Electricity Technology Perspectives for a Sustainable Electricity Supply in Europe

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European Sustainable Electricity: EUSUSTEL

- Provide recommendations to optimise the future nature of electricity provision and the electricity generation mix in Europe, with respect to:
  i. Cost-effectiveness and affordability
  ii. Environment and climate protection
  iii. Reliability and security of supply

- Analyses of technology perspectives for a sustainable electricity supply in Europe, based on:
  i. Qualitative and quantitative description of generation technologies
  ii. Calculation of total social cost of electricity generation
  iii. Model-based analyses of various scenarios

EUSUSTEL – Conceptual Framework for Sustainable Development

- Potential for beneficial supply of energy services for following generations should be enlarged, i.e. extension of the technical-economical accessible resource base for the provision of energy services.

- Energy induced emissions should not exeed absorption capacity of natural resources as a sink.

- Energy services should be provided with the least resource input possible, including the environmental resources.

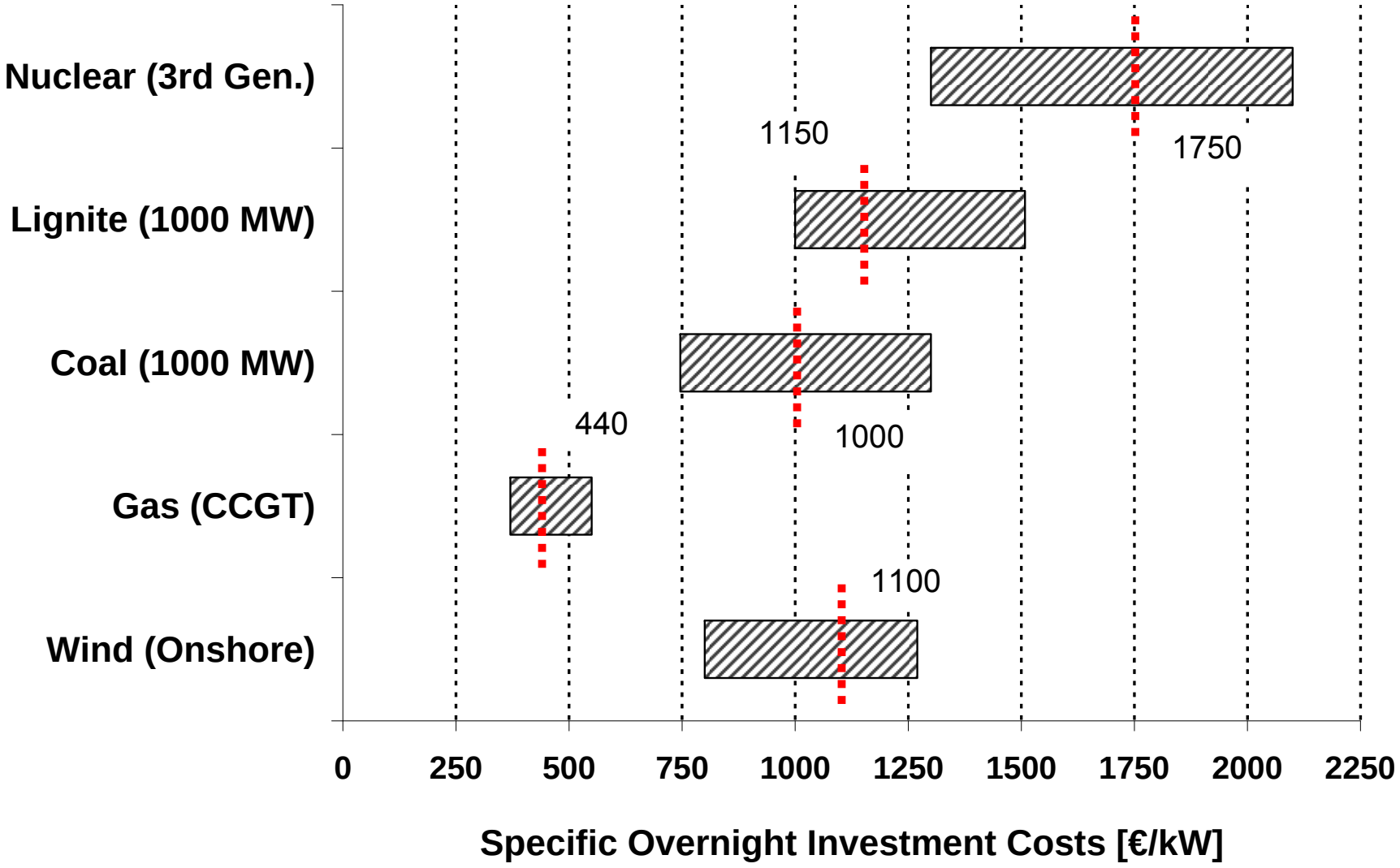
Relative Sustainability of Energy Technologies

- Total resource consumption of energy technologies or energy supply chains is a measure with respect to their relative sustainability.

- Total social cost (i.e. private cost plus external cost) is a useful indicator to account for overall resource consumption per energy service unit.

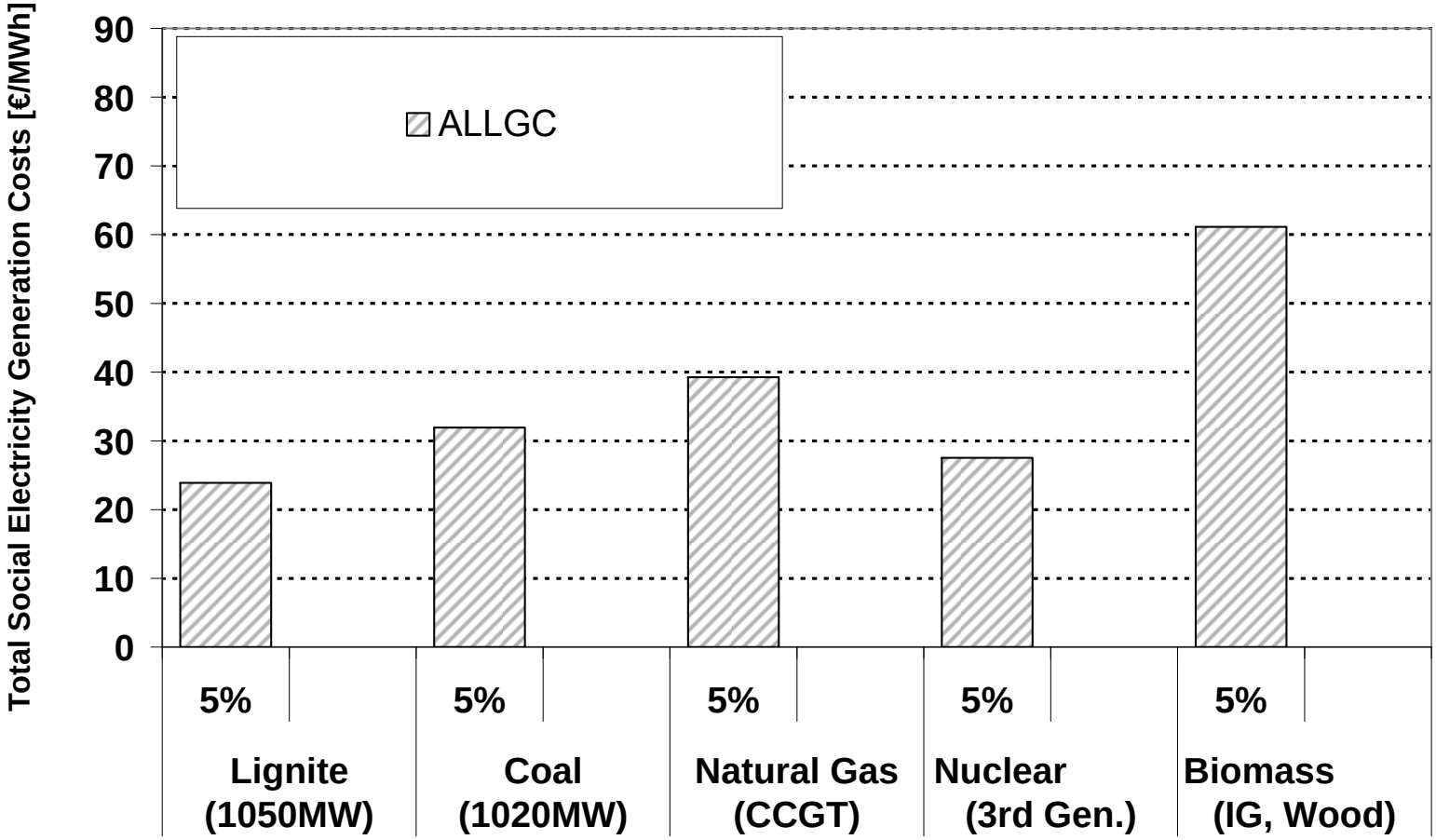
⇒ Measure for the relative sustainability

Range of Specific Overnight Investment Cost



Total Social Costs for different Electricity Generation Technologies 2010 (Baseload)

- *Average Lifetime Levelized Generation Costs (ALLGC). Calculations based on 85 % capacity factor. Discount rate: 5%, 10%.*



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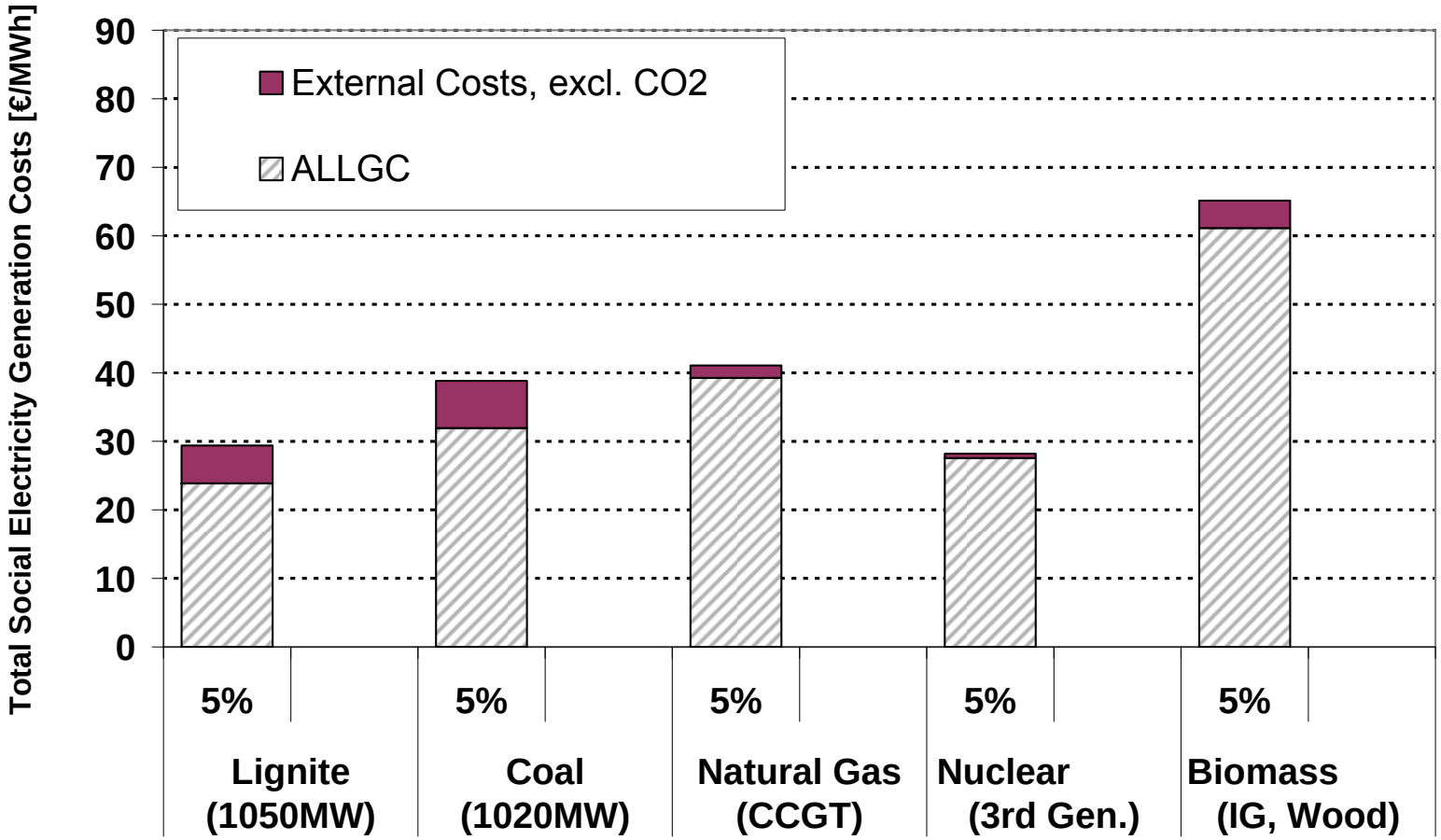

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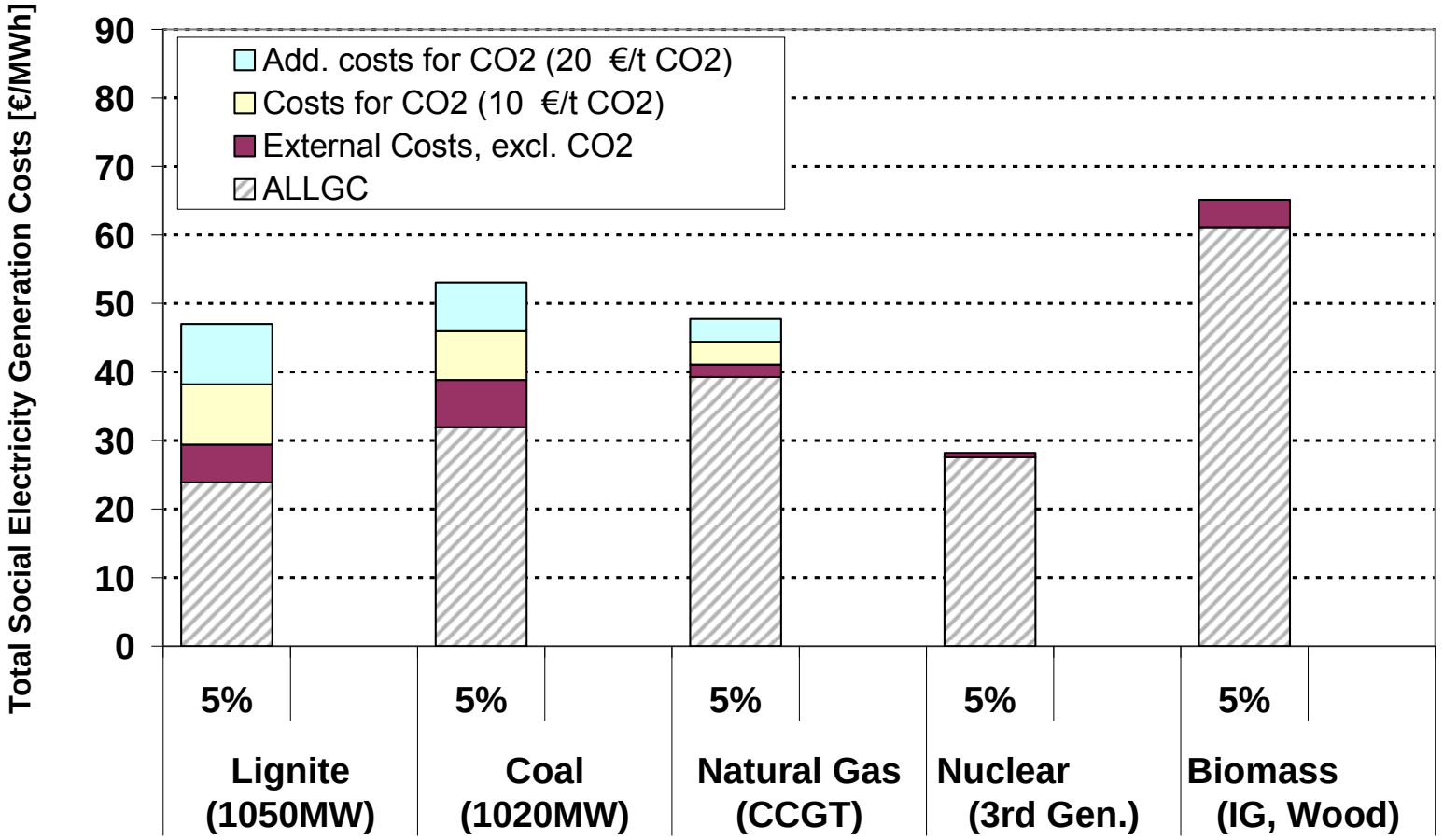

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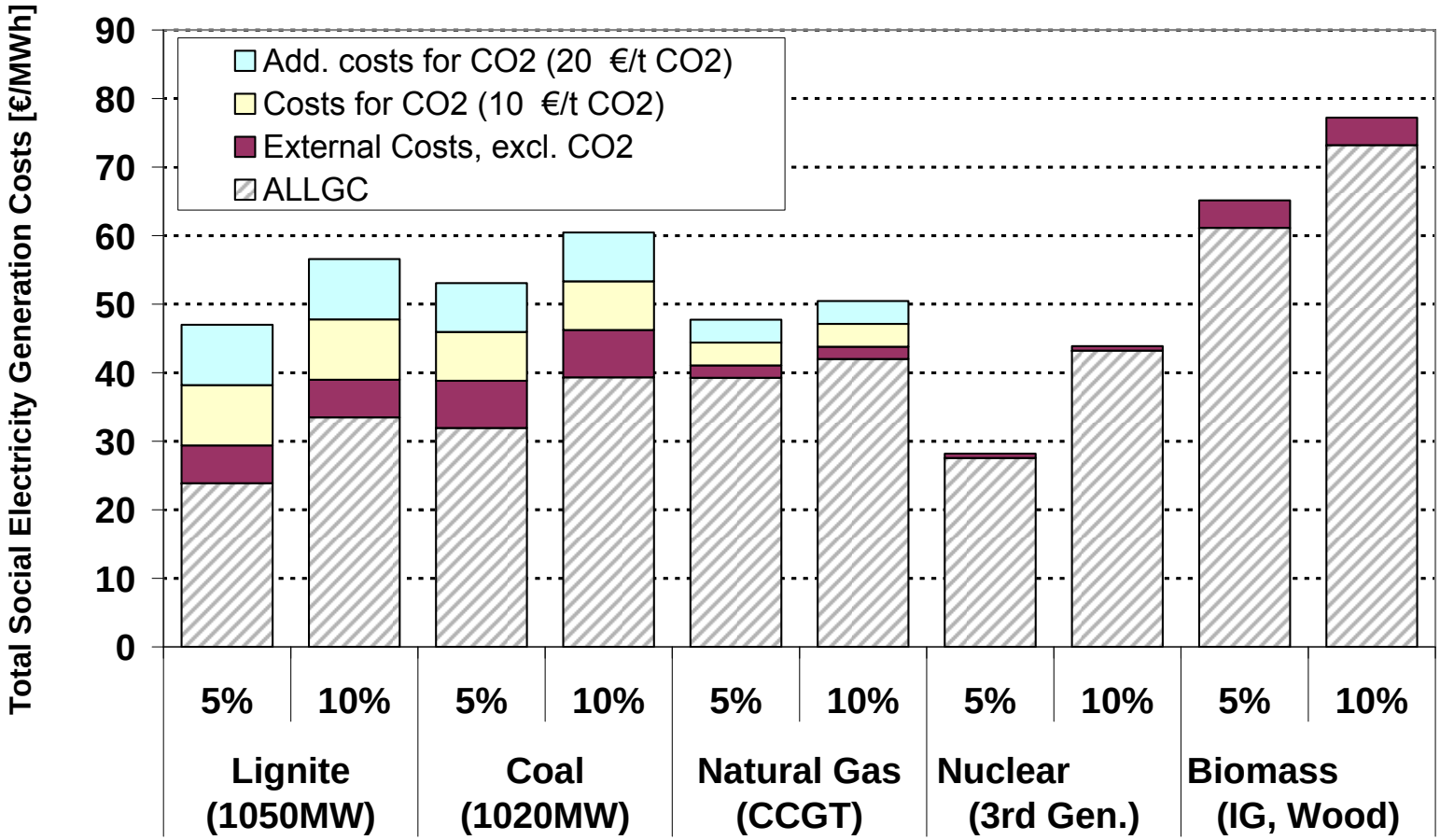
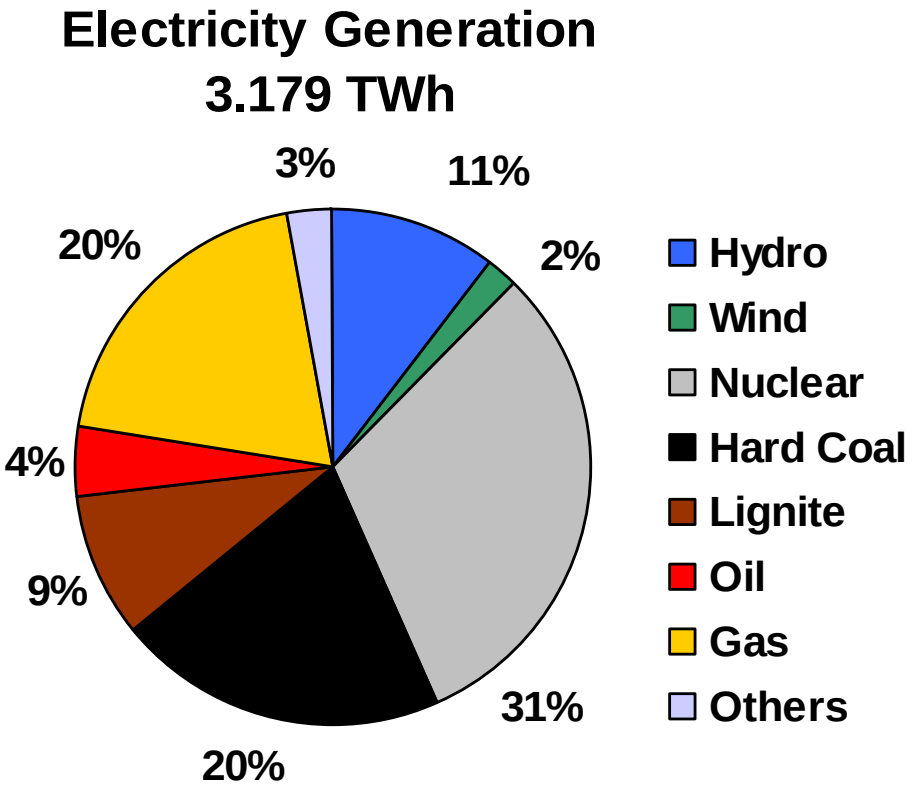
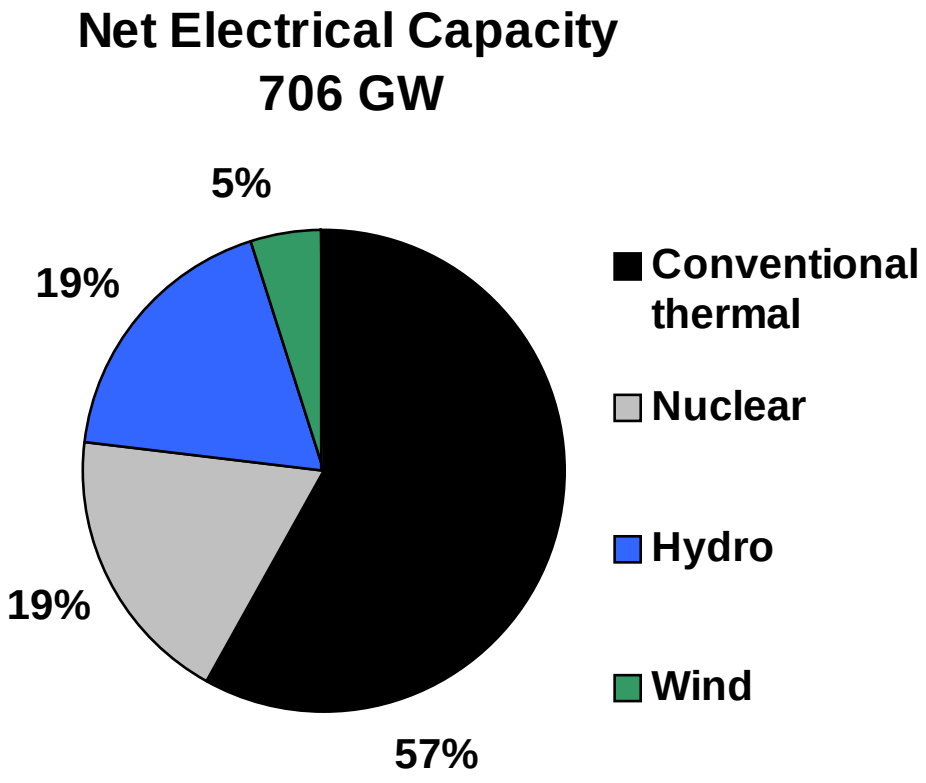
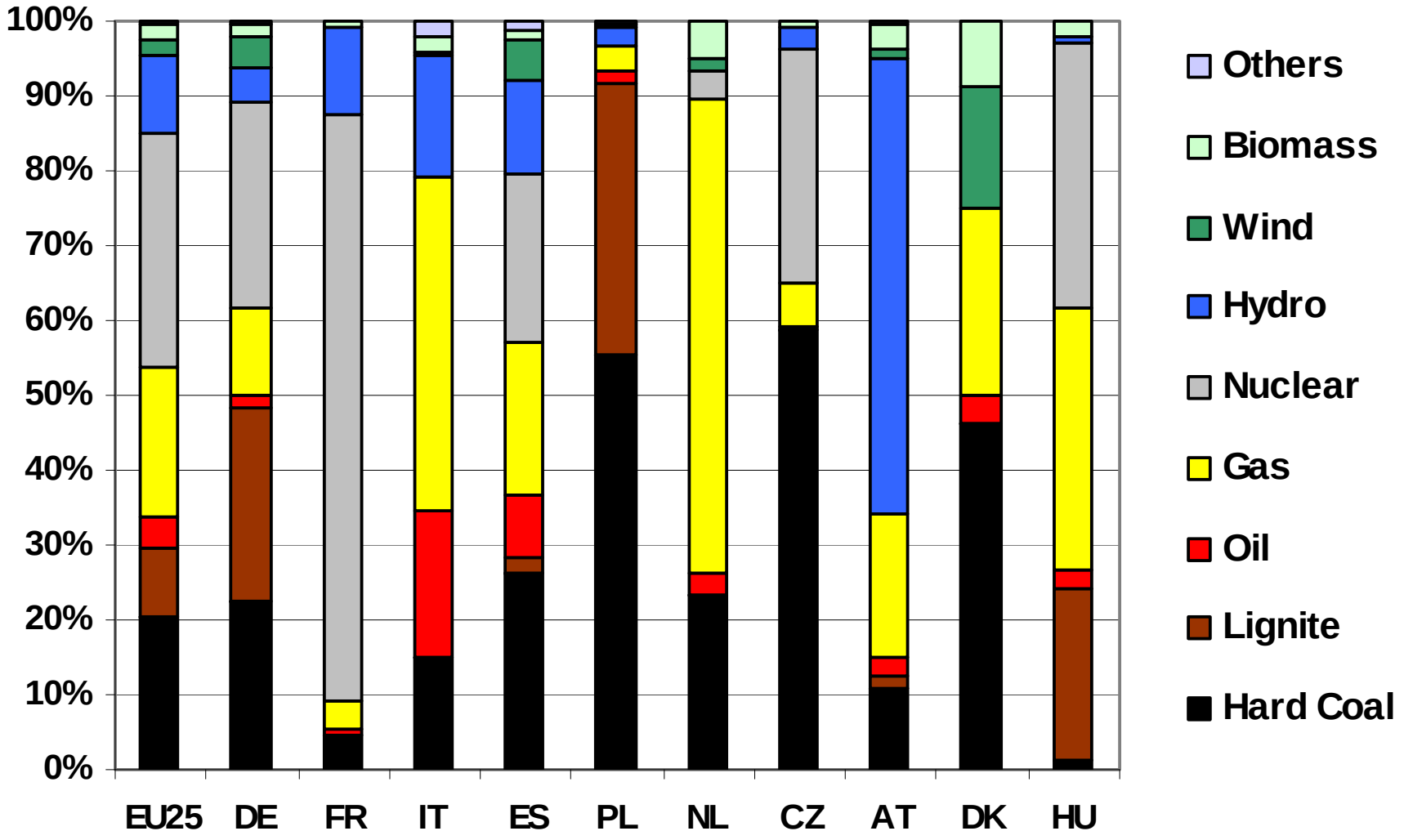


Electricity Generation [TWh] and Electricity Capacity [GW] in the EU-25 (2004)





Electricity Generation Structure (2004)



TIMES-EG: Overview

- TIMES-EG is a electricity (and gas) system model for each of the EU-25
- TIMES-EG is a partial equilibrium model of the European electricity market to perform energy, engineering, economic and environmental analysis
- Technological improvement is explicitly characterized and performance of energy technologies is an important driver of structural development
- For EUSUSTEL, TIMES-EG was used to quantify various policy scenarios of the European electricity system which are compared against a baseline projection

Scenario Characterization (I)

Baseline (BL): Business as usual development in EU-25	
CO_2-Value	5 €/t CO_2 from 2010 until 2030
Nuclear	Nuclear development based on current national policies in EU-25. Nuclear phase-out in Germany, Belgium and Sweden
RES	Continuation of support to renewables

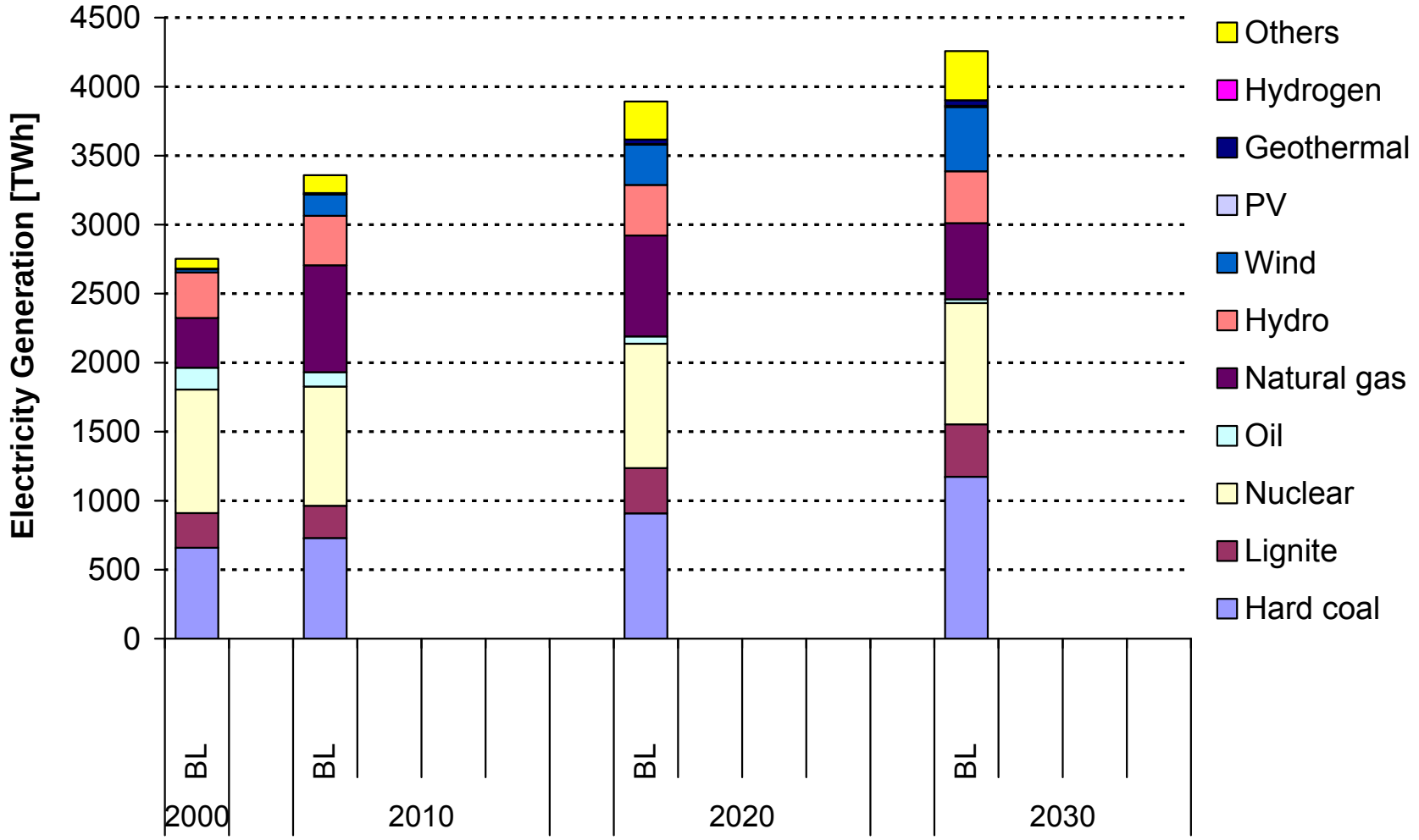
Post-Kyoto (PK800): CO_2-Emission target of 800 Mt in 2030	
CO_2-Target	Reduction of CO_2-emissions of 40 % in 2030 compared to 2005
Nuclear	Nuclear constrained as in Baseline (BL)
RES	RES policies as assumed in Baseline (BL)

Scenario characterization (II)

Post-Kyoto, All Technologies (PKAT800): CO_2-Emission target of 800 Mt in 2030 but allowing for free technological choice	
CO_2-Target	Reduction of CO_2-emissions of 40 % in 2030 compared to 2005
Nuclear	No premature phase-out. New investments allowed in all countries, except for: AT, DK, EE, GR, IR, LV, LU, PT
RES	RES policies as assumed in Baseline (BL)

Least Cost (LC): CO_2-Emission target of 800 Mt in 2030	
CO_2-Target	Reduction of CO_2-emissions of 40 % in 2030 compared to 2005
Nuclear	No premature phase-out. Life time extension. New investments allowed.
RES	Limited support of renewables

Net electricity generation [TWh] by energy carrier in EU-25



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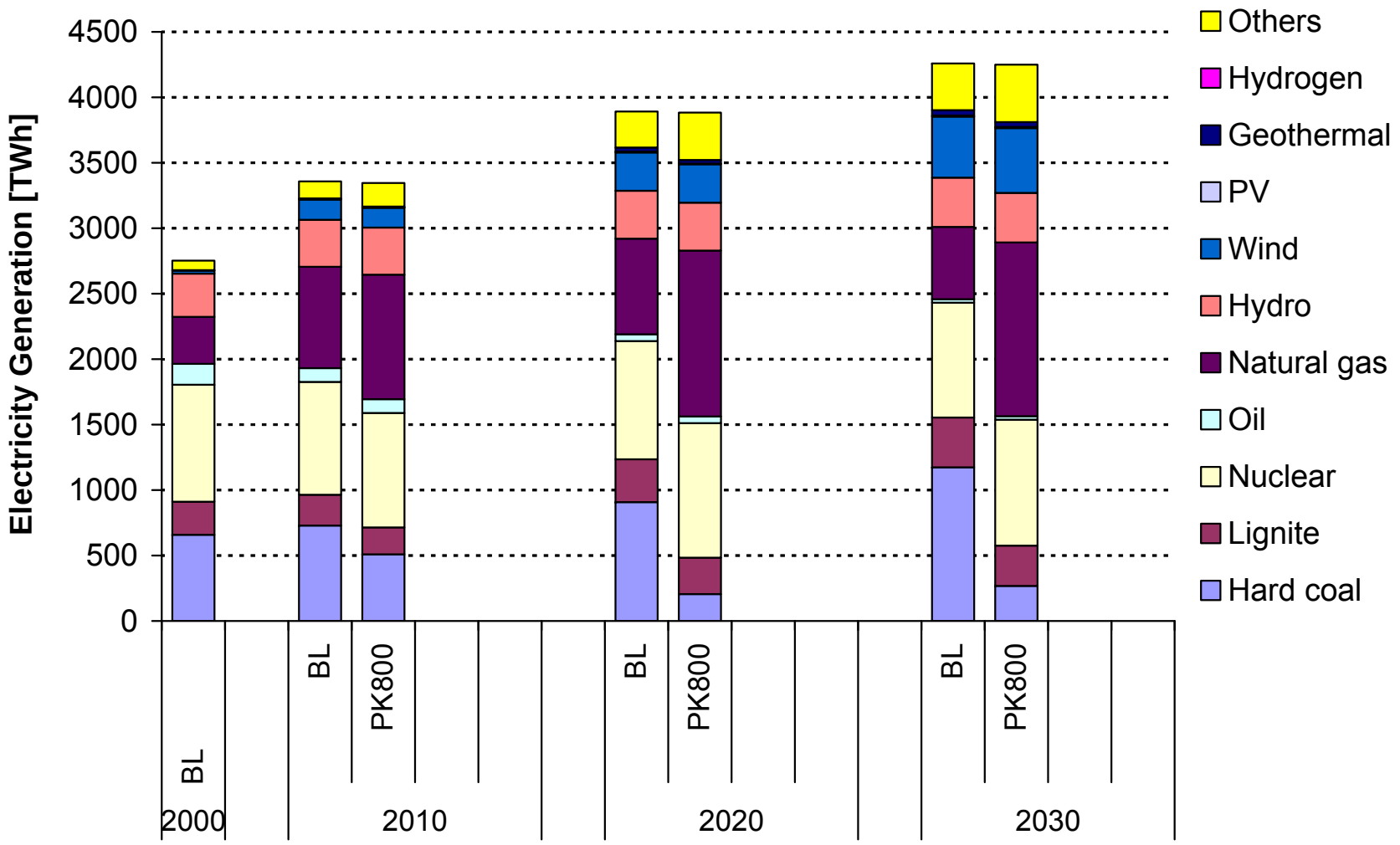

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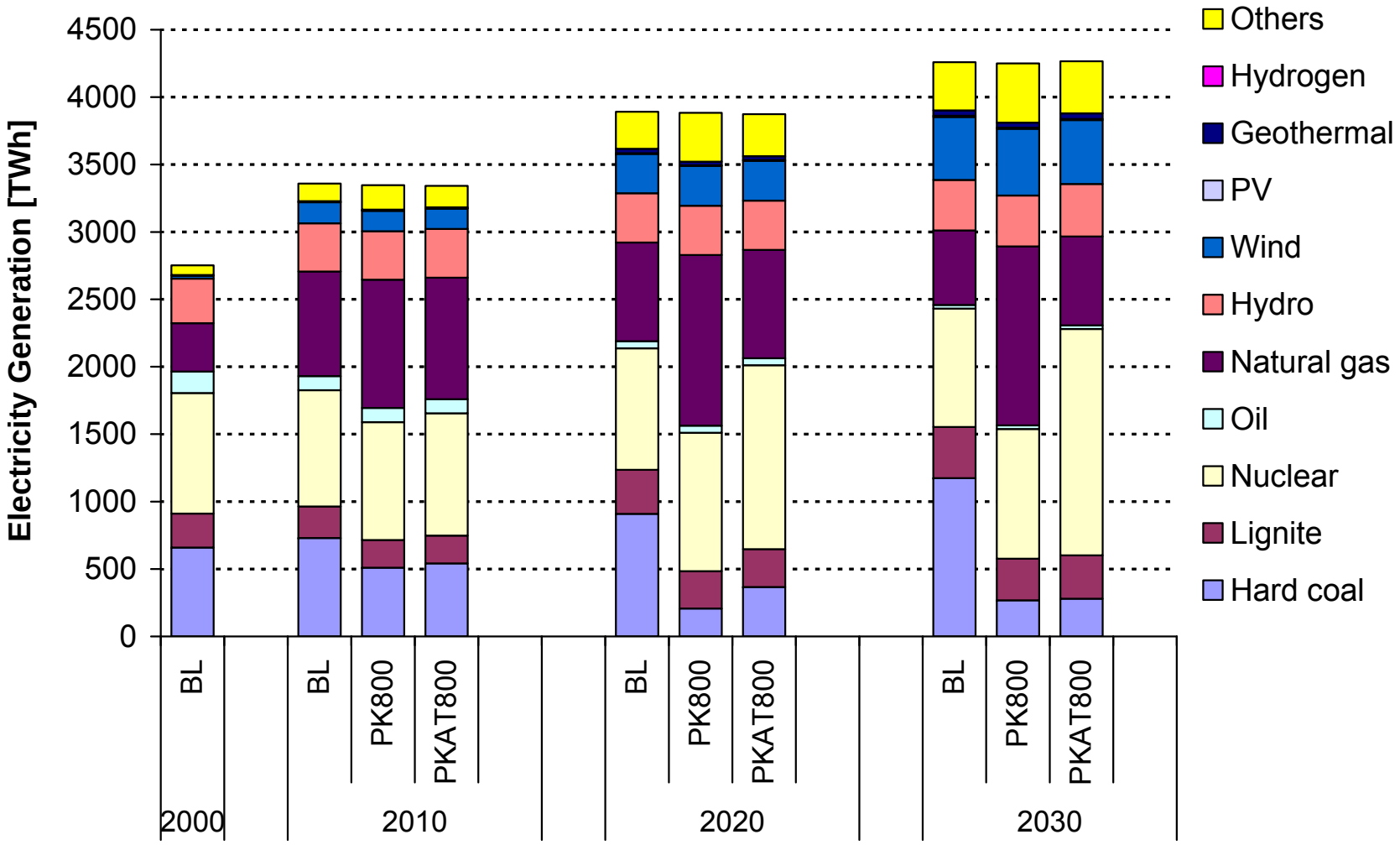

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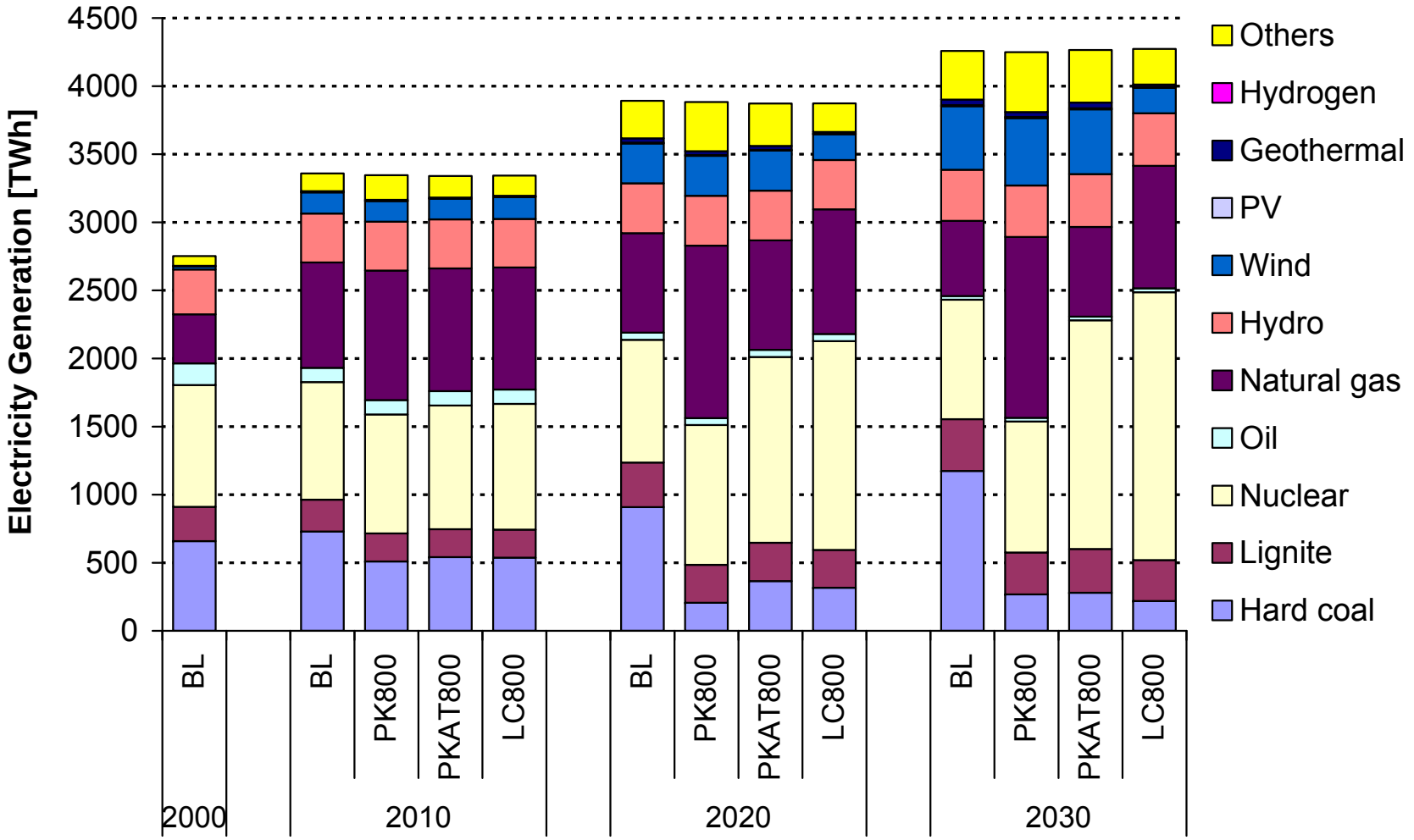

Development of average electricity generation costs

Cost of Electricity Generation [€$_{2000}$/MWh]

	2020	2025	2030
BL	40.7	43.0	44.6
PK800	45.8	51.4	53.4
PKAT800	41.4	42.9	38.6
LC800	38.9	41.4	38.2

Cost implications of various scenarios

	compared against baseline (BL)	
	Total Cost Difference [bn Euro$_{00}$]	Average CO_2 reduction costs in 2030 [Euro/t CO_2]
PK 800	351.0	20.9
PKAT 800	-86.5	-3.4
LC 800	-232.4	-9.7

Concluding Remarks

- Total resource consumption – measured by total social cost – indicates that the relative sustainability of the nuclear power is comparatively high
- The baseline scenario is clearly a non sustainable future in terms of climate impacts and security of supply (import dependency)
- The analysis shows that with current knowledge about technology potential and performance improvements nuclear power seems to be the single most important option
    - to reduce the GHG emissions of the electricity sector
    - to alleviate the import dependence of natural gas and coal
    - to obtain least cost effects on electricity costs under climate constraints
- The analysis did not capture the indirect CO_2-reduction potential of electricity in the end-use sectors e.g. by electrical heat pumps, if low-CO_2 and low-cost electricity is available