



October 2026

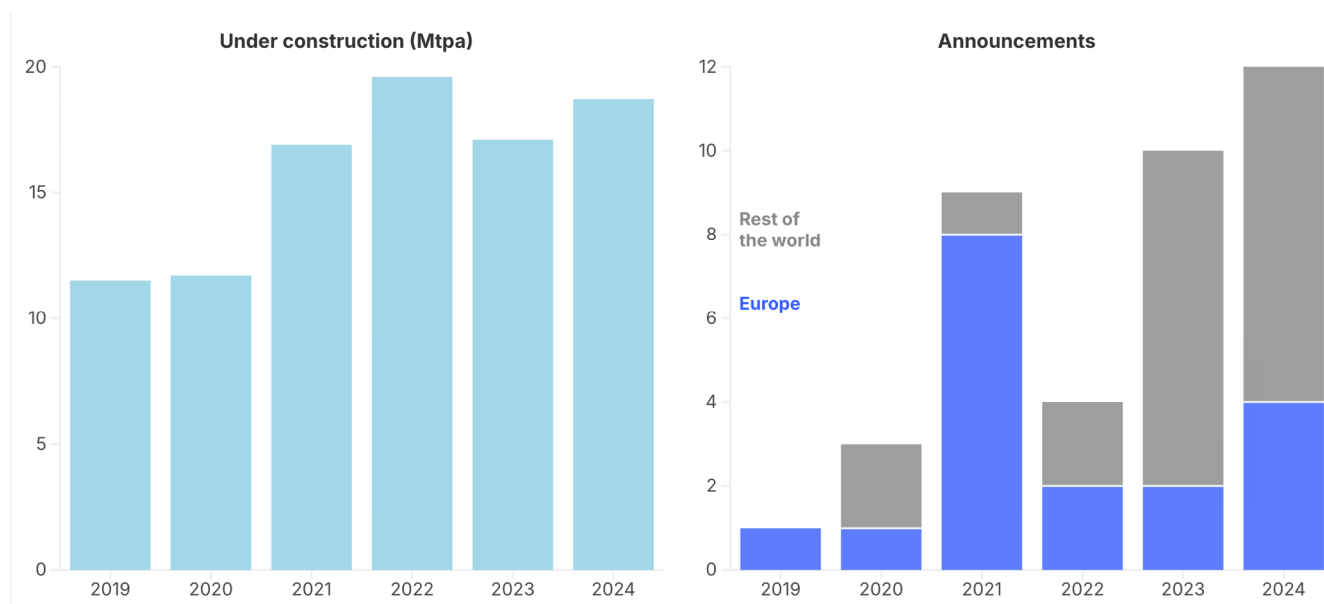
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Leapfrogging gas: How renewables can unlock new DRI on brownfield sites

- *Direct reduced iron (DRI) projects announced and under construction have increased by more than 50% since 2020, but they are facing increasing natural gas costs, particularly in LNG-importing regions including the EU, China and India.*
- *Coke oven gas (COG) was deployed to produce DRI in India from the 1990s until 2014 to avoid costs for natural gas and metallurgical coal. Since 2023, the approach has been revived by two of the largest steelmakers in China.*
- *Replacing onsite electricity generation with renewables and electrifying reheat furnaces will likely reduce costs at blast furnace sites in these regions, allowing the COG that was used for these purposes to be redirected to DRI.*
- *Widespread uptake of the COG DRI approach could reduce metallurgical coal use by 10%-15% (even with high gas prices) across EU, China and India, highlighting further downside risk for exporters like Australia.*

Momentum is building for direct reduced iron (DRI), widely considered a key pathway for decarbonising iron and steelmaking. Project announcements and construction activity are accelerating. According to [Midrex](#) (the largest DRI technology provider) the total amount of capacity under construction is up 50% over the last four years. Similarly, announcements for low-emissions steel projects using DRI spiked in 2021 and have showed continued growth since then.

Figure 1: DRI capacity under construction (left), million tonnes per annum (Mtpa); and number of green steel projects announced (right)



Sources: [Midrex](#), [LeadIT](#).

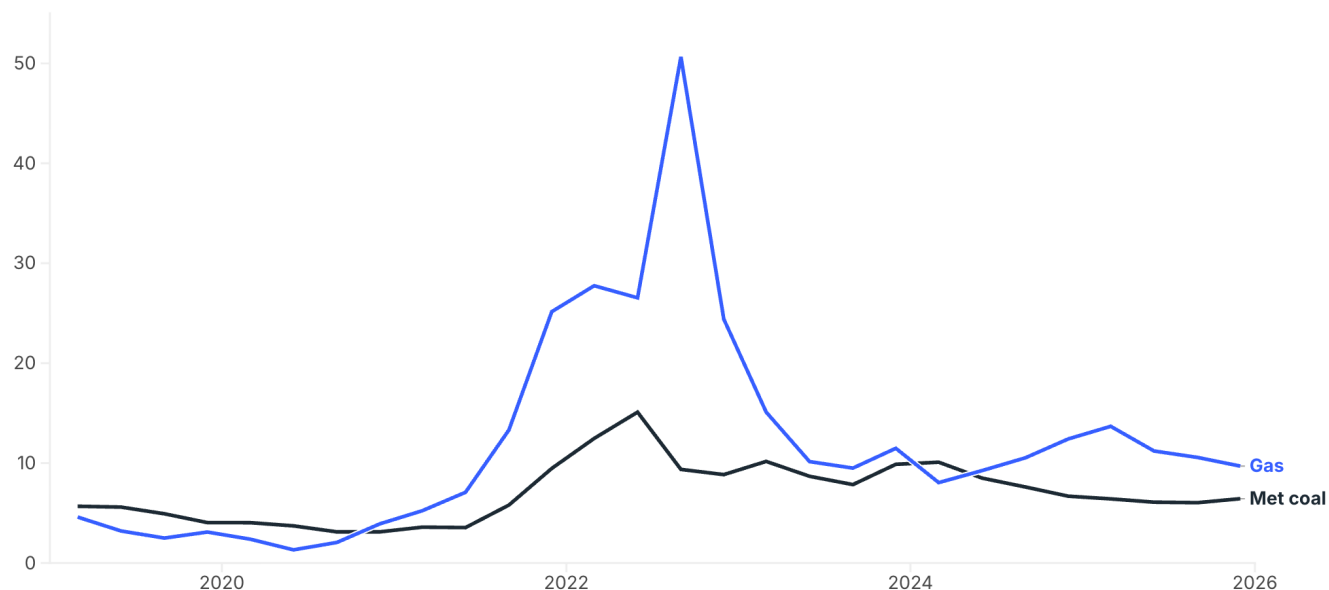
Notes: Project announcements are for commercial-scale DRI projects from LeadIT database.

Interest has been driven by emissions reduction goals both from policymakers and steel producers. Midrex now expects [global demand for DRI to reach 180 million tonnes \(Mt\) by 2030](#) as the steel industry accelerates decarbonisation efforts. Data from the World Steel Association's [emissions survey](#) shows that on average DRI facilities globally produce 40% lower emissions than blast furnaces (BFs). This advantage stems from the use of natural gas in DRI production, compared with metallurgical coal in BFs. Importantly, DRI also has the advantage of being able to run on [hydrogen with relatively low additional capital investment](#).

The EU has been the source of much of the uptick in DRI activity. Previously the EU, which is [dependent on imported gas](#) (either via pipeline predominantly from Norway/Russia, or LNG), had not seen a DRI deployment since being among the first to [implement the technology way back in 1971](#). Instead, DRI investments were focused on locations with access to low-cost natural gas including the Middle East, North Africa and North America.

The recent activity has been driven in part by [EU member states providing grants](#) for existing BFs to transition to DRI, leading to a wave of project announcements. Most of these plants intended to first utilise natural gas before progressively switching to renewable electricity (likely directly for steel plants' [heat needs](#), and via [green hydrogen](#) for the chemical reactions). The EU's strategy was based on near-term access to affordable natural gas, and the expectation of continuing cost declines in renewables. Many of these projects have since [struggled to reach financial close](#) (despite the government grants) as gas prices rose, first due to Russia's invasion of Ukraine, then more recently compounded by disruptions in the Strait of Hormuz.

Figure 2: EU metallurgical coal and gas prices, 2025 USD per gigajoule (GJ)



Sources: [Department of Industry, Science and Resources](#); [International Monetary Fund \(IMF\)](#).

An alternative path

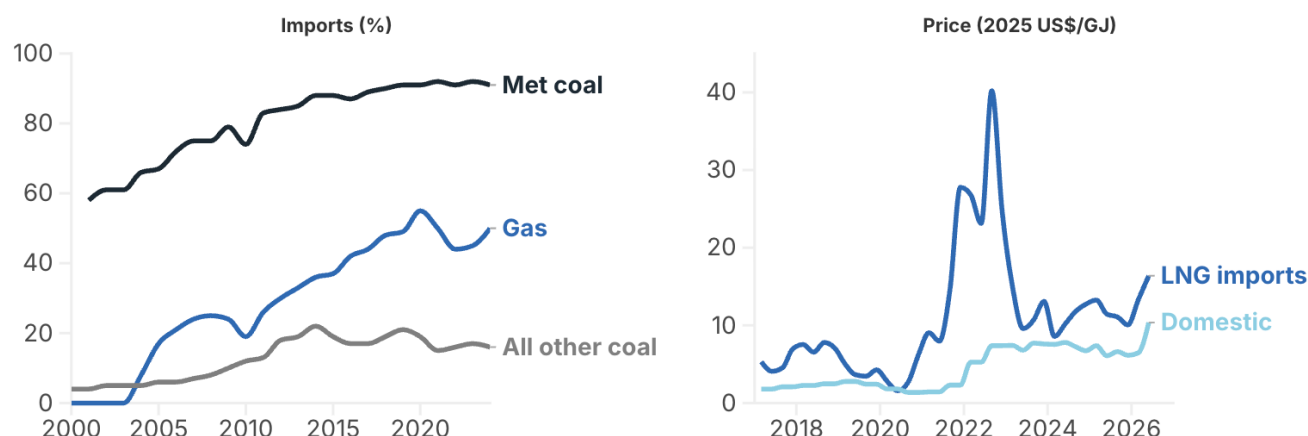
The one region that has historically deployed direct reduction despite a lack of access to low-cost gas is India. Much of its DRI capacity comes from [coal-based kilns](#) that use local low-grade iron ore and coal resources. This approach has low capital costs, but is inefficient and highly emissions-intensive.

Alongside these kilns, India also deployed large-scale efficient shaft furnace DRIs, [starting in the 1990s](#) and continuing [through to 2014](#). Normally this type of facility would use natural gas. However, due to the [unavailability](#) (and high cost) of gas in India, these facilities instead use gases released during coke production. This is possible because the DRI facilities were installed alongside existing BF's, which use coke.

In coke production, about a [quarter of the input metallurgical coal](#) (on an energy basis) is typically converted into an off-gas, which is rich in [methane and hydrogen](#). The coke oven gas (COG) is typically burned to provide heat for other processes in the steelmaking facility (such as the [reheat furnace ahead of rolling](#)) or to generate steam for onsite electricity generation.

These Indian facilities instead utilise the COG (or [other gases](#) from neighbouring smelting operations) to provide heat and chemical energy to an adjacent DRI plant. Originally, many of these DRI facilities used natural gas directly, taking advantage of low-cost domestic suppliers. However, as gas consumption across India rose, leading to an import dependency (via LNG) and increasing prices, these [plants increasingly switched to the COG strategy](#). The COG approach allows for the maximum iron output from a given unit of (higher cost, less abundant) metallurgical coal, allowing lower-grade coal to be used for other heat and electricity needs.

Figure 3: Indian import dependency (left); and gas prices (right)



Sources: [US Energy Information Administration](#); [Petroleum Planning & Analysis Cell](#); [IMF](#); [Ministry of Coal](#).

Reviving the approach

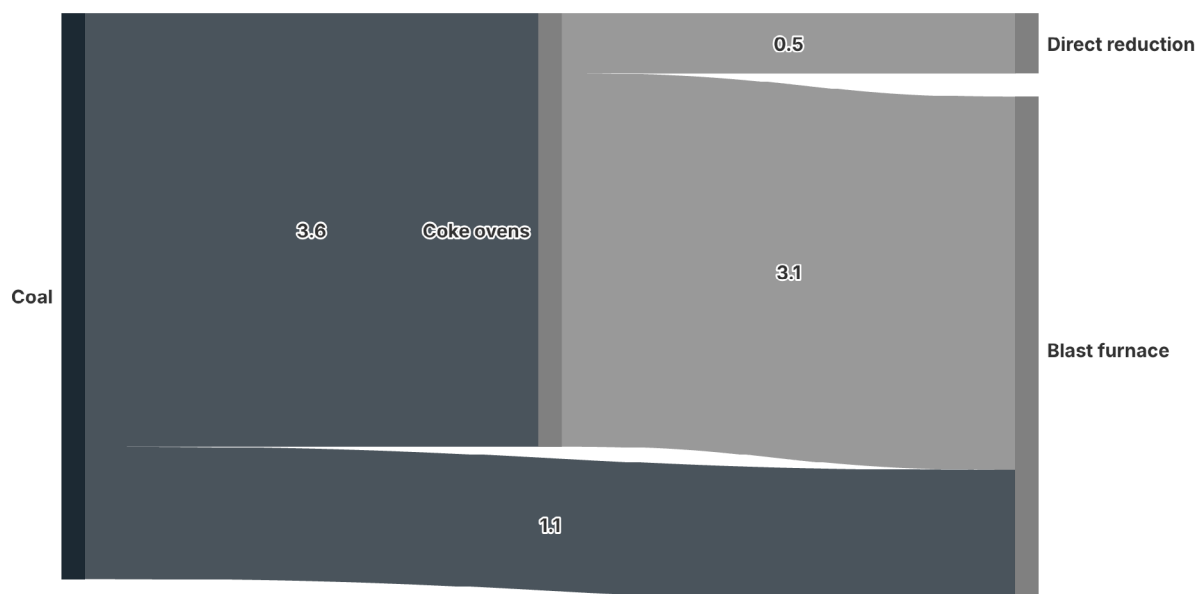
As part of a push towards hydrogen-based metallurgy and reducing steel sector emissions, China has revived the approach of installing DRI alongside existing coke-making facilities. First, [HBIS deployed a 0.6Mtpa Energiron shaft furnace](#) in Zhangjiakou, Hebei, in 2023. Baosteel (a Baowu subsidiary) followed suit in 2024 with a [1Mtpa facility in Zhanjiang, Guangdong](#). Both facilities have produced commercial output volumes while also familiarising engineers and operators with the direct reduction technology.

[HBIS estimates](#) there is 100 billion cubic metres of surplus COG across China, sufficient to support 200Mtpa of COG DRI (about 20% of China's total steel production). The strategy appears to be to first produce DRI using COG and to subsequently switch to green hydrogen. For example, Baowu's clean energy subsidiary is [developing an offshore wind and green hydrogen facility in Yangjiang](#) (approximately 200km from the Zhangjiang DRI plant) and suggested the two facilities could be connected by pipeline in the future.

In 2025, HBIS announced that [10,000 tonnes from the Zhangjiakou DRI plant had been shipped to Italy](#). This volume was exported primarily in response to the EU's Carbon Border Adjustment Mechanism (CBAM), which applies a carbon price – equivalent to the EU Emissions Trading System (EU ETS) – to imports. HBIS noted that this export volume achieved a 50% reduction in emissions intensity, lowering CBAM costs which are due to come into effect from 2027.

During the coke-making process, most of the carbon contained in the input metallurgical coal is maintained in the coke. As a result, off-gas from coke-making contains a similar amount of carbon (per unit of energy) as natural gas. This means direct emissions from COG DRI facilities are similar to other (natural gas-based) DRI on the market, which is significantly less than steel from a BF. Because the ultimate fuel source is coal, the overall emissions intensity for the combined facility (BF + DRI) is higher than just the DRI portion.

Figure 4: Estimated carbon flow for BF with COG DRI (tonne of carbon dioxide-equivalent per tonne of steel via DRI)



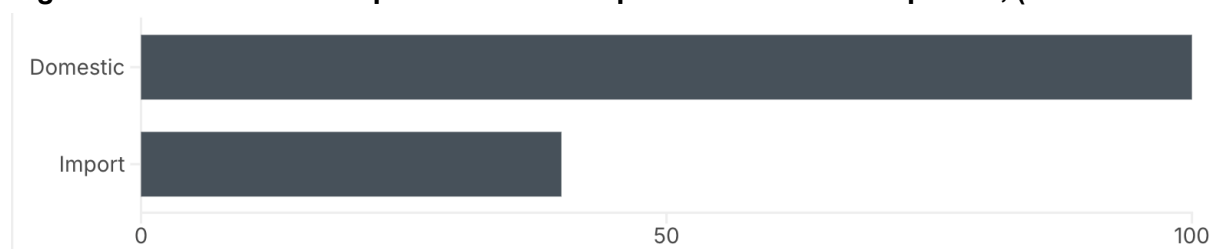
Source: IEEFA analysis.

Notes: Approximately two tonnes of BF steel is produced for every tonne of DRI steel. Analysis assumes no COG use for onsite electricity generation or reheat furnace.

Expanding the approach

Deploying the same approach (DRI using COG) in the EU faces higher costs under the ETS/CBAM rules. Currently, for steel imports from an overseas DRI plant using COG, the EU's CBAM only applies to the emissions from the DRI section of the facility. In comparison, deploying the same approach inside the EU, both the adjacent BF and coke ovens, as well as the DRI, would be required to pay carbon costs under the EU ETS. As a result, the effective carbon cost per tonne of steel is 60% lower for imports than domestic production.

Figure 5: Effective carbon price of COG DRI produced in EU or imported, (EUR/tonne of steel)



Source: IEEFA analysis.

Notes: Based on carbon costs of EUR80 per tonne of carbon dioxide-equivalent with no free allowances

ETS/CBAM rules could be adjusted to equalise the treatment of the COG DRI approach irrespective of whether it is deployed inside or outside the EU. There is still time to make these changes, as the import volumes HBIS demonstrated under this approach are still very small (10,000 tonnes in contrast with [about 30Mt of total steel imported into the EU in 2025](#)), and the [deep reductions in free allowance](#) are still yet to occur.

Because it is a mature market (with increasing scrap generation), the EU also does not need more primary steelmaking capacity. As a result, new DRI facilities would likely replace existing BFs (instead of relining). This means the COG DRI approach only works in the EU for brownfield sites that already operate multiple blast furnaces (allowing the DRI to replace one BF while

others still produce sufficient COG for the DRI). Most BF sites in the EU fit this profile, including ArcelorMittal's Dunkirk and Tata's Ijmuiden facilities.

Another challenge to using this approach in the EU is that (unlike in China) there is no surplus of COG. Existing BF sites are already using COG throughout the steelmaking process and for onsite electricity generation. Freeing up COG will therefore require new low-cost renewable energy to replace onsite electricity generation and to electrify some sources of heat.

Replacing onsite electricity (produced using COG) with renewables is increasingly likely to be cost-effective for EU steelmakers. Because metallurgical coal (the source of COG) is relatively expensive (currently about EUR30 per megawatt-hour [MWh]), and the conversion to [electricity is inefficient](#) (averaging 32% in the EU), onsite electricity generation costs steelmakers about EUR95/MWh just for fuel. In comparison, steelmakers can secure [renewable power purchase agreements \(PPAs\) across the EU](#) for much lower rates. Steelmakers are increasingly entering into these PPAs – most recently, [Salzgitter committed to offtake power](#) from a 147-megawatt solar and battery storage project in Germany.

Replacing only onsite electricity generation is unlikely to unlock sufficient COG for DRI. Integrated sites would likely also need to switch some heat from COG to electricity. This is more difficult economically as the conversion from COG into heat is highly efficient (unlike the conversion to electricity). This means the replacement electricity would need to approach the COG fuel cost (about EUR30/MWh), which is not the case in most locations.

However, electrification of heat can provide other benefits which offset the higher energy cost. For example, electric reheat furnaces eliminate combustion, which causes mill scale (oxidation on the surface of steel). Avoiding mill scale can save [steelmakers USD10 million per year](#), helping to offset the higher cost of the electrified reheat furnace. Similarly, electric reheat furnaces provide the option to apply different levels of energy input to individual steel slabs, helping to reduce total energy requirements.

These benefits can make a strong case for electrification. For example, Cleveland-Cliffs (with support from the US Department of Energy) is investing [USD175 million to replace natural gas with electric induction for reheat furnaces](#) at its operations in Butler, Pennsylvania. The company expects this change to generate USD80 million per year in yield-related cost savings.

Combined, the replacement of onsite electricity generation with renewables and electrification of reheat furnaces could free up sufficient COG for DRI production. As an example, Thyssenkrupp's facility in Duisburg, Germany, recently [renegotiated its grant funding to remove hydrogen requirements](#). As a result, a [2.5Mtpa DRI plant](#), which is still proceeding, will [replace the two smaller blast furnaces onsite](#), leaving it to run alongside the [two larger remaining BFs at the site](#) (with a total capacity of about 7.7Mtpa).

The Duisburg DRI plant is now planned to operate initially on natural gas. However, replacing [onsite power generation](#) (339 megawatts) with renewables (via the grid) and electrifying reheat furnaces could unlock up to 15 gigajoules (GJ) of COG per tonne of DRI capacity, which is more than sufficient (DRI requires about 10GJ per tonne). Avoiding the need to consume natural gas in DRI production would also lower the facility's direct emissions by 10% reducing ETS costs.

The main constraint is securing sufficient renewable energy. In the Duisburg example, about 2.8 gigawatts of solar is needed (about 19 times the size of the recent Salzgitter PPA) to free up sufficient COG for the DRI. Steelmakers can help to accelerate the needed renewables by executing forward-looking long-term PPAs for new solar and wind projects.

Another barrier could be that the existing onsite electricity generation is already tied into long-term contracts – although these could be [terminated early if savings are sufficient](#). By using renewables to free up COG, this approach can also help to avoid dependence on new LNG import infrastructure, as a single DRI facility could consume up to 1% of the EU's current LNG imports.

Outside the EU, other regions could use this approach to reduce near-term emissions and develop the fuel flexibility that will support a future switch to 100% renewables. Like the EU, Southeast Asia lacks gas resources and could adopt a COG DRI strategy quickly as steel and renewable capacity expands in the region. Similarly, India could return to this approach. Export finance from DRI technology-providing regions (US/Japan for Midrex; Italy for Energiron) could help to accelerate these deployments.

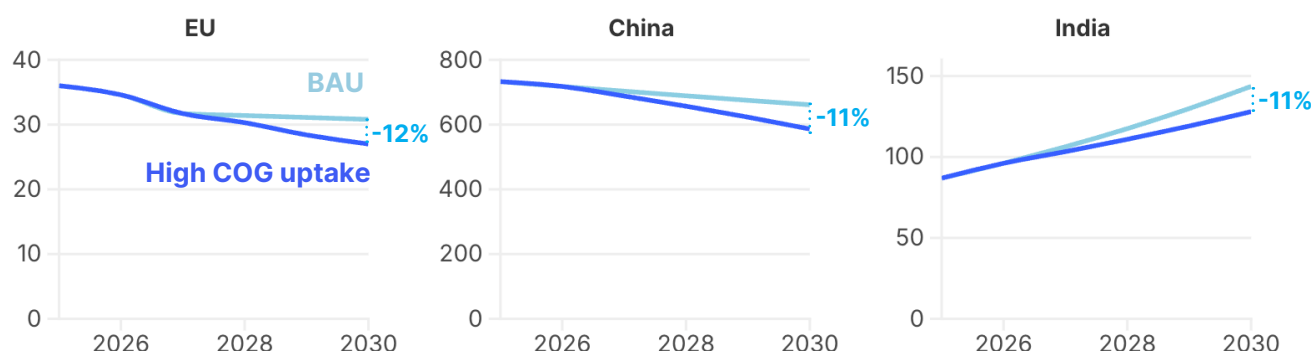
Implications for metallurgical coal exports

The COG DRI strategy has been used in the past to substitute high-cost natural gas or metallurgical coal with lower-cost thermal coal. This is similar to the longer-running trend in the steel industry towards [pulverised coal injection in blast furnaces](#), which similarly reduces metallurgical coal requirements by allowing a fraction (up to about 30%) to be replaced with lower-grade (and lower-cost) coal.

Declining costs for renewables have opened an opportunity to instead use clean electricity as the substitute fuel, providing cost and emissions benefits in regions with high gas and metallurgical coal costs such as China, India and the EU. The COG DRI strategy allows this new renewable electricity to be used in only its most efficient applications within the steelmaking process (i.e. electricity and certain heat applications that provide co-benefits), enabling cost reductions.

It is too early to determine if there will be widespread application of COG DRI, with only the two plants in China deployed over the last few years. However, there is potential given the cost benefits in those regions. If uptake was high, using lower-cost renewables and electrification to free up the necessary COG, metallurgical coal demand could be 10%-15% lower than under a business-as-usual (BAU) scenario for each of the EU, China and India. This highlights a [further downside risk for metallurgical coal exporters like Australia](#).

Figure 6: Forecast metallurgical coal consumption under BAU and High COG Uptake scenarios (Mtpa)



Source: IEEFA analysis.

Notes: Business-as-usual (BAU) scenario is based on no change in asset mix with total steel production forecast based on CAGR [compound annual growth rate] for the past five years using data from [worldsteel](#) and metallurgical coal consumption per the [International Energy Agency](#). EU BAU includes BF replacements already under construction; EU High COG Uptake uses COG DRI instead of future BF relines (per [Global Energy Monitor](#) data). China High COG Uptake assumes COG DRI contributes half of the metal needed to meet the government's 2030 EAF [electric arc furnace] target (20%). India High COG Uptake assumes COG DRI deployments sufficient to keep track with the government's target to reduce steel emissions intensity 25% by 2035.

Deploying DRI without building a new reliance on natural gas – which has experienced two supply-side price shocks in the last five years – is increasingly important both from an emissions and energy security perspective. Lessons from China and India’s experience of COG DRI provide a model that can now be leveraged using renewable energy and electrification (instead of low-grade coal) to both reduce emissions and enhance cost-competitiveness, all while laying the foundation for future near-zero-emissions iron production.

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