Iron ore for a greener future

Even though it is not considered to be a Canadian critical mineral, high-purity iron ore is absolutely critical when it comes to fighting climate change

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Champion Iron plans to build a DRI pelletizing plant at its Bloom Lake iron ore complex in Quebec, which the company expects will produce one of the highest grade iron ore products on the international market. Courtesy of Quebec Iron Ore

In 2022, when the federal government released its list of critical and strategic minerals in The Canadian Critical Minerals Strategy – From Exploration to Recycling: Powering the Green and Digital Economy for Canada and the World, iron ore did not make the cut. That decision frustrated many in Canada's iron ore sector.

Steel is a cornerstone of industrialized societies and it contributes between seven and nine per cent of global CO2 emissions. To decarbonize their processes, including reducing or abolishing the use of coal, steelmakers are largely turning to technologies that require high-purity iron ore with 65 per cent iron content or higher and low levels of impurities, particularly silica, phosphorus and alumina.

Advocates in Canada's iron ore mining sector argue that high-purity iron ore is as critical to the decarbonization of the economy as battery materials. They also point out that Canada's Labrador Trough, which extends from Newfoundland and Labrador to Quebec (and is home to most of the country's iron ore operations), and Nunavut are among the few mining districts in the world with an abundance of such ore.

Whether its product is officially recognized or not as critical for a greener future, Canada's iron ore mining sector is mobilizing to seize the opportunity to become a leading supplier of green iron ore for the decarbonization of steel.

The case for Canadian critical iron ore

According to the Institute for Energy Economics and Financial Analysis as well as others, by 2030, the demand for high-purity iron ore will outstrip supply, hampering the ability of steelmakers to decarbonize.

"People don't realize there is a subclass of iron ore, which is high-grade/high-purity iron ore," said David Cataford, chief executive officer of Champion Iron and the honorary chair for the 9th North American Iron Ore Symposium, which will be hosted alongside the 2023 CIM Convention and Expo in Montreal between April 30 and May 3.

Currently, outside of Canada, most high-purity iron ore is produced in Brazil, Russia and Ukraine. Guinea's Simandou iron ore project, which is in development, could become a major supplier as well. It has one of the world's largest untapped high-grade and high-purity iron ore deposits, but the project — and the country — has been grappling with the political uncertainties brought on by a military coup in September 2021. Additionally, the ore has many contaminants that may prevent its use in alternative steelmaking methods.

In this new era of heightened global geopolitical volatility, Canada's iron ore sector believes it offers more than a high-grade, high-purity product. It also offers critically important high grades in environmental, social and governance (ESG) standards, and the opportunity for a long-term and secure green-iron supply for steelmakers in North America, Europe and Asia. "That puts Canada in a very special spot of niche material that can help with decarbonization," said Cataford.

He believes the exclusion of iron ore from the federal government's critical minerals list will have a detrimental impact on his industry, which is rarely mentioned in the dominant narrative about mining and decarbonization. While nearly all of mined iron ore goes into steel, a material that is the common denominator in solar farms, wind turbines, electric vehicles as well as nuclear and hydro plants, it is minerals such as lithium, cobalt and copper that are considered the heroes in mining's quest to build a greener future.

"The steel industry is one of the most polluting industries on the planet, which is why reducing greenhouse gas emissions is a priority. High-grade iron ore concentrate is an essential element for low-carbon steel production," he said. "Thanks to the high-purity of our products and the low-emission intensity of our operations, we are already playing an important role in the decarbonization of the steel industry. We're proud to say that we're constantly working to improve the purity of our products. We're seeing a potential move to the critical and strategic minerals list. However, I don't think people have realized yet how critical the Canadian iron ore industry is to the world's decarbonization."

Steel

To understand that, one first has to understand that “the world is made of steel,” said Andrew Purvis, director of sustainable manufacturing at the Belgium-based World Steel Association (Worldsteel), whose members represent 85 per cent of global steel production. “What we are doing now as an industry that’s decarbonizing is transforming the future of steel but also transforming the future with steel. All of this decarbonizing that we need to do today as a globe is pretty steel intensive.”

Every year some two billion tonnes of iron ore go into making steel for everything from buildings, bridges and tunnels to trains, ships and planes, farming and mining equipment to high-power lines and home appliances and even canned food as well as decarbonization technologies. Steel is ubiquitous.

One route to reduce the steelmaking environmental impact is the use of recycled scrap steel. Using recycled scrap steel produces approximately 0.67 tonnes of C02 per tonne of steel, which is about a third of the emissions created from traditional steelmaking via iron ore and coal. But already 80 to 90 per cent of steel is being recycled, although that number is lower for structural steel, which has a recycling rate of 50 per cent.

“There are many different projections as to how much the demand for steel will go up,” explained Purvis. “But they all say it will go up and scrap steel is not going to catch up with it. We have to find new ways to make more virgin steel without emitting CO2 into the atmosphere.”

There is another issue with simply recycling. “It’s more difficult to produce high-end steel out of scrap if the scrap is of lower quality steel,” said Cataford. “Even if we use more scrap, we are going to need ultra-pure material to blend down the contaminants from it.”

Worldsteel’s members are committed to decarbonizing their sector with multiple strategies that include improving the quality of raw materials to increase energy efficiencies and reinventing steelmaking using new processes without metallurgical coal and blast furnaces. Due to lack of available scrap steel, the sector is leaning on alternative raw materials, including direct reduced iron (DRI), which replaces metallurgical coal with natural gas or hydrogen to create liquid iron. Instead of iron concentrate, the technology relies on very high-grade/high-purity pellets.

“Pellets are the only suitable feedstock for direct reduction ironmaking, which is much less carbon intensive than blast-furnace ironmaking if natural gas is used,” said Stefanie Vo, a process engineer at Hatch and one of the co-chairs for this year’s North American Iron Ore Symposium. “It even has a path to complete decarbonization if hydrogen is used as a reductant. The blast furnace does not offer this path.”

DRI pellets have also opened up the possibility of using electric arc furnaces (EAFs), currently used primarily for scrap recycling, to make virgin steel as well. The pellets can also be used as a substitute for scrap, or blended with it to produce steel. This low-risk decarbonization technology is gaining momentum across the steelmaking sector, particularly in Canada, the U.S. and China.

According to Worldsteel, conventional blast furnace and basic oxygen furnace steelmaking produces an average of 2.32 tonnes of C02 per tonne of steel. By contrast, DRI and EAF steelmaking is estimated to emit some 1.65 tonnes of CO2 per tonne of steel.

ArcelorMittal, one of the world's largest steelmakers – and iron ore miners – is working towards meeting its net-zero targets by 2050. "Globally, ArcelorMittal is going through a process of decarbonizing," said Mapi Mobwano, president and CEO of ArcelorMittal Mining Canada, which supplies the parent company with 40 per cent of its iron ore supply with product from Mont-Wright, Canada's largest open-pit iron ore mine, as well as its Fire Lake mine. The company also has a 420-kilometre railway, a pellet plant and a seaport at Port-Cartier in Quebec. "The main technology change has been to move from blast furnaces to EAFs."

In Canada, ArcelorMittal is investing $1.765 billion to replace its blast-furnace steelmaking production at its Dofasco plant in Hamilton with DRI and EAF by 2028. That will reduce the operation's CO2 emissions by 60 per cent.

Algoma Steel, based in Sault Ste. Marie, Ontario, is also currently spending $700 million to replace its blast-furnace and basic oxygen steelmaking operations with two new state-of-the-art EAFs that will be powered by Ontario's green electrical grid. Construction on the plant is under way and expected to be completed by mid-2024.

Algoma Steel is installing electric arc furnaces, which will be powered by Ontario's green electrical grid, at its steelmaking operations. Courtesy of Danieli

“EAF is a proven technology,” said Michael Garcia, Algoma’s chief executive officer. “It’s been part of North America’s steel landscape for several decades.”

The company estimates the switch, which will primarily use scrap as feed, will reduce its CO2 emissions by 70 per cent. Algoma will also be able to use DRI pellets, or other virgin iron inputs, in addition to scrap metal, depending on what its customers need in the future.

“When you look to Canada’s commitments to carbon reduction in the Paris Accord for industrial emitters, just this single project here in Sault Ste. Marie delivers 11 per cent of the Canadian goal for 2030 and 100 per cent of the Ontario goal,” said Garcia.

ArcelorMittal Mining Canada is gearing up to provide its steelmaking parent company’s growing EAFs with DRI pellets by the end of 2025. The company is investing $205 million into dedicating its entire Port-Cartier pellet plant to producing 10 million DRI pellets a year.

“Everybody is very excited about lithium but it’s a little less known that DRI pellets are going to be in high demand. That’s why we believe that high-grade iron ore is such a critical strategic mineral,” said Cataford.

The Iron Ore Company of Canada (IOC) is one of the few current producers of DRI pellets, as well as concentrates exceeding 66 per cent iron ore, from its Labrador Trough-based mining operations and is already seeing the demand for its pellets growing.

“Our products are also recognized for their clean chemistry, with low alumina and ultra-low phosphorus content,” said Jarrod Sutcliffe, general manager of business development for IOC, which is owned by Rio Tinto and runs the Labrador City mining complex. “These products, within the broader iron ore market have seen a significant and sustained increase in demand from both blast furnace and EAF steel producers. This is because our high-grade, low-impurity products enable steelmakers to lower their carbon footprint, operate more productively and produce higher quality steels while meeting increasingly stringent environmental standards.”

Champion Iron is also taking a step along the DRI path at its Bloom Lake iron ore mining complex on the south end of the Labrador Trough in Quebec. It has planned a $470.7 million direct reduction pellet feed (DRPF) project that will create a product that can be converted to DRI pellets and used by DRI/EAF steelmakers.

The project proposes to deploy proven technologies to regrind iron ore concentrate prior to submitting it to a reverse flotation process to further remove silica from iron oxides while reducing energy consumption and improving iron recovery compared to traditional flowsheets.

Benefitting from expected access to renewable hydroelectric power, the project is designed to be carbon neutral. The process will increase the iron content of Bloom Lake's iron ore to approximately 69 per cent, exceeding its current high-grade of 66.2 per cent and making it one of the highest-purity iron ore products on the global market. "That number may not seem that high, but you have to take into account that the mineral we're mining is actually hematite, and the theoretical maximum is about 70 per cent, because in the ground, hematite is a mixture of oxygen and iron ore," said Cataford. "When we upgrade it to 69 percent, the actual mineral is nearly 98.5 per cent pure if you consider the oxygen content."

The company has completed the project's feasibility study and its board recently approved $10 million to advance the engineering. "The project, designed to be an extension of the operating Phase II plant, will require an estimated construction period of approximately 30 months. We should be able to go back to the board this summer to get the project sanctioned and begin the actual construction," Cataford said. In addition, Champion Iron has initiated a study on converting its recently acquired plant in Pointe Noire, Quebec, to produce direct reduction grade pellets. The study is being conducted in partnership with an international steel manufacturer and results are expected to be released by the end of the year.

Decarbonizing the decarbonizer

As Canada's iron ore sector works towards products to help decarbonize steelmaking, as with other miners, it is also working towards decarbonizing its own operations. "There are things we can do across the value chain to be part of the solution," said Vo, "from mining greener to electrified mobile equipment to how we pelletize. There are a lot of interesting papers that are being presented at this year's North American Iron Ore Symposium. We're at a critical moment where we need to act, so this is an opportunity for us to exchange ideas, see what's being done and have a discussion as an industry around decarbonization."

Some of the innovative approaches Canada's iron ore sector are taking in terms of replacing fossil fuels in its operations include IOC's $16.9 million project to trial hydro-powered plasma burners at its pellet plant, and ArcelorMittal Mining Canada replacing part of the heavy fuel oil used at its Port-Cartier plant with pyrolytic oil made with wood residues. "We have plans to replace all the fossil fuels and be carbon neutral in our production of DRI pellets," said Mobwano. "For me as a miner, this decarbonization gives purpose to mining. It's not just about digging a hole and making money, it's digging a hole also for purpose and for providing steel for future generations. Being at the forefront of this process, knowing we in the iron ore mining business will be a key for this greener future. That's exciting."

From the perspective of a junior exploration company such as High Tide Resources, which has two lithium projects, Clearcut in Quebec and Big Bang in Ontario, as well as its flagship Labrador West iron ore project in the province's portion of the Labrador Trough, the decarbonization transition taking place both in iron ore mining and in steelmaking is creating exciting opportunities, according to the company's interim CEO and president, Steve Roebuck. "We're in a position where we can potentially start envisaging our project with novel technologies to lower our carbon footprint right from the start," he said.

As well, he added, “it’s an opportunity to try to do something different and plan differently and not to necessarily follow the true-and-tried model of being as big as possible,” he said. “If you are thinking modular, you can start high-grade green iron production at 50,000 to 100,000 tonnes a year, and if it works, you can scale up with additional modules. If you’re producing a green iron product that has a very high value compared to concentrate and pellets, by being modular, small and nimble, you can continue to scale up and eventually produce a million tonnes of product but at five times or more the value, you could end up having the same revenue of a conventional iron ore mine. Sometimes thinking smaller, and greener, is better.”

The big question

The opportunities for Canada’s green iron ore are far greater than most people realize, according to Theo Yameogo, Americas and Canada mining and metals leader at Ernst & Young. Canada’s iron ore sector has the advantage of clean hydro-power that reduces its footprint, a stringent regulatory environment with high ESG standards, a highly skilled and experienced workforce — and it has a far shorter distance to transport its product to the European market than top iron ore producers such as Brazil and Australia.

“The value chain of how we produce iron ore, the high governance and the location, we do have the opportunity to promote our green iron ore for decarbonization,” he said. “We’re not a big producer of iron ore internationally, but we have the potential to do more. We need the support of the system to market the idea that ‘absolutely, Canadian iron ore is very interesting.’”

In the meantime, Canada’s iron ore industry is pushing back on the federal government’s exclusion of iron ore from its critical minerals list, said Cataford. “By focusing on responsible mining and processing of high-purity iron ore resources found in the Labrador Trough, Canada has an opportunity to contribute to significantly decarbonizing the steel industry and thereby strengthening its leadership role in the fight against climate change,” he said. “The steel industry is turning green. It wants to reduce its carbon footprint. Steelmaking technologies using direct reduction and EAFs are proven, reliable, and enable producers to quickly reduce their GHG emissions. To be truly effective, this technology requires a supply of high-purity iron and we are strategically positioned to meet the growing demand. The Canadian iron ore industry is working together to get this message heard at both the federal and provincial levels.”