European Hydrogen Week

//EU HYDROGEN RESEARCH DAYS

15-16 NOVEMBER

Clean Hydrogen Partnership

Co-funded by the European Union

MultHyFuel
Safety and Permitting for Hydrogen at Multifuel Retail

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MultHyFuel

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Project Overview

Call year:
2020

Call topic:
FCH-04-1-2020

Project dates:
01/01/2021 - 31/09/2024

Total project budget:
2,109,906.25 €

MultHyFuel

% stage of implementation
01/11/2023: 80%

Clean Hydrogen Partnership max. contribution: 1,997,406.25 €

Other financial contribution:
112,500.00 €

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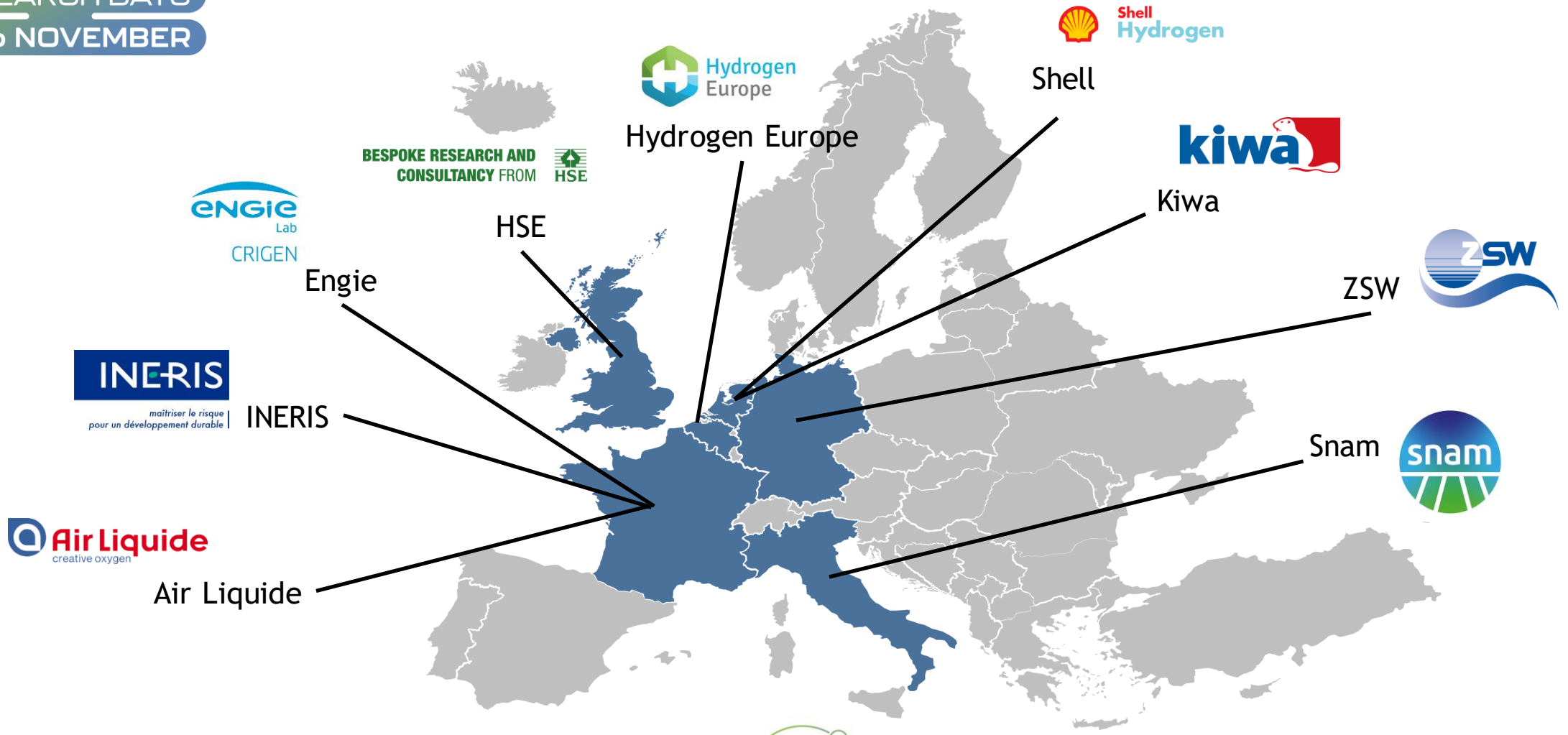
Partners



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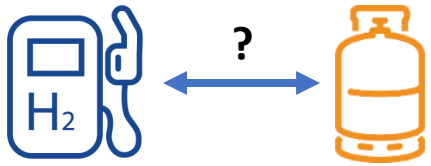
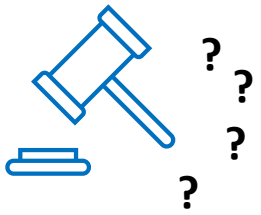
Project Summary

Context:
Increased demand for upscaling and co-locating HRS alongside conventional fuels in commercial and residential areas



Problems:

- Lack of specific HRS regulation in some countries
- Co-location of hydrogen with conventional fuels not foreseen in most safety regulations
- Different approaches



Goals:

- Identification of ***relevant gaps*** in the current legal and administrative framework;
- Acquisition of ***experimental data*** from engineering research on hydrogen leaks, their effects and the effects of mitigation measures;
- ***Active engagement*** with a community of stakeholders in the overall process;
- Successfully disseminate the project's results.

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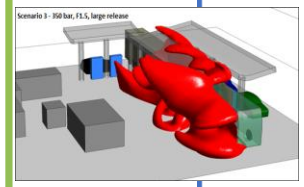
Project implementation

WP6 – Project management

WP1 - Detailed investigation of current status

- T1.1 Definition of scope for regulatory analysis (Cross-country research framework)
- T1.2 Research into permitting requirements and public guidance on required risk assessments
- T1.3 Comparative assessment and gap analysis



WP2 - Practical research to address gaps in current understanding

- T2.1 Leakage characterisation of H2 dispensers
  - Task 2.1.1 Leakage characteristics
  - Task 2.1.2 Dispersion characteristics
  - Task 2.1.3 Ignition probabilities
  - Task 2.1.4 Efficiency of safety barrier
- T2.2 Fire and explosion hazards
  - Task 2.2.1: Defining a zoning threshold
  - Task 2.2.2 Domino effect arising from faults on hydrogen dispensers
  - Task 2.2.3 Vulnerability of hydrogen dispensers to incidents involving other fuel dispensers

WP3 - Generate best practice guidance

- T3.1 State of the art of technology
- T3.2 State of the art on risk assessment methodologies
- T3.3 Preliminary risk analysis
- T3.4 Detailed risk assessment
- T3.5 Identification of critical scenarios
- T3.6 Risk assessment review of critical scenarios & hazardous areas
- T3.7 Best practice guidelines redaction

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Severe
Almost Certain	Medium	High	High	Extreme	Extreme
Likely	Medium	Medium	High	Extreme	Extreme
Possible	Medium	Medium	High	High	Extreme
Unlikely	Low	Medium	Medium	High	High
Rare	Low	Low	Medium	High	High

WP4 – Engagement

- T4.1 Establishment of the Network
- T4.2 Inception phase
- T4.3 Workshop on state of the art and case study models
- T4.4 Workshop on refined case study models and WP2 methodology
- T4.5 Workshop on results of WP2 and WP3
- T4.6 Workshop on development of best practice guidance
- T4.7 Meeting on adoption of best practice guidance (WP3)

WP5 - Dissemination, Communication and exploitation

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Research into permitting requirements

Goal:

- Collect specific information on requirements, rules, conditions, standards applicable at national level in 14 European countries (Network of National Experts);
- Comparative assessment and gap analysis.

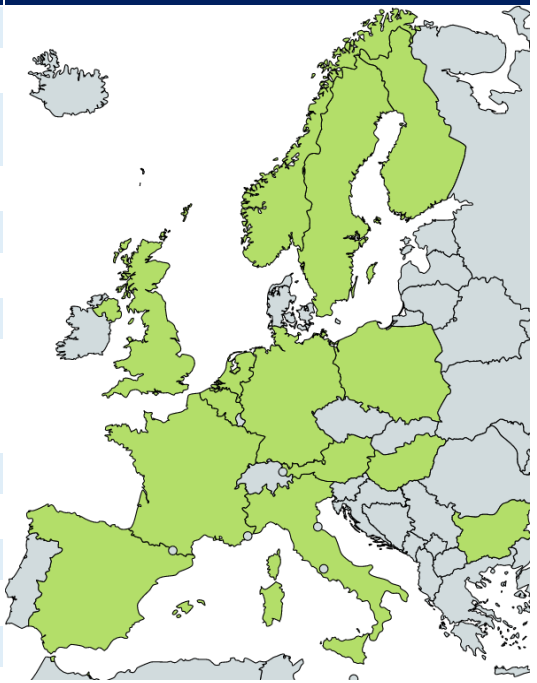
Scope of research

- Existing permitting requirements for HRS;
- Risk Assessment regulations/methodologies;
- Safety or separation distances;
- Intervals and content of equipment maintenance.

Network of National Experts

COUNTRY	ORGANIZATION
AT	Austrian Energy Agency
BE	WaterstofNet vzw
BG	Bulgarian Hydrogen, Fuel Cell and Energy Storage Association
FI	VTT Technical Research Centre of Finland LTD
FR	France Hydrogéne
DE	ZSW
HU	Hungarian Hydrogen & Fuel Cell Association
IT	Italian National Agency for new technologies, energy and sustainable economic development and H2 Italy
NL	NEN
PL	NEXUS Consultants
ES	Aragon Hydrogen Foundation
SE	Hydrogen Sweden
UK	ITM Power
NO	Greenstat

EU COVERAGE & REPRESENTATIVENESS



D1.2 – Permitting requirements and risk assessment methodologies for HRS in the EU (first version)

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Risk assessment and guidelines development

- **3 configurations of HRS defined with fuel distribution** from **60-300 g/s** : ready to deploy, on site H_2 production, High capacity station
- **Preliminary and detailed risk assessment** achieved on the 3 configurations
  - **Preliminary list of safety barriers** : design of canopy, PSV, choice of materials, safe location of vent lines, periodic control of integrity for dispenser accessories, H_2 flame and gas detection with emergency protocols, shut off valves, break aways, flow rate restriction...
  - **Main causes of leak on H_2 dispensers** : hydrogen embrittlement, human error during maintenance, bad connections with hose or nozzle, impact events such as crash, vehicle driveaway or domino effects due to the LOC of other fuels.
  - **Consequences of H_2 leak on dispenser** : explosions in the open air (UVCE) or in a confined environment (VCE inside the dispenser) or to jet fires or flashfires.
  - **Manage the H_2 dispenser risks** by implementation of safety barriers, reducing the numbers of fittings in the dispenser, minimizing number of people in the vicinity of dispensers.
- **Next steps** :
  - **Refinement of the risk assessment** of the scenarios and events by considering results of experiments from WP2 ;
  - **Recommendations for safe implementation of H_2 dispenser** in multi fuel context (safety barriers, sep. distances, ATEX,...)

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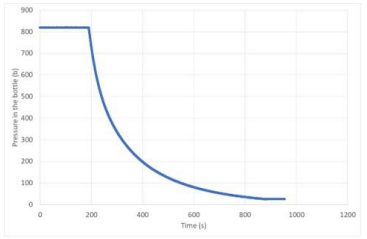
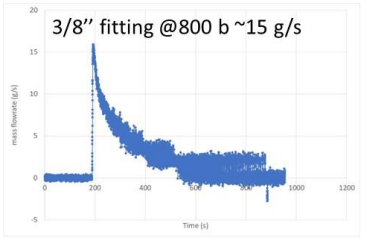
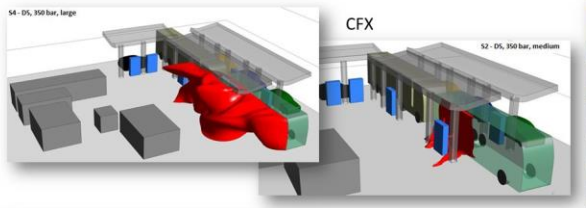
Experimental results – leakages, clouds and ignition

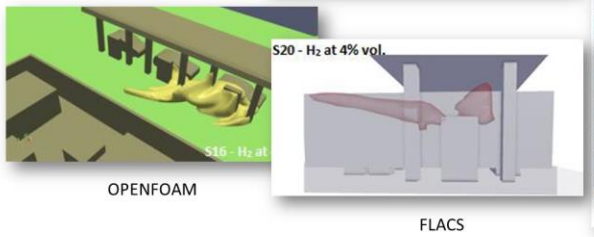
- A rather predictive tool was produced to propose a failure database even if little or no experience exists
- Large flammable clouds can be produced in case of medium leaks
- Ignition may be considered very high probability for catastrophic rupturing, 10-20% otherwise.
- Safety barrier should activate extremely fast to mitigate the consequences of explosions.





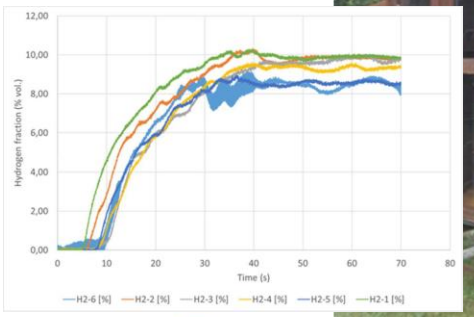
P (b)	component	event	mass flowrate (g/s)	meas % full cross section	Predicted %
800	full bore 0.5 mm	reference	10	100	
800	full bore 2 mm	reference	160	100	
800	full bore 2.6 mm (1/4")	estimated	270	100	
800	full bore 5 mm (3/8")	estimated	1000	100	
800	full bore 7.8 mm (9/16"")	estimated	2434	100	
800	Maximator U fitting 9/16"	Unscrewing/bad mounting	30-50	1,6	**5**
800	Maximator U fitting 3/8"	Unscrewing/bad mounting	15-30	2,0	**8**
800	Maximator U fitting 1/4"	Unscrewing/bad mounting	10	3,7	**19**
800	Maximator valve 9/16"	Bad mounting	1-3	0	**4**
800	Maximator valve 3/8"	Bad mounting	20-30	3	**9**
800	Maximator valve 1/4"	Bad mounting	10-12	4	**24**

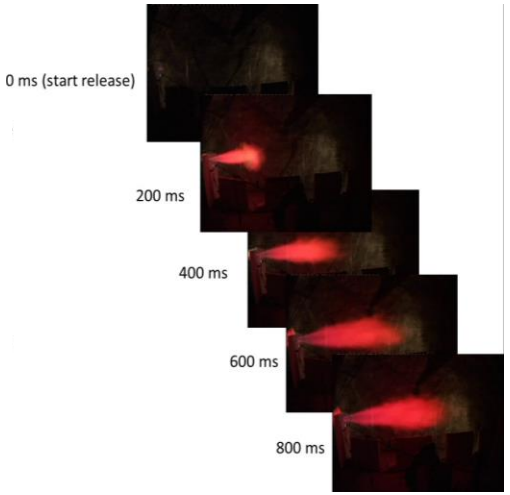




Scenario No.	Release Type	Release Location	Leak Size	Pressure (barg)	Mass Flow Rate (g/s)	Wind Condition	Configuration
1	External	Hose	Medium	350	14.8	F1.5	1
2						DS	
3			Large		120.0*	F1.5	
4						DS	
5			Medium	700	25.9	F1.5	
6						DS	
7			Large		60.0*	F1.5	
8						DS	
9	External	Hose	Medium	350	14.8	F1.5	2
10						DS	
11			Large		120.0*	F1.5	
12						DS	
13			Medium	700	25.9	F1.5	
14						DS	
15			Large		60.0*	F1.5	
16						DS	
17	Internal	Pipe/Valve	Small	1000	1.5	F1.5	3
18						DS	
19			Medium	350	14.8	F1.5	
20						DS	
21	External	Hose	Small	350	0.7	F1.5	
22						DS	
23			Medium		14.8	F1.5	
24						DS	
25			Large		120.0*	F1.5	
26						DS	
27			Large	700	300.0*	F1.5	
28						DS	

Table 14 - List of realistic release scenarios to be modelled using CFD tools. Cases marked with (*) indicate that the mass flow rate is restricted to the dispenser H2 delivery flow rate. All other mass flow rates have been estimated using the FCH2 e-Laboratory *Jet Parameters* tool





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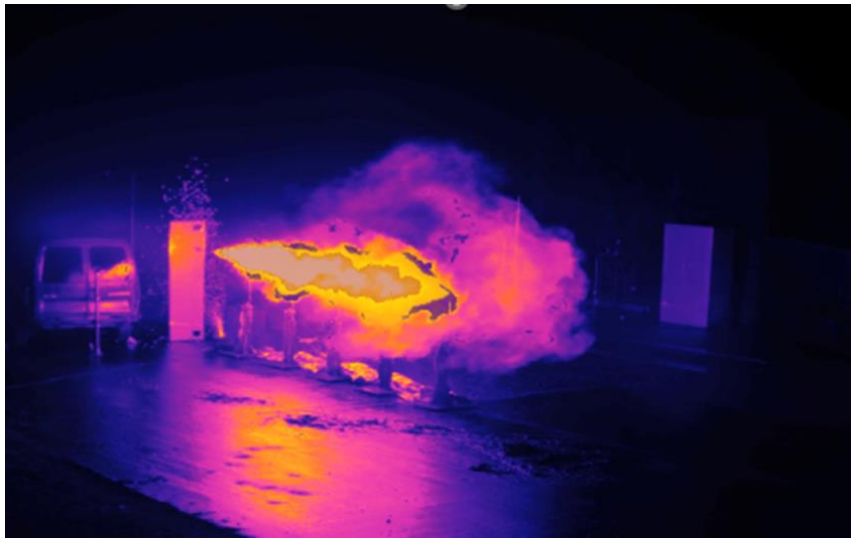
Experimental results – fire and explosion

- Experiments have been undertaken to demonstrate the consequences of failure scenarios outlined in WP3 in relation to fire and explosion hazards.

- The trials undertaken were:
  - Simulated failure of breakaway - ignited
  - Loss of containment on hose - hose whip
  - Loss of containment on pipe / vent (internal releases from pipework within dispenser housing)
  - Loss of containment on pipe / vent (internal releases from pipework within dispenser housing ignited inside)
  - Loss of containment on pipe / vent (internal releases from pipework within dispenser housing ignited outside)
  - Domino effect between different dispensers (pool fire adjacent to pressurised dispenser)



Risks, Challenges and Lessons Learned

Challenges

- Covid 19 pandemic
- Procurement issues
- Experiments implementation

Mitigation

- Extended delivery dates and considering late deliveries
- Considered alternative experiments
- Literature data availability
- Active engagement with stakeholders

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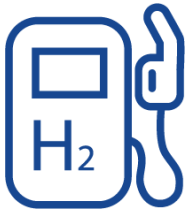
Exploitation Plan/Expected Impact

Exploitation

- Assisting Member States in implementing AFIR goals with developed guidelines
- Development of safety measures and standards for multifuel context hydrogen application
- Using experimental data as a basis for further and future reseearch



Impact

- Achieving AFIR goals
- Unification of safety measures and standards on EU-level
- Development of future experimental projects for safe hydrogen utilization

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Communications Activities

Website

- Project summary
- Public deliverables
- Slides / recordings of events and workshops
- Communication, dissemination and exploitation plan

- www.multhyfuel.eu

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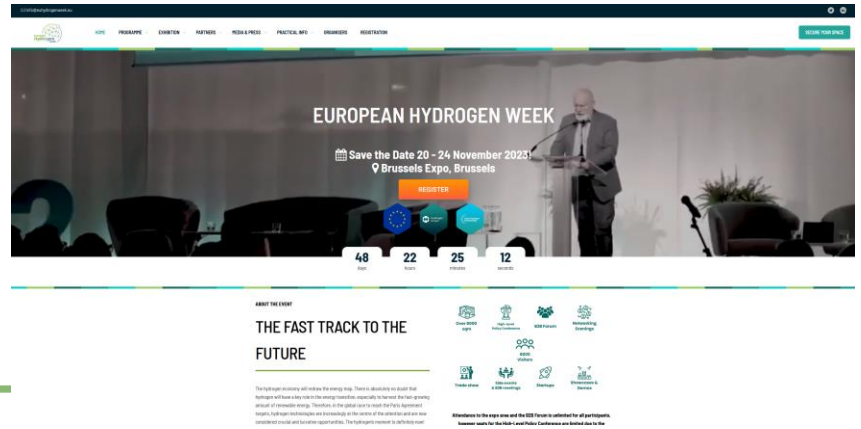
Communications Activities

Side event at European Hydrogen Week

- November 21st 2023, 9.00-13.00h CEST
- Participation of relevant stakeholders (HRS operators, public authorities, manufacturers, end-users, etc.)
- More info on H2Week
- Invitations will be sent out in time!



Preliminary agenda

Time	Subject		Speaker
9 :00 – 9 :15	Registration		
9 :15 – 9 :20	Welcoming words		Clean Hydrogen Joint Undertaking
9 :20 – 9 :35	Alternative Fuels Regulation (AFIR) Introduction		Hydrogen Europe
9 :35 – 9 :45	Introduction to MultHyFuel		Hydrogen Europe
9 :45 – 10 :10	WP1 - Regulatory analysis on permitting requirements in the EU		Hydrogen Europe
10 :10 – 10 :40	WP3 - Risk assessment and development of guidelines (WP 3)		ENGIE
10 :40 – 11 :10	WP 2 – Testing results	Leakages, clouds and ignition	INERIS
11 :10 – 11 :40		Fire and Explosion	HSE
11 :40 – 11 :55	Break		
11 :55-12 :30	MultHyFuel Think Tank - Group 1: Risk assessment and regulatory analysis - Group 2: Experimental data and need for additional testings		engagement with stakeholders
12 :30 – 12 :40	Break		
12 :40 – 12 :55	Discussion on the results		
12 :55 – 13 :00	Conclusions and closing remarks		Hydrogen Europe

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Thank you for your attention!

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