MultHyFuel
Safety and Permitting for Hydrogen at Multifuel Retail

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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 €

% stage of implementation 01/11/2023: 80%
Clean Hydrogen Partnership max. contribution: 1,997,406.25 €
Other financial contribution: 112,500.00 €
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.
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

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
**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.

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**Network of National Experts**

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>ORGANIZATION</th>
<th>EU COVERAGE &amp; REPRESENTATIVENESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT</td>
<td>Austrian Energy Agency</td>
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</tr>
<tr>
<td>BE</td>
<td>WaterstofNet vzw</td>
<td></td>
</tr>
<tr>
<td>BG</td>
<td>Bulgarian Hydrogen, Fuel Cell and Energy Storage Association</td>
<td></td>
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<tr>
<td>FI</td>
<td>VTT Technical Research Centre of Finland LTD</td>
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<tr>
<td>FR</td>
<td>France Hydrogène</td>
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<td>DE</td>
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<td>HU</td>
<td>Hungarian Hydrogen &amp; Fuel Cell Association</td>
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<td>Italian National Agency for new technologies, energy and sustainable economic development and H2 Italy</td>
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<td>NEXUS Consultants</td>
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<td>Hydrogen Sweden</td>
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<tr>
<td>UK</td>
<td>ITM Power</td>
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<tr>
<td>NO</td>
<td>Greenstat</td>
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</tbody>
</table>

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

- 3 configurations of HRS defined with fuel distribution from 60-300 g/s: ready to deploy, on site H₂ production, High capacity station

- Preliminary and detailed risk assessment achieved on the 3 configurations
  
  o Preliminary list of safety barriers: design of canopy, PSV, choice of materials, safe location of vent lines, periodic control of integrity for dispenser accessories, H₂ flame and gas detection with emergency protocols, shut off valves, break aways, flow rate restriction...
  
  o Main causes of leak on H₂ 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.
  
  o Consequences of H₂ leak on dispenser: explosions in the open air (UVCE) or in a confined environment (VCE inside the dispenser) or to jet fires or flashfires.
  
  o Manage the H₂ 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:
  
  o Refinement of the risk assessment of the scenarios and events by considering results of experiments from WP2;
  
  o Recommendations for safe implementation of H₂ dispenser in multi fuel context (safety barriers, sep. distances, ATEX,...)
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.

### Experimental results - leakages, clouds and ignition

<table>
<thead>
<tr>
<th>P(H)</th>
<th>Fitting component</th>
<th>Event</th>
<th>Mass flow rate (g/s)</th>
<th>Mass % full cross section</th>
<th>Predicted %</th>
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</thead>
<tbody>
<tr>
<td>8000</td>
<td>Full bore 1/4&quot;</td>
<td>reference</td>
<td>100</td>
<td>100</td>
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<tr>
<td>8000</td>
<td>Full bore 1/2&quot;</td>
<td>reference</td>
<td>160</td>
<td>100</td>
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<tr>
<td>8000</td>
<td>Full bore 3/8&quot;</td>
<td>estimated</td>
<td>240</td>
<td>100</td>
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<tr>
<td>8000</td>
<td>Full bore 1/2&quot;</td>
<td>estimated</td>
<td>1000</td>
<td>100</td>
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<td>8000</td>
<td>Full bore 3/8&quot;</td>
<td>estimated</td>
<td>2400</td>
<td>100</td>
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<tr>
<td>8000</td>
<td>Maximator v/fitting 3/16&quot;</td>
<td>Unscreened/bad mounting</td>
<td>30-50</td>
<td>1.6</td>
<td>5</td>
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<tr>
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<td>Unscreened/bad mounting</td>
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<tr>
<td>8000</td>
<td>Maximator v/fitting 3/4&quot;</td>
<td>Unscreened/bad mounting</td>
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<td>3.3</td>
<td>24</td>
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<tr>
<td>8000</td>
<td>Maximator valve 1/10&quot;</td>
<td>Bad mounting</td>
<td>1.3</td>
<td>0</td>
<td>4</td>
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<td>8000</td>
<td>Maximator valve 3/8&quot;</td>
<td>Bad mounting</td>
<td>20-30</td>
<td>3</td>
<td>9</td>
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<tr>
<td>8000</td>
<td>Maximator valve 3/4&quot;</td>
<td>Bad mounting</td>
<td>10-12</td>
<td>4</td>
<td>24</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Mitigation</th>
</tr>
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<tbody>
<tr>
<td>Covid 19 pandemic</td>
<td>Extended delivery dates and considering late deliveries</td>
</tr>
<tr>
<td>Procurement issues</td>
<td>Considered alternative experiments</td>
</tr>
<tr>
<td>Experiments ...</td>
<td>Literature data availability</td>
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<tr>
<td>...</td>
<td>Active engagement with stakeholders</td>
</tr>
</tbody>
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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 research

**Impact**

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

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

- www.multhyfuel.eu
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!
Thank you for your attention!

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