Clean Hydrogen Partnership

Co-funded by the European Union

This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (now Clean Hydrogen Partnership) under Grant Agreement No 101007216. This Joint Undertaking receives support from the European Union's Horizon 2020 Research and Innovation program, Hydrogen Europe and Hydrogen Europe Research.

Sustainable SoluTions FOR recycling of end-of-life Hydrogen technologies

Towards the take up

Ilaria Schiavi, ENVIPARK

Antonio Campanale, RINA

CONTENT

Management of EoL fuel cell and hydrogen technologies: barriers and opportunities
Presentation of the findings of the regulatory and standardisation review- where the management of EoL fuel cell could fit in the current situation

- ***Updated as at end of November 2023***

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Current regulatory situation for management of EoL FCH technology

Overall EoL fuel cell & hydrogen technologies have no specific/ dedicated regulatory or standardisation instrument

No significant volumes yet

Opportunity to work on designing in environmental sustainability

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ELECTROLYSERS

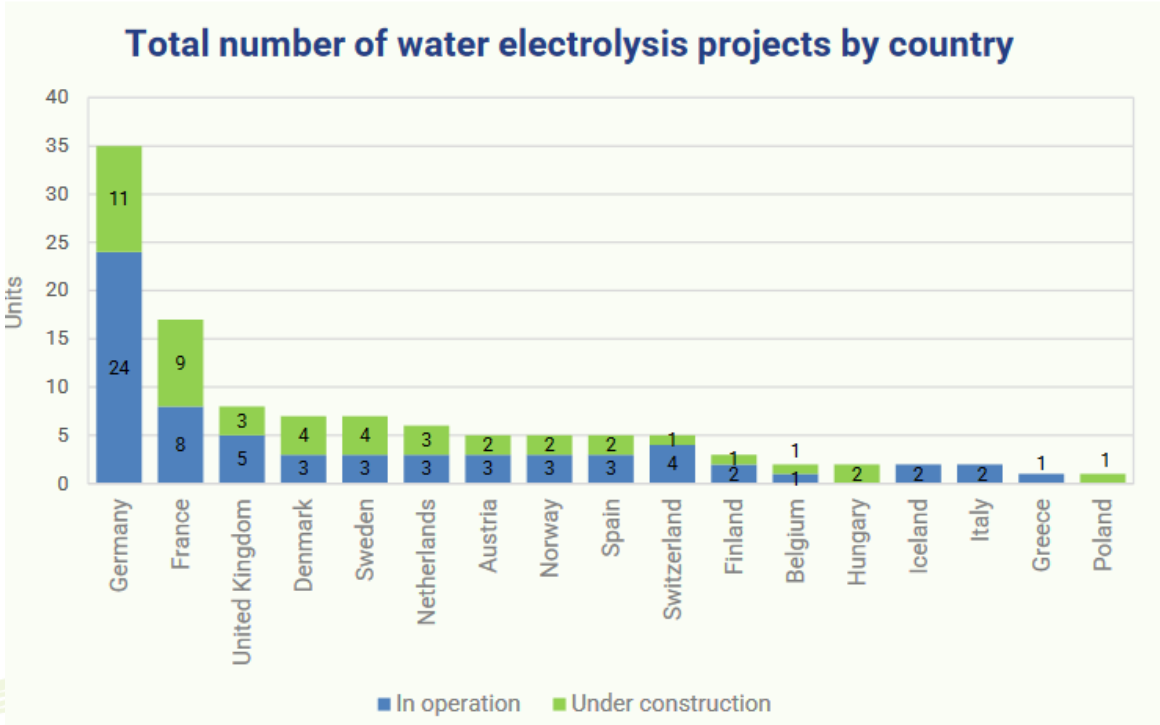
Table 7: Electrolyser technology types commissioned in Europe from 2000 – 2010

Units	2000	2003	2004	2005	2006	2007	2008	2009	2010
PEM	1	1	1	1	1	1	5	1	3
ALK	2	4	3	1	1	2	2	3	5
SOEC									
Unknown						1	1		1

Table 8: Electrolyser technology types commissioned in Europe from 2011 – 2021

Units	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
PEM	4	2	7	2	6	6	3	7	14	1	5
ALK	7	6	6	2	3	2	3	4	3		
SOEC	1	2		1	2	1	1	2	4		
Unknown	2	3	2	1	1			1	1	1	9

<90



97 water electrolysis projects in operation, with 67 of them having a minimum capacity of 0.5 MW;
46 water electrolysis projects under construction becoming operational **from January 2023 to 2025**.

Source: Fuel Cells & Hydrogen Observatory,

- *Tables: Chapter 1 Technology and Market, March 2022;*
- *Graph and text: The European hydrogen market landscape, Nov 2023*

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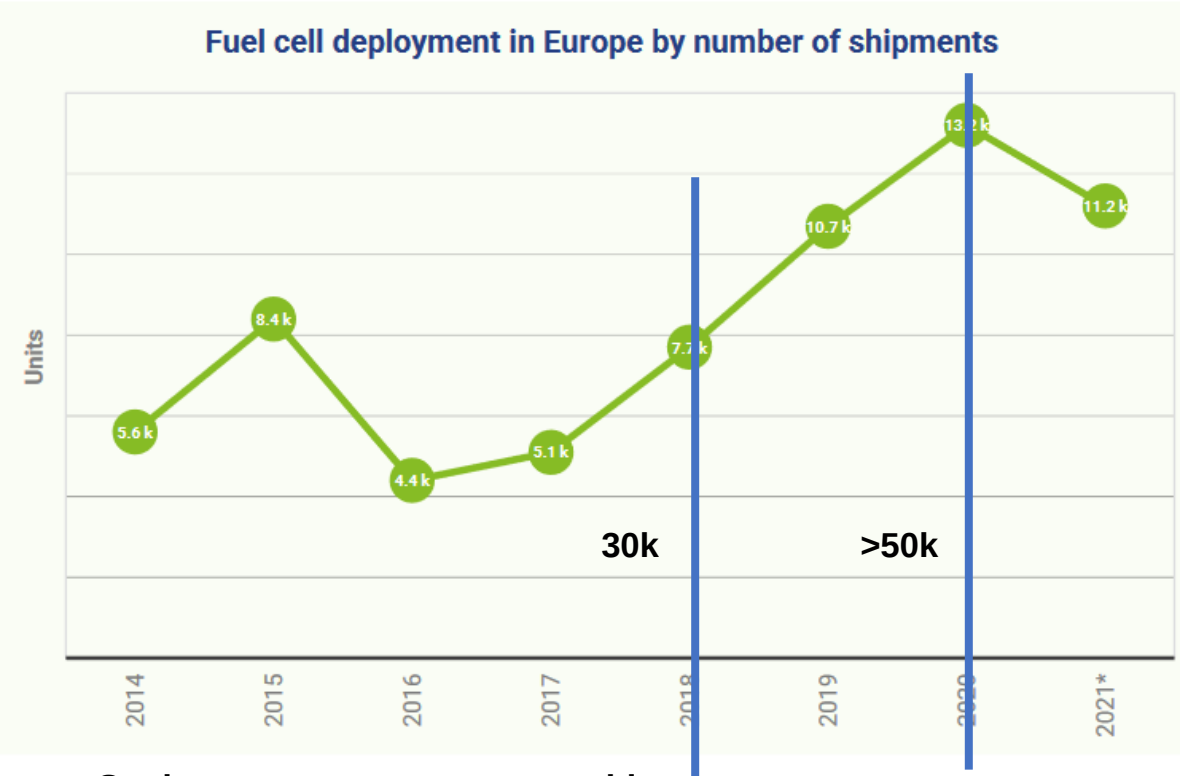
FUEL CELLS



Stationary >> transport > portable
Stationary = 5 x transport
Transport = 2 x portable

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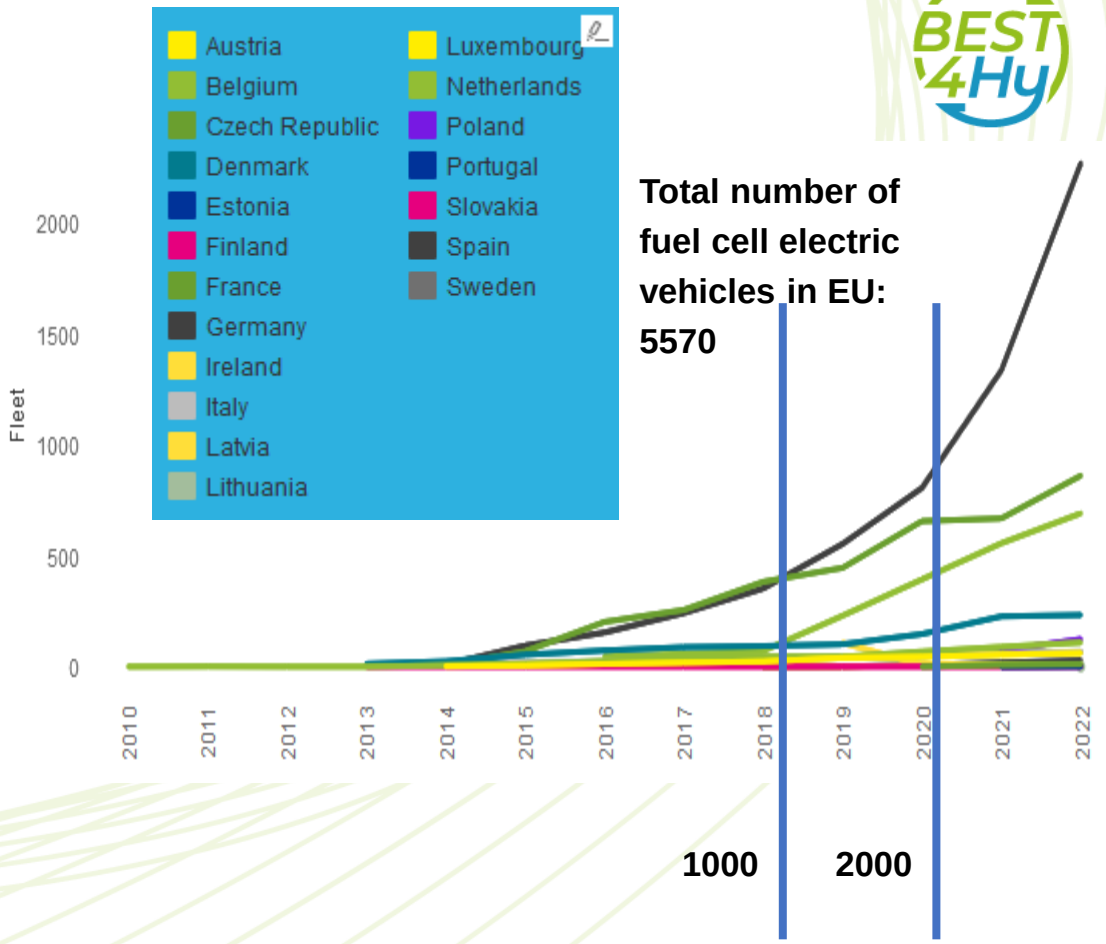
Stationary = 3 x transport
Transport = 5 x portable



Total number of fuel cell electric vehicles in EU: 5570

FUEL CELL ELECTRIC VEHICLES

Source: Fuel Cells & Hydrogen Observatory, The European hydrogen market landscape, Nov 2023

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EoL FUEL CELLS and WASTE REGULATIONS

2023: no significant volumes of discarded (= waste) fuel cell or other hydrogen technology devices, but only instances of devices reaching EoL (e.g. from written-off cars, old test devices, first generation vehicles/electrolysers etc…)

Waste regulations impose a classification of any discarded material as a basis for regulating its management: transport, handling, storage, treatment including recycling.

Classification = identification of the six digit code within the European Waste Catalogue

No specific code exists for EoL fuel cells

→ classification under an existing code

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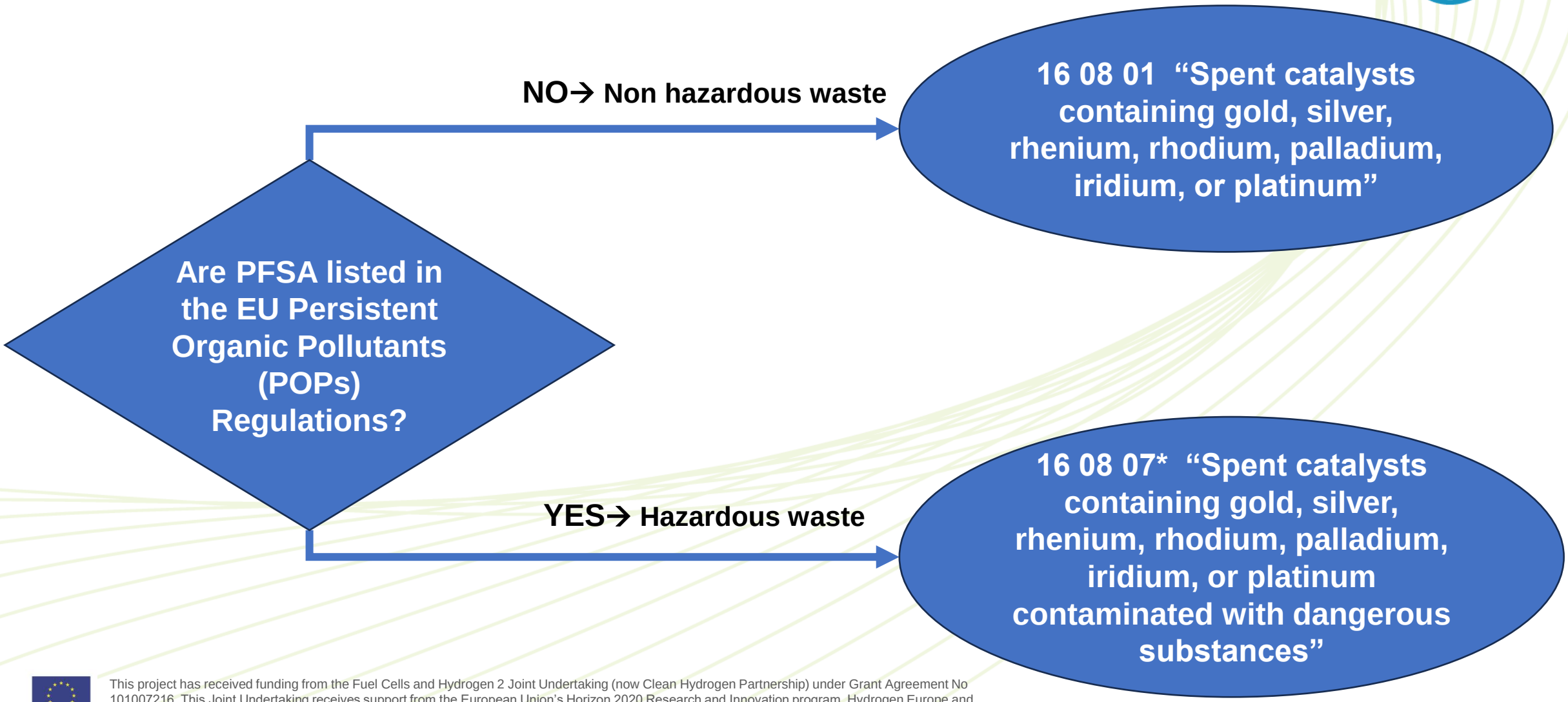
HAZARDOUS or NON-HAZARDOUS?

EoL stacks, MEAs and water electrolysers (WE) contain PFSA (Perfluorosulfonic acids).



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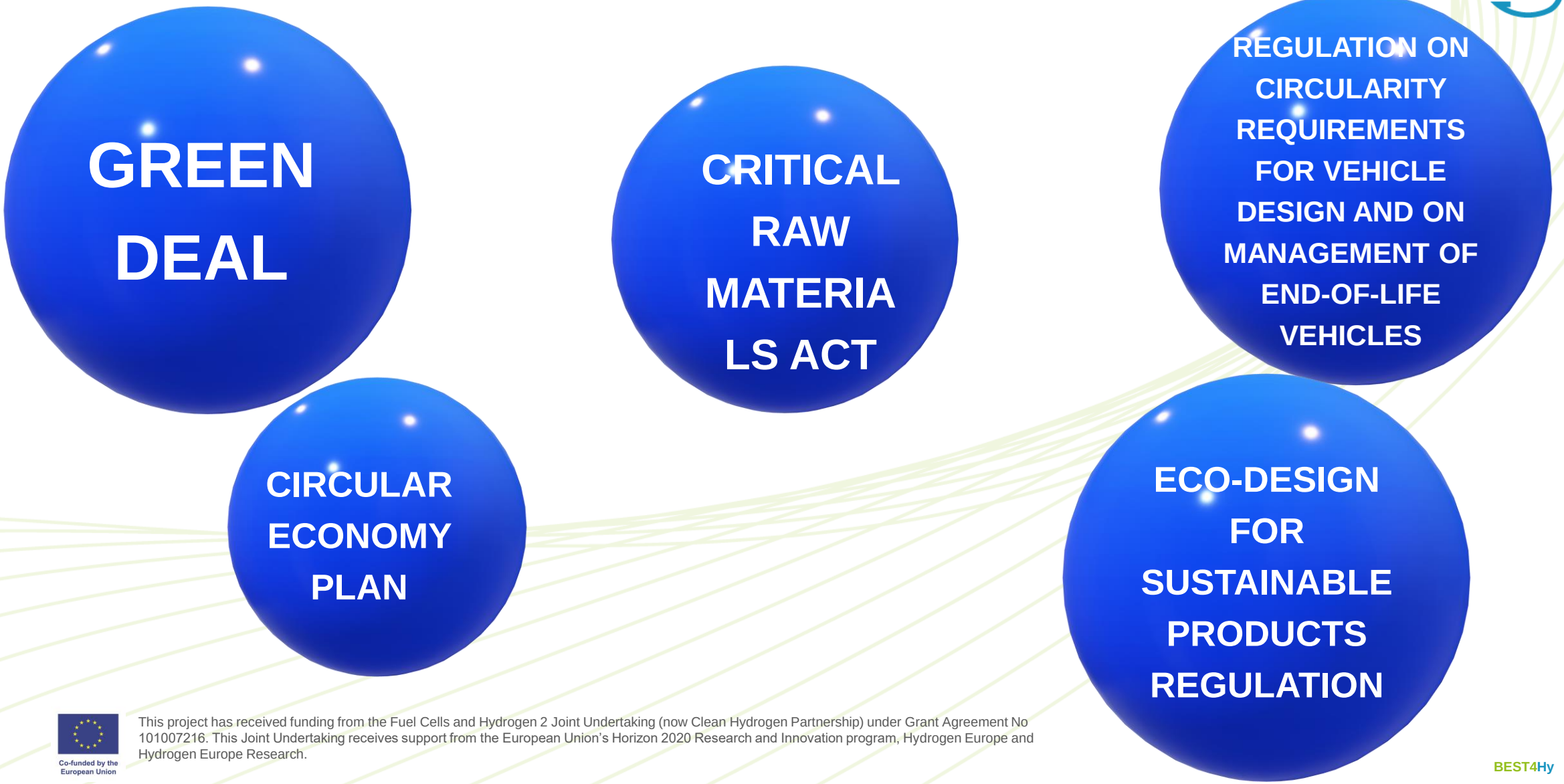
POLICY FRAMEWORK 2024→2030



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THE CRITICAL RAW MATERIALS ACT

“Europe produces less than 3% of total CRMs used in fuel cells globally, while high risk of supply issues is estimated for the raw materials for which the EU is highly dependent from China and Africa. High risk is associated to Lanthanum, Yttrium, while slightly lower risk is associated to Platinum and Cobalt, and much lower risk to Nickel.”*

The Critical Raw Materials Act aims to propose a set of actions with the objectives of ensuring access to a secure, diversified, affordable and sustainable supply of critical raw materials for the European economy.

Targets by 2030 for EU **capacity to be built up** are identified for the whole strategic raw materials supply chain:

- EXTRACTION: at least 10% of the EU's annual consumption
- PROCESSING: at least 40% of the EU's annual consumption
- RECYCLING: at least 15% of the EU's annual consumption for recycling,

**“Supply chain analysis and material demand forecast in strategic technologies and sectors in the EU – A foresight study”, JRC, 2023*

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THE BATTERIES REGULATIONS as a possible MODEL

- **Applicable to all batteries** (incorporated or used on their own), with batteries used for traction in road vehicles become a new separate category of electric vehicle batteries
- Aim to make **batteries sustainable throughout their entire life cycle** – from the sourcing of materials to their collection, recycling and repurposing
- **ECODESIGN**: Batteries should be designed and manufactured to optimise their performance, durability and safety and to minimise their environmental footprint. Specific sustainability requirements for rechargeable industrial batteries with a capacity greater than 2 kWh, LMT batteries and electric vehicle batteries, as such batteries represent the market segment which is expected to increase the most in the coming years.
- Rules on the **sustainability, performance, safety, collection, recycling and second life of batteries as well as on information about batteries for end-users and economic operators**: carbon footprint of battery manufacturing, the ethical sourcing of raw materials and the security of supply in order to facilitate re-use, repurposing and recycling of batteries.
- A harmonised regulatory framework for dealing with the entire life cycle of batteries that are placed on the market in the Union: harmonized product and marketing requirements, including conformity assessment procedures, as well as **requirements to fully address the end-of-life stage of batteries**. Requirements concerning the end-of-life stage are necessary to address the environmental implications of the batteries and, in particular, to support the creation of recycling markets for batteries and markets for secondary raw materials from waste batteries.
- **Application of extended producer responsibility,** including minimum requirements on separate collection and recycling targets, distributor take-back and second life.

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THE BATTERIES REGULATIONS as a possible MODEL: specific requirements

- Obligatory carbon footprint of electric vehicle batteries, rechargeable industrial batteries and light means of transport (LMT) batteries
- Recycled content of certain materials (cobalt, lead, lithium, nickel), in increasing percentages (2031 to 2036)
- Register of producers and products put on the market of each Member State; producers cover the cost of separate collection, transport and treatment “taking into account any revenues obtained from preparation for re-use or preparation for repurposing or from the value of secondary raw materials recovered from recycled waste batteries”
- Increasing collection targets; percentages and timing depending on type of batteries
- Targets on recycling efficiency (% by average weight of batteries, depending on chemistry) and targets for recovery of materials (e.g. 90% for cobalt increasing to 95% in a few years)
- Battery passport: material composition, carbon footprint, share of recycled material, dismantling information

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Standardization Inventory

Electrical and electronic components at EoL of FCH → Handled as WEEE and categorized as EEE

WEEE Directive (2002/96/EC) become effective in February 2003, with some updates in 2008, 2012 and 2014 (for PV environment inclusion).
It promotes collaboration between recyclers and producers and can be accomplished by eco-design.

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Applicable standards for FCH End of Life

IEC and ISO hand over standards to CEN and CENELEC, who add provisions to bring the standards in line with European legislation on topics related to consumer protection, safety, environmental protection. Application to these harmonized standards is still optional.

Technical Committees identified	
Fuel cell technologies	IEC TC 105 ISO TC 197
Recycling Batteries	IEC 62902
Circular economy	IEC TC 111

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Timeline standards

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IEC process

1. • Preliminary Stage (PW)
   • Proposal of a new work item
2. • Proposal stage
   • Brought to the attention of relevant IEC TC/SC via National Committee
3. • Preparatory stage
   • Working Draft developed in a TC/SC
4. • Committee stage
5. • Enquiry stage
   • Committee draft for vote submitted to NC for 12-week voting period
6. • Final approval stage
   • Final draft international standards prepared for a 6-week voting period
7. • Publication stage from IEC International Standard

Building expert consensus

Direct publication if no technical changes

International Workshop Agreement

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IEC process: New Work Item Proposal (NP)

SCOPE of the Proposal		
❑ Standard	❑ Technical Specification	❑ Publicly Available Specification
Purpose and justification		
Market relevance	Need for corresponding standards	Select among the 17 SDGs
Target Date		
Frequency of meetings	Liasons with International Bodies	Concerns known patented Items
Determination of Project leader		

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CONCLUSIONS

- Overall, no existing specific regulations on EoL fuel cells /hydrogen technologies
- Short term issues/ opportunities:
  - How do we classify the EoL FCH becoming waste?
  - Ecodesign of new devices to support recovery of future EoL FCH
- Long term possible regulatory landscape:
  - Learn from batteries experience
  - All-encompassing regulations similar in approach to the Batteries Regulations?
- Standardisation can support regulatory requirements, with timing aligned to the development of ad hoc regulations

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