

HyWays

FIRST PHASE OF THE PROJECT

HYWAYS SCOPING REPORT

(DELIVERABLE D4.1)

Scope of the Roadmap

Baseline scenario

*Hydrogen penetration rates for
stationary and mobile applications*

October 2004

1 Introduction

The development of a Hydrogen economy could offer solutions to several major policy issues over the next decades. These include:

- Environmental Challenges – climate change and local air pollution
- Energy Security – diversity of supply
- Industrial Competitiveness – innovation and job creation

As a result, there is strong international interest in hydrogen activities and several initiatives can be observed in the EU, U.S., China and Japan. However, the introduction of hydrogen as a fuel will be a major technical and economic challenge and could have significant socio-economic impact, not least on existing, competing industries. To ensure the attractiveness of Europe for future hydrogen investment, both European and member states governments will need to develop long term strategies, so-called roadmaps, to set the framework for public and private sector investment in research, infrastructure and fiscal instruments.

The HYWAYS project is aimed at developing the fundamental data and analytical tools needed to help decision makers and hydrogen stakeholders to make key strategic policy decisions. Ultimately, a harmonized European roadmap is aimed at.

The European Hydrogen Roadmap should be balanced, avoiding both unrealistically high and too conservative targets. The roadmap should be ambitious in order to bring Europe to a leading hydrogen position. The aim of this Scoping Report is to put the European Hydrogen Roadmap into the right international perspective and to set the framework and key boundary conditions. The Scoping Report has the agreement of all partners of HyWays (Industry, Institutes, Member States) as well as the European Commission.

Within the Scoping Report the following issues will be dealt with:

- Scope of the Roadmap
- Baseline scenario
- Hydrogen penetration rates for stationary and mobile applications

In addition to the Scoping Report a Technical Annex will be developed. This Annex will specify the issues brought up in this Scoping Report in more detail in order to guide the HyWays modelling work.

2 Scope of the Roadmap

2.1 Timeframe

The timeframe of the Roadmap will cover the period until 2050. The transition period until 2030 will be focused on in detail, whereas the period after 2030 will be dealt with in a more visionary way.

2.2 Geographical coverage

In Phase I of the project a first order detailed Roadmap will be developed based on a country analysis of France, Germany, Greece, Italy, Norway and The Netherlands.

Phase 2 will be extended to an additional X number of additional Member States and the final output will be a harmonized European Roadmap in which also the remaining European countries will be included.

2.3 European hydrogen developments versus other areas in the world

One of the issues having a significant effect on the outcome of the calculations is the assumed learning effect of hydrogen technology with respect to cost reductions. A common way to assess cost reductions is to use 'learning curves'. Learning theory prescribes that every doubling of cumulative production will lead to a certain amount of cost reduction (determined by the "learning factor"). Within HyWays, the cumulative production of hydrogen technology within Europe will be determined. However, prices might fall much faster if the same technology is applied in other areas of the world. If hydrogen cars are introduced in the US, Japan and China at the same speed (or even faster) as in the EU, this affects the development of the total cumulative capacity and therefore the speed in which costs of e.g. fuel cells go down. Within HyWays, it will be assumed that developments outside the EU are in line with developments within the EU.

3 Baseline scenario

3.1 Key figures European Energy and Transport Trends 2030 (Primes)

In HyWays, a baseline scenario is needed in order to determine the impacts of a future hydrogen economy on e.g. security of supply, employment and greenhouse gas emissions. It has been decided to use the key macro-economic and demographic assumptions such as used in the "European Energy and Transport: Trends to 2030" (also known as the Primes scenario) as they are well documented and extensively communicated:

- Population growth
- Number of households
- GDP
- Industrial value added
- Development of energy demand
- Development of transportation activities
- Energy prices

Reference: http://europa.eu.int/comm/dgs/energy_transport/figures/trends_2030/index_en.htm

Forecasts of these parameters for the period 2030-2050 will be taken from other public available sources such as the United Nations (world population prospects).

3.2 Climate change policies and targets

In addition to the key-figures of the Energy Trend scenario, recent EU policy targets and instruments, which lack in Energy Trends, will be included in the HyWays baseline. The reason is twofold:

- Without these policies the major drivers for a transition to hydrogen are lacking
- A comparison of a baseline without a CO₂-reduction target with a hydrogen scenario that includes such a target will not result in a correct estimate of the effects from driving hydrogen applications into the market, since it includes the effects from introducing CO₂-targets at the same time. Assessing the costs of meeting climate change targets is not an objective of HyWays. HyWays aims to show the impact of hydrogen on costs, CO₂-targets, security of supply etc.

Relevant EU policy instruments and targets that will be included in the baseline are:

- GHG emission reduction targets for 2010, 2020, 2030 and 2050
- CO₂-emission trading

- Renewable energy targets for 2010, 2020, 2030 and 2050

In addition, the baseline should provide for actions related to the White Paper on Transport and the Green Paper on Security of Supply. These include for example the full implementation of the EU Directives on Biofuels, Energy Savings in Buildings, CHP, Large Combustion Plants and Integrated Pollution Prevention and Control (IPPC).

The EU long-term target to stabilize the atmospheric CO₂-concentration at the level of 550 ppm from 2050 will not be included in the baseline scenario (see section 4).

3.3 Geographical coverage of the baseline scenario

The baseline scenario will cover the EU-15 plus Norway, Switzerland and Iceland.

3.4 Sensitivity analysis

See deliverable 3.2.

4 Hydrogen scenarios + hydrogen penetration rates

Within HyWays two hydrogen scenarios will be developed:

- HyWays High
- HyWays Low

For the period until 2030 detailed simulations, i.e. six hydrogen energy chains per member state, will be carried out, whereas elaboration until 2050 will have a more visionary character, i.e. a high-level forecast of developments after 2030 including one “wildcard” hydrogen energy chain per member state.

In the hydrogen scenarios no extra policies / policy targets are added on top of the baseline scenario. This implies that the results show the impact of hydrogen on costs, CO₂-emissions, improved security of supply, industrial competitiveness and employment (see also 3.2). The CO₂-emissions and the related CO₂-concentration in the atmosphere in 2050 will be calculated for both the baseline scenario and the hydrogen scenarios. It will turn out whether the application of hydrogen technologies will yield a decrease of CO₂-emissions. If there is a decrease, then the contribution of hydrogen in meeting the 550 ppm target will be shown in comparing the CO₂-concentrations in the baseline with the concentrations in the hydrogen scenarios.

The first step in developing the HyWays hydrogen scenarios is to establish hydrogen penetration rates for the period 2010 – 2050. These hydrogen penetration rates need to be based on best-available expert views: they have to be ambitious though realistic. The analysis of the penetration scenario has to show that the hydrogen transition is realistic and preferable, solving various problems (such as greenhouse gas emission, other pollutant gasses, security of supply) under acceptable conditions (employment impacts, business for industry). In order to study the impacts of differences in hydrogen introduction speed, two hydrogen introduction scenarios will be used. In the following sections, proposals are given for mobile and stationary applications

4.1 Mobile applications

Regarding the overall energy policy goals on security of supply, strengthening of the European economy and reduction of GHG emissions, the road transport sector in general and passenger cars more specifically will experience the strongest long term impact.

Transition steps for hydrogen vehicles towards mass market penetration (Steering Panel Deployment Strategy - Draft Report 2004)

Step	Timing	Vehicle Maturity
1	Today until 2010	Demonstration of hydrogen powered vehicles in controlled fleets
2	>2010	Series production of hydrogen powered vehicles for fleets (1 st generation onboard hydrogen storage)
3	>2020	Series production of hydrogen powered vehicles in broad application (2 nd generation hydrogen on board storage and low-cost high-temperature fuel cell systems)
4	>2030-2040	Hydrogen becomes dominant technology in transport

Two scenarios have been developed to reflect the uncertainties regarding the technological breakthrough of onboard hydrogen storage between 2010-2020. The more conservative scenario (HyWays Low) assumes the mass market introduction will only happen around 2020, leading to a comparatively low population share of hydrogen vehicles in the order of 0.7% of all passenger cars. The innovative scenario (HyWays High) assumes a faster market introduction, leading to a potential share of 3.3% for hydrogen driven cars in 2020.

HyWays Scenarios for a potential development of hydrogen vehicles

Total share of car fleet [%]	2010*	2020	2030	2040	2050
High	-	3,3%	23,7%	59,5%	89,7%
Low	-	0,7%	7,5%	23,6%	47,7%

* demonstration vehicles and fleets

4.2 Stationary applications

The introduction of stationary hydrogen-based applications is influenced, though not determined, by a couple of country specific mediating factors such as type of existing infrastructure and the rate of replacement of this infrastructure. Within HyWays High it is expected that in 2050 10% of all households (dwellings) have installed a 1 kW_e hydrogen-driven micro-CHP system. Within HyWays Low 5% of all households are assumed to have a 1 kW_e system installed. In northern countries, micro-CHP is assumed to be mainly used for space heating, in southern countries for cooling. In addition the total hydrogen-based CHP installed in the tertiary sector (i.e. offices) is assumed to be 30% of the total power in the residential sector. Intermediate values for 2020, 2030 and 2040 will be derived through (non-linear) interpolation.

HyWays Scenarios for a potential development of hydrogen driven micro CHP in households

Total share of Households [%]	2010	2020	2030	2040	2050
High	-	1%	4%	8%	10%
Low	-	0.1%	0.5%	2%	5%

HyWays Scenarios for a potential development of hydrogen driven micro CHP in offices

Total share of Households [%]	2010	2020	2030	2040	2050
High	-	0.3%	1.3%	2.7%	3.3%
Low	-	>0%	0.2%	0.7%	1.7%

4.3 EU and MS / regional level

HyWays will not only deal with development on the EU level but also on the MS / regional level. The scoping report however sets the boundaries on the EU level. Downscaling to MS level is done

taking into account MS-specific conditions (policy, demography, geography etc.). However, MS-specific developments need to be consistent with the general European perspective.