FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

H2ME / H2ME2 Hazards Identification / Risk Assessment Approach

Workshop on Safety of Electrolysis

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H2ME / H2ME2

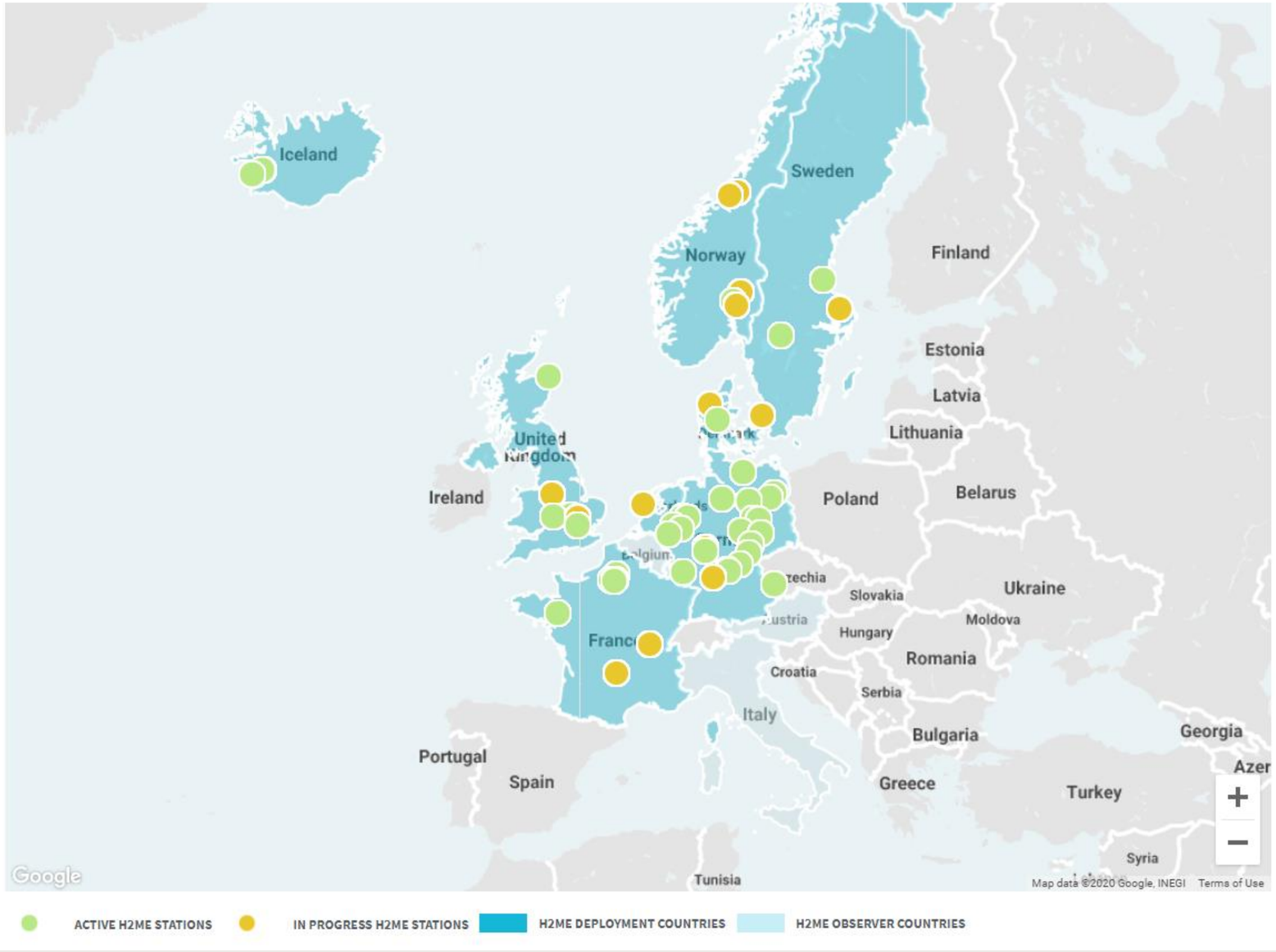
Workshop on Safety of Electrolysis

Project Brief

- Consortium: Large, and mixed – all have safety expertise in their own field
- Other than an RCS report(s), no deliverables where the project require the consortium members to work together on safety – however, learnings transfer into ISO or CEN standardisation work, on a voluntary basis
- Safety Responsible Person: Nothing defined, other than CENEX collating the reports (safety left to responsible individuals in each company)
- Description: Deployment of 49 stations, and >1400 cars and vans over course of H2ME and H2ME2
- Max Inventory, Consumption, Flow: Dependent on location, but all <5 tonnes
- Location: Across Europe – see website: https://h2me.eu/

H2ME / H2ME2

Workshop on Safety of Electrolysis



H2ME / H2ME2

Workshop on Safety of Electrolysis

Project Brief

- Consortium: Electrolyser manufacturers involved:
  - Areva H2Gen
  - ITM Power
  - McPhy
  - Nel
- Unfortunately no other electrolyser manufacturers able to provide feedback for this workshop

DISCLAIMER

ALL INFORMATION SHOULD BE TREATED AS ITM POWER SPECIFIC, AND DOES NOT COVER OTHER ELECTROLYSER MANUFACTURERS INVOLVED IN H2ME OR H2ME2

Regulations, Codes and Standards

- CE marking Directives / Regulations:
  - The Pressure Equipment Directive, *European Directive 2014/68/EU (PED)*;
  - The Machinery Directive, *European Directive 2006/42/EC*;
  - The Low Voltage Directive, *European Directive 2014/35/EU*;
  - The Electromagnetic Compatibility Directive, *European Directive 2014/30/EU*.
  - Elements of the „ATEX Equipment Directive“, *European Directive 2014/34/EU*
- ISO 22734 – however the electrolyser not assessed against this as part of the project
- Refuelling station documents:
  - BCGA CP 41 - *The design, construction, maintenance and operation of filling stations dispensing gaseous fuels*
  - Energy Institute - *Guidance on hydrogen delivery systems for refuelling of motor vehicles. Public use, co-located with petrol filling stations.* (Supplement to the Blue Book)

Regulations, Codes and Standards

- General legislation, for example:
  - Dangerous Substances and Explosive Atmospheres Regulations, DSEAR *(The UK implementation of the European ATEX "Workplace Directive")*
  - Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres (EPS) Regulations *(The UK implementation of the European ATEX "Equipment Directive")*
  - The Pressure Systems Safety Regulations (PSSR)
  - The Provision and Use of Work Equipment Regulations (PUWER)
  - Control of Substances Hazardous to Health Regulations (COSHH)
  - Regulatory Reform (Fire Safety) Order

- Safety rules of Shell (stakeholder / landlord) adopted where deployed on their sites, and over time, these approaches are being used to shape internal ITM processes

Identification of Safety Vulnerabilities ISV

- Main hazards identified are as follows:
  - Pressure – failure of vessels, components etc.
  - Flammable gas (hydrogen) – release to air to form flammable / potentially explosive atmosphere
  - Oxygen – increased propensity for combustion or otherwise non-combustibles
  - Hydrogen/oxygen mixtures – explosion internal to pressure system
  - Electricity - electrocution
  - Moving parts (fans, pumps, etc.)
- Involvement of bodies outside of ITM:
  - PED Notified Body
  - PSSR Competent Person

Risk Assessments

Differs depending on location of system:

- Non-Shell sites – internal ITM risk assessment:
  - HazId, HazOp and LOPA
  - DSEAR risk assessment
  - General risk assessment to summarise more detailed HazOp etc, but also capture hazards that aren‘t related to the process equipment
- Shell sites – additional steps to above (in conjunction with Shell Hydrogen):
  - Bow-tie style Desktop Safety Review (DSR)
  - Pre Start-up Safety Review (PSSR)
- Additional risk assessments (and PTW where appropriate) for individual activities that aren‘t covered by the design risk assessment:
  - Installation / commissioning
  - Maintenance
  - Others (e.g. sampling, unusual refuelling events etc.)

Risk Assessments

- Difficulties encountered:
  - Use of LOPA in the context of an electrolyser system, or compressed gas system, where there isn‘t much that can be added from the perspective of SIF to address low likelihood failures of pressurised components (vessels, fittings, etc)
  - Failure rate data – is it appropriate for hydrogen systems?
  - System interface (i.e. with HRS)
  - Fully quantitative risk assessment challenging, without taking on specialised experts (with cost implications making this difficult - typically no budget within the project for such specialists)

Prevention and mitigation

- Pressure – pressure control (sensors) and pressure relief valves
- Flammable gas - dependent on location / part of system:
  - Stacks – external leak: forced ventilation to achieve Zone 2 NE
  - Stacks – internal leak: water flow, no ignition sources (outside of stack), vessel open to atmosphere, over-pressure calcs
  - Gas drying, buffer storage etc.: Zone 2, natural ventilation, Ex electrics, controlled acces
  - Vents: High level, Zone 1 / 2, natural ventilation, no ignition sources, no impact in case of ignited jet
- Oxygen – vented
- Hydrogen/oxygen mixtures – differential pressure, and de-oxo catalyst with temperature monitoring
- Electricity – Ingress protection (touch and water), procedures (inc. Lock-out, tag out)
- Moving parts (fans, pumps, etc.) – Mechanical guards

Operational concepts, education and training

- Operational steps:
  - Design documentation
  - As built documentation
  - Depending on site, PSSR checks (Shell), WSE checks (UK PSSR regs)
- Training of local first responders (i.e. Security staff / Shell shop staff)
- Development of site specific emergency plan for fire services, also assistance in developing National Operations Guidance (NOG) through BCGA
- Training of local first responders – around time of putting into operation
- Occasional refresher training (or for new staff) when requested (e.g. Shell on annual basis), or „train the trainer“

Safety issues observed so far

- All incidents (only minor) to be reported to HIAD / HELLEN
  - Internal investigations undertaken
    - to provide safety improvements to ITM
    - supply appropriate level of detail to HIAD / HELLEN

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