FROM RESEARCH TO INDUSTRY

cea tech

liten

Outreach Event of the IEA Advanced Fuel Cell Implementing Agreement
April 23rd, 2015, Zurich, Switzerland

Advanced Fuel Cells
Implementing Agreement

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Federal Office of Energy SFOE

Fuel Cell Initiatives in Europe

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H_2 & FUEL CELLS: INTERNATIONAL MOMENTUM WORLWIDE

Current state of initiatives

H2Mobility Germany:
Recent announcement 400 HRS by 2023

H2 Mobilité: Government and industry partners building common strategy based on captive fleets + range extender

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

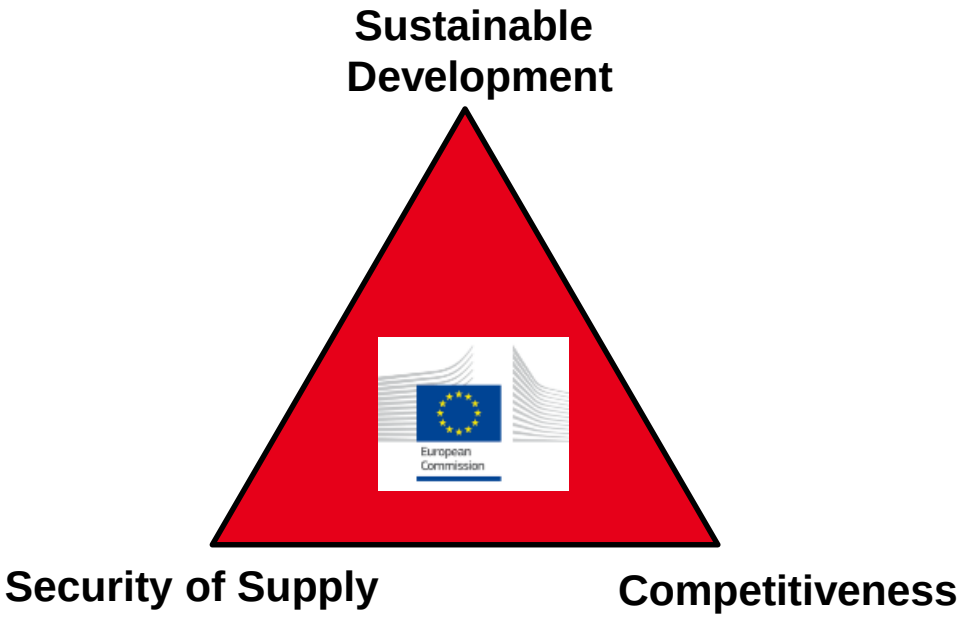
Danish Government has announced an Energy Plan 2020 that includes a range of initiatives for hydrogen infra-structure and FCEVs, amongst which are significant incentives

Government and 13 compa-nies announced program for FCEV mass production and 100 HRS by 2015 connecting 4 metropolitan areas. Toyota will put their car on JP, US and Eu markets in 2015

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

Demo initiatives in California and East Coast H_2 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

European Climate and Energy Policy Framework



From
The 20-20-20 goals by 2020

- 20% increase in renewables
- 20% increase in efficiency
- 20% decrease in GHG *emissions*

To
The EU targets by 2030*

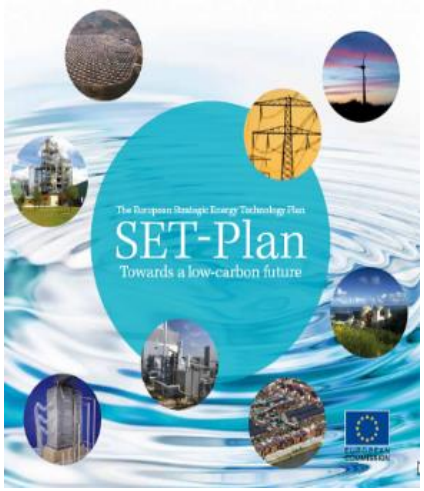
- 27% renewable energy
- 27% improvement of energy efficiency
- 40% reduction in GHG emissions

****European Council conclusions of 23/10/2014***

The European Strategic Energy Technology-Plan (SET-Plan)

Europe has a strategic Energy Technology plan towards a low-carbon future

- H2020
- 10 Years
- 2014-2020
- 79 Billion €



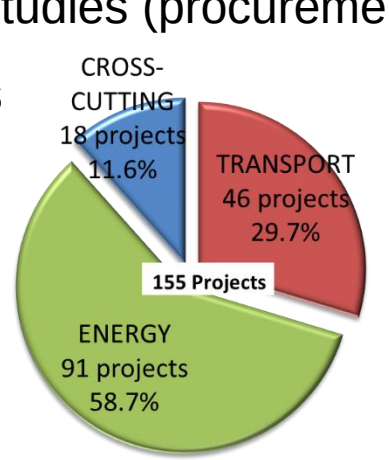
FCH-JU is a Public-Private Partnership

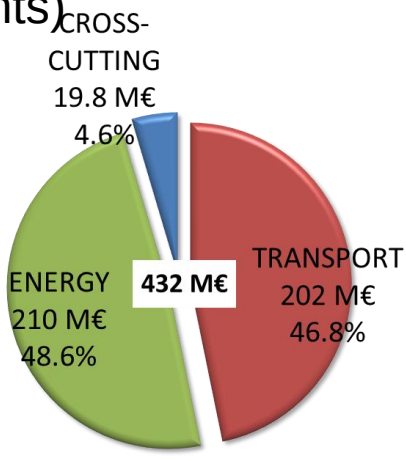
Industry Grouping
NEW-IG
80 members

European Union represented by the European Commission

Research Grouping
N.ERGHY
59 members

- FCH-JU Phase 1 (2008 to 2013) budget 940 M€
- Annual Calls for proposal – 342 enterprises, 73 research organizations, 94 Universities
- 5 Activity Areas (Transport, Hydrogen production, Stationary power generation, Early markets, Cross-cutting) + Studies (procurements)
- 155 projects funded in 2009-2013 + 7 studies

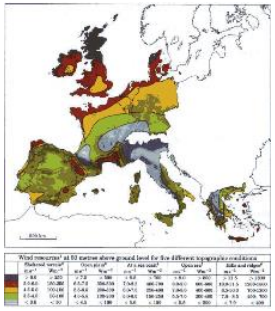


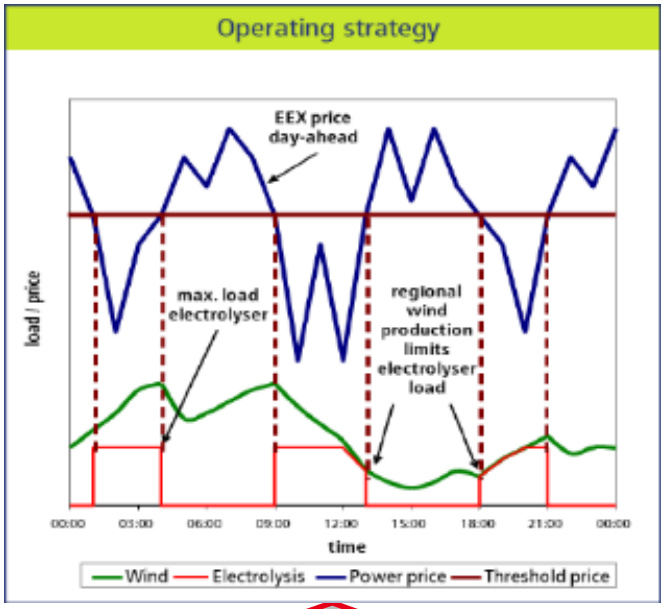


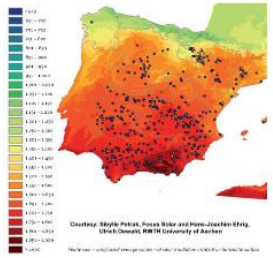
Energy pillar

Hydrogen is an energy vector not a primary energy

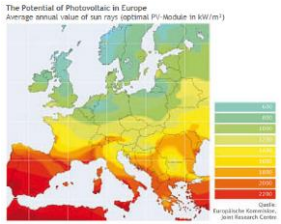
Wind turbines in Danemark







Photovoltaics in Spain



Water electrolysis

- High power (MW-GW)
- Coupling with intermittent energies

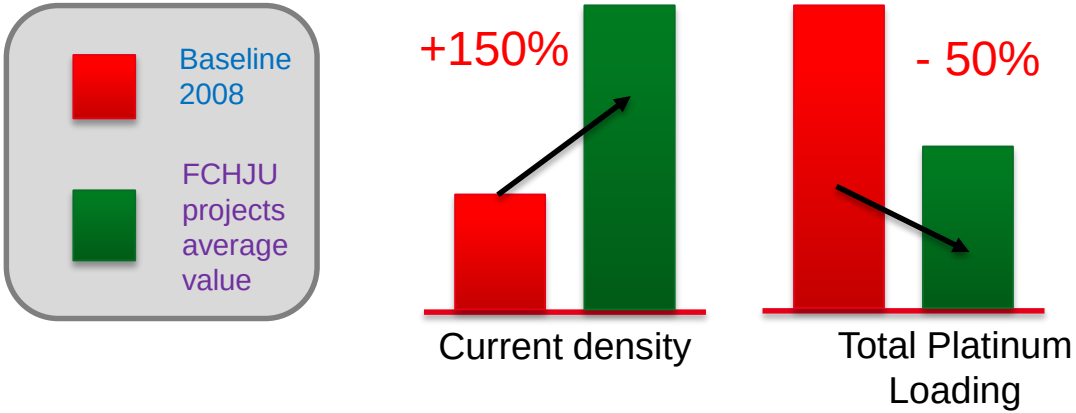
Hydrogen storage

- Underground storage
- Solid state storage

TO INCREASE THE EUROPEAN ENERGY SECURITY OF SUPPLY (20% INCREASE IN RENEWABLES) (2)

Energy pillar

PEM Electrolysers



- Demonstration of high power electrolysers coupled to renewable primary energies
- Demonstration of integrated systems
- Demonstration of hydrogen production through concentrated solar energy
- Hydrogen Underground storage

TO REDUCE EUROPEAN ENERGY CONSUMPTION BY 20%

Energy pillar

SOFT-PACT

ene.field

CLEARgen™Demo

POWER-UP

ELYGRID

Improvements to Integrate High Pressure Alkaline Electrolysers for Electricity/H2 production from Renewable Energies to Balance the Grid

fitup

FCpoweredRBS

Research

100 micro-CHP units (1 manufacturer, 4 countries)

1000 micro-CHP units (9 manufacturers, 12 countries)

1 MW industrial CHP unit /PEM based (in Europe – place tbc)

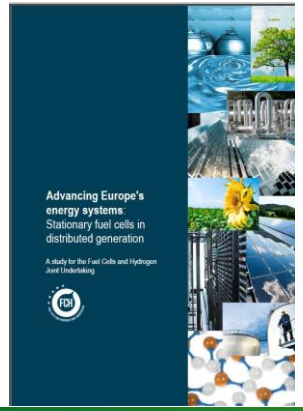
500 kW industrial CHP unit/alkaline based (in Germany)

1 MW alkaline electrolyser (coupled with wind energy, in Spain)

19 back-up and UPS units (3 countries)

18 live Radio stations (off-grid) in Italy

2010 2013 2016



Different climates/technologies/routes-to-market

Increased volumes

Cost reduction/Increased durability

Research

http://www.fch.europa.eu/studies/advancing-europes-energy-systems-stationary-fuel-cells-distributed-generation

Energy pillar

Achievements in m-CHP early-demonstration

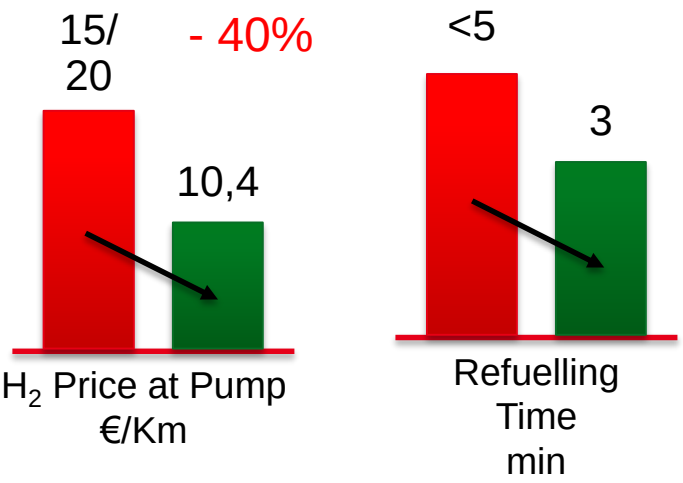
- More than 60 BlueGen units in DE, UK, NL
  - 56% electrical efficiency, 25% reduction of CAPEX
- More than 120 units in DE, FR, CH, IT, DK, AT
  - 10 field trials/manufacturers
  - Commercial discussions on-going (more than other 200 contracts signed and other 200 in final negotiation) – ramping-up of additional 500 units by Sept 2015
  - Electrical efficiency around 35% for PEM units and 45-50% for SOFC units

- **Challenges**
  - Difficulties for new markets (exception DE where Callux project has already built the acceptance)
  - Reduced interest of utilities (mainly electricity), although main route to the market – direct contracts with end-users less suitable for mass-deployment !
  - Only ≈1/3 of the end-users/houses contacted meet the required conditions for m-CHP installation
  - Small quantity supply chain, need for training of installers etc

TO REDUCE GREEN HOUSE GAS (GHG) EMISSIONS IN EUROPE

Transport pillar

HRS for cars



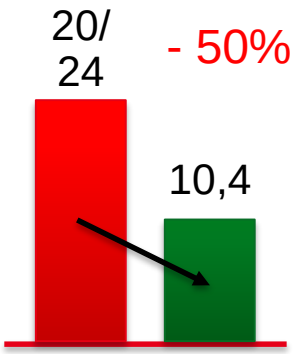
Baseline 2008

FCHJU projects average value

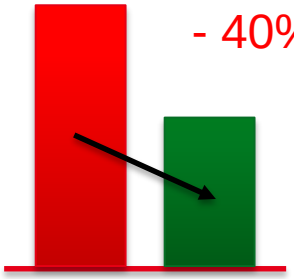
- Demonstration of > 260 hydrogen cars
- Installation of > 20 hydrogen refueling stations
- Demonstration of > 74 hydrogen buses
- Demonstration of > 400 hydrogen materials handling vehicles
- Demonstration of APUs for trucks, planes and maritime applications

TO REDUCE GREEN HOUSE GAS (GHG) EMISSIONS IN EUROPE

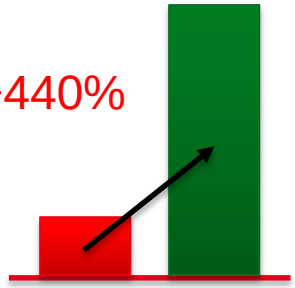
BUSES



Fuel Consumption Kg/100 Km

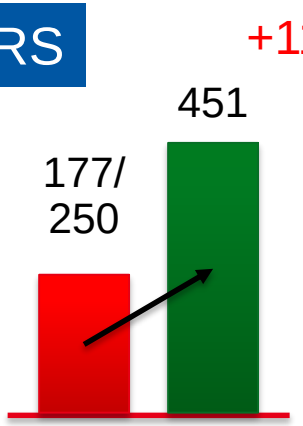


Vehicule Cost

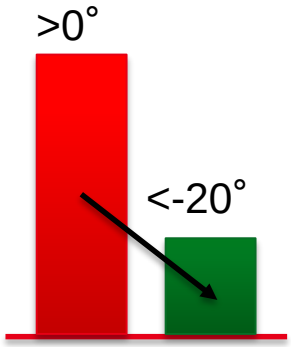


FC bus System Lifetime

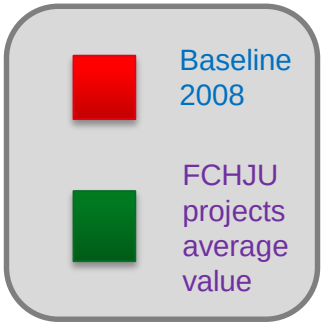
CARS



Range Km

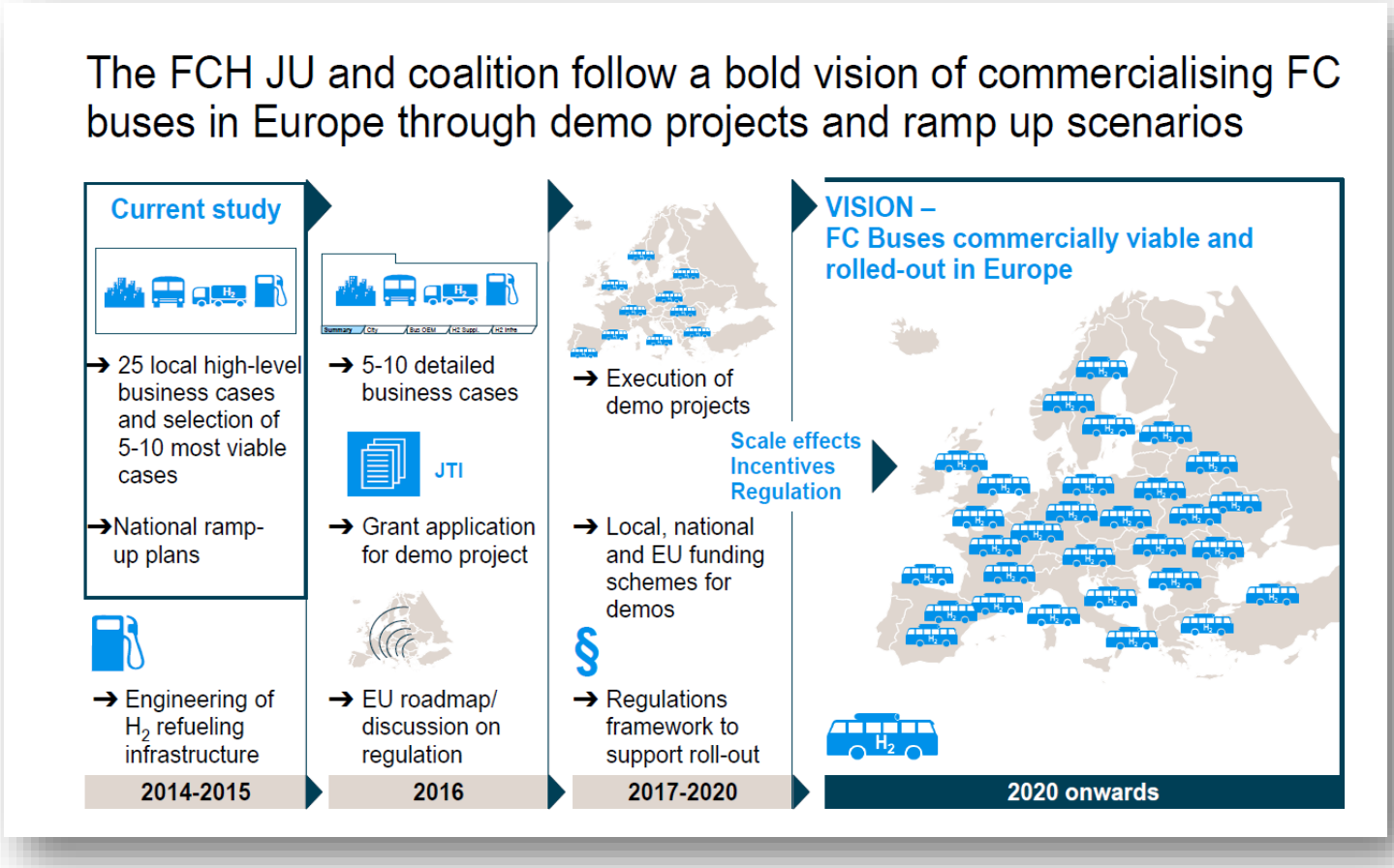


Cold Start Temperature ° C



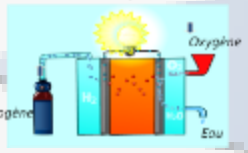
Example of Hamburg, Germany:

- As of 2020, only zero emission buses are purchased
- 6 FC Buses in operation
- 4 hydrogen refuelling stations realised, another one in planning



Achievements - Usages

The scope of applications is widening with time



1995 2000 2005 2010 2015 2020

Backup power

Marine & aerospace

Large scale stationary applications

Forklifts

Energy storage

Hybrid FC Buses

CHP Systems

FCEV

FCEV RE

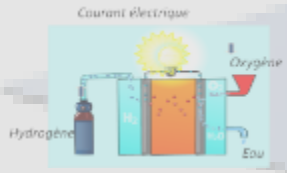
FC in commercial planes

Portable applications

Achievements - Markets

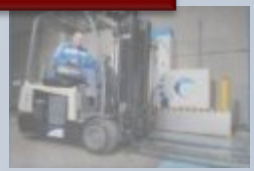
The scope of applications is widening with time

and market deployments have started



Marine & aerospace

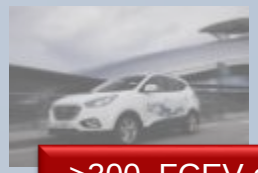
50 forklifts in in Europe



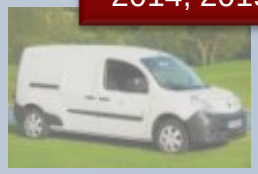
Forklifts

Over 50 buses on the roads

Hybrid FC Buses



>300 FCEV on the roads, launch of market series in 2014, 2015 & 2016



FCEV RE

FC in mmercial planes

1995 2000 2005 2010 2015 2020

Backup power

> 40 backup solutions in Europe

Large scale stationary applications

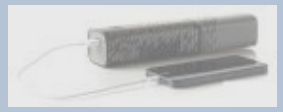
800 CHP in operation in Europe

CHP Systems

300 operational HRS

Energy storage

Several projects on-going



Portable applications

FCH 2 JU under Horizon 2020

Two key activity pillars

TRANSPORT

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

ENERGY

- Fuel cells for power and combined heat & power generation
- Hydrogen production and distribution
- Hydrogen for renewable energy generation (incl. blending in natural gas grid)

CROSS-CUTTING ISSUES

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

Strategic objective

By 2020, fuel cell and hydrogen technologies will be demonstrated as one of the pillars of future European energy and transport systems, making a valued contribution to the transformation to a low carbon economy by 2050.

Budget of €1.33 billion in 2014 - 2020

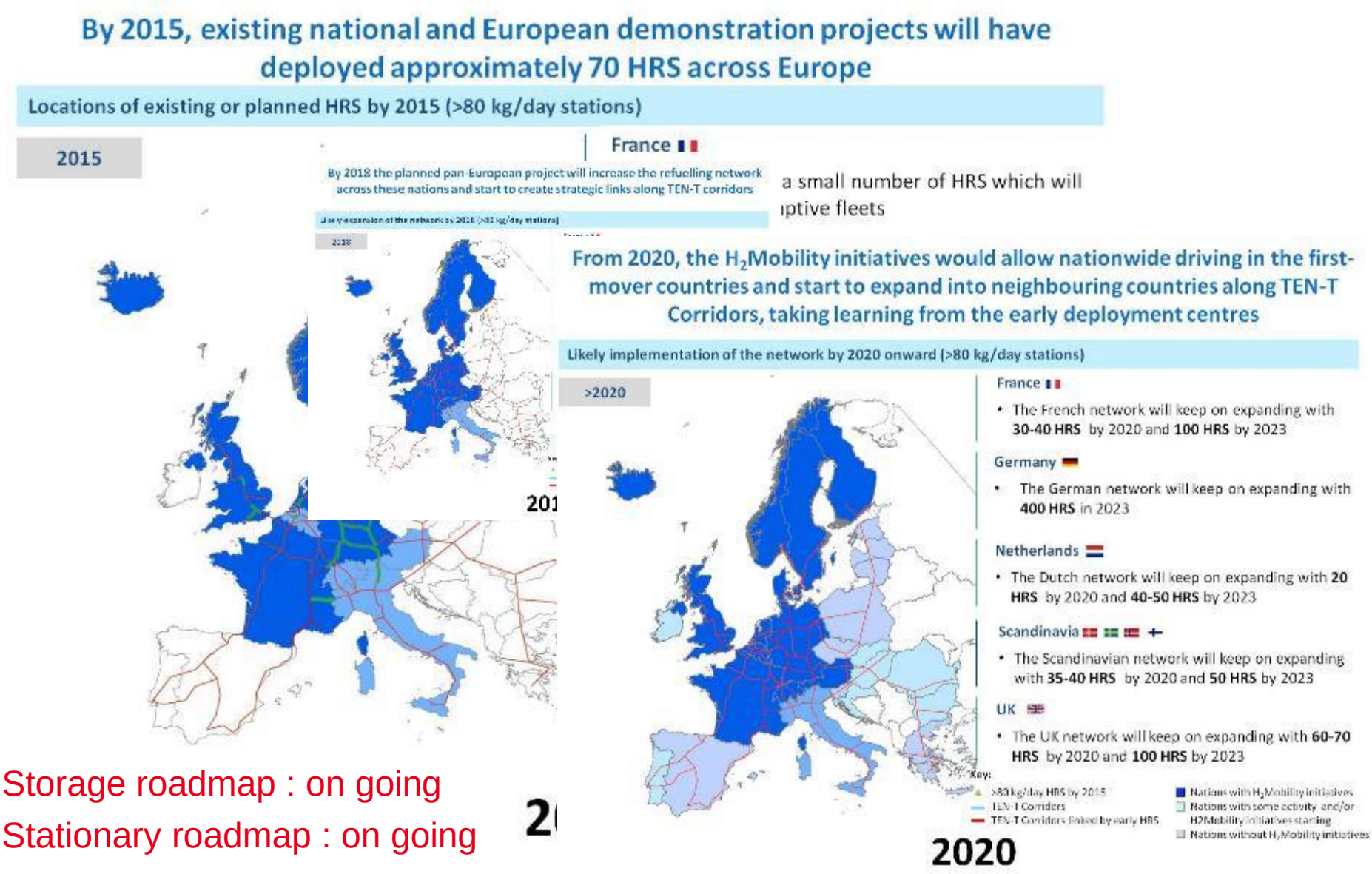
Strong industry commitment to contribute inside the programme + through additional investment outside, supporting joint objectives.

Adopted by the Commission on 10 July 2013

FCH 2 JU under Horizon 2020

- Emphasis on storage of hydrogen for integration of renewable primary energies
- More demonstration and market uptake (66%) with clear strategy and ramp-up plans
- Lower costs with higher efficiences and durability, safety
- Coherent Hydrogen infrastructure and Vehicle deployment
- Increased Cooperation with National and Regional Initiatives

NEW-IG European Roadmap for deployment of FCEVs



- Storage roadmap : on going
- Stationary roadmap : on going

COMPLEMENTARY APPROACHES TO ACCELERATE THE MARKET

Coherent Hydrogen infrastructure and Vehicle deployment

- ✓ Fleets & HRS deployments – towards a low-cost hydrogen distribution network
- ✓ Utility vehicles in urban environments: Zero emissons/Zero CO_2 are a necessity

Mobilité Hydrogène France

Today first Evs & Hybrid

TWO PATHS FOR THE FUTURE

- ✓ Consumer Market PHEV (Electric + Fossil) with a move towards electrification

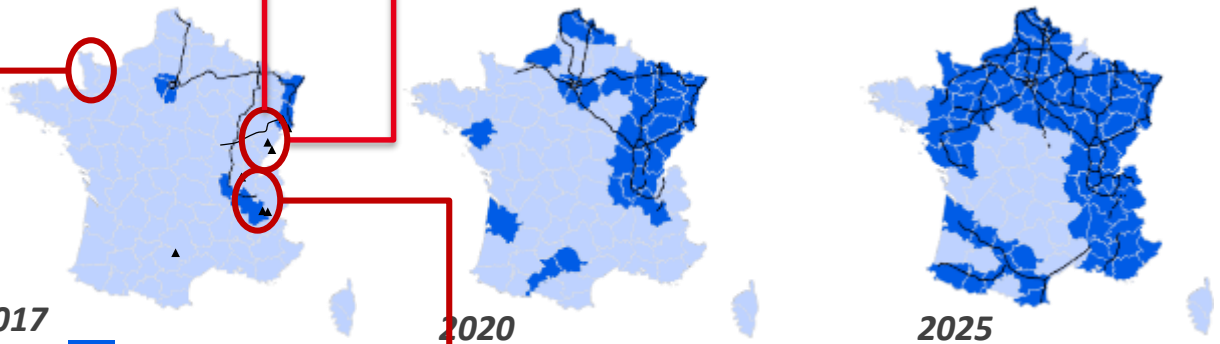
FUTURE PATHS

2020-2025 ?

Full power H_2 private cars

Nationwide H_2 refilling stations

"H_2 MOBILITY FRANCE" INITIATIVE WITH RANGE EXTENDER FLEETS



2014-15: first deployments
≈100 RE-FCEV end 2015

INCREASED COOPERATION WITH NATIONAL AND REGIONAL INITIATIVES

Bundesministerium für Wirtschaft und Energie

RÉPUBLIQUE FRANÇAISE

MINISTÈRE DE L'ÉCONOMIE, DE L'INDUSTRIE ET DU NUMÉRIQUE

Conseil des ministres franco-allemand, 31 mars 2015

Déclaration commune sur l'intégration économique

Une initiative commune sur la mobilité à l'hydrogène devrait aussi être lancée, couvrant à la fois le déploiement de projets public-privé de véhicules à piles à combustible et la création d'infrastructures pour l'hydrogène. Dans ce cadre, la mobilité transfrontalière devrait être encouragée en vue d'un déploiement commercial de masse. Les possibilités de financements européens (programme Entreprise commune PCH, RTE-T) devraient aussi être mobilisées.

Es sollte auch eine gemeinsame Initiative im Bereich der Wasserstoffmobilität ergriffen werden, in deren Rahmen sowohl öffentlich-private Projekte für Kraftfahrzeuge mit Brennstoffzellen durchgeführt werden, als auch eine entsprechende Wasserstoffinfrastruktur aufgebaut wird. In diesem Zusammenhang sollte die grenzübergreifende Mobilität gestärkt werden, um einen Einsatz auf dem Massenmarkt vorzubereiten. Europäische Finanzierungsmöglichkeiten (FCH JU Programm, Ten-T) sollten in Kombination genutzt werden.

Sigmar GABRIEL
Vizekanzler und Bundesminister für Wirtschaft und Energie der Bundesrepublik Deutschland

Emmanuel MACRON
Minister für Wirtschaft, Industrie und Digitales
der Französischen Republik

Hydrogen refuelling station from Total in Heidestrasse, Berlin

Conclusions

- Hydrogen & Fuel Cells are fully part in the European strategic energy technology plan towards a low-carbon future
- Significant technological, usage and market achievements through FCH-1 JU
- Emphasis on storage of hydrogen for integration of renewable energy sources
- More demonstration and market uptake (2/3) with clear strategy and ramp-up plans
- Coherent Hydrogen infrastructure and vehicle deployment by using complementary approaches
- Increased Cooperation with National and Regional Initiatives

Thank you for your attention !

Further info :

- **FCH JU : http://fch-ju.eu**
- **NEW-IG : http://www.new-ig.eu**
- **N.ERGHY : http://www.nerghy.eu**