Sustainability –

what are the major challenges and tasks for national and international energy economics?

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Conceptual framework for sustainable development

- Sustainable development is the general accepted guiding principle (concept) for further development.

Gothenburg European Council (2001)

- "Sustainable Development offers the European Union **a positive long-term vision** of a society that is more prosperous and more just, and which promises a cleaner, safer, healthier environment – a society which delivers a better quality of life for us, for our children, and for our grandchildren. Achieving this in practice requires that economic growth supports social progress and respects the environment, that social policy underpins economic performance, and that environmental policy is cost-effective."

- But, there are many different definitions and interpretations of ‘sustainable development’. A widely acceptabled operational definition of SD is lacking.

Conceptual framework for sustainable development

- Various international and national organisations have been developing criteria and sets of indicators to measure and assess one or more aspects or Sustainable Development
- Indicators for Sustainable Development in General
  - CSD
  - OECD
  - EU Commission
- Indicators for Sustainable Development of the Energy Sector
  - IAEA, UNDESA, IEA, Eurostat and EEA
  - Enquete Commission of the German Parliament
  - International Committee of Nuclear Energy (ILIC)
- But, a generally acknowledged set of specific indicators does not currently exist and approaches for integrating them, to assess the sustainability performance, have not yet been established.

Conceptual framework for sustainable development

Sustainability Concepts

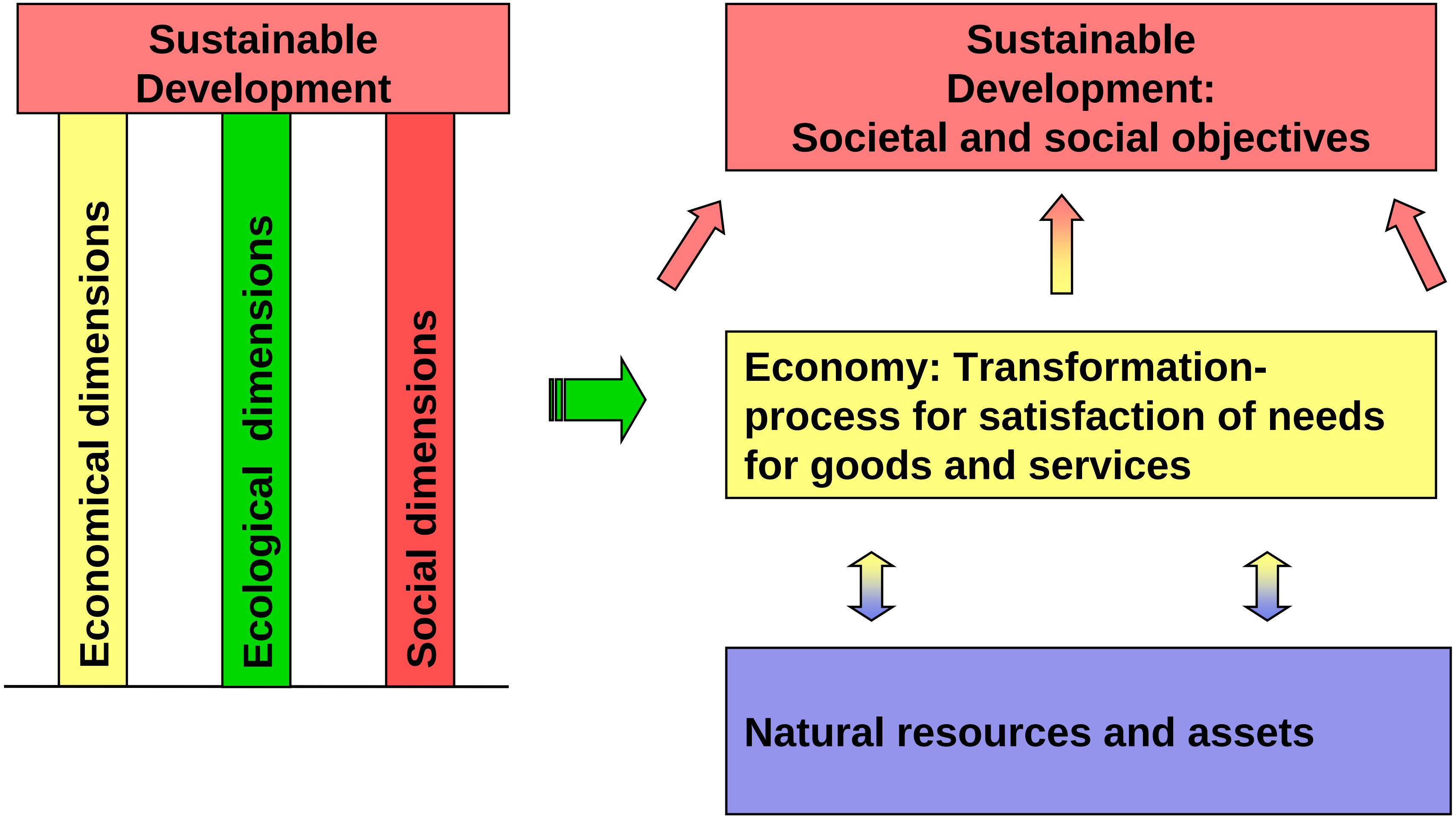
- Weak Sustainability:
  - Substitution paradigm – postulating a largely substitutability of natural resources by man-made capital
- Strong Sustainability:
  - Non-substitutability of natural capital by man-made capital preservation of naturel capital
- Three – Pillar Model
  - Economical dimension
  - Ecological dimension
  - Social dimension

The Brundtland Commission‘s Definition of Sustainable Development

"Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

It’s “a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change are made consistent with future as well as present needs.”

Conceptual framework for sustainable development



"Sustainable development": What does it mean for the energy sector

- **Scientific fundamentals**
- **Sustainability and the use of finite *(non-renewable)* resources**
- **Sustainability and the economic principle**

➢ Scientific fundamentals

- Second law of thermodynamics => Life and development of economical and cultural achievements require a permanent input of workable energy and material.

- Growing knowledge (*Gestaltungsfähigkeit*) and the connected possible technological progress create the base for preserving and expanding the abilities of future generations.

- Environmental pollution results from the release of substances into the environment, not from the energy degradation.

➢ Sustainability and the use of finite *(non-renewable)* resources

- Can the use of finite resources (e.g. Oil and Coal) be consistent with the principles of sustainability?
- Supply of energy service requires the use of workable energy, but also the use of non-energetic resources and materials.
- Use of finite resources require a compensation
  => the extension of the technical-economical accessible
  resource base for the provision of energy services.
- State of technology determines the technological-economical accessible base *(potential)* of raw materials and energy as well as the productivity of the resource base.

➢ Sustainability and the economic principle

- Prudent use of scarce resources (incl. the environmental resources) represents a key aspect of sustainability.

  ⇒Energy services to be provided using the minimal amount of energy, material and other resources possible.

- Also the general economic principle targets at minimising the use of resources.

  ⇒Costs and prices are a measure for use of various scarce resources.

- Total resource use has to be taken into account

  ⇒ Internalisation of external costs (Getting prices right).

Sustainable energy provision if

- The potential for an economic provision of energy services increases (or does not decrease) for the following generation.
- The substance release due to energy service provision does not exeed the assimilation capacity of the natural environment.
- The energy related risk for human health are smaller than the avoided natural risk due to the provision of energy services.
- Energy services are provided with the least resource input possible, including the environmental resources.

Relative sustainability of energy technologies and energy supply chains

- 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

- **A comparative assessment of electricity generation options**

Reference Technologies for Electricity Generation

	Technology	Power installed (netto) [MWe]	Efficiency el [%]	Technical Life Time [Years]
Hard Coal	Pulverised Combustion	**700**	**45,5**	**35**
Lignite	Pulverised Combustion	**800**	**43**	**35**
Gas CC	Combined-Cycle	**777,5**	**57,5**	**35**
Nuclear	actual PWR	**1375**	**33**	**40**
Wood CHP	Combined Heat and Power	**20**	**24**	**35**
PV-Modul poly 5 kW	polycristalline	**0,005**	**12,5**[1)]	**25**
WEA 1500 kW (5,5)[3)]	horizontal	**1,5**	**2450 h/a** [2)]	**20**
WEA 1500 kW (4,5)[3)]		**1,5**	**1680 h/a** [2)]	**20**
Hydro 3,1 MW	Run-of-River	**3,1**	**90**	**60**

[1)] system efficiency; full load hours: 880h/a   [2)] full load hours   [3)] average wind speed (in 10 m height)

Quelle: IER 2005

Specific Cumulated Energy Demand (CED) and Energy Pay-Back Time (EPBT)

	Cumulative Energy Demand (CED) (without fuel) [kWh_{Prim} / kWh_{el}]	Energy Pay-Back Time (EPBT) [months]
Hard Coal	0,27	3,1
Lignite	0,16	3,2
Gas CC	0,17	0,8
Nuclear (PWR)	0,07	2,8
Wood CHP	0,08	13,2
PV-Modul poly 5 kW	0,61	66,3
WEA 1500 kW (5,5)	0,06	4,9
WEA 1500 kW (4,5)	0,08	7,2
Hydro 3,1 MW	0,04	11,0

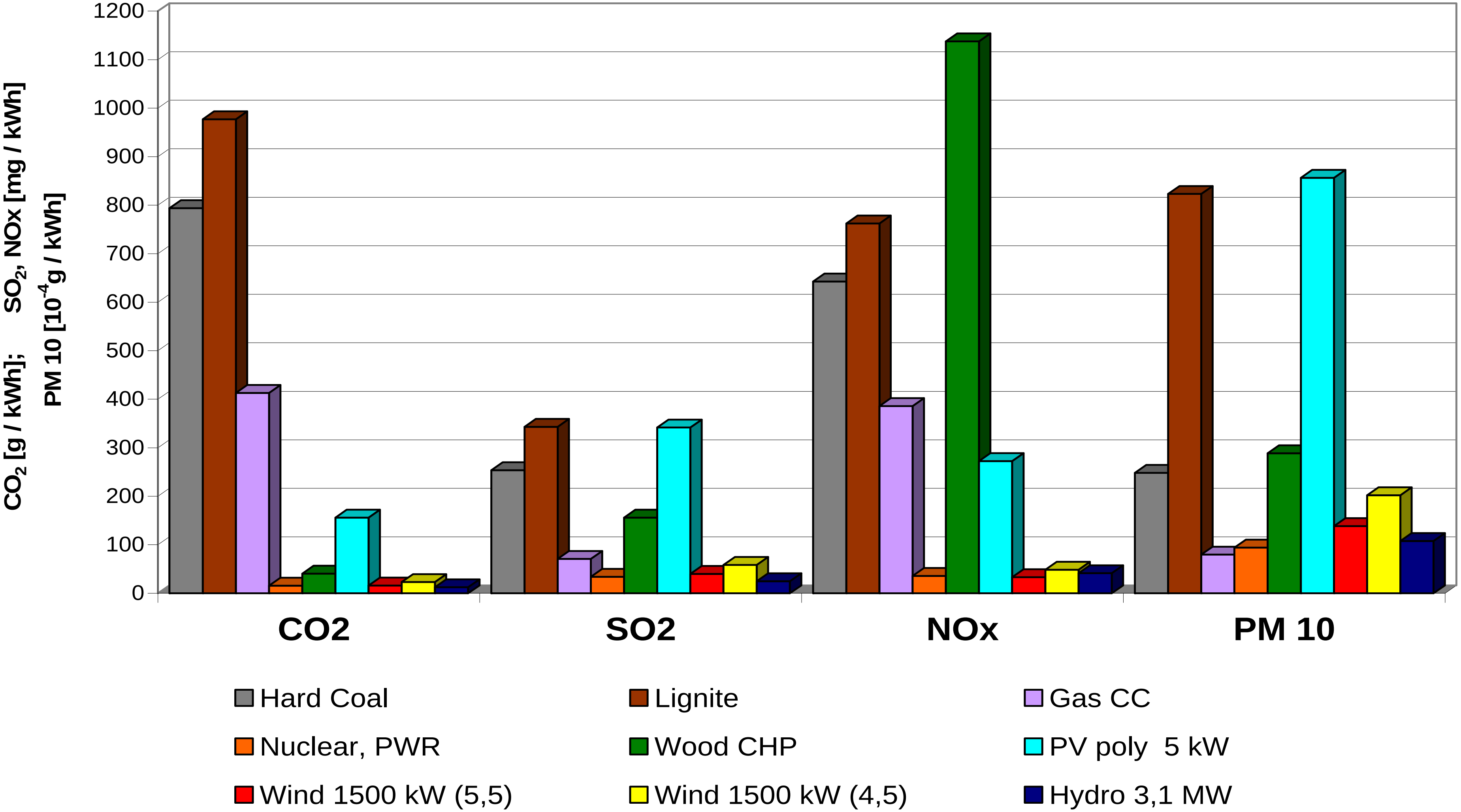
Quelle: IER 2005

Material and Resource Use

	Iron [kg/GWh$_{el}$]	Copper [kg/GWh$_{el}$]	Bauxite [kg/GWh$_{el}$]
Hard Coal	1.700	8	30
Lignite	2.134	8	19
Gas CC	1.239	1	2
Nuclear, PWR	457	6	27
Wood CHP	934	4	18
PV poly 5 kW	4.969	281	2.189
Wind 1500 kW (5,5)	3.066	52	35
Wind 1500 kW (4,5)	4.471	75	51
Hydro 3,1 MW	2.057	5	7

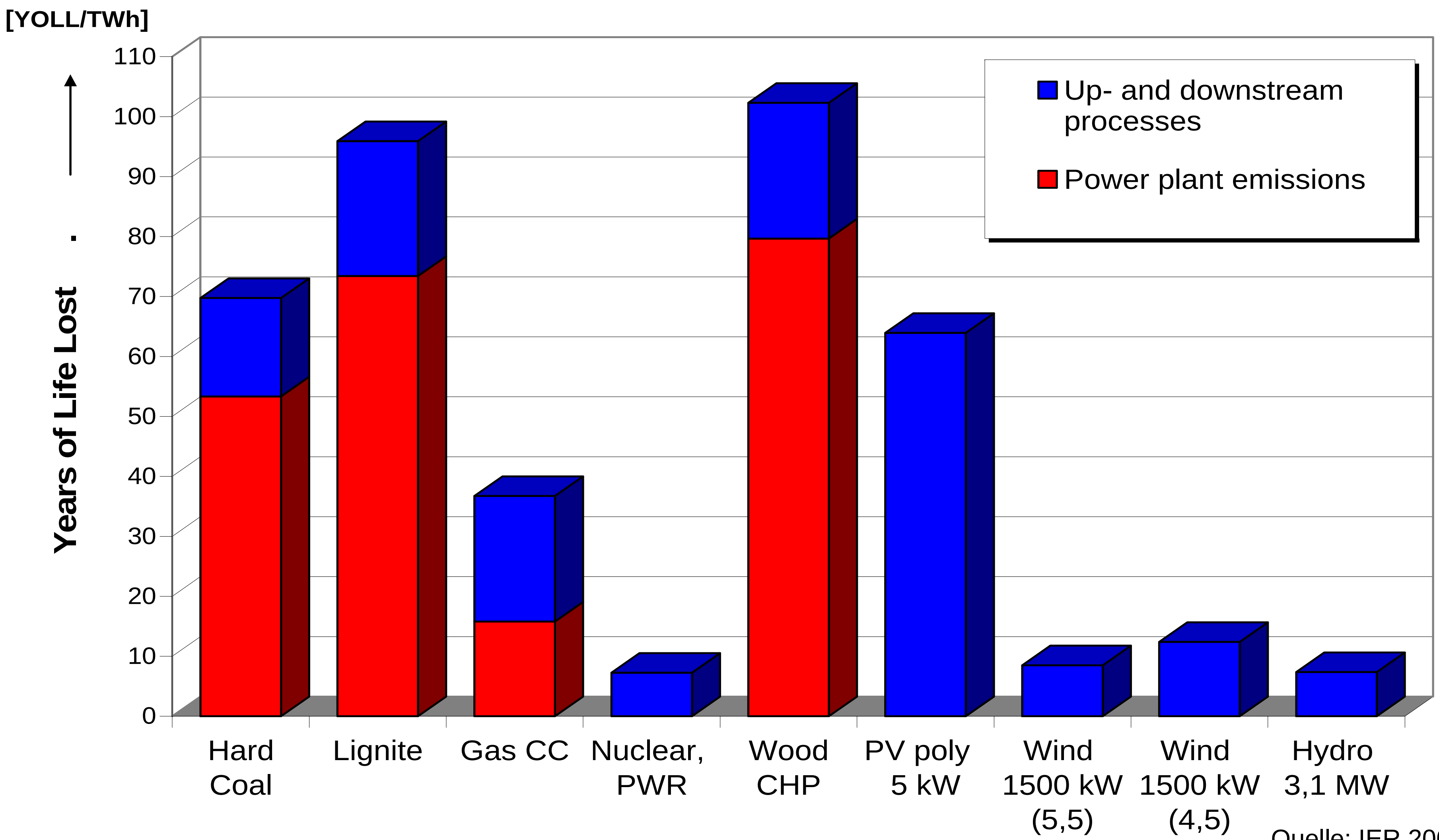
Quelle: IER 2005

Total Life Cycle Emissions



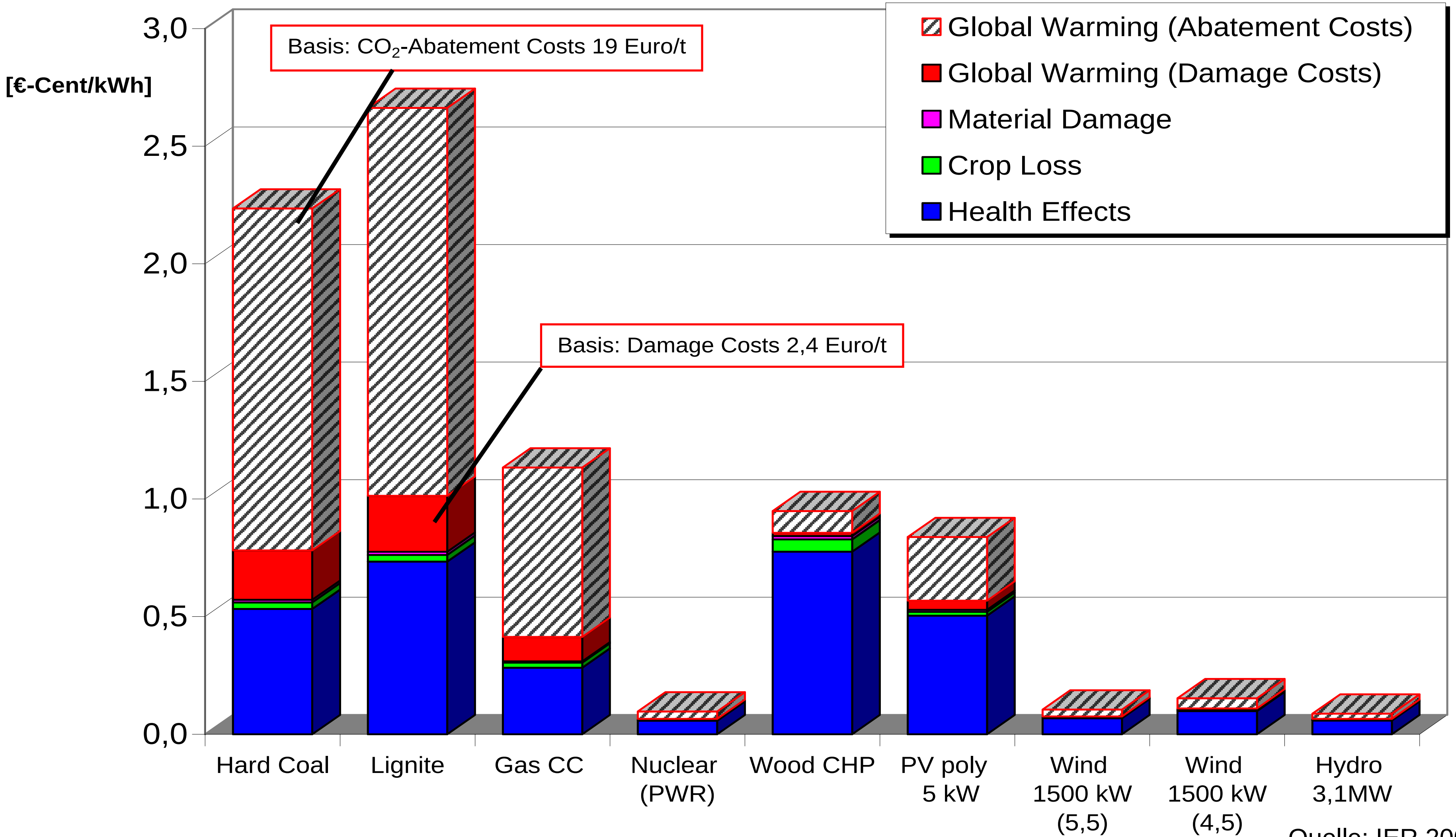
Quelle: IER 2005

Health Risks



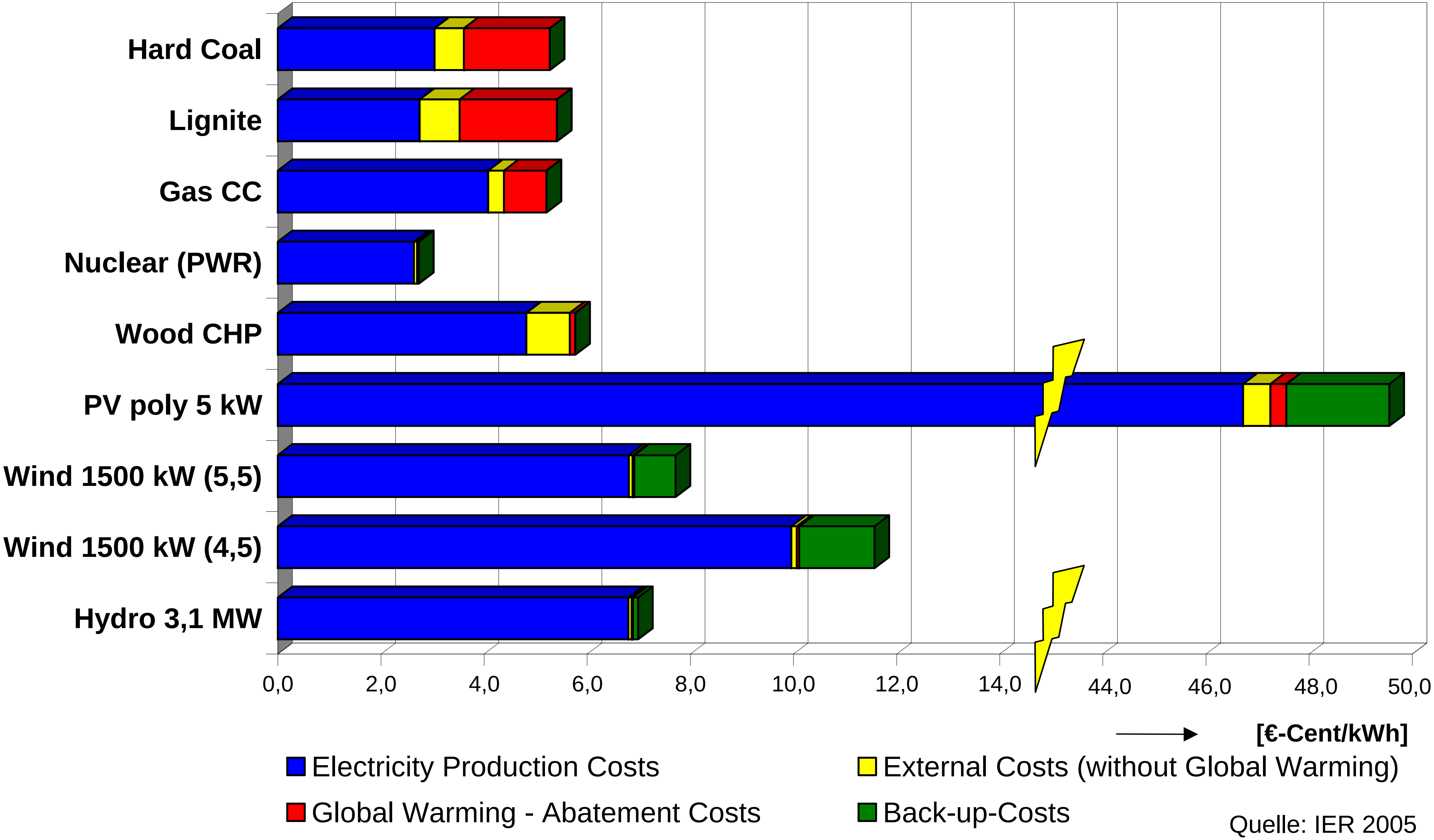
Quelle: IER 2005

External Costs



Quelle: IER 2005

Total Costs of Electricity Generation Technologies



Quelle: IER 2005


Thank you very much for your attention!