EU policy framework
Stationary Fuel cells

Mirela Atanasiu, Project Manager/Team Leader Energy Applications

Outline

- FCH activities in the EU political context
- Overview of achievements – status of activities in FCH1 JU (2008-2013) – focus on stationary FC
- Future plans for next programme FCH2 JU (2014-2020)

Energy Union

(European Commission Communication Feb.2015)

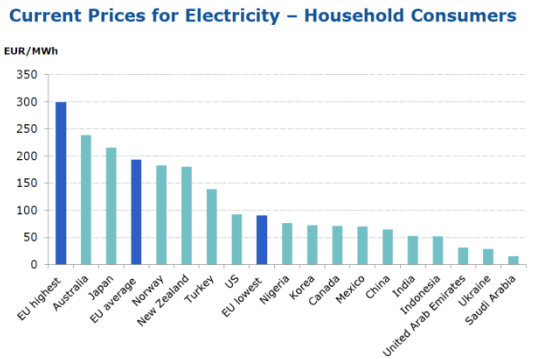
"I want to reform and reorganise Europe's energy policy in a new European Energy Union."
Jean-Claude Juncker (President of the European Commission)

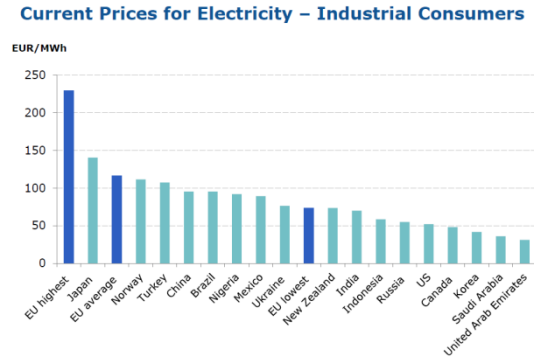
The vision of the Energy Union:

- a sustainable, low-carbon and climate-friendly economy that is designed to last;
- strong, innovative and competitive European companies that develop the industrial products and technology needed to deliver energy efficiency and low carbon technologies inside and outside Europe;
- with citizens at its core, where citizens take ownership of the energy transition, benefit from new technologies to reduce their bills, participate actively in the market, and where vulnerable consumers are protected.

The Energy Union strategy has five mutually-reinforcing and closely interrelated dimensions:

- Energy security, solidarity and trust;
- A fully integrated European energy market;
- Energy efficiency contributing to moderation of demand;
- Decarbonising the economy, and
- Research, Innovation and Competitiveness.





Reference year 2012

Source: European Commission

Energy Union

Actions (1)

- Diversification of sources and suppliers:
  Review of Security of Gas Supply regulation (Southern Gas Corridor, strategy to better use the potential of liquefied natural gas and storage, and establishment of liquid gas hubs with multiple suppliers in Central and Eastern Europe as well as in the Mediterranean)
- Transparency of contracts:
  Commission will review the Intergovernmental Agreements Decision and will propose options to ensure that the EU speaks with one voice in negotiations with third countries
- New market design:
  Enhanced rules for cross-border energy trade and appropriate measures to encourage renewable energy producers to better integrate in the wider electricity market
- European energy regulator:
  EU-wide regulation of the single market should be strengthened through a significant reinforcement of the powers and independence of ACER
- Leverage investment in energy infrastructure:
  Only a small number of infrastructure projects in Europe will need grants under the Connecting Europe Facility (CEF); other projects could make use of other financing methods that provide more leverage than the grants/direct financial aid e.g. European Fund for Strategic Investments (EFSI)
- Energy taxes:
  National taxation policies should strike the balance between providing incentives for a more sustainable energy use and the need to ensure competitively priced and affordable energy to all consumers
- Energy efficiency of the building sector:
  Review of the Energy Efficiency and Energy Performance of Buildings Directives, Heating and Cooling Strategy, Energy Labelling Directive

Energy Union

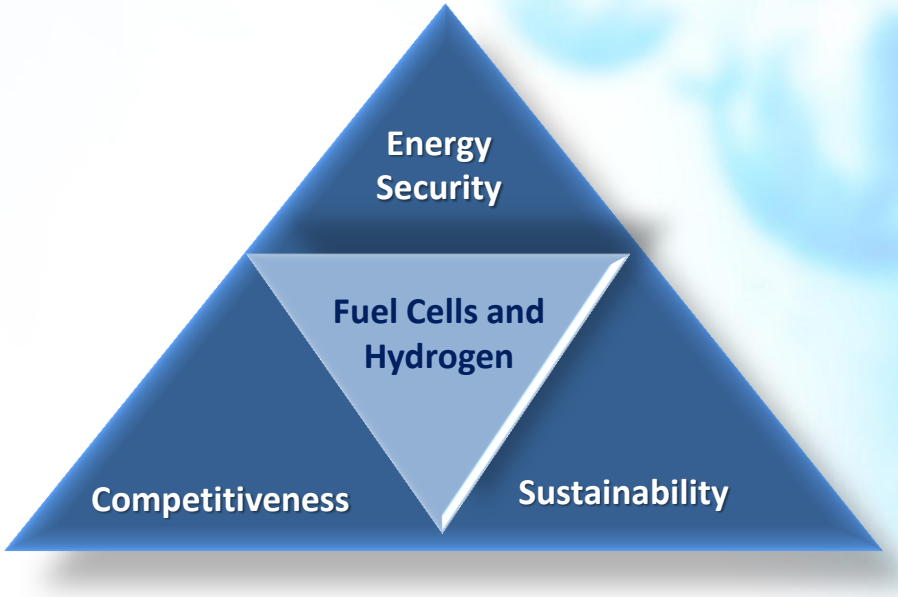
Actions (2)

- Europe the leader on renewables:
  Fully implement existing legislation and put in place new market rules; facilitate cooperation and the convergence of national renewable energy policies and support schemes; promote more focused renewable energy research and demonstration, including through dedicated EU funds
- Emission reduction target of at least 40% for 2030:
  Revision of the EU ETS Directive for the period post-2020,including carbon leakage and introducing a market stability reserve (MSR) + analysis of national targets for emission reductions in the non-ETS sectors, including improved flexibility mechanisms and incorporation of land use, land use change and forestry
- Decarbonise road transport:
  Mandatory CO2 targets for cars and vans; strategy to reduce fuel consumption and CO2 emissions from trucks and buses; increase renewable fuels in transport; market development of alternative fuels and their infrastructure
- Research and innovation:
  Implementation of **Horizon 2020/Energy theme**
- European cohesion policy:
  About €38 billion over 2014-2020 will help Member States, regions, local government and cities implement much needed investments in energy efficiency in buildings, renewable energy, smart grids or sustainable urban transport

Fuel Cells & Hydrogen technologies in the context of the European Energy policy

Sustainability

- 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 CO_2 emissions



Energy Security

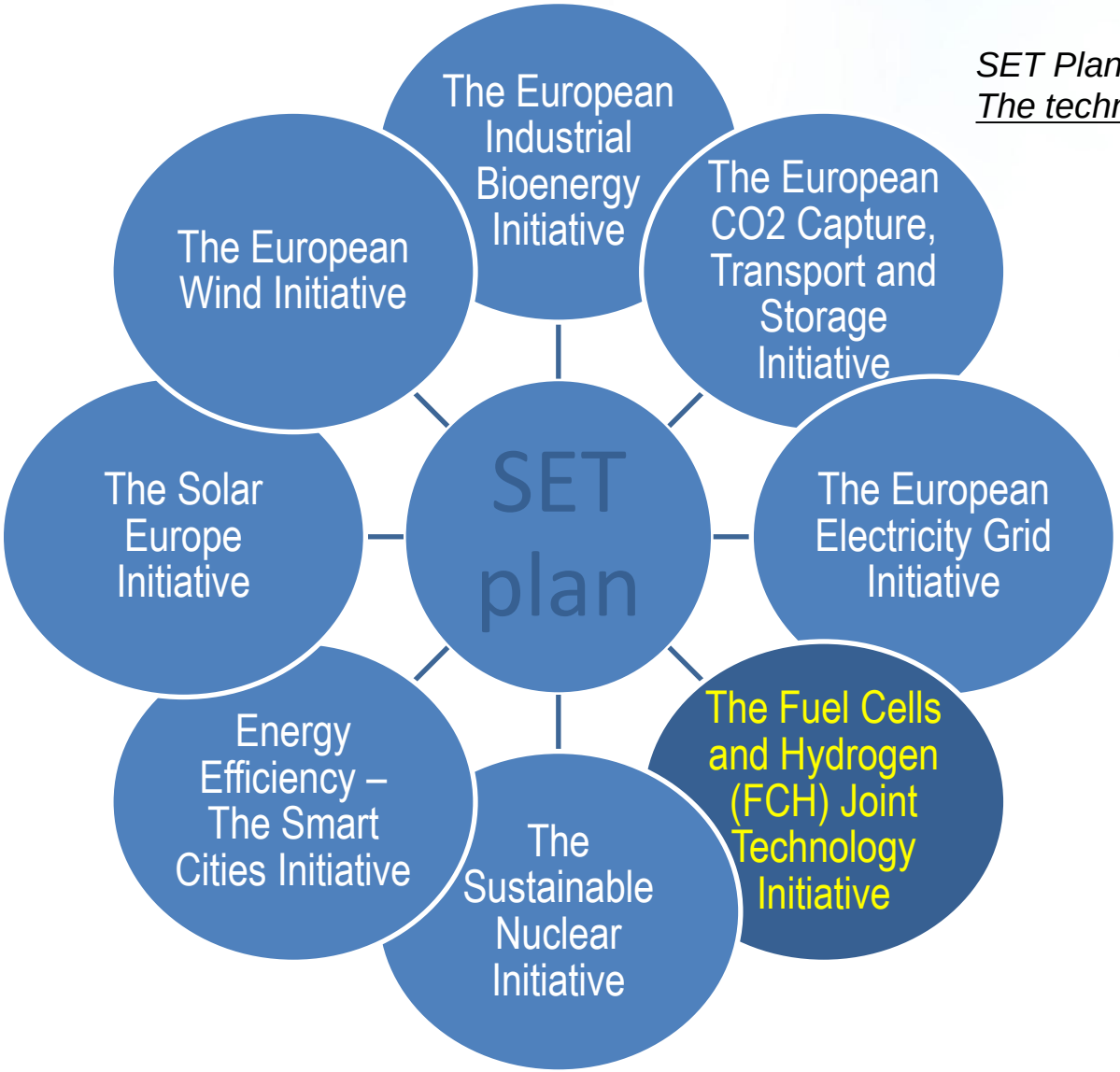
- Increase independence from unstable outside regions

Competitiveness

- research excellence leading to industry innovation and growth

From 80% dependency on fossil fuels to
80% reduction in GHG emissions in 40 years !
→ A reinvention of our energy system…

The FCH JU/JTI in the SET plan



SET Plan = Strategic Energy Technology Plan
The technology pillar of the Energy Union !

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
- Budget: 1.4 bill.€ (2014-2020)**
- FCH JU Programme Office

*European Council, October 2014
** continuation of previous exercise for 2008-2013 with a budget of approx. 1 bill.€

Strong Public-Private Partnership with a focused objective

Fuel Cells & Hydrogen Joint Undertaking

Industry Grouping
Over 80 members
~ 50% SME

European Union
represented by the
European Commission

Research Grouping
Over 60 members

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

To accelerate the development of technology base towards **market deployment of FCH technologies** from 2015 onwards

Fuel Cell and Hydrogen community in Europe

+10%

average increase of annual **turnover** (on a 2012 total of €0.5 billion)

+8%

average increase of **R&D expenditures** (2012 total €1.8 billion)

+6%

average increase of **market deployment expenditures** (2012 total €0.6 billon)

+6%

growth in **jobs** per year (~4,000 FTE in 2012) while average EU job market has contracted

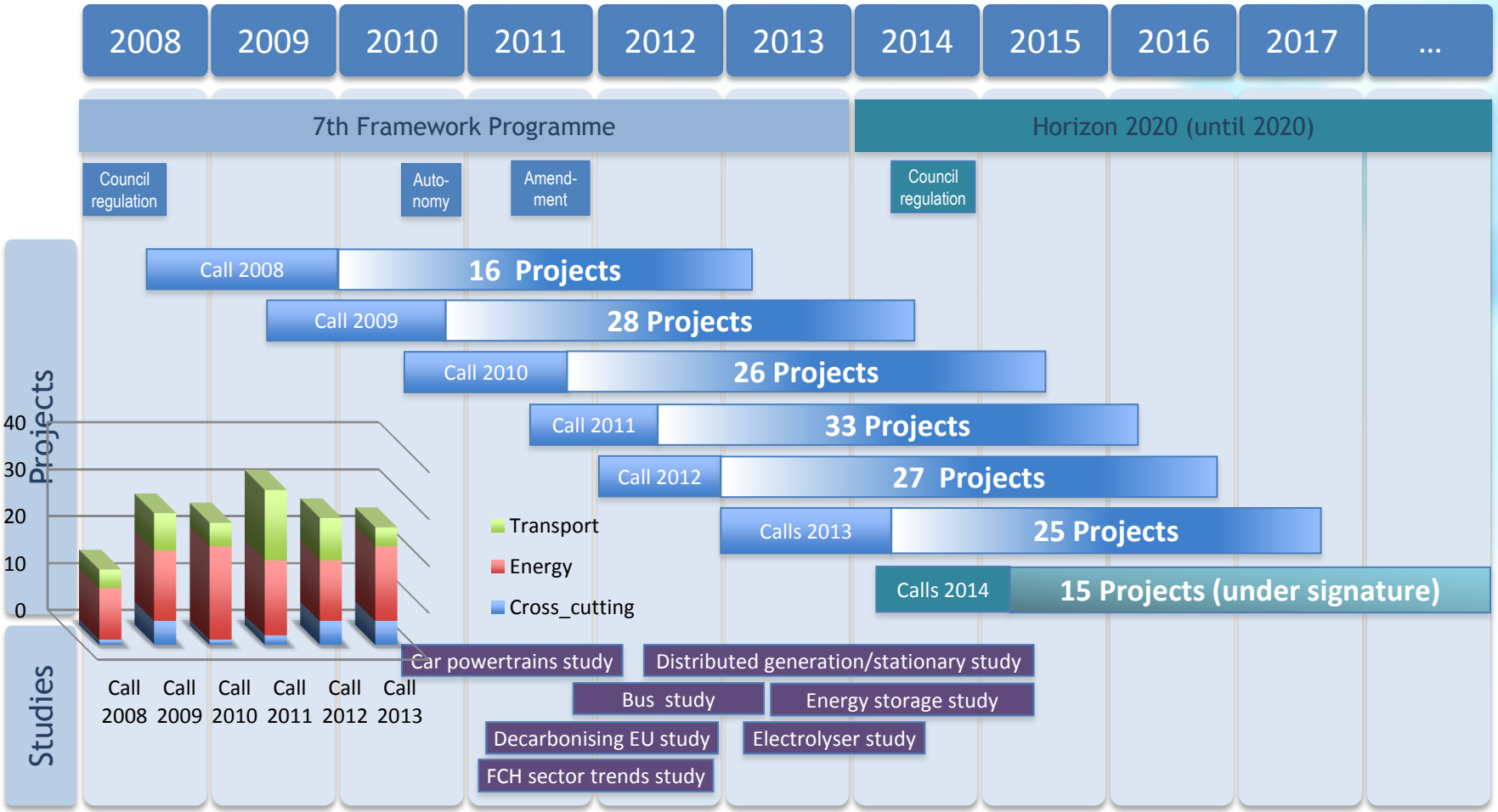
+16%

annual increase in **patents** granted in the EU to European companies (average 1.5% for all European industries)

Source: Trends in investments, jobs and turnover in the Fuel cells and Hydrogen sector, 2012

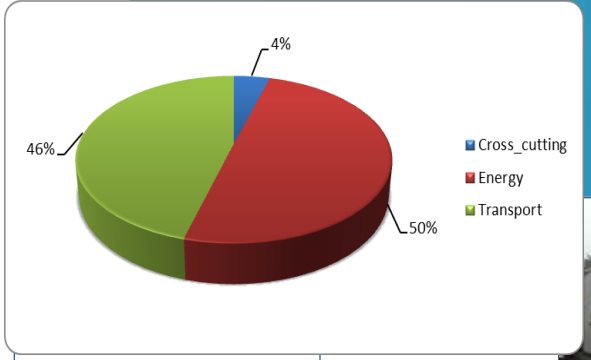
Supported R&D activities 2008-2013 (and beyond…)

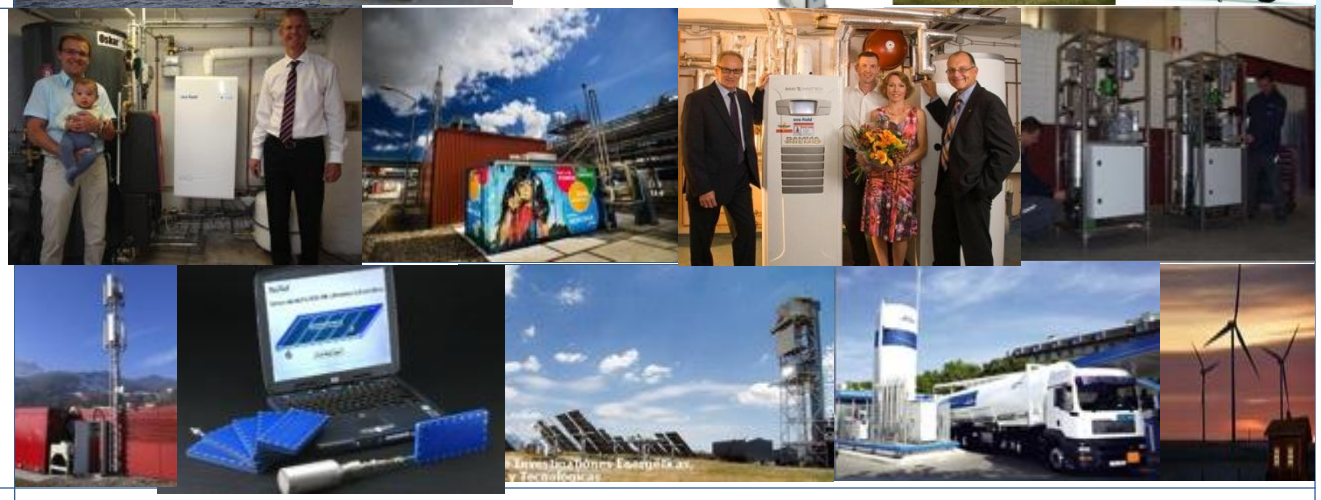
(under 7th Framework Programme of the EU)



- Total of **155 research and demo** projects (supported by 7 studies)
- Total value of about **1 bill €** ***(incl 450 mill € EU support)***

FCH JU current portfolio: 155 projects



TRANSPORTATION & REFUELLING INFRASTRUCTURE	**45 projects** 202 mill EUR	
ENERGY (HYDROGEN PRODUCTION & STATIONARY FUEL CELLS)	**91 projects** 210 mill EUR	
CROSS - CUTTING	**19 projects** 20 mill EUR	Regulations, Codes and Standards (RCS), Safety, Education, PNR, …

Projects involving 22 EU Member States

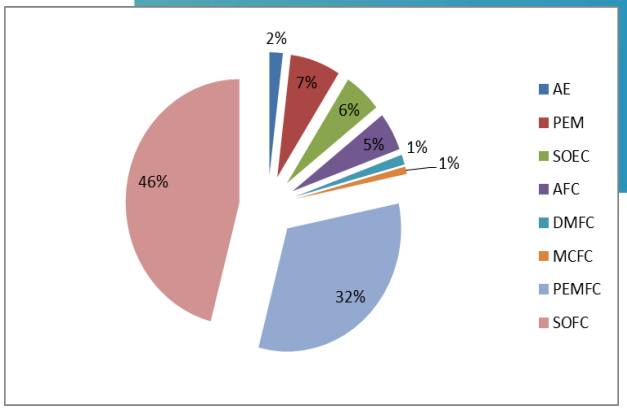
with **545** participants of which

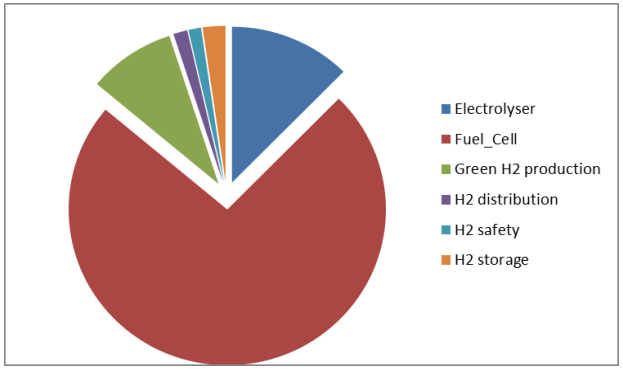
- **192 industries** (35%)
- **154 SMEs (28%)**
- **149 research** organisations (27%)
- **20** higher education (4%)
- **30** other (6%)

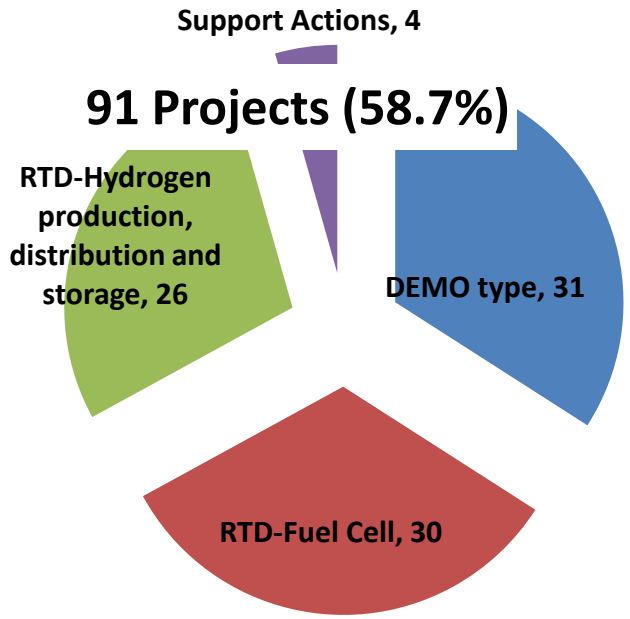
Incl international cooperation outside EU

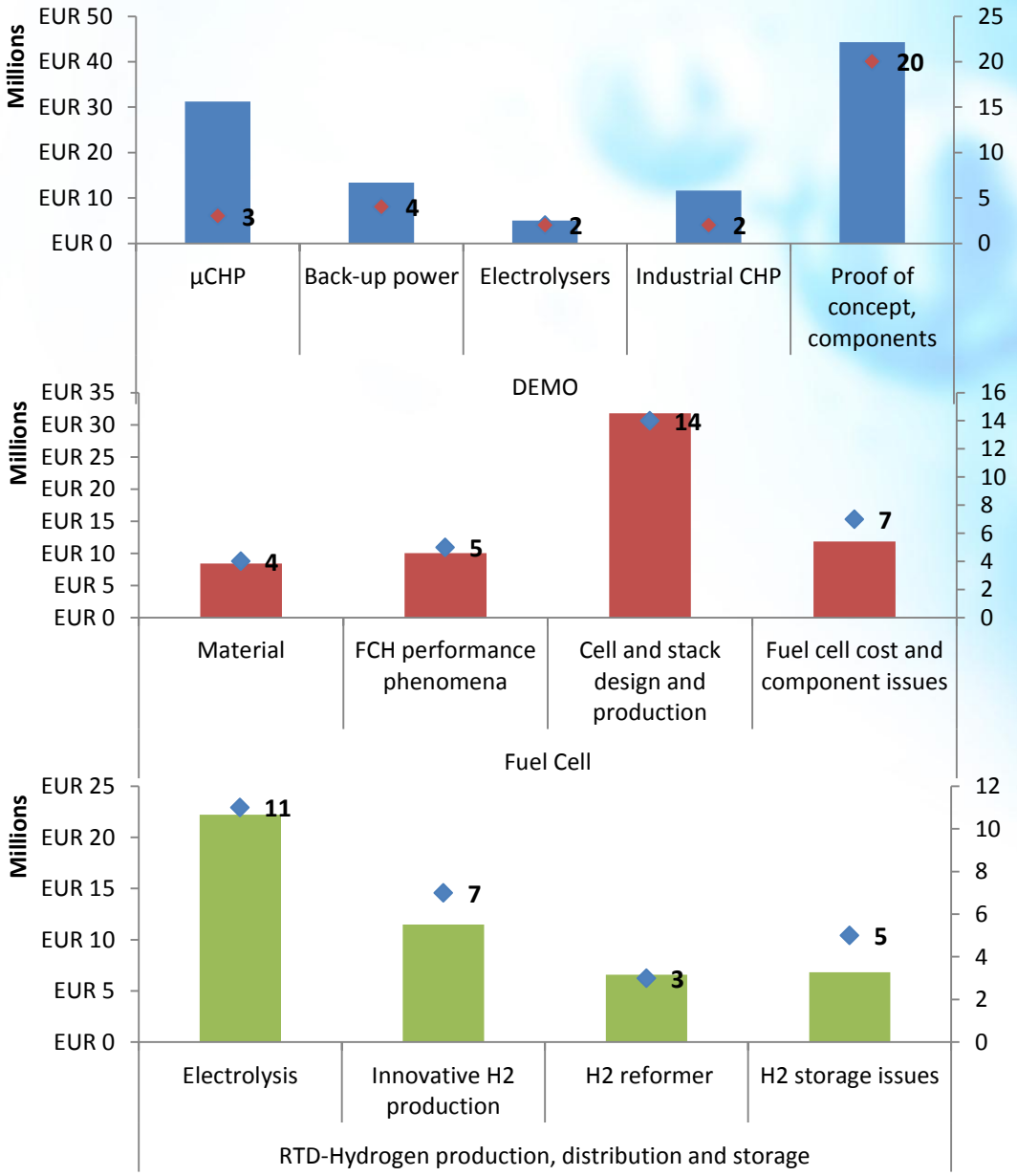
Additional non-EU countries:
CH, NO, IL, TR, IS, RS, CN, RU & US

FCH JU Funding in Energy projects (FP7 legacy) – 210 mill EURO

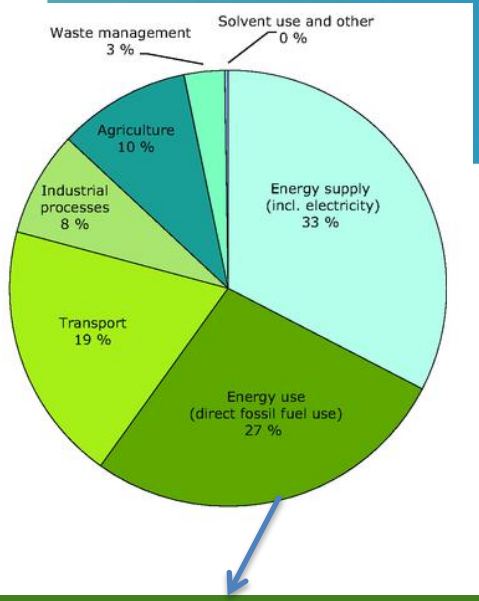






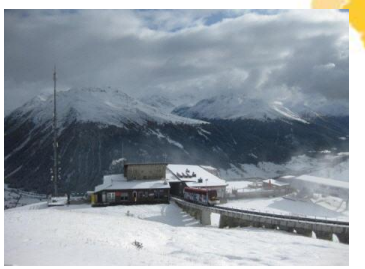


Reduce European energy consumption by 20%



- Demonstration of > 1000 residential micro-CHP units in 12 Member States (system efficiency > 95%)
- Demonstration of 3 industrial CHP projects >1,5 MW
- Demonstration of > 37 back-up power systems

ene.field ★ SOFT-PACT FCpoweredRBS fitup



Reduce electricity and gas bill while minimizing CO_2 emissions with FC-mCHP

Achievements

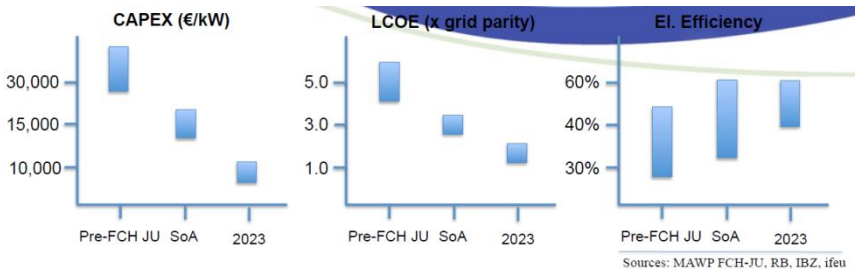
- Technology is ready; FC m-CHP entering the market through different routes/contracts (via utilities, installers, ESCOs etc)
- Reliabilities confirmed in e.g. SOFT-PACT, ene.field and parallel national programmes CALLUX, Danish Fuel Cell Programme
- About 1.300 units in Europe installed overall
  - **Ene.field:** at present more than 250 units already installed in 9 countries (DE, IT, NL, CH, FR, DK, UK, AT, LU) and additional 400 contracts signed before Sept 2015
  - **SOFT-PACT:** almost 100 units installed by EoN in UK and DE
- About 23 % less primary energy compared to central generation
- Up to 80 % less CO2, no NOx, SOx etc.
- Up to 60 % el. efficiency (more than 90% in cogeneration mode), lower grid loss
- Storage (H2), grid support (flex base load), decentralized
- Addressable Market: 2 GW with 2.5 mill µCHP units

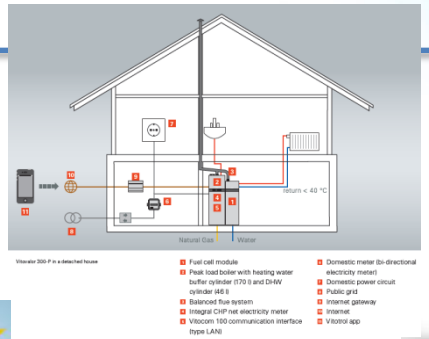
Challenges

- Cost reduction (e.g. by volume, incl manufacturing and standardisation of components and design to cost)
- Further improvement of stack lifetime
- Competition from heavily subsidized Japanese/Korean industry
- Proper labelling (based on efficiency) for fair competition with benchmarking technologies
- Involvement of national, regional and local authorities to put in place suitable support mechanisms (financial and non-financial)

Next Steps

- Implement scale up projects
- Build financing models (depending on the routes-to-market for Europe), eventually learn from previous successful innovative technologies (e.g. PV industry)
- Inform potential customers about the technology





ene.field
Fuel Cells x Combined Heat and Power

SOFT-PACT

Lower cost energy for industry with Fuel Cell CHP

Achievements

- Products ready for commercialization
- Demonstrated Reliability
  - Multi MW plants globally used
  - Suitable business models developed
- Grid support potential for advantages in flexibility
- About 23 % less primary energy compared to central generation
- Up to 80 % less CO2, no NOx, SOx etc.
- Addressable Market:
  - 2 - 8 GW only in 5 selected industrial applications
  - Multi GW in utility sector, carbon capture and renewable hydrogen

Challenges

- Volume ramp up for further cost reduction (incl. manufacturing processes), consolidate supply chain
- Further improvement of efficiency, stack lifetime, system reliability
- Harmonization of (sulphur free) natural gas odorants

Next Steps

- Scale up & Identify business models/niche markets for immediate commercialisation
- Continue R&D to further enhance durability and performance

500 kW in Stade, DE
to start operation end 2015

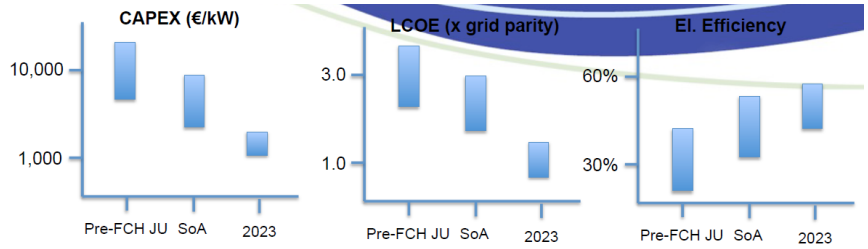
Power-UP

DEMCOPEM 2MW

2 MW in China to start operation mid 2016

CLEARgen™Demo

1 MW near Bordeaux, FR to start operation end 2016



A Reliable and Clean solution for Back-up Power through Fuel Cells

Achievements

- 19 back-up and UPS systems deployed in three countries[1]
- LCA analysis show lower TCO compared to both Diesel and battery UPS[1]
- Average reliability demonstrated was 99.4%[1]
- Response time<5ms[1]
- Lifetime of system 15 years (1500h) > Lifetime of battery[1]
- 18 off-grid systems deployed in Radio Stations in Italy[2]
- Demonstrated efficiency of 45%[4]
- Silent operation < 60dB [2]
- BoP efficiency has exceeded the MAIP target[2]
- BoP cost 160 €/kW @ 100 units lower than the MAIP target[2]
- Durability of 10,000h for Air blower[2]

Challenges

- CAPEX for system still too high – 5,5k€/kW
- Durability still an issue with the hydrogen blower
- Lowering even more BoP power consumption can be challenging due to air blower.

fitup[1]

FCpoweredRBS[3]

FLUMABACK[2]
Fluid Management component improvement for back-up fuel cell systems

LiquidPower[4]

Next set of Actions

- Project Liquid power claims a cost of 1300/kW @ 5000 units production hence manufacturing should be supported to increase volumes achieve the economies of scale necessary for market penetration
- Investments in R&D should continue to improve durability on certain components e.g. hydrogen blower
- Identify business models/niche markets for early deployment

FCH JU Stationary Study: Fuel cells are the highly efficient and complementary choice to future energy systems based on more and more renewables

European vision for stationary fuel cells

Fuel cell vision

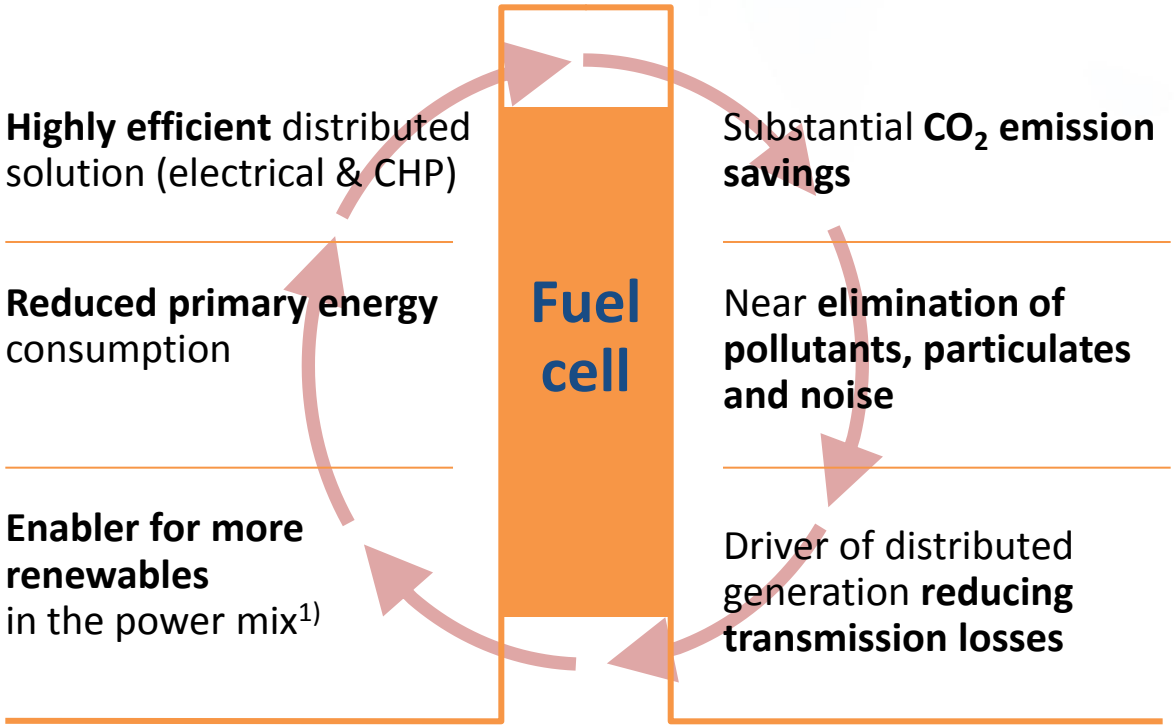
- Highly efficient conversion of natural gas (and eventually green gas or pure hydrogen)
- In distributed generation, i.e. at the site of consumption
- Lowering the carbon footprint of energy supply
- Playing a omplementary role to renewables[1)]

1) E.g. Stationary fuel cells as operating reserve with good performance at partial loads, complementary cycles of heat-driven CHP with electric heating demand

Source: FCH JU Coalition, Roland Berger

Stationary fuel cells bear substantial, interrelated benefits – First a gas-based bridge technology, then carbon-free potential

Stylised overview of main benefits of stationary fuel cells



- **Fuel cell initially as bridge technology** with significant potential to reduce primary energy demand and emissions
- **Afterwards, transformation to a renewable technology** through decarbonisation of the gas grid

1) E.g. Stationary fuel cells as operating reserve with good performance at partial loads, complementary cycles of heat-driven CHP with electric heating demand

Source: FCH JU Coalition, Roland Berger

However, to become economically competitive, capital costs must be reduced substantially by increasing production volumes

Residential segment – Example of Germany

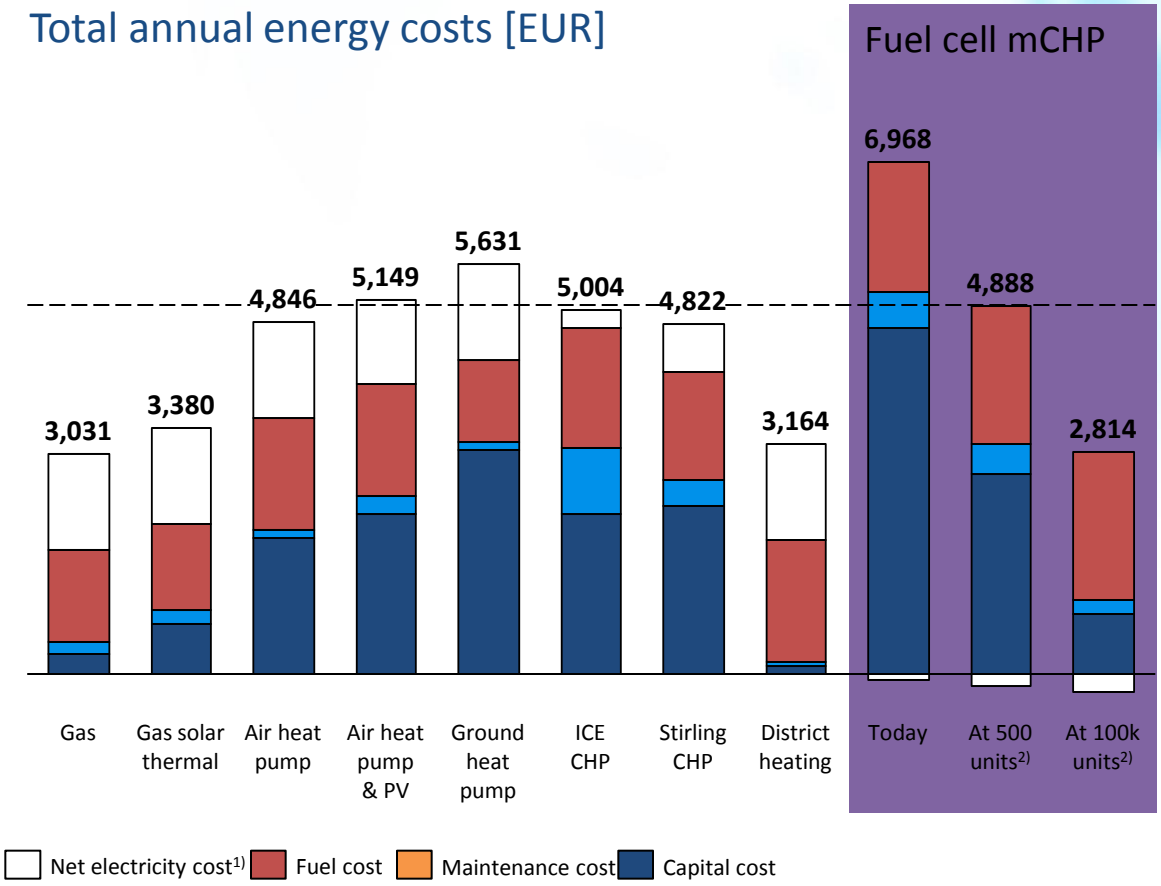
Use-case specific economic benchmarking

MUNICH

Fuel cell micro-CHP system

Electric capacity	1 kW_{el}
Thermal capacity	1.45 kW_{th}
Electric efficiency	36%
Thermal efficiency	52%
System lifetime	15 years
Required stack replacements	2

Total annual energy costs [EUR]

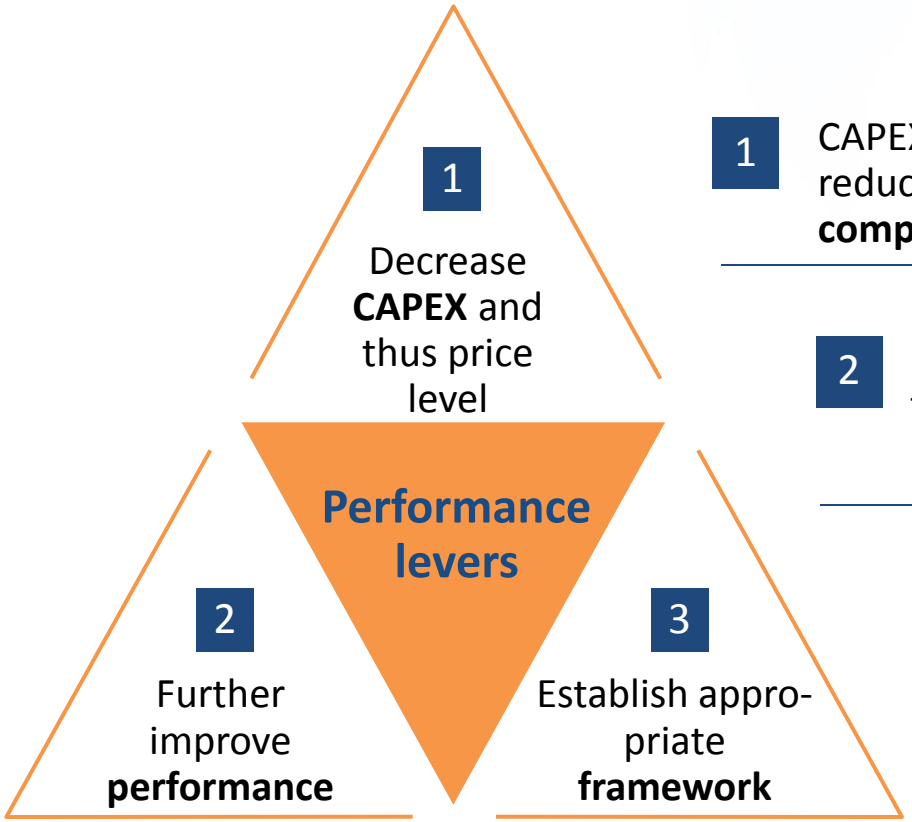


1) Negative electricity cost reflect higher earnings from power feed-in than residual purchase of grid power. 2) Cumulative production volume per compar

Source: FCH JU Coalition, Roland Berger

To enable commercialisation, three levers need to be triggered – Decrease CAPEX, sustain performance and establish framework

Three levers to unlock the benefits of stationary fuel cells[1)]



1 CAPEX and thus price level must be reduced to **enable FC competitiveness**

2 **Performance must be improved** further to prolong lifetime and increase efficiency

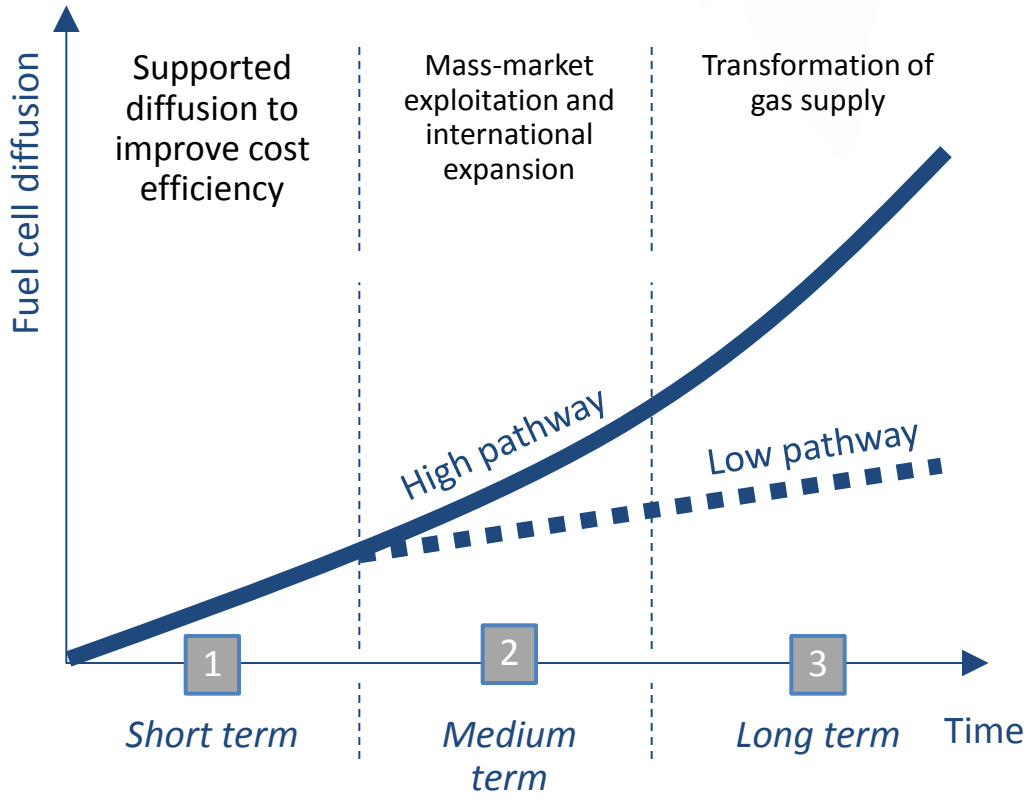
3 **Policy framework must allow to explore FC benefits** (e.g. funding to support initial commercialisation)

1) The three levers are of different importance for different fuel cell product clusters and market segments. Please refer to the Study for detailed information.

Source: FCH JU Coalition, Roland Berger

The commercialisation of fuel cells will go through three main phases – Long-term potential as mass-market technology

Potential development stages and pathways of the fuel cell technology



1 **Fuel cell systems reach competitive cost level to high-end heating solutions**
- > Policy support to trigger market pick-up and thus cost reduction
- > Starting point in the residential segment

2 **Fuel cell systems reach competitive cost level to mass-market solutions**
- > Continuous support if cost targets are reached
- > Commercial segment to be supported

3 **Fuel cell systems become a renewable technology through decarbonisation of gas supply**
- > Further growth and mass-market solution possible if gas supply becomes greener and more domestic

Source: FCH JU Coalition, Roland Berger

Multi-annual Work-Plan 2014-2020

Continuation of EU support under Horizon 2020

EU budget: 665 mill. EUR

Objectives: reduce the (production) cost, increase the lifetime, increase the efficiency, reduce 'Critical raw materials'

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

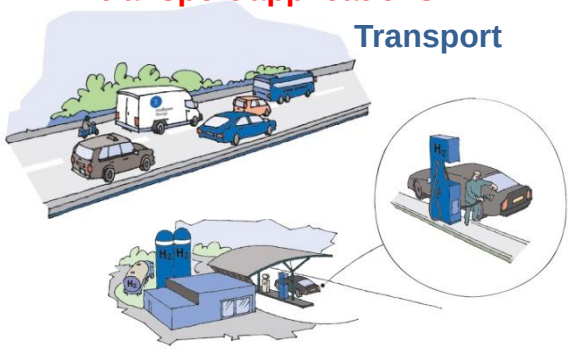
(e.g. standards, consumer awareness, manufacturing methods, …)

FCH 2 JU objectives

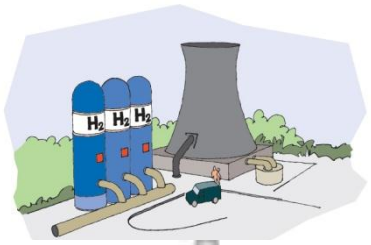
Reduction of production costs of long lifetime FC systems to be used in transport applications

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

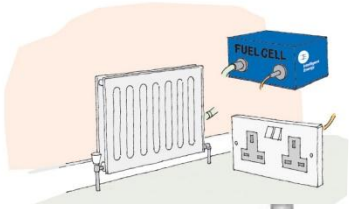
Transport



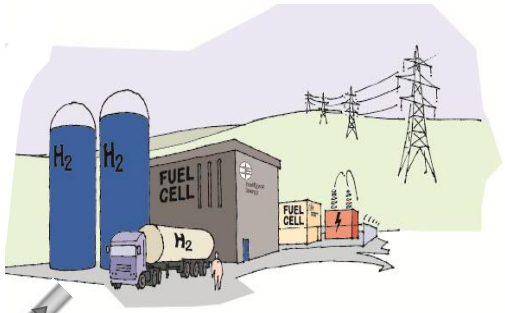
Industrial applications



Residential CHP



Feed to electricity grid

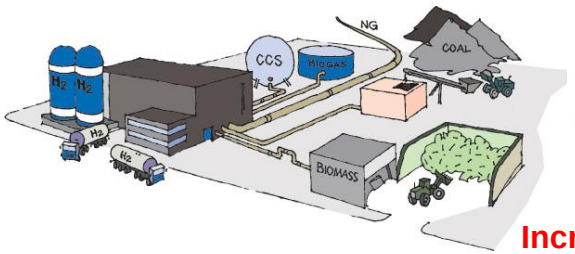


Reduce the use of critical raw materials

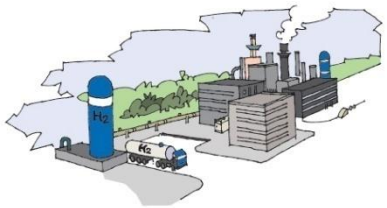
Existing natural gas, electricity and transport infrastructures

Methanisation feed to natural gas grid

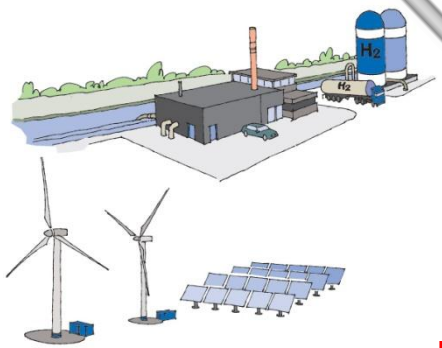
By-product from Chemical Industry



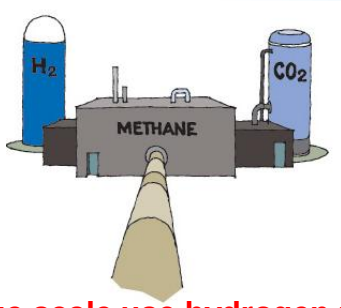
Natural gas, biogas, coal, biomass



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



Renewable generation, storage and 'buffering'



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

FCH JU Annual Event 2015

Place: "Charlemagne building", Rue de la Loi 170, B-1040 Brussels,
in the heart of the EU Institutions area

8th Stakeholder Forum : 19 November 2015

European Industry and Research communities together with decision-makers will discuss on alignment and integration of activities and instruments at Regional, National, European and International level to accelerate the commercialisation phase of Fuel Cells and Hydrogen technologies

Programme Review Days: 17 – 18 November 2015

All FCH JU funded projects (a selection will also present) will be assessed for their progress status and the targets fixed in the multi-annual and annual work plans

Details of the programme and registration information will be available at the beginning of September 2015 at www.fch.europa.eu

Thank you for your attention !