Transatlantic Climate Bridge

Embassy of the
Federal Republic of Germany
Washington

The German Energy transition
State of Play

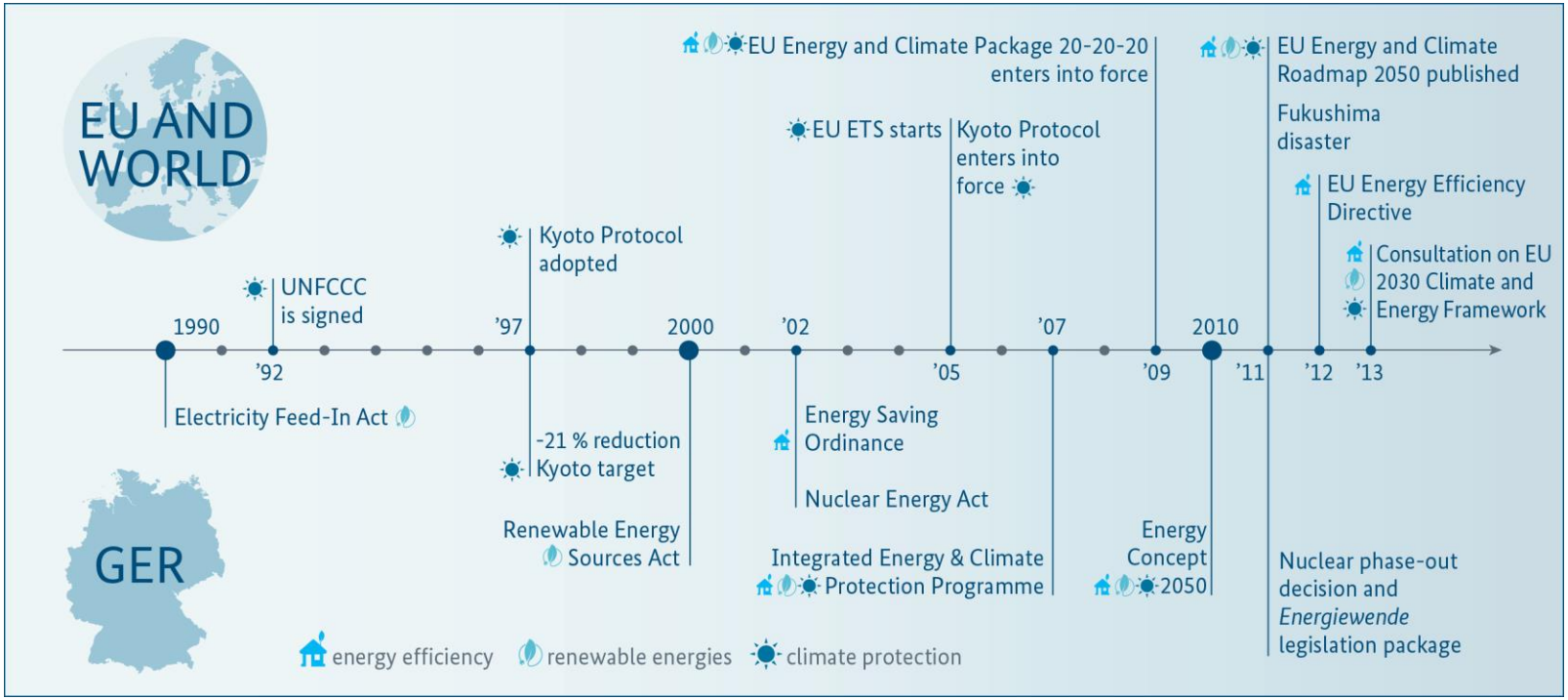
Dr. Georg Maue, First Secretary Climate and Energy Policy
Embassy of the Federal Republic of Germany
4645 Reservoir Road, Washington, DC 20007

Tel: +1 (202) 298 4355
Fax: +1 (202) 298 4391
E-mail: wi-6@wash.diplo.de

Discussion Points

- Frame and Motivation for energy transition
- Policies and Measures
- Challenges & Opportunities
- Costs
- Nuclear phase-out
- Some Myths around the energy transition
- Way Forward – Revision of the EEG

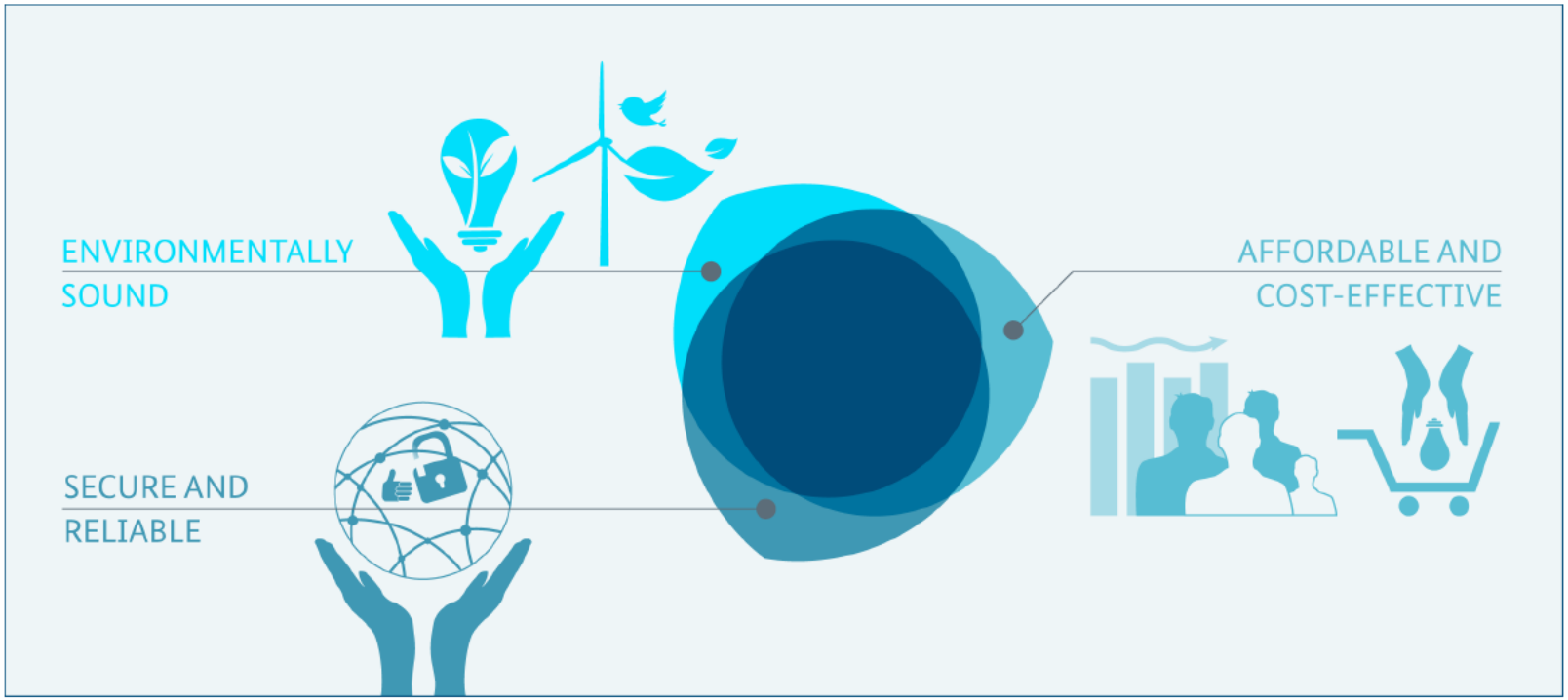
Milestones of the *Energiewende*



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

Motivation for the German Energy Transition (Energiewende):
Previous energy business as usual was not sustainable, would cause huge economic and ecologic damage, therefore:

Three target areas of the *Energiewende*



Affordability, reliability and environmental protection are interlinked.

Long Term Scenarios and cost/benefit Strategies underlay targets and measures of the energy transition

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

DLR (German Aerospace Center)

Fraunhofer IWES

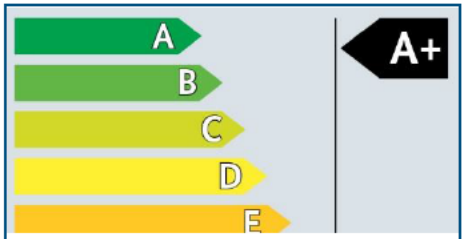
IfnE Ingenieurbüro für neue Energien

- Multi-year modeling and simulation
- All technology sectors:
  - Electricity
  - Transportation
  - Heating
  - Combined Heat and Power
  - Energy Storage – Power to Gas
- Economic and demographic inputs:
  - 10% decline in population by 2050
  - 40 % increase in GDP by 2050
  - Moderate fossil fuel price increases
- Scenario 2011A – middle scenario:
  - 50% market adoption of electric vehicles
  - Hydrogen as a renewable energy storage medium
  - Other scenarios varied by rate of adoption of electro/gas-mobility and storage for renewables.

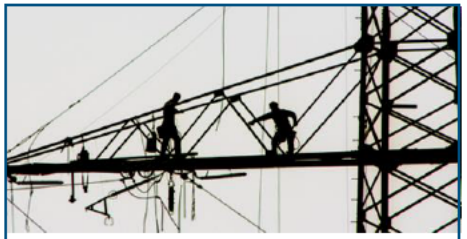
The Concept of the Energiewende

Three pillars of the *Energiewende*

Renewable energy



Energy efficiency



Future grid

Renewable Energy Sources Act

National Climate Initiative

Market Incentive Programme

Energy Saving Ordinance

Grid Expansion Acceleration Act

Federal Requirement Plan

- Steady growth
- Cost-efficient
- Environmentally friendly

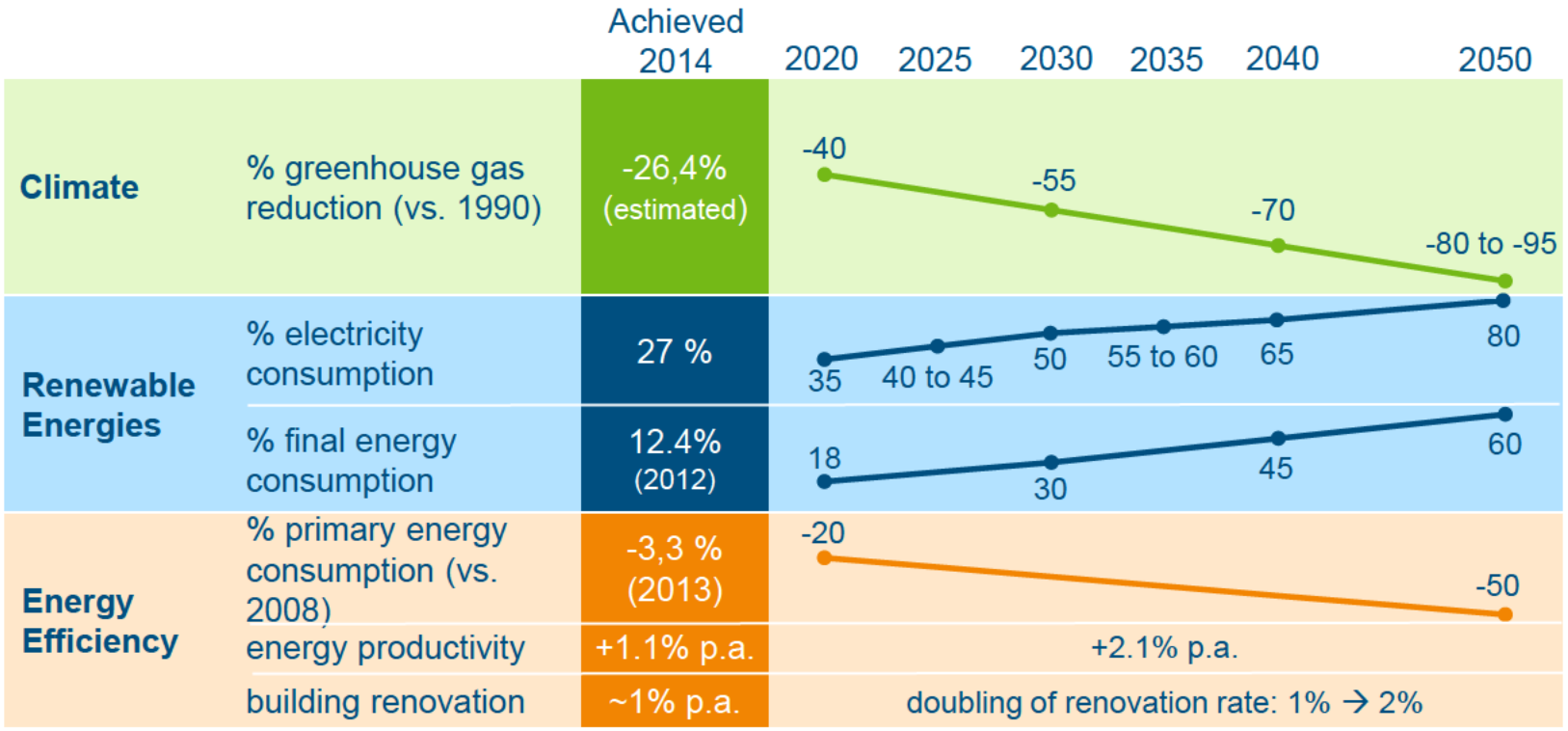
- Reduce energy consumption
- Improve efficiency

- Increase flexibility
- Enlarge capacities
- Integrate renewables

Switch to renewables, halve energy consumption and upgrade grids.

Energiewende targets until 2050

and progress made so far

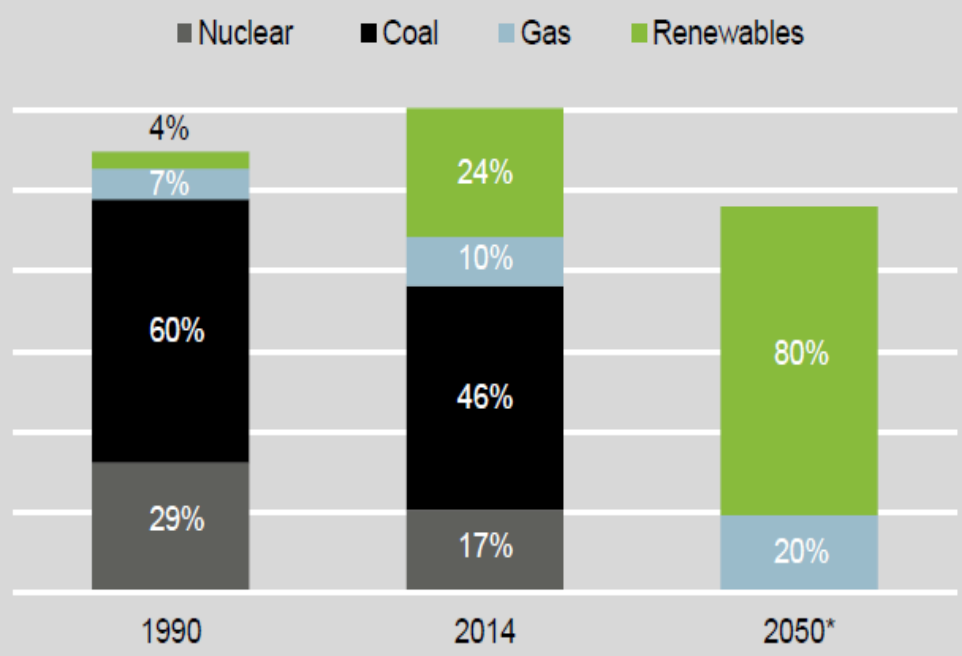


Source: Federal Government 2010, BMU/BMWi 2014, AGEE-Stat 2014

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

The *Energiewende* means fundamentally changing the power system

Structure of gross electricity production in 1990, 2014 and 2050*



AG Energiebilanzen (1990/2014), BMWi (2015)

*illustrative

Greenhouse Gas Emissions
Reduction of 40% by 2020 and
80% to 95% by 2050 below 1990 levels

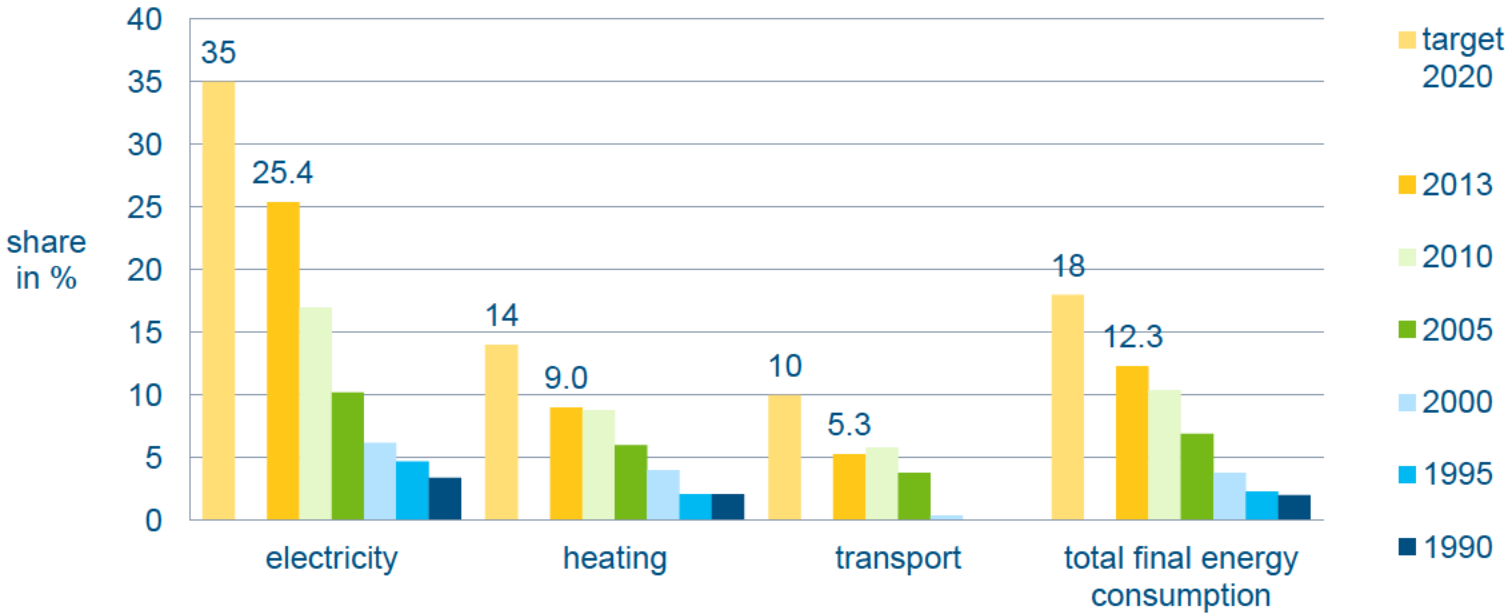
Nuclear
Stepwise shut down of all power plants until 2022

Renewables
Share in gross electricity consumption of 40-45% by 2025, 55-60% by 2035 and at least 80% by 2050

Efficiency
Reduction of electricity demand by 10% by 2020 and 25% by 2050 below 2008 levels

Where do we stand:

Renewable energy development in Germany



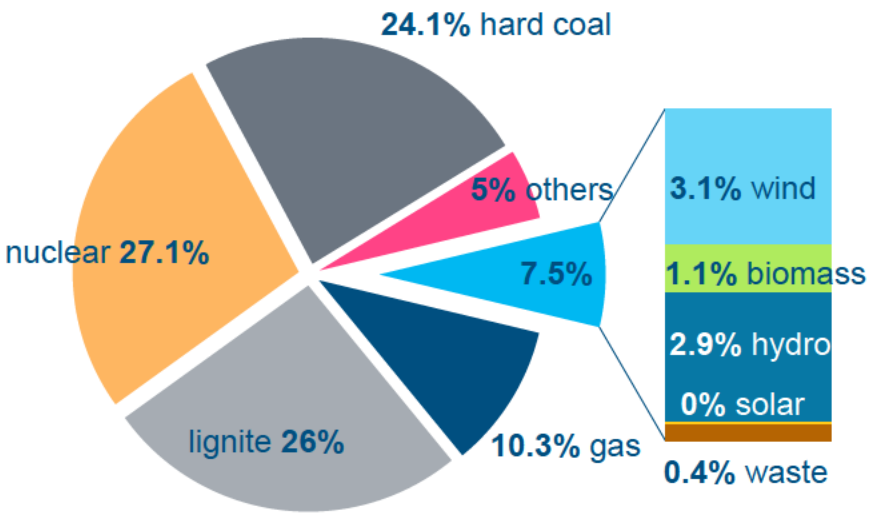
Source: AGEE-Stat 2014

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

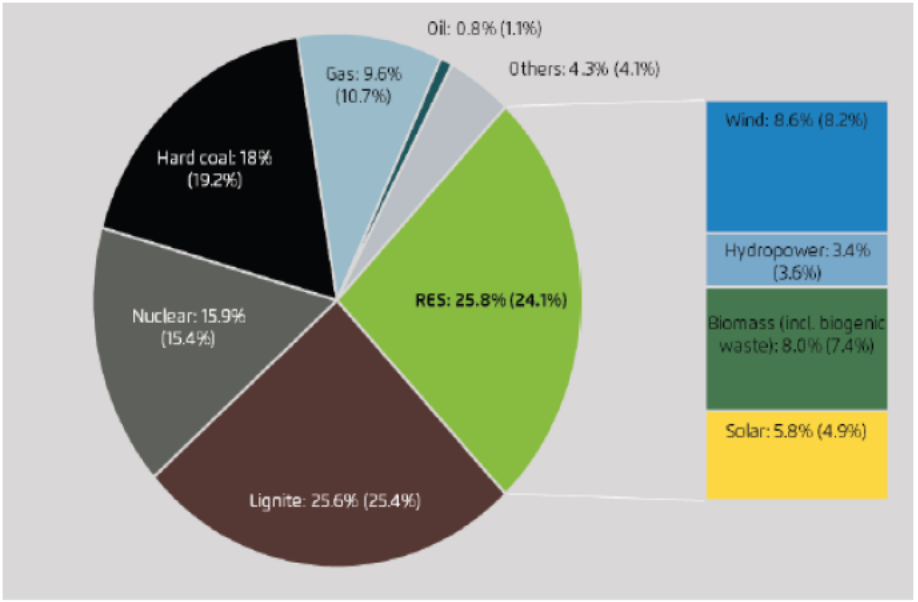
Transatlantic Climate Bridge

Trends in gross German electricity production

2003 total: 608.8 TWh
renewables share: 45.6 TWh



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



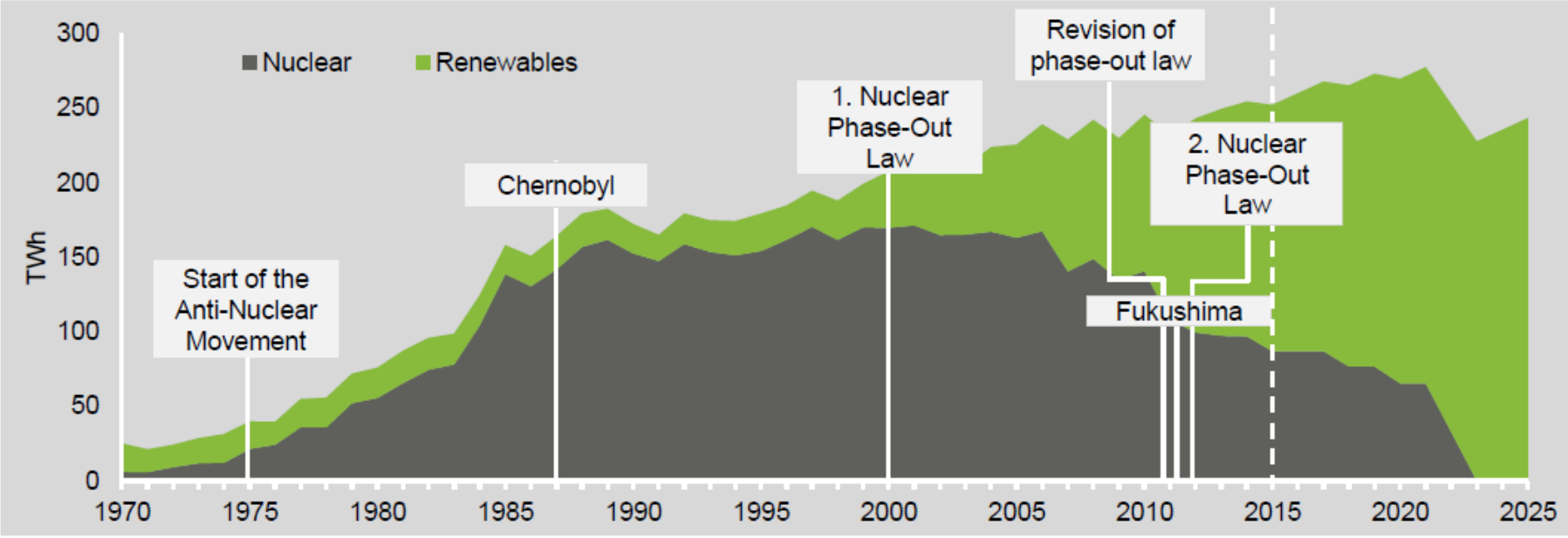
The renewables share in electricity production tripled within ten years.

RE are now biggest source of electricity

Transatlantic Climate Bridge

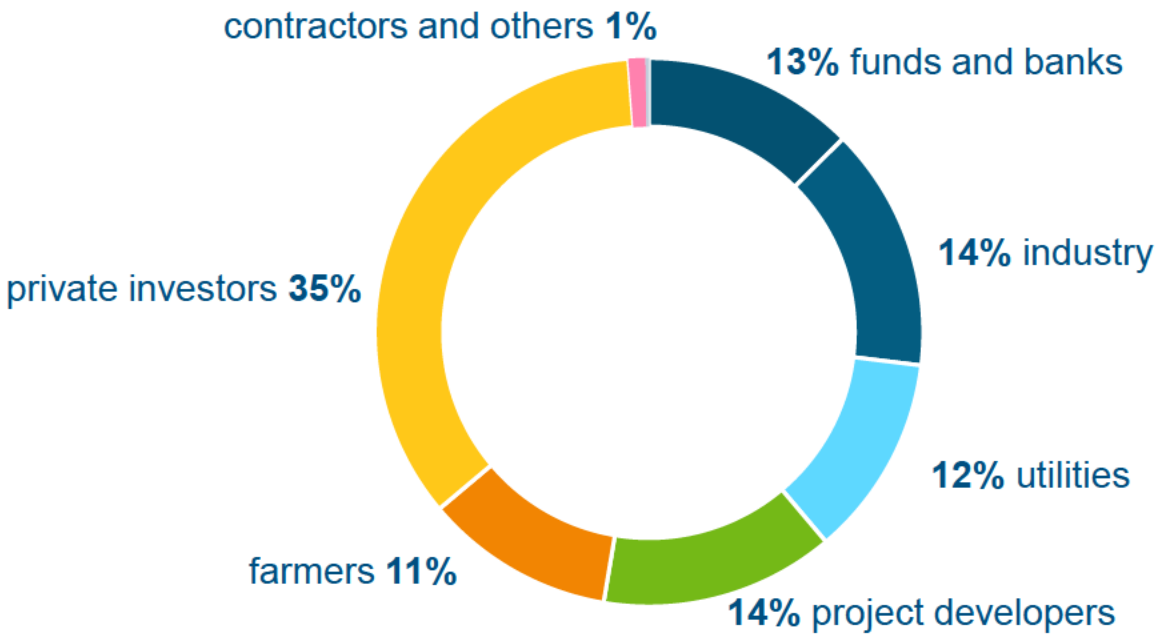
The nuclear energy act foresees the shut down of all nuclear power plants by 2022 with renewables more than replacing their generation

Gross electricity production by nuclear and renewable sources 1970 – 2025 in TWh



AG Energiebilanzen (1970 – 2014), BNetzA, own calculations (2015 – 2025)

Ownership structure of German RES facilities in 2012

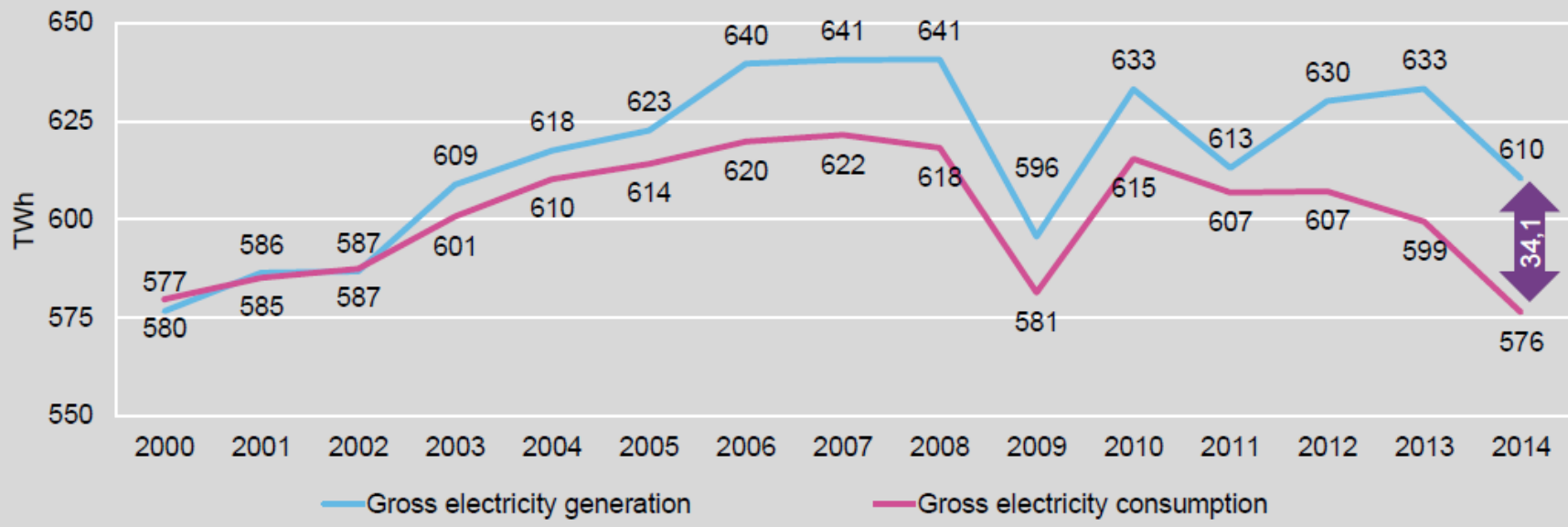


Source: trend:research 2013

Renewable installations create multiple opportunities for new entrepreneurship.

Since 2001, Germany has produced more electricity than it uses. Usage has been decreasing since 2007, and in 2014 was below the level last seen in 2000.

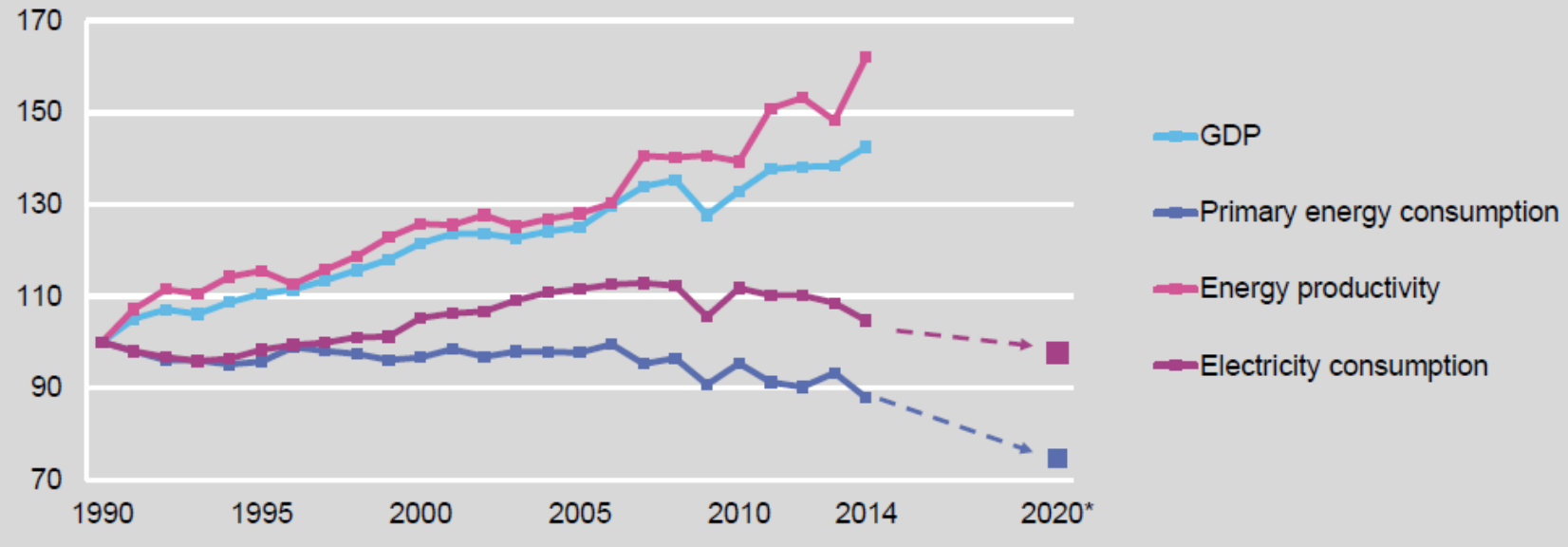
Gross electricity generation and production in TWh



AG Energiebilanzen 2014

Germany decoupled economic growth from energy consumption – but there is still work to do to reach the 2020 efficiency targets

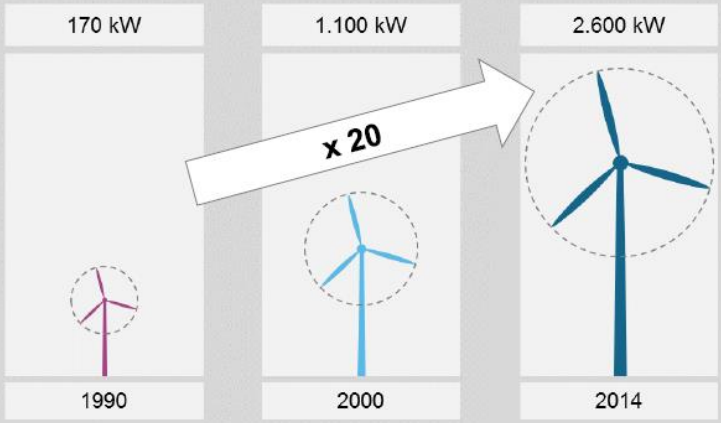
Energy productivity and consumption and economic growth 1990 – 2014 (Index, 1990=100)



AG Energiebilanzen (2014), BMWi (2014)

Wind Energy has become a mature technology, with windmills of 2-3 MW being standard

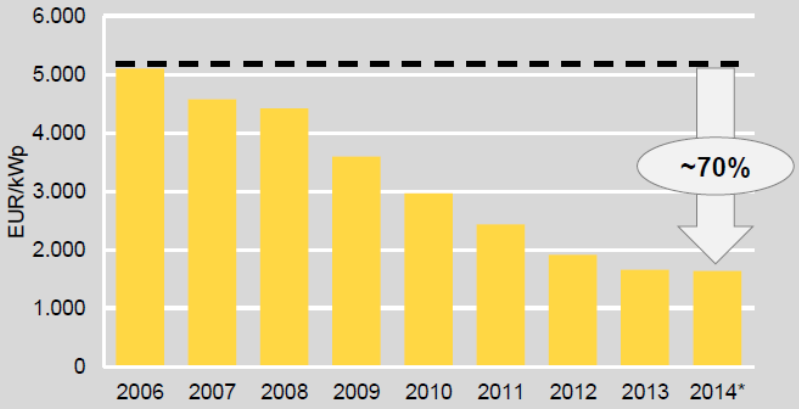
Size development of wind turbines (onshore)



Fraunhofer IWES

Cost breakthrough in solar PV reduced cost by ~70% since 2006

Average system price for new roof-mounted PV in EUR/kWp

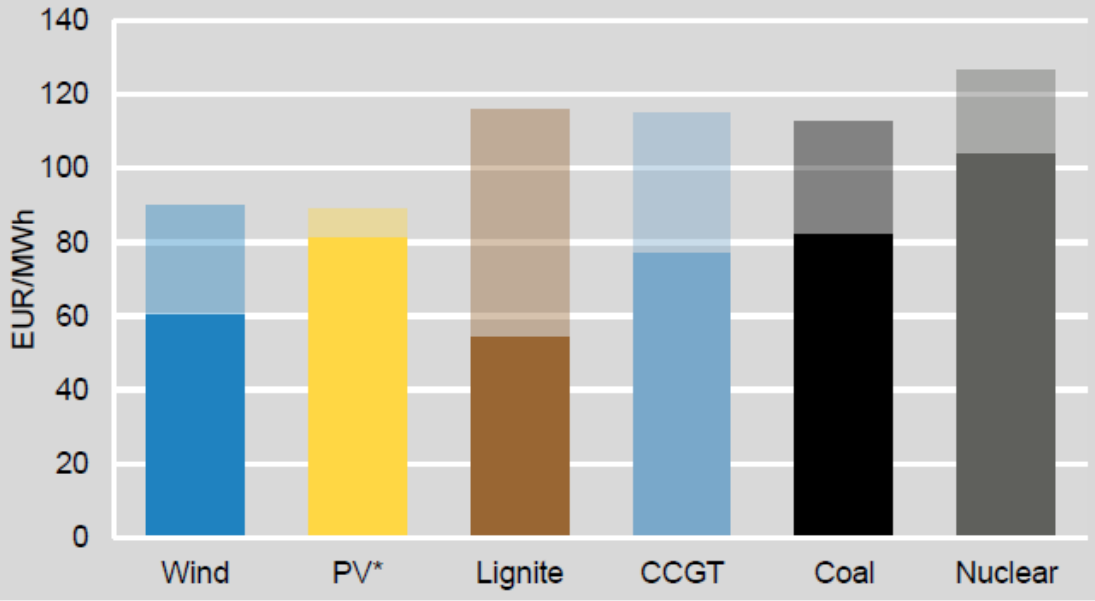


BSW Solar (2014), own calculations

* only Q1 2014

Today, wind and solar are already cost competitive to all other newly built conventional energy sources

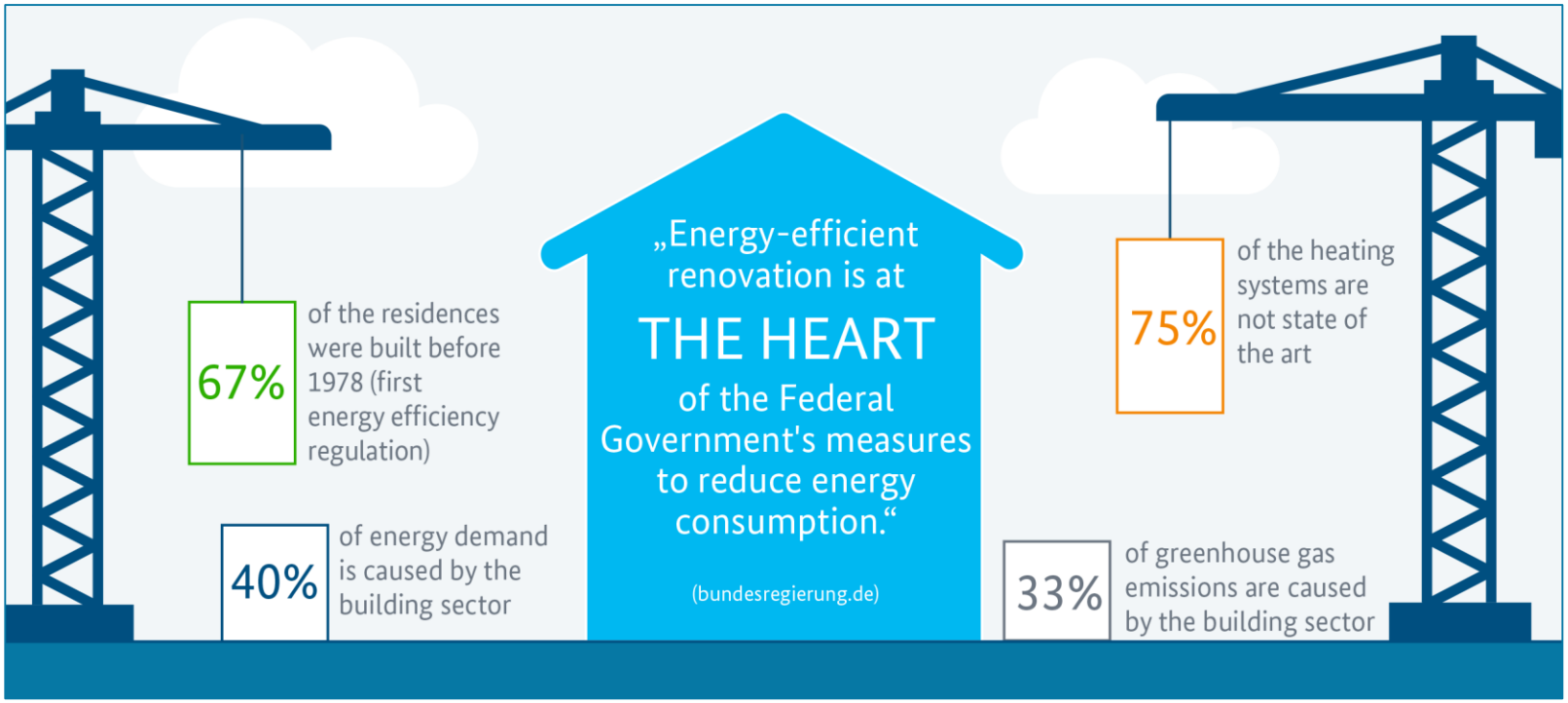
Range of levelized cost of electricity (LCOE) in 2015 in EUR/MWh



Agora Energiewende (2015)

The Challenge No. 1:

Saving potential of buildings



Source: BDH

The Energiewende can only be successful if existing buildings are included.

The Challenge No.2: New (and smart) Infrastructure

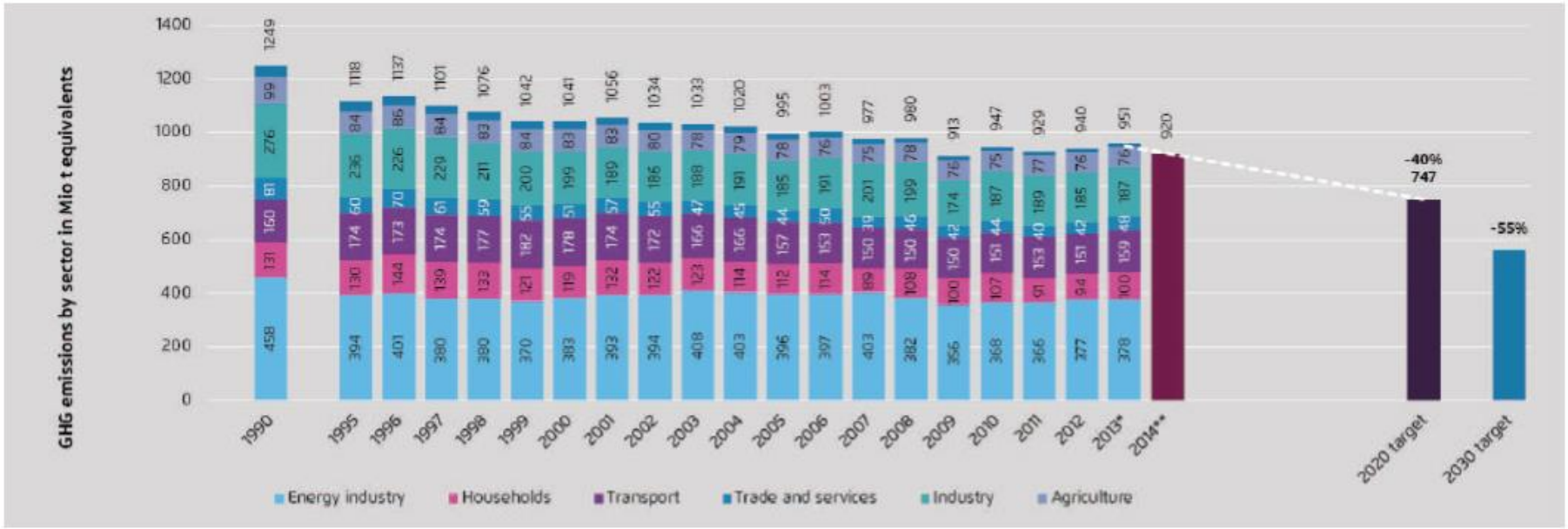
- 2013 Network Development Plan led by Federal Network Agency
  - Identified need for over 3800 km of new transmission (HVDC)
  - Financing mechanisms in development
- Grid Expansion Acceleration Act (NABEG)
- Additional efforts on energy storage:
  - Pumped hydro
  - Power to gas
  - EU electricity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

The Challenge No. 3:
German greenhouse gas emissions

Reduced emissions by the energy industry and the mild winter lead to a major decline in greenhouse gas emissions 2014. However, there is still a lot to do in order to reach the 2020 climate target.

Agora Energiewende

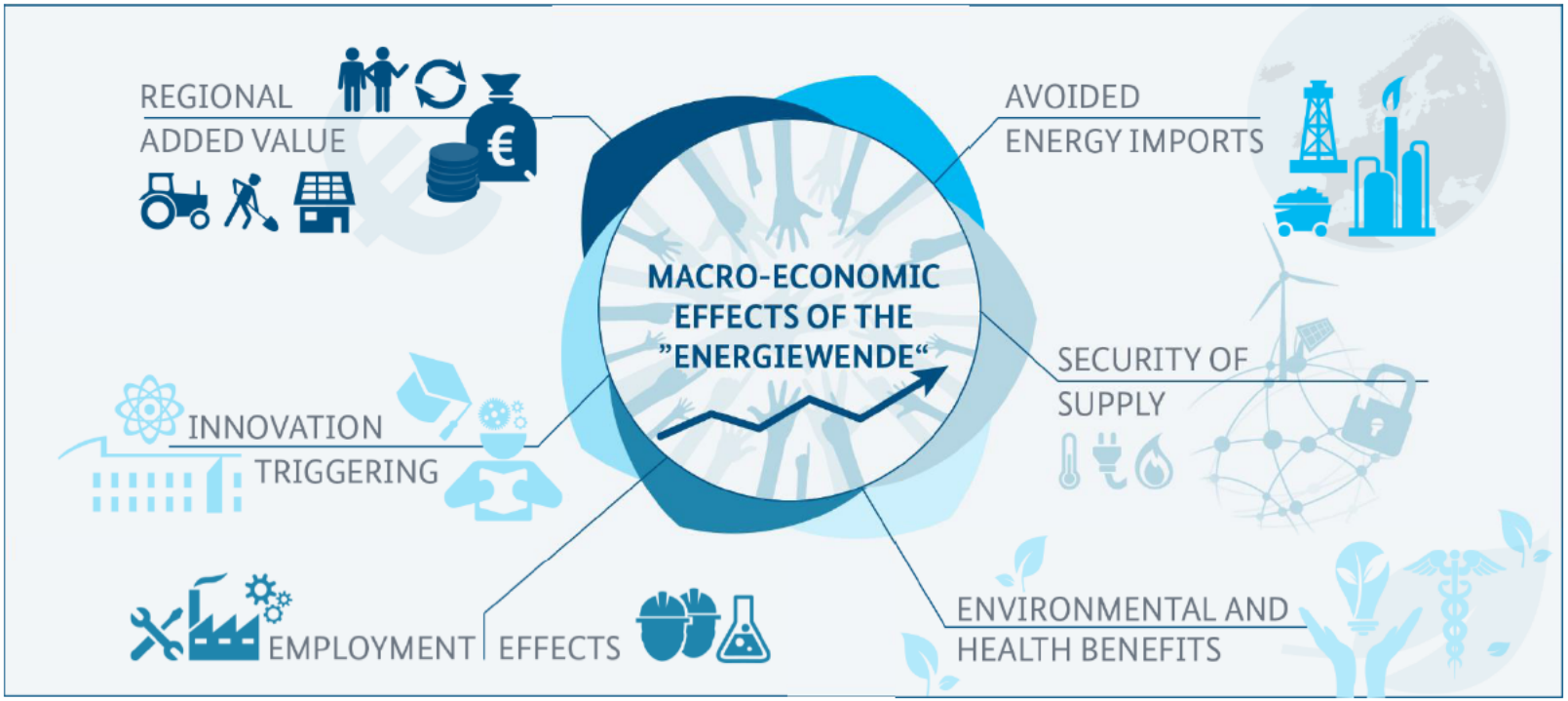
Greenhouse gas emissions by sector in mio. t CO_2-equivalents, as well as German government targets for 2020 und 2030



UBA 2014, own calculations, *preliminary, **own estimates

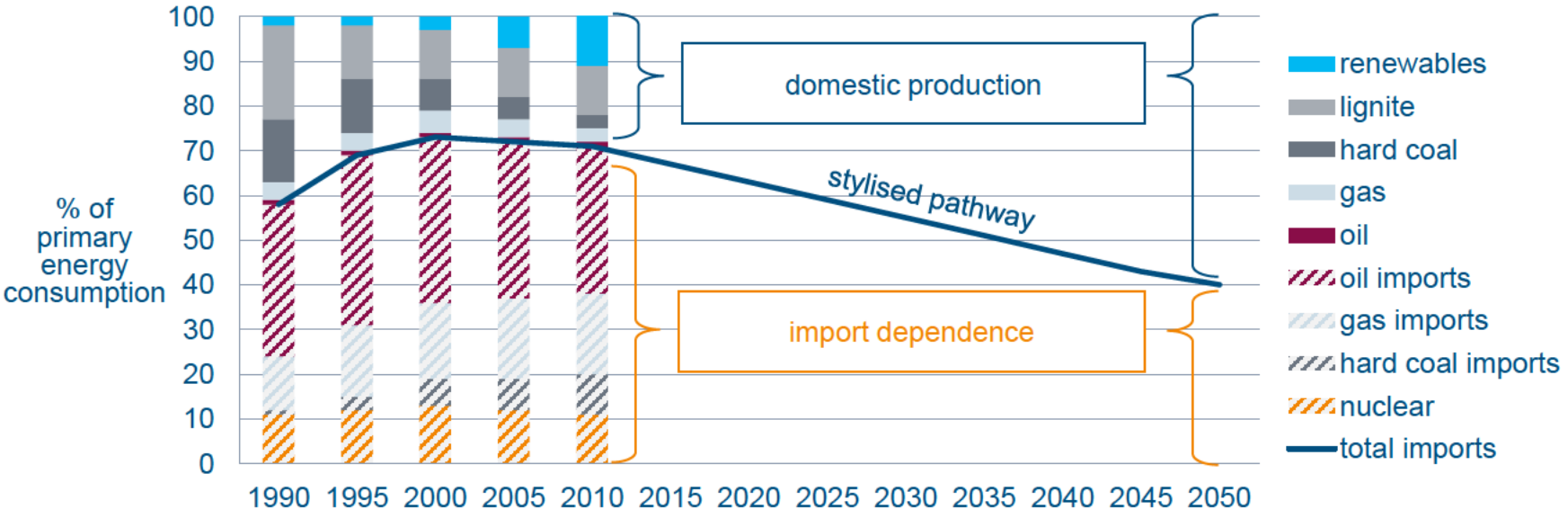
Its worth the efforts and investments:

Benefits of fostering energy efficiency and renewables



The energy transition has positive effects on various levels.

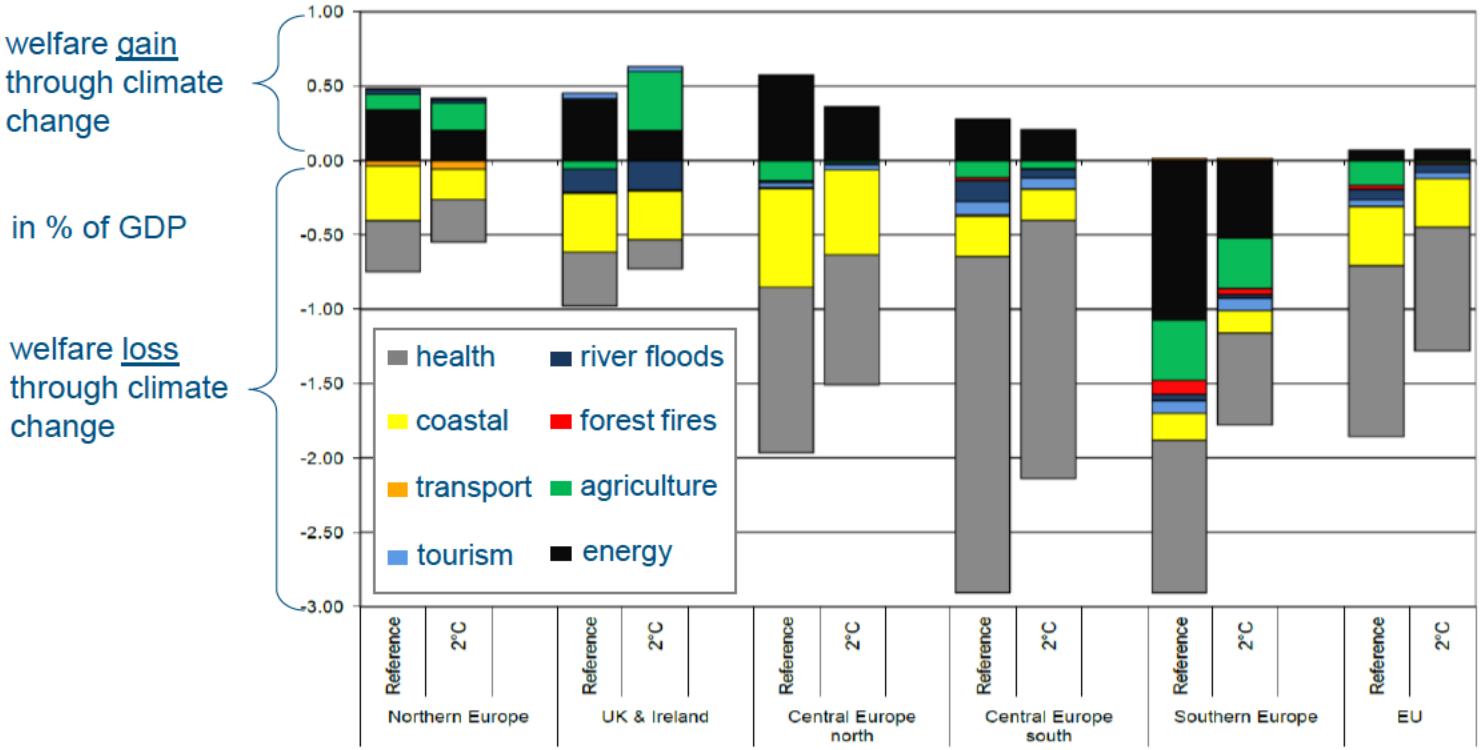
Energy imports and domestic production in Germany



Source: BMWi 2013

Renewables reduce Germany's energy dependence.

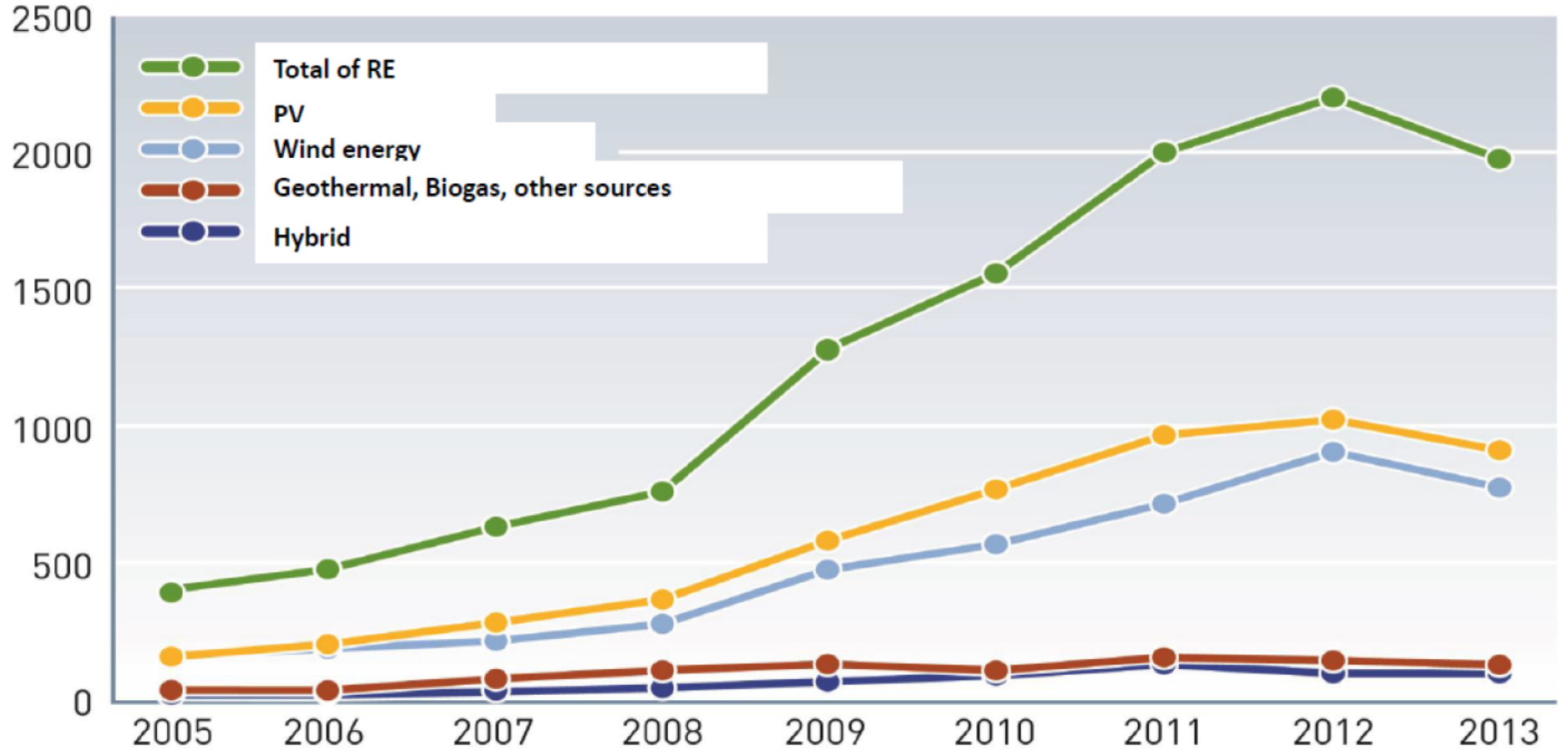
Impacts of climate change on regional European GDP



Source: JRC PESETA II project 2013

Ambitious climate action will create considerable economic benefits.

Numbers of patent application in renewable Energy sector in Germany 2005-2013



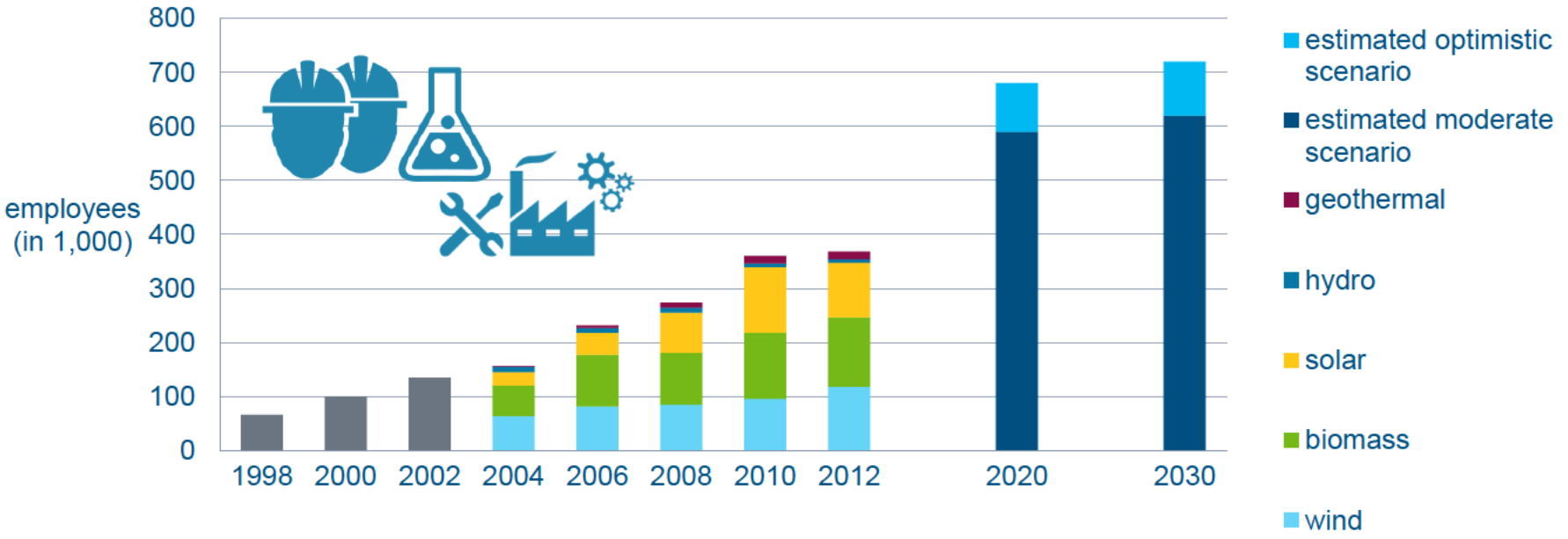
Quelle: DPMA; Stand: 06/2014

www.unendlich-viel-energie.de

Agentur für Erneuerbare Energien

WORLDWATCH

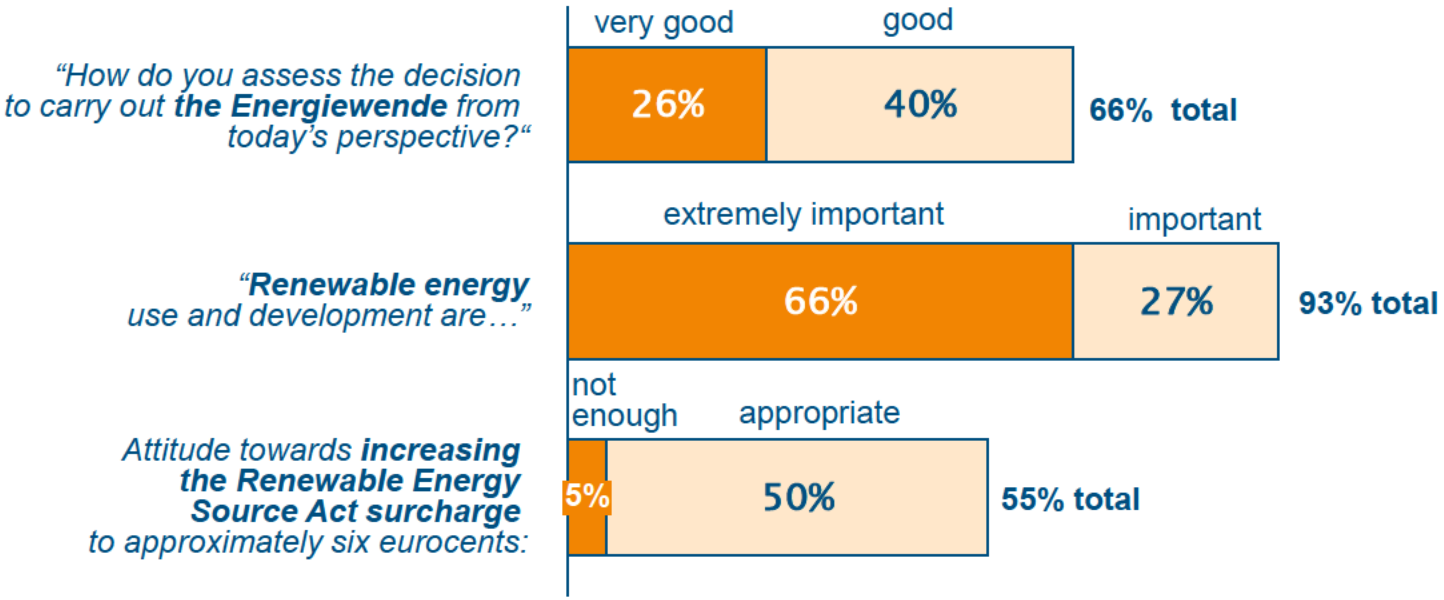
Job creation in the German renewables sector



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

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

Public acceptance of the *Energiewende*

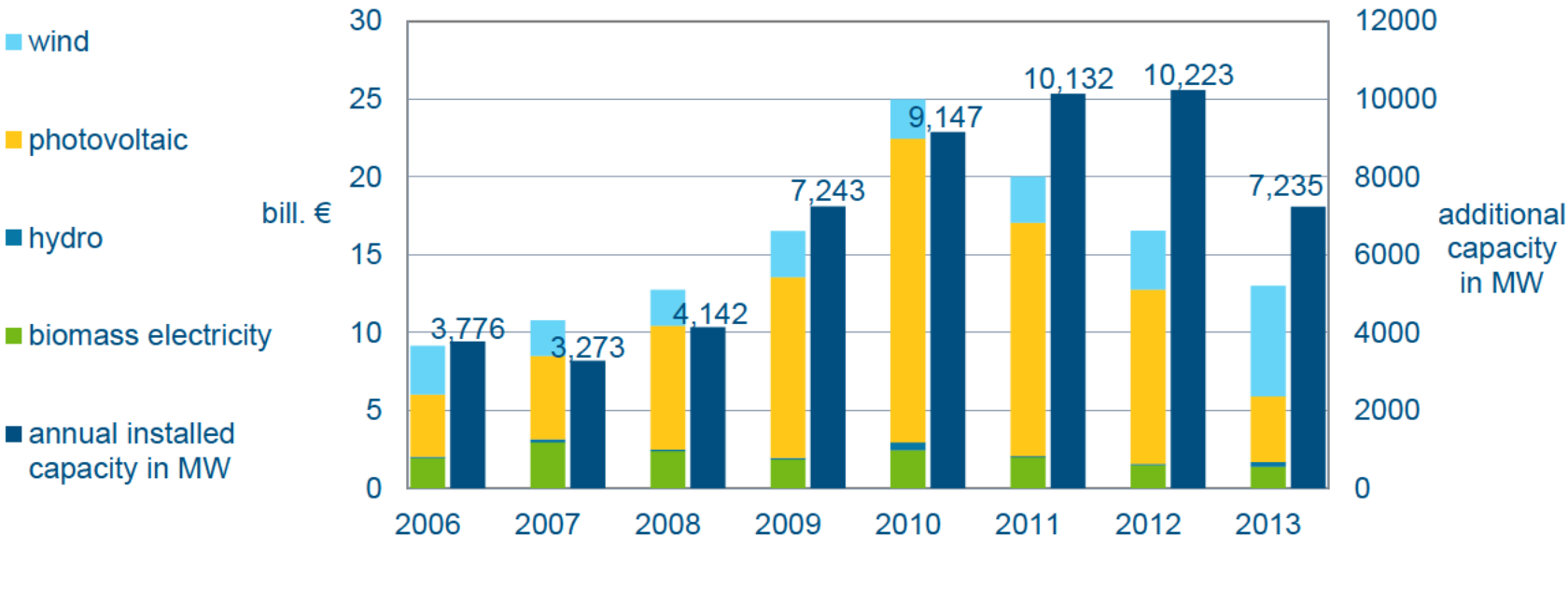


Source: Infratest 6/2012, 9/2013

The German public broadly supports the Energiewende.

Costs

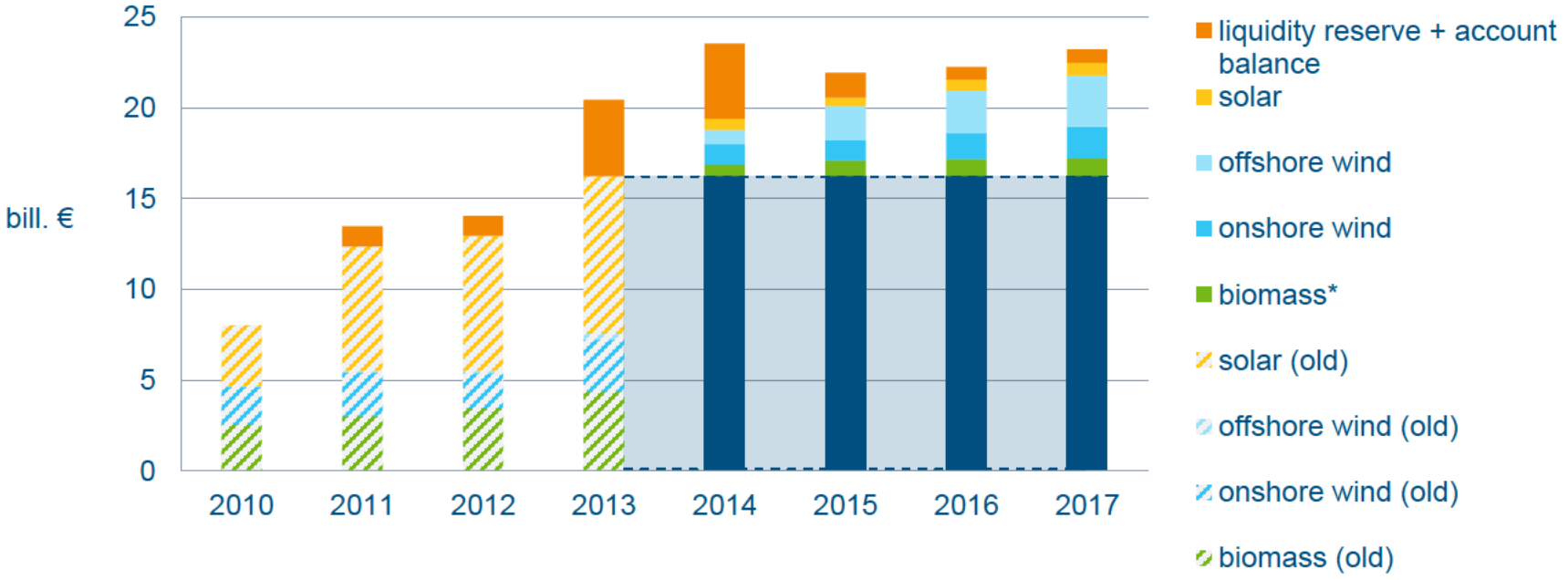
Investments and additional capacity in Germany



Source: AGEE-Stat 2014

Market growth has significantly driven down costs per megawatt.

Net feed-in payment trends in Germany

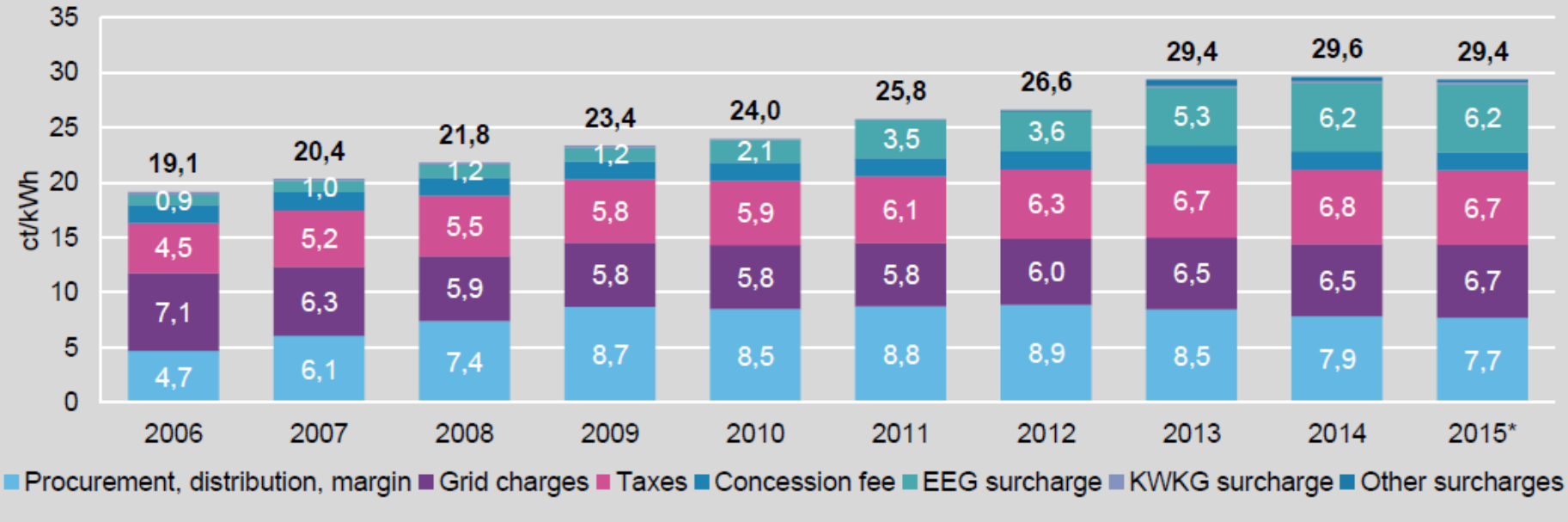


Source: Agora Energiewende / Öko Institut, 2014
** Biomass development "low" scenario*

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

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

Composition of household electricity prices 2006-2015

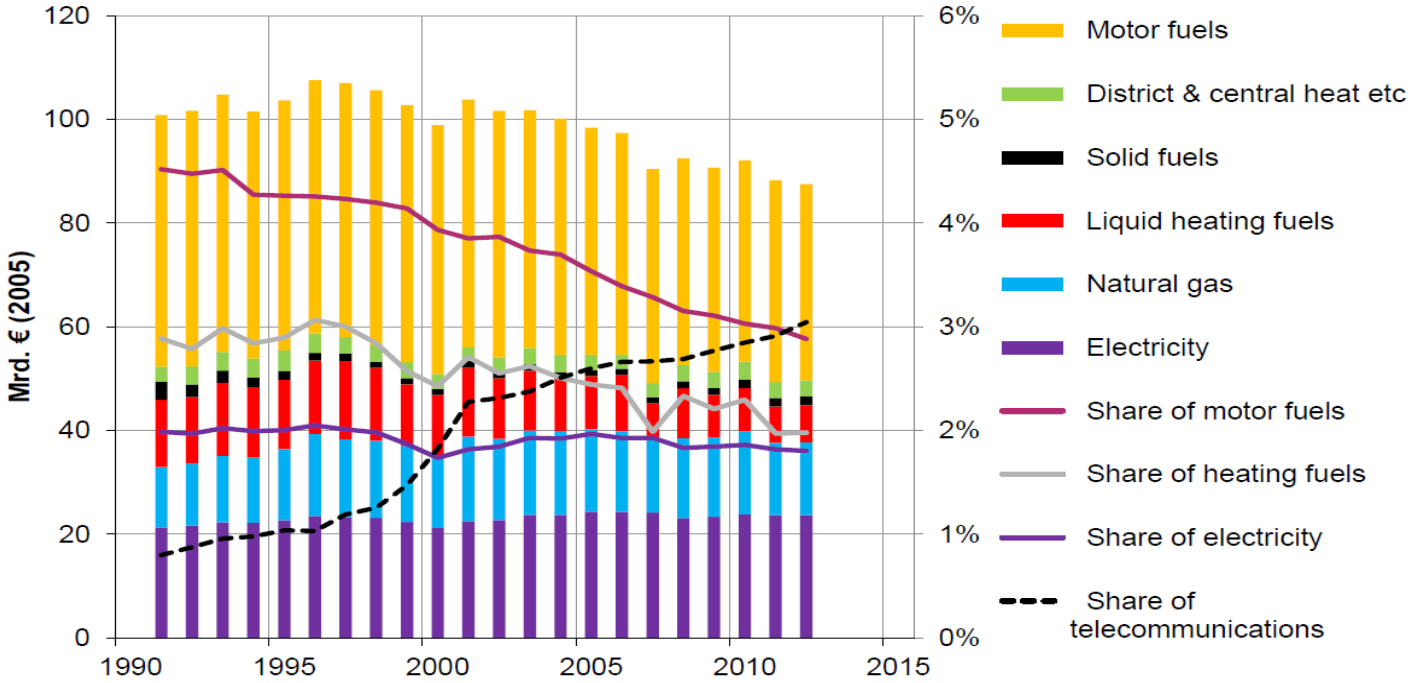


BDEW 2014, BNetzA 2014, own calculations;

*Prognosis for 2015

…Electricity Share in Consumer spending remained constant

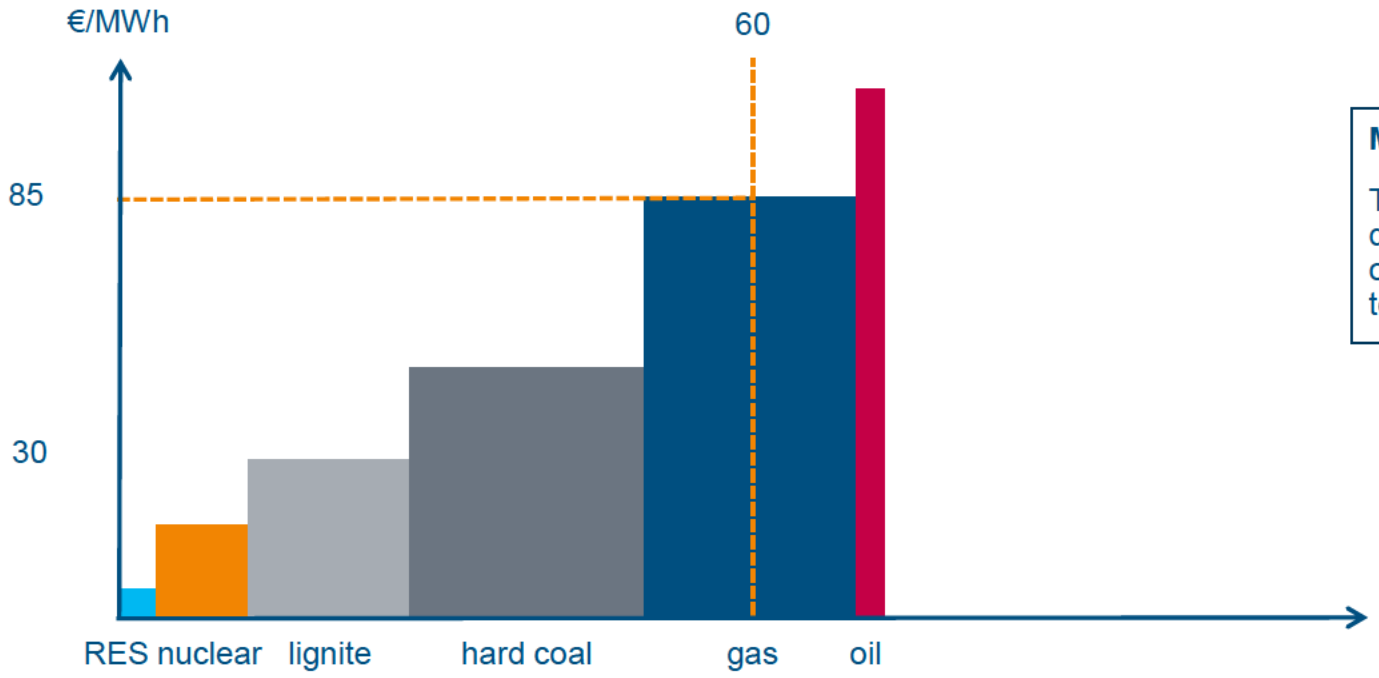
German household spending on energy



Source: Agora Energiewende 2013

Electricity share in consumer spending is lower than other energy costs and has remained constant at around 2%. (this share is around 2,4 % in the US)

Electricity market price plotted against merit order



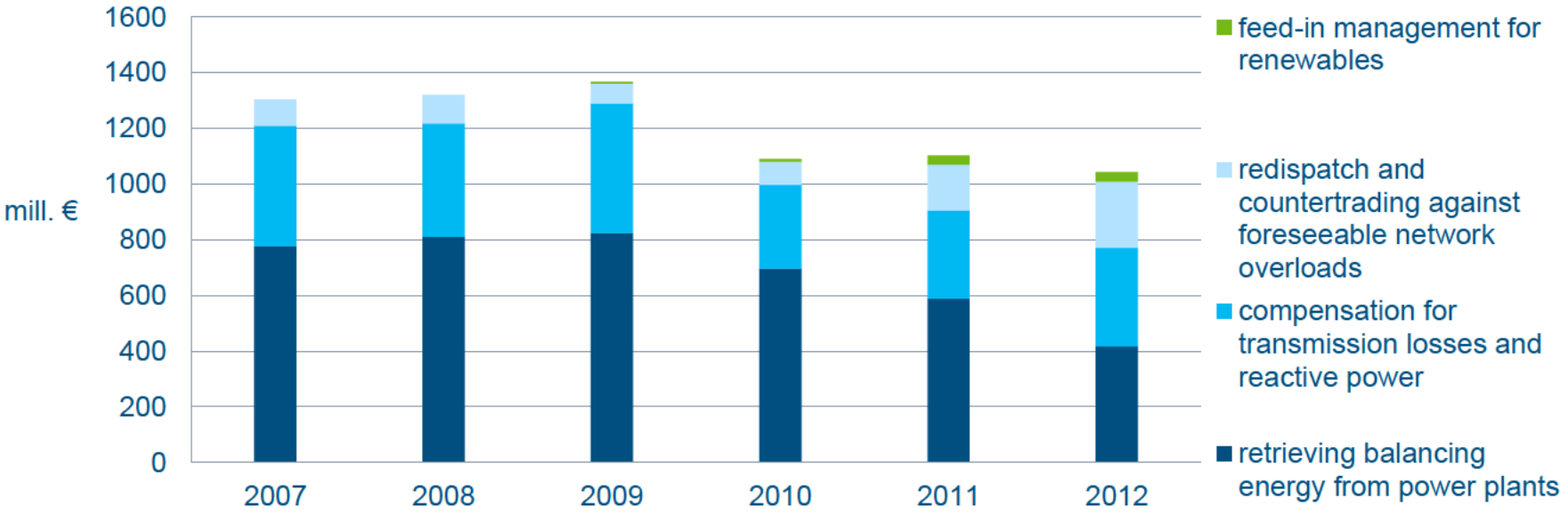
Merit order (stylised)

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 of balancing measures to ensure grid stability



Source: BMWi and BMU 2012

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

Nuclear Phase-Out

The Nuclear Phase Out

- 6/20
  202:

2000

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

- Does Germany need to import electricity after shutting down 8 NPP?

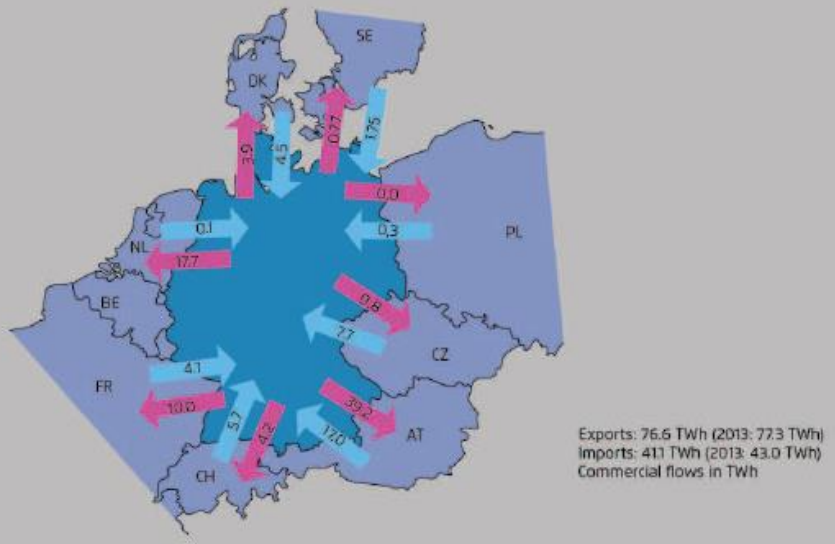
  - Does Germany face outages with rising RE and less NPP?
  - Does Germany have to use more coal to compensate for NPP?
  - (Industry) Studies from 2011 predicted negative effects on German GDP due to increase in wholesale electricity prices, CO2 prices. Did that happen?

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

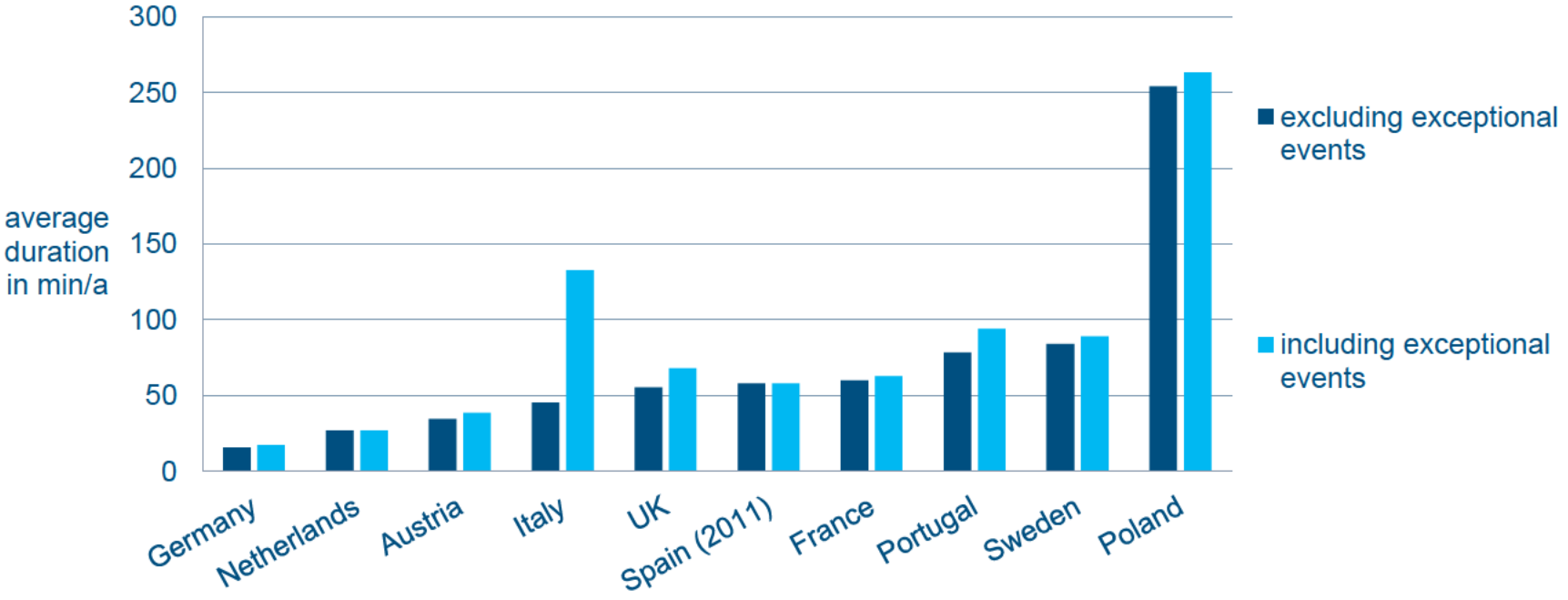


Own calculations based on ENTSO-E 2014; commercial trade flows, not displaying physical power flows

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.

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

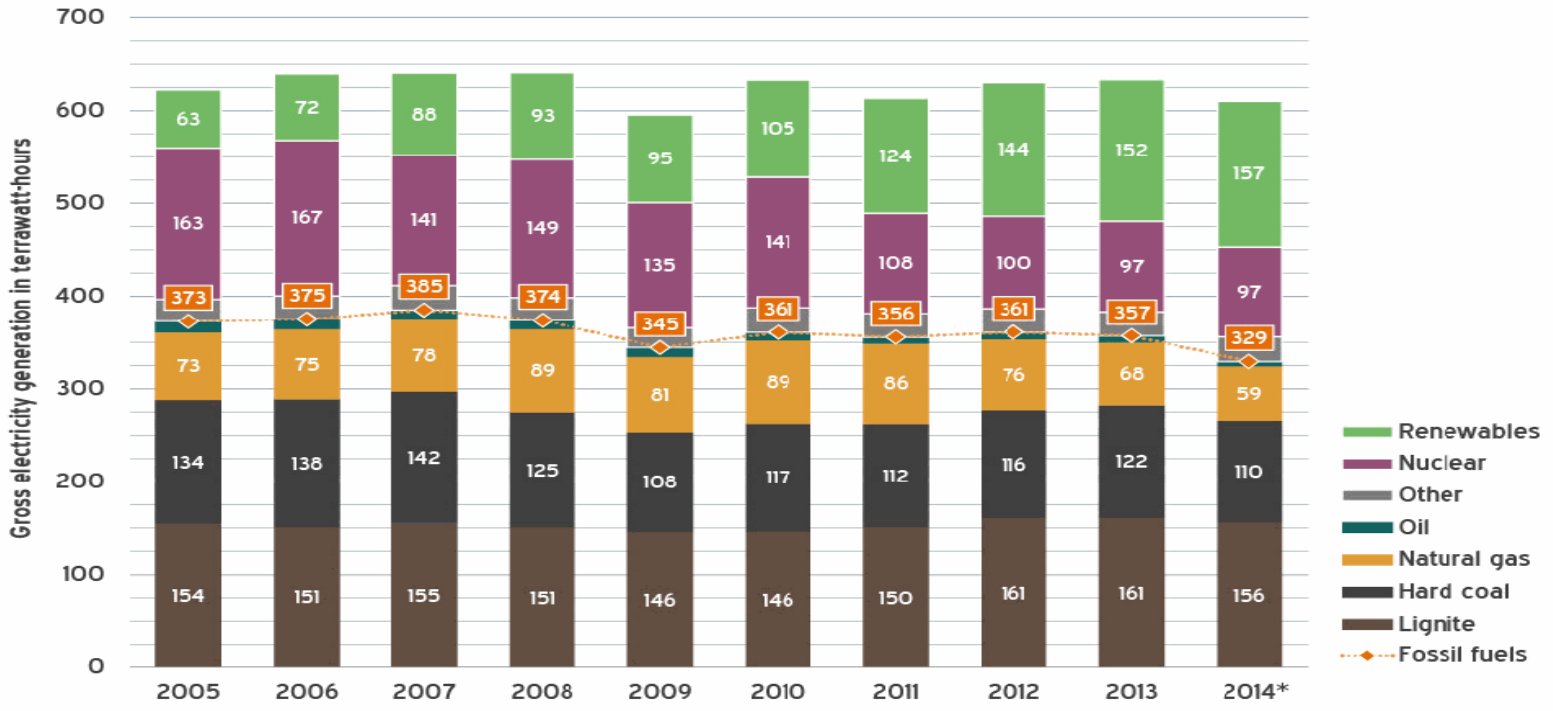
- Does Germany need to import electricity after shutting down 8 NPP?
- Does Germany face outages with rising RE and less NPP?
- **Does Germany have to use more coal to compensate for NPP?**
- (Industry) Studies from 2011 predicted negative effects on German GDP due to increase in wholesale electricity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

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

Power generation from fossil fuels in Germany at a historic low in 2014

Electricity generation by source, Germany 2005-2014

Source: AG Energiebilanzen



Source: AGEB 2014

Renewables have become the biggest source of power generation.

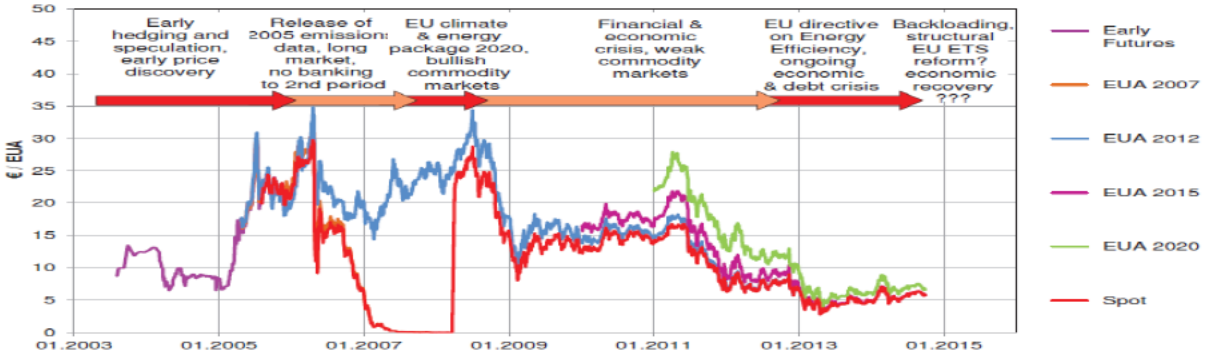
Fact-Check for some Myths around the Energiewende (4)

- 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

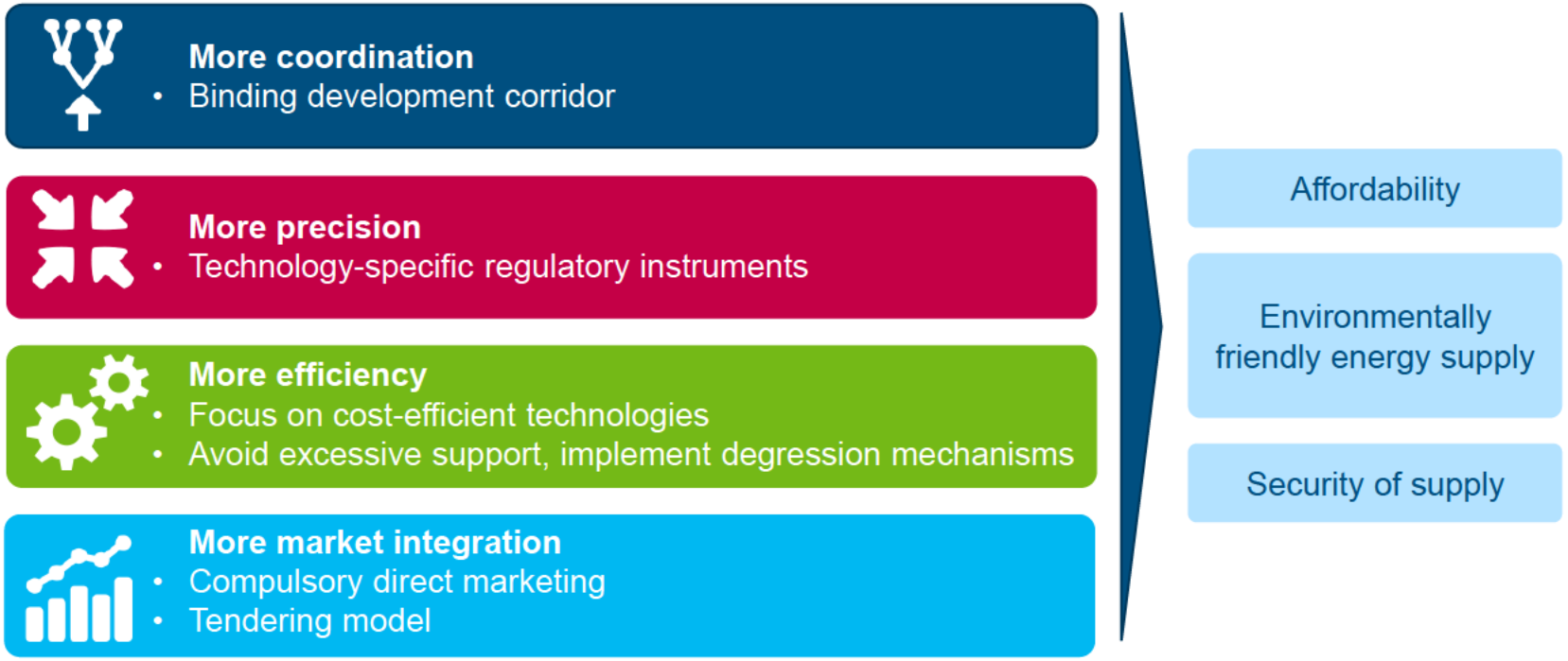
2) CO2 prices down by > 60% since 2011



Quelle: Evomarkets, ICE ECX, EEX

The Way Forward

Renewable Energy Sources Act Amendment 2014



Germany is maintaining ambitious goals, but is optimising mechanisms and increasing market integration.

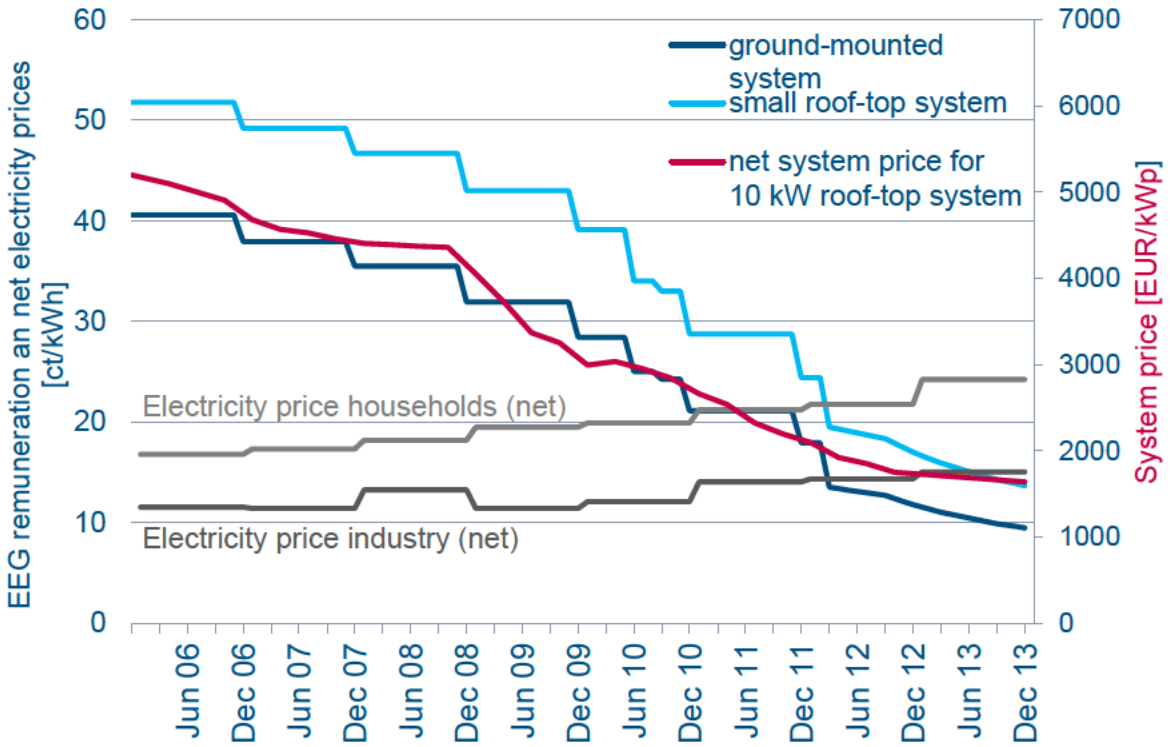
Technology specific support levels EEG 2014

	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)	2,400 – 2,600 MW (gross)	9.23 – 13.15 (and tenders for ground-mounted PV)	-0.5 % per month from 09/2014

Source: Renewable Energy Act 2014 (Draft, 26.06.2014)

Feed-in Tariffs for PV: support costs decline constantly

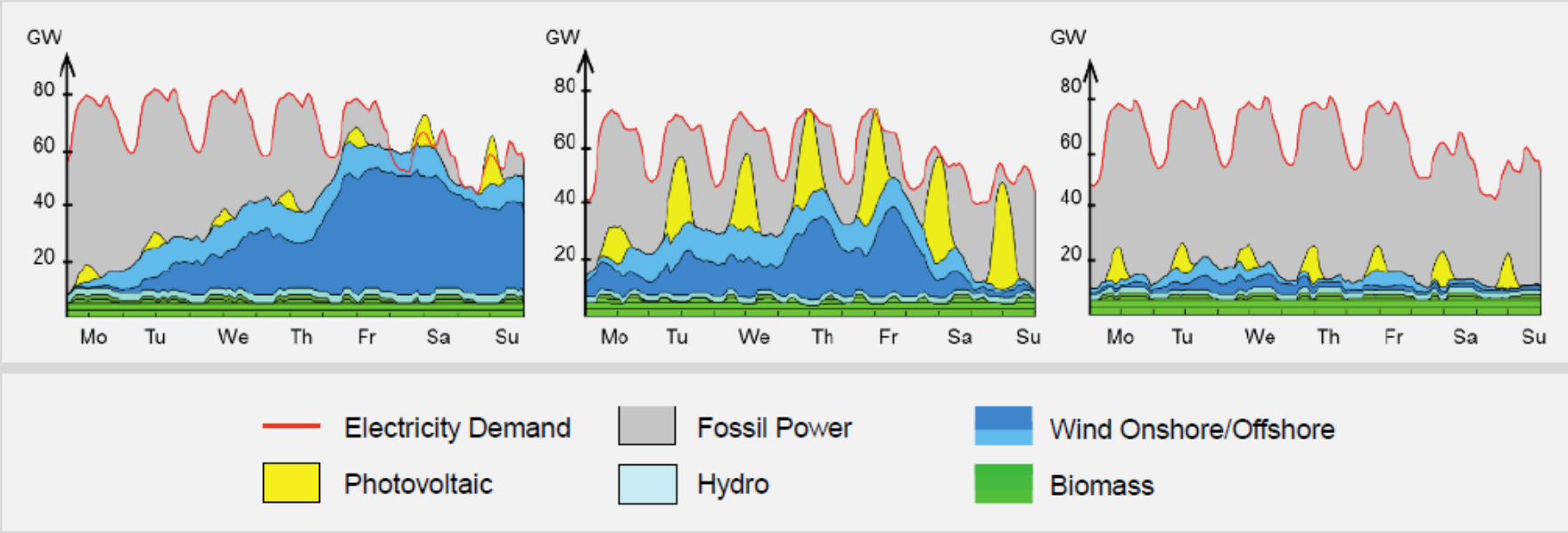
Feed-In Tariff Solar energy (Cent/kWh)	January 2006	August 2014
Roof-top installations		
< 10 kW	51,80	13,15
< 30 kW**	51,80	12,8
< 100 kW	49,28	11,49
< 1000 kW	48,74	11,49
< 10 MW	48,74	9,23
Ground-mounted	40,60	9,23 (2015: tender)



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

The power system and power markets will need to cope with a highly fluctuating power production from wind and solar

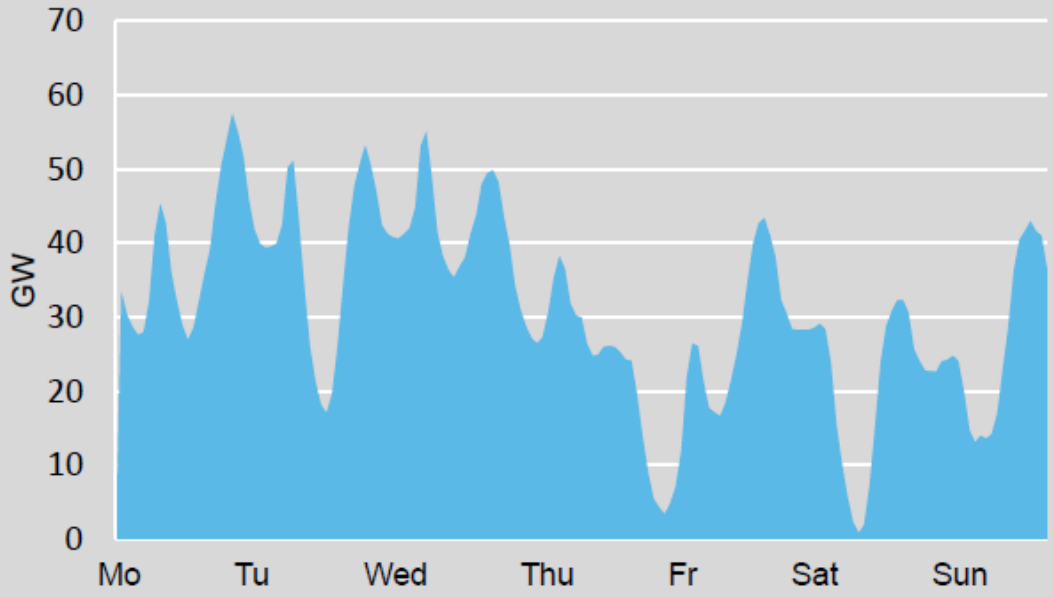
Electricity generation and demand in sample weeks of February, August and November 2023*



Agora Energiewende (2013)

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

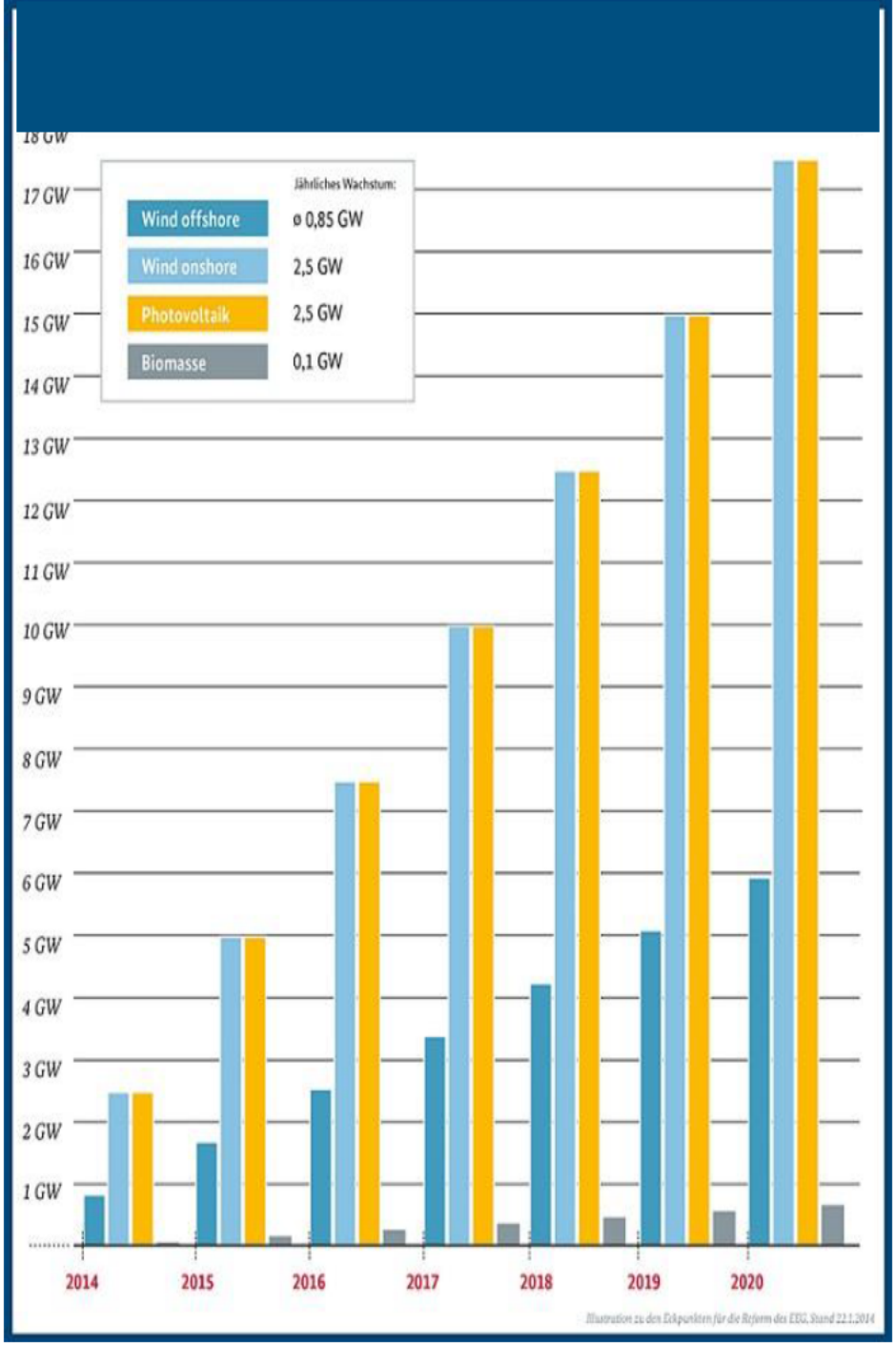
Residual load in a sample week in February 2023 in GW



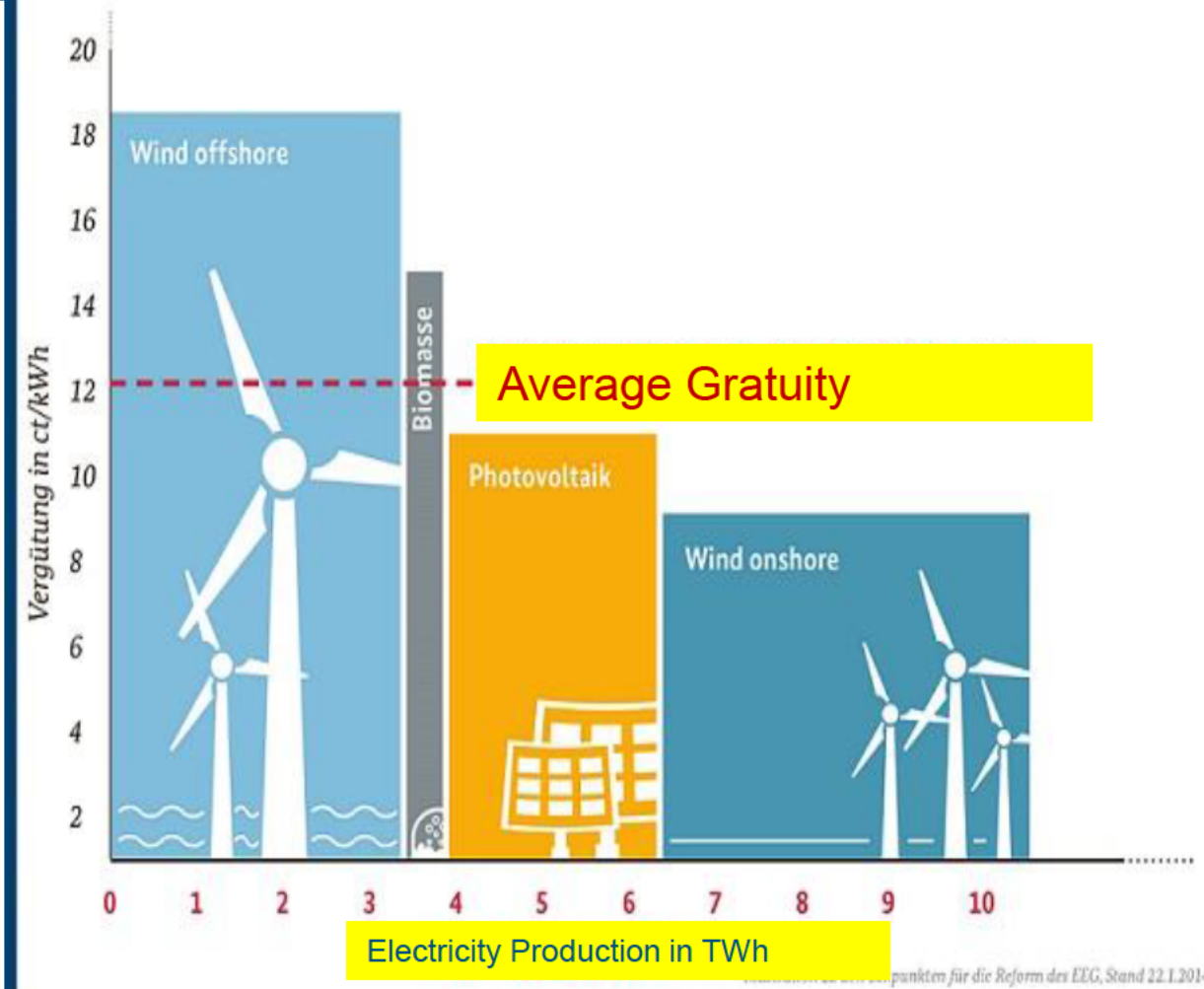
Agora Energiewende/RAP (2013)

Caps for new Capacity

Wind Onshore: 2,5 GW/year
Solar PV 2,5 GW/year
Biomass: 0,1 GW/year
Wind Offshore 6,5 GW until 2020
aver. 0,85 GW/year

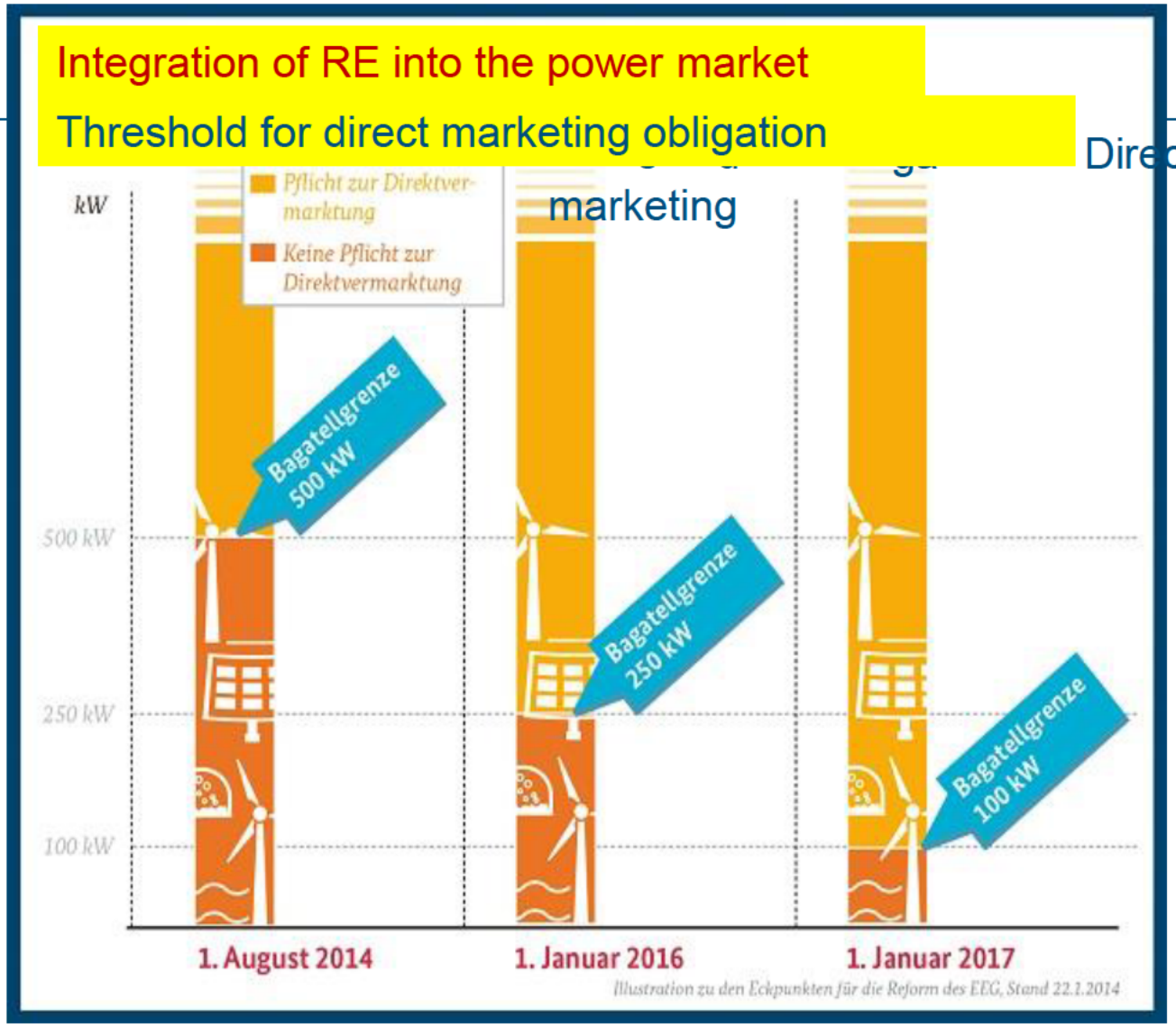


Gratuity for new plants in 2015



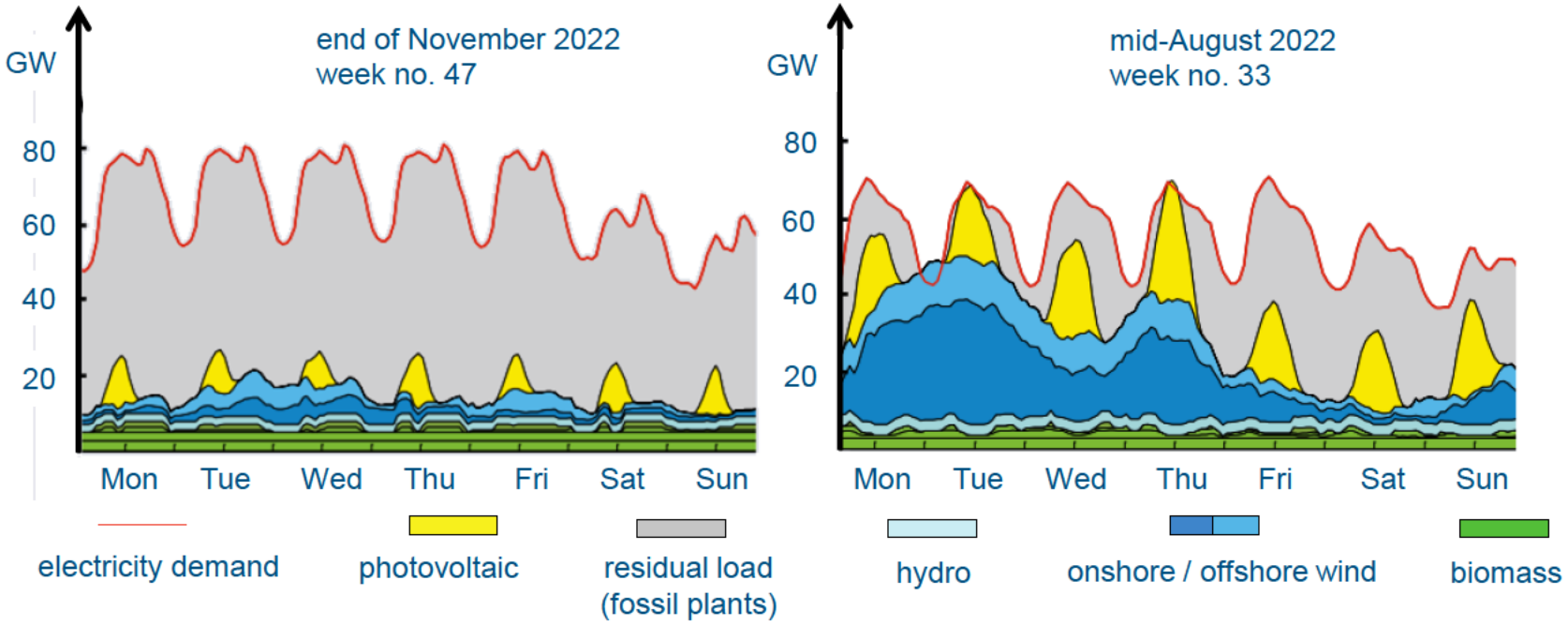
Integration of RE into the power market

Threshold for direct marketing obligation



Direct marketing

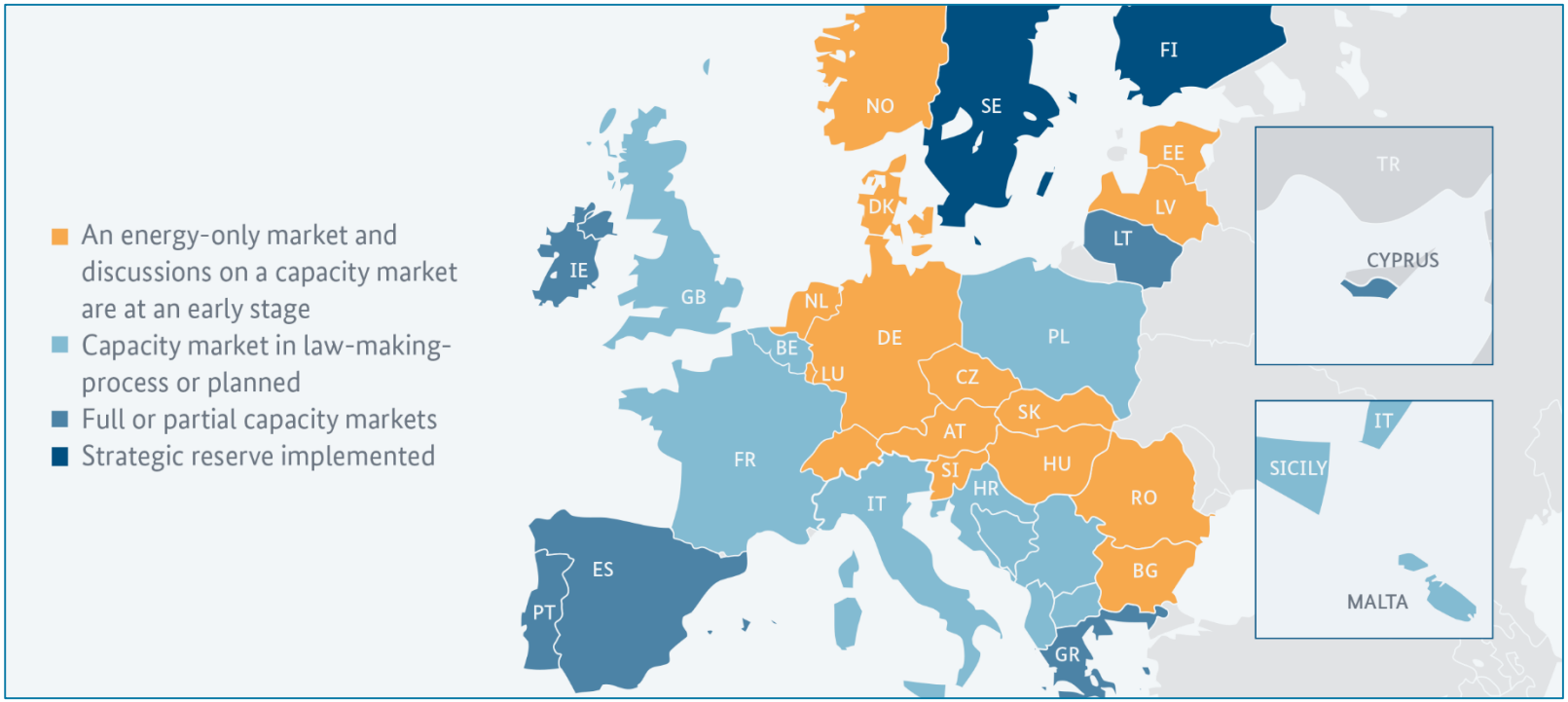
German electricity-system volatility in 2022



Source: Agora Energiewende 2012

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

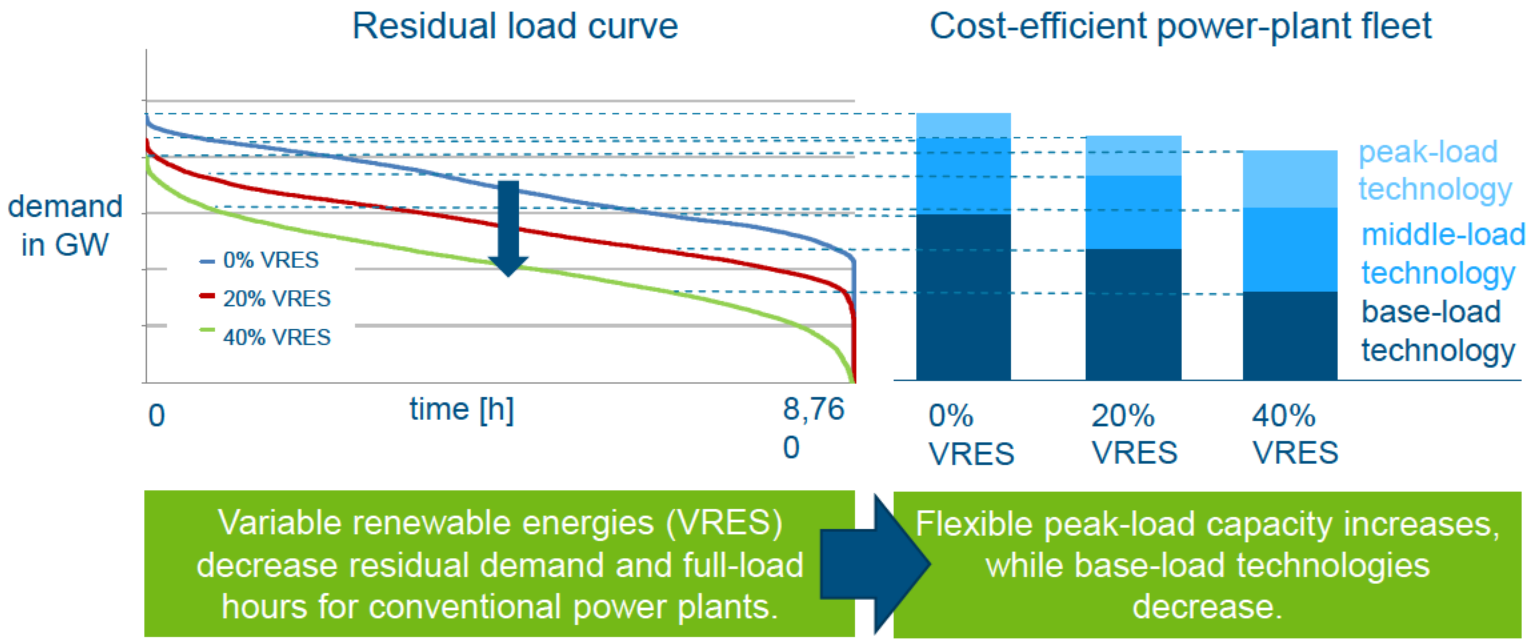
Capacity markets: a way to ensure back-up power?



Source: Ecofys based on Ragwitz et al. 2012

Payment schemes for providing capacity are being discussed in Europe.

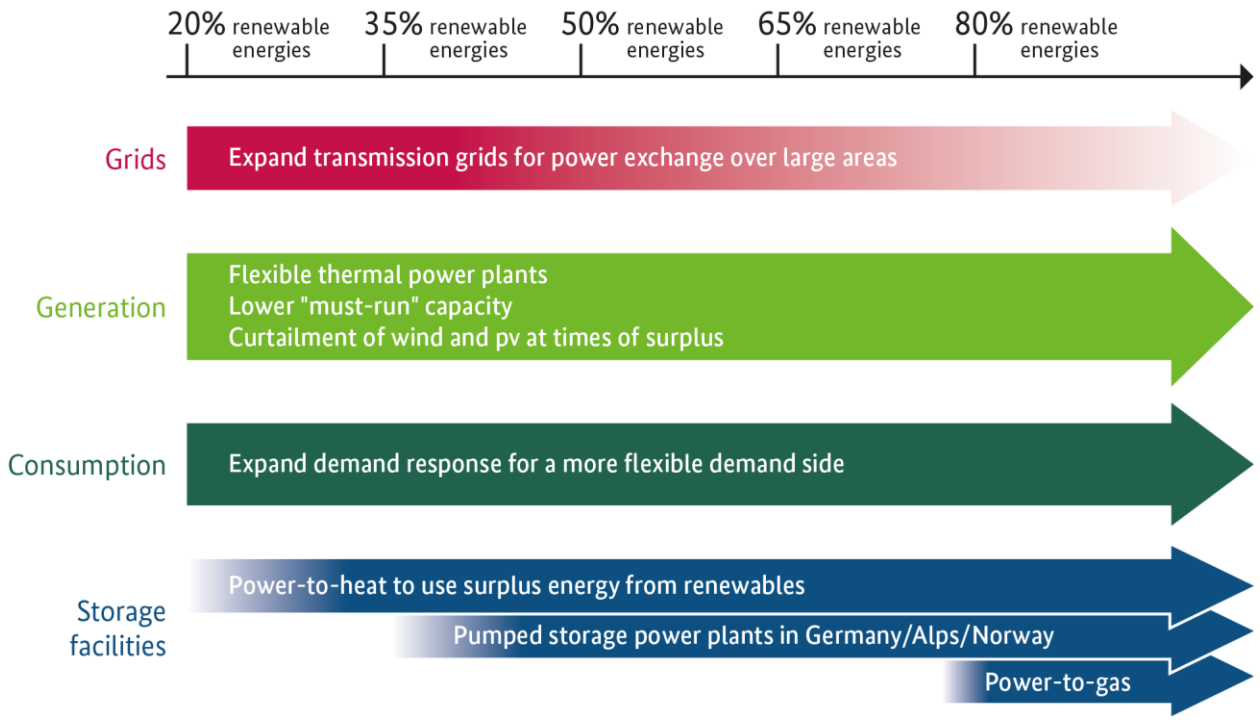
Changes in the economic viability of power plants



Source: Nabe 2006

The power-plant fleet needs time to adjust, but capacity mechanisms should not distort market functions or the energy transition.

Flexibility measures depending on renewables share



Source: BMU 2012

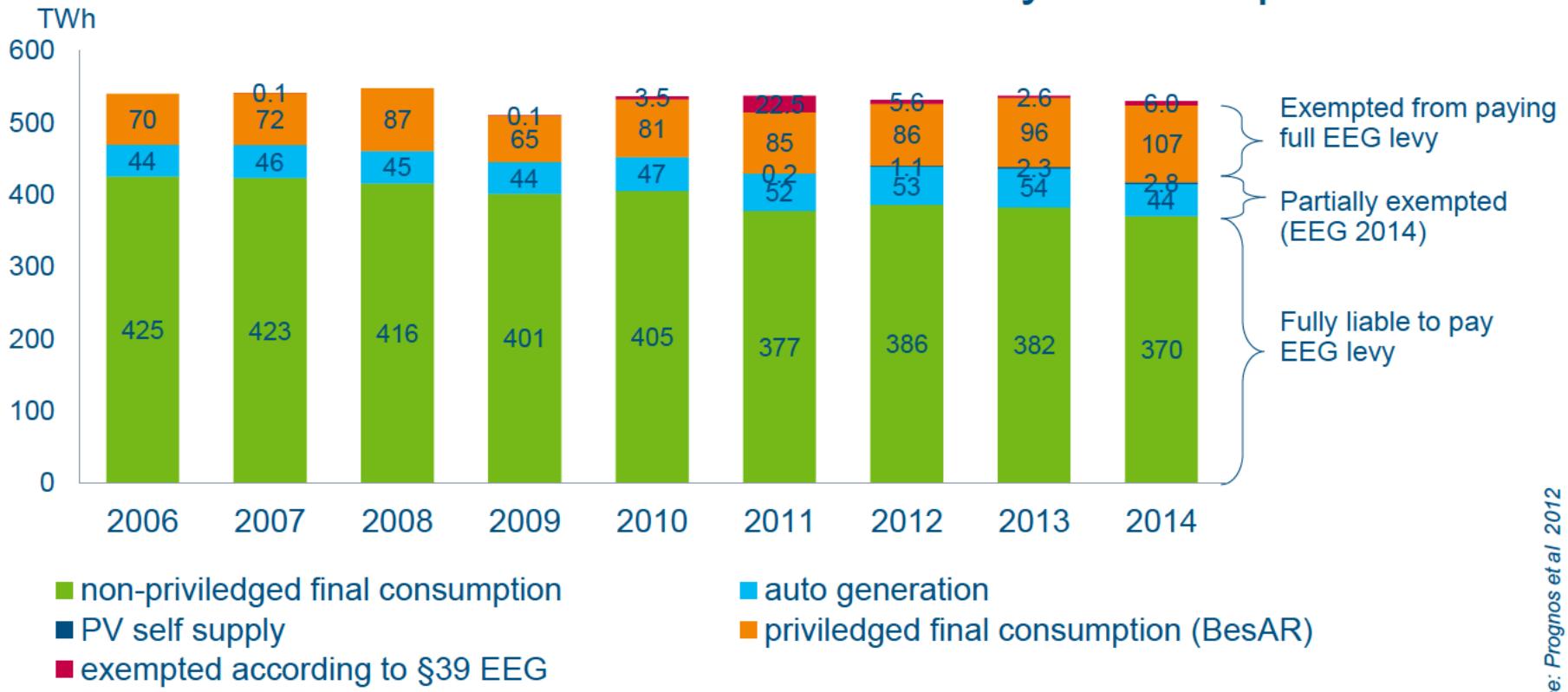
Flexibility needs can mainly be covered by market mechanisms. New storage capacities are only needed for high renewables shares.

(5) Tendering scheme

- General intention: determine support levels through tenders for renewable technologies by 2017
- First, necessary experience needs to be gained
- The first pilot phase from 2015 will cover ca. 400-600 MW ground-mounted PV per year
- Several challenges need to be solved before rolling out tendering, e.g.
  - underbidding,
  - non-realisation,
  - higher risks for investors,
  - strategic bidding

Auctions can help to achieve further support cost reductions.

Distribution of costs – Final electricity consumption



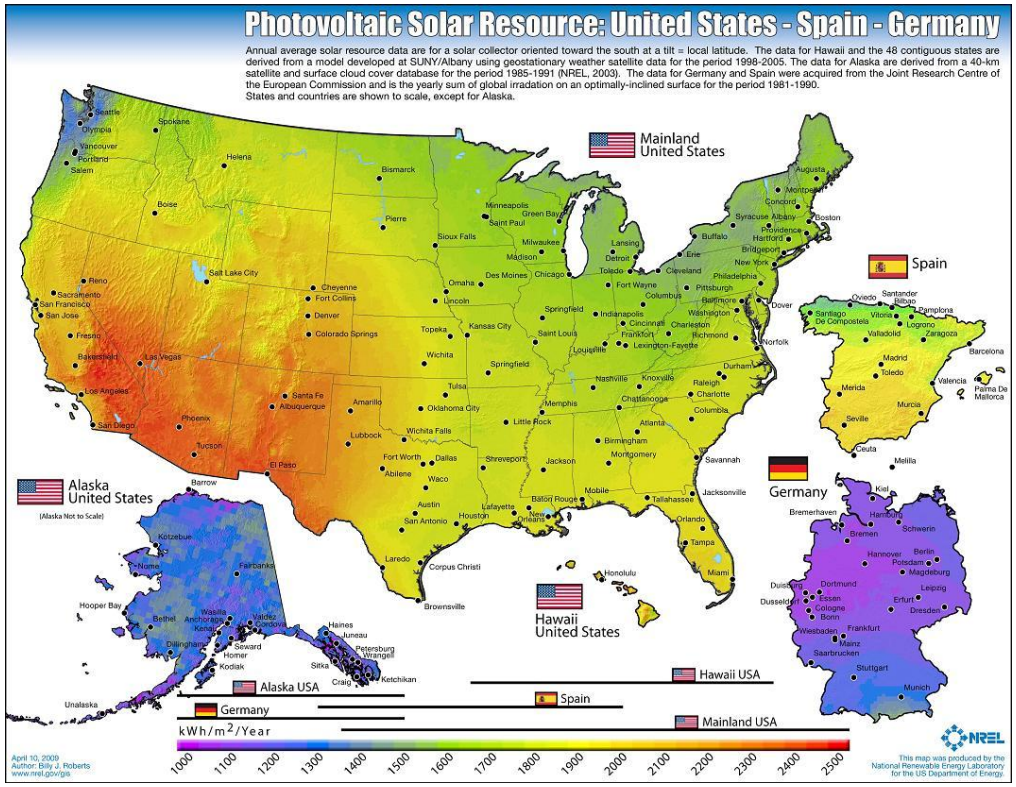
The new EEG also involves those who benefit from the EEG.

Source: Prognos et al 2012

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 is required within Germany and across Europe.
- Energy efficiency potential is greatest in the residential sector and in a shift to co-generation.
- The restructuring offers numerous economic opportunities (for new and existing industries).
- Transportation sector and energy storage are largest variables in planning for the future.
- The implementation will be monitored regularly.

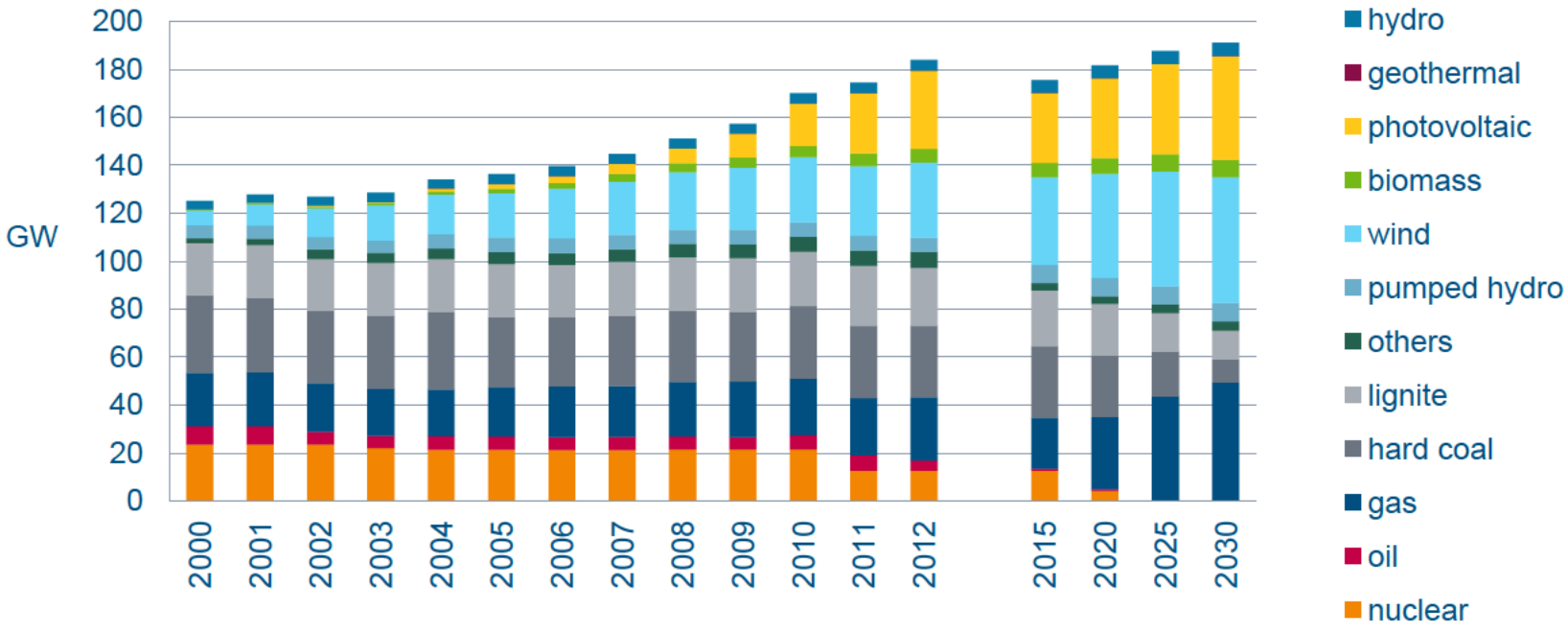
Thank you for your attention!



Dr. Georg Maue, First Secretary Climate and Energy Policy
Embassy of the Federal Republic of Germany
4645 Reservoir Road, Washington, DC 20007

Tel: +1 (202) 298 4355
Fax: +1 (202) 298 4391
E-mail: wi-6@wash.diplo.de

Gross power-generation capacities in Germany

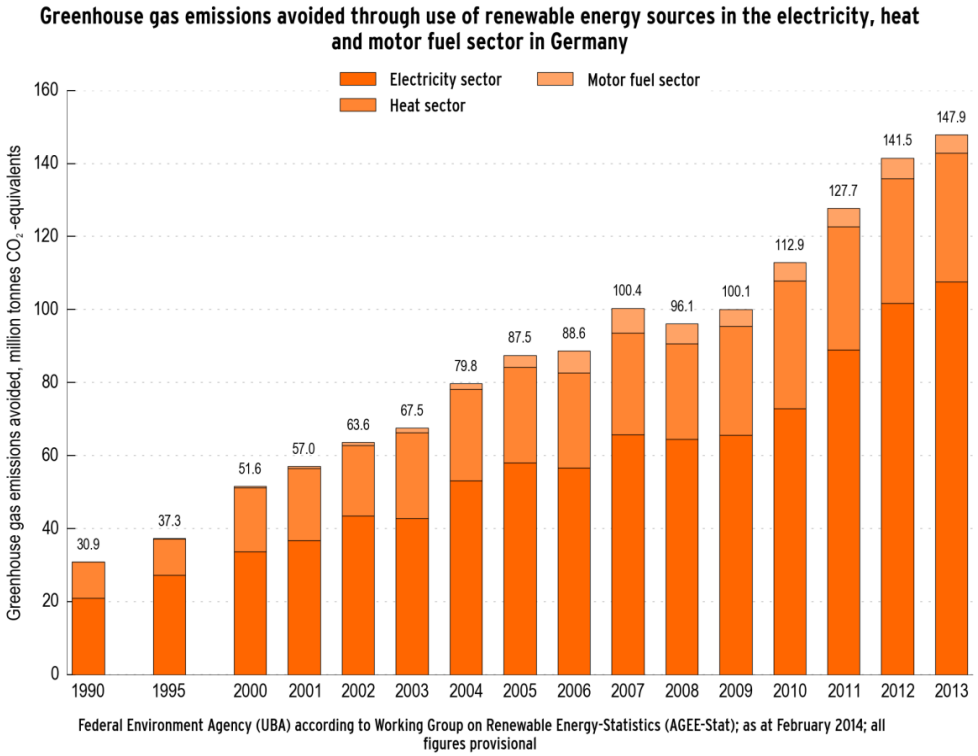


Source: BMWi 2013, Prognos et al 2011

Renewables expansion led to huge growth in capacity. Nuclear and fossil-fuel phase-out only started recently.

Transatlantic Climate Bridge

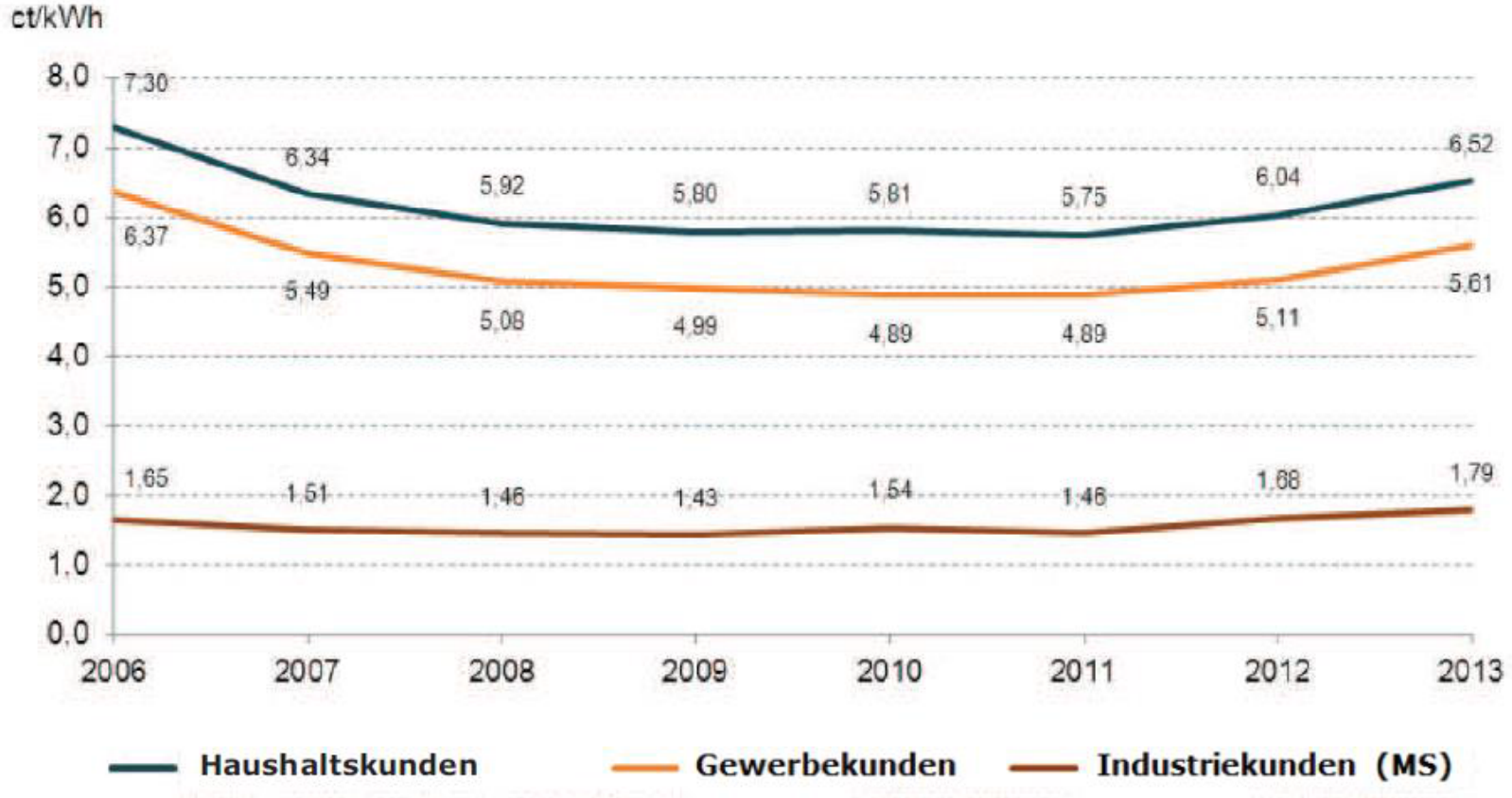
GHG emission savings through renewables use



Source: AGEE-Stat (2014)

In 2013 renewables avoided 148 million tonnes of CO_2 in Germany.

Netzentgelte im Zeitverlauf

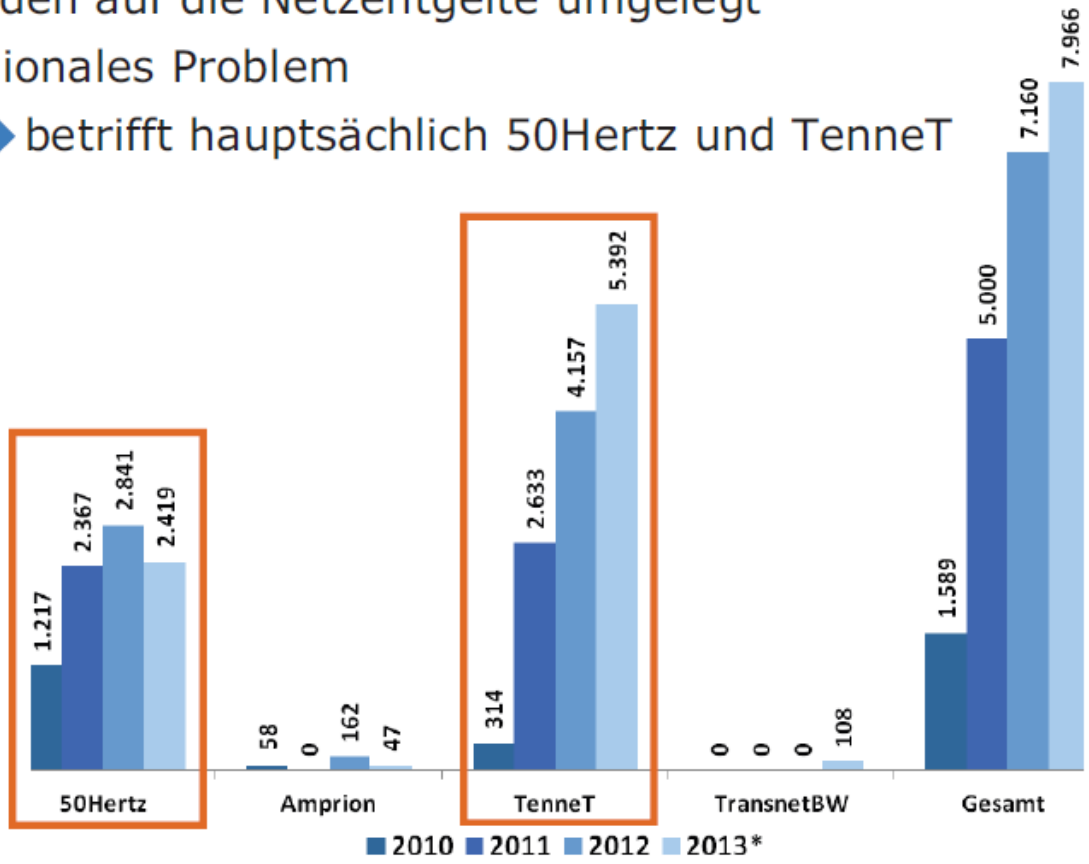


Quelle: BNetzA, Monitoringbericht 2013

Redispatch-Kosten

- Redispatch-Kosten sind Teil der vorgelagerten Netzkosten und werden auf die Netzentgelte umgelegt
- Regionales Problem

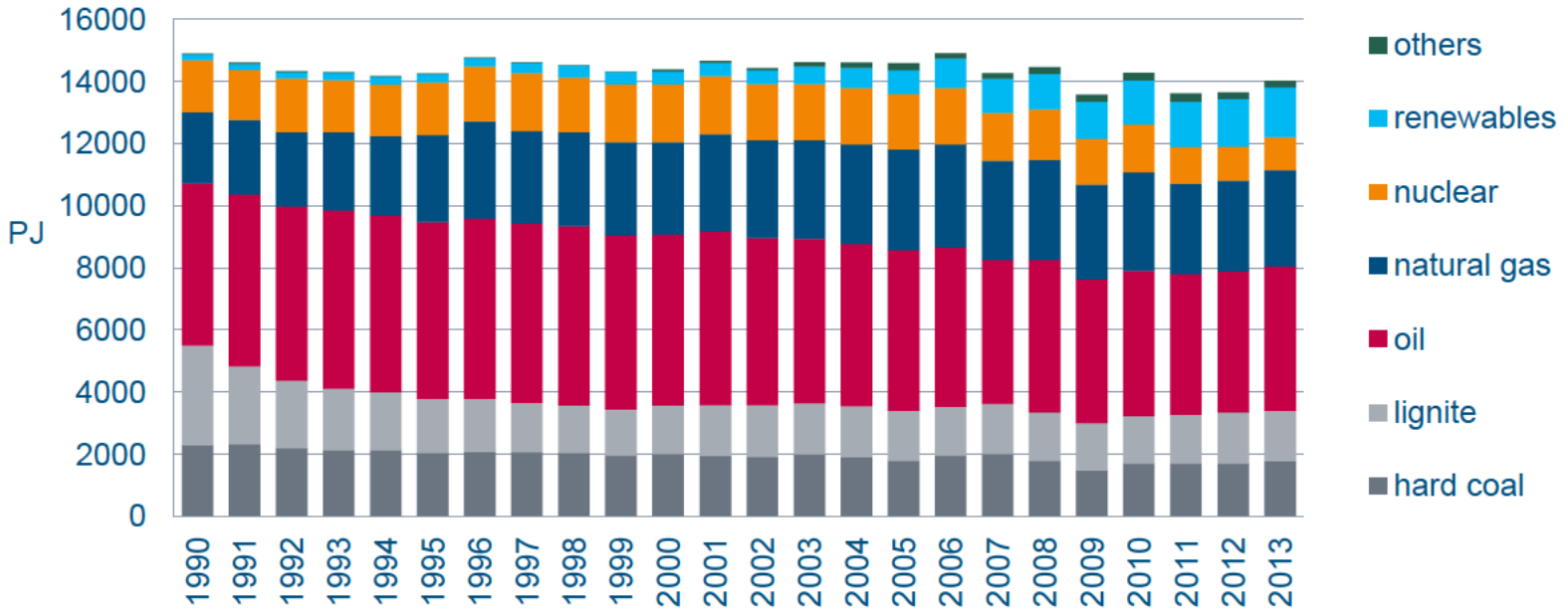
  ➡ betrifft hauptsächlich 50Hertz und TenneT



Entwicklung des Redispatch-Einsatzes (in Stunden)

Quelle: BNetzA

German energy mix (primary energy)

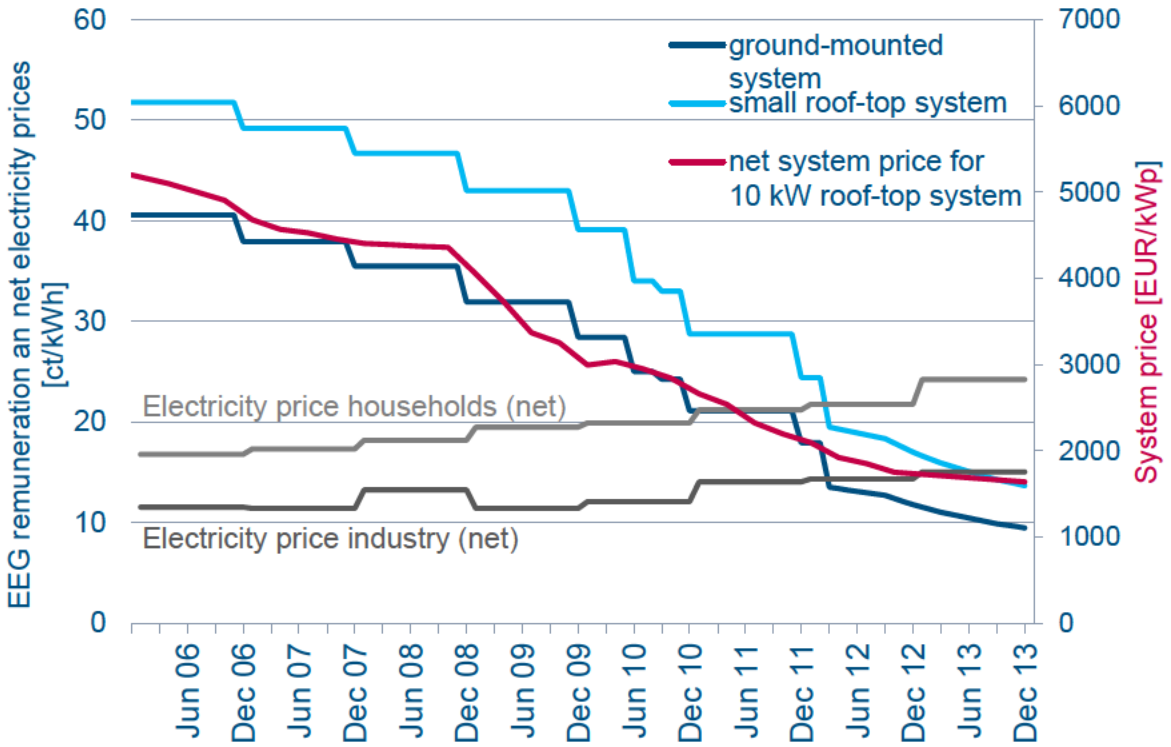


Source: AGEB 2014

Energy efficiency and the switch to renewables are gaining momentum.

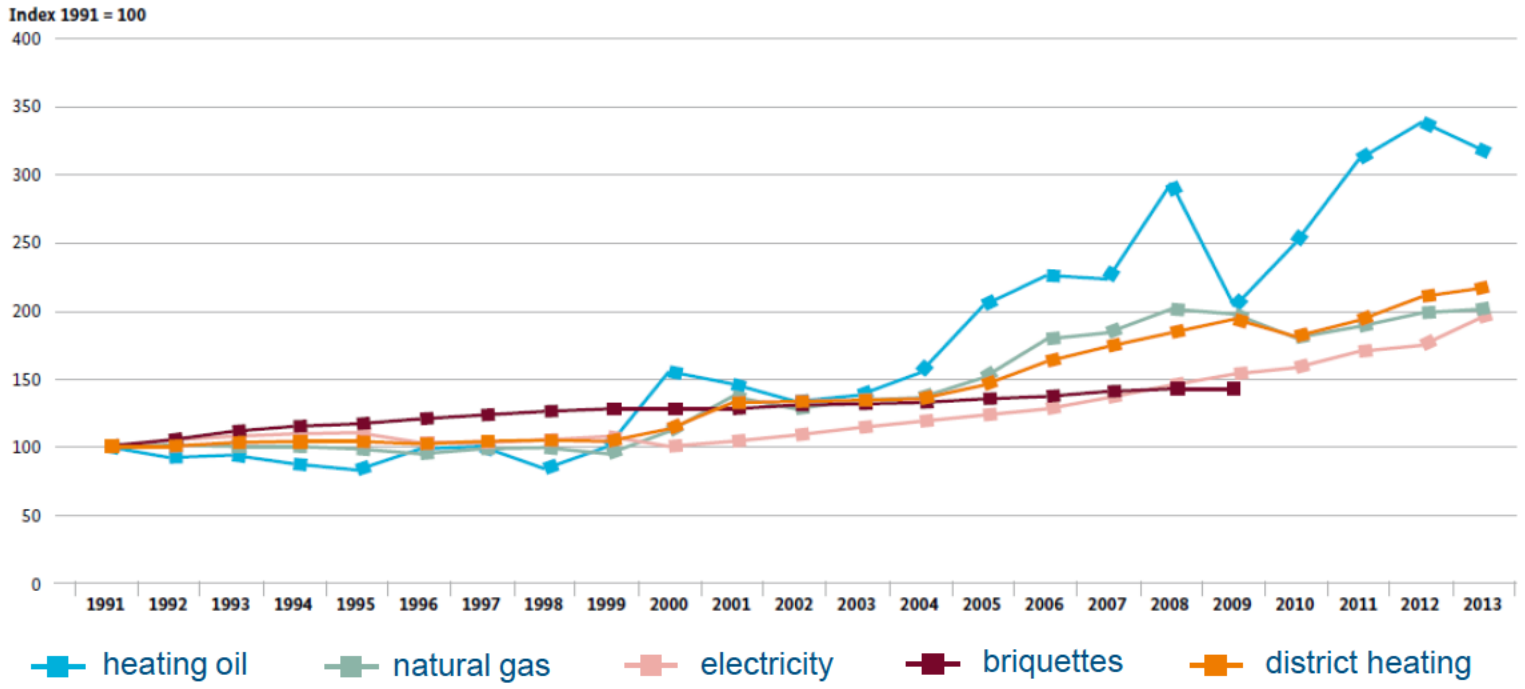
(3) Feed-in Tariffs for PV: support costs decline constantly

Feed-In Tariff Solar energy (Cent/kWh)	January 2006	August 2014
Roof-top installations		
< 10 kW	51,80	13,15
< 30 kW**	51,80	12,8
< 100 kW	49,28	11,49
< 1000 kW	48,74	11,49
< 10 MW	48,74	9,23
Ground-mounted	40,60	9,23 (2015: tender)



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

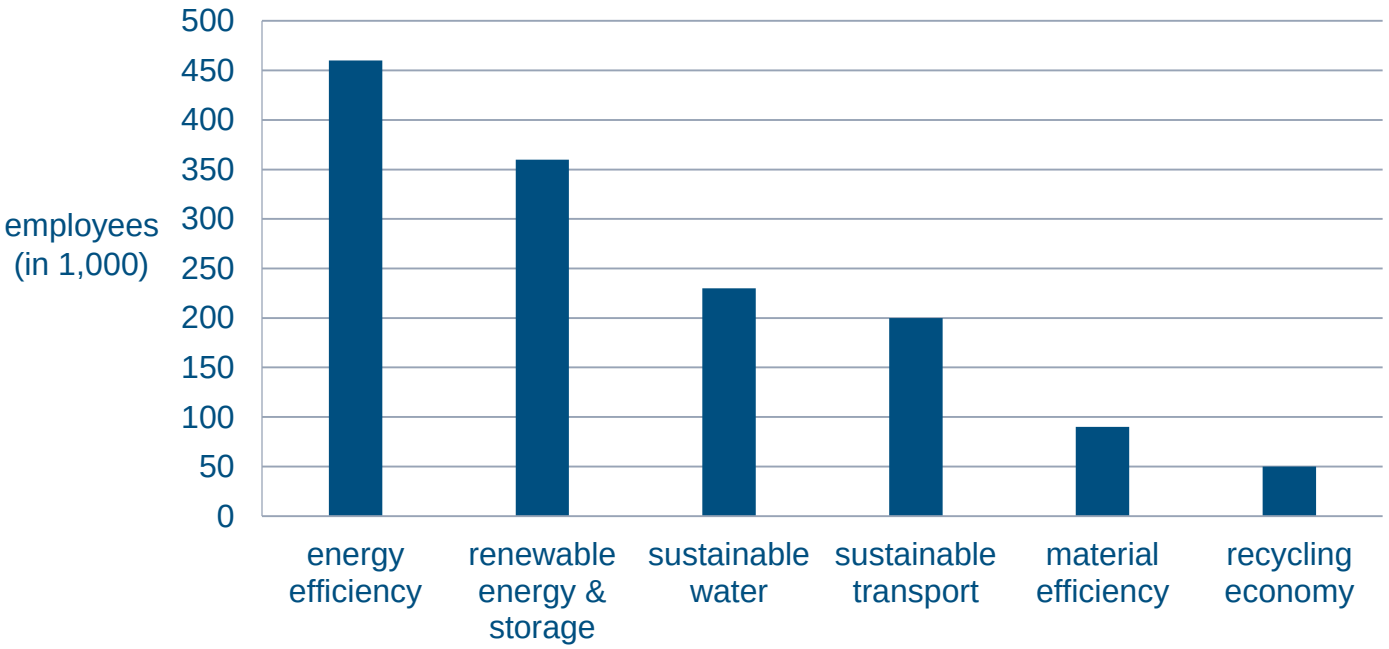
Development of energy prices for private households



Source: BMWi 2014

The household spending for electricity has increased much less than heating cost.

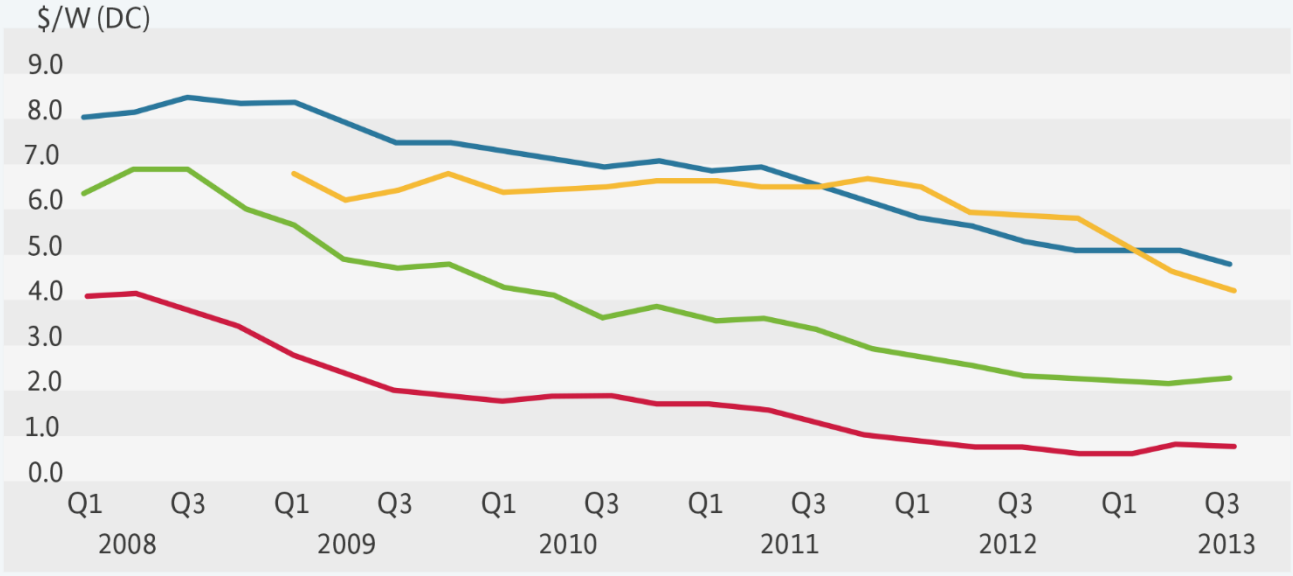
Job creation in the German green tech sector



Source: BMU 2012

The green tech sector already employed 1.4 million people in 2011, with efficiency and renewable energies as the main drivers.

Cost decline of photovoltaic systems



Source: Bloomberg New Energy Finance

Broad market development and constant tariff reduction have more than halved photovoltaic system costs in Germany.

(4) Increase market integration through premium system

- Market price signal reaches RES-E generators, who thus react to market needs
  - RES-E generators can create additional profit by adjustment to market prices
  - Efficient market integration, incentives improved prognosis and balancing

The market premium bears new opportunities and incentivises flexibility.

(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

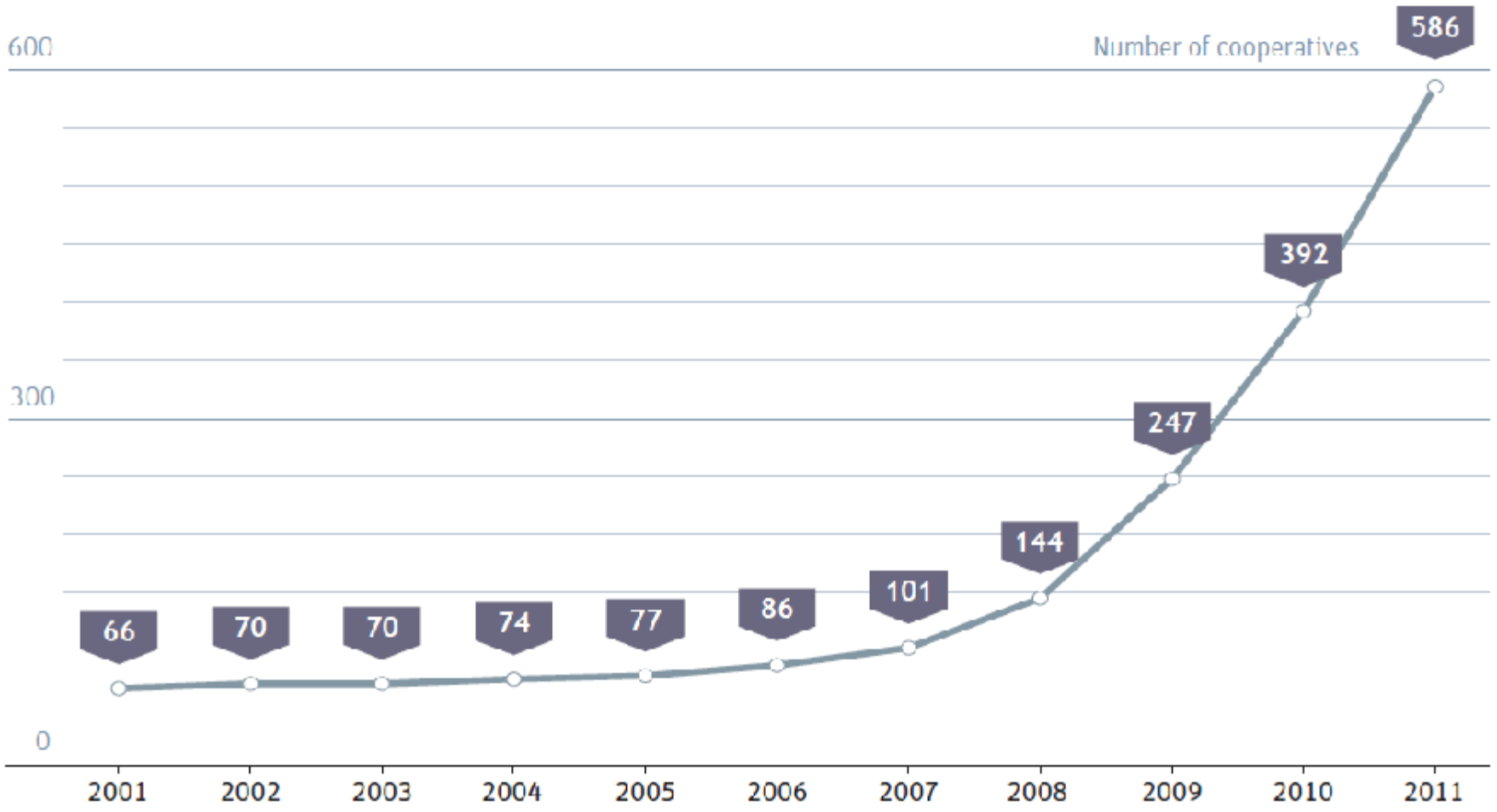
- **Minimum contribution:** full EEG surcharge for the first GWh
- **Price:** In principle, 15% of the EEG surcharge,
  cap at 0,5 % / 4% of gross value added, but at least 0.1 ct for every kWh beyond 1 GWh

The adjusted compensation scheme follows the EU Commission guidelines.

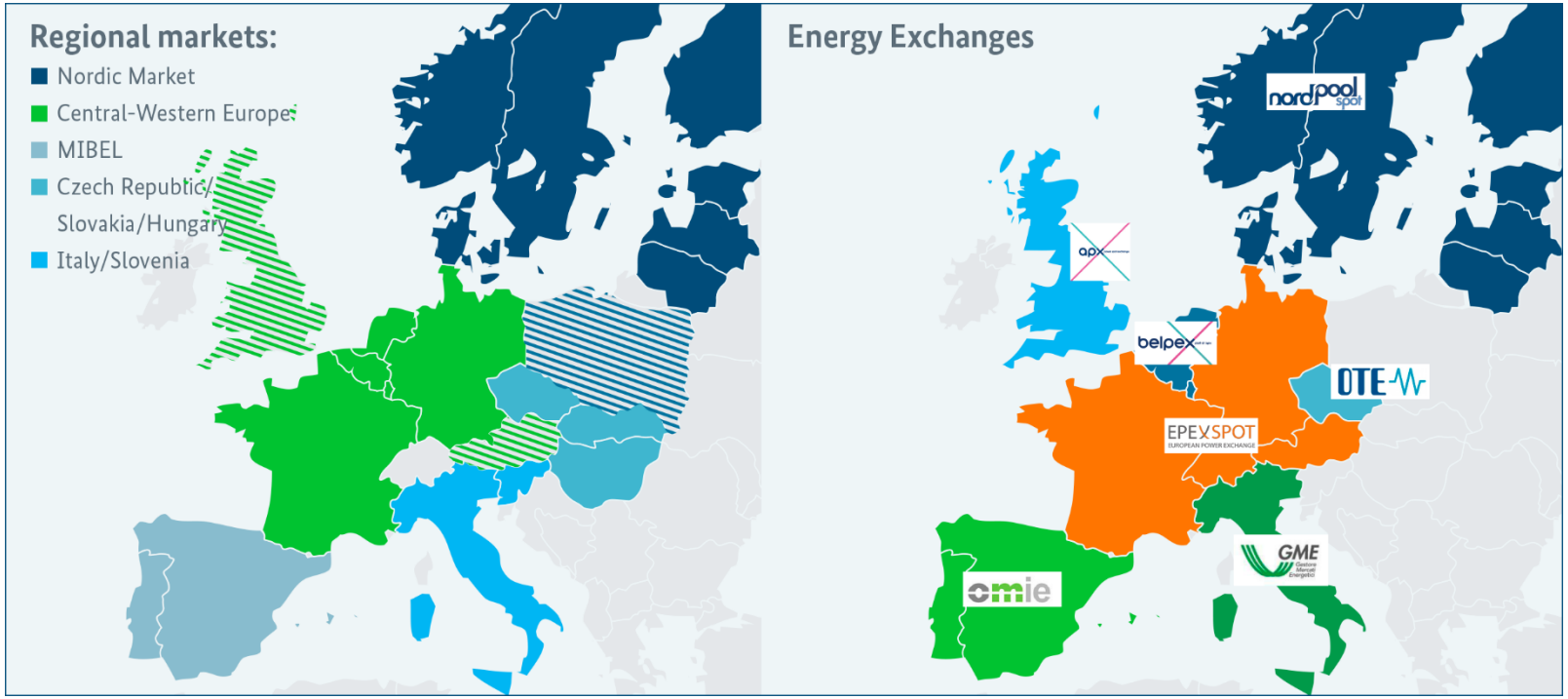
Citizens form cooperatives to drive the energy transition

Number of energy cooperatives in Germany, 2001–2011

Source: AEE



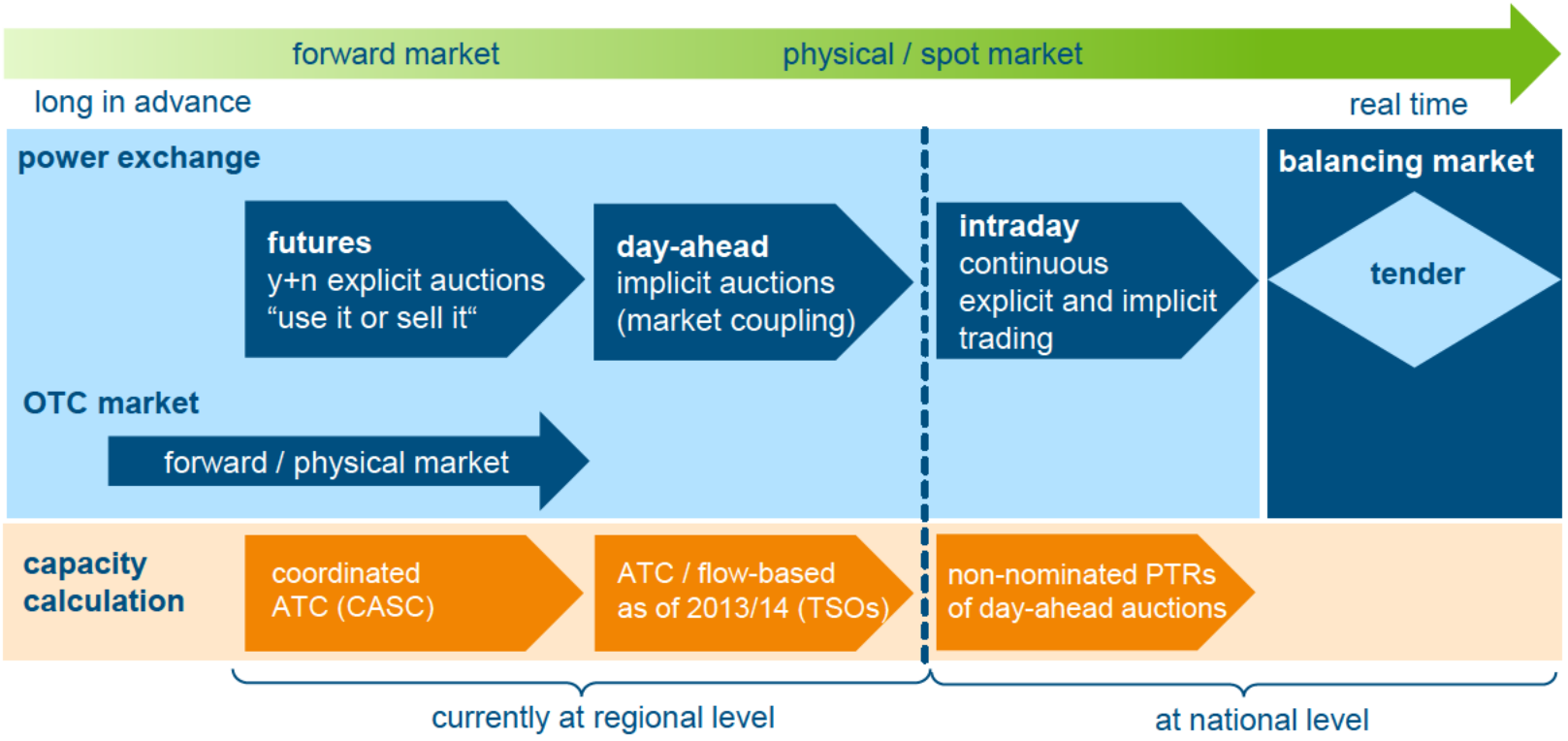
Regional power markets and energy exchanges



Source: REE , 2012, ACER, 2012

Market coupling is an essential bottom-up approach towards establishing a European internal electricity market.

Electricity market segments and products



Source: ENTSO-E, 2012

The is no single European wholesale market, but rather a range of regional and national market segments.

What about the costs and subsidies?