

Material Flow Analysis from a Circular Economy Perspective

Action Plan Promoting Circular Economy in the Cree village of Mistissini

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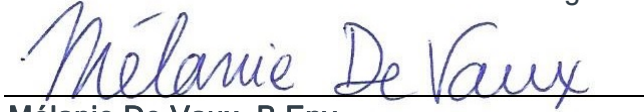
Prepared by:



Dominic Lafleur, Geographer, M.Env.

Project Manager

Environmental Studies and Climate Change



Mélanie De Vaux, B.Env.

Project Manager

Environmental Studies and Climate Change

Reviewed and approved by:



Jean-Luc Bugnon, Biol., M.Sc., CEA™

Project leader, Industrial Sector

Environmental Studies and Climate Change

Production team

Partners

| | |
|--|---|
| RECYC-QUÉBEC (partner, coordination) | Hélène Gervais, M.Env. Environmental Advisor |
| Ministère des Ressources naturelles et des Forêts (MRNF) (partner) | Charles Drouin-Lavigne Advisor |
| Société du Plan Nord (partner) | David Denoncourt Economic Advisor |

Englobe Corp.

| | |
|------------------|---|
| Project Director | Jean-Luc Bugnon, Biol., M.Sc., CEA™ |
| Project Manager | Dominic Lafleur, Geographer, M.Env. |
| Writing | Jean-Luc Bugnon, Biol., M.Sc., CEA™ Dominic Lafleur, Geographer, M.Env. Vincent Gautier-Doucet, Anthropologist, M.Sc. Mélanie De Vaux, B.Env. Camille Vinette, B.A. |
| Analysis | Dominic Lafleur, Geographer, M.Env. Vincent Gautier-Doucet, Anthropologist, M.Sc. |
| Mapping/GIS | Jean-Michel Bolduc, B.Sc. |
| Publishing | Julie Korell, B.A. |
| Translation | Geneviève Desbiens, B.Trad., B.A. |

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Executive summary

In summer 2021, RECYC-QUÉBEC commissioned Englobe to perform a material flow analysis (MFA) to develop an action plan promoting circular economy in northern communities and a mining company. The project is supported by three partners, which are RECYC-QUÉBEC, the Société du Plan Nord (SPN) and the Ministère des Ressources naturelles et des Forêts (MRNF). Although, circular economy has been studied for a few years in Quebec, no large-scale study has been performed on this concept in Quebec so far among northern communities or mining companies operating in the region.

The project is intended to identify solutions for optimizing the use of certain materials to promote circular economy north of the 49th parallel. This document covers the MFA for the Cree village of Mistissini (Mistissini).

This document is about the circular economy optimization through an MFA for the community of Mistissini. It provides a short description of the community, of its population as well as its issues relating to its supply, which is mainly linear. The MFA allows to outline the four main flows typical of the community's input and output management. The material flows presented in Sankey diagrams are used to establish the community's circularity rates. Finally, the report addresses the possible circular economy solutions and comes with an action plan to implement these.

Description of the Cree Village

The village of Mistissini, which is about a hundred kilometres north from Chibougamau, can be reached via Route 167 and is served by the Chibougameau/Chapais Airport (located about 110 km southwest).

The territory of the Cree Nation of Mistissini (CNM) is divided into three land categories (I, II and III) based on the exclusive or non-exclusive land use classification by community members under the James Bay and Northern Quebec Agreement (JBNQA).

Economic and institutional activities

Mistissini is constantly developing. New development projects are carried out from year to year, including a new planned residential area over the next few years west of the current village, on the other side of a narrow extension of Lake Mistassini.

In addition, there are more than 80 institutions, businesses and organizations throughout the territory. In the village, there is, for example, a grocery store, a sports complex, several daycares and three convenience stores, some of which include service stations and/or sell prepared meals.

In Mistissini, there are also two schools from the Cree School Board – the Voyageur Memorial Elementary School and the Voyageur Memorial High School – as well as a health centre.

Current residual materials management

In 2013, the Cree village of Mistissini developed a plan to manage its residual materials to extend the life of the landfill used by the community and to recover recyclable and compostable materials. The action plan includes new actions concerning residual material collection, the development of a new landfill, household hazardous waste (HHW) collection, recyclable materials collection and sorting as well as an information, awareness and education (IAE) program for community members.

A truck used for collecting recyclable materials serves every house, as well as industrial, commercial and institutional establishments (ICI) once a week.

The CNM implemented the collection of organic matter. Following their collection, this organic matter is placed into an industrial rotating composter.

Since 2017, there is an ecocentre for all community's residents and business owners. The ecocentre mainly gathers the following materials: tires, propane tanks, oils, paints, wood, household electrical appliances, end-of-life vehicles, metals, electronic products as well as cells and batteries.

Material flow analysis

For this study, the approach chosen to carry out the MFA is a hybrid model based on the Eurostat methodology along with the Baccini and Brunner methodology. This model is suitable for the project objectives since it identifies the main activities within the community as well as materials involved in these activities (no "black box"). This approach is recommended when the purpose of the study is to gain a better understanding of the territory's flow circulation to assess the possibility of implementing circular economy projects (Morris, 2016). This was thus the preferred methodology in the context of the Cree village of Mistissini.

The approach chosen by Englobe focuses on four topics (or flows):

- Energy;
- Water;
- Materials extracted within the boundaries of the MFA;
- Consumer products.

Mistissini's administrative boundaries are the geographic boundaries chosen to carry out the MFA. The latter is limited to the period from January 1 to December 31, 2021.

The information needed to perform this MFA has been gathered through questionnaires submitted to Mistissini's ICI, visits to ICI and the characterization of residual materials disposed of in the landfill.

Energy

The entire energy is imported to Mistissini. It is then consumed by the community's citizens and ICI sector mainly for transportation, building heating and lighting as well as for devices and equipment operations (residential, commercial, etc.). The main outputs are the air emissions in the form of carbon dioxide equivalent (CO₂ eq). The energy flow analysis reveals that the community of Mistissini consumes about 437,000 GJ annually.

Water

The water of Mistissini is consumed by citizens and ICI. The water extracted is solely intended for the Mistissini community, not for exportation. The areas where water is the most widely consumed are households. The water flow analysis reveals that the community of Mistissini consumes about 1,000,000 m³ of water annually. All water consumed is drinkable and comes from the water system.

Wastewater is conveyed through the sewer system towards the wastewater treatment facility. Per year, the quantity of wastewater to be treated is about 1,000,000 m³ and the quantity of sludge generated is about 38 t. At the moment, this sludge accumulates at the bottom of aerated ponds.

Materials extracted within the community

In the context of Mistissini, a quarry is operated near the village. Nonetheless, there was no available information regarding the quantity extracted. The quarry (and the category) was then not included in the MFA due to the absence of data.

Consumer products

The main consumer products imported to Mistissini are food and construction materials. Food is imported to Mistissini by retailers while a portion of construction materials are used for buildings and

infrastructure. As part of an MFA, the latter corresponds to stock. For example, in 2021, two new structures have been constructed in Mistissini. Within an MFA, it then corresponds to a stock of wood and construction materials.

Finally, the residual materials in Mistissini are outputs mainly sent to the separate collection of recyclable materials, the ecocentre or the trench landfill (TL) receiving Mistissini's residual materials.

Mistissini's MFA summary and implemented actions

Mistissini imports energy, materials and consumer products. Energy imports are mainly used for transportation while materials are used for construction as well as the built environment of this fast-growing community. People of the village must also import all the consumer products necessary for everyday life, such as food. Extractions for household purposes include water and aggregates from the quarry – for which Englobe has no information and are thus not included in the Sankey diagram).

The MFA also reveals that Mistissini's economy has linear flows, which indicates at first glance that few circular economy strategies are carried out. However, some strategies in line with the circular economy, such as responsible consumption, process optimization and renting, can be hardly exposed in an MFA. Also, during our visit in Mistissini, some existing circular economy initiatives were identified:

- Heavy equipment renting services that are offered by some companies using these types of equipment in their operations (e.g. construction and excavation company);
- Facebook groups called Mistissini Qc Buy, sell & everything else and MISTISSINI, BUY SELL & TRADE & COMMUNITY ANNOUNCEMENTS that allow community members to sell, trade or donate some materials (about 15 posts are published every day);
- Some small actions, such as heat recovery from refrigerators in a service station to heat the building;
- The decision by some companies to change their lighting system to use LED bulbs;
- An existing regulation banning the use of single-use plastic bags in Mistissini.

Circular economy solutions

Several circular economy solutions have been selected for the Mistissini community. The next paragraphs present solutions suitable for the Mistissini community for each of the 12 circular economy strategies. Some of the actions suggested may be related to more than one type of strategy.

Ecodesign

Given the absence of product manufacture plants or complexes, it is hard to implement ecodesign in Mistissini. Nevertheless, this type of strategy could be implemented in the built environment planning and the following circular economy strategy presented may be considered.

Built environment planning

The construction of new infrastructure due to population growth could be based on ecodesign's principles for material choice, energy supply and avoiding fuel use. When more sustainable materials are used, the import of new materials is less frequent, thereby reducing construction, renovation and demolition (CRD) waste as well as impacts related to the transportation of these materials. But long before the construction stage, the design is also important and should prioritize buildings that could be adapted to future needs to prevent their obsolescence.

Responsible consumption and procurement

Observations and discussions made during the visit in Mistissini helped identify circular economy solutions to be analyzed.

Electrification of municipal vehicles

As for transportation, municipal gasoline- or diesel-powered vehicles could be replaced with electric vehicles.

Sustainable procurement for Mistissini's ICI

Quebec's ICI are more frequently implementing sustainable procurement policies that integrate environmental and social criteria related to purchase as well as contract and supplier selection. Without necessarily establishing a comprehensive policy, the CNM could promote and simplify sustainable procurement within ICI.

Process optimization

Several measures could be implemented for optimizing ICI's processes. It is possible to make a transition towards energy efficiency within the village itself and the ICI located on the territory.

Support for ICI for optimizing their processes

Mistissini's businesses and industries could be supported by a specialist to confirm whether it is possible to optimize their processes. An energy assessment based on the principles of the ISO 50001 standard could be performed.

Sharing economy

There are several types of sharing economies. Sharing economy comes in various forms. During the visit in Mistissini, storage was rather an issue.

Sharing of storage spaces

To have a type of economy based on collaboration, it would be necessary to identify available vacant areas that could be used for outside and inside storage. It would be important to confirm whether it is possible to share these areas, so that they could be used by several ICI while ensuring the safety of their goods.

Carpooling or shuttle to Chibougamau

Several daily trips to Chibougamau are made by ICI's employees and citizens. To simplify the trips made between these two urban centres, an online carpooling platform could be created. Another idea that is less directly related to sharing economy could be to use an electric-powered shuttle for the trips made between these two cities at fixed times.

Short term renting

The Mistissini community is rather isolated from the rest of the province and some services offered in the Quebec major centres are difficult to obtain, which means that the renting strategy is more interesting within this community.

Implementation of a list for renting services offered by companies

Some companies located in Mistissini, such as construction companies, offer renting services for their heavy equipment to community residents. By implementing a list of the renting services offered through these companies, it would simplify the access to these services and made the information available to the members of the community – thus encouraging them to use these services – and the different subcontractors temporarily working in Mistissini.

Renting of furniture and household appliances

A significant number of temporary workers from different fields (e.g. school board or health centre) come to Mistissini annually. They must then temporarily live somewhere in Mistissini. Therefore, a business model could be designed in collaboration with temporary workers' employers by establishing agreements on the use of furniture and household appliances over a short period of time. The necessary equipment would be made available to these workers that would not have to buy it.

Maintenance and repair

To extend the life of consumer products, it would be possible to involve the community in the different actions that could be implemented both by the CNM and the citizens.

Repair activities

It would be interesting to organize a local mobilizing event during which volunteers would repair different kinds of objects, thereby extending the life of the citizen's goods while being involved in citizen mobilization.

Donating and reselling

There are Facebook groups dedicated to the Mistissini community in which citizens display the reusable objects they want to sell or donate. The Facebook group Mistissini Qc Buy, sell & everything else is a good example of this kind of group. However, to the best of our knowledge, there is no used goods store or nor physical space dedicated to the donating or reselling of objects in Mistissini.

Used goods store

Normally, a used goods store is divided into two areas. The first one is used for receiving, inspecting and sorting the objects donated. Sometimes, the objects in poor condition are refurbished (refurbishing strategy). The second area is more like a retail space used to sell reusable objects. In these two areas, objects should not be exposed to weather conditions. This approach is beneficial by avoiding landfill of products, reducing imports of new products, putting objects back into circulation within the community and giving citizens access to lower-cost products.

Community refrigerator project

In Mistissini, there are two restaurants, a few food counters in stores and some citizens from the community prepare ready-to-eat meals to take away. To reduce food waste, community companies and citizens could bring uneaten meal or food in a community refrigerator to give back or for people in need.

Refurbishing

The remote location of Mistissini involves that goods requiring to be replaced come from major urban centres. The refurbishing of repairable objects would then reduce the import of new goods while reducing landfill.

Refurbishing of household and small electrical devices

These appliances could be refurbished to give them new life. When it is impossible to refurbishing them, the parts in good condition could be removed to be reused to repair another one. This action is perfectly in line with the used goods store suggestion.

Performance economy

Performance economy is based on the use of goods or services instead of their sale.

Performance economy consortium (Économie de la fonctionnalité et de la coopération du Québec [EFC Québec])

The results of a performance economy project focusing on substituting product sale by product use value from a consortium formed by 20 companies will soon be made publicly available. The results of the study should be analyzed to inspire the community.

Industrial ecology

Industrial ecology is a circular economy strategy focusing on giving resources a new life through exchanges of materials, energy or resources between several organizations.

Implementation of an industrial symbiosis

To add circularity regarding materials produced within the territory, an industrial symbiosis project could be developed in the region, such as a networking workshop for Mistissini's ICI that must subsequently be supported for potential synergies to be created between ICI. The Cree Nation Government (CNG) could be involved in the follow-up with the ICI interested in industrial ecology.

Recycling and composting

Recycling and composting enable resources to have a new life. Several circular economy solutions have been identified in Mistissini.

Improvements to the ecocentre

There is already an ecocentre in Mistissini, but some space organization improvements should be made. For example, there is a problem regarding storage of materials sent to the ecocentre. Indeed, most of them are segregated and directly placed on a permeable soil. Therefore, these are not protected against weather conditions and water may accumulate. Furthermore, the CNM must undertake the necessary procedures to also turn the ecocentre into an official collection point for all materials concerned by extended producer responsibility (EPR) to avoid on-site accumulation of materials. It is possible to get funding to improve the ecocentre.

Organic matter management optimization

In Mistissini, organic matter is already collected and composted. However, a solution still needs to be found concerning the use of the compost produced. For example, it could be used for a possible northern greenhouse project. However, before its use, it should be sieved to remove impurities.

Collection of refundable containers

At the moment of the study, there was no refundable can and bottle collection in Mistissini's convenience stores, grocery stores and service stations. A deposit system is easy to implement and would be a great opportunity for Cree communities. The organization responsible for the beverage container deposit system is the Quebec Beverage Container Recycling Association (QBCRA). This strategy would also reduce the quantity of materials to be landfilled in the Mistissini's TL. The containers that could be collected are the ready-to-drink beverage containers made of plastic, glass, cardboard or multi-layered from 100 ml to 2 L.

Recovery

Recovery is the last strategy for avoiding landfill. Several circular economy solutions have been identified throughout this study.

Recovery of residual granular materials

The CNM seemed interested in residual granular material recovery. Residual granular materials are non-melting abrasives spread on the community's roads throughout the winter and are collected during street sweeping and cleaning work. These types of materials are then stocked outside the village.

From a regulatory standpoint, such work requires a ministerial authorization. In the spirit of circular economy, sieved abrasives could be reused as winter abrasives. Finally, to optimize these processes, the CNM could own a sifter for residual granular materials as well as for compost.

Recovery of municipal biosolids

The water flow analysis revealed that municipal biosolids are produced in Mistissini. However, the latter are not presently recovered. It would be beneficial for the village to locally recover these fertilizing residual materials. For example, they could be used to revegetate the TL once covered.

Recovery of clean wood

The ecocentre is currently collecting clean wood and wood materials. A small portion of the wood is ground and mixed with organic matter when it is recovered. Nonetheless, most of the wood is landfilled in the TL. Thus, there is no collection process for these materials. It would then be interesting to find solutions to recover the wood.

Action plan to optimize material circularity in Mistissini

The action plan created for the Cree village of Mistissini identifies circular economy strategies and opportunities that could be implemented by the community. This action plan results from the MFA, residual materials characterization work as well as the interviews done with Mistissini's ICI.

The action plan, which includes eight specific actions, outlines the actions that could be implemented along with a schedule as well as an estimate of the investment necessary for implementing them.

Englobe chose to further analyze some of the circular economy solutions presented previously. The actions described within the action plan have been selected to get a broad picture of Mistissini and involve as many circular economy strategies as possible. Some of these may imply several solutions. Nevertheless, although not all circular economy strategies have been selected for the action plan, all the other strategies presented previously must be analyzed to validate the relevance of their implementation.

| Action | Description of the action | Priority level | Budget estimate |
|--------|--|----------------|-----------------------------------|
| 1 | Improvements to the ecocentre | Priority | Between \$100,000 and \$1,000,000 |
| 2 | Management of the products concerned by EPR | Priority | Less than \$25,000 |
| 3 | Compost production optimization | Priority | Between \$25,000 and \$100,000 |
| 4 | Creation of a space for donating and reuse | Priority | Between \$25,000 and \$100,000 |
| 5 | Residual granular material recovery | Priority | Less than \$25,000 |
| 6 | Compost recovery | Priority | Less than \$25,000 |
| 7 | Development of new outlets for wood | Lower priority | Variable, depends on the project |
| 8 | Development of IAE tools for organic matter collection | Lower priority | Less than \$25,000 |

Recommendations

Several examples of projects that were carried out show that it is possible for the community to be united to reduce resource consumption as well as share the existing tools and resources. Local stakeholders should collaborate to start and prioritize regional projects with the different ICI.

It is recommended for the Mistissini community to create a circular economy committee.

When choosing the actions to be implemented, the existing funding programs could be decisive. In addition to providing funding, these programs may sometimes provide specialized resources to help implement projects. The recommendations specific to the actions suggested are as follows.

| Action | Description of the action | Priority level | Summary assessment of the investment and recommendations |
|--------|-------------------------------|----------------|--|
| 1 | Improvements to the ecocentre | Priority | Requires a significant investment at the beginning to reorganize storage areas as well as create a management protocol for input and output materials. Since there is already an ecocentre that is operational and known by everyone in Mistissini, little efforts and few costs will be required to operate the ecocentre itself. |

| Action | Description of the action | Priority level | Summary assessment of the investment and recommendations |
|--------|--|----------------|--|
| 2 | Management of the products concerned by EPR | Priority | Requires a moderate investment since it mostly consists of communicating with the different RMO and undertake the necessary steps to become an official collection point. Very beneficial to the CNM and especially for the ecocentre since the output of the materials concerned by EPR will be simplified. |
| 3 | Compost production optimization | Priority | Requires little investment since it mostly consists of implementing procedures and protocols to optimize compost quantities and quality. These actions could be quickly implemented at low cost. |
| 4 | Creation of a space for donating and reuse | Priority | Requires a voluntary investment from the community. Normally not expensive but could require storage capacities for objects. Also requires reception logistics, inventory management and purchases. The investment could be significant, depending on the community's goals. |
| 5 | Residual granular material recovery | Priority | Requires some studies to correctly characterize the type, quality and quantity of granular materials that could be recovered. Requires obtaining environmental authorizations. The investment may vary based on the volume of the aggregates produced. |
| 6 | Compost recovery | Priority | Simply requires an implementation step and little costs. |
| 7 | Development of new outlets for wood | Lower priority | First studies quickly obtained with at low cost. Implementation requiring more time and significant costs to carrying out recovery and diversion of wood from landfill. |
| 8 | Development of IAE tools for organic matter collection | Lower priority | Simply requires an implementation step. An awareness campaign has already been done in the past, which could be used as a basis for these new IAE tools. Requires little costs and could change habits within the community that could be beneficial for quality of the compost produced. |

Throughout the study, some circular economy solutions that have been identified are not presented in the action plan. The reader could thus refer to Section 5 of this report to see the other possible actions. However, this report focused on eight actions with significant impacts or that can be quickly implemented. If these actions are implemented, they will have an influence on resilience and reduction of the community's environmental footprint.

Conclusion

Data collection on Mistissini's territory helped identify inputs, outputs and stocks to carry out an MFA according to three main flows: energy, water and consumer products. Mistissini's MFA reveals linear flows, which means that little action regarding circular economy is currently in place.

The information coming from the MFA helps identify circular economy solutions that could be implemented by the community. From these solutions, eight specific actions divided into four circular economy strategies have been analyzed. Other actions could be raised and analyzed by the members of the community. The implementation of the actions promoting circular economy may limit the quantity of natural resource imports and therefore reduce environmental releases. Moreover, the implementation of strategies will optimize the use of the resources within the Mistissini community.

Successful transition from a linear economy to a more circular economy depends on the involvement of community members. The remote location of Mistissini from the major urban centres implies that challenges may be significant. However, the possibility to reduce product and energy imports through the actions suggested in this document could increase the sense of belonging to the region while reducing the impacts of residual material sent to the landfill or resource loss in high demand in Quebec and elsewhere in Canada. Circular economy implementation also increases resilience of these communities having to implement mechanisms and actions when supply disruptions happen to address resource loss.

Examples of actions supported by local stakeholders, such as CNM's initiatives on residual materials management (e.g. purchase of an industrial rotating composter), reveal a willingness to act and these actions should be promoted.

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ABBREVIATIONS

| | |
|--------------------|---|
| CAE | Business Development Centres |
| CAPI | Canadian Agri-Food Policy Institute |
| CC | Childcare centres |
| CERMIM | Centre de recherche sur les milieux insulaires et maritimes |
| CHTISB | Cree Hunters and Trappers Income Security Board |
| CIRAIG | International Reference Center for Life Cycle Assessment and Sustainable Transition |
| CIRANO | Centre interuniversitaire de recherche en analyse des organisations |
| CNG | Cree Nation Government |
| CNM | Cree Nation of Mistissini |
| CO ₂ eq | Carbon dioxide equivalent |
| CRD | Construction, renovation and demolition |
| CSSS | Health and social services centre |
| CTTÉI | Centre de transfert technologique en écologie industrielle |
| CVBU | Centre de valorisation du bois urbain |
| DMO | Designated management organization |
| EFC | Économie de la fonctionnalité et de la coopération |
| EIJBRG | Eeyou Istchee James Bay Regional Government |
| EPR | Extended producer responsibility |
| EPRA-Québec | Electronic Products Recycling Association of Québec |
| EQA | <i>Environment Quality Act</i> |
| FCM | Federation of Canadian Municipalities |
| FNQLEDC | First Nations of Quebec and Labrador Economic Development Commission |
| FNQLSDI | First Nations of Quebec and Labrador Sustainable Development Institute |
| GHG | Greenhouse gases |
| GMF | Green Municipal Fund |
| HHW | Household hazardous waste |
| IAE | Information, awareness and education |
| ICI | Industrial, commercial and institutional establishments |
| INAC | Indigenous and Northern Affairs Canada |
| Institut EDDEC | Institut de l'environnement, du développement durable et de l'économie circulaire |

| | |
|---------|--|
| IPD | Institute for Product Development |
| JBNQA | James Bay and Northern Quebec Agreement |
| MEDDE | Ministère de l'Écologie, du Développement durable et de l'Énergie |
| MEIE | Ministère de l'Économie, de l'Innovation et de l'Énergie |
| MELCC | Ministère de l'Environnement et de la Lutte contre les changements climatiques |
| MELCCFP | Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs |
| MFA | Material flow analysis |
| MFFP | Ministère des Forêts, de la Faune et des Parcs |
| MRNF | Ministère des Ressources naturelles et des Forêts |
| MTMD | Ministère des Transports et de la Mobilité durable |
| PTOMBC | Program for the treatment of organic matter through biomethanization and composting |
| QBCRA | Quebec Beverage Container Recycling Association |
| RBQ | Régie du bâtiment du Québec |
| RLIRM | <i>Regulation respecting the landfilling and incineration of residual materials</i> |
| RMO | Recognized management organization |
| SADC | Community Futures Development Corporation |
| SOGHU | Société de gestion des huiles usagées |
| SPN | Société du Plan Nord |
| SWOT | Strengths, weaknesses, opportunities and threats |
| TEQ | Transition énergétique Québec |
| TL | Trench landfill |

Glossary

| |
|---|
| Material flow analysis |
| The material flow analysis (MFA) of a given system (territory, sector, activity, etc.) aims to quantify the flow of materials generated through the system as mass or energy. An MFA firstly requires delineating the system analyzed for which inflows, outflows and stocked flows are quantified. The resulted are then analyzed to characterize the system in terms of its material needs, exchanges with other systems, external dependence, environmental impacts, etc. (Ministère de l'Écologie, du Développement durable et de l'Énergie [MEDDE], 2014). |
| Circular economy |
| A production, exchange and consumption system aiming to optimize resource use in every stage in the life cycle of a product or service through a circular approach, reduce the environmental footprint and contribute to the well-being of individuals and communities (Pôle québécois de concertation sur l'économie circulaire, 2016). |
| Linear economy |
| An economic model used since the Industrial Revolution focusing on extracting, processing as well as using resources and then throw them away at the end of their useful life (take-make-waste) without considering how to reduce the quantity of resources entering the system or the amount of waste leaving it (Ellen MacArthur Foundation, n.d.). |
| Output |
| Product exported for consumption, use, recycling or recovery outside the MFA boundaries or released into the environment (e.g. residual materials for disposal). |
| Material flow |
| The sequence of a product or material from its introduction within an MFA (input), through its use, to its output from the system or released into the environment (output). |
| Input |
| All resources, materials or objects produced within the MFA boundaries (domestic extraction) or coming from the outside of the MFA boundaries that are imported for consumption or use (imports). |
| Trench landfill |
| A residual materials management site developed in accordance with the requirements of the <i>Regulation respecting the landfilling and incineration of residual materials</i> (RLIRM) to provide a disposal method suitable for small municipalities and remote or isolated territories (<i>Environment Quality Act</i> [EQA], chapter Q-2, r. 19) (Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs [MELCCFP], 2022a). |
| Waste sorting and recovery centre |
| A place where goods and materials are collected, recovered and resold on a given territory. |
| Stock |
| The difference between the quantities of materials entering and leaving a territory, corresponding to the net accumulation of materials within the territory (e.g. building and road infrastructure). |

Category I lands

Lands allocated to the Cree communities. The Gouvernement du Québec retain certain rights over these lands, particularly subsurface rights.

Category I lands are divided as follows:

- “Category IA lands: Québec retains the ownership of these lands, but their administration, management and control has been transferred to the Government of Canada, for the exclusive use and benefit of the Cree First Nations.”
- Category IB lands: The collective ownership of these lands has been transferred by the Gouvernement du Québec to Cree landholding corporations that administer the lands and may grant rights on them. These lands may not, however, be sold or ceded except to Québec.”

(Eeyou Istchee James Bay Regional Government [EIJBRG], 2023a)

Category II lands

The Crees have exclusive hunting, fishing, and trapping rights there. These lands, which are public lands in the domain of the State may be developed for other purposes, on the condition that the parcels of land affected are replaced or compensated for. (EIJBRG, 2023a)

Category III lands

The Regional Government is responsible for managing Category III lands (public lands in the domain of the State). The latter cover a total area of approximately 277,000 km² and are located between the 49th and 55th parallels. The Crees have exclusive trapping rights on these lands (except in the southern zone) as well as certain non-exclusive hunting and fishing rights and benefit from an environmental and social protection regime. Category III lands include all the territory lands covered by the JBNQA located south of the 55th parallel and are not included in other land categories (EIJBRG, 2023a).

1 Project background

In summer 2021, RECYC-QUÉBEC commissioned Englobe to perform a material flow analysis (MFA) to develop an action plan promoting circular economy in northern communities and a mining company. The project is supported by three partners, which are RECYC QUÉBEC, the Société du Plan Nord (SPN) and the Ministère des Ressources naturelles et des Forêts (MRNF). Although, circular economy has been studied for a few years in Quebec, no large-scale study has been performed on this concept in Quebec so far among northern communities or mining companies operating in the region.

This project is part of the government's approach used to identify optimization solutions for the use of certain materials to promote circular economy north of the 49th parallel. This mandate focuses on six communities as well as one mining company, all located north of the St. Lawrence River and the 49th parallel. These study subjects were selected based on their interest and regional representativeness.

Each study participant volunteered to take part in the project. The Cree village of Mistissini (Mistissini) expressed interest in participating in this study.

In this project, MFA has been used as a tool for identifying material flows with development potential from a circular economy perspective. This analysis aims to quantify the mass, volume and energy of the material flows generated by a given system (territory, sector, activity, etc.). The results are then analyzed to characterize the system in terms of its material needs, exchanges with other systems, external dependence, environmental impacts, etc. (Ministère de l'Écologie, du Développement durable et de l'Énergie [MEDDE], 2014).

The MFA performed in Mistissini consists of a balance sheet based on a quantitative approach of the material flows entering and leaving the community's territory. This analysis is therefore based on the use of the concepts of inputs and outputs according to the principles of conservation of mass and energy. As part of this project, the MFA is a tool used to understand and outline the dynamics and interactions of the various resources and materials imported, extracted, used, released or exported at the scale of the Mistissini territory.

The MFA is also based on data collected during a characterization of the residual materials in the trench landfill (TL) of the Mistissini community. Both the MFA and the residual materials characterization made it possible to identify as many inputs and outputs as possible with a view to improving understanding of local resource management and thereby making it easier to identify potential circular economy solutions and develop an action plan.

This report presents the results of both the MFA and the residual material characterization that led to the development of an action plan specific to Mistissini. This plan will enable the community to continue its efforts to optimize its resources and reduce the quantity of materials disposed of in its landfill. The circular economy actions suggested in the action plan could also boost the economy while considering the ecosystem-carrying capacity.

Although the study is specific to Mistissini, the circular economy solutions described in this report may guide or inspire public and provincial authorities for promoting the emergence of similar initiatives within other communities.

1.1 Selection of Mistissini

The mandate called for the selection of a Cree community in Eeyou-Ishtchee. In the past few years, Mistissini implemented a wide range of actions relating to residual materials management to reduce the volumes of these materials landfilled at the two Mistissini trench landfills. These actions include the opening of an ecocentre and the implementation of a recyclable and organic matter collection program. Then, these initiatives led the community to be interested in developing local circular economy projects.

The Mistissini community represents well achievable potential circular economy actions among communities in Eeyou Ischtee connected by the provincial road network to its demography, position close to non-Indigenous communities and dynamism regarding its residual materials management. Finally, both the band council of the Cree Nation of Mistissini (CNM) and the Cree Nation Government (CNG) expressed their interest in this analysis to be carried out on their territory and provided resources to simplify its execution. The selection of Mistissini was unanimous since it is the only community of this region that expressed its interest in the project.

Moreover, Mistissini is a good representative sample of the region for several reasons:

- Its demography, which is typical of the region;
- Its central geographical location in the region;
- Its dynamism concerning residual materials management (initiatives for recyclable material selective collection, organic matter collection, etc.).

1.2 Objectives

The study aims to meet two objectives set by the project partners:

- Raise awareness among six northern communities as well as a mining company located north of the 49th parallel and mobilize them to act as a circular economy testing ground;
- Conduct an MFA and a residual materials characterization for each selected community as well as the mining company to identify opportunities for reducing and optimizing the use of resources. These opportunities were formulated based on the circular economy strategies and were designed to generate savings, support community life and improve environmental quality.

1.3 Project timelines

The project took place over a 17-month period, from fall 2021 to spring 2023 (Table 1).

Table 1: Project timelines

| Activity | Fall 2021 | Winter 2022 | Spring 2022 | Summer 2022 | Fall 2022 | Winter 2023 | Spring 2023 |
|--|-----------|-------------|-------------|-------------|-----------|-------------|-------------|
| Select participating communities | X | | | | | | |
| Kick-off meeting with Mistissini representatives | | X | | | | | |
| Formulate methodology | | X | | | | | |
| Plan field visit | | | X | | | | |
| Send out surveys to industrial, commercial and institutional establishments (ICI) | | | X | | | | |
| Carry out the field visits (residual materials characterization, ICI visits, etc.) | | | | X | | | |
| Process information obtained during the field visits, including the ICI visits | | | | X | X | | |
| Develop circularity scenarios and the action plan | | | | | X | | |
| Prepare the report | | | | | X | X | |
| Submit the report to project partners, and the community | | | | | | | X |

2 Description of the community

2.1 Community and territory

The Cree village of Mistissini is the place where the CNM is established, an indigenous community in northern Quebec located south of the territory of Eeyou Istchee James Bay. The members of the CNM are the Crees from lands (*nuchimiiniiyuuch*), which are different from the Crees from coastal communities (*winipakiiyuuch*) from cultural and linguistic points of view. Mistissini is located on Category IA lands, which are lands that are exclusively used by the members of the CNM according to the James Bay and Northern Quebec Agreement (JBNQA) (Comex, 2021). The latter occupies and manages a much wider territory of more than 124,000 km² extending from Lake Mistassini to the north-east to the Caniapiscau Reservoir. There are several multi-family campsites on this large territory that can be reachable by snowmobile, craft and helicopter or bush airplane.

The village of Mistissini, which is about a hundred kilometres north from Chibougamau, can be reached via Route 167 and is served by the Chibougameau/Chapais Airport that is located about 110 km southwest (Figure 1).



Figure 1: Location of Mistissini

2.2 Rights and land use

The territory of the CNM is divided into three land categories (I, II and III) based on the exclusive or non-exclusive land use classification by community members under the James Bay and Northern Quebec Agreement (JBNQA). This large area includes 81 trapping territories (traplines) to which every member of the community is associated with, normally through filiation or marriage, that is of ancestral spirit. The CNM occupies its traditional lands at various levels, based on their occupations, jobs within the village or in Chibougamau as well as their family situation. For example, the activities carried out on traplines are governed by a traditional structure where some people have different social roles for maintaining environmental stewardship on their territory.

2.3 Demographic profile

Data from Indigenous and Northern Affairs Canada (INAC) makes it possible to correctly estimate the Cree population of Mistissini while it is harder to estimate the non-Indigenous population who is permanently living there. There are also a lot of health care and construction workers who are temporarily living in Mistissini. Based on the 2021 census, the population consisted of 3,731 inhabitants.

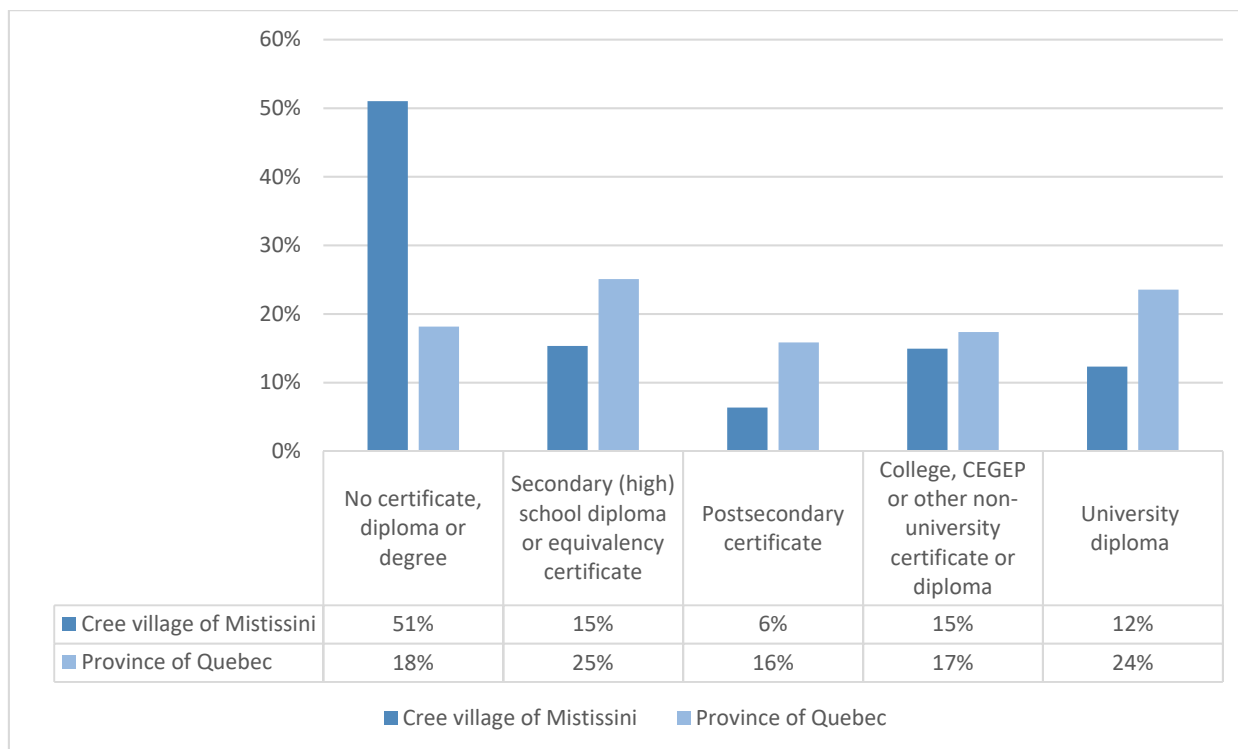
According to Statistics Canada (2022), the population growth of this community is 2.1% per year since 2006, which is a significantly higher rate than the provincial average rate (0.07%). Rapid population growth in Mistissini results in significant growing challenges relating to dwelling, health care and public service needs. The demographic profile of the CNM is also different from the rest of Quebec's demographic profile (Table 2). Indeed, the population under 20 years is overrepresented in Mistissini since the median age is 29 years, which is well below the rest of Quebec's median age (43 years).

Table 2: Population proportion by age group

| Geographic entities | Year of census | Total population | Population proportion by age group (proportion in %) | | | |
|----------------------------|----------------|------------------|--|-----------------|-------------------|-------------------|
| | | | 0-19 years | 20-64 years | 65 years and over | Median age (year) |
| Cree village of Mistissini | 2016 | 3,510 | 1,380 (39%) | 1,945 (55%) | 185 (5%) | 26.4 |
| | 2021 | 3,731 | 1,441 (39%) | 2,020 (54%) | 270 (7%) | 29.0 |
| Québec | 2016 | 8,164,361 | 1,763,080 (22%) | 4,906,085 (60%) | 1,495,195 (18%) | 42.5 |
| | 2021 | 8,501,833 | 1,820,760 (21%) | 4,927,545 (58%) | 1,753,530 (21%) | 43.2 |

References: AADNC (2016) and Statistics Canada (2022).

More than 50% of the inhabitants of Mistissini do not have a degree or diploma (Figure 2). About 15% of them have a secondary school diploma or the equivalent and 15% of them have a college diploma. Main Mistissini employers are related to the education and health care sectors. Indeed, the largest employers are the Cree School Board and the Cree Board of Health and Social Services of James Bay.



Source: Statistics Canada, 2021

Figure 2: Education level of the population of 15 years and over based on the highest diploma owned (Statistics Canada, 2021)

2.4 Key and local stakeholders

Due to their role in residual materials management or circular economy and based on their respective mandates, the following local stakeholders have been chosen as part of the MFA in Mistissini: the CNM, the CNG and the Eeyou Istchee James Bay Regional Government (EIJBRG).

The environmental mission of the CNG is to monitor, implement, coordinate and provide environmental advice on the Cree territory in accordance with agreements and legislation.

As for the CNM, it manages daily the various environmental aspects in the field, such as TL, compost and ecocentre operations.

CNM and CNG’s logistical support made it possible to efficiently contact the various local stakeholders as well as some facilitating organizations from this field, which improved data collection for the MFA. These organizations also identified the main generators of residual materials, provided a detailed picture of the existing residual materials management methods and provided data on the built environment of the community.

Regionally, Mistissini is part of the Eeyou Istchee James Bay region. The EIJBRG is a joint regional government composed of Crees and Jamésiens, enabling both communities to significantly contribute to the territory’s prosperity and its promising future.

As mentioned on the organization’s website: “[...] powers vested in the Regional Government allow for greater participation in the development of the region by creating favourable conditions in which to carry out mobilizing projects. The new government acts as a growth catalyst, capable of identifying development potential for the territory and its natural resources, based on its specific needs, by establishing inclusive, respectful relations between Jamésiens and Crees” (EIJBRG, 2023b). In a circular resource approach, the EIJBRG is therefore a stakeholder.

2.5 Transportation infrastructures

Mistissini can be reachable by road. There is no airport in this region. The nearest airport is the one in Chibougamau-Chapais that is located about 110 km to the south. As for the railway, Quebec's railway network is not connected to Mistissini.

Given the geographical location of the community, which is approximately in the centre of the province, there is obviously no dock for goods transportation.

2.6 Economic and institutional activities

Almost 82 institutions, businesses and organizations in 2019 are registered in the enterprise registrar of the Société du Plan Nord in Mistissini (Table 3), most of them having fewer than 20 employees (Table 4). The comprehensive list of ICI is presented in Appendix A. A significant portion of Mistissini's population also participates in traditional activities related to the management of their ancestral territories. Therefore, from 15 to 18% of the Cree population in Eeyou Istchee are beneficiaries of the program managed by the Cree Hunters and Trappers Income Security Board (CHTISB, 2018).

Table 3: Number of businesses in Mistissini by sector

| Sector of activity | Number of businesses |
|-----------------------------------|----------------------|
| Food industry | 1 |
| Aviation | 2 |
| Retail trade | 14 |
| Construction | 14 |
| Education | 3 |
| Mining extraction | 3 |
| Forestry | 3 |
| Accommodation | 1 |
| Community organizations | 8 |
| Religious organizations | 2 |
| Catering | 4 |
| Maintenance services | 1 |
| Childcare | 2 |
| Financial services | 1 |
| Professional services/Consultants | 4 |
| Public services | 8 |
| Health care | 1 |
| Telecommunication | 3 |
| Transportation | 7 |
| Total | 82 |

Reference: SPN, 2022.

Table 4: Number of employees in Mistissini per number of businesses

| Number of employees | Number of businesses |
|---------------------|----------------------|
| 1 to 4 | 39 |
| 5 to 19 | 24 |
| 20 to 49 | 18 |
| 100 to 199 | 1 |
| Total | 82 |

Reference: SPN, 2022.

There are then various businesses and institutions in Mistissini that meet the needs of the population such as a grocery store, a sport complex and several daycares. There are also three convenience stores, two of which include service stations, within the community. Furthermore, one of the convenience stores sell prepared meals, such as sandwiches, muffins, pizza and various snacks. In addition, several company owners have more than one company in Mistissini.

Two schools from the Cree School Board – the Voyageur Memorial Elementary School and the Voyageur Memorial High School – serve the community, which respectively have 500 and 400 students. These have classrooms, offices and sports infrastructure, but they have no cafeteria. They also own almost a hundred apartments that can accommodate school management and teaching staff.

Finally, a health centre within the community (Community Miyupimaatisiun Centre) provides various services, such as a walk-in clinic, medical imaging, a pharmacy, mental health care, dental services, an emergency department, etc. The nearest hospital is in Chibougamau. An ambulance is available within the community to transport patients to the hospital in emergency situations. Like the Cree School Board, the health-care centre also has almost a hundred apartments to accommodate its staff.

Mistissini is constantly developing. New development projects are carried out from year to year, including a new planned residential area, over the next few years, west of the current village, on the other side of a narrow extension of Lake Mistassini, where a sandpit can be found.

2.7 Current management of residual materials

In 2013, the Cree village of Mistissini developed a plan to manage its residual materials to extend the life of the landfill used by the community and to recover recyclable and compostable materials (Dessau, 2013). Since the 1970s, several landfills have reached their capacity and have been closed on Category I lands where provincial regulation does not apply. In 1995, a TL with an area of about 137 000 m² has been implemented and is currently close to reaching its maximum capacity. A second site is operational, but it is not suitable for annual trench landfill. Since 2012, several solutions have been tested by the CNM to implement a new strategy to manage residual materials. The action plan includes new actions concerning residual material collection, the development of a new and more suitable landfill, household hazardous waste (HHW) collection, recyclable materials collection and sorting as well as an information, awareness and education (IAE) program for the members of the community.

2.7.1 Recyclable materials from the selective collection

A truck used for collecting recyclable materials once a week serves every house and ICI. It should be noted that this truck cannot directly collect wheeled bins. Indeed, it has a front-loading container of about 4 yd³ and workers must empty these bins in the container that is attached to the front of the truck.

Materials are then transported to a garage owned by the CNM to be sorted by one or two employees of the community. This first sorting involves removing contaminants and separate cardboard. A

press (Figure 3) compact cardboard in bales while other recyclable materials are placed in two containers dedicated to this purpose. Bales are then temporarily stocked in a container (Figure 4).



Figure 3: Cardboard press



Figure 4: Cardboard bales stocked in a container

About once a week, a truck owned by Groupe Ungava come to pick up the containers holding the recyclable materials and cardboard bales. The latter are transported to the transload centre of Chibougamau. The quantity of materials diverted from landfill is about 20 t of recyclable materials per week. It should be noted that the cost related to the transportation of these materials increases every year. It is then a growing concern for the community.

2.7.2 Organic matter

The CNM implemented the collection of organic matter. When this service was implemented, IAE tools have been sent to all community residents, such as leaflets and refrigerator magnets with explanations. Moreover, a “green patrol” also went door to door to raise public awareness. Based on our communications with the CNM, the residents would be the main participants of this collection and few ICI used this service. However, during the on-site visits made by Englobe, some major generators expressed their interest in taking part of it (hotel, restaurants, etc.).

The organic matter collected is processed through an industrial rotating composter designed by the company Brome Compost inc. (Figure 5).



Figure 5: Rotating composter used in Mistissini

The composter was not in operation during the on-site visit (July 2022). The collection was suspended due to a mechanical failure of the composter that forced its shutdown during winter 2022. Previously, it has been used for a period of six months, which led to the production of about 20 t of compost. The collection of organic matter was supposed to begin again in the next few weeks following the on-site visit made by Englobe.

According to some retailers, the quantity of organic matter generated by ICI is sometimes large. Additional collections and/or equipment would then be necessary to provide optimal services and be able to process all the organic matter generated. The employees of the CNM also add woodchips – acting as a bulking agent for the compost – to the organic matter collected. Englobe noted that an additional step would be necessary during processing (e.g. sieving) to remove any inorganic contaminants from the compost (Figure 6).



Figure 6: Compost produced in Mistissini

At this time, there is no outlet regarding compost. It is simply stocked close to the composter. However, a possible northern greenhouse project could be carried out in Mistissini and that compost could be used within this project.

As for sludge, it is removed from aerated ponds about once every 15 years. The last cleaning was performed in 2019, in which the sludge has been mixed with ashes and spread in the former TL of the community. This material mixture allowed the creation of a vegetation cover in the former TL.

2.7.3 Other residual materials

Since 2017, there is an ecocentre (Figures 7 and 8) opened for every resident and retailer of the community. This ecocentre mainly collect the following materials:

- Tires;
- Propane tanks;
- Oils;
- Paints;
- Wood;
- Household appliances;
- End-of-life vehicles;
- Plastic;
- Metals;
- Cells and batteries;
- Electronic products.



Figure 7: Reception building of the ecocentre

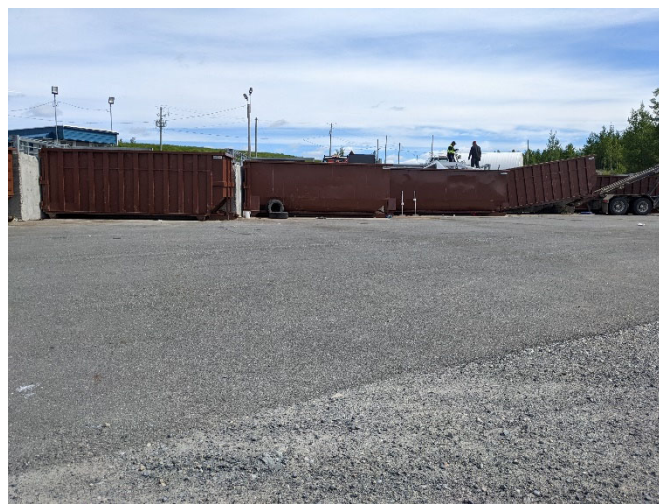


Figure 8: Containers found in the ecocentre

Based on official registers, most of the organizations managing the materials covered by extended producer responsibility (EPR) are not located in Mistissini, except for the Société de gestion des huiles usagées (SOGHU) whose collection point is found in the ecocentre of Mistissini. Moreover, a RECYC-QUÉBEC's collection point for managing tires is also found in this ecocentre. As for the other materials covered by EPR, the closest official collection point is found in the ecocentre of Chibougamau, about 70 km to the south (Table 5). It should be noted that paints are collected in the ecocentre of Mistissini. Nevertheless, according to the Éco-Peinture's website, the closest official collection point would be in Chibougamau.

Table 5: Management of EPR products and tires

| EPR-covered products and tires | Recognized management organization | Nearest official drop-off point |
|---|---|---------------------------------|
| Mercury lamps | RecycFluo | Chibougamau's ecocentre |
| Electronics | EPRA-Québec | Chibougamau's ecocentre |
| Oils, coolants and antifreeze as well as their filters and containers | Société de gestion des huiles usagées (SOGHU) | Mistissini's ecocentre |
| Household appliances and air conditioners | GoRecycle | Chibougamau's ecocentre |
| Paints and paint containers | Éco-Peinture | Chibougamau's ecocentre |
| Batteries | Appel à Recycler/Call2Recycle | Mistissini's post office |
| Tires ¹ | RECYC-QUÉBEC | Mistissini's ecocentre |

¹ Tires are not designated as an EPR product and are handled directly by RECYC-QUÉBEC.

As for tires, the current collection frequency is not suitable in Mistissini. As a result, tires are accumulating on the site. Also, the way these are stored could have an impact on the collection frequency and the number of tires collected. RECYC-QUEBEC, which manage the *Programme québécois de gestion des pneus hors d'usage*, has different requirements in its collection points, such as scrap tire condition and accessibility as well as any other terms set by RECYC-QUÉBEC. To optimize the way community's scrap tires are stored, the CNM must follow these requirements.

Englobe also noted issues related to the storage of hazardous materials (paints, oils, etc.). The latter are sometimes not collected by the organizations managing them. Reasons for not collecting household hazardous waste (HHW) were that some materials were not identified or in disarray or that some of them showed signs of leakage. Finally, some materials collected and sorted within the ecocentre are nevertheless landfilled, as it is the case for wood, which is not collected. HHW sorting is promoted within the community through various IEA campaigns, including the creation of a "green patrol", meeting residents at their homes and encouraging them to take part in these initiatives (Macleod, 2018).

In addition, street cleaning work carried out in spring in Mistissini result in a significant amount of residual granular materials (Figure 9). The community is currently searching for new outlets regarding this material.



Figure 9: Granular materials generated during street cleaning work

The community generated various types of waste, such as asphalt, concrete and wood waste. A small portion of wood waste is used during compost production. Wood waste acts as a bulking agent when the compost is in production. These materials are stocked a few kilometres from the community. Moreover, the CNM undertakes the treatment of contaminated soils in this area (Figure 10).



Figure 10: Treatment of contaminated soils

2.7.4 Disposal of residual materials

The residual materials to be disposed of are collected once a week and then carried to the TL located about 10 km from the community. At this time, this second TL (Figure 11) is filling more quickly than expected. At the very beginning, the TL's operating life was estimated at about 30 years, but, after only 5 years of operation, the CNM believes that the TL will reach its full capacity in about 15 years, which is a total operating life of 20 years. It is then another major concern for the community.



Figure 11: TL of Mistissini

3 Methodology

3.1 MFA

The purpose of an MFA of a given system (territory, sector, activity, etc.) is to quantify its system-generated material flows as mass or energy. The first requirement of an MFA is to determine the boundaries of the system concerned and quantify its inflows, outflows and stocked flows. The MFA results are then analyzed to characterize the system in terms of its material needs, its exchanges with other systems, its external dependence or its environmental impacts.

The MFA then firstly implies to collect data to establish the most accurate picture of the situation on which the MFA is based.

Finally, it is important to remember that the purpose of the MFA is to help identify community's circular economy potentials in Mistissini.

3.1.1 Choice of an MFA

There are several methods to complete an MFA. In her essay called *L'analyse de flux de matières au Québec : méthodes et enjeux d'opérationnalisation dans une perspective d'économie circulaire* (Morris, 2016), Audrey Morris describes several methods to do so, including the one developed by Eurostat as well as the one designed by Peter Baccini and Paul H. Brunner.

Eurostat's "top-down" method (Morris, 2016) is based on macro data applied to a territory targeted for an MFA. This method is based on specific types of materials such as biomass, minerals and fossil energy. This method creates a kind of "black box" since it is solely based on the territory's inputs and outputs and it does not consider interactions within the territory itself. In addition, it does not consider water consumption, as it represents an overly large quantity, thus masking the other results (Morris, 2016). Finally, it also does not consider issues associated with low mass flows, even if such flows are rare or toxic (Morris, 2016).

For its part, Baccini and Brunner's "bottom-up" method (Morris, 2016), which was originally developed to describe and evaluate industrial processes. This method relies on detailed data to establish an accurate picture of the flows within a given system. It avoids the "black box" concept as it describes the various flows within the system. Baccini and Brunner's method is also based on activities, not only on types of materials.

As part of this mandate, the method chosen is a hybrid one based on both methods. Such a tailored method was used to conduct the MFA of the Brussels region in 2015 (EcoRes, 2015). It is also well suitable for the project's objectives since it identifies not only the community's main activities (no "black box"), but also materials related to these activities. Moreover, this hybrid method is also recommended when the aim of the MFA is to better understand the flow circulation in a target territory to assess whether it is possible to implement circular economy projects (Morris, 2016). This type of method was then preferred for the context of Mistissini.

Englobe's methodology focused on four parameters (or flows):

- Energy;
- Water;
- Materials extracted within the MFA boundaries;
- Consumer products.

All these flows are presented in the MFA to quantify them and understand how they behave in Mistissini's economic system. This exercise identified the main incoming (inputs), whether imported or extracted, outgoing (outputs), whether exported or released into the environment, as well as stocked (staying in the community) resources. As applicable, the flow dynamics obtained should also illustrate the loop of the outputs coming back to the community, thus circular.

3.1.2 MFA boundaries in space and time

The administrative boundaries of Mistissini (Figure 12), the participating community, represent the geographical boundaries used for the MFA.

The MFA covered the period from January 1 to December 31, 2021.

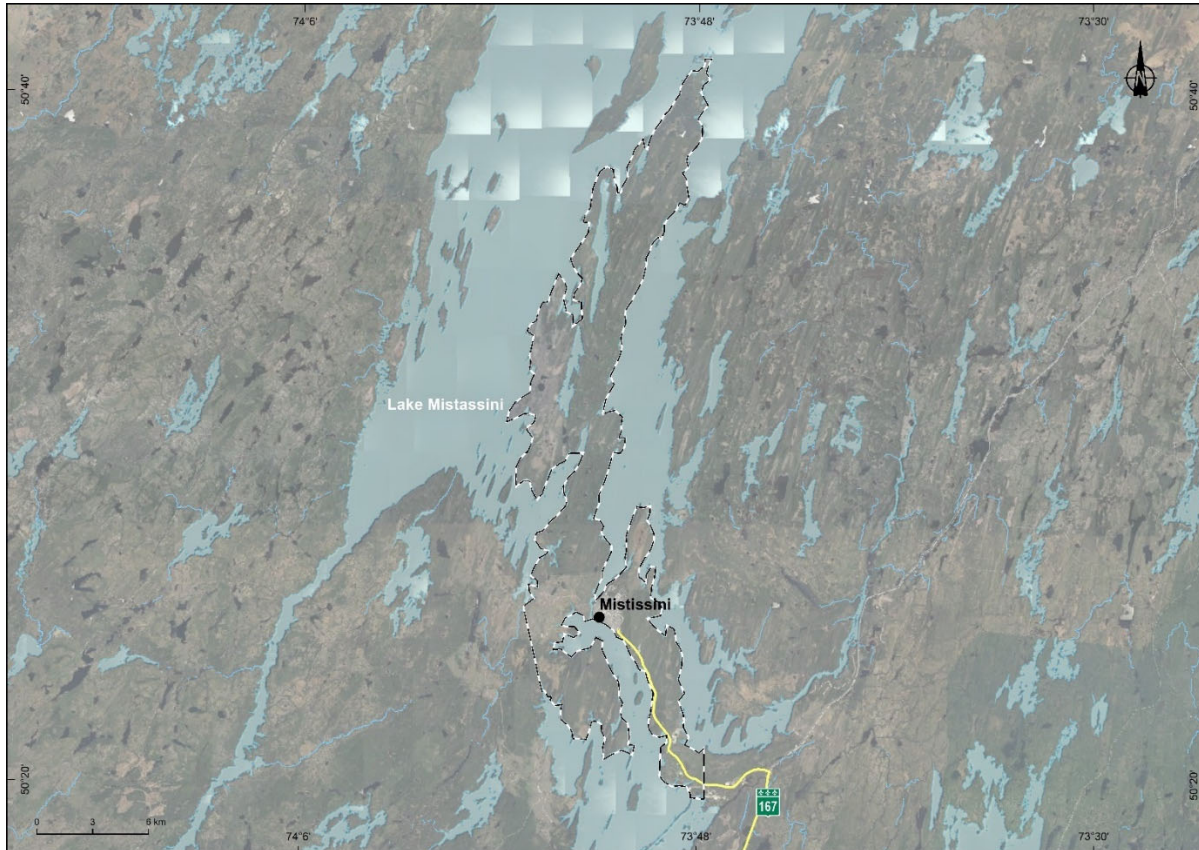


Figure 12: Mistissini's geographic boundaries

3.2 Data collection

Since the purpose of the MFA is to help identify community's circular economy potentials within Mistissini's territory, efforts made focused on the identification of the inputs and outputs specific to this village.

Two main approaches were used to collect the necessary data for the MFA: data collection with the territory's ICI to identify the types of inputs and outputs as well as a characterization of the residual materials disposed of at the TL of Mistissini to identify the types of outputs.

It should be noted that outputs managed by municipal authorities are generally weighed or quantified. For example, loads of recyclables, such as HHW and EPR products, are all weighed. As for materials

to be disposed of, they are generally also weighed on the landfill. Data coming from a recent study (Charmard, 2021) have been used for quantifying outputs.

3.2.1 ICI

Since the MFA was performed on a territory with a limited number of ICI, all the latter were approached to gather as much data as possible on purchases (inputs), residual materials management and releases into the environment (outputs).

To get the information regarding ICI's inputs and outputs, the following actions have been carried out:

- Submission of a questionnaire;
- Six-day visit in the community to meet several ICI and see public infrastructure.

3.2.1.1 Questionnaires

Three questionnaires were developed based on ICI sectors and one was developed for the CNM. The templates of the latter are found in Appendix B.

One questionnaire has been emailed to about 50 ICI within the territory to identify the different inputs and outputs related to their respective types of activities. These questionnaires focused on the material manufacturing processes occurring within the operations of these ICI as well as the by-products generated by their activities. A few questions relating to circular economy were also included.

The CNM received a questionnaire focusing on gathering information on water production, residual materials management, road work and the new buildings constructed on the territory. This questionnaire has not been filled out by the CNM, which may affect the accuracy of the MFA.

3.2.1.2 ICI visits

In July 2022, professionals from Englobe went to Mistissini.

The most active ICI in terms of resource consumption or residual material generation were asked to attend an information meeting. A total of 32 ICI have been met out of the 51 initially targeted. Of these, 18 agreed to participate in the project and subsequently responded to the questionnaire.

During this visit, Englobe's team then met with the main local stakeholders to complete with them the questionnaire previously sent and visit their sites.

Through these questionnaires and meetings, inputs of the ICI visited were identified, including the raw materials required by industries. As for businesses, inputs mainly are items intended for retail sale. Inputs comprise materials imported into the community as well as those from domestic extraction, within the community (Morris, 2016). Outputs were also identified.

3.2.1.3 Infrastructure visits

In addition to the meetings with ICI, Englobe also visited the residual materials management facilities, including the TL, the ecocentre, the transload centre for recyclable materials and the wastewater treatment facility. These visits helped gather information on how these outputs are managed.

3.2.2 Disposed-of residual materials characterization

To specify the types of outputs generated by the community, Englobe performed characterized the residual materials sent to the TL of Mistissini (July 7, 2022).

A sorting area has been set up in one of Mistissini's municipal garages. The material sampled was taken from a load of residual materials that were collected in around 20 residences. The sample coming from

Mistissini has been analyzed according to 42 categories of materials. Most of the waste in this sample was found in bags. The comprehensive characterization methodology is described in Appendix C.

3.3 Data processing

An MFA is designed to obtain overviews of entire communities. However, not all the ICI in Mistissini participated in the MFA. Extrapolations therefore had to be made using the data gathered through the questionnaires and the information available about each of them, including their sector, site area and number of employees. Combined data from ICI and extrapolations were used to quantify all Mistissini's inputs and outputs.

Data gathered from questionnaires and the characterization was processed and converted into data that could be used to establish Mistissini's material flow. The data processing was adapted to inputs and outputs.

Particular attention was paid to material quantification to prevent inputs and outputs from being counted twice (in more than one flow).

The information gathered through the questionnaires, ICI visits and the residual materials characterization has been processed and analyzed in an Excel database. Data were processed to simplify the identification of the sectors that may contribute to optimizing local economy circularity in Mistissini.

3.3.1 Conversion of data into weight values

The information gathered from the questionnaires and the visits to the ICI showed that data on inputs (mostly purchases) and outputs (products sold, residual materials, etc.) are generally not quantified in terms of mass. The data have been sometimes collected in the form of:

- Volume (e.g. waste and recycling bin volume, fuel tank volume, litres of fuel, etc.);
- Monetary value (e.g. annual purchases of food, toilet paper, etc.);
- Numbers (e.g., number of pallets of materials received, number of cardboard boxes, number of car batteries, etc.).

The first step was then to convert this information into weight values. Research was conducted to develop a conversion table for converting the collected data into weight values. For example, this table shows:

- The weight of specific objects (e.g., wood pallets, car batteries, cardboard boxes, vehicle tires, etc.). The values used came from the literature as well as from the characterization;
- The precise density of materials (e.g. oil, gasoline, diesel fuel, etc.). The values used came from the literature as well as from the characterization;
- The density of various categories of materials (e.g. household waste, mixed recyclable materials, etc.). The values used came from the literature as well as from the characterization;
- The monetary value conversion (\$) of specific objects into weight values. For this conversion, Englobe had access to purchase orders from grocery and convenience stores indicating the weight and price of purchased items. Cost-per-weight ratios (\$/kg) were calculated;
- The use of a common basis for measuring energy – in this case, the various energy sources (electricity, gasoline, diesel fuel, fuel oil, etc.) were converted into gigajoules.

3.3.2 Data annualization

After having converted the quantitative data into weight values, these were extrapolated for one year. This step was carried out taking into account the seasonal nature of the operations of some businesses and institutions not operating all year round (e.g. seasonal restaurants opened only during the summer tourist period).

3.3.3 Extrapolation based on response rate

The data and other information obtained by Englobe were processed to cover the entire territory of Mistissini, bearing mind that not all ICI participated in the study. This means that the data collected by the participating ICI must be extrapolated to represent the entire ICI sector in Mistissini.

An initial extrapolation considered the response rate or the representativeness based on the number of employees. The organizations that responded to the questionnaire represent approximately 345 employees. According to the SPN, there are about 608 jobs in Mistissini. Given that 345 employees were reached during the study, the working population's representativeness rate in Mistissini would be around 56%. An extrapolation was done to estimate the inputs of all this working population (100%).

To achieve this 100% representation, Englobe used two types of information, which are the number of ICI and the number of employees. The employee number variable was selected as being more representative. This representative proportion was then used to estimate the inputs of this entire working population in order to cover all ICI in the territory.

3.3.4 Output quantification and categorization

The data coming from a residual materials management study performed by Chamard in 2021 have been used to determine more precisely the quantity of some of the territory's outputs, which are those collected, recovered or disposed of.

In addition, the results of the residual materials characterization carried out on the TL site were also used to classify the outputs disposed of in the TL according to 42 categories of materials. For example, this analysis determined the amount of wood disposed of in the territory. The characterization results are shown in Appendix D.

3.4 MFA limitations

Englobe obtained data directly from some of the ICI of the community. However, where this was not possible, Englobe proceeded by estimation. In such cases, Englobe used estimation factors that are available and recognized in the literature. The data sources, which are indicated when appropriate, come from organizations (e.g. Statistics Canada) and provincial or federal departments. When no information was available for Quebec or Canada, international estimation factors were used.

3.4.1 Response rate

Most of the input data came from private companies, which represented the main obstacle in the execution of this MFA. Some companies may not have cooperated as effectively as possible in this analysis and may have refused to share certain sensitive information related to their activities (e.g. sales revenue). Where necessary, inputs and outputs were therefore estimated using publicly available assumptions and statistics.

Since a significant portion of the methodology relied on the questionnaires sent, the analysis could have been affected by a low ICI response rate. However, since the project implied a small community, the

total number of ICI remained relatively small and reminders as well as follow-ups were made. The largest generators of inputs and/or outputs have thus been met (including the completion of the questionnaires) during the visits made by Englobe's professionals in Mistissini.

3.4.2 Metals

In the case of consumer products, the questionnaire did not provide for a specific estimate of metal imports. Metals are mainly associated with vehicles and household appliances. Since the questionnaire was intended for ICI and given the absence of car dealers and appliance retailers, no metal-specific data were collected via the questionnaires.

To address this gap, Englobe used a metals-specific study prepared by the International Reference Center for Life Cycle Assessment and Sustainable Transition (CIRAIG) called *Métaux et économie circulaire au Québec – Analyse de flux de matières du cuivre, du fer et du lithium* (CIRAIG, 2017) was used. The latter provides a complete picture of an MFA made for metals, including their extraction, the production of metal objects as well as their use and the end of their useful life. For the purposes of this project, only the "use" and "end-of-life" parameters were used. Quantities were estimated based on Mistissini's population.

3.4.3 Inputs from outside Mistissini

Since the questionnaires were only intended for ICI, they did not include the goods purchased outside the community's territory (e.g. purchases made in a superstore in Chibougamau or in Saguenay), which represented another limitation for this study. These goods may include, among other things, food products, furniture, electronic devices or vehicles.

3.5 Data collection confidence level

The study reached most of Mistissini's working population through meetings, such as the community's main employer (the hospital centre), institutional activity representatives as well as representatives of the largest retailers. Moreover, the companies met operate a wide range of businesses (garage, restaurant, hotel, etc.). Several institutions were also met (childcare centre [CC], school, medical clinic and the CNM).

For all these reasons, Englobe believes that the level of confidence in the MFA is adequate – a level that reflects the consensus view of the project team. However, this confidence level cannot be interpreted as a specific percentage applicable to the data.

4 MFA results

This section describes the flow of materials and the different types of energy in Mistissini from an MFA perspective. As previously mentioned, the hybrid methodology used is a combination of the Eurostat as well as the Baccini and Brunner methods. This approach focuses on four main parameters (flows):

- Energy;
- Water;
- Consumer products.

A quarry is also in operation in Mistissini, but the CNM has no data regarding the quantity of materials extracted. This activity would have been found in the "extracted materials" category. Nevertheless, given the absence of quantitative data, the quarry and this category have not been included in the MFA. As for the other components, the MFA identifies inputs imported into the community (e.g. fossil fuels) and the ones directly extracted or created in the community (e.g. electricity produced through solar panels).

When these inputs are consumed, used or stocked, their consumption or use generates outputs that are either released into the environment (e.g., atmospheric emissions or landfilled waste) or exported outside the community (e.g. recyclables).

The following sections present the flow dynamics and an analysis of each of the parameters (energy, water and consumer products). The dynamics identifies the different types of inputs and outputs as well as the consumers and users, while the analyses describe, for example, the inputs breakdown and the relative importance of consumers and users (expressed in percentage). Finally, circularity elements are identified, then Sankey diagrams show each flow in detail by associating quantities of inputs and outputs with users.

4.1 Energy

Three types of energy are consumed in Mistissini:

- Electricity;
- Fossil fuels;
- Propane.

All the electricity consumed in Mistissini comes from Hydro-Québec's main electrical distribution network.

All petroleum products consumed in the community are imported. There are two gasoline service stations for vehicles. It should be noted that there is no natural gas distribution in the Mistissini's territory. As for the propane, it is mainly consumed by retailers (e.g. to heat a terrace).

4.1.1 Energy flow dynamics

Fossil fuels include fuels (gasoline and diesel fuel), which are not produced in Mistissini, but rather imported. These types of fuel are mainly available in the local service stations and are almost exclusively used for motor vehicles as well as motorized recreational vehicles (boats, all-terrain vehicles and snowmobiles).

All the electricity consumed in by the residents and ICI of the community comes from Hydro-Québec's network. It is then imported in Mistissini.

As for outputs, energy consumption generates releases into the environment (air emissions). The diagram in Figure 13 presents the energy flow dynamics in Mistissini.

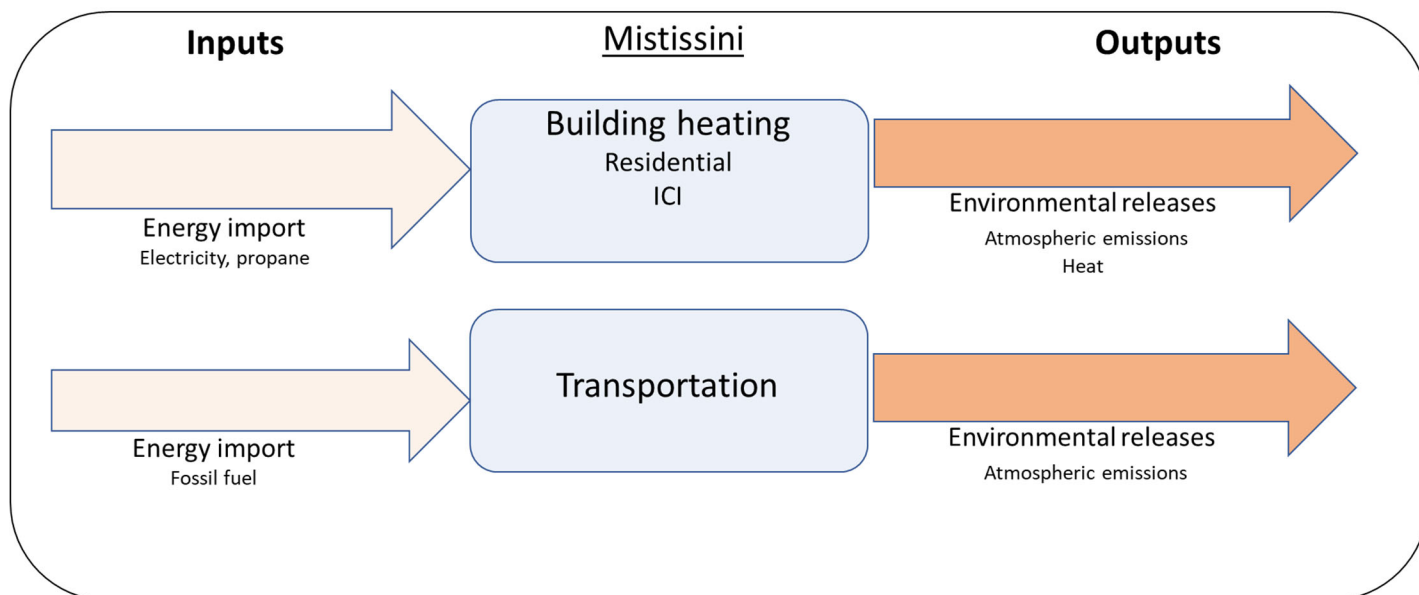


Figure 13: Energy flow dynamics in Mistissini

Figure 13 shows the types of energy (inputs), people using these types of energy (users) as well as releases (outputs) generated from their use. The analysis regarding quantities as well as the breakdown of energy consumption are detailed in Section 4.1.2.

4.1.2 Energy flow analysis

All the energy consumed by citizens and ICI in Mistissini is imported. The energy is mainly used for transportation, building heating and lighting as well as appliances and equipment (residential, commercial, etc.). The main outputs are air emissions, which are in the form of carbon dioxide equivalent (CO₂ eq). The energy flow analysis shows that the Mistissini community consumes about 437,000 gigajoules annually.

The types of energy used, according to their gigajoule equivalents, are shown in Figure 14. Based on the figure, the two main types of energy are electricity and petroleum products (gasoline and diesel fuel), which is the most consumed type of energy. Very small amounts of propane are also consumed.

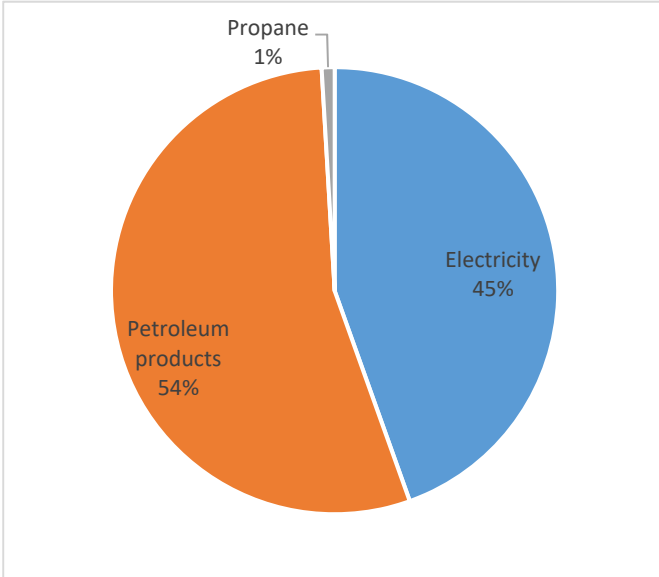


Figure 14: Types of energy consumed in Mistissini

Figure 15 divides the breakdown of energy consumption (gigajoules) into four sectors: residential, transportation as well as commercial, industrial and institutional activities.

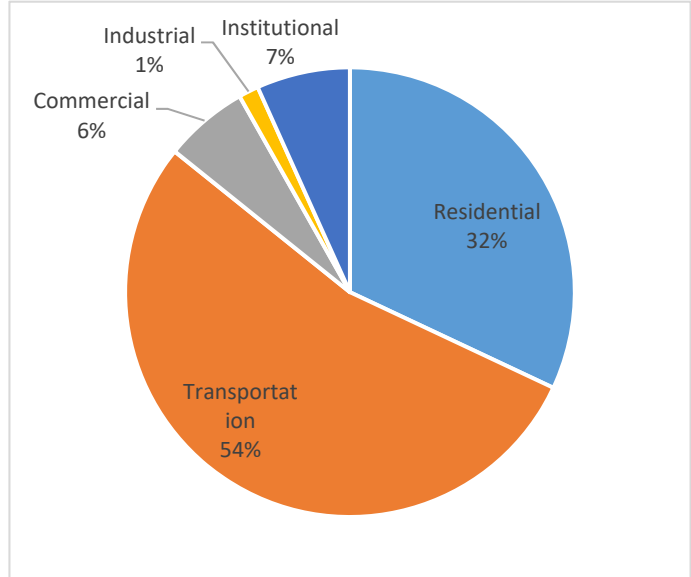


Figure T15: Breakdown of energy used by sector in Mistissini

Thus, the main energy sources consumed in Mistissini are petroleum products (54%) and electricity (45%). The first energy source is primarily used for transportation, while the second one is used for residences and ICI.

4.1.3 Circularity elements

Figure 16 shows the energy flows on the Mistissini community through a Sankey diagram, presenting the different types of energy used within the community or inputs (left portion). The types of energy are then distributed according to the different types of uses (central portion). Based on this diagram, petroleum products are for transportation, while electricity is divided between several different users. Moreover, the thickness of the arrows connecting the types of energy to the users is proportional to the quantities consumed. Thus, thick arrows represent larger amounts of energy compared to thin ones. Finally, the right portion of this figure presents the outputs generated by energy consumption in Mistissini, which are air emissions mainly generated by the combustion engines of vehicles.

Based on the figure, there is an absence of circularity regarding energy flows. Indeed, energy use in Mistissini is solely linear. Nonetheless, it is possible to notice potentials relating to circular economy. The observations made by Englobe’s team revealed that the electricity consumed in Mistissini is used to heat most of the buildings. Several heating units may be installed to recover, for example, wood or wood residues composed of wood pallets or wood pellets. The wood pallets that are currently landfilled in the TL may be crushed, while wood pellets (standardized fuel) may be imported into the community. A great initiative made by the Cree community of Oujé-Bougoumou, which implemented a heating network using forest waste, could be used as a model for the Mistissini community regarding its energy flow.

INPUTS

USAGE

OUTPUTS

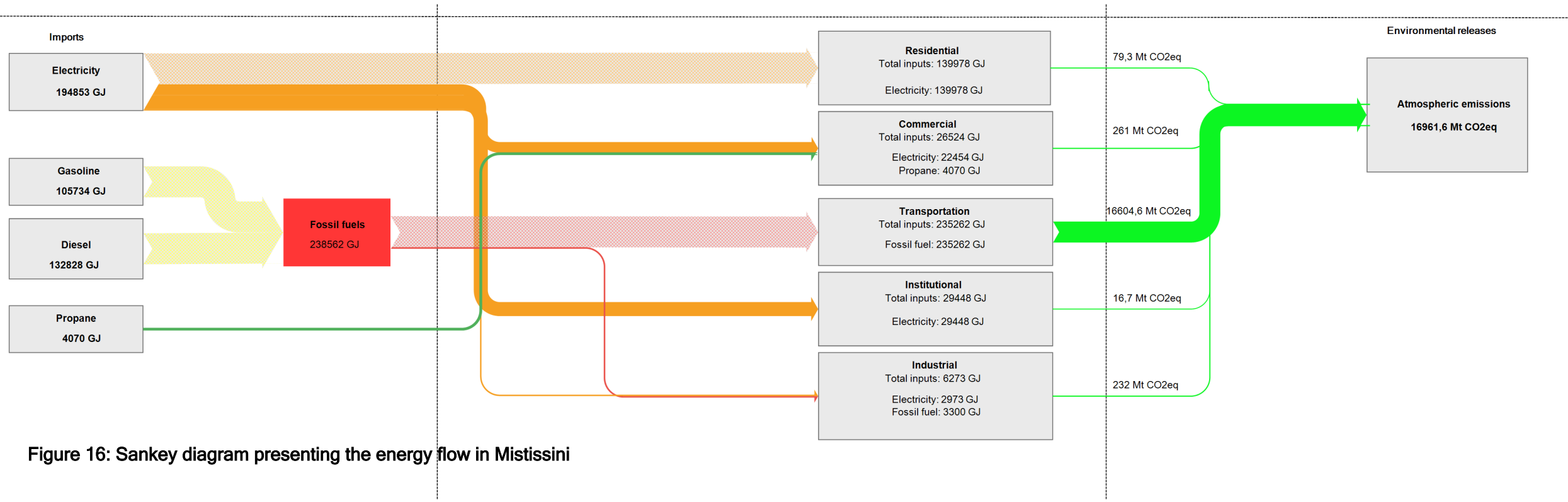


Figure 16: Sankey diagram presenting the energy flow in Mistissini

4.2 Water

As for the water parameter, the MFA focuses on the drinking water produced and consumed within the community. In Mistissini, drinking water is distributed through a water-supply system. Originally, the water distributed within the community comes from a groundwater source. Generally, no chlorination treatment is required, except for some special situations where there are significant limestone deposits.

4.2.1 Water flow dynamics

Water in Mistissini is consumed by citizens and ICI. There is no water extraction activity dedicated to the export within the community.

The residential area in Mistissini is where the water use is the highest. As for wastewater, which is the output associated with drinking water, it is collected by the sewer system and it flows towards the treatment facility (aerated ponds). Then, the water received by the treatment facility eventually generates sludge and a compliant effluent released into the environment.

Figure 17 shows a summary of the water production and use in Mistissini.

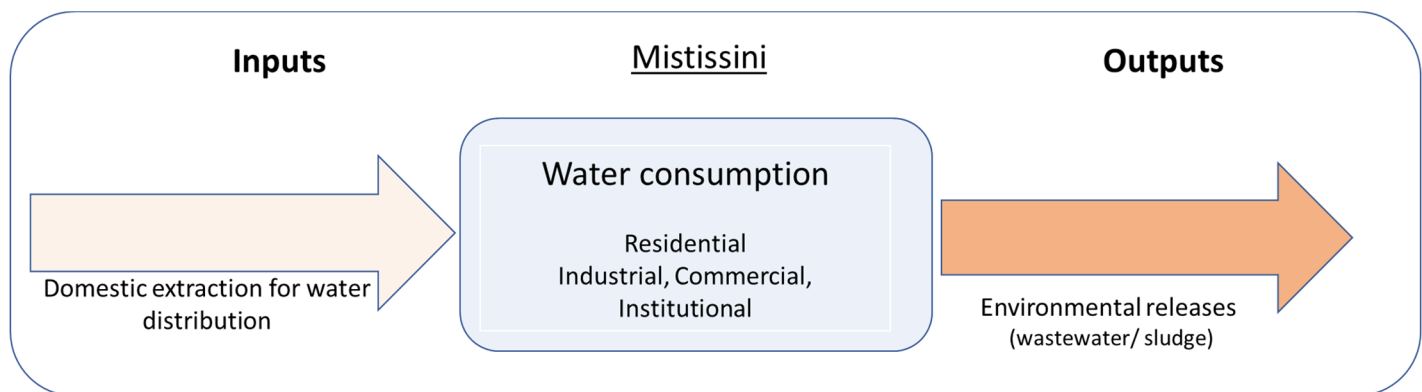


Figure 17: Water flow dynamics in Mistissini

4.2.1 Water flow analysis

The water flow analysis shows that about 1,000,000 m³ of water, which is drinking water coming from the water supply system, is annually consumed in Mistissini.

Wastewater flows through the sewer system towards the wastewater treatment facility. Annually, the amount of wastewater to be treated is also about 1,000,000 m³ and the amount of the sludge produced is about 38 t. At the moment, this sludge accumulates at the bottom of aerated ponds.

Figure 18 divides water consumption into four sectors: residential, industrial, commercial and institutional. For this figure, rainwater and water from septic tanks in Mistissini have not been considered.

In Mistissini, most of the water is used by the residential area.

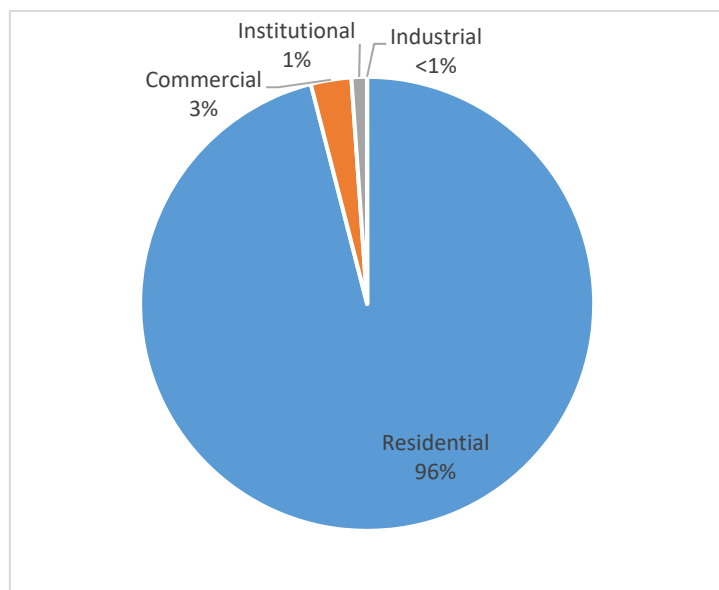


Figure 18: Breakdown of the water consumed by activity sector in Mistissini

4.2.1 Circularity elements

Generally, the Sankey diagram (Figure 19) shows the water flow dynamics in Mistissini.

The amount of drinking water consumed by Mistissini's citizens (residential consumption) is about 600 L per person per day, which seems to be high compared to the data coming from the CIRANO who, in its report called *Consommation d'eau municipale en 2019*, estimates the average residential consumption of water in Quebec at 268 L per person per day (CIRANO, 2021). An example of circularity would be to raise awareness about the reduction in drinking water consumption within the community.

An initiative supporting the circularity of the water flow could also be the recovery of sludge. The latter currently accumulates in the aerated ponds. This fertilizing residual material could eventually be recovered and used as an input, for example, by agricultural or forestry companies if they comply with the required agricultural conditions.

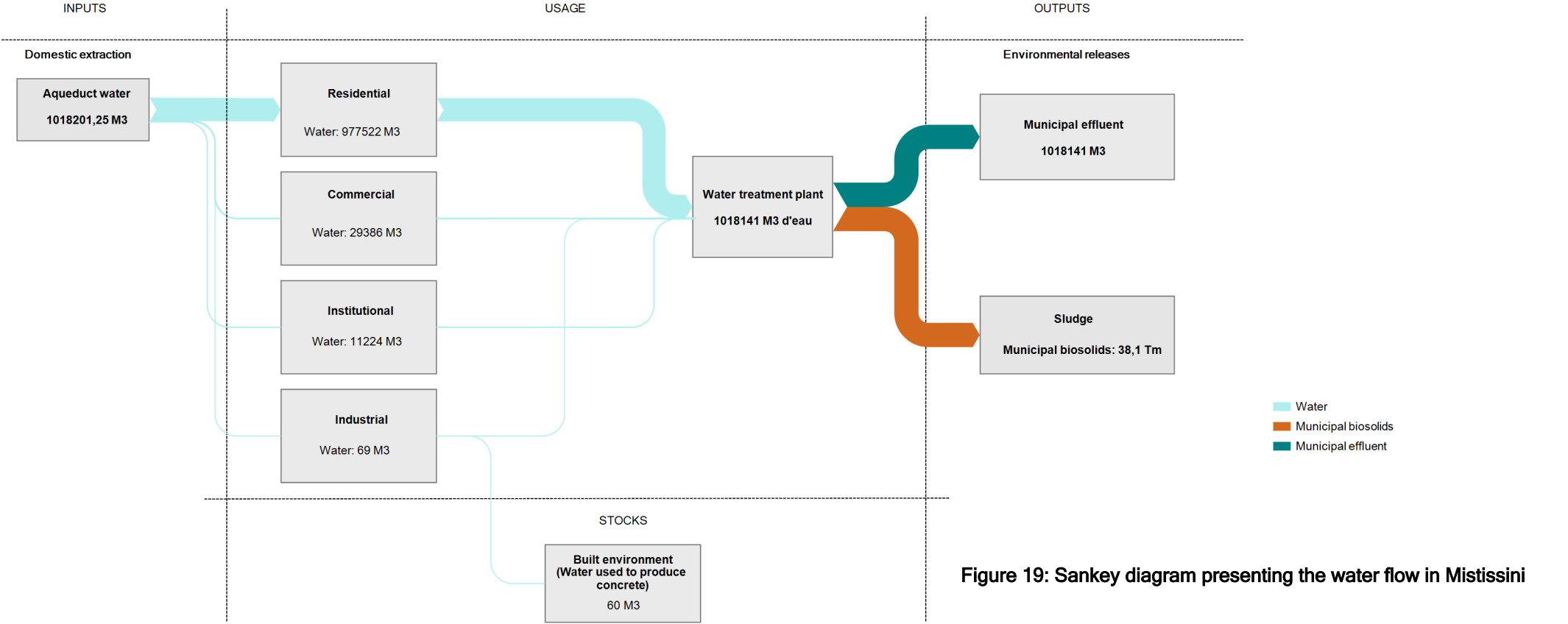


Figure 19: Sankey diagram presenting the water flow in Mistissini

4.3 Consumer products

This category covers all goods, materials, products and equipment imported, used and consumed within the community. According to the information gathered in Mistissini, the goods, materials, products and equipment imported for consumption are brought into the community by residents and ICI. These importers are:

- Stores, which import perishable, frozen or non-perishable food (canned goods, pasta, etc.) as well as beverages;
- Companies, which import construction materials (wood, HHW, EPR products, etc.);
- Schools, which import school supplies via the school service centre;
- A local community service centre (CLSC), which imports medical equipment;
- Residents, who import vehicles and home furnishing items (furniture, appliances, electronics, etc.).

4.3.1 Dynamics of the flow of goods, materials, products and equipment

Validating some of the data in this category proved difficult because. Indeed, due to Mistissini's geographical location, stores are limited in their product offering, so that residents have to travel to the closest city, which is Chibougamau, to buy certain goods or use services not offered in Mistissini. It is then difficult to precisely quantify the flow dynamics of this consumer product category.

The composition of the flow of goods, materials, products and equipment in this study is as follows:

- Metals
- Food products (food and beverages);
- Lumber;
- Construction materials (gypsum, asphalt shingles and other construction materials);
- HHW;
- Products currently covered by EPR:
 - Household appliances and air conditioners;
 - Oils, coolants and antifreeze as well as their filters and containers and other associated products;
 - Mercury lamps;
 - Cells and batteries;
 - Electronics;
 - Paints and paint containers
- Medical equipment and school supplies (including office supplies such as paper);
- Other objects.

At the end of their useful life, goods, materials, products and equipment are mainly recycled or disposed of. Figure 20 shows the flow dynamics of goods, materials, products and equipment imported into Mistissini.

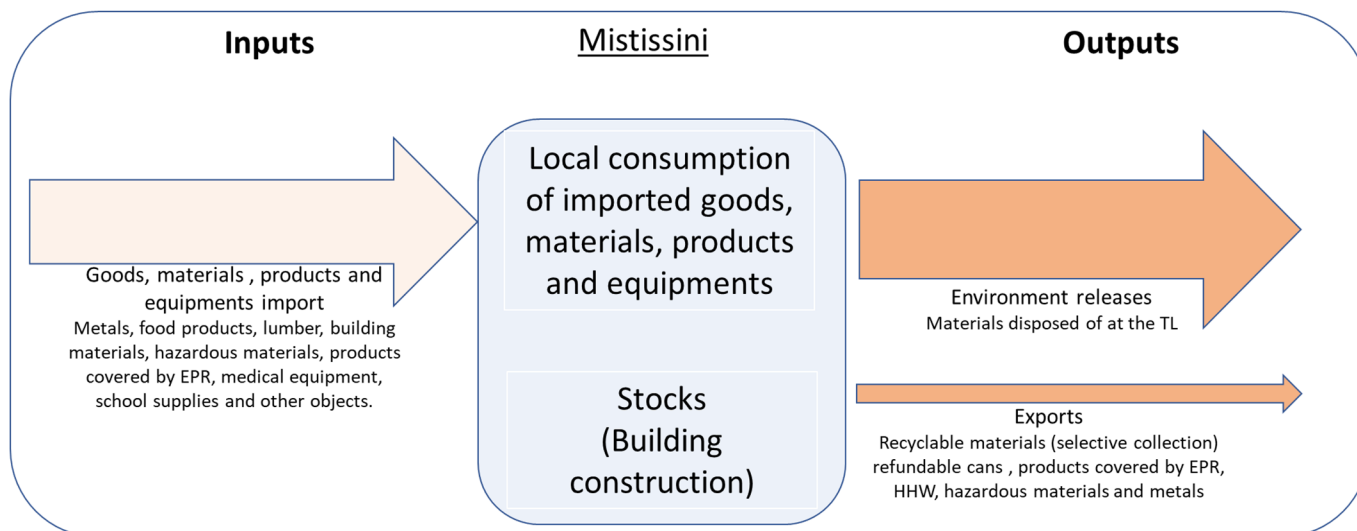


Figure 20: Flow dynamics of the consumer products imported into Mistissini

Food products mainly consist of the food and drink imported into Mistissini by retailers (e.g. grocery store, restaurants, convenience stores, etc.). The data associated with food products to which Englobe has had access is mostly expressed in total weight. These data do not include the weight of containers and packaging, such as water or soft drink bottles (plastic) and cardboard packaging. The characterization of residual materials at the TL as well as the data collected during the execution of the selective collection were used to estimate the quantities of glass, plastic, cardboard, etc.

It is important to mention that a certain portion of wood and construction material inputs are turned into buildings and infrastructure. As part of the MFA, it corresponds to stock. As an example, in 2021, two new structures were constructed in Mistissini, which corresponds to wood and construction stock in an MFA perspective.

Finally, the residual materials in Mistissini are outputs that are mainly destined for the selective collections of recyclables, the ecocentre or the TL receiving residual materials in Mistissini.

4.3.2 Analysis of the flow of goods, materials, products and equipment

Data on goods, materials, products and equipment mainly come from the information obtained through the questionnaires. Based on the analysis performed, material imports are carried out the ICI. However, this method has a limitation since materials directly imported by residents are not considered (e.g. purchases made online or outside Mistissini, such as in Chibougamau, Saguenay or Quebec). In addition, the data used to calculate metal imports (including vehicles) are based on a study carried out by the CIRAIG (2017).

Figure 21 shows the breakdown of imported goods, materials, products and equipment by product type.

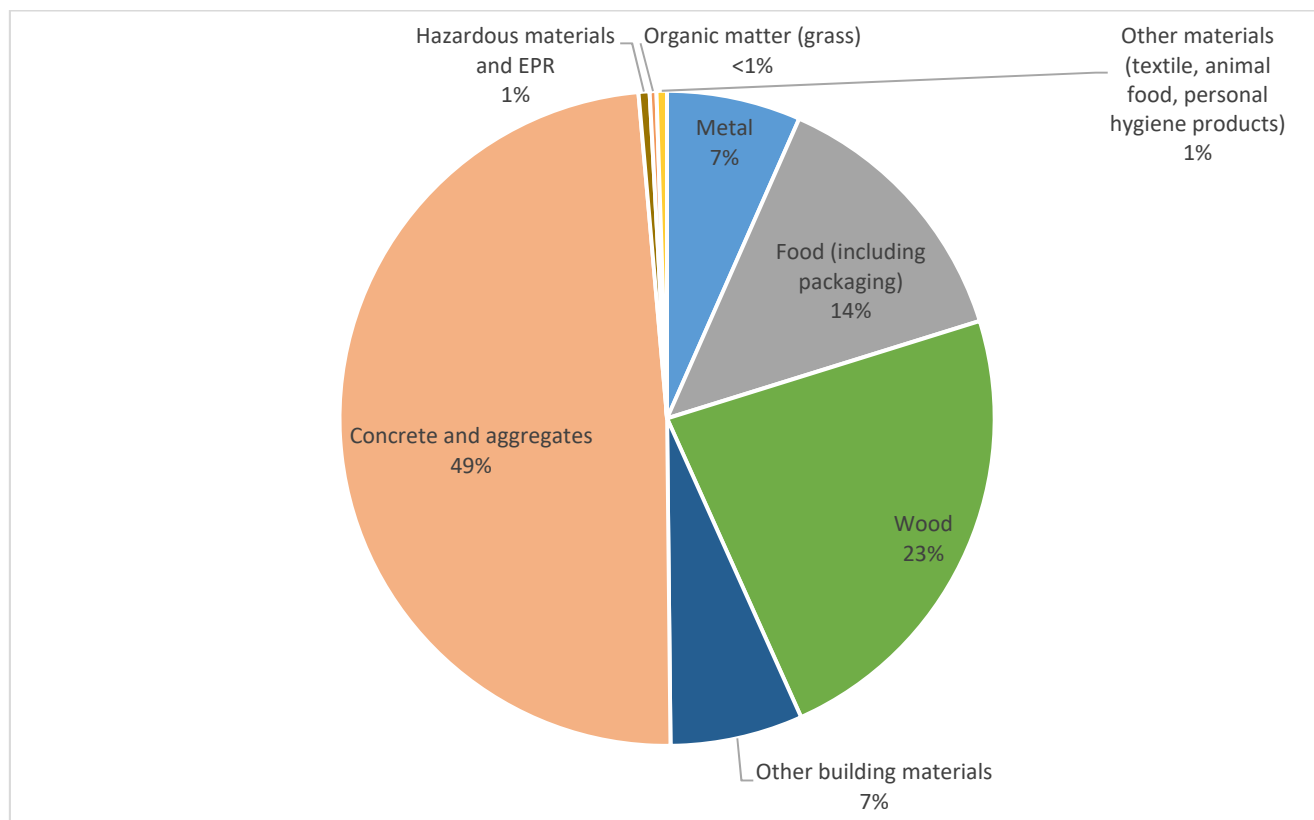


Figure 21: Breakdown of imported goods, materials, products and equipment

The products and materials relating to construction (wood, concrete, aggregates and other construction materials) are the main imports. Food products (food) are next, in front of metal. The weight of food products also includes the weight of containers and packaging, a portion of which is recyclable and sent to the selective collection.

As for construction products and materials, these are used in Mistissini. Indeed, several buildings were constructed in the community’s housing stock in 2021.

4.3.3 Circularity elements

In Mistissini, there are infrastructures for residual materials landfill, which may firstly sound like an element belonging strictly to linear economy. However, a certain circularity was implemented within the community. Indeed, Englobe’s team noted that the ecocentre is promoting the collection of several types of materials, including metals and EPR products.

The CNM is nonetheless facing challenges. As an example, it receives large numbers of pallets that are not sorted to keep the ones in good condition. These pallets are then directly sent to the TL.

The flow of the goods, materials, products and equipment is shown in the Sankey diagram in Figure 22.

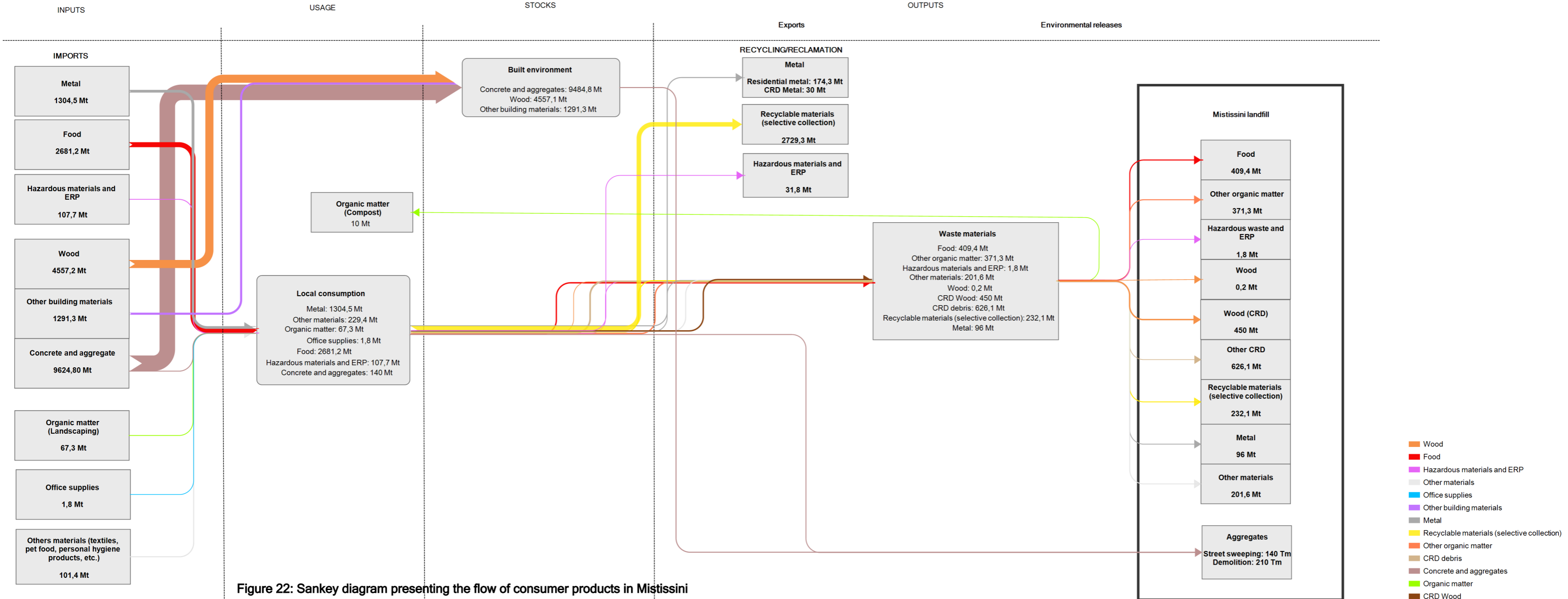


Figure 22: Sankey diagram presenting the flow of consumer products in Mistissini

4.4 Summary of the MFA for Mistissini and existing initiatives

A Sankey diagram (Figure 23) groups the information concerning energy, water and consumer products. It also shows stocks as well as outputs like exports and releases into the environment.

Figure 23 shows that Mistissini's economy is characterized by linear flows, which indicates at first glance that few circular economy strategies are carried out.

The main inputs in Mistissini are imports. The community imports energy, materials and consumer products. Imported energy is mainly used for transportation. As for materials, these are used for construction and the built environment of this fast-growing community. The local population is required to import all the consumer products it needs for everyday life, especially food. There are some local extraction activities, such as water as well as the aggregates in the quarry (for which Englobe has no information and are thus absent from the Sankey diagram).

The MFA also reveals that the Mistissini's economy has linear flows, which indicates at first glance that few circular economy strategies are carried out. However, some strategies in line with circular economy, such as responsible consumption, process optimization and short term renting, can be hardly exposed in an MFA. Also, during our visit in Mistissini, some existing circular economy strategies were identified:

- Heavy equipment renting services that are offered by some companies using these types of equipment in their operations (e.g. construction and excavation company);
- Facebook groups called Mistissini Qc Buy, sell & everything else and MISTISSINI, BUY SELL & TRADE & COMMUNITY ANNOUNCEMENTS that allow community members to sell, trade or donate some materials (about 15 posts are published every day);
- Some small actions, such as heat recovery from refrigerators in a service station to heat the building;
- The decision by some companies to change their lighting system to use LED bulbs;
- An existing regulation banning the use of single-use plastic bags in Mistissini.

Event though these types of circular initiatives can hardly be included in the Sankey diagram, they deserve to be highlighted.

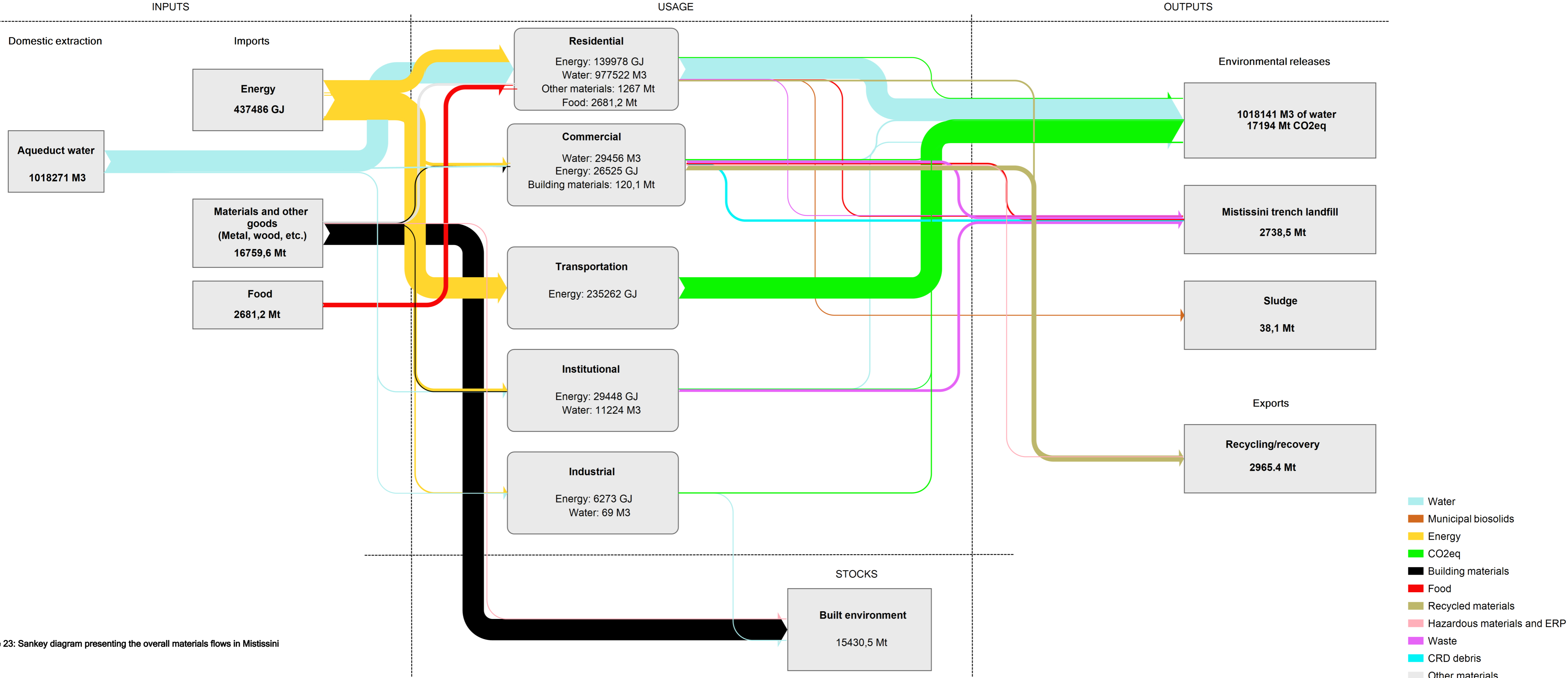


Figure 23: Sankey diagram presenting the overall materials flows in Mistissini

5 Circular economy solutions

Based on the results from the questionnaires, the MFA, the visits and the interviews done, potential circular economy solutions for the Mistissini community can be identified.

The MFA describes the community's main flows identifying the movements of input and output materials of the community. Onsite work and interviews done within the community identified, among other things, the nature and the quantity of residual materials disposed of as well as existing initiatives and opportunities.

Mistissini is characterized by its population of more than 3,500 people, its population growth rate that is higher than the provincial average as well as its young population. In addition, Mistissini is also characterized by the fact that there are many ICI, despite its distant location from major urban centres. These ICI meet the different and significant needs of community members.

Circular economy actions are already in place by the CNM, such as the selective collection of recyclables, the presence of an operational ecocentre and the implementation of an organic matter collection and recovery program, although the latter was not in operation during the on-site visit made by Englobe.

This chapter discusses opportunities for the implementation of circular economy solutions in Mistissini. It addresses 12 circular economy strategies broadly recognized in Quebec.

Circular economy is defined as “a production, exchange and consumption system aiming to optimize resource use in every stage in the life cycle of a product or service through a circular approach, reduce the environmental footprint and contribute to the well-being of individuals and communities” (Pôle québécois de concertation sur l'économie circulaire, 2016).

This economic model consists of 12 strategies for achieving two main objectives:

- Rethink production and consumption patterns in order to consume fewer resources and protect the ecosystems that generate them;
- Optimize the use of resources that already circulate within societies by:
 - Intensifying product use;
 - Extending the life of products and components;
 - Giving resources a new life (RECYC-QUÉBEC, 2022a).

The 12 circular economy strategies with their respective objectives and definitions (RECYC-QUÉBEC, 2022b) are shown in Table 6, while the principles of the circular economy (Institut de l'environnement, du développement durable et de l'économie circulaire [EDDEC], 2018) are shown in Figure 24.

Table 6: Circular economy strategies

| | Strategy | Objective | Definition |
|----|---|--|--|
| 1 | Ecodesign | Rethink | Integrating environmental aspects as early as possible in the design phase of products and services in order to minimize their environmental impacts throughout their life cycle. |
| 2 | Responsible consumption and procurement | Rethink | Integrating sustainable development and social responsibility in the purchasing or acquisition of goods and services by consumers or private and public organizations. |
| 3 | Process optimization | Rethink | Improvement of each of the organization's processes by seeking to reduce the consumption of raw materials, energy and water and the amount of waste generated. |
| 4 | Sharing economy | Optimize: intensify product use | A set of exchanges among users that relies on shared use, collaborative production, and barter. Preference is given to the temporary pooling of resources or the permanent redistribution of goods with or without compensation. |
| 5 | Short term renting | Optimize: intensify product use | Using goods or services for a fixed period in exchange of remuneration. |
| 6 | Maintenance and repair | Optimize: extend the life of products and components | The action of keeping objects in good condition to extend their life. |
| 7 | Donating and reselling | Optimize: extend the life of products and components | Putting used goods back into circulation by donating or selling them to a third party. |
| 8 | Refurbishing | Optimize: extend the life of products and components | Restoring objects for the purpose of resale. |
| 9 | Performance economy | Optimize: extend the life of products and components | Company business model that prioritizes sale of the use of the product rather than sale of the product itself. Users buy the function, not the product. |
| 10 | Industrial ecology | Optimize: give resources a new life | Network of companies and communities linked together by exchanges of materials (e.g. by-products), water or energy. These exchanges form synergies whereby the waste from one becomes the raw material for the other. |
| 11 | Recycling and composting | Optimize: give resources a new life | Recycling is defined as the use of collected materials to replace raw materials in manufacturing processes. Composting is defined as a biological treatment process that uses aerobic microorganisms to biodegrade organic matter. |
| 12 | Recovery | Optimize: give resources a new life | Any non-disposal operation that aims to obtain useful products or energy from residual materials. |

Reference: RECYC-QUÉBEC, 2022b

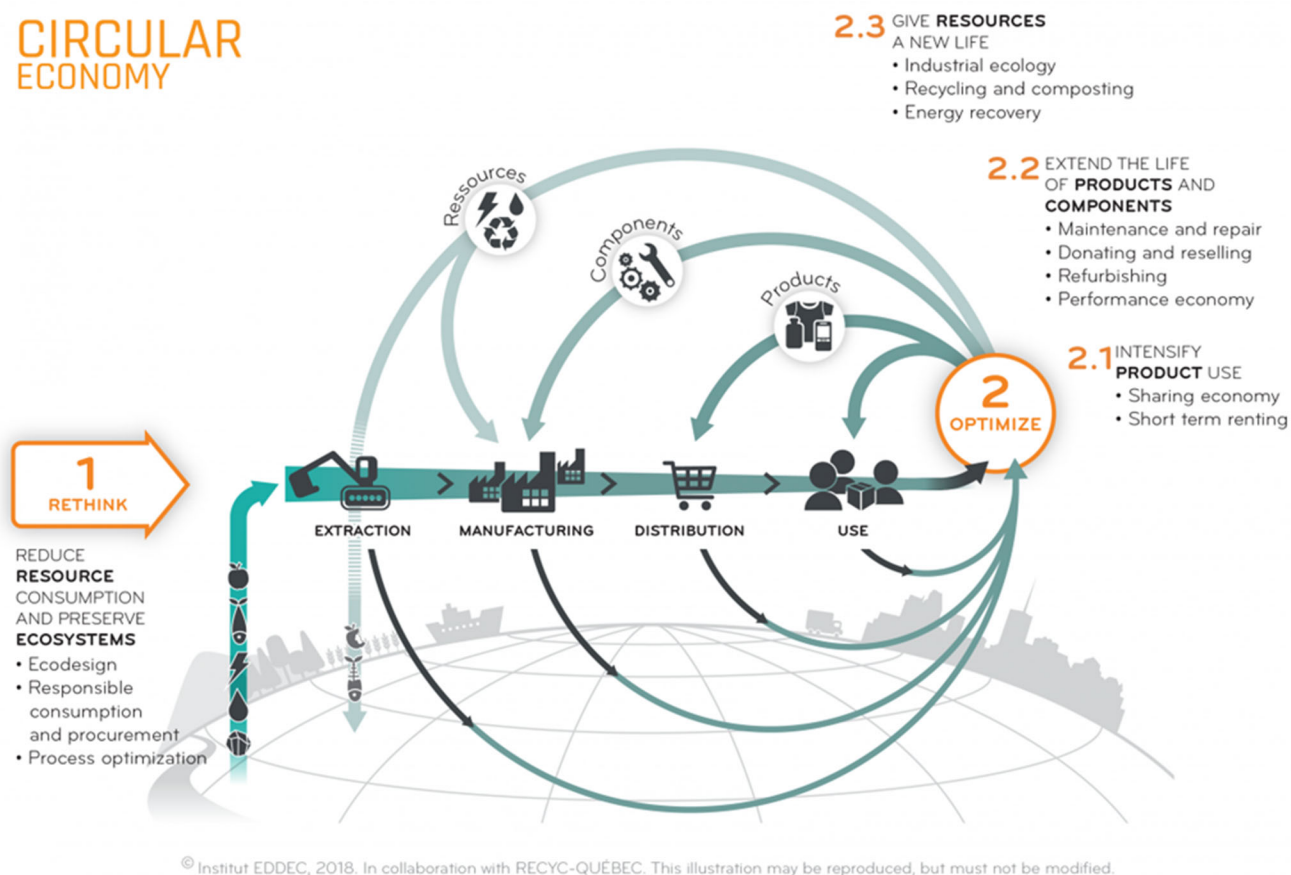


Figure 24: Circular economy diagram

These strategies offer circular economy solutions that the Mistissini community could implement. In fact, several Quebec companies are already using circular economy strategies. One of these is Bilodeau Canada, a Lac-Saint-Jean company that manufactures outdoor clothing. It has developed products using milkweed as an alternative to synthetic fibre (BILODEAU Canada, 2022a). Milkweed is a native Quebec plant that has insulating properties. This fibre is also compostable (ecodesign strategy). The company optimizes its processes by using a software that minimizes production rejects as early in the product design stage as possible (process optimization strategy). In addition, the hair shed from its fur products is used by other companies as knitting wool (industrial ecology strategy) (BILODEAU Canada, 2022b). Furthermore, the sawdust used in its manufacturing process is subsequently recovered by spreading it on farmland (industrial ecology and recovery strategy).

A series of examples, mostly from Quebec, relating to the 12 circular economy strategies are described in Appendix E, which could be used as an inspiration for the Mistissini community or other northern communities.

The following sections offer circular economy solutions for each of the 12 circular economy strategies applicable to Mistissini. Some of these initiatives can be linked to several strategies.

5.1 Ecodesign

Ecodesign involves integrating environmental aspects as early as possible in the design phase of products and services in to minimize their environmental impacts throughout their life (RECYC-QUÉBEC, 2022b). Ecodesign is applicable to all economic sectors.

Ecodesign is difficult to promote in Mistissini due to the absence of a factory or manufacturing facility. Thus, this strategy cannot currently be applied to the manufacture of products directly on the territory, except for the construction of new buildings and renovation of existing buildings that could be included into an environmental approach. However, it could be implemented when planning the built environment, and the circular economy solution described below could be considered at that time.

5.1.1 Built environment planning

At the moment, the community is experiencing population growth, which may require the construction of new houses and buildings. Indeed, for some years now, and according to the CNM, about 20 new houses are constructed in Mistissini annually. This could then be a great opportunity for built environment planning. For example, the construction of new houses as well as the renovation and demolition of existing buildings could be based on ecodesign principles in terms of choice of materials, energy supply, and alternatives to fossil fuels. Ecodesign strategies could be implemented to collect and reuse construction materials for existing or new buildings.

Also, the construction of new commercial, institutional or residential buildings should be designed to take into account the specific climate in Mistissini, which is a northern climate with intense cold periods. In this context, an appropriate built environment planning could reduce energy requirements, thus reducing the generation of greenhouse gas (GHG) emissions. Based on the approach implemented by the community of Oujé-Bougoumou relating to its heating network, the community of Mistissini could plan to construct a new neighbourhood with this type of heating energy supply system.

Proper planning of the built environment, supported by governmental organizations, should also result in better use of sustainable and energy-efficient materials, which would have positive impacts beyond the building envelope. Indeed, the more durable the materials used, the less the replacement materials imported, thereby reducing CRD waste as well as the impacts related to the transportation of these new materials.

5.2 Responsible consumption and procurement

Responsible consumption and procurement constitute a circular economy strategy that integrates sustainable development and social responsibility in the purchasing or acquisition of goods and services by consumers or private and public organizations (RECYC-QUÉBEC 2022b). This strategy reduces resource consumption and preserves ecosystems. It implies a goods and services procurement process that integrates environmental, social and economic considerations.

The on-site observations and exchanges made by Englobe's team led to the identification of two circular economy solutions in the field of fossil fuel substitution for transportation related to the activities of the CNM and for the implementation of responsible procurement requirements among ICI.

5.2.1 Electrification of the CNM's vehicles

As for transportation, municipal gasoline- or diesel-powered vehicles could be replaced with electric vehicles. When replacing its current fleet of vehicles, the CNM could prioritize the purchase of electric vehicles. Several funding programs could facilitate this transition, such as the *Roulez vert* program (Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs [MELCCFP], 2022b) and the *Écocamionnage* program (Ministère des Transports et de la Mobilité durable [MTMD], 2023).

5.2.2 Implementation of sustainable procurement criteria for Mistissini's ICI

Currently, Quebec's ICI are increasingly implementing sustainable procurement policies integrating environmental and social criteria related to purchase as well as contract and supplier selection. Though the CNM may not need to establish a comprehensive policy, it could promote and simplify sustainable procurement within ICI by providing a brief document guiding these decisions, such as sustainable product sale, item selection based on their packaging, their end-of-life handling, etc. This guide would be used as guidelines for Mistissini's ICI, without directly supporting every ICI throughout this process.

5.3 Process optimization

Process optimization is a strategy used to improve each of the organization's processes by seeking to reduce the consumption of raw materials, energy and water as well as the amount of waste generated (RECYC-QUÉBEC, 2022b).

This type of strategy can be easily integrated thanks to the various skills the Mistissini community has. Based on the examples described in Appendix E, there are several measures that could be implemented to optimize ICI's processes.

5.3.1 Support services for ICI to optimize their processes

Despite its size, there is a wide variety of ICI in Mistissini, the largest being various institutions and companies operating the field of construction. Due to the significant amount of ICI, businesses and institutions could be accompanied by a specialist to determine whether their processes could be optimized. An energy assessment based on ISO 50001 principles could be conducted. This standard aims to improve the energy performance of organizations, particularly by identifying energy-reducing solutions. At first glance, these optimization measures could initially target the largest institutions in Mistissini, which are the Community Miyupimaatisiun Centre (hospital), some CNM's buildings as well as schools. Monitoring and analysis grants to improve the energy performance of community buildings are available through the Green Municipal Fund (FMV, n.d.).

5.4 Sharing economy

Sharing economy is a set of exchanges among users that relies on shared use, collaborative production and barter. Preference is given to the temporary pooling of resources or the permanent redistribution of goods with or without compensation (RECYC-QUÉBEC, 2022b). Some examples of sharing economy models are described in Appendix E.

5.4.1 Sharing of storage spaces

In general, the ICI indicated a lack of “standard” storage spaces for their operations. This could be an opportunity to develop a sharing economy project. For example, vacant land available for outdoor storage as well as other spaces for indoor storage should be identified. The possibility of sharing these spaces so that several ICI might use them, while ensuring the security of the goods of the individual ICI concerned, should be examined. This whole initiative could be coordinated via a web platform to assign spaces.

5.4.2 Carpooling or shuttle to Chibougamau

The discussions with community members and ICI revealed that several daily trips to Chibougamau are made by ICI’s employees and citizens, since this city offers a complementary range of stores. As previously mentioned, the distance between Mistissini and Chibougamau is about 87 km. To simplify the trips made between these two urban centres and reduce the GHG emissions generated by the significant number of trips, an online carpooling platform could be created. This would further encourage trips with smaller impacts, while bringing economic benefits to the residents offering carpooling services. Another idea, though less directly related to sharing economy, would be to use an electric-powered shuttle for the trips made between these two cities at fixed times.

5.5 Short term renting

Renting is the contractual use of goods or services for a fee (RECYC-QUÉBEC, 2022b). Renting facilitates the optimal use of products by optimizing their usage frequency. When owners rent out their physical property, property usage can be maximized by having several renters. As shown by the examples in Appendix E, renting covers both goods and workspaces.

Due to its geographical location, the Mistissini community is isolated from the rest of the province.

The remoteness of this community makes renting an even more attractive option.

Some services offered in Quebec’s major urban centres are difficult to obtain in Mistissini.

5.5.1 Implementation of a list for the renting services offered by companies

Some companies located in Mistissini, such as construction companies, offer renting services for their heavy equipment to community residents. By putting together a list of all renting services offered through these companies, the access to these services would be simplified. Furthermore, the information would be made available to the members of the community – thus encouraging the use of these services – and to the different subcontractors temporarily working in Mistissini.

5.5.2 Renting of furniture and household appliances

A significant number of temporary workers from different fields, especially school board and health centre, come to Mistissini annually. They must then temporarily live somewhere in the community. Therefore, a business model could be designed in collaboration with temporary workers’ employers by establishing agreements on the use of furniture and household appliances over a short period of time. The necessary equipment would be made available to these workers so that they will not have to buy it.

5.6 Maintenance and repair

A maintenance and repair strategy aims to keep objects in good condition in order to extend their life (RECYC-QUÉBEC, 2022b). This strategy can either be implemented by the object owners or by specialized organizations. It should be noted that a vehicle mechanical maintenance and repair company is present in Mistissini. Several initiatives and opportunities could easily be implemented within ICI and the population.

To lengthen the life cycle of consumer products, it would certainly be possible to involve the community in initiatives that could be implemented by the CNM as well as its inhabitants. Such initiatives or projects require few resources in terms of time, money or planning.

5.6.1 Repair activities

A local, day-long community event where volunteers would offer their services to repair various items could be organized. This would be an opportunity to not only extend the lives of residents' appliances and devices but also to energize the community. Many residents in Mistissini have talents that could be used in this way in the community. Such a community-mobilizing event would reduce the quantity of items like pants, boots, bikes, lawnmowers, hand mixers and answering machines going to the TL and also become a place of exchange for the community. Also, it would be an opportunity regarding local repairing, thus avoiding travelling to major urban centres. Several cities in Quebec already organize this type of event, such as Environnement Mauricie (2022a), who has been organizing them over the last few years.

5.7 Donating and reselling

The giving-away-and-reselling strategy involves putting used goods back into circulation by donating or selling them to a third party (RECYC-QUÉBEC, 2022b). This strategy extends the life of products that are no longer needed by their owners but are still in good condition by putting them back into circulation. This form of circular economy is widespread in Quebec.

To our knowledge, Mistissini does not have a used goods store or a physical location specifically for the donating or reselling of items.

5.7.1 Creation of a used goods store

An initial giving-away-and-reselling circular economy solution would involve developing a site where reusable items would be received, sorted and stocked. Since the ecocentre is a resource that seems to be mainly used by the residents and ICI within the community, a space dedicated to donating materials and other goods received at the ecocentre could be added. For household items, a used goods store could be created directly in the village.

A used goods store is typically arranged in two sections. The first section is used for receiving, inspecting and sorting donated items. In addition, items in less than suitable condition could be refurbished (refurbishing strategy). The second section, the equivalent of a sales area, is used to display reusable items. Items should be stocked under weatherproof conditions in both sections. Such a used goods store is beneficial in several ways: it diverts products from landfill, reduces the importation of new products, puts used items back into circulation in the community, and gives residents access to cheaper products.

An excellent example is the City of Baie-Comeau which has a used goods store called Phase 2. This store receives many used items that can be refurbished in a cabinetmaking workshop or a mechanical workshop adjacent to the store. A wide range of products such as furniture, decorative objects and practical items are given an extended life through resale in this store (MRC de Manicouagan and Régie de gestion des matières résiduelles Manicouagan, 2021).

5.7.2 Implementation of a community refrigerator project

The characterization carried out by Englobe revealed that a significant quantity of organic matter is generated in the community. In Mistissini, there are two restaurants, a few food counters in stores and some citizens from the community prepares ready-to-eat meals to take away. To reduce food waste, community companies and citizens could bring uneaten meal or food in a community refrigerator to give back or for people in need.

5.8 Refurbishing

A refurbishing strategy involves to refurbish objects for the purpose of resale (RECYC-QUÉBEC 2022b). This strategy extends the life of products. Items can be refurbished at both the CNM and ICI levels.

5.8.1 Refurbishing of electronic products

Currently, end-of-life electronic products are directly sent to the TL or the ecocentre of Mistissini to be carried to the associated EPR. Sometimes, these products could, however, be refurbished to extend their life. To this end, refurbishing workshops for electronic products could be offered to secondary school students, who would receive a training to be able to extend the life of electronic materials of the students and staff's families as well as products used in school. Such a project could be supported by different programs, such as the *Matière verte* program from ENvironnement JEUnesse, which is supported by the Ministère de l'Éducation (Environnement Jeunesse, 2022).

5.8.2 Refurbishing of household appliances and small electrical devices

The CNM could set up a repair and refurbishing shop to extend their life. This shop would be operated by community members, who might require some training. The kinds of appliances targeted for this project would include refrigerators, freezers, stoves, washing machines, and small electrical devices. The project could be carried out directly in the ecocentre or be linked to the used goods store project. When refurbishing is not possible, parts in good condition could be removed for possible reuse in repairing other equipment. An at-home repair service could also be offered.

5.9 Performance economy

Performance economy is a circular economy strategy that extends the life of products based on a "company business model that prioritizes sale of the use of the product rather than sale of the product itself. Users buy the function, not the product" (RECYC-QUÉBEC, 2022b). Consumers thus purchase a service and not a good. The best-known example is the use of a printer where the cost of its use depends on the number of pages printed rather than a monthly fixed cost. It does not imply to rent the printer, but rather an invoicing based on its use.

5.9.1 Performance economy consortium (EFC Québec)

In 2021, EFC Québec created a consortium composed of 20 companies to support them in replacing sale of products by value of use. The result of this pilot project to be completed in spring 2023 should be analyzed to inspire the community.

To implement this type of economy, the CNM should establish a list of the community's needs and contact EFC Québec to find out the support available. The First Nations of Quebec and Labrador Sustainable Development Institute (FNQLSDI) could also become a partner for the implementation of such a project.

5.10 Industrial ecology

Industrial ecology is a circular economy strategy that gives resources a new life by encouraging the inter-organizational exchange of materials, energy or resources. This strategy consists of a network of companies and communities linked together by exchanges of materials (e.g. by-products), water or energy. These exchanges form synergies whereby the waste from one becomes the raw material for the other (RECYC-QUÉBEC, 2022b). For example, the output of one company could be useful in the production process of another. Industrial ecology is becoming increasingly popular these days with steadily growing linkages among different ICI.

Industrial ecology initiatives require the exchange of materials between at least two organizations. This exchange can take place in both the private and public sectors, as demonstrated in the example of the City of Québec (see Appendix E, Strategy 10). The Mistissini community can participate in this strategy by stimulating exchanges among its ICI

5.10.1 Implementation of an industrial symbiosis

The Mistissini community offers several services for its members. There are several ICI specialized in residential or industrial construction. There is a total of eight construction companies as well as one landscaping company, whose activities often generate significant quantities of CRD waste that are generally landfilled. It would be useful for the CNM to implement a storing space for good quality CRD waste that could extend their life. For example, the lumber used could be shared to the other construction companies following the completion of construction work. This sharing would avoid the importation of new materials, reduce purchasing costs and avoid landfilling of materials that are still usable. Nevertheless, there is an obstacle regarding this strategy, which is the competitiveness spirit between ICI. It should be noted that this competitiveness is not only found within the CNM, but rather throughout Quebec. The competitiveness between the ICI from the same sector could create uncertainty for ICI to implement a sharing system. Thus, the CNM should participate in the creation of such a project and encourage local companies to participate in it. A pilot project could be created to implement this approach.

There are also four ICI in the field of accommodations and two in the field of janitorial services. Accommodation establishments could be large generators of used cloth, such as towels or sheets. In contrast, janitorial service work requires the use of cloth for cleaning operations. Accommodation establishments could offer the towels and sheets not used anymore for cleaning work, thus reducing landfilling of these materials, while avoiding the potential importation of this material, or even avoiding the use of single-use paper towels.

An industrial symbiosis project could be developed in the region to add circularity to the materials produced on the territory. The community of Mistissini could organize a training on the benefits of circular economy as well as a networking workshop with its ICI in partnerships with the EIJBRC and the Community Futures Development Corporation (SADC) Chibougamau-Chapais. Potential material exchanges between ICI could be identified, which would reduce the quantity of residual materials

generated and the use of resources. Moreover, other circular economy strategies could be created by ICI during networking workshops.

Each networking workshop needs to be followed by some coaching so that potential synergies with ICI can be achieved. The SADC Chibougamau-Chapais could be involved in the follow-up with the ICI interested in industrial ecology.

A practical guide, outlining the steps for creating industrial symbiosis (industrial ecology), has been prepared by the Centre de transfert technologique en écologie industrielle (CTTÉI, 2013). This centre could help the CNM in planning an industrial symbiosis project.

Financial assistance programs for businesses that wish to adopt environmentally responsible business practices are also available, namely, the Fonds Écoleader (2021) and *Virage vert* program (Réseau des SADC et CAE [Business Development Centres], 2021).

5.11 Recycling and composting

Recycling and composting give resources a new life. Recycling is defined as the use of collected materials to replace raw materials in manufacturing processes. Composting is defined as a biological treatment process that uses aerobic microorganisms to biodegrade organic matter (RECYC-QUÉBEC, 2022b).

There are several opportunities to implement recycling and composting circular economy solutions on the territory of Mistissini. The solutions described in the following sections are related to the ecocentre, organic matter and the collection of refundable containers.

5.11.1 Improvements to the ecocentre

There is already an ecocentre in Mistissini, but some space organization improvements should be made so that collection could be carried out by collection organizations. Oils, paints and tires are currently collected.

Moreover, there is a problem regarding storage of materials sent to the ecocentre. Indeed, most of them are segregated and are directly placed on a permeable soil. Therefore, these are not protected against weather conditions and water may accumulate.

The ecocentre, enabling the collection of materials received, has currently an appropriate space organization based on its size. However, storage areas accumulating materials should be redesigned to optimize them.

It is possible to get funding to improve the ecocentre. Furthermore, the CNM must undertake the necessary procedures to turn the ecocentre into an official collection point for all materials concerned by EPR to avoid on-site accumulation of materials.

Compared to the municipalities of Témiscamingue or Côte-Nord, Mistissini is not the furthest from major centres. For example, the distance between Mistissini and Quebec is about 600 km, while the distance between Havre-Saint-Pierre, an official collection point for several EPR objects, and Quebec is more than 800 km. Also, Ville-Marie, which is the main municipality of Témiscamingue, is located more than 650 km from Montreal. Thus, the distance recyclers must travel to get to Mistissini should not be a problem, especially since this community can be easily reached through Route 167, a provincial paved road.

To become such a collection point, the CNM will have to comply with the storage conditions specified by regulations as well as different recognized management organizations (RMO) regarding EPR to make sure products are correctly exported and managed.

Implementing good practices in the ecocentre could then simplify sorting, improve storage areas, as well as allowing the collection of more materials that are normally sent to landfills by collectors from the region or from Quebec.

5.11.2 Organic matter management optimization

In 2020, the Quebec government released its *Stratégie de valorisation de la matière organique* outlining its organic matter recovery strategy (Ministère de l'Environnement et de la Lutte contre les changements climatiques [MELCC], 2020). As part of this strategy, the government set ambitious targets:

- Apply organic matter management in 100% of municipalities by 2025;
- Manage organic matter in 100% of ICI by 2025;
- Recycle or recover 70 % of organic matter by 2030.

The main objective is thus to give residents and ICI throughout the province the opportunity to collect organic matter. There is already an organic matter collection service in Mistissini.

However, a solution still needs to be found concerning the use of the compost produced. For example, it could be used for a possible northern greenhouse project. It could also be used for mining restoration and revegetation to revive nutrient poor soils. Furthermore, the compost could be used to improve grass surfaces in the short term, or when a greater use of this output is not possible.

However, before using compost, it is recommended to purify it prior to its use. For example, the compost could be sieved to remove larger impurities, such as foreign matter or plastic.

Moreover, the residual materials characterization revealed significant quantities of food waste and organic matter in the residual materials disposed of in the TL. New IAE activities could optimize the quantities of materials that could be composted rather than be landfilled.

5.11.3 Collection of refundable containers

At the time of the study, there was no refundable can and bottle collection in Mistissini's convenience stores, grocery stores and service stations. A deposit system is easy to implement and would be a great opportunity for Cree communities.

Modernization of deposit systems (MELCCFP, 2023a) is a great opportunity for communities from the Nunavik region. The Quebec Beverage Container Recycling Association (QBCRA) is the DMO responsible for the beverage container deposit system. Changes expected and management made by this DMO would reduce the quantity of materials to be landfilled in the Mistissini's TL. The containers that could be collected are the ready-to-drink beverage containers made of plastic, glass, cardboard or multi-layered from 100 ml to 2 L (RECYC-QUÉBEC, 2023a).

The *Regulation respecting the development, implementation and financial support of a deposit-refund system for certain containers* specifies that the DMO should add deposit-refund collection points for refundable containers on isolated or remote territories (Government of Quebec, 2022).

However, the implementation of this kind of system in northern communities may take time. The village could thus contact this DMO to express their desire to quickly benefit from this service in Mistissini.

5.12 Recovery

Recovery is any non-disposal operation aiming at obtaining useful products or energy from residual materials. It is the ultimate strategy to avoid landfill of materials (RECYC-QUÉBEC, 2022b).

Through observations and discussions made in Mistissini, Englobe's team identified some recovery solutions for materials that the community generates in significant quantities, such as residual granular materials.

5.12.1 Recovery of residual granular materials

The CNM seemed interested in residual granular material recovery. Residual granular materials are non-melting abrasives spread on the community's roads throughout the winter and are collected during street sweeping and cleaning work. These types of materials are then stocked outside the village.

Normally, these aggregates are characterized, sorted, crushed and reused. As for abrasives, they do not need to be crushed. However, these materials should be sieved to remove impurities and contaminants. Recovery options are specified in the *Regulation respecting the reclamation of residual materials* (Q-2, r. 49) (MELCCFP, 2022c). For example, residual granular materials recovered could be used, among other things, as road abrasives, rockfill, backfilling for areas excavated during a demolition or roadway backfilling and could be used to grading down or raising up ground level.

From an operational standpoint, recovery of aggregates requires:

- A storage space for materials to be sieved;
- A space and the necessary sieving equipment;
- A storage space for the sieved materials that could be recovered.

From a regulatory standpoint, such work requires a ministerial authorization. In the spirit of circular economy, sieved abrasives could be reused as winter abrasives. Finally, to optimize these processes, the CNM could own a sifter for residual granular materials as well as for compost.

5.12.2 Recovery of municipal biosolids

According to the water flow analysis, municipal biosolids are generated in Mistissini. The CNM would benefit from locally recovering these fertilizing residual materials for projects in a forest environment or to revegetate deteriorated areas (as a TL). Several Quebec's municipalities already do this type of operation, which avoids handling and transporting them over great distance, while reducing the importation of fertilizers used for the same type of work.

However, the recovery of this sludge requires a ministerial authorization under certain conditions, while provisions of the *Environment Quality Act* (EQA) may also allow for easier use. Advice from an agronomist would be necessary to ensure that any action the CNM might take on this front complies with applicable regulations.

5.12.3 Recovery of clean wood

The ecocentre currently collects clean wood and wood materials. A small portion of the wood is grounded and mixed with organic matter when it is recovered. Nonetheless, most of the wood is landfilled in the TL. Thus, there is no collection process for these materials. It would then be interesting to find solutions to recover this type of wood.

Several solutions could be considered:

- Turn it into mulch for landscaping projects within the community;
- Recover it into energy wood by the residents for their houses or camps;
- Manufacture indoor and outdoor furniture (by local artisans), which could be projects carried out with the refurbishing centre, schools or other organizations (is rather a recycling and composting strategy) that would be a great option for wood management.

6 Action plan for optimizing material circularity in Mistissini

The action plan developed for the CNM presents circular economy strategies and opportunities that the community can implement. This action plan is based on the MFA, the residual materials characterization and the interviews done with Mistissini's ICI.

The plan consists of brief descriptions of each proposed action, the main steps for its implementation as well as the organizations and partners involved.

The feasibility of each action is then assessed using a timeline and a preliminary budget framework. The timelines are presented according to one or other of three timeframes:

- Short term: less than 2 years;
- Medium term: 2 to 5 years;
- Long term: more than 5 years.

Budget estimates are provided in terms of one or other of four financial ranges:

- \$: less than \$25,000;
- \$\$: \$25,000 to \$100,000;
- \$\$\$: \$100,000 to \$1,000,000;
- \$\$\$\$: over \$1,000,000.

The budget estimates are based on the team's knowledge and not on specific price quotes from potential suppliers. The estimates must therefore be used with some reservation regarding budgets that could be associated with the implementation of the actions.

The positive and negative aspects of each action are presented using a SWOT (strengths, weaknesses, opportunities and threats) approach.

Strengths correspond to the inherent strengths of the stakeholders involved in each strategy. This may include staff expertise, operational efficiency, low staff turnover, etc. Variables or situations over which stakeholders have some control are also considered.

Weaknesses are the internal factors that reduce a given stakeholder's ability to achieve its goals. These weaknesses could include lack of expertise, lack of space or equipment, obsolete machinery, etc. Negative or unfavourable situations that stakeholders can address were also considered.

Opportunities are external factors that enable organizations to grow and become more profitable. These may take the form of government support, regulatory requirements, etc.

Threats are external obstacles that must be overcome to implement the strategy. These obstacles may be a declining economy, labour shortages, lack of social acceptability, stringent regulations, etc.

The action plan is broken down into eight separate actions. Englobe has carefully analyzed some of the circular economy solutions described in the previous section. These actions were selected to embrace a broad vision of Mistissini and include as many circular economy strategies as possible. Some of the actions may involve multiple solutions. However, even if every circular economy solution is not included in the action plan, the other solutions suggested in the previous section deserve to be analyzed in terms of the relevance of their implementation.

The various circular economy strategies relating to the proposed actions for the Mistissini community are presented in Table 7.

The level of action defined in this table is based on the potential improvements that would have the maximum impact on the circularity of Mistissini’s local economy. This level of action remains a project team priority. The CNM is encouraged to define its own priority level among the proposed actions, taking into account the opportunities that may arise after this report is published.

Table 7: Proposed circular economy strategies in line with presented solutions to increase circularity within the community of Mistissini

| Action | Action description | Level of action | Circular economy strategy |
|--------|--|-----------------|---|
| 1 | Improvements to the ecocentre | Priority | <ul style="list-style-type: none"> – Process optimization – Recycling and composting |
| 2 | Management of the products concerned by EPR | Priority | <ul style="list-style-type: none"> – Recycling and composting |
| 3 | Compost production optimization | Priority | <ul style="list-style-type: none"> – Recycling and composting |
| 4 | Creation of a space for donating and reuse | Priority | <ul style="list-style-type: none"> – Donating and reselling |
| 5 | Residual granular material recovery | Priority | <ul style="list-style-type: none"> – Recovery |
| 6 | Compost recovery | Priority | <ul style="list-style-type: none"> – Recovery |
| 7 | Development of new outlets for wood | Lower priority | <ul style="list-style-type: none"> – Responsible consumption and procurement – Donating and reselling – Recycling and composting – Recovery |
| 8 | Development of IAE tools for organic matter collection | Lower priority | <ul style="list-style-type: none"> – Process optimization – Recovery |

If the CBN implements the proposed actions, it would divert a considerable quantity of residual materials from the TL, reduce the overall amount of energy needed in the community as well as water consumption. Moreover, some actions would decrease the importation of fossil fuels and other resources that should normally be imported into Mistissini.

However, the investments required to implement the actions presented below will necessitate a financial effort that the CNM could not possibly provide alone. While some actions are inexpensive, those likely to have a greater impact on residual materials management could be supported by funding programs. Relevant funding programs currently available are listed in the corresponding action description, as applicable. Other funding programs that Englobe is unaware of could also be available, while other programs not yet available will be by the time the CNM implements the related action. It should be noted that the *Fonds d'actions nordiques* (Government of Quebec, 2023) and the *Programme de soutien aux communautés isolées* (RECYC-QUÉBEC, 2023b), managed by the Quebec government, offer financial support for projects in northern communities. Other programs provide financial support for circular economy projects, such as the *Fonds Moins c'est plus* (La Ruche, 2021), the *Fonds économie circulaire* (Fondation, 2022) as well as the *Collision* program (Esplanade Québec, 2023).

6.1 Priority actions

Some actions were considered priorities for different reasons. These could be related to current or future regulatory requirements or directions announced by regulatory bodies. The priority actions can also be linked to materials available in large quantities on the territory of Mistissini. The main positive effects of priority actions are to extend the life of the TL as well as reduce the importation of materials and GHG emissions.

6.1.1 Improvements to the ecocentre

| Circular economy strategy | Process optimization as well as recycling and composting | |
|--|--|--|
| Brief description of the action | The ecocentre is successful. Thus, new storage spaces for materials received and operational changes should be made so that materials are exported at a steady rate (see strategy 5.11.1). | |
| Implementation steps | <ul style="list-style-type: none"> – Make a list of the materials currently stocked on the site; – Implement an input register to document arrival frequencies of new materials; – Assess storage needs based on the requirements of the different materials on the site and collected by the ecocentre; – Have containers designed to stock HHW; – Install shelters (maritime container, trailer, MegaDome^{MD} buildings, etc.) for the other materials; – Purchase and install different storage structures; – Implement a management protocol for input and output materials. | |
| Organizations and partners involved | <ul style="list-style-type: none"> – CNM; – CNG. | |
| Timeline | Budget estimate | Success indicators |
| Medium term | \$\$\$ | <ul style="list-style-type: none"> – Quantities of input and output materials; – Compliance of facilities. |
| Strengths | | Weaknesses |
| <ul style="list-style-type: none"> – Ecocentre already used by citizens; – Improvement regarding the site cleanliness; – Reduction of environmental impacts at the ecocentre; – Reduction of the quantity of materials landfilled at the TL. | | <ul style="list-style-type: none"> – Storing structure currently used by a heavy equipment (loader); – Possible reorganization related to the parking area of the loader; – Administrative delays related to purchases. |
| Potential opportunities and levers regarding the strategy | | Potential threats and obstacles to the strategy |
| <ul style="list-style-type: none"> – Regulatory requirements related to HHW storage; – Contractual requirements related to EPR material storage (between the CNM and the organizations managing EPR); – Life extension of the T; – Financial support programs. | | <ul style="list-style-type: none"> – High investment regarding storage work and infrastructure. |

6.1.2 Management of the products concerned by the EPR

| Circular economy strategy | Recycling and composting | |
|---|---|---|
| Brief description of the action | Action intended to turn Mistissini into an official collection point for all materials covered by EPR and directly related to the optimization of the ecocentre space organization, as described above. | |
| Implementation steps | <ul style="list-style-type: none"> – Contact every RMO and complete the required administrative processes to obtain the official title; – Train the staff of the ecocentre regarding compliance with the requirements related to material condition, storage and access; – Develop a schedule for the collection to avoid material accumulation at the ecocentre; – Monitor new materials managed by an RMO (e.g. fuel pressure cases and pharmaceutical products). | |
| Organizations and partners involved | <ul style="list-style-type: none"> – CNM; – CNG; – All the RMO regarding EPR (RecycFluo, EPRA-Québec, SOGHU, GoRecycle, Éco-Peinture, Appel à Recycler, etc.); – RECYC-QUÉBEC. | |
| Timeline | Budget estimate | Success indicators |
| Medium term | \$ | <ul style="list-style-type: none"> – Number of agreements with RMO; – Quantities of materials collected; – Quantities of materials managed by RMO. |
| Strengths | | Weaknesses |
| <ul style="list-style-type: none"> – Service desired by the population; – Reduction of the quantity of materials landfilled at the TL; – Better storage management at the ecocentre. | | <ul style="list-style-type: none"> – Requirements and constraints regarding storage; – Rigorous administrative monitoring to avoid accumulation. |
| Potential opportunities and levers regarding the strategy | | Potential threats and obstacles to the strategy |
| <ul style="list-style-type: none"> – EPR materials have a regulatory framework; – Regulation amending the <i>Regulation respecting the recovery and reclamation of products by enterprises</i>. | | <ul style="list-style-type: none"> – Action dependant on the storage organization of the materials at the ecocentre (action 6.1.1). |

6.1.3 Compost production optimization

| Circular economy strategy | Recycling and composting | |
|---|---|--|
| Brief description of the action | By implementing organic matter collection as well as a composting process, Mistissini is ahead of a great number of municipalities. During the on-site visit made by Englobe, the rotating composter (designed by Brome Compost inc.), was not in operation due to a mechanical failure. Moreover, a quick analysis of the compost produced in 2022 revealed the presence of contaminants, such as plastic bags. The compost production process could be improved to avoid another equipment failure and improve the quality of the compost produced. | |
| Implementation steps | <ul style="list-style-type: none"> – Determine the cause of the mechanical failure with the manufacturer; – Review operational processes and protocols of the composter to avoid another failure; – Perform physical changes on the site where the composter is located, if required; – Remind employees on the information received concerning composter use and operation; – Sieve the compost to remove contaminants (the sifter could also be used for residual granular materials); – Analyze the compost for grade and quality identification; – Carry out IAE with communities and ICI. | |
| Organizations and partners involved | <ul style="list-style-type: none"> – Brome Compost inc.; – CNM. | |
| Timeline | Budget estimate | Success indicators |
| Short term | \$\$ | <ul style="list-style-type: none"> – Hours of operation for the composter; – Quantity of compost produced; – Quantity of compost used. |
| Strengths | | Weaknesses |
| <ul style="list-style-type: none"> – Collection system already implemented; – Reduction of the quantity of materials landfilled at the TL. | | <ul style="list-style-type: none"> – Resource and specialized resource availability to operate, maintain and repair the composter; – Training needs; – May require the addition of new equipment (rotating sifter). |
| Potential opportunities and levers regarding the strategy | | Potential threats and obstacles to the strategy |
| <ul style="list-style-type: none"> – Future regulatory requirement to recover organic matter; – Funding available with the <i>Programme de traitement des matières organiques par biométhanisation et compostage</i> (PTOMBC) (MELCCFP, 2022d); – Reduction of GHG emissions; – Life extension of the TL. | | <ul style="list-style-type: none"> – Risk of contamination by non-compostable materials (glass, plastic, etc.); – Need to find one or many new outlets for the output (the compost produced). |

6.1.4 Creation of a space for donation and reuse

| Circular economy strategy | Donating and reselling | |
|--|--|--|
| Brief description of the action | The community of Mistissini does not have a used goods store or physical sites for the donation and reuse of objects, materials or others. Therefore, a space to receive and donate reusable materials and items in Mistissini could be implemented. Generally, it requires an area to receive (and temporarily store) donations. These objects are inspected and are displayed in the area dedicated to donating and reselling if they meet quality and reuse criteria. Items should preferably be stocked in places protected against weather conditions. | |
| Implementation steps | <ul style="list-style-type: none"> – Assess the feasibility of setting up a physical space, for example at the ecocentre, to receive, sort, stock and give away or sell certain reusable items (e.g., building materials or electrical appliances); – Purchase storing structures (standard maritime containers, modified ocean containers, MegaDome^{MD} buildings, etc.); – Implement an online platform to publish new available items; – Prepare a periodic report on the items that have been offered and diverted from landfill. | |
| Organizations and partners involved | <ul style="list-style-type: none"> – CNM; – CNG; – EIJBRG. | |
| Timeline | Budget estimate | Success indicators |
| Medium term | \$\$ | <ul style="list-style-type: none"> – Number of items recirculated; – Value of items recirculated; – Quantity of materials diverted from landfill. |
| Strengths | | Weaknesses |
| <ul style="list-style-type: none"> – Ecocentre known and used by citizens; – Reduction of goods imports through reuse. | | <ul style="list-style-type: none"> – Requires the creation of a storage space; – Requires the hiring of employees or presence of volunteers. |
| Potential opportunities and levers regarding the strategy | | Potential threats and obstacles to the strategy |
| <ul style="list-style-type: none"> – Reduction in residents' expenses (free products or cheaper than buying the same new product); – Social impact (mutual aid and reduction in isolation); – Reduction of the quantity of materials landfilled at the TL; – Possibility of links between the already existing virtual exchange space and the physical space (e.g. weekly publication of "new arrivals" with photos); – Use of existing business models (e.g. <i>ÉcoDon</i> operated by the Régie de gestion des matières résiduelles du Lac-Saint-Jean [2022]); – Possibility of adding an item refurbishing section; – Financial support program. | | <ul style="list-style-type: none"> – The management of a physical space (e.g. at the ecocentre) requires a minimum of logistics to separate reusable material from broken materials, ensure some rotation of available items, etc.; – Surplus items must be managed in the physical space (storage or disposal of unsold items). |

6.1.5 Recovery of residual granular materials

| Circular economy strategy | Recovery | |
|--|--|---|
| Brief description of the action | During spring street cleaning, the CNM collect the abrasives that were used during winter. They are mainly composed of sand and fine gravel. These residual granular materials are temporarily stocked on a site within the community. The strategy is then to sieve these materials to reuse them for next winter. | |
| Implementation steps | <ul style="list-style-type: none"> – Carry out a characterization of residual granular materials to analyze their condition, confirm whether they contain contaminants, etc.; – Identify regulatory requirements; – Start processes to obtain storage authorizations, sieving and recovery of materials; – Implement logistics to recover residual granular materials (e.g. storage, conditioning, sieving size and transportation). | |
| Organizations and partners involved | <ul style="list-style-type: none"> – CNM; – CNG; – MELCCFP. | |
| Timeline | Budget estimate | Success indicators |
| Short term | \$ | – Quantity of residual granular materials. |
| Strengths | | Weaknesses |
| <ul style="list-style-type: none"> – Resources available in the region; – Storage spaces already available. | | <ul style="list-style-type: none"> – Presence of residual materials (that will be managed during sieving) in residual granular materials; – Characterization work that is expensive and that lasts for a long time. |
| Potential opportunities and levers regarding the strategy | | Potential threats and obstacles to the strategy |
| <ul style="list-style-type: none"> – Good examples of reuse and successful projects elsewhere in Quebec; – Possibility to use the same rotary sieve used for the compost; – Life extension of the TL; – Reuse of materials following the end of their useful life. | | <ul style="list-style-type: none"> – Little control over procurement quality and quantity; – Ministerial authorization required for storage and conditioning; – If recovery criteria are not met, these materials could be residual hazardous materials. |

6.1.6 Compost recovery

| Circular economy strategy | Recovery | |
|---|---|--|
| Brief description of the action | At the moment of the on-site visit (July 2022), the compost produced in Mistissini was not recovered. This action, related to the optimization of the compost process, focuses on finding new outlets for the compost locally produced. | |
| Implementation steps | <ul style="list-style-type: none"> – Sieve the compost to remove contaminants; – Characterize the compost to analyze its quality; – Recover the compost based on its quality and use specified through regulations. It could be forest projects, distribution to citizens, improvements of grass surfaces, etc.; – If required, recover the compost for a possible greenhouse project; – In the absence of such a project, use the compost to restore or revegetate degraded sites (e.g. the former TL). | |
| Organizations and partners involved | <ul style="list-style-type: none"> – CNM; – CNG. | |
| Timeline | Budget estimate | Success indicators |
| Medium term | \$ | – Quantity of compost recovered (in weight or volume). |
| Strengths | | Weaknesses |
| <ul style="list-style-type: none"> – During the distribution to citizens, it would reward people involved in the organic matter collection. | | <ul style="list-style-type: none"> – Requires logistics; – A sieving should be carried out; – Potential presence of contaminants in organic matter. |
| Potential opportunities and levers regarding the strategy | | Potential threats and obstacles to the strategy |
| <ul style="list-style-type: none"> – The use of the compost is the logical continuation of the compost production; – Compost improves soil quality. | | <ul style="list-style-type: none"> – Possible use of the output depending on the quality of the compost; – Quality of the compost related to the processes, the quality of raw materials collected and the success of the awareness-raising efforts put regarding organic matter collection. |

6.2 Lower-priority actions

Lower-priority actions are initiatives not linked to regulatory requirements or involving smaller quantities of materials or objects on the territory.

6.2.1 Development of new outlets for wood

| Circular economy strategy | Responsible consumption and procurement, donating and reselling, recycling and composting as well as recovery | |
|--|--|---|
| Brief description of the action | This action aims to divert wood (forest residues and wood pallets) from elimination to reuse it (e.g. reuse of CRD waste, energy, composting input, mulch, pyrolysis, pellets, etc.). | |
| Implementation steps | <ul style="list-style-type: none"> – Characterize the wood sent to the TL and the ecocentre (type, quantity, quality, etc.) to get an accurate picture of the wood generated; – Analyze the different supply sources (the generators); – Describe current residue management based on generators; – Identify regulatory requirements; – Identify issues and constraints related to collection and recovery; – Identify the different recovery options for wood, as heating, manufacturing of wood value-added products (pellets, pyrolysis oil, etc.), reuse of pallets, use of wood as an input for organic matter recovery, etc.; – Separate wood used for construction work to be reused for the renovation or construction of new buildings; – Identify potential reclaimers in the region (e.g. in Chibougamau or in Chapais) and the acceptability parameters and criteria for recovery (e.g. conditioning and necessary equipment); – Analyze advantages and disadvantages for the different recovery options; – Implementation of a logistics for wood recovery (e.g. wood collection at the source, storage, if required, conditioning and transportation). | |
| Organizations and partners involved | <ul style="list-style-type: none"> – CNM; – CNG; – People generating, conditioning and recovering; – Major energy consumers (Chapais énergie, Chantier Chibougamau and Barrette-Chapais ltée). | |
| Timeline | Budget estimate | Success indicators |
| Medium term | \$\$\$-\$\$\$\$ | <ul style="list-style-type: none"> – Quantity of wood diverted from elimination; – Number of stakeholders involved. |
| Strengths | | Weaknesses |
| <ul style="list-style-type: none"> – Wood available in large quantities in the region; – Stimulation of the regional economy. | | <ul style="list-style-type: none"> – Variable wood quality subject to changes; – Require creating a storage and conditioning space; – Lack of knowledge on the generators outside Mistissini and on potential reclaimers. |
| Potential opportunities and levers regarding the strategy | | Potential threats and obstacles to the strategy |
| <ul style="list-style-type: none"> – Current or future regulatory requirements (e.g. prohibition regarding wood elimination or regarding oil furnace repairs, etc.); – Development of a heat network based on the approach set by the community of Oujé-Bougoumou or for a greenhouse; – Possibility of energy transition and development opportunities of renewable energy systems with funding support (e.g. programs from Transition énergétique Québec [TEQ], such as <i>ÉcoPerformance</i> [MELCCFP, 2023b] and <i>Bioénergies</i> [MELCCFP, 2023c] as well as the <i>Programme d'aménagement durable des forêts</i> [ministère des Forêts, de la Faune et des Parcs; MFFP, 2021]); – Life extension of the TL. | | <ul style="list-style-type: none"> – Little control over procurement; – Ministerial authorization required for storage and conditioning; – Development of a market nearby to dispose of collected and refurbished wood; – Potential investments necessary from reclaimers; – High transportation costs; – Lack of expertise for companies on the possibility to reclaim wood in their operations. |

6.2.2 Development of IAE tools for the collection of organic matter

| Circular economy strategy | Process optimization | |
|--|---|--|
| Brief description of the action | Results from the characterization of residual materials revealed that significant quantities of organic matter, mainly food waste, are thrown away in Mistissini. An awareness campaign has already been conducted. A new awareness campaign would then be necessary, especially since the organic matter collection service has been temporarily stopped due to a mechanical failure of the composter. | |
| Implementation steps | <ul style="list-style-type: none"> – Develop an awareness campaign on organic matter collection; – Benefit from this campaign to develop IAE tools to raise awareness among the community about food waste and suggest tools to reduce it; – Focus on citizens and ICI; – Carry out the campaign as well as a follow-up. | |
| Organizations and partners involved | <ul style="list-style-type: none"> – CNM; – CNG. | |
| Timeline | Budget estimate | Success indicators |
| Short term | \$ | <ul style="list-style-type: none"> – Number of new participating ICI; – Quantity of organic matter collected; – Quantity of compost produced; – Collection rate of organic matter; – Quantity of contaminants in the compost. |
| Strengths | | Weaknesses |
| <ul style="list-style-type: none"> – Collection system already implemented; – Possibility to recruit new participants; – Possibility to improve the quality of the composted materials; – Reduction of the quantity of materials landfilled at the TL. | | <ul style="list-style-type: none"> – Resource and specialized resource availability for the awareness campaign. |
| Potential opportunities and levers regarding the strategy | | Potential threats and obstacles to the strategy |
| <ul style="list-style-type: none"> – IAE tools on organic matter collection (RECYC-QUÉBEC, 2023c) and on food waste (RECYC-QUÉBEC, 2023d) developed by RECYC-QUÉBEC for municipalities; – Regulatory requirements to reclaim organic matter; – Amendments to the <i>Regulation respecting the charges payable for the disposal of residual materials</i>; – Reduction of GHG emissions; – Life extension of the TL. | | <ul style="list-style-type: none"> – No potential threat or obstacle. |

7 Recommendations

Circular economy initiatives in Quebec are becoming more numerous. Several completed projects show that communities can join forces to consume fewer resources and pool their tools and resources. Regional actors must collaborate to initiate and foster regional projects with the various ICI.

Englobe recommends that a circular economy committee be set up in Mistissini. This committee should be made up of stakeholders who want to move ahead with a circular economy in the region. The committee membership could include village employees, the regional administration, private and not-for-profit businesses, economic and environmental organizations, and other residents. The committee's role would be to make recommendations to the village council on which actions should be prioritized. Subcommittees would then be formed to implement each action that the council wishes to pursue.

Existing funding programs may be a determining factor in selecting which actions to prioritize. In addition to funds, these programs can sometimes provide specialized resources to help implement projects. To learn more about the support and funding options available, the following government organizations and agencies can be contacted: the SADC Chibougamau-Chapais, the SPN, the Quebec government's Secrétariat aux relations avec les Premières Nations et les Inuit, Indigenous Services Canada, the First Nations of Quebec and Labrador Economic Development Commission (FNQLEDC) and the Business Development Bank of Canada. For its part, the Ministère de l'Économie, de l'Innovation et de l'Énergie (MEIE) brings together economic development ecosystem actors in each Quebec region (MEIE, 2023).

The actions proposed in the action plan are presented as either "priority" or "lower priority." This approach recognizes that each action, taken individually, has a positive impact on the community's circular economy. However, the actions with greater impact are deemed "priority." The proposed actions as well as a brief evaluation of the investment and recommendations are shown in Table 8.

Table 8: Recommendation's summary regarding their implementation

| Action | Action description | Prioritization | Brief evaluation of the investment and recommendations |
|--------|---|----------------|--|
| 1 | Improvements to the ecocentre | Priority | Requires a significant investment at the beginning to reorganize storage areas as well as create a management protocol for input and output materials. Since there is already an ecocentre that is operational and known by everyone in Mistissini, little efforts and few costs will be required to operate the ecocentre itself. |
| 2 | Management of the products concerned by EPR | Priority | Requires a moderate investment since it mostly consists of communicating with the different RMO and undertake the necessary steps to become an official collection point. Very beneficial to the CNM and especially for the ecocentre since the output of the materials concerned by EPR will be simplified. |
| 3 | Compost production optimization | Priority | Requires little investment since it mostly consists of implementing procedures and protocols to optimize compost quantities and quality. These actions could be quickly implemented at low cost. |
| 4 | Creation of a space for donating and reuse | Priority | Requires a voluntary investment from the community. Normally not expensive but could require storage capacities for objects. Also requires reception logistics, inventory management and purchases. The investment could be significant, depending on the community's goals. |
| 5 | Residual granular material recovery | Lower priority | Requires some studies to correctly characterize the type, quality and quantity of granular materials that could be recovered. Requires obtaining environmental authorizations. The investment may vary based on the volume of the aggregates produced. |
| 6 | Compost recovery | Lower priority | Simply requires an implementation step and little costs. |

| Action | Action description | Prioritization | Brief evaluation of the investment and recommendations |
|--------|--|----------------|---|
| 7 | Development of new outlets for wood | Lower priority | First studies quickly obtained at low cost. Implementation requiring more time and significant costs to carrying out recovery and diversion of wood from landfill. |
| 8 | Development of IAE tools for organic matter collection | Lower priority | Simply requires an implementation step. An awareness campaign has already been done in the past, which could be used as a basis for these new IAE tools. Requires little costs and could change habits within the community that could be beneficial for the quality of the compost produced. |

Several other circular economy solutions were identified during the study but were not included in the action plan, in order to focus efforts on high-impact actions or actions that could be speedily implemented, as it is the case for the eight actions that would improve the community's resilience and reduce its ecological footprint. Nevertheless, the other potential actions are described in Section 5 of this report.

8 Conclusion

The purpose of this study was to carry out an MFA that would serve as the basis of an action plan to promote the circular economy in northern communities and a mining company. This report was prepared for the community of Mistissini.

Data collected on Mistissini's territory were used to identify inputs, outputs and inventories, and conceive an MFA based on four main flows: energy, water, materials extracted in the community, and consumer products. The Mistissini MFA is characterized by linear flows in the sense that there are few ongoing circular economy initiatives.

The MFA information highlights circular economy solutions that can be implemented within the community. Eight distinct actions representing four circular economy strategies were analyzed. Other actions could be identified and analyzed by community members. Circular economy actions would reduce the quantity of natural resource imports and thus the quantity of waste into the environment. Implementation of these strategies would also maximize the use of resources available within the community of Mistissini.

Successfully transitioning from a linear economy to an increasingly circular economy will depend on the involvement of the members of the community. Major local challenges are due to the community's remoteness from urban centres. However, the possibility of reducing imports of products and energy through the actions proposed in this report could give the region a greater sense of belonging and reduce the impacts of residual material landfill or the loss of the resources that are in high demand elsewhere in Quebec and the rest of Canada. Implementation of a circular economy also increases the resilience of these communities, which, during supply disruptions, have developed mechanisms and reflexes to overcome a lack of resources.

Examples of actions already implemented by local ICI, such as heat recovery to heat spaces, but also the CNM, including the regulation banning the use of single-use plastic bags, the implementation of an ecocentre as well as organic matter recovery in Mistissini, demonstrate local willingness to act. These actions should be then promoted.

9 References

- ATELIER LA PATENTE. 2023. *Café réparation*. [Online]: <https://atelierlapatente.org/cafe-reparation/> (Accessed on January 12, 2023).
- BILODEAU CANADA. 2022a. *L'asclépiade fait son entrée chez BILODEAU Canada*. [Online]: <https://bilodeaucanada.com/fr/nouvelles/asclepiade-fait-son-entree-chez-bilodeau-canada> (Accessed on December 22, 2022).
- BILODEAU CANADA. 2022b. *L'écoconception levier de valorisation des rejets de la fourrure*. [Online]: <https://bilodeaucanada.com/fr/nouvelles/ecoconception-levier-valorisation-rejets-fourrure> (Accessed on December 22, 2022).
- CARBONEUTRALITÉ DE LA MRC DE MASKINONGÉ. n.d. *Comité citoyen*. [Online]: <https://www.carboneutralitemaski.com/citoyens-1> (Accessed on January 12, 2023).
- CENTRE DE TRANSFERT TECHNOLOGIQUE EN ÉCOLOGIE INDUSTRIELLE (CTTÉI). 2022. *Recueil de synergies 2022*. [Online]: <https://www.cttei.com/wp-content/uploads/RecueilDeSynergies2022.pdf> (Accessed on January 12, 2023).
- CENTRE DE TRANSFERT TECHNOLOGIQUE EN ÉCOLOGIE INDUSTRIELLE (CTTÉI). 2021. *Recueil de synergies 2021*. [Online]: <https://www.cttei.com/wp-content/uploads/RecueilDeSynergies2021.pdf> (Accessed on January 12, 2023).
- CENTRE DE TRANSFERT TECHNOLOGIQUE EN ÉCOLOGIE INDUSTRIELLE (CTTÉI). 2020. *Recueil de synergies 2020*. [Online]: <https://www.cttei.com/wp-content/uploads/RecueilDeSynergies2020.pdf> (Accessed on January 12, 2023).
- CENTRE DE TRANSFERT TECHNOLOGIQUE EN ÉCOLOGIE INDUSTRIELLE (CTTÉI). 2013. *Création d'une symbiose industrielle*. [Online]: <https://synergiequebec.ca/documentation/> (Accessed on February 28, 2023).
- CENTRE DE VALORISATION DU BOIS URBAIN (CVBU). 2020. *Processus de valorisation*. [Online]: <https://cvbu.ca/processus/> (Accessed on 12 janvier 2023).
- CENTRE INTERNATIONAL DE RÉFÉRENCE SUR L'ANALYSE DU CYCLE DE VIE ET LA TRANSITION DURABLE (CIRAIG). 2017. *Métaux et économie circulaire au Québec – Analyse de flux de matières du cuivre, du fer et du lithium*. [Online]: <https://mern.gouv.qc.ca/documents/mines/AFM-cuivre.pdf> (Accessed on September 1, 2022).
- CENTRE INTERUNIVERSITAIRE DE RECHERCHE EN ANALYSE DES ORGANISATIONS (CIRANO). 2021. *Consommation d'eau municipale en 2019 par province*. [Online]: <https://qe.cirano.qc.ca/theme/environnement-energie/environnement/consommation-matieres-residuelles/graphique-consommation-deau-municipale-2019-province> (Accessed on September 1, 2022).
- CHAMARD. 2021. Regional study on solid waste management of the Cree Nations of Eeyou Istchee - Local report for the Cree Nation of Mistissini.
- CHAUMONT, J. 2022. *Faire du neuf... avec du vieux*. La Presse. [Online]: https://plus.lapresse.ca/screens/4d099a20-2174-4b39-b9d3-7f4f20637168__7C__0.html?utm_content=email&utm_source=lpp&utm_medium=referral&utm_campaign=internal+share (Accessed on January 12, 2023).
- CHAUVEAU, J. 2006. *Michelin et Xerox sur le chemin de l'économie de fonctionnalité*. Les Échos. [Online]: <https://www.lesechos.fr/2006/05/michelin-et-xerox-sur-le-chemin-de-leconomie-de-fonctionnalite-571849> (Accessed on January 12, 2023).
- CIRCULE. 2023. *À propos*. [Online]: <https://circule.ca/fr/about> (Accessed on January 12, 2023).

- COMITÉ D'EXAMEN DES RÉPERCUSSIONS SUR L'ENVIRONNEMENT ET LE MILIEU SOCIAL (COMEX). 2021. La Convention de la baie James et du Nord québécois. Cadre administratif et juridique. <https://comexqc.ca/a-propos/cadre-administratif-juridique/> (Consulté le 10 décembre 2021).
- CPQ, CPEQ et ÉEQ. 2018. *Économie circulaire au Québec : Opportunités et impacts économiques*. [Online]: <https://www.cpq.qc.ca/wp-content/uploads/2018/03/economie-circulaire-au-quebec.pdf> (Accessed on January 12, 2023).
- CUBES ÉNERGIE. 2023. *La Petite Expé*. [Online]: <https://cubesenergie.com/fr/ecole-primaire-du-quebec/pages/la-petite-expe> (Accessed on January 12, 2023).
- DESSAU. 2013. Mistissini Waste Management Plan.
- ÉCONOMIE DE FONCTIONNALITÉ. 2010. *Michelin*. [Online]: <http://economiedefonctionnalite.fr/en-pratique/michelin/> (Accessed on January 12, 2023).
- ÉCO-RÉNO. 2023. *À propos*. [Online]: <https://ecoreno.com/> (Accessed on 12 janvier 2023).
- ECORES. 2015. *Métabolisme de la Région de Bruxelles-Capitale : identification des flux, acteurs et activités économiques sur le territoire et pistes de réflexion pour l'optimisation des ressources*. [Online]: https://document.environnement.brussels/opac_css/electfile/RAP_20150715_Metabolisme_RB_C_rapport_compile.pdf (Accessed on July 5, 2022).
- ELLEN MACARTHUR FOUNDATION. 2015. *Circular Economy Overview*. [Online]: <http://www.ellenmacarthurfoundation.org/circular-economy/overview/principles> (Accessed September 15, 2022).
- ÉNERGÈRE. 2023a. *CISSS de Lanaudière*. [Online]: <https://energere.com/fra/projets/sante/csds-du-nord-de-lanaudiere/> (Accessed on January 12, 2023).
- ÉNERGÈRE. 2023b. *Ville de Shawinigan*. [Online]: <https://energere.com/fra/projets/municipal/ville-de-shawinigan/> (Accessed on January 12, 2023).
- ENVIRONNEMENT JEUNESSE, 2022. *Le programme matière verte*. Leaflet 2022 and 2023. [Online]: <https://enjeu.qc.ca/wp-content/uploads/2023/02/Depliant-MV.pdf> (Accessed on March 17, 2023).
- ENVIRONNEMENT MAURICIE. 2022a. *La shop à réparer 2022*. [Online]: <https://www.environnementmauricie.com/la-shop-a-reparer-2022/> (Accessed on November 11, 2022).
- ENVIRONNEMENT MAURICIE. 2022b. *Recueil 2022. Bonnes pratiques en économie circulaire Mauricie et Portneuf*. [Online]: https://www.environnementmauricie.com/wp-content/uploads/2022/06/Recueil_ECM_2022-05-10.pdf (Accessed on December 20, 2022).
- ESPLANADE QUÉBEC. 2022. *9 nouveaux projets innovants en économie circulaire*. [Online]: <https://esplanade.quebec/9-projets-innovants-economie-circulaire-collision-2022/> (Accessed on December 19, 2022).
- ESPLANADE QUÉBEC. 2023. *Collision. Réussir le lancement de votre projet d'impact*. [Online]: <https://esplanade.quebec/accompagnement/nos-programmes/collision/> (Accessed on January 27, 2023).
- FEDERATION OF CANADIAN MUNICIPALITIES (FCM). 2023. *La FCM annonce les lauréats des Prix des collectivités durables 2022 de la FCM*. [Online]: <https://fcm.ca/fr/nouvelles-et-medias/communiquel/la-fcm-annonce-les-laureats-des-prix-des-collectivites-durables-2022> (Accessed on January 20, 2023).
- FINGZ. 2023. *Qui sommes-nous*. [Online]: <https://www.fingz.fr/> (Accessed on January 12, 2023).
- FONDACTION. 2022. *Fonds économie circulaire, financement et accompagnement*. [Online]: <https://www.fondaction.com/fonds-economie-circulaire/> (Accessed on January 12, 2023).

- FONDS ÉCOLEADER. 2021. *Découvrir le Fonds Écoleader*. [Online]: <https://www.fondsecoleader.ca/decouvrir-le-fonds/> (Accessed on December 19, 2022).
- GREEN MUNICIPAL FUND. n.d. *Subvention pour le suivi et l'analyse d'un bâtiment communautaire*. [Online]: <https://fondsmunicipalvert.ca/financement/subvention-suivi-analyse-batiment-communautaire> (Accessed on march 17, 2023).
- GOVERNEMENT DU QUÉBEC. 2023. *Fonds d'initiatives nordiques*. [Online]: <https://www.quebec.ca/gouvernement/politiques-orientations/developpement-territoire-nordique/aide-financiere/fonds-initiatives-nordiques> (Accessed on January 26, 2023).
- GOVERNEMENT DU QUÉBEC. 2022. *Règlement visant l'élaboration, la mise en œuvre et le soutien financier d'un système de consigne de certains contenants*. [Online]: <https://www.legisquebec.gouv.qc.ca/fr/document/rc/Q-2,%20r.%2016.1%20/> (Accessed on March 31, 2023).
- EEYOU ISTCHEE JAMES BAY REGIONAL GOVERNMENT (EIJBRG). 2023a. *Territory*. [Online]: <https://greibj-eijbrg.com/en/regional-government/territoire> (Accessed on February 17, 2023).
- EEYOU ISTCHEE JAMES BAY REGIONAL GOVERNMENT (EIJBRG). 2023b. Représentant jamésien. [Online] : <https://www.greibj-eijbrg.com/fr/58-service2> (Accessed on February 16, 2023).
- INSERTECH. 2022. *À propos d'Insertech*. [Online]: <https://www.insertech.ca/a-propos> (Accessed on November 2, 2022).
- CANADIAN AGRI-FOOD POLICY INSTITUTE (CAPI). 2019. *L'agriculture efficace en tant que fournisseur de solutions aux gaz à effet de serre*. [Online]: https://capi-icpa.ca/wp-content/uploads/2019/09/2019-09-16-CAPI-fournisseur-solutions-GES-Fr_WEB.pdf (Accessed on January 12, 2023).
- INSTITUTE FOR PRODUCT DEVELOPMENT (IPD). 2016. *L'écoconception chez Lumec dans 10 cas succès d'écoconception*. [Online]: https://www.idp-innovation.com/wp-content/uploads/pdf/10-CAS-SUCCESS_ECOCONCEPTION_IDP.pdf (Accessed on January 12, 2023).
- INSTITUT DE L'ENVIRONNEMENT, DU DÉVELOPPEMENT DURABLE ET DE L'ÉCONOMIE CIRCULAIRE (Institut EDDEC). 2018. *Schémas de l'économie circulaire*. [Online]: https://www.recyc-quebec.gouv.qc.ca/sites/default/files/default_images/schema-economie-circulaire-mars2020.png (Accessed on february 24, 2023).
- LA REMISE. 2022. *Notre mission*. [Online]: <https://laremise.ca/la-remise/notre-mission/> (Accessed on December 22, 2022).
- LA RUCHE. 2021. *Le Fonds Moins c'est plus : Moins d'empreinte, plus d'impact!* [Online] : <https://laruchequebec.com/fr/nouvelles/article/le-fonds-moins-cest-plus--moins-dempreinte-plus-dimpact> (Accessed on January 12, 2023).
- LE PARTAGE CLUB. 2023. *À propos*. [Online]: <https://www.partage.club/> (Accessed on January 12, 2023).
- LE VÉLO VERT. 2023. [Online]: <https://www.levelovert.com/> (Accessed on 12 janvier 2023).
- LOOP MISSION. 2023. *À propos de nous*. [Online]: <https://loopmission.com/fr/pages/about> (Accessed on January 12, 2023).
- MACLEOD, P. 2018. *Initiatives de gestion des matières résiduelles à Mistissini. Présentation au Colloque sur la gestion des matières résiduelles*. First Nations of Quebec and Labrador Sustainable Development Institute. Janvier 2018.
- MASKI RÉCOLTE. 2023. *Mission*. [Online]: <https://www.maskirecolte.com/> (Accessed on January 12, 2023).
- MINISTÈRE DE L'ÉCOLOGIE, DU DÉVELOPPEMENT DURABLE ET DE L'ÉNERGIE (MEDDE). 2014. *Comptabilité des flux de matières dans les régions et les départements - Guide méthodologique*.

[Online]: <https://www.ecologie.gouv.fr/sites/default/files/EIT%20-%20comptabilite%20des%20flux%20de%20matieres.pdf> (Accessed on April 13, 2022).

MINISTÈRE DE L'ÉCONOMIE, DE L'INNOVATION ET DE L'ÉNERGIE (MEIE). 2023. *S'informer, Par région*. [Online]: <https://www.economie.gouv.qc.ca/objectifs/informer/par-region> (Accessed on January 11, 2023).

MINISTÈRE DE L'ENVIRONNEMENT ET DE LA LUTTE CONTRE LES CHANGEMENTS CLIMATIQUES (MELCC). 2020. *Stratégie de valorisation de la matière organique*. [Online]: <https://www.environnement.gouv.qc.ca/matieres/organique/strategie-valorisation-matiere-organique.pdf> (Accessed on September 6, 2022).

MINISTÈRE DE L'ENVIRONNEMENT, DE LA LUTTE CONTRE LES CHANGEMENTS CLIMATIQUES, DE LA FAUNE ET DES PARCS (MELCCFP). 2023a. *Modernisation des systèmes québécois de consigne et de collecte sélective*. [Online]: <https://www.environnement.gouv.qc.ca/matieres/consigne-collecte/index.htm> (Accessed on March 13, 2023).

MINISTÈRE DE L'ENVIRONNEMENT, DE LA LUTTE CONTRE LES CHANGEMENTS CLIMATIQUES, DE LA FAUNE ET DES PARCS (MELCCFP). 2023b. *ÉcoPerformance*. [Online]: <https://transitionenergetique.gouv.qc.ca/affaires/programmes/ecoperformance> (Accessed on December 22, 2023).

MINISTÈRE DE L'ENVIRONNEMENT, DE LA LUTTE CONTRE LES CHANGEMENTS CLIMATIQUES, DE LA FAUNE ET DES PARCS (MELCCFP). 2023c. *Bioénergie*. [Online]: <https://transitionenergetique.gouv.qc.ca/affaires/programmes/bioenergies#:~:text=Le%20programme%20Bio%C3%A9nergies%20est%20offert,de%20conversion%20%C3%A0%20une%20bio%C3%A9nergie.> (Accessed on December 22, 2023).

MINISTÈRE DE L'ENVIRONNEMENT, DE LA LUTTE CONTRE LES CHANGEMENTS CLIMATIQUES, DE LA FAUNE ET DES PARCS (MELCCFP). 2022a. *Loi sur la qualité de l'environnement. Règlement sur l'enfouissement et l'incinération des matières résiduelles*. [Online]: <https://www.legisquebec.gouv.qc.ca/fr/document/rc/Q-2,%20r.%2019%20/#:~:text=145%3B%20D.-,451%2D2011%2C%20a.,des%20articles%2020%20%C3%A0%2024> (Accessed on April 13, 2022).

MINISTÈRE DE L'ENVIRONNEMENT, DE LA LUTTE CONTRE LES CHANGEMENTS CLIMATIQUES, DE LA FAUNE ET DES PARCS (MELCCFP). 2022b. *Programme Roulez vert*. [Online]: <https://vehiculeselectriques.gouv.qc.ca> (Accessed on 11 janvier 2023).

MINISTÈRE DE L'ENVIRONNEMENT, DE LA LUTTE CONTRE LES CHANGEMENTS CLIMATIQUES, DE LA FAUNE ET DES PARCS (MELCCFP). 2022c. *Règlement concernant la valorisation de matières résiduelles*. [Online]: <https://www.legisquebec.gouv.qc.ca/fr/document/rc/Q-2,%20r.%2049%20/> (Accessed on August 17, 2022).

MINISTÈRE DE L'ENVIRONNEMENT, DE LA LUTTE CONTRE LES CHANGEMENTS CLIMATIQUES, DE LA FAUNE ET DES PARCS (MELCCFP). 2022d. *Programme de traitement des matières organiques par biométhanisation et compostage*. [Online]: <https://www.environnement.gouv.qc.ca/matieres/organique/strategie-valorisation-matiere-organique.pdf> (Accessed on September 1, 2022).

MINISTÈRE DES FORÊTS, DE LA FAUNE ET DES PARCS (MFFP). 2021. *Programme d'aménagement durable des forêts*. [Online]: https://cdn-contenu.quebec.ca/cdn-contenu/forets/documents/CN_programme_aménagement_durable_foret_MFFP.pdf?1646923697 (Accessed on January 11, 2023).

MINISTÈRE DES TRANSPORTS ET DE LA MOBILITÉ DURABLE (MTMD). 2023. *Programme Écocamionnage*. [Online]: <https://www.transports.gouv.qc.ca/fr/aide-finan/entreprises-camionnage/aide-ecocamionnage/Pages/aide-ecocamionnage.aspx#:~:text=Le%20programme%20%C3%89cocamionnage%20vise%20%C3>

%A0,utilisation%20d'%C3%A9nergies%20de%20remplacement (Accessed on January 11, 2023).

- MORRIS, A. 2016. *L'analyse de flux de matières au Québec : Méthodes et enjeux d'opérationnalisation dans une perspective d'économie circulaire*. [Online]: https://savoirs.usherbrooke.ca/bitstream/handle/11143/8173/Morris_Audrey_MEnv_2016.pdf?sequence=1&isAllowed=y (Accessed on November 7, 2021).
- MRC DE JOLIETTE. 2017. *Nos services : Emprunt de la camionnette électrique*. [Online]: <https://mrcjoliette.qc.ca/votre-mrc/camionnette-electrique/> (Accessed on January 12, 2023).
- MRC DE MANICOUAGAN ET RÉGIE DE GESTION DES MATIÈRES RÉSIDUELLES DE MANICOUAGAN. 2021. *Projet de plan de gestion des matières résiduelles (PPGMR) 2022-2029*. [Online]: https://regiemanicouagan.qc.ca/wp-content/uploads/2022/06/24_01_2022_Projet-de-PGMR-revise-Manicouagan-2021-Complet.pdf (Accessed on March 22, 2023)
- CREE HUNTERS AND TRAPPERS INCOME SECURITY BOARD (CHTISB). 2018. *Working together to guarantee the next generation of land users: The Income Security Program*. Chisasibi.
- PHARE CLIMAT. n.d.-a *Collecter les matières organiques chez les grands générateurs, Ville de Drummondville*. [Online]: <https://www.phareclimat.com/387-collecter-les-matieres-organiques-chez-les-grands-generateurs> (Accessed on January 12, 2023).
- PHARE CLIMAT. n.d.-b *Valoriser les biosolides issus du traitement des eaux usées, Ville de Repentigny*. [Online]: <https://www.phareclimat.com/338-valoriser-les-biosolides-issus-du-traitement-des-eaux-usees> (Accessed on January 12, 2023).
- PISCINE ET SPA POSÉIDON. 2023. *Spas réusinés*. [Online]: <https://www.psposeidon.com/spas-reusines/spa-poseidon> (Accessed on January 12, 2023).
- PÔLE QUÉBÉCOIS DE CONCERTATION SUR L'ÉCONOMIE CIRCULAIRE. 2016. *Définition de l'économie circulaire*. [Online]: <https://www.quebeccirculaire.org/static/h/issues-and-definition.html>
- PRANA FOODS. n.d. *Une petite graine aux grandes ambitions!* [Online]: <https://pranafoods.ca/fr/pages/regenerative-pumpkin-seeds> (Accessed on January 12, 2023).
- QUÉBEC CIRCULAIRE. 2023. *Québec circulaire et RECYC-QUÉBEC vous proposent un répertoire d'initiatives locales en économie circulaire*. [Online]: <https://www.quebeccirculaire.org/initiative/#page1:local> (Accessed on January 12, 2023).
- QUÉBEC CIRCULAIRE. 2022a. *Couturière volante dans le réseau des friperies de La Matanie*. [Online]: <https://www.quebeccirculaire.org/initiative/h/couturiere-volante-dans-le-reseau-des-friperies-de-la-matanie.html> (Accessed on December 22, 2022).
- QUÉBEC CIRCULAIRE. 2022b. *Valorisation des bouteilles de 18 litres de plastique utilisées comme mini serres en champs*. [Online]: <https://www.quebeccirculaire.org/initiative/h/valorisation-des-bouteilles-de-18-litres-de-plastique-utilisees-comme-mini-serres-en-champs.html> (Accessed on January 12, 2023).
- QUÉBEC CIRCULAIRE. 2022c. *Transformation et valorisation des déchets plastiques : solution pour une économie circulaire des plastiques*. [Online]: <https://www.quebeccirculaire.org/initiative/h/transformation-et-valorisation-des-dechets-plastiques-solution-pour-une-economie-circulaire-des-plastiques.html> (Accessed on December 23, 2022).
- QUÉBEC CIRCULAIRE. 2021a. *Récupération de chaleur au centre de distribution*. [Online]: <https://www.quebeccirculaire.org/initiative/h/recuperation-de-chaleur-au-centre-de-distribution.html> (Accessed on January 12, 2023).

- QUÉBEC CIRCULAIRE. 2021b. *Des pièces électromécaniques deviennent du matériel pédagogique !* [Online]: <https://www.quebeccirculaire.org/initiative/h/des-pieces-electromecaniques-deviennent-du-materiel-pedagogique.html> (Accessed on January 12, 2023).
- QUÉBEC CIRCULAIRE. 2020. *Retournzy - Réseau de partage de contenants réutilisables consignés pour la restauration.* [Online]: <https://www.quebeccirculaire.org/initiative/h/retournzy-reseau-de-partage-de-contenants-reutilisables-consignes-pour-la-restauration.html> (Accessed on January 12, 2023).
- RADIO-CANADA. 2022a. *Intérêt croissant pour les frigos communautaires.* [Online]: <https://ici.radio-canada.ca/ohdio/premiere/emissions/bon-pied-bonne-heure/segments/entrevue/427601/entrevue-frigo-communautaire> (Accessed on January 12, 2023).
- RADIO-CANADA. 2022b. *Planter des crabes.* La Semaine Verte, épisode du 30 avril 2022. [Online]: <https://ici.radio-canada.ca/tele/la-semaine-verte/site/segments/reportage/399762/residus-marins-compost-iles-de-la-madeleine> (Accessed on January 12, 2023).
- RADIO-CANADA. 2020. *La biomasse forestière pour s'affranchir du propane.* [Online]: <https://ici.radio-canada.ca/nouvelle/1523420/biomasse-forestiere-combustible-remplacement-propane-viandes-biologiques-charlevoix> (Accessed on March 9, 2023).
- RADIO-CANADA. 2017. *Une porcherie des Viandes biologiques de Charlevoix rasée par les flammes.* [Online]: <https://ici.radio-canada.ca/nouvelle/1064720/incendie-porcherie-viandes-biologiques-charlevoix-saint-hilarion> (Accessed on March 9, 2023).
- RECYC-QUÉBEC. 2023a. *Foire aux questions.* [Online]: <https://www.recyc-quebec.gouv.qc.ca/entreprises-organismes/mieux-gerer/consigne/foire-aux-questions#modernisation-de-la-consigne> (Accessed on March 31, 2023).
- RECYC-QUÉBEC. 2023b. *Programme de soutien aux communautés isolées.* [Online]: <https://www.recyc-quebec.gouv.qc.ca/entreprises-organismes/mieux-gerer/aide-financiere-entreprises-organismes/programme-communautaires-isolees> (Accessed on January 12, 2023).
- RECYC-QUÉBEC. 2023c. *Recyclage (compostage) des résidus verts et alimentaires, Campagne La vie en brun.* [Online]: <https://www.recyc-quebec.gouv.qc.ca/municipalites/matieres-organiques/recyclage-residus-verts-alimentaires> (Accessed on January 23, 2023).
- RECYC-QUÉBEC. 2023d. Bilan 2021 de la gestion des matières résiduelles au Québec - L'élimination. [Online]: <https://www.recyc-quebec.gouv.qc.ca/sites/default/files/documents/bilan-gmr-2021-elimination.pdf> (Accessed on March 9, 2023).
- RECYC-QUÉBEC. 2022a. L'économie circulaire, une priorité [Online]: <https://www.recyc-quebec.gouv.qc.ca/entreprises-organismes/mieux-gerer/economie-circulaire/> (Accessed on December 21, 2022).
- RECYC-QUÉBEC. 2022b. *Outil 1.3.2 : Schémas, définitions et exemples.* [Online]: <https://www.recyc-quebec.gouv.qc.ca/sites/default/files/documents/1.3.2-schemas-definitions-exemples-fdr-ec.pptx> (Accessed on December 19, 2022).
- RÉEMPLOI +. 2022a. *De l'écocentre aux tablettes.* [Online]: <https://www.reemploi.ca/comment-contribuer/de-l-ecocentre-aux-tablettes> (Accessed on November 16, 2022).
- RÉEMPLOI +. 2022b. *À propos.* [Online]: <https://www.reemploi.ca/> (Accessed on November 16, 2022).
- RÉGIE DE GESTION DES MATIÈRES RÉSIDUELLES DU LAC-SAINT-JEAN. 2022. *Le service ÉcoDon.* [Online]: <https://www.rmrlac.qc.ca/ecodon> (Accessed on November 16, 2022).
- RELATIONS COURONNES-AUTOCHTONE ET AFFAIRES DU NORD CANADA (AADNC). 2016. Profil des Premières Nations (Mistissini). [Online]: https://fnp-ppn.aadnc-aandc.gc.ca/fnp/Main/Search/FNMain.aspx?BAND_NUMBER=8&lang=fra (Accessed on December 8, 2021).

- RÉSEAU DES SADC (COMMUNITY FUTURES DEVELOPMENT CORPORATIONS) ET CAE (BUSINESS DEVELOPMENT CENTRES). 2021. *Virage Vert Program*. [Online]: sadc-cae.ca/en/virage-vert-program/ (Accessed on January 22, 2023).
- RETOURNZY. 2023. *À propos*. [Online]: <https://retournzy.ca/a-propos/> (Accessed on January 12, 2023).
- ROCHETTE, M. 2022. *Groupe Bellemare ou voir l'avenir en... verre*. [Online]: <https://www.lenouvelliste.ca/2022/10/25/groupe-bellemare-ou-voir-lavenir-en-verre-video-f2434e3c97608d98246e214f06eb70ca> (Accessed on January 12, 2023).
- ROSSIGNOL. 2022. *The essential, le ski à haut potentiel de recyclabilité, éco-conçu et fabriqué dans les Alpes*. [Online]: <https://www.rossignol.com/essential> (Accessed on December 22, 2023).
- SAUVE TA BOUFFE. 2020. *Répertoire des frigos communautaires du Québec*. [Online]: <https://sauvetabouffe.org/boite-a-outils/repertoire-des-frigos-communautaires-du-quebec> (Accessed on January 12, 2023).
- SIMAX. 2021. *Mobilier urbain*. [Online]: <https://www.simax.ca/mobilier-urbain> (Accessed on January 12, 2023).
- SOCIÉTÉ DU PLAN NORD (SPN). 2022. Communication personnelle.
- SOLUTION ERA. 2023. *Habitat écologique*. [Online]: <https://solutionera.com/habitat-ecologique/> (Accessed on January 17, 2023).
- STATISTICS CANADA. 2021. *Population of Mistissini (Quebec). 2016 Census*. [Online]: <https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CSD&Code1=2499804&Geo2=PR&Code2=24&SearchText=Nord-du-Quebec&SearchType=Begins&SearchPR=01&B1=Population&type=0&wbdisable=true> (Accessed on February 23, 2023).
- STATISTIQUE CANADA. 2022. *Population de Mistissini (Québec). Recensement de 2021*. [Online]: <https://www12.statcan.gc.ca/census-recensement/2021/dp-pd/prof/details/page.cfm?Lang=F&SearchText=Mistissini&DGUIDlist=2021A00052499804&GENDERlist=1,2,3&STATISTIClist=1&HEADERlist=0> (Accessed on July 2022).
- UNIVERSITÉ DE MONTRÉAL. 2022. *UNIVERCYCLO - Vélocation*. [Online]: <https://velo-udem.com/velocation/> (Accessed on December 22, 2022).
- VILLE DE DRUMMONDVILLE. 2018. *Implantation de la collecte des matières organiques chez les grands générateurs à vocation alimentaire*. [Online]: https://www.phareclimat.com/uploads/initiative/387/387_document.pdf (Accessed on January 12, 2023).
- VISION BIOMASSE QUÉBEC. 2022. *Vitrine de projets – Municipalité de Causapsca*. [Online]: <https://visionbiomassequebec.org/projets/municipalite-de-causapsca/> (Accessed on March 9, 2023).

Appendix A

ICI list



Table 1 : Mistissini ICI list

| ICI Name | North American Industry Classification System (NAICS) description |
|---|---|
| Adels Restaurant | Full-service restaurants |
| Apatisiwin Skills Development - Mistissini | Aboriginal public administration |
| Mistassini Outfitting Camps inc. | Business associations |
| Atuscheu Contractors inc. | Industrial building and structure construction |
| Auberge Mistissini Lodge | Motels |
| Big Rock Sports & Grill | Full-service restaurants |
| Awessha Store | Industrial Machinery, Equipment and Supplies Wholesaler-Distributors |
| Caisse Desjardins Eenou Eeyou - Mistissini | Local credit unions |
| Mista Hotdog | Mobile food services |
| Gordon Sandy Memorial Youth Center | Fitness and recreational sports centres |
| Centre des services et à la famille Awash | Child day-care services |
| Mistissini Sports & Recreation | Sports stadiums and other presenters with facilities |
| Chiiwetin Gas Station | Gasoline stations with convenience stores |
| CINI-FM Mistissini Lake | Radio broadcasting |
| Conseil Cri de la santé et des services sociaux de la Baie James - Mistissini | All other residential care facilities |
| Cree Source for sports | Sporting goods stores |
| Cree Tech Management | All other miscellaneous store retailers (except beer and wine-making supplies stores) |
| Cree Trappers Association - Mistissini | Business associations |
| Coonishish, Minnie | Gift, novelty and souvenir stores |
| D.S. MacLeod, business consultant | Other business support services |
| Diamants Stornoway - Mistissini | Diamond mining |
| Voyageur Memorial Elementary School | Elementary and secondary schools |
| Voyageur Memorial High School | Elementary and secondary schools |
| Eenatuk Forestry Corporation | Logging (except contract) |
| Eenou Taxi | Taxi service |
| Eenou Béton Ltée | Ready-mix concrete manufacturing |
| Entreprises Mistay Inc. | All other traveller accommodation |
| EnviroCree ltd | Environmental consulting services |
| Eskan Company | Residential building construction |
| Exploration Coon-Come Inc. | Other support activities for mining |
| Firme RJPET | Administrative management and general management consulting services |
| Gestion ADC Inc. | Janitorial services (except window cleaning) |
| Gestion CBCC Inc. | Commercial and institutional building construction |
| Gestion Mistishebe S.E.C. | Full-service restaurants |
| Gîte Bella | Motor hotels |
| James Bay Cree Communications | Radio broadcasting |
| KESI Construction | Industrial building and structure construction |
| L'Assemblée de l'eau vivante | Social advocacy organizations |
| Mistassini Outfitting Camps inc. | Recreational (except hunting and fishing) and vacation camps |

| ICI Name | North American Industry Classification System (NAICS) description |
|--|--|
| Les Entreprises JCQ | Car washes |
| Les Entreprises Yoshtin Inc. | Hunting and fishing camps |
| Mats Électrique | Electrical contractors |
| M.Y. Construction Inc. | Surveying and mapping (except geophysical) services |
| M.Y. Surveying Inc. | Surveying and mapping (except geophysical) services |
| Makaahiikan Construction | Residential building construction |
| Matoush Tire Shop | Tire dealers |
| Meechum L'Inter Marché | Supermarkets and other grocery (except convenience) stores |
| Mista Hotdog | Limited-service eating places |
| Mistissini Native Women Association Inc. | Civic and Social Organizations |
| Mistissini Readaptation Center | Child and youth services |
| Naococane Construction | Commercial and institutional building construction |
| Cree nation of Mistissini | Aboriginal public administration |
| Neeposh Enterprises Reg'd | Support activities for forestry |
| Nisk Construction - Mistissini | Industrial building and structure construction |
| Pimii Plus (Esso) | Gasoline stations with convenience stores |
| Postes Canada - Mistissini | Postal services |
| R & D Eenou Lumber Inc. | Home centres |
| Restaurant Lake View s.e.n.c. | Full-service restaurants |
| Réparation d'auto GB | General automotive repair |
| Richard Shecapio Consultant | Administrative management and general management consulting services |
| Sabtuan Adult Education Services | All other schools and instruction |
| Service Consultant Linda L. Shecapio | Administrative management and general management consulting services |
| Service de police Eeyou Eenou - Mistissini | Municipal police services |
| Service du commerce et de l'industrie | Aboriginal public administration |
| Services de campements Kiskinchiish | Janitorial services (except window cleaning) |
| S.N. Land Works | Landscaping services |
| Solution Aamuu S.E.N.C. | Computer systems design and related services |
| Swallow-Fournier Inc. | Other heavy and civil engineering construction |
| Transitional Elders Home | Community care facilities for the elderly |
| Transport M. Mark | General freight trucking, local |
| Travaux Eenou Inc. | Industrial building and structure construction |
| Vachon-Roseberry, David | Offices of lawyers |
| Waasheshkun Airways | Scheduled air transportation |
| Waasteskun Inc. | Caterers |
| Wachihih Ressources | Environmental consulting services |
| Wapachee & Son | General freight trucking, long distance, truck-load |

Source : SPN, 2022

Appendix B

Questionnaires





1 Information about the project

RECYC-QUÉBEC and his partners, the ministère de l'Énergie et des Ressources naturelles (MERN) and the Société du Plan Nord (SPN) has tasked Englobe to carry out a material flow analysis (MFA) as part of a project focused on circular economy prospects in various communities located north of the 49th parallel. For this project, Englobe will calculate all resources (energy, water, consumer goods, extracted materials, etc.) that enter, leave or are produced in the community. The purpose of this survey is to better understand the inputs and outputs of materials. With this information, Englobe will be able to create a profile of your community and propose actions to optimize resource and waste management, from a circular economy perspective. A report will be submitted which will benefit the whole community. A report will be submitted which will benefit the whole community.

Englobe would like to ask for your participation in this project. Please note that any information provided is kept strictly confidential. Only the total volume or weight results for the entire community will be included in the publicly available final report. If you have any questions, please don't hesitate to contact us anytime at (418) 781-0191, extension 105441 (Jean-Luc Bugnon). Please return the survey by email: jean-luc.bugnon@englobecorp.com.

Englobe would like to speak with you and thank you for your participation. If needed, we are available to answer your questions or help you answer the survey.

2 Glossary

Circular economy: A system of production, exchange and consumption aimed at optimizing the use of resources at all stages of the life cycle of a good or service, with circular logic, while reducing the environmental footprint and contributing to the well-being of individuals and communities.

Extended Producer Responsibility (EPR): The principle that companies that market products in Quebec are responsible for their end-of-life management. In Quebec, the products covered by EPR are: oils, antifreeze, coolants (including containers and filters), mercury lamps, paints (including containers), batteries, electronic products, household and air conditioning appliances.

Inputs: All materials, objects and resources that enter your organization in order to accomplish your activities or operations (raw materials, tools, equipment, goods, etc.).

Outputs: Manufactured products (drinking water) as well as all types of residual materials generated by municipal activities and also by the community as a whole (organic materials, recyclable materials, waste), and also wastewater, heat, etc.

Residual hazardous materials: Corrosive, toxic, explosive or flammable products, on which the danger pictograms can be found

3 Municipality Identification

| | | | |
|----------------------------------|---------|----------------------|--|
| Name of the municipality: | | Number of employees: | |
| Brief description of activities: | | | |
| Address: | | | |
| Contact person: | Name: | Telephone: | |
| | E-mail: | | |

4 Issues Specific to Municipal Activities

This section is about the services provided by the municipality. All questions are for the year 2021 and are limited to your community.

| | | |
|---------------|---|--|
| POTABLE WATER | What is the volume of potable water produced by the municipality per year? | |
| | What type of waste is generated by the potable water filtration/ chlorination systems? Please specify the quantity of waste. | |
| | Do you have any clients that consume large volumes of this water? If yes, please specify their name. | |
| | How are biosolids managed? (Please include the quantity and (%) humidity). | |
| ROADS | During an average year, how many new streets are added to the road network? (In metres or kilometres) | |
| | What is the length of the road network managed by the municipality (during 2021)? | |

| | | |
|-------|---|--|
| ROADS | During an average year, how much asphalt is used for the repair or maintenance of the existing roads? | |
| | What types of road winter abrasives are used by the Municipality and in what quantity (during 2021)? | |
| OTHER | Do you have any building or storage space that is not currently in use? If yes, please specify. | |

5 Vehicle Fleet

This section is about the municipal vehicle fleet (if any), during the year 2021.

| Type | Number | Average annual milage travelled per vehicle (km) | Type | Number | Average annual milage travelled per vehicle (km) |
|------------------|--------|--|---------------------------|--------|--|
| Car | | | Heavy machinery (specify) | | |
| Van | | | Other (specify) | | |
| Heavy-duty truck | | | | | |

Do you have any fossil fuel service stations? If yes, specify the type of product distributed, the size of the tanks and the volume of fossil fuel distributed.

Do you plan to replace any fleet vehicles with electric or hybrid equivalent vehicles? If yes, please specify:

6 Inputs used the municipal government

The purpose of this section is to identify all the inputs and resources used by your organization to carry out its activities and operations. The activities in this section have been divided into two areas : (1) offices and city hall and (2) activities related to public works, municipal workshops and garages.

The quantities listed in this survey may be expressed in weight (kilograms, pounds, tonnes, etc.) or in volume (cubic metres, cubic feet, barrels, litres, etc.). It is very important to indicate the unit of measurement. The quantities listed are those of the year 2021.

The column relating the « Origin and transportation type » is to learn about the way imports are transferred to your municipality (truck, boat, airplane) and the country or region they come from. This information will also be used to identify the type of energy used during your activities.

Offices / City Hall

| Resource Category | Input Description | Estimated quantities (year 2021) - <i>Include unit of measurement.</i> | Origin and transportation medium (boat, truck, airplane, etc.) |
|---|-------------------|--|--|
| Materials used to provide the service Feel free to add lines if needed. | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| Other inputs that are necessary or supplementary to the activities (water, stationery, furniture, food, clothing, etc.) | | | |
| | | | |
| | | | |
| | | | |
| Energy (diesel, oil, gas, wood, etc.) | | | |
| Annual electricity consumption (kW/h) | | | |

Garages / Municipal workshops / public works

| Resource Category | Input description | Estimated quantities (for 2021) - <i>Include unit of measurement.</i> | Origin and transportation medium (boat, truck, airplane, etc.) |
|--|-------------------|---|--|
| Materials used to provide the service Feel free to add lines if needed. | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| Other inputs that are complementary or incidental to the activities (water, stationery, furniture, food, clothing, etc.) | | | |
| | | | |
| | | | |
| | | | |
| Energy (diesel, oil, gas, wood, etc.) | | | |
| Annual electricity consumption (kW/h) | | | |

7 Outputs Generated by the Municipal Government

The purpose of this section is to identify all outputs and by-products that are generated by municipal operations. The outputs include excavated materials, waste collected from street cleaning, food waste, packaging, construction and demolition waste, hazardous materials, used oil, etc. “Management Method” refers to how the outputs are managed. For example, they may have been collected for disposal or recycle, or they may have been sold or donated for reuse, repair or energy recovery.

Outputs associated with offices / City Hall

| Type of output | Estimated quantity (year 2021) <i>Include unit of measurement.</i> | Management Method (e.g., sold or donated for reuse, sent for recycling, sent for composting sent for energy recovery, sent to landfill, etc.) | Destination (specify if the organization associated with the output is within or outside the community) |
|---|--|---|--|
| Organic material, food waste | | | |
| Cardboard packaging | | | |
| Other collected materials (paper, glass, metal, plastic)? <i>Please specify which ones.</i> | | | |
| Miscellaneous household waste | | | |
| Textiles | | | |
| Wood waste (construction wood, pallets, etc.) | | | |
| Construction, renovation and demolition waste (excluding wood waste) | | | |
| Extended Producer Responsibility products (specify which ones) | | | |
| Hazardous waste (specify) | | | |
| Other (heat, waste dust, etc.) <i>Please specify:</i> | | | |

Outputs associated with garages / municipal workshops / public works

| Type of output | Estimated quantity (2021) indicate the unit of measurement | Management Method (e.g., sold or donated for reuse, sent for recycling, sent for composting sent for energy recovery, sent to landfill, etc.) | Destination (specify if the organization associated with the output is within or outside the community) |
|--|---|--|---|
| Excess soil, rock or gravel | | | |
| Organic material, food waste | | | |
| Cardboard packaging | | | |
| Other collected materials (paper, glass, metal, plastic). Please specify which ones. | | | |
| Miscellaneous waste and household waste | | | |
| Textiles | | | |
| Concrete and asphalt waste | | | |
| Wood waste (construction wood, pallets, etc.) | | | |
| Construction, renovation and demolition waste | | | |
| Extended Producer Responsibility products (specify which ones) | | | |
| Hazardous waste (specify) | | | |
| Other (heat, waste dust, etc.) Specify: | | | |

8 Community waste management statement

At a community level, what waste materials were generated in the year 2021 (or the most recent year for which data is available)? If necessary, provide separate documents.

| Type of waste collected | Estimated quantity (2021) (specify the unit of measurement) | Management Method (e.g., sold or donated for reuse, sent for recycling, sent for composting sent for energy recovery, sent to landfill, etc.). | Destination (specify if the organization associated with the output is within or outside the community) |
|---|--|---|---|
| Waste collection | | | |
| Recyclable materials collection | | | |
| Organic materials collection (Brown bins) | | | |
| Leaf litter and green residues collection | | | |
| Christmas tree collection | | | |
| Bulky waste collection | | | |
| Household hazardous waste collection | | | |
| Voluntary materials collection (Eco Centre) | | | |
| EPR collection. <i>Please specify which.</i> | | | |
| Other, which: | | | |

10 Other questions related to circular economy

Do you have any waste materials in need a disposal solution? If so, which?

Do you have any waste management stories that you would like to share? If so, which?

Do you know if any of your assets/tools/equipment that could be improved or optimized? An example of this is the replacing equipment at the end of its lifecycle with more efficient or less energy consuming equipment. If so, please specify:

Do you have any equipment/vehicles/tools that are not used every day? If so, which ones?

Could these equipment/vehicles/tools be shared or rented to other organizations?

Do you consider environmental criteria when choosing your supplies and purchases (for example, local purchasing, eco-design, durability, ease of repair, recyclable, recycled content)? If so, which ones?

Have you taken any steps or actions towards having a circular economy? If so, which ones?



1 Information about the project

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Inputs: All materials, objects and resources that enter your organization in order to accomplish your activities or operations (raw materials, tools, equipment, goods, etc.).

Outputs: Products sold and any types of residual materials produced by the manufacturing activities. Examples include organic materials, recyclable materials, waste, and also wastewater and heat, among others.

Residual hazardous materials: Corrosive, toxic, explosive or flammable products, on which the danger pictograms can be found.

3 Business Identification

| | | | |
|----------------------------------|---------|----------------------|--|
| Name of the business: | | Number of employees: | |
| Brief description of activities: | | | |
| Address: | | | |
| Contact person: | Name: | Telephone: | |
| | E-mail: | | |

4 Inputs used by the Business

The purpose of this section is to identify all the inputs and resources used by your business to carry out its activities and operations. For example, for a bicycle shop, the inputs include new bicycles, metal parts, tires, bike accessories, etc. For a restaurant, the inputs include food, oil, etc.

The quantities listed in this survey may be expressed in weight (kilograms, pounds, tonnes, etc.) or in volume (cubic metres, cubic feet, barrels, litres, etc.). It is very important to indicate the unit of measurement. The quantities listed are those of the year 2021.

The column relating the « Origin and transportation type » is to learn about the way imports are transferred to your municipality (truck, boat, airplane) and the country or region they come from. This information will also be used to identify the type of energy used during your activities.

| Resource Category | Input Description | Estimated quantities (year 2021) - <i>Include unit of measurement.</i> | Origin and transportation medium (boat, truck, airplane, etc.) |
|---|-------------------|--|--|
| Materials used to provide the service Please add lines if needed | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

| Resource Category | Input Description | Estimated quantities (year 2021) - <i>Include unit of measurement.</i> | Origin and transportation medium (boat, truck, airplane, etc.) |
|---|-------------------|--|--|
| Other inputs that are necessary or supplementary to the activities (water, stationery, furniture, food, clothing, etc.) | | | |
| | | | |
| | | | |
| | | | |
| Energy (diesel, oil, gas, wood, etc.) | | | |
| Annual electricity consumption (kW/h) | | | |

5 Outputs generated by the Business

The purpose of this section is to identify all the outputs and by-products produced by your business activities. For a bicycle shop, the outputs include cardboard packaging and scrap metal. For a restaurant, the outputs include food waste, cardboard or plastic packaging, used oil, etc. The Management Method refers to how the outputs are managed. They may be collected for disposal or recycling. They could also be sold or donated for reuse, repair or energy recovery.

| Type of Output | Estimated quantity (year 2021) <i>Include unit of measurement.</i> | Management Method (e.g., sold or donated for reuse, sent for recycling, sent for composting sent for energy recovery, sent to landfill, etc.). | Destination (specify if the organization associated with the output is within or outside the community) |
|---|--|--|---|
| Materials or products sold | | | |
| Commercial waste (unsold, returned, expired, etc.) <i>Please specify:</i> | | | |
| Organic materials, food waste, green waste | | | |
| Cardboard packaging | | | |

| Type of Output | Estimated quantity (year 2021) <i>Include unit of measurement.</i> | Management Method (e.g., sold or donated for reuse, sent for recycling, sent for composting sent for energy recovery, sent to landfill, etc.). | Destination (specify if the organization associated with the output is within or outside the community) |
|--|---|---|---|
| Other collected materials (paper, glass, metal, plastic)? <i>Please specify which ones.</i> | | | |
| Plastic film and bags | | | |
| Miscellaneous household waste | | | |
| Textiles | | | |
| Wood waste (construction wood, pallets, etc.) | | | |
| Construction, renovation and demolition waste (excluding wood waste) | | | |
| Bulky waste (furniture, tires) | | | |
| EPR products. <i>Please specify which.</i> | | | |
| Scrap metal | | | |
| Hazardous waste <i>Please specify which.</i> | | | |
| Other (heat, water, biosolids, etc.). <i>Please specify which.</i> | | | |

6 Other questions related to circular economy

Do you have any waste materials in need a disposal solution? If so, which?

Do you have any waste management stories that you would like to share? If so, which?

Are the products and services you offer available for rent (short or long-term)? If so, please specify:

Do you know if any of your assets/tools/equipment that could be improved or optimized? An example of this is the replacing equipment at the end of its lifecycle with more efficient or less energy consuming equipment. If so, please specify:

Is there any equipment, process or operation that would be suitable for heat reuse? An example of this is heat exchangers. If so, which ones?

Do you have any equipment/vehicles/tools that are not used every day? If so, which ones?

Could these equipment/vehicles/tools be shared or rented to other organizations?

Do you have any buildings or storage space (indoor or outdoor) that are not fully utilized? If so, which ones?

Do you consider environmental criteria when choosing your supplies and purchases (for example, local purchasing, eco-design, durability, ease of repair, recyclable, recycled content)? If so, which ones?

Have you taken any steps or actions towards having a circular economy? If so, which ones?



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Inputs: All materials, objects and resources that enter your organization and are needed to accomplish your activities or operations (raw materials, tools, equipment, goods, etc.).

Outputs: Manufactured products and any types of residual materials produced by the manufacturing activities. Examples include organic materials, recyclable materials, waste, and also wastewater and heat, among others.

Residual hazardous materials: Corrosive, toxic, explosive or flammable products, on which the danger pictograms can be found

3 Manufacturer Identification

| | | | |
|----------------------------------|---------|----------------------|--|
| Name of the Manufacturer: | | Number of employees: | |
| Brief description of activities: | | | |
| Address: | | | |
| Contact person: | Name: | Telephone: | |
| | E-mail: | | |

4 Inputs used by the Manufacturer

The purpose of this section is to identify all the inputs and resources used by your manufacturing facility to carry out your activities and operations. For example, for a machine shop, the inputs would normally be steel, welding gas, electrodes, etc.

The quantities listed in this survey may be expressed in weight (kilograms, pounds, tonnes, etc.) or in volume (cubic metres, cubic feet, barrels, litres, etc.). It is very important to indicate the unit of measurement. The quantities listed are those of the year 2021.

The column relating the « Origin and transportation type » is to learn about the way imports are transferred to your municipality (truck, boat, airplane) and the country or region they come from. This information will also be used to identify the type of energy used during your activities.

| Resource Category (including water) | Input Description | Estimated quantities (year 2021) - <i>Include unit of measurement.</i> | Origin and transportation medium (boat, truck, airplane, etc.) |
|---|-------------------|--|--|
| Materials used to provide the service Please feel free to add lines if needed. | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

| Resource Category (including water) | Input Description | Estimated quantities (year 2021) - <i>Include unit of measurement.</i> | Origin and transportation medium (boat, truck, airplane, etc.) |
|---|-------------------|--|--|
| Other inputs that are necessary or supplementary to the activities (water, stationery, furniture, food, clothing, etc.) | | | |
| | | | |
| | | | |
| | | | |
| Energy (diesel, oil, gas, wood, etc.) | | | |
| Annual electricity consumption (kW/h) | | | |

5 Outputs produced by the Manufacturer

The purpose of this section is to identify all outputs and by-products that are produced by your activities. For a machine shop, the outputs would normally be the finished products, scrap metal, waste, air emissions, wastewater, etc. The Management Method refers to how the outputs are managed. For example, they may have been collected for disposal or recycle, or they may have been sold or donated for reuse, repair or energy recovery.

| Type of output | Estimated quantity (year 2021) <i>Please include unit of measurement.</i> | Management Method (e.g., sold or donated for reuse, sent for recycling, sent for composting sent for energy recovery, sent to landfill, etc.). | Destination (specify if the organization associated with the output is within or outside the community) |
|---|---|--|---|
| Manufactured products <i>Please specify:</i> | | | |
| Air emissions | | | |
| Wastewater | | | |

| Type of output | Estimated quantity (year 2021) <i>Please include unit of measurement.</i> | Management Method (e.g., sold or donated for reuse, sent for recycling, sent for composting sent for energy recovery, sent to landfill, etc.). | Destination (specify if the organization associated with the output is within or outside the community) |
|--|--|--|---|
| Organic material, food waste, green waste | | | |
| Cardboard packaging | | | |
| Other collected materials (paper, glass, metal, plastic). <i>Please specify which ones.</i> | | | |
| Plastic film and bags | | | |
| Miscellaneous household waste | | | |
| Textiles | | | |
| Wood waste (construction wood, pallets, etc.) | | | |
| Construction, renovation and demolition waste (excluding wood waste) | | | |
| Bulky waste (furniture, tires) | | | |

| Type of output | Estimated quantity (year 2021) <i>Please include unit of measurement.</i> | Management Method (e.g., sold or donated for reuse, sent for recycling, sent for composting sent for energy recovery, sent to landfill, etc.). | Destination (specify if the organization associated with the output is within or outside the community) |
|--|--|---|---|
| EPR products. <i>Please specify which.</i> | | | |
| Scrap metal | | | |
| Hazardous waste <i>Please specify which.</i> | | | |
| Other (heat, etc.) <i>Please specify which.</i> | | | |

6 Other Questions Related to Circular Economy

| |
|---|
| <p>Do you have any waste materials in need of a disposal solution? If so, which?</p> |
| <p>Do you have any waste management stories that you would like to share? If so, which?</p> |
| <p>Among your inputs needed, are there any materials that you would like to purchase locally (for example, within the community, region)? If so, which?</p> |

Are the products and services you offer available for rent (short or long-term)? If so, please specify:

Do you know if any of your assets/tools/equipment could be improved or optimized? An example of this is the replacing equipment at the end of its lifecycle with more efficient or less energy consuming equipment. If so, please specify:

Is there any equipment, process or operation that would be suitable for heat reuse? An example of this is heat exchangers. If so, which ones?

Do you have any equipment/vehicles/tools that are not used every day? If so, which ones?

Could these equipment/vehicles/tools be shared or rented to other organizations?

Do you have any buildings or storage space (indoor or outdoor) that are not fully utilized? If so, which ones?

Could these buildings / spaces be shared or rented?

Do you consider environmental criteria when choosing your supplies and purchases (for example, local purchasing, eco-design, durability, ease of repair, recyclable, recycled content)? If so, which ones?

All data and information are confidential.

Have you taken any steps or actions towards having a circular economy? If so, which ones?



1 Information about the project

RECYC-QUÉBEC and his partners, the ministère de l'Énergie et des Ressources naturelles (MERN) and the Société du Plan Nord (SPN) has tasked Englobe to carry out a material flow analysis (MFA) as part of a project focused on circular economy prospects in various communities located north of the 49th parallel. For this project, Englobe will calculate all resources (energy, water, consumer goods, extracted materials, etc.) that enter, leave or are produced in the community. The purpose of this survey is to better understand the inputs and outputs of materials. With this information, Englobe will be able to create a profile of your community and propose actions to optimize resource and waste management, from a circular economy perspective. A report will be submitted which will benefit the whole community.

Englobe would like to ask for your participation in this project. Please note that any information provided is kept strictly confidential. Only the total volume or weight results for the entire community will be included in the publicly available final report. If you have any questions, please don't hesitate to contact us anytime at **(418) 781-0191, extension 105441** (Jean-Luc Bugnon). Please return the survey by email: jean-luc.bugnon@englobecorp.com.

Englobe would like to speak with you and thank you for your participation. We are available to answer your questions or help you answer the survey.

2 Glossary

Circular economy: A system of production, exchange and consumption aimed at optimizing the use of resources at all stages of the life cycle of a good or service, with circular logic, while reducing the environmental footprint and contributing to the well-being of individuals and communities.

Extended Producer Responsibility (EPR): The principle that companies that market products in Quebec are responsible for their end-of-life management. In Quebec, the products covered by EPR are: oils, antifreeze, coolants (including containers and filters), mercury lamps, paints (including containers), batteries, electronic products, household and air conditioning appliances.

Inputs: All materials, objects and resources that enter your organization in order to accomplish your activities or operations (raw materials, tools, equipment, goods, etc.).

Outputs: Any type of residual materials generated by municipal activities and also by the community as a whole (organic materials, recyclable materials, waste). Outputs also include wastewater and heat.

Residual hazardous materials: Corrosive, toxic, explosive or flammable products, on which the danger pictograms can be found.

4 Institution Identification

| | | | |
|----------------------------------|---------|----------------------|--|
| Name of the institution: | | Number of employees: | |
| Brief description of activities: | | | |
| Address: | | | |
| Contact person: | Name: | Telephone: | |
| | E-mail: | | |

5 Inputs used by the Institution

The purpose of this section is to identify the inputs and resources that are used by the institution to carry out its activities. For example, for a school, the inputs are, among other items, teaching materials, cleaning products, food, etc.,

The quantities listed in this survey may be expressed in weight (kilograms, pounds, tonnes, etc.) or in volume (cubic metres, cubic feet, barrels, litres, etc.). It is very important to indicate the unit of measurement. The quantities listed are those of the year 2021.

The column relating the « Origin and transportation type » is to learn about the way imports are transferred to your municipality (truck, boat, airplane) and the country or region they come from. This information will also be used to identify the type of energy used during your activities.

| Resource Category | Input Description | Estimated quantities (year 2021) - <i>Include unit of measurement.</i> | Origin and transportation medium (boat, truck, airplane, etc.) |
|--|-------------------|--|--|
| Materials used to provide the service <i>Please add lines if needed</i> | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

| Resource Category | Input Description | Estimated quantities (year 2021) - <i>Include unit of measurement.</i> | Origin and transportation medium (boat, truck, airplane, etc.) |
|---|-------------------|--|--|
| Other inputs that are necessary or supplementary to the activities (water, stationery, furniture, food, clothing, etc.) | | | |
| | | | |
| | | | |
| | | | |
| Energy (diesel, oil, gas, wood, etc.) | | | |
| Annual electricity consumption (kW/h) | | | |

6 Outputs generated by the Institution

The purpose of this section is to identify the outputs and by-products produced by the institution's activities. For a school, the outputs include food waste, recyclable paper, construction, renovation and demolition waste, fluorescent lights, etc. The Management Method refers to how the outputs are managed. They may be collected for disposal or recycling. They could also be sold or donated for reuse, repair or energy recovery.

| Type of Output | Estimated quantity (year 2021) <i>Include unit of measurement.</i> | Management Method (e.g., sold or donated for reuse, sent for recycling, sent for composting sent for energy recovery, sent to landfill, etc.) | Destination (specify if the organization associated with the output is within or outside the community) |
|---|--|---|---|
| Organic materials, food waste, green waste | | | |
| Cardboard packaging | | | |
| Other collected materials (paper, glass, metal, plastic)? <i>Please specify which ones.</i> | | | |
| Plastic film and bags | | | |

| Type of Output | Estimated quantity (year 2021) <i>Include unit of measurement.</i> | Management Method (e.g., sold or donated for reuse, sent for recycling, sent for composting sent for energy recovery, sent to landfill, etc.) | Destination (specify if the organization associated with the output is within or outside the community) |
|---|---|---|---|
| Miscellaneous household waste | | | |
| Textiles | | | |
| Wood waste (construction wood, pallets, etc.) | | | |
| Construction, renovation and demolition waste (excluding wood waste) | | | |
| Bulky waste (furniture, tires) | | | |
| EPR products. <i>Please specify which.</i> | | | |
| Scrap metal | | | |
| Hazardous waste <i>Please specify which.</i> | | | |
| Other (heat, water, biosolids, etc.). <i>Please specify which.</i> | | | |

7 Other questions related to circular economy

Do you have any waste materials in need a disposal solution? If so, which?

Do you have any waste management stories that you would like to share? If so, which?

Do you know if any of your assets/tools/equipment could be improved or optimized? An example of this is the replacing equipment at the end of its lifecycle with more efficient or less energy consuming equipment. If so, please specify:

Is there any equipment, process or operation that would be suitable for heat reuse? An example of this is heat exchangers. If so, which ones?

Do you have any equipment/vehicles/tools that are not used every day? If so, which ones?

Could these equipment/vehicles/tools be shared or rented to other organizations?

Do you have any buildings or storage space (indoor or outdoor) that are not fully utilized? If so, which ones?

Could these buildings / spaces be shared or rented?

Do you consider environmental criteria when choosing your supplies and purchases (for example, local purchasing, eco-design, durability, ease of repair, recyclable, recycled content)? If so, which ones?

Have you taken any steps or actions towards having a circular economy? If so, which ones?

Appendix C

Characterization methodology



1 Characterization Methodology

1.1 Coordination meeting

The purpose of the coordination meeting was to bring together stakeholders and schedule site visits prior to the residual materials characterization. The meeting was an opportunity for those present to:

- Go over the project's background and objectives;
- Specify the role of each stakeholder (Englobe, the village administration, onsite workers, etc.);
- Explain the sorting area layout, the sorting methodology, and the residual material categories;
- Identify health and safety risks.

1.2 Equipment

The sorting area consisted of two tables on which the materials were placed for sorting. The scale was on a third table.

The scale used was an Ohaus model RC31P with a sensitivity of 0.001 kg (1 g), capable of weighing objects up to 30 kg.

The residual materials were sorted manually and then placed in 20-L plastic bins.

1.3 Sampling the materials

The collection truck had to unload the residual materials for sampling in a ribbon pattern on the ground. The materials were manually sampled on the ground using the 8-portion technique to randomly select from one of eight piles with the help of a mobile app.

Since the characterization lasted only one day and only one load was available, several portions of the same load were collected.

If the unloading and sorting locations were different, the collected materials were identified and placed in bins for transport to the sorting area.

1.4 Residual materials characterization

The residual materials were sorted into 42 categories grouped into five primary classes: recyclable materials; organic materials; construction, renovation and demolition (CRD) waste; household hazardous waste (HHW); and other.

The numbers in parentheses indicate the categories used by RECYC-QUÉBEC in the current study to characterize disposal of residual materials throughout the province.

1.4.1 Recyclable materials eligible for selective collection

The recyclable materials found in the sample were sorted into the following categories (with examples):

- Paper: office paper, newspapers, kraft paper, envelopes, magazines, flyers, photographs, paper bags, etc. (cats. 1, 2, 3, 4, 5, 6, 8 and 10);
- Recyclable cardboard: flat cardboard and corrugated, pressed cardboard (cats.7 and 9);
- Other paper and cardboard: laminated paper, composite containers, paper or cardboard sheets lined with a plastic or aluminum layer, composite containers (e.g., frozen juice), gable-top containers (milk cartons), Tetra Pak and laminated fibre containers for immediate consumption (cats. 11, 12, 13, 14 and 55);
- Nos. 1 to 5 plastics: non-refundable bottles and containers with caps and lids, seals, kettles, barrels and packaging nos. 1 to 5 (cats. 26, 27, 29, 31, 33, 35 and 54);
- Nos. 6 and 7 plastics: unidentified (unnumbered) packaging and caps, no. 6 plastic containers, and packaging, and no. 7 plastic and other rigid plastic packaging (cats. 37, 38 and 39);
- Flexible plastic: bags, plastic film (cheese wrappers and garbage bags), shopping bags, cellophane paper, packaging bags and film (cats. 40 to 47);
- Refundable plastic: refundable plastic containers (cat. 25);
- Refundable glass: refundable glass bottles (cat. 16);
- Non-refundable glass: glass bottles and containers, flat glass, stoneware and ceramics (cats. 17, 18 and 19);
- Metal: non-refundable aluminum containers, aluminum packaging and foil, caps and lids (cats. 21 and 22);
- Refundable aluminum: refundable beverage cans (cat. 20).

1.4.2 Organic materials

The organic materials found in the sample were sorted into the following categories (with examples):

- Food waste (cat. 49);
- Green waste: grass, soil, garden waste, dead leaves, branches, stumps and trees (cats. 48 and 51);
- Other organic materials: paper napkins, paper towels, paper tissue, compostable fibres, food-soiled paper or cardboard, hair, sanitary products, animal litter and excrement (cats. 50 and 52);
- Disposable diapers (cat. 53);
- Liquid in containers (cat. 49).

1.4.3 Construction, renovation and demolition waste

The CRD waste found in the sample was sorted into the following categories (with examples):

- Clean wood: containers and packaging made of untreated or unpainted wood (e.g. pallets, planks, etc.) (cats. 15 and 61);
- Other wood: chipboard, laminate, composite, treated, painted, etc. (cats. 62 and 63);
- Furniture and other household items: furniture, mattresses, pool covers, sports equipment, etc. (cat. 59);
- Plastic/Coroplast® (corrugated plastic sheet): advertising posters, social distancing stickers, plastic parts and pieces not eligible for selective collection, etc. (cats. 28, 30, 32, 34, 36 and 57a);
- Asphalt shingles (cat. 65);
- Metal accessories: metal hangers and hooks, various metal parts, scrap metal, sheet metal, nails, wire, etc. (cats. 23 and 24);
- Aggregate: brick, concrete, asphalt, etc. (cat. 67);
- Tires (cats. 60, 60a, 60b and 60c);
- Other CRD waste: gypsum, roofing products (cats. 64 and 66).

1.4.4 Textiles

The textiles found in the sample were sorted into the following category (with examples):

- Textiles: clothing, work gloves, satchels, shoes, belts and stuffed toys (cats. 68 to 73, and 76 [except for rubber]).

1.4.5 Household hazardous waste

The HHW found in the sample were sorted into the following categories (with examples):

- Soiled fibres and textiles (cat. 89);
- Other HHW: acids, bases, tubes of glue, etc. (cat. 89).

1.4.6 EPR current and future products

- Paint and paint containers (cats. 80 and 80a);
- Oils, coolants, antifreeze, as well as their filters, containers and other similar products; (cats. 81 and 81a to 81e);
- Mercury lamps: mercury lamps, compact fluorescent lamps and fluorescent tubes (cats. 82 and 82a to 82c);
- Electronics (cats. 83 and 83a to 83j);
- Batteries (cats. 84, 84a and 84b);
- Small household appliances and other home or office accessories (cats. 58, 85 and 85a to 85d);
- Pressurized fuel containers: aerosol paints, pressurized fuel containers (cats. 80b, 87, 87a and 87b).

1.4.7 Other residual materials

Materials in the sample not included in the above categories were sorted into the following categories (with examples):

- Pharmaceutical products (cat. 88);
- Rubber products: gaskets, conduit, piping, hose, etc. (cat. 76 [except for textiles]);
- Personal protective equipment: gloves, visors and rapid tests (cat. 75);
- Personal protective masks (cat. 74);
- Fine particles: various residual materials, approx. 1 cm or less in size (cat. 79);
- Single-use materials: plates and utensils, straws, coffee pods, coffee cups, etc. (cats. 56 and 57b);
- Other objects: small multi-component objects, shampoo and agricultural products (cats. 77, 78, 86 and 86a to 86f).

After the materials were spread out on the sorting area, they were sorted according to the different categories of materials and placed in separate bins. Once the bins were full, they were weighed, and the weights were recorded. The weights of the sorting bins were not included in the calculations.

If any object or material to be sorted contained liquid, the liquid was weighed, and the weights were recorded in the "liquid" category. The empty containers were then weighed as well.

Small materials (approx. 1 cm or less in size) were classified in the "fine particles" category, while multi-component objects were classified as "other."

1.5 Analysis of the characterization results.

An analysis of the characterization results is presented in a table in Appendix D.

Appendix D

Characterization results



1 Residual materials characterization

A residual materials characterization was held at Mistissini’s municipal garage during the village visit. The data gained from this exercise contributed to the comprehension and quantification of a significant portion of outputs generated by Mistissini, primarily associated with materials being extracted or imported into the community.

In total, approximately 279 kg of residual materials were sorted (Table 1). Because the trench landfill does not have a scale, the total weight of a truck load was unknown. Therefore, Englobe had to estimate this data. The collected sample came from a truck load representing approximately 25 houses. According to the volume of residual materials unloaded from the truck and the quantity that was characterized, it is estimated that the truck load where the sample was taken contained close to 300 kg of residual materials. Annually, the Cree village of Mistissini disposes of approximately 2 300 tons of residual materials into the trench landfill.

In general, and in terms of weight, organic materials (mostly food waste) and plastics are the most abundant categories which respectively account for 63,0% and 12,2% of sorted residual materials (Table 1).

Table 1 : Characterization results of residual materials sent to Mistissini’s trench landfill NL

| Types of materials | Analyzed quantity (kg) | Proportion (%) |
|---------------------------|------------------------|----------------|
| Fibres | | |
| Paper | 4.3 | 1.5 |
| Recyclable cardboard | 18.4 | 6.6 |
| Other paper and cardboard | 4.9 | 1.8 |
| Subtotal - Fibres | 27.5 | 9.9 |
| Plastics | | |
| Nos 1 to 5 plastics | 17.3 | 6.2 |
| Nos 6 to 7 plastics | 7.5 | 2.7 |
| Soft plastics | 9.0 | 3.2 |
| Refundable plastics | 0.3 | 0.1 |
| Subtotal - Plastics | 34.2 | 12.2 |
| Glass | | |
| Refundable glass | 0.0 | 0.0 |
| Non-refundable glass | 8.0 | 2.9 |
| Subtotal - Glass | 8.0 | 2.9 |
| Metal | | |
| Metal containers | 4.0 | 1.4 |
| Refundable aluminum | 4.0 | 1.4 |
| Subtotal - Metal | 7.9 | 2.8 |
| Organic materials | | |
| Food waste | 92.2 | 33.0 |
| Green waste | 13.8 | 4.9 |
| Other organic materials | 41.8 | 15.0 |

| Types of materials | Analyzed quantity (kg) | Proportion (%) |
|---|------------------------|----------------|
| Disposable diapers | 18.9 | 6.8 |
| Liquids | 9.1 | 3.3 |
| Subtotal - Organic materials | 175.9 | 63.0 |
| CRD waste | | |
| Clean wood | 0.1 | 0.0 |
| Other wood | 0.0 | 0.0 |
| Furniture and other household items | 0.0 | 0.0 |
| Plastic/ <i>Coroplast</i> | 0.0 | 0.0 |
| Asphalt shingles | 0.0 | 0.0 |
| Bulky metal items | 0.0 | 0.0 |
| Aggregate: brick, concrete, asphalt | 0.0 | 0.0 |
| Tires | 0.0 | 0.0 |
| Other CRD waste | 0.2 | 0.2 |
| Subtotal - CRD | 0.3 | 0.2 |
| Textiles | | |
| Textiles | 16.0 | 6.1 |
| Subtotal - Textiles | 16.0 | 6.1 |
| HHW | | |
| Soiled fibres and textiles | 0.0 | 0.0 |
| Other HHW | 0.1 | 0.0 |
| Subtotal - HHW | 0.1 | 0.0 |
| EPR current and future products | | |
| Paint and paint containers | 0.0 | 0.0 |
| Oils, coolants, antifreeze, as well as their filters, containers and other similar products | 0.0 | 0.0 |
| Mercury lamps | 0.0 | 0.0 |
| Electronics | 1.1 | 0.4 |
| Batteries | 0.2 | 0.1 |
| Pressurized fuel containers | 0.1 | 0.0 |
| Subtotal - EPR | 1.4 | 0.5 |
| Other residual materials | | |
| Small household appliances and other home or office accessories | 0.0 | 0.0 |
| Pharmaceutical products | 0.3 | 0.1 |
| Rubber products | 0.0 | 0.0 |
| Personal protective equipment | 0.6 | 0.2 |
| Personal protective masks | 0.7 | 0.3 |
| Fine particles | 0.4 | 0.2 |
| Single-use materials | 2.5 | 0.9 |
| Other objects | 2.2 | 0.8 |
| Subtotal - Other residual materials | 6.9 | 2.6 |
| Total | 279.4 | 100.0 % |

Appendix E

Circular economy examples



1 Circular Economy Examples

This appendix describes the 12 circular economy strategies. A definition and sample projects are included for each strategy. Several of the listed projects that may involve more than one strategy are still presented under only one strategy.

The examples below were initiated by organizations. The senior management of these organizations integrated circular economy strategies into their organization's business model. These initiatives can inspire other organizations to set up similar projects or integrate circular economy principles into ongoing projects.

Please consult the references below to learn about other circular economy projects in Quebec besides those described in this appendix. This list of references for projects that include circular economy principles is not exhaustive.

- RECYC-QUÉBEC, 2022b;
- Esplanade Québec, 2022;
- Québec circulaire, 2023
- Centre de transfert technologique en écologie industrielle, 2022;
- Centre de transfert technologique en écologie industrielle, 2021;
- Centre de transfert technologique en écologie industrielle, 2020;
- Environnement Mauricie, 2022b.

1.1 Ecodesign

Ecodesign involves integrating environmental aspects as early as possible in the design phase of products and services in order to minimize the environmental impacts of these products and services throughout their life cycle (RECYC-QUÉBEC, 2022b). Ecodesign is applicable to all economic sectors.

Planning projects to reduce CRD waste

CRD waste represents nearly 22% of the total materials disposed of in Quebec in 2021 (RECYC-QUÉBEC, 2023d). Resource extraction and landfill usage can be reduced by applying circular economy principles to the construction industry. At the project planning stage, materials with low environmental impact can be selected and can also be used for other purposes if a given project is redesigned or dismantled. Ecodesign can also be applied to building renovation. In Hamilton, Ontario, a multi-unit residential building was retrofitted as a passive house and qualified for international passive house certification by the Passive House Institute (FCM, 2023). A passive house refers to the energy intensity required to maintain a pleasant environment. Passive house design involves certain features, namely, structure, spatial orientation, thermal insulation, and building sealing, all of which reduce GHG emissions from air conditioning.

Various Quebec organizations now train individuals or companies to implement ecological housing projects. For example, training topics include incorporating green heating methods, choosing green materials, and excavating in a responsible manner (ERA Solution, 2023). In this way, environmental protection can be integrated into home design.

Using recycled materials in the manufacture of skis

An analysis of the life cycle of Rossignol Group's alpine skis found that their components represented from 60% to 70% of the product's total environmental impact. This French company then redesigned its products to facilitate their end-of-life management. For example, the company designed its *Essential* skis to contain less material, include 34% recycled material and 39% bio-sourced material. The company also minimized the environmental impact of its packaging (Rossignol, 2022).

Using lighting fixtures that require less material and energy

Lumec, an outdoor lighting fixture manufacturer, designed an LED lighting fixture to replace traditional fixtures. The new model is lighter and smaller than the previous one, requiring 27% less material to manufacture and 35% less energy to use. In addition, 80% of the fixture can be recycled after dismantling (IDP, 2016).

1.2 Responsible consumption and procurement

Responsible consumption and procurement constitute a circular economy strategy that integrates sustainable development and social responsibility in the purchasing or acquisition of goods and services by consumers and private or public organizations (RECYC-QUÉBEC 2022b). This strategy reduces resource consumption and preserves ecosystems. It offers a goods and services procurement process that integrates environmental, social and economic considerations.

Reducing GHG emissions through regenerative agriculture

Prana Foods, an agri-food company, has partnered with a farmer in the Centre-du-Québec region to source organic pumpkins, grown according to regenerative agriculture principles (Prana Foods, n.d.). This production method produces several benefits such as higher soil carbon content (ICPA, 2019).

Free electric van use by users of the Joliette regional county municipality's ecocentre

The Joliette regional county municipality (RCM) lets its citizens borrow an electric van free of charge to transport residual materials to its ecocentre. The sole requirement is simply to contact the ecocentre to book the van. This initiative reduces not only GHG emissions in the RCM but also the costs associated with residual materials management. The environmental gains are huge, especially in relation to bulky household waste, which currently has a low recovery rate partly due to transportation challenges (MRC de Joliette, 2017).

Combating food waste with LOOP

LOOP Mission is a Quebec company that combats food waste by transforming rejected fruits, vegetables and other products from the food industry into juices, beers, gin, soap and more. To date, more than 15,000 tons of fruit and vegetables have been collected and recycled, 12,000 tons of GHG emissions avoided, and 900,000,000 L of water not consumed (LOOP Mission, 2023).

1.3 Process optimization

Process optimization is a strategy that improves each of an organization's processes by seeking to reduce the consumption of energy, water and raw materials as well as the amount of waste generated (RECYC-QUÉBEC, 2022b).

Energy efficiency at the CISSS in Lanaudière

The CISSS in Lanaudière is an integrated health and social services centre that is committed to improving the energy efficiency of its buildings, namely, the Centre hospitalier régional de Lanaudière

(CHRL) and 10 residential centres (ÉNERGÈRE, 2023a). The measures implemented include installing a geothermal system at the CHRL, which has resulted in significant savings due to reduced need for natural gas. The centre's energy bill has decreased by 35% and annual CO₂ emissions have dropped by 5,467 metric tons (ÉNERGÈRE, 2023a).

Redistributing heat at Harnois Énergies

In winter, the Harnois Énergies distribution centre in Saint-Thomas redistributes the heat produced by its machinery throughout its building to certain parts of the building; in summer, simply expels the heat. This approach reduces the company's heating costs and ecological footprint through lower natural gas consumption (Québec Circulaire, 2021a).

Modernizing the City of Shawinigan's streetlamps

In 2016, the City of Shawinigan collaborated with Énergère to upgrade 6,141 of its municipal streetlamps by using LED technology and a smart control system. The remote-control system facilitates network monitoring in various ways, such as modulating lighting intensity in real time, diagnosing failures and intervening as required. This smart lighting management system has resulted in energy and servicing savings and a reduction in GHG emissions (ÉNERGÈRE 2023b).

1.4 Sharing economy

Sharing economy is a set of exchanges among users that relies on shared use, collaborative production, and barter. Preference is given to the temporary pooling of resources or the permanent redistribution of goods with or without compensation (RECYC-QUÉBEC, 2022b).

The emergence of numerous networking or e-commerce platforms has facilitated and multiplied financial transactions between individuals. Carpooling as well as short-term accommodation in dwellings and housing upon remuneration are exchanges that fall into this category.

These are just two of many forms of the sharing economy. Some other sharing economy examples are described in this appendix.

Maski Récolte, a harvest gleaning project

The aim of Maski Récolte, a project set up in the Maskinongé RCM in 2018, is to organize people to glean post-harvest residue in the fields of participating farms. These gleanings are then equally divided among the RCM's gleaners, producers, institutions and community organizations. This prevents the waste of certain crops that would otherwise be abandoned in the field (Maski Récolte, 2023). This project has inspired other similar projects. For example, the Des Chenaux organization has drawn on the experience of the Maskinongé RCM to collect food in the neighbouring Des Chenaux RCM.

La Petite Expé (Le Grand défi Pierre-Lavoie)

La Petite Expé, an initiative spearheaded by Le Grand défi Pierre-Lavoie (a fundraising initiative based on cycling), encourages partner cross-country ski centres to lend ski equipment for free to all children under 12 years old. Thanks for this initiative, ski equipment is made accessible to all elementary schools in Quebec during the week and on weekends so that children can enjoy this sport with their families (Cubes Énergies, 2023). This initiative encourages the sharing of sports equipment among communities and maximizes their use.

Le Partage Club

Le Partage Club [The Sharing Club] is a mobile app in Quebec that facilitates the unlimited sharing of items among neighbours. It encourages people to borrow before buying (thus limiting consumption); it also promotes the reuse of items and reduces waste. The app offers multiple categories of goods, shares information about people's needs, reinforces neighbourly trust, and provides a borrowing management calendar (Le Partage Club, 2023).

1.5 Short term renting

Short term renting is the use of goods or services for a fee within a defined framework (RECYC-QUÉBEC, 2022b). Renting facilitates the optimal use of products by increasing their usage frequency. When owners rent physical property; usage of the property is maximized by having several renters. As the following examples demonstrate, short term renting can involve both goods and workspaces.

La Remise, a tool library

A model like La Remise [The Shed], an initiative of the Villeray citizens' collective could be implemented in other communities (La Remise, 2022). Its primary aim is to share knowledge, workspaces and useful equipment by discouraging overconsumption. For example, it lets its members borrow commonly used items as well as workspaces (e.g., a woodworking shop or a sewing space). La Remise also offers training and promotes intergenerational and intercultural exchange. Its catalogue of available items includes tools for woodworking, horticulture, cooking, gardening and so on. The borrowing principle is the same as in a library. Members can borrow up to 12 tools at a time for a period of seven days. Membership simply requires a monthly or annual subscription (La Remise, 2022). This initiative combats overconsumption and maximizes the use of resources. It is both a short-term renting strategy and a sharing economy strategy.

A Quebec short term rental platform

The Circule platform is a Quebec-based web app for renting and sharing geolocated objects among individuals and professionals. This promotes environmentally responsible solutions by encouraging local consumption, less waste (and packaging), and less travel (Circule, 2023). This leads to a better use of resources and maximizes use of the rented items.

UniverCyclo, bike rentals at the Université de Montréal

UniverCyclo is a long-term bike rental service for international students at the Université de Montréal. For the students, this service is an alternative to buying a bike that would only be used for a few months. Abandoned bicycles found on campus are collected, repaired and then rented to students (Université de Montréal, 2022). This project reuses bikes that would otherwise be thrown away and avoids buying one that would only be used temporarily.

1.6 Maintenance and repair

A maintenance and repair strategy that focuses on keeping objects in good condition in order to extend their useful life (RECYC-QUÉBEC, 2022b). This strategy can be implemented by either item owners or specialized organizations. Many such initiatives and opportunities can easily be integrated within ICI and the general population.

Repair café and getting together

In recent years, many community-based repair initiatives have been set up across the province. These include initiatives like Maski s'répare set up by the Comité citoyen carboneutre [Carbon-neutral citizens' committee] in the Maskinongé RCM where residents in a particular district combat overconsumption by getting together from time to time to repair their everyday items (Carboneutralité de la MRC de Maskinongé, n.d.). Repair cafes are another similar initiative. La Patente in Quebec City is one such example. It is a regular weekly workshop that connects repair experts with people who want to have their broken items repaired (Atelier La Patente, 2023).

La couturière volante [Flying seamstress]

La couturière volante is a mobile sewing service in the Matane region that repairs clothing onsite for various clients such as thrift stores as well as for the general population. The seamstress travels to different municipalities in the region to offer her services. This initiative aims not only to repair clothing, but also create new products from collected fabrics and offer sewing training to develop this skill in the local population (Québec circulaire, 2022a).

Fingz repair company (France)

Fingz is an online platform in France that combats overconsumption by connecting consumers with artisans who can repair items and extend their useful lives. People submit their repair requests by simply registering on the website. The system then recommends repairers and suggests appointment times (Fingz, 2023).

1.7 Donating and reselling

The donating and reselling strategy involves putting used goods back into circulation by donating or selling them to a third party (RECYC-QUÉBEC, 2022b). This strategy thus extends the useful life of products that are no longer needed by their owners but are still in good condition by putting them back into circulation. This form of circular economy is widespread in Quebec.

Éco-Réno

Éco-Réno is a Montreal social economy enterprise that specializes in the collection and resale of new and used materials, as well as old architectural fixtures like wood, windows, doors, bathtubs, sinks, lamps, etc. Besides operating a storefront, the enterprise's services include picking up donations and transporting materials. They also offer a consulting service on projects to dismantle or reuse materials (Éco-Réno, 2023).

Electromechanical parts donated by Arjo Magog

Arjo Magog is a medical equipment manufacturing company that used to have stocks of discontinued parts. Since this equipment was no longer available on the market due to safety considerations, the company donated some of it for educational purposes to the Sherbrooke CEGEP (a general and vocational college) and the Université de Sherbrooke (Québec Circulaire, 2021b).

Community fridges

To combat food waste and encourage generosity and social solidarity, hundreds of community fridges are now available throughout Quebec. People simply leave freshly prepared food or meals in these fridges (Radio-Canada, 2022a). A directory of community fridges in Quebec is available on the Sauve ta bouffe website (Sauve ta bouffe, 2020).

1.8 Refurbishing

A refurbishing strategy involves restoring objects for resale (RECYC-QUÉBEC 2022b). This strategy extends the useful life of products. Items can be refurbished at both the municipal and ICI levels through projects like Réemploi+.

Le Vélo Vert

Le Vélo Vert is a company located in the city of Quebec that collects used bicycles for future use. More than 2,000 bicycles are collected each year and then resold in the company's store. Bikes can be donated directly to the store or through a seasonal home collection service. To encourage buyers to

return their old bikes, Le Vélo Vert offers a 15% discount on the purchase of a new bike (Le Vélo Vert, 2023).

Insertech

Insertech extends the useful life of computers by repairing, refurbishing and reselling them. The company trains unemployed young adults to refurbish computer equipment. In this way, it combats overconsumption, obsolescence and resource wastage, and participates in the social reintegration of young adults in difficulty (Insertech, 2022).

Réemploi+

Réemploi+ is a social economy enterprise that reuses residual materials from the ecocentre network in the Lac-Saint-Jean census metropolitan area (CMA) by diverting them from the landfill. A drop-off area at each ecocentre has been designated for donated items. These items are then sold either *as is* in R+ hardware stores or recovered in R+ workshops before being resold (Réemploi+, 2022a, 2022b). In 2022, the Lac-Saint-Jean CMA won a 2022 FCM sustainable community award in the residual materials category for its Réemploi+ project (FCM, 2023).

Piscines et Spas Poséidon

Piscines et Spas Poséidon is a spa and swimming pool business that installs, opens, repairs, decommissions and closes both residential and commercial spas and pools (CPQ, CPEQ, EEQ, 2018). The company sells new spas, and also retrofits and refurbishes spas between 4 and 8 years old to extend their useful life (Piscines et Spas Poséidon, 2023).

1.9 Performance economy

Performance economy is a circular economy strategy that extends the useful life of products based on company business models that prioritize sale of the use of the product rather than sale of the product itself. Users buy the function, not the product (RECYC-QUÉBEC, 2022b). Since the emphasis is on the use of the product, consumers purchase a service rather than a good.

Xerox

Xerox developed a system for renting photocopiers to businesses. This system avoids the need for each company to purchase its own photocopiers. Instead, Xerox manages the use of all its photocopiers. In this way, it retains ownership of the equipment and directly manages their life cycle. This approach also supports the development of recycling techniques and makes it easier to retrofit equipment (Chauveau, 2006).

Michelin

Michelin has stopped selling tires to heavy truck fleets. Their business strategy is now to retain ownership of these products while committing to service, inflate and repair the tires as required. Heavy truck customers no longer buy Michelin tires, but instead pay for a package deal that takes into account the distances covered by the tires. With this approach, Michelin takes over the life cycle management of its tires. This approach has succeeded in extending the life cycle of Michelin heavy truck tires by up to 1 million km (Chauveau, 2006; Économie de fonctionnalité, 2010).

Retournzy

The Retournzy cooperative is a social economy enterprise that rents and distributes returnable food containers to the food service industry (restaurants, food trucks, food combats, etc.). The company collects, washes, sanitizes and redistributes clean containers. In this way, it reduces at-source waste in the event, corporate, institutional and food-service sectors (Retournzy, 2023; Québec Circulaire, 2020).

With this business strategy, food service companies can offer ecological and sustainable alternatives to their customers.

1.10 Industrial ecology

Industrial ecology is a circular strategy giving resources a new life by promoting the inter-organizational exchange of materials, energy or resources. This strategy is defined as a network of companies and communities linked together by exchanges of materials (e.g., by-products), water or energy. These exchanges form synergies whereby the waste from one becomes the raw material for the other (RECYC-QUÉBEC, 2022b). For example, the output of one company could be used in the production process of another. Industrial ecology in terms of linkages among different ICI is becoming increasingly popular these days.

Recycling 18-L plastic bottles for use in fields

La Hutte is a cooperative currently working on a synergy project with Onibi, a company that produces still and carbonated water in a variety of flavours. The Co-op wants to reuse 18-L bottles of Onibi drinks that are currently sent for recycling. The Co-op intends to conduct trials on using these bottles as growing containers for field tomatoes (Québec Circulaire, 2022b).

The City of Quebec recovers some of its concrete

The City of Quebec wanted to recover the concrete from its ecocentres as part of its *Vision 2018-2028*. However, the recovery of this concrete through traditional channels was more complex due to the heterogeneous nature of the concrete and the presence of contaminants. The city therefore turned to its internal market to develop a value-added product for its own needs. The concrete from its ecocentres was thus crushed to remove contaminants and then used to construct a snow dump embankment (CTTEI, 2021).

SIMAX, a manufacturer of urban furniture

SIMAX uses recycled polystyrene to manufacture a range of urban furniture. In practice, this approach results in a relatively solid product. SIMAX obtains its raw material from Éco-Captation, a company that collects polystyrene from ecocentres (Chaumont, 2022). SIMAX products can thus contain up to 70% recycled polystyrene and glass. Moreover, the company can crush its products at the end of their life cycle and reintegrate the material directly into their manufacturing process (SIMAX, 2021; Chaumont, 2022).

1.11 Recycling and composting

Recycling and composting extend the life of resources. Recycling is defined as the use of collected materials to replace raw materials in manufacturing processes. Composting is defined as a biological treatment process that uses aerobic microorganisms to biodegrade organic matter (RECYC-QUÉBEC, 2022b).

Modix Plastique

Modix Plastique is a company that collects plastic film by transforming it into LDPE (low-density polyethylene) resins. The plastic film comes from various sorting centres in Quebec and other parts of North America. The resins produced are then sent to various plastic product manufacturers. This reduces the need for raw materials and extends the life of plastic film (Québec Circulaire, 2022c).

Glass recycling with Groupe Bellemare

Groupe Bellemare, a Quebec company based in Trois-Rivières, recycles tons of glass every year. By grinding the glass into different sizes, the company creates a range of by-products. These include

material for sandblasting, swimming pool filtration, and decorative flower bed mulch. When ground into glass powder, this material can also be added into various processes for making concrete, fiberglass, insulation wool, and cellular glass (Rochette, 2022).

Mandatory composting for 30 ICI in Drummondville

In 2018, the City of Drummondville required 33 large generators of organic materials to join its municipal residual materials collection system. The other ICI in the city were given the option of joining voluntarily. This initiative has supported the ICI in a rapid shift towards managing their organic materials, while also improving the City's residual materials management performance (Ville de Drummondville, 2018; Phare Climat, n.d.-a).

Centre de valorisation du bois urbain

The Centre de valorisation du bois urbain [Urban wood recovery centre] in Montérégie is a social economy enterprise that extends the life of urban wood. For example, in recent years many ash trees across Quebec have had to be cut down due to infestation by emerald ash borer. As an alternative to disposing of these trees in a landfill, the wood can be processed to make paper, lumber, or hardwood flooring (CVBU, 2020).

1.12 Recovery

Recovery is the ultimate strategy to prevent residual materials from ending up in landfills. Recovery is any non-disposal operation that aims to obtain useful products or energy from residual materials (RECYC-QUÉBEC, 2022b).

Spreading crab shells on fields in the Magdalen Islands

The CERMIM (Centre de recherche sur les milieux insulaires et maritimes) a Centre for research on island and marine environments has launched a project to reuse marine residual materials from processing plants in the Magdalen Islands. Marine shells fresh from the processing plants are now used by local farmers as a source of amendments and lime for spreading on their fields. Although not all marine residual materials are recovered in this way, CERMIM is trying to create a product that can be stored for longer before being used on fields (Radio-Canada, 2022b).

Recovering biosolids from wastewater treatment in Repentigny

The City of Repentigny's water resource collecting plant (StaRRE) recovers all the biosolids from its wastewater treatment. This sludge is sent to biomethanization centres for digestion and then to rotary presses for dehydration in order to obtain a class B organic amendment. This amendment is then used on farmland in Lanaudière (Phare Climat, n.d.-b).

Energy recovery from biomass

Biomass-fuelled heating networks are becoming increasingly common in Quebec. In 2012, for example, the City of Causapscaal in the Lower St. Lawrence region installed a biomass system to heat seven buildings (including the city hall, the arena and the community hall) via a network of underground pipes. This innovation generated the city annual savings of 72,000 L of fuel oil and 47,000 L of propane. In addition to heating the seven buildings, the municipality also sells this biomass energy to a church and a nearby elementary school (Vision Biomasse Québec, 2022).

Several Quebec companies have also opted for this heat source. For example, hog farmer Les Viandes biologiques de Charlevoix turned to biomass as a heat source when their hog barn burned down in 2017 (Radio-Canada, 2017). The company now uses biomass supplied by the Groupe Lebel sawmill in Saint-Hilarion, located a few kilometres away. This change was made possible with financial assistance from Transition énergétique Québec (TEQ). It has been estimated that the cost of this biomass system will pay for itself in less than five years (Radio-Canada, 2020).

