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HOW STEEL CAN TAKE THE LEAD IN DECARBONIZATION

Cross-industry alliances can help bring green steel to scale

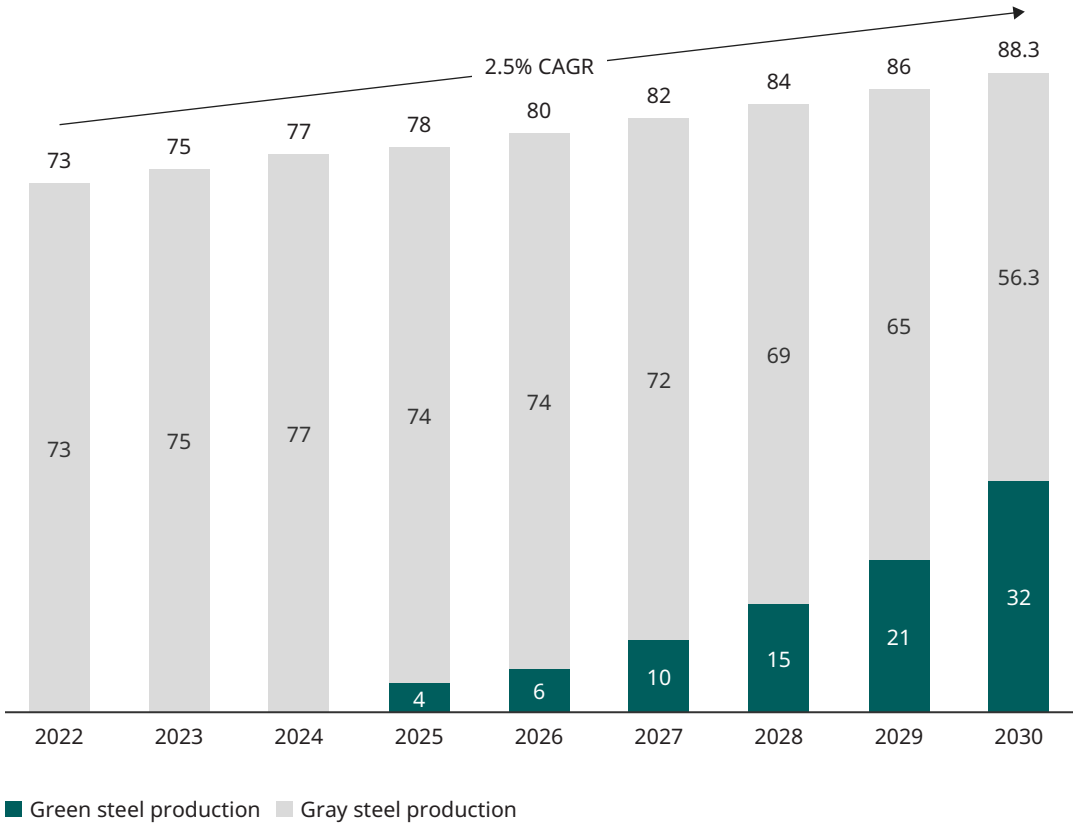
Nils Naujok
Holger Stamm

The recent volatility of the steel markets in pricing and demand, especially after the all-time high set in 2021, offers global producers — particularly in Europe — a window of opportunity to distinguish themselves as leaders in decarbonization. This will require a shift in production to green steel — that is, steel produced without using energy from fossil fuels. With the strong post-pandemic demand for this building block of the global economy and ever more policies and regulations pushing green technologies, the situation is ripe for steel producers willing to commit the necessary resources to redefine the industry.

But steel producers cannot change the industry alone. The key to the transformation in steel will be partnerships, joint ventures, and alliances with other industries, including energy, mining, chemicals, private capital, and end users such as automotive and construction companies. The future leader in steel will be the producer that can create and manage new industrial ecosystems that can build the necessary infrastructure to help the global supply chain transition from carbon-intensive steel to green.

While most of the technology needed to produce green steel already exists in pilot form at least, decarbonized steel production still needs the infusion of sizable capital expenditures (CAPEX) in excess of €2 trillion to €3 trillion for capacity to reach commercial scale. That amounts to an average investment of €1,000 to €1,500 per ton of steel produced annually. It is unlikely that any steel producer or even the entire industry en masse would be willing to supply that magnitude of CAPEX. But by joining forces across industries, steel can pool resources with deep-pocketed industries that also will benefit from steel's conversion. Ultimately, steel has the potential to become a global economic model for decarbonization through these ecosystems.

Exhibit 1: Expected flat steel production volumes in Europe
In megatonnes



Note: "Gray Steel" refers to conventional steel made with energy from fossil fuels and/or in the basic oxygen furnace (BOF) route. CAGR stands for compound annual growth rate. Growth scenario is best case; more pessimistic scenarios are possible due to structural and cyclical challenges such as energy costs in Europe.

Source: Oliver Wyman analysis

The next seven years will be make-or-break, given how long it will take to build these ecosystems and transition the industry. To be a survivor over the long run, a steel producer will need to be a part of one of these networks. Otherwise, it would likely go out of business or become so peripheral to what will eventually become a global green steel market that it might as well be. This is not only because the demand will increasingly shift to green steel. Banks and institutional investors — on their own quests to decarbonize portfolios — are already raising the cost of capital to carbon-intensive businesses, meaning growth or even operational improvements may come at a steep price. Eventually, some banks could cut off access entirely.

GREEN STEEL NEEDS GREEN ENERGY

Where conventional steel uses high-carbon coal called coke in blast furnaces to produce the intensive heat necessary to make steel, green steel production relies on renewable energy both to create green hydrogen and run electric arc furnaces. Hydrogen has been identified as probably the best replacement for coke because it burns hot enough for the direct reduction of iron ore with only water as its emissions. The CAPEX funds for steel production would be used to construct sufficient hydrogen-based DRI capacity, as well as to replace blast oxygen furnaces with electric arc furnaces.

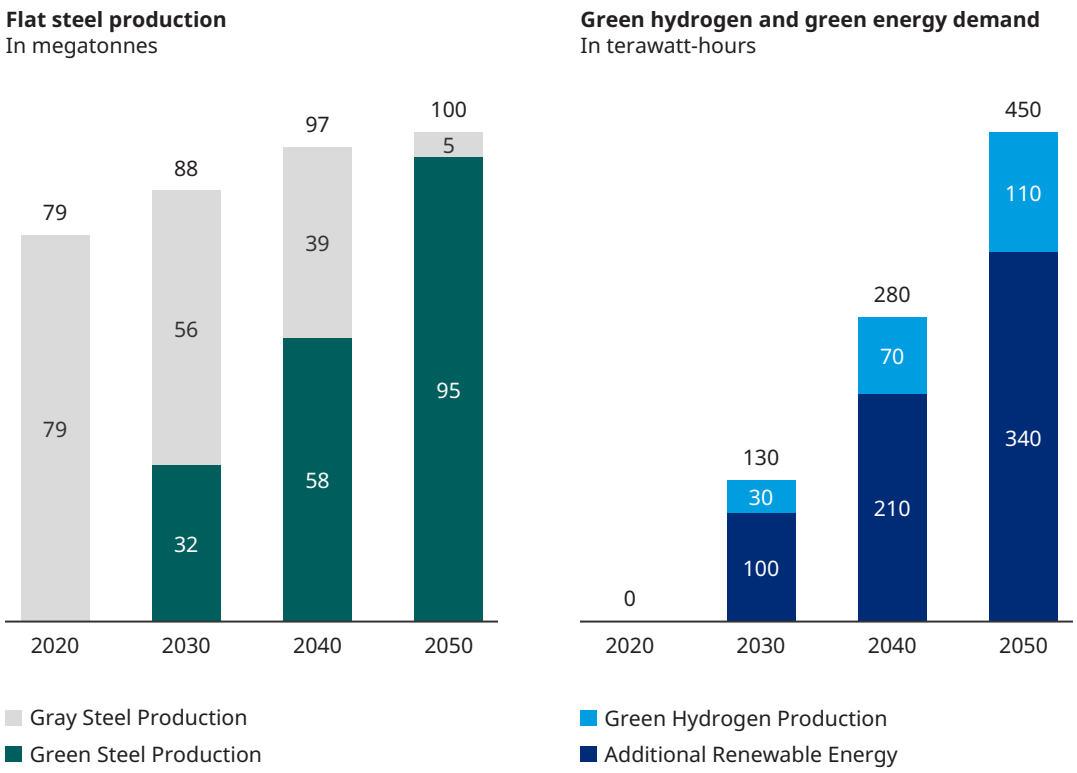
Meanwhile, the industry must also deal with the shortage of renewable energy — probably the biggest immediate obstacle to steel's efforts to decarbonize. The International Energy Agency (IEA) has stressed that the period between now and 2030 must become one of unprecedented clean energy investment, requiring the addition of some 630 gigawatts (GW) of solar photovoltaics and 390 GW of wind by the end of this decade. That would be four times the record levels set in 2020. Today the largest sources of low-carbon energy are provided by hydro and nuclear power, which also should be expanded.

The good news, according to the IEA, is that all the technologies needed to achieve the necessary cuts in global emissions by 2030 already exist. The key will be the trillions of investment dollars needed to expand the renewable energy capacity sufficiently to allow industries, like steel, to decarbonize. The IEA estimates that annual investment in clean energy must surge to $5 trillion by 2030.

Without expansion of renewable energy, industries like steel will end up competing with each other for what's available, leaving the losers with only fossil fuels to meet demand. For example, by 2030, producing 32 million tonnes of flat green steel in Europe would consume 12% of the renewable energy available in the region, while still only satisfying about 30% of demand. By 2050, to produce 95% of the projected European green steel demand would require the industry to consume more than 40% of Europe's available renewable energy, creating a huge imbalance between the supply and demand for renewable energy.

While part of that imbalance will likely be addressed with imports of green hydrogen as well as synthetic gas and biomethane, Europe may not want to create unhealthy energy dependence on other regions. The only way to reduce that potential dependence would be for Europe to expand dramatically its current renewable capacity, beginning today.

Exhibit 2: Forecasts for steel, hydrogen, and renewable energy production in Europe



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EARLY MOVERS AND PARTNERS

The reward for early movers could be considerable. Besides creating a global market for green steel, leaders in decarbonization will also spawn trading in commodities used in green steel production. On the energy side, these might include green hydrogen, synthetic gas, and biomethane — all low-carbon energy sources that will not reach commercial scale without sufficiently developed marketplaces.

Raw materials used in green steel production like high-grade iron ore and scrap metal would also get a boost. Finally, and perhaps most importantly, it will generate the demand necessary to justify extensive new capacity in renewable energy and storage, whether it's solar, wind, hydro, nuclear, or thermal.

Executives who intend to lead the industry must, first, identify the appropriate stakeholders with which to form alliances. This could mean joining forces with automotive manufacturers as H2 Green Steel in Sweden did when it partnered with Mercedes Benz or Boston Metal in the United States did with an investment from BMW. The advantage for sizable end users is the ability to guarantee a source of green steel through pre-arranged supply deals in the early days when green steel will be in short supply.

Both green steel startups also received sizable investments from some of the world's largest steelmakers: ArcelorMittal in the case of Boston Steel and Kobe Steel in the case of H2 Green Steel. Mining giant BHP also invested venture capital in Boston Metal.

THE NEED FOR DEEP POCKETS

But given that energy is the component most elusive in green steel production, smart partnerships moving forward should consider bringing deep-pocketed energy producers into their ecosystems to help ensure sufficient green power. For example, Hitachi Energy invested in H2 Green Steel in 2022. Finnish power company Fortum has signed an agreement to supply H2 Green Steel carbon-free electricity generated primarily from hydro power.

Steel executives must shift their mindset from managing one company to managing a network of cross-industry relationships. Companies will need to decouple steel production from steel rolling, to manage different transformation paths. They will also have to accelerate their own programs for sourcing green hydrogen and renewable energy, relying on partners in the energy and chemicals industries.

The green transformation will take decades and be costly. Given the many challenges that need addressing, the efficiency of investments will ultimately determine the leaders of the new industry. Greenfield players have an advantage initially because of the absence of legacy elements of the old steel in place and their ability to locate near renewable energy production. While first movers and startups will gain useful knowledge and scoop up partnerships, legacy players can catch up by going all-in with a green transformation strategy that is apt to result in higher CAPEX efficiency and a faster transformation.

WHY FOCUS ON STEEL

Steel is an economic building block of the global economy. It is a key commodity in the production of cars, ships, trains, and aircraft as well as in the construction of everything from factories and skyscrapers to societal infrastructure, construction and agricultural equipment, machinery, appliances, and even robots. Expansion of the global economy would not be possible without steel. Thus, its decarbonization will automatically reduce the carbon footprints of other major industrial sectors, as the introduction of green steel should result in a sizable cut in emissions for its end users as well.

Globally, the demand for steel is expected to expand 30% by 2050, according to the World Economic Forum (WEF). Given that the steel industry is the largest-emitting manufacturing sector, producing 7% of all man-made greenhouse gas emissions, a significant increase in production would be disastrous for global warming without substantial conversion to less carbon-intensive steel.

Green steel produced with green hydrogen is not the only way the industry could go. There is also the option of replacing blast furnaces with electric arc furnaces and making steel from scrap metal, or steel producers could install carbon capture and storage technology, which prevents CO2 emissions from entering the atmosphere. Both approaches have drawbacks and would require significant CAPEX dollars to scale up. First, there is not enough scrap steel to replace all the production of conventional steel, and unless electric arc furnaces are powered by renewable energy, there are still significant emissions, despite the recycling aspect of using scrap.

Carbon capture technology is pricey and would needs substantial investment to lower costs. Ultimately, the solution to emissions over the next five to 10 years is likely to involve a combination of all these approaches as the industry attempts to pursue its pledges to cut emissions significantly by 2030 and get to net zero by 2050.

ADVANTAGE EUROPE?

While the opportunities with green steel are available to all steel producers, the European industry may sit in a particularly advantageous position to capitalize on them soonest. The EU has some of the world's most supportive policies encouraging a steel transition, and European steel producers — the backbone of the industrial landscape in Europe, with two-thirds of industrial jobs in steel-intensive sectors — should take advantage of them. Among recent legislation: the Carbon Border Adjustment Mechanism, which goes into effect in October, and the Emissions Trading System, which created the world's largest carbon trading market.

The EU is also contemplating a requirement that public infrastructure projects must use a certain percentage of green steel. European steelmakers should support such a mandate. These kinds of laws and policies help establish markets for new commodities like green steel and its supply chain. By 2030, European steel production is expected to grow 2.5%.

Thirty percent of the green steel produced in 2023 was provided by new industry players. First movers have already begun investing in green flat steel production, and volumes are expected to reach industrial scale in two years, with many frontrunners based in Europe, including SSAB, Salzgitter, and H2 GreenSteel.

By 2030, about 60% to 70% of the green steel produced in Europe (flat) will come from established players, such as Arcelormittal, Salzgitter, SSAB, or voestalpine. The remaining 30% to 40% will be produced by startups like H2 Green Steel.

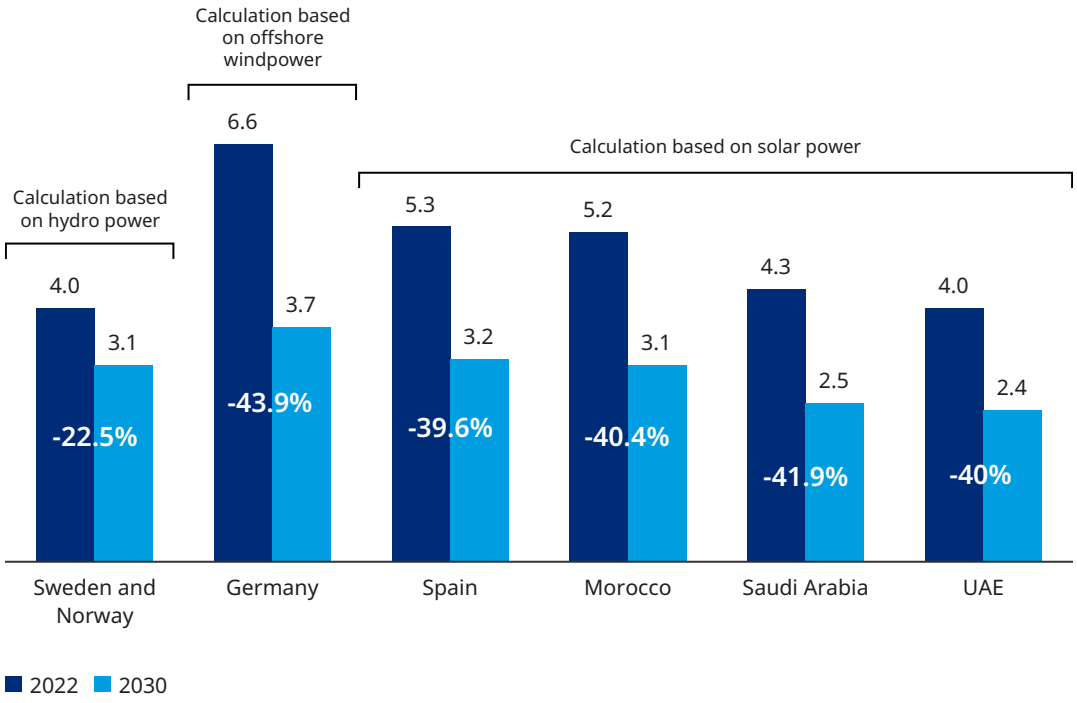
COST DIFFERENTIAL

Green steel will cost more than conventional steel because its production process is more costly. But it will have the added value of helping users reduce their emissions. Given that conventional steel prices will face downward pressure, the value-added green steel products will also offer producers an opportunity to decommoditize their products and protect their margins.

The first green steel volumes in 2025 are expected to cost up to 20% higher than high-carbon steel, depending on the quality and product differentiation. The question: Will end users and consumers pay the premium without regulations that force them? For a car, the extra cost of green steel might add as much as €500 to €800 to the price tag.

But not all regions will experience rising costs for steel equally. Access to cheaper green energy, such as hydro power, could give certain steel-producing regions an advantage. For instance, Boston Metal is building its first full-scale green steel facility in Brazil, the second largest producer of hydropower by installed capacity. H2 Green Steel already benefits from Scandinavia's cheaper hydro energy.

Exhibit 3: Levelized cost of green hydrogen
In euros € per kilogram

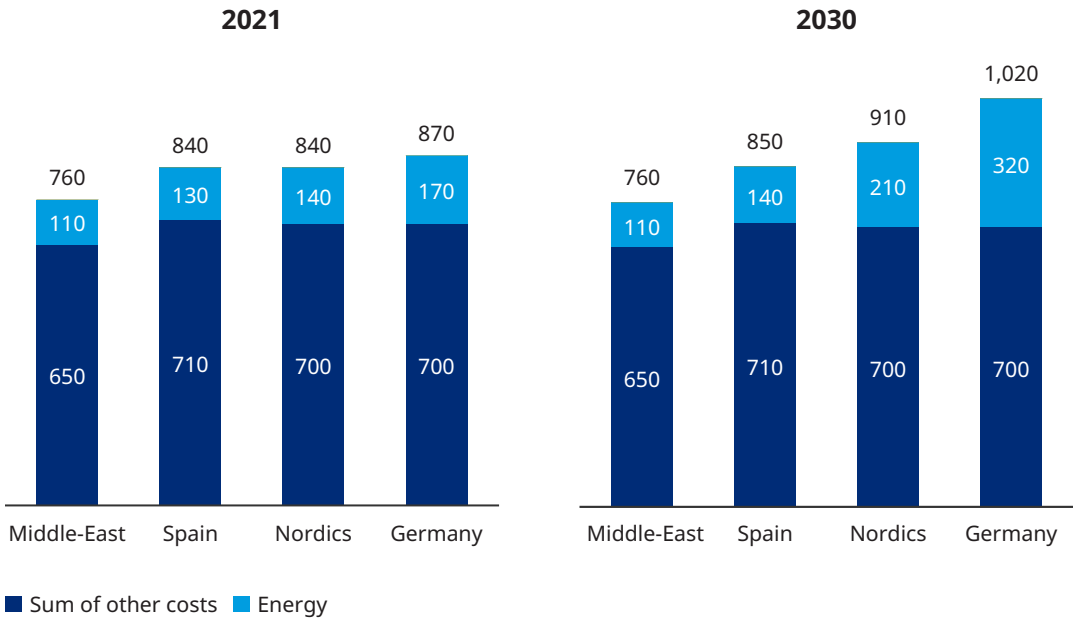


Source: Oliver Wyman analysis

Starting in 2025, as the first substantial quantities of green steel enter the market, most of Europe will be supplied by the operations in the Nordics, such as H2 Green Steel and SSAB. Salzglitter, Germany's second largest steelmaker, was recently awarded €1 billion of government funding for its SALCOS hydrogen-based steel production project. But competition will spring up eventually in places like the Middle East where, for instance, Indian steel maker Jindal Steel and Power has invested $3 billion in an Oman green steel facility.

Until 2030, the energy costs differences between various regions will be key for green steel manufacturers, and those regions with lower energy prices, such as the Middle East, could gain an advantage. Nordic countries, for example, would likely enjoy an 11% cost differential compared with Germany. The Middle East would have a 22% to 25% cost advantage. By 2030, the equivalent of one big European steel plant's production could be replaced by green imports such as slabs from places in the Middle East.

Exhibit 4: Production cost of gray steel versus green steel by country
In euros € per tonne of crude steel (pre-inflation)



Note: Gray steel production via blast furnace and basic oxygen furnace; green steel production via direct reduced iron and electric arc furnace

Source: Oliver Wyman analysis

HOW TO LEAD

Still, the undeveloped green steel market offers opportunity for an ambitious steel company to grab the pole position. The suppliers with the fastest ramp-up curve, technical leadership for decarbonized production, and the most efficient partnerships for renewable energy and green hydrogen are likely to turn the industry rankings upside down.

It will take vision and the ability to adapt to entirely new ecosystems and players. For green steel to succeed, the producers will need to enlist support from end users to pay higher prices and from the government to require increasing amounts of green steel by all industries.

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For more information, please contact the marketing department by phone at one of the following locations:

Americas	EMEA	Asia Pacific
+1 212 541 8100	+44 20 7333 8333	+65 6510 9700

AUTHORS

Nils Naujok
Partner
nils.naujok@oliverwyman.com

Holger Stamm
Partner
holger.stamm@oliverwyman.com