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Embassy of the
Federal Republic of Germany
Washington

The German Energy transition
State of Play of Renewable Energies

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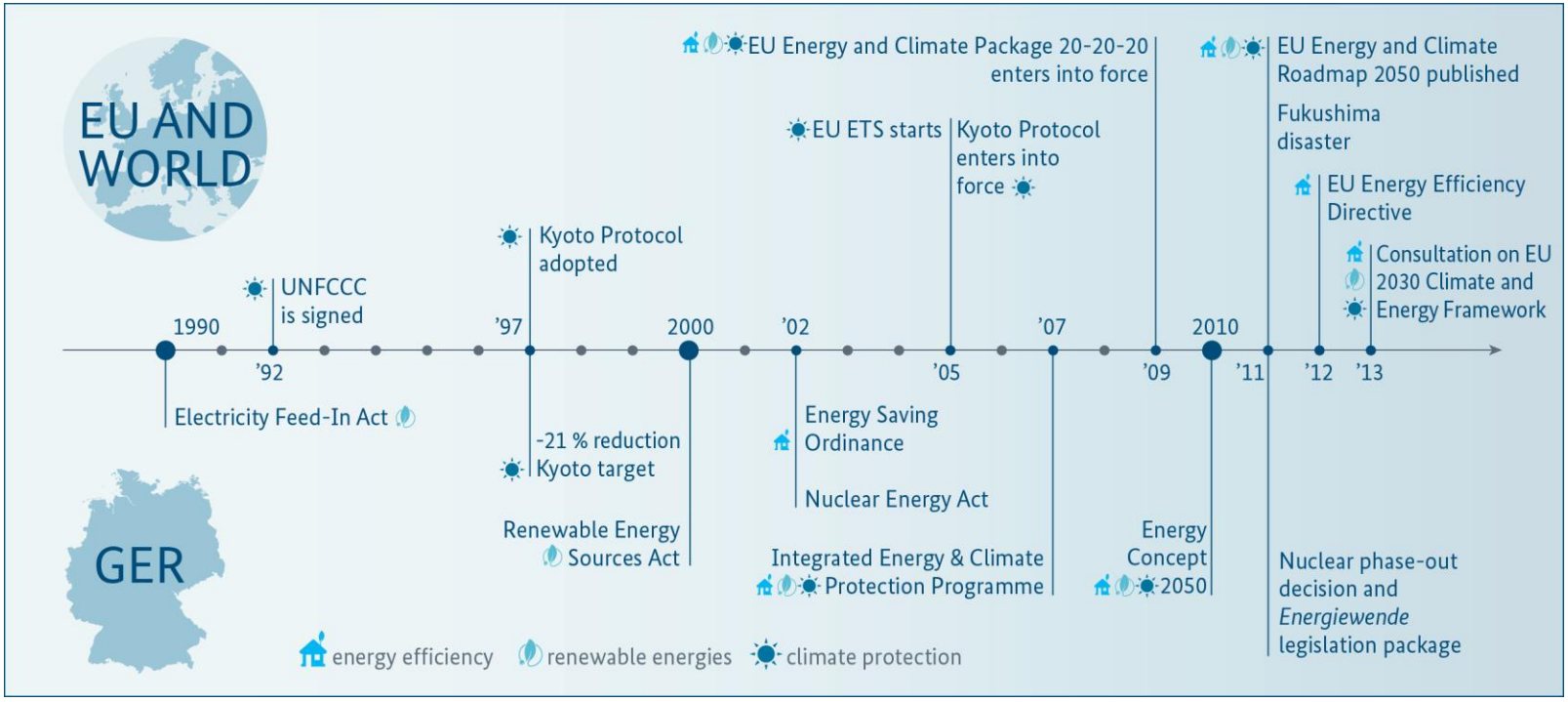
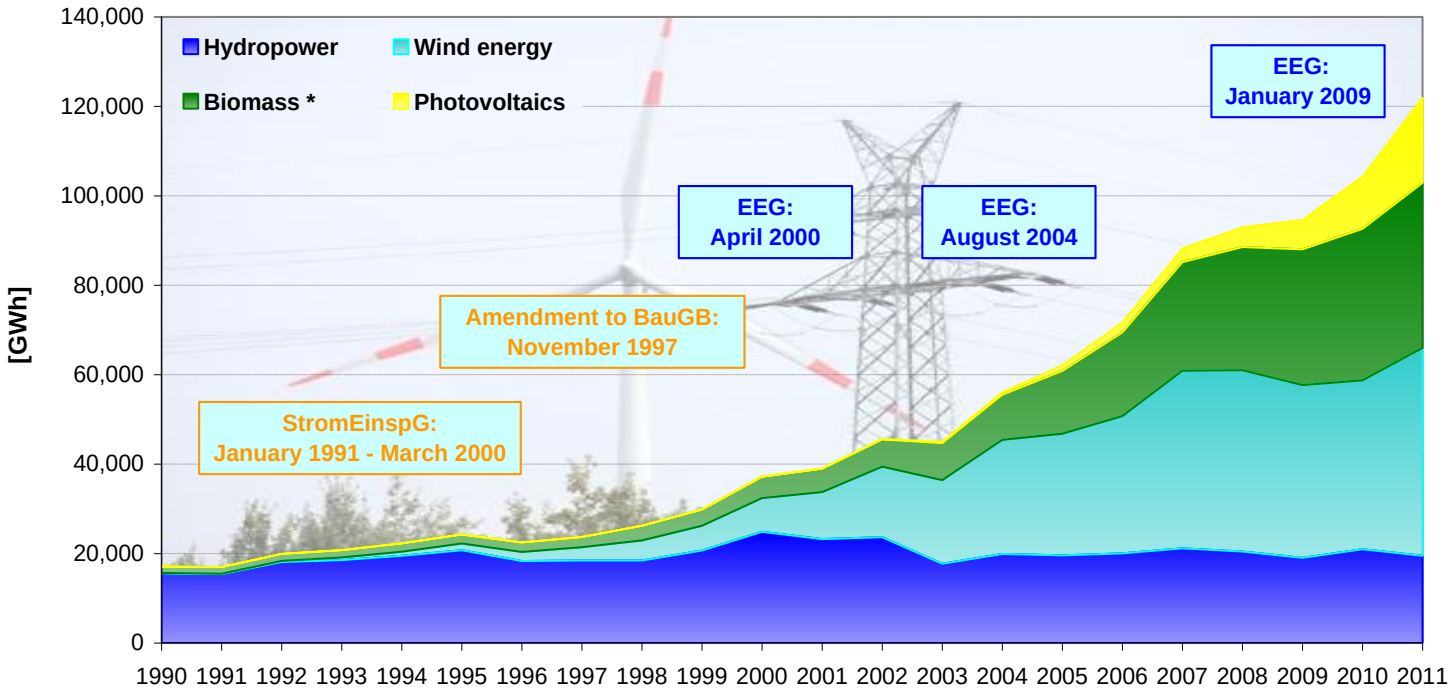
Milestones of the *Energiewende*



Germany is part of an integrated European energy and climate strategy.

RE Act has pushed growth of RE

Development of electricity generation from renewable energy sources in Germany since 1990

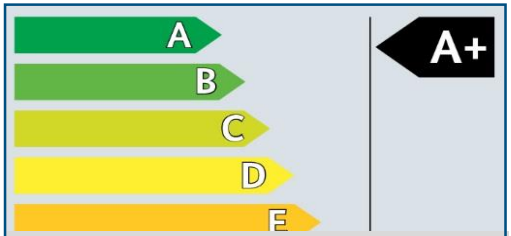


* Solid and liquid biomass, biogas, sewage and landfill gas, biogenic share of waste; electricity from geothermal energy not presented due to negligible quantities produced; 1 GWh = 1 Mill. kWh;
StromEinspG: Act on the Sale of Electricity to the Grid; BauGB: Construction Code; EEG: Renewable Energy Sources Act;
source: BMU-KI III 1 according to Working Group on Renewable Energy-Statistics (AGEE-Stat); image: BMU / Christoph Edelhoff; as at: March 2012; all figures provisional

Cornerstones of the Renewable Energy Sources Act

- Guaranteed grid access; priority transmission and distribution
- Fixed price (tariff or premium) for every kWh produced
- Tariffs are set for each type of technology and with regard to further provisions (e.g. site and size)
- Additional costs for renewable energy production are offset through the EEG levy (2014: ~ 6,24 ct/kWh), with reductions for energy-intensive industries
- Additional costs are offset via grid operators and independent of the public budget
- Regular monitoring and evaluation; accompanying research

Two pillars of the *Energiewende*



Energy Efficiency

Key legislation:

Energy Saving Ordinance
Heating Cost Ordinance

- Reduce energy consumption
- Cost-efficient

Supporting fields of action

Renewable Energy

Key legislation:

Renewable Energy Sources Act
Renewable Energy Heat Act

- Steady growth
- Environmentally friendly

The energy transition's foundation are renewables and reduced energy consumption.

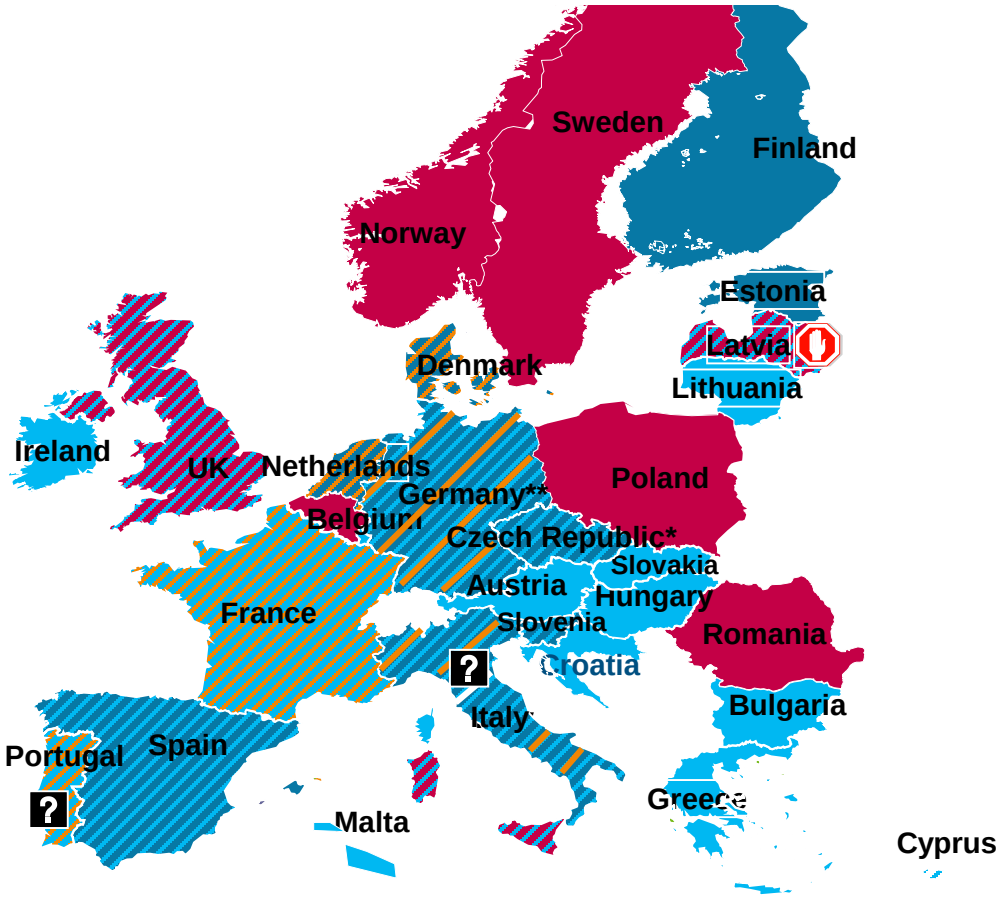
Renewable electricity support mechanisms in Europe

Quota obligation
Feed-in tariff
Feed-in premium
Tendering
Mixed models

Support scheme currently suspended

Policy uncertainty

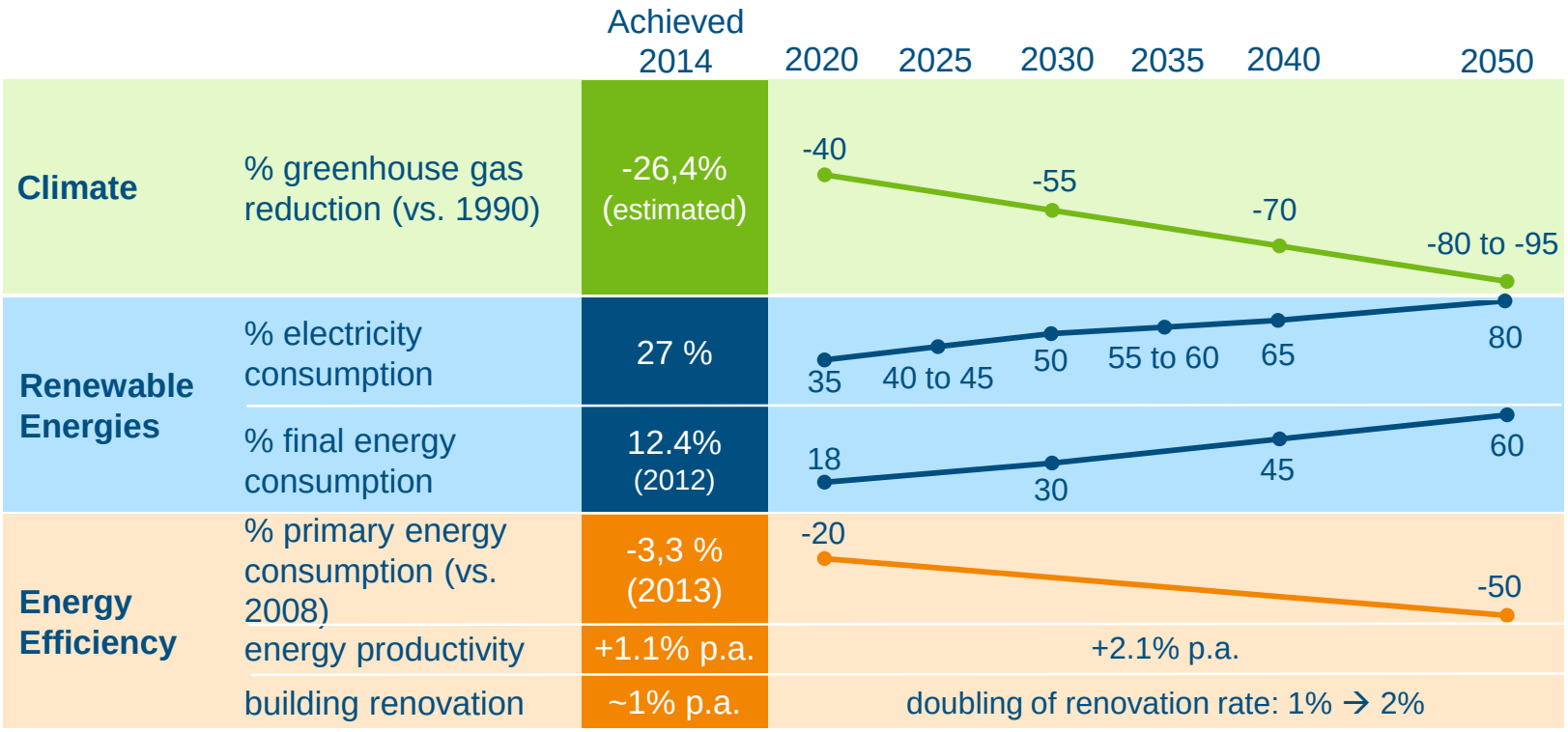
* support scheme was cut significantly
** Germany will start tendering ground-mounted PV in 2015



Source: Ecofys 2014, based on Ragwitz et al. (2012)

Energiewende targets until 2050

and progress made so far

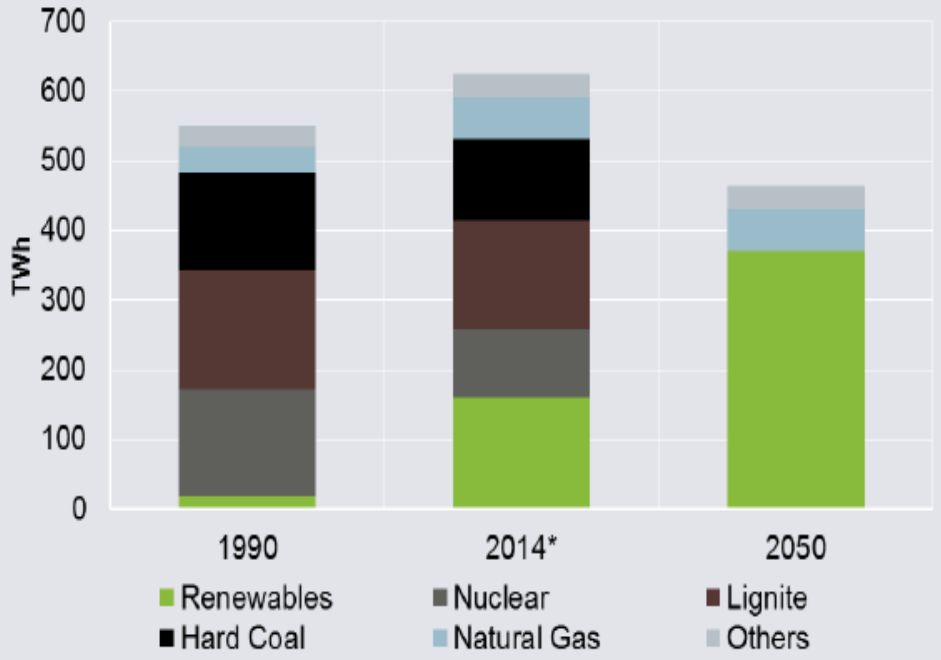


Source: Federal Government 2010, BMU/BMWi 2014, AGEE-Stat 2014

Germany has set ambitious targets in all sectors and is partly on track.

The Energiewende means fundamentally changing the power system

Gross electricity generation 1990, 2014 and 2050



AGEB (2015a), BReg (2010), EEG (2014), own calculations * preliminary

Phase out of Nuclear Power
Gradual shut down of all nuclear power plants until 2022

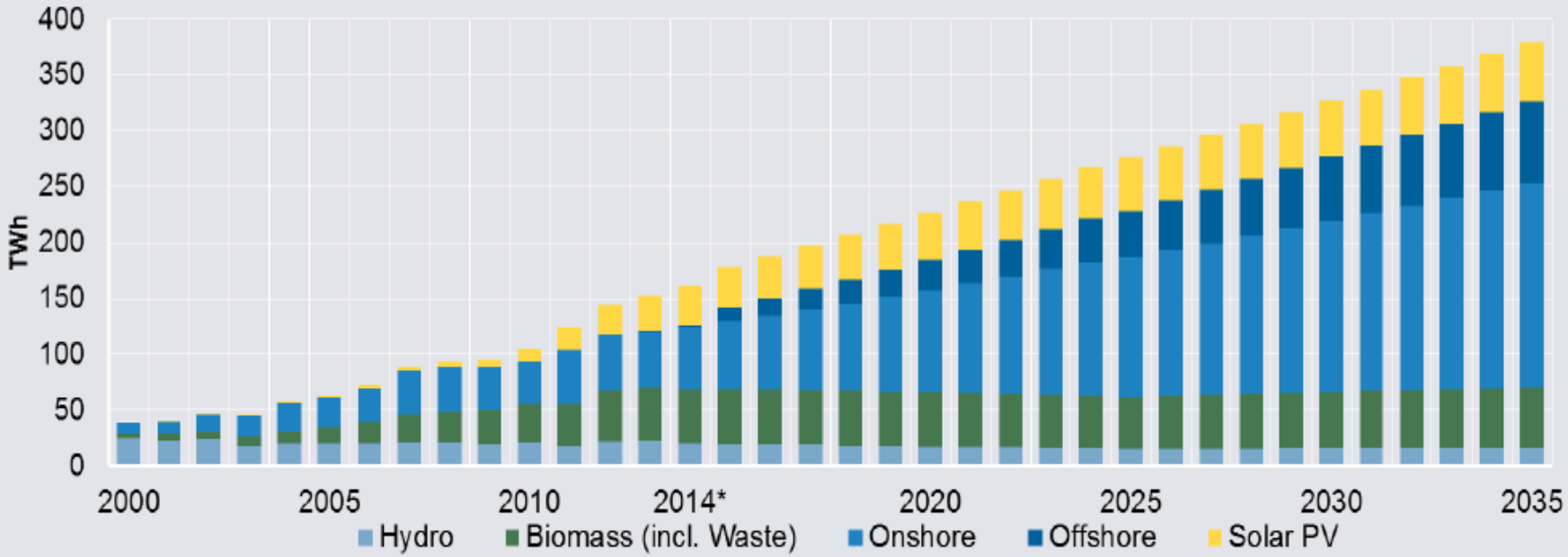
Reduction of Greenhouse Gas Emissions
Reduction targets below 1990 levels:
- 40% by 2020; - 55% by 2030; - 70% by 2040;
- 80% to - 95% by 2050

Development of renewable energies
Share in power consumption to increase to:
40 - 45% in 2025; 55 - 60% in 2035; ≥ 80% in 2050

Increase in efficiency
Reduction of power consumption compared to 2008 levels: - 10% in 2020; - 25% in 2050

Lesson 1: The key insight for the Energy Transition: It's all about wind and solar!

Gross electricity generation of renewable energies 2000 - 2035

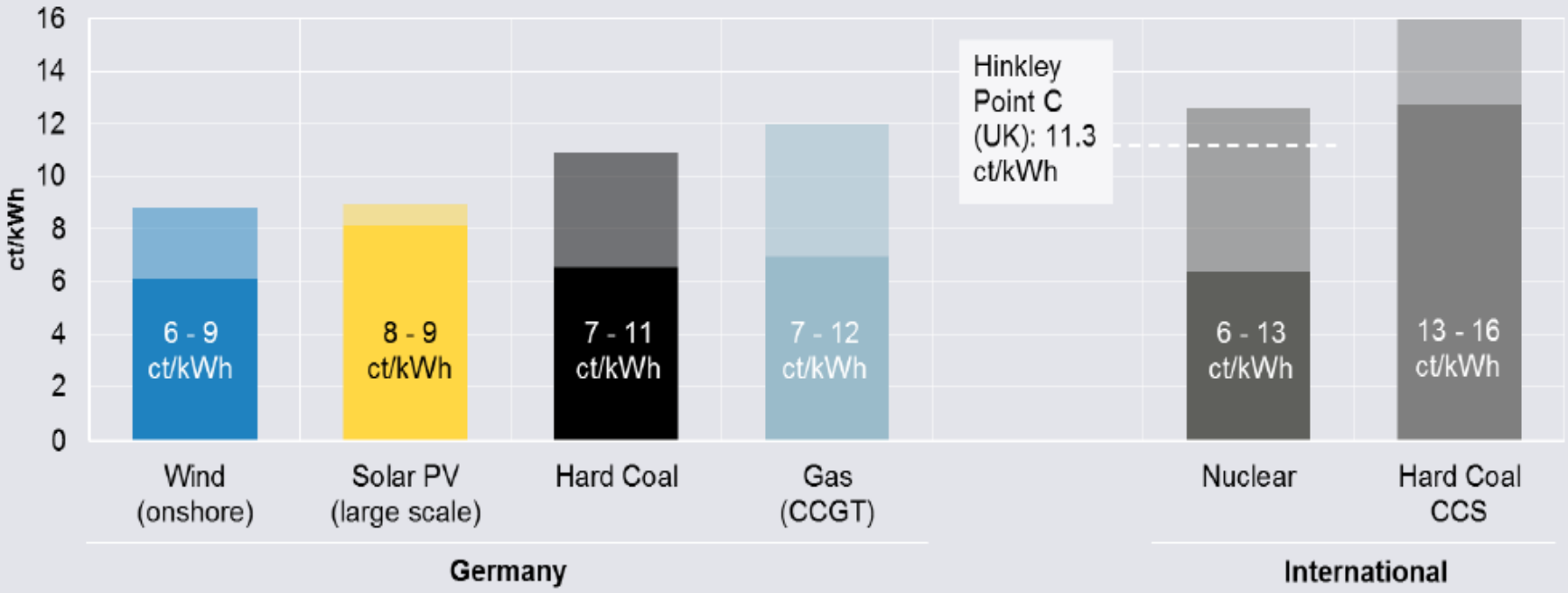


2000 - 2014: AGEB (2015a); 2015 - 2035: own calculation on basis of BNetzA (2014)/BNetzA (2015b)

* preliminary

Wind and Solar are (in most regions) the cheapest low-carbon power source and already cost competitive to newly built fossil power plants

Range* of levelized cost of electricity (LCOE) 2015



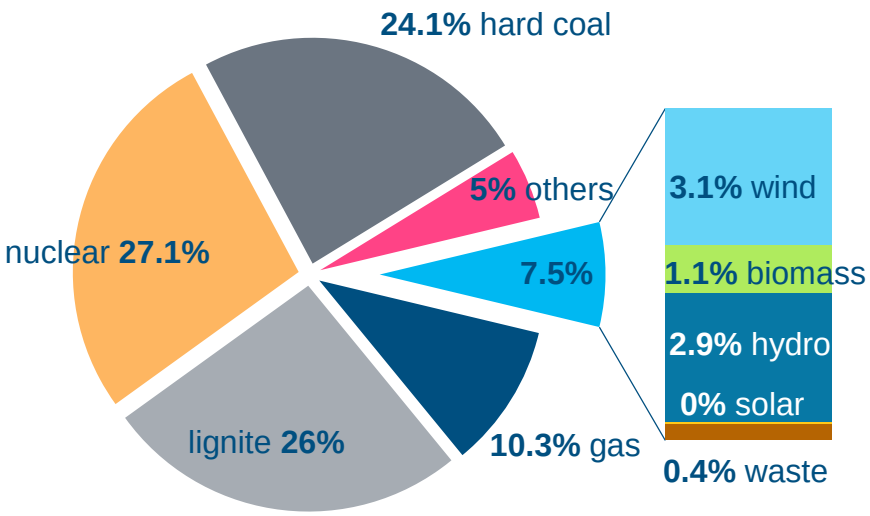
Agora Energiewende (2015e)

* based on varying utilization, CO_2-price and investment cost

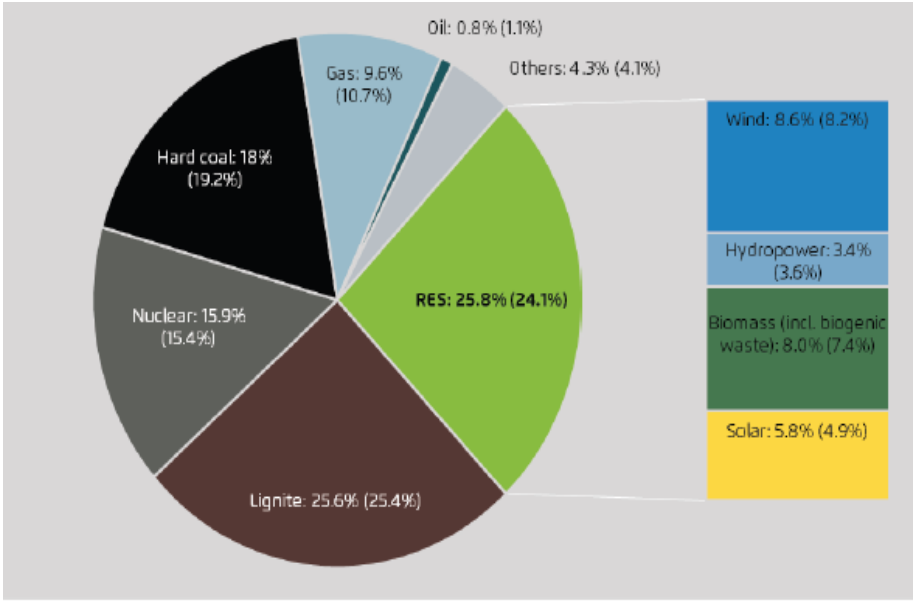
Where do we stand:

Share of renewables is growing in all sectors, but fastest in electricity.

2003 total: 608.8 TWh
renewables share: 45.6 TWh



2014 total: 610,4 TWh
renewables share: 157,4 TWh



The renewables share in electricity production tripled within ten years.

RE are now biggest source of electricity

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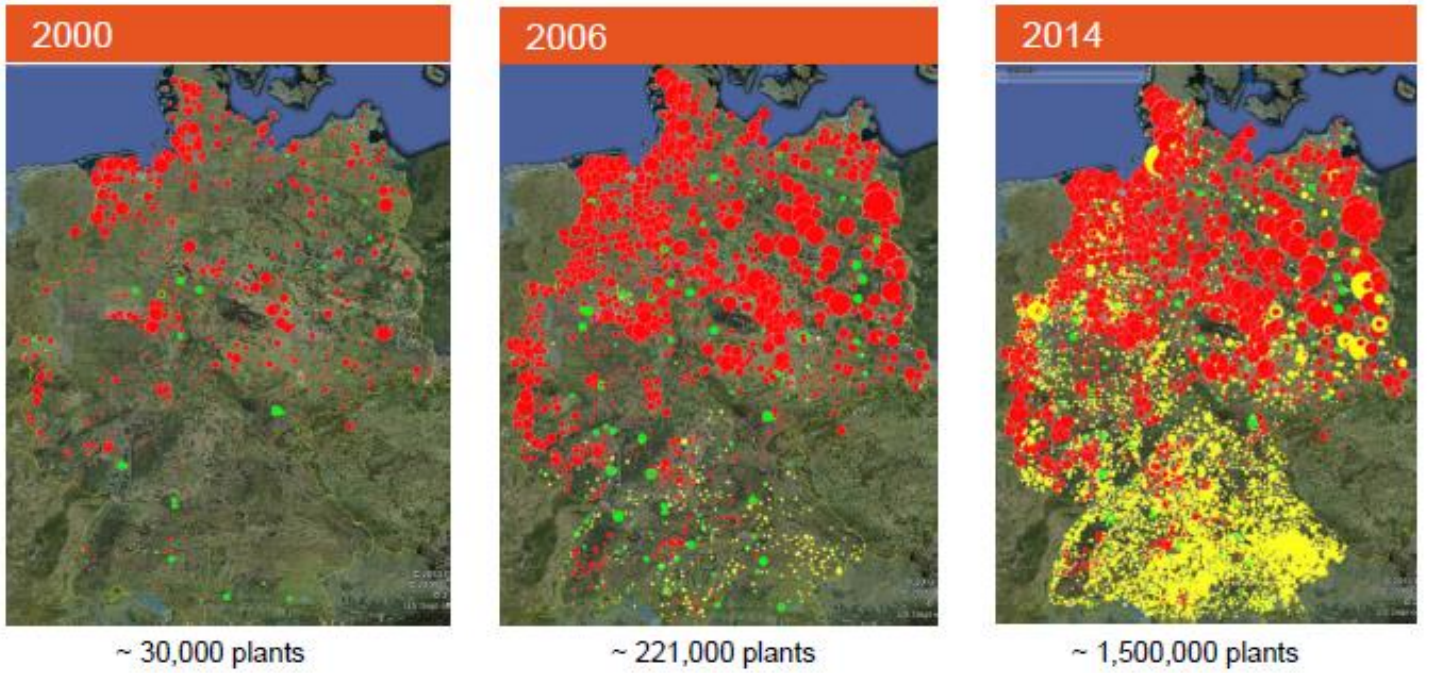
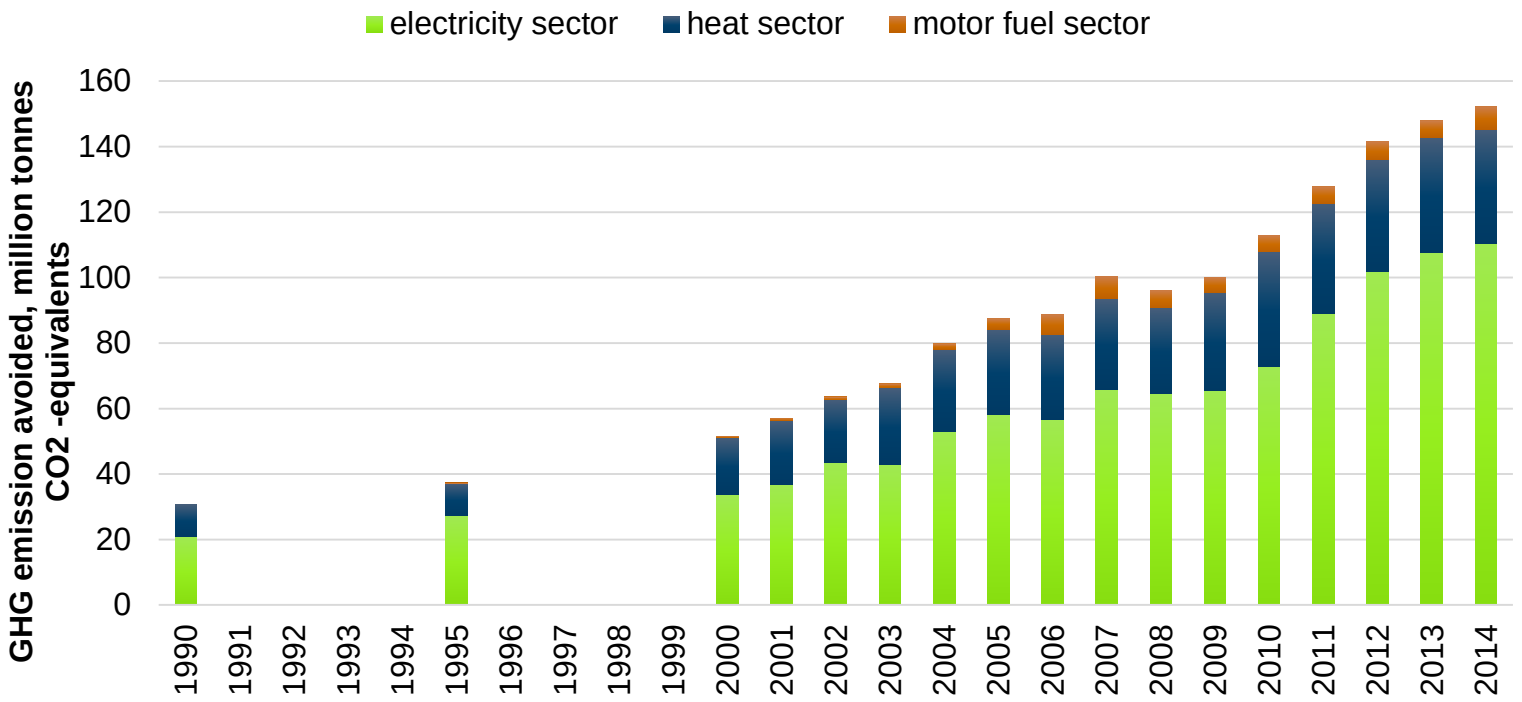
Expansion of renewable energy sources in Germany



Sourece: 50hertz, Boris Schucht 2015

The number of renewable power plants as grown exponentially over the past 14 years.

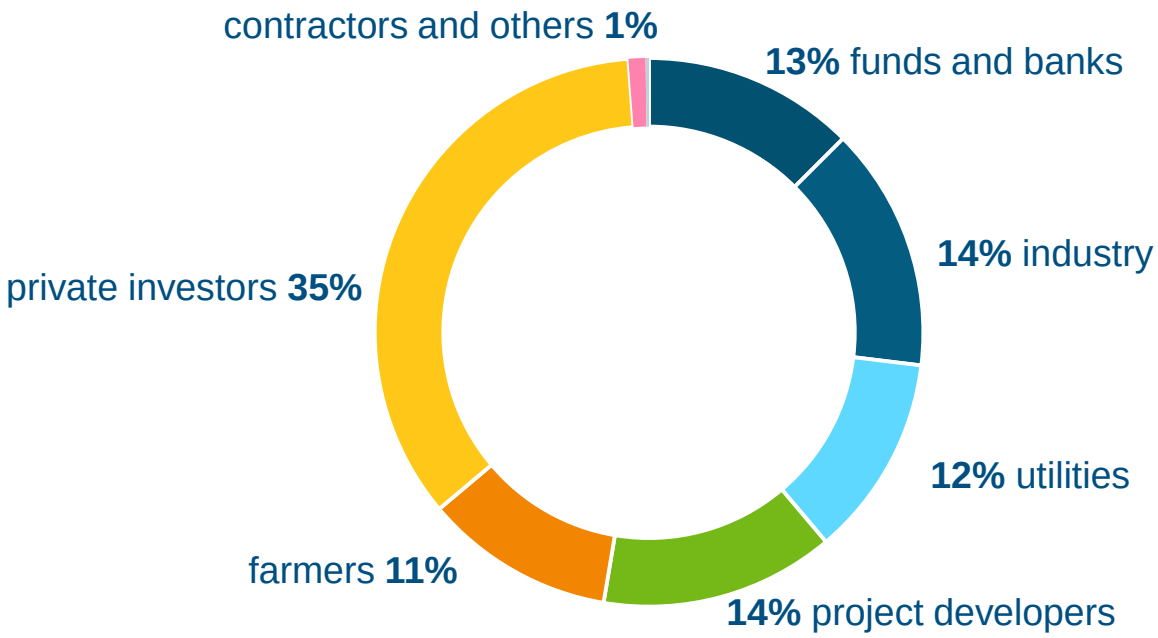
GHG emission savings through renewables use



Source: BMWi AG EE-Stat 2014

In 2014 renewables avoided 152 million tonnes of CO_2 in Germany.

Ownership structure of German RES facilities in 2012



Source: trend:research 2013

Renewable installations create multiple opportunities for new entrepreneurship.

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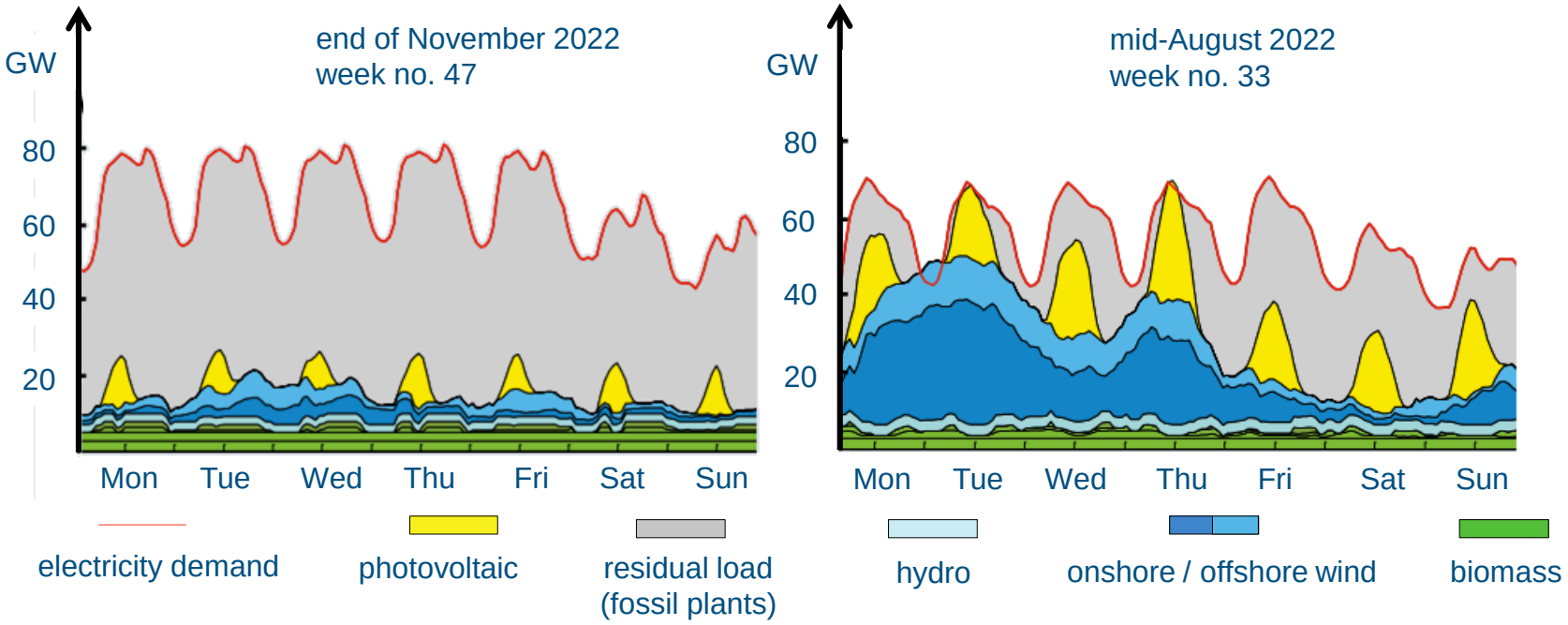
Challenge No.1: New (and smart) Infrastructure

- 2013 Network Development Plan led by Federal Network Agency
  - Identified need for over 3800 km of new transmission (HVDC)
  - Financing mechanisms in development
- Grid Expansion Acceleration Act (NABEG)
- Additional efforts on energy storage:
  - Pumped hydro
  - Power to gas
  - EU electricity grid interconnection
  - Research funding
- Smart Grid and E-Energy pilot communities
- Demand-side management

The Challenge No.2:

German electricity-system volatility in 2022

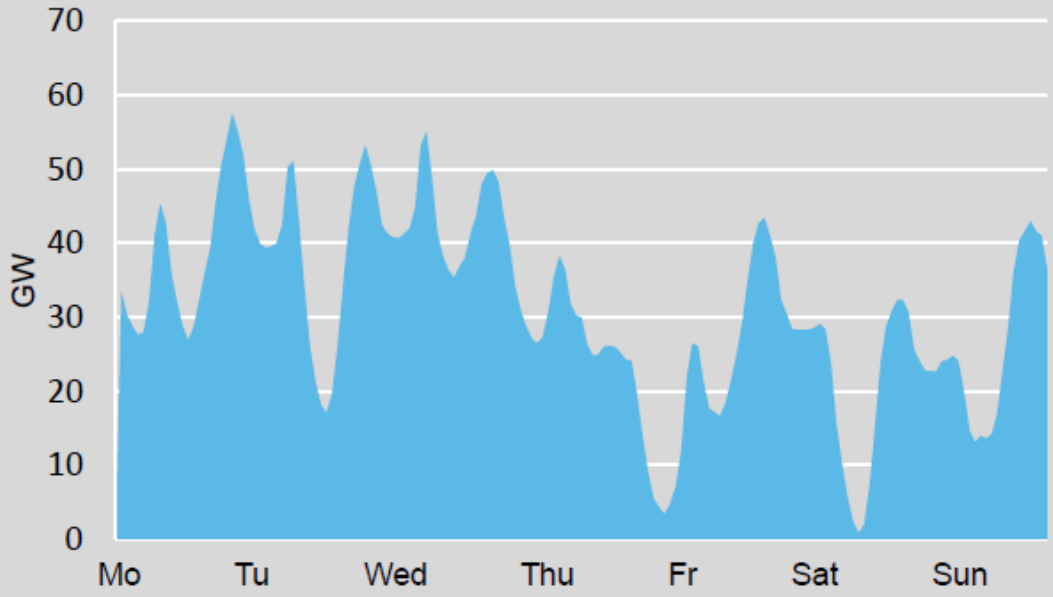


Source: Agora Energiewende 2012

Renewables will partially cover 100% of demand by as early as 2022.

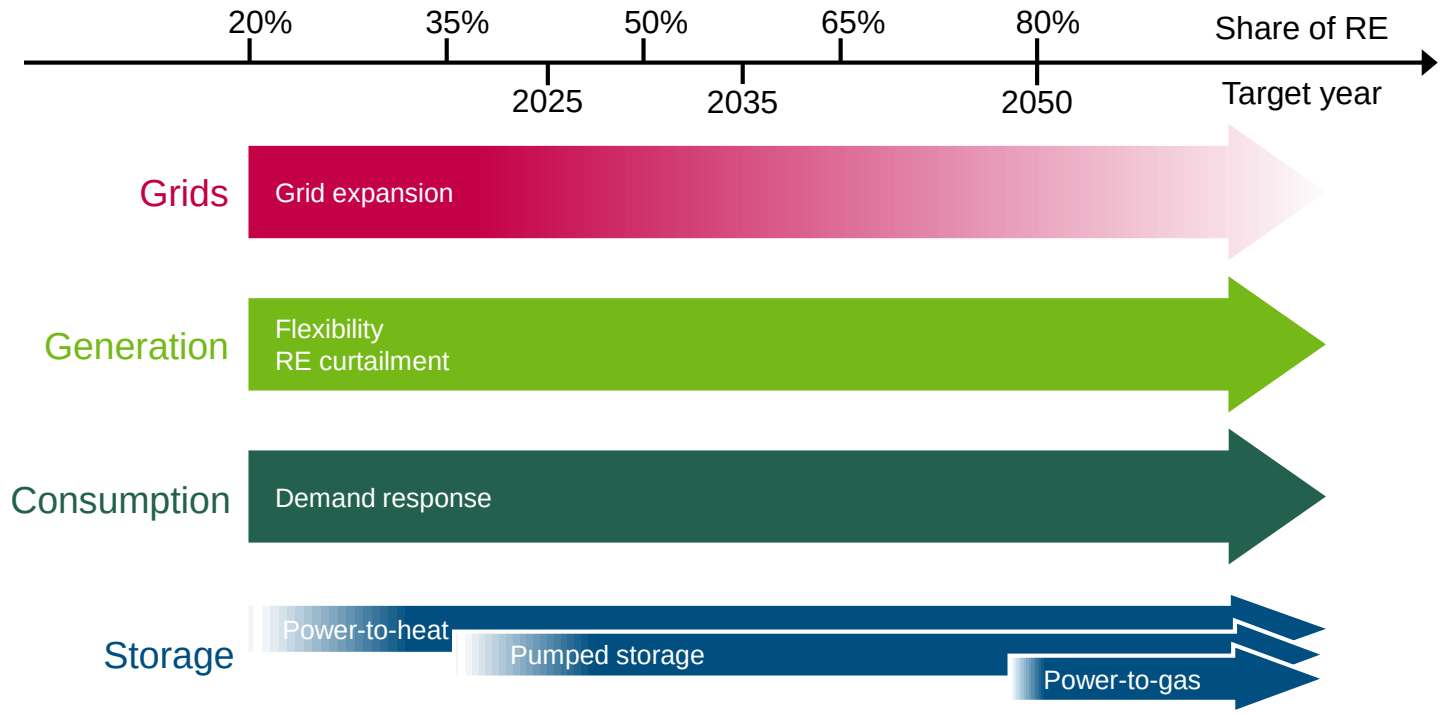
No baseload capacities are needed any more – the fossil power fleet rather needs to become highly flexible

Residual load in a sample week in February 2023 in GW



Agora Energiewende/RAP (2013)

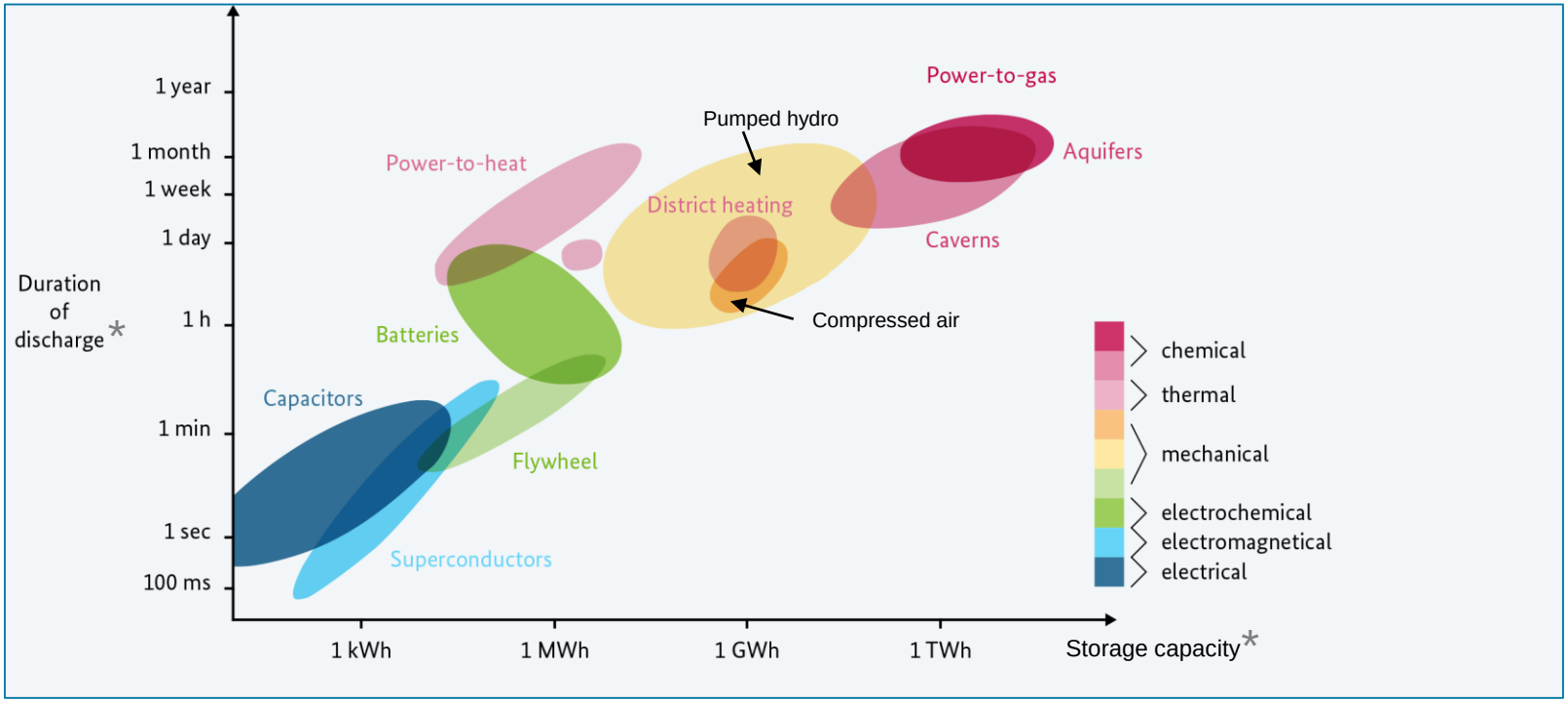
Four areas to increase flexibility



Source: BMU 2012

Different flexibility measures are suitable for varying shares of volatile renewables.

Characteristics of power storage technologies



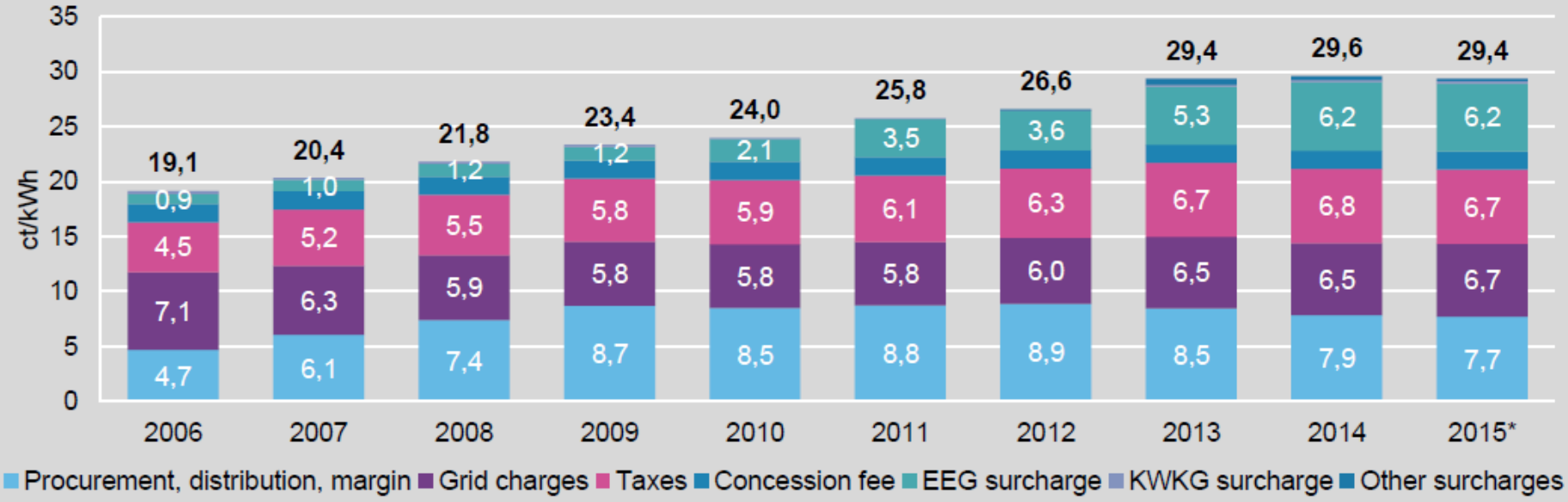
*logarithmic scales

Source: Sterner, Stadler et al 2014

Technologies differ widely in duration of discharge and storage capacity.

In 2015, the rise in household electricity prices will be suspended

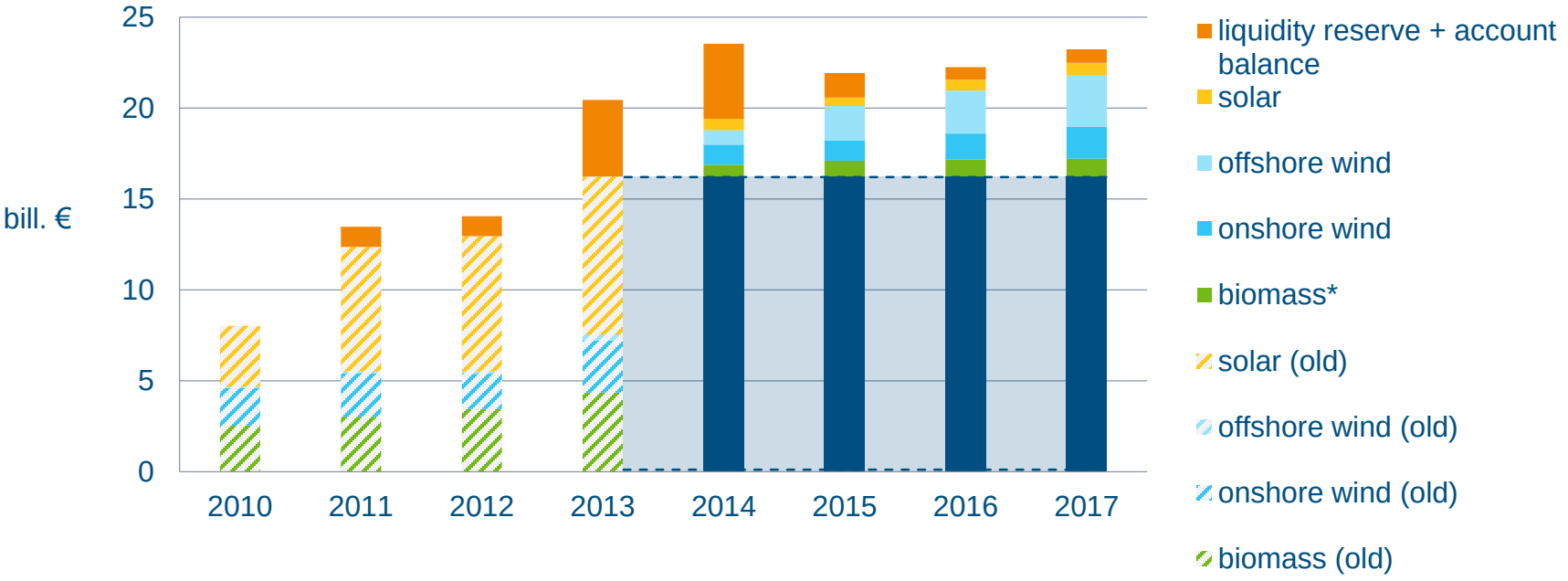
Composition of household electricity prices 2006-2015



BDEW 2014, BNetzA 2014, own calculations;

*Prognosis for 2015

Net feed-in payment trends in Germany



Source: Agora Energiewende / Öko Institut, 2014
** Biomass development "low" scenario*

The main share of payments for renewable electricity goes to existing plants. New installations account for a much smaller share.

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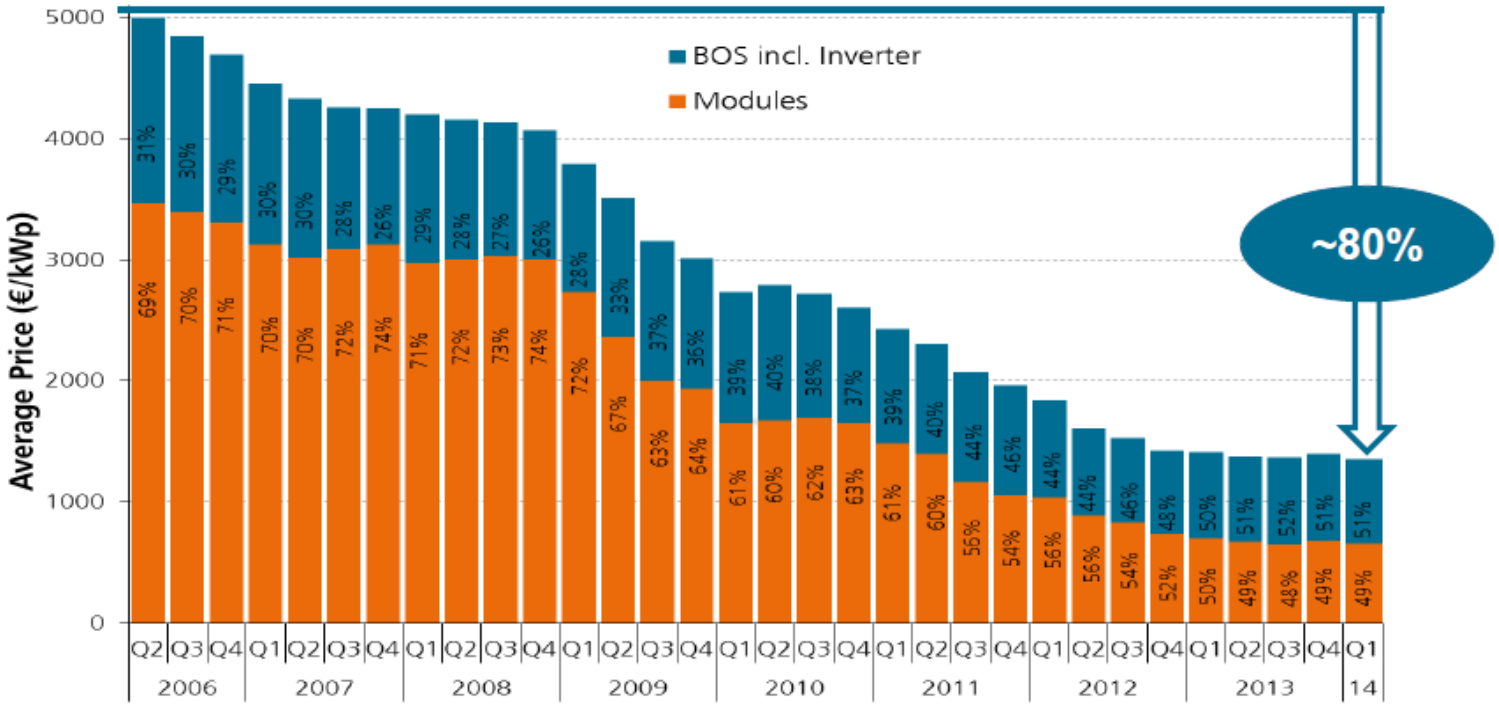
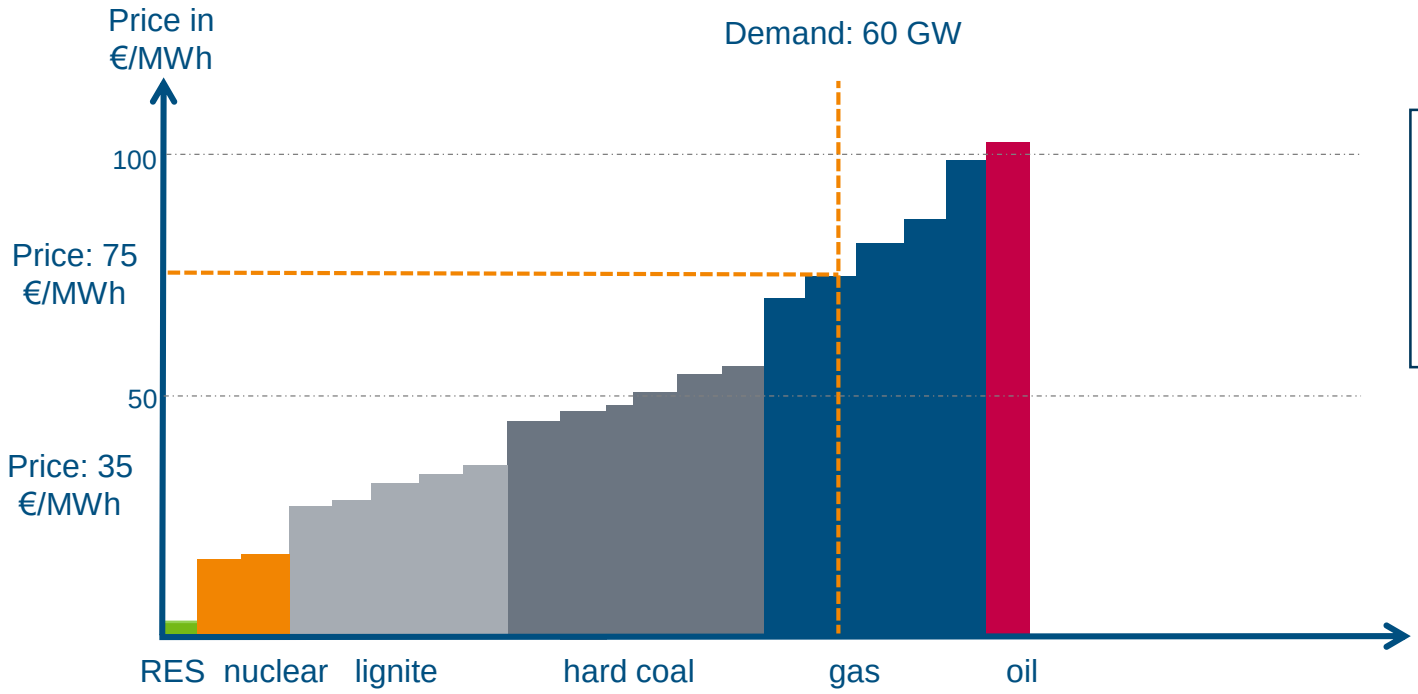
Average price of rooftop PV systems in Germany



Declining module costs in particular have driven down PV system.

Source: Fraunhofer ISE 2014 based on data from BSW

Wholesale market pricing with merit order



Merit order (stylised)

The price is determined by the cost of the marginal technology.

Source: TU Wien, DIW Berlin, 2013

Renewables shift the merit order and lower price levels.

Costs and benefits of renewable energy sources

Distribution benefits
- Reduced electricity market prices (merit order effect)
- Local added value

Macroeconomic benefits
- More jobs created in the renewables sector than jobs lost in conventional sect.
- GDP effect: reduced power market prices
- Avoided fuel imports

Systemic benefits
- Avoided environmental damage
- Portfolio effect: more diversity

Distribution burden
- Difference costs electricity
- Public support spending

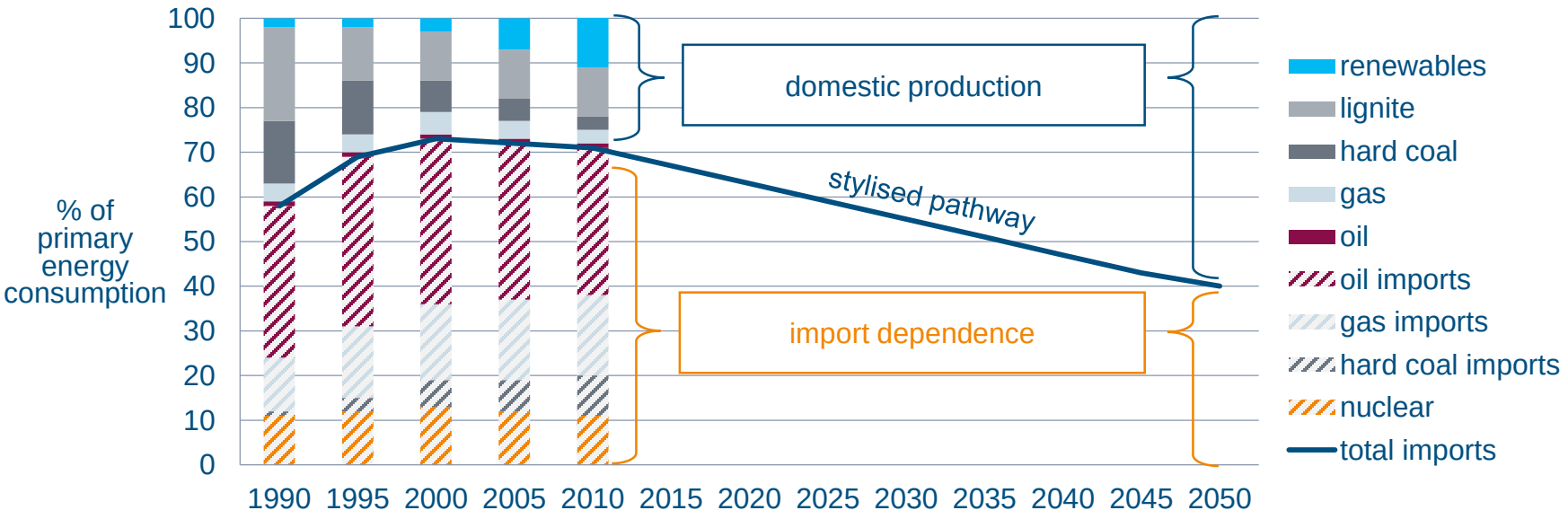
Macroeconomic burden
- Less jobs in conventional energy sector
- Increasing energy prices for end-users

Systemic costs
- Transaction costs: public support costs
- Balancing energy, grid extension costs
- Difference costs

Source: Fraunhofer ISI, DIW, GWS & IZES (2013)

The benefits of a more sustainable energy supply outweigh the costs.

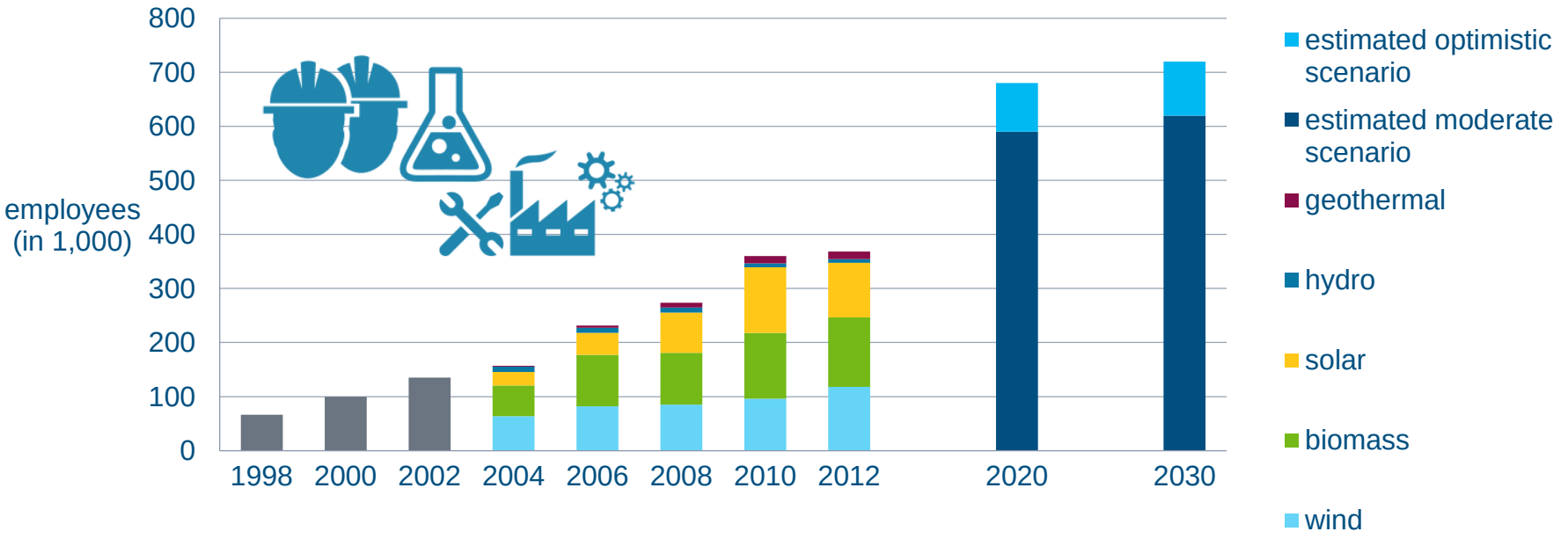
Energy imports and domestic production in Germany



Source: BMWi 2013

Renewables reduce Germany's energy dependence.

Job creation in the German renewables sector



Source: adelphi 2013, DLR/DIW/ ZSW/GWS 2013, BMU 2012

The renewables sector will grow to around 600,000 jobs in 2020.

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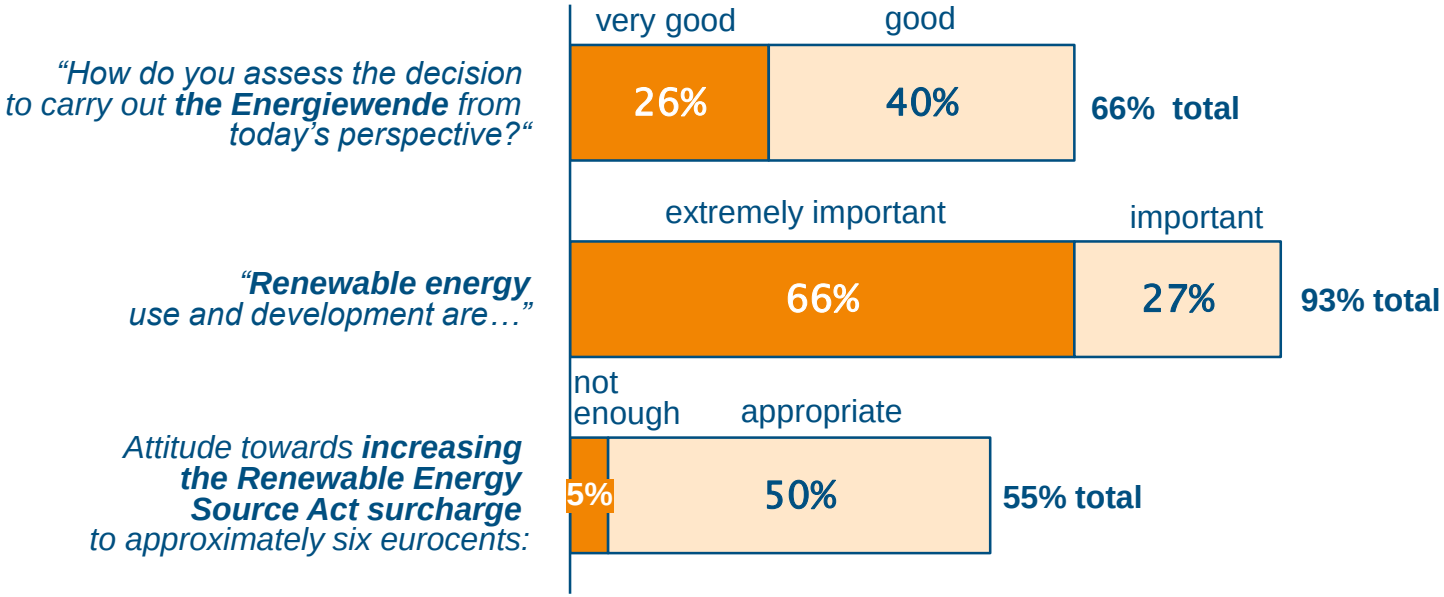
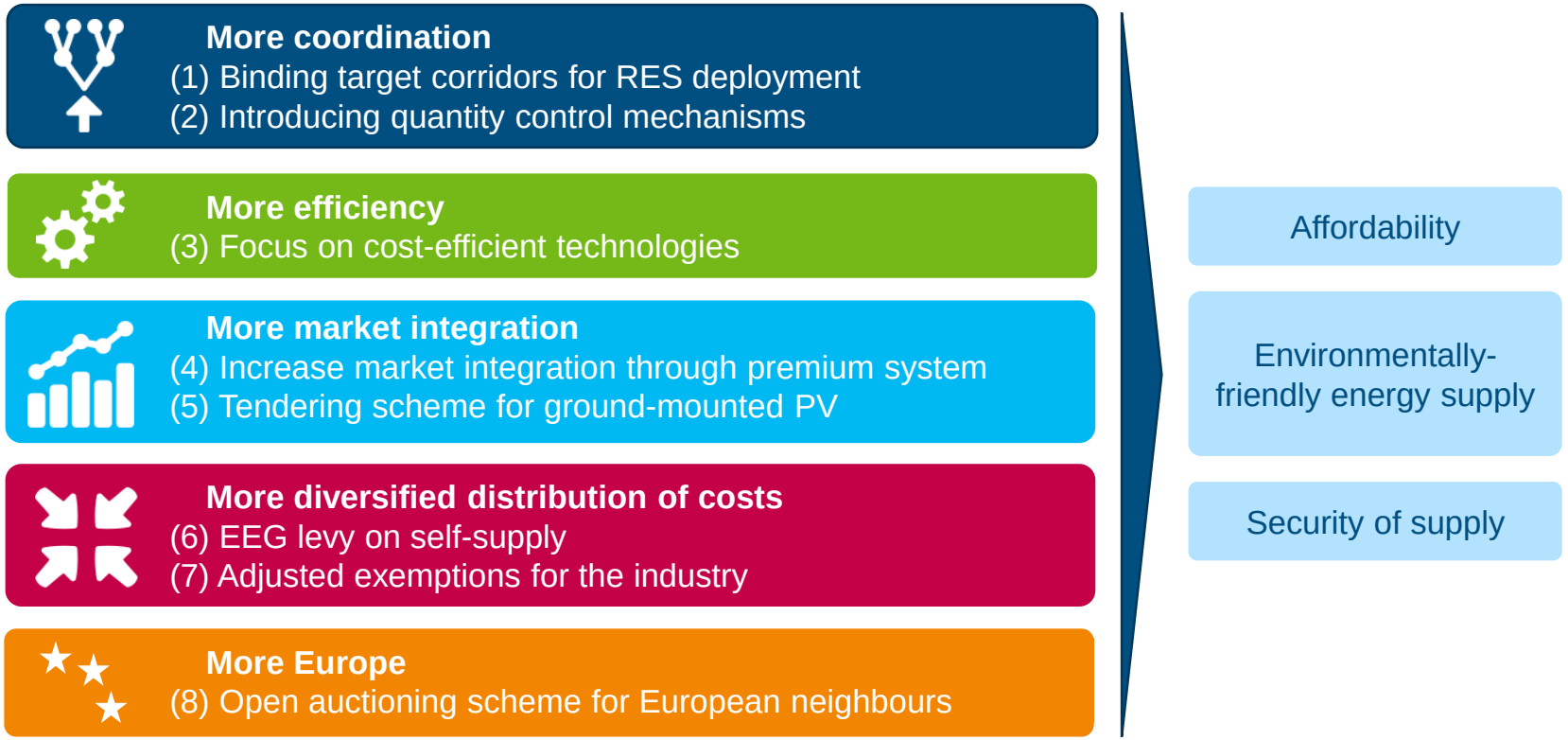
Public acceptance of the *Energiewende*



Source: Infratest 6/2012, 9/2013

The German public broadly supports the Energiewende.

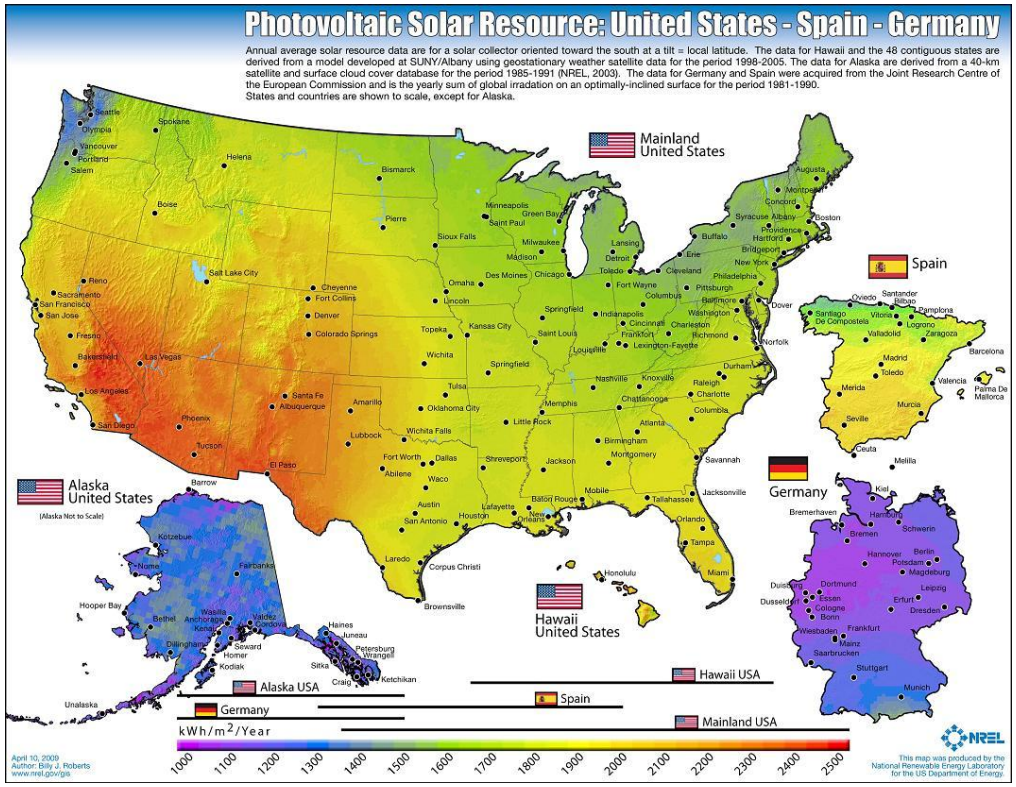
Renewable Energy Sources Act Amendment 2014



Summary

- The German energy transformation is a concrete programme and it is happening.
- Renewable energy generation will be led by wind and solar power.
- Grid expansion and integration, more flexibility solutions (incl. storage) are required within Germany and across Europe.
- The restructuring offers numerous economic opportunities (for new and existing industries).
- The implementation will be monitored regularly.

Thank you for your attention!



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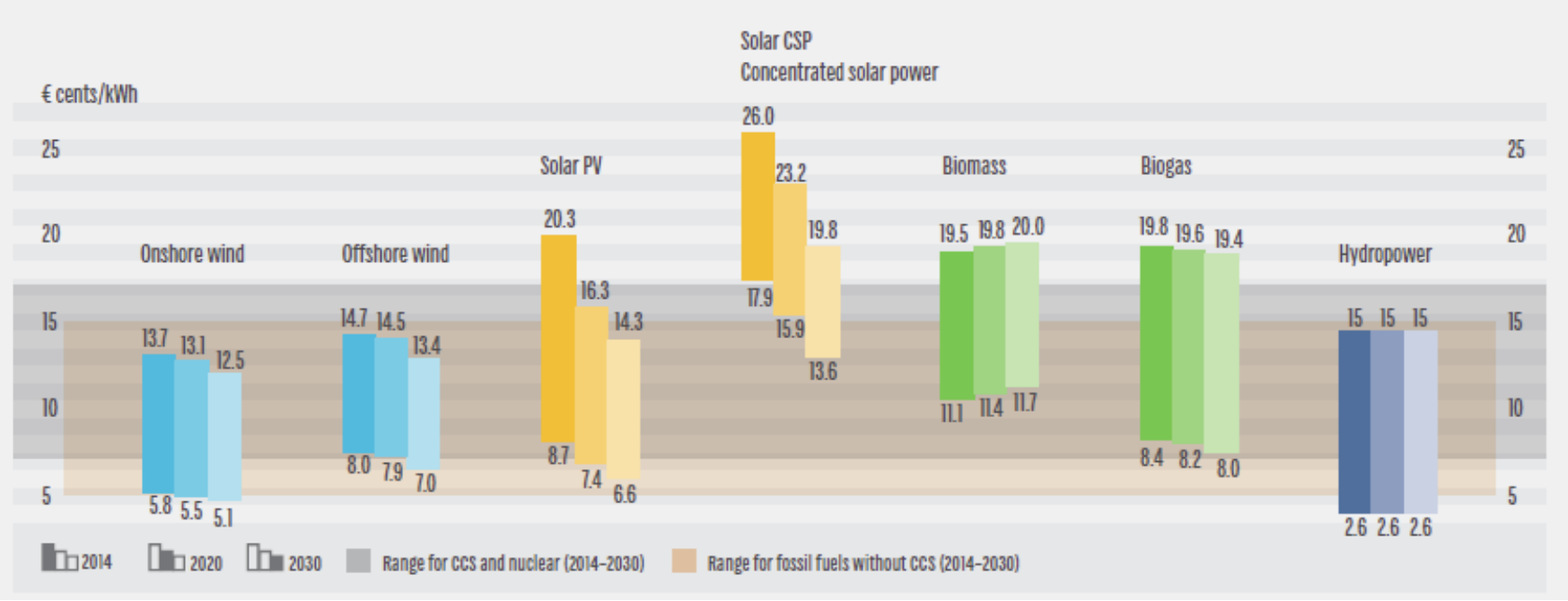
Levelised cost of electricity in Europe 2014, 2020, 2030

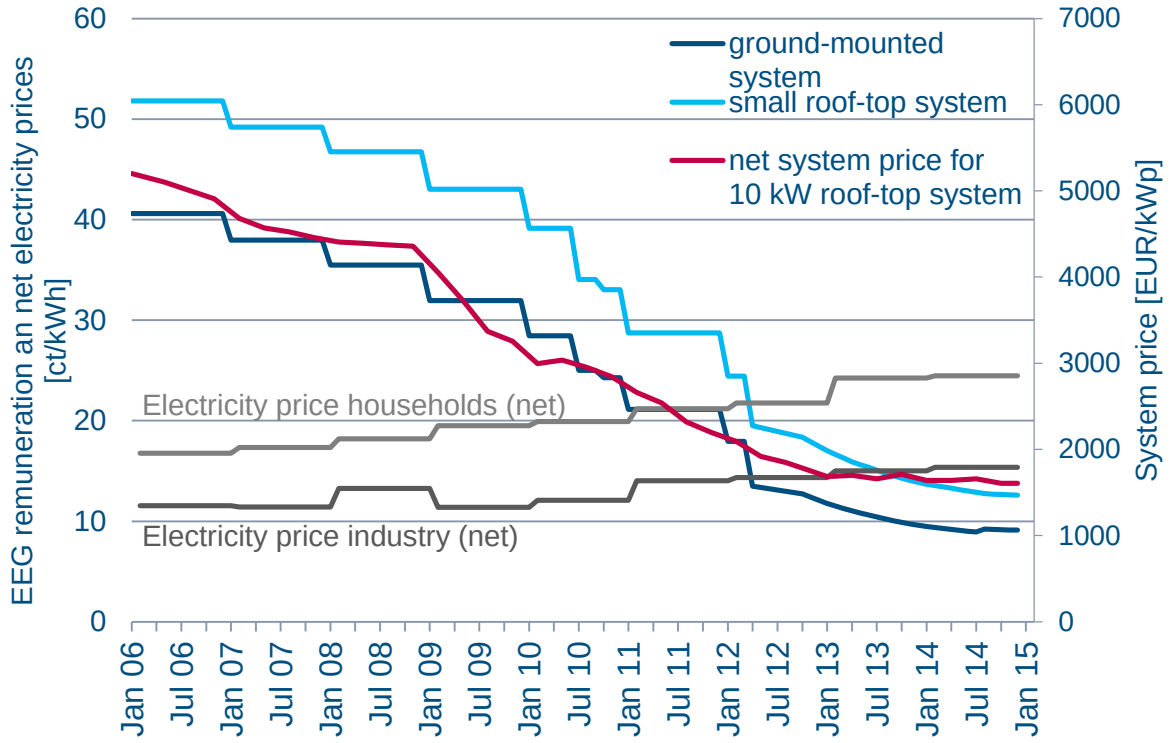


Source: Fraunhofer ISI 2014

Many technologies can already compete with conventional powerplants, onshore wind in particular.

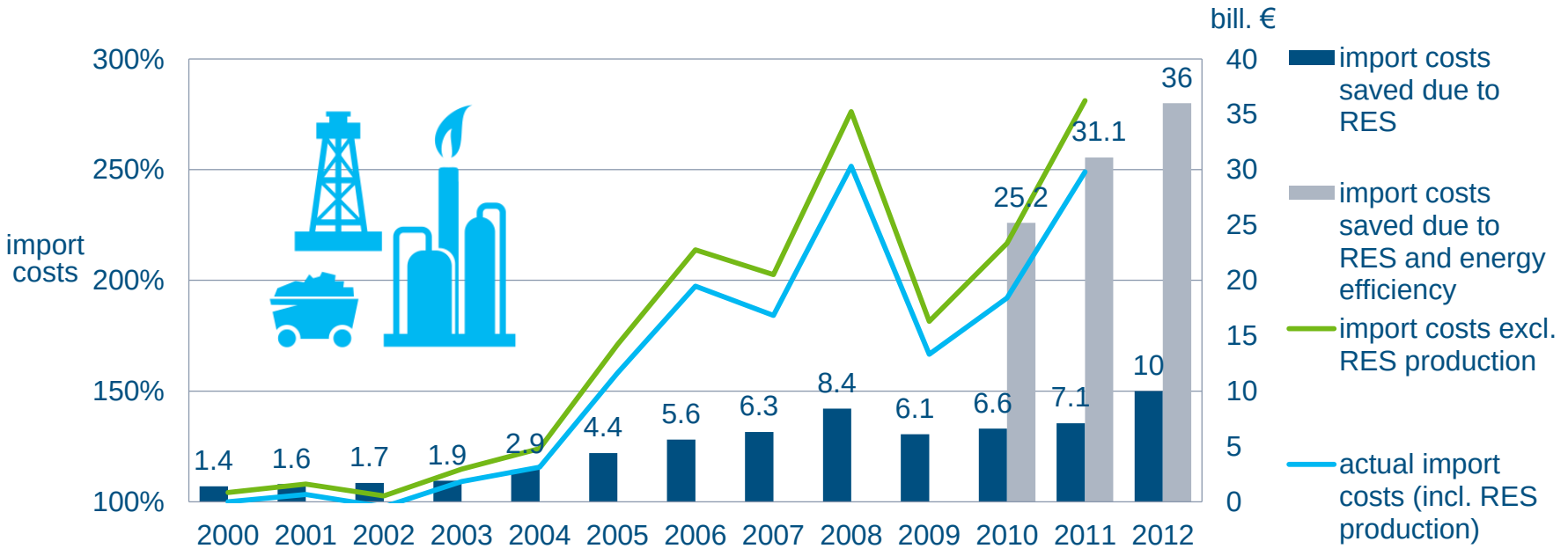
(3) PV support costs decline steadily

Support levels solar energy (Cent/kWh)	January 2006	March 2014
Roof-top installations		
< 10 kW	51,80	12,59
< 40 kW	51,80	12,25
< 100 kW	49,28	10,59
Large installations	FiT	FiP
< 1000 kW	48,74	11,26
< 10 MW	48,74	9,05
Ground-mounted	40,60	tendered



Source: EEG 2014 (Draft, 26.06.2014), BSW 2013, 2014, BMWi 2013

German energy imports cost trend



Source: BMU 2013, BMWi 2014

Renewables save Germany billions in import costs for fossil fuels.

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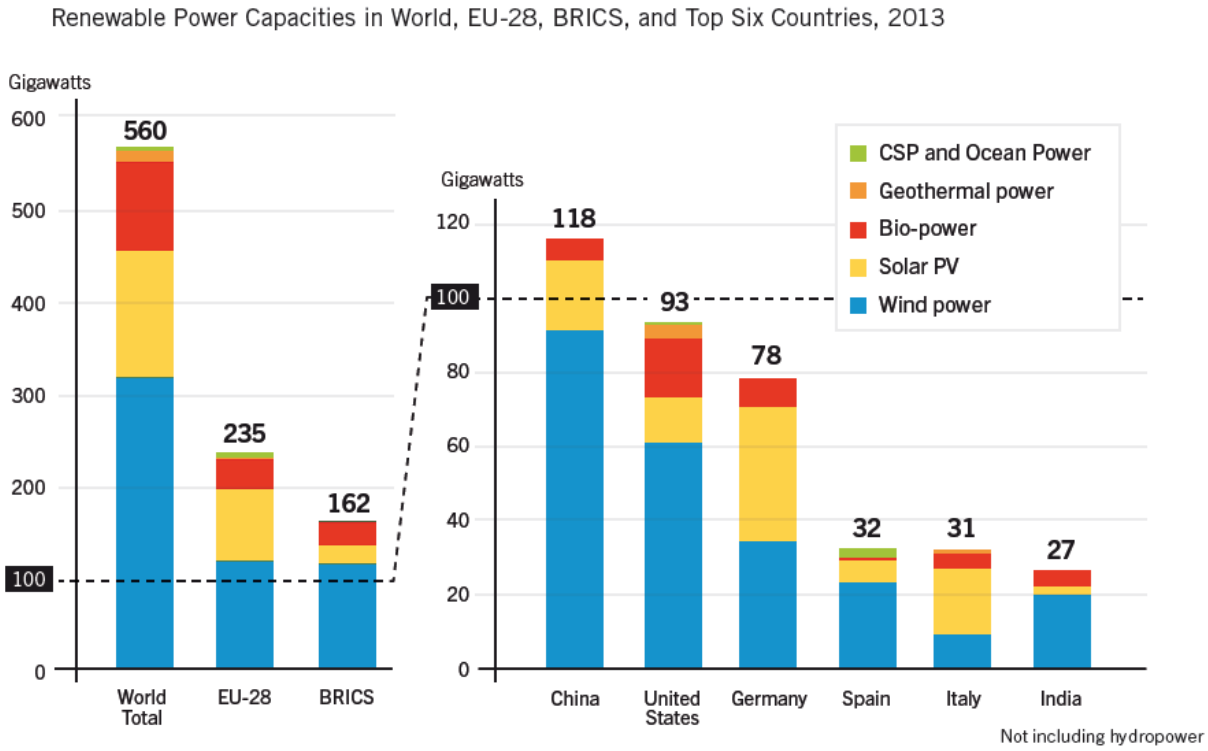
(3) Technology specific support levels EEG 2014

	Corridor	Remuneration in ct/kWh	Degression
Hydropower	-	3,50 – 12,52	-0.5 %/a from 2016
Landfill, sewage and mine gas	-	3.80 – 8.42	-1.5 %/a from 2016
Biomass	100 MW (gross)	5.85 – 23.73 (dependent on fuel and size)	-0.5 % every three months from 2016
Geothermal		25.20	- 5.0 %/a from 2018
Wind energy onshore	2,400 – 2,600 MW (net)	Standard tariff: 8.90, for at least 5 years; Minimum 4.95	-0.4% every quarter from 2016
Wind energy offshore	-	Initial tariff: 15.40 for min.12 years; Option: 19.40 for min. 8 years if installed before 2020 Minimum 3.90	Standard tariff: - 0, 5 ct/kWh in 2018, 1 ct/kWh in 2020 - 0,5 ct/kWh/a 2021; Option: - 1 ct/kWh in 2018
Solar energy (PV)	2400 – 2600 MW (gross)	9.05 – 12.89 (and tenders for ground-mounted PV)	-0.5 % per month from 09/2014

Source: Renewable Energy Act 2014 (Draft, 26.06.2014)

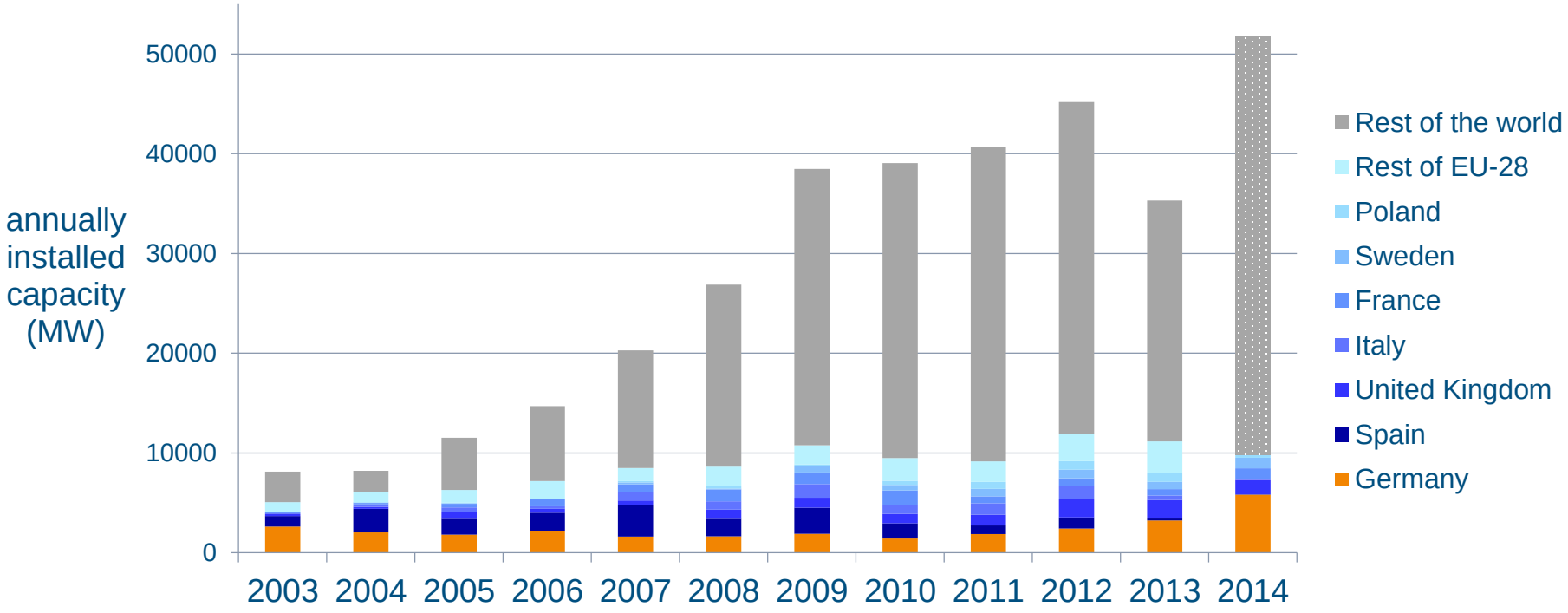
Renewable power capacities worldwide



Source: *REN 21 2014*

After hydropower, wind is the leading renewable source. Its main market is China.

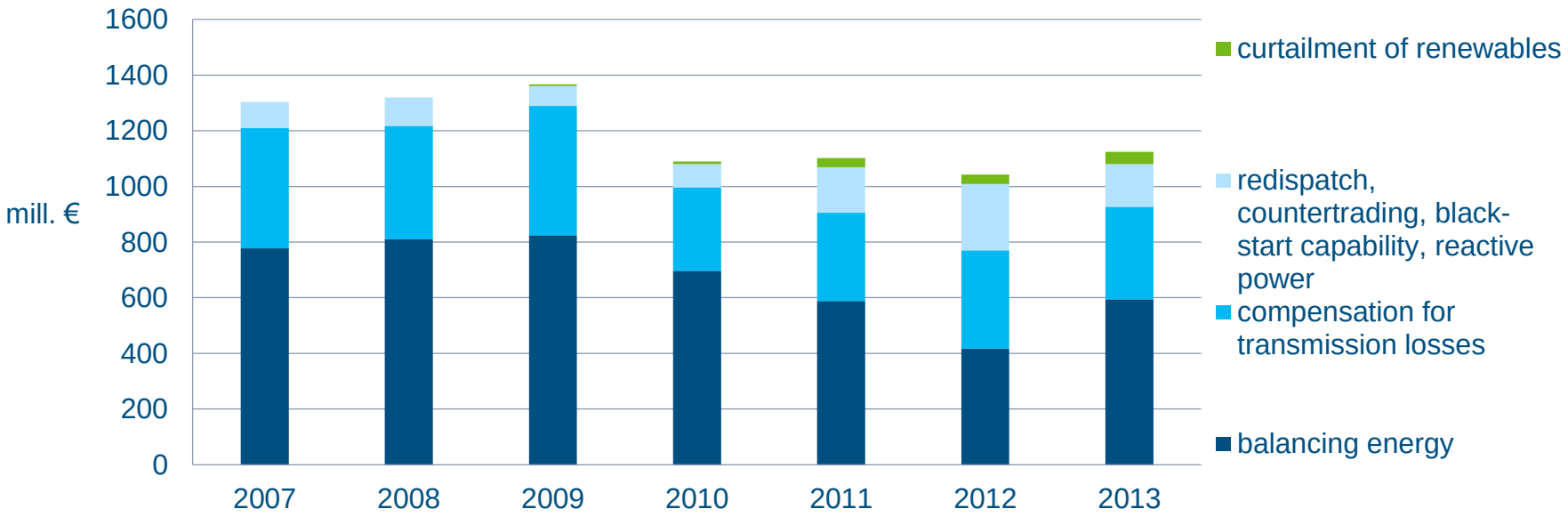
Wind market development worldwide



Source: OECD 2013, GWEC 2014, WWEA 2015

The German wind market has grown steadily, while other European markets have experienced highs and lows.

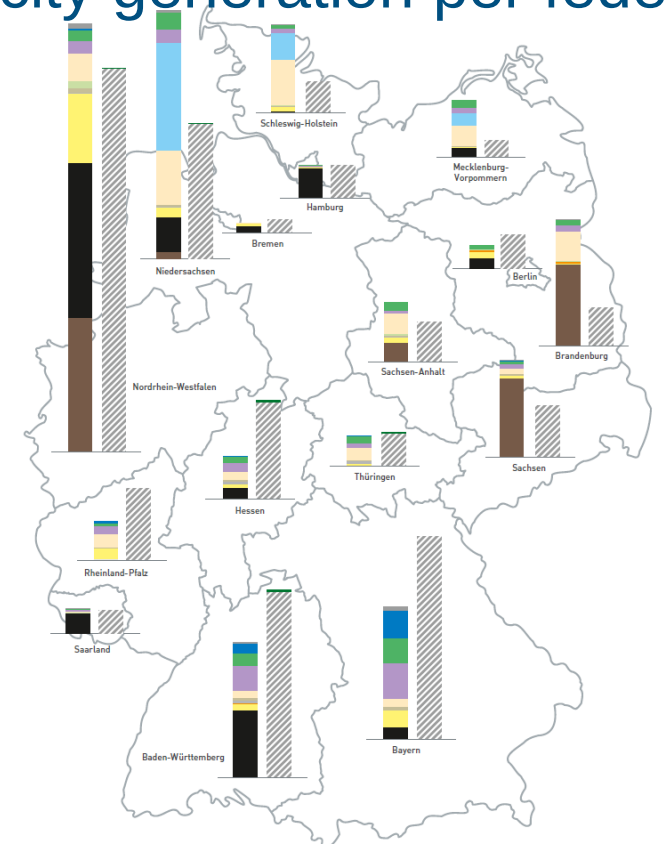
Costs of balancing measures to ensure grid stability



Source: BMWi and BMU 2012, BNetzA and BKartA 2012-2014

System service costs fell despite the energy transition. Better coordination between the four TSOs has reduced costs since 2010.

Electricity generation per federal state in 2023



- Lignite
- Hard coal
- Natural gas
- Oil
- Pump storage generation
- CHP
- Other conventional
- Wind onshore
- Wind offshore
- PV
- Biomass
- Hydro power
- Other renewable
- Demand
- Pump storage consumption

Source: NDP 2013 baseline scenario 2023

Generation capacity in the North will cover demand in the South.

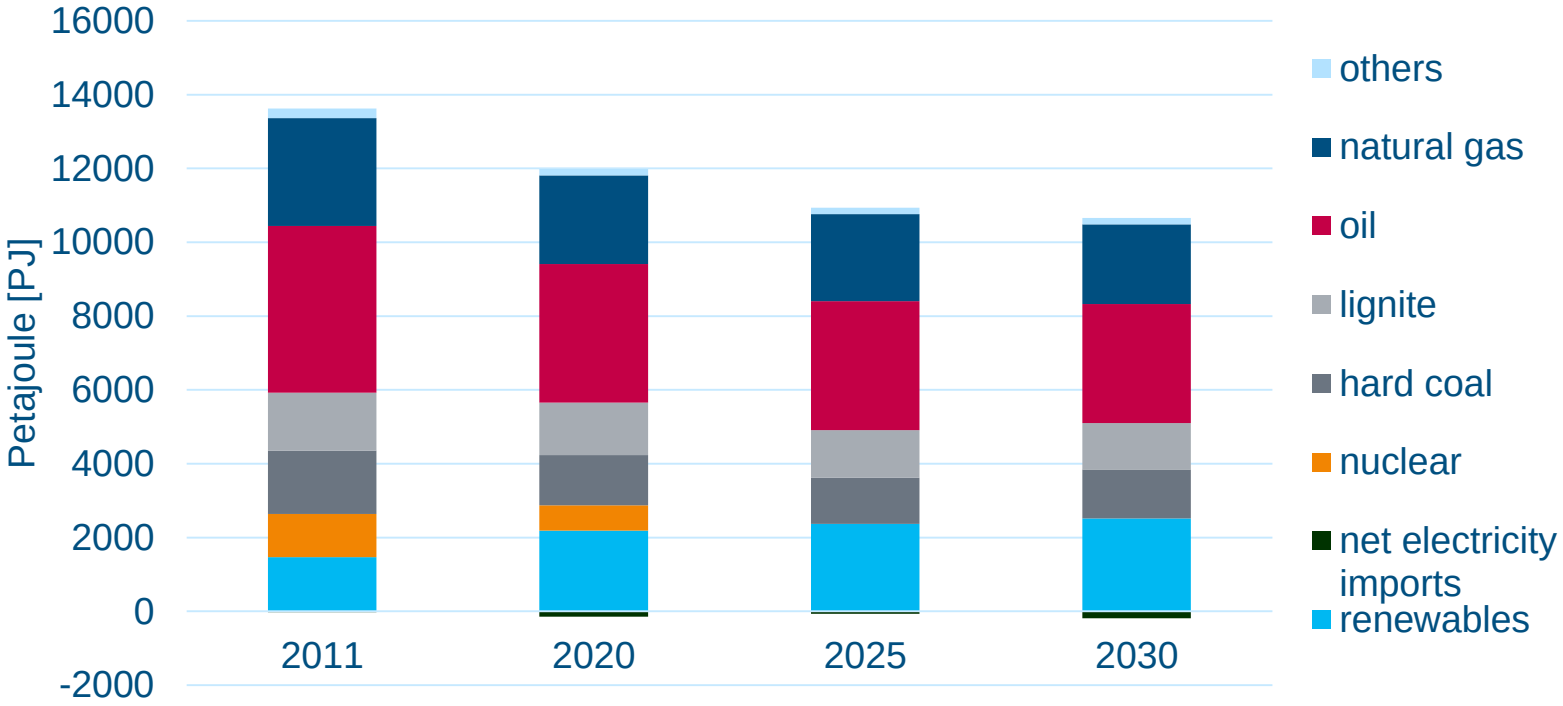
Offshore wind potential

Figures for Germany	Capacity (MW)
In operation (as of June 2014)	628.3
Under construction	approx. 2,300
Electricity generation offshore wind	2012: 675 MWh (June 2014 estimate: 2.5 TWh)
Target	6.5 GW by 2020, 15 GW by 2030

Large offshore wind will support the system as baseload power plants.

Source: Map from Offshore Stiftung 2014, Data BMWI 2014

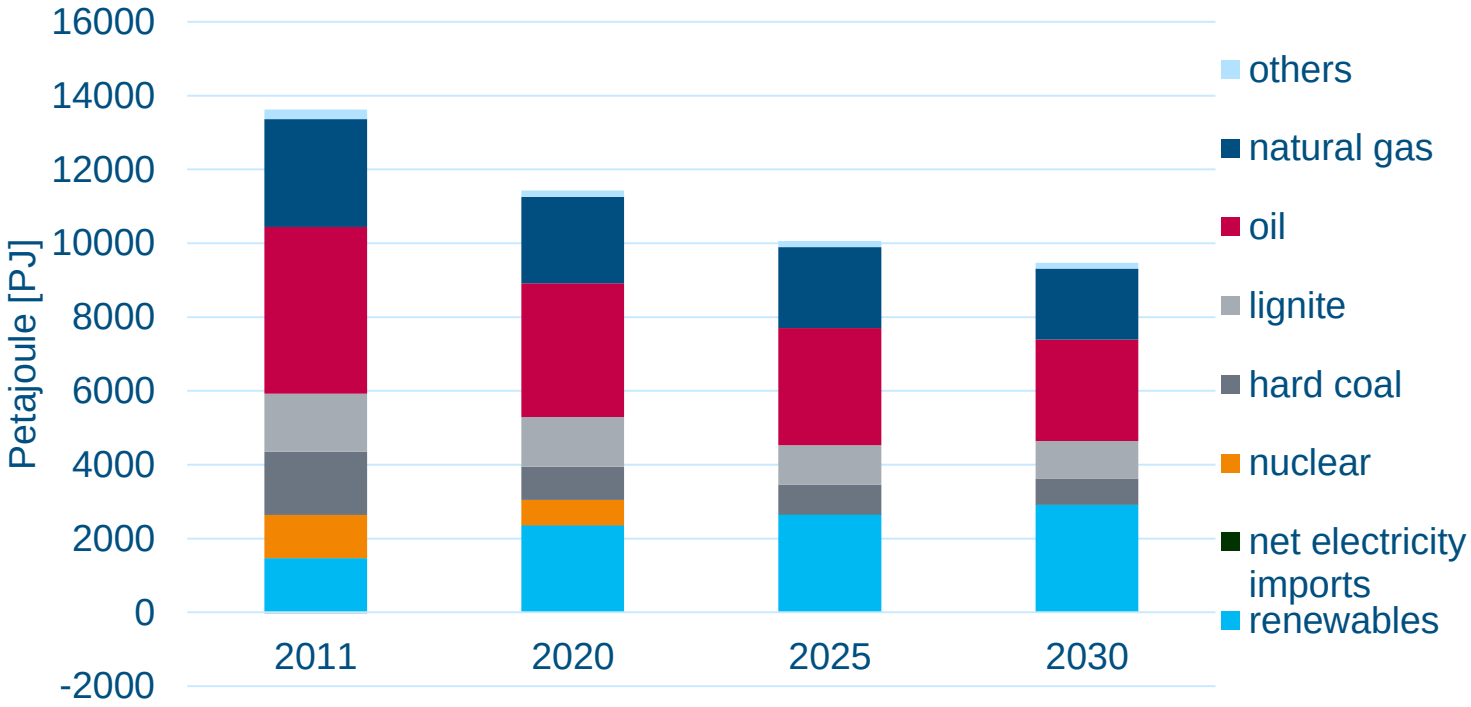
Trends in German primary energy consumption (reference scenario)



Source: Prognos, EWI, GWS 2014

Renewable energies play an increasingly important role in the energy supply.

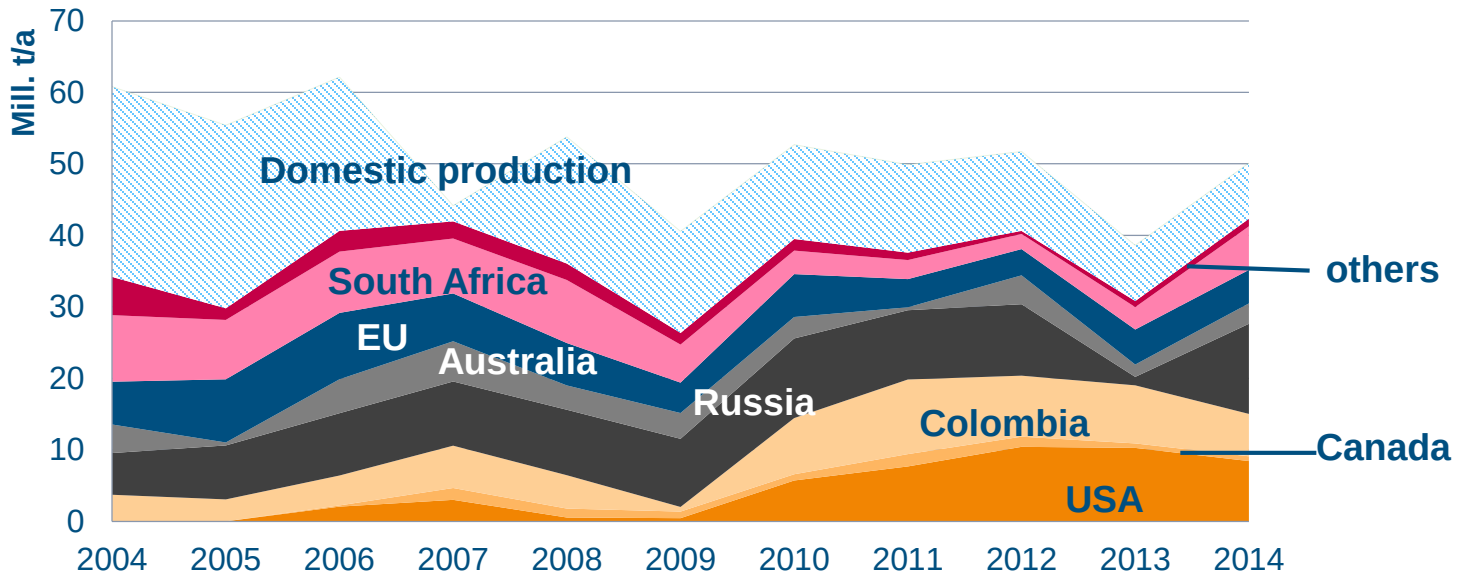
Trends in German primary energy consumption (target scenario)



Source: Prognos, EWI, GWS 2014

Renewable energies play an increasingly important role in the energy supply.

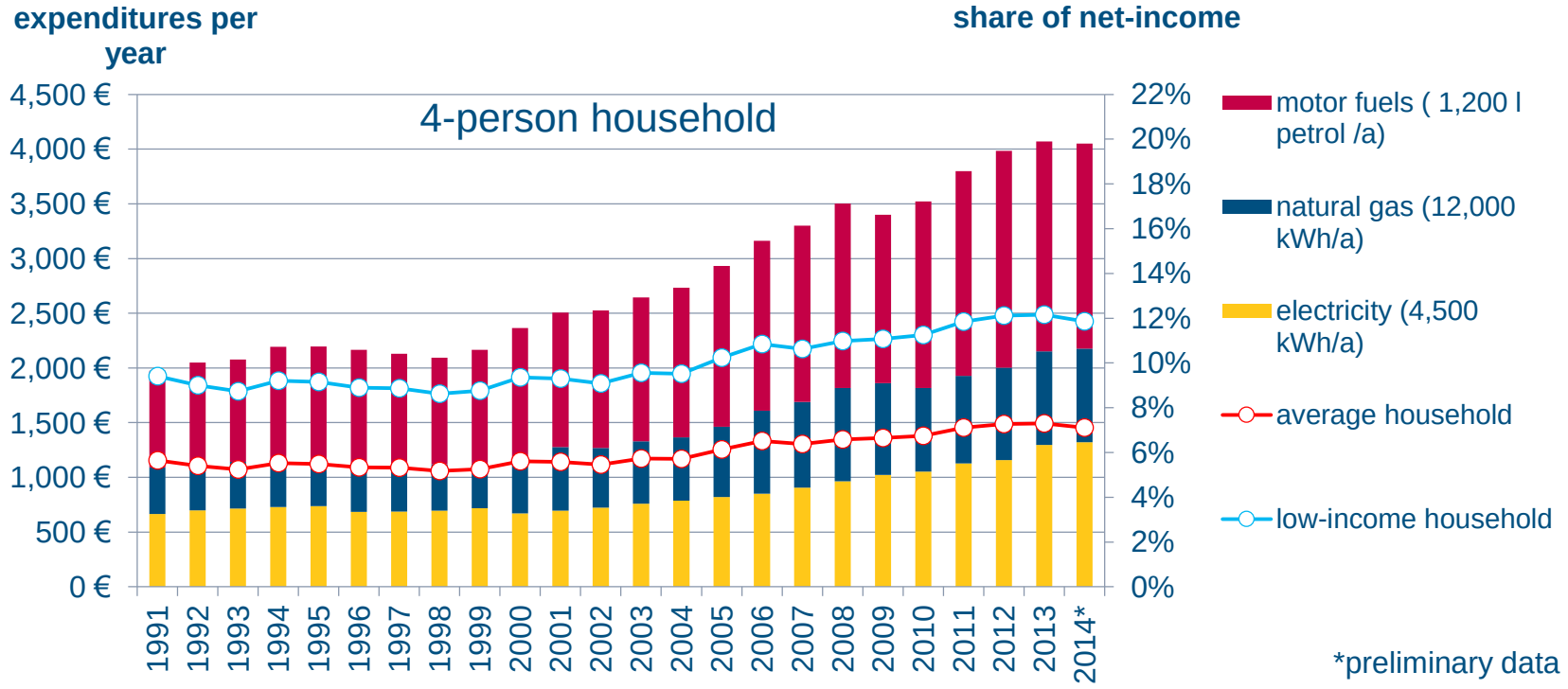
Hard coal suppliers for the German market



Source: Statistisches Bundesamt 2014

Coal imports remain stable while domestic production has declined.

German energy expenditures and shares

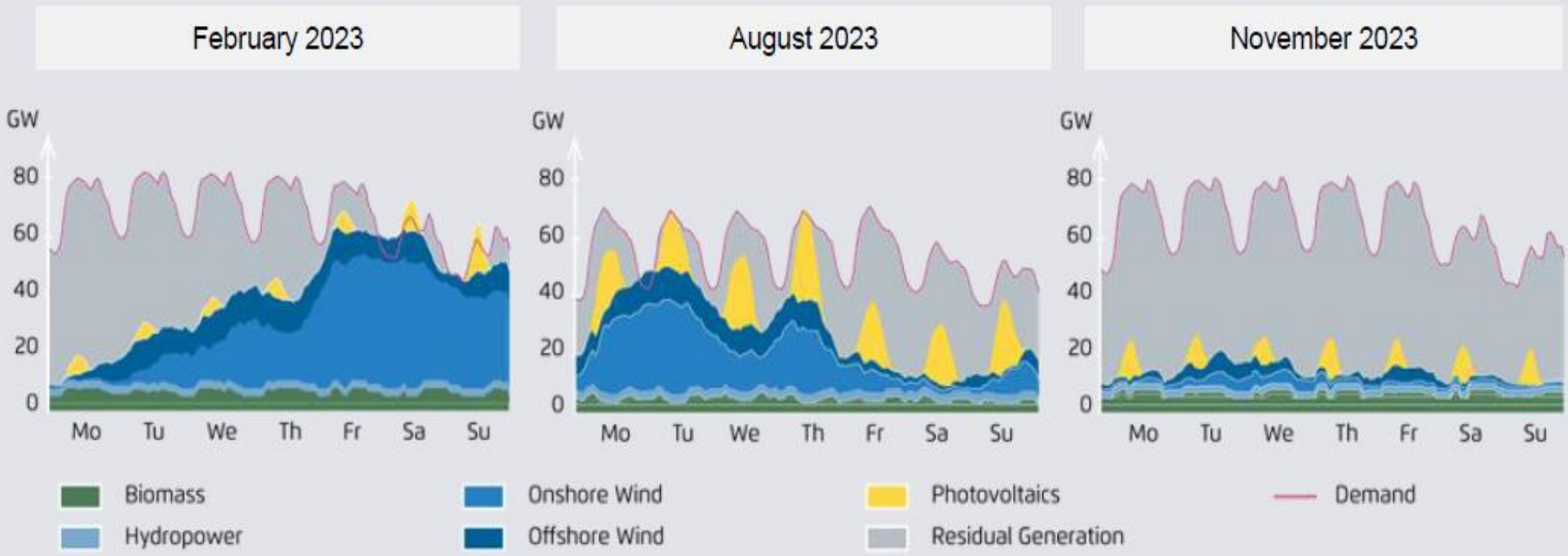


Source: Ecofys 2015 based on BMWi 2014

An average 4-person household spends roughly 7% of it‘s income on energy. Petrol accounts for the the largest share.

Lesson 2: Flexibility is the paradigm of the new power system

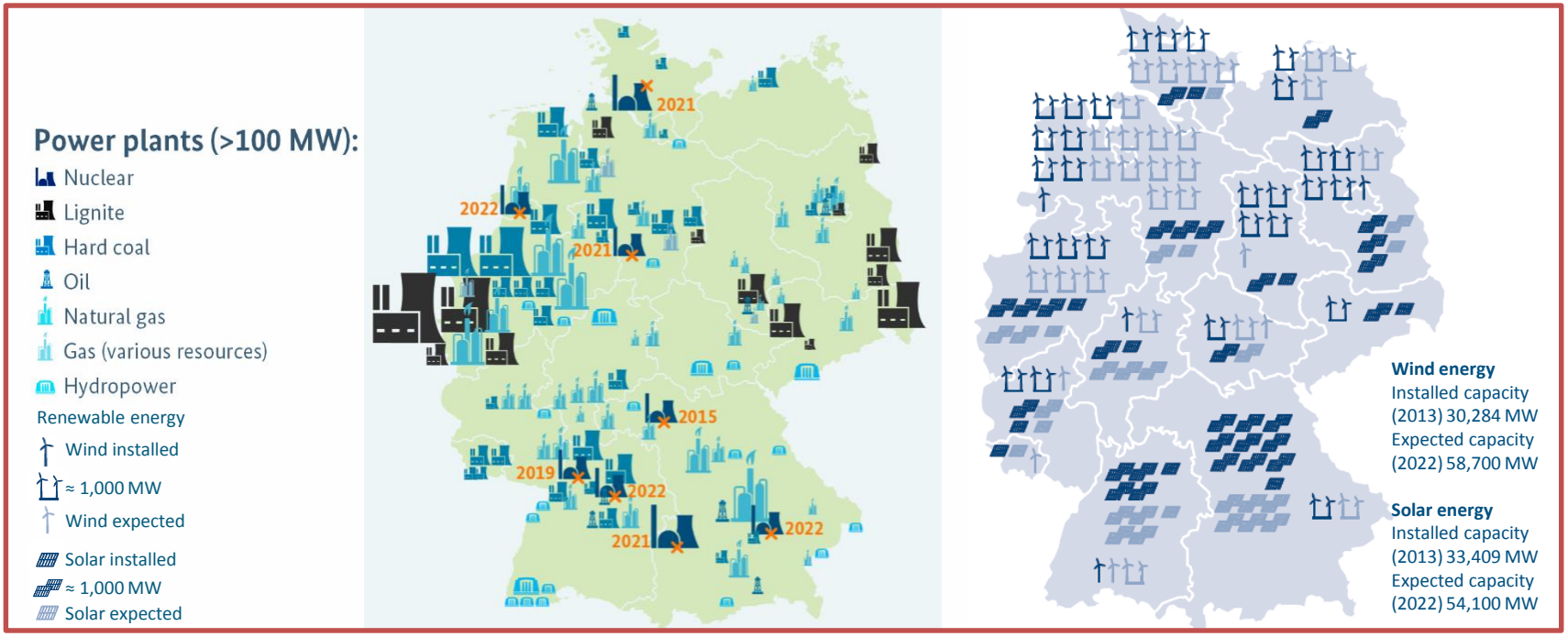
Electricity generation* and consumption* in three sample weeks, 2023



Fraunhofer IWES (2013)

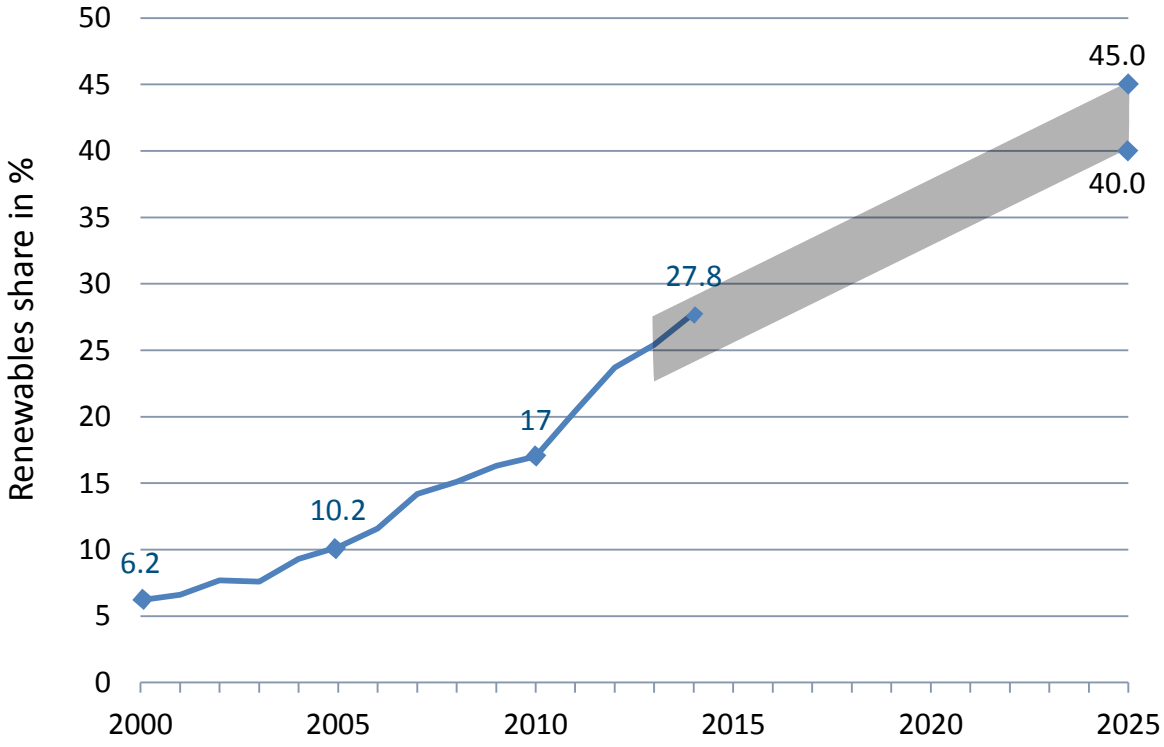
* Modelling based on 2011 weather and load data

German power generation capacities by region



Nuclear phase-out will affect regions to a different extent: High capacity loss in southern and northwestern Germany will be replaced manly by PV, hydropower and biomass in southern Germany and by wind from northern Germany.

(1) Renewables share in gross electricity consumption



Overall **target corridor**

- In 2025: between 40% and 45% RES-E
- In 2035: between 55% and 60% RES-E

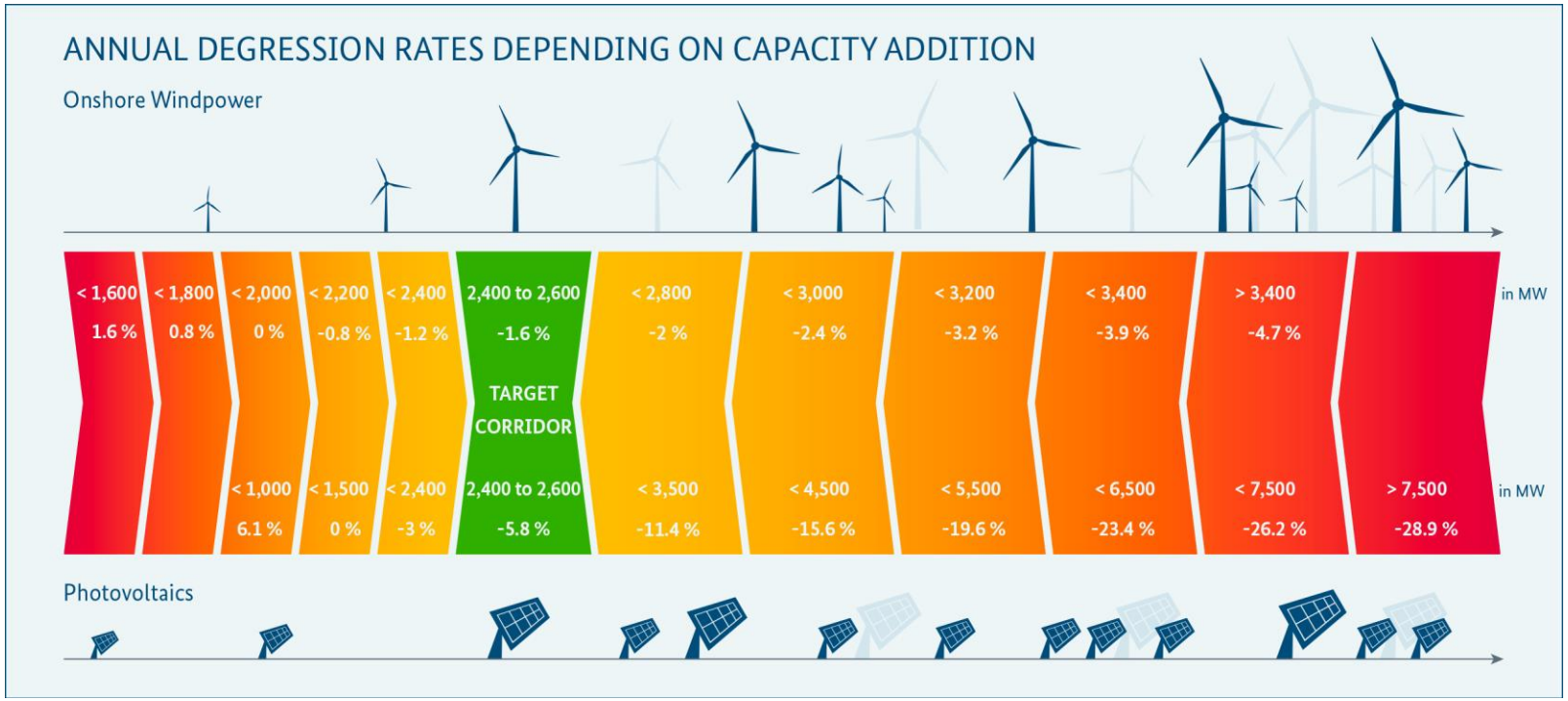
Capacity additions

- **Onshore wind and PV** 2 500 MW (2.5 GW) per year each
- **Bioenergy** 100 MW per year
- **Offshore wind** 6.5 GW by 2020, 15 GW by 2030

Focus on Wind and PV as most cost-effective solutions

Source: BMWi 2014

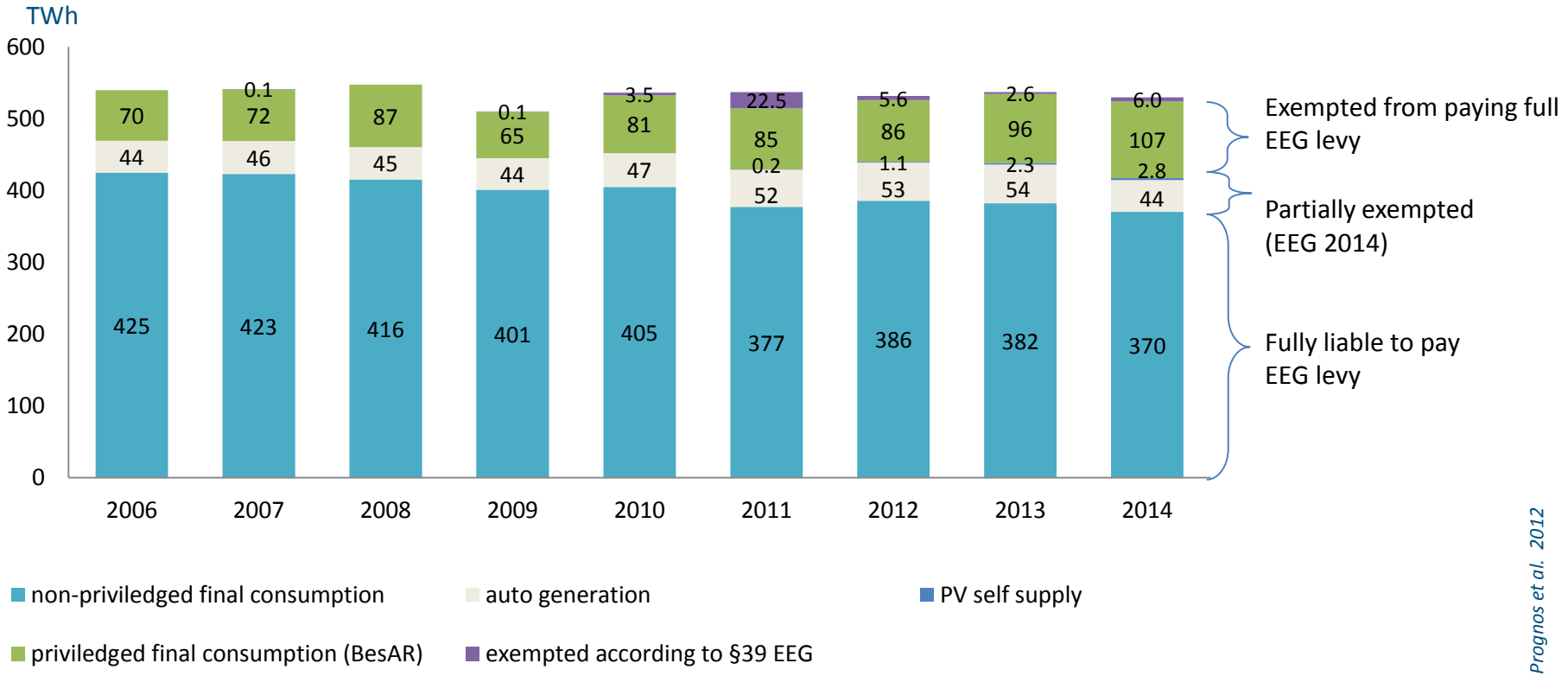
(2) Flexible adjustment of capacity expansion



Source: BMWi 2014

Support levels react flexibly to market development.

Distribution of costs – Final electricity consumption



Source: Prognos et al. 2012

The new EEG also involves those who benefit from the EEG.

(7) Exemptions for energy intensive industries

Eligibility criteria	
Requirement	**Description**
Electricity intensity	Companies that work in one of the electricity-intensive sectors registered in the EU wide “list 1”
International trade	Additional sectors prone to international competition as featured in „list 2“ of the EU Commission
Electricity cost intensity	• List 1: required electr. cost intensity of 16-17% • List 2: required electr. cost intensity of 20%

Support scheme
• **Minimum contribution:** full EEG surcharge for the first GWh • **Price:** In principle, 15% of the EEG surcharge, cap at 0,5 % / 4% of gross value added, but at least 0.1 ct for every kWh beyond 1 GWh

The adjusted compensation scheme follows the EU Commission guidelines.

Fact-Check for some Myths around the Energiewende (1)

- Does Germany need to import electricity after shutting down 8 NPP?
- Does Germany face outages with rising RE and less NPP?
- Does Germany have to use more coal to compensate for NPP?
- (Industry) Studies from 2011 predicted negative effects on German GDP due to increase in wholesale electricity prices, CO2 prices. Did that happen?

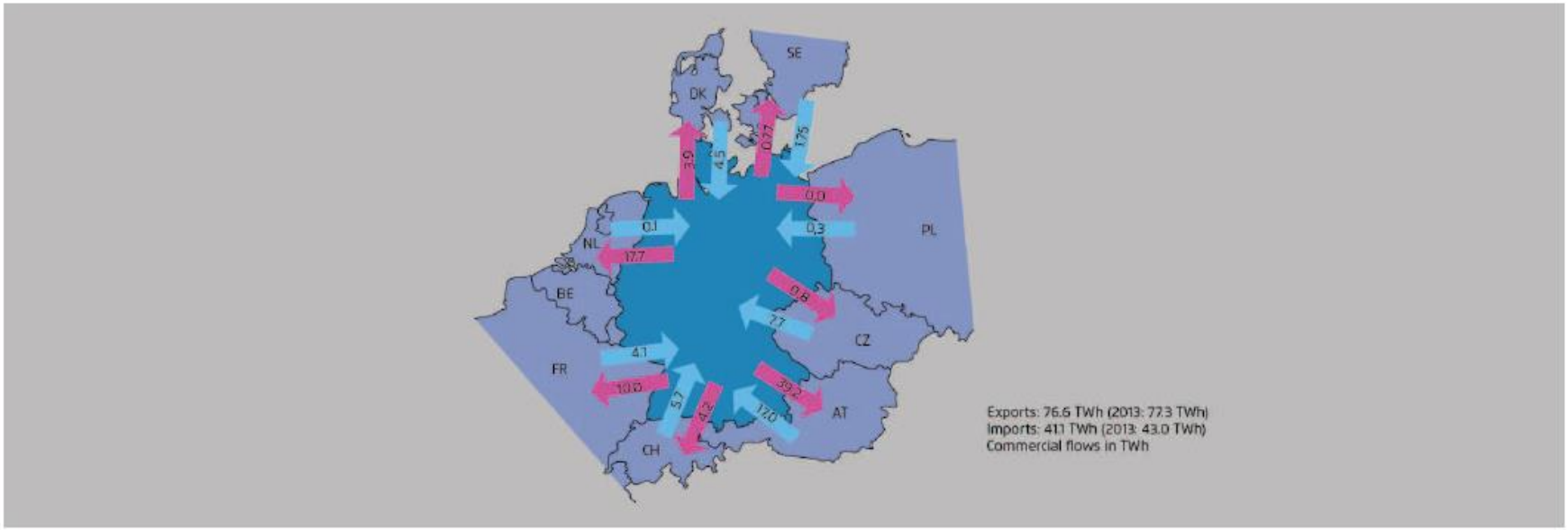
Electricity import and export balance (load flow)

No! Germany rather exported (net) more electricity than ever (in 2014 net export added up to 35 TWh = 6 % of total production.)

In 2014, Germany set a new record in net power exports – especially the Netherlands, Austria and France have been importing power due to lower German wholesale prices

Agora Energiewende

Cross-border power trades in TWh



Own calculations based on ENTSO-E 2014; commercial trade flows, not displaying physical power flows

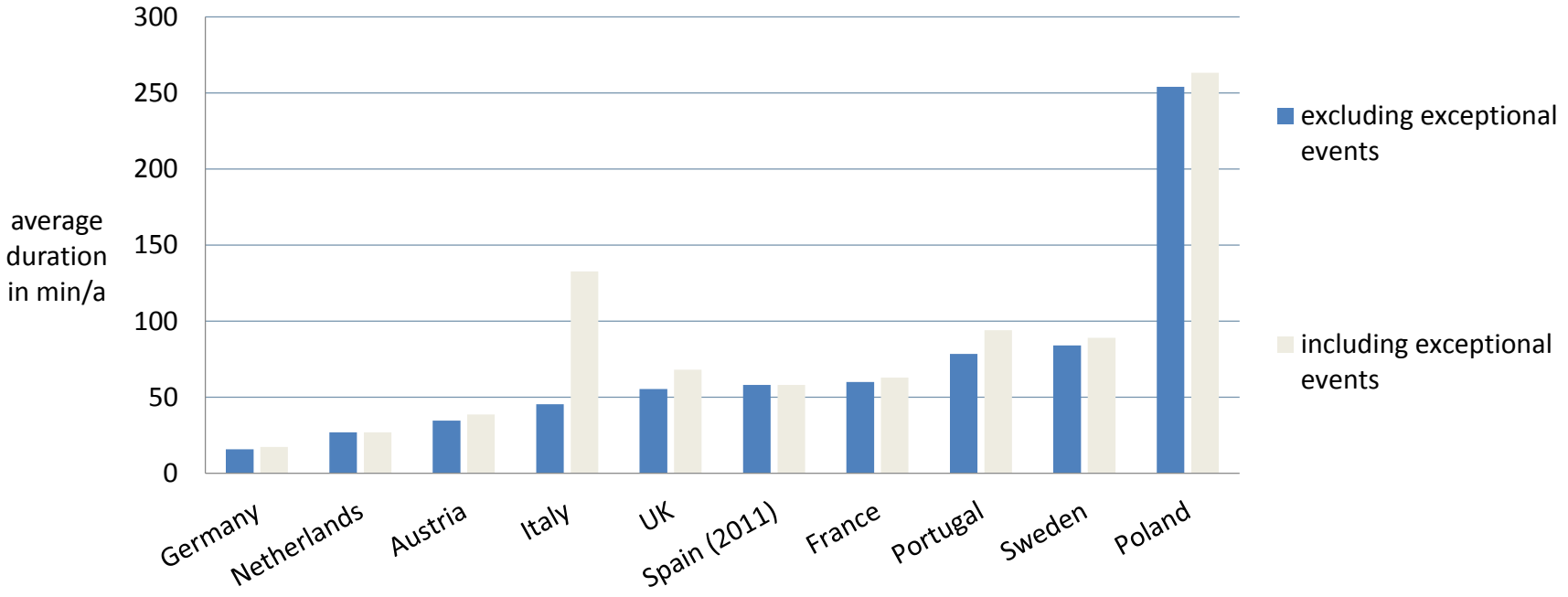
Source: Agora Energiewende 01 July 2014

Transatlantic Climate Bridge

Fact-Check for some Myths around the Energiewende (2)

- Does Germany need to import electricity after shutting down 8 NPP?
- Does Germany face outages with rising RE and less NPP?
- Does Germany have to use more coal to compensate for NPP?
- (Industry) Studies from 2011 predicted negative effects on German GDP due to increase in wholesale electricity prices, CO2 prices. Did that happen?

Average duration of supply failures in 2012



Source: CEER 2014

Germany will maintain top security levels despite the energy transition.

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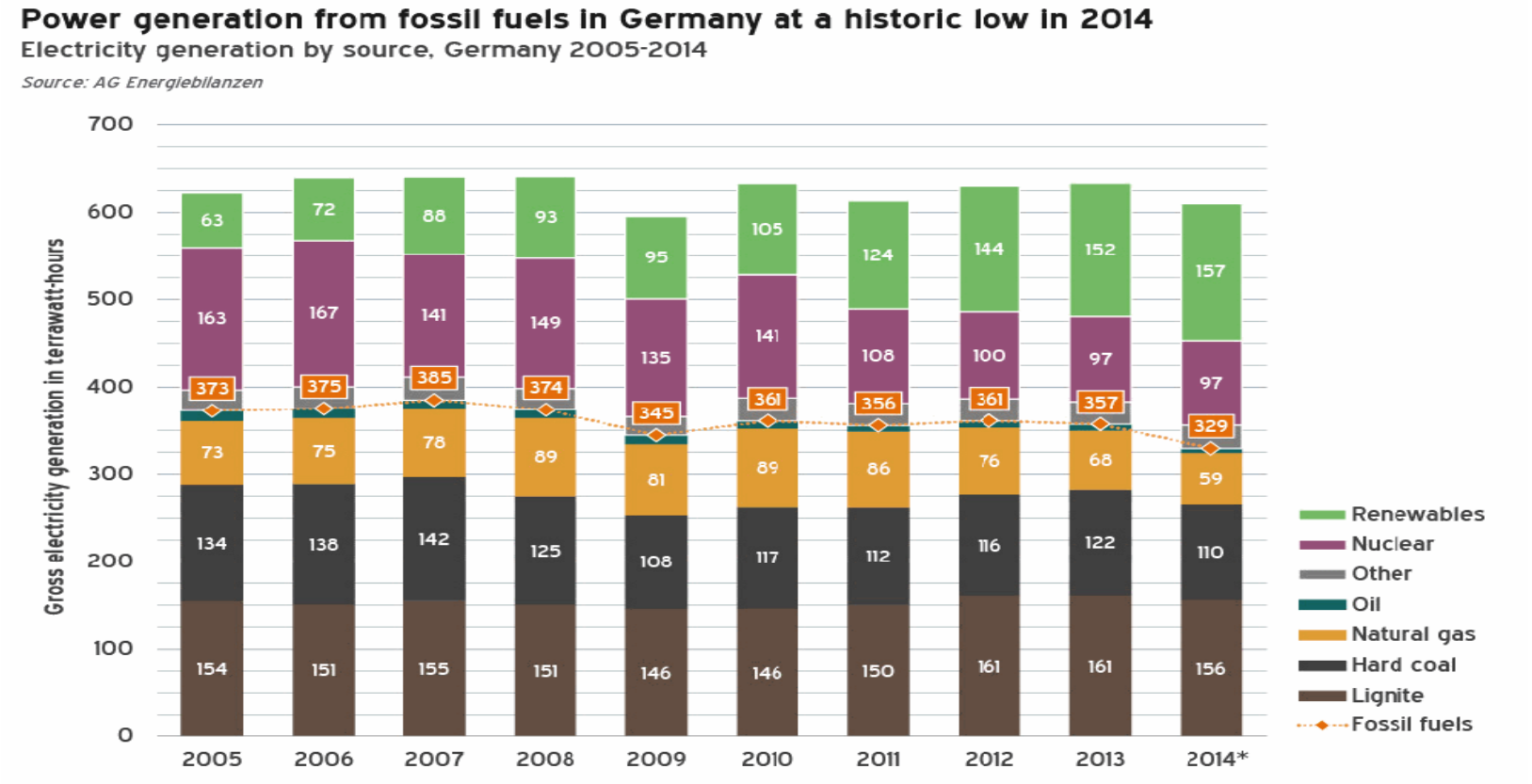
Fact-Check for some Myths around the Energiewende (3)

- Does Germany need to import electricity after shutting down 8 NPP?
- Does Germany face outages with rising RE and less NPP?
- Does Germany have to use more coal to compensate for NPP?
- (Industry) Studies from 2011 predicted negative effects on German GDP due to increase in wholesale electricity prices, CO2 prices. Did that happen?

German electricity mix (gross power generation) trends:continuous RE growth; less fossils/nuclear



Source: AGEB 2014

Renewables have become the biggest source of power generation.

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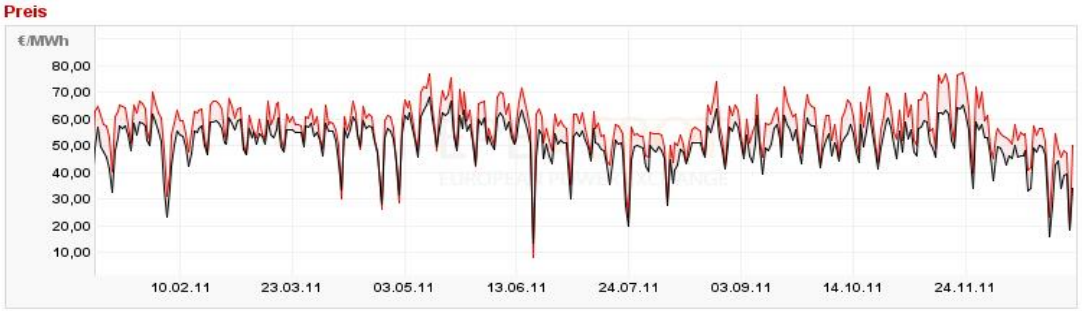
Fact-Check for some Myths around the Energiewende (4)

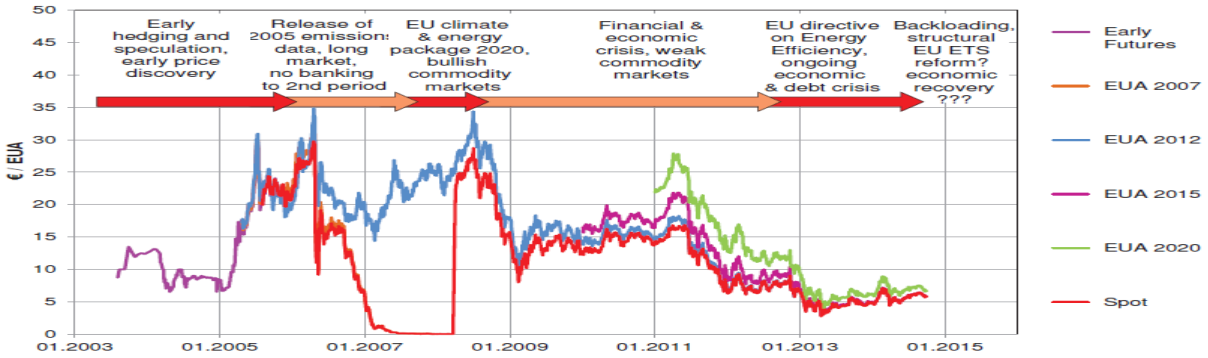
- Does Germany need to import electricity after shutting down 8 NPP?
- Does Germany face outages with rising RE and less NPP?
- Does Germany have to use more coal to compensate for NPP?
- (Industry) Studies from 2011 predicted negative effects on German GDP (German Industries) due to increase in wholesale electricity prices, CO2 prices.
  Did that happen?

Negative predictions did not come true

1) Electricity wholesale prices down by > 30% since 2011
good for industry, bad for renewable surcharge



2) CO2 prices down by > 60% since 2011



Quelle: Evomarkets, ICE ECX, EEX