

Renewable Energy in Germany – Present Situation and perspectives

A. Heissenhuber

TU München - Weihenstephan

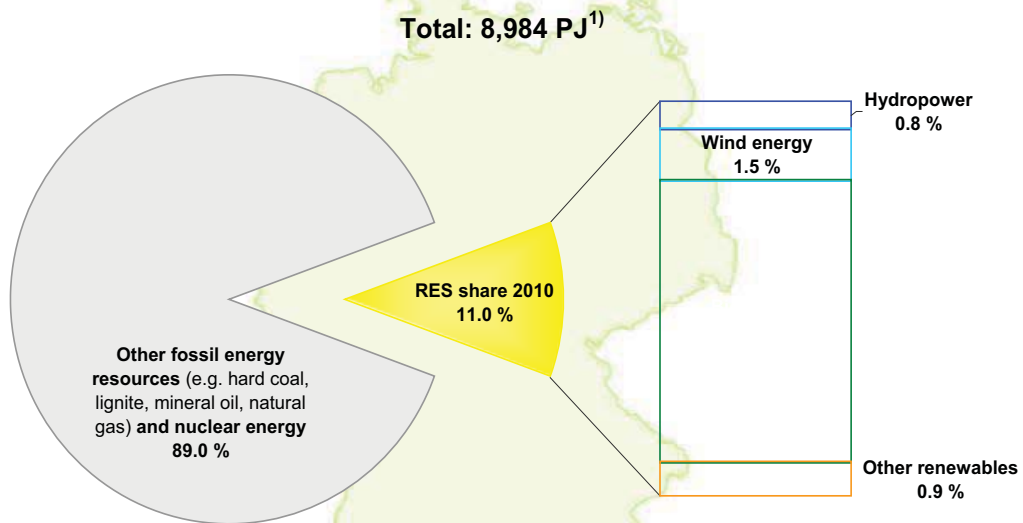
Tokyo, Sept. 2011

Outline

- **Overview**
 - **Importance of renewable energy**
 - **Electric Energy**
 - **Warmth Energy**
 - **Fuel**
 - **GHG-Abatement**
 - **Investment, working places**

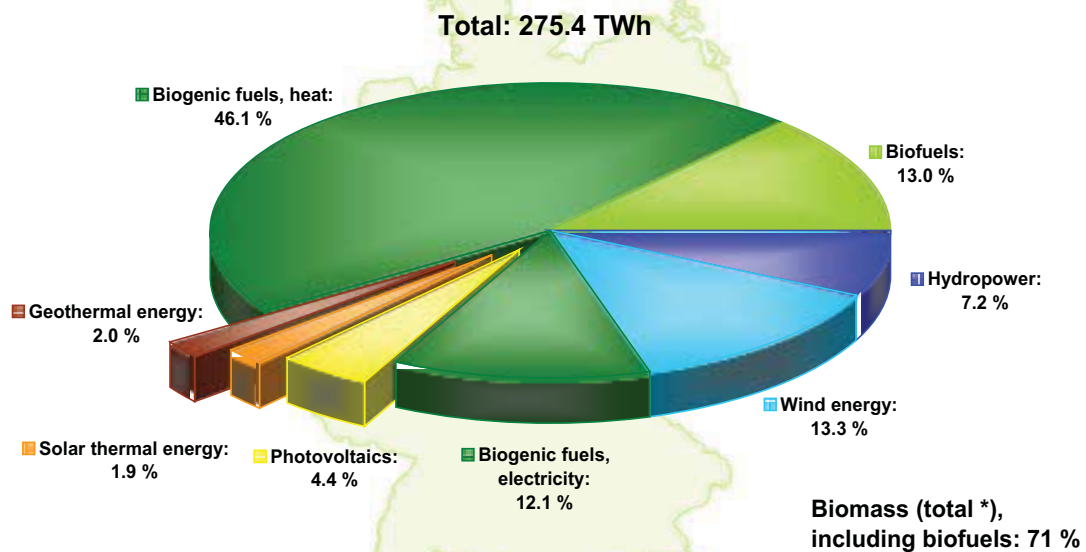
- **Special aspects**
 - **Biogas**
 - **Fuel**
 - **Rivalry food and fuel**
 - **GHG-Abatement costs**

Shares of renewable energy sources among total final energy consumption in Germany 2010



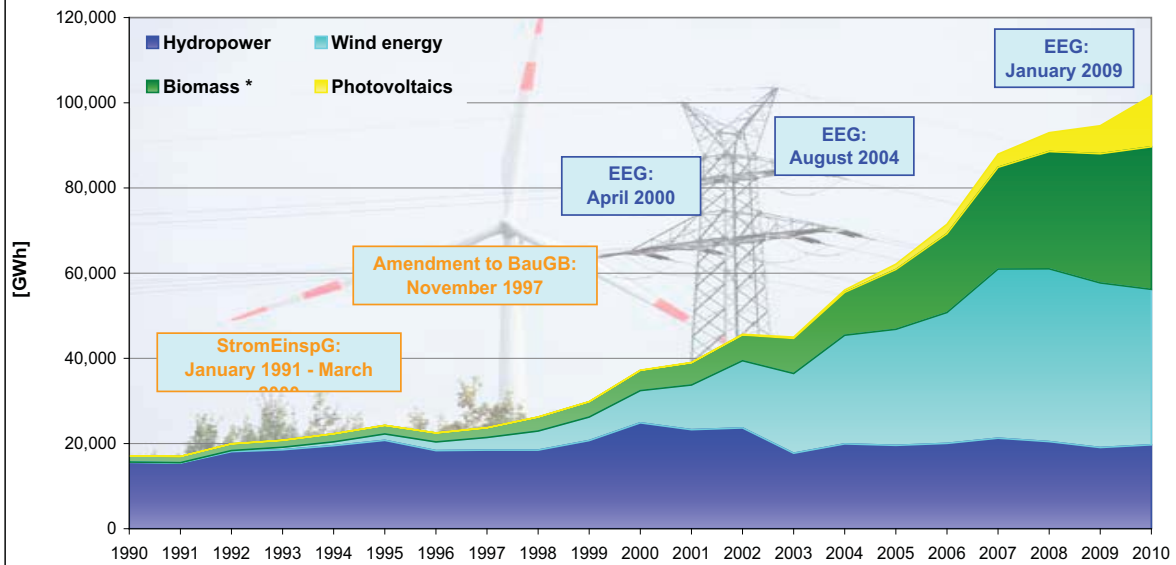
¹⁾ Energy Environment Forecast Analysis (EEFA) GmbH & Co KG; 2) Solid and liquid biomass, biogas, sewage and landfill gas, biogenic share of waste, biogenic fuels;
 Source: BMU-KI III 1 based on Working Group on Renewable Energy Sources-Statistics (AGEE-Stat) and the Centre for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW), according to Working Group on Energy Balances e.V. (AGEB); RES: Renewable Energy Sources; deviations in the totals are due to rounding; 1 PJ = 10¹⁵ Joule; as at: March 2011; all figures provisional

Structure of final energy supply from renewable energy sources in Germany 2010



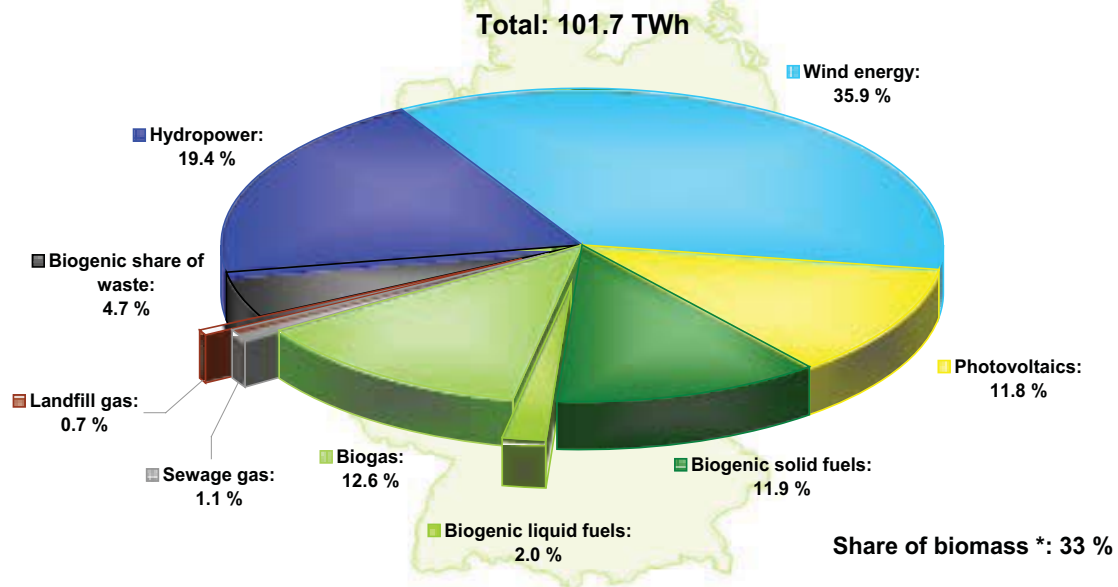
* Solid and liquid biomass, biogas, sewage and landfill gas, biogenic share of waste and biofuels; 1 TWh = 1 Bill. kWh; deviations in the totals are due to rounding;
 Source: BMU-KI III 1 according to Working Group on Renewable Energy Sources-Statistics (AGEE-Stat); as at: March 2011; all figures provisional

Development of electricity generation from renewable energy sources in Germany



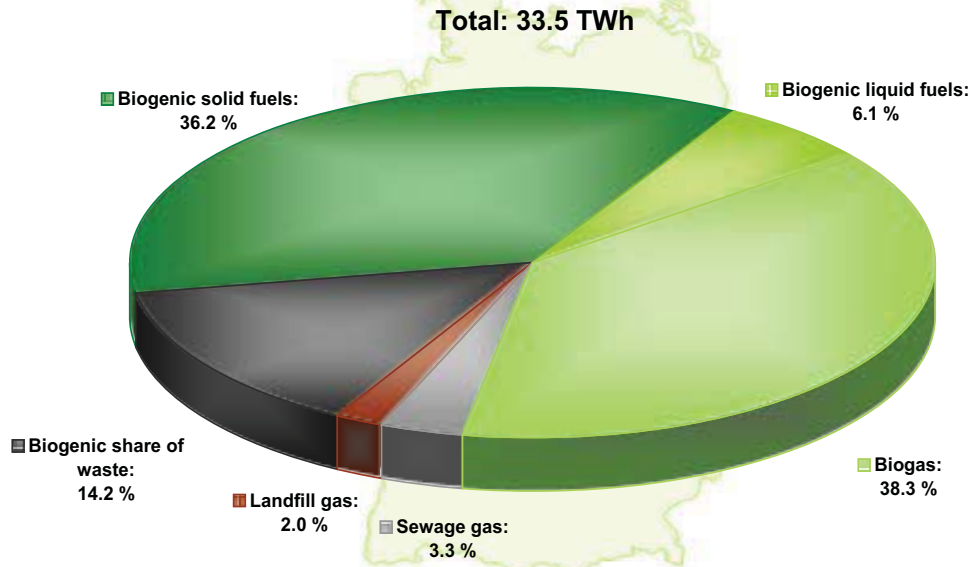
* Solid and liquid biomass, biogas, sewage and landfill gas, biogenic share of waste; electricity from geothermal energy not presented due to negligible quantities produced; 1 GWh = 1 Mill. kWh; StromEinspG: Act on the Sale of Electricity to the Grid; BauGB: Construction Code; EEG: Renewable Energy Sources Act; Source: BMU-KI III 1 according to Working Group on Renewable Energy Sources-Statistics (AGEE-Stat); image: BMU / Christoph Edelhoﬀ; as at: March 2011; all figures provisional

Structure of electricity supply from renewable energy sources in Germany 2010



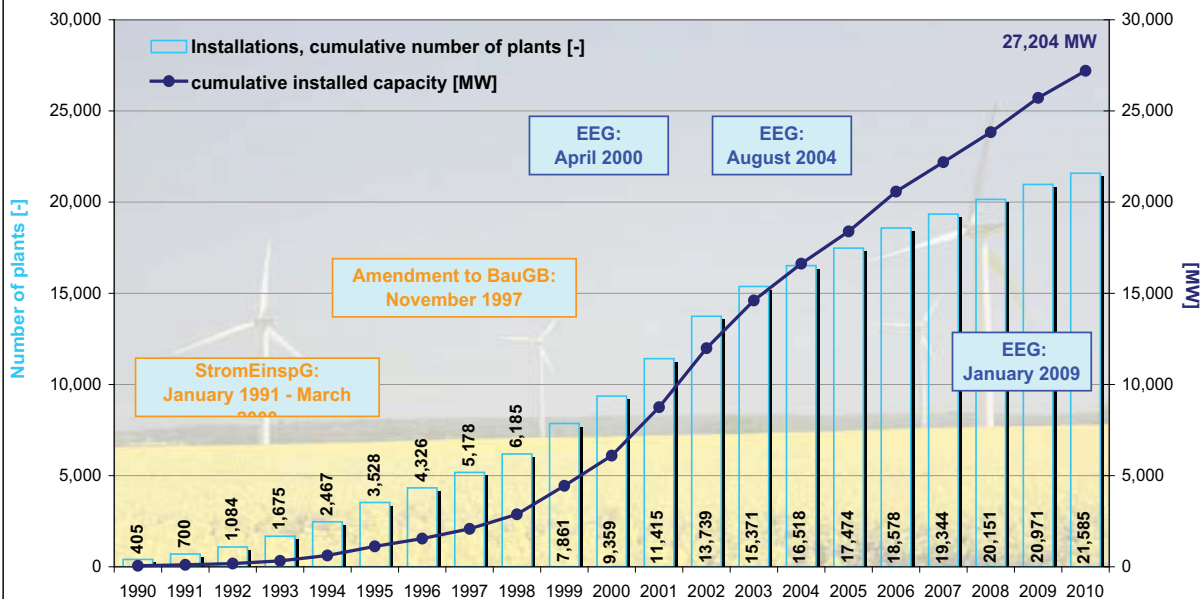
* Solid and liquid biomass, biogas, sewage and landfill gas, biogenic share of waste; electricity from geothermal energy not presented due to negligible quantities produced; deviations in the totals are due to rounding; 1 TWh = 1 Bill. kWh; Source: BMU-KI III 1 according to Working Group on Renewable Energy Sources-Statistics (AGEE-Stat); as at: March 2011; all figures provisional

Structure of electricity supply from biomass in Germany 2010



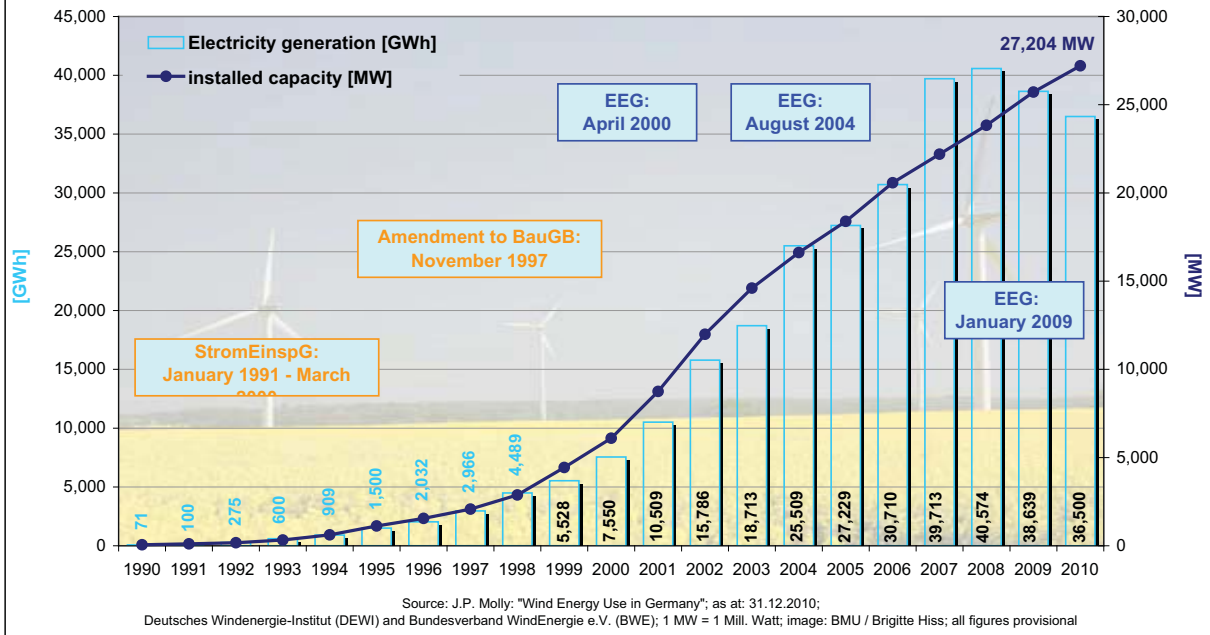
Source: BMU-KI III 1 according to Working Group on Renewable Energy Sources-Statistics (AGEE-Stat); 1 TWh = 1 Bill. kWh; deviations in the totals are due to rounding; as at: March 2011; all figures provisional

Development of the number and installed capacity of wind energy plants in Germany



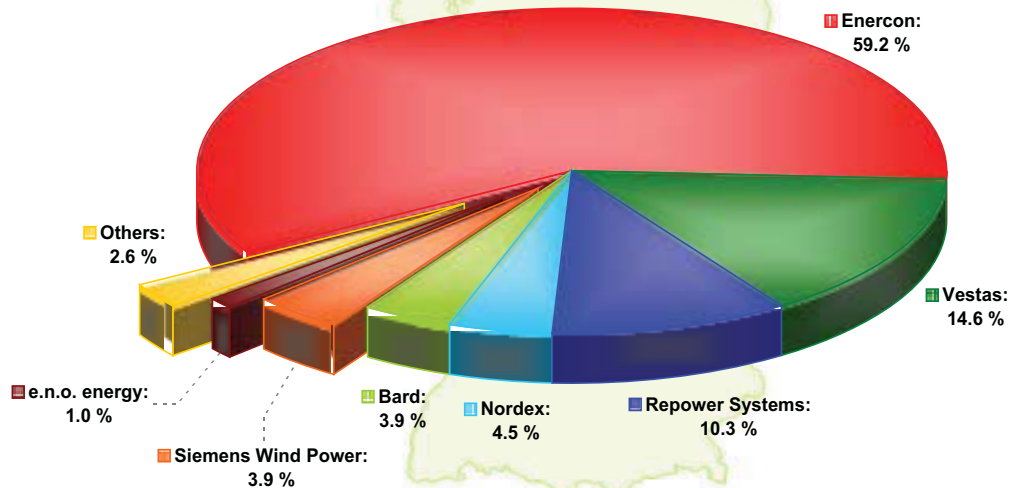
Source: J.P. Molly; "Wind Energy Use in Germany"; as at: 31.12.2010; Deutsches Windenergie-Institut (DEWI) and Bundesverband WindEnergie e.V. (BWE); 1 MW = 1 Mill. Watt; image: BMU / Brigitte Hiss; all figures provisional

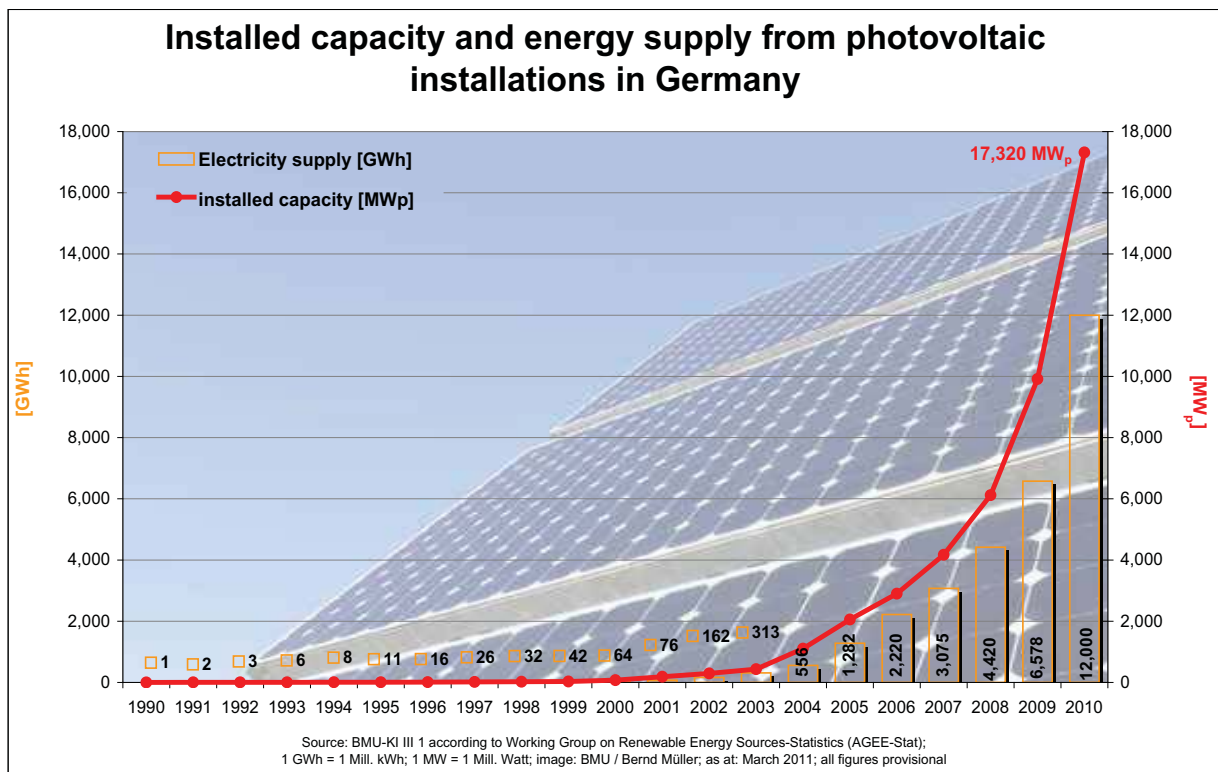
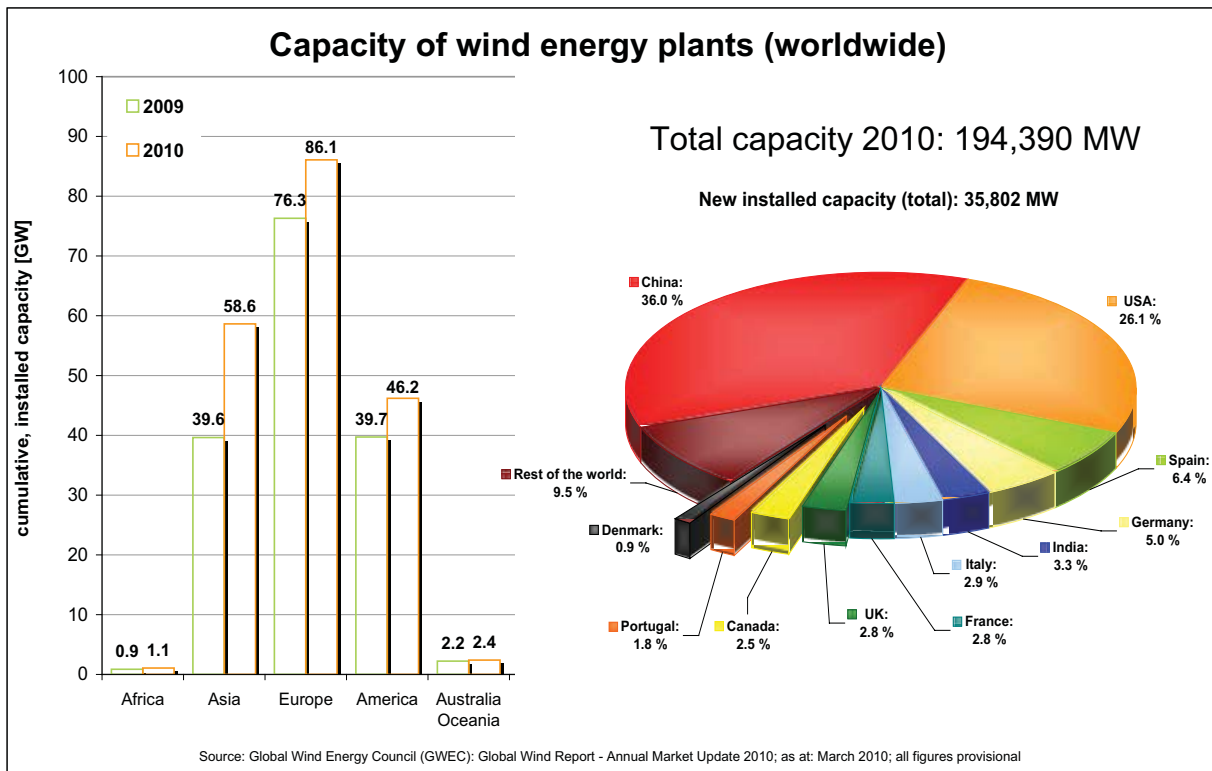
Development of electricity production and installed capacity of wind energy plants in Germany



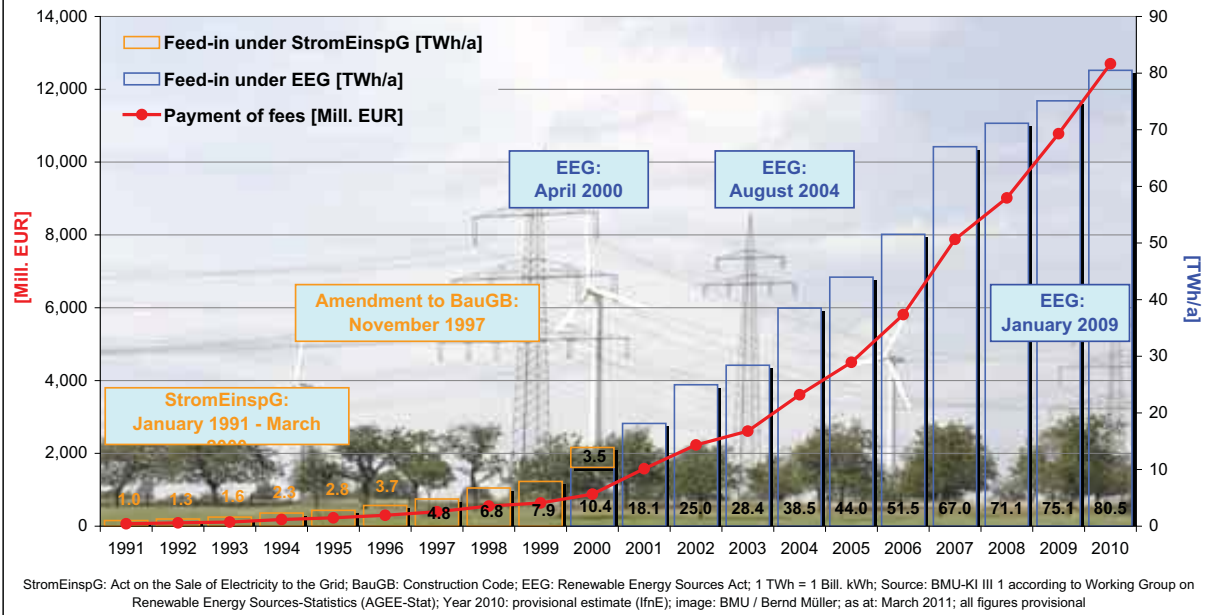
Share of providers of wind energy installations in newly installed capacity in Germany up to end of 2010

New installed capacity (total): 1,551 MW

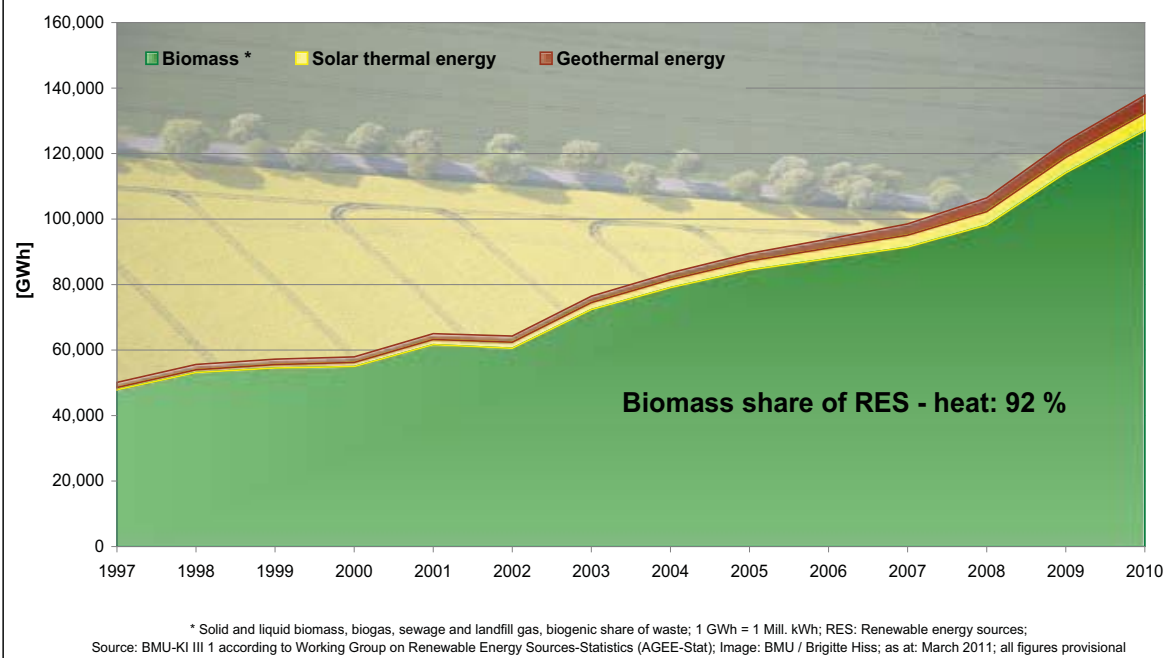




Feed-in and payment under the Electricity Feed Act (StromEinspG) and the Renewable Energy Sources Act (EEG) in Germany

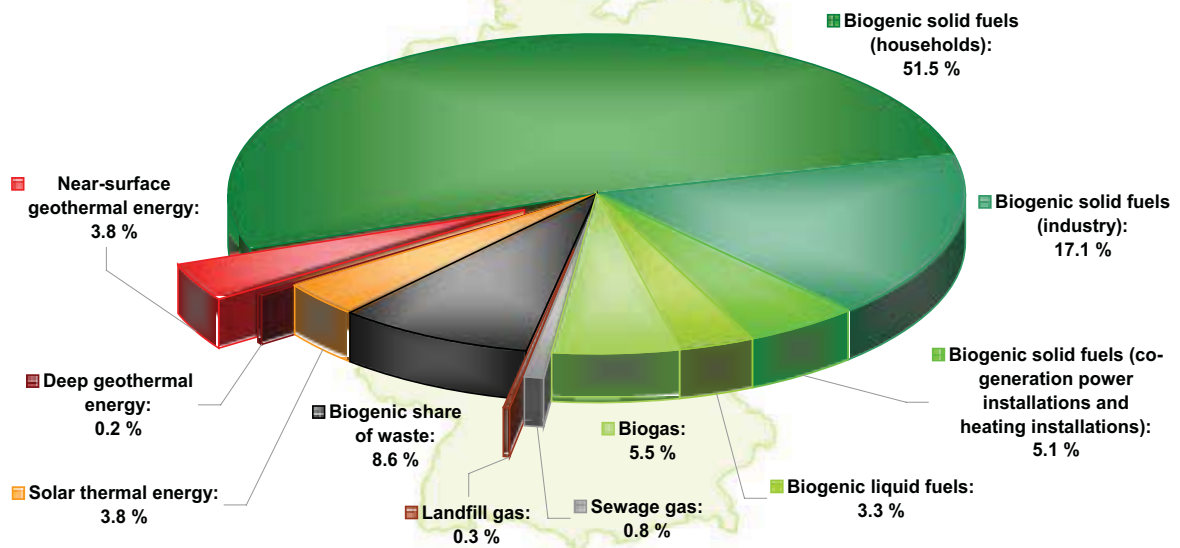


Contribution of renewable energy sources to heat supply in Germany



Structure of heat supply from renewable energy sources in Germany 2010

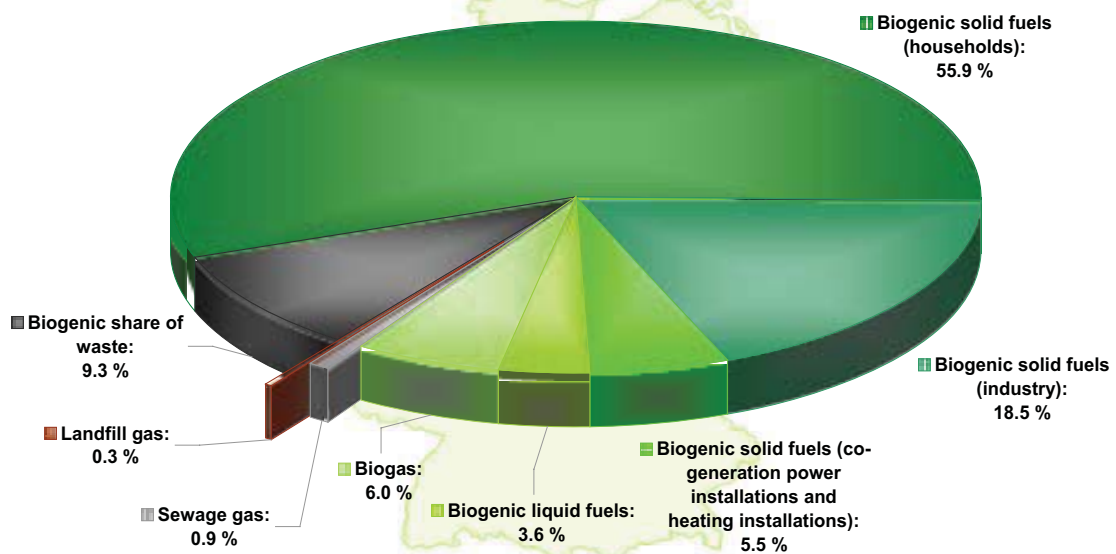
Total: 137.8 TWh



Source: BMU-KI III 1 according to Working Group on Renewable Energy Sources-Statistics (AGEE-Stat); 1 TWh = 1 Bill. kWh; deviations in the totals are due to rounding; as at: March 2011; all figures provisional

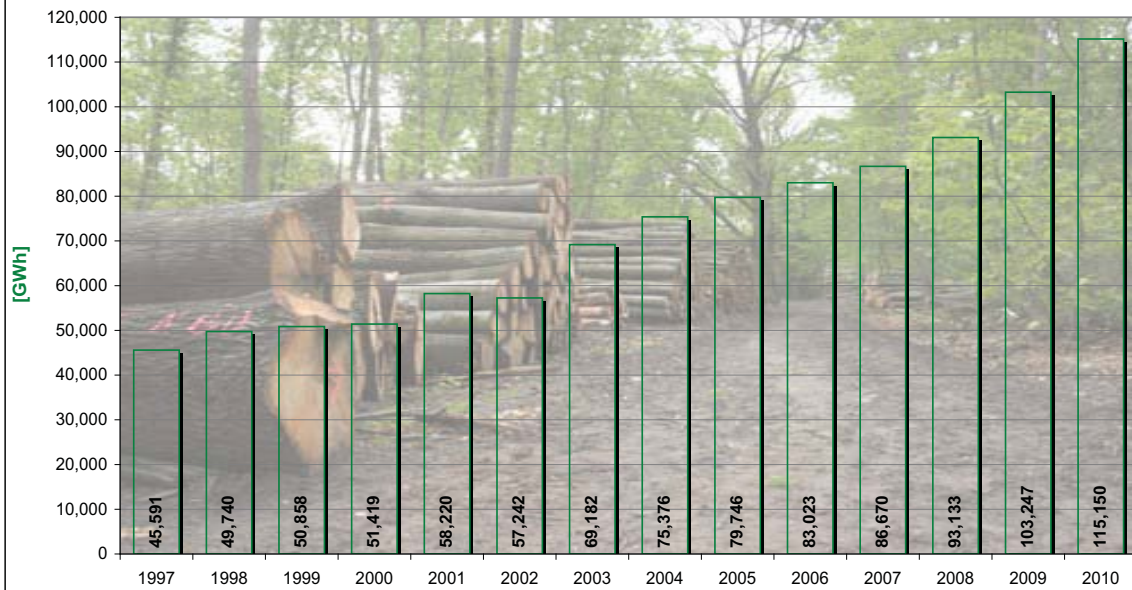
Structure of heat supply from biomass in Germany 2010

Total: 127.0 TWh



Source: BMU-KI III 1 according to Working Group on Renewable Energy Sources-Statistics (AGEE-Stat); 1 TWh = 1 Bill. kWh; deviations in the totals are due to rounding; as at: March 2011; all figures provisional

Development of biomass* use for heat supply in Germany



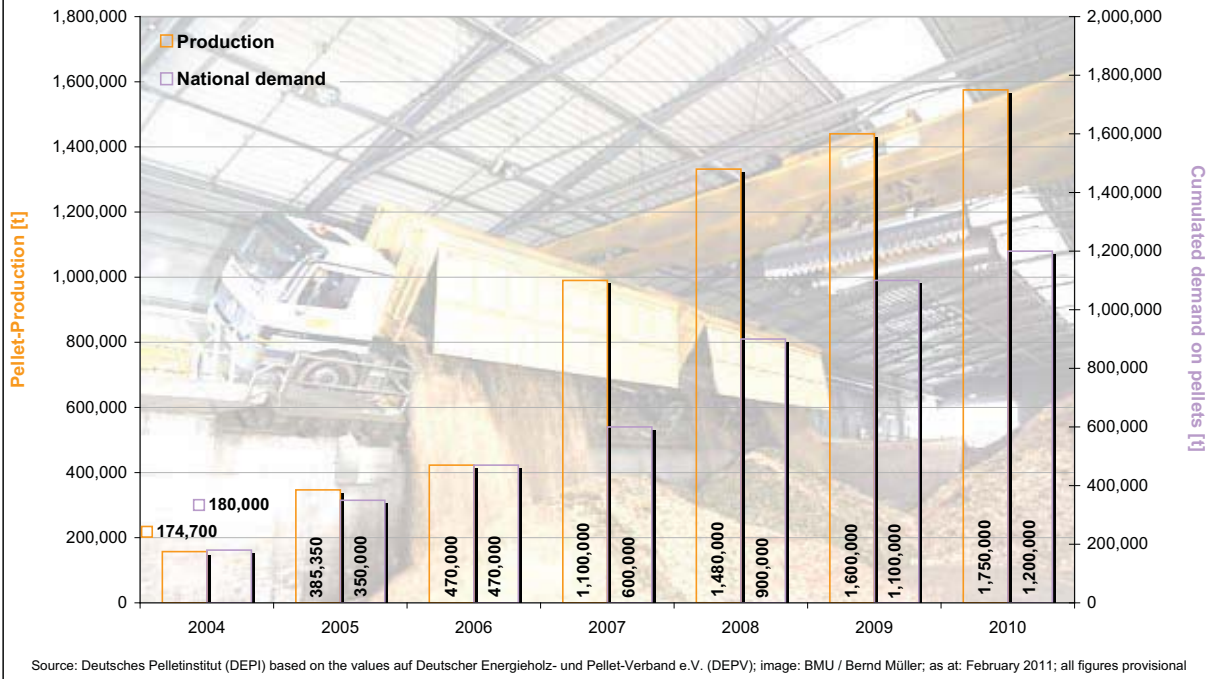
* Solid and liquid biomass, biogas, sewage and landfill gas; 1 GWh = 1 Mill. kWh;
Source: BMU-KI III 1 according to Working Group on Renewable Energy Sources-Statistics (AGEE-Stat); image: BMU / Brigitte Hiss; as at: March 2011; all figures provisional

Development of pellet-based heatings in Germany

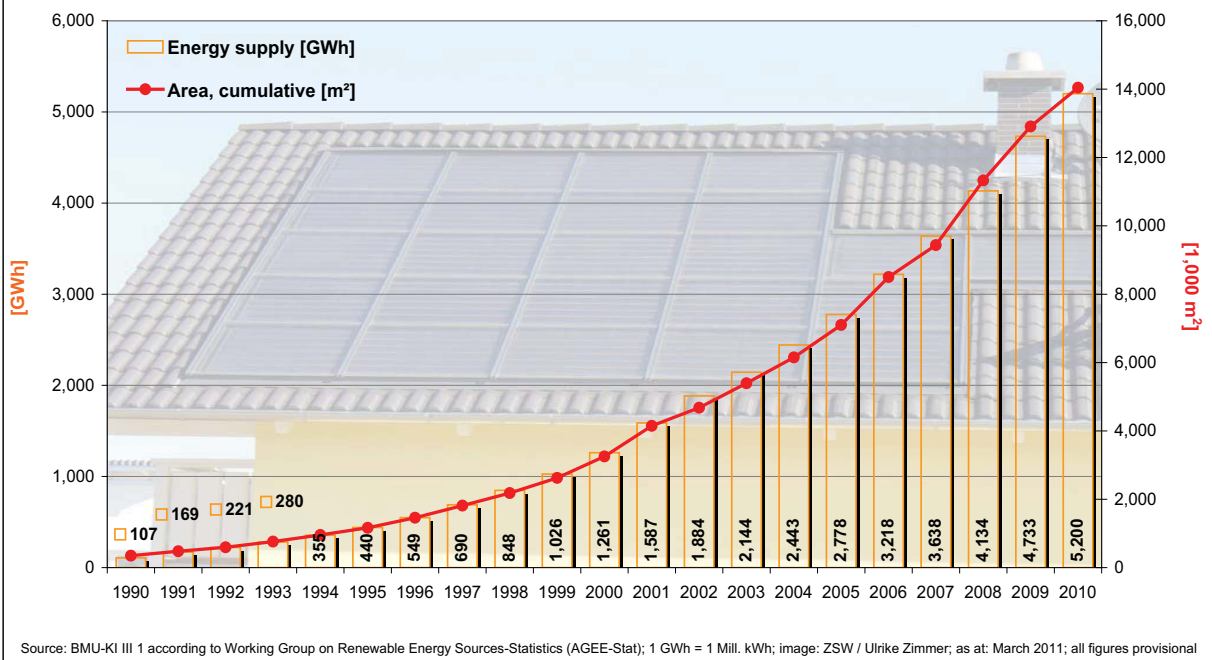


Source: Deutsches Pelletinstitut (DEPI), based on the values of Bundesamt für Wirtschaft und Ausfuhrkontrolle (BAFA) and Bundesindustrieverband Deutschland Haus-, Energie- und Umwelttechnik e.V. (BDH); image: BMU / Bernd Müller; as at: February 2011; all figures provisional

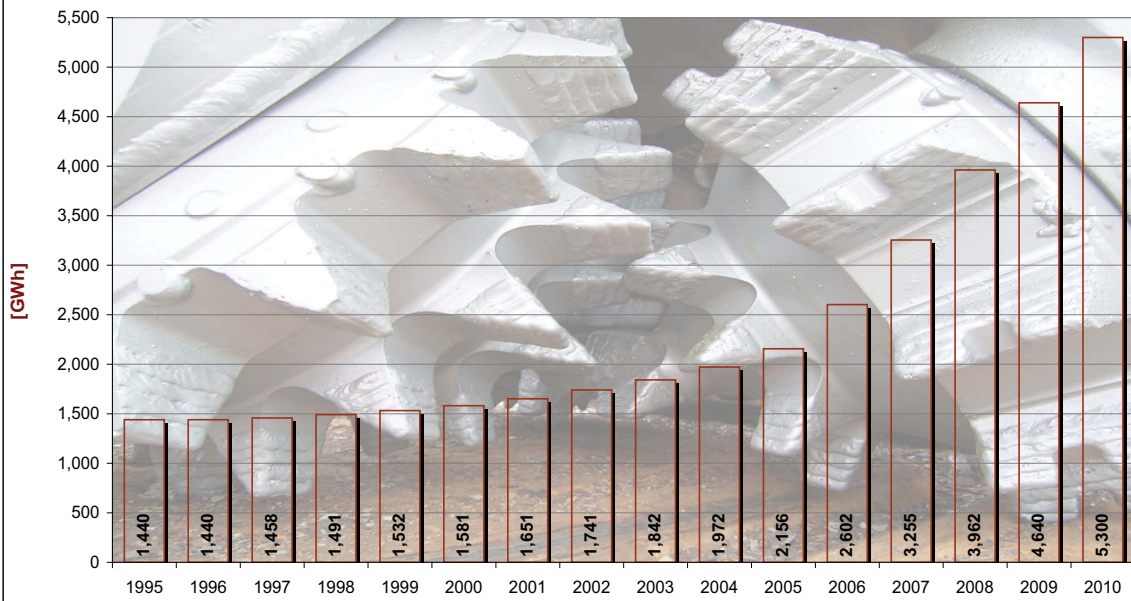
Development of pellet production in Germany



Development of collector area and energy supply of solar thermal installations for heat supply in Germany

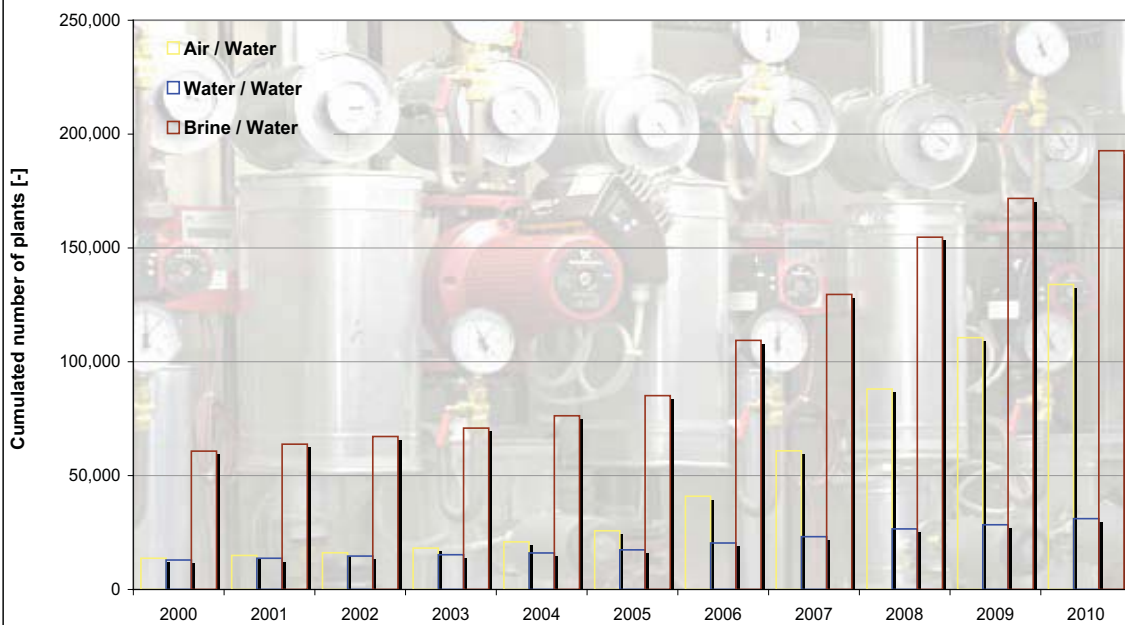


Development of (near-surface) geothermal energy use^{*)} for heat supply in Germany



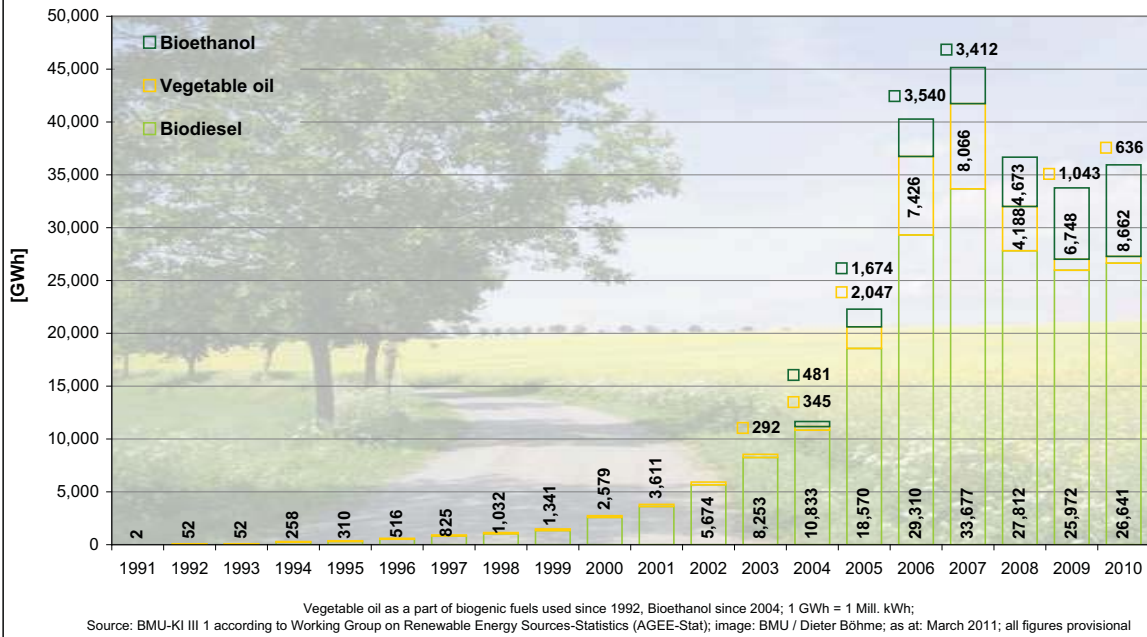
^{*)} Including Air/Water-, Water/Water- and Brine/Water- Heat Pumps; 1 GWh = 1 Mill. kWh;
 Source: BMU-KI III 1 according to Working Group on Renewable Energy Sources-Statistics (AGEE-Stat); image: ZSW / Ulrike Zimmer; as at: March 2011; all figures provisional

Development of the market for heat pumps in Germany



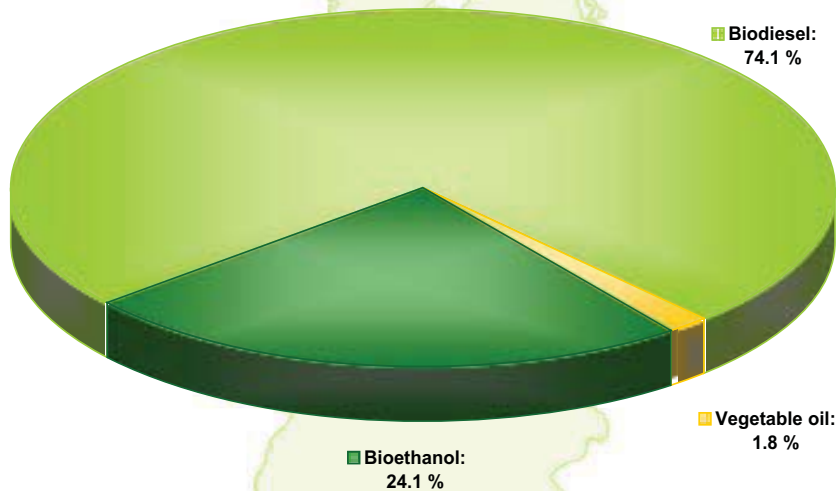
Sources: Years 2000-2008: GeothermieZentrum Bochum (GZB), Survey: "Analyse des deutschen Wärmepumpenmarktes, Bestandsaufnahme und Trends", as at: November 2009;
 Years 2009 and 2010: Bundesverband Wärmepumpe e.V. (BWP), Press releases "Branchenstatistik", as at: March 2011; image: BMU / Brigitte Hiss; all figures provisional

Contribution of renewable energy sources to fuel supply in Germany

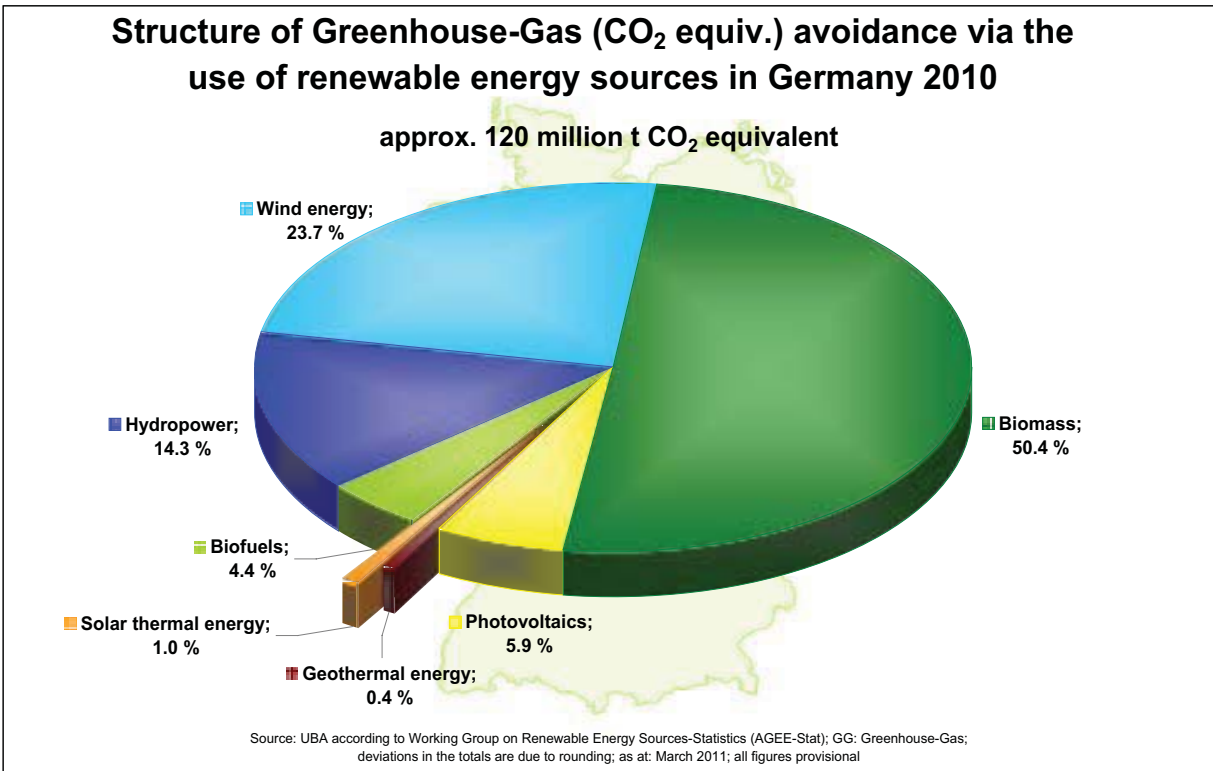
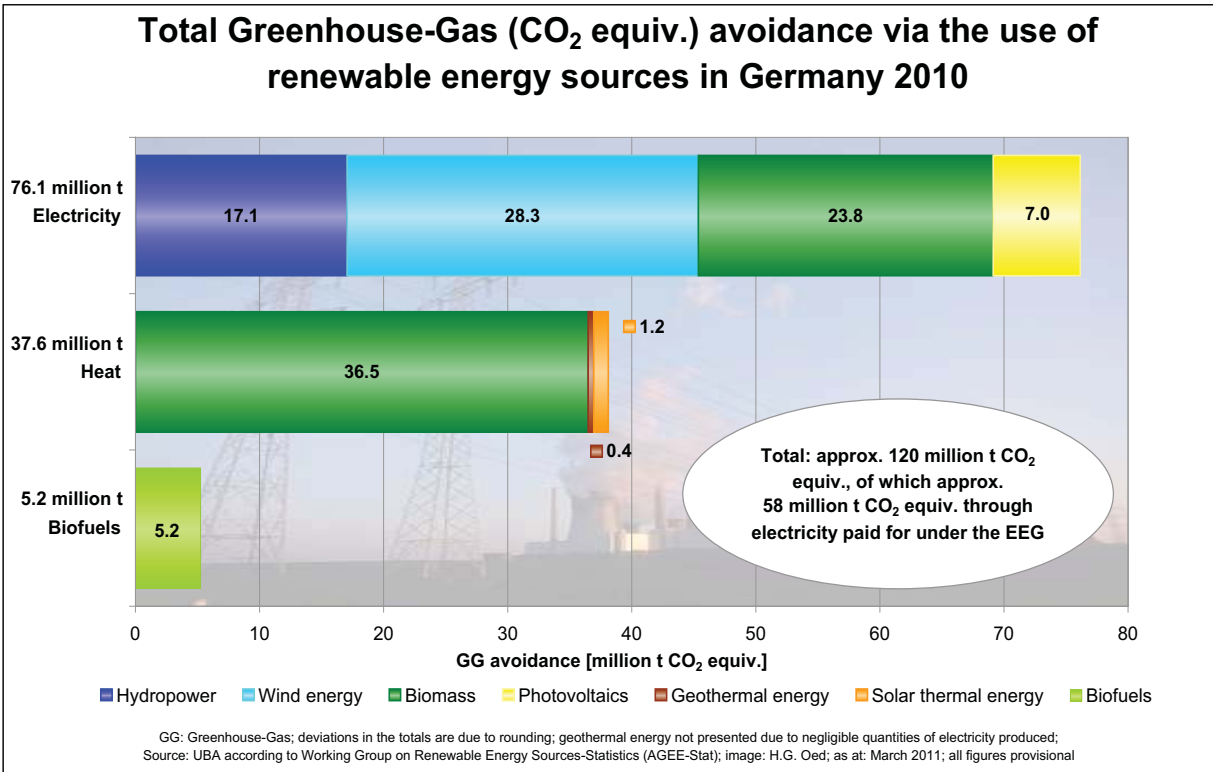


Structure of biogenic fuels in Germany 2010

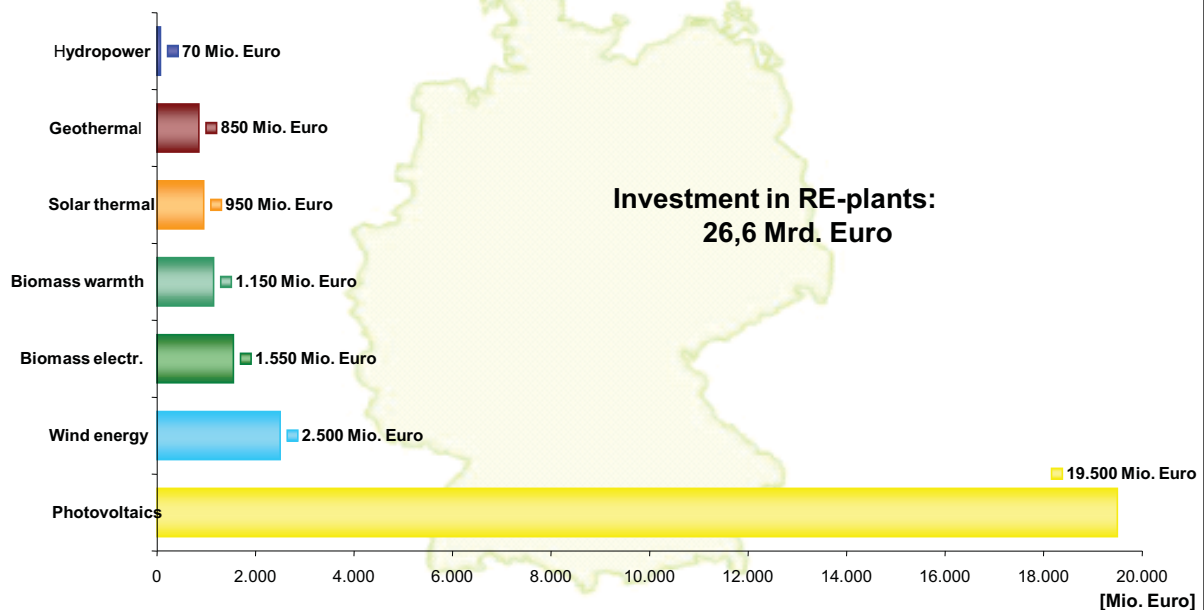
Total: 35.9 TWh



Source: BMU-KI III 1 according to Working Group on Renewable Energy Sources-Statistics (AGEE-Stat);
1 TWh = 1 Bill. kWh; deviations in the totals are due to rounding; as at: March 2011; all figures provisional

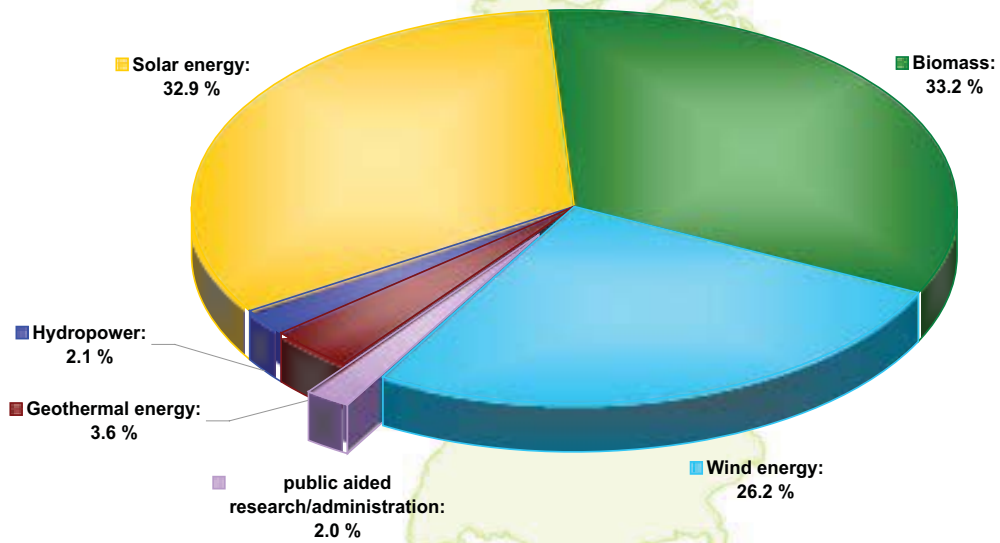


Investment in Plants for Renewable Energy in Germany 2010



* Großanlagen und Wärmepumpen; Abweichungen in den Summen durch Rundungen;
 Quelle: BMU-KI III 1 nach Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW); Stand: März 2011; Angaben vorläufig

Spread of the approx. 367,400 jobs in the renewable energy sources sector in Germany 2010



Figures for 2010 are provisional estimate; deviations in totals are due to rounding;
 Source: O'Sullivan/Edler/van Mark/Nieder/Lehr: "Bruttobeschäftigung durch erneuerbare Energien im Jahr 2010 – eine erste Abschätzung", as at: March 2011; interim report of research project „Kurz- und langfristige Auswirkungen des Ausbaus erneuerbarer Energien auf den deutschen Arbeitsmarkt“

Outline

- **Overview**
 - Importance of renewable energy
 - Electric Energy
 - Warmth Energy
 - Fuel
 - GHG-Abatement
 - Investment, working places

- **Special aspects**
 - Biogas
 - Fuel
 - Rivalry food and fuel
 - GHG-Abatement costs

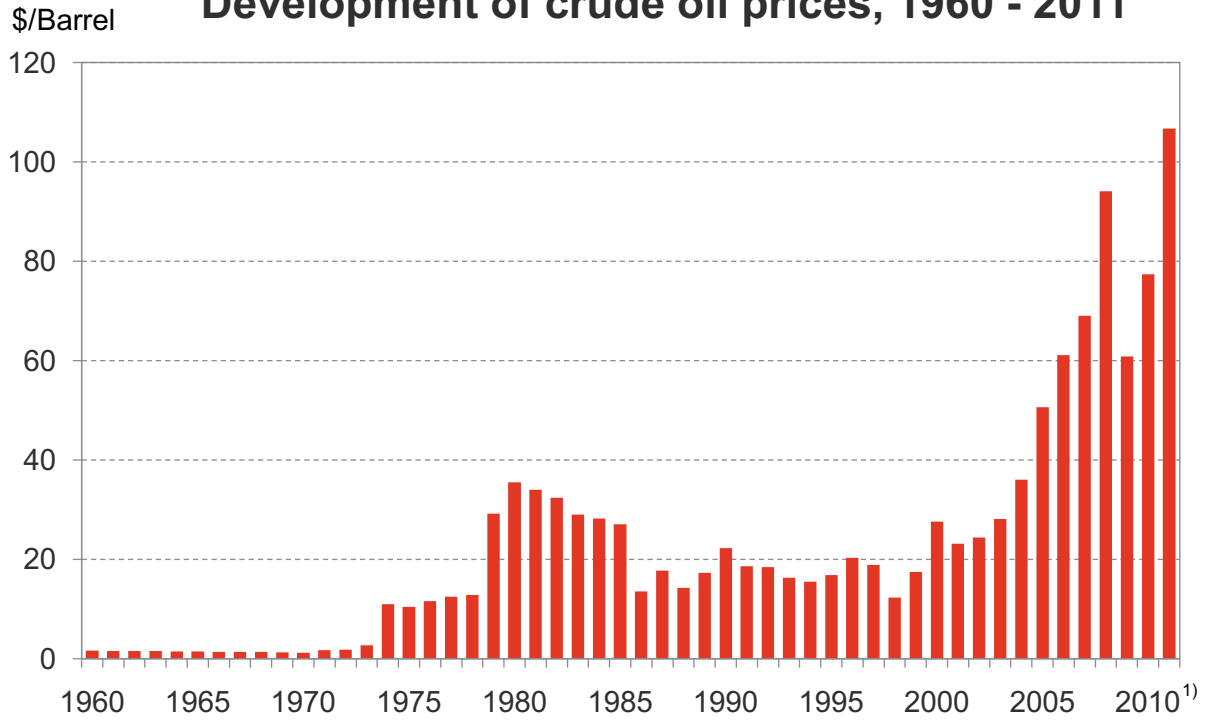
29

Energy from biomass - why?

- **Low prices on the agricultural markets until 2005**
- **Strong import dependence on energy**
- **Increasing prices for fossil fuels**
- **Withdrawal from nuclear energy**
- **Increasing environmental pollution (greenhouse gases)**

30

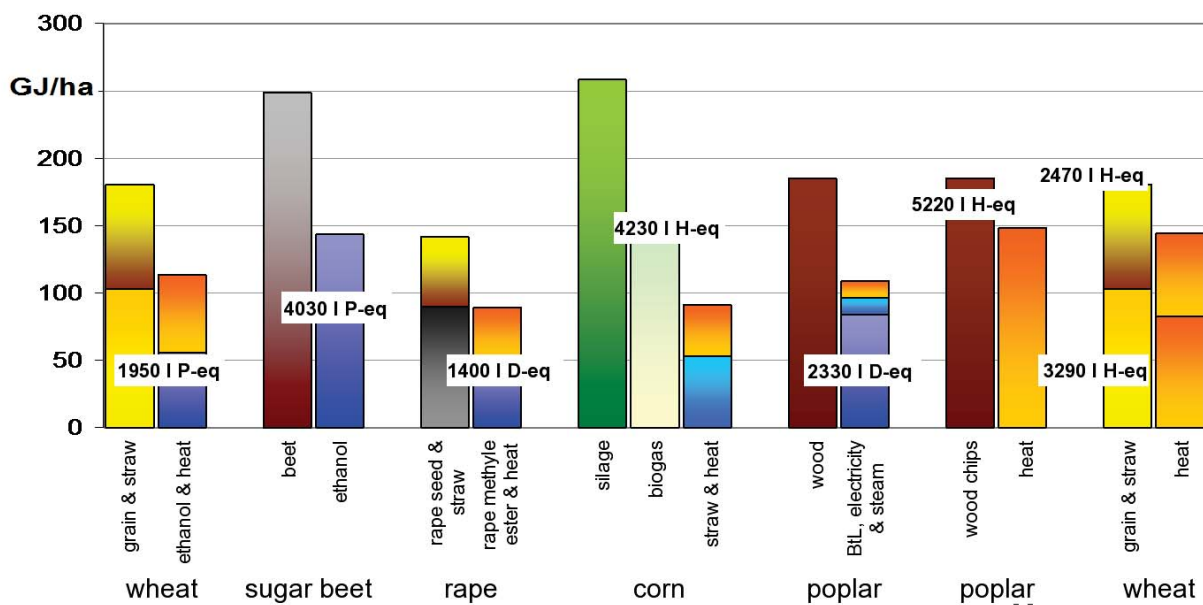
Development of crude oil prices, 1960 - 2011



1) Annotation: Average price , first half year of 2011
Data basis: MWV, 2007 - 2011

31

Primary and final energy content of different plants

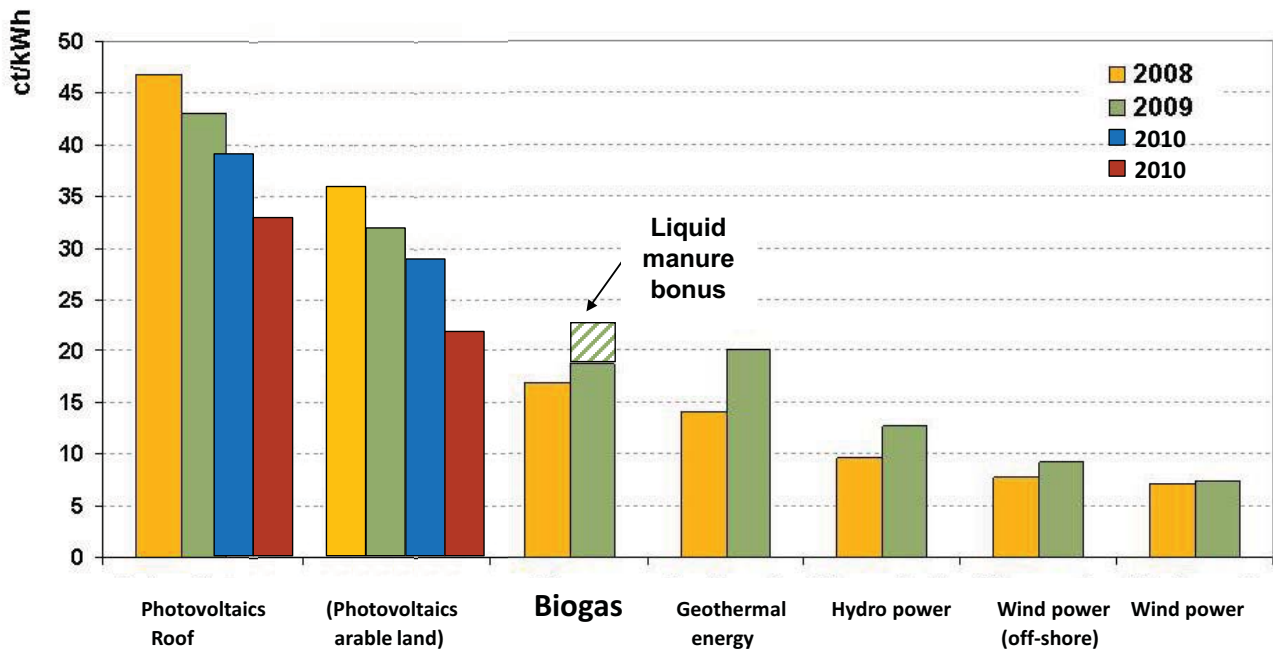


P-eq: Petrol equivalent; D-eq: Diesel equivalent, H-eq: Heating oil equivalent

grain of wheat: 7,7 t/ha, rape seed 3,5 t/ha, corn: 45 t/ha, sugar beet: 60 t/ha, poplar: 10 t_{atro}/ha

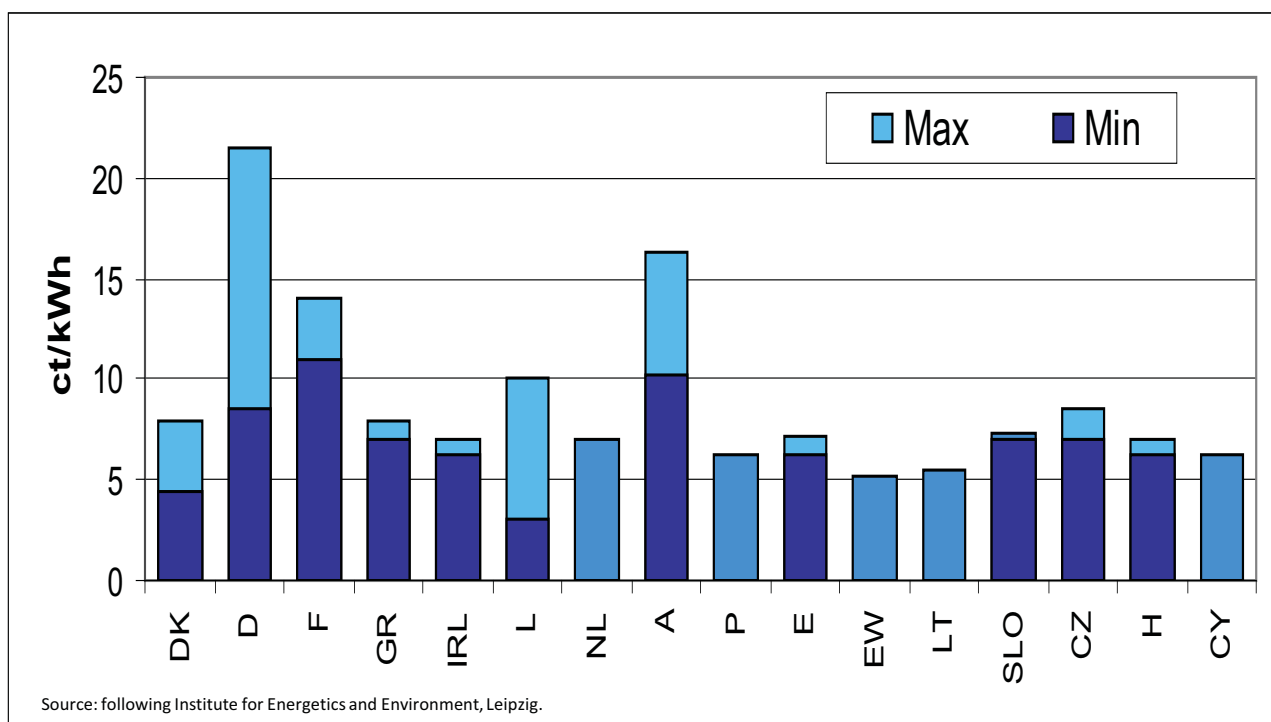
32

Feed in Tariffs for Electricity of RE



33

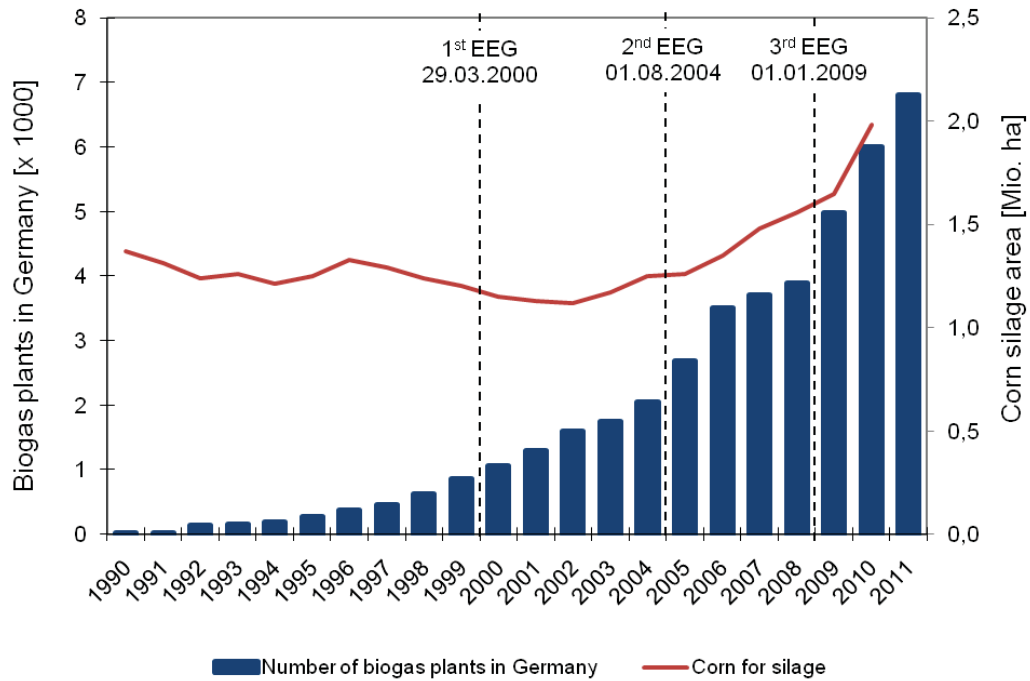
Feed-in-compensations for electricity from biomass in selected european countries



Source: following Institute for Energetics and Environment, Leipzig.

34

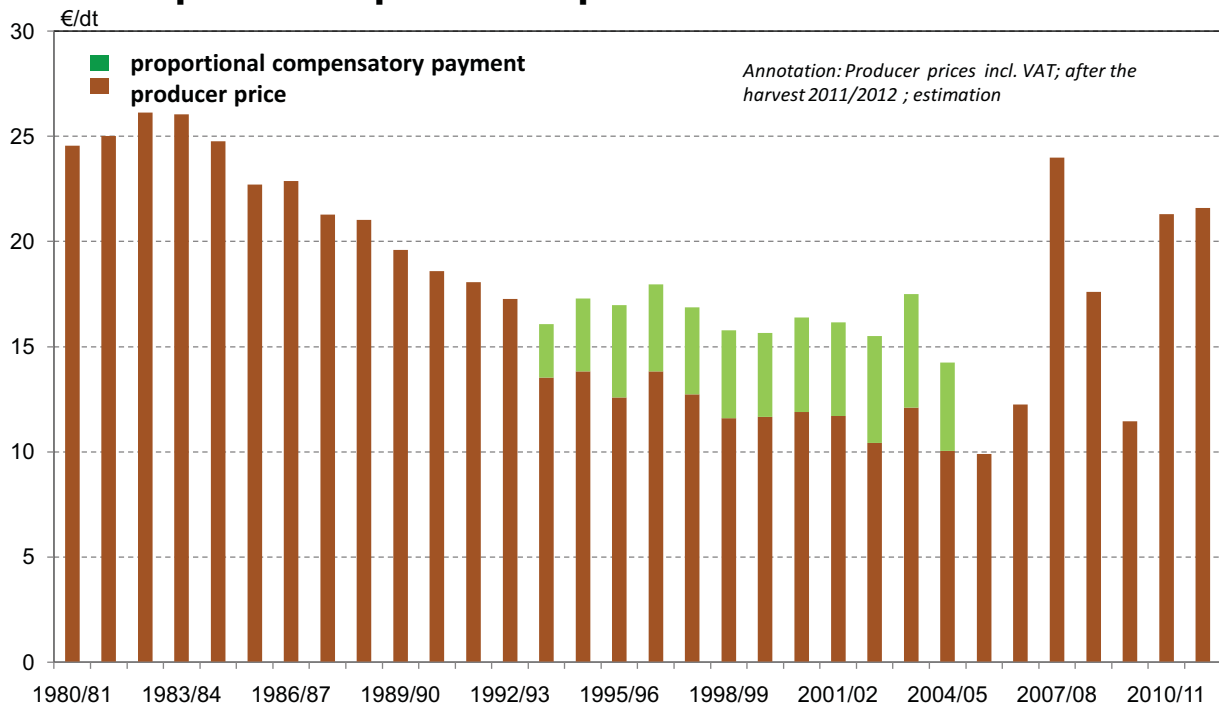
Biogas Plants in Germany and Corn silage area



Source: (Fachverband Biogas 2011), (DMK 2011)

35

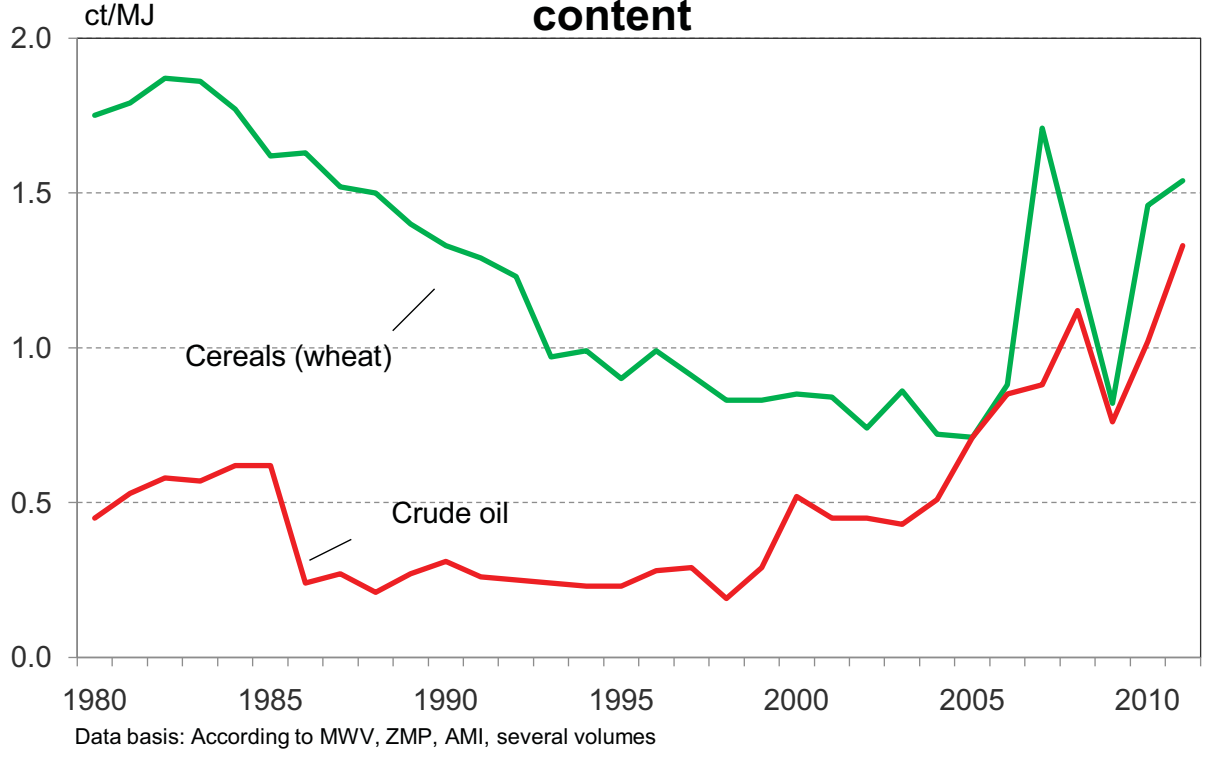
Development of producer prices for wheat



Data basis: own presentation according to ZMP, AMI, several volumes.

36

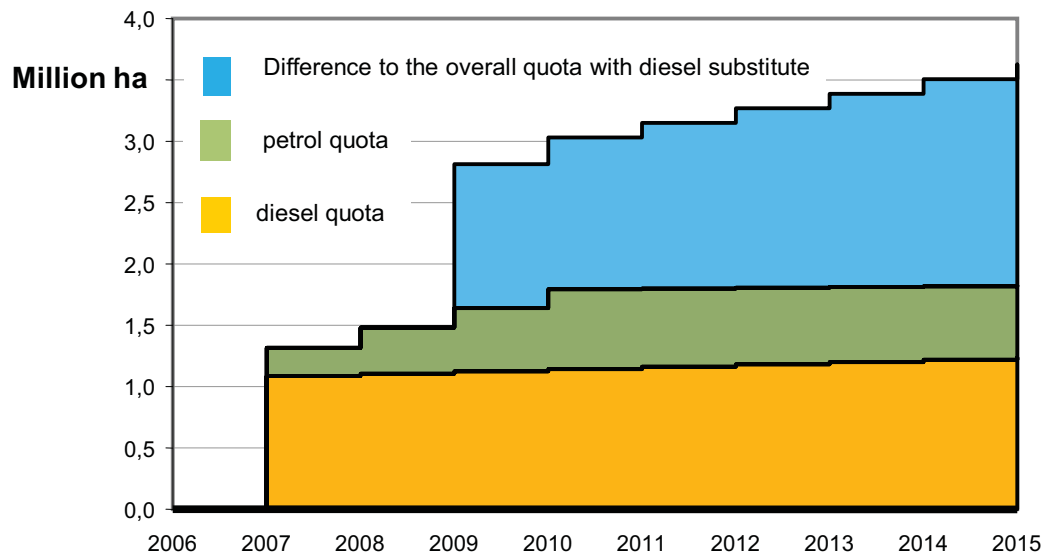
Prices of cereals and crude oil depending on energy content



Bioethanol made from wheat as a petrol substitute



Areas for biofuels according to the biofuel admixture obligation



Linear forward projection of the consumption of diesel and petrol in Germany (1990 to 2015)
 Diesel quota: Rape to RME (rapeseed oil methyl ester) (1400 l diesel equivalent/ha); Petrol quota: Wheat to ethanol (1950 l petrol equivalent/ha); difference to the overall quota: rape to rape oil methyl ester (1400 l diesel equivalent/ha)

39

Primary energy potential of biomass produced on arable land

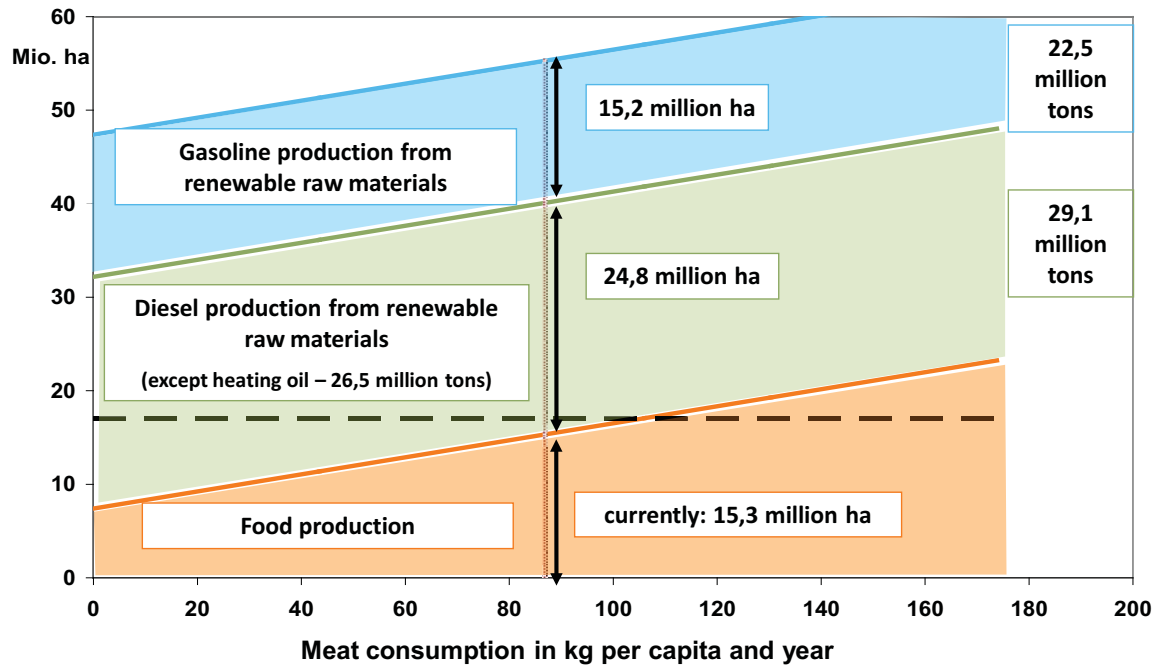
Crop		yield t/ha	primary energy GJ/ha
wheat	grain	7	105
	straw	5	75
	grain + straw		180
rapeseed	grain	3,5	84
corn	silage	45	250

Primary energy potential of a biomass- energy-mix consisting of 30% wheat, rapeseed and corn
 ⇒ 1 Mio. ha crop land = 1,2 % of the whole current primary energy consumption of 14.000 PJ/year

Source: Berenz 2006

40

Area requirement for food and fuel production

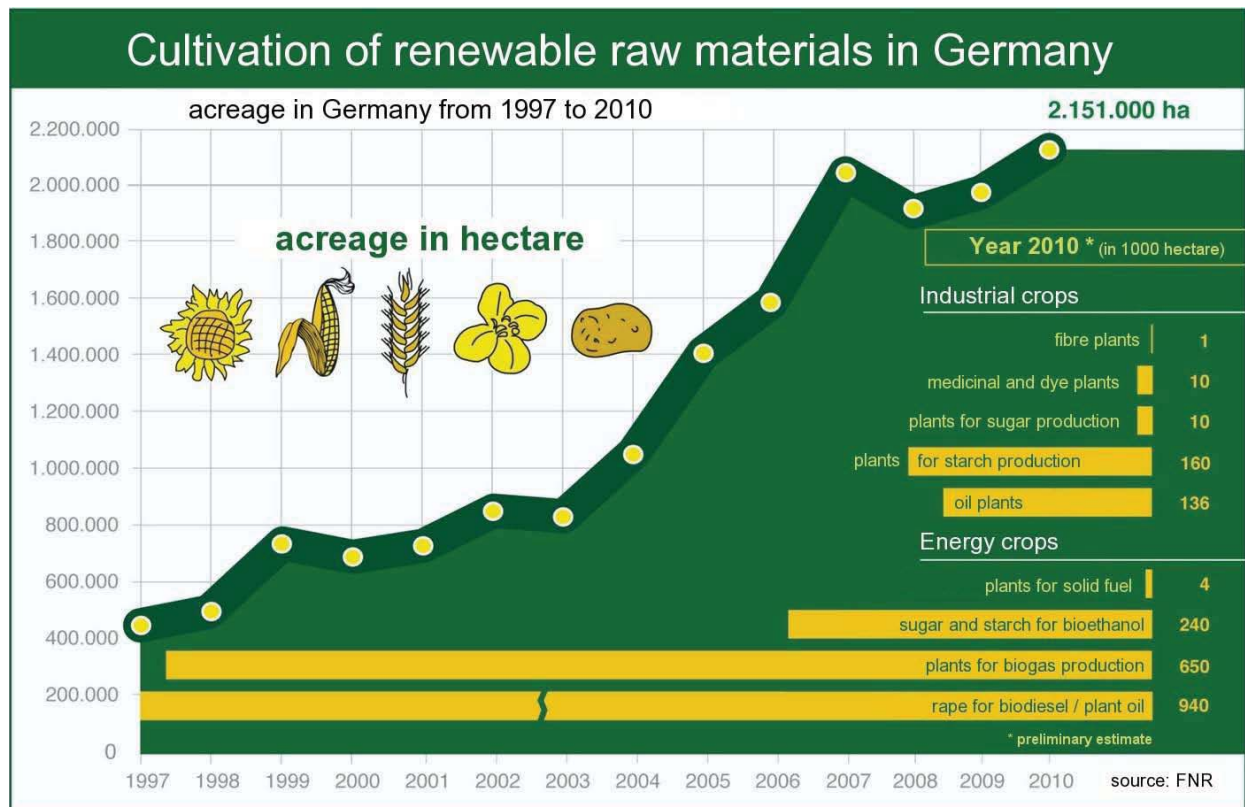


Annotations: Diesel production: 24,8 million ha rapeseed to RME (1.400 l DÄ/ha) or 14,9 Mio. ha short rotational plantations to BtL (2.330 l DÄ/ha); gasoline production: 7,3 million ha sugar beets to Ethanol (4.030 l BÄ/ha) or 15,2 million ha cereal to Ethanol (1.950 l BÄ/ha); heat production: 6,0 Mio. ha Kup to fuels (5.220 l HÄ/ha)

Source: According to Berenz, 2006; BMELV, 2006; Seemüller, 1999; MWV, 2007

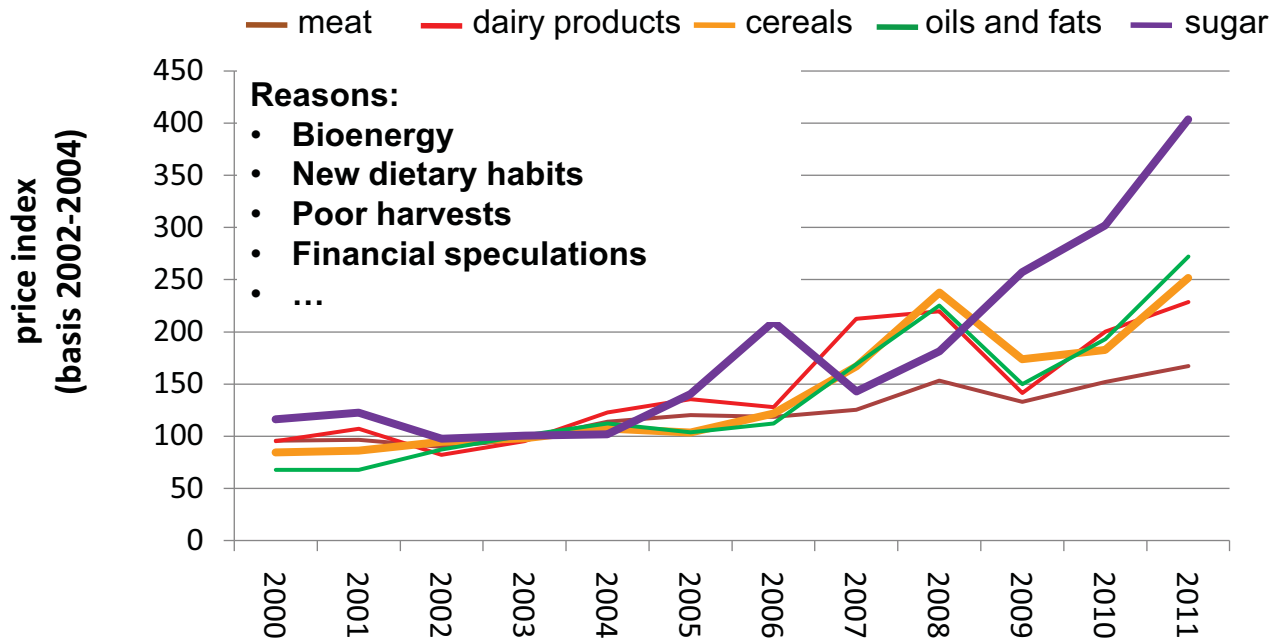
41

BtL = Biomass to Liquid



42

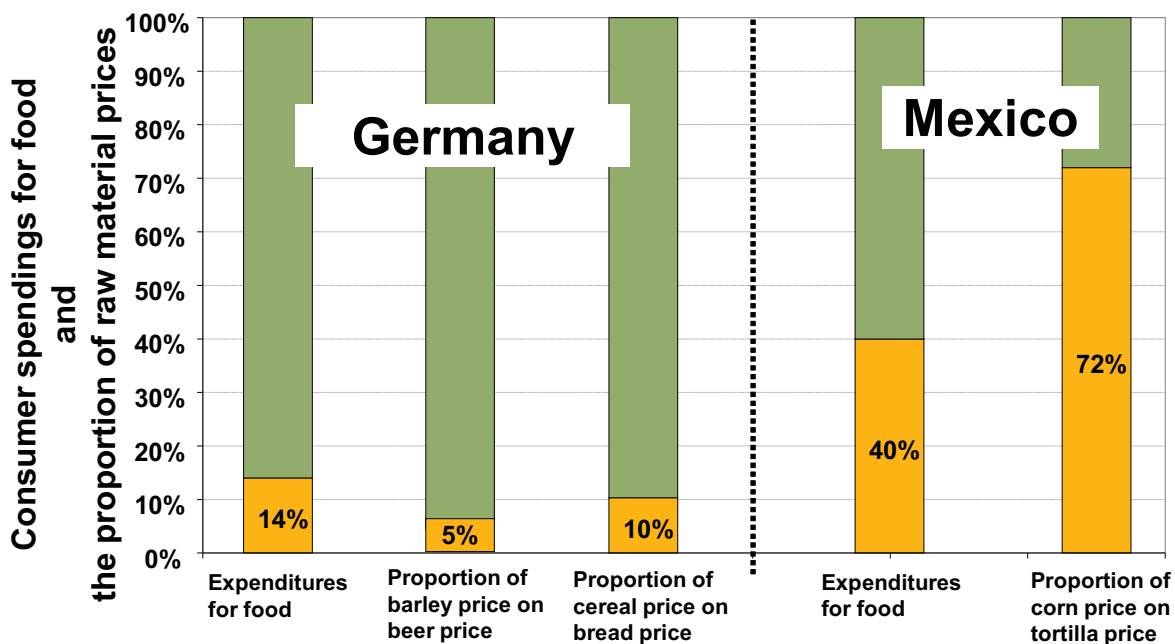
FAO Food Price Index 2000-2011



Source: in accordance with FAOSTAT

43

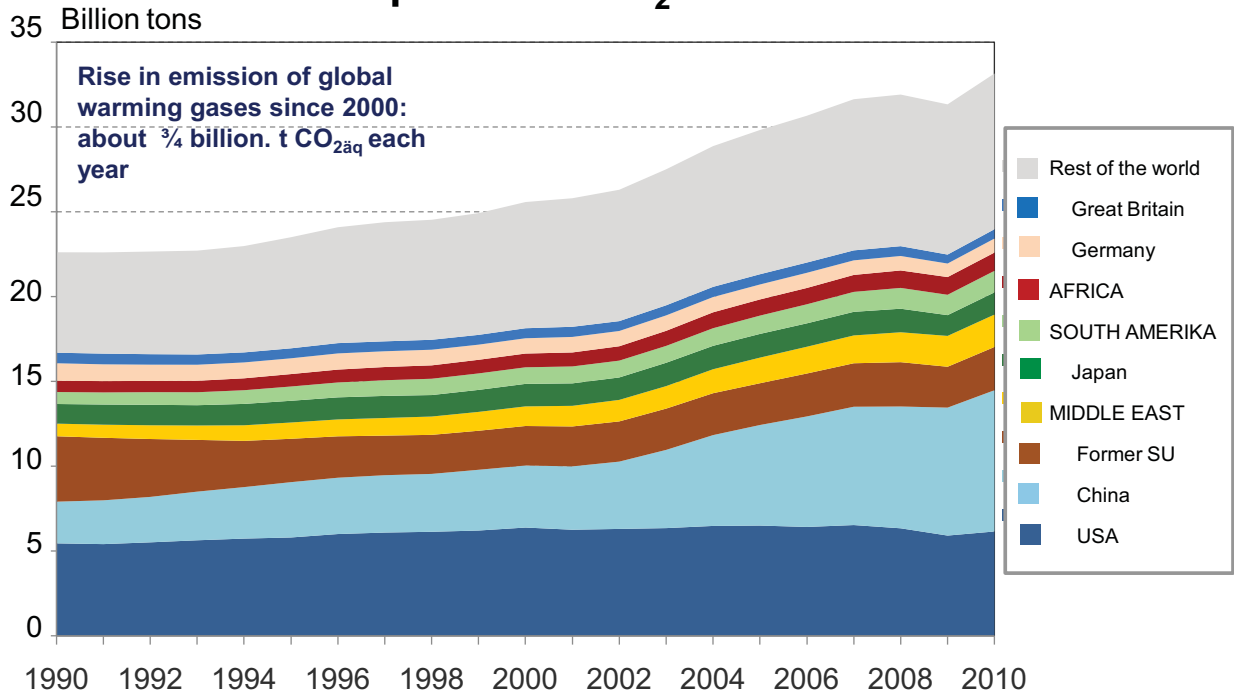
Consumer spendings for food and the proportion of raw material prices



Source: Hübner (2009) according to SISTEMA NACIONAL DE INFORMACIÓN E INTEGRACIÓN DE MERCADOS, 2008

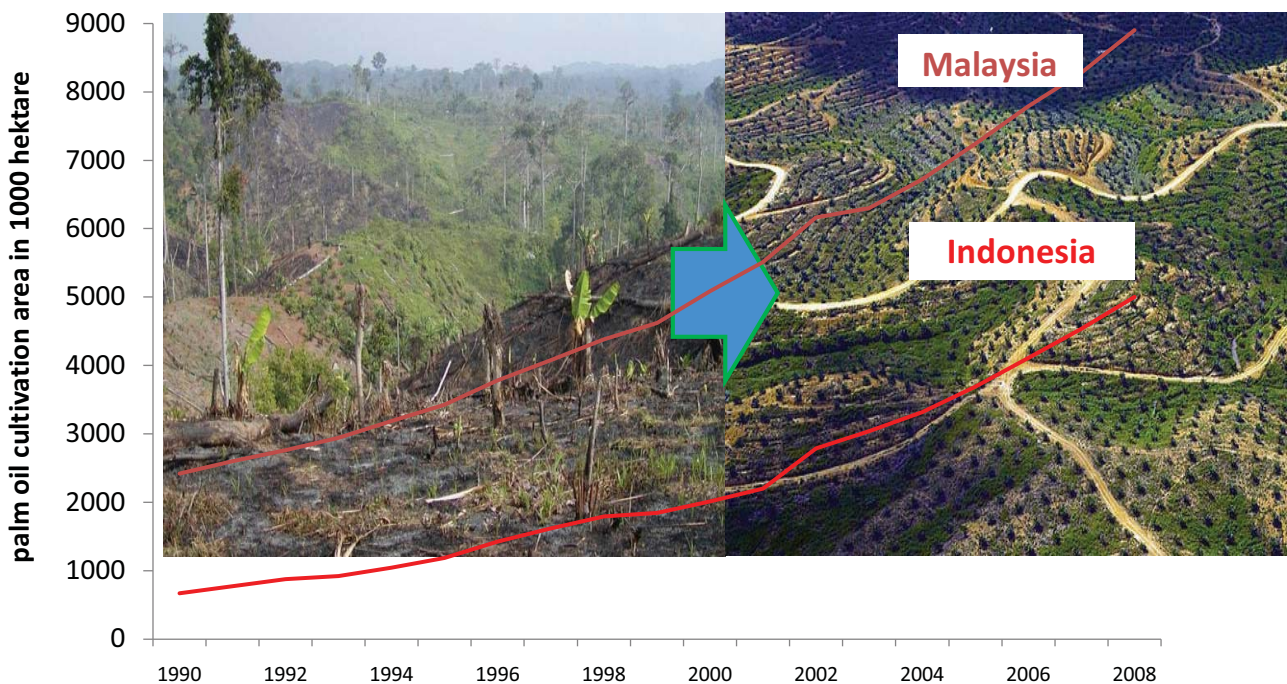
44

Development of CO₂ - emissions



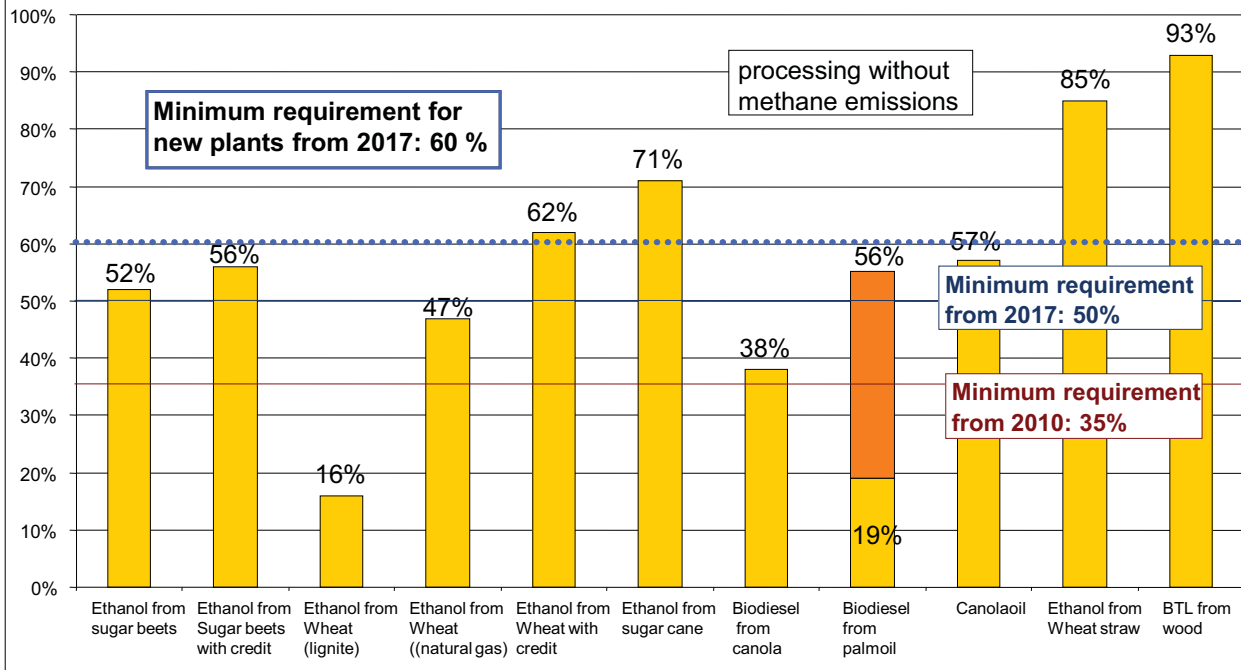
45

Changes in land-use: Extension of palm oil plantations



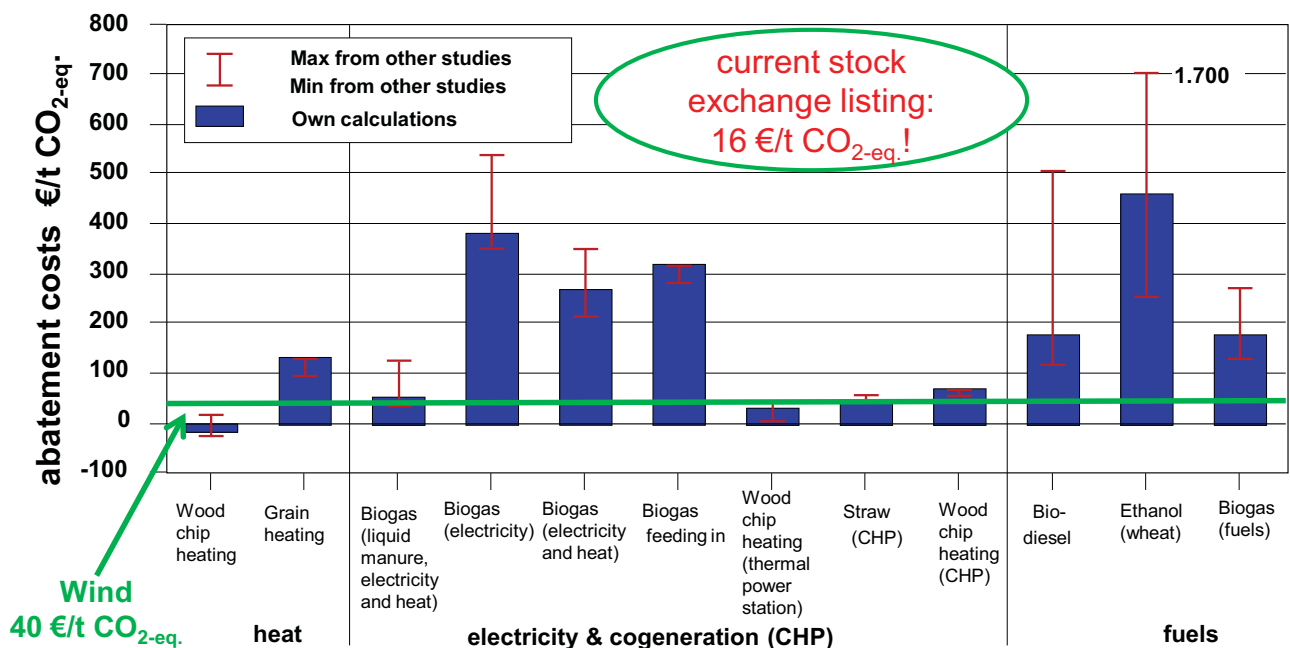
46

Certification of biomass fuel

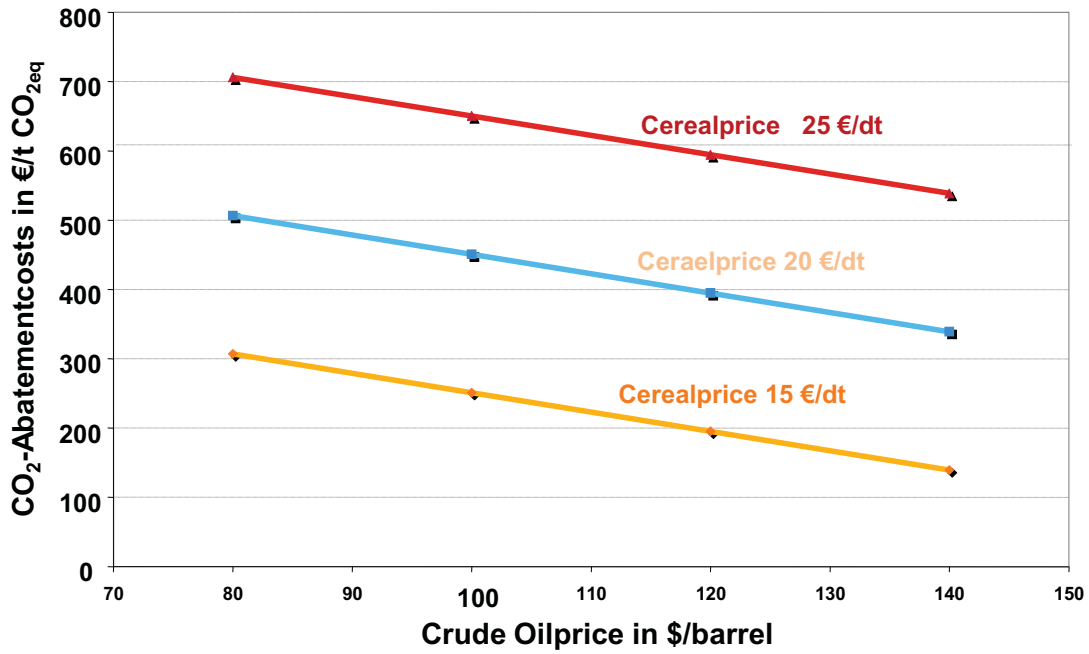


The credit was given when replacing the feeding stuff soya meal with vinasse (as an alternative for sugar beet) or with DDGS (as an alternative for wheat).

CO₂-eq. abatement costs of different bioenergy sources



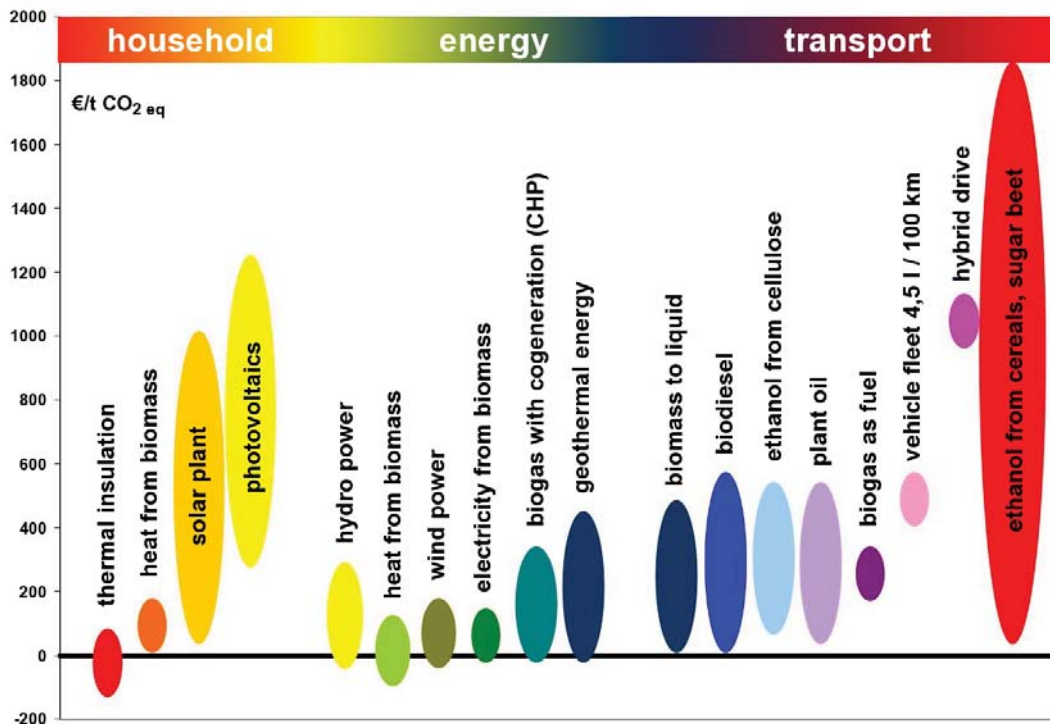
CO₂-Abatement Costs for Ethanol from Cereal in Relation of Price



Quelle: Rauh 2009

49

The CO₂-Abatement Costs - Literature Review

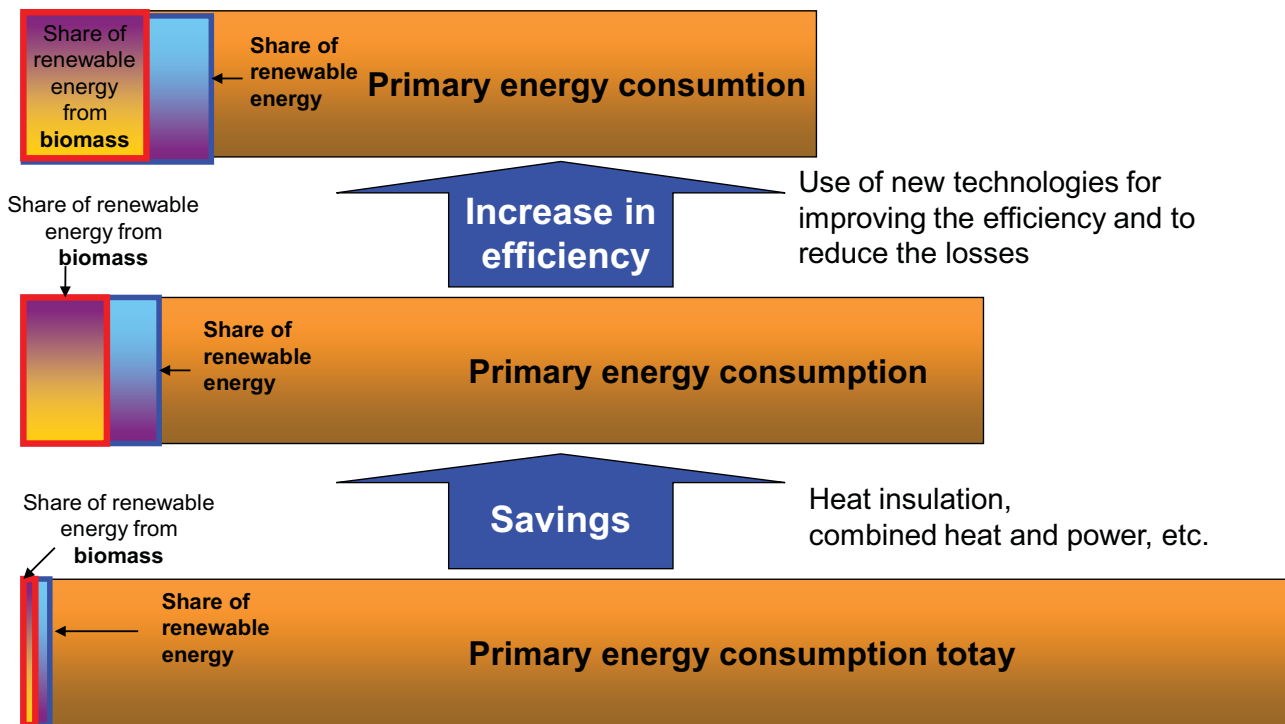


Source: own presentation in accordance with BEE 2006, EUCAR 2006, Grube inFVS 2006, Lettner in OTTI 2006, Picard aus TAB 2006, Schmitz 2006, Steiger 2006, Hartmann 2005, BMU 2004, FVV 2004, ITAS 2003, Specht aus FVS 2003, Scharmer 2001

50

50

Significance of renewable energy for sustainable energy supply



51

Munich's Energy Concept

- **Expansion of renewable energies**
 - electricity from 4 % to 20 % by 2020
 - Water, wind (offshore, repowering), geothermal energy, biogas, photovoltaics, solar thermal energy (southern Europe)
- **grid expansion**
- **Cofiring**
- **Enlarge gas storage**
- **Emissions trading**
- **Clean development mechanism (CDM)**
- **Energy saving through thermal insulation**

52

Danke für Ihr Interesse

Thank you for your interests

ご静聴ありがとうございました