



The Pan European NEEDS-TIMES model

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First CEEH Energy Externality Workshop
Roskilde, Denmark, February 6, 2008

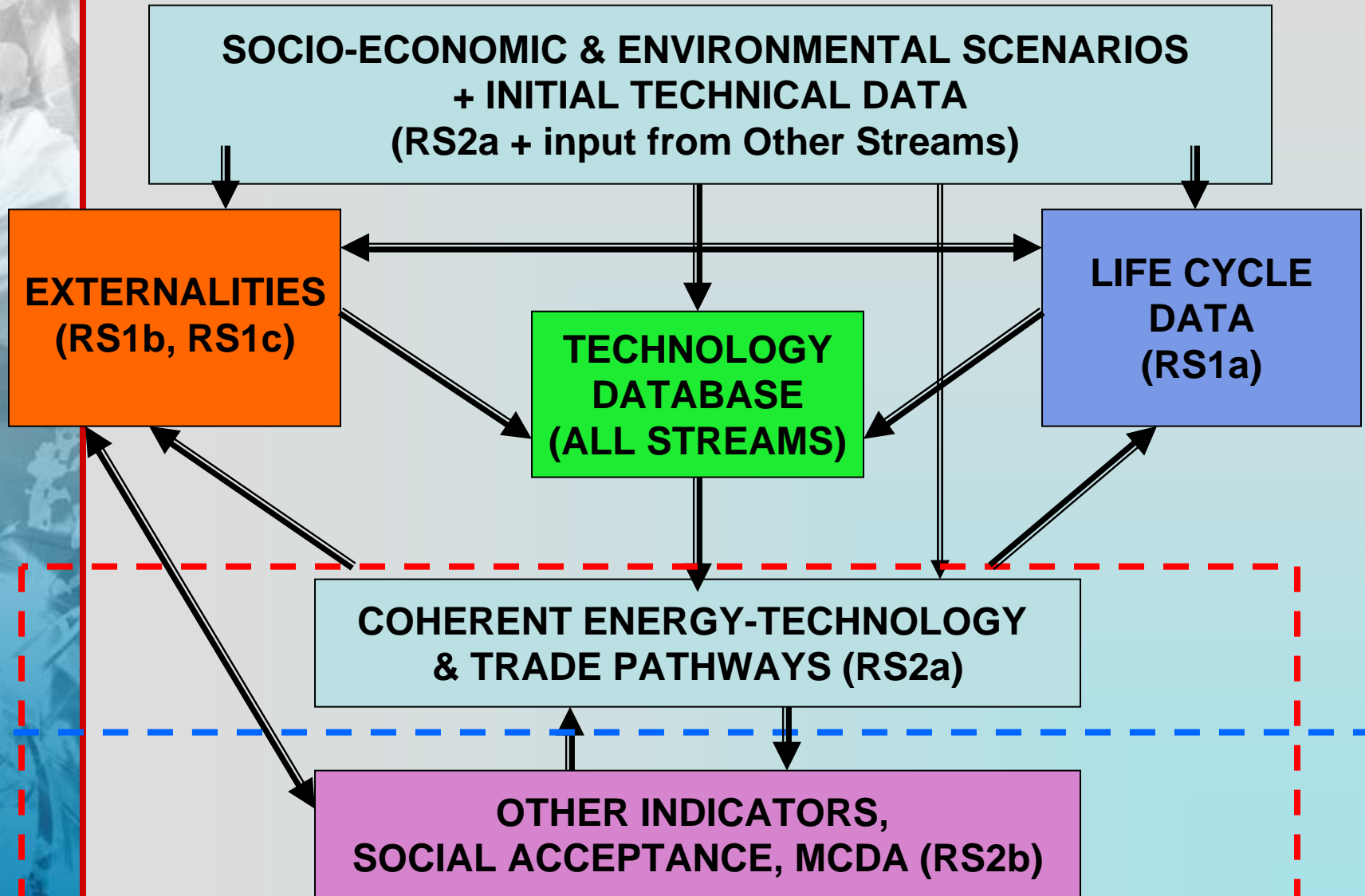
Objective of NEEDS

The ultimate objective of the NEEDS Integrated Project is to evaluate the full costs and benefits (i.e. direct + external) of energy policies and of future energy systems, both at the level of individual countries and for the enlarged EU as a whole.

From the scientific and technological viewpoint, this entails major advancements in the current state of knowledge in the following main areas of:

- Life Cycle Assessment (LCA) of energy technologies
- Monetary valuation of externalities associated to energy production, transport, conversion and use
- Integration of LCA and externalities information into policy formulation and scenario building
- Multi-criteria decision analysis (MCDA), which allows examining the robustness of the proposed technological solutions in view of stakeholder preferences.

Structure of NEEDS



Objectives of the Modeling part in NEEDS

- **To generate** via The Integrated MARKAL- EFOM System (TIMES) partial equilibrium technology rich economic **models of each Member State and of the EU as a whole (Pan-European model)**, **including** the most important emissions, materials, and damage functions used by **LCA and ExternE**, in their long term development.
- To compare **scenarios that simulate various policy approaches** (setting thresholds for CO₂ emission, renewables penetration, etc.) using the key base data received form the other streams to calculate equilibrium quantities and prices.

ETSAP

IEA (International Energy Agency)

Implementing Agreements

Energy Technology Systems Analysis Programme (ETSAP)



Operating Agent



www.etsap.org

Technology oriented analysis of energy system models with focus on greenhouse gas abatement strategies



- Analysis of national and multinational strategies
- Technology data review
- Model development (MARKAL, TIMES)

Outreach



Development

- The Integrated MARKAL EFOM System
- By ETSAP
- Implementation in GAMS
- Model generator

TOOLS

- ANSWER, ABARE
- VEDA, GERAD
- HALOA, GERAD

Methodology

- Bottom-up Model
- Perfect competition
- Perfect foresight
- Optimisation (LP)

Min/Max Objective function
 s.t.
 Equations, Constraints
 Decision Variables \Leftrightarrow Solution
 Input parameters

TIMES

Applications (IER)

- TIMES-BY
- TIMES-GES
- TIMES-D
- TIMES-EE
- TIMES-World

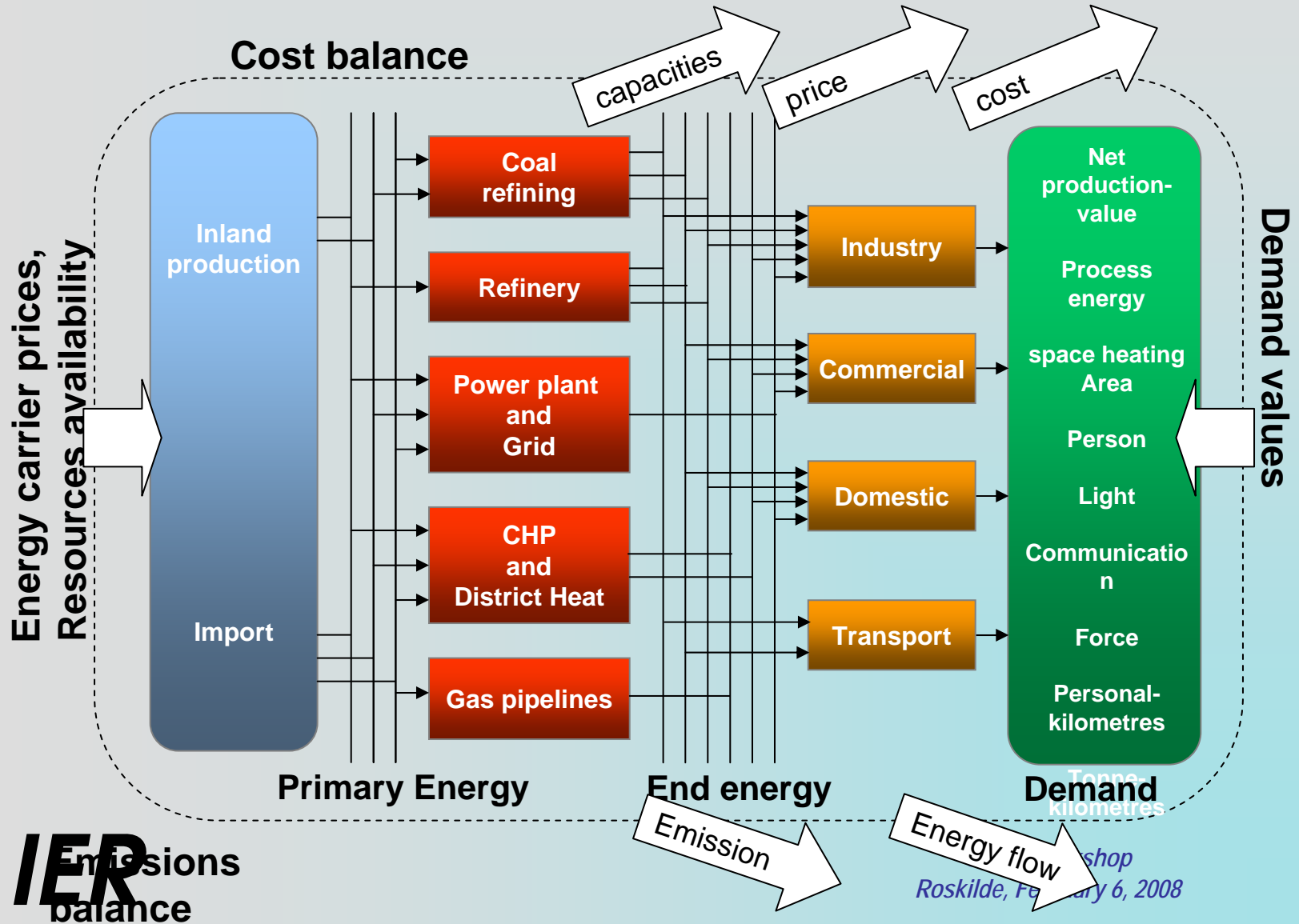
Future Features

- NLP (experience curves, macroeconomic linkage)
- Stochastic Programming
- MCP (Multi-agent model)

Features

- Regions
- Elastic demands
- Vintaging
- Inter-temporal
- Load curve
- Endogeneous technological learning
- Discrete capacity expansion

Basic structure of energy system models



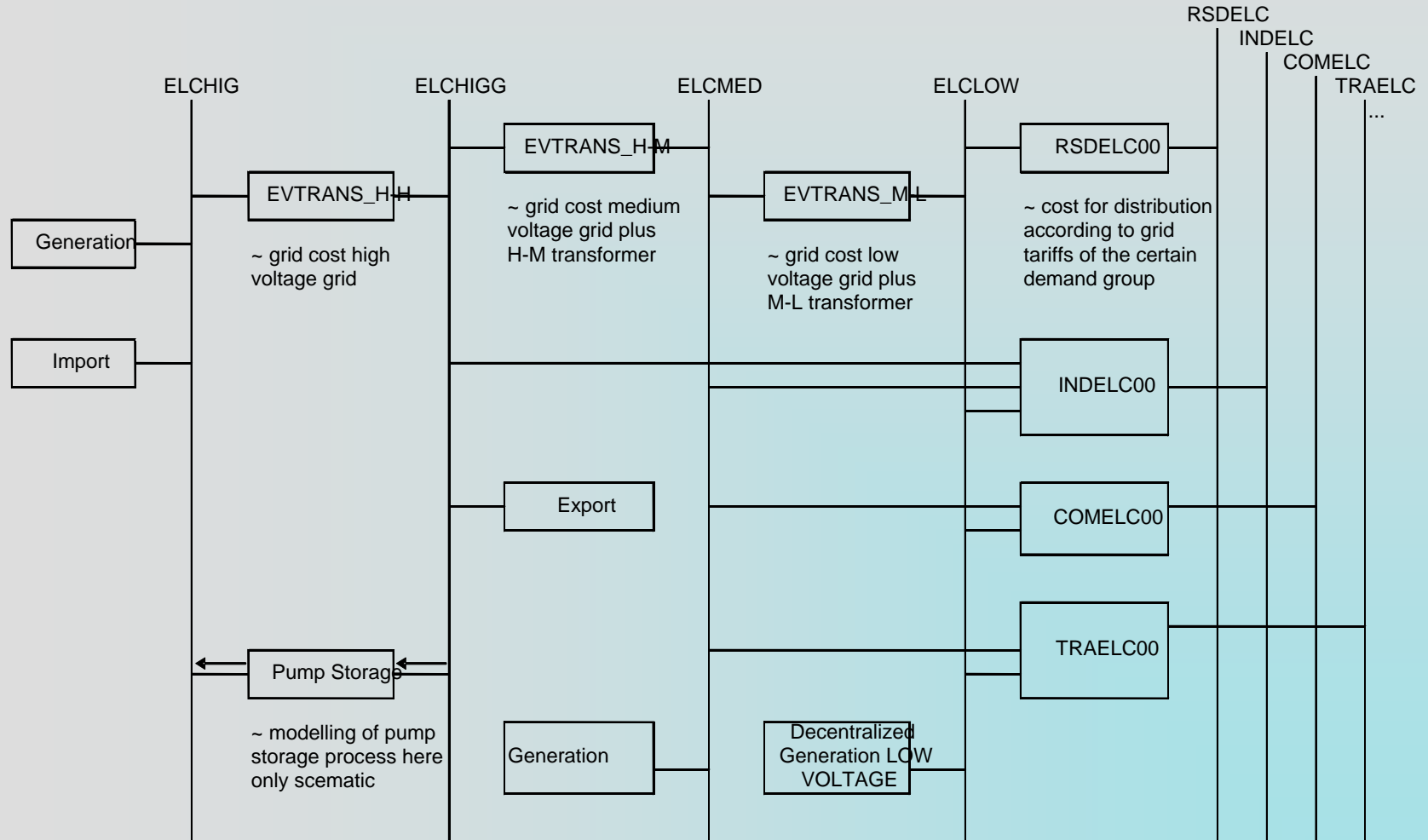
Characterization of the Pan-European TIMES model

- 29 region model (EU 25 + Ro, No, CH, IS)
- Energy system model
 - SUPPLY: reserves, resources, exploration and conversion
Country specific renewable potential and availability (onshore wind, offshore wind, geothermal, biomass, biogas, hydro)
 - Electricity: public electricity plants, CHP plants and heating plants
 - Residential and Commercial: All end use technologies (space heating, water heating, space cooling and others)
 - Industry: Energy intensive industry (Iron and steel, aluminium copper ammonia and chlorine, cement, glass, lime, pulp and paper), other industries , autoproducer and boilers
 - Transport: Different transport modes (cars, buses, motorcycles, trucks, passenger trains, freight trains), aviation and navigation
- Country specific differences for characterisation of new conversion and end-use technologies
- Time horizon 2000-2050
- GHG: CO₂, CH₄, N₂O, SF₆ /Others pollutants: SO₂, NO_x, CO, NMVOC, PM_{2.5}, PM₁₀

The modelling team of the country models

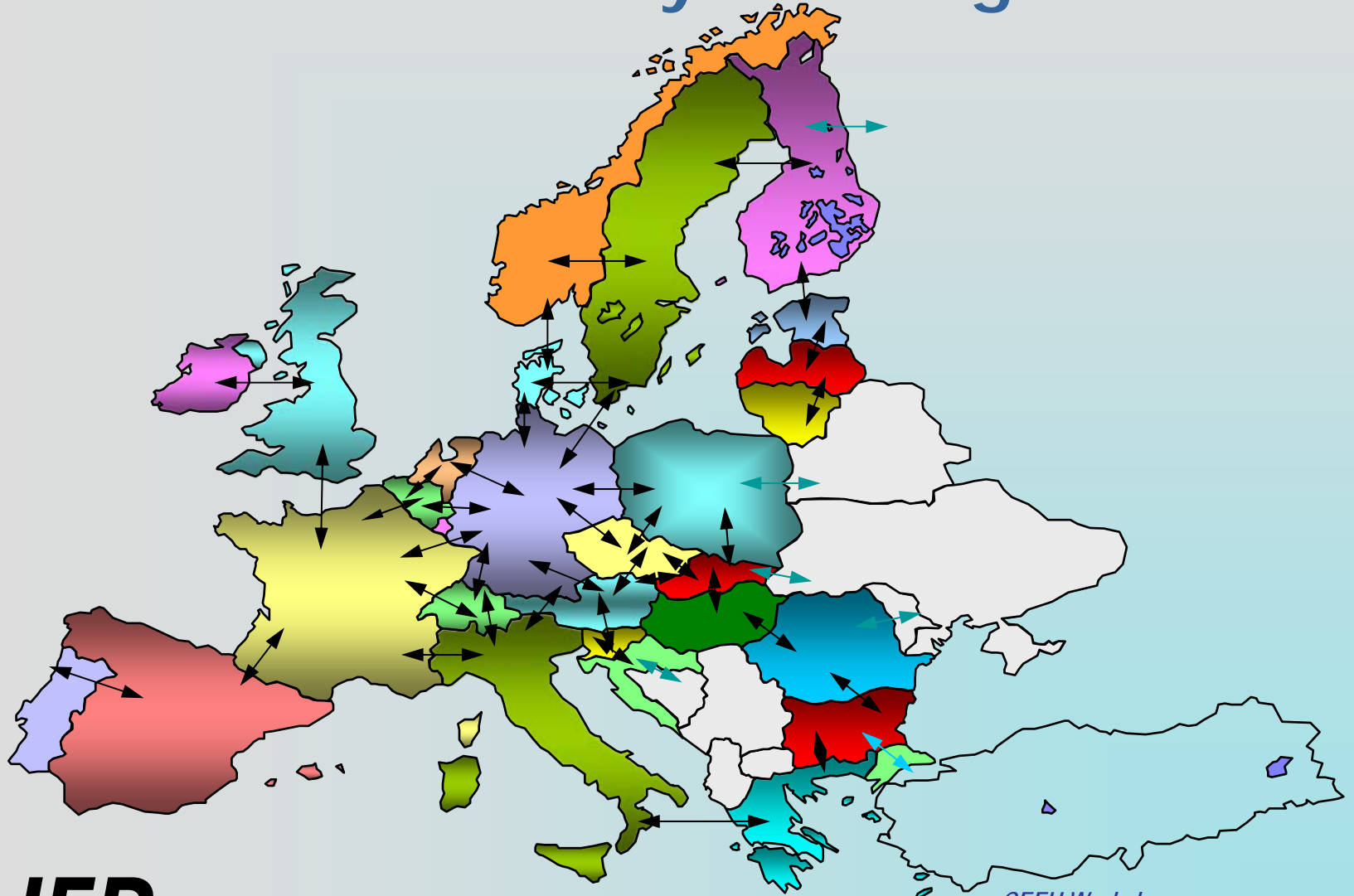
Institution	Country	Member State Model (MSM)	Contact person
CHALMERS	Sw	Sweden, Norway, Iceland	<i>Erik Ahlgren</i>
CIEMAT	E	Spain, Portugal	<i>Yolanda Lechon</i>
CRES	GR	Greece, Malta, Cyprus	<i>George Giannakidis</i>
ECN	NL	The Netherlands, Ireland	<i>Koen Smekens</i>
ENERO	RO	Romania	<i>Anka Mihaela Tuhai</i>
IMAA-CNR	I	Italy	<i>Vincenzo Cuomo</i>
INFM	I	Slovenia	<i>Maria Macchiato</i>
JRC	E		<i>Antonio Soria</i>
KANLO	F		<i>Amit Kanudia</i>
KUL	B	Belgium, Luxembourg, France	<i>Denise van Regemorter</i>
POLITO	I	UK	<i>Evasio Lavagno</i>
PSI	CH	Switzerland	<i>Socrates Kypreos</i>
RISOE	DK	Denmark	<i>Poul Erik Grohnheit</i>
TTU	EST	Estonia, Lithuania, Latvia	<i>N.N.</i>
USTUTT	D	Germany, Austria, Czech R., Hungary, Slovakia, Poland + Bulgaria	<i>Markus Blesl</i>
VTT	FIN	Finland	<i>Antti Lehtila</i>

Electricity structure in the PAN-European Model



The Pan-European TIMES model

- Linking the countries together by electricity exchange



Scenario analysis - The Key Policy Cases in the NEEDS Project

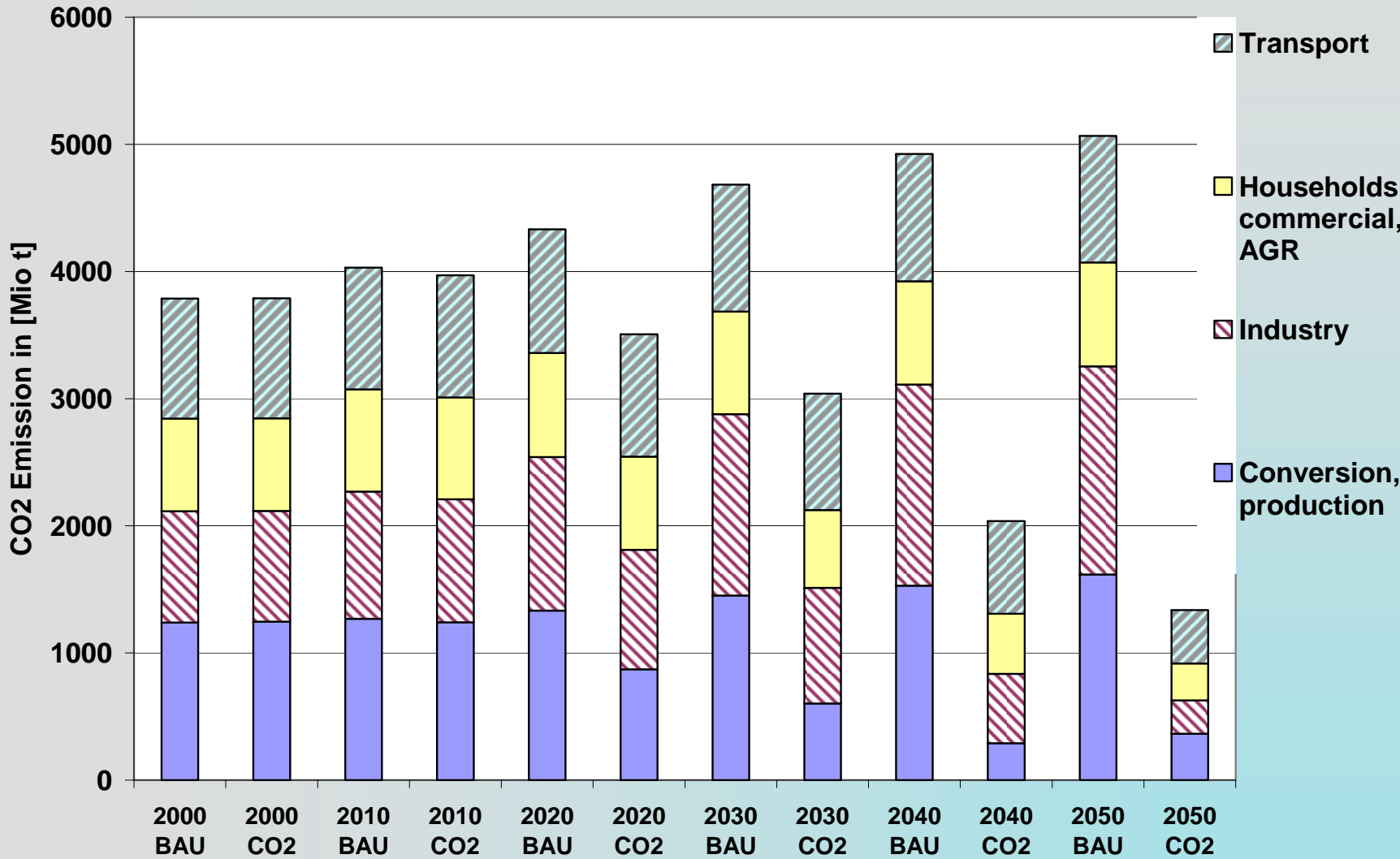
Today

1. Specification of the **Baseline** case (BAU)
2. **Post-Kyoto** climate policy to stabilize CO₂e concentrations at 440 ppmv (CO₂)
3. **Enhancement of endogenous energy resources**, (constraining imports of fossil fuels to foster the use of renewables, efficiency standards and new nuclear)
4. Improve **environmental quality** by endogenizing externalities related to local air pollution (i.e., w/o global externalities)

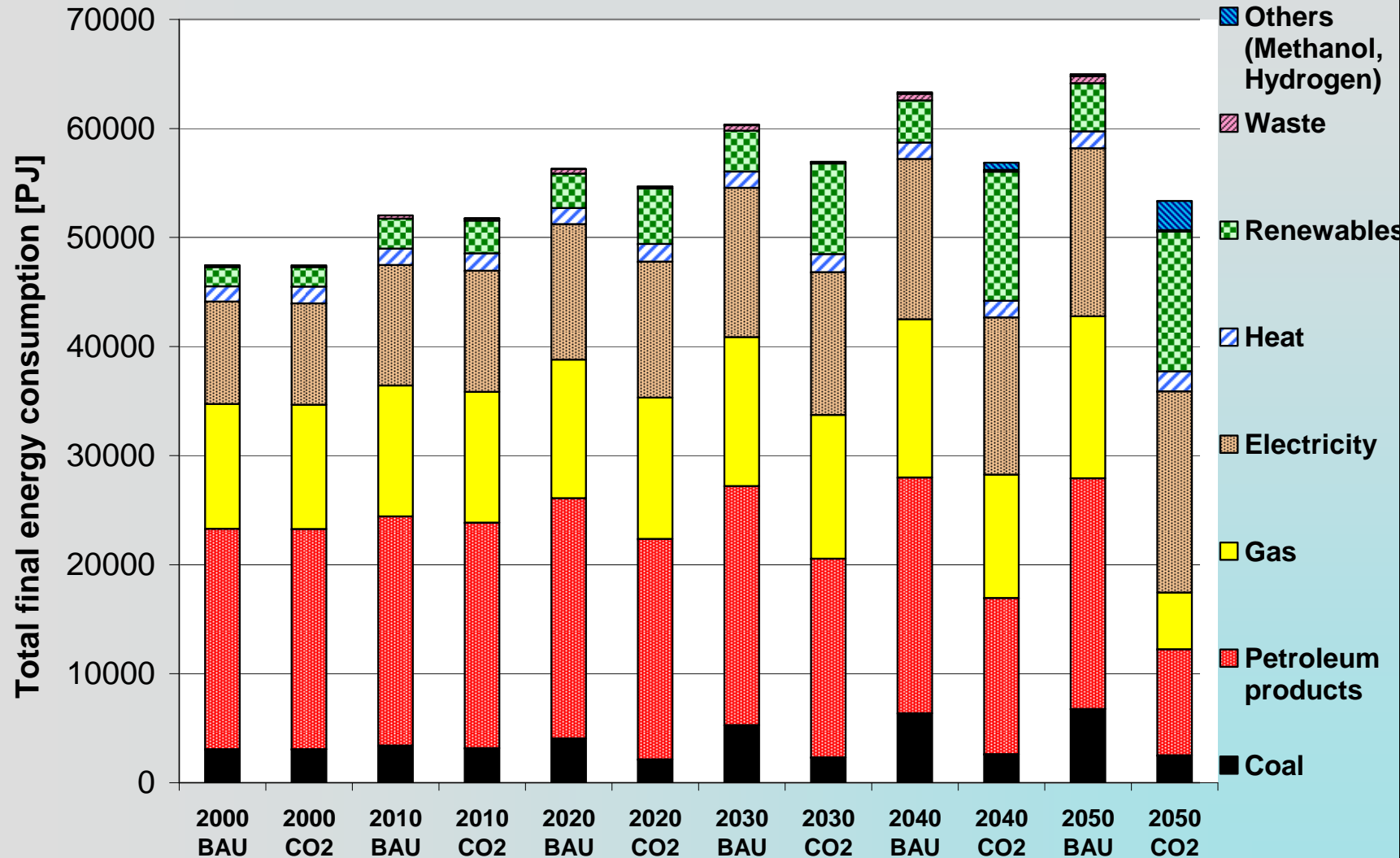
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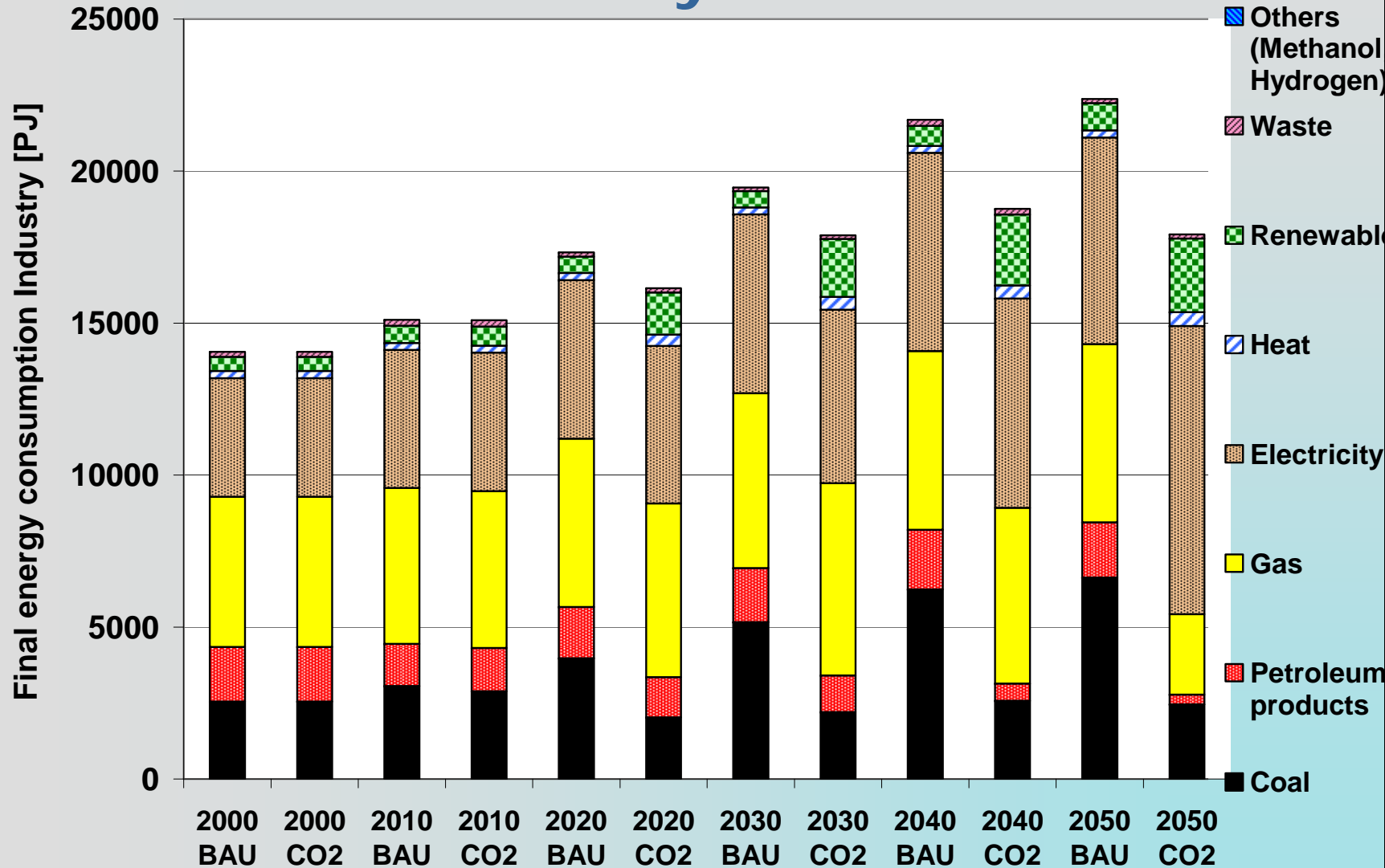
Total CO₂ emission in the EU 27



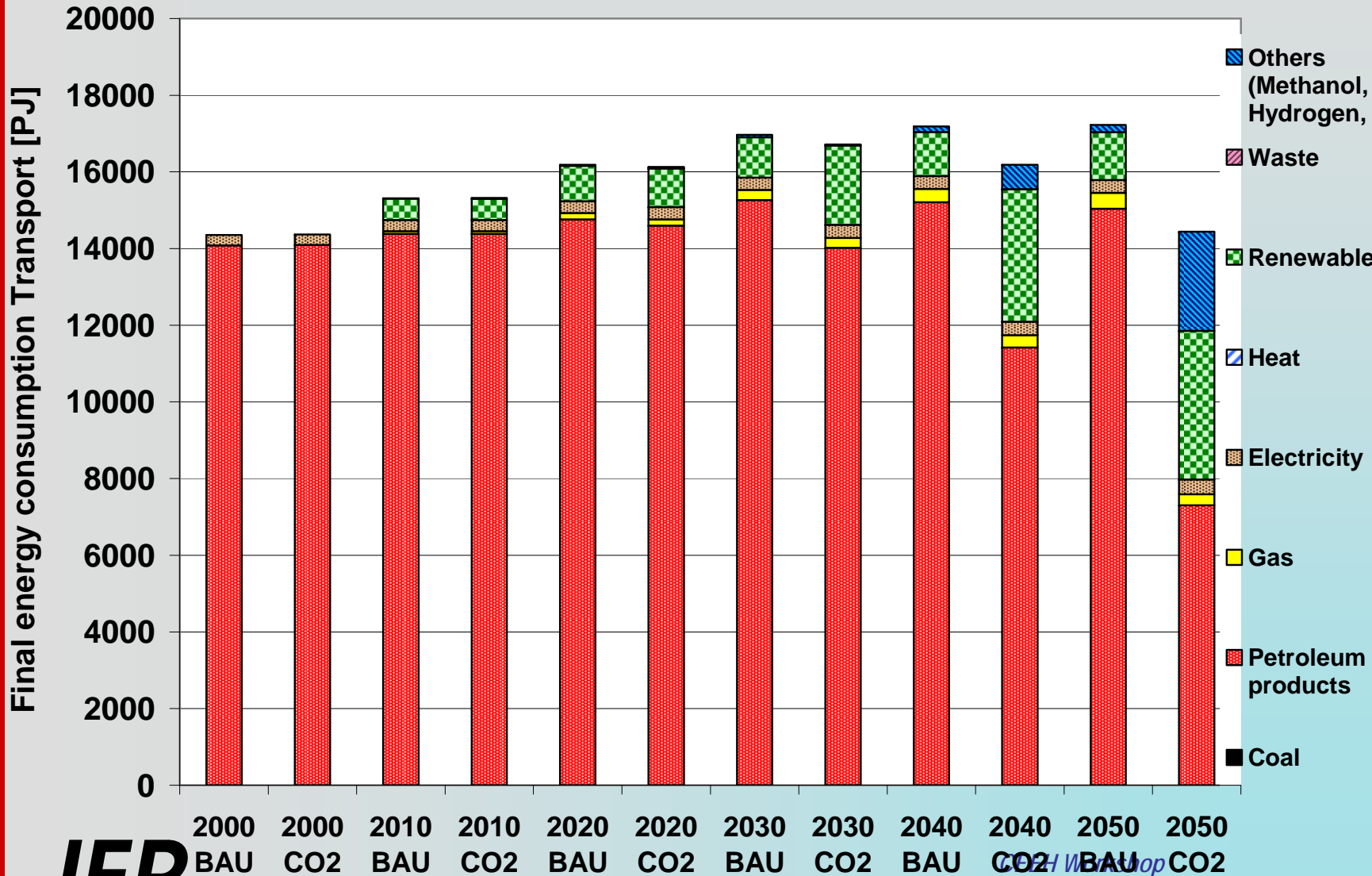
Total final energy consumption EU 27



Total final energy consumption industry EU 27

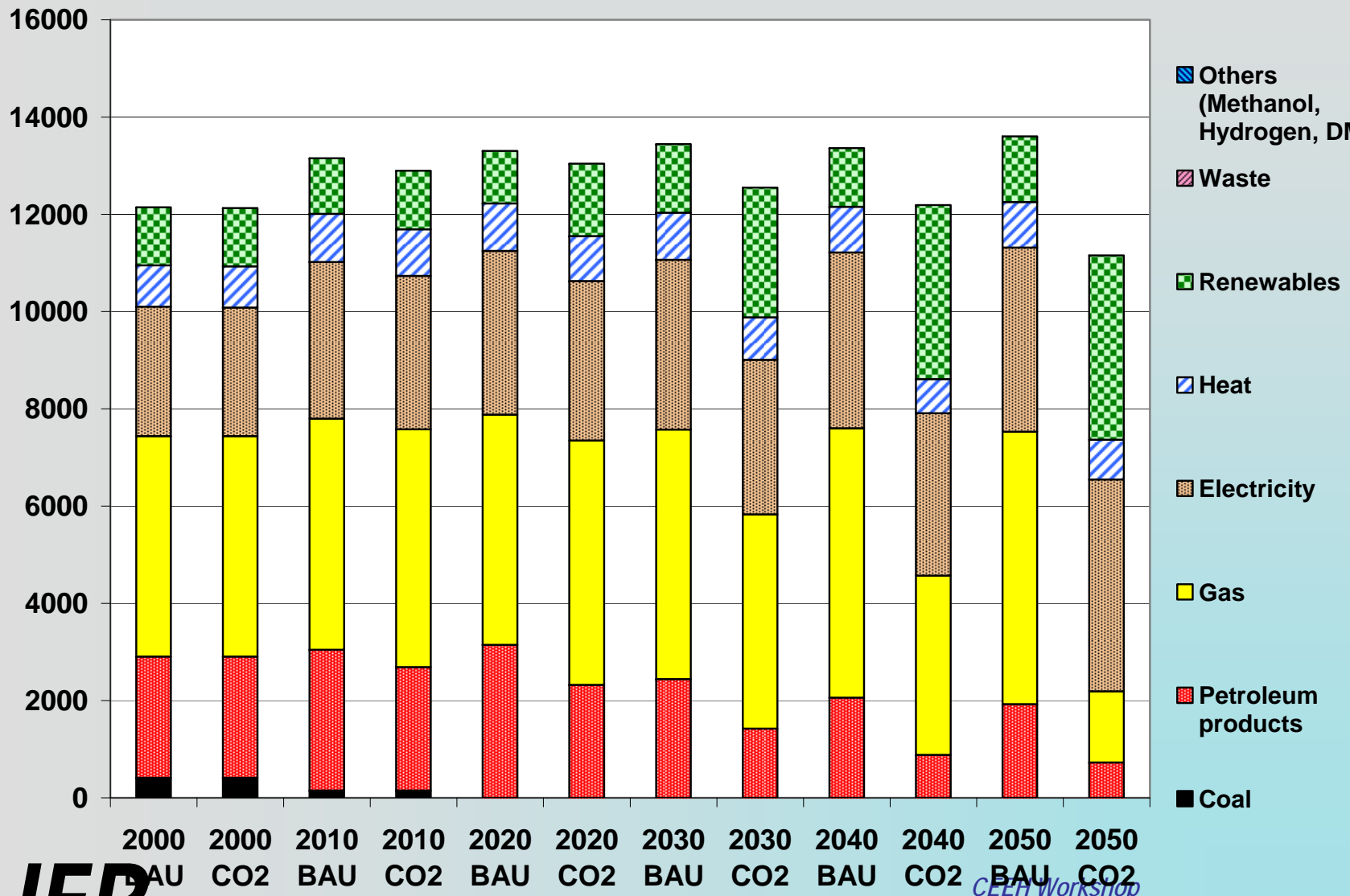


Total final energy consumption transport EU27

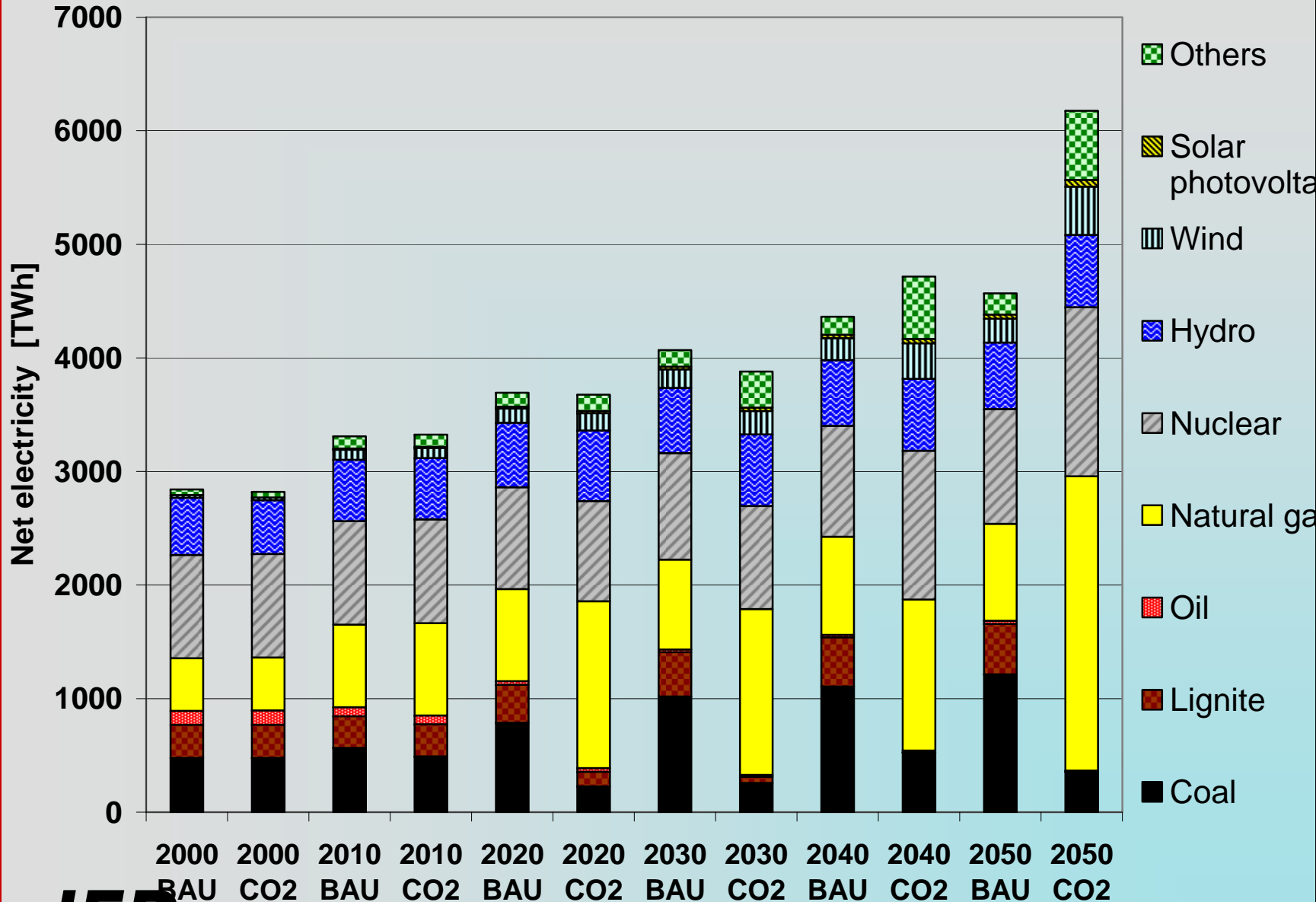


Total final energy consumption residential EU27

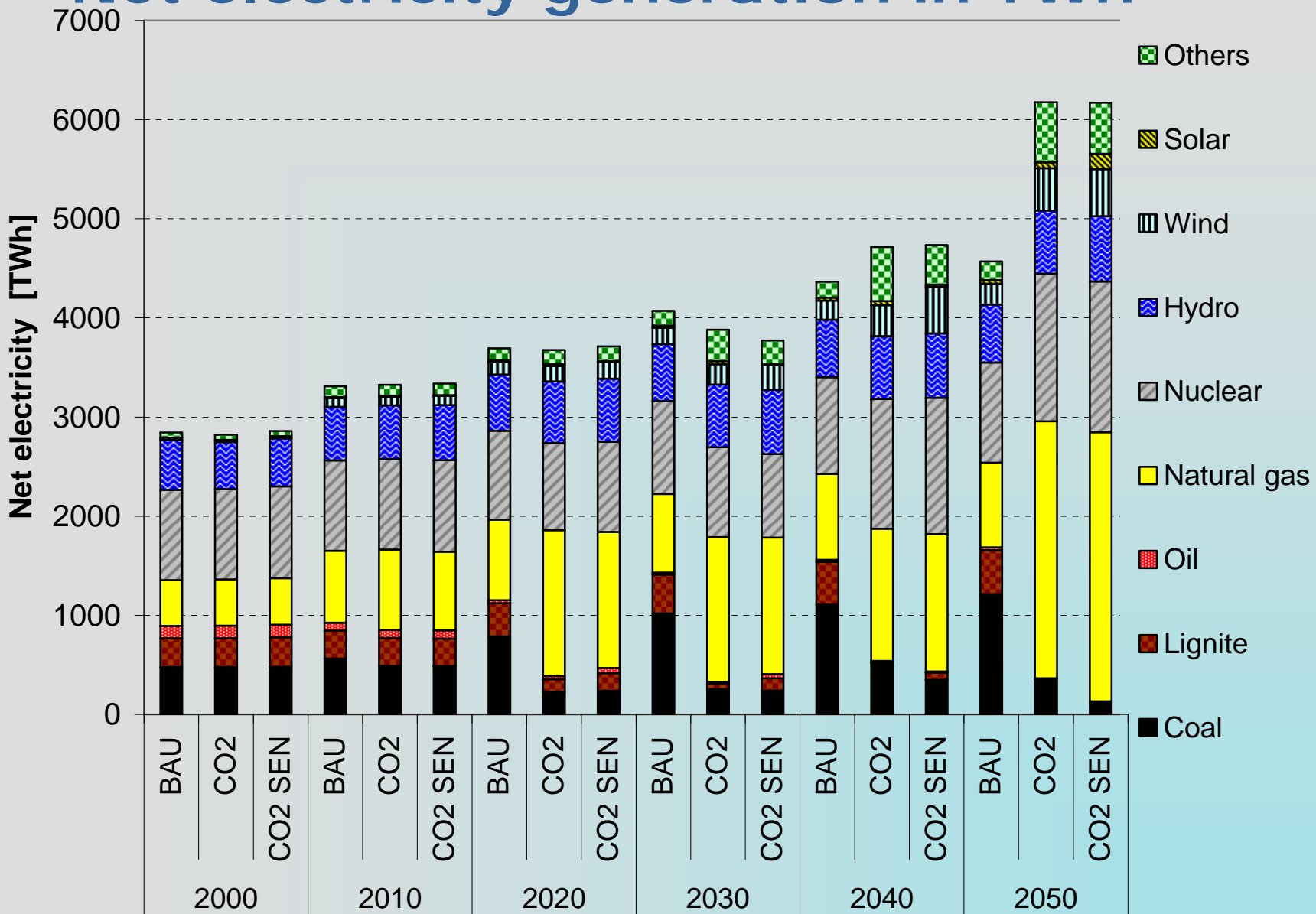
Final energy consumption Residential [PJ]



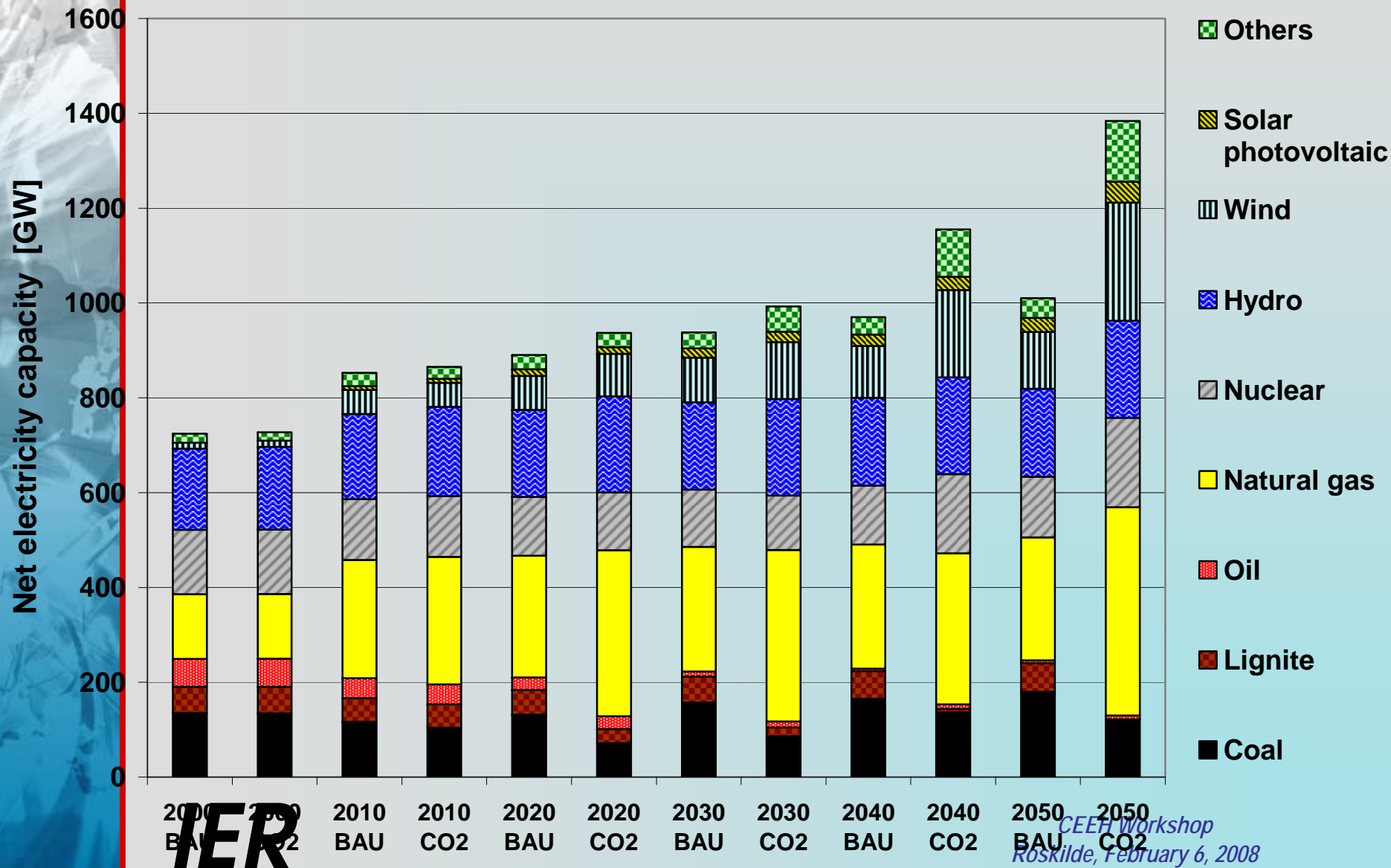
Net electricity generation in TWh



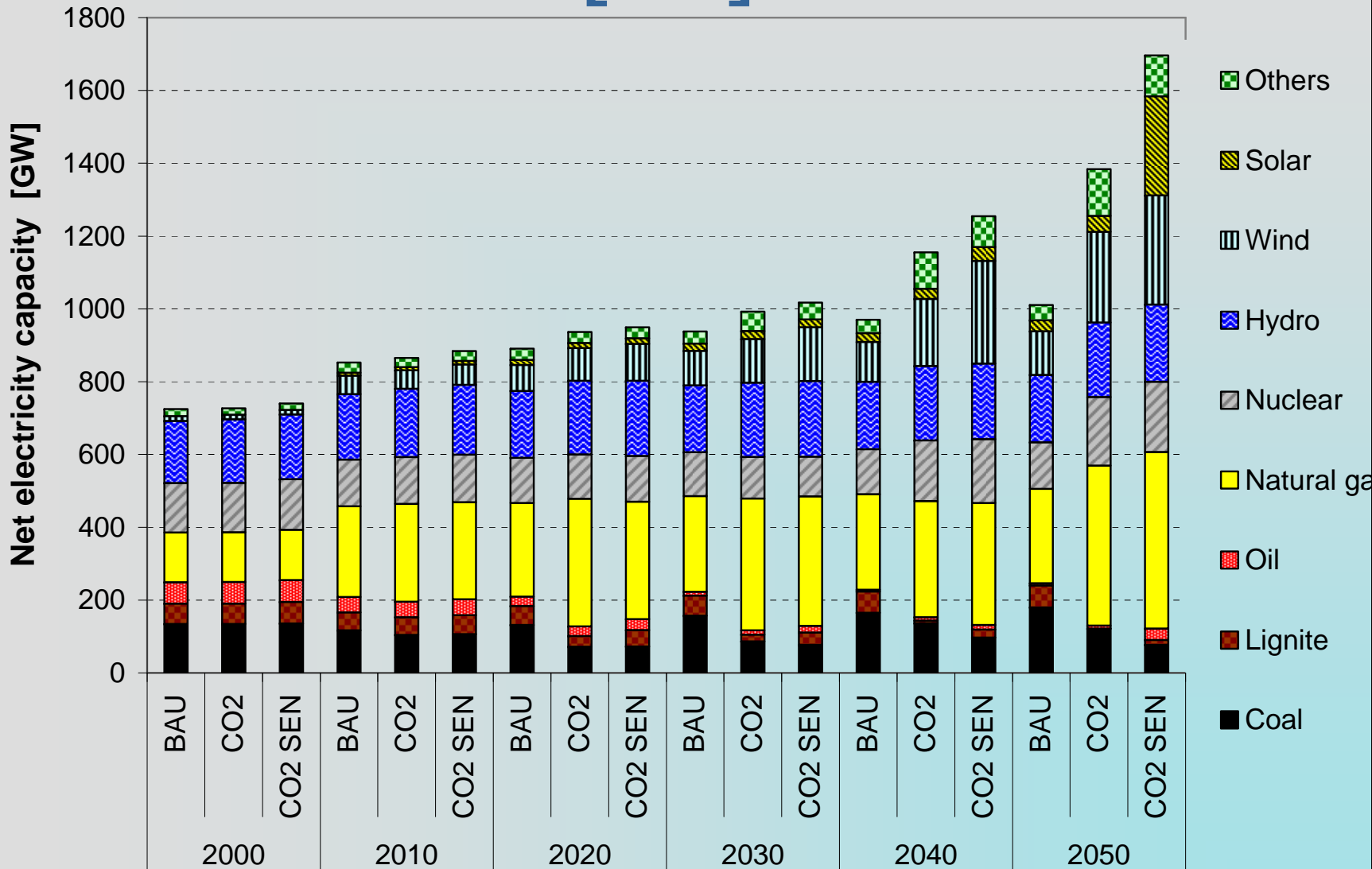
Net electricity generation in TWh



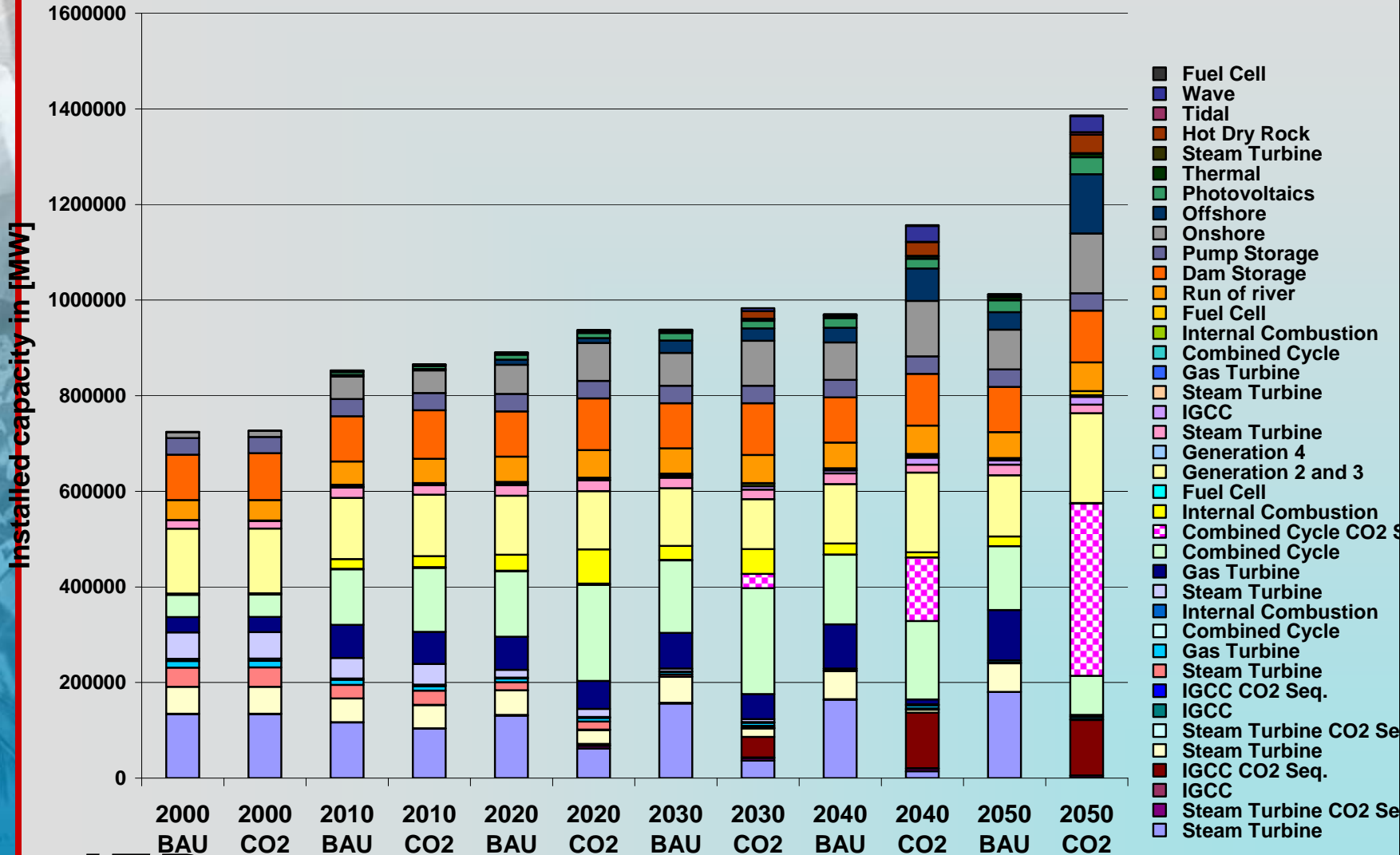
Net electricity generation capacity in [GW]



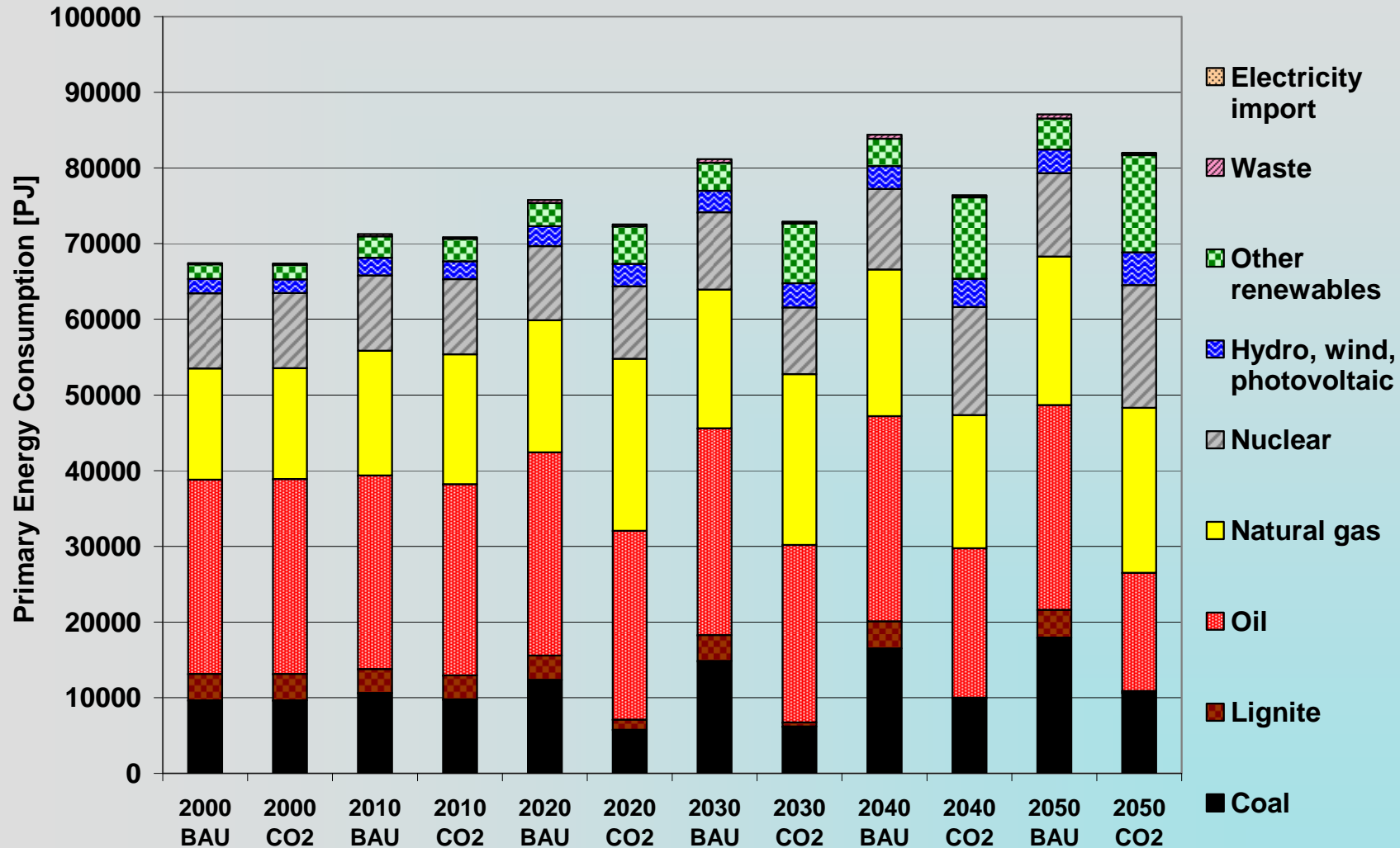
Net electricity generation capacity in [GW]



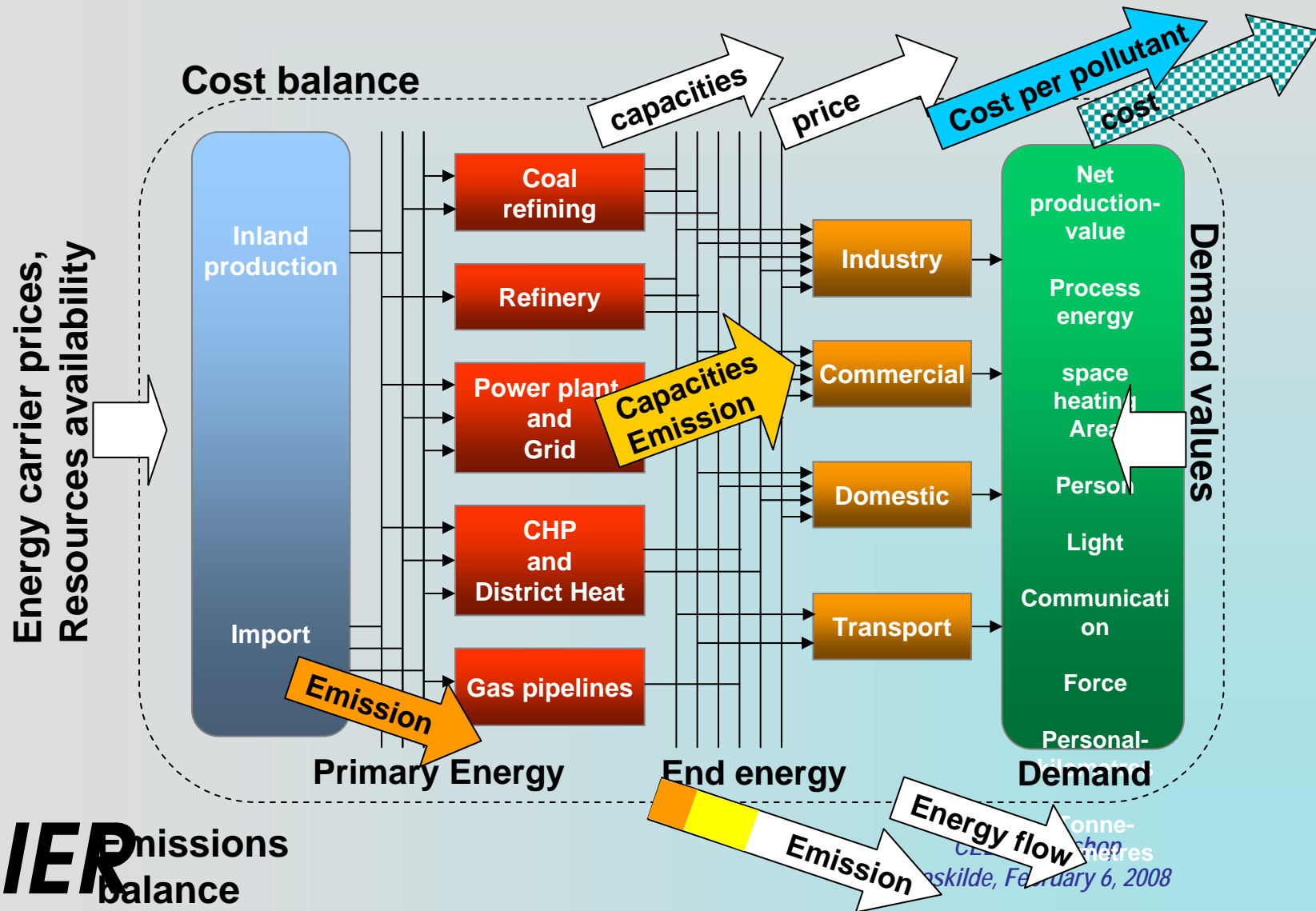
Net electricity generation capacity by technologies in [GW]



Total primary energy consumption EU



Integration of LCA and External costs in the Pan-European TIMES model





Thank you for your attention !