IMPACT ASSESSMENT REPORT

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Executive summary

Green steel can be achieved through various technological pathways, some of which may be more suitable for specific producers and regions, depending on local factors related to energy infrastructure and demand. EU policy has an important role to play in the decarbonisation of the steel industry. Nevertheless, member state environmental, energy and industrial policies can also affect the prospects for certain industrial decarbonisation pathways. In the long term, some decarbonisation technologies may end up being more successful and competitive than others. This summary examines some of the most promising policy options that can support the technological pathways[1] and leverage the funding opportunities[2] identified in the project.

It includes policy options directly linked to specific technologies, such as green hydrogen, CCUS, renewables and scraps, but also options related to specific policy strategies such as carbon pricing – which is strengthened by the EU's Fit-for-55 package – and funding, which applies horizontally across the policy areas. Some options aim to address specific problems related to the individual technologies, while others could support industrial decarbonisation or emission reductions more generally. A number of cross-cutting policy options that can contribute to all policy areas have also been identified.

Below, the **six policy areas (funding, carbon pricing, renewable electricity, green hydrogen, CCUS, scraps)** are discussed separately, covering the specific policy problems, policy objectives, and policy options as well as the expected results from the most promising options.

1. Funding

The general problem for funding is the limited amount of funding flowing towards decarbonisation technologies in the steel industry. This does not necessarily mean there is an insufficient amount of potential funding, but rather that the business case for individual transformational investments in (costlier) green steelmaking production capacity is still missing.

Specifically, the funding challenges of green steel are also rooted in the – as of yet – higher costs of green steelmaking, both with regard to CAPEX and OPEX. In addition, green steelmaking technologies are unproven at scale (although there is rapid progress in some technologies, such as hydrogen-based steelmaking) and therefore carry greater risk. While some public funding is available to be invested in emission reduction technologies for the industrial sectors, they are not sufficient considering the transformational investment needs. Moreover, funding is especially required to fill the gap between R&D and commercial deployment at scale. Investments will also depend on there being a market for green steel specifically.

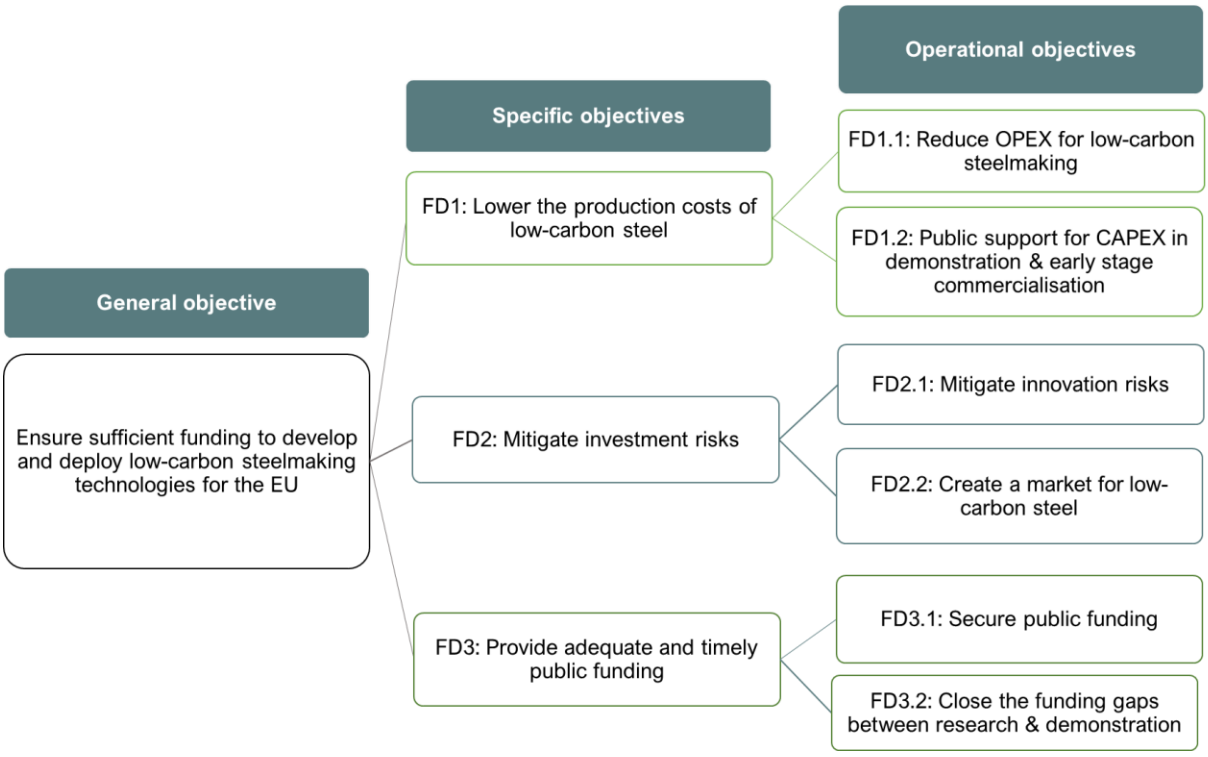
Green steel funding should, therefore, cover a wide range of drivers that lead to an increase in costs and investment needs. This includes new low-carbon production plants that replace existing blast

[1] See Work Package 1 of GreenSteel
[2] See Work Package 2 of GreenSteel

furnaces, as well as low-carbon energy sources and infrastructure (e.g. hydrogen and CCUS). While public funding is inevitable to a degree, private funding would ideally constitute the biggest share of green steel investments. However, the market conditions for green steel will be a key driver for such private investment. The risk of carbon leakage can negatively impact it all. Competition from non-EU producers that face lower carbon costs can deter investments in green steel. Policy interventions aimed at creating a market – for example through green public procurement (GPP) – can, nevertheless, improve the business case for such green steel investments. However, knowledge about green steel, and demand for it, should be present throughout the whole steel value chain.

There are also several challenges related to combining various public and private funding mechanisms to ensure that their impact is maximalised. It is not always possible to blend different sources of funding, even if that would increase the impact. Furthermore, steel investments have long lead times and require lengthy financial commitments, even if some funding instruments operate on shorter-term project bases. Furthermore, in the wake of the Covid-19 pandemic, the capacity of member states to provide funding (i.e. State aid) may be constrained due to budgetary pressure.

Figure 1: Policy objectives of funding (FD) for decarbonisation technologies in the EU steel industry



Source: Authors' own composition.

The objectives of funding policies are threefold in light of the above problems: the production costs of green steel need to decrease (specific objective FD1), investment risks should be mitigated (specific objective FD2), and funding should be aligned with the needs of the steel industry in terms of timing

and scale (specific objective FD3) (see Figure 1). Some problems require specific and dedicated solutions.

- To address the greater OPEX costs of green steel, the use of EU funding programmes such as the ETS innovation fund is recommended. The large CAPEX requirement cannot be fully covered with public funds, it therefore requires the mobilisation of private funds (see specific objective FD1).
- Public support could also go beyond direct funding, using tools such as risk mitigation instruments and loan guarantees to lower capital costs. Besides 'technology-push' measures, policies that result in 'demand-pull' for green steel are also important. These measures, such as GPP, green labels and standards, are not classic funding instruments but can nevertheless address some of the gaps in the current steel investment landscape. In fact, these three policy tools can often address multiple policy objectives at once, going beyond funding goals. They are therefore also reviewed separately as cross-cutting policy options, together with the impact of higher carbon prices and carbon contracts for differences (CCfDs) (see specific objective FD2).
- Finally, synergies between funding instruments are important. Initiatives such as the Clean Steel Partnership (CSP) can play an important role here, as well as coordination instruments such as the Important Projects of Common European Interests (PCEIs), as they could target technologies that enable green steelmaking (as is already happening with hydrogen) or the steel value chain as a whole (see specific objective FD3).

Table 1: Overview of policy solutions[3] – Funding

	Effectiveness	**Efficiency**	**Feasibility**	**Coherence**
Option FD1: promoting the use EU funding programmes to finance OPEX of low-carbon steel				
Option FD2: mobilising private funding to support CAPEX of decarbonisation technologies				
Option FD3: ensuring public support for CAPEX beyond direct public funding				
Option FD4: introducing risk mitigation and loan guarantee instruments for investments in decarbonisation technologies				
Option FD8: ensuring that EU resources will support the green transition in the steel industry				
Option FD9: identifying pathways (2030 & 2050) for decarbonisation technology routes and ensuring that EU & national policy makers account for them				
Option FD10: creating synergies in EU level funding via the Clean Steel Partnership				

[3] Policy options FD3-5 have not been included in this overview as these options are assessed in the cross-cutting policy chapter

Option FD11: creating additional synergies in EU level funding via blending & sequencing of different opportunities				
Option FD12: establishing an IPCEI for low-carbon steel				

Note: This table presents the policy options in the funding area that would support the decarbonisation of the EU steel industry. The options are assessed based on the four criteria under the Better Regulation guidelines: their effectiveness, efficiency, feasibility and coherence. Colour legend: orange - low, yellow – moderate, green – high. For instance, a policy option that has a green cell in the Effectiveness column is considered to be "highly" effective. Source: CEPS (2021)

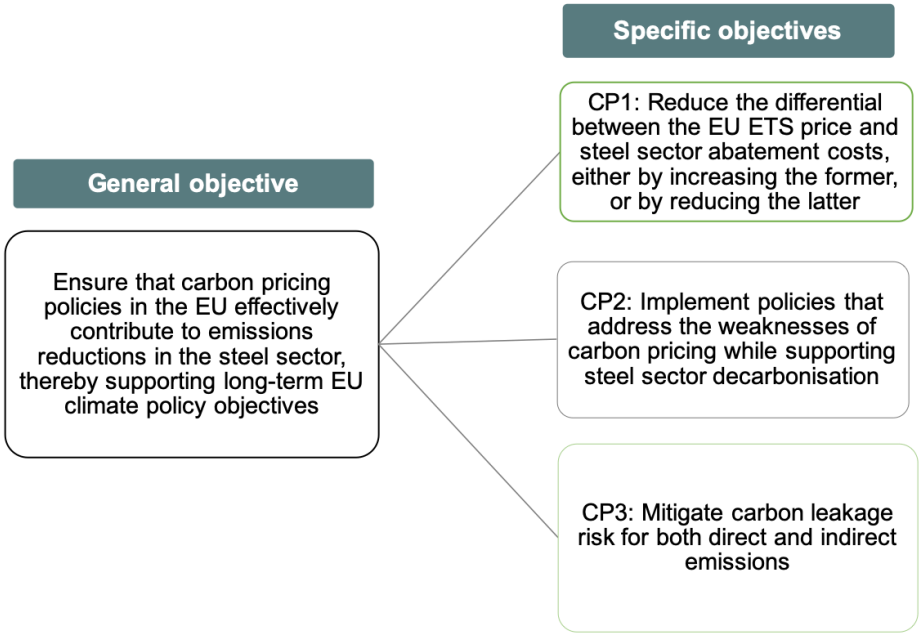
2. Carbon pricing

The EU's main carbon pricing policy – the EU ETS – also applies to steel sector emissions. However, the EU ETS is insufficient, on its own, to fully decarbonise the sector. This is partly because carbon prices are too low compared to the abatement costs in the steel sector, but also because there are other economic and non-economic barriers to the deep decarbonisation of energy-intensive industries that make carbon pricing on its own insufficient. In addition, the steel sector is considered at risk of carbon leakage, which may deter private investment in climate-neutral technology.

Several specific issues hinder the ability of the EU ETS to contribute to the decarbonisation of the steel sector. The supply of allowances in the ETS is relatively rigid, even if it has become more responsive to fluctuations in demand after the introduction of the Market Stability Reserve. Demand is more volatile, however, which has led to supply-demand imbalances in the ETS, and with it, to carbon price volatility. This volatility undermines predictability and deters investment. While the ETS price increasingly reflects future scarcity, this is insufficient, in the short term, to drive the investments the steel sector requires. The long lead times of the steel sector's investments exacerbates this issue. Furthermore, so long as the market for green steel remains limited, private investments may likewise lag.

The risk of carbon leakage can hinder the effectiveness of carbon pricing not just because of the purported threat to competitiveness, but also because of the measures that are taken to mitigate said carbon leakage risk. Free allocation can support the bottom line of steel companies, but it also dampens the carbon price signal. The suggested alternative, i.e. the carbon border adjustment mechanism (CBAM), can have many different designs, each with significant impacts on investment signals and competitiveness. Beyond direct carbon costs, the carbon leakage risk may also arise through indirect costs, i.e. higher energy prices (mostly for electricity) due to the pass-through of the carbon price in energy prices. Finally, the competitiveness of the steel industry is affected by many more (global) factors beyond climate policy. This too, will affect the capacity and willingness to invest in green steelmaking.

*Figure 2: **Policy objectives on carbon pricing (CP) to decarbonise the EU steel sector***



Source: Authors' own composition.

The general objective of policy interventions should be to make carbon pricing contribute effectively to the steel sector's decarbonisation. To achieve that, the carbon pricing instruments themselves could be strengthened, but, as an alternative, policies that reduce abatement costs in the steel sector could be implemented instead. Once abatement costs are lower and green steelmaking is more competitive, the impact of a carbon price signal increases. Some additional policies that address the inherent weaknesses of carbon pricing are nevertheless recommended. This includes, for example, demand-side policies that can support an increased market for green steel. Finally, the carbon leakage risk should be mitigated for both direct and indirect carbon costs. However, mitigating carbon leakage risk is not always the same as supporting industrial competitiveness, and vice versa.

The most promising policy option is the introduction of CCfDs. CCfDs specifically address a key weakness of current carbon pricing policies in the EU: carbon prices are too volatile and too low to trigger investments in green steel. By agreeing on a 'strike price' that would enable a producer to invest in green steelmaking capacity, a variable subsidy could be agreed. CCfDs work in tandem with the EU ETS: if the carbon price gets closer to the agreed strike price, the subsidy payments can be lowered.

In general, policies (such as public investments) aimed to lower the steel sector's abatement costs would be effective, as the ETS price level at which carbon-intensive steelmaking would be discouraged and made less competitive will decrease as well. The CBAM can also make investments in green

steelmaking more attractive, although much depends on the design of the mechanism and what happens to existing free allocation.

Table 2: Overview of policy solutions[4] – Carbon pricing

	Effectiveness	Efficiency	Feasibility	Coherence
Option CP1: adopting a hybrid MSR design				
Option CP2: reducing steel sector abatement costs				
Option CP5: introducing CCfDs				
Option CP6: implementing a CBAM				
Option CP7: introducing a separate industrial competitiveness policy for the steel industry				

Note: This table presents the policy options in the carbon pricing area that would support the decarbonisation of the EU steel industry. The options are assessed based on the four criteria under the Better Regulation guidelines: their effectiveness, efficiency, feasibility and coherence. Colour legend: orange - low, yellow – moderate, green – high. For instance, a policy option that has a green cell in the Effectiveness column is considered to be "highly" effective. Source: CEPS (2021)

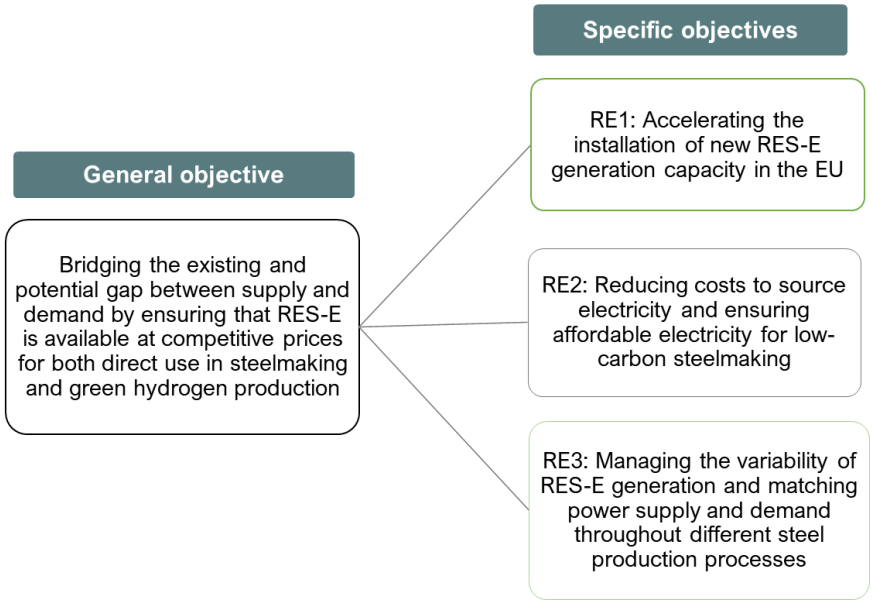
3. Renewable electricity

Renewables can contribute to the decarbonisation of the steel industry in two ways: directly, using electricity to power electric arc furnaces; or indirectly, due to electrification through hydrogen-based steelmaking. In both cases, vast additional volumes of renewables are needed, ranging up to 400TWh by 2050 (up from 55TWh today – which is a little more than Romania's total annual electricity demand). The general problem is therefore the gap between demand and supply of renewable electricity (RES-E) for the steel industry. There are three specific reasons for this gap:

- the first is the insufficient installed capacity of renewables – a challenge for the whole economy, as electrification and renewables are the preferred decarbonisation option in many sectors. Volatile and occasionally low electricity prices can, nonetheless, deter further investment in renewables deployment. In addition, the deployment of some RES-E projects is sometimes hindered by administrative or local barriers;
- the second is increasing network costs and unharmonized rules on RES-levies for the industry, which affect industrial power prices and can also deter investment. Furthermore, indirect carbon costs are compensated unequally, while Power Purchase Agreements (PPA) may also have divergent rules across MS;
- the third is the inherent variability of renewable electricity, which is a challenge per se. To this end, increased investments in electricity storage and balancing, or in demand-side responses are needed.

[4] Policy options CP3 and CP4 have not been included in this overview as these options are assessed in the cross-cutting policy chapter

Figure 3: Policy objectives on the availability of RES-E (RE) to decarbonise the EU steel sector



Source: Authors' own composition.

The EU's policy interventions to bridge the gap between RES-E supply and demand from the steel sector can be supported by: (i) accelerating the installation of new RES-E generation capacity; (ii) reducing costs to source electricity and ensuring affordable electricity for green steelmaking, and (iii) managing the variability of RES-E generation and matching power supply and demand in steelmaking.

The proposed policy options would affect the availability of RES-E for the steel industry by facilitating RES-E investments (through funding, better permitting rules, better rules on PPAs) and addressing the variability of RES-E supply (through an increase in RES-E storage capacity and better balancing services). EU policies can also lead to lower energy costs for the EU steel industry through a lower levelized cost of electricity (LCOE) of RES-E, improved mechanisms for indirect carbon costs, updated rules on demand-response measures and PPAs. The most promising policy interventions are to continue to financially support RES-E technologies, support PPAs and green energy offers (e.g. a reformed guarantees of origin system), and to improve the availability of energy storage solutions.

Table 3: ***Overview of policy solutions – Renewable electricity***

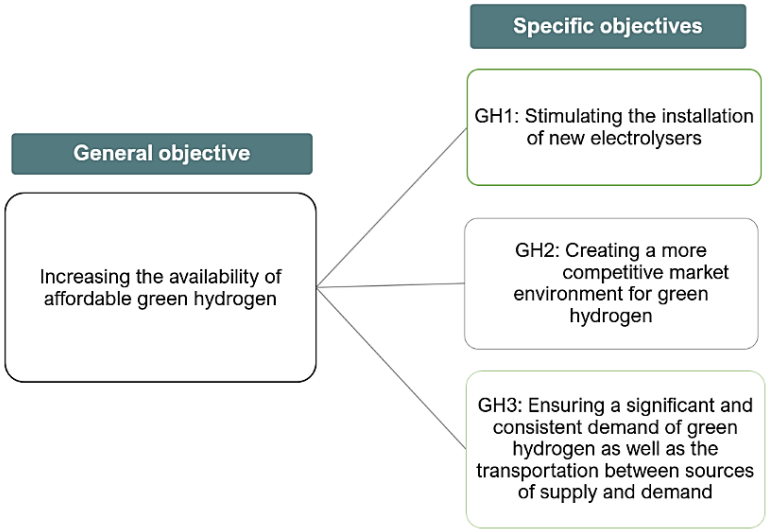
	Effectiveness	Efficiency	Feasibility	Coherence
Option RE1: EU funding for RE technologies				
Option RE2: EU guidelines on permitting process for RE projects				
Option RE3: compensation of indirect emission costs				
Option RE4: EU guidelines on demand-response measures				
Option RE5: PPAs or green energy offers				
Option RE6: balancing and shaping costs in national markets				
Option RE7: policies on energy storage				

Note: This table presents the policy options in the energy area that would support the decarbonisation of the EU steel industry. The options are assessed based on the four criteria under the Better Regulation guidelines: their effectiveness, efficiency, feasibility and coherence. Colour legend: orange - low, yellow – moderate, green – high. For instance, a policy option that has a green cell in the Effectiveness column is considered to be "highly" effective. Source: CEPS (2021)

4. Green hydrogen

Green hydrogen – i.e. hydrogen produced through electrolysis powered by RES-E – can be used in certain green steelmaking pathways. Today, however, there is only limited availability of green hydrogen, nor is it competitively priced. This limited availability of green hydrogen is driven by a limited production capacity, i.e. lack of installed electrolyser capacity. The technological readiness of electrolysers running on variable electricity is still improving, therefore funding and projects may be risky and low in number. In addition, green hydrogen is not the only type of hydrogen, nor even the only type of hydrogen that can deliver significant emissions reductions. Green hydrogen, therefore, needs to compete with these other hydrogen types such as blue and grey hydrogen, which for now are more cost-competitive. Finally, there is a poor link between the supply and demand for green hydrogen. The use of green hydrogen in the steel industry requires significant capital investments in production facilities that can produce steel this way. Furthermore, infrastructure is required to match supply and demand.

Figure 4: Policy objectives on availability of green hydrogen (GH) to decarbonise the EU steel sector



Source: Authors' own composition.

To increase the availability and competitiveness of green hydrogen, EU policies should foster the installation of new electrolyser capacity, create a more competitive market environment for green hydrogen specifically and support a wider demand for green hydrogen as well as the infrastructure to transport it.

The most promising policy options to support green hydrogen availability are a more widespread availability of CCfDs to green hydrogen producers and a wider support to MS initiatives – in particular through State aid guidelines. EU funding support for electrolysis and investment in transport infrastructure can also be worthwhile options.

*Table 4: **Overview of policy solutions – Green hydrogen***

	Effectiveness	Efficiency	Feasibility	Coherence
Option GH1: supporting MS initiatives				
Option GH2: providing financing for electrolysers at EU level				
Option GH3: improving the GOs framework				
Option GH4: offering a premium such as CCfDs				
Option GH5: financial support for hydrogen transport infrastructure				

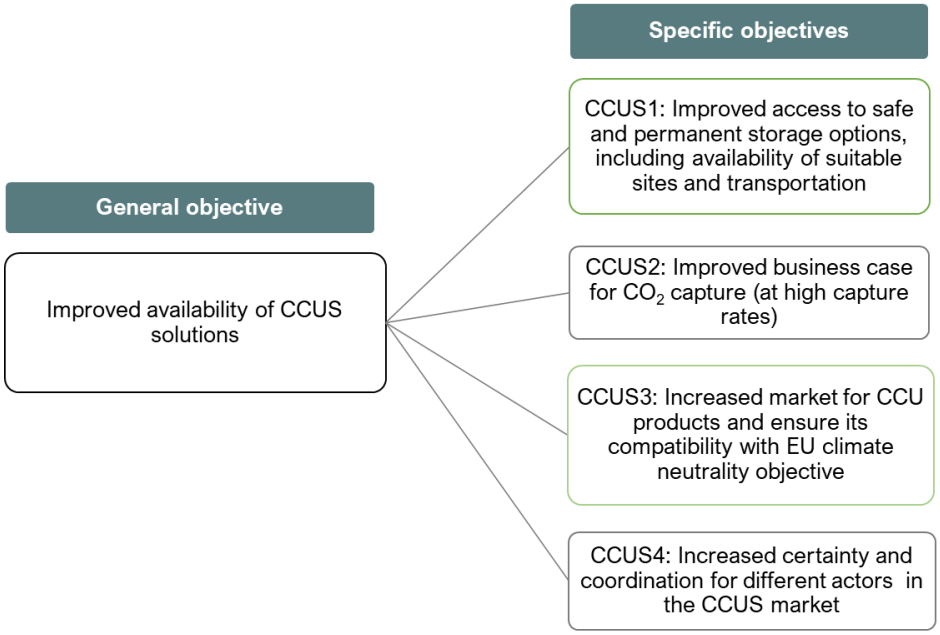
Note: This table presents the policy options in the green hydrogen area that would support the decarbonisation of the EU steel industry. The options are assessed based on the four criteria under the Better Regulation guidelines: their effectiveness, efficiency, feasibility and coherence. Colour legend: orange - low, yellow – moderate, green – high. For instance, a policy option that has a green cell in the Effectiveness column is considered to be "highly" effective. Source: CEPS (2021)

5. Carbon capture and use or storage (CCUS)

CCUS provides another technological pathway for the steel sector's decarbonisation. While CCUS has been deployed at small scale throughout the world, there is not yet widespread deployment of CCUS infrastructure, especially as part of industrial clusters. The specific reasons for this limited availability of CCUS solutions for the steel industry are related to the individual parts of the CCUS value chain: (i) CO2 storage sites are not yet available; (ii) CO2 capture is energy-intensive, faces challenges with capture rates and is costly, and (iii) many use-cases for CO2 (CCU) are incompatible with climate neutrality. In addition, there are also cross-chain issues, such as the underinvestment in CO2 transport infrastructure so long as CO2 capture and storage remain limited.

The different parts of the CCUS value chain are often interdependent, which raises coordination challenges. CO_2 purity levels, expected volumes, or the availability of other low-carbon infrastructures may all affect the choices of other decision-makers in the value chain. To improve the availability of CCUS solutions for the steel industry, EU policies should: (i) target an improved access to safe CO_2 storage sites; (ii) improve the business case for CO_2 capture at high capture rates; (iii) develop a market for CCU products that is compatible with climate neutrality, and (iv) support coordination efforts along the value chain.

Figure 5: Policy objectives on availability of CCUS solutions to decarbonise the EU steel sector



Source: Authors' own composition.

The most promising policy options are to provide increased public funding for R&D to optimise CO_2 capture rates; foster the use of climate-neutral CCU applications under the EU ETS; provide a coordination platform; and focus public support on entire industrial clusters, as CCUS solutions could provide decarbonisation options for (industrial) sectors beyond the steel sector, thereby increasing the efficiency of decarbonisation efforts.

Table 5: Overview of policy solutions[5] – CCUS

	Effectiveness	Efficiency	Feasibility	Coherence
Option CCUS2: supporting other CO_2transport methods beyond pipelines, as well as recognising and promoting negative emissions technologies in ETS				
Option CCUS3: providing funding (CAPEX and OPEX) for CO_2 storage and transport infrastructure				
Option CCUS5: providing increased public support and funding for R&D&I to optimise capture at high rates				
Option CCUS6: promoting the use of climate-neutral CO_2				
Option CCUS7: providing a platform where different actors in the value chain meet and coordinate				
Option CCUS8: supporting clusters/industrial symbiosis				

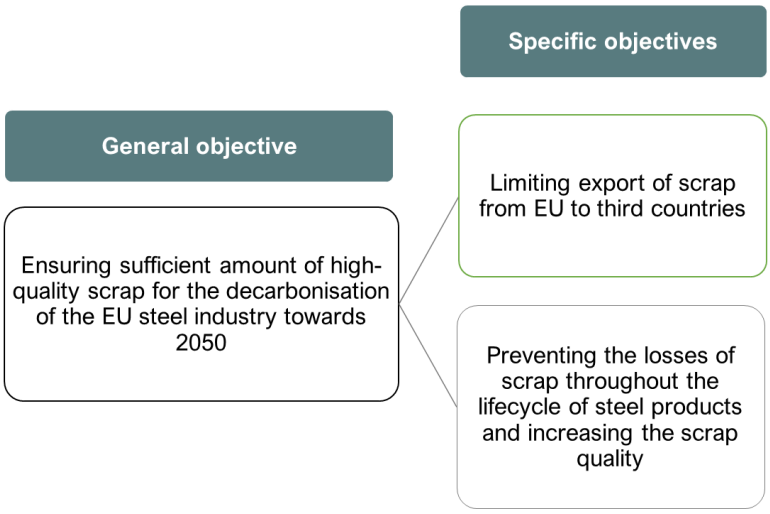
Note: This table presents the policy options in the CCUS area that would support the decarbonisation of the EU steel industry. The options are assessed based on the four criteria under the Better Regulation guidelines: their effectiveness, efficiency, feasibility and coherence. Colour legend: orange - low, yellow – moderate, green – high. For instance, a policy option that has a green cell in the Effectiveness column is considered to be "highly" effective. Source: CEPS (2021)

6. Iron and steel scraps

Increasing the reuse of ferrous scrap in steel production is effective in reducing CO2 emissions from steelmaking. However, the EU steel industry can count on only limited amounts of steel scrap, particularly high-quality scrap for steelmaking with electric arc furnaces (the EAF route). There are two reasons for this: the first one is that a large share of steel scrap generated in the EU is exported to third countries, first of all because scrap processing in third countries costs less, and secondly because scrap prices there are high enough to cover transport costs. The second reason is that steel scrap is lost during the steel's life cycle and end-of-life scrap contains high level of impurities that reduce the quality of steel produced in the EAF route.

[5] Options CCUS1 and CCUS4 have not been included in this overview as these options are assessed in the cross-cutting policy chapter

Figure 6: Policy objectives on the availability of steel scrap in the EU



Source: Authors' own composition.

Policy measures should therefore ensure the availability of a sufficient amount of high-quality scrap in Europe, either through limiting the export of scrap to non-EU countries or preventing the loss of steel throughout the use cycle and increasing the scrap quality. The most promising policy options could have positive impacts on increasing the quality of steel scrap for EU steelmakers through promoting the use of best available technologies (BATs) and fostering innovation of scrap refining solutions. Reducing illegal scrap export, or increasing the recyclability of steel-contained products, can also be useful means to increase the availability of steel scrap in the EU.

Table 6 ***Overview of policy solutions – Iron and steel scrap***

	Effectiveness	Efficiency	Feasibility	Coherence
Option SC1: revision of the EU regulatory framework on scrap exports				
Option SC2: improving the quality of scrap available in the EU				
Option SC3: ensuring that final products are recyclable				

Note: This table presents the policy options linked to steel scrap that would support the decarbonisation of the EU steel industry. The options are assessed based on the four criteria under the Better Regulation guidelines: their effectiveness, efficiency, feasibility and coherence. Colour legend: orange - low, yellow – moderate, green – high. For instance, a policy option that has a green cell in the Effectiveness column is considered to be "highly" effective. Source: CEPS (2021)

7. Cross-cutting policy options

Several policy options were identified separately in the individual chapters and are considered to have the potential to contribute to many different problem areas at the same time. These include GPP, labels for green steel, CCfDs, increased ETS scarcity and low-carbon standards. These options also represent policy approaches that could be applied to other industrial sectors as well – which often face similar decarbonisation challenges as the steel industry. As such, these options could constitute a particularly coherent set of policy measures to support the industrial dimension of the European Green Deal.

Increased ETS scarcity is a given with the Fit-for-55 package. A higher ETS price will further deter carbon-intensive steel production, and it may also support other policy proposals. A higher ETS price would reduce the subsidy payments made through CCfDs, while the latter could still provide crucial funding for specific green steel investments. The EU carbon price can also be used in GPP projects as a guiding factor for investments. Green labels could also support a market for green steel by making it easier for steel customers to choose climate-neutral products. Longer term, low-carbon standards could harmonise the playing field and protect EU producers of green steel, as such standards would apply to both domestic producers and importers.