

INDUSTRY

Steel and Iron



10.3 STEEL AND IRON

Function	Basic material of industrial civilization; key input to construction, automotive, energy, manufacturing, and other sectors.
GHG emissions	Total Emissions: 2.1% of Canadian emissions in 2023 (14.5 Mt).[389]¹ Primary Steel: Represents ~54% of Canadian steel output, 91% of total sector emissions (13.2 Mt CO₂e in 2023).[389,390] Secondary Steel: Represents ~46% of Canadian steel output, 9% of total sector emissions (1.3 Mt CO₂e in 2023).[389,390]
Options for decarbonization	Primary Steel: - Decarbonization Pathways: Electric arc furnaces, direct reduced ironmaking with net-zero hydrogen. - Bridge Pathways: Carbon capture and storage for blast furnaces and basic oxygen furnaces. - Niche Pathways: Biomass based charcoal, selected fuel switching. - Enabling Pathways: Hot briquetted iron, co-located iron and net-zero hydrogen production. Secondary Steel: - Decarbonization Pathways: Scrap-based electric arc furnaces. - Niche Pathways: Selected fuel switching.
Stage of transition	Primary Steel – Emergence: Select integrated facilities have begun moves to electric arc furnace or direct reduced iron-electric arc furnace. Most output remains coal-based, and near-zero blast furnace-basic oxygen furnaces remain pre-commercial. Secondary Steel – Mature: Technically mature and already much lower-emission than blast furnace-basic oxygen furnace. Near-zero primary iron inputs are emerging. Clean electricity access for electric arc furnaces varies across regions.
Nature of the problem today	Asset-replacement cycles limit timing for long-lived assets; lack of commercially available low-carbon iron/steel technologies; thin margins and expected cost increases; low willingness to pay green-steel premiums; major needs for clean and cheap electricity, hydrogen, and CO ₂ infrastructure; limited availability and quality of scrap; limited supply of direct reduction grade iron ore.
Other systemic issues	Highly competitive and trade-exposed sector; global oversupply and subsidization push prices downward; Canadian producers face scale disadvantages and tariff pressures; carbon capture and storage risks locking in coal-based production; transitions to electric arc furnace impact local labour and shift skill requirements.
Strategic opportunities and concerns	Growing demand from industries with lifecycle emissions targets; Canada has globally low steel GHG intensities; access to low-carbon electricity and emerging hydrogen supply; risks include reliance on natural gas direct reduced iron, limited net-zero energy, local employment impacts, tariff exposure, and volatile export markets.

¹ All noted references can be found in the full Playbook document.

Priorities for action	Advance R&D and pilots for low-carbon iron and steel; improve scrap recovery and upgrading; secure clean electricity and hydrogen supply; establish offtake agreements and procurement mandates; develop product standards; define site-specific transition pathways.
Longer-term issues	Border-carbon leakage and competitiveness; securing long-term clean-energy, hydrogen, or biomass supply; aligning with emerging near-zero definitions; ensuring transitional natural gas direct reduced iron does not become a long-term end-state.
Indicators of progress	Sector-wide emissions and emissions intensity; share of output from net-zero pathways (hydrogen-direct reduced iron, carbon capture and storage-enabled operations, molten oxide electrolysis,); blast furnace-basic oxygen furnace retirements/conversions; low-carbon electricity penetration; scrap utilisation and quality; investment in hydrogen, electricity, CO ₂ , biomass, and scrap-processing infrastructure.

10.3.1 Current Status

Steel is a foundational material for Canada's industrial economy due to its high strength-to-weight ratio and versatility across applications.[391] Globally, demand is driven by buildings and infrastructure (52%), mechanical equipment (16%), and the automotive sector (12%), with additional use in metal products (10%), electrical equipment (3%), and other transport segments (5%).[392]

Canada has a well-established steel sector. In 2024, iron and steel mills contributed \$3.1 billion to GDP and steel product manufacturing added \$1.3 billion,² supporting approximately 23,000 jobs.[393,394] Steel is an important source of export earnings as well. From 2015 to 2024, the average annual value of exports was \$10.0 billion, peaking at \$14.1 billion in 2022 due to post-COVID demand before decreasing to \$12.1 billion in 2024.[395,396] Canada's steel is typically exported almost entirely to the United States (91%), Mexico (4%), and the Netherlands (1.3%)[397]. Canada has maintained a steel trade deficit since 2005, and in 2024, imports originated mainly from the U.S. (45%), China (9%), and South Korea (6%).[398] Given the steel industry's heavy reliance on trade with the U.S., American tariffs, along with Canada's retaliatory measures, have tightened profit

margins and introduced volatility into the Canadian steel market.[399] As a result, increased focus has been placed on expanding interprovincial shipments of domestic steel products, which are usually constrained by high transportation costs.[400]

Steel production involves two main steps :

- **Ironmaking**, which is carried out either in blast furnaces (BFs), which use coke or biomass-based reductants such as biochar to remove oxygen from iron ore and produce molten iron, or through direct reduced iron (DRI), which uses syngas (a mixture of hydrogen and carbon monoxide produced from natural gas or coal) or pure hydrogen to remove oxygen without melting the ore.
- **Steelmaking**, where impurities are removed in basic oxygen furnaces (BOFs) or electric arc furnaces (EAFs). Traditional integrated plants combine BF ironmaking with BOF steelmaking, while mini mills use EAFs to produce secondary steel from recycled scrap and, in some cases, primary steel from DRI feeding EAFs. Additional downstream operations include continuous casting, reheating, and hot rolling.

2 Chained (2017) Canadian dollars

In 2023, Canada's steel sector produced 6 million tonnes of iron and more than 12 million tonnes of steel, representing about 0.6% of global production.[401–403] The sector includes two integrated BF-BOF mills in Ontario, one ilmenite-based integrated facility in Quebec, and nine stand-alone (EAF-based) mini-mill facilities across Alberta, Ontario, Quebec, Manitoba, and Saskatchewan. Only one mini-mill facility, ArcelorMittal in Quebec, also operates DRI-EAF in addition to scrap-EAF. There are 16 finishing facilities producing finished steel goods from semifinished products.[390] The Canadian Steel Producers Association includes 17 member companies across more than 30 facilities in these provinces.[404]

10.3.2 Nature of the Problem

Iron and steelmaking accounted for about 2.1% of national emissions in 2023 (14.5 Mt CO₂e)[389] with approximately 67% from process emissions and 33% from combustion. Emissions intensities vary significantly between production routes: integrated **BF-BOF facilities represented about 54% of production but roughly 91% of emissions**, while **EAF mini-mills accounted for 46% of production and about 9% of emissions**.[390] These figures are expected to change beginning in 2026, following the completion of Algoma Steel's transition from BF-BOF to scrap-based EAF production, which will significantly increase the share of EAF steelmaking and reduce sector emissions by up to 3 Mt CO₂e.

Scrap-based EAF production is lower-emission, but scrap quality and supply cannot meet long-term demand from current BF-BOF production. Continued production of primary

iron from ore is required and remains a primary focus for lowering emissions. **Figure 32** displays steel production emission intensities from the Transition Accelerator report *Hydrogen and the Decarbonization of Steel Production in Canada*[390], and global benchmarks.³

Integrated BF-BOF facilities produce primary steel from iron ore and supply many of the flat and high-specification products required in automotive, energy, and construction applications. Although these mills perform relatively well compared with global peers, they are responsible for the majority of sectoral greenhouse gas emissions[390] due to the coal-based chemistry of blast furnace ironmaking and the high process emissions embedded in coke and BOF operations.

Mini-mills produce secondary steel primarily from recycled scrap using EAFs and, where higher-quality iron units are required, from DRI or hot briquetted iron (HBI). This route has substantially lower emissions than BF-BOF operations and contributes a significant share of Canada's steel output. [390] Continued expansion of secondary production, including entry into higher-grade flat products, depends on strengthening scrap collection, sorting, and quality upgrading, as well as securing low-carbon primary iron feedstocks and electricity to complement recycling.

Canada's steel transition can be framed through two production pathways:

- **Primary Steel Production (BF-BOF & DRI-EAF):** Converts iron ore into primary steel through BF-BOF (or emerging DRI-EAF processes) and accounts for a majority of sectoral emissions.

3 "Transition Accelerator Report" values are drawn from *Hydrogen and the Decarbonization of Steel Production in Canada*. "General" refers to global benchmarks not specific to Canadian steel production processes, and *How Clean is U.S. Steel* provides additional estimates for Canadian steel GHG emissions. Note that emissions accounting boundaries and electricity grid emission factors vary across these sources.

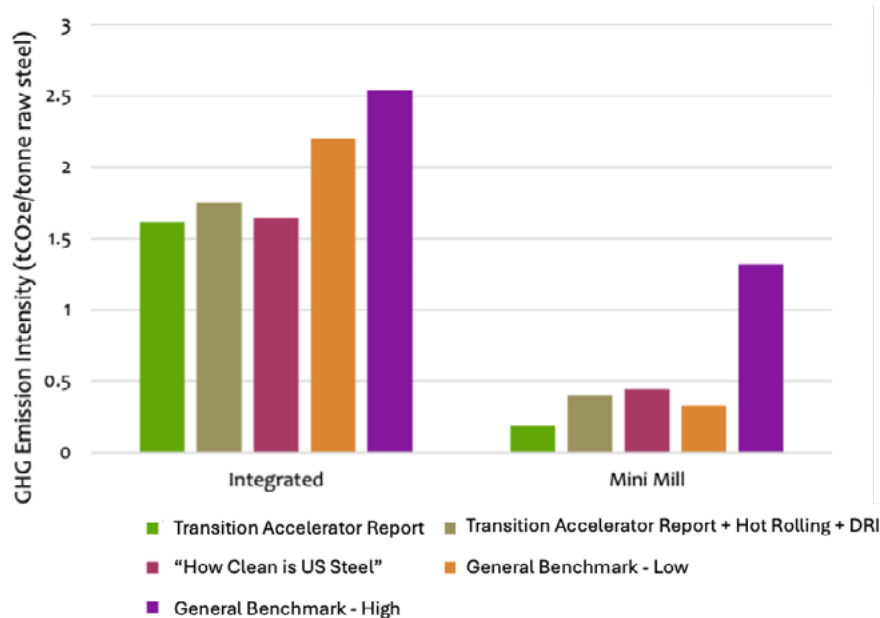


Figure 32 Comparison of the emissions intensity for Canadian steel by production route

Source: Transition Accelerator, "Hydrogen and the Decarbonization of Steel Production in Canada"[390]

- Secondary Steel Production and Material Efficiency:** Re-melts secondary recycled scrap in EAFs and plays an important role in lowering emissions through recycling, circularity, and material-efficiency strategies that reduce demand for virgin steel.

Primary Steel Production

Primary integrated steel mills are anchored by capital-intensive, long-lived assets. Blast furnaces operate for decades between relines, limiting opportunities for major process changes. Any recent upgrades at Canadian sites extend the life of existing BF-BOF equipment, narrowing the near-term window for transitioning to alternative technologies. The global steel market also faces persistent overcapacity and thin margins, constraining producers' ability to finance "first-of-a-kind" decarbonization or BF-BOF carbon capture and storage (CCS) projects.

System-level constraints compound these challenges. Large and reliable supplies of low-carbon electricity and hydrogen will be required to support primary steel DRI-EAF conversion or hydrogen-based ironmaking, yet these resources are not available at scale in most regions. Trade exposure and uncertainty around demand for low-emission steel further increases investment risks, making early conversion difficult without coordinated infrastructure planning and clear long-term market signals.

Low- to no-emission ironmaking technologies remain in early stages of deployment, and their maturity, scalability, and cost vary widely. Many pathways require large-scale clean electricity, hydrogen, sustainable biomass, or CCS, yet these inputs remain difficult to access because of infrastructure, cost, and geographic limitations.[405] Existing equipment lifespans also create challenges for recovering capital if assets are retired early.

Preliminary estimates find low-carbon steelmaking to cost 15–40% more than conventional processes[390,395,406], and near-term prices will be strongly influenced by hydrogen availability and pricing.[407]

Secondary Steel Production

Scrap-based EAF production provides significant emissions reductions relative to producing primary BF-BOF steel from iron ore. However, secondary scrap supply alone cannot meet projected demand: the total available scrap is insufficient and its quality varies, limiting its use in applications requiring high-grade or advanced flat steels.[408] Expanding secondary production therefore depends on improved scrap collection, sorting, and contaminant control, as well as the availability of low-carbon primary iron units such as DRI or HBI.

EAF operations also depend on provincial electricity costs and grid carbon intensity. These factors affect both operating margins and achievable emissions performance. Access to natural gas, clean electricity, hydrogen, and DR-grade iron ore will determine the feasibility of producing low-carbon DRI or HBI to complement scrap. Like integrated mills, mini mills face pressure from global oversupply, tariff uncertainty, and narrow margins. These factors influence the pace at which plants can justify investment in new DRI capacity, upgraded power systems, and enhanced scrap-handling infrastructure.

10.3.3 Net-Zero Pathways

The Canadian Steel Producers Association states that transformative projects already announced may deliver more than a 45% reduction in sectoral greenhouse gas emissions by 2030, with additional measures required to achieve the industry's longer-term ambition of net-zero emissions. [409,410] This figure was primarily dependent

on two projects: Algoma Steel's EAF transition (completed in January 2026) and ArcelorMittal Dofasco's Hamilton DRI-EAF project (materially restructured, with DRI production shifted to Contrecoeur and federal funding agreement extended to 2050).[411] Nonetheless, achieving the industry's longer-term net-zero ambition requires addressing both energy-related emissions and process emissions inherent to iron reduction.[412]

Primary Steel Production

The primary pathway for integrated BF-BOF sites to reduce emissions while maintaining the ability to produce steel grades that required a primary iron input is a structural transition to DRI-EAF configurations. Facilities would initially rely on natural gas-based DRI (NG-DRI), then transition to hydrogen-based DRI (H₂-DRI) as low-carbon hydrogen becomes available. H₂-DRI is the most promising pathway currently available for achieving near-zero ironmaking, while NG-DRI paired with top-gas CCS could deliver substantially lower emissions relative to BF-derived hot metal.

Emissions reduction measures can lower greenhouse gas emissions in existing BF-BOF operations but cannot fully eliminate them. CCS can address BOF-related emissions where carbon storage capacity exists, but a BF-BOF facility typically achieves no more than ~50% capture after retrofit while extending the lifespan of coal-based systems.[413] Combining CCS with hydrogen injection, biochar substitution, and efficiency improvements can reduce coal and coke use and achieve deeper emissions reduction but may still fall short of net-zero requirements.

Blast furnaces can also be retrofitted to capture both combustion and process-related emissions, but such configurations remain pre-commercial, increase system

complexity, and are subject to site-specific technical and economic constraints.[414] More broadly, CCS integration at integrated steel plants is capital intensive, energy intensive, and technically complex due to multiple emission sources and off-gas streams. As existing assets reach end of life, replacement with DRI-EAF configurations offers a pathway to deeper emissions reductions, especially when paired with low-carbon hydrogen and electricity.

Two steel plants in Ontario have progressed projects to electrify and decarbonize operations, supported by largely repayable funding agreements with both the federal and provincial governments[415,416]. One plant, Algoma Steel (Sault Ste. Marie, Ontario), ended integrated steelmaking and shut down its coke-making and BF-BOF facilities in mid-January 2026—a year earlier than previously planned. The facility now produces steel exclusively via Electric Arc Furnace (EAF), with one EAF in operation since summer 2025 and a second EAF to be commissioned later in 2026.[417,418] However, the plant will not be able run both EAFs at full capacity simultaneously until new local and regional transmission lines are installed to supply the total power demand of 300 MW.[419,420] Another plant, ArcelorMittal Dofasco (Hamilton, Ontario) has broken ground on a project to transition the site to DRI-EAF steelmaking, with a hydrogen-ready DRI plant that will initially operate on natural gas.[421]

Beyond emissions reduction, DRI-EAF configurations can also offer advantages over BF-BOF, including greater operational flexibility. As blast furnace ironmaking is a continuous process that is difficult to start and stop, integrated BF-BOF operations are generally less able to adjust output quickly in response to demand. In contrast, EAF steelmaking is a batch process and is

commonly described as more flexible, including the ability to reduce operating days or stop and restart more readily, which can help producers better align production with changing market demand and idle capacity during downturns.[390,422]

Hot Briquetted Iron (HBI), a denser and more stable form of DRI, offers several advantages. It can be used as a sole iron source or blended with scrap to meet quality requirements in EAF steelmaking.[423] Its higher density and lower reactivity simplify transport relative to DRI, enabling strategic geographic separation of ironmaking and steelmaking to reduce emissions, which is sometimes called “spatial decarbonization.”[41] Iron production can occur in hubs with access to DR-grade ore and low-cost clean hydrogen, while steelmaking can be located where scrap availability and clean electricity are abundant.[424]

Over the longer term, multiple electrolysis-based ironmaking technologies—including low-temperature electrowinning and high-temperature molten oxide electrolysis (MOE)—could enable near-zero primary iron production when supplied with sufficient low-carbon electricity.[425,426] Switching entirely to EAF steelmaking would eliminate most on-site emissions where electricity is zero-carbon, but this would also triple electricity demand per tonne of steel[390]. Scrap availability and quality will also limit the extent to which EAF steelmaking can meet future demand[424], emphasizing the need to decarbonize primary ironmaking even as EAF capacity expands.

Secondary Steel Production

Further decarbonizing the secondary mini-mill production route centres on three levers: maximizing the use of high-quality scrap, ensuring access to low-carbon electricity for EAF operations, and securing low-carbon primary iron sources to supplement recycling.

Canadian steel contains high levels of recycled content, with approximately 7 million tonnes of scrap utilized annually by steel producers, but more action can be taken to improve the availability and quality of scrap and thereby minimize the need for supplementary primary iron.[427] Designing products that allow for steel to be easily recovered and developing more infrastructure to collect and distribute reclaimed steel can increase the supply of scrap.[428] As steel can be recycled almost infinitely, contaminants that are difficult to remove can accumulate and affect the mechanical properties of the metal. Implementing standards for scrap steel classification and

processing, as well as employing technological innovations for more advanced sorting, testing, and treatment of scrap, can improve its quality.[429]

Where scrap supply and quality cannot meet the specifications for all flat and advanced grades, EAF steelmaking can be supplemented with lower carbon primary iron units (NG-DRI, H₂-DRI, HBI, MOE) instead of pig iron. Additional emissions reductions from both integrated steel mills and mini mills can come from electrifying downstream processes, including reheating and rolling, where suitable thermal storage or heat pump technologies can replace fossil fuels.

Competitiveness Implications

Canada produces roughly 0.6% of global steel and faces persistent scale disadvantages in finished products — conditions decarbonization alone will not reverse. But the worldwide shift from blast furnace to electric arc furnace steelmaking is reshaping which segment of the value chain matters most. As EAF capacity grows, steelmakers need merchant primary iron that scrap cannot supply. Hot briquetted iron is the form best suited to fill that gap: dense, shippable, and produced by decoupling ironmaking from steelmaking and siting it where DR-grade ore, clean electricity, and hydrogen converge. Canada holds that input combination. Co-locating hydrogen generation with ironmaking avoids the transport and storage costs that burden hydrogen supply chains elsewhere. Two Ontario BF-BOF conversions already underway provide near-term anchor demand, with the U.S. EAF market — destination for 91% of Canadian steel exports — as the scaled export pathway. The question is whether Canada will build low-carbon HBI supply capacity before competing jurisdictions lock in their own iron feedstock chains, and whether hydrogen infrastructure will advance at the rate the window requires.



10.3.4 Priorities for Action

Support for research, development, and demonstration is needed to bring innovative technologies and solutions to market.[405] As DRI with low-emission hydrogen is currently the only technologically available net-zero solution for ironmaking, it is important to develop regional and provincial strategies around hydrogen production, storage, and transport. In parallel, enabling conditions for low-emissions secondary steelmaking must be maintained, including access to clean electricity and high-quality scrap feedstocks.

Support and buildout of hubs with hydrogen production and ironmaking facilities (which include HBI) can help reduce the costs associated with low-carbon primary ironmaking. These hubs will be key to improving economic feasibility and ensuring efficient deployment of hydrogen-based DRI technologies. For secondary steel production, strengthening domestic scrap collection, sorting, and upgrading systems can increase the availability of suitable feedstock and support higher recycled content in steel production.

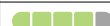
A domestic market for premium low-carbon steel should also be developed to drive investments in decarbonization technologies. Public procurement, large companies motivated by ESG targets, and smaller companies acting collectively, for example through buyers' clubs, represent likely first purchasers of low-emission steel. Key early demand sectors include automotive, construction, renewable energy, and white goods, as companies in these sectors are increasingly setting lifecycle emissions targets and may provide producers with revenue certainty through offtake agreements that

commit them to purchase goods before their production at a predictable cost.[430] Alternatively, procurement requirements can specify emissions standards for products or use policies, such as the application of a carbon price to products, when reviewing bids. Suppliers should work closely with buyers to ensure common emissions definitions, calculation methodologies, and targets. Terms such as low-carbon, green, or low-emissions steel can have different meanings among stakeholders and require greater alignment to support market transparency. Once early demand markets are secured, the uptake of low-carbon steel across other sectors can be addressed. Additional derisking measures include long-term clean-power contracts and government support for grid upgrades, scrap supply, and DRI or HBI feedstock availability ahead of project construction.[431]

Carbon leakage (defined as production shifting to jurisdictions with weaker climate policies) remains a competitiveness risk to Canadian steel producers and reinforces the need for policy alignment beyond domestic measures. Border carbon adjustments and related trade measures can support low-GHG steel; however, because Canada represents a small share of global steel output and China produces more than 50% of the world's steel[392], their effectiveness depends on adoption by major steel-producing and importing jurisdictions.[422] In the Canadian context, any BCA would need to be carefully sequenced with North American trade-policy developments to avoid compounding existing export-market pressures. As a result, Canadian decarbonization strategies must be paired with international coordination to avoid competitiveness impacts while enabling investment in low-emissions steel.[422]

 Fails to meet criteria Meets in some respect
 Not promising Potentially meets criteria
 Meets criteria

ALIGNMENT WITH CARBON NEUTRALITY	Economic		Technical			Social		
	ECONOMIC VIABILITY	ECONOMIC DEVELOPMENT OPPORTUNITY	MATURITY	OPERATIONAL FIT	INFRA-STRUCTURE AND SUPPLY CHAIN SUITABILITY	SOCIAL ACCEPTABILITY	RELEVANCE TO STAKEHOLDERS	RELATED BENEFITS AND COSTS
Can be net zero but depends on the carbon intensity of hydrogen.	Net-zero hydrogen costs are high and require carbon pricing or some type of subsidies.	Potential economic opportunities in producing low-carbon hydrogen and iron for domestic and international markets.	A full-scale green hydrogen iron plant operates in Sweden.	Requires process and regulation changes to switch operations from natural gas to hydrogen.	Requires hydrogen supply chain and infrastructure which is not established, as well as stable supply of DR-grade iron ore pellets.	Can be some concern around the safety of hydrogen.	Seen by some producers and government as a feasible option, but significant investment risk still exists with uncertain carbon pricing and dependencies on hydrogen market.	Better air quality with discontinuation of natural gas combustion.
Can be net zero or even negative emissions, but only when coupled with high enough carbon capture rates.	Biochar is more expensive than coal and coke but may have lower energy requirements for production.	Canada is building the largest biochar plant in North America.	A few pilots and demonstrations have occurred globally. Large-scale testing to begin in Canada.	Biochar and coke have different properties, so complete substitution does not work for all furnaces.	Supply chain for biochar is emerging. Biomass logistics and procurement can be difficult.	Lacks public visibility but will have similar concerns to operating a regular BF.	Some steel plants in Canada have already committed to trying biochar. The government is investing in biochar.	Avoids methane from waste decomposition.
Achieves net zero and can reduce lifecycle emissions associated with mining and waste.	Higher capital and operational costs than other alternatives. High-temperature processes with large electrical demand.	Technology is not developed or deployed in Canada. Abundant clean electricity offers an advantage.	Full scale is expected soon. Demonstration plant in Brazil produces some iron.	Easier maintenance because of multiple small vessels operating independently. Retraining and regulation changes required.	Requires scale-up of net-zero electricity. Lower quality inputs can be used in production.	No particular concerns. Environmental impacts are very low.	Investments into the technology from companies that operate in Canada.	Works with all iron grades. Byproduct is oxygen, no air quality concerns. No water or hazardous chemicals are needed.

PATHWAY ELEMENTS	ROLE IN NET-ZERO SYSTEM	SIGNAL TO DECISION-MAKERS	ALIGNMENT WITH CARBON NEUTRALITY	Economic		Technical			Social		
				ECONOMIC VIABILITY	ECONOMIC DEVELOPMENT OPPORTUNITY	MATURITY	OPERATIONAL FIT	INFRA-STRUCTURE AND SUPPLY CHAIN SUITABILITY	SOCIAL ACCEPTABILITY	RELEVANCE TO STAKEHOLDERS	RELATED BENEFITS AND COSTS
Electro-winning	<i>Potential Decarbonization Pathway</i> Could produce net-zero iron without combustion.	Incubate Track pilot results and support research collaborations. Prepare enabling conditions should the technology reach commercial readiness.	 Achieves net zero and can reduce lifecycle emissions associated with mining and waste.	 Modularization could reduce costs to the point of competitiveness with incumbent steel production.	 Technology is not developed, tested, or deployed in Canada.	 One project in pilot phase internationally and a few other research groups in Europe and Australia.	 Easier maintenance because of multiple small vessels operating independently. Retraining and regulation changes required.	 Requires scale-up of net-zero electricity. Lower quality inputs can be used in production.	 No particular concerns at this time, but full environmental impacts unknown.	 Backed by the biggest steelmaker in the U.S. and climate tech investors.	 Can use lower-grade ores and tailings, less mining product is wasted. Environmental impacts are not yet well documented.
Hot Briquetted Iron (HBI)	<i>Enabling Pathway</i> Decouples steel and iron production so that iron can be manufactured where low-carbon energy (i.e. hydrogen) is available and shipped to steel facilities in other provinces.	Deploy Advance HBI production capacity. Position Canada as a low-carbon HBI exporter. Build out hydrogen supply where HBI is produced.	 De-couples iron and steel production so each may be produced in a region with access to a relevant low-carbon energy source.	 Slightly higher capital and operating costs due to additional processing step. Transportation costs may rise if steel production is completed far from iron production.	 Creates a new export opportunity of low-carbon HBI from DRI. Canada has abundant hydrogen production potential compared to other countries.	 Commercial technology with two HBI plants in the U.S.	 Requires installation of briquetting equipment into existing DRI plants. Need the space to add this process downstream of hot DRI production.	 Fits into the existing supply chain and transportation for global shipping. Improves supply chain by decoupling iron and steel.	 No particular concerns.	 Linkage to lowering emissions may not be well understood.	 HBI can improve product quality out of EAFs and produce basic grade steels with lower-grade scrap, reclaiming scrap and reducing waste.
Co-located Iron and Net-Zero Hydrogen Production	<i>Enabling Pathway</i> Increases feasibility of critical ironmaking pathway.	Enable Invest in co-location planning and infrastructure at existing DRI sites. Support regulatory and permitting frameworks for integrated hydrogen-iron facilities.	 Improves access to low-carbon-intensity hydrogen.	 Better economics than separate production. Transportation and storage costs are significantly reduced.	 Potential economic opportunities in producing low-carbon hydrogen and iron for domestic and international markets.	 A couple of pilot hydrogen hubs operate in Canada with other sectors as end users.	 Space can be limited near existing steel plants so can constrain hydrogen production. Zoning is already industrial for iron production.	 Storage and transport infrastructure for hydrogen is avoided. Local H ₂ consumption reduces the need for robust supply chains. If steel production is present, electrical grid requirements may add complexity.	 Can be some concern around the safety of hydrogen.	 Aligns with iron producer interests as it lowers the risk of investing in hydrogen as a fuel by securing supply.	 Land use changes near existing iron facilities. Positive air quality benefits. Potential for other industries to cluster near hydrogen hubs.

			ALIGNMENT WITH CARBON NEUTRALITY	Economic		Technical			Social		
PATHWAY ELEMENTS	ROLE IN NET-ZERO SYSTEM	SIGNAL TO DECISION-MAKERS		ECONOMIC VIABILITY	ECONOMIC DEVELOPMENT OPPORTUNITY	MATURITY	OPERATIONAL FIT	INFRA-STRUCTURE AND SUPPLY CHAIN SUITABILITY	SOCIAL ACCEPTABILITY	RELEVANCE TO STAKEHOLDERS	RELATED BENEFITS AND COSTS
 Iron and Steelmaking											
Carbon Capture and Storage (CCS) for Blast Furnaces (BF) and Basic Oxygen Furnaces (BOFs)	Bridge Pathway Provides emission reductions so long as BF-BOF remains in use.	Don't Prioritize Track existing projects but prioritize hydrogen DRI and EAF pathways. Support CCS technologies and CO ₂ transport and storage networks.	 Cannot get to net zero alone due to multiple off-gas sources and dilute flue gases.	 High costs even where government support is available.	 Potential economic opportunities in CCS supply chain.	 Demonstration; one steel facility operates with CCS outside of Canada.	 Allows for continued use of BFs and BOFs. Regulations and permitting can be difficult. Capture rate is currently low.	 Requires buildout of carbon offtake infrastructure and supply chain.	 Skepticism about the continued use of fossil fuels and carbon leaks. Need to engage community to gain support.	 Expected to become less relevant as many steelmakers planning for low-carbon steelmaking are opting for hydrogen DRI.	 Doesn't fully address local air pollution. Continued coal mining upstream emissions.
 Steelmaking											
Electric Arc Furnaces (EAFs)	Priority Decarbonization Pathway Used widely today to recycle scrap steel. Can be combined with decarbonized ironmaking to produce primary decarbonized steel.	Deploy Accelerate the transition to EAF steelmaking by supporting grid and scrap supply chain investment.	 Already widely implemented and replaces basic oxygen furnaces, eliminating combustion emissions. Requires decarbonized electricity.	 Current successful technology that runs economically today.	 Supports construction jobs but can reduce steel jobs with higher-efficiency operations. Potential to meet domestic and international demand for low-carbon steel.	 Commercial and widely used globally and in Canada.	 Significant operator training hours needed to switch from BF-BOF as the operating process is different.	 Electrical demand is tripled per tonne of steel. Scrap steel can't fully meet demand. Can be issues with obtaining enough high-quality scrap steel or decarbonized iron.	 No particular concern. Local air quality benefits.	 Switchover already being implemented by two Canadian steel companies.	 Uses more recycled steel. Significantly reduces air emissions.

			ALIGNMENT WITH CARBON NEUTRALITY	Economic		Technical			Social		
PATHWAY ELEMENTS	ROLE IN NET-ZERO SYSTEM	SIGNAL TO DECISION- MAKERS		ECONOMIC VIABILITY	ECONOMIC DEVELOPMENT OPPORTUNITY	MATURITY	OPERATIONAL FIT	INFRA- STRUCTURE AND SUPPLY CHAIN SUITABILITY	SOCIAL ACCEPTABILITY	RELEVANCE TO STAKEHOLDERS	RELATED BENEFITS AND COSTS
 Casting, Hot Rolling, and Reheating											
Heat Batteries	Potential Decarbonization Pathway Could support all casting, hot rolling, and reheating temperatures with net-zero heat, contingent on commercialization for higher temperatures.	Incubate Fund demonstrations for high-temperature applications in steelmaking. Support development of co-located clean power to improve economics.	 Net zero but depends on carbon intensity of electricity.	 Currently relies on carbon credits or restructuring of electrical rates for competitive pricing. Capital costs expected to fall.	 Some research is occurring on coupling thermal batteries with nuclear power. Useful to multiple Canadian industries.	 Commercially available up to middle operating temperatures. Technology for high temperatures is expected to be commercial within the decade.	 Would need to replace current furnaces, and align with equipment replacement timelines, but operates very similarly. Can use renewables to provide industrial heat, avoiding intermittency.	 Strongly tied to availability and pricing of electricity. Functions better with co-located clean power.	 Change is implemented within a facility. May be pushback with land changes with buildout of renewables.	 Fits long-term goals but low relevance because this affects a small portion of energy and emissions.	 Land required to co-locate renewables. Less air pollution from replacement of combustion furnaces.
Industrial Heat Pumps	Potential Niche Pathway Can be net zero with clean electricity, but applies to very specific low-temperature use cases.	Incubate Fund targeted demonstrations for low-temperature steelmaking applications. Monitor technology advances toward higher temperature capabilities.	 Net zero, but depends on carbon intensity of electricity.	 Could be cost competitive for low low-temperature use cases.	 Not developed in Canada. Could be useful to multiple Canadian industries.	 Early commercial deployments in U.S. and Europe. Hasn't been used within steel and iron sector.	 Only provides low temperature heat, so useful for limited types of reheating.	 Requires clean electricity. Industrial heat pump supply chain is emerging.	 Change is implemented within a facility and therefore probably not public facing.	 Fits long long-term goals but low relevance because this effects a small portion of energy and emissions.	 Less air pollution from replacement of combustion furnaces. HFC leakages are possible from refrigerants.
Fuel Switching (RNG or Hydrogen)	Niche Pathway Low-carbon fuel substitution. Availability will depend on location and adoption by other closely located sectors.	Enable Support biofuel and hydrogen production. Focus on facilities where fuel switching can be paired with broader decarbonization.	 Reduces combustion emissions in product manufacturing and casting, but dependent on feedstock carbon intensities.	 Hydrogen and biofuels carry cost premiums.	 Could boost Canada's bioenergy and hydrogen sectors.	 Some fuel-switching options are already commercially available.	 Low-disruption for biofuels that are drop-in. More significant retrofit required for hydrogen.	 Requires some infrastructure: biofuels need storage. Hydrogen needs more substantial upgrades.	 Supported for cutting GHGs and improving air quality, though biomass fuels raise some forestry concerns.	 Fits long long-term goals but low relevance because this effects a small portion of energy and emissions.	 Reduces air pollutants.