Powertrains for Sustainable Transport Systems: Current Status and Perspectives of Fuel Cells & Hydrogen Technologies

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Chair of the FCH2JU Scientific Committee

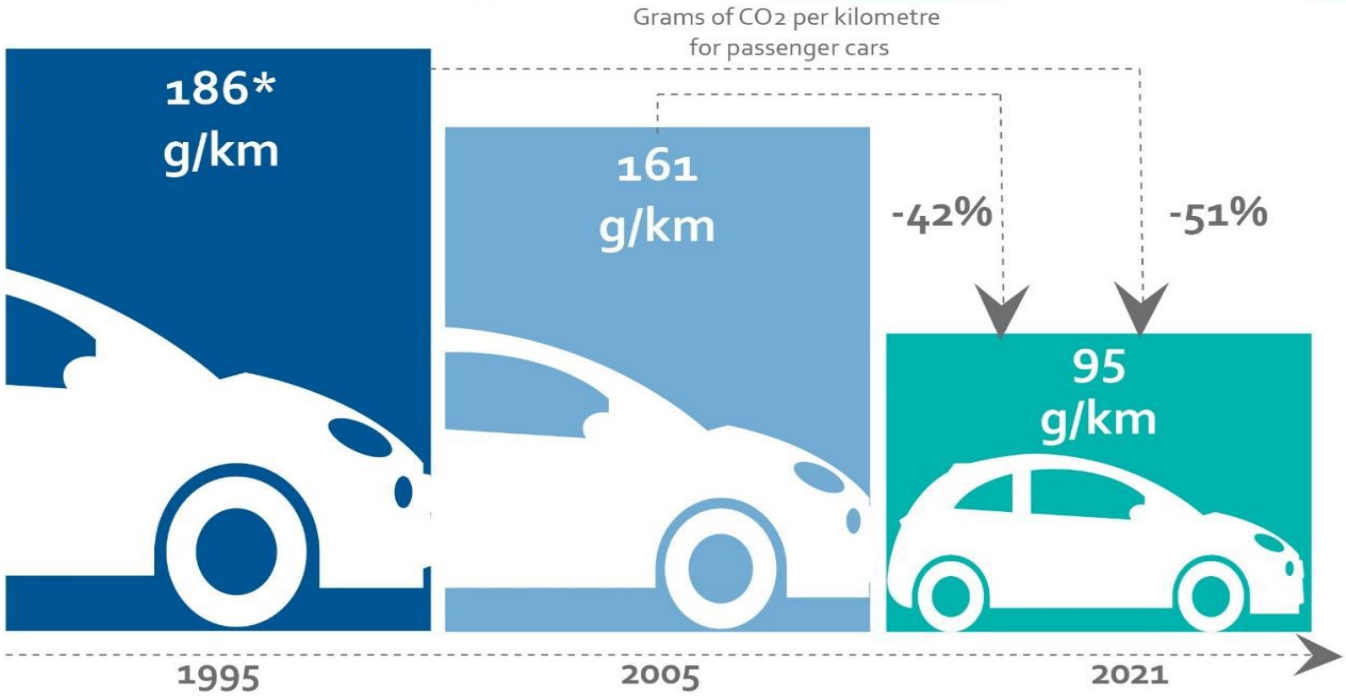
http://www.fch.europa.eu/

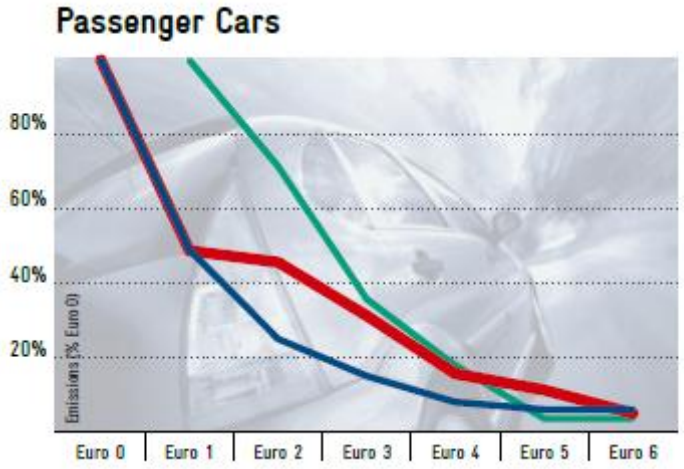
OUTLINE

- Current challenges for the Automotive Industry;
- Powertrains based on FCH2 solutions;
- Brief presentation of FCH2JU;
- Main Achievements;
- Perspectives, MAWPs, AWPs;
- Conclusions.

A Complicated World

Remarkable Achievements

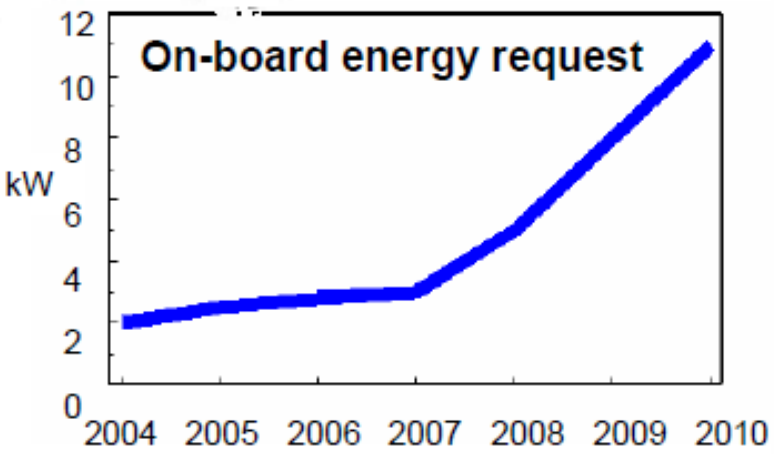


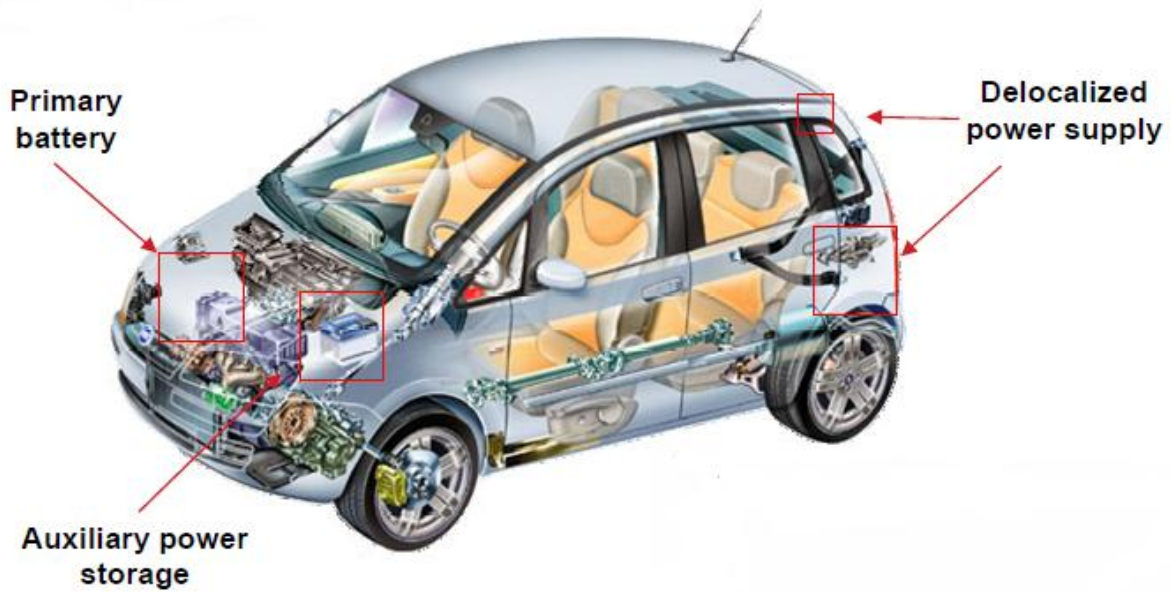


Electricity on Board

Automotive Electrical Loads

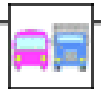
Load	Max Power (kW)
Electrical AC compressor	3.8 to 4.0
Electrically actuated valve train	3.0 to 3.2
Preheated catalyst	3.0
Windshield heating	2.5
Brake-by-wire	2.0
Steer-by-wire	1.8
Mobile AC power outlet	1.5
Electric power steering	1.0
Electrohydraulic brakes	0.9
Lights	0.6
ABS pump	0.6
Power windows (front)	0.5 to 0.7
Power windows (rear)	0.5 to 0.7
Heated front seats (left and right)	0.5
Heated rear seats (left and right)	0.5
High-power stereo	0.3
Front wiper motor	0.2 to 0.3
Sunroof motor	0.2





Intelligent Vehicles & Infrastructures

Intelligent Infrastructure

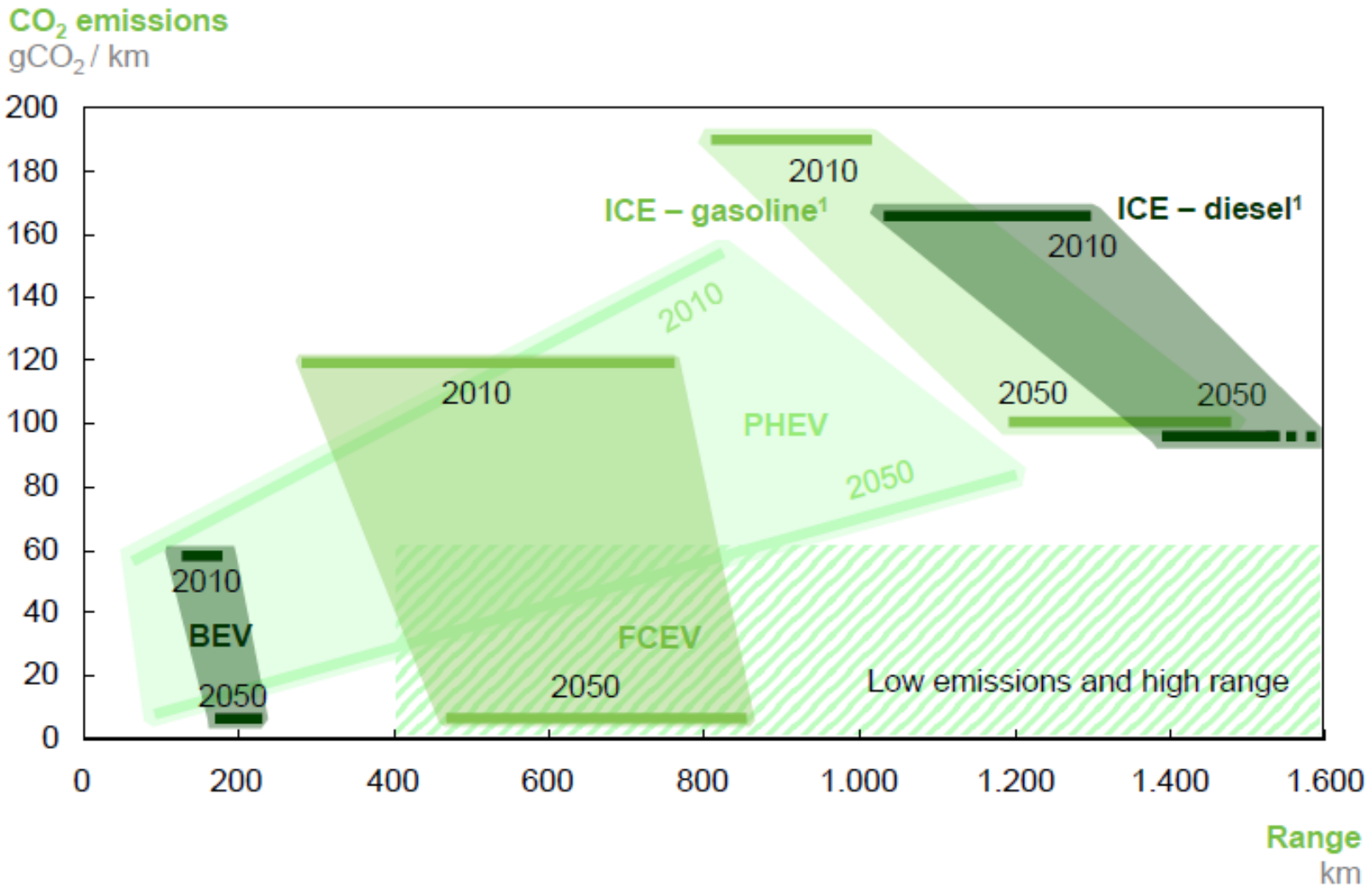
Arterial management	Freeway management	Crash prevention & safety	Road weather management	Roadway ops & maintenance
Transit management	Traffic incident management	Emergency management	Electronic payment & pricing	Traveller information
Information management	 Commercial vehicle operations	Inter modal freight	Traffic management center	

Intelligent Vehicles

Collision avoidance	Driver assistance	Collision notification

Fuel Options

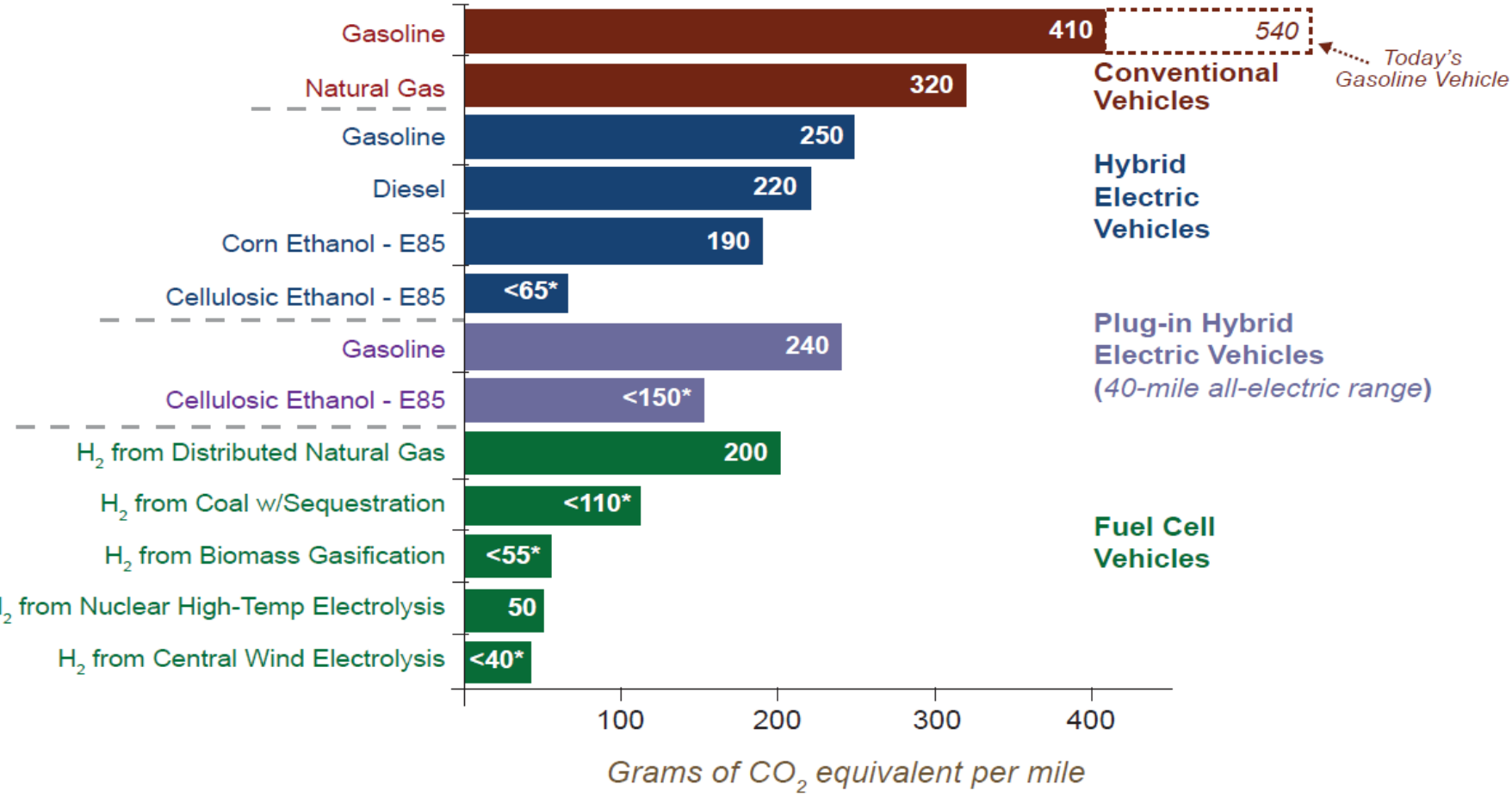
Expectations



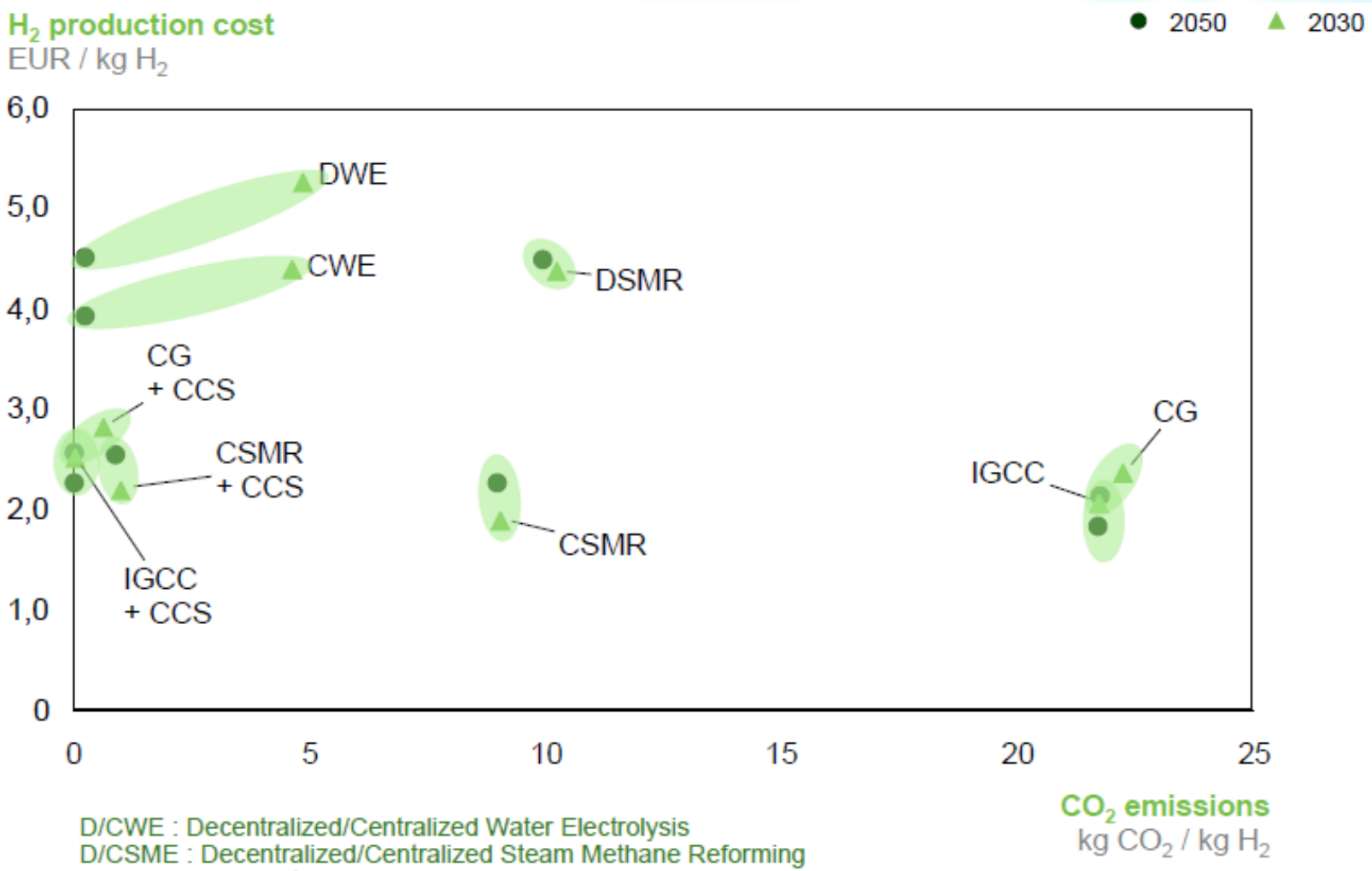
A Life Cycle Approach

Well-to-Wheels Greenhouse Gas Emissions[5]

(direct emissions, based on a projected state of the technologies in 2020)

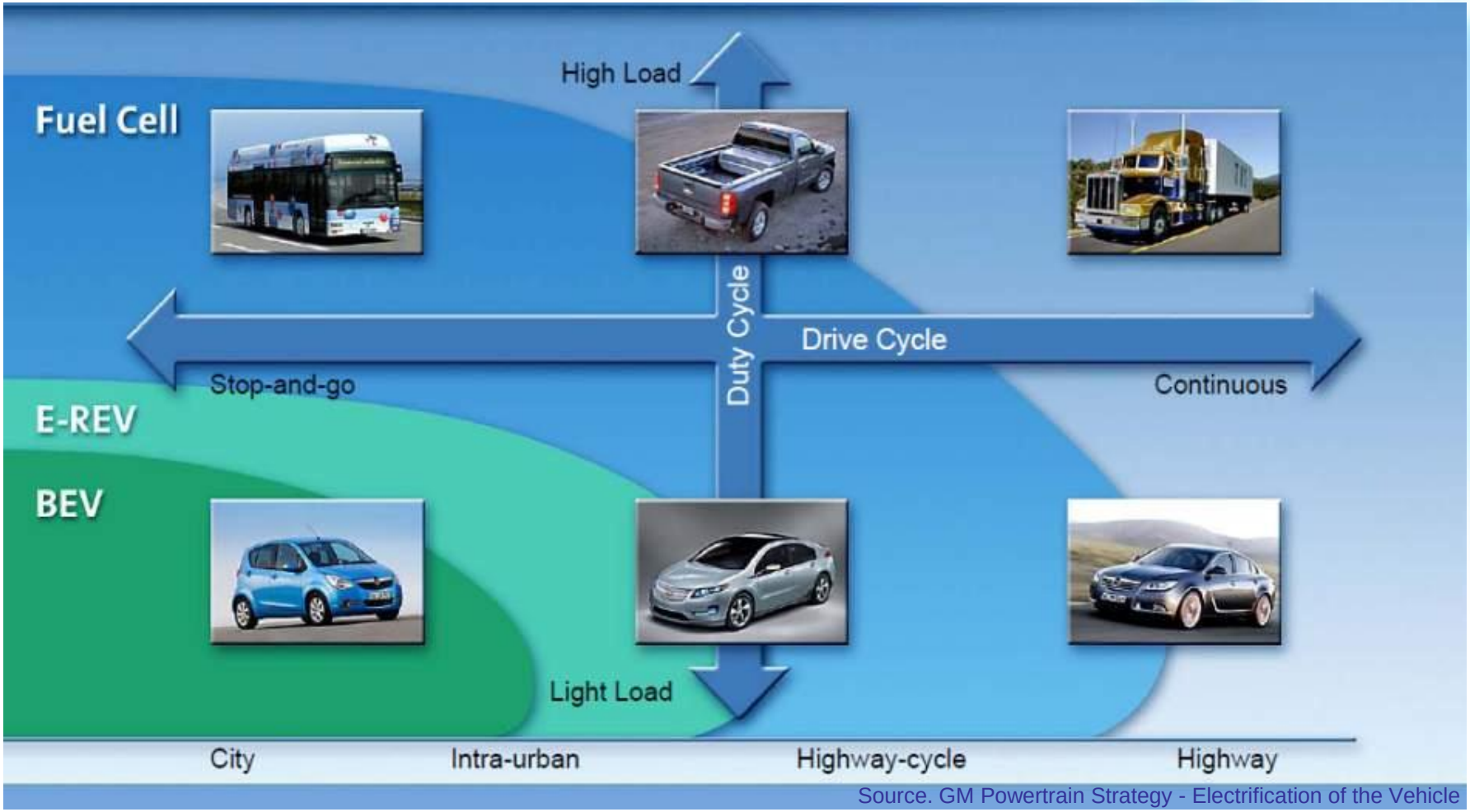


Hydrogen



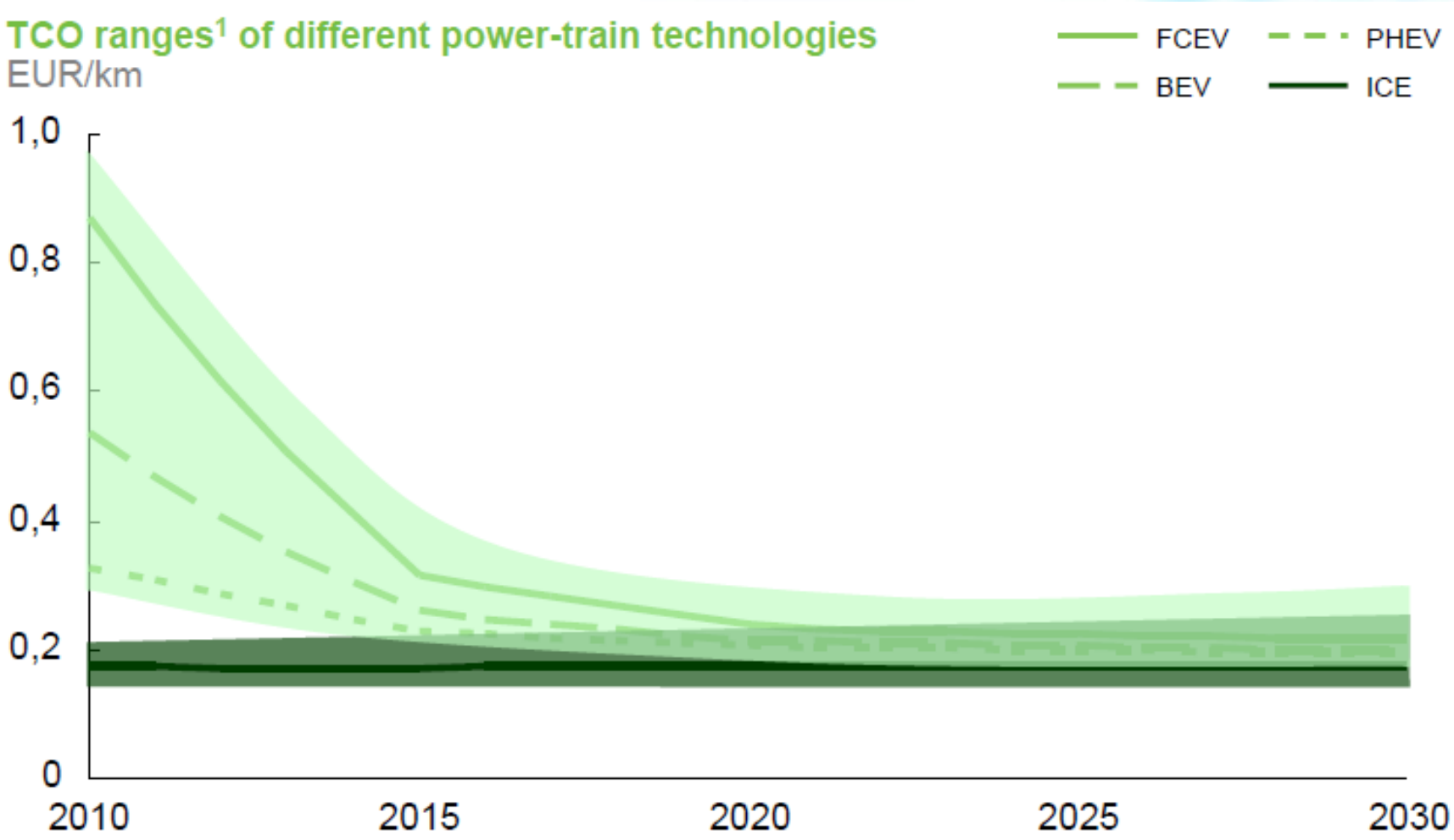
D/CWE : Decentralized/Centralized Water Electrolysis
D/CSME : Decentralized/Centralized Steam Methane Reforming
CG : Coal Gasification
CCS : Carbon Capture & Storage
IGCC : Integrated Gasification Combined Cycle

Alternative Powertrains



Source. GM Powertrain Strategy - Electrification of the Vehicle

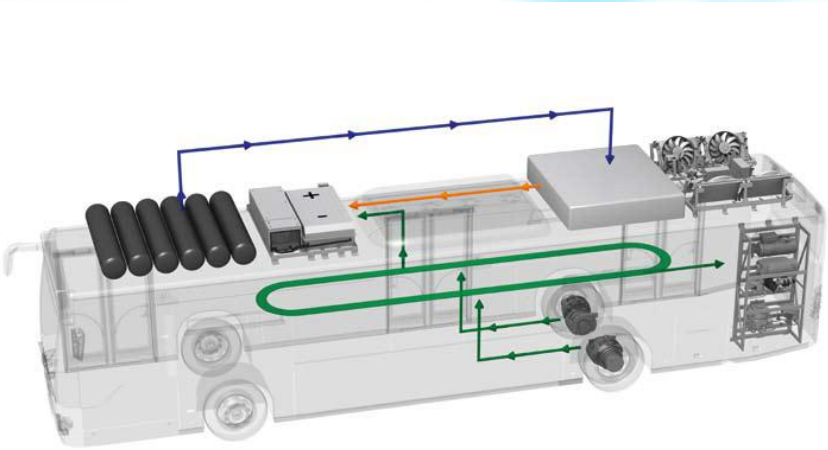
Cost Perspectives



From Dream to Reality

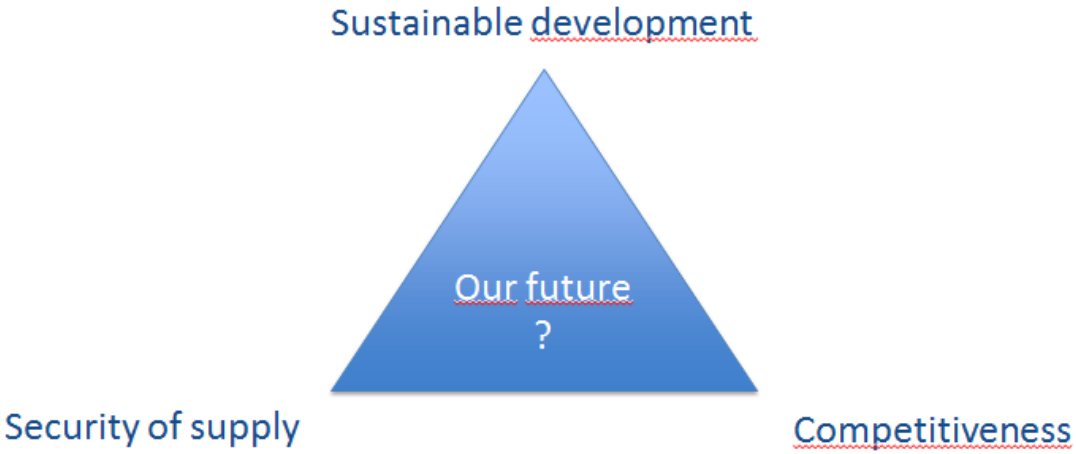
The State of Art

Mercedes-Benz B Class
Fuel Cell Stack type: PEM, 80 kW
Electric Motor: 70 kW nominal /100 kW peack
Maximum Torque: 320 Nm
Fuel: H_2 (70 MPa)
Autonomy: 400 km
Maximum Seed: 170 km/h
Batttery: Li-ion



Daimler Citaro Bus
Fuel Cell Stack: PEM, 120 kW (cont.)
Electric Motor: 2 x 80 kW
Fuel: H2 35 kg (35 MPa)
Autonomy: 250 km
Battery: 250 kW
Average consumption: 10-14 kg/100 km

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

Joint Undertaking – Public Private Partnership
Council Regulations:

521/2008 of 30 May 2008 **(FP7)**
1183/2011 of 14 November 2011
559/2014 of 6 May 2014 **(H2020)**

FCH2 JU

Fuel Cells & Hydrogen 2 Joint Undertaking

New Energy World IG

Industry Grouping
NEW-IG
87members

European Union
represented by the
European Commission

N.ERGHY
research on fuel cells & hydrogen

Research Grouping
N.ERGHY
63 members

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

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*

Goals & Means

TRANSPORT

- Road vehicles
- Mobile systems and MHS
- Fuel Supply Infrastructure
- Applications in the field of maritime, rail and air

ENERGY

- Fuel Cells for CHP
- Distributed production of Hydrogen
- Hydrogen for RES (including injection in NG pipelines)

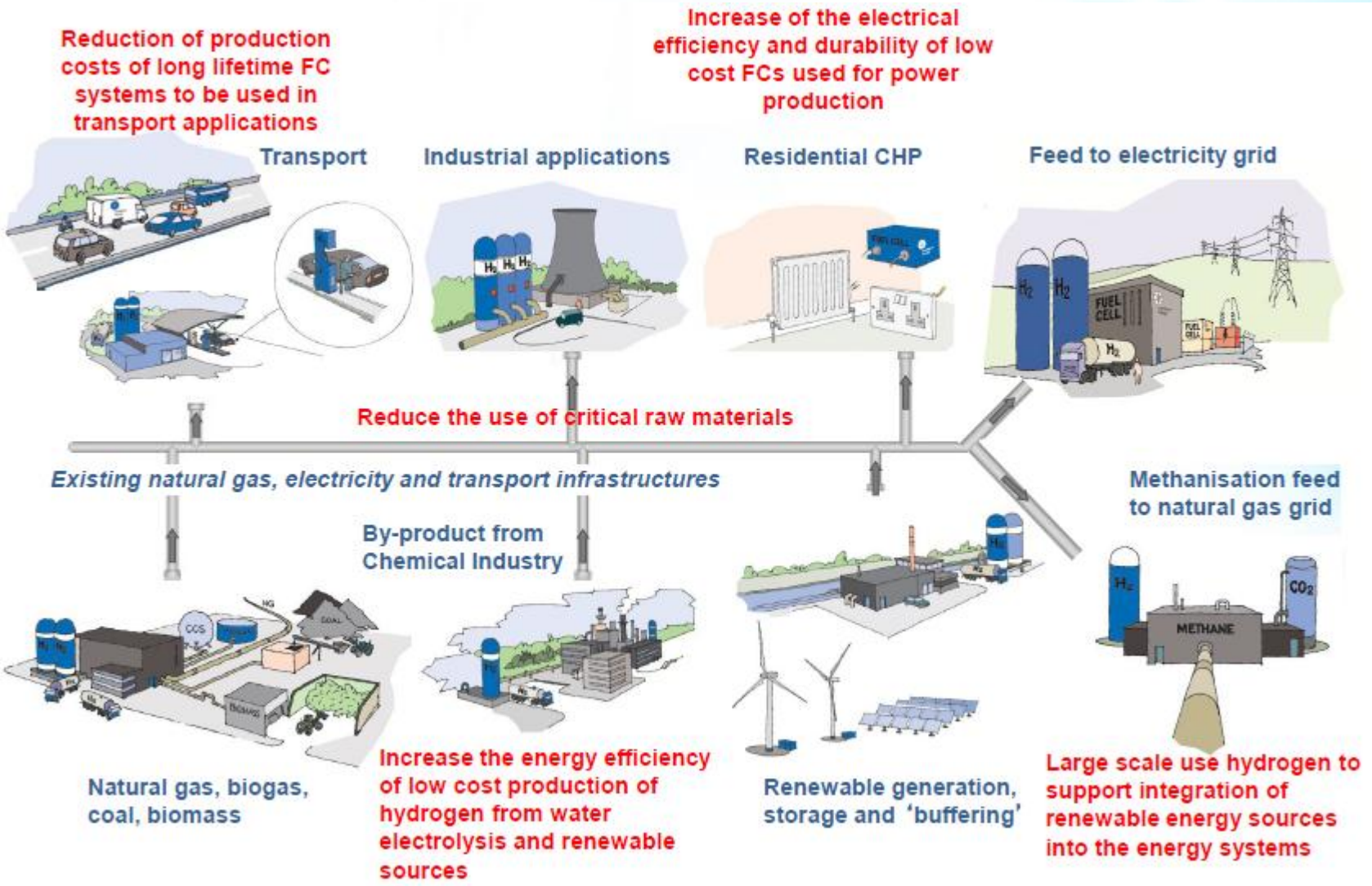
CROSSCUTTING ISSUES

(strandardization, public awarness, manufacturing technologies, studies)

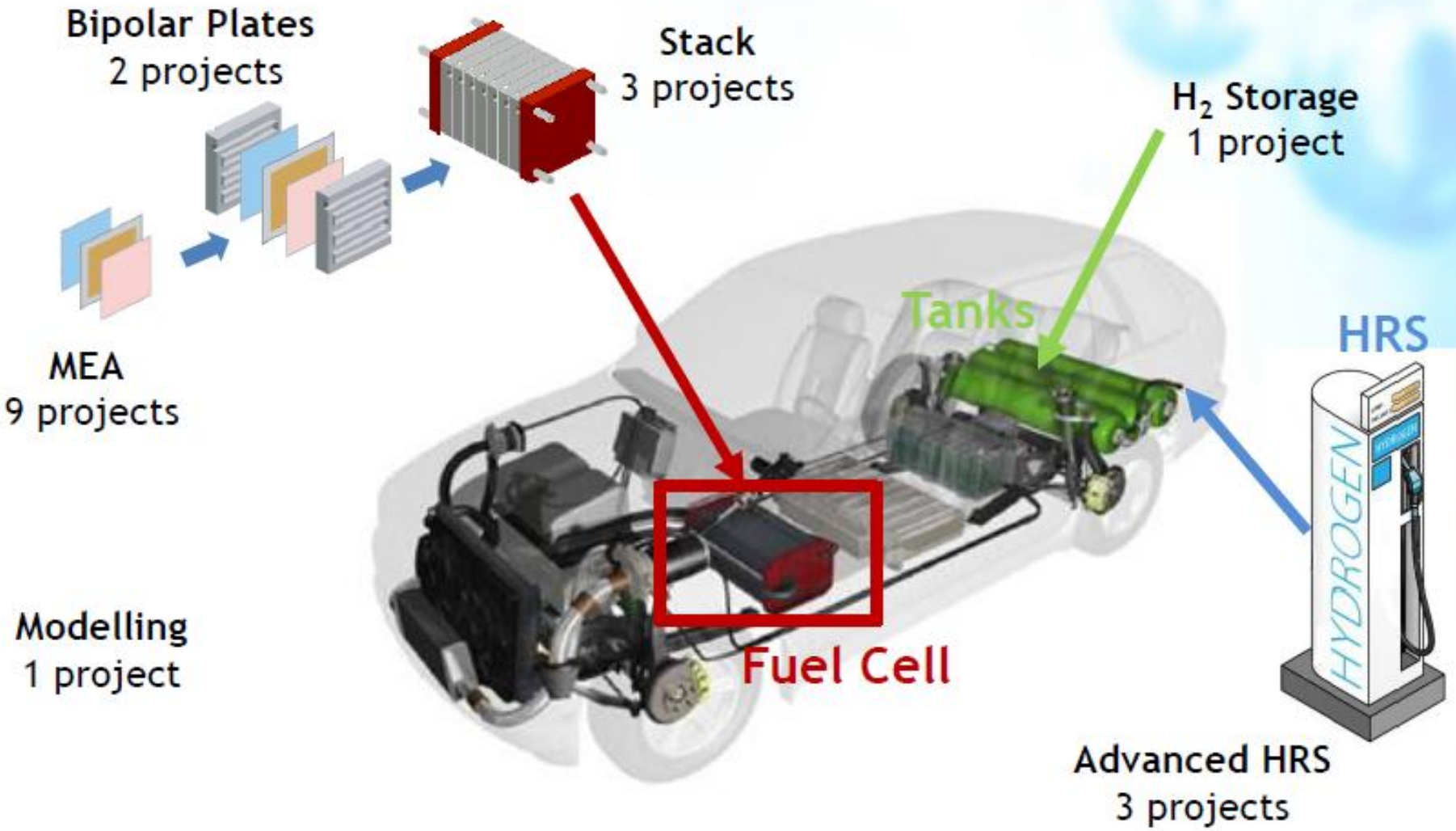
Budget of 1.33 Bln. Euro for the period 2014 – 2020

With a robust involvement of the Industry in the implementation of the programme and by additional investment that could support common goals.

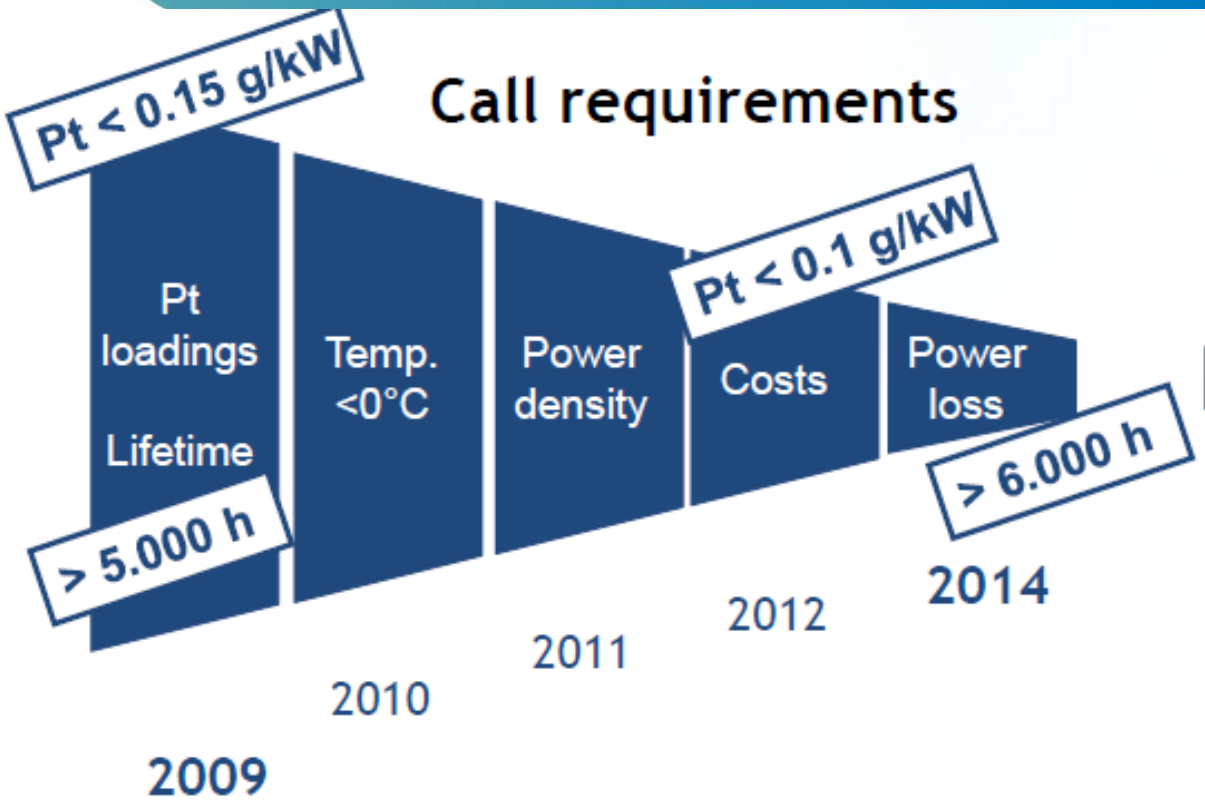
The Big Picture



Core Technologies



Steps Forward



With each year call, stringent requirements to meet the 2020 goals

2020 goals

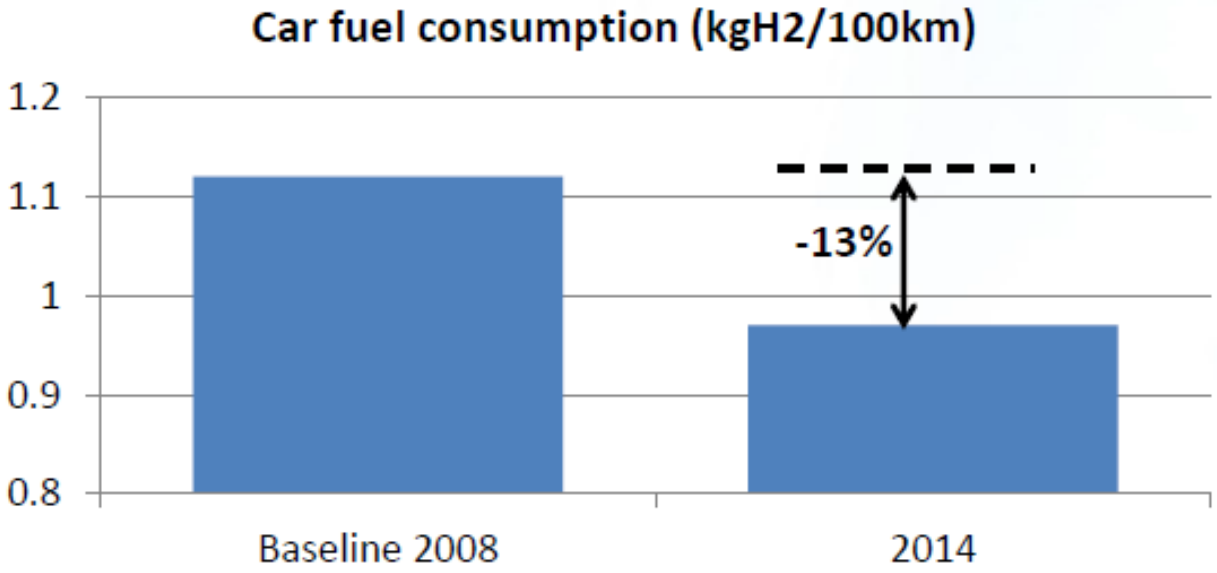
100 €/kW at 50.000 units per year

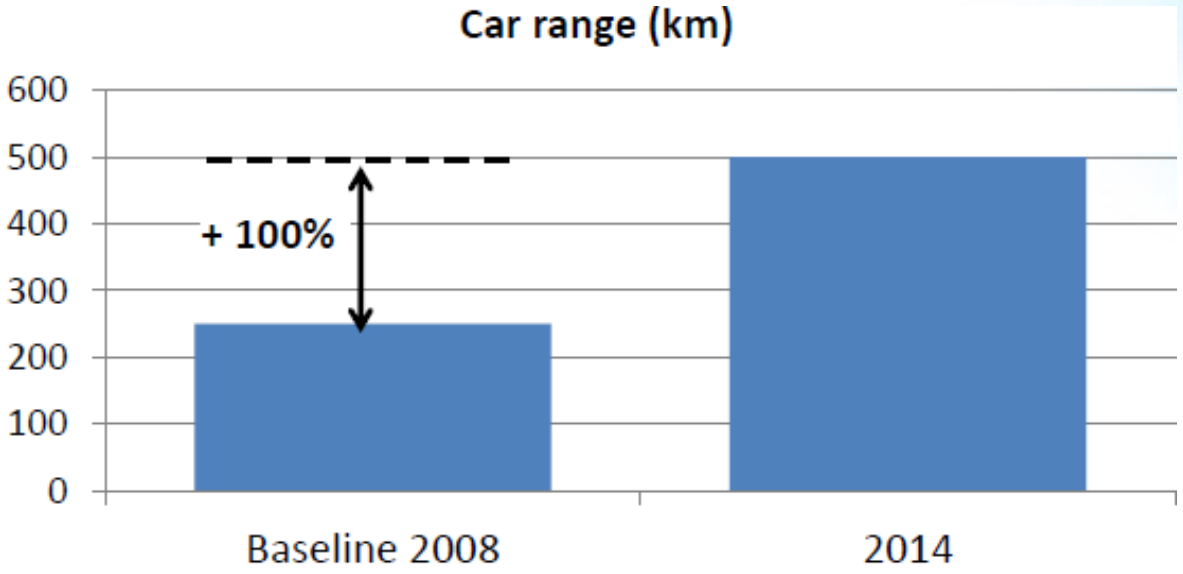
> 6.000 h lifetime

MEA/FCs status

	From 2009	To 2020
Costs	✗	✓
Durability	✗	✓
Performance	✗	✓

Achievements





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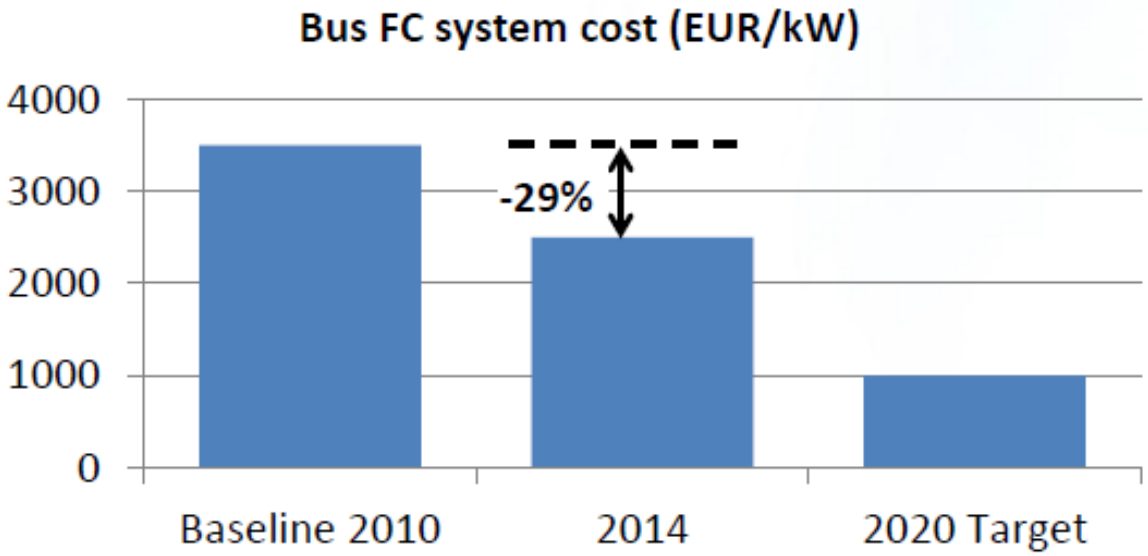

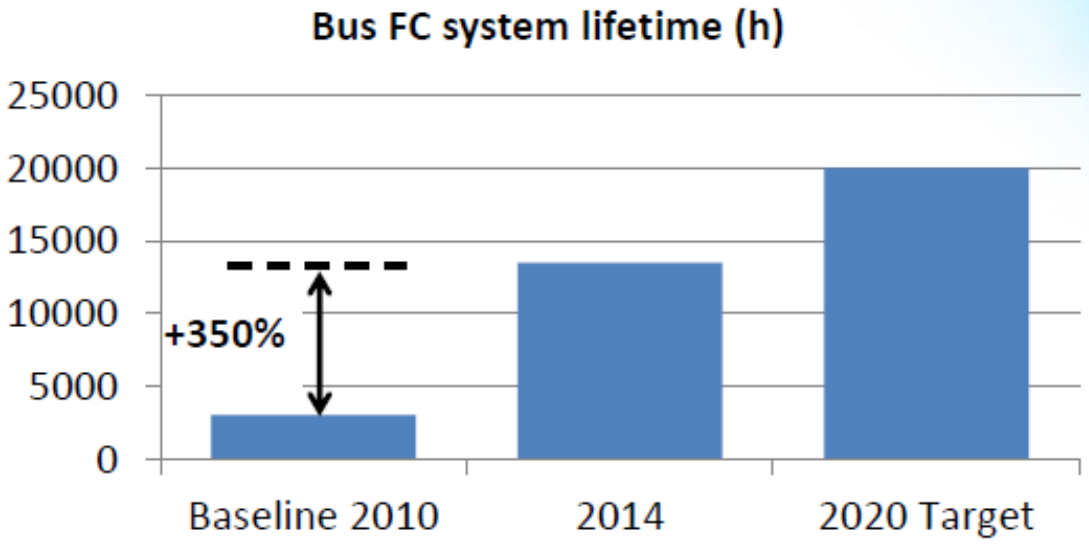

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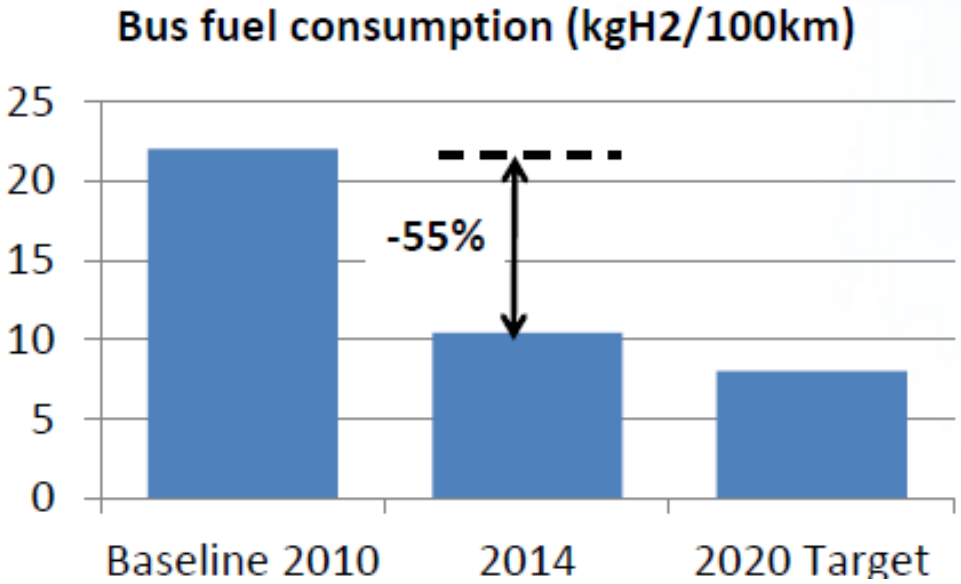
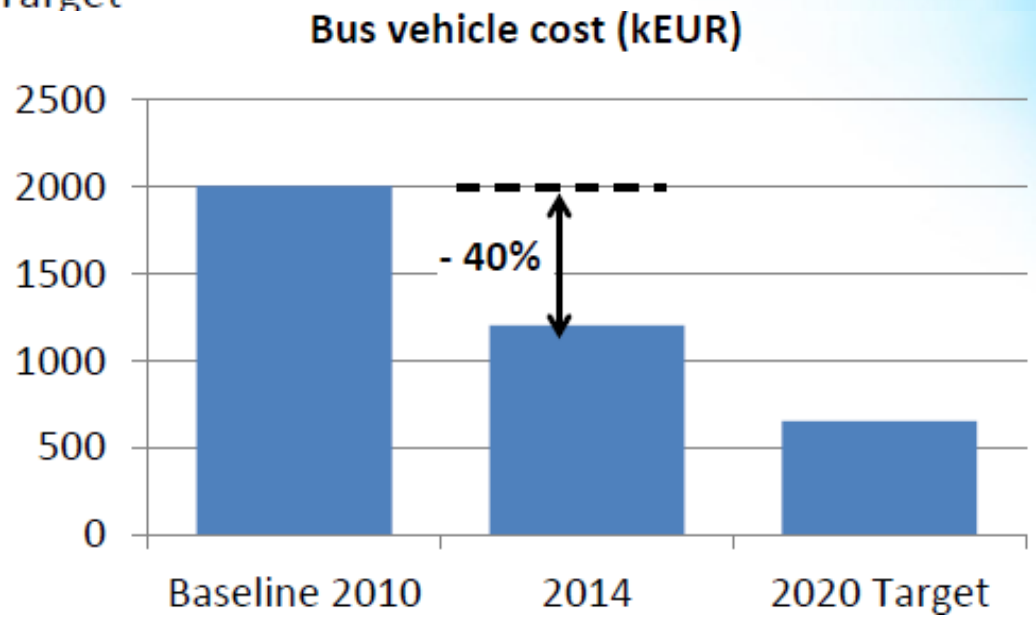
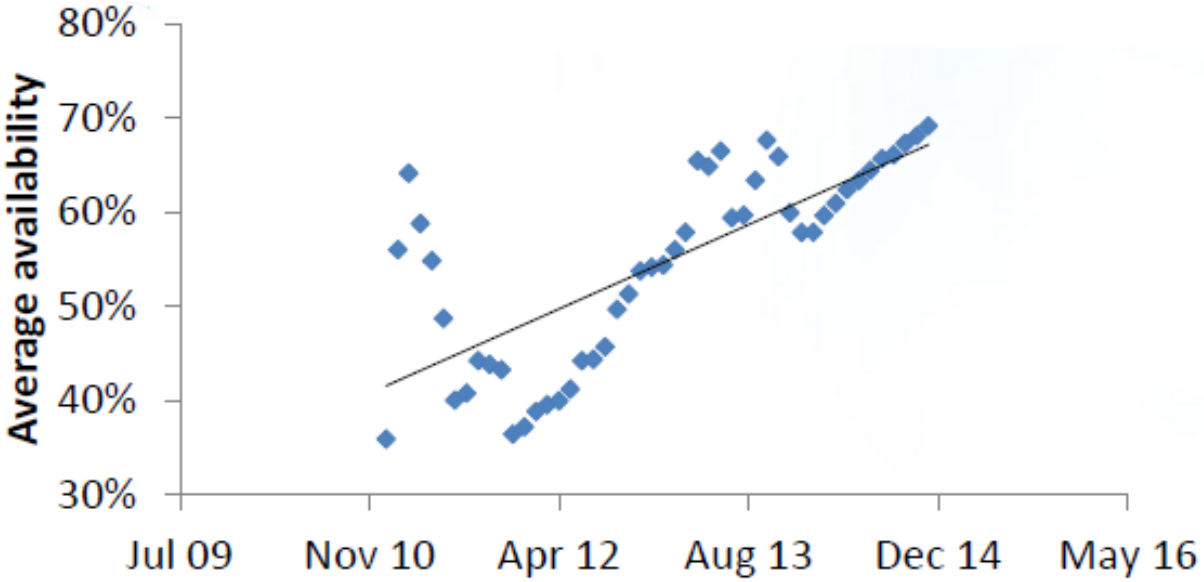
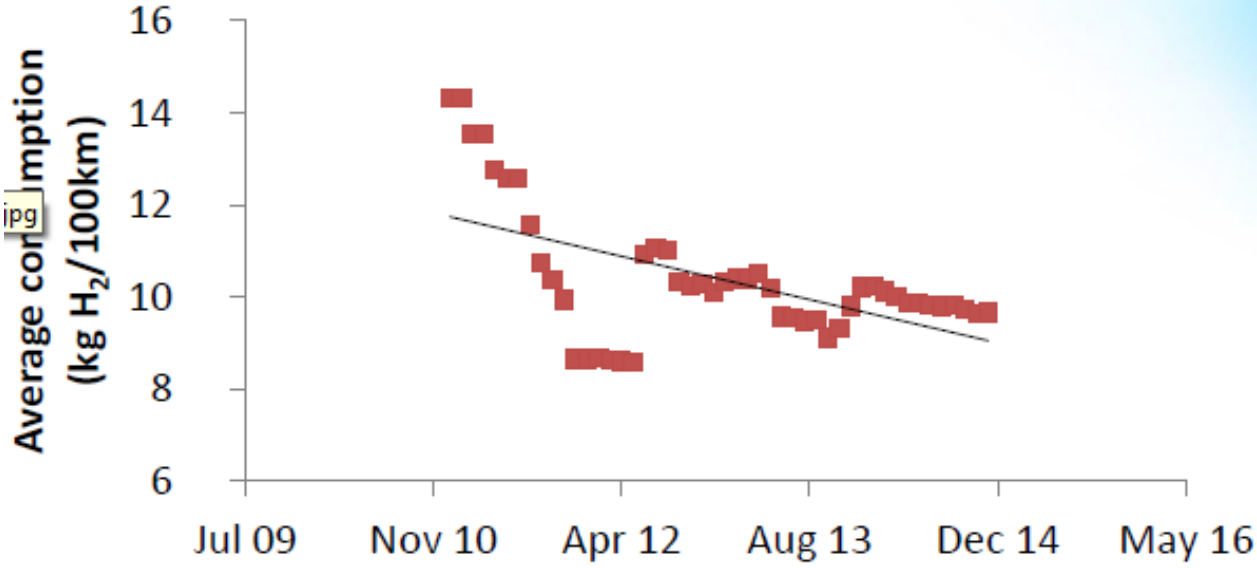




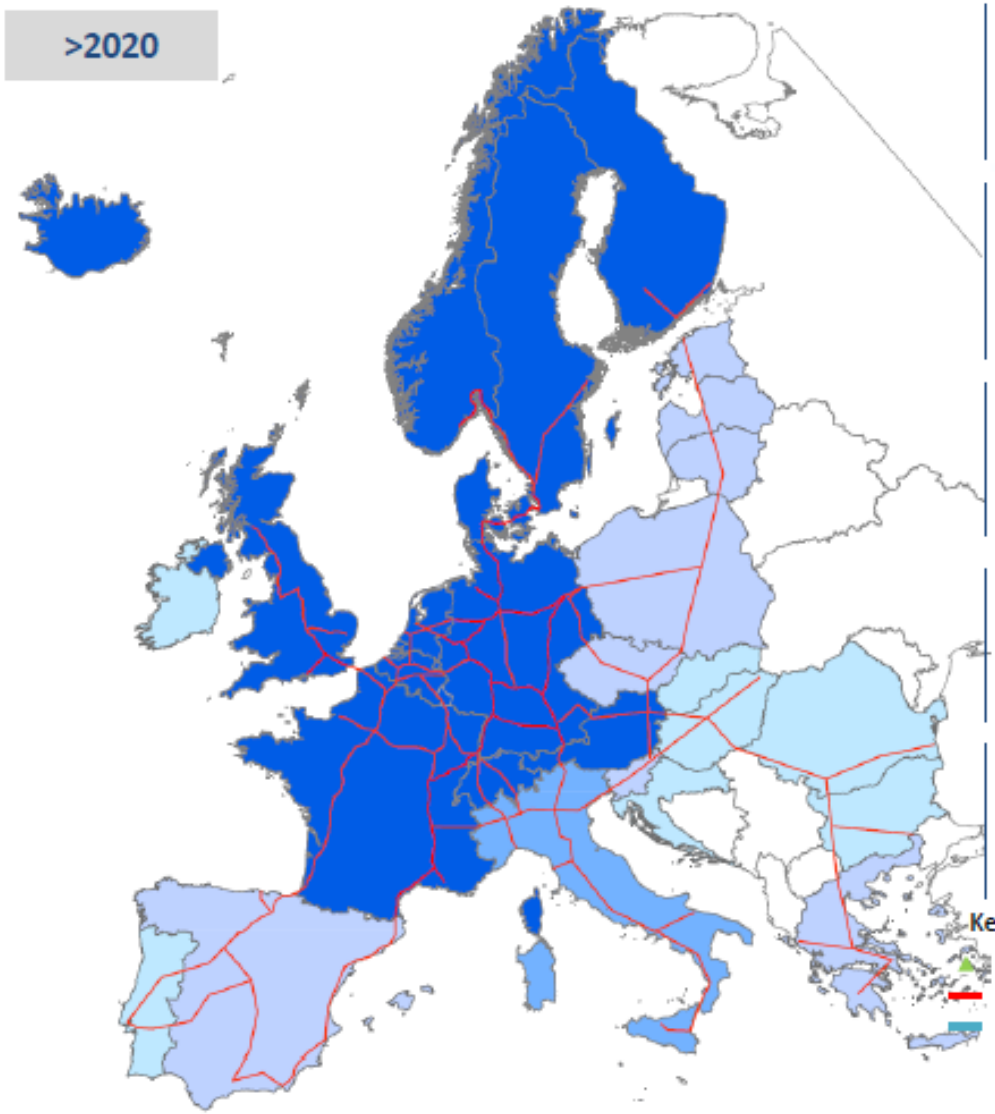
Achievements





Achievements

Likely implementation of the network by 2020 onward (>80 kg/day stations)



France

- The French network will keep on expanding with **30-40 HRS** by 2020 and **100 HRS** by 2023

Germany

- The German network will keep on expanding with **400 HRS** in 2023

Netherlands

- The Dutch network will keep on expanding with **20 HRS** by 2020 and **40-50 HRS** by 2023

Scandinavia

- The Scandinavian network will keep on expanding with **35-40 HRS** by 2020 and **50 HRS** by 2023

UK

- The UK network will keep on expanding with **60-70 HRS** by 2020 and **100 HRS** by 2023

Achievements

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

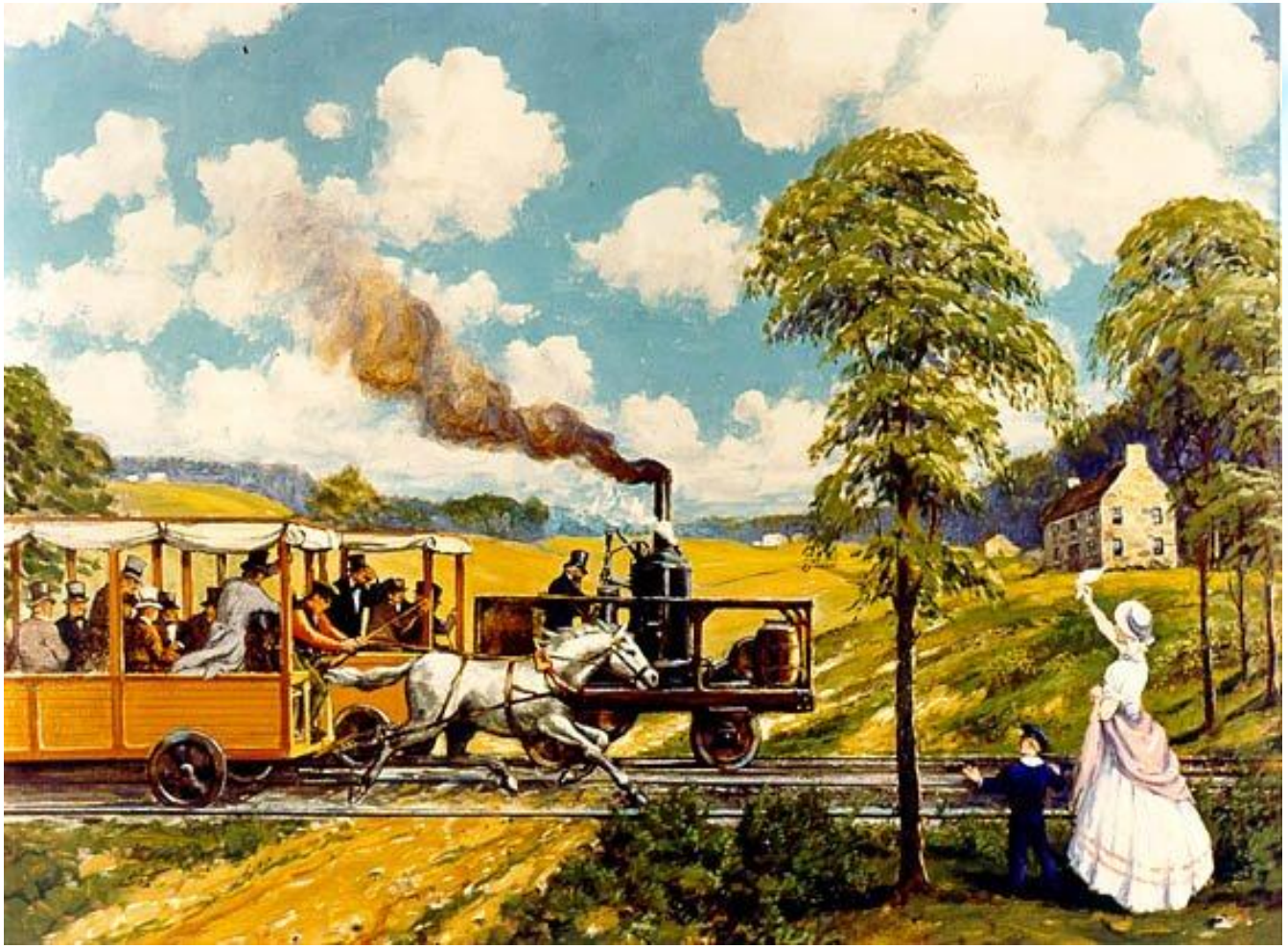
2020 onwards

Participating locations

Conclusions

- Coordinated approach has to be followed for infrastructure build-up with regards to locations, technology, capacity /performance.
- Much more focus and professional approach for putting a strong emphasis on customer views.
- Creative solutions for market deployment have to be encouraged for new approaches as the concept of Infrastructure as a Service.

Thank you for your attention!



Peter Cooper's Tom Thumb Races a Horse

(U.S. Dept. of Transportation, August 28, 1830)