CLEAN ENERGY CANADA

Submission

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Ontario Critical Minerals Framework Discussion Paper

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Summary and Key Recommendations

Clean Energy Canada is an initiative of the Morris J. Wosk Centre for Dialogue Simon Fraser University. We are a national think-tank with staff located across the country. We conduct original research, convene influential dialogues, inform policy leadership, and build citizen engagement.

We are pleased to provide comments and feedback on Ontario's proposal for developing a critical minerals strategy. The growing demand for electric vehicle batteries and clean energy is an economic and environmental opportunity for Ontario. With the demand for battery minerals projected to grow between 20 and 40 times by 2040,[1] Ontario can play a role as a supplier of responsibly produced minerals to support the energy transition.

However, Ontario can—and should—go further than just supplying the world with its raw materials. The province should also focus on how to leverage its existing strengths in auto manufacturing, clean electricity, mining and innovation to develop a domestic battery and electric vehicle supply chain.

Ontario can reap the significant economic and environmental benefits that accompany the shift towards clean vehicles, but the province must take decisive and immediate action to retain jobs, build economic competitiveness, and avoid losing out to competing jurisdictions. **Therefore, we recommend that Ontario:**

1. **Ensure responsible and sustainable production of critical minerals;**
2. **Increase supply chain capacity, with a focus on midstream processing and refining;**
3. **Grow the demand for batteries and electric vehicles; and,**
4. **Support the emerging battery recycling sector.**

[1] International Energy Agency, The Role of Critical Minerals in Clean Energy Transitions, May 2021

The case for action

Over the next two to three decades, demand for critical minerals is expected to surge as uptake of electric vehicles, energy storage and renewable energy increases. The International Energy Agency (IEA) projects that demand for minerals used in clean energy technologies could grow by four to six times current levels by 2040.[2] Demand for minerals used in electric vehicle (EV) batteries could grow as much as 19 to 42 times over the next 20 years.[3]

In this mineral-intensive future, Ontario has an opportunity to be a leading supplier of responsibly-produced raw materials to companies and countries around the world transitioning to clean energy. In addition, Ontario should also work to build domestic critical mineral value chains and link our raw material supply to value-added activities such as processing and EV or battery manufacturing. This has the potential to create more economic and environmental benefits right here in Ontario, compared with a single-minded focus on increasing mineral extraction.

Figure 1. Critical minerals with existing or potential production in Ontario

Critical mineral	Production in Ontario	Clean technology uses and projected growth
Nickel	8th largest global producer; Key producer of Class 1 Nickel used in batteries	EV batteries (cathode); 19-fold growth in demand by 2040
Cobalt	13th largest global producer	EV batteries (cathode); 21-fold growth by 2040
Graphite	No production, but significant exploration projects and large deposits	EV batteries (anode); 25-fold growth by 2040
Lithium	No production, but significant exploration projects and large deposits	EV batteries (cathode, electrolyte); 42-fold growth by 2040
Copper	18th largest global producer	EVs, renewable energy, electricity networks; doubling of demand by 2040

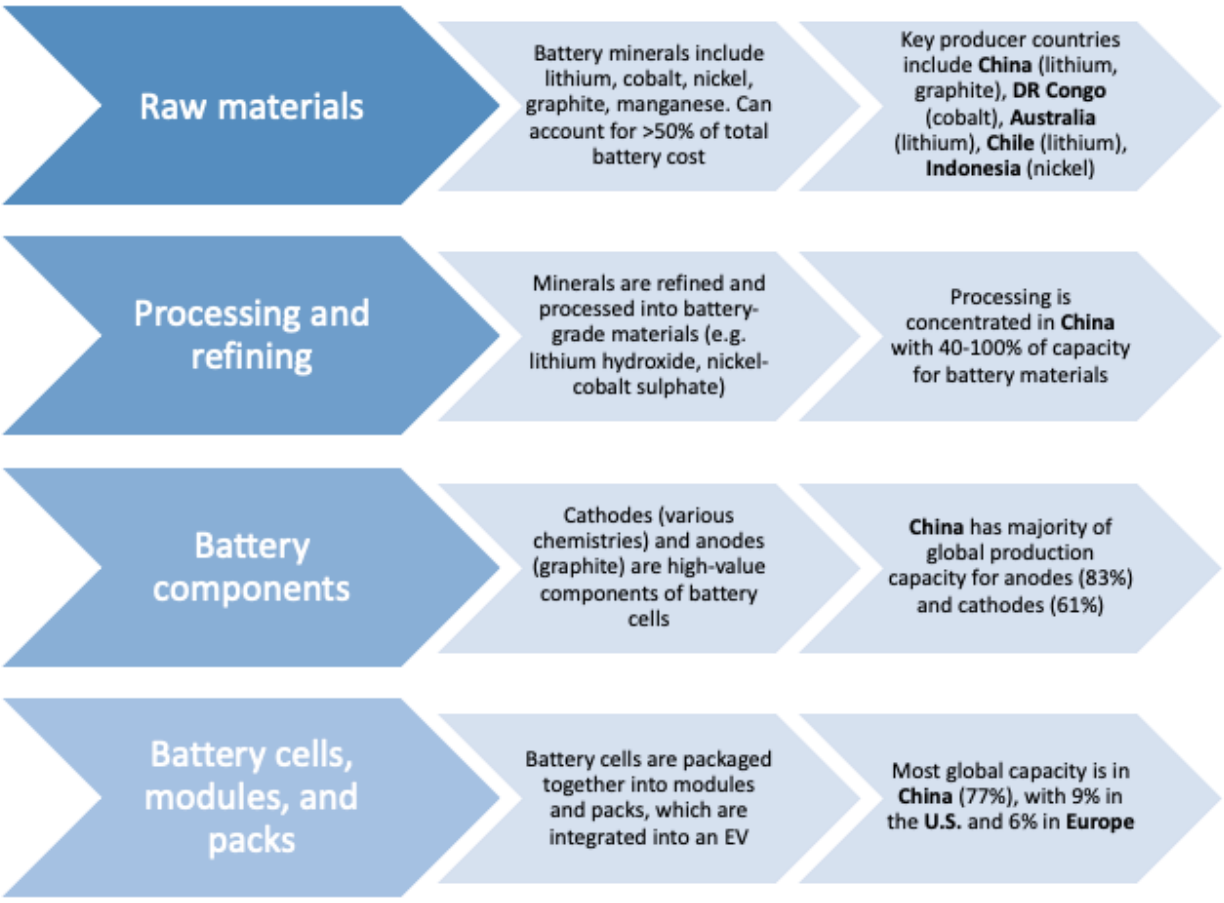
Source: Ontario Critical Minerals Framework discussion paper, International Energy Agency, World Bank

A prime opportunity for Ontario is around the lithium-ion battery market, which is seeing rapid growth in response to increasing demand for EVs. In 2020, global EV sales increased 41% from the previous year to 3 million (despite overall car sales dropping 16%).[4] The IEA projects the number of EVs globally will grow from the current 10 million vehicles to between 140 million and 200 million by 2030.[5] This is driving huge growth in demand for lithium-ion

[2] International Energy Agency (IEA), The Role of Critical Minerals in Clean Energy Transitions, May 2021
[3] The IEA projects demand for lithium to grow 42 times, graphite 25 times, cobalt 21 times, and nickel 19 times
[4] IEA, Global EV Outlook 2021, April 2021
[5] IEA, Global EV Outlook 2021

batteries, and for the minerals that are used in their production - many of which are already produced or could be produced in Ontario (Figure 1; see Appendix for a longer list of minerals and technologies).

Figure 2: Global battery supply chain



Source: International Energy Agency, Benchmark Minerals Intelligence, S&P Global

Batteries are the highest-value component in EVs, accounting for 30-40% of total vehicle costs, and there is strong competition among automakers and battery manufacturers to produce low-cost batteries with a high range.[6] China currently dominates both battery production (with 148 out of 200 battery factories globally)[7] and the entire battery supply chain (Figure 2),

[6] U.S. International Trade Commission, Lithium-Ion Battery Materials for Electric Vehicles and their Global Value Chains, 2020
[7] Benchmark Minerals Intelligence, Global Battery Arms Race, March 2021

although Europe is emerging as a competitor on the back of a supportive policy environment, substantial government investment, and strong consumer demand for EVs.[8]

North America has lagged behind the rest of the world, both in terms of battery/EV production and sales. The Biden administration is hoping to change this with a planned $174 billion investment in EVs and battery manufacturing. The United States and Europe are reportedly both interested in sourcing battery materials from Canada in order to feed into their domestic battery sectors.[9] [10]

Ontario's battery minerals opportunity

"In order to have a good sales position in the electric vehicle sector, you need to have proper integrity through the whole system — and that starts with clean energy."
Vic Fedeli, Ontario Minister of Economic Development, Job Creation and Trade.[11]

Ontario's battery supply chain potential is clear. The province is endowed with:

- Abundant critical minerals resources and established mining and processing sectors
- The second-largest North American automobile and auto parts sector, with billions of dollars committed to EV manufacturing
- A low-emissions electricity grid with surplus capacity
- An ecosystem of cleantech companies specializing in EV charging, battery recycling and other low-emissions technologies
- Strong research and development capacity

Despite this potential, Ontario has no battery cell or pack production.[12] Neither does any of its mineral extraction and processing currently feed into battery production.[13] Given the dynamic and highly competitive nature of the global battery market, it is imperative that Ontario recognizes the opportunity and takes strong and rapid action to secure domestic supply chain and manufacturing capacity. This is not something that can be left to the market on its own. Leading countries and regions have made significant investments and used a range of policy and regulatory tools to attract investments, build domestic supply chains, and encourage consumer demand for EVs.

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[8] S&P Global, Top electric vehicle markets dominate lithium-ion battery capacity growth, February 2021
[9] Reuters, U.S. looks to Canada for minerals to build electric vehicles - documents, March 18 2021
[10] European Commission, Critical Raw Materials Resilience: Charting a Path towards greater Security and Sustainability, September 2020
[11] TVO, Can Ontario boost EV battery recycling before it's too late?, April 22, 2021
[12] Although Windsor Essex Economic Development Corporation has submitted a bid for a $2-billion battery plant; Windsor Star, Windsor in pursuit of major battery plant, February 25, 2021
[13] Benchmark Minerals Intelligence, Testimony to House of Commons Standing Committee on Natural Resources, February 22, 2021

Below we outline four priority areas of action that Ontario should take to capitalize on the battery opportunity and build on the foundation of the critical minerals framework:

1. Ensure responsible and sustainable production of critical minerals
2. Increase supply chain capacity, with a focus on midstream processing and refining
3. Grow the demand for batteries and electric vehicles
4. Support the emerging battery recycling sector

Detailed comments

Priority 1. Ensure responsible and sustainable production of critical minerals

Recommendations:

1.1 Clear commitment to clean electricity grid and electric vehicle adoption
1.2 Invest in off-grid mine electrification
1.3 Support investment in new critical minerals projects through financing, streamlined permits and better information

We agree with the need to maintain high environmental and social standards while increasing supply of critical minerals, as outlined in the discussion paper. This is important for several reasons:

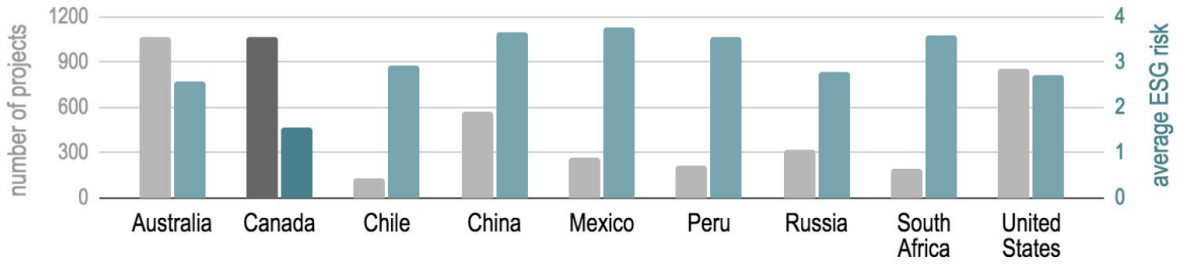
- **Markets and investors are increasingly demanding high environmental, social and governance (ESG) standards across supply chains**. For example, the European Union's proposed Sustainable Batteries Regulation, which is scheduled to come into force in January 2022, sets mandatory life-cycle environmental and social requirements for all batteries imported into the EU. These include minimum levels of recycled content for cobalt, lithium, and nickel, carbon footprint performance labels, and supply chain due diligence requirements.[14]
- **Automakers are committing to sustainable supply chains** in order to reduce emissions from battery production and to minimize the ethical risks of sourcing from certain jurisdictions (e.g. cobalt from the Democratic Republic of Congo). General Motors has committed to reducing emissions from its supply chains and sourcing more sustainable and recycled materials, in addition to phasing out production of internal combustion engine vehicles by 2035.[15] Ford has established a supplier code of conduct relating to expectations around human rights, responsible sourcing and environmental performance.[16] BMW has set a goal to reduce lifecycle emissions by one third and has

[14] European Commission, Sustainable batteries for a circular and climate neutral economy, Dec 2020
[15] Reuters, On top of zero-emission vehicles, GM looks to clean up its own operations, April 30, 2021
[16] Reuters, ibid.

signed contracts with battery and raw materials suppliers to ensure sustainable supplies.[17] Many other leading carmakers have made similar commitments.

- **Ontario will struggle to compete with jurisdictions such as China on price, but can use its clean electricity grid and high ESG performance as a competitive advantage**. This is similar to what Sweden, Finland and Norway are planning. Ontario's mining sector has generally low levels of ESG risk (Figure 3)[18] and the mining industry has developed voluntary standards - the Towards Sustainable Mining program - to manage risk and improve performance.[19] Several similar programs exist, and the province could play a role in developing consistent standards, ensuring compliance, and using incentives to encourage continuous improvement.[20]

Figure 3. Canadian mining projects have lower than average Environmental, Social and Governance risk



Source: Research Interfaces; Lebre et al., 2020, Nature

Ontario should take the following actions to ensure continued high ESG performance and attract investment in new mineral projects:

A clear commitment to the energy transition: governments must provide clear policy signals around the direction of travel and future demand for critical minerals, to reduce uncertainty for companies looking to make long-term investment decisions.[21] For Ontario, this means committing to a clean electricity grid and encouraging higher domestic demand for EVs (see section 3). Although Ontario's grid is currently around 95% emissions-free, this is expected to fall to 85% by 2030[22] as natural gas generation is used to replace nuclear power from Pickering. The Atmospheric Fund projects that peak grid carbon-intensity will be 150% higher in 2035 as a result.[23] This risks reducing Ontario's competitive advantage relative to other provinces (e.g. Quebec) and jurisdictions (e.g. Sweden) looking to produce sustainable minerals and batteries.

[17] GreenBiz, BMW, Ford, other automakers rev up carbon commitments, July 2020; BMW Group, Sustainable Production Using Wind and Hydroelectric Power
[18] Lebre et al. 2020, Nature, The social and environmental complexities of extracting energy transition metals
[19] Mining Association of Canada's Towards Sustainable Mining
[20] Clean Energy Canada, Mining for Clean Energy, 2018
[21] IEA, The Role of Critical Minerals in Clean Energy Transitions – Analysis, May 2021
[22] Pollution Probe, Replacing Pickering: The Next Step in the GTA's Clean Energy Transition, March 2020
[23] The Atmospheric Fund, A Clearer View on Ontario's Emissions, 2019

Ontario must plan accordingly to reduce reliance on gas-fired generation and expand alternatives, including low-cost conservation, renewables, and energy storage.[24]

Invest in off-grid mine electrification: According to the Mining Association of Canada, 52% of nickel and 62% of cobalt shipped in Canada in 2018 came from off-grid mines powered by diesel, which creates local air pollution and releases higher levels of carbon dioxide relative to Ontario's grid.[25] Ontario should follow the lead of other provinces and territories (including Quebec,[26] Yukon,[27] and NWT[28]) and develop an action plan to transition off-grid mines and other communities to renewable or clean energy sources.

Take additional measures to attract investments, including providing financing support to de-risk strategic critical minerals projects, streamlining permit procedures for projects on the critical minerals list, and working with provincial and federal partners to share data and improve understanding of critical mineral resources.

Priority 2: Increase supply chain capacity, with a focus on midstream processing and refining

Recommendations:

2.1 Develop a battery supply chain strategy to identify strengths, gaps and investment opportunities

2.2 Build capacity in critical minerals processing and refining to feed into battery components and cell production

2.3 Work with industry and other partners to attract battery manufacturing to Ontario

Ontario has strengths at each end of the battery supply chain: significant raw material resources at one end, and $4.5 billion invested by the Big Three automakers in EV production**. But in the middle of the supply chain, Ontario's capacity is much weaker**. This is where the best opportunities for economic development are, according to international experts and industry representatives.[29]

Investments in the midstream supply chain (Figure 4) will have benefits both upstream and downstream. Processing and refining capacity - to produce battery materials such as coated spherical purified graphite (coated-SPG), lithium carbonate and hydroxide, and nickel-cobalt sulphate - can encourage investments in new mineral supply by reducing

[24] Pollution Probe, ibid.
[25] Mining Association of Canada, Testimony to House of Commons Standing Committee on Natural Resources, February 19, 2021
[26] Hydro-Quebec, Overview of Hydro-Québec's Energy Resources, November 2019
[27] Canadian Energy Regulator, Overcoming the challenges of powering Canada's off-grid communities, October 2018
[28] Canadian Energy Regulator, ibid.
[29] Testimony to House of Commons Standing Committee on Natural Resources, February 19 and 22, 2021, by Benchmark Minerals Intelligence, Canadian Critical Minerals and Materials Alliance, Mining Association of Canada, Battery Metals Association of Canada

uncertainties around future demand. As China has demonstrated, expanding midstream capacity can also attract raw material imports and support further downstream value-added activities such as production of cathodes, anodes and other battery components.[30]

Figure 4. The electric vehicle battery supply chain

Source: Clean Energy Canada

Attracting battery production is also essential to retaining jobs in Ontario's auto sector. Boston Consulting Group estimates that electric and internal combustion engine vehicles require a similar total amount of labour, but for EVs there is a greater concentration of labour in battery production.[31] RBC Economics found that at least 4,500 jobs in Canada's auto sector (which is concentrated in Ontario) are at risk without a greater emphasis on the upstream EV supply chain, notably battery cell production.[32]

Ontario's recent $5 million investment in cobalt refining capacity was a promising signal that the province is willing to act to bolster its critical minerals supply chain.[33] To ensure other potential supply chain opportunities, from processing to battery production, come to fruition, Ontario should look to similar jurisdictions like Sweden and Quebec that have developed battery supply chain strategies.

- **Sweden** has a number of similarities with Ontario - raw materials, world-leading mining industry, clean electricity grid, auto manufacturing base, research capacity, and proximity to a growing market - and has developed a 'Strategy for a sustainable battery value chain' to carve out a position as a producer of clean batteries and minerals.[34] Sweden has relied on its technological innovation and clean energy advantage to compete in international commodity markets, and has developed a homegrown battery manufacturing and recycling sector to supply the growing EU market. It also has low-emission mines, with many existing processes and operations electrified, and the sector has a target of net-zero emissions by 2045. Initiatives to further reduce emissions include electrification of mining equipment and longer term projects to decarbonize downstream processing.[35]

[30] Benchmark Minerals Intelligence, Testimony to House of Commons Standing Committee on Natural Resources, February 22 2021
[31] Boston Consulting Group, Shifting Gears in Auto Manufacturing, September 2020
[32] RBC Economics, Trading Places: Canada's place in a changing global economy, March 2021
[33] Mining.com, First Cobalt gets C$10m government boost to refinery, December 2020
[34] Fossil Free Sweden, Strategy for a sustainable battery value chain, December 2020
[35] Stockholm Environment Institute, The Swedish mining sector in sustainable futures, May 2019

- **Quebec** has developed a Plan for the Development of Critical and Strategic Minerals (2020-2025)[36] and has assessed the potential for development of a domestic lithium-ion battery sector.[37] Quebec's plans are linked and clearly focused on a vision of a clean energy future. They include details on how mineral extraction can feed into high value processing and battery production, the importance of creating consumer EV demand, and how to create a circular economy to ensure high rates of recycling and reuse.

Ontario should develop a battery supply chain strategy - learning from jurisdictions like Sweden and Quebec - that identifies existing strengths, and assesses gaps and opportunities for raw materials to feed into the battery supply chain and EVs. The strategy should also identify potential policy actions and investments that could attract additional supply chain capacity to Ontario, and areas of coordination with neighbouring provinces and/or the federal government. Additional policy actions could include **government support for commercial-scale demonstration projects** to process and refine battery materials, as well as **engaging with manufacturers of battery components (e.g. cathodes) and cells,** to understand what they would need to set up plans in Ontario.

Priority 3. Grow the demand for batteries and electric vehicles

Recommendations

3.1 Increase consumer choice through an Ontario Zero-Emission Vehicle Standard
3.2 Expand Ontario's EV charging networks to areas most in need
3.3 Use public procurement to lead by example and support the EV market

High EV uptake by consumers is a critical element of attracting battery manufacturing, with most new capacity going to the world's largest markets of Europe and China.[38] According to the European Battery Alliance, growing EV demand across Europe has been instrumental in attracting total battery investments of more than 60 billion Euros since 2018. Because of the high costs and safety issues associated with shipping batteries long distance, producers prefer to locate close to final markets and EV assembly locations.

Higher consumer demand for EVs in Ontario could have multiple benefits, including:

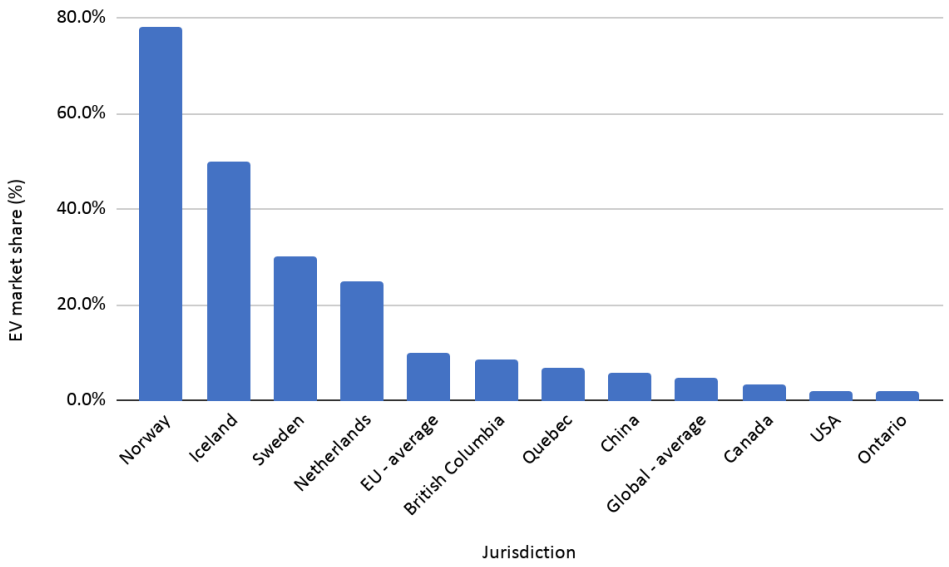
- Supporting Made-in-Ontario products and manufacturing (GM will start producing commercial electric vans in 2021, and Ford and Stellantis plan to produce passenger EVs from 2024-25)
- Improving air quality and public health outcomes (internal combustion engine vehicles are a major cause of air pollution, which contributes to 6,600 premature deaths annually in Ontario, according to Health Canada)[39]

[36] The Québec Plan for the Development of Critical and Strategic Minerals 2020-2025
[37] Propulsion Quebec, Developing a promising Lithium-ion Battery sector for Quebec's economy, April 2019
[38] S&P Global, Top electric vehicle markets dominate lithium-ion battery capacity growth, February 2021
[39] Health Canada, Health Impacts of Air Pollution in Canada 2021 Report

- Reducing GHG emissions and consumer costs (switching to an EV in Ontario reduces GHG emissions by 96% and save $1,000 annually in fuel and maintenance costs)[40]
- Take advantage of surplus baseload electricity to reduce waste and system costs[41]

Despite the benefits, **Ontario, with around 2% EV market share, lags behind other provinces** such as Quebec and British Columbia when it comes to EV sales - and far behind leading jurisdictions in Europe (Figure 5). According to Deloitte, EV adoption is driven by government policy, as well as changes in consumer sentiment, automaker production strategies, and corporate agendas (e.g. making company cars all-electric).[42] Ontario consumers are increasingly supportive of EVs and government incentives - recent surveys show 70% of Ontarians plan to buy an EV in the next 5 years.[43] However, consumer concerns remain, especially around upfront costs and availability of charging stations.[44] As well, Ontarians who are keen on purchasing an EV can struggle to find models available, with fewer than 1 in 5 dealers stocking EV models.[45]

Figure 5. Electric vehicle market share in select jurisdictions, 2020



Sources: IEA; Statistics Canada

Ontario should address these barriers through a mix of policy and regulation, including:

- **Develop an Ontario Zero Emission Vehicle (ZEV) Standard**: this is an approach already used by Quebec, British Columbia, California and a number of US states,

[40] Clean Energy Canada, How Canada can cut carbon pollution and revitalize its auto sector, 2020
[41] Toronto Region Board of Trade, Getting Ready for Autonomy, 2020
[42] Deloitte, Electric vehicle trends, July 2020
[43] Electric Autonomy, Nearly seven in 10 Canadians intend to make their next vehicle purchase an EV: survey, March 2021
[44] Global News, Internal government poll shows strong support for electric vehicle subsidy, February 2021
[45] Dunsky Energy Consulting, Plug-in Electric Vehicle Availability, Q1 2020

requiring automakers to produce a steadily increasing number of EVs over time. The Conservative Party of Canada also recently proposed a federal ZEV standard.[46] In order to boost supply and meet its own 2030 climate targets, Ontario should adopt a ZEV standard aiming for 50% of vehicle sales to be zero emission by 2030.

- **Improve access to EV charging networks** in areas with limited accessibility through targeted infrastructure investments (e.g. in rural or suburban areas) and 'right-to-install' legislation to make it easier for condo owners to install chargers.
- **Lead by example by using public procurement** spending to electrify the Ontario government's fleet of 5,500 passenger vehicles and 250 transit buses.[47]

Priority 4. Support the emerging lithium-ion battery recycling sector

Recommendations:

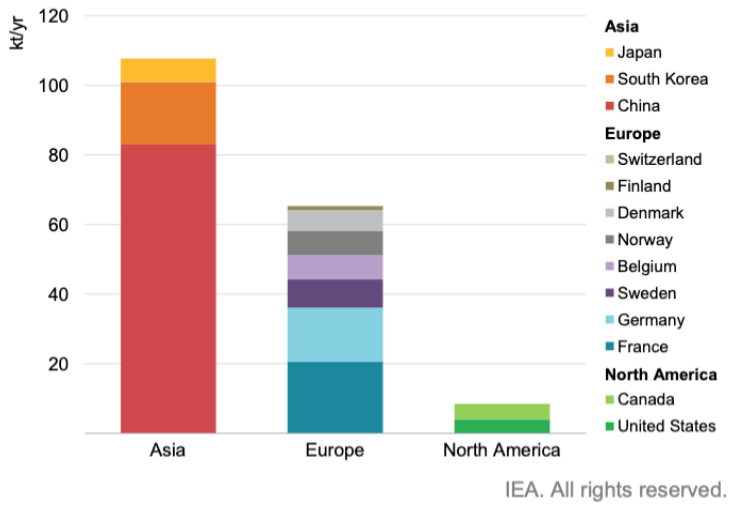
4.1 Facilitate the collection and transport of spent EV batteries
4.2 Consider setting minimum recycled content requirements for batteries
4.3 Developed standardized labels and product designs to aid recycling

The need for battery recycling is set to grow rapidly as the number of EVs on the road increases. The European Commission expects the number of batteries ready for recycling will increase 700 times between 2020 and 2040.[48] The IEA forecasts that the number of spent batteries will surge after 2030, growing 14-fold in the following decade.[49]

This presents a challenge but also an opportunity for Ontario, as recycling is expected to become an $11 billion industry by 2027.[50] Recycling rates are currently low for critical minerals (for example around 10% of cobalt and less than 20% of copper is currently recycled) largely due to technological and logistical barriers (such as collection and transport of spent batteries).[51] However, with the demand for some minerals expected to exceed supply in the next 5-10 years, recycling could present an opportunity to fill this gap and reduce the need for investments in new mines, as well as the associated energy use and emissions.[52]

Figure 6. Existing and announced lithium-ion battery recycling capacity to come online by 2021

[46] Clean Energy Canada, The Conservative climate plan is real, even if it raises a few questions, April 2021
[47] Environmental Commissioner of Ontario, Annual Greenhouse Gas Progress Report 2017; GO Transit, Our Vehicles | About Us
[48] European Commission, Sustainable Batteries Regulation, December 2020
[49] IEA, The Role of Critical Minerals in Clean Energy Transitions – Analysis, May 2021
[50] Fortune Business Insights, Lithium-Ion Battery Recycling Market USD 11.07 Billion in 2027, February 2021
[51] IEA, Role of Critical Minerals, 2021
[52] Institute for Sustainable Futures, Responsible minerals sourcing for renewable energy, April 2019



Sources: IEA analysis based on company announcements, press research and Swedish Energy Agency (2019).

Canada lags far behind Asia and Europe when it comes to recycling capacity (Figure 6), but there is potential for growth. Li-Cycle, an Ontario-based recycling company, recently opened North America's largest battery recycling facility in Rochester, NY, and aims to expand further to take advantage of growing battery markets in Europe and Asia.[53] Recycling can also support economic clusters, such as the 'closed life cycle loop' agreement between BMW and Northvolt (a Swedish battery producer), where BMW collects and delivers spent batteries to a recycling company, which extracts and produces cathode material to feed back into Northvolt's battery production, which then supplies BMW's vehicles.

Ontario should support the nascent battery recycling industry through policies that:

- **Facilitate the collection and transport of spent EV batteries**, for example by expanding Ontario's extended producer responsibility requirements[54]
- **Consider setting minimum recycled content requirements** for batteries and components manufactured in Ontario
- **Developed standardized labels and product designs** to provide information on battery components and chemistry, and facilitate safe battery disassembly and recycling.

[53] Globe and Mail, Battery recycling company Li-Cycle sees 'tsunami' of opportunity, eyes possible IPO to fund expansion, November 2020
[54] Resource Productivity and Recovery Authority, Batteries Regulation

Appendix

Critical minerals on Ontario's draft list have uses in a range of clean energy technologies.

Mineral	Clean technology			Projected 2050 demand (% of 2018)	Supply chain issues
	EVs and batteries	Wind	Solar PV		
Chromite				1%	
Cobalt**				460%	High reliance on DRC for production and China for refining
Copper**				7%	Mines in South America and Australia have high ESG risks (pollution, climate stress)
Graphite				494%	Production concentrated in few countries (China, Mozambique, Brazil)
Indium*				231%	
Lithium				488%	ESG concerns (water pollution, climate stress) from mines; production and processing concentrated in few countries (Australia, China, Chile, Argentina)
Manganese				4%	
Molybdenum				11%	
Nickel**				99%	ESG concerns (water pollution). Indonesia,the world's largest producer, recently banned exports
Rare Earth Elements				N/A	China dominates rare earth production and processing
Selenium**				N/A	
Tellurium**				N/A	High reliance on China for production
Vanadium				189%	
Zinc*				9%	

Sources: World Bank; International Energy Agency; Institute for Sustainable Futures.

* = mineral is produced in Ontario; ** = also processed in Ontario. Green highlight means use in that technology.

Note: 2050 demand is projected annual demand from energy technologies as a percentage of 2018 annual production (World Bank)