



Guidelines and approaches for using funding in line with technological developments (Deliverable D2.5)

Monika Draxler, Axel Sormann (K1-MET)

Tobias Kempken, Thorsten Hauck (BFI)

Jean-Christophe Pierret, Jean Borlee (CRM)

Michele De Santis, Pietro Gimondo (CSM)

Vittorio Ratto, Eliana Streppa (CSM)

Almudena Gonzalez, Paula Queipo (IDONIAL)

Wojciech Szulc (IMZ)

Chuan Wang (SWERIM)

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List of abbreviations

AIE	Alkaline iron electrolysis
BF-BOF	Blast furnace-basic oxygen furnace
BFI	VDEh-Betriebsforschungsinstitut GmbH
BMWi	BundesMinisteriums für Wirtschaft und energie (German Federal Ministry for economic affairs and energy)
CCU	Carbon capture and utilisation
CCUS	Carbon capture usage or storage
CDA	Carbon Direct Avoidance
CEF	Connecting Europe Facility
CF	Cohesion Fund
COSCO	Coal and Steel Committee (of the RFCS)
CPR	Common provision regulation
CRM	CRM Group
CSA	Credit support annex
CSM	Rina Consulting – Centro Sviluppo Materiali S.p.A.
CSP	Clean Steel Partnership
DE	Digital Europe
EAF	Electric Arc Furnace
EAFRD	European agricultural fund for rural development
EBRD	European Bank for Reconstruction and Development
EC	European Commission
ECSC	European Coal and Steel Community
EFSI	European Fund for Strategic Investment
EGDIP	European Green Deal Investment Plan
EIC	European Innovation Council
EIB	European Investment Bank
ERC	European Research Council
ERDF	European Regional Development Fund
ESTEP	European Steel Technology Platform
EU ETS	European Union Emissions Trading System
EUROFER	European Steel Association
FCH JU	Fuel cells and hydrogen joint undertaking
GA	Grant agreement
GBER	General block exemption regulation
GHG	Greenhouse gases
GREENSTEEL	Green Steel for Europe
H2020	Horizon 2020
H ₂ -DR	Hydrogen-based direct reduction

HEU	Horizon Europe
HPSR	Hydrogen plasma smelting reduction
HYBRIT	Hydrogen breakthrough ironmaking technology
IBRSR	Iron bath reactor smelting reduction
IF	Innovation Fund
InnovFin	EU Finance for Innovators
IPCEI	Important projects of common European interest
JTM	Just Transition Mechanism
MF	Modernisation Fund
MISE	Italian Ministry of economic development
MOE	Molten oxide electrolysis
MS	Member states
MSCA	Marie Skłodowska-Curie Actions
MWIDE	North Rhine-Westphalian Ministry of Economic Affairs, Innovation, Digitisation and Energy
P4P	Process4Planet
PI	Process Integration
PPP	Public-private partnership
R&D&I	Research, development and innovation
R&I	Research and innovation
RFCS	Research Fund for Coal and Steel
RIES	Research Initiative for European Steelmaking
RP	Recovery Plan
SET-Plan	Strategic Energy Technology Plan
SME	Small and medium enterprises
SPIRE	Sustainable process industry through resource and energy efficiency
SustSteel	Sustainability for steel construction products mark
SWERIM	Metals Research Institute Swerim
TGA	Technical Group Acier
TRL	Technical readiness level

Executive summary

Huge investment in innovation and breakthrough technologies are crucial if the European steel industry is to meet EU climate and energy targets, boost its competitiveness and give stakeholders a ‘first-mover’ advantage on the global scene.

This report provides **guidelines to EU and national policymakers and industry players** on how to harness existing and forthcoming funding opportunities to decarbonise the EU steel industry and achieve the EU energy and climate targets. The guidelines are developed based on the main findings of the report on Funding Opportunities to Decarbonise the EU Steel Industry¹.

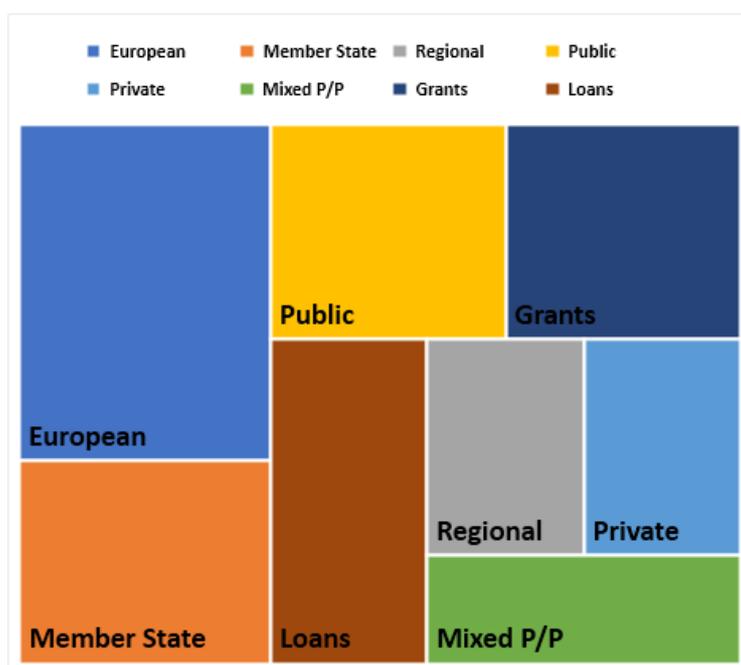
D2.4 finds that the financial support relevant to the steel sector consists of **25 EU programmes** (19 public and 6 private), **24 private funding opportunities** (mainly from banks, including both conventional instruments and green bonds; 13 with specific tables) and **81 national and regional instruments** (from 11 countries). All the main relevant financial instruments are analysed based on the information currently available, including blending and sequencing options, to enable a global view of funding to reach the 2050 European zero greenhouse gases (GHG) emission target. Findings of the Funding Opportunities to Decarbonise the EU Steel Industry report and the Investment Needs report² also show that the support ensured by the **funding programmes dedicated to the investment needs of the EU steel industry is currently not sufficient**. Considering the significance and key role of the European emissions reduction target for future generations and the high impact of the steel industry on overall CO₂ emissions, an enormous effort is required from steel stakeholders.

To achieve the challenging CO₂ reduction objectives, a strong collaboration and joint commitment of the private and public sector are needed at EU, national and regional level (see Figure 1).

¹ Deliverable D2.4 of the ‘Green Steel for Europe project’- GREENSTEEL

² Deliverable D2.2 of GREENSTEEL

Figure 1 - Main funding elements of the blending framework



Source: authors' own compilation.

At **European level**, the following synergies of funding programmes are suggested:

- Combining Research Fund for Coal and Steel (RFCS) and Horizon Europe (HEU). To better achieve the synergies at European level, three options could be considered:
 - Combining HEU and RFCS funds and assets under the same Clean Steel Partnership (CSP) call for proposals (the so-called 'one-stop shop approach') to ensure synergies at European level;
 - Presenting the call as a single package (the so-called 'single package approach'); and
 - Publishing at least (RFCS and HEU) CSP calls with the same deadline.
- Combining RFCS and HEU with the Innovation Fund (IF):
 - HEU and IF: HEU can support innovation up to the pilot phase and IF can support innovation in the demonstration and scale-up phases;
 - RFCS and IF: RFCS can support innovation for the research phase and up to the pilot and demonstration phase, and IF can support innovation for the scale-up phase.
- Combining RFCS and HEU with LIFE program:
 - HEU and LIFE: the EU is now working to provide more support through the LIFE Climate Action financial instrument to have a basis for a larger number of projects.
 - RFCS and LIFE: the LIFE Climate Action sub-programme supports projects to develop innovative ways to respond to the challenges of climate change in Europe. In particular, one of the main objectives of the sub-programme is to contribute to the shift towards a low-carbon and climate-resilient economy. Importantly, this objective can be reached through synergies with the RFCS.
- Combining RFCS and HEU with IPCEI:

- Member states, the EU steel industry and other actors (under the supervision of the CSP) could explore the possibility to table a proposal for setting up an IPCEI on Green Steel. This IPCEI would create a legal framework allowing the combination of EU, national, regional and private funding in compliance with state aid rules.
- In this respect, the European Commission may consider an ‘integrated project’, i.e. a group of single projects inserted in a common roadmap or programme aiming at the same objective and based on a coherent systemic approach. The individual components of the integrated project may relate to separate levels of the supply chain but must be complementary and necessary for the achievement of the important European objective.
- Combining HEU with ESIF:
 - Over the next budget cycle, the Cohesion Fund and the structural funds aim at supporting the green transition. In this respect, the combination of funding among HEU and ESIF for ambitious industrial projects is especially concerning. In this report an extensive analysis of this two instruments’ combination, an overview of the differences between H2020 and structural funds and finally, on the practical side, a real industrial case of combination between ESIF and EIB loans are presented.

Synergies and blending of funding program at national and regional level is also necessary to achieve the abovementioned objectives. Current national and regional instruments are often insufficiently coordinated in terms of their scope, timeline and funding availability. Since there are potentially €800 M available from national and regional instruments to support the CO₂ emissions reduction in the steel sector for the period 2021-22³ in the 11 EU countries considered, full knowledge of those instruments is needed to create synergies with the EU instruments. In this case, the general aim is to establish formal and informal mechanisms of cooperation with member states to create additional synergies with national and regional policies and programmes.

Finally, **synergies at project level** can be achieved through a combination of:

- funding related to the same project idea;
- inter-related or successive projects,
- parallel projects;
- projects at different Technology Readiness Levels (example of 'vertical' synergies in Table 1).

Table 1 - Synergies among projects in terms of Technology Readiness Level (TRL)

TRL	Funding instrument
TRL 1 – Basic principles observed	HEU, RFCS, regional funds
TRL 2 – Technology concept formulated	HEU, RFCS, regional funds
TRL 3 – Experimental proof of concept	HEU, RFCS, regional funds
TRL 4 – Technology validated in lab	HEU, RFCS, regional funds
TRL 5 – Technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)	HEU, RFCS, IF
TRL 6 – Technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)	HEU, RFCS, IF
TRL 7 – System prototype demonstration in operational environment	HEU, RFCS, IF
TRL 8 – System complete and qualified	HEU, InvestEU
TRL 9 – Actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies)	HEU, InvestEU

Source: authors' own compilation.

From the analysis of private instruments at European, national and regional level, including banking instruments, several **possible synergies between public and private** sectors have emerged:

- involvement of public and private investors to increase the total amount of financing available to projects as compared to support through grants only;
- greater and more extensive support to beneficiaries that may not be supported by a single grant at EU or national level, also considering state aid rules;

- risk reduction and bridging over the ‘innovation valley of death’; and
- higher alignment of company interests and the successful outcome of the project.

Several possible blending scenarios are shown in Table 2.

Finally, Table 3 evidences in a comprehensive way the possible synergies existing between the main European funding programmes, national and regional funding opportunities. While at European level the various programmatic resources can generally be combined (left side of the table), synergies between EU and national/regional instruments are generally not allowed, except for a small number of cases (right side of the table).

Besides suggestion for synergies of funding, the report also presents several ‘**success stories**’ - examples of funding instruments used by steel companies to support their decarbonisation technologies. Several examples of funding instruments used by the steel sector are EIB’s loan to Arcelor Mittal, Marcegaglia Group and Aperam; EIB, H2020 and national instrument’s financing and guarantee for Salzgitter AG; and the Swedish Energy Agency’s funding support for SSAB, LKAB and Vattenfall.

As a final comment, to reach the 2050 climate objectives, private and public funding must join forces within a consistent and coordinated framework. The steel industry and other stakeholders will need to cooperate to overcome the technological and economic challenges regarding the implementation of CO₂-low production technologies.

Table 2 - R&D&I funding instruments – Blending

	HEU	CSP	P4P	Clean Hydrogen for Europe	RFCS	Innovation Fund	LIFE	EGDIP calls	JTF	Erasmus+	ERA-NET	IPCEI	Recovery Plan	EIB	EBRD	InnovFin	InvestEU	Austria	Belgium	Finland	France	Germany	Italy	Luxembourg	Netherlands	Poland	Spain	Sweden		
HEU	Grey	Green	Green	Green	Green	Green	Green	Green	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	
CSP	Grey	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
P4P	Grey	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
Clean Hydrogen for Europe	Grey	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
RFCS	Grey	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
Innovation Fund	Grey	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
LIFE	Grey	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
EGDIP calls	Grey	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
JTF	Grey	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
Erasmus+	Grey	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
ERA-NET	Grey	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
IPCEI	Grey	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
Recovery Plan	Grey	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
EIB	Grey	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
EBRD	Grey	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
InnovFin	Grey	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
InvestEU	Grey	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
Private Banks	Grey	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red



Source: authors' own composition. Note: green: the project size is within the scope of the instrument; red: the project size is outside the scope of the instrument; and yellow: the instrument is still under discussion. More details in the Report.

Table 3 - Main financial instruments available to the steel sector by project size

	Project with funding <7.5 M€	Project funding between 7.5 and 100 M€	Project funding between 100-250 M€	Projects with funding > 250 M€
Horizon Europe (HEU) and related relevant PPPs (P4P, Clean Hydrogen)*	Pillar 2 calls to be published at the beginning of 2021.			
Clean Steel Partnership (CSP)	Expected calls in April/May 2021;			
Research Fund for Coal and Steel (RFCS)	Usual call every year; Average project dimension 1.5 M€ funding.			
Innovation Fund (IF)	IF small-scale instrument (no calls currently open. Calls expected to be launched on beginning 2021).	<ul style="list-style-type: none"> - Budget up to 150 M€ - Calls published on 3rd of July 2020. Deadline 29th October - At least 7.5 M€ CAPEX. - A single legal entity, as well as consortium, can apply. - Breakthrough projects; it is funded the innovation gap respect to conventional plant. - Maximum grant 60% of the relevant costs. - Payments against GHG emissions avoidance. - Cost incurred prior of the signature of the GA are not included in the calculation of the relevant cost. - IF grant is not considered to be State aid - A project that has received the IF support may also receive a contribution from any other Union programme. 		

European Green Deal (EGD) Calls	CSA projects starts from 2 M€	Topic Area 3 (of interest of the Steel Sector). Work Programme available. 10 -40 M€ project dimension. Deadline on January 2021	
InvestEU	The InvestEU Fund is expected to mobilise more than 372 B€ of public and private investment through an EU budget guarantee of 26,2 B€ that backs the investment of financial partners such as the EIB Group and others.		
Important Projects of Common European Interest (IPCEI)	<ul style="list-style-type: none"> - Two types of IPCEI actions interesting for the GREENSTEEL project: <ol style="list-style-type: none"> 1. IPCEI - Hydrogen for climate action 2. IPCEI – Low carbon industries (still in preparation) - Currently the maximum amount for a single MS, based on the two already active IPCEI (Microelectronics and Batteries), amount to 400 M€. - Funding up to 100% of the relevant cost, even if industry co-financing is highly expected. - IPCEI follows the State aid rules (2014/C 188/02). 		
National and Regional	Considering the wide variety of rules, these instruments have to be specifically verified on a case-by-case base.		
EIB		Loans > 25M€, e.g. InnovFin Energy Demonstration Projects up to 75M€	No defined upper limit
ERBD	Loans available in the range 3-250 M€ (average amount €25 M). Full details are negotiated with the client on a case-by-case basis-		
Banks	Conventional instruments and green bonds		

Source: authors' own composition. Note: green = funding available; yellow = funding rules under definition; red = funding not available.

*Links to the programs and relevant detailed info on the project website <https://www.estep.eu/green-steel-for-europe/>.

1. Introduction

1.1. Context

The European iron and steel industry generates annually over 200 M tonnes of carbon dioxide (MtCO₂), which amounts to 5% of all CO₂ emissions produced across EU-28 countries in 2016 (Eurostat, 2016).

The EU can lead the way by investing in realistic technological solutions that can empower citizens and by aligning actions in key areas such as industrial policies, finance and research.

1.2. Challenges – EU steel industry under severe strain

The EU steel industry is one of the main backbones of the EU manufacturing sector, involving 23 member states (MS), with an output of about 177 M tonnes of steel a year. Even if EU crude steel production is the 11% of global output,⁴ it is under fierce competition with non-EU Countries, i.e., China. Moreover, steel production is energy-intensive and responsible for 30% of EU industrial CO₂ emissions. R&I are needed to develop breakthrough technologies allowing both the Union and the industry to remain competitive worldwide while respecting the climate change targets.

Keeping in mind the EU energy and environment targets for 2030 and 2050, European public and private investments should be increased to be aligned to the sector's needs. The European partnership on green steel would be a first important step allowing sharing risks among public and private actors, providing inputs to a European sustainable re-industrialisation and creating strategic synergies between public and private funding.

In this context the present report aims to provide:

- a mapping work of existing funding instruments at European, MS and regional level, including both public and private funding;
- an analysis of the blending/sequencing of the identified funding instruments accompanied by guidelines to create synergies among EU and national/regional funding; and
- an analysis of funding and investment needs accompanied by relevant guidelines.

1.3. Current activities at EU level

EU legislation – The EU is providing the regulatory framework on antitrust and state aid that is essential for a vibrant EU single market and for providing a level playing field for the steel industry.

Industrial policy – The European Commission (EC) has adopted relevant communications such as “A New Industrial Strategy for Europe”, “Just Transition Mechanism” and “The Sustainable European Investment Plan”:

- A New Industrial Strategy for Europe (COM/2020/102);⁵

⁴ For further details, please see

https://ec.europa.eu/growth/sectors/rawmaterials/industries/metals/steel_en

⁵ For further details, please see https://ec.europa.eu/knowledge4policy/publication/communication-com2020102-new-industrial-strategy-europe_en

- the Just Transition Mechanism (COM/2020/22);⁶
- the Sustainable European Investment Plan (COM/2020/21).⁷

In addition, the state of the art, the major issues and the challenges concerning the sectors related to the EU steel industries in 2018 and 2019 are addressed in the following publications:

- European steel – The Wind of Change;⁸ and
- Steel and coal – A New Perspective. Research and Innovation in Action.⁹

Finally, the report on the seven-year (2011-2017) monitoring and assessment of the RFCS was published in 2020 (RFCS Monitoring and Assessment Report (2011-2017))¹⁰.

Below the list of the on-going actions already detailed in Green Steel for Europe (GREENSTEEL) Report D2.4 – Report on funding opportunities to decarbonise the EU steel industry, Chapter 2:

- EU funds available for the EU steel industry;
- European Strategic Energy Technology Plan (SET-Plan);
- high level group on Energy-intensive industry;
- EU emissions trading system (EU ETS);

Under Horizon Europe (HEU) and the upcoming Innovation Fund (IF) there is no earmarked budget for the steel sector. This holds true for other EU funding instruments, where many industry sectors will compete for support.

Therefore, there is a strategic need to create synergies of EU funds (European Coal and Steel Community (ECSC) assets, HEU and IF) and co-programming and co-financing with the EU steel industry. Such combined funds and efforts would provide the EU steel industry a critical mass to ensure breakthrough technology, facilitate joint vision development, and agenda setting. This could be initially achieved by the HEU partnership on clean steel.

A list of funding instruments analysed in this report are reported in Table 3, and are further classified by their level of development in Figure 1.

Table 3: List of funding instruments having an expected impact on CO₂ emission reduction for the steel sector

EU public funding opportunities (grant)	Public and private EU, national and regional funding opportunities (loan and guarantee)	National/regional opportunities (grant and financial support)
Horizon Europe (HEU), including PPPs; Process4Planet (P4P) and Clean Hydrogen for Europe	European Investment Bank (EIB)	Austria and related regions

⁶ For further details, please see <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020PC0022>.

⁷ For further details, please see <https://www.eumonitor.eu/9353000/1/j9vvik7m1c3gyxp/vl5bgbjymzx>.

⁸ For further details, please see https://ec.europa.eu/info/publications/european-steel-wind-change_en.

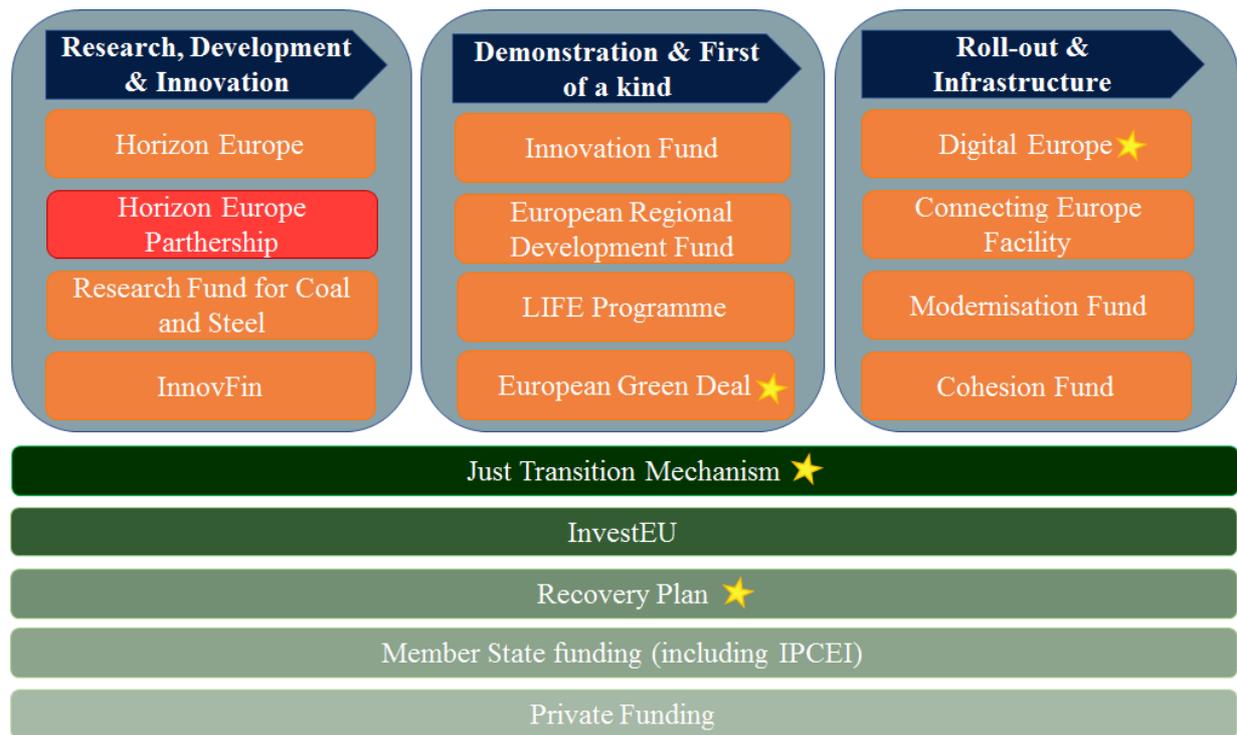
⁹ For further details, please see https://europa.eu/newsroom/events/steel-and-coal-new-perspective-%E2%80%93-research-and-innovation-action_en.

¹⁰ For further details, please see https://ec.europa.eu/info/publications/research-fund-coal-and-steel-monitoring-and-assessment-report_en.

Clean Steel Partnership (CSP)	European Bank for Reconstruction and Development (EBRD)	Belgium and related regions
Research Fund for Coal and Steel (RFCS)	European Fund for Strategic Investment (EFSI)	Finland
Innovation Fund (IF)	European Regional Development Fund (ERDF)	France
LIFE Programme (LIFE)	EU Finance for Innovators (InnovFin)	Germany and related regions
European Green Deal Investment Plan (EGDIP)	InvestEU	Italy and related regions
Just Transition Mechanism (JTM)	Private banks (conventional instruments)	Luxembourg
Digital Europe (DE)	Private banks (Green Bonds)	The Netherlands
Connecting Europe Facility (CEF)		Poland and related regions
Modernisation Fund (MF)		Spain and related regions
Cohesion Fund (CF)		Sweden
Erasmus +		
Era-Net		
Small and medium enterprises (SME) Programme		
Important Projects of Common European Interest (IPCEI)		
Recovery Plan (RP)		

Source: authors' own composition.

Figure 1: EU programmes supporting the decarbonisation of the steel industry



★ NEW

Source: authors' composition.

2. Funding versus investment needs

In this paragraph, technological investment needs are reported, as resulting from the GREENSTEEL D2.3 Report “Report on funding opportunities to decarbonise the steel industry”. The information refers to already running projects upscaled to a demo level (TRL 8) on decarbonisation techniques and detailed in other deliverables of the GREENSTEEL project.¹¹ The results allow to identify the financial needs as an order of magnitude of tens up to few hundreds €/tonne of crude steel for production in the frame of decarbonisation techniques. This represents, in turn, an investment of at least €10 M to take an average-sized plant from demo up to industrial level, and an investment of several hundred euros if various advanced techniques are to be combined or if the plants have a significant production.

To support producers in achieving its energy and climate targets, the EU is going to launch a public-private-partnership (PPP), the CSP. As strategic objective, the CSP is designed to tackle two major challenges: climate change and sustainable growth for the EU.

The CSP is in line with the European Green Deal, the ‘Clean Planet for All’ strategy and the Paris Agreement (European Parliament, 2015), it takes an integrated approach to fighting climate change and aims at moving towards climate neutrality by 2050, zero-pollution ambition towards a toxic-free environment and a circular economy (European Commission, 2018).

Moreover, it supports the EU commitment to the United Nations sustainable development goals and contributes to sustainable growth based on knowledge and innovation, as promoted by the HEU framework.

Decarbonising the steel sector is crucial not only to reduce emissions, but also to keep a highly competitive European steelmaking production, contributing to a more circular economy. Reducing CO₂ emissions will fundamentally alter the profile of pollutants emission and have significant impacts on reducing pollution levels.

Based on industry sources, CO₂-low new production technologies will require investments of around **€50 to 60 B** and will result in capital and operating costs expected to be between €80 and 120 B per year¹².

The analysis of the EU funding programmes – combining HEU, CSP, RFCS, IF – available as grants shows that, overall, **only €2 B of EU would be available for activities dedicated to CO₂ emission reduction in the steel sector for the period 2021-30**. Even if this resources reach a considerable amount, it **does not have the critical mass for breakthrough technologies and for overcoming the EU challenge to be climate-neutral by 2050**¹³.

¹¹ See D1.1. - Assessment and roadmapping of technologies; D1.3 - Technology Investment Needs Consultations; D2.1 - Draft investment needs, <https://www.estep.eu/green-steel-for-europe/publications/>

¹² EUROFER Discussion Paper, September 2019

¹³ For further details, please see GREENSTEEL D2.2 Investment needs and <https://www.estep.eu/green-steel-for-europe/publications/>.

3. Investment roadmapping

For the investment needs, publicly available data have been completed with information obtained through interviews with steel producers and technology providers, as reported in the GREENSTEEL D2.6 report on consultation strategies. The investment needs of the main technological solutions (the so-called “technology routes” in the GREENSTEEL D.1 report “Assessment and Roadmapping of Technologies”) have also been put in relation with the periods in which they will be required towards 2050, to further support formulating an investment roadmap. Based on the analysis of the selected decarbonisation technologies and their investment needs, an investment roadmapping has been developed. The investment needs along the time scale are composed of:

1. **the cost for development up to technical readiness level (TRL) 8:** investments needed to upgrade the technology from the existing TRL to the level of a complete system, including small-scale demonstration in an operational environment;
2. **the cost for first industrial deployment (TRL 9):** the investments needed for a scale-up and full industrial validation of a first-of-a-kind industrial plant;¹⁴
3. **the cost for production plants:** the investments needed for a full-scale industrial production plant (normalised to a production capacity of 1 M tonnes); and
4. **the cost for deployment of auxiliary technologies:** the investments needed for auxiliary enabling technological solutions, with similar development/investment steps as described above.

Most investments for industrial deployment will occur between 2030 and 2050, meaning that the great majority of the overall investments will be needed from 2020 onwards, but will continue also beyond 2030 and up to 2050. A summary of the investment roadmapping for single technologies and technology routes is shown in the table below.

The table is split into three parts:

1. investments for the development of single technologies;
2. investments for auxiliary technologies; and
3. investments for technology routes resulting from combination of technologies to represent complete steel production chains.

In case of lack of some information, a common TRL info or a common investment need for plant deployment is given. Besides, data refer to technology development from greenfield.¹⁵

¹⁴ At least one-year operation with about 30% (or higher) of industrial plant production capacity.

¹⁵ In fact, it is worth noting that in Europe the optimized BF-BOF route will most probably be based on existing installations (brownfield) rather than new installations (greenfield). The CAPEX for BF-BOF brownfield (BF-BOF retrofit) is estimated to be a bit less than 40% of the CAPEX of greenfield BF-BOF. [42].

Table 4: Summary of investment roadmapping for single technologies & technology routes

Technology	TRL development			Investment needs up to TRL 8 (M€)	Investment needs for 1 st industrial deployment (TRL 9, M€)	Investment needs for full industrial plant (M€)	CO ₂ abatement (max %)
	2020	2030	2050				
H ₂ -DR (100 % H ₂)	6-8	7-9	9 (ind. depl.)	100	150	250*	95
HPSR	5	6	9 (ind. depl.)	100	200	500	95
AIE	5-6	6-8	9	250	500	Not evaluated due to low TRL	95
MOE	2	3-4	9	1000	Not evaluated due to low TRL		95
CCUS	5- 8	9	9 (ind. depl.)	150	300	1000	60
IBRSR	6	8	9 (ind. depl.)	400	850 **		20-80
BF-Gas injection	5-9	8-9	9 (ind. depl.)	150	400**	600**	20-60
Biomass usage	2-7	8	9 (ind. depl.)	5	15		30-100
Increased scrap usage	4-7	7-9	9 (ind. depl.)	50	100		100(with CCS).
Auxiliary technologies							
Technology	TRL development			Investment needs up to TRL 8 (M€)	Investment needs for 1 st industrial deployment (TRL 9, M€)	Investment needs for full industrial plant (M€)	CO ₂ abatement (max %)
	2020	2030	2050				
CO ₂ capture	5-6	8-9	9 (ind. depl.)	(independent from steel industry, existing reference on 120 M€)		200	-
Water electrolysis	5-8	7-9	9 (ind. depl.)	Not evaluated (independent from steel industry)		100	-
Technology routes							
Technology route	TRL development			Investment needs up to TRL 8 (M€)	Investment needs for 1 st industrial deployment (TRL 9, M€)	Investment needs for full industrial plant (M€)	CO ₂ abatement (max %)
	2020	2030	2050				
Optimised BF-BOF	2-9	7-9	9 (ind. depl.)	2000***	4000		95
Direct reduction	4-8	7-9	9 (ind. depl.)	500		650	95
Based on smelting reduction	2-6	6-8	9 (ind. depl.)	400	500**	600**	85
Based on iron electrolysis	2-6	3-6	9	250	400	Not evaluated due to low TRL	95

Source: authors' own compilation based on desk research and stakeholders' interviews (for complete references, see the bibliography). Note: data refer to a crude steel capacity of 1 Mt/a as

a reference¹⁶. *€500 M including EAF. ** Excluding CO₂ transport and storage, *** From greenfield (brownfield CAPEX costs 40% with respect to BF-BOF). For the abbreviations used, please see the List of abbreviations.

The investment costs correspond to one (pilot/demonstration/industrial) plant at a time. However, it is strongly recommended to operate at least two plants for each technology in order to ensure reliable results and receive a broad range of experiences.

The information on the technical maturity is given as range of TRL, representing different aspects of the respective technology or technology route. Regarding the readiness for first industrial deployment, the upper limit of the TRL range is relevant, since the less mature aspects are usually optional.

3.1 Technologies versus CO₂ emission abatement potential

The investments roadmap needs to be put into the **sustainability perspective** for a competitive and resource-efficient industry, providing better safety for workers and new job opportunities.

To this aim, the costs of the different options have to be considered, as well as the expected maturity progress of the technologies. Technologies related to biomass, increased scrap usage, gas injection in BF and carbon capture usage or storage (CCUS) have lower impact on CO₂ emissions as single application, but are the closest to the industrial development and have relatively low investment costs. Conversely, the new, innovative steelmaking technologies, such as hydrogen plasma smelting reduction (HPSR) and iron ore electrolysis have a big potential, but they need long time and large investments for the industrial deployment due to a currently rather low TRL.

The hydrogen-based direct reduction (H₂-DR) technology provides a compromise, as it has a moderate TRL and a very high CO₂ abatement potential. Its installation in European steel plants will enable a significant decrease in the CO₂ footprint of the European steel industry.

These industrial DR plants could afterwards be used for further R&D activities with the aim of maximising the ratio of hydrogen to natural gas. This approach could avoid having to wait several years for less mature techniques to be developed before a major CO₂ abatement of industrial emissions can be reached. Instead, depending on local boundaries (e.g., favourable conditions with respect to economical and legal barriers and with respect to energy/resource costs), first industrial sites could build DR plants within a couple of years. However, this approach would also have a significant impact on the investment needs. As can be derived from the previous comprehensive table, huge investments on industrial scale (up to €1-2 B) will be needed on the short-term, after a first demonstration plants step with lower investment needs.

As a general remark, across Europe there is a wide distribution of projects and related experimental and demo plants based on new technologies (for a comprehensive list, see GREENSTEEL D1.2, 2021), but how many EU plants will be actually involved in the options identified within the GREENSTEEL project will depend on several factors, such as enablers, legal framework, public financial support for R&D&I in particular, and upscaling of the current demo.

¹⁶ In general, the actual sizes of real industrial plants differ depending on each specific technology.

New low-CO₂ production technologies will require investments of around €50 - 60 B, with capital and operating costs of €80 ÷120 B/ year. The cost of production per tonne of primary steel will increase by 35% and up to 100%. New technologies would result in additional production costs for the EU steel industry of at least €20 B/year compared to the retrofitting of existing plants (i.e. upgrading of existing plants with best available techniques). At least 80% of this share are due to OPEX, mainly because of increased use and higher prices for CO₂ lean energy. All the above mentioned figures are detailed extensively in the D2.2 GREENSTEEL report on the investment needs.

Moreover, local conditions can foster the deployment of some of the presented technologies: for example Belgium, France and the Netherlands can benefit from the opportunity of CC storage in North Sea ports, while Sweden can benefit from the availability of green energy.

How all these opportunities can be turned into reliable pathways will depend also on other external aspects, such as financial and policy-related ones. A dedicated report is going to provide a thorough analysis of the most promising pathways identified and of a general indication of the expected positive effects on the investment needs.

4. Blending and sequencing

This chapter is dedicated to the blending funding opportunities, for which a reference array of European, national and regional resources have been accounted for, together with public and private funding, grants and loans.

Based on the analysis performed so far, 25 EU programmes, 24 bank opportunities and 81 national and regional instruments available in Europe can be blended, at least to some extent. This will create multiple advantages, such as:

- involving public and private investors, thereby increasing the total amount of funds available for projects, when compared to support through grants only;
- providing a greater, more extensive and more stable support to beneficiaries that may not be supported by a single grant at EU or national level, also considering state aid rules;
- reducing the innovation risk and bridging the typical funding gap characterising the 'innovation valley of death'; and
- providing higher alignment of interested companies and improving the dissemination of the successful outcomes of the projects.

4.1 Blending/synergies at programme and project level

This present section considers synergies between European and national programmes respectively, as well as synergies at project level, focusing on those fostering CO₂ reduction in the steel sector. This analysis is also aligned with a similar assessment of funding opportunities performed in the context of the SET-Plan Action 6 led by DG ENER of the EC¹⁷, with the aim of making a possible coordination of the output of both activities easier, should the need arise.

4.1.1 Synergies at EU level

To achieve synergies all levels and stages of programming and implementation need to be addressed, starting at the strategic level with awareness and understanding of the opportunities offered by the different EU programmes. In this context, this report provides specific detailed rules and provisions from HEU programmes related to cumulative blending and sequencing that apply to all combinations below involving HEU.

4.1.1.1 Combining RFCS and Horizon Europe

While a more comprehensive assessment of the options to ensure coordination between the RFCS and HEU will be performed in work package 3 of GREENSTEEL, here follows a preliminary analysis of such options.

To achieve the challenging CO₂ reduction objectives a strong collaboration and joint commitment of the private and public sector are needed. This is essential to mobilise private and public funding opportunities, and improve synergies among the EU funding instruments that are particularly useful and suitable to achieve the above-mentioned objectives, such as the RFCS and HEU. Such a synergy is still expected to be fostered.

¹⁷ For further details, please see <https://setis.ec.europa.eu/implementing-integrated-set-plan/energy-efficiency-industry-ongoing-work>.

The systematic exchange of information among the relevant institutions and stakeholders managing the RFCS and HEU is the first step to maximise synergies in order to avoid duplication and foster collaboration.

The ideal setting could be a single funding mechanism (the so-called 'one-stop shop approach') for the RFCS and HEU, where research activities, objectives and funding opportunities are aligned. However, this single funding mechanism is not easy to achieve, mainly due to the timing constraints, and political, organisational and financial reasons.

To improve the synergies between the two programmes, and as an alternative to the 'one-stop shop', the following harmonisation steps can be considered.

An adequate budget should be made available to reach the EU's goal to achieve climate neutrality by 2050: in this respect, a reinforced long-term HEU and RFCS budget (at least for the period 2021-27) is a necessary step.

- Reinforced budget for HEU: the HEU budget for pillar II 'Global challenges and industrial competitiveness' should be increased, more specifically within:
 - cluster 4 - 'Digital, industry and space', aiming to achieve three main objectives, namely (i) ensuring the competitive edge and autonomy of EU industry; (ii) fostering climate-neutral, circular and clean industry, and (iii) bringing a major contribution to inclusiveness; and
 - cluster 5 - 'Climate, energy and mobility', aiming at fighting against climate change and improving the competitiveness of the energy and transport industry as well as the quality of the services that these sectors bring to society. The reduction of GHG emissions in the steelmaking process, including through energy efficiency and the use of renewable energy, is remarkably connected to the objectives of this cluster.

The CSP, under pillar II of HEU, currently offers a specific HEU public funding of €350 M for the period 2021-27 (based on a comparable private industrial effort).

- Reinforced budget for RFCS: the RFCS research programme should continue to support collaborative research with a budget of at least €40 M per year and should be able to fund new large clean steelmaking R&I breakthrough projects (as proposed in COM(2020) 319 final, COM(2020) 320 final and COM(2020) 321 final).

For the CSP, RFCS sets out a specific budget of €350 M from the assets of the ECSC in liquidation, i.e. €50 M each year for the period 2021-27.

Another option to be considered is presenting the CSP calls as a single package (the so-called 'single package' approach). The proposal is to coordinate calls for both the RFCS and HEU in terms of technical topics, timing and evaluation.

RFCS and HEU proposals should ensure alignment in terms of eligibility criteria and thus a common denominator between the two programmes. For example, for Horizon 2020 (H2020) a minimum of three independent legal entities established in different MSs or associated countries are requested (and the same criterion is expected for HEU), while the RFCS requires at least three legal entities for research projects and at least two legal entities for pilot and demonstration projects or accompanying measures, independent from each other and established in at least two different EU MSs. In light of the above, in general alignment should ensure a less binding context, also considering that for H2020 (and the same is expected for HEU) the success rate is lower than that for the RFCS. In addition, RFCS

and HEU proposals should be evaluated on the basis of the same selection and award criteria, i.e. 'excellence', 'impact' and 'quality and efficiency of the implementation'.

As it is in line with the spirit of the EGD and HEU, the annual priority for RFCS can be maintained, in order to cater for unforeseen and unpredictable technical issues (but not only) and to mitigate a possible negative market context.

RFCS and HEU calls for the CSP should avoid the submission of project proposals in the same monthly cut-off date of 'conventional' RFCS calls (September) and HEU ones, e.g. generally January-February for SPIRE and April for the FCH JU. It also has to be considered that the first call of IF last year was published on 29 October. One common deadline for CSP calls should be identified instead. The suggestion is to make sure that deadlines for conventional (both RFCS and HEU) and CSP calls do not overlap.

Furthermore, a timing of CSP calls for proposals is being defined, in order to avoid setting the same deadline of already existing relevant calls for the sector. A proper alignment of both RFCS and HEU calls for proposals for CSP is needed: for instance, a suggestion of timing for CSP calls could be to have them on a yearly base in May/June or, possibly, in early/mid-December.

RFCS and HEU proposals for the CSP could be evaluated on the basis of a common, central evaluators database, under the supervision of EC staff and with the contribution of independent external experts acting as evaluators promoting impartial criteria. Following the EU practices, this evaluation should be carried out by ensuring that indicatively around 50% of the experts participating are new ('new expert' means someone who has not participated either in the RFCS or HEU evaluation process in the previous three years), and that for each expert a maximum of three consecutive participations in the RFCS or HEU evaluation phase are allowed.

RFCS and HEU should be evaluated at programme level, having midterm evaluations to inform the respective Programme committees (Programme committee for HEU and the Coal and Steel Committee (COSCO) for RFCS). The evaluation should aim to determine the overall progress of the implementation of the actions of the specific programme, in order to assess the degree of accomplishment of the specific and operational objectives, and to measure progress in terms of the concrete changes to the production processes.

To better achieve the synergies at European level, these are the suggested options:

- Option 1 – Combining HEU and RFCS funds and assets under the same CSP call for proposals (the so-called 'one-stop shop approach') to ensure synergies at European level;
- Option 2 – Presenting the call as a single package (the so-called 'single package approach'); and
- Option 3 – Publishing at least (RFCS and HEU) CSP calls with the same deadline.

The HEU / RFCS CSP should steer the process.

The numerous European instruments (as well as national and regional ones) have to be strategically organised on both sides, public and private, and a coordinated action is needed in order to maximise the efficiency of these instruments. The system already in place could be used to that end. If the institutional process is completed successfully, establishing the CSP, that partnership could be used strategically to co-programme HEU, the RFCS and possibly other useful instruments also on the private side.

The EC adopted on 16 July 2020 three communications composing the RFCS modernisation packages:

- COM(2020) 319 on Decision 2003/76/EC establishing the measures necessary for the implementation of the Protocol;
- COM(2020) 320 on Decision 2008/376 (European Council, 2016) on the adoption of the Research Programme and on the multiannual technical guidelines, _ and
- COM(2020) 321 (DG BUDG) on Decision 2003/77 (European Commission, 2020f) laying down multiannual financial guidelines for managing the assets of the ECSC in liquidation.

This revision paves the way to increase synergies between EU funds and to co-programme the CSP with HEU and RFCS funds.

In addition, a Task Force under the European Steel Association (EUROFER) chairmanship has been formed, with the aim of looking at possible future issues for the RFCS programme and of proposing measures to counteract any possible current inadequacy. The members have been proposed via the European Steel Technology Platform (ESTEP) Steering group. The Task Force is reporting to the EUROFER Refocus WG.

According to the Task Force, the RFCS program must remain an important pillar of collaborative research on EU level, bringing the steel research community together. Changes to the RFCS because of modifications of the legal package – past or future ones, related to the CSP – have altered the RFCS programme. In any case, the RFCS modernisation package has been widely appreciated. Nonetheless, the Task Force has sought to propose improvements of the RFCS programme in line with the existing and anticipated framework.

Potential improvements in the RFCS Programme can be related to the following issues:

- Call and Info Pack: is the information clear, could anything be improved?
- Priorities: should annual priorities be kept, and if so, how many and with what bonus?
- Evaluation process: does this work well or is there room for improvement? If yes, what could be improved, and how?
- Reporting: are the reporting requirements clear, justified and adequate or is there room for improvement? If so, what and how?
- Technical Group Acier (TGA): do the groups work well, is the workload reasonable and is the feedback to the projects useful?
- Strategy: where should the RFCS programme be in 10 years' time? What steps should be taken now?

The aim was that responses can be structured and fully prepared for input to the EC prior to the Steel advisory group meeting in December 2020.

4.1.1.3 Combining Horizon Europe and RFCS respectively with the Innovation Fund

The IF is one of the world's largest funding programmes for demonstration of innovative low-carbon technologies and focuses on:

- innovative low-carbon technologies and processes in energy-intensive industries, including products substituting carbon-intensive ones;
- carbon capture and utilisation (CCU);

- construction and operation of carbon capture and storage (CCS) (ZEP, 2011 and 2013);
- innovative renewable energy generation; and
- energy storage.

The IF will focus on highly innovative technologies and big flagship projects with European value added that can bring on significant emission reductions.

The IF grant is not considered to be state aid. To cover the remaining costs, a project applicant can combine the IF grant with public support by a MS.

The IF provides funding above and below €7.5 M CAPEX with two separated calls (large and small-scale projects). The first large-scale project call was opened in the second half of 2020, while the opening call for small-scale projects is expected for the first half of 2021.

According to the explaining examples provided by the EC (referring to the processing industry), the IF can generally provide, with a rough estimation, between 20% and 30% of funding.

IF grants can be combined with funding from other support programmes, such as HEU and the RFCS.

HEU and IF. The combination of HEU and IF could ensure a better synergy for the steel sector: HEU can support innovation up to the pilot phase and the IF can support innovation also in the demonstration and scale-up phases.

RFCS and IF. Blending the two instruments is formally possible, provided that there is no double funding. In this case, the RFCS can support innovation for the research phase and up to the pilot and demonstration phase, and the IF can support innovation also for the scale-up phase. The RFCS programme provides three different levels of funding: 50% for pilot and demonstration projects, 60% for research projects and up to 100% for accompanying measures. In order to consider blending with the IF, the RFCS should be used mainly for the pilot and demonstration phase, providing 50% of funding.

As a result, considering the statements above, a potential practical synergy between these two instruments is possible, mainly for pilot and demonstration projects below €7.5 M. To properly evaluate the blending and sequencing opportunities for the two instruments, however, three other elements are extremely relevant: project maturity (which can be measured for both instruments based on the TRL), degree of innovation and GHG emission avoidance.

Currently the IF call for projects below €7.5 M is not open yet, but its publication is likely expected in the first semester of 2021.

4.1.1.4 Combining Horizon Europe and the RFCS respectively with LIFE

HEU and LIFE. HEU and LIFE could be combined to obtain better synergies for CO₂ reduction in the steel sector. The LIFE Climate Action sub-programme has been strongly supporting projects in the renewable energy and energy efficiency fields (Pardo, 2013) to contribute to the CO₂ emission reduction targets, and funding projects with high TRL. To that end, the EU is now working to provide more support through the LIFE Climate Action financial instrument in order to have a basis for a larger number of projects. On the practical side, for instance, the funds of the next call cut-off date (October 6th) have been increased by roughly 30% compared with information provided initially.

RFCS and LIFE Climate Action. The RFCS and LIFE could also be combined to obtain better synergies. The LIFE Climate Action sub-programme supports projects to develop innovative ways

to respond to the challenges of climate change in Europe. In particular, one of the main objectives of the sub-programme is to contribute to the shift towards a low-carbon and climate-resilient economy. Importantly, this objective can be reached through synergies with the RFCS.

4.1.1.5 *Combining Horizon Europe and the RFCS with IPCEIs*

The IPCEI is not an EU funding scheme, but a legal framework that allows pooling different types of funding (EU, national, regional and private) for a project with a strong EU added value. The notion of the IPCEI is enshrined in Article 107 of the Treaty, which provides that “aid to promote the execution of an important project of common European interest” may be considered to be compatible with the internal market. In order to qualify for public funds under the IPCEI framework, the projects must fulfil five conditions: (i) contribute to strategic EU objectives; (ii) involve several MSs; (iii) include private financing by the beneficiaries, (iv) generate positive spillover effects across the EU; and (v) be highly ambitious in terms of research and innovation (R&I), i.e. go beyond what is widely regarded as the ‘state of the art’ in the sector concerned. In addition, the project should not provide an unfair advantage to companies financed by public funding, as prohibited by state aid rules.

The advantages of an IPCEI are the following:

- **the existence of the market failure** affecting the project can be presumed (under normal R&D&I aid rules, this needs to be proven for larger projects);
- **the project can be aided up to 100% of the funding gap on the basis of a large set of eligible costs** (normal regional aid and R&D&I aid rules provide for upper limits and the closer to the market, the lower the cap);
- **costs of first industrial deployment (i.e. between pilot lines and the start of mass production)** are considered eligible.

In the wake of the Covid-19 crisis, the IPCEI framework is currently under revision, as part of the ‘fitness check’ to improve EU regulation and cut red tape.

MSs, the EU steel industry and other actors (under the supervision of the CSP) could explore the possibility to table a proposal for setting up an IPCEI on Green Steel (Olofsson, 2019). This IPCEI would create a legal framework allowing the combination of EU, national, regional and private funding in compliance with state aid rules.

In this respect, the EC may consider eligible an ‘integrated project’, i.e. a group of single projects inserted in a common structure, roadmap or programme aiming at the same objective and based on a coherent systemic approach. The individual components of the integrated project may relate to separate levels of the supply chain but must be complementary and necessary for the achievement of the important European objective.

To achieve this, a constant coordination is needed between the CSP and the EC in order to align the RFCS and HEU calls, and national and regional contributions with the objectives of the IPCEI.

The IPCEI on Green Steel could be organised into three layers:

- **European level** (grants): EU direct funding schemes like the RFCS, HEU and others in order to support research on the three main roots and pilot demonstrations. This would represent the European common denominator of the IPCEI project;

- **national level** (grants): specific projects at national level (for example Hydrogen in Sweden and Austria, CCS/CCU in Italy and Poland) to be financed by regional or national funds. Structural funds and national funds could be used for the deployment of the specific technologies and converting of the existing steel plants (i.e. ex-ILVA in Taranto, Italy); and
- **lending facilities** (loans, public sector guarantees, private equities and other financial instruments): the EIB and private banks (InvestEU, JTM, etc.) to complement funding from EU and national programmes or other sources to reach the scale needed for innovation and deployment projects.

If the EC finds that the aid is necessary, proportional and transparent, and that its negative effects in terms of potential to distortion of competition and on trade between MSs are limited and outweighed by the positive effects, it may declare the aid compatible with the internal market. In such cases – and where justified by the funding gap analysis – the aid can cover up to 100% of the funding gap based on a large set of eligible costs. Where it allows for the development of a new product with high R&D&I content or of a fundamentally innovative production process, the aid can also cover the critical phase of upscaling or ramping up of the first demonstration or pilot line and the testing phase, which include the upscaling of first-in-kind equipment and facilities for which significant research and development work is still necessary. Regular upgrades of existing facilities without an innovative component and the development of newer versions of existing products do not qualify as IPCEI. Table 5 below presents a possible structure of an IPCEI on Green Steel.

Table 5: Possible structure of an IPCEI on Green Steel

Public and private lending facilities	EIB, <i>Cassa depositi e prestiti</i> , KfW, private banks	EIB, private banks	EIB, EBRD, private banks
National level (contribution allowed under the IPCEI framework)	Italy/Spain/Germany – Building on the research at EU level; specific applications to existing steel plants existing in Italy, Spain and Germany	Sweden, Austria Focus on CDA	Poland, Romania, Slovakia Focus on CCU/CCS
European level (grants)	Research and demonstration on the three paths (CDA, CCU/CCS, PI); upgrade of the technology from the existing TRL to the TRL expected respectively in 2030 and 2050; EU wide research serving as baseline to apply technologies in the different countries (see the national level).		

Source: authors' own compilation.

4.1.1.6 Combining Horizon Europe with ESIF

HEU and ESIF. Over the next budget cycle, the CF and the structural funds aim at supporting the green transition. In this respect, the combination of funding among HEU and ESIF for ambitious industrial projects is especially concerning. Figure 2 details an extensive analysis of this two instruments' combination, whereas Table 6 provides an overview of the differences between H2020 and structural funds. Finally, on the practical side, a real industrial case of combination between ESIF and EIB loans is reported in the third example of Section 5.

Figure 2: Combination of funding for the steel industry - Horizon 2020 and ESIF.



Source: European Commission, 2014b.

Table 6: Overview of the differences between Horizon 2020 and the structural funds

Horizon Europe	EU Structural funds
DIFFERENCES	
Non-territorial, mainly transnational approach based on excellence and impact; H2020 does not take into account geographic specificities in allocating funding.	Place-based approach supporting economic and social cohesion; co-funding rates vary according to the region and programme. .
Individual and collaborative R&D&I projects tackling the whole cycle of innovation, taking into account strategic approaches at EU level, e.g. through European innovation partnerships and the SET-Plan. Co-Fund actions: focus on co-funding specific R&I calls or programmes (pre-commercial procurement/public procurement of innovation, PPP, peer-to-peer, ERA-NETs, etc.).	Largely focused on improving the R&I capacities and R&I eco-systems with the objective of regional growth and a place-based economic transformation towards higher added value and more knowledge-intensive activities (RIS3). Increase of support to R&I activities as such too, e.g. business/university cooperation and closer-to-the-market activities (prototyping, pilot lines, early product validation actions, advanced manufacturing capabilities and first production).
Directly managed (EC / executive agency) and awarded directly to final beneficiaries or managed by a Union body or multi-country entity; in case of programme co-funding, with a dedicated implementation structure (indirect management).	Shared management with national and regional public intermediaries (managing authorities, implementing agencies and intermediate bodies) defining the implementation details and allocating the funding to final beneficiaries.
Not counted for EU state aid purposes.	Counted for EU state aid purposes.

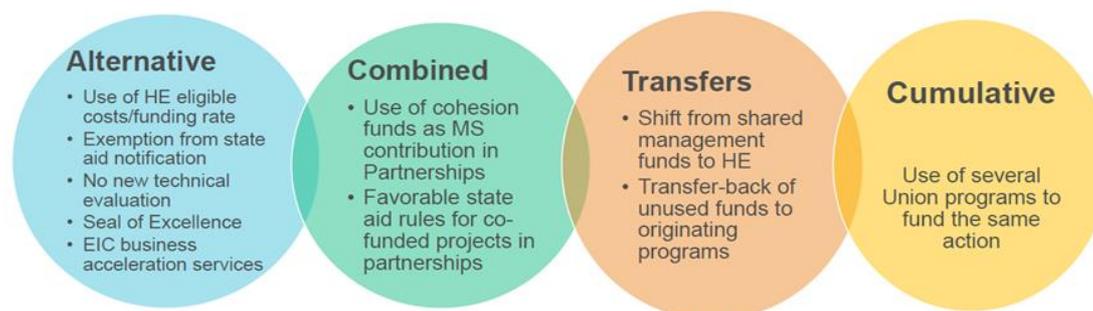
<p>Competitive calls for proposals addressed to multi-country consortiums (participation beyond the EU is possible) without geographic pre-allocation.</p> <p>(European Research Council and Marie Skłodowska-Curie Actions also address individuals; SME instrument also addresses single SMEs).</p>	<p>Policy-related prioritisation based on cohesion considerations and RIS3 priorities to individual firms/bodies and consortiums within the territory covered by the operational programme (and only within the EU).</p> <p>Increasing use of competitive attribution through calls and aid schemes based on project selection criteria (depending on MS).</p>
<p>OPPORTUNITIES</p>	
<p>Focus on promoting industrial leadership and tackling major societal challenges; maximising the competitiveness impact of R&I; and raising and spreading levels of excellence in R&I.</p> <p>Actions fostering research and innovation included.</p> <p>Objective of spreading excellence and widening participation.</p> <p>Award of the ‘Seal of excellence’ to certain types of action (including the SME Instrument) proposals that fulfil excellence criteria but cannot be supported from H2020 to be taken up by national/regional programmes to facilitate access to project funding.</p>	<p>Besides improving the innovation eco-systems, the cohesion policy partly increasing the capacity of regions and MSs to participate in H2020 and partly funding R&D&I activities in a MS/region that can build on EU framework programme projects.</p> <p>Possibility for regional programmes to take up good practices and project formats that were tested under H2020, e.g. public procurement of innovative solutions, pre-commercial public procurement, stage-gating for projects (like in the SME Instrument), knowledge-triangle settings like in the Knowledge and Innovation Communities of the European Institute of Innovation and Technology, ‘proof of concept’ type of actions like under the European Research Council (ERC), social and public sector innovation approaches, etc.</p> <p>Support from H2020 for policy development at national and regional levels.</p>
<p>Similar cost options that may facilitate combining funds: lump sums, flat rates, unit costs etc.</p>	

Source: authors' own composition.

4.1.2 Different types of synergies between Horizon Europe and Cohesion Funds post 2020

The figure below shows different types of synergies between HEU and Cohesion Funds post 2020

Figure 3: Different types of synergies between Horizon Europe and Cohesion Funds - post 2020



Source: European Commission.

Alternative funding (Seal of excellence)

HEU proposals with the Seal of excellence may get support from ERDF, ESF+, or the European Agricultural Fund for Rural Development (EAFRD).

- **Beneficiaries:** mainly for mono-beneficiaries support, e.g. the European Innovation Council (EIC) accelerator, MSCA, ERC proof-of-concept (multi-beneficiaries support not excluded but difficult to implement);
- **funding rules:** seal of excellence proposals funded according to the common provisions regulation (CPR) rules with some exceptions where HEU rules apply (categories, maximum amounts and methods of calculation of eligible costs); and
- **state aid rules:** pending revision of general block exemption regulation (GBER), the Seal of excellence support is exempted, under certain conditions, from the notification requirement.

Combined funding (partnerships and co-fund actions)

Financial contributions from programmes co-financed by the European Structural and Investment Funds may be considered as contribution of a MS for participating in HEU partnerships, under certain conditions.

- **Example 1:** co-funded partnerships under HEU (where national funding bodies provide financial support to third parties, which are reimbursed by the EC); and
- **Example 2:** institutionalised European partnership (Article 185/7 of the Treaty on the Functioning of the European Union, TFEU).

Managing authorities still need to respect priority areas supported by the smart specialisation strategy.

- Important to assess proposals relevance also based on partnership; and
- create 'hooks' to link in an efficient way in the related MS programmes.

Transfer of resources

MS have the possibility to voluntarily **transfer up to 5%** of the initial allocation of each fund under shared management to any other instrument under direct or indirect management for the benefit of the MS concerned.

Transferred resources must be implemented in accordance with the rules of the fund or the instrument to which the resources are transferred.

- **Mirroring provision in HEU:** resources allocated to MSs under shared management may, at their request, be transferred to the HEU Programme and be used for the benefit of the MS/region; and
- **transfer-back:** where the EC has not entered into a legal commitment under HEU by 31 August of n+1, the corresponding uncommitted resources may be transferred back to the respective programmes co-funded by the European structural and investment funds.

Cumulative funding

- The same action may receive two separate contributions from two Union funds or programmes, with due regard to the principle of co-financing laid down in the Financial regulation (cumulative funding cannot exceed 100% of the eligible costs);
- rules of contributing programmes apply to their respective share;
- combination is possible between two directly managed programmes or between a directly managed programme and a programme under shared management, and
- two separate grant agreements (GAs) will be signed for each respective part. The GAs will specify the link to the other GA ('linked action').

4.1.3 *Blending/synergies at member state and regional level*

4.1.3.1 *Member state level*

Considering the needs involved and the objectives to be achieved, actions for decarbonisation (production routes and technologies) must be immediate and coordinated across MSs, and must have sufficient public support.

To that end, the CSP aims to help removing R&D&I and systemic bottlenecks such as the transition from the pilot phase to industrial-scale deployment, high technology-related risks, large capital requirements and higher production costs. By relying on strong collaboration and joint commitment from both the private and public sectors, it aims to accelerate the transformation of the steel industry by tackling important R&D&I challenges, bringing a range of breakthrough technologies for clean steel production up to large-scale demonstration by 2030 and developing technologies at TRL 8 to reduce CO₂ emissions stemming from EU steel production by 80-95% compared to 1990 levels by 2050, ultimately leading to carbon neutrality.

The general aim is therefore to establish formal and informal mechanisms of cooperation with MSs to create additional synergies with national and regional policies and programmes.

As a matter of fact, energy-intensive industries are not only paramount for the EU, but also for MS, at their national level. See, for example, the national operational programme on enterprises and competitiveness.¹⁸

4.1.3.2 *Regional level*

The Smart Specialisation Strategy is an approach that aims to boost growth and jobs in Europe, by enabling each region to identify and develop its own competitive advantages. Through its partnership and bottom-up approach, smart specialisation brings together local authorities,

¹⁸ For further details, please see https://ec.europa.eu/regional_policy/en/atlas/programmes/2014-2020/italy/2014it16fop003.

academia, business spheres and the civil society, working for the implementation of long-term growth strategies supported by EU funds. The strategy consists of the following building blocks:

- SMART: as it identifies the region's own strengths and comparative assets;
- SPECIALISED: as it carries out priority R&I investments in competitive areas, and
- STRATEGIC: as it defines a shared vision for regional innovation.

An example of Smart Specialisation Strategy is the ERDF 2014-20 regional operational programme of the Italian region of Apulia,¹⁹ mainly aiming at promoting full convergence of the region in terms of growth and employment, while ensuring sustainability.

4.1.4 Blending/synergies at project levels

Synergies aimed at amplifying R&I investments and their impact, carrying out innovative ideas along the innovation cycle or value chain up to the market, and obtaining a greater impact on competitiveness, jobs and growth in the EU can also be achieved acting on project level.

Project synergies can be achieved through the combination of:

- funding related to the same project idea, as HEU and other EU funds (RFCS, structural funds, IF, EUInvest and CEF), through a single action or a group of coordinated actions/operations, always provided that there is no double funding of the same expenditure item, with a view to achieving cohesion and greater impact and efficiency;
- bricolage or successive projects, benefitting from the activities and results of the previous project and building a main technological road map;
- parallel projects, complementing each other when projects following different technological paths can run in parallel with a combination of different funding; and
- projects at different stages, vertically and horizontally.

Table 7 shows examples of vertical synergies among projects with different TRLs and different funding instruments according to the relevant TRL.

Table 7: Vertical synergies among projects

TRL	Type of funding
TRL 1 – Basic principles observed	HEU, RFCS, regional funds
TRL 2 – Technology concept formulated	
TRL 3 – Experimental proof of concept	
TRL 4 – Technology validated in lab	
TRL 5 – Technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)	HEU, RFCS, IF
TRL 6 – Technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)	
TRL 7 – System prototype demonstration in operational environment	
TRL 8 – System complete and qualified	HEU, InvestEU
TRL 9 – Actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies)	

¹⁹ For further details, please see https://ec.europa.eu/regional_policy/en/atlas/programmes/2007-2013/italy/operational-programme-puglia

Table 8 shows examples of horizontal synergies between single projects with different activities that can be carried out at EU, MS and regional level.

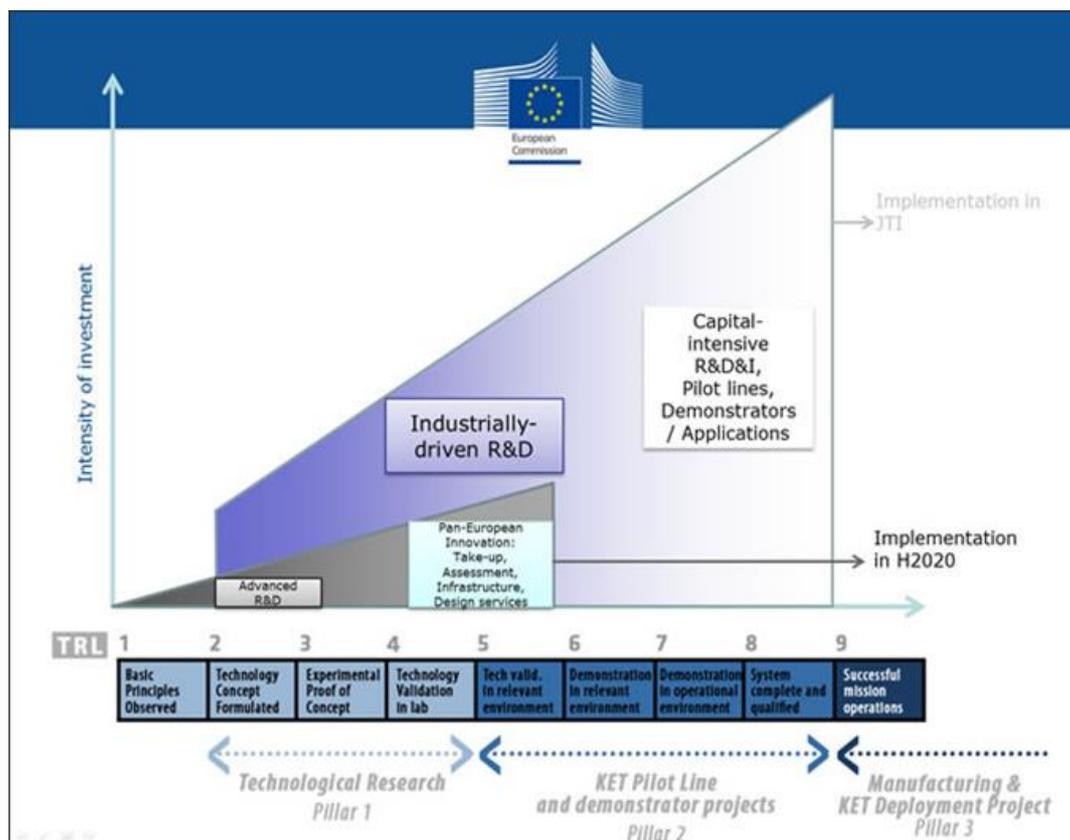
Table 8: Horizontal synergies between projects

EU/Member State/Region	Type of funding
ESTEP - EU wide research activities	HEU and RFCS
Rena - EU wide research activities	
Italy - Italian steel industry	HEU and RFCS + national programme on industry (financed by the ERDF)
Italy - Apulia	
Italy - Friuli-Venezia Giulia	
Belgium	

Source: authors' own compilation.

Synergies among projects are clearly necessary when complex frameworks arise, adequate coordination is essential, high financial efforts are required, the TRL plays a key role (see Figure 4 below) and stakeholders have to properly manage and address activities to achieve the expected results.

Figure 4: TRL versus intensity of investment



Source: European Commission.

Additionally, other organisations relevant to the steel sector are working to foster synergies aimed at reducing CO₂ emissions in this field. They are, among others: EUROFER (EUROFER 2013, 2014; Ghenda, 2017), ESTEP and the Research Initiative for European Steelmaking (RIES).

EUROFER is an international not-for-profit organisation under the Belgian law, based in Brussels. It was founded in 1976 and represents the entirety of steel production in the EU. EUROFER members are steel companies and national steel federations throughout the EU. The major steel companies and national steel federations in Switzerland and Turkey are associate members.²⁰

ESTEP was created in 2004 and recognised by the EC. It serves as a spokesman for the whole steel sector in terms of technological foresight, innovation and R&D and as a privileged interlocutor to the EC. It can be defined as a think tank, gathering representatives of the stakeholders of the steel industry (including its value chain, and the research and academic institutions that are related thereto) and focusing both on foresight and on actions to be carried out in the context of the roadmaps that it produces collectively with its members. ESTEP's mission is to engage in collaborative EU actions and projects on technology which are tackling EU challenges (notably on renewable energy, climate change, low-carbon emission and circular economy) in order to create a sustainable EU steel industry. In addition, a Mirror Group was established gathering the members of the Steering Committee and MS representatives to ensure information and communication between the Steering Committee and MSs as regards the implementation of the strategic research agenda of ESTEP within the different programmes funded by the EU. The work is carried out by experts representing its members in the Focus Groups (FGs). FGs aim to foster a collaborative approach to tackle European projects within the EU framework, such as Industry 4.0, circular economy, digitalisation, light weight solutions, ultra-low carbon steelmaking projects, CO₂ emission avoidance, etc.²¹

RIES is a virtual network supported by VDEh-Betriebsforschungsinstitut GmbH (BFI), CRM Group (CRM), Rina Consulting – Centro Sviluppo Materiali S.p.A. (CSM), and the Metals Research Institute Swerim (SWERIM), established to reach critical mass to carry out ambitious and large-scale projects. Overall, RIES gathers more than 600 graduate and postgraduate researchers. RIES has matched skills and resources to increase the competitiveness of the European steel industry and to coordinate a strategy for European research. The mission of RIES is to strengthen the R&D offer of the steel industry in Europe by making leverage on and integrating the research capabilities and the experience of its members in order to:

- provide innovative and breakthrough ideas;
- reach critical mass to establish ambitious and large-scale projects;
- develop and validate technical concepts in prototypes and pilot installations; and
- implement solutions on suitable industrial scale.

RIES is open to any European research institute which deals with the steel manufacturing process, is independent and has a considerable relevance at national level as well as international recognition.

²⁰ For further details, please see www.eurofer.eu.

²¹ For further details, please see www.estep.eu.

4.2. Overview of blending and sequencing opportunities

Table 9 below shows the existing synergies between the main European funding programmes among them, and between the main European funding programmes, on the one side, and the selected national and regional funding instruments, on the other, with regard to CO₂ emission reduction in the steel sector.

The different colours mean the following:

- green: a synergy is possible between the instruments;
- red: synergies are generally not allowed;
- yellow: the instrument is still under discussion at political level; and
- grey: information is currently not sufficient to have a clear picture.

For ease of reading, the MS columns consider all national and regional financial instruments for that MS in one single cell, showing the general relationship between those instruments and EU ones. While the various instruments at European level can generally be combined (left side of the table), synergies between EU and national instruments are generally not allowed, except for very few cases (right side of the table).

In any case, exhaustive information for each instrument, from European to national to regional ones, is reported with more details in Annex 6 of GREENSTEEL Report D2.4 (similar to the table of the SET-Plan Action), in order to properly compare all information. This comprehensive Excel table serves as GREENSTEEL database of financing programmes for CO₂ emission reduction in the steel industry.

Table 9: R&D&I funding instruments – Blending

HEU	CSP	P4P	Clean Hydrogen for Europe	RFCs	Innovation Fund	LIFE	EGDIP calls	JTF	Erasmus+	ERA-NET	IPCEI	Recovery Plan	EIB	EBRD	InnovFin	InvestEU	Austria	Belgium	Finland	France	Germany	Italy	Luxembourg	Netherlands	Poland	Spain	Sweden		
HEU																													
CSP																													
P4P																													
Clean Hydrogen for Europe																													
RFCs																													
Innovation Fund																													
LIFE																													
EGDIP calls																													
JTF																													
Erasmus+																													
ERA-NET																													
IPCEI																													
Recovery Plan																													
EIB																													
EBRD																													
InnovFin																													
InvestEU																													
Private Banks																													

Source: authors' own compilation. Note: green = blending generally allowed; yellow = funding rules under definition; red = blending generally not allowed.

Table 10 below is meant as a guideline in order to navigate through the different European instruments related to CO₂ emissions reduction in the steel sector. In particular, the table provides information on the main European funding instruments based on the project's financial dimension. The project sizes showed in the table reflect a typical small (<€7.5 M), medium (between €7.5 M and €100 M) and large scale (>€100 M) GHG emission avoidance demonstrator. The €7.5 M limit (CAPEX) is also set in the IF to separate small-scale from big-scale demonstrators. The €100 M limit is the expected upper limit of the CSP instrument.

The different colours mean the following:

- green: the project size is within the scope of the instrument;
- red: the project size is outside the scope of the instrument; and
- yellow: the instrument is still under discussion at political level.

Table 10: Guidelines on the main financial instruments available to the steel sector by project size

	Projects with funding <€7.5 M	Projects with funding between €7.5 and 100 M	Projects with funding between €100 M and 250 M	Projects with funding >€250 M
Horizon Europe (HEU) and related relevant PPPs (P4P, Clean Hydrogen)	Pillar 2 calls to be published at the beginning of 2021.			
Clean Steel Partnership (CSP)	Calls in April/May 2021.			
Research Fund for Coal and Steel (RFCS)	Usually a call every year; Average project dimension €1.5 M funding.			
Innovation Fund (IF)	IF small-scale instrument: no calls currently open; calls expected to be launched beginning of 2021.	<ul style="list-style-type: none"> - Budget up to €150 M. - Calls published on 3 July 2020. Deadline October 29th. - CAPEX: at least €7.5 M. - Application: both single legal entities and consortiums. - Breakthrough projects: funding aimed at closing the innovation gap compared to conventional plants. - Maximum grant: 60% of the relevant costs. - Payments against GHG emissions avoidance. - Costs incurred prior of the signature of the GA not included in the calculation of the relevant cost. - Grants not considered to be state aid. - Possibility for a project funded by the IF to be also supported by other Union programmes. 		

European Green Deal (EGD) calls	CSA projects starts from 2 M€	Topic Area 3 (of interest to the steel sector). Work Programme available. Project dimension: €10-40 M. Deadline: January 2021.	
InvestEU	The InvestEU Fund is expected to mobilise more than €372 B of public and private investment through an EU budget guarantee of €26,2 B that backs the investment of financial partners such as the EIB Group and others.		
Important Projects of Common European Interest (IPCEI)	<ul style="list-style-type: none"> - Two types of IPCEI actions interesting for the GREENSTEEL project: <ol style="list-style-type: none"> 1. IPCEI - Hydrogen for climate action; and 2. IPCEI – Low-carbon industries (still in preparation). - Current maximum amount for a single MS, based on the two already active IPCEIs (Microelectronics and Batteries): €400 M. - Funding up to 100% of the relevant cost, even though industry co-financing is highly likely. - IPCEIs follow state aid rules (2014/C 188/02). 		
National and regional	Instruments have to be specifically verified on a case-by-case basis because of the variety of rules.		
EIB		Loans: > €25M	No upper limit defined.
ERBD	Loans available in the range €3-250 M for specific well-defined countries.		
Banks	Conventional instruments and green bonds		

Source: authors' formulation. Note: green = funding available; yellow = funding rules under definition; red = funding not allowed.

Sequencing

Sequencing is the possibility to continue funding a project which has already been funded in the past with the same or similar instrument. It is an important aspect for funding the long-term technological evolution of a project but, from the information collected, sequencing is often a key bottleneck and it needs to be better defined in the rules of the various instruments. This aspect, though, has not generally been highlighted neither at EU nor at national or regional level.

Within the instruments' rules, sequencing is defined only in very few cases. Consequently, it is clear that sequencing management is not based on an actual definition stemming from the rules of the funding instrument, but rather on the specific technical project nature or its own evolution.

Examples of blending and sequencing

Finally, two hypothetical test cases of blending and sequencing involving European and national/regional instruments (from Germany and Italy) are provided below based on a project dimension of €50-100 M.

A) Germany - €50-100 M project example - Blending and sequencing	
Project funding dimension:	
ca. €30-50 M€ funding intended (about 50-100 M€ overall project budget)	
TRL:	
6-9	
Past or on-going projects to be taken as reference:	
<i>H₂BF – CO₂-Minderung durch H₂-Injektion in den Hochofen – Projektphase 1</i> (CO ₂ mitigation by H ₂ injection into the blast furnace – project phase 1)	
<i>H₂Stahl – Reallabor Wasserstofftechnologien zur schrittweisen Dekarbonisierung der Stahlindustrie</i> (real laboratory hydrogen technologies for gradual decarbonisation of the steel industry)	
European instruments covering at least 20% of the investment:	
None	
National/regional instruments covering at least 20% of the investment:	
National - Public:	<i>Reallabore der Energiewende</i> (real laboratories of the energy), transition by the German Federal Ministry for Economic Affairs and Energy (BMWi)
National - Private:	none
Regional - Public:	<i>progres.nrw</i> , by the North Rhine-Westphalian Ministry of Economic Affairs, Innovation, Digitisation and Energy (MWIDE)
Regional - Private:	none
Blending and sequencing:	
For each type of instrument mentioned above, see specific detailed reference in the tables included in the report, as mentioned below.	
For national/regional public instruments:	<i>Reallabore der Energiewende</i> national instruments <i>progres.nrw</i> regional instruments
Overall comments:	

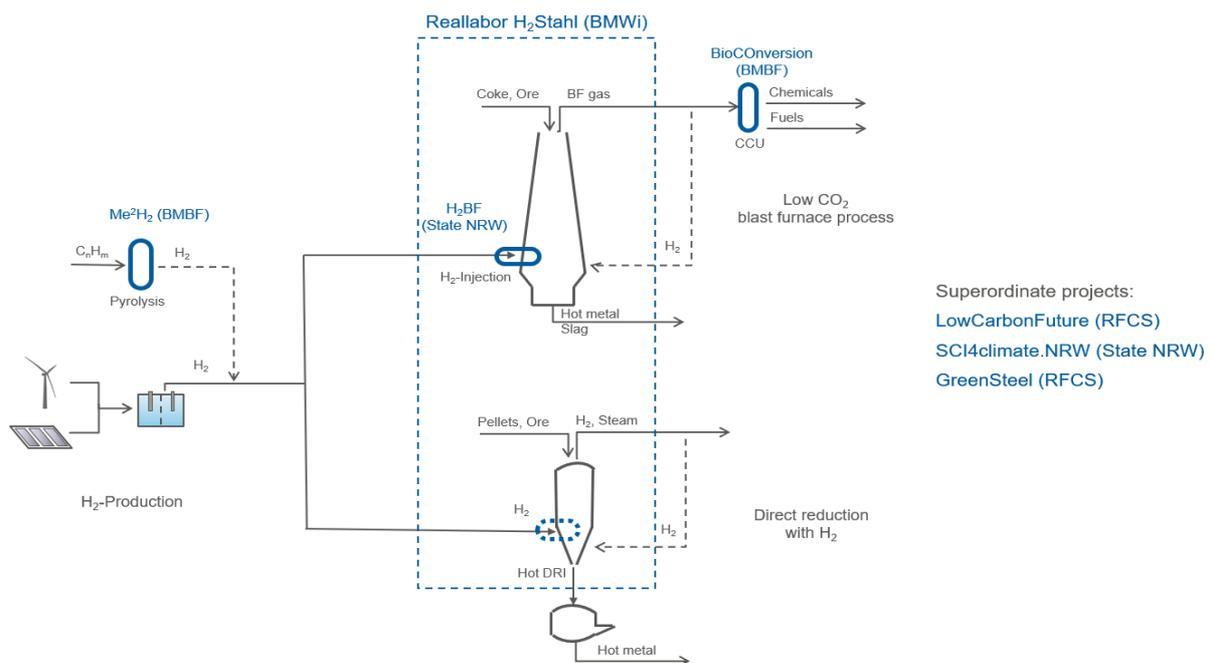
Sequencing of projects:

- First overall project phase (H₂BF project) investigates a partial adjustment at TRL 6.
- H₂BF has an overall budget of €2.7 M for a duration of 14 months.
- Its funding consists of 40% for industrial partners via *progres.nrw* by the MWIDE (regional funding).
- The second project phase (H₂Stahl project) includes an increasing adjustment at TRL 7-9 as well as an alternative process at TRL 5.
- H₂Stahl funding consists of 40% for industrial partners via the *Reallabore der Energiewende* programme by the BMWi (national funding), for both research activities and investments into plant adjustments.

Blending of (partial) projects:

- In the first overall project phase (H₂BF project) additional research demands besides H₂Stahl were discovered, leading to a different research project being carried out in parallel to H₂Stahl.
- This project is funded by *progres.nrw* regional funding.

Table 11: Blending and sequencing visualisation



Source: authors' formulation. Note: German €50-100 M project example.

B) Italy - €50 M project example - Blending and sequencing	
Project funding dimension:	
€50 M	
TRL:	
7-8	
Past or on-going projects to be taken as reference:	
None.	
European instruments covering at least 20% of the investment:	
Public:	CSP; IF; European Green Deal Calls;
Private:	EIB; EBRD.
National/regional instruments covering at least 20% of the investment:	
National - Public:	Italian Ministry of economic development (MISE) instruments;
National - Private:	national banks and industry own resources;
Regional - Public:	instruments by the region Apulia;
Regional - Private:	regional banks.
Blending and sequencing:	
Expected blending and sequencing of the various instruments:	
<ul style="list-style-type: none"> • EU public instruments: CSP, IF, large-scale demonstrator and EGD; • EU private instruments: EIB, EBRD; • national/regional public instruments: instruments by the Italian MISE and the region Apulia. • national/regional private instruments: national/regional banks and industry own resources. 	
Overall comments:	
<p>The risk related to a first-of-a-kind demonstrator is to be mitigated by public financial support. For small and large-scale demonstrators to be deployed respectively in the period 2021-35 and 2036-50, funding instruments should provide a long-term visibility as well as stability.</p> <p>In breakthrough industrial project OPEX is an important cost (in addition to CAPEX). Currently the only instrument covering OPEX is the IF, support to OPEX should therefore be reinforced.</p> <p>The identified national/regional instruments have no regular calls and do not allow for an easy blending and sequencing of EU instruments. As a consequence, improved coordination at EU and MS level is desirable.</p>	

Furthermore, in GREENSTEEL D2.4 (Draxler, 2020), as well as in Chapter 5 below, six additional real examples of already concluded, large-dimension demonstrator projects are extensively reported, where various instruments such as EIB, Investment Plan, EFSI and national instruments have been used. These projects are: Steelanol and Torero from ArcelorMittal; a project from Salzgitter AG in Germany; a project from Marcegaglia in Italy; a project from Sidenor in Spain, a project from Aperam; and the Innovation strategy and the Hydrogen breakthrough ironmaking technology (HYBRIT) project supported by companies SSAB, LKAB and Vattenfal.

4.3. Main Horizon Europe provisions related to cumulative blending and sequencing

The legal provisions of the European Commission (2018b) proposal for a Regulation establishing Horizon Europe, the Framework Programme for Research and Innovation, laying down its rules for participation and dissemination.

“TITLE II - RULES FOR PARTICIPATION AND DISSEMINATION [...]

CHAPTER II – Grants [...]

Article 23 - Cumulative funding

An action that has received a contribution from another Union programme may also receive a contribution under the Programme, provided that the contributions do not cover the same costs. The rules of each contributing Union programme shall apply to its respective contribution to the action. The cumulative funding shall not exceed the total eligible costs of the action and the support from different Union programmes may be calculated on a pro-rata basis in accordance with the documents setting out the conditions for support. [...]

CHAPTER V - Blending operations and blended finance

Article 41 - Blending operations

Blending operations decided under this Programme shall be implemented in accordance with the InvestEU Programme and Title X of the Financial Regulation.

Article 42 - Horizon Europe and EIC Blended finance

1. The grant and reimbursable advance components of Horizon Europe or EIC blended finance shall be subject to Articles 30 to 33.
2. EIC blended finance shall be implemented in accordance with Article 43. The support under the EIC blended finance may be granted until the action can be financed as a blending operation or as a financing and investment operation fully covered by the EU guarantee under InvestEU. By derogation from Article 209 of the Financial Regulation, the conditions laid down in paragraph (2) and, in particular, paragraph (a) and (d), do not apply at the time of the award of EIC blended finance.
3. Horizon Europe blended finance may be awarded to a programme co-funded where a joint programme of Member States and associated countries provides for the deployment of financial instruments in support of selected actions. The evaluation and selection of such actions shall be made in accordance with Articles 19, 20, 23, 24, 25 and 26. The implementation modalities of the Horizon Europe blended finance shall comply with Article 29, by analogy Article 43(9) and with additional conditions defined by the work programme.
4. Repayments including reimbursed advances and revenues of Horizon Europe and EIC blended finance shall be considered as internal assigned revenues in accordance with Articles 21(3)(f) and 21(4) of Financial Regulation.
5. Horizon Europe and EIC blended finance shall be provided in a manner that does not distort competition.

5. Real examples of funding instruments used by the steel sector.

Example 1: EIB - ArcelorMittal

The EIB, with the support of the EC, has granted a €75 M loan to ArcelorMittal for the construction of two ground-breaking projects at ArcelorMittal Ghent, Belgium, to considerably reduce carbon emissions by converting waste and by-products into valuable new products, helping to develop low-carbon steelmaking technologies, in line with the EU's climate objectives.

Details of the projects include:

- Steelanol is a €165 M industrial-scale demonstration plant that will capture waste gases from the blast furnace and biologically convert them into recycled-carbon ethanol, the first commercial product of ArcelorMittal's Carbalyst® family of recycled carbon chemicals. The ethanol produced can be blended and used as liquid fuel. The technology was developed by LanzaTech, with whom ArcelorMittal has entered a long-term partnership, together with Primetals and E4tech. Once completed, the plant is expected to produce up to 80 M litres of recycled carbon ethanol a year. The new installation will create up to 500 construction jobs over the next two years and 20 to 30 new permanent direct jobs. The project is expected to be completed in 2022.
- Torero is a €50 M large-scale demonstration plant that will convert waste wood into bio-coal, partially replacing the coal currently injected into the blast furnace. In the early stage, the Torero plant will be able to convert up to 60,000 tonnes of waste wood into around 40,000 tonnes of bio-coal every year. This volume will be doubled in a second stage of the project, after the start of the first Torero reactor. The new installation will create around 70 external jobs and around ten new permanent direct jobs for the operation of this installation. The plant, which is being developed in partnership with Torr-Coal, Renewi, Joanneum Research Centre, Graz University and Chalmers Technical University, is expected to be operational by the end of 2022.

Example 2: EIB, H2020, National Instrument - Salzgitter AG.

Salzgitter AG is one of Europe's largest steel producers and the global market leader in the large-diameter pipes business. The Group operates cutting-edge and resource-efficient production sites in Germany and abroad. It consists of more than 150 subsidiary and holding companies and, headed by Salzgitter AG, is structured as a holding comprising the five business units of Strip steel, Plate/Section steel, Trading, Mannesmann and Technology.

New financing will strengthen Salzgitter's research, development and innovation (R&D&I), while financing from EU banks are also supported by the Juncker Plan.

The company will use the €150 M provided by the EIB to strengthen its competitiveness and increase sustainability through technological innovation and digital transformation. The financing of the EU bank is backed by a guarantee from the EFSI. EFSI is a core component of the Investment Plan for Europe – also known as the Juncker Plan – under which the EIB and the EC are working together as strategic partners to boost the competitiveness of the European economy. EC Executive Vice-President Valdis Dombrovskis, responsible for 'An Economy that Works for People', said: "I am pleased that the EU, via the Juncker Plan, is helping the steel industry to

become more modern, digital and sustainable. By investing in research and development with this EIB financing, Salzgitter will improve its productivity and quality, ultimately benefitting the consumer”.

EIB vice-president Ambroise Fayolle, responsible for operations in Germany and the EFSI, said: “The transaction will strengthen Salzgitter’s expertise and technical know-how in particular in the field of lightweight high-strength steels for the transport industry, which is identified by the EU as a key enabling technology for advanced material. The investment will assist to safeguard about 750 jobs in Salzgitter AG's research, development and innovation and indirectly support the company’s workforce in Europe of over 20,000 people.” And the vice-president added: “I very much welcome this new cooperation with Salzgitter AG, which is backed by the Juncker Plan, as this demonstrates Europe's clear and strong engagement to support the industry in its digital transformation process”.

Salzgitter AG chief financial officer Burkhard Becker said: “The cooperation with the EIB is an important factor for our group's R&D budget financing. Salzgitter AG's long-term success is based on acting responsibly and conducting sustainable business. The EIB financing enables us to continue our intensive research and development activities towards innovative and sustainable steelmaking”.

The operation is also partially financed by national and EU grants support (H2020).

Example 3: EIB and EFSI - Marcegaglia Group.

On 29 July 2019, the EIB and Marcegaglia Group signed a seven-year loan agreement having a total value of €100 M for the digitisation and energy efficiency of its production plants.

The loan, which is the first granted by the EIB to the Mantua steel group and included in the EFSI, will also be used to build two thermal energy plants and some photovoltaic plants for the independent production of electricity and heat, which can meet 75% of the internal needs, with a significant reduction in costs and GHG emissions into the air.

In 2019 the Marcegaglia Group launched a plan of measures totalling around €600 M over the next five years to strengthen the activities of the main plants in its production chain in Italy and abroad.

Example 4: EIB and EFSI - Sidenor.

The EIB has taken a further step in fostering innovation in the steel industry financing Sidenor, a European leader in the production of specialised steel, to carry out its strategic innovation plan centered on improving cost efficiency, modernising and digitalising its facilities, and developing new products with higher added value.

The EIB granted on 22 July 2019 a €50 M loan to Sidenor under the EFSI, the main pillar of the Investment Plan for Europe, also known as the Juncker Plan.

Sidenor will use the EIB funding to acquire state-of-the-art technologies to enhance the quality of its steels and improve its production efficiency to meet the latest market demand. These investments will also enable Sidenor to reduce its environmental impact by producing in a more sustainable way with less energy consumption.

Related works will be carried out up to 2021, in the company’s plants (located mainly in the Basque Country), aimed at safeguarding jobs in the steel sector.

The European Commissioner Miguel Arias Cañete, responsible for Climate Action and Energy, said: “With this investment, the EU is providing tangible support to achieve our decarbonisation objectives, while helping the transition and competitiveness of our industry. Addressing emissions

from carbon-intensive industries is a key priority in this context, and also fosters Europe's global leadership of climate-friendly technologies".

Example 5: EIB - Aperam

The EIB and Aperam signed, on 25 February 2019, a financing contract where the EIB will make available to Aperam an amount of €100 M. The purpose of this contract is the financing of investments in the cold rolling, annealing and pickling line at Aperam's plant.

This financing contract with EIB will support Aperam's strategy to enlarge its product range, to incorporate the most demanding applications, to increase efficiency and cost competitiveness, and to continuously enhance its health, safety and environmental impact.

EIB Vice-President Ambroise Fayolle said: "The EIB is proud to continue supporting Aperam in its plant modernisation investments in France (Nord Pas-de-Calais) and Belgium (Châtelet) and also to contribute to the upgrading of its Genk (Belgium) plant with advanced stainless-steel manufacturing technology. Innovation, at the heart of competitiveness, is the best response against the challenges currently facing the stainless-steel industry and the EIB is there to support it."

Example 6: National Instruments – HYBRIT (2021-27).

HYBRIT is the largest running decarbonisation project in Sweden in the area of iron- and steelmaking. In 2016, SSAB (global leader in high-strength steels), LKAB (Europe's largest iron ore producer) and Vattenfall (one of Europe's largest electricity producers) joined forces to create HYBRIT, an initiative that endeavours to revolutionise steelmaking. HYBRIT aims to replace coking coal, traditionally needed for ore-based steelmaking, with hydrogen.

In order to achieve the goal, this joint venture between SSAB, LKAB and Vattenfall was formed, which is a ground-breaking effort to reduce CO₂ emissions and de-carbonise the steel industry.

In 2018, work started on the construction of a pilot plant for fossil-free steel production in Luleå, Sweden. The goal is to have a solution for fossil-free steel by 2035. If successful, HYBRIT means that Sweden's CO₂ emissions can be reduced by 10% and Finland's by 7%.

The total cost for the pilot phase is estimated to be SEK 1.4 B. The Swedish Energy Agency contributes more than SEK 500 M to the pilot phase and the three owners, SSAB, LKAB and Vattenfall, will each contribute one third of the remaining costs. The Swedish Energy Agency has earlier contributed SEK 60 M to the pre-feasibility study and a four-year-long research project. The pilot phase is planned to last until 2024, after which it will move to the demonstration phase in 2025-35.

Already before a solution for fossil-free steelmaking is in place, SSAB aims to cut its CO₂ emissions in Sweden by 25% as early as 2025, through conversion of the blast furnace in Oxelösund, Sweden, to an electric arc furnace. Between 2030-40, the aim is to also convert the blast furnaces in Luleå, Sweden and Raahe, Finland to eliminate most of the remaining CO₂ emissions and to reach the target of being fossil-free by 2045.

Overall, the expected impact on CO₂ emission reduction is 25% by as early as 2025 and 100% by as early as 2040 for SSAB in Sweden and Finland. As regards possible recommendations to the institutional frame, the following should be considered. To be able to carry out the HYBRIT initiative, significant national contributions are still required from the state, research institutions and universities. There must be good access to fossil-free electricity, improved infrastructure and rapid expansion of high voltage networks as well as research initiatives, faster permit processes and the government's active support for the pilot and demonstration facilities, plus a long-term support at EU level.

6. Concluding remarks

CO₂ emissions are difficult to abate in a sector such as steel, but new technological solutions are becoming more and more relevant.

The EU steel industry produces a basic material that is needed at present and will continue to be essential for our modern society. The most relevant greenhouse gas for the steel industry is carbon dioxide and the steel industry is one of the biggest industrial actors in terms of CO₂ emissions. In addition, the global steel production is forecasted to grow from 1.7 B tonnes in 2018 to 2.8 B tonnes in 2050, with the EU being the second largest producer of steel in the world after China. Therefore, CO₂ emissions from the steel industry need to be significantly reduced.

Climate transition entails various policy, technology and market risks for the EU steel sector. The steel industry, moreover, generally operates with low profit margins in very competitive markets and, in addition, has been severely hit by Covid-19. It therefore needs financial support for the implementation of CO₂-low production technologies.

The steel industry is likely to face technological challenges in deploying a carbon-neutral steel production. Each technology has a role to play in cutting CO₂ emissions with a view to reaching climate neutrality by 2050, but their implementation at industrial scale requires huge investments. New CO₂-low production technologies will require around €50 to 60 B (EUROFER, 2019) of investment and will result in capital and operating costs between €80 and 120 B per year. The price per tonne of primary steel will increase by 35% up to 100%. In other words, large investments in innovation and integrated breakthrough technologies for the European steel industry are crucial to achieve the EU's climate and energy targets, boost its competitiveness and, at the same time, give stakeholders a 'first-mover' advantage in the global scene.

Both EU and national financial support schemes for the decarbonisation of industrial installations must be made available at a sufficient scale for the entire transition period from 2021 to 2050. Based on currently available information, the analysis of national and regional funding instruments carried out for 11 European countries has found that **approximately €400 M per year** (for the period 2021-22) **would be available for reducing CO₂ emissions in the steel sector**. Moreover, current national and regional instruments are not sufficiently coordinated in terms of their scope, timeline and funding availability. Those instruments need long-term visibility and stability to better allow blending with the new set of EU instruments, to properly support the CO₂ emission reduction in the steel sector.

In conclusion, the 2050 climate challenge can only be met if private capital is sufficiently supported by a consistent and coordinated framework of public funding opportunities at EU, MS and regional level. In addition, the steel industry and other stakeholders will need to cooperate in order to overcome the technological and economic challenges they face in implementing CO₂-low production technologies.

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