

HyWays
A European Hydrogen Roadmap Project

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on behalf of the HyWays Consortium

www.hyways.de

HYPROSTORE

TUBITAK, Turkey, 13 April 2006

Motivation

Project goals

Partners

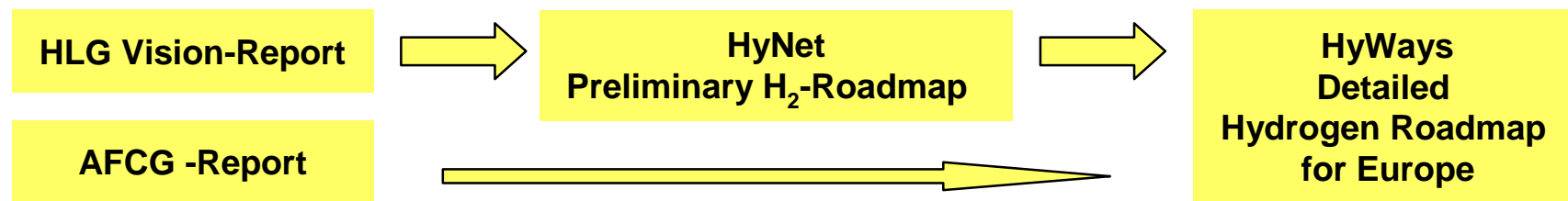
Methodology

Preliminary results

Acknowledgement

Motivation

Need for a European hydrogen energy roadmap as orientation and decision basis for industry and politics



Project goals

“If hydrogen has an X share in the future energy system...

- no prediction, no commitment, but **plausible assumptions**

... then what is the impact...

- on **greenhouse gases** and other **emissions**, **economy**, **industry** and **society** (competitiveness, employment)

... and how can we get there?”

- **Scenarios** for market introduction of hydrogen applications (vehicles, CHP, ...), infrastructure build-up and energy diversification (hydrogen production)
- **Recommendations** to EC, Member States and industry

Partners

Partners

HyWays

Industry



Member states

SenterNovem

Institutes

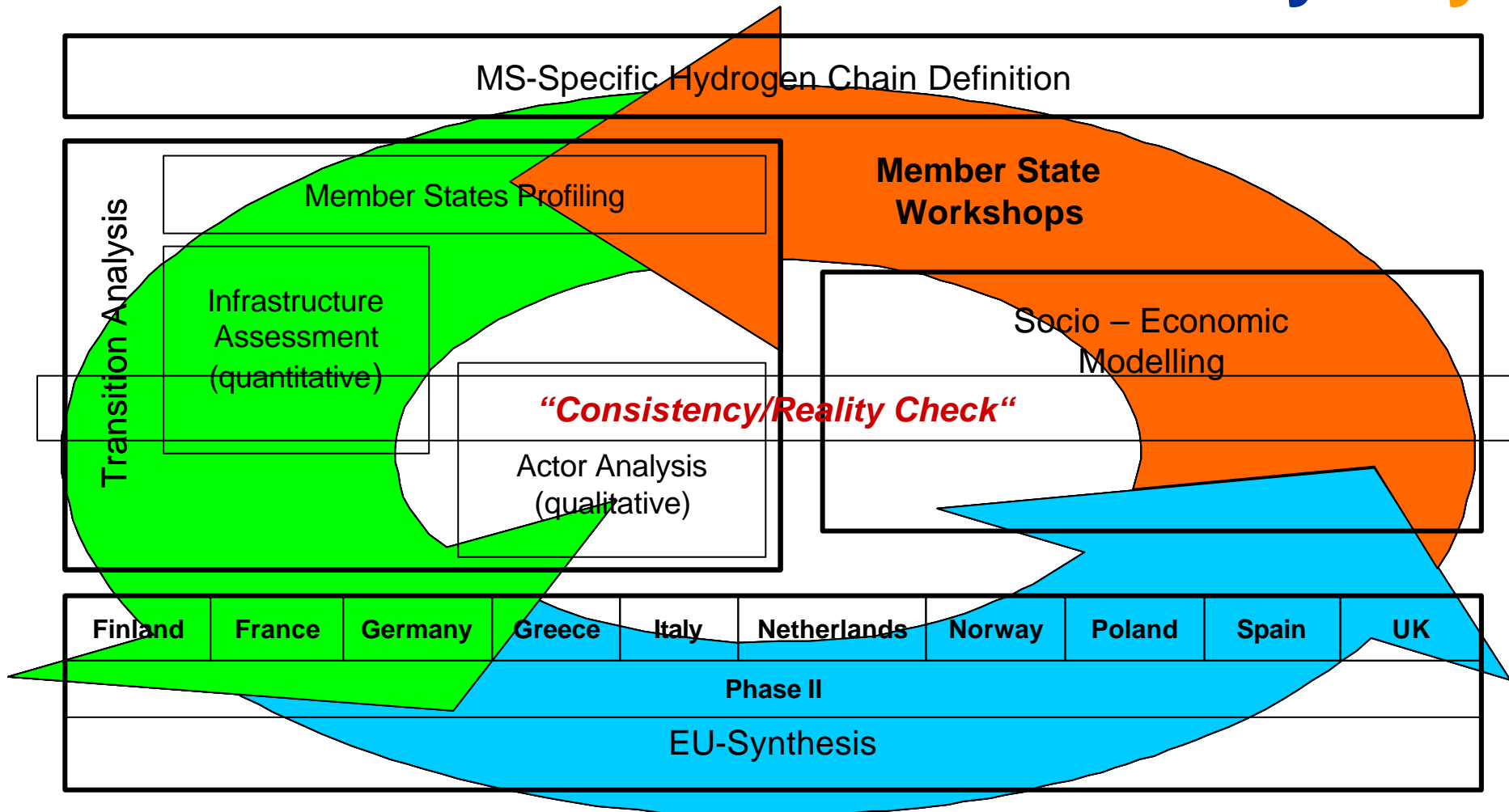


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APR 04 - MAR 07 in 2 phases of 18 months each; 7.9 M€budget and 4 M€EU funding

Methodology

Methodology (1) - Major Tasks and Their Cohesion

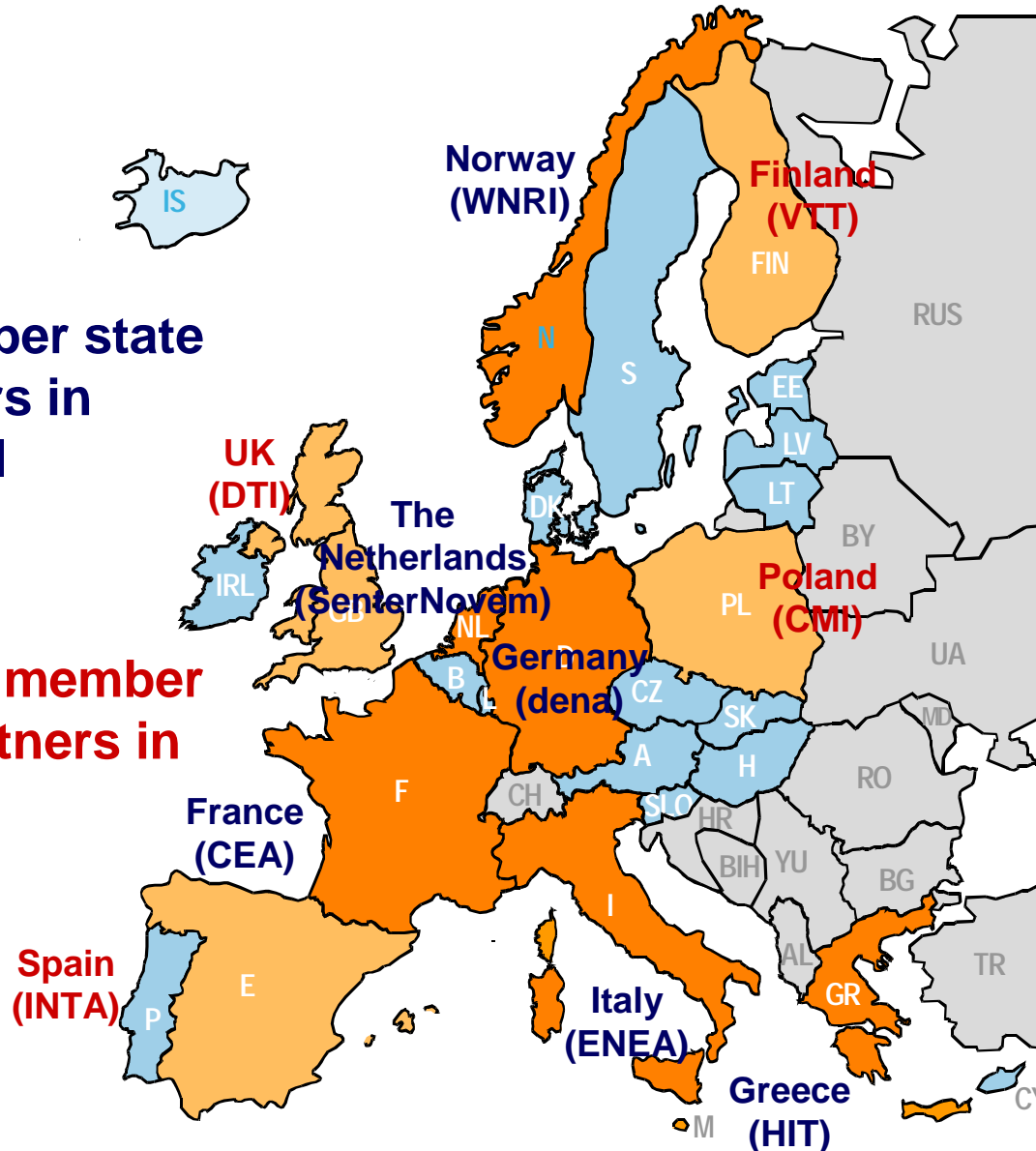


Methodology (2) - Geographical Representation of MS



6 member state partners in Phase I

4 further member state partners in Phase II



TIME HORIZON

2010 / 2020 / 2030 / 2050

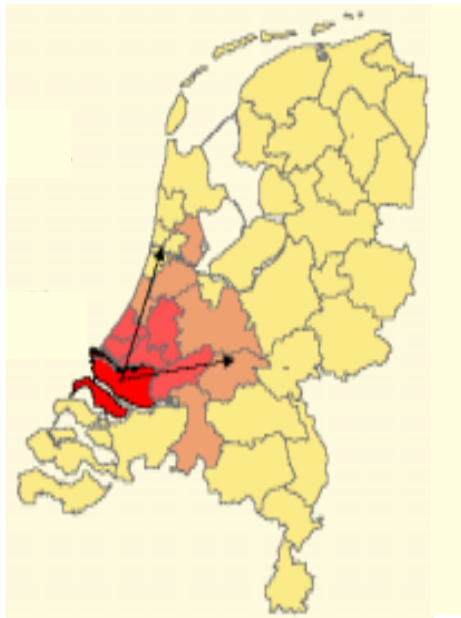
	Coverage [%] by	
	land area	population
Phase I	49,7	39,2
Phase I+II	80,5	71,4

Preliminary results

- HyWays – A European Roadmap – Assumption and robust results from Phase I
- Phase I flyer and glossy external publication on the public website (<http://www.hyways.de/docs/main1.html>)
- Kick-Off Workshop incorporating further 4 member states in Phase II held in Frankfurt on 20 March 2006
- 6 Phase I modelling reports and one Background Document submitted to EC by 13 January 2006
- EU HFP AC recognition as "Special Initiative Group" for Roadmapping (now handled by one of the HFP IP Vice Chairs)
- IPHE project recognition achieved
- Member state profiling reports for D, F, GR, I, N and NL
- Up to six hydrogen energy chains WtW and StU for D, F, GR, I, N and NL

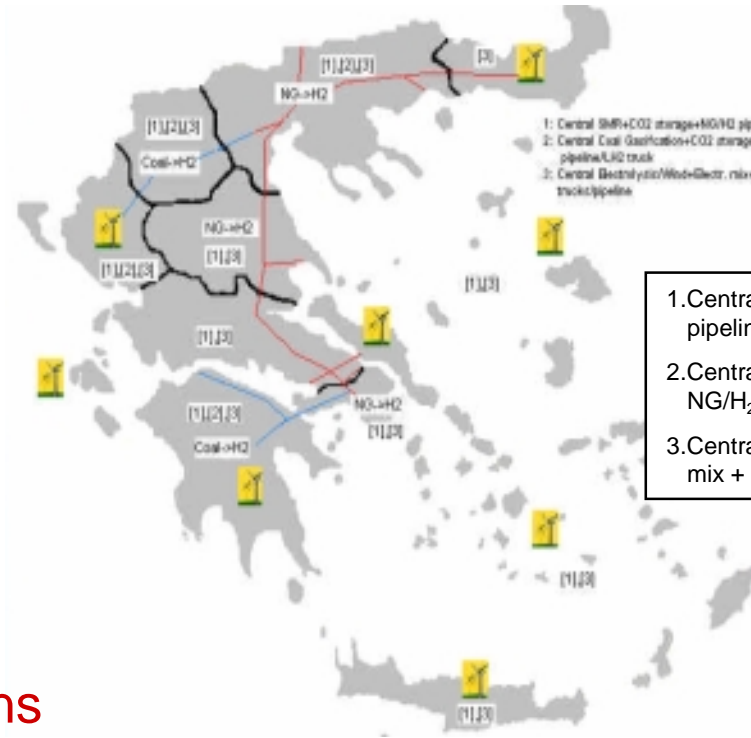
- D: Lacking primary energy potentials require high degree of diversification
- F: Vision of CO₂-free hydrogen production from nuclear energy (electrolysis, HTR thermocycle) and from biomass
- GR: Large demand in distributed solutions for islands, CHP
- I: Strong political interest in CCS for combined CO₂-free production of electricity and of hydrogen as vehicle fuel
- N: Renewable energies and potentials for carbon sequestration
- NL: Focus in transition on natural gas and pipeline-based solutions

**Challenge to synthesise different strategies,
arising from fertile European diversity,
into one harmonised European Hydrogen Energy Roadmap**



The Netherlands H₂ Vision

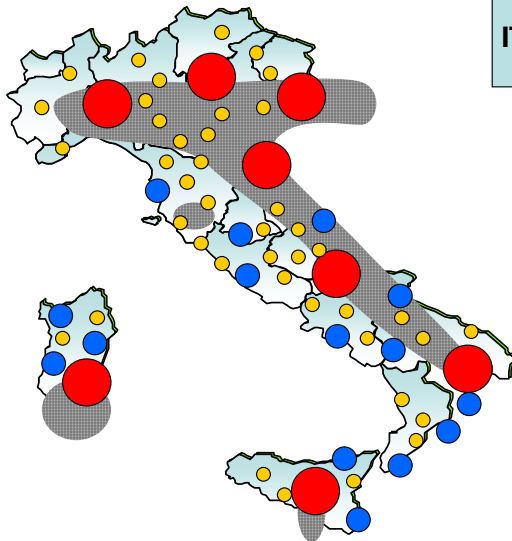
Pipeline grid: Central hydrogen production capacity located e.g. in Rijnmond area. Infrastructure can grow to neighbouring regions.



Greece H₂ Vision

1. Central SMR + CCS + NG/H₂ pipeline/LH₂ truck
2. Central coal gasification + CCS + NG/H₂ pipeline/LH₂ truck
3. Central electrolysis/wind + EL mix + H₂ pipeline/LH₂ trucks

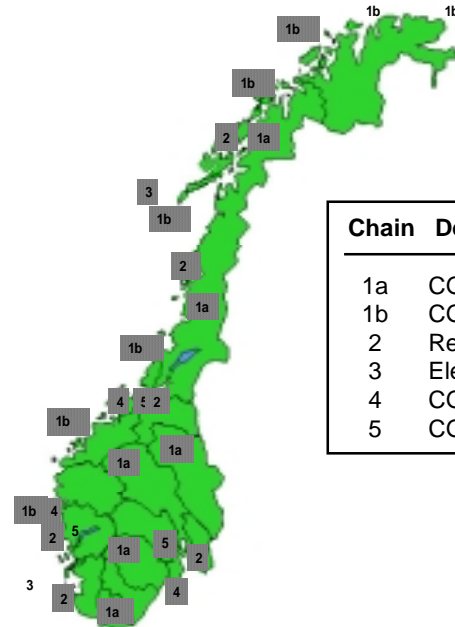
Member and Associate States Visions



ITALY H₂ Vision

Source: Italian Ministry for the Environment, 2004

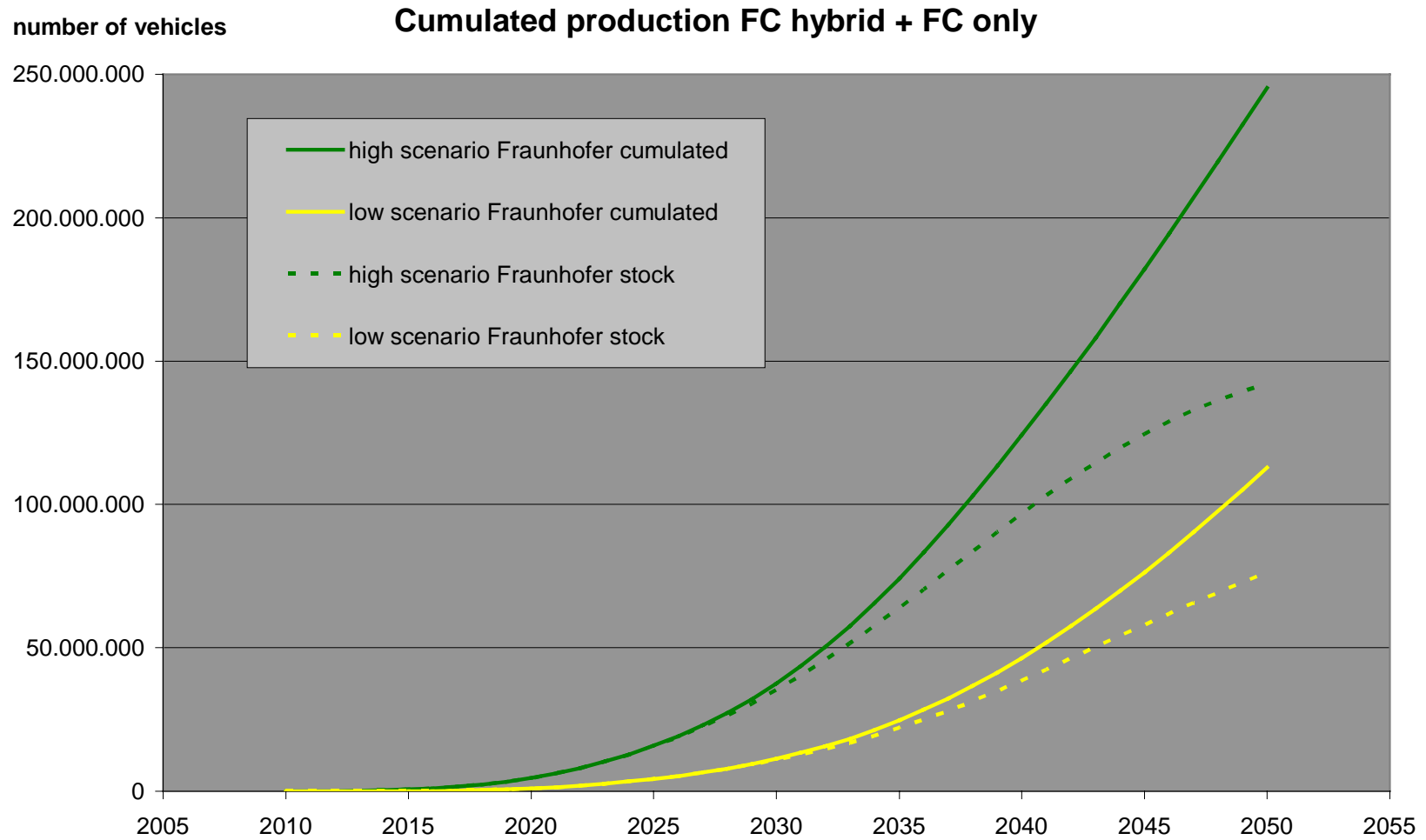
- Possible sites for CO₂ geological sequestration
- Hydrogen Hub Fossil Fuel based
- Hydrogen Hub Solar Energy based
- Hydrogen Hub Biomass based



Norway H₂ Vision

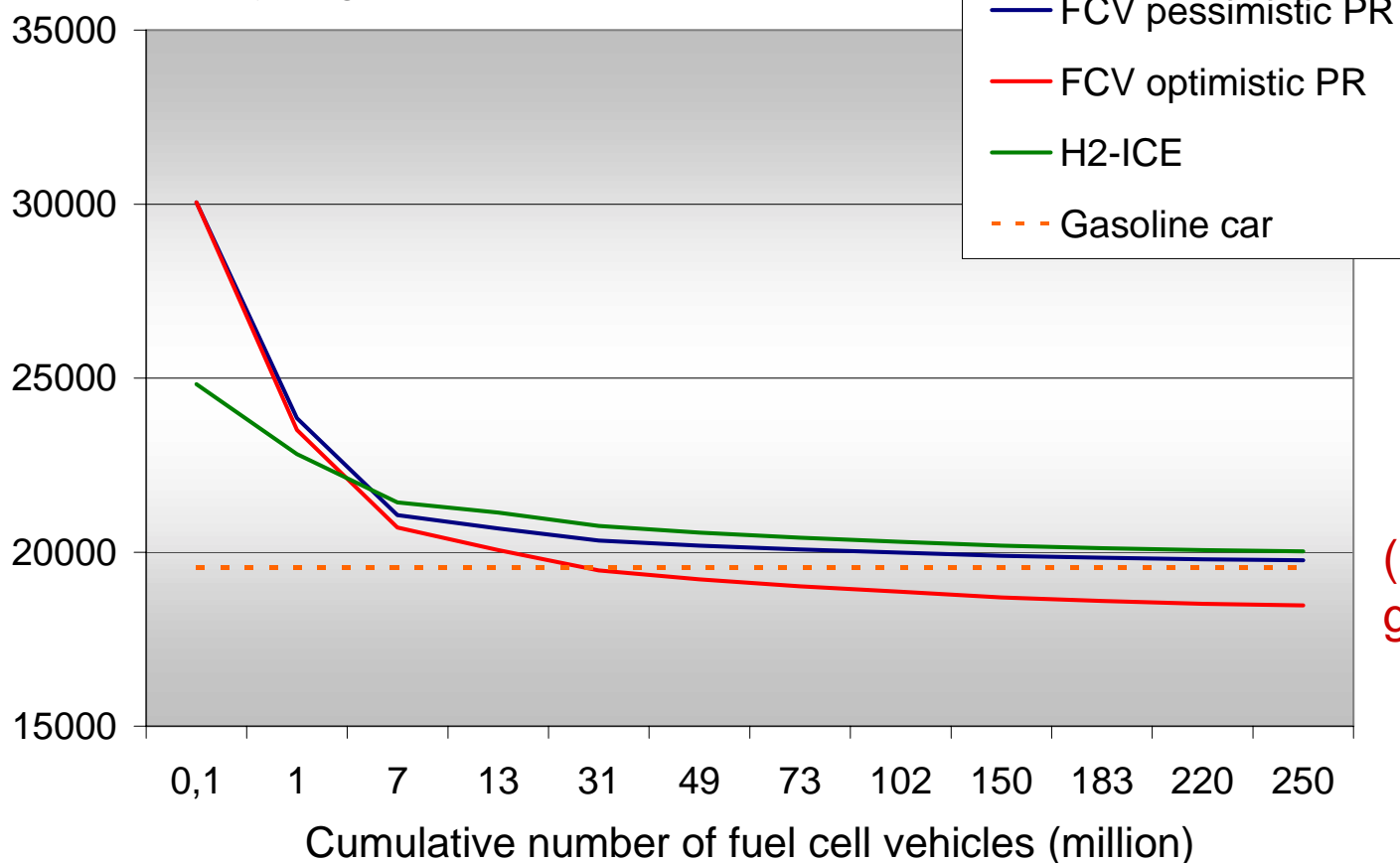
Chain	Description
1a	CGH ₂ local electrolysis „NordPool electricity“
1b	CGH ₂ local electrolysis „new renewables“
2	Regional SMR
3	Electrolysis from remote wind („Utsira“)
4	CGH ₂ by-product hydrogen (NG for substitution)
5	CGH ₂ biomass (e.g. wastewood)

Production curve of FC cars



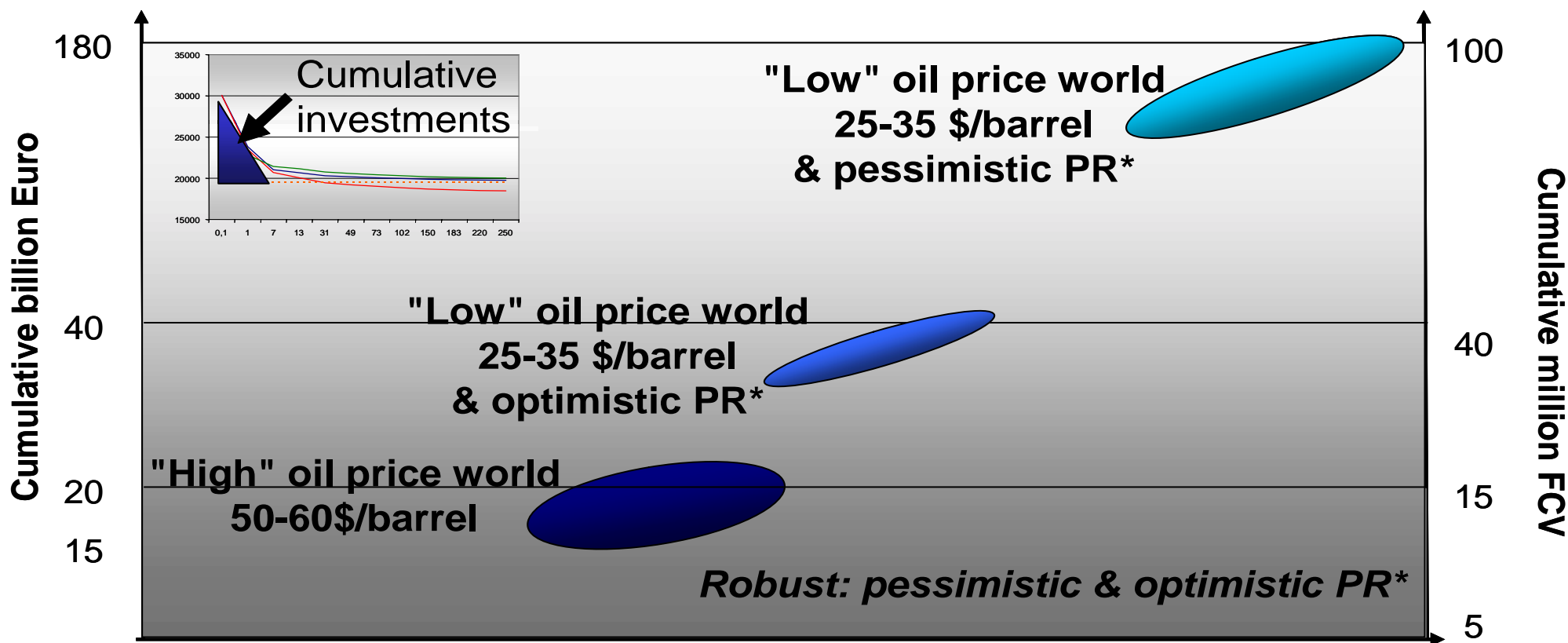
Cost reduction of hydrogen cars (only medium class cars) shown for two progress ratio scenarios

Retail price of hydrogen vehicle



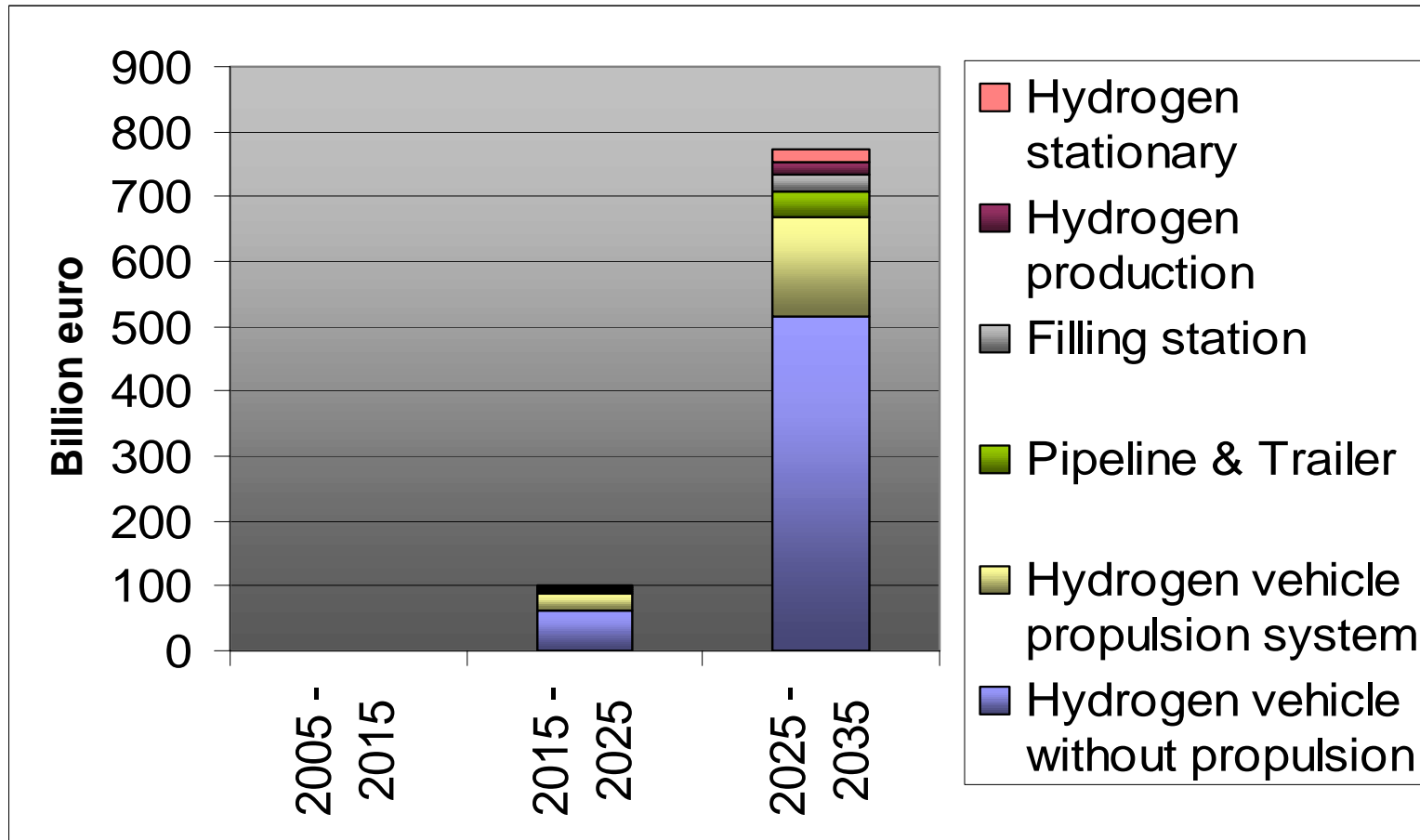
(reference is 2010 gasoline car)

Accumulated investments in hydrogen vehicles and number of cars until cost-competitiveness of FCV is reached



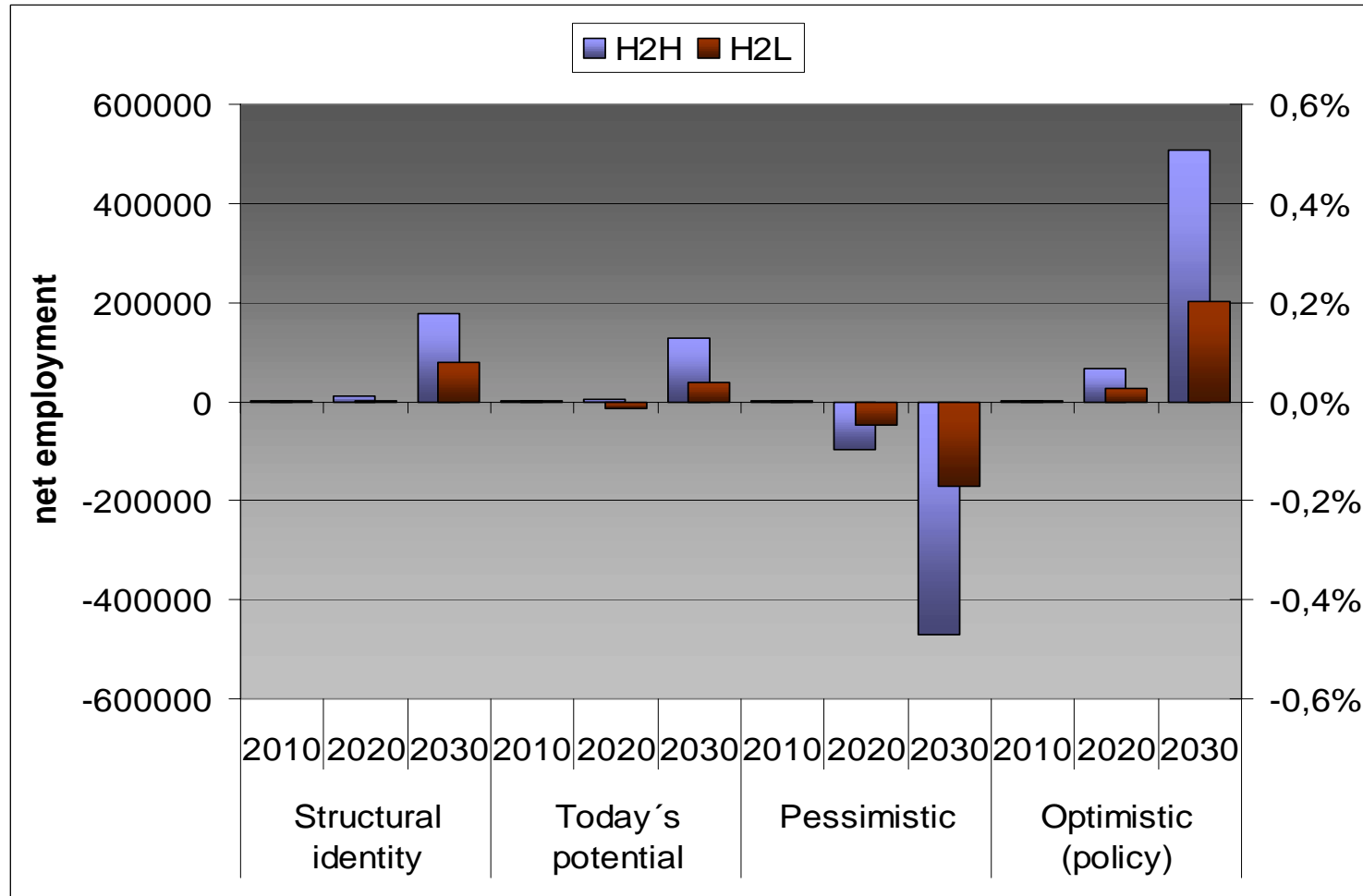
(without externalities and interest rate, from the beginning of mass production {€ 10,000 more for a fuel cell car}, worldwide)

Structure of the investments in a hydrogen economy of the six HyWays countries



(cumulative investments for a ten-year period, hydrogen high penetration scenario)

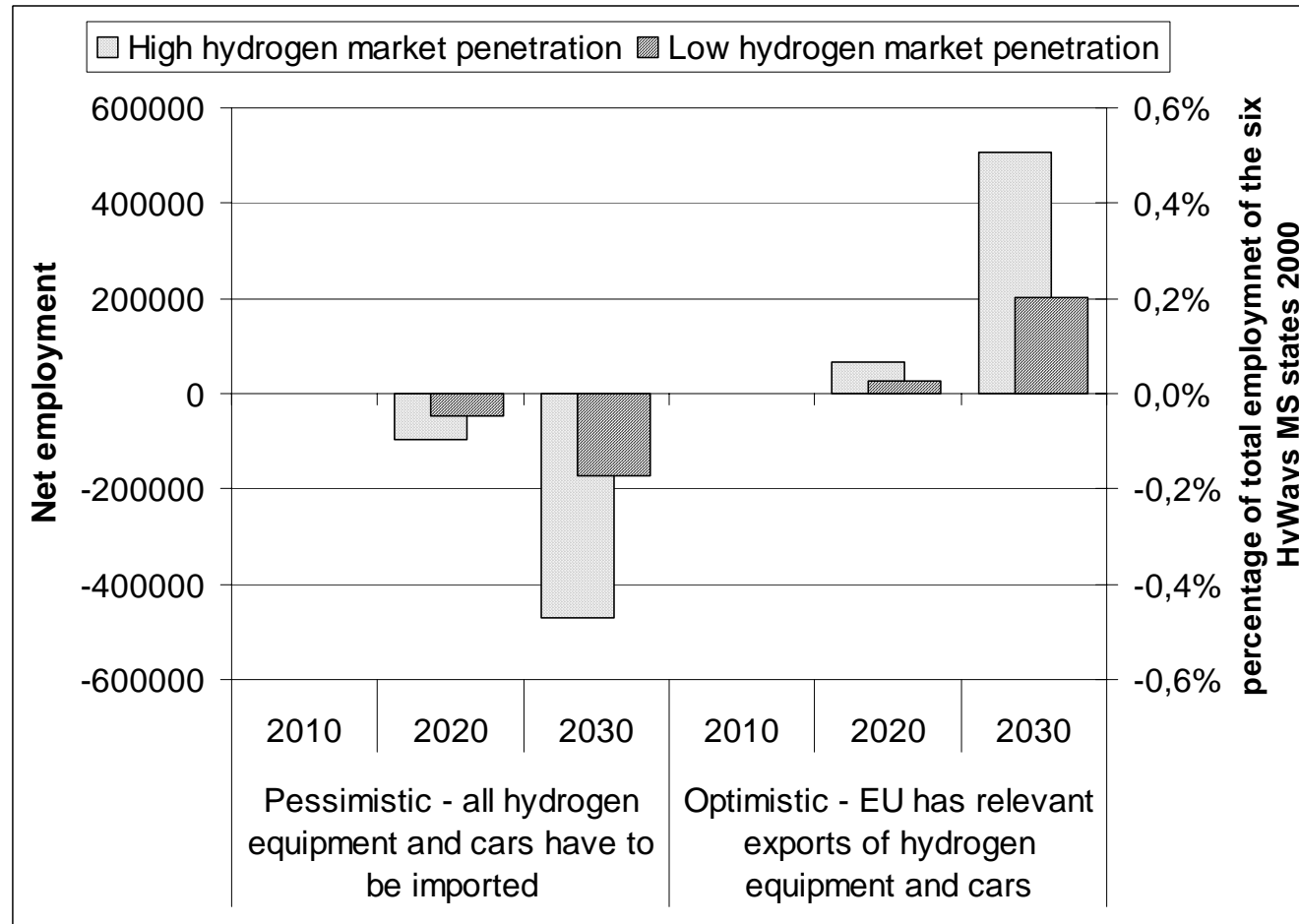
Net employment effects for two penetration scenarios (low = H2L and high = H2H) for 2010 - 2030



Assumed are high learning rates for hydrogen passenger cars.

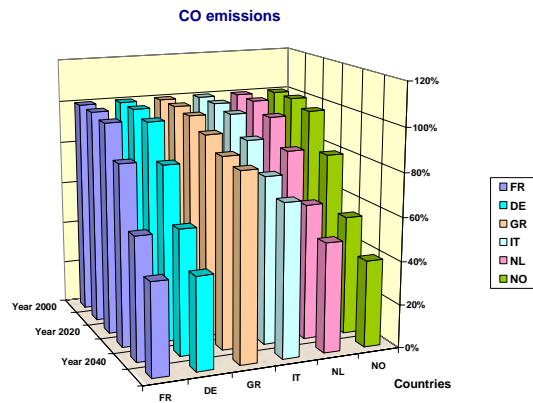
The net employment effects for the six HyWays Phase I countries are shown for four import/export scenarios in number of employments gained/lost

Net employment effects for two penetration scenarios (low and high) for 2010 - 2030

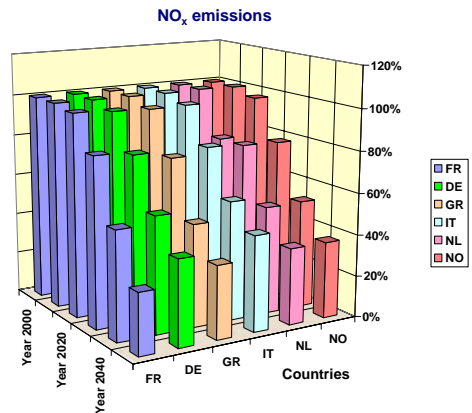


Net employment effects for the “hydrogen high penetration” and “hydrogen low penetration” scenarios with high learning rates for hydrogen passenger cars for the years 2010-2030. Shown are the net employment effects for the six HyWays Phase I countries in two import/export scenarios (HyWays calculations)

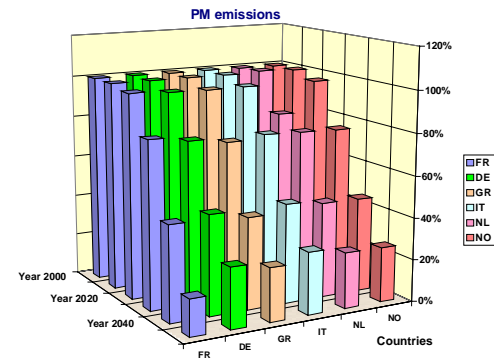
Development of CO, NO_x and PM emissions 2000-2050



Development of CO emissions normalised to reference scenario for the period 2000 - 2050



Development of NO_x emissions normalised to reference scenario for the period 2000 - 2050

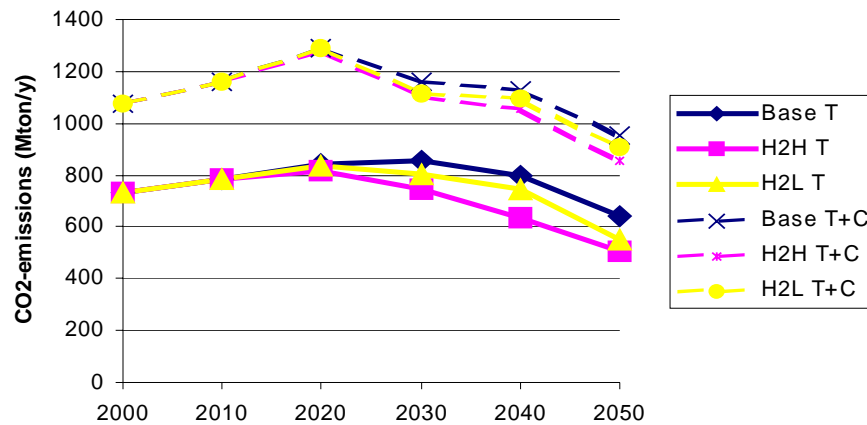


Development of the PM emissions normalised to reference scenario for the period 2000 - 2050

GHG-emissions from road transport WTW

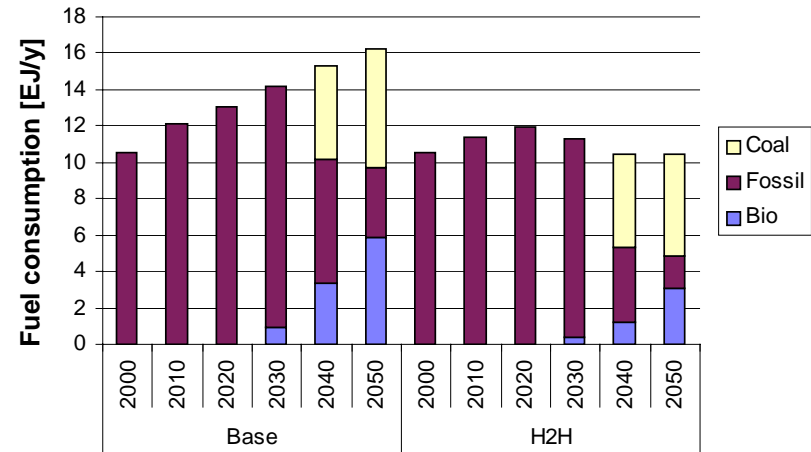
(Sum of all greenhouse gas emissions in CO₂-equivalent)

Results from HyWays (MARKAL):
CO₂-emissions



Base = scenario with high biofuel share
 H2H = scenario with high hydrogen share
 H2L = scenario with low hydrogen share
 T = TTW only
 T+C = TTW + fuel production

Results from HyWays (MARKAL):
Use of fuels in transport sector



Use of fuels in the transport sector in the WEU region in the baseline (left) and H2H high hydrogen penetration scenario. The contribution of H₂ in the fuel consumption is not shown

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