ASSESSING STEEL DECARBONISATION PROGRESS
READY FOR THE DECADE OF DELIVERY?

November 2022
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Executive Summary

The steel sector is key for achieving climate goals, accounting for nearly 8% of global emissions from the energy sector. COP 26 raised the urgency of increasing ambition and enshrined the momentum for steel decarbonisation through the Breakthrough Agenda. Equally, an increasing number of initiatives have been launched to support the transition of the sector. While the nature and implications of the transformation have been largely explored, turning ambition into action is now the imperative. This echoes the COP 27 Presidency’s call for implementation, the current decade being critical to achieve the Paris Agreement’s objectives.

The steel industry is making progress in several areas. However, selected indicators in this brief highlight that the steel sector is not on a trajectory compatible with climate goals. This underscores the scale of the challenge to reduce emissions in steel production by 90% from 2020 levels by 2050.

With countries’ net-zero pledges booming, the steel sector should decarbonise. More than 90% of global steelmaking capacity and production is now located in countries that have announced a net-zero target. This trend results from an overall increase in commitments in 2021, although uneven levels of ambition on target stringency persist.

Similarly, steel companies - the drivers of steel production and of steel decarbonisation - have increasingly announced net-zero targets. However, there is a mismatch between corporate commitments and country-level pledges. As of end-2021, companies with net-zero targets accounted for 30% of global steel production. This share has doubled over the last year, though more commitments would help reduce the mismatch even more.

Beyond the pledges, near zero emission steel production has not yet taken off sufficiently. Although scrap-based Electric Arc Furnace (EAF) plants can indeed contribute to decarbonisation, reaching near zero emission also needs a more structural shift that goes beyond business as usual. In terms of asset structure, emission-intensive plants prevail. Basic Oxygen Furnace (BOF) plants account for two-thirds of global capacity. Crucially, BOF capacity represents more than half of the newly planned capacity, exacerbating the risk of stranded assets if not equipped with Carbon Capture Utilisation and Storage (CCUS).

The project pipeline of innovative near zero emission technologies is promising but faces a low-level of industrial maturity. Echoing corporate and country targets, projects focussing on such production routes have more than doubled in the last two years. Overall, reaching net-zero by 2050 trajectory calls for scaling up technologies significantly.

As one of the policy tools used to support emission reductions, carbon-pricing mechanisms currently cover less than 20% of global steelmaking capacity. When considering the prices applied, they have not reached the level that would be required to be in line with a net-zero pathway by 2050.

Finally, closing the gap observed between the level of ambition and implementation faces multiple challenges. These include scaling-up innovative technologies, investments, competitiveness, ensuring a global playing field, markets for near zero emission steel, strategic inputs, and social aspects.

Steel decarbonisation is a global challenge that requires a global response. Collaboration among countries, as well as between public and private stakeholders, will be essential to accelerate progress towards a net-zero pathway. The OECD steel policy community stands ready to support the move towards implementation, as well as to foster synergies with existing steel decarbonisation initiatives.
1. From hard to abate to hard to evade

The steel sector plays a key role in achieving climate goals, as it accounts for nearly 8% of global emissions from the energy sector. However, the path to net-zero requires a deep transformation, bringing new challenges that are likely to reshape the steel industry.

Considering this decarbonisation imperative, an increasing number of initiatives have been launched in recent years. Whether driven by governments, industry, or multi-faceted partnerships, they aim to support and guide this transformation (Box 1). Equally, through the Breakthrough Agenda, COP 26 has further increased this momentum (COP26, 2021[1]).

Box 1. Connecting the Dots on Steel Decarbonisation Initiatives

In September 2022, the OECD hosted an event called “Connecting the Dots on Steel Decarbonisation Initiatives: Contributing to a Global Inclusive Dialogue”. The goal of this event was to explore the wide landscape of initiatives that have been launched in recent years to accelerate the decarbonisation of the steel sector and to identify where possible gaps may exist, but especially where synergies could be created amongst them. In addition, the event aimed to uncover how the collaboration between policymakers, steel industry associations and private, as well as public-led initiatives can be leveraged to support this transition, recognizing that each actor has an important role to play.

The event focused on two particular areas where efforts are increasing but remain too fragmented: data and trade. First, data represent the backbone of any true implementation effort as they are crucial to measure and compare progress across industries and countries on their path to net-zero emissions. To this aim, stakeholders underlined the importance to have access to disaggregated data for embedded steel carbon emissions at the plant and national level. These data will also be crucial to reach agreement on standards and definitions for “near zero or low-carbon emission steel production”, which in turn, will be foundational to shape trade measures.

As steel account as a highly export-oriented commodity, trade policies are essential to underpin decarbonisation efforts. With countries and companies undertaking costly investments to transition the steel industry towards near zero emissions, carbon leakage has become a major concern and levelling the playing field an urgent response to this issue. In this regard, many proposals have been advanced in recent years, which include a Carbon Border Adjustment Mechanism (CBAM), but also a Carbon Alliance or Carbon Clubs. Although a multilateral solution is not yet within reach, the importance to push for a common adoption of standard and definition has been widely reiterated, which recalled how they are a prerequisite of any effective anti-carbon leakage policy.

While the nature of the transformation and its implications have been explored extensively, the stake now lies in turning ambition into action. This echoes the COP 27 Presidency’s call for implementation, the current decade being depicted as critical to achieve the Paris Agreement’s objectives (COP26, 2021[2]) (COP27, 2022[3]). This brief aims to provide evidence-based trends on key indicators of steel decarbonisation progress to support the COP27 call for action. The focus includes carbon emissions, countries’ and companies’ net-zero targets, production, capacity, breakthrough technologies, and carbon pricing.
2. The decarbonisation journey: the starting point and the end goal

The steel industry is a key sector to reach climate goals…

With direct emissions equating to 2591 Mt CO_2 in 2020 (IEA, 2021[4]), the iron and steel sector accounts for nearly 8% of global emissions from the energy sector. It further ranks as the largest emitting sector in industry, representing 30% of industrial carbon emissions (IEA, 2021[4]). With such a large carbon footprint, decarbonising the steel sector is key to achieve climate goals.

… largely dominated by highly carbon intensive production

Steel production and its related CO_2 emission intensity form the core drivers of carbon emissions. In 2020, global steel production reached 1878 mmt (worldsteel, 2021[5]), with an average direct carbon intensity of 1.4 tCO_2/tsteel (IEA, 2021[6]).

BOF is by far the predominant steelmaking route accounting for 73% of total output (worldsteel, 2021[5]). This outlines the dominance of high carbon intensive production processes, underpinned by a 75% share of coal in final energy demand in the steel sector (IEA, 2021[7]).

A long way to go for reaching near zero emission

To meet the Paris Agreement objective of limiting global warming to 1.5 °C, global CO_2 emissions must decline on an unprecedented scale, reaching net-zero in 2050 (IPCC, 2022[8]). To comply with this overall goal, direct emissions of the steel sector and related carbon intensity have to decrease by 90% from 2020 levels by 2050 (IEA, 2021[9]) (Figure 1). This shows that the steel industry has a long way to go for reaching near zero emission and how the carbon neutrality target is a game changer for the steel industry, calling for a deep transformation of the sector.

![Figure 1. Direct CO2 emissions and intensity trajectory in the NZE scenario](image)

3. Is the level of ambition of steel producing countries up to the task?

With net-zero pledges booming, the steel sector must decarbonise

As of end of 2021, more than 90% of global steelmaking capacity and crude steel production were in countries that had announced a net-zero target. This represents a sharp increase compared to 2020 (Figure 2). Given these pledges, the global steel industry is bound to follow a net-zero pathway1.

![Figure 2. Share of global crude steel production and capacity covered by a net-zero target](image)


Despite encouraging progress, uneven levels of ambition nuance such high scores

The nature of announced targets provides a more balanced perspective (World Resources Institute, 2020[10]). As of end-2021, only 18% of global steelmaking capacity and production was in countries with a net-zero target enshrined ‘in law’, about 60% related to a ‘policy document’ status, and 18% upon a ‘political pledge’ (Figure 2).

However, the comparison with 2020 levels reveals some encouraging signs. The 2021 growth in net-zero capacity and production coverage has been combined with a significant change in target types. There has been thus an overall increasing level of ambition, with most of the capacity covered by a ‘political pledge’ in 2020 shifting to ‘in policy document’ in 2021. Equally, major steel producing countries raised their level of ambition, from a net-zero target ‘in policy document’ to an ‘in law’ status.

1 While net-zero pledges are not directed to the steel sector itself (but to the whole economy), such targets imply a deep decarbonisation of steel production. In this policy brief, capacity/production ‘subject to a net-zero target’ or ‘covered by a net-zero target’ refers to capacity/production ‘located in countries covered by a net-zero target’.
While being an essential step, pledging is not enough

Setting a net-zero target is a first crucial step but does not by itself guarantee that emission reductions will be achieved. Such targets should be seen as a commitment to take ambitious actions to curb emissions, thus the starting point for developing decarbonisation strategies.

When moving to implementation, a major pitfall lies in the fact that net-zero pledges are not sector specific but cover the whole economy. By providing a focused objective, setting sectoral targets could support the development of strategies and policies considering sectoral specificities. Equally, acknowledging that there is no ‘one-size-fits all approach’ calls for defining tailored approaches, in particular taking into account country’s specificities.

4. As implementers, are steel companies aligned with net-zero?

A mismatch between countries’ and corporate pledges

Companies as drivers of steel production are key implementers of decarbonisation. To follow a net-zero pathway, it is therefore essential that countries’ pledges are mirrored by those of steel producers.

As of end-2021, 30% of global crude steel production and steelmaking capacity were covered by a corporate net-zero target² (Figure 3). Similar to countries’ pledges, this share has significantly increased compared to 2020 levels. This doubling in coverage is mainly due to announcements from several top 10 steel producers in 2021.

Figure 3. Steel producing companies with a net-zero target – Related share in global steelmaking capacity / production


² Objective to reach carbon neutrality (or similar) by 2050 or before, depending on the companies.
Overall, the share of steel production and capacity covered by corporate net-zero targets (30%) is well short of the one related to steelmaking countries’ pledges (more than 90% coverage, Section 3). The reasons for this clear gap towards implementation are the following.

First, there may be a time lag between companies’ responses and the pledge announcements of the country in which they operate. In addition, and referring to Section 3, it is worth noting that net-zero countries’ pledges refer to their whole economy but are not written from a sectoral perspective. Furthermore, steel decarbonisation related challenges (whether related to investments, technologies, and/or competitiveness) may hinder companies’ ambition to commit to such targets.

Given the variety of company and country profiles, a tailored approach is warranted

In terms of a company’s profile, an increasing number of the world’s top 10 producers have pledged for net-zero over the last year (Figure 4). As of end-2021, this category represented a quarter of the total number of listed steel producers having pledged for net-zero. However, in terms of the number of companies, the category of smaller companies is still important (companies below rank 45 of the largest steel producers according to (worldsteel, 2022[17]), with annual production below 10 mmt).

From a regional perspective, Europe accounts for the majority of companies with net-zero targets. Whereas steel companies’ pledges have increased in various regions worldwide, the Asian region and the People’s Republic of China (hereafter “China”) have especially experienced a significant growth. They now represent the second regional pool, after Europe.

Overall, the diversity of companies committed to net-zero adds to the countries’ specificities raised previously. Typically, the EAF (or BOF) share ranges from 0% to 100% depending on the company (Global Energy Monitor, 2022[18]). Equally, the age and location of the assets, as well as their technological...
leadership (especially with respect to breakthrough technologies) are other characteristics shaping each company’s decarbonisation roadmap. The size of the firm and its investment capacity are key features driving decarbonisation implementation. When combining all these aspects, low-carbon business strategies and related investments are likely to be specific to each company, and even project based. This further reinforces the imperative of a tailor-made approach to ensure a successful sectoral decarbonisation.

5. Beyond the pledges, are steel production and capacity on the right track?

Achieving near zero emission steel relies on a diversification of production routes

‘Near zero emission steel production’ refers to crude steel production whose emission intensity is compatible with a global net zero pathway by 2050. To identify the steelmaking routes complying with this requirement, the quantitative thresholds of emission intensity defined by the IEA (IEA, 2022[19]) are leveraged.

Based on these considerations, production levels compatible with a near zero emission pathway amounted to 20% of global crude steel production, scrap-based EAF being the contributing route ((worldsteel, 2021[5]), (IEA, 2021[20])). Next to scrap-based EAF, a further structural shift in production methods for decarbonisation purposes is needed.

The lack of diversified near zero emission steel production routes currently available at commercial scale hinders the ability to significantly increase this share in the short-term. Scaling-up breakthrough technologies (such as CCUS and hydrogen) will be particularly crucial to unlock this potential.

Carbon emissions intensive assets prevail, with regional disparities

As of end-2021, BOF assets clearly dominate the global landscape, accounting for around two-thirds of total capacity (Figure 5). Since the BF-BOF production routes are not equipped with Carbon Capture Utilisation and Storage (CCUS), the current structure of assets is not yet aligned with a net-zero pathway.

Figure 5. Global steelmaking capacity and related asset structure

Source: OECD Steel Capacity Database.
The regional picture reveals strong disparities, with EAF shares ranging from less than 15% to more than 80% (Figure 6). When combining the BOF/EAF share with capacity levels, Asia stands as a critical region. Accounting for nearly 70% of global capacity, its EAF share is only around 20%.

**Figure 6. Steelmaking capacity and related share of EAF – Regional breakdown**

Source: OECD Steel Capacity Database.

*New projects are not going in the right direction, increasing the risk of stranded assets*

The previous trends are even more pronounced when looking at future steelmaking projects. As of end-2021, there were about 160 mmt of new capacity projects underway or planned over the next three years (2022-24). Most of the capacity relates to BOF (55%) (Figure 7). From a regional perspective, more than half of the capacity planned is located in Asia, and 90% of planned capacity in Asia are BOF projects (OECD, 2022[15]).

**Figure 7. New steelmaking projects and related asset structure**

Note: The capacity data contains both underway and planned projects over the next three years (2022-24), as of end of 2021. It does not consider closures that may occur during the period.

Source: Calculations based on (OECD, 2022[15]).
BF-BOF plants (if not equipped with CCUS) risk to become stranded assets\(^3\). The high share of BOF assets in planned projects further increases this risk, by contributing to locked-in emissions for decades. This risk does not only arise from a domestic perspective, but also from an international one. Such assets are unlikely to be able to compete in future markets for low-carbon emission steel, or as trade aspects based on carbon content criteria emerge.

Complying with emission reduction objectives and mitigating the risk of stranded assets would imply massive retrofits or early retirements. In addition to increasing the cost of the low-carbon transition, this equally involves high social impacts on workers and communities. In view of the current structure of assets, it is therefore critical to develop specific strategies for the management of existing assets.

### 6. Are the next technologies ready to take over?

**Projects implying innovative routes keep on growing**

Achieving near zero emission steel production strongly relies on the uptake of innovative routes. As of mid-2022, there were around 40 innovative near zero emission steelmaking projects worldwide (Figure 8). This project pipeline covers announced projects involving a facility plant based on an innovative near zero emission production route (hydrogen-based DRI\(^4\) EAF, CCUS, or others such as direct iron ore electrolysis (IEA, 2022[19])). The number of such projects has grown steadily in recent years, more than doubling between 2020 and mid-2022. This trend is consistent with the increasing announcements in terms of emission reductions, both from governments and steel companies (Sections 3. and 4.).

![Figure 8. Number of innovative near zero emission steelmaking projects](image)

Note: ‘Innovative near zero emission steelmaking projects’ refer to announced projects involving a facility plant based on an innovative near zero emission production route (e.g hydrogen-based DRI EAF, CCUS, iron ore electrolysis). Source: Calculations based on various information sources (Metal Expert, Kallanish, Platts, media, companies and regional steel associations websites).

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\(^3\) Whereas this rationale primarily relates to the BF-BOF route (given its relative high carbon intensity), it also applies to fossil fuels based DRI EAF. Even if less carbon intensive, such facilities are nevertheless not aligned with near zero emission steel production, if not transitioning to low-carbon hydrogen or equipped with CCUS (IEA, 2022[19]).

\(^4\) Direct Reduced Iron
Europe stands at the forefront of innovative near zero emission steelmaking projects since 2020, driving the global project pipeline growth. As of mid-2022, Europe accounted for about 65% of the project portfolio, China accounted for almost 15%, and North America for 8% of the projects. Alongside the pledge of carbon neutrality by 2060 and the target for emissions peaking by 2030, major Chinese steel producers have launched projects involving innovative steelmaking technologies (HBIS, Baowu).

**DRI technology is the cornerstone of innovative projects**

DRI technology is by far the major route, representing nearly 75% of the innovative near zero emission project pipeline as of mid-2022. Besides innovation challenges, the impetus for hydrogen-based DRI route brings new strategic inputs, for which securing access becomes crucial. The remaining projects involved CCUS-based technologies, and less advanced routes in terms of technology readiness, such as direct iron ore electrolysis.

**A low-level of industrial maturity calls for a massive technology scale-up**

More than 60% of the innovative near zero emission steelmaking projects are designed to run on an industrial scale, but are not yet in operation (Figure 9). Project announcements for industrial scale plants have more than tripled in the last two years, underlining both advances in technology readiness and the growing engagement of steel companies towards decarbonisation (Section 4.). Early industrial stage projects represent a further third, implying pilot or demonstration-scale facilities. Only a few projects are operating at an industrial scale. The first established one has been operating with CCS since 2016 in the UAE (ADNOC, 2022[21]), whose captured CO₂ is used for Enhanced Oil Recovery purposes (and thus not driven by steel decarbonisation purposes).

Overall, the low-industrial maturity level observed for the project pipeline highlights the mismatch with a net-zero by 2050 trajectory. Such a gap reveals the crucial need to scale-up breakthrough technologies, and the central role of innovation in the low-carbon transition.

![Figure 9. Innovative near zero emission steelmaking projects – Industrial maturity level](image-url)

Note: ‘Innovative near zero emission steelmaking projects’ refer to announced projects involving a facility plant based on an innovative near zero emission production route (e.g hydrogen-based DRI EAF, CCUS, iron ore electrolysis).

Source: Calculations based on various sources of information (Metal Expert, Kallanish, Platts, media, companies and regional steel associations websites).
7. To what extent does carbon pricing apply to the steel sector?

Only a small fraction of global steelmaking capacity is subject to carbon pricing…

Aiming to incentivise the shift towards lower emitting technologies, carbon pricing is one of the policy tools used to support emission reductions. Existing carbon pricing mechanisms implemented worldwide cover both carbon taxes and Emissions Trading Systems (ETS), and are applied at the (inter)national or/and subnational level. (The World Bank, 2022[22]), (ICAP, 2022[23]).

However, not all of them are relevant when focusing on steel decarbonisation. For instance, some of them do not relate to a steel producing country, do not apply to the steel sector, or are implemented only at a pilot stage. Furthermore, carbon pricing often includes exemptions (free allocations, thresholds on plant capacity). Thus, even if a carbon pricing mechanism is in force for the steel sector in one specific jurisdiction, the total steel production and capacity of this jurisdiction may not fall under the category ‘covered by a carbon price’.

Without accounting for potential exemptions, carbon pricing covered around 20% of global steelmaking capacity and production in 2021. Given that it constitutes a maximum share (namely without prejudging of the level of capacity/production subject to exemptions), this relatively low order of magnitude underlines the current limited contribution of carbon pricing as a tool to foster steel industry decarbonisation.

…with prices not in line with a net-zero ambition

This trend is further reinforced when considering the level of price applied (Figure 10). None of the carbon prices accounted for above reached the threshold of USD 120 per tonne of CO2. This threshold is the level of carbon price which would be required in 2030 to be in line with a net-zero pathway by 2050, should carbon pricing play a major role in the overall decarbonisation effort (OECD, 2021[24]). Even by selecting a threshold of USD 60 per tonne of CO2 (which would be consistent with a net-zero pathway by 2060 (OECD, 2021[24])), it is still less than 10% of global steelmaking capacity and production that is subject to such a price level.

The risk of losing competitiveness on global markets, as well as carbon leakage concerns, are some reasons underpinning carbon price exemptions observed for the steel sector. It thus highlights the central role of international cooperation in enhancing the global level playing field, as one of the means to ensure an efficient low-carbon transition.
8. Towards COP27: the urgency of implementing

Despite important progress in several areas, key indicators in this brief show that the steel sector is not yet on a trajectory compatible with the Paris Agreement objectives. This underscores the scale of the challenge to reduce emissions in steel production by 90% from 2020 levels by 2050.

Countries’ net-zero pledges are booming, with more than 90% of global steelmaking capacity and production located in jurisdictions that have announced such targets. Similarly, steel producing companies have increasingly announced net-zero targets.

However, there is a mismatch between corporate commitments and country-level pledges. As of end-2021, companies with net-zero targets accounted for 30% of global steel production. This share has doubled over the last year, though more commitments would help reduce the mismatch even more. Beyond the pledges, near zero emission steel production has not yet taken off sufficiently. Although scrap-based EAF indeed can contribute significantly to decarbonisation, reaching near zero emission also needs a more structural shift.

In terms of assets structure, emissions intensive plants prevail. BOF plants, which are currently not fit for a low-carbon future, account for two-thirds of global capacity. While this share is undeniably linked to past decades legacy of the steel industry (given long lifetimes of these assets), BOF capacity still represents more than half of the newly planned capacity as of end 2021. Such projects are not compatible with decarbonisation objectives if not equipped with CCUS and exacerbate the risk of stranded assets. This is even more compelling as most of these projects are located in countries that have pledged for carbon neutrality.
The project pipeline of innovative near zero emission technologies is promising but faces a low-level of industrial maturity. Only a few projects are operating at an industrial scale. Overall, reaching net-zero by 2050 trajectory calls for scaling up technologies significantly.

As one of the policy tools used to support emission reductions, carbon-pricing mechanisms currently cover less than 20% of global steelmaking capacity. When considering the prices applied, they have not reached the level that would be required to be in line with a net-zero pathway by 2050.

Finally, the gap between the level of ambition and implementation faces multiple challenges. These include for example, scaling-up innovative technologies, investments, competitiveness, ensuring a global playing field, establishing markets for near zero emission steel, securing strategic inputs, or addressing asocial aspects.

Steel decarbonisation is a global challenge requiring a global response. Collaboration among countries, as well as between public and private stakeholders, will be essential to accelerate progress towards a net-zero pathway. The OECD steel policy community, convening both governments and industry, stands ready to support the move towards implementation, as well as to foster synergies with existing steel decarbonisation initiatives.
References


