German energy policy: Its impact nationally and across Europe

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Ten key data for South Africa and Germany

Parameter	Unit	South Africa	Germany
Size of the country	1,000 square kilometres	1,219	357
Population	million	53	81
Energy consumption in 2013	Mtoe	122	325
there of coal consumption	Mtoe	88	81
CO_2 emissions in 2013	Mt	441	843
Power generation in 2013	TWh	256	634
Share of coal in power generation	%	93	45
Energy consumption per capita	toe	2.3	4.0
Power generation per capita	kWh	4,830	7,827
CO_2 emissions per capita	t	8.3	10.4

Source: BP Statistical Review of Word Energy, June 2014

Centres of energy production in Germany

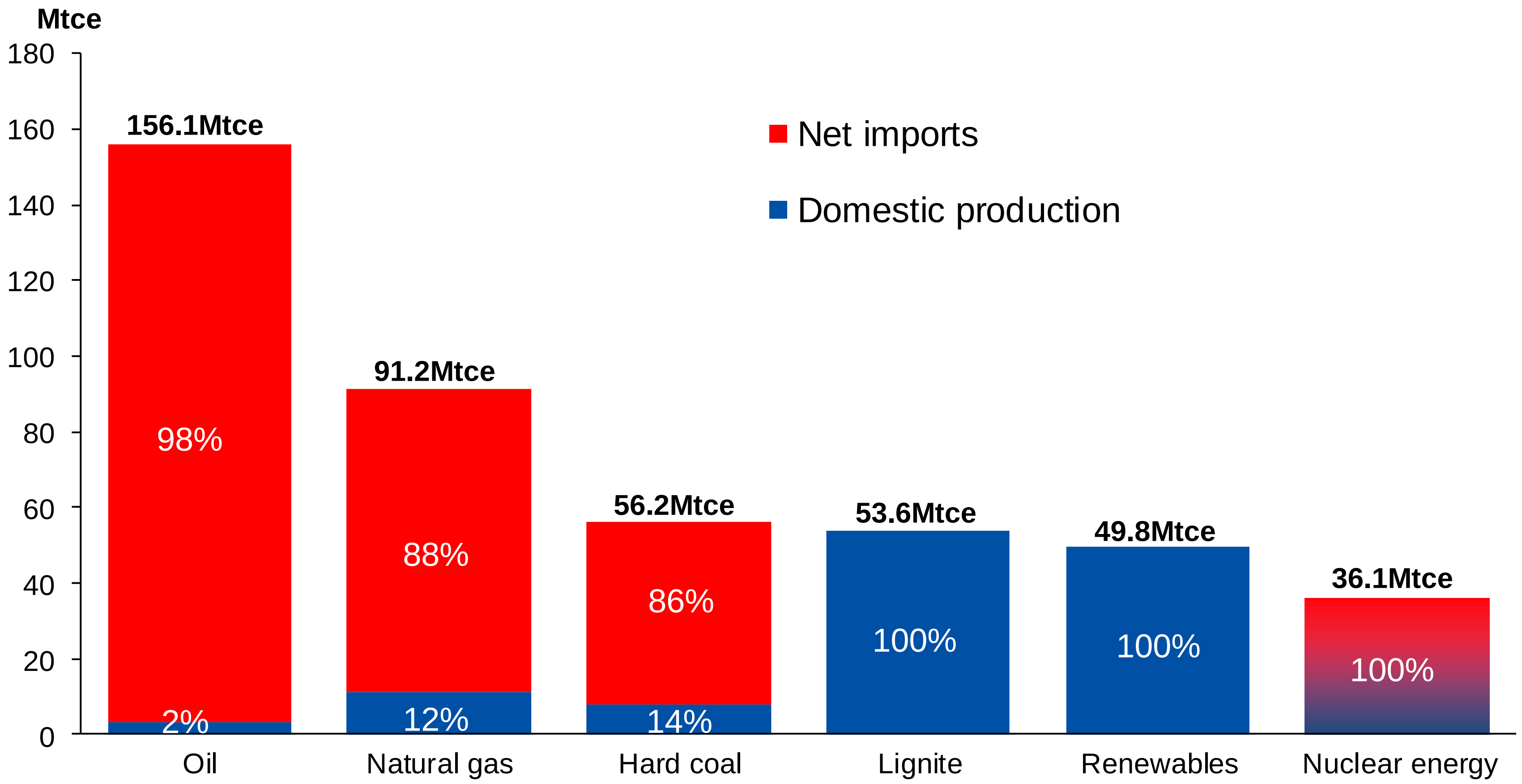
1 Prosper-Haniel (Bottrop)
2 Auguste Victoria (Marl)
3 Ibbenbüren

Lignite
Hard Coal
Natural gas
Crude oil

Position: February 2015

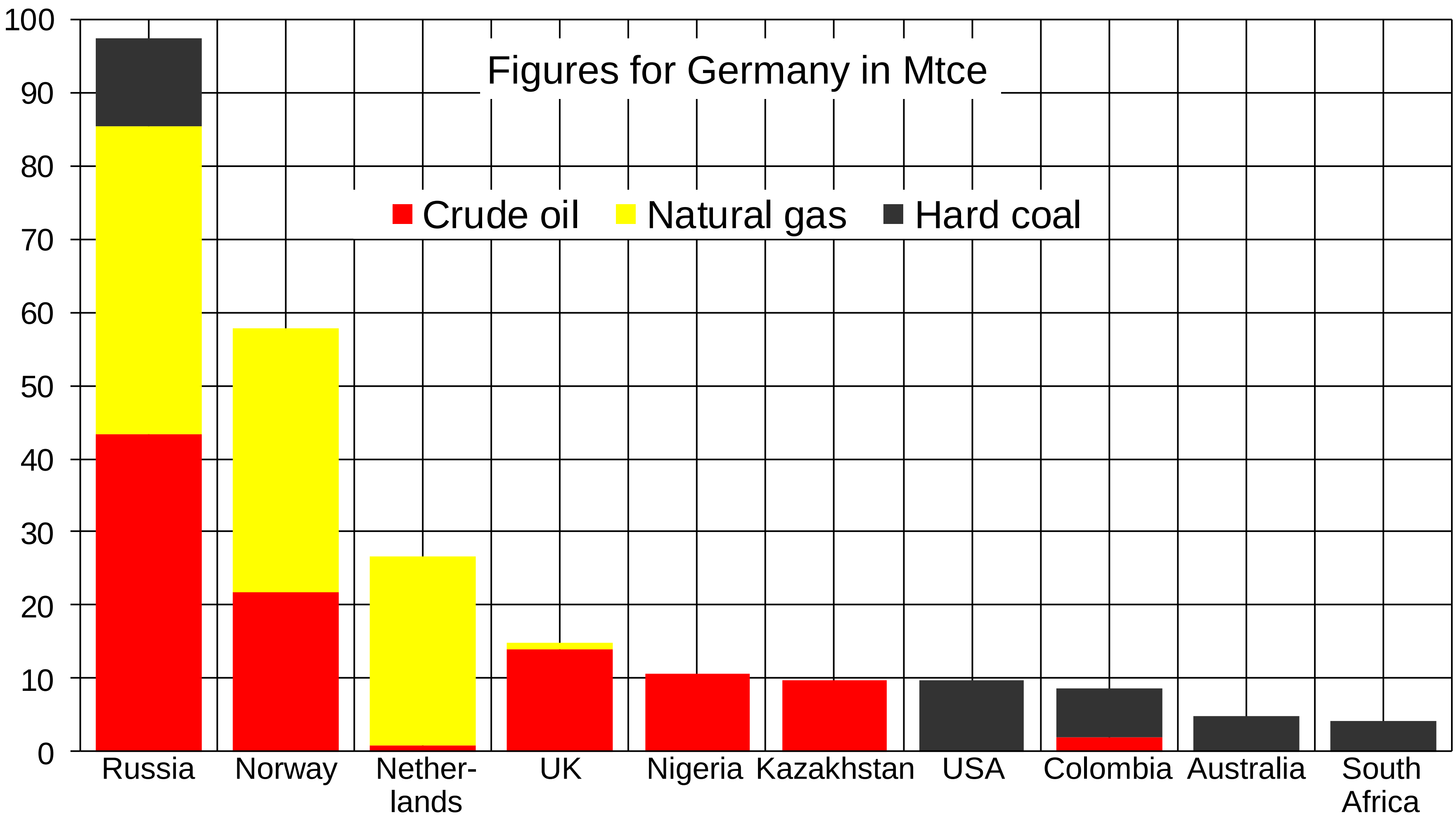
Source: H.-W. Schiffer, Energiemarkt Deutschland

Germany's dependency on energy imports in 2014



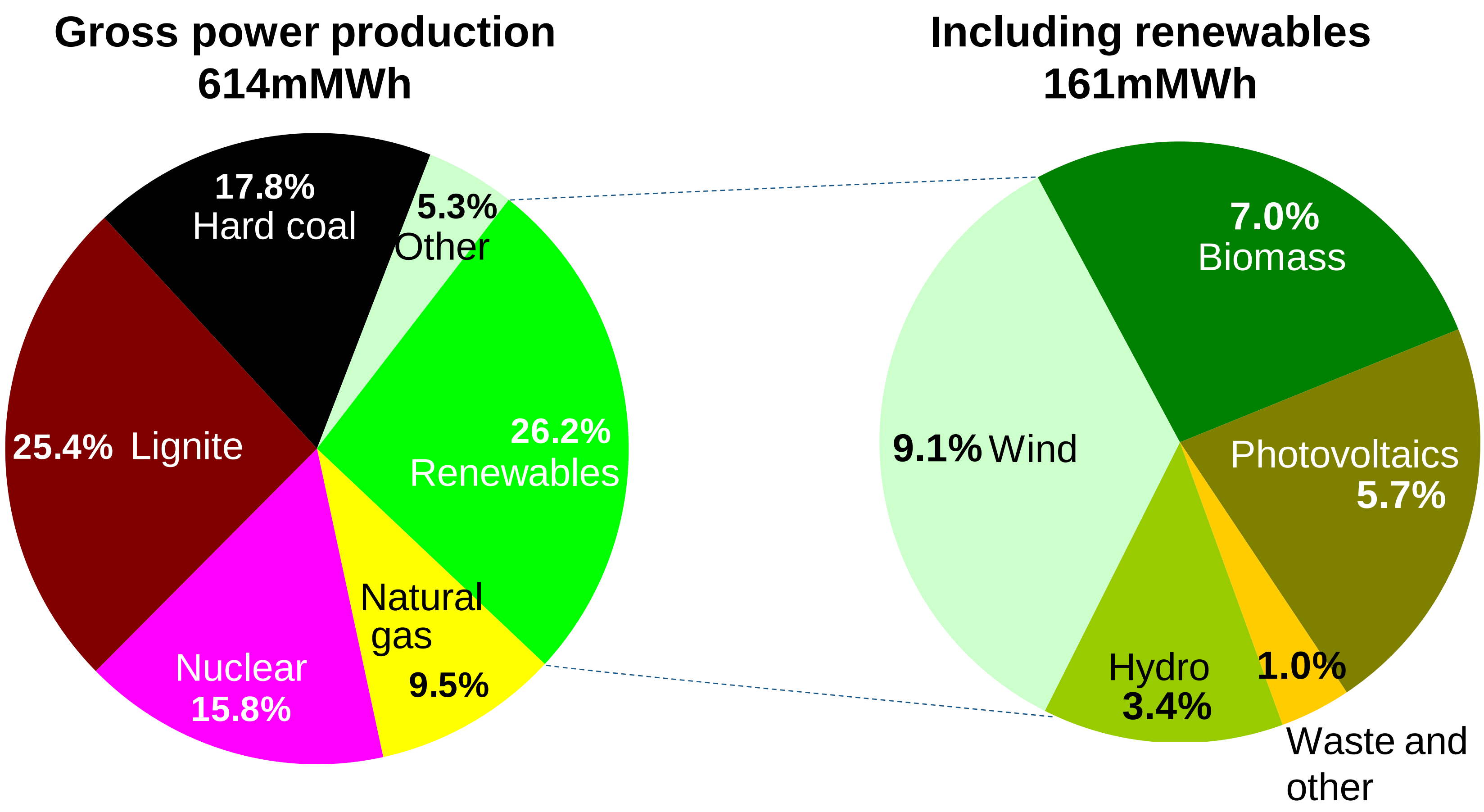
Source: AGEB 2/2015 (other energy sources: 3.3Mtce; total primary energy consumption: 446.3Mtce)

Energy feedstock suppliers in 2014



Source: H.-W. Schiffer (ascertained on the basis of BAFA)

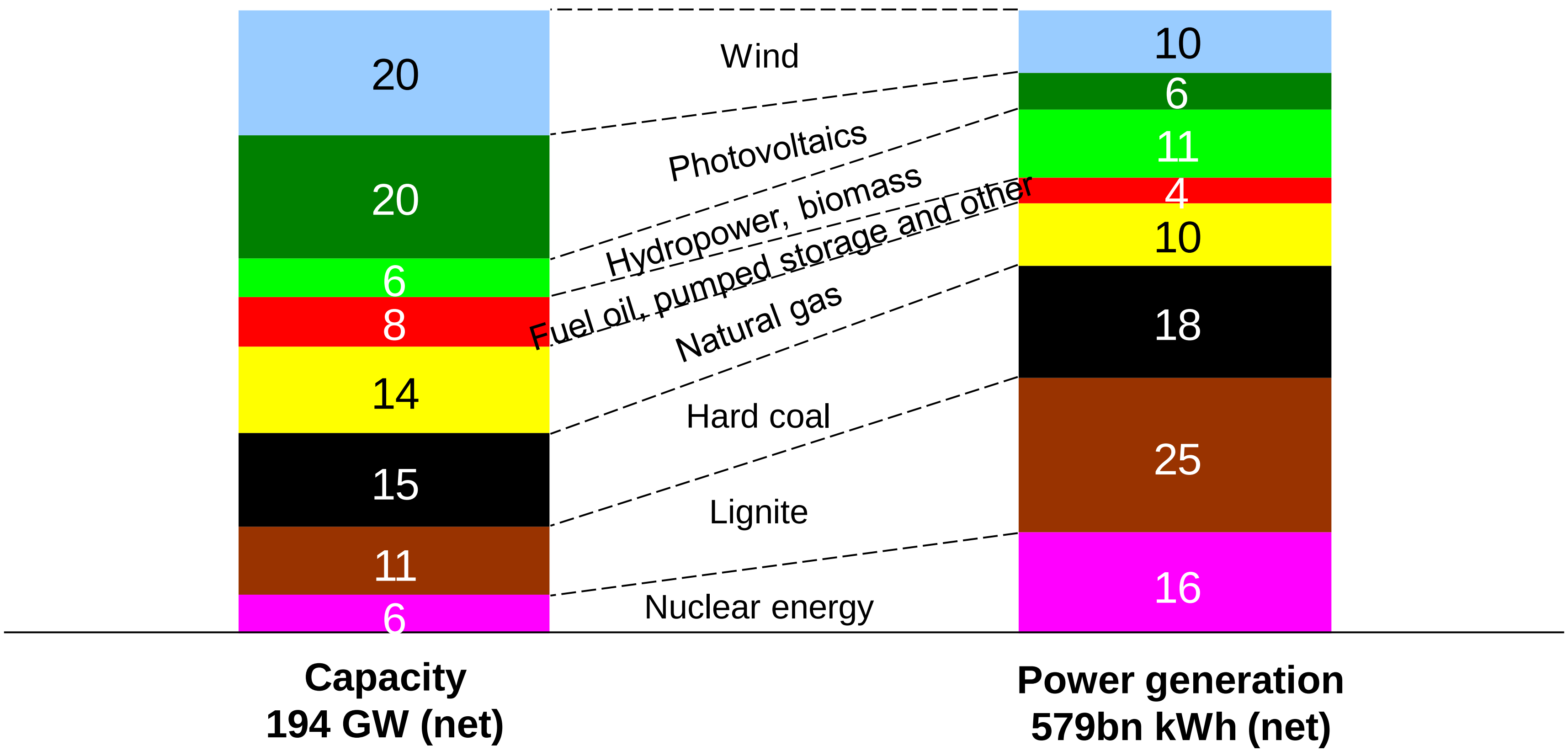
Energy mix in 2014 power production



Source: BDEW, 02/2015

Power generation capacity (31/12/2014) and net electricity generation in 2014 in Germany

Share of various energy sources in %



Source: BDEW, Position: February 2015

Short history of German Energy Policy since the 1990s

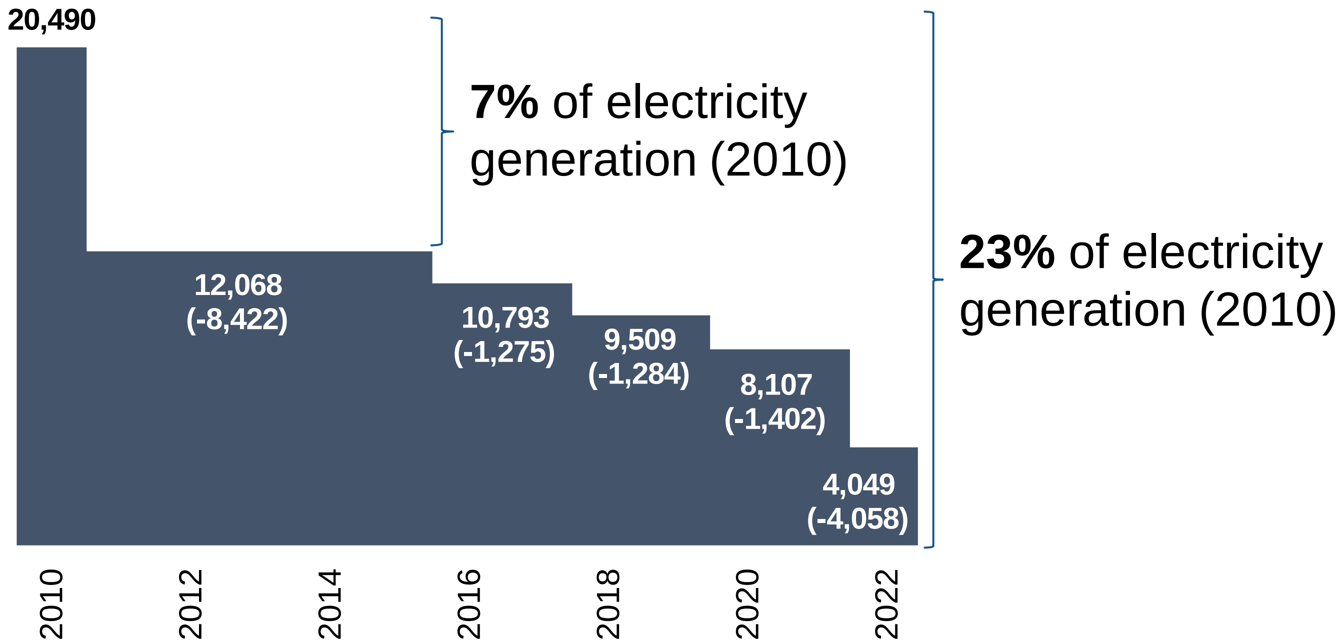
	Main characteristics and key events
Until the 1990s	• Regulated energy markets and monopolies; few efficiency gains • Meeting ever-growing demand with nuclear and fossil • 1991 in Germany: first law regulating feed-in of RES[1] into the grid
1996/1998	• Deregulation begins: first EU directive and national law introducing competition for electricity
2000-2010	• 2000: German Renewable Energy Act (EEG) truly kick-starts development of new RES with high feed-in prices and priority access rights • Multiple policy turnarounds concerning nuclear energy: – 2001: Nuclear phase-out plan (until early 2020s) – 2010: Energy concept of the federal government with lifetime extension to build a bridge to a low-carbon economy (+12 years for nuclear fleet on average; until mid-2030s) • Strong growth of RES continues
2011	• **Energiewende[2]** launched after Fukushima • 2011: Immediate phase-out of 8.5 GW (pre-1980s plants) and expedited phase-out until 2022
Nov. 2013	• Coalition agreement of the new conservative-socialist government (phasing-out decision confirmed)
July 2014	• Reform of Renewable Energy Act (EEG) – Introduction of binding direct marketing for new installations – Determined corridor for wind, PV and biomass expansion – Starting with auctioning in 2017 in order to determine the market premium for renewables

1) RES = renewables 2) Energiewende = energy transition

No nuclear power plant is going to generate electricity in Germany from 2023 onwards

Timeline of scheduled nuclear phase-out in Germany

Development of installed capacity of nuclear power in Germany (MW)



Source: BDEW

Central elements of the German Energiewende

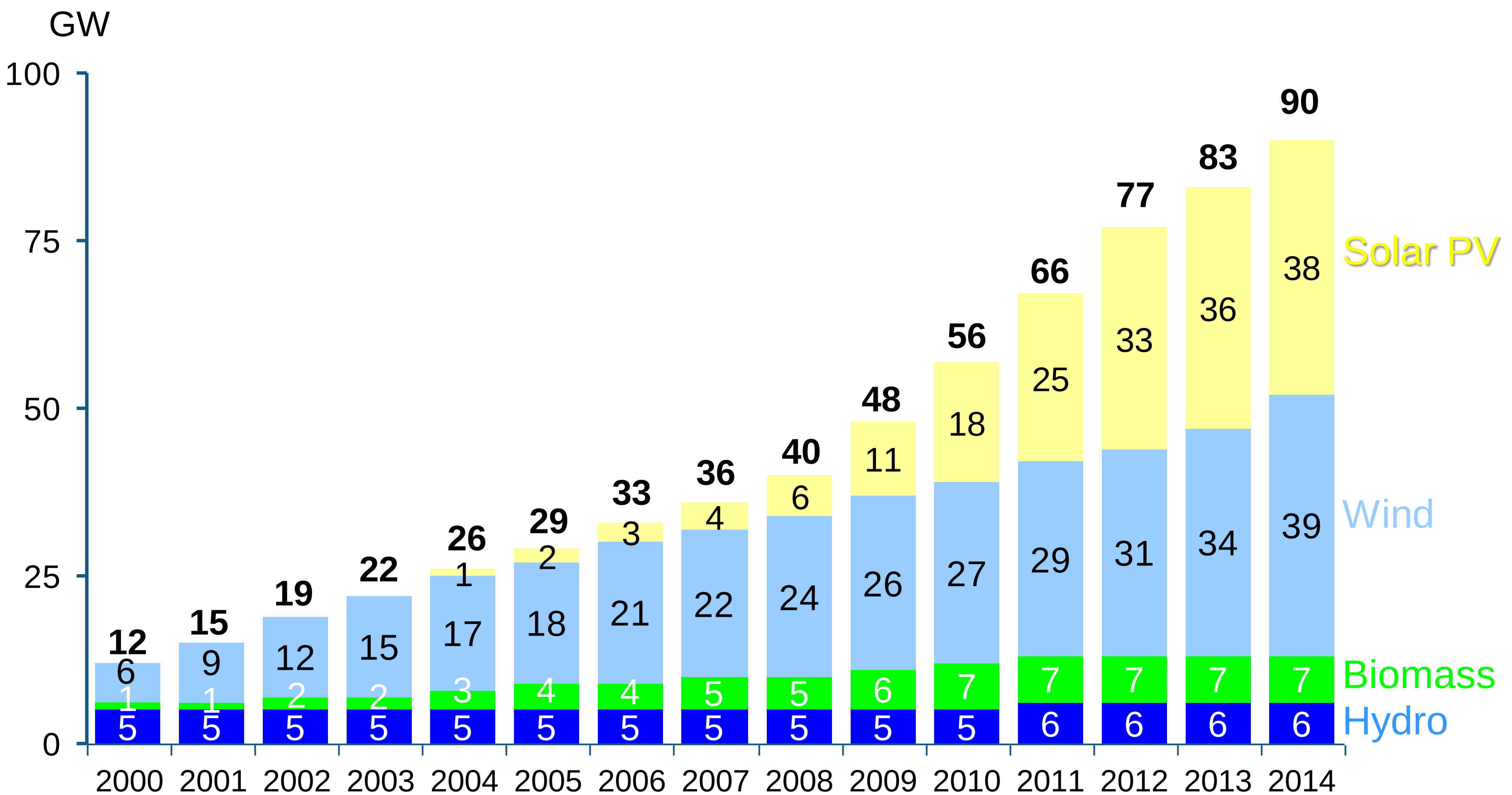
- **Reduction in GHG emissions** by 40% by 2020 and 80 to 95% by 2050 – compared with 1990 level (2014: reduction of 25% compared to 1990)
- Increase in the **share of renewable energy in total energy consumption** to 30 % in 2030 and 60 % in 2050 (share in 2014: 11 %).
- Increase in the **share of renewable energy in total power consumption** to 50% in 2030 and 80% in 2050 (share in 2014: 28%)
- Complete **nuclear phase-out** by the end of 2022
- Improved **energy efficiency**: Halving the primary energy consumption by 2050 compared with 2008 level

The project is based on the assumption that a highly industrialised society can be securely and competitively supplied by a generation system based predominantly on RES

Promotion of green electricity by Renewable Energy Sources Act (EEG)

- Guaranteed feed-in payments for green electricity for 20 years after commissioning the plant concerned
- Grid operators are obliged to immediately and as a priority purchase the entire quantity of green electricity offered
- The plant operator is paid the EEG feed-in tariff by the local grid company; the four German transmission system operators are in charge of selling this electricity at the (usually lower) market price via the power exchange
- The trading companies pass on the deficit (feed-in tariff minus market price) to consumers by imposing an EEG reallocation charge

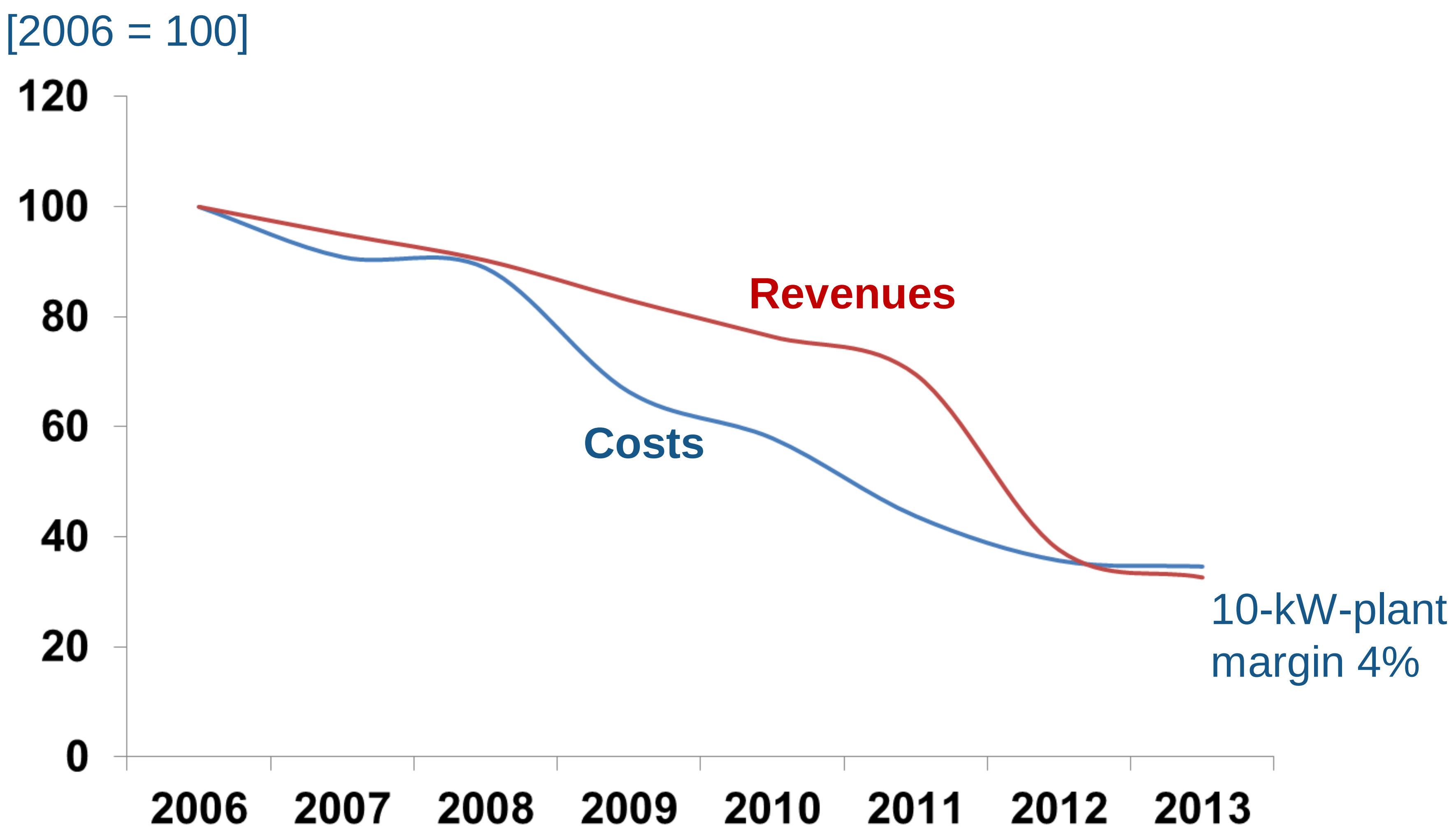
Installed capacity for power generation in Germany on the basis of renewables



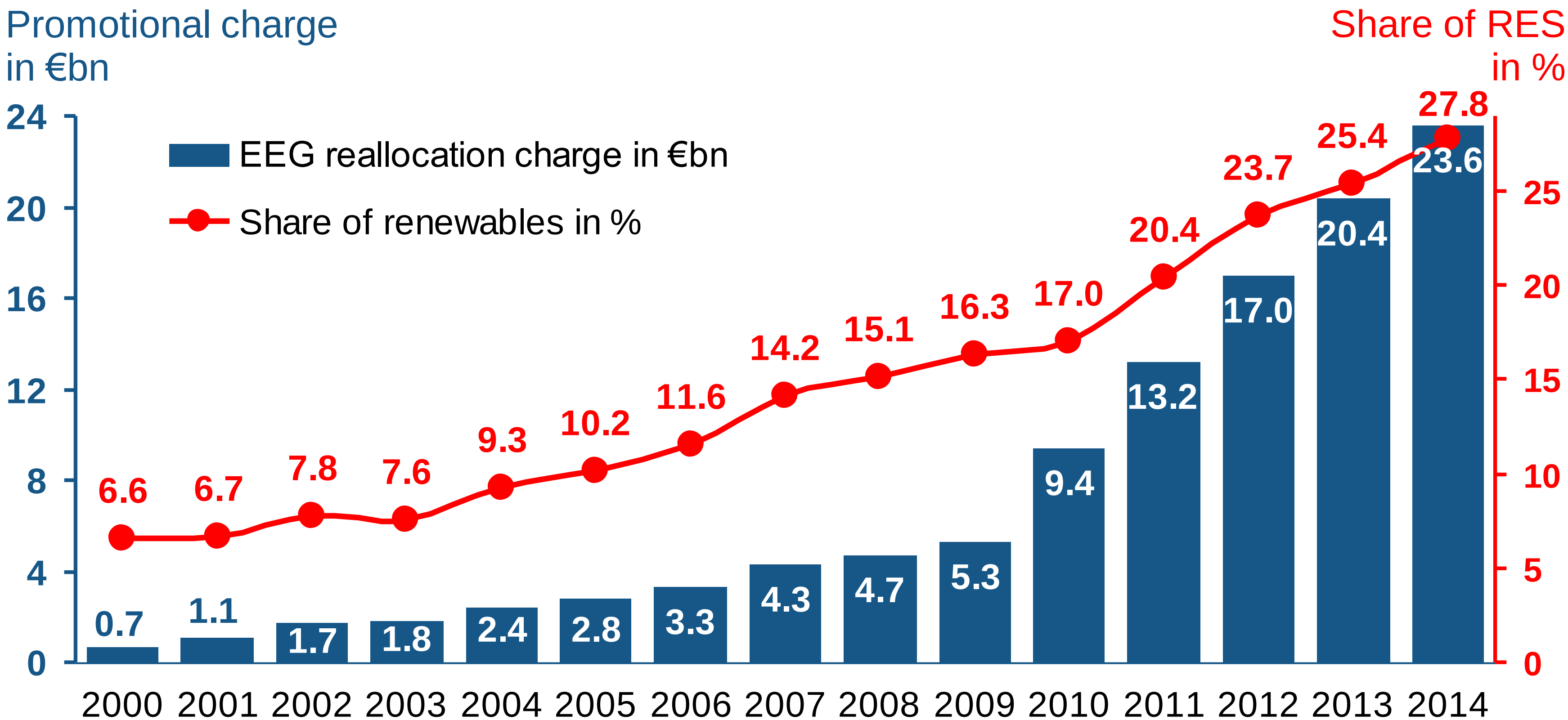
Year	Hydro	Biomass	Wind	Solar PV	Total
2000	5	1	6		12
2001	5	1	9		15
2002	5	2	12		19
2003	5	2	15		22
2004	5	3	17	1	26
2005	5	4	18	2	29
2006	5	4	21	3	33
2007	5	5	22	4	36
2008	5	5	24	6	40
2009	5	6	26	11	48
2010	5	7	27	18	56
2011	6	7	29	25	66
2012	6	7	31	33	77
2013	6	7	34	36	83
2014	6	7	39	38	90

Source: AGEE-Stat und BDEW, February 2015

Costs and revenues of PV plants in Germany

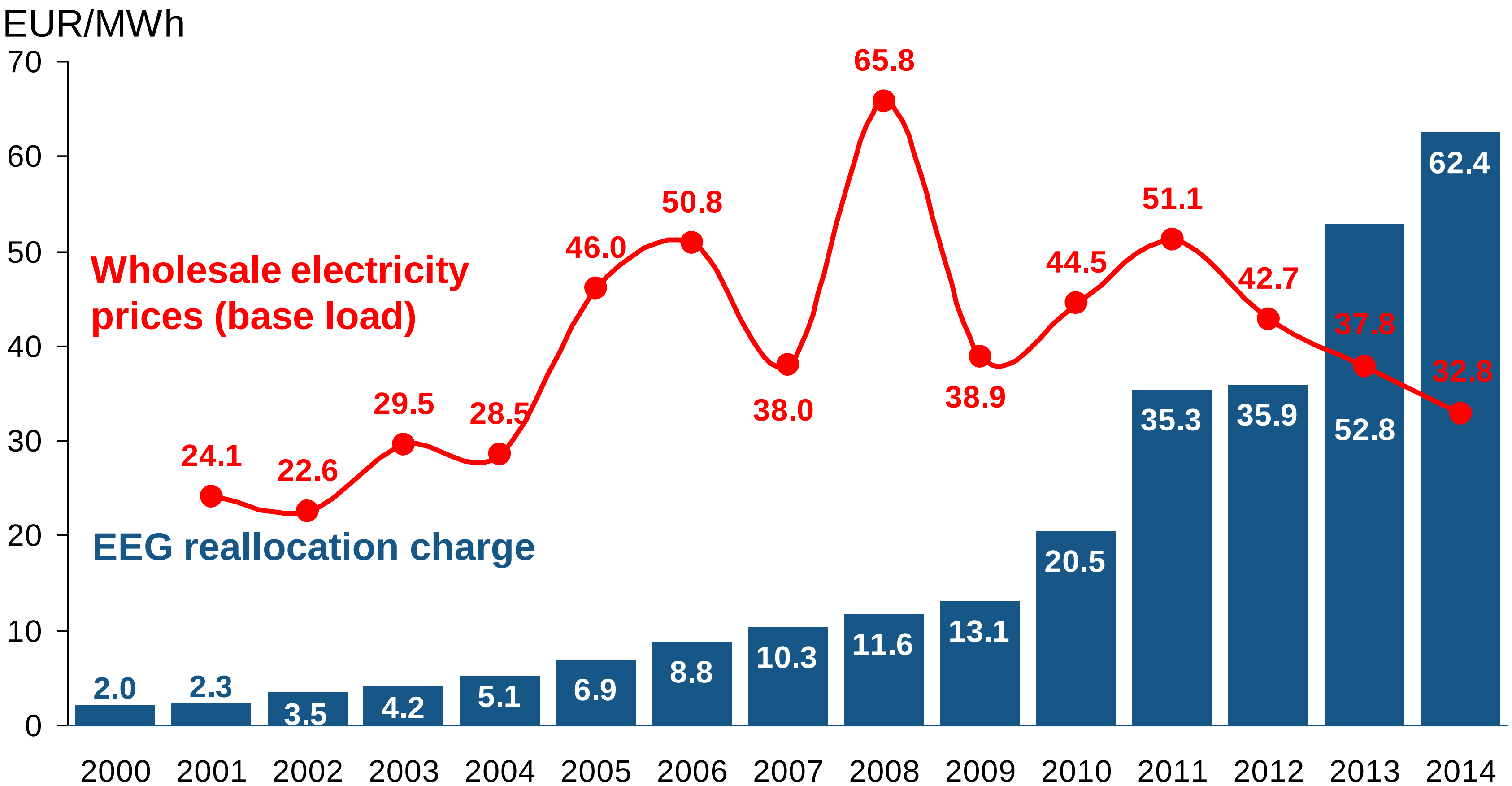


Share of renewables in meeting electricity demand and total volume of EEG reallocation charge



22%-point increase over 1999 – funding provided to this end by electricity consumers between 2000 and 2014: approx. €112bn

Development of wholesale prices for electricity in Germany and EEG reallocation charge

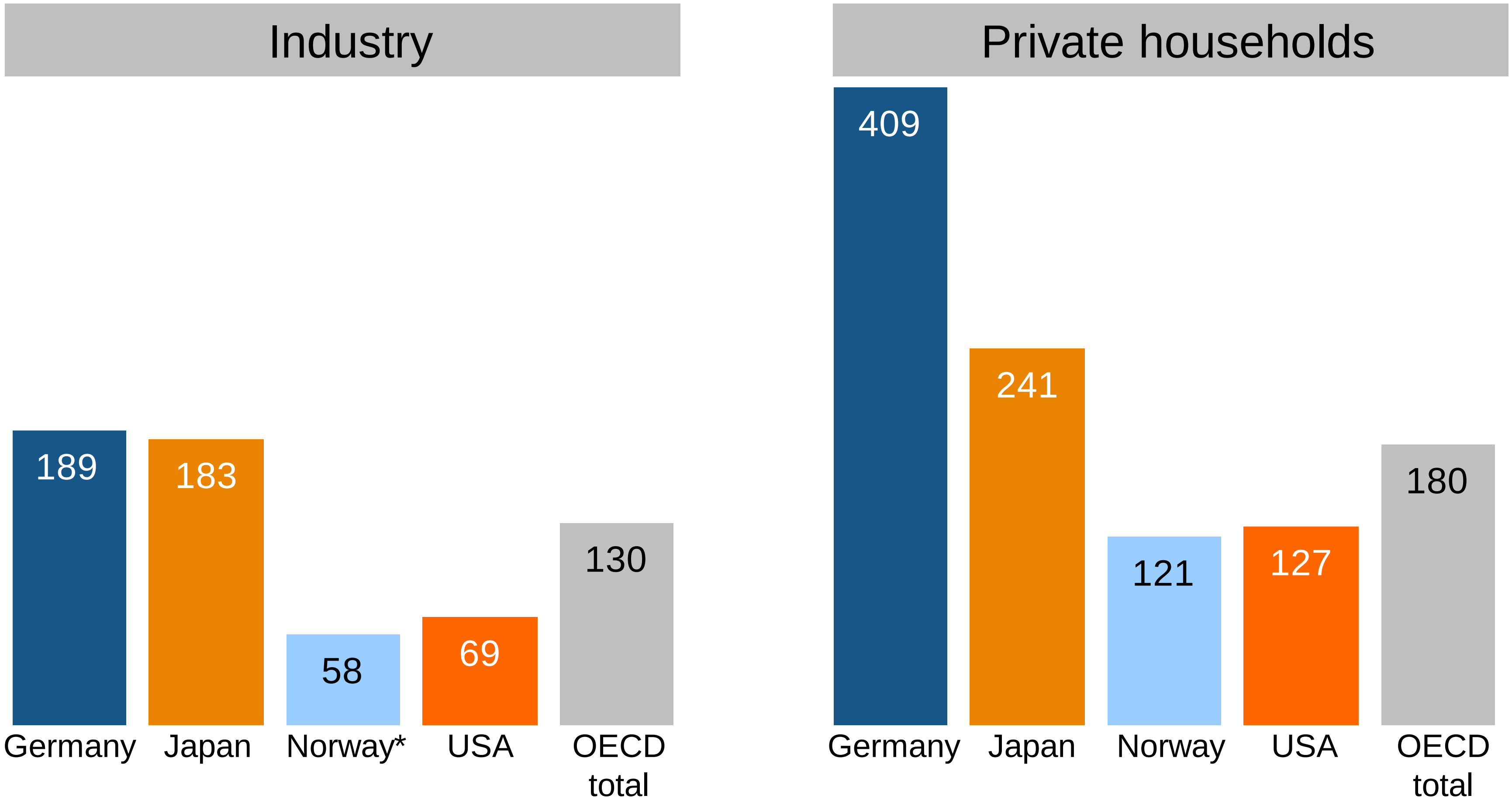


Position: February 2015

Source: Transmission system operators' transparency platform

Electricity prices, 2nd quarter 2014

Figures in USD/MWh



* Available only for the first quarter 2014

Source: IEA, Energy Prices and Taxes, third quarter 2014, Paris 2014, p. 241 and 342

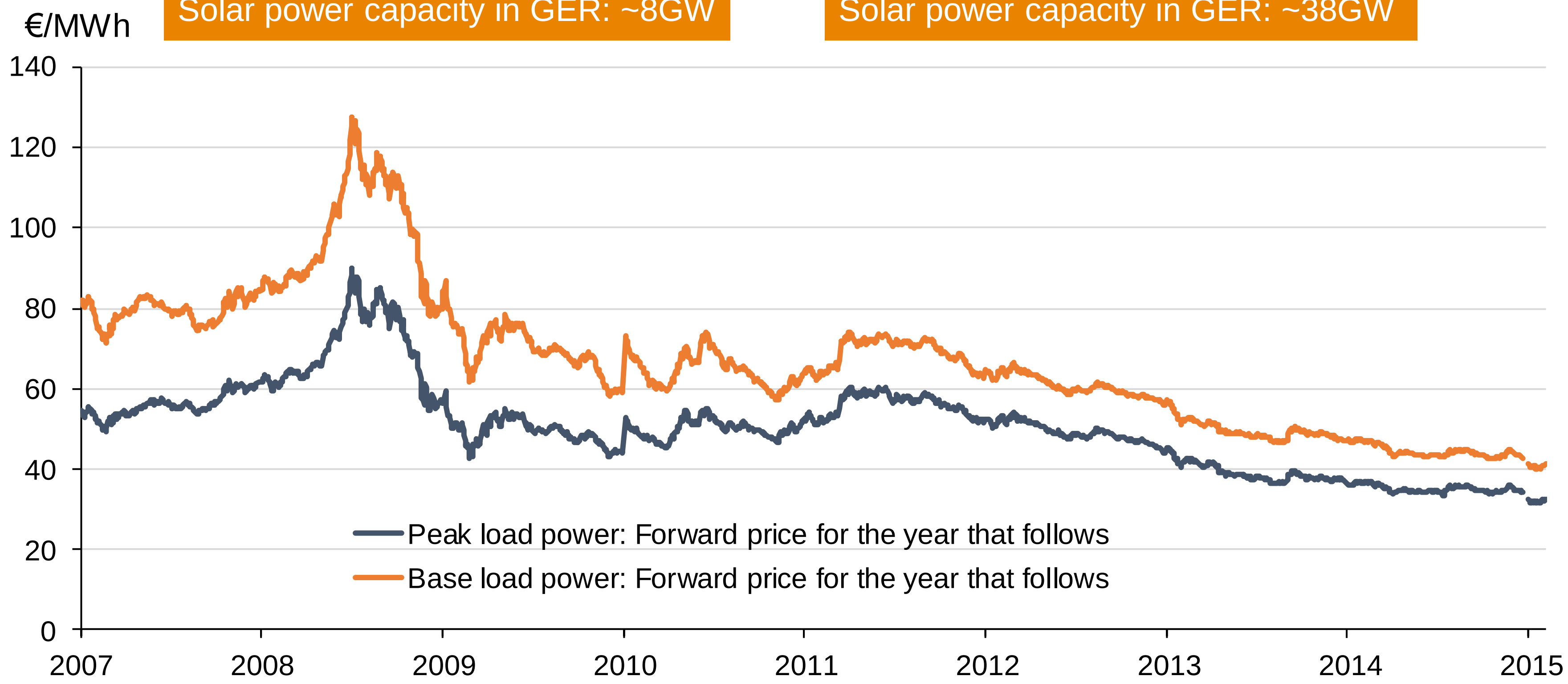
The price decline in electricity wholesaling affects all conventional power plants in Germany

Mid-2008

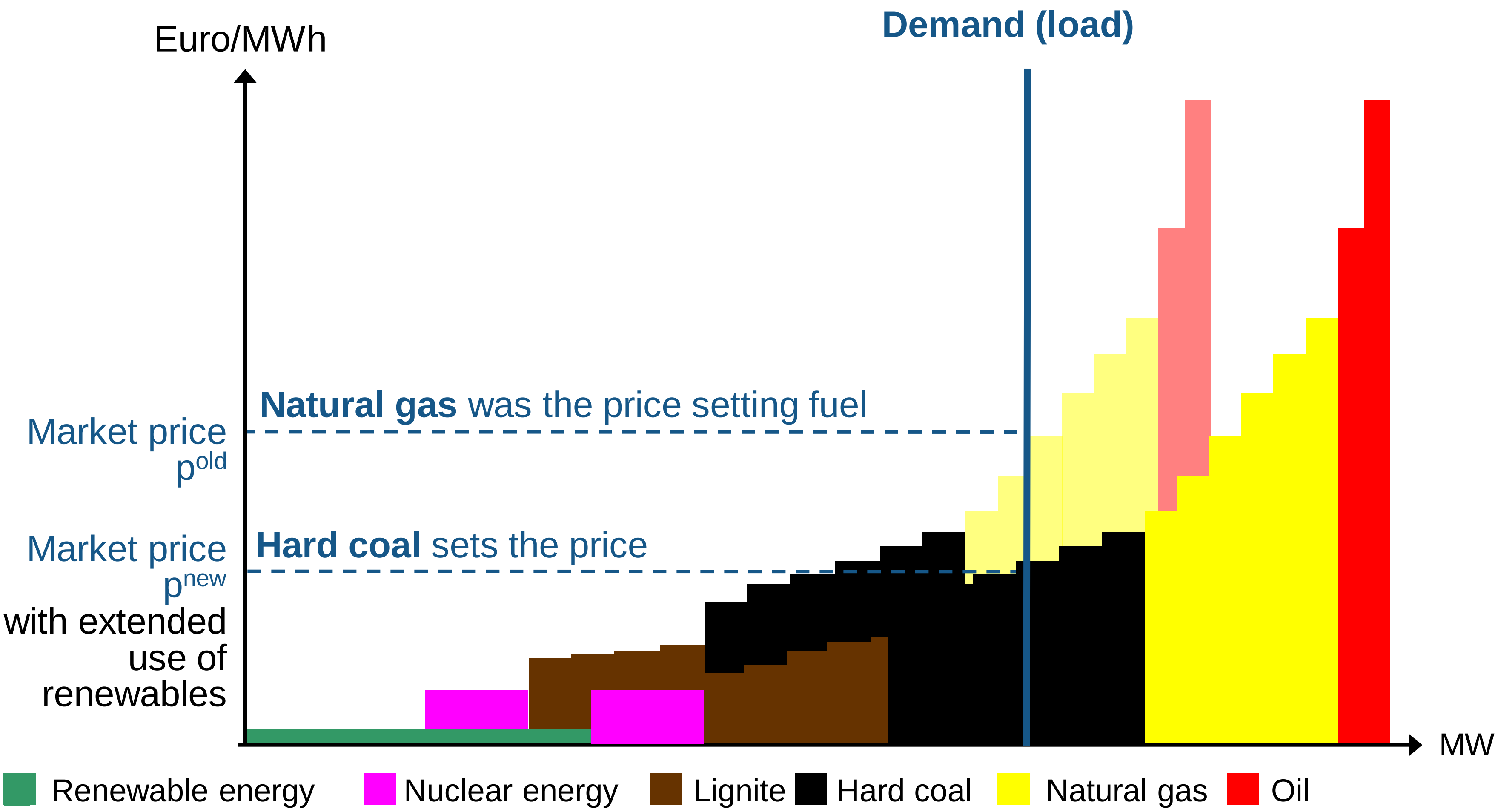
Hard coal price CIF-NWE: US$210/t
CO_2 price: €29/EUA
Solar power capacity in GER: ~8GW

End of 2014

Hard coal price CIF NWE: US$72.5/t
CO_2 price: €7.30/EUA
Solar power capacity in GER: ~38GW

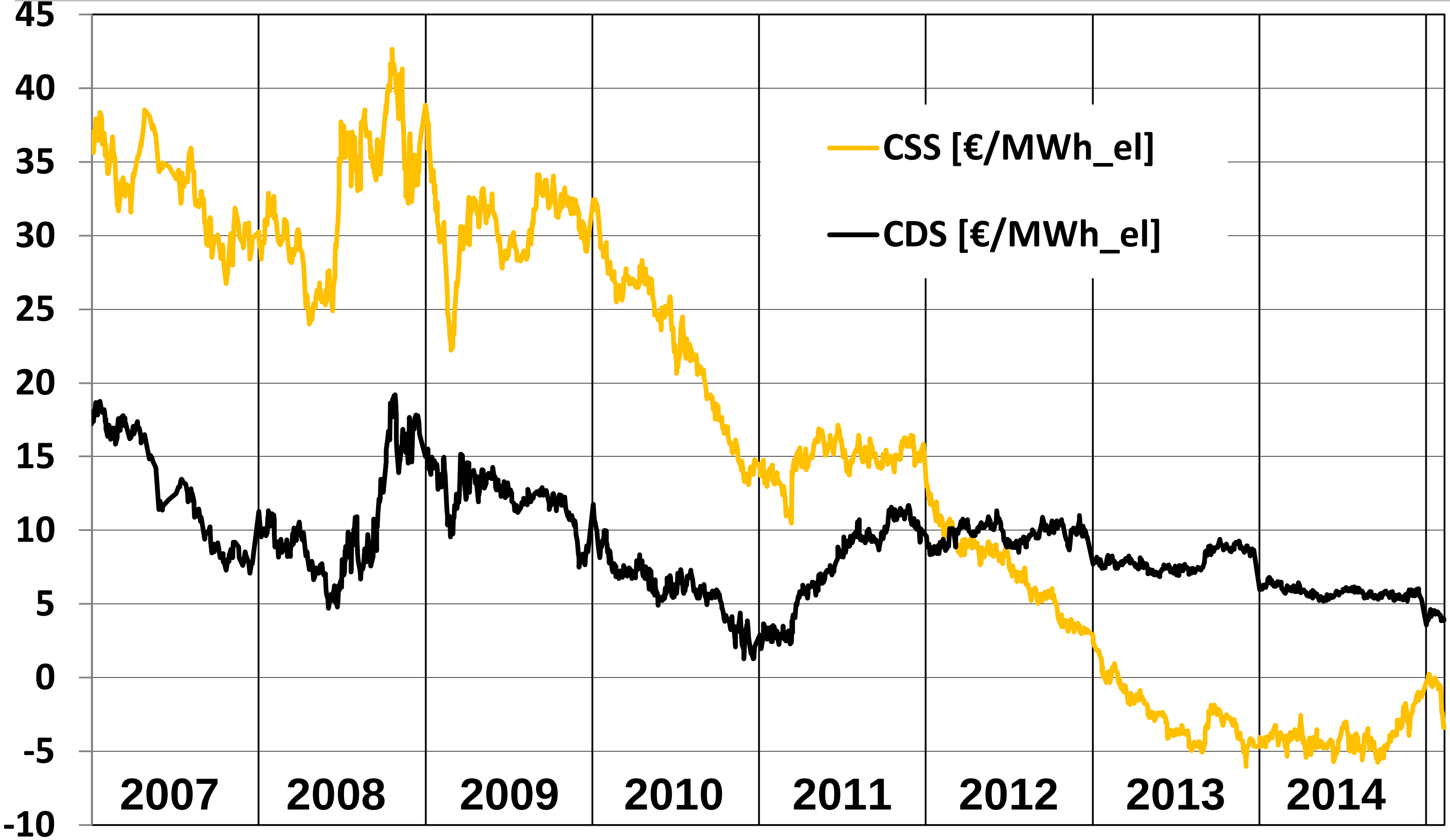


Price setting for electricity on the wholesale market – principle



Clean Dark and Clean Spark Spread (Margins of gas- and hard coal-fired power plants)

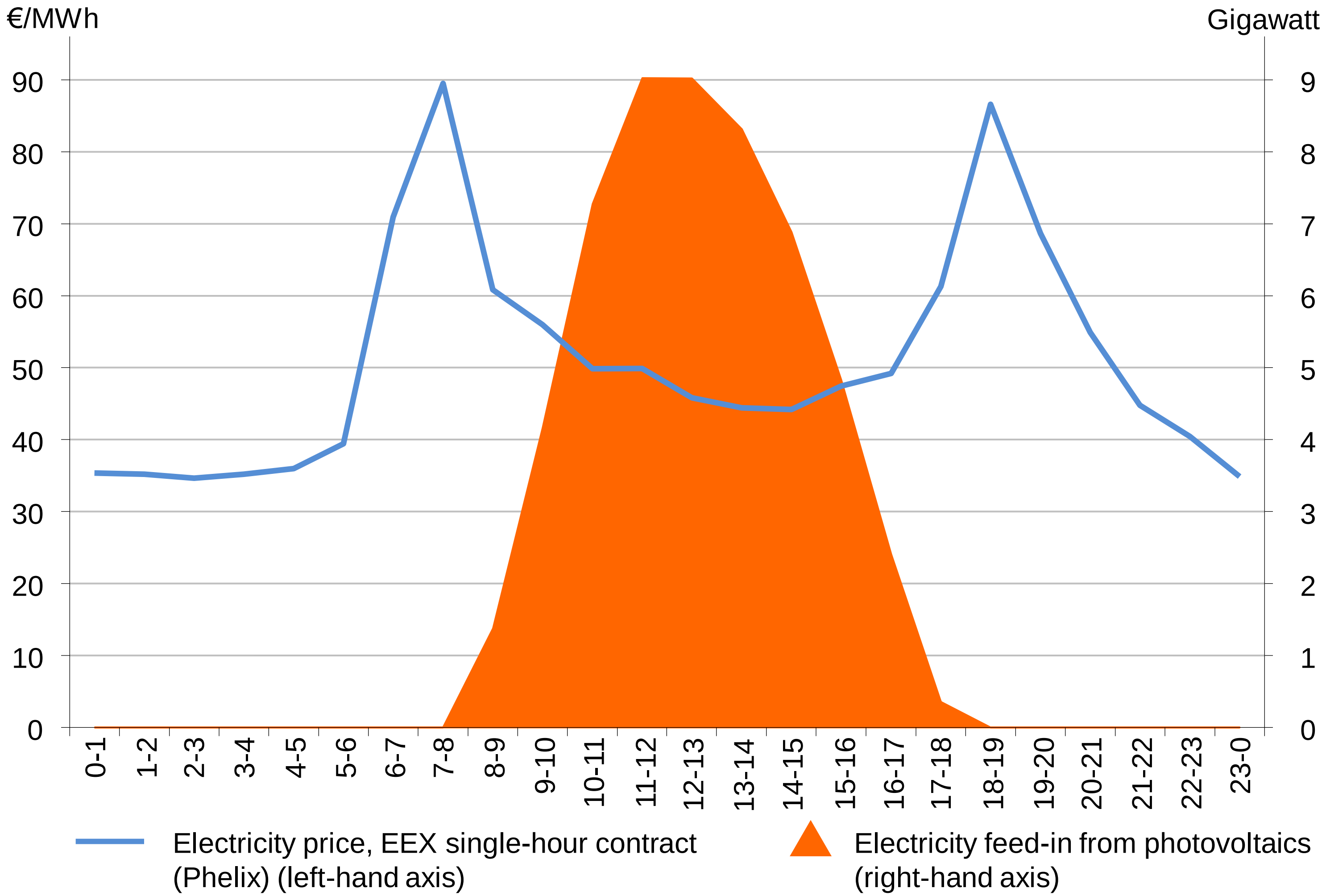
Assumed efficiency rate for baseload 36 % and for peakload power plants 58.35 %



CSS= clean spark spread (peak load electricity price minus cost of natural gas and CO_2 determined for the year that follows)
CDS= clean dark spread (base load electricity price minus cost of hard coal and CO_2 determined for the year that follows)

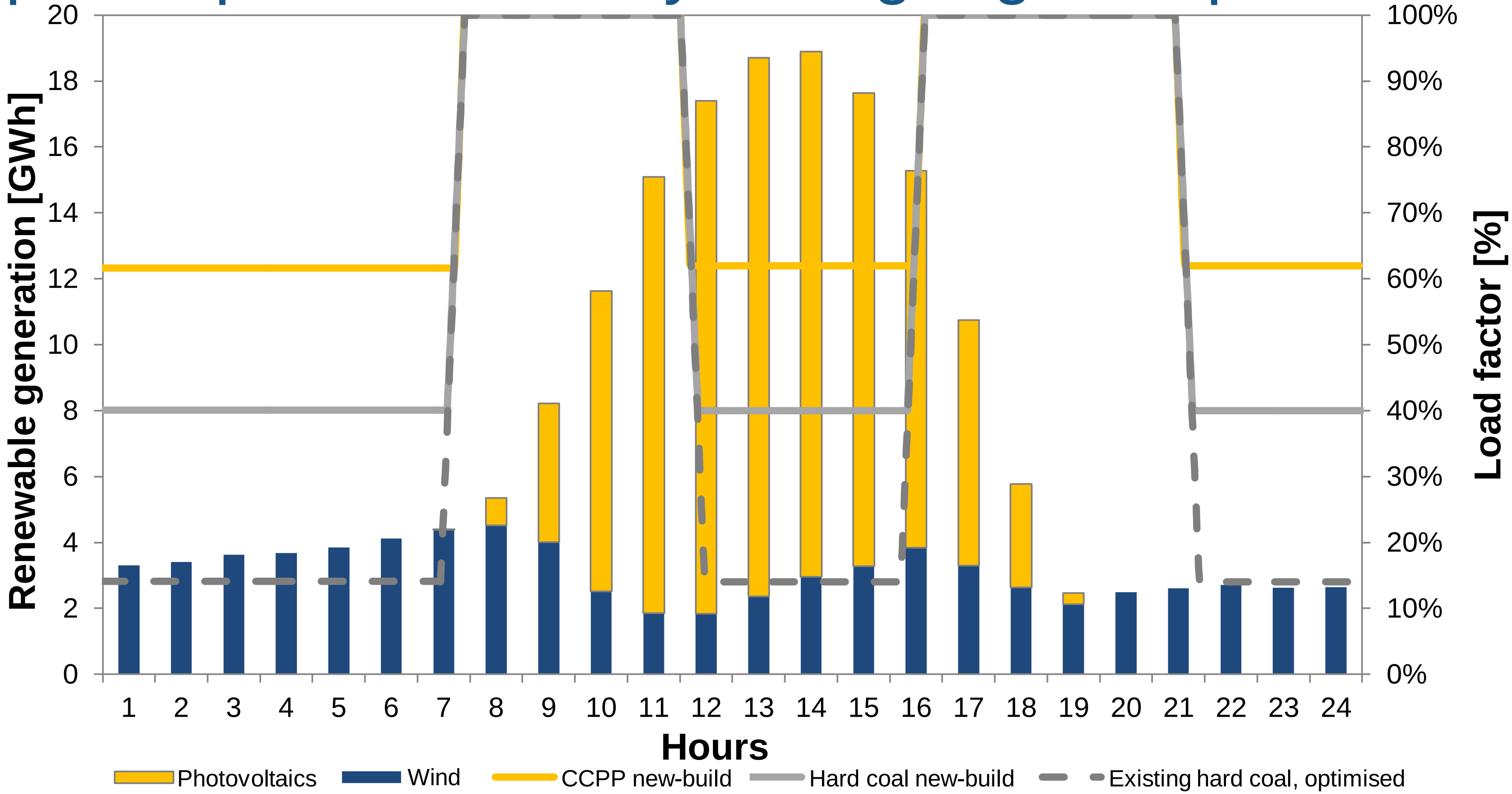
M-shaped electricity price curve on sunny days

Example: 20 February 2012



Sources: EEX, RWE Supply & Trading

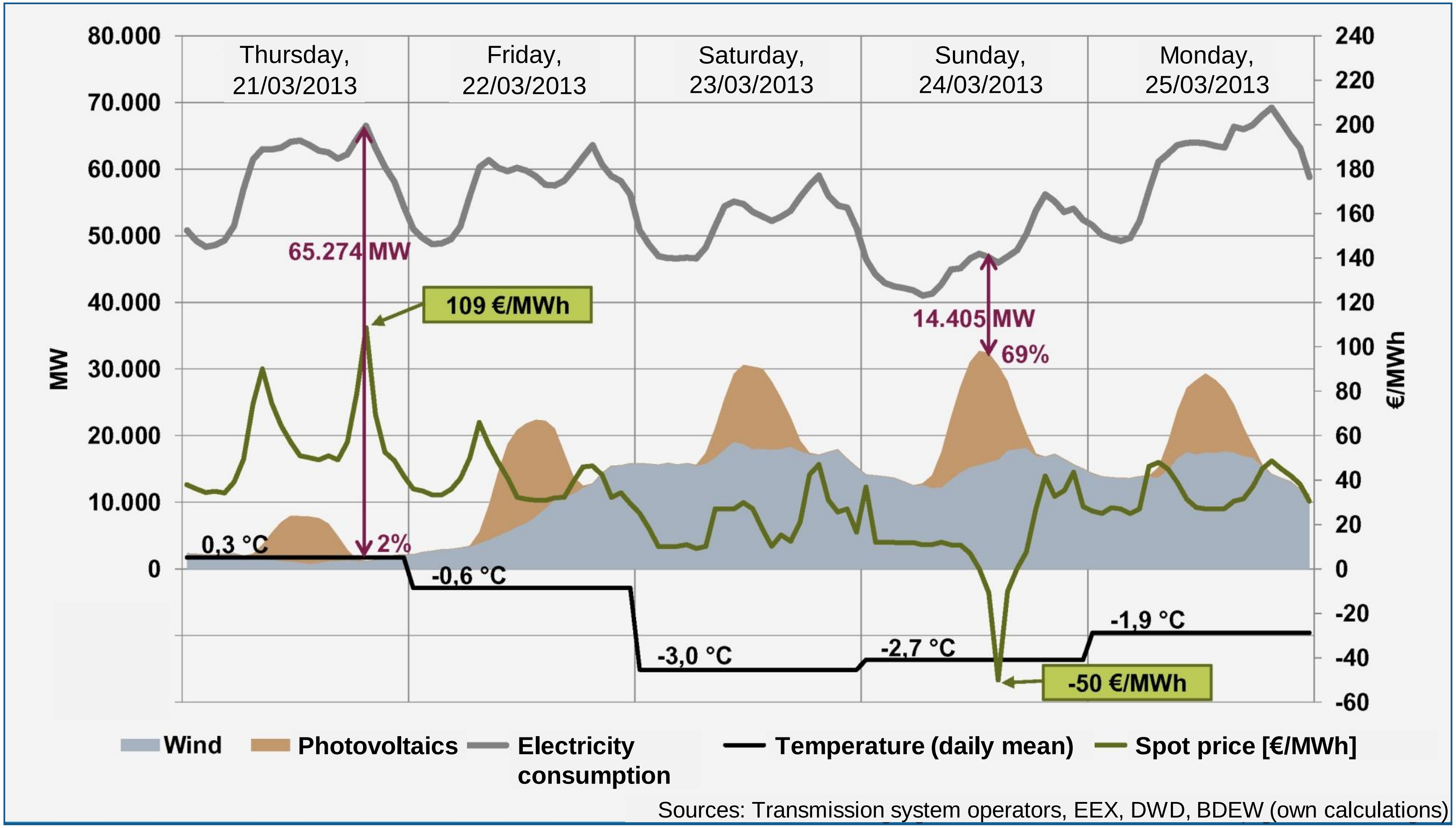
Feed-in from renewables (16/03/2012) and example illustration of hard-coal and gas-fired power plants' flexibility during regular operation



* Regular operation of two gas turbines and one steam turbine

Source: http://www.transparency.eex.com

Situation on 24 March 2013



Source: **BDEW** (German Association of Energy and Water Industries)

Example flexibility parameters for coal- and gas-fired power plants

Parameter	Unit	Natural gas CCPP new-build[1)]	Hard coal New-build	Lignite New-build	Hard coal Exist. plant (optimised)
Capacity	MW	800	800	1,100	300
Minimum-load point/ rated-load point (P_{Min}/P_{Rated})	%	~ 60	~ 25 to 40	~ 25[2)] to 40	~ 20
Mean load change rate[4)]	%/min.	~ 3.5	~ 3[3)]	~ 3	~ 3

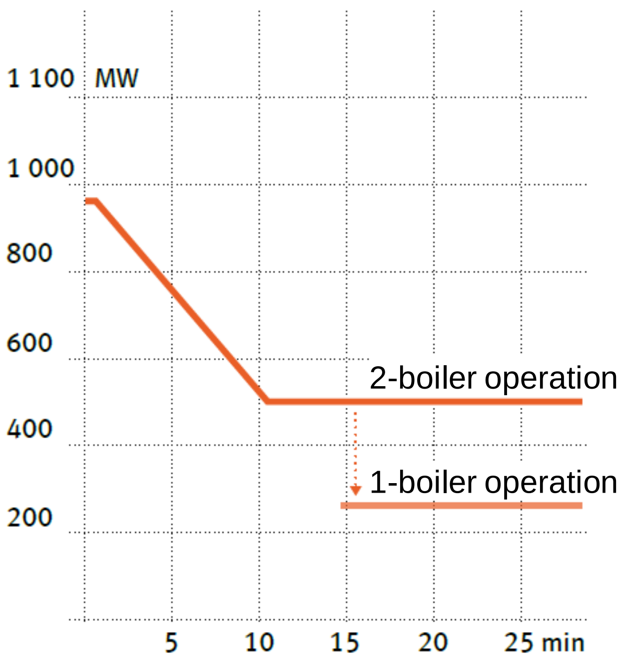
1) Regular operation of two gas turbines and one steam turbine
2) Thanks to the "BoA-Plus" design (lignite-fired power plant with optimised plant technology plus upstream coal drying) a minimum-load point of 25% is possible today but has not been implemented yet
3) In the lower load range (25 to 40%) the operating gradient differs from this value
4) With respect to rated load

Source: RWE

Comparison of load flexibility of new-build gas- and lignite-fired power plants

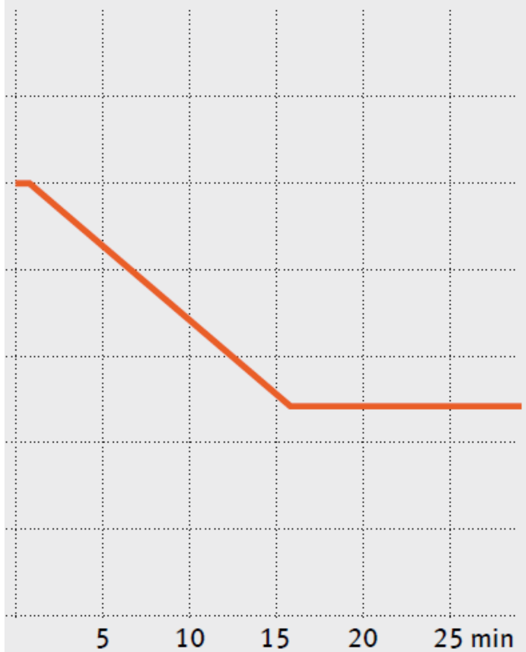
LOAD FLEXIBILITY OF A COMBINED-CYCLE POWER PLANT

LINGEN CCPP
Maximum capacity: = 2x440MW
Minimum capacity: = 520/260MW
Maximum load change rate: +/- 32MW/min

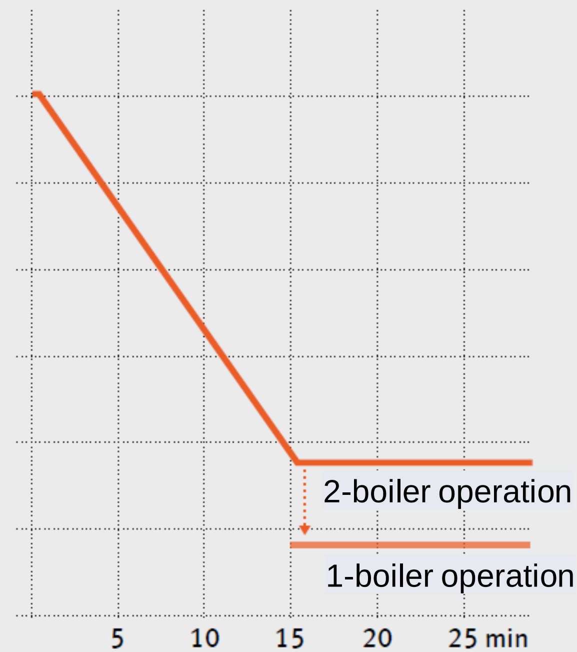


LOAD FLEXIBLITY OF SELECTED POWER PLANTS IN THE RHINELAND

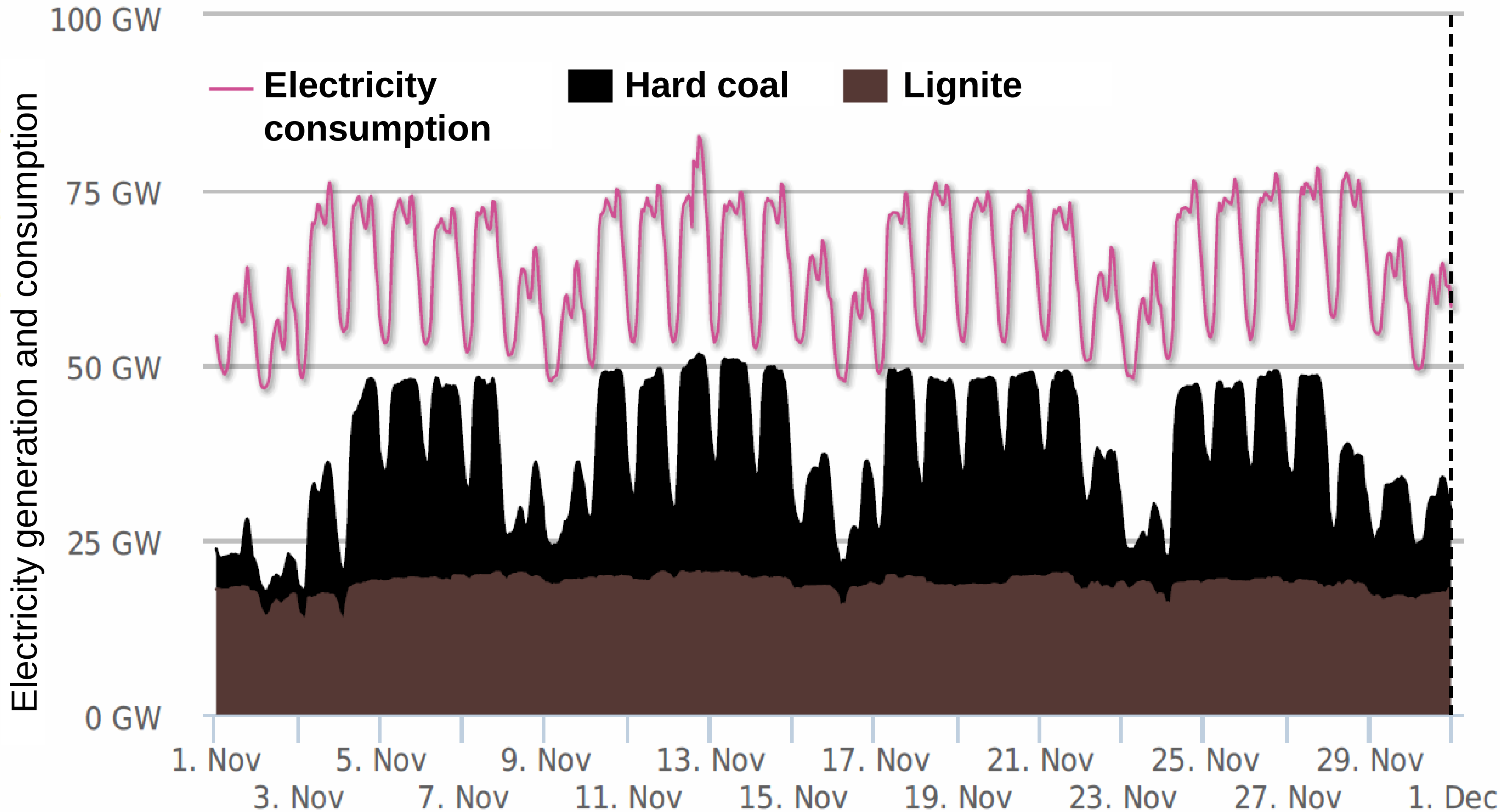
BOA 1 – 3
Maximum capacity: = 1,000MW
Minimum capacity: = 500MW
Maximum load change rate: +/- 30MW/min



BOA*PLUS*
Maximum capacity: = 2x550MW
Minimum capacity: = 350/175MW
Maximum load change rate: +/- 30MW/min



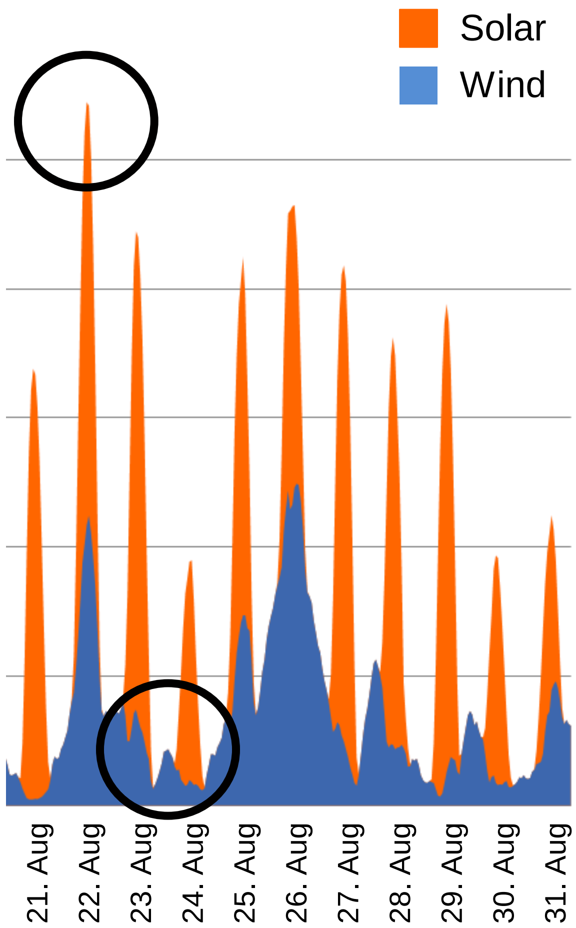
Electricity demand in Germany and electricity produced by coal-fired power plants in November 2014



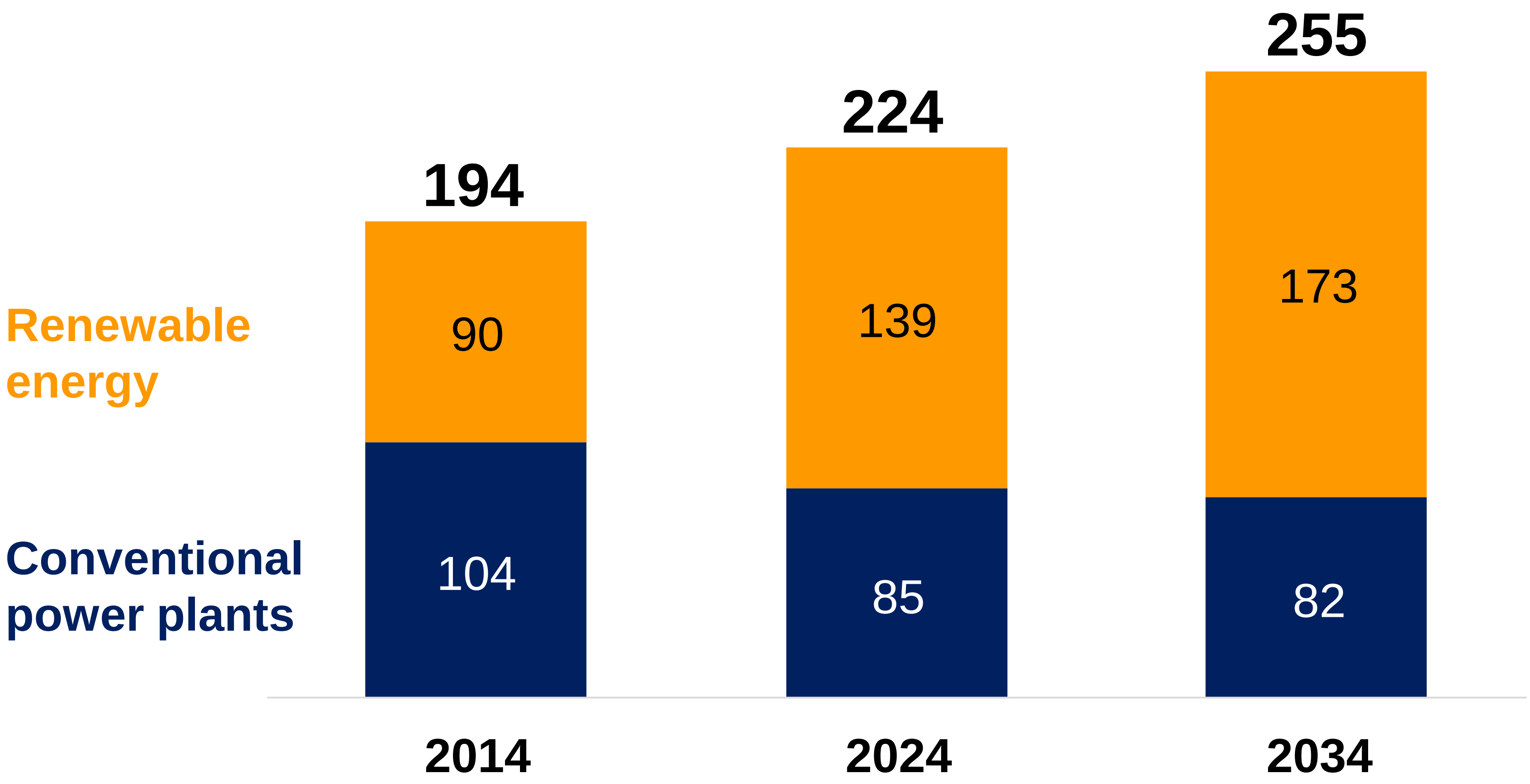
Source: Agora Energiewende, position: 12/12/2014

The biggest drawback of renewables: Their availability is not in our hands

- At times, wind and solar power meet more than three-quarters of electricity demand …
- … while at others they all but vanish from the scene
- Conventional power plants are needed to ensure security of supply
- But the expansion of renewables leads to conventional power plants becoming increasingly unprofitable

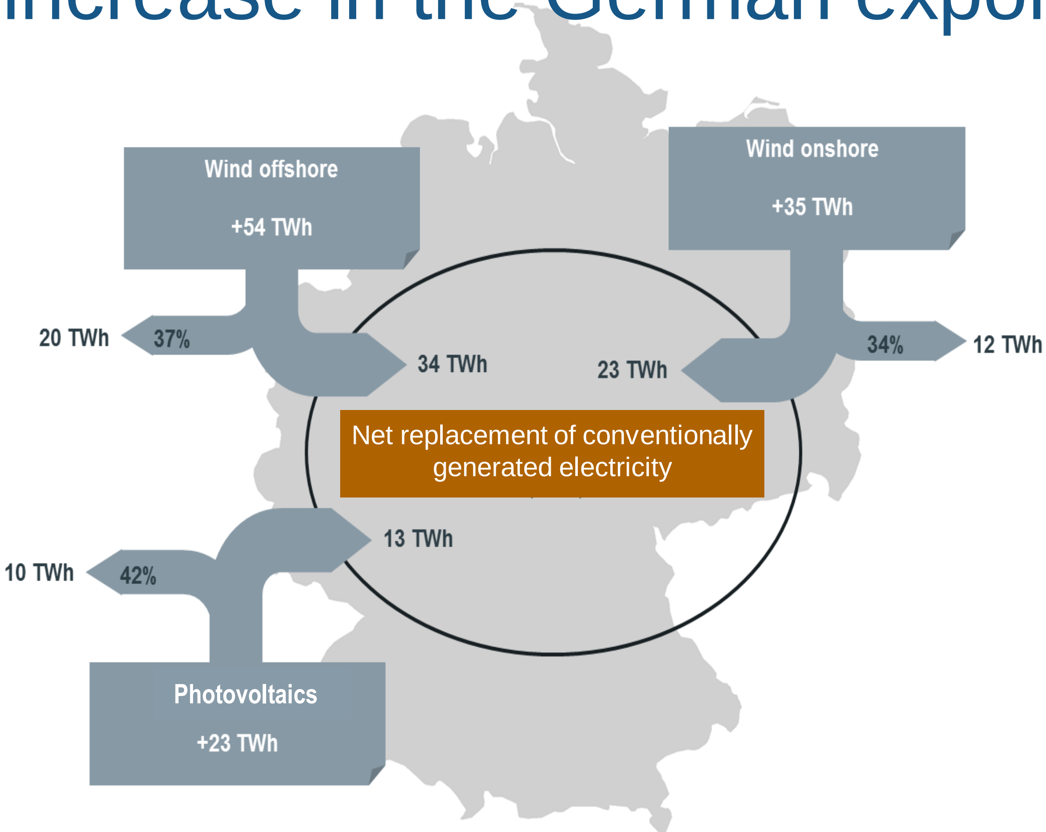


Power generation capacity in Germany
GW (net)



Source: BDEW 02/2015 and 2014 Electricity Grid Development Plan, scenario B

More than one-third of additional renewable generation in 2022 will merely contribute to the increase in the German export surplus



Overview: Selected expected electricity flows in 2022 (target scenario)

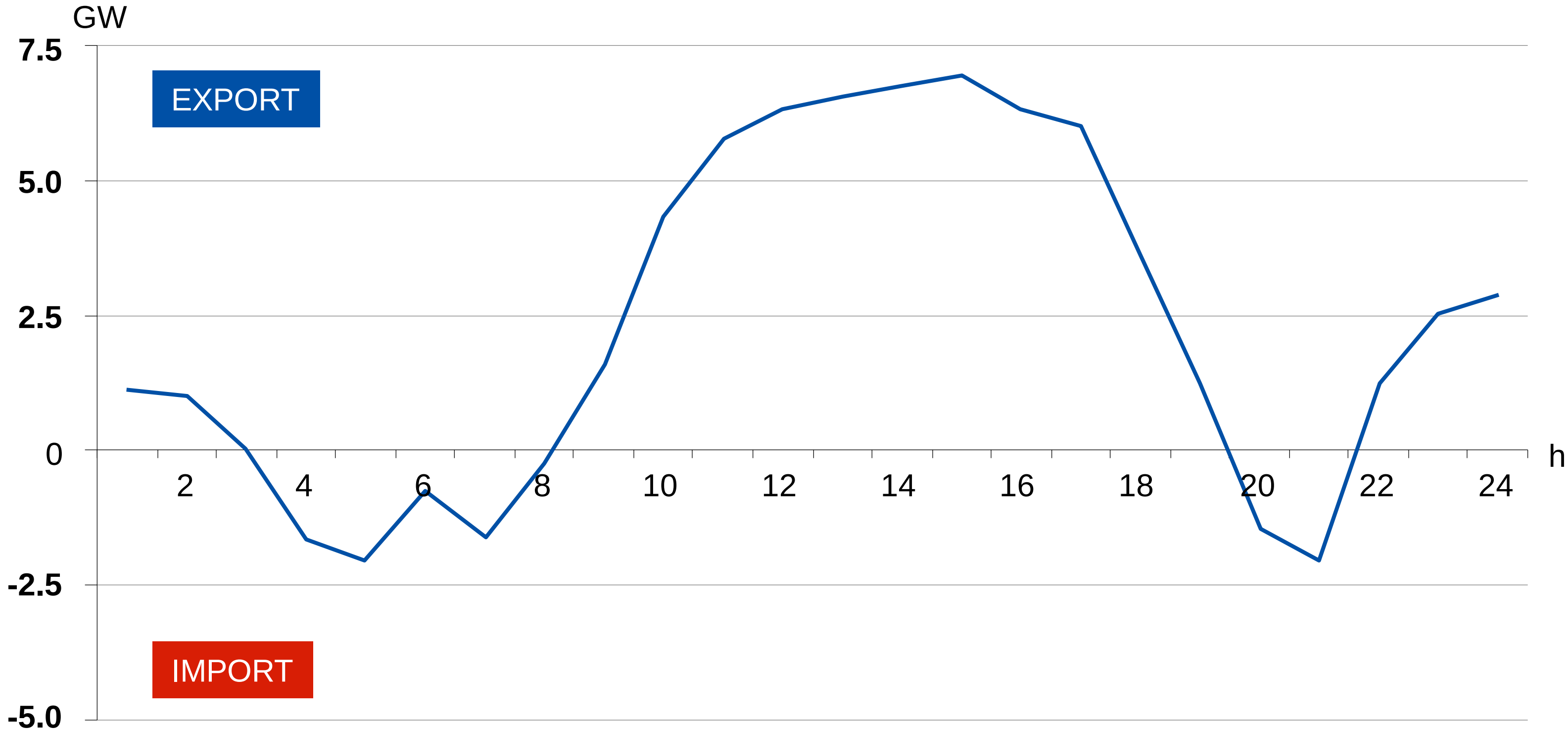
- Generation and load in Germany will diverge
- Hours of high feed-in of renewables and low demand create market incentives to export electricity abroad
- In 2022, only about two-thirds of the electricity generated from renewables can be integrated into the German electricity market

The energy turnaround is a European challenge and thus has to be approached at the European level.

Source: EWI

Heavily subsidised photovoltaic power drives down prices on the energy exchange around midday and is exported to neighbouring European countries

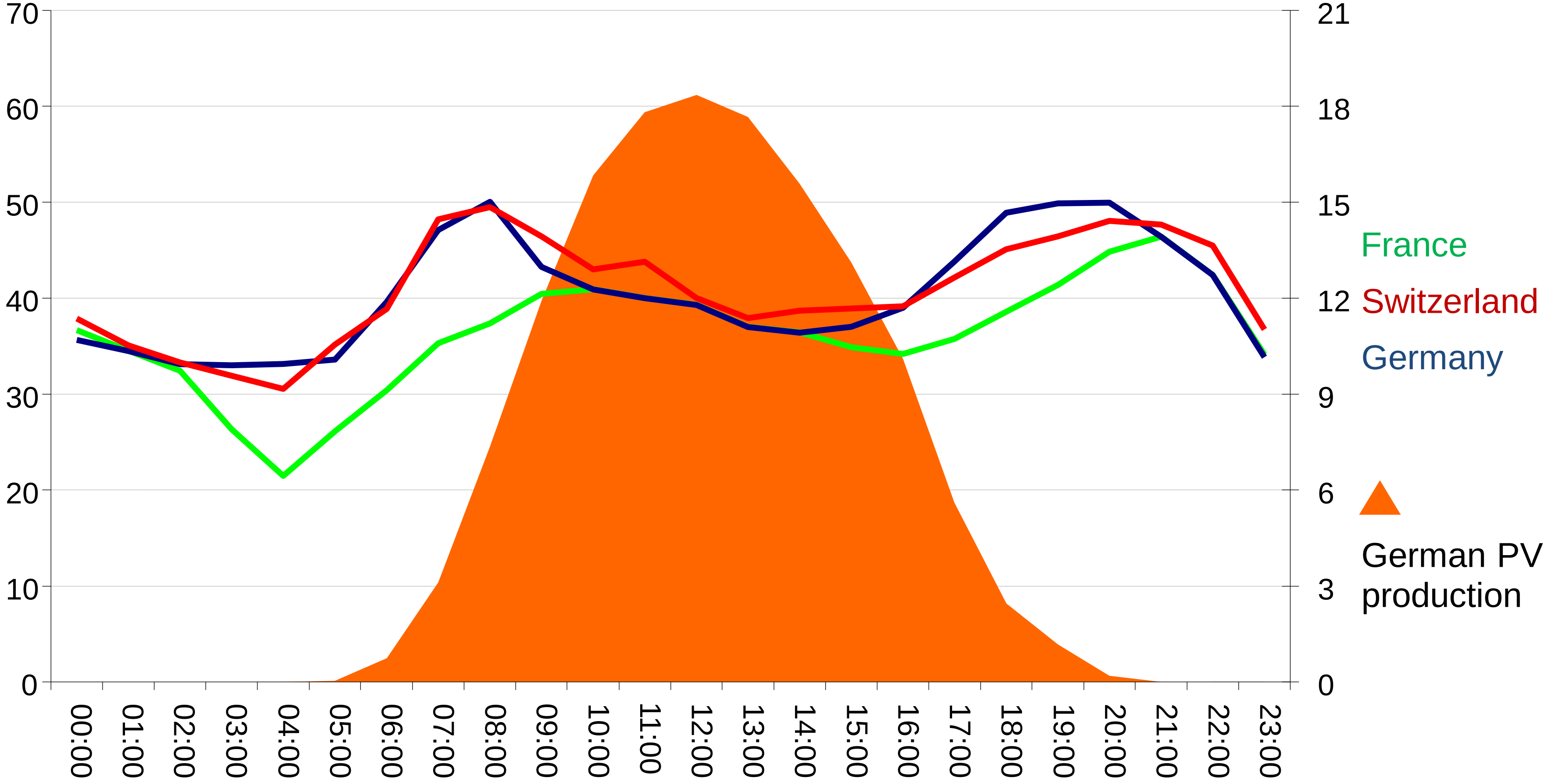
Germany's hourly power export balance on 17 April 2012



The single European market for electricity is working and systematically exploiting national solo runs that are out of touch with the market

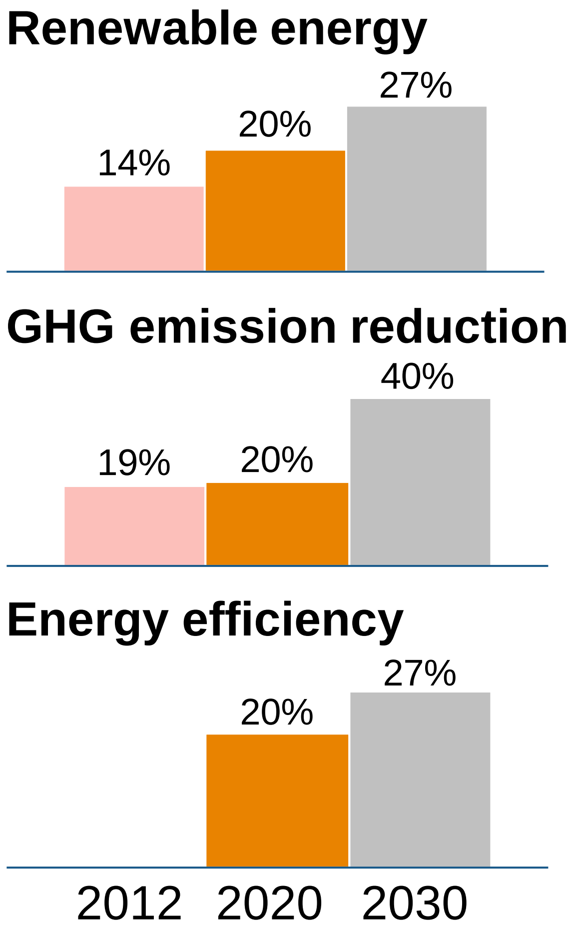
Photovoltaic power produced in Germany significantly influences peak-load power prices in Europe

Power prices for hourly contracts traded on European energy exchanges (in €/MWh (left-hand axis)) and German PV power production (in GW (right-hand axis)); 8 May 2012*



* Source: EEX; RWE Supply&Trading.

Energiewende is not a solely German trend: EU sets ambitious targets for 2030



- > Renewable targets – in % of total energy consumption
- > GHG emission reduction – in % compared with 1990 emission levels
- > Energy efficiency – in % reduction in energy consumption compared with the reference projection of 2007

Current
Targets for 2020
Targets for 2030

Source: EU Commission

2030 framework for the European power sector

Climate target	GHG emission reduction by 40% compared with 1990 emission levels

Emission reduction of 43% by 2030 compared with 2005 emission levels for sectors which are part of the ETS (power sector and industry)

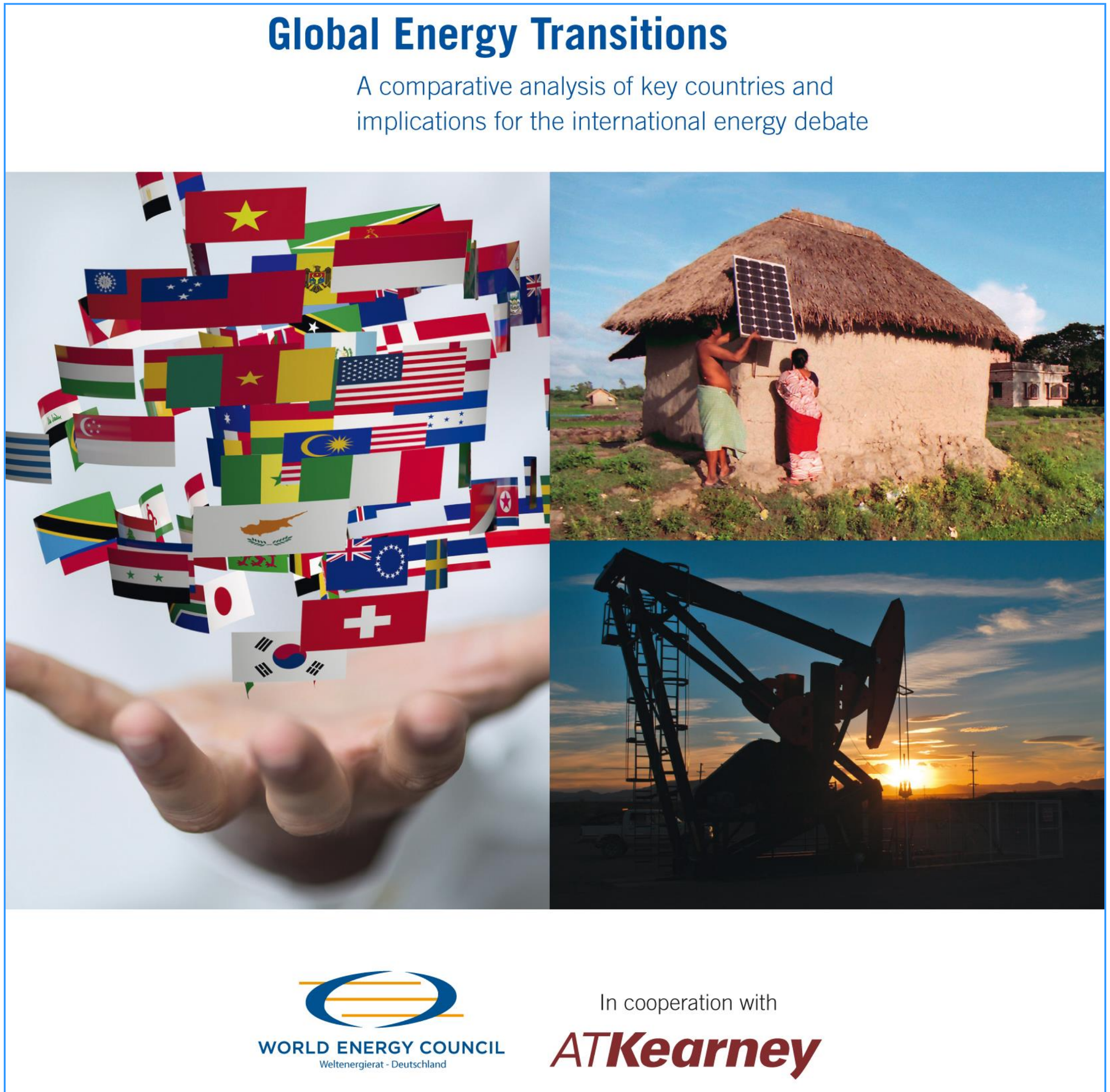
Emission reduction of 30% by 2030 compared with 2005 emission levels for sectors which are not part of the ETS (households, traffic)

ETS = Emission Trading Scheme

Expectation for the power sector	Increase in the share of renewable energy in power generation from 21% in 2012 to 45% in 2030

Conclusion

- The **central targets of energy policy** are security of supply, competitive and affordable prices and environmental protection.
- These targets have the same rank.
- There should be **one instrument for each target**.
- To keep energy affordable and competitive we should support renewables via **auctioning systems** and give them market responsibility.
- As far as conventional energy sources are concerned, we should rely on **least cost solutions**.
- Whether preference is given to coal or to nuclear energy should be a **rational decision**.
- **CCS is technically feasible** – the risks involved are very limited.
- CCS contributes to **employment within the country**.
- For **energy security**: discrimination of cost-efficient domestic energy sources is to be avoided.



http://www.weltenergierat.de/wp-content/uploads/2014/10/Global-Energy-Transitions-2014_EfG2014-mit-AT-Kearney.pdf