Article

Critical Minerals and Canadian Strategic Policymaking

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Abstract

Critical minerals such as copper and rare earths have recently emerged as a focus of Canadian federal and subnational government strategic industrial policy. Canadian action has been matched by policymaking in other countries in addition to analytical work by such global institutions as the World Bank and the International Energy Agency. In this section, we explore why critical minerals are increasingly important, why Canadian critical minerals are of particular interest, and what should be done to heighten Canada's opportunities in conjunction with Japanese and other partners.

Introduction

Specialists have debated for several years whether there are adequate supplies of critical raw materials to meet the projected demand for significantly increased renewable energy, let alone scenarios of global decarbonization.[1] But concerns about decarbonization's material demand ballooned in 2021. In May, the International Energy Agency (IEA) published the first comprehensive and global study of the supply constraints, lifecycle costs, environmental justice, and related challenges confronting the critical minerals used in electric vehicles, renewable energy equipment, and the myriad other elements of the clean energy transition. This report was *The Role of Critical Minerals in Clean Energy Transitions*.[2] The IEA

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1) One example of the debate is seen in Peter Viebahn, et al., "Assessing the need for critical minerals to shift the German energy system towards a high proportion of renewables," *Renewable and Sustainable Energy Reviews*, Vol. 49, September 2015: https://www.sciencedirect.com/science/article/pii/S1364032115003408

2) *The Role of Critical Minerals in Clean Energy Transitions*, International Renewable Energy Agency, May 2021 is accessible at the following URL: https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions

followed up that study with its *World Energy Outlook 2021*, which projects that – in a net-zero energy emissions by 2050 scenario – the value of trade in critical minerals that are employed in clean energy and energy transition sectors is forecast to parallel fossil fuels by 2030 and the dramatically exceed the latter in 2050.[3] Moreover, even the International Renewable Energy Agency – ordinarily quite heedless of critical mineral risks – included a warning in its January 2022 report *Geopolitics of the Energy Transformation: The Hydrogen Factor*. The report indicated that critical minerals for electrolyzers may be a constraining factor because "[w]hile geological supplies of most minerals and metals are presently sufficient, markets are bound to tighten with rapidly rising demand and long lead times in mining and refining projects."[4]

More recent analyses by Rystad Energy, S&P Global, Benchmark Minerals, and other analytical agencies and academic collaborations warn that copper, lithium and other critical mineral prices are climbing in the face of increasing demand and inadequate investment in new supply.

Specifically, as shown in figure 1, in early January of 2022 Rystad Energy warned that battery-grade lithium prices had tripled in 2021 and could be expected to climb by a further 50% over the coming two years.[5]

In tandem with that, as we see in figure 2 Rystad Energy also noted on January 14, 2022 that copper prices were escalating and may have unstoppable momentum. Rystad adds that its projections are conservative, as they do not take account of likely demand for copper from ongoing Indian urbanization of several hundred million people and several other factors. Even so, they expect global demand for copper to exceed supply – from both current and probable projects – by a massive 6 million tons in 2030, with the gap beginning to open in about 2023.

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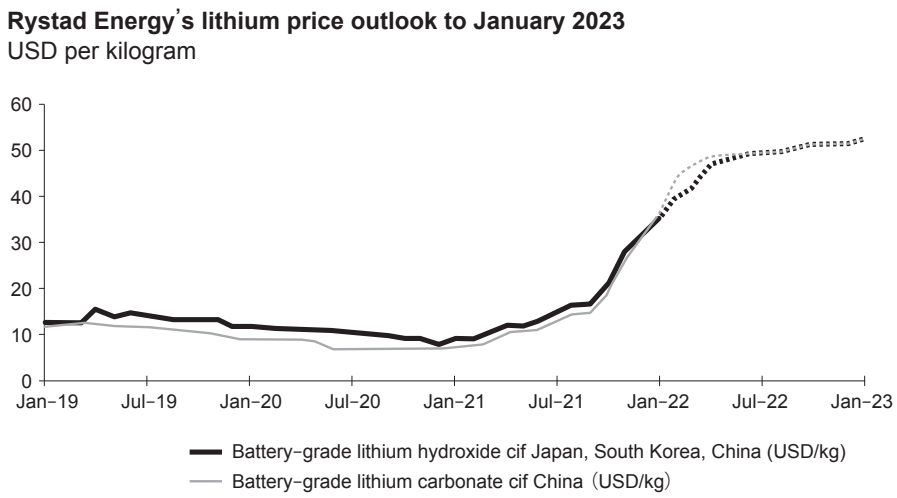
3) *The Role of Critical Minerals in Clean Energy Transitions*, International Energy Agency, Paris, May 2021, p.11. The report is accessible at the following URL: https://www.iea.org/reports/world-energy-outlook-2021

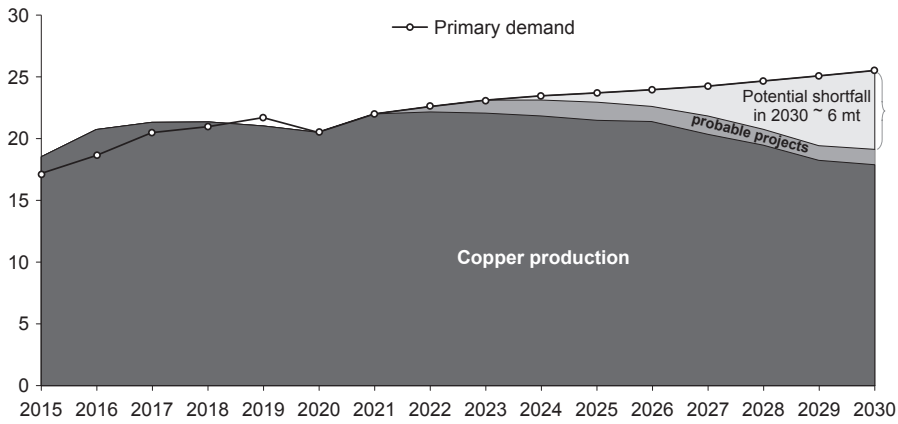
4) *Geopolitics of the Energy Transformation: The Hydrogen Factor*, International Renewable Energy Agency, Abu Dhabi, January, 2022, p.89. The report is accessible at the following URL: https://irena.org/-/media/Files/IRENA/Agency/Publication/2022/Jan/IRENA_Geopolitics_Hydrogen_2022.pdf

5) "Electric car makers brace for cost headache as battery-grade lithium price set to rise 50% within a year," Rystad Energy, January 13, 2022: https://www.rystadenergy.com/newsevents/news/press-releases/electric-car-makers-brace-for-cost-headache-as-battery-grade-lithium-price-set-to-rise-50pct-within-a-year/



Source: Rystad Energy Battery Materials Cube, research and analysis
Source: Rystad Energy, 2022[6)]

Figure 1 Lithium price outlook to 2023



Source: Rystad Energy research and analysis, Western Copper and Gold, IWCC, IEA
Source: Rystad Energy, 2022[7)]

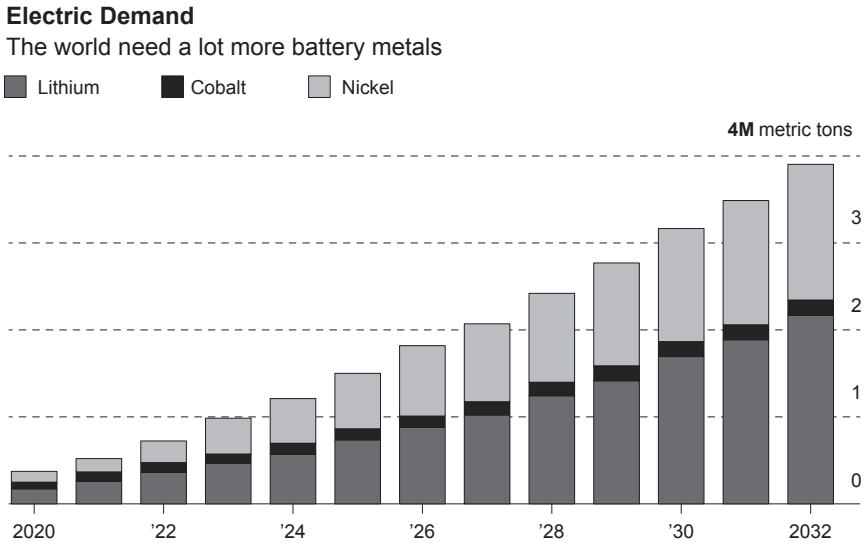
Figure 2 Global outlook for primary copper demand and supply, 2015-2030

6) "Electric car makers brace for cost headache as battery-grade lithium price set to rise 50% within a year," Rystad Energy, January 13, 2022: https://www.rystadenergy.com/newsevents/news/press-releases/electric-car-makers-brace-for-cost-headache-as-battery-grade-lithium-price-set-to-rise-50pct-within-a-year/

7) "Copper supply deficit of 6 million tons by 2030 threatens renewables, EVs, as investment

In addition, plenty of analyses by the IEA and other agencies warn that opening new mining for lithium and other critical mineral projects confronts increased local resistance due to environmental and other concerns. Moreover, producer countries are increasingly aiming at enhanced local value-added plus royalties. For example, Indonesian policymakers aim to use their nickel, copper and other mineral resources as leverage for domestic development of battery and related ecosystems.[8] The significance of these challenges are seen in figure 3, which displays the enormous increase in demand for 3 key battery metals – lithium, cobalt, and nickel – between 2020 to 2032. The Bloomberg New Energy Finance projections indicate that demand will skyrocket from 230,000 tons in 2020 to 3.9 million tons in 2032.

The critical mineral cost increases are already visible in the world's most popular electric vehicles. Table 1 shows the effect of rising costs of graphite, lithium, cobalt and



Source: BloombergNEF
Source: Biesheuvel and Savic (2022)[9]

Figure 3 Projected battery-metal demand for lithium, cobalt, and nickel, 2020-2032

lags demand," Rystad Energy, January 14, 2022: https://www.rystadenergy.com/newsevents/news/press-releases/copper-supply-deficit-of- 6 -million-tons-by-2030-threatens-renewables-evs-as-investment-lags-demand/

8) "Indonesian resource nationalism could spell tough times for metals sector: ANZ," S&P Global, January 20, 2022: https://www.spglobal.com/platts/pt/market-insights/latest-news/metals/012022-indonesian-resource-nationalism-could-spell-tough-times-for-metals-sector-anz

9) Thomas Biesheuvel and Misha Savic, "The World Wants More Lithium But Doesn't Want More Mines," *Bloomberg News*, December 18, 2021: https://www.bloomberg.com/news/articles/2021-12-18/even-a-mine-needed-to-fight-climate-change-isn-t-proving-popular

Table 1 Price increases in various electric vehicles due to rising costs of graphite, lithium, cobalt and manganese, 2020–21

TOP 20 BEST SELLING ELECTRIC CARS IN 2021 AND THE RISE IN PRICE OF THE GRAPHITE, LITHIUM,COBALT AND MANGANESE USED IN THEIR BATTERIES

	Model	Sales	C ($)	Li ($)	Ni ($)	Co ($)	Mn ($)	Per Car 2021 ($)	Per Car 2020 ($)
1.	Tesla Model 3	418.7K	18.4M	393.6M	255.6M	72.7M	1.6M	1,772	847
2.	Wuling Hongguang MINI	343.7K	3.2M	62.2M	12.1M	15.6M	2M	277	108
3.	Tesla Model Y	327.3K	16.3M	372.4M	313.2M	94.1M	3.2M	2,442	1,237
4.	Volkswagen ID.4	102.8K	5.8M	129.4M	106.9M	46.7M	6.5M	2,873	1,445
5.	BYD Han EV	76.6K	5.1M	87.1M	–	–	–	1,204	342
6.	Volkswagen ID.3	67.8K	3.3M	74.7M	58.9M	27.1M	4.5M	2,486	1,236
7.	Changan BenBen e-Star	66.1K	1.6M	38.8M	17.9M	23.1M	3M	1,280	587
8.	Renault Zoe	65.7K	2.7M	62M	48.6M	22.4M	3.9M	2,124	1,054
9.	Chery eQ1	64.9K	1.7M	37.2M	14.3M	18.6M	2.4M	1,143	507
10.	Kia Niro	59.2K	2.5M	60.3M	40.6M	43.7M	3.8M	2,550	1,253
11.	Great Wall ORA Euler R1	55.4K	1.4M	34M	17.1M	22.1M	2.9M	1,397	651
12.	Hyundai Kona	55K	2.3M	55.4M	37.3M	40.2M	3.5M	2,520	1,239
13.	Nissan Leaf	55K	2.1M	54.4M	30.6M	39.6M	5.1M	2,398	1,140
14.	Roewe Clever EV300	53.6K	1.1M	26.3M	16.2M	14.3M	2.5M	1,128	538
15.	Xpeng P7	53.1K	3.1M	67.4M	46.7M	29.5M	3.2M	2,822	1,378
16.	BYD Qin Plus	49.2K	2.5M	42.4M	–	–	–	913	259
17.	Ford Mustang Mach-E	49.1K	3.2M	73.3M	57.4M	26.5M	4.6M	3,361	1,669
18.	GAC Aion S	46.6K	2.1M	51.4M	26.3M	33.8M	4.4M	2,530	1,182
19.	Hozon Neta V	44.4K	1.2M	27.8M	14.2M	14.4M	2.2M	1,349	624
20.	Audi e-tron Quattro	43.6K	2.8M	67.3M	45M	48.7M	4.3M	3,861	1,895

Source: Adamas Intelligence Battery Capacity & Battery Metals Tracker Registrations light duty vehicles in 100 + countries Jan to end-Nov 2021 Graphite, Lithium Carbonate Equivalent (LCE). Cobalt Sulphate (100% basis), Nickel Sulphate (100% basis) prices: Benchmark Mineral Intelligence Dec 2021/2020. Manganese Sulphate (100% basis) : Asian Metal Dec 2021/2020

Source: Frik Els, 2022[10)]

MINING [DOT] COM EVMETAL INDEX

manganese during 2020–21, by brand of EV. The right-hand side of the chart compares the increased cost per car between 2020 and 2021, for graphite, lithium, cobalt and manganese, as a lump sum. The increases are at least double, and in some cases more. Yet it is important to note that the costs are calculated as of mid-2021, after which price increases continued. Hence, the data are quite conservative. And over the same period the costs of copper, aluminum, and rare earths used in EVs also rose. So the costs per car for the totality of critical minerals are significantly understated.

10) Frik Els, "RANKED: Top 20 EVs of 2021 – costs jump as lithium, cobalt, nickel prices surge," Mining, January 13, 2022: https://www.mining.com/ranked-top-20-evs-of-2021-costs-jump-as-lithium-

In short, many critical minerals are becoming increasingly costly to obtain. The price increases also appear to be structural rather than transitory. And the challenge of addressing ESG rules is almost certain to increase these costs.

The Canadian Critical Mineral Strategy

Canada's attractiveness in this context as highlighted by the IEA in its *Canada 2022: Energy Policy Review*, wherein it noted that "as the clean energy transition brings new vulnerabilities from an energy security perspective, Canada has developed plans to increase its production and supply chains of critical minerals for both domestic consumption and export."[11)]

The IEA analysis adds that:

> "As the evolving energy system decreases its reliance on traditional hydrocarbons and increases its reliance on clean fuels and technologies, Canada sees the notion of energy security evolving from security of fossil commodity supply to a broader sustainability model that stresses the efficiency of energy use, production of cleaner energy, greater reliance on clean power, using technology to harness renewable resources and a cleaner fuel mix.
>
> As the clean energy transition unfolds, accessing secure supplies of critical minerals and key components necessary for the manufacture of clean energy technologies that are not available domestically will be an increasing focus of energy security for Canada. Canada is uniquely positioned as one of the few countries in the western hemisphere with all the minerals and metals needed for the production of advanced batteries, and has the fourth-largest reserves of rare earth elements, which are essential components in the permanent magnets used in electric vehicle (EV) motors and wind turbines."[12)]

Indeed, the Canadian federal government emphasizes a "mines to manufacturing" approach, using Canada's resource endowments and mining expertise to build the battery and critical mineral supply chains needed to supply the global electric vehicle market and sup-

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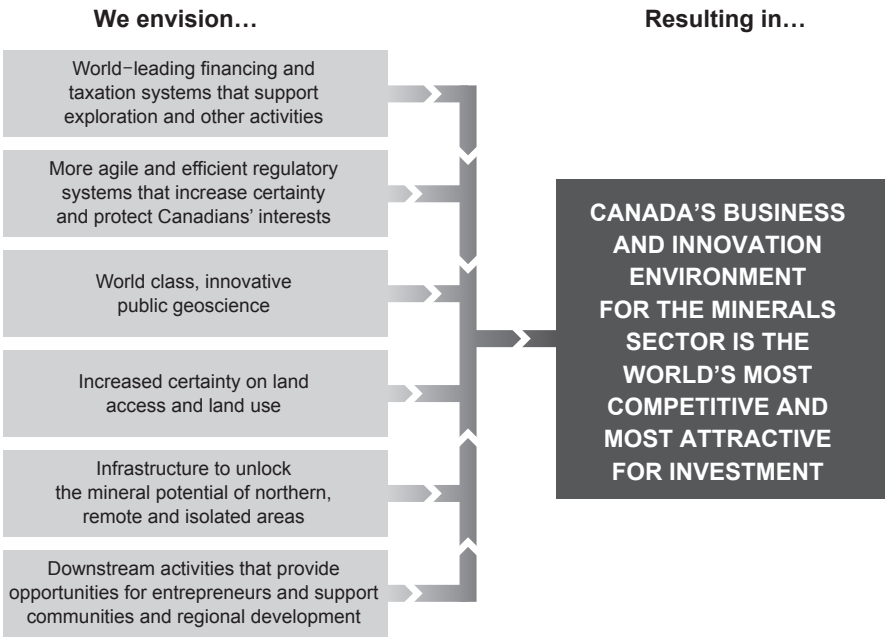
cobalt-nickel-prices-surge/

11) *Canada 2022: Energy Policy Review*, International Energy Agency, Paris, January 2022, p. 12: https://www.iea.org/reports/canada-2022

12) *Canada 2022: Energy Policy Review*, International Energy Agency, Paris, January 2022, p. 40: https://www.iea.org/reports/canada-2022



Source: Natural Resources Canada, 2019[13)]

Figure 4 Summary of aims for the Canadian Minerals and Metals Plan

port the wider clean energy transition. The key framework is the Canadian Minerals and Metals Plan (CMMP) of March 2019. The overall aims of the CMMP are summarized in figure 4. The goals are to create the world's most innovative and attractive minerals sector. To achieve these ends, the CMMP includes revising the taxation and regulation regime, promoting advanced geoscience, enhancing investor certainty concerning projects, building infrastructure to open up potentially vast critical mineral deposits in the Canadian north, and undertaking investments and other measures that ensure domestic development is a key element of the benefits.

This CCMP policy framework is not a top-down exercise. Rather, it was developed in collaboration with provincial and territorial governments, industry, indigenous groups, and other stakeholders. The CCMP is also iterative, in that it is updated by CMMP Action Plans. The federal government also followed up its role in the CCMP by announcing its first-ever formal critical minerals list in March 2021, identifying 31 minerals, displayed in Table 2. Notable among Canada's additions of critical minerals were copper, gallium, germanium, tin and other materials essential for decarbonizing and digital technologies.

13) "The Canadian Minerals and Metals Plan," Natural Resources Canada, March, 2019: https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/CMMP/CMMP_The_Plan-EN.pdf

Table 2 Canadian list of critical minerals, March 2021

• 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	

Source: Natural Resources Canada, 2022[14)]

Canada has three criteria for deeming a mineral "critical":

1）essential to Canada's economic security
2）essential for Canada's transition to a low-carbon economy
3）a sustainable source of critical minerals for Canada's partner countries[15)]

Thus Canada's critical mineral list is unique in explicitly seeking to address the needs of trading partners. Natural Resources Canada (a federal government agency) stresses that "[t]he list provides greater certainty and predictability to industry, investors, provinces and territories and Canada's international partners on Canada's mineral priorities. It also enables policy makers to target and address key points in supply chains." Natural Resources Canada also emphasizes that 82% of Canadian electricity is generated by hydro, nuclear, and other low-carbon sources, so Canadian-made aluminum and other critical minerals generally have "the lowest carbon footprint among the world's other large producers."[16)]

This assessment is confirmed by the highly regarded and London-based environmental, social, and corporate governance (ESG) consultancy Skarn Associates. Skarn's comparative assessments suggest that Canada uses less carbon than most countries to produce minerals and metals. For example, Skarn's data show that Canadian nickel is eight to 15 times

14), 15), 16) "Critical Minerals," Natural Resources Canada, March 19, 2021: https://www.nrcan.gc.ca/our-natural-resources/minerals-mining/critical-minerals/23414

less carbon-intensive, on average, than nickel produced in other countries.[17)]

Canada is also committed to exploiting its advantage of clean power to produce "green critical minerals," meaning critical minerals with very low lifecycle carbon costs. Canadian Industry Minister François-Philippe Champagne confirmed this point in December of 2021. Ahead of discussions with US automobile industry representatives Champagne declared that "Canada will be the first country in the world to produce green steel, green aluminum and now we're working on the green battery ecosystem ... it doesn't make sense to mine critical minerals in Africa, for them to be refined in China, and for the assembly to be done with coal power."[18)]

Canada also underscores its geopolitical position. This was noted in remarks aimed at the American audience, from Canada's Consul General in Detroit. He stressed that "Canada is the only country in the Western Hemisphere with all the critical minerals needed to make batteries for use in EVs. It only makes sense to continue to source metals and minerals like cobalt and nickel from your neighbor and friend Canada, instead of distant countries that may not always have the United States' best interests in mind."[19)]

The ESG and related rule-making that underlies these statements should be taken seriously. ESG rules are becoming one of the primary mechanisms countries are using to build strategic autonomy and resilience. EU experts have already undertaken detailed comparative assessments of the carbon footprints of critical minerals made in China versus those produced in Europe. Their data indicate that a given weight of Chinese-made aluminum was 2.8 times as carbon-intensive as its EU-made equivalent. For nickel, the difference was even greater, at 8 times. Similar China-EU gaps are evident for the silicon needed in solar, semiconductors, and other applications; and the zinc used in galvanizing steel, batteries, and other areas pertinent to decarbonization.[20)]

Moreover, the EU "taxonomy" of sustainability rules applied to its Critical Raw

17) "Canada Nickel Announces Industry Leading Low Carbon Footprint," *Bloomberg News*, June 1, 2021: https://www.bloomberg.com/press-releases/2021-06-01/canada-nickel-announces-industry-leading-low-carbon-footprint-kpdxjfeu?sref=n 8 vchuia

18) Ryan Tumilty, "Industry minister says despite recent numbers, major investments in Canada are coming," *Strathroy Age Dispatch*, December 6, 2021: https://www.strathroyagedispatch.com/news/politics/champagne-says-despite-recent-numbers-major-investments-in-canada-are-coming

19) Joe Comartin, "Building Back Better requires a Canada-U.S. approach to electric vehicles: Joe Comartin," Cleveland.com, December 26, 2021: https://www.cleveland.com/opinion/2021/12/building-back-better-requires-a-canada-us-approach-to-electric-vehicles-joe-comartin.html

20) Tomas Wyns and Gauri Khandekar, "Metals for a Climate Neutral Europe: A 2050 Blueprint," Institute for European Studies, 2019: https://eurometaux.eu/metals-blue-print-2050/

Material Action Plan is very strict. The carbon thresholds for aluminum (one of the EU critical minerals) is so restrictive that "[o]nly producers with access to massive volumes of nuclear or hydropower can meet such a requirement."[21] Chinese aluminum, produced via its coal-based power grid, would certainly not make the cut. But Canadian aluminum certainly would.

The upshot of these ESG rules is that a manufacturer of, say, EV batteries or renewable power generation equipment will need to factor in the additional "cost" of the environmental impacts of critical minerals imported to make the relevant devices. Put simply, in the choice between a kilogram of critical mineral produced with clean energy and another with carbon-intensive energy, the former will become more attractive. This is a major reason Canada stresses its clean-power advantage and geographical proximity to major markets. And Canada has competitors, such as Russia's Norilsk Nickel which is emphasizing its "green" Class 1 nickel.[22] As ESG rules become standardized, the cost of critical minerals will be assessed in terms of both production costs and ESG impacts. The resulting all-in cost may in time also include an emissions tax and similar measures.[23]

Canada's Subnational Government Strategies

Canada's subnational governments (provinces and territories) also have significant authority over mineral resources. So it is very important that these developments at the federal level are occurring in tandem with initiatives at the provincial and territorial levels. In October 2020, Quebec launched its Plan for the Development of Critical and Strategic Minerals 2020-2025, including CAD 90 million (CAD= Canadian Dollars) of investment. Quebec's plan is notable for aiming to match the accelerating demand for critical minerals with their environmentally sustainable supply.[24] And in March 2021, the Ontario govern-

21) See Anna-Michelle Asimakopoulou, "The EU Taxonomy: a means to an end that risks being the end of many industries," EURACTIV, January 20, 2021: https://www.euractiv.com/section/energy-environment/opinion/eu-taxonomy-for-sustainable-activities-a-means-to-an-end-that-risks-being-the-end-of-many-european-industries/1556327/

22) "Metals industry needs regulation or framework to make 'green' sales viable: miners," S&P Global, December 10, 2021: https://www.spglobal.com/platts/en/market-insights/latest-news/energy-transition/121021-metals-industry-needs-regulation-or-framework-to-make-green-sales-viable-miners

23) A discussion of these ESG-related tax and other measures can be found in the "OECD Business and Finance Outlook 2020: Sustainable and Resilient Finance," OECD, 2020: https://www.oecd-ilibrary.org/sites/bebb0add-en/index.html?itemId=/content/component/bebb0add-en

24) "Québec Plan for the Development of Critical and Strategic Minerals," Government of Quebec,

ment announced it is developing its first-ever Critical Minerals Strategy.[25] British Columbia and other provinces and territories are either compiling their own strategies or have recognized the role of critical minerals in innovation-related documents. All of these plans address ESG-related concerns, including stakeholder engagement and low-carbon electricity for mining and processing.

For example, British Columbia's Innovation Roadmap – an extensive collaboration between the province and the mining industry – points out that "mineral exploration activities in the province are robust, establishing a strong pipeline of future potential mines. Today, BC is one of the world's leading suppliers of metals and minerals that are essential for creating the types of products needed to transition to a low carbon economy such as electric vehicles and renewable energy infrastructure … BC's mining companies meet the highest standards of environmental, social and governance performance."[26]

Canadian Federal and Subnational Public Investment and Other Support

Canada is increasing its public-sector investment and other support for critical minerals. These supports include direct investment, investment incentives, fostering human resources and innovation, and cooperation with international partners. This expansion of support is an additional signal of the sector's strategic importance.

For example, the Canadian federal government Budget of 2021 earmarked an investment of CAD 9.6 million over three years to create a Critical Minerals Centre of Excellence at Natural Resources Canada and CAD 36.8 million over three years for federal R&D to advance critical battery mineral processing and refining expertise.[27]

On March 15, 2021 the Canadian federal government and the provincial government of Quebec announced a CAD 100 million (comprising CAD 50 million from each level of government) investment in electric vehicle battery plant for the Montreal-area company Lion

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January 26, 2022.: https://www.quebec.ca/en/government/policies-orientations/quebec-plan-development-critical-strategic-minerals

25) "Ontario Developing First-Ever Critical Minerals Strategy," Energy, Northern Development and Mines, Province of Ontario, March 10, 2021: https://news.ontario.ca/en/release/60622/ontario-developing-first-ever-critical-minerals-strategy

26) BC Mining Innovation Roadmap, Mining Association of British Columbia, March 15, 2021, p. 9 : https://www.mining.bc.ca/sites/default/files/MABC_BC_Mining_Innovation_Roadmap_FINAL.pdf

27) Part 2 : Creating Jobs and Growth, Budget 2021, Department of Finance, Canada, April 19, 2021: https://www.budget.gc.ca/2021/report-rapport/p 2 -en.html

Electric.[28] The province of Quebec had previously announced that it would invest CAD 1.4 billion to developed a lithium battery industry, from ore extraction through to battery production and recycling.[29]

In August 2020, the provincial government of Saskatchewan announced CAD 31 million in funding for a Rare Earth Separation and Processing Facility in Saskatchewan. This project is the first of its kind in Canada. It is likely to be expanded because Canada contains 7% of global rare earth resources and is 10th in the world in reserves.[30]

In April 2020, the government of Quebec invested around CAD 5 million to support Nouveau Monde Graphite's initiative to produce ESG-compliant graphite (a project also supported by the federal government). The company's project is expected to start operations in 2023 and become the largest graphite mine in North America and Europe.[31]

International Collaboration

The Canadian Government also works closely with international partners, on strategic partnerships. On July 28 of 2021, Canada and the United States undertook their third meeting of the U.S.-Canada Critical Minerals Working Group. Their representatives discussed means "to strengthen the Joint Action Plan for Critical Minerals to target a net-zero industrial transformation, and to support clean energy deployment, including batteries for zero-emissions vehicles, as well as stationary energy storage."[32] Canada is also an member of the Conference on Critical Materials and Minerals, which started in 2011 with membership of Japan, the U.S., and the European Union (EU). Canada became an observer country in 2019,

28) "Ottawa and Quebec sending $100M to Laurentians' Lion Electric for battery plant," CTV News, March 15, 2021: https://montreal.ctvnews.ca/ottawa-and-quebec-sending-100m-to-laurentians-lion-electric-for-battery-plant-1.5347552

29) Karim Zaghib, "Quebec on its way to homegrown battery industry, Propulsion Quebec, January 29, 2021: https://propulsionquebec.com/impulsionmtl/en/2021/01/29/quebec-on-its-way-to-homegrown-battery-industry/

30) "Could rare earth minerals give coal country a second life?" Corporate Knights, January 25, 2022: https://www.corporateknights.com/mining/could-rare-earth-minerals-give-coal-country-a-second-life/

31) Mehanaz Yakub, "Nouveau Monde to start graphite mine construction," *CIM Magazine*, February 11, 2021: https://magazine.cim.org/en/news/2021/nouveau-monde-starts-graphite-mine-construction-en/

32) "United States and Canada Forge Ahead on Critical Minerals Cooperation," U.S. Department of State Press Release, July 31, 2021: https://www.state.gov/united-states-and-canada-forge-ahead-on-critical-minerals-cooperation/

and then a full member in 2020. The most recent conference was the 12th, taking place on December 6 and 8, 2021, and was chaired by Japan. The conference "participants reaffirmed the importance of making the supply chains for critical materials more resilient, and confirmed that they will continue to promote collaborative efforts between Japan, the US, the EU, Australia and Canada."[33]

The collaborative efforts are not limited to high-level discussions. For example, on July 19, 2021, Canada's Minister of Natural Resources and the European Commissioner for Internal Market announced a framework for Canada-EU Strategic Partnership on Raw Materials within the mandate of the EU-Canada Comprehensive Economic and Trade Agreement. They declared that "[t]he security of supply chains for the minerals and metals essential to the transition to a carbon-neutral and digitized economy is a priority for both Canada and the European Union." The aims of the partnership include the following:

1) developing critical raw material projects in Canada and the EU
2) aligning European and Canadian financial support for critical mineral projects to leverage and de-risk private investments
3) exploring opportunities for prize-based innovation challenges on mining critical raw materials from waste sources
4) advancing best practices for resource classification and mapping, including mapping mineral potential from waste sources
5) organizing a joint Tracing Net-Zero Battery Minerals event to support research and innovation[34]

Canadian Public Acceptance of Critical Mineral Development

As noted above, outside of Canada, there are increasing difficulties in developing new critical mineral projects due to public opposition. Canada does feature some controversies over mining projects, notably mining for coal, oil sands and natural gas.[35] But overall the

33) "12th Conference on Critical Materials and Minerals Held," Ministry of Economy, Trade and Industry, Japan, December 9, 2021: https://www.meti.go.jp/english/press/2021/1209_002.html

34) "Joint Statement by Canada's Minister of Natural Resources and the European Commissioner for Internal Market," Natural Resources Canada, July 19, 2021: https://www.canada.ca/en/natural-resources-canada/news/2021/07/joint-statement-by-canadas-minister-of-natural-resources-and-the-european-commissioner-for-internal-market.html

35) For example, opposition to coal mining is discussed in "Mayor fears Rocky Mountain coal-mining

Canadian public seems quite supportive of critical mineral projects. A March 3–11 2020 online poll of 2,600 Canadians by the Mining Association of Canada found that:

1）88% want to see Canada increase its role in producing critical minerals for world markets
2）86% want to encourage international investment into Canadian critical minerals and metals companies that are sustainability leaders
3）83% want to encourage Canadian production of critical minerals so Canada can compete with China
4）81% want to promote interest in Canadian critical minerals by drawing attention to Canada's high standards of sustainability[36]

In short, nearly 90% of the respondents support the possibility of Canada becoming an international centre for critical mineral mining and processing. They also agree to government investment and other action in addition to encouraging foreign investment.

The Canadian Mining Industry

One reason for broad public support for mining is that Canada is a significant player in global mining. Canada is noted for its advanced technology, such as through the Green Mining Initiative led by Natural Resources Canada.[37] The Canadian mining industry also features robust capital markets and extensive international activity. Canada's domestic mining industry included over 200 active mines in 2019, and produced more than 60 minerals and metals. Concerning critical mineral production, Canada is ranked 1st for potash, 2nd in uranium and niobium, 3rd for nickel, aluminium, and platinum group elements (PGEs), and 4th for cobalt.[38]

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concerns will be ignored after meeting Kenney," SASKTODAY, January 27, 2022: https://www.sasktoday.ca/national-news/mayor-fears-rocky-mountain-coal-mining-concerns-will-be-ignored-after-meeting-kenney-5001392

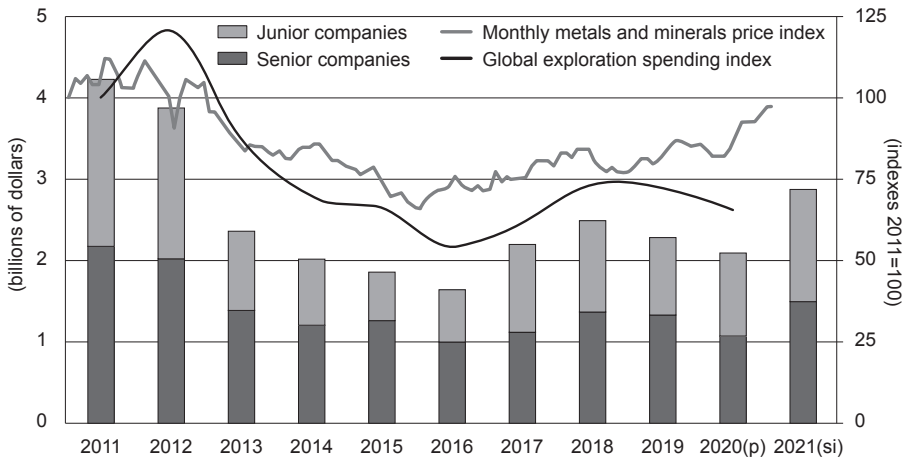
36）"Canadians want to seize Opportunity in Critical Minerals," Mining Association of Canada, May 13, 2020: https://mining.ca/resources/press-releases/canadians-want-to-seize-opportunity-in-critical-minerals/

37）"Green Mining Innovation," Natural Resources Canada, August 8, 2018: https://www.nrcan.gc.ca/our-natural-resources/minerals-mining/mining-resources/green-mining-innovation/8178

38）Jacob Ambrose Wilson, "Canada: The Centre of the Mining Universe," *Resource Global Network*,

The direct and indirect impacts of the Canadian mining sector as a whole (not just critical minerals) generated CAD 109 billion – 5 % of Canada's total GDP – in 2019. Canadian minerals exports in the same year totaled CAD 106 billion exported – 19% of Canada's total exports. Mining also directly employed 392,000 persons and indirectly a further 327,000 persons, for a total of 719,000 jobs. These jobs were well-paid, too, as the average annual salary in the mining industry was CAD 126,000, double the all-industry average salary of CAD 63,000. This employment is expected to grow further through an estimated CAD 82 billion set aside for mining projects over the next decade.[39]

Evidence that the Canadian mining industry stands to benefit a great deal from critical minerals is seen in **figure 5**. The figure shows that exploration for metals and minerals globally ("Global exploration spending index") vary with market circumstances and commodity prices ("Monthly metals and minerals price index"). Investment generally lags the movements in commodity prices, but declined significantly under the impact of COVID even



p=preliminary expenditures, si = spending intentions
Source: Natural Resources Canada, 2021[40]

Figure 5 Exploration and deposit appraisal expenditures, by type of company, global exploration spending index and monthly metals and minerals price index, 2011-21

Volume 8, Issue 5, 2021, p. 18: https://issuu.com/andersonmurraymedia/docs/rgnv 8 i 5 ?fr=sYTEy NDQzNDc 4 ODI

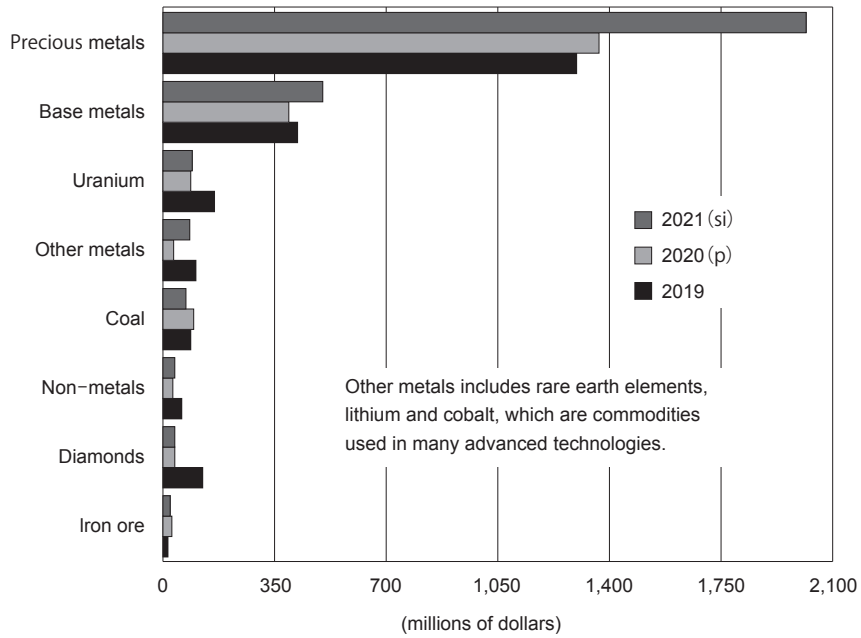
39) "Minerals and the Economy," Natural Resources Canada, January 27, 2022: https://www.nrcan.gc.ca/our-natural-resources/minerals-mining/minerals-metals-facts/minerals-and-the-economy/20529#GDP

40) "Canadian Mineral Exploration Information Bulletin," Natural Resources Canada, May, 2021: https://www.nrcan.gc.ca/maps-tools-and-publications/publications/minerals-mining-publications/canadian-mineral-exploration/17762

though commodity prices began to spike from 2020. We have seen earlier that copper, nickel and other critical mineral prices are undergoing a major structural increase as demand outpaces supply capacity. This fact bodes well for major producers like Canada, which have significant reserves in addition to activist industrial policy.

Canada's investment response is evident in **figure 6**, which compares expenditure for exploration and deposit appraisal by metal and mineral category, for 2019-21 (in CAD millions). The data show that investment in precious metals (such as silver, gold and platinum) accounted for 65% of spending, an increase over their 57% share of expenditures in 2019.

The bulk of the spending outlined in **figure 6** was devoted to gold, which is not a critical mineral but is often used in electronics and other devices and frequently is associated with copper and other critical minerals in geologic deposits. Silver is similar, in that it is not a critical mineral but is a key item used in solar panels and other applications. And we have



p=preliminary expenditures, si = spending intentions
Source: Natural Resources Canada, 2021[41)]

Figure 6 Exploration and deposit appraisal expenditures, by mineral commodity, 2019-21

41) "Canadian Mineral Exploration Information Bulletin," Natural Resources Canada, May, 2021: https://www.nrcan.gc.ca/maps-tools-and-publications/publications/minerals-mining-publications/canadian-mineral-exploration/17762

already seen that platinum is indeed a critical mineral, crucial to the electrolyzers needed for producing hydrogen. Meanwhile, Canadian expenditure on such base metals (non-ferrous metals that are not precious) as copper, nickel, and zinc increased somewhat in 2021 compared to 2019, after declining in 2020 during the uncertainty of the COVID pandemic. Uranium (3rd in the figure) is also an important critical mineral in Canada. Not only does Canada generate 15% of its power from nuclear sources and host a thriving nuclear-medicine and related industry, it is also the world's second-largest uranium exporter. Canada holds the world's largest deposits of high-grade uranium, or ore-grades of over 20%, a level that is 100 times the global average. And Canada exports 85% of its domestic uranium production, using the remainder to fuel its own nuclear reactors.[42)]

Recommendations for Expanded and Accelerated Action

Critical mineral issues have been studied by the Canadian Parliament's Standing Committee on Natural Resources. On June 17, 2021 the committee released a report titled "From Mineral Exploration to Advanced Manufacturing: Developing Value Chains for Critical Minerals in Canada." Among the most relevant recommendations, the Committee advised that the federal government promote responsible, sustainable and inclusive development of Canada's critical minerals sector by:

1) supporting research on critical minerals, including the development of research infrastructure and technological innovation platforms
2) encouraging initiatives to develop mining and mineral processing activities that reduce the sector's environmental impact, including waste recovery and mineral recycling, and ensuring that the regulatory framework allows it
3) launching a roadmap for the integration of renewable and low-greenhouse gas energy into off-grid mine energy systems in remote and Northern regions, taking into account reliability and cost
4) fostering the implementation of best practices for electrifying mining operations
5) offering critical mineral training programs and supporting initiatives to diversify the mining sector's workforce

42) "About Uranium," Natural Resources Canada, September, 2020: https://www.nrcan.gc.ca/energy/energy-sources-distribution/uranium-nuclear-energy/uranium-canada/about-uranium/7695

The Committee also advised that the federal government support the development of value-added processing in Canada in order to increase the number of markets for critical minerals in the country and build a domestic industry and domestic expertise by:

1）helping set up demonstration facilities for promising value-added product manufacturing, ensuring no duplication with provincial facilities
2）assessing the possibility of expanding the scope of financial and tax measures, such as the Mineral Exploration Tax Credit and the flow-through share system, to support the development of value-added critical mineral processing[43)]

The work on critical minerals by the Standing Committee on Natural Resources is now being followed up by the Standing Committee on Industry and Technology.[44)] In all likelihood, that Committee will generate more ideas and perhaps a full-fledged report.

A 7-part study by Fasken experts of Canada's federal and subnational critical mineral strategies concluded on December 15, 2021, and added emphasis to this encouragement to act faster and more aggressively. They laud the efforts to develop and implement policy, but are concerned that – even in Canada itself – critical mineral supply will not match the demand due to electrification of mobility, decarbonization of energy, digitalization of the economy, and other factors. The Fasken experts warn that:

"As a country, we are making an enormous effort, a special effort, to encourage our citizens to electrify their consumer goods, for example, buying electric cars. But we do not make a corresponding effort on the supply side. Thus far, only Québec has realized that there must be a match between demand and supply.

Sweden, a country that Canadian law-makers and citizens often study, had this to say in its Mineral Strategy: 'Green growth without access to raw materials for green technology is unfeasible.'" [45)]

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43) *From Mineral Exploration to Advanced Manufacturing : Developing Value Chains for Critical Minerals in Canada, Report of the Standing Committee on Natural Resources*, (Chair: James Maloney), House of Commons, Canada, June 17, 2021: https://www.ourcommons.ca/Content/Committee/432/RNNR/Reports/RP11412677/rnnrrp06/rnnrrp06-e.pdf

44) "Committees: INDU Standing Committee on Industry and Technology," Parliament of Canada site, from November 22, 2021 – Present: https://www.ourcommons.ca/Committees/en/INDU

45) André Durocher , Michael Bourassa , Ron Ezekiel and Shannon Snow, "Canada: The Role Of Critical Minerals In The Energy Transition: A Canadian Perspective (Part 7)," Mondaq, December 15,

Conclusions

We have seen that Canadian initiatives on critical minerals are increasing. Certainly there is a need for greater domestic and international action. IEA data suggest that as the pressure for global decarbonization intensifies, there is good potential for Canadian critical minerals to substitute for a likely decline in demand for Canadian coal, oil, and natural gas. Canada cannot do this on its own, as investment costs for harnessing northern resources are likely to be very high. Without clear and reasonable rules on project development plus confidence in future demand, the business risks would simply be too onerous. Thus maximizing the Canadian critical mineral opportunity entails collaborative partnerships that foster greater assurance of project viability in addition to certainty of demand for Canadian-produced and ESG-compliant critical minerals.

2021: https://www.mondaq.com/canada/mining/1142464/the-role-of-critical-minerals-in-the-energy-transition-a-canadian-perspective-part- 7