The Socio-/Economic Toolbox of the EU Hydrogen Roadmap Project HyWays

A Project Funded by EU/DG-RTD

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Introduction to HyWays

Scope, Objectives, Partners, Program

First Results

The Socio-Economic Toolbox

General Approach

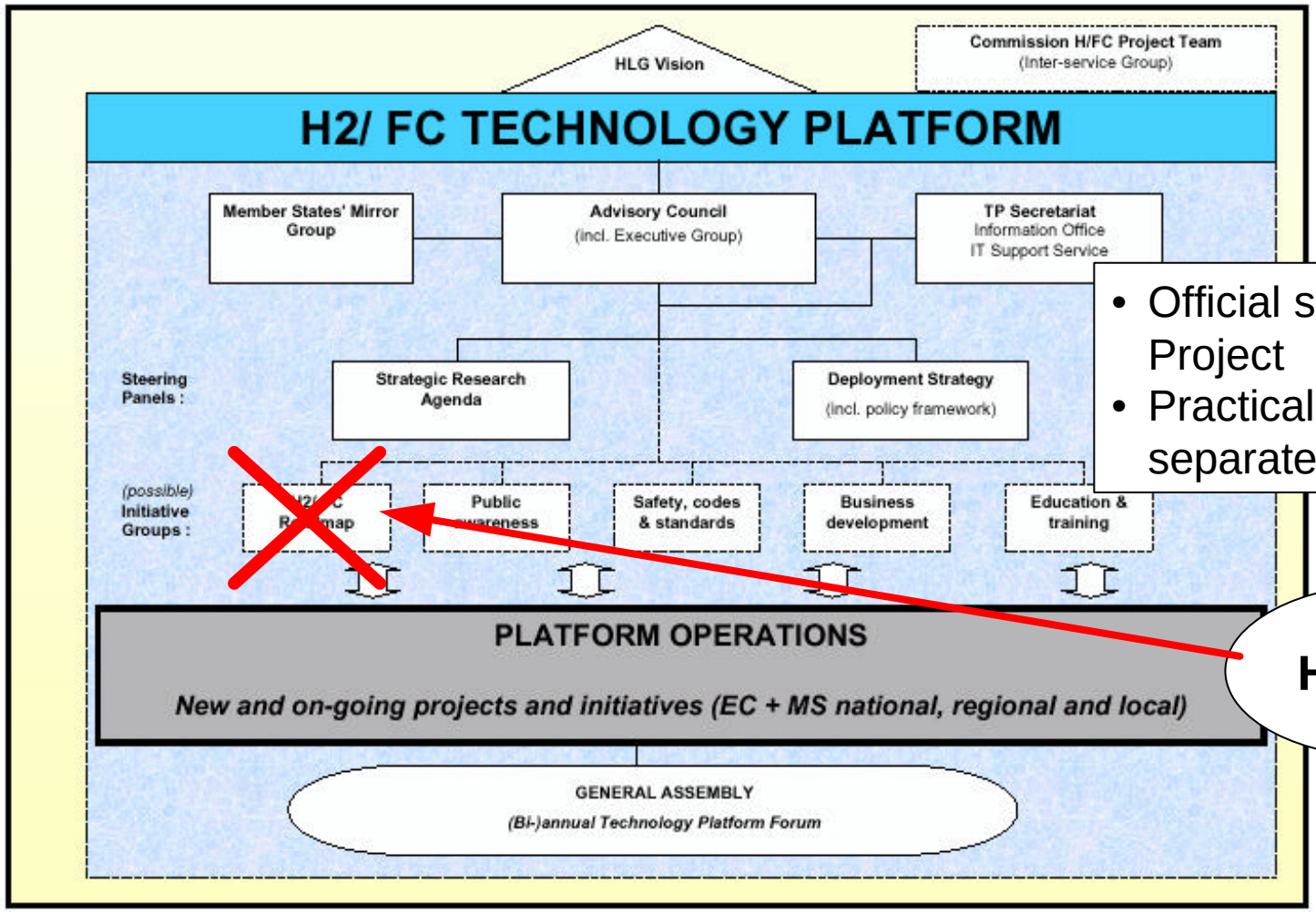
Expected Outcomes

Introduction to HyWays

Scope, Objectives, Partners, Program

Scope

HyWays



- Official status of a Platform Project
- Practically adhoc replacing separate „Initiative Group“

HyWays

Initiation by HyNet: May 2002

(early involvement of MS initiatives HyFrance, H2-IT, etc.)

Start of HyWays: 01 April 2004

Duration: 3 years (in 2 phases of 18 months)

Total Budget: 7.9 M€

Funding: 4.0 M€

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***.

Partners

HyWays

Industry

Member states

Institutes

H_2-Infrastructure build-up analysis

Capital investments and timescales for H_2 infrastructure build-up

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

Emissions analysis

Potential GHG and pollutant emissions reductions for given scenarios

Development of the European Hydrogen Energy Roadmap

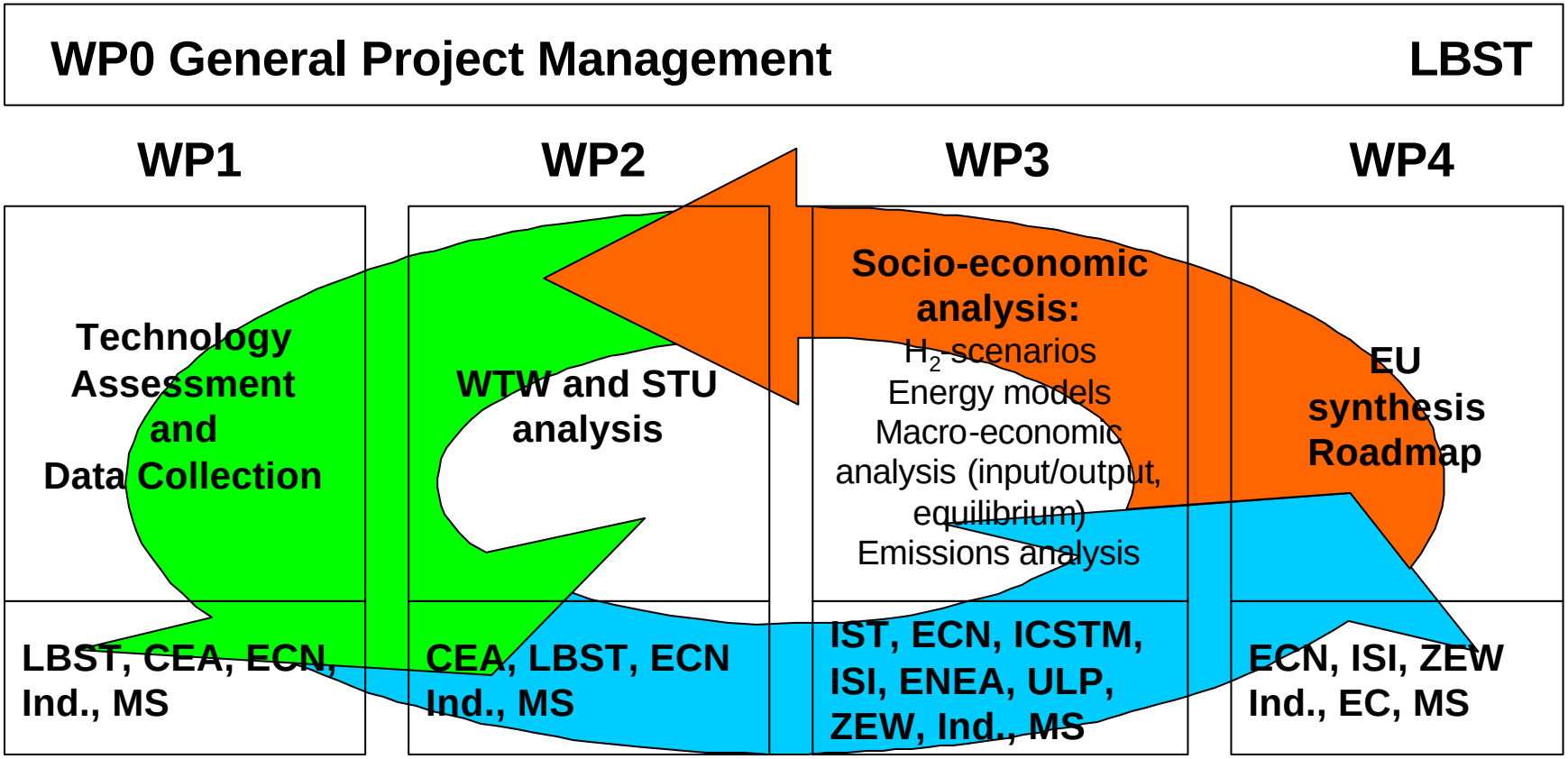
Integration of aggregated member state specific results into proposal for an EU Hydrogen Energy Roadmap:

- 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

HyWays



Ind. - Industry (21 auto, energy/oil and process companies)
MS – 6 regional or member state experts

Introduction to HyWays

First Results

Finalised:

- European Scoping Report with technical annex
- Member state profiling reports for D, F, GR, I, N and NL
- Up to six hydrogen energy chains WtW and StU for each MS
- Handbook for further member state partners
- Interface description for software tools E3 Database, MARKAL, ISIS, GEM-E3 and COPERT
- Image brochure and flyer

In progress:

- Socio-economic and emissions modelling at micro-, meso- and macro-level
- Actors analysis
- Infrastructure build-up analysis
- European synthesis

Selected Results – Choice of Greek H_2 Energy Chains

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	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

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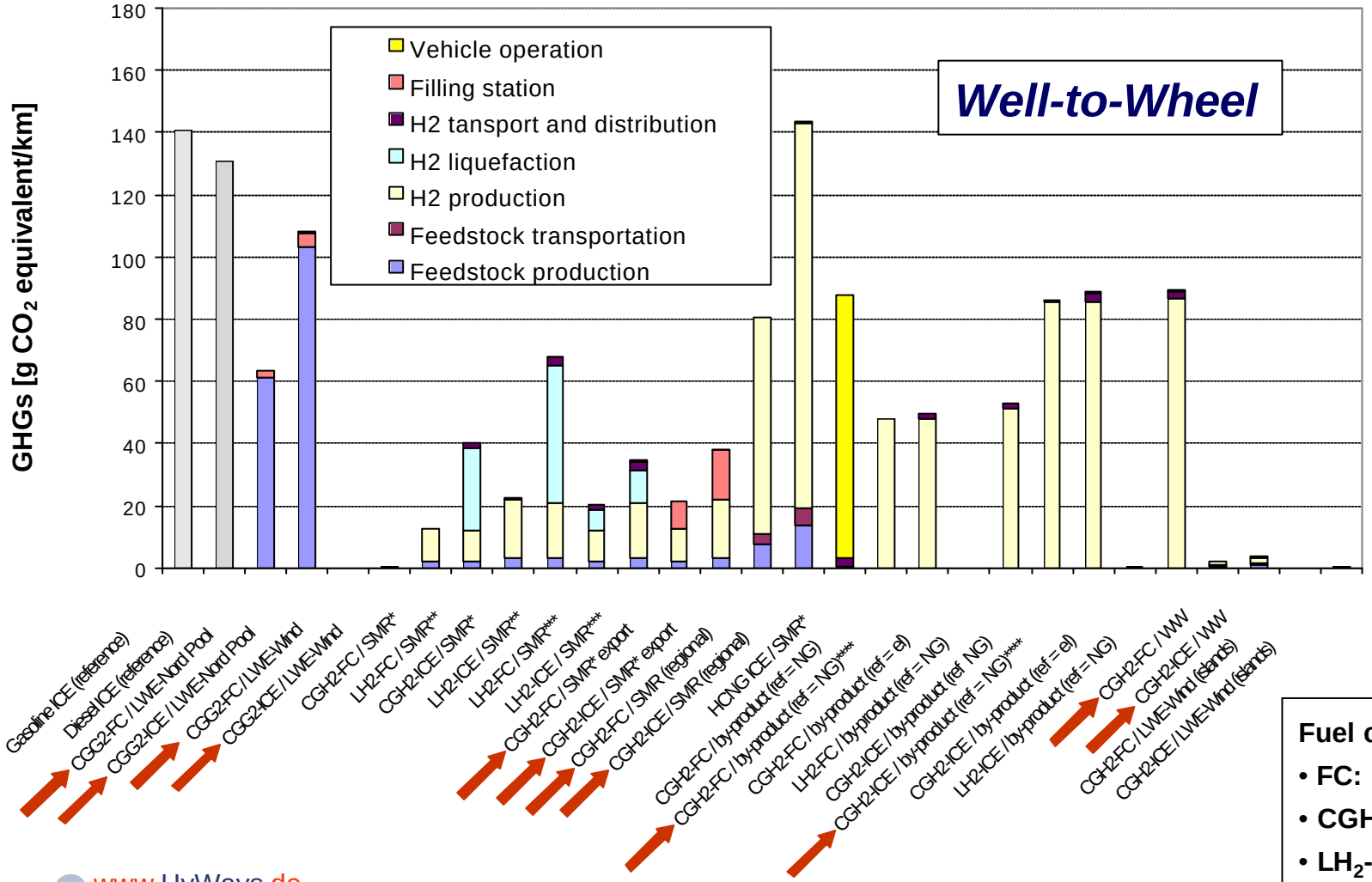


* with CO_2 capture and sequestration

** 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**

Method:

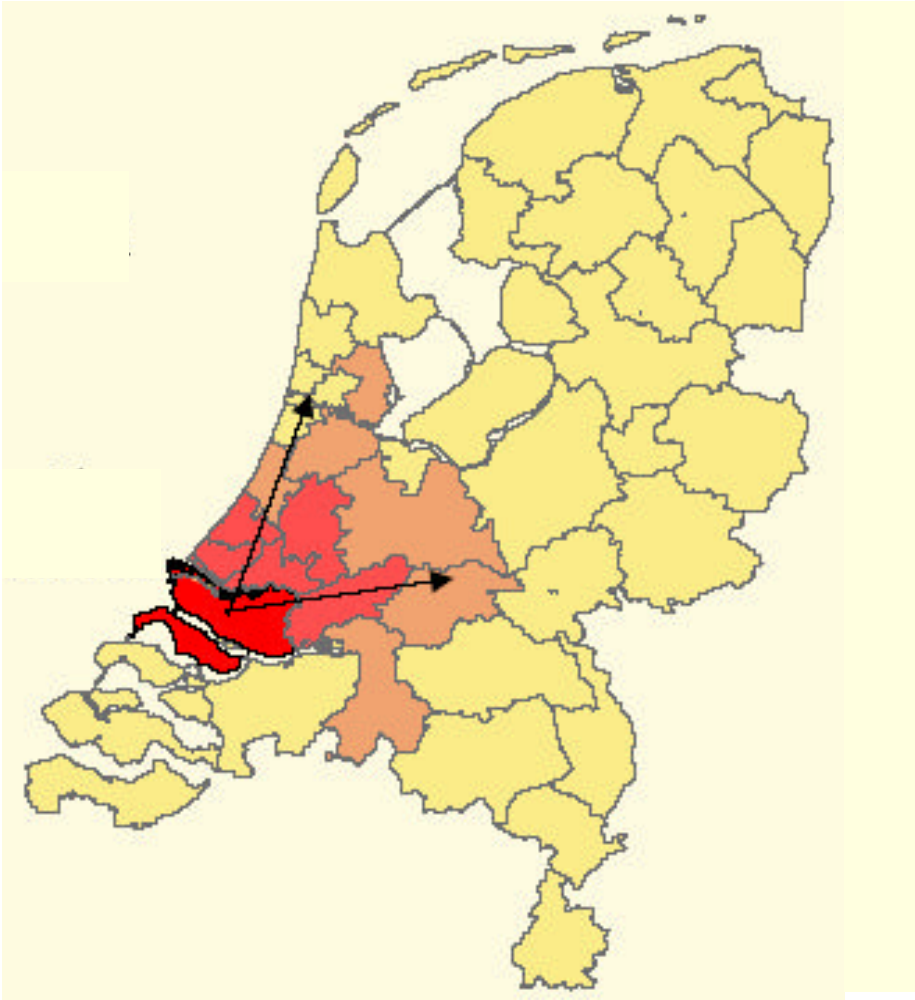
1.) identify regional nodes

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

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

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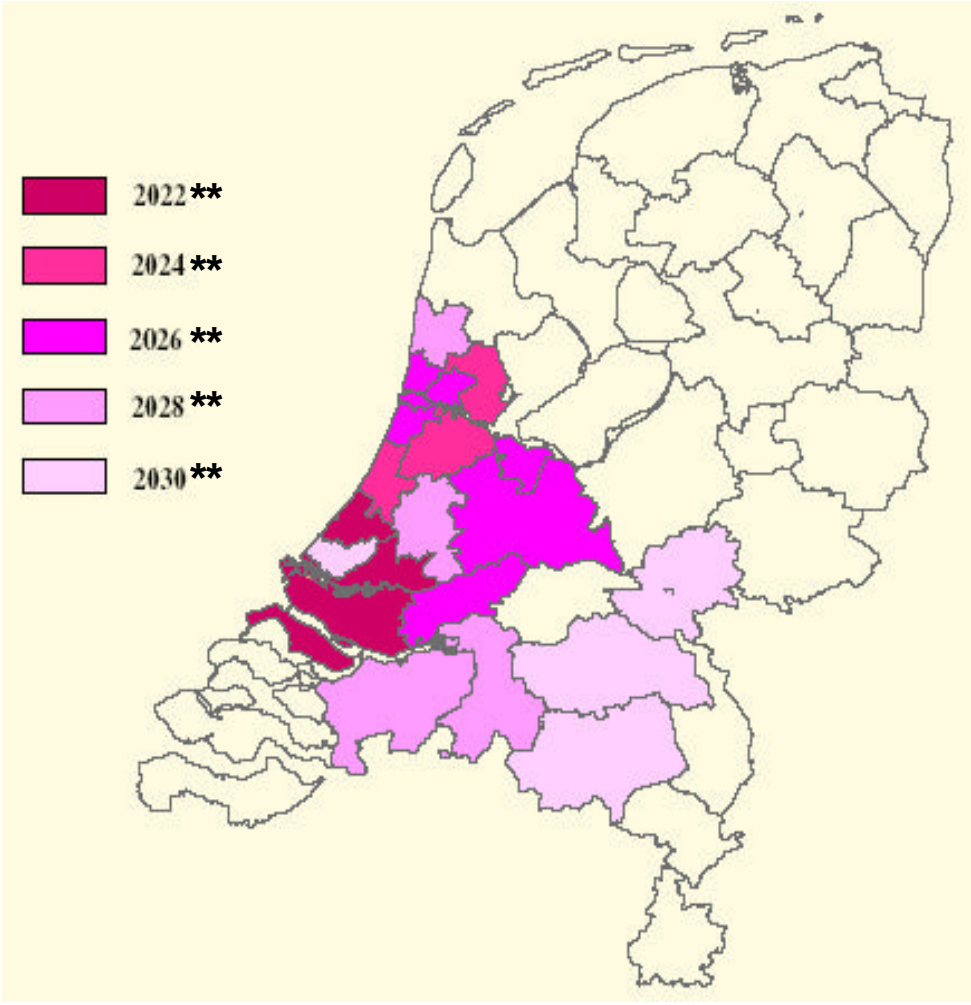
Method:

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

The Socio-Economic Toolbox

General Approach

The transition towards a hydrogen based society is the starting point

- Simulation models show usually “no hydrogen” (short term benefits vs. long term profits)
- Backcasting studies show the value added of hydrogen
- Backcasting / forecasting approach

HyWays is not a modelling exercise but aims to develop a roadmap for Hydrogen

- Realistic though ambitious (comparison to US, Japan etc.)
- Well accepted (MS and EC, industry, institutes, end-users)
- Validated (rely on existing and proven modelling framework, various validation workshops)
- A technology transition is not just a matter of achieving the right ‘pay back time’

The multi level perspective of a transition

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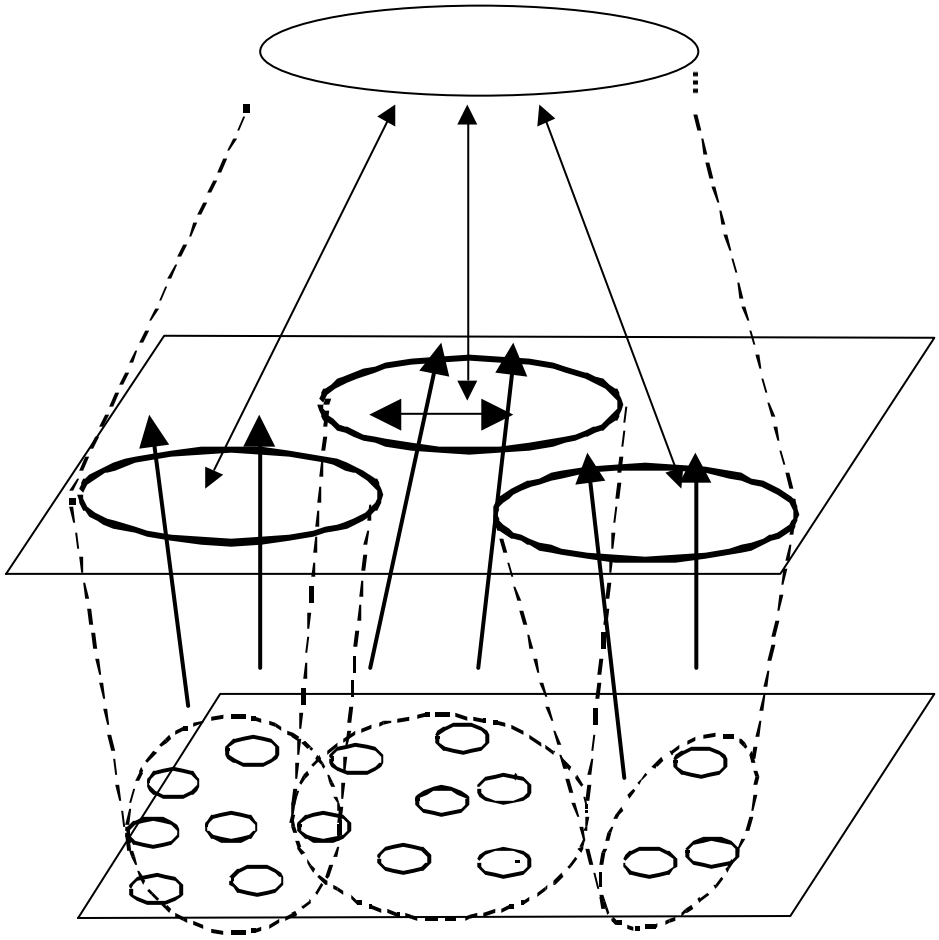
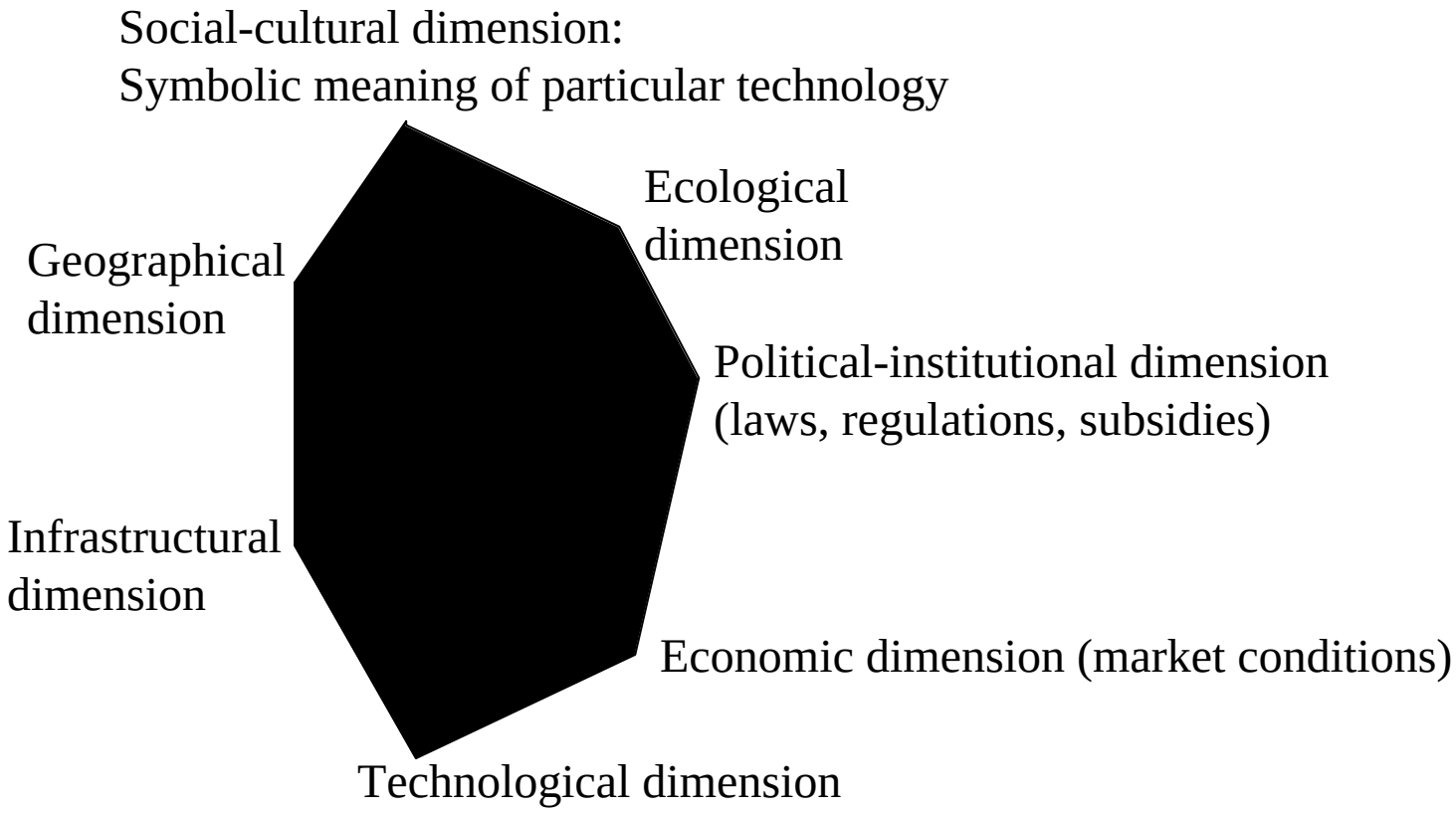


Macro level
(landscape)

Meso level
(regimes)

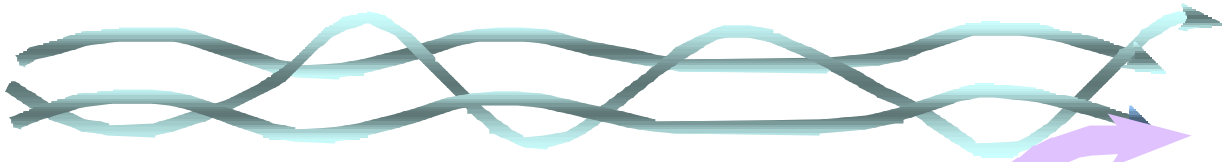
Micro level
(niches)


Social-cultural dimension:
Symbolic meaning of particular technology
Ecological dimension
Geographical dimension
Political-institutional dimension (laws, regulations, subsidies)
Infrastructural dimension
Economic dimension (market conditions)
Technological dimension

Transition at work: mechanisms towards societal change

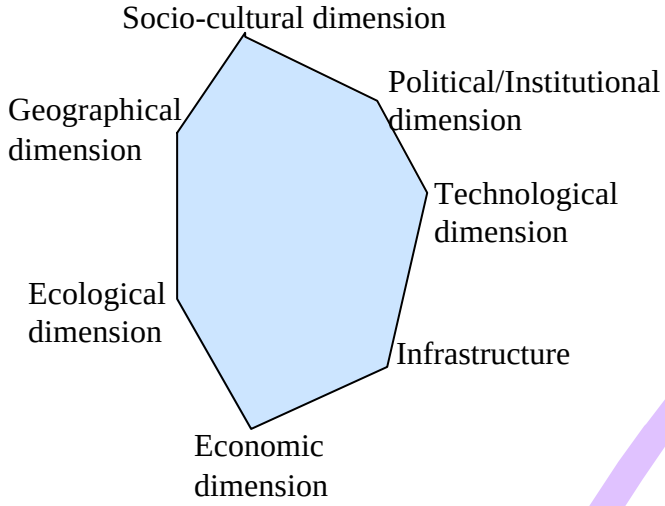
HyWays

Macro: Landscape developments



Regime A (t0)

Meso: Socio-technical regimes



Micro: Technological niches

Time

Transition at work: mechanisms towards societal change

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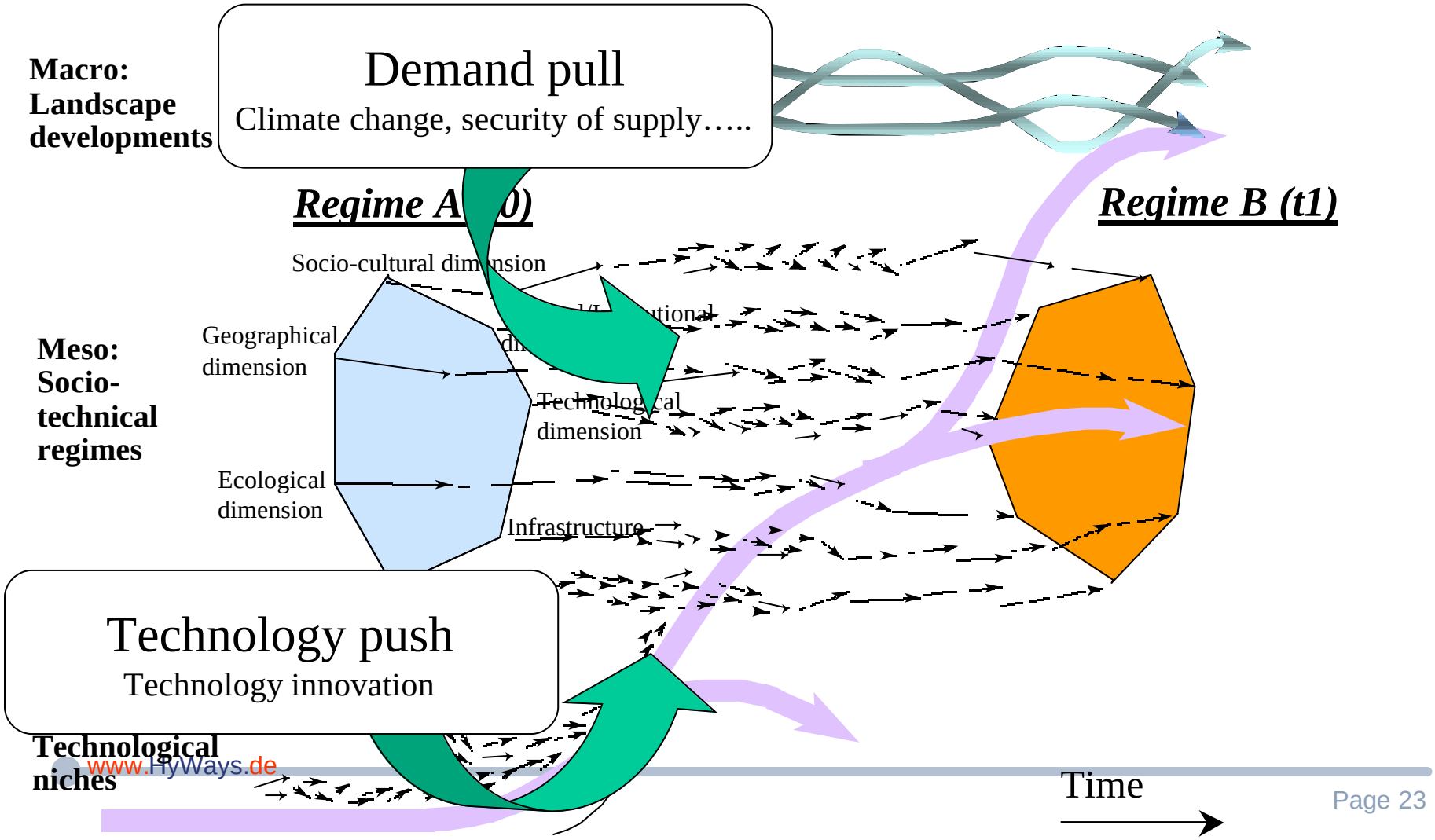

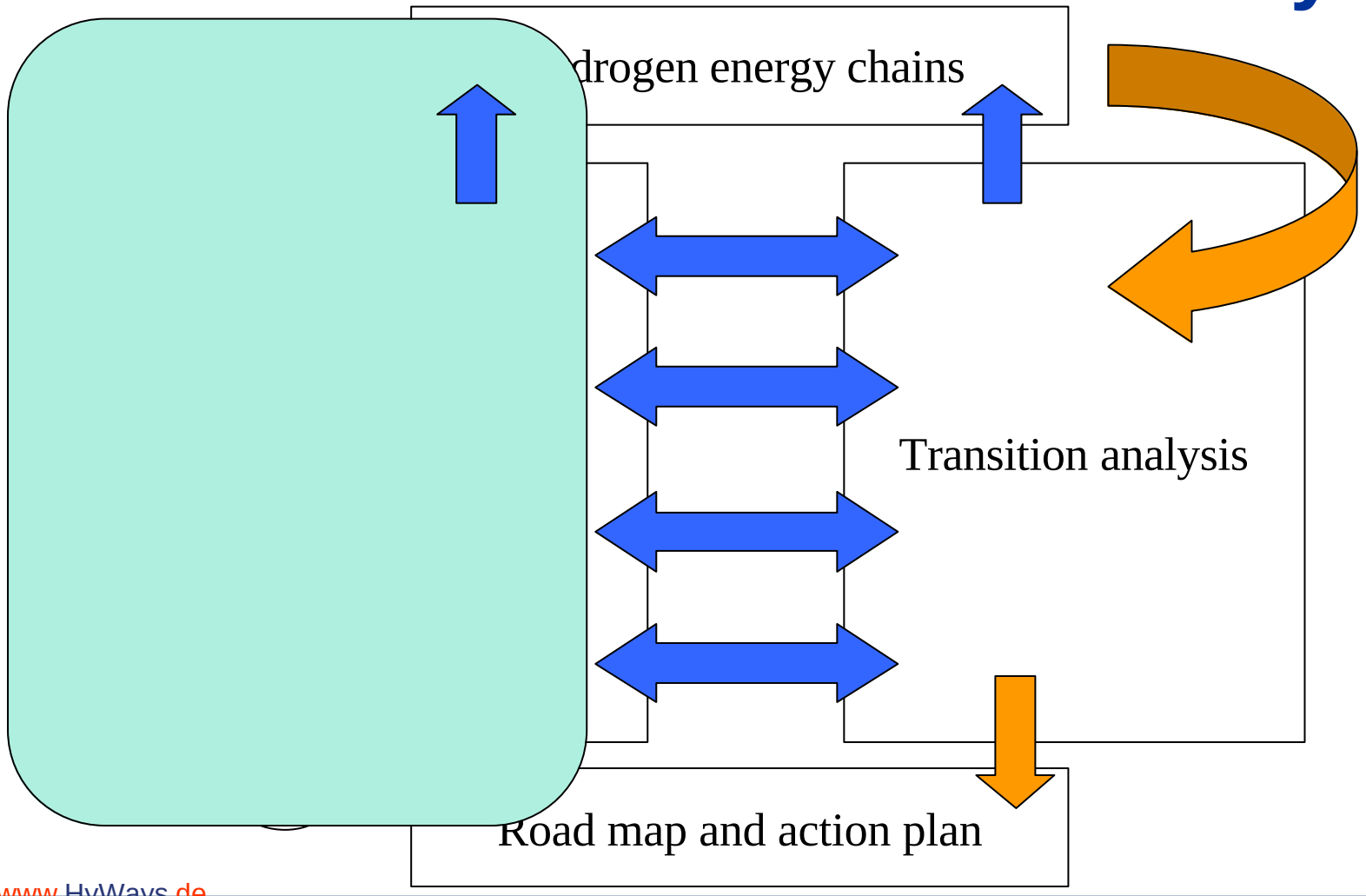
drogen energy chains
Transition analysis
Road map and action plan

Methodology – Modelling framework

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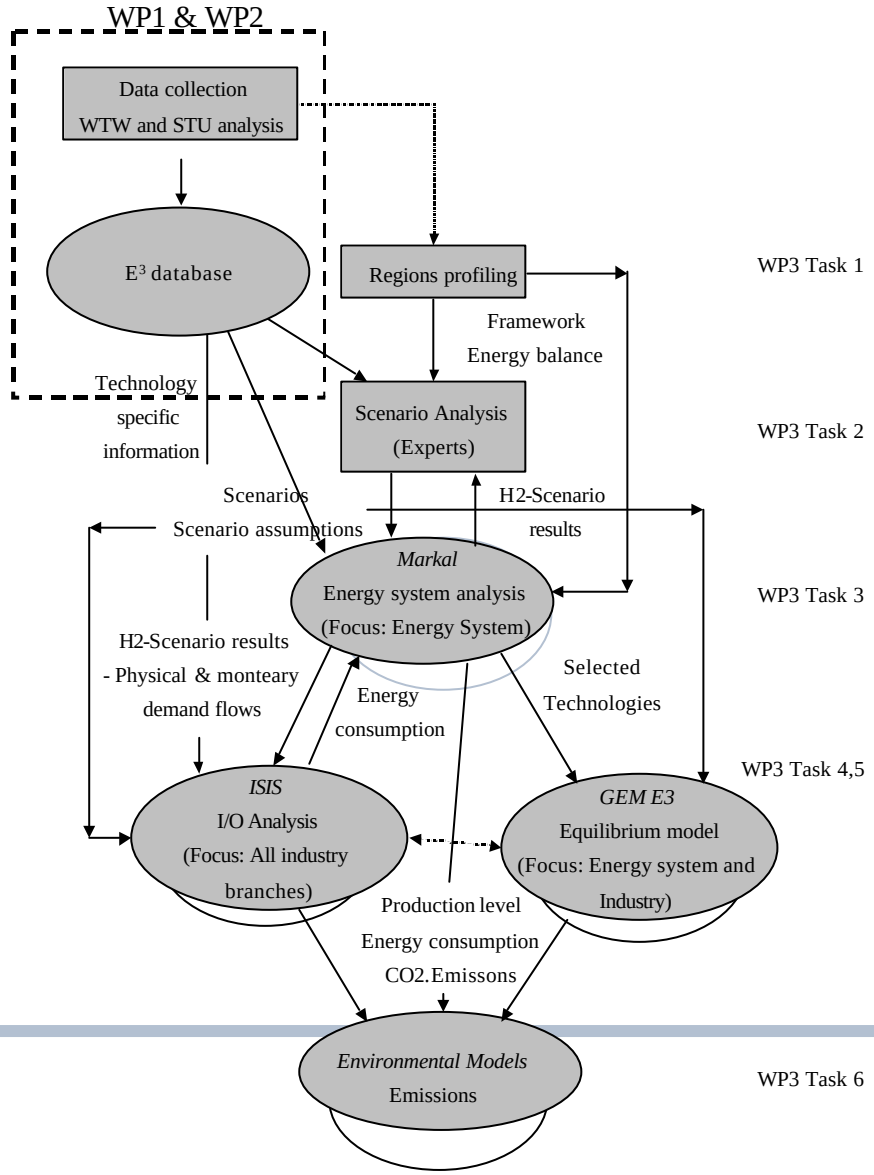
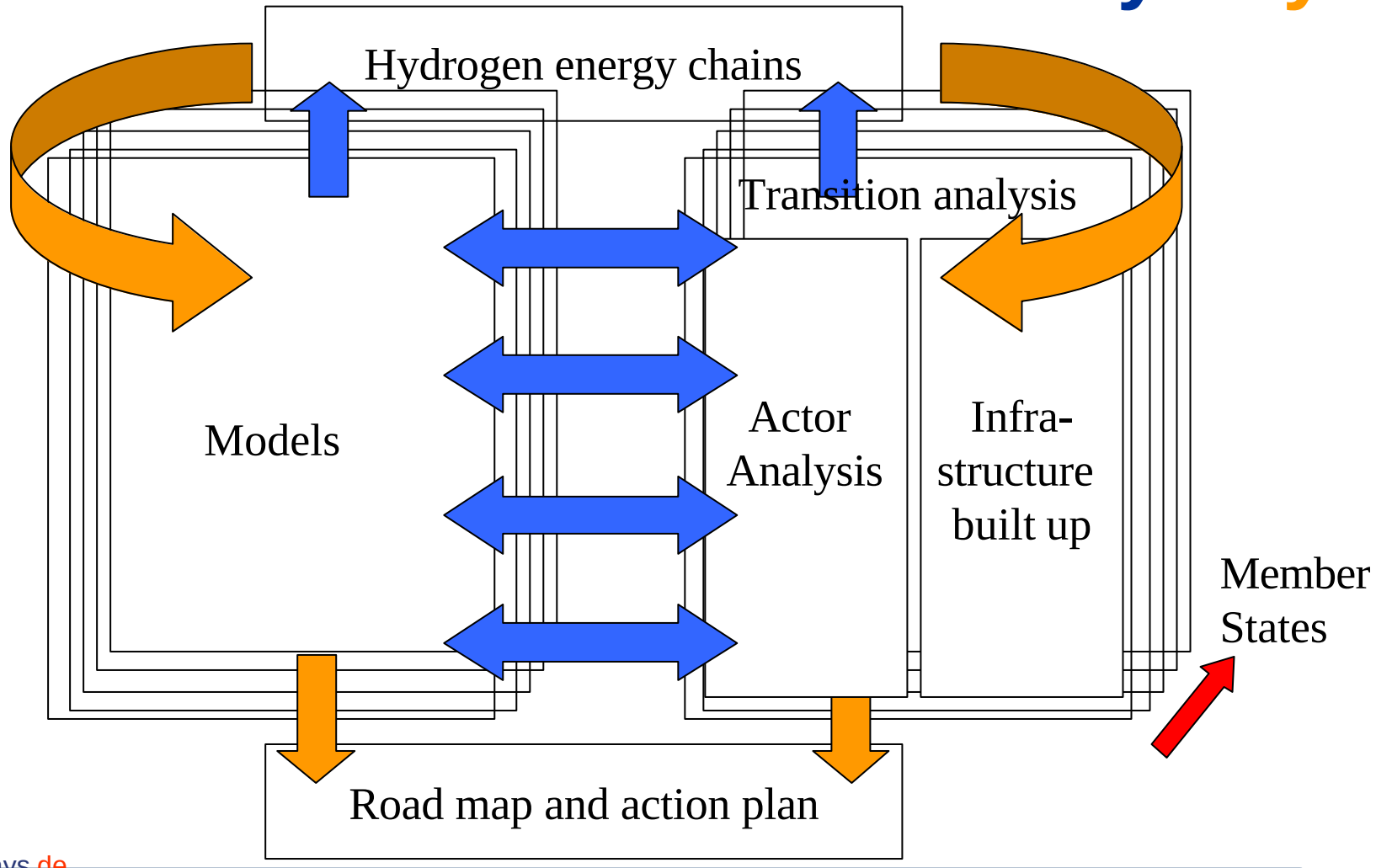


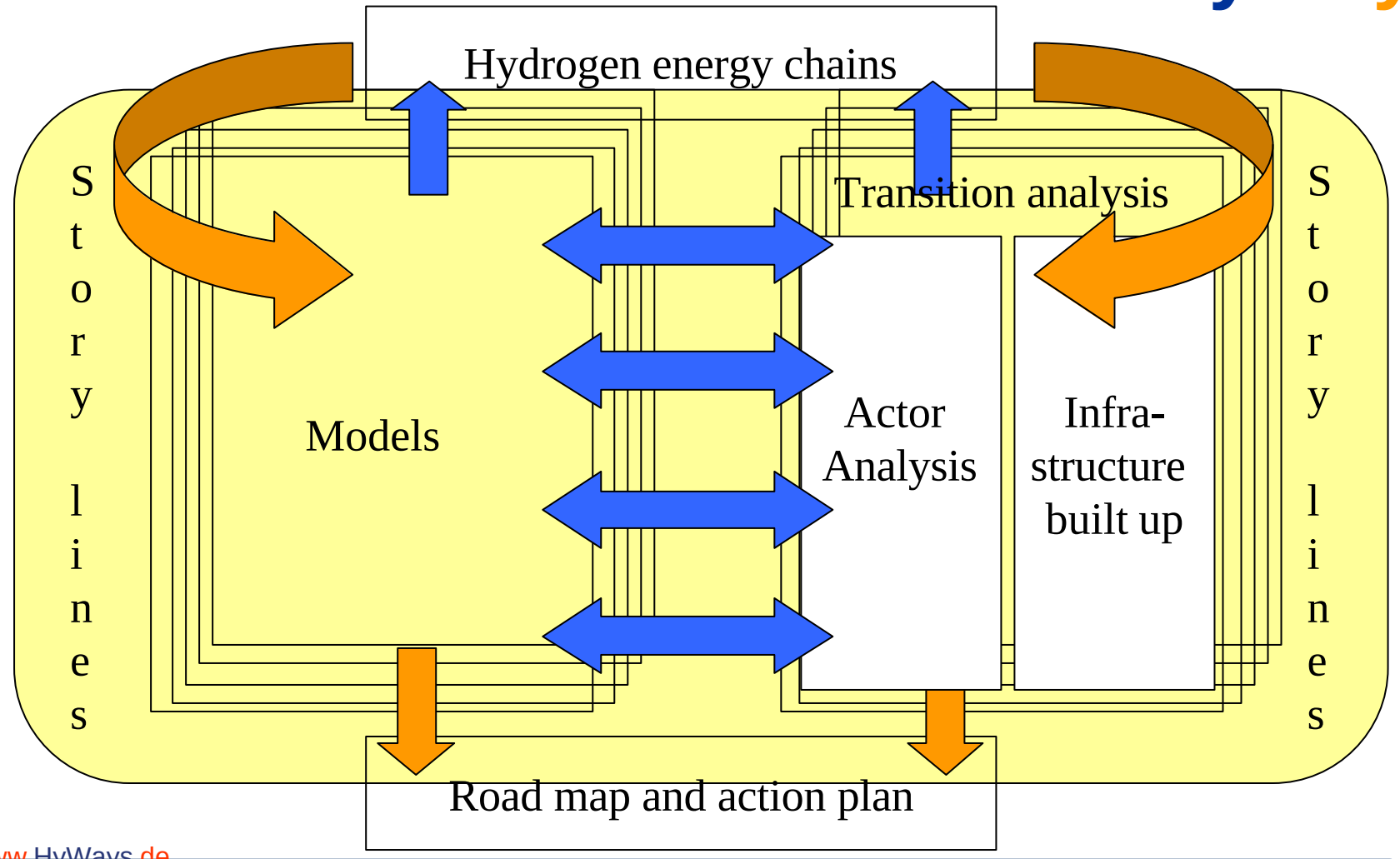
Methodology – Transition analysis and Story lines (1)

HyWays



Methodology – Transition analysis and Story lines (2)

HyWays



Transition analysis

- Take into account non-economical aspects
  - Technical, institutional, political, social and geographical aspects
- Identify key changes
- Actor analysis – critical actors
  - Actors that support the required changes
  - Actors that oppose (i.e. since their business is affected)
  - Actors that are neutral
- Infrastructure built up
  - Take into account specific regional conditions

Multi level approach

- Technology analysis – E3-database and MARKAL
- Sectoral level – ISIS I/O-model
- Macro level – PACE-T(H2), a derivative of GEM-E3 equilibrium model
- Emission impacts – based on COPERT III

Features

- Technology learning
  - Learning curve approach
  - Learning by doing: investments costs decrease as function of experience: cumulative capacity
- Spill over effects
  - e.g. what impact can the introduction of fuel cells for stationary have on the implementation of fuel cells in the transport sector (or vice versa)

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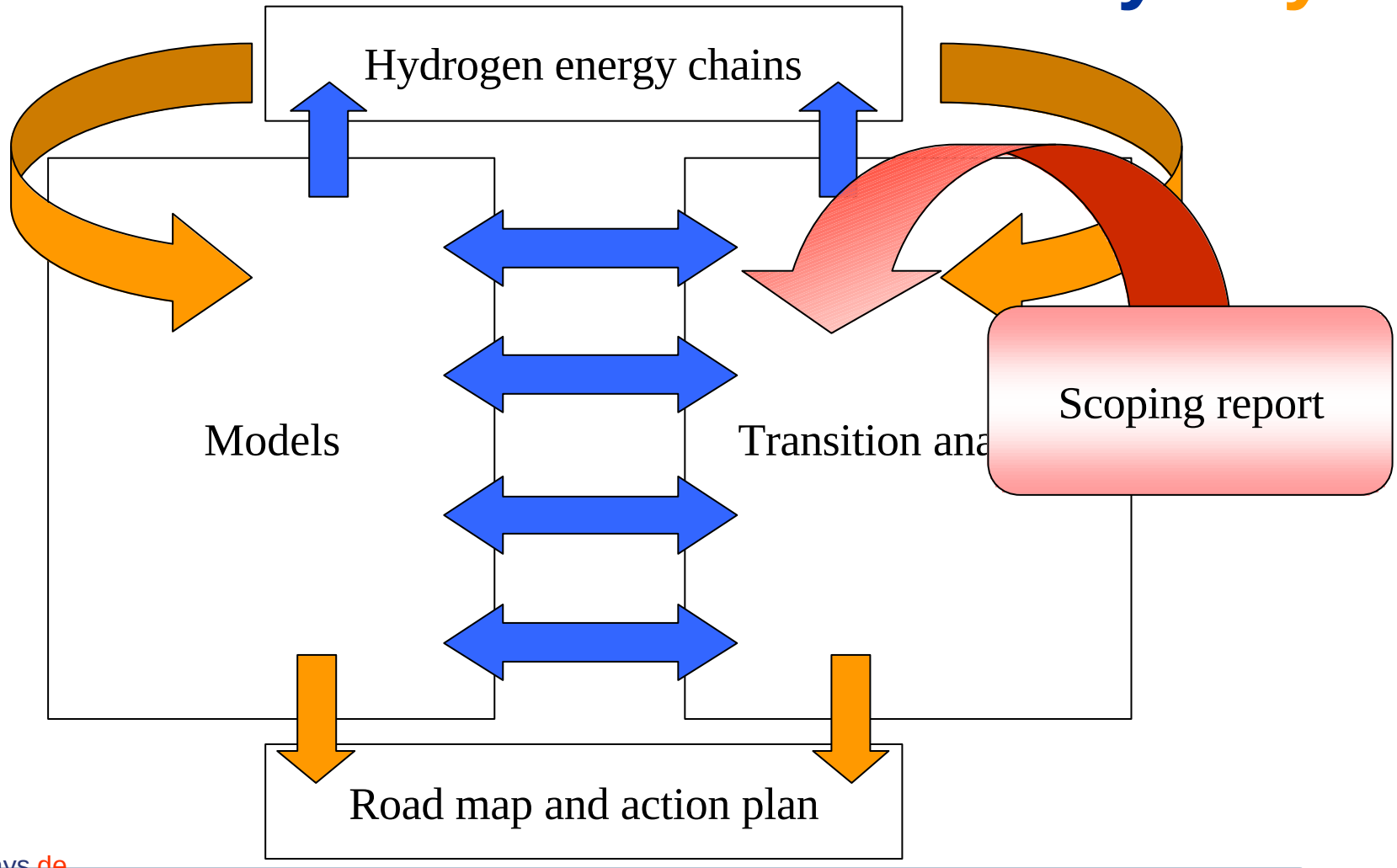
Hydrogen energy chains
Models
Transition ana
Scoping report
Road map and action plan

Methodology – Stakeholder involvement

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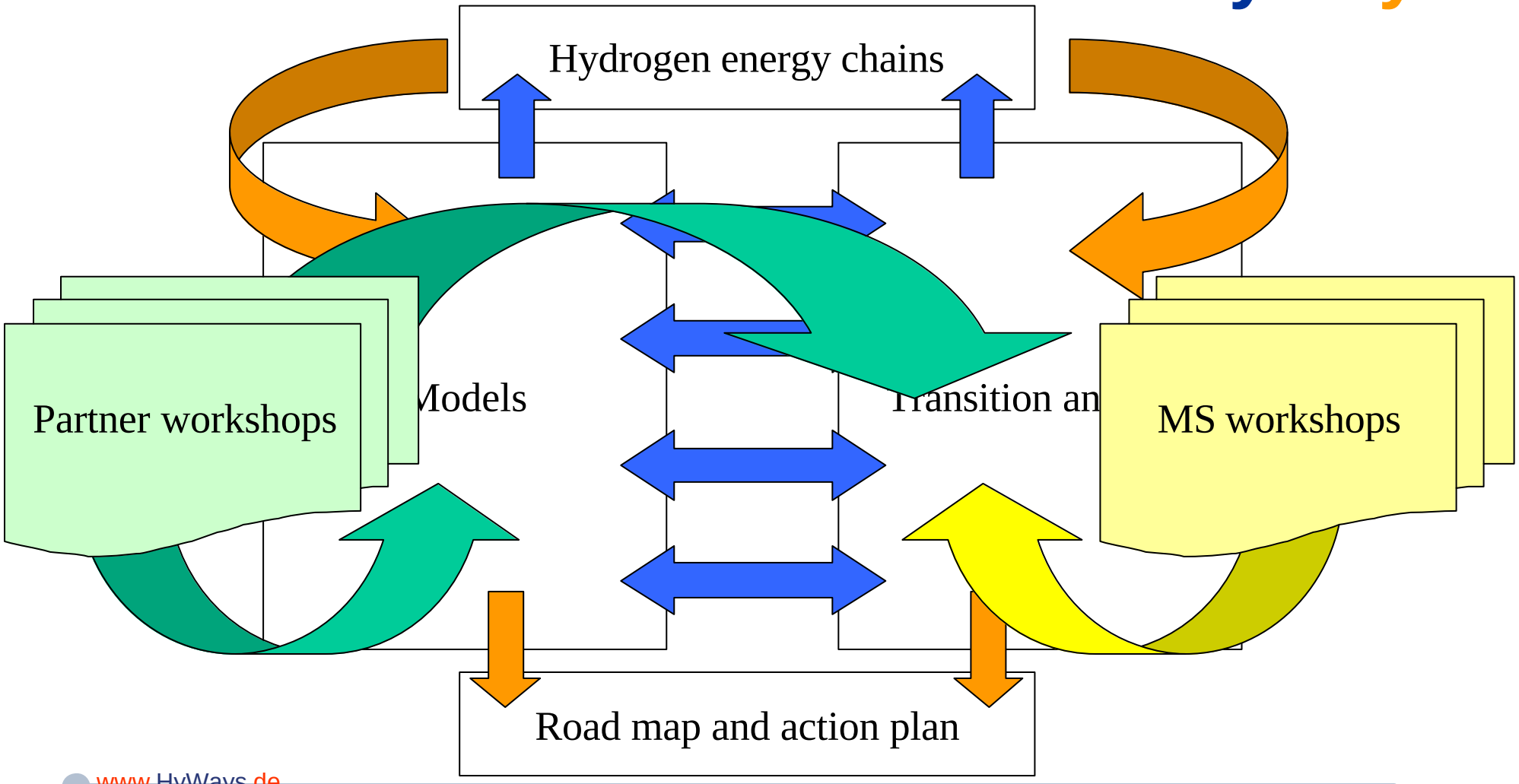

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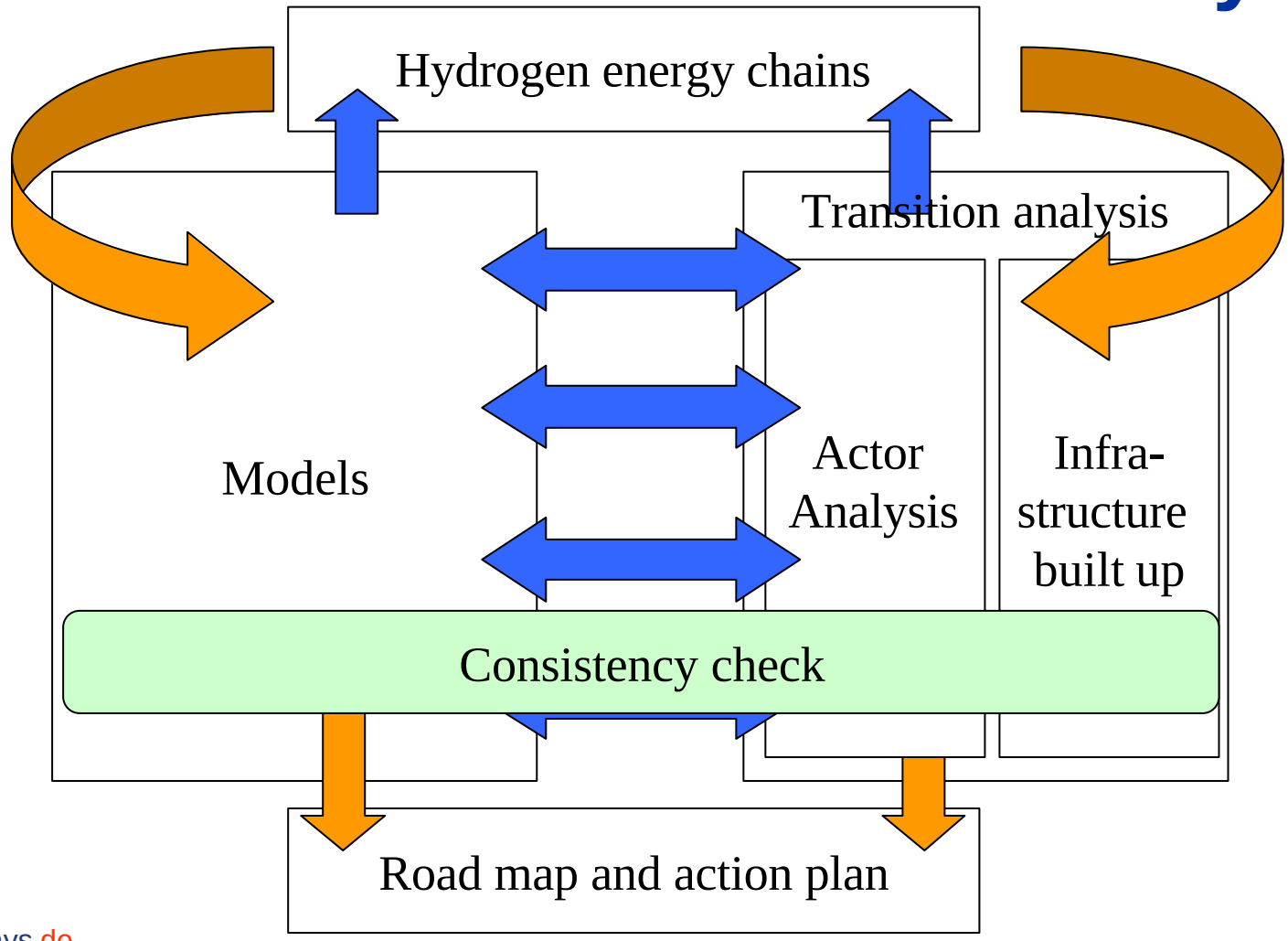
Hydrogen energy chains
Transition analysis
Models
Actor Analysis
Infra-structure built up
Consistency check
Road map and action plan

www.hyways.de

Base line and hydrogen scenarios

- Energy demand based on *Energy Trends 2030* (extrapolation to 2050)
  - demand for transport is (too) high
  - optimistic about fossil fuel availability (projection up to 2030) and energy prices
- Policy targets:
  - 30% GHG emission reduction by 2050
  - fixed share of renewable energy based on 2020 policy targets
- *High* and "*50% High*" Hydrogen introduction scenarios
- Stationary and mobile applications

Main research questions

- Penetration of hydrogen as an energy vector for mobile and stationary applications;
  - Development of penetration rate and investment (additional) costs of hydrogen relevant technologies
  - Pathway analysis, including identification of critical actors and key changes and plausible hydrogen production routes matched to feasible timelines
  - Changes in primary and final energy demand (security of supply)
  - Blueprint of a possible future hydrogen based society (stationary and mobile)
  - Emission analysis indicating achievable reductions in greenhouse gases and pollutant emissions
- Demands on infrastructure
  - Estimated costs, capital investments and timescales for infrastructure build-up

Main research questions

- Identification of different (most promising) regional markets for a hydrogen economy in Europe and development of regional market strategies
- Development of industry R&D strategies for the creation of hydrogen economies; identification key technologies and needs for further research (R&D)
- Analysis of economic (i.e. subsidies, taxation) and legal conditions (i.e. regulatory policies) under which a hydrogen economy can become competitive in order to derive a European set of recommendations
  - Impacts on GDP, EU balance of trade, economic structure, employment effects, private and public investments, security of supply and social justice
  - Impacts of introducing general policy instruments such as a CO_2-tax, emission trading etc.

Time line and available results

- Scoping report available
- Base line available
  - Internal validation
- Model results hydrogen scenarios
  - First run available (what happens if….)
  - Internal validation (project partners) and MS workshops
  - Process modifications: second run (available end of April)
- Infrastructure analysis (regional and EU-level)
- Actor analysis
- Story lines
- European synthesis and Action Plan