Call 2016: - Energy Pillar Topics

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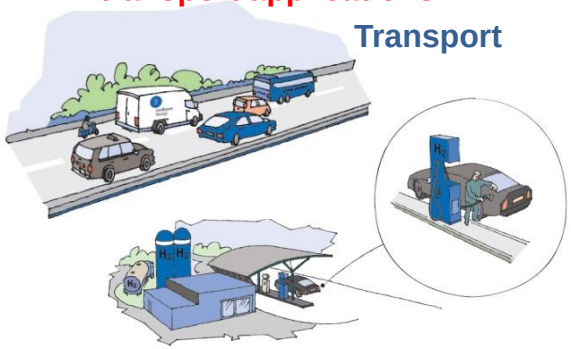
Nikolaos Lymperopoulos – Hydrogen Production
Dionisis Tsimis – Stationary Fuel Cells applications

FCH 2 JU objectives

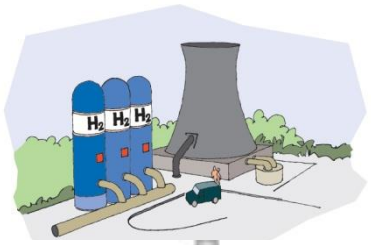
1. Reduction of production costs of long lifetime FC systems to be used in transport applications

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

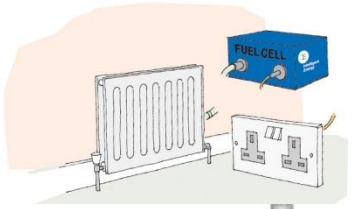
Transport



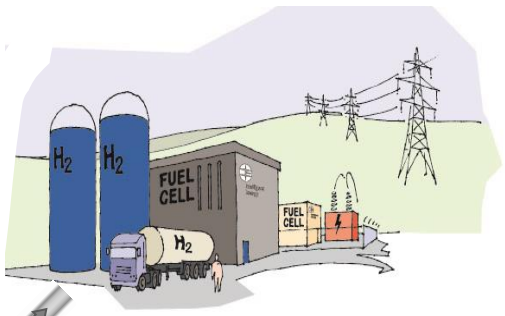
Industrial applications



Residential CHP



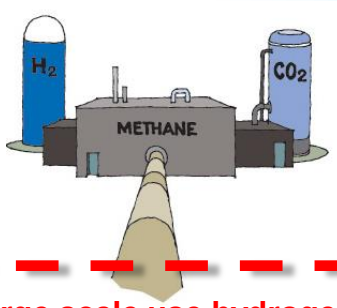
Feed to electricity grid



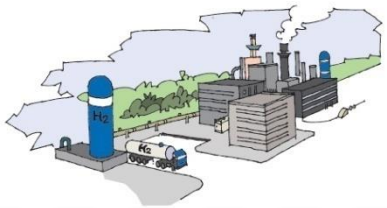
5. Reduce the use of critical raw materials

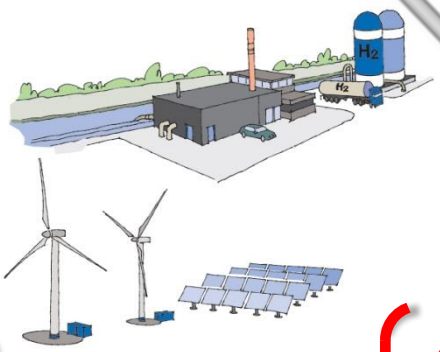
Existing natural gas, electricity and transport infrastructures

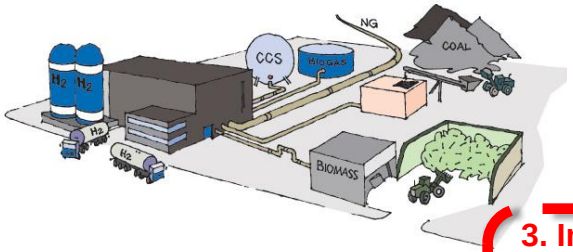
Methanisation feed to natural gas grid



By-product from Chemical Industry







Natural gas, biogas, coal, biomass

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

Renewable generation, storage and 'buffering'

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

2016 Topics & Budgets

- 6 RIA with an indicative budget of **16 M€**
  - 4 on H_2 production
  - 2 on FCs
- 5 IA with an indicative budget of **40 M€**
  - 1 on H_2 production
  - 4 on FCs

Hydrogen production Topics

Topic	Type of Action
FCH-02-1-2016: Establish testing protocols for electrolysers performing electricity grid services	**Research & Innovation (RIA)**
FCH-02-2-2016: Development of compact reformers for distributed bio-hydrogen production	
FCH-02-3-2016: Development of processes for direct production of hydrogen from sunlight	
FCH-02-4-2016: Co-generation of hydrogen and electricity with high-temperature fuel cells	
FCH-02-7-2016: Demonstration of large-scale rapid response electrolysis to provide grid balancing services and to supply hydrogen markets	**Innovation (IA)**

Energy pillar RIA
Topic 2-1: Establish testing protocols for electrolysers performing electricity grid services

Challenge
- Provision of grid services by electrolysers: not only better components, but also benchmarks, standardised tests and economic analysis

Scope
- Benchmarking of components, assessment of improvements through a specific testing methodology to evaluate potential of electrolysers to provide grid services
- Standardization of a testing protocol to evaluate the ability of electrolysers to provide grid services - Establishment of power curves
- Testing power electronics, stack and BoP
- Definition of a business model, assessment of the services with the highest potential

Impact
- Development of standardised tests
- Specific performance indicators for provision of each grid service
- Assessment of economic gains from providing grid services

Other information
- EU contribution of 2 M€ -- 1 project -- 3 years
- TRL from 4 to 6

Energy pillar RIA

Topic 2-2: Development of compact reformers for distributed bio-hydrogen production

Challenge

- Demonstrate the potential of using biogas, bio-alcohols and other biofuels for a decentralized bio-hydrogen production in more compact and efficient reforming technologies

Scope

- Develop compact reformers that can be applied cost-effectively at small scale in the distributed production of hydrogen from biofuels
- 100-500kg/day H_2 @ 99.9% purity
- Improve heat integration; flexibility to process less clean biofuels
- Load variation 20-100%
- Cold start < 2h

Impact

- H2 cost of 3 – 5 €/kg
- Design life time of 10 years, η>80%
- Demonstration > 4,400 hours

Other information

- EU contribution of 3 M€ -- 1 project -- 4 years
- TRL from 3 to 5

Energy pillar RIA

Topic 2-3: Development of processes for direct production of hydrogen from sunlight

Challenge

- Direct conversion of solar energy to hydrogen
- Develop reliable and highly flexible photo-electrolysis devices that operate at high solar-to-hydrogen-efficiencies and exhibit lower production costs

Scope

- Develop full technology (materials, prototype, tecno-economic evaluation) and demonstrate
- Proof-of-concept device for decentralised production
- Socio-tecno-economic assessment to determine investment cost

Impact

- Prototype system of 10 m^2
- H_2 production > 15g/h
- η > 5%, running of 6 months with < 10% degradation, H_2 cost< 5€/kg

Other information

- EU contribution of 2.5 M€ -- 1 project -- 4 years
- TRL from 3 to 5

Energy pillar RIA

Topic 2-4: Co-generation of hydrogen and electricity with high-temperature fuel cells

Challenge

- Develop SOFC-based systems that produce power, heat and hydrogen by converting part of the syngas produced into hydrogen
- Flexibility between products to meet demand

Scope

- > 20kg H_2 / day
- η > 65%
- H_2 : Power modulation from 0 (100% e^-) to 1 (50% e^- + 50% H_2)
- Testing > 1,000 h, H_2 purity > 99.9%

Impact

- More efficient use of NG
- Better grid stabilisation than GTs

Other information

- EU contribution of 4 M€ -- 1 project -- 4 years
- TRL from 4 to 6

Topic 2-7: Demonstration of large-scale rapid response electrolysis to provide grid balancing services and to supply hydrogen markets

Challenge

- Demonstration of large electrolysis units (>3 MW) using the latest available PEM or pressurized alkaline technology
- Convert excess renewable electricity to H_2 that can be stored and re-electrified at a later time, or used for other energy consuming or industrial processes
- Provide grid balancing services/power demand management on a commercial basis

Scope

- Develop > 3MW electrolyser of sufficiently rapid response time (of the order of a few seconds) to participate in primary and secondary grid balancing markets
- Improve electrolyser dynamic performance
- <52kWh/kg for alkaline and <48kWh/kg for PEM
- 630 Euro/kW for alkaline and 1000 Euro/kW for PEM
- SOTA systems installed & operated for > 2 years

Impact

- Demonstrate feasible operation of large scale rapid response electrolysis
- Techno-economic analysis of the performance of these systems
- Assessment and operation experience, including safety, of the contractual and hardware arrangements required to distribute and supply hydrogen to multiple markets
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Other information

- > 1 member of IG or RG
- EU contribution of 16 M€ -- 2 projects -- 4-5 years
  - 1 project PEM, 6MW (1x6 or 2x3), 12 M€
  - 1 project alkaline, 3MW, 4 M€
  - Grid connection & e- for testing eligible / e- for operation not eligible
- TRL from 6/7 to 8

Stationary fuel cells topics

Topic	Type of Action
FCH-02-5-2016: Advanced monitoring, diagnostics and lifetime estimation for stationary SOFC stacks and modules	**Research & Innovation (RIA)**
FCH-02-6-2016: Development of cost effective manufacturing technologies for key components or fuel cell systems for industrial applications	
FCH-02-8-2016: Large scale demonstration of commercial fuel cells in the power range of 20-100kW in different market applications	**Innovation (IA)**
FCH-02-9-2016: Large scale demonstration of commercial fuel cells in the power range of 100-400kW in different market applications	
FCH-02-10-2016: Demonstration of fuel cell-based energy storage solutions for isolated micro-grid or off-grid remote areas**	
FCH-02-11-2016: MW or multi-MW demonstration of stationary fuel cells	

Energy pillar RIA

Topic 2-5: Advanced monitoring, diagnostics and lifetime estimation for stationary SOFC stacks and modules

Challenge

- Limited monitoring of the state of SOFC during operation in the field.
- Stack monitoring needed to evaluate SoH and counteract to prevent damage to stack.
- From the lab to practical commercial products.

Scope

- Enhanced understanding of degradation mechanisms
- Target cost <3% total FC system cost
- Prolong lifetime by 5% and increase availability by 1%
- Consortium should include at least 1 stack manufacturer & research institution & academic group
- Consortium must include at least one member of IG/RG to be eligible
- TRL 3 → 5

Impact

- Most relevant degradation mechanisms / Monitoring parameters / Counter measures
- Improved durability & reduction of TCO → market penetration
- Integration and validation in a system

Indicative Funding; No. of projects

- EU contribution of 2.5 M€ -- 1 project -- 3 years

Energy pillar RIA

Topic 2-6: Development of cost-effective manufacturing technologies for key components or fuel cell systems for industrial applications

Challenge

- Production in small quantities with manual input
- For mass deployment high yield robust manufacturing processes needed

Scope

- Apply best in class novel manufacturing technologies, production processes equipment, and tooling → lower cost
- Production processes: fewer steps, tolerance to variability of raw materials, lower cost materials, reduced environmental impacts, and quality control.
- Industry wide arrangements for standardisation of BoP components
- Consortium should include at least two manufacturers & partner specializing in manufacturing automation and/or production systems & a research institution
- TRL 4 →6

Impact

- From high cost small scale production → low cost high volume
- Cost reduction to achieve overall system CAPEX < 3000€/kW for industrial segment
- Reduce time-to-market by 20-30%
- Availability of systems produced >=97%

Indicative Funding; No. of projects

- EU contribution of 2 M€ -- 1 project

Energy pillar IA

Topic 2-8: Large scale demonstration of commercial fuel cells in the power range of 20-100kW in different market applications

Challenge

- Key markets for such power ranges have been identified as indicated by Roland Berger study.
- The investment costs, availability and lifetime however should be comparable to conventional alternatives.

Scope

- Installed power at least 400kW at minimum 20 sites (min. 3 countries) and 1 unit per site 20-100kW
- Demonstration, evaluation and optimisation of new solutions and components.
- Online monitoring of operating conditions, load demands and outputs.
- Establishment of commercialisation pathway
- Consortium should include min. 3 FC manufacturers (min. 2 and max.10 units)
- Consortium must contain at least one IG/RG member
- TRL 6 → 7-8

Impact

- 42-55% elec. and 90% combined -- Reduction of CAPEX <6,000€/kW
- Lifetime> 15 years and increased maintenance interval
- Raise public awareness, establish confidence in technology and develop business models that involve end-users and authorities.

Indicative Funding; No. of projects

- EU contribution of 7.5 Meuro -- 1 project -- 3-5 years

Energy pillar IA

Topic 2-9: Large scale demonstration of commercial fuel cells in the power range of 100-400kW in different market applications

Challenge

- Key markets for such power ranges identified as indicated by Roland Berger study.
- The investment costs, availability and lifetime however should be comparable to conventional alternatives.

Scope

- Total installed power at least 1MW (3 manufacturers/min 100kW)
- 3 different sites at 3 different countries
- Demonstration, evaluation and optimisation of new solutions and components, diagnostics and monitoring and new BoP components.
- Online monitoring of operating conditions, load demands and outputs.
- Scaling models, prediction of energy needs combined with FC performance
- Establishment of commercialisation pathway by involving customers including distributors and end-users
- TRL 6 → 7-8

Impact

- 42-55% elec. and 90% combined -- Reduction of CAPEX <6,000€/kW
- Lifetime> 15 years and increased maintenance interval
- Raise public awareness, establish confidence in technology and develop business models that involve end-users and authorities.

Indicative Funding; No. of projects

- EU contribution of 7.5 M€ -- 1 project -- 3-5 years

Energy pillar IA

Topic 2-10: Demonstration of fuel cell-based energy storage solutions for isolated micro-grid or off-grid remote areas

Challenge

- Exploitation of RES in remote areas with micro-grids, where the cost of fossil fuels is high

Scope

- Demonstrate the techno-economic viability of FC technologies to generate electrical energy in micro-grid or stand alone solutions.
- FC systems of 5-200kW will be demonstrated in minimum 2 sites
- Total minimum capacity is 200kW
- Demonstration of electrolyser of at least 500kW and storage equipment (use of existing RES)
- Consortium should include EU FC manufactures, relevant suppliers for BoP components, research institutions and academic groups
- TRL 6→7

Impact

- Establish confidence in technology and raise public awareness
- Establish business models with end-users and authorities
- Energy independency - RES absorption – Lower cost of electricity for end-users
- Reduce CAPEX towards 5000€/kW for FC and 2M€/t/d for electrolysers
- Increase lifetime >15 year and increase maintenance interval

Indicative Funding; No. of projects

- EU contribution of 5 M€ -- 3-5 years -- 1 project

Energy pillar IA

Topic 2-11: MW or multi-MW demonstration of stationary fuel cells

Challenge

- There is a need for dedicated demonstrations → volume increase → reduction in costs.
- Demonstrate the capability of the technology at such scale and open the path to full commercial deployment

Scope

- Techno-economic feasibility for usage of the system in commercial/industrial environment where the heat by-product can be utilized. (heat/cold)
- Deployment of power plant in a grid with large share of RES
- The power range of 1MW or several MWs (Preference for higher levels)
- Aim at creating partnerships between end users, industry, local SMEs, financiers and local authorities

Impact

- Reduction of CAPEX 4,000€/kW (>=1MW) and 3,000-3,500€(>=2MW)
- Reduction in CO2 emissions >10% compare to average national grid
- Reduction of maintenance cost to 0.05€/kWh (<2MW) and 0.035€/kWh for larger systems.
- Increase fuel cell system lifetime towards 20 years(stack replacement incl.)
- Replicable business case

Indicative Funding; No. of projects

- EU contribution of 6 M€ -- 5 years -- 1 project