Roadmap and challenges for iron ore, DRI, pelletisation and induction furnaces/ EAF in India towards decarbonization

September 2024

EY Parthenon
Building a better working world

> Steel is a major contributor to the journey of Viksit and Utkrisht Bharat, not only through the sector's rapid growth but also by driving momentum across all consumption sectors. While this bodes well for the economy, the industry must embed sustainability into every aspect of its operations. Emissions from current steel manufacturing technologies are high, but there is a clear effort to explore avenues for producing green steel. Effective collaboration between the government and industry players in policy, R&D, and technological advancements will accelerate progress toward the net zero goal

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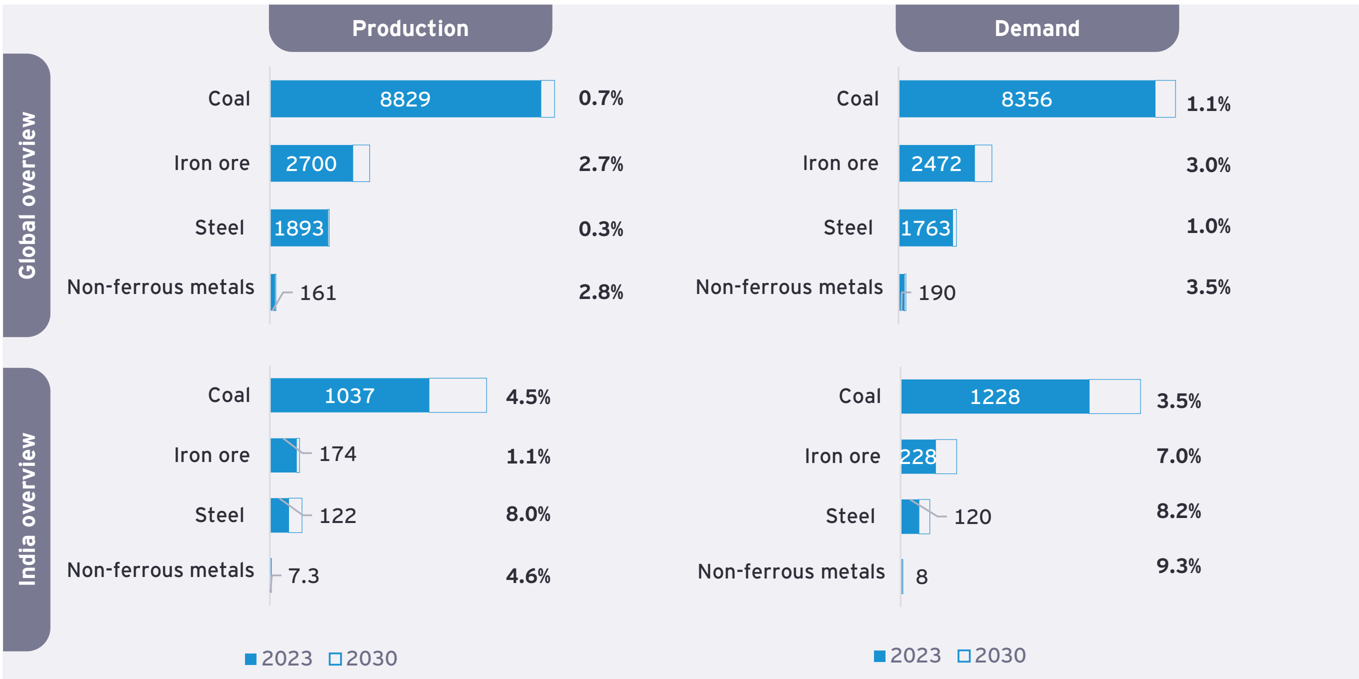
Executive summary

Overview of the metal industry: India and global

The global metals and mining industry is valued at US$1.3 trillion and is set to grow by more than 5% until 2030, driven by growth in end-industries supported by various government investments.

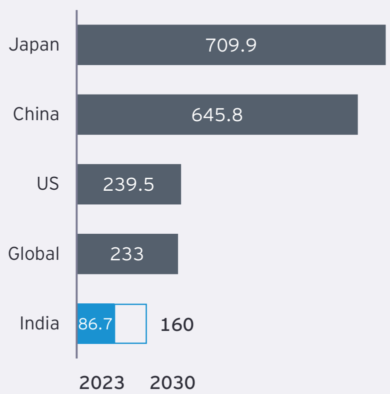


Growth drivers

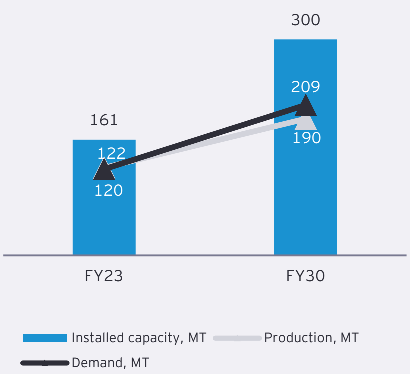
- End-use industries such as construction, infrastructure, and automotive will drive growth.
- Government initiatives like Make in India, the National Infrastructure Pipeline, and the Production Linked Incentive scheme are expected to fuel growth in end-use industries.
- Domestic production is expected to boost mineral sales in open markets, creating opportunities to explore and mine 80% of India's reserves using advanced technologies.

India steel industry overview

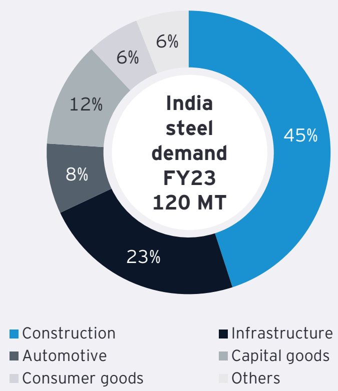
Per capita steel consumption



India steel industry overview



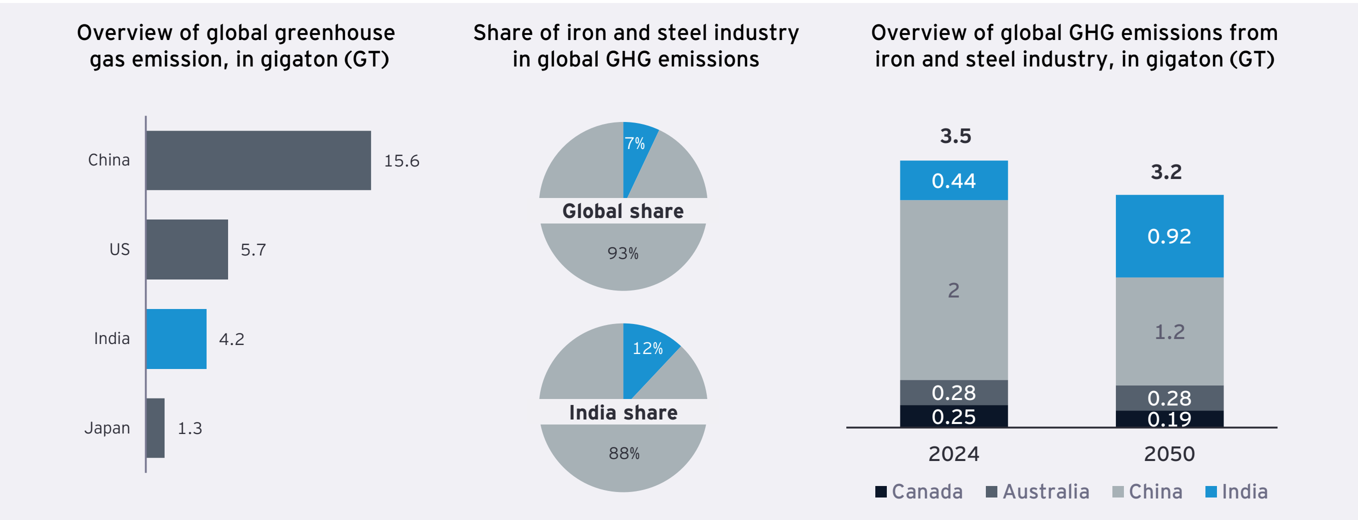
Steel demand by end-use industry



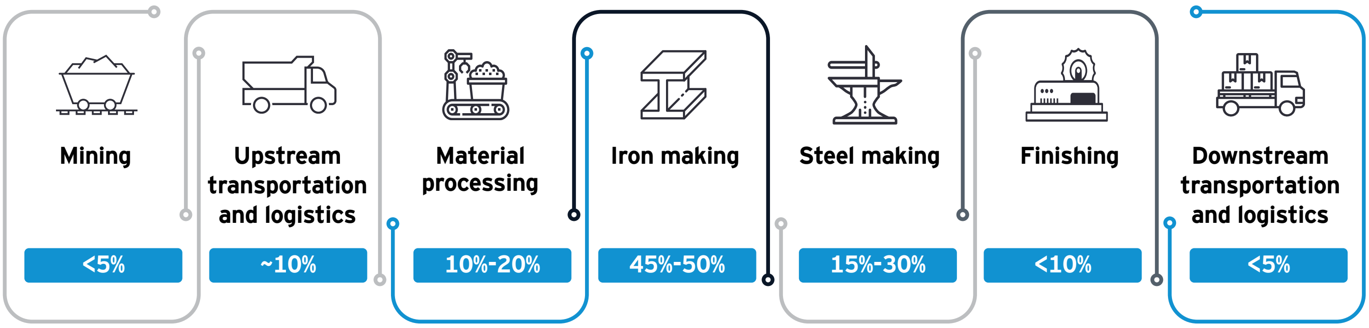
- India currently has a lower per capita steel consumption compared to the global average. The National Steel Policy has set a target of achieving 160 kg per capita by 2030.
- Government plans to support this target by boosting domestic demand across various end-use industries with more than 65% demand coming from construction and infrastructure segments.
- To meet this growing demand, the Steel Ministry of India has announced plans to promote domestic production and expand steel-making capacity to achieve the target of 300 MT by 2030.

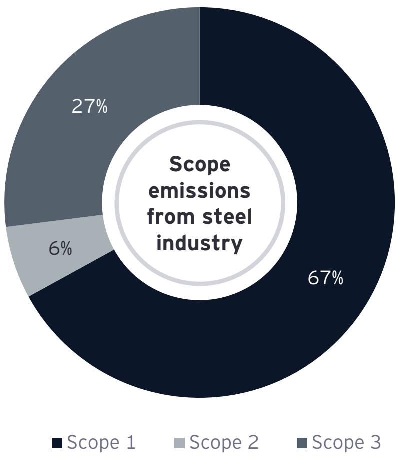
Greenhouse gas (GHG) emissions: an ongoing concern

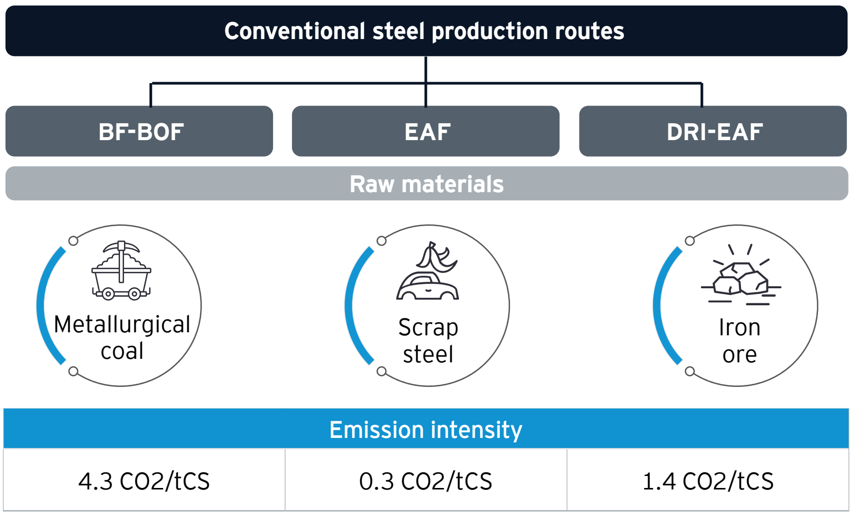
- India is the fourth largest greenhouse emitter, with its steel industry accounting for 12% of the total emissions.
- The expansion of steel-making capacity is expected to rely on the Blast Furnace-Basic Oxygen Furnace (BF-BOF) route, a process that significantly increases carbon emissions. As production scales up, this method will contribute to the growing challenge of reducing greenhouse gas emissions in the industry.
- India's emissions are expected to rise until 2050, when it reaches peak per capita steel consumption, after which it will begin decarbonizing to achieve net zero by 2070.
- Other economies are already on their path to net zero and are actively adopting Electric Arc Furnace (EAF), which is expected to achieve 48% by 2050.



Steel industry value chain







- Direct Reduced Iron (DRI) and Electric Arc Furnace (EAF) routes account for 33% of global steel-making capacity rising from 29% in 2021, indicating a slow transition.
- Major steel players are currently leading this transition by pioneering decarbonization strategies, retrofitting their existing capabilities or adopting alternative production routes.

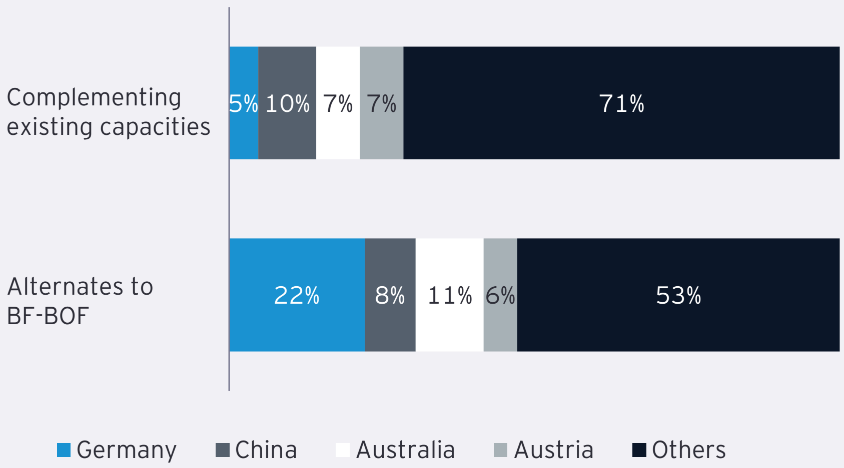
Executive summary

Decarbonizing steel industry

Production approach	Commercial	5- 20 years	More than 20 years
Energy	Biomass for BF-BOF	Natural gas DRI to H2 DRI	
	DRI using syngas	Green H2 DRI	
Material	BF-BOF to Scrap-EAF	DRI-Melt-BOF	
Carbon capture	BF-BOF with carbon capture		
Alternate technologies	Electric smelting	Electrowinning process	Electrochemical process

Up to 30% emission reduction
30% - 60% emission reduction
More than 60% emission reduction

- Globally, about 78 projects for green steel have been announced with majority of them complementing their existing capabilities
- Decarbonization is witnessing sluggish adoption rates in emerging economies owing to multiple challenges, high initial costs being a key one followed by inaccessibility to technology and ineffective funding alternatives
- Global governments have announced funding schemes to help steel players navigate through cost barriers and strengthen their decarbonization strategy



Technology	Natural gas - DRI	Scrap EAF	Hydrogen DRI	Carbon capture	Electrolysis
Technology costs, 2021	US$470-580	US$530-660	US$690-860	US$750-930	US$1100-1350
Technology costs, 2050	US$470-580	US$520-640	US$430-530	US$620-760	US$480-600

Types of funding	Example
Sustainability-linked bonds/ green bonds	US Steel Corp issued green bonds to finance their electric arc furnace; China Hydrogen Alliance is expected to offer soon
Government fundings or subsidies	US Dept of Energy (DoE) announced US$6b funding for steel decarbonization
Debt financing	European Investment Bank and other banks together offered a debt financing of EUR1.2 b to H2 Steel in Sweden
Peer investments	Arcelor Mittal invested US$120 m in Boston Metal for expansion of their production plant in Brazil
Other financial institutions	Glasgow Financial Alliance for Net Zero, a group of 450 firms committed US$100 trillion for net zero transition by 2050

Steel decarbonization in India

- India steel installed capacity is dominated by DRI+EAF route with 58% share and is likely to witness rise in BF-BOF share by 2030 due to capacity expansion.
- India is the only to country to use coal-based DRI process for steel production due to easy access to cheap domestic coal and unavailability of coking-coal in adequate quantities.
- Steel industry has a net zero target by 2070, with green hydrogen-based routes accounting for 71% of the total production among others while completely phasing out the coal-based routes.

India steel decarbonization capabilities			
Poor access to low-carbon technologies in India has compelled the industry to look for alternate options which include retrofitting the existing capabilities	Transitional approach for Indian steelmakers to reduce emission and will continue for coming years until decarbonization technologies are affordable and commercially available	Existing facilities can transition to low-carbon technologies by replacing coal with syngas or natural gas before eventually transforming into a hydrogen-based facility	Alternatively, adoption of smelting reduction facilities as an interim solution to pave way for CCUS adoption and reduce emissions

India's steel decarbonization investment				
National Green Hydrogen Mission	Green hydrogen and green ammonia	Phased approach	Strategic interventions for green hydrogen transition	Solar Energy Corporation of India

- Access to domestic and offshore bonds, securities, capital markets and diversified fundings suitable for PSUs transitioning to green steel
- Access to funding provided by sustainability finances (green bonds), bank loans and capital market issuances suitable to support nascent technologies with their repayment terms
- Support from government regulations, banking and non-banking financial corporations (NBFCs) to help their transition

Challenges in India's decarbonization journey

- Lack of clear definition for green steel
- High cost of hydrogen-based steel production route
- Inadequate performance of carbon capture technology
- Limited availability of steel scrap
- Cost competitiveness of steel decarbonization
- Negligible demand for green steel

Government support

- Establish green steel definition
- Promote hydrogen adoption by making in affordable
- Mandate the procurement of renewable energy
- Facilitating green finances for easy transition
- Expanding scrappage policy to improve scrap utilization
- Stringent PAT targets for efficient steel manufacturing
- Demand creation for green steel through government procurement
- Creating border tariffs like CBAM to levy taxes on carbon-intensive steel imports
- Incentivizing green steel manufacturing to help players absorb green premiums

Stakeholder support

- Pursue offtake agreements or procurement allianceswith customers and government
- Collaborations with industry stakeholders to establish partnerships and de-risk new technology adoption
- Use of low-carbon hydrogen as an interim solution until green hydrogen becomes affordable
- Decommissioning old or close to end-of-life facilities to make way for future capabilities
- Investors to align themselves to invest in decarbonization projects and achieve the goal
- Financial institutions to build capabilities to cater to the growing capital demands
- Supply-chain decarbonization will demonstrate stakeholder commitment to net zero and create demand

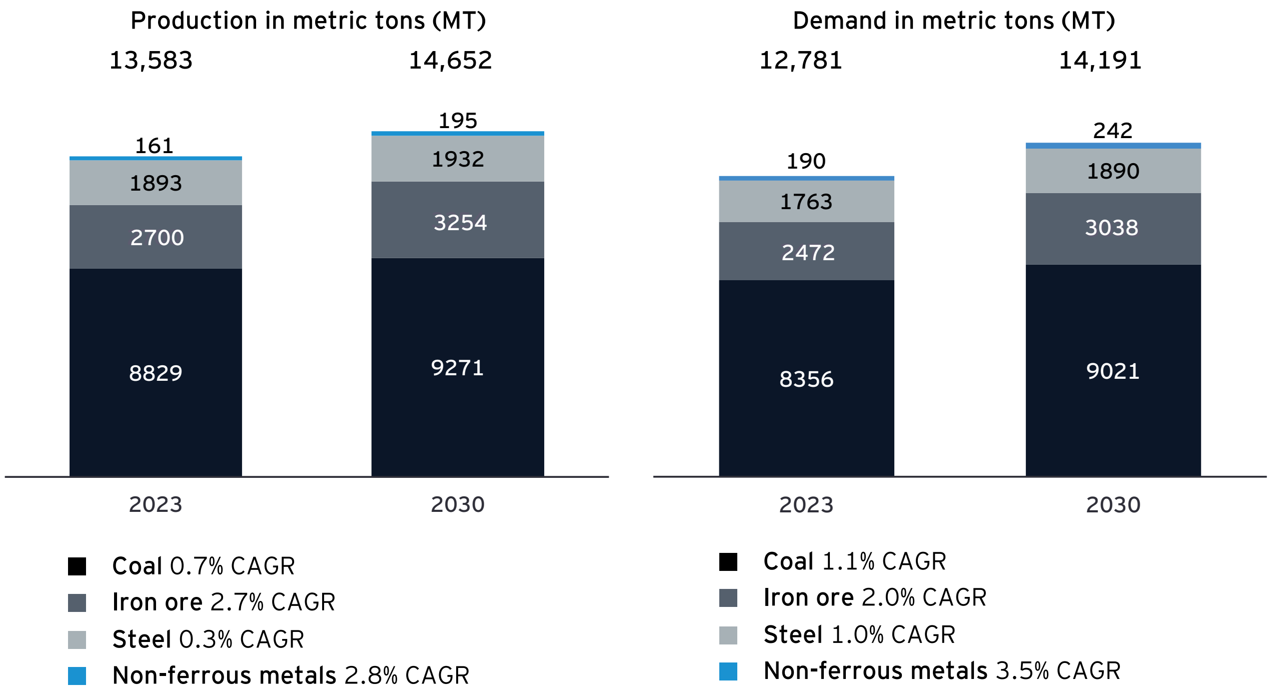
Overview of the metals and mining industry

01

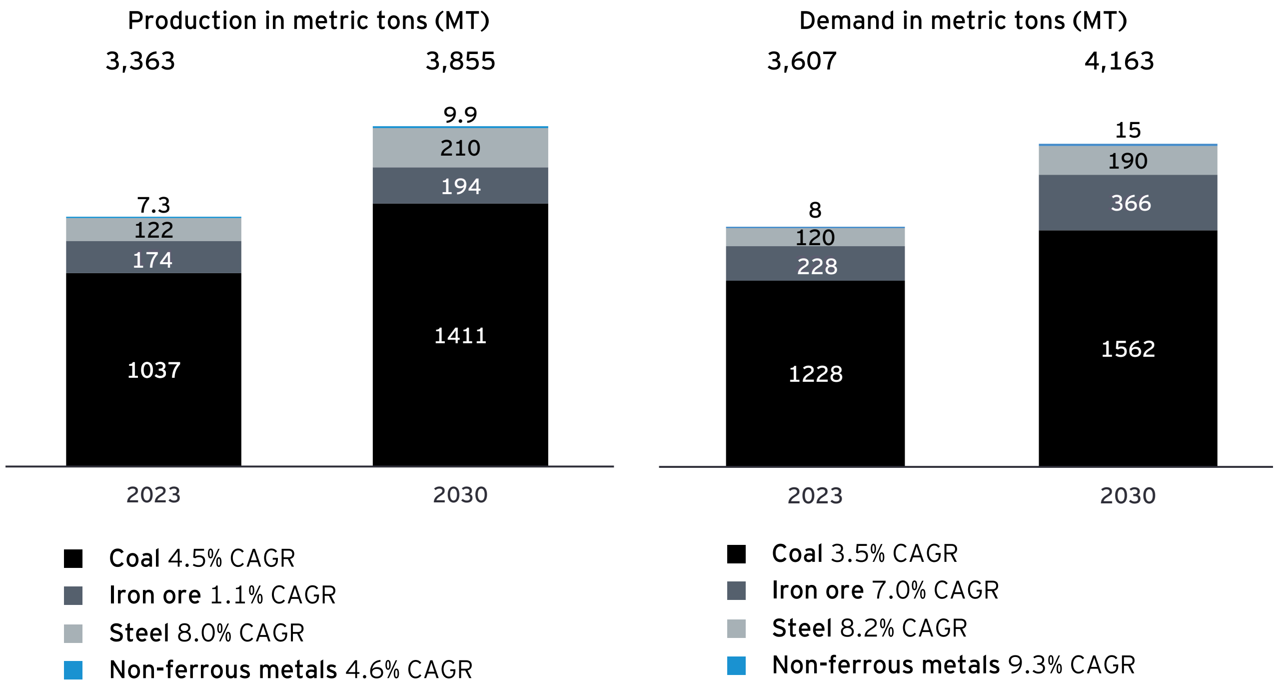
Global metal demand is set to grow at a CAGR of 2% through 2030, driven by end-use industries' increasing reliance on metals and supported by government investments to meet rising needs.

Rising industrial activities are driving the demand for various metals, minerals and mineral fuels, leading to the growth of the global metals industry. Governments and regulatory authorities are backing investments and promoting environmentally friendly mining practices to meet the growing demand.

Global metals industry overview



India's metals industry overview

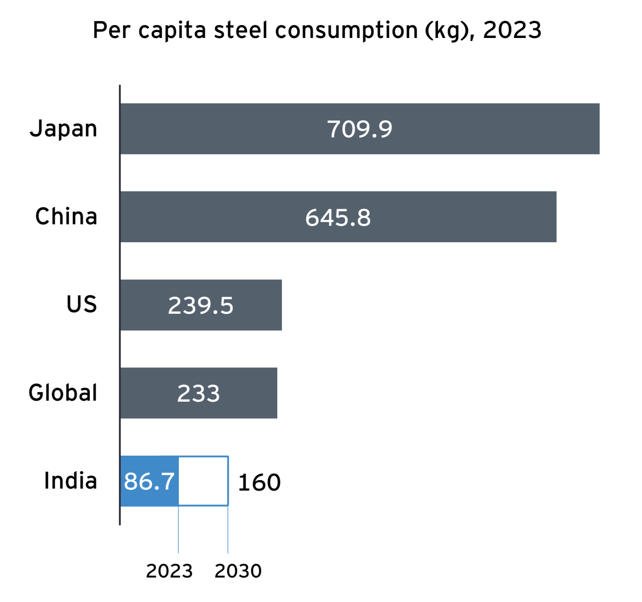


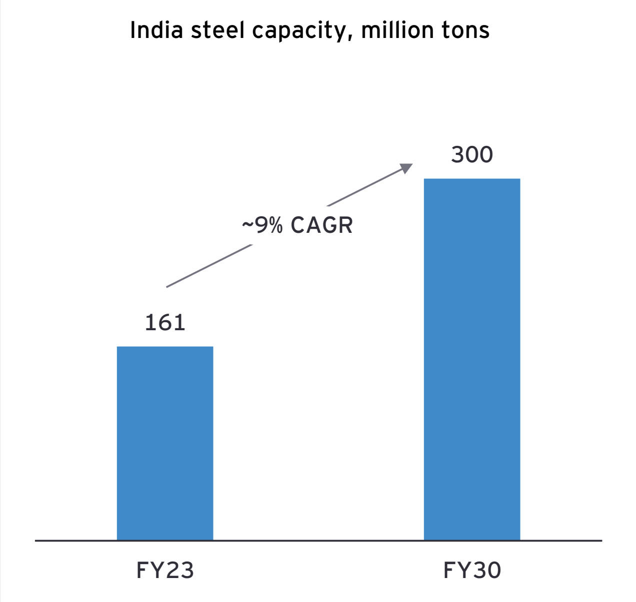
Coal, iron and steel account for a major share in production trends both globally and domestically and have been identified as the focus area to study the decarbonization roadmap in this report.

Source: World metrics, World mining data, IEA, Foundry India, World Steel Association and EY analysis

Government schemes and policies are expected to drive end-use industries such as construction, infrastructure and automotive, and boost the per capita consumption

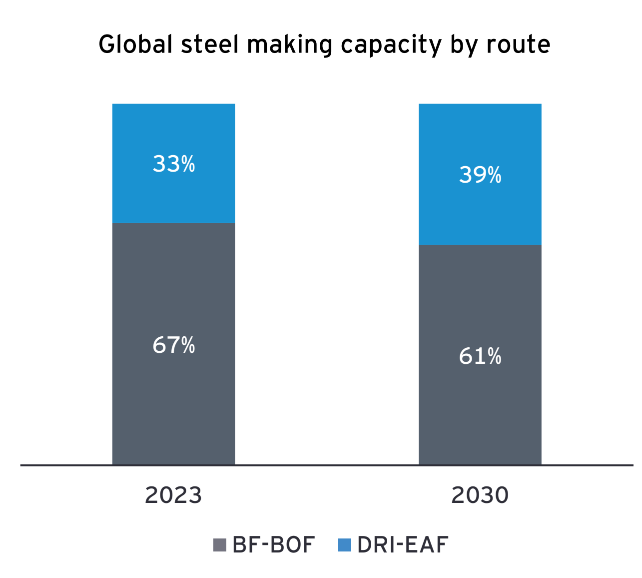
India's steel demand is projected to increase by over 8% annually until 2030, fueled by the growth of industries like construction, infrastructure, automotive, and capital goods. This growth is expected to raise the per capita consumption of steel from the current 86.7 kg to 160 kg by 2030, in alignment with the goals outlined in the National Steel Policy.

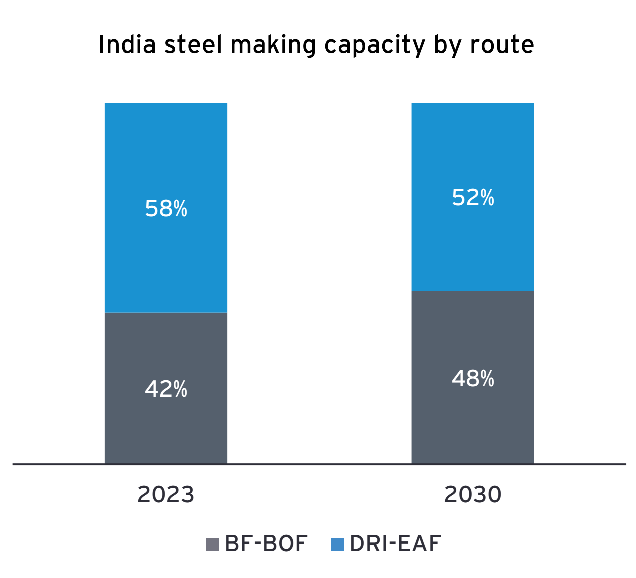




Source: World metrics, World mining data, IEA, Foundry India, World Steel Association and EY analysis

India's per capita steel consumption is far lower than the global average, indicating room for growth. Government schemes and investments to promote construction and infrastructure activities along with booming automotive and capital goods industry are likely to create an increasing demand for steel in the coming years, thus boosting per capita consumption. To support this growing demand, the ministry has announced capacity additions to achieve 300 MT installed capacity by 2030. While steel is expected to lead India's metal demand trajectory, other metals too are expected to follow suit.





Source: India Steel, PIB, Ministry of Steel, RHP, Company annual reports and EY analysis

The metals and mining industry worldwide is a significant contributor to greenhouse gas emissions, with the steel industry being a major culprit due to its reliance on energy-intensive production methods, the use of coal as the primary energy source in furnaces and the carbon emissions resulting from chemical reactions involved in reducing iron ore. Rise in steel demand driven by growing end use industries and capacity additions to promote per capita consumptions are expected to contribute to growing GHG emissions from India in the coming years.

Source: PIB, Ministry of Steel, DRHP, India steel and EY analysis

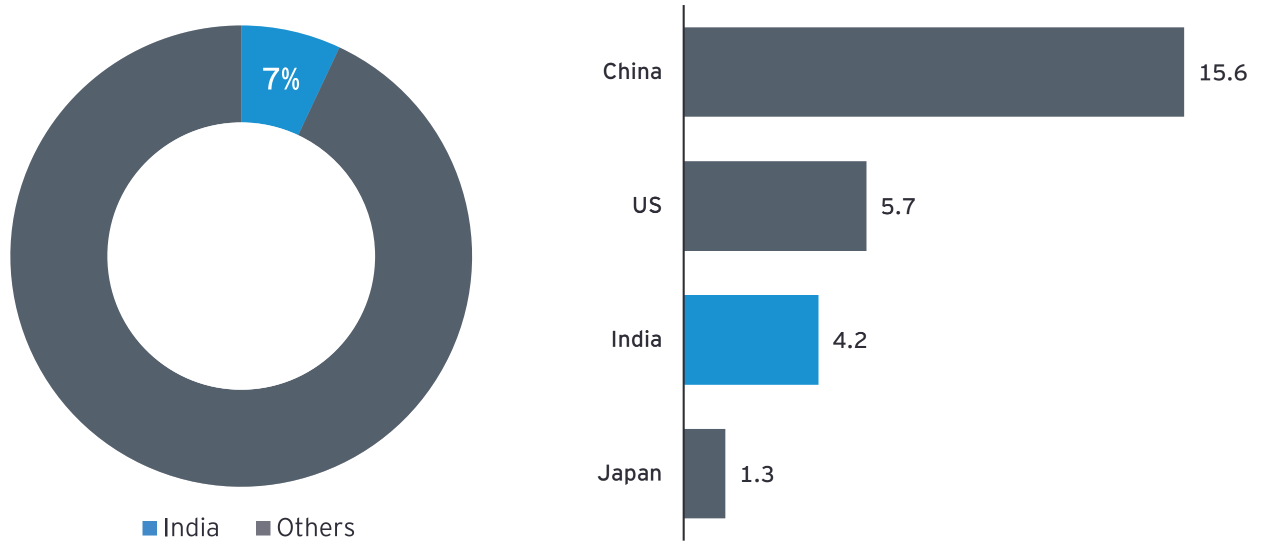
Carbon emissions from the steel industry

02

Steel industry accounts for about 12% of India's total emissions and is likely to contribute more due to capacity expansions and improved per capita consumption in the coming years

India's steel industry is a significant emitter, accounting for 12% of emissions compared to the global industry's 7%, largely due to its heavy reliance on coal in conventional production methods. The government's push to increase steel-making capacity, primarily through the BF-BOF (Blast Furnace-Basic Oxygen Furnace) route, is expected to further contribute to India's rising emissions in the years ahead.

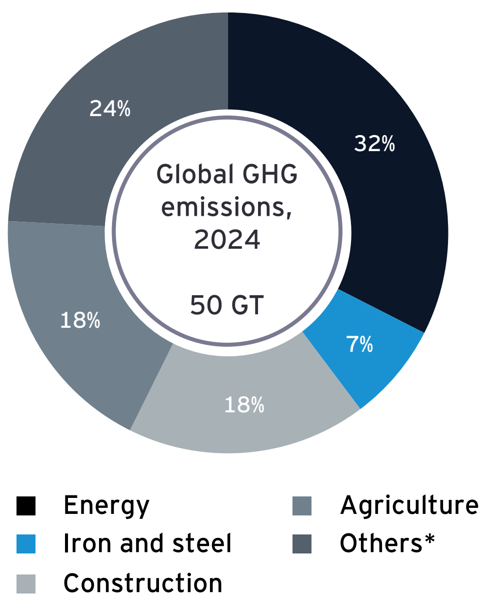
Overview of global greenhouse gas emission, GT



Source: Our world in data, World emissions, NITI Aayog and EY analysis

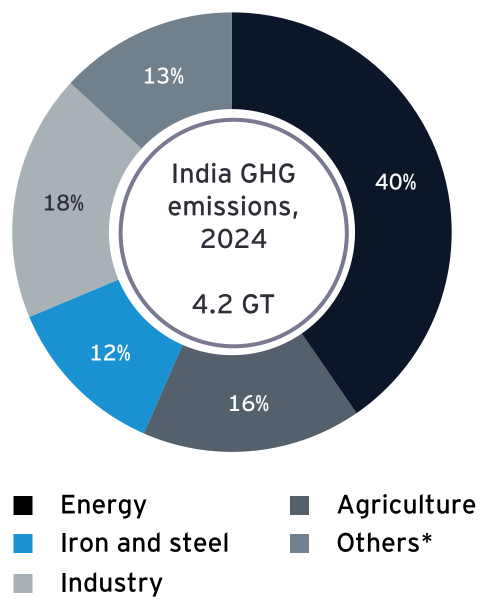
Government efforts for capacity expansions to reach 300 MT by 2030 will majorly be achieved through BF-BOF route, resulting in higher share of the technology in India's total installed capacity. Such capacity expansions to meet the growing demand and boost domestic per capita consumption is expected to result in growing emissions for coming years.

Overview of global greenhouse gas emission, GT



Source: Our world in data, World emissions, NITI Aayog and EY analysis

Overview of India greenhouse gas emission, GT

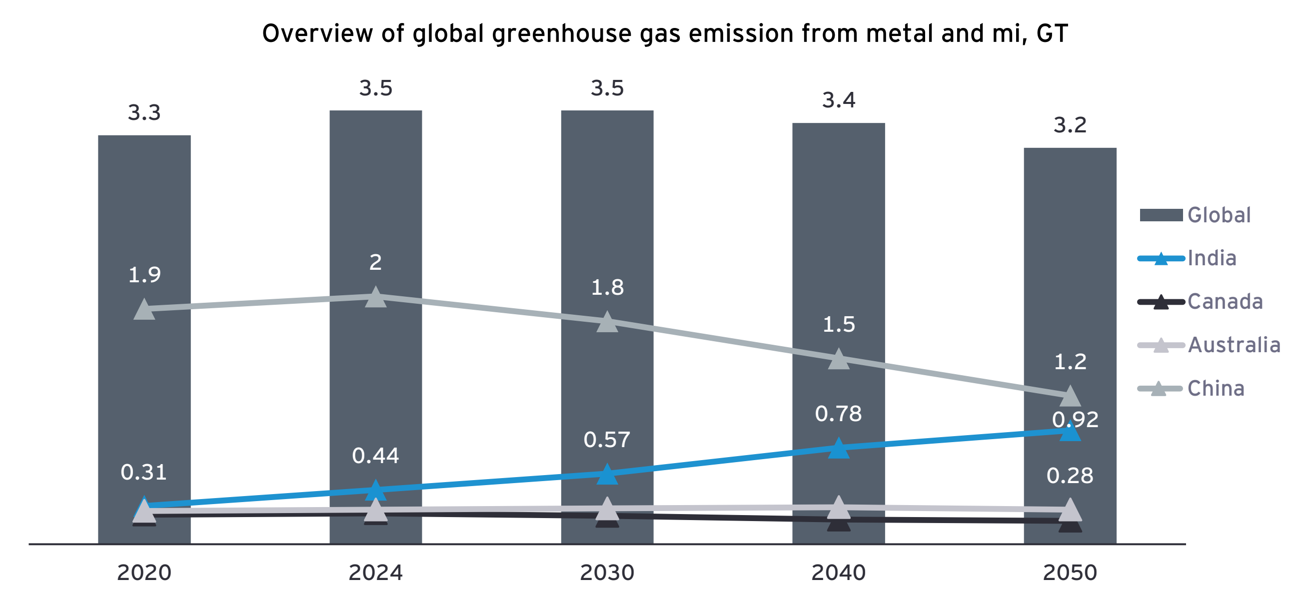


*Others include transportation, waste and industrial processes

Source: Our world in data, NITI Aayog, World emissions TERI and EY analysis

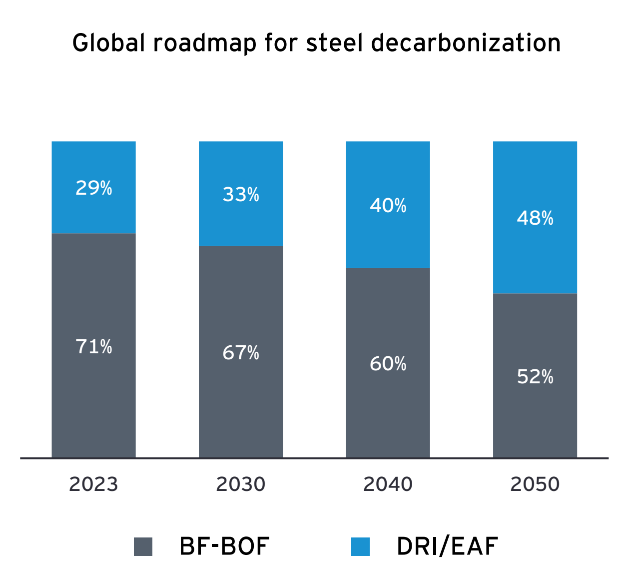
Global steel industry emissions have decreased due to net zero commitments, but India's emissions are expected to rise until 2050 before transitioning to net zero by 2070.

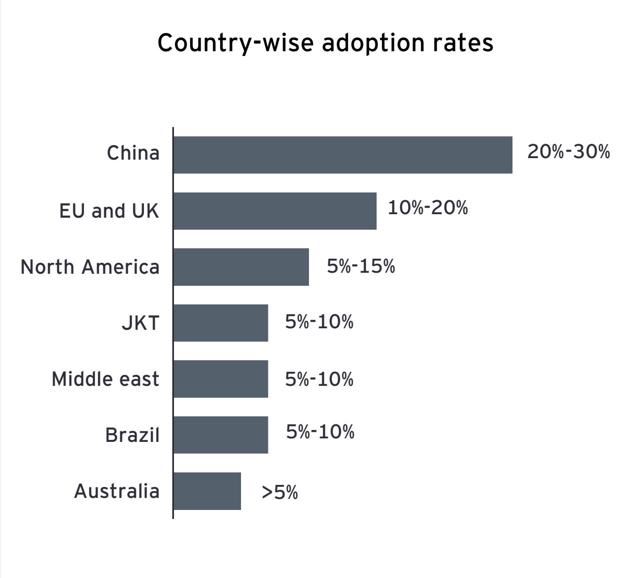
India's emissions are projected to increase until 2050, as the focus is on improving per capita consumption before transitioning to net zero. In contrast, the global steel industry is already on its way to decarbonization, with the current adoption of Electric Arc Furnace (EAF) accounting for 29% and expected to reach 48% by 2050, driven by commitments to achieve net zero emissions.



Source: Our world in data, World emissions, NITI Aayog and EY analysis

Commitment to the Paris Climate Agreement and targets to achieve net zero by 2050 are compelling all industries to undergo green transition. Leading economies have already achieved adequate per capita steel consumption rates resulting in peak emissions historically and are now transitioning to net zero with declining emissions. With high room for growth, India's steel sector will continue to contribute to growing emissions by 2050 before it effectively transitions to net zero by 2070.





Source: TERI, IEA, WEF, Wood mac and EY analysis

Due to climate commitments and net zero agreements, countries have witnessed rising adoption of electric-arc furnace (EAF) technology, which is expected to reform steel production to achieve net zero. With the current penetration of 29%, EAF is expected to conquer 48% of the total steel production output by 2050 with China dominating the adoption rates while the UK, Europe and North America are expected to follow the trend.

Source: Our world in data, World emissions, TERI, IEA, WEF and EY analysis

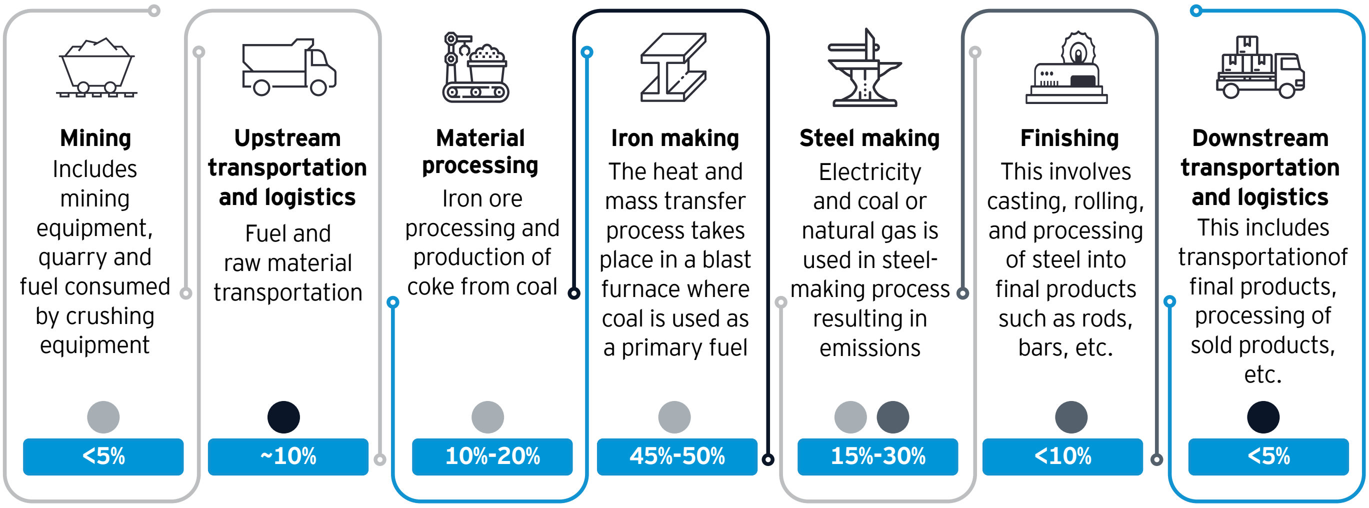
Decarbonization technology overview

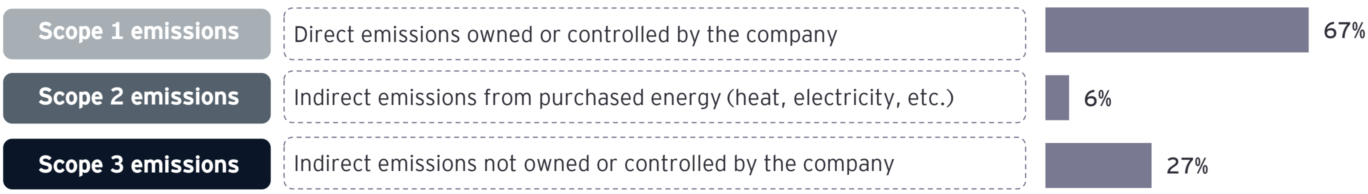
03

BF-BOF is a dominant steel producing route globally and is responsible for higher emissions from the iron and steel-making process and is expected to be decarbonized through altering processes across value chain nodes

The BF-BOF production process is responsible for the majority of scope 1 emissions because of its heavy reliance on coal and the iron reduction process in the furnace. To reduce these emissions, it is crucial to implement effective decarbonization practices throughout the value chain. This can be achieved by making changes to the energy or material mix, adopting innovative technologies, or resorting to carbon capture as a last resort.

Steel industry value chain

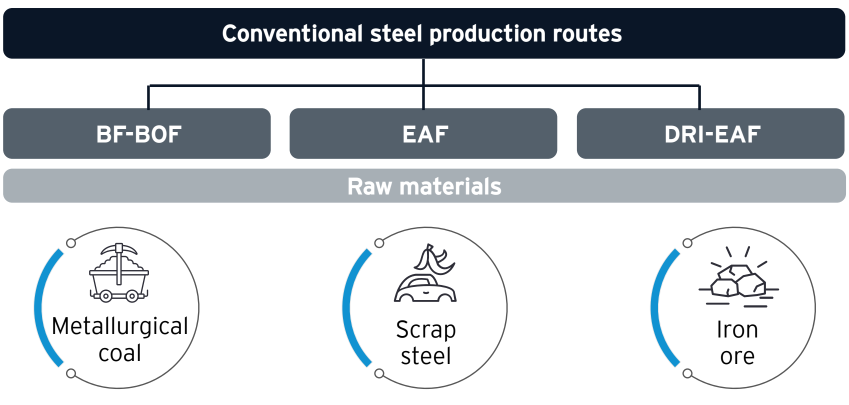




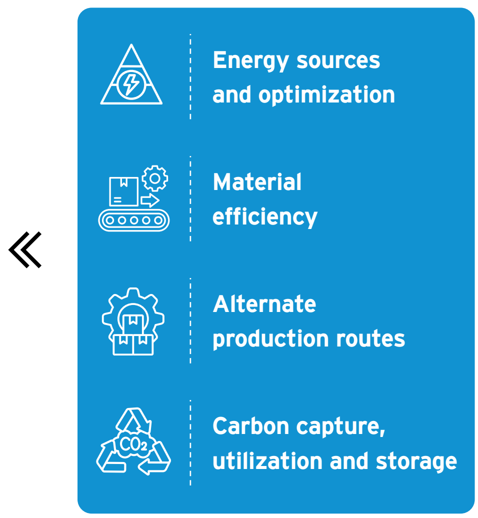
Note: xx% indicates contribution to GHG emissions from value chain nodes of the steel industry
Source: Shell, IEA NZE by 2050, World Economic Forum and EY analysis

● indicates scope emissions

DRI and EAF, identified as relatively greener routes, currently account for 33% of the global steelmaking operating capacity rising from 29% in 2021, indicating a slow transition. This green transition is currently led by leading steel makers pioneering the decarbonization strategy either by complementing their existing capabilities or adopting alternate production routes, while the larger segment of the industry comprising small and medium-sized players is still in the early stages of adoption.



Emission intensity		
4.3 CO2/tCS	0.3 CO2/tCS	1.4 CO2/tCS



Source: IEA, World steel Association, Shell, WEF and EY analysis

Industry's transition to green steel is supported by manufacturers' inclination towards altering the existing routes through changes in energy and material mix while newer technologies gain adoption rates

Steel manufacturers are inclined towards using electricity or renewable energy such as biomass of green hydrogen or use of scrap steel and their input to promote energy and material efficiency and reduce emissions while other innovative technologies such as carbon capture or electrochemical processes are yet to witness resilient market penetration.

Transition areas	Energy optimization	Material efficiency	Carbon capture	Alternate routes
Categories	▸ Electrification using RE ▸ Green hydrogen / Biomass	▸ Improved efficiency ▸ Scrap usage or waste heat recovery	▸ Carbon credits ▸ Carbon capture, utilization and storage	▸ Molten electrolysis (MOE) ▸ Shift in technologies (BOF to DRI)
Description	▸ Replacing fossil fuels with electricity from renewable energy ▸ Using clean energy sources such as biomass or hydrogen in furnaces	▸ Less input material per unit of output material for better yield ▸ Increased share of scrap usage and reusing waste heat from blast furnace	▸ Capturing and storing carbon emitted during steelmaking ▸ Credits that allow emitters to take credit for carbon reductions	▸ Using MOE cell which release oxygen as byproduct ▸ Shift from BF-BOF integrated steel plants to hydrogen ready DRI
Application	▸ Electrification for steel making ▸ Green hydrogen/ biomass for iron making	▸ Improved efficiency across value chain ▸ Reuse across steel and making	▸ Carbon capture for iron and steel ▸ Carbon credits across entire value chain	▸ Technology shift for iron and steel making ▸ MOE for steel industry
Adoption rates	●●●○○	●●●○○	●○○○○	●○○○○

Significant share of steel manufacturers are inclined towards altering their current production routes by leveraging the transition areas such as a change in energy mix or material circularity to reduce their emissions. Few manufacturers are transitioning from coal-based energy sources to electricity or renewable energy, such as biomass of green hydrogen to support their existing capacities, while others have adopted the use of scrap input to improve material efficiency across the value chain. Additionally, other technologies such as carbon capture for BF-BOF or alternate routes, including molten electrolysis or electrochemical processes are potential solutions available but witness lower adoption rates.

Production approach	Energy source and optimization	Material efficiency and circularity	Alternate production routes	Carbon capture, storage and utilization
BF-BOF	▸ Biomass or bioenergy or biofuel ▸ Renewable energy BOF ▸ H2 / Green H2 DRI-Melt-BOF ▸ Zero carbon electricity ▸ Electrolytic H2 blending	▸ Shift to Scrap based EAF	▸ DRI-Melt-BOF (slag bath furnace) using low grade iron	▸ Use of CCU/CCS/ CCUS ▸ Bioenergy with CCS (BECCS) for BF-BOF
DRI	▸ DRI with Syngas ▸ H2 / Green H2 DRI-EAF ▸ DRI-EAF with renewable energy ▸ Zero carbon electricity	▸ DRI-EAF with scrap steel	▸ DRI-Melt-BOF (slag bath furnace) using low grade iron	▸ DRI-EAF with carbon capture ▸ DRI-Melt-BOF with CCS
Others	▸ Molten oxide electrolysis (MOE)	▸ Smelting reduction	▸ Electrolyser-EAF ▸ Electrowinning-EAF ▸ Electrochemical process	▸ Smelting reduction with CCS

Source: IEA, WEF, Wood mackenzie, MIT News, IEA and EY analysis

Green transition routes that complement existing capacities have witnessed higher adoption rates, primarily across the European countries, with emission reduction ranging between 30% to 60%

Alongside the current capacity upgrades, the industry has seen the introduction of cutting-edge technologies like DRI powered by green hydrogen, electrolysis, and other electrochemical processes. These advancements hold the potential for over 50% reduction in emissions. However, their high cost and limited accessibility present ongoing challenges for their widespread adoption.

Steel decarbonization commercial routes

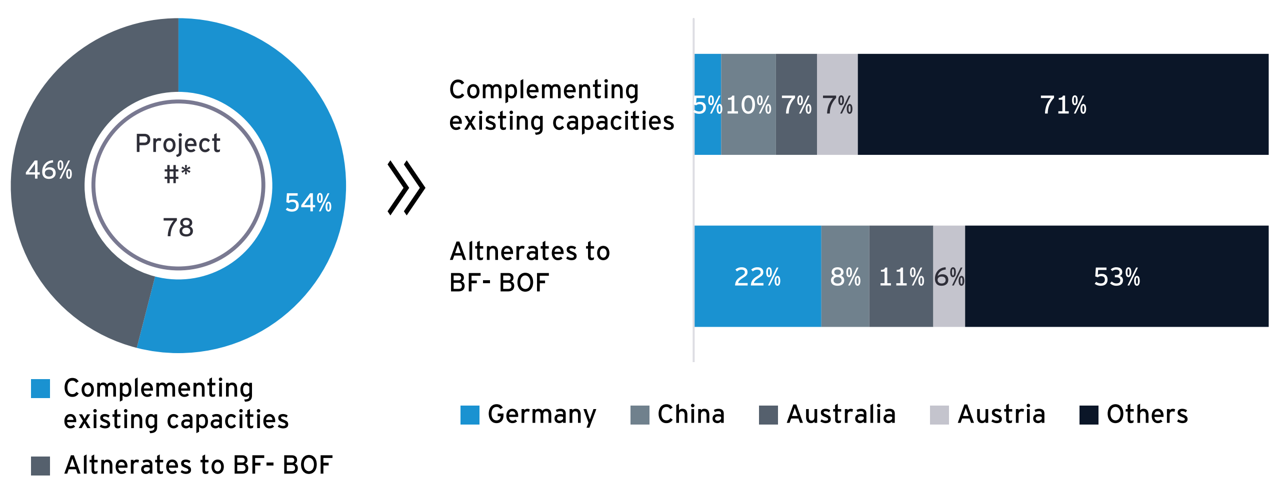
Production routes	Description	Emission reduction	Adoption status	Adopting countries
Biomass for BF-BOF	Blending biomass with coal to use as fuel or as a sintering reducing agent	Up to 30%	Commercial	Australia, Belgium, Brazil
BF-BOF to Scrap-based EAF	Replacing BF with NG-DRI and BOF with EAF powered by renewable energy	More than 60%	Commercial	Sweden, Austria, Spain
BF-BOF using CCU/ CCS/ CCUS	Capturing emissions and using it as feedstock for methanol production	30% - 60%	Commercial	Austria, Belgium, France
DRI using Syngas	Direct reduction using blend of H2 and CO gas (syngas) to reduce iron ore	More than 60%	Commercial	India, South Africa
NG-DRI to Hydrogen DRI	Replacing 30% natural gas with green hydrogen up to 100%	30% - 60%	5-10 years	Algeria, Egypt, India, Russia, US
Green hydrogen DRI	Use of 100% low-carbon or green hydrogen for direct reduction	More than 60%	10-20 years	Austria, Germany
Electrochemical process	Molten oxide electrolysis to run a zero-carbon production facility	30% - 60%	>20 years	US
Electrowinning	Produce solid state iron at low temp. and feed it to coal-based EAF	More than 60%	10-20 years	France
Electric smelting	Addition of iron ore and coal directly to a metal-slag phase to reduce iron ore	Up to 30%	Commercial	Sweden, Germany

Adoption status: Commercial; 5-10 years; 10-20 years; >20 years

Emission reduction: Up to 30% emission reduction; 30% - 60% emission reduction; More than 60% emission reduction

Globally, 78 green steel projects have been reported. Of these, 31% are already online, and 9% are expected to go live by the end of the year. By 2050, 40% of the projects will be operational, while 21% are still in the early stages. A significant number of projects focus on solutions that enhance existing steel-making capacities using green energy and carbon capture. Others focus on alternative methods like Hydrogen-DRI, Molten Electrolysis (MOE), and electrochemical processes. However, these alternatives face low adoption rates due to high costs and limited access to advanced technologies.

Global projects for decarbonization of steel industry

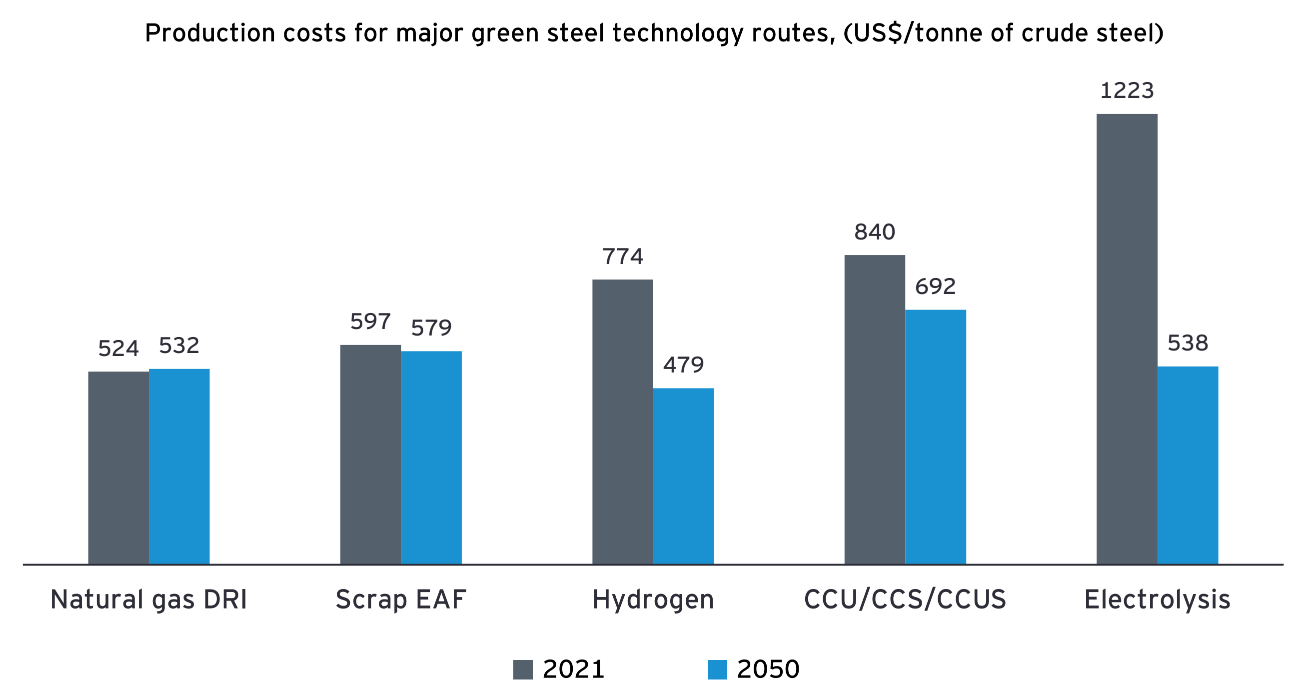


Source: Global energy monitor, World steel association and EY analysis

Source: Global energy monitor, Science direct, World Steel Association and EY analysis

Steel decarbonization technologies witness adoption challenges due to their high initial production costs and are mitigated using government subsidies and public or private investments

Steel decarbonization faces adoption challenges due to high initial production costs. However, public and private investments, backed by supportive policies and legislation, are helping to accelerate the transition to greener technologies.



Source: BNEF, IEA, World steel, Green steel economics and EY analysis

Decarbonization technologies have high capital expenditure (capex) and operating expenditure (opex) costs, which hinder their global adoption rates. While emerging economies face challenges in accessing technology and securing funding, countries like Sweden, Germany, the US, and South Korea have announced ambitious green steel projects. These countries are committed to achieving net zero emissions, which has led to the establishment of strong policy frameworks and investment opportunities. The transition to green steel is estimated to require a total investment of $372 billion by 2050. This investment will be directed towards transformation, policy reform, and interventions such as carbon pricing, subsidies, and incentives for technology development. These investments are supported by subsidies, incentive schemes, and both public and private funding.

Types of funding	Description	Example
Sustainability-linked bonds / green bonds	Steel players to offer green bonds to help other players to transition from conventional to green steel	US Steel Corp issued green bonds to finance their electric arc furnace; China Hydrogen Alliance is expected to offer soon
Government fundings or subsidies	Government pays subsidies that help steel producers transition from coal-based routes to green routes	US Dept of Energy (DoE) announced US$6 b funding for steel decarbonization
Debt financing	Company raises money by selling debt instruments mostly in the form of bank loans or bonds	European Investment Bank and other banks together offered a debt financing of EUR1.2 billion to H2 Steel in Sweden
Peer investments	Peer companies investing in other companies to fund their green steel projects	Arcelor Mittal invested US$120 million in Boston Metal for expansion of their production plant in Brazil
Other financial institutions	These are a cluster of banks, lenders and other credit institutions that offer loans for green transition	Glasgow Financial Alliance for net zero, a group of 450 firms committed US$100 trillion for net zero transition by 2050

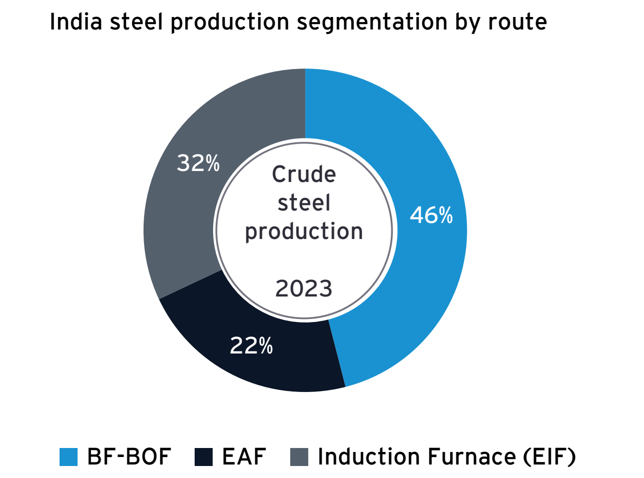
Source: Reuters, Citizen.org, Canary media, Capital IQ and EY analysis

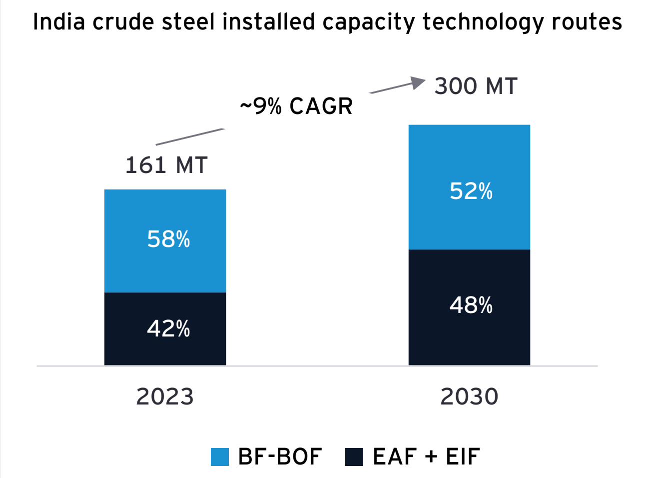
Steel decarbonization scenario in india

04

India's crude steel capacity expansion through the BF-BOF route will contribute to growing emissions and can be mitigated using natural gas or CCUS in the interim until low carbon technologies become available and affordable

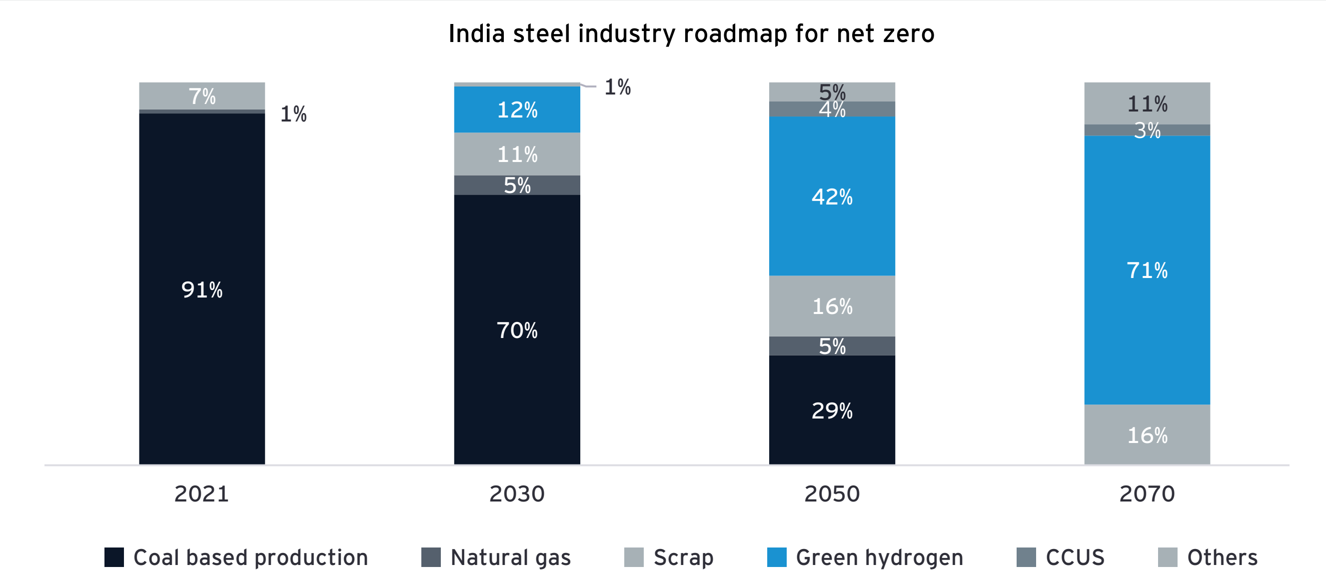
Easy access of lower grade input materials facilitates quicker adoption of BF-BOF, leading to a 48% share in overall capacity by 2030, contributing to growing emissions. This is likely to create a heavy reliance on carbon capture and storage due to technological limitations of other levers, thus increasing the cost and complexity of the sector decarbonization.





Source: One of the largest MNC professional services company, Global Energy monitor, Climate policy initiative and EY analysis

India has a significant proportion of electric furnaces, including arc furnaces and induction furnaces, accounting for 54% of its installed crude steel capacity. This dominance in electric furnaces leads to a higher consumption of sponge iron compared to other countries. As a result, India stands alone as the only country utilizing the coal-based direct reduced iron (DRI) process for steel production. This is primarily due to the country's easy access to affordable domestic coal and the insufficient availability of coking coal in adequate quantities.



Source: IEEFA, One of the largest MNC professional services companies, TERI, Climate policy initiative and EY analysis

Current steel decarbonization capabilities in India

- Poor access to low-carbon technologies in India has compelled the industry to look for alternate options, which include retrofitting the existing capabilities.
- Indian steel makers are actively pursuing the transitional approach for emission reduction and are likely to continue for the coming years until decarbonization technologies are affordable and commercially available.
- Current facilities in India can be switched to low-carbon technologies by replacing with coal-based syngas or natural gas before eventually transforming into a hydrogen-based facility.
- Alternatively, adoption of smelting reduction facilities during the coming decade will eventually pave the way for CCUS adoption and reduce emissions.

Source: Climate policy initiative, One of the largest MNC professional services company, IEEFA, TERI and EY analysis

India's investments in green energy and favorable policy framework for access to both domestic and international monetary provisions can support industry stakeholders to overcome operational and financial barriers

PSUs and private sector stakeholders have various funding options. These include domestic and offshore bonds, bank loans, and capital markets. These options are made available through government policies and schemes. On the other hand, MSMEs, which make up a significant portion of the industry, can transition with the support of regulatory intervention from banks and NBFCs.

Investments in India's steel decarbonization journey

Investments and funding	Description
National Green Hydrogen Mission	Commitment for INR19,744 Cr supported by the National Green Hydrogen Policy to the development of an ecosystem to decarbonize the steel sector in the long term
Green hydrogen and green ammonia	Anticipated cumulative investments of INR10.43 lakh Cr across value chains in India by 2030 to bolster local green hydrogen and electrolyzer production
Phased approach	Ministry of steel has been allocated with INR1460 Cr as 30% of the pilot project budget
Strategic Interventions for Green Hydrogen Transition	MNRE developed SIGHT with an outlay of INR 4440Cr for localized electrolyzer manufacturing and INR 13,000 Cr for green hydrogen production
Solar Energy Corporation of India	Issued two tenders, one 1.5GW tender for local electrolyzer manufacturing and second for producing 450,000 ton/annum

Government has announced multiple schemes and initiatives to support India's decarbonization goal that helps first movers to navigate through operational as well as financial barriers. In addition to robust investments in the renewable energy and green hydrogen segment, government has also drafted policies that provide access to domestic as well international finances and funding such as climate finances, sustainability linked bonds and global bank loans among others that adequately address the capital needs of all both segments – public and private including the sizeable chunk of MSME and ensure a smooth transition.

Public sector

- PSUs funded by a mix of domestic and offshore bonds, securities and diversified bank fundings.
- For green hydrogen associated transitions, PSUs can fund their transition through access to capital markets.
- Strong financial standings and government backing to help PSUs access financial markets

Private sector

- Large corporates are financing their decarbonization routes through domestic finances, capital market issuances and bank loans, among others.
- Sustainability linked bonds or loans (SLBs or SLLs) are ranked most preferable by the corporate players.
- These options are suitable to support nascent technologies with repayment terms linked to achieving pre-determined sustainability goals.

MSMEs

- These account for a higher presence in the steel industry and are the most difficult segment for transition due to lack of financial resources.
- Their transition will be driven by a regulatory push and will be supported by several financing avenues.
- This segment will be primarily supported by banks and non-banking financial corporations (NBFCs) for their transition.

Industry developments in India

- Leading Stainless Steel Manufacturer set up a green hydrogen plant in Haryana to support green steel manufacturing
- Kalyani Group launched green steel products under 'KALYANI FeRRESTA' using EAF powered by renewable energy and 70% recycled scrap input
- Arcelor Mittal and Greenko Group collaborated for a renewable energy project to reduce AM/NS India's carbon emissions by 1.5 million ton per annum
- Tata Steel signs MoU with Primetals Technologies for green steel transition
- Announcement of National Green Hydrogen Mission that aims to reduce hydrogen technology costs
- JSW Steel to power its Vijayanagar plant using green hydrogen to supply green steel within a year
- Pilot carbon capture and storage plants to reduce emissions from BF-BOF
- JSPL to greenify its Odisha facility by building coal gasification and produce steel using clean coal technology
- Vedanta and IIT-B collaborated to develop technology to produce green steel using hydrogen instead of coke

Despite significant efforts to transition the steel industry to net zero, India faces challenges with infrastructure and investments that continue to hinder decarbonization progress

Lack of definition of low-carbon or green steel, price sensitivity impacting the technology adoption and willingness to pay premium and inefficient performances of carbon capture to reduce emissions among others are hindering the industry's decarbonization progress.

1

Lack of definition for green steel in India

Despite government efforts to decarbonize the steel industry and frequent references to green and low-carbon steel, the Indian market lacks the definition for green steel without which the transition route remains unclear

2

High cost of the hydrogen-based steel production route

Green hydrogen costs around US$4/kg to US$7/kg as compared to US$1.8/kg cost of grey hydrogen which proves to be a strong competition in adoption of green hydrogen and will be mitigated when there is a significant legislative push to promote domestic green hydrogen manufacturing

3

Inadequate performance of carbon capture technology

Inefficiencies associated with CCUS, such as low capture rate, high capital cost, inadequate availability of potential storage sites and high energy-intensive process among others, have proved that CCUS can only be used as an interim solution for decarbonization.

4

Limited availability of steel scrap

India's scrap market is unorganized, making it challenging to secure the availability of scrap, since the majority of the nation's infrastructure is new and yet to be built. There is an import dependency for scrap steel. But with China increasing its scrap-based capacity, India will be deficient in scrap steel.

5

Cost competitiveness of steel decarbonization

Decarbonization technologies such as DRI, Hydrogen based routes and CCUS are priced higher than the conventional routes. India, being a price sensitive market, would be unwilling to pay a premium for green steel would impact the adoption of these technologies.

6

Negligible demand for green steel

Green steel being priced higher than the conventional steel is hindering the demand creation in the Indian market and estimates suggest that green steel will have to generate additional US$115 per ton to break even and improve the adoption rates.

Source: IEEFA, TERI, Responsible steel and EY analysis

Decarbonization of the steel industry requires collaborative efforts from both the government and industry stakeholders through strong policy framework and technology partnerships

Government needs to proactively define green steel definition and standards and establish stringent rules to promote higher adoption of renewable energy and scrap steel and promote affordable availability of green hydrogen. Additionally, steelmakers need to pursue offtake agreements to create green markets and decommission older capacities to pave the way for the new technologies.

How can government support to achieve India's decarbonization goal?

- Introduce green steel definition and product standards to help consumers choose products for their decarbonization efforts
- Promoting hydrogen adoption by making it affordable through a boost in domestic manufacturing of electrolyzers
- Promoting adoption of renewable energy by mandating the procurement of RE-based electricity
- Facilitating access to green finances such as green bonds, SLBs and concessional finance among others for R&D to support the transition to all large and MSME players
- Expanding the scrappage policy beyond automotive to make scrap easily available and improve utilization rates
- Setting up stringent PAT targets to ensure that steel manufacturers are more efficient
- Creating demand for green steel through government procurement and mandated demand terms for customers
- Incentivizing the steel sector transition and developing a domestic carbon trading market with the PAT scheme like the EU Emissions Trading Scheme (ETS)
- Creating carbon border tariffs like CBAM that could levy additional taxes on the imports of steel with higher carbon intensity, thus promoting domestic steel and creating additional revenue
- Inability of the Indian steel market to absorb a green premium should be supported by incentivizing the first movers of green steel

What can stakeholders do to support this goal?

- Pursue offtake agreements or procurement alliances between steelmakers, customers and government to achieve a mass demand and create guaranteed green steel markets
- Pursue collaborations with the government, peer companies, technology providers and academia, among others, to establish public-private partnerships and de-risk new technology adoption
- Until the availability of affordable green hydrogen, steel makers could resort to the use of low-carbon hydrogen to support their transition or could establish smelting reduction facilities over the coming years
- Steelmakers need to decommission old or close to end-of-life facilities to make way for future capacities
- Investors and financers must align themselves with the broader goal of net zero and support the industry by investing in decarbonization projects
- Financial institutions need to build their capacities and capabilities to cater to the capital demands of the Indian steelmakers and help them remain competitive in the global market
- Decarbonization throughout the supply chain in the steel industry could demonstrate customers' commitment to sustainability and create a demand for low-carbon steel

Source: TERI, IEA, WEF, Wood mac and EY analysis

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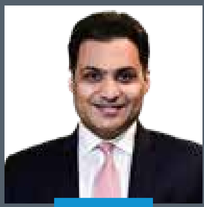

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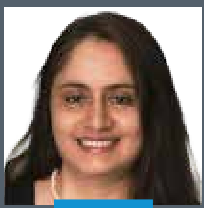

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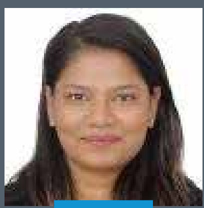

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