
Reframing sustainable transport: exploring hydrogen strategies using Integrated Sustainability Assessment (ISA)

Presented at

L2L - Sustainable Neighbourhood – from Lisbon to Leipzig through Research
4th BMBF-Forum for Sustainability, May 8-10th May, Leipzig

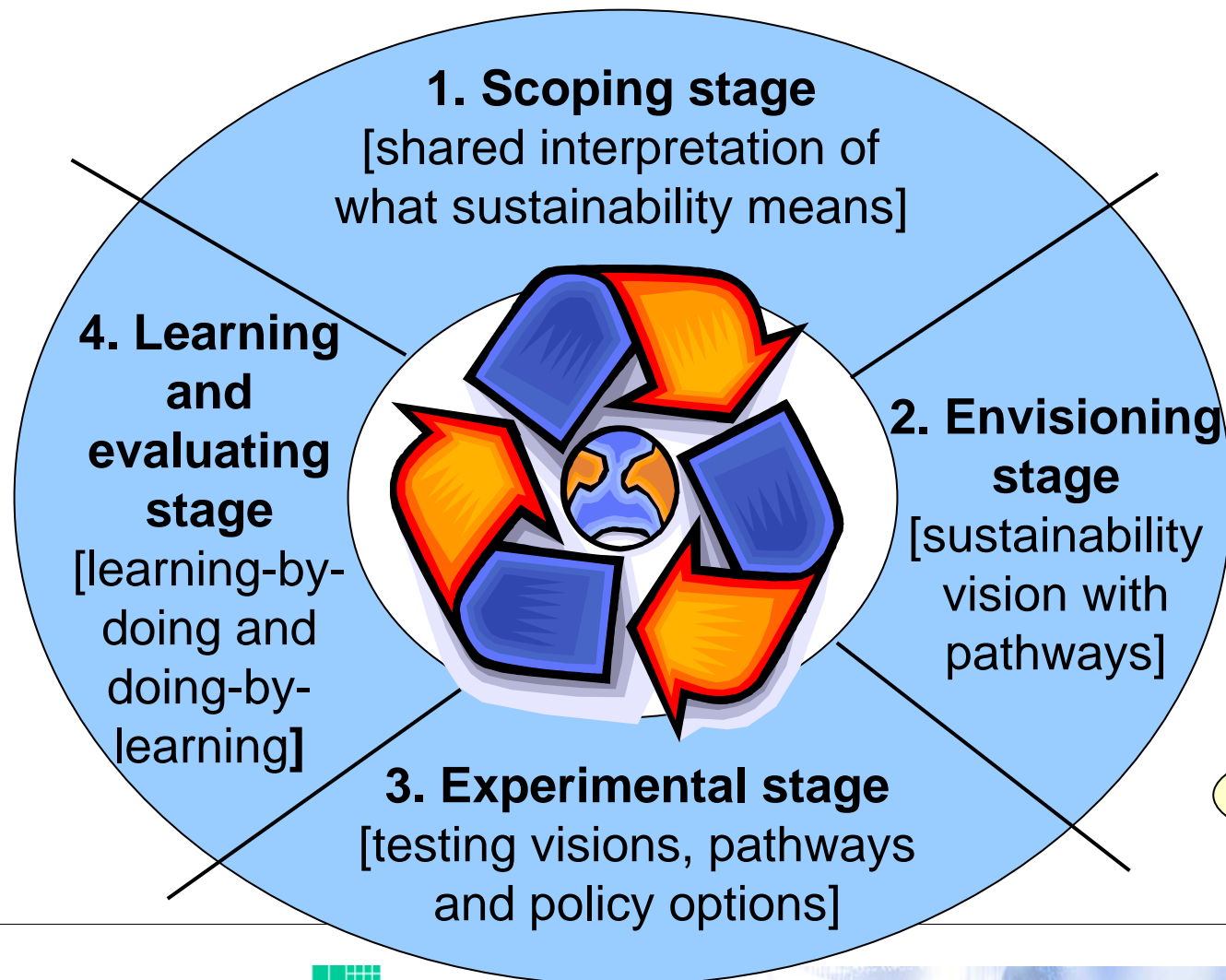
Dr. Wolfgang Schade, w.schade@isi.fraunhofer.de

Dr. Martin Wietschel, Fraunhofer ISI, Karlsruhe, Germany

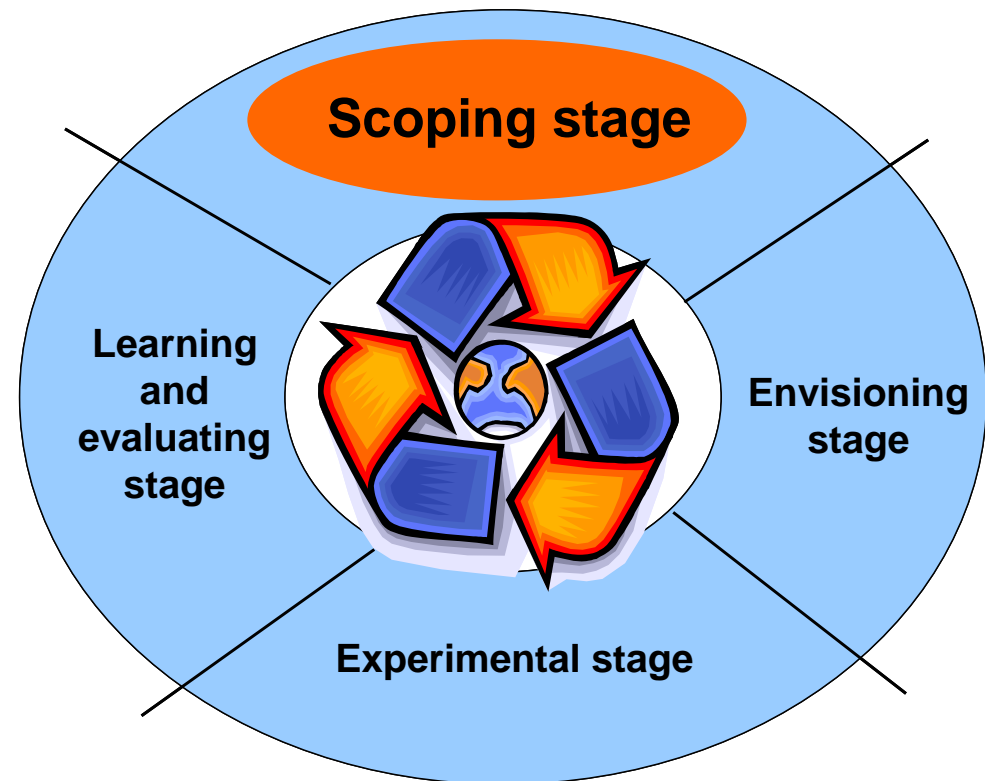
Dr. Paul Weaver, Wolfson Research Institute, University of Durham, UK



Integrated Sustainability Assessment (ISA): ISA-cycle concept



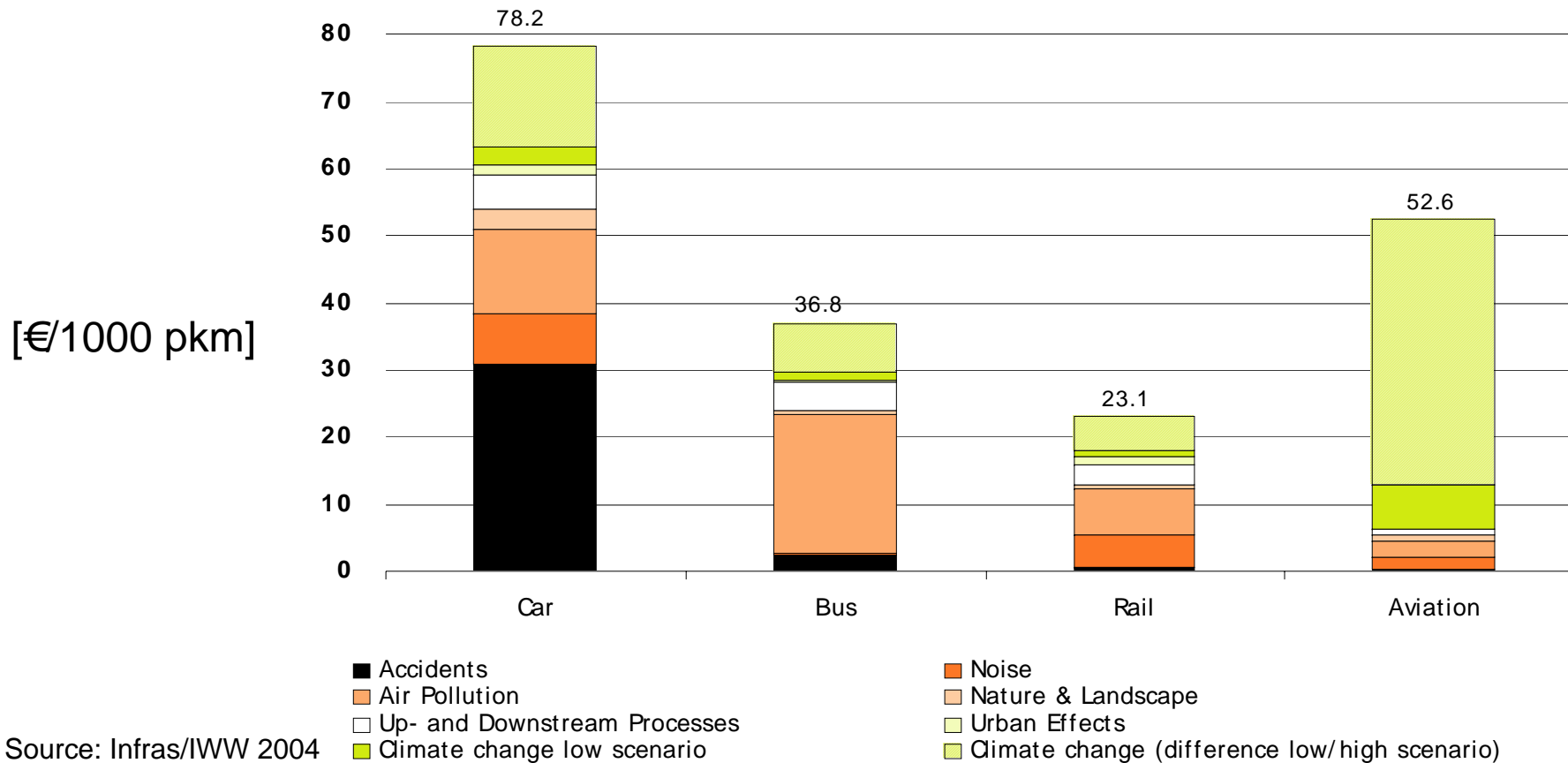
Scoping stage: problem perception and sustainability interpretation



Scoping stage



Scoping stage: external cost of passenger transport by mode

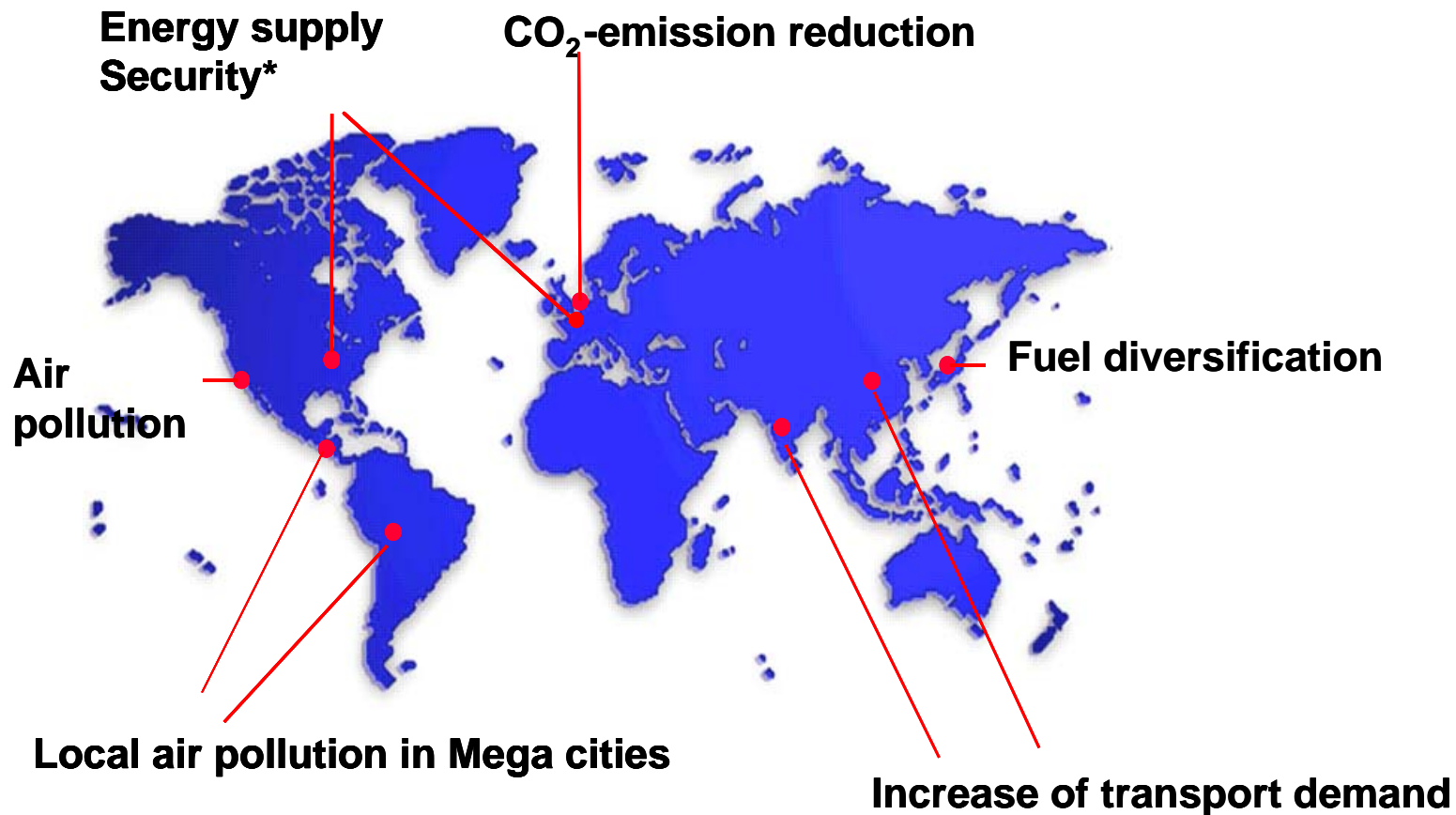


Scoping stage



Scoping stage: problem perception – why use hydrogen?

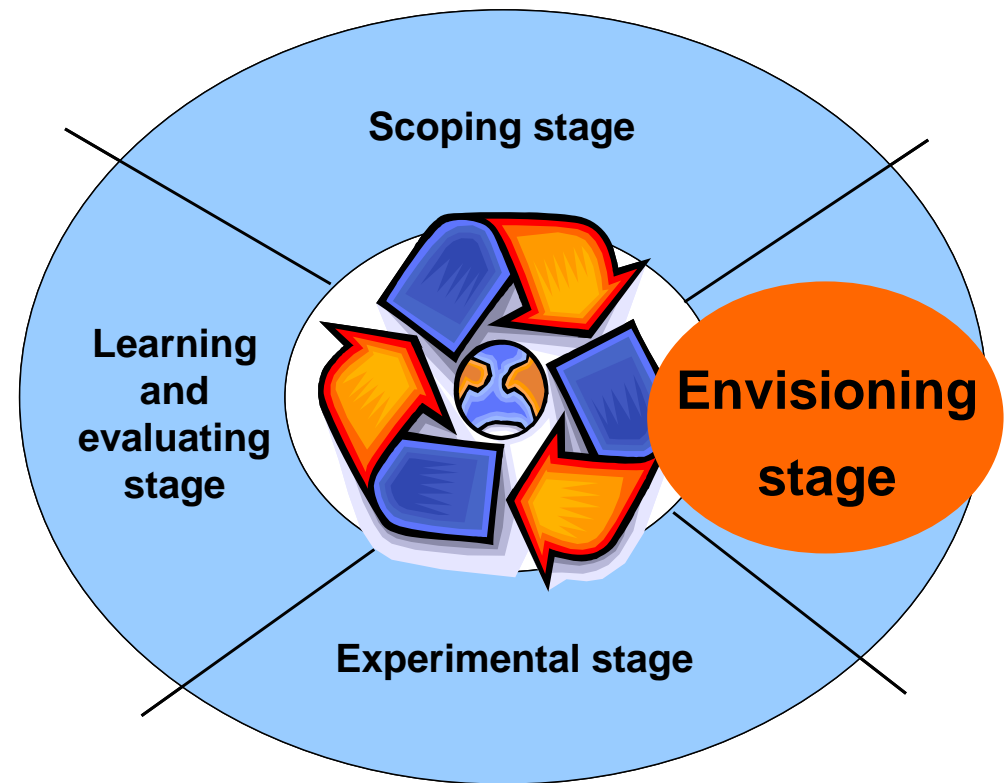
Globally: International competitiveness and innovation



Scoping stage

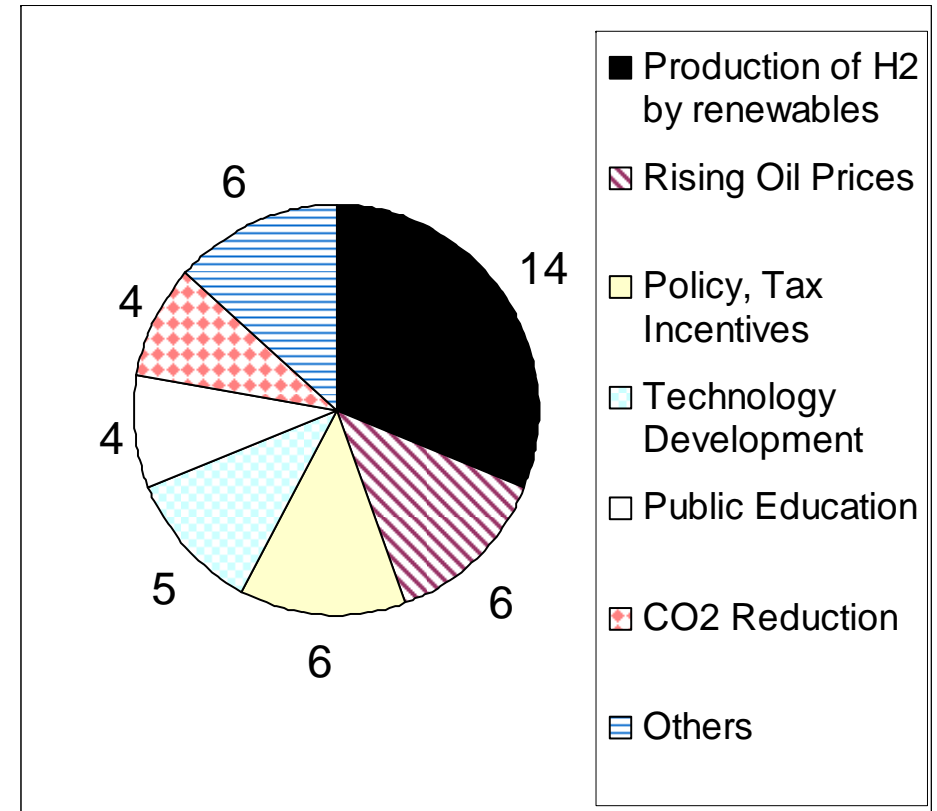
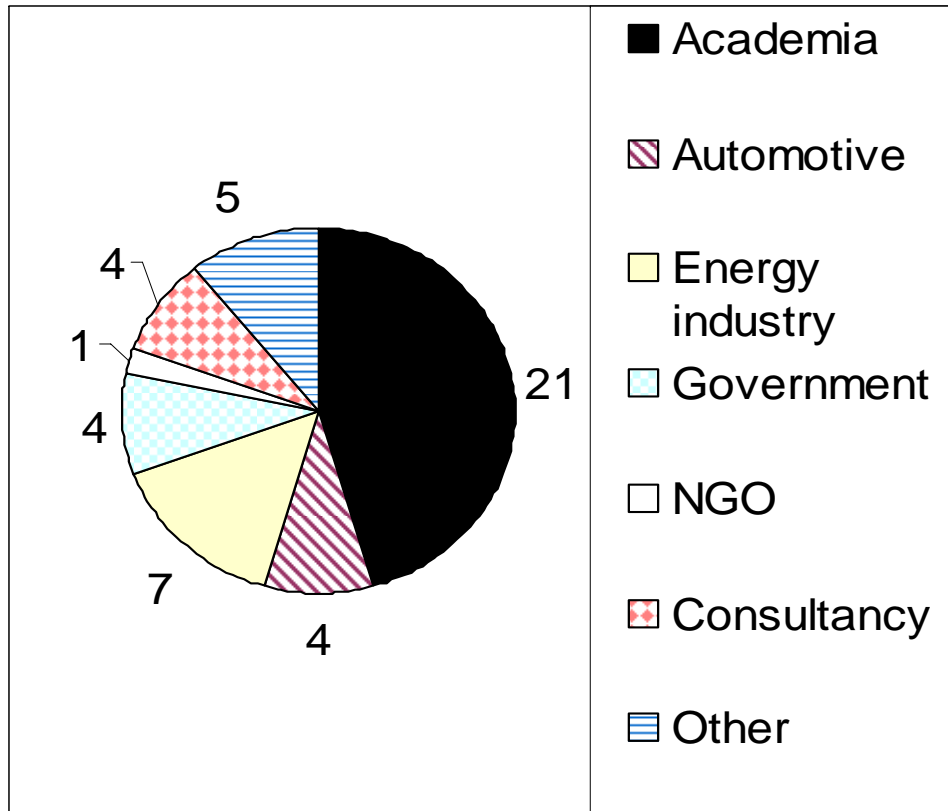


Envisioning stage: sustainability vision and pathways



Envisioning stage

Stakeholder workshop: What will ensure that the use of hydrogen will be sustainable?



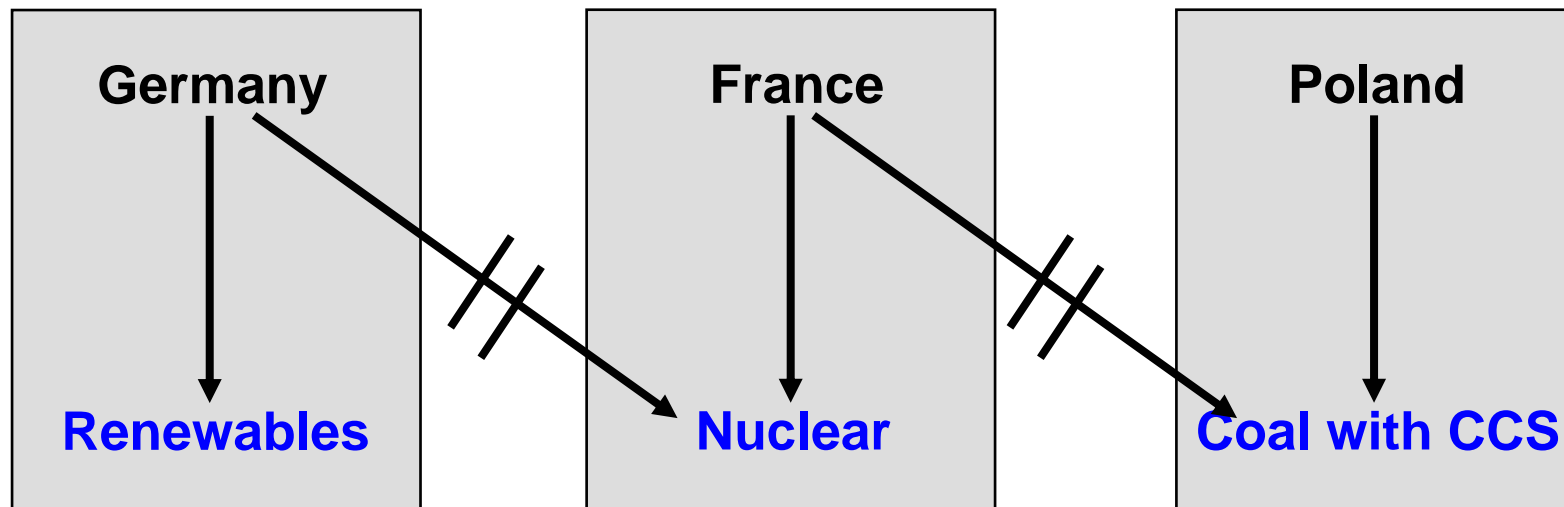
Envisioning stage



Stakeholder views:

How to reduce greenhouse gas emissions with hydrogen ?

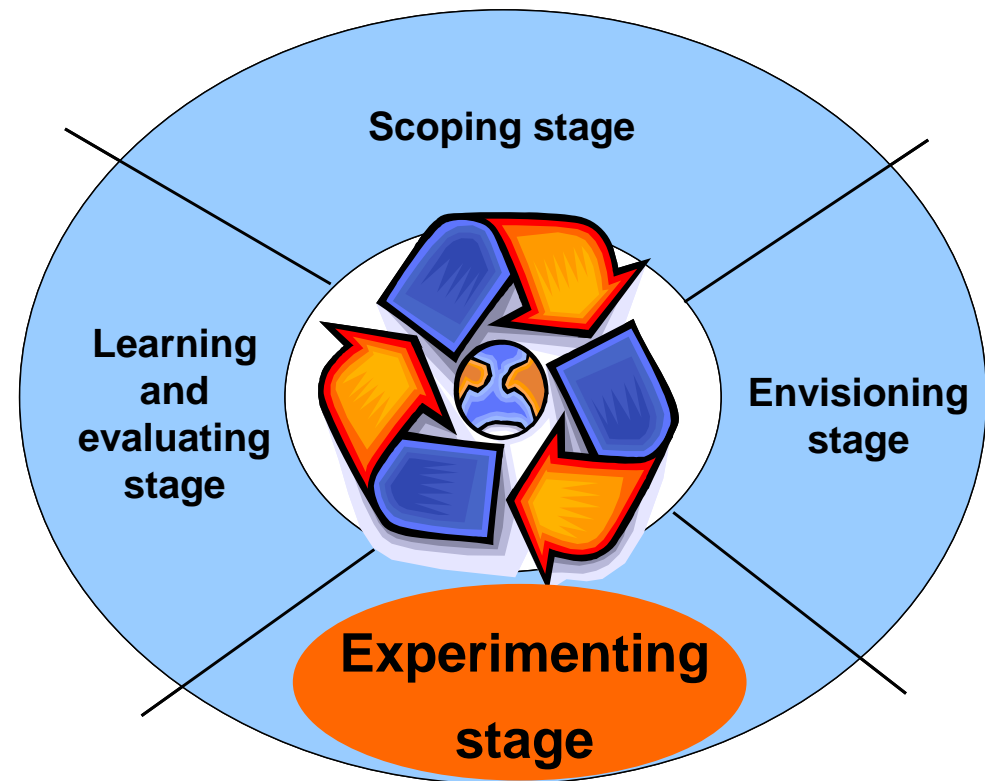
Country visions:



Envisioning stage



Experimenting stage: consistency, pathways and policies



Experimenting stage



Scenario assumptions for the model-based experiments

Scenario on penetration of hydrogen ICE and FC cars into EU car fleet:

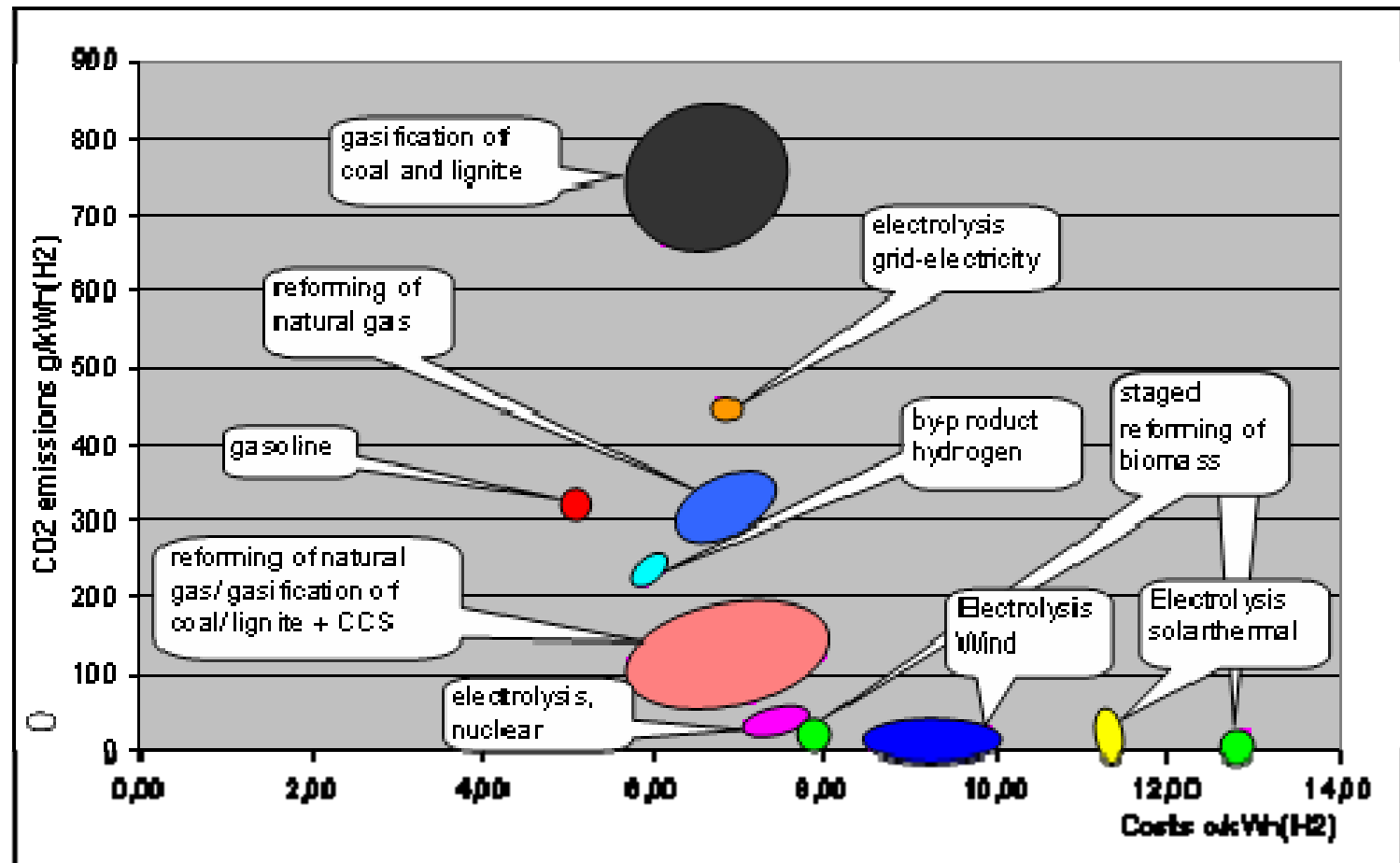
- Hydrogen penetration rates from HyWays high penetration scenario
- Structural identity scenario for vehicle production
- Hydrogen infrastructure can be build-up from H2 revenues
- Cost to produce hydrogen by different pathways are taken from HyWays project
- Hydrogen cars have to be subsidised to enter the market
- European countries apply different pathways to produce hydrogen, and hence additional investments into renewables differ between countries
- Demand for hydrogen cars shifts demand for vehicles partially from transport equipment sector to electronics and chemicals sector

Experimenting stage



Scenario inputs for use of H2 in transport: hydrogen cost

Trade-off between CO2 emissions and cost of different H2 pathways in comparison with gasoline ●

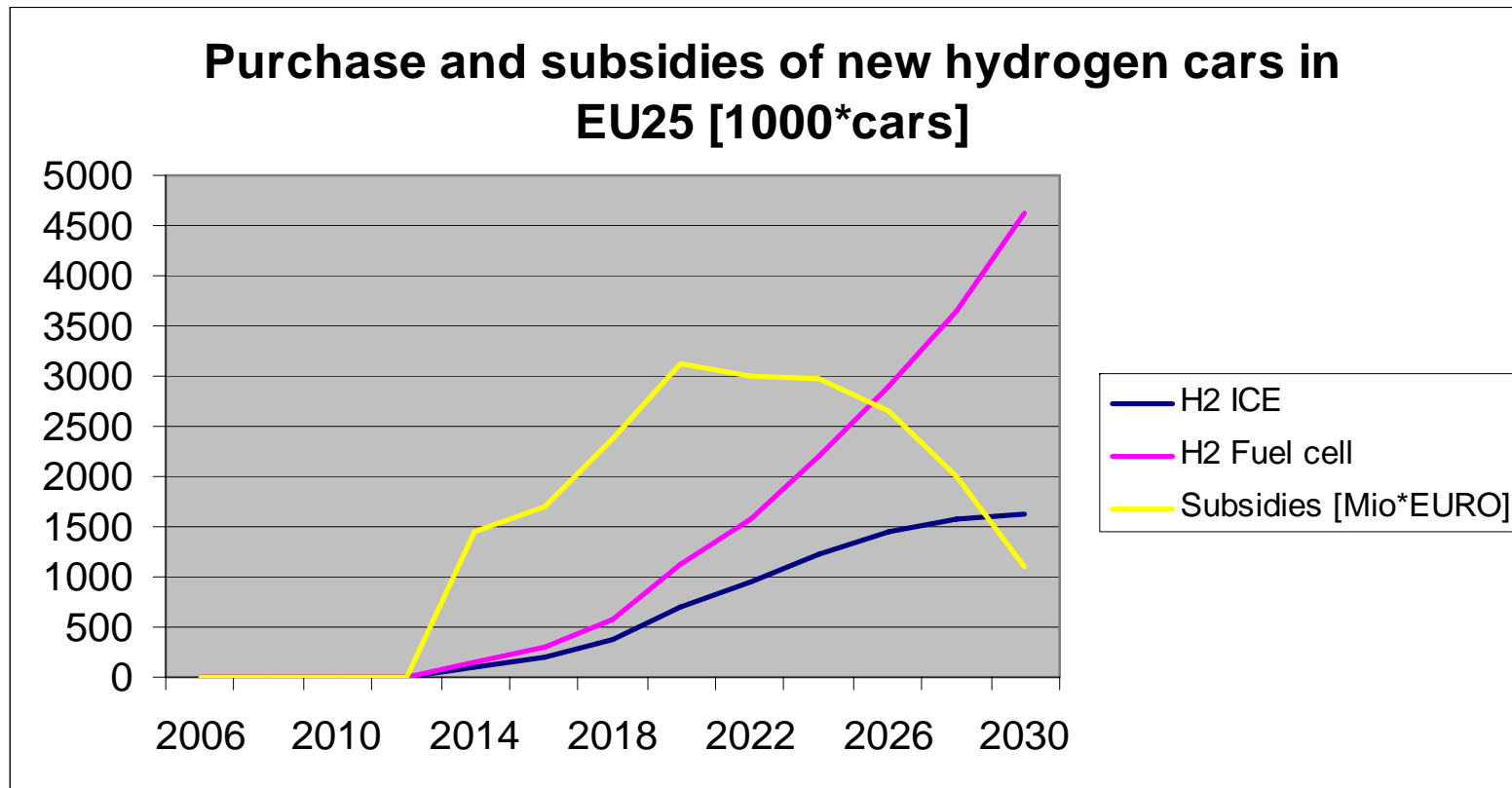


Scenario inputs: hydrogen

Source: HyWays results



Scenario inputs for use of H2 in transport: H2 cars penetration

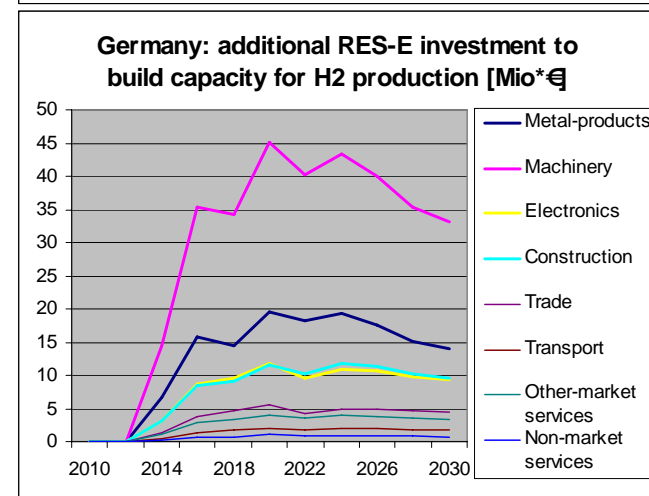
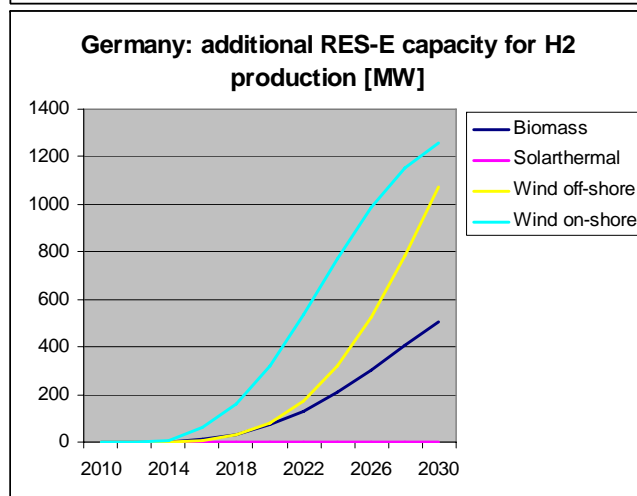
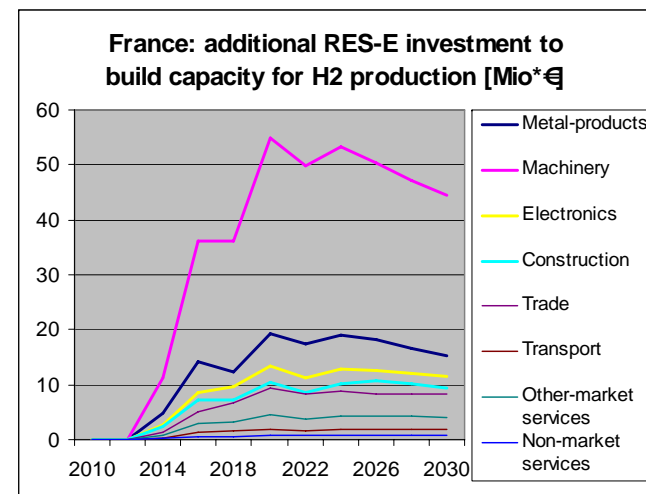
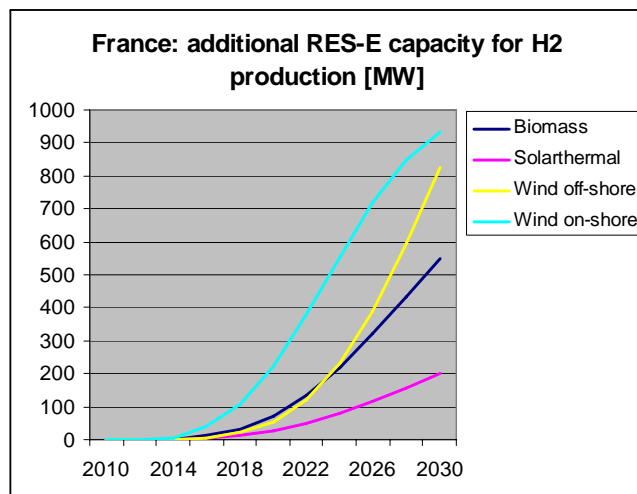


Scenario inputs: hydrogen

Source: HyWays & ASTRA results



Scenario inputs for use of H2 in transport: renewables



Scenario inputs: renewables

Source: GreenX & ASTRA results



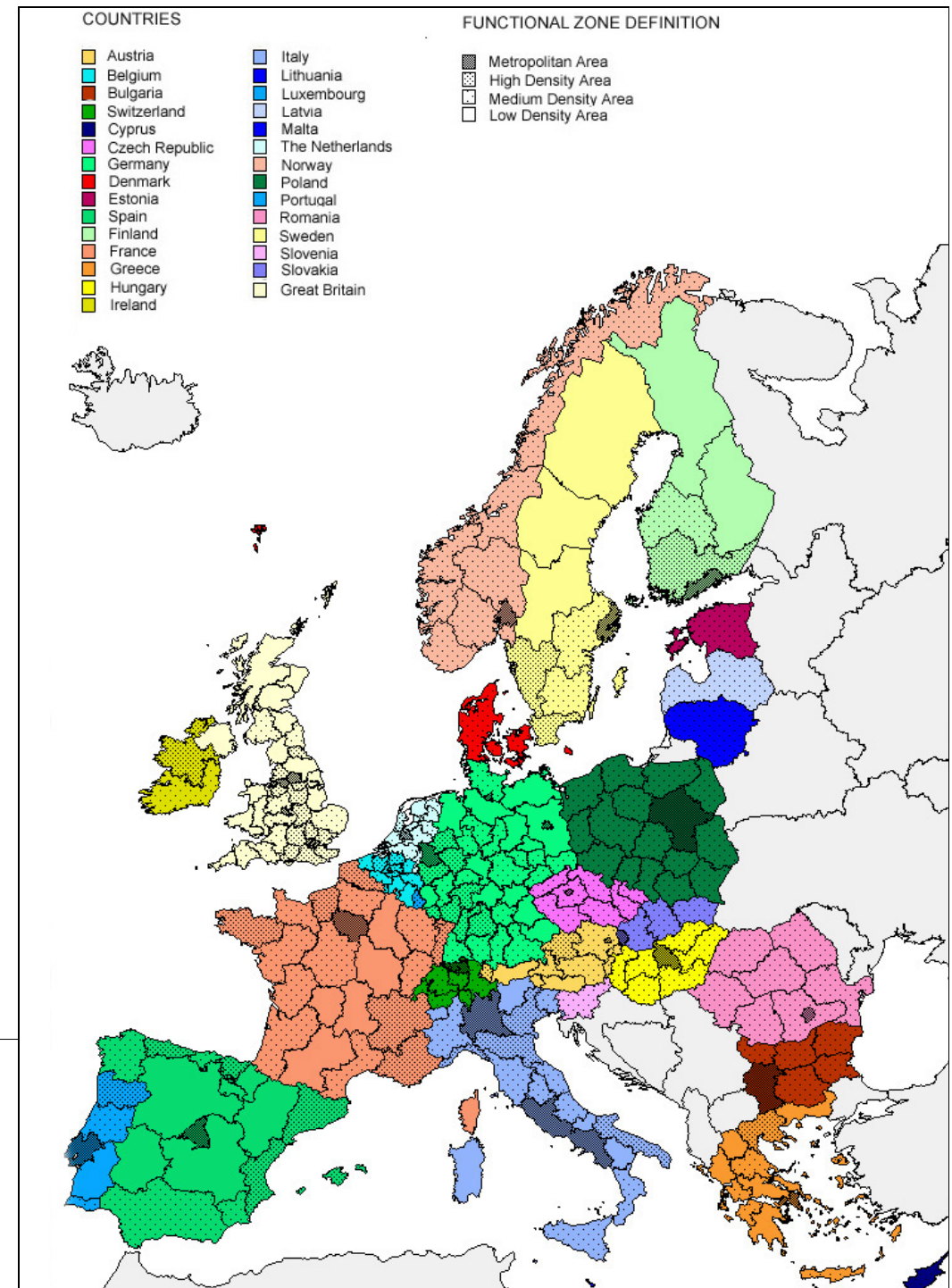
ASTRA structure: Overview of spatial representation

Spatial disaggregation for EU29 countries:

- 14 EU15 countries (B+L)
- each with 4 functional zones
- 12 new EU member states plus Swi + Nor
- with 1-2 functional zones

At maximum four functional zones per country classified by settlement density:

- Metropolitan zone
- High density zone
- Medium density zone
- Low density zone



Model structure

ASTRA structure: Overview of modules and interactions

Key features:

- **Integrated models**
- **System Dynamics (Vensim)**
- **29 EU countries**
- **76 zones**
- **25 economic sectors**
- **>20000 OD flows (P, F)**
- **8 modes (P+F)**
- **550 MB of output data**
- **Time horizon 2030 (2050)**

Abbreviations for 8 Modules:

POP = Population Module

MAC = Macroeconomics Module

REM = Regional Economics Module

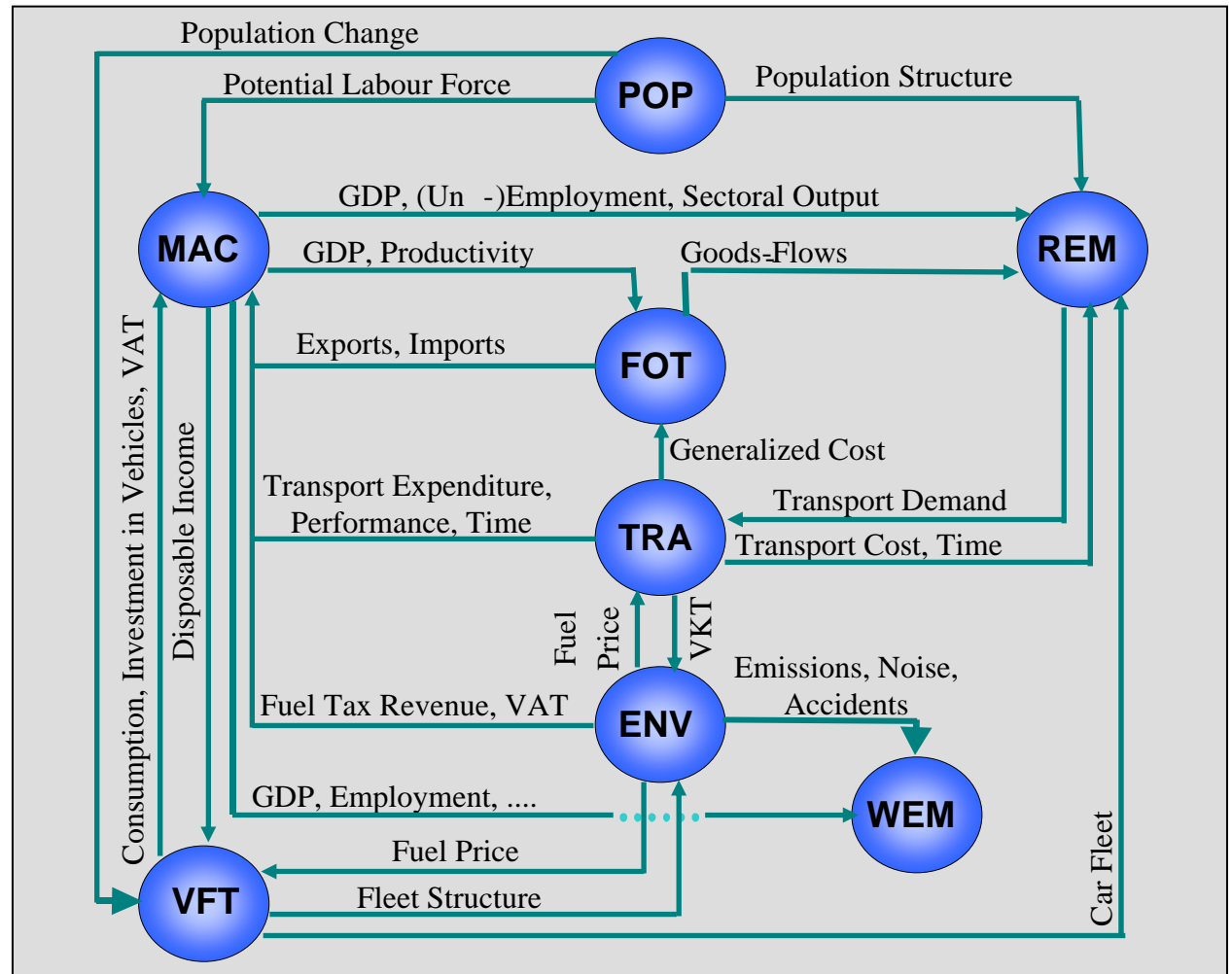
FOT = Foreign Trade Module

TRA = Transport Module

VFT = Vehicle Fleet Module

ENV = Environment Module

WEM = Welfare Measurement Module



Model structure

ASTRA structure: policy levers for hydrogen scenario

Sectoral investments

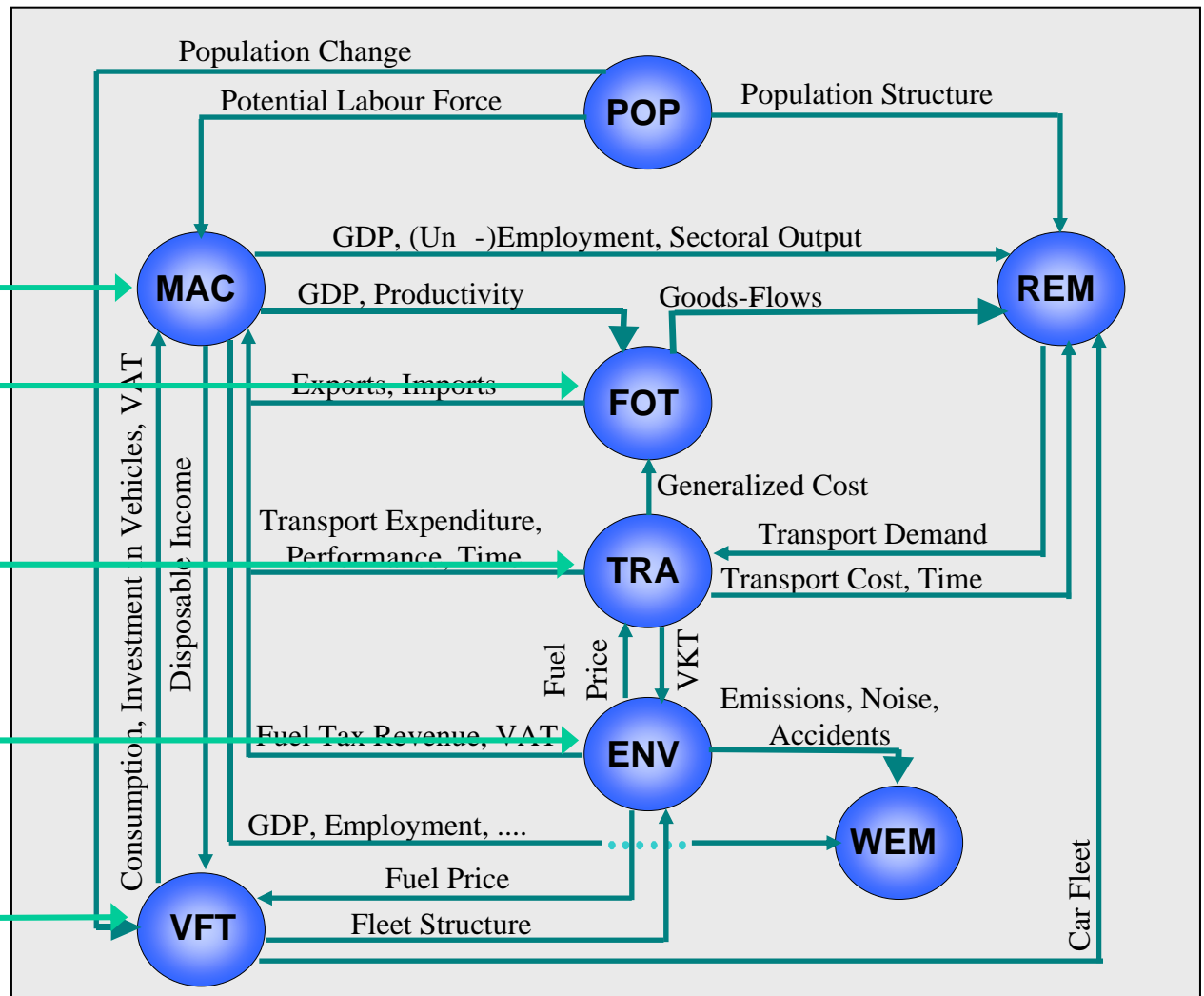
Sectoral trade flows

Modal
choice decisions

Fuel cost

Vehicle cost

Vehicle purchase decisions



Model structure

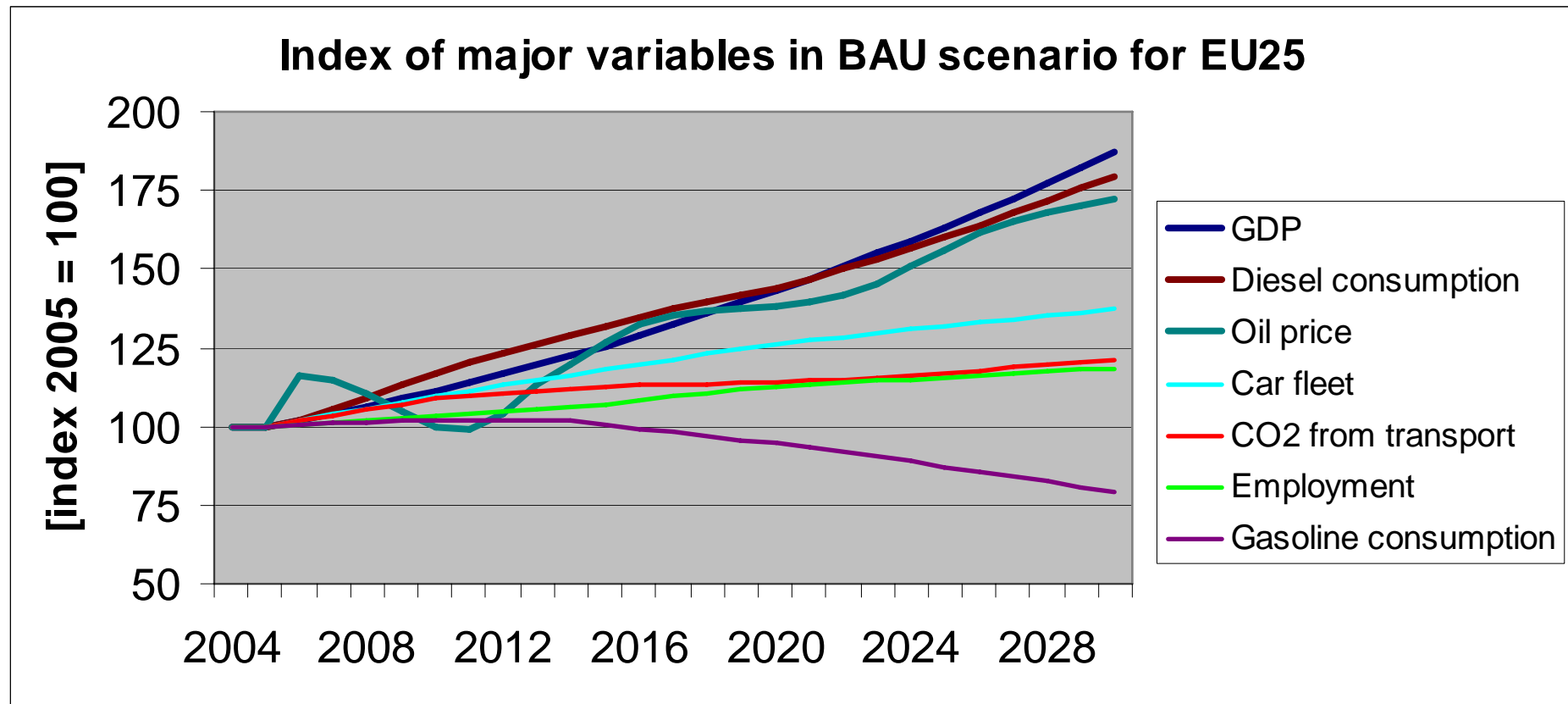


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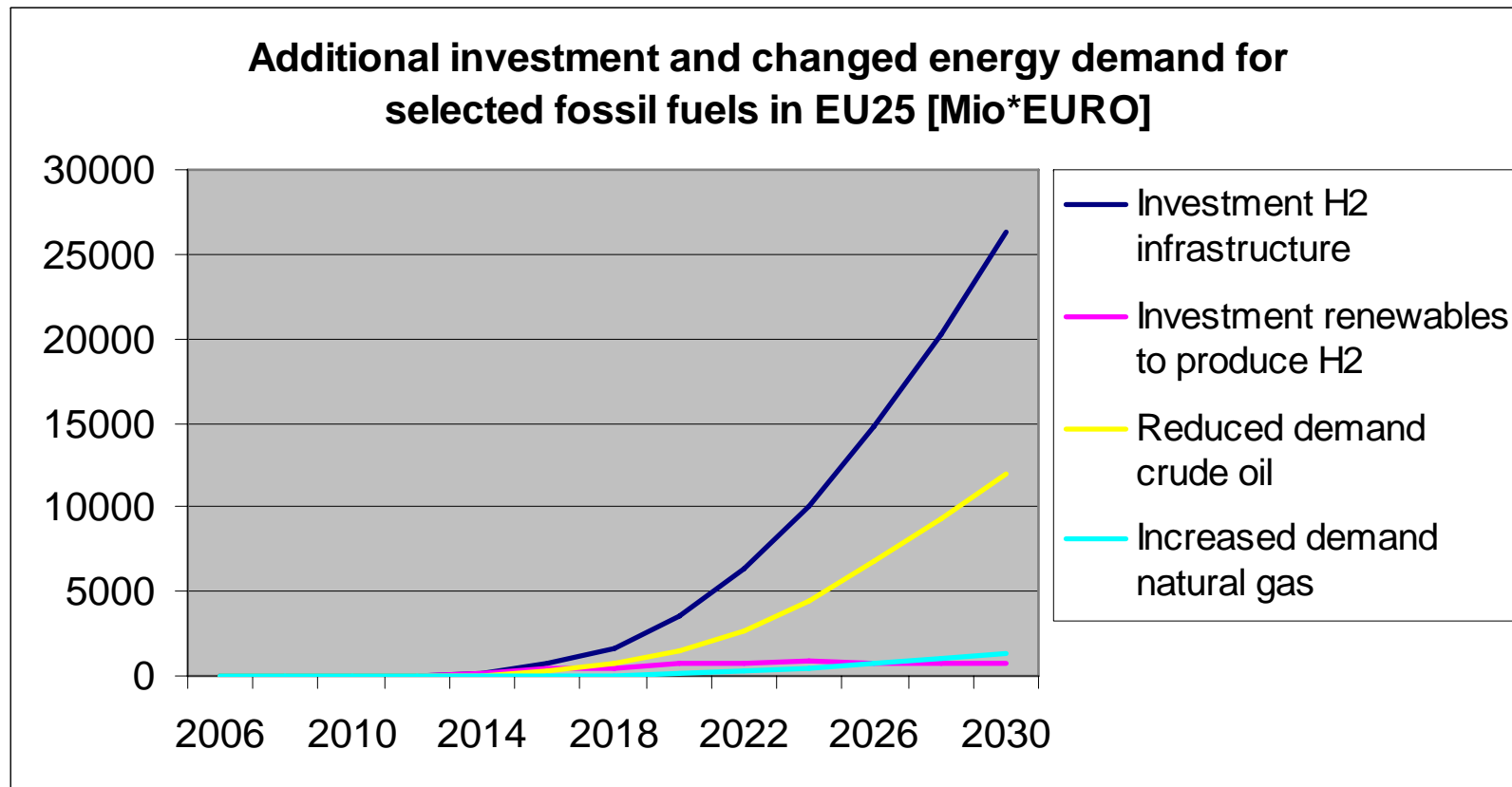
Scenario results: Major trends of BAU scenario for EU25



Scenario results: BAU

Source: ASTRA results

Scenario results: Investment and changes of energy demand

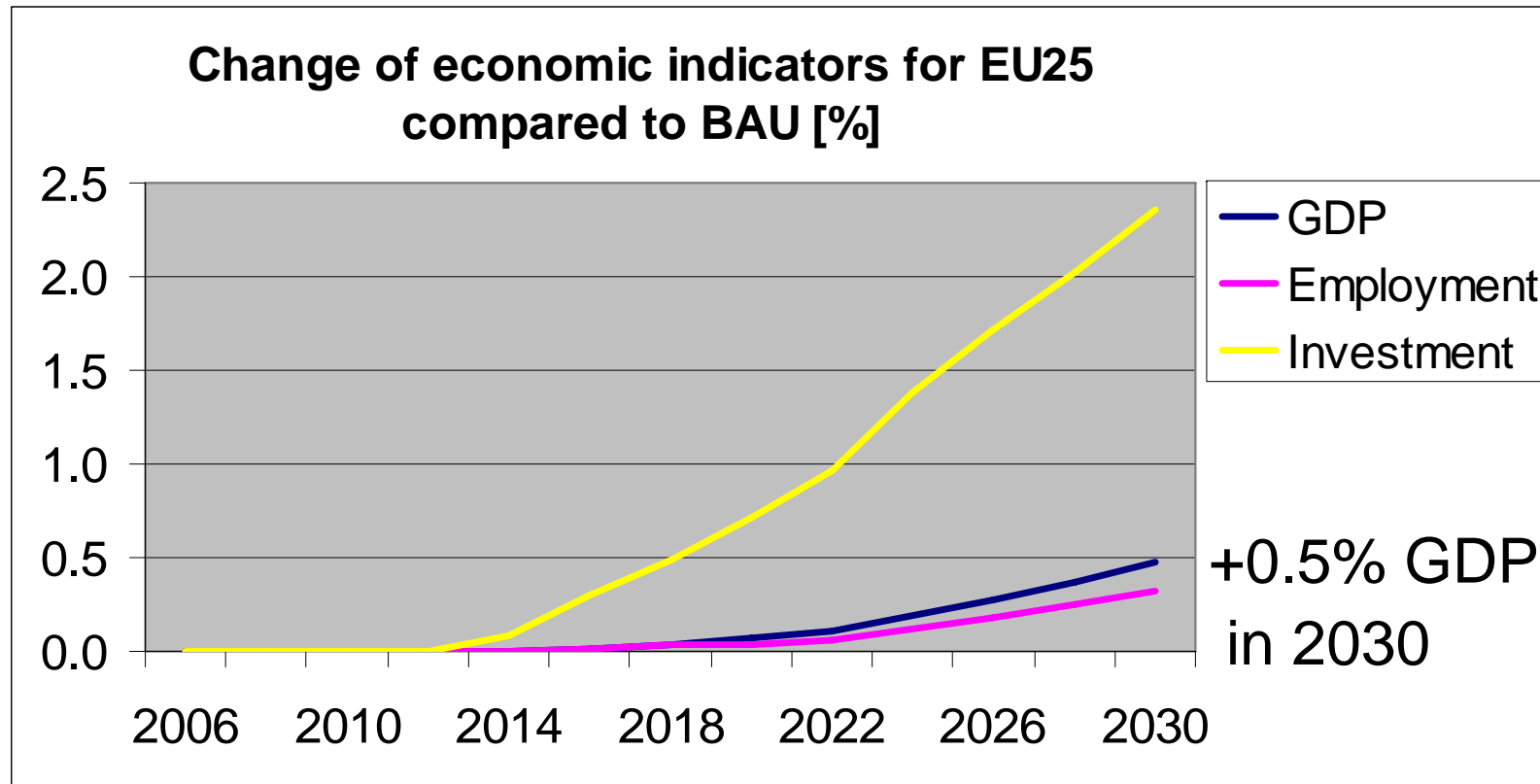


Scenario results: hydrogen

Source: ASTRA results



Scenario results compared with BAU: Economy

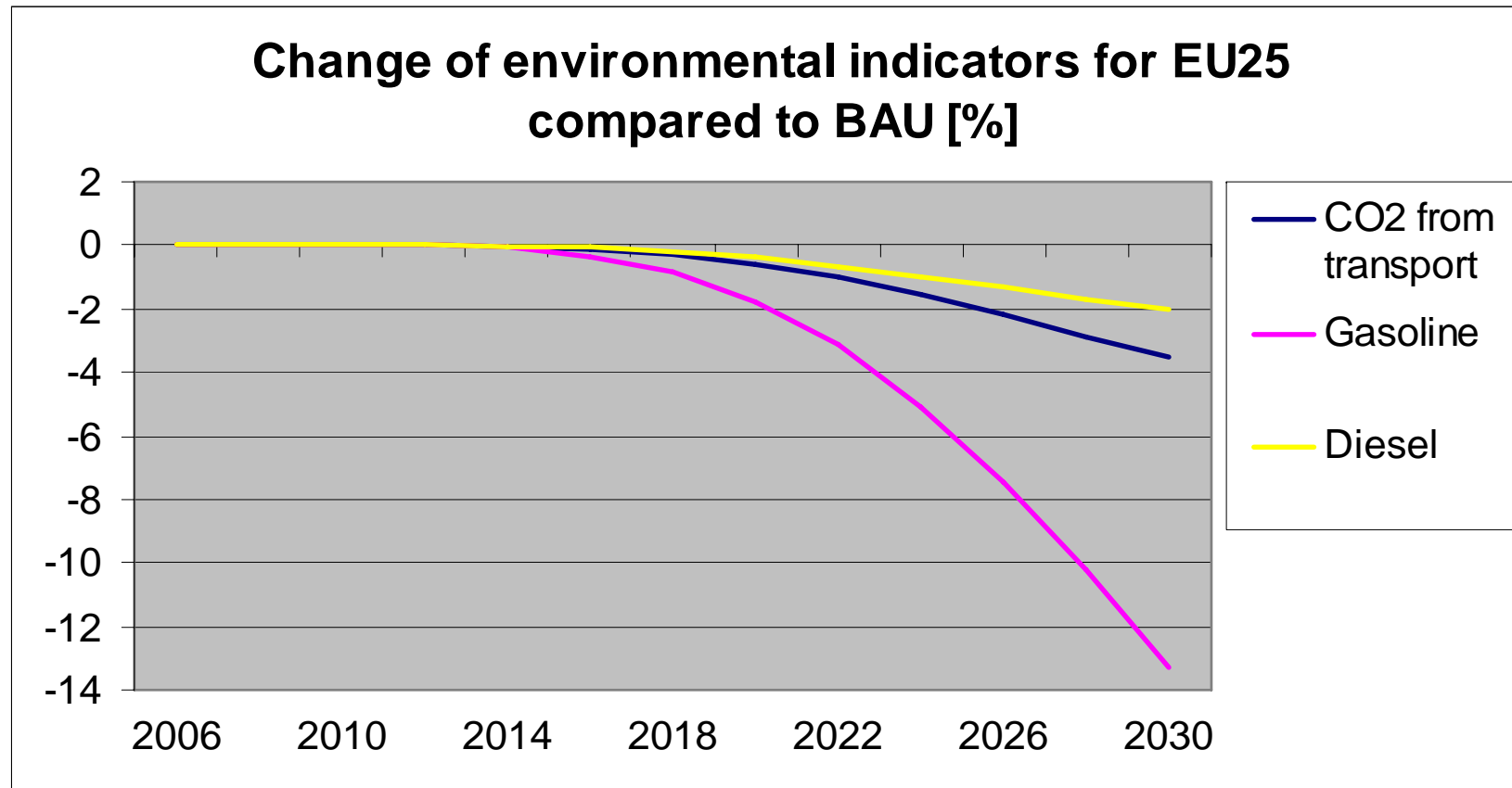


Scenario results: hydrogen

Source: ASTRA results



Scenario results compared with BAU: Environment

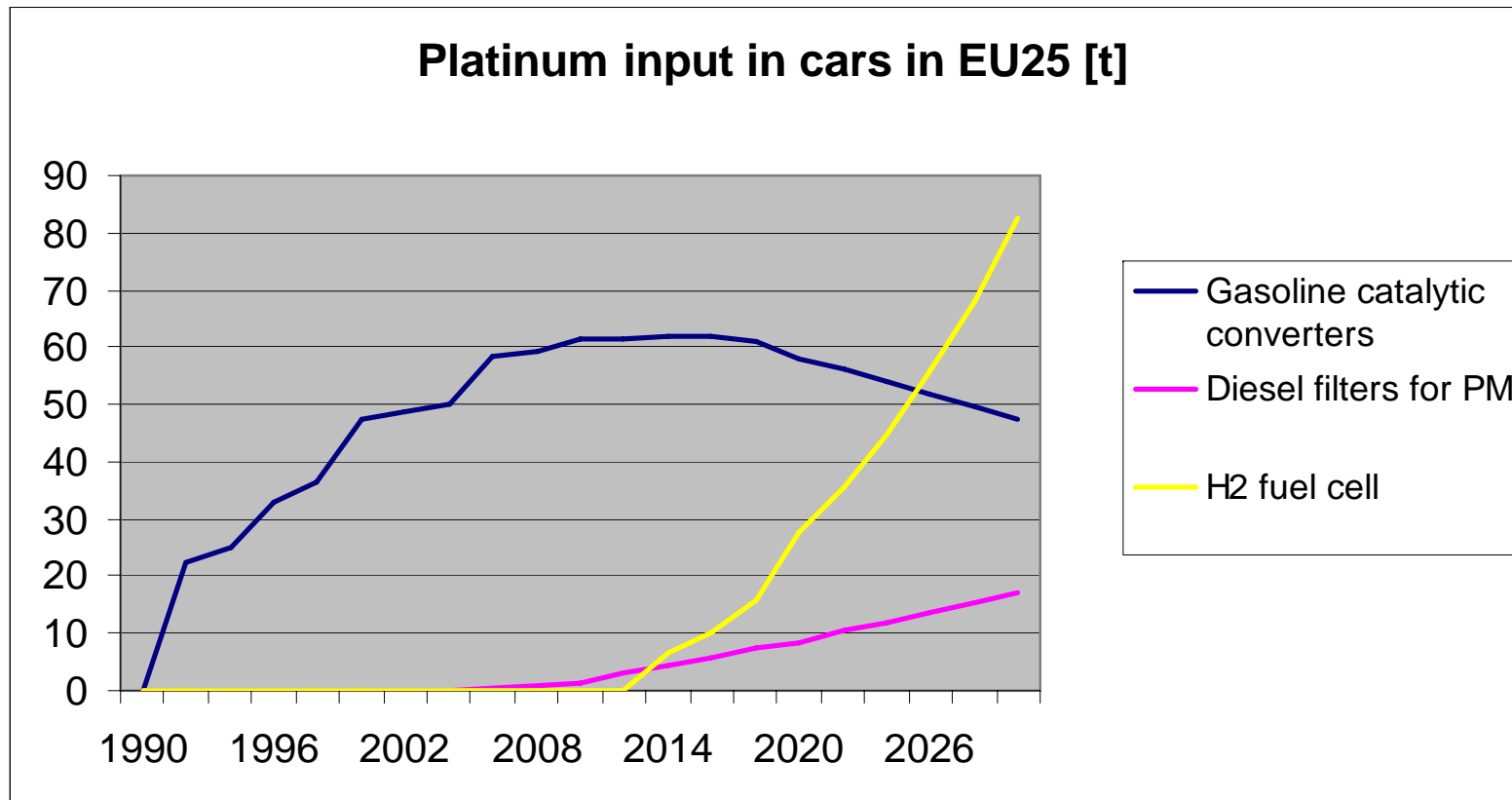


Scenario results: hydrogen

Source: ASTRA results



Scenario results: Platinum for car production

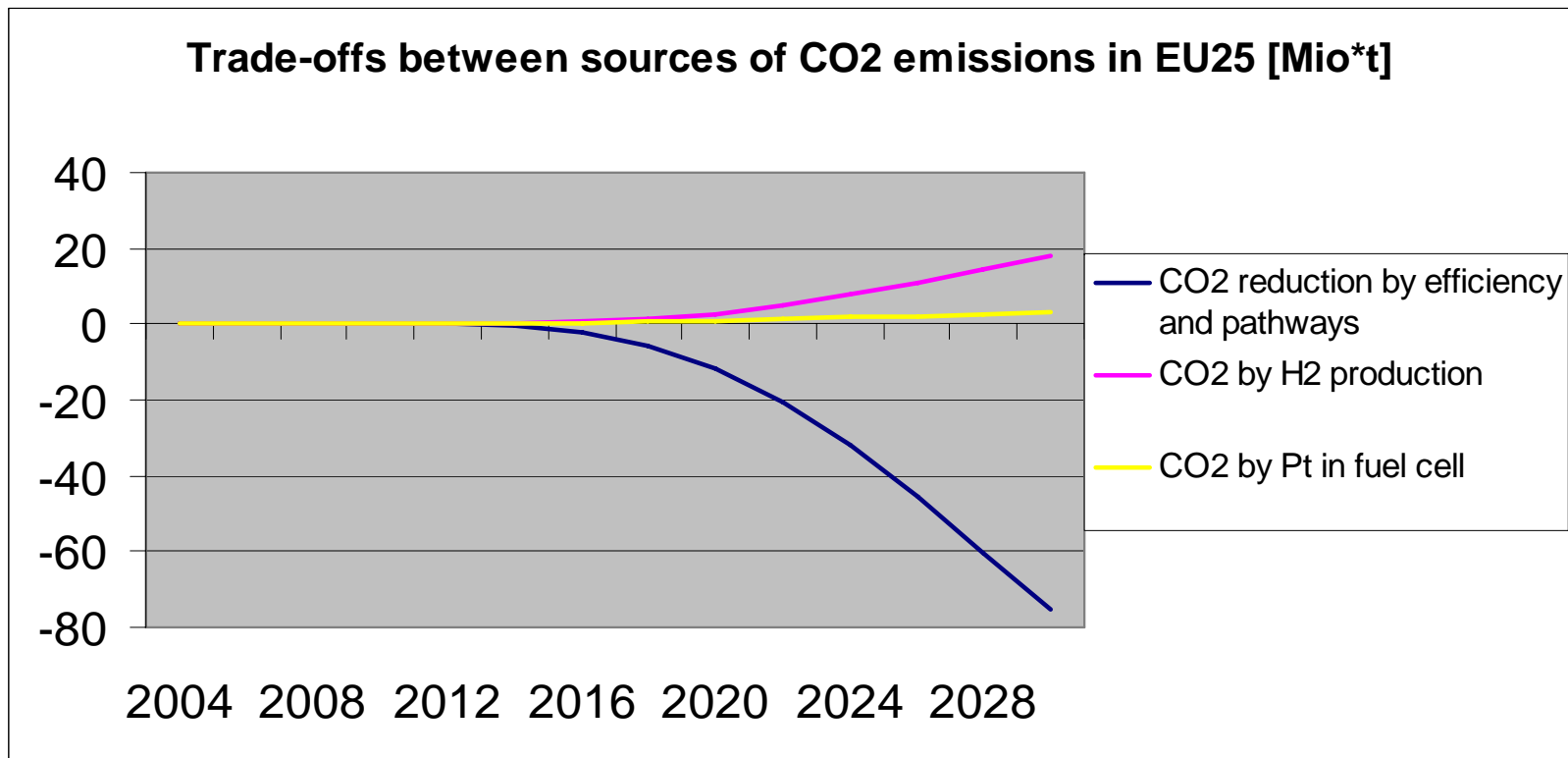


Scenario results: hydrogen

Source: ASTRA results



Scenario results: Trade-offs CO2 Emissions



Scenario results: hydrogen

Source: ASTRA results



Overview on results of the scenario analysis

Economy	GDP	Employment	Investment	
Impact of H2 cars	↑	↑	↑↑	
Resources	Gasoline	Diesel	Import of natural gas	Platinum
Impact of H2 cars	↓↓	↓	↑	↑↑
Transport emissions	CO ₂ driving	CO ₂ upstream	CO ₂ total	NO _x emissions
Impact of H2 cars	↓	↑	↓	↓

Scenario results: hydrogen

Source: ASTRA results



Conclusions on sustainable H2 use for transport

- So far, no unified vision across countries and actors, how a sustainable transport system build on hydrogen would look alike
- Potential trade-off or win-win situations for the economy:
 - Introduction of new technology stimulates investments
 - but it could increase cost, which may be compensated by higher investment and growth
- Potential trade-off or win-win situations for the ecology :
 - Reduced emissions during transport activity
 - May increase upstream emissions
 - Trade-off H₂: reduction of domestic emissions, but increase of imported emissions and metarial input

Conclusions



Invitation to next cluster & stakeholder workshop:

Running transport on hydrogen and biofuels: scenarios, policies and sustainability assessment

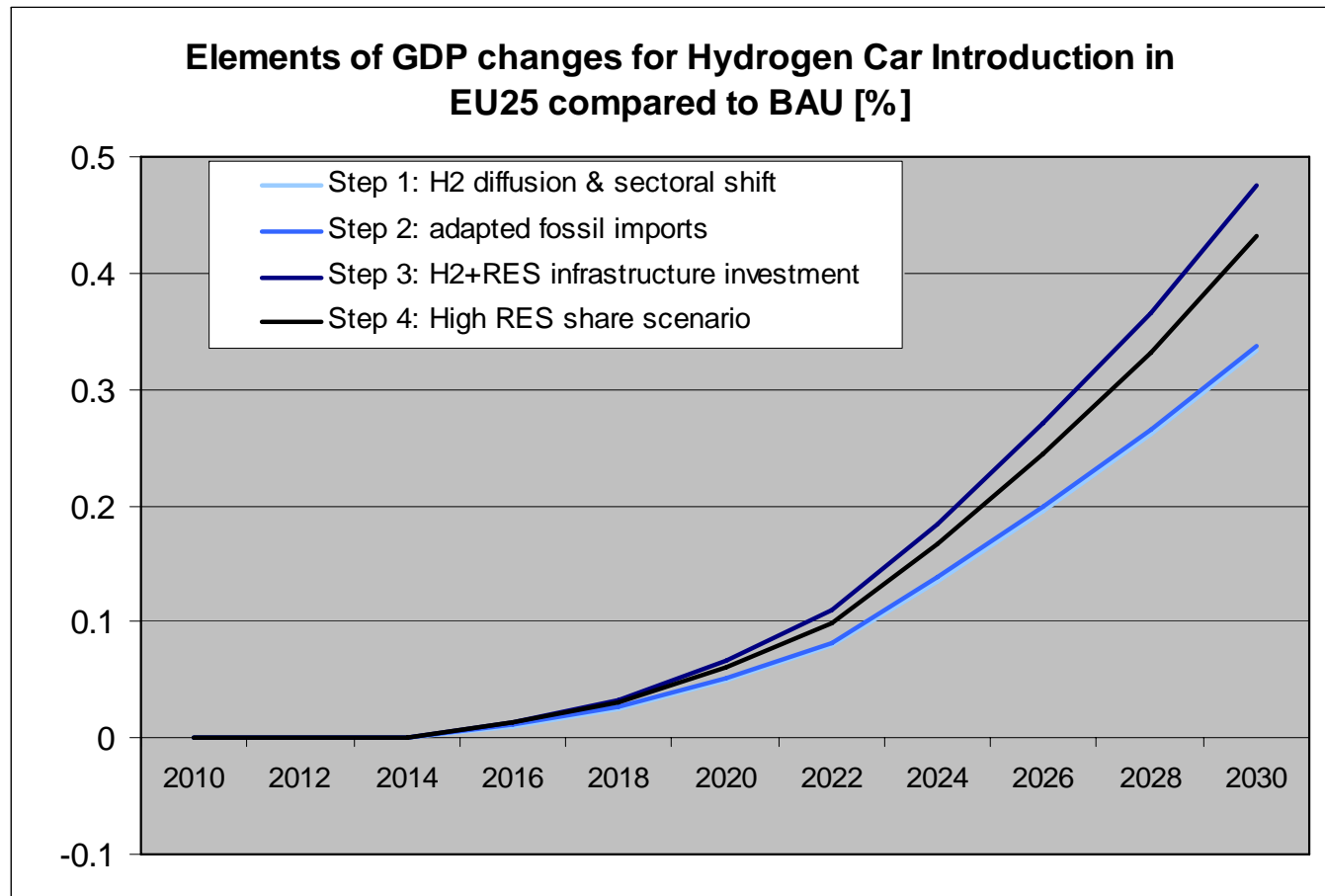
Frankfurt, June 15th 2007, 09:00 – 16:30, Dinner on 14th

Registration at Fraunhofer ISI, s.mohr@isi.fraunhofer.de

Information: <http://www.isi.fhg.de/TRIAS/>



Scenario results compared with BAU: GDP impacts of scenario elements

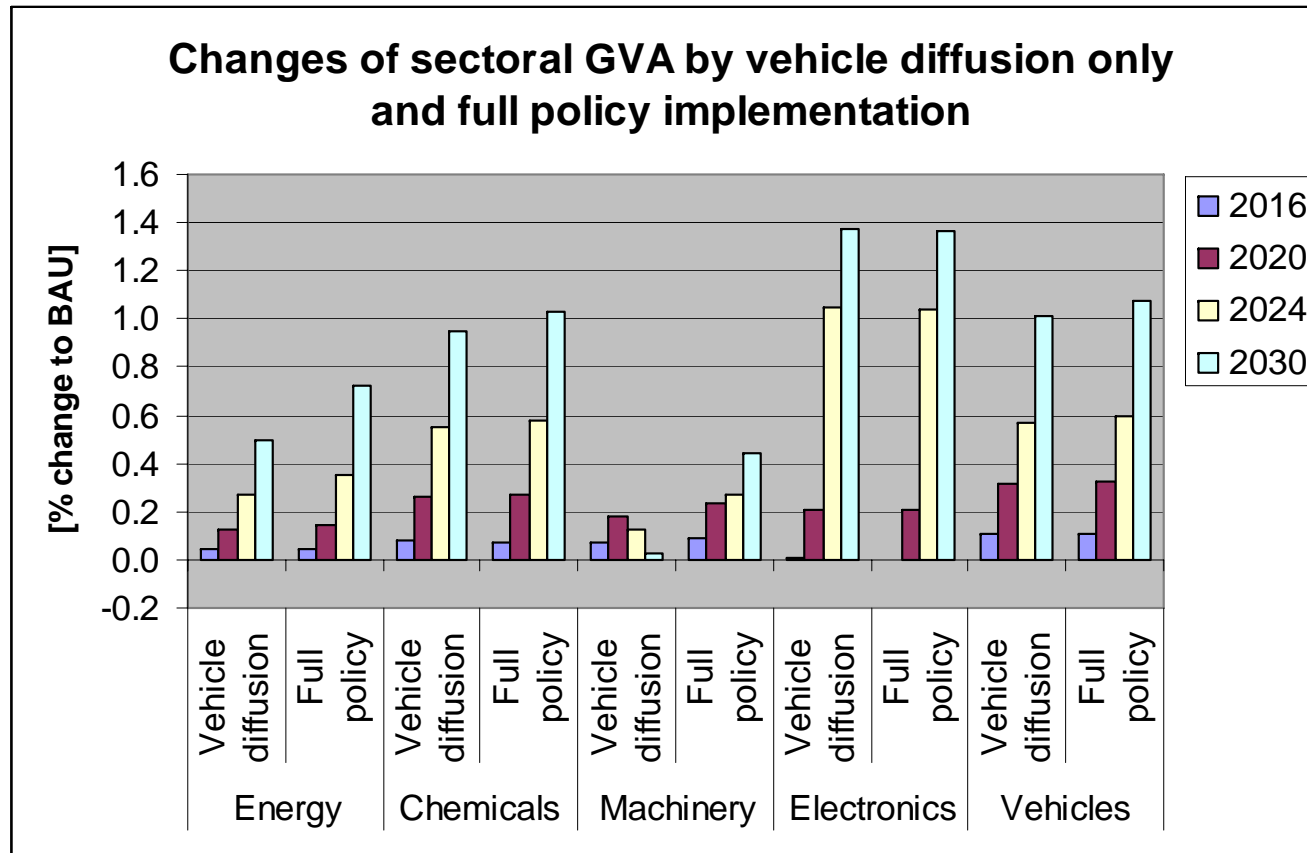


Scenario results: hydrogen

Source: ASTRA results



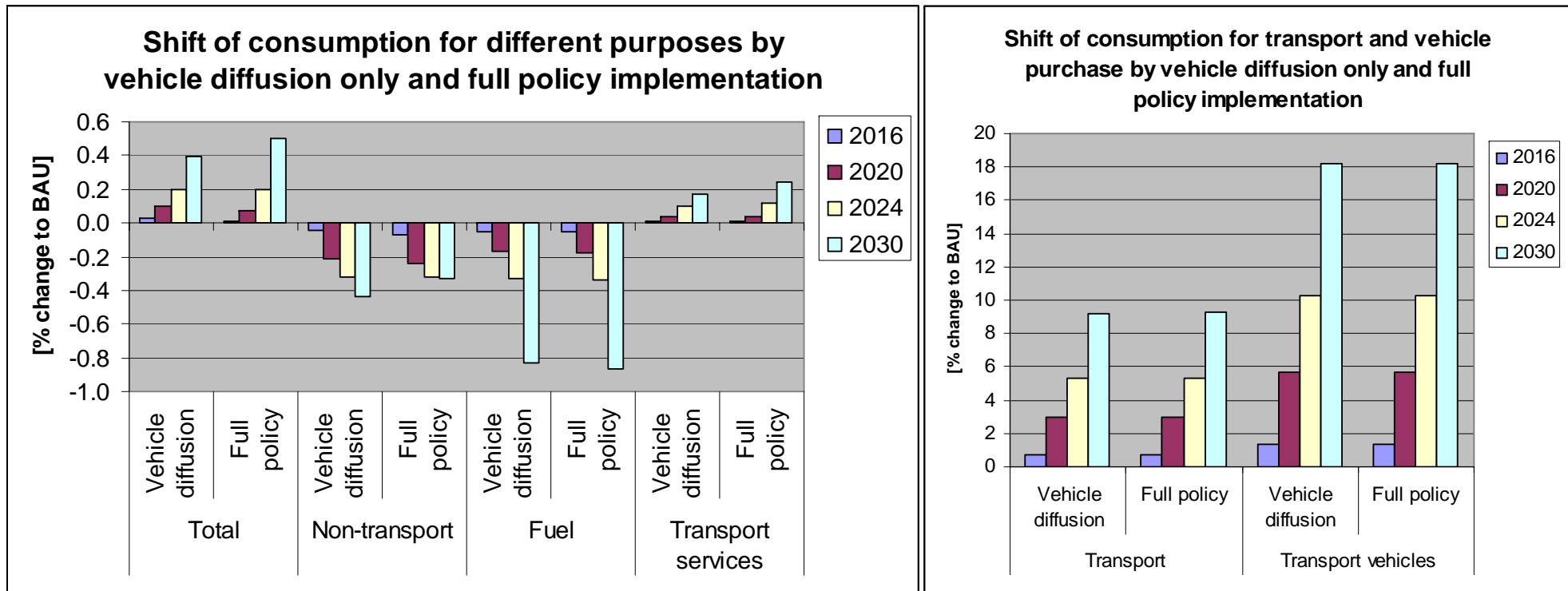
Scenario results: change of GVA by most affected sectors



Source: ASTRA results



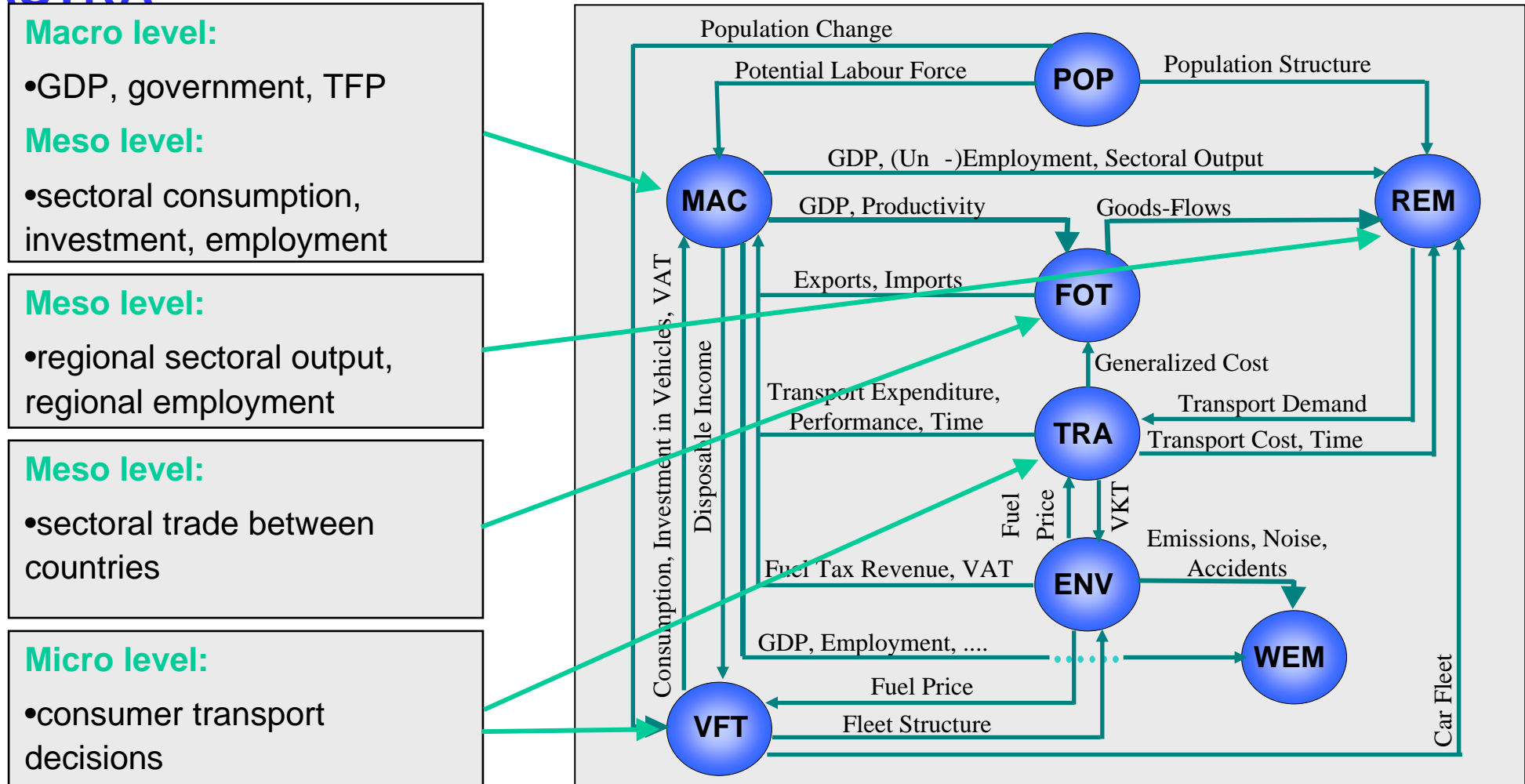
Scenario results: consumption shift compared to BAU



Source: ASTRA results



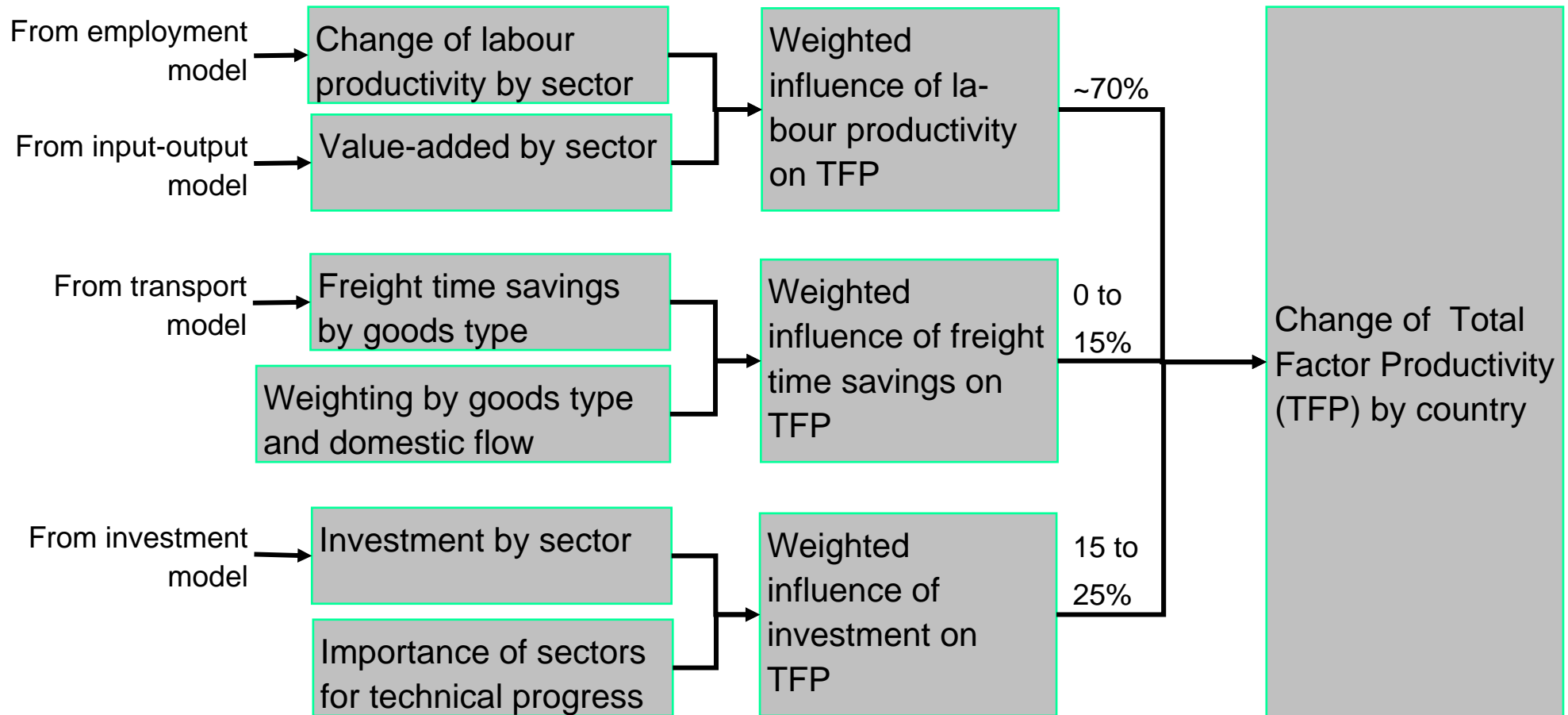
Connecting micro-meso-macro levels in ASTRA



ASTRA model structure



Influences on total factor productivity (TFP) in the economies



Structure of economic models



Structure of ASTRA model: ECONOMY

Manufacturing

- **Fuel and power products, water**
- Ferrous and non-ferrous ores and metals
- Non-metallic mineral products
- Chemical products
- Metal products except machinery
- Agricultural and industrial machinery
- Optical goods, office+data processing mach.
- Electrical goods
- **Transport equipment**
- Food, beverages, tobacco
- Textiles and clothing, leather and footwear
- Paper and printing products
- Rubber and plastic products
- Other manufacturing products

Services

- Recovery, repair services, wholesale, retail
- Lodging and catering services
- **Inland transport services**
- **Maritime and air transport services**
- Auxiliary transport services
- Communication services
- Services of credit and insurance institutions
- Other market services
- Non-market services

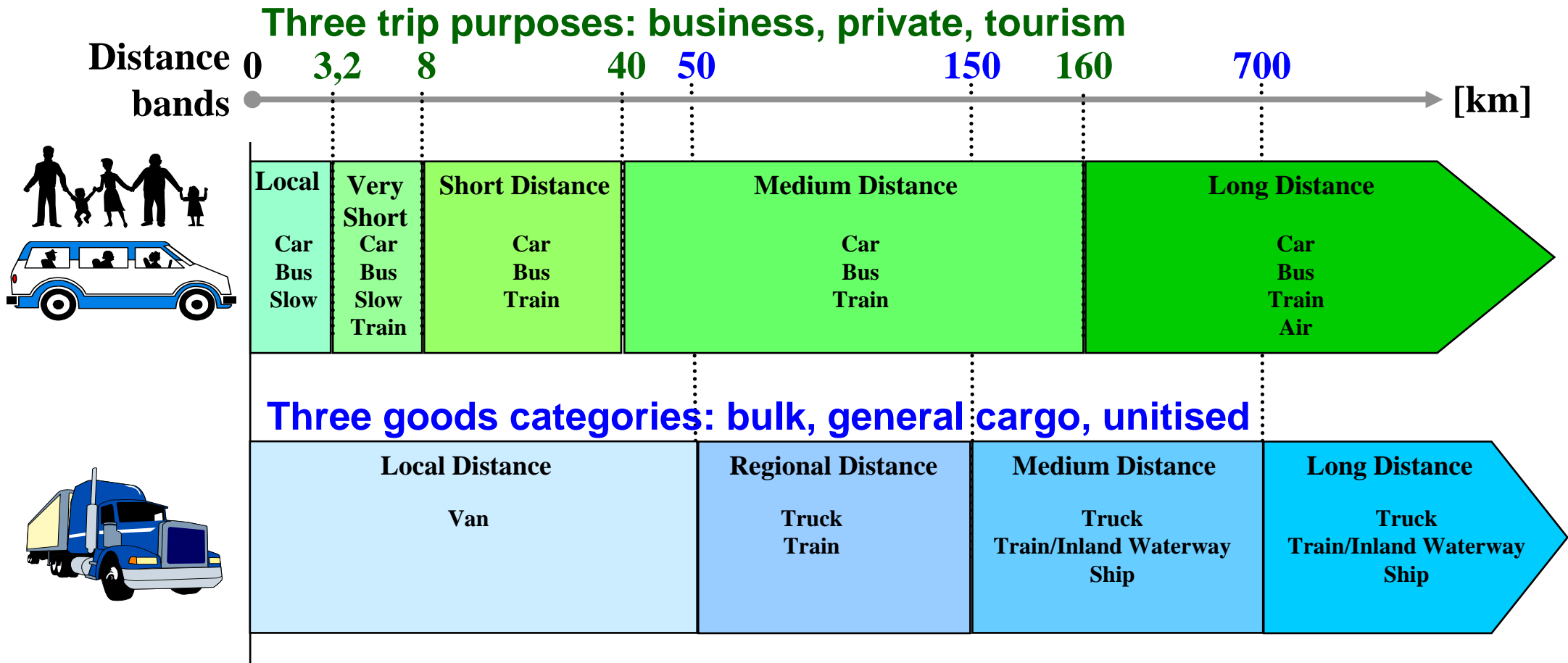
Other

- Agriculture, forestry and fishery products
- **Building and construction**

ASTRA model structure



Structure of ASTRA model: TRANSPORT



ASTRA model structure

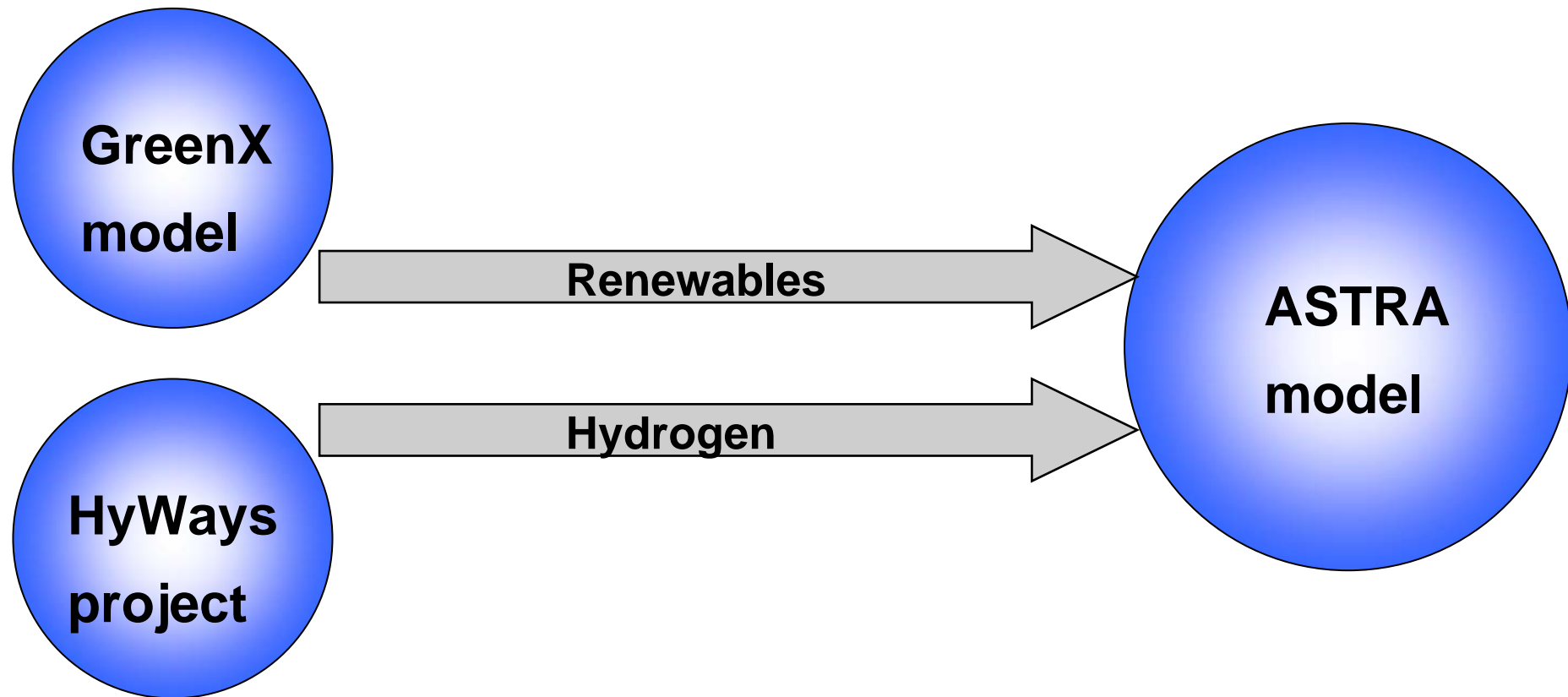
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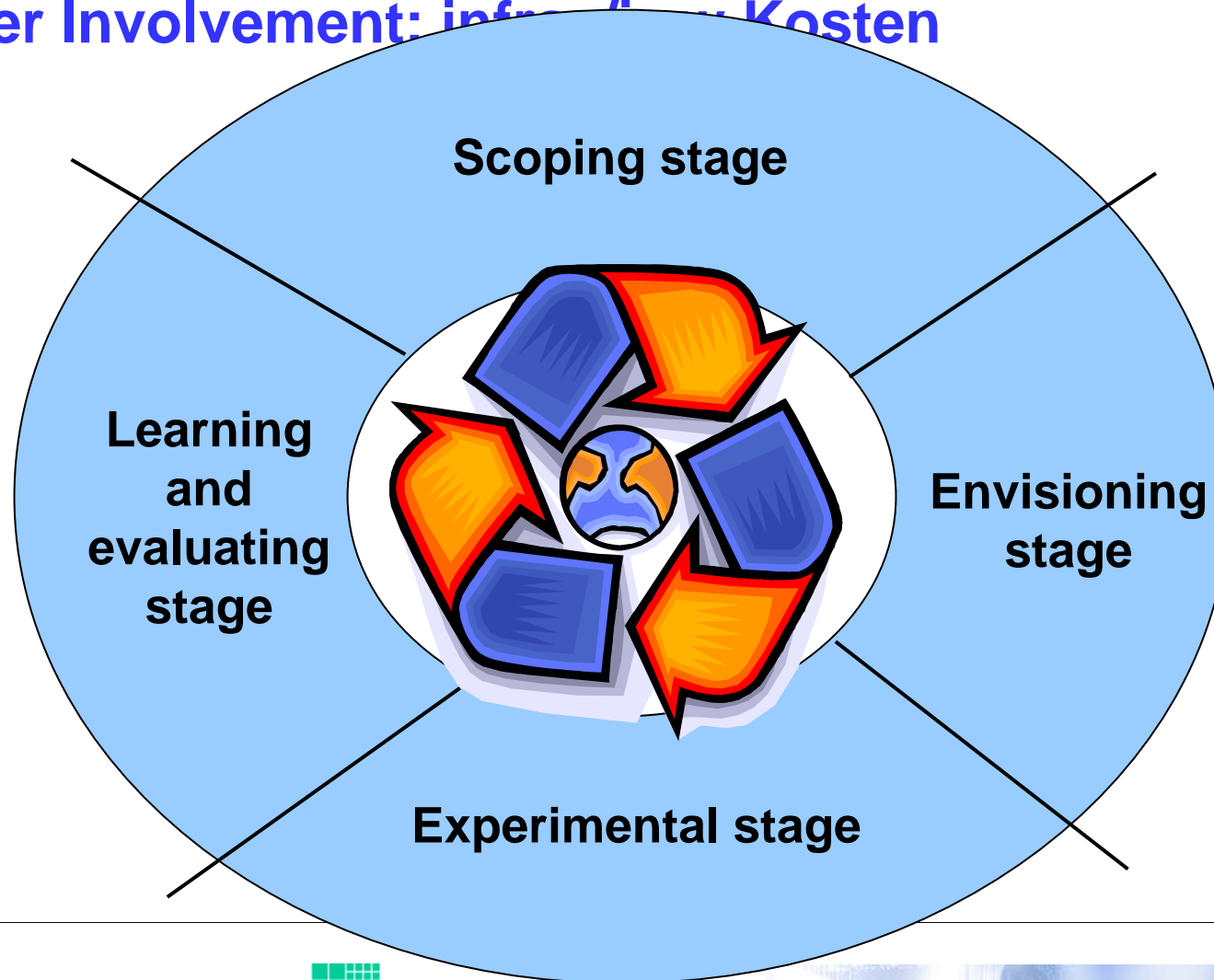


Interaction of models and projects



Modeling of scenarios

Stakeholder Involvement: infrastructure Kosten



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