# Enhancing Domestic Critical Mineral Supply Chains

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pwc

Canadian Chamber of Commerce

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# Executive summary

Critical minerals are the foundation of many high-growth industries that underpin the push for net zero emissions. They are essential inputs for electric vehicles, solar panels, wind turbines and many everyday products. Demand for critical minerals is expected to increase by 400% – 600% by 2040 and there is strong corporate and political momentum to build resilient North American supply chains in an effort to reduce dependence on countries that present greater sovereign risk and to bolster economic development.

Canada's deep expertise in mining and its manufacturing ingenuity, combined with plentiful resources, make it superbly positioned to expand its activity across critical mineral supply chains. There is potential to substantially increase the mining, production and processing of minerals to meet rising global demand. Canada can also build on its strength in raw materials and existing clusters to increase its manufacturing footprint in those sectors making use of critical minerals. However, to capitalize on this opportunity, Canada needs to act quickly and decisively to address barriers that are currently standing in the way.

This report has been commissioned by the Canadian Chamber of Commerce's Critical Minerals Council, which brings together over 20 members, including upstream and downstream corporations, academic institutions and Indigenous associations working in critical minerals.

In this report we highlight several areas of opportunity to expand Canada's critical mineral-related industries in the following supply chains: Electric Vehicles (EVs), wind turbines, solar panels, advanced materials and fertilizers. Secondly, supported by industry interviews, we have developed a set of policy recommendations to address barriers and accelerate growth of these industries in Canada.

The Council welcomes the recent release of the Canadian Critical Minerals Strategy and thanks the government of Canada for their leadership in this area. The recommendations contained in this report are strongly aligned with the five objectives set out in the federal strategy and it is the Council's hope that they make a positive contribution to future policy development.

## Areas of opportunity for Canada

The summary table below highlights the wide range of opportunities afforded by Canada's endowment of critical minerals. These areas offer potential for Canada to grow economic clusters, create well-paid jobs, enhance the resilience of strategic supply chains and support the transition to net zero.

### Summary of critical mineral-related growth opportunities

| Exploration, mineral production and processing | | Component manufacturing | End-use assembly | Recycling |
|---|---|---|---|---|
| • Aluminum<br>• Beryllium<br>• Cadmium<br>• Chromium<br>• Cobalt<br>• Copper<br>• Callium<br>• Craphite<br>• Gallium<br>• Germanium<br>• Indium<br>• Lithium | • Magnesium<br>• Manganese<br>• Nickel<br>• Niobium<br>• Potash<br>• Phosphate<br>• Rare Earth Elements<br>• Scandium<br>• Selenium<br>• Tellurium<br>• Titanium | • Electric Vehicle battery cells, modules and electric motors<br>• Solar panel components such as wafers and polysilicon<br>• Wind turbine permanent magnets, rotors, nascelles, generators, towers<br>• Potash fertilizer, ammonia, sulfuric acid, nitric acid<br>• Other automotive, aerospace and defense components | • Electric Vehicle manufacturing<br>• Wind farms and solar panel installation<br>• Aerospace manufacturing<br>• Potash-based fertilizers<br>• Phosphate-based fertilizers | • Electric Vehicles and batteries<br>• Solar panels<br>• Wind turbines<br>• Advanced materials |

## Policy recommendations to address barriers and accelerate growth

This report contains 14 recommendations for further development of critical mineral supply chains. These are grouped across four categories:

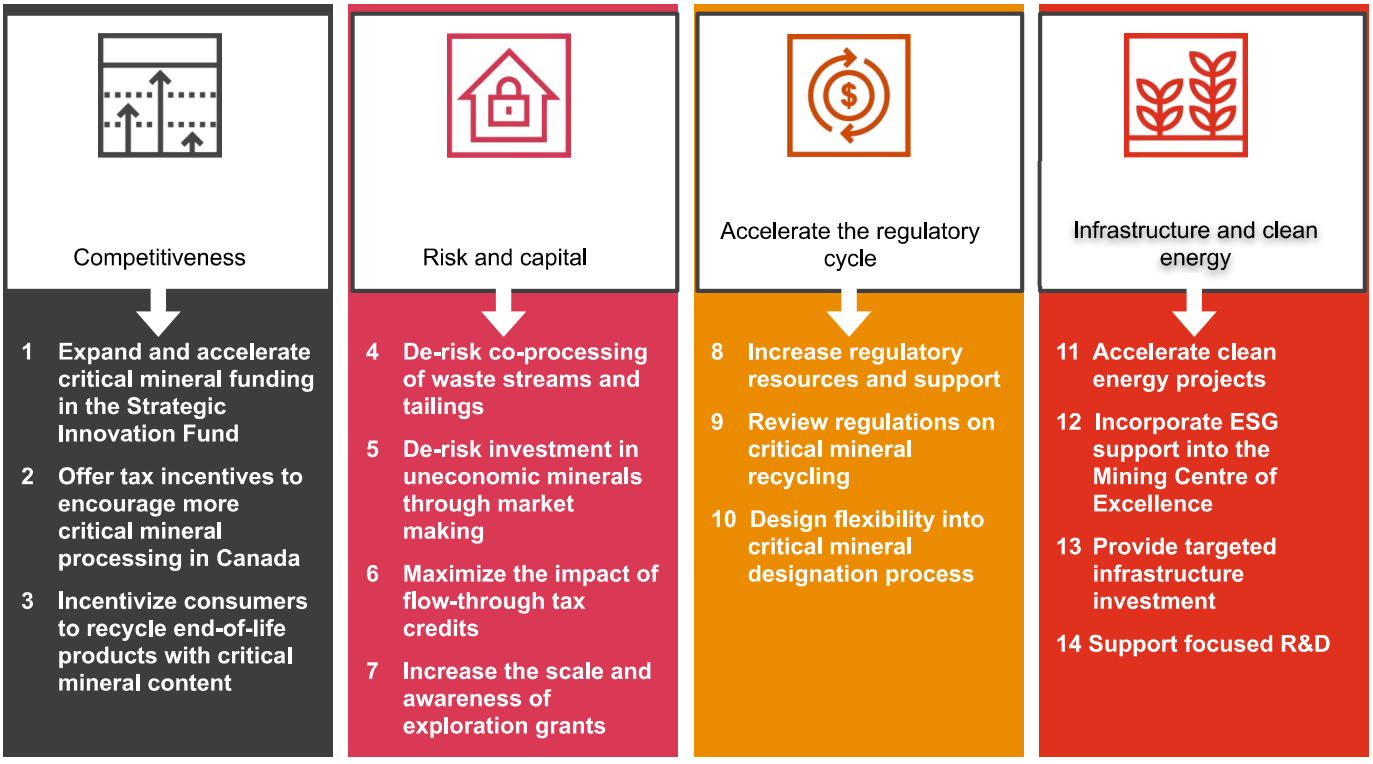
1. **Competitiveness:** Countries like China and the US have strong existing clusters within many critical mineral-based supply chains, in some cases, developed with the support of interventionist industrial policy. These recommendations focus on how Canada can improve its competitiveness to encourage investment.

2. **Risk and capital:** Several stages of these supply chains (e.g. mining) require extensive upfront capital spending and exhibit long delays and uncertainty over when positive cash flows will begin. Competing economies have been subsidizing the emergence of many of these sectors and these recommendations discuss the role the government can play in reducing risk.

3. **Accelerate the regulatory cycle:** Getting a new mine to production in Canada typically takes 10 to 15 years, whilst investments to extend the operational life of current mines is also at risk from permitting delays. Accelerating the regulatory cycle, whilst maintaining high standards and increasing the transparency of regulatory processes, would increase the attractiveness of critical mineral production in Canada.

4. **Infrastructure and clean energy:** Availability of infrastructure (road, rail, clean power, water, etc.) is an important driver of financial attractiveness and ESG performance of mining projects that are critical to investors. Government can play a role in developing infrastructure and encouraging the development and deployment of new technologies — in the areas of electricity, transportation, robotics, communication and energy — to improve these factors in resource-rich and remote locations.

## Overview of recommendations




The foundation for any growth in critical mineral supply chains in Canada is a commitment to reconciliation with Indigenous peoples. Actions that grow these segments of the economy must also be delivered in a way that:

- Supports economic reconciliation and opportunities for Indigenous communities;
- Protects Indigenous rights and supports the implementation of United Nations Declaration on the Rights of Indigenous Peoples; and
- Includes meaningful and early engagement of Indigenous governments and organizations from project conception to development and oversight.

# 1 Introduction and overview of the supply chains

Global demand for critical minerals is increasing rapidly. They are the foundations of many high-growth industries that underpin the push for net zero emissions, including EV batteries, permanent magnets, solar panels and wind turbines, as well as advanced manufacturing applications, including defense and security technologies, semiconductors and consumer electronics, and critical infrastructure[1].

The International Energy Agency (an intergovernmental organization that provides policy recommendations and analysis on the global energy industry) estimates that to meet sustainability targets the global demand for critical minerals will increase by between 400% and 600% by 2040[2]. Minimizing the harmful effects of the climate crisis requires a huge effort to increase the supply of these minerals and grow the industries that harness them. The scale of change is a paradigm shift not unlike the ICT revolution in the 1990s/2000s and the industrial revolution.

Canada's deep expertise in mining and its manufacturing ingenuity, combined with plentiful resources, make it superbly positioned to lead in this sector across different parts of the supply chain. The Minister for Natural Resources has rightly described this as a "generational opportunity" and the Government of Canada has earmarked $3.8bn in the recent federal budget to implement a new critical minerals strategy, which will support existing efforts by provinces and territories.

However, achieving a leadership position is not easy and Canada is currently behind the curve in many aspects of critical mineral supply chains. Both China and the US already have highly competitive clusters in many critical mineral-based industries and they are aggressively pursuing further growth to deliver strategic resilience and unlock economic opportunities.

This report has been commissioned by the Canadian Chamber of Commerce and aims to contribute to the public discourse on enhancing growth in specific supply chains: Electric Vehicles, wind turbines and solar panels, advanced materials and fertilizers. Creating these supply chains in Canada is not only an economic opportunity, it is also imperative for the resilience of Canada's strategic supply chains and its energy independence.

We have approached this question by:

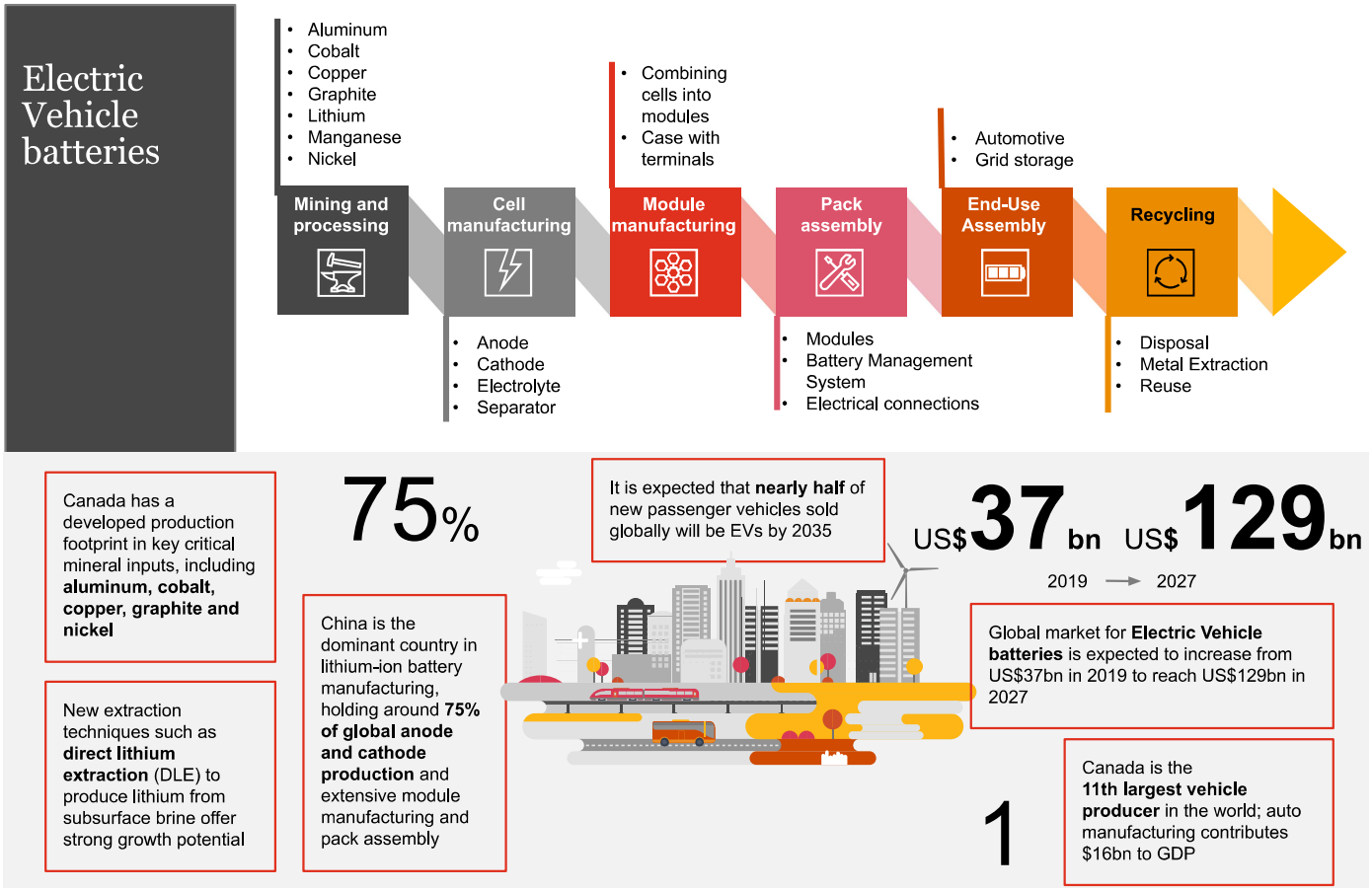
- first, assessing the current opportunities in key Critical Mineral supply Chains;
- second, through interviews with leading members of the Chamber's Critical Mineral's Council and our own research, we have identified a list of key barriers that businesses face when developing these supply chains in Canada; and
- third, by compiling a list of policy options that the government should consider implementing in order to facilitate the establishment of world class critical mineral-based supply chains.

(1) See appendix A for a full list of critical minerals.
(2) IEA "The Role of Critical Minerals in Clean Energy Transitions".

# Electric Vehicles

Electric Vehicles (EVs) require a far greater quantity and breadth of critical minerals than conventional Internal Combustion Engine (ICE) vehicles. According to the International Energy Authority, around 200 kg of critical minerals (including lithium, nickel, cobalt, graphite, Rare Earth Elements (REE), copper and manganese) are required to produce a typical EV, compared to around 30 kg in a traditional ICE vehicle[3]. The EV supply chain in Canada has received a great deal of attention given Canada's significant automotive assembly cluster and the importance of EVs to net zero plans. We highlight the key stages of the EV battery supply chain below, but critical minerals are also essential in other EV components such as electric motors and electronics.

## Overview of EV battery supply chain




*Sources: Canadian Vehicle Manufacturers' Association, US Geological Survey, International Energy Authority, IBISWorld, Allied Market Research.*

The growth potential for this market is substantial. It is expected that nearly half of new passenger vehicles sold globally will be EVs by 2035[4] and that the global market for Electric Vehicle batteries will increase more than threefold between 2019 and 2027[5]. This creates opportunities for Canada across the supply chain, for example:

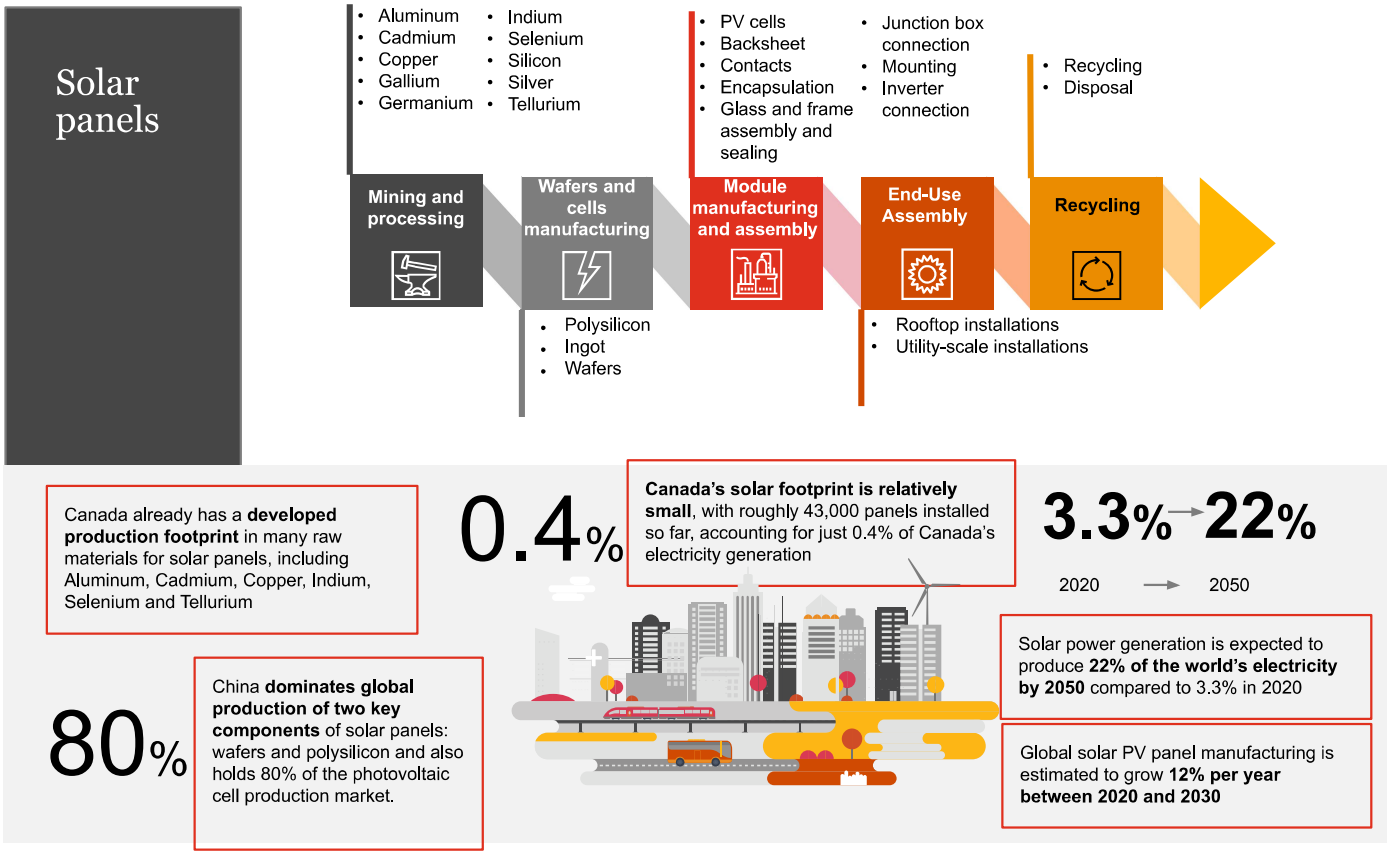
- Through increased demand for mineral production and processing in lithium, nickel, cobalt, graphite, REEs, copper, aluminum and manganese. In the case of lithium, for example, Canada is making use of new technologies known as direct lithium extraction (DLE) in Alberta's oil fields to extract lithium from subsurface brine.
- Through the increase of the footprint of battery component manufacturing activities, many of which are currently dominated by China. The recent advent of the US Inflation Reduction Act (IRA) brings with it tax credits that encourage North American component sourcing, providing a strong incentive for component manufacturers to come to Canada or the US.
- With the rapid growth of Electric Vehicles, there will soon be a major increase in the supply of used vehicles, batteries and other components for recycling, thus creating an opportunity to foster a world-leading EV recycling industry in Canada.

(3) *ibid*, excludes aluminium which IEA does not include in the list critical minerals .
(4) Bloomberg New Energy Finance. Electric Vehicle Outlook 2021.
(5) Allied Market research (2020), Lithium-ion-battery-market.

# Solar panels

Solar panels require a large array of critical minerals to produce absorbent and conducting layers and module frames. Key mineral inputs for solar panels include aluminum, cadmium, copper, gallium, germanium, indium, selenium, tellurium and REE.

## Overview of solar panel supply chain




*Sources: US Geological Survey, International Energy Authority, International Trade Administration, Bloomberg New Energy Finance, Allied Market Research.*

Growing Canada's solar industry will be a major part of the net zero energy transition and will support energy independence. Solar power generation is expected to produce 22% of the world's electricity by 2050, compared to 3.3% in 2020[6]. Canada's current solar footprint is relatively small, with roughly 43,000 panels installed so far, accounting for just 0.4% of Canada's electricity generation[7].

The production of solar PV panels globally is expected to grow at around 12% per annum through the 2020s. This rapid growth provides a number of economic opportunities for Canada, such as:

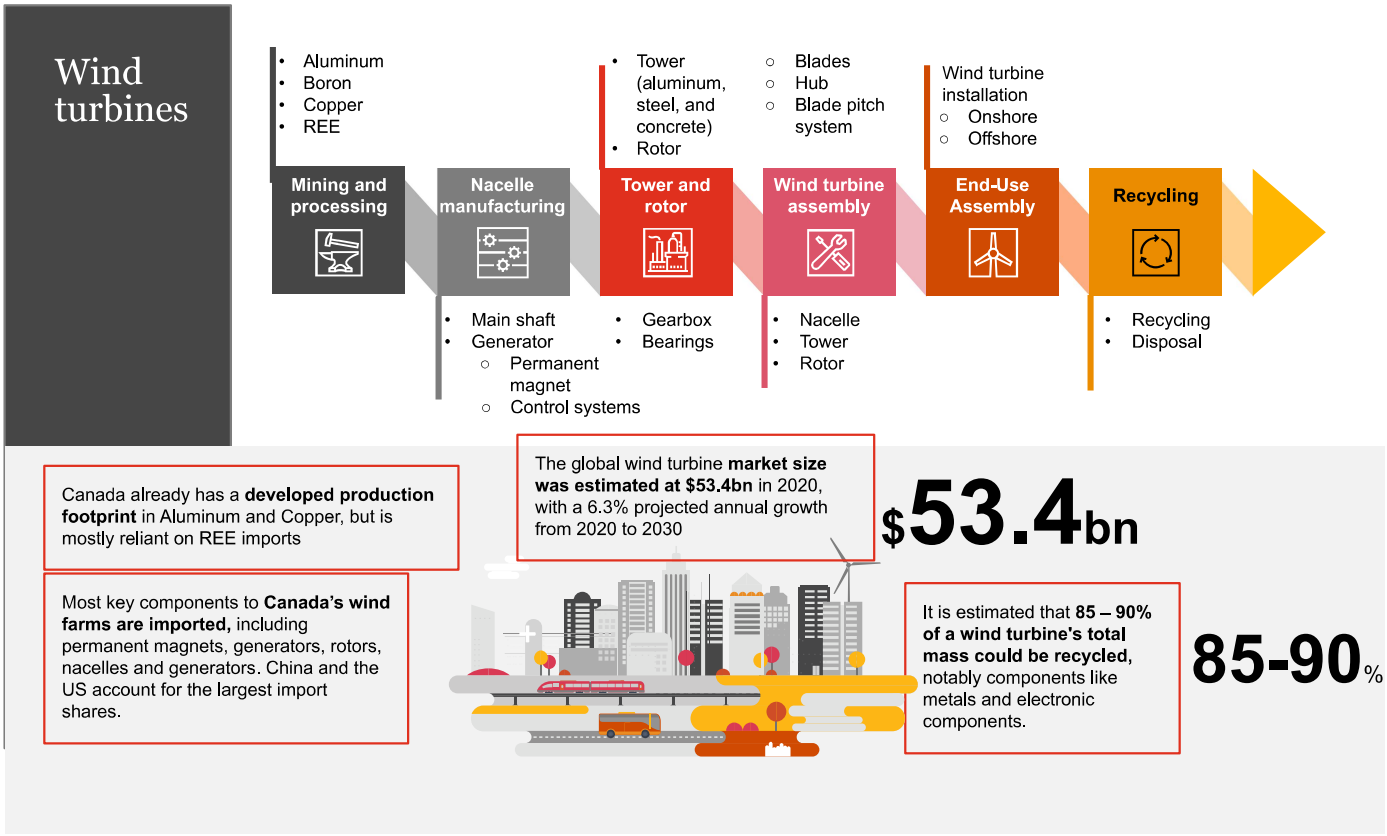
- Expanding mineral production and processing of key inputs to solar panels including copper, aluminum, REEs, cadmium, gallium, germanium, indium, selenium and tellurium.
- The potential to develop a larger solar panel component manufacturing footprint in Canada, a sector currently dominated by China, such as the production of wafers and cells.
- Enhancing the circular economy through a solar recycling industry, which, while relatively nascent in North America, will expand over time as more PV panels reach end-of-life.

(6) Bloomberg New Energy Finance, New Energy Outlook 2021.
(7) International Trade Administration (2020), Canada – Renewable Energy.

# Wind turbines

Wind turbines make use of critical minerals like copper, REE and aluminum. These are critical inputs to cables, electrical components, coils and permanent magnets. Wind energy is currently more widespread than solar, accounting for 5.3% of Canada's electricity generation[8]. It is expected to grow by around 6% per annum over the next ten years[9].

## Overview of wind turbine supply chain




*Sources: US Geological Survey, International Energy Authority, Statistics Canada, Allied Market Research, Mordor Intelligence, Canadian Renewable Energy Association.*

The growing use of wind turbines provides a number of economic opportunities for Canada, such as:

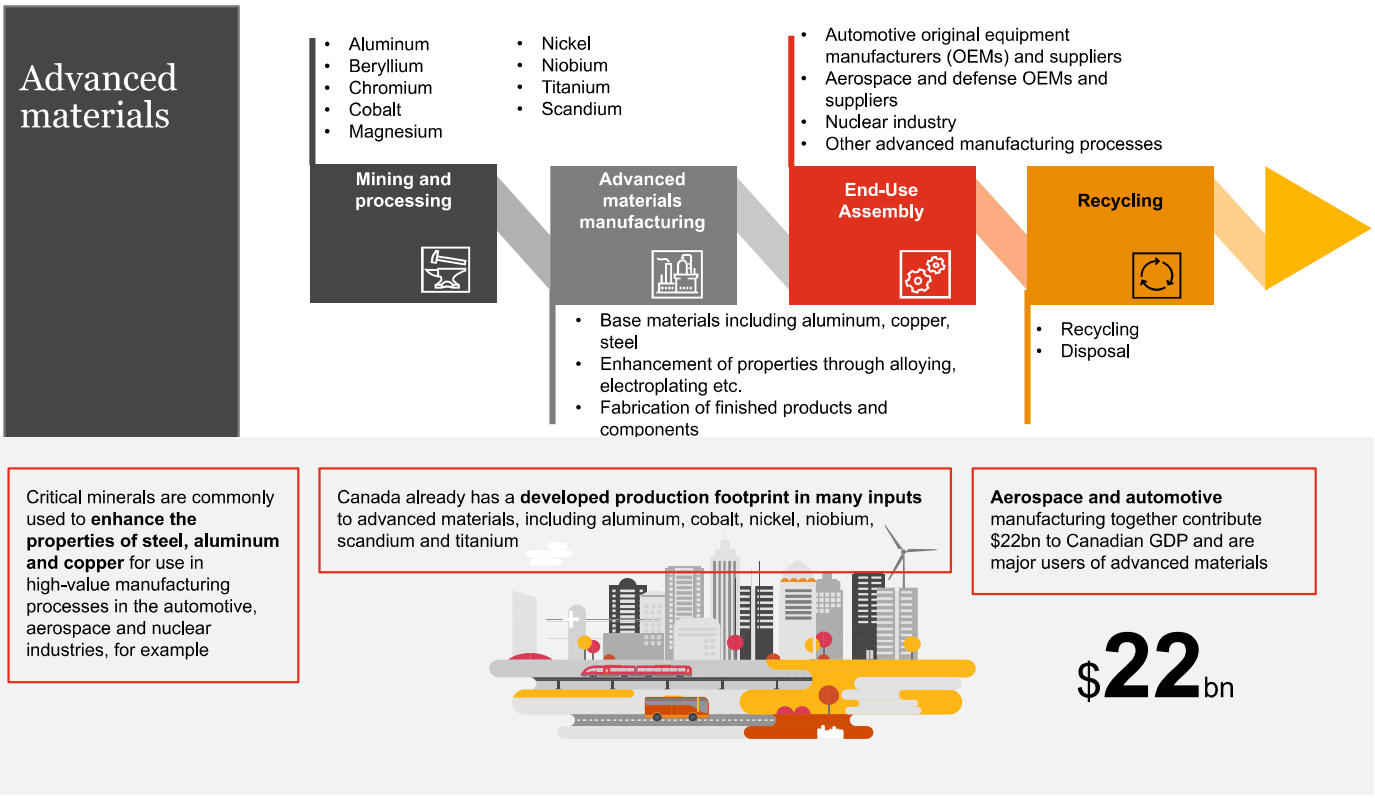
- Increasing demand for mineral production and processing in copper, aluminum and REE. There are also indirect impacts on mineral demand in the battery supply chain shown previously, as intermittent energy sources like wind and solar are commonly paired with energy storage facilities such as grid scale batteries.
- Increased need for final turbine assembly, which generally occurs on-site due to the size of turbines.
- Increased domestic component manufacturing. Canada already has some production of wind turbine towers and blades, but production of many other key components such as magnets, generators and nacelles (the cover that houses all the power-generating components of a wind turbine) are dominated by China.

(8) International Trade Administration (2020), Canada – Renewable Energy.
(9) Mordor Intelligence, Canada Wind Energy Market, Allied Market Research.

# Advanced materials

Critical minerals are commonly used to enhance the properties of metals (e.g. steel, aluminum) for use in high-tech manufacturing applications in sectors including automotive, aerospace and nuclear. The key critical minerals used in this supply chain include aluminum, beryllium, chromium, cobalt, magnesium, niobium, scandium and titanium. This process delivers performance advantages over unmodified materials (e.g. scandium can be added to aluminum to reduce weight, increase strength and help resist corrosion).

## Overview of advanced material and metal supply chain




*Sources: Canadian Vehicle Manufacturers' Association, Aerospace Industry Association of Canada, International Energy Authority, US Geological Survey.*

Canada already hosts major steel and aluminum and metalworking clusters and possesses strong end-use customers for these materials in the aerospace, automotive and nuclear industries, for example. Additional opportunities include:

- Increasing demand for mineral production and processing in aluminum, beryllium, chromium, cobalt, magnesium, nickel, niobium, titanium and scandium. There are also indirect impacts from further development in these industries to support the resilience and competitiveness of the automotive, aerospace and nuclear industries.

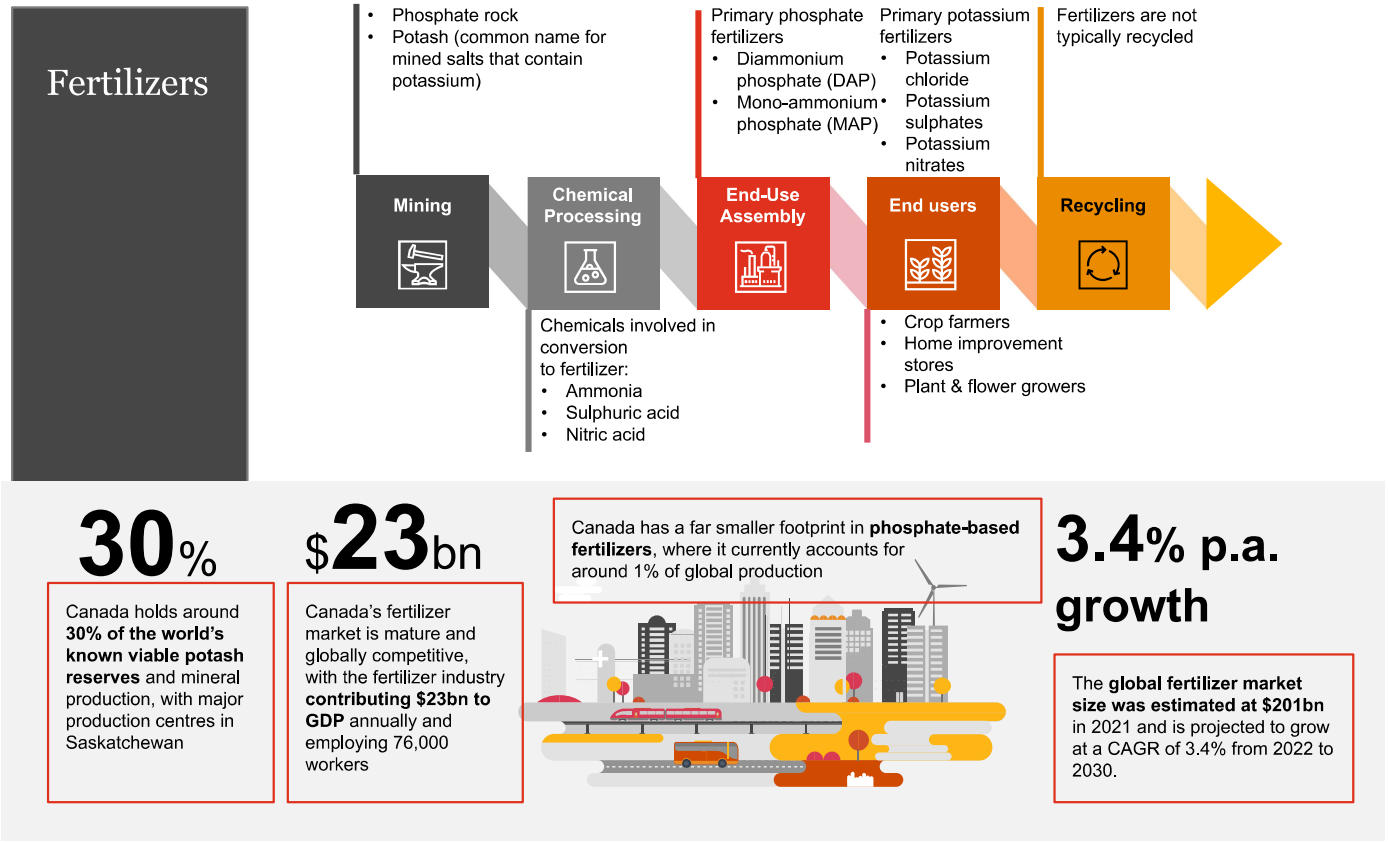
- Canada has significant production capacity in metalworking industries that use critical minerals to create advanced alloys. However, generally these industries have substantial net imports, which can signal opportunities for growth. For example[10], Canada had net imports of $4.5bn of iron and steel mill and ferro-alloy manufacturing products in 2021 (with 40% from the US and 5% from China) and net imports of $11.7bn in fabricated metal products (with 46% from the US and 25% from China)[11].

(10) Note that the trade data does not distinguish between metal products that have been combined with critical minerals and those that have not, so these figures will include both.
(11) Statistics Canada (2021), Naics 3311 – iron and steel mills and ferro-alloy manufacturing and Statistics Canada (2021), Naics 332 – fabricated metal product manufacturing.

# Fertilizers

Canada's potash-based fertilizer market is mature and globally competitive, with the fertilizer industry contributing $23bn to GDP annually and employing 76,000 workers[12]. Canada holds around 30% of the world's known viable potash reserves and mineral production, centred in Saskatchewan, and a developed supply chain for extraction, processing and distribution.

## Overview of fertilizer supply chain




*Sources: US Geological Survey, Statistics Canada, Fertilizer Canada, Precedence Research.*

The critical minerals potash and phosphate are major ingredients for key fertilizers used in agricultural production. The global fertilizer market size was estimated at US $201bn in 2021 and is projected to grow at a CAGR of 3.4% from 2022 to 2030[13]. Canada is a global leader in potash-based fertilizers, but it has a far smaller footprint in phosphate-based fertilizers, where it currently accounts for around 1% of global production.

Several growth opportunities exist:

- The demand for fertilizers is ever increasing, given population growth and rising demand for food. This creates opportunities to continue the growth of the potash supply chain. In addition, geopolitical factors are affecting this industry as sanctions and conflict have impacted potassium chloride exports from Russia and Belarus, which creates a further opportunity to support our allies in meeting their supply needs.
- Increasing exploration and mining of phosphates, which, subject to finding more economically viable reserves, can also offer opportunities for expansion. This may also provide an opportunity to leverage the existing expertise, labour market and infrastructure developed in the potash market.

(12) Government of Canada (2022), Government of Canada invests over $1.6 technology for high-efficiency fertilizers.
(13) Precedence Research, *Fertilizer Market Size to Worth Around US$ 271.6 Bn by 2030*, note that this also includes nitrogenous fertilizers which do not use critical minerals.

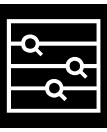
# 2 Growing critical mineral supply chains in Canada

As the previous section illustrates, the rapid growth in demand across a number of critical mineral-based industries presents a major opportunity for Canada. Government policy will play a role in realizing these opportunities and, in the section that follows, we present recommendations for enhancing growth.

## Policy recommendations: competitiveness

The current structure of global critical mineral supply chains is not purely the result of market forces. Recently, the US government has described them as "rife with political intervention and distortionary trade practices"[14]. For example, China prohibited foreign ownership and investment into many aspects of the REE supply chain while using VAT rebates to encourage growth of the domestic industry[15]. We continue to see governments take active interventionist measures in these supply chains for reasons of resiliency as well as economic development. In many countries, the extent of financial support for these interventions is rising. For example:

- The recent US "Inflation Reduction Act" and "CHIPS Act" both contain incentives to encourage domestic production.
- Australia offers a $2bn dedicated critical minerals loan facility and $1.3bn in Modern Manufacturing Initiative (MMI) grants. The latter has already dispersed grants to companies in critical mineral supply chains[16].



### Recommendation 1. Expand and accelerate critical mineral funding in the Strategic Innovation Fund (SIF)

The Federal Budget has recently allocated $1.5bn to critical mineral projects through the Strategic Innovation Fund, with prioritization given to manufacturing, processing and recycling applications. These funds are designed to be utilized over a six-year period commencing in 2024 – 25. This move is welcome and the Fund is already making a difference in critical mineral supply chains, for example, through supporting investments in the Electric Vehicle market.

Incentive programs like the SIF can offer good value for money to the government. For example, the SIF has facilitated around $10 of capital investment for every $1 spent on incentives[17]. Once companies are established, most will stay for a long period of time and generate ongoing economic activity and taxes. The impact of previously announced critical mineral SIF funding could be further enhanced by:

- **Accelerating the implementation period** ahead of 2024 – 25, or outlining terms for support as early as possible and well ahead of the implementation period.
- **Broadening the priorities for this funding** beyond manufacturing, processing and recycling applications to include mining, and also highlighting the availability of SIF funding to enhance and expand existing facilities (and not just greenfield investments).
- **Expanding the SIF available for critical minerals projects** to take advantage of the "generational opportunity" in many of these supply chains. Incentive packages for major projects can run into hundreds of millions of dollars. For example, a single incentive package from the SIF and Government of Ontario to support Ford's modernization of its plant in Oakville, Ontario was allocated $590m[18]. A larger funding envelope will be able to support more investments, including for major anchor companies, and signal Canada is open for business.

(14) The White House, 2021, Building Resilient Supply Chains, Revitalizing American Manufacturing And Fostering Broad-Based Growth, Page 152.
(15) *ibid*
(16) https://www.globalaustralia.gov.au/industries/critical-minerals
(17) ISED, as of December 2022 the SIF reported contributing $6.9bn to leverage $67bn in investment.
(18) https://www.investontario.ca/press-release/historic-ford-canada-investment-transforming-ontario-global-electric-vehicle-manufacturing-hub

## Recommendation 2. Offer tax incentives to encourage more critical mineral processing in Canada

It is desirable that critical minerals mined in Canada be also processed here where possible. As well as supporting economic development, doing so strengthens the ecosystem and encourages manufacturing activities further down the supply chain.

A targeted measure to support investment and expansion in critical mineral processing facilities could provide a major boost for this segment of the supply chain. This could take the form of an enhanced Investment Tax Credit for capital expenditures to expand, modernize and decarbonize existing processing facilities and encourage investment in new facilities. The federal government has recently employed targeted credits of this nature in other sectors. For example, the Investment Tax Credit for Carbon Capture, Utilization, and Storage introduced by the federal government to incentivize decarbonization in the energy sector and energy-intensive manufacturing.

## Recommendation 3. Incentivize consumers to recycle end-of-life products with critical mineral content

Recycling will become an increasingly important source of critical minerals, and supporting the circular economy will help to minimize the environmental impacts of resource extraction. Given the typical lifespan of products using critical minerals (e.g. Electric Vehicles, solar panels) is 10-30 years, there will be a significant lag before growing demand translates into increased feedstock for recycling. But the recycling of EV batteries is now accelerating and the recycling of other critical mineral-based products is likely to follow.

We heard several suggestions for measures that can encourage growth in the recycling industry:

- A key issue inhibiting growth is the limited development of networks to collect, dismantle, store and transport end-of-life products. Use of direct payments to consumers and businesses gathering recycled material would accelerate this industry, potentially modeled on the Deposit Return Program in the liquor industry.
- Once recycled supply becomes available at scale and where technically suitable, guidelines could be developed for manufacturers to encourage use of a certain level of recycled critical mineral content
- Linked to recommendation 1, accelerating and expanding the SIF would also encourage new recycling operations to be established in Canada.

# Policy recommendations: risk and capital

Investments in critical mineral supply chains often carry significant risk due to high capital intensity, reliance on volatile world commodity prices and operations in sensitive environmental ecosystems.

Targeted measures to reduce these risks could significantly boost the development of critical mineral value chains in Canada by strengthening the incentive to invest.

## Recommendation 4. De-risk co-processing of waste streams and tailings

A fast way to increase critical mineral production is to utilize the untapped potential of co-processing waste streams and encouraging processing of mine tailings. Lack of processing facilities or prevailing market prices often mean only a primary mineral is extracted from ore, but streams that currently become mine waste can be rich in other minerals such as Rare Earth Elements, nickel, magnesium, cobalt, and tungsten.

Interviews also highlighted that regulatory barriers deter access to these resources. For example, a company seeking to test the feasibility of reprocessing tailings will take on a high level of environmental liability on the site where they are stored, which deters investment.

This potential has been recognized by the government through Natural Resources Canada's Mining Value from Waste Program and the CanmetMINING pilot program, for example. This form of production can also be more environmentally friendly than primary production and have the potential to enhance site remediation in unused sites through the application of modern standards. This opportunity could be supported by:

- considering targeted financial incentives to encourage co-processing of waste streams;
- a review of the regulatory steps for accessing tailings, with particular focus on speed of approval and clarifying environmental liability rules between the new operator, previous operator (if different) and government; and
- in consultation with industry, NRCAN should provide leadership by identifying the high-potential sites for tailings and mine waste processing by assessing the mineral properties of these deposits.

## Recommendation 5. De-risk investment in uneconomic minerals through market-making

Many of the recommendations listed in this report have the potential to incentivize investment in critical mineral supply chains, but even if all these ideas are implemented, some minerals are likely to remain uneconomic to produce.

Certain critical minerals, while essential, are only required in very small quantities and for niche products where demand is uncertain. Consequently, the small and volatile market for such products does not provide sufficient incentive to invest. For example, the principal use of germanium is in night-vision goggles, the demand for which is heavily dependent on the prevalence of global conflict. The low volume needs of this mineral also mean that global production is often little more than 100 tons per annum.

For minerals falling into this category, and where there is limited interest in private investment, the government should make a clear decision over whether these markets should be supported for the purpose of supply chain resiliency, downstream economic development or strategic value. Two intervention options in these types of markets include:

- Establishing a national mineral stockpile (potentially in concert with the United States) in certain strategic minerals, which includes a commitment to minimum guaranteed annual purchases from Canadian producers over a defined time period.
- Establishing price-smoothing mechanisms such that Canadian production (within certain quotas) will remain viable even when world prices are low.

## Recommendation 6. Maximize the impact of flow-through tax credits

Financial support for exploration is already available in Canada, notably through grants and flow-through tax credits. These are important, as junior mining companies that typically undertake exploration can be pre-revenue and seen as too risky to attract significant market finance. Companies interviewed felt that flow-through tax credit programs are perceived positively, but small reforms could make them even more impactful to incentivize growth of the industry. The suggested reforms included:

- To relax the time limit for making qualifying expenditures, especially where regulatory delays prevented the company from spending in the allotted time frame. Many companies felt that a relaxation of these time limits or the ability to link deadlines to the timing of regulatory milestones would be valuable. We note that some jurisdictions, like BC, did extend the timeline during the pandemic.
- To expand the breadth of qualifying pre-production expenditures for flow-throughs to include additional items like management team salaries, ESG improvements, training, consultation, baseline studies, infrastructure and geotechnical studies.

## Recommendation 7. Increase the scale and awareness of exploration grants

- Linked to recommendation 6 above, grants are another key support for junior mining companies that help fund exploration. Currently, grants awarded through provincial programs vary in their design and size — in Ontario, for example, the Ontario Junior Exploration Program program covers 50% of junior exploration costs up to $200,000, while Nova Scotia's Mineral Resources Development Fund program awards $40,000 in prospecting grants.
- Given the unique growth opportunity critical minerals offer, a top-up to these grants could be provided to further bolster exploration activity. Increased financial support, however, regardless of form, has an impact only when there is awareness: interviewees noted that specific financial and advisory support are not always fully understood by the mineral exploration and mining industry, especially by junior mining firms. Increasing visibility of the funding sources available could also have a positive impact.

# Policy recommendations: accelerate the regulatory cycle

Permitting timelines and processes are seen as a key barrier to investment in Canada, especially for new mine developments and mine life extensions. The regulatory cycle means that it can take 10 – 15 years for a new mine to become operational, which is out of sync with the investment cycle (typically 3 – 5 years) by which investors seek to receive a return on their funds. While fully aligning these cycles may not be possible, any steps to speed up regulatory processes would increase the attractiveness of investment in Canada. Investments that extend the operational life of current mines can also be at risk from permitting delays. Many companies we interviewed also reported feeling insufficiently supported through the regulatory process and cited a lack of clarity over the requirements and steps required.

## Recommendation 8. Increase regulatory resources and support

Improving the regulatory process is recognized as a goal in recent provincial and federal critical mineral strategies and NRCAN recently announced support such as $21.5m in funding for the Critical Minerals Centre of Excellence (CMCE).

The companies we interviewed had varying experiences navigating the regulatory process. Some reported positive experiences and welcomed developments such as the establishment of the Impact Assessment Agency of Canada and the clearer guidance it provided and the proposals by Ontario to provide more centralized support on large projects.

But variability in levels of support, knowledge and skill amongst the bodies involved in permitting mine operations was felt to often slow progress and lead to a risk-averse approach that deterred progress. Companies recognized the importance of the high standards that are applied in Canada and were not seeking deregulation, but greater efficiency, clarity and simplification in the application of current rules. Steps that could improve this include:

- To provide a dedicated project manager with appropriate seniority and expertise within government to work with companies on major projects. This person would provide a concierge service and preferably coordinating authority to help navigate processes, different departments and branches of government.
- Review current processes for opportunities to simplify regulatory procedures and option to scale regulatory procedures according to the magnitude of the project.
- To consider adopting a single entity and process to facilitate the critical mineral regulatory process, which would combine the current federal and provincial processes, building on the “One Project, One Assessment” objective noted in the Canadian Critical Mineral Strategy.

## Recommendation 9. Review regulations for critical mineral recycling

Recycling of products containing critical minerals is a relatively new field, but it is likely to be a major source of supply in the future. We heard from interviewees that certain regulatory barriers are inhibiting the growth of the sector and a review of rules to ensure they are fit for purpose for this emerging sector would be valuable.

One example raised was the designation of used EV batteries as “hazardous waste”, which significantly increases the cost of transportation and inhibits their movement across Canada and across borders to processing facilities.

## Recommendation 10. Design flexibility into critical mineral designation process

The recent conflict in Europe has had major knock-on effects on critical minerals and energy supply, bringing into focus the global nature of the supply chains and the impact of shocks.

Canada should be reactive to such shocks and put in place a process that allows critical mineral designation to be quickly updated in response to them. There are a number of possible candidates to be added to the list, such as steelmaking coal and high-grade (Direct-Reduced grade) iron ore.

# Policy recommendations: infrastructure and clean energy

With many of Canada's Critical Mineral deposits located in remote regions, infrastructure is critical for deposits to be economically viable. Access to roads, rail, potable water and housing are important as is access to clean energy.

## Recommendation 11. Accelerate clean energy projects

Federal funding for clean energy projects through the Canada Infrastructure Bank, including the $5bn clean power priority investment area, was welcomed by interviewees. We heard that alongside traditional investment drivers such as mineral quality and financial return on investment, ESG and whole-life carbon emissions are becoming more important. Many manufacturers who source critical minerals, especially those making "green" products such as Electric Vehicles, are increasingly requiring their suppliers to commit to becoming carbon neutral.

Canada already has a low carbon grid by international standards but the lack of clean energy sources in some remote, mineral-rich parts of the country are a barrier. The government should support the sector by fast-tracking hydroelectric, solar, wind and small modular reactor (SMR) projects that are accessible to mining areas or by expanding the existing low carbon grid to mining sites where possible.

## Recommendation 12. Incorporate ESG support into the Mining Centre of Excellence

As noted above, manufacturers sourcing critical minerals increasingly consider supply chain adherence to high ESG standards. ESG is important because it promotes sustainable production with reduced disruption to the environment and surrounding communities. Canada currently provides global leadership in site-level standards through the Toward Sustainable Mining program, and the Government of Canada Responsible Business Conduct strategy. However, Canada can do more to build on its ESG-positive brand in this sector by through promotion and helping companies to further improve ESG performance.

Recently the government of BC has committed to develop an ESG Centre of Excellence to assist all companies in the province with ESG adoption, with the view that it will become a positive differentiator and support competitiveness. We see an opportunity for a national critical minerals-focused ESG function to provide training and advice to companies and build on Canada's international brand in this field. This could be structured as a division within the federal mining Centre of Excellence. This could also be complemented by incentives for companies that significantly improve their ESG performance over time, such as through enhanced grants, capital allowances or tax credits.

## Recommendation 13. Provide targeted infrastructure investment

Building on recommendation 11 regarding clean energy infrastructure, other forms of infrastructure investment are also critical in making deposits in remote areas financially viable to access.

The government's announcement of $1.5bn for infrastructure development of critical mineral supply chains and the ability to partner with the Canada Infrastructure Bank for additional funding was welcomed by interviewees. But the government should also look to set out clearer plans, timelines and commitments for infrastructure development in areas with high mineral potential. It should also accelerate shovel-ready projects in roads, telecommunications, rail, water, energy and housing and consider the potential for greater funding of critical mineral infrastructure.

## Recommendation 14. Support-focused R&D for critical minerals

The federal government recently set aside $47.7m for targeted critical mineral R&D through Canada's research labs and a further $144.4m for critical mineral research and development. While broadly the technology to extract and process critical minerals already exists, we heard there are several areas that would benefit from further research:

- Technologies to reduce the environmental impact of mining. We heard that community relations can be made more challenging by issues like noise, effluent and water run-off, and air pollution. Innovations like electric mining vehicles, 5G technologies in mines and robotics and autonomous machinery may help to reduce any negative impacts.
- Improvements to ore processing techniques, especially those focussed on processing mine tailings and waste. New techniques could improve the economic efficiency of these processes and reduce energy use and environmental impact.
- Support for critical mineral "test beds" where industry, academia and start-ups can work together on new applied techniques. These test beds foster collaboration and improve the matching of business needs and post-secondary institutions' research topics. For example, they can be used to set challenges (e.g. increase the percentage of minerals extracted from a given ore concentrate) and assign funding for technological development that has a clear commercial end use.
- Alternative transportation means to overcome the high cost of developing transportation infrastructure in remote areas, as well as their potential to intrude on hunting and fishing activities.

# 3 Appendix: List of critical minerals

For the purposes of this study, critical minerals are defined based on their inclusion in the federal government critical minerals list, or those of the Provinces of Ontario, Quebec or Alberta.

## List of critical minerals in selected jurisdictions[19]

| Mineral | Jurisdiction | | | |
|---|---|---|---|---|
| | Canada | Ontario | Quebec | Alberta |
| Aluminum | ✅ | ❌ | ❌ | ✅ |
| Antimony | ✅ | ✅ | ✅ | ❌ |
| Arsenic | ❌ | ❌ | ❌ | ✅ |
| Barite | ❌ | ✅ | ❌ | ✅ |
| Beryllium | ❌ | ✅ | ❌ | ❌ |
| Bismuth | ✅ | ✅ | ✅ | ✅ |
| Cadmium | ❌ | ❌ | ✅ | ❌ |
| Cesium | ✅ | ✅ | ✅ | ❌ |
| Chromite/Chromium | ✅ | ✅ | ❌ | ✅ |
| Cobalt | ✅ | ✅ | ✅ | ✅ |
| Copper | ✅ | ✅ | ✅ | ❌ |
| Fluorspar | ✅ | ✅ | ❌ | ❌ |
| Gallium | ✅ | ✅ | ✅ | ✅ |
| Germanium | ✅ | ✅ | ❌ | ✅ |
| Graphite | ✅ | ✅ | ✅ | ✅ |
| Hafnium | ❌ | ❌ | ❌ | ✅ |
| Helium | ✅ | ❌ | ❌ | ❌ |
| Indium | ✅ | ✅ | ✅ | ✅ |
| Lithium | ✅ | ✅ | ✅ | ✅ |
| Magnesium | ✅ | ✅ | ✅ | ✅ |
| Manganese | ✅ | ✅ | ❌ | ✅ |
| Molybdenum | ✅ | ✅ | ❌ | ❌ |
| Nickel | ✅ | ✅ | ✅ | ✅ |
| Niobium | ✅ | ✅ | ✅ | ✅ |
| Phosphate | ❌ | ✅ | ❌ | ❌ |
| Platinum group metals | ✅ | ✅ | ✅ | ✅ |
| Potash | ✅ | ❌ | ❌ | ✅ |
| Rare Earth Elements | ✅ | ✅ | ✅ | ✅ |
| Scandium | ✅ | ✅ | ✅ | ✅ |
| Selenium | ❌ | ✅ | ❌ | ❌ |
| Tantalum | ✅ | ✅ | ✅ | ✅ |
| Tellurium | ✅ | ✅ | ✅ | ❌ |
| Tin | ✅ | ✅ | ✅ | ✅ |
| Titanium | ✅ | ✅ | ✅ | ✅ |
| Tungsten | ✅ | ✅ | ❌ | ❌ |
| Uranium | ✅ | ✅ | ❌ | ✅ |
| Vanadium | ✅ | ✅ | ✅ | ✅ |
| Zinc | ✅ | ✅ | ✅ | ✅ |
| Zirconium | ❌ | ✅ | ❌ | ❌ |

(19) List sourced from individual critical mineral strategies: NRCAN (Canada's Critical Minerals List 2021), Ontario (Critical Minerals Strategy 2022-2027), Québec (Plan For The Development Of Critical And Strategic Minerals 2020-2025), Alberta, Government of Alberta Identified Critical Minerals with Opportunities in Alberta, November 2021.