Hydrogen Mobility Europe










Project introduction

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Document prepared by: Element Energy

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FCH | FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

H2ME initiative (2015 – 2022)
Project overview

HRS: Hydrogen Refuelling Station
FCEV: Fuel Cell Electric Vehicle
RE-EV : Range-Extended Electric Vehicle

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New hydrogen refuelling stations:

- **20** - 700bar HRS in Germany
- **10** - 350bar and 700bar HRS in France
- **10** - 700bar HRS in Scandinavia
- **6** – 350bar and 700bar HRS in the UK
- **1** - 700bar HRS in NL

Fuel cell vehicles:

- **500** OEM* FCEVs
- **900** fuel cell RE-EV vans

Hydrogen rollout areas:

- Scandinavia, Germany, France, UK, The Netherlands

Observer coalitions:

- Belgium and Luxembourg

Industry observer partners:

- Audi, BMW, Nissan, Renault, Renault Trucks, OMV

Proposed HRS locations under H2ME-1
Proposed HRS locations under H2ME-2

*OEM refers to original equipment manufacturer

H2ME – a major pan-European effort to underpin these commercialisation strategies.

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H2ME 1

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

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

A major European activity!

H2ME 2

18 stations
>1100 cars, vans and trucks
€100m total cost
€35m funding
Started May 2016

H2ME brings together high level partners in these initiatives in a European approach

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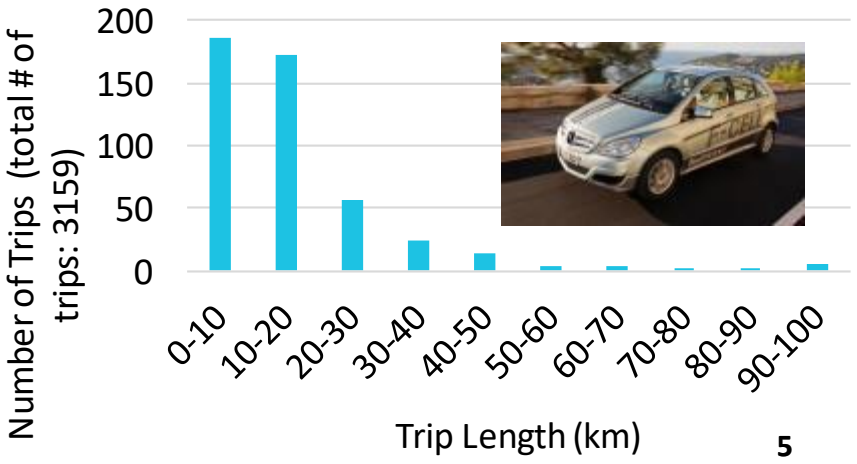
Project Snapshot

- ***To date, 184 vehicles have been delivered and 6 HRS are in operation***
- By the **end of 2018, over 45 stations will be installed**
- Large fleet customers are now committing further vehicle roll-out (taxi, police, utility etc)
- As of June 2017, ***726 200km*** *has been driven with* ***8 960kg*** of hydrogen have been consumed
- From this data it seems that ***customers are using their hydrogen vehicles in a similar fashion to users of conventional vehicles***::
  - trip distance distribution is similar to any passenger car
  - on average, tanks are being refuelled to about 50% of their capacity

Trip Distance Distribution for FCEV



*the significant difference in total distance driven is due to the progressive introduction of Symbio vehicles in comparison to Daimler who deployed all 40 of their vehicles at once

Hydrogen Mobility Europe deployment timeline

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2015 2016 2017 2018 2019 2020 2021 2022

Daimler FCEVs

40 B-Class F-Cell
2015Q3 - 2016Q2

150 GLC F-Cell
2018Q3 - 2022Q3

Honda FCEVs

10 Honda Clarity
2017Q2-2022Q3

FC range-extended electric vans

900+ Renault Kangoo ZE-H2
2015Q3 - 2021Q2

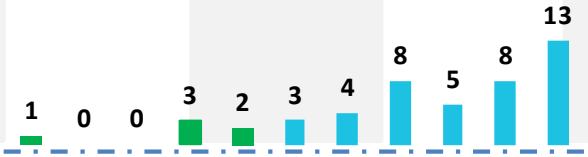
FC range-extended electric trucks

3 Symbio RE Maxity
2017Q4 - 2019Q1

Procurement of other FCEVs

300+ other vehicle types procured and deployed between 2017Q2 - 2022Q1

HRS



Significant HRS and Vehicle deployment outside H2ME projects

By the end of 2018, a network of 130 stations should be in operation across Europe

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Early remarks on the project and the status of the deployment of FCEVs

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The OEM **vehicles are working well**, customers are using them as a like for like replacement for conventional vehicles

Today's rate of **OEM hydrogen vehicle roll-out in Europe** is constrained by production limitations, cost and limited infrastructure coverage

However, **attractive vehicle ownership models are starting to emerge for FCEV owners** which can overcome these issues

- ***captive fleets requiring range in locations/organisations with a zero emission commitment***
  - *taxis in cities with strict environmental targets*
  - *car sharing*
  - *police fleets*
  - *utility maintenance fleets*
- ***private sales in high vehicle tax jurisdictions***

Using these models it has been possible to make **commercial sales to real customers**

Improving the communications around the vehicles and ***creating an aspirational element*** as well as ***clarity over the value case*** is a key priority

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Early remarks on the project and the status of the deployment of HRS

The pace of station deployments in Europe is increasing – this means some countries (e.g. Denmark, Norway) and cities (Hamburg, Berlin) already have a **first plausible hydrogen network**

Further **cities and countries will see plausible coverage in 2018** (London, Paris, Iceland, Germany)

However, the process of installation is slowed by:

- ***Approvals*** – tend to slow the process - further work to improve processes and educate regulators is required
- ***Access to utilities and land***
- Inefficiencies in the ***supply chain for station installation***

Initial data from this project confirms that **average refuelling time (minutes) is comparable to petrol or diesel** (based on data from the H2 Logic HRS in Kolding)

Station reliability is improving, though there is still a need for this improvement to be sustained and managed at a network level. This is a key factor in customer acceptance

Further investment is likely to be contingent on additional demand arriving from an expanded fleet of OEM vehicles in each location.

H2ME will also investigate the impact of hydrogen generation by electrolysis on the efficiency of the energy system

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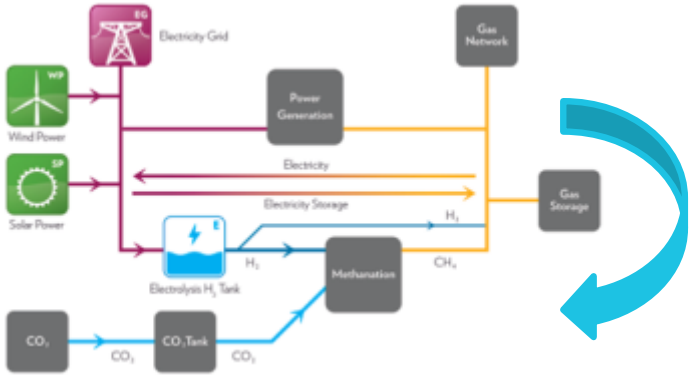
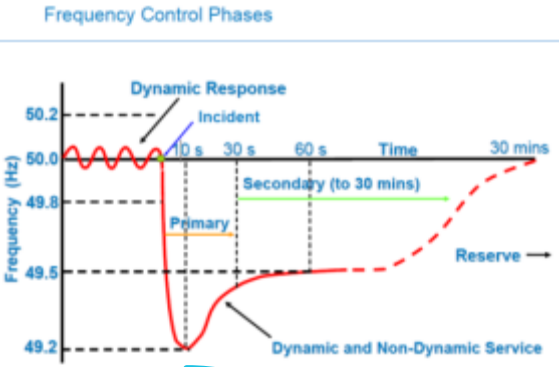
- As more intermittent sources of energy generation and new electrical demands (for heating and transport) are added to the grid, the requirement for grid balancing becomes increasingly important
- H2ME is developing **protocols which will allow testing** of the ability of electrolyser-based HRSs to provide these services and positive effects on net-balancing
- H2ME will also **demonstrate the ability to monetise** the provision of grid balancing services using water electrolysers
- This will be done in collaboration with local utilities, demand response aggregators and distribution network operators in order to carry out a **real world test of HRS-electrolysers** and demonstrate the ability to enter revenue earning contracts for the provision of grid services





The balancing services and electricity markets of Germany, France and the UK have been mapped

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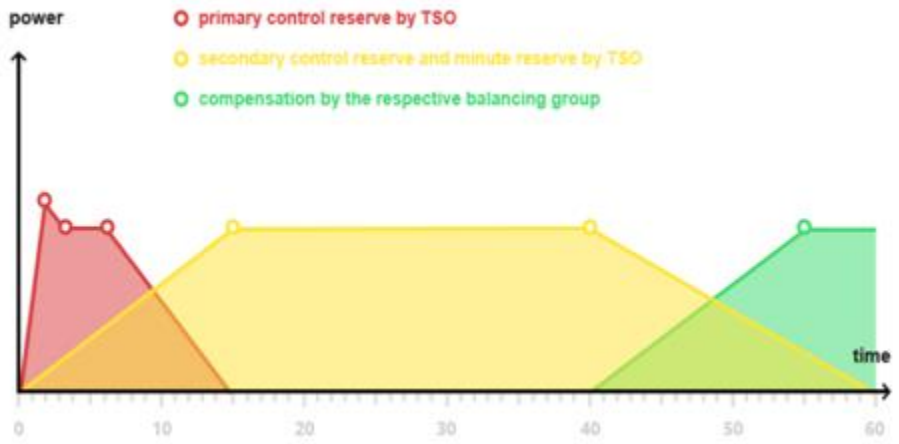
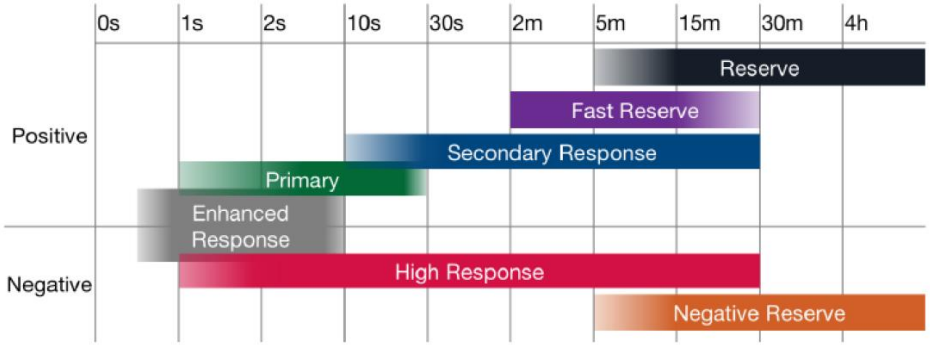
German service timescales

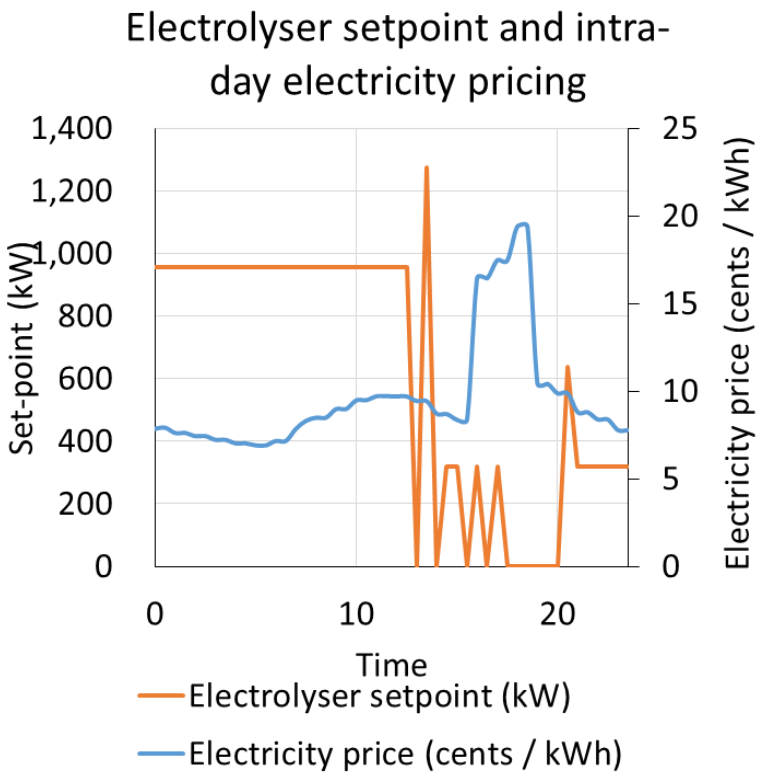


UK service timescales



- This exercise analysed the balancing and flexibility products offered by the National Transmission System Operators across the UK Germany and France
- This work set out the requirements and market structures for different services in the various markets, including:
  - Service market size (in MW)
  - Response times required to provide services (see plots on the left)
  - Today's payments for services
  - Bidding structure (for trading on the day-ahead electricity market)

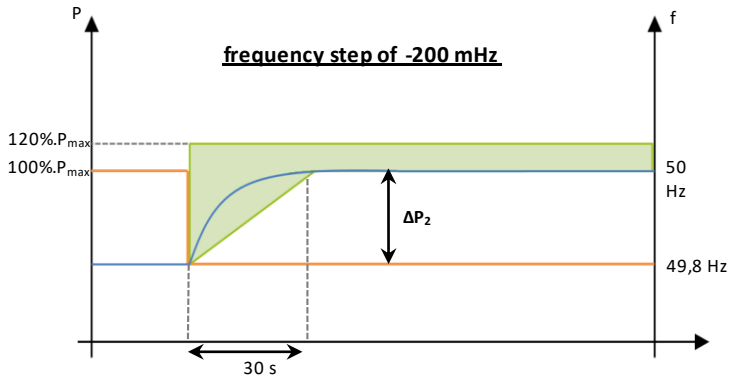
Projections of H_2 uptake and national electricity system plans feed into the system level modelling

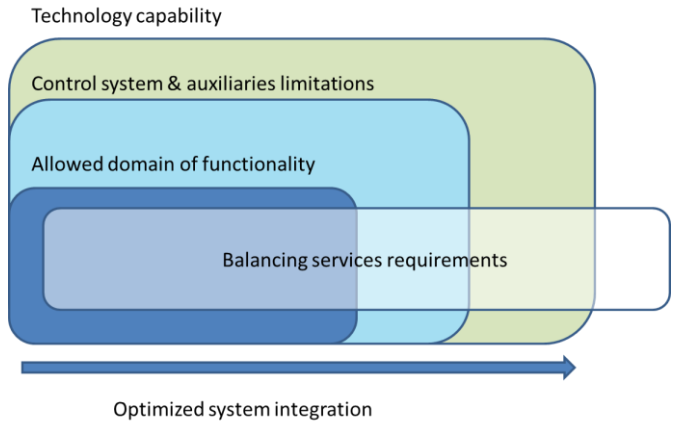


- The WP has set out a series of scenarios setting out
  - Net-demand of hydrogen
  - How much of this could be met by electrolysers
  - National level electricity generation and grid development plans
- These inputs feed into **University of Manchester's energy system model**.
- This generates price signals for electrolysers for electricity and balancing services
- The model also assesses the system impact of using electrolysers to provide frequency response / reserve
- Finally an **electrolyser operating model** assesses the impact of these signals on the optimal control strategy for the electrolyser.

WP4 has developed testing protocols to be implemented at the project's electrolysers

- Based on the balancing products review set out in the first section, **testing protocols** e.g. for providing frequency response have been developed
- These will be implemented at many of the projects electrolytic HRS
- The protocols are designed to demonstrate that the electrolysers are sufficiently responsive to provide either response and reserve
- Ultimately, the more electrolysers that are suitable for providing services, the more flexibility can be provided, leading to increasingly positive system impacts!





The project is off to a good start, with great collaboration – watch this space for more results!

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