Emerging Conclusions

2. H2ME projects overview

Document prepared by: Element Energy

A project co-funded by
under the Grant Agreement n.671438 and n. 700350
Emerging Conclusions
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The H2ME initiative is a flagship European project, deploying hundreds of fuel cell hydrogen cars, vans and trucks and the associated refuelling infrastructure, across 8 countries in Europe.

It will create the first truly pan-European network, and the world’s largest network of hydrogen refuelling stations.

The project is made up of two phases, H2ME, which started in 2015, and H2ME-2, which will end in 2022. Over the course of these two phases, more than 1400 vehicles and 45+ hydrogen refuelling stations will be deployed.

The project is being supported by the European Union through the Fuel Cells and Hydrogen Joint Undertaking (FCH 2 JU) but is driven by the continuous engagement of the industry.

This documents provides a summary of the project status, highlights key achievements and also suggests some of the emerging issues which need to be tackled by the fuel cell vehicle sector as it moves towards a commercially viable mass market proposition.

This is a living document that will be updated as the project progresses. It is intended to:

- Give first hand information to stakeholders, policy-makers etc.;
- Align H2ME partners on the common themes emerging from the early demonstration results;
- Serve as a basis for additional dissemination materials.
H2ME brings together high level partners in these initiatives in a European approach

This project has received funding from the **Fuel Cells and Hydrogen 2 Joint Undertaking** under grant agreement No 671438 and No 700350. This Joint Undertaking receives support from the **European Union’s Horizon 2020** research and innovation programme, **Hydrogen Europe Research** and **Hydrogen Europe**.
H2ME – a major pan-European effort to support commercialisation. These activities are part of a much larger vehicle and HRS rollout in Europe

**H2ME 1**
- 29 stations
- >300 cars and vans
- €70m total cost
- €32m funding
- Started June 2015

- >45 refuelling stations
- >1400 cars, and vans
- €170m total cost
- €67m funding
- > 40 organisations

A major European activity!

**H2ME 2**
- 20 stations
- >1100 cars, vans and trucks
- €100m total cost
- €35m funding
- Started May 2016
H2ME initiative (2015 – 2022)

Project overview

**Fuel cell vehicles:**
- 500 OEM* FCEVs
- 900 fuel cell RE-EV vans

**Hydrogen rollout areas:**
- Scandinavia, Germany, France, UK, The Netherlands

**New hydrogen refuelling stations:**
- 20 - 700bar HRS in Germany
- 11 - 350bar and 700bar HRS in France
- 11 - 700bar HRS in Scandinavia
- 6 – 350bar and 700bar HRS in the UK
- 1 - 700bar HRS in NL

**Observer coalitions:**
- Belgium, Luxembourg, and Italy

**Industry observer partners:**
- Audi, BMW, Nissan, Renault, Renault Trucks, AGA, OMV

*OEM refers to original equipment manufacturer
## Vehicles deployed under H2ME initiative

### Deployment of partner models

<table>
<thead>
<tr>
<th>Model</th>
<th>Hydrogen Tank Pressure</th>
<th>Number Deployed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daimler B-Class F-CELL</td>
<td>700 bar hydrogen tank</td>
<td>40 already deployed</td>
</tr>
<tr>
<td>Daimler GLC F-CELL</td>
<td>700 bar hydrogen tank</td>
<td>150 being deployed</td>
</tr>
<tr>
<td>Toyota Mirai</td>
<td>700 bar hydrogen tank</td>
<td>100 being deployed</td>
</tr>
<tr>
<td>Honda Clarity Fuel Cell</td>
<td>700bar hydrogen tank</td>
<td>10 already deployed</td>
</tr>
<tr>
<td>Renault Kangoo ZE RE H2</td>
<td>5kW fuel cell module with 350-bar</td>
<td>&gt;900 being deployed</td>
</tr>
<tr>
<td>Symbio 3.1t light commercial vehicle</td>
<td>350bar hydrogen tank</td>
<td>3 being deployed</td>
</tr>
</tbody>
</table>

### Other vehicles procured

300 other vehicles will be procured by project partners e.g. in Paris and in Hamburg.
**National Strategy**

- **Risk sharing JV** - Widespread deployment of 100 HRS by 2019 and further expansion in line with development of vehicle numbers to provide a national network and allow OEM vehicle introduction.

- Deployment based on **expected sales of OEM vehicles (facilitated by tax regime)**. Aiming at a network of stations by 2020 across the SHHP countries to allow transnational driving within the region.

- **Deployment in 3 stages** - clustered phase (2015-2020), accelerated ramp-up (2020-2025) and established market (2025-2030) characterised by a progressive introduction.

- **Initial strategy based on 350bar RE-EVs in captive fleet** linking H₂ supply and vehicles, which de-risks early hydrogen infrastructure investments across the country before OEM vehicles arrive.


**HRS network**

- 20 x 700 bar HRS in Germany
- 10 x 700 bar HRS in Scandinavia
- 6 x 350/700 bar HRS in the UK
- 10 x 350/700 bar HRS in France
- 1 x 700 bar HRS in the Netherlands

**Vehicles**

- 400 FCEVs across Scandinavia, Germany, France, the UK and the Netherlands
- >1,000 RE-EV vans and trucks in France, Germany, Norway and the UK
# Hydrogen Mobility Europe deployment timeline

<table>
<thead>
<tr>
<th>Year</th>
<th>FCEVs</th>
<th>Procurement of other FCEVs</th>
<th>FC range-extended electric vans</th>
<th>FC range-extended electric trucks</th>
<th>HRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>Daimler FCEVs B-Class F-Cell from 2015Q2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2016</td>
<td>Honda FCEVs Honda Clarity from 2017Q1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2017</td>
<td>Toyota FCEVs Toyota Mirai from 2017Q3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2018</td>
<td>Procurement of other FCEVs other vehicle types procured and deployed from 2017Q2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2019</td>
<td>40 in operation in the project</td>
<td>18</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td>GLC F-Cell from 2018Q3</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td>150 in operation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2022</td>
<td>Symbio 3.1t light commercial vehicle from 2019Q2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>900+ in operation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Significant HRS and Vehicle deployment outside H2ME projects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
German strategy

Widespread deployment of **100 HRS by 2019 (700bar)** and **further expansion in line with development of vehicle numbers to provide confidence by delivering a dense national network** in parallel to the large-scale introduction of OEM vehicles.

An increasing focus is now being placed on **‘demand-led’ deployments of stations** where vehicle demand is secured in advance of site selection.

The German government provides **grants for station installation** and incentives covering up to 40% of the cost premium, and **tax exemptions for FCEVs**.

In 2018 the Federal Ministry of Transport, Building and Digital Infrastructure (BMVI) released a call for bids with a total of up to **15 million euros of funding available for FCEVs and HRS**.

UK strategy

HRS network rollout from 2016 to 2023

<table>
<thead>
<tr>
<th>1) Initial cluster in the South East</th>
<th>2) Create new HRS clusters</th>
<th>3) Secure basic national driving</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Network in and around London</td>
<td>▪ New HRS clusters (min. 2 stations) in large urban areas with a H2 strategy and willing early adopters</td>
<td>▪ A basic national coverage along the major North-South and East-West motorways</td>
</tr>
<tr>
<td>▪ Stations sited near main roads</td>
<td>▪ Sited near main roads and also major national motorways</td>
<td>▪ Located near to urban centres to seed add. uptake</td>
</tr>
<tr>
<td>▪ ~ 20 stations provide initial coverage</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Originally, no specific linkage between vehicle and HRS deployment was planned but letters of intent are increasingly being sought in advance of HRS deployments to guarantee H\(_2\) demand.
- The UK government provides grants for both HRS installation and purchase/lease of FCEVs for fleets.
- The Office for Low Emission Vehicles (OLEV) has created a **£23 million fund** to accelerate the uptake of FCEVs and HRS (2018).
# HRS deployed under H2ME initiative (1/3)

## Germany and the UK

<table>
<thead>
<tr>
<th>OEM</th>
<th>Site(s)</th>
<th>Type of HRS</th>
<th>Source of H2</th>
<th>Project</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Germany</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air Liquide</td>
<td>Laatzen, Leverkusen, Magdeburg, Berg bei hof, Dortmund, Bayreuth, Monchengladblac, Furth, Passau, Schnelldorf</td>
<td>10 HRS ≥ 200kg/day @700 bar</td>
<td>Supplied with trucked in H₂</td>
<td>H2ME</td>
<td></td>
</tr>
<tr>
<td>Linde</td>
<td>Leipzig, Potsdam, Berlin, Erfurt, Frankfurt, Aachen, Essen, Hagenow, Halle, Herten</td>
<td>10 HRS ≥ 150kg/day @700 bar</td>
<td>Supplied with trucked in H₂ from renewable sources and off-site water electrolysis via district pipelines</td>
<td>H2ME</td>
<td></td>
</tr>
<tr>
<td><strong>United Kingdom</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BOC (Linde)</td>
<td>Aberdeen</td>
<td>1 HRS ≥ 320kg/day @700 bar</td>
<td>On- site water electrolyser</td>
<td>H2ME</td>
<td></td>
</tr>
<tr>
<td>ITM</td>
<td>Beaconsfield, Gatwick</td>
<td>2 HRS ≥ 100-150kg/day, @dual pressure</td>
<td>On- site water electrolyser</td>
<td>H2ME</td>
<td></td>
</tr>
<tr>
<td>ITM</td>
<td>Swindon, Birmingham, London</td>
<td>3 HRS ≥ 200kg/day @dual pressure</td>
<td>On- site water electrolyser</td>
<td>H2ME 2</td>
<td></td>
</tr>
</tbody>
</table>
French strategy

**HRS network rollout from 2017 to 2030**

- **Phase 0 - Clusters**
- **Phase 1 – Linkage of clusters and growth of network**
- **Phase 2 – Self-contained**

- **National network started using lower-cost 350bar HRS** to support local captive fleets with limited dual-pressure (700 & 350bar) HRS deployed. There is now an *increasing focus on dual-pressure stations* to ensure future-proofing for passenger cars.

- **100 HRS to be built by 2023** and **400 by 2028**

- **Strategy based on captive fleet applications** which allows hydrogen stations to be deployed at the same time as a vehicle fleet, thereby securing demand and de-risking early HRS investments. *Letters of intent are obtained prior to HRS investment decisions*, thereby confirming demand and HRS utilisation.

- The French government has announced **100 million euros in funding** for the development of the hydrogen sector from 2019.

**Source:** Element Energy  

1 – Based on consultation of OEM partners in H₂M France
# HRS deployed under H2ME initiative (2/3)

## France

<table>
<thead>
<tr>
<th>OEM</th>
<th>Site(s)</th>
<th>Type of HRS</th>
<th>Source of H2</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Liquide</td>
<td>Paris Sud (Orly)</td>
<td>1 HRS ≥ 200kg/day @ dual pressure</td>
<td>Supplied with trucked in H$_2$</td>
<td>H2ME</td>
</tr>
<tr>
<td>Air Liquide</td>
<td>Paris North, Paris West, Versailles, Creteil</td>
<td>4 HRS ≥ 200kg/day @ dual pressure</td>
<td>Supplied with trucked in H$_2$ and on-site water electrolysis</td>
<td>H2ME2</td>
</tr>
<tr>
<td>ArevaH2Gen / EIFER</td>
<td>Rodez</td>
<td>1 HRS ≥ 80kg/day @350bar</td>
<td>On-site water electrolyser</td>
<td>H2ME</td>
</tr>
<tr>
<td>ArevaH2Gen / SEMITAN/ EIFER</td>
<td>Nantes</td>
<td>1 HRS ≥ 80kg/day @350bar</td>
<td>On-site water electrolyser</td>
<td>H2ME2</td>
</tr>
<tr>
<td>McPhy / EIFER / CASC</td>
<td>Sarreguemines</td>
<td>1 HRS ≥ 40kg/day @350 bar</td>
<td>On-site water electrolyser</td>
<td>H2ME</td>
</tr>
<tr>
<td>McPhy / CNR / GNVERT</td>
<td>Paris, Lyon</td>
<td>2 HRS ≥ 80kg/day @350 bar</td>
<td>On-site water electrolyser</td>
<td>H2ME2</td>
</tr>
<tr>
<td>ITM / GNVERT</td>
<td>Paris</td>
<td>1 HRS ≥ 80kg/day @700 bar</td>
<td>On-site water electrolyser</td>
<td>H2ME2</td>
</tr>
</tbody>
</table>
Strategy based on introduction of 700bar OEM FCEVs to create a **first network across Scandinavia**.

Vehicle deployment is supported by **generous national tax regimes and other support mechanisms** (free public parking, etc.).

There are both **government grants and tax exemptions for vehicles and HRS**.

It has been assumed that low taxes would be a sufficient trigger for FCEV breakthrough but **vehicle costs and the popularity of BEVs (and limited availability of FCEVs) have proved to be barriers**.
Dutch strategy

- Strategy based on **gradual deployment of HRS and vehicles clustering around major cities** (e.g. The Hague).
- Vehicle and infrastructure deployment is supported by **generous national tax regimes and other support mechanisms** (free public parking, access to bus lanes etc.).
- Planned deployment of **4 public HRS by 2018 and 20 in 2020**.
HRS deployed under H2ME initiative (3/3)
Scandinavia and Netherlands

<table>
<thead>
<tr>
<th>OEM</th>
<th>Site(s)</th>
<th>Type of HRS</th>
<th>Source of H2</th>
<th>Project</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scandinavia</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>AGA (Linde)</td>
<td>Mariestad, SW</td>
<td>1 HRS ≥ 800kg/day @700bar</td>
<td>Off-site wind electrolysis and off-site water electrolysis via district pipelines</td>
<td>H2ME 2</td>
<td></td>
</tr>
<tr>
<td>HYOP</td>
<td>Hovik, NO</td>
<td>1 HRS ≥ 200kg/day @700bar</td>
<td>On-site water electrolysers and trucked in H₂</td>
<td>H2ME</td>
<td></td>
</tr>
<tr>
<td>HYOP</td>
<td>Ryen, Oslo Airport, NO</td>
<td>2 HRS ≥ 200kg/day @700bar</td>
<td>On-site water electrolysers and trucked in H₂</td>
<td>H2ME 2</td>
<td></td>
</tr>
<tr>
<td>Nel H2</td>
<td>Kolding, DK</td>
<td>1 HRS ≥ 200kg/day @700bar</td>
<td>On-site water electrolysers and trucked in H₂</td>
<td>H2ME</td>
<td></td>
</tr>
<tr>
<td>Nel H2</td>
<td>Reykjavik, Keflavik, Selfoss, IS</td>
<td>5 HRS ≥ 200kg/day @700bar</td>
<td>On-site water electrolysers and trucked in H₂</td>
<td>H2ME 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stockholm, SW, Herning DK</td>
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<td></td>
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<tr>
<td><strong>Netherlands</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kerkhof</td>
<td>The Hague</td>
<td>1 HRS ≥ 200kg/day @700bar</td>
<td>Trucked in H₂</td>
<td>H2ME 2</td>
<td></td>
</tr>
</tbody>
</table>
In addition to its deployment activities, the H2ME initiative is conducting a number of cross cutting activities

The H2ME initiative is:

- **Sharing best practices and lessons learnt between industry partners** to ensure processes such as HRS installation, metering and billing etc. are streamlined and improved across Europe.

- Using data collected as part of the project to **better understand the status of vehicle and HRS technology**

- Conducting analysis to **better understand customers’ needs and experience of the technology**

- Conducting economic and strategic analysis to provide **recommendations for the rollout of hydrogen mobility**, with a particular focus on national rollout strategies and business cases for early adopters.

- Analysing the **impact of hydrogen generation by electrolysis on the efficiency of the energy system and demonstrate the ability to monetise the provision of grid balancing services** using water electrolysers via real world tests of HRS-electrolysers.

The results generated by the project are shared with industry, politicians, and the wider public to support the commercialisation of hydrogen mobility.
Acknowledgements

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