1) PILOT PROJECTS

A tailored approach to equip sorting centres with innovative technologies. Our partners, Québec-based manufacturer Machinex and producer Krysteline Technologies from Great-Britain, offer care and support throughout all months of the pilot projects.

- EBI Environnement Inc. in St-Paul-de-Joliette (Lanaudière)
- Tricentris - tri, transformation, sensibilisation in Terrebonne (Lanaudière)
- La Régie intermunicipale de traitement des matières résiduelles de la Gaspésie in Grande Rivière (Gaspésie)
- Récupération Frontenac in Thetford Mines (Chaudière-Appalaches)
- Centre de tri de Québec, operated by Société VIA, in Québec City (Capitale-Nationale)

2) FINANCIAL SUPPORT

ÉEQ offers financing and support to conditioners and recyclers eager to commercialize new eco-materials in order to give a second life to the glass collected through curbside recycling.

POSITIVE IMPACTS ON A LARGE SCALE

The *Innovative Glass Works Plan* confirms Québec's leader position in North America, generating positive impacts on the economy, the environment and society:

- Guaranty a supply of quality glass, meeting market's standards for a better integration of recycled glass in a larger scale of applications;
- Develop and secure local jobs, some of which are part of social economy;
- Favor the rise of a circular and green economy in Québec and stimulate the emergence of innovative companies presenting potential for exportations and international influence;
- Offer a reliable solution for all glass containers collected through curbside recycling.

All the details can be found on the website at **www.ecoentreprises.qc.ca/glass**
For information: **glass@ecoentreprises.qc.ca**

FACTSHEET

ECO-MATERIALS MADE FROM GLASS
COLLECTED THROUGH CURBSIDE RECYCLING

Éco Entreprises Québec

GLASS: MULTIPURPOSE MATERIAL

Éco Entreprises Québec (ÉEQ) works in collaboration with conditioners and recyclers in Québec to ensure that the glass that citizens put in their recycling bins is processed into new products. The aim is to enhance current market opportunities and stimulate the development of innovative ecomaterials made from glass collected through curbside recycling. ÉEQ's vision provides greater economic and environmental value for recycled glass.
Glass is an alternative to the use of sand, a non-renewable resource which is, according to many experts, heading into shortage on a more or less long term perspective.

CEMENT ADDITIVES AND CONCRETE

Recycled glass reduced to a fine powder is added to the cement mix that goes into concrete, which is used to build a range of infrastructures and equipment, including sidewalks, skateboard parks, park benches and noise barriers. In addition to cutting the amount of cement required to make the concrete—and therefore considerably lessening the CO2 emissions generated during production—the glass powder enhances the structural resistance of the concrete and makes it a lighter colour, which is popular with designers and minimizes the urban heat island effect. The mix is also more waterproof, more durable and more resistant to freeze-thaw cycles.

Glass may also be added to ''ultra-high performance" fiber-reinforced concrete (UHPFRC), whose exceptional resistance and durability mean that three to four times less concrete is required for different types of works and structures.

MELTING BOTTLES AND CONTAINERS

Recovered glass, which is referred to as cullet once it is sorted, is highly sought-after by glassmakers. First, the glass is cleaned and prepared. It is then combined with other raw materials and heated at high temperatures to shape new bottles. Recovered glass containers can be re-melted over and over again and transformed into new glass containers. Glass re-melting helps save sand and energy and reduces greenhouse gas emissions.

Éco Entreprises Québec

WATER FILTERS

Used to filter drinking water, wastewater and pool water, glass particles provide superior filtering as compared to standard materials since the ionic charge of the recycled glass curbs bacterial growth. The particles also ensure better draining than sand for less backwash and greater water, energy and money savings.

MINERAL WOOL

Mineral wool has been available on the market for many years and is widely used in the building sector as thermal, soundproofing and fire insulation. Mineral wool that contains recycled glass is manufactured through a high-temperature fusion process. In North America, some 30 plants make mineral wool from recycled glass.

ABRASIVES

Recycled glass particles are also used as abrasives. In high-pressure blast systems, they may be used to polish rough surfaces or remove contaminants for repainting. Unlike other types of abrasives, recycled glass is low cost and contains no heavy metals or free silica, making it a better choice for worker safety.

ORNAMENTAL AND HORTICULTURAL MULCH

Recycled glass particles are used in the landscaping sector to provide a touch of colour and originality, keep the ground warm and prevent crawling insects and molluscs from wreaking havoc on plants. The mulch is also flameproof and protects installations from cigarette ends that accidently end up on the ground.

Éco Entreprises Québec

CELLULAR GLASS

Made from fine recycled glass powder and a mineral additive, cellular glass is a pumice-like material that resembles volcanic stone. When fired at high temperatures, the mix expands and traps thousands of microbubbles of air that give cellular glass its particular shape. Light, resistant, durable, flameproof, insulating and filtering, cellular glass has been used for the past two decades across Europe in insulation for conduits, road foundations, fill for bridges and overpasses and green roofs.

GREEN PAVING STONE

Glass may also be used to manufacture green paving stone made from 100% recycled materials. In Québec, Gaudreau Environnement markets ecological paving under the Regénération brand. The stones are made from 75% glass, 20% plastic bag and 5% porcelain. Available in a range of colours and sizes, they are a green alternative to standard coverings in any urban development project.

MULTIPURPOSE FILL

When processed into precipitated silica, glass may be used in inks, tires and paints and as filler for reinforced silicones and rubbers.

SPORTS FIELDS

FIFA approved the use of glass particles as a foundation and surface material for synthetic sports fields since they enhance drainage and extend the service life of the pitches. North American manufacturers have yet to venture into this sector.

All the details can be found on the website at **www.ecoentreprises.qc.ca/glass**
For information: **glass@ecoentreprises.qc.ca**

FACT SHEET

FILTRATION GLASS USED FOR MUNICIPAL WATER TREATMENT: A 2ND LIFE FOR GLASS COLLECTED VIA CURBSIDE RECYCLING

Éco Entreprises Québec

MARKET OUTLETS FOR FILTRATION GLASS USED FOR MUNICIPAL WATER TREATMENT

Various types of filters can be used to treat drinking water and wastewater. This kind of treatment consists in forcing water through a filter that retains the suspended particles. Currently, silica sand or zeolite filters are most often used, but glass is gaining ground, particularly in France and Great Britain.

Glass performs better than traditional filters, and its electrostatic properties prevent the proliferation of bacteria.

TARGET MARKET AND POTENTIAL POOL OF CUSTOMERS

Municipal organizations constitute the main customer base for this material. In Quebec only, there are 236 municipal water treatment plants that produce drinking water from surface water, while Quebec's 2015-2025 infrastructure Plan indicates investments in the tens of millions of dollars to improve the entire drinking water and wastewater treatment network.

That, and information on the current use of sand filtration, leads us to believe that Quebec's municipal sector constitutes an estimated 18,000 t/year market for filtration glass.

MARKET

Given the potential of 18,000 t/year of filtration glass that can be used for municipal water treatment in Quebec, the market is worth between $1.2 million and $1.9 million at the current average retail price ranging from $65/t and $105/t[1].

COMPETING MATERIALS

- Silica (sand)
- Garnet (sand)

MARKET FOR FILTRATION GLASS

The market for water filtration glass is relatively new in North America, while it is already well-established elsewhere in the world. In Great Britain, for instance, filtration glass used in municipal water treatment has grown significantly since 2010 (approximately 6% per year), particularly due to stricter requirements for wastewater disposal.

POSITIVE MARKET PENETRATION INDICATORS

- At this time, there are no North American manufacturers that are certified for marketing filtration glass used for drinking water treatment.

- In North America, the market for water treatment equipment is estimated to grow by approximately 8%/year over the next five years.
- Quebec is planning major investments in the modernization and construction of water treatment plants.

1 Amounts indicated are in Canadian dollars.

TECHNICAL CRITERIA AND CERTIFICATION

CERTIFICATIONS

- **NSF/ANSI 61 Drinking Water System Components:** North American certification standards.
- **AWWA B100 Granular Filter Media Certification:** North American certification specifying the characteristics of filtration media.

CRITERIA

Criteria vary depending on what the filtration glass will be used to treat (wastewater, drinking water). Generally, the criteria specify:

- Granulometry
- Gravity (glass density/water density)
- Solubility
- Hardness of the material

It is important to note that the physical characteristics of the filtration glass must comply with provincial and federal regulations on water quality standards and the properties required for wastewater disposal. In Quebec, for example, Regulation Q-2, r. 40, on the quality of drinking water requires that output water turbidity meets levels of between 1.0 and 5.0.

FACT SHEET

FILTRATION GLASS USED
FOR POOL WATER TREATMENT:
A 2ND LIFE FOR GLASS COLLECTED
VIA CURBSIDE RECYCLING

Éco Entreprises Québec

MARKET OUTLETS FOR FILTRATION GLASS USED FOR POOL WATER TREATMENT

Various filters can be used to treat water. This kind of treatment consists in forcing water through a filter that retains the suspended particles. Currently, silica sand or zeolite filters are most often used, but glass is gaining ground, particularly in France and Great Britain.

Glass performs better than traditional filters, and its electrostatic properties prevent the proliferation of bacteria.

TARGET MARKET AND POTENTIAL POOL OF CUSTOMERS

Gaining market share for filtration glass used in pool water treatment is usually accomplished via a network of distributors. Currently, there are at least eight major distributors in North America.

According to sources in various Canadian and American institutions, using recovered glass to filter pool water is still new in North America. Demand is estimated at 45,000 t/year in in the northeast U.S. and eastern Canada.

INNOVATIVE GLASS WORKS

MARKET

Given a potential demand for 45,000 t/year in the northeast U.S. and eastern Canada, the market for filtration glass to treat pool water could reach $13.3 million at a retail sale price of up to $295 /t.[1].

COMPETING MATERIALS

- Silica (sand)
- Garnet (sand)

MARKET FOR FILTRATION GLASS

The market for filtration glass to treat water is still new in North America but, unlike municipal water treatment, its use for pool water filtration has grown significantly.

POSITIVE MARKET PENETRATION INDICATORS

- In North America, the market for water treatment equipment is estimated to grow by approximately 8%/year over the next five years.
- Product that offers a longer useful life than other filtration media.
- Product that prevents the accumulation of bacterial biofilms and therefore reduces maintenance requirements.

1 Amounts indicated are in Canadian dollars.

TECHNICAL CRITERIA AND CERTIFICATION

CERTIFICATIONS

- **NSG/ANSI 50 – Equipment for Swimming Pools, Spas, Hot Tubs and other Recreational Water Facilities:** North American certification (not mandatory for marketing purposes)

CRITERIA

Generally, the criteria specify:

- La granulométrie
- La gravité (densité verre/densité eau)
- La solubilité
- La dureté du produit

FACT SHEET

FOAM GLASS:
A 2ND LIFE FOR GLASS COLLECTED
VIA CURBSIDE RECYCLING

Éco Entreprises Québec

MARKET OUTLETS FOR FOAM GLASS

Foam glass is a "pumice stone" type of material composed of 95% recovered glass that is pre-sorted in sorting centres. The glass is reduced to a fine powder and mixed with a mineral additive, then cooked at high temperature, causing the particles to expand and capture thousands of gas bubbles. Light, hard-wearing, durable, fire-resistant with insulating properties, foam glass has been used in many European countries for the past thirty years and in many applications, especially in the construction sector. It is an ecological product with good value added.

TARGET MARKET AND POTENTIAL POOL OF CUSTOMERS

Currently, there are no foam glass producers in Quebec and only a few in North America. The product has considerable commercial potential and could benefit from proven marketing experience gained in Europe.

European producers mainly target the construction and landscaping markets, particularly for:

- Foundation and concrete wall insulation
- Ductwork, pipe and storage tank insulation
- Road or sports field sub-layers
- Green roof sub-layers
- Fill material for landscaping work

Éco Entreprises Québec

MARKET

Still very new in North America, this material presents a promising market for local businesses compared to Europe, where it is in its mature stage. There are foam glass manufacturing plants in many countries, including Switzerland, Germany, Sweden, Spain, the Czech Republic, Austria, Italy and Lithuania.

A typical plant produces between 30,000 t/year and 50,000 t/year of foam glass, and generates sales ranging from $45 million to $75 million per year[1].

COMPETING MATERIALS

- Fill materials (gravel, sand)
- Insulation materials (gravel, sand, expanded polystyrene)

MARKET FOR FOAM GLASS

The biggest markets for foam glass are the construction and landscaping sectors. In 2014, the construction industry alone accounted for $45 billion in investments according to the Association de la construction du Québec (ACQ), which intimates the niche that foam glass can occupy in that market.

POSITIVE MARKET PENETRATION INDICATORS

- A mature market in Europe, but great potential in North America
- The product's properties provide competitive advantages:
  - Moisture resistant
  - Fire resistant
  - Thermal efficiency: the product does not absorb moisture
  - Dimensional stability: does not swell, warp, shrink or lose its shape
  - Highly resistant to compression
  - Light-weight product with drainage properties

1 Amounts indicated are in Canadian dollars.

TECHNICAL CRITERIA AND CERTIFICATION

Currently, there are no standards for this product in North America or Europe. On the other hand, it is wise to seek out application-specific criteria in order to gain market share. For example, in the building sector, foam glass must meet Régie du bâtiment du Québec (RBQ) technical criteria for building green roofs.

Criteria vary according to the application, and include:

- Facilitates water drainage
- Reduces water absorption
- Resists crushing
- Reduces structural load
- Resists freezing and the freeze-thaw cycle

FACT SHEET

ABRASIVE GLASS:
A 2ND LIFE FOR GLASS COLLECTED
VIA CURBSIDE RECYCLING

Éco Entreprises Québec

MARKET OUTLETS FOR ABRASIVE GLASS

Sandblasting is an industrial cleaning technique that uses compressed air to propel an abrasive through a nozzle onto the surface under high pressure.

Glass recovered via curbside recycling can be ground up and used as an abrasive to polish rough surfaces or remove contaminants on a surface that will be subsequently repainted. Unlike other types of abrasives, recycled glass produces a whiter result, a cleaner finish and does not contain heavy metals, which means that the product is safer for workers to handle.

TARGET MARKET AND POTENTIAL POOL OF CUSTOMERS

Customers for abrasives are mainly marine-based industries, oil refineries as well as bridge maintenance and repair companies. These prosperous industrial sectors are located in the northeast U.S. and Canada, where there are at least 12 naval bases, 15 refineries and 7 major sandblasting companies. Public works departments are also potential contract originators who may require recycled glass abrasives to clean graffiti, monuments as well as stone or metal infrastructures, or to strip paint.

Excluding public works departments, actual market outlets for abrasives in those three industrial sectors in Quebec, Ontario and northeast United States alone use 152,000 t/year of glass abrasives.

Éco Entreprises Québec

MARKET

Given the 152,000 t of glass abrasives used by the above three industrial sectors, the market is worth between $41 million and $53 million/year at the current average distributors' sale price ranging from $270 /t to $350 /t[1].

COMPETING MATERIALS

- Silica
- Slag

SUPPLIERS OF ABRASIVE GLASS

Currently, there are 14 main suppliers of glass abrasives in North America, two of which are in Quebec and four in other Canadian provinces.

The abrasives market is expected to continue its strong growth, estimated at 3.8%/year until 2019.

POSITIVE MARKET PENETRATION INDICATORS

- Well-known abrasive in the sandblasting industry, which will facilitate and drive marketing and development.
- Safe abrasive, without free silica or heavy metals.

- Abrasive that produces a whiter result and cleaner finish than mineral or slag-based abrasives.
- Sought out by the market to replace other materials:
  - Slag is banned in several American States due to heavy metal content
  - Silica is classified by the OHSA as a material that presents a risk to health
- Glass abrasives are on several North American government organizations' QPLs (qualified products lists).

1 Amounts indicated are in Canadian dollars.

TECHNICAL CRITERIA AND CERTIFICATION

CERTIFICATIONS

There is no mandatory certification for glass abrasives.

However, compliance with the two following standards is recommended in order to be included on Qualified Products Lits (QPLs):

- **SSPC-AB1 Mineral and Slag Abrasives:** standards developed by the Society for Protective Coatings to ensure the protection of metal structures
- **MIL-A-22262 Abrasive blasting media – Ship Hull blast cleaning:** standards developed by the American army

All product compliance testing must be carried out according to ASTM International standards.

CRITERIA

Criteria to meet standards vary according to the surface on which the abrasive is used, required cleaning frequency or the purpose for which the surface to be stripped will be used. The most commons criteria are:

- Contamination rate
- Humidity rate
- Proportion of chloride
- Required shape
- Granulometry

FACT SHEET

CEMENT ADDITIVE:
A 2ND LIFE FOR GLASS COLLECTED VIA CURBSIDE RECYCLING

Éco Entreprises Québec

MARKET FOR RECYCLED GLASS AS A CEMENT ADDITIVE

Cement additives can be made using glass that is recovered and pre-sorted at the sorting centre, purified and ground to a fine powder a few dozen microns in size. It is used mainly in a mix with traditional ingredients to make concrete, providing better structural resistance, impermeability to chloride ions, durability and easy handling during application on work sites. Similarly to other cement additives, glass powder reduces production costs and GHG emissions per cubic metre of concrete generated. That last point is all the more important for cement manufacturers as this industrial sector is targeted by Quebec's GHG emission cap and trade system (carbon exchange).

TARGET MARKET AND POTENTIAL POOL OF CUSTOMERS

Public works is one of the main markets for cement additives that include glass collected via curbside recycling, particularly for non-structural equipment and installations. Cement and concrete manufacturers working in the construction industry (road infrastructures, sidewalks, sound abatement walls, urban furniture) are the main customers for glass powder used as a cement additive in concrete.

The market potential of this material is huge and could top 100,000 t/year, the equivalent of the glass collected via curbside recycling in Quebec

Éco Entreprises Québec

MARKET

The market for using glass powder is more mature in the U.S., while it is still growing in Quebec.

COMPETING MATERIALS

Other materials compete with powdered glass as cement additives, including:

- Fly ash from coal-fired plants
- Combustion residues from the metal industry
- Silica fumes

MARKET FOR RECYCLED GLASS AS A CEMENT ADDITIVE

The construction industry is the main market outlet for powdered glass as a cement additive. According to the Association de la construction du Québec (ACQ), $45 billion was invested in the construction industry in 2014. This sector therefore constitutes a significant market for this material.

POSITIVE MARKET PENETRATION INDICATORS

- Glass powder is produced locally and therefore incurs lower transportation costs compared to other cement additives that must be imported to Quebec.
- Glass powder gives concrete very attractive properties, including:
  - Smaller environmental footprint
  - Impermeability to chloride ions
  - Better structural resistance
  - Better handling of concrete

TECHNICAL CRITERIA AND CERTIFICATION

CERTIFICATIONS

Two types of certification demonstrate the qualities of glass powder and encourage its use:

- Certification of glass powder as a cement additive (CSA A3001-13 standard)
- Certification of concrete made with glass powder for certain applications

While certification for this material is not required when used for urban furniture or sidewalks, it is necessary for other applications, such as roadwork, as this sector is subject to Transport Québec standards.

CRITERIA

Certification criteria to demonstrate the performance of concrete depends on the intended application. General criteria include:

- Durability
- Resistance to rutting
- Density
- Humidity
- Granulometry

FACT SHEET

EQUIPMENT AND PARTNERS FOR THE DEMONSTRATION PROJECTS

TECHNOLOGICALLY-ADVANCED EQUIPMENT TO SORT AND CLEAN GLASS COLLECTED VIA CURBSIDE RECYCLING

After reviewing available technologies, Éco Entreprises Québec (ÉEQ) established a diagnosis which facilitated the selection of innovative and proven technologies to implement in Quebec sorting centres as part of demonstration projects. Manufacturers Krysteline Technologies and Machinex are combining their expertise to provide a customized approach as well as technical support to the selected sorting centres throughout the project period.

WHAT IS GLASS IMPLOSION?

Krysteline Technologies has developed innovative implosion technology to transform glass into small fragments. With the implosion system, a calibrated-speed rotor sends a shock wave to glass bottles or pieces. This wave, which travels back and forth, causes instantaneous implosion of the glass without shredding the labels or capsules, which are therefore easier to sort and extract. This method is less costly to maintain and uses less energy than conventional grinding processes. As an added benefit, the edges of the treated glass are rounded, not sharp.

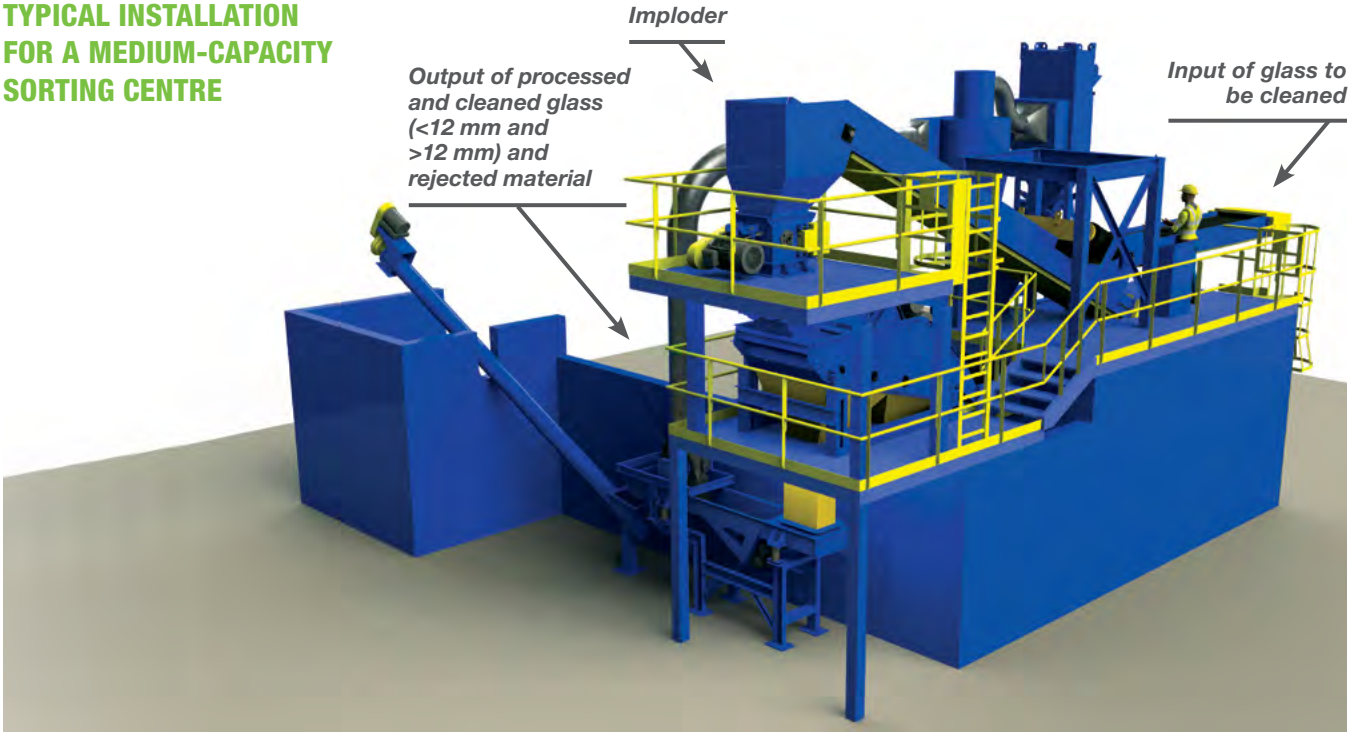
EQUIPMENT CONFIGURATION

Cleaning systems by suction of light contaminants (paper) and sieving (also called screening) will be combined in different configurations, according to:

- Characteristics of the selected sorting centres
- Current quality of the glass in sorting centres
- Target market outlets

The specific choice of equipment and final configuration in the area dedicated to glass processing will be finalized after a detailed implementation study in collaboration with selected sorting centre managers.

TYPICAL INSTALLATION FOR A MEDIUM-CAPACITY SORTING CENTRE



GLASS AFTER PROCESSING (VARIOUS SIZES POSSIBLE)

CREATING AN INTERNATIONAL BUSINESS OPPORTUNITY

As part of its *Innovative Glass Works* Plan, Éco Entreprises Québec (ÉEQ) works in collaboration with a partner in Quebec, Machinex, and another in the United Kingdom, Krysteline Technologies. They form a strategic alliance that holds great promise for the future of the recycling industry in Quebec and throughout North America.

ÉCO ENTREPRISES QUÉBEC (ÉEQ)

Éco Entreprises Québec (ÉEQ) is the organization that develops the Schedule of Contributions and collects company contributions, which are then redistributed to finance municipal curbside recycling services in Quebec. ÉEQ also encourages innovation and sharing of best practices in order to optimize the recyclable materials value chain. To do so, ÉEQ cooperates, on the one hand, with companies to reduce quantities of materials at the source and encourage the use of recyclable materials, and on the other, with municipalities to increase recycling and the economic value of recovered materials. ÉEQ is a private non-profit organization created by companies that put containers, packaging and printed matter on Quebec's market to represent them. The organization was accredited by RECYC-QUÉBEC in 2005 under the *Environment Quality Act*.

MACHINEX

In the early 1980s, Machinex became the first company in Canada to design machinery for sorting centres. The company immediately established itself as a leader in designing profitable quality recycling sorting systems. Today, Machinex is still a world leader in the industry, developing cutting edge sorting, waste management and recycling technology. Over the years, its experts have designed and installed over 350 turnkey facilities in partnership with leading MRFs in Canada, the United States, Europe and Australia.
For further information, visit:
www.machinexrecycling.com/en
or write to: **info@machinex.ca**

KRYSTELINE TECHNOLOGIES

Krysteline Technologies has been providing patented glass processing systems on a global scale since 1998. Krysteline is a provider of bespoke solutions to the materials processing industry. Centred on its unique implosion systems developed for the quick, efficient and cost effective size reduction of a wide range of materials including glass, ceramics, minerals, ores and furnace slags, Krysteline Technologies has over 20 years' experience designing and building a wide range of processing systems from simple stand-alone units to multi-functional purification plants. Krysteline's strategy is to provide processing solutions for all collected glass no matter its size or quality. Its unique patented technology can make use of 100% of the waste glass stream to meet market needs and develop new outlets.
For further information, visit:
www.krysteline.com
or write to: **info@krysteline.com**

All the details can be found on the website at **www.ecoentreprises.qc.ca/glass**
For information: **verre@ecoentreprises.qc.ca**

FACT SHEET

EXAMPLES OF SUCCESSES IN THE WORLD

Éco Entreprises Québec

EXAMPLES OF SUCCESSES IN THE WORLD

The equipment to be installed in Quebec sorting centres as part of demonstration projects is already used in several cities around the world and are good examples in a context of *mixed materials recycling*.

GREAT BRITAIN

ARUNDEL

Like Quebec, Great Britain is a major wine importer but has very few green glass bottle manufacturing plants. The Arundel sorting centre operated by Viridor is located at the south end of England, far from traditional markets for recycled glass. Viridor, Great Britain's leading glass conditioner, owns several sorting centres. This highly mechanized centre processes in excess of 80,000 tpa, of which almost 20,000 tonnes of glass, and serves a population of one million. It has been using Krysteline Technologies' implosion equipment since 2008, in addition to complementary integrated screening and cleaning machines.

Glass market outlets: Aggregate for local use as sand substitute for infrastructure projects

NORTH LONDON

Europe's largest sorting centre, located in North London, is highly mechanized and sorts up to 350,000 tpa, of which 55,000 tonnes of glass, and serves a population of one million. The Krysteline implosion system, integrated into the centre's operations since 2013, makes it possible to adapt glass production to market demand.

Glass market outlets: Made into new bottles and mineral wool, glass sand, abrasives and filtration sand

PEOPLE'S REPUBLIC OF CHINA

MACAU

Macau, which is located across from Hong Kong on the south coast of People's Republic of China, is the most densely populated region in the world with a population of 636,200 living in an area of 30.2 km^2. Since Macau is a popular tourist destination, it generates a great deal of glass, especially in the many casinos and restaurants.

Since 2012, the Macau sorting centre has used Krysteline equipment to convert glass into products for local use.

Glass market outlets: Glass sand in the construction of block paving for pathways

AUSTRALIA

MACKAY, ROCKHAMPTON AND LISMORE TOWNSHIPS

The three sorting centres in the townships of Mackay, Rockhampton, in Queensland, and Lismore, in New South Wales, Australia, each serve a population of 150,000. Representatives of these sorting centres were seeking a local solution to sort and recycle glass because the distances to traditional markets of recycled glass were too far away. Thanks to a glass implosion and cleaning system featuring a gyratory screener, they now purify and calibrate glass for various alternative markets. This innovative technology solution has enabled them to develop new markets while significantly reducing transportation costs.

Glass market outlets: Glass sand for filtration, abrasives, and other local uses such as aggregates

Photo: Mackay sorting centre

All the details can be found on the website at **www.ecoentreprises.qc.ca/glass**
For information: **verre@ecoentreprises.qc.ca**

A NEW ERA
IN GLASS RECYCLING

Éco Entreprises Québec

Technology for the benefit of the circular economy

The ultimate challenge in glass recycling is to produce high-quality glass that meets the criteria of the conditioners and recyclers that process it for commercial applications.

In North America, standard sorting centre equipment produces glass that contains up to 20% impurities (labels, corks, metal, etc.), leading to high costs and environmental impacts generated by the transport of such a significant amount of contaminants over long distances.

TOWARD A CIRCULAR ECONOMY BASED ON RECYCLED GLASS

By investing to upgrade sorting centre equipment, ÉEQ is creating the channel that was missing between the various stakeholders in the circular economy of glass. The new equipment will enable sorting centres to produce high-quality glass that meets conditioner criteria and improves the entire production chain.

IN THE PAST: LOW QUALITY, HIGH COSTS

- ✖ Transport and landfilling costs
- ✖ Additional processing needed
- ✖ CO_2
- ✖ Little economic interest for conditioners to use glass from curbside recycling to give it a second life

The low quality of the glass processed by sorting centres led to economic and environmental impacts in the subsequent phases, making it difficult to use the material in new products.

TODAY: HIGH-QUALITY GLASS FOR A RANGE OF APPLICATIONS

- ✔ Up to 99% of impurities eliminated at the sorting centre
- ✔ Simpler subsequent conditioning
- ✔ Transport savings
- ✔ Reduction in CO2 emissions
- ✔ Elimination of its use as landfill cover
- ✔ Two standard sharp-free grain sizes for many different commercial applications

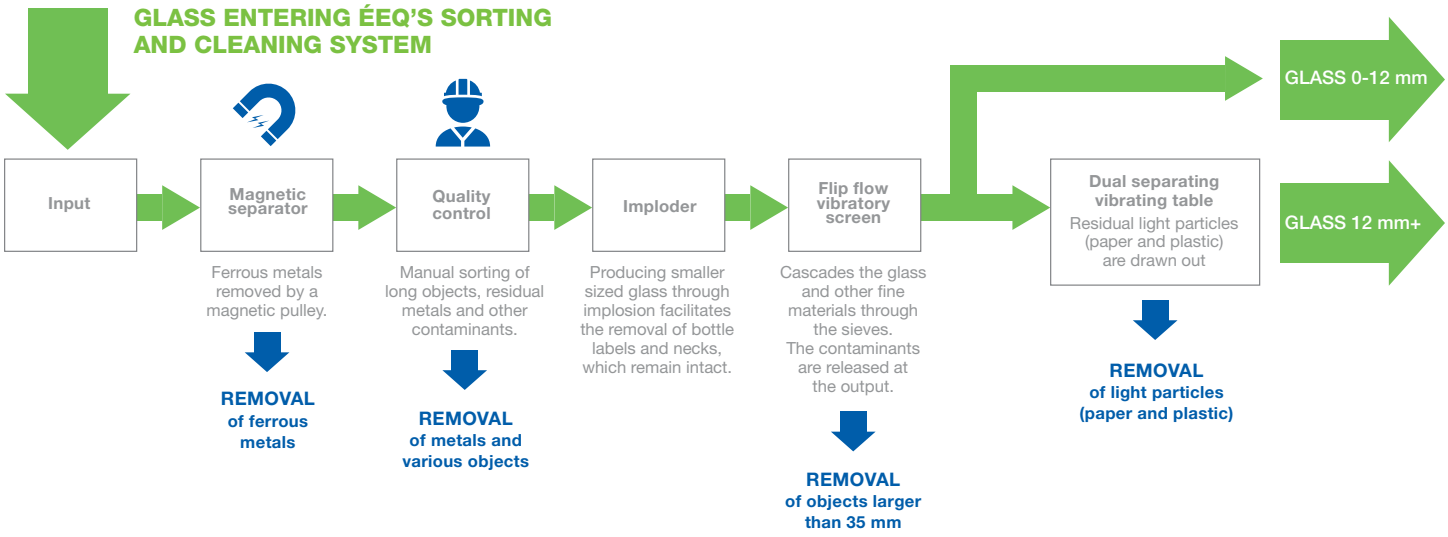
› FOR SORTING CENTRES:
The assurance of being able to provide clean sorted glass to conditioners means more efficient operations management.

› FOR CONDITIONERS AND RECYCLERS:
It becomes economically viable to process higher quality glass for commercial markets.

Éco Entreprises Québec

THE ADVANTAGES OF A CUTTING-EDGE TECHNOLOGY

Combining the implosion technology developed by Krysteline and the related equipment installed by Machinex changes the way glass is sorted and cleaned.

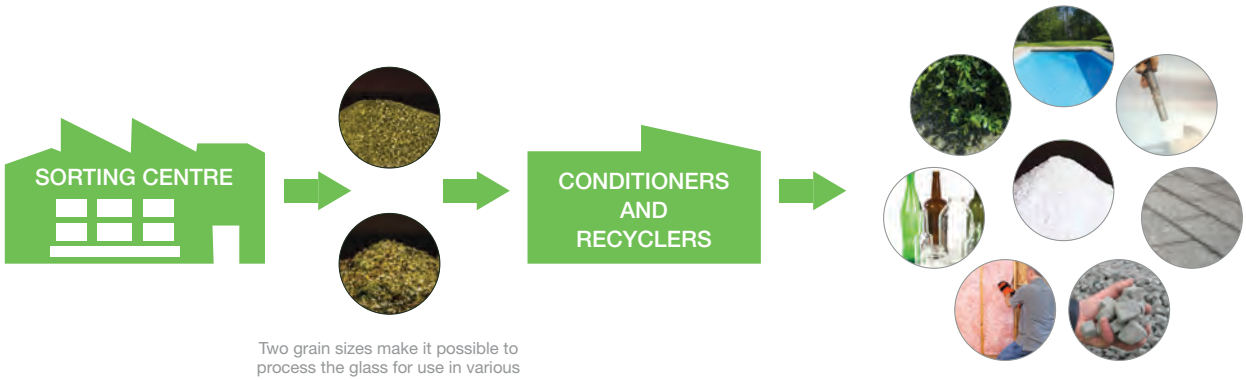


For the first time in the world, a single system sorts and cleans, streamlining the processes across the production line. The new equipment produces glass in two grain sizes that conditioners and recyclers then transform for use in a range of innovative ecomaterials.

A SECOND LIFE FOR GLASS: FROM RECYCLING BINS TO ECOMATERIALS

After sorting and cleaning at the sorting centre, the glass may be processed by conditioners and recyclers for use in new applications.

- Abrasives for sandblasting
- Cellular glass
- Mineral wool
- Water filtration agents
- Bottle and container remelting
- Cement additives for concrete
- Ornamental and horticultural mulch
- Green paving stone
- Glass powder fillers
- Sports fields



Two grain sizes make it possible to process the glass for use in various commercial applications