REGIONAL SUPPLY CHAIN STUDY

LOWER COLUMBIA

Lower Columbia Initiatives
Economic Development

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Executive Summary

CoVID-19 has disrupted global supply chains across multiple sectors and has resulted in rising commodity prices, operating costs, shipping costs, and time. Regional micro & medium-sized enterprises have limited margins to survive in such an uncertain environment, making it difficult to stay competitive in the global market. Further, most regional companies do not have dedicated resources to pursue research & development projects to resolve such issues. However, given regional companies do share these common problems, the LCIC took action to support regional companies through a collective macro-level supply chain study (primary research-based). To this end, a supply chain-focused collaborative study was undertaken with regional companies to identify common issues and guide the path for LCIC's business advocacy & support services to make the supply chain more resilient in the future. The scope of the project also included identifying the potential to reuse or recycle by-products & wastes generated within the value chain. The scope of this research aligns with LCIC's Metal Tech Alley (MTA) project that is focused on supporting business transition from the linear economy to a sustainable circular economy model.

As part of Phase One of the study, twenty-one (21) companies participated, including core companies in battery recycling, graphite manufacturing, ultra-high purity metals, and the forestry sector (5 core sectors). The remaining participants consisted of contractors, suppliers, or service providers. The study has highlighted several common issues; increased supply chain costs (transportation and input material cost), limited capital investment, stagnated business growth, and widened skill gaps(especially in trucking). These issues directly or indirectly point to gaps in infrastructure, funding, business support & human resources. Specifically, the metallurgy (battery recycle, graphite manufacturing) sector has US inbound/outbound logistics dependence on trucking transportation that is not cost-effective & efficient. The forestry industry struggles with rising prices and limited timber supply (cap on the harvestable forest), squeezing profit margins. As these core companies drive business for the rest of the local economy (i.e. contractors, suppliers & service providers), resolving the issues relating to core sectors would ultimately reduce the impact of supply chain gaps on these dependent companies.

After the completion of Phase One of the supply chain study, with a focus on issues that would make a broader impact to stimulate business growth in the region, the high-level recommendations are as follows:

a) Support Supply Chain Infrastructure Development
b) Support transition up in the value chain(value-added products) for core companies
c) Support to create industry cluster in emerging markets (to enhance attractiveness for new businesses)
d) Support to provide business resources through cross-industry collaboration (business & non-business)

These initiatives align with LCIC's vision for business attraction & expansion, relationship building & community development for the region's wellbeing.

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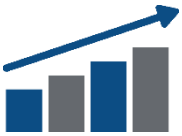


Business Attraction & Expansion

Relationship Building

Community Development Support

The LCIC (Lower Columbia Initiatives Corporation) is an economic development corporation that works collaboratively in the Lower Columbia region with local agencies, organizations, and businesses to develop and implement strategies to strengthen the local economy.

Since its inception in 2010, the LCIC has worked on innovative projects such as Metal Tech Alley (focused on promoting the industrial circular economy). The LCIC undertakes Research & Development(R&D) related activities/projects with different stakeholders to inform economic development activities and programs in the region. These R&D projects may include anything from the preliminary study, feasibility analysis to data collection. These project outcomes help the LCIC improve business advocacy, economic development, and support programs.

Metal Tech Alley (MTA) supports the business ecosystem to lead the transition to an industrial circular economy (reduce, recycle, recover and reuse) in rural Canada. The existing micro closed-loop systems in the regional economy include: critical mineral extraction (Lithium, Lead), battery recycling, and renewable power generation through natural gas plants driven by waste wood from the forestry industry. The purpose is to expand these closed loops to include more companies & materials in the industrial circular economy. This supply chain study supports the MTA project as the by-product & waste quant data inputs, and high-level recommendations would lead to the circular economy-based initiatives.

About the Supply Chain Project

Introduction

Due to CoVID-19, global supply chains across various sectors are now unstable with the rise in commodity prices and uncertainty in shipping time & cost. Regardless of size or sector, regional companies face both temporary and long-term difficulties in their supply-chains. These supply chain-related issues could be company-specific and/or caused by external factors beyond their control. Through this project, the LCIC's main objective is to support these companies with a collective macro-level supply-chain study to locate common issues across regional companies. The following

sections provide the rationale behind the study, the research objectives, and the methodology adopted to execute the project.

Rationale

•**Limited Research & Development Resources:** Regional companies have resources focused on managing routine operations but do not have a dedicated R&D budget for understanding the supply chain dynamics. A collective study would be an efficient way to analyze the supply chain on behalf of these companies.

•**Resilient Supply Chain:** Phase One of this study is focused on understanding the supply chain dynamics at the macro level. The following phases of the study will expand on these findings to explore further the possibilities for making the supply chain resilient to uncertainties in the long run.

•**Encourage Collaboration among companies:** The major supply chain gaps identified are outside the scope of any single company. For future phases, the LCIC proposes a collaborative study where regional companies and other stakeholders work together to resolve common external issues.

•**Industrial Circular Economy Initiative:** The project will uncover the opportunities in by-products, waste produced, and contribute to Metal Tech Alley's (MTA) vision on circular economy innovations by local businesses.

•**Designing business advocacy & support programs:** With the unprecedented impact of COVID-19 on supply-chains, the LCIC, will strive to better understand regional supply chains, to design business advocacy & support services.

Objectives of the Study

•**Develop high-level Regional Supply Chain Cluster Map:** Phase One developed the foundational quantitative and qualitative data for regional industry's supply chains. With the use of an industry survey, data was collected regarding supplier management, sourcing of raw materials, order management, customer landscape, logistics, competition, and material stewardship. The data helped visualize in/outflow of goods & services into the system to develop a high-level supply chain map.

•**Hard Data-Input/Output in the Supply Chain:** The survey provided (quantitative) data from companies regarding primary raw material input, output, by-products, and wastes. This information will highlight the existing closed-loop system and uncover future opportunities for industrial circular economy action by local companies.

•**Identify the Supply Chain issue/gaps:** While company knowledge is limited to individual supply chains, through this study, a high-level perspective was achieved to identify common difficulties faced by firms in the core sectors

•**Next Step high-level Recommendations:** As part of Phase One, actionable next steps were identified to address the supply chain gaps. The proposed recommendations are focused on making a broader long-term impact that aligns

with the LCIC vision for business stimulation & the wellbeing of the region. These next steps will define the objectives of the next phase of the supply chain project.

Methodology

A holistic approach was adopted for gathering quantitative and qualitative data through a combination of modes; direct discussions with the company executives, followed by a survey form and a supply chain datasheet.

To ensure the reliability of the information, the Phase One process included a short 30 minute to 1-hour discussion call with executives to learn about the company's supply chain. Questions were asked about material sourcing, logistics, operations, or any other challenges facing the business. Inquires were also made about collaborating with other local businesses to resolve common issues.

In the follow-up to the interview, the survey form was sent to the company executives. The survey form was designed to categorize the companies based on their demographics and learn about their competitive & customer landscape. Additionally, this provided a quick snapshot of their feedback about supply chain-related risks in the Trail Area. This exercise was the major contributor to the high-level supply chain map- from sourcing raw materials to shipping to customers.

In the interview, executives were asked details about the major input and output material and any significant by-products, and waste generated. The type of output could be a service, a commodity, a value-added product or a rare metal. If the data was readily available it was shared in the interview or provided via email. Companies did mention that this data varies from year to year depending on the business requirement so they often provided a range or an average numeric figure.

Snapshot of the Industry in Trail Region

The city is home to the lead & zinc smelter operated by Teck Resources (formerly Cominco), which is the region's largest employer. After metallurgy, forestry is the second largest sector, followed by other suppliers & contractors who provide products & services to these companies. These sectors are interdependent and fuel the momentum of the regional economy. Teck Trail Operations, other metallurgy based businesses, and forestry companies are part of global supply chains, whereas the supplier & contractors depend on the local supply chain. These companies source and supply from all across the world (though the majority of trade is with the USA). The City of Trail is 10 Km from the USA border at Washington State. The region has a competitive advantage in R&D, and in the labour force's technical skills & expertise which has accumulated over the years. The region also proudly houses world-class battery recycling & pure metals-based Industry.

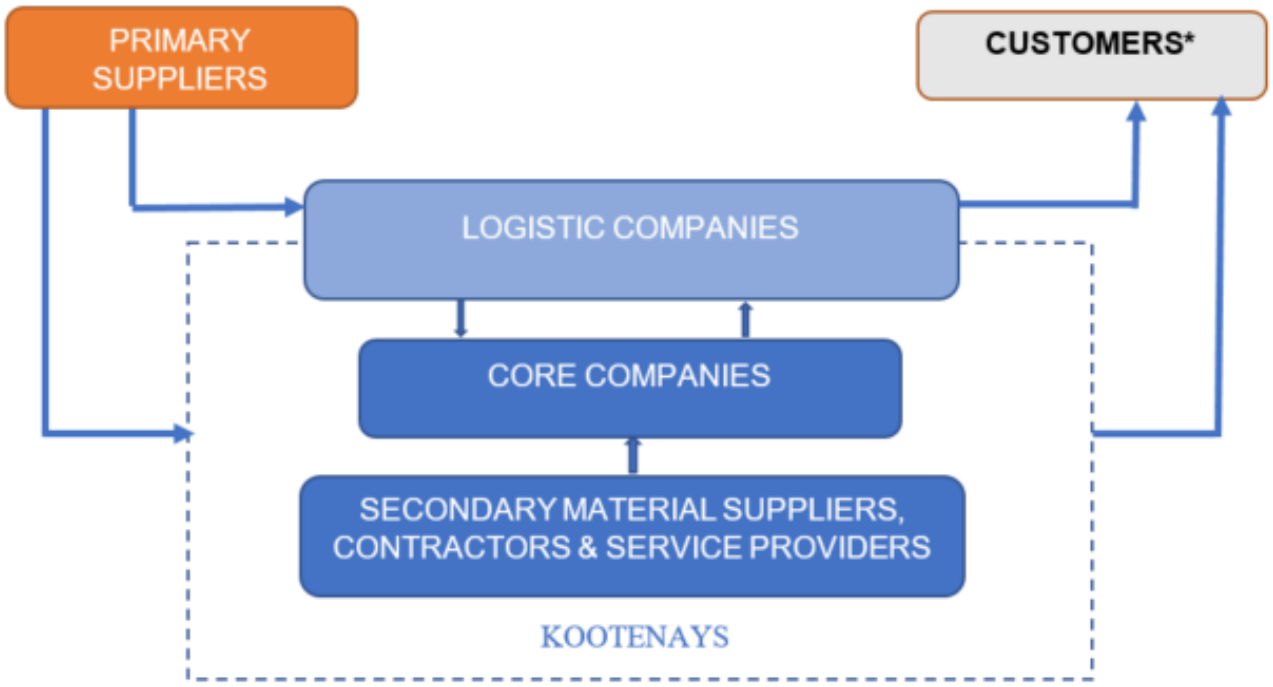
Supply Chain Cluster Mapping, Analysis & Hard I/O Data

Supply Chain Cluster Map Overview

The supply chain encompasses all the activities and resources required to flow physical goods/services from supplier to end consumer. It includes but is not limited to processing, manufacturing, packing, and shipping activities. From the economic or non-technical perspective, it is a group of multiple stakeholders located in the same or different

geographic location who exchange goods or services that create jobs and contribute to the growth and business development in the region. The strategy focused on strengthening the supply chain and its supporting infrastructure can have a broader impact on the region by creating more opportunities.

As shown below, suppliers, customers, regional core companies, contractors & service providers in the region, and logistic organizations are significant stakeholders. The first part of this section discusses the availability of primary suppliers, contractors & service providers, and logistics infrastructure as common essential success factors for the regional supply chain. The second part provided insights on each core company, followed by a macro-level supply chain cluster map.



*The study had limited scope on customers. All the information gathered on customers is as Annexure-D.

*For a full list of participating companies, see Annexure-F.

Industry-wide Common Key Success Factors(KSFs) of Supply Chain

Key success factors (KSFs) in the supply chain are the necessary elements required to operate a supply chain successfully. Company composition for the study was quite diverse, with size varying from 10 employees to 100 employees and revenue ranging from 5 million to 50 million. While each company has a different value chain (the company's activities), the report focused on analyzing common KSFs of the supply chain (as shown on the previous

page). The common KSFs are primary suppliers, secondary material suppliers, contractors & service providers, and logistics companies. These are analyzed as follows:

a) Availability of Primary suppliers or Primary Supplier Management

b) Availability of secondary material, contractors & service providers

c) Freight/Logistics Infrastructure

Availability of Primary suppliers

For the common commodities (industrial plastics, steel alloys, heavy metals, wood-based companies), the suppliers are usually traders located within Canada. Occasionally companies do source directly from suppliers for rare materials not available through traders. Traders source these commodities from suppliers throughout the world. As such, the supply & prices of these commodities are susceptible to changes in international trade, disruption in the supply chain, and demand-supply volatility. When Covid-19 disrupted the supply chain, it forced companies to look for alternatives or reschedule their work delivery milestones. All the companies dependent on commodities reported that prices followed the steep upward trend that reduced their profit margins and sales as their customers postponed orders to manage uncertainty.

"The traders source these commodities from the suppliers throughout the world. As such, the supply & price of these commodities is susceptible to changes in international trade, disruption in supply chain and demand-supply volatility."

Some of the mineral & metal commodities (Graphite & Cadmium) are sourced from within the Kootenays. Eagle Graphite is a company that owns the graphite mine and sells purified graphite to its customers. The metals (Lead, Cadmium) are sourced from Teck Trail Operations smelter in Trail. The typical type of wood is also sourced from the Kootenays forest by the forestry companies to trade or sell.

Graphite

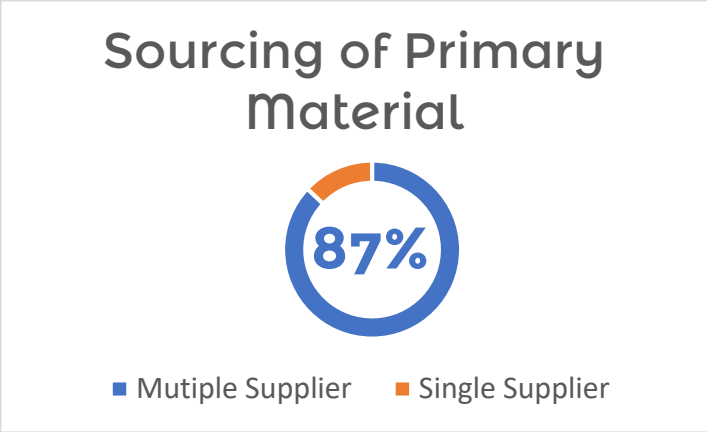
Metals(Lead, Cadmium)

Lumber/Wood

Locally sourced commodities

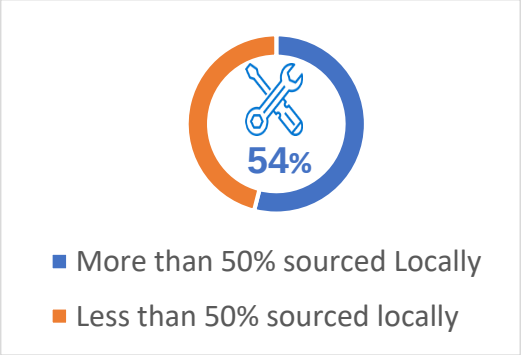
In our survey, 87% of the companies reported using multiple suppliers. These companies are small to medium scale enterprises with less than 50 employees (78% of the companies) and revenue less than $C 5 Million (62% of the

companies). Eighty-six percent (86%) of the companies do not have any long-term contracts with suppliers. The success of this transaction is driven by trust and long-term business relations with the suppliers.



Availability of Secondary suppliers, Contractors & Service Providers

In addition to primary materials, companies procure routine operational inventory such as safety supplies, and industrial supplies referred to as secondary materials in the report.



Fifty-four percent (54%) of the companies reported sourcing more than 50% of their secondary materials locally. This local supply chain plays an essential role in the operations of the core companies. The major source for these companies is Teck Trail Operations.

"Core Companies did report a decreasing trend in the sourcing of secondary materials from local sources. The existing industrial suppliers said that some secondary material suppliers had moved their stores out of the region because of reducing business opportunities."

Core companies use services like engineering design, fabrication, operational maintenance from local contractors & service providers.

“Contractor & service providers reported issues related to increasing logistics expenses and decreasing business growth. ”

Freight & Logistics Infrastructure

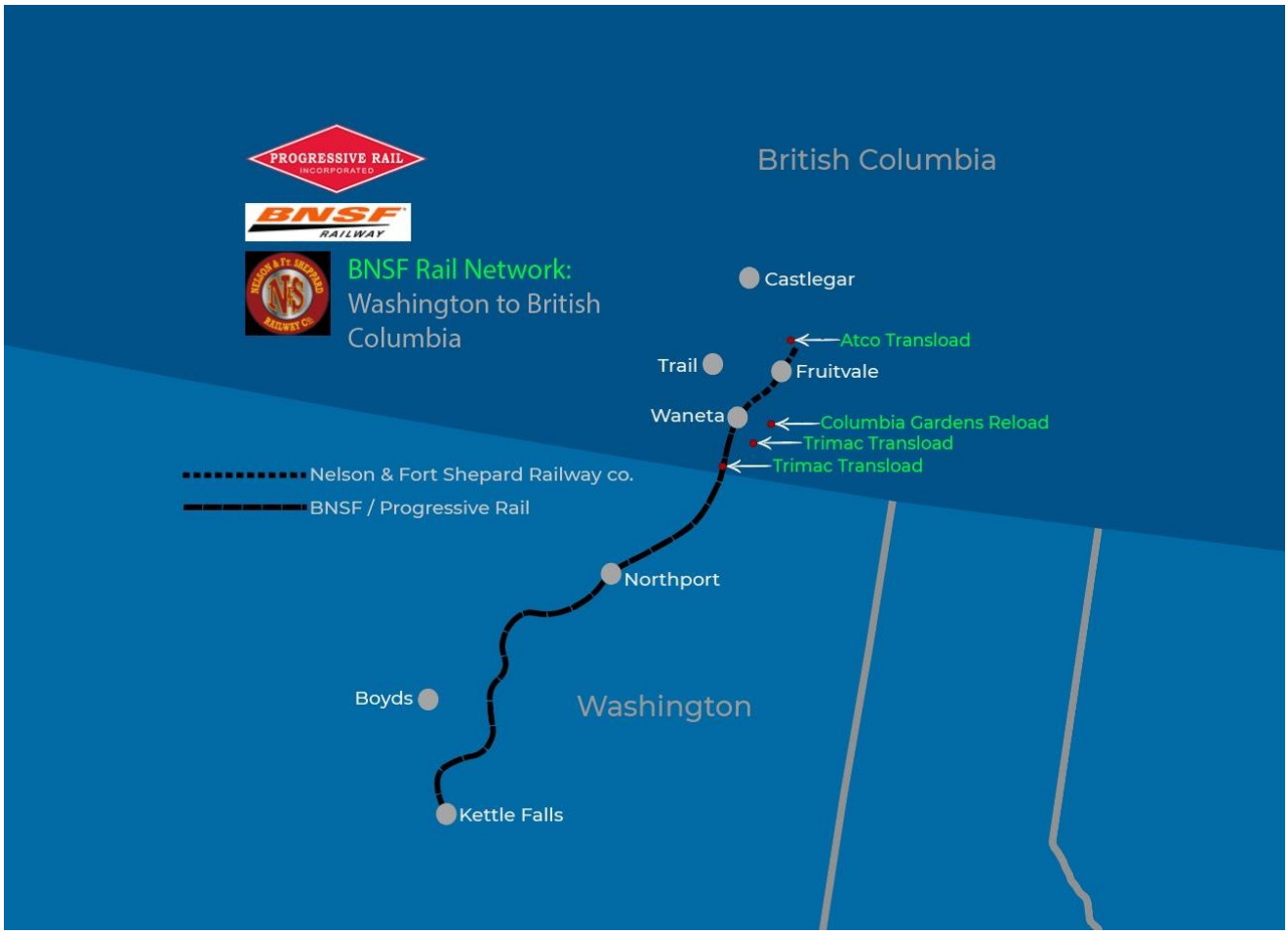
Multiple stakeholders exist in the logistics & freight sector of the supply chain on three layers: Courier companies, Trucking companies, Railway freight. Some companies own their own truck fleet for long-haul shipping and vans for short-distance shipping.

Companies reported using more than one mode for shipping purposes depending upon the location & size of the consignment.

"According to the survey, 57% of the companies reported using third-party trucking fleet services; 38% owned their trucks(mostly the companies that manage hazardous materials or recycle waste). While 32% used courier services and a handful use railway freight(only the major forestry company uses the rail freight)."

Railway Shipping Infrastructure:

The short railway line and the dedicated transload facilities provide economical & efficient transportation access to the broader US market. As shown below, the two transload facilities are exclusively for the Teck Resources operations, and the remaining two cater to the forestry industry.



The Lithium-ion battery and Lead-acid battery industries have more than 80% and 40% of their customers in the US market, respectively. However, these sectors depend on truck shipping for their operations which is comparatively expensive. The growing use of batteries worldwide will increase the demand for battery recycling and railway shipping would be more economical & efficient for the Industry.

It emerged during the study that companies have discussed shipping the battery recycling material over the railway infrastructure with transload stations. These discussions were not fruitful because, there is probability that materials like cadmium, lead, and lithium may contaminate the other material shipped on the existing transload facility or railway carts.

A possible solution could have been building a dedicated transload facility on the railway line to manage the battery recycling materials. It is important to mention that the transload facility is either organized by a third-party company or owned by the company that uses that transload facility for shipping its materials. For example, Columbia Gardens is a third-party managed facility, and the Fruitvale transload facility is company-owned.

"The real problem is that it may not be financially viable for an individual company to invest in a dedicated transload facility of their own. It may not be lucrative for a third-party transload facility company to invest at the beginning stage."

Trucking Logistics:

Many national trucking companies, through their service, provide broader North American landscape outreach to the regional companies. The largest consumer of trucking services is the forestry industry and battery recycling.

Sutco, one of the largest log and heavy haul trucking transportation companies in the Kootenay region, participated in the study.

"The primary issue for the company is to find skilled/trained trucking drivers, and there is more demand than supply in the trucking market."

MTI (Mountain training Institute), Kootenays, mentioned that individuals' upfront training charges investment is between C $8000- $15,000 for 8 to 12 weeks course involving on-road training. However, there is no funding or bursary support for pursuing these driving courses to become a skilled driver. The maximum funding support possible for aspiring candidates is under C$7,000 through EI(employment insurance). However, the ROI is relatively high as most drivers land jobs that pay C$ 70,000 to $ 90,000 per year.

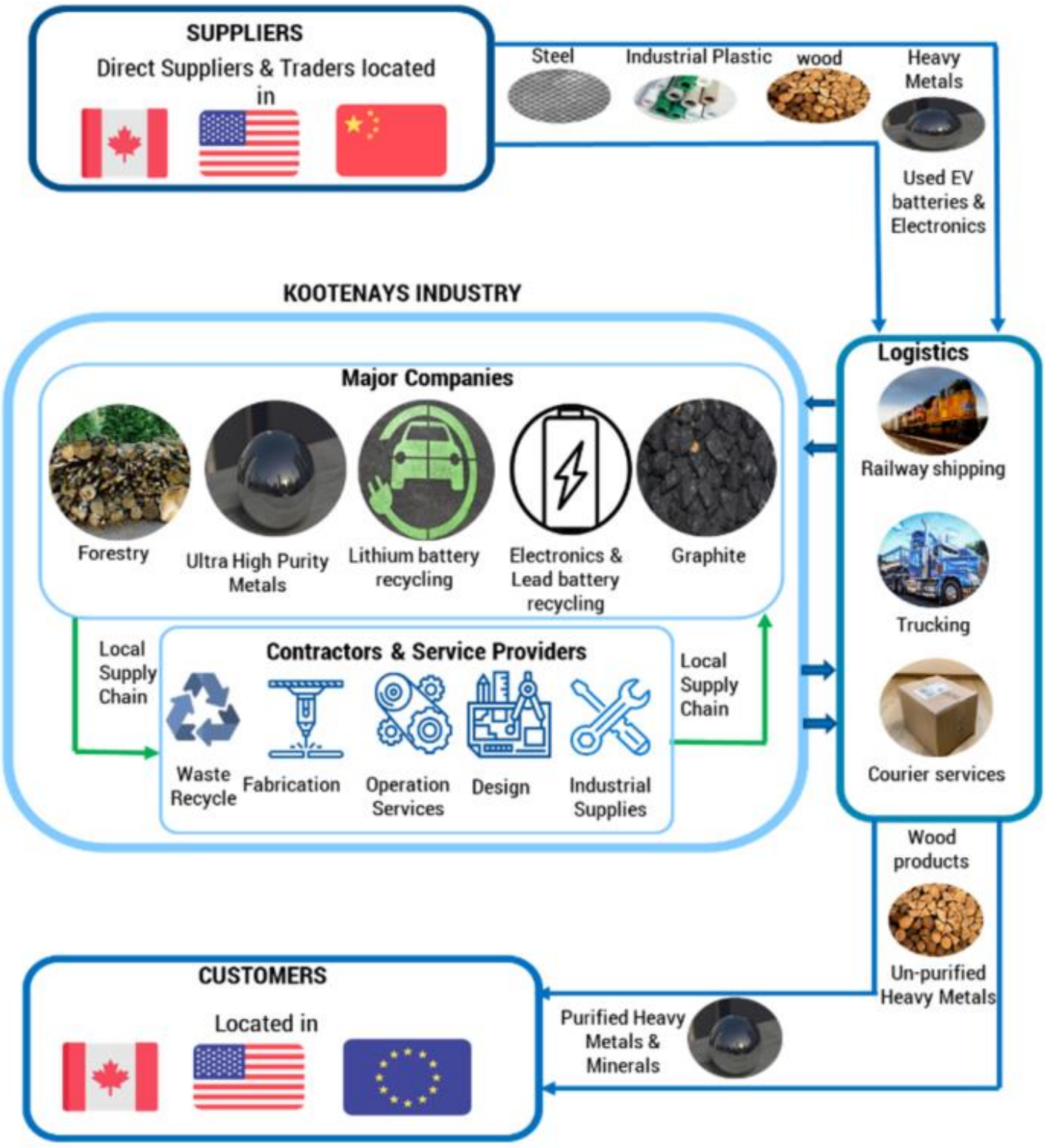
Courier Logistics:

All the major courier companies(FedEx, DHL, CanAm, Ace couriers), offer their services to regional companies. Companies with small consignments or few shipments per year to be shipped within Canada or overseas prefer the courier as the cost-effective and reliable mode.

"Companies mention that remote location is one of the reasons the shipping Is not cost-effective and efficient. They cannot commit to price & delivery to their clients because of uncertainty in prices & delivery."

For example, one local contractor reported that shipping costs for two different consignments, one 1600 pounds of steel and the other 160 pounds of steel, would be very close.

Regional Industry's Supply Chain Cluster Map



Description	Reference
Details on primary supply material & Suppliers	Annexure-A
Details on Contractors & Service Providers	Annexure-B
Details on Material Flow	Annexure-C
Hard Input/Output Data on Supply Chain	Annexure-D

Regional Companies-(Supply Chain Insights)

The core companies consist of battery recycling (Lithium & Lead-acid batteries), electronics waste recycling, forestry, graphite manufacturing, and high purity metals refining. The graph below indicates the market size vs competition positioning of these sectors.

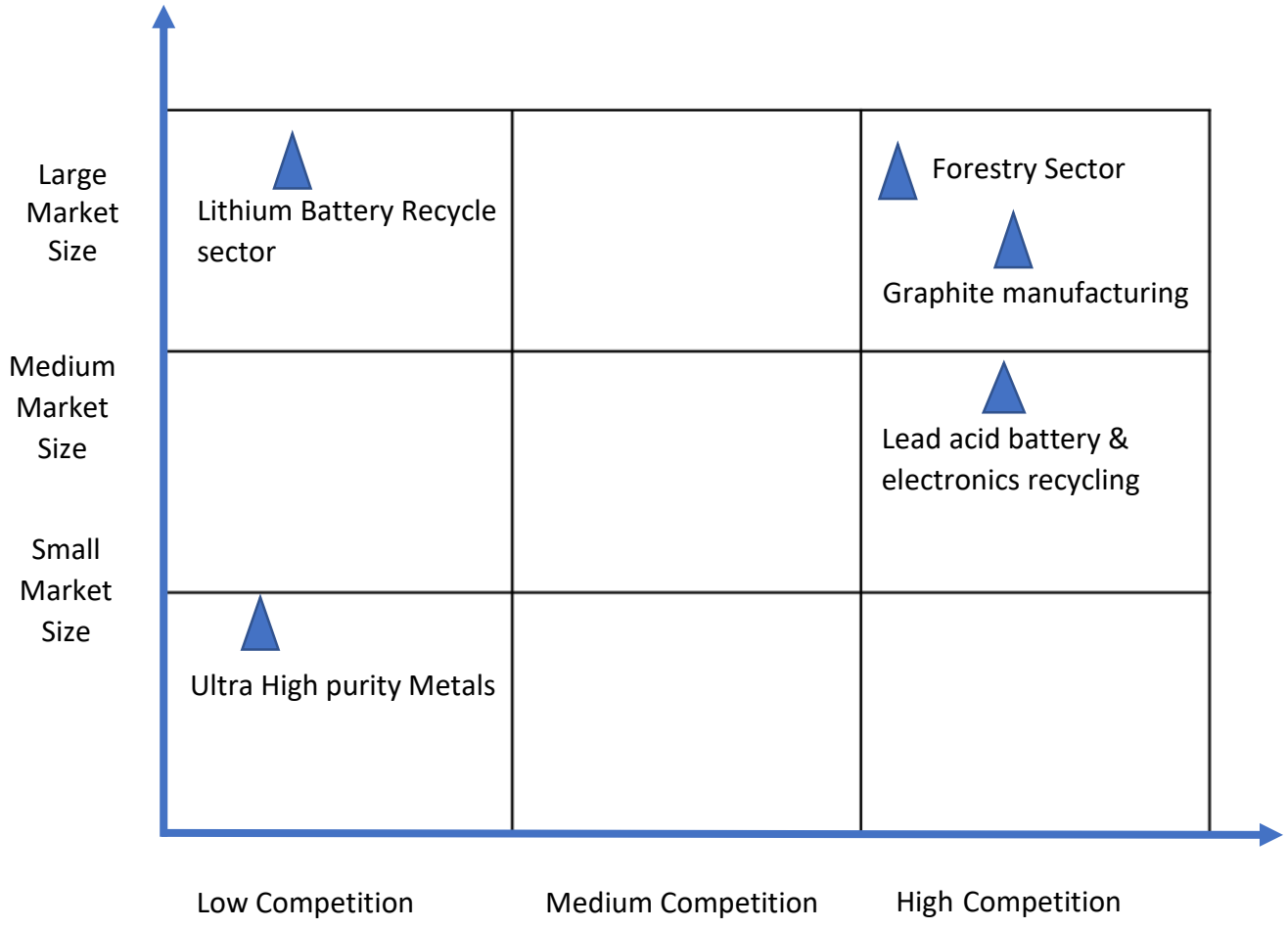


Fig: Sector Growth Potential Map (Annexure-G)

Lithium Battery Recycle Sector: The Region is home to a battery recycling & management company Retriev Technology who leads the industry in the North American market. The expertise includes all kinds of industrial, consumer & household lithium battery recycle management. As lithium battery-based electric vehicle sales are picking up, their competitive advantage in the sector can make the region a center-place for circular economy in battery recycling for the North American market.

"However, the remote location, lack of logistics & freight infrastructure are the hurdles to scale up with market size or growth. There is certainly an opportunity to explore the logistic & freight infrastructure development. "

Lead Battery & electronics Recycle Sector: KC-Recycling is the largest lead-acid battery recycling in western Canada and recycles electronics & CRT glass. Lead is the largest commodity recycled and is sold to Teck Trail Operations smelter for further refining. The company is growing its operations to include polypropylene extruding operations at KC-Recycling to make in-house finished recycled plastic directly sold to the consumer.

"The company's expertise aligns with the circular economy vision at MTA(Metal Tech Alley). However, there are other players in the Canadian market, and infrastructure investment can help reduce the shipping cost expenses due to the remote location of Kootenay. "

Graphite Manufacturing Sector: Eagle Graphite owns a graphite quarry in Kootenays region and sells purified graphite for lubricants, graphene, and fuel cells. Graphite is an abundant mineral across the world and the profit margins are very low. The upstream value-added products made from graphite earn higher profit margins than selling the graphite itself. Graphite is the active anode material used in lithium-ion batteries for electric vehicles and currently, graphite anode manufacturing & battery assembly is centered in the Asian continent (Korea, Japan & China).

"A purpose-based advocacy work can be pursued to explore the graphite anode manufacturing(Value added product) in Kootenays to meet the demand by upcoming EV manufacturing companies in the US."

Forestry Sector: There are around four major forestry companies located in the West Kootenay region including timber harvest, pulp & paper companies. However, only Atco Wood which harvests timber and Mandala Homes which manufactures pre-fabricated homes participated in the study. The rising price of wood and shipping costs are hitting hard on the margins of the Industry. Also, a mill's total wood processing capacity is currently higher than the wood available to harvest due to sustainable forestry regulations. Companies compete for the same amount of wood, and the demand for timber is rising with the boom in the housing market (at time of writing). This reduces the margins for BC forestry companies in comparison to wood sourced from US companies.

"Forestry companies can pivot from wood to produce high margin upstream value-added products(finished wood sheets etc)."

Ultra-high purity metals sector: Fenix Advanced Materials was established in 2015 and makes Ultra-high purity metals from 5N to 6N and has wide application in the semiconductor industry. The company benefits from its proximity to Teck operations as some heavy metals are directly sourced from the Teck resources.

"The company is actively pursuing R&D for next-gen Lithium-Tellurium (LiTe) battery technology for EV vehicles. There is potential for Collaboration with battery recycling companies."

Supply Chain Issues & Gaps

Supply Chain-Issues:

The core companies, contractors, suppliers, and service providers reported issues specific to their supply chain. All these issues are complied at the Annexure-E for reference. The vision behind the study was to build resilient supply chains, encourage collaboration among regional businesses, support industrial circular economy initiatives under MTA, and better design the LCIC business advocacy programs for the regional industry. Hence, the report focused on the vision-inclusive issues that are spread across the supply chain of many study participants. The problems highlighted are as follows:

Price Volatility & impact of Covid-19: As discussed in the previous sections, many business models depend on commodities like processing wood, metals, and graphite etc. These commodity markets are competitive, and profit margins are continually narrowing. The prices will continue to be sensitive to global demand, trade variations, and supply chain disruption that exposes the industry to the impact of unprecedented changes like Covid-19.

Rising Inbound/Outbound Logistics Cost: The remote location, limited outreach of freight companies in the region adds additional costs for shipping. The railway shipping infrastructure is limited to cater to the forestry sector & Teck Trail Operations. There is enormous traffic for the US market shipped through trucking services, and companies would be far better off using railway shipping instead.

"25% of the companies reported the logistics & Freight Infrastructure in Trail area below average."

Lack of Business Resources(Capital & Human): While many companies have business growth or expansion plans, they do not have access to capital investments at affordable interest rates. Thus, funding or financing project development remains a problem. Further, investment decisions require financial modeling or pre-feasibility reports and not all companies have the in-house resources for this analysis.

While metallurgy & forestry companies can easily hire talent, the contractors & service providers(especially trucking) struggle to find trade-skill labor.

"50% of the companies reported the availability of skilled people(HR) in Trail & area as average or below average."

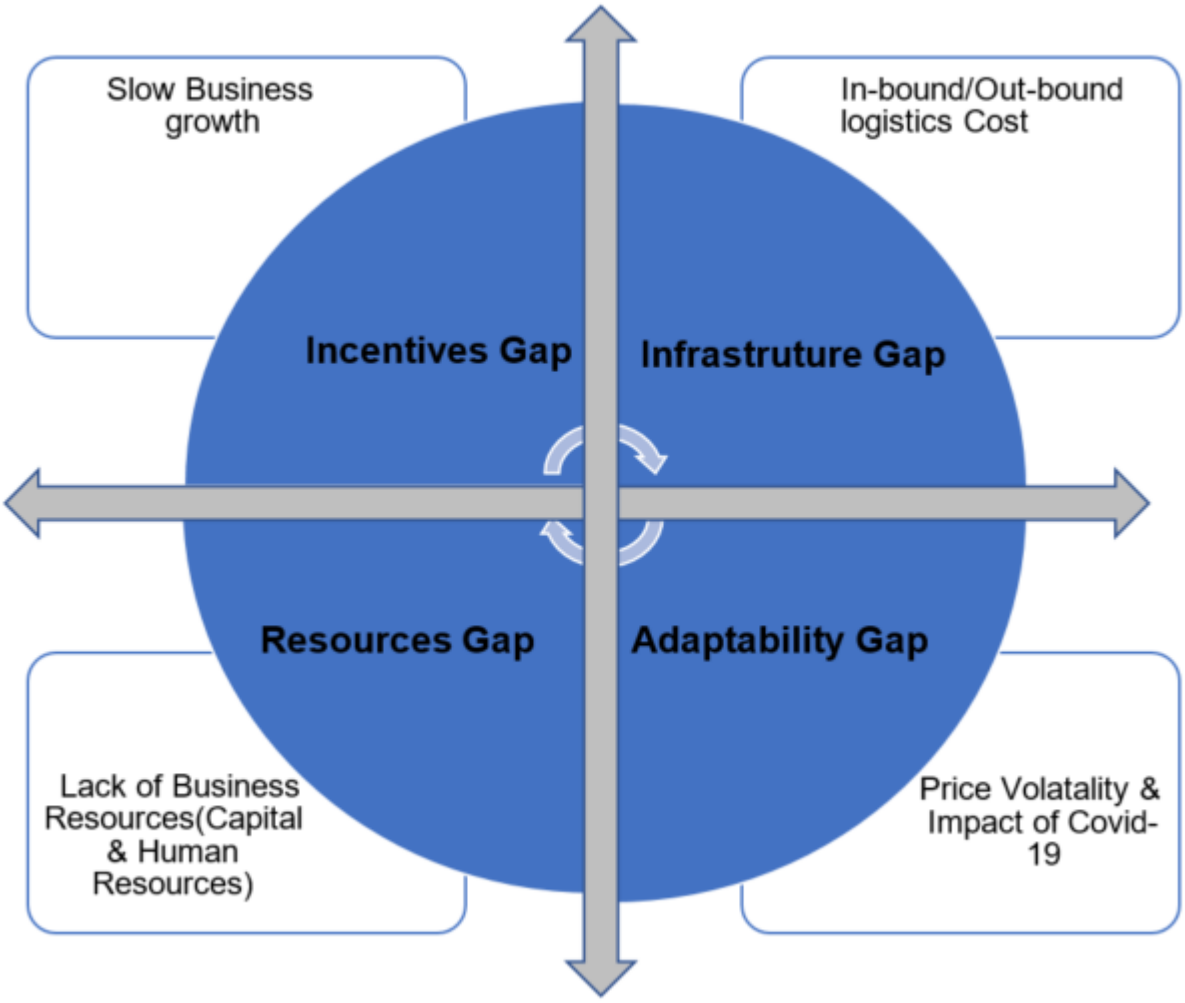
Slow Business growth: The core companies are experiencing slower growth than a decade ago. As the national economy grew, the region has not seen the same economic development. Similarly, the rest of the companies (contractors, suppliers & service providers) reported reduced business opportunities over the last few years as they are dependent on core companies for their business.

"56% of the companies reported the business growth potential in Trail & Area as average or below average."

The core companies need business stimulation through better freight infrastructure, funding support, and business advocacy programs. The business stimulus of core companies would ultimately reflect on the rest of the companies.

Supply Chain-Gaps

The issues highlighted in the previous section are related to the following gaps:



Infrastructure Gap: Despite being near the US border, cheap hydropower, and world-class expertise in metallurgy, the region must invest in making logistics efficient for metallurgy companies to stay competitive in the global market.

Resources Gap: Small enterprises need funding support to upgrade or add new facilities or equipment. These enterprises may not always be eligible for government funding /grants as most of these grants are relating to the environment & emissions. There is not enough pool of skilled labor to cater to the operational need of contractors, suppliers & service providers (especially trucking).

Incentives Gap: The status quo on stagnated business growth could change if new business opportunities arise, attracting new companies to establish their business in the region. The region should use its competitive advantage to create value and incentivize new businesses to make setup in the area.

Adaptability Gap: The business model for core companies focuses on commodities and has been the same for a long time. The companies could transition to more risk-averse business models that are more resilient to uncertainties in commodity availability & prices.

High-Level Recommendations

A. Support Supply Chain Infrastructure Development

As discussed in the previous sections, the supply chain costs (inbound & outbound logistics) are high due to the region's location and limited outreach of logistic companies. LCIC should pursue addressing the issues of supply chain infrastructure at the regional level, thus directly impacting supply chain costs.

One promising infrastructure project is building an additional transload facility on the existing short railway shipping line from Kettle Falls, the US to Fruitvale, Nelson (Canada). The insights from battery recycle companies showed that more than half of their customers are in the US, and they rely on trucking for the shipping of material which is not cost-effective or efficient. This on-road traffic could be switched on railway shipping. As the world is transitioning towards the net-zero emission goals, the demand for batteries and recycling will grow in the future. The battery recycling companies can capitalize on their competitive advantage if supported by solid logistic infrastructure. The transition to railway shipping would reduce the supply chain's delivery time, cost, and carbon footprint. It would bring business & economic growth to the region. LCIC can start by carrying out a detailed feasibility study i.e ROI, funding, plain landscape availability, and financial model for the project.

B. Support transition up in the value chain for core companies

The profit for core companies is directly dependent on low-profit margin commodity products (purified graphite, wood, metals, etc.). Some of these commodities are quite common and any variation in prices and shipping costs (e.g. due to Covid-19) would reduce the profit margins, making it hard to be competitive. The product offerings have

been the same for a long time, and companies can diversify to include the high-profit margin value-added products made from these commodities.

One potential pilot project could be with the forestry industry to explore the transition from timber to value-added products (e.g. plywood) made from timber. Wood is a commodity product with low-profit margins, and the companies who sell value-added (i.e.plywood) have a higher markup. Therefore, allocating resources to value-added products can help forestry companies to increase revenue and resilience to market fluctuations. At the macro level, the resulting productivity would result in forestry companies' job creation and reinvestment in new technologies.

However, this will require capital investments to be competitive against existing players in value-added products. LCIC could pursue cost-benefit & market fit analysis with regional forestry companies to assess the market opportunities.

C. Support to create industry cluster in emerging markets (to enhance attractiveness for new businesses)

The region needs economic activity stimulus to revive from slow business growth. New businesses tend to invest in locations that offer rare skills, rare resources, and capabilities. These rare values are linked to the competitive advantage of the industry in the region. The region can benefit by developing an industrial cluster around its competitive advantage(s), thereby creating value and economies of scale to attract new business to that cluster.

The one promising cluster example is developing "industrial circular economy based recycling integrated battery manufacturing ecosystem" in the region. As discussed in the industry insights section, this region has the rare competitive advantage of having the lithium battery recycling facility, lead battery & electronics waste recycling facility, lead smelting facility, and graphite manufacturing at one location. These facilities are the necessary value chain activities (battery manufacturing & processing steps) required to make a closed-loop battery ecosystem (recycle, reuse, remake). The cluster could attract electric vehicle battery manufacturing companies, graphite processing companies etc., to invest in the region.

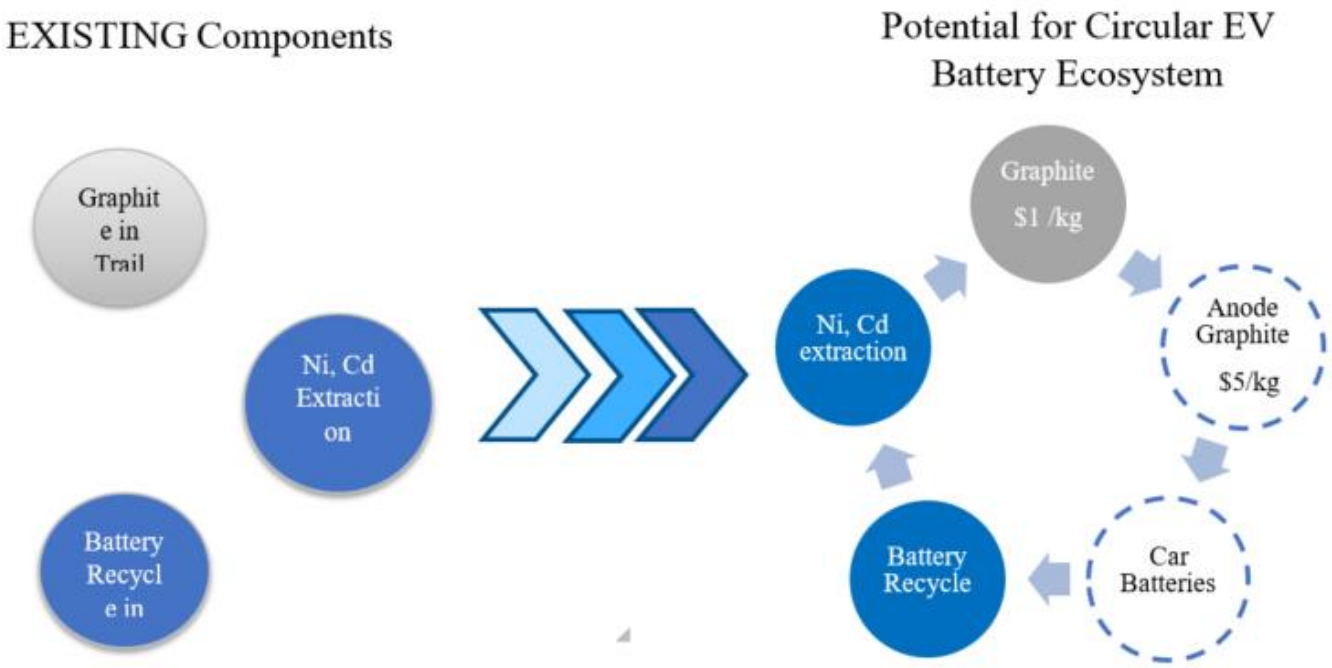
LCIC can pursue a feasibility study for this cluster formation with the concerned stakeholder companies from the region and assess the market fit, existing ecosystem capacity, and capital investment required to complete the ecosystem.

The visual below represents the high-level circular economy-based EV battery ecosystem.

D. Support to create business resources through cross-industry collaboration (business & non-business)

The LCIC, as an economic development organization, can lead the narrative on collaborations to create a sustainable business ecosystem in the region. Any multi-stakeholder agenda is more achievable if pursued through partnerships. The outcome of the strategic alliances is more than the summation of capabilities; it results in innovative solutions and uncovers new opportunities through knowledge & resource spillover.

Collaborations could pave the way for problems like lack of funding resources to expand, skill gaps in different trades, and similar common issues that directly or indirectly impact the businesses.



Conclusion

The participating group of companies is diverse in their size and sectors, so companies' value chains (set of specific operational activities companies perform) differ widely. The report's scope covered the common external issues & relevant insights about the supply chain of core companies. The focus was to develop the first primary research-based comprehensive regional industries' supply chain cluster map and knowledge resource (quantitative & quantitative data) on the supply chain. It leads to identifying significant issues across the companies relevant to their value chain or supply chain. The report narrowed the focus to the problems that are more inclusive and will have a broad impact on business growth.

Issues like rising logistics cost, slow business growth, cost volatility due to Covid-19, lack of business resources (capital & human resources) spread across most companies at different magnitudes. Supply chain issues are linked to gaps in infrastructure, funding resources, business support & human resources.

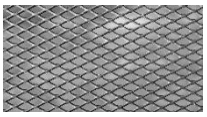
The report recommends the next high-level actionable steps to improve regional supply chain resiliency:

a) Support Supply Chain Infrastructure Development
b) Support transition up in the value chain(value-added products) for core companies
c) Support to create industry cluster in emerging markets (to enhance attractiveness for new businesses)
d) Support to provide business resources through cross-industry collaboration (business & non-business)

Collaboration among companies and stakeholders complemented with business support initiatives can give life to these ideas. These findings helped defined the path for the next phase in the supply chain project of LCIC.

Annexure-A

Primary Material(s) & Suppliers: Companies in the region source their primary material from multiple sources located mostly in the North Americas and partially from other continents(Asia & Europe) thriving on the global supply chain. The type & details of the primary material sourced is as follows:

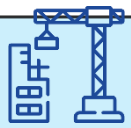
	Sourced From	Sourced Through	Sourced For	Sourced By
 Steel	Canada, US, Asia	Traders , Suppliers	New equipment Fabrication/Repair, Structure Manufacturing	Fabrication & Manufacturing Contractors/companies
 Used Cell Batteries	US	Battery Collection Companies	Recycle service	Battery recycling companies
 Used Li-ion Car Batteries	US	Battery Collection Companies	Unassemble & Recycle Service	EV battery recycling company
 Industrial Plastic	Canada, US	Traders , Suppliers	Structure & Support fabrication	Fabrication & Manufacturing Contractors/companies
 wood	Canada, US	Forestry Companies	Lumber Log manufacturing	Forestry Companies
 Graphite	Trail (Canada)	Company Owned Quarry	Making high purity Graphite	Graphite selling company(Quarry owned by Company)
 Metals(Cd, In, Te, Sn, Sb)	Canada(Teck), Asia(China)	Suppliers, Traders	Making Ultra High Purity Metals(6N5+)	Metal Refining Company

Annexure-B

Secondary Material Suppliers & Contractors & Service Providers: The secondary material like regular consumables & tools procured by core companies for their routine operations drive the local supply chain. Industrial supplies include anything from lubricating oil, PPEs, filter equipment, construction materials, nut & bolts. In addition to supply of materials, companies drive local supply chain by utilizing the local contractors & service providers for construction, operation & maintenance and fabrication of equipment services.

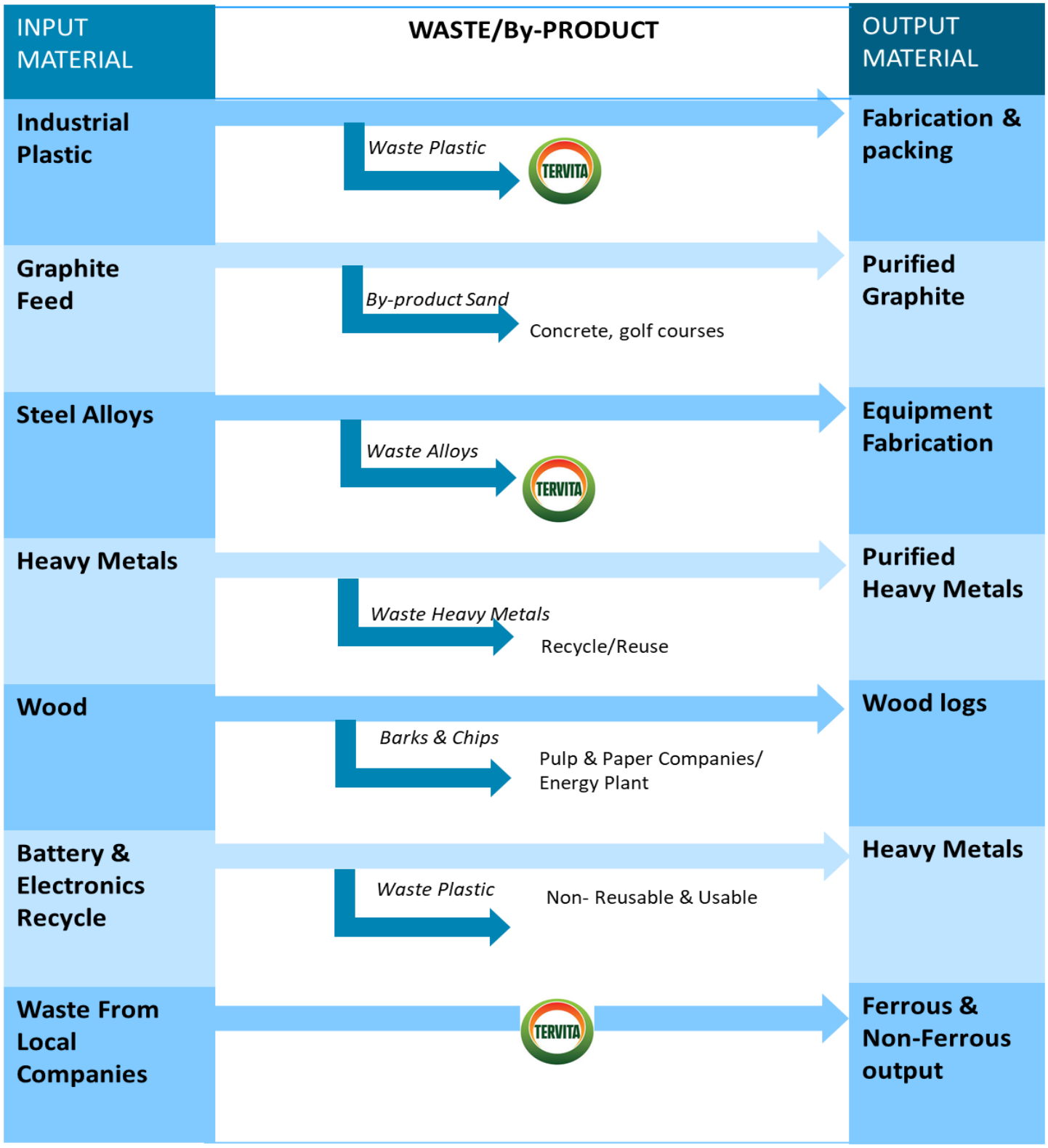
Type	Company	Description	Services
 Industrial Suppliers	Vallen	Corporate Office & warehouse in Calgary. Regional Store in Trail.	Industrial safety products & some basic welding products
	Columbia Filter Ltd.	Trail based company(Source material from Calgary)	Air & fluid filters for industrial & commercial use
	Trail Hammer & Bolt	Trail based company(Source material from multiple suppliers)	Range of safety, operation & maintenance tools
	Beaver Falls Machining	Trail based company(Source material from traders & suppliers)	Range of steel & plastics
	XL Quality Industrial Services	Trail based company(Source material from traders & suppliers)	Range of steel & plastics

Type	Company	Description	Services
 Fabrication Services	Beaver falls machining	Located in Trail(Steel & Plastic based fabrication & replacement of equipment's)	Machine Shop-CNC machines & Manual Machines
	XL quality services Limited	Located in Trail (Steel & alloy based fabrication & replacement of equipment's	Fabrication, welding, machining, protective coating & sand blasting
	MoFab	Located in Trail	Fabrication & welding shop
	Able Plastics	Located in Trail	Full service-plastic & fiberglass shop

Type	Company	Description	Services
 Operation & Maintenance	West kootenay mechanical	Located in Trail(Steel & Plastic based fabrication & replacement of equipment's)	Machine Shop-CNC machines & Manual Machines
	Venture Mechanical system	Located in Trail (Steel & alloy based fabrication & replacement of equipment's	Fabrication, welding, machining, protective coating & sand blasting
	Automan Controls	Located in Trail	Fabrication & welding shop
Type	**Company**	**Description**	**Services**
 Construction Services	Hil-Tech Contracting Limited	Located in Kootenays	Design, construction management services
	Castlegar Ready Mix	Multiple locations in Kootenays	Ready mix concrete & aggregates for construction projects
	Kays Contracting	Located in Kootenays	Excavation contractors
Type	**Company**	**Description**	**Services**
Engineering Design	I/O Design	Located in Trail(use deign software & make drawing to be used by local fabrication shops)	Engineering Design customised new equipment & retrofitting equipment
	Left-of-the-center design	Located in Trail(sub-contract with technician & skill expert personnel to make designs)	Mechanical design of industry-reverse engineering

These companies have been the integral to the local ecosystem from past two decades. Not all of these companies were part of the supply chain study. However, a diverse set of companies were selected to understand the importance &market for each sub-sector.

Annexure-C



** Material flow & supply chain data is based on companies who participated in the study. It does not include the data for Teck resources & some major forestry companies*

It is important to mention that all the companies have material stewardship in place to manage the by-products or waste. For example, the waste wood chips & barks are sold to energy company to produce electricity and the sand by-product from graphite processing is use in concrete and golf courses. The battery recycling companies produce metals that are sent to metal smelters for further purification. The plastic extracted form battery waste is reusable except plastic waste from Lithium ion batteries that is sent to landfills.

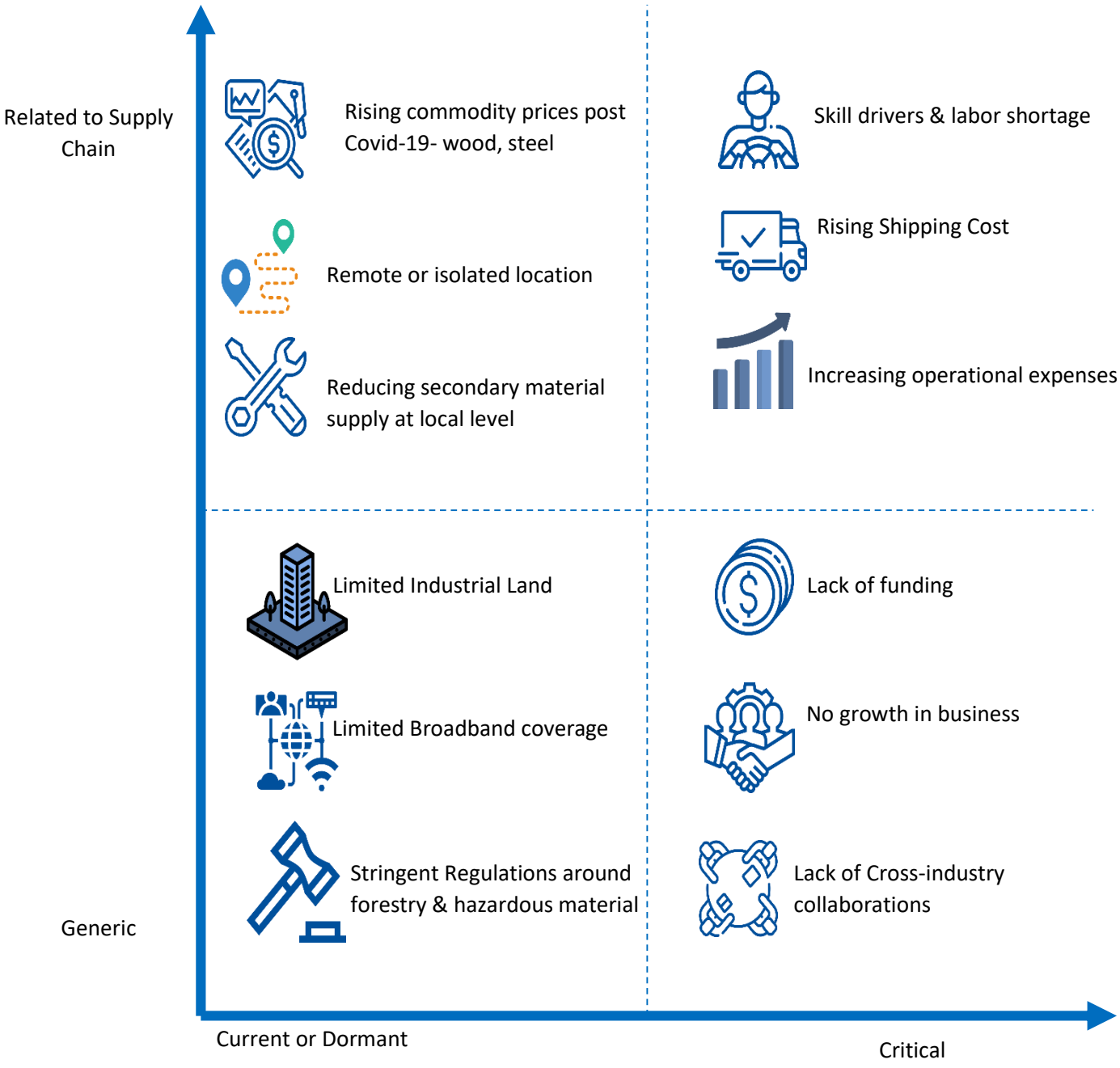
Tervita is one of the biggest waste recycle company in the region and all the plastic & steel alloy waste is recycled by Tervita to make ferrous & non-ferrous reusable material sold to companies across US & Canada.

Annexure-D

Hard Input/Output Data

In		
Type	**Description**	**Amount per year**
Metals	Cd, Antimony,Tin, Tellurium, Indium	**2500kg**
Battery & electronics Recycle(Metals, plastic, graphite)	EV batteries, Cell batteries & electronics waste	**120 Million Pounds**
Alloys	various types of steel, Aluminium alloys	**1.1 Million pound**
Wood	Lumber	**200,000 cubic meter**
Plastic	Industrial grade fabrication plastic	**10000 pounds**
Out		
Type	**Description**	**Amount per year**
Metals(Non-purified)	Ouptput from Battery recycling companies.(Sent to Teck smelter in Trail & Co& Ni Smelter in Ontario, Sudbury)	**55 Million Pounds**
Metal & Minerals (purified)	Graphite & Utltra High purity Metals	**4000 tons**
Waste sold after recycle(Ferrous & Non-Ferrous)	Its alloy, metal and plastic based waste.Sent to companies in US & Canada	**20,000 tons**
Wood logs	Wood logs & finished sheets	**120 Million Square feet**
Recycled Plastic	25% non-reusable plastic. Remaining sent to plastic recycling companies and this step will be relocated within region soon.	**4 Million pounds**

Annexure-E



As shown above some issues are directly related to supply chain while others are generic but do impact the performance of supply chain. These issues could be passive, relevant to the current situation(Covid-19), or critical and need proactive measures resulting in quick wins.

Annexure-F

Website Reference for Website of Study Respondent companies:

1. Retriev Technologies - https://www.retrievtech.com/

2. KC Recycling - http://kc-recycling.com/

3. ATCO Wood Products - https://www.atcowoodproducts.com/

4. Fenix Advanced Materials - http://fenixam.com/

5. Eagle Graphite - https://www.eaglegraphite.com/

6. Sutco Transportation - https://sutco.ca/

7. Advanced BioCarbon 3D - https://advancedbiocarbon3d.com/

8. XL Quality Systems - https://xlquality.com/

9. Tervita - https://tervita.com/

10. Vallen - https://www.vallen.ca/content/trail

11. Able Plastics - http://www.ableplastics.ca/

12. Beaver Falls Machining - https://www.bfmachining.com/

13. Mountain Transport Institute - https://www.drivemti.com/

14. Trail Hammer & Bolt Company - https://trailhammerandbolt.com/

15. I/O Design & Engineering - https://www.iodesign.ca/iowordpress/

16. D-Pace - https://www.d-pace.com/

17. Left of Centre Design - https://www.leftofcenterdesign.com/

18. Progressive Rail - https://www.progressiverail.com/

19. Columbia Gardens Reload - http://www.columbiagardensreload.ca/

Annexure-G

Lithium-ion Battery market size US $41 Billion and is expected to grow annually by 12.3% from 2021 to 2030. The regional company has limited competetion.

Lead-acid battery market size is US $ 17 billion and is expected to grow annually by 6%. There are many competitors in lead-acid battery recycling industry.

The forestry industry in Canada contributed US $ 33 billion for export in 2019. There are multiple players in the sector.

Graphite manufacturing market size is US $ 14.3 billion and is expected to grow annually by 5.3%. Graphite is easier to make, and multiple companies exist.