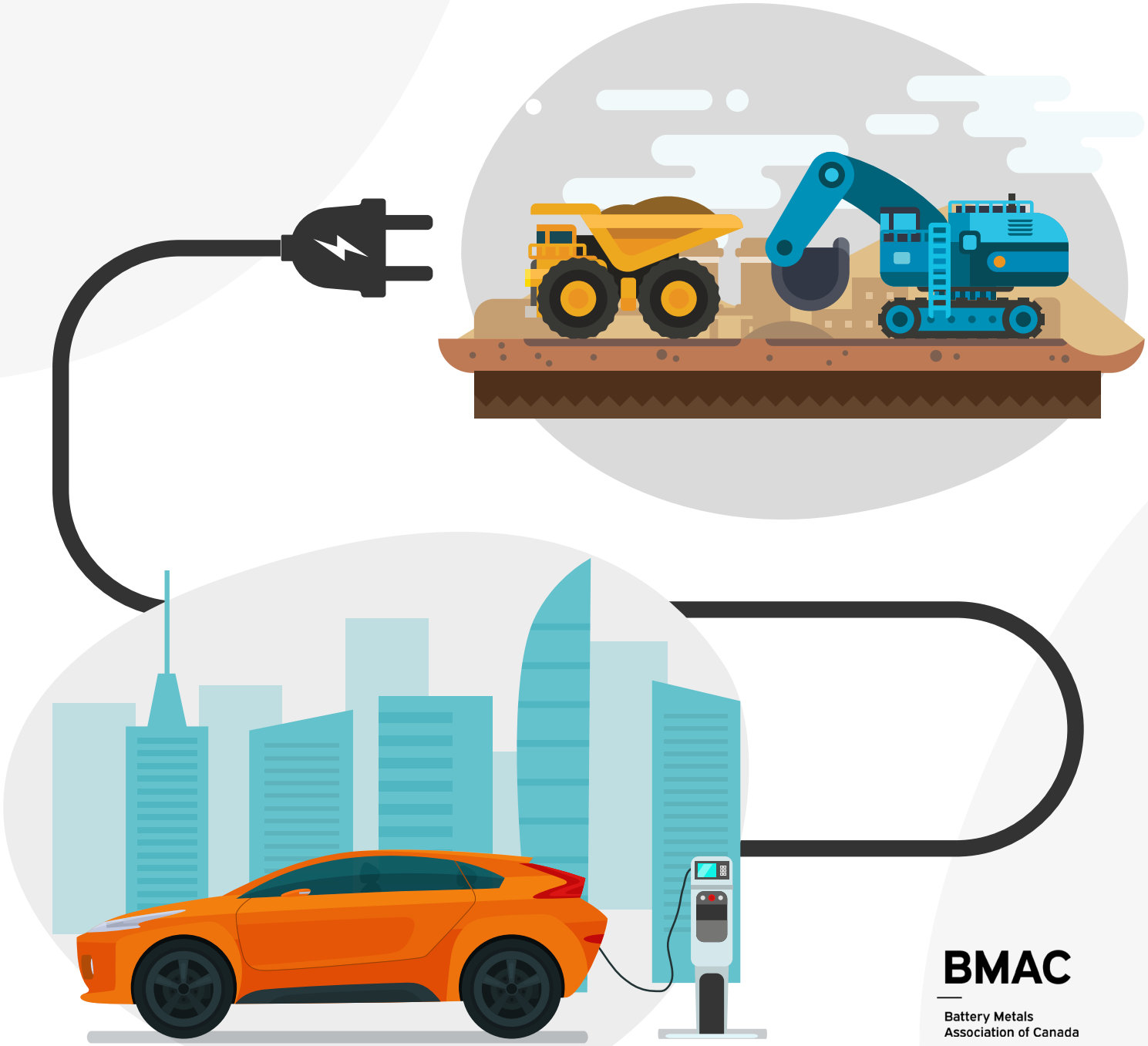
Maximizing Canada's Battery Metals Sector

Building a thriving "mines to mobility" supply chain



BMAC

Battery Metals Association of Canada

BMAC Greeting

The Battery Metals Association of Canada (BMAC) is a trade organization of entrepreneurs, explorers, developers and producers of battery metals, materials and products, who have joined together to support a rapidly changing energy landscape. What we share is a desire to grow the domestic lithium-ion battery value chain in Canada.

Our vision is a thriving Canadian battery metals value chain, from mines to mobility to recycling.

As a national non-profit association, BMAC aims to connect, support and grow the industry to reach its full potential. We will help lead the effort to ensure Canada fully captures its abundant economic potential through the responsible and sustainable growth of Canada's battery metals value chain.

We wish to extend sincere thanks to our growing community of volunteers, sponsors, members and partners who all contributed to help make this event a resounding success!

Sponsors

Illuminate your path forward in the critical mineral and energy industry with GLJ's global consultants. GLJ supports organizations like yours to identify and evaluate opportunities, improve business strategies and attract sustained investment. Demystify material business risks and uncertainties, by using GLJ to enhance your decision-making and stakeholder engagement from concept to marketplace.

As a supporting member of BMAC, GLJ looks to accelerate Canada's impact in the global battery metals industry.

McCarthy Tétrault established its position as Canada's premier full-service law firm by understanding our clients' businesses, providing the right skills and expertise, and developing customized client-focused service teams to fully meet our clients' needs. Our Power group provides leading advice on national and international conventional and alternative power projects, offering our clients a 360 degree view of the power industry. For our clients, this means comprehensive advice that reflects the peculiarities of the sector, mitigates business risks, and advances even the most complex goals.

Fluor has provided engineering, procurement, fabrication, construction, and project management services to Canada's energy industry for 72 years. With the vision to Build a Better Future, Fluor's team is applying its extensive experience, proven technology, and leading-edge systems to benefit Canada's energy transition in areas such as carbon capture, hydrogen, biofuels, liquified natural gas, energy storage, and small modular reactors. Fluor is committed to positively contributing to Canada's energy tomorrow by focusing on safe and sustainable solutions today.

Spartan Controls is the leading provider of digital, automation, valves, measurement, process control, solutions and services in Western Canada. For over 55 years, Spartan has provided customers with high performance solutions, industry expertise, lifecycle support, and technical training — delivering value our Customers want.

Our automation solutions are used in all process industries including solution mining, hard rock mining, agritech, building technology, food & beverage, municipal, oil and gas, oil sands, pulp and paper, power, pipeline and terminals. We are dedicated to providing exceptional customer experiences and delivering superior business results where expertise and collaboration come together.

E3 Metals' overarching vision is to be a leader in responsibly sourced lithium to fuel the global transition towards a brighter energy future. Combining resources and proprietary technology, our goal is to produce battery-quality, sustainable lithium products for the growing battery sector. By developing lithium on the backbone of Alberta's sophisticated oil industry, we benefit from an abundance of existing data, infrastructure and skilled workers to accelerate our commercialization and minimize our environmental impact.

Matrix Solutions is one of Canada's leading providers of integrated environmental and engineering solutions, serving public and private sector clients in markets ranging from municipal infrastructure and mining to renewable energy and oil and gas. The company's services combine multi disciplinary expertise throughout every project stage including early environmental and resource assessments, regulatory permitting, water management and modelling, environmental monitoring, and end-of-life remediation and reclamation. Matrix is committed to providing innovative solutions which attain the highest environmental standards while reducing costs through streamlined, risk-based approaches and cross-disciplinary integration of outcomes.

Matrix is a proud member of BMAC and sees great opportunity to support the development of a thriving and world class battery supply chain upholding and building upon robust Canadian environmental, governance, and social standards.

Acknowledgement of facilitators

Caralyn Bennett, GLJ LTD

Wendy Ell, JWN Energy Intelligence

Kimberly Howard, McCarthy Tétrault LLP

Jim Parsons, Spartan Controls Ltd.

Juli Rohl, Energy Futures Lab

David Redford, Cassels Brock & Blackwell LLP

Steve Shikaze, Matrix Solutions

Acknowledgement of partners

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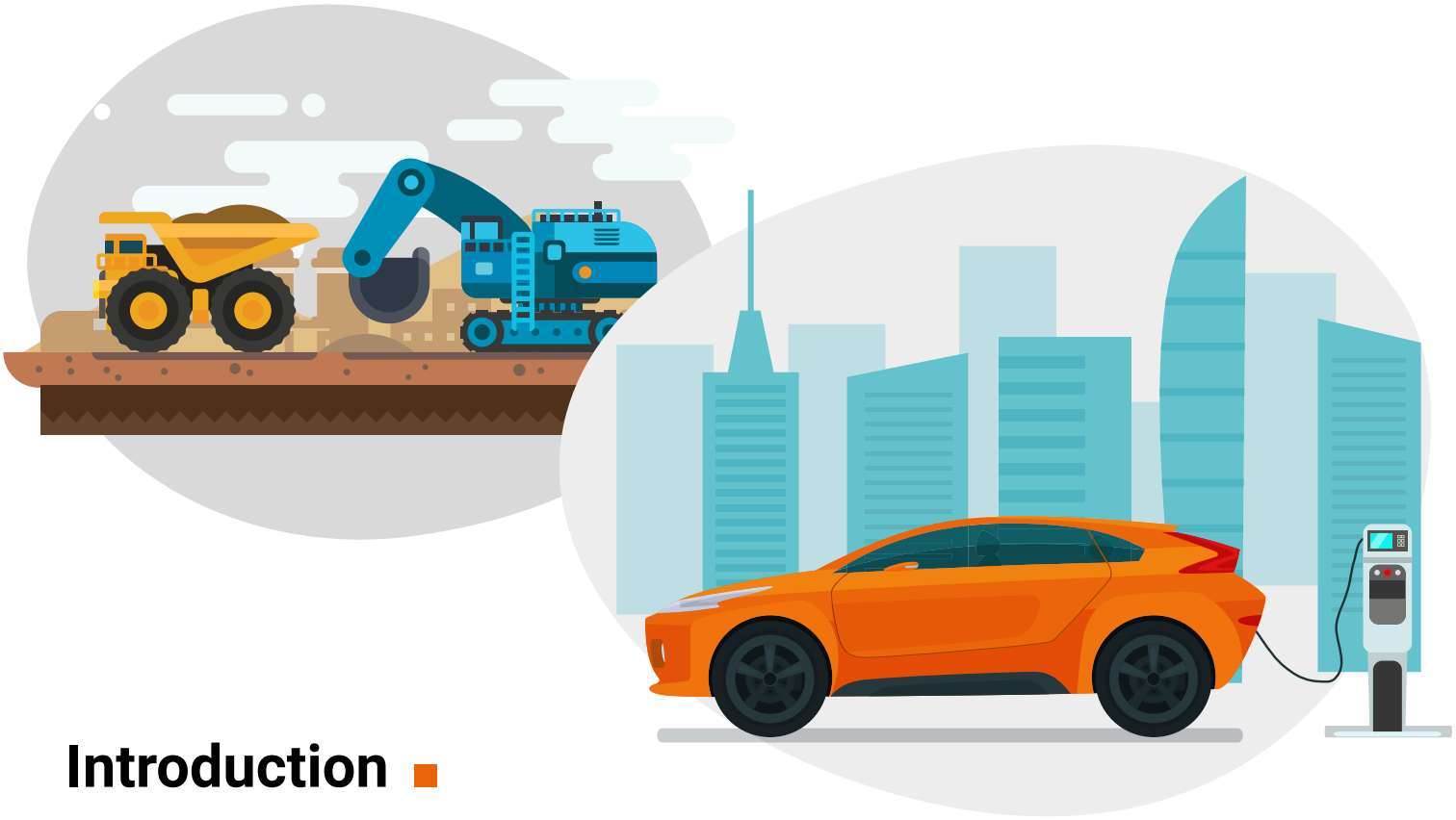


Introduction

The world is transitioning towards a net-zero emission future in response to climate change. With demand for lithium-ion batteries rapidly increasing to enable clean mobility and energy storage, a monumental build out of the global battery supply chain is now under way.

In 2020 electric vehicle (EV) sales jumped by 43% to more than three million vehicles, despite a pandemic-induced drop in overall vehicle sales. EVs accounted for 4.3% of global sales overall, up from 2.5% in 2019.

In its *Electric Vehicle Outlook 2020* report, Bloomberg New Energy Finance (BNEF) expects the pace of EV adoption to accelerate going forward as battery technology and charging infrastructure advance, and global efforts to cut greenhouse gas emissions intensify. By 2030, BNEF predicts almost 30% of new vehicle sales will be electric, that number doubling by 2040.

Battery energy storage linked to renewable power generation is also expanding, though at a slower pace than EVs. Lithium-ion batteries currently make up more than 90% of the stationary battery power market, according to BNEF.

As the industry grows, demand for battery metals is expected to rise exponentially, and so will the need for raw material processing. The manufacturing of precursors, battery components, and the assembly of battery cells are expected to follow suit. Battery recycling will also see important growth, especially as early EVs reach end of life.

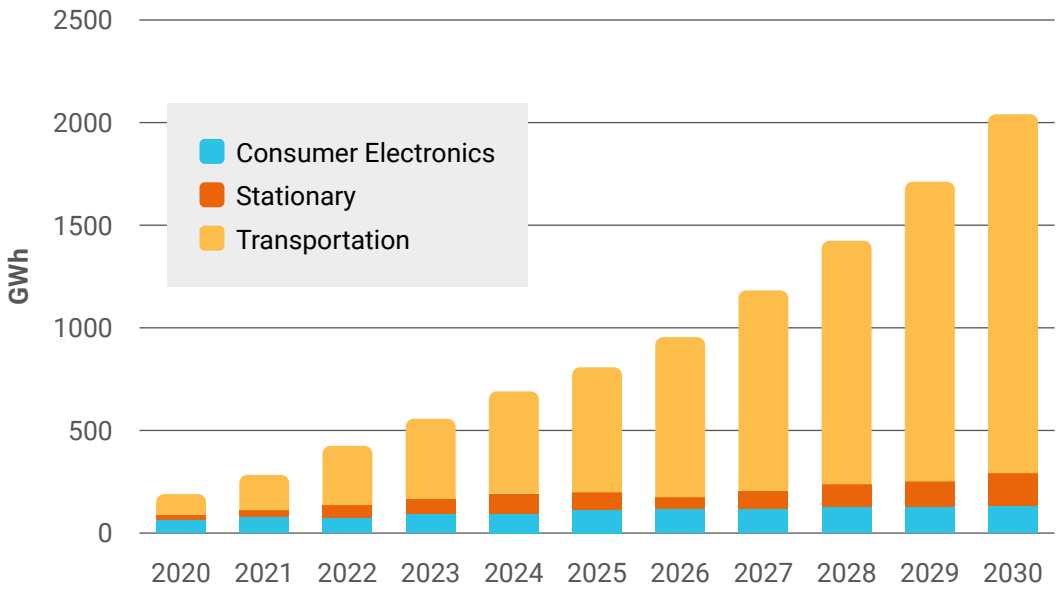
Home to abundant raw materials and an emerging industry, Canada strives to contribute to all segments of this rapidly growing supply chain both domestically and abroad. In late March, the Battery Metals Association of Canada (BMAC) held a virtual workshop bringing together leadership from across the battery supply chain. Participants worked

together to identify roadblocks hindering Canada from participating in the global battery market, and then identify actions to overcome market barriers and drive global competitiveness. Representatives from the Canadian and Albertan governments outlined current policy efforts and research work they believe will provide a framework for the creation of a thriving battery supply chain.

Workshop participants were also asked to identify the barriers to success along each segment of the supply chain and develop corresponding solution pathways to overcome those barriers. They were then challenged to identify specific policy and research needs to accelerate the supply chain build-out, and identify value-added opportunities that could drive the sector forward.

This report reflects input from workshop attendees, summarizing the discussions and outcomes. It also highlights the attendees' mutual objective to further advance this emerging supply chain identified as critical to Canada's economic success. BMAC will build upon the workshop results to help amplify and connect voices across the Canadian supply chain and advance a vision for the battery metals industry, from mining to end use and recycling.

BNEF projected global Li-ion deployment – all markets



Current government engagement on the battery metals supply chain

Natural Resources Canada

With the release of the Canadian critical minerals list, the Canadian government has made its attention on this emerging sector clear. It is focused on collaborating across departments, with provinces and territories and with industry to move the battery file forward. The effort is driven by rising global demand for cleantech to meet climate change targets, and increased demand for responsibly sourced products as building blocks said Luc Leboeuf, Director, International Affairs and Trade Division, at Natural Resources Canada (NRCan). While Canada is often viewed only as a source of raw materials from the mining industry, Leboeuf said the COVID-19 pandemic and global trends are changing that perspective. Globally there is a drive to re-shore supply chains downstream of mining and Canada could be a supplier of choice - if it can position itself within these supply chains.

The automotive industry is building production hubs and integrating across the battery value chain to ensure a stable supply, said Leboeuf. Mineral abundance and robust ESG standards are some of Canada's strengths, and the federal government is focused on leveraging them to build each segment of the battery value chain in Canada, from mines to mobility.

Identifying some challenges, Lebouef said all the major battery minerals are found in Canada; however, many are not actively produced. Some minerals, like lithium, are found in variable or unique deposits requiring specialized extraction technology. Given the nascent state of the industry, there remains a lack of processing capacity for many battery minerals in Canada with many countries significantly ahead. Stiff global competition to attract industrial production throughout the supply chain adds to this geopolitical challenge whether from mineral production, chemical and component manufacturing, or cell manufacturing.

Considering these challenges, there is a significant research and development (R&D) effort underway across the supply chain to help Canada compete, said Leboeuf. NRCan is focused on improving mining and mineral processing with CanmetMINING, CanmetMATERIALS and other federal laboratories working on material development and clean energy technologies.

Andrew Ghattas, director of the critical minerals task force at NRCan, said the recently released critical minerals list accounts for a wide variety of minerals but all the battery minerals are considered critical. He reiterated the goal to be a responsible, secure source of minerals critical to the low carbon and digital technology supply chain.

The task force is also focused on working with international partners - the US being one of the key partners, and to compete globally in the battery market while ensuring Canada's interests are represented.

Alberta Minerals Strategy

Many provinces are developing their own minerals strategy and the Alberta government offered its provincial perspective as one example. As part of Alberta's Recovery Plan, Alberta's effort is driven by creating conditions to become a producer and supplier of raw materials and mineral products, including battery minerals along the value chains, said Yihong Wang, director, Emerging Resources with Alberta Energy.

The province has favorable geology for many minerals including battery minerals such as lithium, vanadium as well as rare earth minerals, continued Wang. Most mineral resources in the province are under-explored and there is the belief that potential exists for almost all Canadian critical minerals.

With stakeholder engagement completed to inform the development of a modern minerals strategy, the Alberta government is planning to release the strategy in 2021. While the new strategy aims at various key areas to position Alberta towards becoming a new mineral producer and provider, work has already begun to increase its mineral public geoscience information and modernize its mineral regulatory and tenure frameworks to enhance competitiveness.

CANADA'S CRITICAL MINERAL LIST

Aluminum	Helium	Scandium
Antimony	Indium	Tantalum
Bismuth	Lithium	Tellurium
Cesium	Magnesium	Tin
Chromium	Manganese	Titanium
Cobalt	Molybdenum	Tungsten
Copper	Nickel	Uranium
Fluorspar	Niobium	Vanadium
Gallium	Platinum group metals	Zinc
Germanium	Potash	
Graphite	Rare earth elements	

Sizing up opportunity in the battery metals supply chain

There are a number of available forecasts estimating growth in the various stages of the supply chain. The World Economic Forum's Global Battery Alliance report: *A Vision for a Sustainable Battery Value Chain in 2030*, predicts demand for lithium-ion batteries will grow 14-fold by 2030, driven almost entirely by the electric mobility market. By 2030, passenger cars will account for the largest share (60%) of global battery demand, followed by the commercial vehicle segment with 23%. Energy storage will make up most of the remainder of demand, although the storage market is in its early stages and could rapidly increase along with growing renewable power generation.

Demand for raw materials like lithium, nickel and cobalt, driven by battery applications, will experience unprecedented growth in the coming years, the WEF report states. A little over half of today's lithium is mined for battery-related purposes. With steep increases in battery demand, lithium supply will need to grow by a factor of six from 2018 to 2030.

Major applications for nickel currently fall predominately outside the battery sector (e.g. stainless-steel fabrication) and require, to a large extent, class 2 nickel with low purity levels. The growing demand for batteries in EVs, will require high-purity class 1 nickel, increasing that need by a factor of 24 in 2030 compared to 2018 levels, putting the market under pressure in the next few years.

Cobalt's demand for use in batteries is expected to increase by a factor of four in 2030 versus today's levels (the doubling of overall global demand is predicted in 2030). Cobalt is almost exclusively a by-product commodity, obtained mostly from copper and nickel mines. While overall demand is increasing, the share of cobalt in future cell chemistries is continuously decreasing, causing less optimistic demand growth for this mineral, the WEF report states.

Demand for refining and processing raw minerals is also expected to grow, mirroring the trajectory for increased mineral production. The supply chain as a whole is expected to grow 14-fold to 2030 as more EVs are sold.

The battery components market is expected to expand 15-fold, with cell production growing 19-fold over the same

period, reports the WEF. Based on current investment levels, an additional $140 billion of funding until 2030 would be needed to meet demand.

An estimated 54% of end-of- life batteries are expected to be recycled in 2030, thereby contributing 7% to the overall demand for raw materials for battery production that year. This will require recycling capacities to be increased by a factor of more than 25 in 2030 compared to today, the WEF report states.

The growth in demand across the supply chain has the potential to create annual revenues of $300 billion in 2030--an eight -old increase from today. The largest global revenue pool, at 45%, is in cell manufacturing followed by refining operations at 24%. Revenues from recycling and repurposing operations will only account for 4% of global revenues in the base case but are expected to grow exponentially beyond.

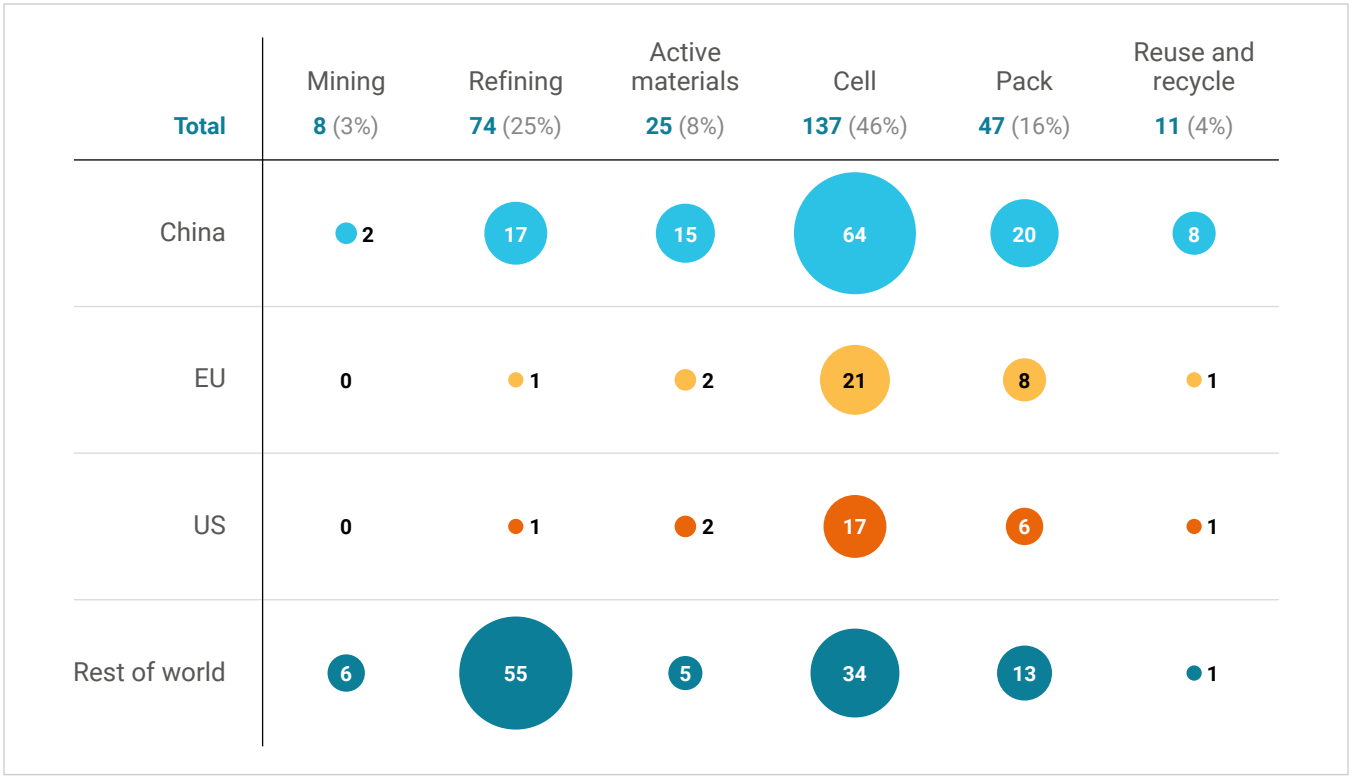
Canada is well positioned to capture a share of this market expansion. According to a ranking from Bloomberg, Canada is ranked fourth in the world in terms of having the elements needed to build a complete "lithium-ion battery supply chain."

It has abundant raw materials, a strong environmental and regulatory framework, and is viewed as a reliable global trading partner. It also has a well-established cleantech industry featuring an advanced innovation and R&D ecosystem, skilled workforce, and a low-carbon, renewable power grid to power the production of batteries.

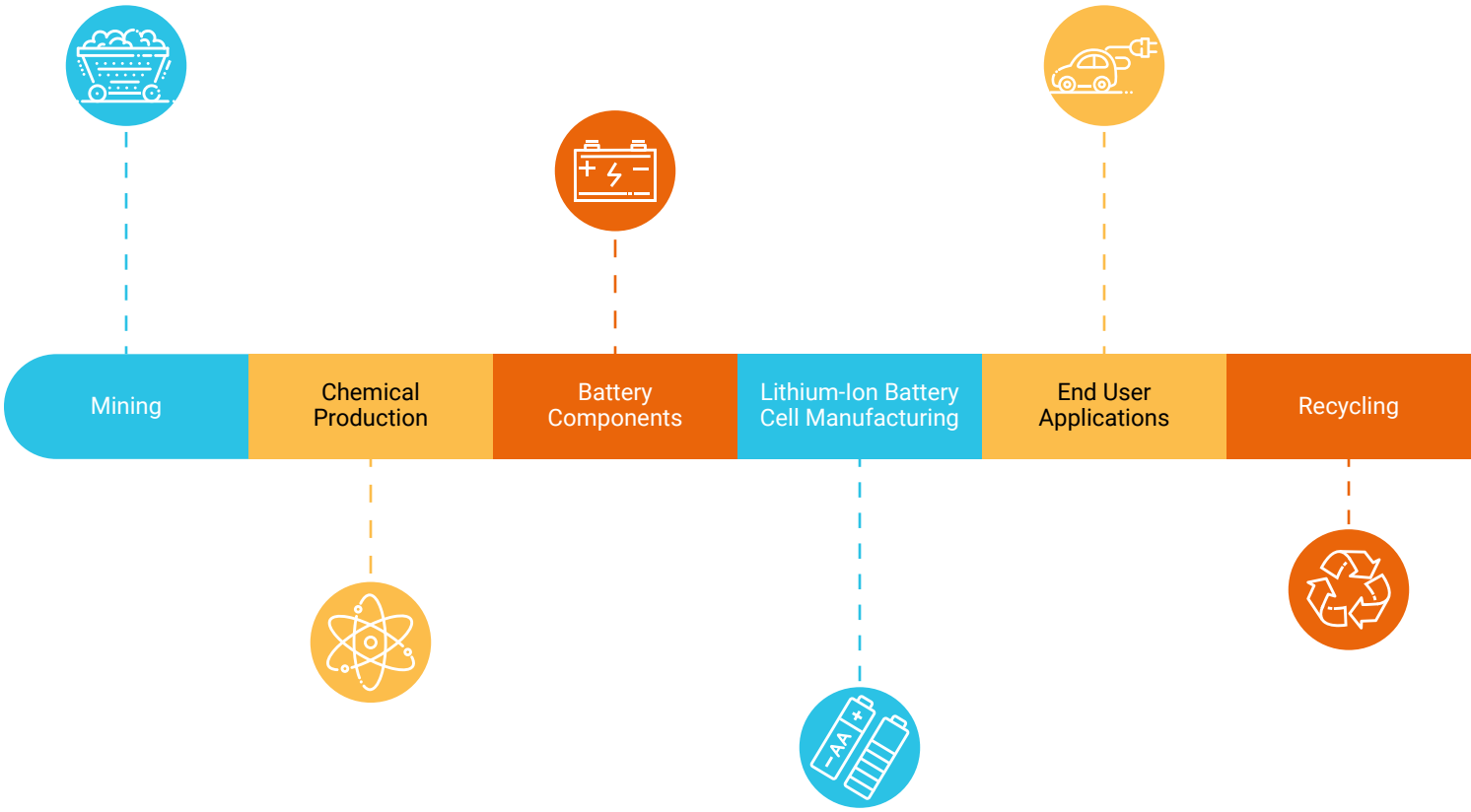
Canada is also a leader in research and innovation applied to waste by-products, such as the reuse of metals in old batteries and the repurposing of produced non-potable water from the oil and gas sector.

Lithium-ion battery value chain provides revenue opportunities of $300 billion by 2030

Revenues, base case 2030, $ billion



Note: Calculated based on demand from mobility, energy storage and consumer electronics applications as well as battery pack prices for 2030 (not including lead-acid batteries)
Source: World Economic Forum, Global Battery Alliance, McKinsey analysis



Breaking down the battery supply chain

BMAC's battery metals supply chain model divides the supply chain into six major components:

- Mining
- Chemical Production
- Battery Components
- Battery Cell Manufacturing
- End User Applications
- Recycling

Developing a thriving industry not only depends on the growth of the individual parts of the value chain - but also on building connections between those individual parts. Building connections across this sector is equally as important as the support of government, the financial sector and institutions engaged in R&D help to enable this growth.

The workshop attendees were challenged to identify key barriers within the six major areas of the supply chain and to identify solution pathways to move forward.

Mining

Raw materials used for batteries differ depending on the battery chemical composition. However, there are five battery minerals that are considered critical for Lithium-ion batteries: cobalt, graphite, lithium, manganese and nickel. Demand for all five of these minerals is expected to grow rapidly as EV and renewable energy applications grow.

As a supplier, Canada ranks fourth in the world for cobalt, third for nickel and third for graphite. Critical minerals are found across the country. Exploration for lithium is occurring in many provinces as demand increases. Exploration for rare earth minerals, also important to battery manufacturing, is also increasing.

The workshop attendees identified the following barriers and solution pathways to increasing critical battery metal mining output in Canada:

BARRIERS	SOLUTION PATHWAYS
Long lead-times from exploration to production: It can take as long as 15 years to go from exploration to production, vastly hindering Canada's potential to rapidly capture market share. If companies wait for deficits to emerge before committing to new projects, this could lead to a prolonged period of market tightness and price volatility.	• Streamline project approval processes to reduce timelines from exploration to production while also protecting the environment and local stakeholders
Remote resources mean higher costs: The cost of exploration is 2-6 times higher off grid, it is 2-6 times more expensive to build a mine off grid, and operational costs are 60% more expensive off grid.	• Invest in power and transportation infrastructure remotely to lower mining costs • Leverage other parallel energy decarbonization efforts to support remote operations. (eg. Canadian Small Modular Reactor (SMR) initiative) • Promote decentralized energy solutions (microgrids)
Access to capital across development phases: Retail and Canadian investors currently fund junior-mining companies. Industry needs a wider reach of investors to fund early-stage developments.	• Provide incentives to invest in early-stage exploration as well as support for academic research to de-risk and define resource potential • Once a mine nears production, implement a made-in-Canada pricing system that partitions a portion of supply for domestic use at competitive prices through subsidy to help limit long term pricing risk • Provide government incentives including lower royalties, tax credits or lower taxes to encourage investment

BARRIERS	SOLUTION PATHWAYS
Need for new discoveries: Lack of exploration means Canada is working down already discovered resources and reserves. It was suggested that nickel/cobalt end-of life is only 12 years away. High geographic concentration of production and declining resource grade, especially with copper, is also of major concern.	• Tax or direct grant incentives for explorers • Increase government spending on exploration for battery minerals that are not currently produced
Unproven alternative mineral sources: Some extraction and processing methods for hard rock and subsurface lithium brine development are yet to be proven and scaled.	• Increase R&D spending on alternative mineral extraction like new hard rock technology direct lithium extraction (DLE) from brines • Earmark research funding for exploration data to further de-risk early/new resource initiatives
Regulatory Issues: Federal The new federal project approval affects everything—new mines, downstream investments, as well as Indigenous and gender equity. This framework does not exist in other jurisdictions and is something that sets Canada apart; however, the framework can also impact Canada's ability to compete at a global level when it comes to cost and development timelines. **Regulatory Issues: Provincial** Some provincial regulations are antiquated and cumbersome, having been developed for other resources. Other much-needed provincial regulations have not yet been drafted or enacted, which also slows development.	• Set companies up for success, providing support to meet regulatory requirements (eg. education, regulatory concierge, funding support) • Promote the Canadian mining brand • Address regulatory issues and antiquated mineral claim work requirements slowing production and adding costs to level the playing field with other mining countries
ESG standards: There are many ESG risks in mining. There is also a political aspect when dealing with local communities and ESG. Costs are increasing incrementally, especially as companies develop lower-grade ores which requires more energy. This exerts upward pressure on production costs, greenhouse gas emissions and waste volumes that all must be handled appropriately within an ESG framework.	• Develop a standardized assessment framework for ESG in mining • Develop a marketing program to make ESG a competitive advantage for Canadian mining so developers can fetch higher prices for sustainably produced raw materials

Chemical Production

Processing and refining battery metals occurs between the mining and manufacturing steps in the supply chain. It involves a number of processes depending upon the original mineral. In hard rock production, these include crushing and smelting the mined material to separate valuable metals. Novel brine deposits from oil and gas provinces utilize new technology to concentrate and selectively extract lithium for use as a battery grade product.

Demand for raw material processing is expected to increase 14 times by 2030 (BNEF 2020) with China currently dominating the market. In 2019, China processed 65% of the world's nickel, 82% of the world's cobalt, 93% of global manganese supply, 59% of the world's lithium and nearly all global graphite supply.

Canada ranks among the top countries outside of China for refined nickel production and is working to increase its capacity for cobalt, graphite, lithium and other rare earth element processing with plants in the planning stage across the country. These facilities will be able to directly supply cathode and anode manufacturers as the next value-added stage of the battery supply chain.

The workshop attendees identified the following barriers and solution pathways to increasing battery metal processing output in Canada:

BARRIERS	SOLUTION PATHWAYS
Lack of conversion to battery-grade: There is a lack of capacity for refining and processing existing production of nickel and cobalt to battery specifications. There is no capacity for potential lithium and other battery minerals.	• Incentives to change the mindset of exporting raw commodities should be put in place, including direct government investment to build out chemical production capacity
High capital costs: Facilities can cost as much as $2 billion, requiring significant investment.	• Apply a phased approach with intermediary steps to facilitate early requirements before building to scale (eg. support academic labs and piloting facilities in expanding their battery chemical testing and processing facilities)
Lack of product specifications: Need more market intelligence to understand product specification of customers building battery components and battery cells.	• Work with, or partner with domestic component and cell manufacturers to target chemical production to specifications. Apply learnings to target international markets
Long project timeframes: Building new refining and processing capacity can take years and like new mines, must go through the federal impact assessment process.	• Streamline project approval processes
Logistics: Remote locations of mines mean facilities are a long-distance from markets and require high-cost off grid power. Processing locations closer to end use markets requires shipping over long-distances.	• Promote/provide incentives for domestic or on-site processing capacity to reduce transportation costs

Battery Components

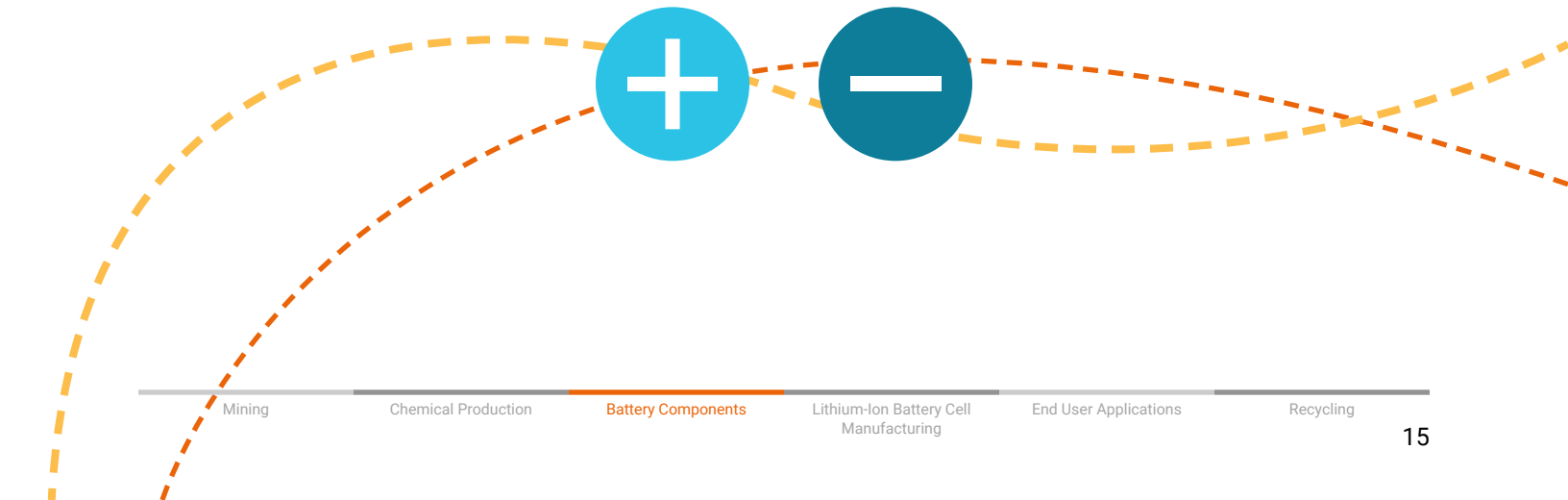
Conventional battery design comprises four primary components: two electrodes (anode and cathode), a separator, and an electrolyte to transfer charge between the electrodes. By 2030, demand for these components is expected to increase 15-fold from the current rate of production (BNEF 2020).

Anodes, primarily composed of graphite, are manufactured in five countries including China, Japan, the United States, the Republic of Korea, and India. Cathodes have developed a range of chemistries for various applications, yet most include a significant portion of nickel and cobalt in high energy density lithium-ion batteries in electric vehicles. These account for up to 55% of the total cost of EV batteries which in turn represents the most costly step in current EV designs. Electrolyte and separator production has trended with anode and cathode production, with over 90% of this overall manufacturing capacity controlled by China.

Despite the global manufacturing capacity concentration, Canada is well positioned to produce battery components as many global markets look to end reliance on Asian manufacturing.

The workshop attendees identified the following barriers and solution pathways to increasing component manufacturing in Canada:

BARRIERS	SOLUTION PATHWAYS
Global competition: Market dominated by Asia and EU. Need manufacturing in North America.	• Attract domestic battery manufacturing through strategic partnerships and government support
Market Intelligence: Different battery designs used by end users should be addressed.	• An immediate focus on upstream and chemical production would ensure spec product is available for a variety of battery components and battery designs • Create and align on a national strategy outlining anticipated timelines for different battery types. If this can be agreed upon to some degree, then a portion of supply can be allocated to this specific end use



Lithium-Ion Cell Manufacturing

Lithium-ion cell manufacturing has emerged in three primary hubs including Asia, Europe and North America. Asia currently dominates this space with nearly 80% of the global manufacturing capacity. Europe has made significant advancements in recent years with 12% of capacity followed by North America with 8%. In Europe, large facilities in Germany and France capable of producing 1 million batteries annually are planned and supported by government and private funding.

As an emerging competitor, Canada has made recent advances in cell manufacturing. Canadian company Lion Electric, a manufacturer of all-electric trucks and buses, is currently building a $185 million battery manufacturing plant and innovation center in Quebec with a planned yearly production capacity of 5 gigawatt-hours in battery storage. This will allow the electrification of approximately 14,000 medium and heavy-duty vehicles annually.

The workshop attendees identified the following barriers and solution pathways to increasing cell manufacturing in Canada:

BARRIERS	SOLUTION PATHWAYS
High entry costs: Cost to build Giga-factories is in the billions.	• Use incentives to bring in a big player. Benefits will filter down to the rest of the supply chain • Tax IP exclusivity use in Canada • A national stockpile subsidized and accessible at discount prices in Canada may entice majors
Specialization: With end users like auto manufacturers creating their own unique batteries, it is challenging to anticipate and then meet specific demands.	• Leverage government support to engage with end users to see where Canadian batteries can fit in their procurement strategies
Scale: Canadian market not large enough to drive battery cell manufacturing.	• Focus domestically first, then grow and export excess capacity
Market development: Need to work with multinational end users (focus on US first) to develop market for Canadian battery cell supply.	• Focus on being a low cost, politically stable, socially responsible and environmentally friendly supplier

> Manufacturing infrastructure is hard to pick up and move. Once it's built, it becomes a long-term advantage for Canada.

End Users

By 2030, BNEF predicts almost 30% of new vehicle sales will be electric, that number doubling by 2040. Canada's history in automotive manufacturing positions the country well in building out a "mines to mobility" supply chain. GM, Ford Motors and Fiat Chrysler have all committed to building EVs in Canada, with the sum of their announced investments totaling $5.75 billion.

It also has a number of domestic EV manufacturers, including: New Flyer, NovaBus (Volvo), Lion Electric Company, GreenPower Motor Company, Grande West and BYD all currently making zero-emission buses in Canada. B.C.-based Electra Meccanica designs and builds single-person electric cars.

Canada also has a rapidly developing renewable energy sector that requires battery storage backup. This creates another opportunity for end-use expansion.

The workshop attendees identified the following barriers and solution pathways to increasing battery usage in Canada:

BARRIERS	SOLUTION PATHWAYS
Small domestic market: Domestic market is limited for building out end-use applications at scale.	• Start domestically and build out specific end use applications before entering export market
Global competition: Automotive market is global with global supply chains tied to regions with lowest production costs.	• Geopolitical factors may give Canada the edge if a North American hub is developed • Work to lower production costs while leveraging ESG performance to market Canada as value-added manufacturing hub
Low profitability: Automotive and utility markets have thin profit margins.	• A phased approach which uses the high margins of one end of the supply chain to fund the development and support competitiveness at the other end • Horizontally integrate within the supply chain in low margin segments to lower costs
Procurement processes: Automotive industry has its own procurement processes in place and the Canadian supply chain has to fit within those processes.	• Work with existing partners in the automotive sector to fit into their global supply chains
Changing battery chemistry: End users focused on improving the utility of batteries by adjusting or changing battery chemistry to meet consumer demand. Risk of investing in wrong battery technology.	• Continue to study and research changing battery chemistries and designs to remain viable in market • Focus efforts on producing flexible chemical products upstream • Align with a national strategy in the medium term to satisfy the anticipated battery types and their application timelines

Recycling

Battery recycling will play a key role in ensuring the sector can meet future growth expectations, along with answering environmental concerns about what happens at end of battery life.

The European Union's Green Deal will require EVs and industrial batteries sold in Europe to disclose their carbon footprint, comply with a CO2 emissions limit, disclose their content of recycled raw materials, and later use a minimum share of recycled cobalt, lithium, nickel and lead. It is very likely similar expectations will be put in place in North America and other regions.

Canada has numerous companies in the recycling market including: Lithion Recycling, Retriev Technologies, American Manganese and Li-cycle. Li-cycle is ramping up to build the largest lithium-ion battery recycling plant in North America with a network of hubs to increase capacity to serve North American, European and Asian markets.

The workshop attendees identified the following barriers and solution pathways to increasing battery recycling in Canada:

BARRIERS	SOLUTION PATHWAYS
Technology: Currently there is no technology to recycle all battery parts, although there are efforts underway for closed loop recycling.	• Government support and incentives for R&D in recycling • Set technology IP terms to strategically limit for domestic use only, thus forcing majors to locate domestically and use Canadian tech to recycle their feedstocks
Costs: Cost of recycling is higher than new production.	• Mandate minimum amounts of recycled content in batteries
Scaling: Low numbers of batteries currently at end of life due to stage of development. Challenging to get to scale with limited feedstock.	• Ensure Canadian EVs are recycled in Canada • Develop with a phased approach
Logistics: Batteries spread across geography need to be brought to centralized recycling location. Transportation concerns with shipping batteries.	• Build out a network of battery storage hubs in connection with traditional scrap yards to collect larger amounts of material for safe shipping
End products: Need to create end products that fit into supply chain and move end products from recycling back into supply chain.	• Mandate design with recycling in mind to ensure efficiencies are captured

> Once resources are exported, they are gone, with no opportunity to recycle them in a circular economy.

Macro challenges and solution pathways

BMAC asked leaders across the battery metals value chain to identify the broad-based challenges facing development in Canada, with the subsequent goal of identifying solution pathways to move forward successfully.

BMAC also sought advice on where the battery sector needs to put its focus to drive the rapid development that is so urgently needed.

CANADA COULD BE LEFT BEHIND

There was general consensus that Canada has a tremendous opportunity to build out its battery metals supply chain, but is also competing against other advanced markets. Many attendees said while this is a challenge, it is also an opportunity. The US, like Canada, also lags behind. By integrating our efforts with those of our neighbours, a North American hub similar to those in Asia and Europe could be developed.

Efforts are already under way to formalize an US/Canada critical minerals strategy, which should be applied across the entire chain. A North American battery metals strategy could be developed to first meet domestic demand and in time, compete against other global centers of battery production.

By partnering with the US, the Canadian battery metals sector would also gain the economy of scale needed to grow existing companies from the start-up phase. This addresses a concern among some attendees that the Canadian domestic market was too small to support a mining to mobility supply chain.

GEOPOLITICAL CONSIDERATIONS

The idea of building a North American supply chain was closely linked to concerns about geopolitics. Attendees pointed out many countries including China see the battery supply chain as strategically important and are tying up mineral supplies and subsidizing manufacturing to gain advantage. A North American strategy would ensure access to key battery minerals to enable the sector in both Canada and the US to develop further downstream.

A broader partnership across North America would also ensure Canadian end-use battery suppliers would have access to a large enough market to compete globally.

REGULATORY CHALLENGES

Many attendees said there were a number of opportunities to create regulatory incentives, and better streamline existing regulations (environmental, projects approvals), to enable Canada to rapidly advance the battery metals supply chain and compete globally.

High labour costs, energy costs, project development costs and transportation costs are challenges. Tax incentives could better reflect the growing importance of battery metals or a national drive to expand this sector, as well as attract investment.

A NEED FOR POLICY

Many attendees highlighted the necessity of a national battery metals policy to align regulations and incentives to encourage development of the supply chain.

There was general consensus industry needs to work with governments to remove or reduce regulatory hurdles and streamline the approval process to accelerate development times and lower project costs. An important part of this effort is to encourage government to build out strategic infrastructure to support prospective projects and regions while lowering energy and transportation costs. Attendees also said governments need to provide more support to educate and train workers for jobs in the battery sector and provide incentives to invest in productivity enhancing technologies.

The path ahead

Industry leaders from across the supply chain were asked to identify key steps needed to move the Canadian battery metals sector forward towards capturing its share of the global market.

RECOMMENDED FOCUS - A NATIONAL BATTERY INDUSTRIAL POLICY

Given the number and scale of challenges facing the entire Canadian supply chain in a developing battery industry, and the variety of potential solution pathways available, there is a need for an over-arching framework to enable success.

Governments have a key role in developing research and development goals, enabling collaboration, and providing financial incentives to ensure success.

There is a need for a national battery metals industrial policy encompassing all these factors, said a number of industry leaders.

They added this not free market competition, but that other countries, even entire regions are competing to own battery supply chains, while individual Canadian companies cannot compete successfully on their own.

Lessons learned from the COVID-19 pandemic were also recognized: Canada cannot rely on other countries to meet its demand for critical goods. There is a need to develop domestic or North American focused regional supply chains that are resilient in times of crisis.

RESEARCH & DEVELOPMENT PRIORITIES

- Greater engagement with academia to leverage its experience and resources
- More testing facilities to move innovation to commercialization across the supply chain and verify product grades to customers
- Greater cross-border collaboration on research and development where needs align
- More leadership from end users to direct R&D and specify/standardize their needs
- Increased research on novel materials to improve battery effectiveness and careful strategic use of IP terms to attract multinational firms to work in Canada
- Leveraging of other decarbonization efforts and integrate national infrastructure spending to support robust access to more remote projects and reduce mining costs

FINANCIAL INCENTIVES PRIORITIES

- Increased tax incentives. Most effective tax incentives in Canada are natural resource extraction related, such as the accelerated capital cost allowance. These could be extended to alternative extraction methods, processing and manufacturing to make the sector more effective
- Lowering investor risk is the highest priority. De-risk investment through thoughtful policy reform and commodity pricing stability assurance for medium to long timeline projects like mines and manufacturing facilities

FINANCIAL INCENTIVES PRIORITIES

- Earmark support for academic research in the acquisition of valuable data informing resource understanding, lowering data scarcity risk
- Matching funds or loan guarantees for higher-risk investments
- Target early development stage incentives, with a higher rate of tax after production has started, to claw back incentives with clear timelines set
- Ensure royalties are competitive as they come off the top line of revenues
- Royalty revenues could be re-directed or "invested" back into development of subsequent stages of the supply chain providing positive feedback. This may provide proponents and producers a higher tolerance for paying such royalties if they can see closely peripheral benefits
- Mineral industry needs incentives tied to price to expand. Without stable, long-term pricing mining will be slow to bring on new supply, impacting the rest of the supply chain
- Tax and IP policies have to incentivize people to come to Canada rather than competitors elsewhere

SEQUENCING OF SUPPLY CHAIN DEVELOPMENT

The question arose if whether a simultaneous effort across the supply chain would prove advantageous, or if certain segments should be prioritized in a sequence for R&D, investment, and government policy to help build out the supply chain in a phased approach.

There was no clear consensus on where to start, but there were signals many believed the raw materials sector was best positioned for future growth, so focus should go elsewhere. It was stated that the upstream market would grow on its own in response to market demand, especially with the right incentives and regulatory programs in place.

A focus on the middle of the supply chain was preferable to many attendees. The manufacture of chemicals and components is believed to have strong potential, especially with the need for the development of specialty chemicals and not just raw materials. A national standard to manage quality requirements would provide buyers and suppliers with added confidence to choose Canadian products on the global stage.

While battery manufacturing was identified as a key area missing in Canada's supply chain, attendees believed it should not yet be the focus of initial development. A major theme was to start with chemical production and battery components, then focus on cell manufacturing.

A minority said the focus of efforts should be on end user applications to pull the other segments of the supply chain along. This perspective was tied closely with the belief Canada needs to build its own domestic market and then focus on exports. Canada has a strong auto-manufacturing sector to build upon; however, questions were raised about the additional resources required to support zero emissions vehicles.

> Canada needs to leverage its strengths towards developing value-added production domestically. There is no problem finding export markets for raw materials. This is what other countries want Canada to do.

VALUE-ADDED BENEFITS FROM A BATTERY MARKET

If Canada can find the right policy, innovation, and investment mix to successfully develop its supply chain, battery production could have other value-added benefits driving future economic growth.

Among the key value-added benefits identified:

- A unique opportunity to unite the country coast to coast as each region has a piece of the supply chain
- Support for Canada's brand as a clean, sustainable supplier
- Becoming a key supplier of battery minerals for other downstream products
- Future high-tech manufacturing—auto/electric suppliers can participate in clusters
- Knock-on effects from cleantech like space sector-splinter industries will emerge
- Post-secondary education improvements as universities become technology leaders, and development of intellectual property that can be retained in Canada.

> We need to continue advancing trade partnerships to compete against concentrated battery supply chains in Asia.

Conclusion

The global market for electric vehicles (EVs) is rapidly expanding.This demand push is expected to result in a $300 billion market for lithium-ion batteries by 2030.

Canada is well positioned to expand its presence in the battery metals market across all sectors of the supply chain. It has the critical mineral resources needed, a mature regulatory framework, and strong capital markets.

However, it faces a number of key challenges, including global competitors that are ahead in many supply chain sectors. The industry also needs a cohesive strategy to compete on costs and ESG performance.

A national industrial strategy is required to establish a vision for the battery metals sector – one that includes incentives to attract investment from mining to mobility, and funding to drive R&D to ensure the country becomes a technology leader in this sector.

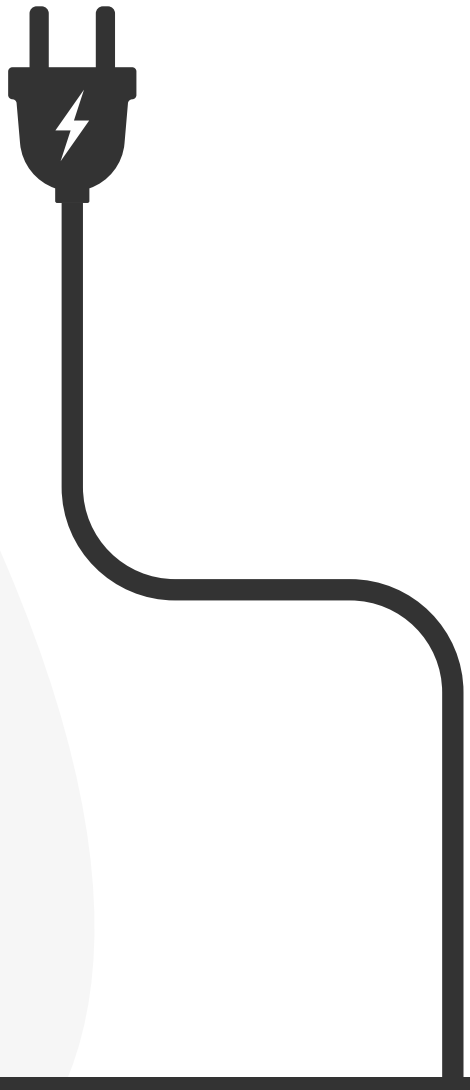
Building out the battery supply chain will provide additional benefits beyond direct investment and work opportunities. It can also position Canada as a leader in the cleantech and high-tech sectors and create spin-off industries with expanded economic potential.

BMAC has integrated the suggestions from experts and leaders in this industry to capture relevant Canadian challenges. Though many solutions were discussed, it is clear that the complexity of building a new supply chain will require further collaboration across the sector within Canada's rich ecosystem of innovation.

Drilling down into the specific needs of the industry will remain a core priority for BMAC, and will be further explored in a series of additional workshops and events.

Canada is on the cusp of a rare, once-in-a generation opportunity to develop its critical mineral industry and compete in this major new market with vast potential.

By acting swiftly, together, efficiently and responsibly – we believe Canada can realize the abundant opportunities before us. We hope this will resonate with you and encourage those interested in supporting the initiative by joining BMAC to continue advancing this effort.



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Association of Canada