Towards commercial deployment plans

Bert De Colvenaer,
FCH JU Executive Director

Fuel Cell & Hydrogen technologies can contributes 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

EC targets	By 2020	By 2030 *
Increase of renewables	20 %	27 %
Increase of efficiency	20 %	27 %
Decrease of GHG	20 %	40 %

*European Council conclusions of 23/10/2014

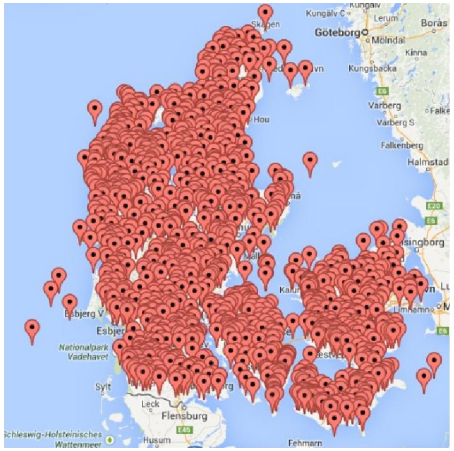
Energy Security

- Increase independence from unstable outside regions

Competitiveness

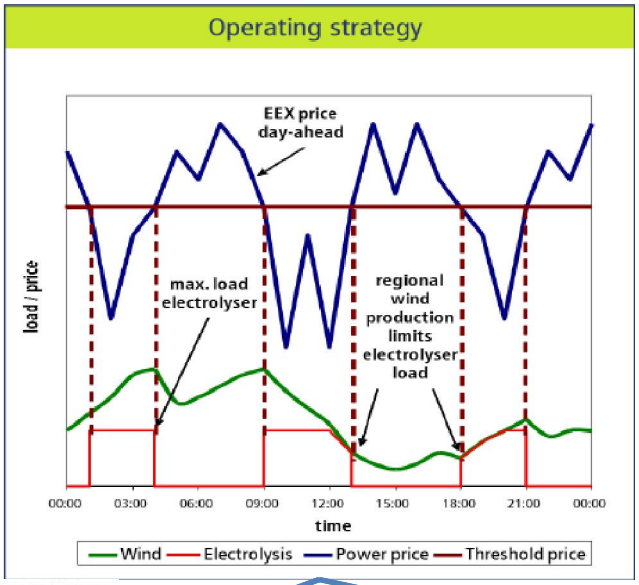
- research excellence leading to industry innovation and growth

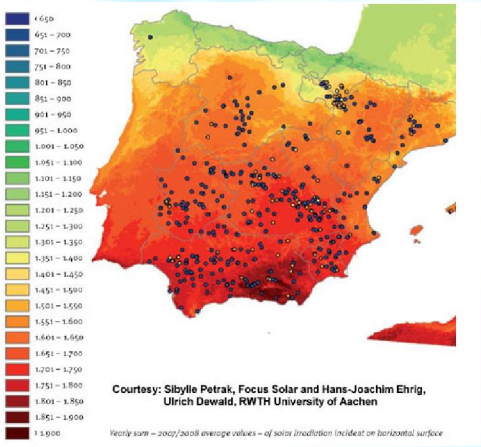
… increase of renewables



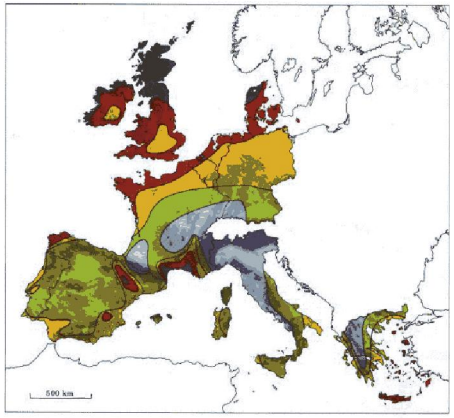
Wind turbines in Danemark

Hydrogen is an energy vector not an energy source





Photovoltaics in Spain



Wind resources[1] at 50 metres above ground level for five different topographic conditions

	Sheltered terrain[2]		Open plain[3]		At a sea coast[4]		Open sea[5]		Hills and ridges[6]	
	m s⁻¹	W m⁻²	m s⁻¹	W m⁻²	m s⁻¹	W m⁻²	m s⁻¹	W m⁻²	m s⁻¹	W m⁻²
	> 6.0	> 250	> 7.5	> 500	> 8.5	> 700	> 9.0	> 800	> 11.5	> 1800
	5.0-6.0	150-250	6.5-7.5	300-500	7.0-8.5	400-700	8.0-9.0	600-800	10.0-11.5	1200-1800
	4.5-5.0	100-150	5.5-6.5	200-300	6.0-7.5	250-400	7.0-8.0	400-600	8.5-10.0	700-1200
	3.5-4.5	50-100	4.5-5.5	100-200	5.0-6.0	150-250	5.5-7.0	200-400	7.0- 8.5	400- 700
	< 3.5	< 50	< 4.5	< 100	< 5.0	< 150	< 5.5	< 200	< 7.0	< 400

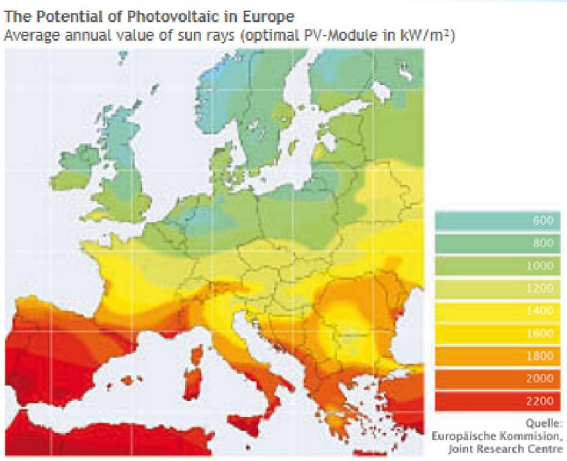
ludwig bölkow systemtechnik

Water electrolysis

- High power (MW-GW)
- Coupling with intermittent energy sources

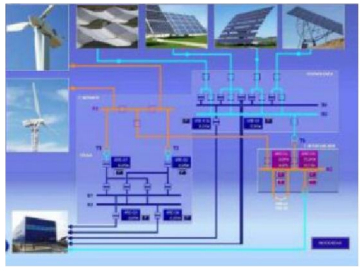
Hydrogen storage

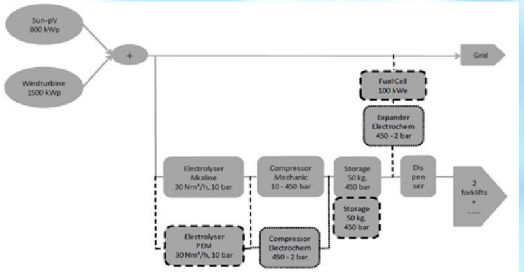
- Underground storage
- Solid state storage

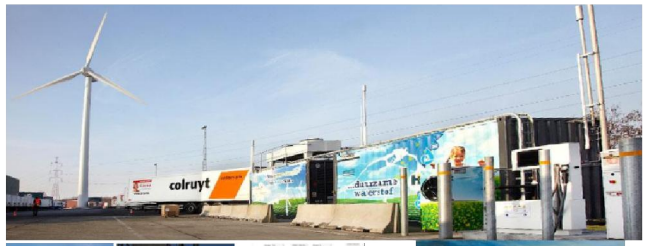


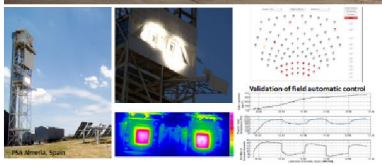
Hydrogen production and storage in FCH 1 JU

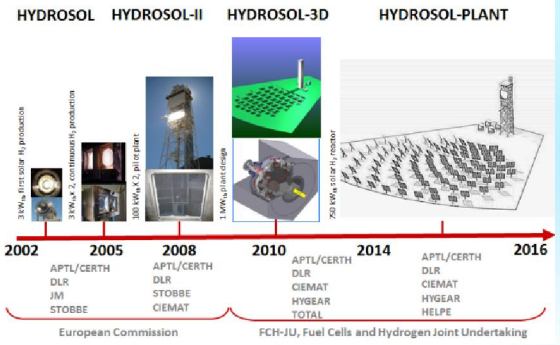
- Demonstration of high power electrolysers coupled to renewable energy sources
- Demonstration of integrated systems
- Demonstration of hydrogen production through concentrated solar energy
- Hydrogen Underground storage

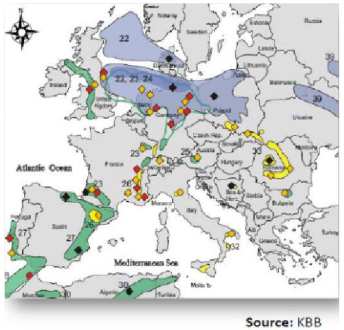




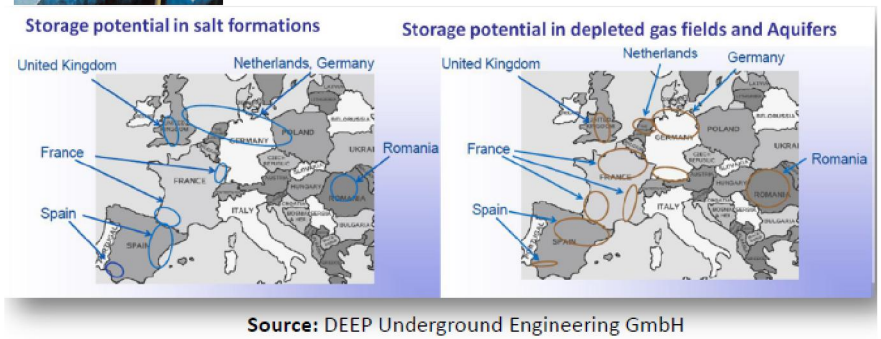








Source: KBB



Source: DEEP Underground Engineering GmbH

Stationary FC applications in FCH 1 JU

- 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

Transport in FCH 1 JU

- 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

H2moves.eu SCANDINAVIA

HYTEC

SWARM

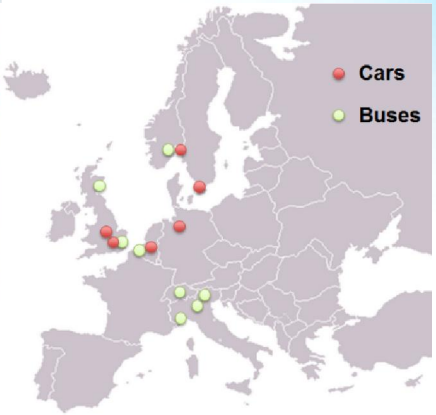
HyFIVE

CHIC

HIGHVLOCITY

HyTransit

3EMotion



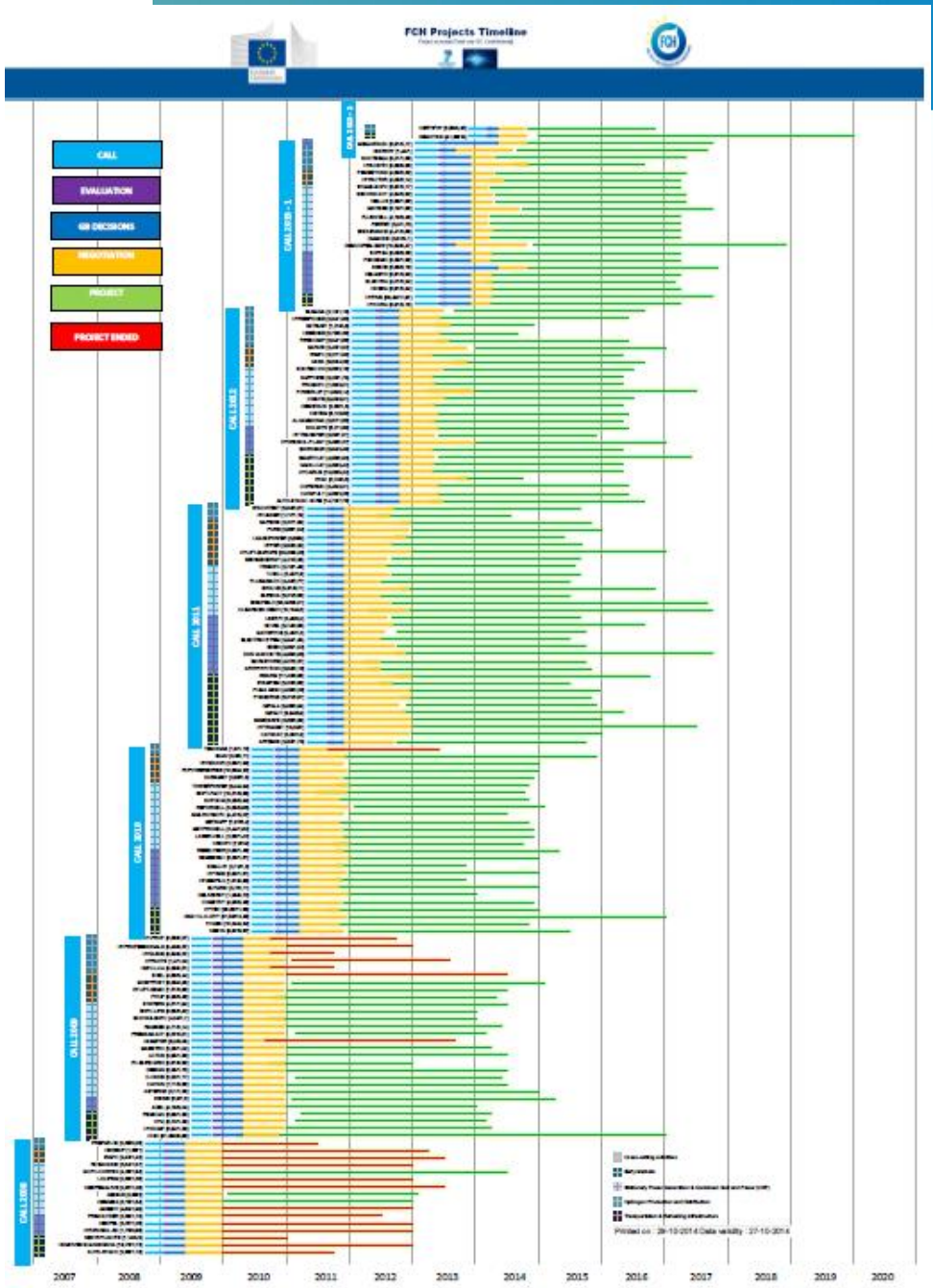
HYPER

HyLIFT Clean Efficient Power For Materials Handling

SAPIENS

pure

FCH 1 JU



- **155 R&D D** projects financed
- over **7** calls for proposal
- covering **5** application area's
- total value of **900 M €**
- with **545** participants of which
  - **192 industries** (35%)
  - **154 SMEs (28%)**
  - **149 research** organisations (27%)
  - 20 higher education (4%)
  - 30 other (6%)
- international cooperation outside EC
- **Mature European FCH community :**
  - Strong, visible and coherent
  - Consensus strategy (MAIP/AIP)
  - Pre-competitive collaboration

FCH 1 JU with 22 EU member states

- 22 EU MS represented
- Missing:
  - Ireland
  - Latvia
  - Slovakia
  - Malta
  - Cyprus
  - Luxemburg

Non EU MS beneficiaries:
CH, NO, IL, TR, IS, RS, CN, RU US

FCH 2 JU

1. Budget (EC contribution) :

budget : 665 M €

administration : 19 M €

7 calls : 2014 – 2020

+ IG additional acitivities

2. Funding rates :

	Direct cost	Indirect cost flat rate of direct cost
R&I	100 %	25 %
I	70 %	17,5 %

3. Funding distribution :

	Research and Innovation	Innovation	Total
Transport	94 (±5)	213 (±10)	307
Energy	94 (±5)	213 (±10)	307
Cross-Cutting			32 (5%)
Total (in M€)	192 (29%)	426 (66%)	646

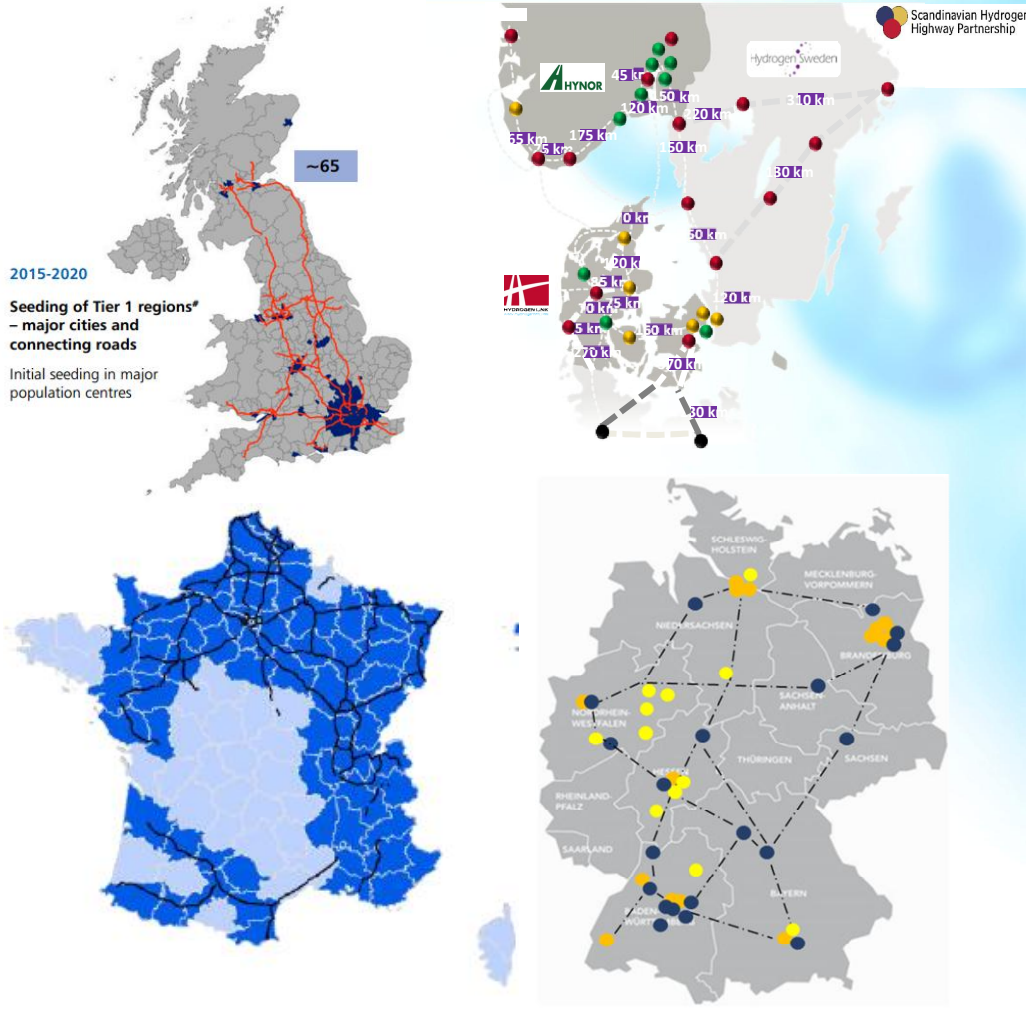
4. Objectives (transport & energy)

- reduce the (production) cost
- increasing the lifetime
- increase the efficiency
- demonstrate (large scale) hydrogen as RES integration and energy storage medium
- reduce 'Critical raw materials'

FCH cars and HRS

Advanced FCEV and HRS programs

- **France** – a large private consortium has agreed a strategy based on a transition from captive fleets to nationwide infrastructure for FCEVs.
- **Germany** –
  - 50 H2 stations by end of 2015 under the Clean Energy Partnership. Government and industry invest jointly over 40 M€.
  - the H2Mobility project has already signed a "term sheet" linking six industrial players to deploy 100 stations by 2017 and 400 by 2023 for 350 M€.
- **Scandinavia** – An initial network provides coverage for FCEVs, which can be purchased at equivalent ownership cost.
- **UK** – a consortium with significant Government presence has agreed a strategy based on seeding a national network of 65 stations by 2020. 7.5M£ have been committed by the Government for 15 HRS by 2015.



Similar initiatives are starting or running in other countries: **Austria , Belgium, Finland**, **Netherlands** (plan to be published before the end of 2014), **Switzerland**.

FCEV developments for Europe





HYUNDAI TOYOTA HONDA Mercedes-Benz BMW


Symbio FCell

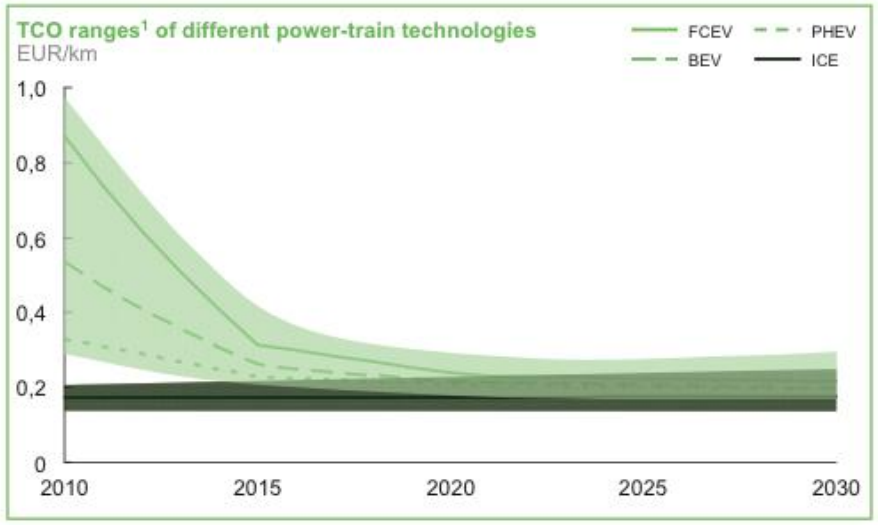
Intelligent Energy

POWERCELL

LA 18/11/2014

The product is ready for the market, get the market ready for the product

FCH cars and HRS



EU HRS infrastructure by 2020

•250[1] units at 1M€/unit & 0,1M€/Y

FCEV in EU by 2020

•100.000 cars at 50.000 €/car

•Current price : 65.000 € – 100.000 €

[1] Numbers are indicative and based on public statements from each initiative

possible FCH JU funding for EU HRS infrastructure :

•75 HRS at 70 % + 2 year opex : 60 M€

•remaining 175 HRS by CEP, CEF, national governments (ref CPT)

possible FCH JU funding for FCEV :

•estimated 2000 cars at 70 % with max (FCEV at 500 €/kW and FCEV RE[2] at 2000 €/kW) : 60 M€

•remaining 98.000 FCEV ?

[2] Range Extender

FCH Busses

Current study

- Local high-level cost analyses
- Mobilisation of interested locations
- Preparation joint procurement

- Engineering of H_2 refueling infrastructure

2014-2015

- Detailed cost analyses

JTI

- Grant application for demo project

- EU roadmap/ discussion on regulation

2016

- Execution of demo projects
- Local, national and EU funding schemes for demos

§

- Regulations framework to support roll-out

2017-2020

VISION – FC electric buses commercially viable and rolled-out in Europe

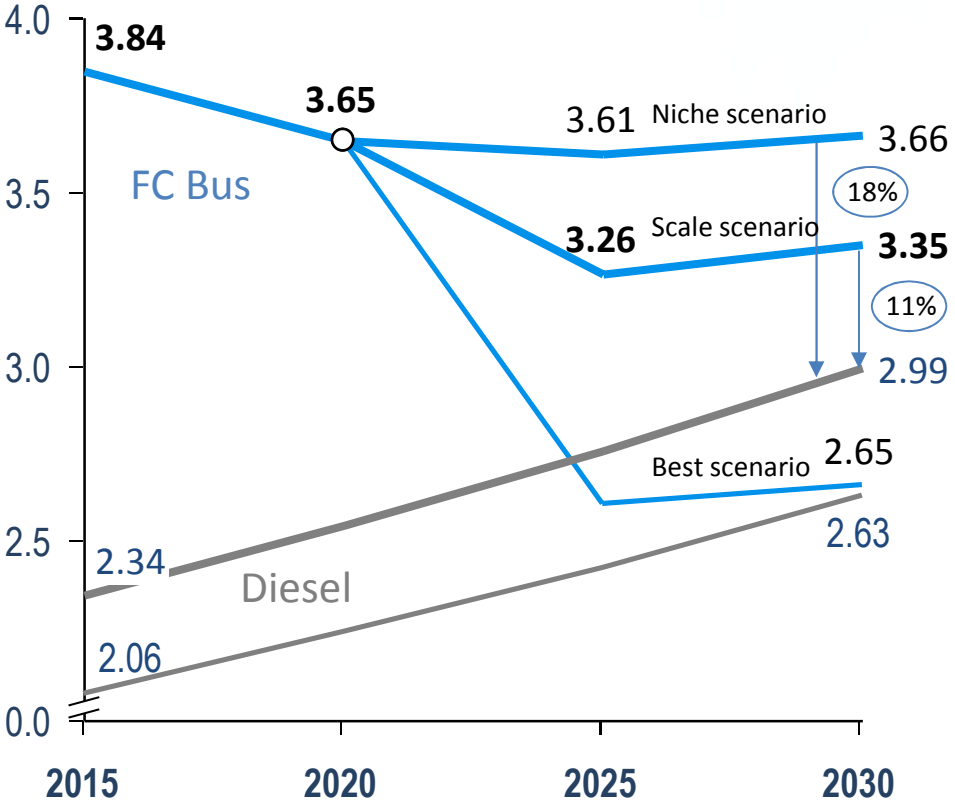
Scale effects
Incentives
Regulation

2020 onwards

FCH Busses

FC bus deployment costs analysis indicates financing gap/cost premium

Total Servicing Cost development scenarios (EUR/km)



1,500 FC buses until 2025

8.000 - 10,000 FC buses until 2025

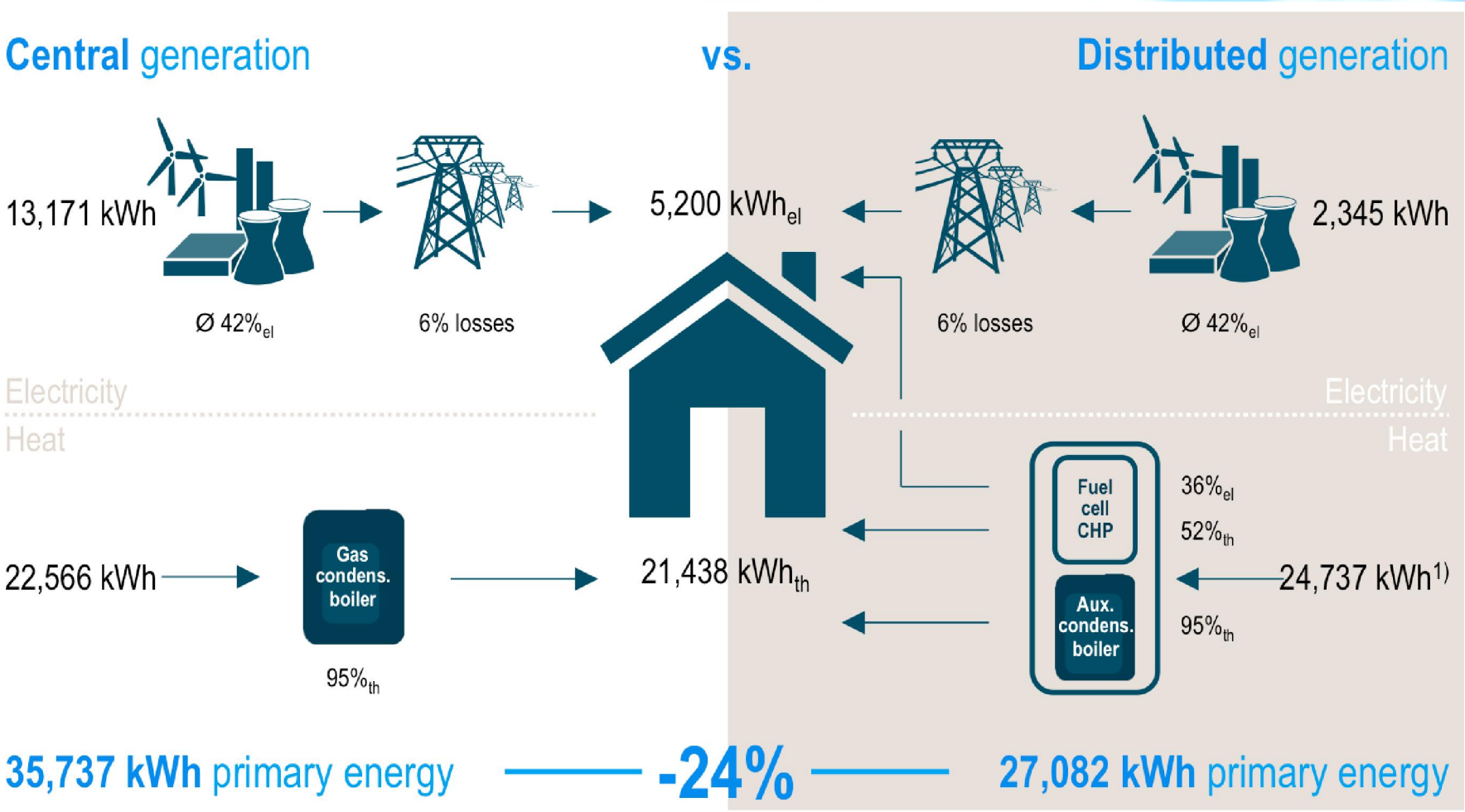
Best case scenario : Lower hydrogen and financing costs and increased FC bus lifetime assumed

- > Deploying more buses earlier will support scale effects and cost reduction
- > More locations as first-movers need to be mobilized
- > TSC gap to the diesel bus expected to decrease to 11%, but can remain higher
- > Synergies with fuel cell passenger car industry offer further significant cost reduction potential (not depicted here)

TSC = Total Servicing Cost: TCO plus diesel bus replacement cost due to lower availability of FC buses

µ-CHP

Typically, distributed CHP is more efficient than central generation due to superior technologies and avoidance of transmission losses



1) Exemplary case of a German, partially renovated 1/2-family dwelling 2) Net gas consumption after crediting the primary energy equivalent of power feed-in from CHP

To become economically competitive however, capital costs must be reduced substantially by increasing production volumes

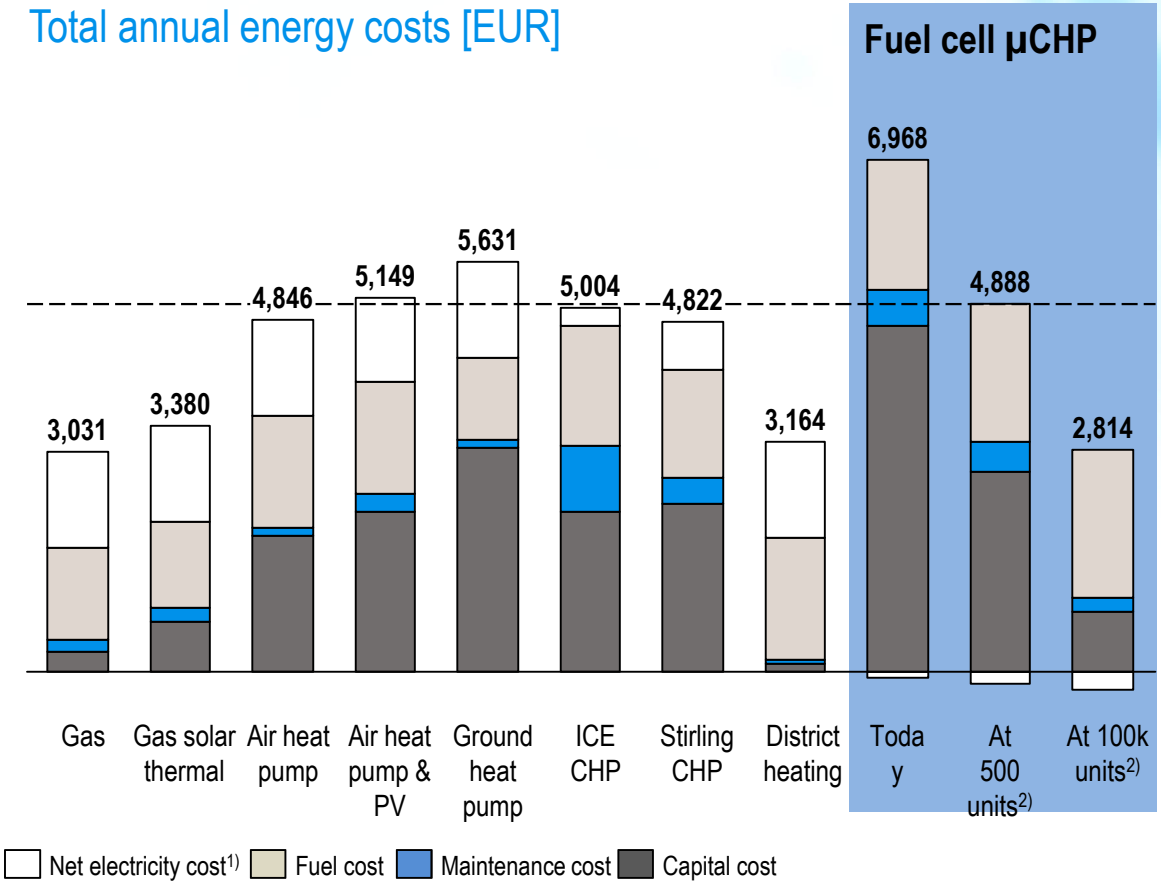
Use-case specific economic benchmarking

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]



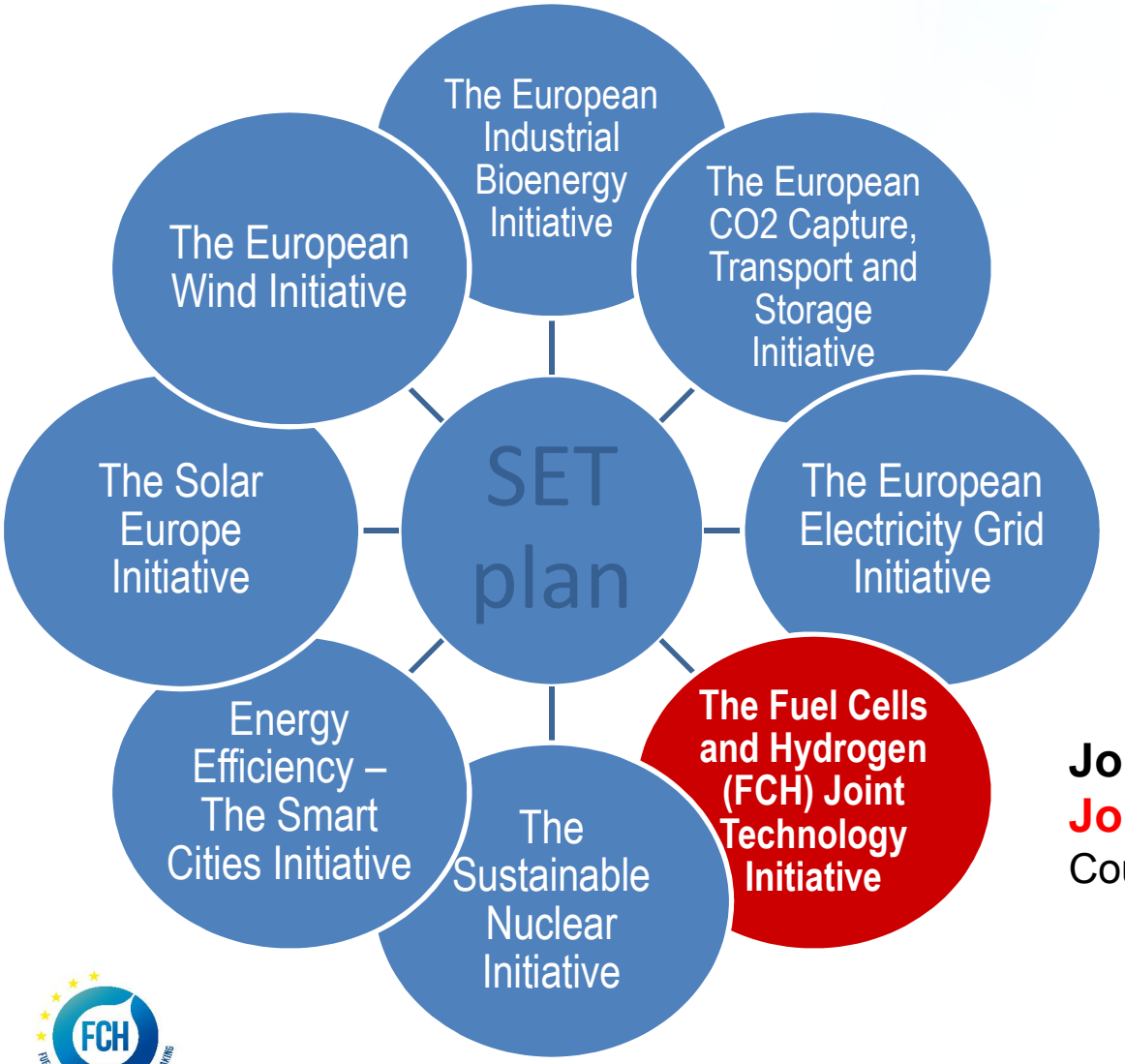
1) Negative electricity cost reflect higher earnings from power feed-in than residual purchase of grid power. 2) Cumulative production volume per supplier.

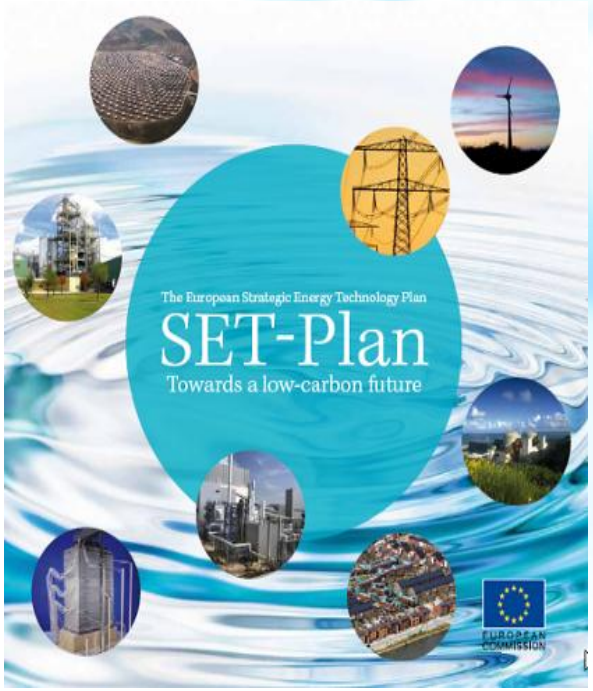
Conclusions 1/2

Next to FCH Research and Innovation activities on Energy and Transport and cross cutting activities, FCH 2 JU will help

- to realise FCH **cost reduction** through initial deployment
- for FCH applications for **cars**, **HRS**, **busses** and **µ-CHP**
- with a mandate to search for **co-financing** :
  - European Structural & Investment Funds, …
  - Smart Specialisation (05/02/15)
  - Financial Engineering

Strategic Energy Technology Plan 2/2





Joint Technology Initiative →
Joint Undertaking
Council Regulations:
521/2008 of 30 May 2008 **(FP7)**
1183/2011 of 14 Nov 2011
559/2014 of 6 May 2014 **(H2020)**

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**