

Clean Hydrogen Calls for Proposals 2022

Information day for Slovenian stakeholders

31st March 2022

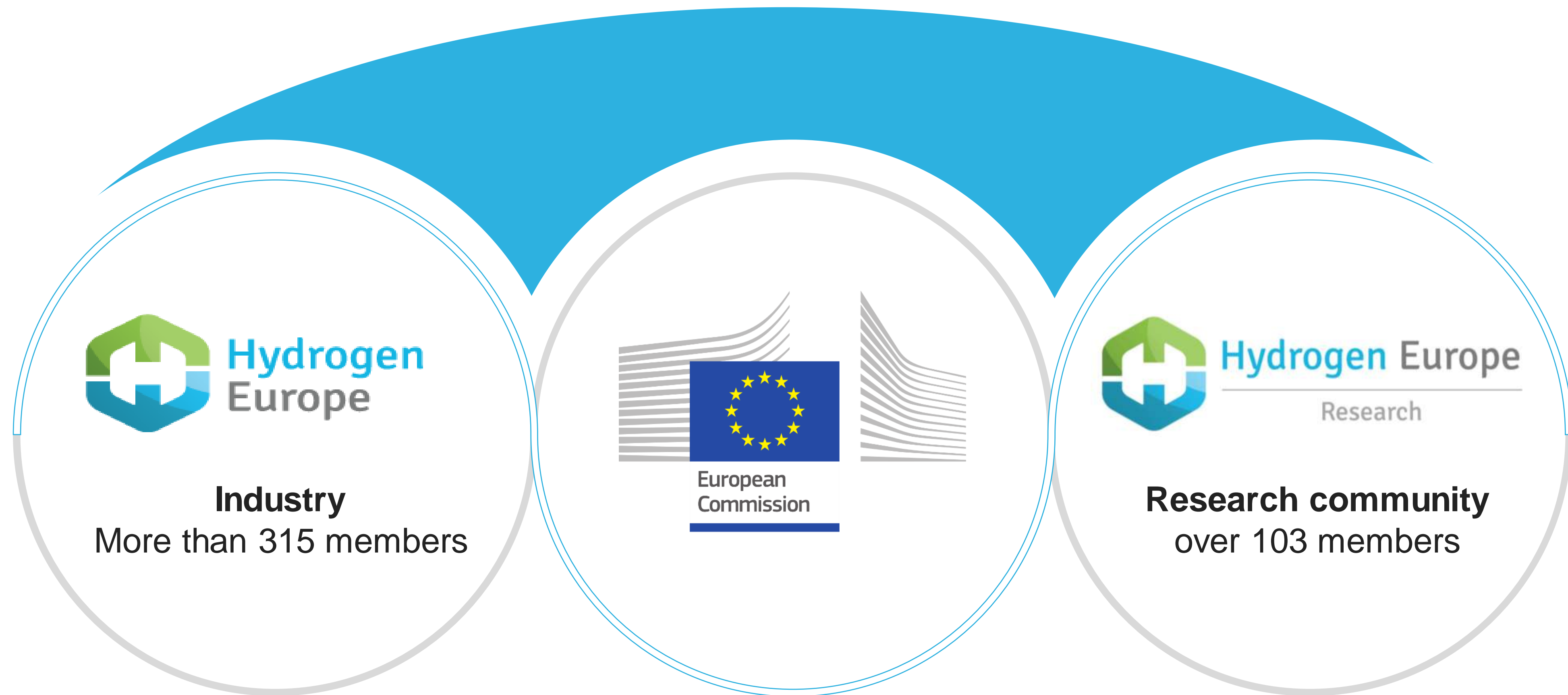
Pedro GUEDES DE CAMPOS

Clean Hydrogen Joint Undertaking



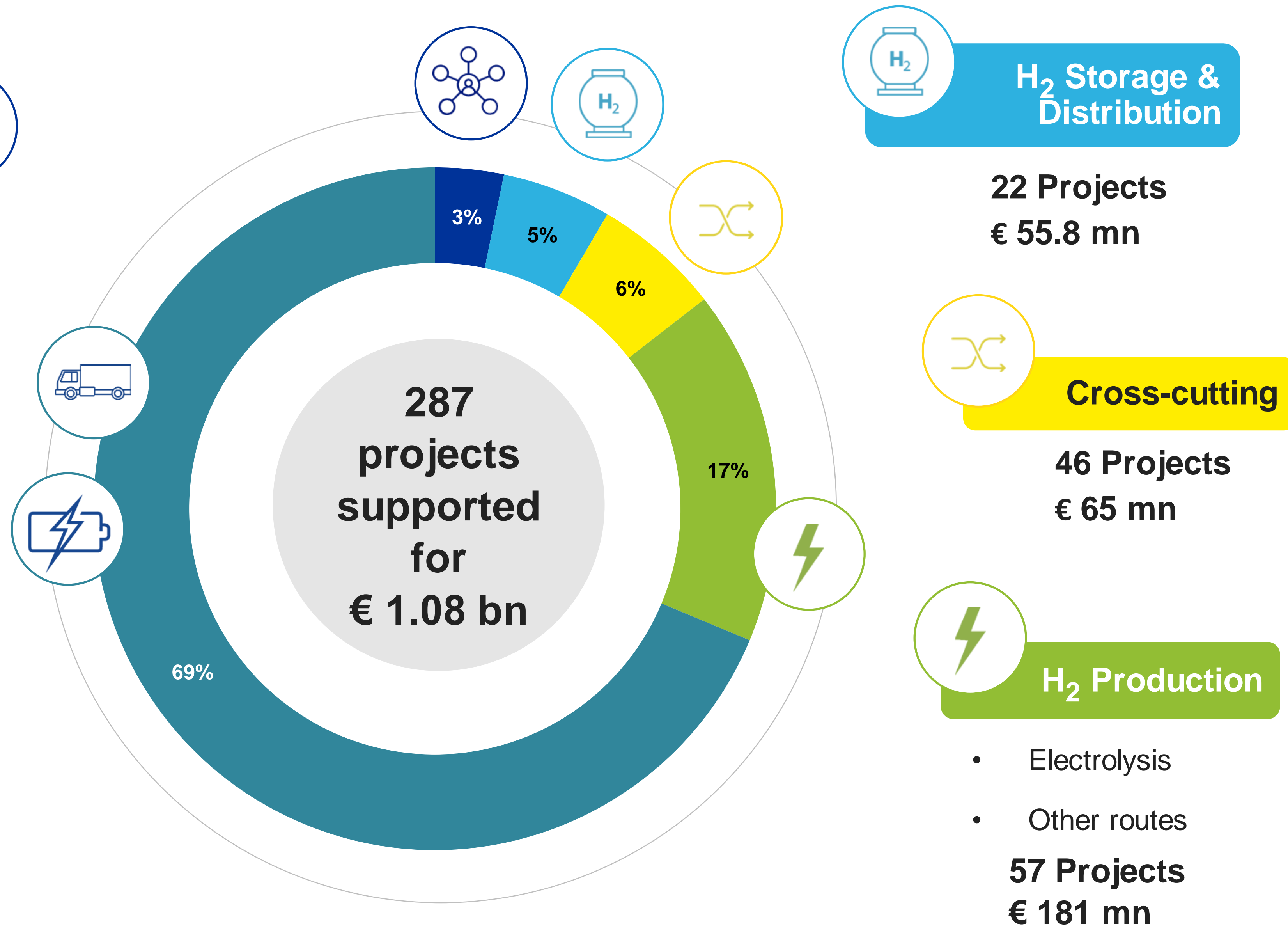
Clean Hydrogen Joint Undertaking

EU Institutional Public-Private Partnership (IPPP)



To facilitate the transition to a greener EU society through the development of hydrogen technologies

Projects in the Clean Hydrogen JU



H₂ Valleys

3 Projects
€ 35 mn

H₂ End Uses

Transport Applications

Clean Heat and Power
159 Projects
€ 739.6 mn

H₂ Storage & Distribution

22 Projects
€ 55.8 mn

Cross-cutting

46 Projects
€ 65 mn

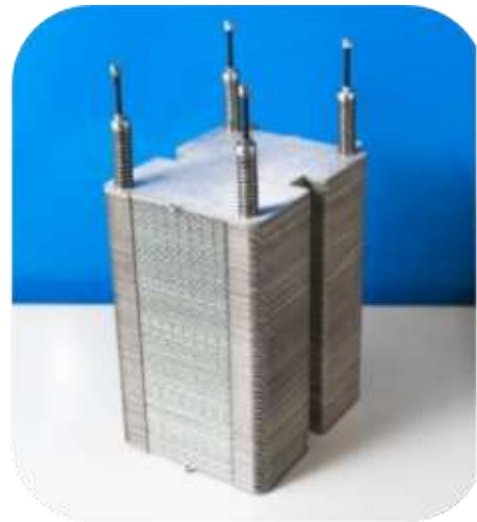
H₂ Production

- Electrolysis
- Other routes

57 Projects
€ 181 mn

A 14 years journey of the Fuel Cells and Hydrogen JU

From research to delivering hydrogen solutions in the market: from individual applications to H2 Valleys



Manufacturing



Green H2
production



Buses



ships



Aviation



Research

PoC



Domestic heat
and power



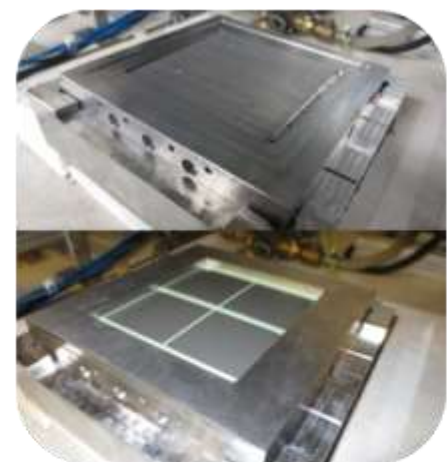
Heat and power
for industry



Heavy duty trucks



Logistics machinery



Materials



Gensets



Light duty
vehicles



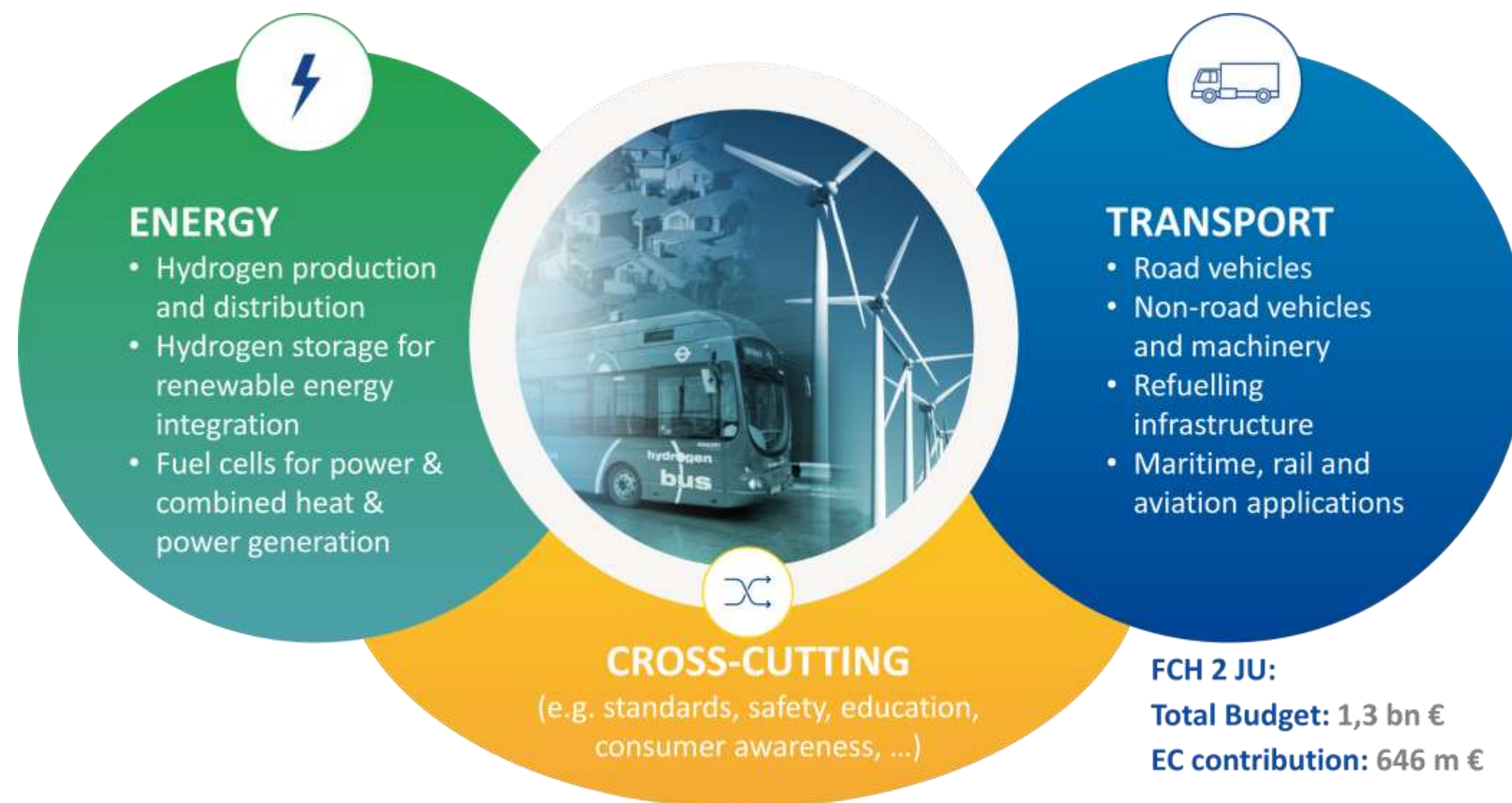
Trains

Clean Hydrogen Partnership Continuation of the FCH 2 JU

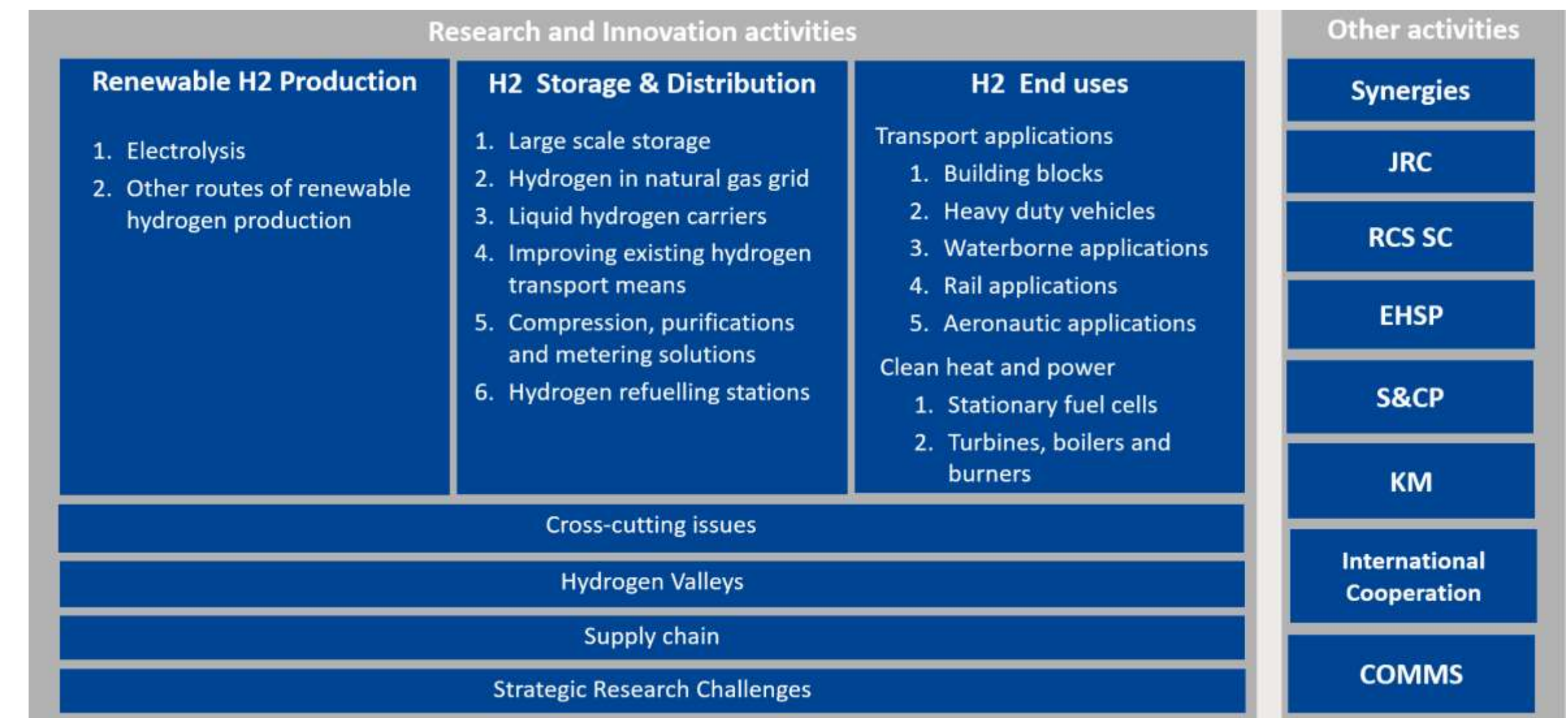


- Clean Hydrogen Partnership (legal name: Clean Hydrogen Joint Undertaking)
- Universal successor of the Fuel Cells and Hydrogen 2 Joint Undertaking (FCH 2 JU) and has taken over its legacy portfolio
- (HORIZON EUROPE) Budget: EUR 1 billion 2021-2027 (>50% increase compared to HORIZON 2020)

FCH 2 JU Programme structure



Clean Hydrogen JU Programme structure





Objectives




General

- 

Support the implementation of the Commission's **Hydrogen Strategy**
- 

Stimulate **research and innovation on clean hydrogen** production, distribution, storage and end use applications
- 

Strengthen the **competitiveness of the EU clean hydrogen value chain**
- 

Contribute to the EU ambitious **2030 and 2050 climate ambition**

Specific

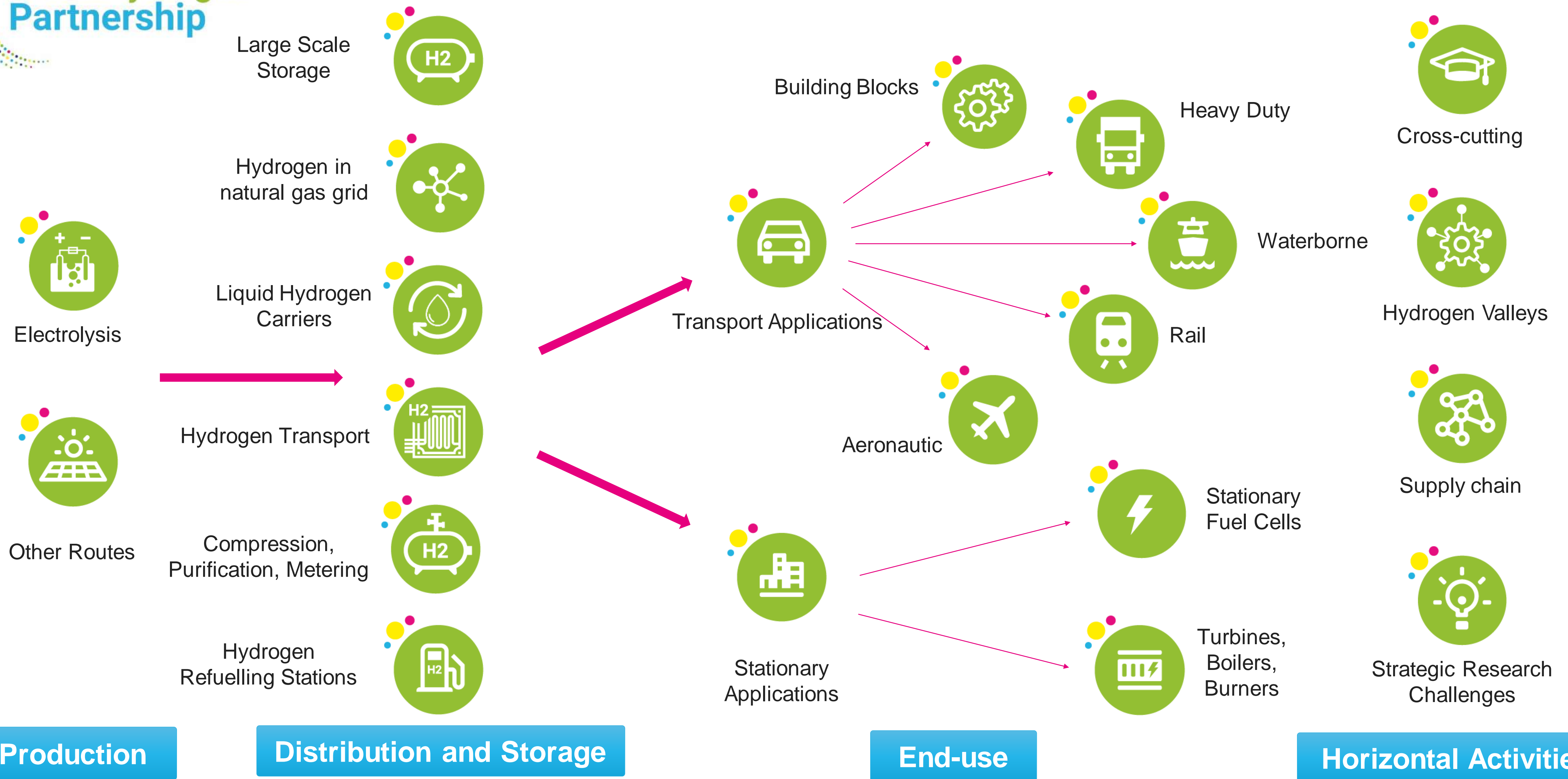
- 

Improve the **cost-effectiveness, efficiency, reliability**, quantity and quality of clean hydrogen solutions across **entire value chain**
- 

Strengthen the **knowledge/capacity of scientific and industrial actors** along the Union's hydrogen value chain while supporting the **uptake of skills**
- 

Demonstrations of clean hydrogen solutions with a view to **local, regional and Union-wide deployment**, aiming to involve stakeholders in all Member States and across **entire value chain**
- 

Increase **public and private awareness, acceptance** and uptake of clean hydrogen solutions





Clean Hydrogen Partnership

SRIA: Key Performance Indicators (KPIs) - Overview

Annex 2 - State-of-the-art and future targets – Renewable Hydrogen production

Table 2: KPIs for Alkaline Electrolysis (AEL)

No	Parameter	Unit	SoA	Targets	
			2020	2024	2030
1	Electricity consumption @ nominal capacity	kWh/kg	50	49	48
2	Capital cost	€/ (kg/d)	1,250	1,000	800
		€/kW	600	480	400
3	O&M cost	€/ (kg/d)/y	50	43	35
4	Hot idle ramp time	sec			
5	Cold start ramp time	sec			
6	Degradation	%/1,000h			
7	Current density	A/cm²			
8	Use of critical raw materials				

Notes:

(General for system): Standard boundary conditions are different. All KPIs are interdependent and should be used in combination. KPI-1: Electrical energy demand at nominal capacity required for cooling.

Table 3: KPIs for Proton Exchange Membrane Electrolysis (PEMEL)

No	Parameter	Unit	SoA	Targets	
			2020	2024	2030
1	Electricity consumption @ nominal capacity	kWh/kg	55	52	48
2	Capital cost	€/ (kg/d)	2,100	1,550	1,000
		€/kW	900	700	500
3	O&M cost	€/ (kg/d)/y	41	30	21
4	Hot idle ramp time	sec	2	1	1
5	Cold start ramp time	sec	30	10	10
6	Degradation	%/1,000h	0.19	0.15	0.12
7	Current density	A/cm²	2.2	2.4	3
8	Use of critical raw materials		2.5	1.25	0.25

all system KPIs: Input of AC power and tap water; output of pure H₂. Correction factors may be applied if actual boundary conditions are different. KPI-2: kg H₂ produced per day per m² of reactor volume. KPI-3: Reactor size measured in m² of fermenter. KPI-4: Capital cost of plant divided by the nominal hydrogen production. Capital cost includes all the cost related to all the equipment necessary for the normal operation of the plant. Based on an estimated production of 940,200 m³ H₂ per year, therefore the capacity of the reference plant is 232 kg H₂/d. KPI-5: Operation and maintenance cost averaged over the first 10 years of the system. Routine maintenance and "wear and tear" (rotating parts, cleaning of equipment, etc.) considering a lifespan of 20 years. Costs such as water use, personnel and chemicals are included. The fermenter size is assumed as 200 m³, treating 100 tons of food waste per day.

€ (SOA 2.0 mg/cm²) and platinum as the cathode catalyst (SOA 2.0 mg/cm²).

Unit	SoA	Targets	
	2020	2024	2030
Wh/kg	40	39	37
€/kg	9.9	9	8
(kg/d)	3,550	2,000	800
€/kW	2,130	1,250	520
(kg/d)/y	410	130	45
sec	600	300	180

Table 8: KPIs for biological production

No	Parameter	Unit	SoA	Targets	
			2020	2024	2030
1	System carbon yield	kg H ₂ / kg COD	0.012	0.015	0.021
2	Reactor production rate	kg H ₂ /m²/d	7.5	15	>15
3	Reactor scale	m²	3	10	100
4	System capital cost	€/ (kg/d)	450	400	350
5	System operational cost	€/kg	3.2	3	2.5

Notes: KPI-1: System carbon yield: kg H₂ obtained from biomass fed to the reactor expressed in Kg COD (Chemical Oxygen Demand). Max theoretically obtainable is 0.041 KgH₂/kg. KPI-2: kg H₂ produced per day per m² of reactor volume. KPI-3: Reactor size measured in m² of fermenter. KPI-4: Capital cost of plant divided by the nominal hydrogen production. Capital cost includes all the cost related to all the equipment necessary for the normal operation of the plant. Based on an estimated production of 940,200 m³ H₂ per year, therefore the capacity of the reference plant is 232 kg H₂/d. KPI-5: Operation and maintenance cost averaged over the first 10 years of the system. Routine maintenance and "wear and tear" (rotating parts, cleaning of equipment, etc.) considering a lifespan of 20 years. Costs such as water use, personnel and chemicals are included. The fermenter size is assumed as 200 m³, treating 100 tons of food waste per day.

Table 9: KPIs for solar thermal production

No	Parameter	Unit	SoA	Targets	
			2020	2024	2030
1	Hydrogen production rate*	kg/m²/d	1.13	2.16	4.11
2	System capital cost	k€/ (kg/d)	29.99	15.19	7.41
3	System operational cost	€/kg	1.17	0.59	0.30

Notes: * Boundary conditions: location with direct normal irradiation (DNI) of 2500 kWh/m²/year. Output of hydrogen meeting ISO 14687-2 at a pressure of 16 bar and hydrogen purity 5.0. KPI-2: System capital cost for a specific hydrogen production rate based on kg of hydrogen generated per day at a given cumulative DNI per year. Capital cost should include all the cost related to all the equipment necessary for the normal operation of the plant. KPI-3: O&M cost averaged over the first 10 years of the system. Routine maintenance and "wear and tear" (rotating parts, cleaning of equipment, etc.) Electricity costs for operation of auxiliary units included. System level losses such as heliostats collector area losses, replacement parts, operation, and maintenance are included in the cost calculations.

Annex 3 - State-of-the-art and future targets – Hydrogen storage and distribution

Table 11: KPIs for hydrogen storage

No	Parameter	Unit	SoA		Targets
			2020	2024	2030
	Underground storage – Depleted gas fields				
1	Capital cost	€/kg	n/a	10	5
	Underground storage – Salt Caverns				
2	Gas field size	ton (100% H ₂)	880	>1000	>3000

Table 13: KPIs for hydrogen transportation

		No	Parameter	Unit	SoA		Targets	
					2020	2024	2030	
4	Storage siz	Hydrogen Pipelines						
5	Capital cos	1	Total capital investment	M€ /km	1.1	1	0.9	
		2	Transmission pressure	bar	90	100	120	
		3	H ₂ leakage	%	na	0	0	
Notes:								
Depleted gas field; pressure hydrogen								
Salt cavern; underground hydrogen (considered (100% H ₂))								
Aboveground storage; hydrogen stor container, skeleton trailer, etc.) and st								
KP-1: Capital costs include all nece purification. The costs are referred to !								
Road transport of compressed hydrogen								
KP-3: Based on the working mass of								
KP-4: Storage density of more than pipes, per-stressed concrete containe								
		4	Tube trailer payload	kg	850	1,000	1,500	
		5	Tube trailer CAPEX	€/kg	650	450	350	
		6	Operating pressure	bar	300	500	700	
Road transport of liquid hydrogen								
		7	LH2 tank trailer payload	kg	3500	4000	4000	
		8	LH2 tank trailer capex	€/kg	>200	200	100	
					0.3-0.6			

Table 15 KPIs for hydrogen refuelling stations

No	Parameter	Unit	SoA	Targets	
			2020	2024	2030
1	Energy consumption	700 bar 350 bar LH ₂ kWh/kg	5 3.5 0.5	4 2.5 0.5	3 2 0.3
2	Availability	700 bar 350 bar LH ₂ %	98 97 95	98 98 97	99 99 99
3	Mean time between failures	700 bar 350 bar LH ₂ d	48 96 144	72 144 216	168 336 504
4	Annual maintenance cost	700 bar 350 bar LH ₂ € / kg	1 0.66 1	0.5 0.35 0.5	0.3 0.15 0.3
5	Labour	700 bar 350 bar LH ₂ person h/kh	70 42 70	28 17 28	16 10 16
6	CAPEX for the HRS 700 bar (200-1,000 kg/d)	700 bar 350 bar LH ₂ k€ / (kg/day)	2-6 0.8-3.5 2-6	1.5-4 0.65-2.5 1.5-4	1-3 0.5-2 1-3
7	HRS contribution in hydrogen price	700 bar 350 bar LH ₂ €/kg	4 2.5 4	3 2 3	2 1.25 2

Notes:

KPI-1: Station energy consumption per kg of hydrogen dispensed when the station is loaded at 80% of its daily capacity – For HRS which stores H₂ in gaseous form, at ambient temperature, and dispense H₂ at 700bar in GH₂ from a source of >30 bar hydrogen. KPI-2: Percent of hours that the hydrogen refuelling station is able to operation versus the total number of hours that it is intended to be able to operate (consider any amount of time for maintenance or upgrades as time at which the station should have been operational). KPI-3: Mean time between failures (MTBF). How long the HRS will run before failing. A filling failure is stated when the fuelling cannot reach 80% of the reservoir capacity. KPI-4: Parts and labour based on a 200 kg/day throughput of the HRS. Includes also local maintenance infrastructure. Does not include the costs of the remote and central operating and maintenance centre. KPI-5: Person-hours of labour for the system maintenance per 1,000 h of operations over the station complete lifetime. KPI-6: Total costs incurred for the construction or acquisition of the hydrogen refuelling station, including on-site storage. Exclude land cost & excluding the hydrogen production unit. Target ranges refer to stations' capacity between 200-1,000 kg/d. CAPEX is dependent on the size of the station, the number of dispensers, the profile of consumption required, the need for buffers, the design. KPI-7: Contribution of the HRS to the final cost of the hydrogen dispensed, amortisation and O&M costs included. Hydrogen production and transport is not considered. Public subsidies are excluded.

Annex 4 - State-of-the-art and future targets – Hydrogen end use: transport applications

Table 16 KPIs for fuel cell technology for Heavy-Duty-Vehicles

No	Parameter	Unit	SOA	Targets			
			2020	2024	2030		
Fuel Cell Building Blocks							
1	FC module CAPEX	€/kW	1,500	<480	<100		
2	FC module availability	Table 17 KPIs for Maritime					
3	FC stack durability						
4	FC stack cost						
5	Power density	No	Parameter	Unit	SoA	Targets	
					2020	2024	2030
		Fuel Cells for ships					
		1	FC power rating	MW	0.5	3	10
6	PGM loading	2	Hydrogen bunkering rate	ton H ₂ / h	0	2	20
		3	Maritime FCS lifetime	h	20,000	40,000	80,000
		4	Product design reaching type approval	number	0	15	40
		5	PEMFC system CAPEX	EUR/kW	2,000	1,500	1,000

Notes:

KPI-1: Power output of fuel cell based power generation (FC system output power). KPI-2: Bunkering capacity of hydrogen in compressed, liquid form or as part of another hydrogen carrier (shore to ship infrastructure). KPI-3: Lifetime of integrated fuel cell systems in maritime conditions and associated operation profile, not excluding the replacement of fuel cell stacks and system components at SoA intervals.KPI-4: Type approval on FC and H₂ storage solutions. To allow products to be used for maritime propulsion beyond prototype phase, products need to be type approved. KPI-4: Type approval is a procedure for the approval of the product design for compliance with classification or flag administration requirements. The type approval is a mandatory requirement for critical apparatus installed on any classified vessel. KPI-5: CAPEX of PEMFC for shipping per kW of power at certain (low) production volume. FC module is defined as FC stack plus air supply system, cooling system, internal engine control unit, media manifold and other BoP (recirculation, humidifier, sensors, DC-DC converter, etc).

Table 18 KPIs for Trains

12	LH: tank vo Capacity				
No	Parameter	Unit	SoA	Targets	
			2020	2024	2030
Fuel Cells for Trains					
1	FC stack durability	h	15,000	20,000	30,000
2	FC stack cost	€/kW	n/a	n/a	<50
3	Areal power density	W/cm² @ V	n/a	1.0@ 0.675	1.2@ 0.675
4	PGM loading	g/kW	0.4	High TRL 0.35	High TRL 0.30 Low TRL < 0.25

KPI-5: Power density in W/cm² (referring to the active geometric area of the electrodes) at a defined cell voltage. Linked to FC stack efficiency, PGM Loading. Low TRL figures are also valid for all types of end-use applications, not only HDV vehicles (as per the Building Blocks, Section 3.4.1). KPI-6: Ratio of the PGM loading (in mg/cm²) over the power density (in W/cm²) at a defined operating point in voltage. Linked to FC stack cost, FC stack Power density, FC stack efficiency. Low TRL figures are also valid for all types of end-use applications, not only HDV vehicles (as per the Building Blocks, Section 3.4.1).

Annex 5 - State-of-the-art and future targets – Hydrogen end use: stationary applications

Table 20: KPIs for SO stationary fuel cells (SOFC)

No	Parameter	Unit	SoA	Targets		
			2020	2024	2030	
System						
1	CAPEX	<5 kWe 5-50 kWe 51-500 kWe	€/kW	10,000 10,000 10,000	6,000 5,000 5,000	3,500 2,500 2,000
2	O&M cost	<5 kWe 5-50 kWe 51-500 kWe	€/kWh	10 12 10	8 7 5	2.5 2.0 1.5
3.1	Electrical Efficiency η_{el}	<5 kWe 5-50 kWe 51-500 kWe	% LHV CH ₄	35-55 (90) 55 (85) 55 (85)	55 (90) 58 (85) 60 (85)	55 (90) 62 (85) 66 (85)

Table 22: KPIs for Turbines (DLE combustion)

No	Parameter	Unit	SoA 2020	Target 2024	Target 2030
1	H ₂ range in gas turbine fuel	% mass % vol.	0 – 5 0 - 30	0 – 23 0 - 70	0 - 100 0 - 100
2	NO _x emissions	NO _x ppmv@15%O ₂ /dry NO _x mg/MJ fuel	<25 31	<25 29	<25 24
3	Max. H ₂ fuel content during start-up	% mass % vol.	0.7 5	3 20	100 100
4	Max. efficiency reduction in H ₂ operation	% points	10@30% H ₂	10@70% H ₂	10@100% H ₂
5	Minimum ramp rate	% load / min	10@30% H ₂	10@70% H ₂	10@100% H ₂
6	Ability to handle H ₂ content fluctuations	% mass / min % vol. / min	±1.4 ±10	±2.21 ±15	±5.11 ±30

Notes:

Standard boundary conditions: location with direct normal irradiation (DNI) of 2500 kWh/m²/year. Output of hydrogen meeting ISO 14687-2 at a pressure of 16 bar and hydrogen purity 5.0. KPI-1: Capital cost at a steady state operation in capital cost. Cost

KPI-1: Hydrogen percentage content in gas turbine fuel, by mass (volume).

Boundary Conditions: applicable only to DLE technology. WLE technologies are not in scope. While state-of-the-art gas turbines can already handle 20% hydrogen by vol (blended in natural gas), development of gas turbines (and more specifically combustors) is required to handle higher H₂ content.

Annex 6 - State-of-the-art and future targets – Cross-cutting issues

Table 23: KPIs on recycling processes

No	Parameter	Unit	SoA	Targets	
			2020	2024	2030
1	Minimum CRMs/PGMs (other than Pt) recycled from scraps and wastes	%	n/a	30	50
2	Minimum Pt recycled from scraps and wastes	%	n/a	95	99
3	Minimum ionomer recycled from scraps and wastes	%	n/a	70	80

Call for proposals 2022

Call: HORIZON-JU-CLEANH2-2022

- Hydrogen production
- Hydrogen distribution
- Transport
- Heat and Power
- Cross-cutting
- Hydrogen Valleys



**Total budget:
€300.5 mn**

41 topics

41 topics available

10 - Renewable Hydrogen Production

11 - Hydrogen Storage and Distribution

8 - Transport

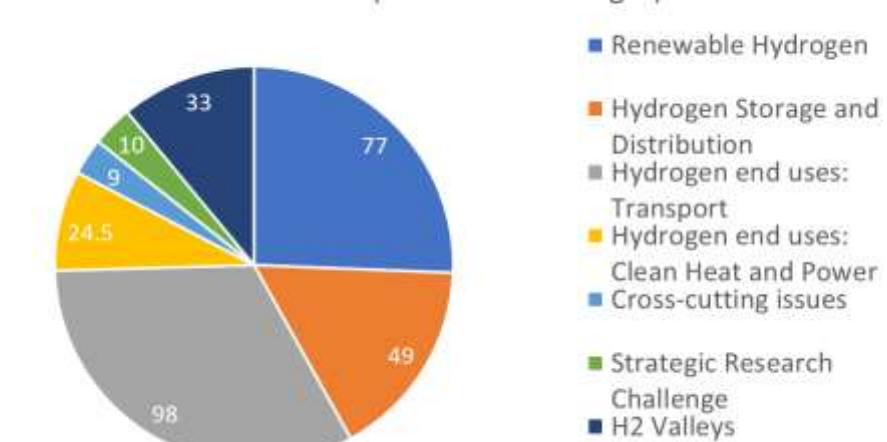
4 - Heat and Power

5 - Cross-cutting

2 - Hydrogen Valleys

1 - Strategic Research challenge

AWP 2022 (allocation of budget)



The topics will be grouped into 10 Innovation Actions (IA), 29 Research and Innovation Actions (RIA) and 2 Coordination and Support Actions (CSA). 6 Innovation Actions (IA) are considered of strategic importance and are selected as **flagship projects**, expected to have a significant impact in accelerating the transition to a hydrogen economy.

Synergies with other European partnerships and programmes, as well as with Member States and regional programmes are at the core of a number of topics.

	Budget (EUR 300.5 million)	Publication	Deadline
First deadline	179.5	1 st March 2022	31 st May 2022
Second deadline	121.0	1 st March 2022	20 th September 2022

Types of Actions and funding rates

RIA - Research and Innovation Actions

Activities that aim primarily to establish new knowledge or to explore the feasibility of a new or improved technology, product, process, service or solution. This may include **basic and applied research**, technology development and integration, testing, demonstration and validation of a small-scale prototype in a laboratory or simulated environment.

funding rate
max. **100%**

IA- Innovation Actions

Activities that aim directly to produce plans and arrangements or designs for new, altered or improved products, processes or services. These activities may include prototyping, testing, demonstrating, **piloting, large-scale product validation and market replication.**

funding rate
max. **70%***

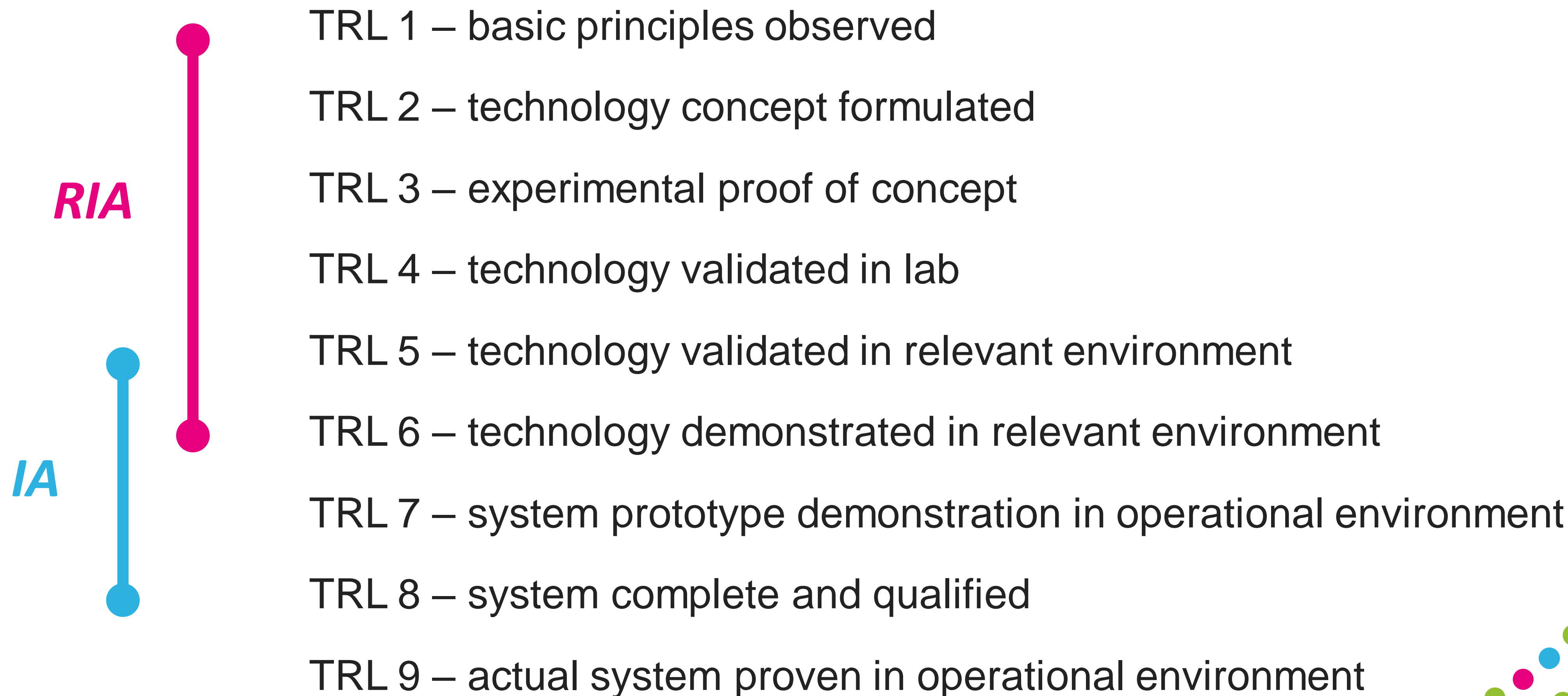
*Funding 100% for non-profit legal entities

CSA - Coordination and Support Action

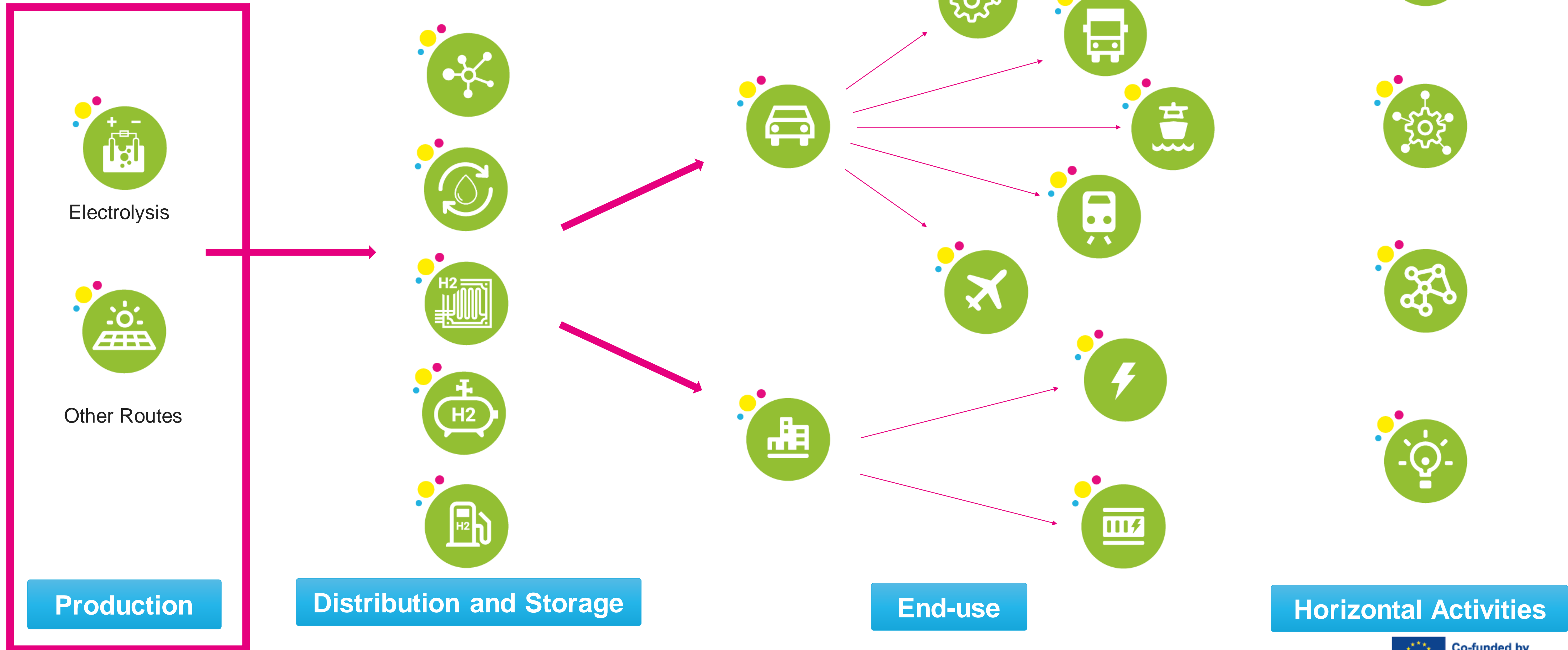
Activities that contribute to the objectives of Horizon Europe. This **excludes R&I activities**. Also eligible are bottom-up **coordination actions which promote cooperation** between legal entities from Member States and Associated Countries **to strengthen the European Research Area**, and which receive no EU co-funding for research activities

funding rate
max. **100%**

Technology readiness levels (TRL)



Manufacturing Readiness Level applies instead for Topics 01.04 and 04-01



Renewable Hydrogen Production Overview

13



Main Focus

- Cost reduction and efficiency increase for renewable hydrogen production routes:
 - New LT and HT electrolyser designs for high pressure operation
 - Larger cell electrolyser stacks
 - Large scale electrolysers in industry, off-grid and offshore
 - Improved efficiency solar thermochemical H₂ production.





What is new

- Circularity
- Improved electrolyser manufacturing

Renewable Hydrogen Overview

Topic	Type of Action	Ind. Budget (M€)	Deadline
HORIZON-JTI-CLEANH2-2022 -01-01: Development and validation of pressurised high temperature steam electrolysis stacks (Solid Oxide Electrolysis)	RIA	2.5	31/05/2022
HORIZON-JTI-CLEANH2-2022 -01-02: Development and validation of pressurised high temperature steam electrolysis stacks (Proton Conducting Ceramic Electrolysis)	RIA	2.5	31/05/2022
HORIZON-JTI-CLEANH2-2022 -01-03: Development of low temperature water electrolyzers for highly pressurised hydrogen production	RIA	2 x 2.5	31/05/2022
HORIZON-JTI-CLEANH2-2022 -01-04: Design for advanced and scalable manufacturing of electrolyzers	RIA	2 x 2	20/09/2022
HORIZON-JTI-CLEANH2-2022 -01-05: Scaling up of cells and stacks for large electrolyzers	RIA	6	20/09/2022
HORIZON-JTI-CLEANH2-2022-01-06: Efficiency boost of solar thermochemical water splitting	RIA	4	31/05/2022

Renewable Hydrogen Overview

Topic	Type of Action	Ind. Budget (M€)	Deadline
HORIZON-JTI-CLEANH2-2022-01-07: Bringing renewable hydrogen MW scale off-grid installations closer to technical and financial maturity	IA	9	31/05/2022
HORIZON-JTI-CLEANH2-2022-01-08: Integration of multi-MW electrolyzers in industrial applications	IA 	18	20/09/2022
HORIZON-JTI-CLEANH2-2022-01-09: Scaling-up technologies for SOEL	RIA	2 x 3	31/05/2022
HORIZON-JTI-CLEANH2-2022-01-10: Demonstrating offshore production of renewable hydrogen	IA 	20	20/09/2022

Renewable Hydrogen - Topics

HORIZON-JTI-CLEANH2-2022-01-08: Integration of multi-MW electrolyzers in industrial applications



Demonstrate electrolyser technologies beyond state-of-the-art in a specific industrial application



- >25MW electrolyser, LT or HT
- Possible innovations: possibly supply two customers; use of O₂ and heat; grid services; footprint reduction
- Includes a go-no go decision, then 2-year operation
- Investigate synergies with Process4Planet or Clean Steel Partnerships

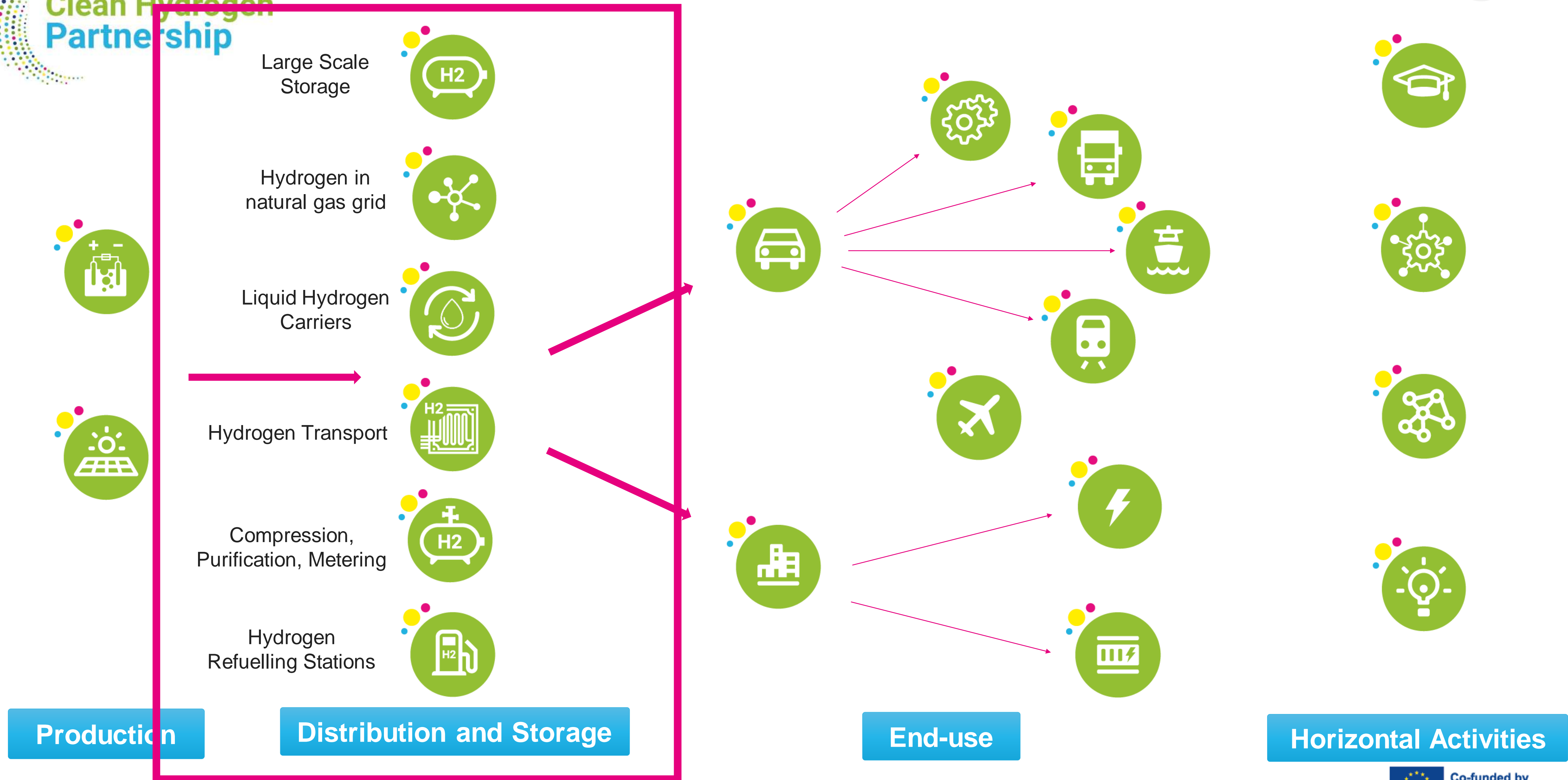
HORIZON-JTI-CLEANH2-2022-01-10: Demonstrating offshore production of renewable hydrogen



Design, construct and integrate a > 5MW electrolyser in an offshore infrastructure



- Re-use existing offshore oil/gas infrastructure or develop new – export wind energy as H₂
- Safety aspects, remote control, autonomous operation, inspection & maintenance
- Design, construction & 2 years operation, assessment of performance (degradation, OPEX and maintenance costs), economic viability of using existing offshore infrastructure or building new



Hydrogen Storage and Distribution Overview

18



Main Focus

- Improved hydrogen carriers
- Preparing hydrogen refuelling stations for the demands of Heavy-Duty applications
- Scaling-up innovative hydrogen compression solutions



What is new

- Next generation liquefaction units and large scale liquid H₂ storage for shipping.
- Developing increased capacity tube trailers
- Improving quality control for Hydrogen dispensed in HRS

Hydrogen Storage and Distribution Overview

Topic	Type of Action	Ind. Budget (M€)	Deadline
HORIZON-JTI-CLEANH2-2022-02-01: Compatibility of Distribution non-steel metallic gas grid materials with hydrogen	RIA	2.5	20/09/2022
HORIZON-JTI-CLEANH2-2022-02-02: Hydrogen and Hydrogen/Natural gas mixture leak detection system for continuous monitoring and safe operation of HRS and future Hydrogen/Natural gas mixture networks	RIA	2.5	31/05/2022
HORIZON-JTI-CLEANH2-2022-02-03: Validation of a high-performance hydrogen liquefier prototype	RIA	5	31/05/2022
HORIZON-JTI-CLEANH2-2022-02-04: Ammonia to Renewable Hydrogen: efficient system for ammonia cracking	RIA	3	20/09/2022
HORIZON-JTI-CLEANH2-2022-02-05: Efficient system for dehydrogenation of liquid organic hydrogen carriers	RIA	3	20/09/2022
HORIZON-JTI-CLEANH2-2022-02-06: Development of large scale LH2 containment for shipping	RIA	6.5	20/09/2022

Hydrogen Storage and Distribution Overview

Topic	Type of Action	Ind. Budget (M€)	Deadline
HORIZON-JTI-CLEANH2-2022-02-07: Increased hydrogen capacity of GH 2 road trailers	RIA	2.5	31/05/2022
HORIZON-JTI-CLEANH2-2022-02-08: Development of novel or hybrid concepts for reliable, high capacity and energy-efficient H2 compression systems at real-world scale	IA	5	31/05/2022
HORIZON-JTI-CLEANH2-2022-02-09: Sampling methodology and quality assessment of HRS	RIA	4	31/05/2022
HORIZON-JTI-CLEANH2-2022-02-10: Implementing new/optimised refuelling protocols and components for high flow HRS	RIA	2 x 4	31/05/2022
HORIZON-JTI-CLEANH2-2022-02-11: Development and demonstration of mobile and stationary compressed hydrogen refuelling solutions for application in inland shipping and short-distance maritime operations	IA	7	20/09/2022

Hydrogen Storage and Distribution - Topics

HORIZON-JTI-CLEANH2-2022-02-06: Development of large scale LH₂ containment for shipping



To develop and validate containment concepts intended for the bulk shipping of liquid hydrogen



- Concept selection for large scale LH₂ containment to be used in shipping
- Detailed design, construction, and testing of a scaled-down prototype of at least 10 t LH₂ capacity
- General Approval for the LH₂ containment system by one of the major IACS classification societies

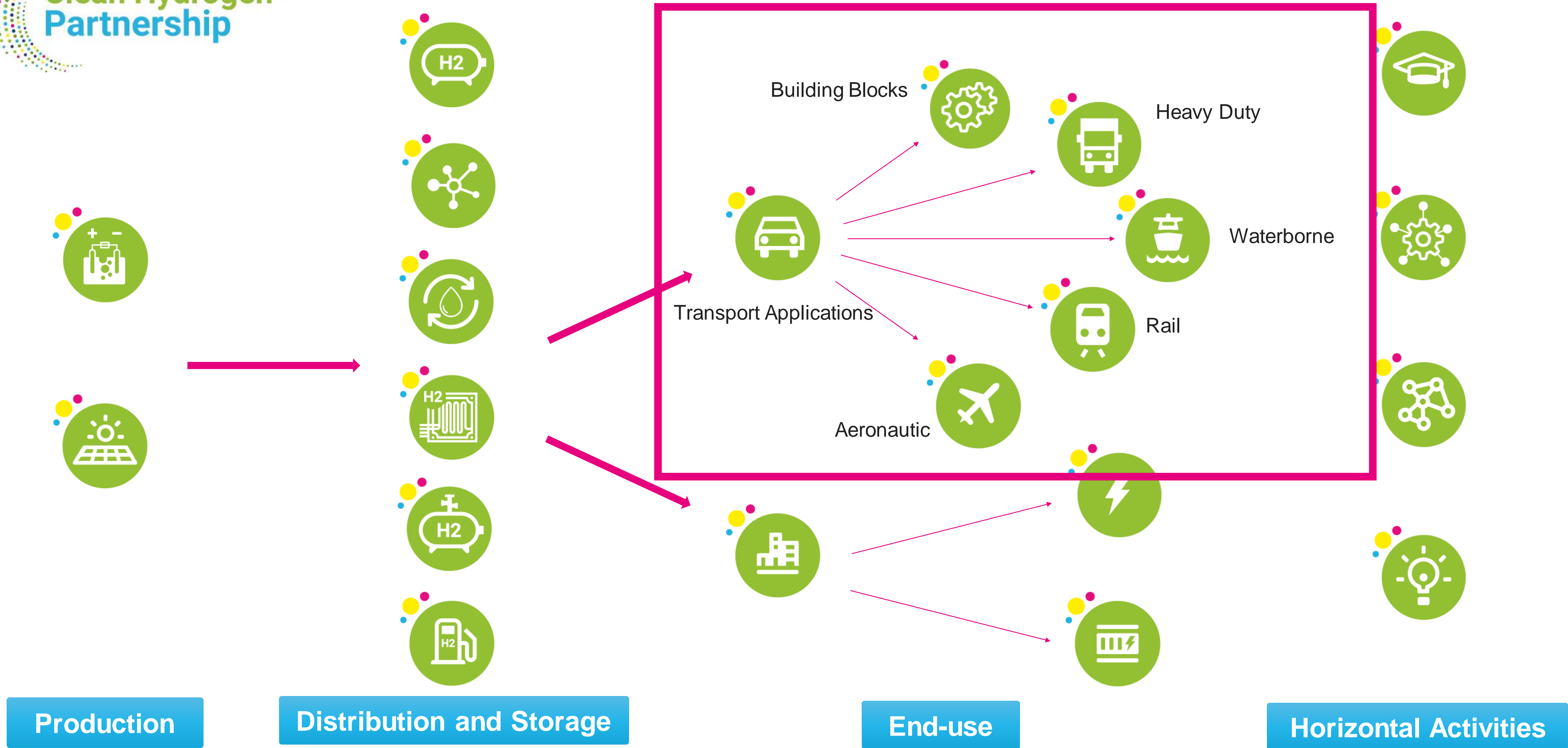
HORIZON-JTI-CLEANH2-2022-02-11: Development and demonstration of mobile and stationary compressed hydrogen refuelling solutions for application in inland shipping and short-distance maritime operations



To focus on either a stationary (pipe-to-ship) or on a floating (ship-to-ship or platform-to-ship) solution



- Demonstrate smart and safe logistics solutions and develop a market standard to support front-running shipping projects.
- Techno-economic analysis of the proposed solution.
- Standardisation of the developed engineering solutions, including components such as refueller, connections, nozzles, as well as of fuelling protocols, is also a key priority.
- Synergies with HORIZON-JTI-CLEANH2-2022-03-05.



Transport Overview



Main Focus



- Adaptation of key FC system components for heavy duty applications
- Push toward aviation propulsion: upscaling stack and LH2 storage
- Bringing the learnings from first demonstrations (inland vessels and trucks) to fleets



What is new

- Large scale demonstration of trucks
- Decarbonisation of the inland waterways
- Cooperation with Connecting Europe Facility for Transport work programme

Transport Overview

Topic	Type of Action	Ind. Budget (M€)	Deadline
HORIZON-JTI-CLEANH2-2022- 03-01 : Development and optimisation of reliable and versatile PEMFC stacks for high power range applications	RIA	2 x 3.5	20/09/2022
HORIZON-JTI-CLEANH2-2022- 03-02 : Innovative and optimised MEA components towards next generation of improved PEMFC stacks for heavy duty vehicles	RIA	2 x 3	31/05/2022
HORIZON-JTI-CLEANH2-2022- 03-03 : Large scale demonstration of European H2 Heavy Duty Vehicle along the TEN-T corridors	IA 	30	31/05/2022
HORIZON-JTI-CLEANH2-2022- 03-04 : Liquid hydrogen tanks for heavy-duty vehicles	RIA	2 x 2.5	31/05/2022
HORIZON-JTI-CLEANH2-2022- 03-05 : Large scale demonstration of hydrogen fuel cell propelled inland waterway vessels	IA 	15	31/05/2022
HORIZON-JTI-CLEANH2-2022- 03-06 : Development and optimisation of a dedicated Fuel Cells for Aviation: from dedicated stack (100s kW) up to full system (MWs)	RIA	20	31/05/2022

Transport Overview

Topic	Type of Action	Ind. Budget (M€)	Deadline
HORIZON-JTI-CLEANH2-2022-03-07: Development of specific aviation cryogenic storage system with a gauging, fuel metering, heat management and monitoring system	RIA	10	31/05/2022
HORIZON-JTI-CLEANH2-2022-03-08: Development and optimisation of a dedicated Fuel Cells for Aviation: disruptive next-gen high temperature Fuel Cells technology for future aviation	RIA	5	31/05/2022

Transport - Topics

HORIZON-JTI-CLEANH2-2022-03-03: Large scale demonstration of European H2 Heavy Duty Vehicle along the TEN-T corridors

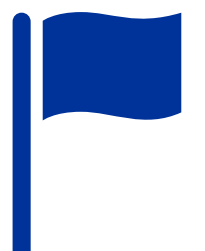


Deployment and operation in real-life conditions of 150 FCH trucks.



- Trucks rigid or tractors
- Minimum range for 50% of the trucks: 600 km and at least 65% of the fleet should be long haul: > 37 tons
- Trucks to be operated for a minimum of 2 years, yearly minimum milage 40,000/60,000 km (distribution/long haul)
- Solid data monitoring strategy
- Deployment along the core and comprehensive TEN-T corridors – complementary proposal to CEF Transport for the HRS funding

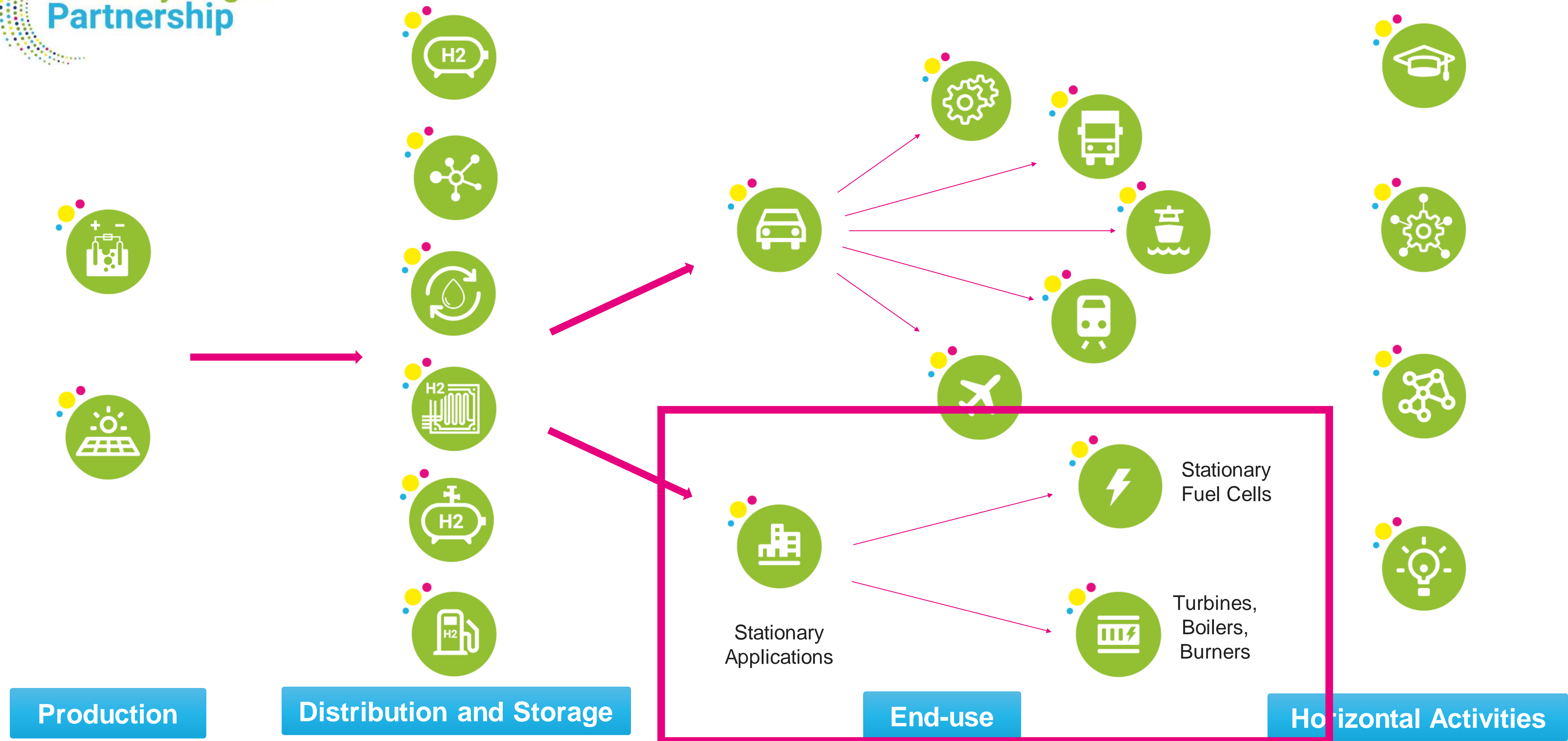
HORIZON-JTI-CLEANH2-2022 -03-05: Large scale demonstration of hydrogen fuel cell propelled inland waterway vessels



Deployment of 5 inland waterway vessels with fuel cells and electric propulsion.



- Retrofitting and/or new build with a focus on converting ship types with the highest impact on emissions
- FC power above 500kW and preferably at 1 MW scale (modular and easy-to-scale solution)
- Bunker hydrogen in at least 2 different ports
- Deployment along the core and comprehensive TEN-T corridors – complementary proposal to CEF Transport for the HRS funding



Clean Heat and Power Overview



Main Focus

- Cost reduction through manufacturing
- Fuel and technology diversification
- Enhanced system flexibility



What is new

- Automation of manufacturing, equipment manufacturers at the core of the action
- Gas turbines running on 0-100% H₂ in gas

Clean Heat and Power Overview

Topic	Type of Action	Ind. Budget (M€)	Deadline
HORIZON-JTI-CLEANH2-2022-04-01: Design and industrial deployment of innovative manufacturing processes for solid oxide fuel cells systems and fuel cell components	IA	7	20/09/2022
HORIZON-JTI-CLEANH2-2022-04-02: Ammonia powered fuel cell system focusing on superior efficiency, durable operation and design optimisation	RIA	4	31/05/2022
HORIZON-JTI-CLEANH2-2022-04-03: Reversible SOC system development, operation and energy system (grid) integration	RIA	5.5	31/05/2022
HORIZON-JTI-CLEANH2-2022-04-04: Dry Low NOx combustion of hydrogen-enriched fuels at high-pressure conditions for gas turbine applications	RIA	2 x 4	31/05/2022

Clean Heat and Power - Topics

HORIZON-JTI-CLEANH2-2022 -04-01: Design and industrial deployment of innovative manufacturing processes for Solid Oxide Fuel Cells systems and fuel cell components



Automation of time-consuming manufacturing steps and time/resource efficient quality control



- adaptation & development of manufacturing processes on prototype tool, progress measured by increase in MRL
- automation/equipment manufacturer/s at the core -> beneficial to all SOC manufacturers
- several manufacturing processes can be targeted; synergies with Made in Europe partnership to be explored
- stack production cost <800 €/kW @ annual production volume of 100 MW (single manufacturing line)

Production

Distribution and Storage

End-use

Horizontal Activities



Cross-cutting



Hydrogen Valleys



Supply chain



Strategic Research Challenges



Cross-cutting Issues - Overview

32



Main Focus

- Raise public awareness and trust towards FCH technologies
- Safety-related aspects of (i) Cryogenic H₂ transfers for mobile applications, (ii) H₂ injection management at network-wide level
- Test methods and requirements for measuring devices in the gas network
- Support cooperation with the African continent



What is new

- Guidance for raising awareness and trust in the public and key stakeholders in Europe
- Addressing safety aspects on (i) new distribution applications, and (ii) network management
- Test methods and limits and tolerances for currently used devices
- Shape future cooperation with African countries on renewable H₂ tech.

Cross-cutting Issues Overview

Topic	Type of Action	Ind. Budget (M€)	Deadline
HORIZON-JTI-CLEANH2-2022-05-01: Public understanding of hydrogen and fuel cell technologies	CSA	1	20/09/2022
HORIZON-JTI-CLEANH2-2022-05-02: Safety of cryogenic hydrogen transfer technologies in public areas for mobile applications	RIA	2	31/05/2022
HORIZON-JTI-CLEANH2-2022-05-03: Safe hydrogen injection management at network-wide level: towards European gas sector transition	RIA	3	20/09/2022
HORIZON-JTI-CLEANH2-2022-05-04: Development of validated test methods and requirements for measuring devices intended for measuring NG/H2 mixtures	RIA	2	31/05/2022
HORIZON-JTI-CLEANH2-2022-05-05: Research & Innovation co-operation with Africa on hydrogen	CSA	1	31/05/2022

Hydrogen Valleys & Strategic Research Challenges Overview

Topic	Type of Action	Ind. Budget (M€)	Deadline
HORIZON-JTI-CLEANH2-2022-06-01: Hydrogen Valleys (large-scale)	IA 	25	20/09/2022
HORIZON-JTI-CLEANH2-2022-06-02: Hydrogen Valleys (small-scale)	IA 	8	20/09/2022

Topic	Type of Action	Ind. Budget (M€)	Deadline
HORIZON-JTI-CLEANH2-2022-07-01: Addressing the sustainability and criticality of electrolyser and fuel cell materials	RIA	10	31/05/2022

Hydrogen Valleys - Topics

HORIZON-JTI-CLEANH2-2022-06-01: Hydrogen Valleys (large-scale)



Develop, deploy and demonstrate a large-scale H₂ valley with interlinkages outside its boundaries



- Production of $\geq 5,000$ tonnes of renewable H₂ per year using new hydrogen production capacity (GOs)
- ≥ 2 FCH applications from ≥ 2 sectors (energy, industry, transport)
- Demonstrate: existing/new H₂ markets, contribution to economic growth, impact and replicability, commitment of stakeholders
- Financing structure and strategy describing the business model, including envisaged sources of co-funding/co-financing needed

HORIZON-JTI-CLEANH2-2022-06-02: Hydrogen Valleys (small-scale)



Develop, deploy and demonstrate a H₂ valley (particular attention to areas of Europe with no or limited presence of H₂ Valleys)



- Production of ≥ 500 tonnes of renewable H₂ per year (GOs)
- Supply more than one end sector or application (mobility, industry energy) / $>20\%$ H₂ produced for each of the 2 main applications
- Demonstrate: existing/new H₂ markets, contribution to economic growth, impact and replicability and commitment of stakeholders
- Financing structure and strategy describing the business model, including envisaged sources of co-funding/ co-financing needed

Strategic Research Challenges - Topic

HORIZON-JTI-CLEANH2-2022-07-01: Addressing the sustainability and criticality of electrolyser and fuel cell materials



Removing the CRMs and materials of environmental concerns from electrolysers and fuel cells




- Development of low or free-CRM catalysts and poly/perfluoroalkyls-free ionomers according to SRIA's KPIs
- Improvement of CRM and ionomer recycling from scraps, wastes and end-of-life equipment
- Three innovative solutions for each PEM, AEM, AEL, PCC and SOC technologies
- Breakthroughs in electrocatalysts, coatings, electrode architectures and cell designs
- Life cycle analyses



Flagship projects

expected to have significant impact in accelerating the transition to a hydrogen economy, to demonstrate the viability of clean hydrogen solutions at scale

Topic	Full Cap. Costs	Seal of Excellence	Limited JU funding		Dead line
HORIZON-JTI-CLEANH2-2022-01-08: multi-MW electrolyzers in industrial applications	X			X	20/09
HORIZON-JTI-CLEANH2-2022-01-10: offshore RES to H2	X			X	20/09
HORIZON-JTI-CLEANH2-2022-03-03: HD Trucks along TEN-T	X		X	X	31/05
HORIZON-JTI-CLEANH2-2022-03-05: H2 (FC) inland waterway vessels (TEN-T)	X		X	X	31/05
HORIZON-JTI-CLEANH2-2022-06-01: H2Valleys (large)	X	X	X	X	20/09
HORIZON-JTI-CLEANH2-2022-06-02: H2Valleys (small)	X	X	X	X	20/09



Complex projects requiring special conditions and preparation (in particular on synergies with CEF/regional funds)

Further guidance provided by the Programme Office (contact us!)

- **Six Innovation Actions considered of strategic importance** (combined budget of EUR 116 million)
- Normally, **first-of-a-kind demonstration at scale, in real operational environment of the different generations of hydrogen products (including sectoral integration such as Hydrogen Valleys).**
- Concrete **synergies with other programmes and instruments** (such as other partnerships or other instruments at EU, national or regional level)

Novelties in the call conditions

38



Full capitalised costs for purchases

(equipment, infrastructure or other assets purchased specifically for the action)

For the topics listed below, in line with the Clean Hydrogen JU SRIA, mostly **large-scale demonstrators or flagship projects specific equipment, infrastructure or other assets purchased specifically for the action (or developed as part of the action tasks) can exceptionally be declared as full capitalised costs.**



Seal of Excellence

For **two topics in the Call (related to H2 Valleys)** the 'Seal of Excellence' will be awarded to applications exceeding all of the evaluation thresholds set out in this Annual Work Programme but cannot be funded due to lack of budget available to the call.

Novelties in the call conditions

39



Maximum EU/JU funding per topic

- **Additional eligibility criterion to limit the Clean Hydrogen JU requested contribution**
- For actions performed at high TRL level, including demonstration in real operation environment and with important involvement from industrial stakeholders and/or end users such as public authorities
- **Expected to leverage co-funding as commitment from stakeholders.** e.g. through the private investment or co-funding from regional/local funds



Hydrogen
Europe



Hydrogen Europe
Research

Involvement of private members

- **Additional eligibility criterion to ensure that one partner in the consortium is a member of either Hydrogen Europe or Hydrogen Europe Research**
- For topics targeting actions for large-scale demonstrations, flagship projects and strategic research actions, where the industrial and research partners of the JU play a key role in accelerating the commercialization of hydrogen technologies

Opportunities for synergies – for all applicants (in particular flagship projects)

- Possibilities for **complementary funding from other R&I-relevant EU, national or regional programmes** (such as European Structural and Investment Funds, Recovery and Resilience Facility, Just Transition Fund, Connecting Europe Facility, Innovation Fund, Modernisation Fund, LIFE, InvestEU, etc.), as well as private funds or financial instruments.
- Encouraged to consult **the national recovery and resilience plans in order to identify specific mentions of synergies with Horizon Europe** and to detect further opportunities for complementarity between the plans' rich R&I portfolio and the Framework Programme.
- Specific opportunities for **synergies with other partnerships** have been included in some topics' description.
- Whenever synergies are foreseen, they should be reflected in **a financing structure and strategy describing the business model, including envisaged sources of co-funding/co-financing and in line with state-aid rules.**

Call 2022 specific requirements:

- Two flagship topics (deployment of hydrogen trucks and inland vessels) in the Call 2022 strongly recommend **synergies/complementary funding for the H2 refuelling infrastructure from the Connection Europe Facility for Transport** (realisation of the alternative fuels targets for hydrogen along the TEN-T networks)
- Additional two flagship topics (Hydrogen Valleys) strongly recommend **synergies/complementary funding from regional/local funding** and foresee the awarding of a 'Seal of Excellence' to applications which cannot be funded due to lack of budget, therefore increased chances to find alternative funding in other Union programmes, including those managed by national or regional Managing Authorities.

Safety Plans

- For all topics a **‘safety by design’ approach should be considered**. In particular, for topics involving Innovation Actions proposals should provide a **preliminary draft on ‘hydrogen safety planning and management’ at the project level**, which will be further developed during project implementation (deliverables to be reviewed by the European Hydrogen Safety Panel)
- For topics involving Research and Innovation Actions or Innovation Actions, projects should foresee to **report any safety-related event that may occur during the project implementation to the European Commission's Joint Research Centre (JRC) dedicated database HIAD** through mailbox JRC-PTT-H2SAFETY@ec.europa.eu

CertifHy

- For some of the topics involving Innovation Actions it is expected that **Guarantees of Origin (GOs) will be used to prove the renewable character of the hydrogen that is produced/used**.

Projects with hydrogen production/consumption:

- Issuance/purchase and subsequent cancellation of GOs from the relevant Member State issuing body;
- If the latter is not yet available, the consortium may proceed with the issuance/purchase and cancellation of non-governmental certificates (e.g CertifHy).

Explicit encouragement for International Collaboration



Mission Innovation 2.0



For some identified topics, **proposals are expected to contribute towards the activities of Mission Innovation 2.0 - Clean Hydrogen Mission**. Cooperation with entities from Clean Hydrogen Mission member countries, which are neither EU Member States nor Horizon Europe Associated countries, is encouraged.



In recognition of the benefits that international collaboration can bring, encouragement of international collaboration beyond EU Member States and Horizon Europe Associated Countries could be foreseen.

A particular example is topic ***HORIZON-JTI-CLEANH2-2022-05-05: Research & Innovation co-operation with Africa on hydrogen***, in which additional eligibility criteria have been introduced to allow African countries to

- i)* participate in proposal,
- ii)* be eligible for funding and
- iii)* ensure a sufficient geographical coverage of the African continent.

Summary of novelties/call conditions elements to pay attention to:

43



Evaluation by independent experts

European Commission database of experts

Register through the **Funding & tender opportunities Portal** and **notify us with your interest**

Selection of experts

- High level of skill, experience and knowledge
- Independence and absence of conflict of interest

And a **balance** in terms of:

- geographical diversity
- gender
- where appropriate, the private and public sectors, and
- an appropriate 'rotation' from year to year.

In principle, each proposal will be examined by **at least three experts**

Presence of **one or more independent observers**

Experts that have a **conflict of interests** will be excluded by us !



25% new experts



Large fields of expertise



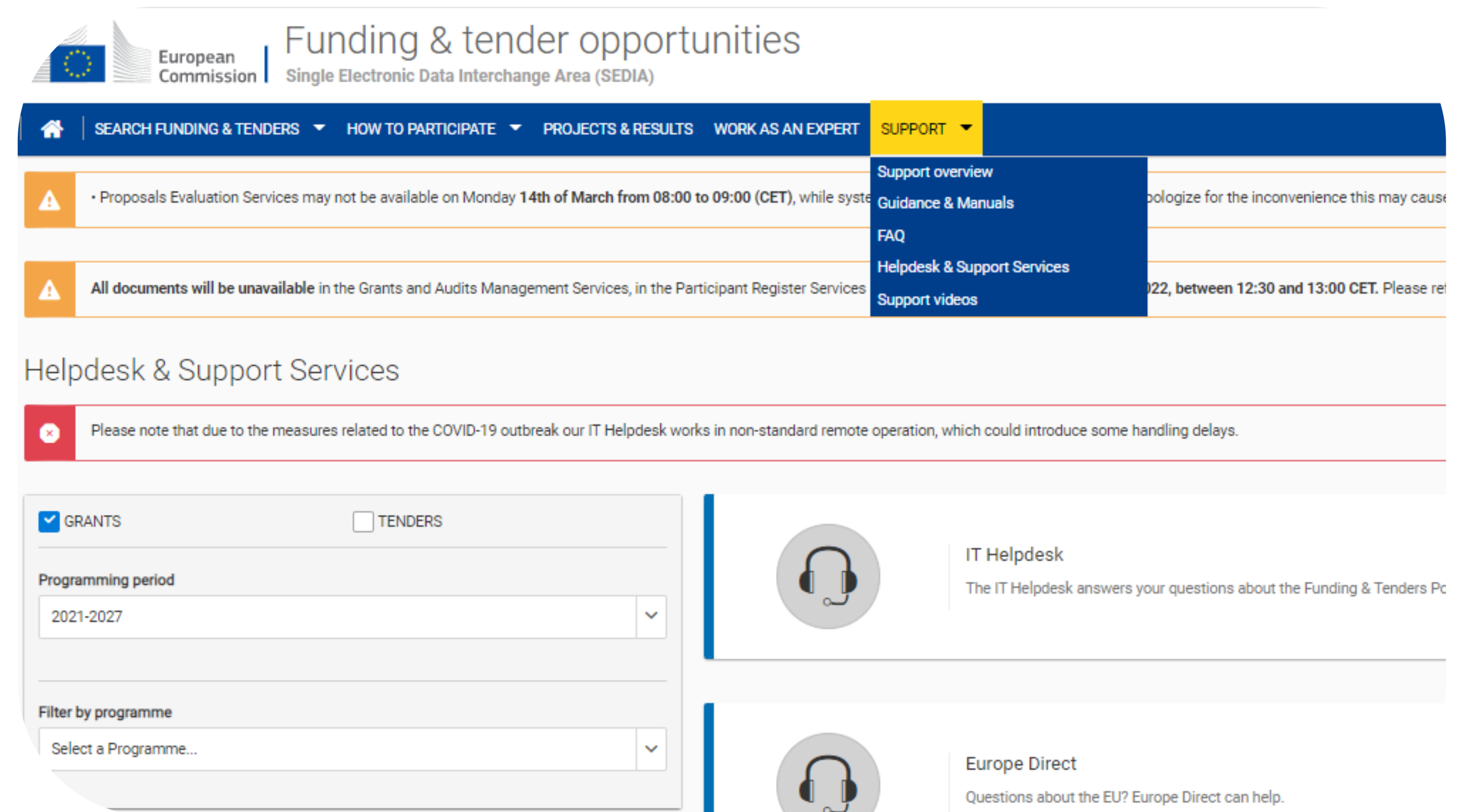
Network with fellows

Resources and Support

Funding and Tenders Opportunities Portal

Get Support

- [Online Manual](#) is your guide on the procedures from proposal submission to managing your grant
- [Funding & Tender Portal FAQ](#) find the answers to most frequently asked questions on submission of proposals, evaluation and grant management
- [Research Enquiry Service](#) enquiries about the validation process of the legal entities
- PROJECTS@clean-hydrogen.europa.eu



Pedro GUEDES DE CAMPOS
Financial Engineering Officer

pedro.guedes-de-campos@clean-hydrogen.europa.eu



For further information
<https://www.clean-hydrogen.europa.eu/>

