Hydrogen and Fuel Cells as Strong Partners of Renewable Energy Systems

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EHA

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Content

EHA in Brussels

EU Renewable Policy

Hydrogen and fuel cells: strong partners

Aan de slag!

EUROPEAN HYDROGEN ASSOCIATION

EHA in Brussels

Mission and objectives

Foster the development of hydrogen technologies and their use in industrial, commercial and consumer applications;

Membership includes 14 national associations (Belgium, Switzerland, Germany, Spain, France, Hungary, Italy, Latvia, Norway, Netherlands, Portugal, Poland, Sweden, United Kingdom) and the main hydrogen production and distribution companies.

Brussels office follows all main dossier affecting hydrogen development: monthly policy report.

EHA Taskforce “Hydrogen in the City”: support of coordination of regional activities; EHA is secretariat of HyRaMP since April 2008.,

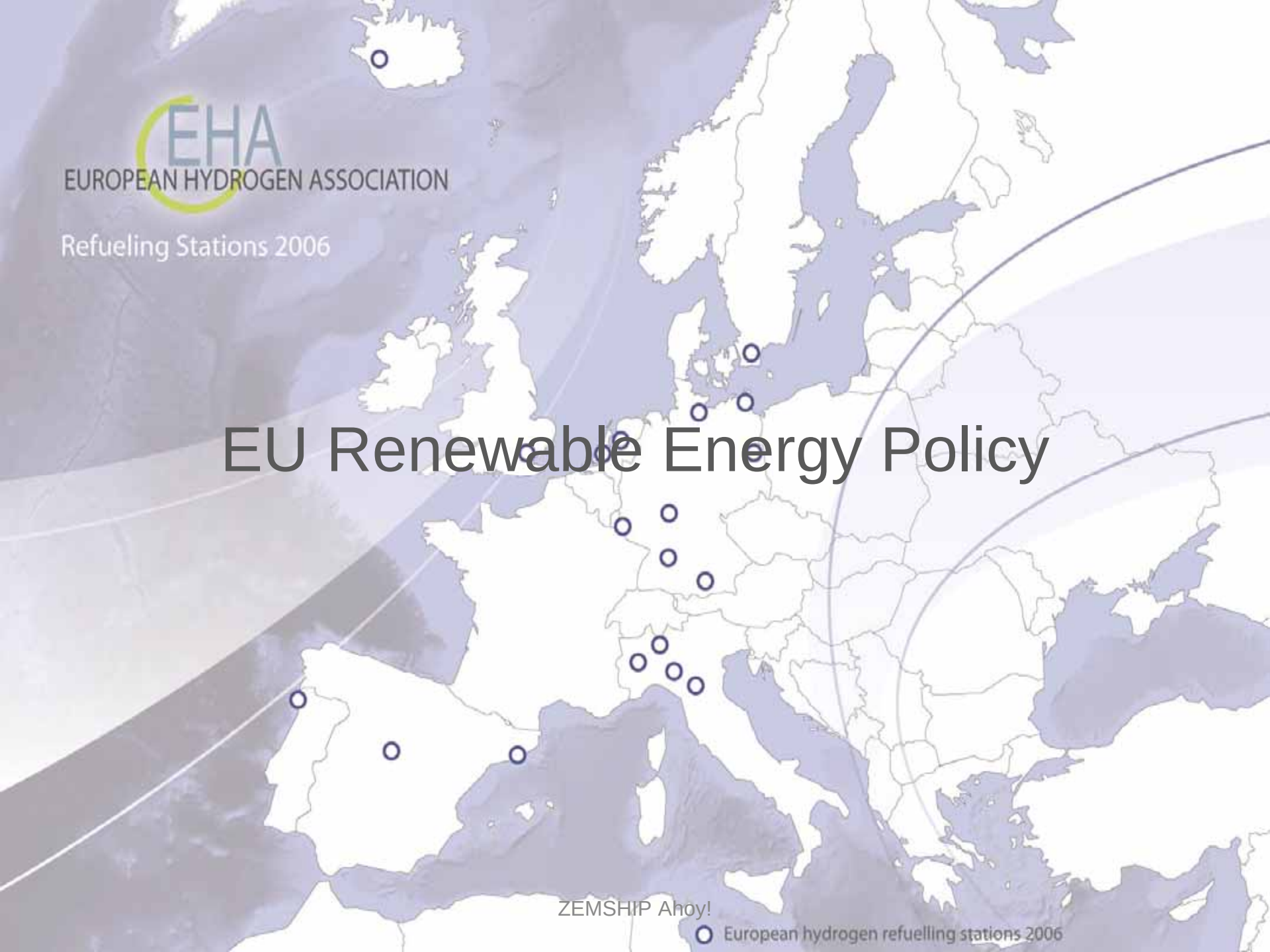
EHA in Action

EHA Brochures: “Where does the energy for hydrogen production come from?” and “Hydrogen and fuel cells as strong partner of renewable energy systems”.

Collect insight in and support for local developments through involvement in EU and national projects of EHA national association members; EHA industrial members are member of Industrial Grouping of FCH JTI.

EHA is actively following EU’s Research, Energy and Transport policy;
online database of policy affecting the use of hydrogen,

EHA Taskforce “EU Strategic Energy Technology Plan” on RE/H2 energy chains.



EU Renewable Energy Policy

Climate change at heart of EU Policy

A political consensus has crystallised in 2006/2007 to put Climate Change at the heart of the European Union's political programme.

"A guiding theme for the Union, central to the Lisbon strategy for growth and jobs, and of primary importance in Europe's relations with partners worldwide."

EU Energy Package Overview

2.1 Acceleration Internal Market: unbundling production/distribution, one EU regulating body,

2.2. MES Solidarity : oil reserves and network inter connections;

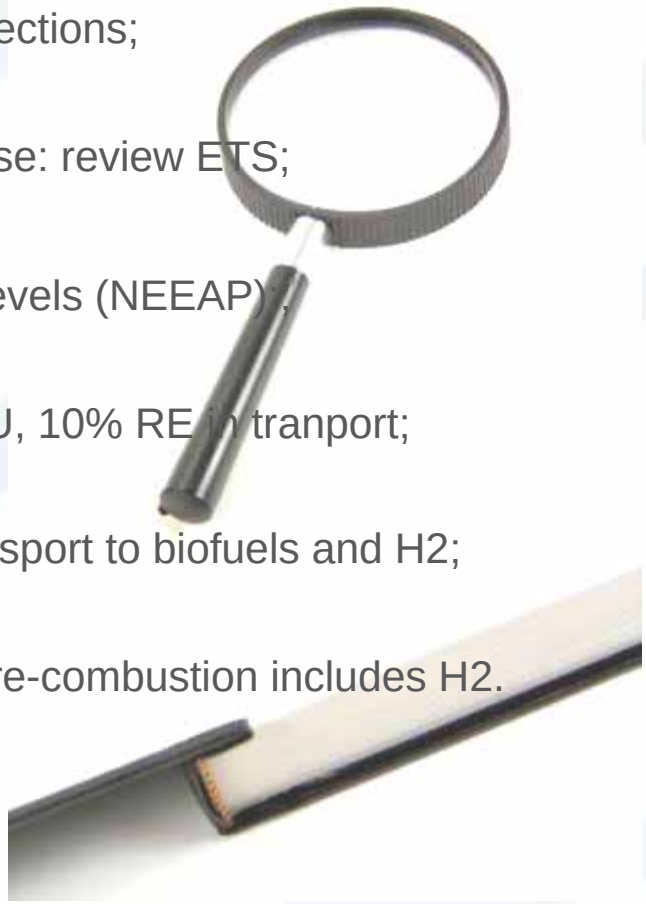
2.3 Climate change measurers to arrive under 2C increase: review ETS;

2.4 Execution Energy Efficiency Action Plan at national levels (NEEAP);

2.5 Review Renewable Energy Roadmap: 20% RE in EU, 10% RE in tranport;

2.6 Strategic Energy Technoloy Plan: by 2030 adapt transport to biofuels and H2;

2.7 CCS and 12 zero mission power plants in EU: only pre-combustion includes H2.



Renewable Energy Directive

EHA Action:

1. Organised **SET Plan hearing** on renewable hydrogen energy chains in 2007;

2. Requested and obtained **written statement** of the Commissioon that H2 produced by by all RE sources is counted towards10% renewable energy in transport target in new Renewable Energy Directive.

3. Published brochure "**Hydrogen and Fuel Cells as strong partners of renewable energy systems**."

4. **SET Plan Steering committee** of Member States representatives could support development of RE/H2 chains;

5. **Second Strategic Energy Review of November 13, 2008**: Renewabel Eenrgy finacing facility; is H2 included.

Climate Action Package: as we speak…….

- Review ETS; from allocation to auctioning: big Hydrogen production plants are now included.
- Action sectors outside ETS; buildings, transport, agriculture, waste and industrial plants falling under the threshold for inclusion in the ETS. The target for these sectors would be a 10% reduction in emissions
- Renewable Energy Package: including biofuels criteria, national action plans; includes reference to hydrogen in 10% renwable energy in transport part.
- CCS Directive.

Second EU Strategic Energy Review

- Commission proposes a five-point EU Energy Security and Solidarity Action Plan focusing on:

- • Infrastructure needs and the diversification of energy supplies : Blue print large off shore wind park in the north Sea;

- • External energy relations;

- • Oil and gas stocks and crisis response mechanisms;
  - Ending oil dependence in transport: (i) the need for tax breaks and other (ii) the possibility of requiring a minimum percentage of all new government and local authority vehicles to be electric, bio methane or hydrogen and (iii) the possible requirement for filling stations to introduce the necessary infrastructure to permit the rapid development of alternative transport across Europe..

- • Energy efficiency : review in 2009 of EE Action Plan, Energy Tax Package;

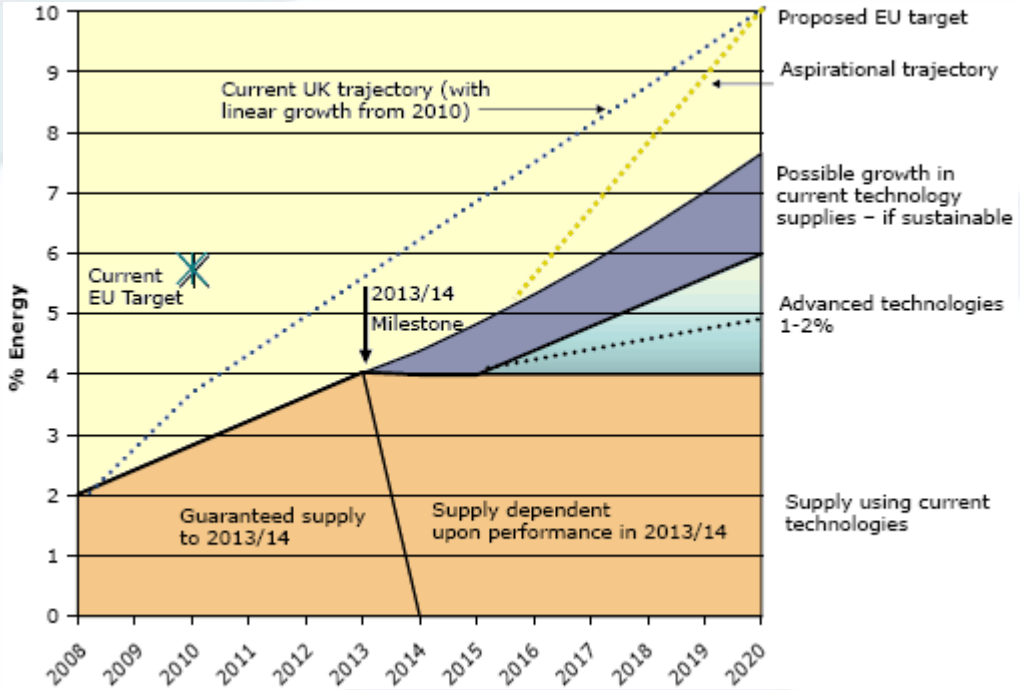
- • Making the best use of the EU's indigenous energy resources.
  - EU Sustainable Energy Financing Initiative ;
  - Communication on Financing Low Carbon Technologies

EU Transport Policy

EU Fuel Policy: Fuels Directive

Review EU Directive on Specification of petrol, diesel and gas-oil and introducing a mechanism to monitor to monitor and reduce greenhouse gas emissions from the use of road transport

Sets sustainability criteria for biofuels and is now including hydrogen:



Latest News: December 3, 2008: EU Council, Parliament and Commission struck deal on 10% of EU's transport fuel needs from renewable sources, including biofuels, hydrogen and green electricity; biofuels need to contribute to 35% carbon emission savings, 50 % by 2017

Green Paper: Towards a clean urban transport

1. promoting the exchange of good practice (joint procurement) at all levels (local, regional or national);
2. underpinning the establishment of common standards and the harmonisation of standards if necessary;
3. offering financial support to those who are in greatest need of such support;
4. encouraging research of the applications of which will make it possible to bring about improvements in mobility safety and environmental;
5. simplifying legislation and, in some cases, repealing existing legislation or adopting new legislation.

EHA Action:

- submitted contribution to EU public consultation on the need to confront different clean transport solutions at local level:

-Support national associations promote joint procurement: **Procura Seminar December 17, 2008**

EU Promotion of clean vehicles

EU Directive on the Promotion of clean and energy efficient road transport vehicles:

-sets mandatory standards for public procurement of all vehicles by 2015 (EU Parliament requested 2010).

-Vote October 2008 in EU Parliament was positive for compromise report.

-Commission will set up information network for public authorities on how to procure AFV's.

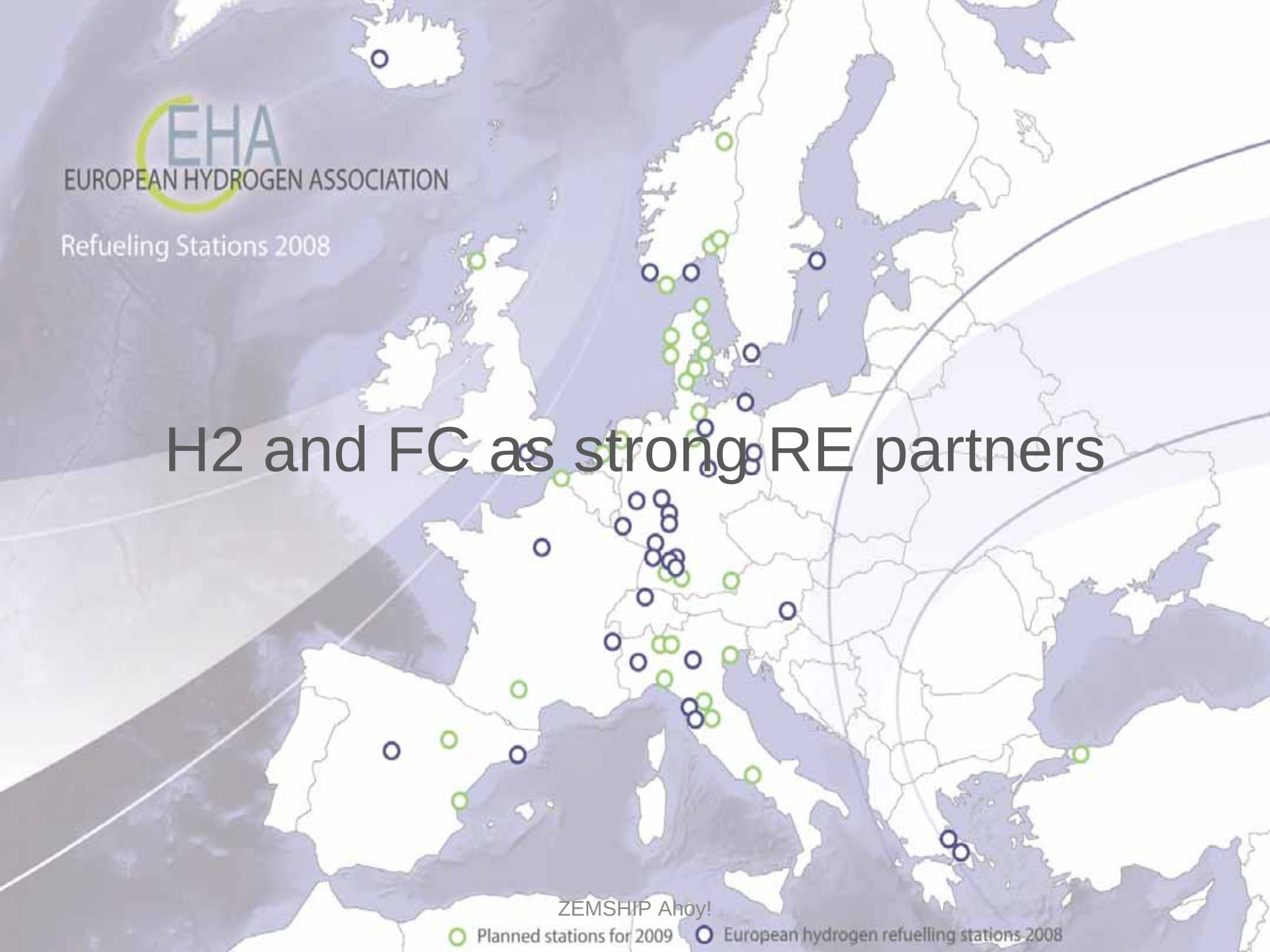
EHA Action : EHA is part of DG Enterprise Hydrogen Working Group that is preparing implementing measures of the Homologation Regulation

1.Public procured passenger cars in EU : 110.000, 1% market share

2.Public procured service vehicles in EU: 110.000, 6% market share

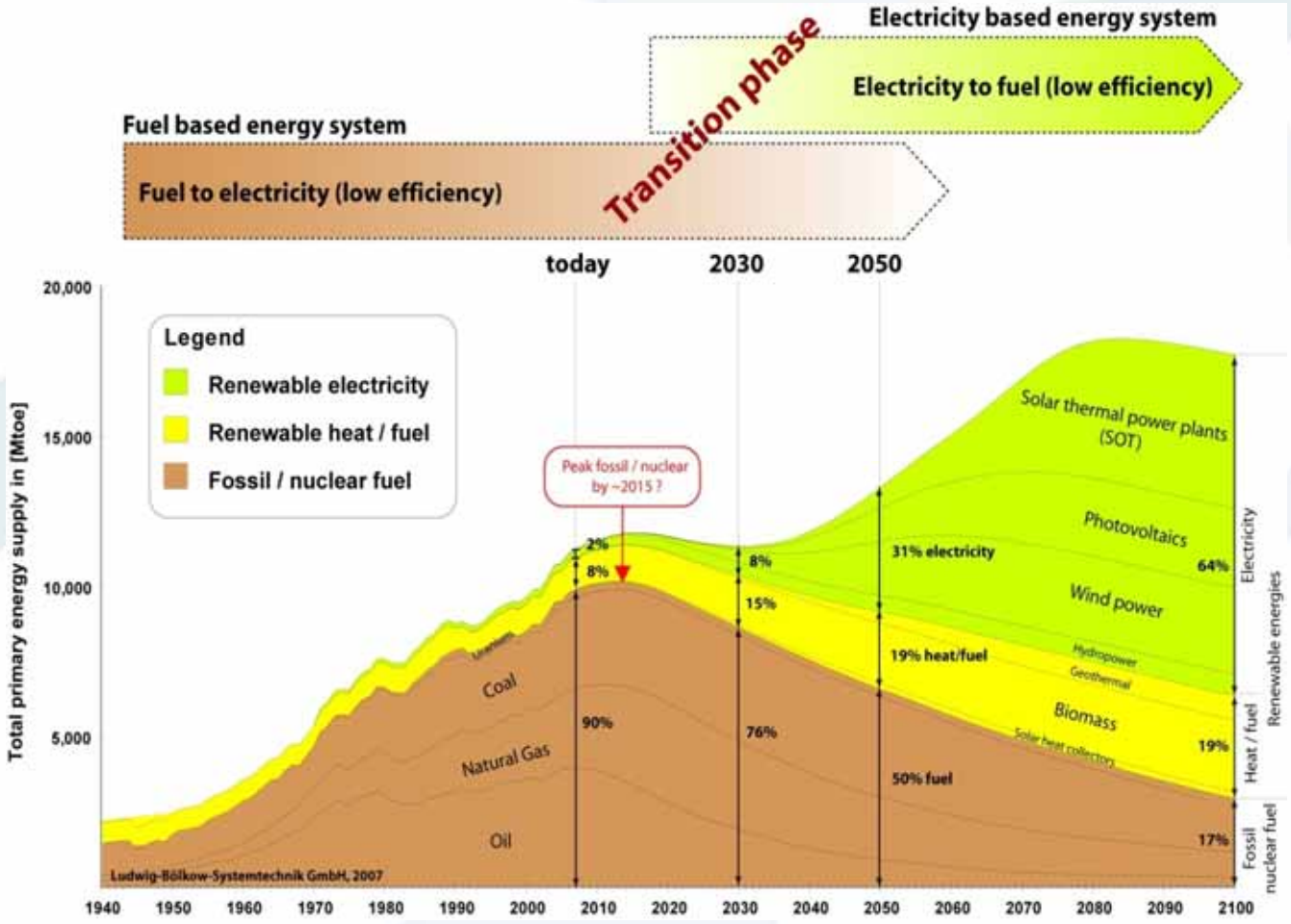
3.Public procured Lorries in EU: 35.000, 6% market share

4.Public procured buses in EU: 17%, 33% market share



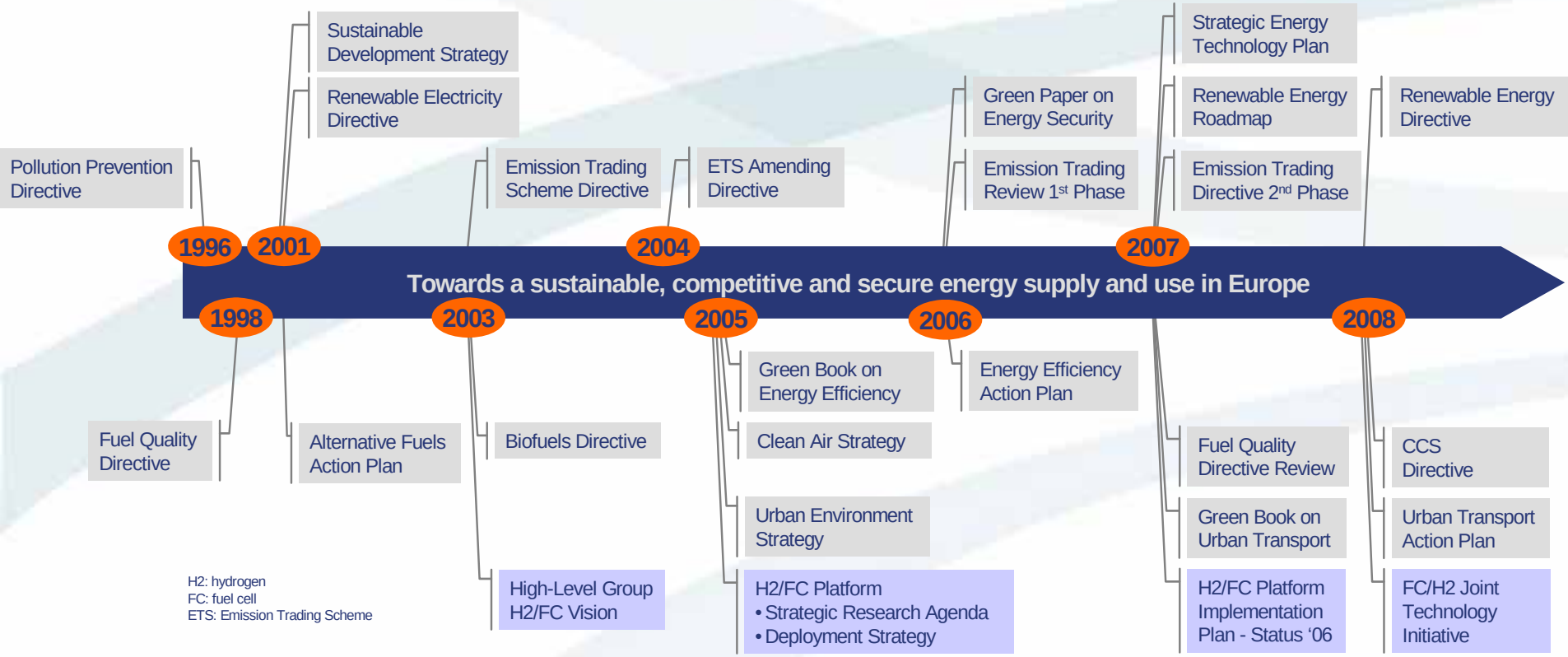
H2 and FC as strong RE partners

Future primary energy supply



- Peak of fossil and nuclear fuels by 2015
- Transition from a fuel based energy system to an electricity-based one
- Transport sector will use “electricity as major primary energy source”
- Future infrastructure has to change:
- Storage of electricity will become essential – hydrogen will function as an important electricity storage media and become a strong partner for renewable energies and the transport sector

EU reduction of GHG emissions



European energy policies

Transport sector

Challenges of urban transport

Introduction of alternative fuels

2020 – 20% share of renewable energies

European Joint Technology Initiative

EU reduction of GHG emissions

Legal and political conditions

Type of policy support for hydrogen

Tax exemption – example Denmark

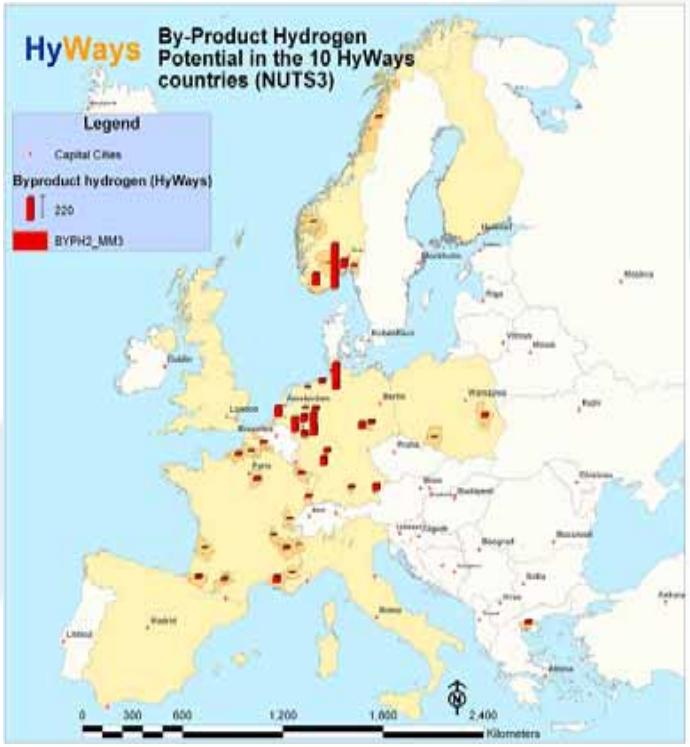
Major challenges for the introduction of hydrogen

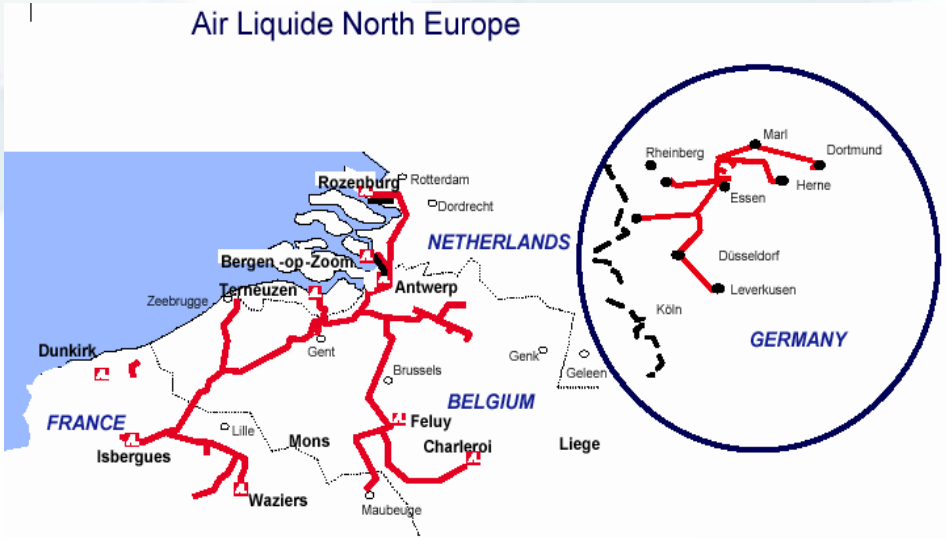
deployment support
cost reduction
cash flow during infrastructure build-up

Changing legal and political conditions as enabler for transition to market

Zero Emission Vehicle (ZEV) Requirement
– example California, USA

First markets – role of by-product H_2





In Germany, France, Belgium and the Netherlands, hydrogen is even available in extensive industrial pipeline systems.

In Europe, largest quantities of by-product hydrogen are identified in

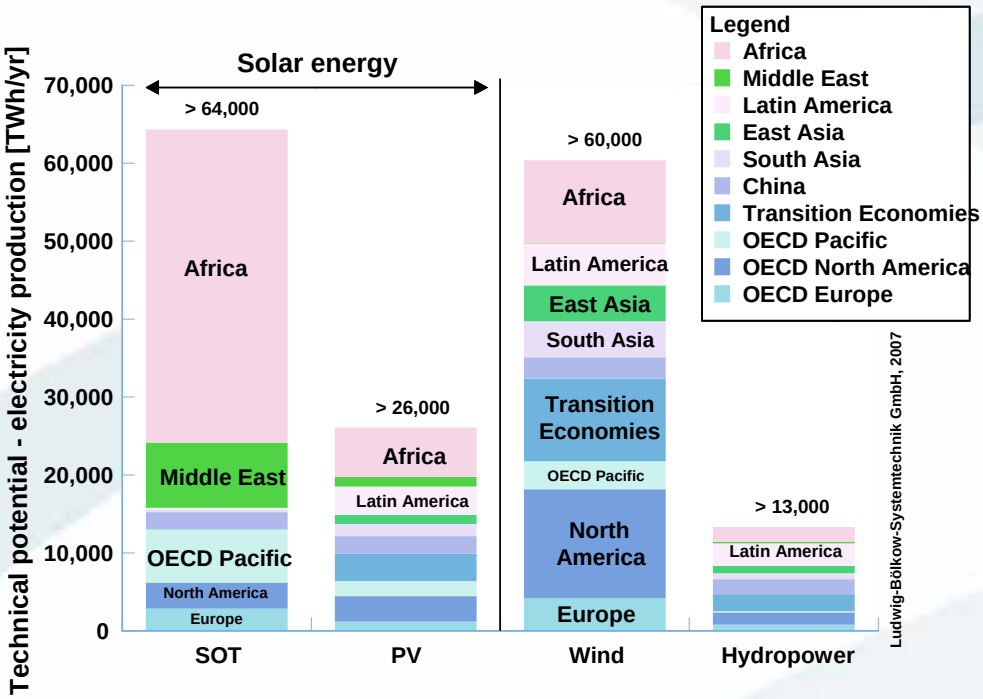
- Germany (~ 850 million Nm³ per year),
- Norway (~650 million Nm³ per year),
- France (~300 million Nm³ per year)
- the Netherlands (~100 million Nm³ per year).

[Source HyWays 2007]

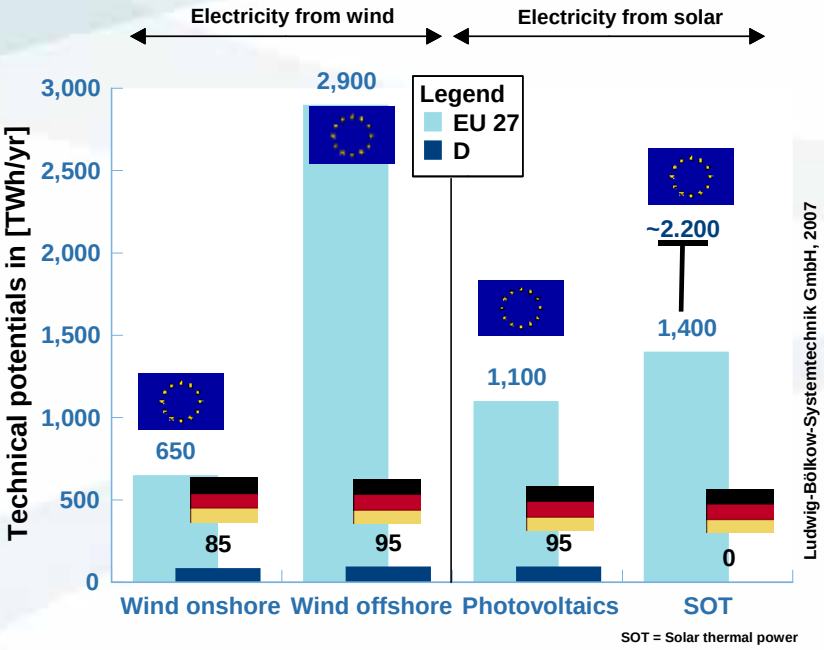
Air Liquide:		
Belgium, France, NL	966 km	10 MPa
Germany:		
Rhine-Rhur Pipeline [operative since 1938]	240 km	1.1/ 2.3/ 30 MPa
Leuna-Merseburg, Linde	100 km	2-2.5 MPa
Air Products Pipelines:		
Europoort, NL	50 km	
UK:		
ICI Teeside	16 km	5 MPa
Sweden:		
Chemical Industry	18 km	0.5-2.8 MPa

Linde H_2 pipeline network, Leuna, Germany

Renewable electricity potentials

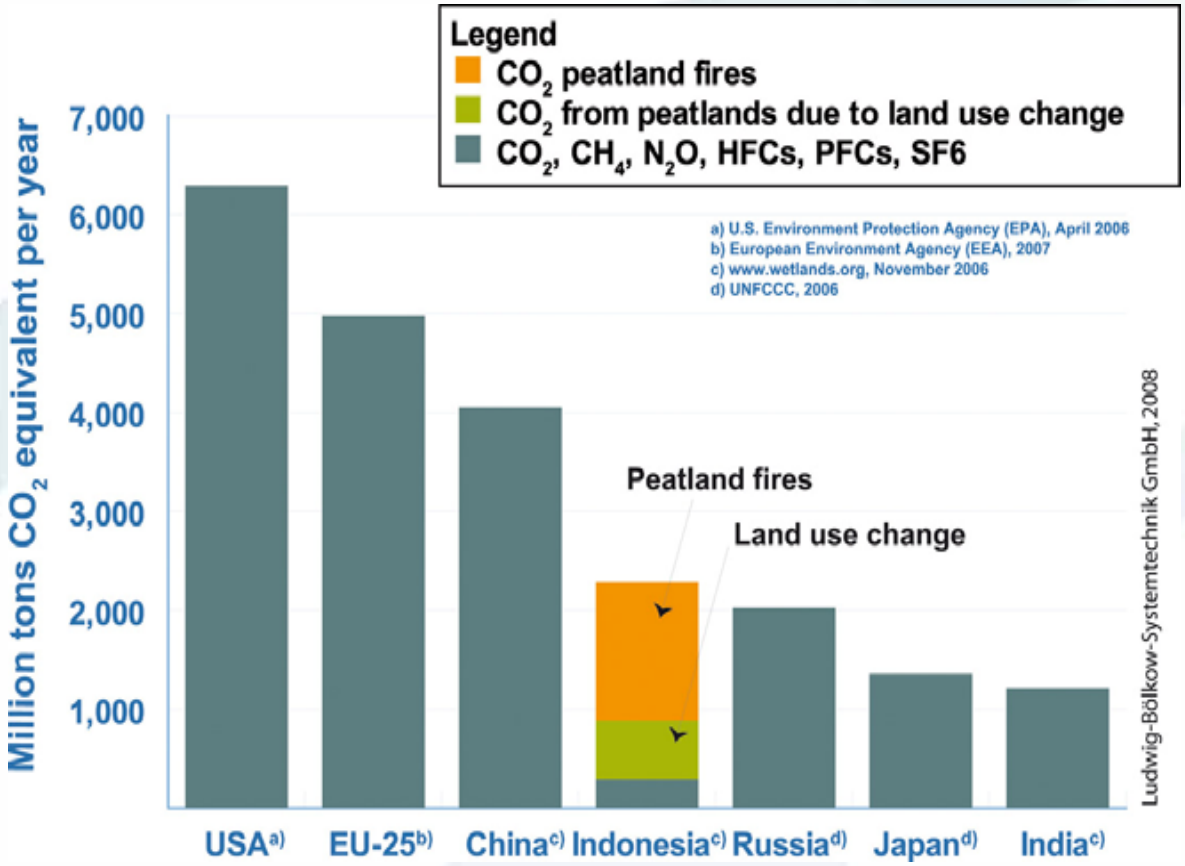


Technical potential of renewable electricity – worldwide



Technical potential of electricity production from wind and solar energy in Europe (EU) and Germany (D)

Biomass – GHG and potentials



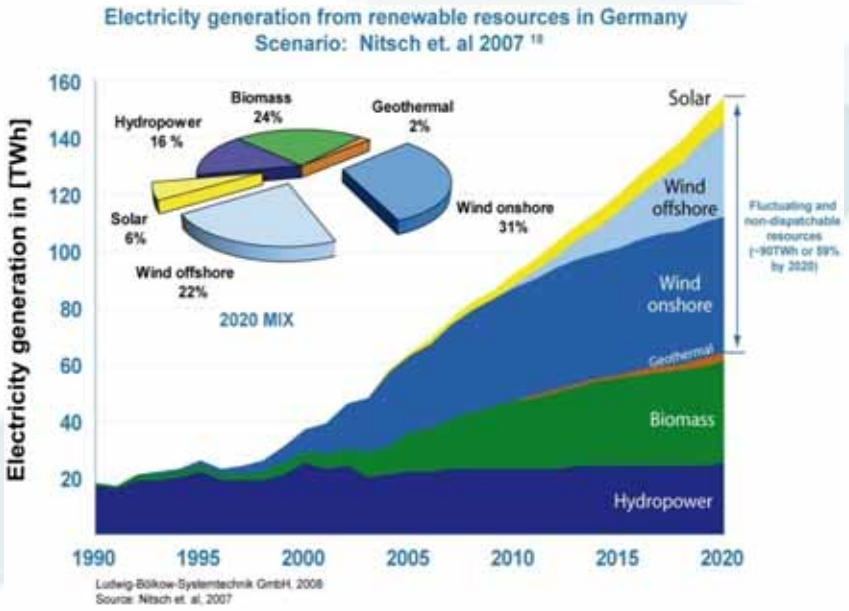
European potential

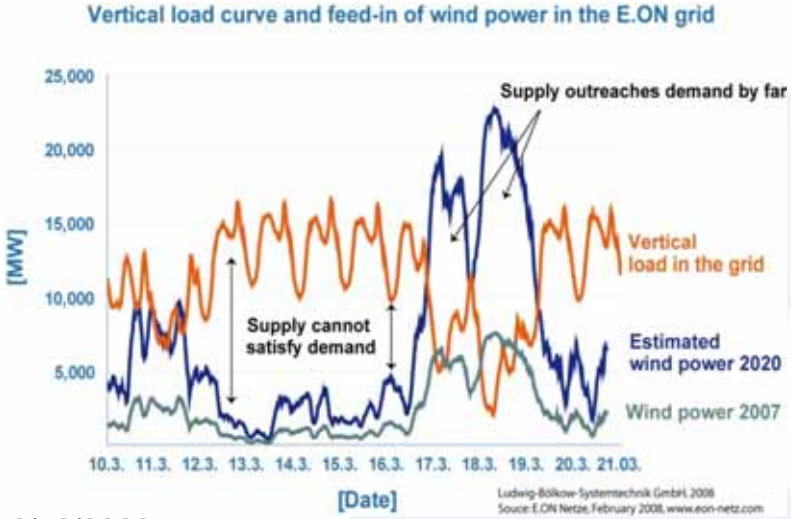
The potential of solid biomass within the EU amounts to about 7 to 8 EJ. Additionally the potential for biogas from residues amounts to about 0.6 to 1.0 EJ per year which is sufficient for the generation of about 50 to 90 TWh electricity per year.

The efficiency for the conversion of solid biomass to BTL is about 42% leading to a potential for BTL of about 3 EJ per year without taking into account the competing use of biomass in the stationary sector (heat and electricity generation). For comparison, the transport fuel demand in Europe in 2004 was 15.3 EJ (road: 12.7 EJ; aviation: 2.1 EJ; rail: 0.3 EJ; domestic navigation: 0.2 EJ) [Non-OECD 2006], [OECD 2006].

Short and medium term use of long term set aside land like pasture or permanent grass land are not an option for climate neutral biomass or biofuel production because carbon bound in the soil is emitted as CO_2 if permanent grass land is converted to arable land until a new equilibrium (the typical carbon content of arable land) is reached [Renewable Energy Directive 2008], [IPCC 2006].

Fluctuating renewable electricity





Scenario – renewable electricity in Germany until 2020

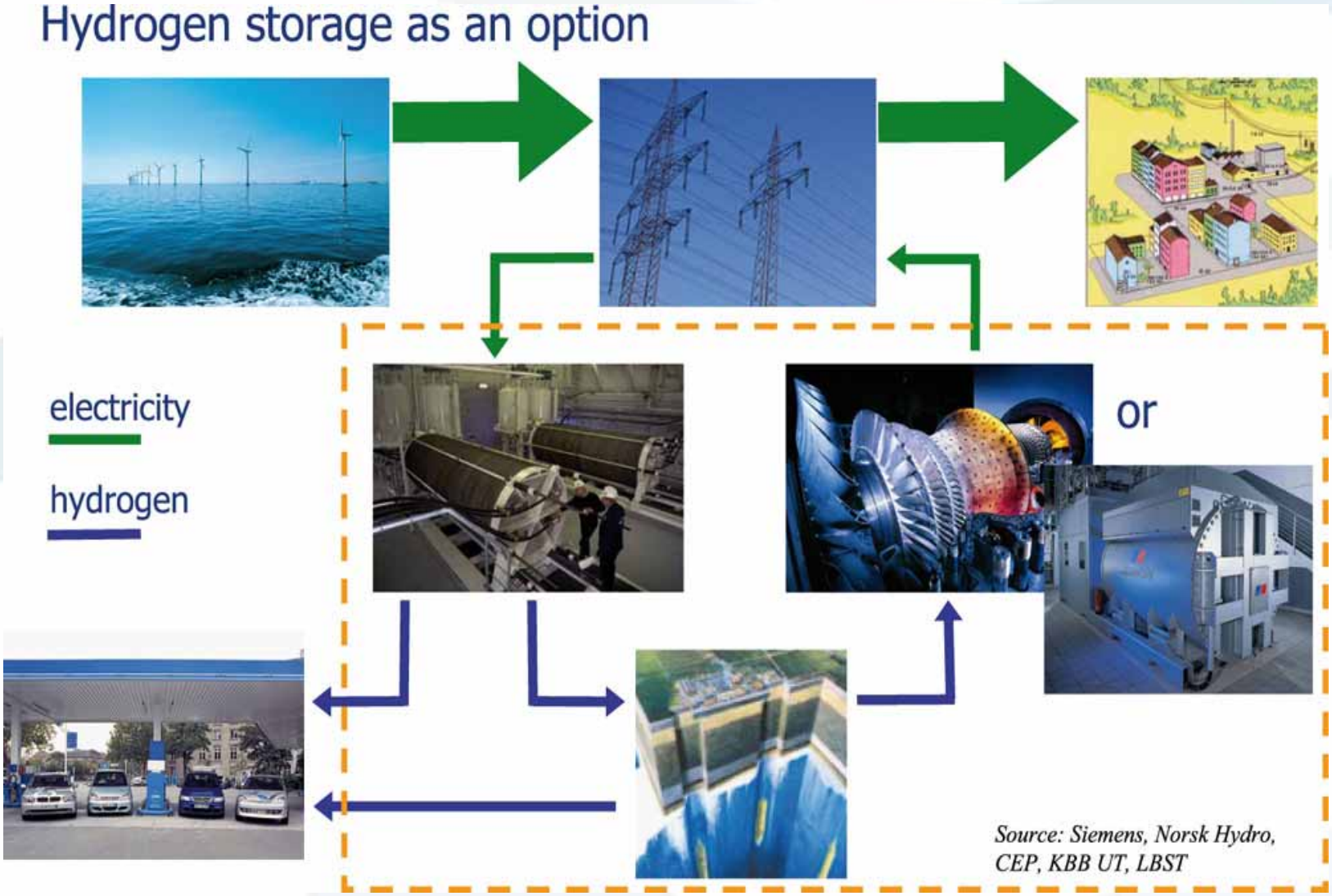
As can be seen in the figure the share of fluctuating and non-dispatchable renewable resources (onshore wind, offshore wind, solar) is increasing steadily reaching 59% of all renewable electricity in 2020 where offshore wind energy will be the main contributor to this growth.

The proportion of this fluctuating and non-dispatchable resources will amount to 90 TWh in 2020, about 3 times the value of 2006.

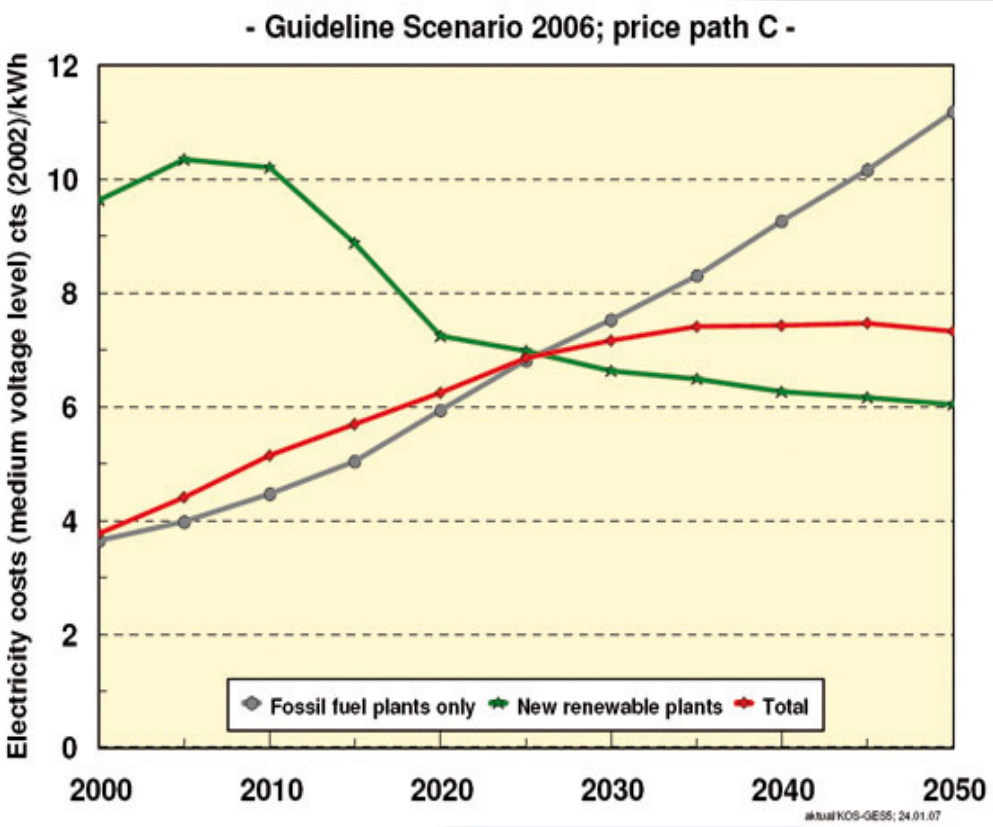
Fluctuations within the electricity grid

A factor of 3 is considered and shown by the dark blue line giving an example of how production from fluctuating resources may look like in 2020 (wind energy production of 2006 has been up-scaled by this factor). The graph shows that periods of very limited electricity production can last for several days (at special weather conditions even weeks) and that on the other hand **in periods of strong winds the electricity grid is not capable of absorbing the large amounts of energy**. Both weather conditions may occur also stretched over large areas.

Hydrogen as storage option



Competitive renewable electricity



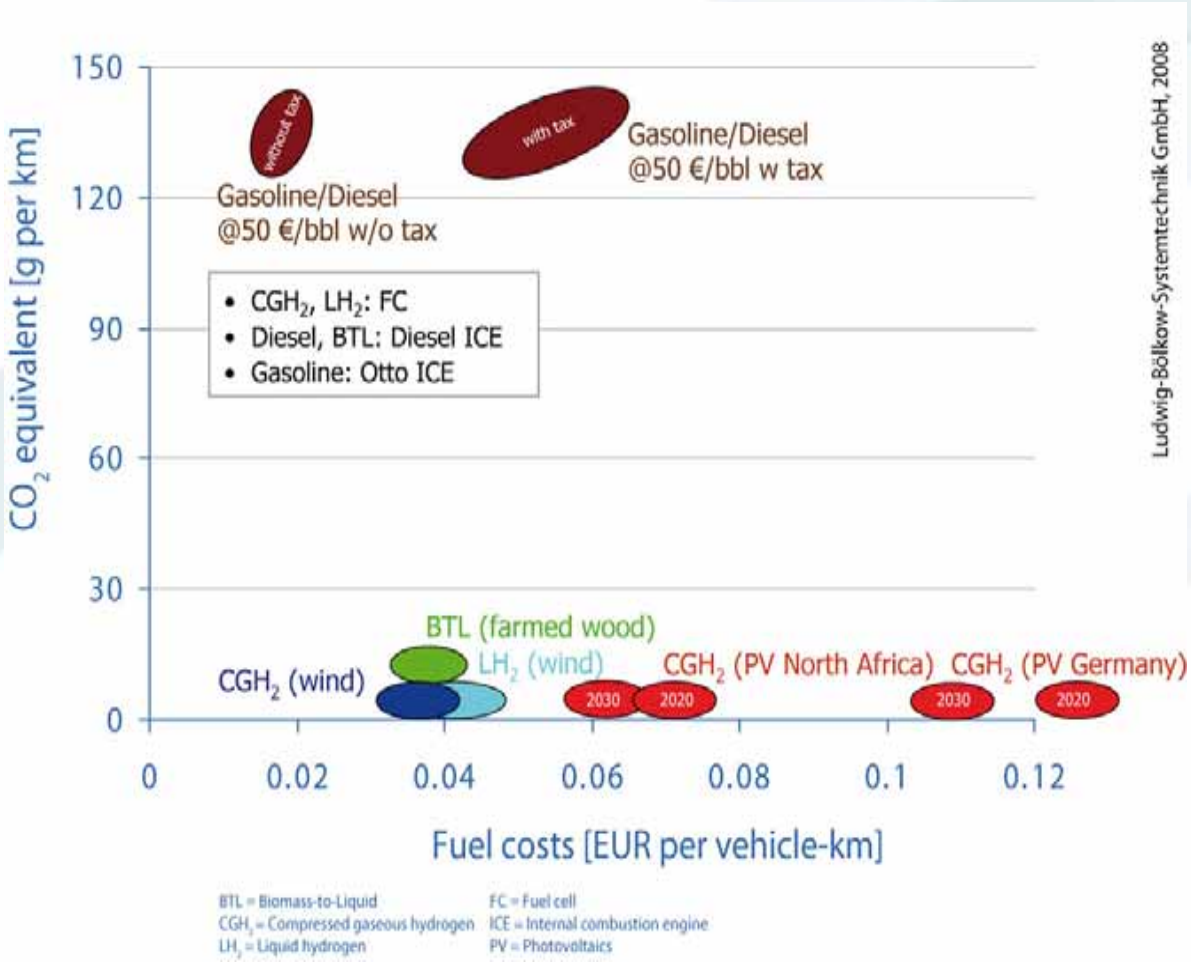
Average electricity cost scenario for renewable and fossil plants (without CCS)

The graph shows rising costs for fossil energy sources and decreasing costs for renewable energies depending on the assumption that the break-even point between fossil and renewable electricity production will occur sometime between 2020 and 2030.

Up to this date, the introduction of renewable energies will lead to higher average energy cost whereas after passing the break-even point, the growing contribution of renewable energy sources will reduce electricity costs compared to a purely fossil scenario.

[Source: Nitsch et. al 2007]

Costs of transport fuel



Major assumptions

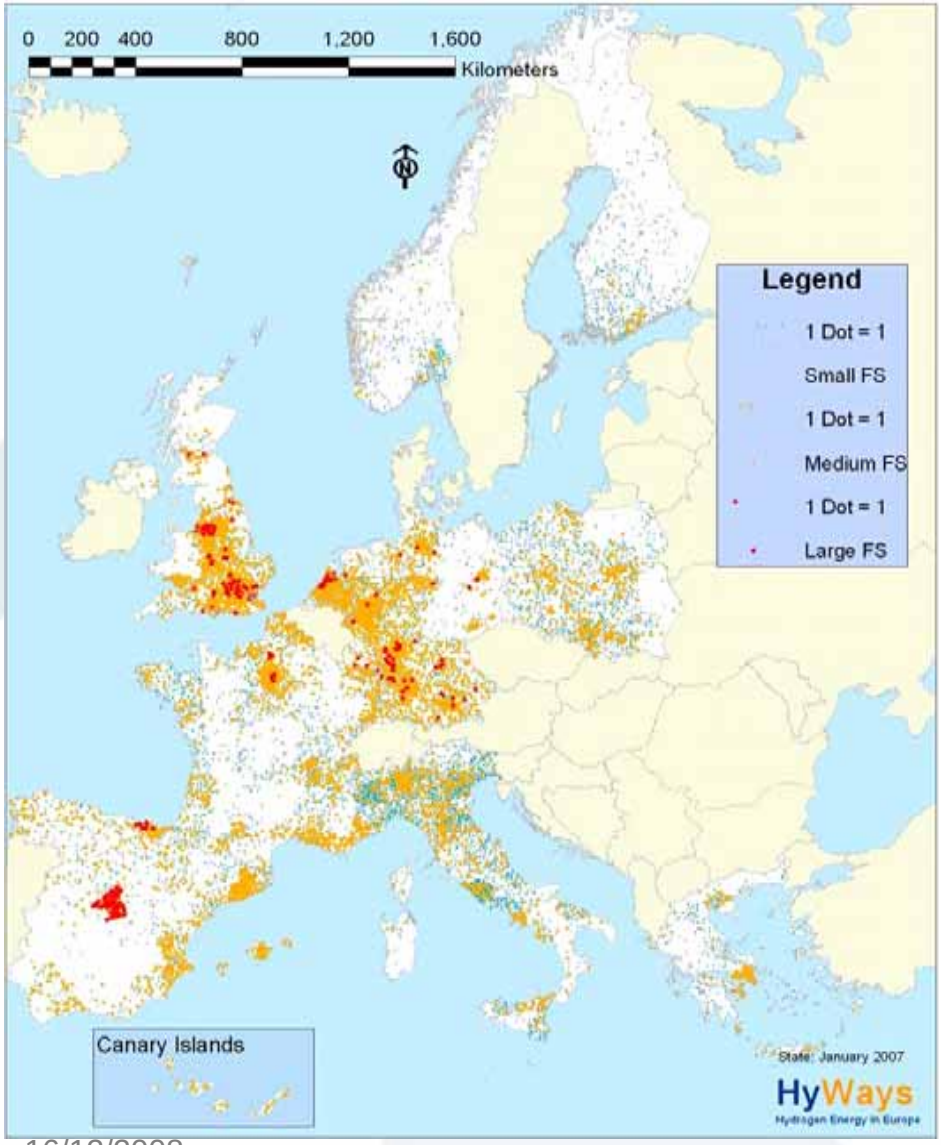
The fuel consumption of the hydrogen fuelled fuel cell hybrid vehicle is assumed to be 0.84 MJ/km (~ 2.6 l gasoline equivalent per 100 km).

The fuel consumption of the gasoline fuelled hybrid vehicle amounts to about 1.62 MJ/km (~ 5.0 l gasoline equivalent per 100 km)

and the fuel consumption of the diesel fuelled hybrid vehicle amounts to about 1.46 MJ/km (~4.5 l gasoline equivalent per 100 km or ~4.0 l diesel per 100 km).

The fuel consumption for the vehicles is derived from [CEJ 2007].

Implications of H_2 infrastructure



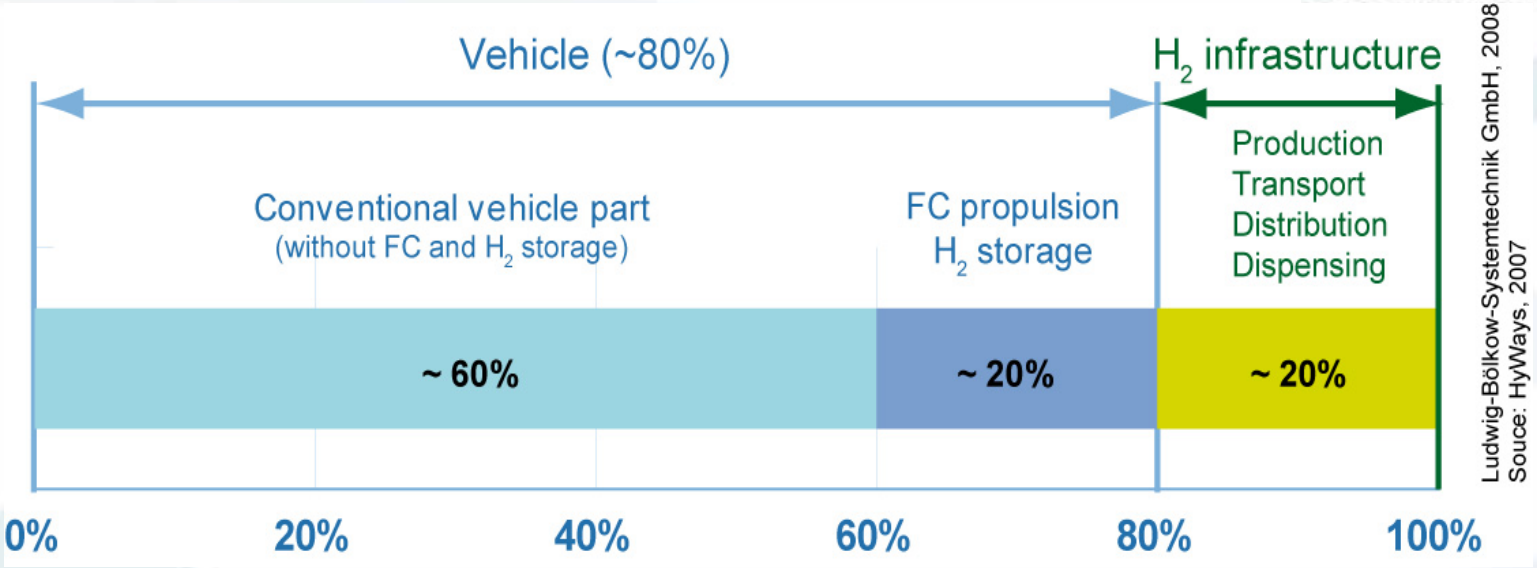
Between **2004 and 2007**, HyWays, an integrated project, co-funded by research institutes, industry and by the European Commission has developed a roadmap for the introduction of hydrogen as transport fuel in Europe [Source: HyWays 2007].

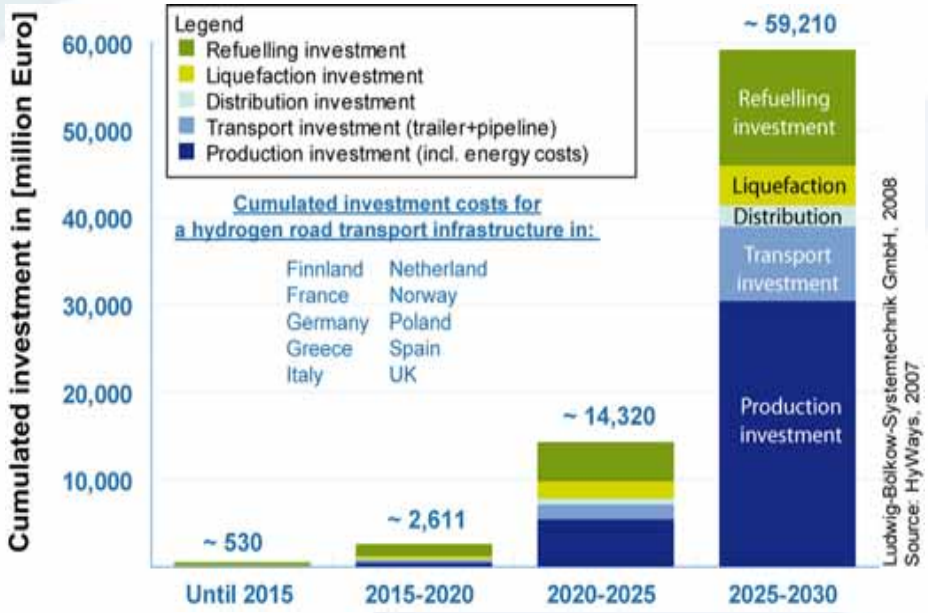
In the first phase (2010-2015)
limited number of small hydrogen refuelling stations (HRS) should be build within Europe. **400 local HRS** should serve hydrogen fuel for 10.000 vehicles and **another 500 HRS** would be required for selected "**hydrogen corridors**".

In the second phase (2015-2025)
bigger and **more HRS will be build**. Between **13,000 to 20,000 HRS** could provide hydrogen fuel for up to 10 million hydrogen vehicles.

After 2025,
the hydrogen infrastructure will gradually increase in extent and density to **approach coverage of conventional refuelling infrastruture.**

Cost H_2 supply and dispensing





Cumulative Investment Costs for a Hydrogen Road Transport System in 6 European Countries

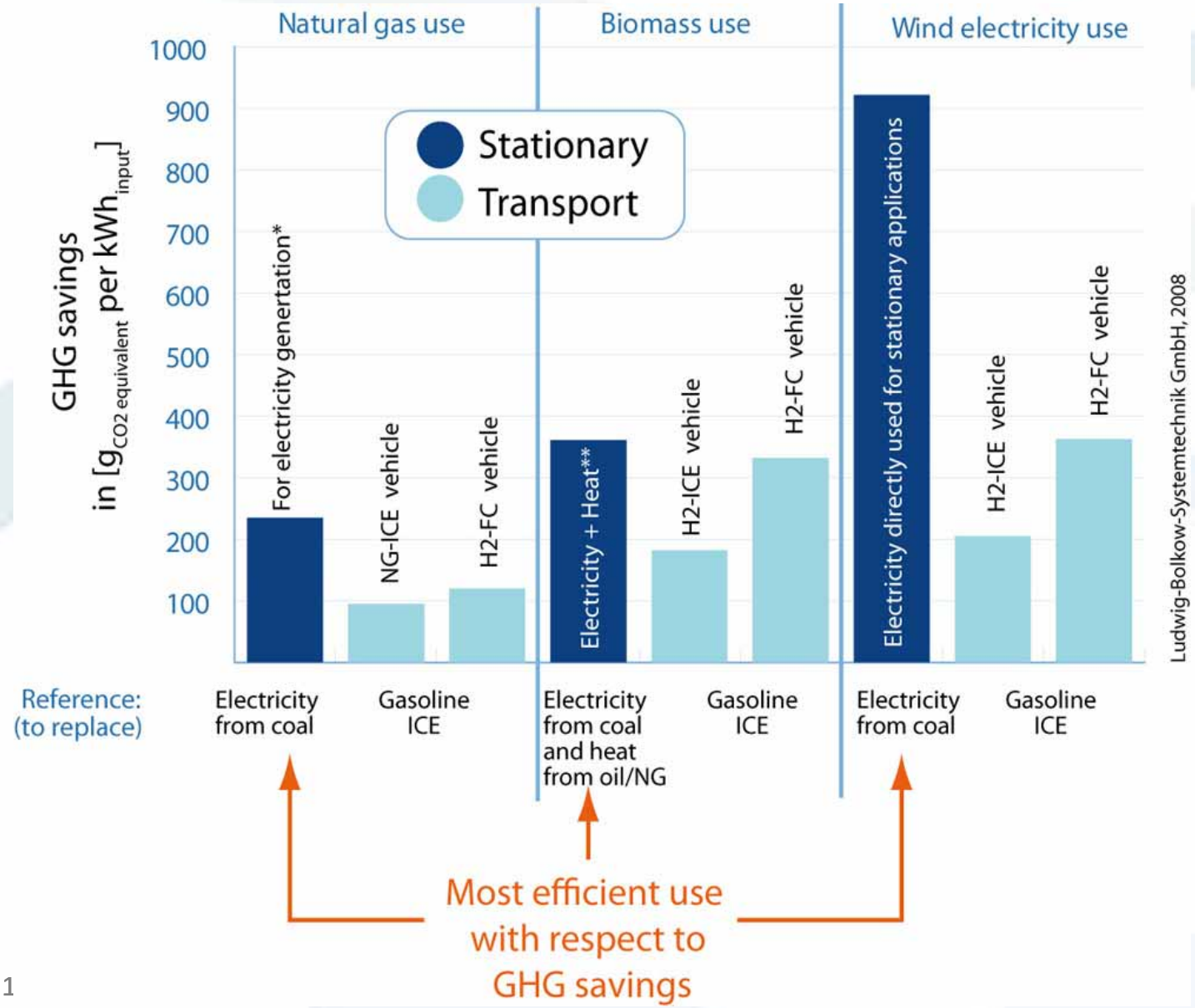
For a fully functioning hydrogen road transport system for a 2035, the HyWays project [www.hyways.de] assumed a scenario covering 6 European countries :be shown that

- more than **60%** of the total investment costs are for **conventional part of the vehicle**.

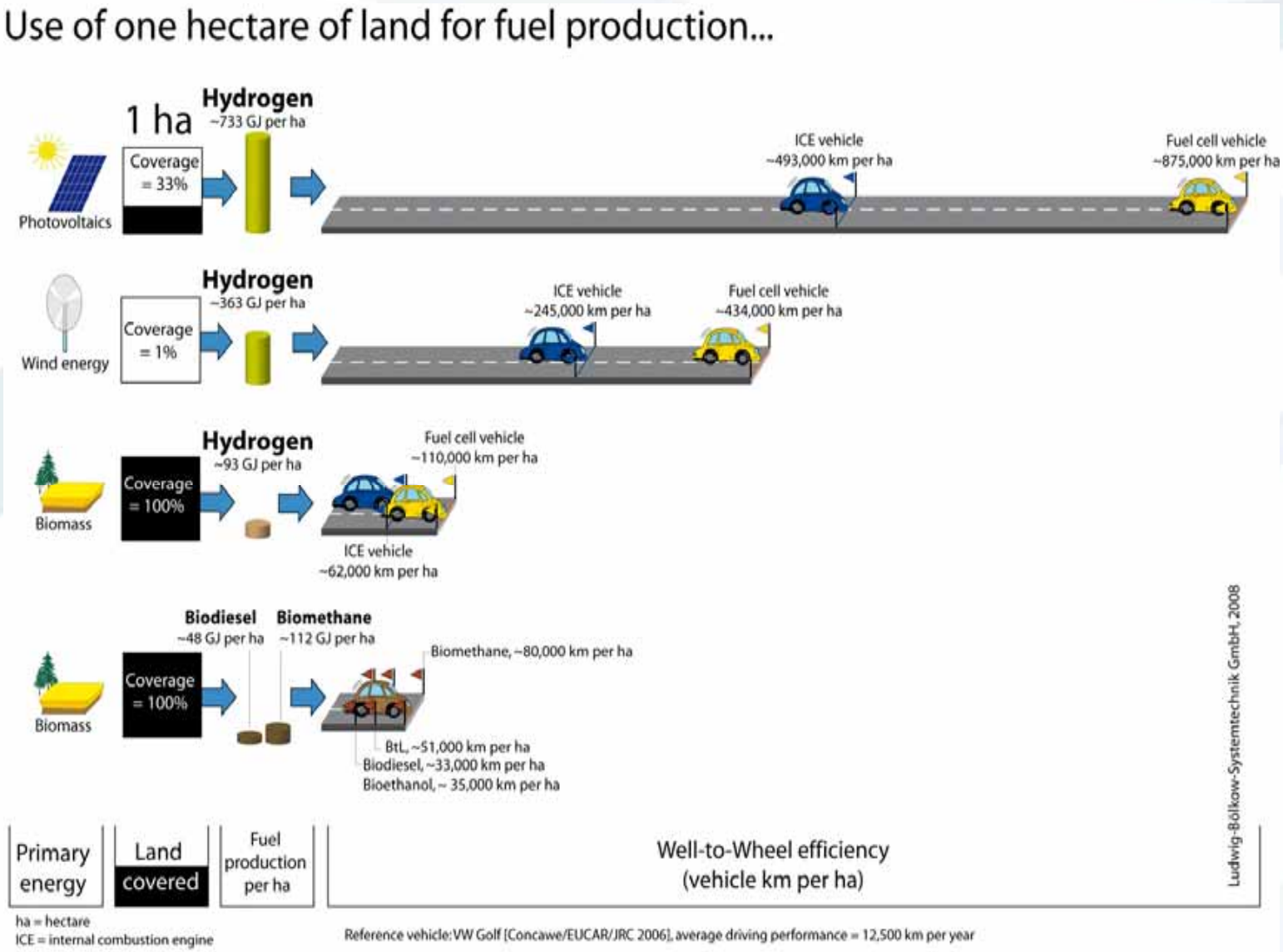
- **20%** are **H_2-specific onboard part** of the vehicle (e.g. FC and storage).

- **20%** are for the **H_2 production, transport, distribution and dispensing**.

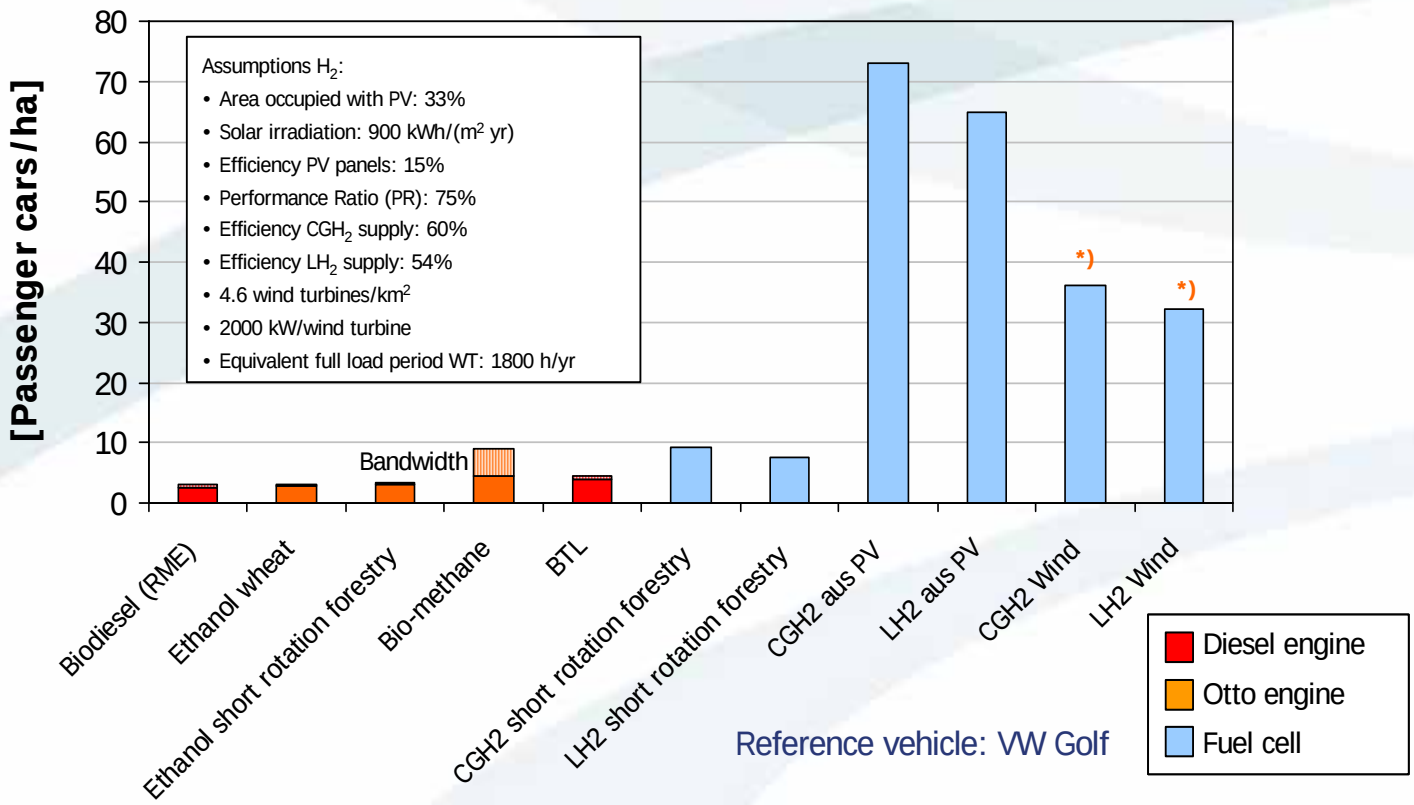
GHG emissions savings



Km per hectare yield



Vehicle per hectare yield



*) more than 99% of the land area can still be used for other purposes e.g. agriculture
Remark: wind energy convert units of 2 MWe today represent the bottom limit for wind park installation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Refueling Stations 2006
European hydrogen refuelling stations 2006

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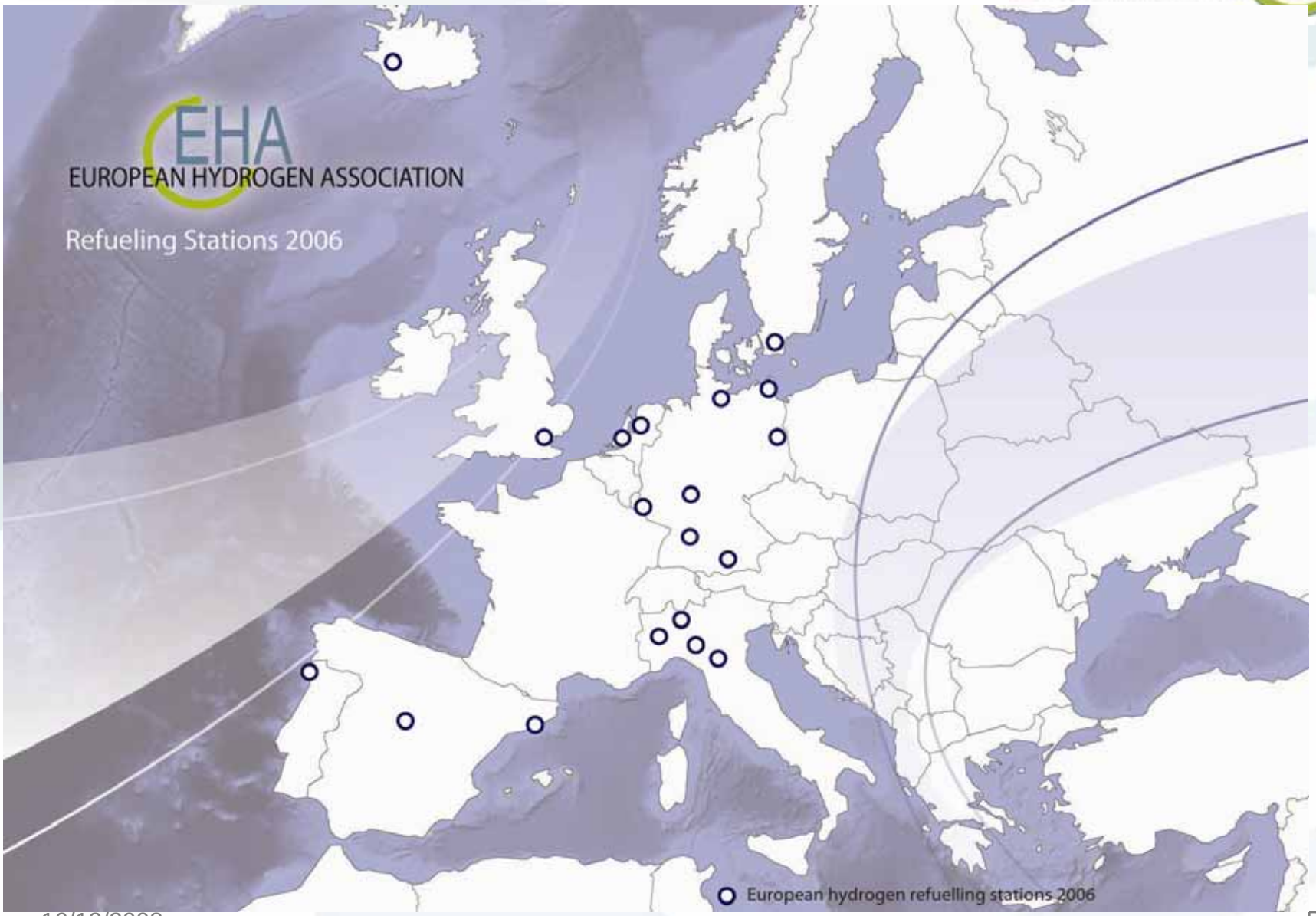
EHA Action Plan 2009

1. Prepare key messages for new EU Parliament and EU Commission; RE/H2 need to be part of Renewable Roadmap and finacing facility;

2. Clean energy technology integration in urban areas needs to include hydrogen and fuel cell applications: communication to High Level Group on Sustainable cities;

3. Together with national member associations address Steering Committee of EU Strategic energy Plan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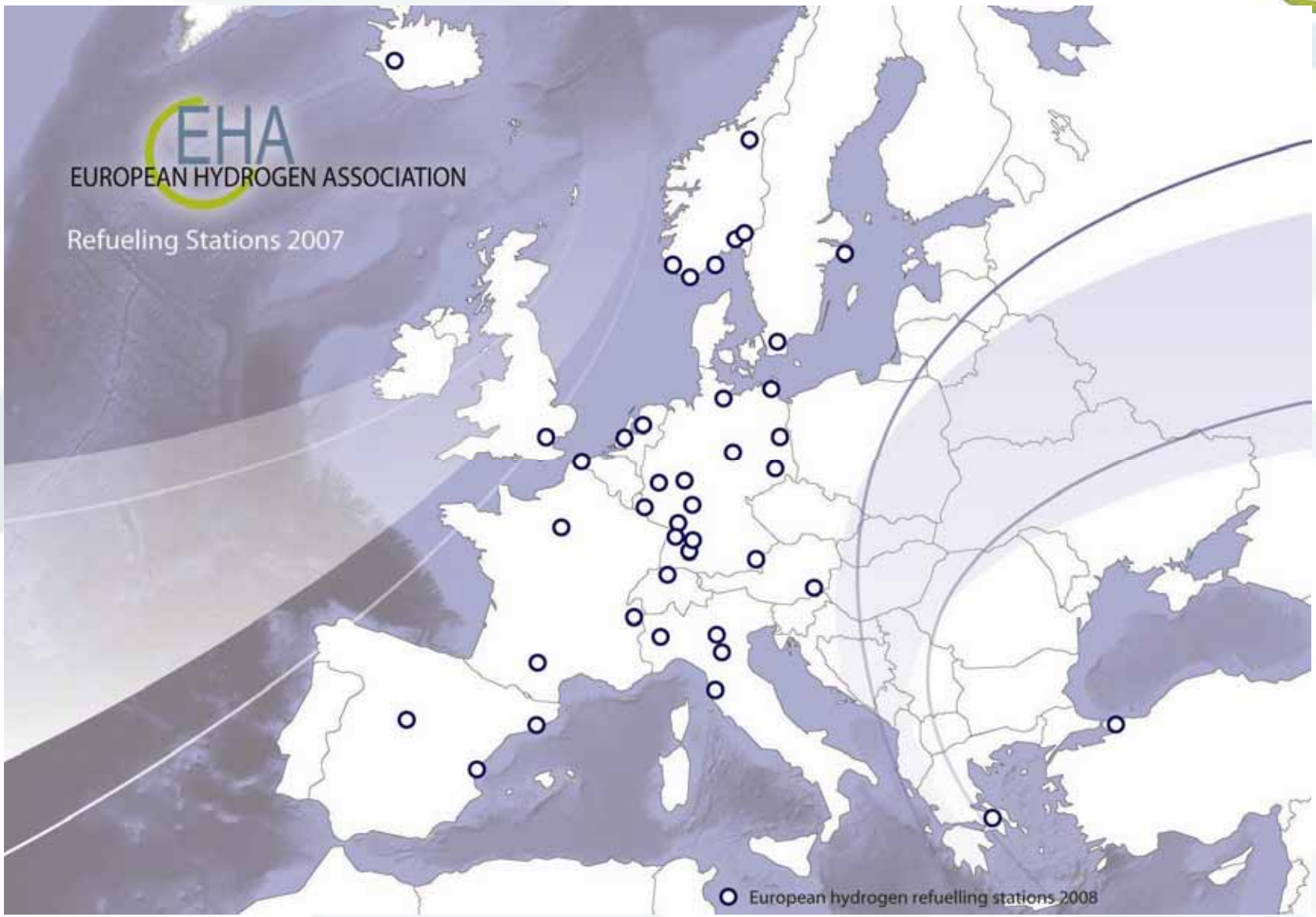
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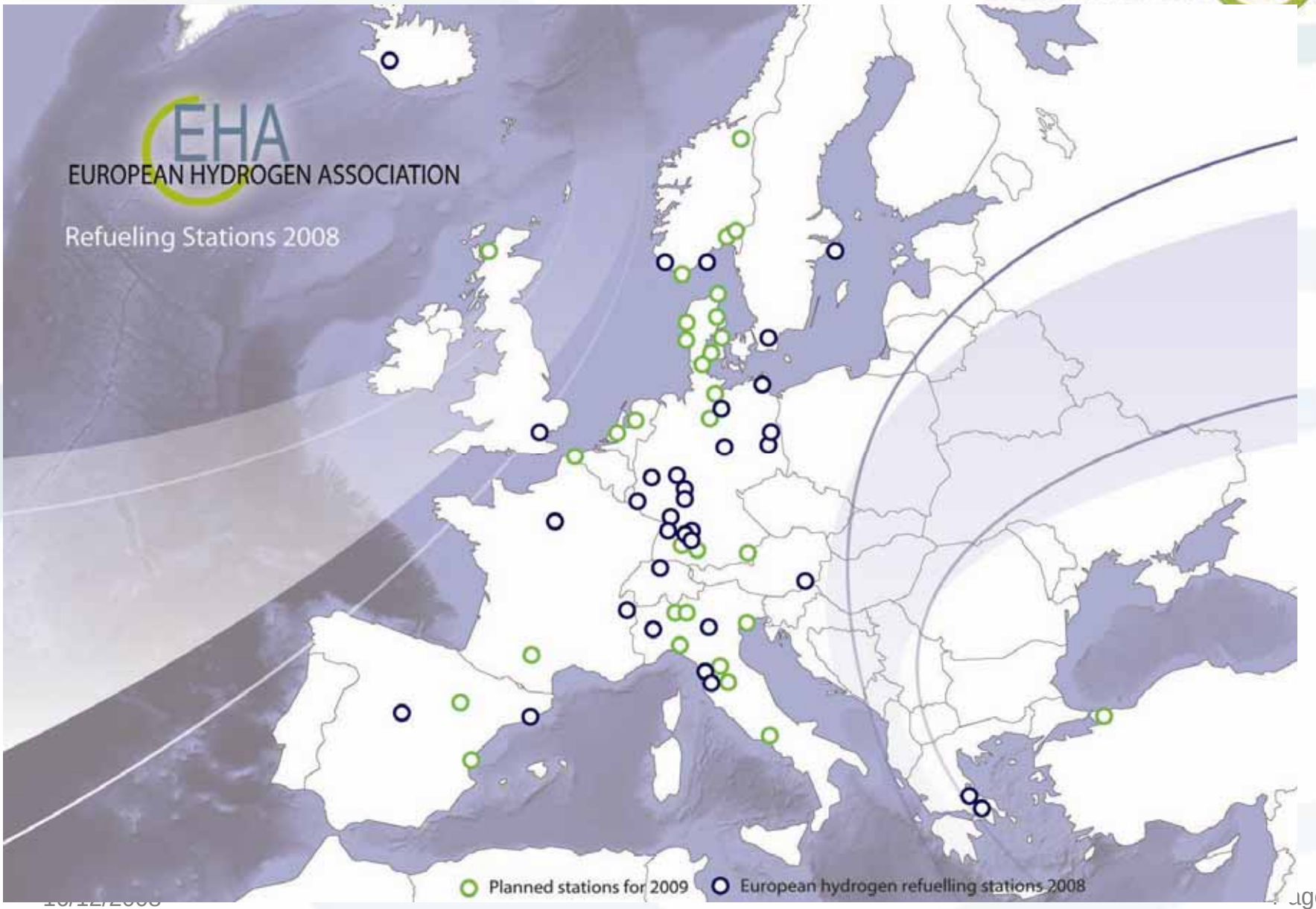
Refueling Stations 2007
European hydrogen refuelling stations 2008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Refueling Stations 2008
Planned stations for 2009
European hydrogen refuelling stations 2008

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