Activities and Achievements in HyWays
An Integrated Project to Develop the European Hydrogen Roadmap

Reinhold Wurster

on behalf of the project partners

First Austrian Hydrogen Conference

Graz, 10-11 October 2005

Objectives

Budget and Duration

Partners

Deliverables

Methodology

Tentative results

Next steps

Objectives

HyWays is an ***Integrated Project*** to

- develop a harmonised ***European Roadmap*** for H_2 energy,
- provide recommendations for an ***Action Plan*** (Roadmap implementation),
- develop a **standard procedure** for the roadmap process,

by means of

- describing the ***future steps*** towards H_2's large-scale introduction,
- considering ***transport and power sectors*** (storage medium for renewables),
- using inputs from EU ***industry, R&D institutes*** and ***member state experts,***
- combining known ***technology databases*** and ***socio-economic analysis,***
- evaluating ***stakeholder scenarios*** for sustainable H_2 energy systems and
- reflecting real life member state ***opportunities and barriers***.

Budget, Duration & Partners

Budget, Duration & Partners

HyWays

Initiation by HyNet:	May 2002
Start of HyWays:	01 April 2004
Duration:	3 years (in 2 phases of 18 months)
Total Budget:	7.9 M€
Funding:	4.0 M€

Industry

BMW Group

DaimlerChrysler

GM

Opel

GE Power Systems

Air Products

stuartenergy

Air Liquide

Linde

DNV

bp

Repsol YPF

Statkraft

EHN

Total

Hydro

Vattenfall

EDF

Hexion

infraserv höchst

Member states

SenterNovem

dena

ENEA

Hellenic Institute of Transport

Institutes

ZEW

Imperial College London

ECN

IDMEC

Fraunhofer ISI Institute Systems and Innovation Research

Bureau d'économie théorique et appliquée (BETA) UMR 7522

L-B-Systemtechnik

Deliverables

H_2 infrastructure build-up analysis

Graphical assessment in time and capital investments and timescales

Economic impacts analysis

Impacts on micro-, meso- and macro-economic level (e.g. GDP, EU balance of trade, employment creation/substitution and security of supply)

Policy measures analysis

Effect of policy measures on H_2 market penetration (e.g. carbon trading, taxation and preferential city-centre access for clean vehicles)

Analysis of technology impacts

Technology learning (cost reduction, technology breakthroughs), e.g. price competitive durable FCs for transport and residential/ industrial use, H_2 storage, CO_2-capture and reliable sequestration

All analyses are on regional level considering country / region specific conditions

Emissions analysis

Potential GHG and pollutant emissions reductions for given scenarios

Development of the European Hydrogen Energy Roadmap

Integration of aggregated member state specific results into proposal for an EU Hydrogen Energy Roadmap:

- GHG emissions,
- preferred H_2 production and infrastructure technologies and
- build-up of supply infrastructure and end-use technologies

for the timeframes 2020, 2030 and 2050

In Phase II the Roadmap based on 6 member states‘ input will be broadened to other interested member states

The real benefit is not only ***"technical learning"*** from complex simulations based on an involvement of experienced partners…

…but also

"social learning" by intense highly disciplined discussions among the HyWays partners and specifically an extended reach into the member states resulting in

- multiple mutual learning effects (European synthesis) and
- dynamic iterative generation of new insights.

Methodology

Methodology – HyWays Building Blocks

HyWays

Decision on 5 - 7 member state specific hydrogen energy chains

Phase I: D, F, GR, I, N, NL
Phase II: 4 - 6 others

Iterative decision process:

- Provision of technology database
- Chain proposal from MS
- Comparative chain assessment
- Discussion with MS stakeholders
- Adaptation and re-calculation

Results
- GHG emissions
- Micro-economic costs

Relevance of hydrogen for energy markets and assessment of economic, social and environmental impact

Iterative assessment process:

- Infrastructure analysis
- Sensitivity analysis of energy markets (e.g. on energy prices, H_2 uptake level)
- Impact on industry branches
- Macro-economic impact (labor, etc.)
- GHG emissions (here: transport)
- Actor analysis

Results
- Feasibility of introducing hydrogen energy in transport and stationary markets for individual member states

European Synthesis

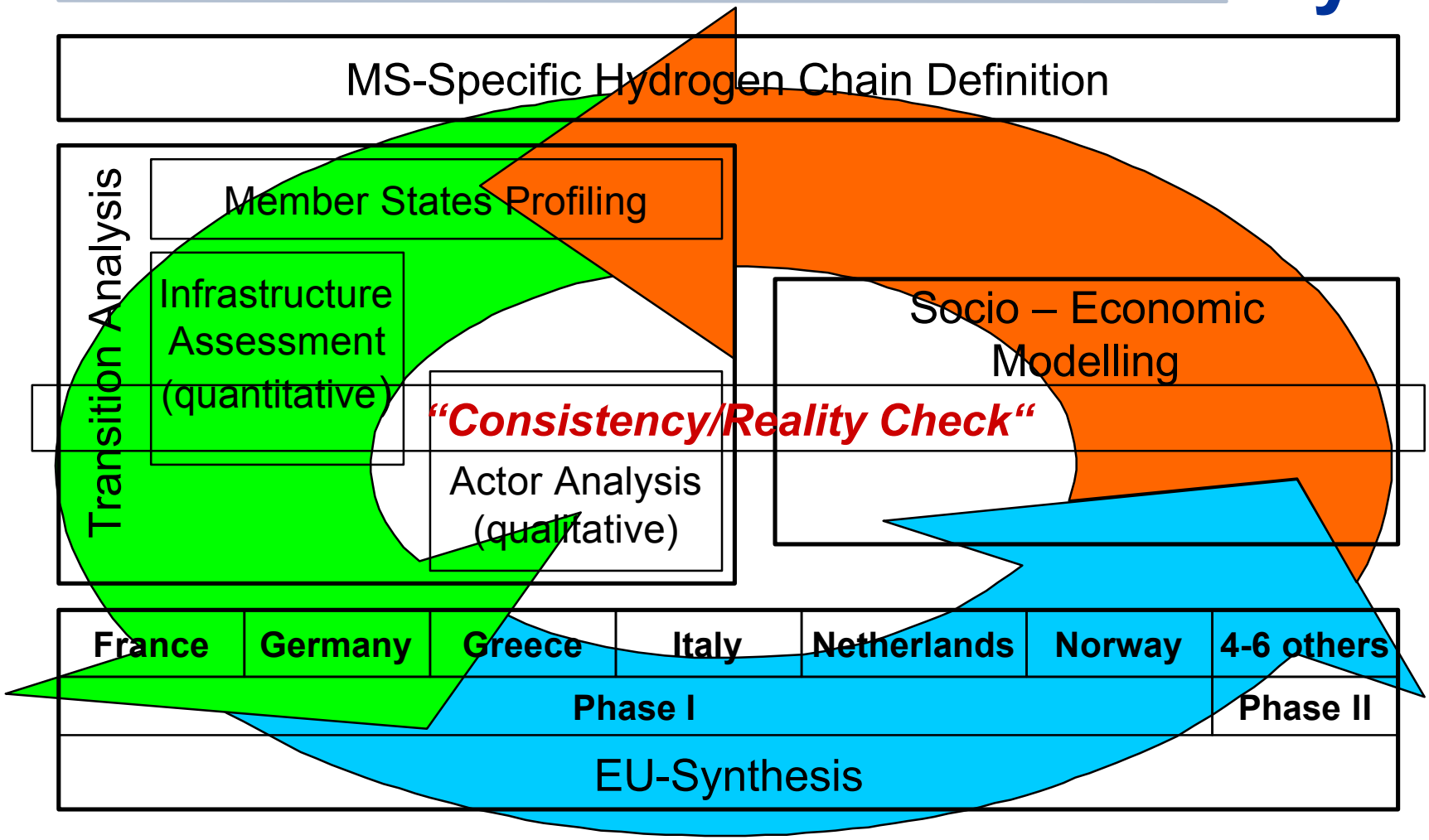
Contract individual member state strategies to European scale

Identify:
- differences and commonalities
- European strengths and weaknesses

Results
- Roadmap
- Action Plan

Methodology – A Multi-Dimensional Approach

HyWays



Tentative Results

Selected Results – Choice of Greek H_2 Energy Chains

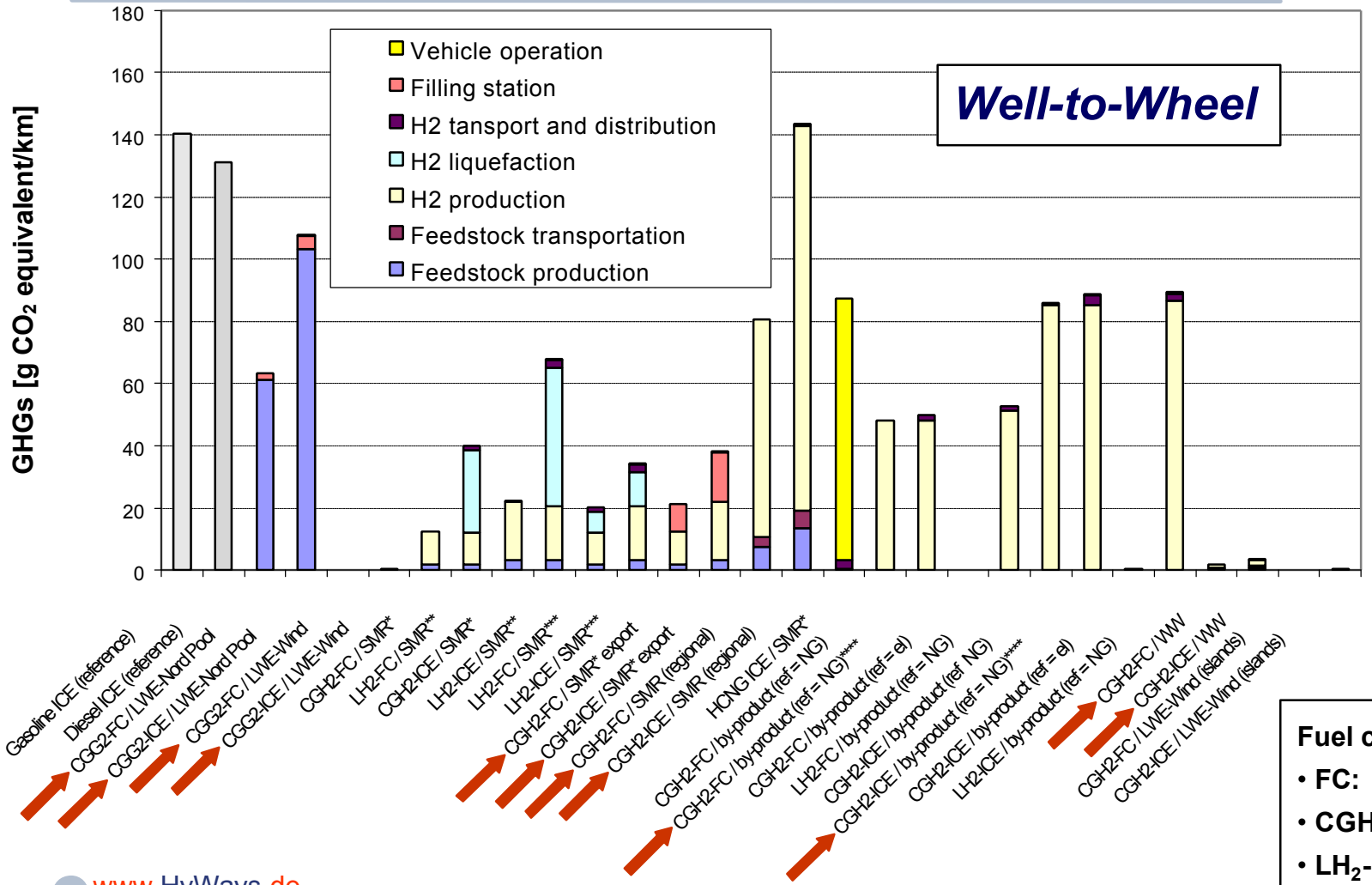
HyWays

	Feedstock	Production	1st Conversion	Transport/distribution	End-use
1	Wind electricity	Central Electrolysis	-	GH_2 pipeline CGH_2 FS	FC car
2	Wind electricity	De-central Electrolysis***	-	CGH_2 Fuelling Station	FC car
3	Natural gas	Central SMR*	-	GH_2 pipeline + CGH_2 FS	FC car
4	Hard Coal	Gasification*	-	GH_2 pipeline + CGH_2 FS	FC car
5	Wind Electricity	Central Electrolysis	-	GH_2 pipeline + local H_2 grid	CHP system
6	Wind Electricity	De-central Electrolysis	-	Local H_2 grid	CHP system
7	Natural Gas	Central SMR*	-	GH_2 pipeline + local H_2 grid	CHP system
8	Hard coal	Gasification *	-	GH_2 pipeline + local H_2 grid	CHP system
9	Natural Gas	Central SMR**	-	GH_2 - NG pipeline	Regular Boiler

*With Carbon Capture & Storage **Mix H2 into the NG grid ***Dedicated on-shore wind electricity for island

Selected Results – Norwegian GHG-Emissions Hybrid-Cars

HyWays



* with CO_2 capture and sequestration

** with CO_2 capture and sequestration, H_2 liquefaction with NG fueled CCGT

***with CO_2 capture and sequestration, H_2 liquefaction with H_2 fueled CCGT

**** trucked CGH_2

Fuel consumption vehicles [1)]

- **FC: 0.23 kWh/km**
- **CGH_2-ICE: 0.41 kWh/km**
- **LH_2- ICE: 0.39 kW/km**
- **HCNG-ICE: 0.41 kWh/km**
- **Gasoline-ICE: 0.45 kWh/km**
- **Diesel-ICE: 0.41 kWh/km**

→ selected H_2 energy chains

HyWays

Method:

1.) identify regional nodes

40 regions in NL *(COROP grid):* Starting nodes for a hydrogen fuelling station network

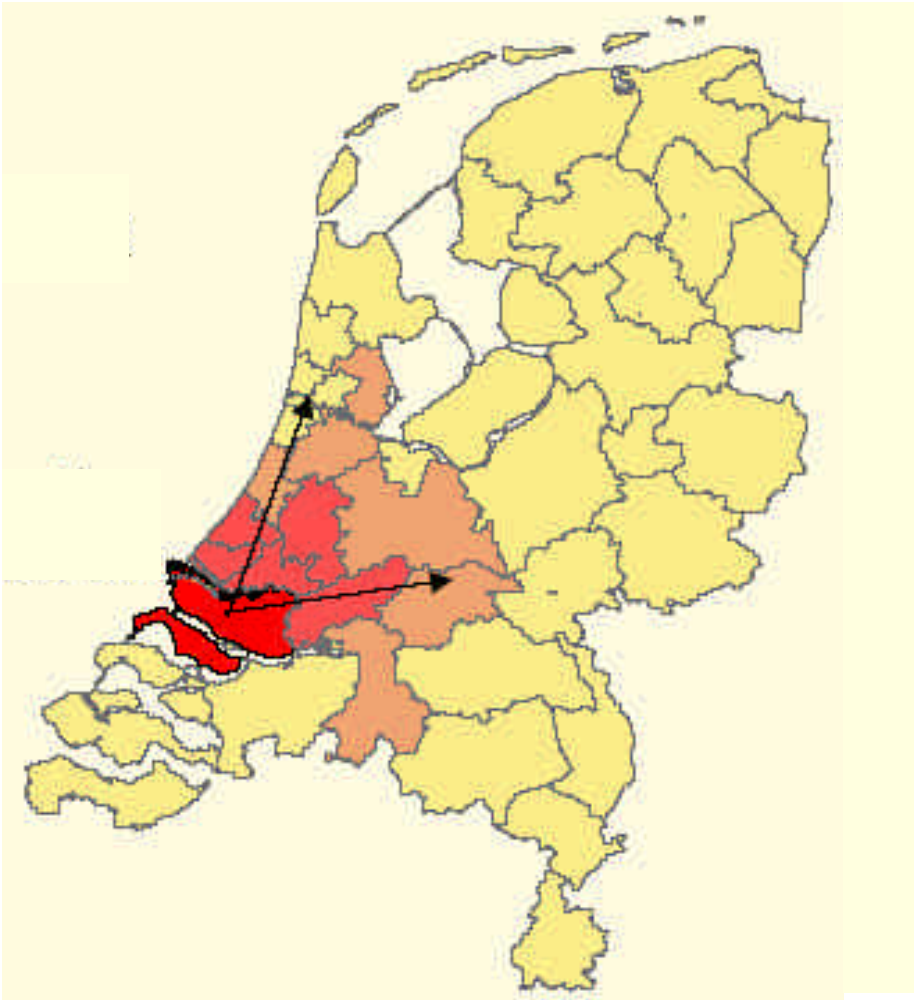
Preliminary Results – Netherlands H_2 Infrastructure Build-Up

HyWays

Method:

1.) identify regional nodes

2.) Rotterdam mainly merchant hydrogen as starting point*



Pipeline grid:

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

* Other locations may provide hydrogen (e.g. by-product), but Rotterdam has largest potential

Preliminary Results – Netherlands H_2 Infrastructure Build-Up

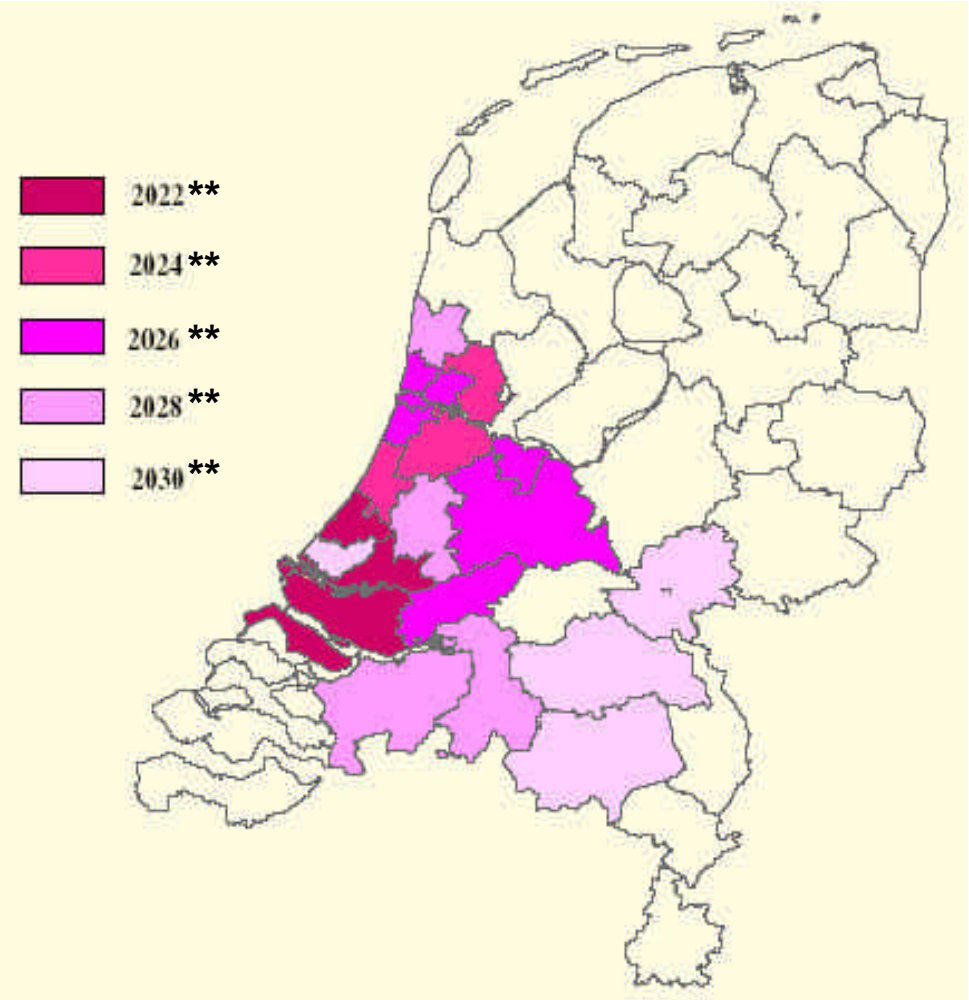
HyWays

Method:

1.) identify regional nodes

2.) Rotterdam mainly merchant hydrogen as starting point*

3.) Use dedicated H_2-pipeline grid for hydrogen transport and distribution (based on data from NG grid)



Scenario:

"High hydrogen penetration rates"

* See previous slide

** Tentative indicative point in time for profitability to shift from local production to pipelines

Next Steps

HyWays

- Validate infrastructure build-up analysis
- Validate actor analysis
- Member State Workshop to intensify exchange of results and experience between member states
- Intermediate public report by early October 2005
- Incorporating further 4 - 6 member states in Phase II (January 2006)
- Apply for an extension with non-European IPHE partners through the present EC DG RTD Energy-4 Call

International Partnership for the Hydrogen Economy

This project is financed by the HyWays partners and by funds from the European Commission under FP6 Priority [1.6] contract number 502 596.

The co-ordination of HyWays is a rewarding and satisfying task due to the innovation potential and creativity of the HyWays partners.

We would like to thank the EC to create the right framework for the discussion process, and the HyWays partners for their support during the long and exhausting proposal and contract preparation phase.