UNIVERSITY OF BIRMINGHAM

MILLENNIUM POINT

FCH2 2017

TECHNICAL CONFERENCE

31st May – 1st June 2017

MILLENNIUM POINT, BIRMINGHAM

Review of the European Activity

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Université Libre de Bruxelles

Content

- The Energy Union context
- FCH JU structure and objectives
- FCH JU projects portfolio
- FCH JU success stories
- Conclusions

Energy Union (1)

> "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;
- Citizens at its core, where citizens take ownership of the energy transition, benefit from new technologies to reduce their bills and participate actively in the market, and where vulnerable consumers are protected.

The targets of EU policy on the EnergyUnion and climate action:

- Reduction of greenhouse gas emissions by 40% compared to 1990;
- Increase in renewable energy to 27% of total production;
- Making 27% energy savings compared to 1990.

Energy Union (2)

Energy Union strategy:

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

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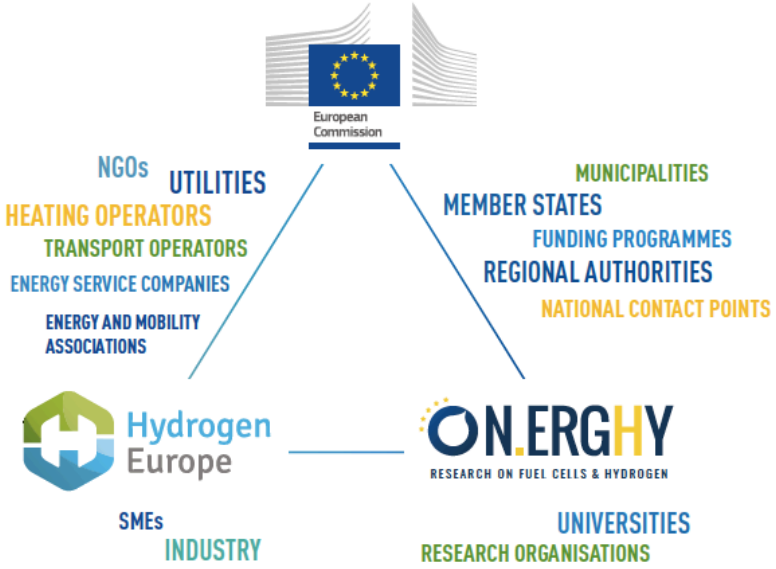
The FCH JU – A strong Public Private Partnership (PPP)



FCH JU - 1: 2008-2014 budget €940 million (FP7)
FCH JU - 2: 2014-2020 budget €1.33 billion (H2020)

Fuel Cells & Hydrogen Joint Undertaking (FCH 2 JU)

Hydrogen Europe
Industry Grouping
Close to 100 members

European Commission

ON.ERGHY
RESEARCH ON FUEL CELLS & HYDROGEN
Research Grouping
Over 60 members

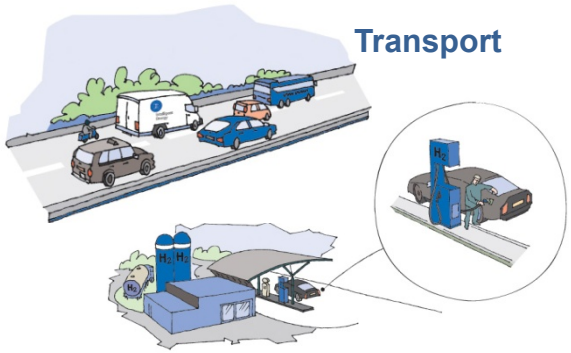
The Joint Undertaking is managed by a Governing Board composed of representatives of all three partners and lead by Industry.

To implement an optimal research and innovation programme to bring FCH technologies to the point of **market readiness by 2020**

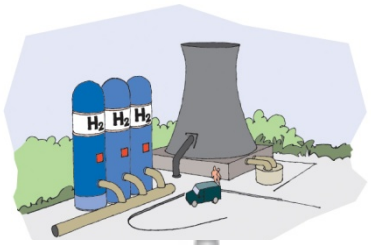
FCH JU - 2 objectives

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

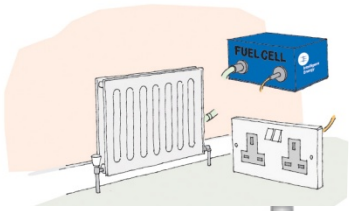
Increase of the electrical efficiency and durability of low cost FCs used for power production



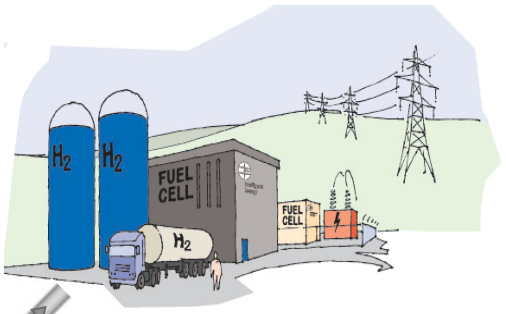
Transport



Industrial applications



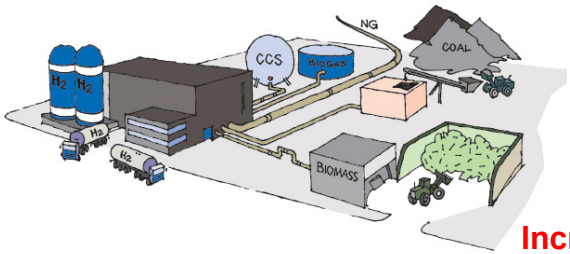
Residential CHP



Feed to electricity grid

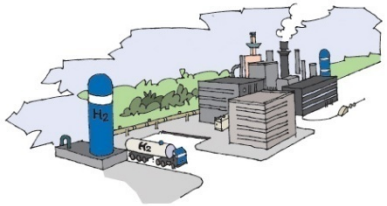
Reduce the use of critical raw materials

Existing natural gas, electricity and transport infrastructures

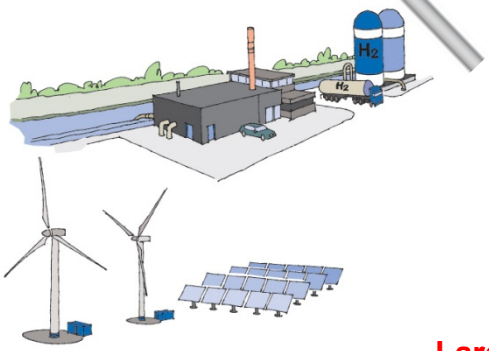


Natural gas, biogas, coal, biomass

By-product from Chemical Industry

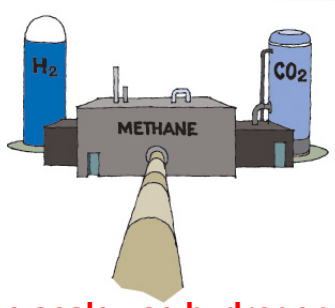


Increase the energy efficiency of low cost production of hydrogen from water electrolysis and renewable sources



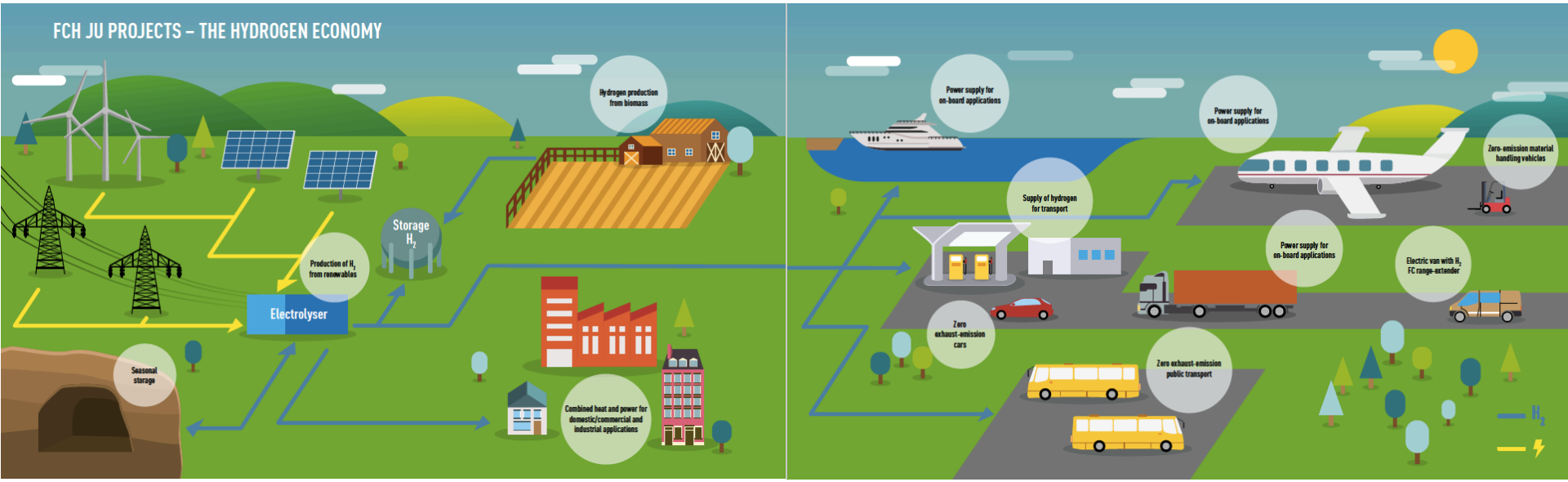
Renewable generation, storage and 'buffering'

Methanisation feed to natural gas grid



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

The FCH JU in the Energy Union context



HORIZON 2020

Energy

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

Transport

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

Cross-cutting Issues

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

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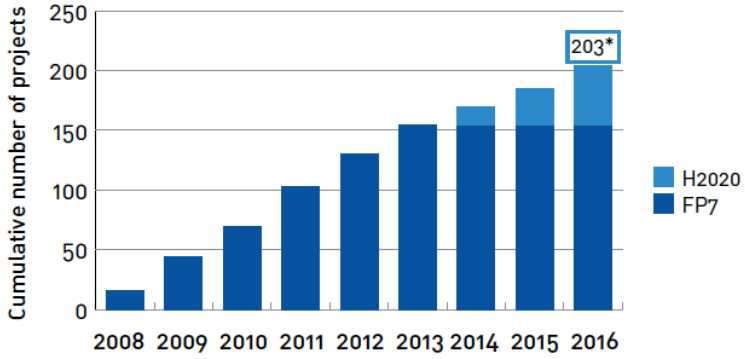
FCH JU 1&2 results



*projects signed at 01/03/2017

Success rate: 24%

Newcomers: 31%

204 projects supported for 737 M€

Similar leverage of private funding: 782 M€

ENERGY
117 projects

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

360 M€, 49%

337 M€, 46%

39 M€

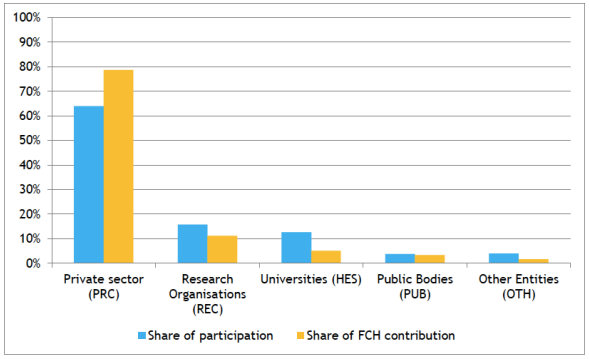
TRANSPORT
53 projects

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

Cross-cutting, 34 projects

(e.g. standards, safety, education, consumer awareness, …)

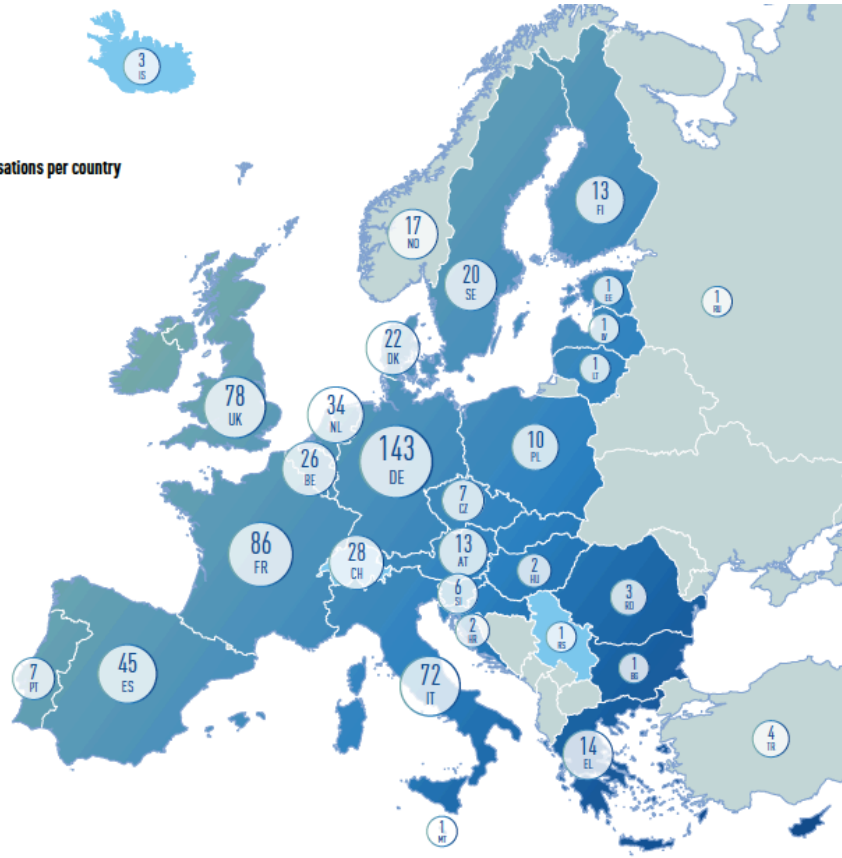
Beneficiary and funding distribution per country

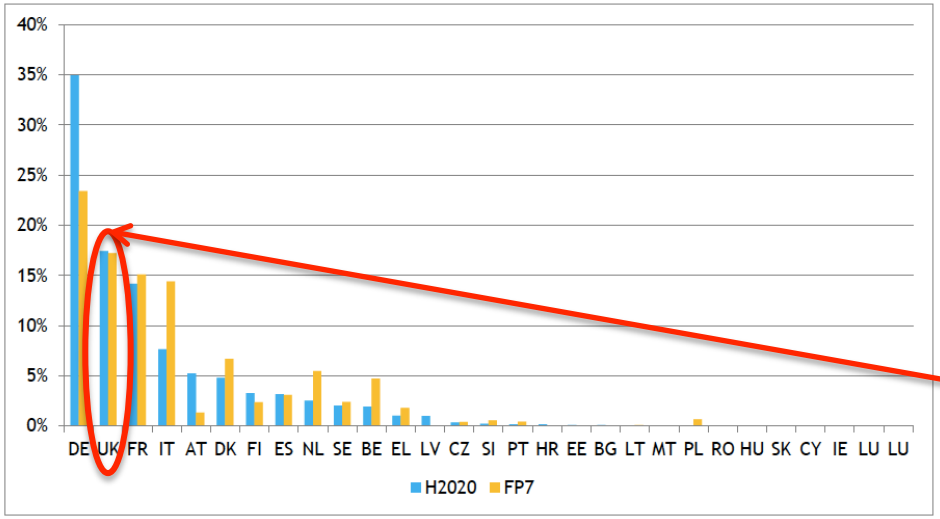


COUNTRY DISTRIBUTION

The figures indicate the number of FCH JU participating organisations per country

NON EUROPE	
CANADA	3
CHINA	2
ISRAEL	2
REPUBLIC OF KOREA	1
UNITED STATES	2



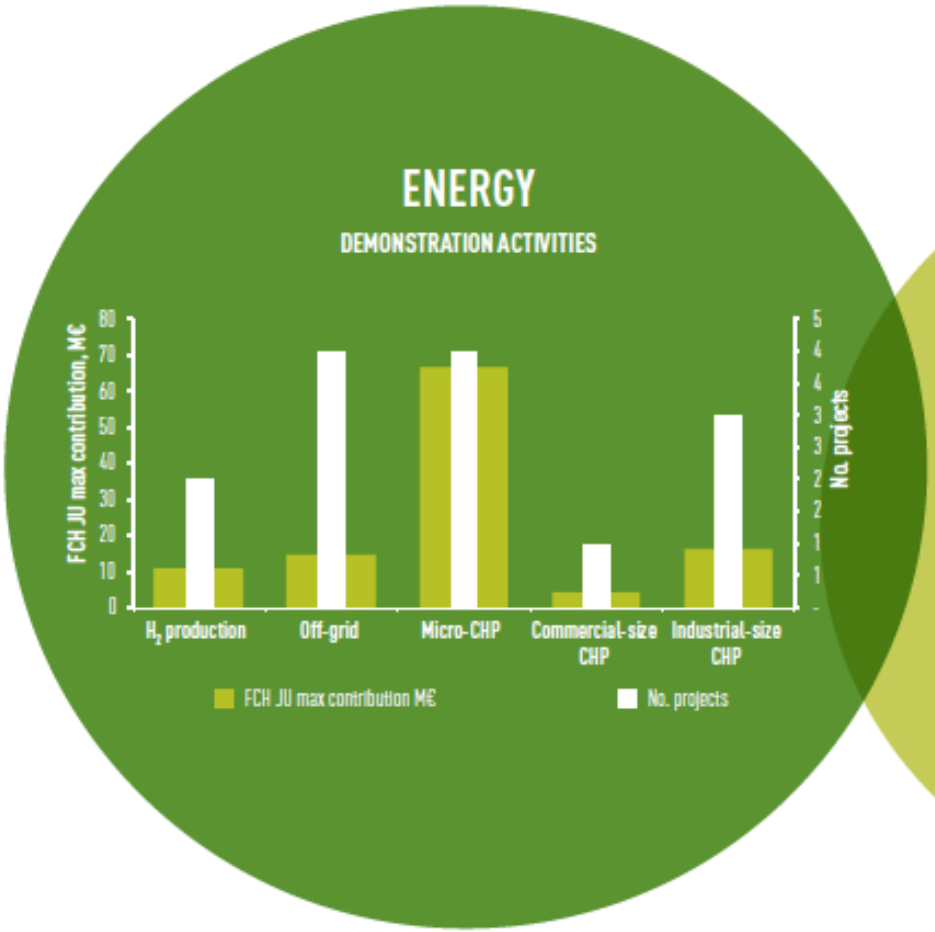


UK funding 2008-2015: €98 million

Energy projects

HOW IS THE BUDGET DISTRIBUTED AMONG THE DIFFERENT PILLARS?

in M€

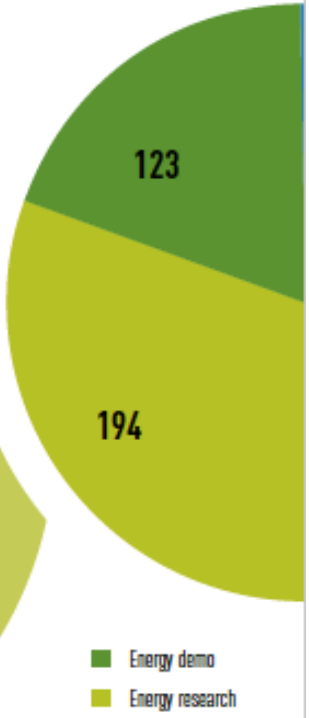


RESEARCH ACTIVITIES

These focus on stationary fuel cells and hydrogen production.

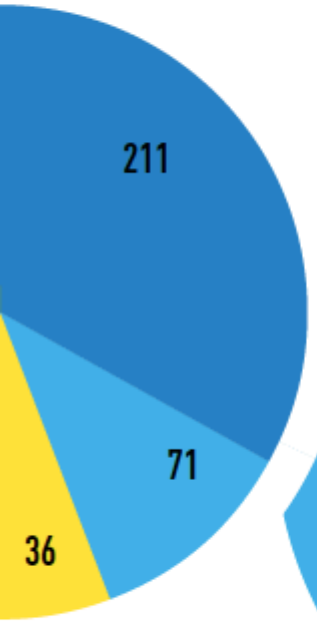
The emphasis for fuel cells is on high-temperature fuel cells for diverse applications, to improve their performance and increase their durability.

Hydrogen production research targets better dynamic performance of electrolysers to improve their integration with variable renewable energy sources. It also aims to develop innovative routes for producing hydrogen, involving biogas via reforming, solar energy via concentrated solar power or photo-electrochemical means, or using wet or dry biomass via biological reactors or gasifiers.



Transport projects

in M€



Transport demo

Transport research

Cross-cutting

RESEARCH ACTIVITIES

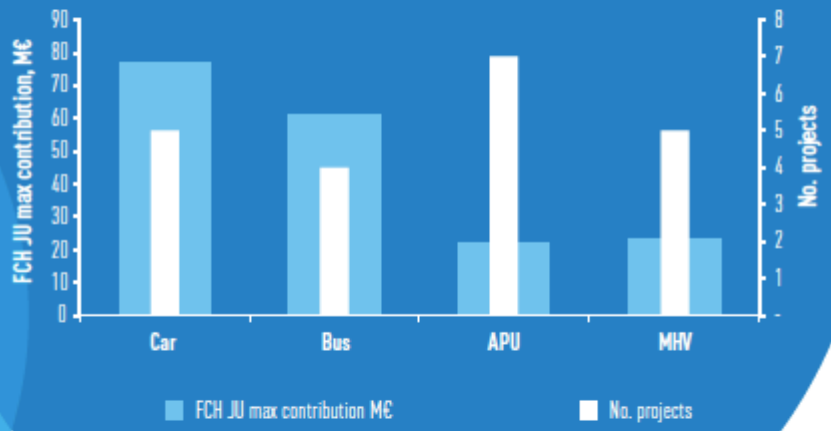
These aim to reduce the production cost of fuel cell systems to be used in transport applications, while increasing their lifetime to levels competitive with conventional technologies.

In particular, projects on membrane electrode assembly (MEA) aim to reduce the use of platinum and other critical raw materials; projects on bipolar plate (BPP) investigate advanced coatings; projects on stacks and on balance of plant (BoP) aim to improve manufacturing techniques.

Modelling of cells, improvements in compression technologies at hydrogen refuelling stations (HRS) and the manufacture of low-cost H2 on-board tanks complete the span of the FCH JU research portfolio.

TRANSPORT

DEMONSTRATION ACTIVITIES



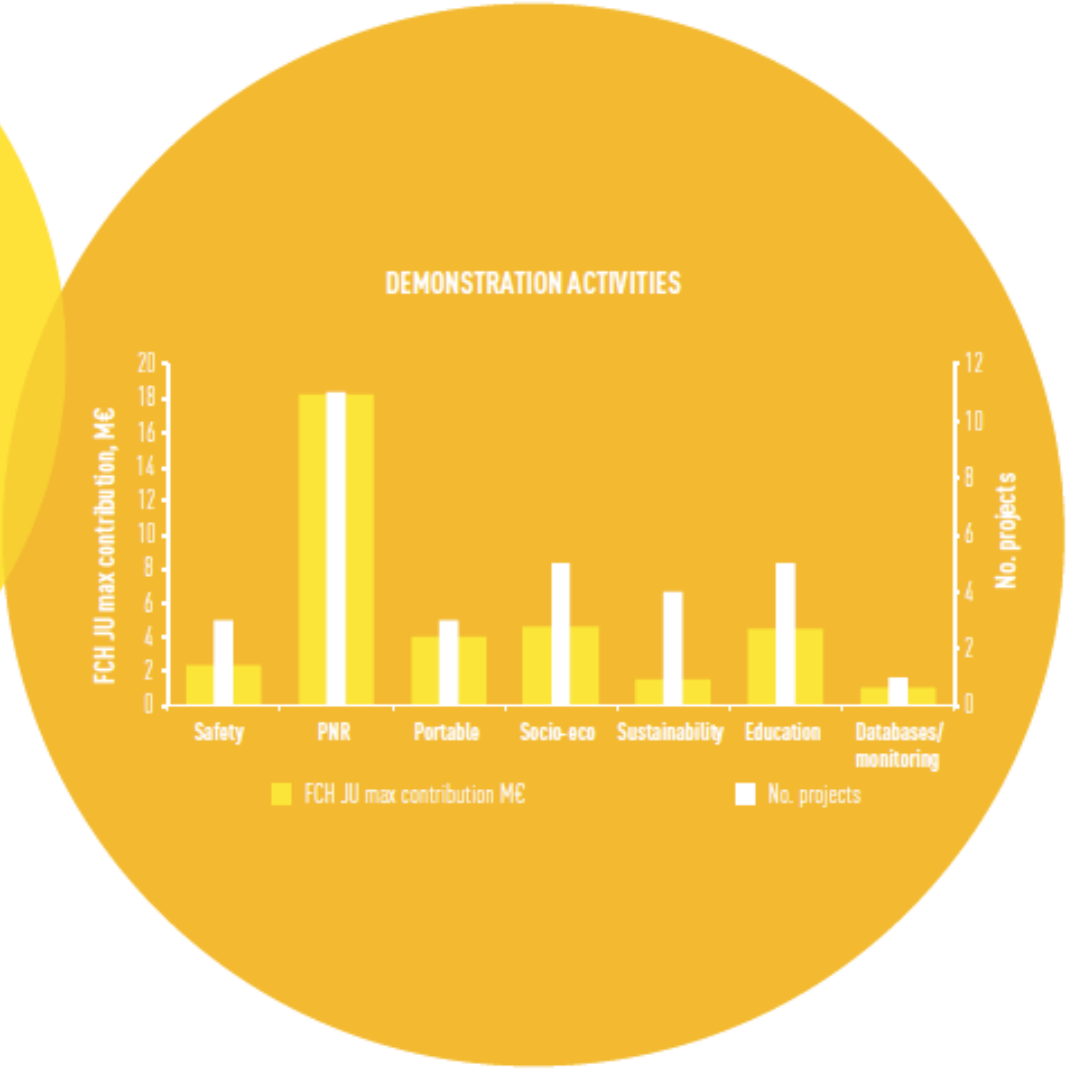
Cross-cutting projects

CROSS-CUTTING PROJECTS

The FCH JU programme also covers a wide range of cross-cutting activities that support both energy and transport developments.

Backing deployment activities and technical developments alone is not enough to ensure smooth entry into the market. It is crucial to remove regulatory barriers and encourage the public to be aware of and have trust in emerging technologies.

Therefore an important part of the FCH JU portfolio supports projects dealing with topics that help technical developments become part of everyday life. These include safety innovations and tests, education and public awareness, and pre-normative research – research whose results are used to develop regulations and standards.



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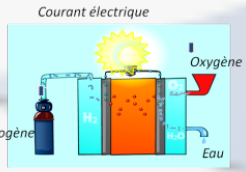
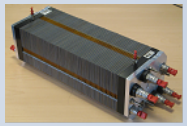
Fuel Cells scope of applications





Marine & aerospace

Forklifts

Hybrid FC Buses

FCEV RE

FCEV

FC in commercial planes

1995 2000 2005 2010 2015 2020

Backup power

Large scale stationary applications

Energy storage

CHP Systems

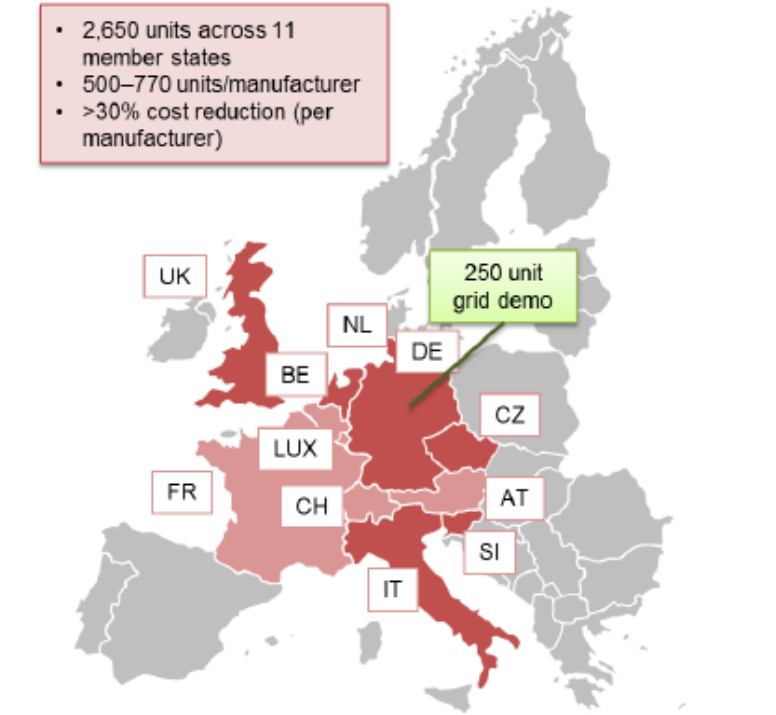
Portable applications

Residential Market Segment (< 5 kW)

m-CHP: from National to EU initiative(s)
initial volume uptake, market readiness

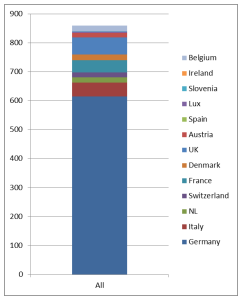
PACE: Pathway to A Competitive European FC mCHP market

- 2,650 units across 11 member states
- 500–770 units/manufacturer
- >30% cost reduction (per manufacturer)



ene.field

More than 500 units installed in 10 countries of Europe, reliabilities and OPEX confirmed, very good customer satisfaction (over 70% positive feedback),



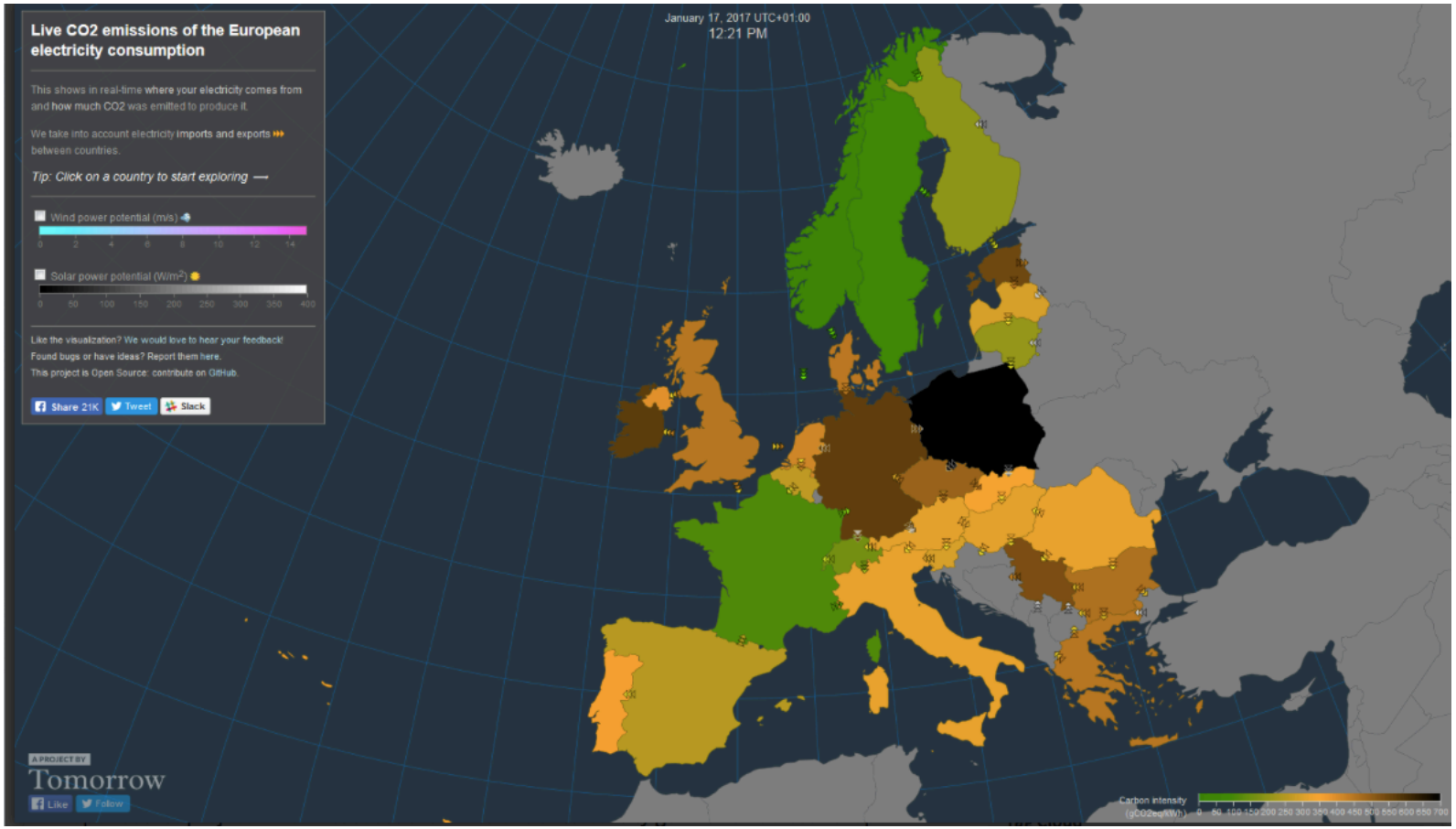
Micro-CHP:
3600 (750)

SOFT-PACT

65 fuel cell systems, electrical efficiency higher than 42 % over lifetime (total efficency higher than 78%), 25% cost reduction

Importance of the energy mix composition

https://www.electricitymap.org/?wind=false&solar=false&page=map



To achieve a reduction of GHG emissions by 40% with FCs in distributed generation, the energy mix must emit more than 255 gCO_2/kWh.

The higher the percentage of renewable energy in the energy mix, the lower the GHG emissions and the less interesting the distributed energy generation.

Hydrogen enables us to get the most out of our Wind and Solar energy

Achievements

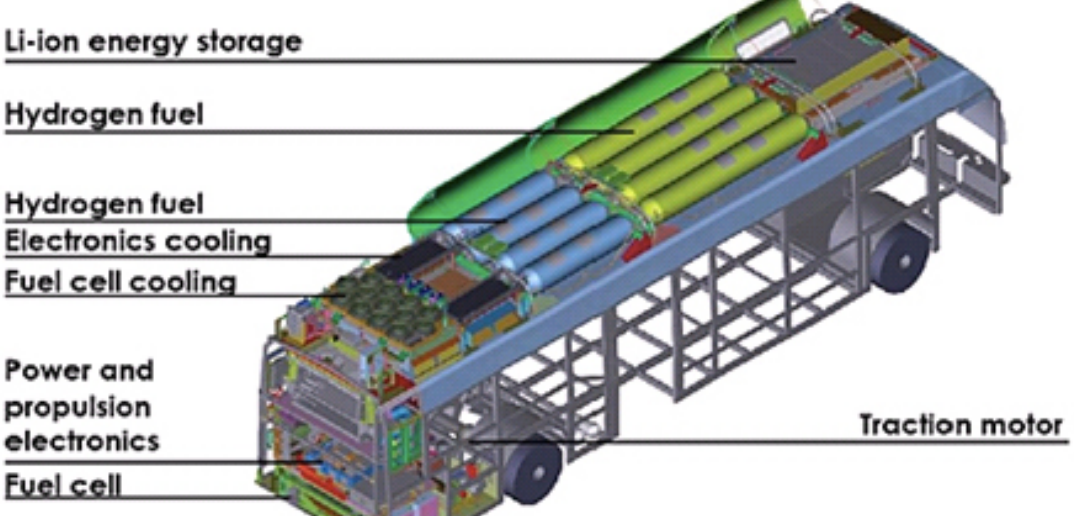
On-site installation of hydrogen equipment after receiving exploitation permit, certification and CE conformity:

- Solar pannels (800 kWp) and wind turbines (1500kWp)
- 2 Electrolysers (one alkaline and one PEM): 130 kg H_2/day
- 2 Compressors
- Hydrogen storage capacity 100 kg at 45 Mpa
- Hydrogen dispenser for a fleet of 200 fuel cell forklifts and FC cars
- 100 kWe Fuel Cell connected to the grid

DONQUICHOTE
hydrogen out of wind turbine energy

https://www.youtube.com/watch?v=hvsEiN-XFsg

Fuel Cell Bus



Situation and Outlook in Europe: 91 buses in operation or about to start

Ongoing EU-funded fuel cell bus projects

CHIC

- ✓ Bolzano, IT– 5 FC buses (2013)
- ✓ Aargau, CH –5 FC buses (2011)
- ✓ London, UK – 8 FC buses (2011)
- ✓ Milan, IT – 3 FC buses (2013)
- ✓ Oslo, NO – 5 FC buses (2013)
- ✓ Cologne, DE* – 4 FC buses (2011/14)
- ✓ Hamburg, DE* – 6 FC buses (2011/2015)

High V.LO-City

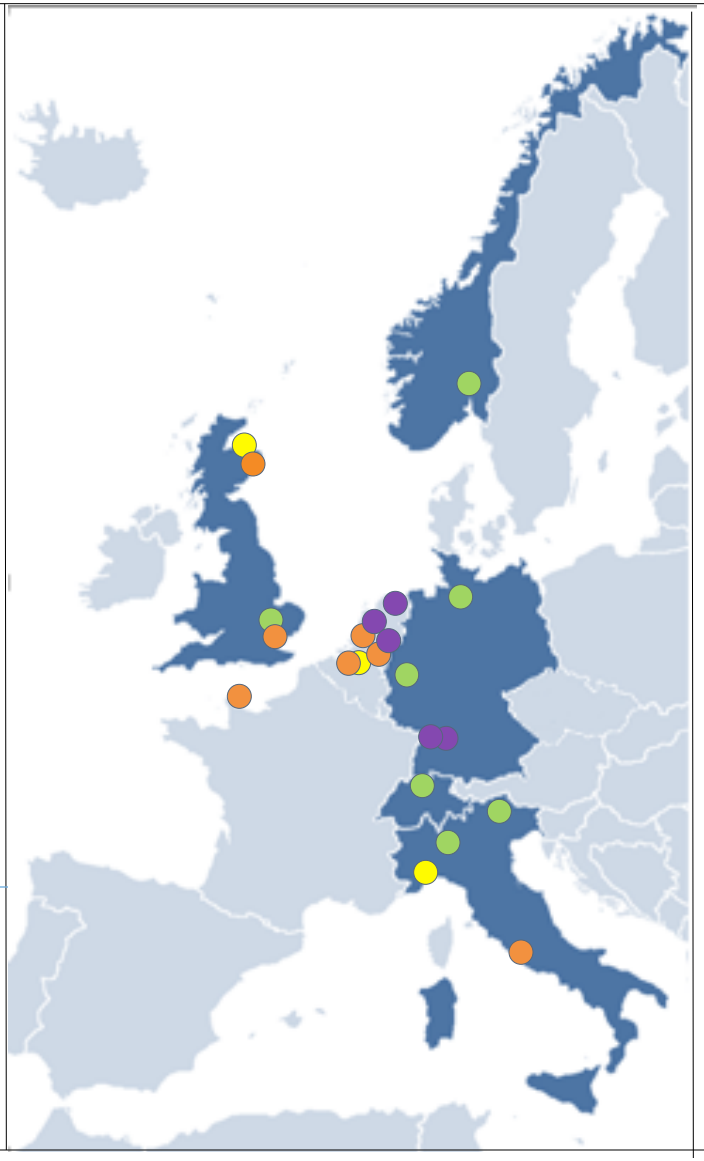
- ✓ Liguria, IT – 5 FC buses (2015)
- ✓ Antwerp, BE – 5 FC buses (2015)
- ✓ Aberdeen, UK – 4 FC buses (2015)

HyTransit

- ✓ Aberdeen, UK – 6 FC buses (2015)

Legend

- CHIC countries
- ✓ In operation
- ✓ Planned operation
- (2015) Operation start/planned start
- * Co-financed by regional/national funding sources



Ongoing EU-funded fuel cell bus project

3Emotion

- ✓ Cherbourg, FR – 5 FC buses (2016/17)
- ✓ Rotterdam, NL – 4 FC buses(2016/17)
- ✓ South Holland, NL – 2 FC buses
- ✓ London, UK – 2 FC buses (2016/17)
- ✓ Flanders, BE – 3 FC buses (2016/17)
- ✓ Rome, IT – 5 FC buses (2016/17)

Current national/regional-funded fuel cell bus projects

- ✓ Karlsruhe, DE * – 2 FC buses (2013)
- ✓ Stuttgart, DE * – 4 FC buses (2014)
- ✓ Arnhem, NL* – 3 FC buses (2016/17)
- ✓ Groningen, NL* – 2 FC buses (2016/17)
- ✓ Brabant, NL* – 2 FC buses (2016/17)

Last update: October 2015

Refuelling stations:
81 (20)

PEM Water electrolysis for Hydrogen as a clean, local fuel for transport

Electrohypem

Achievements

- 1 MW water electrolysers powered by **wind or solar energy sources**, ensuring security of low carbon energy supply
- New Proton Exchange Membrane Electrolysers (PEMFC) with high efficiency and operability (10-100% of full range and stable when off)
- High Hydrogen purity complying with SAE J2601 (2014) : 99,999% at 70 MPa
- Compact and easily scalable
- Electrolyser capital cost below 3.7 M€/(ton H_2/day)
- PRAEDRUS VIDEO v1-Mobile.mp4
- Stable and compact PEM water electrolyser operating at high temperature (up to 140°C) with low catalyst loading (PGM <0.5 mg/cm² MEA) and new high efficient **Aquivion®** membrane
- Electricity consumption 45 KWh/kg H_2 (vs 2017 target of 52-55 KWh/kg H_2) for electrolysis
- Increased hydrogen output per stack by 50%
- Rapid response (< 2 s from min to max power)
- Long term stability (degradation lower than 5 µV/hr/cell)
- **European technology:** electrolysis system commercialised by an European SME, stack components (membrane, catalyst) commercialised by European Industry and SME

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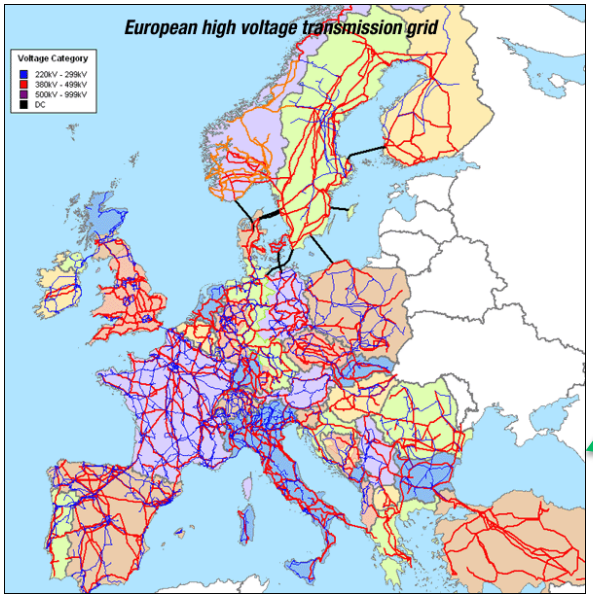
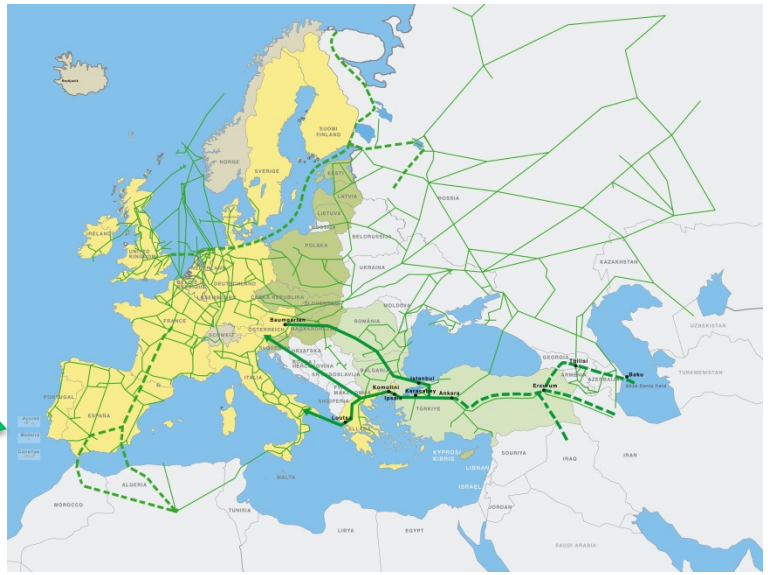
Connecting the European grids



Electricity grid

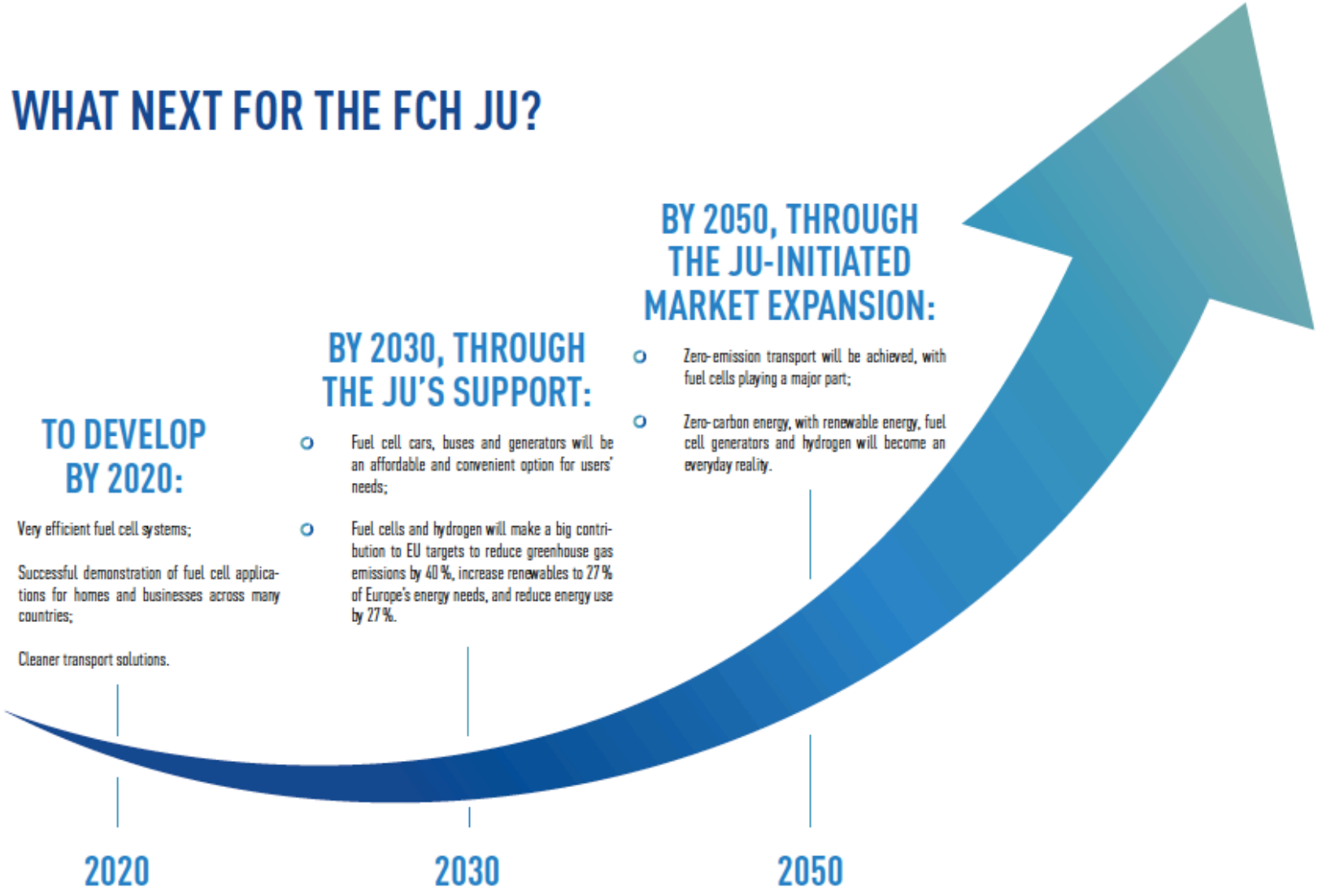
The H_2 energy vector



Natural gas grid

Trans-European Transport Network

V. WHAT NEXT FOR THE FCH JU?



TO DEVELOP BY 2020:

- Very efficient fuel cell systems;
- Successful demonstration of fuel cell applications for homes and businesses across many countries;
- Cleaner transport solutions.

BY 2030, THROUGH THE JU'S SUPPORT:

- Fuel cell cars, buses and generators will be an affordable and convenient option for users' needs;
- Fuel cells and hydrogen will make a big contribution to EU targets to reduce greenhouse gas emissions by 40 %, increase renewables to 27 % of Europe's energy needs, and reduce energy use by 27 %.

BY 2050, THROUGH THE JU-INITIATED MARKET EXPANSION:

- Zero-emission transport will be achieved, with fuel cells playing a major part;
- Zero-carbon energy, with renewable energy, fuel cell generators and hydrogen will become an everyday reality.

2020 2030 2050

For more information

Thank you for your attention !

Further info :

- **FCH JU : http://www.fch.europa.eu/**
- **HYDROGEN EUROPE : www.hydrogeneurope.eu**
- **N.ERGHY : http://www.nerghy.eu**