R&D NEEDS TO ENABLE ON-SITE PRODUCTION OF HYDROGEN AT FUELLING STATIONS

INTERNATIONAL HYDROGEN INFRASTRUCTURE WORKSHOP

BOSTON | 11TH SEPTEMBER 2018

NICK HART (ITM POWER, UK)

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Presentation Contents:

- Introduction
- Typical areas for research
- Areas for coordinated research
- Future standardisation requirements

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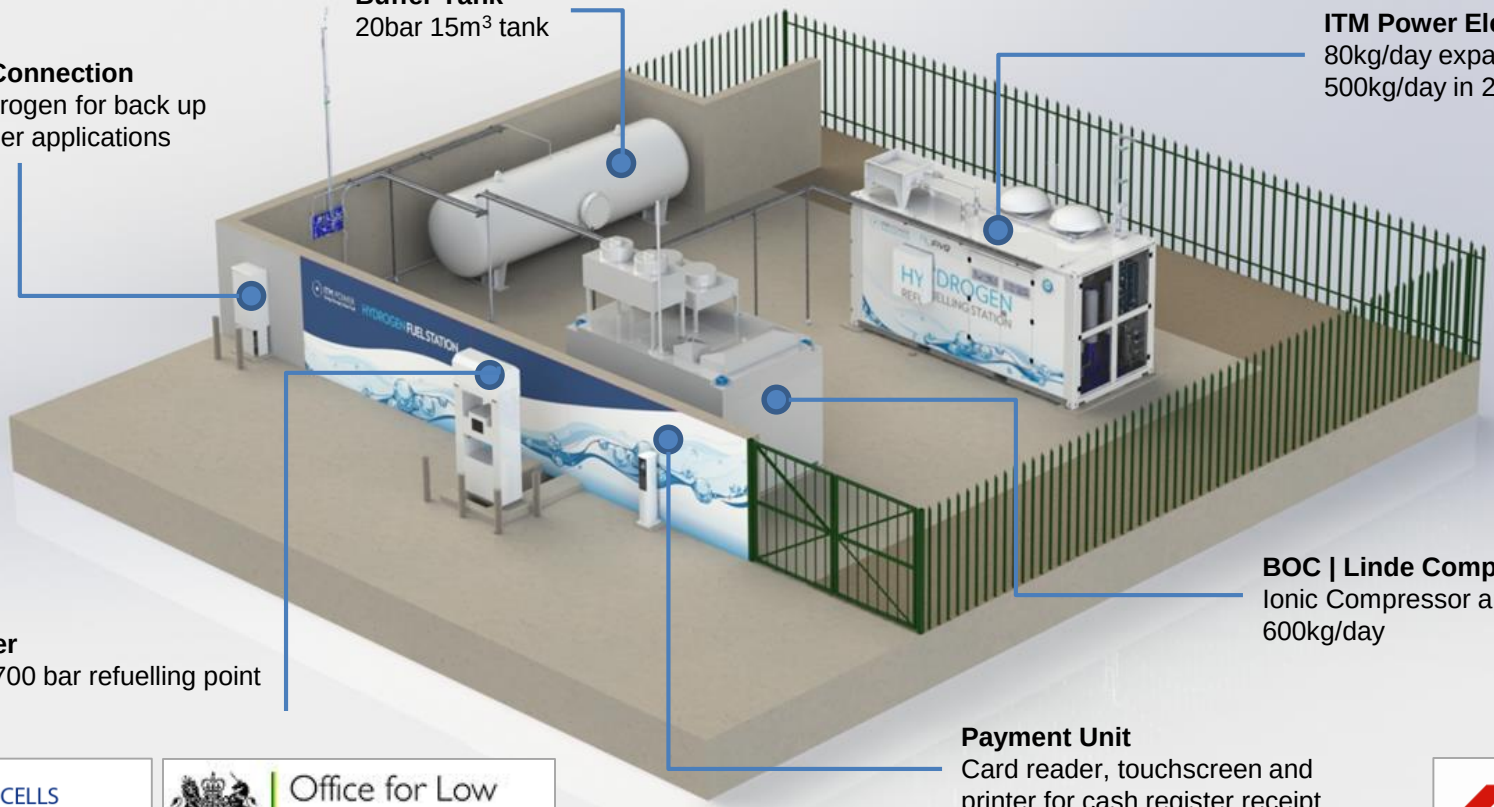
EXAMPLE: ITM HYDROGEN REFUELLING STATION



Buffer Tank
20bar 15m^3 tank

Tube Trailer Connection
Off take of hydrogen for back up supply and other applications

ITM Power Electrolyser
80kg/day expandable to 500kg/day in 20ft container

BOC | Linde Compression
Ionic Compressor and gas storage, 600kg/day

Dispenser
350 and 700 bar refuelling point

Payment Unit
Card reader, touchscreen and printer for cash register receipt

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

Office for Low Emission Vehicles

BOC
Member of The Linde Group

HYDROGEN REFUELLING STATION

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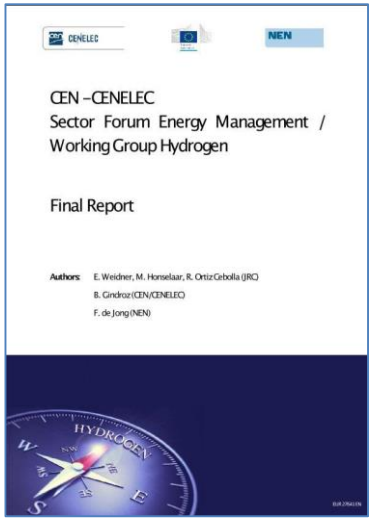
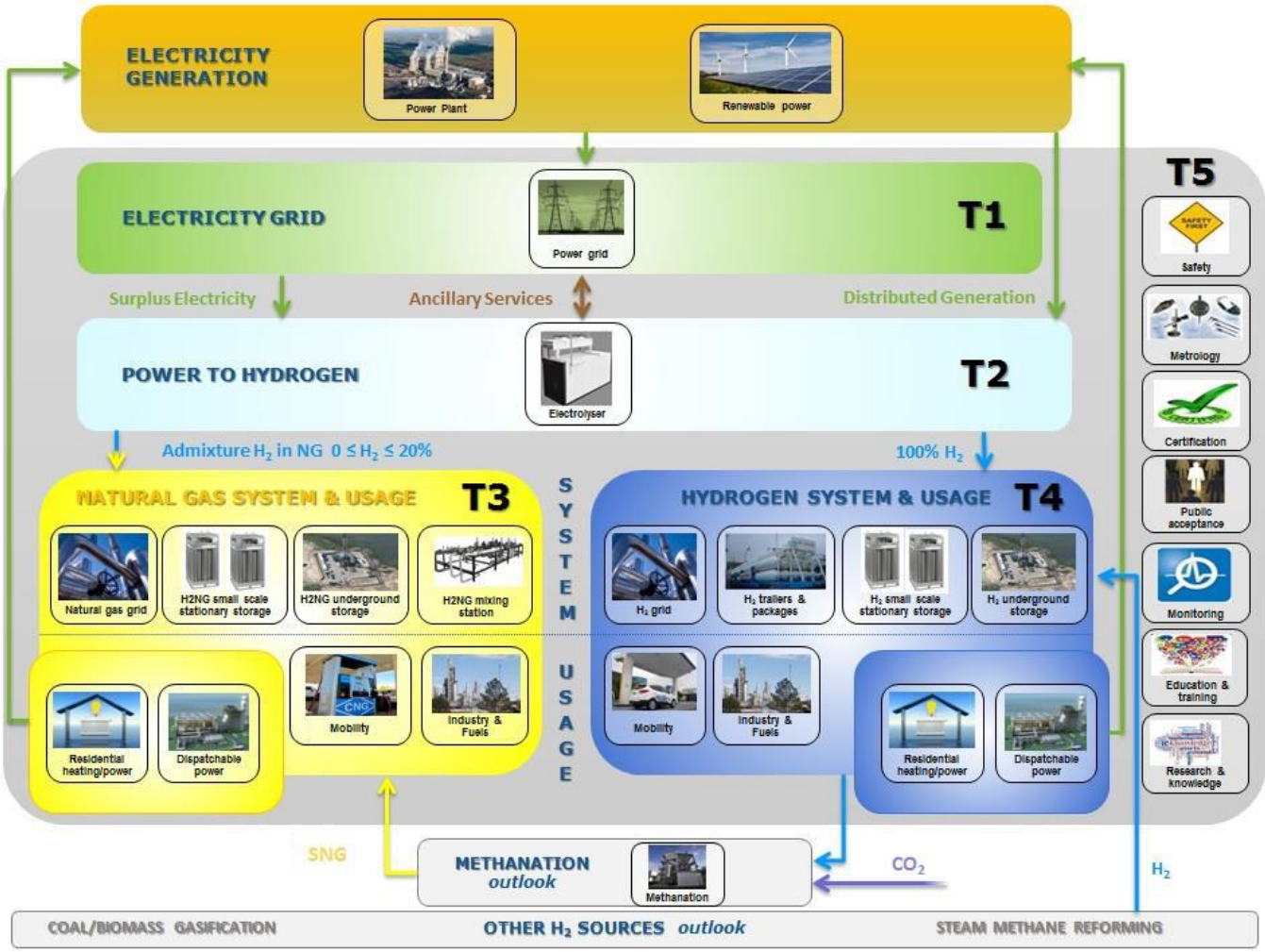
TYPICAL AREAS FOR RESEARCH

R&D needs – typically individual electrolyser manufacturers

- Reduction in cost (CapEx / OpEx):
  - Improved efficiency: lower OpEx, however, higher CapEx?
- Reduction in footprint
- Ability to respond faster to change in generation rate:
  - Enables grid-balancing: extra income
  - Cost implication: cost of power electronics, reduced stack lifetime?
- Increase in generation pressure:
  - Reduced footprint of buffer storage for same mass
  - Reduction in need for compression by other means
  - Increased effectiveness of drying systems
  - However, can lead to increased cost & regulatory issues?
- Cost benefit analysis of on-site vs trucked in:
  - Usage, land availability, proximity to centralised generation
- Balance needs to be found





Source : https://ec.europa.eu/jrc/en/publication/cen-cenelec-sector-forum-energy-managementworking-group-hydrogen-final-report

AREAS FOR CO-ORDINATED R&D

HYDROGEN ENERGY SYSTEMS

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AREAS FOR COORDINATED RESEARCH

R&D needs - examples

- Harmonisation of / Reduction in legislative barriers:
  - Industrial Emissions Directive in Europe
  - Electrical Grid Operator requirements?
  - Considerations for electrolyser stacks (ATEX / PED)
- Development of Guarantees of Origin Scheme to add value to Green hydrogen
  - Ties in with need for appropriate text in RED II
- Development of income sources as a rapid response load (grid balancing)
  - Availability of suitable Power Electronics
  - Operation, and effect on lifetime
- Hydrogen quality control
  - Learnings from quality control risk assessments (ISO 19880-8)
  - Availability of appropriate humidity sensors, etc

INDUSTRIAL EMISSIONS DIRECTIVE

Directive 2010/75/EU… on industrial emissions (integrated pollution prevention and control):

- Annex I, Clause 4: Chemical industry
- For the purpose of this section, production within the meaning of the categories of activities contained in this section means the production on an industrial scale by chemical or biological processing of substances or groups of substances listed in points 4.1 to 4.6
- 4.2. Production of inorganic chemicals, such as:
  (a) gases, such as ammonia, chlorine or hydrogen chloride, fluorine or hydrogen fluoride, carbon oxides, sulphur compounds, nitrogen oxides, hydrogen, sulphur dioxide, carbonyl chloride;

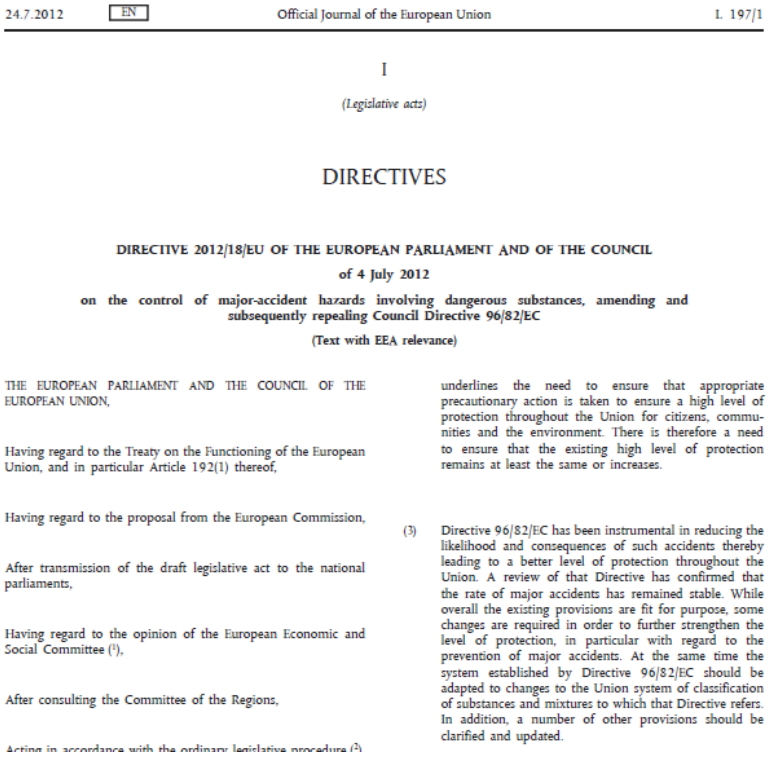
- Any commercial production of hydrogen could be regarded as falling under IED (research systems exempt)

INDUSTRIAL EMISSIONS DIRECTIVE

Implementation of IED across Europe:

- Different requirements across Europe:
  - UK – Environmental Agency Permit: <$2000
  - France – Need to gain exemption from local authorities to avoid stringent permitting requirements, including public consultation
  - Germany – Implementation tied into BImSchV – this also implements SEVESO (Directive 2012/18/EU) which is more targeted at major hazards, for instance storage >5 tonnes hydrogen (or 3 tonnes in Germany)

    (Rather than BetrSichV for <3 tonnes)



24.7.2012 EN Official Journal of the European Union L 197/1

I

(Legislative acts)

DIRECTIVES

DIRECTIVE 2012/18/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 4 July 2012
on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC
(Text with EEA relevance)

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty on the Functioning of the European Union, and in particular Article 192(1) thereof,

Having regard to the proposal from the European Commission,

After transmission of the draft legislative act to the national parliaments,

Having regard to the opinion of the European Economic and Social Committee (1),

After consulting the Committee of the Regions,

Acting in accordance with the ordinary legislative procedure (2)

underlines the need to ensure that appropriate precautionary action is taken to ensure a high level of protection throughout the Union for citizens, communities and the environment. There is therefore a need to ensure that the existing high level of protection remains at least the same or increases.

(3) Directive 96/82/EC has been instrumental in reducing the likelihood and consequences of such accidents thereby leading to a better level of protection throughout the Union. A review of that Directive has confirmed that the rate of major accidents has remained stable. While overall the existing provisions are fit for purpose, some changes are required in order to further strengthen the level of protection, in particular with regard to the prevention of major accidents. At the same time the system established by Directive 96/82/EC should be adapted to changes to the Union system of classification of substances and mixtures to which that Directive refers. In addition, a number of other provisions should be clarified and updated.

INDUSTRIAL EMISSIONS DIRECTIVE

EC Guidance now available, but leads to inconsistency?

What is the meaning of "production on an industrial scale by chemical or biological processing in Annex I section 4"?

<u>“production on an industrial scale”:</u>

Annex I Section 4 (“chemical industry”) refers to “production on an industrial scale” and contains no quantitative capacity thresholds. The scale of chemical manufacture can vary from a few grams (of a highly specialised product), to many tonnes (of a bulk chemical product); yet both may correspond to “industrial scale” for that particular activity.

…….

As a general remark and in view of the very large number of possible situations (as regards chemical and biological processing, chemical substances or groups of substances produced, types and places of activities), it remains for the competent authorities to make an informed and justified judgment on whether or not a particular installation falls under the scope of the IED, using this guidance as a tool to promote consistency and prevent possible abuse in the interpretation of the scope of the Directive as regards section 4 of Annex I.

http://ec.europa.eu/environment/industry/stationary/ied/faq.htm#annex1

GUARANTEES OF ORIGIN

Development of Renewable Energy Directive 2009/28/EC – Proposal for RED II

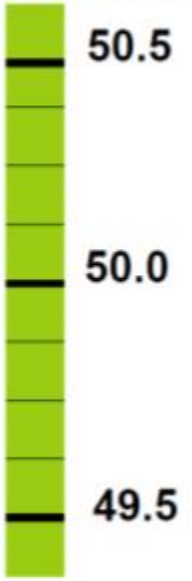
"(47) Guarantees of origin, which are currently in place for renewable electricity, should be extended to cover renewable gas. Extending the guarantees of origin system to non-renewable energy sources should be an option for Member States. This would provide a consistent means of proving to final customers the origin of renewable gases such as biomethane and would facilitate greater cross-border trade in such gases. It would also enable the creation of guarantees of origin for other renewable gases such as hydrogen."
https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CONSIL:ST_10308_2018_INIT&from=EN

For on-site generation of hydrogen, there must be a way to enable coupling to the grid:

- to ensure hydrogen can be generated when it is required, not just where renewables can be sited and directly coupled
- to take into account where "the fuel producer is adding to the renewable deployment or to the financing of renewables"
- to enable grid balancing, and to utilise constrained RES

The text of the RED II could limit / enable the ability of on-site hydrogen generation to have added value as a "renewable fuel".

BALANCING SUPPLY AND DEMAND:
SECOND BY SECOND

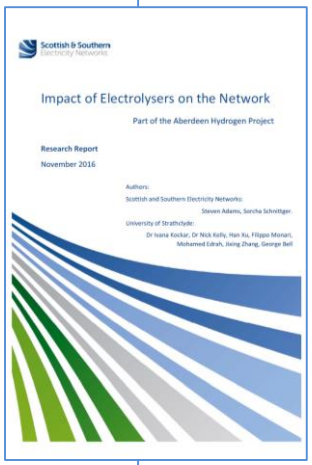


Dynamic	Supply Side Balancing Action	Demand Side Balancing Action
Rising Frequency	Turn OFF a generator	Turn ON a load
Falling Frequency	Turn ON a generator	Turn OFF a load

UK WIND CONSTRAINT PAYMENTS

Curtailment | Grid Balancing

- 2015 Curtailment | 1.27 TWh | payments average 7p/kWh
- 2015 NG Grid balancing payments of £1.1bn



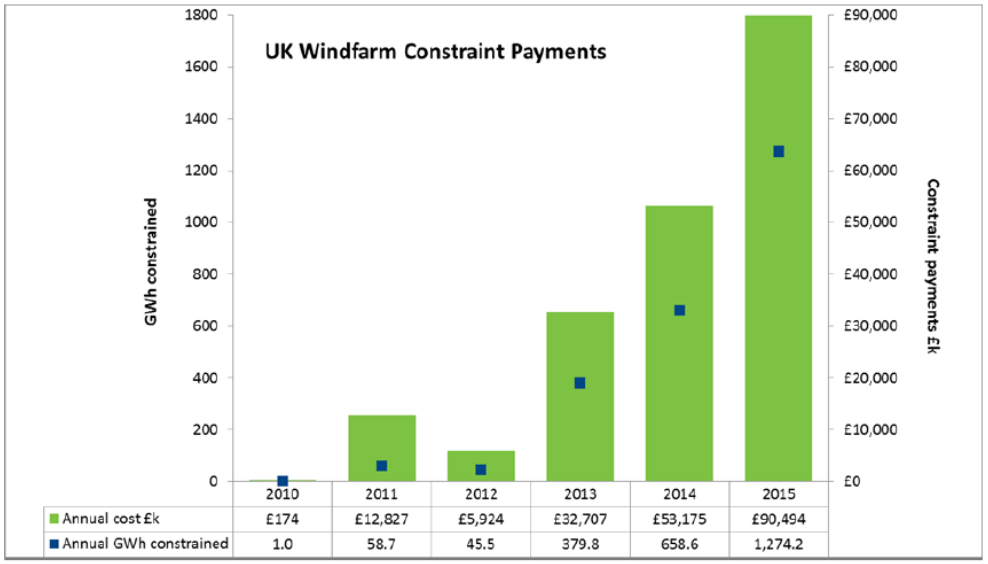


Figure 3.4 Constraint Payments UK [69]

FUTURE STANDARDISATION REQUIREMENTS?

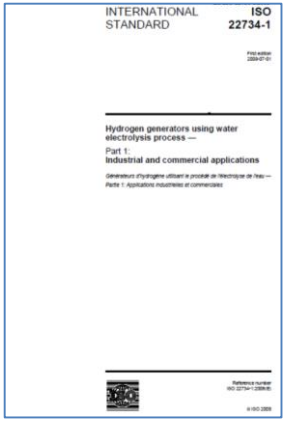
ISO TC 197:

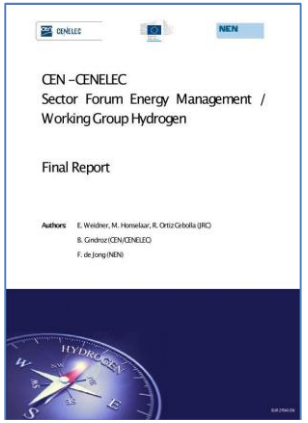
- WG26: electrolysers – safety standard
- Also WG27 / WG28: hydrogen quality

CEN/CLC TC 6:

Location (/potential) for standards on:

- Guarantees of Origin (WG2)
- Key performance indicators for electrolysers?
- Example leak sizes / zones?





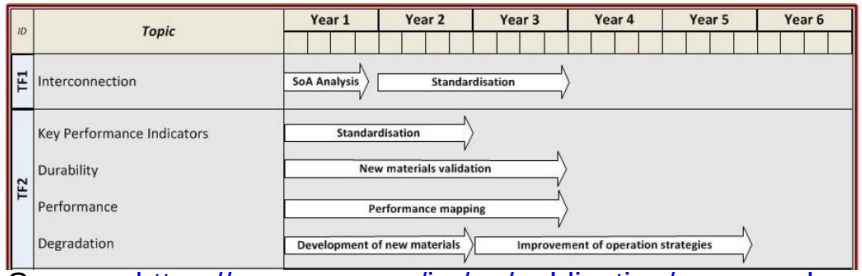


Table 1: Short and near term standardization actions

Topic	Description	Standardization action
Electrolysers	Definition of key performance indicators	Update of ISO 22734 or New EN standard
Electrolysers	Include SOEC technology	Update of ISO 22734
Electrolysers	Definition of electrolyser system boundaries	Update of ISO 22734
Electrolysers	Oxygen quality specifications for cases in which the oxygen stream can be utilised.	Update of ISO 22734 or New EN standard
Electrolysers	Installation and operational standards	New EN standard
Gas grid infrastructure	Pre-mixing stations → Definition of requirements	New EN standard

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