Karlsruher Institut für Technologie

ECON

Economic Assessment of Green and Healthy Transport Systems

Werner Rothengatter

Karlsruhe Institute of Technology

Karlsruher Institut für Technologie

Economic Assessment of Green and Healthy Transport Systems

ECON

- Objectives formulated by UNECE and ILO
- Integrated assessment methods (IAMs)
- E3ME and application to clean car strategy in Germany
- EXIOBASE as a favoured model by UNECE/ILO
- Needs of IAMs for capturing the impacts of industrial transformation

Karlsruher Institut für Technologie

Objectives formulated by UNECE and ILO

ECON

- Improve transport efficiency
- Reduce energy consumption, air, noise pollution, GHG emissions
- Increase safety and health
- Preserve job opportunities facing rapid industrial transformations

Karlsruher Institut für Technologie

Economic Assessment of Green and Healthy Transport Systems

ECON

- Objectives formulated by UNECE and ILO
- Integrated assessment methods (IAMs)
- E3ME and application to clean car strategy in Germany
- EXIOBASE as a favoured model by UNECE/ILO
- Needs of IAMs for capturing the impacts of industrial transformation

Assessment Methods

ECON

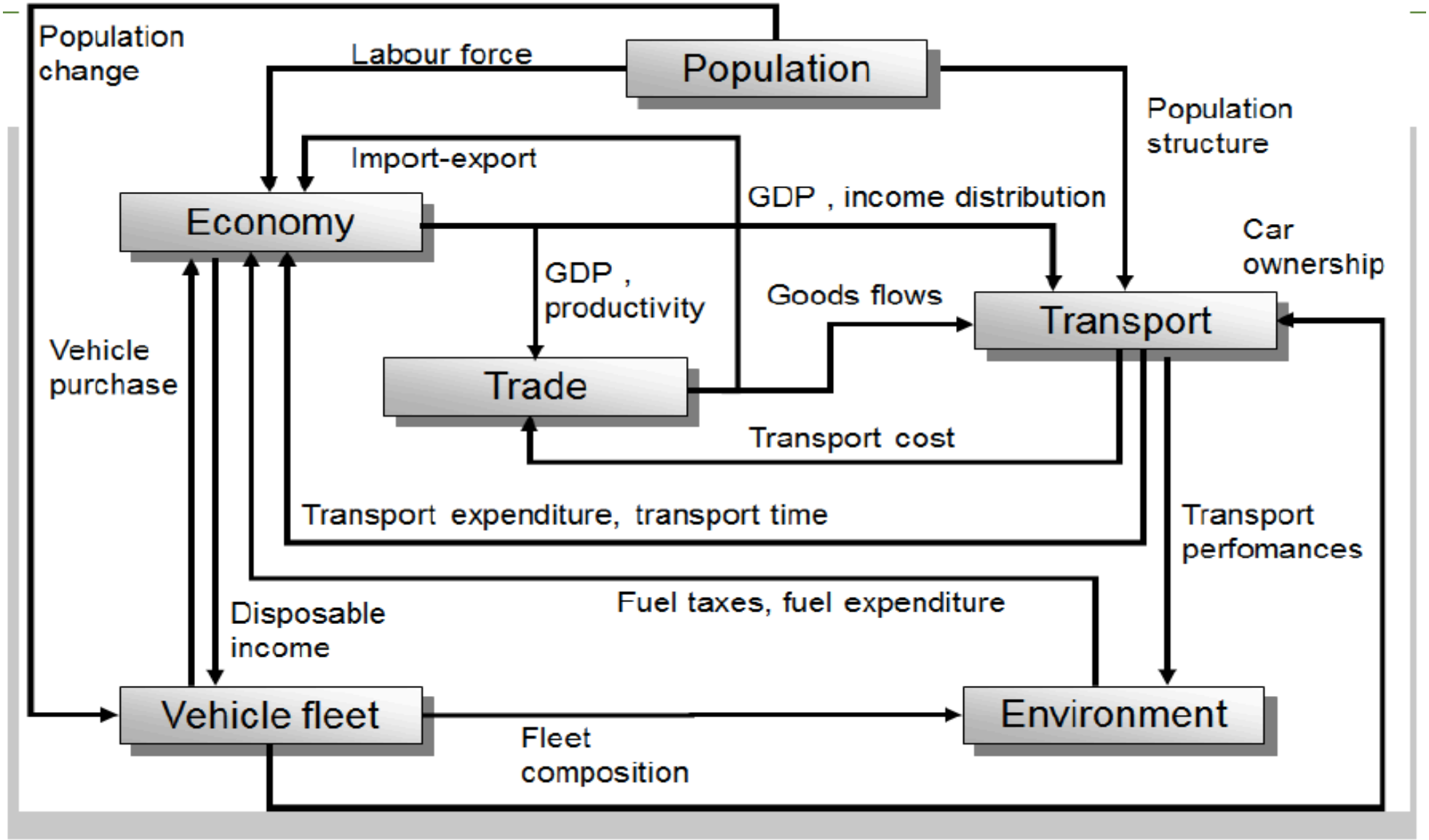
- Cost-benefit analysis and SCGEs (welfare measurement, resource savings, productivity effects through migration of factors)
- Wider economic impact (WEI): Measurement of GDP and employment effects; productivity, terms of trade and multiplier effects)
- Integrated assessment models: WEI plus technology, plus energy, plus environment/ climate

Integrated assessment models

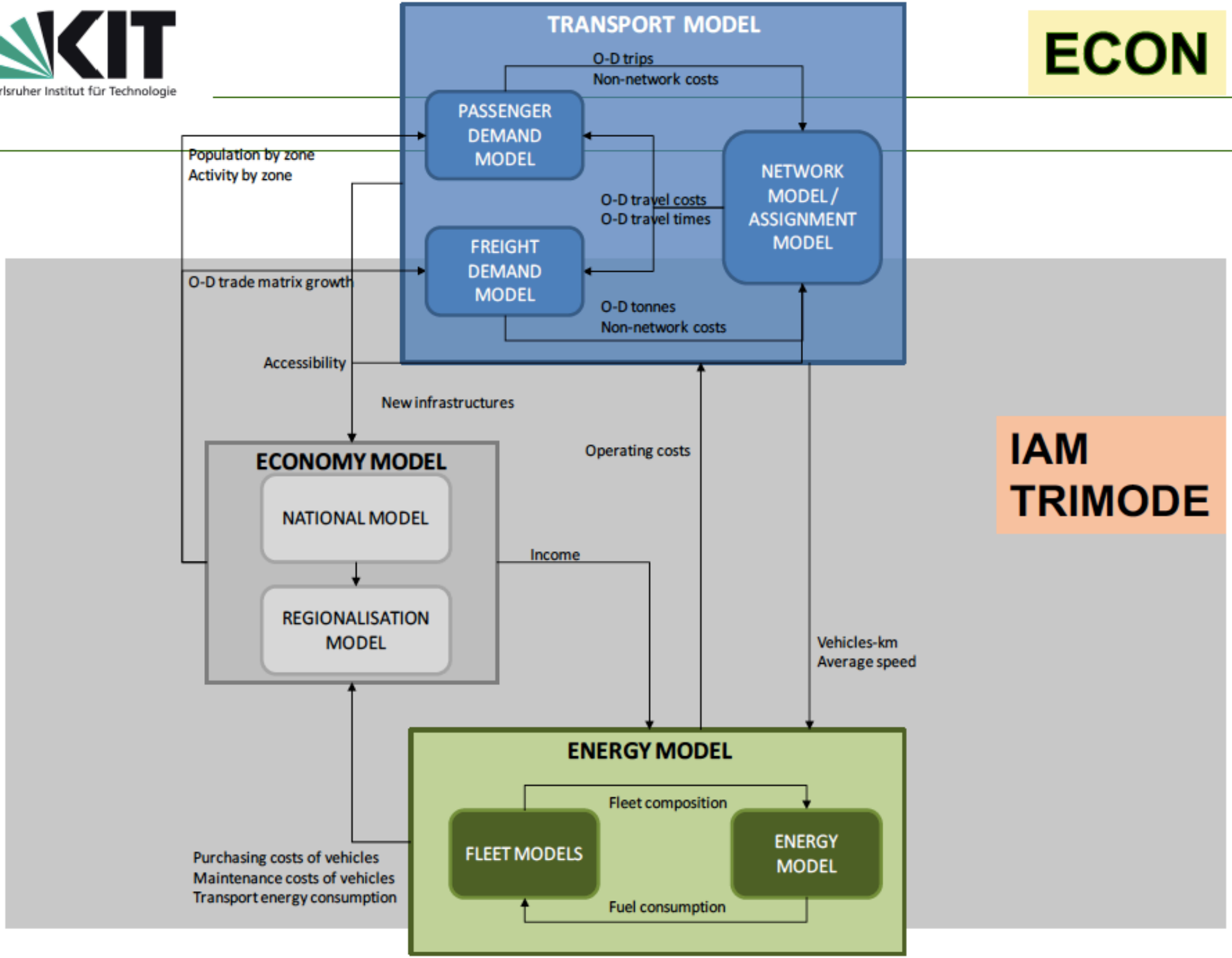
- Spatial computed general equilibrium models (SCGE)
- System dynamics models
- Combined econometric, Input-Output, technology, energy, environment mod.
- Multi-regional multi-sector Input-Output modelling

Linked modules in ASTRA

ECON



Source: TRT - Fraunhofer-ISI


Karlsruher Institut für Technologie
TRANSPORT MODEL
O-D trips
Non-network costs
PASSENGER DEMAND MODEL
FREIGHT DEMAND MODEL
NETWORK MODEL / ASSIGNMENT MODEL
O-D travel costs
O-D travel times
O-D tonnes
Non-network costs
Population by zone
Activity by zone
O-D trade matrix growth
Accessibility
New infrastructures
Operating costs
ECONOMY MODEL
NATIONAL MODEL
REGIONALISATION MODEL
Income
Vehicles-km
Average speed
ENERGY MODEL
Fleet composition
FLEET MODELS
ENERGY MODEL
Fuel consumption
Purchasing costs of vehicles
Maintenance costs of vehicles
Transport energy consumption
ECON
IAM TRIMODE

Karlsruher Institut für Technologie

Economic Assessment of Green and Healthy Transport Systems

ECON

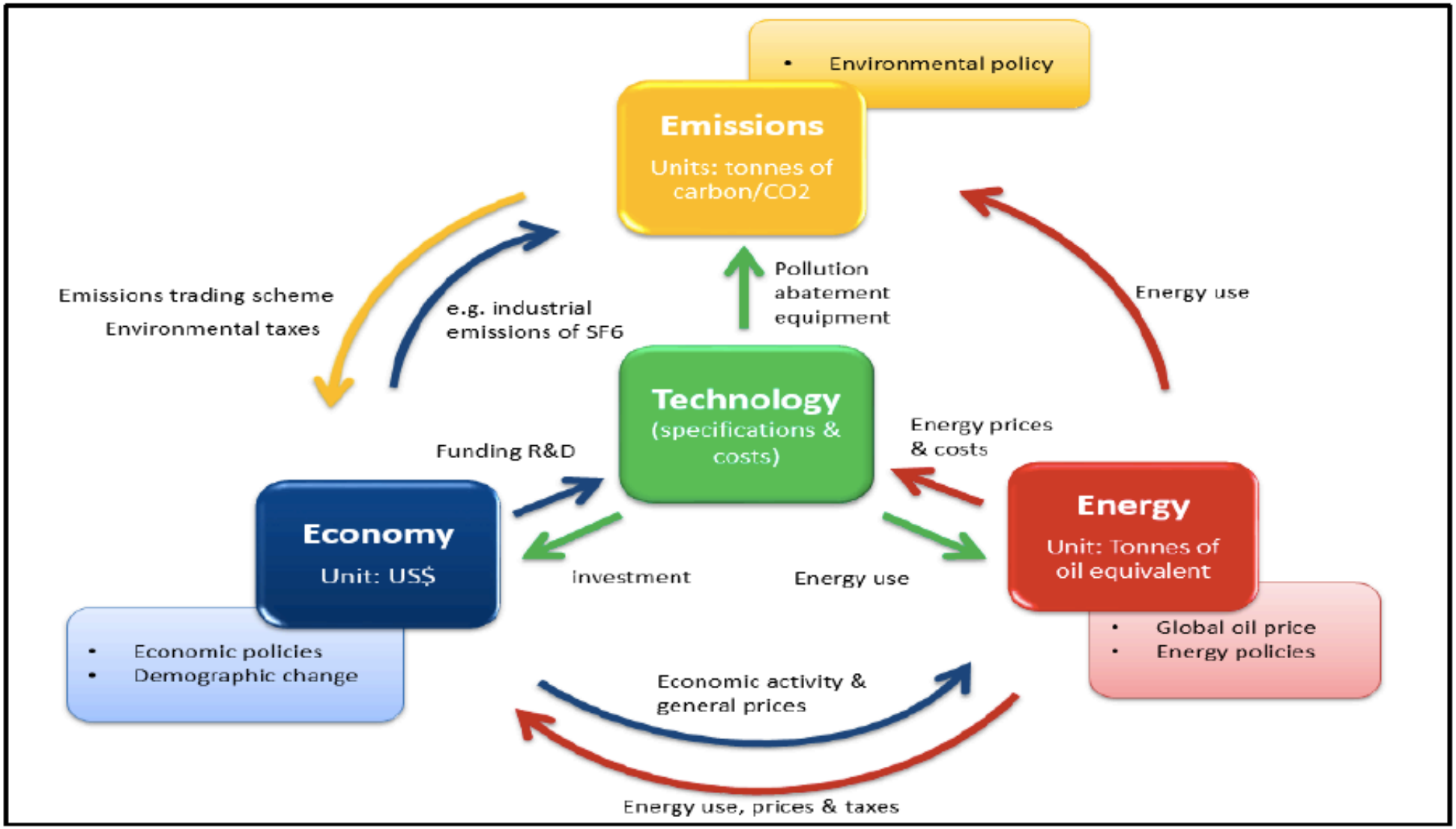
- Objectives formulated by UNECE and ILO
- Integrated assessment methods (IAMs)
- E3ME and application to clean car strategy in Germany
- **EXIOBASE as a favoured model by UNECE/ILO**
- **Needs of IAMs for capturing the impacts of industrial transformation**

Karlsruher Institut für Technologie

Low carbon cars in Germany

Study for CEF prep. by Cambridge Econ., m-five, element energy

ECON



Karlsruher Institut für Technologie

E3ME Basic features

ECON

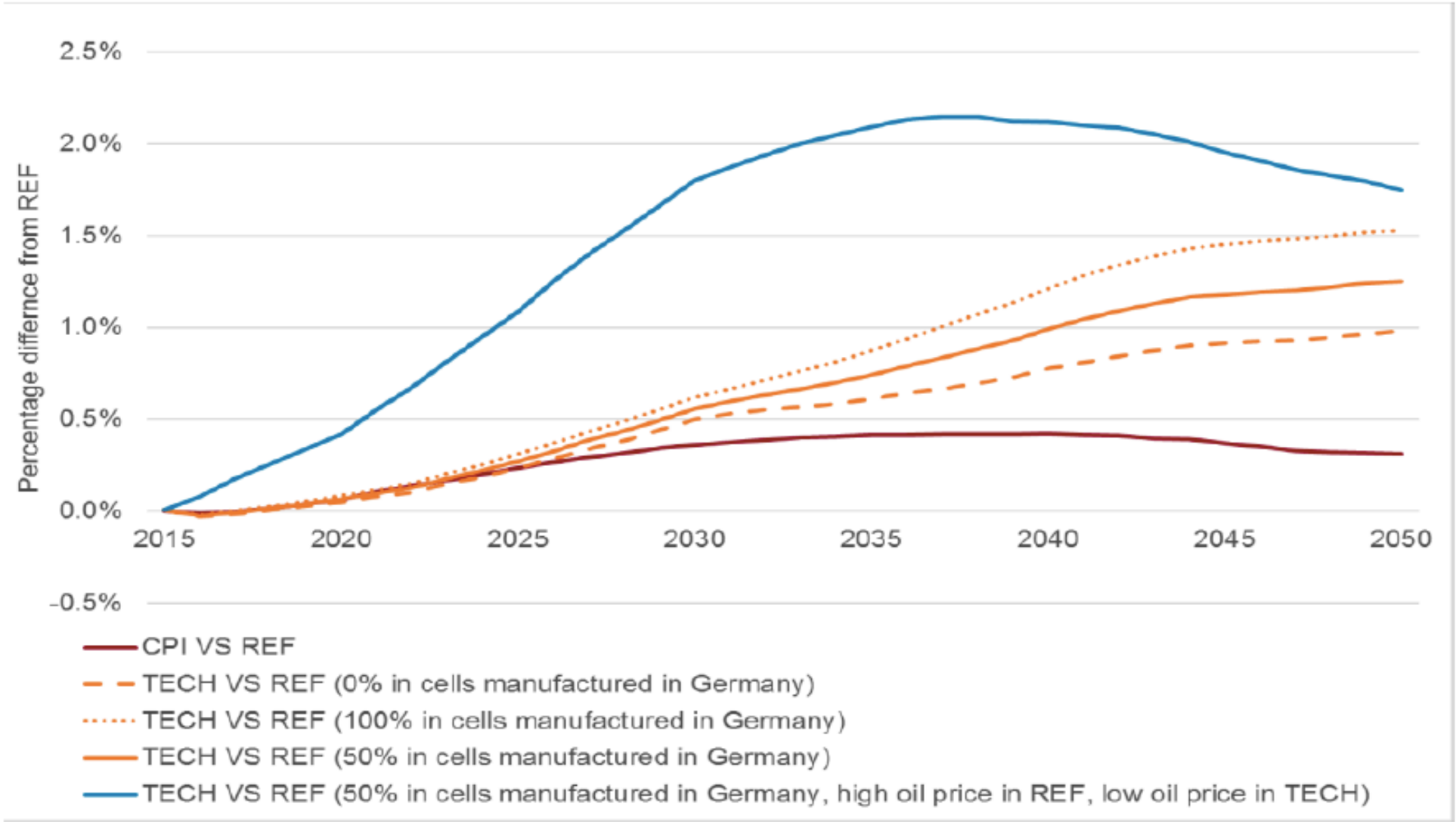
- Geographical coverage: EU countries, 3 candidates, Norway, Switzerland, 11 other major economies, rest of the world: 53 regions (43 non-EU)
- Industries (IO): 69
- Calibration period: 1970-2012
- Solution periods: 1995-2050
- Economic philosophy: Keynesian (demand driven)
- Basic economic model: econometric equations
- Structural changes: driven by endogenous growth, related to R&D activity

Clean cars Germany
Scenarios

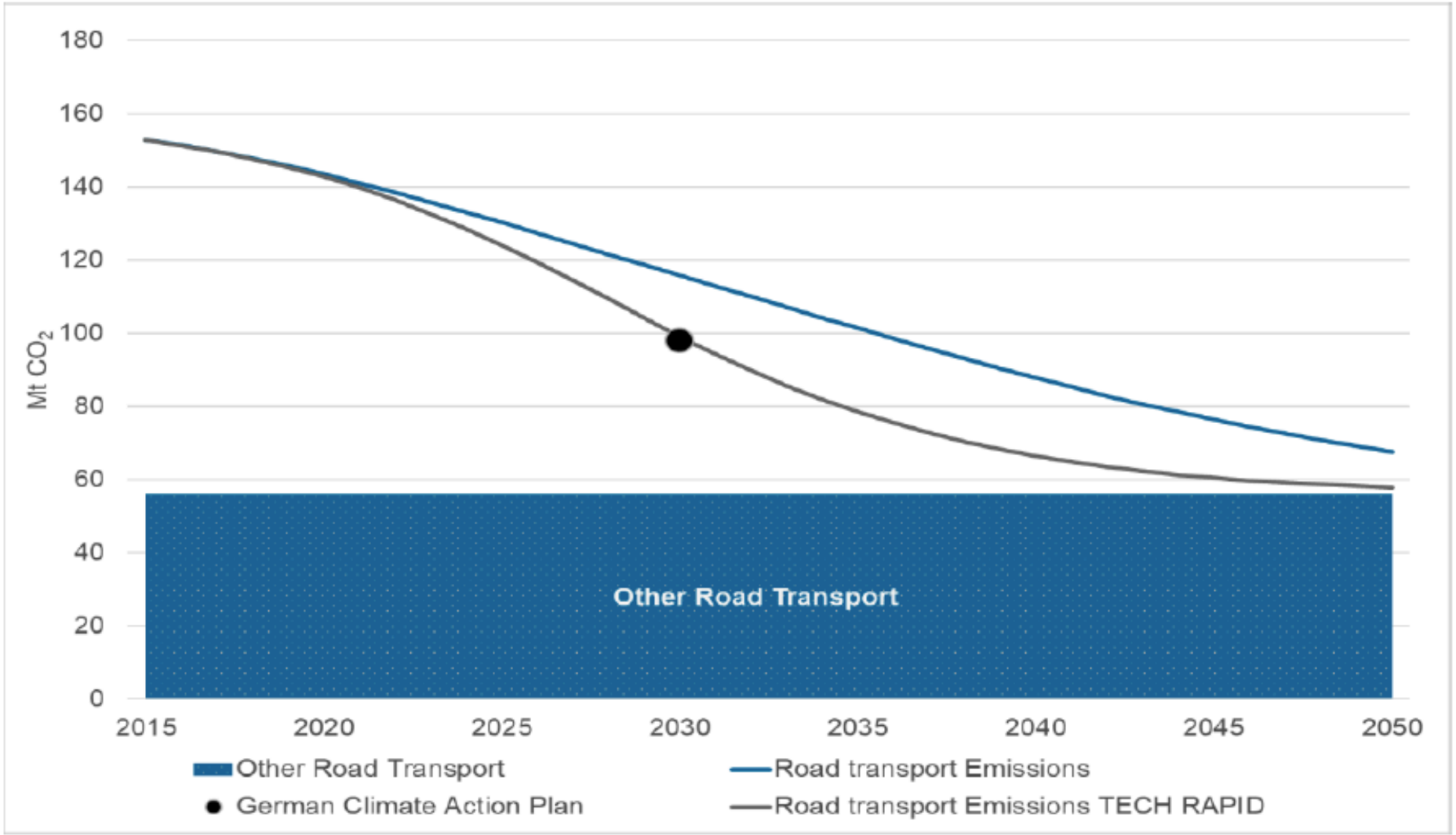
- Reference
- Current policy
- Technology (with variants)
- Technology rapid

- By 2040 86% advanced powertrains
- By 2030 40% less oil demand, by 2050 90% compared to 2015
- By 2050 plus 8% electricity demand
- Cost reductions and extended ranges for BEV

Economic impacts
% difference from REF

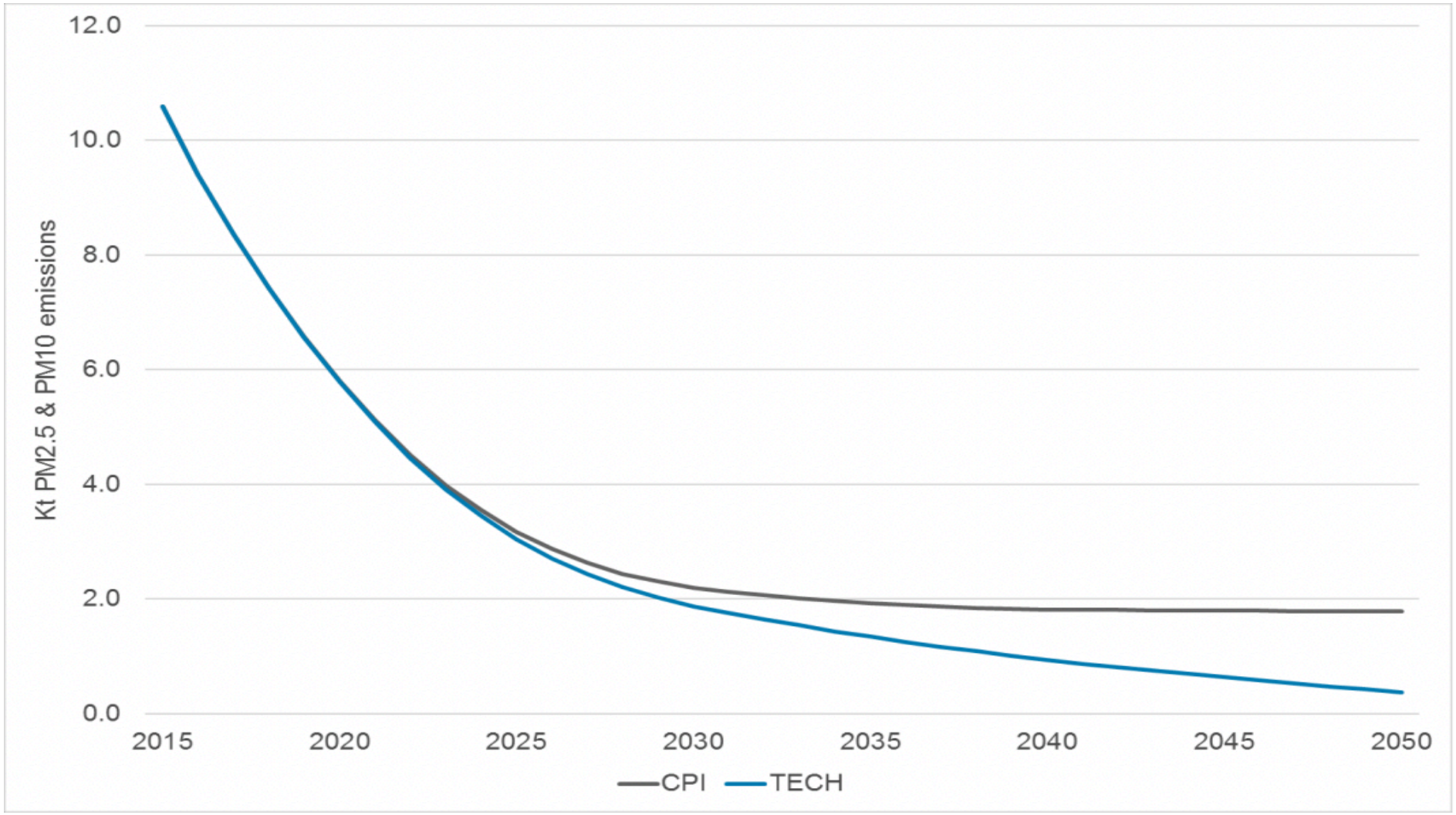


CO_2 Impacts Tech RAPID

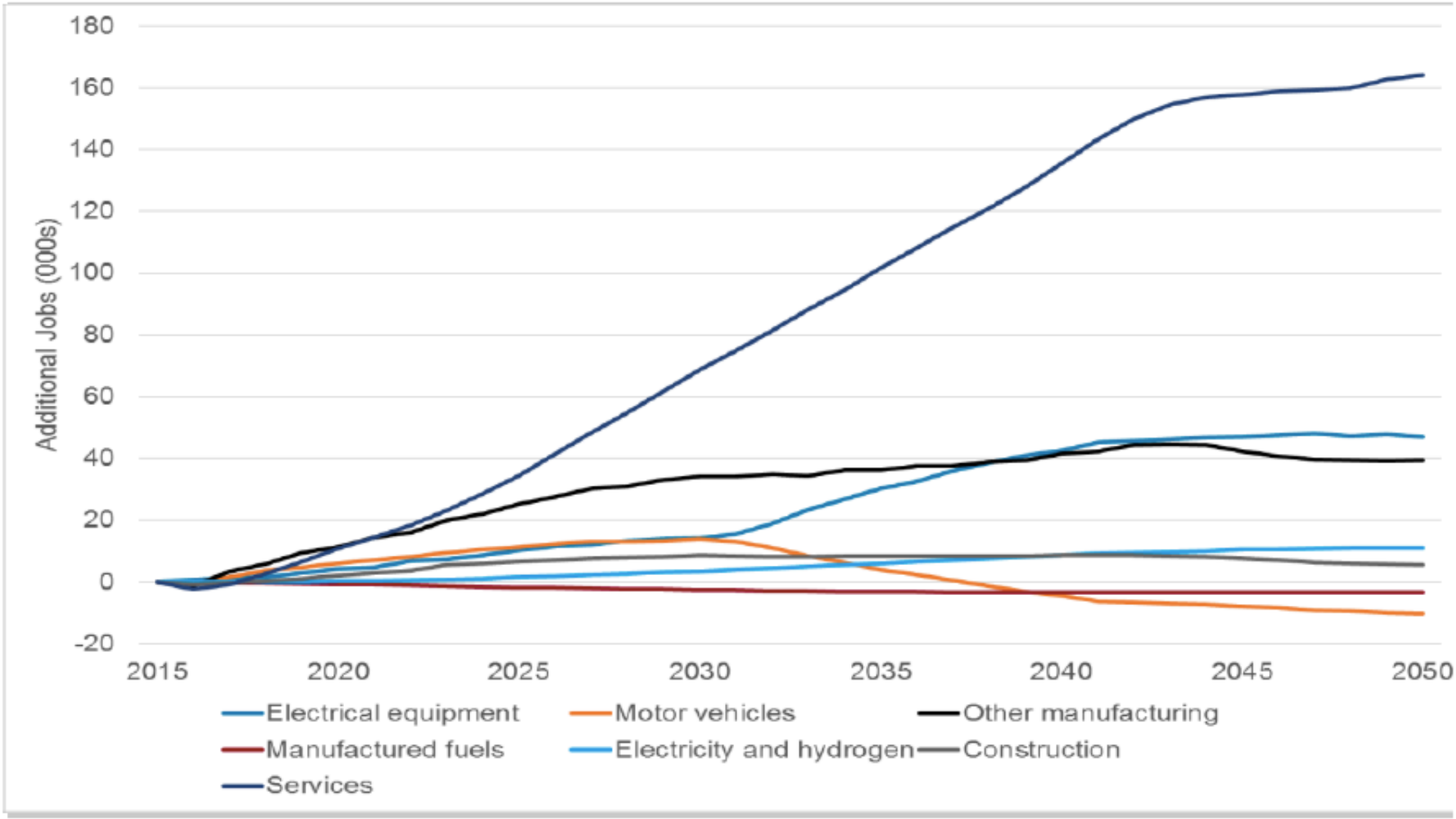


Impacts on PM Emissions

ECON



Employment impacts



Karlsruher Institut für Technologie

Economic Assessment of Green and Healthy Transport Systems

ECON

- Objectives formulated by UNECE and ILO
- Integrated assessment methods (IAMs)
- E3ME and application to clean car strategy in Germany
- EXIOBASE as a favoured model by UNECE/ILO
- **Needs of IAMs for capturing the impacts of industrial transformation**

Extension from IO to SAM matrices

$$a_{ij} = x_{ij} / X_j$$

$$AX + Y = X$$

$$\Delta X = \left[E - A\right]^{-1} \Delta Y$$

$$B = \left\{b_{ij}\right\} = \left[E - A\right]^{-1}$$

Leontief Multiplier

Extension from IO to SAM matrices

ECON

			EXPENDITURES						
			ENDOGENOUS			EXOGENOUS			TOTALS
			FACTORS	HOUSEHOLDS	PRODUCTIVE ACTIVITIES	GOVERNMENT	REST OF THE WORLD	CAPITAL ACCOUNT	
RECEIPTS OR INCOMES	ENDO-GENOUS	FACTORS	0	0	T_{13}	X_{14}	X_{15}	X_{16}	Y_1
		HOUSEHOLDS	T_{21}	T_{22}	0	X_{24}	X_{25}	X_{26}	Y_2
		PRODUCT ACTIVITY	0	T_{32}	T_{33}	X_{34}	X_{35}	X_{36}	Y_3
	EXO-GENOUS	GOVERNMENT	L_{41}	L_{42}	L_{43}	t_{44}	t_{45}	t_{46}	Y_4
		REST OF WORLD	L_{51}	L_{52}	L_{53}	t_{54}	t_{55}	t_{56}	Y_5
		CAPITAL ACCOUNTS	L_{61}	L_{62}	L_{63}	t_{44}	t_{45}	t_{46}	Y_6
	TOTALS		Y_1	Y_2	Y_3	Y_4	Y_5	Y_6	

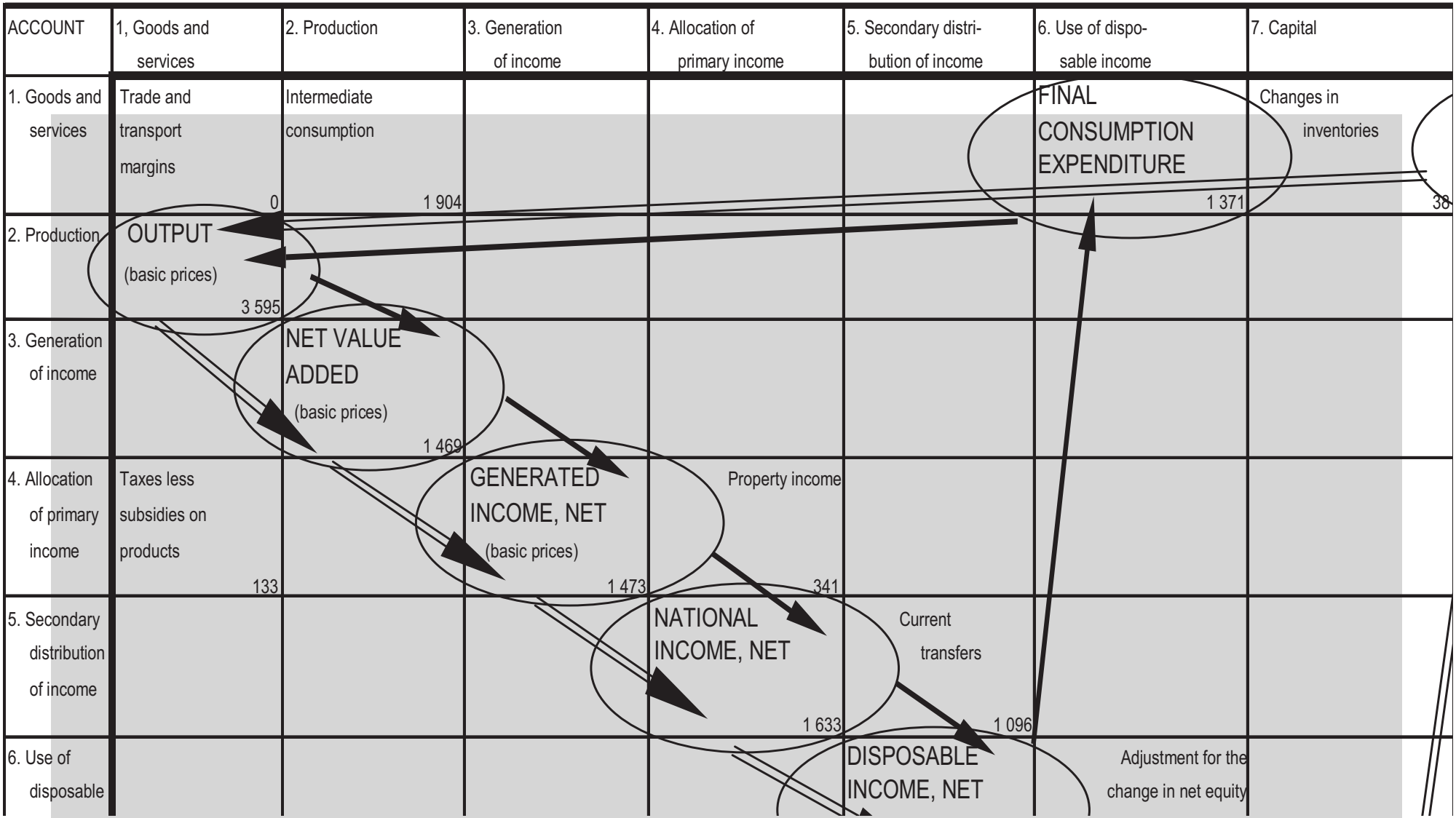
SAM multiplier

$$M^S = [E - M]^{-1}$$

M^S : SAM multiplier

M : expenditure shares

Table 2.9 : Aggregate National Accounts Matrix showing the Circular Flow of Income for a Closed Economy



Karlsruher Institut für Technologie

EXIOBASE 3 MRIO

ECON

- Time series 1995-2011
- Multiple social and environmental satellite accounts
- 44 countries (28 EU) plus 5 for rest of the world
- Rectangular supply/use tables for 163 industries and 200 products
- Energy accounts: 60 primary and secondary energy products
- Emissions: 27 pollutants from combustion processes
- Further accounts: water, material, land, waste, labour

Karlsruher Institut für Technologie

EXIOBASE 3 EE MRIO

ECON

	EXIOBASE 1	EXIOBASE 2	EXIOBASE 3
Base-year(s)	2000	2007	1995–2011
Products	129	200	200
Industries	129	163	163
Countries[a]	43	43	44
RoW[b] regions	1	5	5
Emissions			
Combustion	26	26	27
Noncombustion		11	27
HFC/PFC/SF6		3	3
N/P/SOx from waste			5
N/P from agriculture			7
Water accounts (per activity)			
Green	47	172	194
Blue	47	172	194
Material accounts			
Energy products[c]	69	69	69[d]
Extraction (used/unused)	48/48	48/48	222/222
Land accounts	14	15	15[e]
Employment accounts	6[f]	6[f]	14[g]

EXIOBASE 3

ECON

- IO and SUT
- Product by product tables
- Industry by industry tables
- 14 GB RAM for the time series 1995-2011

Assumptions for IO and SAM

ECON

- Production functions are linear and limitational.
- Production and expenditure coefficients are fixed over time.
- Industrial sectors are homogenous and not changed over time.
- There are no temporary limits or supply restrictions.
- There is no time dimension, no driver of growth, no innovation or technical progress.

Use of EXIOBASE for IAM

ECON

- Forward looking through macro-economic scenarios
- Changes of technology and demand to be introduced exogeneously
- Example: EXIOBASE+TIMES+REMES (NTNU)

Karlsruher Institut für Technologie

Economic Assessment of Green and Healthy Transport Systems

ECON

- Objectives formulated by UNECE and ILO
- Integrated assessment methods (IAMs)
- E3ME and application to clean car strategy in Germany
- EXIOBASE as a favoured model by UNECE/ILO
- Needs of IAMs for capturing the impacts of industrial transformation

- General question: which degree of disaggregation?
- Ex post analysis, short-term forecast, long-term forecast
- Main forecasting issues outside of IO and SAM
- Structural changes to be modelled by other approaches

Karlsruher Institut für Technologie

ECON

Werner Rothengatter
Karlsruhe Institute of Technology

rothengatter@kit.edu