ESTEP & Clean Steel Partnership

Klaus Peters, Secretary General ESTEP

10 July 2023

ESTEP
European Steel Technology Platform

CSP
The Clean Steel Partnership

Challenge for all industries

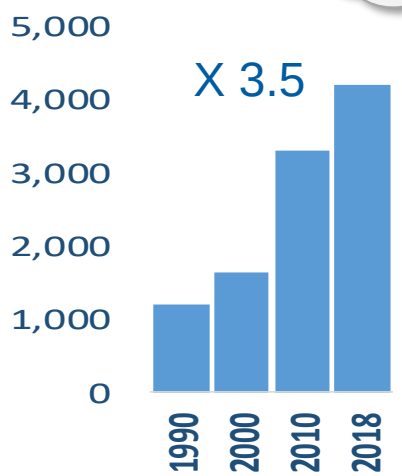
How to meet the growing global demand in a Sustainable + Climate Neutral way

Global production

Million tonnes

Cement

1t CO_2/t



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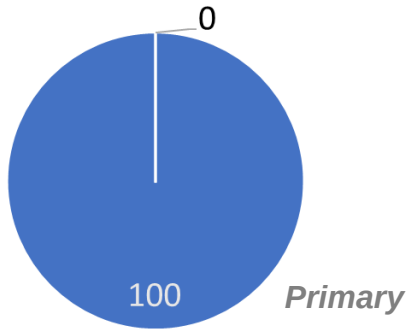
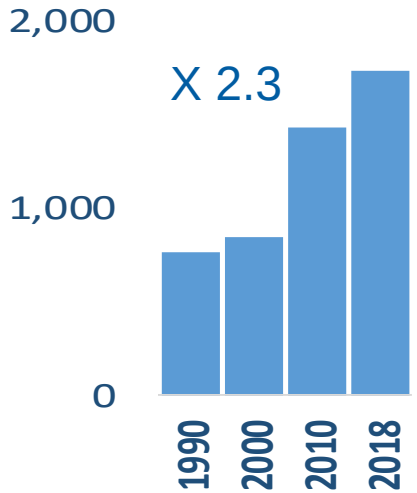
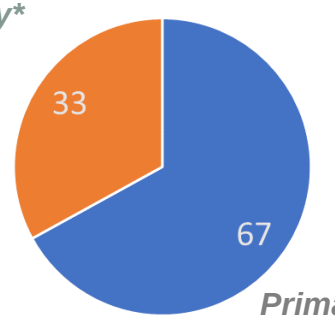


Steel

2t CO_2/t



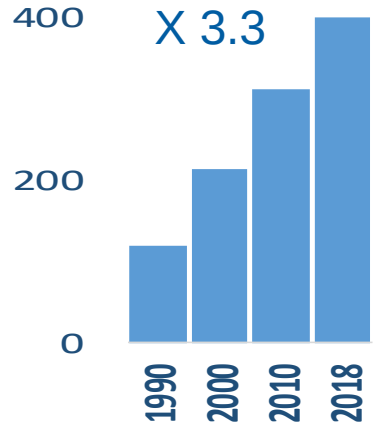
Secondary*



Plastics

CO_2 *when produced from primary sources*

6t CO_2/t



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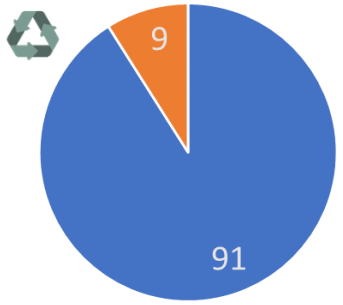


Materials are responsible for 25% of GHG and demand has tripled over the last 30 years.

* Defined as end of life material recycled to make same material again

Sources: WSA, Plastics Europe, ArcelorMittal Corporate Strategy analysis

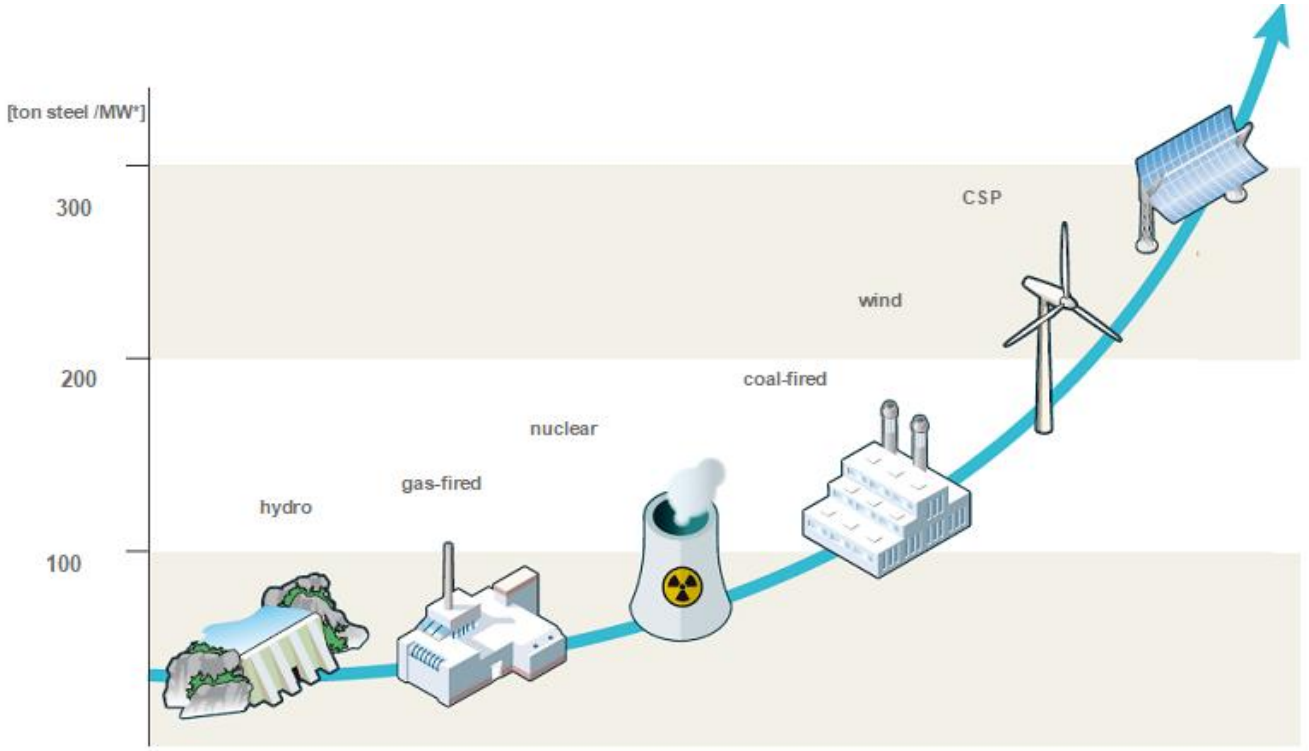
Vision – Ambitions of Clean Steel Partnership

Long-term vision for CO_2 emissions reductions compared to 1990 levels:

- Develop technologies reducing CO_2 emissions from steel production by 50% by 2030 compared to 1990 levels; and
- Reduce CO_2 emission by 80-95% by 2050 compared to 1990 levels, ultimately achieving climate neutrality.

Immediate and intermediate ambitions consist of piloting and demonstrating breakthrough technologies that can significantly reduce the impact of steel production on the climate footprint.

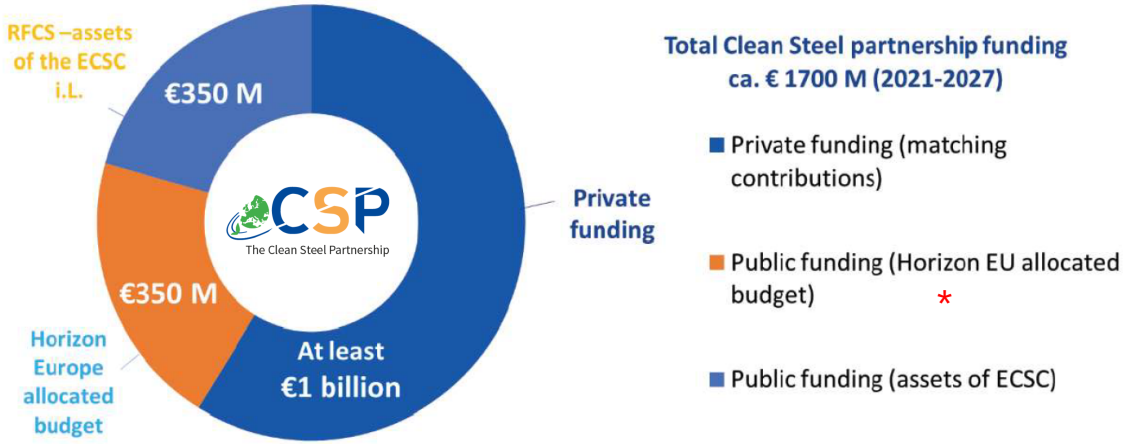
The achievement of sustainable growth will depend largely on the EU spearheading global efforts on **renewable energy**. Steel is an essential material in modern energy solutions, which is why clean steel will be instrumental to reach this common vision.



EU Steel Research Programs
Horizon Europe + Research Fund for Coal and Steel (RFCS)

Horizon Europe 2021-2027

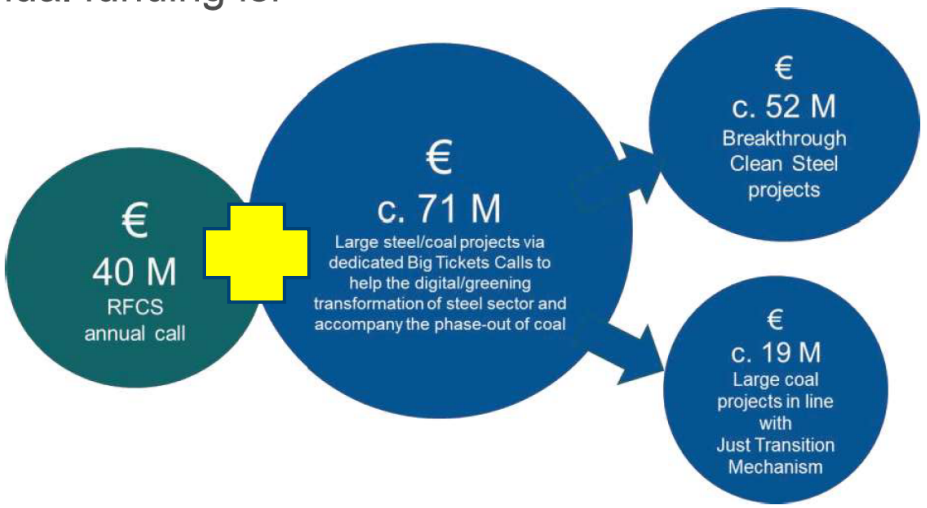
- Dedicated investment of € 350 million, with contribution of private funding.
- Clean Steel has 2 sources of funding, HE and RFCS, contributing to research & innovation with a total of € 700 million in the period 2021-2027.



* ECSC=European Coal and Steel Community (grandfather of the EU)

RFCS

- By Council decision it relies on multiannual technical guidelines.
- With the new legal base in force since 2021 the annual funding is:



The distribution of funding is set at **27.2 %** for coal-related research and **72.8 %** for steel-related research, as provided for by Article 4(2) of the implementing measures, decided by the Council in 2003.

Strategic Research Innovation Agenda & MoU

MoU

EN
Annex 3

Memorandum of Understanding for the
Co-programmed European Partnership for Clean Steel - Low Carbon Steelmaking

The ESTEP aisbl, representing the partners other than the Union (its constituent entities[1]), the registered offices of which are in Avenue Cortenbergh 172, 1000 Brussels, Belgium, hereafter referred to as the "Partners other than the Union", and the European Union, represented by the European Commission, (jointly hereinafter referred to as "the Partners"),

Considering that:

- Parts of Horizon Europe – the Framework Programme for Research and Innovation ('Horizon Europe')[2] – may be implemented through Co-Programmed European

FOR THE EUROPEAN COMMISSION	FOR THE ESTEP AISBL
	Dr. Franz M. Androsch President of ESTEP
	VICE-PRESIDENT of ESTEP

SRIA

The Clean Steel Partnership

Clean Steel Partnership – CSP

- Horizon Europe (2021-2027)
- **Co-programmed** Partnership
- Two financial funding pillars
  - Horizon Europe
  - Assets of Research Fund for Coal and Steel (RFCS)
- Established by **Memorandum of Understanding** (MoU)
  - ESTEP
  - DG RTD & DG Grow
- SRIA explains in detail the **intended activities of CSP**
- **SRIA adopted** by the Partnership Board of the Clean Steel Partnership on 13 December 2021
- **SRIA Update** end 2023/beginning 2024

CSP = co-programmed public private partnership

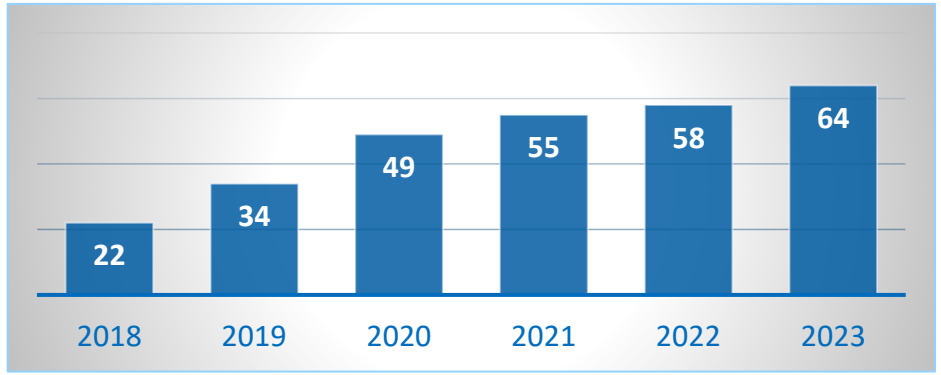
- Public calls open to every organization
  - According to Horizon Europe (HEU) regulation
  - According to Research Fund for Coal and Steel (RFCS) regulation
  - No membership etc. required

- ESTEP facilitates the private side of the Clean Steel Partnership
  - Membership in ESTEP (European Steel Technology Platform) available for steel stakeholder
  - Clean Steel Partnershipboard private side composed of ESTEP members
  - ESTEP organises CSP related events for its members (in addition to open events)
    - Contribute to definition of the call texts of CSP (HEU+RFCS)
    - Information sharing
    - Brokerage event, consortium matchmaking

ESTEP Members

Continuous growth of ESTEP membership

- founded in March 2018 by 13 organisations



Country

	Count of Member
Austria	6
Belgium	6
Finland	2
France	4
Germany	12
Italy	18
Luxembourg	1
Norway	1
Poland	1
Portugal	1
Spain	3
Sweden	5
The Netherlands	2
United Kingdom	2
Grand Total	**64**

Type

	Count of Member
Academia	6
EUROFER	1
Industry	39
RTO	17
SME	1
Grand Total	**64**

European Steel Technology Platform (ESTEP)

- European Technology Platform (EU 2020)
  - Created in **2004** (ULCOS) and reconfirmed by EC in 2013
  - Legal entity (AiSBL): incorporation by 13 founders in March 2018
  - Members almost 5-fold by 2023: 64 members (Apr 2023)
  - Open for organisations from EU + associated countries

- ESTEP mission

  Collaborative EU actions (projects)
  on innovative technology
  to tackle EU challenges
  (renewable energy, climate change (CO_2), Circular Economy) in order
  to create a sustainable EU steel industry

- Collaborative work in 6 Focus Groups
  - Thematic mini-conferences
  - Initiate proposal writing
  - Road mapping and publication
  - Work towards standardisation

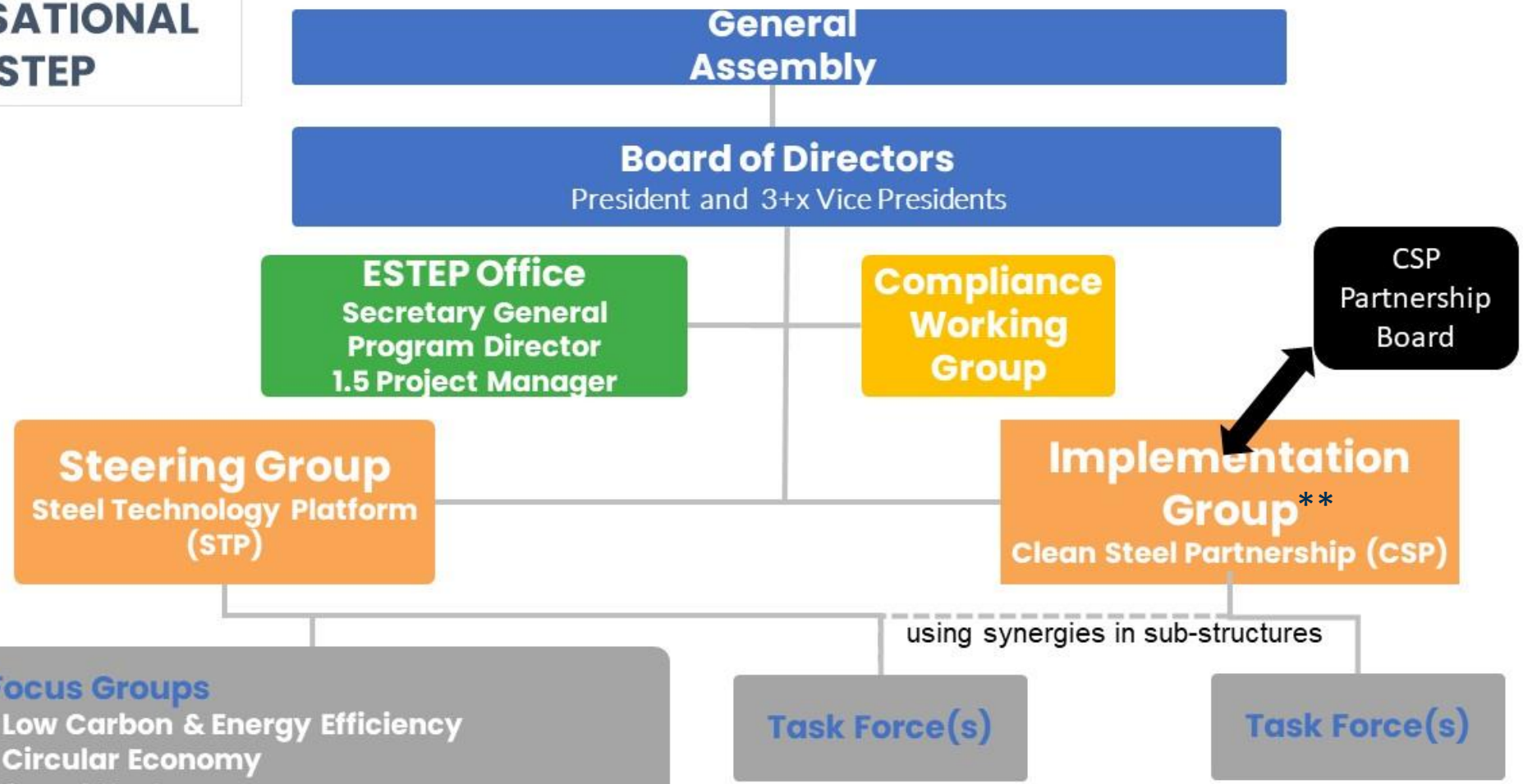
- EU Clean Steel Partnership

CSP SRIA available at ESTEP.eu

ESTEP SRA available at ESTEP.eu

ESTEP Governance
Steel Technology Platform & Clean Steel Partnership

ORGANISATIONAL CHART ESTEP



** The ESTEP Implementation Group will prepare the input to the PB.

Open, transparent and inclusive:
- All members attend Steering Group and Implementation Group
- Minutes of SG + IG + Board are shared with all members

EU Clean Steel Partnership
Governance

Private side

- ESTEP
- Members:
  EUROFER
  Steel Producers
  Plant Builders
  Research
  others

Partnership Board

1x / year

Up to 2 external advisory groups

Public side

- Commission
- DG RTD
- DG Grow
- others

EU Clean Steel Partnership

Accelerate towards net zero CO_2 steelmaking

- Partnership in the frame of Horizon Europe (HEU) in 2021 to 2027/2030
  - Unique setting due to synergies of public financial pillars (HEU + **R**esearch **F**und **C**oal+**S**teel)
  - Memorandum of Understanding signed by ESTEP + European Commission (RTD+Grow)
- CSP-Budget: € 1.7 billion
  - €350 million from Horizon Europe
  - €350 million from assets of the ECSC* in Liquidation (source of RFCS funding)
  - At least matched by steel sector (expected €1.000 million)
- Projects
  - size: € 10-100 million
  - Developments starting at TRL 6 to end up with TRL 8 (Technology Readiness Level)
    exceptional start at 5 to end up with at least TRL 7
  - 2 + 2 demonstrators showing CO_2 emission reduction potential of at least 50% (80%)
- Strategic Approach by 12 Building Blocks
  - Building Blocks define collaborative research areas
  - Impact by linking the Building Blocks with company pathways
    - Carbon Direct Avoidance
    - Smart Carbon Usage (Process Integration and CCUS)
    - Circular Economy

*ECSC=European Coal and Steel Community (grandfather of the EU)

EU Clean Steel Partnership
Strategic approach

3 Technology Pathways

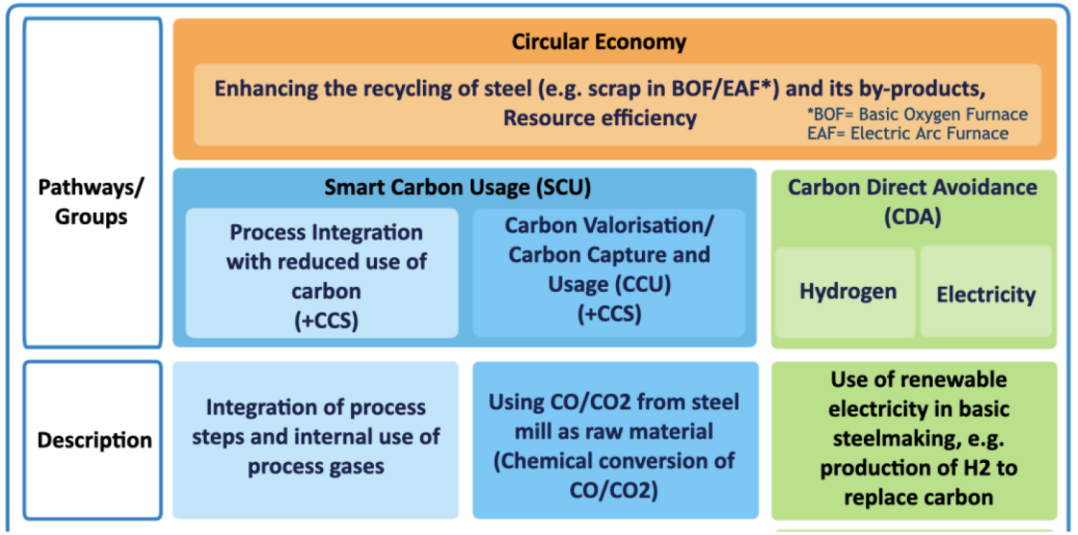
- Carbon direct avoidance (CDA)
- Smart carbon Usage (SCU)
- Circular Economy (CE)

6 Areas of Intervention

- CDA, SCU-PI, SCU-CCUS, CE, combination
- Digitisation, Social Innovation

12 Building Blocks (BB)

- Bring to TRL8 at large scale
- Foster collaborative projects
- **Integrating BB into the 3 Pathways**



TRL=Technology Readiness Level
CSP roadmap (SRIA): www.estep.eu/clean-steel-roadmap

Overview of 14 Awarded Projects in 2021 + 2022
Horizon Europe Cluster 4 for Clean Steel + RFCS Big Tickets for Steel

Topic 18: Carbon Direct Avoidance in steel: Electricity and hydrogen-based metallurgy

Topic 19: Improvement of the yield of the iron and steel making

Topic 22: Adjustment of Steel process production to prepare for the transition towards climate neutrality

Topic 13: Raw material preparation for clean steel production

Topic 16: Modular and hybrid heating technologies in steel production

Prg.	Year	Topic	Project Acronym
HEU	2021	18	MaxH2DR
		19	HiYield
		19	ReMFra
		19	CAESAR
		22	RecHycle
	2022	13	PureScrap
		13	TransZeroWaste
		16	GreenHeatEAF
		16	ModHEATech
		16	HyTecHeat

Obj. 1: Preparation of steel CO/CO2 gases for Carbon Capture Use and Storage (CCUS)

Obj. 2: Process Integration (PI) in steel plants to reduce the use of fossil carbon and associated CO2 emissions

Obj. 3: CO2 neutral iron ore reduction (Increasing the use of pre-reduced iron carriers)

Obj. 4: Developing technologies to reduce the specific energy required to produce steel

Prg.	Year	Obj.	Project Acronym
RFCS Big Ticket Steel	2022	2	MODIPLANT
		2	FullH2Reheat
		2	HYDREAMS
		2	TWINGHY

Overview of 14 Awarded Projects in 2021/22
HE Cluster 4 for Clean Steel and RFCS

no	project acronym	EU funding
1	MaxH2DR	4,2
2	CAESAR	5,6
3	HIYIELD	3,6
4	RemFRa	4,8
5	RecHycle	6,2
6	PURESCRAP	5,0
7	TransZeroWaste	5,0
8	GreenHeatEAF	3,6
9	HyTecHeat	3,4
10	ModHEATech	3,4
11	FULL2REHEAT	8,6
12	HYDREAMS	4,3
13	MODIPLANT	8,0
14	TWINGHY	4,5

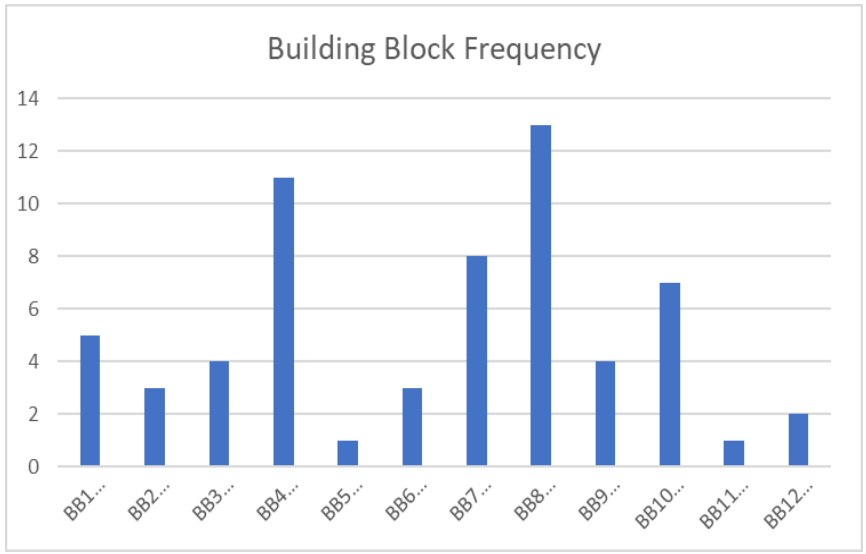
Total > 70 million Euro

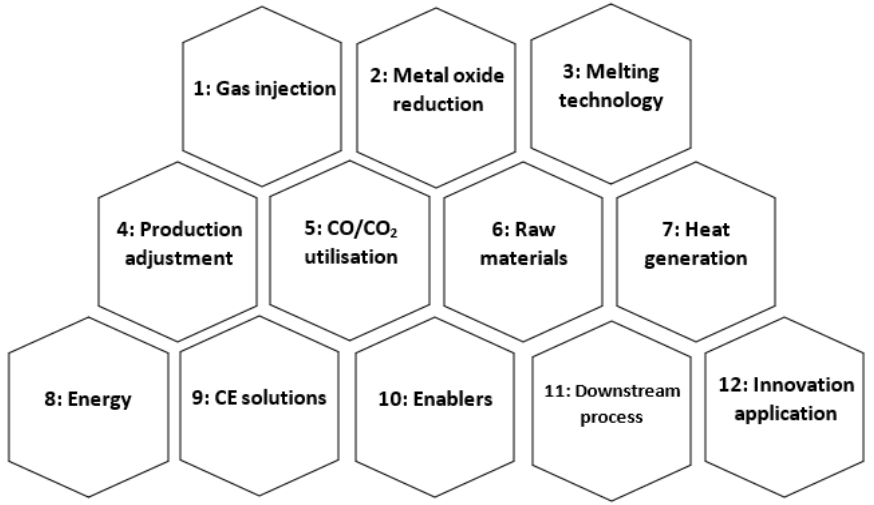
Long project title

1. MaxH2DR provides missing knowledge and data of reduction processes
2. CirculArity Enhancements by Low quality Scrap Analysis and Refinement
3. Highly efficient technologies for increased yields in steelmaking processes and reduced environmental impact
4. Improving circularity and sustainability in the EU steel industry
5. Recycling renewable hydrogen for climate neutrality
6. Purity improvement of scrap metal
7. Upgrading of low-quality iron ores and mill scale with low carbon technologies
8. Electric arc furnaces to reduce steelmaking emissions
9. Hybrid technologies for low-CO2 steel manufacturing
10. MOdular HEAting TECHnology through renewable resources for steel production
11. Demonstrator of Industrial Transformation with Hydrogen for HAV long products rolling mills
12. Clean Hydrogen and Digital tools for REheating And heat treatMent for Steel
13. MODular hybrId technology in the Steel PLANT production
14. Digital TWINs for Green HYdrogen transition in steel industry

HEU-RFCS 2021-2022 Project fit with building blocks CSP Strategic R&I agenda (SRIA)

Call	Call Topic	Project Name	BB1 Gas Injection	BB2 Metal Oxide Reduction	BB3 Melting Techology	BB4 Product Adjustment	BB5 CO/CO2 Utilisation	BB6 Raw Materials	BB7 Heat Generation	BB8 Energy	BB9 CE Solutions	BB10 Enablers	BB11 Downstream Process	BB12 Innovation Application
HEU 2021	#18	MaxH2DR	x	x		x				x		x		x
	#18	RecHycle	x	x		x	x			x		x		x
	#19	HiYield				x				x	x			
	#22	ReMFra		x							x			
	#22	CAESAR				x		x		x	x	x		
HEU 2022	#13	PURESCRAP			x			x		x	x	x		
	#13	TransZeroWaste			x			x	x	x				
	#16	GreenHeatEAF			x	x			x	x				
	#16	ModHEATech			x	x			x	x				
	#16	HyTecHeat				x			x	x		x		
RFCS BT 2022		MODIPLANT	x			x			x	x				
		FULL2REHEAT	x			x			x	x		x	x	
		HYDREAMS	x			x			x	x				
		TWINGHY				x			x	x		x		





Overview of 14 Awarded Projects in 2021/22
HE Cluster 4 for Clean Steel and RFCS

Prg.	Year	Topics	Funding budget	# proposals	Requested funding	Total project costs
HEU	2023	43	23	2		
		45	12	8		
RFCS		1-5	130	9	90	263

90 / 263 = 34.2% << 50%
High commitment of private side in RFCS

CSP calls 2023 Cluster 4 Horizon Europe

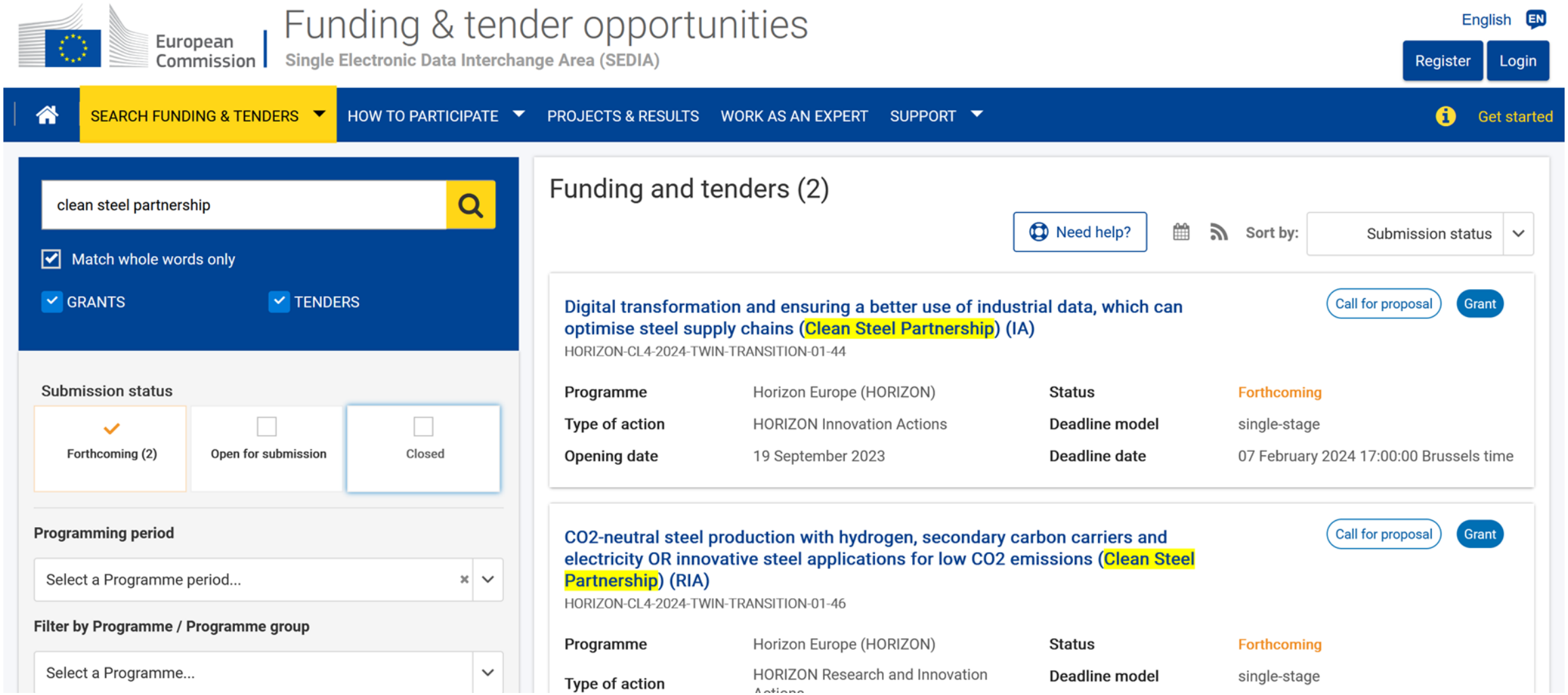
Topic 43: Low carbon-dioxide emission technologies for melting iron-bearing feed materials OR smart carbon usage and improved energy & resource efficiency via process integration

Topic 45: Circular economy solutions for the valorisation of low-quality scrap streams, materials recirculation with high recycling rate, and residue valorisation for long term goal towards zero waste

CSP RFCS BIG Ticket call objectives

1. CO2 neutral iron ore reduction (Increasing the use of pre-reduced iron carriers)
2. Developing technologies to reduce the specific energy required to produce steel
3. Circular economy and sector coupling solutions to meet the zero-waste goal for steelmaking
4. Preparation of steel CO/CO2 gases for Carbon Capture Use and Storage (CCUS)
5. Process Integration (PI) in steel plants to reduce the use of fossil carbon and associated CO2 emissions

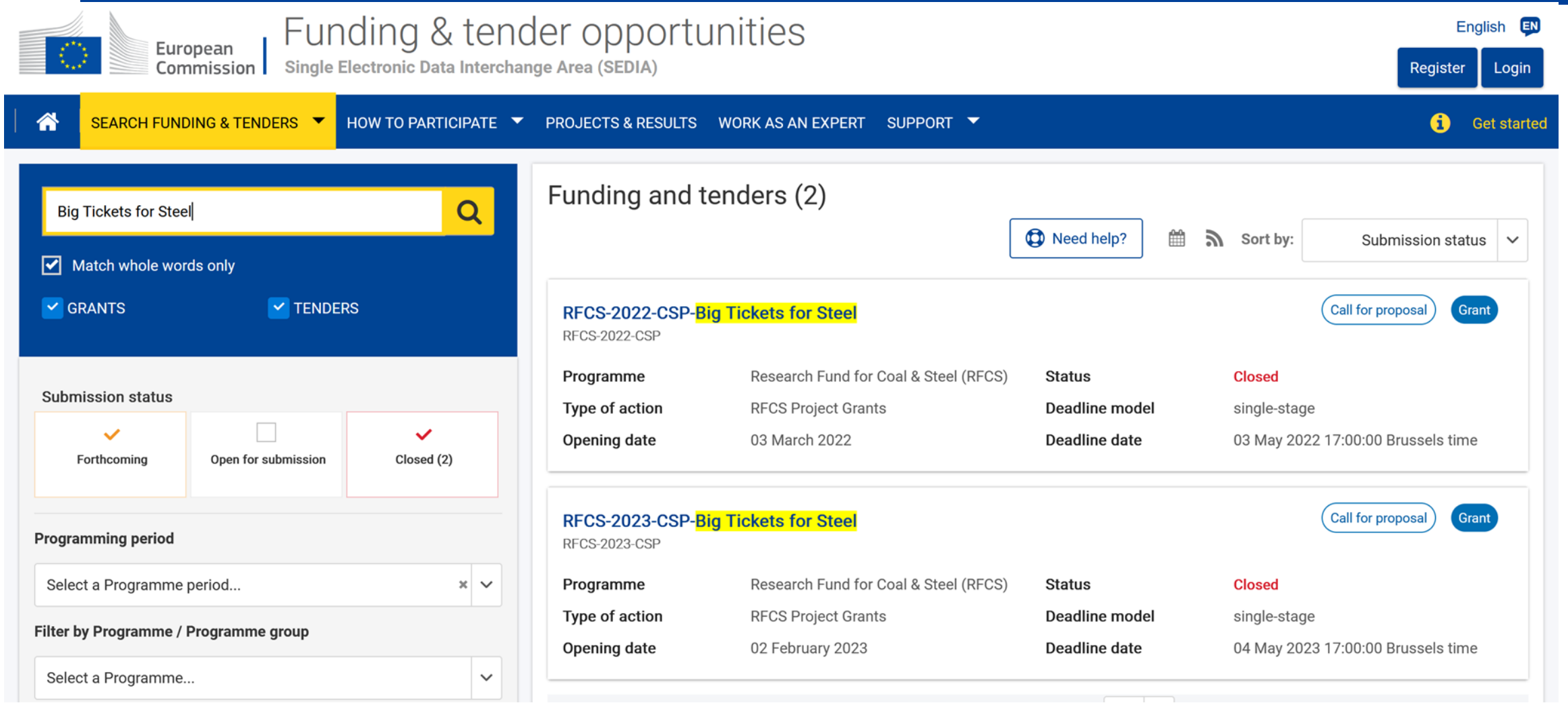
Upcoming calls 2024 Horizon Europe



Link: https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-search

Search: Clean Steel Partnership

Upcoming calls 2024 RFCS



Link: https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-search

Search: Big Tickets for Steel

Call topics and objectives 2024
Cluster 4 for Clean Steel and RFCS

CSP calls 2024 Cluster 4 Horizon Europe

Topic 44:

Digital transformation and ensuring a better use of industrial data, which can optimise steel supply chains

Topic 46:

CO_2-neutral steel production with hydrogen, secondary carbon carriers and electricity **OR** Innovative steel applications for low CO_2 emissions

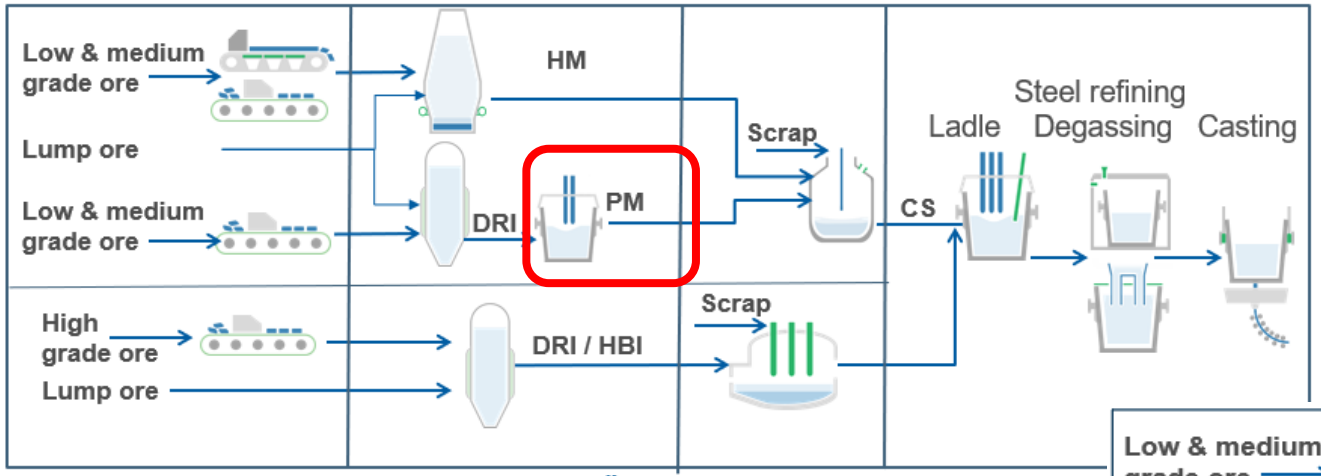
CSP RFCS Big Ticket 2024 call objectives *

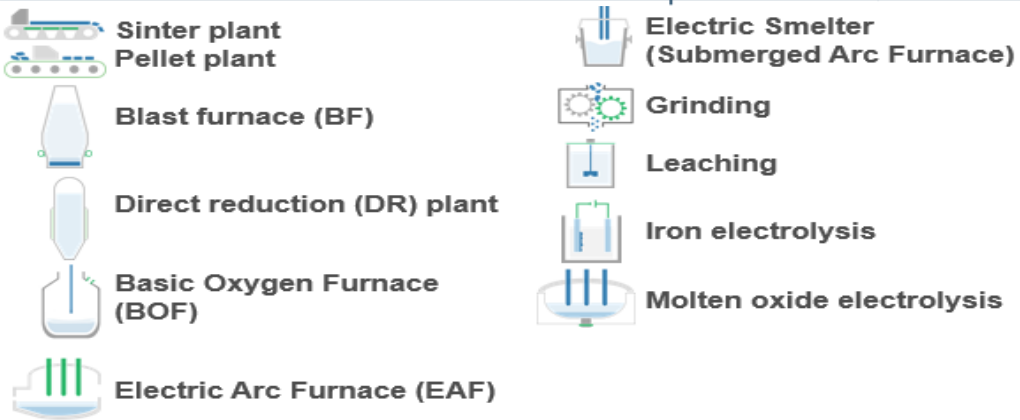
1. Cross cutting issues: digitalisation, skills and social innovation
2. CO2 neutral iron ore reduction (Increasing the use of pre-reduced iron carriers)
3. Technologies to improve energy efficiency, increase heat recovery and enhance Process Integration (PI) approaches in steel production.
4. Advanced steel alloys for special applications
5. Circular economy and sector coupling solutions to meet the zero-waste goal for steelmaking
6. Preparation of steel CO/CO_2 gases for Carbon Capture Use and Storage (CCUS)

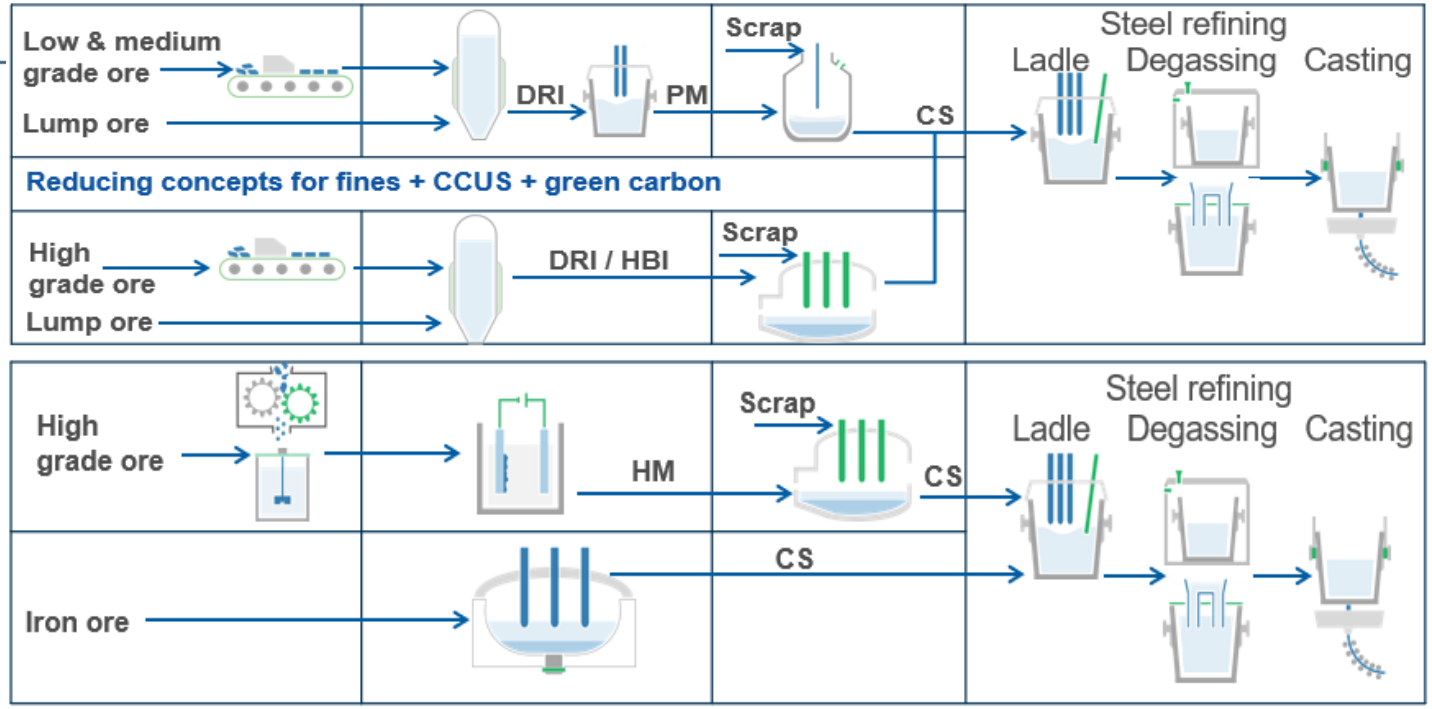
* Subject to changes

Co-existence of new breakthrough and traditional steelmaking processes

Near term (2030) | Mid term (2040) | Long term (2050)







HM Hot Metal
DRI Direct Reduced Iron
PM Pre Melt
CS Crude Steel
HBI Hot Briquetted Iron
CCUS Carbon, Capture, Utilization and Storage

Source: sustainability summit 2022

Key steel low-CO2 projects of the EU steel industry

ESTEP
European Steel Technology Platform

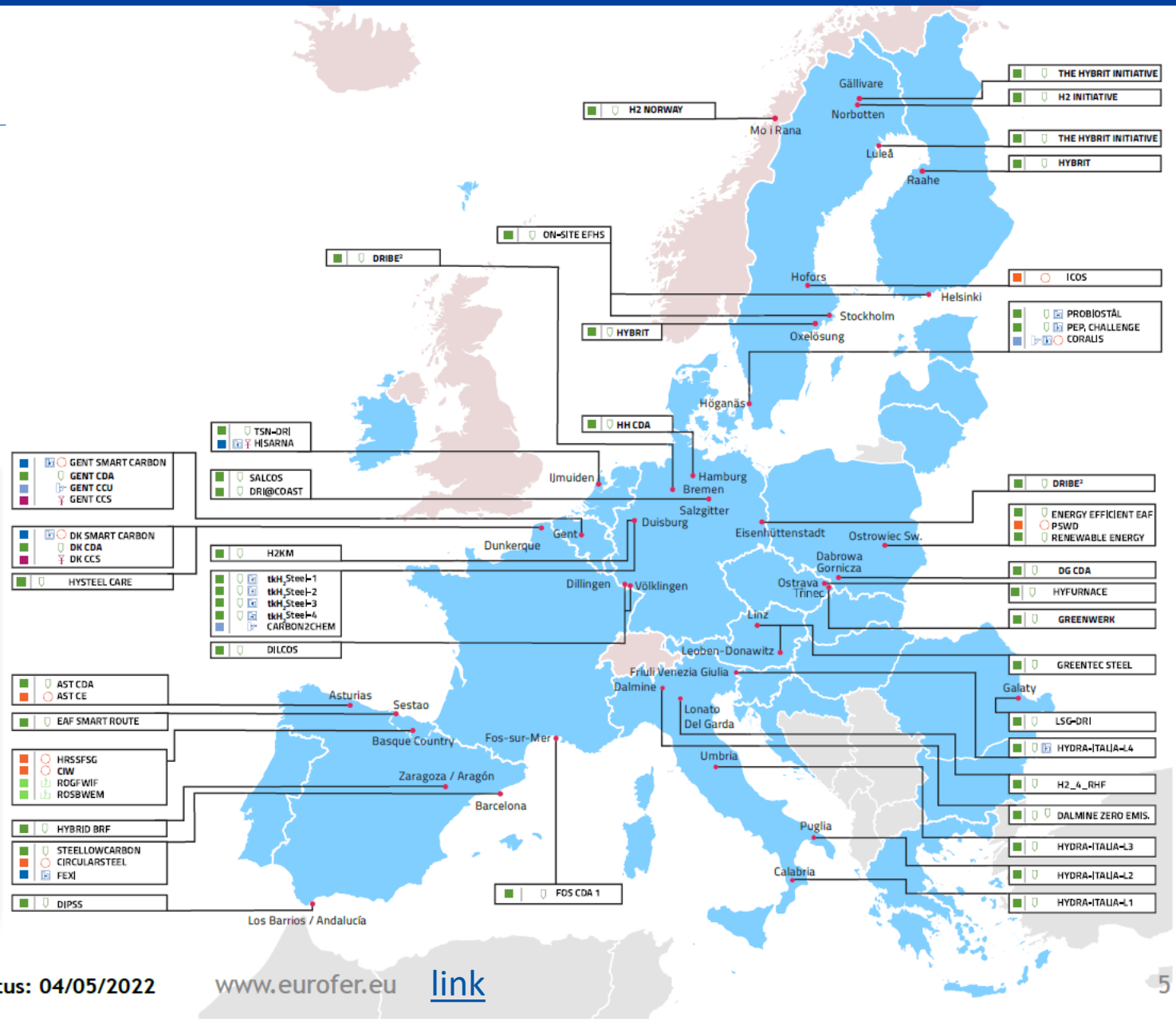
Circular Economy (CE)

Carbon Direct Avoidance (CDA)
- H_2-based metallurgy
- Electricity-based metallurgy

Smart Carbon Usage (SCU)
- Proces Integration
- Carbon Valorisation/CCU

Carbon Capture and Storage CCS²
(not included in SCU, CDA or CE)

- **60** projects
- Technology Readiness Level : at least **TRL 7**
- Starting year: almost all **before 2030**
- Potential CO_2 abatement in 2030 **: 81.5 Mio tons/year** (over 1/3 of current direct and indirect CO_2 emissions)
- **Capex** needs : **31 bn** EUR
- **Opex** needs : **54 bn** EUR

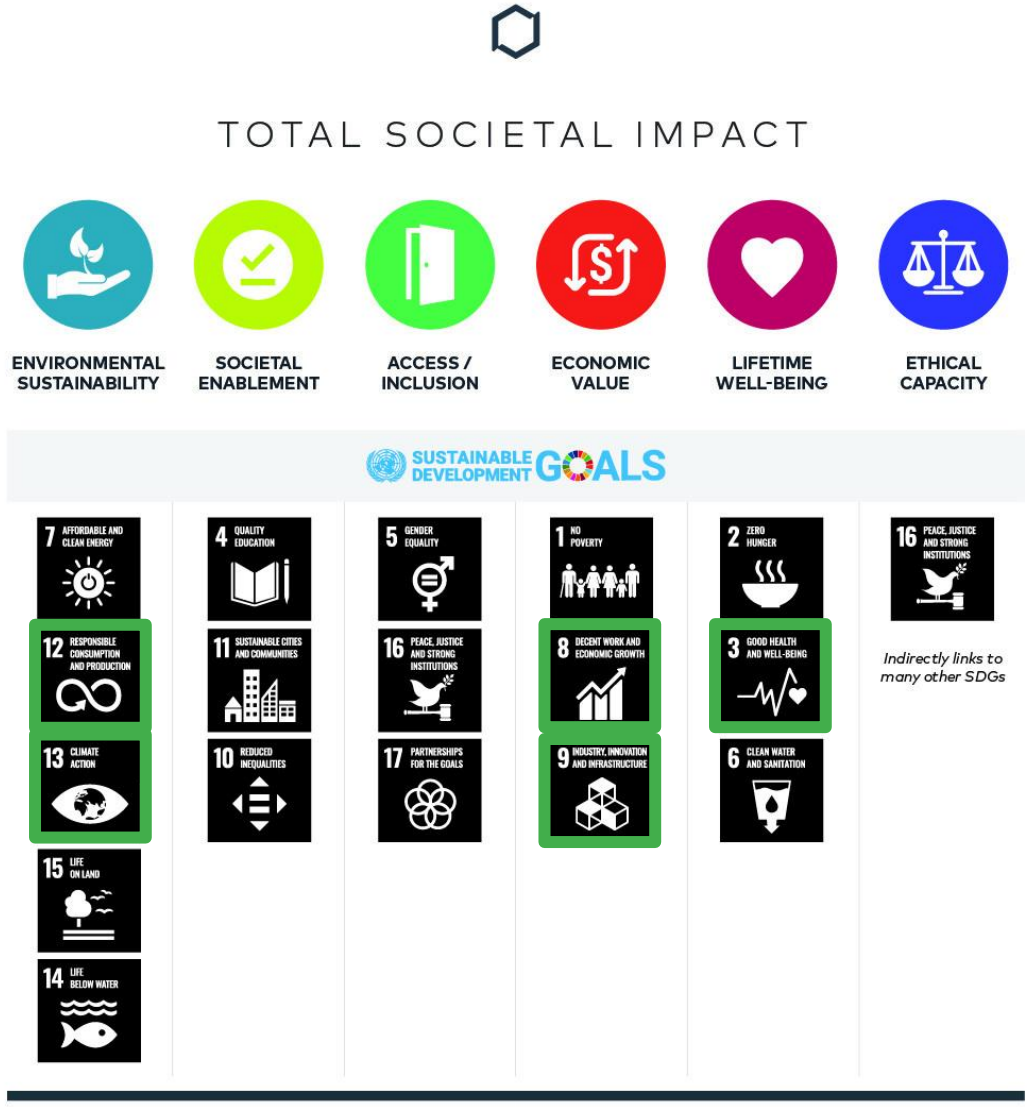


Status: 04/05/2022

www.eurofer.eu link

Impacts on industry and society

- The objectives and impacts of the Partnership are in line with **the pathways of Horizon Europe**
- Contribute to **the Sustainable Development Goals** 3, 8, 9, 12 and 13 under the United Nation's 2030 Agenda
- Impacts in various areas, such as:
  - **CO_2 reduction**: new technologies will be deployed that could reduce emissions from EU steel production by 50% by 2030, compared to 1990 levels;
  - **Industry and EU competitiveness**: The support for the deployment of the decarbonisation technologies will allow the **EU to remain a global leader** in the steel industry and to reinforce its knowledge-based competitive advantage;
  - **Resource efficiency**: coordination of technological progress in the use of steel scrap and by-products, leading to an enhanced, larger use of those resources;
  - **Jobs and skills**: the Partnership will support the preservation of high-quality jobs in the steel making value chain.



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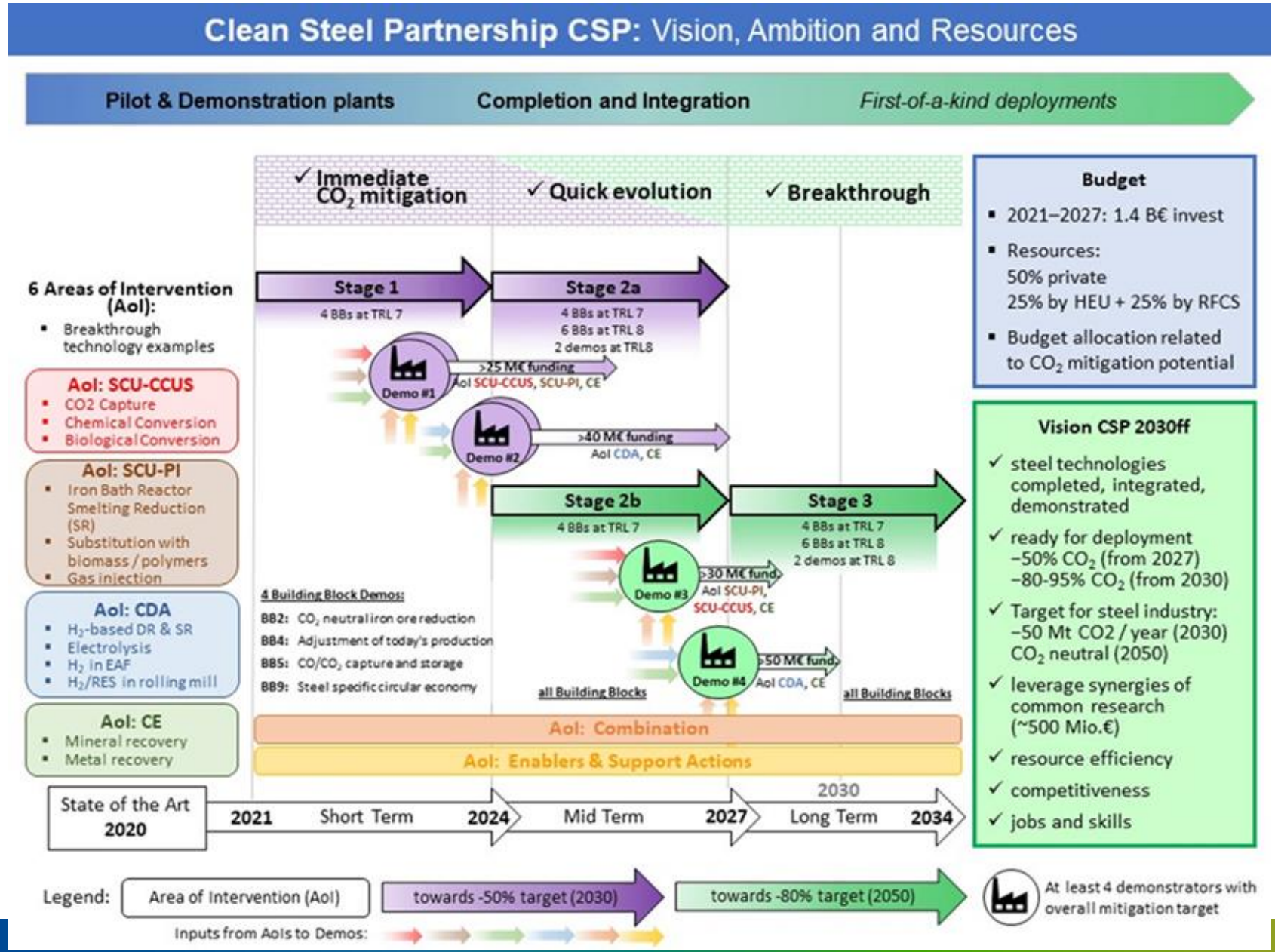


The Clean Steel Partnership

European Steel Technology Platform

www.estep.eu
klaus.peters@estep.eu

Timeline of the Clean Steel Partnership

2004
- ULCOS
- Launch ESTEP

Sep 2017
- Large Scale Research Project
- 1 high TRL collaborative project

Nov 2017
- Big Ticket
- ESTEP Steering Committee (former General Assembly)
- EUROFER Vice-President letter to EC President Juncker

2018
- Big Scale
- EU Partnership
- More than 1 sector
- Steel high on policy agendas
- ESTEP legal entity

2019
- Clean Steel Partnership
- Preparation of documents

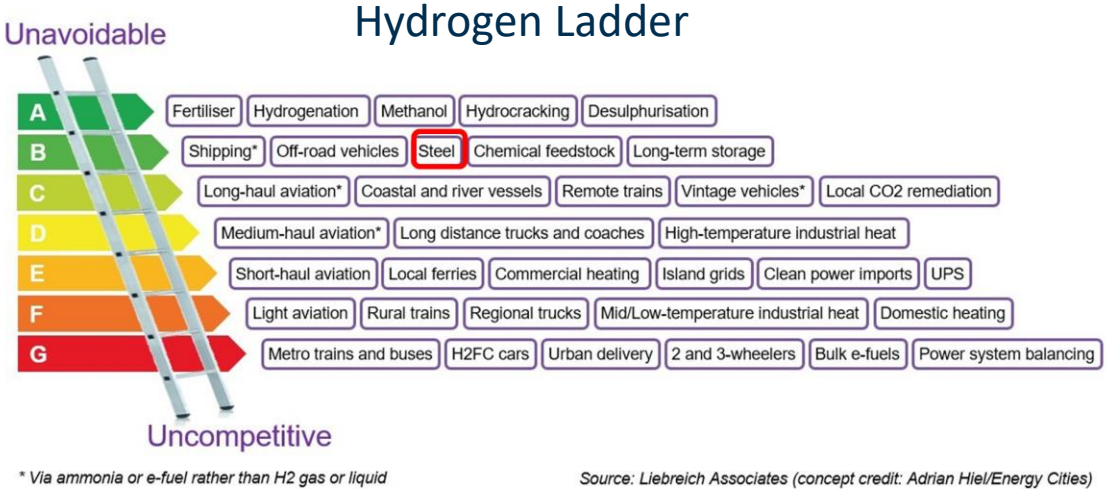
2020
- CSP Proposal
- CSP Roadmap

2021
- CSP MoU
- CSP Brokerage
- Start of CSP

Barriers for the Decarbonisation Transformation

- Reliable, predictable policy framework supporting the transformation
- Global level playing field
- Renewable Energy (electricity)
  - Supply
  - Affordability
- Hydrogen
  - Supply & Infrastructure (pipelines)
  - Affordability
- Risk sharing
  - Robust business case for low carbon steel production (CAPEX+OPEX)
  - Mile stone approach from technology development to market roll-out
- Work force empowerment and talent recruiting
- Development and implementation of digital solutions

Hydrogen Ladder



** Via ammonia or e-fuel rather than H2 gas or liquid*

Source: Liebreich Associates (concept credit: Adrian Hiel/Energy Cities)