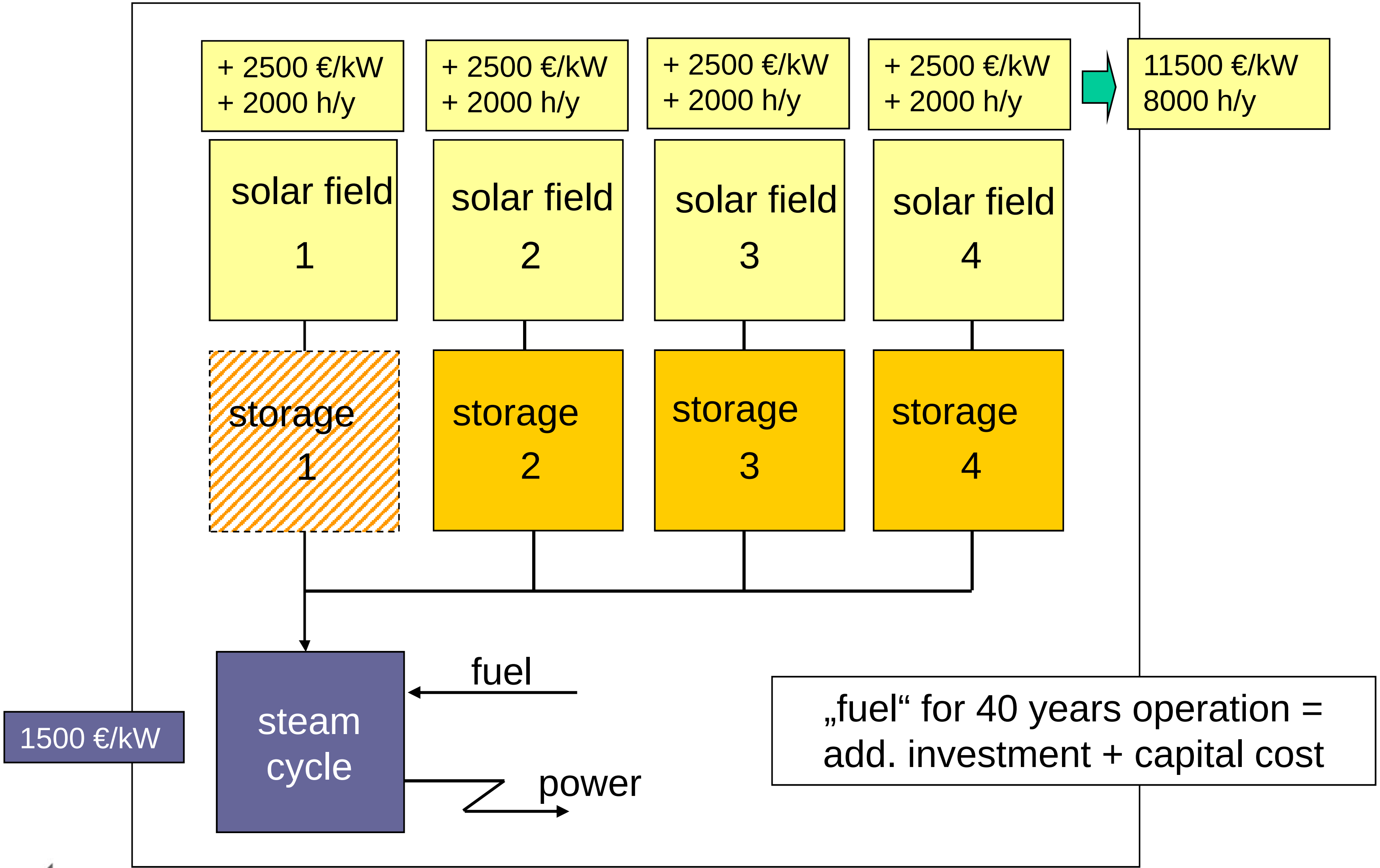
# Part 6: How to provide Policy and Finance

**Franz Trieb**

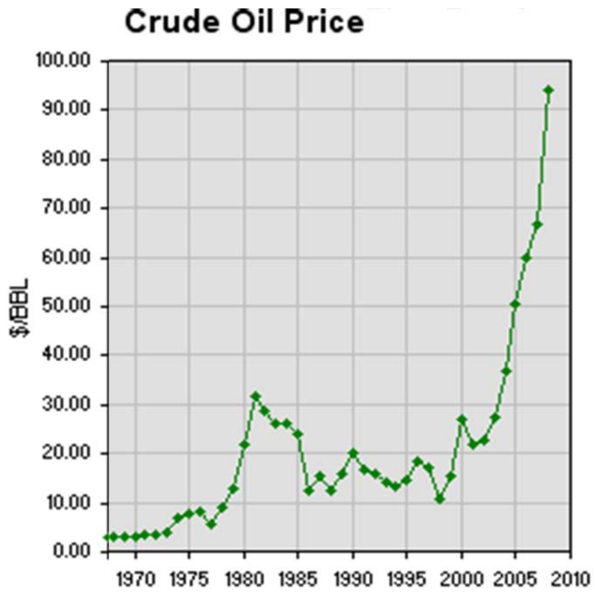
MBA Energy Management, Vienna, September 12-13, 2012

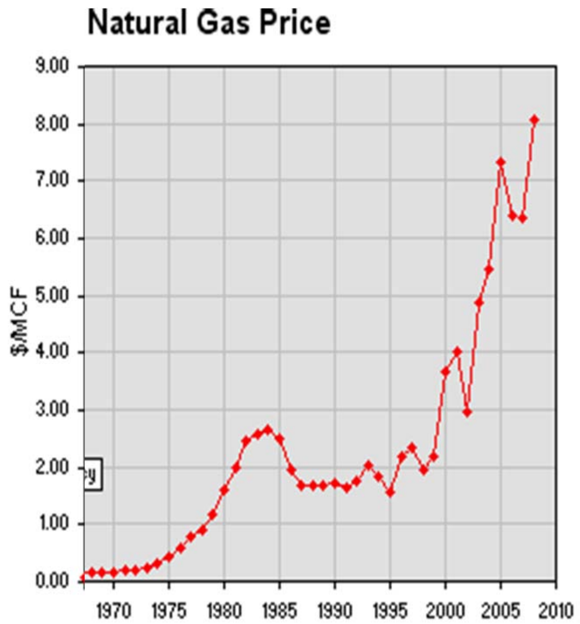
# Renewable Energy Investment Challenges

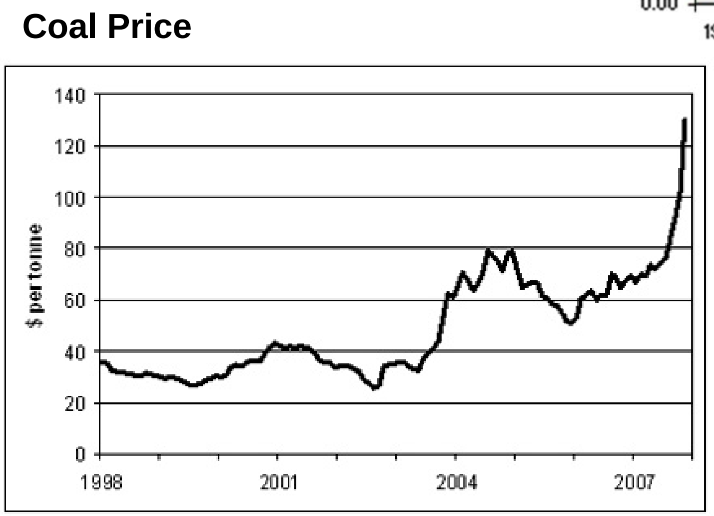
# Challenge 1: Investment replaces fuel consumption



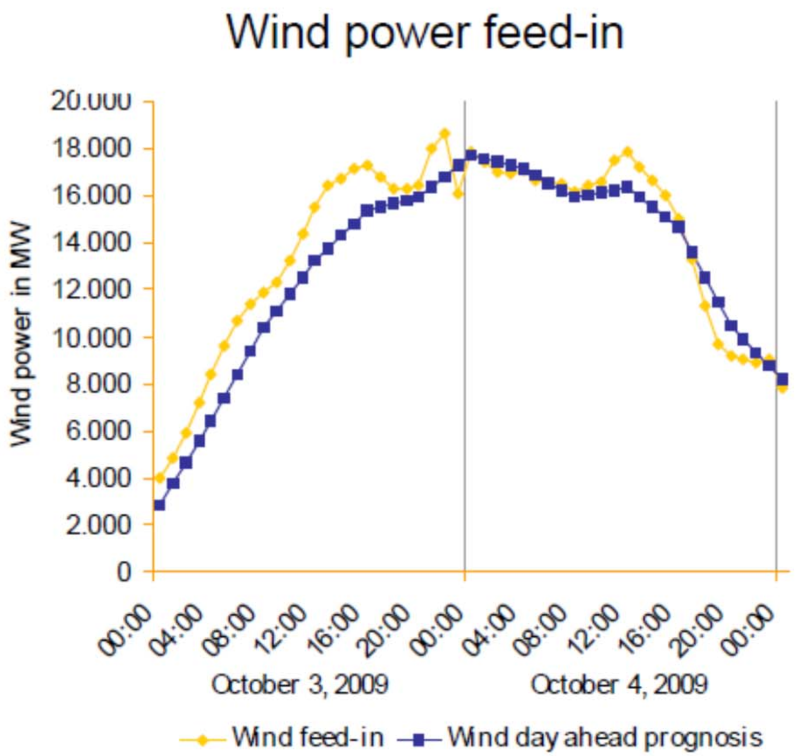
# Challenge 2: Known immediate cost but unknown future savings



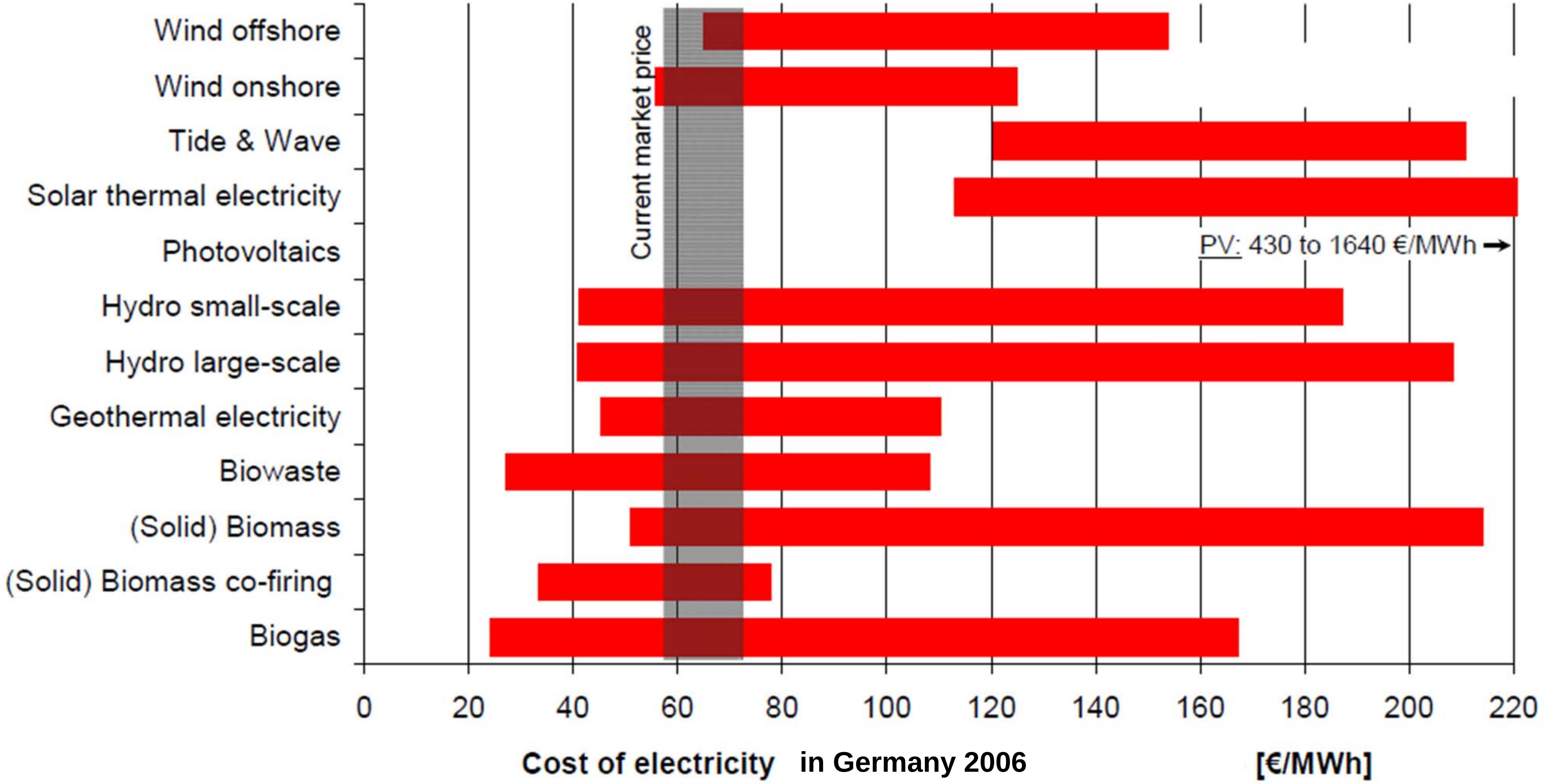
## Challenge 3: Fix Cost but Non-Fix Revenue





German power market during the first week-end of October 2009

# Challenge 4: Initial Cost Levels above Market Price



# Investment Challenges

1. Long-term investment (20-40 years) not only for the power plants but also for their „fuels“.
2. Unknown future savings compared to volatile and unpredictable conventional fuel prices.
3. Known long-term cost but unknown long-term revenues if electricity output is fluctuating and sold at spot markets.
4. Additional cost of early plants cannot be recovered under conventional market conditions and less if competitors are subsidized.

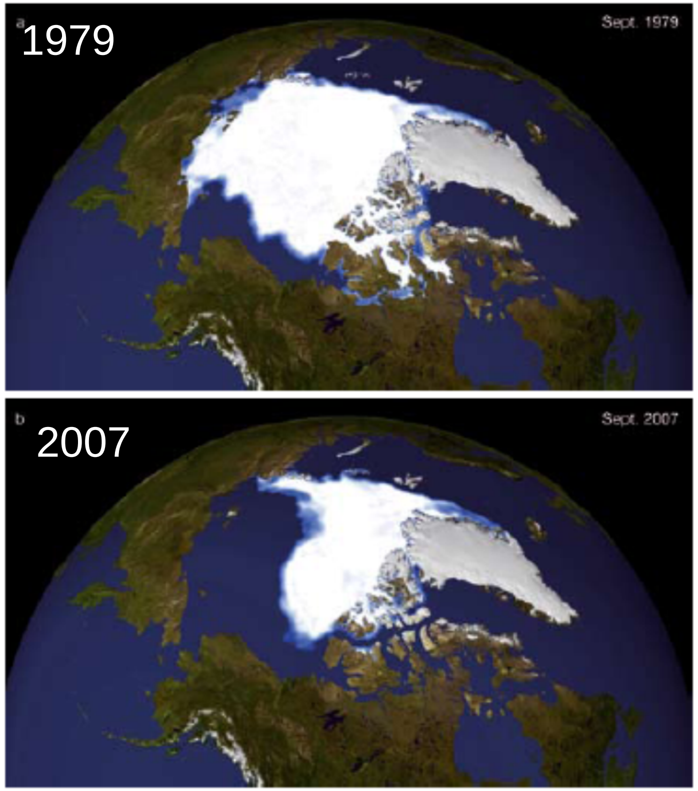
➔ Pioneers are punished by market forces because markets are adapted to conventional power schemes.

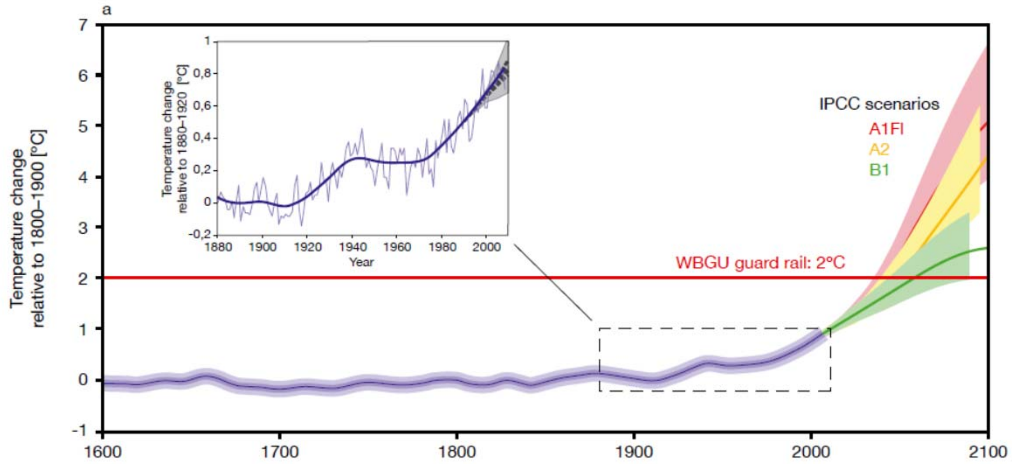
# Policies

# Policy Drivers for Renewable Energy

1. Global Climate Change
2. Fuel Import Dependency and Security of Supply
3. Volatility and Escalation of Fossil Fuel Prices
4. Environmental Impacts of Fossil Fuel Combustion
5. Cost of Nuclear Decommisioning and Disposal
6. Risk of Nuclear Proliferation and Accidents
7. Exploding Subsidization of Conventional Power Schemes

# The Threat of Global Climate Change



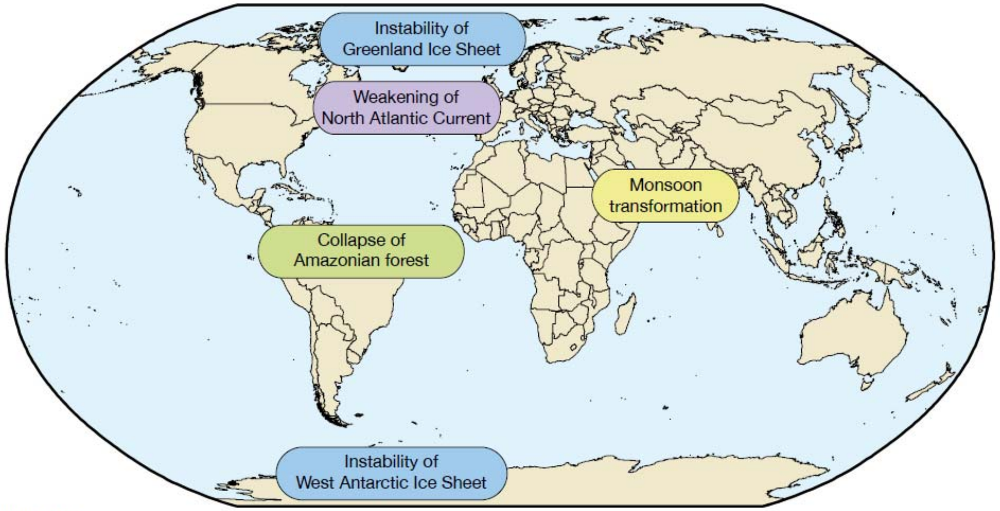
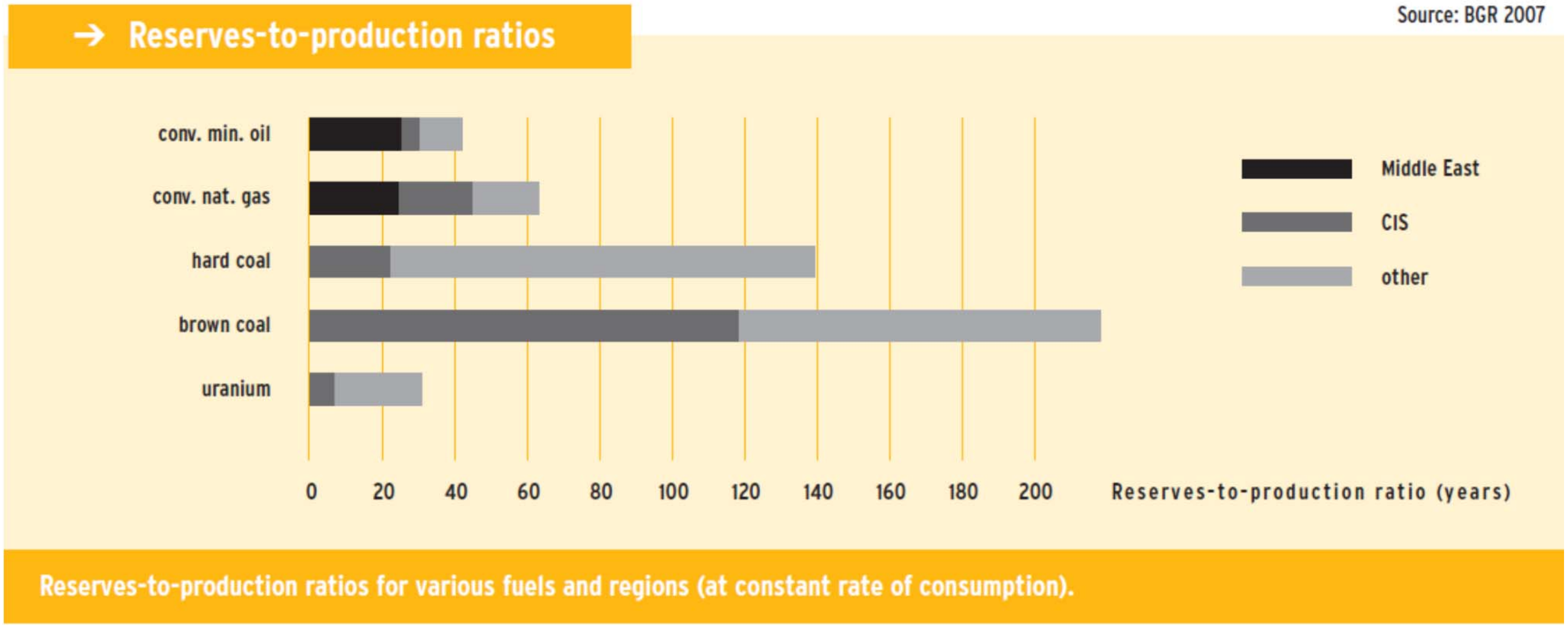



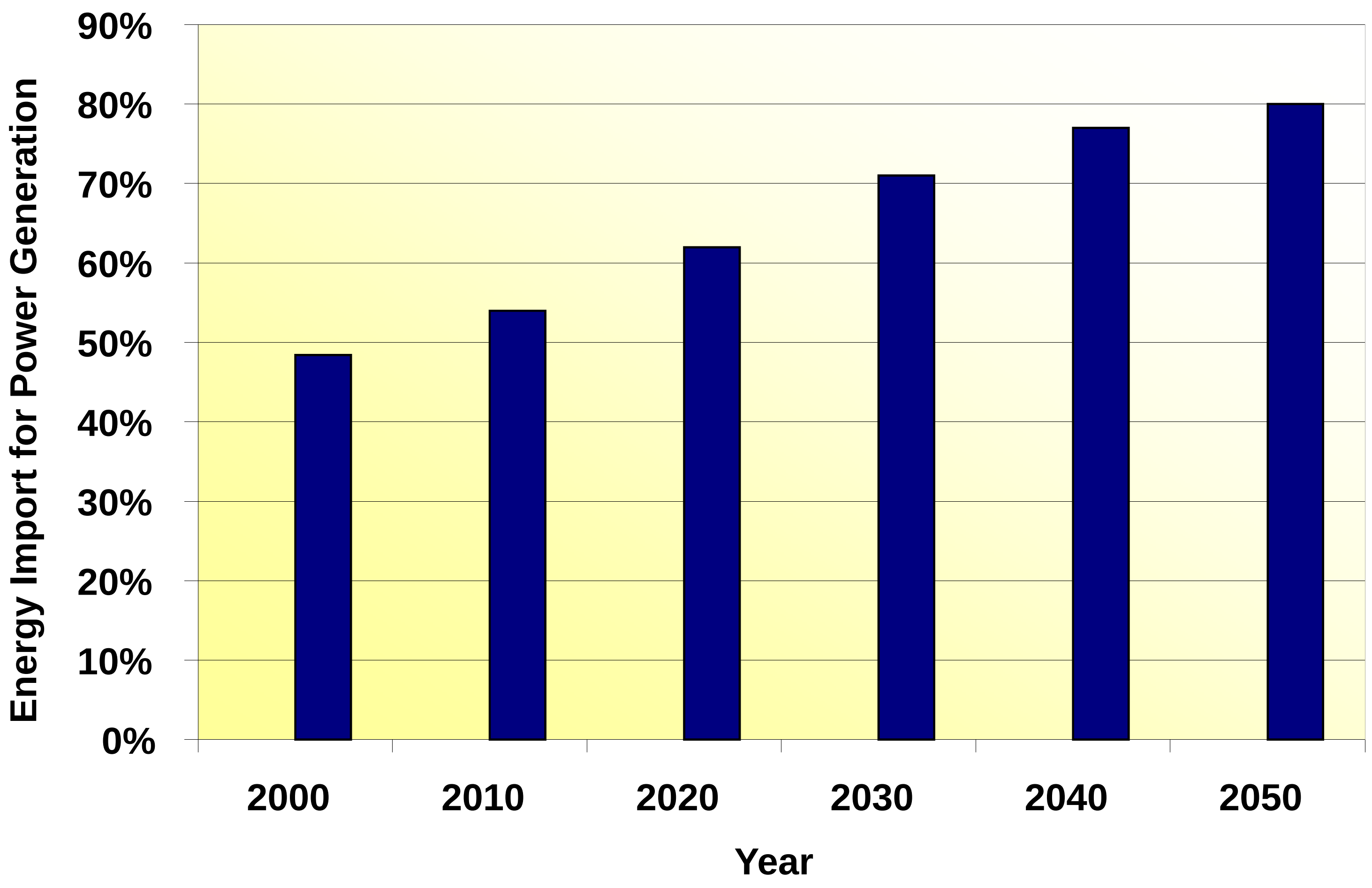

**Figure 2.2-3**
Selected tipping elements within the climate system.
Source: WBGU, 2008

# Availability of Fossil Fuels




„There is still enough fossil fuel left to ruin the planet.“

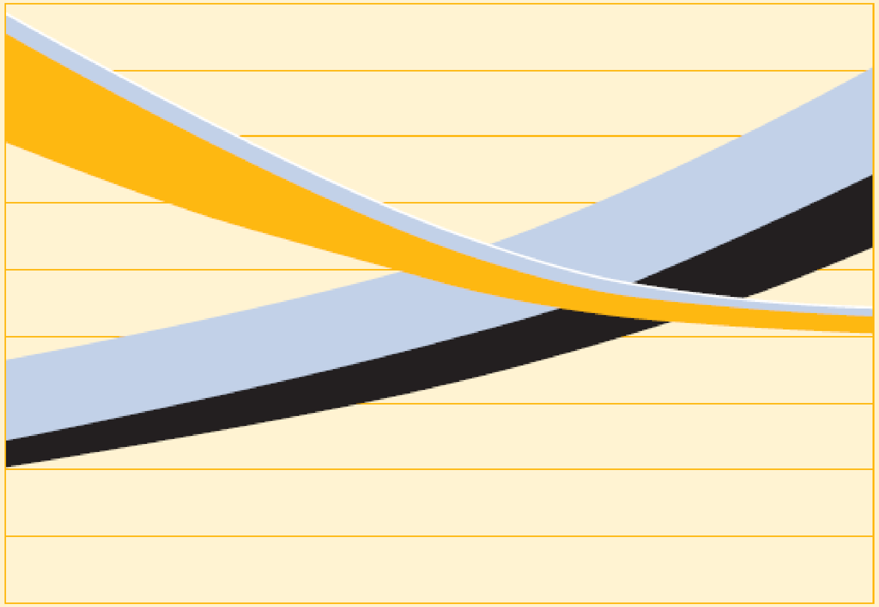
# Import Dependency of European Power Generation



Source: DLR

## → Development of costs for renewable and conventional energy sources

Specific energy costs



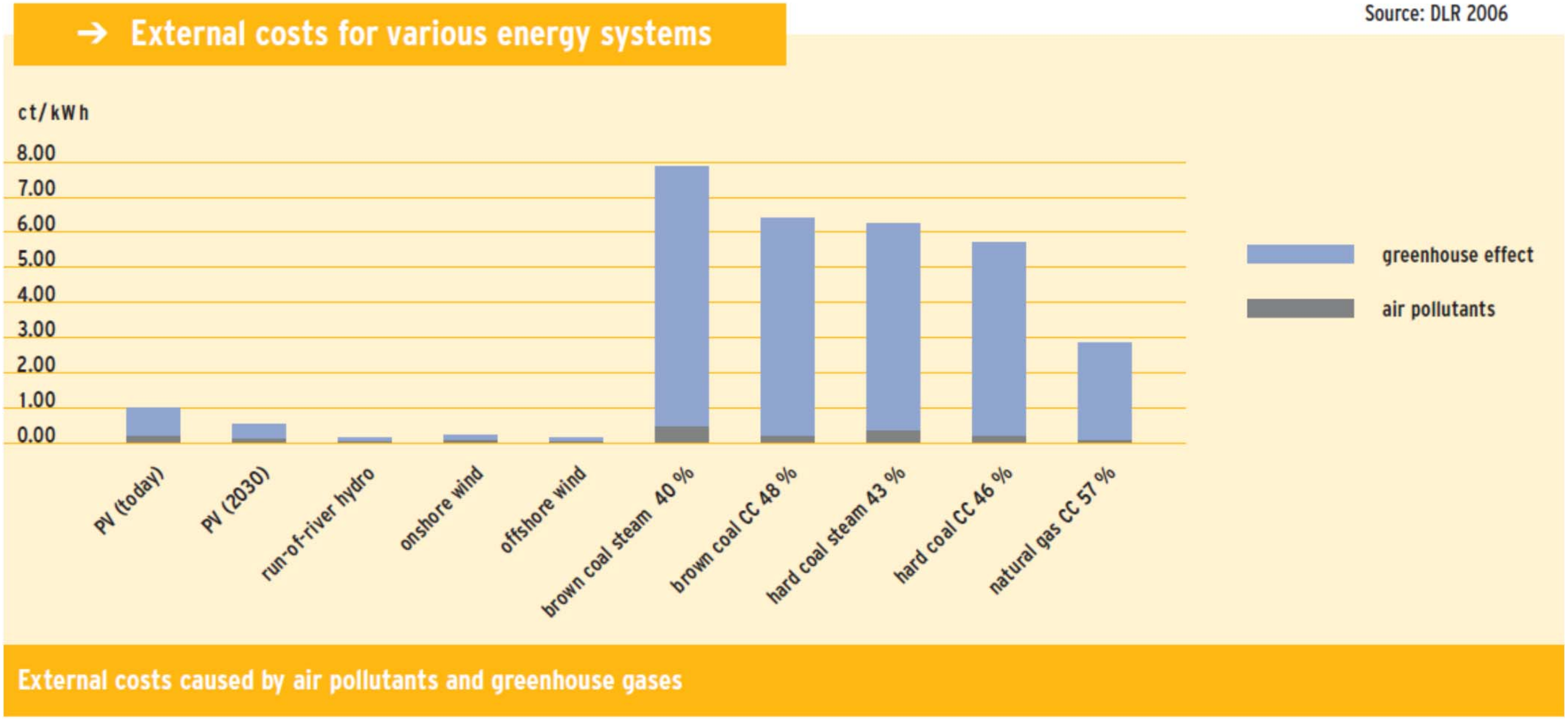
time ➔

Renewable energies | Fossil and nuclear energies | External costs

**Renewable energies**
- Young technologies; large potential for technological progress and cost reduction
- Unlimited, global availability
- Globally applicable, can not be misused, practically no hazards
- Low external costs (system manufacture)

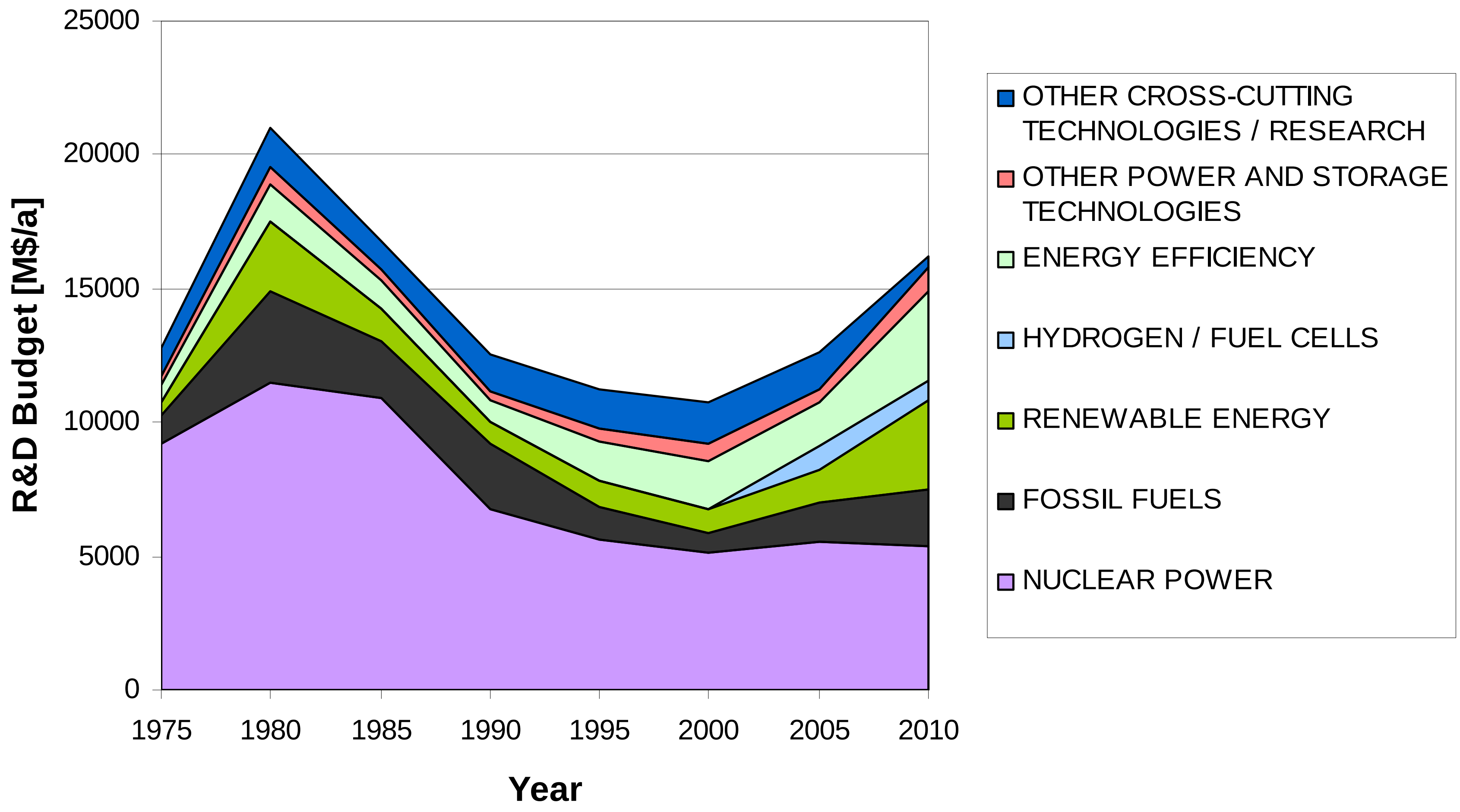
**Fossil and nuclear energies**
- Limited resources, unequal regional distribution
- Prices increase in the long term
- Expensive and high-risk nuclear technologies (breeders) required to substitute fossil resources
- Nuclear energy is not globally available; high potential for misuse and high-risk
- External costs: prohibitive in the long term for fossil fuels (climate change), probably prohibitive for nuclear

**Renewable energy sources provide the cheapest energy in the long run.**



→ External costs for various energy systems
Source: DLR 2006
ct/kWh
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
PV (today)
PV (2030)
run-of-river hydro
onshore wind
offshore wind
brown coal steam 40 %
brown coal CC 48 %
hard coal steam 43 %
hard coal CC 46 %
natural gas CC 57 %
greenhouse effect
air pollutants
External costs caused by air pollutants and greenhouse gases

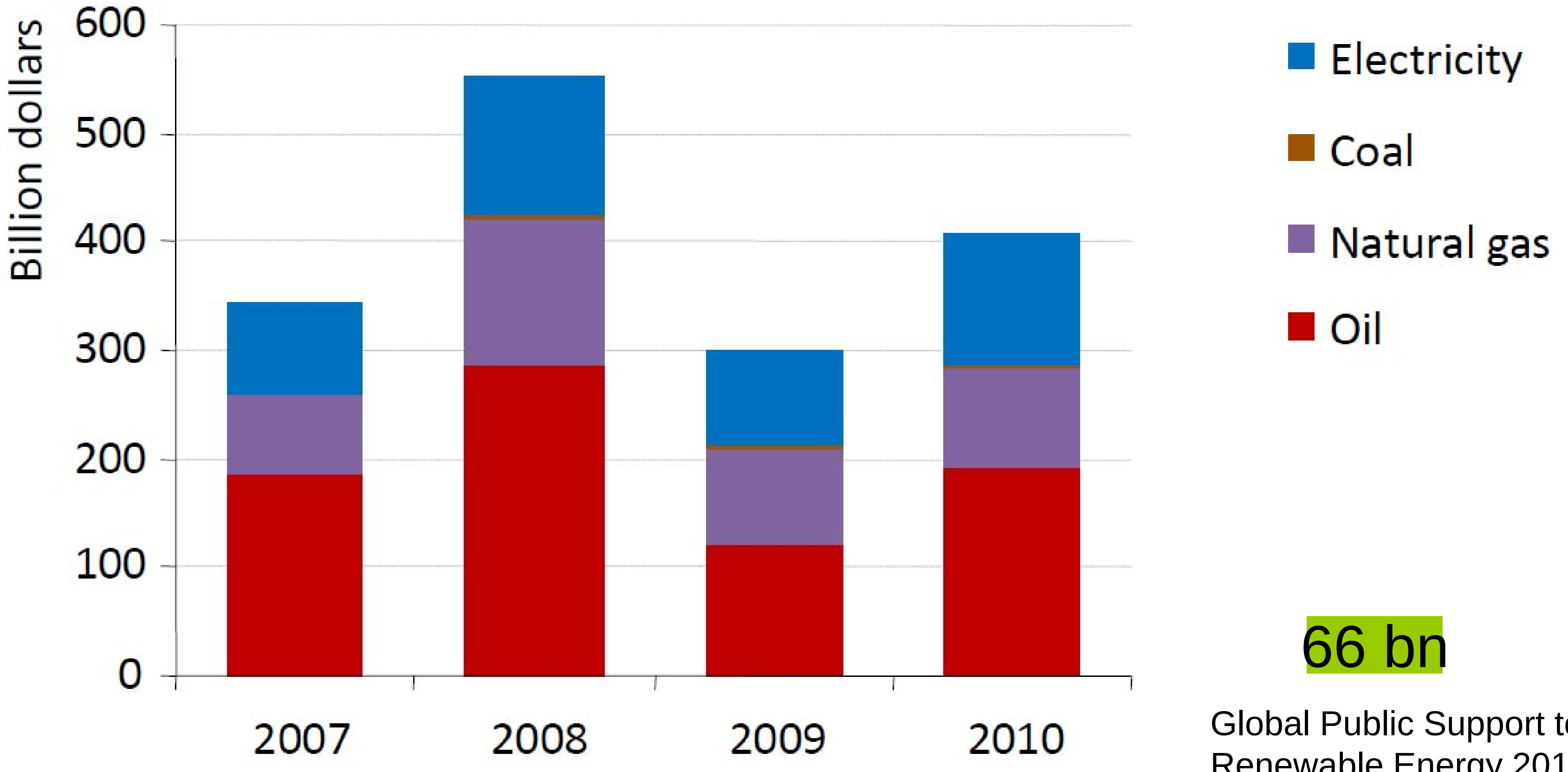
# Government Energy R&D Budget in IEA Countries






IEA 2011a

# Global Energy Subsidies




66 bn

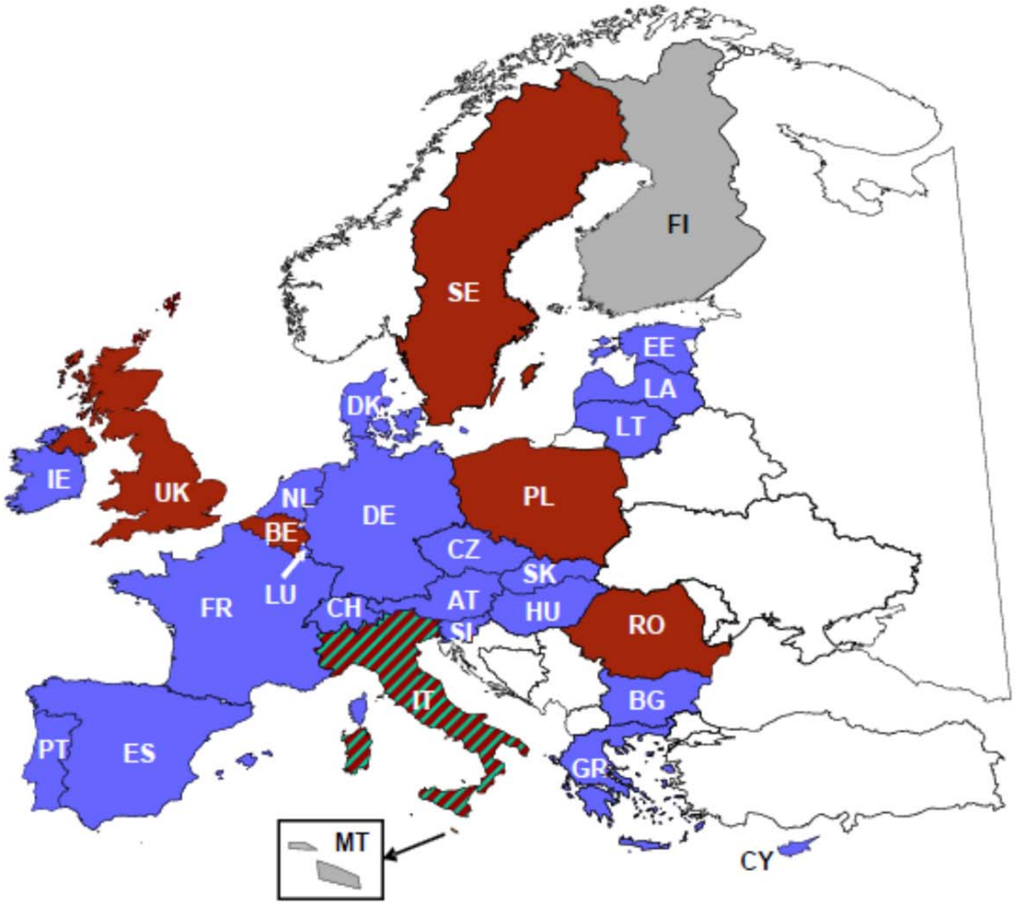
Global Public Support to Renewable Energy 2010

mainly developing countries

mainly industrial countries

IEA 2011b

# Support Models in European Countries




- Feed-In Tariffs
- Quota + Carb. Certif.
- Quota + Carb. Certif., Feed-In Tariff
- Tax Credits, Grants

# Carbon Trading

## Key elements of the budget approach

- The 2°C guard rail is adopted as legally binding in international law.
- For carbon dioxide ($CO_2$) from fossil sources, a global emission budget that is compatible with the 2°C guard rail is adopted.
- The global $CO_2$ budget is subdivided into national $CO_2$ budgets among all countries on an equal per-capita basis.
- Global $CO_2$ emissions must start to decrease between 2015 and 2020.
- Each country is committed to producing verifiable decarbonization road maps.
- An international emissions trading system is established, with all countries participating.
- The extent and institutional arrangements for financial and technology transfers are agreed.
- A decision is taken to establish a world climate bank.
- For $CO_2$ emissions resulting from land-use changes, especially deforestation, a separate legally binding regime is agreed.
- Specific agreements are reached on other greenhouse gases and climate-relevant substances.



**WBGU 2009**

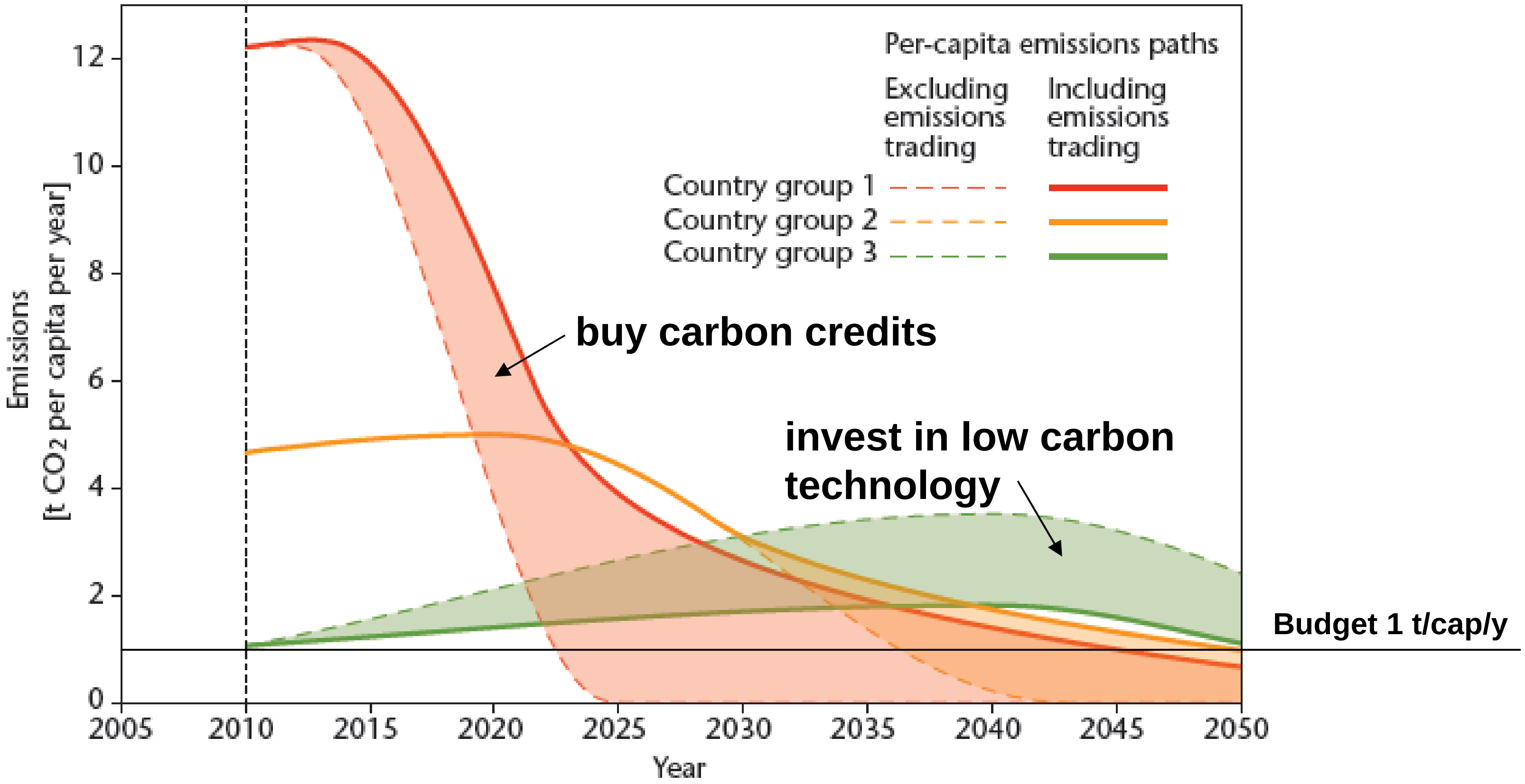
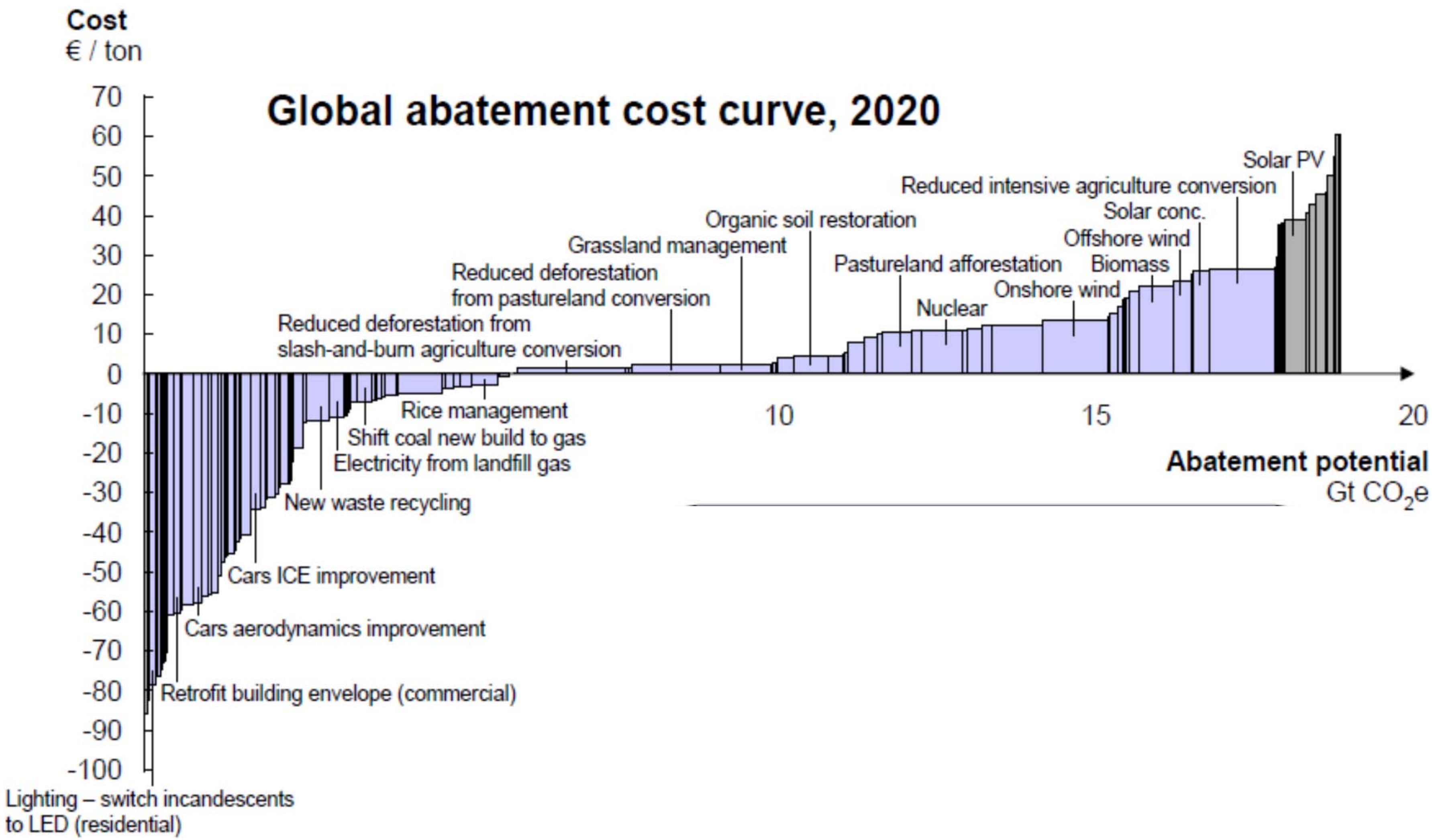
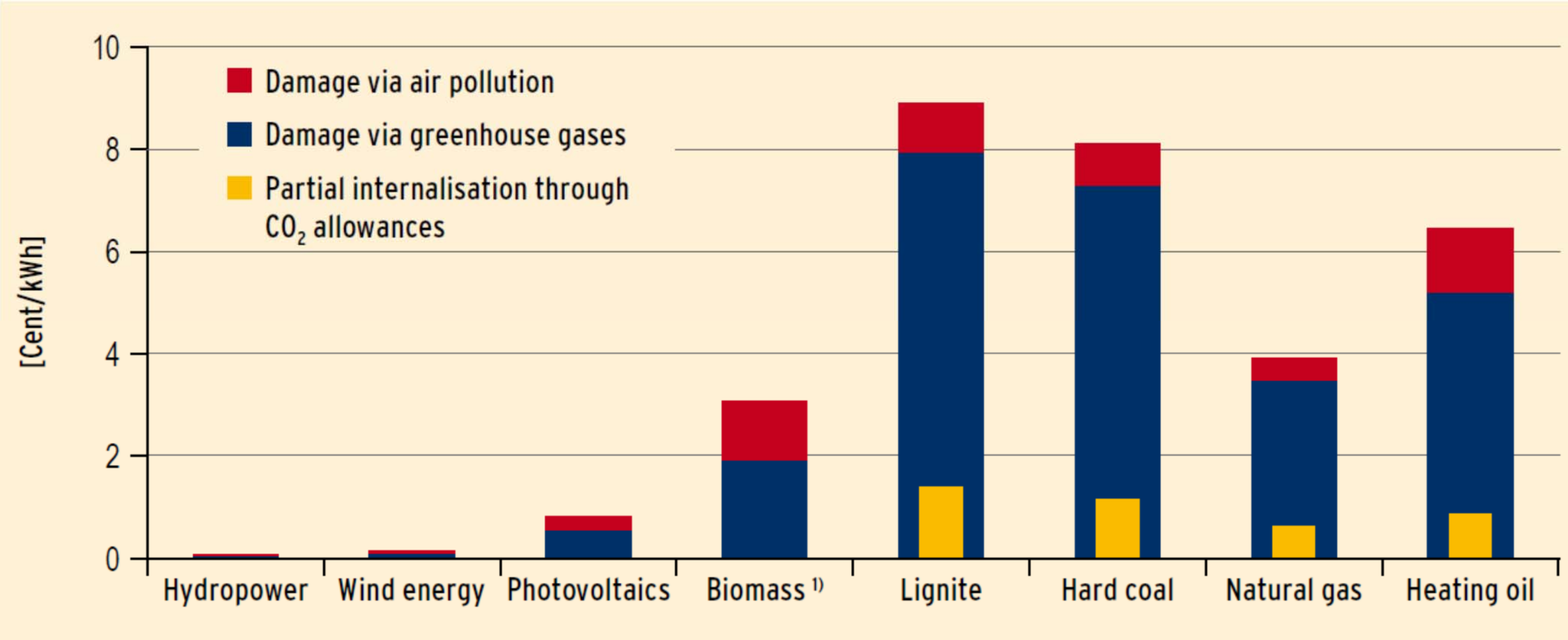



**Figure 1:** Examples of per-capita $CO_2$ emissions trajectories without (broken curves) and with (unbroken curves) emissions trading. It is assumed that Group 1 countries increase their budget by purchasing emission allowances for 122 Gt $CO_2$, at a cost of €10–30 per t $CO_2$, equivalent to €20–60 per capita per year on average. Total annual costs would amount to €30–90 billion. Group 2 countries purchase emission allowances totalling 41 Gt $CO_2$. The suppliers of the sum total, i.e. 163 Gt $CO_2$, are the Group 3 countries.
Source: WBGU, 2009



Cost
€ / ton
Global abatement cost curve, 2020
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
10
15
20
Abatement potential
Gt $CO_2e$
Solar PV
Reduced intensive agriculture conversion
Solar conc.
Offshore wind
Biomass
Onshore wind
Organic soil restoration
Grassland management
Pastureland afforestation
Nuclear
Reduced deforestation
from pastureland conversion
Reduced deforestation from
slash-and-burn agriculture conversion
Rice management
Shift coal new build to gas
Electricity from landfill gas
New waste recycling
Cars ICE improvement
Cars aerodynamics improvement
Retrofit building envelope (commercial)
Lighting – switch incandescents
to LED (residential)

## Environmental damage from emission of greenhouse gases and air pollutants vs. CO2 allowance costs in 2010 – electricity generation




BMU 2011a

# Carbon Trading:

A global $CO_2$ per capita budget must be agreed and enforced.

Carbon trading will accellerate avoidence in developing countries and delay avoidence in industrial countries.

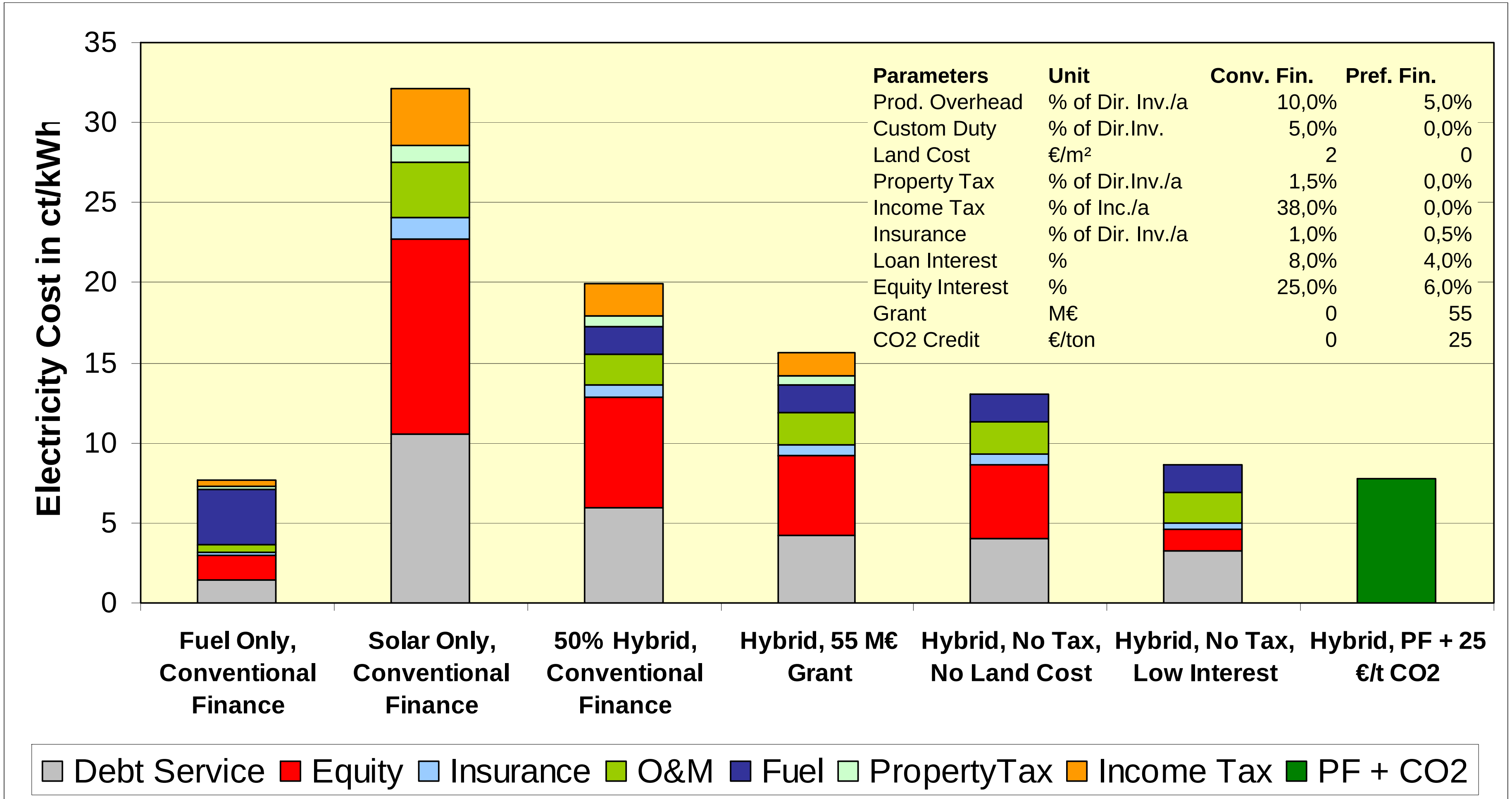
Least cost options will be realized first (no learning curve is initiated for other options).

Allowance prices are not  equivalent to external costs.

"**Carbon pricing** alone will not be sufficient to reduce emissions on the scale and pace required … **deployment incentives** for low emission technologies should increase two to five times … **public energy R&D funding** should double" – Stern Review

# Buy Down Subsidies

# Effects of Preferential Subsidized Finance on CSP Project




**medium load plant with 3600 full load hours per year**

# Buy Down Subsidy:

**No guarantee that plant will ever produce electricity.**

**The investment risk is mostly left to the investor.**

**Due to the high investment risk remaining for the investor, most money goes into interest rates rather than into the production of equipment.**

# Quota Models

# Quota Model:

**A portfolio standard is set by government, and market players are forced to introduce a certain amount of renewable energy.**

**Market will select the most economic solutions.**

**Is considered the most market-oriented instrument by some groups.**

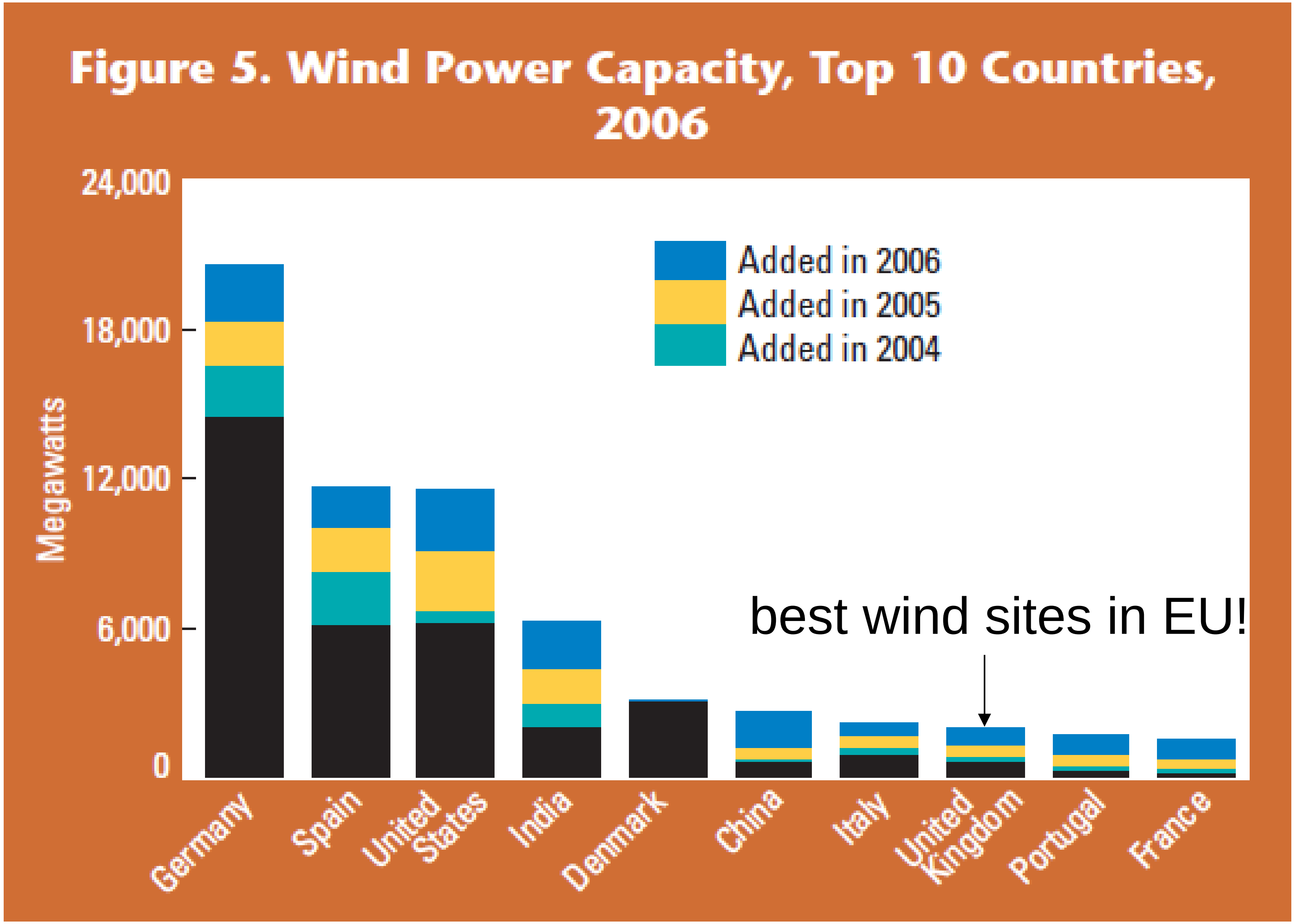
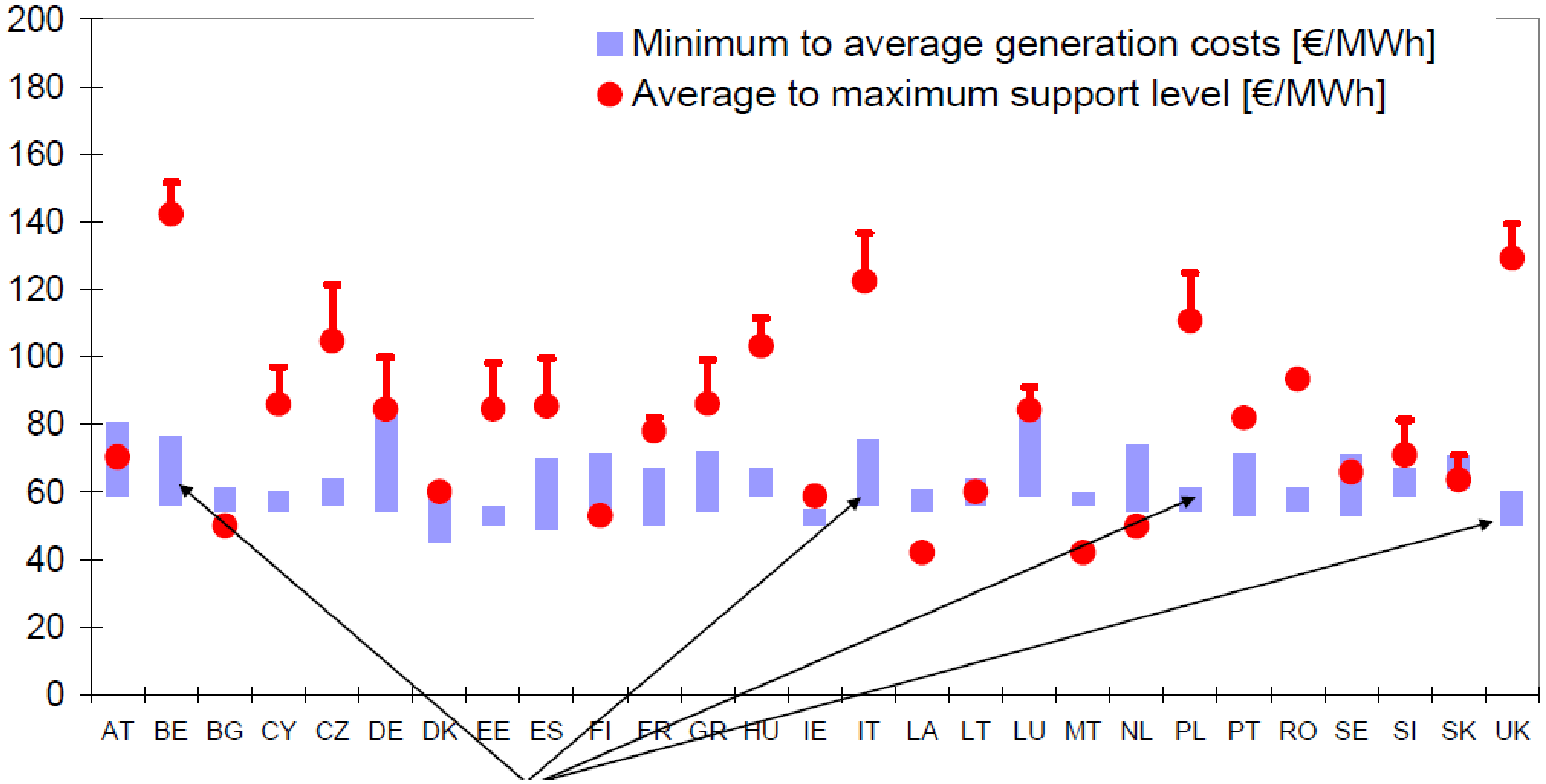


Figure 5. Wind Power Capacity, Top 10 Countries, 2006
Megawatts
24,000
18,000
12,000
6,000
0
Added in 2006
Added in 2005
Added in 2004
best wind sites in EU!
Germany
Spain
United States
India
Denmark
China
Italy
United Kingdom
Portugal
France

# Support Levels in European Countries




Quota Models have higher Policy Cost

# Quota Model:

High risk for investors leads to high (capital) cost.

Only least cost options are selected (no learning curve is initiated for other options).

Was the favorite instrument of Mao Tse Tung.

# Feed-In Law

# How does a Renewable Electricity Feed-In Law Work?

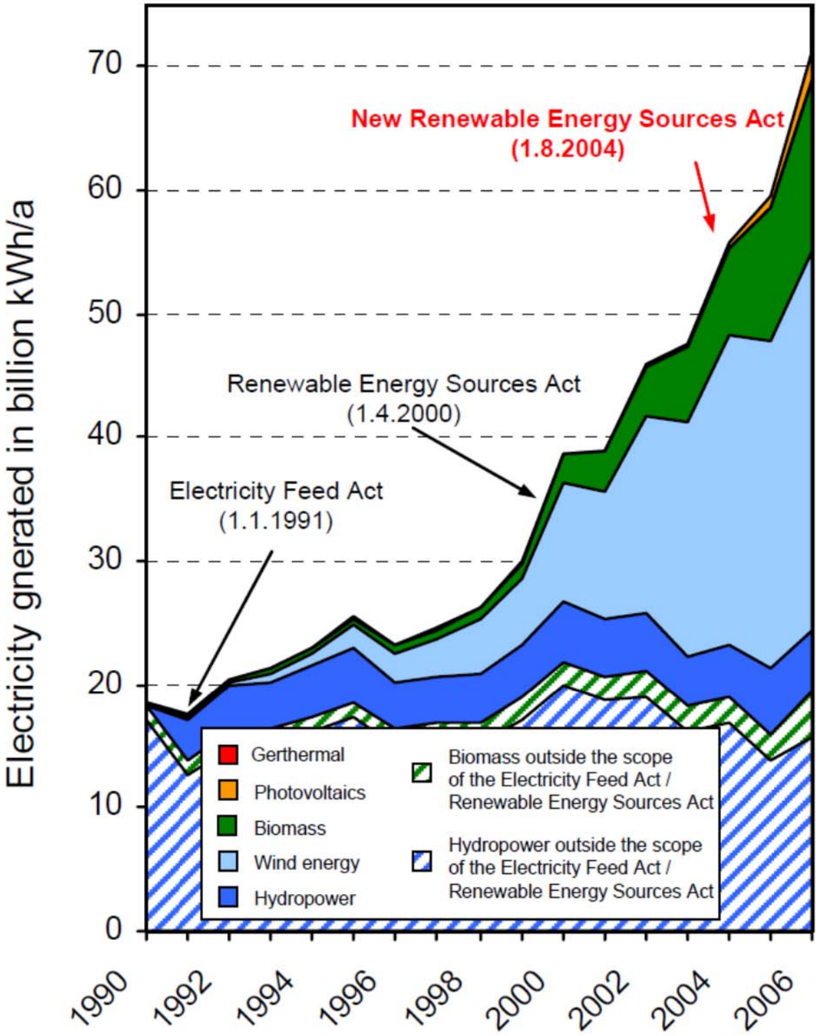
1. A feed-in law is a long-term power purchase agreement enforced and guaranteed by the government.
2. Utilities must take renewable electricity as generated and pay a fix tariff or an additional premium per kWh to producers.
3. Utilities bill additional costs to consumers.
4. Feed-in tariffs must be adjusted to local conditions, e.g.:
   - renewable resource potential
   - technology type, status and learning curve
   - inflation rates
5. Regulation must be reliable, transparent and predictable and should only be fine-tuned after implementation.

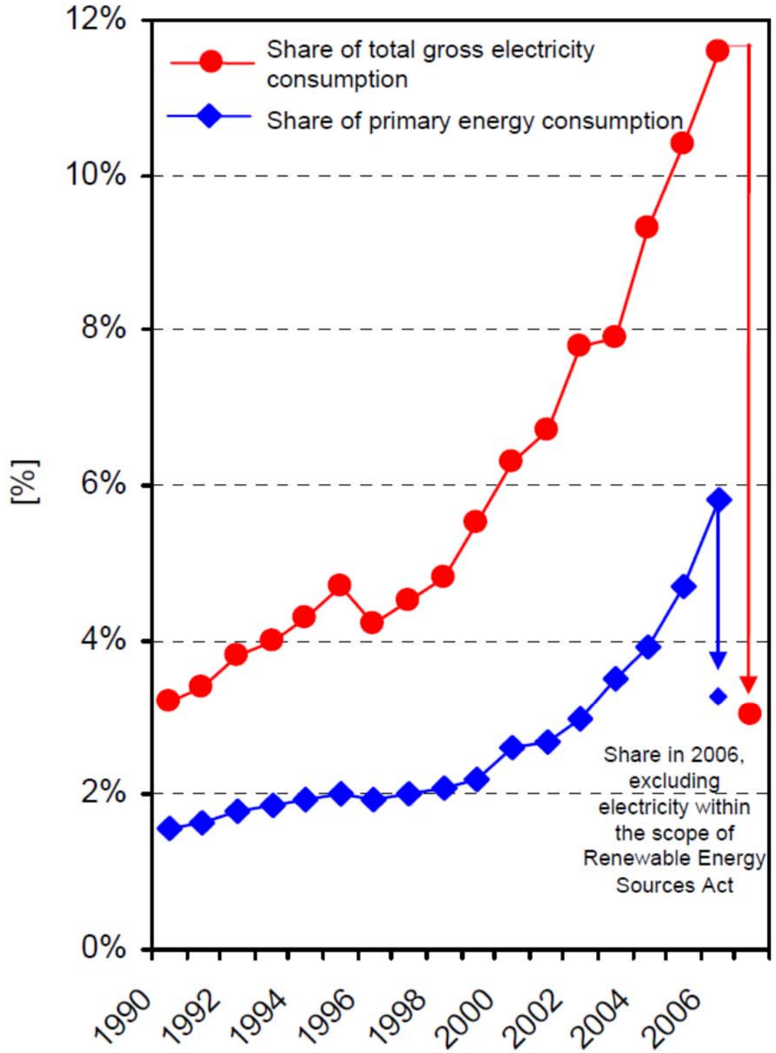
# German Feed-In Law: Example Tariffs 2008

| | Feed-In Tariff | Annual Degression | Payment Period |
|---|---|---|---|
| | ct/kWh | %/a | a |
| large Hydro | 3.55 - 7.36 | 1.0 | 15 |
| small Hydro | 6.65 - 9.67 | 0.0 | 30 |
| Biogas | 7.92 - 16.65 | 1.5 | 20 |
| Geothermal | 7.16 - 15.00 | 1.0 | 20 |
| Wind onshore | 5.07 - 8.03 | 2.0 | 20 |
| Wind offshore | 6.07 - 8.92 | 2.0 | 20 |
| Photovoltaic | 35.49 - 51.75 | 5.0 | 20 |

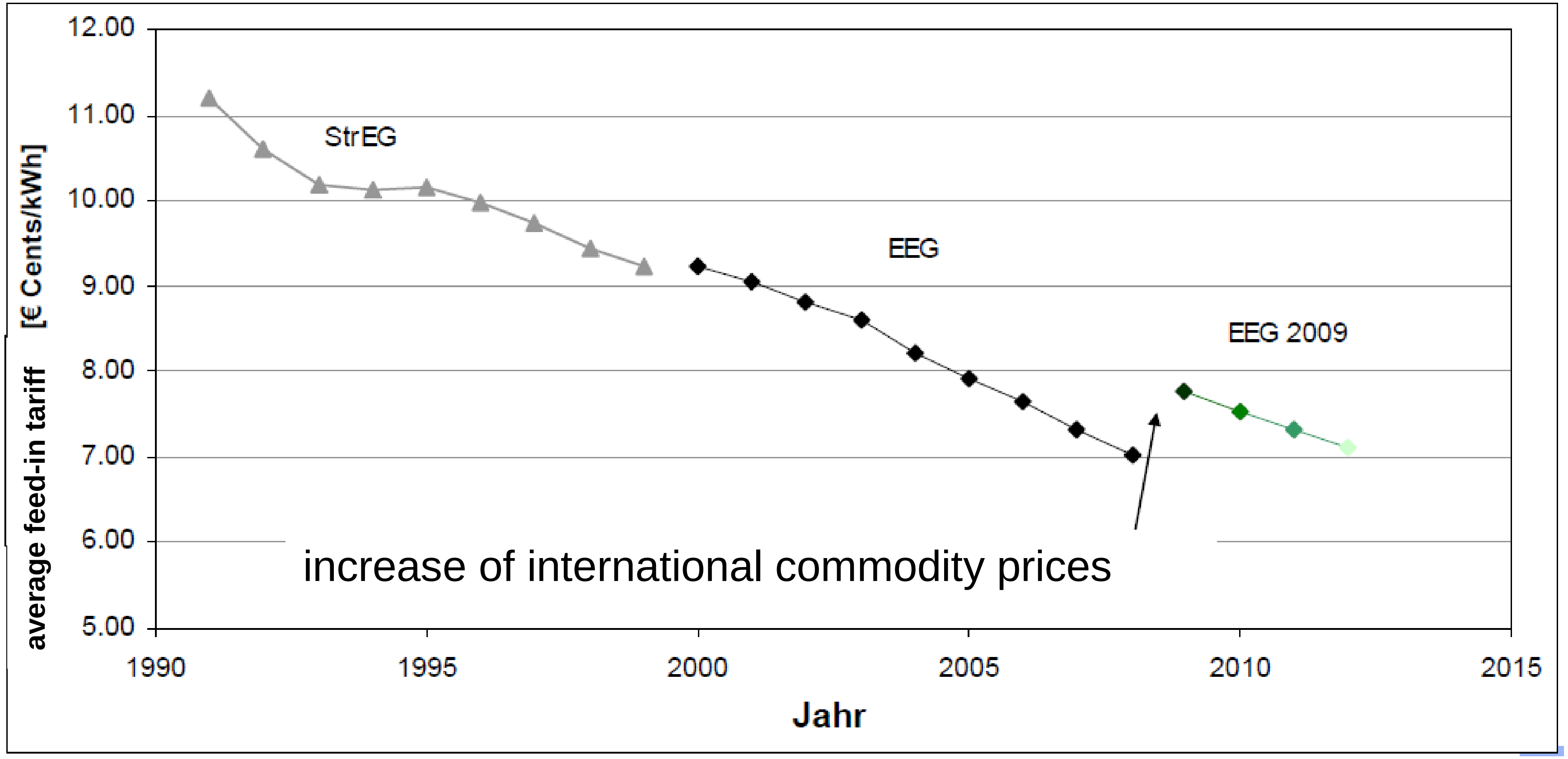
higher values: first 5 years and bonus additions

# German Feed-In Law: Impact on RES Utilization

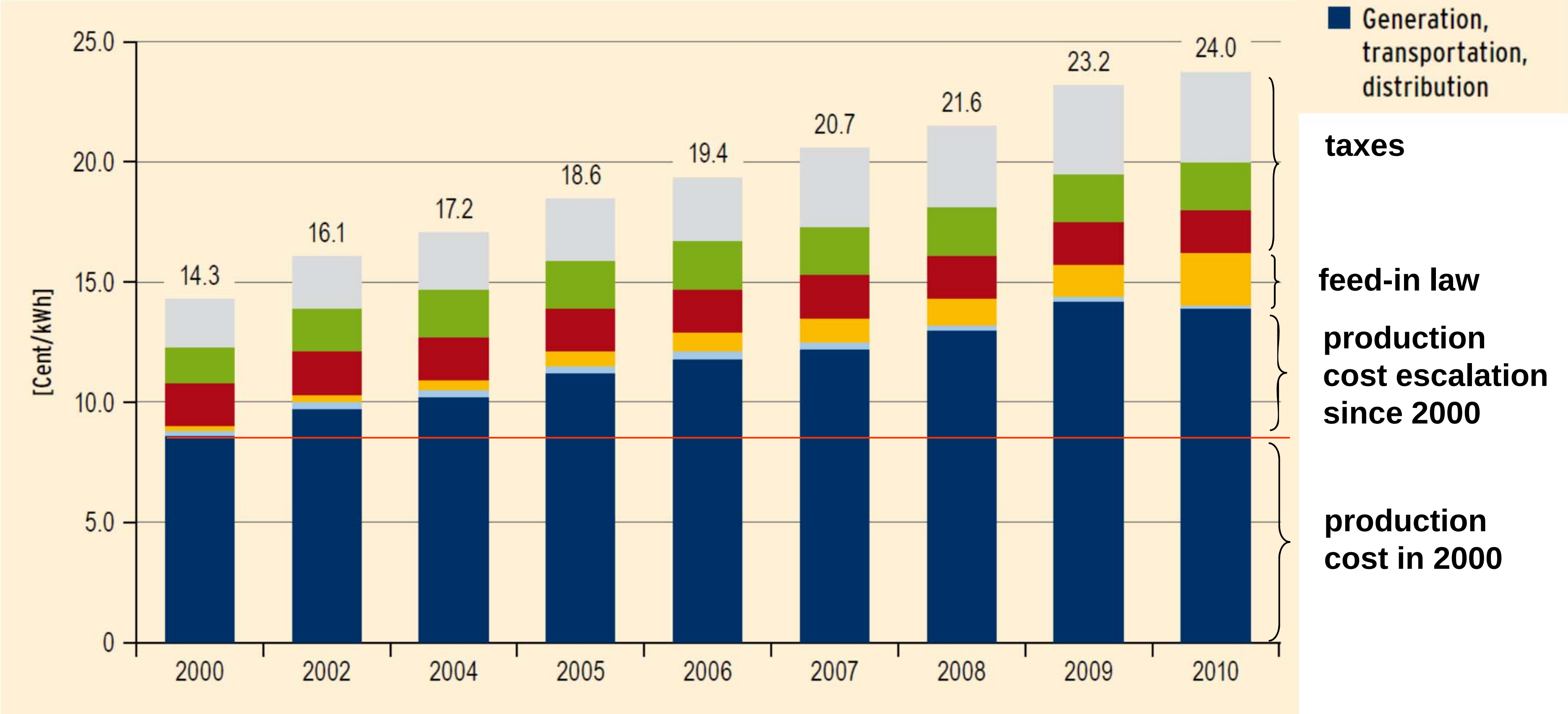


# Support Level of the German Feed-in Tariff System



# German Feed-In Law: Impact on Consumers

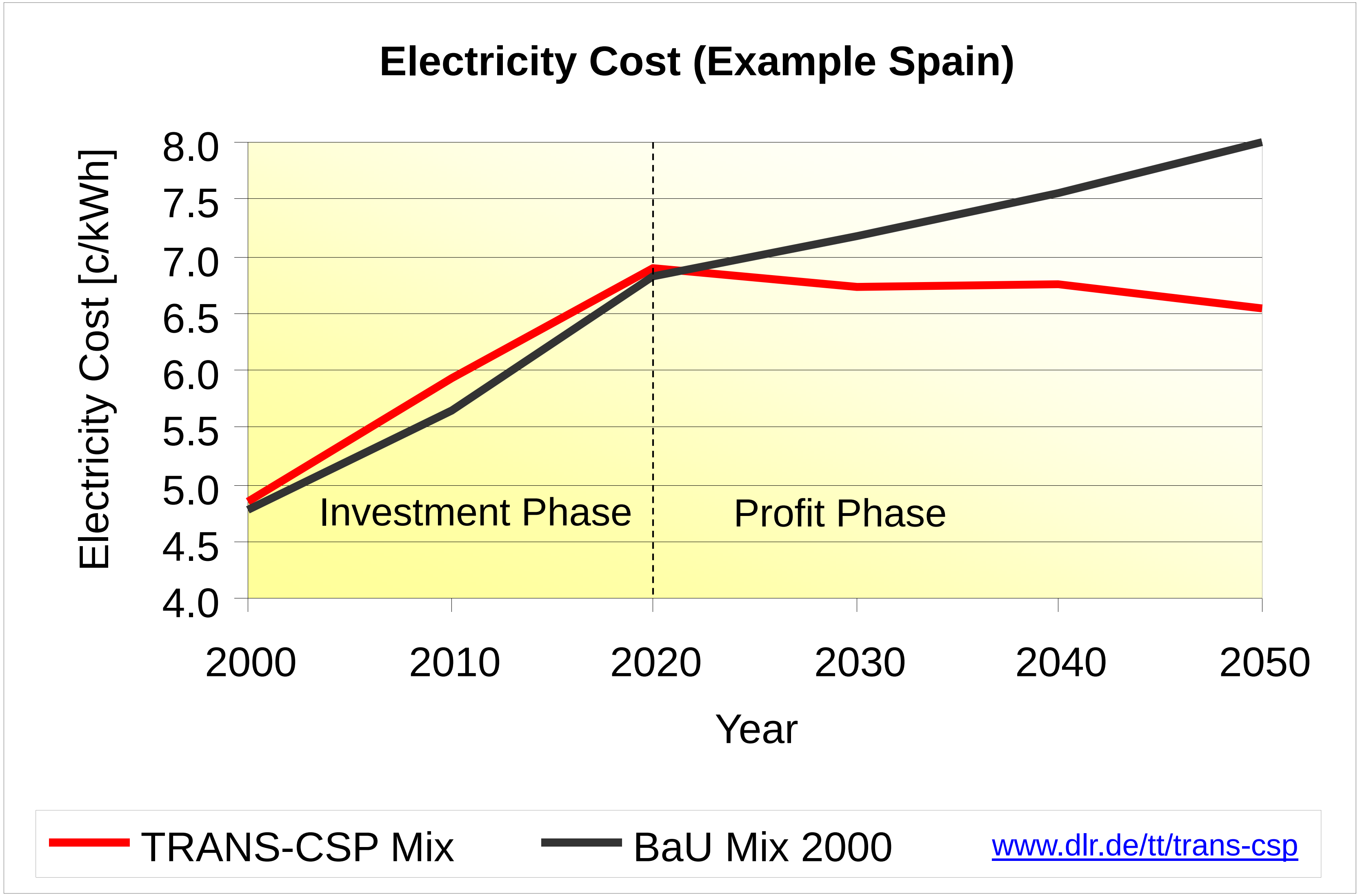



➔ 2010: 2.3 ct/kWh added but 0.6 ct/kWh avoided

# German Feed-In Law: Impact on Consumers

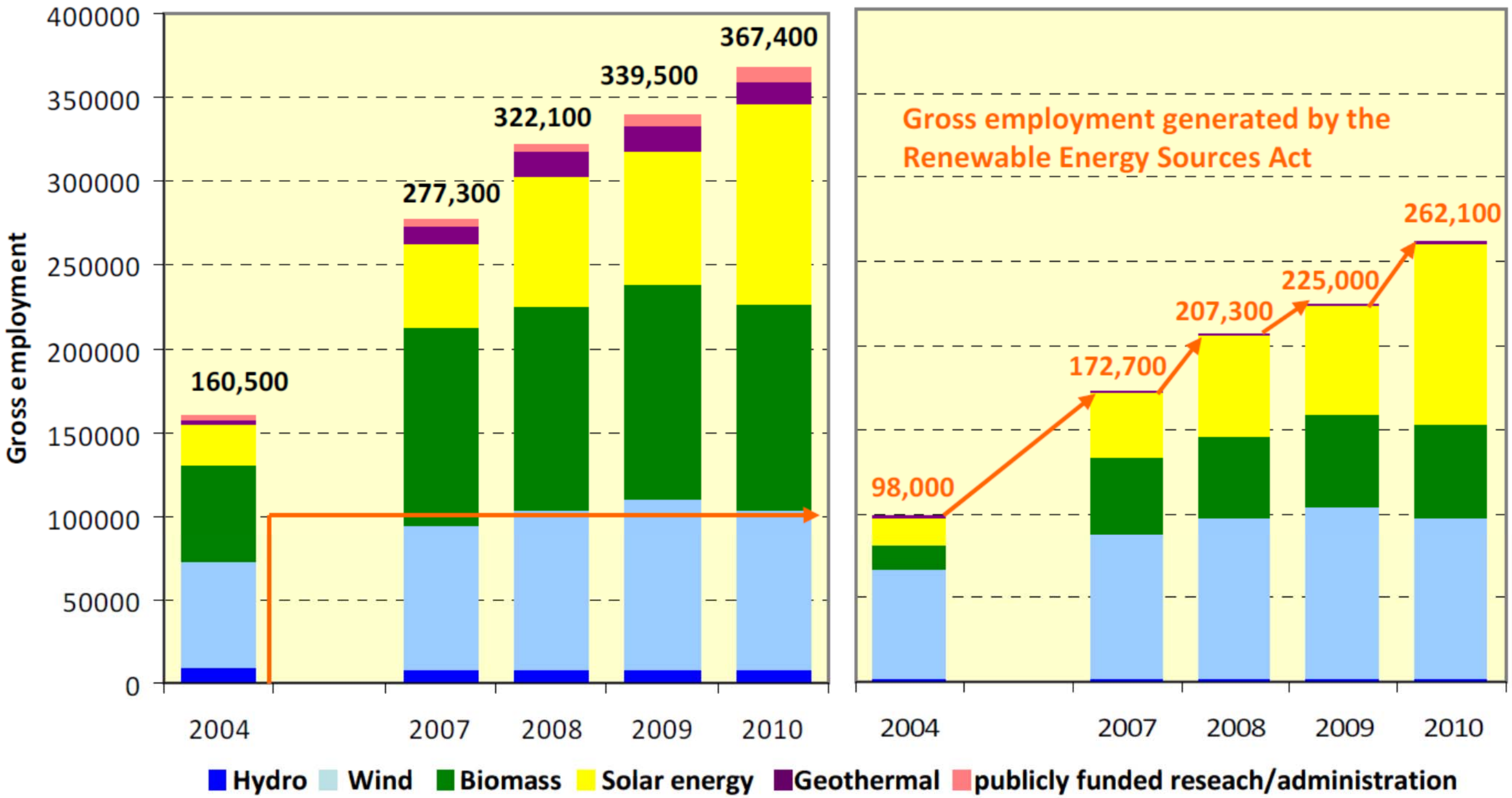
| Year | Gross Power Consumption | Feed-In Electricity | Feed-In Tariffs Paid | Avoided Fuel Cost | Additional Load to Consumers | Consumer Tariff Addition | Avoided Cost Escalation |
|---|---|---|---|---|---|---|---|
| | GWh/y | GWh/y | Billion Euro | Billion Euro | Billion Euro | €-cent/kWh | €-cent/kWh |
| 2000 | 580000 | 10391 | 1,00 | 0,10 | 0,90 | 0,200 | 0,017 |
| 2001 | 585000 | 18145 | 1,58 | 0,48 | 1,10 | 0,300 | 0,082 |
| 2002 | 587000 | 24970 | 2,23 | 0,53 | 1,70 | 0,400 | 0,090 |
| 2003 | 599000 | 28417 | 2,61 | 0,81 | 1,80 | 0,400 | 0,135 |
| 2004 | 608000 | 38511 | 3,61 | 1,21 | 2,40 | 0,600 | 0,199 |
| 2005 | 612000 | 43967 | 4,50 | 1,70 | 2,80 | 0,600 | 0,278 |
| 2006 | 617000 | 51545 | 5,81 | 2,51 | 3,30 | 0,800 | 0,407 |
| 2007 | 618000 | 67010 | 7,61 | 3,31 | 4,30 | 1,000 | 0,536 |
| 2008 | 614000 | 71150 | 9,02 | 4,32 | 4,70 | 1,100 | 0,704 |
| 2009 | 600000 | 75053 | 10,78 | 5,48 | 5,30 | 1,200 | 0,913 |
| 2010 | 604000 | 80700 | 13,18 | 3,78 | 9,40 | 2,300 | 0,626 |

BMU 2011a




$€_{2000}$, Fuel Cost: IEA / WEO 2005, after 2020 CCS

# German Feed-In Law: Impact on Labour



# Why does a Renewable Electricity Feed-In Law Work?

1. Long-term investments need long-term power purchase agreements. Renewables guarantee long-term price stability.
2. PPA security leads to lower interest rates expected by investors (6-7% vs. 10-15%). This reduces dramatically the (capital) cost.
3. Consumers do not feel the temporary additional load but profit from more stable prices and fuel savings.
4. Feed-in tariffs leave room for competition within each technology segment, but assure that new sources are made accessible.
5. Well balanced feed-in tariffs reduced from year to year optimise cost reductions by learning, competition and economies of scale.

➔ its a cost-effective investment in new energy, not a subsidy

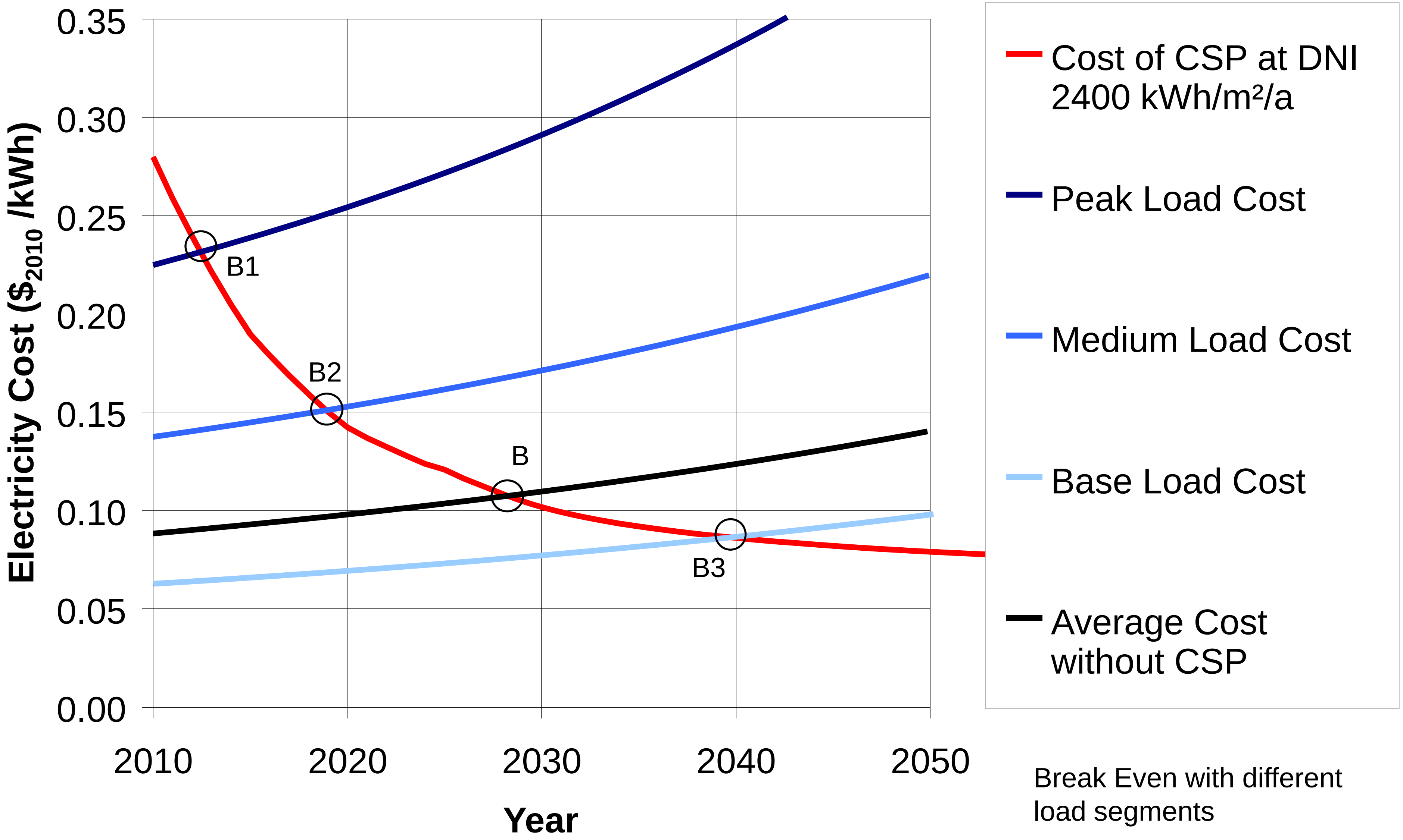
# Feed-In Law:

**Pioneers are rewarded while consumers are forced to invest in new sources of energy.**

**Additional cost is only paid for delivered renewable kWh.**

**➔ not a cheap option but a least cost strategy**

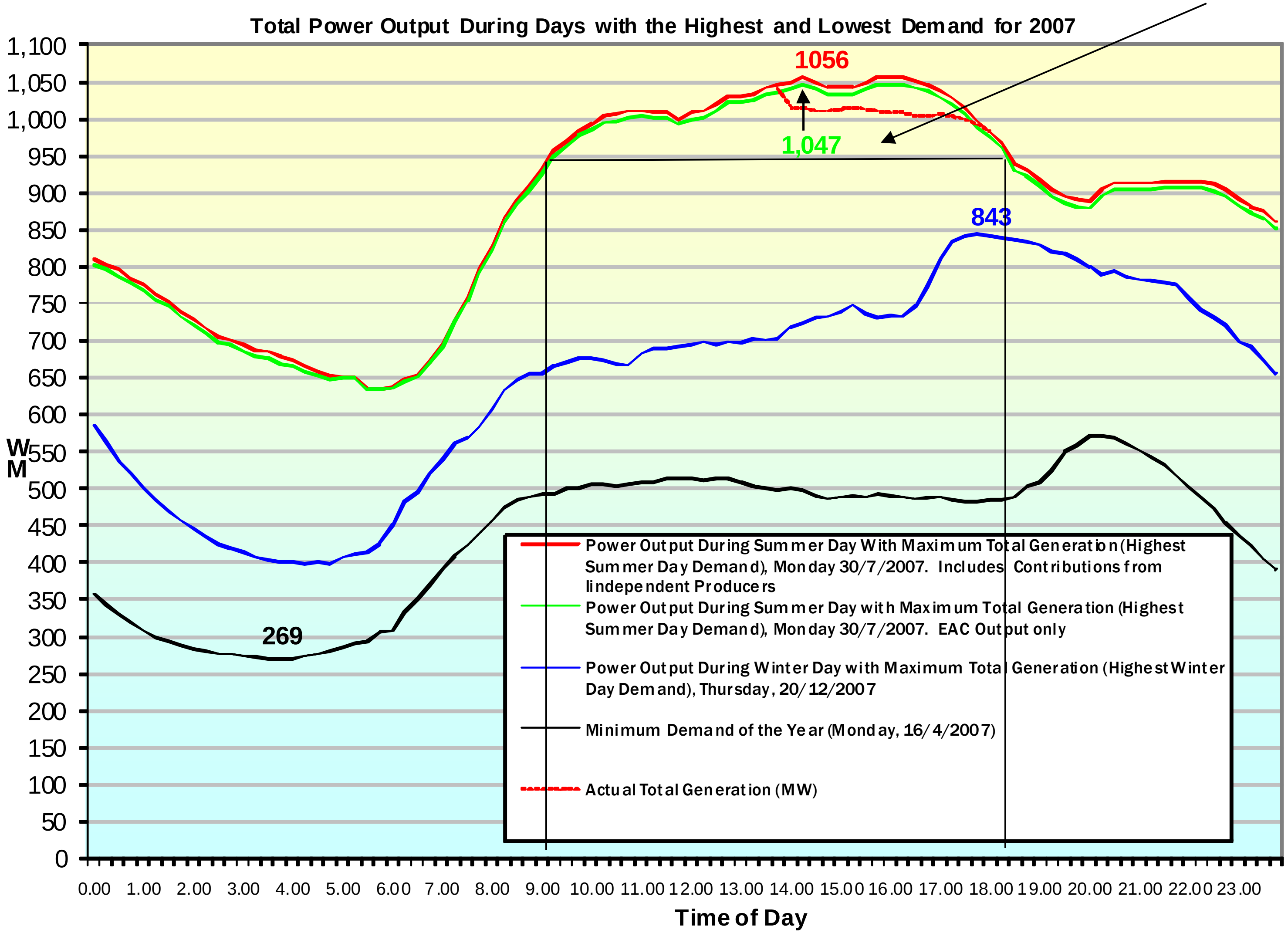
# Niche Markets




Break Even with different load segments

# Example: Load Curve in Cyprus 2007

Gas Turbines fired with Diesel



# Niche Markets:

**In summer 2008, those who claimed to be too poor to invest in renewable energy, learned that in fact they are too poor to not invest in renewable energy.**

# Sources and Literature


| | |
|---|---|
| WETO 2003 | European Commission Directorate-General for Research, World Energy Technology Outlook, Brussels 2003 http://ec.europa.eu/research/energy/pdf/weto_final_report.pdf |
| Neij 2003 | Neij, L., et al., Experience Curves: A Tool for Energy Policy Assessment, Lund University, European Commission, Lund 2003 http://www.iset.uni-kassel.de/extool/Extool_final_report.pdf |
| Neij 2008 | Neij, L., Cost development of future technologies for power generation—A study based on experience curves and complementary bottom-up assessments, Energy Policy 36 (2008) 2200– 2211 |
| oilnergy 2008 | www.oilnergy.com |
| DLR 2009 | Dr. F. Trieb, C. Hoyer-Klick, Dr. C. Schillings, Global Potential of Concentrating Solar Power, SolarPaces Conference, Berlin Stuttgart 2009, www.dlr.de/tt/csp-resources |
| greenpeace 2008 | energy [r]evolution – a sustainable global energy outlook, greenpeace 2008 http://www.greenpeace.org/raw/content/international/press/reports/energyrevolutionreport.pdf |

| | |
|---|---|
| BMU 2009 | German Federal Ministry for the Environment,<br>Renewable Energy Sources Act (EEG), Progress Report 2009<br>Berlin 2009<br>http://www.erneuerbare-energien.de/inhalt/2720/42038/ |
| BMU 2009 | Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)<br>Dr. M. Pehnt (IFEU/coordination) with D. Jessing,<br>P. Otter, R. Vogt, G. Reinhardt (IFEU)<br>Dr. W. Krewitt, M. Nast, Dr. J. Nitsch, Dr. F. Trieb (DLR)<br>Renewable Energies - Innovations for a Sustainable Energy Future<br>Berlin 2009<br>http://www.erneuerbare-energien.de/inhalt/44744/4590/ |
| BMU 2011a | Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)<br>Renewable energy sources in figures - national and international development<br>Dipl.-Ing. (FH) C.I Linkohr, Dr. F. Musiol, Dipl.-Ing. (FH) M. Ottmüller, Dipl.-Kffr. U. Zimmer<br>Center for Solar Energy and Hydrogen Research Stuttgart<br>Berlin 2011<br>http://www.bmu.de/english/renewable_energy/doc/39831.php |
| REN21 2011 | Renewables 2011 – Global Status Report, Paris 2011<br>www.ren21.net/Portals/97/documents/GSR/REN21_GSR2011.pdf |
| Kagel 2006 | Alyssa Kagel<br>Geothermal Energy Association<br>Washington D.C. 2006<br>http://www.geo-energy.org/publications/reports/Socioeconomics%20Guide.pdf |

## Sources and Literature


| | |
|---|---|
| Sander 2009 | http://research.edf.com/the-edf-offers/research-and-development/discover-rd/events/oct-8th-2009-re-luck-and-challenge-602182.html |
| WBGU 2009 | Solving the climate dilemma: The budget approach, Berlin 2009 http://www.wbgu.de/wbgu_sn2009_en.pdf |
| Ragwitz 2009 | Humboldt-Forum Wirtschaft, http://www.hufw.de/index.php?id=419 |
| IEA 2011a | http://wds.iea.org/WDS/Common/Login/login.aspx |
| IEA 2011b | http://www.iea.org/weo/Files/ff_subsidies_slides.pdf |
| McKinsey 2009 | McKinsey&Company, Pathways to Low Carbon Economy, 2009 http://www.mckinsey.com/clientservice/ccsi/pathways_low_carbon_economy.asp |
| BMU 2011b | http://www.erneuerbare-energien.de/files/english/pdf/application/pdf/ee_beschaeftigung_2010_en_bf.pdf |
| Index Mundi 2011 | http://www.indexmundi.com/commodities/?commodity=crude-oil&months=120 |