FCH2 JU: Making hydrogen and fuel cells a reality in Europe

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http://www.fch.europa.eu/
The Energy Union

Background: The Energy Union
(European Commission Communication Feb. 2015)

"I want to reform and reorganise Europe’s energy policy in a new European Energy Union."

Jean-Claude Juncker
(President European Commission)

The 5 Pillars of the Energy Union:
1. Security of supply
2. Integrated European energy market
3. Energy efficiency
4. Decarbonisation
5. Research and Innovation => SET-Plan

Strategic Energy Technology Plan
The FCH 2 JU in the SET plan to realize EU 2030 targets

**EU 2030 targets**:  
- 27% increase in renewables  
- 27% increase in efficiency  
- 40% decrease in emissions

**Fuel Cells and Hydrogen Joint Undertaking**  
- FCH JU - EU body  
- FCH JU Programme Office

*European Council, October 2014  
** continuation of previous program for 2008-2013 with a budget of approx. 1 bill.€
Energy Security
- Increase independence from unstable outside regions

Competitiveness
- Research excellence leading to industry innovation and growth

Sustainability
- \( \text{H}_2 \) is a clean energy carrier
- Transport and Energy applications, generate electricity and heat with very high efficiency
- Possibility for storage of renewable energy sources
- Reduction of \( \text{CO}_2 \) emissions

Fuel Cells & Hydrogen technologies role in the Energy Union
Continuous Support in the EU Framework Programmes

* 470 mill EUR implemented by FCH JU + about 10 mill EUR already spent from EU 2007 budget, before FCH JU in place
** 665 mill EUR only to be implemented by the FCH2 JU + additional budget from EU programmes for low TRL (basic research) and structural funds/smart specialisation
Fuel Cells & Hydrogen Joint Undertaking (FCH2 JU)

The Joint Undertaking is managed by a Governing Board composed of representatives of all three partners and lead by Industry.

Legal basis:
Council Regulations:
559/2014 of 6 May 2014 (H2020)
Industrial applications
- Natural gas, biogas, coal, biomass
- Renewable generation, storage and ‘buffering’

Residential CHP
- Methanisation feed to natural gas grid

FCH2 JU objectives

- Reduction of production costs of long lifetime FC systems to be used in transport applications

- Increase of the electrical efficiency and durability of low cost FCs used for power production

- Increase the energy efficiency of low cost production of hydrogen from water electrolysis and renewable sources

- Renewable generation, storage and ‘buffering’

- Methanisation feed to natural gas grid

- Large scale use hydrogen to support integration of renewable energy sources into the energy systems

- Reduce the use of critical raw materials

- Existing natural gas, electricity and transport infrastructures

- By-product from Chemical Industry

- Natural gas, biogas, coal, biomass

- Feed to electricity grid
Multi-Annual Work Plan, MAWP (2014-2020)

Estimated budget of €1.4 billion
Strong industry commitment to contribute inside the programme + through additional investment outside, supporting joint objectives.

TRANSPORT

- Road vehicles
- Non-road vehicles and machinery
- Refuelling infrastructure
- Maritime, rail and aviation applications

ENERGY

- Hydrogen production and distribution
- Hydrogen storage for renewable energy integration
- Fuel cells for power and combined heat & power generation

Cross-cutting Issues
(e.g. standards, consumer awareness, manufacturing methods, ...
Strong FCH community in Europe
Projects involving 23 EU Member States

571 Beneficiaries:
- 35% Industries
- 28% SMEs
- 27% Research Organizations
- 4% High Education Institutions
- 6% Others

Incl international cooperation outside EU
(Additional non-EU countries: CH, NO, IL, TR, IS, RS, CN, RU & US)

Funding of beneficiaries categories
- Higher Education: 2%
- Research: 32%
- Industry: 32%
- SME: 27%
- Others: 7%
185 projects supported for about 638 mill €

50/50 distribution between Energy and Transport pillars

Similar leverage of private funding: 682 mill €

Continuous/constant annual support (through annual calls for proposals)
Total FCH2 JU support:

- **290 M€** for 47 projects

Transport portfolio:

- **Total of 1,774** passenger cars in 6 projects
  - Of which **1,112** with FCs as range extender
- **Total of 61** refuelling stations
- **Total of 67** buses from 4 projects in 12 locations

- **Over 400** MHVs in 4 projects
- MHVs operated for **12,413hrs** = **2200** shifts with overall availability of **95%**
- **4,000** refuellings with **99.5%** HRS availability
Advanced FCEV and HRS programs

- **France** – a large private consortium has agreed a strategy based on a transition from captive fleets to nationwide infrastructure for FCEVs.

- **Germany** –
  - the H2Mobility project has already signed a “term sheet” linking six industrial players to deploy 100 stations by 2017 and 400 by 2023 for 350 M€.

- **Scandinavia** – An initial network provides coverage for FCEVs, which can be purchased at equivalent ownership cost.

- **UK** – a consortium with significant Government presence has agreed a strategy based on seeding a national network of 65 stations by 2020. 7.5M£ have been committed by the Government for 15 HRS by 2015.

Similar initiatives are starting or running in other countries: Austria, Belgium, Finland, Netherlands, Switzerland.
A broad stakeholder coalition of 82 organizations has been established – Operators and local governments from 35 locations.

<table>
<thead>
<tr>
<th>Participating locations</th>
<th>Industry coalition members</th>
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<tr>
<td><strong>Buses: from demo to a 1.5 B€ market appetite</strong></td>
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<td>&gt;140 buses</td>
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<td>Appetite for 500 more</td>
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- Operators and local governments from 35 locations

**Participating locations**:
- London
- Oslo
- Hamburg
- Aachen
- Wuppertal
- Cologne Region
- Aberdeen
- South Holland Province
- Riga
- Rotterdam
- North East England Region
- Imperia Province
- Regione Lazio/Rome
- Münster
- Stuttgart
- Bozen
- Mainz
- Agglomération Havraise
- Dole
- Grenoble-Isère Region
- Belfort
- Flanders
- Dundee
- Birmingham
- Perth/Kinross
- Switzerland
- Torres Vedras
- Potsdam
- Inverness/Highlands
- Berlin
- Tallinn
- Pärnu
- Budapest
- Rouen
- Bordeaux

**Industry coalition members**:
- **Bus manufacturers**
  - MAN
  - Solaris
  - SKODA
  - VanHool
  - EvoBus
  - APTs
  - VDL

- **Infrastructure/\(H_2\) providers**
  - H2 Logic
  - Ballast Nedam
  - Linde
  - AIR LIQUIDE
  - ITM Power
  - Air Products
  - Hydrogenics

- **Technology providers**
  - Ballard
  - Siemens
  - PM Power technologies
  - Intelligent Energy

- **Other organisations**
  - Government of the Netherlands
  - NOW
  - Die Verkehrsunternehmen
  - Energie Liga NRW
  - Solutions
But it is not only cars and buses

Two large demonstration sites
First greenfield fully FC site
More than 400 under 5 funded projects
Generating the business case

Focus on APUs
Moving towards prototyping of propulsion systems
Exploring harbor applications

Solving electrification gaps
First prototyping activities towards propulsion systems

Demos of land activities (tow trucks)
Galley applications
Possible taxiing opportunities
106 projects under Energy pillar, for more than 326 mill €

Technology neutral approach, however most support to Solide Oxide and PEM for both fuel cells and electrolyser applications
Higher chance to reach 2030 Energy Goals with Stationary Fuel Cells!

- 65 units Solid Oxide FC mCHP
- 40% $\eta_{\text{electric}}$ 79% $\eta_{\text{total}}$
- 25% cost reduction
- FC system life > 10,000 hours

- 1,000 units (10 manufacturers) in 11 EU member states
- 30-150 units from each manufacturer

- 240kW
- 61% $\eta_{\text{electric}}$
- FC system life > 13,500 hours
Accomplishments
(examples of projects achievements)

ene.field project: more than 500 units installed in 10 countries of Europe, reliabilities confirmed, very good customer satisfaction (70% positive feedback),

SOFT-PACT project: 65 fuel cell systems, electrical efficiency higher than 42% over lifetime (total efficiency higher than 78%), 25% cost reduction

SOFCOM project: proof-of-concept poly-generation SOFC systems fed by biogenous primary fuels (biogas and bio-syngas, locally produced), modular concept, cost driver identified → next step: upscaling to hundreds kW size (DEMO-SOFC project)

POWER-UP project: first module of 40kW (out of 240 kW) in the field, 61% electrical efficiency

ClearGenDemo project: 1 MW PEM to be installed near Bordeaux, FR on by-product H2 from clori-alkali plant

DEMCOPEM-2MW project: 2 MW PEM (European technology) to be demonstrated in China

Sources: MAWP, Roland Berger Study, IBZ/Callux
Roland Berger Study: **Advancing Europe's energy systems: Stationary fuel cells in distributed generation**

- Industry coalition composed of more than 30 stakeholders – Results reflect common understanding
- The most comprehensive assessment of the commercialisation potential of stationary fuel cells in Europe (4 focus markets, 6 generic fuel cells, 35 years time horizon, 45 different use cases, >30 benchmark technologies, >3 energy scenarios, >34,000 resulting data points)

Today FC can reduce CO₂ emissions by more than 30%, while NOₓ emissions can be eliminated entirely; however, to become economically competitive, capital costs must be reduced substantially by increasing production volumes

Industry sees ambitious potential (larger volumes allow for automation and bundled sourcing strategies, standardisation must increase within and across technology lines)

Industry is fully committed to decreasing cost with sufficient installation volumes!
95% of FCH JU support on H₂ production goes to renewable pathways.
Green Hydrogen Study identified 6 most promising pathways besides RES+WE

Pathways
(2) Raw biogas reforming
(1) Biomass gasification
(3) Thermo-chemical water splitting
(6) Supercritical H2O gasification
(5+2) Fermentation
(4) PEC

Criteria
- TRL
- Feedstock
- GHG-emissions
Industry acknowledges the potential of Hydrogen to the greening of industrial products through increased penetration of renewables.
Non-hydrogen P2P and heat storage will only be able to absorb a small part of the excess energy generated, resulting in the necessity of curtailment – from societal point of view, such electricity could be used at close to zero cost.

The excess energy can be used to produce hydrogen via water electrolysis for re-electrification or use outside of the power sector.

If the value of hydrogen at the point of production can reach a price in the range of 2-4 €/kg, very large installed electrolyzer capacity would be economically viable and able to utilize nearly all of the excess electricity.

Such use of the excess electricity would create value for the society and the surplus could be divided between the electricity and hydrogen producer.

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1 Installed electrolyzer capacity achieving 60 EUR/installed kW per year of benefits at given hydrogen plant gate cost – this corresponds to 370 EUR/kW capex, 8% WACC, annual opex at 1.2% of total capex and 10 years lifetime (FCH JU 2014)
Assumes electricity for free, no grid connections fees and no time-shift storage is in place.
The scope of applications is widening with time.
Thank you for your attention!

Further info:

- HYDROGEN EUROPE: www.hydrogeneurope.eu
- N.ERGHY: http://www.nerghy.eu