



VO Kernenergie und Umwelt
TU Graz

Eileen Langegger,

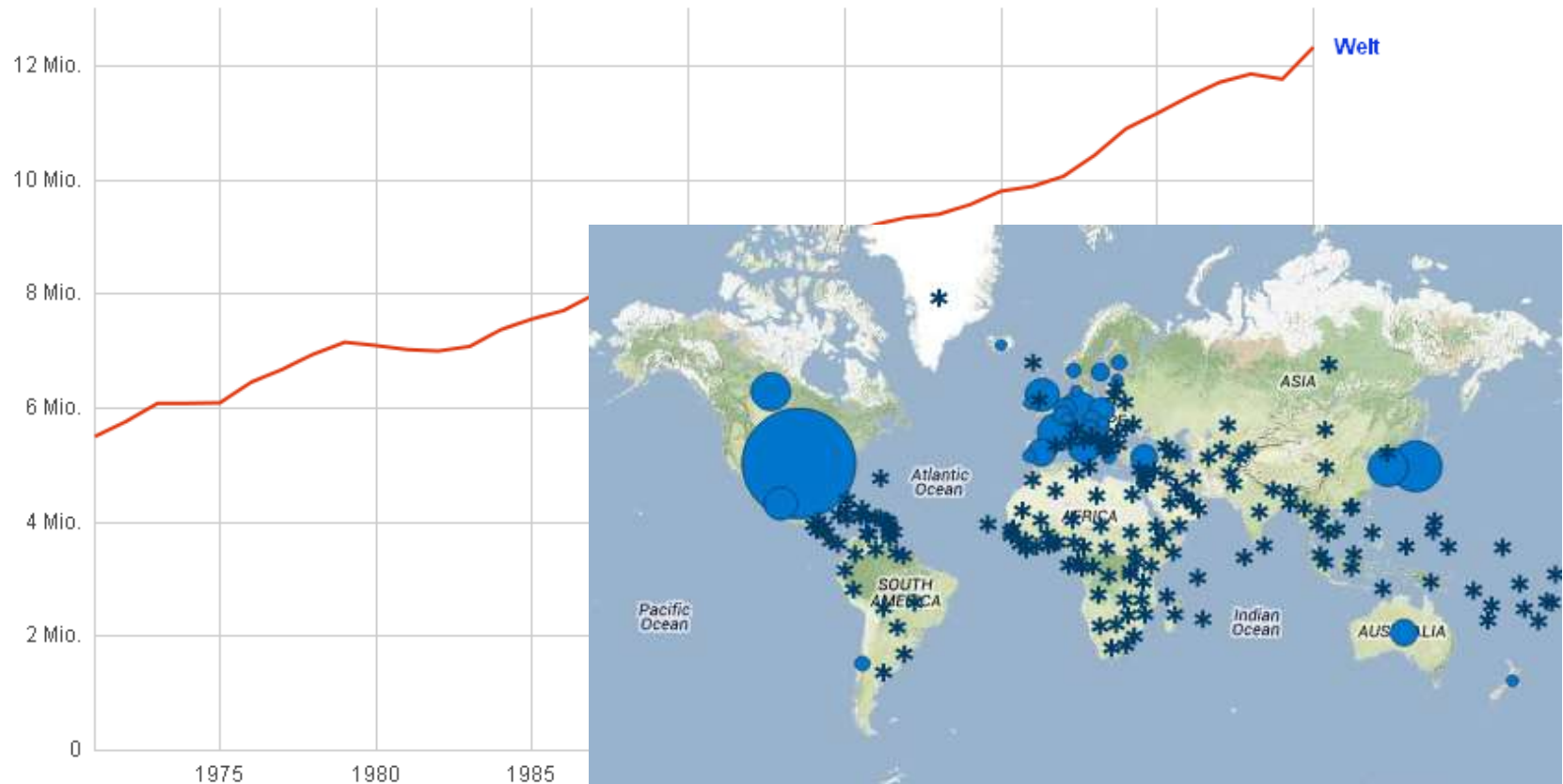


Module 13

Electricity generating costs



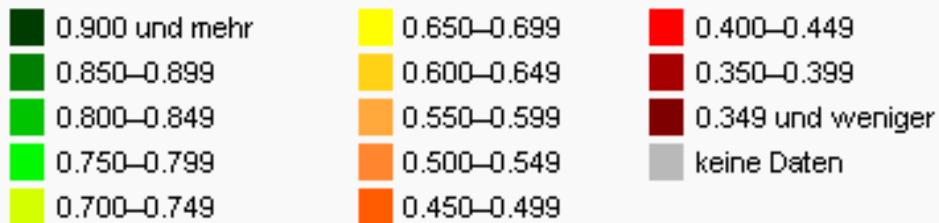
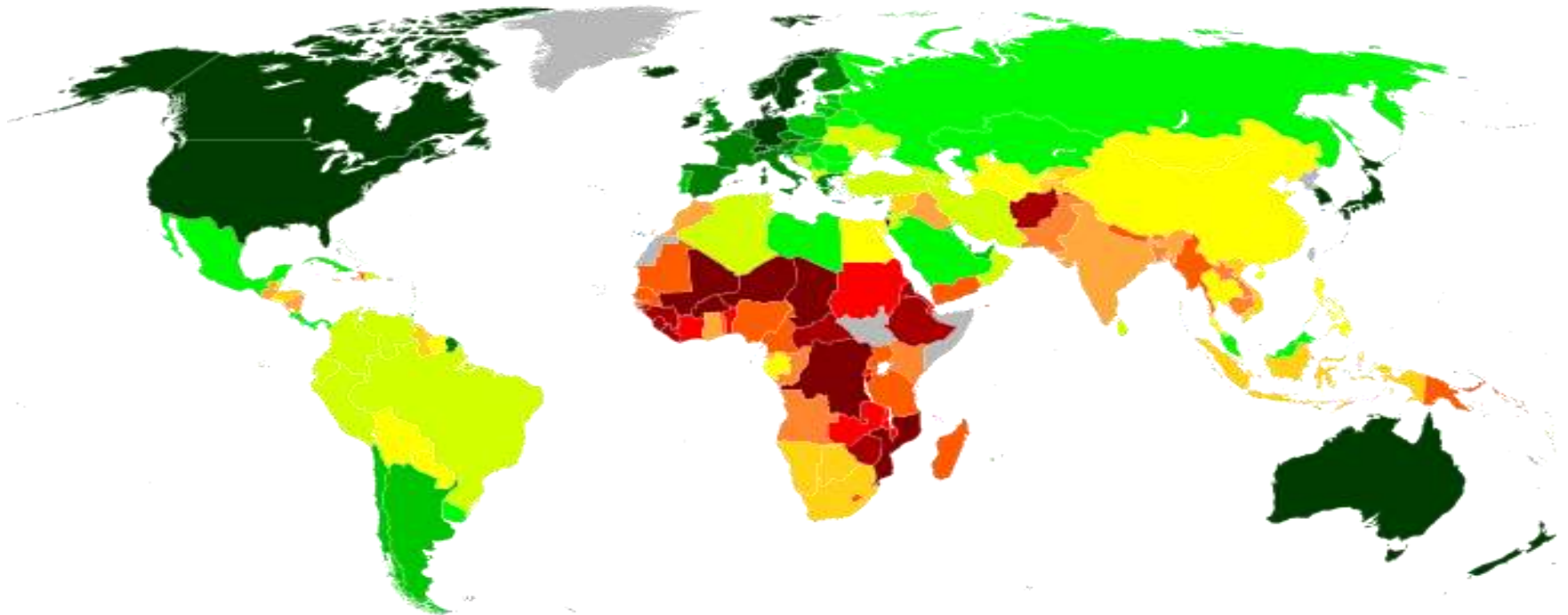
Energy Consumption



Energy consumption refers to primary energy before conversion into other fuels for final consumption.

Source: Weltbank

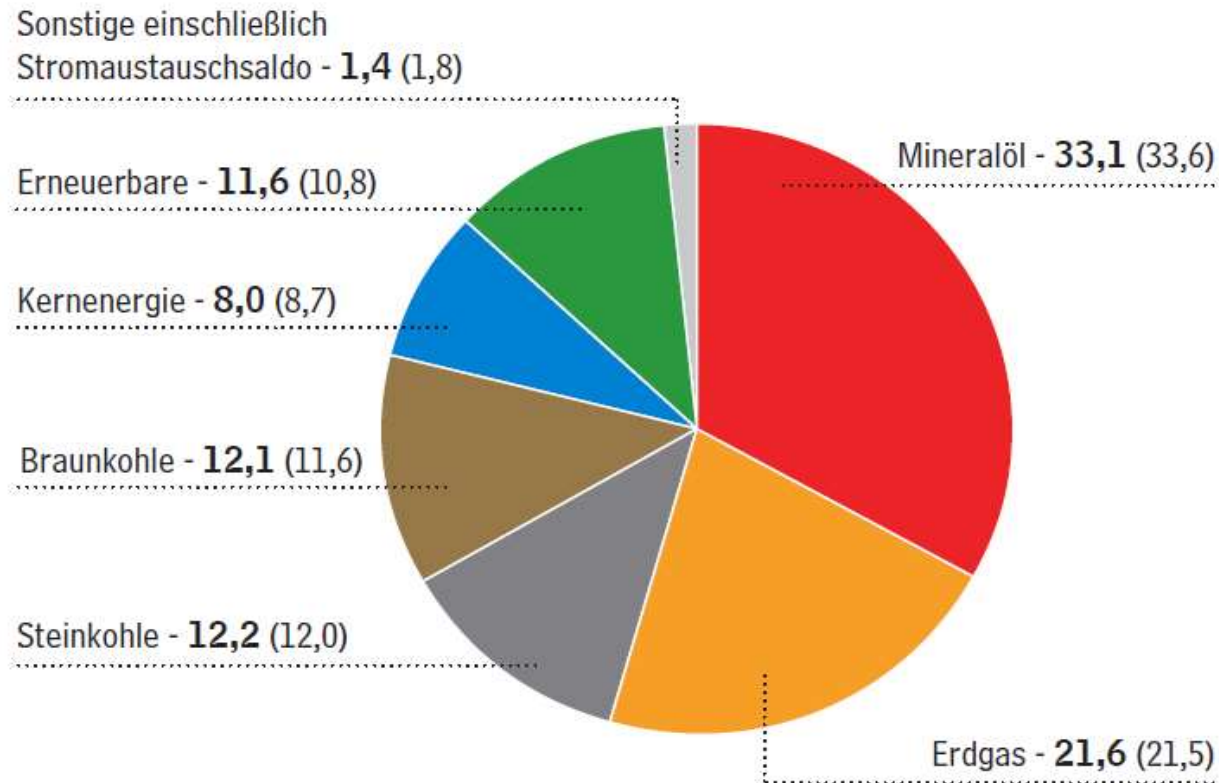
Human Development Index (HDI)



function:

- live expenctancy
- education
- GNI/capita

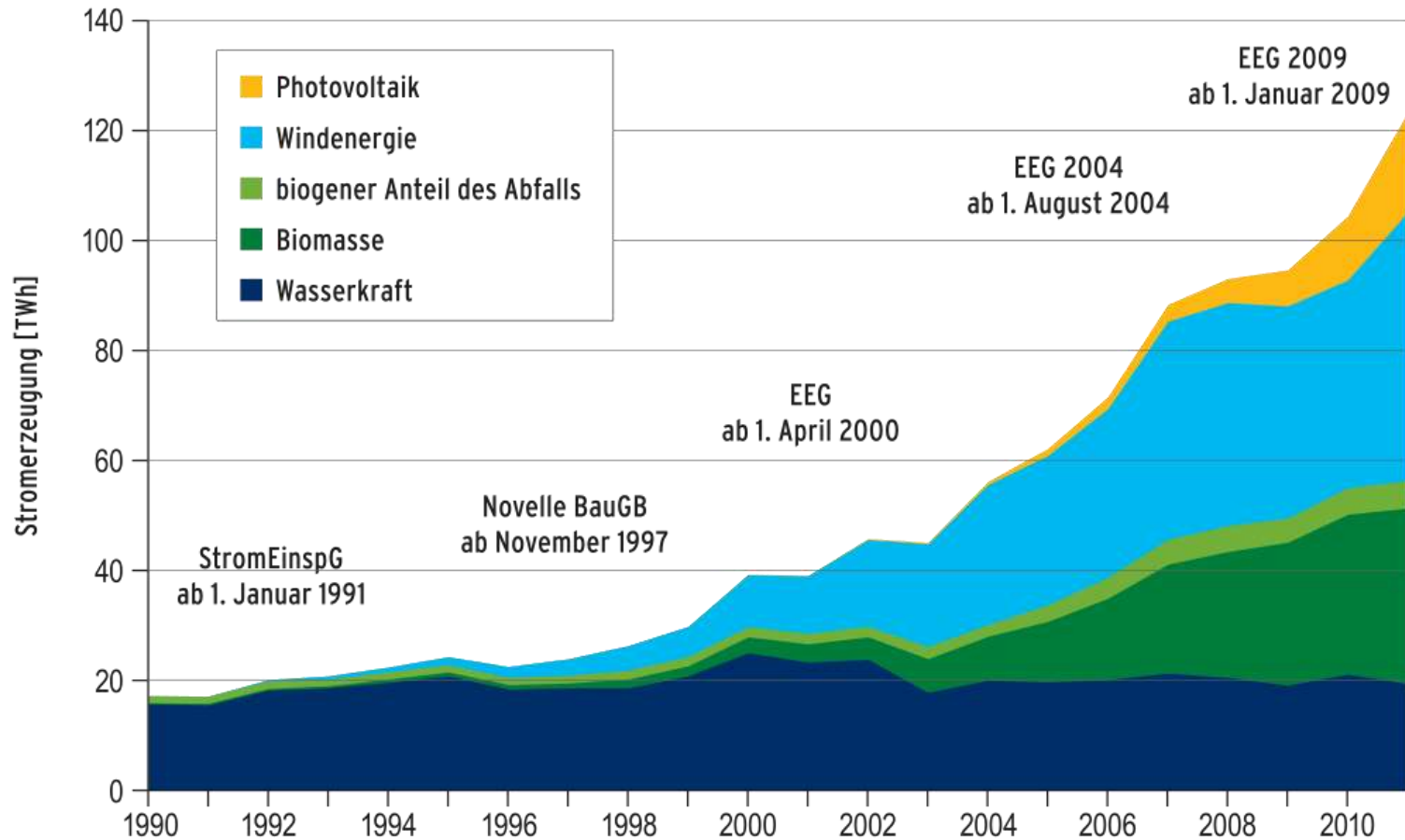
Energy Mix – Primary Energy Consumption (Germany 2012)



**approx. 4/5 of the energy supply comes
from fossil fuels**

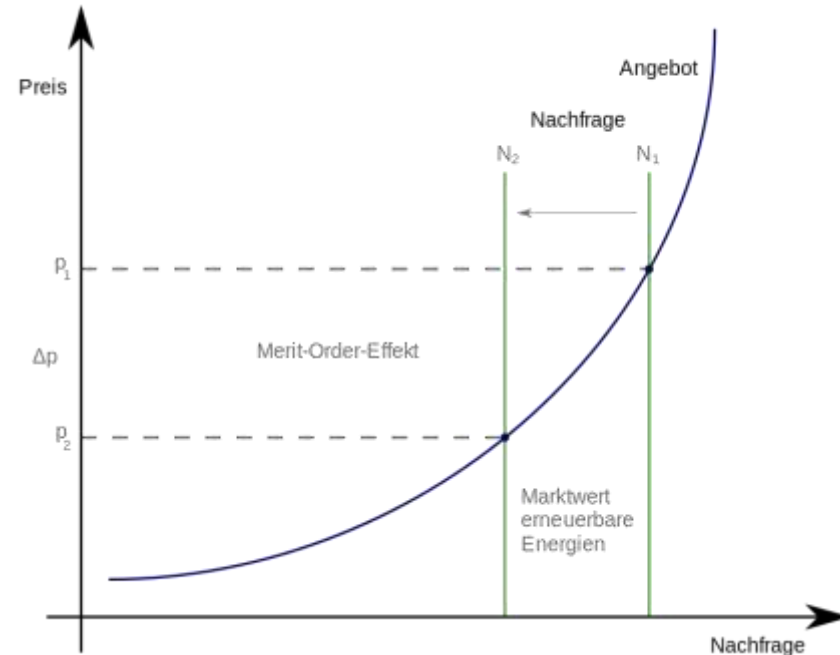
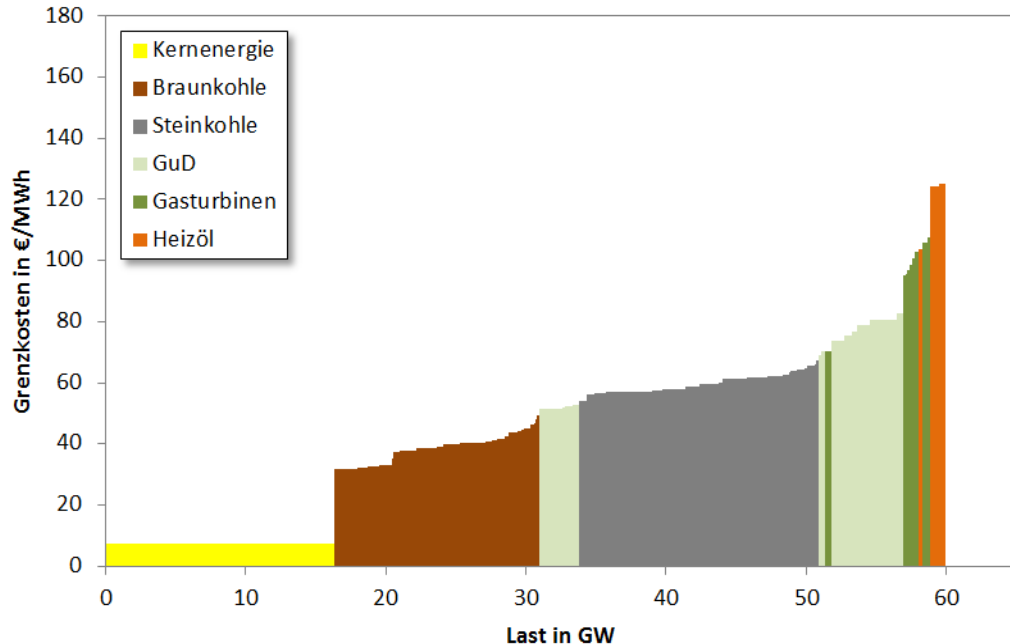
Source: AGEB, 2013

Gross Electricity Generation from Renewable Energies (Germany)



Comparison: 1 PWR $\sim 1,4 \text{ GW}_e$ produces
approx. 12 TWh/a

Merit-Order



Merit order effect: Displacement of expensive power plants by the entry of a power plant with lower marginal costs

⇒ Intervention and displacement by the "Renewable Energy Sources Act"



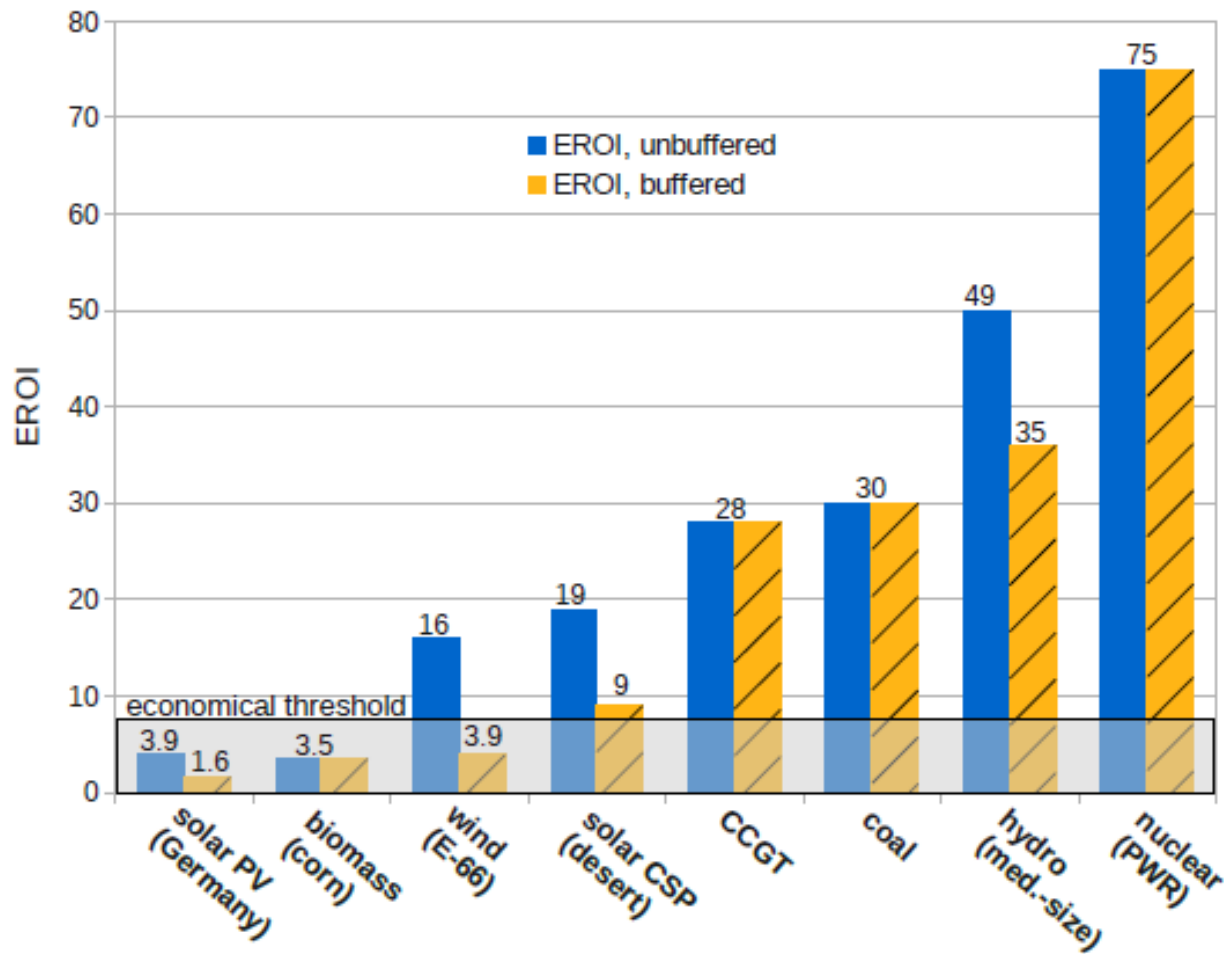
Energy Return on Energy Invest (EROI)

It is a distinct measure from energy efficiency.

Typ	Erntefaktor	Amortisationszeit
Druckwasserreaktor, 100 % Zentrifugenanreicherung	106	2 Monate
Braunkohle, Tagebau	31	2 Monate
Steinkohle, Untertagebau ohne Kohletransport	29	2 Monate
Gaskraftwerk (GuD), Erdgas	28	9 Tage
Gaskraftwerk (GuD), Biogas	3,5	12 Tage
Laufwasserkraftwerk	50	1 Jahr
Wüste, Parabolrinnen + Phenylverbindungen-Medium[3]	21	1,1 Jahre
1,5-MW Windkraftanlage (E-66), 2000 VLh (deutsche Küste)	16	1,2 Jahre
1,5-MW Windkraftanlage (E-66), 2700 VLh (deutsche Küste, Strand)	21	0,9 Jahre
200-MW-Park (5-MW-Anlagen), 4400 VLh (offshore)	16	1,2 Jahre
Poly-Silizium, Dachinstallation, 1000 VLh (Süddeutschland)	4	6 Jahre
Poly-Silizium, Dachinstallation, 1800 VLh (Südeuropa)	7	3,3 Jahre

$$EROEI = \frac{\text{Energy Delivered}}{\text{Energy Required to Deliver that Energy}}$$

Energy Return on Energy Invest (EROI)



Economically necessary EROI: ~ 7

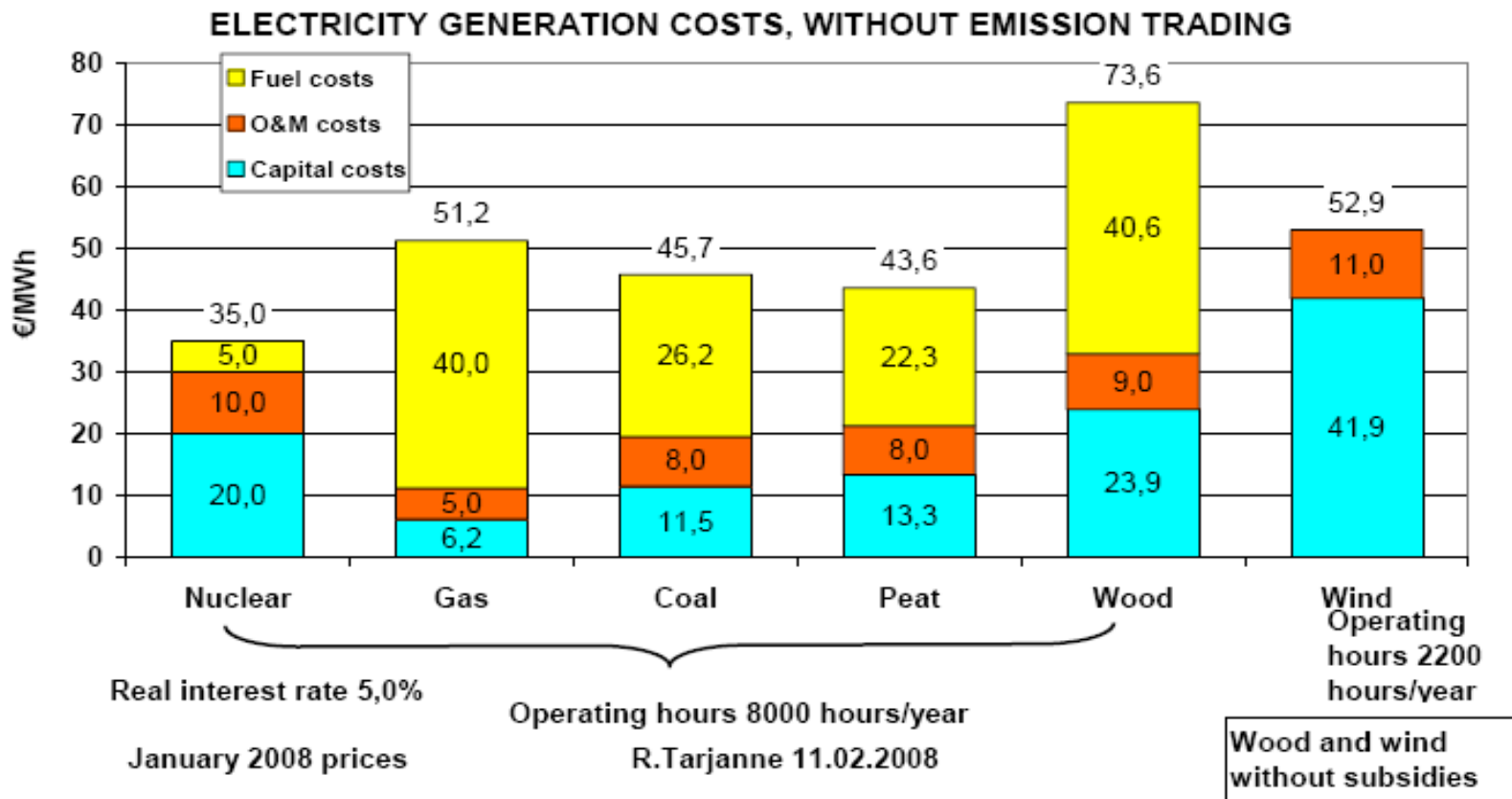
Performance and Costs of Different Electricity Sources

INPUT DATA

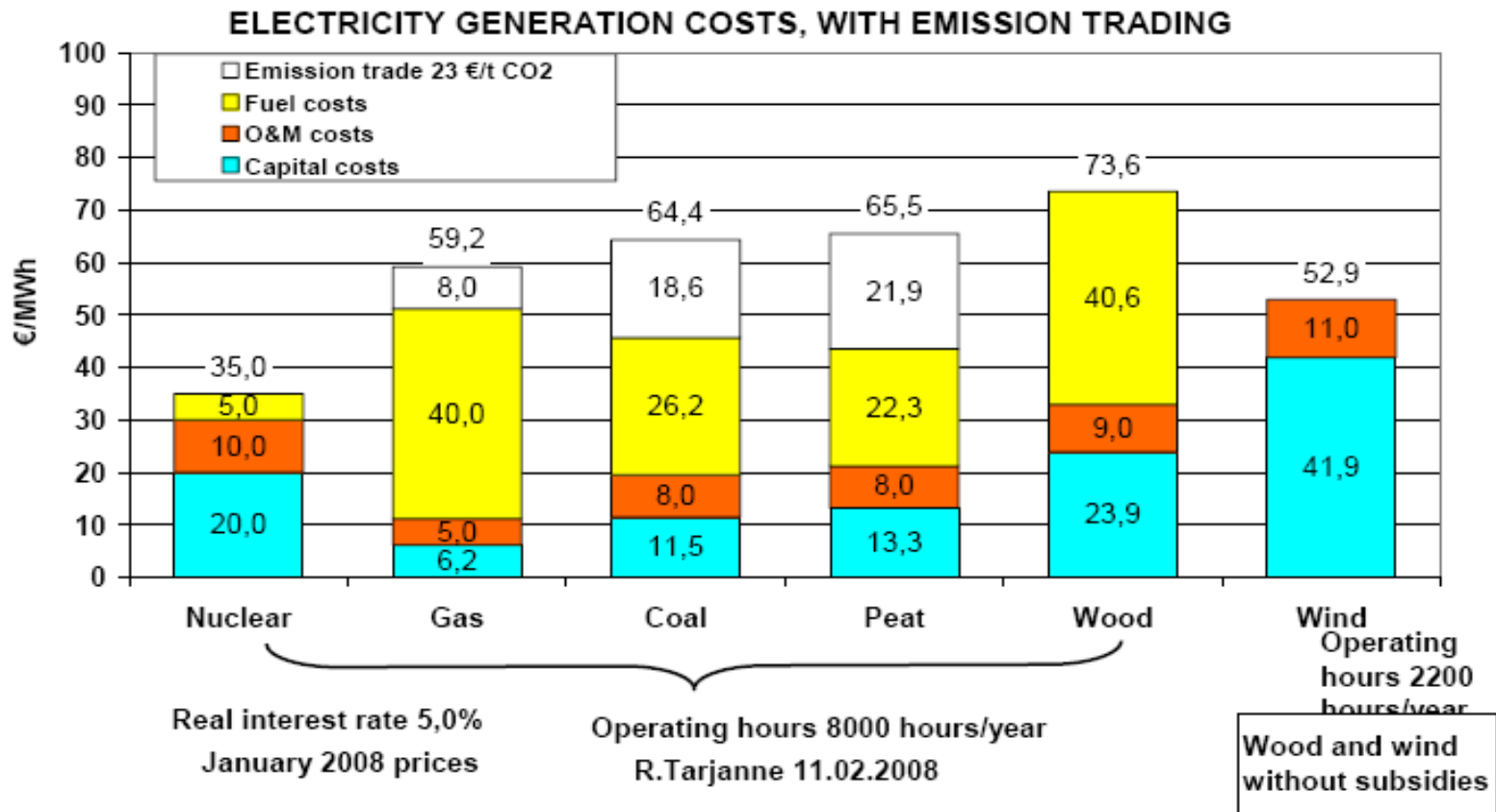
January 2008 prices

	NUCLEAR	GAS	COAL	PEAT	WOOD	WIND
ELECTRIC POWER [MW]	1500	400	500	150	30	3
NET EFFICIENCYRATE [%]	37 %	58 %	42 %	40 %	33 %	-
INVESTMENT COST [million €]	4125	280	650	225	81	3,9
SPECIFIC INVESTMENT COST [€/kW]	2750	700	1300	1500	2700	1300
FUEL PRICE [€/MWh]	1,85	23,20	11,00	8,90	13,40	-
FUEL COST OF ELECTRICITY PRODUCTION [€/MWh]	5,00	40,00	26,19	22,25	40,61	-
OPERATION AND MAINTENANCE COSTS, WHEN 8000 h/a [€/MWh]	10,00	5,00	8,00	8,00	9,00	11,00
SHARE OF VARIABLE O&M COSTS [%]	50 %	65 %	70 %	50 %	40 %	40 %
ECONOMIC LIFETIME [a]	40	25	25	25	25	25
REAL INTEREST RATE [%]	5,00 %	5,00 %	5,00 %	5,00 %	5,00 %	5,00 %
ANNUITY FACTOR [%]	5,83 %	7,10 %	7,10 %	7,10 %	7,10 %	7,10 %
EMISSION PRICE [t/CO ₂]	23	23	23	23	23	23
FULL LOAD UTILIZATION TIME [h/a]	8000	8000	8000	8000	8000	2200
CAPACITY FACTOR [%]	91,3 %	91,3 %	91,3 %	91,3 %	91,3 %	25,1 %

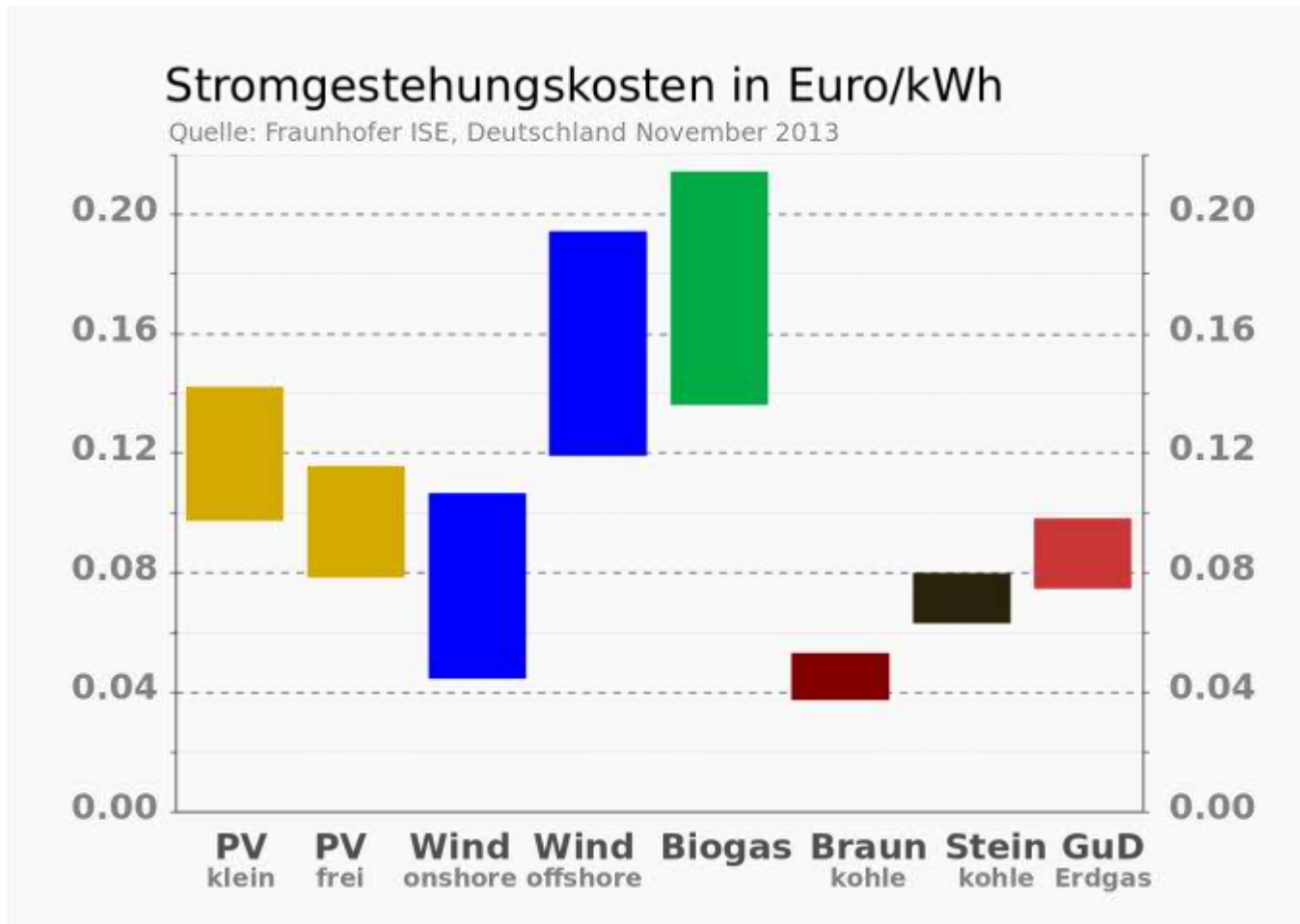
Electricity generating costs without emission trading (2008)



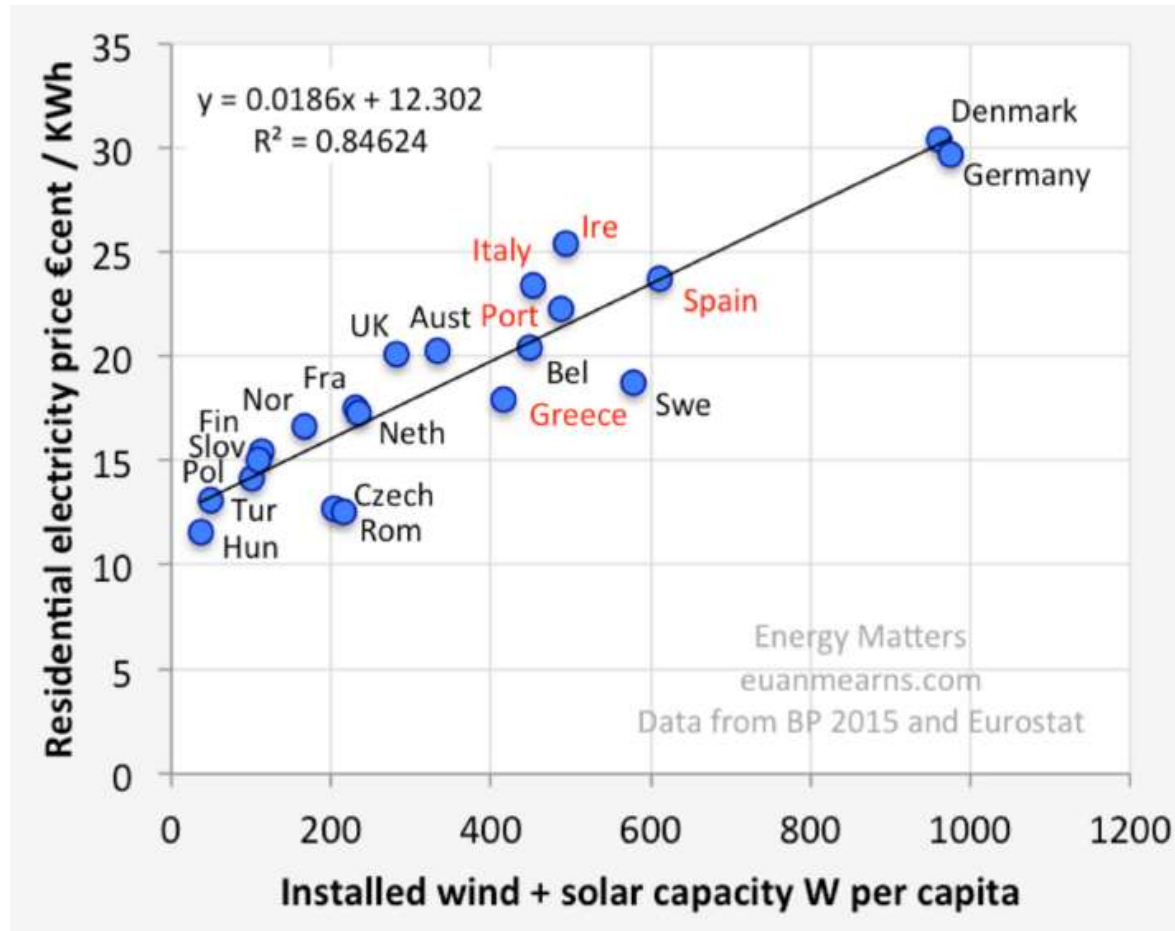
Electricity generating costs with emission trading (2008)



Electricity generating costs



Europe Electricity Price vs Installed Wind + Solar Capacity



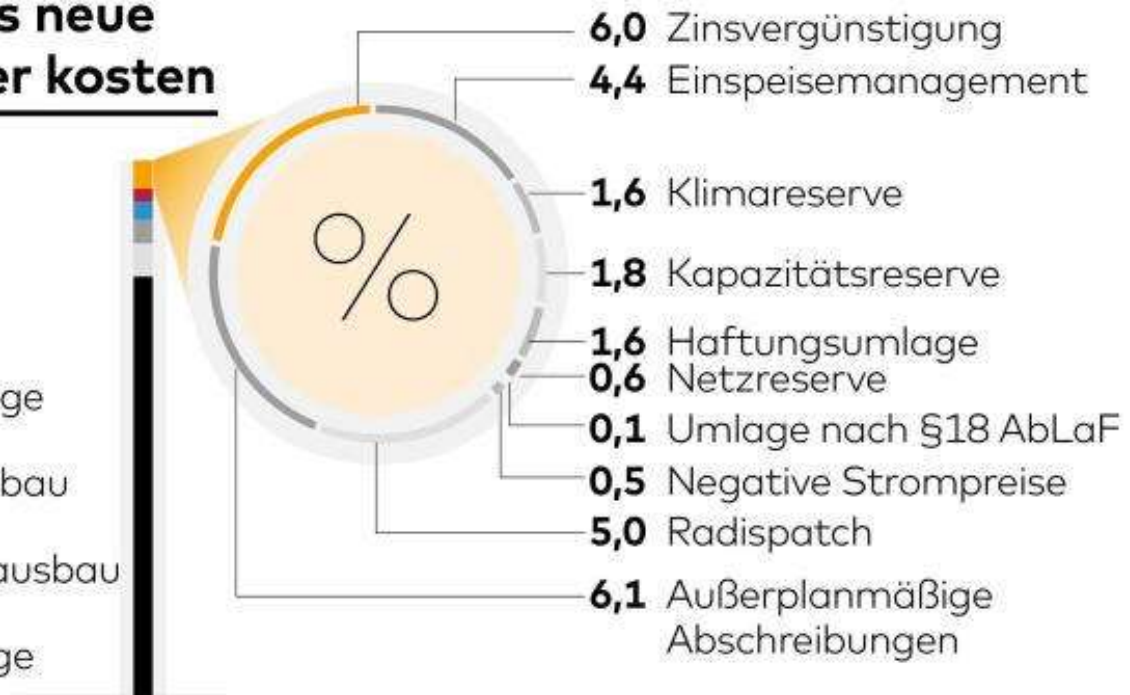
The Y-axis shows residential electricity prices for the second half of 2014 from Eurostat. The X-axis installed wind + solar capacity for 2014 as reported in the 2015 BP statistical review normalized to W per capita using population data for 2014 as reported by the UN.

Costs of the German „Energiewende“

So viel wird das neue Energiezeitalter kosten

- **27,6 Mrd. €**
Sonstiges
- **12,2 Mrd. €**
Forschungsausbau
- **18,0 Mrd. €**
KWK-Gesamtumlage
- **23,0 Mrd. €**
Verteilungsnetzausbau
- **32,3 Mrd. €**
Übertragungsnetzausbau
- **407,5 Mrd. €**
EEG-Gesamtumlage

WELT

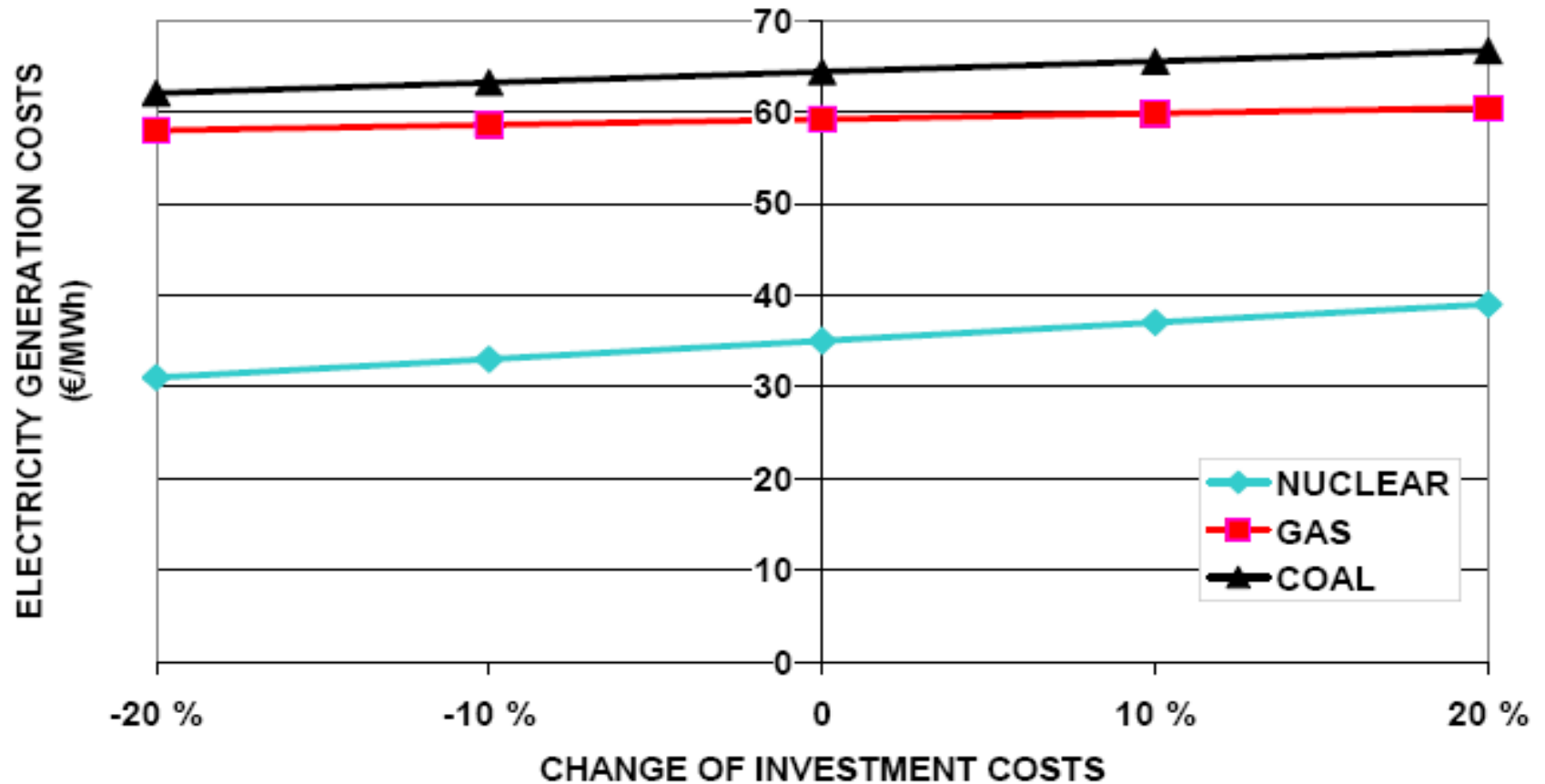


Quelle: DICE Consult GmbH

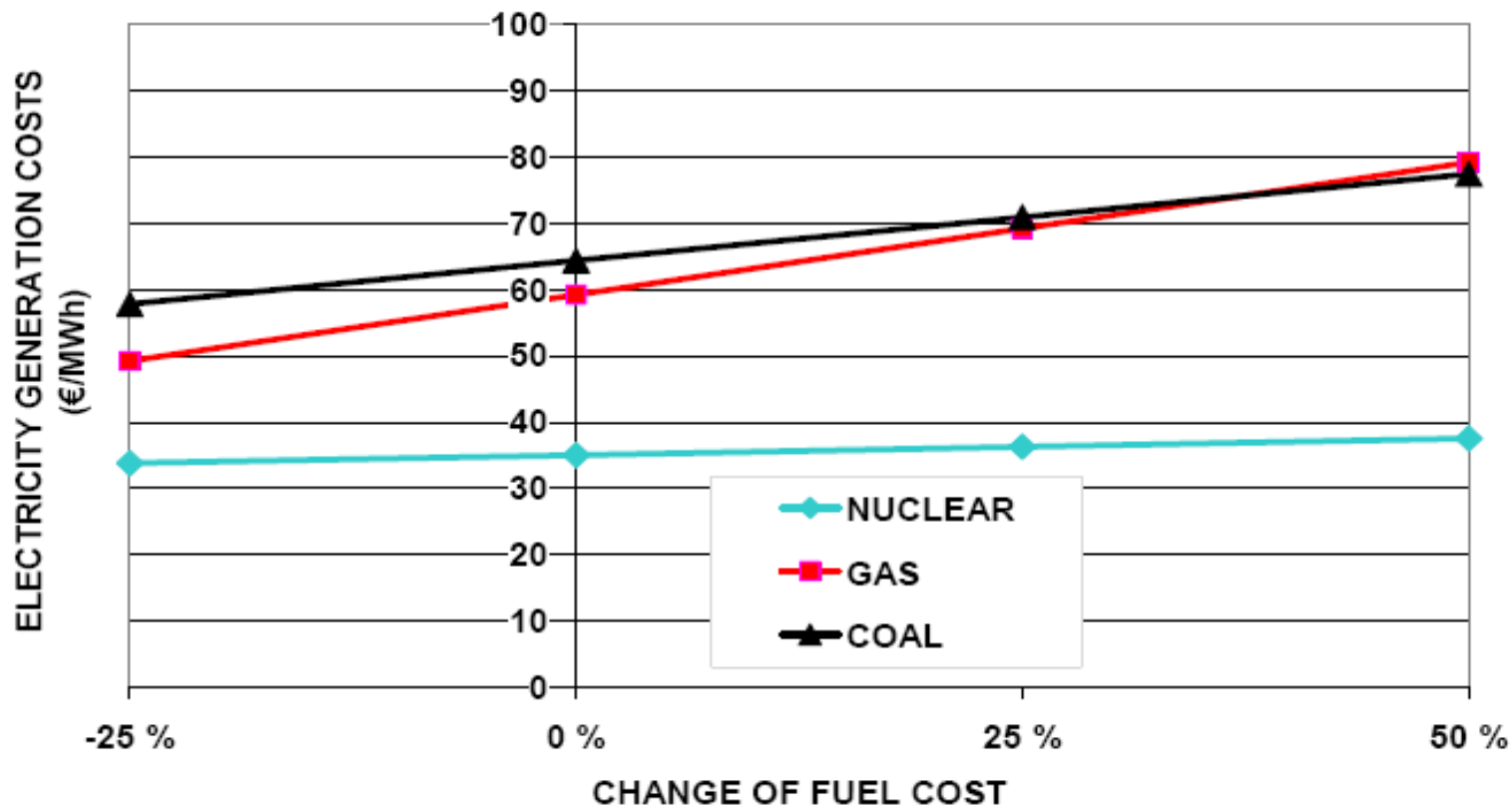
Estimated total costs of the „Energiewende“ in Germany between 2000 and 2025:
520 billion Euro (till 2016: ~ 167 bn)

Source: Infografik, „Die Welt“ vom 10.10.2016; Institut für Wettbewerbsökonomie, Düsseldorf (2016)

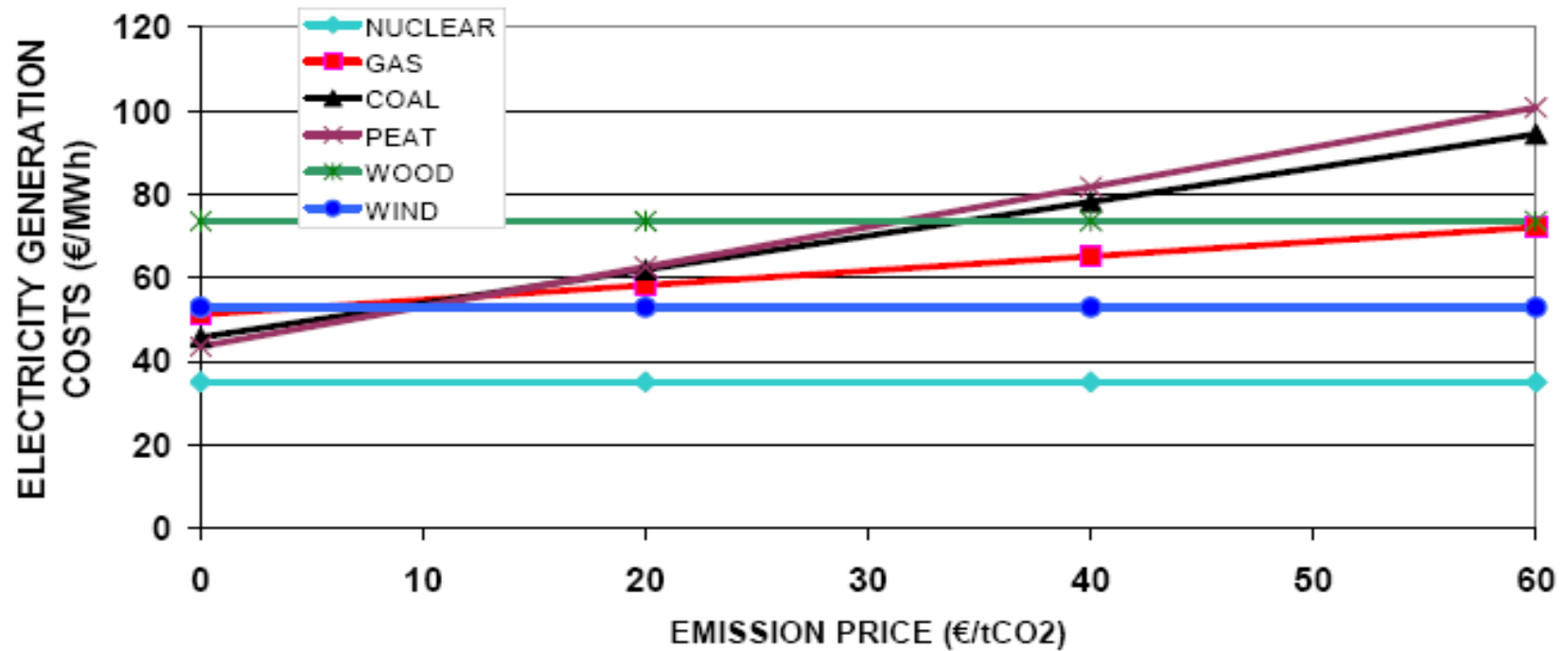
Impact of Investment Costs on Power Generation Costs



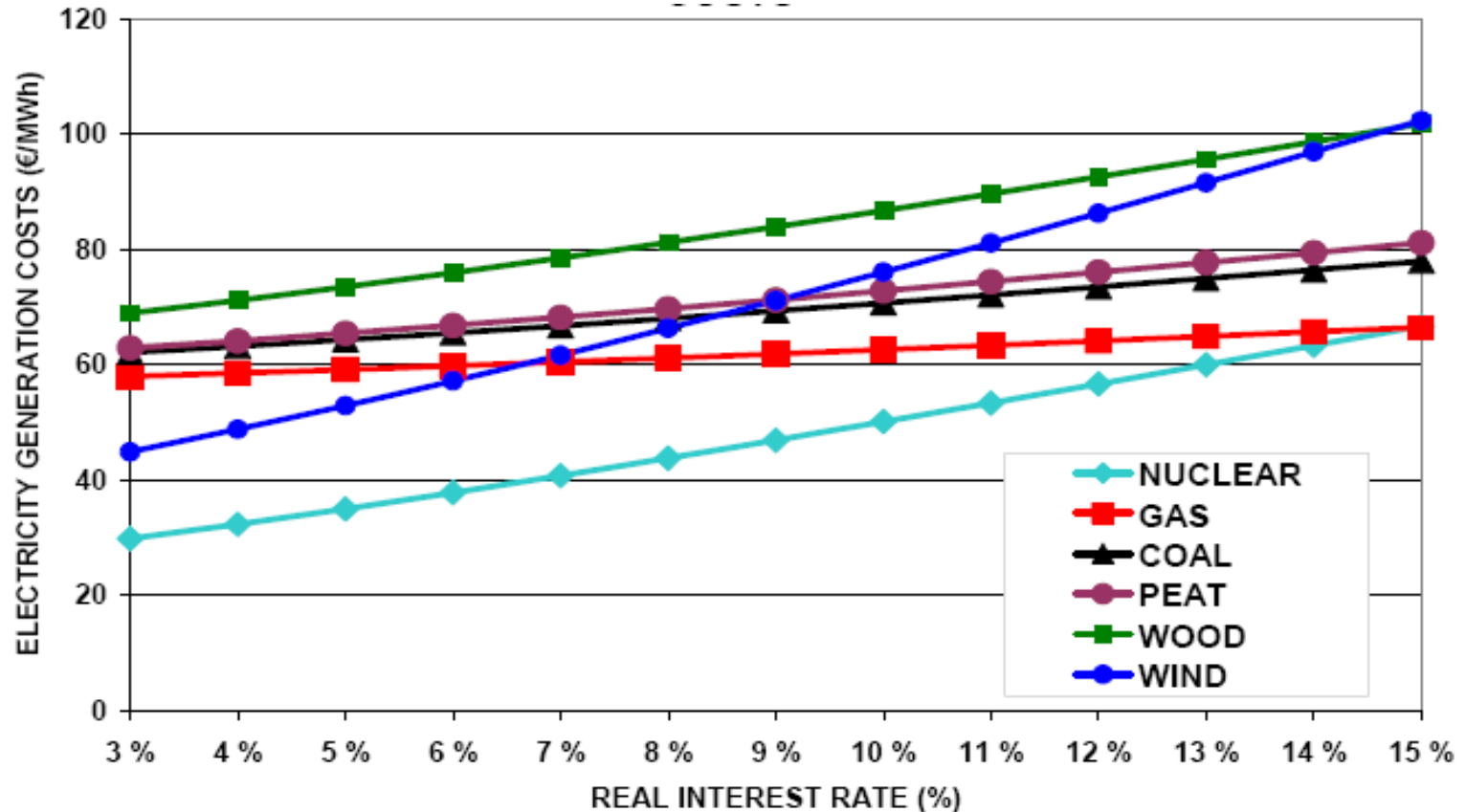
Impact of Fuel Costs on Power Generation Costs



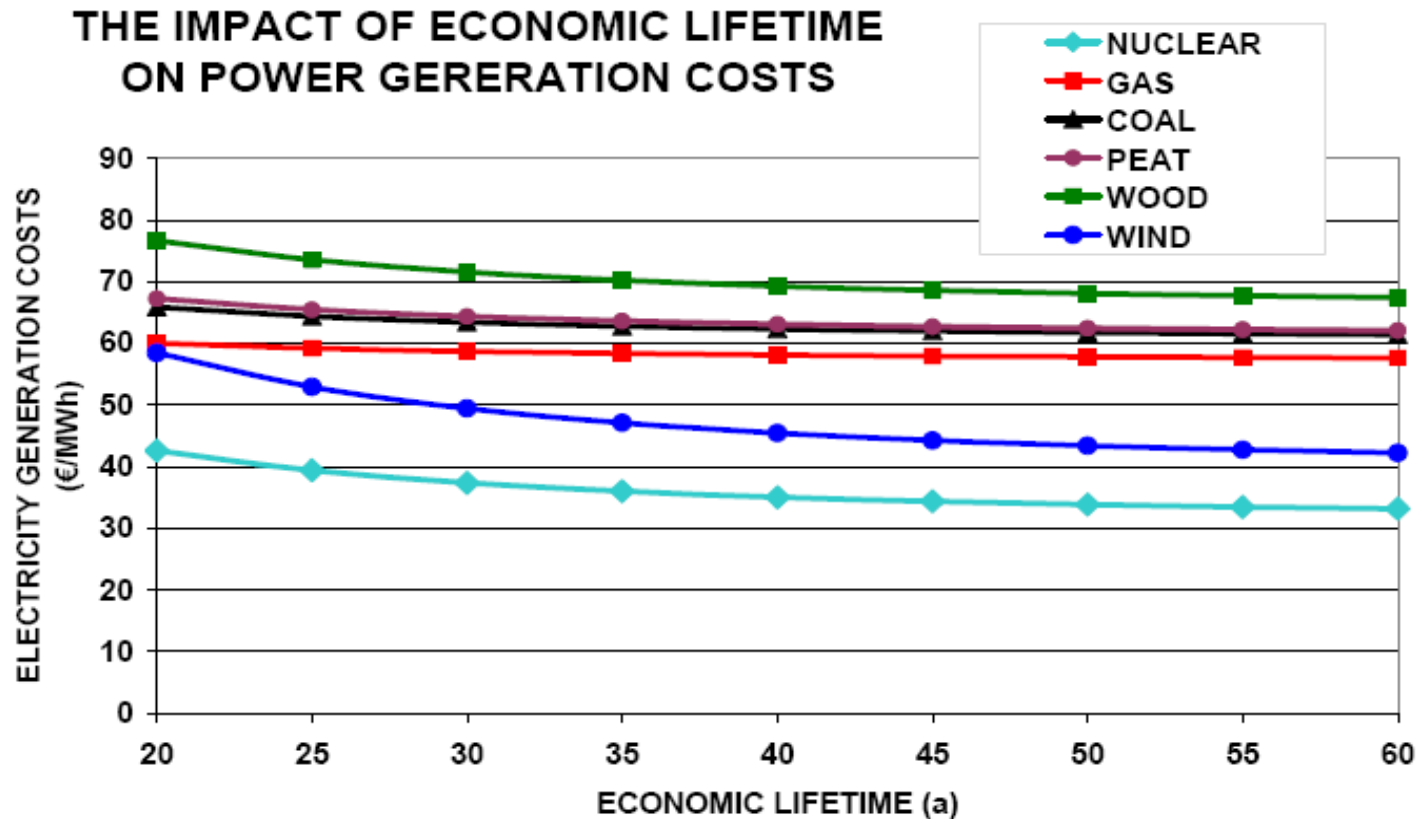
Impact of Emission Price on Power Generation Costs



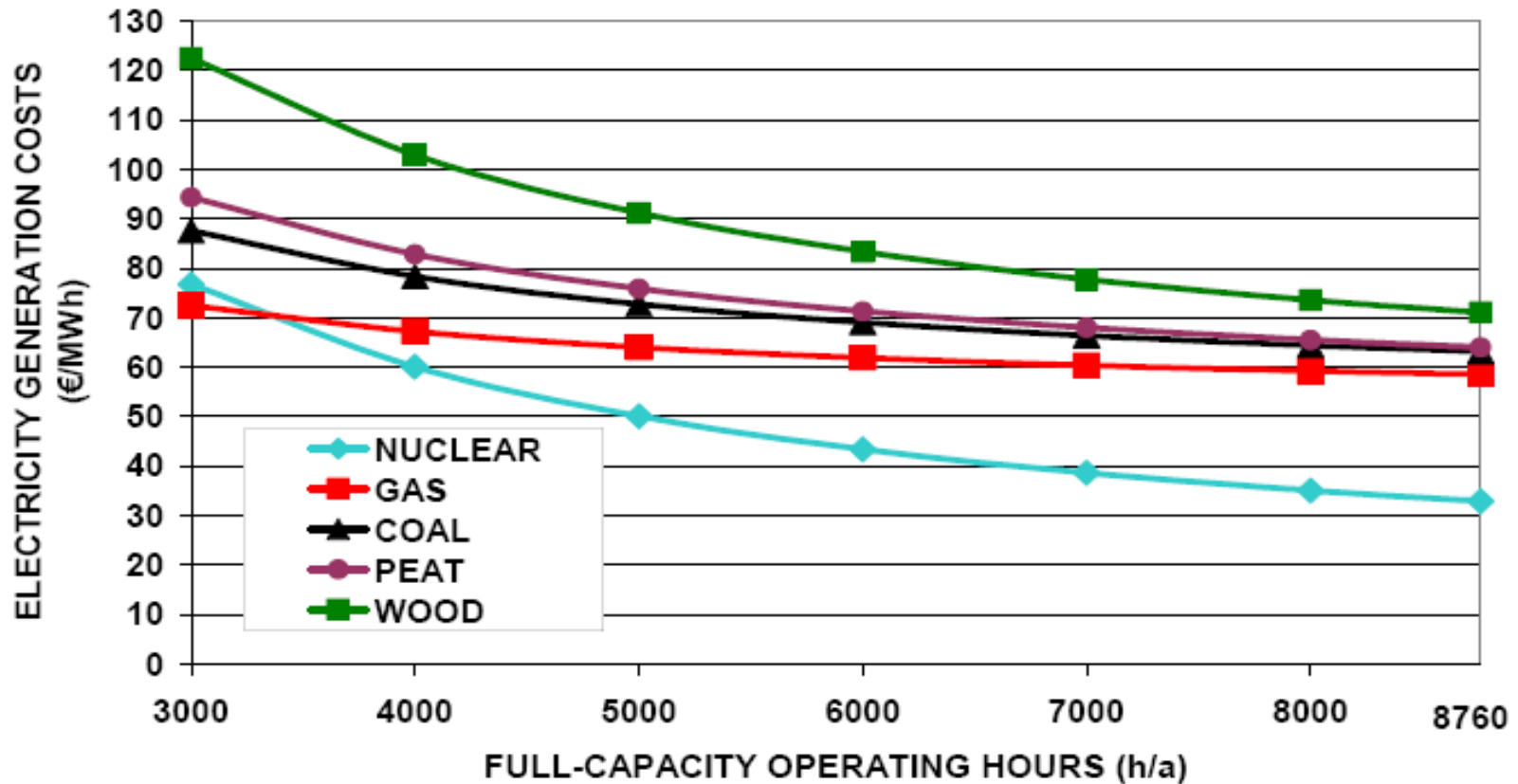
Impact on Interest Rate on Power Generation Costs



Impact of Power Plant Economic Life Time



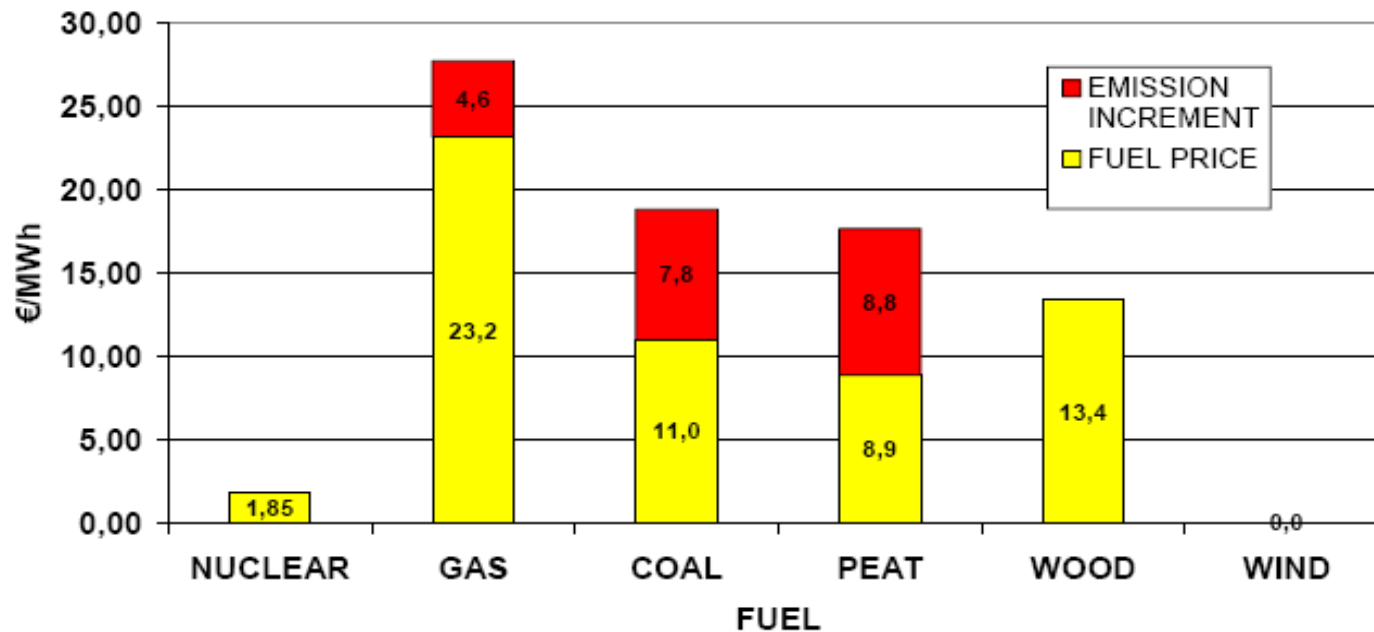
Impact of Full Capacity Hours on Power Generation Costs



Fuel Price & Increment due to Emission Price of € 23/to CO₂

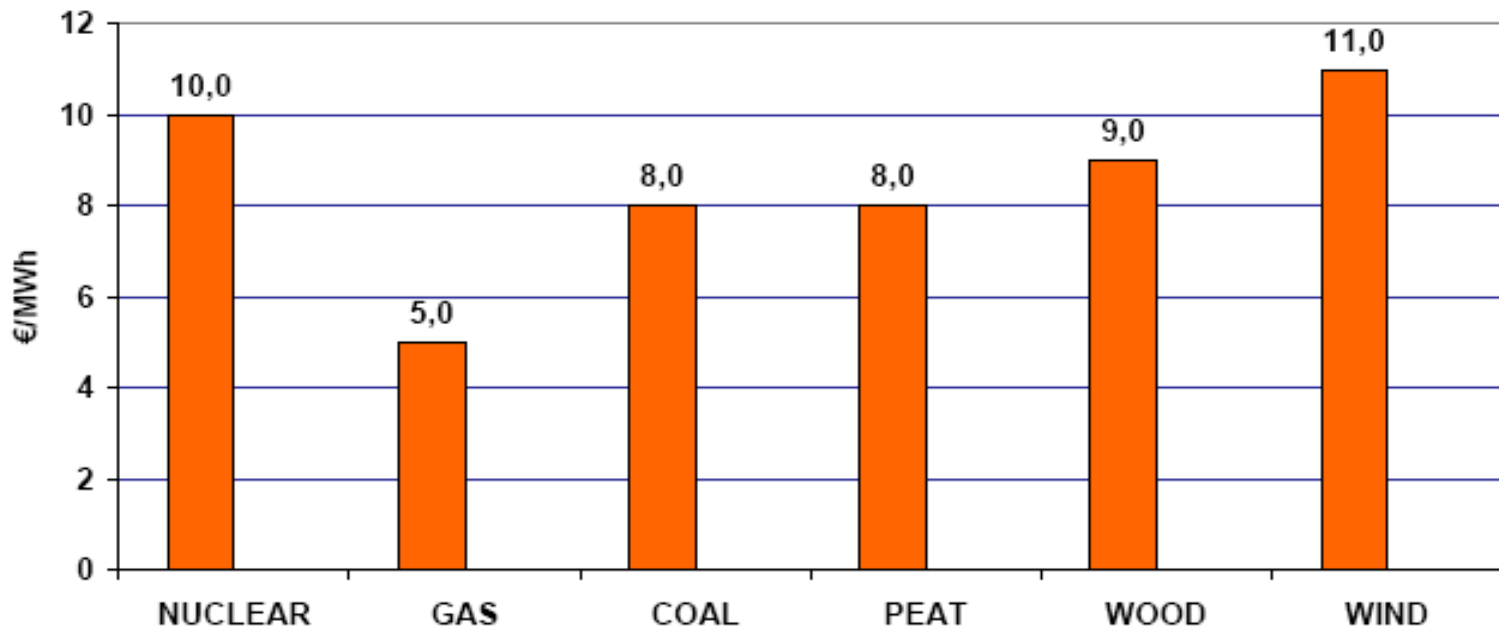
FUEL PRICE & INCREMENT DUE TO EMISSION PRICE OF 23 €/TON CO₂

January 2008



Operation and Maintenance Costs

(NUCLEAR WASTE MANAGEMENT COSTS ARE INCLUDED IN THE O&M COSTS. THEIR SHARE OF O&M COSTS IS ABOUT 25 %. THEY COVER THE COSTS OF MANAGEMENT OF SPENT FUEL, DECOMMISSIONING OF NPP AND LOW AND MEDIUM ACTIVE WASTE.)



References

1. Lappeenranta University of Technology: Faculty of Technology Department of Energy and Environmental Technology, Research report EN A-56
2. www.world-nuclear.org/info/inf02.html

