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REPORT

BUILDING AMERICA'S STEEL ADVANTAGE:
HOW DIRECT REDUCED IRON WILL STRENGTHEN THE STEEL INDUSTRY

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ABBREVIATIONS

BF-BOF	blast furnace–basic oxygen furnace
CBAM	carbon border adjustment mechanism
CDRI	cold direct reduced iron
DRI/HBI	direct reduced iron/hot briquetted iron. This report will discuss mainly the production of DRI. HBI is a special form of DRI optimized for safe transport.
HDRI	hot direct reduced iron
EAF	electric arc furnace
ESF	electric smelting furnace
Mt	million metric tons
Mtpy	million metric tons per year
OBM	ore-based metallics

EXECUTIVE SUMMARY

The United States is the fourth-largest steelmaker in the world, largely because of ample availability of scrap steel and advancements in scrap-based steelmaking. However, scrap-based steel alone can't meet the purity specifications required for critical products like automotive sheet and electrical steel; for that you also need virgin iron inputs. American electric arc furnace (EAF) mills rely on imported virgin iron to fill this need, while integrated mills produce iron domestically using blast furnaces, an outdated, heavily polluting, and inflexible technology. This current operating structure of the domestic iron and steelmaking industry thus leaves the industry exposed to volatile markets, pollutes communities, and constrains long-term competitiveness. Building a more self-sufficient and resilient industry will require investing in domestic capacity to produce these iron units in a more cost-competitive, clean, and flexible manner.

A blast furnace at Edgar Thomson Steel Works in Braddock, Pennsylvania.

As an environmental organization, NRDC sees this as more than an industrial policy problem; it is a missed opportunity to also cut pollution. We seek a clean and competitive industrial sector that supports healthy communities and a resilient economy. Clean technologies that are also economically viable are the surest path to strengthening domestic industry while reducing pollution.

For the U.S. steel industry, the most prominent such technology is direct reduced ironmaking (DRI), which can produce iron domestically while emitting significantly less pollution than conventional ironmaking. Expanding domestic DRI production through policy action would therefore serve two goals at once: reducing the industry's reliance on iron imports and cutting its climate and environmental pollution.

Iron is an important input for steelmaking, whether that steel is produced through the scrap-based EAF pathway or the coal-based blast furnace–basic oxygen furnace (BF-BOF) pathway. Most steelmaking in the United States has shifted from BF-BOFs to EAFs due primarily to the economic advantages and operational improvements of EAFs.[1] But this transition has not eliminated the steel industry's reliance on virgin iron. To produce higher-quality, higher-margin products and to dilute contaminants present in the growing supply of lower-quality scrap, EAFs are relying more and more on virgin iron inputs to produce steel.[2] Because the United States does not produce enough virgin iron domestically to meet this need, EAF steelmakers rely heavily on iron imports from just two countries, leaving the industry vulnerable to supply chain shocks, as evidenced by the 46 percent increase in pig iron import prices after the start of the Russia–Ukraine war.[3]

So, how should the United States produce more iron domestically? Virgin iron is made through one of two pathways: pig iron production via blast furnaces or DRI production. Our evaluation of these two pathways shows that DRI is more competitive. We assess competitiveness on the basis of six factors: access to raw materials, low capital expenditures, low operating expenditures, high operational flexibility, ability to produce high-quality steel, and low exposure to environmental policy and regulatory risks. DRI performs particularly well on operating costs, flexibility, and environmental performance relative to blast furnaces. Most DRI capacity in the United States currently relies on natural gas, and DRI's emissions advantage will grow further in the future if natural gas is partially or fully replaced with clean hydrogen. DRI is therefore positioned as the leading near-term pathway within the broader global shift toward clean iron production and markets preferring lower-carbon goods.

DRI has clear economic, operational, and environmental advantages over pig iron from blast furnaces but has not yet achieved meaningful scale within the U.S. steel industry, held back primarily by the capital costs of new facility construction and limited domestic production of higher-grade iron ore pellets that improve the efficiency of DRI in downstream steel production.

Targeted policy intervention is needed to overcome the barriers that slow the build-out of new industrial capacity and to ensure that growth happens in a way that protects workers and communities. Such intervention will accelerate the transition of the domestic iron and steel industry toward a more economic and resilient pathway while also ensuring important labor and environmental protections.

To accomplish the task of building out DRI production in the United States, we recommend a suite of policy levers organized around strengthening supply, building demand, and ensuring that the transition benefits workers and communities (figure ES-1).

STRENGTHENING SUPPLY:

1. **Offset capital costs for new DRI facilities.** The capital costs of building a new DRI facility are lower than the cost of a new blast furnace, and the DRI-EAF process has lower operating costs than the BF-BOF process. Still, a significant cost barrier remains to build any large, new industrial facility. Public support to lower these capital costs can spark new DRI build-out.
2. **Expand pellet production while controlling pollution.** DRI production can benefit from higher-grade iron ore pellets compared to blast furnaces due to efficiency considerations in downstream EAF steelmaking processes. Policies can motivate upgrades to pelletizing operations to produce higher-grade pellets while also maintaining and strengthening pollution standards around ore processing to protect people and the environment from harmful chemicals such as mercury.
3. **Support the growth of a domestic clean hydrogen industry.** Clean hydrogen production would support resiliency in DRI production (hydrogen-ready DRI plants can switch from natural gas to hydrogen as hydrogen prices decrease). It would also prepare domestic products to compete in markets created by international policies such as the European Union's Carbon Border Adjustment Mechanism (CBAM) to prioritize cleaner manufacturing. Policies that invest in domestic clean hydrogen production now will ensure a sufficient supply of affordable, clean hydrogen in the future.

BUILDING DEMAND:

4. **Create demand for steel produced with DRI.** DRI production currently makes up a small but growing portion of ironmaking in the United States. Policies that create demand for steel produced from DRI will accelerate the growth of the DRI market and thereby encourage DRI production.
5. **Implement new trade policy.** Steel produced from DRI has much lower associated carbon and other pollutant emissions than steel produced from blast furnace–made pig iron. Globally, markets that prefer lower-carbon goods are

FIGURE ES-1: OVERVIEW OF THIS REPORT: EVALUATION OF THE U.S. STEEL INDUSTRY'S COMPETITIVENESS AND POLICY RECOMMENDATIONS

already being created via EU CBAM. The United States can design complementary trade policies that disincentivize imports of steel products with high associated carbon and other pollutant emissions to further drive demand for domestic DRI production.

PROTECTING WORKERS:

6. **Prioritize worker safety and labor protections.** A strong steel industry requires a strong workforce. Policies must promote good labor practices that prioritize family-sustaining wages, stable employment, workforce training, and worker safety.

Expanding domestic DRI production is central to unlocking the full potential of the U.S. steel industry. A reliable domestic DRI supply will further enable the production of high-quality steel, improve supply chain resilience, and position domestic producers for a future shaped by evolving market and policy dynamics. By scaling domestic DRI capacity, the United States will not only close a critical input gap but also build a more competitive, secure, and forward-looking steel industry.

INTRODUCTION

Steel—which is made from iron—is a material fundamental to modern society. In the United States, steel is used primarily in construction and automotive manufacturing, as well as in other vital products such as energy equipment, machinery, and appliances (figure 1). Despite the necessity of steel in important economic sectors, domestic steel supply has not kept up with steel demand. The United States is now a net importer of steel, primarily from Canada, Mexico, and Brazil.[4] Revitalizing the U.S. steel industry is important to securing the supply chains that rely on steel and decoupling essential industries from volatile global markets and geopolitical situations.

Given that steel is a globally traded commodity, reshoring U.S. steelmaking will require strengthening the competitiveness of the U.S. steel industry. Steel products in the United States must be produced at a cost that allows pricing that is not undercut by global competitors.

As an environmental organization, NRDC focuses on mitigating environmental and climate impacts from activities such as steelmaking. Still, solutions that clean up steelmaking also need to be economically viable and support the competitiveness of the steel industry at large. In other words, building a better domestic steel industry means building a cleaner, more resilient, and economically competitive industry in the United States.

Improving the competitiveness of the U.S. steel industry creates opportunities for economic development in local communities, and reshoring production allows greater oversight on pollution and labor impacts, leading to better environmental and labor outcomes.

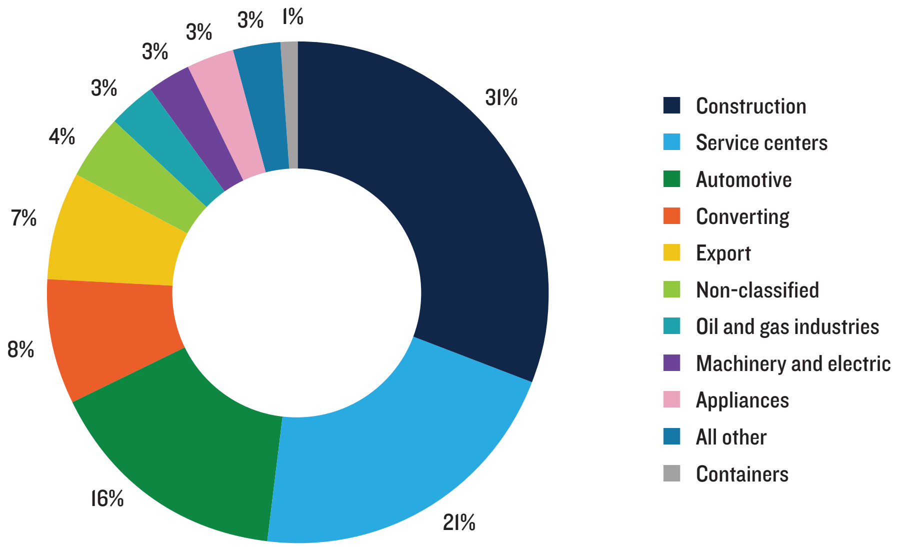
In this report, we identify the growth of direct reduced iron (DRI) production to be the key to unlocking a competitive, resilient, and cleaner steel industry.

We first introduce and utilize a framework (section 1) to evaluate the competitiveness of different iron and steel production pathways in the United States. This framework explains why U.S. steelmaking capacity has been expanding in the form of scrap-based electric arc furnaces (EAFs) while integrated blast furnace–basic oxygen furnace (BF-BOF) steelmaking has declined (section 2).

Ironmaking is an integral step for both forms of steelmaking (figure 2). While EAF steelmaking—which has historically relied mostly on scrap steel inputs—has emerged as the dominant steelmaking pathway in the United States, its increasing reliance on iron inputs to create higher-quality steel products presents a supply chain vulnerability. Currently, domestic ironmaking capacity is not sufficient to meet the demand from EAFs, as evidenced by iron import volumes: U.S. EAFs rely on iron imports to meet around 50 percent of their iron demand (see section 2.2).

FIGURE 1: SHARE OF U.S. DOMESTIC STEEL SHIPMENTS BY END USE IN 2024

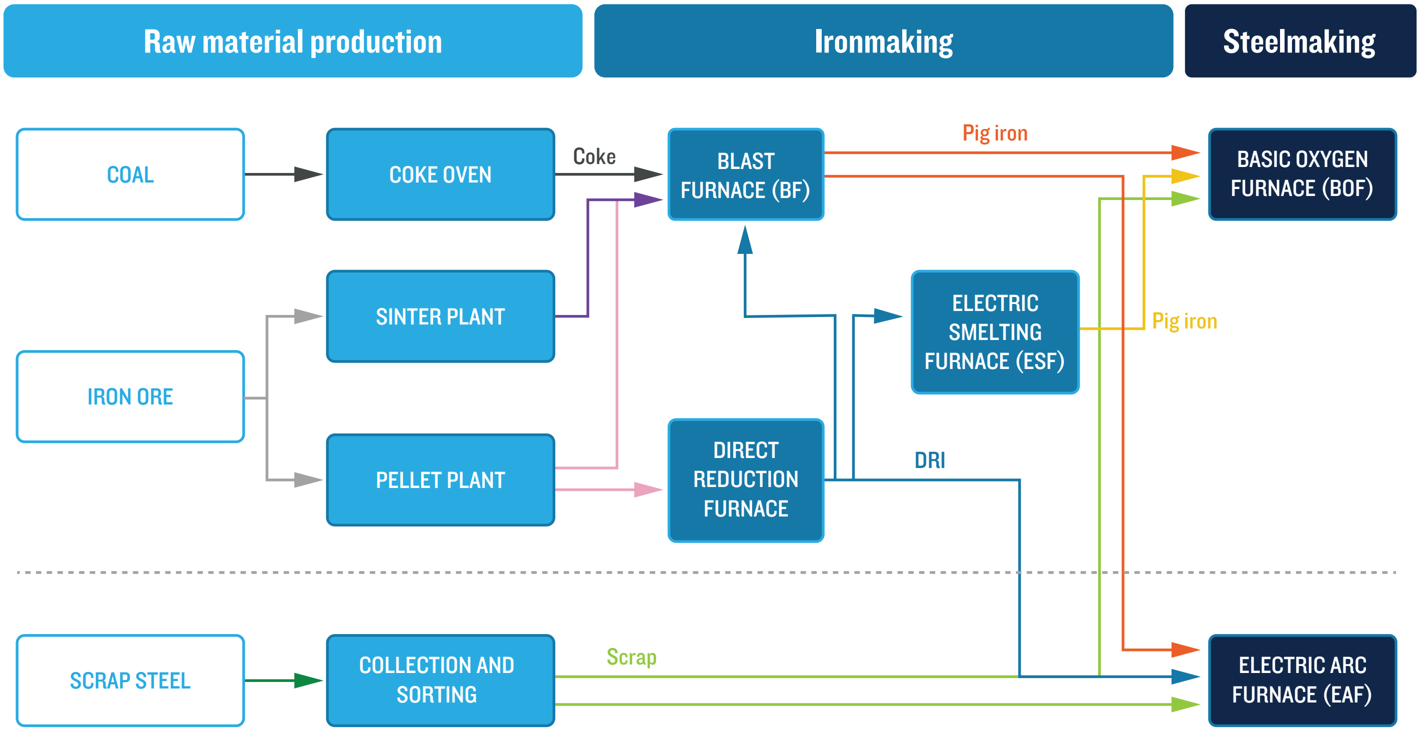
Service centers buy steel in bulk from manufacturers, store it, and sell it to end users, especially small and medium enterprise businesses. Service centers may also process the steel to sizes and shapes specified by end-use customers.



Data source: American Iron and Steel Institute, *2024 Annual Statistical Report*, 25.

FIGURE 2: REPRESENTATION OF IRON AND STEEL SUPPLY CHAIN PATHWAYS

Note that these pathways require additional inputs not shown here, such as fuel inputs or lime fluxes (used to remove impurities in all ironmaking and steelmaking furnaces).



Expanding domestic iron production therefore is an opportunity to further the U.S. steel industry's resiliency and competitiveness in global markets. There are two main iron production pathways that can be pursued: pig iron production from blast furnaces and DRI production.[a] DRI is produced via gases (syngas produced from natural gas or hydrogen) that chemically reduce iron ore in its solid state into DRI, and it creates much lower carbon emissions than does blast furnace pig iron production. Our competitiveness analysis in section 3 indicates that DRI production is more favorable than pig iron production to fill the domestic iron supply gap.

Finally, this report provides recommendations for federal and state policymakers, iron and steel industry representatives, analysts, and policy advocates who are interested in using policy tools to make the U.S. steel industry more competitive (section 4). These policy levers can be used to accelerate the growth of domestic DRI production, ensure that worker and environmental protections are included with DRI build-out, and prepare the steel industry for a decarbonizing future in which products with high carbon intensities become uncompetitive. Achieving these policy objectives will support the expansion of DRI production to strengthen the domestic steel industry for decades to come.

a When this report refers to DRI in the United States, it is referring to gas-based DRI, or DRI produced from using either natural gas–derived syngas or hydrogen as the reducing agent. Some countries, notably India, use coal-based DRI production methods.

SECTION 1:
A FRAMEWORK TO EVALUATE COMPETITIVENESS IN THE STEEL MARKET

In this section, we introduce a framework to evaluate the competitiveness of steel and iron production pathways in the United States. We then use this framework to analyze steel and ironmaking pathways in sections 2 and 3, respectively. Steel is a globally traded commodity, meaning that domestic producers compete directly with international suppliers and are exposed to shifting demand, input costs, and trade dynamics. In this globalized context, competitiveness is not determined by a single factor, but rather by a set of interrelated market forces that influence production costs, operational performance, and risk exposure. The following framework identifies six key criteria—ranging from access to raw materials to policy risk—that together define the characteristics of a competitive domestic steel industry, one that can thrive and grow in an increasingly dynamic and globally integrated market.

i. ACCESS TO RAW MATERIALS

Iron and steelmaking require reliable access to key inputs, including iron ore, scrap steel, and energy. The availability, quality, and cost of these materials are fundamental drivers of competitiveness: Producers with abundant, high-quality, and low-cost inputs can reduce production costs and maintain more stable operations. Secure access to raw materials also lessens exposure to supply chain disruptions and price volatility—an important advantage in a globally traded market where input constraints can quickly erode margins and competitiveness.

ii. LOW CAPITAL EXPENDITURES REQUIRED TO BUILD FACILITIES

Building new steel or ironmaking capacity is inherently capital intensive, but pathways with lower up-front costs reduce investment risk and enable faster, more flexible expansion of capacity. Lower capital intensity improves project economics because of lower financing costs and shorter payback periods that together free up capital that firms can reinvest elsewhere. In contrast, highly capital-intensive technologies tend to lock producers into long-lived assets and rigid cost structures, limiting their ability to adapt to evolving market conditions.

iii. LOW OPERATING EXPENSES OF FACILITIES

Operating costs directly shape the marginal cost of iron and steel production and, in turn, competitiveness in global markets. Pathways with lower and more flexible operating expenses can offer more competitive pricing while maintaining margins, particularly during periods of market volatility. Lower operating costs also reduce firms' exposure to fluctuating input prices, strengthening their ability to sustain production and remain viable across economic cycles.

iv. HIGH OPERATIONAL FLEXIBILITY TO RESPOND TO MARKET CONDITIONS

Iron and steel markets are highly dynamic, with demand, input costs, and energy prices shifting over time. Production pathways that allow operators to adjust output levels, alter product mix, or change fuel inputs can better respond to these fluctuations. This flexibility enables steelmakers to limit losses during downturns, capture opportunities in high-demand periods, and maintain more consistent profitability in a globally traded and volatile market.

v. ABILITY TO PRODUCE HIGH-QUALITY STEEL

Steel demand spans a wide range of applications with varying performance requirements, from basic construction materials to advanced, specification-driven products. Producers that can consistently meet the stringent quality requirements of higher-end applications—such as automotive and appliances—are better positioned to access premium markets and capture higher margins. This capability is therefore a key driver of competitiveness by enabling producers to move beyond commodity segments and differentiate their product offerings.

vi. LOW EXPOSURE TO POLICY AND REGULATORY RISKS

Domestic and global policies shape iron and steel production economics, creating both opportunities and risks. Production pathways with lower exposure to regulatory penalties and greater alignment with existing and emerging policies are better positioned to avoid compliance costs, capitalize on incentives, and gain access to markets, thus remaining competitive in an evolving policy landscape.

SECTION 2:
THE RISE OF AMERICAN EAF STEELMAKING

The United States was once the world's largest steel producer, accounting for 47 percent of global raw steel production in 1950.[5] From a peak of 120 million metric tons (Mt) of steel produced in 1970, U.S. steel production declined precipitously in the 1970s and 1980s.[6] Since 2010, U.S. raw steel production has stabilized at around 80 Mt per year, and today, the United States is the fourth-largest steelmaker in the world.[7]

While overall American steel production has stabilized, the nature of U.S. steelmaking has changed drastically. Throughout the 20th century, steelmaking occurred mainly via the integrated BF-BOF pathway. Most of these facilities have closed over the past couple of decades; only seven facilities are operating blast furnaces today. In contrast, scrap-based EAF steelmaking has grown to dominate the domestic industry since the early 2000s; 85 EAF mills were operating in the United States as of 2025.[8] The United States now has one of the highest shares of EAF steel capacity in the world (figure 3). In this section we evaluate this historical growth in U.S. EAF steelmaking within our competitiveness framework to demonstrate why EAFs will likely continue to dominate U.S. steelmaking going forward.

2.1 EAF STEELMAKING IN THE COMPETITIVENESS FRAMEWORK

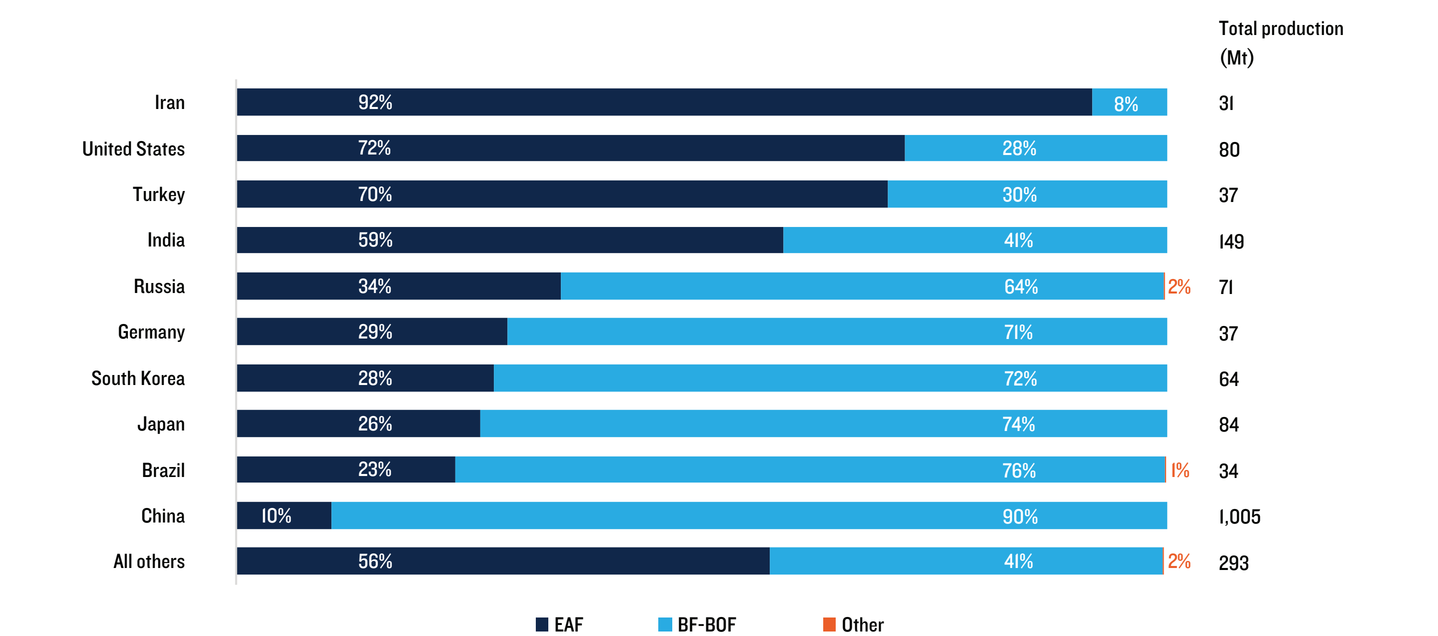
2.1.1 ACCESS TO RAW MATERIALS

The United States has a large and accessible supply of scrap for use in EAFs because many finished steel products have already reached their end of life.[10] Additionally, EAFs can be run mostly on scrap, which is easy to transport. Further, whereas BF-BOFs require coal and iron ore and were historically sited in regions of coal and/or iron ore supply, EAFs—less constrained by access to raw materials—can be sited in places with lower energy costs and higher product demand (i.e., closer to end-use manufacturing facilities).[11]

2.1.2 LOW CAPITAL EXPENDITURES REQUIRED TO BUILD FACILITIES

EAFs have lower capital costs than BF-BOF mills.[12] The initial rise of EAFs in the 1970s and 1980s was driven partly by the lower capital costs of building EAF mills compared with BF-BOF mills. In the 1980s, an EAF mill cost $30–50 million to build, which was a fraction of the construction cost of a BF-BOF integrated mill.[13] For example, in 1962, Bethlehem

FIGURE 3: SHARE OF EAF STEELMAKING AMONG TOP STEEL-PRODUCING COUNTRIES IN 2024[9]



An electric arc furnace at the Steel Dynamics Columbus mill in Columbus, Mississippi.

Steel announced a $250 million investment to begin building Burns Harbor, a BF-BOF integrated mill that is still running today, operated by Cleveland-Cliffs.[14] Currently, an EAF's capital cost per ton of steel is $287, whereas a new BF-BOF mill's capital cost would be $688 per ton.[15]

2.1.3 LOW OPERATING EXPENSES OF FACILITIES

Overall, EAFs and BF-BOF mills have similar total operating costs.[16] However, EAFs rely less on fixed costs—expenses that do not change with production levels—thus giving them greater flexibility to scale output up or down while maintaining more stable margins than BF-BOFs.[17] Lower fixed costs generally allow more flexibility and responsiveness to market conditions, as discussed below.

2.1.4 HIGH OPERATIONAL FLEXIBILITY TO RESPOND TO MARKET CONDITIONS

EAFs can easily modulate production quantity based on demand, whereas blast furnaces are more complicated and costly to idle.[18] EAFs can also easily switch between producing different kinds of steel.[19] Finally, EAFs are more flexible in their raw material inputs. They can minimize raw material costs by using different combinations of scrap, DRI, and pig iron depending on input prices.[20]

2.1.5 ABILITY TO PRODUCE HIGH-QUALITY STEEL

Initially, EAFs were only able to produce lower-quality steel products, such as rebar used in construction.[21] EAF production capabilities have been continually improving, and EAFs can now produce higher-quality, higher-margin products, such as steel for automotive applications.[22] (EAFs still do not produce exposed automotive sheet, the most demanding steel segment, but may begin to do so with Nucor's new, state-of-the-art EAF in West Virginia, scheduled to begin operations in 2027.[23])

2.1.6 LOW EXPOSURE TO POLICY AND REGULATORY RISKS

EAFs produce steel with much lower carbon and pollutant intensity. While this advantage has not been as prominent historically, EAFs are better prepared for a world that is moving toward carbon-conscious trade policies, which penalize traded goods with higher carbon intensities. Additionally, EAFs are at lower risk than BF-BOFs of facing regulatory fines, legal action, and community pushback due to their lower levels of environmental pollution.

2.2 DOMESTIC IRON PRODUCTION MUST BE EXPANDED TO SUPPORT EAF COMPETITIVENESS

2.2.1 DEMAND FOR VIRGIN IRON TO INCREASE WITH EAF PRODUCTION

A critical factor that has enabled the growing capabilities of EAFs to produce higher-quality products and increase their market share, particularly in higher-margin segments such as automotive applications, is the use of virgin iron as a feedstock. As mentioned above, EAFs were initially only able to make lower-quality products ("longs") produced almost exclusively from scrap steel. Now, EAFs can produce high-quality steel ("flats") by adding ore-based metallics (OBMs) to their feedstocks.[24] OBMs refer to iron, such as pig iron and DRI, produced directly from ore. When used in EAFs, OBMs dilute impurities in scrap steel. With OBM inputs, EAFs can produce some of the highest-quality steels needed for automaking (see call-out box). High-quality flats, half of which are produced by EAFs, comprise about two-thirds of domestic steel shipments (figure 4).[25]

OBMs can also allow EAF operators to use lower quality scrap. This benefit is evidenced by mills that produce longs still using OBMs.[26] Doing so allows the increased usage of lower-quality scrap, which alone may have too many impurities to be used for steelmaking.[27] Also, higher-quality, so-called prime scrap is limited in supply and will not keep up with demand.[28] Therefore, EAFs will require more OBM inputs to maintain production quality of steel products, especially for higher-quality steel products that have lower tolerances for impurities.

TECHNOLOGICAL ADVANCEMENTS IN EAF STEELMAKING FOR AUTO MANUFACTURING

Historically, auto manufacturing required high grades of steel with specifications that could be met only by BF-BOF steelmaking. Today, EAFs account for one-third of the automotive sheet market.[30] According to industry, EAFs are able to produce very high grades of steel—such as advanced high-strength steel and ultra-high-strength steel—that are needed for cars.[31] Some car components are made from lower grades of steel as well: U.S. automakers use mild steel and high-strength EAF steels for vehicles' frames.[32] EAFs can produce these high grades of steel by incorporating high-quality scrap and OBM inputs.[33] For example, there are plans to build a new DRI plant at U.S. Steel's advanced Big River EAF facility in Arkansas to further support automotive steel production.[34]

From 2021 through August 2025, nearly 80 percent of the 19 Mt of newly planned, completed, or under-construction EAF steel production capacity was for higher-quality flats (table 1).[35] As more of this high-quality production comes online, more OBMs will be needed to supply the expanding EAF facilities.

However, U.S. domestic OBM supply cannot keep up with the growing OBM demand of the U.S. EAF fleet, which is reliant on imports to meet OBM demand (see section 2.2.2). Growing domestic OBM (i.e., ironmaking) capacity can fill this gap and support the continued, resilient growth of domestic EAF steelmaking.

FIGURE 4: U.S. DOMESTIC STEEL SHIPMENTS BY PRODUCT TYPE IN 2024[29]

Flats are a category of steel products referring to sheets and plates. Longs are a category of steel products referring to bar, structural, wire, and rail products.

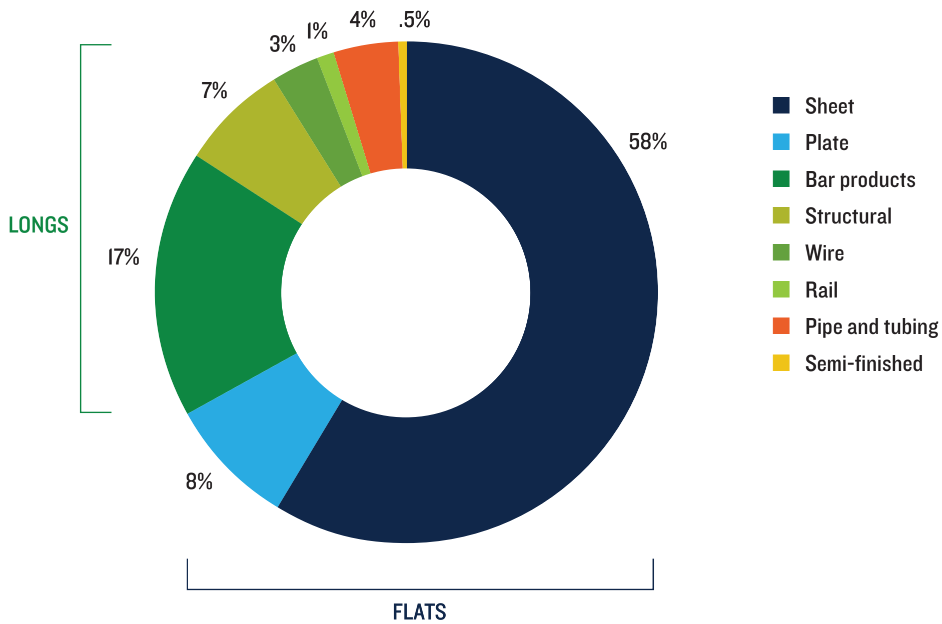


TABLE 1: EAF PRODUCTION CAPACITY PLANNED, COMPLETED, OR UNDER CONSTRUCTION SINCE 2021[36]

	Steel company	Location	Production capacity (Mtpy)
Reinforcing bar	Hybar	Osceola, AR	0.5
	Nucor	Kingman, AZ	0.5
	CMC	Mesa, AZ	0.5
	CMC	Berkeley, WV	0.5
	Pacific Steel	Mojave, CA	0.4
	Nucor	Lexington, NC	0.4
	Vinton Steel	Vinton, TX	0.1
		TOTAL	2.9
Flat-rolled steel	Hyundai Steel	Donaldsonville, LA	2.7
	U.S. Steel	Osceola, AR	2.7
	Nucor	Mason, WV	2.7
	Steel Dynamics	Sinton, TX	2.7
	ArcelorMittal	Calvert, AL	1.5
	Nucor	Ghent, KY	1.3
	Nucor	Brandenburg, KY	1.1
	North Star BlueScope	Delta, OH	0.9
		TOTAL	15.6

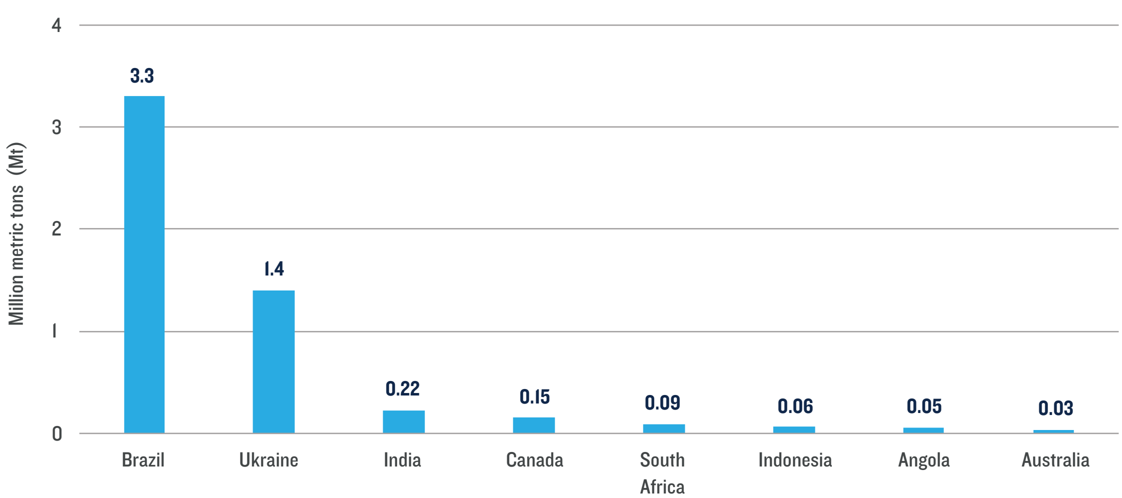
2.2.2 RELIANCE ON OBM IMPORTS LEAVES THE DOMESTIC STEEL INDUSTRY VULNERABLE TO THE GLOBAL MARKET

The current gap between OBM supply and demand in the United States is clear in the EAF steelmaking segment's large reliance on OBM imports.[37] U.S. EAFs rely on imported OBMs to meet around 50 percent of their OBM demand: Every year, between 4 and 6 Mt of OBMs are produced domestically (all DRI, no pig iron) for EAFs, compared with 5 to 7 Mt of OBMs imported for EAF consumption.[38]

Not only does the U.S. EAF segment significantly rely on OBM imports, but it relies on a nondiversified source of OBMs. In 2025, the United States imported 6.8 Mt of OBMs: 1.5 Mt of DRI and 5.3 Mt of pig iron.[39] Of the 5.3 Mt of pig iron imported in 2025, 3.3 Mt, or 62 percent of the total, came from Brazil (figure 5). All of the 1.5 Mt of DRI came from Nucor's Nu-Iron facility in Trinidad and Tobago.[40] With 70 percent of its OBM imports coming from just two countries, U.S. EAFs, which comprise the majority of the country's steelmaking industry, are left extremely vulnerable to supply chain disruptions.

FIGURE 5: IMPORTS OF PIG IRON TO THE UNITED STATES IN 2025 BY COUNTRY[41]

The United States imported 5.3 Mt of pig iron in 2025. More than 60 percent of it came from one country: Brazil.



Historical events further highlight this vulnerability of the U.S. EAF steelmaking supply chain. Between 2018 and 2021, Ukraine and Russia accounted for more than 70 percent of pig iron imports into the United States, and imports from Brazil comprised most of the remainder.[42] The start of the Russia-Ukraine war in February 2022 severely disrupted pig iron supply chains, causing U.S. steelmakers to search for other sources.[43] This disruption sent pig iron unit values soaring more than 40 percent, with the average unit value going from less than $550 per ton in January 2022 to $781 per ton in June 2022.[44] In August 2025, Brazilian pig iron was exempted from a proposed 50 percent tariff after the threat of the tariff alone led to canceled orders and production stoppages.[45]

While it is not uncommon for steel industries around the world to be dependent on nondiversified, concentrated sources of raw materials (e.g., Australia and Brazil contributed almost 90 percent of China's iron ore imports in 2022), history shows us that such dependency leaves the steelmaking supply chain vulnerable to external forces.[46] The United States must expand domestic iron production to secure the OBM supply that is critical to EAF steelmaking. The following section discusses why DRI is the best iron production pathway to building that resilient domestic supply chain.

SECTION 3:
MARKET FORCES WILL FAVOR DIRECT REDUCED IRONMAKING (DRI) OVER BLAST FURNACE IRONMAKING

Domestic OBM supply needs to grow to ensure the continued competitiveness of U.S. steelmaking. Both pig iron and DRI are currently essential to U.S. EAF competitiveness, but as the industry grows, it must decide whether to invest in both ironmaking pathways equally or prioritize one over the other. By evaluating the two ironmaking pathways within the framework laid out in section 1, this section will demonstrate that investing in DRI capacity as opposed to blast furnace ironmaking capacity will be more competitive.

DRI is already growing faster than blast furnace ironmaking; DRI production globally grew 23 percent[b] between 2020 and 2024, whereas pig iron production fell 2 percent, showing that global markets already favor the growth of DRI.[47] In the United States in particular, three DRI facilities have been built in the last 15 years while blast furnace capacity has been steadily declining, thus showcasing the favorable domestic market conditions that support DRI production (table 2).[48]

TABLE 2: DRI PLANTS IN THE UNITED STATES, OPERATING AND PLANNED[49]

DRI plant	Location	Start date	Capacity (Mt)	Product category
OPERATING				
Cleveland-Cliffs	Toledo, OH	2020	1.9	HBI (MIDREX®)
Nucor	St. James Parish, LA	2013	2.5	CDRI (Energiron)
ArcelorMittal	Corpus Christi, TX	2017	2	HBI (MIDREX®)
PLANNED				
U.S. Steel	Big River, AK	2029	2.5	HDRI/HBI (MIDREX®)
Hyundai	Ascension Parish, Louisiana	2029	2.7	HDRI, CDRI (Energiron)

b This figure excludes the growth of DRI in India, where most DRI is produced via coal-based methods.

3.1 ACCESS TO RAW MATERIALS

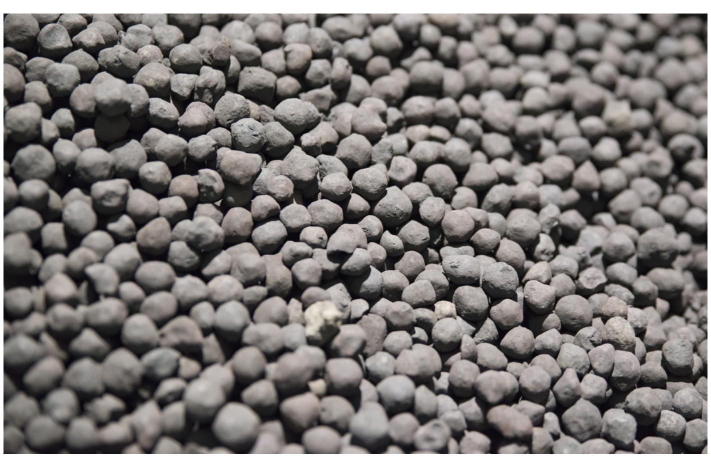
The large, existing iron ore reserves in the United States are composed mostly of low-grade taconite, an appropriate feedstock for blast furnace ironmaking. Blast furnaces can take iron as an input in several different forms and with differing iron content: lump iron ore, sinter fines, and pellets. Blast furnace–grade pellets typically have an iron content of 65 percent or lower, with lump iron ore and sinter fines traded at a baseline iron content of 62 percent.[50] In contrast, DRI plants require iron ore in the form of pellets.[51] Conventionally, pellets with iron content higher than 67 percent are used for DRI production. This constraint is not a technical limitation of DRI furnace technology but rather a practical one: When DRI is fed into downstream EAFs to make steel, higher levels of impurities from the iron pellets can lead to significant efficiency losses in the EAF.[52]

Improvements in ore processing technologies have already enabled production of high-grade iron ore pellets from the low-grade U.S. iron ore supply and will continue to do so. Taconite processing can profitably extract iron and yield high-grade pellets to maximize DRI efficiency in EAFs.[53] Two pelletizing plants that produce higher grade pellets already exist in the United States, both co-located with iron ore mine sites in Minnesota, and a new mine and high-grade pellet plant are under construction, also in Minnesota.[54]

3.2 LOW CAPITAL EXPENDITURES REQUIRED TO BUILD FACILITIES

As in most places in the world, the United States' current blast furnace ironmaking capacity is larger than its DRI capacity. Some analyses may therefore compare the capital costs of existing blast furnaces with the higher capital costs of building new DRI facilities. The main capital cost for existing BF-BOF mills is relining the blast furnace, and this represents only one-third of the capital costs required to build a new DRI-EAF steelmaking facility.[55]

However, given the old age of the current U.S. blast furnace fleet and the trend of idling and shutting down blast furnaces in recent decades, strengthening U.S. steelmaking will require investments in new facilities. When considering new builds, DRI plants have much lower capital costs. In 2010, Nucor was considering a phased $2 billion investment to build two blast furnaces and a coking facility in St. James Parish, Louisiana.[56] However, Nucor eventually decided to construct one DRI facility in lieu of one of the blast furnaces because the capital cost for a blast furnace and accompanying coke oven would have been more than twice the capital cost for a DRI facility; the would-be second blast furnace was never built.[57] This example highlights the favorable capital expenses of a DRI facility when the real-world investment decisions facing steelmakers are evaluated.



A pile of iron ore pellets.

A blast furnace at U.S. Steel's Gary Works mill, located on the shore of Lake Michigan in Gary, Indiana.

3.3 LOW OPERATING EXPENSES OF FACILITIES

The lower cost of fuel and reducing agent for DRI production leads to lower operating costs for DRI relative to blast furnaces. Today in the United States, the natural gas DRI-EAF steelmaking pathway has lower operating expenses than the coal-based BF-BOF steelmaking pathway due primarily to lower costs of natural gas compared with metallurgical coal.[58]

However, given the large renewable energy potential in the United States, operating costs for clean hydrogen–based DRI production could become cost competitive in the future. Natural gas DRI facilities that are hydrogen-ready will be best poised to capitalize on future lower operational expenses afforded by hydrogen as a reductant (see call-out box and section 3.6).

3.4 HIGH OPERATIONAL FLEXIBILITY TO RESPOND TO MARKET CONDITIONS

DRI production is flexible on the reducing agent that turns iron ore into iron, whereas blast furnaces are reliant on coal. DRI plants can be built to accept a mixture of natural gas and hydrogen in what is often referred to as hydrogen-ready DRI (see figure 6) and can optimize their reductant mix based on market conditions such as price, price volatility, and supply chain risk.

Blast furnaces, on the other hand, rely on metallurgical coal, which must be processed into coke in energy-intensive coking ovens.[59] While natural gas is currently the least expensive reducing agent for DRI production, it may not always be the cheapest or most favorable option, especially as some global markets move toward favoring low-carbon-intensity steel products (see section 3.6). Therefore, DRI production's ability to use multiple feedstocks increases its resiliency to fluctuating market conditions.

In addition to being flexible to reducing agent input with a hydrogen-ready plant configuration, DRI production can be more easily idled and restarted than blast furnace iron production. The inside of an operating blast furnace has multiple states. Different solid inputs (iron ore, coke, and limestone) are added in alternating layers at the top. The bottom of the furnace, where the temperature is highest, has molten iron sitting below a layer of molten slag (i.e., impurities).[60] If a blast furnace is idled for longer than ten days, all of the material inside will cool and become solid.[61] Idling and restarting a blast furnace therefore requires a careful sequence of operations to ensure the material structure inside does not collapse.

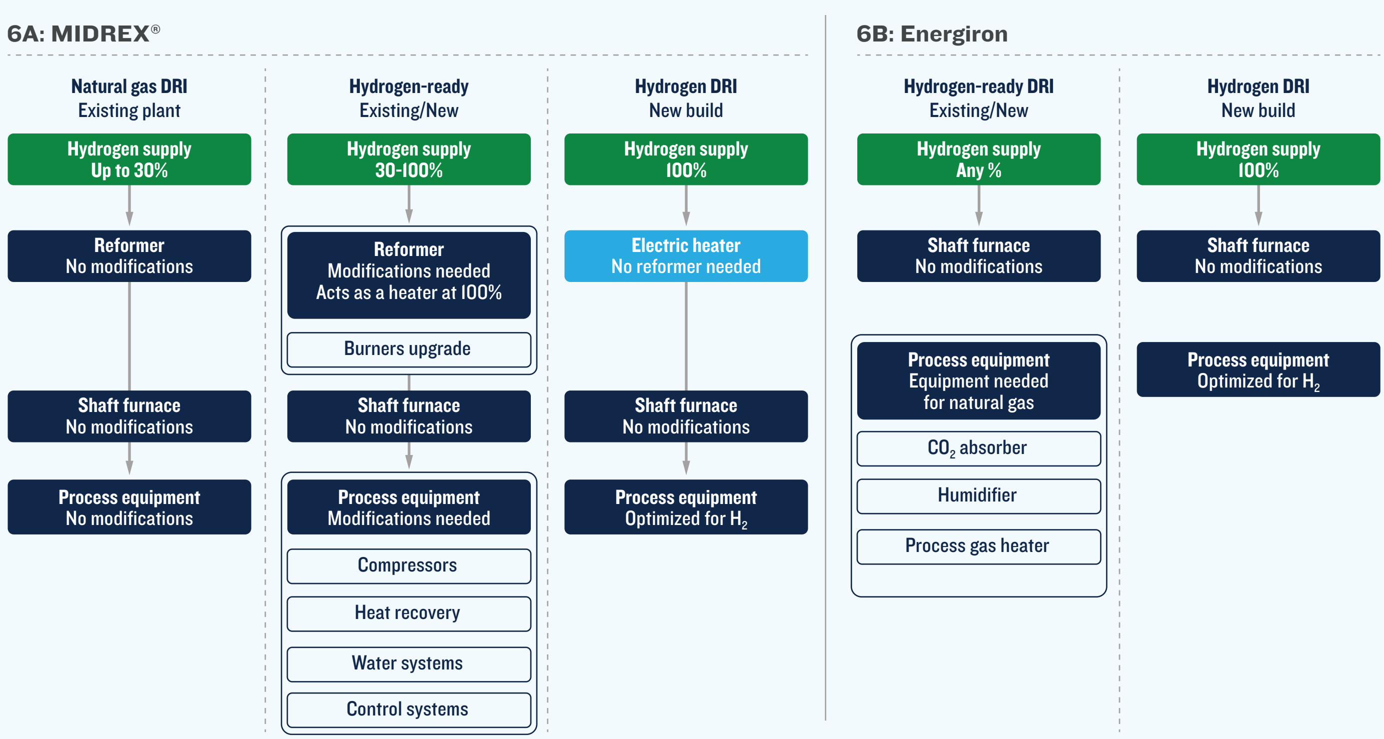
In contrast, the inside of a DRI furnace is much less complicated. Iron ore pellets fall from the top as hot gases travel upwards; the iron remains in a solid state.[62] Therefore, restarting an idled DRI furnace is a less sensitive procedure. DRI furnaces can also be run at reduced capacity for extended periods of time, whereas blast furnaces always operate at or near full capacity.[63] The ability to more easily idle and restart and to adjust DRI production gives DRI production an edge over blast furnace ironmaking to meet shifting demand in today's volatile steel markets.

CONFIGURATIONS OF DRI PLANTS BY REDUCTANT

Current natural gas-based production of DRI first converts natural gas into syngas, a mixture of hydrogen and carbon monoxide. The syngas reduces the iron oxide pellets into iron in the shaft furnace. There are two commercialized DRI production processes used in the United States: the MIDREX® Process and Energiron.[64] The MIDREX® Process utilizes an external reformer to convert natural gas into syngas, whereas the Energiron process converts natural gas to syngas inside the shaft furnace itself.[65] The Energiron process has an extra CO_2 absorber to control CO_2 levels in the process gases, which are recycled into the shaft furnace.[66]

Both processes (MIDREX® and Energiron) can replace significant amounts of natural gas with hydrogen addition.[67] Some equipment, including heating, compressing, heat recovery, and process water systems would require modifications for optimal performance at high levels of hydrogen substitution.[68] For a new build that uses 100 percent hydrogen, a MIDREX® plant would not require a reformer; it could instead use an electric heater.[69] While an Energiron plant does not have a reformer to begin with, a 100 percent hydrogen configuration would not require natural gas-specific process equipment, such as a CO_2 absorber and extra heaters.[70]

FIGURE 6: CONFIGURATIONS OF DRI PLANTS, INCLUDING HYDROGEN-READY DRI, WITH A) MIDREX® AND B) ENERGIRON TECHNOLOGIES[71]



3.5 ABILITY TO PRODUCE HIGH-QUALITY STEEL

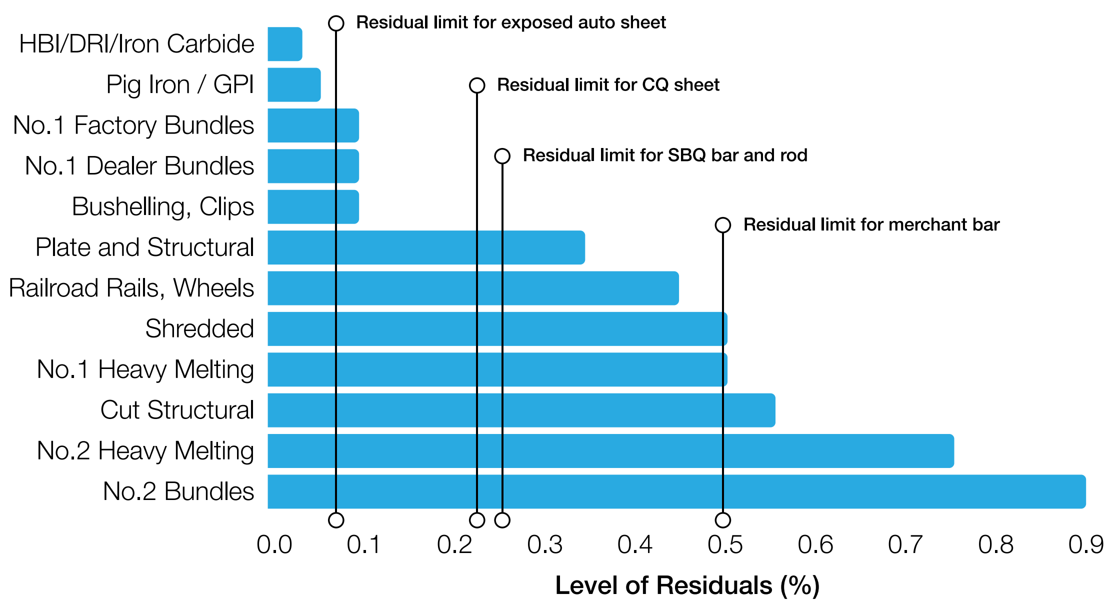
DRI allows EAF steelmakers to produce higher-quality (i.e., higher-value) steel products than with scrap inputs alone. Higher-quality steel products require iron inputs that are low in impurities. DRI and pig iron are the only sources of iron metallics with residual (i.e., contaminant) levels low enough for the most stringent applications, such as automotive sheet manufacturing (figure 7).

Not only does DRI provide a significant value-add for high-quality steelmaking by EAFs, but it can also support high-quality steelmaking for BF-BOF steelmakers. The blast furnace can be replaced with a DRI furnace and an electric smelting furnace (ESF)[c] while maintaining the existing equipment (e.g., the basic oxygen furnace) and high-quality product portfolio at a BF-BOF mill.[72] The ESF uses electricity to melt DRI, which is in a solid state, into liquid iron that can then be directly fed into the BOF at an integrated mill (figure 8). In other words, the ESF allows the BOF equipment to operate without changes, as the BOF was designed to take in liquid pig iron directly from the blast furnace, and can therefore minimize the risk of stranded assets for existing BF-BOF mills.

Furthermore, the DRI-ESF-BOF pathway offers flexibility beyond even that of a DRI-EAF by allowing a wider range of grades of iron ore inputs. The ESF step removes impurities from iron, so a DRI-ESF configuration can use lower-quality, blast furnace–grade iron ore pellets (without the efficiency losses that doing so in the DRI-EAF configuration would cause).[73]

FIGURE 7: RESIDUAL LIMITS (PERCENTAGE OF STEEL MELT CHEMISTRY) FOR COMMON TYPES OF STEEL PRODUCTS

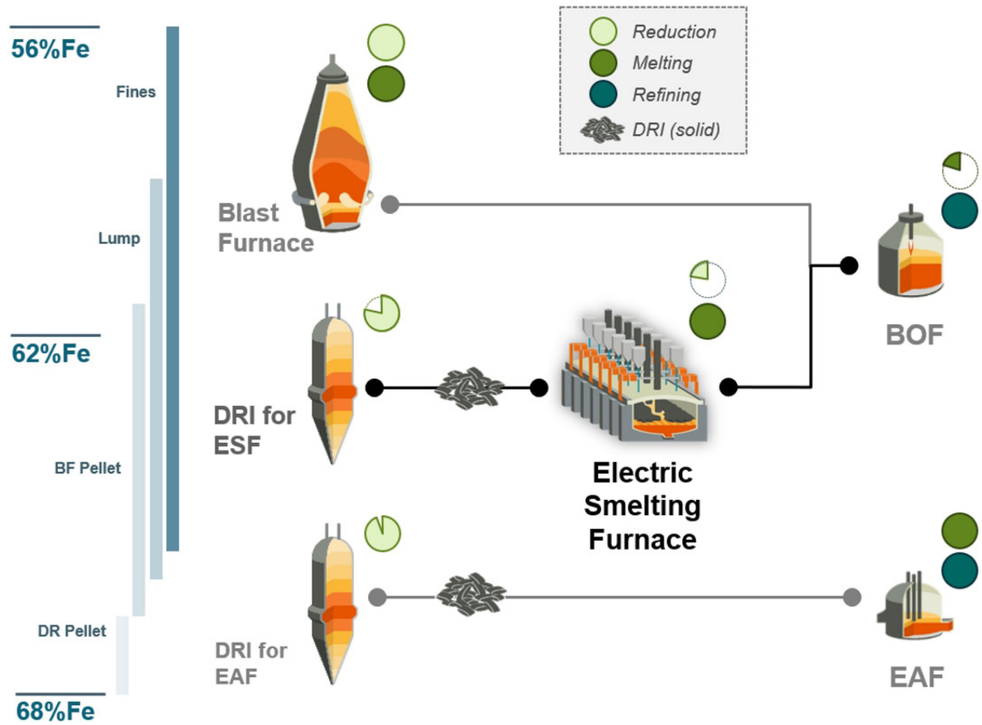
Higher-quality steel products have lower levels of residuals. Only DRI and pig iron fall under the residuals threshold for automotive-quality sheet.



Source: International Iron Metallics Association, Fact Sheet #11, https://www.metallics.org/wp-content/uploads/2024/08/IIMA_OBM_Factsheet_11_DRI_EAF_Steelmaking.pdf, 2.

c In this report, "electric smelting furnace" refers to the category of equipment that melts and reduces iron. ESF types include the submerged arc furnace. ESFs are also sometimes called electric melting furnaces.

FIGURE 8: REPRESENTATION OF RECONFIGURING INTEGRATED STEEL MILLS WITH DRI PRODUCTION



Source: Gadd et al., 2023, https://www.bhp.com/news/bhp-insights/2023/06/pathways-to-decarbonisation-episode-seven-the-electric-smelting-furnace.

3.6 LOW EXPOSURE TO POLICY AND REGULATORY RISKS

DRI production emits significantly lower levels of both carbon and air pollutant emissions than blast furnace pig iron production. As a result, steel products made from DRI are at lower risk of being excluded from emerging markets for low-carbon products. DRI facilities are also at lower risk of regulatory action from running afoul of pollutant limits, losing their social license to operate in communities, and facing community opposition to their operations.

3.6.1 CARBON-CONSCIOUS TRADE POLICY

Carbon-conscious trade policy that penalizes imports of high-carbon-intensity materials and prevents carbon leakage is creating markets for low-carbon steel products. The European Union's Carbon Border Adjustment Mechanism (CBAM) is the most noteworthy example of such a policy.[74] EU CBAM increases the competitiveness of lower-carbon-intensity production routes by raising the cost of imports of products whose associated carbon emissions exceed a certain benchmark. The United Kingdom, Norway, Canada, and Australia are also considering CBAMs.[75]

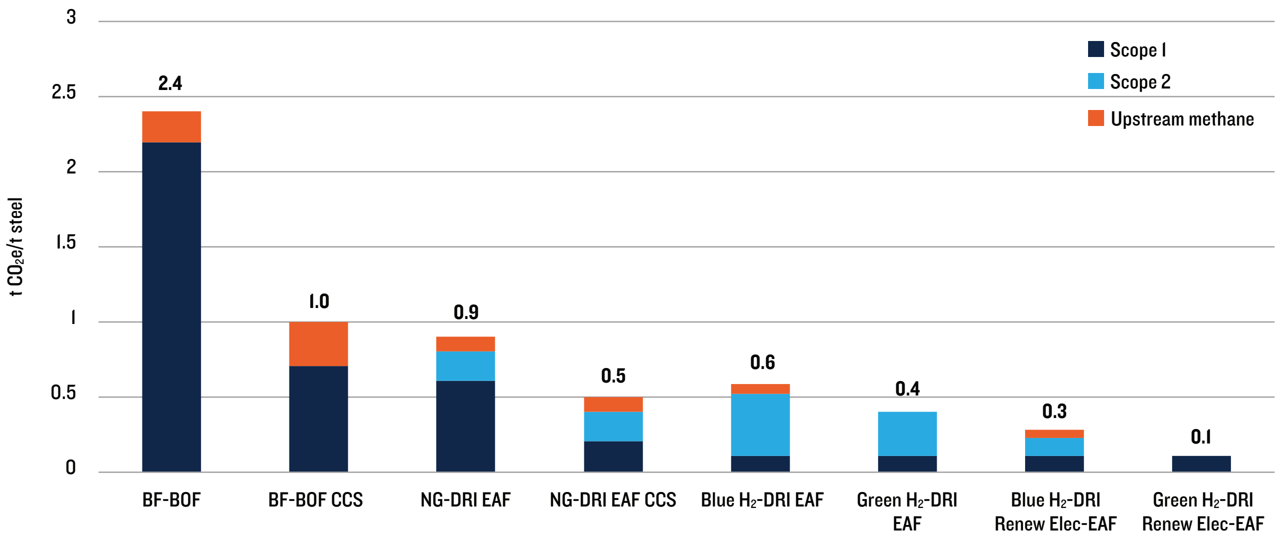
The direct carbon emissions from a DRI furnace are less than half of those from a blast furnace, even when DRI production is natural gas–based.[76] As a result, DRI-EAF steel has much lower emissions than BF-BOF steel and will be more competitive in markets that prioritize low-carbon-intensity goods (figure 9). In fact, the carbon intensity of unabated BF-BOF production for U.S. plants surpasses the EU CBAM provisional benchmark (1.370 tCO_2e/t steel), and only the lowest-carbon-intensity DRI-EAF routes meet the relevant CBAM benchmark (0.481 tCO_2e/t steel).[77]

As previously noted, installing hydrogen-ready DRI allows DRI plants to adjust their reductant mix depending on market conditions. Investing in hydrogen-ready DRI may also prevent stranded assets and other opportunity costs in the face of markets prioritizing decarbonization.

Generally, steel made from DRI that uses hydrogen produced from renewable electricity (clean hydrogen), and steel made from EAFs running on renewable electricity, will yield the lowest-emissions product. However, clean hydrogen production costs—\$3 to \$8/kg H_2—are too high for this pathway to be economical right now, as ironmakers and steelmakers are willing to pay only \$1 to \$2/kg H_2.[78] If clean hydrogen were priced closer to \$1/kg H_2, hydrogen DRI steel would be cheaper than natural gas DRI steel.[79] Absent any policy intervention, clean hydrogen costs are projected to decline significantly and could be lower than \$2/kg H_2 in 2050.[80] As hydrogen costs become more competitive due to both technology advancements and emerging policies such as EU CBAM, hydrogen-ready DRI plants can gradually increase the share of hydrogen in their reductant mix to minimize costs and gain access to markets protected against products with high carbon intensity.

FIGURE 9: AVERAGE CARBON EMISSIONS INTENSITY OF STEELMAKING PATHWAYS

CCS stands for carbon capture and storage; NG stands for natural gas; blue H_2 is hydrogen produced from natural gas with CCS; green H_2 is hydrogen produced from electrolysis with renewables. Assumptions: 2023 U.S. grid for base EAF, 1.2 percent methane leakage rate, 75 percent CCS on BF and NG-DRI, 96 percent CCS on blue H2, 50 kg H_2/t steel for DRI, 20 percent scrap steel used for all pathways.



Data sources: RMI, "Forging a Clean Steel Economiy in the United States," 2023; GREET 2023.

3.6.2 REGULATORY RISK

DRI's lower pollutant emissions compared with blast furnace iron production also reduce business operational risk. DRI-EAF produces significantly lower emissions of pollutants such as carbon monoxide, particulate matter, sulfur dioxide, and nitrogen oxides[d] than does BF-BOF, which includes pollution from coking operations (figure 10).[81] These reductions in harmful emissions lower the likelihood of steelmakers facing compliance costs and potential lawsuits for violating air quality regulations.

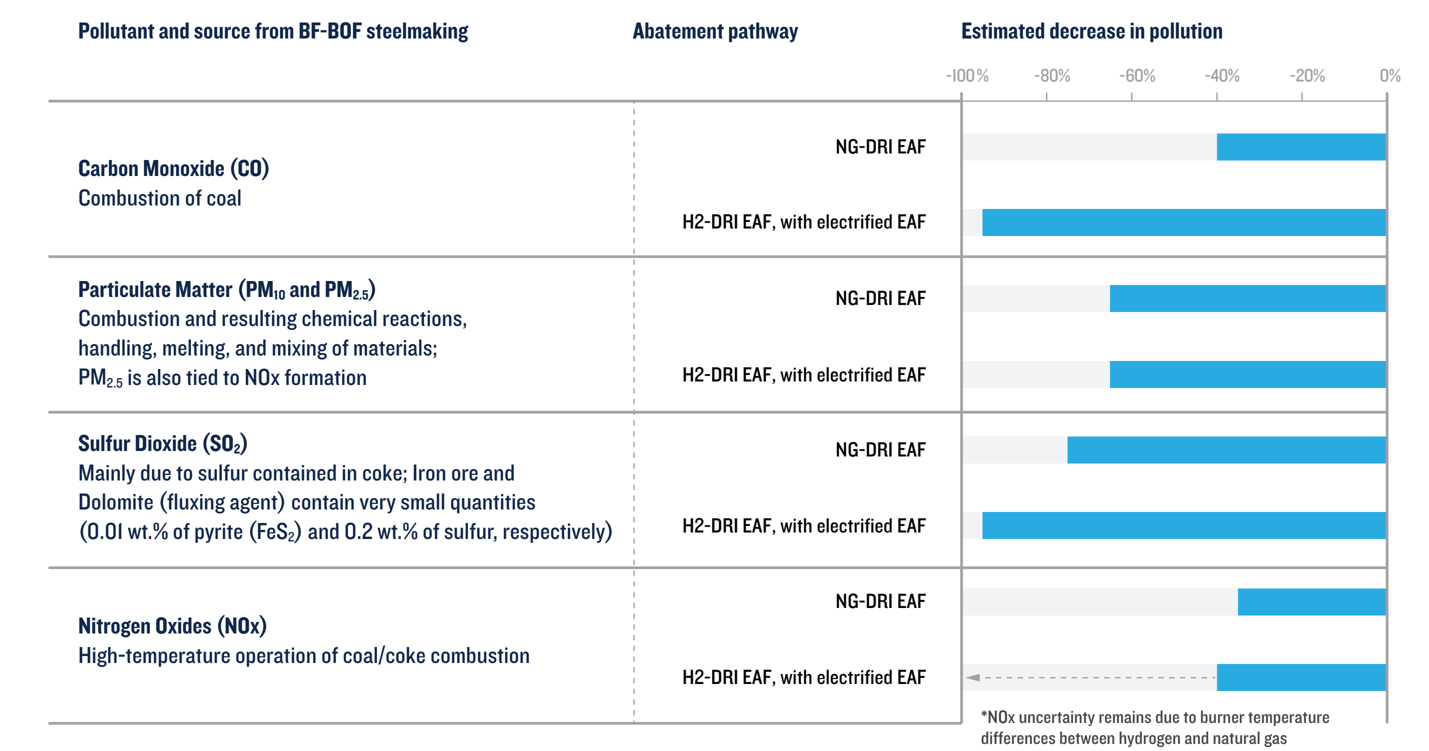
Conversely, harmful pollution from blast furnaces increases the likelihood of community opposition, which can ultimately hurt the bottom line for steelmakers and endanger their social license to operate from nearby communities. For example, in 2024, U.S. Steel reached a $42 million settlement in a citizen-enforced lawsuit for pollution violations at Clairton Coke Works; this settlement also requires U.S. Steel to close dozens of their worst-polluting coke ovens at the site.[82]

© Drew Angerer/Getty Images

Edgar Thomson Steel Works, located near a residential neighborhood in Braddock, Pennsylvania.

d In the case of hydrogen DRI, further work must be done to quantify nitrogen oxides (NOx) emissions from hydrogen DRI production. Regardless, these emissions would need to be controlled.

FIGURE 10: ESTIMATED DECREASE IN POLLUTION FOR DRI-EAF STEEL PRODUCTION COMPARED WITH BF-BOF STEELMAKING



Adapted from source: Masterson et al., 2025, https://rmi.org/resources/reline-or-revitalize-the-narrowing-window-to-modernize-the-us-steel-industry/.

THE HEALTH COSTS OF BLAST FURNACES

The pollution from blast furnace ironmaking disproportionately impacts vulnerable communities. For example, 47 percent of those living within three miles of Cleveland-Cliffs' Dearborn Works facility are Black, indigenous, or people of color, and 60 percent are low-income.[83] More than 44 percent of those who live within three miles of U.S. Steel's Clairton Coke Works in Pennsylvania are Black, and 30 percent live below the poverty line, ranking the city of Clairton in the 90th percentile for poverty.[84] Carcinogens and pollutants from the plant and other nearby facilities have resulted in some of the highest childhood cancer and asthma rates in the United States, with Clairton also having one of the highest rates of air pollution–related deaths.[85] These statistics highlight why community opposition to steelmaking can be so strong and underline the urgent need to mitigate harmful pollution from steelmaking by transitioning to less-polluting pathways.

Clairton Coke Works, owned by U.S. Steel, is located near a residential neighborhood in Clairton, Pennsylvania.

Clairton resident Melanie Meade at a 'Rally for Our Health' protest outside the MetCoke Conference held in Pittsburgh, Pennsylvania, on November 8, 2023.

SECTION 4:
POLICY OBJECTIVES TO ENABLE NEW DRI CAPACITY IN THE UNITED STATES

While DRI production is favored domestically and globally by market forces, policies are needed to accelerate the growth of domestic DRI capacity to secure U.S. steelmaking supply chains. The United States was the sixth-largest producer of DRI globally as of 2024, but its capacity of 6 million metric tons per year (Mtpy) is still only a small fraction of global DRI capacity of 89 Mtpy.[86]

The U.S. steel industry is well poised to strengthen its resiliency and competitiveness. Given the existing market advantages of DRI production, moderate and finite policy support can catalyze a huge shift in domestic iron and steelmaking and pay dividends for decades to come. Additionally, it is important for policymakers to send strong, reliable policy signals to create real momentum for DRI growth in the United States (see call-out box).

POLICY UNCERTAINTY CAN INHIBIT NEW DRI PROJECTS

In 2024, the U.S. Department of Energy's (DOE) Office of Clean Energy Demonstration's Industrial Demonstrations Program announced funding for 29 industrial decarbonization projects, including awarding $500 million each to two projects to build new DRI plants in the United States. However, the abrupt pivot in policy priorities between the Biden and Trump administrations led to these DRI projects stalling.[87] Steel company SSAB was selected to build a first-of-its-kind hydrogen DRI plant in Mississippi. In January 2025, SSAB officially withdrew from negotiations with DOE. In the second project, Cleveland-Cliffs was selected to build a hydrogen-ready DRI-ESF plant to replace its blast furnace at Middletown Works in Ohio. In 2025, Cleveland-Cliffs announced plans to use the funds to continue coal-based steel production and reline its blast furnace.[88] This uncertainty showcases the importance of policy clarity in sending a strong signal to companies to invest in new large capital projects.

While states can play pivotal roles in helping to transform domestic ironmaking, as shown by an example in Louisiana (see call-out box), the federal government can mobilize billions—rather than millions—of dollars to accomplish the task. Therefore, federal policies must take the lead in revitalizing previous momentum to support the modernization and resiliency of the domestic steelmaking industry by building new DRI facilities.

To support DRI growth and the resiliency of the steel industry more broadly, federal policymakers should focus on six key objectives to strengthen supply, build demand, and protect workers.

POLICY TOOLS COMING TOGETHER AT THE STATE LEVEL

Hyundai's planned DRI-EAF facility in Louisiana shows the power of policy to create a supportive financial ecosystem to catalyze large manufacturing investments. In the wake of high steel tariffs that increased the cost of steel imports by 25 percent in 2025, Hyundai Steel Company chose to build their $5.8 billion facility in Louisiana after the state offered Hyundai a compelling incentives package that included the following:[89]

- $100 million performance-based grant for infrastructure improvements
- Tax incentives
- Partnership with the Port of South Louisiana to build a deep water dock for steel and other material shipments
- Major transmission projects by Entergy Louisiana to provide additional load-serving capacity for new projects like Hyundai's steel mill

The multi-pronged nature of Louisiana's incentives package demonstrates the many types of government action needed to secure investment in capital-intensive manufacturing projects. In particular, the package included infrastructure improvements that are crucial to the success of a new iron and steelmaking facility.

Iron being transported at ArcelorMittal's HBI facility near Corpus Christi, Texas.

4.1 STRENGTHENING SUPPLY OF DRI

In this section, we outline three policy objectives to increase the supply of DRI in the United States. Increasing supply will require not only building new DRI facilities but also supporting the supply chains of the raw materials needed for DRI production.

4.1.1 OFFSET CAPITAL COSTS FOR NEW DRI FACILITIES

Once new DRI plants are built, their operations will be favored by market forces. The capital costs of new DRI facilities are also lower than the capital costs of new blast furnaces (section 3.2). Still, public funds can provide an essential catalyst to overcome the initial capital barriers to building new DRI facilities, whose capital costs can amount to more than $1 billion.[90] Policies should support both building greenfield DRI plants and transitioning existing blast furnaces to DRI-ESF assets.

Although momentum for supporting new DRI facilities has somewhat stalled at the federal level, policies should re-catalyze this investment momentum. **Grant programs**, such as the currently stalled Industrial Demonstrations Program, can reduce the initial capital barriers for companies to build new plants. Other federal policy levers that can help offset capital costs and provide debt financing for new DRI facilities include **tax credits** and **loan programs**.

The MIDREX® Module 2 DRI shaft furnace at the Tosyali Algerie complex in Oran, Algeria. This plant is tied for the largest single module DRI plant in the world with a capacity of 2.5 Mtpy.

The Northshore Mining taconite plant located on Lake Superior in Silver Bay, Minnesota.

4.1.2 EXPAND PELLET PRODUCTION WHILE CONTROLLING POLLUTION

The expansion of higher-grade pellet production will support a secure domestic DRI supply chain, but this expansion must not come at the cost of greater pollution. Producing higher-grade pellets requires more steps than producing BF-grade pellets, and upgrading ore processing operations can be expensive: Cleveland-Cliffs invested $100 million in expanding its Northshore Mining operations to produce higher-grade pellets in 2019, and U.S. Steel invested $150 million in installing DRI pellet capability at Keetac in 2024.[91] Public grants or loans, such as Minnesota's loan to support Mesabi Metallics' new mine and higher-grade pelletizing plant, can accelerate these necessary upgrades and expansions.[92]

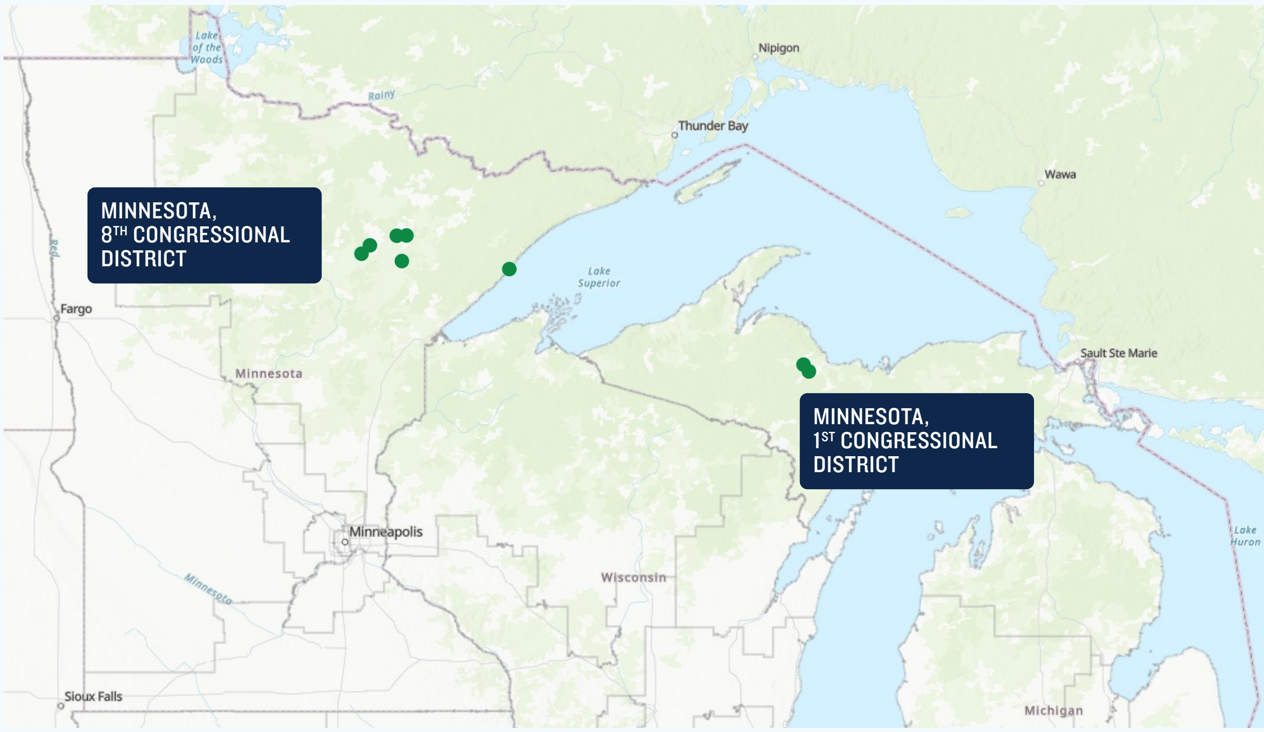
Still, public dollar investments in modernization must be paired with **pollution regulations** to mitigate environmental and community health risks from pellet production. Ore processing emits harmful pollutants such as mercury and hydrofluoric acid. For example, Minnesota, where most domestic iron ore mining occurs, has been unable to meet its statewide mercury emissions reduction goals due to uncontrolled emissions from mining operations.[93] To combat ore processing pollution, the U.S. Environmental Protection Agency (EPA) released amendments to the National Emissions Standards for Hazardous Air Pollutants (NESHAP) in 2024 to require additional controls at some ore processing facilities to further reduce mercury and acid gas emissions.[94] However, in 2025, the Trump administration extended the compliance deadline by two years, and it is considering rolling back the rule (see call-out box).[95]

For pollution reductions to truly materialize across the industry, the EPA must reinstate the NESHAP amendment for taconite ore mining and enforce state air and water permits. To qualify for federal funding, projects should also have to upgrade pollution control and monitoring practices at mining facilities.

AT WHAT COST? EXEMPTIONS FROM EMISSION STANDARDS

In 2024, the EPA established limitations on the emissions of acid gases and mercury from ore processing facilities to protect communities from unreasonable and active exposure and risk, with compliance required by 2027.[96] Despite compliance costs estimated at less than 1 percent of annual sales revenue, in 2025, the federal government granted taconite ore processing facilities a blanket exemption from these hazardous air pollution limits, in contradiction to the EPA's own scientific and technical findings from just a year prior (figure 11).[97] The taconite ore exemption was one of several exemptions from hazardous air pollution standards applicable to more than 180 facilities. NRDC is challenging the full suite of exemptions in court.[98] A thriving, modern, and competitive iron and steel supply chain need not come at the expense of people's health.

FIGURE 11: MAP OF TACONITE ORE SITES (GREEN DOTS) WHERE AIR TOXICS STANDARDS (FOR MERCURY AND ACID GASES) ARE EXEMPTED[99]



4.1.3 SUPPORT THE GROWTH OF A DOMESTIC CLEAN HYDROGEN INDUSTRY

Policies should also support the development of a domestic clean hydrogen industry, as doing so would be a valuable and complementary step to support the future resiliency of the domestic DRI industry. Hyundai is already considering the use of hydrogen in its forthcoming DRI plant in Louisiana.[100] The plant will employ Energiron technology, which can use natural gas or hydrogen and is expected to be 100 percent hydrogen ready.[101] As shown previously in this report, clean hydrogen DRI production will be advantageous in the long term given the growth of markets for low-carbon goods led by the implementation of the of EU CBAM, as well as the decreasing costs of hydrogen production (section 3.6.1). Additionally, clean hydrogen for DRI production will increase the carbon advantage of U.S. steel products and can generate revenue for the domestic steel industry when paired with carbon-conscious trade policy (section 4.2.2). Therefore, investing in the nascent domestic clean hydrogen industry now can ensure a sufficient supply of clean hydrogen for cleaner DRI production in the future. An immediate step that policymakers can take is **extending the shortened 45V hydrogen production tax credit**, a technology-neutral incentive that offers a subsidy per kilogram of clean hydrogen produced depending on its carbon intensity.[102] The 45V credit is currently set to expire for projects that do not commence construction by the end of 2027.

4.2 BUILDING DEMAND FOR DRI

In this section, we highlight two policy objectives to increase demand for DRI-made steel products to encourage upstream production of DRI.

4.2.1 CREATE DEMAND FOR STEEL PRODUCED WITH DRI

Given that DRI still makes up a relatively small portion of ironmaking in the United States and globally, policies that create demand for steel produced from DRI will help grow the DRI market and encourage DRI production. To drive demand for these cleaner downstream steel products, government policy can establish benchmarks for clean steel through definitional **standards** and motivate producers to collect and verify carbon emissions data on their products.

BEYOND DRI, EMERGING IRON PRODUCTION TECHNOLOGIES COULD SHAPE THE FUTURE OF THE INDUSTRY

DRI is a readily available, competitive, commercialized ironmaking technology, but there is exciting innovation that may in the future significantly change the landscape of the U.S. ironmaking and steelmaking industry. For example, U.S. startup Electra is developing a low temperature process to use electricity and acidic solutions to convert iron ore into iron without the use of coal or natural gas for heat or as a reducing agent.[103] Boston Metal had also been developing an electrochemical steel production process but is now focusing on other metals.[104] Another startup, Hertha Metals, produces steel from any grade of iron ore in a single step using natural gas (or hydrogen) and electricity.[105] These technologies are less commercialized than DRI and are still moving from pilot scale to demonstration plants, with some setbacks.[106] RD&D funding and investment should continue to support innovation in these technologies, especially since they have the potential to provide the competitiveness benefits of DRI to the same or greater extent once commercialized. These technologies can unlock the use of lower grades of iron ore, are built in modular formats to allow greater operational flexibility and ease of scalability, and eliminate significant sources of environmental and carbon pollution from ironmaking and steelmaking.[107]

A pile of hot-briquetted iron, a form of DRI suitable for shipping.

A number of nongovernmental groups including Responsible Steel and the Low Emission Steel Standard have already begun work to define international standards that reward steel producers taking action to reduce their carbon emissions. To avoid being left out of the international market, the United States must develop policies supporting a standardized definition of clean steel that is both interoperable with international standards and compatible with domestic incentive policies.

Collecting data on steel products' life cycle carbon emissions and reporting results in environmental product declarations are important components in creating standards.[108] **Environmental product declarations** are documents that show verified and standardized environmental impacts, including greenhouse gas emissions, of a product based on its life cycle assessment. They provide a baseline understanding of emissions within an industry's product portfolio and make it possible to set emissions benchmarks. They also contain important information about a specific product to allow verification if a product meets a certain emissions standard.

Policies should support manufacturers in creating these environmental product declarations. For example, the EPA's Environmental Product Declaration Assistance Program funded foundational activities to support manufacturers in developing environmental product declarations for construction materials.[109] Expanding this program or creating new programs to go beyond the construction sector and cover environmental product declarations for all steel products will pave the way to clean steel standards and consequently enable levers that increase demand for DRI.

Once robust data and standards are established, additional supply incentives and demand creation measures, such as public or private procurement policies for clean steel, can be implemented.

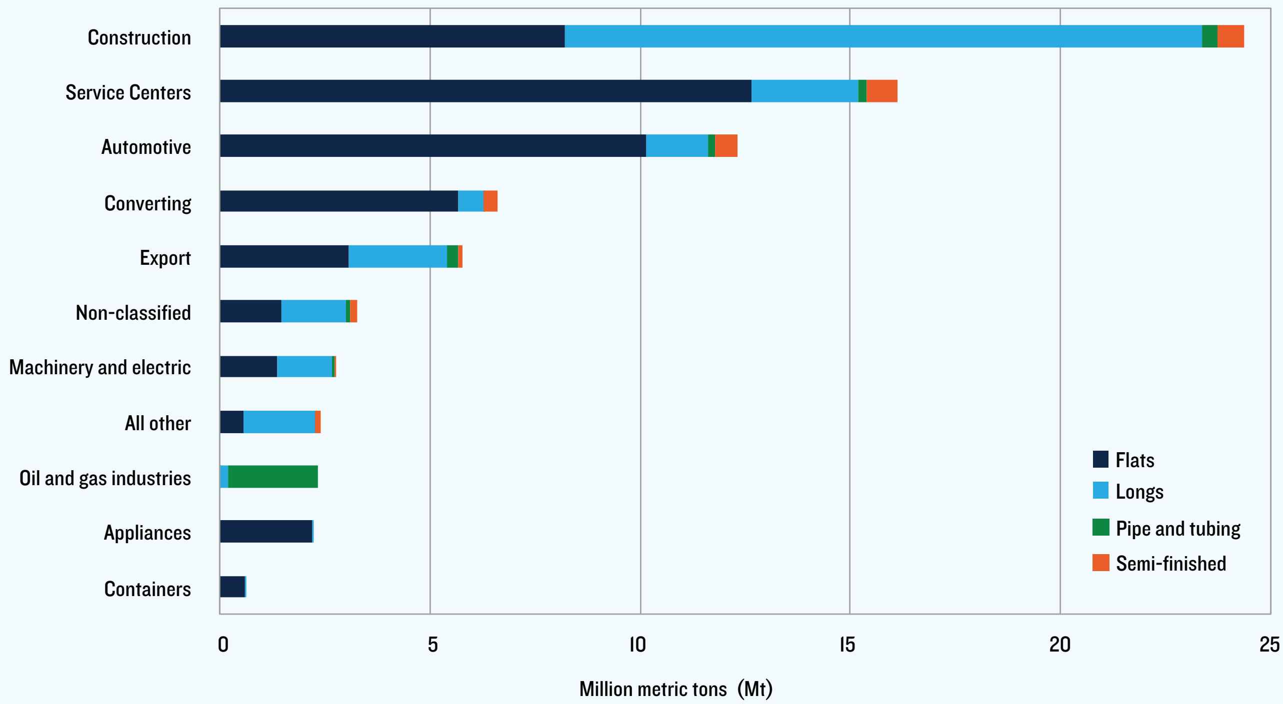
Contracts for difference are one mechanism to address potentially low demand (and resulting low prices) for clean steel products made with DRI. Contracts for difference lower the cost of private capital by reducing investment risk. This is done by guaranteeing a price for steel products. A contract for difference sets a predetermined "strike price" at which steel producers could produce clean steel profitably.[110] If the market price for clean steel falls below this strike price, the government pays the difference.

The U.S. government can also **support private-sector initiatives** that increase demand for cleaner steel. One such initiative is SteelZero, a global corporate effort that brings together organizations to commit to buying net zero emissions steel by 2050 and to collaborate on working toward commitments, thus strengthening the market for net zero steel.[111] The U.S. government can also work with large steel end users, such as automakers, to drive demand. The auto industry is quite consolidated—just six automakers make up more than 70 percent of the U.S. automotive market—so the government could facilitate purchasing commitments that drive demand for cleaner steel and, consequently, DRI production, by collaborating with just a handful of automakers.[112] Of note is the dual challenge of supply and demand for cleaner steel in the automotive sector (see call-out box).

AUTOMOTIVE PROCUREMENT OF DRI-MADE CLEAN STEEL FACES DEMAND AND SUPPLY BARRIERS

The automotive sector's large consumption of higher steel grades and commitments to sustainability goals make it an important demand driver for DRI production. The automotive sector accounted for 16 percent of domestic steel shipments in 2024, making it the second-largest end use for steel shipments after construction (excluding intermediate service centers).[113] The sector's high usage of higher steel grades, which need OBMs, presents an opportunity to increase demand for DRI: More than 80 percent of steel products shipped for the automotive industry were higher-quality flats products in 2024 (figure 12).[114]

FIGURE 12: U.S. DOMESTIC STEEL SHIPMENTS BY END-USE MARKET IN 2024[115]



Interestingly, the cost premium of procuring cleaner steel made from DRI is not high for the automotive sector. One 2025 analysis showed that if U.S. cars' body-in-white steel[e] (representing 40 to 70 percent of total steel in a vehicle) were replaced with steel made from clean hydrogen, the cost premium of the steel itself would be 42 percent, but the total cost premium for an average vehicle would be less than 1 percent.[116] Even with this low expected cost premium, automakers may not voluntarily purchase lower-emissions steel, as evidenced by the sector's unwillingness to commit to offtake steel from the formerly proposed DRI project at Middletown Works.[117] Therefore, policy levers to increase demand for DRI-made steel are essential to support upstream DRI production.

In addition to soft demand, a significant barrier to DRI-made steel being used in automotive end uses will likely be the lack of clean steel supply. The top six auto manufacturers in the United States all have carbon neutrality commitments by 2050 at the latest.[118] However, automakers do not have a lot of control over the available steel supply (perhaps with the exception of Hyundai, whose steel arm is building the new DRI-EAF plant in Louisiana). Even with the advancement of EAF technology for automaking, the reliance of U.S. EAFs on pig iron imports will make achieving these carbon neutrality commitments quite difficult. Therefore, bolstering the supply of domestic DRI is essential to unlock truly clean steel for automaking.

e The stage in automotive manufacturing when a vehicle's frame has been assembled but before it has been painted or fitted with moving parts and trims (e.g., motor, electronics, seats, glass).

4.2.2 ADVANCE NEW TRADE POLICY

To prepare the domestic iron and steel industry for a world increasingly rewarding lower-carbon-intensity goods, the United States should design complementary trade policies that disincentivize imports of dirtier iron and steel products to further drive demand for domestic DRI production. One such mechanism, **pollution border fees**, places fees on imported goods that have higher carbon and other pollutant emissions intensities than equivalent products produced domestically. Fees increase as the difference in emissions intensities widens. As a result, domestic steelmakers that invest in cleaning up their production avoid having their sales undercut by cheaper, dirtier products made elsewhere. The best-known example of a pollution border fee applied to carbon emissions intensity is the EU CBAM.

The United States is currently considering two proposals that apply only to carbon emissions: the Foreign Pollution Fee Act (FPFA), first introduced by Sen. Bill Cassidy in 2023, and the Clean Competition Act (CCA), first introduced by Sen. Sheldon Whitehouse in 2022. Both of these proposals were reintroduced in the current (119th) Congress.[119] The FPFA would place a tariff on imported goods with higher carbon intensities than the same goods produced in the United States. The CCA would place a similar carbon-based fee on higher emissions intensity imports but would also include a domestic carbon price, which would apply a fee per ton of carbon dioxide emitted above a certain benchmark. The CCA also specifies that revenue generated from the carbon border fee would subsidize cleaner domestic production. Such design elements create a funding source for new cleaner technology deployment, like DRI. Future proposals can include additional pollutants.

4.3 PROTECTING WORKERS

In this section, we emphasize the need for policies to adequately protect workers, as a strong workforce is necessary to ensure a healthy steel industry.

4.3.1 PRIORITIZE WORKER SAFETY AND LABOR PROTECTIONS

Revitalizing the iron and steel industry must include prioritizing worker safety and labor protections, as workers will be a vital part of a successful transition to competitive, environmentally friendly, DRI-based steelmaking. In terms

An electric arc furnace at the NLMK Indiana facility in Portage, Indiana.

of worker safety, steps must be taken to prevent workplace accidents and fatalities, such as the tragic deaths of two workers in an August 2025 explosion at U.S. Steel's Clairton Coke Works.[120] Investments in upgrading, transitioning, and building facilities must also include investments in **worker safety measures**.

Labor protections are also crucial to building sustainable and dependable jobs that will support the growth of the U.S. steel industry. Labor practices that prioritize family-sustaining wages, workforce training, stable employment, and worker safety consistently deliver better outcomes for both workers and employers.[121] In the steel industry specifically, where replacing experienced workers carries significant cost, where safe operations depend on accumulated skill and judgment, and where the value of the materials moving through production is high, the business case for these practices is extremely robust.

CONCLUSION

The growth of U.S. DRI production is critical to securing the resilience and competitiveness of U.S. steelmaking, which currently lacks access to a sufficient domestic supply of iron. DRI production offers important market advantages over blast furnace iron production in terms of operating costs, operational flexibility, and future-proofing for low-carbon markets while still supporting high-quality steel production. DRI production also offers significant climate and environmental advantages over pig iron production and is an important piece in decarbonizing and cleaning up the domestic steel industry.

While expanding domestic DRI capacity would be supported by market forces in the long run, policies focused on growing DRI and clean steel would catalyze a favorable investment environment to mobilize capital in an industry that runs on thin profit margins and is susceptible to global market fluctuations. Policies should therefore support the entire value chain of DRI, including securing raw materials and flexible fuels, incentivizing cleaner production facilities with strong worker support, and driving demand for clean steel in downstream manufacturing sectors. By targeting these objectives, policies can unlock a thriving domestic steel industry.

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