Energie-Mix der Zukunft

Role of Electricity

Franz Bauer, VGB PowerTech

Energie-Bedarf und Verbrauchsstrukturen

Effizienz ist entscheidend für

Bedarf & Versorgung

Energie-Bedarf und Verbrauchsstrukturen

- Aufgabenstellung & Gliederung
- Allgemeine Rahmenbedingungen
- Bedarf Stand & Perspektive
  Primärenergie Portfolio
- Technologie Optionen
- Ausblick

Fragenstellung

- Wie sieht unser Energiebedarf, Primärenergie und Strom in 2030 bzw. 2050 aus?
- Wie sieht die Struktur der Stromerzeugung in 2030 bzw. 2050 aus?
- Welchen Einfluss hat die Erfüllung der Klimaziele auf unsere Wirtschaft als Ganzes?
- Gibt es vernünftige Lösungen, all diese Anforderungen zu erfüllen?

→daraus leitet sich die Frage ab:

- **Welche Aufgabe hat in diesem Zusammenhang die Stromversorgung?**
  - **Welche Auswirkungen haben auf der Bedarfsseite neue Anwendungs-Technologien bzw. veränderte Gebrauchsgewohnheiten?**
  - **Welche Möglichkeiten bestehen auf der Versorgungsseite – bezogen auf den Brennstoff und die entsprechende Technologie**
  - **Wie sind die gesamtwirtschaftlichen Zusammenhänge - heruntergebrochen auf die einzelnen Länder der EU**

...entsprechend der Fragestellung gliedert sich die Vorgehensweise (Role of Electricity) in

- **Bedarfs-Analyse - heute und morgen**
- **Untersuchung künftiges Technologie-Portfolio**

  bezogen auf Verbraucher & Versorger Seite
- **Modellierung wirtschaftlichen & technischen Zusammenhänge mittels Szenario - Analyse**

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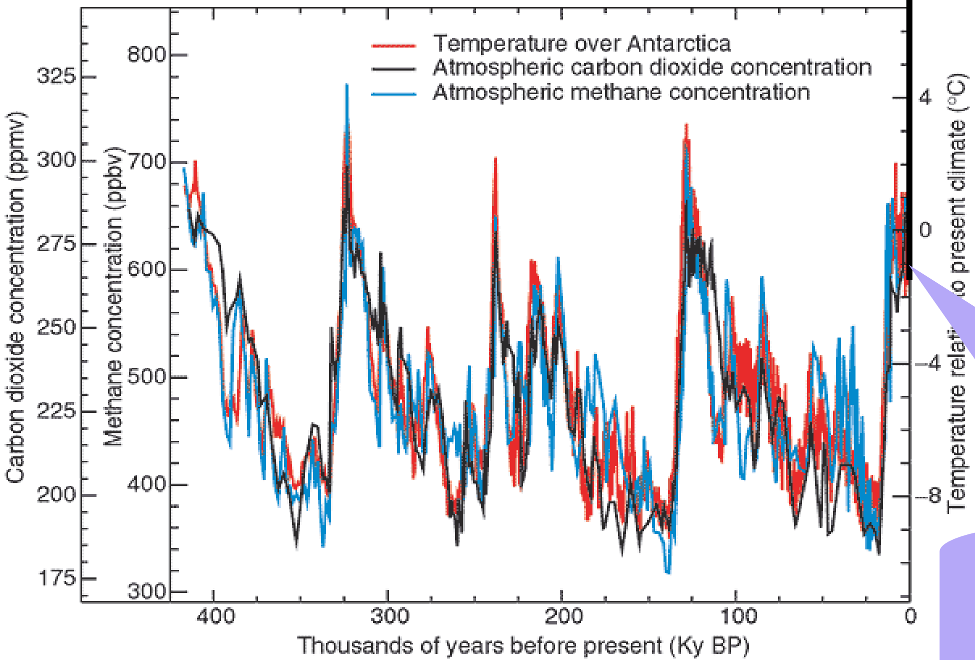
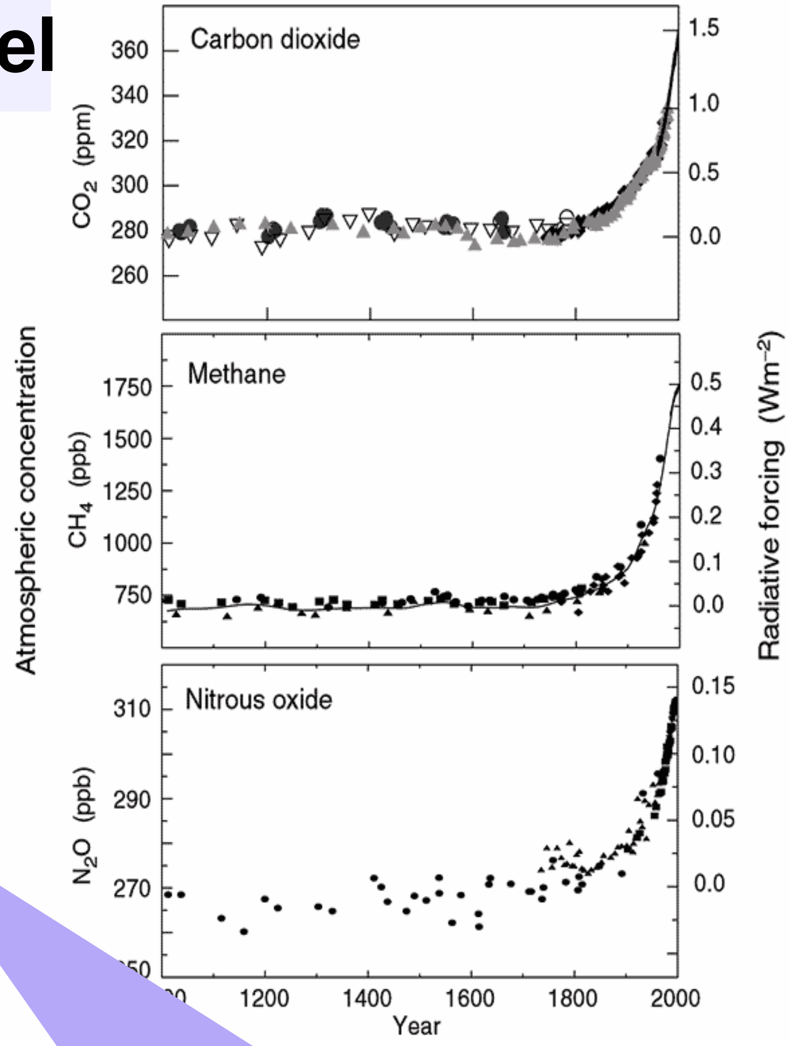
Herausforderung Klima Wandel

Composition of the Atmosphere has been changed in the last Century more than the Centuries before

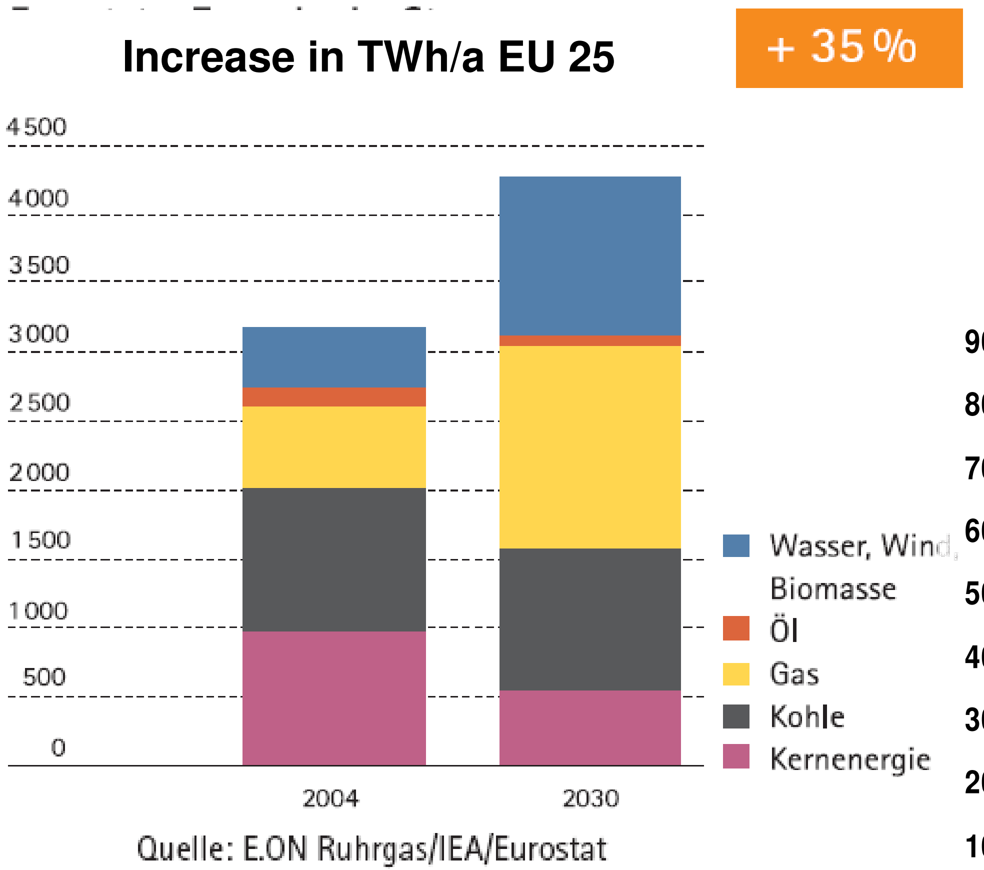
anthropogenic Changes in the Composition of the Atmosphere causes an Unbalance of a complex System

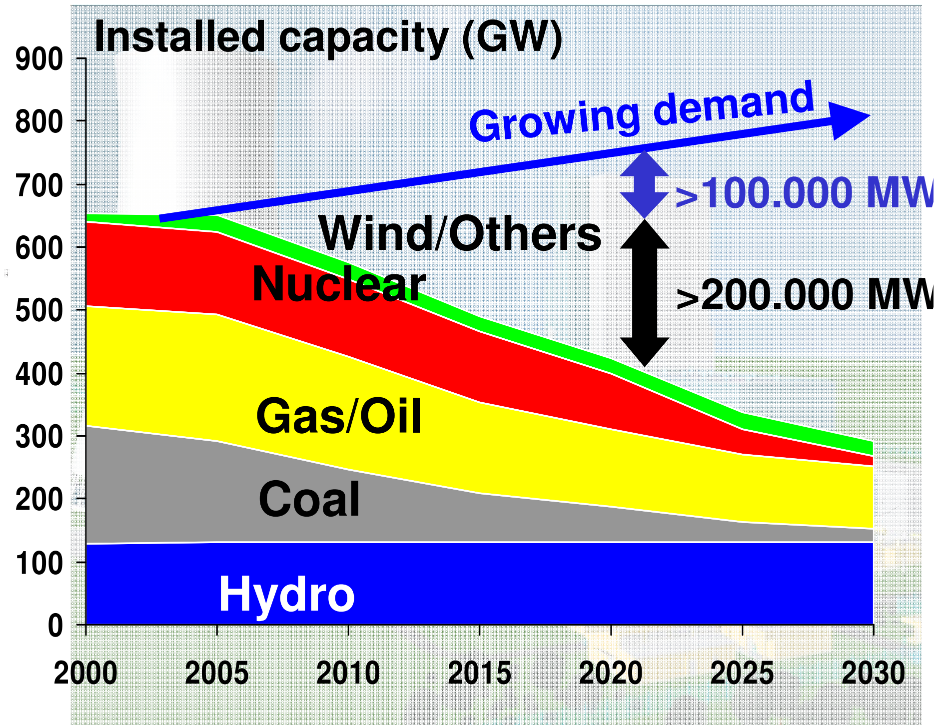




within the Scale of Geology the Changes have a high Velocity

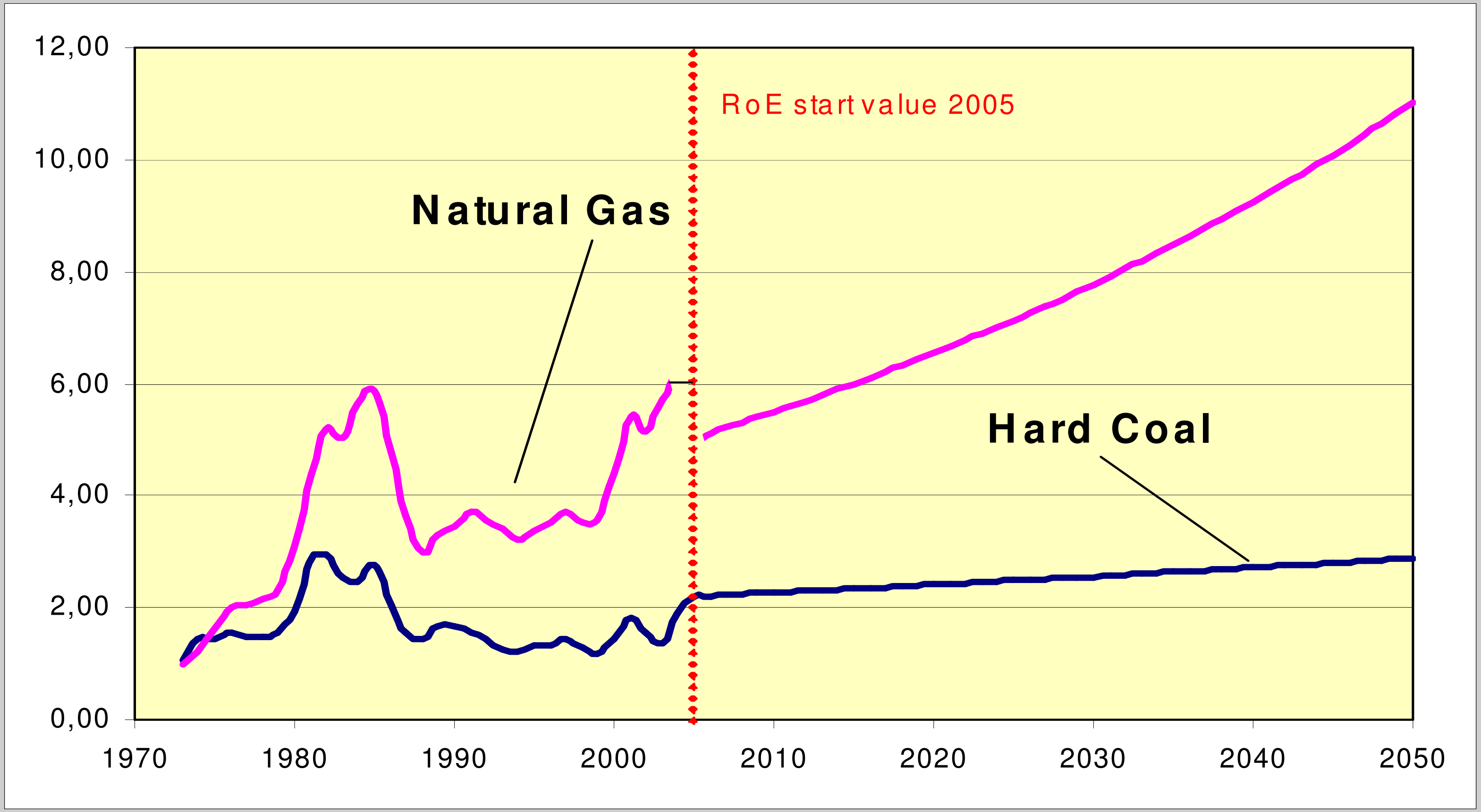
Expected Growth of Electricity Demand And the Need for new Generation capacity





Forecast of Fossil Fuel up to 2050

according IEA Outlook



Europäische Energie - Politik

Beschluss des Europ. Rates vom März 2007Dezember 2009

- **EU to advocate a 30% reduction in GHGs by industrialised nations by 2020 (of 1990 levels)**
- **Unilateral EU target 20% reductions in GHG by 2020**
- **Binding target for renewables: 20% of total EU energy consumption by 2020**
  - **10% binding target for bio fuels**
  - **No sector-specific targets for electricity or H/C**
- **Energy efficiency Improvement overall: 20% by 2020**
- **Emission Trading Scheme with 2013, 100% auctioning**
- **Carbon Capture Storage including Funding Scheme**

Energie-Bedarf und Verbrauchsstrukturen

- Aufgabenstellung & Gliederung
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Bedarfsstrukturen - Einfluss Faktoren

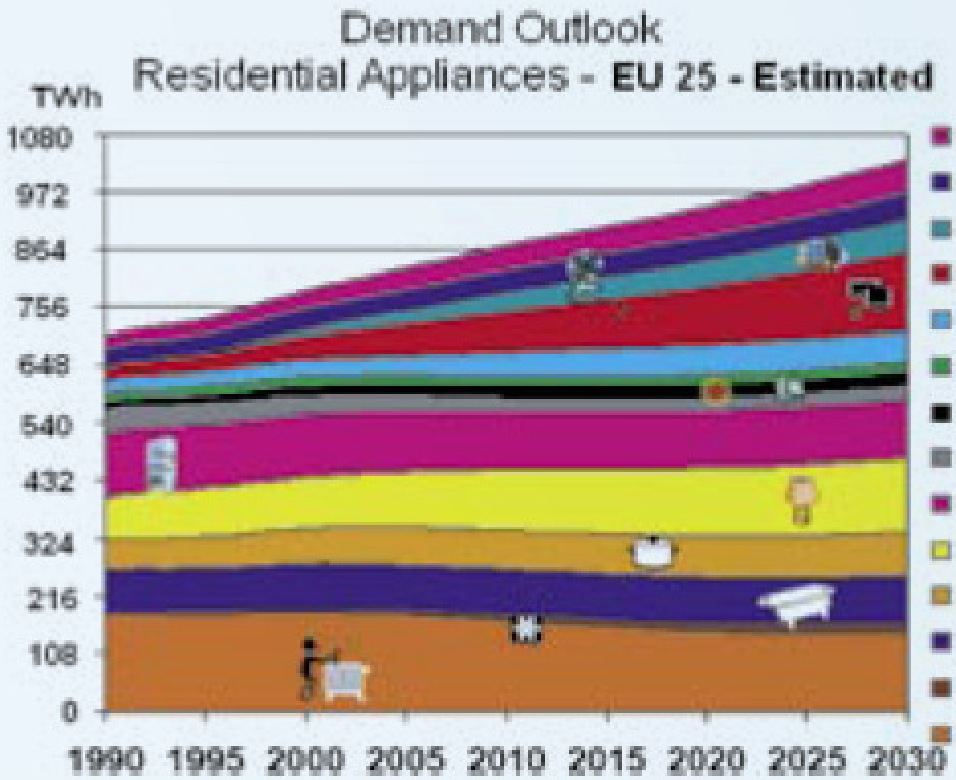
Bedarf an Energie ist bestimmt durch

- individuelle Präferenzen und Gewohnheiten
- ökonomische Möglichkeiten/Zwänge
- politische Ziele →Klima Schutz

und

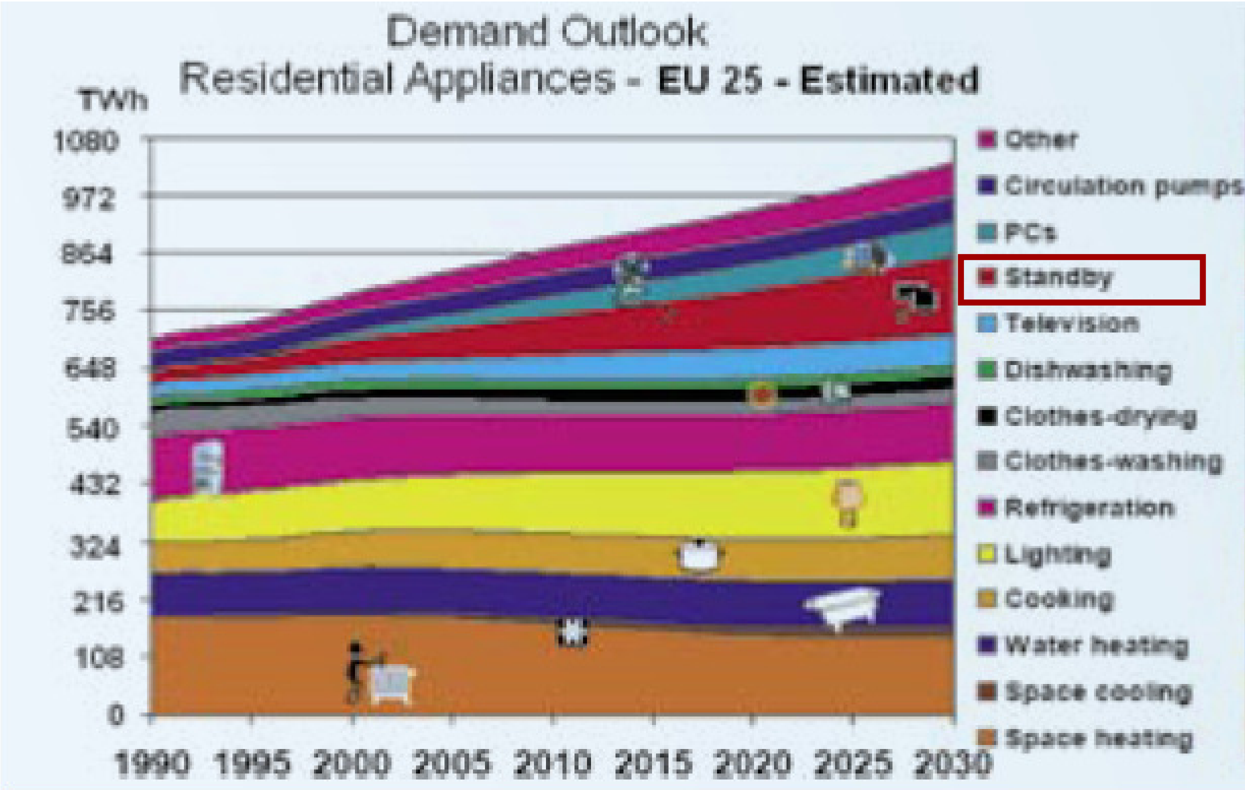
- naturgesetzliche Grenzen

Ausblick Bedarf – Anwendungen im Privatsektor



	year 2000	year 2005	year 2030
Other	4%	5%	7%
Circulation pumps	5%	4%	4%
PCs	1%	3%	6%
Standby	5%	8%	15%
Television	4%	4%	6%
Dishwashing	2%	3%	3%
Clothes-drying	2%	3%	3%
Clothes-washing	4%	4%	3%
Refrigeration	15%	14%	10%
Lighting	12%	11%	8%
Cooking	8%	9%	7%
Water heating	11%	9%	8%
Space cooling	3%	4%	4%
Space heating	23%	20%	14%

Ausblick Bedarf – Anwendungen im Privatsektor



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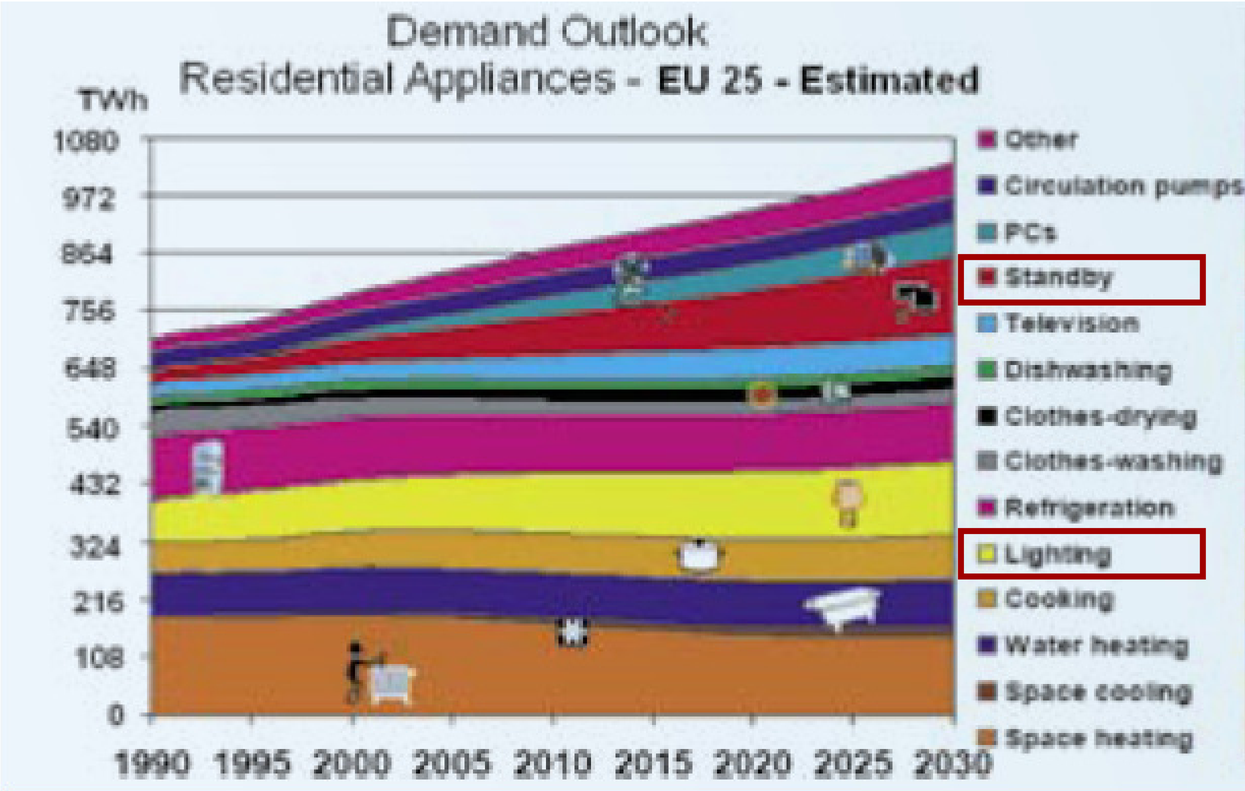

year 2000	year 2005	year 2030
4%	5%	7%
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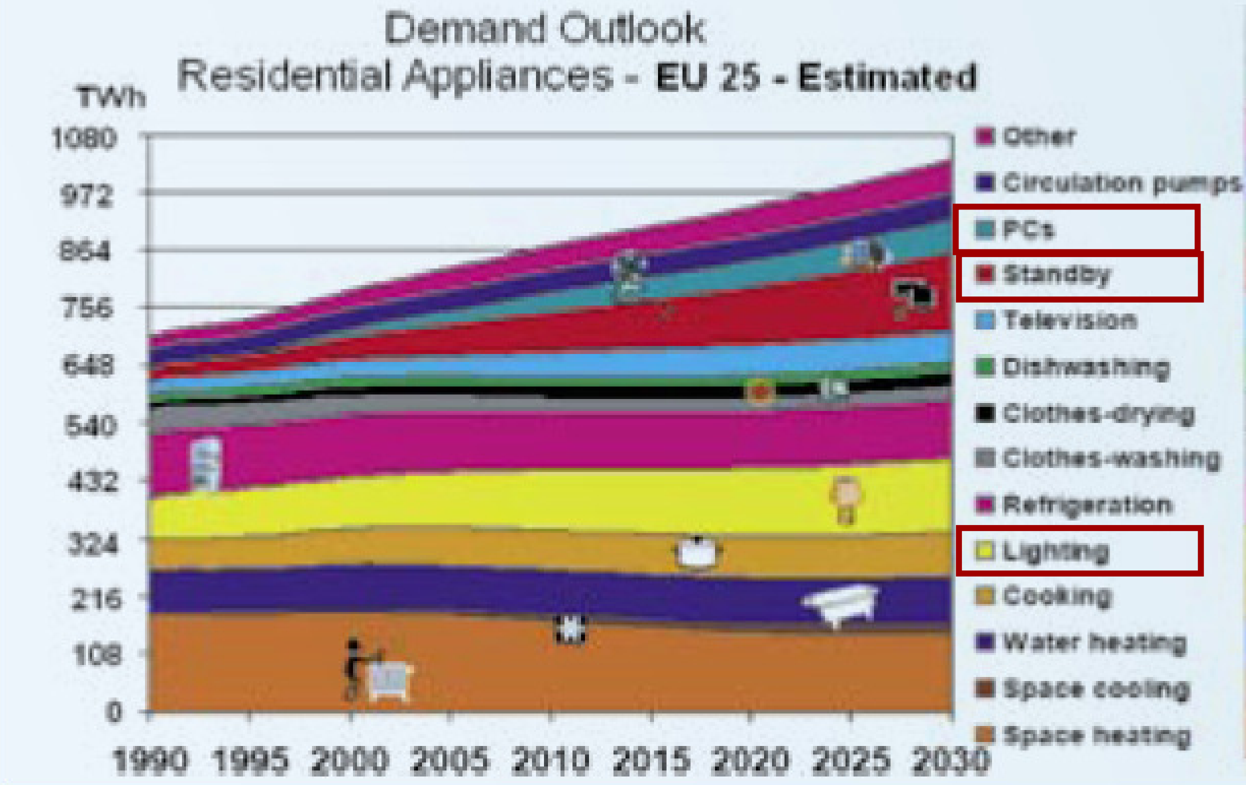
1%	3%	6%
5%	8%	15%
4%	4%	6%
2%	3%	3%
2%	3%	3%
4%	4%	3%
15%	14%	10%
12%	11%	8%
8%	9%	7%
11%	9%	8%
3%	4%	4%
23%	20%	14%

Ausblick Bedarf – Anwendungen im Privatsektor



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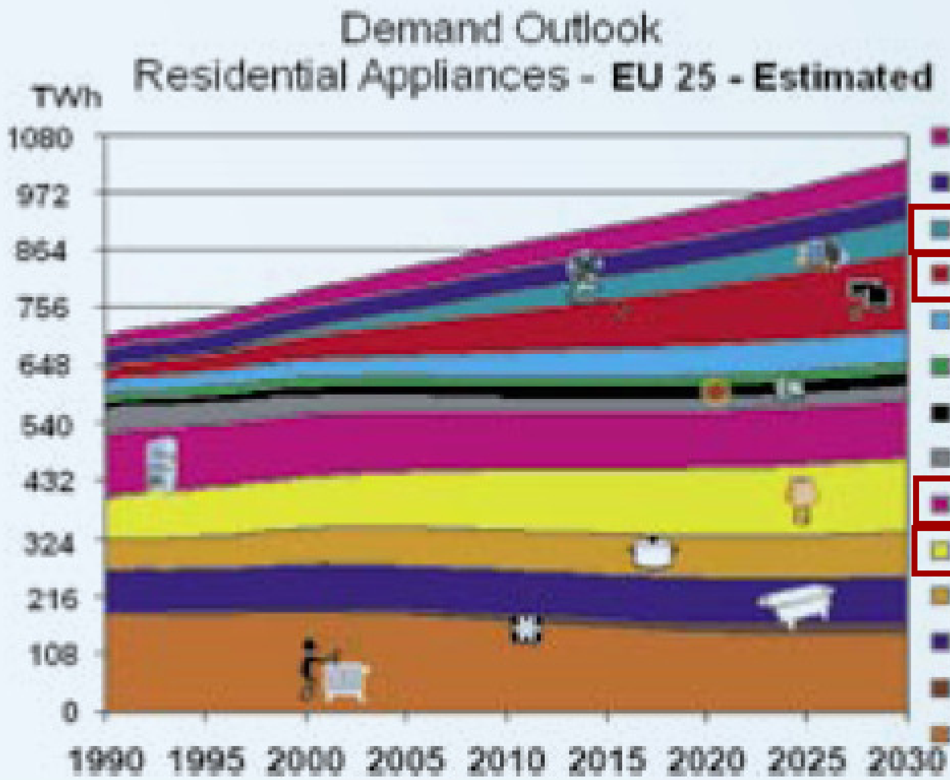

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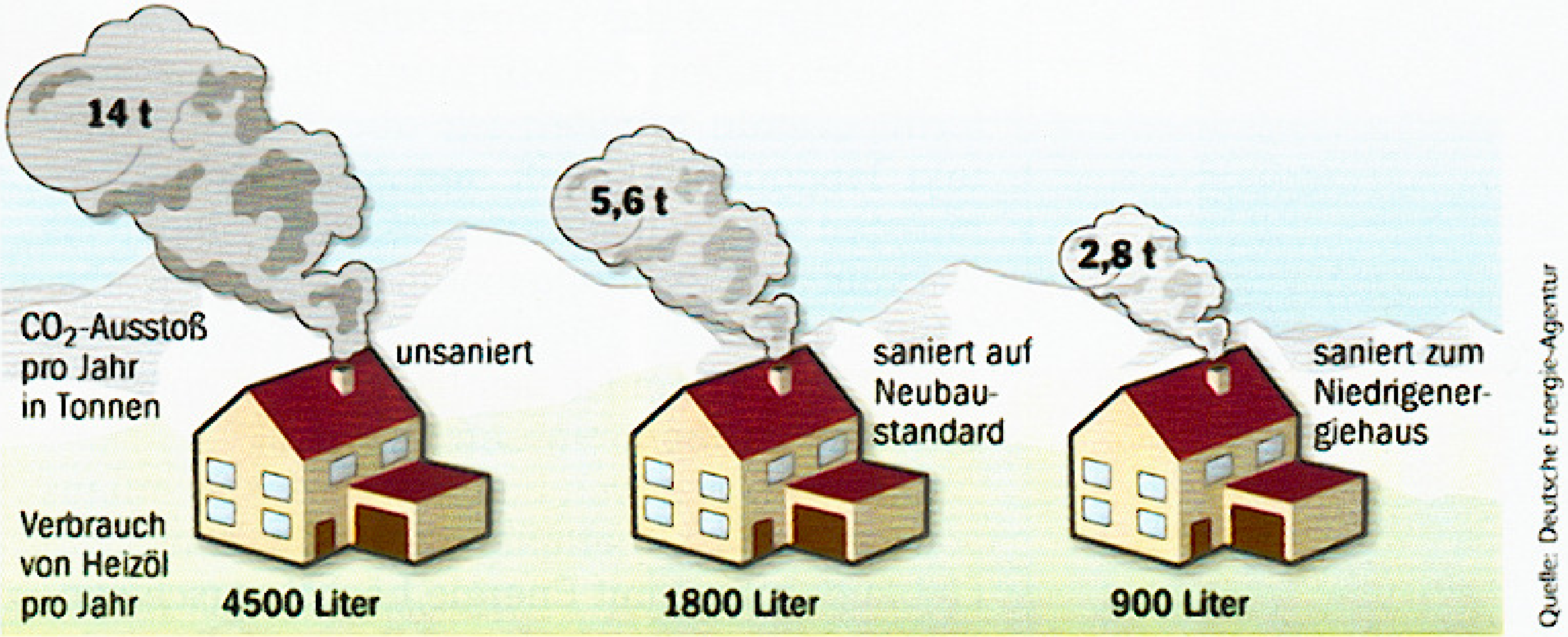
Plug-in Hybrid
Kombination: Benzinmotor – Elektromotor
und
aufladbarer Batterie

Toyota Prius II

..aber bei jedem großen Hersteller in Entwicklung

Niedrig - Energiehaus

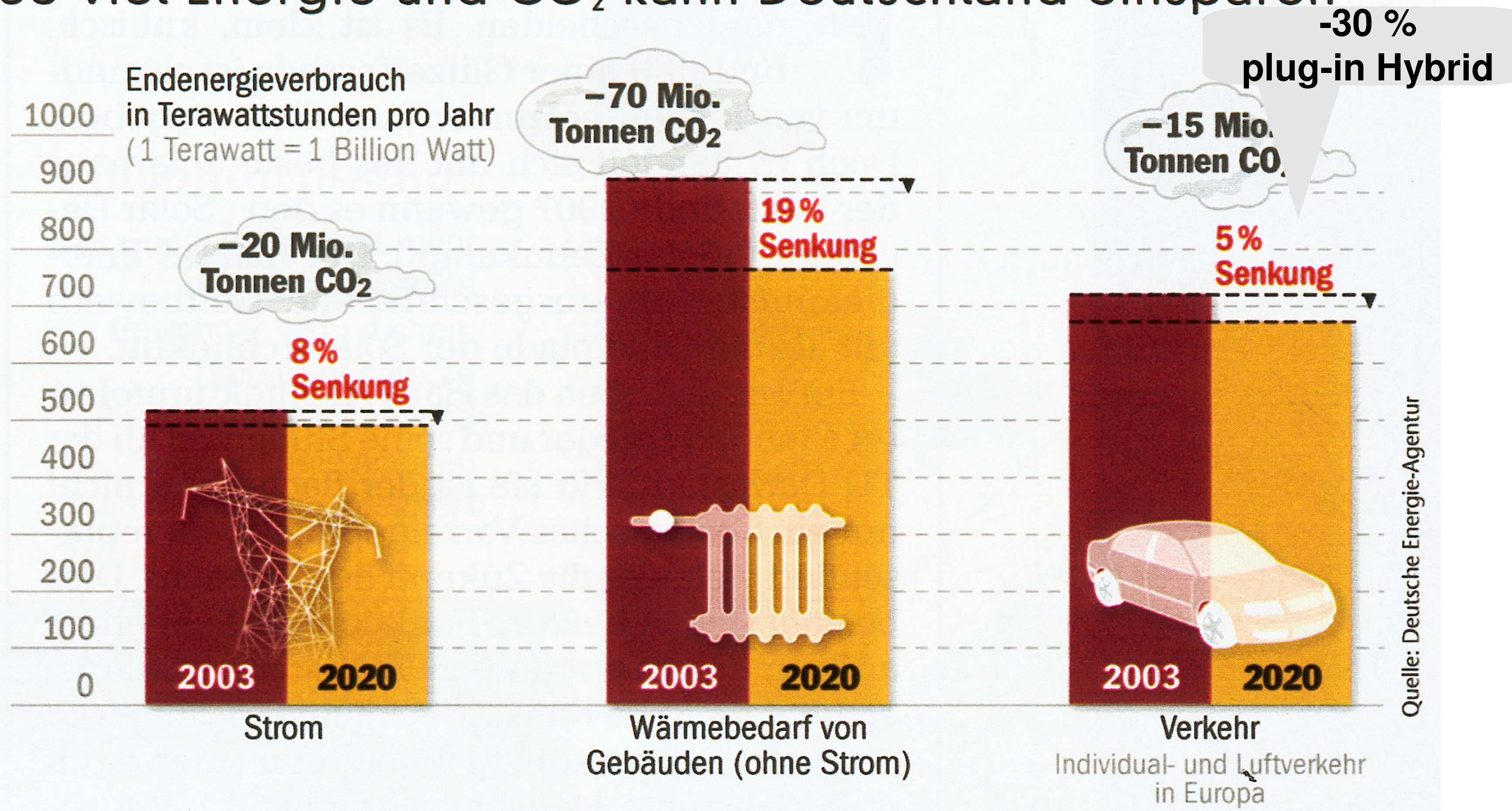
Energetische Sanierung senkt den Brennstoffverbrauch



Basis: Sanierung eines durchschnittlichen Einfamilienhauses, Baujahr 1970, 150 m² Wohnfläche

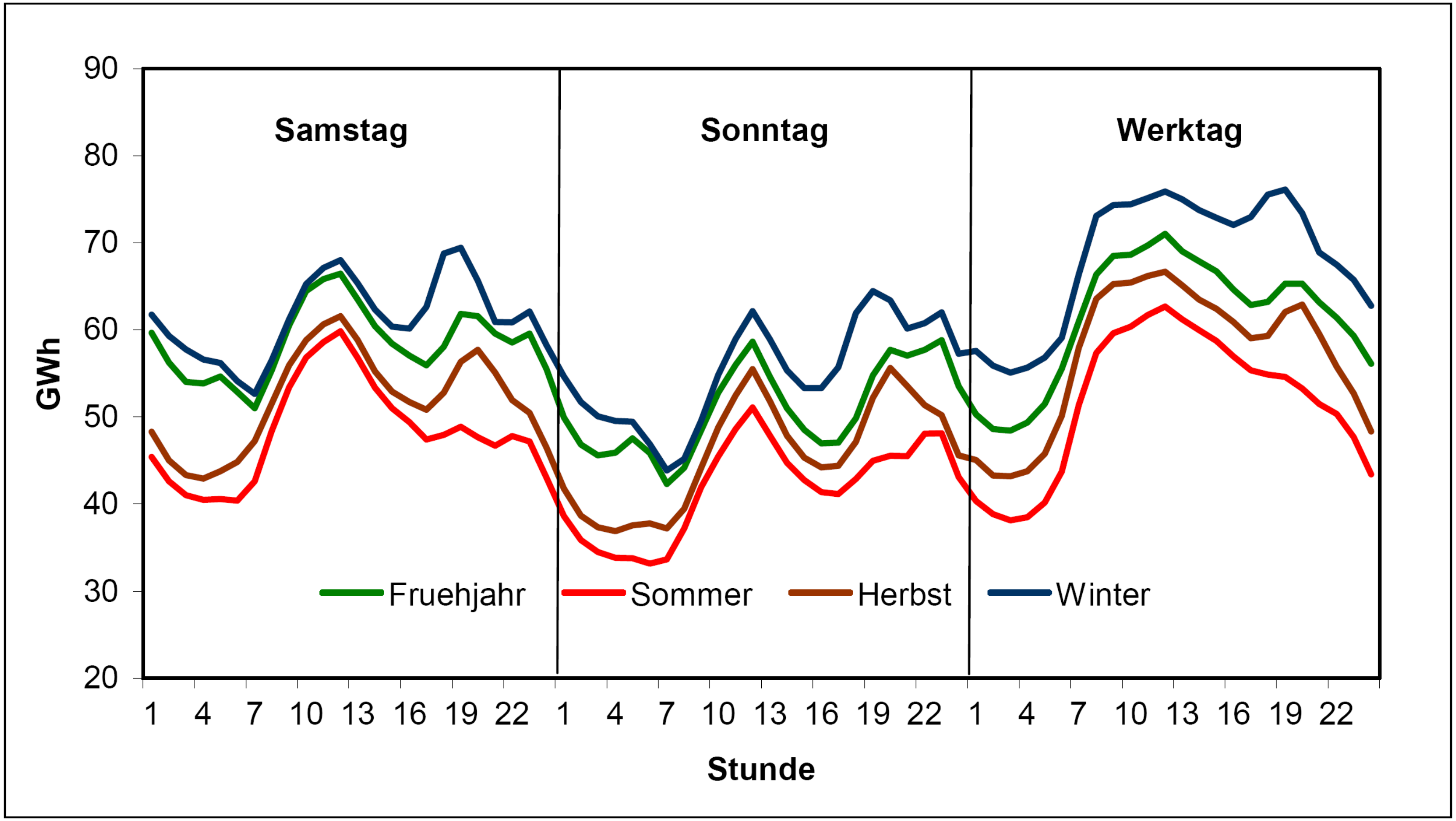
Niedrigenergiehäuser verbrauchen ein Fünftel der Brennstoffmenge, die ein unsanierter Altbau benötigt. Entsprechend sinken die Heizkosten und CO_2-Emissionen

So viel Energie und CO_2 kann Deutschland einsparen

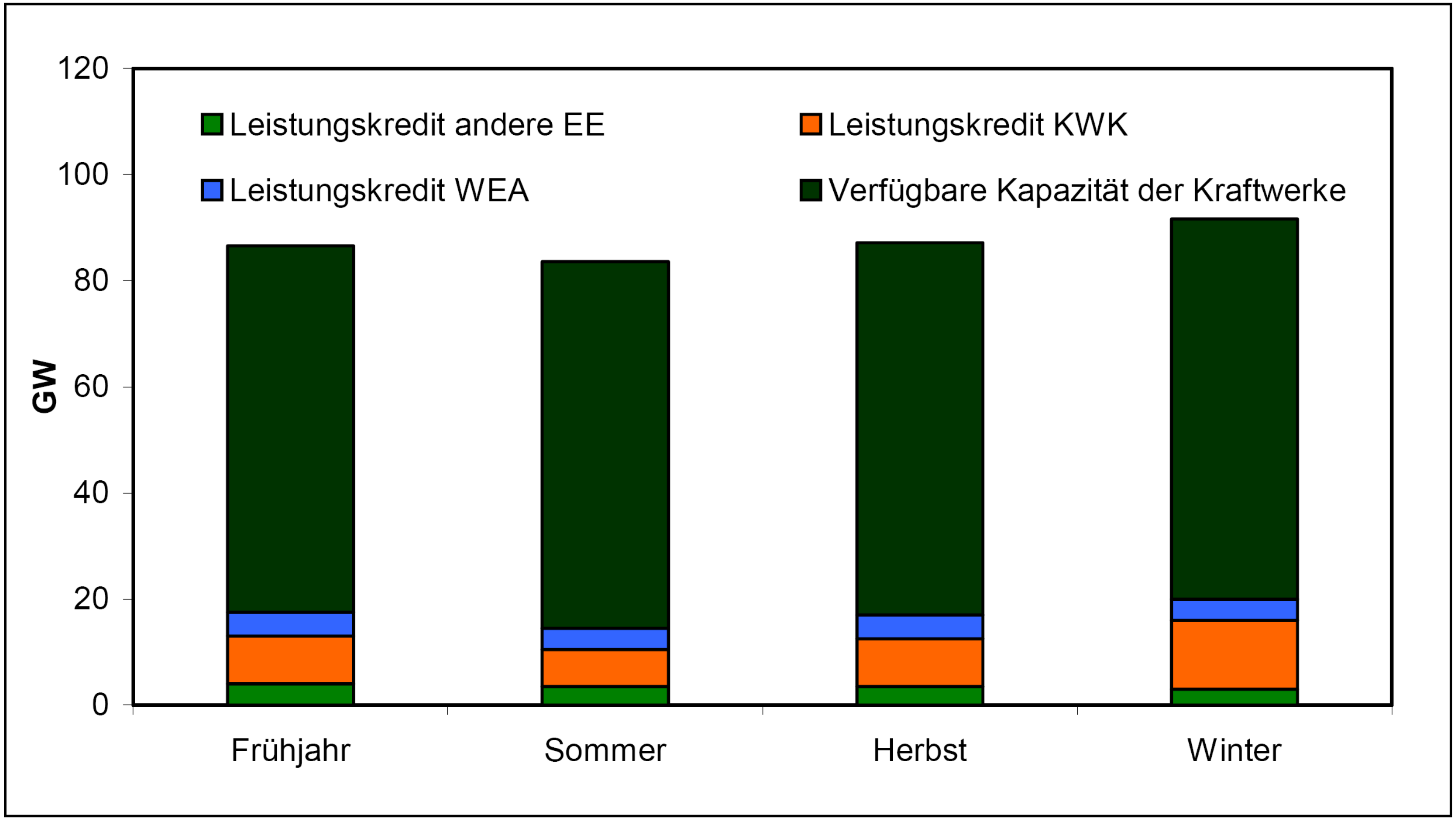


Das Energiesparpotenzial ist auf allen Sektoren enorm. Den größten Effekt haben Effizienzsteigerungen bei strombetriebenen Geräten und Gebäudeheizungen

Last Kurven – *jahreszeitlich/wöchentlich*



Leistungskredit – *jahreszeitlich*



Energie-Bedarf und Verbrauchsstrukturen

- Aufgabenstellung & Gliederung
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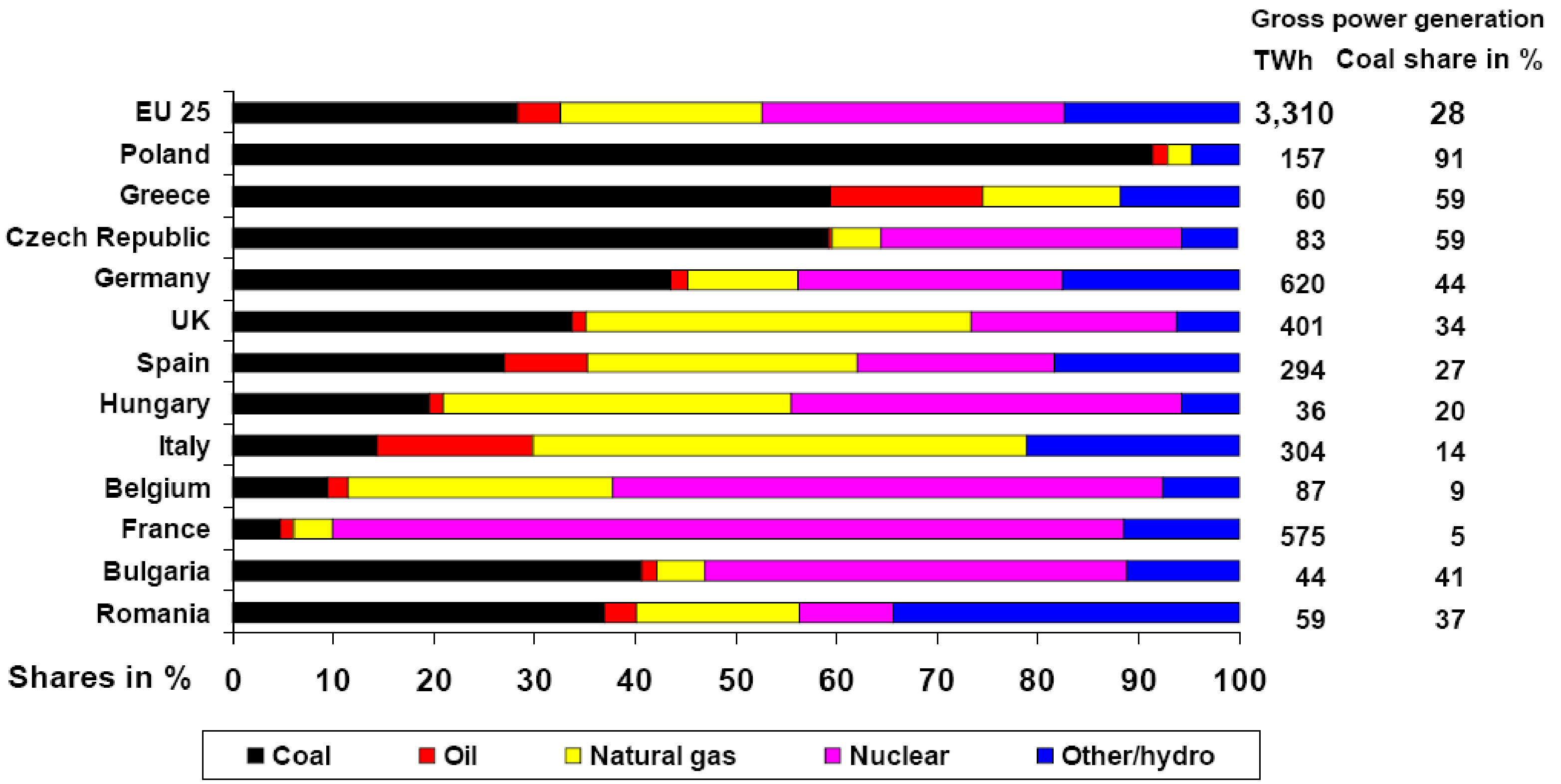
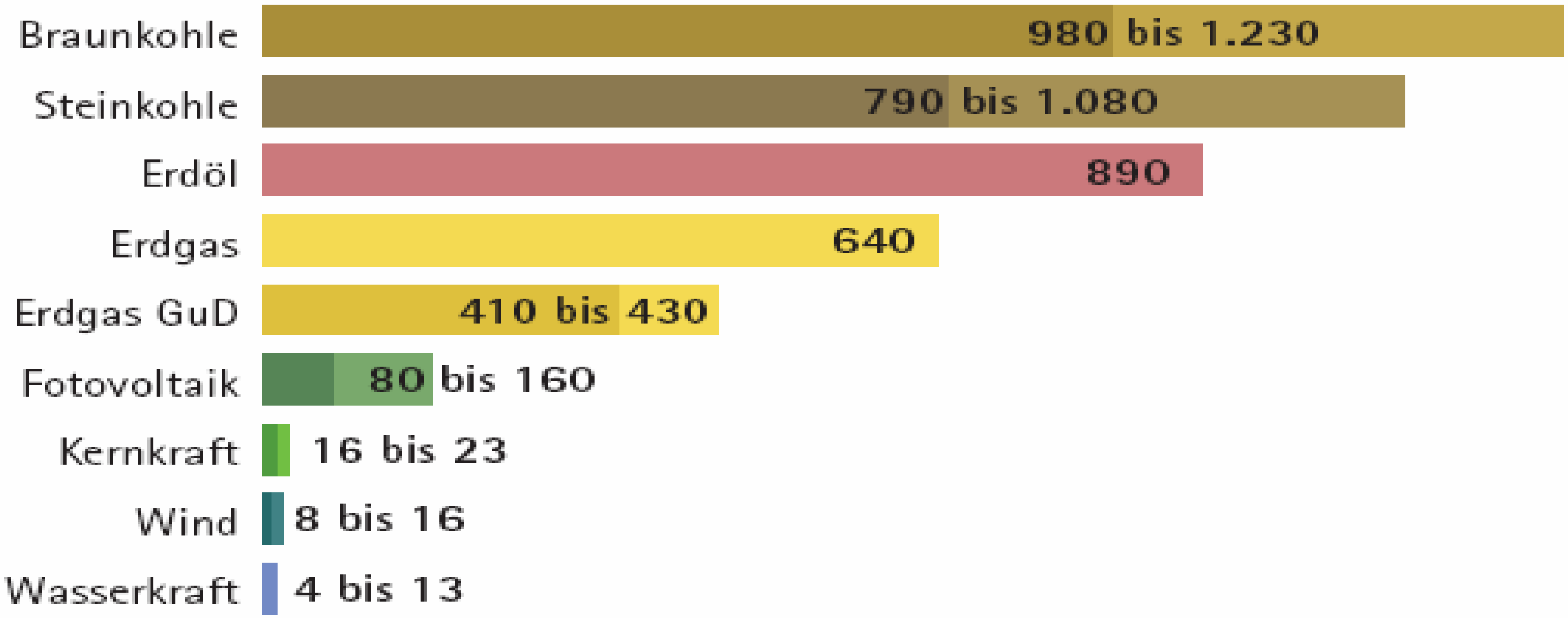
Power generation structures of selected European nations in 2005



Source: EUROSTAT – energy/annual statistics 2005 – 2007 edition (resp. RWE)

CO_2-Ausstoß bei der Stromerzeugung

Gramm Kohlendioxidäquivalent pro kWh Strom, berechnet über den Lebenszyklus des Kraftwerks

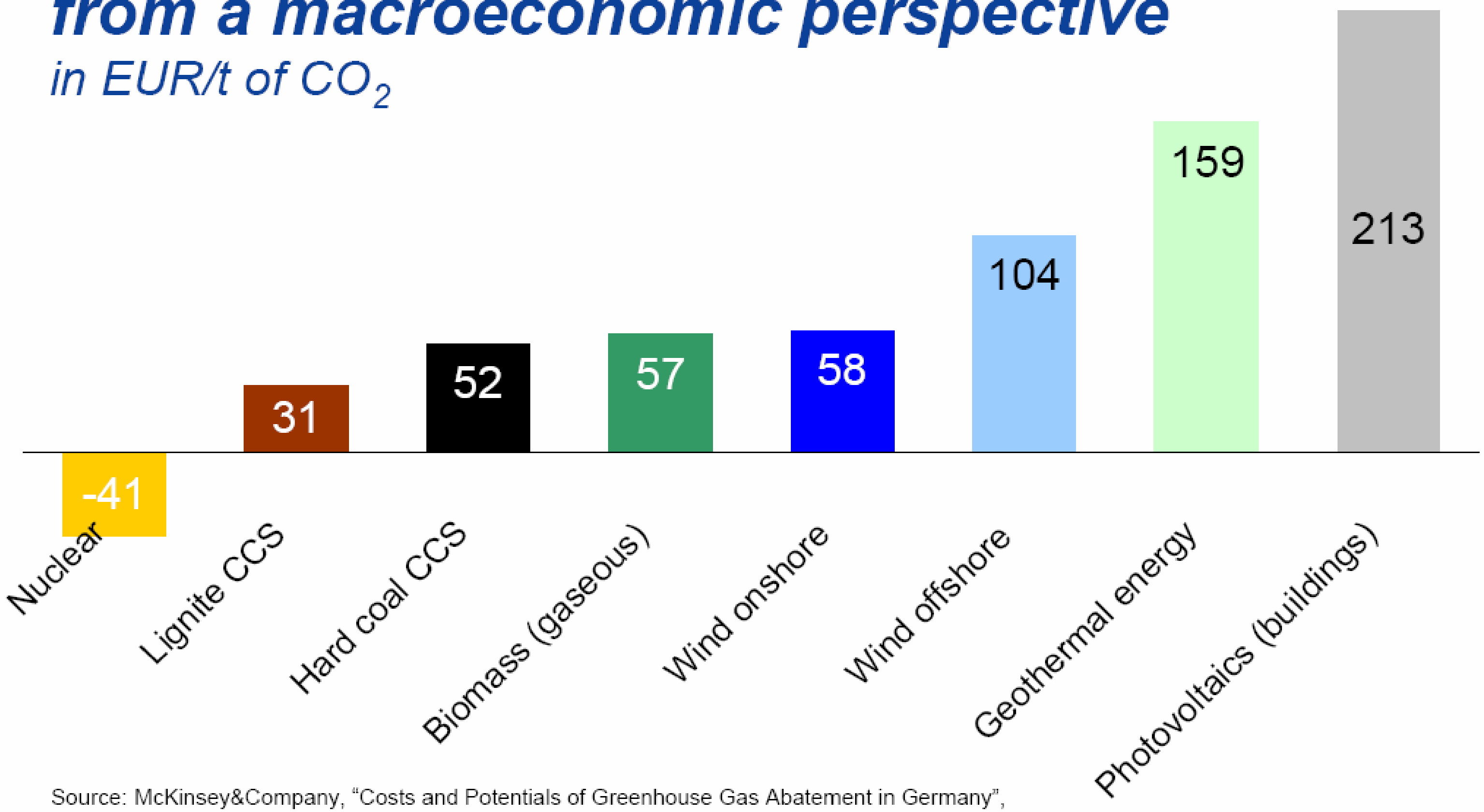


Schwankungsbreiten entstehen durch unterschiedliche Berechnungsmethoden und Standorte der Kraftwerke.

Quelle: PSI Paul-Scherrer-Institut, Schweiz

CO_2 avoidance cost for power generation technologies in 2020 from a macroeconomic perspective

in EUR/t of CO_2



Source: McKinsey&Company, "Costs and Potentials of Greenhouse Gas Abatement in Germany", energy sector perspective; Berlin in September 2007, pp. 48 and 55 (resp. RWE)

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Nutzungspotential - *Erneuerbare*

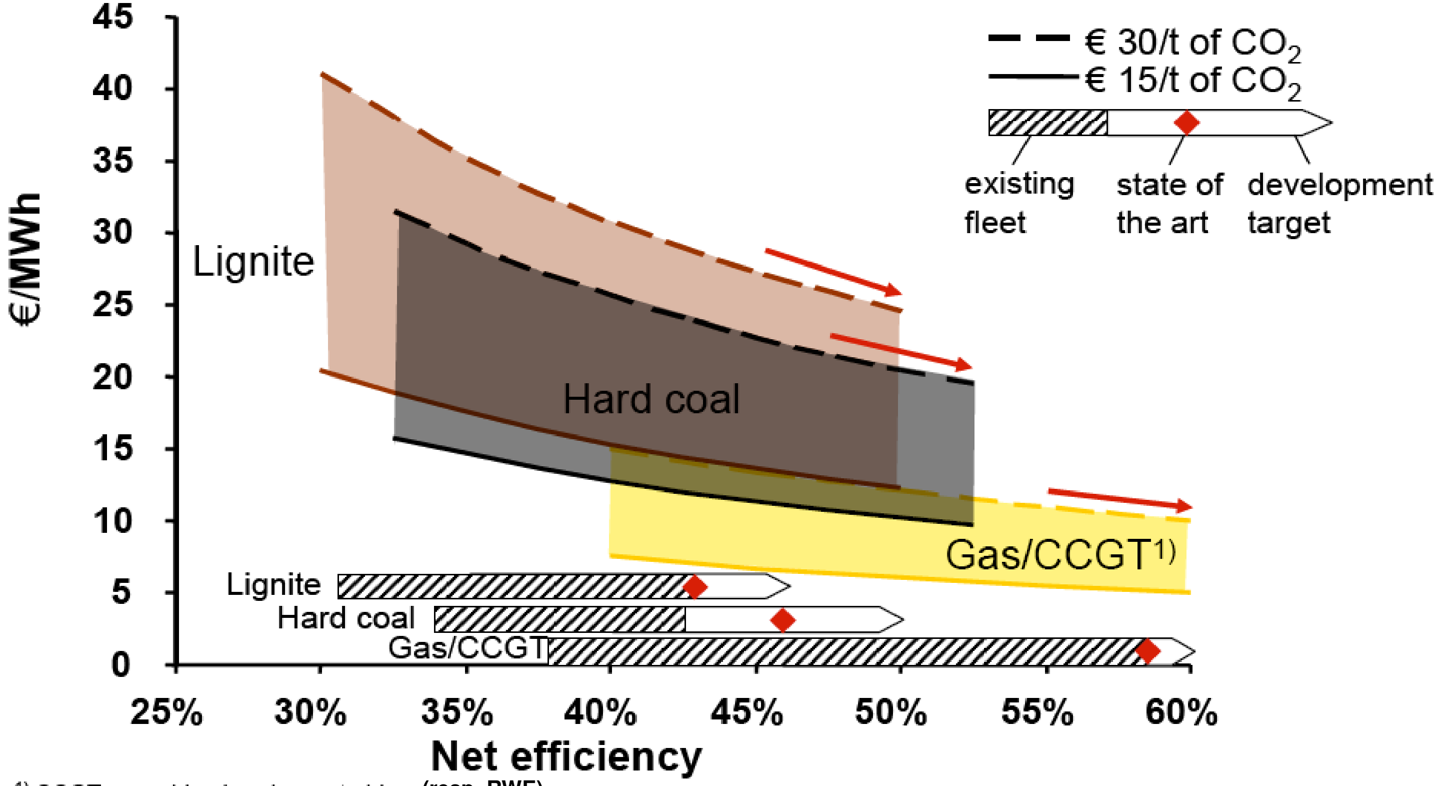
▪ Wind	
▪ on shore	~ 1600 - 2000 h/a
▪ off shore	~ 3600 - 4000 h/a
▪ Wasserkraft	
▪ Pump-Speicher	~ 2800 - 3200 h/a
▪ Laufwasser	~ 6200 - 6600 h/a
▪ Biomasse	analog konventionell
▪ Solarenergie	
▪ Photovoltaik	~ 2200 - 3000 h/a
▪ Solarthermie	~ 2200 - 3400 h/a
▪ Geothermie	~ 4000 - 5800 h/a
▪ Gezeiten/Wellen	~ 2400 - 3000 h/a
▪ ...	

Betriebsstunden pro Jahr

maximal möglich
regional unterschieden

Efficiency improvements in coal-fired plants have the biggest CO_2 effect

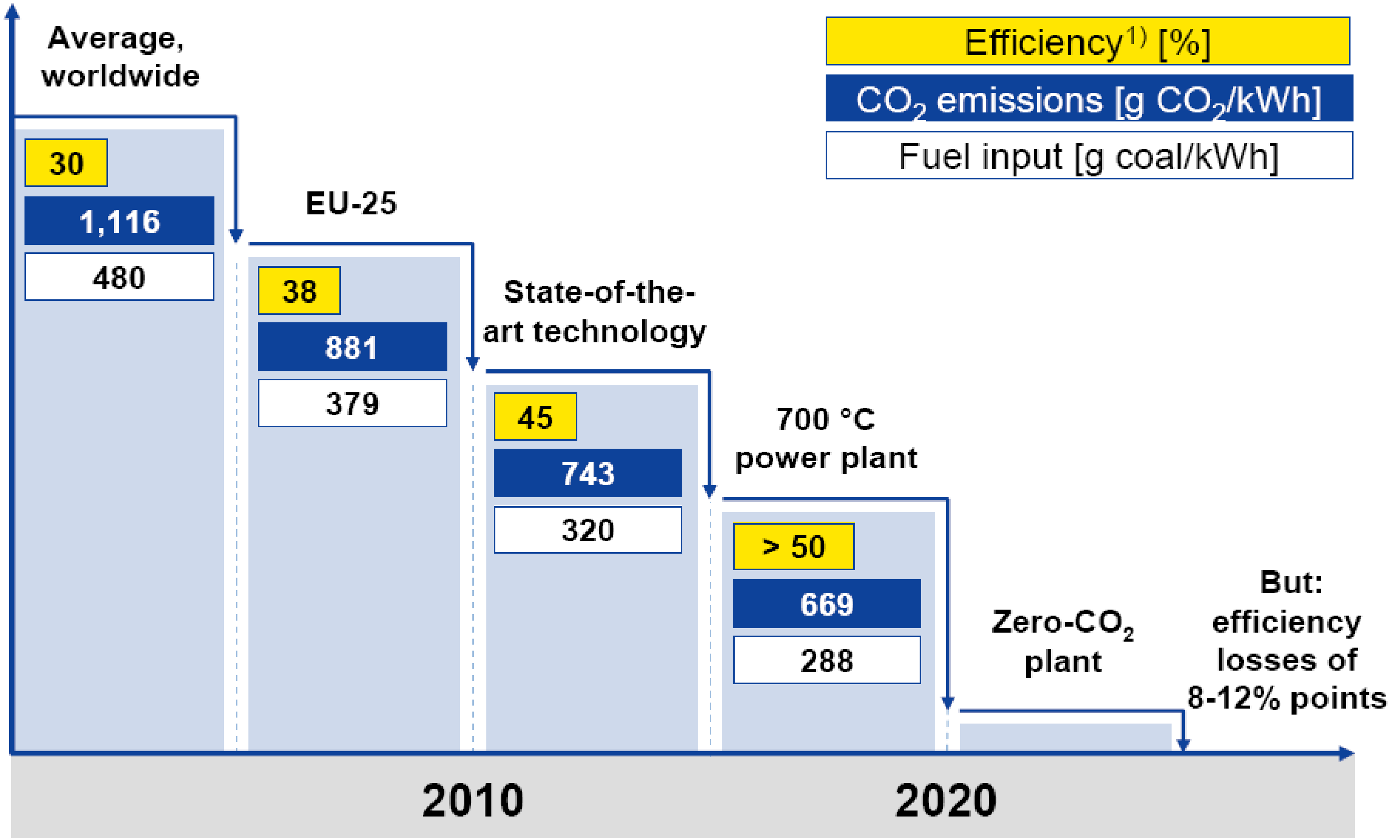
CO_2 as part of electricity costs



[1] CCGT = combined-cycle gas turbine (resp. RWE)

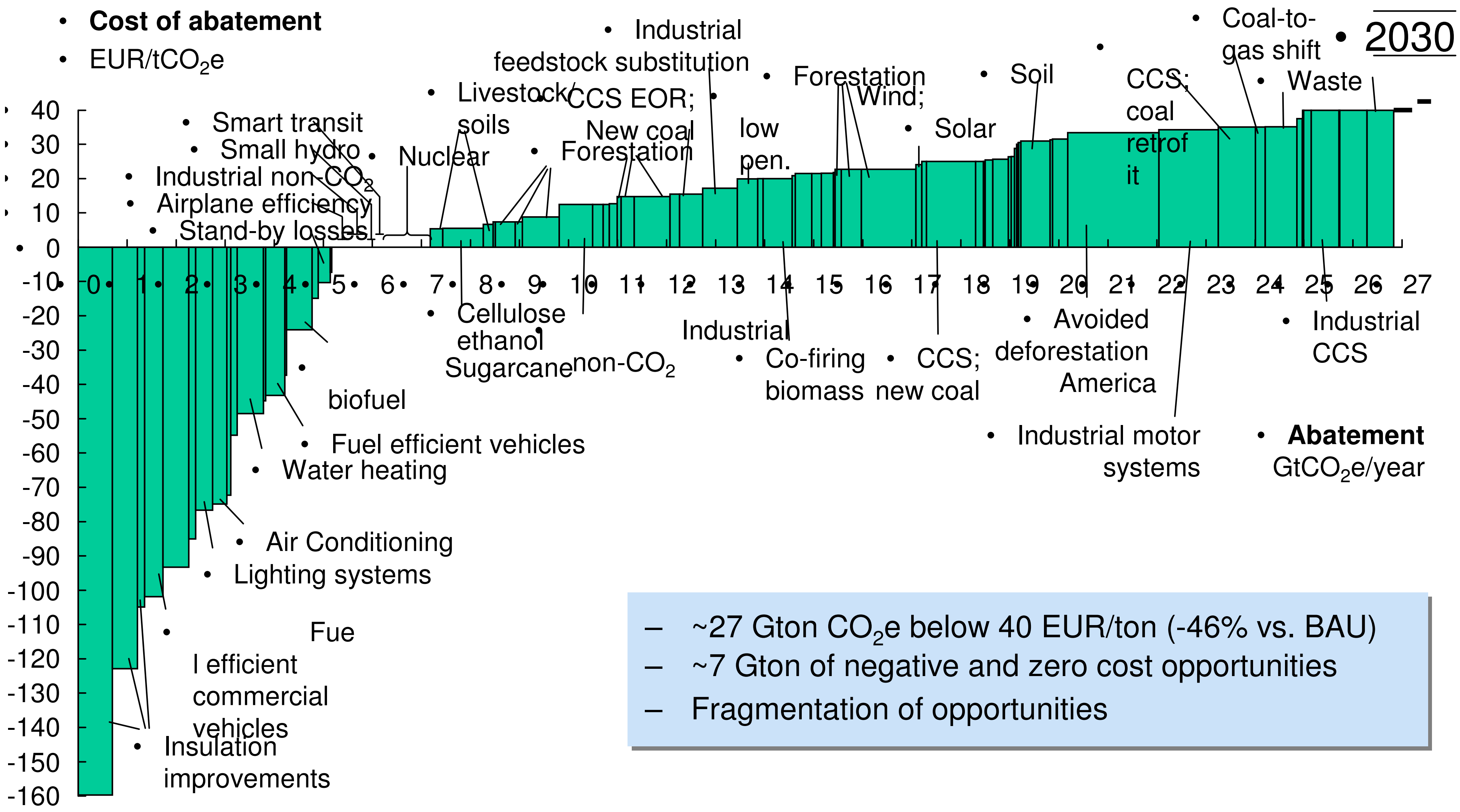
CO_2 reduction through higher efficiency essential for hard coal plants

CO_2 emissions per kWh



[1) Average data for hard coal-fired plants **(resp. RWE)**

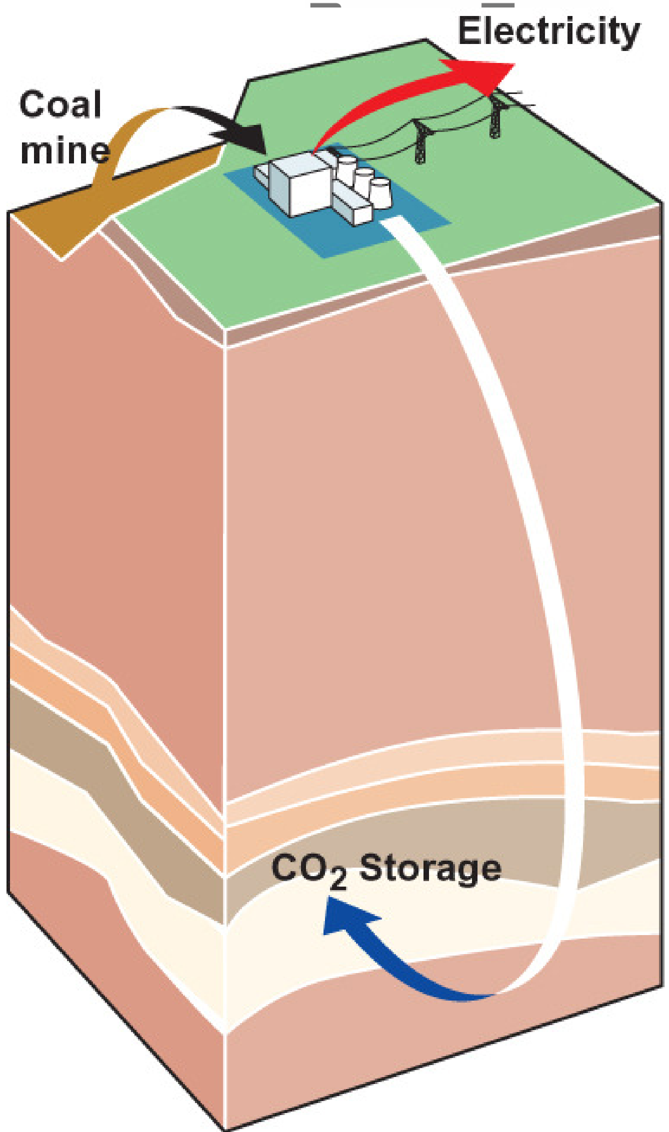
Global cost curve of GHG abatement opportunities beyond business as usual



– ~27 Gton CO_2e below 40 EUR/ton (-46% vs. BAU)
– ~7 Gton of negative and zero cost opportunities
– Fragmentation of opportunities

www.vattenfall.com/climatemap

CO_2-Capture & CO_2-Storage



CO_2 can either separated from the flue gases or from the fuel before the combustion process.

CO_2 will be purified and for permanent storage compressed in liquefied form in poroseous rock formations.

CO_2-Capture

- Post-Combustion in conventional Power Plants
- Pre-Combustion in Power Plants with integrated Gasification
- Oxyfuel-Combustion

CO_2-Storage

- deep saline Aquifere
- Exhausted Oil- and Gasfields
- not-minable Coal Seams
- Mineralisation

Intensive Research is necessary for both areas Capture & Storage. Acceptance for CO_2-free Power Plants can only be achieved by a clear Validation and Confirmation of the Storage Cpabilities.

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Final Energy Demand – EU25

	Baseline		Efficiency & RES		Supply Scenario		Role of Electricity	
	2030	2050	2030	2050	2030	2050	2030	2050
Consumption of energy (Index 2005=100)	117.6	109.0	102.1	85.5	113.3	101.1	105.6	96.8
End-use Sectors, except transport	120.3	115.7	105.3	93.0	115.0	109.5	110.4	109.8
Transport Sector	111.5	93.9	95.0	68.7	109.6	82.2	94.9	67.7
Electricity Consumption	144.5	160.3	126.8	138.1	142.8	162.8	172.1	211.5
	05-2030	05-2050	05-2030	05-2050	05-2030	05-2050	05-2030	05-2050
Energy Efficiency (annual average rate, %)	-1.35	-1.46	-1.90	-1.99	-1.50	-1.62	-1.77	-1.72
End-use Sectors, except transport	-1.26	-1.33	-1.78	-1.81	-1.44	-1.45	-1.60	-1.44
Transport Sector	-1.56	-1.78	-2.19	-2.47	-1.63	-2.08	-2.19	-2.50
	2030	2050	2030	2050	2030	2050	2030	2050
Share of Electricity in Final Energy	24.6	29.4	24.8	32.3	25.2	32.2	32.6	43.7
End-use Sectors, except transport	34.1	39.1	34.1	42.2	35.3	42.2	40.8	50.6
Transport Sector	1.5	2.8	1.8	2.5	1.5	2.3	11.3	18.7

Abnahme des Verbrauches

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Final Energy Demand – EU25

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Einsparung Bedarfsseite

Anstieg im Elektrizitäts-Sektor

Overall Performance of all Scenarios

2005 = 100	Total Cost of Energy 2030	Total Cost of Energy 2050	Dependence on Imported Oil & Gas 2030	Dependence on Imported Oil & Gas 2050	CO_2 Emissions from Energy 2030	CO_2 Emissions from Energy 2050
Baseline	146	159	126	138	110	96
Role of Electricity	147	164	105	102	70	50
Supply Scenario	161	169	115	114	70	50
Efficiency & RES	156	164	128	137	70	50

(Results for 2030 and 2050 expressed as an index, with 2005 = 100)[3]

Transition Process into a new low Carbon World!

at lowest Cost, nearly zero Import Dependency

Zusammenfassung

global und in der EU

- Anstieg des Bedarfs - an Energie und Strom
- Forderung: Versorgungssicherheit
- Muss der Sozialverträglichkeit →Kosten
- Notwendigkeit für verstärkte F&E Aktivitäten CO_2-arme Technologien

aber wir benötigen

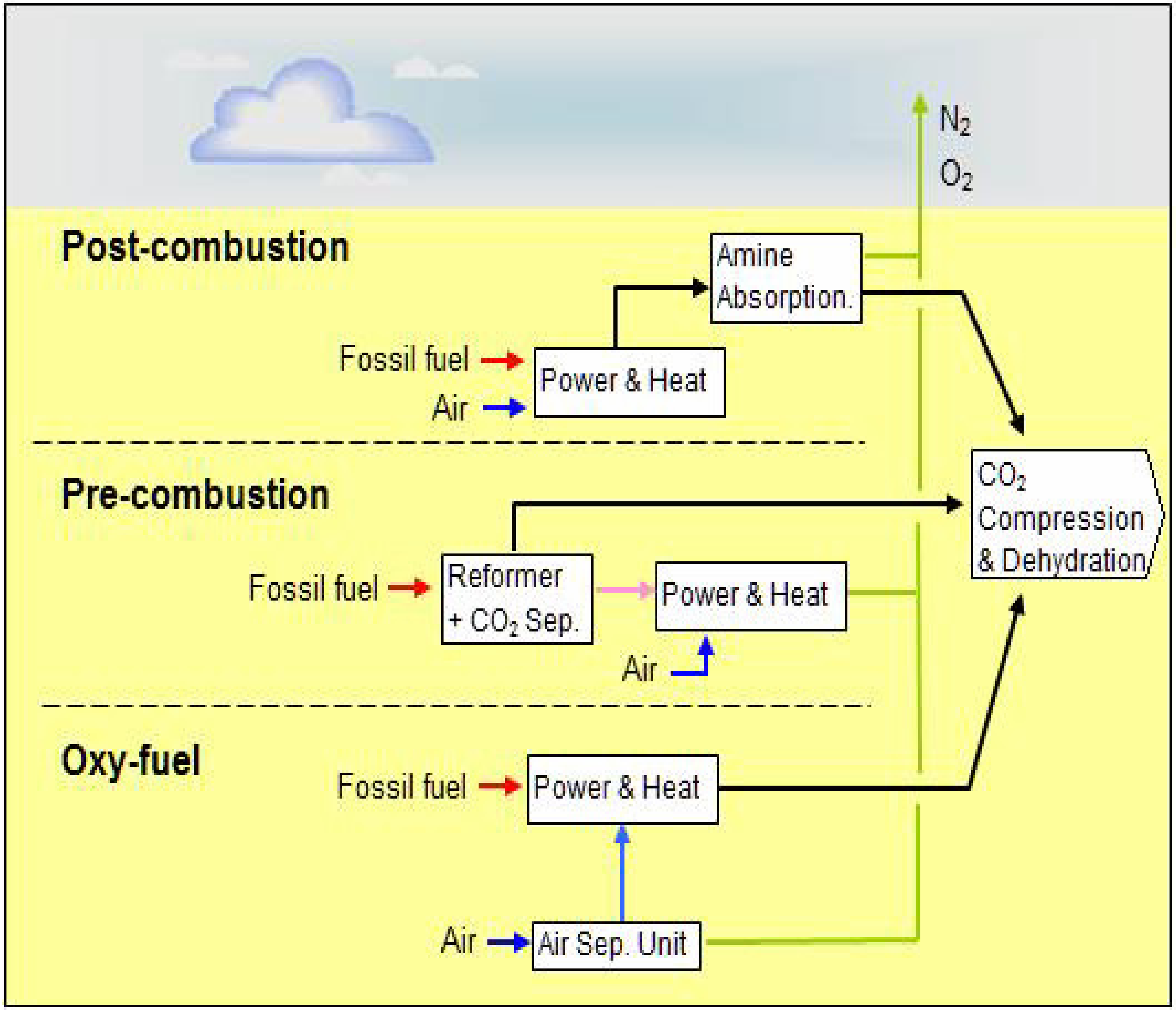
- öffentliches Bewusstsein/Akzeptanz

Effizienz ist und wird „erste Wahl" sein!


Danke für Ihre Aufmerksamkeit

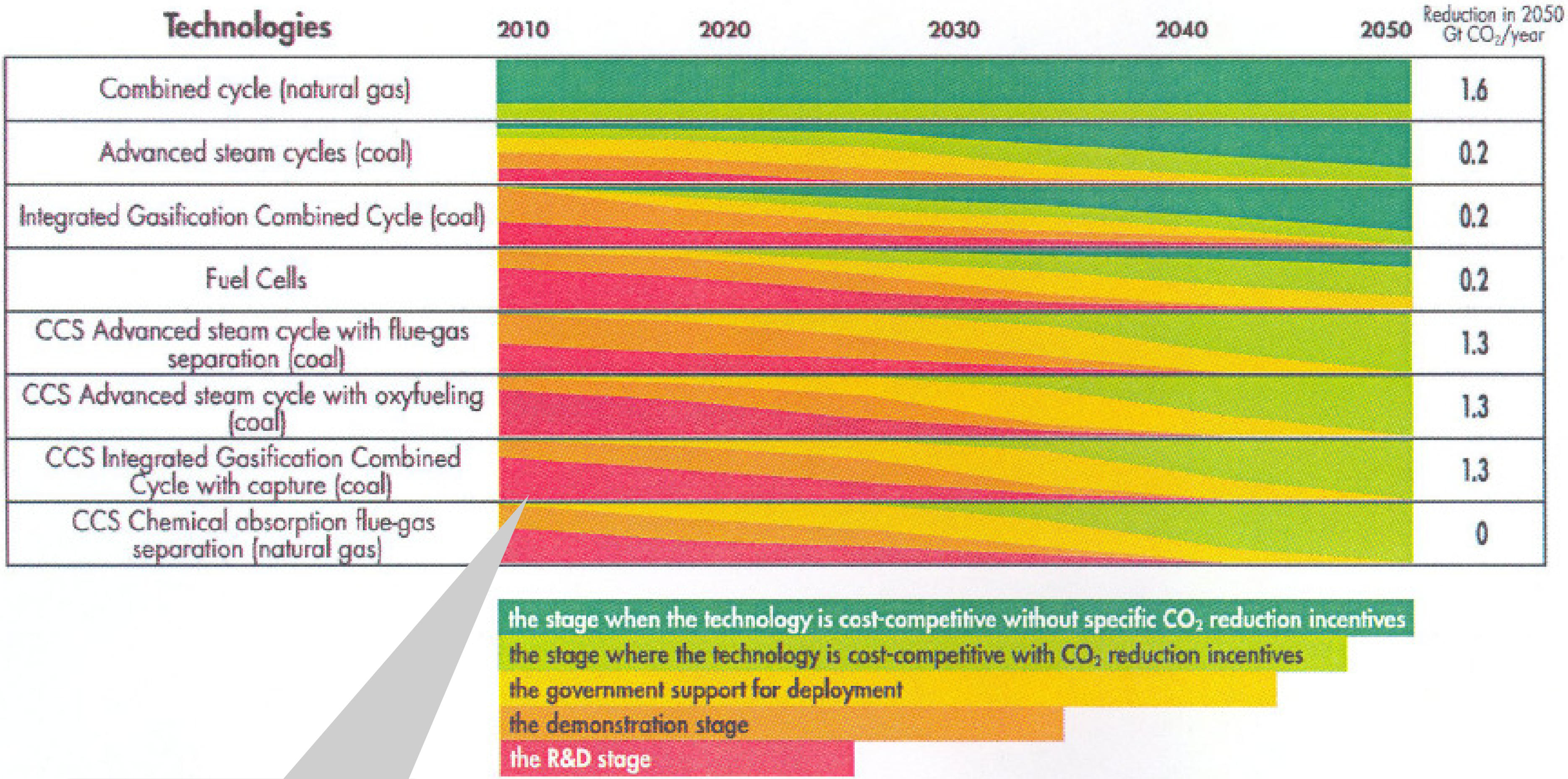
→Three Options to achieve the target 2020

- All using known technologies and Components
- All need Optimisation, Scale-up and Process-Integration.
- Increase of Efficiency is an indispensable Prerequisite.



Year

Pathways towards cost-competitiveness for fossil power generation technologies



An indicator how mature are the tecnologies

IEA Energy Outlook 2006

Perspective of Demand for Primary Resources

→ *Assessment/Comment*

- Challenge Climate Change
- sustainable Development
- social Balance
- Availability resp. Access to Resources

independent from different Scenarios

→ Portfolio of Primary Resources

will not change dramatically

Summary supply block – cost of elcetricity - Overview

	2005	2030	2030 CC	2050 CC
Hard Coal	4.11	6.18	6.72	6.46
Natural Gas	4.44	6.95	7.06	8.76
Lignite	3.72	6.47	6.21	6.19
IGCC	4.79	6.54	5.72	5.43
OxyFuel			6.09	5.95
Nuclear	4.30	4.70		4.90
Hydro run river	4.10		4.10+	
Wind offshore	7.62		7.57	

Cost of Electricity figures are in €-ct/kWh in 2005 prices

reine Erzeugungskosten ohne Übertragung und Verteilung

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Perspective of Demand for Primary Resources

15.000 bln €
Investment

	2005	2030
	11.40 bln toe	17.7 bln toe
Oil	35 %	32 % share
Coal	25 %	28 % share
Gas	21 %	22 % share
Electricity	17 %	22 % share

Endenergieeffizienz													
	BIP real/Endenergie in €/GJ							Veränderungsraten gegenüber 2000 in %					
	2000	2005	2010	2015	2020	2025	2030	2005	2010	2015	2020	2025	2030
Scenario I	223	232	258	288	320	357	395	0,77	1,43	1,71	1,81	1,90	1,92
Scenario II	223	232	256	285	317	355	393	0,77	1,37	1,63	1,76	1,86	1,90

Primärenergieeffizienz													
	BIP real/Primärenergie in €/GJ							Veränderungsraten gegenüber 2000 in %					
	2000	2005	2010	2015	2020	2025	2030	2005	2010	2015	2020	2025	2030
Scenario I	143	150	174	198	225	256	285	0,97	1,97	2,17	2,28	2,36	2,32
Scenario II	143	150	180	206	235	270	302	0,97	2,30	2,44	2,51	2,57	2,52

Stromintensität													
	Stromverbrauch /BIP real in kWh/1000 €							Veränderungsraten gegenüber 2000 in %					
	2000	2005	2010	2015	2020	2025	2030	2005	2010	2015	2020	2025	2030
Scenario I	240	237	220	201	182	166	151	-0,23	-0,84	-1,18	-1,37	-1,46	-1,53
Scenario II	240	237	220	200	182	165	149	-0,23	-0,83	-1,20	-1,38	-1,48	-1,57

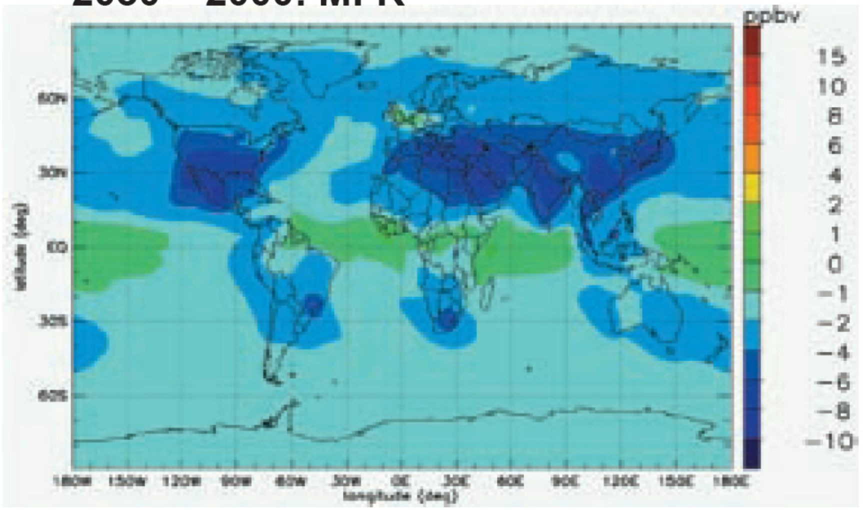
CO2-Intensität													
	CO2-Emissionen/BIP real in kg/1000 €							Veränderungsraten gegenüber 2000 in %					
	2000	2005	2010	2015	2020	2025	2030	2005	2010	2015	2020	2025	2030
Scenario I	454	414	359	321	293	265	240	-1,82	-2,32	-2,28	-2,16	-2,12	-2,10
Scenario II	454	414	337	297	270	243	216	-1,82	-2,95	-2,78	-2,56	-2,47	-2,44

Final energy demand – EU25

	Baseline		Efficiency & RES		Supply Scenario		Role of Electricity	
	2030	2050	2030	2050	2030	2050	2030	2050
Consumption of energy (Index 2005=100)	117.6	109.0	102.1	85.5	113.3	101.1	105.6	96.8
End-use Sectors, except transport	120.3	115.7	105.3	93.0	115.0	109.5	110.4	109.8
Transport Sector	111.5	93.9	95.0	68.7	109.6	82.2	94.9	67.7
Electricity Consumption	144.5	160.3	126.8	138.1	142.8	162.8	172.1	211.5
	05-2030	05-2050	05-2030	05-2050	05-2030	05-2050	05-2030	05-2050
Energy Efficiency (annual average rate, %)	-1.35	-1.46	-1.90	-1.99	-1.50	-1.62	-1.77	-1.72
End-use Sectors, except transport	-1.26	-1.33	-1.78	-1.81	-1.44	-1.45	-1.60	-1.44
Transport Sector	-1.56	-1.78	-2.19	-2.47	-1.63	-2.08	-2.19	-2.50
	2030	2050	2030	2050	2030	2050	2030	2050
Share of Electricity in Final Energy	24.6	29.4	24.8	32.3	25.2	32.2	32.6	43.7
End-use Sectors, except transport	34.1	39.1	34.1	42.2	35.3	42.2	40.8	50.6
Transport Sector	1.5	2.8	1.8	2.5	1.5	2.3	11.3	18.7

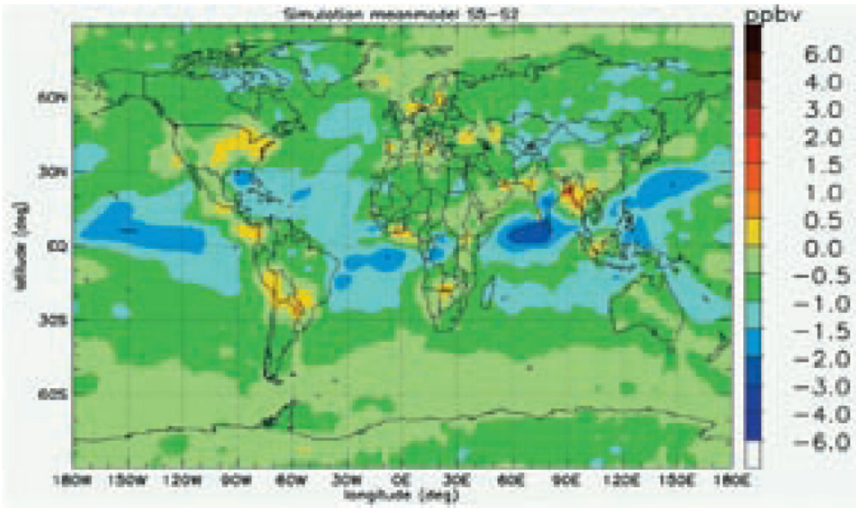
Challenge Climate Change

2030 – 2000: MFR



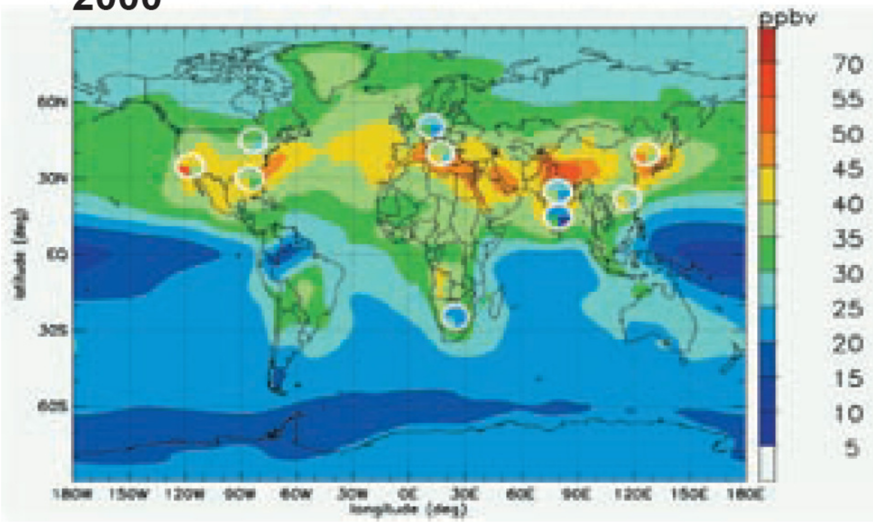
c) Change in surface ozone reductions between 2000 and 2030 achieved when all currently available emission reduction technologies would be implemented (MFR), assuming climate to be stable.

2030 with CC– 2030 without CC: CLE



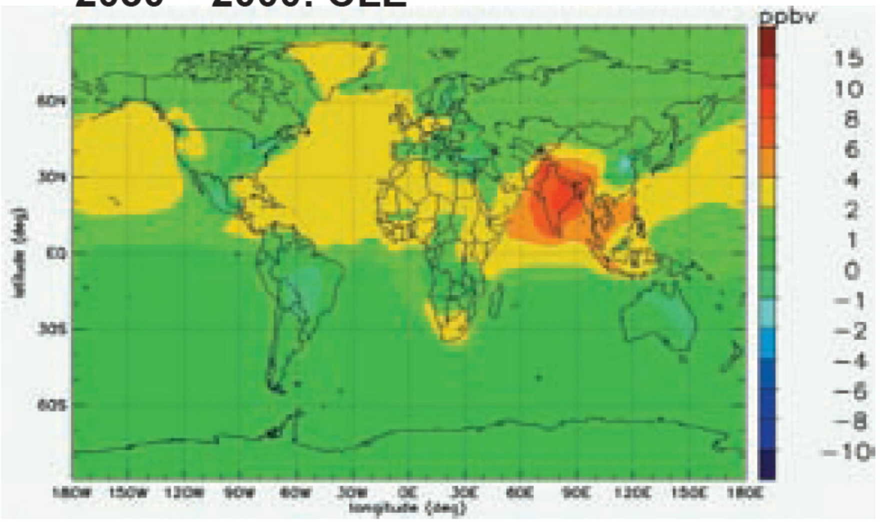
d) Effect of allowing climate to change between 2000 and 2030 on surface ozone in the year 2030. Climate change alone is expected to reduce ozone over the oceans. Over land only small increases (< 1 ppb) are expected in some areas.

2000



a) Global surface ozone concentration [ppbv] in the year 2000 calculated with an ensemble of global air pollution models.

2030 – 2000: CLE



b) Change of surface ozone between 2000 and 2030 as a result of development and currently decided world-wide emission reductions policies (CLE), but assuming climate to remain stable.

Scenarios I II

Scenario	I	II
GHG Reduction of 30 % in 2030		
high Price ← CO_2 → low Price		

CO_2 Price is Indicator for Climate Protection Measures

Energy Consumption for the different Sectors in PJ

	2005	Scenario I 2010	2015	2020	2025	2030
Industrie	2460,0	2305,1	2259,6	2228,5	2161,8	2130,5
Verkehr	2628,0	2586,0	2480,7	2412,6	2371,6	2370,8
GHD	1445,0	1438,0	1392,2	1373,8	1345,6	1322,4
Haushalte	2640,0	2641,7	2592,6	2558,4	2507,2	2479,6
total	**9173,0**	**8970,8**	**8725,0**	**8573,4**	**8386,1**	**8303,2**

VGB PowerTech

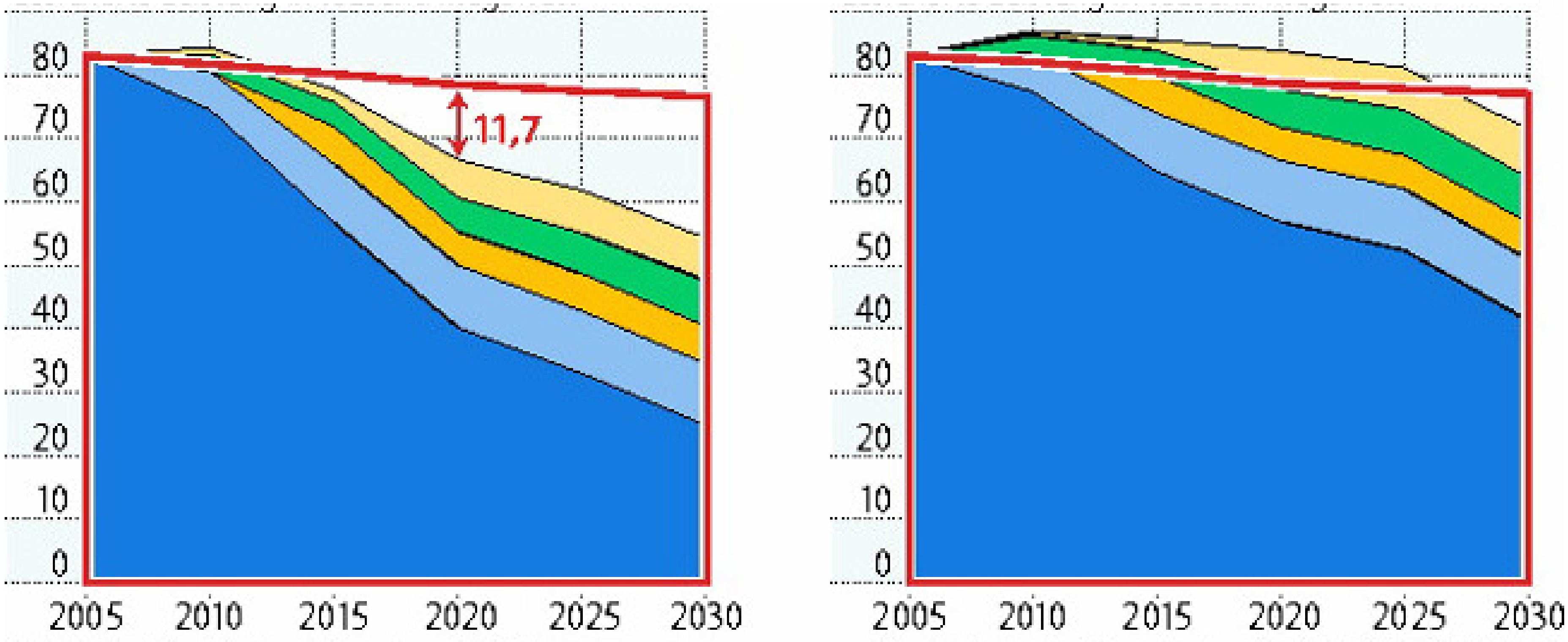
Energy Consumption for the Transport Sector in PJ

		Scenario I					Scenario II				
	2005	2010	2015	2020	2025	2030	2010	2015	2020	2025	2030
Biokraftstoffe	44,0	58,2	68,4	77,0	84,1	94,7	55,4	59,6	63,0	63,7	66,4
Benzin	1032,0	949,0	846,2	787,5	725,8	703,8	970,1	893,9	842,6	782,7	763,7
Diesel	1137,0	1107,7	1074,6	1042,7	1032,6	1023,9	1108,4	1087,9	1059,5	1051,0	1050,8
Kerosin	341,4	387,7	400,6	406,6	413,3	414,3	387,8	401,7	408,3	415,5	416,8
Erdgas	14,7	24,9	30,5	37,5	55,7	73,4	24,9	31,7	39,2	57,9	75,8
Übrig. Gase	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Strom	58,9	58,5	60,4	61,4	60,0	60,8	58,0	60,4	61,6	59,9	59,8
total	2628,0	2586,0	2480,7	2412,6	2371,6	2370,8	2604,5	2535,2	2474,3	2430,6	2433,3

Perspectives of Power plant Portfolio in Germany

Existing Plants
Plants in planning
Cogeneration Plants
Plants in Construction
Renewable Plants
Bedarf

with / without Life Time Extension Nuclear



1) Inklusive Kraft-Wärme-Kopplung (KWK).

Quelle: Deutsche Energie-Agentur / F.A.Z.-Grafik Dobratz

R&D&D Pathway and Goal
CO_2-Capture Technologies (Quelle: ZEP - WG1)