



# Fuel Cells and Hydrogen Joint Undertaking

*Main achievements and development perspectives  
in the frame of Horizon 2020*

*Bert De Colvenaer, Executive Director  
Aix-en-Provence, 3 September 2014*

# Fuel Cells and Hydrogen

technologies can contribute to :

## Sustainability

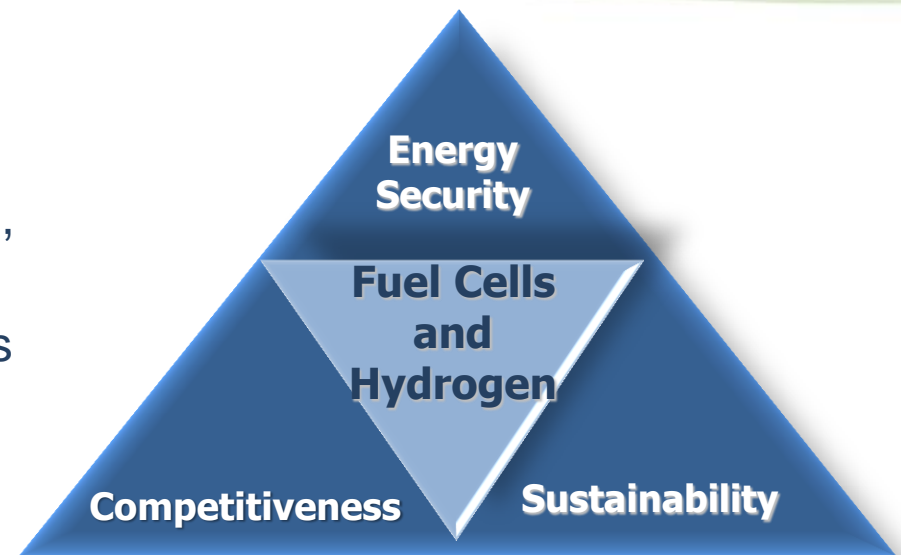
- $H_2$  is a clean carrier of energy
- Transport and stationary applications, generate electricity and heat
- Storage of renewable energy sources
- Reduction of  $CO_2$  emissions

## Energy Security

- Increase independence from unstable outside regions

## Competitiveness

- research excellence leading to industry innovation and growth



# Public-Private Partnership

## Industry led

### Fuel Cells & Hydrogen 2 Joint Undertaking



**Industry Grouping  
NEW-IG**  
76 members



**European Union**  
represented by the  
European Commission



research on fuel cells & hydrogen  
**Research Grouping  
N.ERGHY**  
59 members



*To bring to the point  
of market readiness  
a **portfolio of**  
clean, efficient and  
competitive  
solutions based on  
fuel cells and  
hydrogen  
technologies in  
energy and  
transport*

Both the Industry Grouping and the Research Grouping are non-profit organisations with open membership

# FCH JU Main Achievements

- **155 R&D D** projects financed
- over **7** calls for proposal
- covering **5** application area's
- total value of **900 M €**
- with **540** participants from **33** countries:
  - more than **300 industrial companies**
  - of which almost **50% SMEs**
  - more than **70 research institutes**
  - and more than **90 universities**
- Strong participation of **Joint Research Centre**
- international cooperation outside EC





# Transport applications

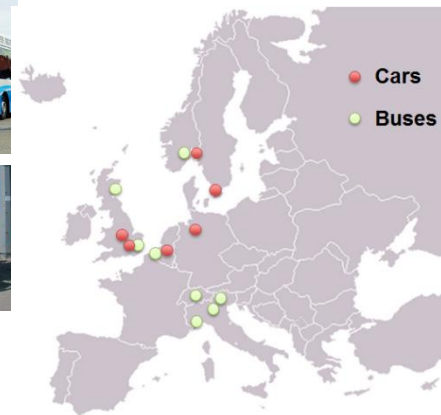


HyFIVE



HyTransit

3EMotion



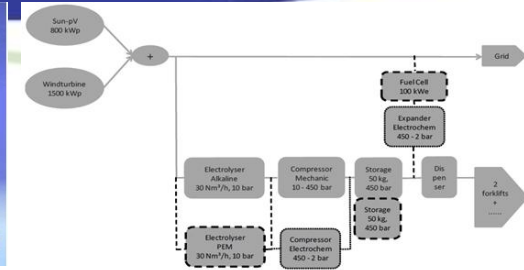
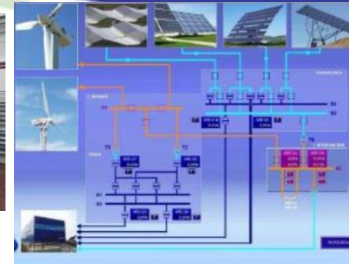
- Demonstration of > 260 hydrogen cars
- Installation of > 20 hydrogen refueling stations
- Demonstration of > 74 hydrogen buses
- Demonstration of > 400 hydrogen materials handling vehicles
- Demonstration of auxiliary power units for trucks, planes and maritime applications



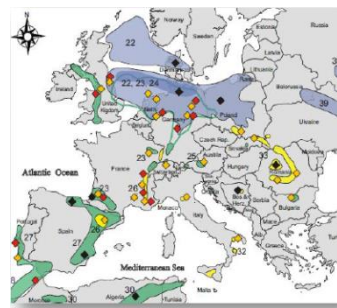
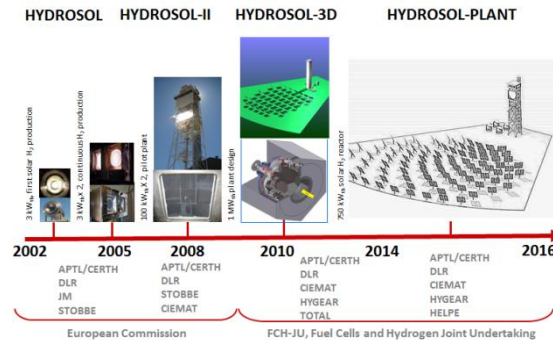
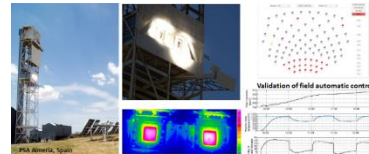
SAPIENS



# Hydrogen production and storage



- Demonstration of high power electrolyzers coupled to renewable energy sources
- Demonstration of integrated systems
- Demonstration of hydrogen production through concentrated solar energy
- Hydrogen Underground storage



Source: KBB

## Storage potential in salt formations



## Storage potential in depleted gas fields and Aquifers



Source: DEEP Underground Engineering GmbH





# Stationary applications (CHP and back-up power units)

ene.field★

SOFT-PACT

FCpoweredRBS

fitup

- 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



# Cross Cutting : projects related to safety

ACRONYM	H <sub>2</sub> CHAIN/TYPE	SHORT DESCRIPTION
<b>HYPACTOR</b>	H <sub>2</sub> storage	<b>Pre-normative research</b> on resistance to mechanical impact of composite overwrapped pressure vessels.
<b>FireComp</b>	H <sub>2</sub> storage	Improve the understanding of the conditions to avoid composite cylinders bursting in case of fire. <b>Contribution to updated RCS.</b>
<b>HyFacts**</b>	H <sub>2</sub> distribution and refuelling stations	Development of <b>training packages</b> and publicly available information materials on public safety experts and regulators on use of H <sub>2</sub> as energy carrier under real conditions.
<b>MATHRYCE</b>	H <sub>2</sub> distribution and refuelling stations	<b>Pre-normative research</b> for metallic components exposed to H <sub>2</sub> -enhanced fatigue (brittleness).
<b>H2Sense</b>	H <sub>2</sub> conversion and FC systems	Development of cost-effective and reliable <b>sensors for use of H<sub>2</sub>.</b>
<b>STACKTEST</b>	H <sub>2</sub> conversion and FC systems	Development of PEMFC <b>reference test procedures</b> for industry.
<b>HyIndoor</b>	H <sub>2</sub> conversion and FC systems	<b>Pre-normative research</b> for safe indoor use of FCH systems by sizing natural forced ventilation systems, and sizing of the vent area for deflagration mitigation.
<b>Hyresponse</b>	H <sub>2</sub> conversion and FC systems	Promote <b>training</b> on state-of-the-art knowledge in hydrogen safety, mock-up real scale hydrogen and fuel cell installations, and innovative virtual reality training.
<b>SUSANA</b>	Tools/databases	Improve <b>guidelines, procedures, databases and tools</b> for the use of CFD for inherently safer design of FCH systems and facilities in Europe.
<b>H2Trust</b>	Tools/databases	Assess the efforts for ensuring that FCH technology is safe and by systematically <b>mapping of safety issues, safety due diligence and best practices.</b>
<b>HYACINTH</b>	Tools/databases	Study <b>the social acceptance of H<sub>2</sub> technologies</b> across Europe, understand barriers and challenges, and develop communication strategies for FCH technologies.

\*\* finished



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- Strong participation of **Joint Research Centre**
- international cooperation outside EC
- **Mature European FCH community :**
  - Strong, visible and coherent
  - Consensus strategy (MAIP/AIP)
  - Pre-competitive collaboration



# Fuel Cell and Hydrogen Community

**+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 billion)

**+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)

# A portfolio of power-trains

for Europe

A portfolio of power-trains for Europe:  
a fact-based analysis



## Industry participants

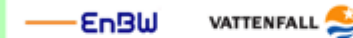
### Car OEMs



### Oil and gas



### Utilities



### Industrial gas companies



### Equipment OEMs



### Wind



### Electrolyser companies



### NGOs, GOs

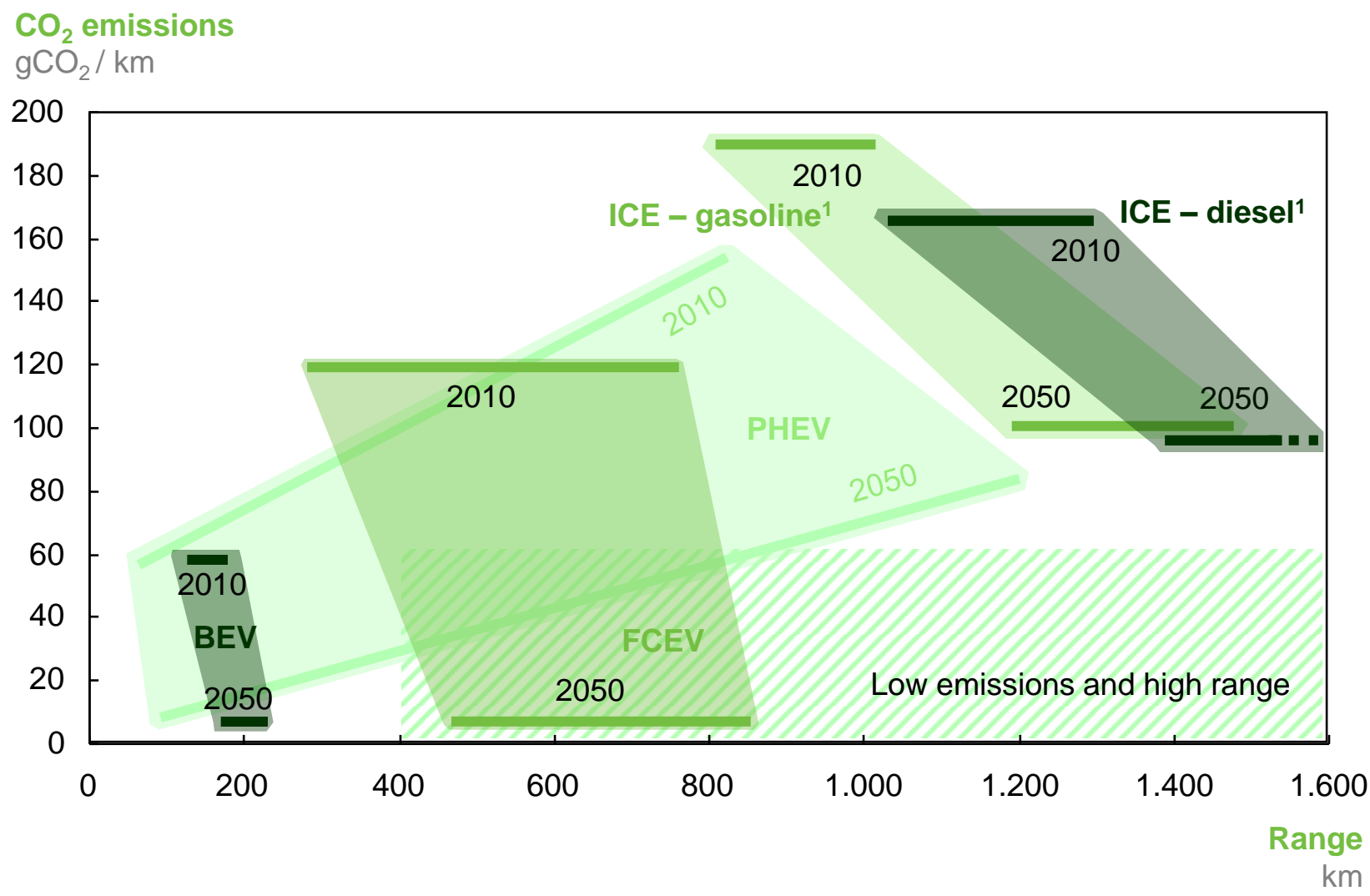


Publication: 8 November 2010

Available on <http://fch-ju.eu> 11


# Battery and fuel cell vehicles can achieve low emissions

C/D SEGMENT





# H2 Mobility in Germany



### H<sub>2</sub> Mobility Initiative

Leading industrial companies agree on an action plan for the construction of a hydrogen refuelling network in Germany

- Hydrogen refuelling network to grow to about 400 filling stations by 2023
- Precondition for the market success of fuel cell powered electric vehicles initiated
- Overall investment of around €350 million planned
- Development plan represents the benchmark at international level

Stuttgart, 30 September 2013 – The six partners in the "H<sub>2</sub> Mobility" Initiative – Air Liquide, Daimler, Linde, OMV, Shell and Total – have set up upon a specific action plan for the construction of a nationwide hydrogen refuelling network for fuel cell powered electric vehicles. By the year 2023 the current network of 15 filling stations in Germany's public hydrogen infrastructure shall be expanded to about 400 H<sub>2</sub> filling stations. As a first step the deployment of 100 hydrogen stations in Germany over the next 4 years is intended. This would ensure a need-related supply for fuel cell powered electric vehicles to be introduced into the market in the next years. An agreement in principle has been signed by representatives of all the partners involved.

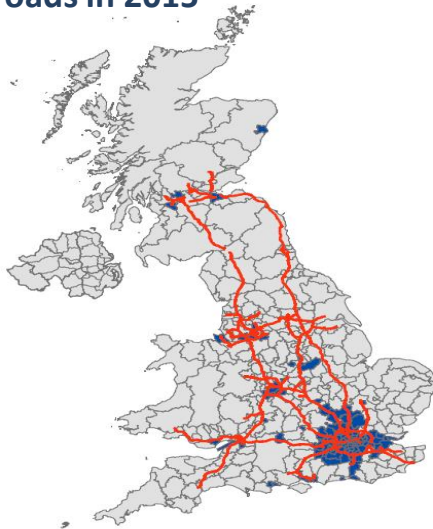
In addition to plans for a nationwide filling station network, the agreement includes the principles for the procurement and distribution of the necessary hydrogen and a request for support to the German Federal Government. Following the foundation of a joint venture (subject to necessary regulatory approvals), gradual expansion of the national filling station network will commence next year. This means that an H<sub>2</sub> supply suitable for everyday use shall be created not only for densely populated areas and main traffic arteries, but also for rural areas. The objective is to offer an H<sub>2</sub> station at least every 90 kilometres of motorway between densely populated areas. According to this plan in metropolitan areas, drivers of fuel cell powered vehicles will have at least 10 hydrogen refuelling stations available each from 2023. Thus, zero tailpipe emission H<sub>2</sub>-mobility is becoming increasingly attractive for customers. The "H<sub>2</sub> Mobility" initiative expects that a total investment of around €350 million will be required for this future-oriented infrastructure project.

The launch of fuel cell powered production vehicles on the German market has been announced by first manufacturers for 2015. In addition to attractive procurement and

- Initiative gathering the German government and 6 major industrial companies
- 400 hydrogen stations by 2023
- Investment of € 350 million
- Benchmark at international level



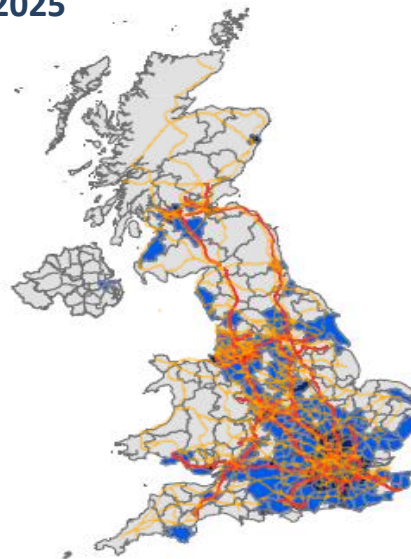
Seeding of Tier 1 regions<sup>1</sup> –  
major cities and connecting  
roads in 2015



~65

Initial seeding in **major population centres**

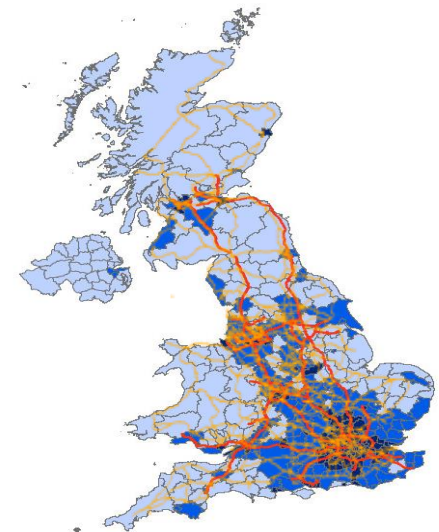
Coverage extended to Tier 2  
regions and all major roads  
<2025



~330

Extend coverage to enable  
close-to-home refuelling to **50% of the population** and long  
distance **travel**

Full population coverage by  
2030



~1,150

Extend close-to-home refuelling  
to the **whole of the UK**,  
including less populated regions

# of HRS

# Strong International Momentum



## Current state of initiatives



### H2Mobility Germany:

Recent announcement made - 350M€ for 400HRS by 2023



**H2 Mobilité:**  
Government and industry partners building common strategy



**UK H2Mobility:**  
Government and 11 companies developed common strategy  
**Business case** in development



**Danish Government** has announced an Energy Plan 2020 that includes a **range of initiatives** for hydrogen infrastructure and FCEVs, amongst which are significant incentives



**Government and 13 companies** announced program for FCEV mass production and **100 HRS** by 2015 **connecting** 4 metropolitan areas



**Government** announced program to finance and deploy **100,000 FCEV** and **170 HRS** by 2020



**Demo initiatives** in California and East Coast H<sub>2</sub> Highway; partially funded by DoE.  
New "**Clean Fuels Outlet**" regulation in California requiring deployment of HRS (to avoid penalties).  
California Fuel Cell Partnership announced roadmap to **rollout 68 stations by 2015**  
**H2USA** started



# Clean Power for Transport Package

- Proposal for Directive on the deployment of alternative fuels infrastructure

- Build a competitive and resource efficient transport system.
- Establish long term fuel strategy.
- Remove technical and regulatory barriers.
- Facilitate a single market for alternative fuels vehicles and vessels.

- Associated costs:

- Electricity = 8 M charging points = 8 B€
- LNG Waterborne = 139 refuelling points \* 15 M€ = 2,1 B€
- LNG trucks = 144 refuelling points \* 0.4 M€ = 58 M€
- CNG road = 654 refuelling points \* 0.25 M€ = 164 M€
- **Hydrogen = 77 refuelling stations \* 1.6 M€ = 123 M€**





# Fuel Cells and Hydrogen 2 Joint Undertaking

## 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, ...)

# Fuel Cells and Hydrogen 2 Joint Undertaking

## Budget :

Total : 1.33 B € = 665 M € (EC) + 665 M € (industry + research)

Administration : 2 \* 19 M €

7 calls : 2014 - 2020

Funding distribution	Research and Innovation		Innovation		Total	
Transports Systems	94 (±5)	14.5%	213 (±10)	33%	307	47.5%
Energy Systems	94 (±5)	14.5%	213 (±10)	33%	307	47.5%
Cross-cutting activities					32	5%
Total	192	29%	426	66%	646	100%

# Fuel Cells and Hydrogen 2 Joint Undertaking

## Particular objectives :

- **reduce the production cost** of fuel cell systems to be used in transport applications, while increasing their lifetime to levels competitive with conventional technologies,
- **increase the electrical efficiency** and the durability of the different fuel cells used for power production, while reducing costs, to levels competitive with conventional technologies,
- **increase the energy efficiency** of production of hydrogen mainly from water **electrolysis** and renewable sources while reducing operating and capital costs, so that the combined system of the hydrogen production and the conversion using the fuel cell system is competitive with the alternatives available in the marketplace,
- demonstrate on a large scale the feasibility of using hydrogen to support **integration of renewable energy sources** into the energy systems, including through its use as a competitive energy storage medium for electricity produced from renewable energy sources,
- reduce the use of the EU defined "**Critical raw materials**", for instance via low or platinum free resources and through recycling or reducing or avoiding the use of rare earth elements.

- Wednesday 12<sup>th</sup> November 2014
- The Hotel, Brussels, Belgium
- Open to all public; registration required.
- Program Review Days on 10 and 11 November
- More info shortly on our website





So, ...



So, ...

- **Proactive** safety management



So, ...

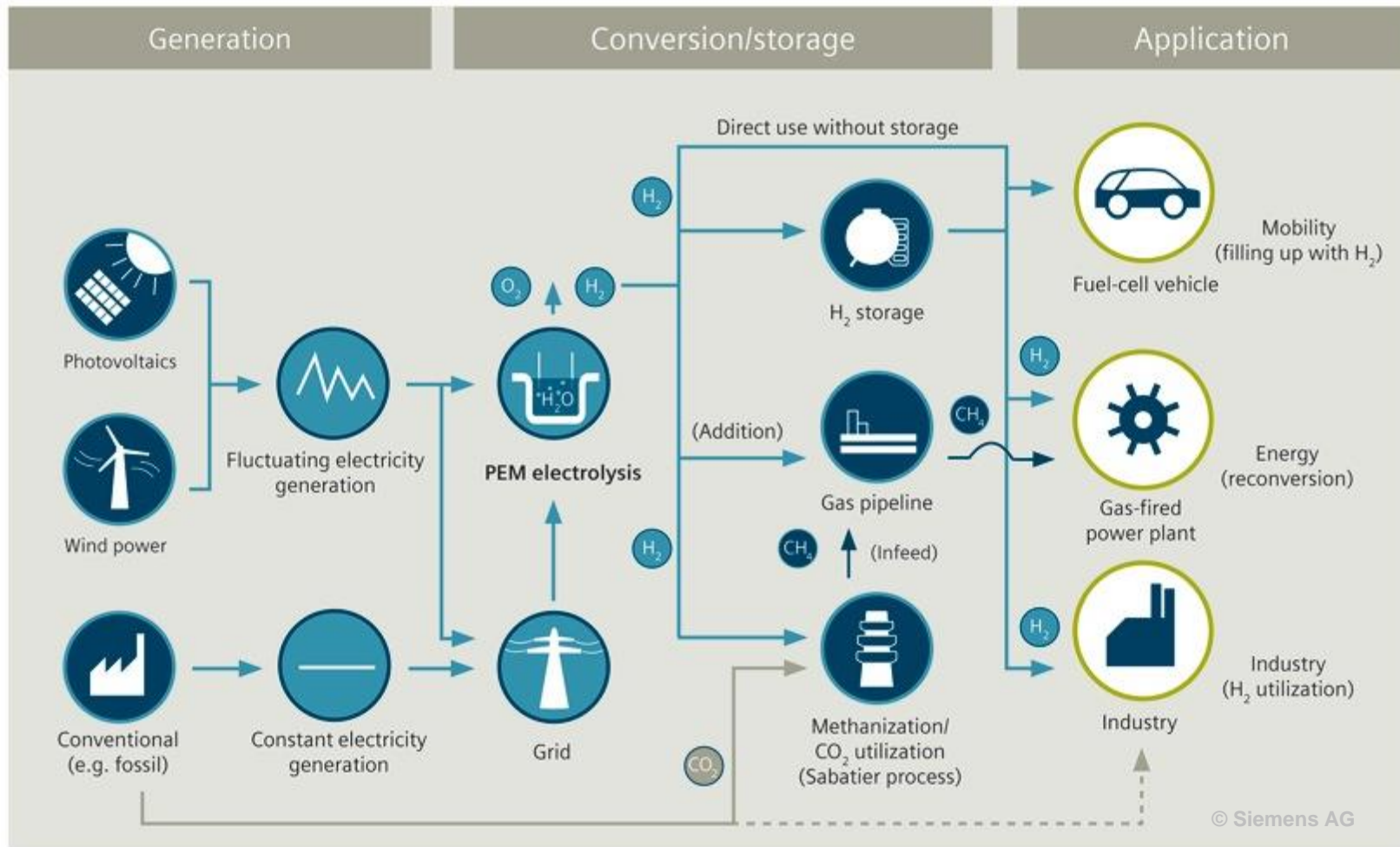
- **Proactive** safety management
- Work **together** and share knowledge

- **Proactive** safety management
- Work **together** and share knowledge
- Draw conclusions and **plan** the future



# Hydrogen as “smart link”

## Conversion of electrical into chemical power



Applications and examples of use of hydrogen electrolysis



# Thank you for your attention !

## Further info :

- FCH JU : <http://fch-ju.eu>
- NEW-IG : <http://www.fchindustry-jti.eu>
- N.ERGHY : <http://www.nerghy.eu>