ASSESSING STEEL DECARBONISATION PROGRESS IN THE CONTEXT OF EXCESS CAPACITY

A STEEL INDICATOR DECARBONISATION DASHBOARD

REPORT PREPARED BY THE OECD FACILITATOR, 2022

Global Forum on Steel Excess Capacity

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Summary: This **synthesis report** is the final deliverable of the 2022 **decarbonisation indicators** work programme, based on the list presented at the **GFSEC Working Level Meeting** (February 2022) and the outcomes of the **feasibility study**.

It aims to provide **evidence-based trends** on the progress of the steel sector towards decarbonisation **objectives**, and places this in the context of excess capacity challenges.

In this way, this report presents **indicators** - as well as their related **analysis -** on **various characteristics**, including on **emissions**, country and company's net-zero **targets**, steel **production** and **capacity**, **innovative projects**, **carbon pricing**. The effects of **excess capacity** on decarbonisation progress are highlighted. Likewise, the potential implications of decarbonisation projects on capacity developments are underlined.

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Executive Summary

With global capacity expected to increase for the fourth year in a row, **excess capacity continues to be a significant challenge for the global steel industry**. The structural imbalance affects steel prices, steel companies' profitability margins, as well as the global playing field. Excess capacity weighs on various features needed for an efficient low-carbon transition, such as investments, innovation, or competition. In a context of deep transformation required for the steel industry to meet climate goals, tackling excess capacity is crucial **to foster decarbonisation**.

Despite progress in a number of areas, this steel decarbonisation indicator dashboard shows that the steel sector is **not on a trajectory compatible** with Paris Agreement objectives. 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. As for the GFSEC group, its level of ambition is one-step ahead both in terms of steel capacity coverage (more than 95%) and in terms of target type.

Similarly, steel companies **-** the key 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. Production routes compatible with a near zero pathway account for **20%** of global output, away from the nearly 100% that would be required by 2050. Besides, this current share stems from **scrap based EAF** only. Although scrap based EAF plants can contribute to decarbonisation, reaching near zero emission needs a more structural shift that relies on **diverse production routes**.

In terms of asset structure, emissions intensive plants prevail. BOF plants account for **two-thirds** of global capacity. While this share is undeniably linked to past decades legacy of the steel industry, BOF capacity also represents more than half of the **newly planned capacity**. Such new projects are not compatible with decarbonisation objectives if not equipped with CCUS**.** By adding carbon intensive steelmaking plants, it further highlights the extent to which excess capacity may hinder the low-carbon transition.

The project pipeline of **innovative near zero emission technologies** is promising but faces a **low-level of industrial maturity.** Echoing corporate and countries 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, or social aspects. Envisioning a tailored approach to decarbonisation is equally essential towards implementation, in light of regional differences in steelmaking routes, access to resources, or the variety of company profiles.

Likewise, addressing structural issues such as **global excess capacity** is crucial for steel companies to be able to sustain this transformation. Conversely, as new plants' projects for decarbonisation purposes further develop, the management of existing assets - especially plant replacement strategies - will be critical in shaping the resulting net-capacity increase.

Excess capacity and steel decarbonisation are both **global challenges** requiring a global response. **Collaboration** among countries, as well as between public and private stakeholders, will be essential to **foster synergies and accelerate progress** towards a net-zero pathway. Equally, addressing excess capacity is critical to pave the way for a successful steel decarbonisation, ultimately meeting climate goals.

1. Introduction

1. The path to net-zero emissions requires **a deep transformation of the steel sector**, bringing new challenges that are likely to reshape the steel industry. To provide insights on these **challenges**, and in response to the interest expressed by the Global Forum on Steel Excess Capacity (GFSEC) Members, the Facilitator proposed a work programme focusing on the **development of indicators**. The overarching objective of these indicators is to **monitor progress** in reaching targets. Furthermore, by **sharing and highlighting key trends**, such outcomes could also inform policymakers regarding the low-carbon transition of the steel industry, including on the nexus with **excess capacity**.

2. To this end, the Facilitator suggested building a set of evidence-based indicators for **short-term implementation** (GFSEC Working Level Meeting, 16 February 2022). These indicators cover various dimensions of steel decarbonisation, such as capacity, production, technologies, industrial projects, trade or policy aspects.

3. As a first step, this set of indicators has been subject to a **feasibility study**. The overall objective was to identify relevant data and methodologies, but also to assess which indicators could be developed in a timeframe compatible with the 2022 GFSEC Working Level Meeting (September 2022). The **resulting list** forms the basis for the 2022 indicators work programme and is summarised in Table 1.

4. This **synthesis report** presents the final assessment of these indicators, as well as their related analysis. It aims to provide **evidence-based trends** on the progress of the steel sector towards decarbonisation objectives. In this way, it echoes the COP 27 Presidency's **call for implementation**, the current decade being depicted as critical to achieve Paris Agreement's objectives ((COP26, 2021[1]) (COP27, 2022[2])).

5. This report first gives an **overall picture** of the steel sector in terms of carbon emissions, as well as the trajectory required to comply with Paris Agreement objectives. Secondly, it analyses the **level of commitment** in emission reductions from both steel producing **countries** and **companies**. Then, the compatibility of current steel **production** and **capacity** with a near zero emission trajectory is assessed. In particular, the focus on capacity aspects further highlights the extent to which global steel excess capacity may hinder the low-carbon transition. Moving to innovation, the characteristics of steelmaking projects based on **breakthrough technologies** are discussed. Finally, the report explores to what extent **carbon pricing** mechanisms apply to the steel sector.

6. It is worth noting that this set of indicators constitutes **a first step** in monitoring steel decarbonisation progress. These outcomes could be a starting point to **develop policy recommendations** on specific challenges related to steel industry decarbonisation and its nexus with excess capacity.

Table 1. List of indicators

Category	Indicator	Figure	Topic / Question covered
CO_2 emissions	Global steel CO_2 emissions	Figure 1 Figure 7	Setting the scene: From the starting point to the end one
	Steel as a share of CO_2 emissions	Figure 1	
	Steel as a share of industry CO_2 emissions	Figure 2	
	CO_2 intensity of steel production	Figure 3, Figure 7	
	Technology breakdown of global steel production (*)[1]	Figure 4	
	Carbon intensities of various steelmaking production routes (*)	Figure 5	
	Share of coal in final energy demand and energy intensity of steel production (*)	Figure 6	
CO_2 emission reduction targets	Steel producing countries covered by a carbon neutrality target	Figure 8, Figure 9	Is the level of ambition of steel producing countries up to the task?
	Share in global steel production		
	Share in global steel capacity		
	Related level of ambition (*)	Figure 10, Figure 11, Figure 12, Figure 13	
	Steel producing companies committed to a carbon neutrality target	Figure 14	As implementers, are steel companies aligned with net-zero?
	Share in global steel production		
	Share in global steel capacity		
	Production ranking breakdown (*)	Figure 15	
	Regional breakdown (*)	Figure 16	
Production	Production compatible with near zero steel production	Figure 17	Beyond the pledges, is current steel production on the right track?
	Share in total steel production		
	Technology breakdown		
	Trajectory upon the NZE by 2050 scenario (*)	Figure 18	
Capacity	Global steelmaking capacity	Figure 19	Is existing steelmaking capacity fit for a low-carbon future?
	EAF capacity as a share of total steelmaking capacity		
	Technology breakdown of global steelmaking capacity		
	Regional breakdown of global steelmaking capacity	Figure 20	
New steelmaking projects	Total capacity of new steelmaking projects	Figure 21	
	Technology breakdown of new steelmaking projects		
	Share of EAF in new steelmaking projects		
	Regional breakdown of new steelmaking projects	Figure 22	

[1] Indicators identified with (*) are complementary indicators added to the initial list, to support the analysis.

Innovative near zero emission steelmaking projects	Announcements on innovative near zero emission steelmaking projects	Figure 23	Are the next technologies ready to take over?
	Technology breakdown	Figure 25	
	Regional breakdown	Figure 24	
	Industrial maturity level (*)	Figure 26	
Carbon pricing	Number of jurisdictions covered by a carbon price applying to the steel sector	Figure 27	To what extent does carbon pricing apply to the steel sector?
	Maximal share of global steel capacity / production covered by a carbon price		
	Related price breakdown (*)	Figure 28	

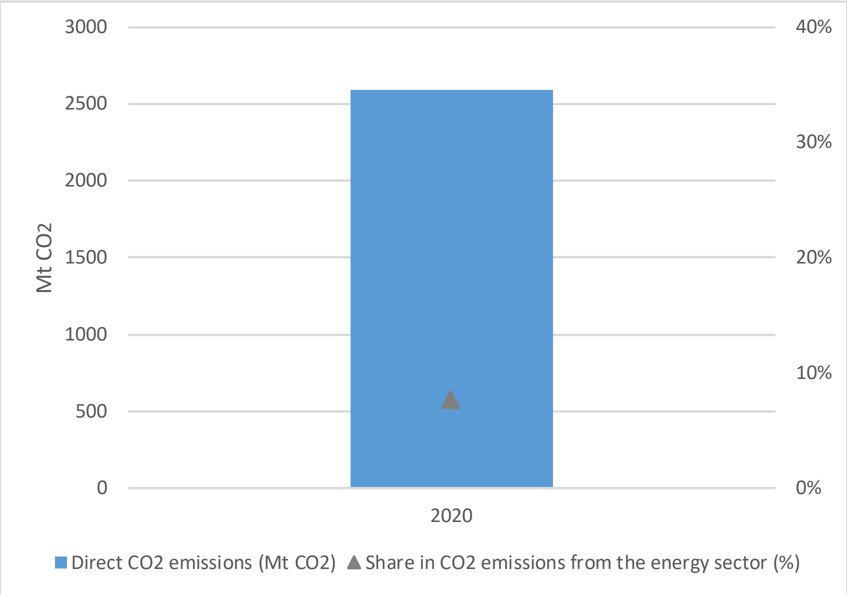
2. Setting the scene: From the starting point to the end one

Where does the steel sector stand in terms of emissions and what is the trajectory required to comply with Paris Agreement objectives?

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

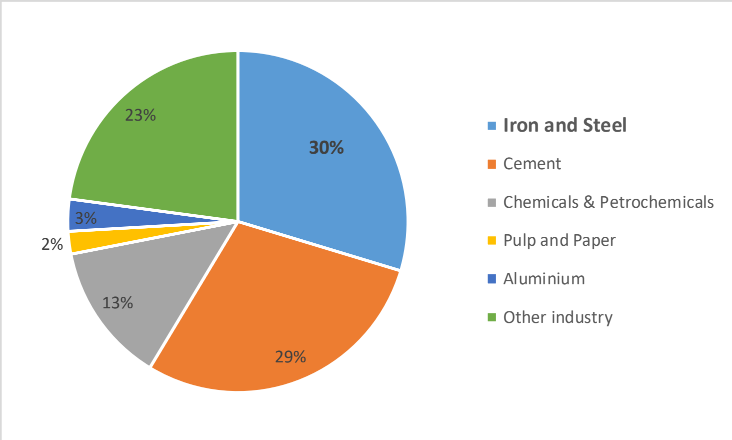
7. With direct emissions equating **2591 Mt CO_2** in 2020 (IEA, 2021[3]), the iron and steel sector accounts for **nearly 8%** of global emissions from the energy sector (Figure 1). It further ranks as the largest emitting sector in industry, representing **30%** of industrial carbon emissions (Figure 2). With such a large carbon footprint, decarbonising the steel sector is key to achieve climate goals.

Figure 1. Global steel direct CO_2 emissions



Notes: CO_2 emissions from the steel sector refer to direct emissions only (including energy and process emissions). CO_2 emissions from the energy sector include both those from the combustion of fossil fuels and industrial process emissions.
Source: Calculations based on (IEA, 2021[3]) and (IEA, 2021[4]).

Figure 2. Steel as a share of direct industry CO_2 emissions

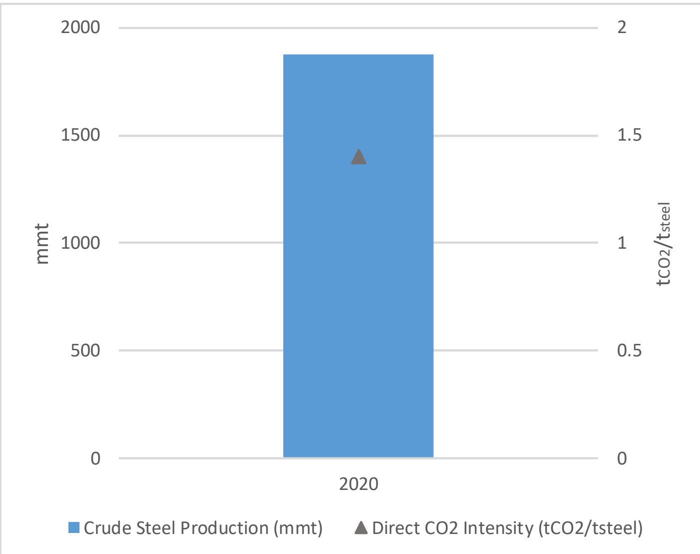


Note: CO_2 emissions refer to direct emissions only, including both those from the combustion of fossil fuels and industrial process emissions. Source: Calculations based on (IEA, 2021[3]).

… largely dominated by highly carbon intensive production

8. 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 t_{CO2}/t_{steel}** (IEA, 2021[6]) (Figure 3).
9. BOF is by far the predominant steelmaking route with **73%** of total output (worldsteel, 2021[5]) (Figure 4), outlining the dominance of the highest carbon intensive production process (Figure 5).
10. As underlying factors shaping carbon intensity, the share of coal in final energy demand and the energy intensity of crude steel production respectively stood at **75%** and **19.4 GJ/t_{steel}** in 2020 (IEA, 2021[7]) (Figure 6).

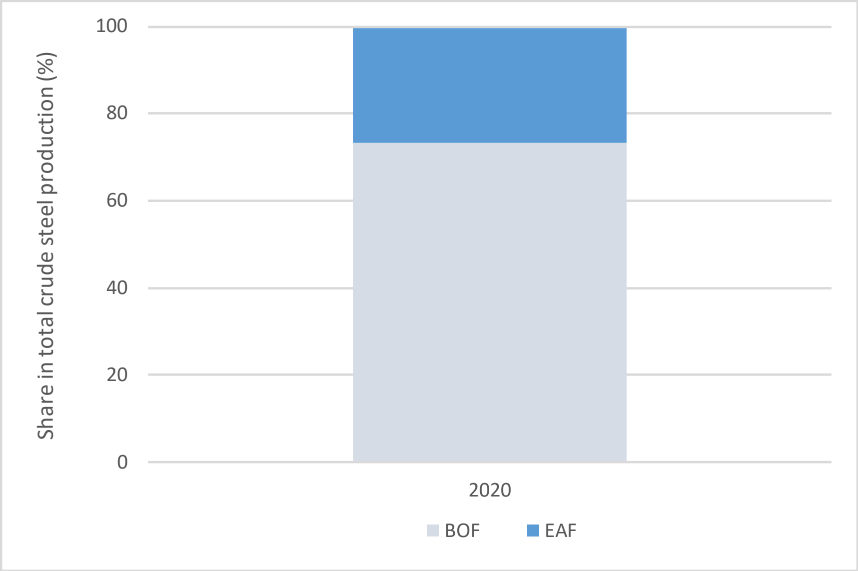
Figure 3. Global steel production and related direct CO_2 intensity



Note: CO_2 intensity from direct emissions only (including energy and process emissions).

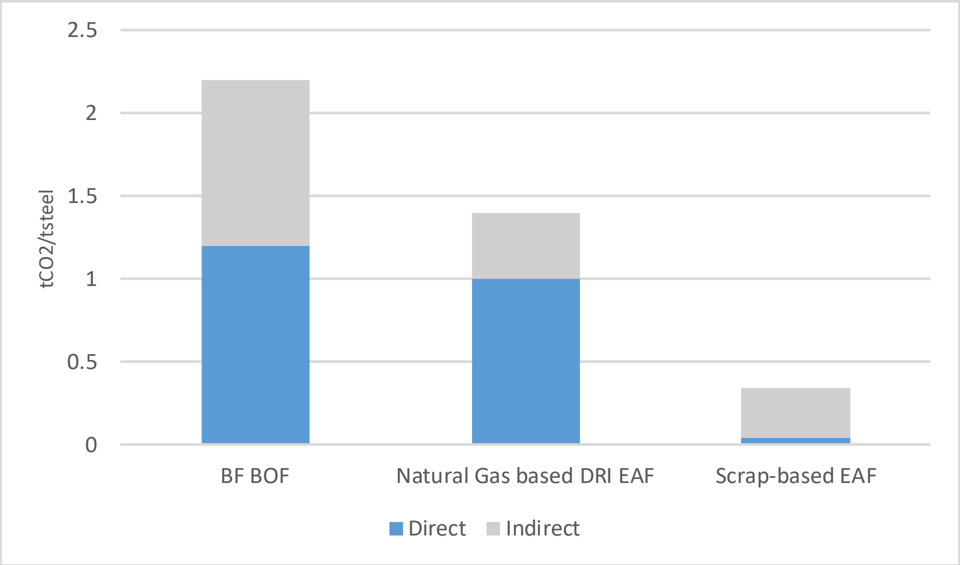
Source: Data from (worldsteel, 2021[5]) and (IEA, 2021[6]).

Figure 4. Technology breakdown of global steel production



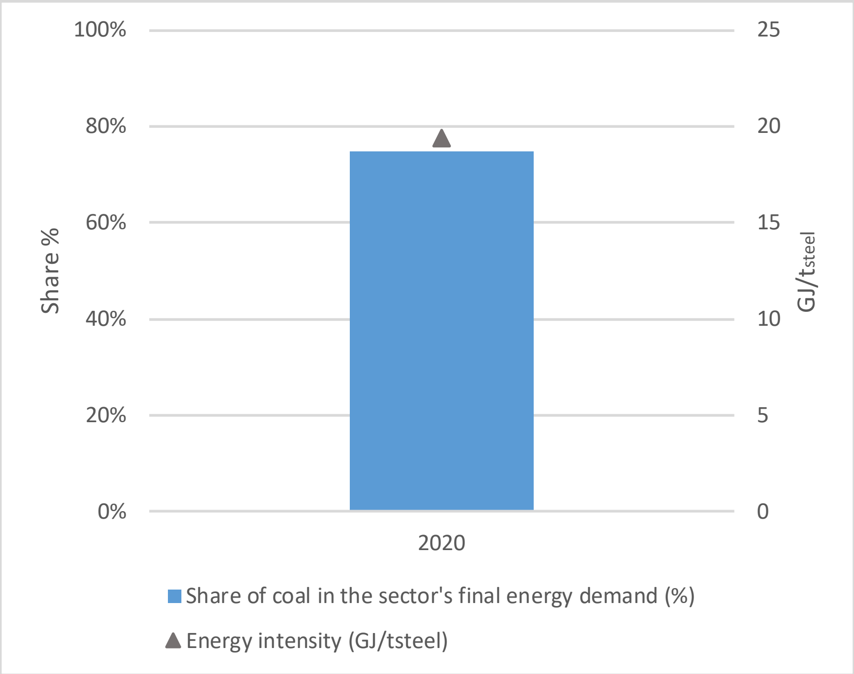
Source: Data from (worldsteel, 2021[5]).

Figure 5. Carbon intensities of various steelmaking production routes



Notes: Direct CO_2 emissions covers energy and process emissions.
Indirect CO_2 emissions include emissions from the power sector and the combustion of steel off-gases.
Source: Data from (IEA, 2020[8]).

Figure 6. Share of coal in final energy demand and energy intensity of steel production



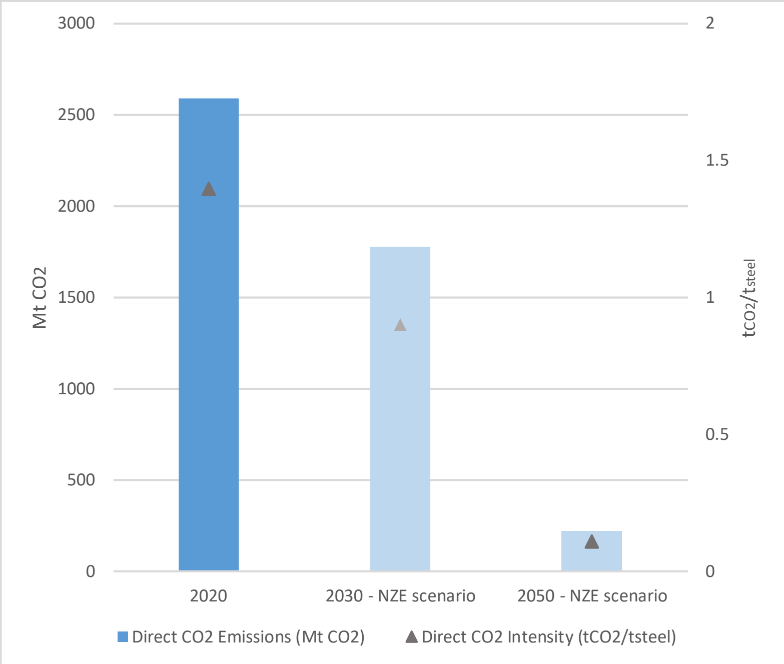
Note: Data relates to energy intensity from crude steel production. The energy accounting methodology is detailed in (IEA, 2020[8]), and considers the energy used for BF and coke ovens, as well as energy within final consumption.
Source: Calculations based on (IEA, 2021[7]).

A long way to go for reaching near zero emission

11. 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[9]).
12. To comply with this overall goal, direct emissions of the steel sector have to decrease by **90%** from 2020 levels, to reach **220 Mt CO_2** in 2050[2] (IEA, 2021[10]). As an intermediate target, this trajectory implies a **30%** emission reduction by **2030** (Figure 7).
13. These emission reductions are underpinned by global steel production levels that are similar (or slightly higher) than the 2020 ones (IEA, 2021[10]). Therefore, reaching near zero emission steel production would require a sharp decrease in carbon intensity, involving a **35%** reduction by **2030**, and **90%** by **2050** (Figure 7).

[2] Based on the IEA's Net-Zero Emissions scenario (NZE). This scenario highlights the trajectory and levels of CO_2 emissions required to comply with the global target of net-zero CO_2 emissions from the energy sector by 2050. This scenario is consistent with the Paris Agreement objective to limit the temperature increase to 1.5 °C.

Figure 7. Direct CO_2 emissions and intensity trajectory upon the NZE scenario



Notes: CO_2 emissions refer to direct emissions only (including energy and process emissions).
NZE : IEA Net Zero Emissions by 2050 scenario.
Source: (IEA, 2021[3]), (IEA, 2021[6]), (IEA, 2021[10]).

14. **The long way to go for reaching near zero emission** highlights to what extent a carbon neutrality target is a game changer for the steel industry. It calls for a deep transformation of the sector, relying on a combination of mitigation options. It necessitates improved performances (through energy efficiency or processes optimisation), fuel switching or breakthrough technologies (including hydrogen and CCUS) for production. On the demand side, material efficiency and circular economy are key drivers contributing to emission reduction. From a broader perspective, such a **deep transformation** calls for a sound business environment, not compatible with the adverse effects of **excess capacity**.

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

Given the massive emission reduction required for the steel sector by 2050, is the level of commitment of steel producing countries consistent with the scale of the challenge?

With net-zero pledges booming, the steel sector has to decarbonise

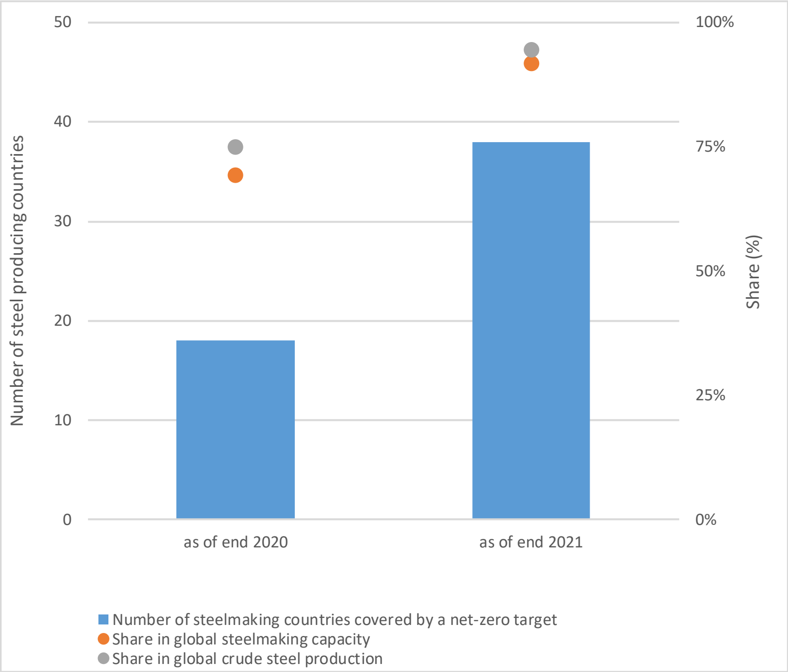
15. As of end of 2021, **38** steel producing countries[3] covering **more than 90%** of global steelmaking capacity and crude steel production had announced a net-zero target (Figure 8). This represents a sharp increase compared to 2020, both in terms of number of countries (18 countries in 2020, namely more than a doubling), and level of capacity and production covered (respectively about 70% and 75% in 2020, namely a third increase).
16. This trend is equally visible for GFSEC active members[4]. While in 2020 around 65% of their capacity and production was covered by a net-zero target, this share increased to **more than 95%** in 2021 (Figure 9).
17. Given these pledges, the global steel industry is bound to follow a net-zero pathway[5].

[3] The European Union and its Member States are accounted for 1 entity.

[4] India has not participated in the GFSEC since early 2020, thus not accounted in the total of "active GFSEC members".

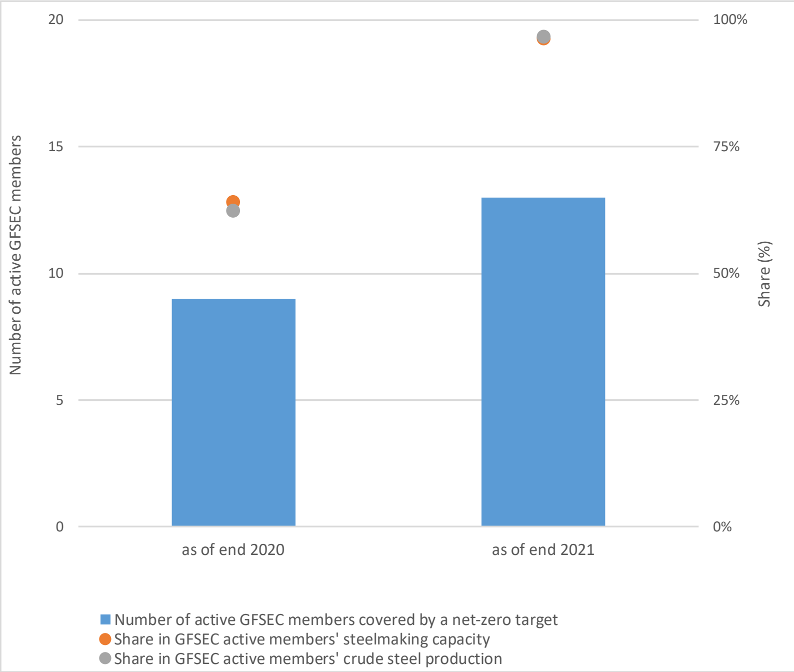
[5] While net-zero pledges are not directed to the steel sector itself (but to the whole economy), such targets imply reaching near zero emission steel production (as depicted in Figure 7). In this chapter, capacity/production 'subject to a net-zero target' or 'covered by a net-zero target' refers to capacity/production 'located in countries covered by a net-zero target'.

Figure 8. Number of steel producing countries covered by a net-zero target – Related share in global steelmaking capacity / production



Note: The indicator considers steel producing countries that have announced a net-zero target for 2050 or beyond, regardless of the status (target enshrined in law, in policy document or political pledge). The European Union and its Member States are accounted for 1 entity.
Source: Calculations based on (World Resources Institute, 2020[11]), (Climate Action Tracker, 2022[12]), (Global Energy Monitor, Caitlin Swalec, Christine Shearer, 2021[13]), (worldsteel, 2022[14]), (OECD, 2022[15]).

Figure 9. Number of GFSEC active members covered by a net-zero target – Related share in active GFSEC members' capacity / production



Note: The indicator considers steel producing countries that have announced a net-zero target for 2050 or beyond, regardless of the status (target enshrined in law, in policy document or political pledge). The European Union and its Member States are accounted for 1 entity.
Source: Calculations based on (World Resources Institute, 2020[11]), (Climate Action Tracker, 2022[12]), (Global Energy Monitor, Caitlin Swalec, Christine Shearer, 2021[13]), (worldsteel, 2022[14]), (OECD, 2022[15]).

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

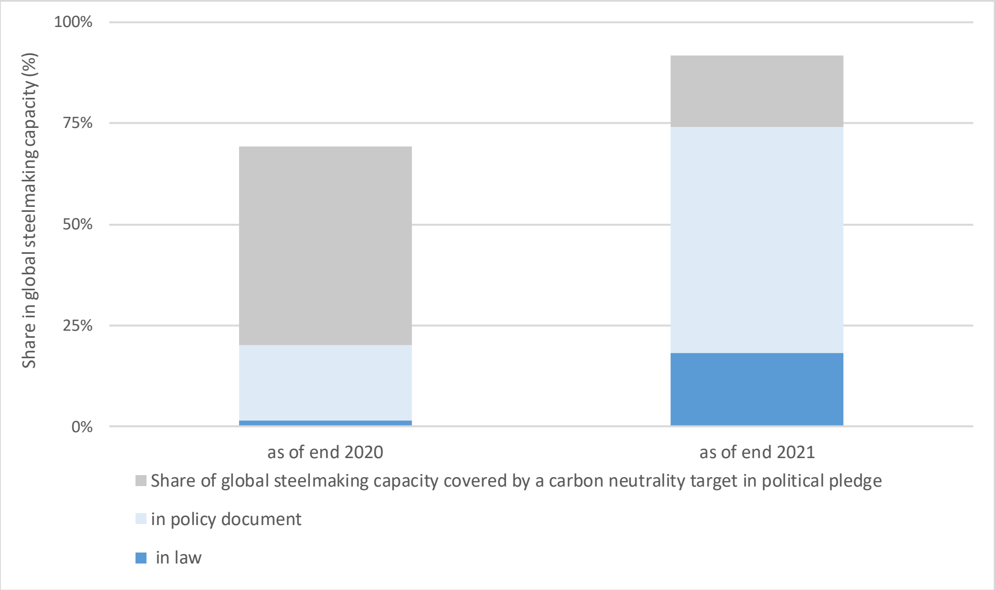
18. Analysing the nature of announced targets provides a more balanced perspective, as they are classified upon three levels of ambition: target 'in law', 'in policy document' or 'in political pledge' (World Resources Institute, 2020[11]).

19. As of end 2021, **only 18%** of global steelmaking capacity and production was located 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 10 and Figure 11).

20. 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 (Figure 10 and Figure 11).

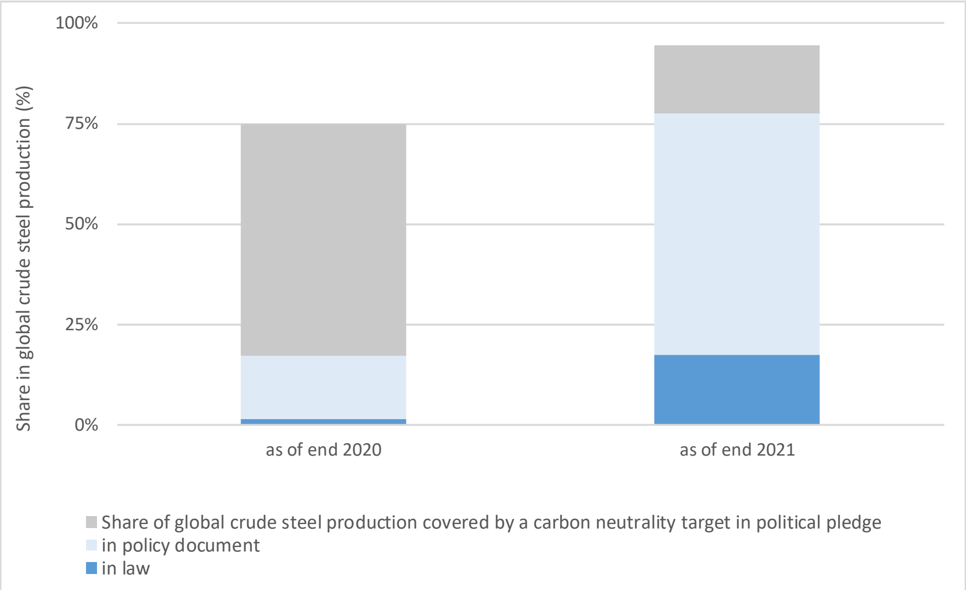
21. In 2020, **50-60%** of global steelmaking capacity and production was subject to a net-zero target upon a 'political pledge' status (namely with the lowest level of policy commitment), and **almost none** was covered by a target 'in law'. There has been thus an overall increasing level of ambition, with most of the capacity covered by a 'political pledge' in 2020 shifting to 'in policy document' in 2021 (driven by China). Equally, major steel producers (including the European Union, Japan or Korea) raised their level of ambition, from a net-zero target 'in policy document' to an 'in law' status.

Figure 10. Share of global steelmaking capacity covered by a net-zero target – Level of ambition



Source: Calculations based on (World Resources Institute, 2020[11]), (Climate Action Tracker, 2022[12]), (Global Energy Monitor, Caitlin Swalec, Christine Shearer, 2021[13]), (OECD, 2022[15]).

Figure 11. Share of global crude steel production covered by a net-zero target – Level of ambition



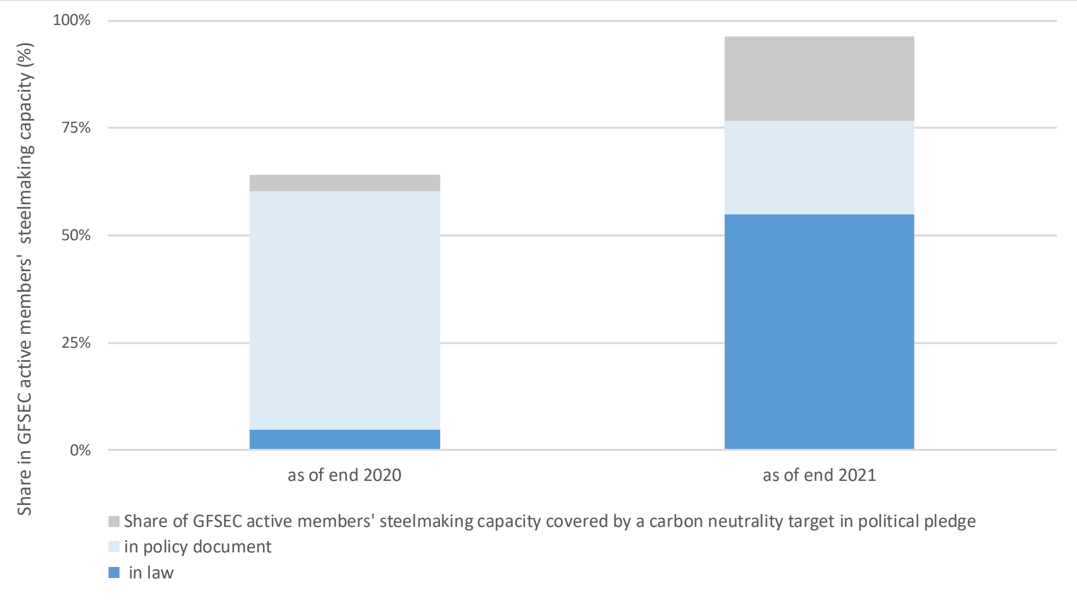
Source: Calculations based on (World Resources Institute, 2020[11]), (Climate Action Tracker, 2022[12]), (Global Energy Monitor, Caitlin Swalec, Christine Shearer, 2021[13]), (worldsteel, 2022[14]), (EUROFER, 2021[16]).

When looking at the targets type, the GFSEC group is one step ahead

22. Among countries having pledged for net-zero, the group of GFSEC active members appears to be more ambitious in terms of targets type. As of end 2021, most of the GFSEC active members' capacity and production subject to a net-zero target had an "in law" status (Figure 12 and Figure 13), while the "in a policy document" status prevailed for the other steel producing countries (Figure 10 and Figure 11).

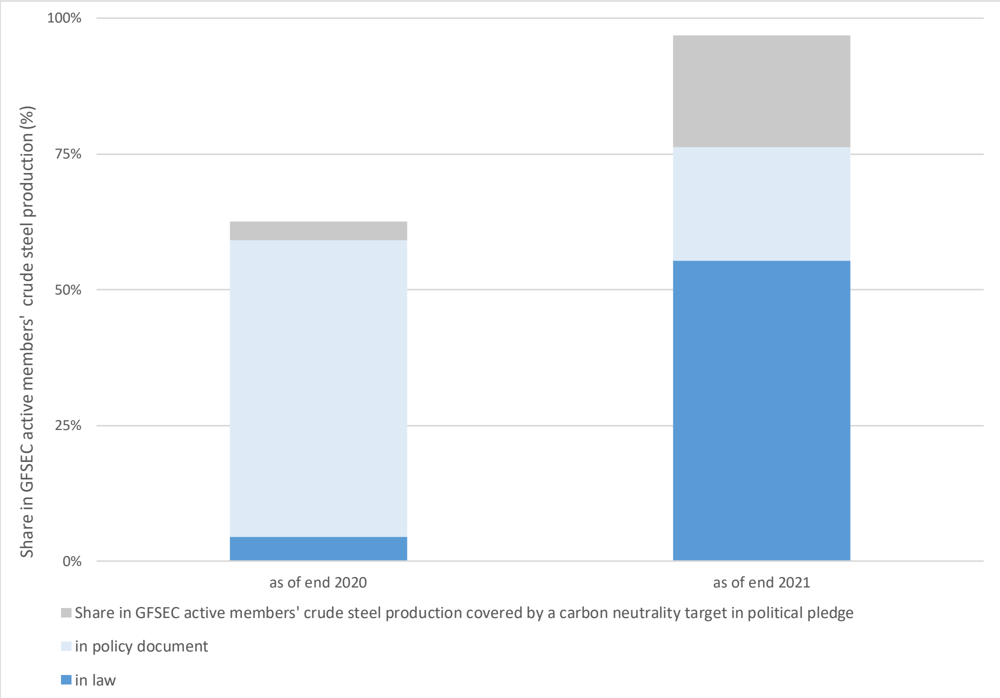
23. In 2020, only 5% of GFSEC active members' steelmaking capacity and production was located in countries with a net-zero target 'in law', but this share grew sharply to **55%** in 2021. This echoes the change in the target type trend observed at the global level (Figure 10 and Figure 11), most of the GFSEC capacity covered by a target in 'policy document' shifting to an 'in law' status in 2021. By contributing to almost all of the steelmaking capacity and production subject to a net-zero target 'in law' worldwide, the GFSEC group comprises the **pioneering countries** of climate action.

Figure 12. Share of GFSEC active members' steelmaking capacity covered by a net-zero target – Level of ambition



Source: Calculations based on (World Resources Institute, 2020[11]), (Climate Action Tracker, 2022[12]), (Global Energy Monitor, Caitlin Swalec, Christine Shearer, 2021[13]), (OECD, 2022[15]).

Figure 13. Share of GFSEC active members' crude steel production covered by a net-zero target – Level of ambition



Note: The indicator considers steel producing countries that have announced a net-zero target for 2050 or beyond, regardless of the status (target enshrined in law, in policy document or political pledge).
Source: Calculations based on (World Resources Institute, 2020[11]), (Climate Action Tracker, 2022[12]), (Global Energy Monitor, Caitlin Swalec, Christine Shearer, 2021[13]), (worldsteel, 2022[14]), (EUROFER, 2021[16]).

While being an essential step, pledging is not enough

24. Setting a net-zero target is a first crucial step, but does not guarantee that emission reductions will actually be achieved. Assessment of current and announced decarbonisation policies indeed suggests that they are not sufficient to deliver the level of emission reduction required to be consistent with the announced net-zero targets ((IEA, 2021[4]), (IPCC, 2022[9])). Such targets should be seen as a commitment to take ambitious actions to curb emissions, thus the starting point for developing decarbonisation strategies.

25. 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 allow for the development of tailor-made strategies and policies, taking into account sectoral specificities. Such an approach is more likely be impactful in terms of implementation.

26. This challenge clearly applies to the steel sector, with the need to set long-term and intermediate emission reduction objectives, as well as decarbonisation roadmaps consistently. As with the low-carbon transition as a whole, acknowledging that there is no 'one-size-fits all approach' calls for defining **tailored approaches**, in particular taking into account country's specificities (Box 1).

Box 1. Across countries, various configurations calling for a tailored approach

Beyond country's relative weight in emissions, the **differences in carbon intensities** underline the diversity of starting points to achieve near zero emission steel production (Hasanbeigi, 2022[17]). Multiple factors underpin these disparities in carbon intensity, notably the **structure of the assets** (BOF vs EAF), the **fuel mix and inputs** for production, the carbon intensity of **electricity**, or plant **energy efficiency** (Hasanbeigi, 2022[17]).

Generally, countries with a **high share of EAF** tend to have a lower carbon intensity of steel production. However, this should be balanced with the type of inputs used for production. For instance, coal based DRI production results in a carbon intensity ranked among the highest, despite it pertains to an EAF route. Similarly, for **electricity**, countries relying on a high share of decarbonised electricity will compare better with countries relying heavily on coal-based power generation, ceteris paribus.

These different factors shape the carbon footprint of a country's steel production. Therefore, selecting the most relevant decarbonisation options from a country perspective (both in terms of carbon emission reduction and economically) closely depends on the **existing configuration and specificities** of its steel industry.

Adopting a **tailored approach** is thus essential when defining a steel decarbonisation roadmap. Such an approach is even more crucial given other broader countries characteristics impacting such a strategy, including its energy mix, access to natural resources and raw materials, or existing low-carbon infrastructure.

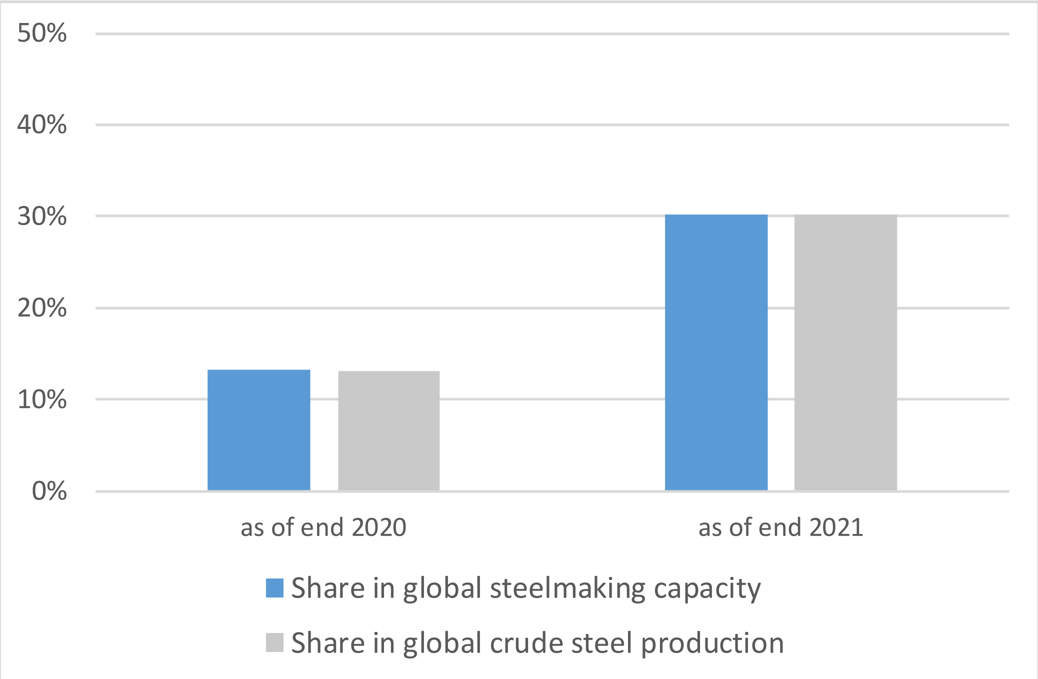
4. As implementers, are steel companies aligned with net-zero?

Besides countries' pledges, how do steel producing companies – the implementers – respond to the Paris Agreement objectives?

A mismatch between countries and corporate pledges

27. Companies being the drivers of steel production, they are key implementers of decarbonisation. To follow a net-zero pathway, it is therefore essential that countries' pledges are mirrored by steel producers.
28. As of end 2021, steel producing companies which have pledged for net-zero emissions[6] represented **30%** of global crude steel production and steelmaking capacity (Figure 14).
29. Similarly to countries' pledges, global production and capacity covered by corporate net-zero targets have significantly increased compared to 2020 levels. This coverage doubling is mainly due to announcements from several top 10 steel producers in 2021 (Baowu, HBIS and Nippon Steel).

Figure 14. Steel producing companies with a net-zero target – Related share in global steelmaking capacity / production



Source: Calculations based on companies websites, (Global Energy Monitor, Caitlin Swalec, Christine Shearer, 2021[13]), (Vogl, 2021[18]), (worldsteel, 2021[5]), (worldsteel, 2022[19]), (worldsteel, 2022[14]), (Global Energy Monitor, 2022[20]), (OECD, 2022[15]).

[6] Objective to reach carbon neutrality (or similar) by 2050 or before, depending on the companies.

30. 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.). This reveals **a clear implementation gap**, which could be explained by several factors.

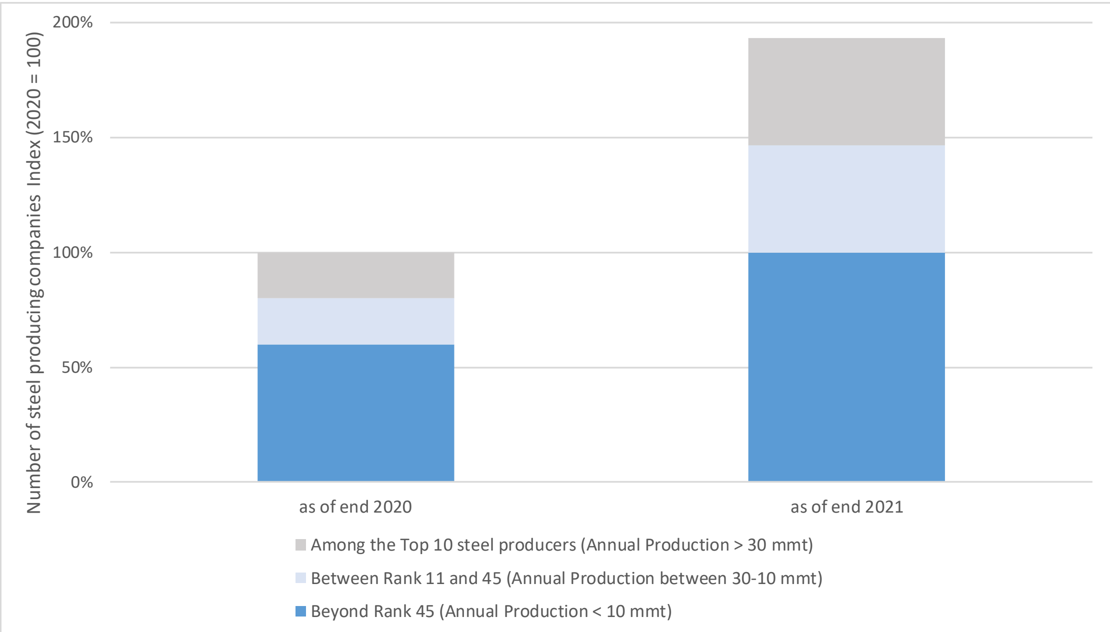
31. Firstly, there may be a **time lag** between companies' responses and the pledge announcements of the country in which they operate. For instance, the emergence of net-zero target announcements from Chinese steel companies in 2021 follows the country's pledge in 2020. On this specific point, monitoring 2022 corporate pledges will be particularly informative to confirm the dynamic (for instance, following India's net-zero pledge end of 2021).

32. 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**. But also, steel decarbonisation **related challenges** (whether on investments, technologies, competitiveness) may hinder companies' ambition to commit to such targets.

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

33. 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. As of end 2021, this category represented a quarter of the total number of listed companies (Figure 15). As mentioned previously, this trend drove the growth in steel production and capacity coverage observed in 2021 (Figure 14). However, in terms of the number of companies, the category of smaller companies is still the predominant one (companies below rank 45 of steel producers, ie with annual production <10 mmt).

Figure 15. Steel companies covered by a net-zero target – Production ranking breakdown



Note: Companies breakdown according to the ranking defined in (worldsteel, 2022[19]).
Source: Calculations based on companies websites, (Global Energy Monitor, Caitlin Swalec, Christine Shearer, 2021[13]), (Vogl, 2021[18]), (worldsteel, 2022[19]).

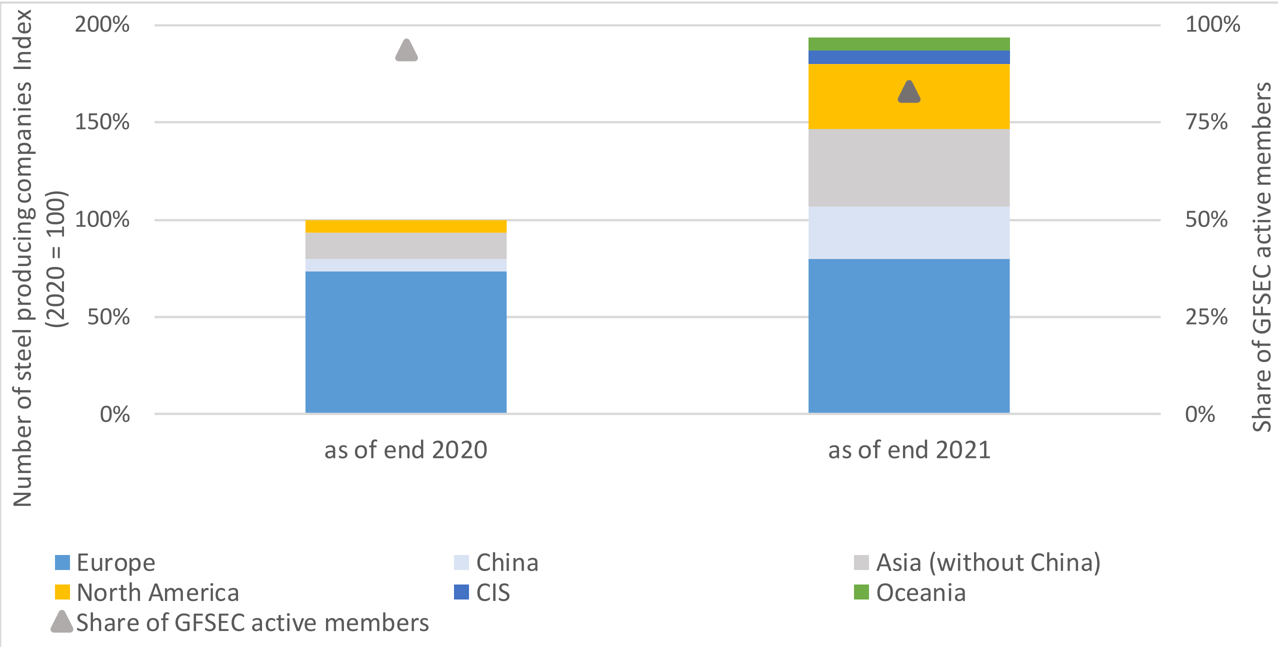
34. From a regional perspective, **Europe** accounts for the majority of companies with net-zero targets (more than 40% of the total number of listed companies) (Figure 16). Looking at their characteristics, almost all of these companies' targets had already been set by 2020 (or even before), reflecting Europe's early commitment in emission reductions. Most of these companies are below rank 45 of steel producers (and even below rank 100).

35. Whereas steel companies' pledges have increased in various regions worldwide, the **Asian region and China** have especially experienced a significant growth (Figure 16). They now represent the second regional pool, followed by North America. Almost all of the Chinese companies having committed to net-zero are among the **world's top 10 producers**, and their related targets are set by 2050, namely 10 years in advance compared to the national objective.

36. As for **GFSEC**, more than 80% of the total number of listed companies are companies related to GFSEC members. This underlines GFSEC members' leading position towards decarbonisation ambition, as depicted in Section 3.

37. In practice, most of these companies are currently **developing strategies** or **projects** to reduce their carbon footprint. Depending on the company, the level of impact and engagement varies, ranging from new plants, plant replacement, process adaptation of existing plants, focusing on reducing indirect emissions to developing technology and R&D programs (see Section 7. for the analysis of innovative near zero emission steelmaking projects).

Figure 16. Steel companies covered by a net-zero target – Regional breakdown



Note: Classification of regional breakdown based on companies HQ location, consistently with (worldsteel, 2022[19]).
Source: Calculations based on companies websites, (Global Energy Monitor, Caitlin Swalec, Christine Shearer, 2021[13]), (Vogl, 2021[18]).

38. Overall, the **diversity of companies** committed to net-zero adds to the countries specificities raised previously (Box 1). Typically, the EAF or BOF share ranges from 0% to 100% depending on the company (Global Energy Monitor, 2022[20]). 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. Analysing the yearly producing companies ranking from worldsteel (worldsteel, 2022[19]), only less of 30% of global steel production comes from the top 10 producing companies. It underscores the crucial role of intermediate and small producers in reaching global steel decarbonisation objectives. When combining all of 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, is current steel production on the right track?

While carbon neutrality commitments are growing both from steelmaking countries and companies, how is current steel production compatible with a near zero emission trajectory?

Near zero emission steel production relies on various routes…

39. 'Near zero emission steel production' refers to crude steel production whose emission intensity is **compatible with a global net zero pathway by 2050**. In order to identify the steelmaking routes complying with this requirement, the thresholds of emission intensity defined in (IEA, 2022[21]) are leveraged.

40. In this way, compatible routes include **various pathways**, whether based on BF-BOF, EAF or other production modes. They include the **scrap-based EAF** secondary route, **primary** routes (ie BF-BOF or DRI EAF) based on **CCUS**, **electrolytic hydrogen based DRI EAF**, or **iron ore electrolysis** (IEA, 2022[21]).

41. It is worth noting that this list of technologies should be only considered as **a proxy to assess the trend**, thus labelled as 'compatible with a near zero emission steel production'. Indeed, it is the precise value of emission intensity of crude steel production (depending on the plant for instance) which should ultimately be compared to the threshold[7]. This aspect underlines that **measuring, certifying and tracing carbon content** of crude steel production will be essential to support such a definition. This is even more crucial as it may constitute a basis for setting various carbon content-based criteria (standards, criteria for trade agreement or investment compliance…).

… but the current picture portrays more of a 'business as usual' approach

42. Based on the previous considerations, production levels compatible with near zero emission steel production amounted to **376 mmt** in 2020, namely **20%** of global crude steel production (Figure 17).

43. The related technology breakdown outlines that **scrap based EAF** is the only contributing route (Figure 17). In this way, this 20% share does not relate to a structural shift in production methods for decarbonisation purposes. Rather, it results from a well-established route, thus referring to a **'business as usual'** steelmaking approach.

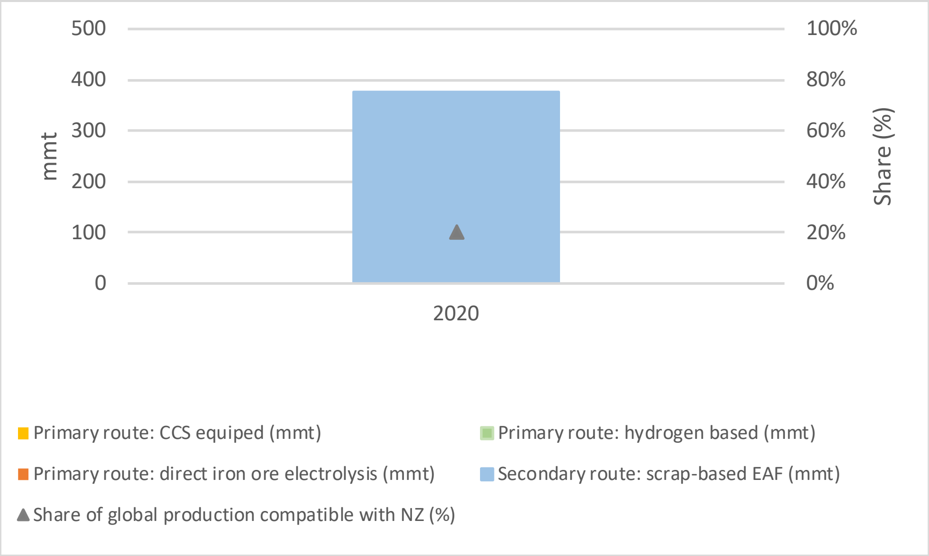
44. Regardless of the type of production route, such a share is **far from the levels** that would be required to be compliant with the Net-Zero Emissions scenario[8] (33% in 2030 and almost 100 % of steel production in 2050, Figure 18). The lack of diversified near zero emission steel production routes observed (Figure 17) hinders the ability to significantly increase this share in the short-term. Scaling-up

[7] For instance, depending on the indirect emissions, scrap based EAF production may be or not compliant with 'near zero emission steel production'.

[8] NZE from (IEA, 2021[10]), and referring to Figure 7

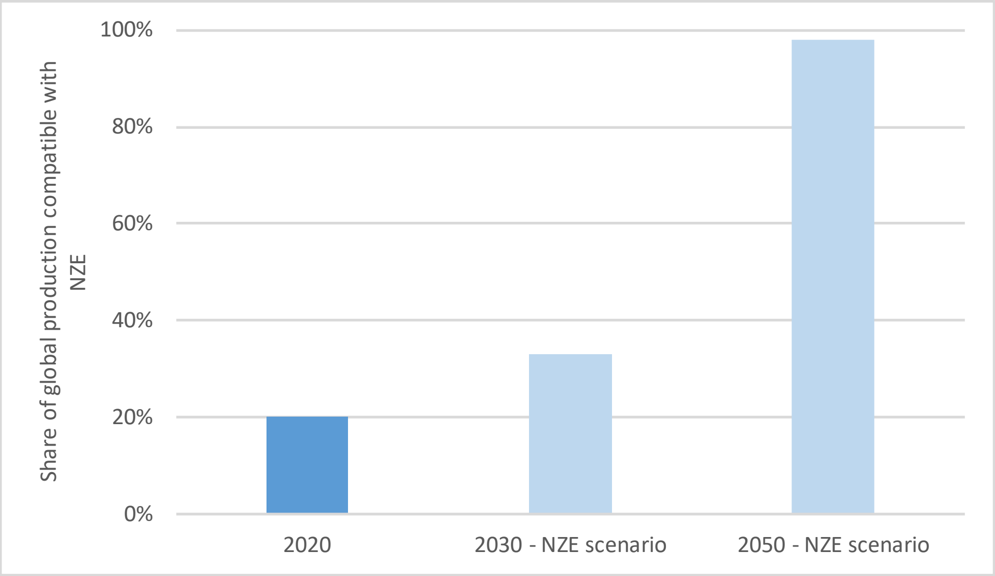
breakthrough technologies is crucial to unlock this potential, as well as addressing the challenges faced by steel companies to switch to such innovative routes.

Figure 17. Production compatible with near zero emission steel



Notes: Steel production routes compatible with near zero emission steel production include scrap-based EAF secondary route, CCS-equipped primary routes, electrolytic H2 DRI EAF primary route, iron ore electrolysis. This list of technologies should be only considered as a proxy to assess the indicator, thus labelled as 'compatible with a near zero emission steel production'.
Source: Data and calculations based on (worldsteel, 2021[5]) and (IEA, 2021[22]).

Figure 18. Production compatible with near zero emission steel –Trajectory upon the NZE scenario



Notes: Steel production routes compatible with near zero emission steel production include scrap-based EAF secondary route, CCS-equipped primary routes, electrolytic H2 DRI EAF primary route, iron ore electrolysis. This list of technologies should be only considered as a proxy to assess the indicator, thus labelled as 'compatible with a near zero emission steel production'. NZE: IEA Net Zero Emissions by 2050 scenario.
Source: Data and calculations based on (IEA, 2021[22]), (IEA, 2021[10]), (IEA, 2021[7]).

6. Is existing steelmaking capacity fit for a low-carbon future?

Deepening previous outcomes on production, is the structure of global steelmaking capacity compatible with a near zero emission pathway? From a mid-term perspective, how do planned commercial projects fit into such a trajectory?

Using the steel asset structure for trend assessment

45. Achieving Paris Agreement objectives implies an increasing share of near zero emission routes by 2050, as depicted in various net-zero scenarios ((IPCC, 2022[9]), (IEA, 2021[10]), (E3G, 2021[23]), (MPP, 2021[24]), (Net Zero Steel, 2021[25])).

46. As for EAF, available capacity data does not make the distinction between ‘scrap-based EAF’ secondary route and ‘DRI-EAF’ primary route. Whereas the scrap-based EAF secondary route could be considered as compatible with a near zero emission pathway (subject to the emission intensity level, (IEA, 2022[21])), this is not necessarily the case for the DRI-EAF primary route (if using fossil fuels as inputs, and without CCUS). In addition, an EAF plant may not be strictly associated to one type of feedstock (scrap or DRI), as it could be feed by both.

47. The share of EAF in global steelmaking capacity should not be thus considered as a ‘near zero emission steel capacity’. It should be viewed as a proxy to assess the compliance of steelmaking capacity with a net-zero pathway.

48. In addition, the BF-BOF route could be considered as compatible with a near zero emission pathway if equipped with CCUS (IEA, 2022[21]). Therefore, BF-BOF CCUS based route is equally taken into account when assessing the compliance of steelmaking capacity with climate goals.

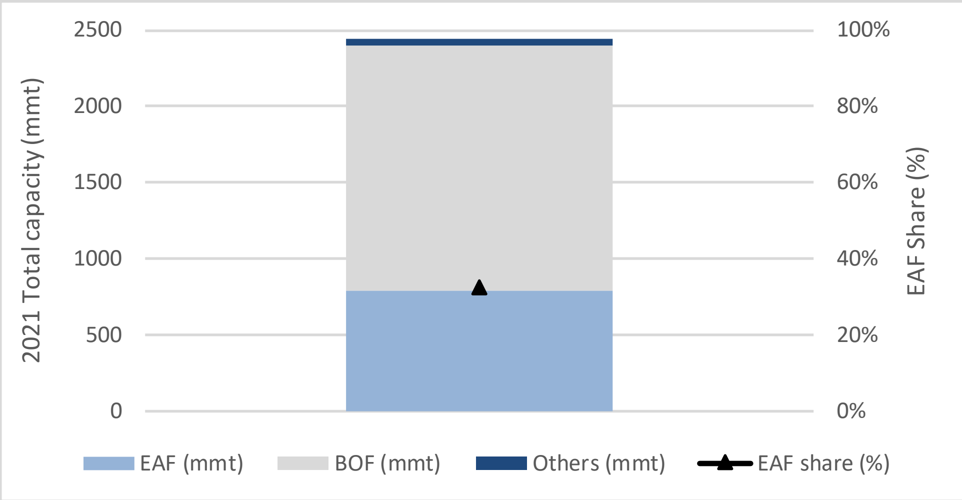
Carbon emissions intensive assets prevail, with regional disparities

49. As of end 2021, EAF represented **about 30%** of global steelmaking capacity. BOF assets clearly dominates the global landscape, accounting for around **two-thirds** of total capacity (Figure 19). Since the BF-BOF production routes are not equipped with CCUS, the current structure of assets **is not yet aligned with a net-zero pathway**.

50. The regional picture reveals strong disparities in the asset structure, for instance with EAF shares ranging **from less than 15% to more than 80%** (Figure 20). As for GFSEC active members, their EAF share reaches 45%, well above the global average. Overall, this variety of configurations points to the need for tailored decarbonisation strategies, as discussed in Box 1.

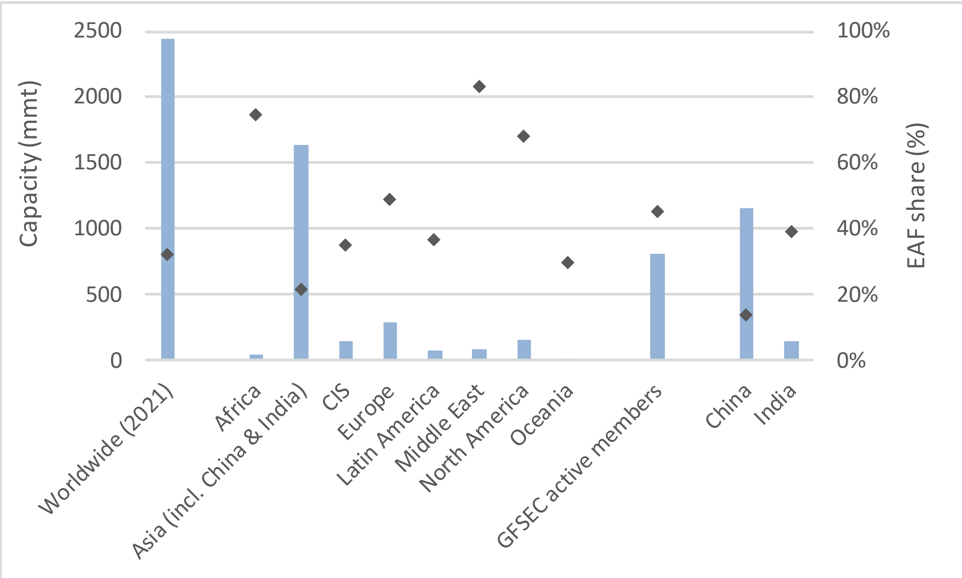
51. The share of EAF or BOF alone is not sufficient to identify the regions with the most challenging asset structure. When combined with the regional levels of capacity, Asia stands as a critical one. Accounting for nearly 70% of global capacity, its EAF share is around 20%, and BF-BOF routes are not equipped with CCUS. This structure is highly driven by China, the latter representing nearly 50% of global capacity, and with an EAF share below 15%.

Figure 19. Global steelmaking capacity and related asset structure



Notes: 2020 levels are not reported in this graph, as they are equivalent to 2021.
The share of EAF should not be considered as a 'near zero emission steel capacity'. Rather, it should be viewed as a proxy to assess the compliance of steelmaking capacity with a net-zero pathway, alongside capacity based on BF-BOF with CCUS.
Source: OECD Steel Capacity Database.

Figure 20. Steelmaking capacity and related share of EAF – Regional breakdown



Notes: 2020 levels are not reported in this graph, as they are equivalent to 2021.
The share of EAF should not be considered as a 'near zero emission steel capacity'. Rather, it should be viewed as a proxy to assess the compliance of steelmaking capacity with a net-zero pathway, alongside capacity based on BF-BOF with CCUS.
Source: OECD Steel Capacity Database.

New projects are not going in the right direction…

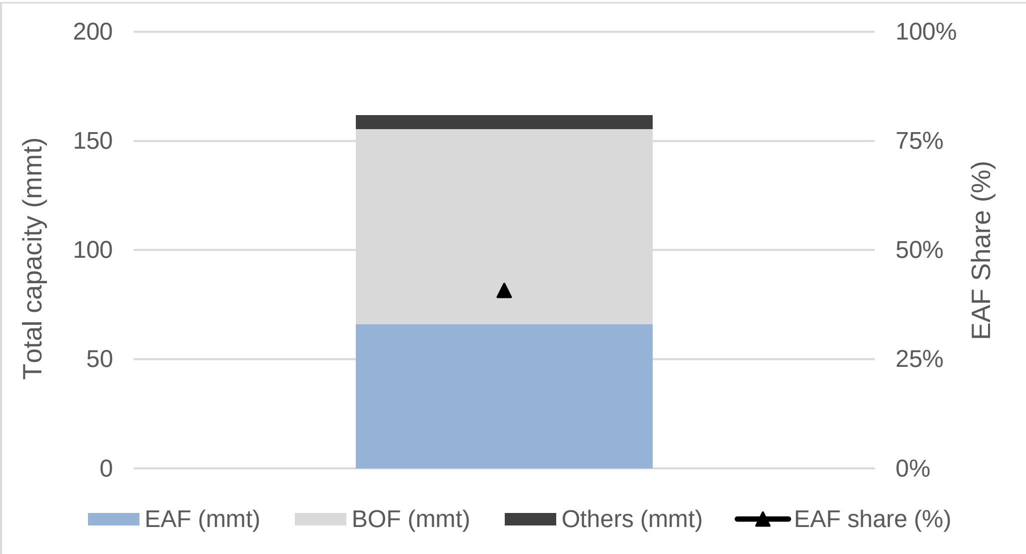
52. Findings in the previous sections are even more pronounced when looking at future steelmaking projects, especially when linking with excess capacity considerations. As of end 2021, there were about 160 mmt of new capacity projects underway or

planned over the next three years (2022-24). **Most of the capacity relates to BOF projects (55%)**, and EAF accounts for about 40% of future capacity (Figure 21).

53. From a regional perspective, more than half of the capacity planned is located in Asia, driven by India and China (Figure 22). Crucially, 90% of planned capacity in Asia are BF-BOF projects without CCUS.

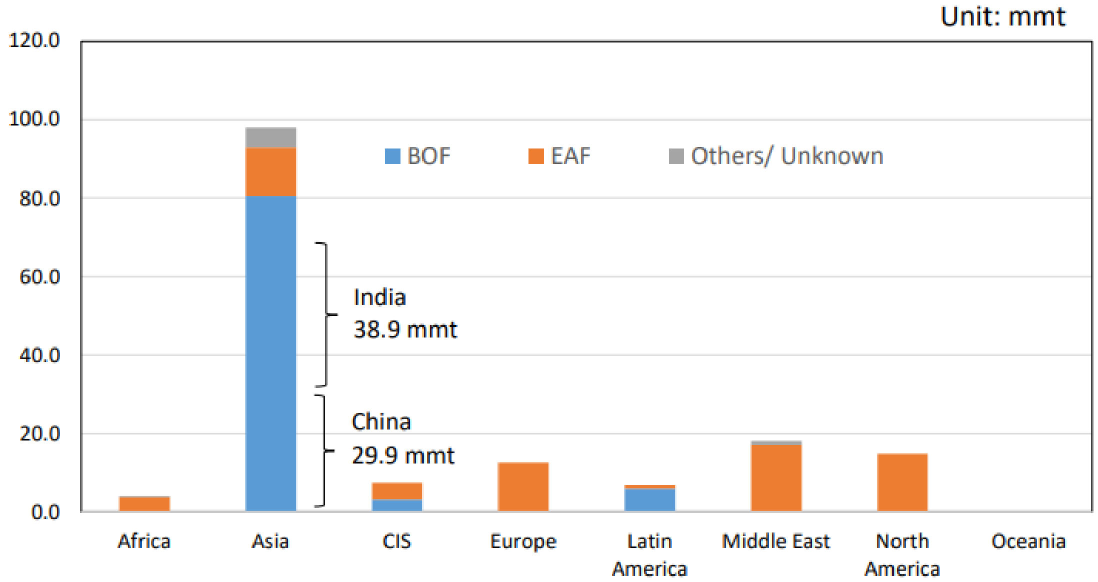
54. By adding new carbon intensive steelmaking plants, it further highlights the extent to which excess capacity may hinder the low-carbon transition.

Figure 21. New steelmaking projects and related asset structure



Notes: The capacity data contains both underway and planned projects over the next three years (2022-24), as of end of 2021. It does not take into account closures that may occur during the period.
The share of EAF should not be considered as a 'near zero emission steel capacity'. Rather, it should be viewed as a proxy to assess the compliance of steelmaking capacity with a net-zero pathway, alongside capacity based on BF-BOF with CCUS.
Source: Calculations based on (OECD, 2022[15]).

Figure 22. New steelmaking projects and related asset structure – Regional breakdown



Notes: The capacity data contains both underway and planned projects over the next three years (2022-24), as of end of 2021. It does not take into account closures that may occur during the period.
The share of EAF should not be considered as a 'near zero emission steel capacity'. Rather, it should be viewed as a proxy to assess the compliance of steelmaking capacity with a net-zero pathway, alongside capacity based on BF-BOF with CCUS.
Source: Figure from (OECD, 2022[15]).

…increasing the risk of stranded assets

55. In countries having pledged for net-zero emissions, carbon intensive plants risk to become stranded assets, as **not compatible** with such a pathway. The high share of carbon intensive assets in planned projects, not equipped with CCUS, would contribute to locked-in emissions for decades. The Asian region appears to be highly exposed to this risk, given both the regional outlook described previously and its relatively young assets[9].

56. This risk does not only arise from a domestic perspective, but also from an international one. Carbon intensive assets are unlikely to be able to compete in future **low-carbon markets**, as trade agreements or measures based on carbon content criteria emerge. For those steel mills whose production is primarily export-oriented, this shift in global markets would contribute to their position as stranded assets.

57. 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**.

[9] Blast furnaces are on average 12 years in China or 15 years in India (IEA, 2020[8]).

Box 2. Tackling excess capacity to foster steel decarbonisation

Steel industry decarbonisation requires a deep transformation, along with the combination of multiple options. This industrial paradigm implies a **long-term strategy calling for a sound business environment, not compatible with excess capacity.** Indeed, the persisting structural imbalance weighs on various features and conditions required for a successful transition, including on investments, technologies, competitiveness, trade.

First, **excess capacity hinders the shift towards near zero emission technologies.** Innovative processes in steelmaking routes and retrofits of existing assets involve significant costs (IEA, 2020[8]). In a context of excess capacity affecting the profitability of companies, the latter are not in a favourable position to bear such investments or increase in production costs.

Moreover, **excess capacity fuels stranded assets doomed to fail in a low-carbon era.** Ensuring a trajectory compatible with the Paris Agreement objectives entails a limited increase in global steel demand, as well as a shift towards low-carbon emission steel production ((IPCC, 2022[9]), (IEA, 2021[10]), (E3G, 2021[23]), (MPP, 2021[24]), (Net Zero Steel, 2021[25])). Hence, the very nature of excess capacity runs counter to this demand trend. Besides, by fuelling carbon intensive facilities (OECD, 2022[15]), excess capacity hampers the low-carbon transition. *In fine*, excess capacity leads to a harder and more costly transition.

Likewise, excess capacity worsens competition in low-carbon markets. The bleak financial health fuelled by excess capacity is likely to strengthen the barriers to entry, in a context of low-carbon transformation and related high investments. This could not only harm market competition, but also innovation (a key ingredient for steel decarbonisation). Furthermore, effects of excess capacity on business competitiveness may feed trade tensions related to the low-carbon transition, ultimately impeding market openness and efficiency.

In developing countries, excess capacity threatens steel industry decarbonisation in the hardest way. Developing economies are associated with the largest cumulative investments required between by 2050 for steel decarbonisation (IEA, 2020[8]). Thus, they are even more exposed to the effects of excess capacity on their investment potential. As depicted previously, the predominance of carbon intensive facilities increases the risk of stranded assets. Excess capacity further strengthens this risk, as companies may not be in a way to bear the costs of retrofitting their plants. Finally, by fuelling stranded assets, excess capacity undermines the steel export potential of these countries.

All in all, such aspects underline how **tackling excess capacity is key for a successful decarbonisation** of the global steel industry.

7. Are the next technologies ready to take over?

Previous assessment underscored the mismatch between the current structure of assets and its compatibility with a net-zero pathway. To what extent are steelmaking projects based on breakthrough technologies ready to reverse this trend ?

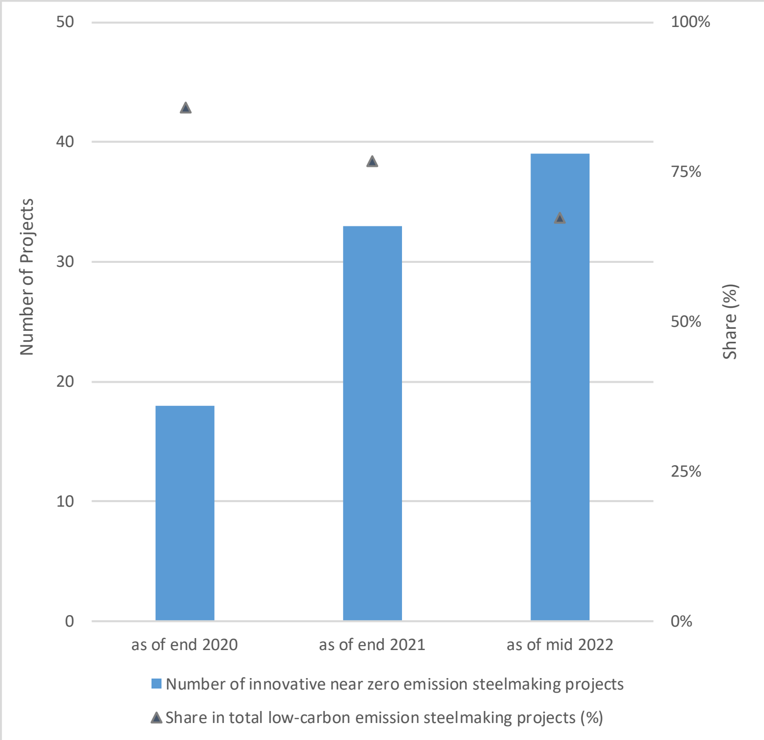
Projects implying innovative routes keep on growing

58. Achieving near zero emission steel production strongly relies on the uptake of innovative routes. More than 60% of total emission reductions required between 2020 and 2050 are indeed expected to result from technologies that are not mature at the commercial scale ((IEA, 2020[8]), (IEA, 2021[6])).

59. As of mid-2022, there were **around 40** innovative near zero emission steelmaking projects worldwide (Figure 23). This project pipeline covers announced projects involving a facility plant based on an innovative near zero emission production route (hydrogen-based DRI EAF, CCUS, or others such as direct iron ore electrolysis (IEA, 2022[21])).

60. 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. , 4.).

Figure 23. Number of innovative near zero emission steelmaking projects



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).
'Low-carbon emission steelmaking projects' cover innovative near zero emission projects, as well as innovative routes for interim emission reduction measures, and transformation site towards EAF.
Source: Calculations based on various sources of information (Metal Expert, Kallanish, Platts, media, companies and regional steel associations websites).

61. When considering a broader range of steel decarbonisation projects (including innovative routes for interim emission reduction measures - such as hydrogen fuel blending in BF-, or plant replacement towards EAF), innovative near zero technologies represented nearly 70% of the portfolio (Figure 23). This share has decreased over the last two years (85% in 2020), mainly due to the increasing number of projects related to process adaptation for existing plants (such adaptations are indeed not based on near zero emission routes). Although providing moderate emission reductions, these adaptations measures (typically BF with hydrogen blending) are key enablers to achieve intermediate carbon emission reduction targets in the short term.

62. It is worth noting that most of the projects rely on **partnerships** between steel producers and other companies, enabling risk mitigation from both a financial and technical perspective. These partnerships are also intended to leverage synergies for industrial hubs or shared infrastructure (e.g. for hydrogen). Most of these partnerships entail energy companies, highlighting the crucial interaction between the latter and the steel sector. Upstream in the value chain, iron ore mining companies are other recurring partnering stakeholders. In both cases, steel companies are actively seeking to secure access to strategic inputs for near zero emission steel production (such as low-carbon electricity, hydrogen, or high grades of iron ores, see Box 3).

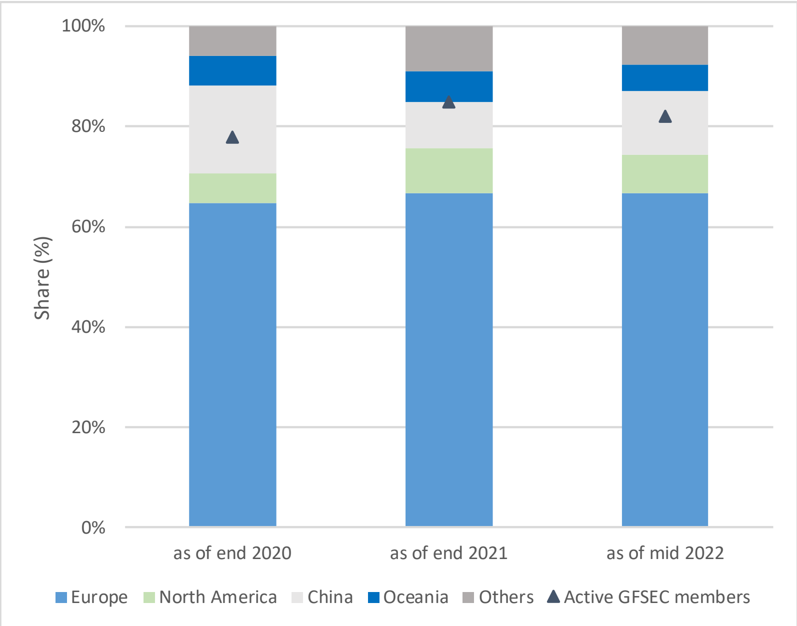
The vast majority of projects is located in Europe, but first initiatives in China are emerging

63. **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 (Figure 24), with Germany and Sweden as the leading countries. This trend reflects the EU early commitment in climate action, coupled with ambitious targets (carbon neutrality by 2050, and at least 55% emissions reduction by 2030). Furthermore, its relatively high share of BOF route in total steel capacity (about 50% (OECD, 2022[15])) pushes for adopting such breakthrough technologies.

64. **China** accounted for **almost 15%** of the projects, and North America for 8%. Alongside the pledge of carbon neutrality by 2060 and target of emission peaking by 2030, major Chinese steel producers have launched significant initiatives, such as the Baowu's Global Low-Carbon Metallurgical Innovation Alliance (GLCMI) (Baowu, 2021[26]). In terms of innovative projects, there is an increasing trend on hydrogen based DRI route, as evidenced by HBIS or Baowu announcements.

65. Regarding active GFSEC members, their overall share was **about 80%** of total innovative near zero projects, as of mid-2022.

Figure 24. Innovative near zero emission steelmaking projects – Regional breakdown



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).

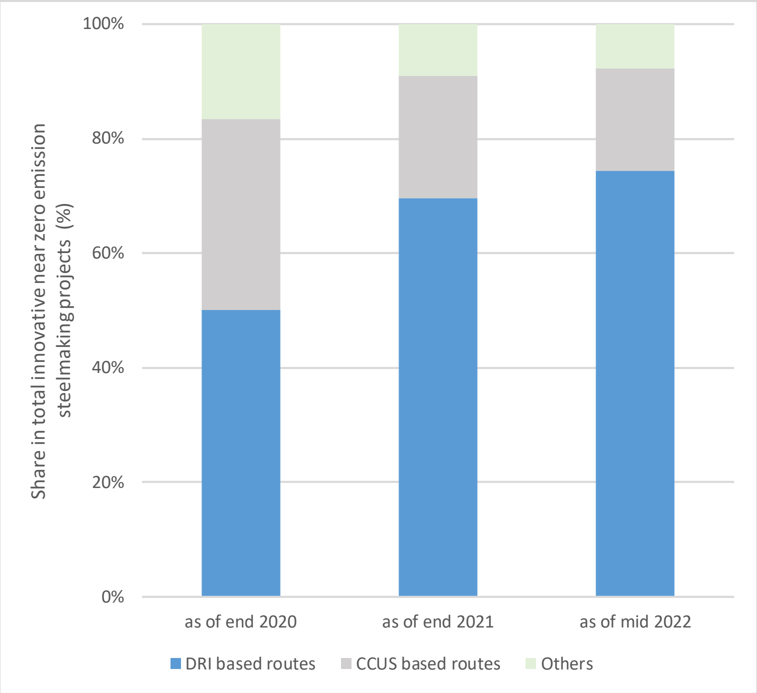
DRI technology is the cornerstone of innovative projects

66. **DRI technology** is by far the major route, representing **nearly 75%** of the near zero emission project pipeline as of mid-2022 (Figure 25). While DRI-based projects accounted for half of the pipeline project in 2020, they have more than doubled in 2021, now driving the overall global project pipeline growth. Such projects are predominantly located in Europe, and involve either a DRI plant only or a DRI coupled with an EAF plant.

67. In terms of feedstock, the DRI strategy consists in either using exclusively green hydrogen, or considering a gradual switch from natural gas to green hydrogen. Besides innovation challenges, the impetus for hydrogen based DRI route brings new strategic inputs, for which securing access becomes at stake (Box 3).

68. The remaining projects involved CCUS based technologies (nearly 20% of the project portfolio), and less advanced routes in terms of technology readiness, such as direct iron ore electrolysis.

Figure 25. Innovative near zero emission steelmaking projects – Technology breakdown



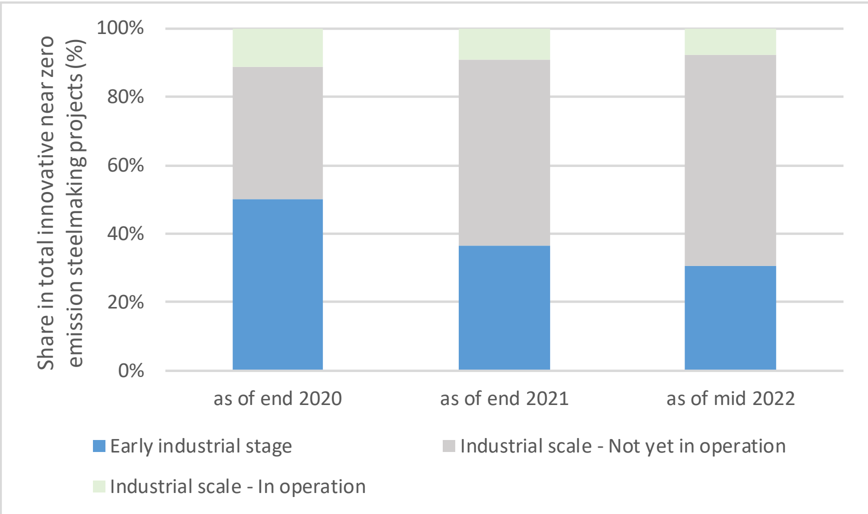
Note: 'Innovative near zero emission steelmaking projects' refer to announced projects involving a facility plant based on an innovative near zero emission production route (e.g hydrogen-based DRI EAF, CCUS, iron ore electrolysis).
Source: Calculations based on various sources of information (Metal Expert,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

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

69. 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 26). 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 actually operating at an industrial scale. The first established one operates using CCS since 2016 in the UAE (ADNOC, 2022[27]), whose captured CO_2 is used for Enhanced Oil Recovery purposes (and thus not driven by steel decarbonisation purposes).

70. Overall, the **low-industrial maturity level** observed for the project pipeline highlights the mismatch with a net-zero by 2050 trajectory. Indeed, the current deployment rate of innovative production routes is well behind the pace required, which would imply for instance, 'more than two new 1 Mt steel plants based on full hydrogen reduction being installed every month on average through to 2050' (IEA, 2020[28]). Such a gap reveals the crucial need to **scale-up breakthrough technologies, and the central role of innovation** in the low-carbon transition.

Figure 26. Innovative near zero emission steelmaking projects – Industrial maturity level



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).

Towards a risk of increased capacity?

71. The low level of industrial maturity observed (Figure 26) inherently limits the impact of such projects on steelmaking capacity increase. However, this trend could be challenged by the upscaling of innovative technologies, fostering the deployment of near zero emission steel plants **at commercial scale**.

72. Equally, as innovative technologies **disseminate worldwide**, such projects are likely to intensify in some regions, or expand in new ones.

73. Therefore, the development of new plants' projects for decarbonisation purposes could be a ground for capacity increase. The **management of existing assets** - especially plant replacement strategies - will be critical in shaping the potential resulting net-capacity increase.

Box 3. Change in production routes, change in strategic inputs

Beyond technological aspects, the shift towards near zero emission steel production equally entails a shift in terms of **strategic inputs**. As highlighted in various net-zero scenarios, the **uptake of EAF** is a key component to achieve deep emission reductions ((IEA, 2021[10]), (E3G, 2021[23]), (Net Zero Steel, 2021[25]), (MPP, 2021[24]), (IPCC, 2022[9])). Hence, **low-carbon electricity** is crucial for steel decarbonisation, and even more central when considering electrolytic hydrogen-based steelmaking. **Scrap** is an other strategic input, given the significant contribution of the secondary route in emission reductions. In addition, **high grades of iron ores** and **hydrogen** are essential inputs for near zero emission primary steel production.

Availability and affordability of such strategic inputs are at stake, not only to ensure a resilient steel value chain, but also to support an effective decarbonisation of the sector. Security of supply covers various dimensions, from sufficient quantities to suitable quality (for scrap and iron ore), as well the required infrastructure for inputs access (scrap collection, hydrogen transport, grids...). Ensuring trade openness is also critical to address potential regional imbalances and avoid market tensions. Affordability of strategic inputs is equally of major importance, given that raw material and energy inputs are key drivers of steel production costs (60-80%, (IEA, 2020[8])).

The specific case of **green hydrogen-based DRI EAF** illustrates how a shift in strategic inputs may reshape the global steel value chain, and possibly implying new configurations and trade routes. For instance, regions combining abundant and affordable renewable electricity for green hydrogen production, as well as high grades of iron ores, could produce direct reduced iron and export HBI. Alternatively, well positioned countries for green hydrogen production could export such a feedstock for DRI production. This configuration could be particularly disruptive in terms of supply chains location. Indeed, some regions with high potential for green hydrogen production are not necessarily currently part of the upstream steel value chain (in particular when considering Africa) (IRENA, 2022[29]). Therefore, this could result in new trade routes for the upstream steel supply chain.

As the move towards decarbonisation is growing, various steel companies seek to **secure access** to such strategic inputs. Recent announcements include ArcelorMittal acquiring scrap facilities (ArcelorMittal, 2022[30]) or partnering for DRI production (ArcelorMittal, 2022[31]). H2GS partnerships with energy companies are other examples, both for low-carbon electricity (Statkraft, 2022[32]) and green hydrogen production (Iberdrola, 2021[33]).

8. To what extent does carbon pricing apply to the steel sector?

Addressing implementation gaps (including for scaling-up innovative technologies) especially relies on an enabling policy framework. Carbon pricing mechanisms being one of the policy tools used to support emission reductions, how does it apply to the steel sector?

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

74. Aiming to incentivise the shift towards lower emitting technologies, carbon pricing is one of the policy tools used to support emission reductions. As of end of 2021, 66 carbon pricing mechanisms were implemented worldwide ((The World Bank, 2022[34]), (ICAP, 2022[35])). These initiatives cover both carbon taxes and Emissions Trading Systems (ETS), and are applied at the (inter)national or/and subnational level. All in all, they covered 21[10] different countries.

75. 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.

76. As of end of 2021, **17 steel producing countries**[11] have implemented carbon pricing mechanisms at full scale, applying to the steel sector. **11**[12] out of these 17 countries are active GFSEC members (Figure 27).

77. Furthermore, when applied to the steel sector, carbon pricing often includes exemptions. This may involve free allocations, thresholds on plant capacity, or minimal thresholds on carbon emissions. 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'.

78. To evaluate an order of magnitude of the carbon pricing coverage for the steel sector, the total steel capacity and production of each jurisdiction accounted in Figure 27 is considered. In this way, this could be defined as the 'maximum share of global steel capacity/production covered by a carbon price', namely without prejudging of the level of capacity/production subject to exemptions.

79. Without accounting for potential exemptions, carbon pricing covered **around 20%** of global steelmaking capacity and production in 2020 and 2021 (Figure 27). Given that it constitutes a maximum share, this relatively low order of magnitude underlines the current **limited contribution of carbon pricing as a tool to foster steel industry decarbonisation.**

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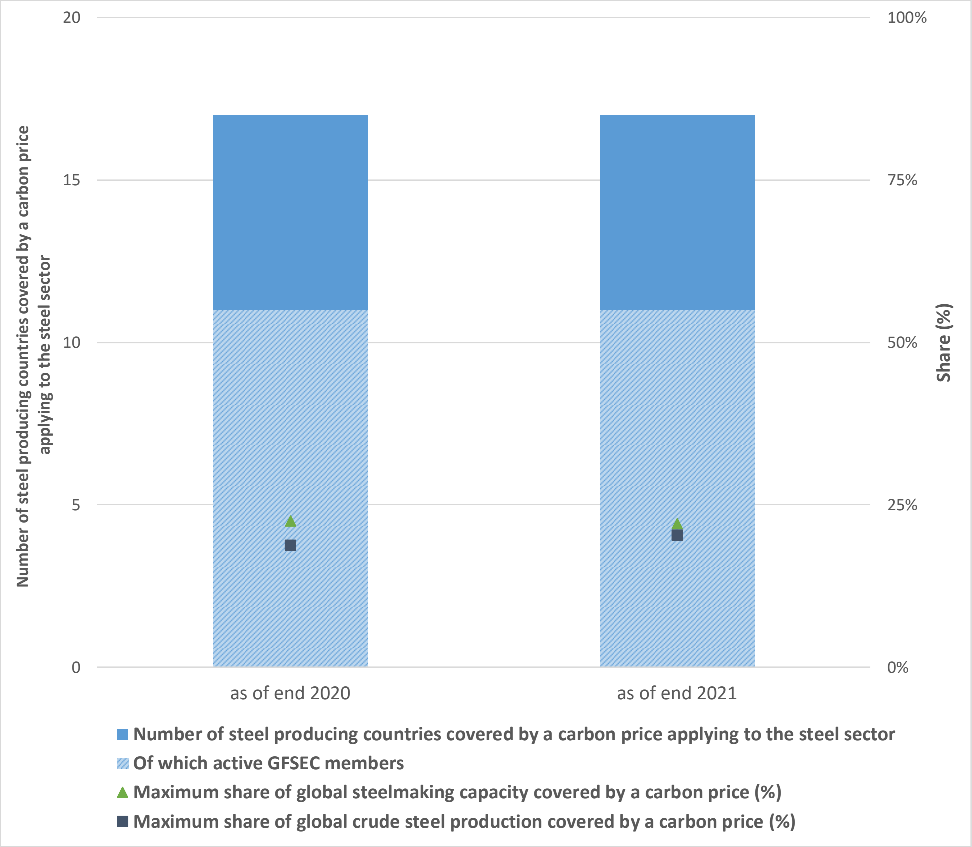
[10] The European Union and its Member States are accounted for 1 entity.

[11] The European Union and its Member States are accounted for 1 entity.

[12] The European Union and its Member States are accounted for 1 entity.

Figure 27. Carbon price applying to the steel sector – Number of steel producing countries covered and related maximum share of global capacity and production

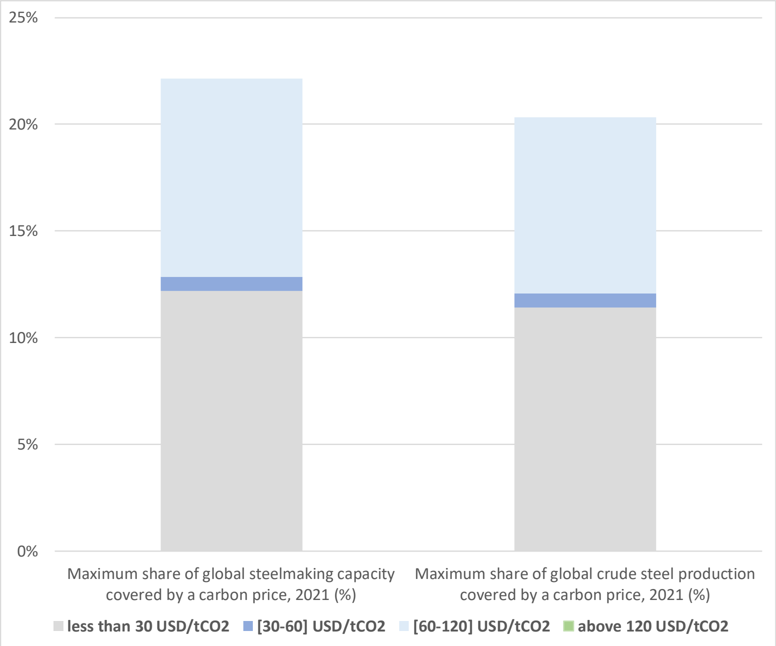


Note: Steel producing countries accounted involve carbon taxes or Emissions Trading Systems (ETS) that are implemented at full scale (not pilot stage).
The European Union and its Member States are accounted for 1 entity.
When carbon prices are not applied at the national level but at the subnational level, only the capacity of the related subnational jurisdiction is accounted.
Level of capacity/production subject to carbon price exemptions is not taken into account (maximum share).
Source: Calculations based on (The World Bank, 2022[34]), (ICAP, 2022[35]), (worldsteel, 2022[14]), (EUROFER, 2021[16]), (OECD, 2022[15]).

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

80. This trend is further reinforced when considering the level of price applied (Figure 28). In particular, none of the carbon prices accounted above reached the threshold of USD 120 per tonne of CO_2. 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[36]). Even by selecting a threshold of USD 60 per tonne of CO_2 (which would be consistent with a net-zero pathway by 2060 (OECD, 2021[36])), it is still less than 10% of global steelmaking capacity and production that is subject to such a price level.

Figure 28. Maximum share of global capacity and production covered by a carbon price – Price breakdown



Note: Level of capacity/production subject to carbon price exemptions is not taken into account (maximum share).
Thresholds of 30, 60 and 120 USD/tCO_2 reflect the alignment with various decarbonisation scenarios, see (OECD, 2021[36]).
Source: Calculations based on (The World Bank, 2022[34]), (ICAP, 2022[35]), (worldsteel, 2022[14]), (EUROFER, 2021[16]), (OECD, 2022[15]).

81. The risk of loss of 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.

9. Conclusion

82. With global capacity expected to increase for the fourth year in a row, **excess capacity continues to be a significant challenge for the global steel industry**. The structural imbalance affects steel prices, steel companies' profitability margins, as well as the global playing field. Excess capacity weighs on various features needed for an efficient low-carbon transition, such as investments, innovation, or competition. In a context of deep transformation required for the steel industry to meet climate goals, tackling excess capacity is crucial **to foster decarbonisation**.

83. **Despite progress in a number of areas**, this steel decarbonisation indicator dashboard shows that the steel sector is **not on a trajectory compatible** with Paris Agreement objectives. So far, the response is not commensurate with the scale of the challenge, requiring a **90% of emission reduction** in steel production from 2020 levels by 2050.

84. **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 companies - the key drivers of steel production and of steel decarbonisation - have increasingly announced net-zero targets.

85. However, **there is a mismatch between countries and corporate commitments.** As of end 2021, **30%** of global steel production was subject to net-zero targets at the company level. This share has doubled over the last year, though more commitments would help reduce the mismatch even more.

86. **Beyond the pledges, near zero emission steel production has not yet taken off sufficiently.** Production routes compatible with a near zero pathway account for **20%** of global output, away from the nearly 100% that would be required by 2050. Besides, this current share stems from **scrap based EAF** only. Although scrap based EAF plants can contribute to decarbonisation, reaching near zero emission needs a more structural shift that relies on **diverse production routes**.

87. **In terms of asset structure,** BOF plants account for **two-thirds** of global capacity. While this share is undeniably linked to past decades legacy of the steel industry, BOF capacity also represents more than half of the **newly planned capacity**. Such projects are not compatible with decarbonisation objectives if not equipped with CCUS. By adding new carbon intensive steelmaking plants, it further highlights the extent to which excess capacity may hinder the low-carbon transition.

88. The project pipeline of **innovative near zero emission technologies is promising** but faces a **low-level of industrial maturity.** Echoing corporate and countries 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.

89. 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, **none** of them have reached the level that would be required to be in line with a net-zero pathway by 2050.

90. 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, or social aspects. Envisioning a tailored approach to decarbonisation is equally essential towards implementation, in light of regional differences in steelmaking routes, access to resources, or the variety of company profiles.

91. Likewise, addressing structural issues such as **global excess capacity** is crucial for steel companies to be able to sustain this transformation.

92. Excess capacity and steel decarbonisation are both **global challenges** requiring a global response. **Collaboration** among countries, as well as between public and private stakeholders, will be essential to **foster synergies and accelerate progress** towards a net-zero pathway. Equally, addressing excess capacity is critical to pave the way for a successful steel decarbonisation, ultimately meeting climate goals.

References

ADNOC (2022), *Energy for Environment Protection - Carbon Capture, Utilization, and Storage (CCUS) at Al Reyadah*, https://www.adnoc.ae/en/hse/environment-and-sustainability/energy-for-environment-protection (accessed on 24 June 2022). [27]

ArcelorMittal (2022), *ArcelorMittal acquires German steel scrap recycling businesses from Alba International Recycling*, https://corporate.arcelormittal.com/media/news-articles/arcelormittal-acquires-german-steel-scrap-recycling-businesses-from-alba-international-recycling# (accessed on 11 May 2022). [30]

ArcelorMittal (2022), *ArcelorMittal signs MoU with SNIM to evaluate the opportunity to jointly develop a pelletisation plant and DRI production plant in Mauritania*, https://corporate.arcelormittal.com/media/news-articles/arcelormittal-signs-mou-with-snim-to-evaluate-the-opportunity-to-jointly-develop-a-pelletisation-plant-and-dri-production-plant-in-mauritania (accessed on 25 May 2022). [31]

Baowu (2021), *China Baowu Initiated the Establishment of a Global Low-Carbon Metallurgical Innovation Alliance*, http://www.baowugroup.com/en/media_center/news_detail/221297 (accessed on 20 November 2021). [26]

Climate Action Tracker (2022), *Climate Action Tracker*, https://climateactiontracker.org/methodology/net-zero-targets/ (accessed on 8 July 2022). [12]

COP26 (2021), *COP26 - UK Presidency*, https://ukcop26.org/uk-presidency/ (accessed on 20 July 2022). [1]

COP27 (2022), *COP27 - Egyptian Presidency*, https://cop27.eg/en/egpresidency (accessed on 20 July 2022). [2]

E3G (2021), *Steel 1.5°C - DECARBONIZING THE STEEL SECTOR IN PARISCOMPATIBLE PATHWAYS*, https://9tj4025ol53byww26jdkao0x-wpengine.netdna-ssl.com/wp-content/uploads/1.5C-Steel-Report_E3G-PNNL-1.pdf (accessed on 24 May 2022). [23]

EUROFER (2021), *EUROPEAN STEEL IN FIGURES 2021*, https://www.eurofer.eu/assets/publications/brochures-booklets-and-factsheets/european-steel-in-figures-2021/European-Steel-in-Figures-2021.pdf (accessed on 28 June 2022). [16]

Global Energy Monitor (2022), *Global Steel Plant Tracker*, https://globalenergymonitor.org/projects/global-steel-plant-tracker/summary-tables/ (accessed on 24 July 2022). [20]

Global Energy Monitor, Caitlin Swalec, Christine Shearer (2021), *Pedal to the Metal : No Time To Delay Decarbonizing The Global Steel Sector*, https://globalenergymonitor.org/wp-content/uploads/2021/06/Pedal-to-the-Metal.pdf (accessed on 20 December 2021). [13]

Hasanbeigi, A. (2022), *Steel Climate Impact - An International Benchmarking of Energy and CO2 Intensities*, https://www.globalefficiencyintel.com/steel-climate-impact-international-benchmarking-energy-co2-intensities (accessed on 6 June 2022). [17]

Iberdrola (2021), *Iberdrola and H2 Green Steel sign 2.3 billion euros green hydrogen deal*, https://www.iberdrola.com/press-room/news/detail/deal-green-hydrogen-iberdrola-h2-green-steel (accessed on 1 December 2021). [33]

ICAP (2022), *International Carbon Action Partnership*, https://icapcarbonaction.com/en/ (accessed on 16 June 2022). [35]

IEA (2022), *Achieving Net Zero Heavy Industry Sectors in G7 Members*, https://iea.blob.core.windows.net/assets/c4d96342-f626-4aea-8dac-df1d1e567135/AchievingNetZeroHeavyIndustrySectorsinG7Members.pdf (accessed on 22 June 2022). [21]

IEA (2021), *Direct CO2 intensity of steel production in the Net Zero Scenario, 2018-2030*, https://www.iea.org/data-and-statistics/charts/direct-co2-intensity-of-steel-production-in-the-net-zero-scenario-2018-2030 (accessed on 19 April 2022). [6]

IEA (2021), *Industry direct CO2 emissions in the Net Zero and Announced Pledges scenarios, 2000-2030*, https://www.iea.org/data-and-statistics/charts/industry-direct-co2-emissions-in-the-net-zero-and-announced-pledges-scenarios-2000-2030 (accessed on 19 April 2022). [3]

IEA (2021), *Iron and steel final energy demand and energy intensity in the Net Zero Scenario, 2018-2030*, https://www.iea.org/data-and-statistics/charts/iron-and-steel-final-energy-demand-and-energy-intensity-in-the-net-zero-scenario-2018-2030 (accessed on 19 April 2022). [7]

IEA (2021), *Net Zero by 2050*, https://www.iea.org/reports/net-zero-by-2050 (accessed on 15 December 2021). [10]

IEA (2021), *Steel production by share of different process routes in the Net Zero Scenario, 2018-2030*, https://www.iea.org/data-and-statistics/charts/steel-production-by-share-of-different-process-routes-in-the-net-zero-scenario-2018-2030 (accessed on 10 December 2021). [22]

IEA (2021), *World Energy Outlook 2021*, https://www.iea.org/reports/world-energy-outlook-2021 (accessed on 15 December 2021). [4]

IEA (2020), *Energy Technology Perspectives*, https://iea.blob.core.windows.net/assets/7f8aed40-89af-4348-be19-c8a67df0b9ea/Energy_Technology_Perspectives_2020_PDF.pdf (accessed on 24 June 2022). [28]

IEA (2020), *Iron and Steel Technology Roadmap*, https://www.iea.org/reports/iron-and-steel-technology-roadmap (accessed on 15 December 2021). [8]

IPCC (2022), *Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, https://doi.org/doi: 10.1017/9781009157926 (accessed on 8 June 2022). [9]

IRENA (2022), *Geopolitics of the Energy Transformation - The Hydrogen Factor*, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Jan/IRENA_Geopolitics_Hydrogen_2022.pdf (accessed on 20 May 2022). [29]

MPP (2021), *Net-Zero Steel Sector Transition Strategy*, https://missionpossiblepartnership.org/wp-content/uploads/2021/10/MPP-Steel-Transition-Strategy-Oct-2021.pdf (accessed on 23 May 2022). [24]

Net Zero Steel (2021), *Global Facility Level Net-Zero Steel Pathways*, http://netzerosteel.org/wp-content/uploads/pdf/net_zero_steel_report.pdf (accessed on 24 May 2022). [25]

OECD (2022), *Latest developments in steelmaking capacity*. [15]

OECD (2021), *Effective Carbon Rates 2021*, https://stats.oecd.org/?datasetcode=ecr (accessed on 11 July 2022). [36]

Statkraft (2022), *H2 Green Steel partners with Statkraft for 14 TWh of renewable electricity*, https://www.statkraft.com/newsroom/news-and-stories/archive/2022/statkraft-signs-ppa-with-h2-green-steel/ (accessed on 8 June 2022). [32]

The World Bank (2022), *Carbon Pricing Dashboard*, https://carbonpricingdashboard.worldbank.org/map_data (accessed on 16 June 2022). [34]

Vogl, V. (2021), *Green Steel Tracker, Version 11/2021*, https://www.industrytransition.org/green-steel-tracker/ (accessed on 25 November 2021). [18]

World Resources Institute (2020), *Climate Watch - Net Zero Tracker*, https://www.climatewatchdata.org/net-zero-tracker (accessed on 8 July 2022). [11]

worldsteel (2022), *2021 Top steel-producing companies*, https://worldsteel.org/wp-content/uploads/2020_2021-top-steel-producers_tonnage.pdf (accessed on 26 July 2022). [19]

worldsteel (2022), *2022 World Steel in Figures*, https://worldsteel.org/wp-content/uploads/World-Steel-in-Figures-2022.pdf (accessed on 28 June 2022). [14]

worldsteel (2021), *2021 World Steel in figures*, https://www.worldsteel.org/en/dam/jcr:976723ed-74b3-47b4-92f6-81b6a452b86e/World%2520Steel%2520in%2520Figures%25202021.pdf (accessed on 20 December 2021). [5]