



**FUEL CELLS AND HYDROGEN**  
JOINT UNDERTAKING

**EHSP**

## **European Hydrogen Safety Panel**

**Workshop on Safety of Electrolysis**

**Iñaki Azkarate**

18 November 2020





# Background

European Hydrogen Safety Panel (EHSP)



## A brief timeline

- In 2006 and 2009 NoE HySafe was suggesting an activity for **sharing lessons learned and hydrogen safety experience across project boundaries** and to **maintain this expertise eventually even beyond program terms**.
- In 2014 the International Association for Hydrogen Safety HySafe proposed the installation of a safety panel to the Executive Director and Governing Board of the FCH JU.
- After several discussions about formal aspects, terms of reference, vision, mission, mandates, etc. the European Hydrogen Safety Panel was launched by the FCH 2 JU in 2017.



# Vision

European Hydrogen Safety Panel (EHSP)



## Reflecting the FCH 2 JU vision

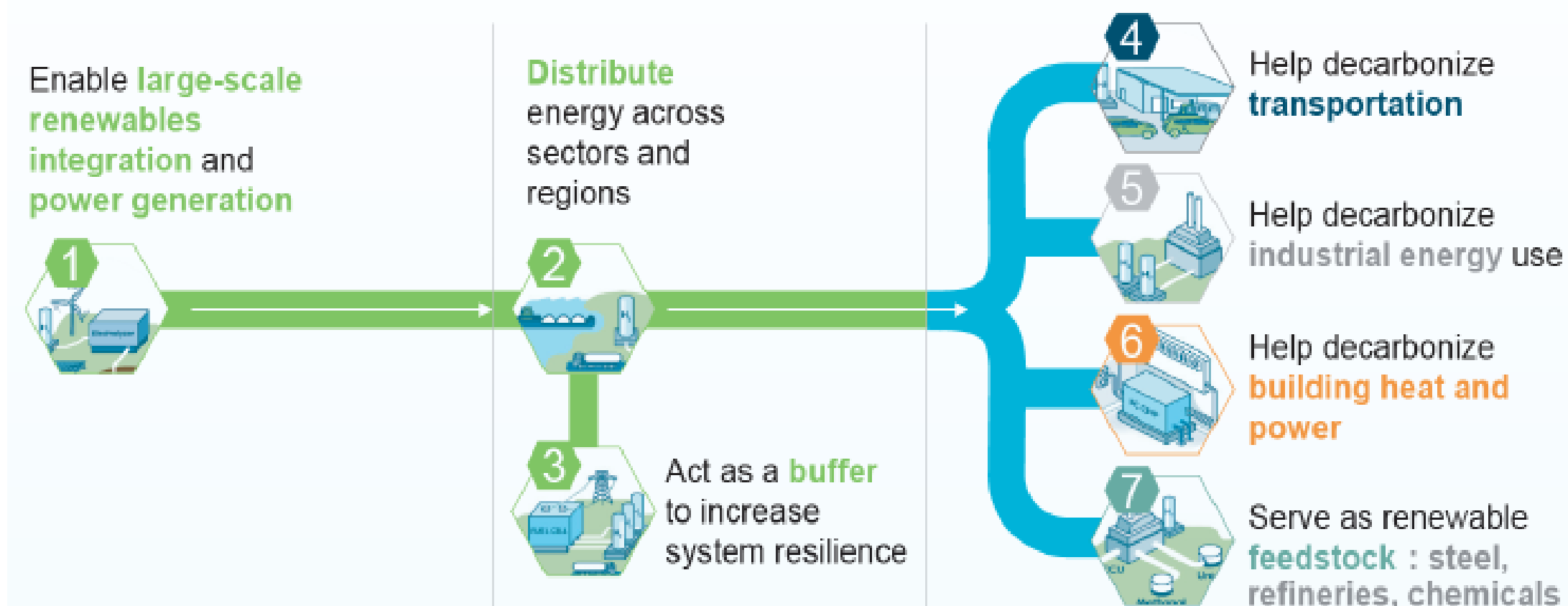
- Hydrogen plays a key role in the Energy System constituting a **safe** and sustainable Energy Carrier.
- Hydrogen is an enabler of the Energy Transition towards a decarbonized system.

### Hydrogen enables the decarbonization of all major sectors in the economy



*Hydrogen can enable a full renewable energy system, providing the sector integration needed for the energy system transition and decarbonize energy end uses*

Enable the renewable energy system → Decarbonize end uses



SOURCE: Hydrogen Council

Projections for Europe indicate that 5 million vehicles and 13 million households could be using hydrogen by 2030, while a further 600kt of hydrogen could be used to provide high grade heat for industrial uses. In this scenario, hydrogen would be abating 80Mt CO<sub>2</sub> and account for an accumulated overall investment of \$62B (52B€) and 850,000 new jobs.





# From Vision to the Strategic EHSP Role

European Hydrogen Safety Panel (EHSP)



## FC and H2 technology developments having a direct impact on safety:

- **Quantitative growth across “established” applications** in mature markets **increases the demand for hydrogen**, and hence increases the number and size of H2 supply units, i.e. HFS
- **Qualitative change**, new applications building on the success of established applications. (50-100 kg H2 for trucks, 200-500 kg for rail, and potentially tons of hydrogen for marine)

**The inevitable consequence** of this increase in consumption will be the requirement for an **increasingly large and competent workforce** [...] technicians, engineers, manufacturers, regulatory authorities etc. on a **very steep hydrogen learning curve**.



**EHSP ROLE**: to provide **independent safety expertise, objective information, education and training** in different forms for various groups of stakeholders and support the anticipated upscaling of hydrogen energy application.



# Mission, Objectives and Corresponding Activities

European Hydrogen Safety Panel (EHSP)



**The EHSP assist the FCH 2 JU both at programme and at project level**

- in assuring that hydrogen safety is adequately managed, and
- to promote and disseminate hydrogen safety culture

Activities structured in  
**4 Task Forces**



**TF1  
Project  
level**



**TF2  
Program  
level**



**TF3  
Data  
Collection**



**TF4  
Public  
Outreach**



# Scope of Activities

European Hydrogen Safety Panel (EHSP)



## Activities are grouped in the 4 pillars and organised in Task Forces (TF)

### TF1 Support at Project level



- Coordination of a package of measures to avoid any accident by integrating safety learning, expertise and planning into FCH2 JU funded project.
- e.g. Safety plans review, in-situ reviews, courses, data collection/ monitoring ...

### TF2 Support at Programme level



- answering urgent questions, short introductions to hydrogen safety
- provision of specific guidelines (collecting inputs from projects)
- ...

### TF3 Data collection and assessment



- Support to HIAD - Hydrogen Incidents and Accidents Database
- Analysis of existing events, derive lessons learned and provide recommendations, collaboration with similar activities of the US DoE and EIGA...

### TF4 Public Outreach



- Development of a comprehensive outreach, education and training programme for the safety component of FCH2 JU projects
- Newsletter and website, containing the lessons learned and links





# Scope of Activities

European Hydrogen Safety Panel (EHSP)



## Contributions of the EHSP

TF1 Support at Project level



Safety Planning

TF2 Support at Programme level



Emergency/crisis management

TF3 Data collection and assessment



Lessons learnt and recommendations

TF4 Public Outreach



Communication, web, FAQ



FUEL CELLS and HYDROGEN 2 JOINT UNDERTAKING  
(FCH 2 JU)

SAFETY PLANNING FOR HYDROGEN AND FUEL CELL PROJECTS



This document is prepared t  
Cell and Hydrogen Joint Und  
implied, or assumes any lega  
apparatus, product, or pro  
Reference herein to any spe  
otherwise does not necessa  
the EHSP.

The views and opinions of a  
EHSP. Additionally, the docu  
system(s), material(s), equip

FUEL CELLS and HYDROGEN 2 JOINT UNDERTAKING  
(FCH 2 JU)

Assessment and lessons learnt from HIAD 2.0 –  
Hydrogen Incidents and Accidents Database

20 September 2019

This document is prepared by  
support of the Fuel Cell and Hy  
makes any warranty, express  
accuracy, completeness, or us  
or represents that its use wou  
commercial product, process,  
not necessarily constitute or li  
or the EHSP.

The views and opinions of not  
FCH 2 JU or the EHSP. Additio  
the FCH 2 JU or the EHSP of a  
document.



EHSP & FCH 2 JU CONFIDENTIAL

FUEL CELLS and HYDROGEN 2 JOINT UNDERTAKING (FCH 2 JU)

European Hydrogen Safety Panel (EHSP)

Communication strategy 2020–2024

24 April 2020

Task Force 4 –

TF4 D4.4: FAQs – Lea

FAQs

**Q1: Is hydrogen more or less safe than other gases?**  
Is hydrogen safe? How safe is hydrogen compared to other gases, such as methane and natural gas? How safe is hydrogen for transport and storage? How safe is liquid hydrogen? Which is safer, compressed or liquid hydrogen? How safe is hydrogen when released? How safe is hydrogen when it is used in fuel cells? (What is the risk of explosion?)

**Q2: Are specific hydrogen technologies safe?**  
Are hydrogen fuel cell cars and buses safe? Are hydrogen fuel cell forklifts safe? Are hydrogen fuel cell powertrains safe? How safe is liquid hydrogen? Which is safer, compressed or liquid hydrogen? How safe is hydrogen when released? How safe is hydrogen when it is used in fuel cells? (What is the risk of explosion?)

**Q3: What are the requirements for testing equipment and components used in hydrogen systems?**  
How are components used in hydrogen systems certified and tested? Which regulations, codes and standards apply? How can event frequencies for emerging hydrogen technologies be estimated, what are the uncertainties in such estimates, and what are the implications for risk assessments?

**NOTICE**  
This document is prepared by the European Hydrogen Safety Panel (EHSP) with the mandate and support of the Fuel Cell and Hydrogen 2 Joint Undertaking (FCH 2 JU). Neither the FCH 2 JU nor the EHSP makes any warranty, expressed or implied, or assumed any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favouring by the FCH 2 JU or the EHSP. The views and opinions of authors expressed herein do not necessarily state or reflect those of the FCH 2 JU or the EHSP. Additionally, the document does not provide any approval or endorsement by the FCH 2 JU or the EHSP of any system(s), material(s), equipment or infrastructure discussed in the document.





# Current EHSP Members – the Pool of Experts

European Hydrogen Safety Panel (EHSP)



Inaki Azkarate



Stuart Hawksworth



Thomas Jordan



Georg Wilfried Mair



Marta Maroño



Vladimir Molkov



Ernst-Arndt Reinecke



Pratap Sathiah



Ulrich Schmidtchen



Etienne Studer



Trygve Skjold



Tom Van Esbroeck



Elena Vyazmina



Jennifer Wen



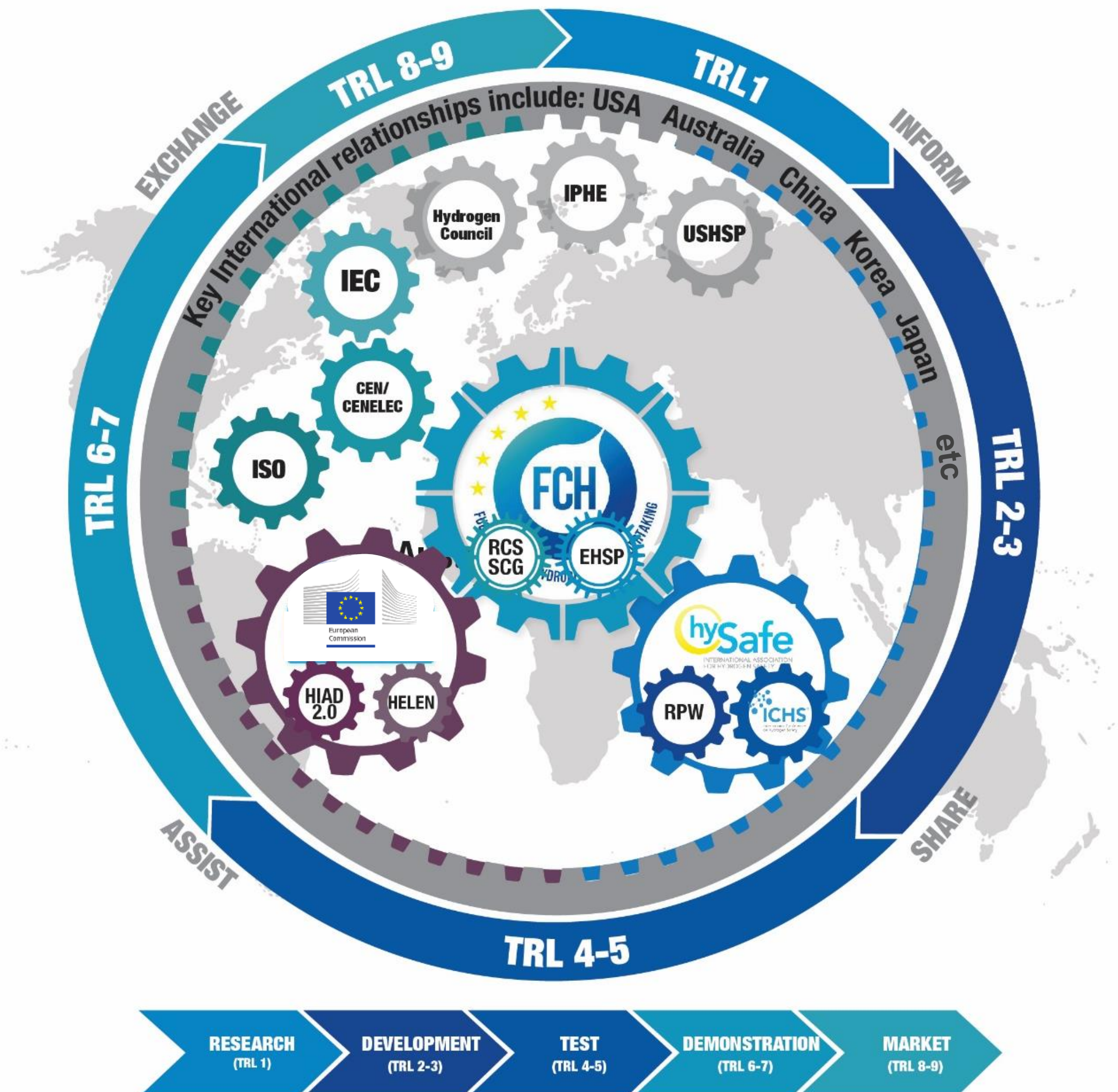
For more information see Members of the EHSP : <https://www.fch.europa.eu/page/european-hydrogen-safety-panel>



# EHSP in the „Big Picture“

International relations for strategic orientation

- Ensure appropriate engagement for hydrogen safety at program level.
- Identify and prioritise gaps with respect to hydrogen safety in close cooperation with RCS SCG, JRC and HySafe.
- Share information and coordinate with similar international activities.
- Support demonstrations of safety.
- Ensure safe implementation and operations for a broader roll-out.



**The members of the EHSP would like to express a strong commitment towards supporting the Hydrogen Community.**

**With our expertise, we can help research projects,  
and in principle all stakeholders, to address matters related to hydrogen safety.**







**FUEL CELLS AND HYDROGEN**  
JOINT UNDERTAKING

**EHSP**

## **Workshop on Safety of Electrolysis**

**Iñaki Azkarate**

18 November 2020



# Workshop on Safety of Electrolysis

European Hydrogen Safety Panel (EHSP)



## Workshop on Safety of Electrolysers

This Workshop consist of a specific activity of the EHSP, particularly of our TF1, *Support at Project level*.

Electrolysis is the process that splits water into hydrogen and oxygen using electricity.

Hydrogen is produced in the cathode and Oxygen in the anode.

Depending on the materials and temperature of the process, several types of Electrolysers are considered:

- Low Temperature Electrolysis (LTE), including
  - Proton Exchange Membrane Electrolysis (PEME) and
  - Alkaline Electrolysis (AE),
  - conventional or
  - AEME (also known as Alkaline PEM)
- and High Temperature Electrolysis (HTE).
  - Solid Oxide Electrolysis (SOE).





# Workshop on Safety of Electrolysis

European Hydrogen Safety Panel (EHSP)



## Challenges

Concerning the challenges of the technology, the Research on Electrolysers is focused on overcoming aspects as:

- Reducing the capital cost.
- Improving energy efficiency for converting electricity to hydrogen.
- Resistance to cross-over.
- Integrating compression into the electrolyser.
- Improving the materials resistance, this process is very demanding concerning materials and their improvement against corrosion processes is needed.



# Workshop on Safety of Electrolysis

European Hydrogen Safety Panel (EHSP)



## Challenges, risks, safety matters

The rate of **H<sub>2</sub>** and **O<sub>2</sub>** **cross-permeation** across the **membrane** and their water solubility both increase with pressure

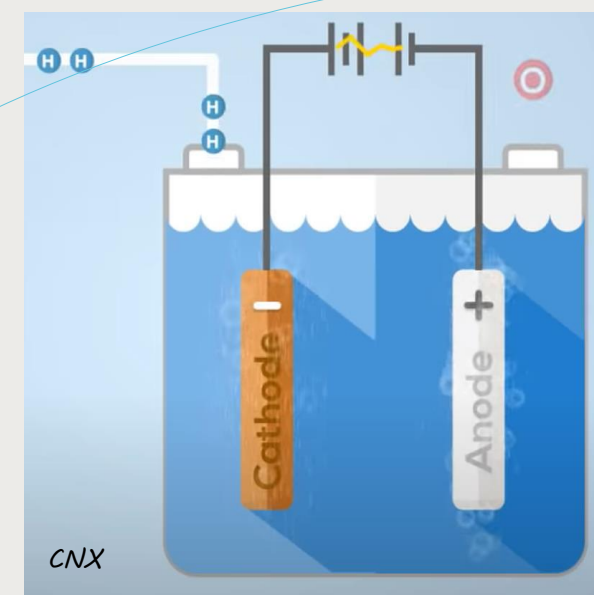
**Electrolyte** defines the technology.  
**Materials** for electrodes, seals and catalysts have to be tuned to the electrolytes

**Flammable H<sub>2</sub>** in close vicinity to **oxydizer O<sub>2</sub>**

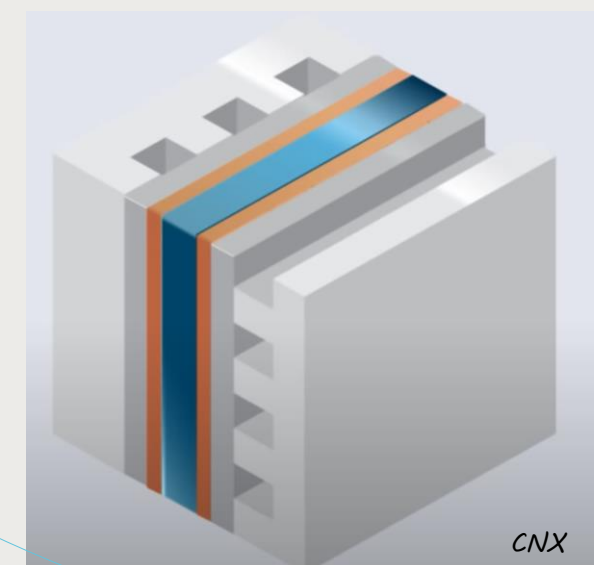
Wet **corrosive** electrochemistry on electrodes

**High direct voltage** (~400V) with transients and potential for hot spots

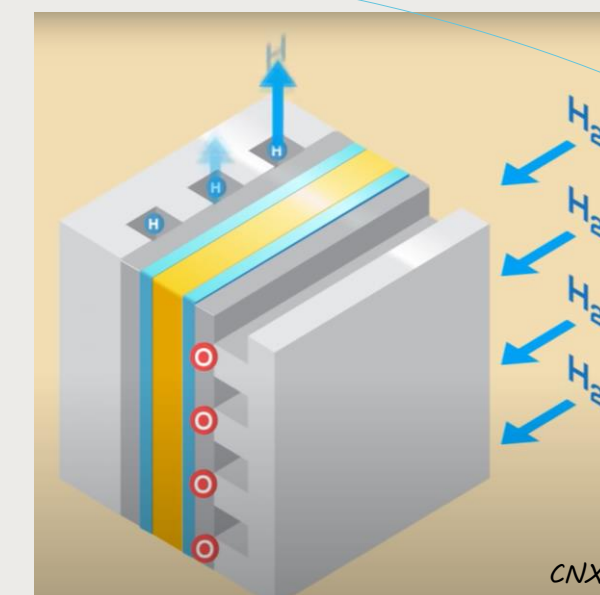
**AE**



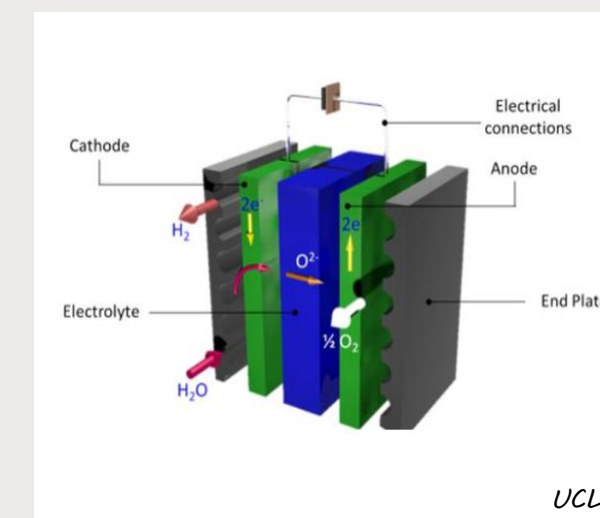
**AEME**



**PEME**



**SOE**



### Membrane Electrode Assembly MEA

Thin membrane separates gas spaces and thin electrodes transfer electrons to the ion conducting electrolyte  
Internal electrodes are designed as **bipolar plates** functioning as cathode (H<sub>2</sub> generation) on one side and as anode (O<sub>2</sub> formation) on the other





Thank you for your attention

*<https://www.fch.europa.eu/page/european-hydrogen-safety-panel>*