# The changing nature of steel capacity

## Summary

Capacity cannot be understood from high level numbers and must be broken down into component parts and assessed relative to demand – both structural and cyclical – for proper conclusions to be drawn.

- For example, whilst much is made of capacity build in Asia over the last five years, when compared to demand growth in the region, this build out has been somewhat conservative.

It is vitally important to understand the cost structure of steel to comment on the capacity situation. Indeed, decisions about how capacity is utilised through the cycle will change under a decarbonised future as cost structures change and this will have implications on how capacity is viewed.

Flexibility across the steel 'system' – at the company, country, regional and global level – is key to ensuring proper price formation. In this regard, 'over-capacity' at both the crude steel and downstream level are important for providing this flexibility. Actions that constrain flexibility (e.g. trade restrictions, policy driven capacity restrictions, sanctions, logistical bottlenecks etc.) are likely to lead to deleterious impacts on the steel market.

- Downstream capacity over-and above that which can be supplied by available crude steel should be classed as 'inaccessible capacity' not 'excess capacity'. Crude steel is a suitable point to measure capacity and capacity utilisation.

## The myth of excess steel capacity

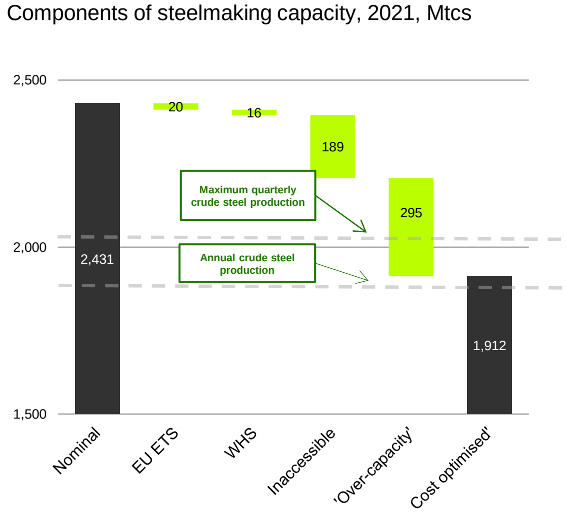
Excess capacity is touted as the major ill of the steel industry, but analysis of capacity and production data globally, coupled with an understanding of steel mill operations and inherent cost structure, does not support this. In fact, it seems the steel industry is well structured, suggesting a highly competitive and well managed industry overall.

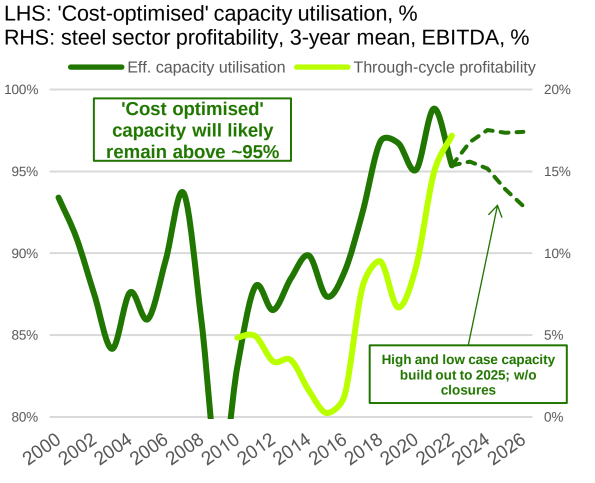
Steel capacity cannot be understood from a single, high-level number; it is a complex concept. Individual steel facilities have a nameplate capacity and crude steel is typically used to define the capacity of a mill, but various factors constrain the ability to achieve this capacity and these need to be understood to inform the true capacity of a mill. Factors that affect this 'cost-optimised' capacity include:

- The inherent cost structure of a steel mill (i.e. necessary 'over-capacity')
- Physical, quality or input constraints (i.e. inaccessible capacity)
- Policy (i.e. constrained capacity)

Without first accounting for these factors, it is impossible to comment on the state of capacity, or capacity utilisation, in terms of its actual impact on market conditions.

### Necessary 'over-capacity' performed its role well in 2021 and the future looks well balanced.




SOURCE: **CRU Crude Steel Market Outlook**; OECD (2022), "Steelmaking capacity by economy", OECD Statistics on Measuring Globalisation (database); presentation by the Secretariat on the latest developments in steelmaking capacity, 92nd Session of the Steel Committee, 19–20 September 2022

To illustrate, the L-H chart above shows the impact of these 3 factors on capacity in 2021. According to OECD statistics, crude steel capacity was 2,431 Mt and typically this would be compared with the crude steel production in the year of 1,910 Mt, implying an 'excess capacity' of ~521 Mt or ~21%; this seems very large. But this comparison fails to account for policy constraints on capacity – arising from the EU ETS and Chinese winter heating season restrictions for example, but also Iranian sanctions could be added here; see later – inaccessible capacity and, most importantly, 'over-capacity' resulting from the inherent cost structure of a mill. Once these are accounted for, the industry looks well balanced and, in fact, the necessary 'over-capacity' that exists – a function of the underlying cost structure – performed its role well, allowing production to flex to accommodate quarterly peaks in demand.

Looking further out, based on OECD high/low capacity build scenarios and CRU forecasts for crude steel production, even in the high capacity build case, 'cost optimised' capacity utilisation is forecast to remain at recent historical levels, even before taking into account potential – and expected – closures over the next few years.

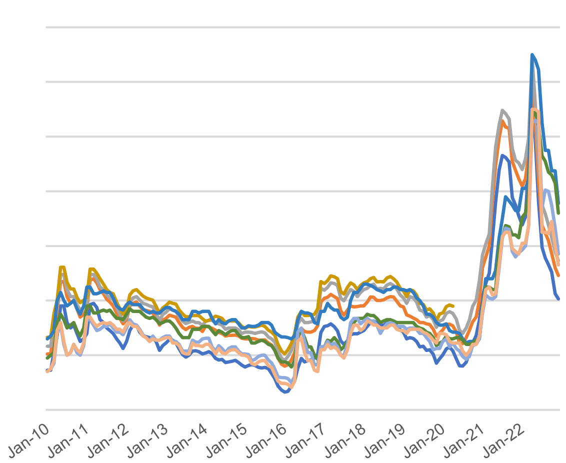
So, at the global level, steel capacity and demand are expected to remain very well balanced and the steel industry – a very competitive and dynamic sector – appears very capable of managing its capacity situation. See the insight article, The myth of 'excess' steel capacity for a fuller discussion of the components of capacity shown in the chart below.

## Does excess capacity exist downstream of crude steel?

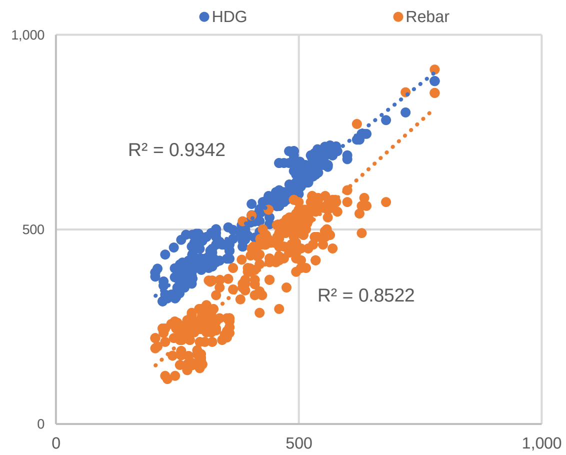
Steel prices largely move in parallel and people talk generally about 'the steel market', the conditions of which are assumed apply broadly to all steel products. That is, although product segment, regional and process route variations can apply, typically steel product prices move up and down together, as shown is the L-H chart below for a range of steel products. Specific correlations for hot-dipped galvanised (HDG) and rebar versus hot-rolled coil (HRC) are shown in the R-H chart.

### Steel prices are broadly aligned and show a close correlation

Historical steel prices, monthly, 2010–2022, €/t




HDG and rebar versus HRC, monthly, 2010–2022, €/t




SOURCE: **CRU Steel Monitors and prices**; NOTE: prices used are for standard commercial grade material delivered to a 'basis point' in all cases

The R-H chart shows us that HDG, rebar and HRC prices are closely correlated. Similar statistics for other products, given below, show the same for a broad range of products.

### Even very different product segments, often with different process routes, show a close correlation.

| Product [versus HRC] | $R^2$ |
|---|---|
| CRC | 0.98 |
| HDG | 0.93 |
| EG | 0.93 |
| Beams | 0.90 |
| Merchant bar | 0.83 |
| Rebar | 0.85 |
| Mesh wire rod | 0.89 |

SOURCE: **CRU Steel Monitors and prices**; NOTE: HDG shows a lower correlation than CRC as cost factors such as the price of zinc can have a specific impact on the cost and, therefore, price of HDG. Beams, merchant bar, rebar and mesh wire rod are also more typically produced from scrap, rather than iron ore, and so cost dynamics can be different than for flat products.

The fact that steel product prices are so closely correlated demonstrates the steel market is intimately inter-connected and, importantly, that there is sufficient flexibility in the broader system to respond to the different supply-demand dynamics in the various product segments. That is, looser supply-demand dynamics in one product segment will see prices fall, but the market can quickly react to divert available crude steel to other product segments such that prices return to an equilibrium (n.b. taking into account typical product differentials that are most often driven by cost).

That is, whilst there exists sufficient flexibility in the wider steel system, over-capacity in one downstream product segment should not lead to structurally lower prices in that segment; rather, available crude steel will simply be diverted to where profitability is highest. That the monthly steel prices above have been closely correlated over a long period of time attests to the fact that this decision process has been, and remains, a dynamic feature of the steel market and, in fact, over-capacity downstream contributes to this flexibility.

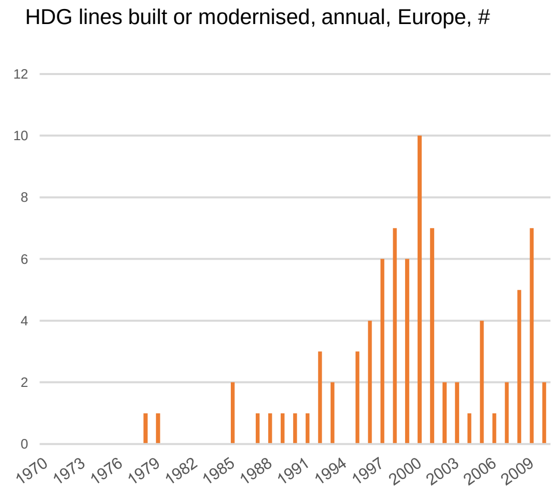
Flexibility does not necessarily have to exist at every steel plant, but it does need to be accessible across the steel making ‘ecosystem’ at country, regional or even global level. Contrarily, in the extreme, where this flexibility does not exist or is severely constrained – due to trade restrictions, policy driven capacity restrictions, sanctions, logistical bottlenecks etc. – then localised supply-demand imbalances and price extremes are more likely to manifest themselves.

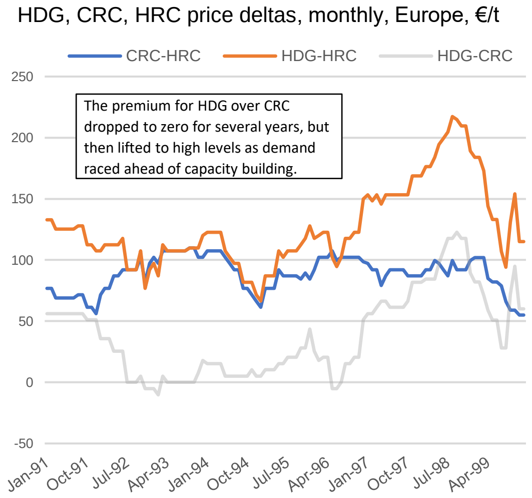
### A case study of market-driven capacity build

In response to competitive threats from auto imports, the 1990s saw a major shift in the European auto sector from the use of cold-rolled (CRC) substrate to coated (HDG) substrate for the body-in-white (BIW), which gave better corrosion protection. Indeed, every steel company that was a supplier to the auto sector felt the need to build suitable capacity, not only to meet the specific growing demand, but also to protect their wider auto portfolio (i.e. galvanised material for the BIW was seen as the de facto entry requirement for all supply; if you couldn’t supply it you would lose all auto sales). Organic coated steel (OCS) supply chains underwent a similar shift, also moving from CRC to HDG substrate. This situation initiated a HDG line building and upgrading spree in Europe. However, steel companies in the region rightly feared the potential for significant excess build out and, to reduce risk, many partnered to get access to new capacity, to avoid each partner building their own line, whereas others focused on upgrading existing lines, rather than build new. That is, the build out of capacity was far from ‘uncontrolled’ – steel mills are very aware of the large capital requirements of new facilities and also that a single poor decision can have long-term negative consequences that they were keen to avoid.

To put this period into context, the below chart shows the number of HDG lines that were either newly built or heavily modified by year – either for volume or quality or both – during the decade:

Of the HDG lines operating in Europe in 2000, >60% had been built or modified in the 1990s




SOURCE: **CRU Steel Capacity database**, **CRU Steel Sheet Monitor and price assessments**; NOTE: The initial build year for 19 HDG lines constructed in the 1970s and 1980s, but modified after that time, are not shown, only the modernisation year is shown.

Thus, after relatively quiet activity in the HDG sector during the 70s and 80s, with 26 HDG lines built or modified over two decades (n.b. 16 of those in the early-1970s), 43 lines were built or modified during the period 1990–2000. The impact of this on price can be seen in the R-H chart, where the premium for HDG over CRC (grey line) is shown dropping to zero for 4 years in the early-to-mid 1990s, despite the additional costs for galvanising (e.g. zinc, energy for annealing, labour, spares and parts as well a yield costs).

So, this provides a clear example of capacity over-building leading to depressed prices in a certain product segment, driven purely by rapid changes to market demand, the consideration of competitive threats, as well as a[n unavoidable?] mismatch between build out and demand growth. Ultimately, the situation reversed and, towards the end of the 1990s, HDG prices lifted to quite high levels as demand for HDG substrate continued to grow, whilst individual company decisions, probably impacted by concerns of possible over-capacity, slowed the build rate.

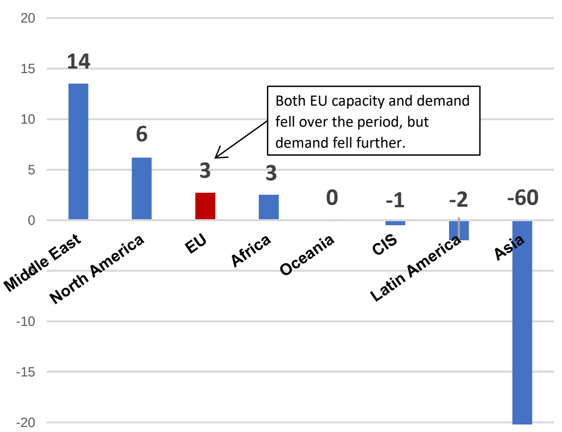
This case study shows that, whilst there will be imperfections in decision making when capacity is built to meet demand – and there were some obvious errors in the decisions made at the time by companies that had not properly seen the direction of the market – in fact, overall, the process was well managed and directed by rational market and financial considerations.

**A case study of policy-driven capacity changes**

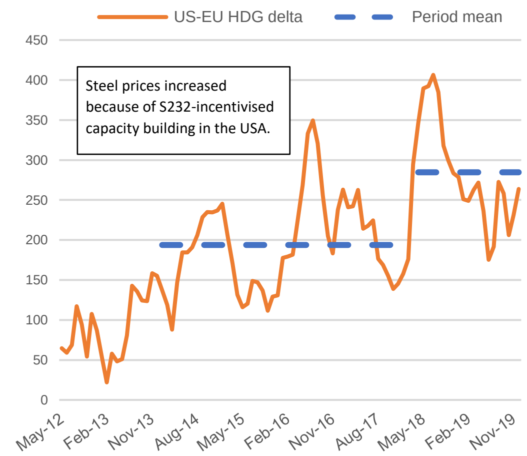
A conclusion from OECD's 'Latest Developments in Steelmaking Capacity 2022' report is that "global steelmaking capacity increases over the last 5 years were led by Asia…" and, whilst it is true capacity increases there have been large, this fails to account for the driver of that capacity, namely, demand. If we look at OECD capacity versus demand changes we see the following:

Given increases in demand, capacity building in Asia has been relatively conservative.

Capacity minus demand changes, 2018–2021, Mt




HDG price delta, US-EU, $/tHDG




SOURCE: **CRU Crude Steel Market Outlook**, OECD Latest Developments in Steelmaking Capacity 2022; NOTE: 2018–2021 period used as 2022 capacity data is estimated. CRU apparent consumption of hot rolled product used for demand, except for Middle East where crude steel production was used due to incomplete trade data.

Here we can see that, when demand changes are taken into account, the largest [relative] capacity increases have taken place in the Middle East, North America – primarily in the USA – and Europe. Europe is coloured red as this is the only region shown where capacity fell over the period, so the positive value shown is more associated with a loss of demand. Overall, it is considered these three largest 'capacity-demand' values are underpinned by policy.

In the case of the Middle East, much of the capacity building is in Iran and broadly linked to a government push to expand steel exports following the Iran nuclear deal (JCPOA) in 2015. In return for limiting nuclear enrichment activities, it was agreed that many sanctions on Iran would be lifted and this opened the possibility to take advantage of a growth in trade, in this instance, underpinned by domestic iron ore and low cost gas. However, the extent that Iran was able take advantage of this 'opening up' was not as great as [they] expected and, further, in 2018, the USA withdrew from the deal, such that significant sanctions remained in place. Thus, whilst capacity has increased, very much linked to policy, as sanctions remain in place, Iran is unable to take advantage of this and it should be regarded as 'inaccessible' capacity at this stage.

The second largest area of capacity build relative to demand is in the USA, where capacity has expanded following the imposition on most countries of Section 232 imports tariffs of 25%. The USA is net steel importer and steel prices in the country are largely determined by the cost of imports. As such, the tariffs had a direct impact on pricing and profitability of US steel production that incentivised investment in new capacity. This capacity reflects a genuine increase in capacity that is also accessible. That is, it has a direct and real impact on the global capacity position and is the direct result of policy decisions taken by the US government.

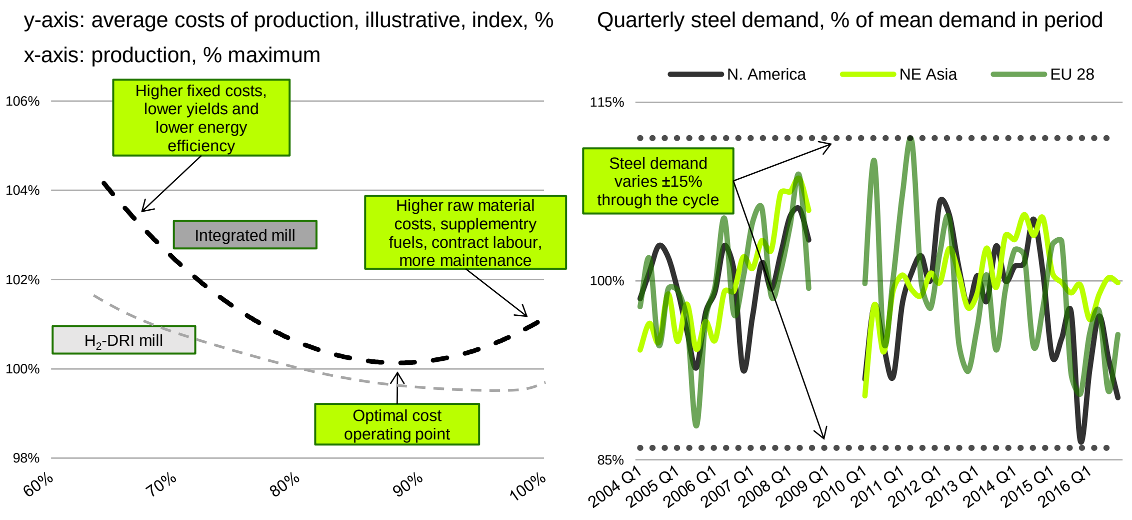
For Europe, capacity has fallen and it is considered this has largely been driven by cost competitive disadvantages associated with carbon charges under the EU Emissions Trading Scheme (ETS). However, this has been outweighed by a loss of demand that may have some links to the EU ETS but is thought to be largely the result of fallout from the Russian invasion of Ukraine and the subsequent energy crisis. Here policy has resulted directly in reductions to capacity.

## The cost structure of green steel will change the rules

As explored in the insight article, [The myth of 'excess' steel capacity](#) referenced above, the cost structure of the integrated steel sector leads to ~15% of built in 'over-capacity', over and above the optimal cost operating point, related to the challenge of integrating a number of different facilities. However, this 'over-capacity' (n.b. 'over-capacity' not 'excess capacity') serves a valuable market purpose as demand itself varies by ±15% through the cycle. That is, the inherent 'over-capacity' built into integrated steel production allows peak market demand to be met and, therefore, attenuates price volatility during the peak of the cycle.

This can be looked at in a different way – because market demand varies by ±15% through the cycle and the steel sector needs to meet maximum demand, steel mills will, by default, operate below full capacity for much of the steel cycle, but the cost structure is such that it supports this. However, a move to 'green' steel production could see this valuable market balancing mechanism diminish, requiring a different set of decision criteria to be in place.

### 'Over-capacity' due to the cost structure of integrated mills matches variability of steel demand well




DATA: **CRU Steel Cost Model**, **CRU Crude Steel Market Outlook**, CRU analysis; NOTE: the x-axis in the L-H chart does not denote capacity utilisation, rather it denotes % of maximum possible production. For the R-H chart, data from 2008–2009 was excluded due to extreme volatility during the Global Financial Crisis (GFC).

For example, whilst the technology combination is new and sophisticated, hydrogen-based DRI steel production has a linear process route – an electrolyser, DRI plant, EAF and caster – and the integration challenge is relatively simple, certainly compared to an integrated mill with multiple parallel facilities, energy and material flows. As such, much like EAFs today, the optimal cost operating point will be very much closer to maximum capacity (c.f. see conceptual shape of curve as the grey line on the L-H chart). In addition, the typical cost curve of an $H_2$-based steel mill will be flatter compared to an integrated mill as fixed costs will be lower and raw material and energy inputs will be more consistent across the operating range. A flatter cost curve means that marginal costs of production are closer to average costs across a wider range of operating points for an $H_2$-based mill. This different shape of cost curve will have potential implications on capacity considerations that include:

- whilst today, the lowest cost operating point essentially forces integrated mills to operate ~15% below capacity through the cycle, for an $H_2$-based mill this decision will need to be made by plant management, but such a decision will have unfavourable cost impacts…
- …but, the cost disadvantages of operating at lower capacity are expected to be less for an $H_2$-DRI mill than for an integrated mill, so decisions that prioritise margin over volume should be easier to make, assuming the technology configuration is flexible.
- today, the level of steel prices in a downturn are dictated by the marginal costs of integrated steel production and these fall away rapidly as capacity utilisation falls from optimum…
- …but marginal costs of an $H_2$-based steel mill are expected to remain closer to average costs across a wider operating range. That is, falling prices dictated by integrated mill marginal costs could have a much larger impact on the operating volumes of $H_2$-DRI mills.

Whilst these issues remain unresolved here, the suggestion is that the transition to $H_2$-based steelmaking could give rise to challenges related to capacity that may differ both during the transition and at the decarbonisation endpoint. During the transition, whilst steel prices at the bottom of the cycle are dictated by marginal costs of integrated steel producers, $H_2$-based steel producers will be disadvantaged as prices fall well below their marginal costs in a downturn. That is, during the transition, $H_2$-based steelmakers may be forced to accept a larger share of sector flexibility to balance the market when markets are poor; the expected greater flexibility of the $H_2$-DRI route may also encourage this. This will have an unfavourable impact on profitability of these mills, as well as perceptions of the 'quality' of their capacity.

Further out, when $H_2$-based steel making takes a greater share of production, market balancing outside of peak demand periods will be more driven by decisions taken by plant managers, supported by a more flexible operating model, rather than the exigencies of the cost curve, as is the case today. This could lead to better management of market balancing where decisions are purely economic, but worse management where there is any other influence to maintain production.

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