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Argus Insight: Hydrogen's role in decarbonising steel production

Executive Summary

The steel industry is a global colossus. Each year 6 billion tonnes of steel and steelmaking materials are moved around the world by truck, rail and ship. Despite a relatively light per tonne carbon footprint, the sheer size of the boot means the sector accounts for 7-9% of global CO2 emissions.

Initially a cautious responder to the hydrogen (H_2) economy, momentum for projects and funding is building. Argus examine a German use-case and funding mechanism recently announced, before discussing newly released metrics offering transparency to hydrogen and steel industry participants.

The Iron Giant: Hydrogen (H_2) demand centre flickers to life

German steel producer Thyssenkrupp in July announced its tkH2Steel project had won €2bn of European Commission (EC) funding for decarbonising steel production. Of this, €550mn will be a direct grant toward capital expenditure-related investments, including a direct reduced iron (DRI) plant and two melting furnaces.

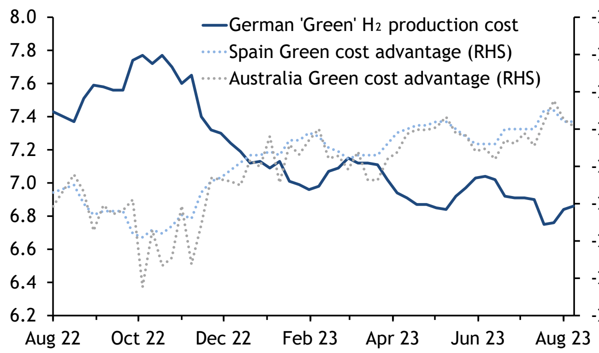
Almost three times, or €1.45mn, as much has been set aside for continuing funding to defray the cost of maximum decarbonisation over the first decade of plant operation. This operational expenditure-focused support is contained within a conditional payment mechanism (CPM) clause.

The CPM scheme encourages the use of renewable (green) over low-carbon (blue) H_2 during the first 10 years of production. This aligns with German national policy, with revisions to its national strategy shutting the door on encouraging domestic blue H_2 production.

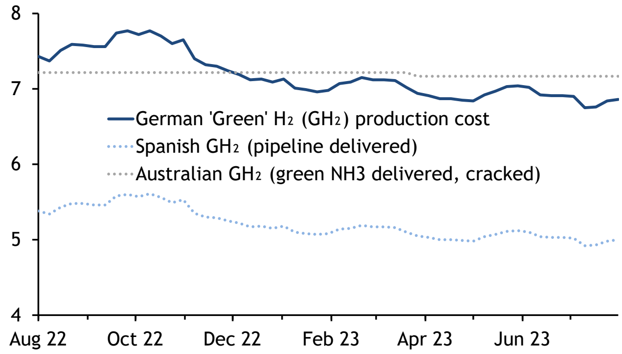
Long arm of the state...offers a helping hand

While the German government has decided to nudge decisions on H_2 carbon intensity it does not appear to be forcing the make or buy decision. The CPM talks about "procured" not

German H_2 costs beckon imports



Delivered costs favour regional supply



"produced" H_2. Given the high cost of German H_2 production, relative to other locations, this implies it could come from overseas.

This may reduce the value of support the EC could be on the hook for.

It is likely that the H_2 will not come too far though. Apparent cost advantages are sharply reduced if imports travel via vector. Taking the example of ammonia, the 20pc cost of cracking ammonia back to nitrogen and H_2 goes a long way to nixing apparent competitive advantage. Supplies may be an intra-European affair, so Iberian gas-state H_2 via pipeline looks attractive.

Thyssenkrupp's "green DRI" plant, produced using green H_2, is scheduled to come on line in 2029, requiring 143,000 t/yr tonnes of renewable H_2 or 1.43mn t over the 10-year funding period.

The €1.45bn is earmarked to bridge the differential between lower blue and higher green H_2 costs.

EC funding...needs more funds?

The spread between German-produced blue and green H_2 costs over the past 12 months has averaged €1.60/kg. Domestic production would leave funding almost €840m underpowered.

But this may seriously understate the level of underfunding, given that the past year has seen extraordinarily elevated natural gas prices. They were so high that at times green H_2 production costs were substantially less than cheaper blue. The green premium to blue delta typically averages over €4/kg.

Comparing less costly potential import sources, such as Spanish green H_2 vs Russian blue (SMR+CCS) H_2, the delta has been stubbornly high and averaging €3.52/kg over the past year.

Will the gap be fully met, or is this a case of greasing the slipway to get decarbonisation under way? Instead of hoping for more funding, Thyssenkrupp may be confident of being able to pass through higher costs to customers for high value-added manufacturing in sectors such as appliances or automotives. And/or that the new reality of low-carbon intensity steel and the EU's Carbon Border Adjustment Mechanism offer a sustainable moat to local producers.

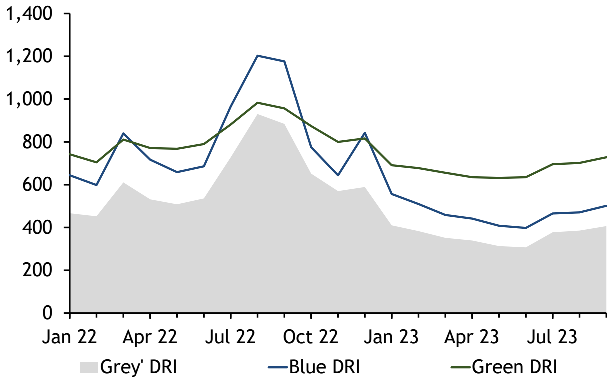
The cost of decarbonisation

This example of funding is specific to one steel producer but the wider sector must also weigh abatement. Argus launched costs for H_2-based DRI, with oxygen in iron ore (Fe2O3) being driven off by H_2, rather than natural gas. DRI can be consumed by steel producers in electric arc furnaces, or briquetted and used in blast furnaces to a 30pc rate.

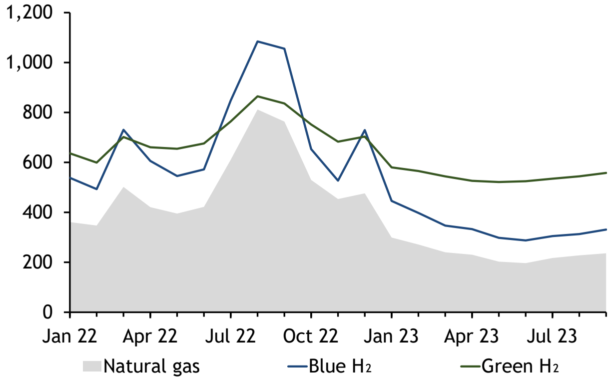
Steel producer feedstock blending can reduce the carbon intensity of overall production, in the same way ammonia co-firing in coal-fired power stations can. DRI use goes beyond reducing emissions at the iron ore sintering stage , although it can also reduce coke use in the hot metal stage.

These display the cost differential between DRI production using natural gas, blue H_2 and green H_2, underscoring why a mechanism is required to encourage "going green". But the EC is funding the cost of H_2, not DRI, as it excludes the iron ore costs.

Dri Full OPEX costs



Gas-only OPEX cost



Argus also launched indexes displaying the outright cost of H_2 alone in DRI production. The right-hand chart displays that differential on a northwest European basis.

Steel production is an area of massive potential for H_2 demand. The 143,000 t/yr highlighted as required by Thyssenkrupp represents 4-5pc of total German 2030 H_2 demand. Given that refining and fertiliser markets come first to most minds, with marine fuel and co-firing power generation leading the novel uses category, this volume of new demand is non-trivial.

A drop in the steel ocean but big ripples locally...

Thyssenkrupp is the world's 43rd largest steel producer.

Its annual output is less than half the mean of the top 50 steel mills and its yearly output would be 10pc under the monthly output of the world's number one producer.

Yet its demand for partial operational decarbonisation is substantial in a national setting.

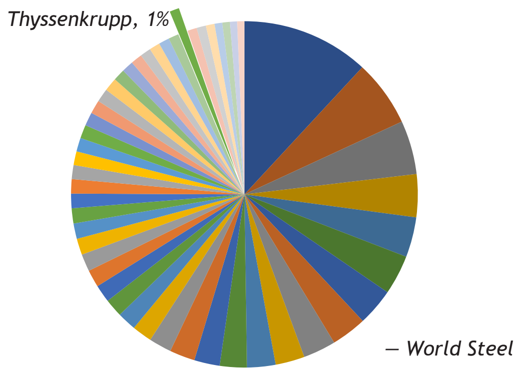
The grant supported DRI plant is planned for operation by 2026, with the 143,000 t/yr of H_2 demand coming as early as 2029. Given the uncertainty surrounding H_2 availability, the DRI plant will run conventionally at first, using natural gas. Then H_2 will be phased in from 2027 and natural gas phased out by 2037, giving 10 years of operational wriggle room.

Top 50 steel producer volume

Company	Vol	Company	Vol	Company	Vol
Baowu	132	Hyundai	19	EVRAZ	(e) 12.5
ArcelorMittal	69	Liuzhou	18	Zenith	12
Ansteel	56	IMIDRO	18	Shaanxi	12
Nippon	44	SAIL	18	MMK	12
Shagang	41	Cleveland-Cliffs	17	Anyang	11
HBIS	41	NLMK	16	Sanming	11
POSCO	39	Rizhao	16	Nanjing	11
Jianlong	37	CITIC	15	Severstal	11
Shougang	34	Techint	15	Thyssenkrupp	10
Tata Steel	30	US Steel	14	SDI	10
Shandong	29	Shenglong	14	Donghai	10
Delong	28	Baotou	14	Jiuquan	9
Hunan	26	Jingye	14	JSPL	8
JFE	26	China Steel	14	Erdemir	8
JSW	23	Sinogiant	14	Jinxi	7
Nucor	21	Tsingshan	14	Voestalpine	7
Fangda	20	Gerdau	14		

— Worl Steel

Top 50 steel producers



Steel decarbonisation is a long-term story: one gathering pace

Yet this will only be the beginning. Thyssenkrupp puts its H_2 demand volume to achieve full carbon-neutrality at 720,000 t/yr — five times larger than the proposed stage one decarbonisation.

Today steel is a small component of overall H_2 demand, largely from off-gas recycling. But if the global steel industry taps H_2 for decarbonisation the sector will be a monstrous consumer.

Nor is this funding isolated. Fellow German steel producer Salzgitter received €1bn of EU funding last year to transition its Lower Saxony site to H_2-produced DRI.

Arcelor Mittal received €850m to decarbonise its French Dunkirk site, which comes on top of €335m won in 2022 for its Belgian Ghent site and a pilot study for H_2-fed DRI production.

New firms are emerging. H2 Green Steel in Sweden has been striking binding agreements to supply "green steel" to auto producers for its 2.5mn t/yr of capacity, which include BMW and Mercedes-Benz. Hydnum Steel in Spain is targeting auto and appliance sectors with its similar output of 2.6mn t/yr of H_2-derived steel.

Demand is clearly expected to be large. German steel distributor Kloeckner and consultancy BCG last month released a report that forecasts green steel demand could exceed supplies by 15mn-20mn t by 2030.

How to watch 'maximum decarbonisation' costs for the steel sector

It is unclear when subsidy support will flow for the operating expenditure component between 2027-37.

Nor is it evident which costs will be compared, such as which import source countries will provide green H_2 prices and the counterfactual blue H_2 prices.

The tenor of changes is unknown at this point. Tenders could be annual affairs or a single 10-year supply contract, which would run the whole term of the support offer.

It remains useful to know how large the gap is that this funding needs to plug. Argus has launched a German decarbonisation index to track the differential between green and blue H_2 domestic production costs in Germany (PA code 0040300).

For those that wish to view alternative country sources, Argus Hydrogen and Future Fuel users can construct bespoke comparisons between 25 countries in Africa, the Americas,

Asia-Pacific, Europe, the Middle East and Russia. These can be stored in multiple self-described environments for continuing reference.

A number of sector-specific subsidy schemes are being rolled out globally. Because of its potential size those for the steel industry will be likely be increasingly important ones to watch.

Hydrogen decarbonisation spread