Material Flow Analysis from a Circular Economy Perspective

Action Plan Promoting Circular Economy in the Northern Village of Inukjuak

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Executive Summary

In summer 2021, RECYC-QUÉBEC mandated Englobe to conduct a material flow analysis (MFA) for the purpose of developing an action plan promoting circular economy in certain northern communities as well as in a mining company. The project is supported by three partners: 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 now in Quebec, no large-scale Quebec study on this concept has so far been conducted in relation to either 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 circular economy optimization through an MFA for the northern village of Inukjuak. 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 the outline of 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 strategies and comes with an action plan to implement them.

Description of Inukjuak

Inukjuak is an Inuk northern village located on the eastern shore of Hudson Bay in Nunavik (Figure 1). Its territory is included in the Nunavik Category I lands under the James Bay and Northern Quebec Agreement (JBNQA). This village is not accessible by road from the south of the province. It can only be accessed by plane, helicopter or boat. Inukjuak covers a total area of approximately 64.83 km^2.

Inukjuak residents make intensive use of their land every season of the year, particularly for subsistence activities. Inuit hunters and fishers catch wildlife and fish from the waters and islands of Hudson Bay, as well as inland. Many Inukjuak residents have hunting camps across the territory which they access by snowmobile or motor canoe.

The Inuit of Inukjuak have exclusive outfitting rights on Category II lands bordering the Category I lands where their community is located. However, they occupy the entire territory of Nunavik with varying degrees of intensity. The Corporation foncière Pituvik (CFP) holds 521 km^2 of Category I lands on behalf of Inujuakmiut beneficiaries. The CFP is responsible for granting land use rights to the population and to organizations according to prevailing regulations.

Economic and institutional activities

The main employers in the village are private companies, the Co-op, and the public sector (schools, municipal government, etc.). On the commercial front, the range of food outlets in Inukjuak is limited, consisting of the FCNQ grocery store and the North West Company's Northern store. On the healthcare and social services front, Inukjuak has a local community service centre (CLSC) (clinic) and a women's shelter.

In terms of institutions, Inukjuak has a KRG office, a childcare centre (CC), a recreation centre, a municipal government building, a post office, and a Kativik Regional Police Force station. The community also has an elementary school, a high school, an adult education centre, and a vocational training centre.

Current residual materials management

The KRG has prepared an RMMP (KRG, n.d.), with the aim of developing standardized residual materials management strategies for Nunavik. This RMMP has been deemed compliant with the official *Québec Residual Materials Management Policy*.

The main goals of the 2021-27 RMMP include:

– Raise awareness among all generators about residual materials on the importance of residual materials management;

– Develop Nunavik-specific management methods consistent with sustainable development concepts;

– Monitor progress in implementing the RMMP and stay abreast of developments in residual materials management around the world.

Inukjuak does not offer selective collection of recyclable materials. However, some initiatives have been implemented. For example, the FCNQ grocery store offers a service for consumers to return cans and collect their financial deposit. The Co-op also collects its cardboard and returns it to the south.

A high proportion of the materials collected and shipped south is generated by local or short-term businesses based in Inukjuak. These are one-off initiatives associated with either contracts or established residual materials management programs within the businesses concerned. Most of these collection initiatives involve materials generated by these businesses and not necessarily those of the overall community.

There is currently no municipal collection of organic matter in Inukjuak. However, in 2019 the KRG proposed a project to set up a thermophilic composter for processing cardboard and organic matter. This project is still in development.

There are no community-managed ecocentres in Inukjuak. However, products targeted by the extended producer responsability (EPR) are collected in Inukjuak, except for household appliances and air conditioners. Tires are also collected.

The Inukjuak northern landfill (NL), located less than 500 m north of the community, is the cause of several environmental and community problems. Normal procedure is for residual materials to be burnt in an NL. However, since this NL is less than half a kilometre from the closest buildings in the village, no burning takes place there, while clean wood is now incinerated at the new NL located a few kilometres from the village. Moreover, the residual materials at the existing Inukjuak NL are not covered because the village does not have access to cover material.

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 the 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 Inukjuak.

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

– Energy;

– Water;

– Materials extracted within the boundaries of the MFA;

– Consumer products.

Inukjuak'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 Inukjuak's ICI, visits to ICI and the characterization of residual materials disposed of in the landfill.

Energy

The MFA reveals that all fossil-based energy is imported into Inukjuak. A small petroleum tanker filled once or twice a year supplies the community. The main fossil-based energy importers are the FCNQ, Hydro-Québec, and the Kativik School Service Centre. Some of the fuel is used to generate electricity. Used oil is also recovered to heat a municipal building. Outputs mainly consist of atmospheric emissions and heat from the thermal power plant. The energy flow analysis shows that the Inukjuak community consumes the equivalent of approximately 430,000 gigajoules per year.

Water

Although the village currently has no water supply system, it operates a plant that produces filtered and chlorinated water which is then distributed to residents. Each building in Inukjuak has its own water tank. These tanks usually need to be refilled every other day. In 2021, the village produced and distributed 80,000 m^3 of water for the year compared to 62,000 m^3 in 2016.

Also, there are no sewage systems in Inukjuak. Each building therefore has its own wastewater tank for temporary storage. The largest water users are the schools and the hospital. Wastewater tanks are regularly emptied. This wastewater is transported to a non-aerated treatment lagoon north of the village.

Materials extracted within the community

In the case of Inukjuak, a gravel pit operates near the village. Gravel is used in the village for road repair and producing hot-mix asphalt. The dynamics of the gravel pit are quite simple: all the gravel is used in Inukjuak. From an MFA perspective, this use in road infrastructure corresponds to a gravel stockpile.

Consumer products

The main imported products include food products and building materials. Food products mainly consist of the food and drink imported into Inukjuak by retailers, primarily the Co-op and the Northern. For the building materials, they are mainly imported by construction companies. For example, some construction contracts in Inukjuak now contain a specific clause for residual materials management, which encourages the export of residual materials generated by construction. For example, contractors from southern Quebec operating in Inukjuak are required to bring their building materials with them and then take back the construction, renovation and demolition (CRD) waste generated by their work. The ultimate destination of these residual materials can vary (recycling, recovery, or disposal). However, this destination is exclusively in the southern part of the province (not the Inukjuak NL). All imported products are brought in by plane (via one carrier) and by sea (via two marine shipping companies that operate cargo vessels).

Inukjuak's MFA summary and implemented actions

The main inputs to Inukjuak are imports. Inukjuak imports energy, consumer products and other materials. Imported energy is mainly used for heating buildings, generating electricity, and fuelling vehicles. The other imported materials are used for construction and a growing population's housing needs. 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 collection and electricity generation. The MFA shows that electricity generation from diesel leads to a significant loss of energy.

Inukjuak's economy is characterized by linear flows, meaning that few circular economy actions stand out. Although some circular economy strategies, such as responsible consumption and procurement, process optimization or short term rental do not appear in the diagram and are difficult to show in an

MFA, some circular economy initiatives were identified during the Englobe team's visit to Inukjuak. For example, some companies ship back south a portion of the residual materials they generate so that these can be reused, recycled or recovered. Others donate their leftover building materials to community members. They also sometimes sell certain machinery that could be of interest to individuals or the village administration. This obviates the imports of certain goods. Also, the FCNQ returns some residual materials resulting from its operations to the south. These include pallets, used oil, tires, cardboard, other liquid HHW from the machine shop, etc.

Circular economy strategies

Several circular economy strategies have been selected for Inukjuak's community. The next paragraphs present solutions suitable for Inukjuak's 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

Ecodesign is difficult to promote in Inukjuak due to the absence of a factory or manufacturing facility. However, this strategy could be implemented when building the built environment and the circular economy solution described below could be considered at that time.

Built environment planning

The Inukjuak region is experiencing population growth and the building of new infrastructures could be based on ecodesign principles in terms of choice of materials, energy supply, and alternatives to fossil fuels. This could be an opportunity in relation to planning the built environment. The more durable the materials used, the less the replacement materials imported, thereby reducing CRD waste but also the impacts from transporting these materials. Also, buildings could be designed to be modular from the pre-construction stage given that modular buildings can be adapted over time as required.

Responsible consumption and procurement

Observations and discussions made during the visit in Inukjuak helped identify circular economy solutions that could be analyzed by the northern village.

Electrification of municipal vehicles

On the transportation front, municipal vehicles powered by gasoline or diesel could be replaced with electric vehicles. The hydroelectric power station that will be soon operational close to Inukjuak will be able to support the use of electric vehicles in the community.

Processing plastics

To reduce costs and optimize the transportation of materials to recyclers, plastic could be processed in Inukjuak before being shipped by cargo vessel for recycling. This processing would increase the quantity of plastic per unit of volume, thereby reducing the costs associated with moving recyclable residual materials.

Eliminating the use of single-use shopping bags

Discontinuing the distribution of single-use shopping bags in the community is a sound way to reduce the amount of waste going for disposal at the NL. The public could make greater use of reusable bags. In fact, one such initiative was listed in one of the Inukjuak businesses. Besides reducing the quantity of materials at the NL, discontinuing the distribution of single-use shopping bags would reduce the amount of waste blown into the village and the environment.

Reduction in packaging

The characterization study revealed that some 32% of the residual materials disposed of at the NL are cardboard. Part of this cardboard is most likely coming from excessive packaging. Inukjuak businesses could ask their suppliers to reduce the amount of packaging before shipping products to the village.

Responsible purchasing of consumer products

To reduce the amount of packaging generated in Inukjuak and reduce the space and weight of the packaging returned as recyclable materials in marine containers, steps to encourage merchants to adopt responsible consumer product purchasing practices could be implemented. It would be relevant to analyze which ecodesigned products should be prioritized for the Inukjuak community and which would be beneficial for both consumers and the community.

Process optimization

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

Support services for ICI to optimize their operations

ICI in Inukjuak could be guided by a specialist to determine whether their operations could be optimized. An energy assessment based on ISO 50001 principles could be conducted.

Improving energy efficiency

Nunavik's climatic and geographic circumstances mean that energy demand per unit area is higher than in the southern part of the province. Energy efficiency is therefore an important consideration for ICI operations. There are several ways to achieve better energy efficiency, such as adopting passive or active technologies.

Reducing water consumption

This strategy promotes water conservation. The use of cost-effective plumbing fixtures and greywater collection systems are highly effective features of this strategy.

Optimizing residual materials management

Residual materials management would be a circular economy solution towards process optimization.

Reducing food waste

Food waste runs as high as 30% at the Co-op's grocery store. These losses include expired products, damaged products, and products that become non-consumable due to refrigerator breakdown. Nutrition North Canada (Government of Canada, 2022) funds the transportation of food to ensure food security in isolated northern communities. This federal agency would benefit from contributing to capacity building to reduce food waste in Nunavik communities.

Sharing economy

There are several types of sharing or collaborative economies. Collaborative economy comes in various forms. During the visit in Inukjuak, storage was rather an issue.

Sharing of storage space

To implement an economy based on collaboration, 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 could use them, while ensuring the security of the goods of the individual ICI concerned, should be examined.

Sharing equipment to collect cardboard

Since cardboard represents a considerable quantity of the materials generated by the village, a cardboard press could be shared among the various merchants to compact the cardboard for sending back south. In fact, some businesses in the community have already expressed interest in purchasing a cardboard press.

If the cardboard press were shared, investment and maintenance costs could be pooled and use of the equipment could be optimized. If demand is not sufficient for the press to be used to its full potential in Inukjuak alone, it could be transported to a few other villages in Nunavik so that they could benefit from this strategy as well.

Short term renting

Each northern village is isolated from the rest of the province. The remoteness of this community makes renting an even more attractive option.

Renting equipment used by ICI

Short term renting is the contractual use of goods or services for a fee (RECYC-QUÉBEC, 2022b). Rental facilitates the optimal use of products by increasing 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, short term renting covers both goods and workspaces. Due to their geographical location, each northern village is isolated from the rest of the province. The remoteness of these communities makes renting an even more attractive option.

Renting tools through a tool library

The creation of a tool library would be a possibility for Inukjuak residents to consider. The borrowing principle is the same as in a library where books can be borrowed. This strategy aims to share equipment, workspaces and knowledge and curb overconsumption at the same time.

Rental of furniture and household appliances

In collaboration with the FCNQ hotel, a business model could be designed that would consist of agreements for temporary workers to rent home furnishings like furniture and appliances on a short-term basis. This strategy also dovetails well with the lease/rental or donation/resale strategy.

Maintenance and repair

To lengthen the life of consumer products, it would certainly be possible to involve the Inukjuak community in initiatives that could be implemented by the village administration and the general population.

Repair activities

A local, day-long community event where volunteers offer their services to repair various items could be organized. This would be an opportunity to not only extend the useful lives of residents' appliances and devices but also to energize the community.

Improving the services offered by the village's mechanical workshop

Inukjuak has a mechanical workshop managed by the Co-op. However, when ATVs or snowmobiles cannot be repaired, the machines must be returned south by boat for repair. Inukjuak's mechanical shop

employees could be trained to perform more complex repairs. The shop could acquire parts and tools to make these new kinds of repairs.

Building maintenance and renovation

To address housing shortage and guarantee access to long-term housing, the renovation and maintenance of these houses must ensure optimal longevity, and the premature construction of new houses must be avoided. In addition, all housing renovations should use sustainable and energy-efficient materials.

Donating and reselling

The Inukjuak Buy, Sell, Trade or Swap Facebook group, which already operates a community page on which residents can post reusable items they wish to sell or donate, is a fine example of this kind of initiative. However, Inukjuak does not have a used goods store or a physical location specifically for the donation or resale of items.

Creation of a used goods store

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 the NL, reduces the imports of new products, puts used items back into circulation in the community, and gives residents access to cheaper products. This strategy can be combined with the maintenance and repair strategy.

Reusing equipment operated by third parties in Inukjuak

Many companies with contracts in Inukjuak import machinery to carry out their work in the village. Instead of taking all their equipment back south at the end of their projects, they could sell to the municipal administration some of the equipment that could be used by the local community.

Refurbishing

The remote location of Inukjuak involves that goods requiring to be replaced come from major urban centres. The restoring of repairable objects would then reduce the import of new goods while reducing quantities sent to the NL.

Refurbishing of household appliances and small electrical devices

These appliances could be refurbished to give them a new life. When refurbishing is not possible, parts in good condition could be removed for possible reuse in repairing other equipment. This strategy can be combined with a used goods store.

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 au 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

An industrial symbiosis project could be developed in the region to add circularity to the materials produced on the territory (e.g. networking workshops). Potential inter-ICI exchanges of materials (industrial ecology strategy) could be identified, which would reduce the quantity of resources used and residual materials generated. KRG could play a role in following up with the various ICI interested in industrial ecology.

Using village-generated outputs

Considerable quantity of cardboard, plastics and organic matter are sent to the NL. In this regard, it could be possible to either use village-generated outputs as resources or find alternatives to imported materials.

Recycling and composting

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

Setting up an ecocentre

Setting up an ecocentre would be necessary to collect household hazardous waste (HHW), products targeted by the EPR as well as CRD waste.

Modernizing deposit-refund and selective collection systems

Modernizing deposit-refund and selective collection systems (MELCCFP, 2023e) represents a tremendous opportunity for Nunavik communities. However, implementation in northern villages may take some time. For example, the rollout of the recycling system for all northern villages is planned for 2027.

Collection and processing organic matter

The main objective is thus to give residents and ICI throughout the province the opportunity to collect organic matter. Currently there is no organic matter collection service in Inukjuak. This service should be included with a processing system (such procedures have already been started) and outlets for compost must be developed.

Recycling wood

Some of the wood for the NL could be used as an input in the processing of organic matter. Wood, suitable for the treatment technology selected, should be shredded before being used in the composting process. This input also constitutes a soil-structuring amendment for the composting of organic matter.

Studies on the feasibility of recovering collecting certain materials

The Inukjuak community currently has no collection of recyclable household materials except for refundable cans. Since exportation is a challenge for the community, an initial study could be conducted on the feasibility of collecting just a single material. This study could identify the various factors to be considered in the collection and transportation of this material to the south and eventually lead to a larger project for other materials.

Recycling and exporting metals

Scrap metals are a major issue for the Inukjuak community because they cannot be incinerated and the transportation costs associated with their export are high. Scrap metals are currently accumulating at the NL and are increasingly not being stocked separately because the NL is reaching the end of its useful life. It would therefore be relevant to find solutions to export these materials for recycling. In addition to the challenges related to export costs and the mobilization required to implement this circular economy solution, temporary storage of scrap metal in the village, which would subsequently facilitate and maximize transportation, could also be optimized. Some metals could be compacted. For example, the Cree village of Mistissini uses an onsite hydraulic press to compact metal barrels (Figure 25).

Recovery

Recovery is the last strategy to avoid materials being sent to the NL. Several circular economy solutions have been identified throughout this study.

Energy recovery

The village already recovers waste oil to heat a municipal building. It would be relevant to make an inventory of the available oil as well as of the buildings that would be suitable for this type of recovery. Onsite recovery would reduce both transportation costs and GHG emissions.

The recovery of wood as a fuel source for small furnaces would reduce the consumption of fuel oil. Pallet wood intended for recovery must be free of contaminants (e.g. paint or fungicide).

Biosolids recovery

The MFA revealed that municipal biosolids are generated in Inukjuak. However, municipal biosolids are not currently being recovered. It would be advantageous for the village to undertake onsite recovery of its residual materials that can be used as fertilizer. For example, these materials could be used to revegetate the NL once it is covered.

Action plan to optimize material circularity in Inukjuak

The action plan developed for the northern village of Inukjuak 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 with Inukjuak ICI.

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

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 Inukjuak 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.

Action	Action description	Level of action	Budget estimate
1	Developing the new NL and closing the existing NL	Priority	Over $1,000,000
2	Setting up an ecocentre	Priority	$100,000 to $1,000,000
3	Collecting cardboard	Priority	$25,000 to $100,000
4	Collection and processing organic matter	Priority	Over $1,000,000
5	Opening a used goods store	Lower priority	$25,000 to $100,000
6	Collection and exporting metals	Lower priority	Over $1,000,000

Action	Action description	Level of action	Budget estimate
7	Reusing equipment operated by third parties in Inukjuak	Lower priority	May vary depending on the project
8	Reviewing the drinking water supply system	Lower priority	Over $1,000,000

Recommendations

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.

It is recommended to set up a circular economy committee in Inukjuak.

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. The recommendations specific to the actions suggested are as follows.

Action	Action description	Prioritization	Brief evaluation of investments and recommendations
1	Developing the new NL and closing the existing NL	Priority	Requiring an important investment because the NL has reached the end of its useful life and that it does not necessarily respond to public health issues. Several studies and authorizations are required.
2	Setting up an ecocentre	Priority	Action requiring an important commitment on the part of the administration to implement such a structure. Can be more or less expensive depending on the chosen infrastructures. Can be implemented in several phases. This could be a good opportunity to plan and add a donating and reselling space.
3	Collecting cardboard	Priority	Action requiring a medium-term commitment on the part of the administration to implement such a system. Requires logistics for transportation, infrastructures, and sorting. Allows progressive material collection within the community.
4	Collection and processing organic matter	Priority	Continuation of a project that has already been initiated by KRG. Requiring important investments, but this project may be implemented in several phases. Requires multiple studies to request funding from the *Program for the treatment of organic matter through biomethanization and composting* (PTOMBC). Could be implemented within three years.
5	Opening a used goods store	Lower priority	Action requiring volunteers within the population. Generally inexpensive but may require storage capacity for certain goods. Action also requiring reception logistics and inventory and procurement management. Requiring important investments depending on the community's ambitions.
6	Recovering and exporting metals	Lower priority	Action requiring a significant number of efforts in planning for material transportation. Multiple requests to organizations to ease the planning and the associated costs. Will directly impact and reduce the quantity of scrap metals sent to the NL
7	Reusing equipment operated by third parties in Inukjuak	Lower priority	Action that can be implemented quickly but requires the collaboration of different temporary actors that are present in the territory. Such a protocol is inexpensive to implement. The purchase of equipment must be negotiated with the owners. These purchases must respond to the community's needs.
8	Reviewing the drinking water supply system	Lower priority	Requiring an important financial investment, but the planning of such a system remains realistic and can be inspired by examples in Québec (the case of Harrington Harbour). Addresses public health issues.

Several other circular economy solutions were identified during the study but are not included in the action plan; some of these potential actions are described in Section 5 of this report. However, to focus efforts on high-impact actions or actions that can be speedily implemented, this report prioritizes eight that, if implemented, will improve the Inukjuak community's resilience and reduce its ecological footprint.

Conclusion

Data collected on Inukjuak 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 Inukjuak 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 in the Inukjuak 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 discharge into the environment. Implementation of these strategies would also maximize the use of resources available within the Inukjuak community.

Successfully transitioning from a linear economy to an increasingly circular economy will depend on the involvement of Inukjuak community members. 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 disposing of residual materials in the NL or losing 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 projects initiated by local actors, such as the FCNQ's residual materials management initiatives or the KRG's rotary composter project, demonstrate local willingness to act. These actions should be encouraged.

Table of contents

TABLES

FIGURES

APPENDICES

ABBREVIATIONS

AEFP	Agri-environmental fertilization plan
APCHQ	Association des professionnels de la construction et de l'habitation du Québec
BAPE	Bureau d'audiences publiques sur l'environnement
CAPI	Canadian Agri-Food Policy Institute
CC	Childcare centre
CFP	Corporation foncière Pituvik
CIRAIG	International Reference Center for Life Cycle Assessment and Sustainable Transition
Co-op	Co-operative
CRD	Construction, renovation and demolition
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
EPR	Extended producer responsibility
EPRA-Québec	Electronic Products Recycling Association of Québec
EQA	*Environment Quality Act*
FCM	Federation of Canadian Municipalities
FCNQ	Fédération des coopératives du Nouveau-Québec
GHG	Greenhouse gases
GMF	Green Municipal Fund
HHW	Household hazardous waste
IAE	Information, awareness and education
ICI	Industrial, commercial and institutional establishments
IDP	Institut de développement de produits
IRDA	Institut de recherche et de développement en agroenvironnement
KEAC	Kativik Environmental Advisory Committee
KEQC	Kativik Environmental Quality Commission
KRG	Kativik Regional Government
MAMH	Ministère des Affaires municipales et de l'Habitation
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
MRNF	Ministère des Ressources naturelles et des Forêts
MTMD	Ministère des Transports et de la Mobilité durable
NL	Northern landfill
NRCan	Natural Resources Canada
PTOMBC	*Program for the treatment of organic matter through biomethanization and composting*
QBCRA	Quebec Beverage Container Recycling Association

RBQ	Régie du bâtiment du Québec
RMMP	Residual materials management plan
RRLIRM	*Regulation respecting the landfilling and incineration of residual materials*
SADC	Community Futures Development Corporations
SOGHU	Société de gestion des huiles usagées
SPN	Société du Plan Nord
SWOT	Strengths, weaknesses, opportunities and threats
TEQ	Transition énergétique Québec

GLOSSARY

Category I Land
Land use planning in Nunavik is governed by the *Act respecting Northern villages and the Kativik Regional Government* (referred to as the "Kativik Act") (Légis Quebec, 2023a), which stems from the James Bay and Northern Quebec Agreement (JBNQA). Category I: Lands for the exclusive use and benefit of the Inuit are governed by the landholding corporation of each northern village (Légis Quebec, 2023b)
Category II Land
Category II: Provincial lands where Inuit have exclusive hunting, fishing and trapping rights; The Inuit and the Kativik Regional Government (KRG) are jointly involved in managing these lands (for hunting, fishing, trapping, and tourism) (Légis Québec, 2023b).
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).
Input
All resources, materials or objects produced within the boundaries of an MFA (domestic extraction) or that originate from outside of the MFA that are imported for consumption or use (imports).
Linear economy
An economic model used since the Industrial Revolution that focuses on extracting, processing and using resources and then releasing them at the end of their useful life without consideration for reducing the quantity of resources entering the system or the amount of waste leaving it (Ellen MacArthur Foundation, 2015).
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 release into the environment (output).
Material flow analysis
Material flow analysis (MFA) of a given system (territory, sector, activity, etc.) aims to quantify the material flows generated by the system as mass or energy. The first requirement of an MFA is to establish the boundaries of the system studied and quantify its incoming, outgoing and stocked flows of materials. 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], 2014a)
Northern landfill
A residual materials management site developed in accordance with the requirements of the *Regulation respecting the landfilling and incineration of residual materials* (RRLIRM) to offer a disposal method suitable for small municipalities and remote or isolated territories (*Environment Quality Act* [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).
Output
Product exported for consumption, use, recycling or recovery outside the MFA boundaries or released into the environment (e.g. residual material for disposal).
Stock
The difference between the quantities of materials entering and leaving a territory this difference corresponds to the net accumulation of materials in the territory (e.g. buildings and road infrastructure).

1 Project background

In summer 2021, RECYC-QUÉBEC mandated Englobe to conduct a material flow analysis (MFA) for the purpose of developing an action plan promoting circular economy in certain northern communities as well as in a mining company. The project is supported by three partners: RECYC-QUÉBEC, the Société du Plan Nord (SPN), and the Ministère des Ressources naturelles et des Forêts (MRNF). Although circular economy has been studied in Quebec for a few years now, no large-scale Quebec study on this concept has so far been conducted in relation to either 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 and one mining company, all located north of the St. Lawrence River and the 49th parallel. These study subjects were selected due to their interest and their regional representativeness.

Each study participant volunteered to take part in the project. The northern village of Inukjuak expressed interest in participating in this study given that its northern landfill (NL) is nearing the end of its useful life.

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], 2014b).

The MFA performed in Inukjuak consists of a balance sheet based on a quantitative estimate of the material flows entering and leaving this northern village's territory. The analysis is therefore based on the use of the concepts of inputs and outputs according to the principles of conservation of mass and energy. The MFA constitutes a tool for understanding and describing the dynamics and interactions of the various resources and other materials imported, extracted, used, released or exported at the scale of the village.

The MFA is also based on data collected during a characterization of the residual materials found in the village's NL. 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 materials characterization that led to the development of an action plan specific to Inukjuak. This plan will enable the community to continue its efforts to optimize its resources and reduce the quantity of materials disposed of in its NL. The circular economy actions proposed in the action plan could also boost the economy while considering the carrying capacity of ecosystems.

Although the study is specific to Inukjuak, the circular economy solutions this report describes may guide or inspire other northern villages and other isolated communities to consider similar actions in their own contexts.

1.1 The selection of Inukjuak

The mandate called for the selection of a northern village in Nunavik. Since both the Inukjuak community and the Kativik Regional Government (KRG) expressed their interest in this MFA/circular economy project, the selection of Inukjuak was unanimous. In fact, the Inukjuak village council as well as the KRG offered their full cooperation.

The performance of an MFA in Inukjuak is particularly relevant in relation to the dam construction project currently taking place on the community's territory and the residual materials management challenges local managers have been facing in recent years.

Since the Inukjuak NL is at full capacity, innovative solutions are required to divert residual materials. The advantage for Inukjuak in exploring circular economy possibilities is all the more salient because of the community's isolation from the province's transportation networks and the lack of opportunities for exporting residual materials due to the community's geographic location.

From a material flow perspective, Inukjuak is a special case in that all materials and products are imported into the territory either by air or by cargo ship. Inukjuak is also a regionally representative community for several reasons:

– Its demography, which is typical of northern villages;
– Its geographical location on Hudson Bay (no road access and only accessible by sea or air).

1.2 Objectives

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

– Raise awareness among six northern communities and one mining company north of the 49th parallel and mobilize them to serve as a circular economy testing ground;
– Conduct an MFA and a residual materials characterization for the selected community and the mining company to identify opportunities for reducing and optimizing resource use. These opportunities were formulated in terms of circular economy strategies designed to generate savings, support community life, and improve environmental quality.

1.3 Project timelines

The project ran for 17 months 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 KRG 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, the KRG, and the northern village							x

2 Description of the northern village

2.1 Community and territory

Inukjuak is an Inuk northern village located on the eastern shore of Hudson Bay in Nunavik (Figure 1). Its territory is included in the Nunavik Category I lands under the James Bay and Northern Quebec Agreement (JBNQA). This village is not accessible by road from the south of the province. It can only be accessed by plane, helicopter or boat. Inukjuak covers a total area of approximately 64.83 km^2 (Ministère des Affaires municipales et de l'Habitation [MAMH], 2010).

In Nunavik, travel between adjacent communities is also undertaken in small boats in summer and on snowmobiles in winter. The Inuit of Inukjuak make use of the vast territory surrounding their village for various purposes, especially their traditional activities of fishing and hunting.

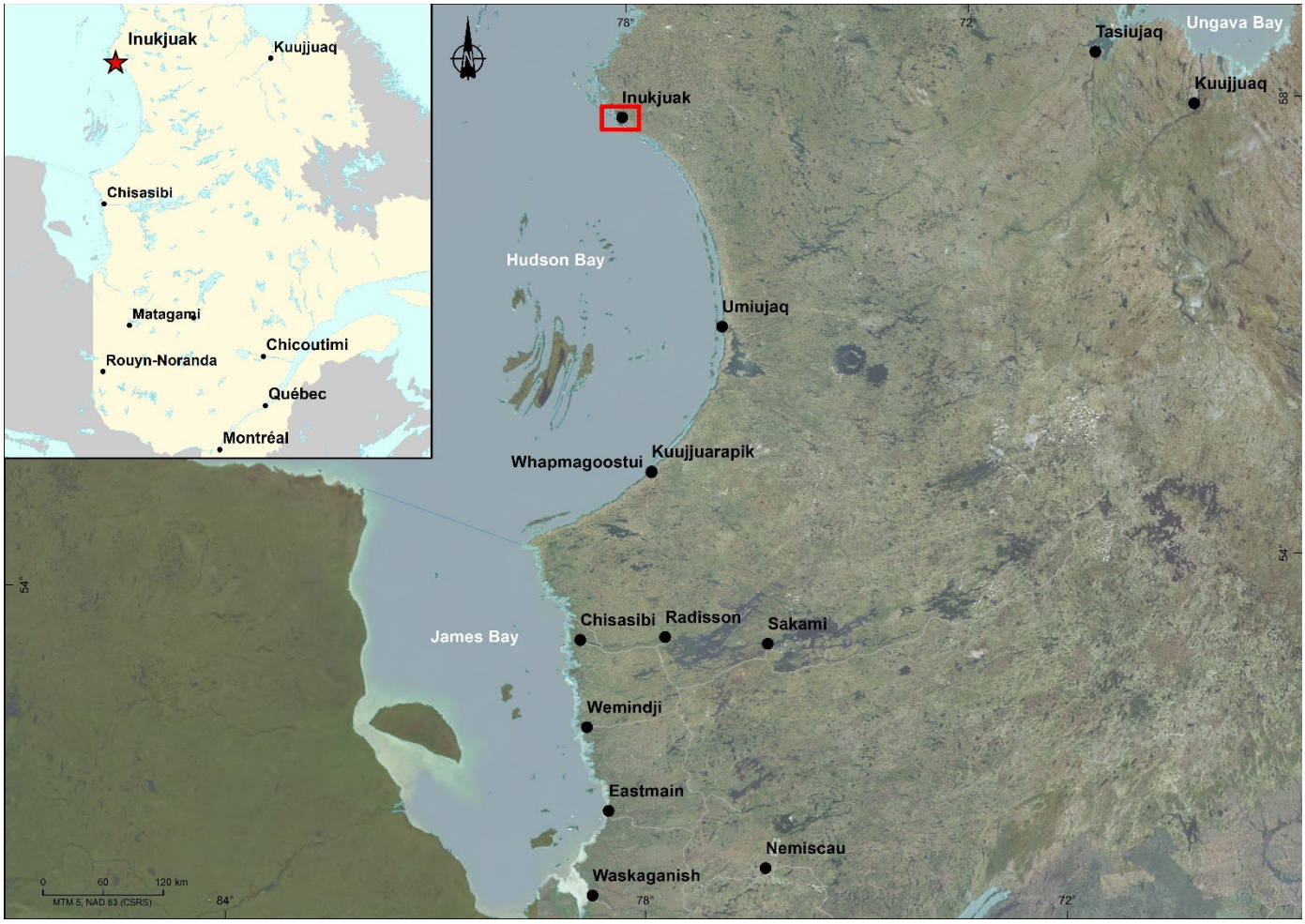

Figure 1: Location of the northern village of Inukjuak

2.2 Rights and land use

Inukjuak residents make intensive use of their land every season of the year, particularly for subsistence activities. Inuit hunters and fishers catch wildlife and fish from the waters and islands of Hudson Bay, as well as inland. Many Inukjuak residents have hunting camps across the territory which they access by snowmobile or motor canoe.

The Inuit of Inukjuak have exclusive outfitting rights on Category II lands bordering the Category I lands where their community is located. However, they occupy the entire territory of Nunavik with varying degrees of intensity. The Corporation foncière Pituvik (CFP) holds 521 km^2 of Category I lands on behalf of Inujuakmiut beneficiaries. The CFP is responsible for granting land use rights to the population and to organizations according to prevailing regulations.

2.3 Demographic profile

Inukjuak had a population of 1,821 at the time of the 2021 census. Like the population in the rest of Nunavik, the population in this village is growing with an increase of around 1% per year from 2016 to 2021. The particularity of Inukjuak's demographic profile is an over-representation of youth; the median age of this group is 22.2 years. In 2021, youth under 20 years of age represented 47% of the census population, compared to only 21% in Quebec as a whole (Table 2). Nearly 97% of Inukjuamiut are Inuit, with non-Indigenous people representing only 3% of the population. Several healthcare and construction workers also reside there but only temporarily.

Table 2: Proportion of population by age group

Geographic entities	Year of census	Total population	Proportion of population by age group (proportion in %)			
			0-19 years	20-64 years	65 years and over	Median age (year)
Inukjuak	2016	1,757	810 (46%)	880 (50%)	65 (4%)	22.7
	2021	1,821	845 (47%)	912 (50%)	60 (3%)	2.2
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

Sources: Statistics Canada, 2017 and 2022

The labour force participation rate of the village's population is 62.5%, close to the Quebec average of 64.1%. The percentage of Inukjuamiut over 15 years of age without high school graduation or a college or university diploma is 64%, more than triple the Quebec average (Figure 2). The practice of subsistence activities on the territory occupies an important place in the lives of Inukjuak residents, which partly offsets the high cost of shipping food to the village.

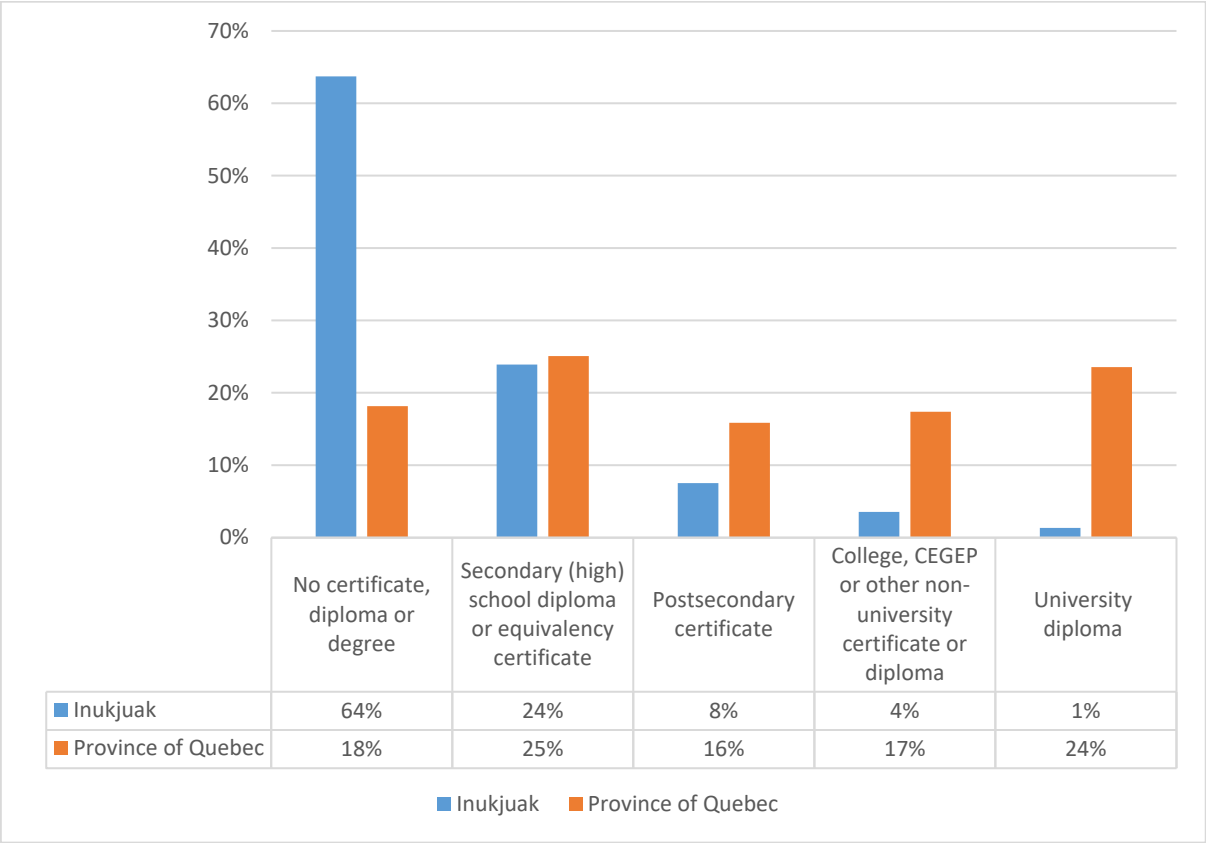

Figure 2: Education level of the population 15 years and older by highest qualification obtained (Statistics Canada, 2022)

The Inukjuak community is growing and new houses are being built almost every year. Although an average of 20 new homes are built per year, this number can vary from year to year depending on the budgets available from the KRG.

2.4 Key and local stakeholders

On the strength of their role in residual materials management or the circular economy, the following local stakeholders were identified for the MFA in Inukjuak: the northern village of Inukjuak, the KRG, the Makivik Corporation, the Fédération des coopératives du Nouveau-Québec (FCNQ), the Kativik Environmental Quality Commission (KEQC) and the Kativik Environmental Advisory Committee (KEAC).

Support from the northern village of Inukjuak and the KRG was essential in liaising and communicating with local stakeholders and obtaining the data required for the MFA. These stakeholders were particularly helpful in the identification of industrial, commercial and institutional establishments (ICI) and the main generators of residual materials, and in providing a detailed picture of recovery initiatives in the context of the circular economy and current residual materials management (including quantification). These stakeholders also provided data from the territory's property assessment rolls.

The KRG is a public organization with jurisdiction over almost the entire territory in Quebec north of the 55th parallel. This jurisdiction includes "municipal matters, transportation, environment, policing, employment, labour training, income security, childcare services, renewable resources, land-use

planning, civil security and economic development" (KRG, 2021). The KRG is responsible for implementing Nunavik's residual materials management plan (RMMP) and improving NLs and wastewater treatment lagoons in the territory (KRG, n.d.).

Inukjuak manages NL operations and both residual material and wastewater collection. Since the community can adopt its own bylaws, Inukjuak has a bylaw governing use of the municipal landfill and the disposal of residual materials (KRG, n.d.).

The shared mandate of the KEQC and the KEAC is to observe, analyze, comment on, and/or decide on projects in Nunavik that have an environmental or social impact (KRG, n.d.).

Makivik Corporation, (Makivik means *rise up* in Inuktitut) is mandated to protect the rights, interests and financial compensation related to the JBNQA (signed in 1975) and the Nunavik Inuit Land Claims Agreement (which came into effect in 2008). Makivik has a variety of distinct mandates. It owns and operates large profitable businesses that create jobs. It also pursues the socio-economic development of the region and the improvement of housing conditions for Nunavimmiut (Makivik Corporation, 2023).

The FCNQ belongs to a group of 14 cooperatives (collectively known as “the Co-op,” the term used hereafter). Co-op members live in the various Inuit communities located along the shores of Hudson and Ungava bays in Nouveau-Québec (now Nunavik). The primary purpose of each local branch of the Co-op is to bring the community together and act as a voice for their interests (FCNQ, 2018).

The Inukjuak Co-op was one of the first co-ops to join the FCNQ shortly after this organization was founded. The Co-op's activities in Inukjuak range from retail outlets (a grocery and a general store) to hotels, cable TV, adventure tourism, and petroleum product distribution. The Co-op is one of the largest job creators in the community (FCNQ, 2018).

2.5 Infrastructures

In terms of its infrastructures, Inukjuak has a breakwater and a cargo unloading/loading area on the shores of Hudson Bay at the western end of the village. Since Inukjuak has no deepwater dock where cargo ships can unload and load, they anchor in deep water where the containers for Inukjuak are transferred to a barge for transporting to the shore.

The village also has a federal airport with a runway approximately 1,200 m long. The village is served by Air Inuit. Several planes land and take off each week from the Inukjuak airport.

2.6 Economic and institutional activities

The main employers in the village are private companies, the Co-op, and the public sector (e.g. schools and municipal government). On the commercial front, the range of food outlets in Inukjuak is limited, consisting of the FCNQ grocery store and the North West Company’s Northern store. On the healthcare and social services front, Inukjuak has a local community service centre (CLSC) (clinic) and a women's shelter. The community also has an elementary school, a high school, an adult education centre, and a vocational training centre.

In terms of institutions, Inukjuak has a KRG office, a childcare centre (CC), a recreation centre, a municipal government building, a post office, and a Kativik Regional Police Force station. The SPN business directory lists 31 organizations, institutions and businesses in Inukjuak (Table 3), most of which employ from 1 to 4 workers (Table 4). A complete list of ICI can be found in Appendix A.

Table 3: Number of businesses in Inukjuak by sector

Sector of activity	Number of businesses
Aviation	2
Retail	2
Construction	4
Education	1
Energy	2
Mining	1
Community organizations	6
Childcare	2
Professional/consulting	1
Public service	7
Healthcare	1
Transportation	1
Marine transportation	1
Total	**31**

Source: SPN, 2022.

Table 4: Number of employees in Inukjuak by number of businesses

Number of employees	Number of businesses
1 to 4	19
5 to 19	8
20 to 49	3
100 to 199	1
Total	**31**

Source: SPN, 2022.

2.7 Current management of residual materials

While the operational requirements of NLs are governed by the *Regulation respecting the landfilling and incineration of residual materials* (RRLIRM, c. Q-2, r.19), the *Act respecting Northern villages and the Kativik Regional Government* (R.S.Q. c. V-6.1) stipulates that each northern village has jurisdiction over both its NL and its residual materials management.

In 2019, the KRG published a review of the implementation of its 2015-20 RMMP. This review identified numerous issues, including a lack of financial resources, a lack of consideration for the specific context of Nunavik, a lack of controlled access at the NL, and the requirement to use marine transportation to transport residual materials to recycling and recovery sites (KRG, 2019a).

The KRG has prepared a RMMP (KRG, n.d.), with the aim of developing standardized residual materials management strategies for Nunavik. This RMMP has been deemed compliant with the official *Québec Residual Materials Management Policy*.

The main goals of the 2021-27 RMMP include:

– Raise awareness among all generators of residual materials on the importance of residual materials management;
– Develop Nunavik-specific management methods consistent with sustainable development concepts;
– Monitor progress in implementing the RMMP and stay abreast of developments in residual materials management around the world.

2.7.1 Recyclable materials

Inukjuak does not offer selective collection of recyclable materials. However, some initiatives have been implemented. For example, the FCNQ grocery store offers a service for consumers to return cans and collect their financial deposit (Figure 3). These cans are then shipped by sea to the south. This source represents approximately four full containers of cans being shipped back annually by sea to the south.

The Co-op also collects its cardboard and returns it to the south as well.

Figure 3: Drop-off point for collecting refundable cans

2.7.2 Organic matter

There is currently no municipal collection of organic matter in Inukjuak. However, in 2019 the KRG proposed a project to set up a thermophilic composter for processing cardboard and organic matter (KRG, 2019b). The location designated for this composter is approximately 300 m from the NL (KEQC,

2023). In 2020, this project received an exemption certificate from the Ministère de l'Environnement et de la Lutte contre les changements climatiques (MELCC), thereby relieving the project of the requirement to conduct an assessment of its impact on the environment and the local community (MELCC, 2020a). This project is still in development.

No home composting initiatives have so far been implemented in Inukjuak.

A non-aerated lagoon more than 200 m wide (Figure 4) treats wastewater and there is also a sludge storage area nearby. The lagoon is located near the new NL, about 3 km from the village.

Figure 4: View of the non-aerated lagoon

2.7.3 Other residual materials

A high proportion of the materials collected and shipped south is generated by local or short-term businesses based in Inukjuak. These are one-off initiatives associated with either contracts or established residual materials management programs within the businesses concerned. Most of these collection initiatives involve materials generated by these businesses and not necessarily those of the overall community. Initiatives by the village council to collect some of these materials are ongoing. However, few such collecting systems are regulated by the local government.

2.7.3.1 Other residual materials collected by the village government

There are no community-managed ecocentres in Inukjuak. However, products targeted by the EPR are collected in Inukjuak, except for household appliances and air conditioners. Tires are also collected. A few short-term or informal residual materials management initiatives have been carried out in Inukjuak over the past 20 years. Some continue to operate, while others have been discontinued due to not only the complexity of shipping to the south, but also to a lack of onsite managers and other staff to maintain these projects.

Ongoing initiatives include the recovery of used oil. Some of the oil generated by the village is recovered to heat a municipal garage. Other entities that generate used oil manage it themselves and ship back this HHW to southern Quebec for processing.

All community members and ICI can drop off their used batteries at the municipal garage where they are stocked for shipment to the south.

2.7.4 Disposal of residual materials

As mentioned in Section 2.7.1, there is no selective collection of residual materials in the territory. Apart from refundable cans and the Co-op-generated cardboard, all other recyclable materials are jointly stocked with waste materials. The municipality operates a door-to-door service for collecting residual materials. Each building in the community has a small front-opening residual materials container (Figure 5). One or two trucks make the rounds Monday through Friday to pick up materials from these containers at home and ICI.

Figure 5: Example of a house, a container for residual materials, and a heating oil tank

The Inukjuak NL, located less than 500 m north of the community, is the cause of several environmental and community problems. Normal procedure is for residual materials to be burnt in an NL. However, since this NL is less than half a kilometre from the closest buildings in the village, no burning takes place there, while clean wood is now incinerated at the new NL located a few kilometres from the village. Moreover, the residual materials at the existing Inukjuak NL are not covered because the village does not have access to cover material. Since this NL is reaching the end of its useful life, residual materials are simply deposited on either side of the road leading to it (Figure 6).

Figure 6: The Inukjuak NL

Materials pile up at this site without being incinerated or covered or fenced in, which poses a problem when high winds blow uncovered materials through the village.

Since the NL and the village are respectively located at an elevation of about 41 m and from 20 m to 30 m, landfill runoff flows towards the village with the result that leachate builds up and stagnates in some spots.

Specific areas of this NL were originally reserved for out-of-service vehicles, metal and bulky metal items (Figure 7) as well as wood (Figure 8).

Figure 7: Metal waste storage area at the Inukjuak NL

Figure 8: Wood storage area at the Inukjuak NL

As this NL site gradually filled up, the boundaries and buffer zones between specific areas were also filled in. As a result, the various mounds of metal and wood are now more or less homogenous.

Another factor is the limited availability of machinery for use at the site since the village does not have a compactor or bulldozer to move and compact residual materials. The available space thus cannot be optimized and is becoming progressively smaller as more residual materials are deposited in it.

In addition, a new site was designated for an NL a few years ago. This site, near the non-aerated lagoon some 3 km from the village, is not used because it floods every spring. At the time of the Englobe team's visit, the only activity taking place at the new NL was the burning of clean construction wood. Residual materials thus continue to pile up at the existing NL.

For all these reasons, residual materials management is a major concern for the community.

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 incoming, outgoing and stocked material 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 implies prior collection of data to establish the most accurate picture of the situation on which the MFA is based.

In the specific case of Inukjuak, it is also important to remember that the purpose of the MFA is to stimulate identification of the community's circular economy potential.

3.1.1 Choosing an MFA

There are several MFA methods. In her essay, *L'analyse de flux de matières au Québec : méthodes et enjeux d'opérationnalisation dans une perspective d'économie circulaire* [Material flow analysis in Quebec: methods and operationalization issues from a circular economy perspective] (Morris, 2016), Audrey Morris describes several methods, including the one developed by Eurostat and that by Peter Baccini and Paul H. Brunner.

The Eurostat "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-based energy. This method creates a kind of "black box" in the target territory because it is based solely on the territory's inputs and outputs and does not take into account interactions within the territory itself. Nor does the method account for water consumption, as this represents an overly large quantity that masks other results (Morris, 2016). Nor does it consider issues associated with low mass flows, even if such flows are rare or toxic (Morris, 2016).

For its part, Baccini/Brunner's "bottom-up" method (Morris, 2016) 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 insofar as it describes the various flows within the system. Baccini/Brunner's method is also based on activities, not just types of materials.

The approach adopted for this mandate is a hybrid one based on both these methods. Such a hybrid method was used to conduct an MFA of the Brussels region in 2015 (EcoRes, 2015). Such a method is also well suited to this project's objectives since it identifies not only the community's main activities (no "black box"), but also the materials related to these activities. Moreover, such a hybrid method is also recommended when the aim of the MFA is to better understand the circulation of material flows in the target territory in terms of possibly carrying out circular economy projects (Morris, 2016). This was the preferred approach for the Inukjuak context.

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

- Energy;
- Water;
- Extracted material (gravel pit) within the MFA boundaries;
- Consumer products.

All these flows were quantified in the MFA so as to understand their expression in the Inukjuak economic system. This exercise identified the main resources that are incoming (inputs), whether imported or extracted, outgoing (outputs), whether exported or released into the environment, as well as the ones stocked (staying in the community). As applicable, the flow dynamics obtained should indicate the loop of outputs that circulate back to the community.

3.1.2 The MFA boundaries in space and time

Inukjuak's administrative boundaries as the participating village (Figure 9) are the geographic boundaries used for the MFA. Due to the village's isolated location, the only ways to import food, equipment, and other products or materials are by air or sea.

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

Figure 9: Inukjuak's geographic boundaries

3.2 Data collection

Since the MFA aims to stimulate identification of Inukjuak's circular economy potential, the primary focus was on identifying the inputs and outputs specific to this northern village.

The types of inputs and outputs were determined using two approaches to collect the required data, including data from the territory's ICI. The output estimate was then completed by a characterization of the residual materials disposed of at the existing Inukjuak NL.

It should be noted that outputs managed by municipal authorities are generally weighed or quantified. For example, loads of recyclable materials, HHW and EPR products are all weighed. On the other hand, the quantities of residual materials disposed of at the Inukjuak NL are not measured because the NL does not have weighed scales. Data on the quantities of these materials were therefore taken from the Nunavik RMMP (KRG, n.d.).

3.2.1 ICI

Since the MFA was performed on a territory with a population of less than 2,000, all ICI operating in Inukjuak were approached to provide as much data as possible on purchases (inputs), residual materials management, and releases into the environment (outputs).

This information was obtained by:

– Questionnaires;

– A six-day stay in the community to meet with several ICI and visit public infrastructure.

3.2.1.1 Questionnaires

Four questionnaires were developed, one for each of the three ICI sectors and one for the municipal government. Appendix B contains these four questionnaires.

Questionnaires were emailed to the 31 ICI in the territory for documenting the various inputs and outputs associated with their respective activities. These questionnaires focused on the material manufacturing processes occurring within ICI operations as well as the by-products generated by those activities. A few questions relating to the circular economy were also included.

The Inukjuak municipal government and the KRG received a questionnaire on water distribution, residual materials management, roadworks, and new construction on the territory.

3.2.1.2 Visits to ICI

The Englobe team visited Inukjuak in September 2022.

The most active ICI in terms of resource consumption or residual materials generation were asked to attend an information meeting. The team met with representatives of 17 ICI out of the total 31. Ten of these organizations agreed to participate in the project and subsequently responded to a questionnaire.

The team then met with these 10 participants to complete their questionnaire with them and visit their work sites.

The inputs of these ICI were identified by the questionnaires and the meetings. Most inputs in the commercial sector are represented by retail items. These inputs include materials imported into the community as well as those stemming from domestic extraction, for example, from within the community (Morris, 2016). Outputs were also identified.

3.2.1.1 Infrastructure visits

During its time in Inukjuak, the Englobe team also visited the airport and several residual materials management facilities, including the existing NL, the new NL and the non-aerated wastewater treatment lagoon. During these visits, the team gathered information on how various outputs are managed.

3.2.2 Characterizing disposed-of residual materials

Englobe characterized the residual materials sent to the NL (September 9, 2022) to determine the types of outputs generated by the Inukjuak community.

A sorting area was set up in the municipal garage to characterize a sample consisting of a load of residual materials taken from approximately 15 homes.

This sample was analyzed according to 42 categories of residual materials, bearing in mind that waste from both residences and ICI are collected jointly. Most of the waste in the sample was in bags. The characterization method used is described in detail in Appendix C.

Note that this characterization is based on one sampling of residual materials and does not necessarily represent all materials sent to the NL.

3.3 Data processing

An MFA is designed to obtain overviews of entire communities. However, not all the ICI in Inukjuak participated in the MFA exercise. Extrapolations therefore had to be made using the data from the questionnaires and the information available about each company, including sector, work site size, and number of employees. These extrapolations combined with the data collected from the ICI were used to quantify all inputs and outputs for Inukjuak.

Both the questionnaire data and the characterization data was processed and converted into data for calculating Inukjuak's material flows. The data processing was based on inputs and outputs.

To prevent duplicate counting of inputs and outputs in more than one flow, particular attention was paid to how the materials were quantified.

The information obtained from the questionnaires, the visits to the ICI, and the residual materials characterization was processed and analyzed in an Excel database. The overall aim was to facilitate identifying sectors that could contribute to optimizing the local economy's circularity.

3.3.1 Converting data into weights

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 information collected was often obtained in the form of:

- Volume (e.g. waste 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 containers, etc.).

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

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

3.3.2 Data annualization

The quantity data converted into weights were then extrapolated to an annualized basis. This step was carried out considering the seasonal nature of the activities concerned. For example, supplies by boat only take place during summer, while the ones made by air are all year round.

3.3.3 Extrapolation based on response rate

The data and other information obtained by Englobe were processed to cover the entire territory of Inukjuak, 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.

An initial extrapolation factored in the response rate or the representativeness based on the number of employees. The organizations that responded to the questionnaire represent approximately 181 employees. According to SPN data, there are approximately 430 employee positions in Inukjuak. Given that 181 employees were reached in the context of this study, the sample's representative proportion of the Inukjuak labour force would be around 42%. An extrapolation was therefore made to estimate the inputs of the entire working population (100%).

To achieve this 100% representation, Englobe used two types of information: number of ICI and 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 workforce to cover all ICI in the territory.

Some extrapolations were also made for the commercial sector. For example, in the case of the retail trade, the data obtained from one business were extrapolated for the other similar business that did not submit information.

3.3.4 Output quantification and categorization

Information obtained from the ICI that participated in the study was used to determine more precisely the quantity of some of the territory's outputs, such as those collected, recovered or disposed of.

In addition, the results of the residual materials characterization at the municipal garage were also used to classify the outputs disposed of in the NL according to 42 categories of material. 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 in the community. However, where this was not possible, the team proceeded by estimation. In such cases Englobe used estimation factors that are available and recognized in the literature, indicating data sources. These sources include organizations such as Statistics Canada and provincial or federal government departments or ministries. International estimation factors were used in cases where no information was available for Quebec or Canada.

3.4.1 Response rate

Most of the input data came from private companies. However, as a category, these companies were the main obstacle in carrying out the MFA. This is because some companies may not have cooperated as optimally as possible since they refused to share certain sensitive information directly relating to their respective businesses (e.g. their sales figures). Where necessary, inputs and outputs were therefore estimated using publicly available assumptions and statistics.

Since a significant portion of the methodology relied on questionnaires, the analysis could have been affected by the low ICI response rate. However, during the Englobe team's visit to Inukjuak, direct contact was made with the largest generators of inputs and/or outputs in the territory; this contact included help with completing the questionnaires.

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 appliances. Since the questionnaire was directed at ICI and given the absence of car dealers and appliance retailers in Inukjuak 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 *Analyse du cycle de vie – Métaux et économie circulaire au Québec – Analyse de flux de matières du cuivre, du fer et du lithium* [Life cycle assessment – metals and the circular economy in Quebec – material flow analysis of copper, iron and lithium] (CIRAIG, 2017). This study provides a complete picture of metal flow analysis, including extraction, production of metal objects, use of these objects, and their end-of-life. For the purposes of this project, only the metal objects' “use” and “end-of-life” parameters were used. Quantities were estimated based on the number of Inukjuak residents.

3.4.3 Inputs from outside Inukjuak

Another limitation of the study is that the questionnaires were only addressed to ICI and did not cover goods that residents purchased outside the territory (e.g. furniture, food products, electronic devices, vehicles, etc., that were bought in Montreal or Val-d’Or) and shipped in by plane or boat.

3.5 Data collection confidence level

The study reached most of Inukjuak's working population through meetings with the community's main employer (the Co-op) as well as with representatives of the municipality and the largest retailers. Moreover, the companies that the team met with operate a wide range of businesses (hotels, stores, etc.). Meetings were also held with most of the community's institutions (schools and the municipal government).

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

– Energy;

– Water;

– Extracted materials (gravel pit) in the community;

– Consumer products.

For each parameter, the MFA identifies inputs either imported into the community (e.g. fossil fuels) or directly extracted or created in the community (e.g. electricity produced by the thermal power plant).

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 waste sent to the landfill) or exported outside the community (e.g. cardboard).

For each of these parameters (energy, water, extracted materials and consumer products), the following sections describe and analyze their flow dynamics. The descriptions identify the different types of inputs, outputs and consumers/users, while the analyses show, for example, the breakdown of inputs and the relative importance of consumers/users (as a percentage). Circularity elements are identified, while Sankey diagrams show each flow in detail by associating input and output quantities with users.

4.1 Energy

Two types of energy are used in Inukjuak:

– Electricity;

– Fossil fuels.

All petroleum products used in the community are imported. Fossil fuels include motor fuels (gasoline and diesel), aviation fuel, and fuel oil.

Electricity is generated by an oil-fired thermal power plant. This plant, operated by Hydro-Québec, is the main electricity source for the community and its ICI.

4.1.1 Energy flow dynamics

Inputs include fossil fuels (including motor fuels). These are used to heat buildings, power vehicles, and generate electricity.

Since this northern village is not connected to the Hydro-Québec network, electricity is produced onsite by an oil-fired thermal power plant. To reduce excessive electricity consumption, Hydro-Québec has implemented a program to finance a portion of the fuel oil used for heating. This program administered by Makivik Corporation aims to reduce electricity demand during winter (Boisseau-Bouvier, 2019). It should be noted that at the time of Englobe's visit, a hydroelectric power station was being built on the Innuksuac River near the village. Hydro-Québec has announced that this power station would become operational in 2023, which would reduce or even eliminate the use of fuel oil for heating in Inukjuak (Hydro-Quebec, 2023a). When completed, this power station will serve Inukjuak. At that point, energy extraction could be considered.

Since buildings in Inukjuak are heated by fuel oil, each home, store or building in Inukjuak has its own fuel oil tank. These tanks must be filled regularly. The fuel oil comes from the FCNQ fuel depot. Hydro-Québec also operates two diesel tanks used to fuel the thermal power plant. On the output front, energy consumption generates releases to the environment (atmospheric emissions). The diagram in Figure 10 below shows the energy flow dynamics in Inukjuak.

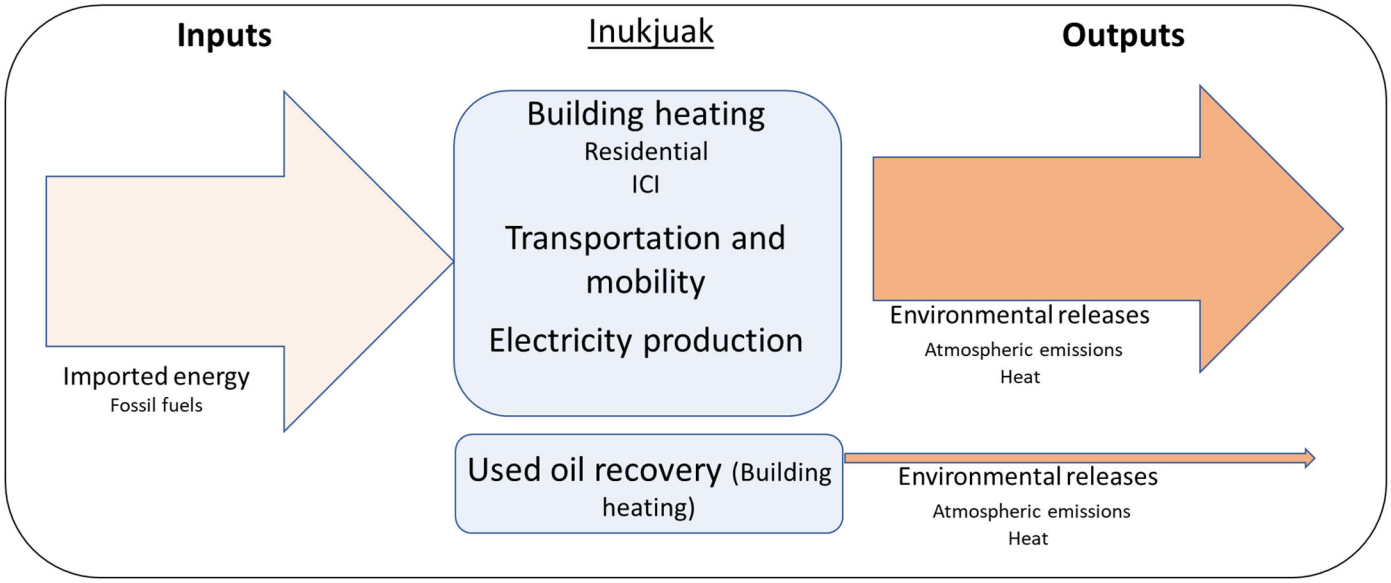

Figure 10: Energy flow dynamics in Inukjuak

4.1.2 Energy flow analysis

All fossil-based energy is imported into Inukjuak. A small petroleum tanker supplies the community once or twice a year. The main fossil-based energy importers are the FCNQ, Hydro-Québec, and the Kativik School Service Centre. According to the Régie du bâtiment du Québec (RBQ, 2023), the FCNQ is authorized to operate eight petroleum product tanks, six of which are located in the petroleum depot. The other two are at the airport and the village service station.

Some of the fuel is used to generate electricity. Used oil is also recovered to heat a municipal building. Outputs mainly consist of atmospheric emissions and heat from the thermal power plant. The energy flow analysis shows that the Inukjuak community consumes the equivalent of approximately 430,000 gigajoules per year.

The types of energy used, according to their gigajoule equivalents, are shown in Figure 11. About 25% of the fossil fuels imported into Inukjuak are used to generate electricity.

Figure 12 shows the breakdown of energy consumption (gigajoules) by five sectors: residential, transportation, industrial, commercial and institutional. It should be noted that the transportation sector includes air transportation.

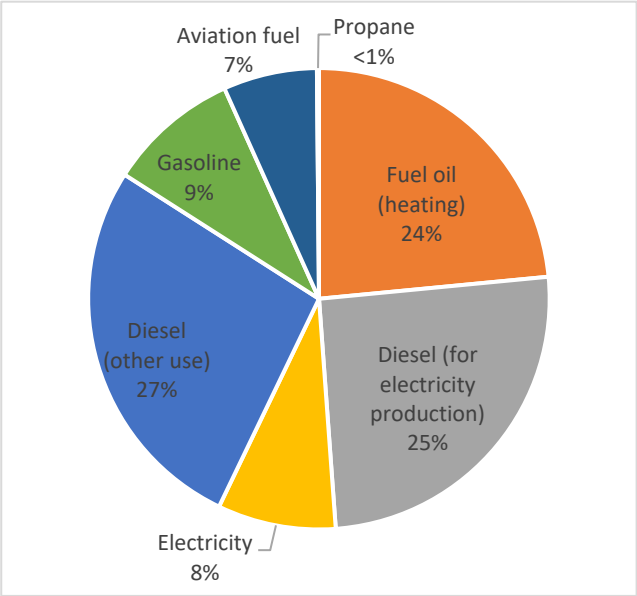

Figure 11: Forms of energy consumed in Inukjuak

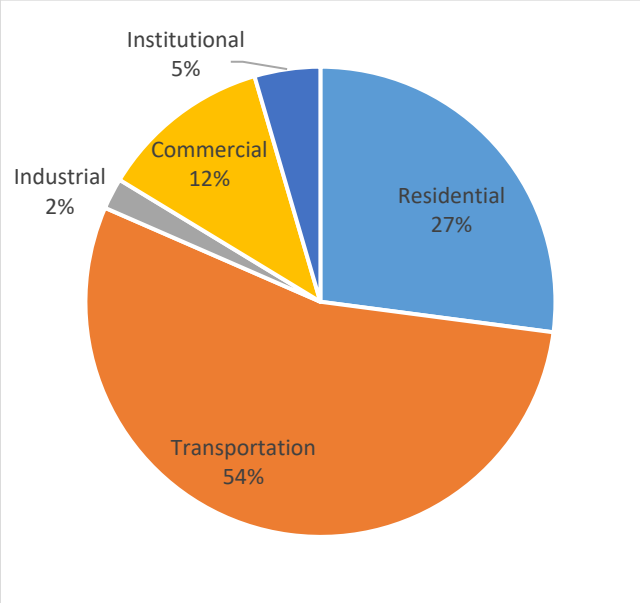

Figure 12: Breakdown of energy use by sector in Inukjuak

The main source of energy in Inukjuak is diesel. This form of energy is mainly used to produce electricity in the village (25%) as well as for other uses (27%), but primarily for transportation.

Fuel oil also accounts for a significant portion of the energy consumption (24%). In the absence of forest resources, almost all the buildings in the village are heated by fuel oil. Petroleum products (gasoline and diesel) are used almost exclusively to power motor vehicles.

It should be noted that the dam under construction on the Innuksuac River will eventually provide most of the community's electricity. Although the current thermal power plant will remain in operation, its role will change from being the sole producer of electricity to being either a backup or the sole source in case of turbine failure at the hydroelectric power station.

4.1.3 Circularity element

The energy flows related to the Inukjuak community are shown in the Sankey diagram in Figure 13. The diagram highlights the energy loss associated with the use of diesel to generate electricity. The diesel fuelling the thermal power plant represents an energy potential of over 100,000 megajoules. However, the electricity produced is only around 35,000 megajoules. The difference between the two values is energy lost mainly in the form of heat. The commissioning of the dam will reduce diesel consumption and energy loss in Inukjuak.

Used oil from motor vehicles is recovered to heat a municipal building. Although this energy source is of fossil-based origin, the recovery of this form of energy constitutes a circularity element.

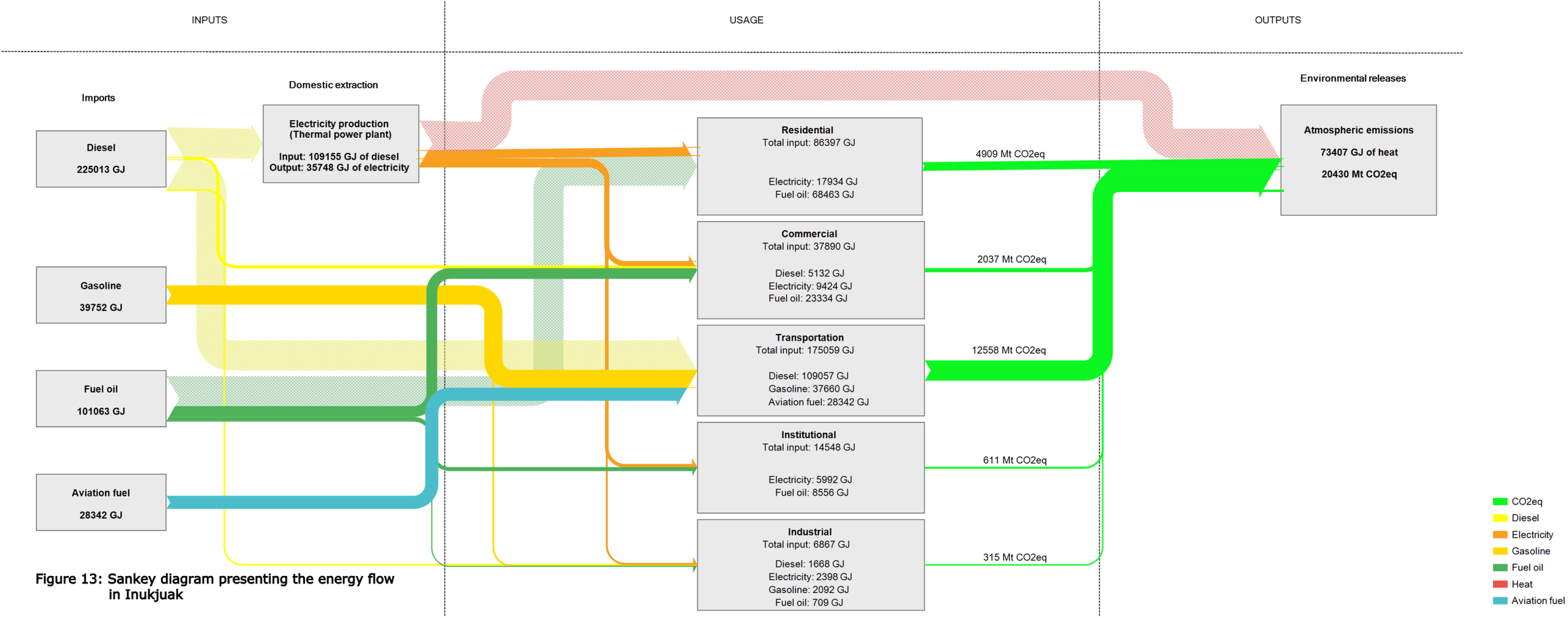

Figure 13: Sankey diagram presenting the energy flow in Inukjuak

4.2 Water

With respect to the water parameter, the MFA focuses on the drinking water produced and consumed within Inukjuak. Although the village currently has no water supply system, it operates a plant that produces filtered and chlorinated water which is then distributed to residents. Each building in Inukjuak has its own water tank. These tanks usually need to be refilled every other day.

However, due to various problems with operating the plant and maintaining the water tanks and delivery trucks, the water in most tanks is not considered suitable for drinking. The water distributed by the village is therefore mainly used for sanitary purposes. Residents either purchase their water for human consumption in bottles or fill their own bottles from a trusted source. In 2021, the village produced and distributed 80,000 m^3 of water for the year compared to 62,000 m^3 in 2016.

Due to the local climate, there is no sewage system in Inukjuak. Each building therefore has its own wastewater tank for temporary storage. These tanks need to be regularly emptied. A light on the side of each building turns on when the tank is full, then a truck comes to empty it. For example, the FCNQ hotel's wastewater tank is emptied every day.

The municipal administration delivers to the water tanks and empties the wastewater tanks. Approximately four trucks are assigned to delivering water and emptying wastewater tanks.

4.2.1 Water flow dynamics

Water in Inukjuak is consumed by residents and ICI. The largest water users are the schools and the hospital. As previously mentioned, in the absence of a sewer system, wastewater is temporarily stocked in tanks that are regularly emptied. This wastewater is transported to a non-aerated treatment lagoon north of the village.

Figure 14 shows a summary of water production and use in Inukjuak.

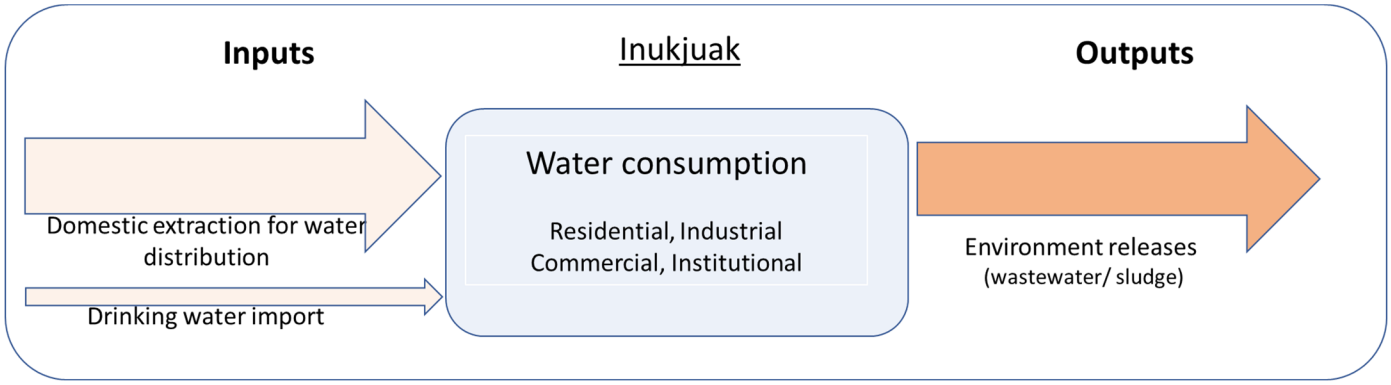

Figure 14: Water flow dynamics in Inukjuak

One particularity of the water flow in Inukjuak is the imports of bottled drinking water. The empty water bottle component is discussed in Section 4.4. If the water production, distribution and domestic storage chain in this northern village were optimized, the need for imported drinking water would be greatly reduced.

4.2.2 Water flow analysis

The water flow analysis shows that Inukjuak produces approximately 80,000 m^3 of water per year partly for sanitary and drinking purposes. Residents can obtain drinking water by directly filling bottles from a reputedly clean source in the community. Otherwise, bottled water is sold in the various stores. It was not possible to estimate the imported quantities of bottled drinking water.

Figure 15 breaks down water consumption into four sectors: residential, industrial, commercial, and institutional.

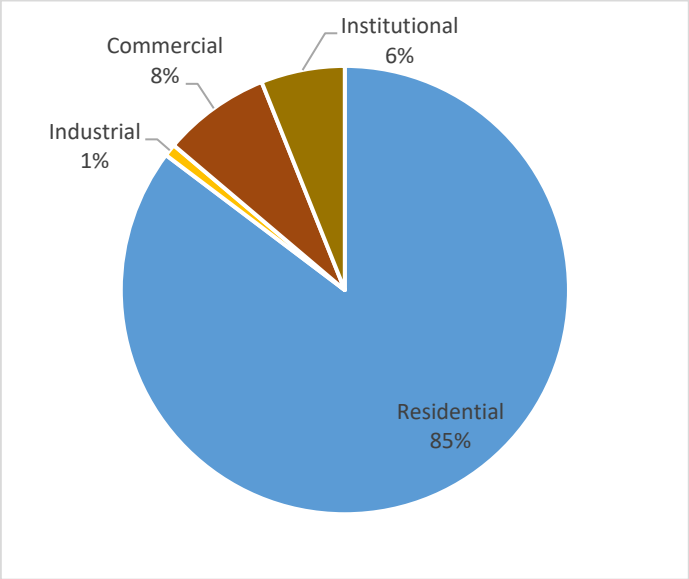

Figure 15: Breakdown of water use by activity sector in Inukjuak

4.2.3 Circularity elements

The Sankey diagram (Figure 16) shows the overall water flow dynamics in Inukjuak.

A noticeable feature of these dynamics is the absence of circularity: water in Inukjuak is simply produced, delivered and consumed. Water consumption is limited by the size of the tanks outside each building. As for wastewater, it is emptied and stocked. Sludge is not recovered.

The imports of drinking water intrinsically involve importing plastic bottles. In a geographical context where transporting (exporting) selective collection containers to a sorting centre for recyclable materials is a real challenge, importing this water (and their bottles) generates an additional problem: the management of empty bottles. These bottles are not recycled and are sent to the NL.

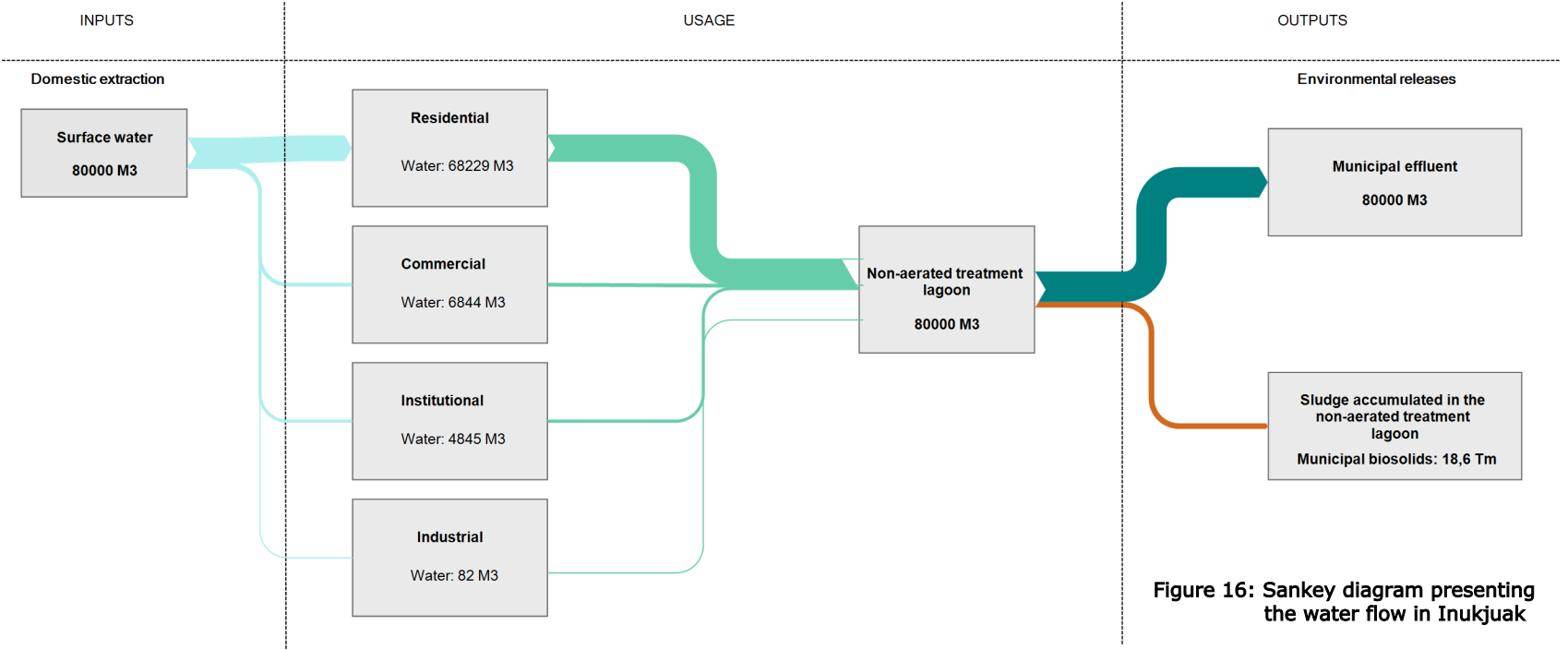

Figure 16: Sankey diagram presenting the water flow in Inukjuak

4.3 Extracted materials (gravel pit) in the community

This category identifies materials extracted or created within the community, including their processing, if applicable. Typically, the extracted materials are due to the exploitation of natural resources (mining, fishing, agriculture, forestry, etc.). In the case of Inukjuak, a gravel pit operates near the village. Gravel is used in the village for road repair and producing hot-mix asphalt.

4.3.1 Extracted material flow dynamics

The dynamics of the gravel pit are quite simple: all the gravel is used in Inukjuak. From an MFA perspective, this use in road infrastructure corresponds to a gravel stockpile. Figure 17 shows the flow dynamics of materials directly extracted into the community.

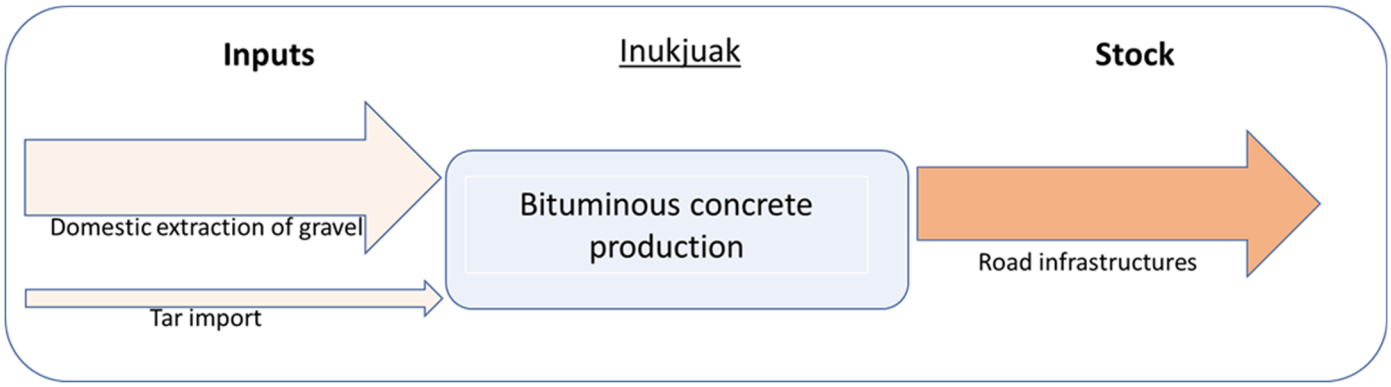

Figure 17: Extracted material flow dynamics in Inukjuak

4.3.2 Analysis of extracted material flows

Tar is required to produce hot-mix asphalt. This tar is imported into Inukjuak and the asphalt is stocked onsite in the road infrastructure.

4.3.3 Circularity elements

There is no circularity element in the use of gravel.

Extracted material flows are shown in the Sankey diagram in Figure 22. This diagram also includes consumer products.

4.4 Consumer products

This category covers all goods, materials, products and equipment imported, used, and consumed within the community.

According to information gathered in Inukjuak, flow of goods, materials, products and equipment imported for consumption are brought into the community by residents and ICI.

These importers include:

- Businesses, which import perishable, frozen or nonperishable food (canned goods, pasta, etc.) as well as beverages, hardware products, office equipment, etc.;
- Companies, which import products for their activities (wood, HHW or EPR products);
- Schools, which import school supplies via the school service centre;
- A medical centre, which imports medical equipment;
- Residents who import vehicles and home furnishing items (furniture, appliances, electronics, etc.).

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

Validating some of the data in this category proved difficult because, due to Inukjuak's geographic location, residents order large quantities of goods that arrive by boat.

Based on an estimate of imported product consumption, the composition of the flow of flow of goods, materials, products and equipment in this study is as follows:

- Metals;
- Food products (food, beverages and packaging);
- Lumber;
- Building materials (gypsum, asphalt shingles and other building materials);
- HHW;
- Products currently covered by EPR:
  - Household appliances and air conditioners;
  - Oils, coolants and antifreeze as well as this their filters and containers;
  - Mercury lamps;
  - Batteries;
  - Electronics;
  - Paint and paint containers.
- Medical equipment and school supplies (including office supplies such as stationery).

Some flow of goods, materials, products and equipment are recycled at the end of their useful life, but most are disposed of. Figure 18 shows the flow dynamics of flow of goods, materials, products and equipment imported into Inukjuak.

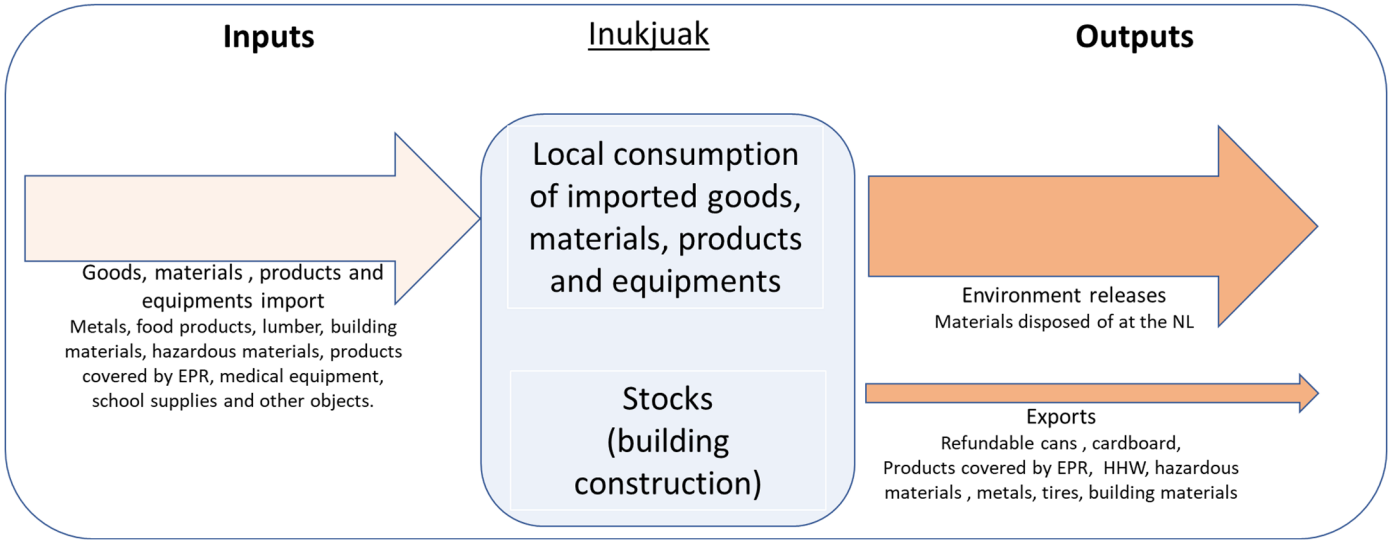

Figure 18: Flow dynamics of consumer products imported into Inukjuak

Food products mainly consist of the food and drink imported into Inukjuak by retailers, primarily the Co-op and the Northern. 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 or glass) and cardboard packaging. The characterization of residual materials at the NL was used to estimate the quantities of glass, plastic, cardboard, etc.

Also, some construction contracts in Inukjuak now contain a specific clause for residual materials management, which encourages the export of residual materials generated by construction. For example, contractors from southern Quebec operating in Inukjuak are required to bring their building materials with them and then take back the construction, renovation and demolition (CRD) waste generated by their work. The ultimate destination of these residual materials can vary (recycling, recovery, or disposal). However, this destination is exclusively in the southern part of the province (not the Inukjuak NL).

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

All imports come in by air (via one carrier) or by sea (via two marine shipping companies that operate cargo vessels). No air carrier or marine shipping company wished to participate in the study. The data on goods, materials, products and equipment are mainly derived from the questionnaires completed by the ICI. These data had to be extrapolated to obtain an overall estimate of the situation. In addition, the data used to calculate metal imports (including vehicles) are based on a CIRAIG study (2017). Figure 19 shows the breakdown of imported flow of goods, materials, products and equipment by product type.

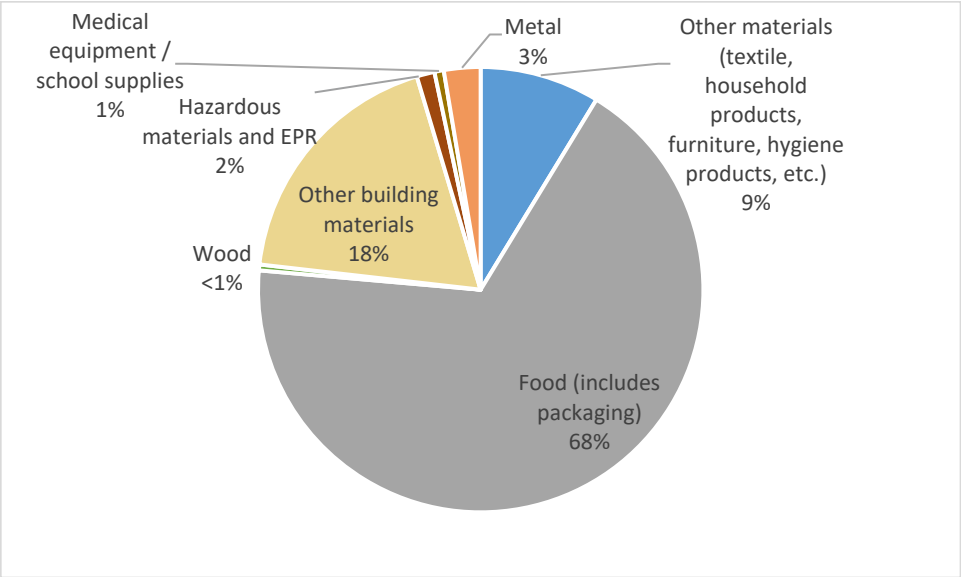

Figure 19: Breakdown of imported goods, materials, products and equipment (excluding residual materials disposed of at the NL)

Food products (food) and building materials (including wood) are the two main imports.

All wood and other building materials are entirely used in Inukjuak. In fact, in addition to the construction of the dam, some 20 buildings were added to the village's housing stock in 2021. These building materials are stocked in Inukjuak.

The site of the largest quantity of materials released into the environment is the NL, which receives residual materials from the village's residents and ICI (Figure 20).

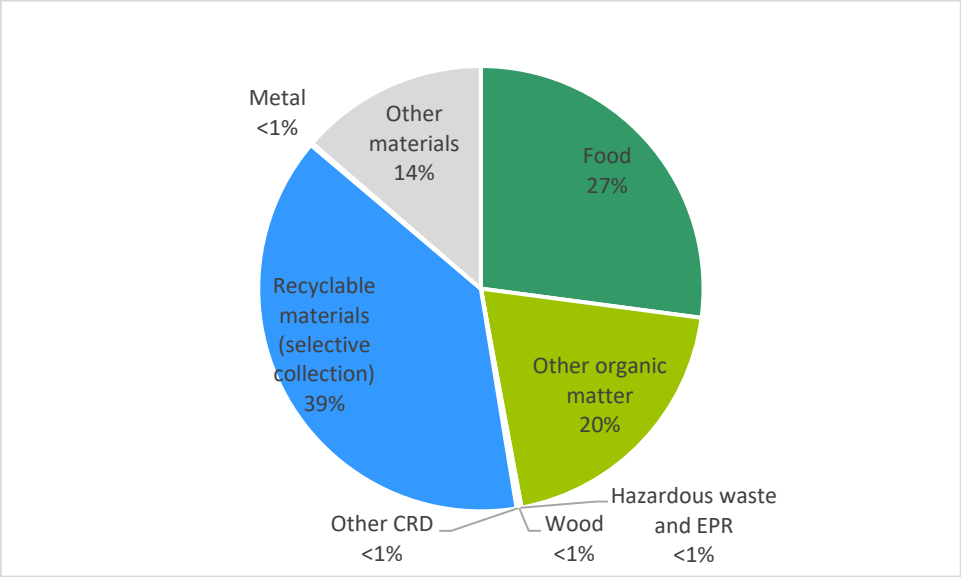

Figure 20: Proportion of material disposed of at the Inukjuak NL

4.4.3 Circularity elements

Like all northern villages in Nunavik, Inukjuak is geographically isolated without any land access. At first sight, a strictly linear economy could be expected. However, some circularity has evolved in this community. As mentioned, these are mostly projects initiated by the FCNQ and the KRG as well as by certain ICI. When collection and recycling initiatives are implemented, they usually include trips to the south. This explains why these initiatives are primarily implemented by ICI. Although shipping materials south comes at a significant cost, these ICI also have easy access to this means of transportation because they import many containers of goods and are already renting these containers. Of these goods and materials brought into Inukjuak, these major importers collect cardboard, pallets, tires, building materials, refundable cans, car batteries and HHW for shipping back south. Some companies also donate leftover building materials to the community.

Grocery stores are trying to sell soft drinks in cans rather than in plastic bottles now that the Co-op ships cans south for recycling. Efforts to make alternative use of expiring food were also noted. In fact, groceries are trying to cook prepared meals for sale using this close-to-expiration food. In the case of the Co-op, however, a lack of workers is an impediment to the expansion of this method. In addition, some food close to its expiry date is sometimes donated to the community. However, such initiatives are not systematic. In addition, the Co-op gives cardboard boxes from their imported goods to their customers to pack their groceries in. The hotel has also implemented smaller-scale actions, including reusing hotel towels as cleaning rags and donating old sheets to the sewing centre. In addition, a portion of Northern's perishable food is distributed in the community when it no longer meets consumer safety standards. This helps reduce food waste.

As for the NL, residents sometimes explore this site for interesting materials for their own use. They call the NL their “Canadian Tire” because they can find all kinds of functional parts that they do not have to buy and ship from the south. Along the same lines, the Inukjuak Buy, Sell, Trade or Swap Facebook group is a marketplace for community members to sell, trade or donate certain materials. About 15 notices are posted every day.

The village also collects batteries. These are stocked in a municipal garage and regularly shipped back south.

The flows of goods, materials, products and equipment are shown in the Sankey diagram in Figure 22. This diagram also groups extracted materials.

4.5 Extracted materials/consumer products group

Extraction activities (gravel pit) and products imported into Inukjuak are grouped within the same Sankey diagram (Figure 22).

The main identified input materials are:

– Food;

– Building materials (e.g. wood and shingles);

– Other materials used in everyday life (e.g. clothing, furniture and household products);

– Metal (e.g. vehicles).

Food is Inukjuak's principal import. Since the local climate is not suited for agriculture and there are no greenhouses in the village, Inukjuak residents are required to import food and other products and materials necessary for daily life.

Furthermore, the Inukjuak population is growing. This implies the construction of new houses and the imports of building materials. The construction of the dam has also required the imports of materials.

Every year, the population also imports vehicles (made of metal, tires and other materials).

The outputs of the extracted materials/consumer products flow fall into two categories:

– Exports;

– Materials released into the environment at the NL.

Exports are mainly represented by materials, objects and products that companies return for recycling, processing or recovery to the south. Tires, cardboard, building materials, refundable cans, HHW, scrap metal, other metals and some EPR products are shipped outside the MFA boundaries and also count as exports. Exports are also represented by materials released into the environment at the NL.

The breakdown of Inukjuak's total exports (e.g. consumer products) are shown in Figure 21. It was observed that companies are mainly responsible for these exports, an observation that was also confirmed by the questionnaires. With a few exceptions, the village government has little influence over exports.

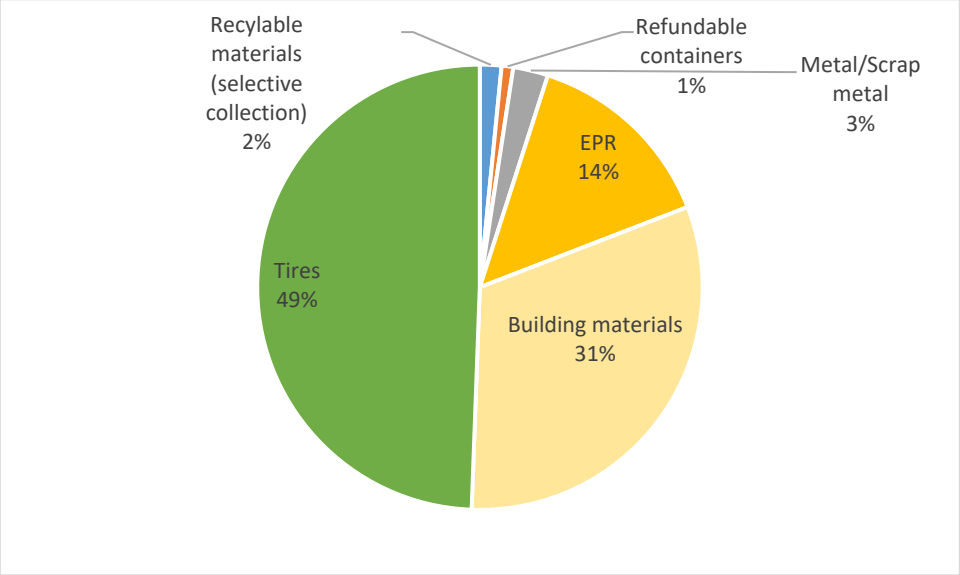

Figure 21: Proportions of exports from Inukjuak

As shown in Figure 21, the main export is scrapped tires (49%). Several containers of scrap tires leave Inukjuak each year. The same goes for building materials (31%). However, these specific export figures are circumstantial since they are associated with the building of the dam. A residual materials management clause was included in the construction contract for this dam, requiring the contractor to return its CRD waste to the south.

Other significant exports to the south include EPR materials (mostly used oil), scrap metal, cardboard, and refundable bottles. All exports are shipped in marine containers on cargo vessels.

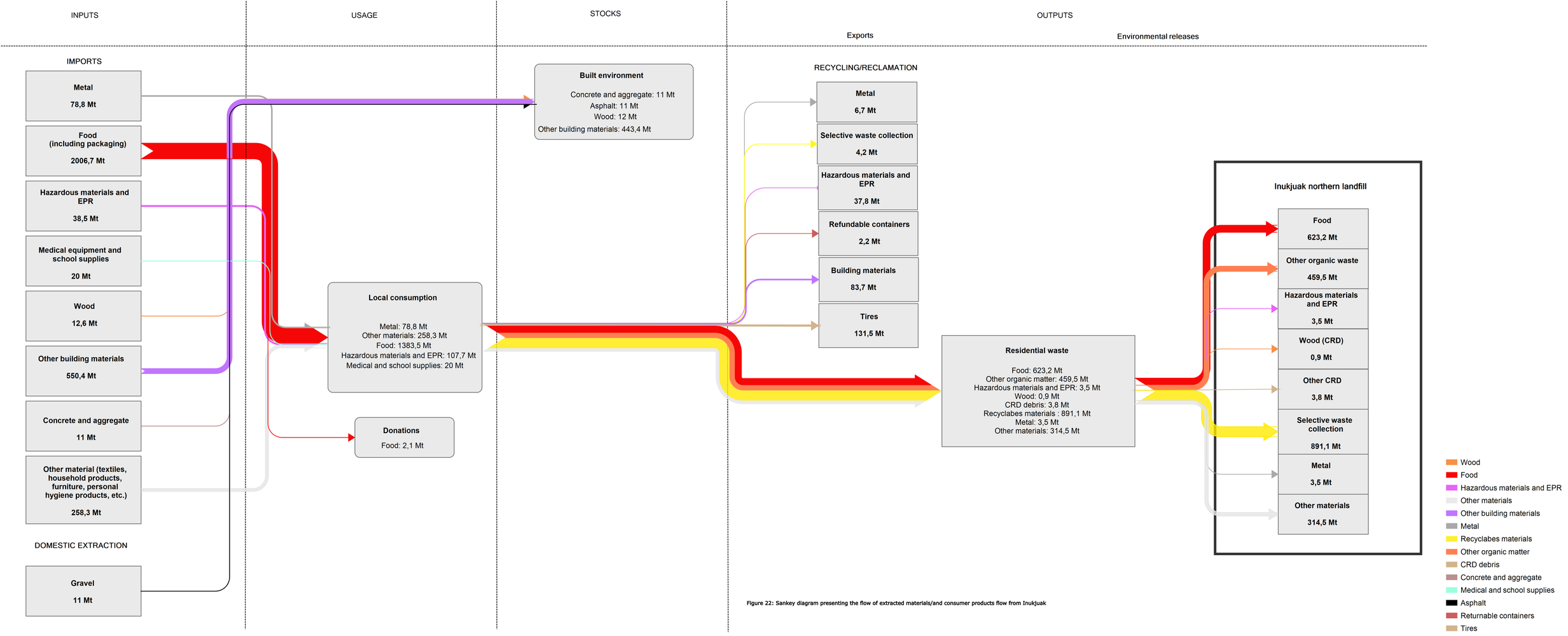

Figure 22: Sankey diagram presenting the flow of extracted materials/and consumer products flow from Inukjuak

4.6 Summary of the Inukjuak MFA and existing initiatives

The Sankey diagram of the overall materials flows in Inukjuak (Figure 23) groups information on energy, water, extraction activities (gravel pit) and consumer products. The diagram also shows stocks as well as outputs like exports and releases into the environment.

The main inputs to Inukjuak are imports. Inukjuak imports energy, consumer products and other materials. Imported energy is mainly used for heating buildings, generating electricity, and fuelling vehicles. The other imported materials are used for construction and a growing population's housing needs. 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 collection and electricity generation. The MFA shows that electricity generation from diesel leads to a significant loss of energy.

As shown in Figure 23, Inukjuak's economy is characterized by linear flows, meaning that few circular economy actions stand out.

Although some circular economy strategies, such as responsible consumption and procurement, process optimization or short term rental do not appear in the diagram and are difficult to show in an MFA, some circular economy initiatives were identified during the Englobe team's visit to Inukjuak:

- A few companies ship back south a portion of the residual materials they generate so that these can be reused, recycled or recovered;
- Some companies donate their leftover building materials to community members. They also sometimes sell certain machinery that could be of interest to individuals or the village administration. This obviates the imports of certain goods;
- The Co-op returns some residual materials resulting from its operations to the south. These include pallets, used oil, tires, cardboard, other liquid HHW from the machine shop, etc.;
- The Co-op collects refundable cans, paint cans and propane tanks generated by the community;
- Grocery stores prioritize the sale of soft drinks in cans rather than in bottles;
- Some stores donate broken items from their stock to the community;
- Towels from the Co-op hotel are reused as cleaning rags, and sheets are donated to the sewing centre;
- Contractors in the area, such as construction companies, sometimes rent out their machinery with a machinery operator;
- A sewing centre has been set up in Inukjuak. This centre trains people to undertake sewing projects such as making tents and coats; it also has a space where people can share sewing expertise;
- The Inukjuak Buy, Sell, Trade or Swap Facebook group is an online marketplace for community members to sell, trade or donate certain materials. About 15 notices are posted every day;
- Residents sometimes explore the NL to find certain materials for reuse in other projects;
- The local administration collects batteries from the community for sending south;
- Waste oil from municipal and community activities is recovered to heat one of the municipal garages.

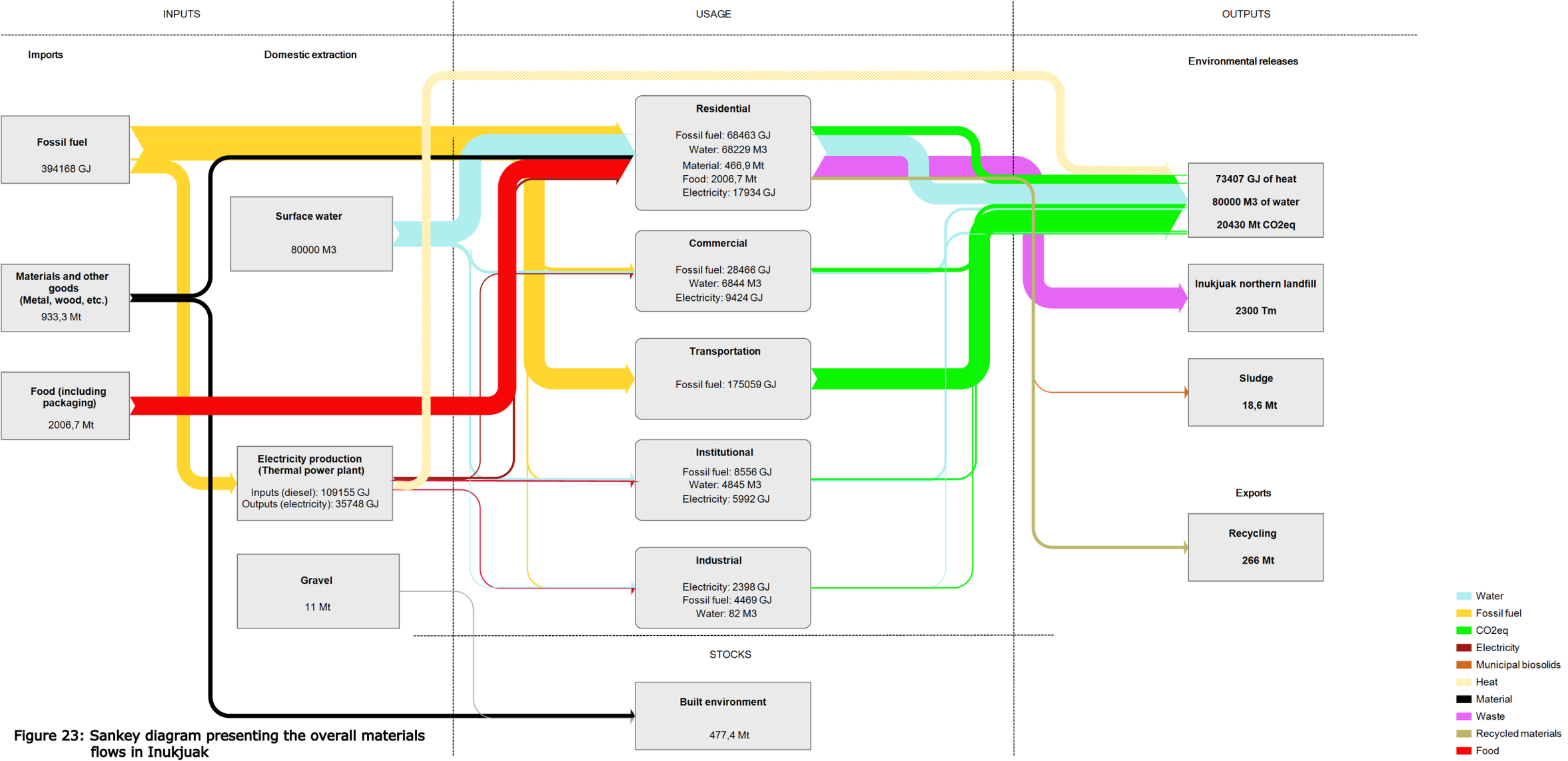

Figure 23: Sankey diagram presenting the overall materials flows in Inukjuak

5 Circular economy solutions

Potential circular economy solutions for the Inukjuak community can be identified based on the results of the MFA, the visits, the interviews, and the questionnaire responses.

The MFA describes the community's main incoming and outgoing material flows. The nature and quantity of residual materials disposed of in the community as well as related circular economy initiatives and opportunities were identified through interviews and other onsite work.

The Inukjuak community is characterized by its isolation, its young population, a high volume of imported products (e.g., energy and drinking water), few residual materials management options other than storage at the NL, the inability to use the new NL, and the challenge of transporting residual materials to conditioning and recovery sites.

This chapter discusses opportunities for circular economy solutions in Inukjuak. 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 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 objectives:

- Rethink production and consumption patterns 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 5, and the principles of circular economy (Institut de l'environnement, du développement durable et de l'économie circulaire [EDDEC], 2018) are shown in Figure 24.

Table 5: Circular economy strategies

	Strategy	Objective	Definition
1	Ecodesign	Rethink	Integrating environmental aspects as early as possible in the design phase of products and services to minimize their environmental impacts throughout their life.
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.

Source: RECYC-QUÉBEC, 2022b.

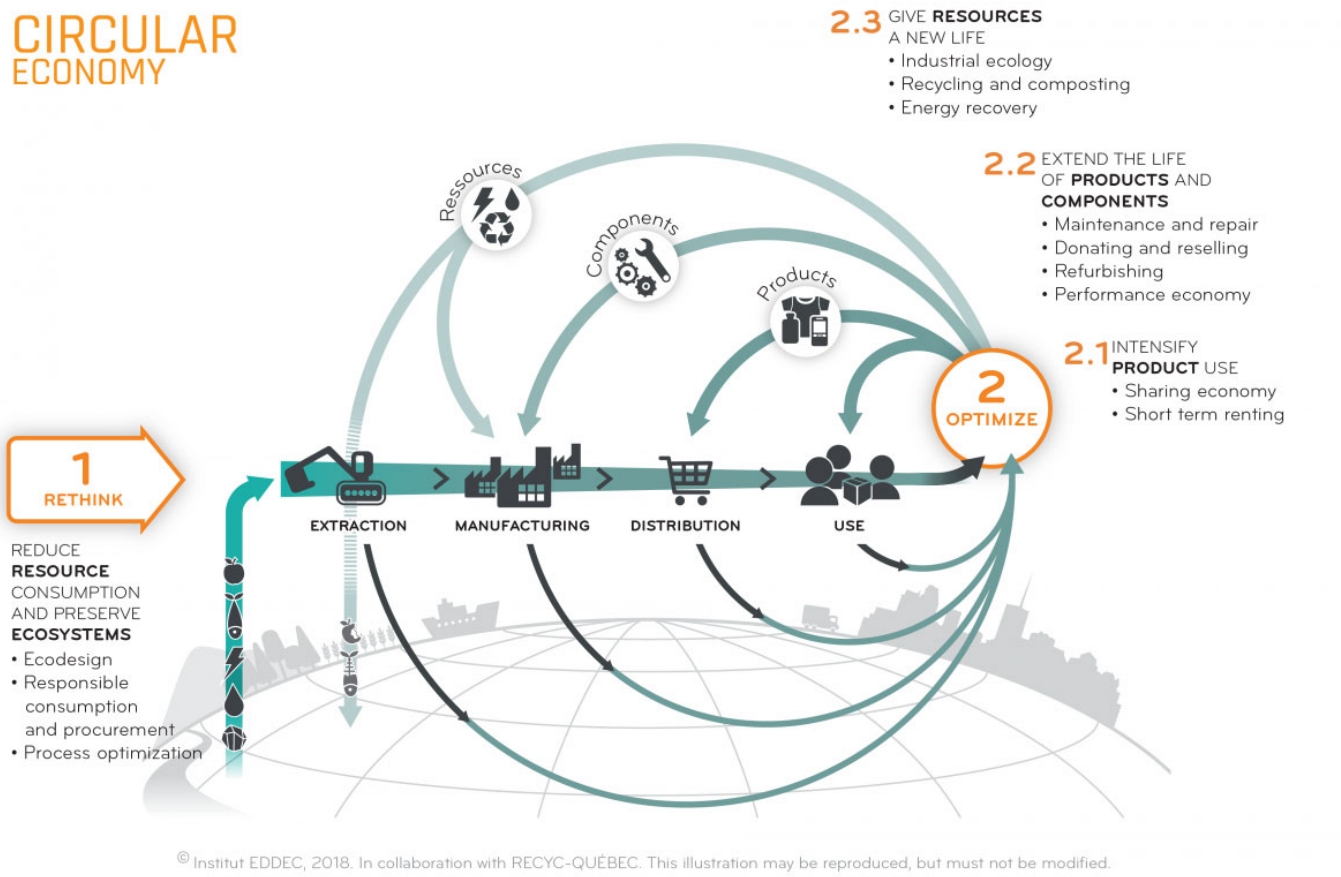

Figure 24: Circular economy

These strategies offer circular economy solutions that the Inukjuak 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 operations by using 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. This appendix could very well be an inspiration for Inukjuak and other northern communities.

For each of the 12 circular economy strategies, the following sections offer circular economy solutions applicable to Inukjuak. 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 to minimize their environmental impacts throughout their life (RECYC-QUÉBEC, 2022b). Ecodesign is applicable to all economic sectors.

Ecodesign is difficult to promote in Inukjuak due to the absence of a factory or manufacturing facility. One example of ecodesign that has not been planned is the recovery of heat from the Hydro-Québec generator that releases heat directly into the environment. This type of plant does not have a turbine with the result that the mechanical energy created by the diesel generator directly drives an alternator to produce electricity. This approach, while effective, is less suited to heat recovery. If the system would have been planned taking into account ecodesign at that time, the system would have been designed to recover heat and then use it to heat infrastructure.

This strategy cannot currently be applied to the manufacture of products directly on Inukjuak territory. 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

The Inukjuak region is experiencing population growth, which may require building new infrastructure. This could be an opportunity in relation to planning the built environment. For example, the building of new infrastructure could be based on ecodesign principles in terms of choice of materials, energy supply, and alternatives to fossil fuels. Also, buildings could be designed to be modular from the pre-construction stage, given that modular buildings can be adapted over time as required. Moreover, modular buildings at the end of their useful life can be dismantled and their materials reused. This prevents buildings from becoming obsolete.

Also, the construction of new commercial, institutional or residential buildings should be designed to take account of the Inukjuak region's climate: a northern coastal climate with intense cold periods. Furthermore, since a hydroelectric power station will soon be operating in the vicinity, new buildings in Inukjuak could possibly be heated and lit with this energy.

Proper planning of the built environment, supported by governmental organizations, should also result in better use of sustainable, energy-efficient materials. This would have positive impacts beyond building envelopes. Indeed, the more durable the materials used, the fewer the replacement materials imported, thereby reducing CRD waste but also the impacts from transporting these 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 proposes a goods and services procurement process that integrates environmental, social and economic considerations.

Several circular economy solutions that could be explored by Inukjuak emerged during observations and discussions throughout the Englobe team's visit.

5.2.1 Electrification of municipal vehicles

On the transportation front, municipal vehicles powered by gasoline or diesel could be replaced with electric vehicles. The hydroelectric power station that will be soon operational close to Inukjuak will be able to support the use of electric vehicles in the community.

When replacing its current fleet of vehicles, this northern village 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). However, an energy efficiency analysis should underpin this circular economy solution, especially in terms of battery efficiency.

Besides encouraging the transition from use of fuel oil to more environmentally responsible energy sources, Inukjuak could promote government programs that incentivize this transition (e.g. encourage the installation of electric heating). Several energy management grants and loans are available for ICI and residences. These include the following programs: *Rénoclimat* (promoting eco-friendly home improvements) (MELCCFP, 2023a), *Chauffez vert* [Green heat] (MELCCFP, 2023b), *ÉcoPerformance* (MELCCFP, 2023c), *Electricity Management Systems* (Hydro-Québec, 2023b), *Efficient Solutions* (Hydro-Québec, 2023c), *Bioénergies* (MELCCFP, 2023d), and *Clean Energy for Rural and Remote Communities* (Natural Resources Canada [NRCan], 2022). In addition, funding is also available for the purchase and installation of heat-accumulator-equipped central heating systems (Hydro-Québec, 2023d).

The supply of renewable energy would reduce the amount of GHG emissions by avoiding the use of fossil fuels.

5.2.2 Processing plastics

To reduce costs and optimize the transportation of materials to recyclers, plastic could be processed in Inukjuak before being shipped by cargo vessel for recycling. This processing would increase the quantity of plastic per unit of volume, thereby reducing the costs associated with moving recyclable residual materials. Processing plastics would reduce their volume and make transportation for recycling more viable. RECYC-QUÉBEC has published a list of plastic processors and recyclers (RECYC-QUÉBEC, 2023a).

There are different processing technologies according to the various categories of plastic (polyethylene terephthalate, polystyrene, etc.). Éco Entreprises Québec (2019) has identified several technologies that improve recycling performance. It would therefore be worthwhile to study the feasibility of sorting and processing the various categories of plastic in Inukjuak.

5.2.3 Eliminating the use of single-use shopping bags

Discontinuing the distribution of single-use shopping bags in the community is a sound way to reduce the amount of waste going for disposal at the NL. The public could make greater use of reusable bags. In fact, one such initiative was listed in one of the Inukjuak businesses. Another option is to let customers pack their purchases in the cardboard boxes that imported goods come in. This practice was also documented in some companies. However, this would not be a good option if the cardboard was subsequently thrown away instead of being transported south for recycling. Since cardboard boxes are already available in some businesses, it would be worthwhile setting up cardboard collection sites for Inukjuak residents.

Besides reducing the quantity of materials at the NL, discontinuing the distribution of single-use shopping bags would reduce the amount of waste blown into the village and the environment.

To make this initiative viable, many municipal organizations in Quebec have amended their municipal bylaws to include this new measure. In addition, information, awareness and education (IAE) campaigns on this topic for both merchants and the public have been carried out.

The northern communities of Kuujjuaq, Puvirnituq and Kuujjuarapik have already banned the distribution of single-use plastic bags in stores. Although one village allows the sale of biodegradable bags (KRG, n.d.), this option should not be considered since it does not reduce resource use and requires end-of-life management of the bags.

Effective late 2023, a federal regulation will prohibit the distribution of bags entirely or partly made of plastic to commercial customers (Government of Canada, 2023).

5.2.4 Reduction in packaging

The characterization study revealed that some 32% of the residual materials disposed of at the NL are cardboard. Since imported consumer products come in pallet loads of cardboard boxes and some of this cardboard is most likely excessive packaging, Inukjuak businesses could ask their suppliers to reduce the amount of packaging before shipping products to the village.

5.2.5 Responsible purchasing of consumer products

To reduce the amount of packaging generated in Inukjuak and reduce the space and weight of the packaging returned as recyclable materials in marine containers, steps to encourage merchants to adopt responsible consumer product purchasing practices could be implemented.

Some everyday products like laundry detergent strips and cleaning products with dissolving capsule refills are now ecodesigned. In fact, according to a study based on Inuit northern villages, “green” solutions can sometimes lead to financial savings for families (Oceans North, 2021). This is especially true of detergent strips, which can save families around $200 a year. The costs associated with liquid detergent reflect the weight of these products that, in Inukjuak's case, must be shipped by sea. Products with less packaging and smaller volume and weight than the originals can be very beneficial to both consumers and the entire community. Not only do these products save money, they also reduce the amount of residual materials generated.

It would be relevant to analyze which ecodesigned products should be prioritized for the Inukjuak community and which would be beneficial for both consumers and the community. This analysis could result in developing an environmentally responsible purchasing guide for Inukjuak's ICI. Responsible purchasing combined with processing reused materials could reduce quantities of materials at source and thus the quantity of outputs.

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 easily be integrated thanks to various skills Inukjuak residents possess. Based on the examples described in Appendix E, there are several measures that could be implemented to optimize ICI operations.

5.3.1 Support services for ICI to optimize their operations

ICI in Inukjuak could be guided by a specialist to determine whether their operations 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 sight, these optimization measures could initially target institutional buildings. Monitoring and analysis grants to improve the energy performance of community buildings are available through the Green Municipal Fund (GMF, n.d.-a).

5.3.2 Improving energy efficiency

Nunavik's climatic and geographic circumstances mean that energy demand per unit area is higher than in the southern part of the province. Energy efficiency is therefore an important consideration for ICI operations. There are several ways to achieve better energy efficiency, such as adopting passive or active technologies.

Hydro-Québec Distribution is responsible for supplying the energy needed for the buildings in Inukjuak. In the case of Quebec's northern villages, it is thus in the public corporation's interest to reduce energy consumption and thereby the use of GHG-emitting fuel oil. In the case of Inukjuak, the construction of the hydroelectric power station will provide electricity from a run-of-river turbine. This new energy will facilitate the community's development. To optimize this development, the best energy-efficiency technologies will need to be adopted in the use of this new energy. Geothermal energy and ultra-efficient heat pumps are two means of reducing energy consumption.

Orienting most windows towards the south to benefit from solar energy is one of the simplest passive technologies to implement (Association des professionnels de la construction et de l'habitation du Québec [APCHQ], n.d.). Coupled with the installation of energy-efficient windows, this initiative provides better insulation as well as a natural heating source (Roy, 2015).

Energy efficiency can also be improved by human behaviour. Awareness of good energy efficiency practices will have to be raised to support the arrival of this new energy in the community.

5.3.3 Reducing water consumption

This strategy promotes water conservation. The use of cost-effective plumbing fixtures and greywater collection systems are highly effective features of this strategy.

Some plumbing fixtures, such as faucet aerators, allow for less water density during flow. The same principle can be applied to showers by purchasing low-flow showerheads that use a maximum of 6.6 L of water per minute (Éco Habitation, 2020). In other words, showerheads and faucet aerators can significantly reduce water flow. Low-flow toilets are also extremely helpful in reducing water usage. Several online resources are available to inform and educate users about the benefits of these accessories. Greywater collection systems collect grey washing water from sinks, baths and showers and make it clear and odourless so that it can be redistributed to toilets. Since grey water is currently collected at each building in the village and transported to the non-aerated treatment lagoon, redistributing it through a collection system would reduce water consumption, water transportation, fuel use, and GHG emissions.

To reduce the amount of bottled water imported into Inukjuak to offset the lack of suitable drinking water from the village's water filtration and distribution system, a system upgrade could reduce the amount of imported water. Without necessarily knowing whether these issues exist in other northern communities, it may be surmised that such an upgrade would also be necessary for them as well.

5.3.4 Optimizing residual materials management

Residual materials management would be a circular economy solution towards process optimization. Although this strategy does not address recycling and collection (as discussed below), it simply implies that residual materials management should be optimized to an adequate level by being properly carried out.

To ensure that residual materials management operations are up to standard, they must involve:

– Controlling access to the NL with a gatehouse to reduce illegal disposal of materials at the site and redirect certain materials to other drop-off points for collection, recycling and recovery;

– Fencing off the NL to not only limit access, but also keep materials inside the NL during high winds;

– Requesting businesses that carry out projects in the community to manage the residual materials produced by them. This request has already been made for certain construction contractors (e.g., the dam) but it could become systematic;
– Implementing initiatives to encourage residents to reduce and collect certain residual materials. Current collection initiatives mainly focus on materials generated by ICI (individual management);
– Using shipping containers rented by ICI to transport residual materials. When vessels arrive in Inukjuak, the marine containers are emptied and put back on the ship. This advantage should be taken of this return to the south to export residual materials. A feasibility study could be conducted on this possibility.

5.3.5 Reducing food waste

Food waste runs as high as 30% at the Co-op's grocery store. These losses include expired products, damaged products, and products that become non-consumable due to refrigerator breakdown.

A lack of human resources means that food waste reduction solutions are limited. Several organizations in Quebec specialize in organizing mechanisms to reduce food waste.

Nutrition North Canada (Government of Canada, 2022) funds the transportation of food to ensure food security in isolated northern communities. This federal agency would benefit from contributing to capacity building to reduce food waste in Nunavik communities.

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 space

In general, the ICI indicated a lack of “standard” storage space 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 could 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. For example, it could be coordinated by the CFP as well as the KRG and administered by the Makivik Corporation.

5.4.2 Sharing equipment to collect cardboard

Inukjuak ICI are not serviced by selective collection. However, some organizations, like the FCNQ, generate significant amounts of cardboard, mainly goods packaging. Since cardboard represents a considerable quantity of the materials generated by the village, a cardboard press could be shared among the various merchants to compact the cardboard for sending back south. In fact, some businesses in the community have already expressed interest in purchasing a cardboard press.

For these cardboard-generating companies, the advantage of a press that is directly available onsite would be to reduce handling. On the other hand, the purchase of a cardboard press implies an investment and, obviously, the management of cardboard bales because these will then have to be sent to recyclers. If an ICI that generates a considerable quantity of cardboard were to purchase such equipment, several small ICI could benefit either by coming to a contractual agreement for sharing in its

use or by adopting an appropriate circular economy strategy (e.g., short term renting or sharing economy approach).

If the cardboard press were shared, investment and maintenance costs could be pooled and use of the equipment could be optimized. If demand is not sufficient for the press to be used to its full potential in Inukjuak alone, it could be transported to a few other villages in Nunavik so that they could benefit from this strategy as well.

This is another initiative that could be coordinated by a local organization like the KRG or Makivik Corporation.

5.5 Short term renting

Short term renting is the contractual use of goods or services for a fee (RECYC-QUÉBEC, 2022b). Rental facilitates the optimal use of products by increasing 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, short term renting covers both goods and workspaces.

Due to their geographical location, each northern village is isolated from the rest of the province. The remoteness of these communities makes renting an even more attractive option.

5.5.1 Renting equipment used by ICI

Equipment rental initiatives in Inukjuak are sometimes carried out under contract with local ICI. A more structured equipment rental system that brings together permanent and transient ICI could optimize such arrangements within the community. The use and availability of machinery in Inukjuak are sometimes limited due to breakdowns but also due to the limited quantity of machinery available in the territory.

5.5.2 Renting tools through a tool library

The creation of a tool library would be a possibility for Inukjuak residents to consider. The borrowing principle is the same as in a library where books can be borrowed. This strategy aims to share equipment, workspaces and knowledge and curb overconsumption at the same time. For example, a tool library lends out commonly used tools (e.g., woodworking tools) and workspaces (e.g., for woodworking or sewing). Training that provides for intergenerational and intercultural exchanges could also be offered. The KRG could administer this initiative. A model like La Remise (an initiative by the Villeray citizens collective) could be implemented (La Remise, 2022).

5.5.3 Rental of furniture and household appliances

In collaboration with the FCNQ hotel, a business model could be designed that would consist of agreements for temporary workers to rent home furnishings like furniture and appliances on a short-term basis. This strategy also dovetails well with the lease/rental or donation/resale strategy.

5.6 Maintenance and repair

A maintenance and repair strategy aims to keep objects in good condition to extend their useful life (RECYC-QUÉBEC, 2022b). This strategy can be implemented by either the object owners or specialized organizations.

To lengthen the life of consumer products, it would certainly be possible to involve the Inukjuak community in initiatives that could be implemented by the village administration and the general population. Such initiatives or projects require few resources in terms of time, money or organization.

5.6.1 Repair activities

A local, day-long community event where volunteers offer their services to repair various items could be organized. This would be an opportunity to not only extend the useful lives of residents' appliances and devices but also to energize the community. Many Inukjuak residents have talents that could be put to use 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 NL as well as become a place of exchange for the community. In the Mauricie region of Québec, Environnement Mauricie (2022a) has been organizing this type of community repair day for several years.

5.6.2 Improving the services offered by the village's mechanical workshop

Inukjuak has a mechanical workshop managed by the Co-op. However, when ATVs or snowmobiles cannot be repaired, the machines must be returned south by boat for repair.

Inukjuak's mechanical shop employees could be trained to perform more complex repairs. The shop could acquire parts and tools to make these new kinds of repairs. By improving the services offered by the village's mechanical shop, the frequency of motorized equipment being shipped to the south for repair could be reduced. This reduction would lower repair costs and free up space in shipping containers.

5.6.3 Preventive maintenance of municipal vehicles

A major problem mentioned by village members is the breakdown of municipal vehicles, particularly the trucks used to supply water and fuel oil and empty sludge and grey water. These services are provided continuously throughout the community. Sometimes truck breakdowns cause delays in residents receiving these essential services. A preventive maintenance program could be set up to avoid such delays and extend the useful life of the trucks.

5.6.4 Building maintenance and renovation

Housing is a widespread issue within the Nunavik Inuit community due to several factors: a shortage of housing stock and the age and premature wear-and-tear of the houses (Government of Quebec, 2014). It is therefore essential to ensure the long-term quality of the houses. The renovation and maintenance of these houses must ensure optimal longevity, and the premature construction of new houses must be avoided. In addition, all housing renovations should use sustainable and energy-efficient materials.

The community should also encourage the storage of unused renovation materials. Construction or home renovation companies are apparently instructed to leave with their unused materials, thus limiting the community's ability to be self-sufficient on the home renovation or maintenance front.

5.7 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 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.

The Inukjuak Buy, Sell, Trade or Swap Facebook group, which already operates a community page on which residents can post reusable items they wish to sell or donate, is a fine example of this kind of initiative. However, Inukjuak does not have a used goods store or a physical location specifically for the donation or resale of items. This strategy dovetails well with the maintenance and repair strategy.

5.7.1 Creation of a used goods store

An initial donating and reselling circular economy solution would involve developing a site where reusable items would be received, sorted and stocked – for example, a space near the NL. 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 the NL, reduces the imports 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 Reusing equipment operated by third parties in Inukjuak

Many companies with contracts in Inukjuak import machinery to carry out their work in the village. Instead of taking all their equipment back south at the end of their projects, they could sell to the municipal administration some of the equipment that could be used by the local community. Such equipment could be a heavy-duty vehicle or the incinerator currently used by the construction company building the Hydro-Québec dam to burn the residual materials generated by its operations.

5.8 Refurbishing

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

5.8.1 Refurbishing of household appliances and small electrical devices

Household appliances and small electrical devices are currently stocked at the NL. The Inukjuak community could set up a repair and refurbishing shop to extend their useful life. This shop would be operated by community members, who could 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 on the site of a new 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 useful life of products based on “company business model 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). Consumers thus purchase a service and not a good.

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.

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 Quebec City (see Appendix E, Strategy 10). The Inukjuak community can participate in this strategy by stimulating exchanges among its ICI.

5.10.1 Implementation of an industrial symbiosis

An industrial symbiosis project could be developed in the region to add circularity to the materials produced on the territory. In partnership with the KRG, the village of Inukjuak could organize a networking workshop with its ICI. Potential inter-ICI exchanges of materials (industrial ecology strategy) could be identified, which would reduce the quantity of resources used and residual materials generated. Other inter-ICI circular economy strategies could also be developed during such networking workshops. The workshops could also include several northern villages.

Each networking workshop needs to be followed by some coaching so that potential synergies with ICI can be achieved. KRG could play a role in following up with the various 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 accompany the Inukjuak community 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* [Green shift] (Réseau des SADC + CAE, 2021).

5.10.2 Using village-generated outputs

The characterization results (Appendix D) show that a considerable quantity of cardboard, plastics and organic matter are sent to the NL. In this regard, it could be possible to either use village-generated outputs as resources or find alternatives to imported materials.

For example, the following aspects could be analyzed:

– Residual materials are not incinerated or covered at the NL and the village does not have a source of covering material. The possibility of using some village-generated outputs as covering material at the NL (e.g. aggregate and crushed glass) could be analyzed;
– One circular economy solution is for plastic to be processed before being exported. However, would it be possible to produce pyrolytic oils as fuel for the oil-fired heating systems used in Inukjuak? Such a technology has been developed, but whether it can be applied in a northern village would need to be checked out (Institut de recherche et de développement en agroenvironnement [IRDA], 2023).

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).

Several opportunities to implement recycling and composting circular economy solution exist in the territory of Inukjuak. The solutions listed below are for recyclable materials (packaging, printed materials and small items containers), organic matter, HHW, EPR products, and CRD waste.

5.11.1 Setting up an ecocentre

Currently, although products targeted by the EPR are collected, there are no official drop off points collection. From this standpoint, an ecocentre to collect at least certain materials – EPR products and CRD waste – should be established. An ecocentre of this type could be set up inside marine containers. At least one onsite employee would be required to maintain order and manage HHW (compliant storage). The village could receive a grant to carry out such a project.

5.11.2 Modernizing deposit-refund and selective collection systems

Modernizing deposit-refund and selective collection systems (MELCCFP, 2023e) represents a tremendous opportunity for Nunavik communities. Éco Entreprises Québec is the designated management organization (DMO) responsible for selective collection and the Quebec Beverage Container Recycling Association (QBCRA) is the DMO managing the deposit-refund system. The changes that these two DMOs have planned and will implement should enable the Inukjuak community to reduce the volume of materials disposed of at the NL. However, implementation in northern villages may take some time. For example, the rollout of the recycling system for all northern villages is not scheduled until 2027. However, at least one northern village is expected to be served by 2025 (Government of Quebec, n.d.). Inukjuak could contact these DMOs to express its wish to have this service available more quickly in its community.

5.11.3 Collection and processing organic matter

In 2020, the Quebec government released its *Stratégie de valorisation de la matière organique* outlining its organic matter recovery strategy (MELCC, 2020b).

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 over 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. However, there is currently no organic matter collection service in Inukjuak.

To encourage public institutions to implement this type of management of food and green waste in Quebec, the provincial government intends to offer compensation for the disposal of residual materials. It should be noted that the government's organic matter collection strategy also aims to encourage the development of a network of ecocentres for wood residue.

Collecting organic matter is therefore not an isolated action, but rather an overall initiative that needs to include processing and recovering the finished product.

Implementing this type of collection in Inukjuak clearly dovetails with the development of a site for processing organic matter (e.g. by composting). Such infrastructure would also require substantial capital investment as well as government approval at the ministerial level.

Organic matter that could be processed through composting include:

– Organic matter from residential brown bins;
– Organic matter from ICI (e.g. stores, schools, and commercial accommodations).

Outlets for the compost will also be needed. For example, these could include projects such as greening the NL or setting up a greenhouse, etc.

Another factor that should be considered is the presence of large wildlife. Mitigation measures will be needed in this regard.

5.11.4 Recycling wood

Some of the wood for the NL could be used as an input in the processing of organic matter. Wood suitable for the treatment technology selected should be shredded before being used in the composting process. This input also constitutes a soil-structuring amendment for the composting of organic matter.

5.11.5 Studies on the feasibility of collecting certain materials

The Inukjuak community currently has no collection of recyclable household materials except for refundable cans. Since exportation is a challenge for the community, an initial study could be conducted on the feasibility of collecting just a single material. This study could identify the various factors to be considered in the collection and transportation of this material to the south and eventually lead to a larger project for other materials. For example, the study could consider the following aspects:

– Choice of material to be collected:
  – Material's level of contamination;
  – Effect of the material on the NL;
  – Estimate of annual quantity generated.
– Types of containers needed to stock the material for the required six months at a time;
– Site for storing the material’s (transshipment location);
– Transportation requirements;
– Estimated quantity;

– Identification of potential partners (including Hydro-Quebec) to participate in various projects related to residual materials management in northern communities;
– Identification of grants or funding available for this type of project.

Grants or funding are available from various organizations, including the GMF (n.d.-b).

5.11.6 Recycling and exporting metals

Scrap metals are a major issue for the Inukjuak community because these cannot be incinerated and the transportation costs associated with their export are high. Scrap metals are currently accumulating at the NL and are increasingly not being stocked separately because the NL is reaching the end of its useful life. It would therefore be relevant to find solutions to export these materials for recycling. In addition to the challenges related to export costs and the mobilization required to implement this circular economy solution, temporary storage of scrap metal in the village, which would subsequently facilitate and maximize transportation, could also be optimized. Some metals could be compacted. For example, the Cree village of Mistissini uses an onsite hydraulic press to compact metal barrels (Figure 25).

Figure 25: Hydraulic press for compacting barrels at the ecocentre in the Cree village of Mistissini

5.12 Recovery

Recovery is the ultimate strategy to prevent materials from being sent to the NL. Recovery is any non-disposal operation that aims to obtain useful products or energy from residual materials (RÉCYC-QUÉBEC, 2022b).

Through its observations and discussions in Inukjuak, the Englobe team identified some recovery solutions for materials that the village generates in significant quantities, namely, oil and biosolids.

5.12.1 Energy recovery

The village already recovers waste oil to heat a municipal building. However, little information was available about the quantities recovered. In addition, some used oil is returned to the south for treatment and/or recovery through the EPR program. It would be relevant to make an inventory of the available oil as well as the buildings that would be suitable for this type of recovery. Onsite recovery would reduce both transportation costs and GHG emissions.

The recovery of wood as a fuel source for small furnaces would reduce the consumption of fuel oil. Pallet wood intended for recovery must be free of contaminants (e.g. paint or fungicide). As part of the energy transition, the use of wood as a fuel would also reduce GHG emissions.

5.12.2 Biosolids recovery

According to the water flow analysis, municipal biosolids are generated in Inukjuak. However, municipal biosolids are not currently being recovered.

It would be advantageous for the village to undertake onsite recovery of its residual materials that can be used as fertilizer. For example, these materials could be used to revegetate the NL once it is covered.

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 village could take on this front complies with applicable legislation and regulations.

6 Action plan to optimize the circularity of materials in Inukjuak

In Chapter 11 of its opinion on the state of the site and the management of its ultimate residues (BAPE, 2022), the Bureau d'audiences publiques sur l'environnement (BAPE) states that it is aware that “the funds granted for residual materials management must be optimal and sufficient for implementing projects in Nunavik. The BAPE and the KEAC recommend that the Ministère de l'Environnement et de la Lutte contre les changements climatiques and RECYC-QUÉBEC collaborate regularly with applicants on assessing grant applications and rigorously following up projects.” Such openness and support are needed to implement the actions and strategies formulated in the context of this project.

The action plan developed for the northern village of Inukjuak 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 with Inukjuak ICI.

The plan consists of brief descriptions of each proposed action, the main steps for its implementation, and 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 implementation team's knowledge and not on specific price quotes from potential suppliers. The estimates must therefore be used with some reservation.

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 Inukjuak 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 Inukjuak community are presented in Table 6 below.

The level of action defined in this table is based on the potential improvements that would have the maximum impact on the circularity of Inukjuak's local economy. This level of action remains a project team priority. The Inukjuak community is invited to define its own priority level among the proposed actions, considering the opportunities that may arise after this report is published.

Table 6: Proposed circular economy strategies in line with presented solutions to increase circularity within the Inukjuak community

Action	Action description	Level of action	Circular economy strategy
1	Developing the new NL and closing the existing NL	Priority	– Process optimization
2	Setting up an ecocentre	Priority	– Recycling and composting – Recovery
3	Collecting cardboard	Priority	– Recycling and composting
4	Collection and processing organic matter	Priority	– Recycling and composting
5	Opening a used goods store	Lower priority	– Donating and reselling
6	Collection and exporting metals	Lower priority	– Recycling and composting
7	Reusing equipment operated by third parties in Inukjuak	Lower priority	– Donating and reselling
8	Reviewing the drinking water supply system	Lower priority	– Process optimization

If this northern village implemented the proposed actions, it would divert a considerable quantity of residual materials from the NL, reduce the overall amount of energy needed in the community, and reduce water usage.

However, the investments required to implement the actions presented below will require a financial effort that the village 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 Inukjuak 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 Government of Quebec, 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* (Fondaction, 2022) and the *Collision* program (Esplanade Québec, 2023).

6.1 Priority actions

Some actions were deemed as 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 in the Inukjuak region or to ease of implementation. The main effect of the priority actions will be to extend the life of the NL.

6.1.1 Developing the new NL and closing the existing NL

<table>
<tr><th>Circular economy strategy</th><th colspan="2">Process optimization</th></tr>
<tr><td>Brief description of the action</td><td colspan="2">Several problems are associated with the two Inukjuak NLs. The current NL is at the end of its useful life and its location directly upstream of the village causes leachate to flow and accumulate in the urbanized portion of the village. In addition, winds blow waste from the NL into the village. At the same time, the site designated for the new NL is prone to flooding and is not used. The purpose of this action is to regularize the situation of the two NLs by properly closing the current NL and restructuring the new NL site to make it usable. To ensure that the new NL can be used over a long period of time, measures to reduce the quantity of materials sent to it should be implemented.</td></tr>
<tr><td>Implementation phases</td><td colspan="2">– Carry out the studies required to prevent leachate seeping from the current NL into the village's urban area;
– Correct the drainage problem that causes recurring flooding at the new NL, carry out a hydrological study and a topographic survey, take the necessary corrective steps, fill the site, etc.;
– Based on the results of the studies, identify a new site for the new NL if the existing site is not suitably located;
– Close both the current NL and the new NL;
– Discontinue using the current NL;
– Reduce the quantity of materials sent to the new NL (e.g. eliminate the use of single-use shopping bags, rent furniture and appliances to temporary workers as well as open a used goods store).</td></tr>
<tr><td>Organizations and partners involved</td><td colspan="2">– The northern village of Inukjuak;
– KRG;
– Specialized firms (surveying, hydrology, etc.).</td></tr>
<tr><th>Timeline</th><th>Budget estimate</th><th>Success indicators</th></tr>
<tr><td>Medium term</td><td>$$$$</td><td>– Number of trucks using the new NL;
– Number of incinerations at the new NL;
– Number of measures implemented to reduce the quantity of waste sent to the NL;
– Quantity of materials disposed of at the new NL.</td></tr>
<tr><th colspan="2">Strengths</th><th>Weaknesses</th></tr>
<tr><td colspan="2">– Reduction in nuisance problems associated with the two NLs;
– Provision of services the population wants.</td><td>– Availability of expertise;
– Rocky land not suitable for normal fencing.</td></tr>
<tr><th colspan="2">Potential opportunities and levers regarding the strategy</th><th>Potential threats and obstacles to the strategy</th></tr>
<tr><td colspan="2">– Regulatory requirements related to operating an NL;
– Extending the useful life of the NL;
– Improving quality of life and addressing a public health issue.</td><td>– Substantial investment in exploratory studies;
– High labour costs.</td></tr>
</table>

6.1.2 Setting up an ecocentre

Circular economy strategy	Recycling and composting, recover	
Brief description of the action	Setting up a site to receive and temporarily stock EPR materials is an interesting strategy for Inukjuak. In addition to collecting tires (administered by RECYC-QUÉBEC and not covered by EPR), the residual materials to be handled would include batteries, electronics, paint and paint containers, household appliances and air conditioners, mercury lamps, oils, and similar products. Other products such as wood could be added. By starting with a small pilot project, Inukjuak could become a model for setting up ecocentres in Nunavik. The Inukjuak ecocentre could be set up using locally available marine containers. At least one employee would be required for the ecocentre. Grants are also available to help isolated communities (e.g. the *Programme d'aide financière visant l'optimisation du réseau d'écocentres québécois* [2023b]).	
Implementation phases	– Begin by approaching each EPR organization to become an official drop-off point; – Conduct a feasibility study on setting up the ecocentre (estimate material quantities, labour requirements, cost of containers and site development, etc.); – Locate a site for the ecocentre; – Identify a funding program; – Purchase and install containers (tendering process, etc.); – Hire and train workers; – Create IAE tools.	
Organizations and partners involved	– The northern village of Inukjuak; – KRG; – Inukjuak residents and businesses (Hydro-Quebec, FCNQ, North West Company, etc.); – EPR organizations (EPRA-Québec, SOGHU, RecycFluo, GoRecycle, ÉcoPeinture, Appel à recycler, etc.); – RECYC-QUÉBEC for tire management; – Marine shipping companies.	
Timeline	**Budget estimate**	**Success indicators**
Medium term	$$$	– Quantities collected/recovered by the various agencies; – Number of containers shipped south.
Strengths		**Weaknesses**
– Consolidation of residual materials management activities and services in a single location (the new NL); – Potential for Inukjuak to be an example of EPR implementation in isolated communities; – Possibility of adding an adjacent used goods store.		– Need for new infrastructure; – Need for workers to operate the site; – Substantial storage requirement (six months to a year) due to limited number of shipments.
Potential opportunities and levers regarding the strategy		**Potential threats and obstacles to the strategy**
– Potential for partnership among different EPR organizations to optimize transportation; – Replicable flagship project for Nunavik and improvement based on the pilot project's results – Available grants; – Extending the useful life of the NL; – Fewer negative impacts caused by the NL.		– Action potentially dependent on development of the new NL; – High transportation costs for relatively small quantities.

6.1.3 Collecting cardboard

Circular economy strategy	Recycling and composting	
Brief description of the action	No household recyclable materials are currently collected in the community, except for refundable cans through the FCNQ initiative. In addition, Quebec's modernization of its deposit-refund and selective collection systems may take several years to be updated in northern villages. The option of applying early to the DMO to set up this kind of collection service in Inukjuak remains possible. However, if the DMO cannot implement this service in Inukjuak soon, the collection and recovery of a single material could help establish mechanisms that could assist future recovery projects in northern communities. Cardboard is a material that seems to be generated in large quantities in Inukjuak. Indeed, according to the residual materials characterization carried out in Inukjuak in fall 2022 (Appendix D), 32% of the residual materials disposed of at the NL were cardboard. Setting up a cardboard collection service could be an attractive opportunity for the community.	
Implementation phases	– Find a building to receive, sort and temporarily stock cardboard; – Buy a cardboard press (bales); – Identify grants or funding available for this type of project; – Make agreements to ship and process the cardboard; – Purchase and distribute cardboard collection containers to residents and ICI; – Create IAE tools.	
Organizations and partners involved	– The northern village of Inukjuak; – KRG; – Inukjuak residents and ICI (FCNQ, the North West Company, Hydro-Québec, etc.); – Marine shipping companies.	
Timeline	**Budget estimate**	**Success indicators**
Medium term	$$	– Number of containers sent south; – Annual quantity of cardboard collected.
Strengths		**Weaknesses**
– Reduction in materials sent to the NL; – Easy-to-use manual press; – Speedy handling because only one material to sort; – Raising awareness among the community about material sorting.		– Closed building for temporarily storing and processing the cardboard; – Workers to collect and process the cardboard; – Equipment required (manual press, pallet truck to move the bales, etc.); – Revamping the use of residual material containers; – High transportation costs.
Potential opportunities and levers regarding the strategy		**Potential threats and obstacles to the strategy**
– Extending the useful life of the NL; – Quality pre-sorting to increase the value of the cardboard; – Available grants; – Opportunity to combine IAE and implementation efforts with the collection of organic matter; – Opportunity to establish principles for the deposit-refund and selective collection systems that will be set up by 2027.		– Need to prepare the cardboard for shipping by sea; – Availability of a recycler in Quebec (ideally near the shipping company's dock) who will agree to receive the cardboard.

6.1.4 Collection and processing organic matter

Circular economy strategy	Recycling and composting	
Brief description of the action	Organic matter like food waste is not the kind of material NLs are intended to handle. Besides attracting vermin and other animals, these residues are usually waterlogged, which reduces combustion efficiency in an NL. The presence of water creates more smoke and partly incinerated residues. This action aims to set up a collection system for organic matter on the territory of Inukjuak and an infrastructure for processing these materials.	
Implementation phases	– Continue implementing the project initiated by the KRG, namely, the installation of a rotating composter in Inukjuak; – Update a feasibility study on collection and processing organic matter (estimated quantities, collection and bin costs, waste and organic matter collection methods); – Validate the possibility of applying for a grant from the *Program for the treatment of organic matter through biomethanization and composting* (PTOMBC) to treat organic matter and/or purchase collection equipment (MELCCFP, 2022c); – Train employees to operate and maintain the rotating composter; – Create IAE tools.	
Organizations and partners involved	– The northern village of Inukjuak; – KRG; – Inukjuak residents and businesses.	
Timeline	**Budget estimate**	**Success indicators**
Medium term	$$$$	– Number of brown bins distributed; – Number of homes served; – Organic matter collection rate (annual quantity collected versus quantity generated); – Quality of materials collected with respect to type of collection (% contaminated); – Quantity and quality of outputs produced (e.g. compost).
Strengths		**Weaknesses**
– Proximity of the NL that can be used as a processing site; – Redistribution of compost to the population; – Reduction in the quantity of residual materials at the NL.		– Reorganization of waste collection schedules and addition of organic matter collection; – Possible purchase of a new collection vehicle or involvement of a private partner; – Reorganization of residents' containers to receive residual materials; – Availability of workers and expertise.
Potential opportunities and levers regarding the strategy		**Potential threats and obstacles to the strategy**
– Regulatory requirement to recover organic matter; – Amendments to the *Regulation respecting the charges payable for the disposal of residual materials*; – Funding available through the PTOMBC; – Reduction in GHG emissions; – Possible recovery of compost in a greenhouse project (in partnership with the school), revegetation degraded areas, etc.		– Risk of contamination by non-compostable materials (glass, plastic, etc.); – Presence of large fauna (polar bears); – No authorized organic matter processing site in the immediate area; – High investment in machinery, facilities, transportation equipment, etc.; – Need to find one or more outlets for the output produced (e.g. compost).

6.2 Lower-priority actions

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

6.2.1 Opening a used goods store

<table>
<tr><th>Circular economy strategy</th><th colspan="3">Donating and reselling</th></tr>
<tr><td>Brief description of the action</td><td colspan="3">The Inukjuak community does not have a used goods store, ecocentre, or physical site for the donation and reuse of objects, materials or other items with the exception of the Inukjuak Buy, Sell, Trade or Swap Facebook group. In addition, due to the difficulty of transporting materials into the village, contractors often order and bring in more materials than they need for projects, repairs, renovations, etc. Some contractors mentioned that they would like to hand over these materials, but since it involves additional management, it is easier to take them directly to the NL. In fact, for the northern population, the term “Canadian Tire” is often associated with the NL because locals can find everything there. The objective is to develop a tool to facilitate the sale or donation of reusable items and goods in Inukjuak.</td></tr>
<tr><td>Implementation phases</td><td colspan="3">– 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);
– Inventory and prepare available items (separate, clean, etc.) and stock;
– Implement the project;
– Prepare periodic reports on the items that have been donated online and thus diverted from the NL.</td></tr>
<tr><td>Organizations and partners involved</td><td colspan="3">– The northern village of Inukjuak;
– KRG;
– Inukjuak community organizations.</td></tr>
<tr><th>Timeline</th><th>Budget estimate</th><th colspan="2">Success indicators</th></tr>
<tr><td>Medium term</td><td>$$</td><td colspan="2">– Number of items recirculated;
– Value of items recirculated.</td></tr>
<tr><th colspan="2">Strengths</th><th colspan="2">Weaknesses</th></tr>
<tr><td colspan="2">– NL known and frequented by residents (if the physical space is located there).</td><td colspan="2">– Requires a storage space (e.g. marine containers);
– Requires volunteers or hired staff.</td></tr>
<tr><th colspan="2">Potential opportunities and levers regarding the strategy</th><th colspan="2">Potential threats and obstacles to the strategy</th></tr>
<tr><td colspan="2">– Reduction in residents' expenses (free products or cheaper than buying the same product new);
– Social impact (mutual aid and reduction in isolation);
– Reduction in the quantity of materials disposed of at the NL;
– 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. ÉcoDon operated by the Régie de gestion des matières résiduelles du Lac-Saint-Jean [Lac-Saint-Jean intermunicipal residual materials management agency] (2022);
– Possibility of adding an item refurbishing section;
– Possibility for a part-time employee from the village to combine their work with this used goods store project.</td><td colspan="2">– 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 of unsold items).</td></tr>
</table>

6.2.2 Collection and exporting metals

Circular economy strategy	Recycling and composting	
Brief description of the action	Scrap metal is an important issue for many isolated communities like Inukjuak. There are two main reasons for this. First, scrap metal cannot be incinerated and thus cannot be eliminated at the NL. Second, the cost of transporting scrap metal is higher than the value of the metal itself. In the absence of road connections, scrap metal in Inukjuak cannot be collected by truck and transported to an urban centre. Collection and removal of scrap metal in a community like Inukjuak requires financial assistance and shipping by sea. This action involves removing from the territory the metals that have accumulated for decades in and around the NL.	
Implementation phases	– Assess policy levers to ensure that the imports of new vehicles (cars, trucks, motorcycles, snowmobiles, ATVs, etc.) into the village is accompanied by a requirement that these vehicles be returned for recycling at the end of their useful life to an urban centre in the southern part of the province; – Optimize the classifying and processing of scrap metal (separation of ferrous and non-ferrous metals, vehicle decontamination (e.g. remove oils and fluids), and storage and conditioning for shipment according to recycler requirements); – Request that the transportation and recovery program for the metal stockpiles in Kangirsuk and Aupaluk be extended to Inukjuak and other northern villages; – Engage with the following ministries and organizations for support to implement programs to optimize residual materials management in the North: MELCCFP, MAMH, SPN, RECYC-QUÉBEC, etc.	
Organizations and partners involved	– The northern village of Inukjuak; – KRG; – Makivik Corporation; – MELCCFP, MAMH, SPN, RECYC-QUÉBEC; – Funding agencies; – Specialized companies.	
Timeline	**Budget estimate**	**Success indicators**
Medium term	$$$$	– Quantity of recycled metals.
Strengths		**Weaknesses**
– Metals present in large quantities; – Industrial, commercial or residential land freed up for economic growth in the village; – Reduction in the quantity of scrap metal in the NL.		– Possibility that some metals, stockpiled for several years, are more difficult to recycle; – Transportation costs higher than the value of the metals; – No road connection.
Potential opportunities and levers regarding the strategy		**Potential threats and obstacles to the strategy**
– Available funding; – Political momentum in the wake of the BAPE report.		– The KRG and the northern villages are not eligible for the *Program of Redistribution to Municipalities of Charges Payable for the Disposal of Residual Materials*; – Some industrial or mining exploration projects leave their metal debris behind.

6.2.3 Reusing equipment operated by third parties in Inukjuak

Circular economy strategy	Donating and reselling	
Brief description of the action	As a continuation of the used goods store project, this action aims to promote and facilitate the reuse of large equipment brought in by institutions or companies. For example, a company currently operating in Inukjuak mentioned that they brought in an incinerator to manage certain residual materials. However, there is no guarantee that this company will remain in Inukjuak once the project is completed. It would be interesting to know whether this equipment could be useful to the Inukjuak community and whether the owner could leave it behind. This incinerator is only mentioned as an example of equipment operated by third parties in Inukjuak; other examples could include heavy vehicles, worker camp materials, other specific equipment, etc. Transporting certain types of equipment is expensive. Under certain conditions, it could be interesting for companies to consider selling, renting or leaving behind some of their equipment, with the agreement of the village administration.	
Implementation phases	– Establish a protocol for identifying equipment currently used in Inukjuak; – Include in tenders for equipment, vehicles, etc. a clause that could potentially benefit the community after the work concerned is completed.	
Organizations and partners involved	– The northern village of Inukjuak; – KRG; – Contractors and institutions carrying out needed projects in Inukjuak.	
Timeline	**Budget estimate**	**Success indicators**
Short term	$ (Budget will vary depending on the agreements made with contractors)	– Number of devices or equipment donated, rented or sold through this protocol.
Strengths		**Weaknesses**
– Reduction in the company's transportation costs; – Reduction in the northern village's transportation costs; – Example of collaboration in reuse.		– Requires assessing the real need for certain machinery and other equipment; – Requires inspection and warranty; – Some equipment may require specific training.
Potential opportunities and levers regarding the strategy		**Potential threats and obstacles to the strategy**
– Favourable demographic context (growing population and need for new buildings and infrastructure); – Possibility of work for residents in the short and medium term; – Possibility of links and mutual aid between the northern villages; – An equipment reserve potentially useful for other contractors, with possible income from sale or rental.		– Risk that this action could become an easy solution for contractors wishing to dispose of end-of-life or poor-quality equipment; – Acquisition of a large quantity of equipment without any intended use; – Potentially difficult and expensive to service and repair the equipment due to the village's remote location.

6.2.4 Reviewing the drinking water supply system

<table>
<tr><th>Circular economy strategy</th><th colspan="3">Process optimization</th></tr>
<tr><td>Brief description of the action</td><td colspan="3">Underground piping to deliver drinking water to Inukjuak residents is virtually impossible due to permafrost. The drinking water distribution system has had to adapt to the specific conditions of the local environment. This means that, in practice, water is distributed to each residence using tanker trucks that draw from a reservoir in the village.
Despite the permafrost-related difficulties, insulated overhead pipe distribution is available. Harrington Harbour on the Lower North Shore experiences extreme climatic conditions as well as rock throughout the village. This small village has an overhead, insulated and heated system for distributing water and collecting wastewater.
Water distribution and wastewater management require the use of fossil fuels. However, the question of the drinking water supply system can now be revisited given the pending completion of the electrical system powered by the new run-of-river hydroelectric power station.</td></tr>
<tr><td>Implementation phases</td><td colspan="3">– Organize a discussion forum between Harrington Harbour and Inukjuak to discuss drinking water distribution issues prior to a diagnosis of Inukjuak’s water production and distribution system;
– Identify issues associated with climatic and geotechnical conditions;
– Involve regional actors in implementing a pilot project to develop a permanent water distribution and collection solution for Inukjuak;
– Identify training requirements for the workforce and for servicing the system (the water distribution and collection system's truckers could also be assigned to service the system);
– Install water-efficient appliances (toilets, showerheads, etc.);
– Raise awareness about water conservation and the new infrastructure.</td></tr>
<tr><td>Organizations and partners involved</td><td colspan="3">– The northern village of Inukjuak;
– KRG;
– CFP;
– Specialized companies.</td></tr>
<tr><th>Timeline</th><th>Budget estimate</th><th colspan="2">Success indicators</th></tr>
<tr><td>Medium term</td><td>$$$$</td><td colspan="2">– Functional drinking water distribution system.</td></tr>
<tr><th colspan="2">Strengths</th><th colspan="2">Weaknesses</th></tr>
<tr><td colspan="2">– Reduction in the use of fossil fuels;
– Reduction in periods of restricted usage due to water shortages or full wastewater tanks;
– Reduction in the quantity of plastic bottles to be handled.</td><td colspan="2">– Risk of increased water consumption due to new abundance.</td></tr>
<tr><th colspan="2">Potential opportunities and levers regarding the strategy</th><th colspan="2">Potential threats and obstacles to the strategy</th></tr>
<tr><td colspan="2">– Responds to a serious public health issue;
– Awareness campaign on responsible water consumption.</td><td colspan="2">– Need for worker training;
– Distribution system that may seem to disturb the visual landscape (exposed overhead pipes);
– More complex system to maintain;
– Specialized labour may be difficult to access in the event of major breakdown.</td></tr>
</table>

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 Inukjuak. 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 Community Futures Development Corporations (SADC) (part of Canada's Community Futures Network), the KRG, the SPN, the Quebec government's Secrétariat aux relations avec les Premières Nations et les Inuit, Indigenous Services Canada, 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 as priorities. The proposed actions and investment estimates for are shown in Table 7 below.

Table 7: Recommendation's summary regarding their implementation

Action	Action description	Prioritization	Brief evaluation of investments and recommendations
1	Developing the new NL and closing the existing NL	Priority	Requiring an important investment because the NL has reached the end of its useful life and that it does not necessarily respond to public health issues. Several studies and authorizations are required.
2	Setting up an ecocentre	Priority	Action requiring an important commitment on the part of the administration to implement such a structure. Can be more or less expensive depending on the chosen infrastructures. Can be implemented in several phases. This could be a good opportunity to plan and add a donating and reselling space.
3	Collecting cardboard	Priority	Action requiring a medium-term commitment on the part of the administration to implement such a system. Requires logistics for transportation, infrastructures, and sorting. Allows progressive material collection within the community.
4	Collection and processing organic matter	Priority	Continuation of a project that has already been initiated by KRG. Requiring important investments, but this project may be implemented in several phases. Requires multiple studies to request financing from the PTOMBC. Could be implemented within three years.
5	Opening a used goods store	Lower priority	Action requiring volunteers within the population. Generally inexpensive but may require storage capacity for certain goods. Action also requiring reception logistics as well as inventory and procurement management. Requiring important investments depending on the community's ambitions.
6	Recovering and exporting metals	Lower priority	Action requiring significant efforts in planning for material transportation. Multiple requests to organizations to ease the planning and the associated costs. Will directly impact and reduce the quantity of scrap metals sent to the NL

Action	Action description	Prioritization	Brief evaluation of investments and recommendations
7	Reusing equipment operated by third parties in Inukjuak	Lower priority	Action that can be implemented quickly but requires the collaboration of different temporary actors that are present on the territory. Such a protocol is inexpensive to implement. The purchase of equipment must be negotiated with the owners. These purchases must respond to the community's needs.
8	Reviewing the drinking water supply system	Lower priority	Requiring an important financial investment, but the planning of such a system remains realistic and can be inspired by examples in Québec (the case of Harrington Harbour). Addresses public health issues.

Several other circularity economy solutions were identified during the study but were not included in the action plan; some of these potential actions are described in Section 5 of this report. However, to focus efforts on high-impact actions or actions that could be speedily implemented, this report prioritizes eight that, if implemented, will improve the Inukjuak community's resilience and reduce its ecological footprint.

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 circular economy in northern communities and a mining company. The report was prepared for the northern village of Inukjuak.

Data collected on Inukjuak 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 Inukjuak 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 in the Inukjuak 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 discharge into the environment. Implementation of these strategies would also maximize the use of resources available within the Inukjuak community.

Successfully transitioning from a linear economy to an increasingly circular economy will depend on the involvement of Inukjuak community members. 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 disposing of residual materials in the NL or losing 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 projects initiated by local actors, such as the FCNQ's residual materials management initiatives or the KRG's rotary composter project, demonstrate local willingness to act. These actions should be encouraged.

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Appendix A
ICI list

ENGLOBE

Table 1: Inukjuak ICI list

ICI name	North American Industry Classification System (NAICS) description
ABC Services	Bookkeeping, payroll and related services
Allavik Fournitures et Services inc.	Stationery and Office Supplies Wholesaler-Distributors
Air Inuit Ltée - Inukjuak	Scheduled air transportation
Inukjuak Airport (MTMDET)	Aboriginal public administration
Association Coopérative - Inukjuak	Business associations
Association Inuit Nunalituqait Ikajuqatiglitut	Business associations
Centre de santé et services sociaux Inuulitsivik Inukjuak	Community health centres
Commission de la faune de la région du Nunavik	Other federal government public administration
Dépanneur Peter N. Qumaluk	Convenience stores
Innalik School	Elementary and secondary schools
Entreprises Max Chargements inc.	Construction, transportation, mining, and forestry machinery and equipment rental and leasing
FCNQ Construction Inc.	Industrial building and structure construction
Fédération des Coopératives du Nouveau-Québec - Inukjuak	Business associations
Hunters Support Program	Other individual and family services
Hydro-Québec Inukjuak	Hydro-electric power generation
Inutsuligaatjuq Excavation inc.	Site preparation contractors
Kativik Municipal Housing - Inukjuak	Lessors of social housing projects
Kativik Regional Government - Inukjuak	Aboriginal public administration
Kativik Police Service - Inukjuak	Federal police services
Kayuk Enterprises Inc.	General freight trucking, local
Maisons Nord	Other individual and family services
Makivik Corporation - Inukjuak	Business associations
Moorhouse Logistique et Expédition inc.	Deep sea, coastal and Great Lakes water transportation (except by ferries)
Daniel Weetaluktuk museum	Non-commercial art museums and galleries
Nunavik Landholding Corporations Association	Real estate property managers
Nunavik Youth Houses Association - Inukjuak	Child and youth services
Pepin Fortin Epoo Construction Inc.	Industrial building and structure construction
Pituvik Landholding Corporation	Real estate property managers
Pituvik Sarvaq Energie Inc.	Hydro-electric power generation
Canada Post - Inukjuak	Postal service
Tasiurvik Child Care Centre	Child day-care services
Unaaq Men’s Association	Other membership organizations

Source: SPN, 2022.

Appendix B
Questionnaires

ENGLOBE

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) - *Include unit of measurement*.	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) - *Include unit of measurement*.	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) *Include 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)
Organic material, food waste			
Cardboard packaging			
Other collected materials (paper, glass, metal, plastic)? *Please specify which ones.*			
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.) *Please specify:*			

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. *Please specify which.*			
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

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. 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: 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) – *Include unit of measurement.*	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) - *Include unit of measurement.*	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) *Include 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)
Materials or products sold			
Commercial waste (unsold, returned, expired, etc.) *Please specify:*			
Organic materials, food waste, green waste			
Cardboard packaging			

Type of Output	Estimated quantity (year 2021) *Include 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)
Other collected materials (paper, glass, metal, plastic)? *Please specify which ones.*			
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. *Please specify which.*			
Scrap metal			
Hazardous waste *Please specify which.*			
Other (heat, water, biosolids, etc.). *Please specify which.*			

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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2 Glossary

Circular economy: A system of production, exchange and consumption whose goal is to use circular logic to optimize resource use at all stages of the life cycle of a good or service, reduce the environmental footprint of the good or service, and contribute 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 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) - *Include unit of measurement.*	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) – *Include unit of measurement.*	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) *Please include 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)
Manufactured products *Please specify:*			
Air emissions			
Wastewater			

Type of output	Estimated quantity (year 2021) *Please include 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)
Organic material, food waste, green waste			
Cardboard packaging			
Other collected materials (paper, glass, metal, plastic). *Please specify which ones.*			
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) *Please include 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)
EPR products. *Please specify which.*			
Scrap metal			
Hazardous waste *Please specify which.*			
Other (heat, etc.) *Please specify which.*			

6 Other Questions Related to Circular Economy

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

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: 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) - *Include unit of measurement*.	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) - *Include unit of measurement*.	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) *Include 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)
Organic materials, food waste, green waste			
Cardboard packaging			
Other collected materials (paper, glass, metal, plastic)? *Please specify which ones.*			
Plastic film and bags			

Type of Output	Estimated quantity (year 2021) *Include 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)
Miscellaneous household waste			
Textiles			
Wood waste (construction wood, pallets, etc.)			
Construction, renovation and demolition waste (excluding wood waste)			
Bulky waste (furniture, tires)			
EPR products. *Please specify which.*			
Scrap metal			
Hazardous waste *Please specify which.*			
Other (heat, water, biosolids, etc.). *Please specify which.*			

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

ENGLOBE

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

ENGLOBE

1 Residual materials characterization

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

In total, approximately 132 kg of residual materials were sorted (Table 1). Because the NL 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 15 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 170 kg of residual materials. Annually, the northern village of Inukjuak disposes of approximately 2,300 tons of residual materials into the northern landfill.

In general, and in terms of weight, organic materials and fibres are the most abundant categories which respectively account for 48.8% and 35.2% of sorted residual materials (Table 1).

It should be noted that this characterization is based on one sampling of residual materials and does not necessarily represent all materials sent to the NL.

Table 1: Characterization results of residual materials sent to Inukjuak's NL

Types of materials	Analyzed quantity (kg)	Proportion (%)
Fibres		
Paper	0.7	0.5%
Recyclable cardboard	41.6	31.7%
Other paper and cardboard	3.9	2.9%
Subtotal - Fibres	46.2	35.1%
Plastics		
Nos 1 to 5 plastics	4.0	3.0%
Nos 6 to 7 plastics	2.2	1.7%
Soft plastics	4.5	3.4%
Refundable plastics	0.1	0.1%
Subtotal - Plastics	10.8	8.2%
Glass		
Refundable glass	3.1	2.4%
Non-refundable glass	0.0	0.0%
Subtotal - Glass	3.1	2.4%
Metal		
Metal containers	1.8	1.4%
Refundable aluminum	1.0	0.8%
Subtotal - Metal	2.8	2.2%
Organic materials		

Types of materials	Analyzed quantity (kg)	Proportion (%)
Food waste	35.7	27.1%
Green waste	0.0	0.0%
Other organic materials	10.5	8.0%
Disposable diapers	12.1	9.2%
Liquids	6.0	4.5%
Subtotal - Organic materials	64.3	48.8%
CRD waste		
Clean wood	0.1	0.0%
Other wood	0.0	0.0%
Furniture and other household items	0.0	0.0%
Plastic/*Coroplast*	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	2.1	1.6%
Subtotal - Textiles	2.1	1.6%
HHW		
Soiled fibres and textiles	0.0	0.0%
Other HHW	0.4	0.2%
Subtotal - HHW	0.4	0.2%
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	0.0	0.0%
Batteries	0.0	0.0%
Pressurized fuel containers	0.0	0.0%
Subtotal - EPR	0.0	0.0%
Other residual materials		
Small household appliances and other home or office accessories	0.0	0.0%
Pharmaceutical products	0.0	0.0%
Rubber products	0.0	0.0%
Personal protective equipment	0.2	0.1%
Personal protective masks	0.0	0.0%
Fine particles	0.1	0.1%
Single-use materials	1.5	1.1%
Other objects	0.2	0.2%
Subtotal - Other residual materials	2.0	1.5%
Total	132	100.0%

Appendix E
Circular economy examples

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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 CO_2 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 Restoring

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

Le Vélo Vert

Le Vélo Vert [Green Bike] 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, restoring and reselling them. The company trains unemployed young adults to restore 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 restores 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, fibreglass, 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 Causapscal 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).

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