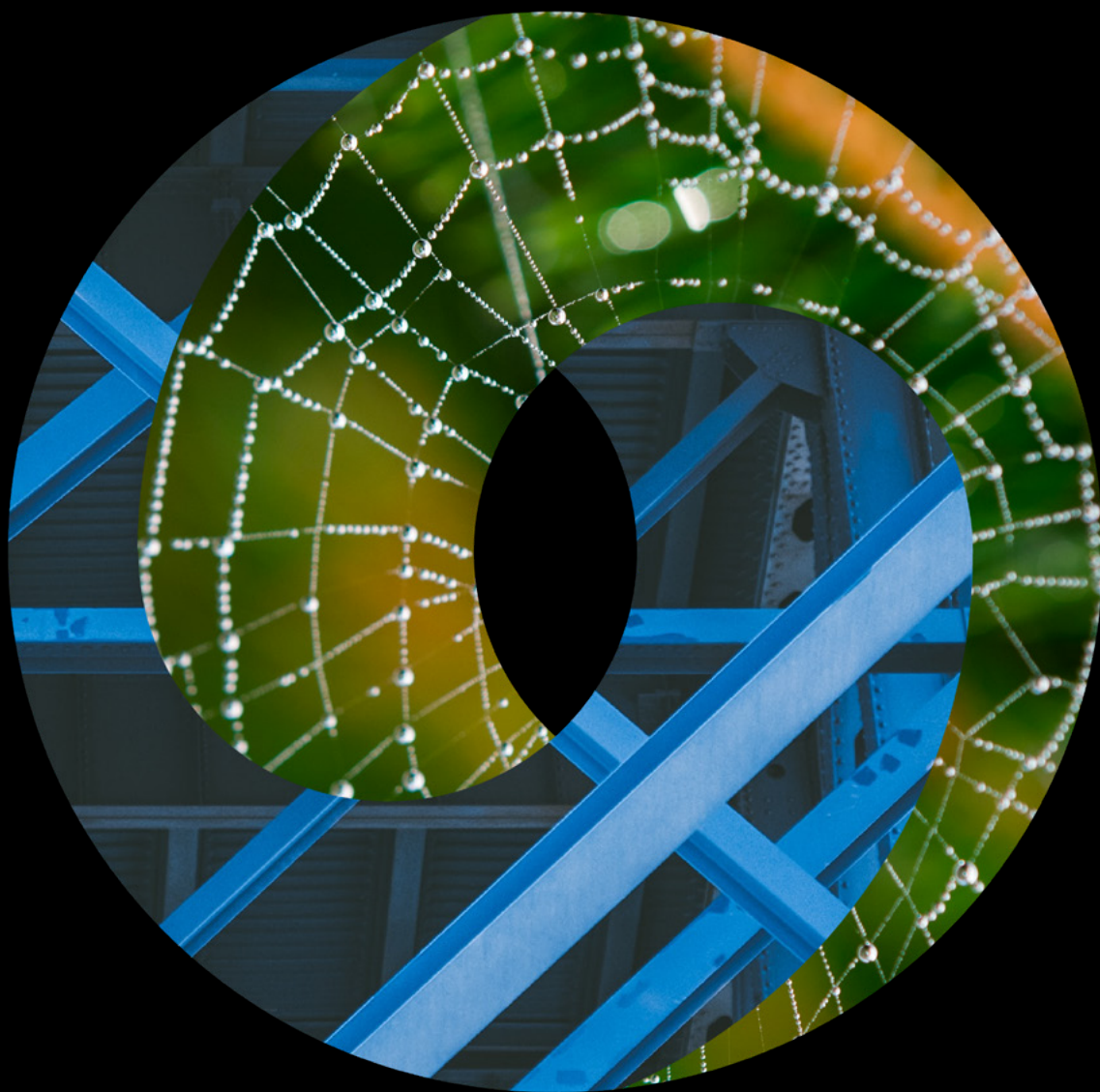


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# Steel

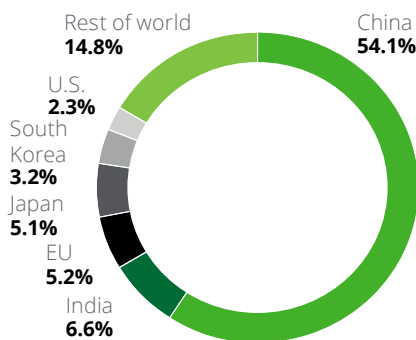
Pathways to decarbonization

# Sector landscape

## The steel sector produces 7% of global industrial emissions

In 2020, the global steel sector was directly responsible for 7% of total worldwide industrial CO<sub>2</sub> emissions—or approximately 2.6 billion tonnes. China was responsible for 50% of total emissions (Figure 1) reflecting, in part, China’s large share of overall steel production.

Figure 1: **Estimated steelmaking CO<sub>2</sub> emissions per region (2019)<sup>1</sup>**



Source: Global Efficiency Intelligence and Deloitte analysis

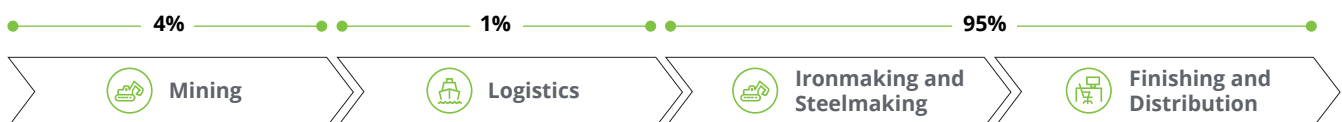
## Emission sources

From a value chain perspective (Figure 2), the sector’s highest source of emissions stem from the use of fossil fuels for different steelmaking production routes—such as coke production (using coke ovens), iron ore melting (using blast furnaces), and iron-to-raw-steel conversion (using basic oxygen furnaces) (Table 1).

Table 1 **Typical direct and indirect emissions generated from different steelmaking production routes**

Steelmaking route	CO <sub>2</sub> emissions (TCO <sub>2</sub> /T steel)
Blast furnace – Basic oxygen furnace (BF-BOF)	2.2
Scrap-based electric arc furnace (EAF)	0.3
Natural gas direct reduced iron (DRI)	1.4

Figure 2: **Proportion of emissions per stage of the steelmaking value chain**



While approximately 70% of global steel is produced globally this way,<sup>2</sup> companies in the steel sector are widely committed to limiting global warming to 1.5 degrees Celsius, as per the Paris Climate Accord. As a result, many have clear commitments to reduce CO<sub>2</sub> emissions between 30% to 40% by 2030 (as compared to previously measured 2015-2018 emission levels). Furthermore, the same companies are committing to a net-zero target date of 2050 (or earlier in some cases).

Moving the entire industry towards decarbonization will be a challenge—as companies are at varying levels of maturity, and many haven’t yet started their transformative journeys. Additionally, decarbonization pathways will vary dramatically from region to region as there are significant differences in how steelmaking technologies are deployed across the world and, as a result, varying CO<sub>2</sub> intensity of steel production (tons of CO<sub>2</sub> per ton of steel). The United States (US) currently has the lowest CO<sub>2</sub> intensity, due to it having the highest share of scrap-based Electric Arc Furnace (EAF) technologies.

In contrast, India and China have the highest CO<sub>2</sub> intensities, due to a predominance of coal as fuel and Blast Furnace (BF) ironmaking. Despite having a relatively high share of BF-based ironmaking of around 60%, the European Union (EU) has achieved the lowest average CO<sub>2</sub> intensity for BF-based steelmaking, through implementing advanced BF technologies, which has successfully reduced emissions by around 50% over the past 50 years.

That said, the good news is, in most cases, the basic necessary conditions for transformation are already set—and most companies have viable technology options. In this article, we’ll explore how emerging technologies, shifting regulations, and customer demand for green steel are shaping the sector—as well as identify potential implementation strategies.

# Implementing a net-zero value chain

## The industry's objective: a net-zero value chain by 2050





Achieving these targets will be anything but easy. In many cases, steel producers will have to make incremental reductions in emission levels through improvements to existing production technologies (such as installing top pressure recovery turbines on a blast furnace) and processes (such as enhanced digital predictive process control and monitoring). Some companies may also have to overhaul their existing methods of primary steel production.

## Emerging technologies and abatement strategies

To achieve net-zero, steel producers are evaluating a number of technologies, many of which are at differing stages of commercial readiness (Table 2). Ironmaking using hydrogen-based direct-reduced iron production is seen as one of the primary approaches to help companies achieve their goals. Additionally, many companies are exploring opportunities to lower emissions through the increased usage of recycled scrap steel, melted via the EAF steelmaking process.

Given differing regional cost dynamics associated with renewable energy and green hydrogen, many companies are also evaluating how these variations may impact key parts of steel value chain—both today and in the future.

Table 2:  
**Examples of (new) decarbonization technologies being evaluated by steelmakers**

			
Hydrogen-based DRI (direct reduced iron)	Electrolysis of iron ore using renewable electricity	Biomass and hydrogen injection in the blast furnace (BF)	CCS/U (Carbon Capture Storage/ Usage)

## Current challenges

Having established ambitious emission targets, some steel producers have already started making the transition. However, the steel industry continues to face several key implementation issues. These include:



### Technology maturity and skills

- Young age of existing steelmaking assets that will be replaced
- Varying maturity of proven enabling decarbonization technologies
- Shortage of skills in engineering, metallurgy, and IT/software



### Shortage and cost of green hydrogen and renewable electricity

- Lack of green infrastructure for renewable electricity and hydrogen production
- High cost of green hydrogen may make green steel uncompetitive



### End-consumer markets

- Variable demand for green steel from different regions and industries
- Low appetite to pay significantly higher “green premium” price for low-carbon steel
- Continued reliance on higher-carbon steel due to China’s (continued) speed of industrialization and the recent global economic downturn



### Regulations and policies

- Phasing in/out of Carbon Border Adjustment Mechanism (CBAM) and EU Emissions Trading System (ETS) could negatively impact steel producers (in EU)
- Lack of a low-carbon steel taxonomy and clear certification standards
- Regulatory framework could level the playing field between different regions and countries



### Financing and capital expenditures

- High-asset investments needed (e.g., in EU estimated at around US\$70-100 billion)
- Steelmakers have low profit margins and may not be able to absorb investment costs



### Raw material availability

- Scarcity of high Fe-content iron ore needed for DRI and pressure on supply sources
- Limited availability of high-quality, prime scrap for EAF production

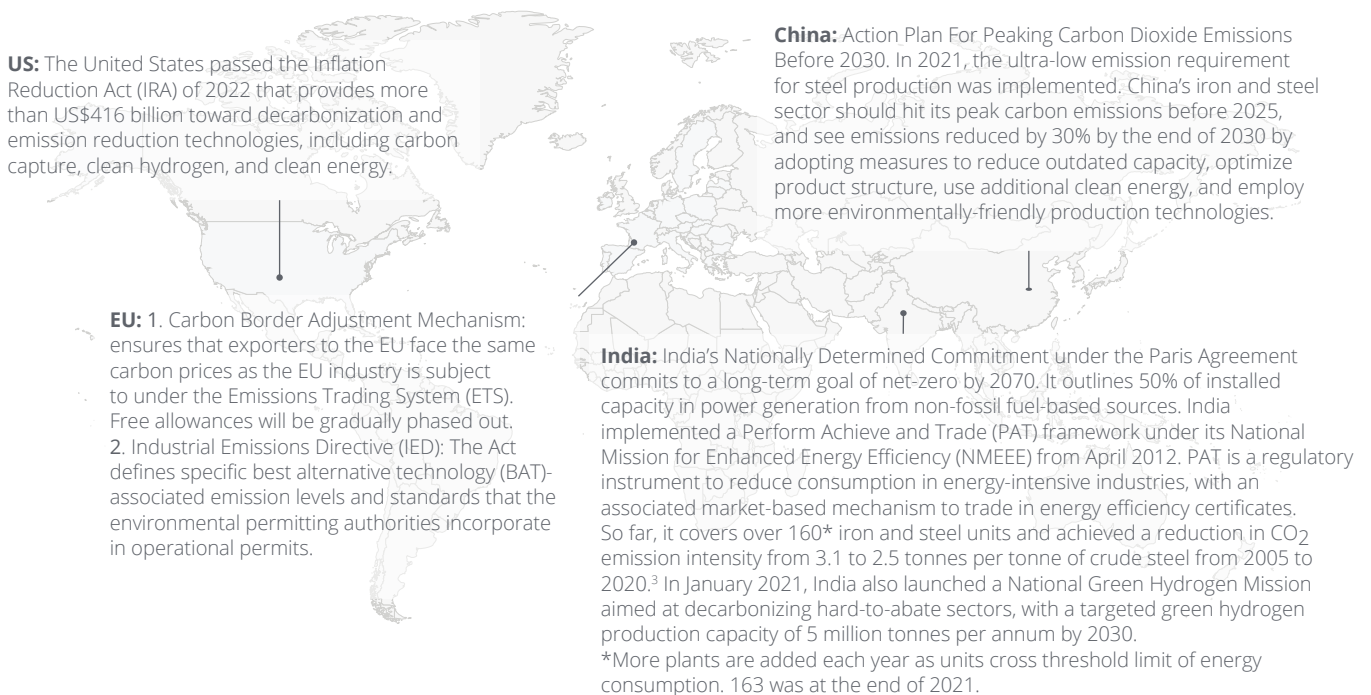
# Regulatory landscape

## Shifting regulations across regions are creating a framework for steel producers to act

There are already a wide range of regional environmental policies and economic instruments that are helping to drive the green steel transition (Figure 3). In addition to stricter regulations, there is a clear trend toward greater transparency and reporting.

Figure 3:

### Selection of regional regulations influencing the decarbonization of the steel industry



## Customer and market demand

Several leading steel producers have already started to deliver “greener” steels—or steel products with a reduced CO<sub>2</sub> footprint—under a variety of branded names. Such steels are typically focused towards the automotive sector, where there is already a clear appetite from the original equipment manufacturers (OEMs) for such products. The automotive sector represents 16% of global demand for green steel—second only to the construction sector.

Such steels are already being sold at a premium price, indicating a clear opportunity for steel producers to move towards value-based selling of green steels in the future. That said, as of yet there is no clear standard for defining green steel—although progress is being made on this front. The ResponsibleSteel™ organization, for instance, is leading work to create a unified, global, and cross-industry standard and certification program. Such an initiative may help create additional momentum and incentives for steelmakers to bring green steel products to the market.

# Key drivers for transformation

## A successful green steel transition will require the involvement of multiple stakeholders

To overcome these challenges, players across the steel value chain ecosystem—including those beyond steel producers and the end steel consuming markets—must take steps to support decarbonization (Figure 4). In many cases, this will involve forming a variety of coalitions to help address key decarbonization requirements, such as increasing access to adequate supplies of green hydrogen and high-quality iron ore, to successfully facilitate a green transition.

Those that seize the moment will likely benefit from a growth in market share, long-term market competitiveness and business viability, as well as stronger brand value.

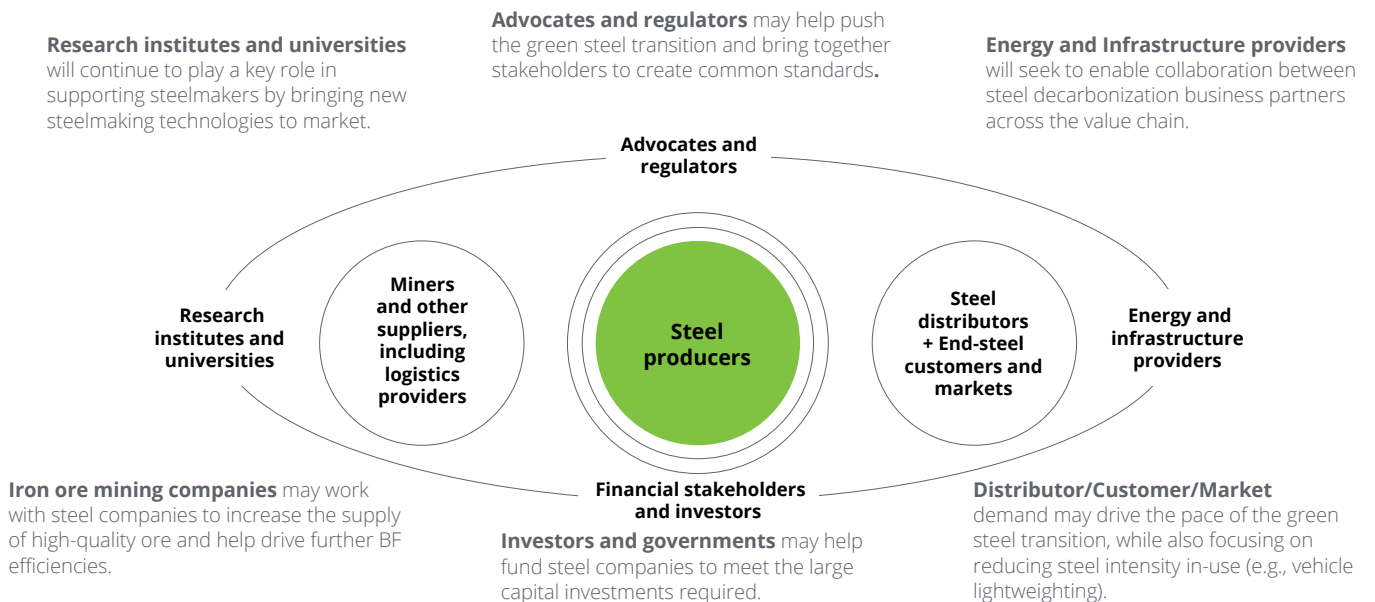
## Seizing the opportunities

In the face of growing demand for green steel, particularly in key end-customer segments such as automotive, those steel producers able to make early investments in decarbonization have the potential to become leaders in their respective core market segments.

Forward-thinking companies should be able to take advantage of the potential regional funding opportunities available today (both governmental and those established through partnerships and joint ventures), to find the large investments needed to support their transformations. Those that seize the moment will likely benefit from a growth in market share, long-term market competitiveness and business viability, as well as stronger brand value.

Figure 4:

### A variety of value chain stakeholders will play key roles in steel decarbonization



# Authors and contacts

This paper is part of a collection of insights on possible pathways to decarbonization for high-impact sectors. Each sector perspective offers a foundational starting point for leaders who would like to better understand the landscape across these critical sectors. For additional sector papers and links to in-depth reports, please visit [Pathways to decarbonization](#) on Deloitte.com.

To learn more about how Deloitte can help your business seize this moment—and adopt a proactive approach to decarbonization that offers substantial business benefits and helps shape tomorrow’s low-carbon future—contact us.



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## Endnotes

- 1 Ali Hasanbeigi, [Steel Climate Impact - An international benchmarking of Energy and CO<sub>2</sub> intensities](#), Global Efficiency Intelligence, 2022 and Deloitte analysis.
- 2 Julian Somers, [Technologies to decarbonise the EU Steel industry](#), Publications Office of the European Union, 2022.
- 3 PIB Delhi, [Indian Steel Industry Reduces its Energy Consumption and Carbon Emissions Substantially with Adoption of Best Available Technologies in Modernisation & Expansions Projects](#), February 2, 2022.



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# Implementing a net-zero value chain

## The industry's objective: a net-zero value chain by 2050

Companies in the steel sector have widely committed to the Paris Agreement goal to limit global warming to 1.5 degrees Celsius, with clear commitments to achieve significant reductions already by around 2030. These reduction commitments typically range from between 30% to 40% of emissions, when compared to previously measured 2015-2018 emission levels. Furthermore, the same companies are committing to a Net Zero target date of 2050 (or earlier in some cases).

Whilst to achieve these targets, steel producers can make incremental reductions in emission levels through improvements to existing production technologies (such as installing top pressure recovery turbines on a blast furnace) and process improvements (such as enhanced digital predictive process control and monitoring), it may be necessary for most companies to change currently established methods used for primary steel production.

## A pathway to net-zero: current challenges

Having established ambitious emission targets, some steel producers have already started making the transition, with a wide variety of different investments in technologies. However, there are still a large number who still find themselves at the beginning of their transformation journey. Whilst basic necessary conditions for transformation have been set and technology options have been identified, the industry faces a number of key implementation issues.



### Technology maturity and skills

- Young age of existing steelmaking assets
- Varying maturity of proven enabling decarbonization technologies
- Shortage of skills in engineering, metallurgy and IT/software



### Shortage and cost of green hydrogen and renewable electricity

- Lack of green infrastructure for renewable electricity and hydrogen production
- High cost of green hydrogen may make green steel uncompetitive



### End-consumer markets

- Demand for green steel from region/industry is variable
- Significantly higher "green premium" price of low-carbon steel will be a challenge to get accepted
- The (continued) speed of industrialization of China, plus the recent global economic downturn



### Regulations and policies

- Phasing in/out of Carbon Border Adjustment Mechanism (CBAM) and EU Emissions Trading System (ETS) could negatively impact steel producers (in EU)
- Lack of a low carbon steel taxonomy and clear certification standards
- Regulatory framework may provide a level playing field between different regions and countries



### Financing and capital expenditures

- High-asset investments needed (e.g., in EU estimated at around US\$70-100 billion)
- Steelmakers have low profit margins and may not be able to absorb investment costs



### Raw material availability

- Scarcity of high Fe-content iron ore needed for DRI and pressure on supply sources
- Limited availability of high-quality, prime scrap for EAF production



# Regulatory frameworks vary regionally

## Regulations across different regions are creating a framework for steel producers to act

The steel industry is already facing a wide range of regional environmental policies and economic instruments that are helping to drive the green steel transition (Figure 3). In addition to stricter regulations, there is a clear trend toward greater transparency and reporting.

## Customers and markets are creating demand for green steel

A number of leading steel producers have already started to deliver reduced CO<sub>2</sub> footprint steels to the market under a variety of branded names. Such steels are typically focused towards the automotive sector—representing the second largest steel consuming segment after construction, at roughly

16% of global steel demand—where there is already a clear appetite from the original equipment manufacturers (OEMs) for such products.

Such steels are already being sold at a premium price, indicating a clear opportunity for steel producers to move towards value-based selling of green steels in the future.

Despite there currently being no clearly agreed standard for how to define what green steel is, progress is being made. The ResponsibleSteel™ organization is leading work to create a unified, global, and cross-industry standard and certification program. Such an initiative may help create additional momentum and incentives for steelmakers to bring green steel products to the market.

\*More plants keep getting added each year as units cross threshold limit of energy consumption. 163 was at end of 2021.

\*\*<https://pib.gov.in/PressReleaseframePage.aspx?PRID=1794782>

**Figure 3:** Selection of regional regulations influencing the decarbonization of the steel industry

<sup>3</sup> Government of India, Energy and Environment management in the iron and steel sector, accessed December 2022

# Many different stakeholders in the steel value chain will play key roles

## **A successful green steel transition will require the involvement of multiple stakeholders**

Many different players in the steel value chain ecosystem—beyond steel producers and the end steel consuming markets—will play a valuable role in enabling decarbonization (Figure 4). A successful green steel transition will require a variety of coalitions to be formed, that may help address key decarbonization requirements, such as access to adequate supplies of green hydrogen and high-quality iron ore, among others.

## **Early focus on a decarbonization transition offers opportunities**

Based on an expected growing demand for green steel in key steel end-customer segments such as automotive, steel producers that are able to make early investments in decarbonization to produce green steel should see opportunities to build an early, leadership position in their core market segments and potentially grow market share. Such a transition should also help producers support long-term market competitiveness and business viability, as well as establish stronger brand value.

Furthermore, early moves by steel companies will enable them to take advantage of potential funding opportunities (both governmental and those established through partnerships and joint ventures), which will help to address the challenge of finding the large investments needed for a complete industry transformation.

