Environmental Policy Research Centre

Freie Universität Berlin

PD Dr. Lutz Mez
Environmental Policy Research Centre
Freie Universität Berlin
lutz.mez@fu-berlin.de
www.fu-berlin.de/ffu

From Nuclear Power to Renewable Energy Policy in Germany

Germany without Nuclear Power. And Czech Republic?
Prague, May 31, 2011

Outline

Facts and figures (TPES, Energy Flow Chart, Electricity)

Implementation of the EU electricity and gas market directive

New Energy Policy since 1998

Nuclear power – a bridging technology?

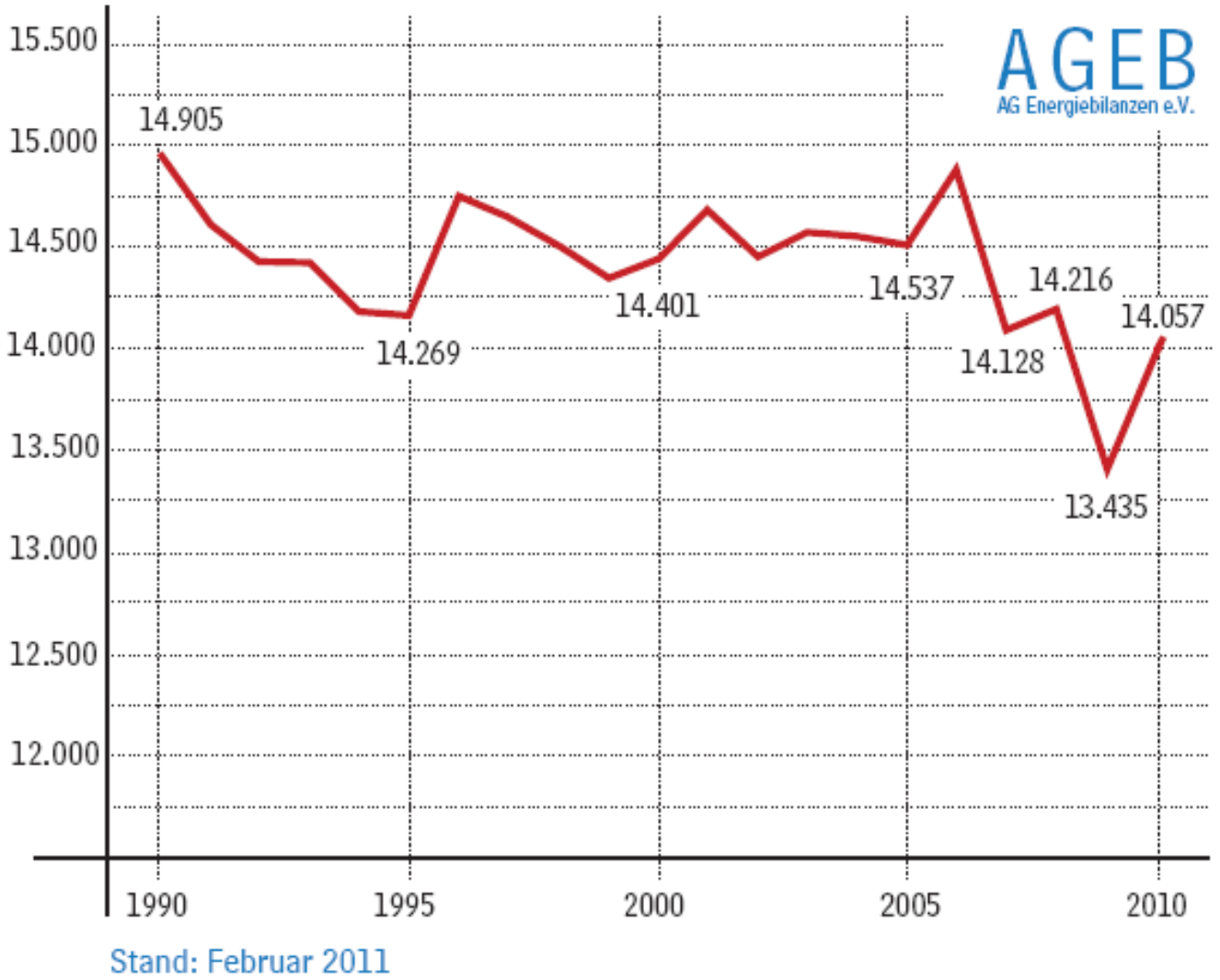
Recent developments and issues after Fukushima

Renewables in Germany

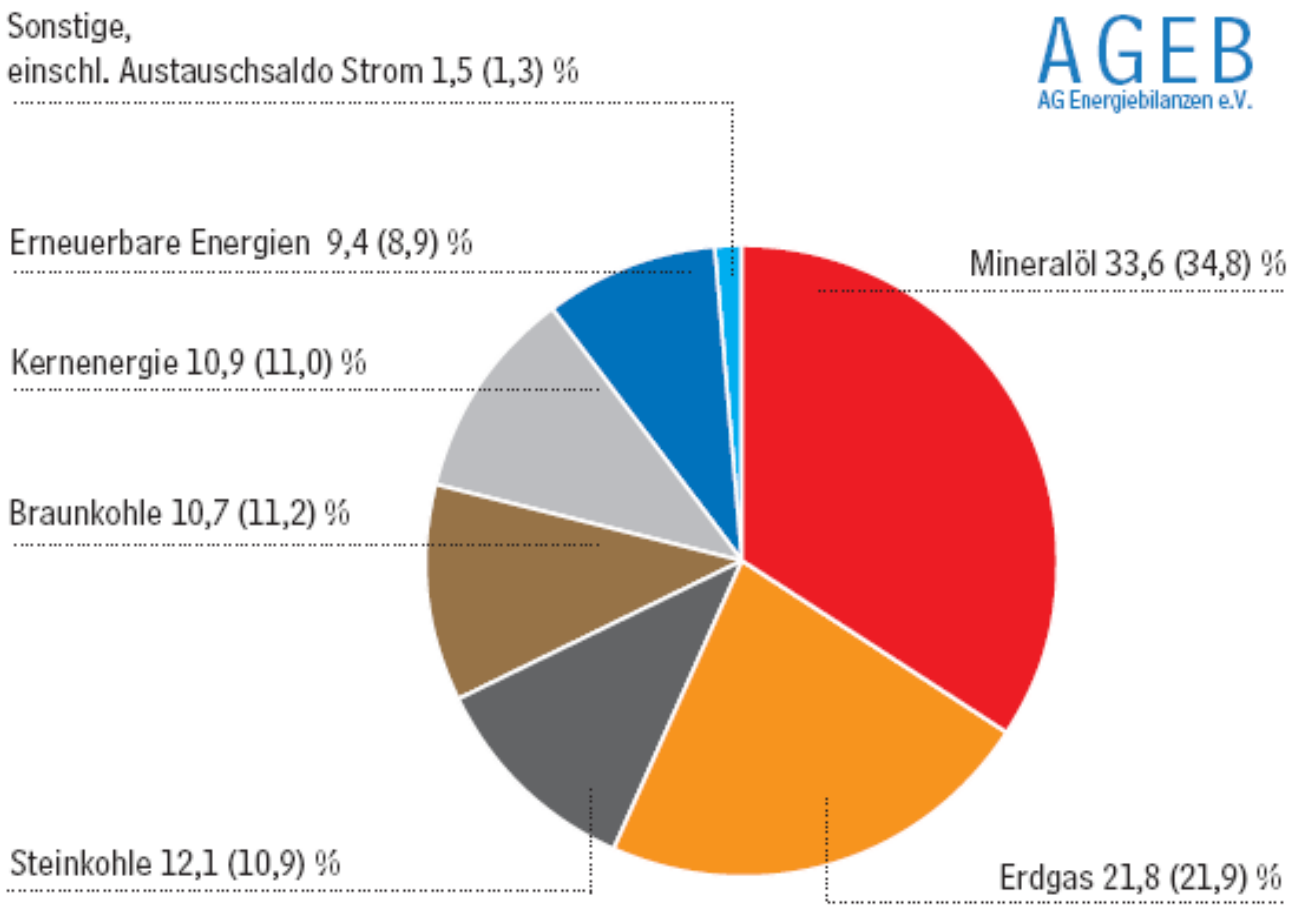
National RES targets 2020

National RES targets 2050

Development of TPES in Germany 1990-2010 in Petagjoule (PJ)



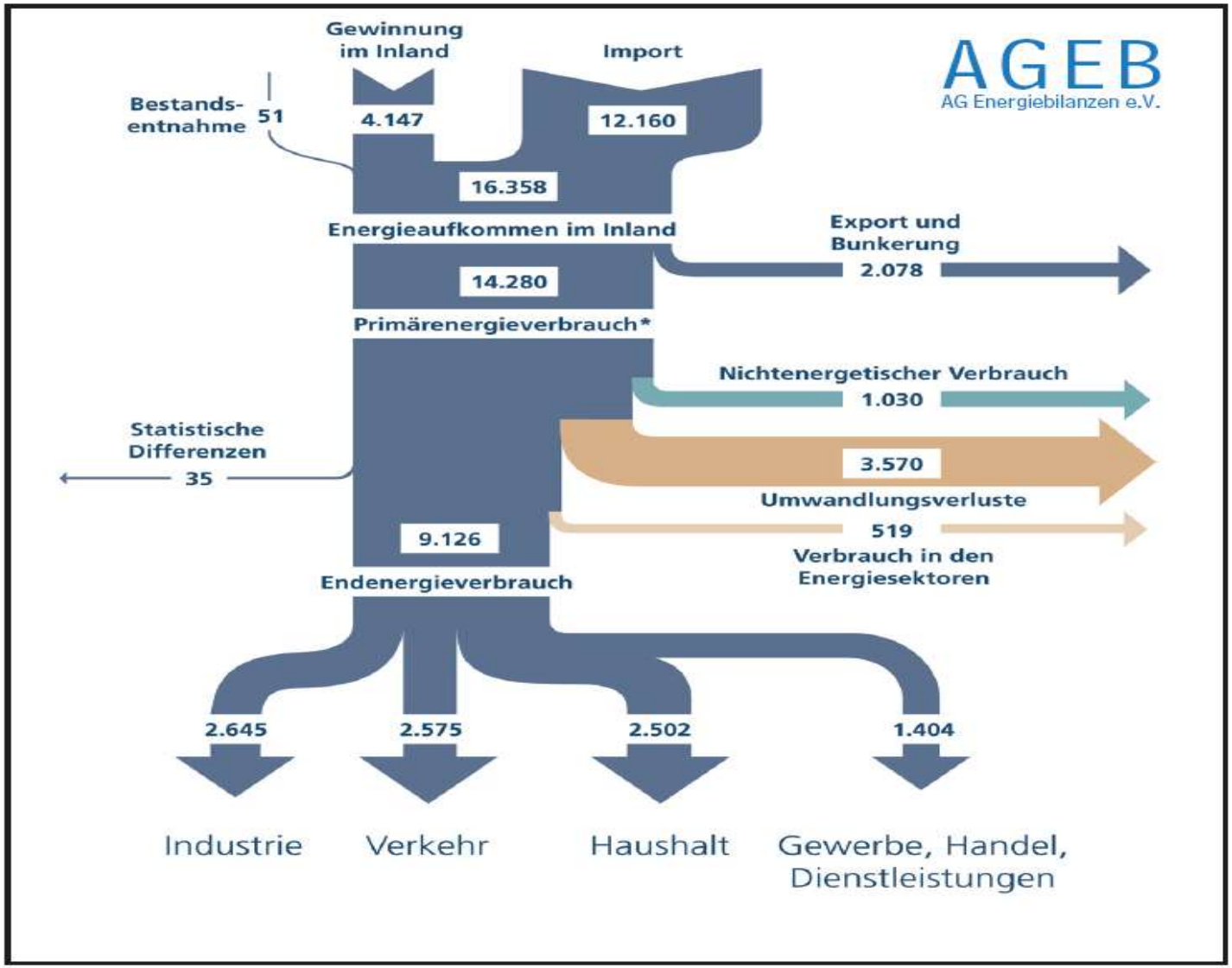
TPES Structure in Germany 2010



Energieflussbild 2008

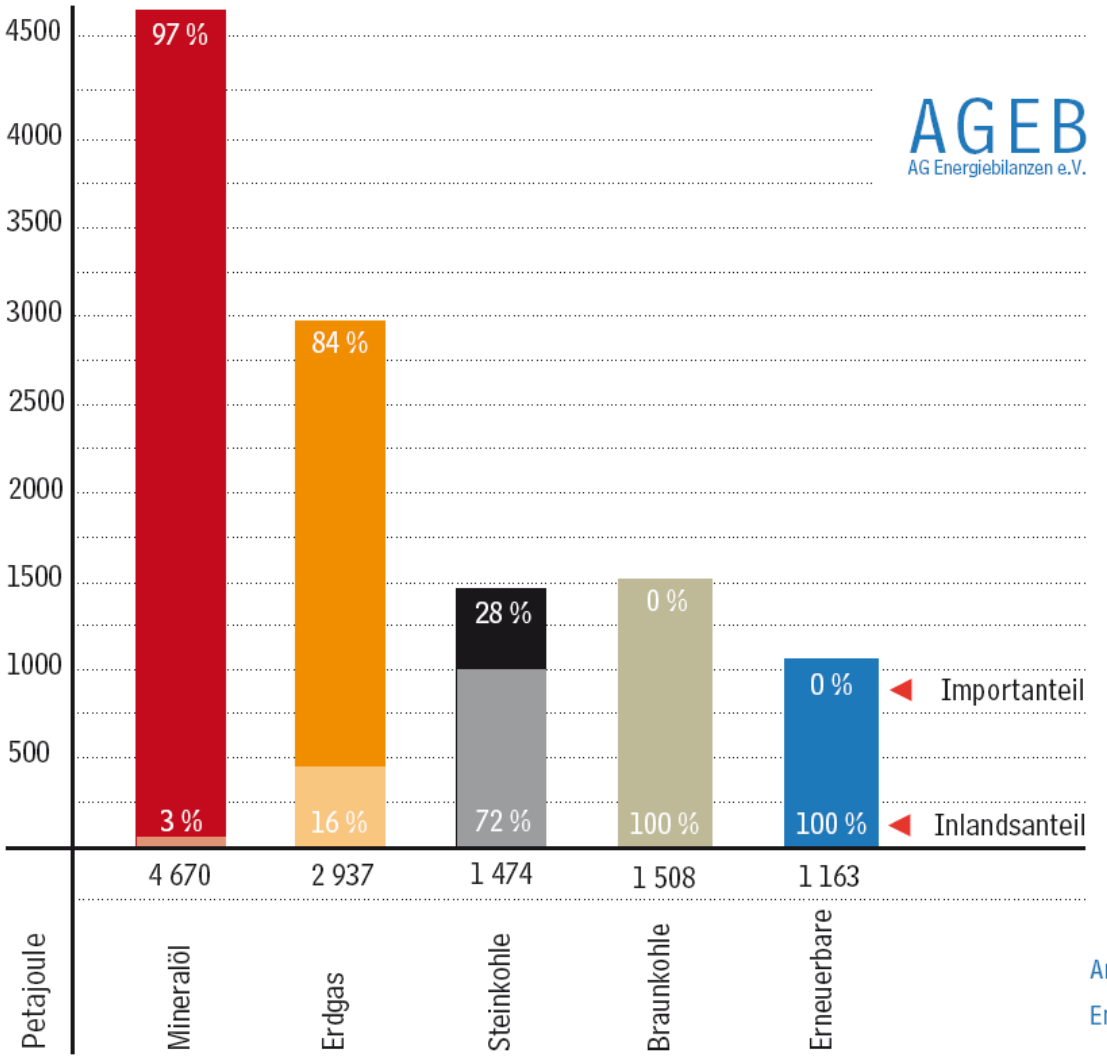
für die Bundesrepublik Deutschland - in Petajoule (PJ)

29,308 PJ ≙ 1 Mio. t SKE



Importabhängigkeit der deutschen Energieversorgung 2009

in Prozent vom Gesamtverbrauch - Gesamt 13 398 PJ - Inlandsgewinnung 3 913 PJ



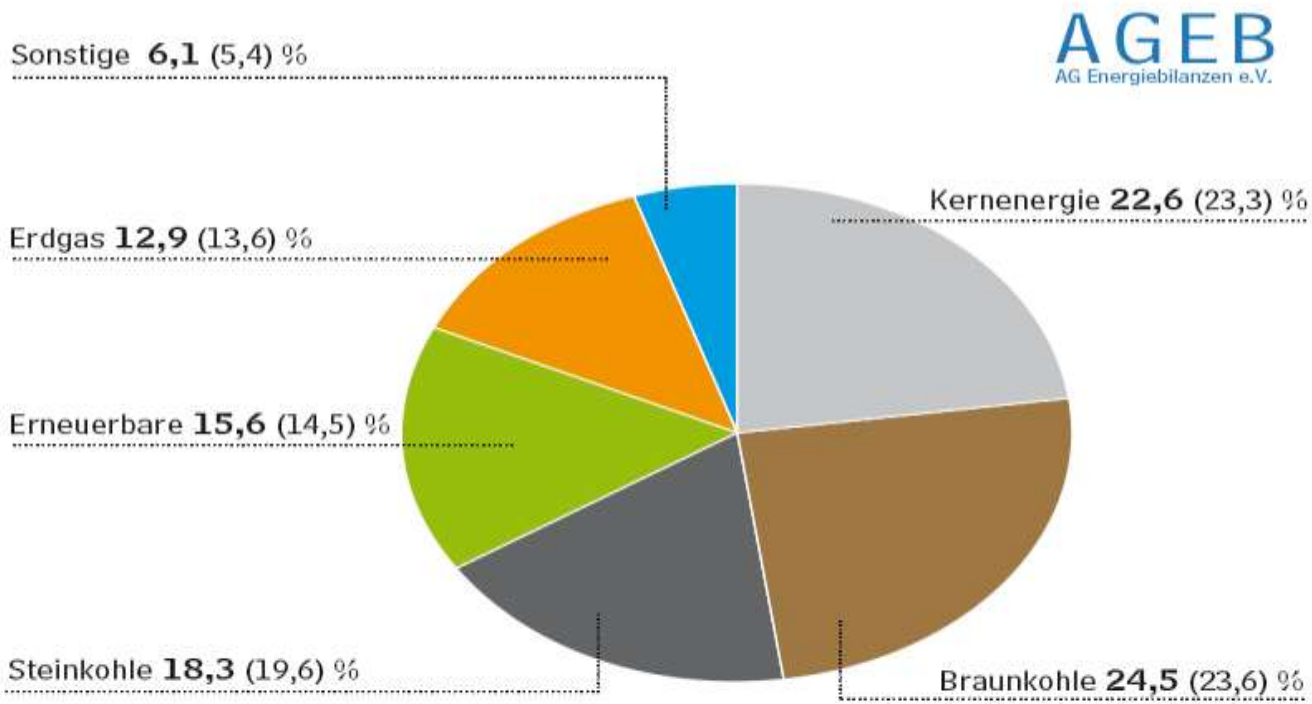
Arbeitsgemeinschaft
Energiebilanzen e.V.

Mohrenstraße 58
10117 Berlin

Stand: Juli 2010

Struktur der Stromerzeugung in Deutschland 2009

gesamt: 597 Milliarden Kilowattstunden (Mrd. kWh)
(Vorjahr in Klammern)



Stand: Februar 2010

Arbeitsgemeinschaft
Energiebilanzen e.V.

German position to Directives 96/92 and 98/30 EC

Energy Business Act of April 28, 1998

Association agreements (Verbändevereinbarungen)

No future for negotiated TPA

Establishment of an energy market regulator in 2005

New German Energy Policy since 1998

Energy Policy as element of ecological modernization

Nuclear power phase-out

Climate change policy

Eco-tax reform

Increased efficiency of energy supply (CHP) and end-use

Promotion of renewable energy

Nuclear Power Plants in Germany in operation and shut-down

Phasing-out nuclear power in Germany - Evaluation

Agreement reached in 2000, signed 2001

Atomic Energy Act amendment January 2002

Introduction of obligatory safety reviews

Abandonment of reprocessing and restriction of waste management to direct final storage

Raising the level of insurance cover for nuclear accident liability from € 255.7 million to € 2.56 billion

Maximum operation time: 32 years

Additional operation time 2010: +8 or +14 years

After Fukushima – nuclear phase out until 2021/22

Slogan **“Nuclear power as bridging technology”** means:

- Bridge to energy future founded on renewables
- Implies **common view: renewables will be the future.**

Until recently, this view was not common at all.

- Until the first oil price crisis 1973/74, energy community + governments were convinced of an immense nuclear potential, and did not at all consider renewables a serious option.

This paradigm worked in the 1960s/70s as self fulfilling prophecy:

- enormous resources spent on development of nuclear,
- absolutely no R&D on renewables until 1973,
- thereafter only modest R&D budgets.

Freie Universität Berlin

World Final Energy Consumption 2008

- share of electricity 17.2 %
- of which nuclear generation 13.5%
- result: share of nuclear electricity 2.3%

Nuclear Contribution to world energy supply, thus to climate protection**: rather modest**

If nuclear energy shall in future contribute substantially, worldwide **nuclear capacity needs large increase**

Source: IEA key world energy statistics 2010

Share of Nuclear Electricity of Total Final Energy Consumption of Six Largest Producers (2008)

	F	KOR	JAP	D	USA	RUS
TPES *in Mtoe*	266.50	226.95	495.84	335.28	2,283.72	686.76
Electricity gener. *in TWh*	570.3	443.9	1,075.0	631.2	4.343.8	1,038.4
Nuclear el. gen. *in TWh*	439.5	151.0	258.1	148.5	837.8	163.1
Share *in %*	77.1	34.0	24.0	23.5	19.3	15.7
TFEC *in Mtoe*	165.55	147.54	318.81	235.67	1,542.25	435.51
Share Electricity of TFEC *in %*	22.5	23.7	26.0	19.1	21.3	14.0
Share Nuclear electricity of TFEC *in %*	*17.3*	*8.1*	*6.2*	*4.5*	*4.1*	*2.2*

Source: IEA 2010

Freie Universität Berlin

Scenario energy revolution 2050

Final energy consumption - 48%, due to

Renewable energy - 21%
CO_2- separation/disposal - 19%
Nuclear energy - 6%

Required nuclear capacity

2005 – 2050, 32 new NPPs 1000 MWe each year
(2005-2010 = 160 new NPPs? – only 16 realised)

Result 2050: 1440 new NPPs, 1440 GW, i.e. 3.3 times the present world nuclear capacity (442 NPPs)

Nuclear Power - as Bridging Technology in Germany?

- **What happens to nuclear waste – today 6,000 t high radioactive nuclear waste**
- **Additional nuclear waste according to nuclear phase-out law – 4,800 t**
- **German NPPs produce annually 450 t nuclear waste**
- **Instead of 10,800 t more than 16,000 t burned fuel rods will exist**
- **Additional profit for NPP operators – about 94 bn. €**
- **Skimming off by the German state – ca. 27 bn. €**
- **Loss of innovation pressure for renewable energies**
- **Danger for security of investment in renewable energy facilities**
- **Inflexible NPPs**

Three decades of German RES policy in a glance

Difficult beginnings
- First oil crisis
- Promotion of R&D

First measures of market creation
100/250 MW wind programme
1,000 solar roof programme

The 1990 Feed-In Law

Promotion of Renewables

100,000 roof photovoltaic program (300 MW)

€ 200 million/year market launch program (Markteinführungsprogramm) for renewable energy sources

Eco-tax reform in five steps until 2003

The Renewable Energy Sources Act of 2000

The 2004 Amendment

The 2009 Amendment

Act Granting Priority to Renewable Energies (RESA)

RESA came into force April 1, 2000

Initiative of the parliament – not primarily government

Aim is to achieve a substantial increase of renewable energy sources to power supply and total energy consumption by 2010

Improving economics of RES substantially by feed-in provisions, fixed remuneration for electricity with decrease over years

Remuneration payments are balanced out between German TSOs

Contribution of renewable energy sources to energy supply in Germany in 2009

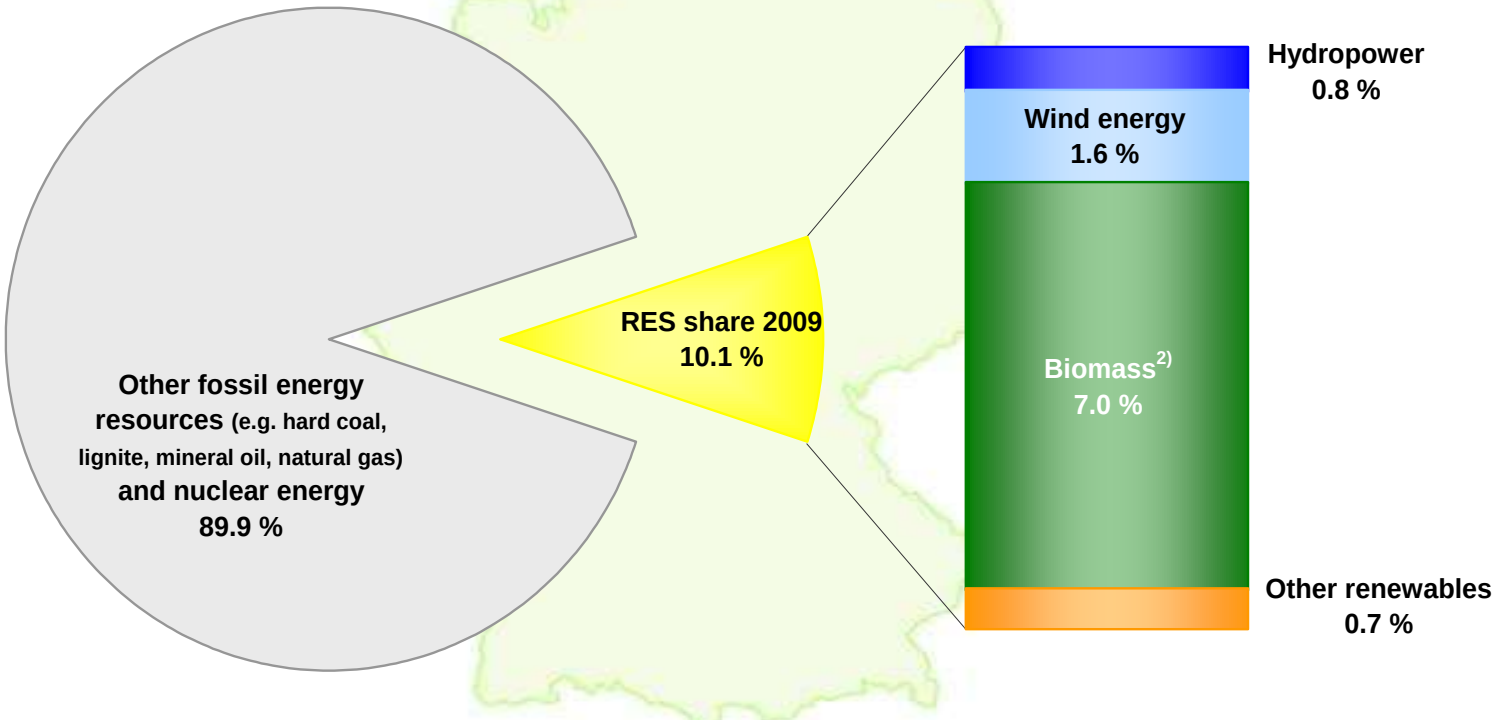
Share of renewable energy sources		
in total final energy consumption	[%]	**10.1**
in total gross electricity consumption		**16.4**
in total heat supply		**8.5**
in total fuel consumption[1)]		**5.5**
in total primary energy consumption[2)]		**8.7**

[1)] Total consumption of engine fuels, excluding fuel in air traffic;

[2)] Source: Working Group on Energy Balances (AGEB);

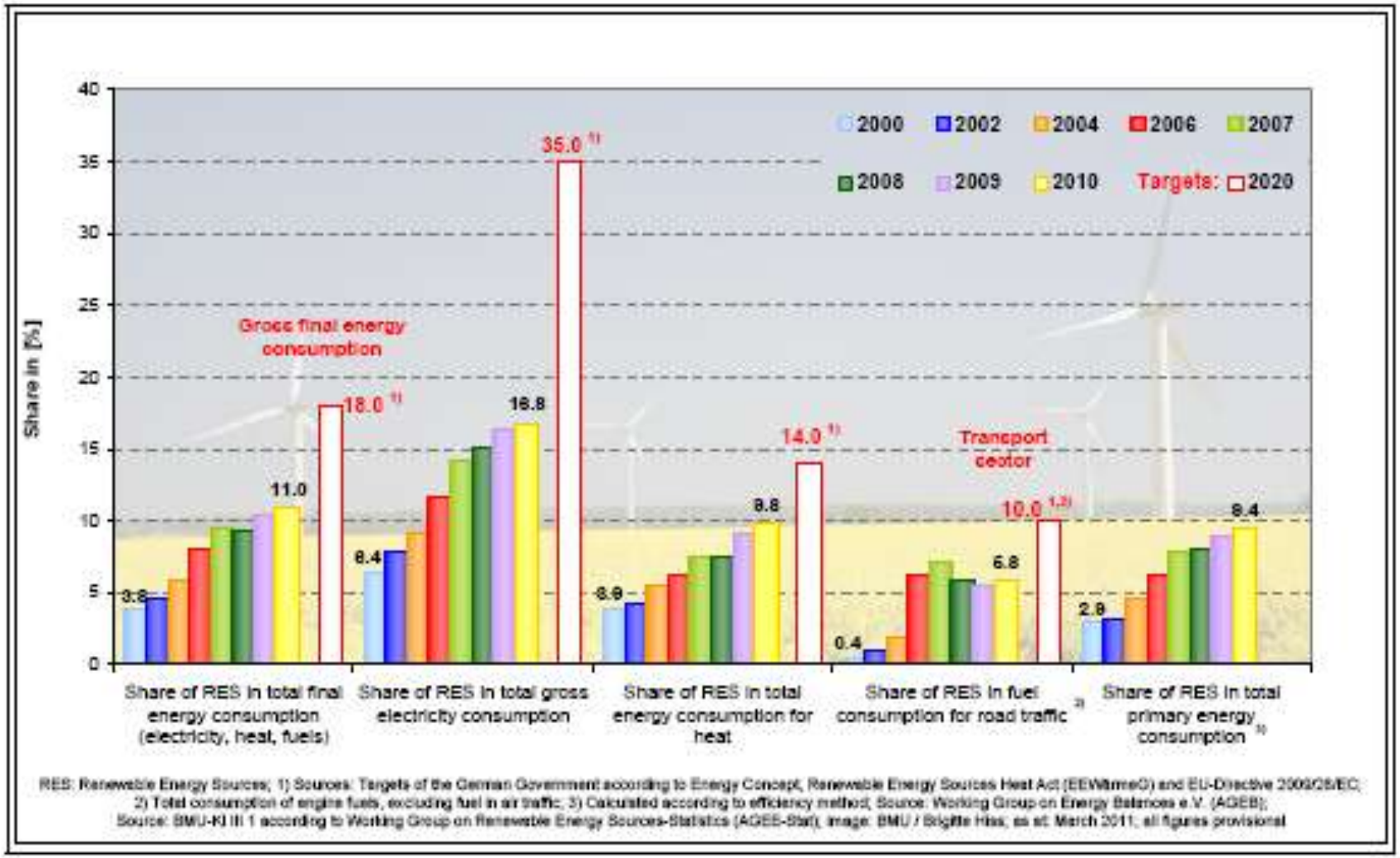
Source: BMU-KI III 1 according to Working Group on Renewable Energies-Statistics (AGEE-Stat); as at: September 2010; all figures provisional

Shares of renewable energy sources among total final energy consumption in Germany 2009



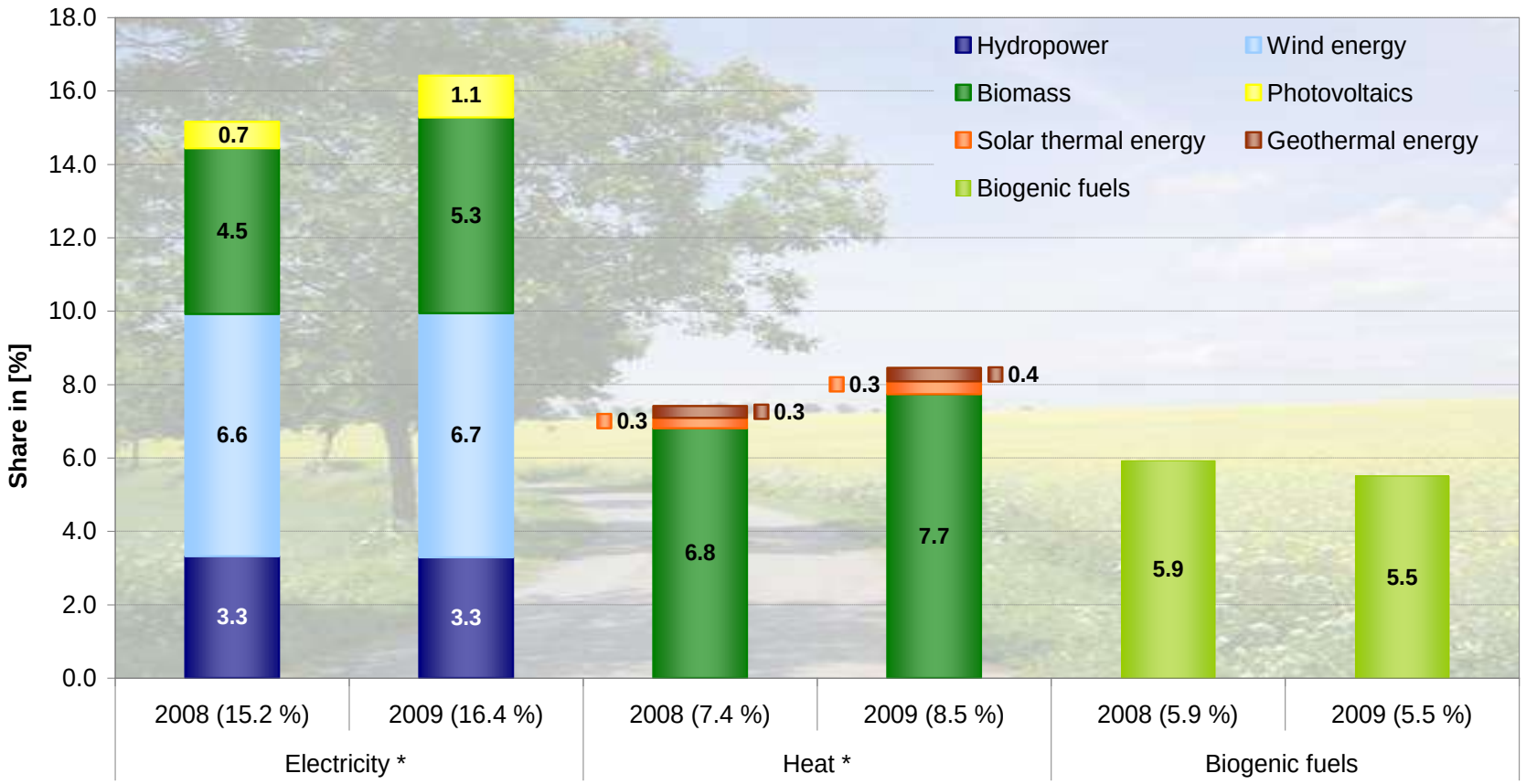
1) Working Group on Energy Balances (AGEB); 2) solid and liquid biomass, biogas, sewage and landfill gas, biogenic share of waste; deviations in the totals are due to rounding; RES - Renewable Energy Sources; Source: BMU-KI III 1 based on Working Group on Renewable Energies-Statistics (AGEE-Stat) and the Centre for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW), according to AGEB; as at: September 2010; all figures provisional

RES as share in German Energy Supply



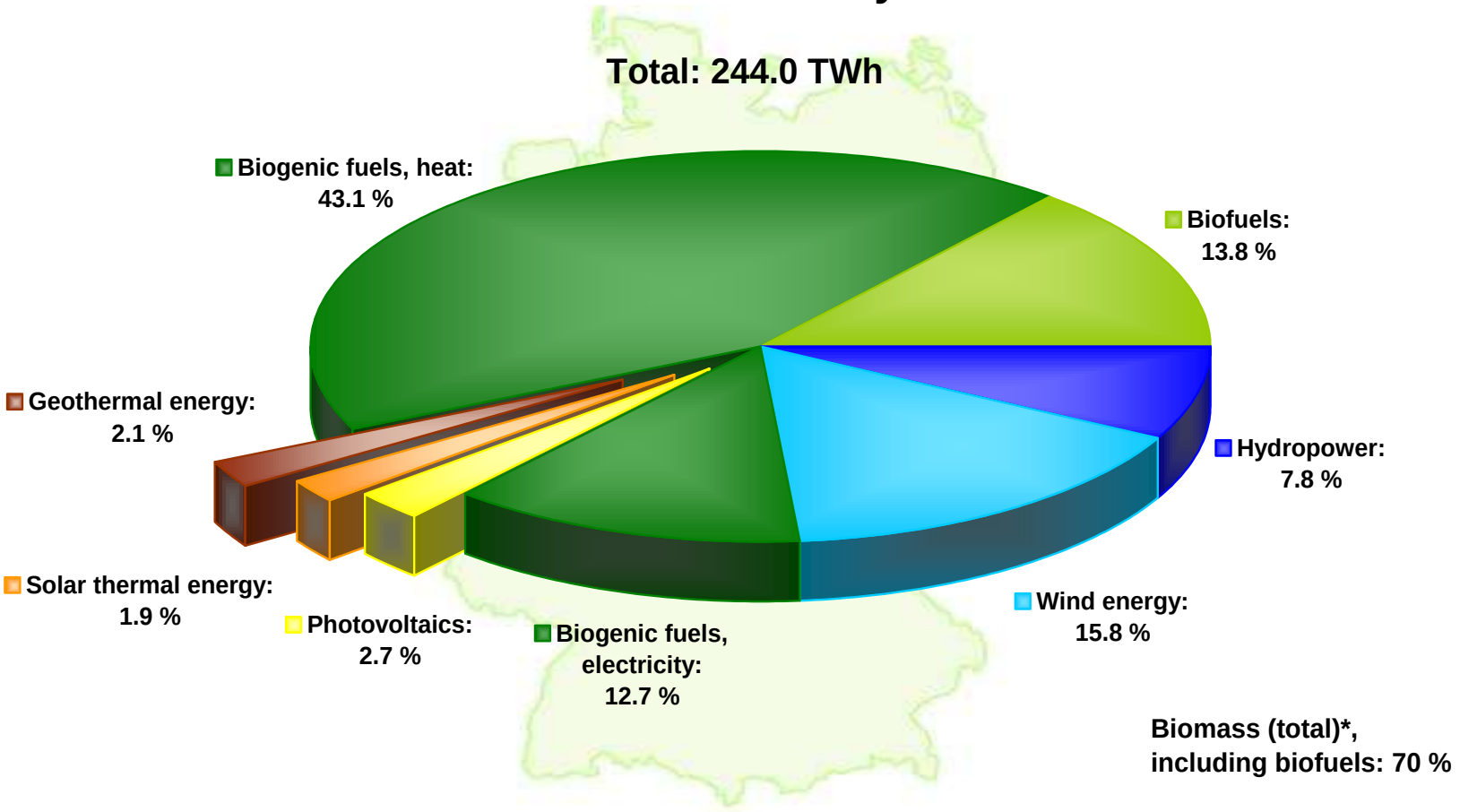
RES: Renewable Energy Sources; 1) Sources: Targets of the German Government according to Energy Concept, Renewable Energy Sources Heat Act (EEWärmeG) and EU-Directive 2009/28/EC; 2) Total consumption of engine fuels, excluding fuel in air traffic; 3) Calculated according to efficiency method; Source: Working Group on Energy Balances e.V. (AGEB); 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

Share of renewable energy sources in total final energy consumption in Germany 2008 / 2009



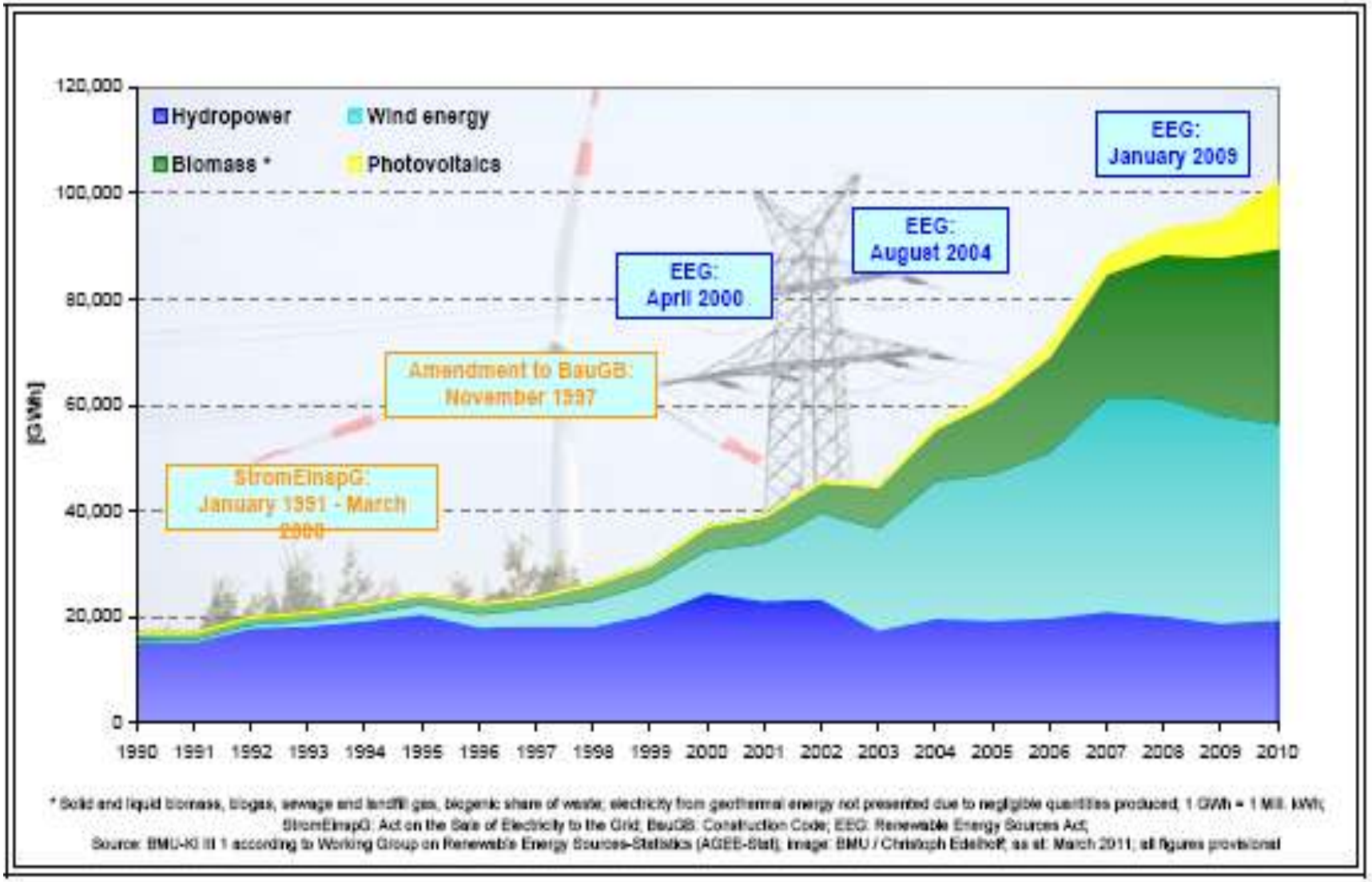
* Solid and liquid biomass, biogas, sewage and landfill gas, biogenic share of waste; deviations in the totals are due to rounding;
Source: BMU-KI III 1 according to Working Group on Renewable Energies-Statistics (AGEE-Stat); Image: BMU / Dieter Böhme; as at: September 2010; all figures provisional

Structure of final energy supply from renewable energy sources in Germany 2009

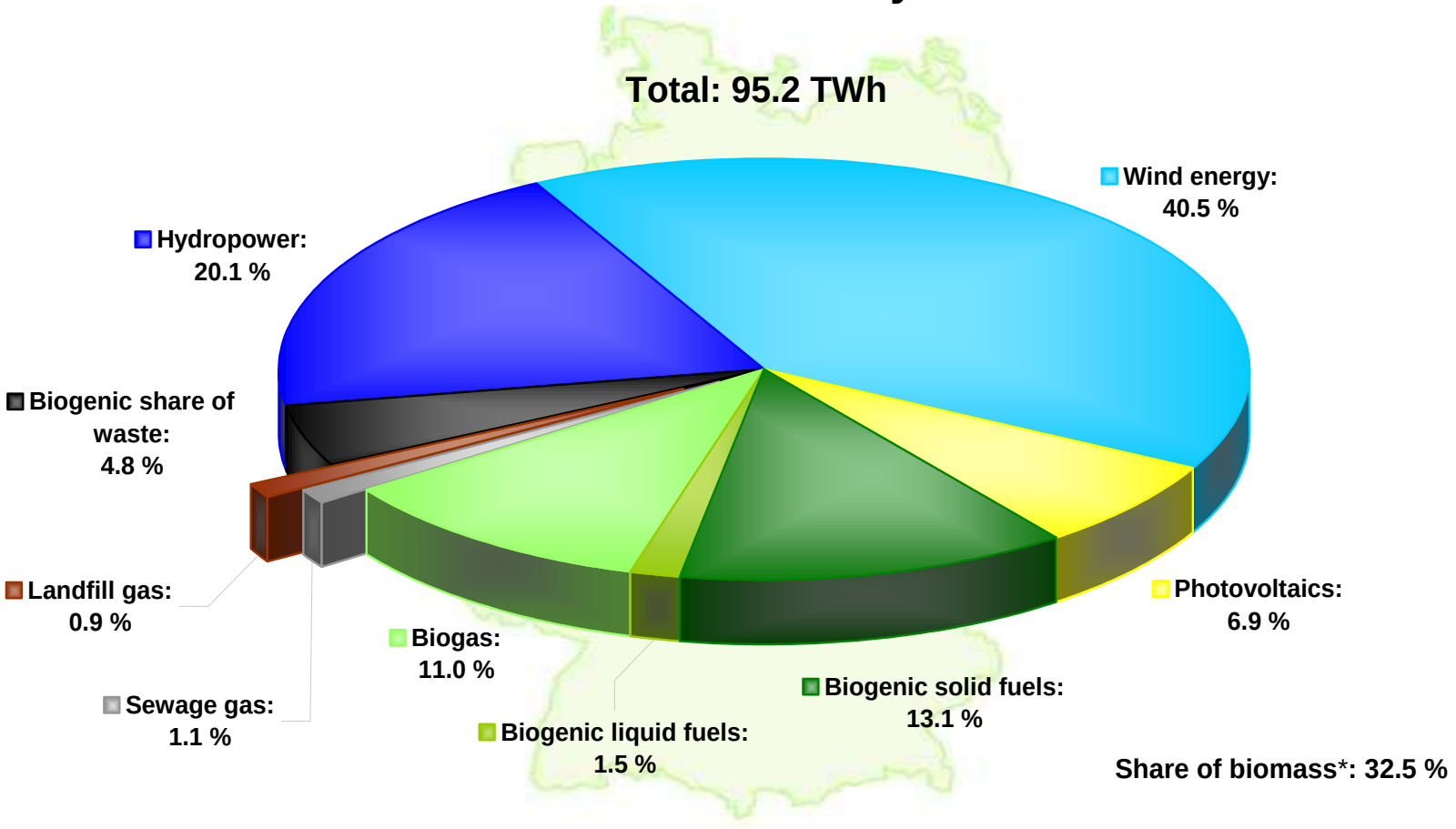


* Solid and liquid biomass, biogas, sewage and landfill gas, biogenic share of waste and biofuels; deviations in the totals are due to rounding;
Source: BMU-KI III 1 according to Working Group on Renewable Energies-Statistics (AGEE-Stat); as at: September 2010; all figures provisional

Contribution of RES to electricity generation

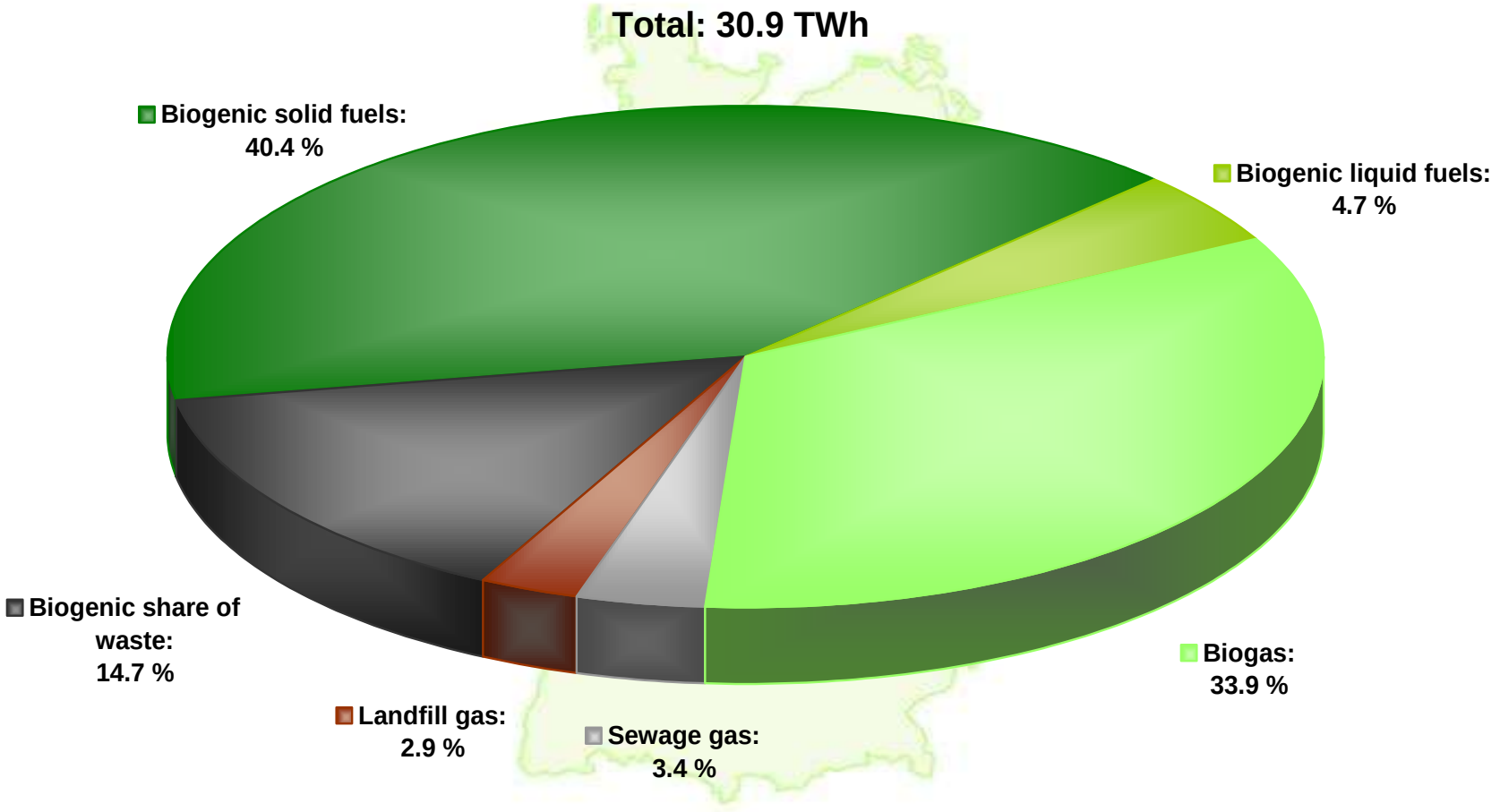


Structure of electricity supply from renewable energy sources in Germany 2009



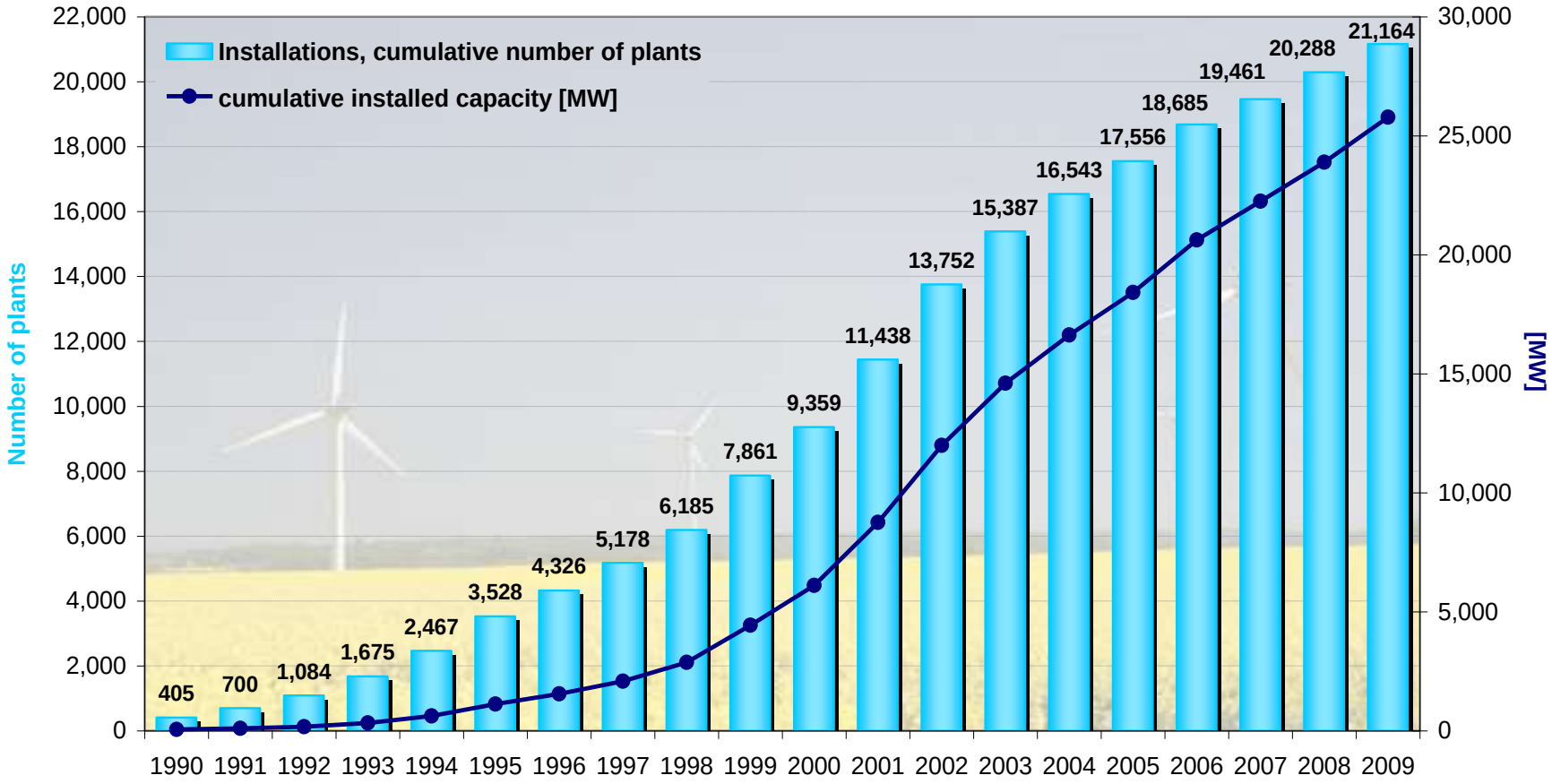
* Solid and liquid biomass, biogas, sewage and landfill gas, biogenic share of waste; Electricity from geothermal energy is not presented due to the negligible quantities of electricity produced; deviations in the totals are due to rounding; Source: BMU-KI III 1 according to Working Group on Renewable Energies-Statistics (AGEE-Stat); as at: September 2010; all figures provisional

Structure of electricity supply from biomass



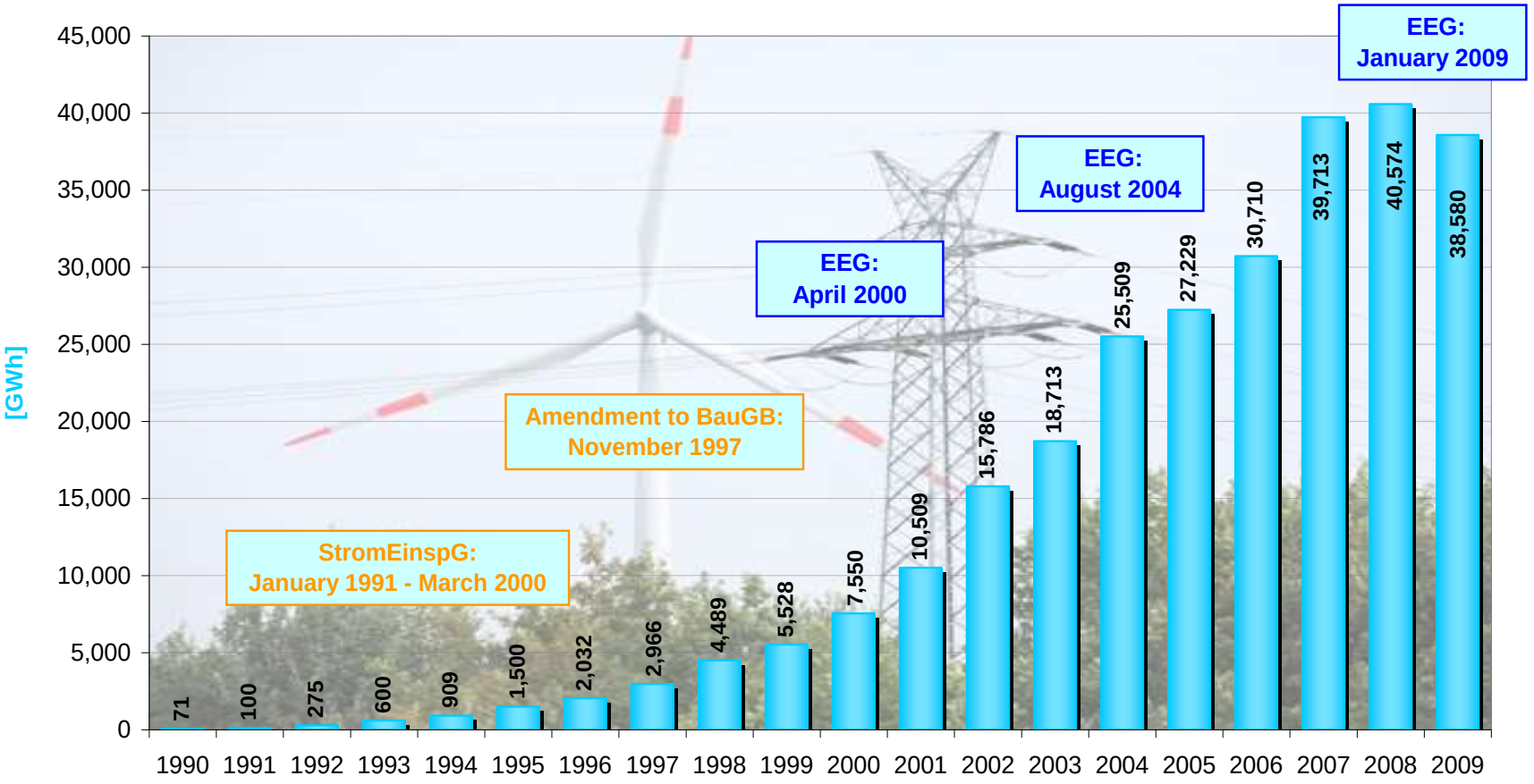
Source: BMU-KI III 1 according to Working Group on Renewable Energies-Statistics (AGEE-Stat); deviations in the totals are due to rounding; as at: September 2010; all figures provisional

Number of wind energy plants and installed capacity in Germany 1990 - 2009



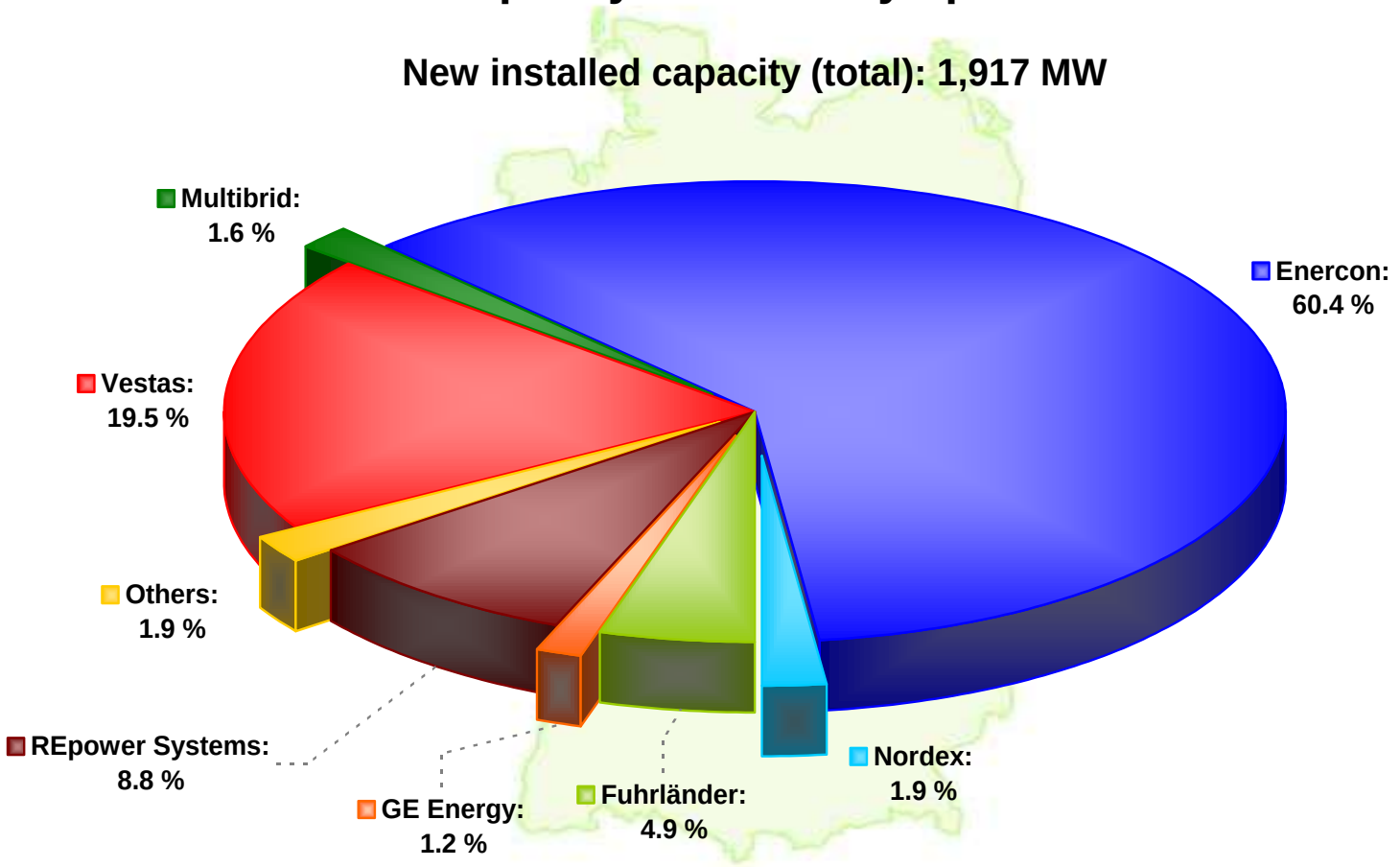
Source: B. Neddermann: Wind Energy Use in Germany - Status; 31.12.2009; Deutsches Windenergie-Institut (DEWI); Image: BMU / Brigitte Hiss; all figures provisional

Development of wind energy use in Germany 1990 - 2009



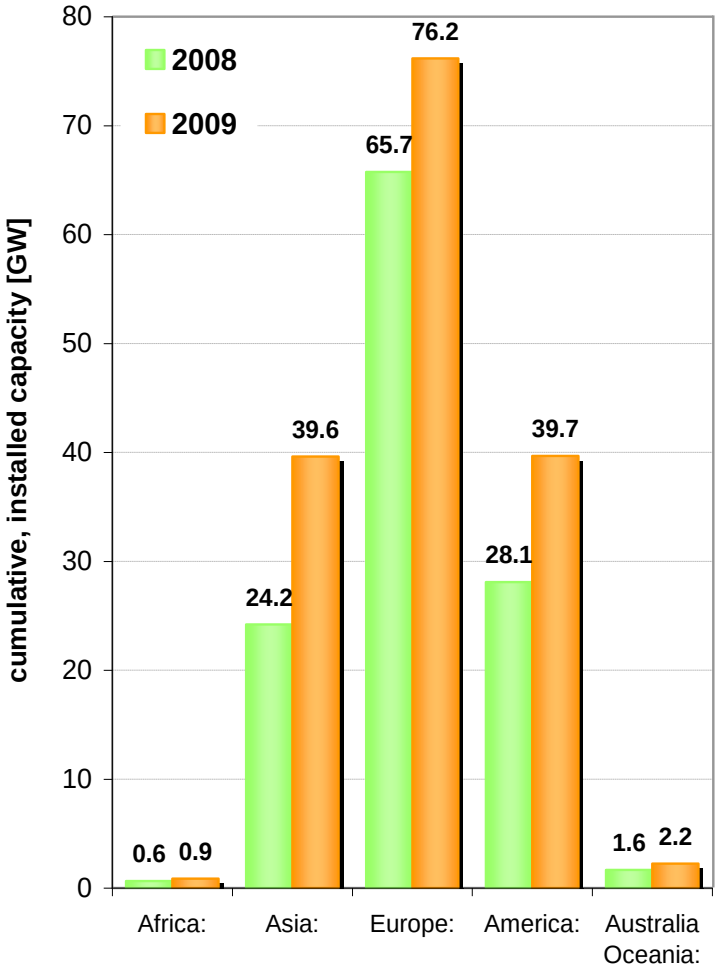
StromEinspG: Act on the Sale of Electricity to the Grid; BauGB: Construction Code; EEG: Renewable Energy Sources Act;
Source: BMU-KI III 1 according to Working Group on Renewable Energies-Statistics (AGEE-Stat); Image: BMU / Christoph Edelhoff; as at: September 2010; all figures provisional

Share of providers of wind energy installations in newly installed capacity in Germany up to end of 2009



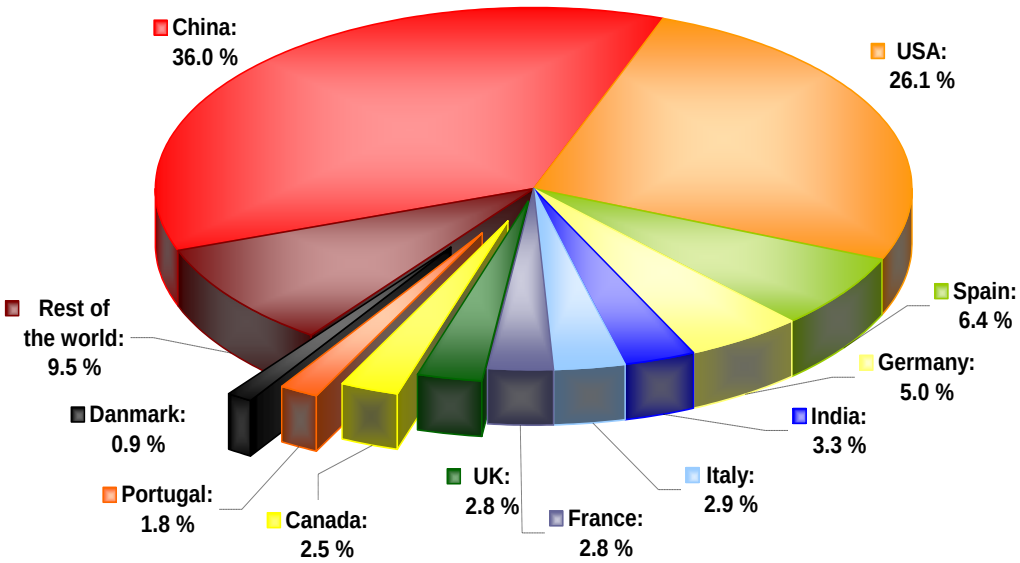
Source: B. Neddermann: Wind Energy Use in Germany; Version: 31.12.2009; Deutsches Windenergie-Institut (DEWI); deviations in the totals are due to rounding; all figures provisional

Capacity of windpower plants (worldwide)



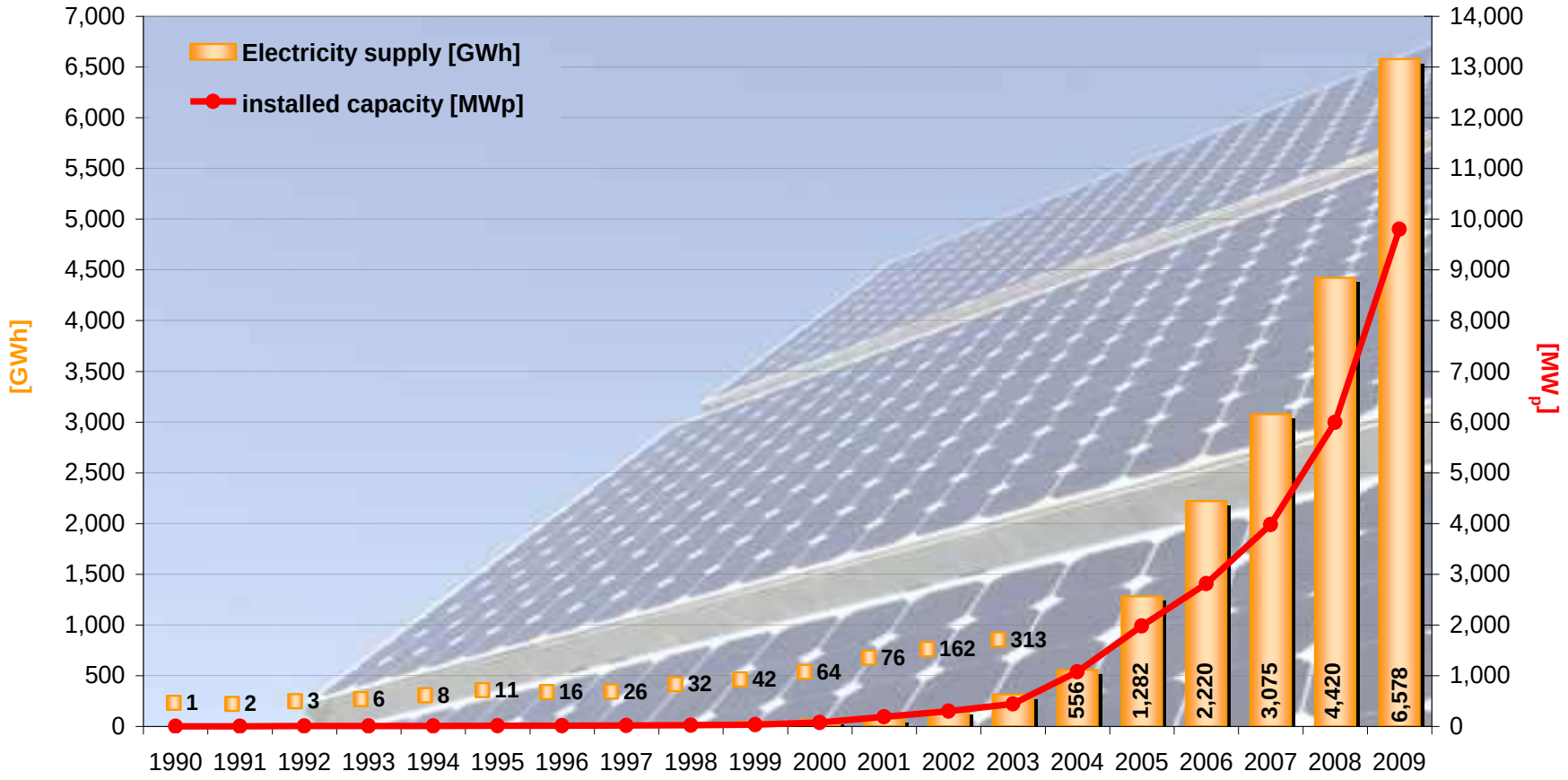
Total capacity 2009: 158,505 MW

New installed capacity (total): 38,343 MW



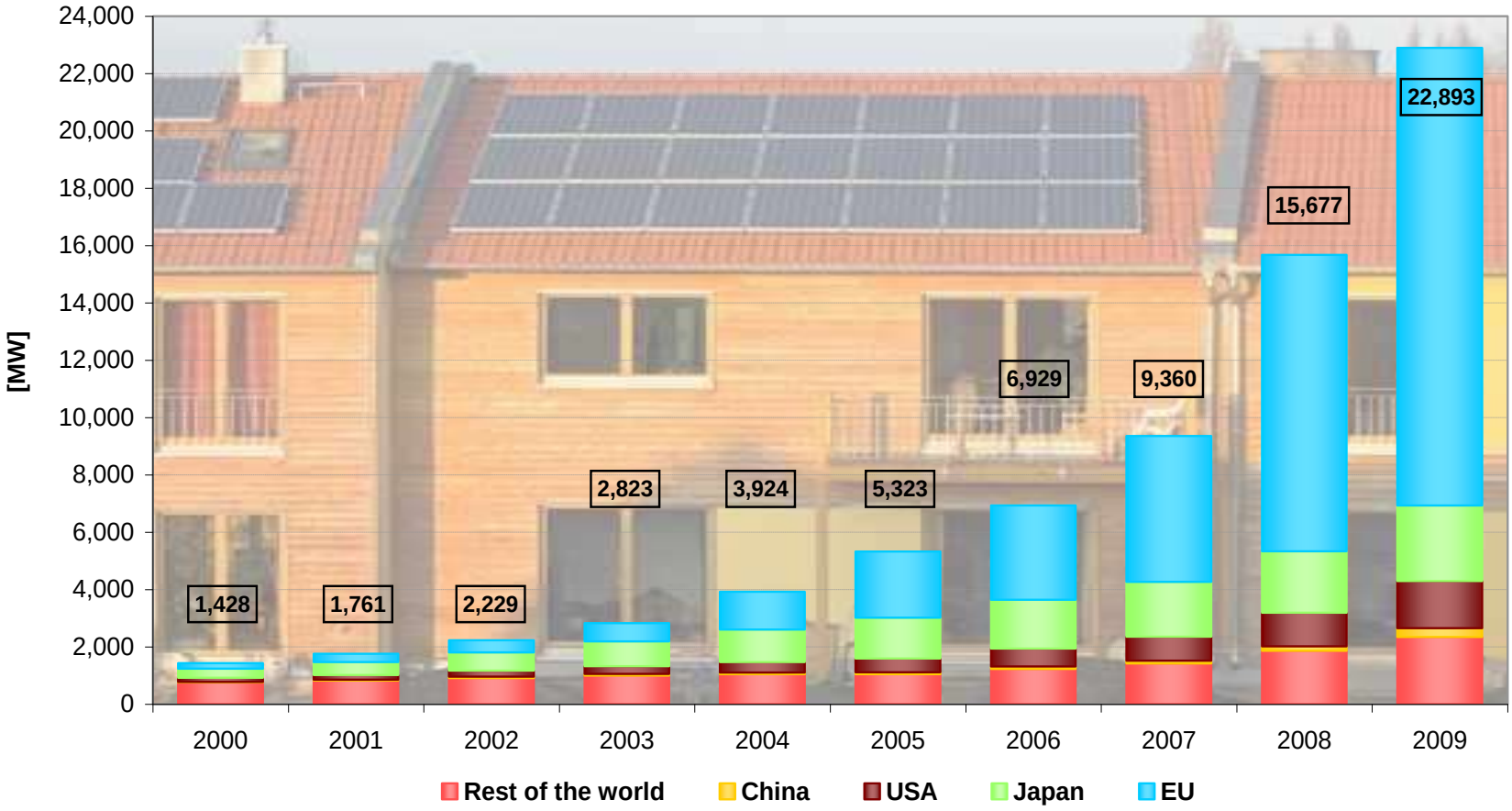
Source: Global Wind Energy Council (GWEC): Global Wind 2009 Report; as at: March 2010; all figures provisional

Installed capacity and energy supply from photovoltaic installations in Germany 1990 - 2009



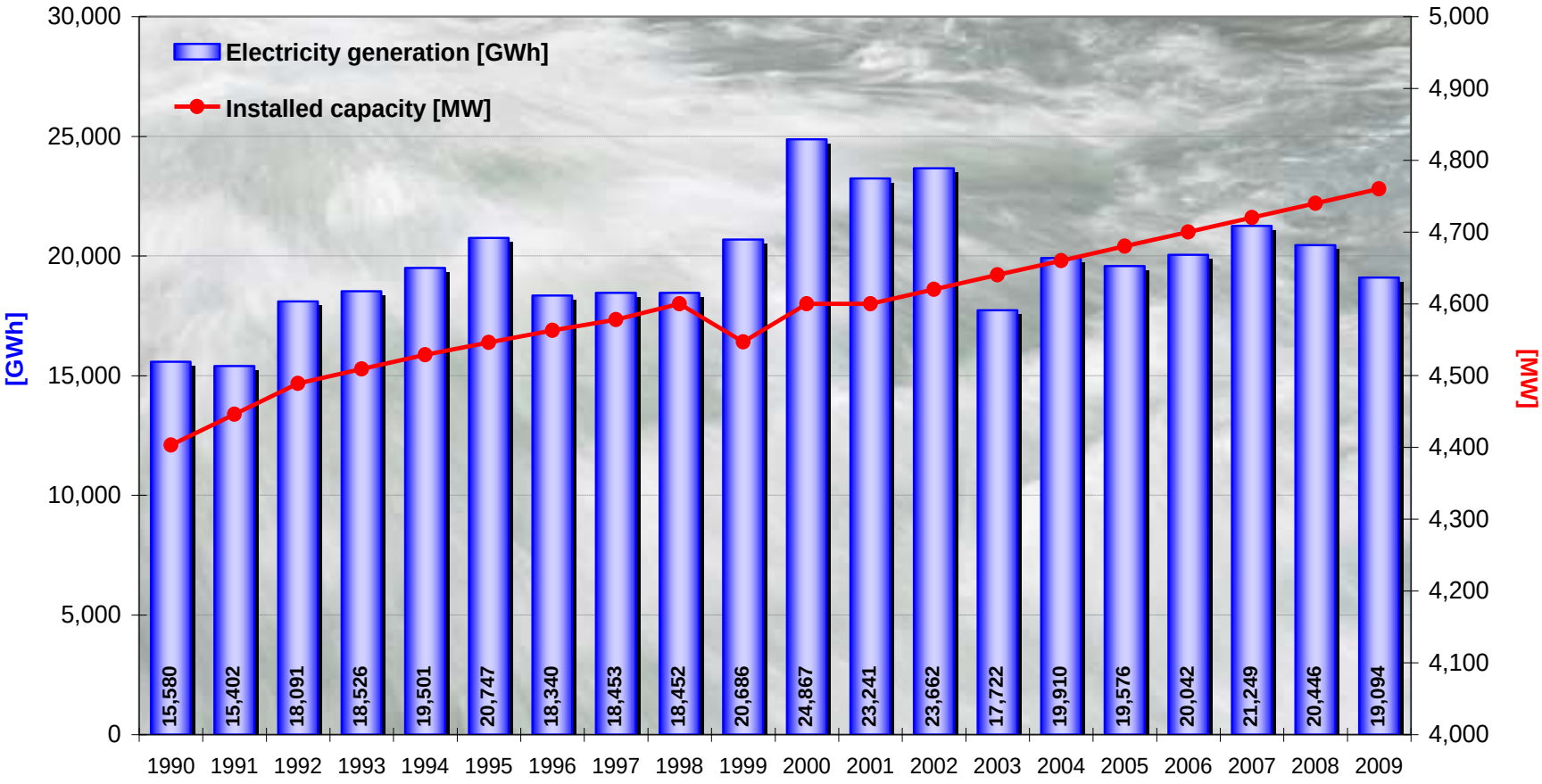
Source: BMU-KI III 1 according to Working Group on Renewable Energies-Statistics (AGEE-Stat); Image: BMU / Bernd Müller; as at: September 2010; all figures provisional

Worldmarket photovoltaics 2000 - 2009
cumulated installed capacity



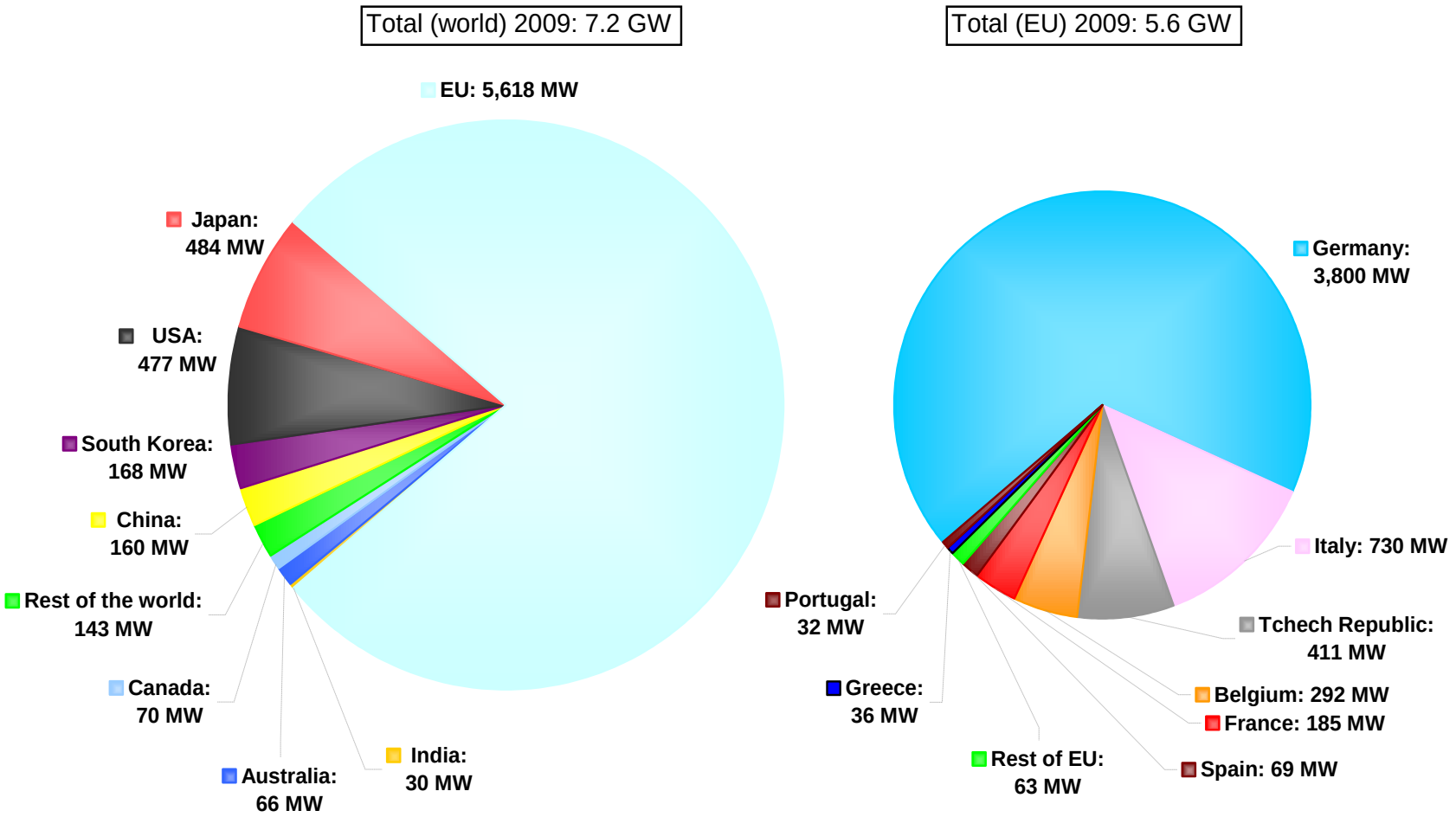
Quelle: European Photovoltaik Industry Association (EPIA); Press release: "Global Market Outlook for Photovoltaics until 2014"; Image: BMU / Brigitte Hiss; as at: April 2010; all figures provisional

Development of hydropower use in Germany 1990 - 2009



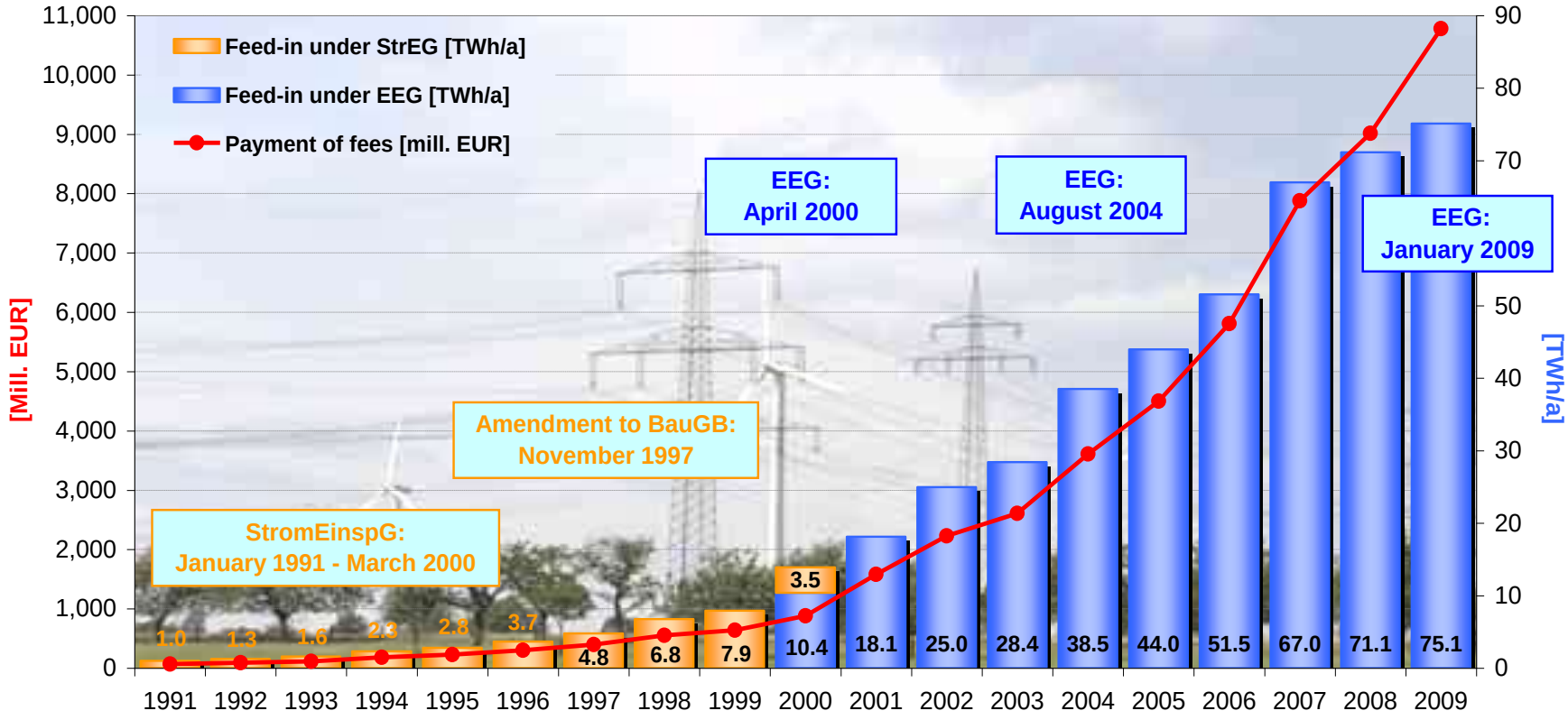
Source: BMU-KI III 1 according to Working Group on Renewable Energies-Statistics (AGEE-Stat); Image: BMU / Bernd Müller; as at: September 2010; all figures provisional

Worldmarket photovoltaics, new installed capacity 2009



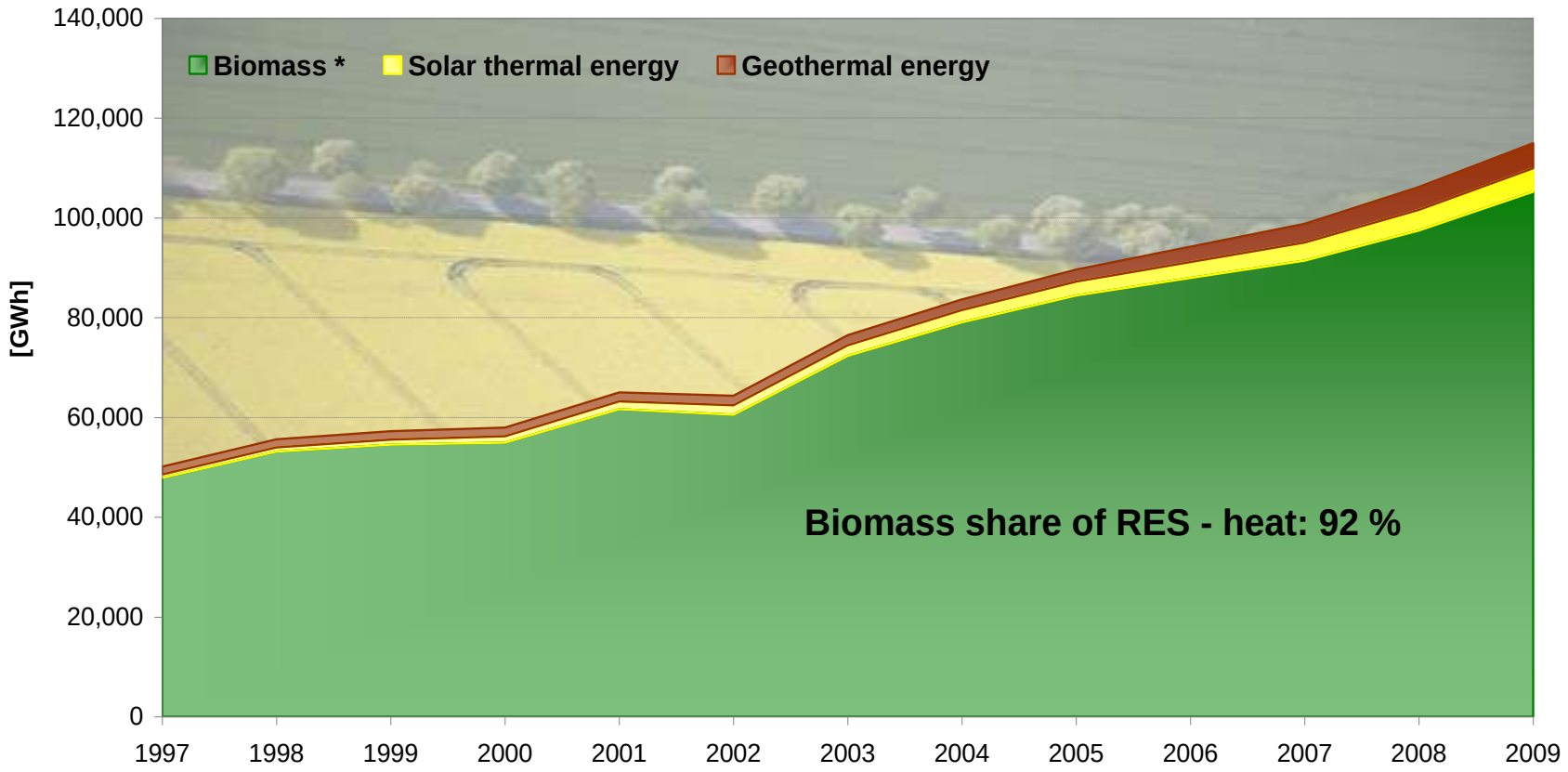
Source: European Photovoltaik Industry Association (EPIA); Press release: "Global Market Outlook for Photovoltaics until 2014"; as at: April 2010; all figures provisional

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



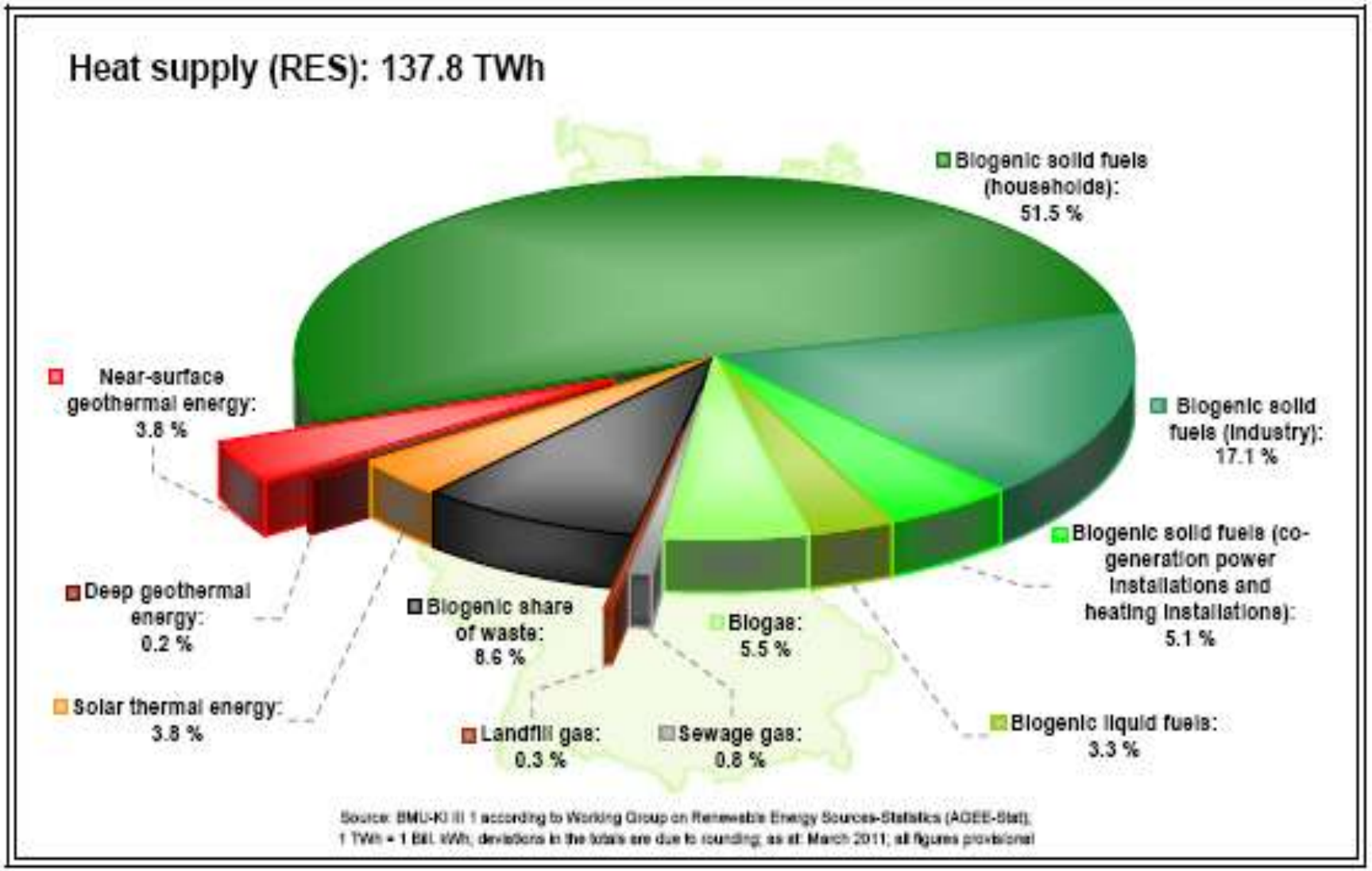
StromEinspG: Act on the Sale of Electricity to the Grid; BauGB: Construction Code; EEG: Renewable Energy Sources Act;
Source: BMU-KI III 1 according to Working Group on Renewable Energies-Statistics (AGEE-Stat); Image: BMU / Bernd Müller; as at: September 2010; all figures provisional

Contribution of renewable energy sources to heat supply in Germany 1997 - 2009

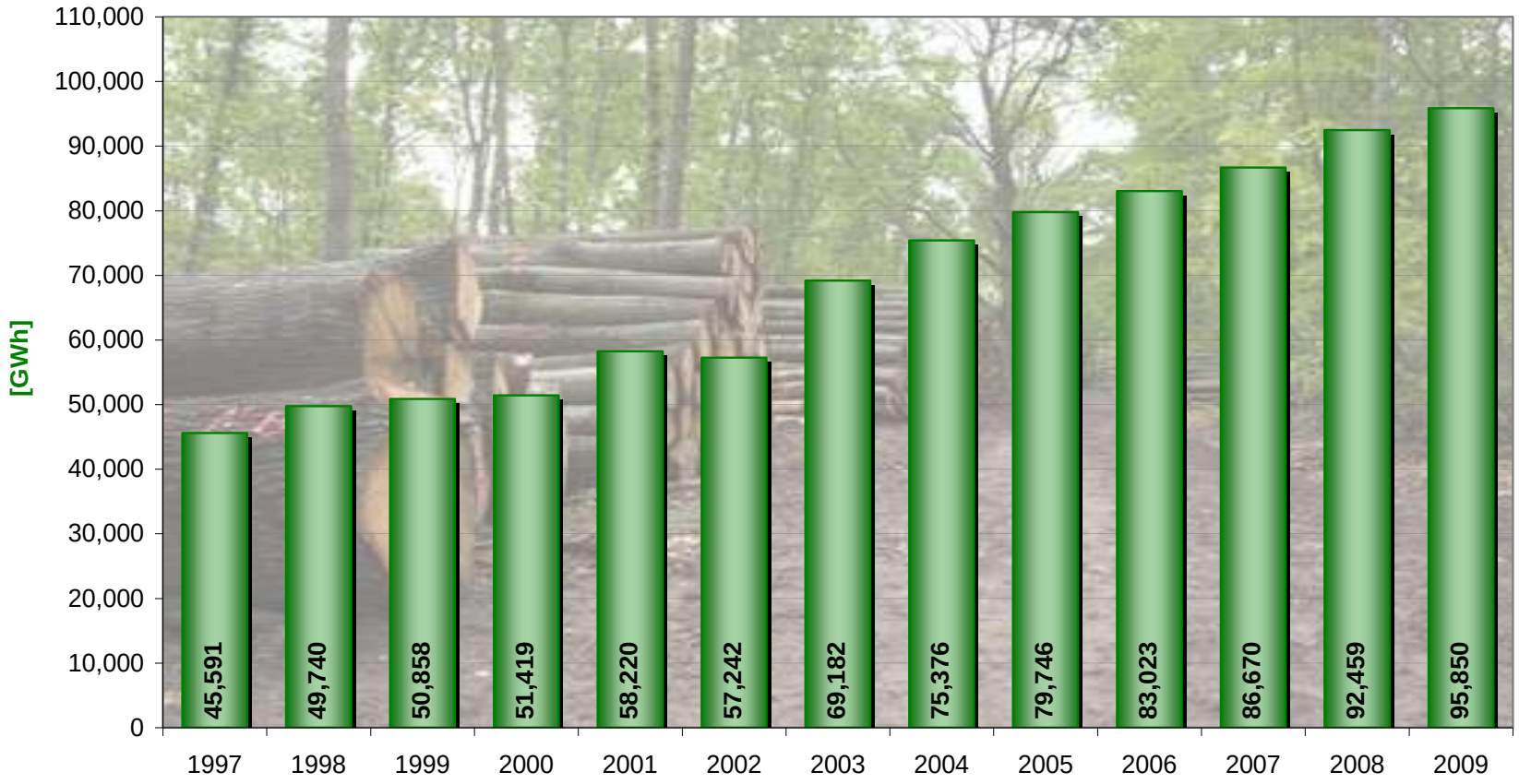


* Solid and liquid biomass, biogas, sewage and landfill gas, biogenic share of waste;
Source: BMU-KI III 1 according to Working Group on Renewable Energies-Statistics (AGEE-Stat); Image: BMU / Brigitte Hiss; as at: September 2010; all figures provisional

Structure of Heat Supply 2010



Development of biomass* use for heat supply in Germany 1997 - 2009

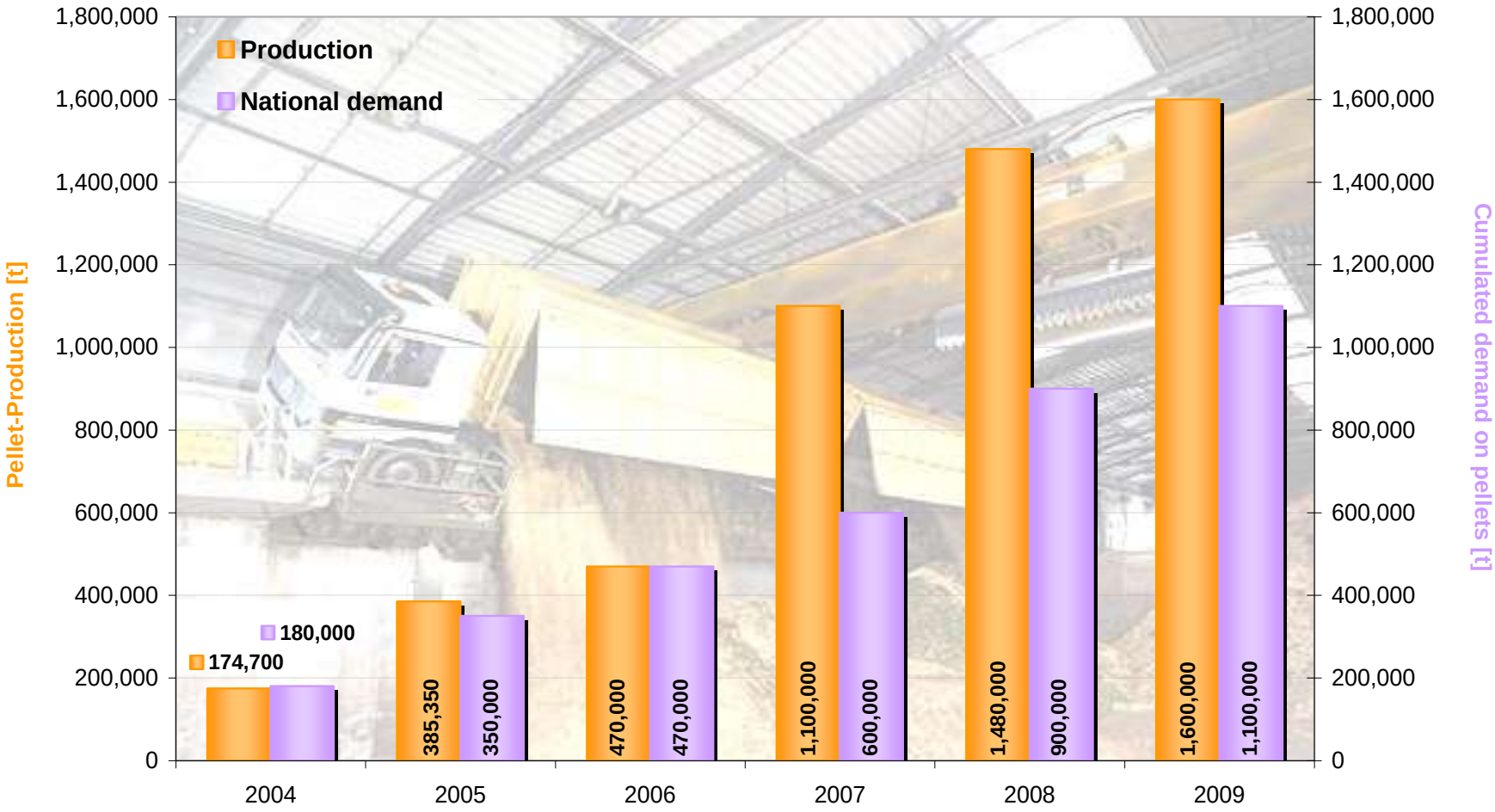


* Solid and liquid biomass, biogas, sewage and landfill gas;
Source: BMU-KI III 1 according to Working Group on Renewable Energies-Statistics (AGEE-Stat); Image: BMU / Brigitte Hiss; as at: September 2010; all figures provisional

Development of pellet-based heatings in Germany

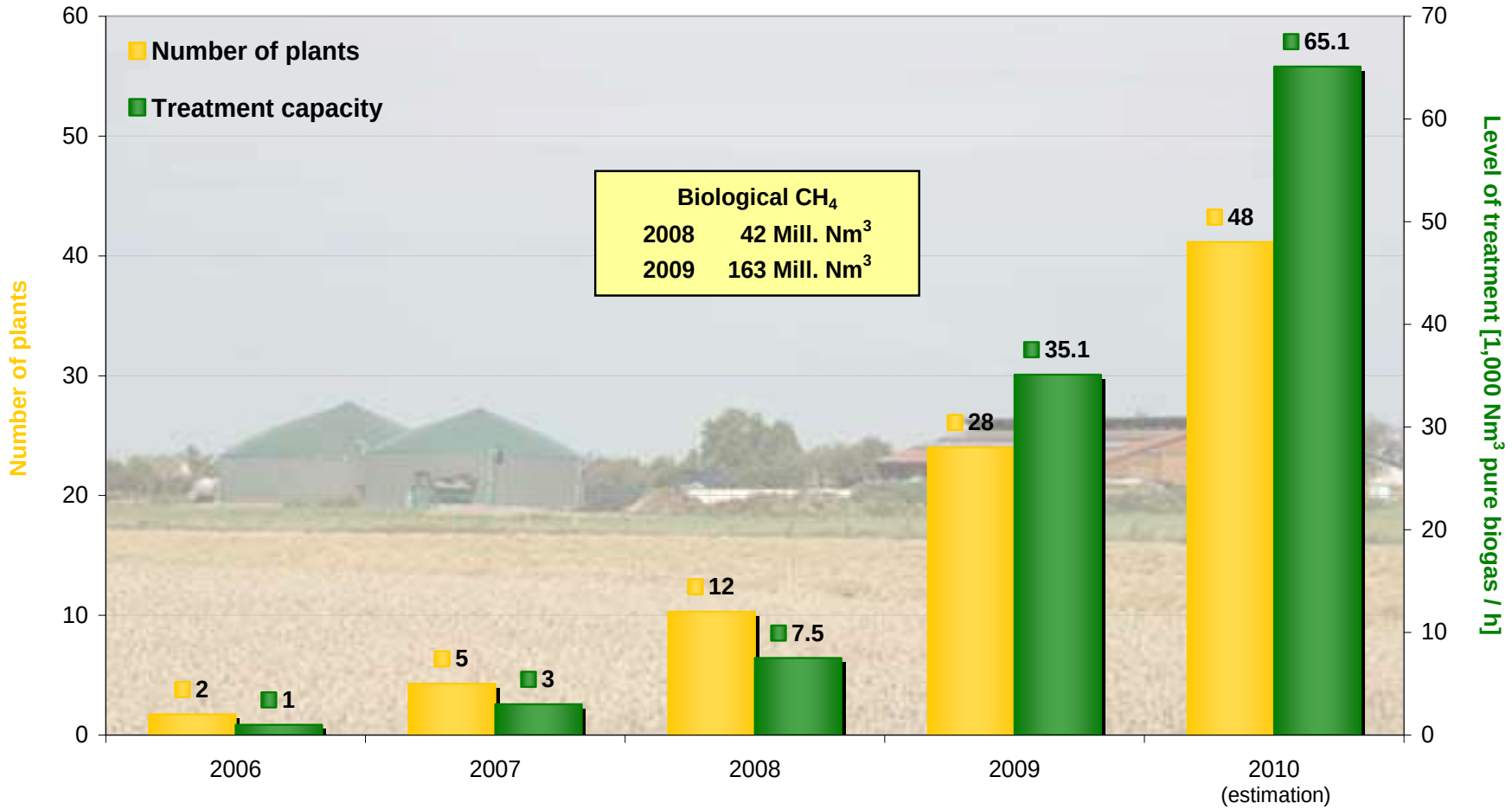
Source: Deutsches Pelletinstitut (DEPI), based on the values of Bundesamt für Wirtschaft und Ausfuhrkontrolle (BAFA) and the Bundesindustrieverband Deutschland Haus-, Energie- und Umwelttechnik e.V. (BDH); Image: BMU / Bernd Müller; as at: July 2010; all figures provisional

Development of production of pellets in Germany



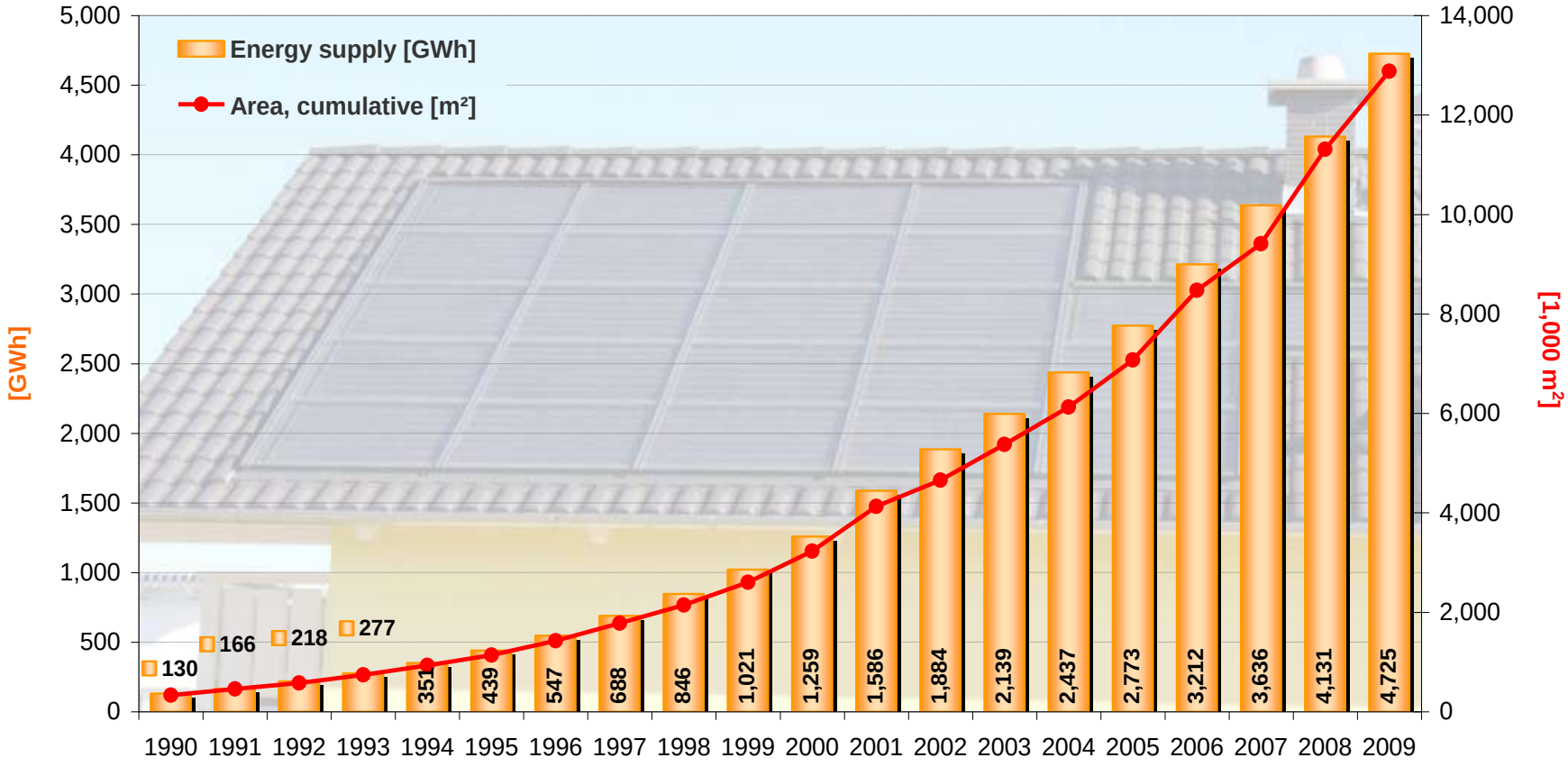
Source: Deutsches Pelletinstitut (DEPI) based on the values auf Deutscher Energieholz- und Pellet-Verband e.V. (DEPV); Image: BMU / Bernd Müller; as at: June 2010; all figures provisional

Biological CH_4 in the German methane-grid



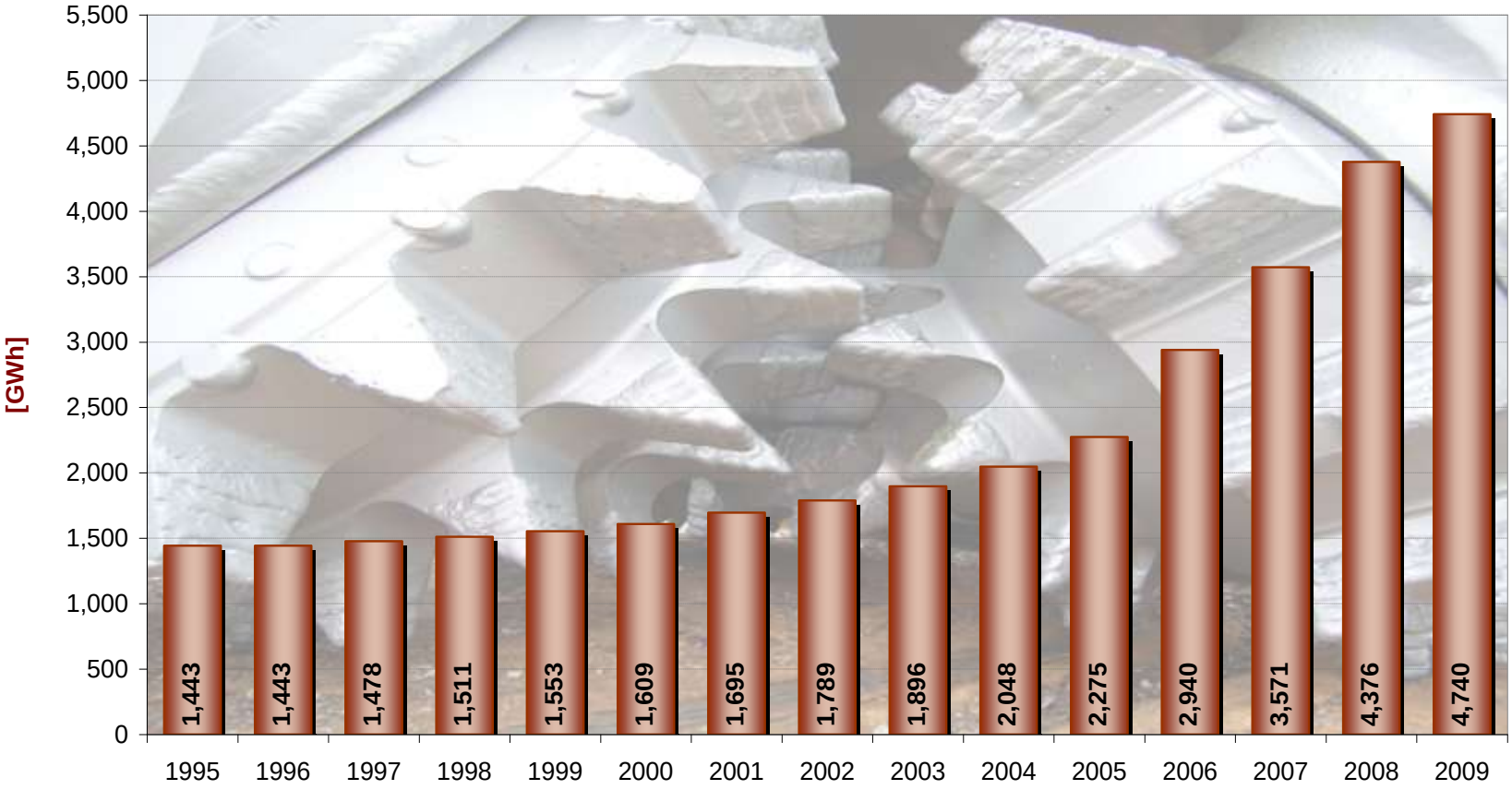
Nm^3: Volume of 1 cu m of gas under specified terms;
Source: Fachagentur Nachwachsende Rohstoffe e.V. (FNR); Image: BMU / Bernd Müller; as at: Mai 2010; all figures provisional

Development of collector area and energy supply of solar thermal installations for heat supply in Germany till 2009



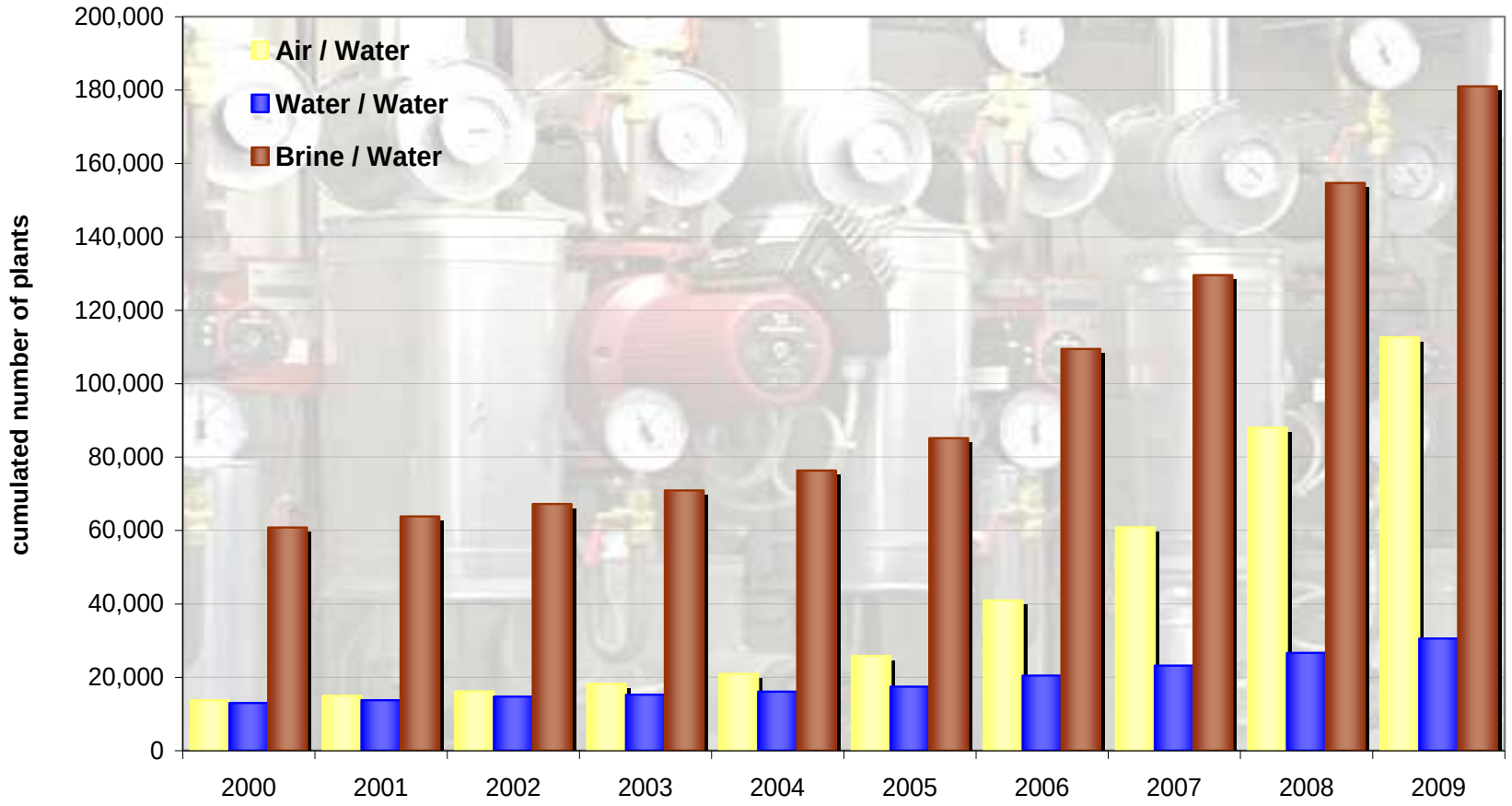
Source: BMU-KI III 1 according to Working Group on Renewable Energies-Statistics (AGEE-Stat); Image: ZSW / Ulrike Zimmer; as at: September 2010; all figures provisional

Development of (near-surface) geothermal energy use for heat supply in Germany 1995 - 2009



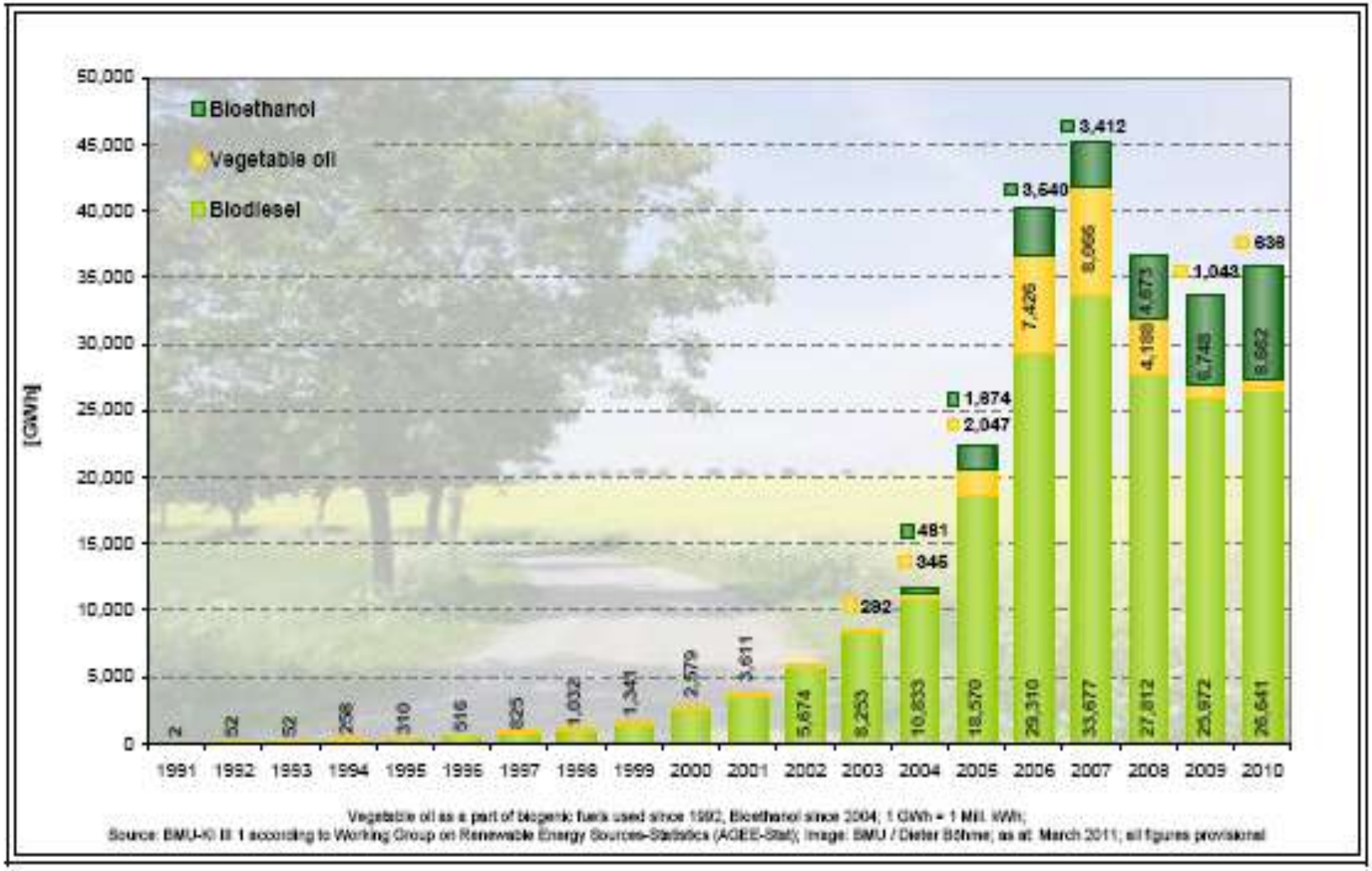
Source: BMU-KI III 1 according to Working Group on Renewable Energies-Statistics (AGEE-Stat); Image: ZSW / Ulrike Zimmer; as at: September 2010; all figures provisional

Development of the market for heat pumps 2000 - 2009

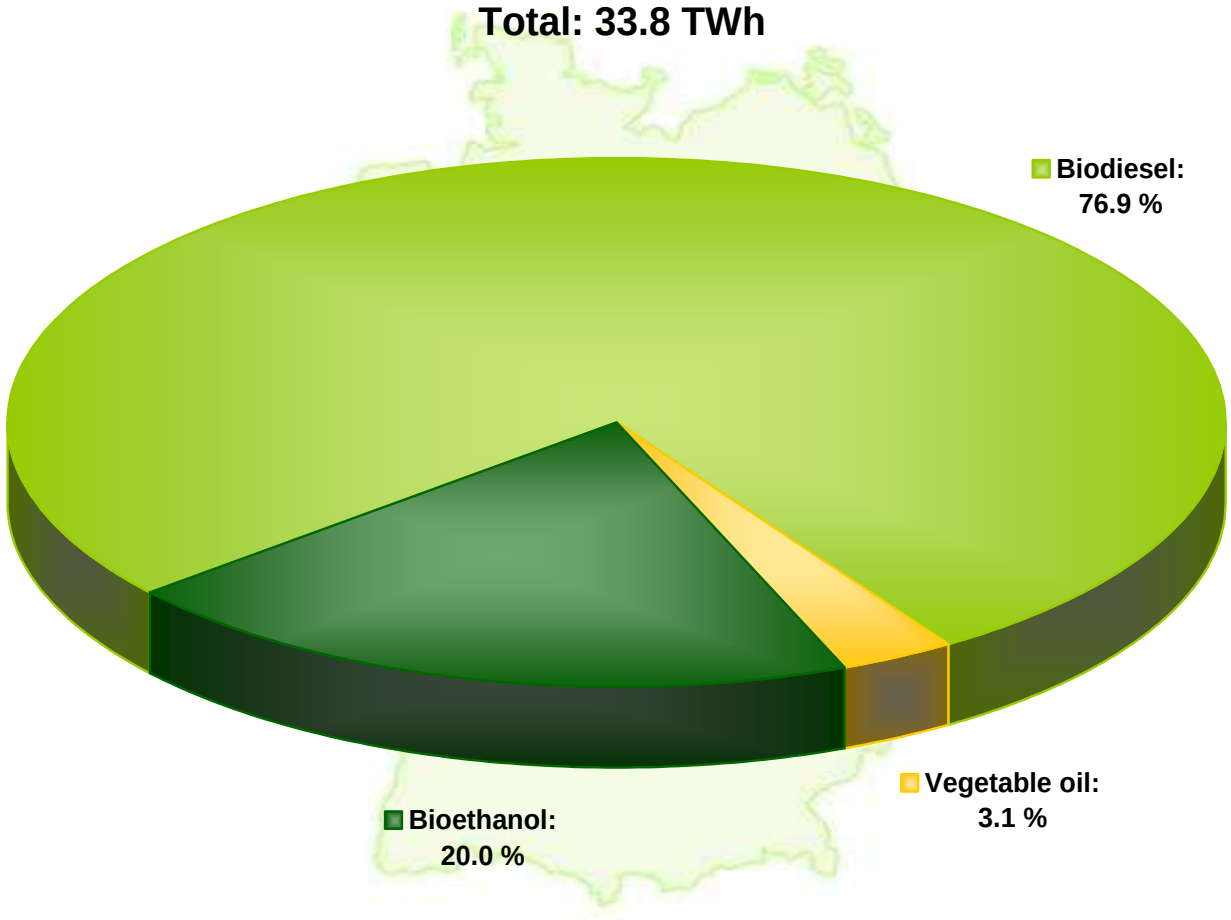


Sources: Years 2000-2008: GeothermieZentrum Bochum (GZB), Survey: "Analyse des deutschen Wärmepumpenmarktes, Bestandsaufnahme und Trends", as at: November 2009; Year 2009: Bundesverband Wärmepumpe e.V. (BWP), Press release: "Branchenstatistik 2009", as at: September 2010; Image: BMU / Brigitte Hiss;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

Contribution of RES to fuel consumption

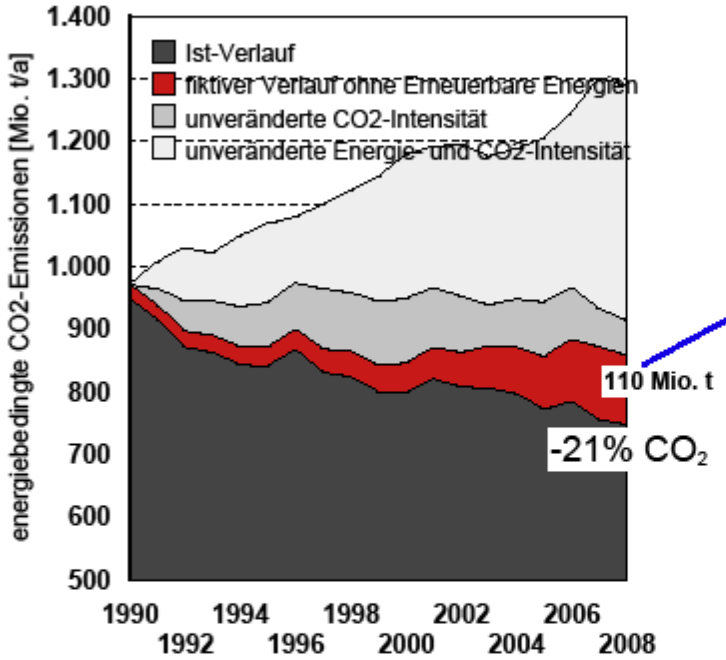


Structure of biogenic fuels in Germany 2009

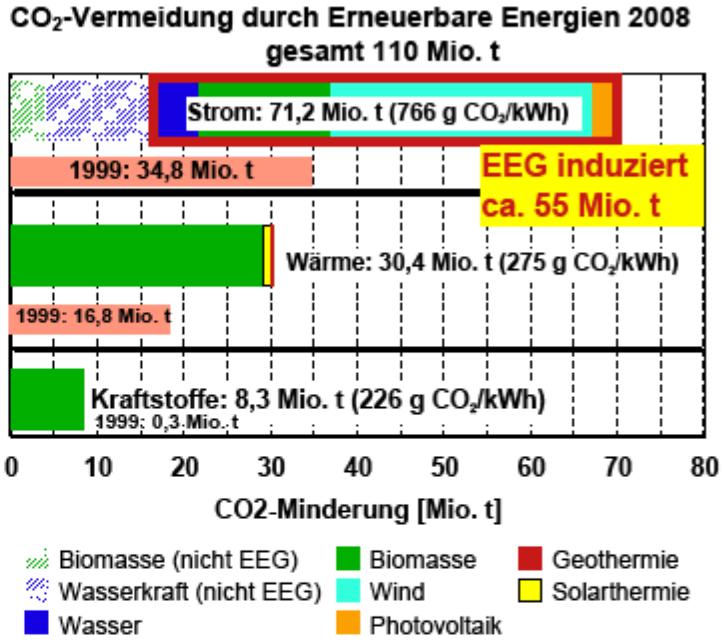


Source: BMU-KI III 1 according to Working Group on Renewable Energies-Statistics (AGEE-Stat); deviations in the totals are due to rounding; as at: September 2010; all figures provisional

CO_2-Vermeidung durch die Nutzung Erneuerbarer Energien



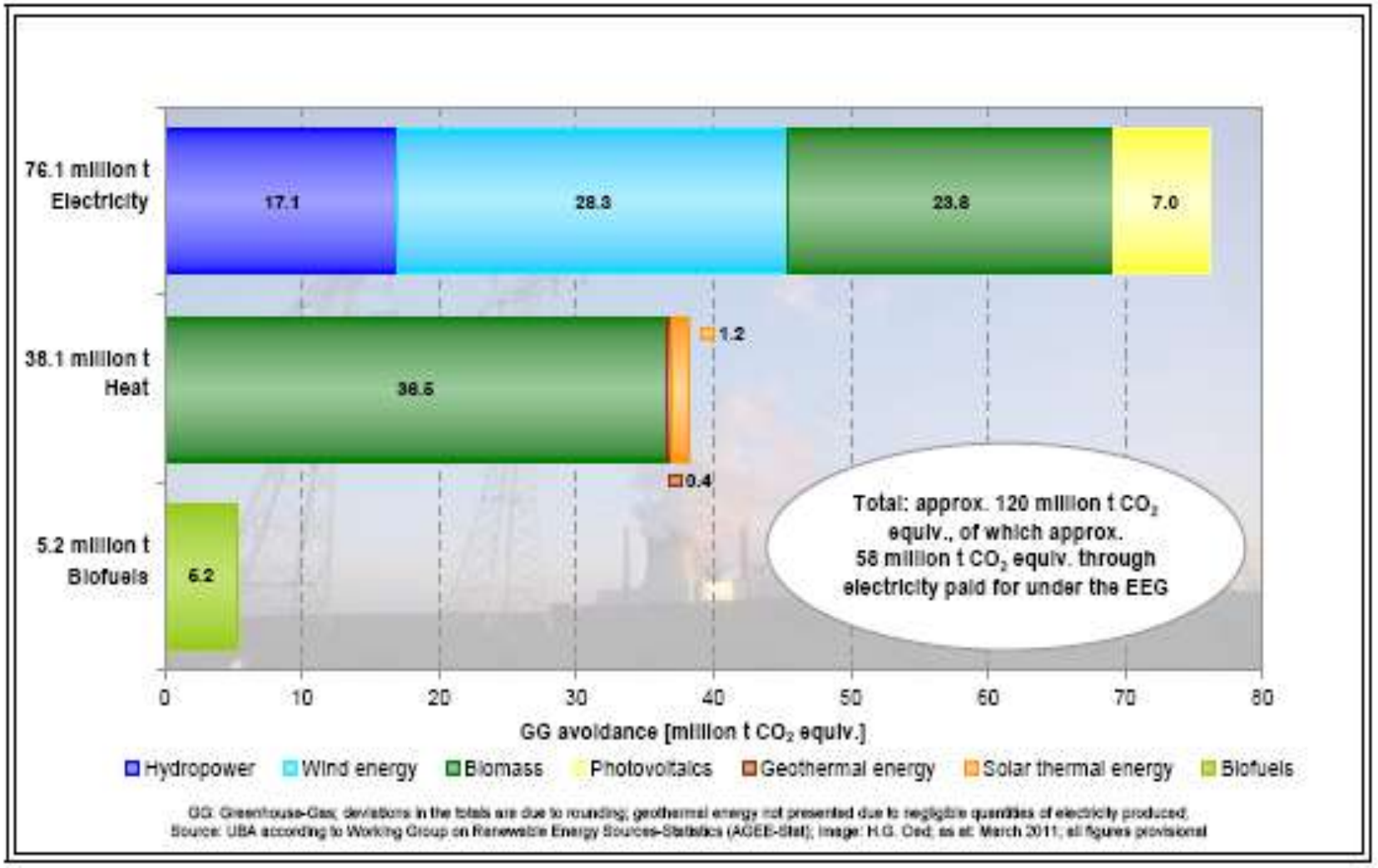
Quelle: eigene Abschätzung



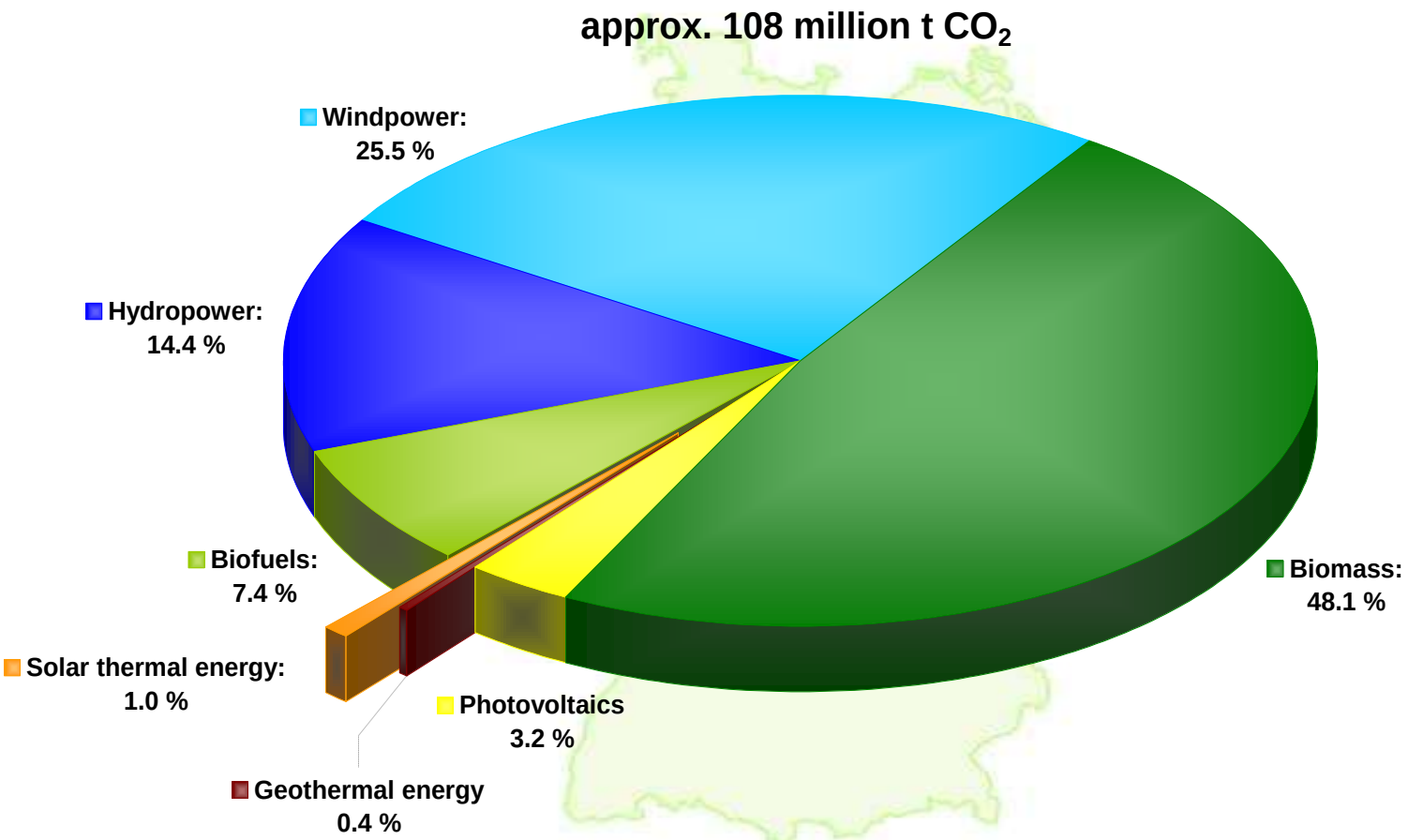
Quelle: AGEE-Stat

➡ **Das EEG ist eines der wichtigsten Klimaschutzinstrumente.**

GG emissions avoided by RES 2010

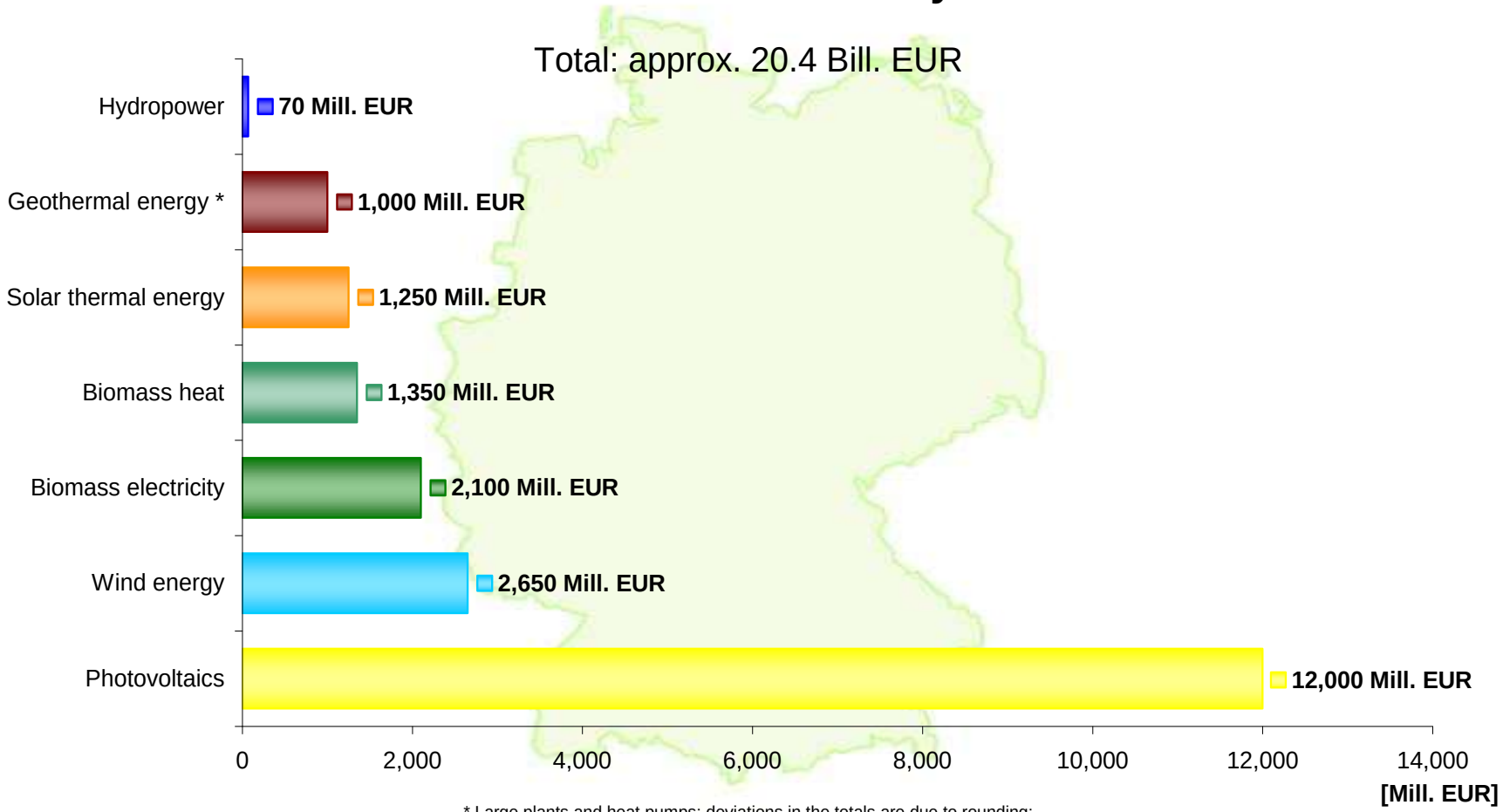


Structure of CO_2 avoidance



Source: UBA according to Working Group on Renewable Energies-Statistics (AGEE-Stat); deviations in the totals are due to rounding; as at: September 2010; all figures provisional

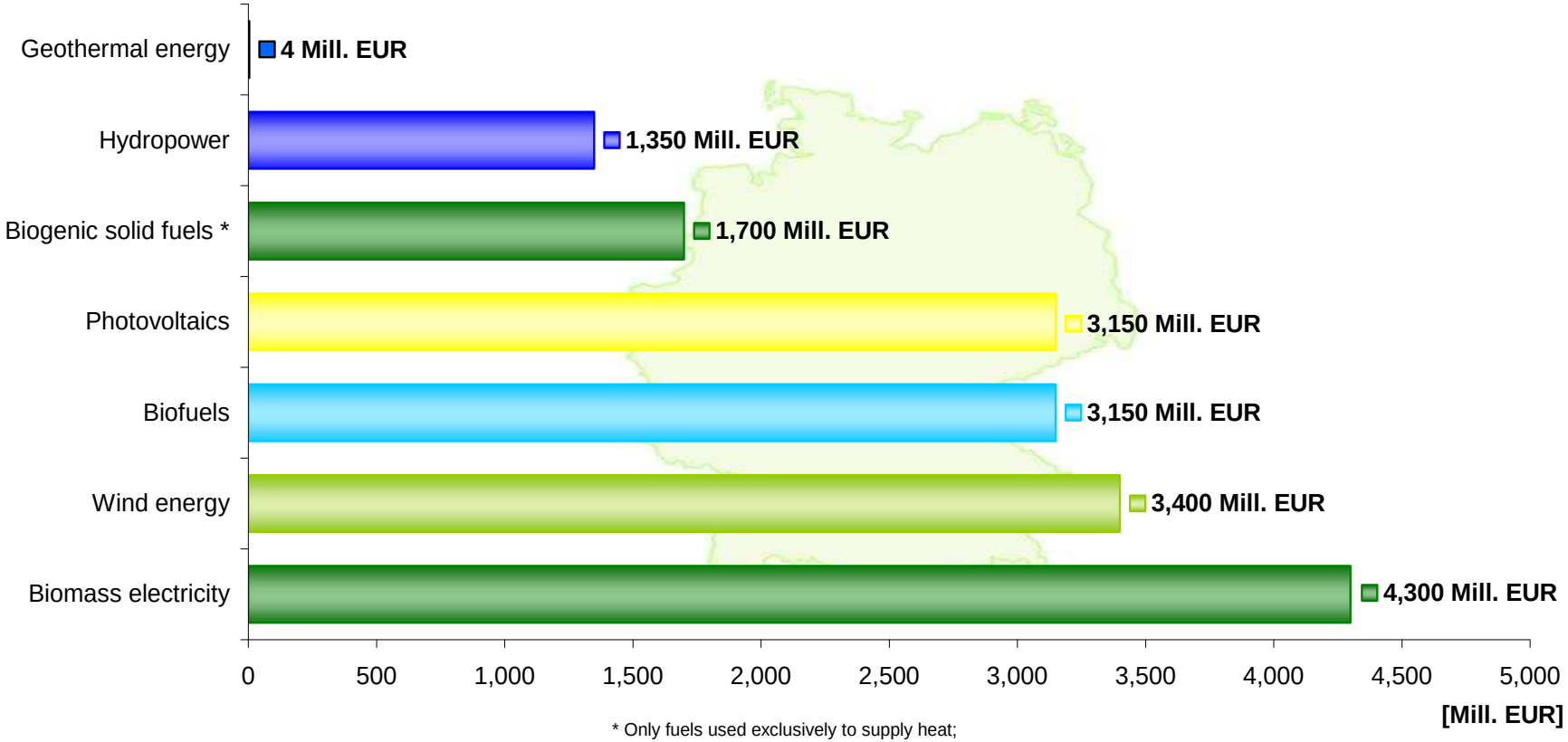
Investments in the construction of renewable energy installations in Germany 2009



* Large plants and heat pumps; deviations in the totals are due to rounding;
Source: BMU-KI III 1 according to the Centre for Solar Energy and Hydrogen Research Baden-Wuerttemberg (ZSW); as at: September 2010; all figures provisional

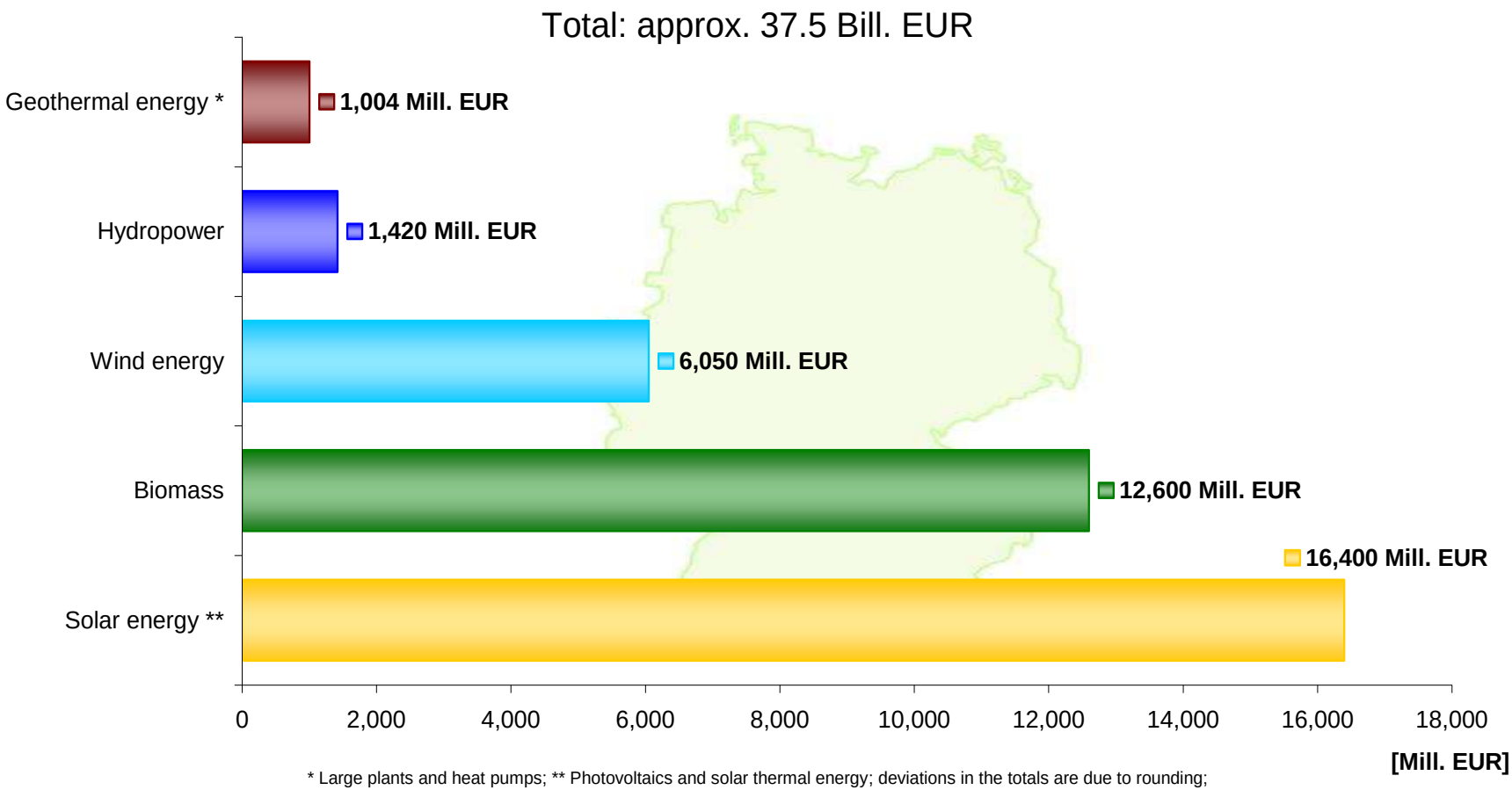
Turnover from the operation of plants for the use of renewable energy sources in Germany 2009

Total: approx. 17.1 Bill. EUR



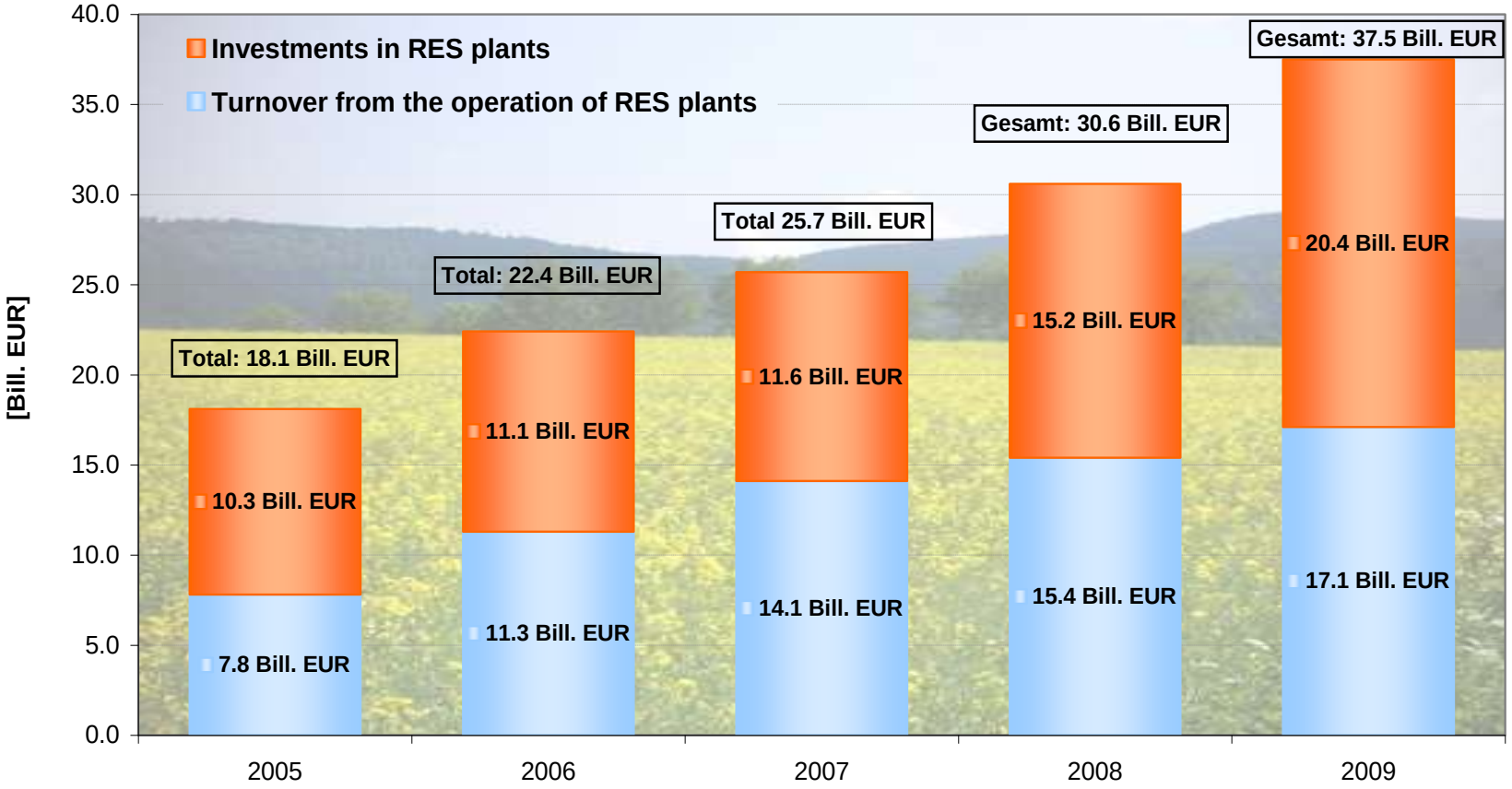
* Only fuels used exclusively to supply heat;
Geothermal energy is not shown in this figure, because of the small turnover by operation (EUR 4.0 million); deviations in the totals are due to rounding;
Source: BMU-KI III 1 according to the Centre for Solar Energy and Hydrogen Research Baden-Wuerttemberg (ZSW); as at: September 2010; all figures provisional

Total turnover from renewable energy sources in Germany 2009 (investments and operation)



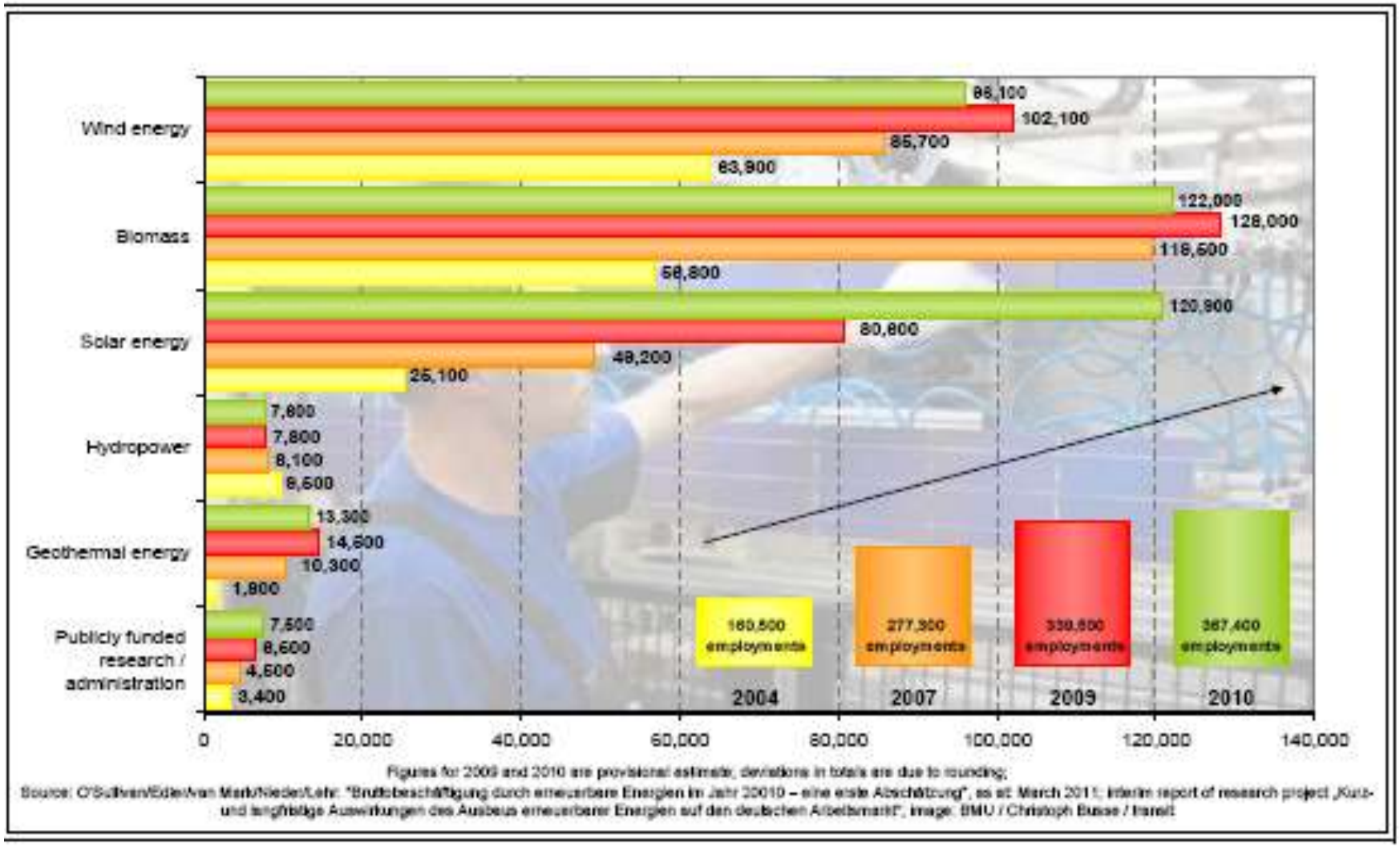
* Large plants and heat pumps; ** Photovoltaics and solar thermal energy; deviations in the totals are due to rounding;
Source: BMU-KI III 1 according to the Centre for Solar Energy and Hydrogen Research Baden-Wuerttemberg (ZSW); as at: September 2010; all figures provisional

Development of the turnover from renewable energy sources in Germany 2005 - 2009



Source: BMU-KI III 1 according to the Centre for Solar Energy and Hydrogen Research Baden-Wuerttemberg (ZSW);
Image: BMU / Dieter Böhme; deviations in the totals are due to rounding; as at: September 2010; all figures provisional

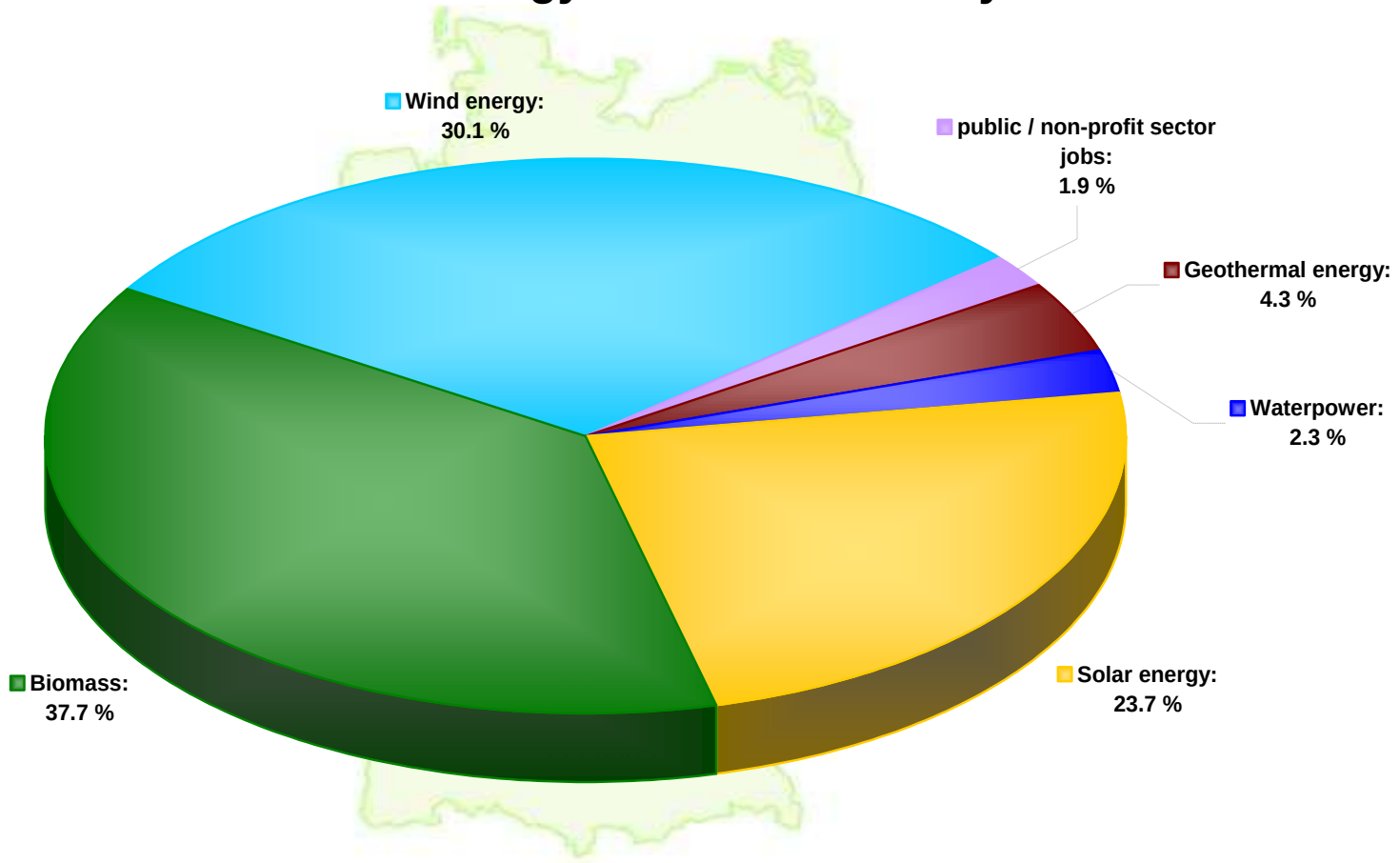
Jobs in the Renewable Energy Sector



Figures for 2009 and 2010 are provisional estimate; deviations in totals are due to rounding;

Source: O'Sullivan/Edler/Ivan Mark/Nieder/Lehr: "Bruttobeschäftigung durch erneuerbare Energien im Jahr 20010 – eine erste Abschätzung", as at: March 2011; interim report of research project „Kurz- und langfristige Auswirkungen des Ausbaus erneuerbarer Energien auf den deutschen Arbeitsmarkt", image: BMU / Christoph Busse / transit

Exact division of the approx. 339,500 employments in the renewable energy sector in Germany



Figures for 2008 and 2009 are provisional estimate; deviations in totals are due to rounding;
Source: BMU-KI III1: "Erneuerbar beschäftigt! Kurz- und langfristige Arbeitsplatzwirkungen des Ausbaus der erneuerbaren Energien in Deutschland"; as at: September 2010

National RES Targets 2020

- Share of RES in final energy consumption in 2005 5.8%
- Until 2020 Germany is obliged to increase the share of RES to at least 18.0% of FEC
- Final energy consumption of 8,255 PJ expected for 2020, thus a minimum of 1,486 PJ from RES
- Share of RES in transport needs to rise to 10%

National RES targets 2050

- Germany defined further targets for its energy strategy
- Energy Concept: comprehensive energy strategy until 2050
  - 80-95% reduction of GHG emissions
  - RES should account for the biggest share in future energy mix
- New targets for renewable energies until 2050
  – 2020: 18% RES 35% RES-E
  – 2030: 30% RES 50% RES-E
  – 2040: 45% RES 65% RES-E
  – 2050: 60% RES 80% RES-E

National Renewable Energy Action Plan – Sector Paths

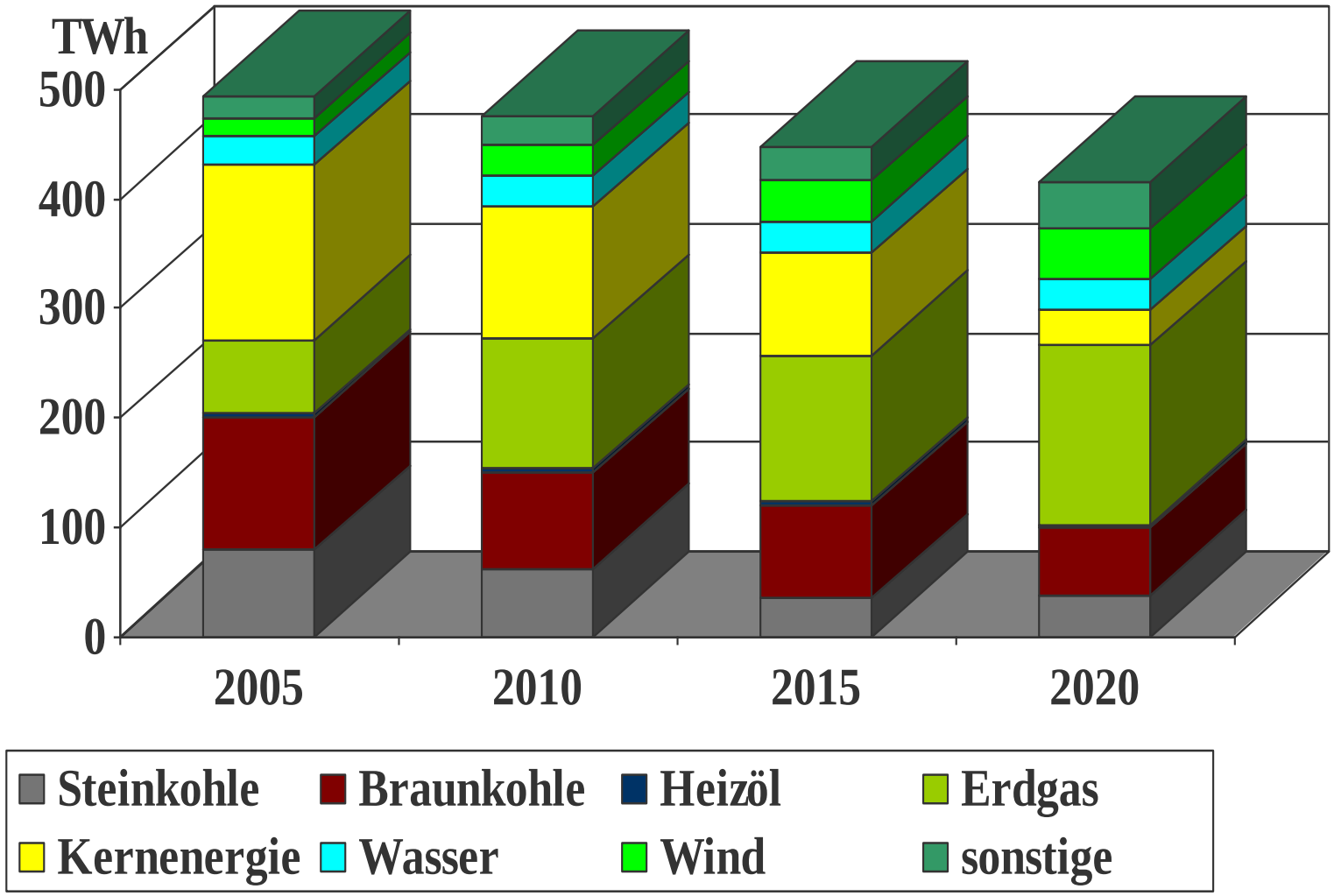
Freie Universität Berlin

Table 1: Expected target path for energy from renewable sources in the sector heating and cooling, power production and transport in Germany, as well as minimum value for the target path by Directive 2009/28/EG (in per cent)

	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Heating & Cooling	6.6	9.0	9.4	10.0	10.5	11.1	11.7	12.4	13.1	13.9	14.7	15.5
Electricity	10.2	17.4	19.3	20.9	22.7	24.7	26.8	28.8	31.0	33.3	35.9	38.6
Transport	3.9	7.3	7.5	7.6	7.0	7.0	7.0	7.1	9.3	9.4	9.7	13.2
Total Share of Renewable Energies	6.5	10.1	10.8	11.4	12.0	12.8	13.5	14.4	15.7	16.7	17.7	19.6
			2011 – 2012		**2013 – 2014**		**2015 – 2016**		**2017 -2018**			**2020**
Minimum Value for the Target Path according to the Directive			8.24		9.46		11.29		13.73			18.00

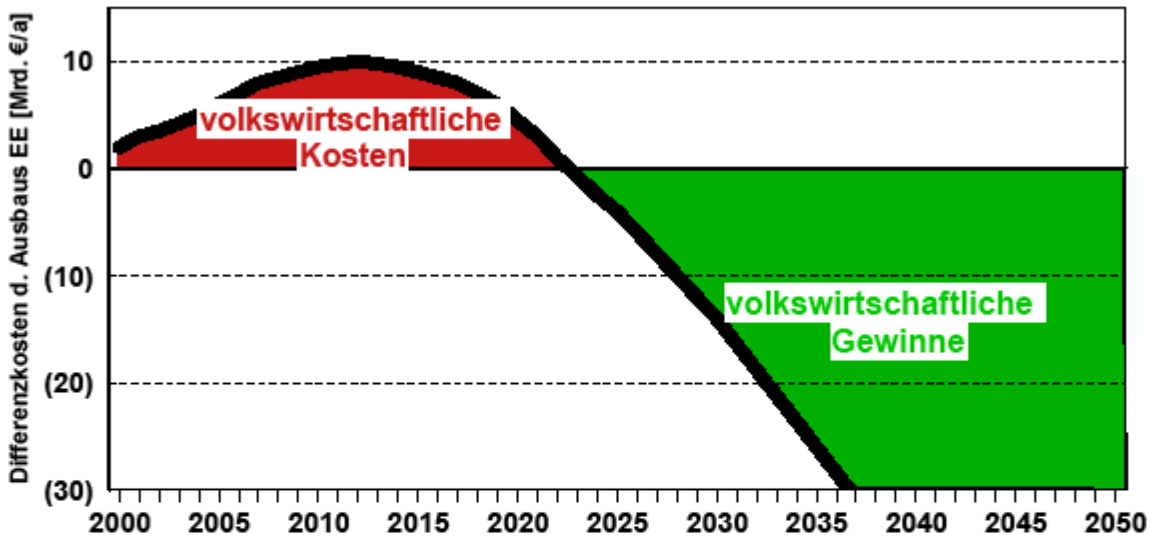
Without additional energy efficiency and energy saving measures in the "reference scenario" the share of renewable energy of TFEC will be about 18.2% in the year 2020 (compared to 19.6% in the "additional energy efficiency scenario").

Green Scenario Electricity in Germany 2020



Quelle: Öko-Institut, Energiewende 2020

Differenzkosten des Ausbaus Erneuerbarer Energien



- Die Wettbewerbsfähigkeit einzelner Erneuerbarer Energien wird zu unterschiedlichen Zeitpunkten erreicht:
- Die Wettbewerbsfähigkeit Erneuerbarer Energien insgesamt kann je nach Preisentwicklung für fossile Energien und weitergehenden Klimaschutzmaßnahmen in 10-15 Jahren erreicht werden.

Member States Progress in RES

	Electricity			Transport		
	2010 target (%)	2010 NREAP (%)	progress made	2010 target (%)	2010 NREAP (%)	progress made
Austria	78.1	69.3	☹	5.75	6.8	☺
Belgium	6	4.8	☺	5.75	3.8	☹
Bulgaria	11	10.6	😐	5.75	1.7	☹
Cyprus	6	4.3	☹	2.5	2.2	😐
Czech Rep.	8	7.4	😐	5.75	4.1	☹
Denmark	29	34.3	☺	5.75	1.0	☹
Estonia	5.1	1.7	☹	5.0	0.0	☹
Finland	31.5	26.8	☹	4.0	5.7	😐
France	21	15.4	☹	7.0	6.4	☺
Germany	12.5	17.4	☺	5.75	7.3	☺
Greece	20.1	13.3	☹	5.75	1.7	☹
Hungary	3.6	9	☺	5.75	3.7	☺
Ireland	13.2	20.4	☺	4.0	3	☹
Italy	22.5	19	☹	5.75	3.5	😐
Latvia	49.3	44.7	☹	5.75	4	☹
Lithuania	7	8	😐	5.75	4	☺
Luxembur g	5.7	4	☹	5.75	2.1	😐
Malta	5	0.6	☹	1.25	2.8	☹
Netherlan ds	9	8.6	☺	4.0	4.1	😐
Poland	7.5	7.5	😐	5.75	5.8	☺
Portugal	39	41.4	😐	10.0	5	😐
Romania	33	27.5	☹	4.0	5.8	😐
Slovakia	31	19.1	☹	5.75	4.1	☺
Slovenia	33.6	32.4	☹	3.0	2.6	☹
Spain	29.4	28.8	😐	5.83	6	☹
Sweden	60.0	55	☺	5.75	7.4	☺
UK	10	8.6	☹	3.5	2.6	😐

Source: Eurostat 2008 and Member States NREAPs

Summary & perspectives

German leadership in renewables as result of a complex process

Problem pressures (oil & gas import dependency, environmental damages of coal, phase-out nuclear etc.)

Strong environmental movement

Broad consensus on need for active climate change policy and promotion of renewables

Conclusions

- Nuclear power plays a modest role in present global energy supply – and will not be much larger in the future
- NPPs cannot combat climate change – and their GHG emissions are rising
- The alarming rise in construction cost estimates, emerging skills shortages and production bottlenecks are problems that will not be quick or cheap to overcome
- Costs for decommissioning, recovery and cleaning up of NPPs are often higher than the construction costs
- The financial crisis amplified the problems of the nuclear industry
- Evidence from Finland, USA & France does not show that new nuclear can be built without special arrangements to protect them from the market The nuclear industry must convince S&P or Moodys, not the public

Freie Universität Berlin

Thank you for your attention!

PD Dr. Lutz Mez
Environmental Policy Research Centre
lutz.mez@fu-berlin.de
http://www.fu-berlin.de/ffu/

More information under: www.erneuerbare-energien.de/inhalt/3860