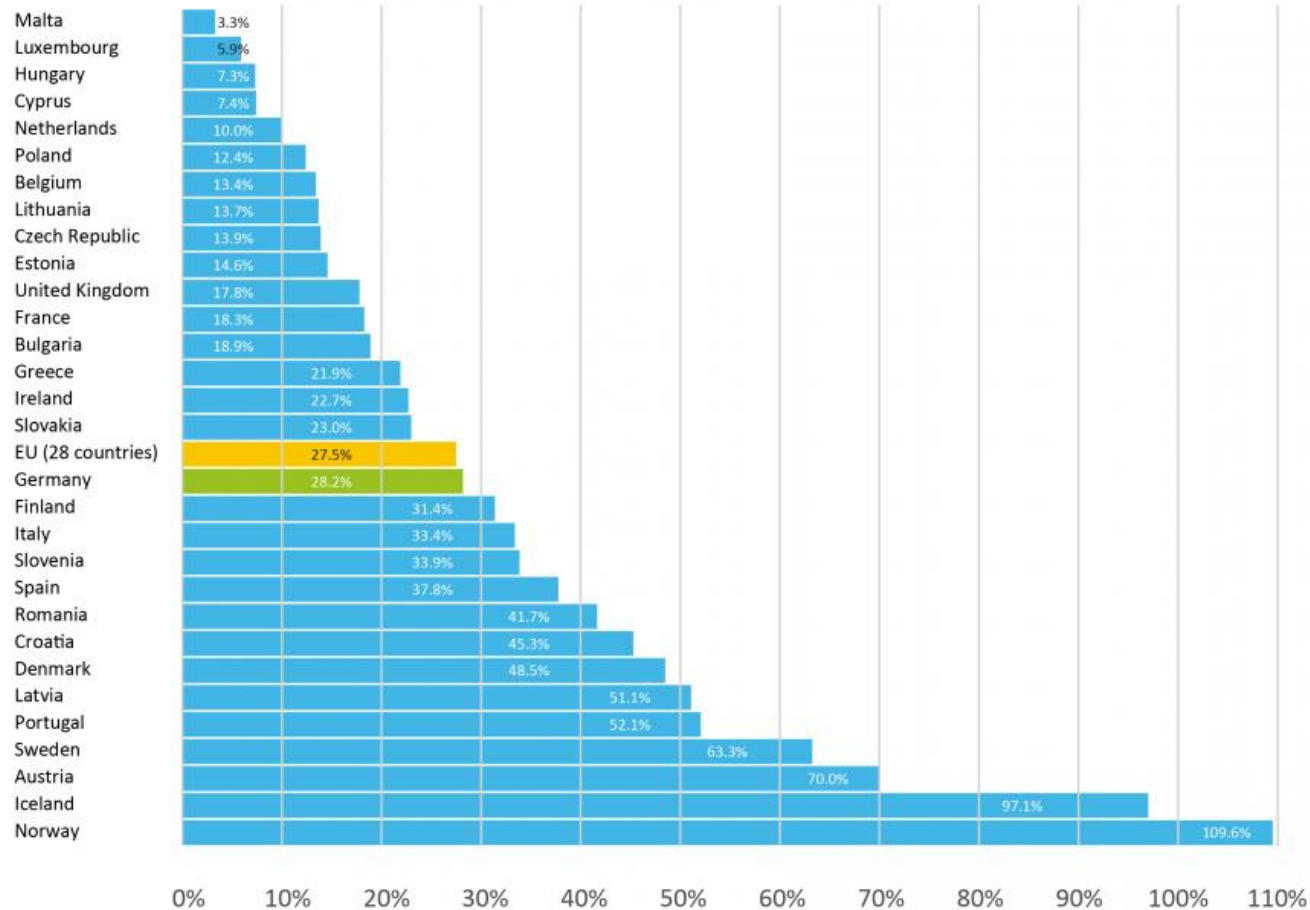


German energy transition - Energiewende

Filip Černoch
cernoch@mail.muni.cz

Share of renewable energy in gross electricity consumption in European countries in 2014.

Data: Eurostat 2016.



Origins of EW

1st pillar: nuclear phase-out

- Long and successful tradition of nuclear industry in Germany – in 70s 17 000MW.
- German anti-nuclear movement – Ausserparlamentarische Opposition in 60s (leftist students), environmental movements, local opposition.
- Three Mile Island in 1979, Chernobyl in 1986.
- 1998 Greens in federal govt (with SPD) – Germany's plan to gradually withdraw from the atom.
- In 2010 the Atomic Energy Act amended – plant lifespan extended, production limits on nuclear electricity increased.
- 2011 Fukushima – phase-out by 2022.

Origins of EW

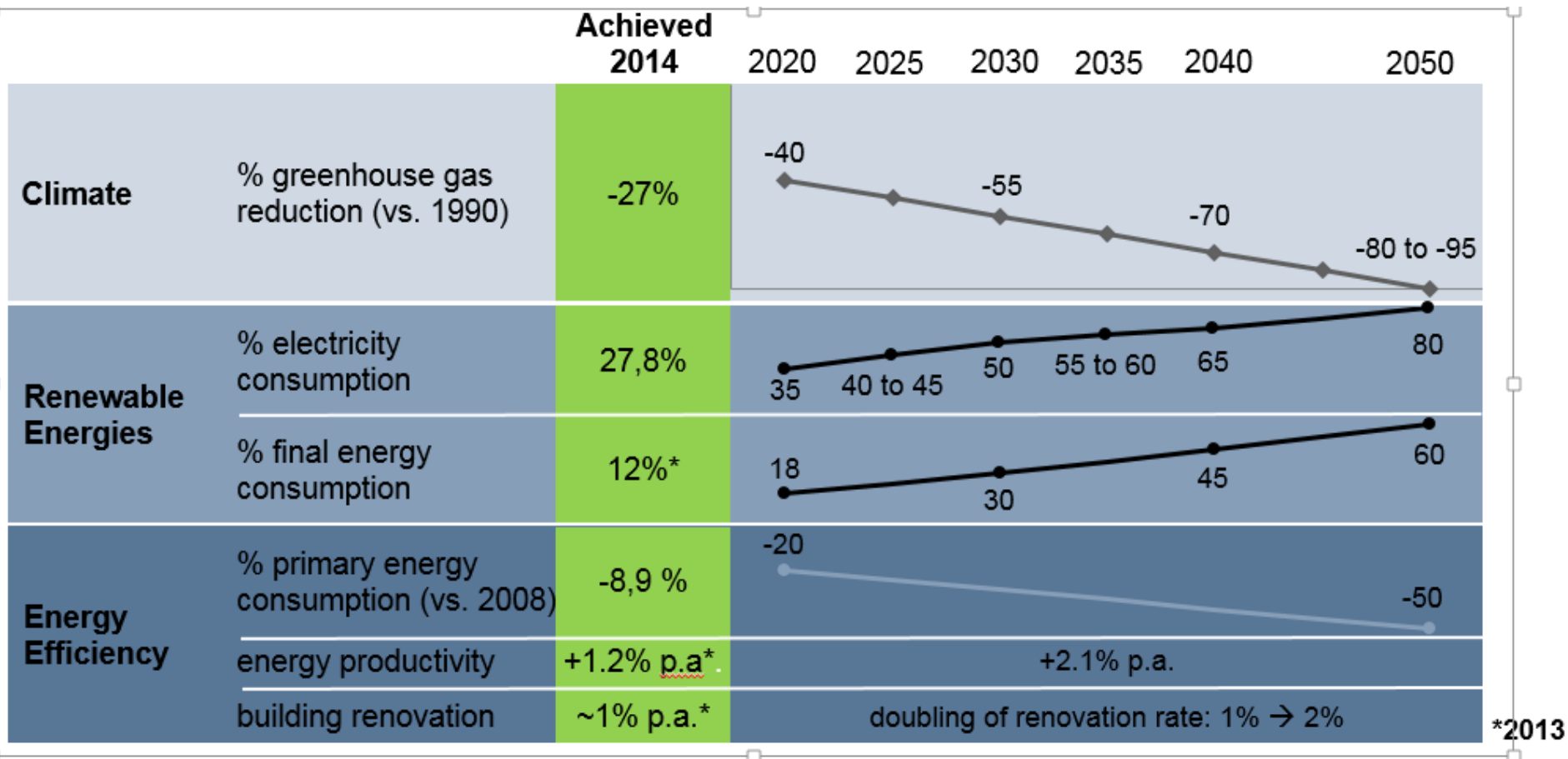
2nd pillar: climate protection measures.

- In 70s anti-nuclear sentiment, environmental consciousness and oil crisis raised the issue of RES.
- 1974 first RES subsidy program – PV parks. Furthered in 1977 – 25% of investment costs reimbursed.
- 1990 – Act on the Supply of Electricity from RES into the Grid (StrEG)
- 2005 – Merkel’s great coalition (CDU/CSU + SPD) – ambitious climate plans, incl. RES and energy efficiency.
- 2010 – Energy Concept for an Environmentally Sound, Reliable and Affordable Energy Supply ->Energiewende

Targets of the EW

- To cut greenhouse gas emissions by 40% by 2020, by at least 80% by 2050.
- Share of RES in gross final energy consumption to 60% in 2050 (10% in 2010). The share of RES in electricity supply 80% by 2050.
- Reduction of energy consumption by 50% by 2050 (reference year 2008).
- By 2050, electricity consumption to drop by 25% compared to 2008. Final energy consumption in the transport sector to be reduced by around 40% by 2050 compared to 2005 levels.
- Nuclear phase out by 2022. (Fukushima Daiichi 2011).

Targets of the EW



Economic growth, power & energy consumption, GHG emissions 1990 - 2016.

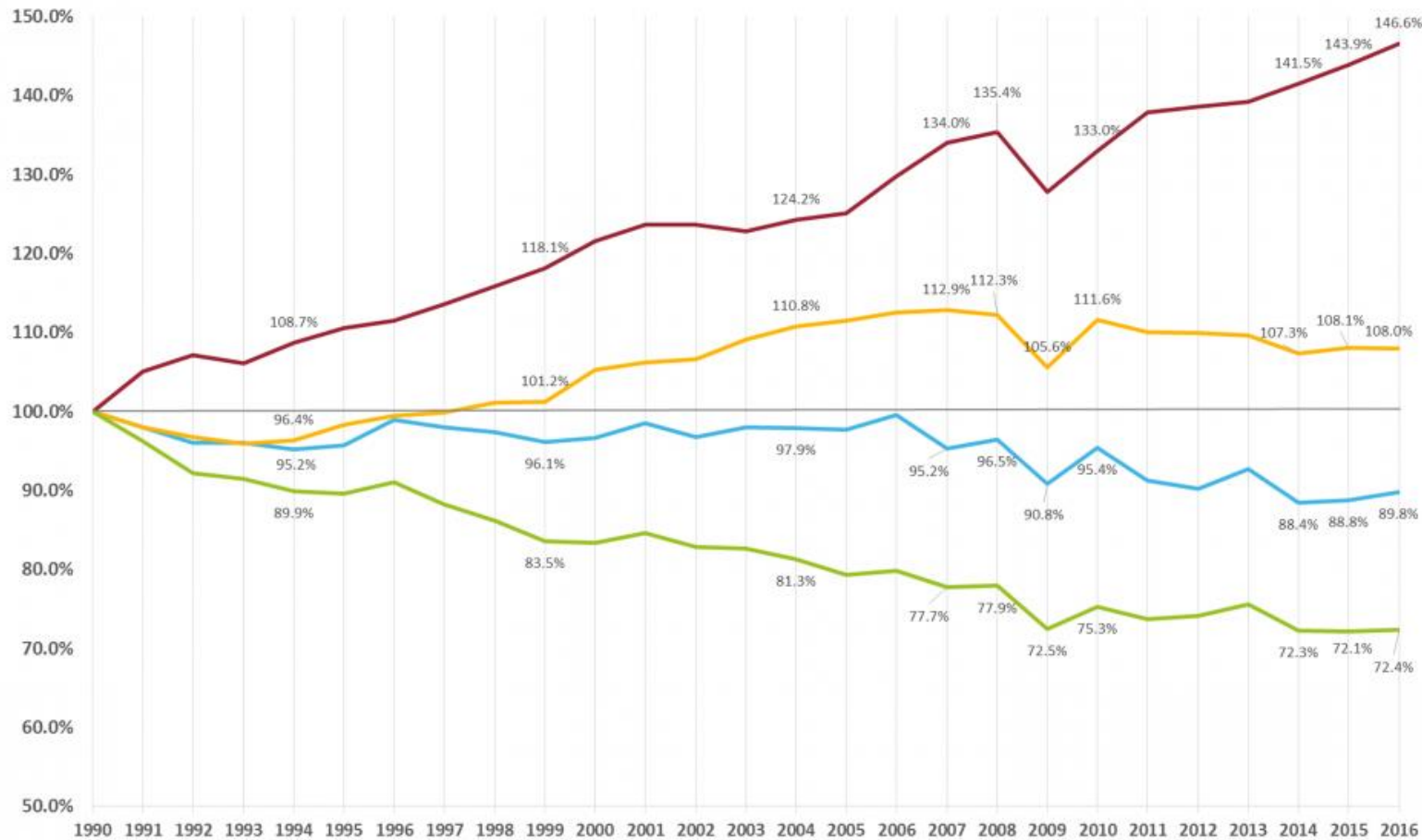
Data: BMWi, UBA 2017.

Gross domestic product (GDP)

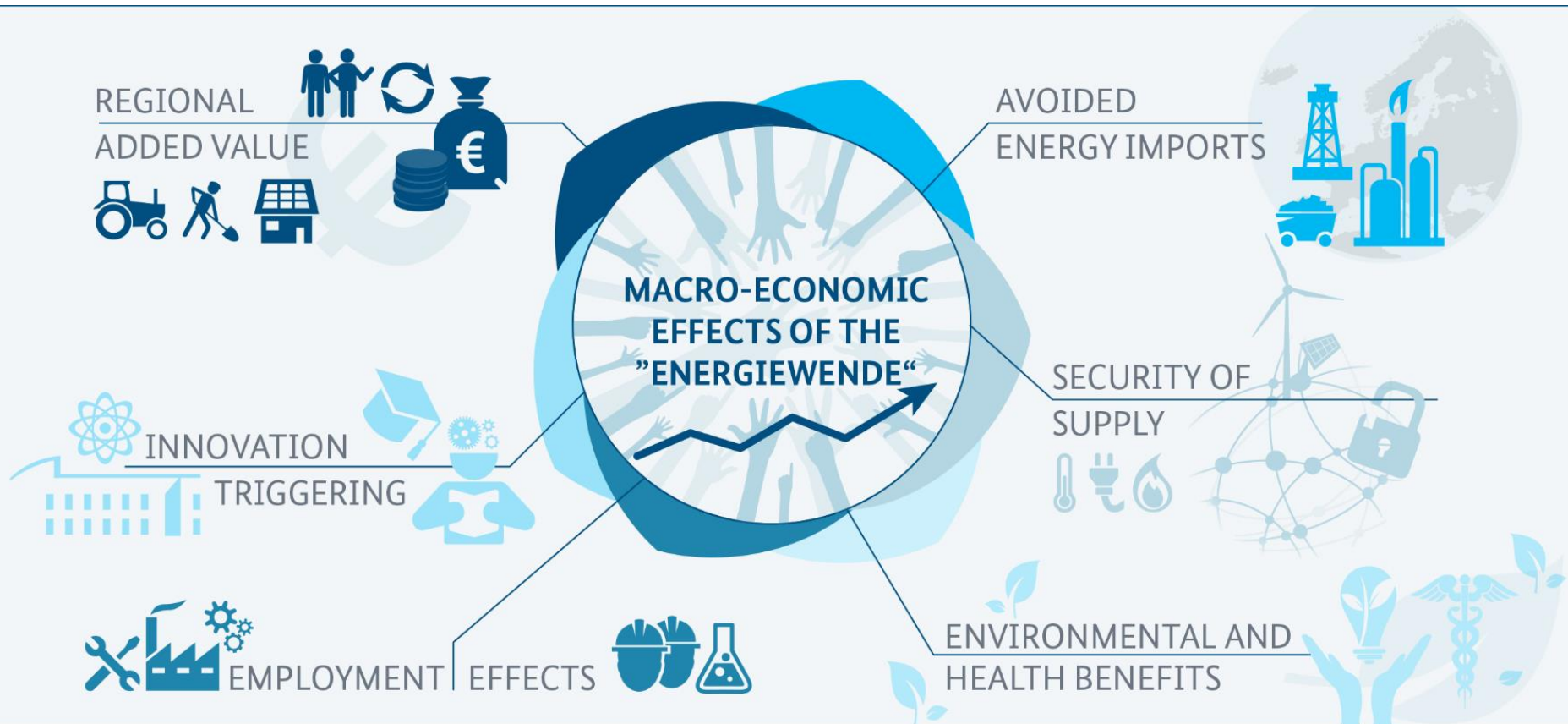
Gross power consumption

Primary energy consumption

Greenhouse gas emissions

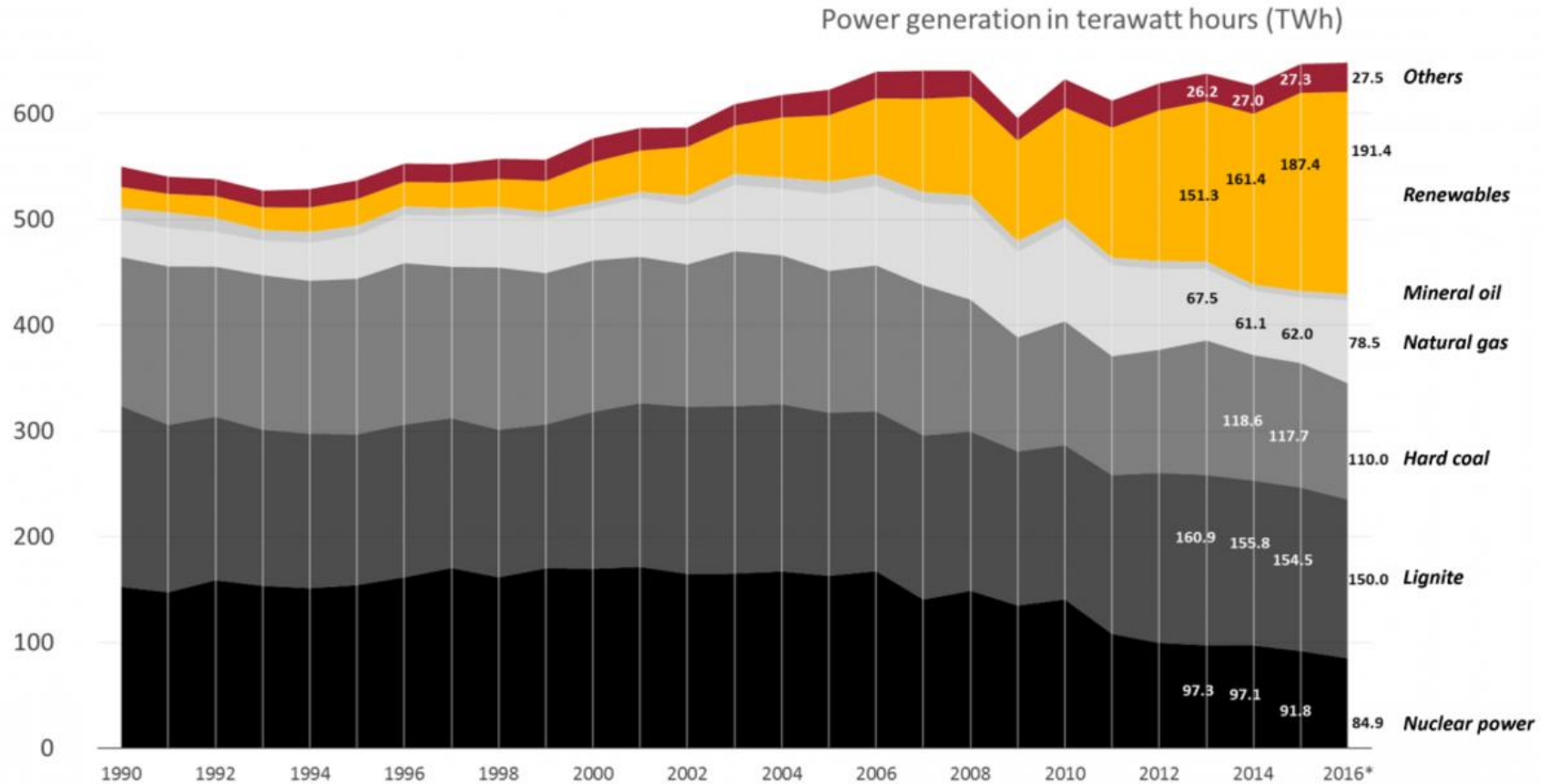


Declared benefits of the Energiewende

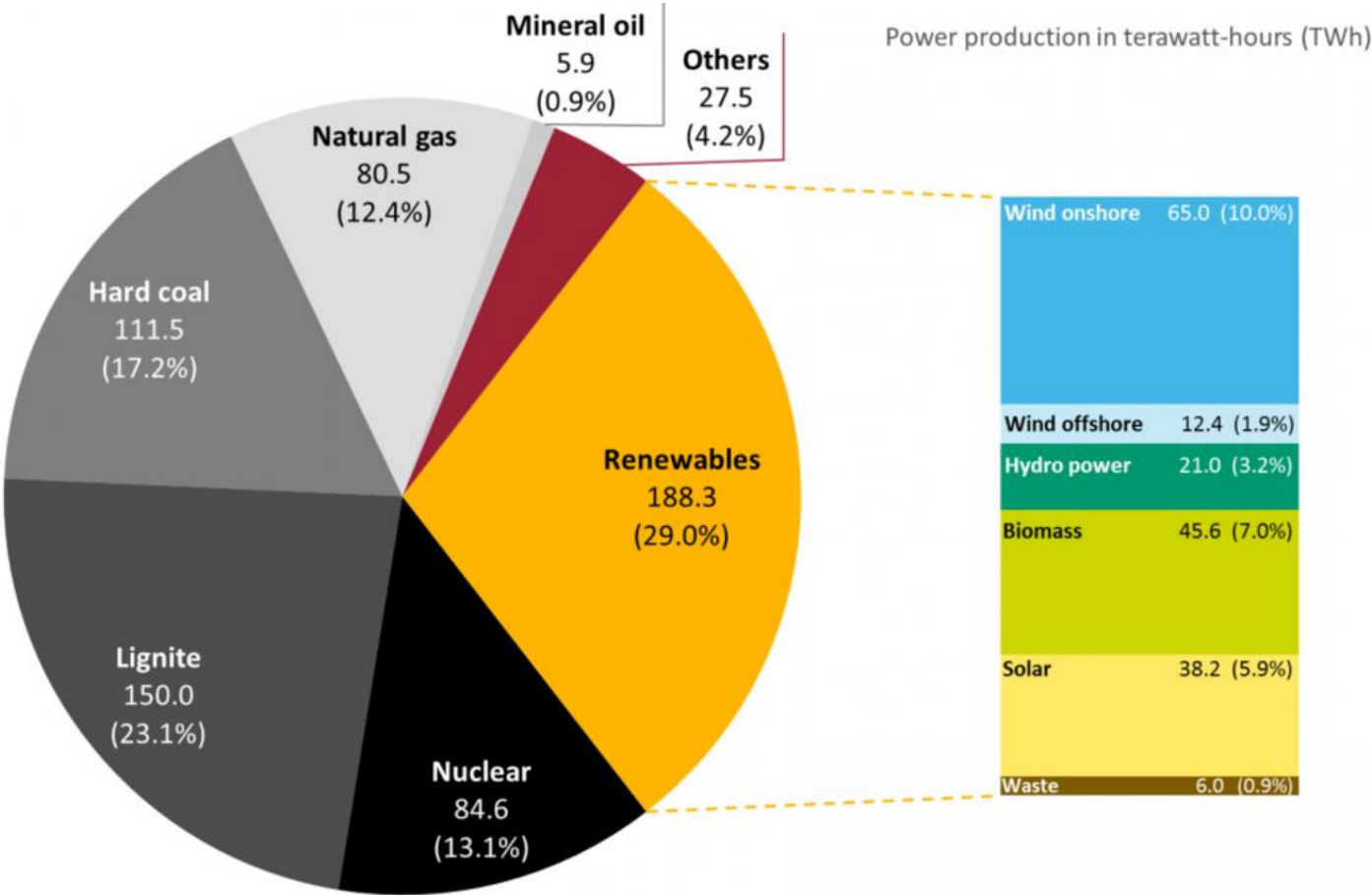


Performance of German energy sector

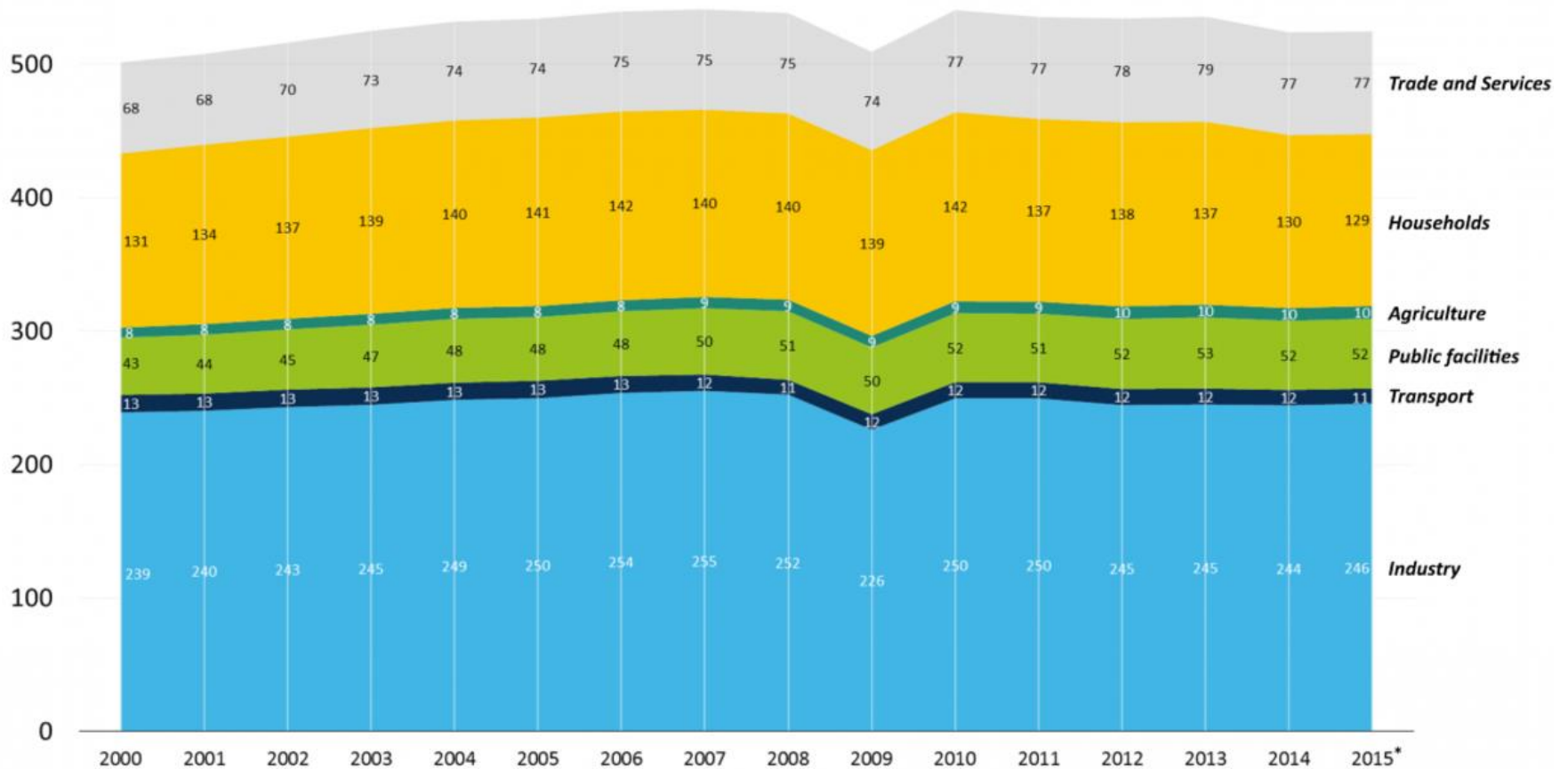
Gross power production in Germany 1990 – 2016 by source, in TWh



Share of energy sources in gross power production in 2016 (preliminary data)



Net power consumption by consumer group 2000 - 2015

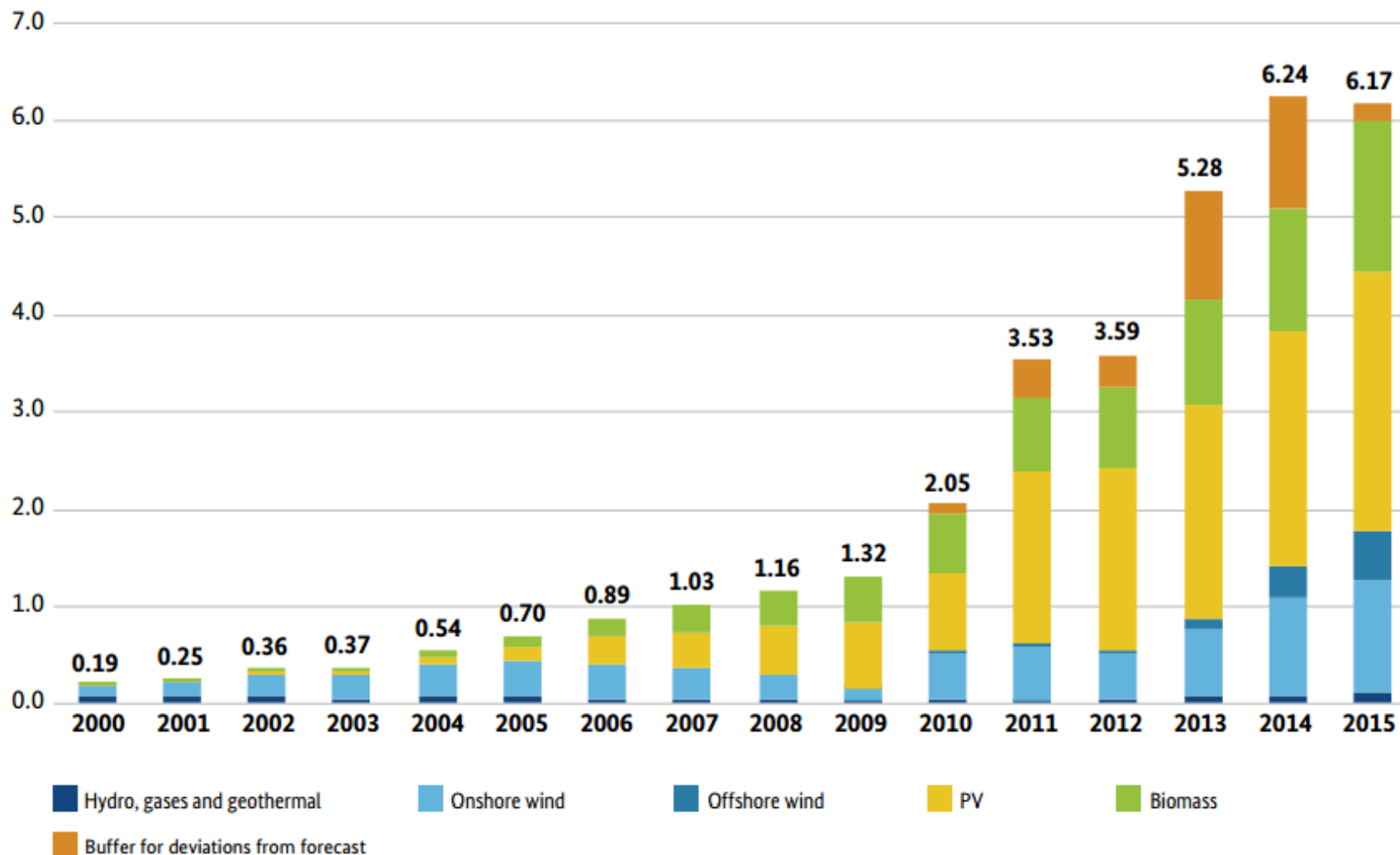


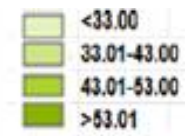
Major challenges

1) Costs of EW

- €550 bn. until 2050 (yearly investments €15bn., or 0,5% of GDP respectively).
 - Costs of Atomausstieg
 - RES surcharges
 - Grid investments and management
 - Additional activities
- Wholesale prices of electricity among the lowest in the EU (this reinforces the competitiveness of industry).
- Households pay one of the highest prices in the EU (regulated component of prices).
- Cost unevenly distributed. Paid mainly by households, companies exempted to a great extend.

EEG surcharge in c/kWh

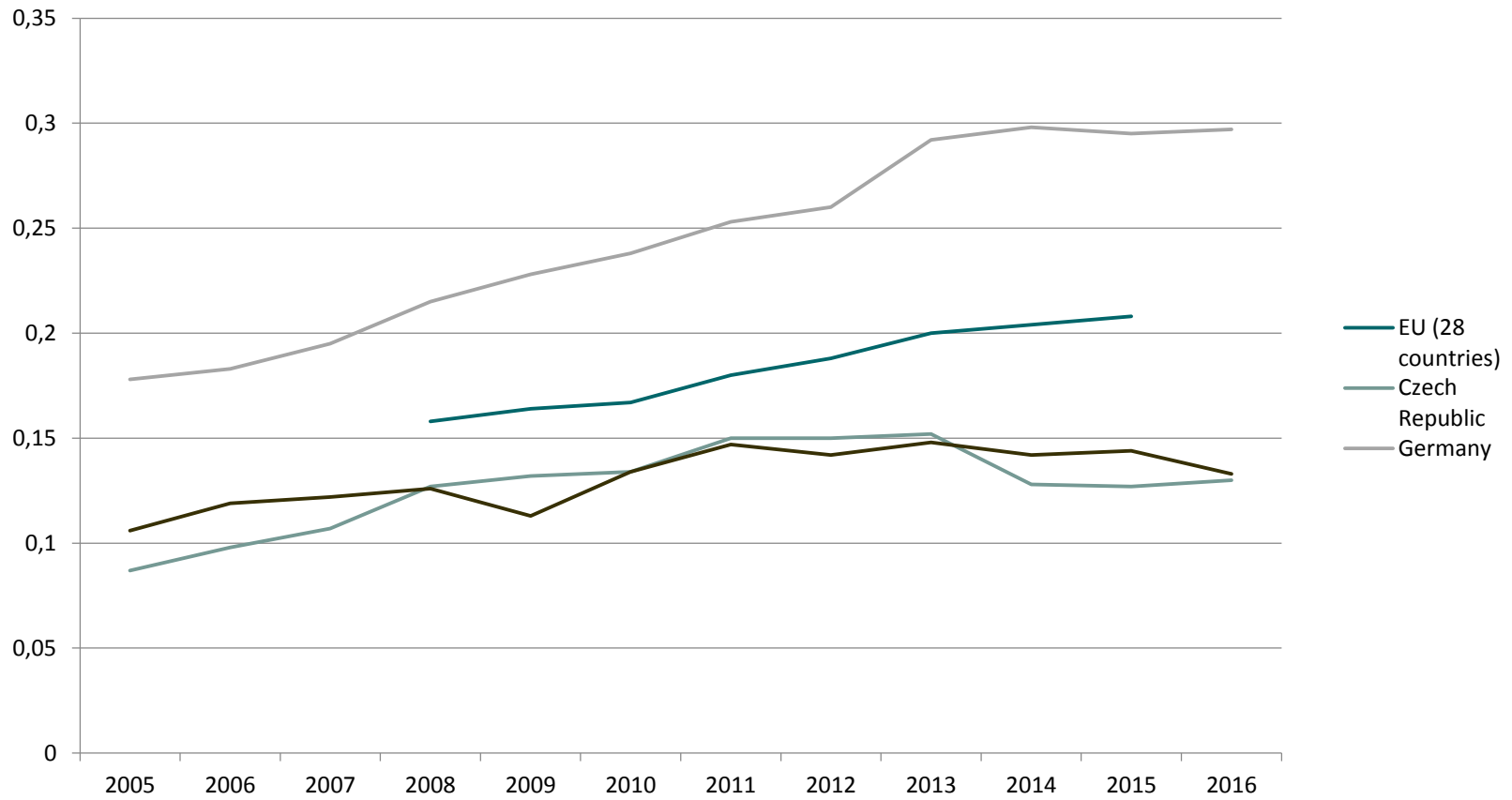




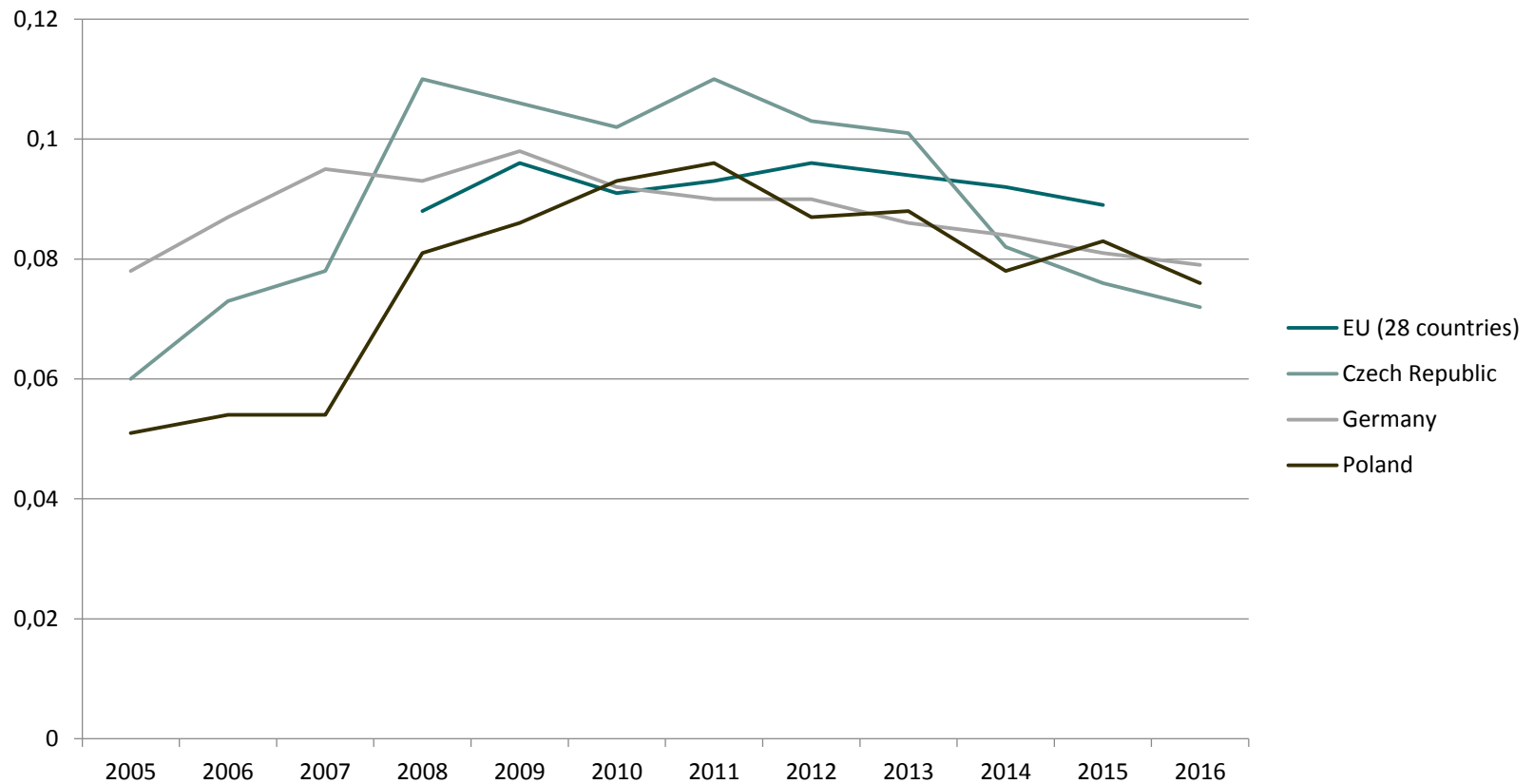
MT: No Data
Malta

CY: No Data
Cyprus

Electricity prices – medium size households (eur/kWh)



Electricity prices – medium size industries (eur/kWh)



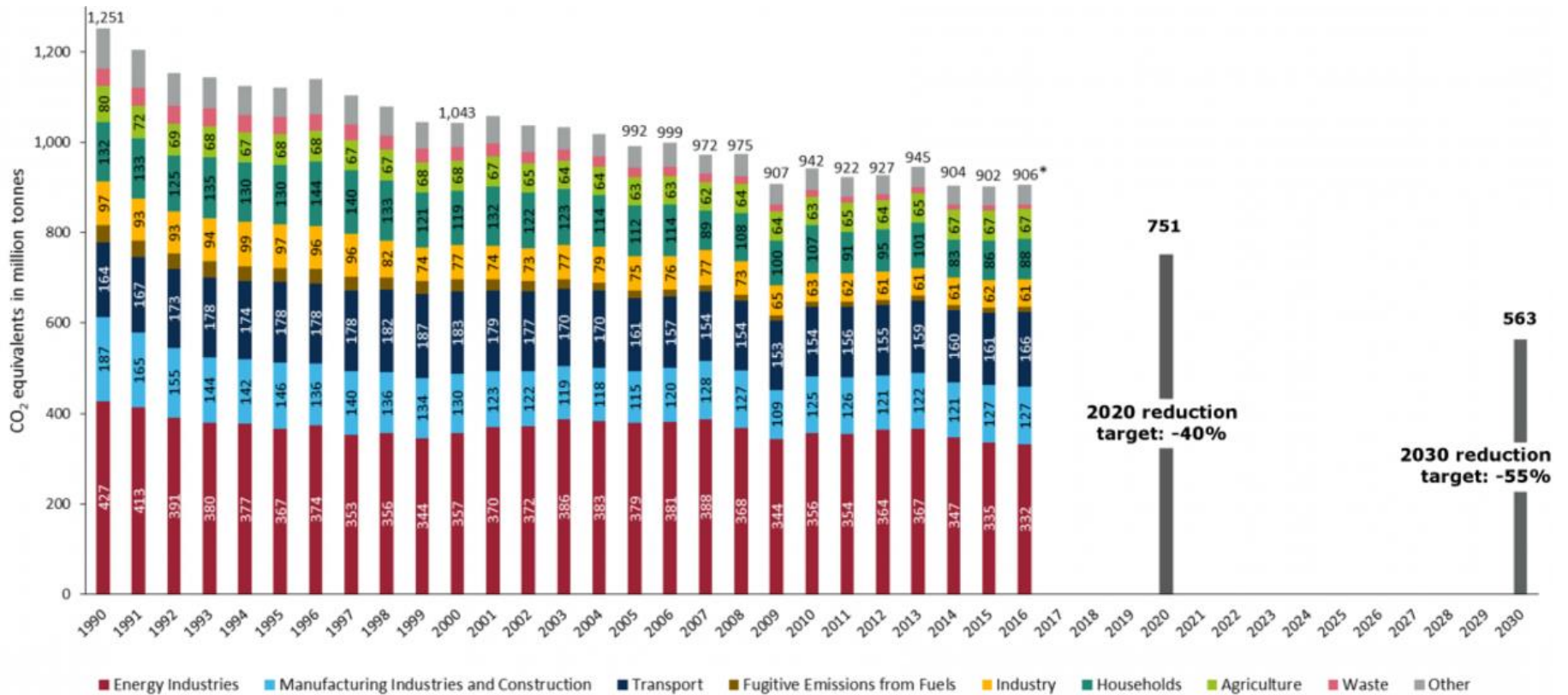
Reform of EEG in 2014

- Annual growth targets (2,5 GW each for wind and solar-PV)
- Growth targets for new biomass minimal
- Auctions for PV-parks (starting 2015) and wind energy announced for 2017
- Balancing and wholesale market integration mandatory for new installations (except small ones)

2) Coal consumption and CO₂ emissions

- Increasing of the proportion of hard (from 117 TWh to 121,7 TWh between 2010-2013) and brown (from 145,9 TWh to 160,9 TWh) coal in electricity production.
- Emissions of CO₂ has been flat/increasing slowly.

Greenhouse gas emission trends in Germany by sector 1990 - 2016



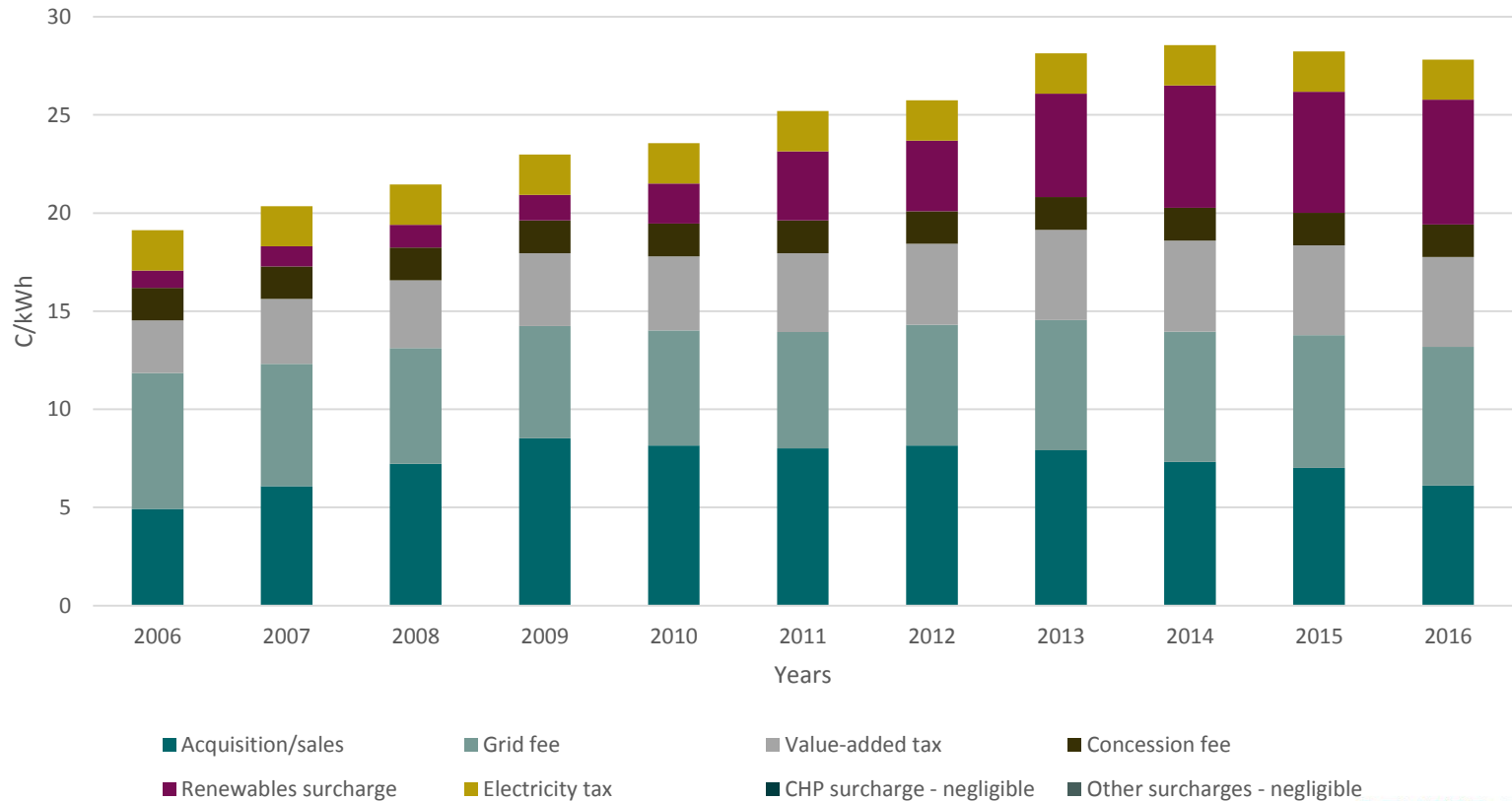
*First estimates by UBA
Without emissions from land use, land-use change and forestry (LULUCF)

3) Public support of EW

- 8 out of 10 german citizens support faster growth of RES.
- Resentments about perceived gap between ambitious targets and rhetoric and reality.
- Less than half of public with positive attitude toward implementation of EW.
- Politics identified as reason for deficits in implementation.

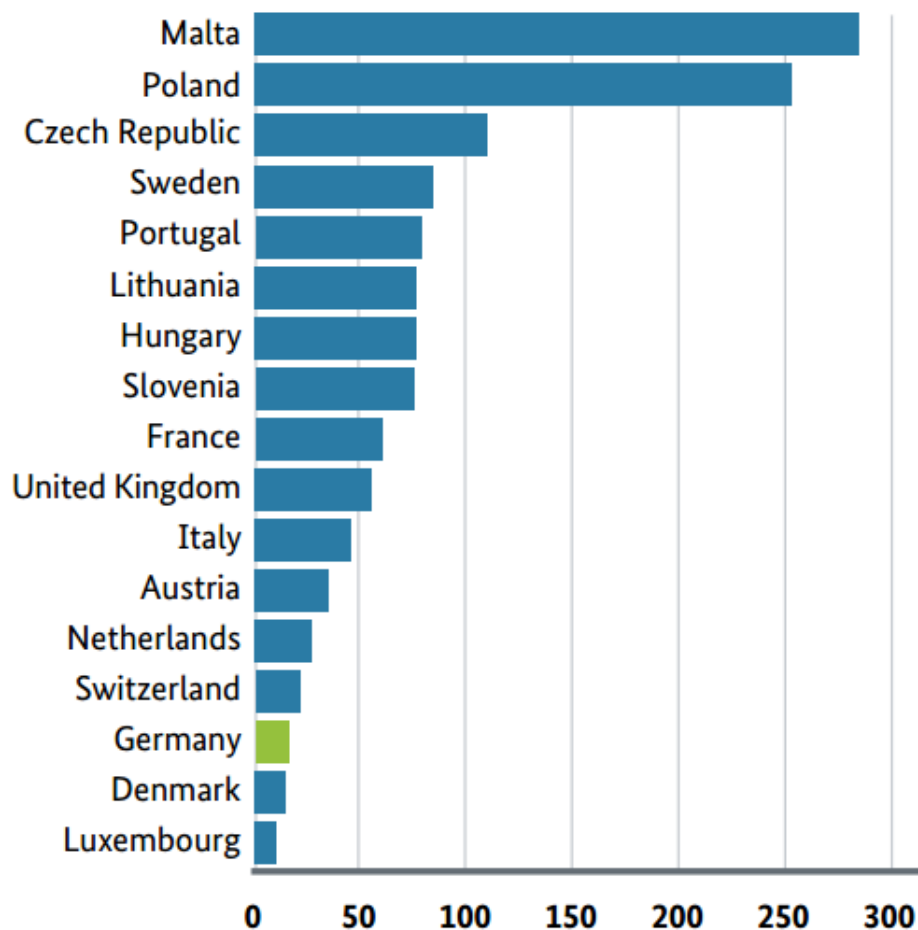
3) Public support of EW

Average power price in c/kWh for a household using 3,500 kWh per year (997 euro/year)



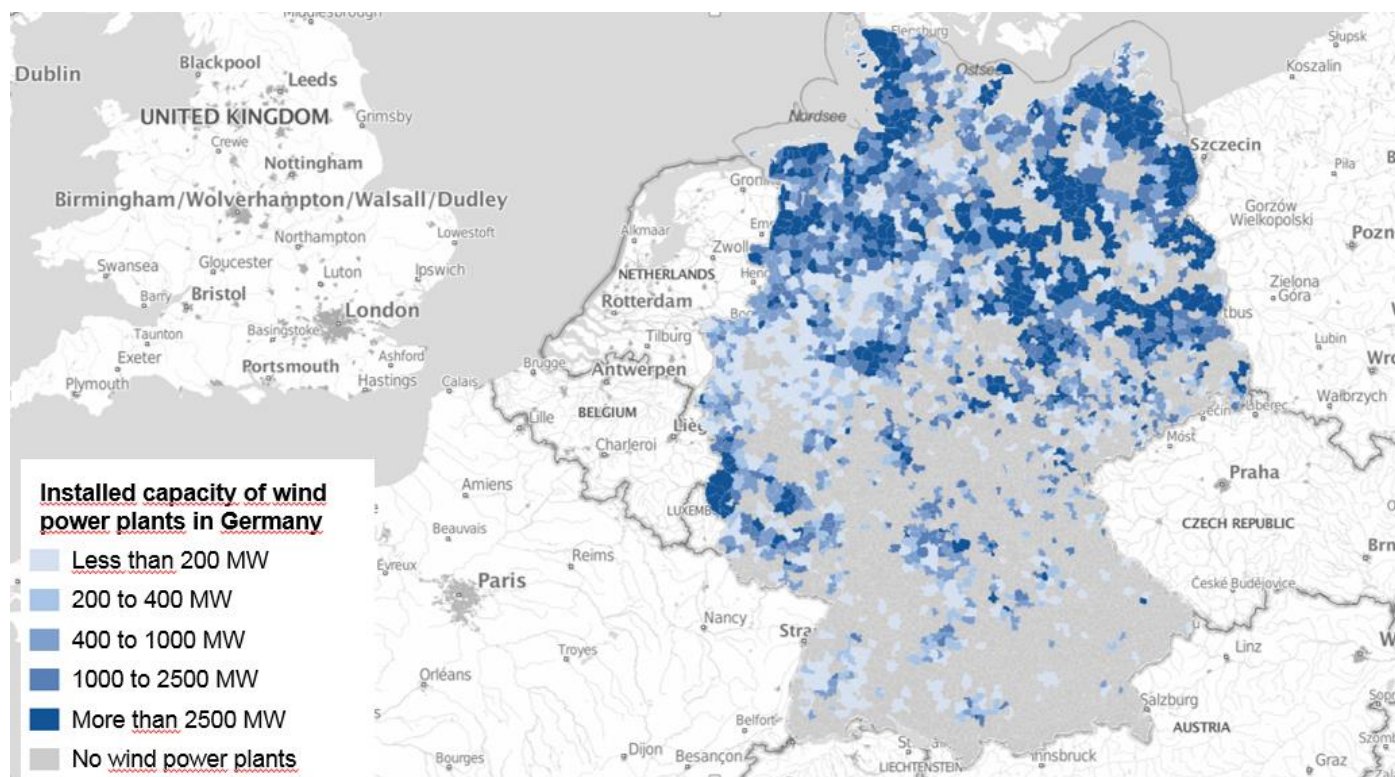
4) Stability of the grid

Unscheduled outages in 2013 (minutes per year)



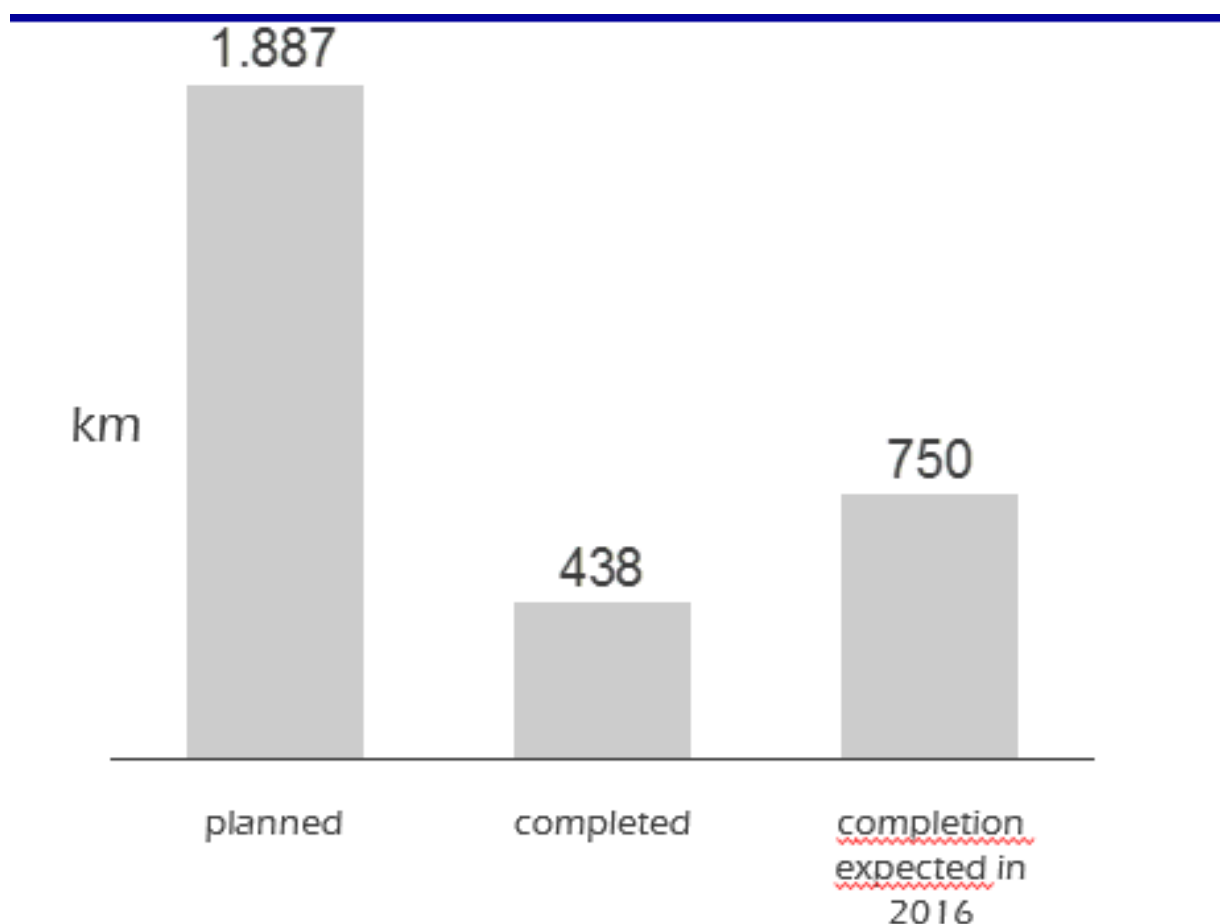
4) Grid capacity

In 2014 24193 onshore wind turbines, 7858 biogas installations, 1,4 million solar PV panels and 1,9 million solar thermal collectors (2013).



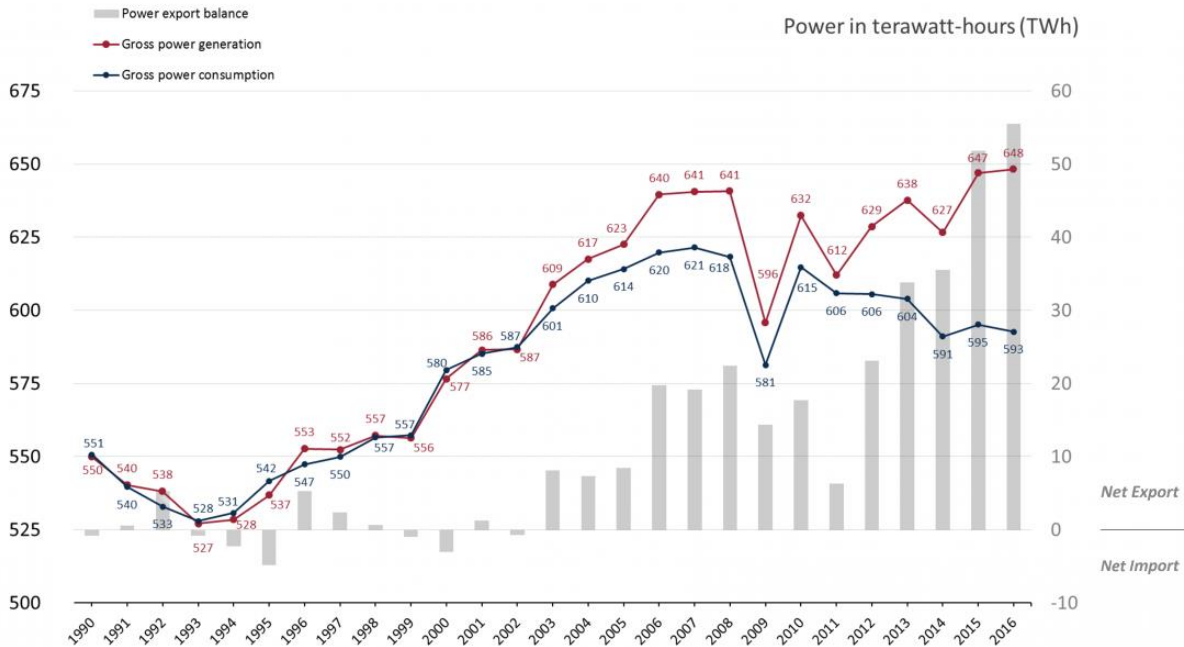
Building of the grid

In 2010 plan to build 1887km by 2015, in Q3 only 23% finished

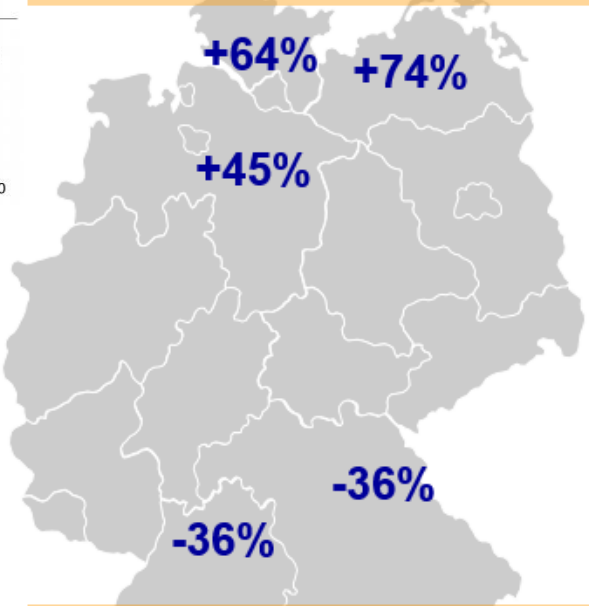


German power export balance 1990 - 2016.

Data: BMWi 2017.



Surplus energy quantities in the North (Wind feed-in)



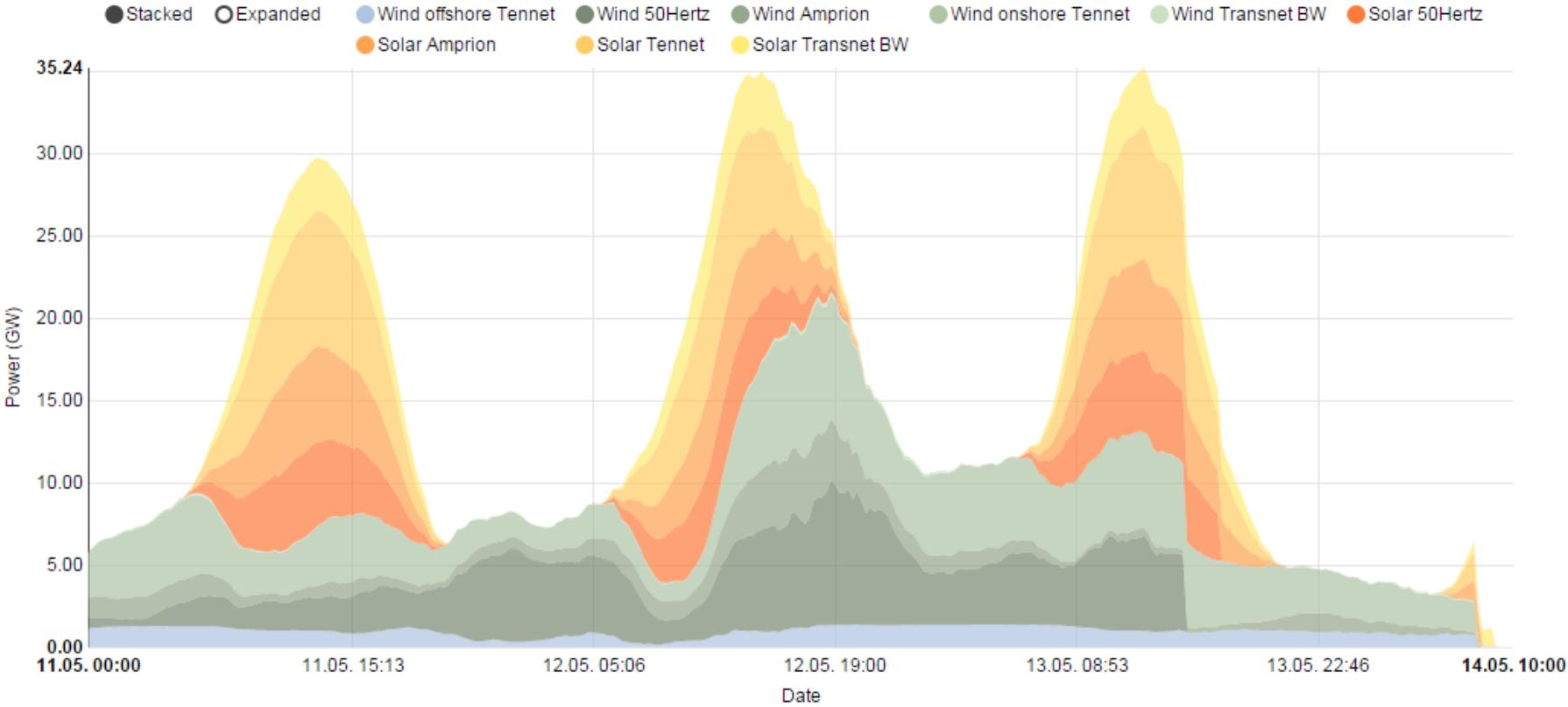
CC BY SA 4.0

Lack of regional energy generation in the South (internal 'imports' needed)

5) Restructuralisation of energy production

- Extensive development of RES at the expense of traditional source. The resulting proportion of these two productive segments will be based on:
 - Almost zero variable (fuel) costs.
 - Financial support of RES paid by the end user within regulated part of the bill.
 - Expenses associated with maintaining balance and stability of network.
- In present, the costs on support of RES and function of networks exceed the savings from lower commodity prices (= higher costs for society). But competitiveness of RES have been changing.

Solar + wind production in Germany in week 20 2015

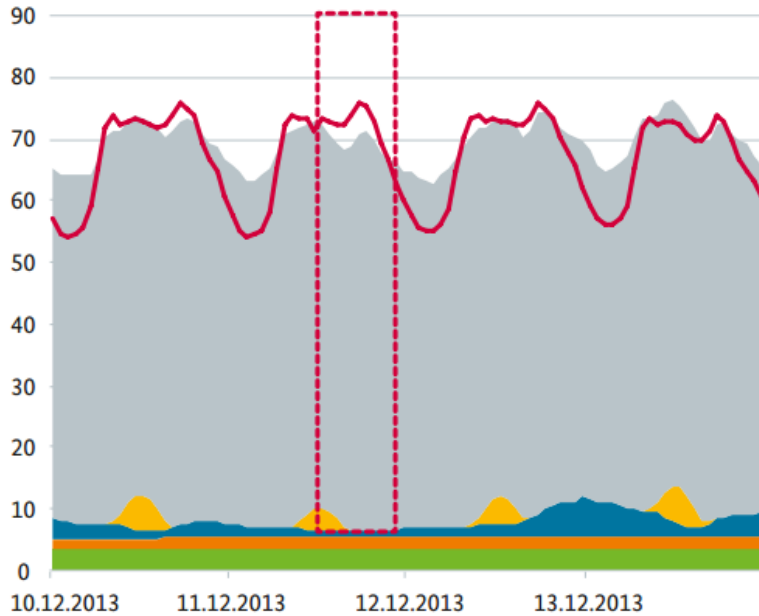


last update: 14 May 2015 10:15

Examples of situations with high and low residual load

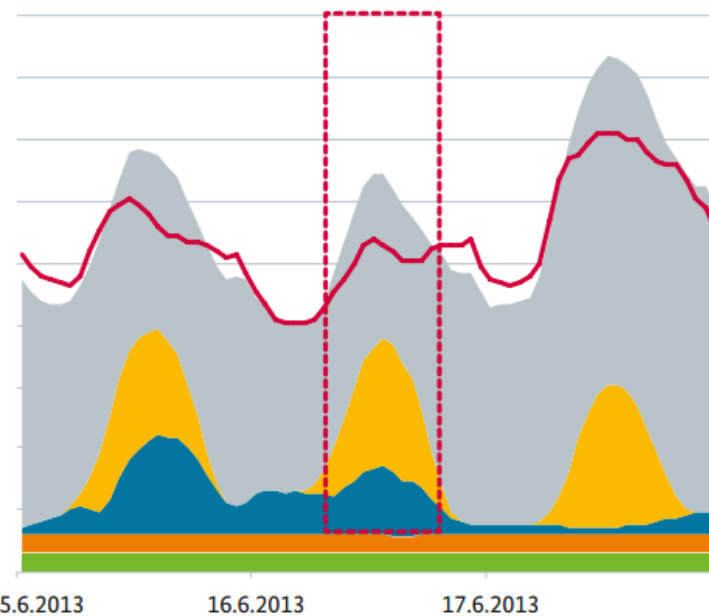
High residual load:
high demand for electricity, little wind and solar power

Residual load in GW



Low residual load:
low demand for electricity, much wind and solar power

Residual load in GW



— Biomass — ROR — Wind — Solar — Conventional power stations — Electricity consumption

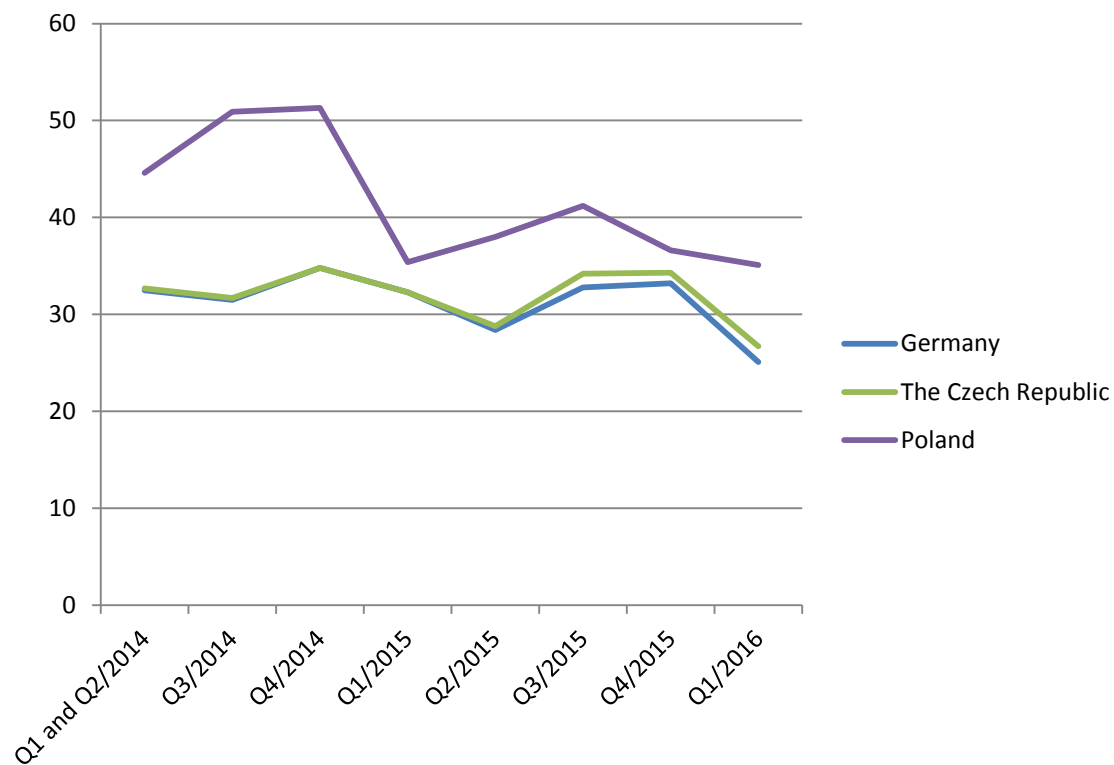
Source: Connect Energy Economics

Source: BMWi, Green paper

Impact of EW on the Czech Republic

Trading with electricity – price convergence

- Price volatility
- Wholesale price of electricity



Impact on Czech producers

- Producers face reduced revenues. (EBITDA of ČEZ decreased from €3,5 bn. in 2009 to €2,5 bn. in 2015, EW one of the reasons).
- Low variable cost generation portfolio (nuclear, hydro) – still profitable company.
- 88 % of electricity generated from low-merit or mid-merit sources (coal 50 %, nuclear 30 %, hydro 5,5 %).

Impact on Czech consumers

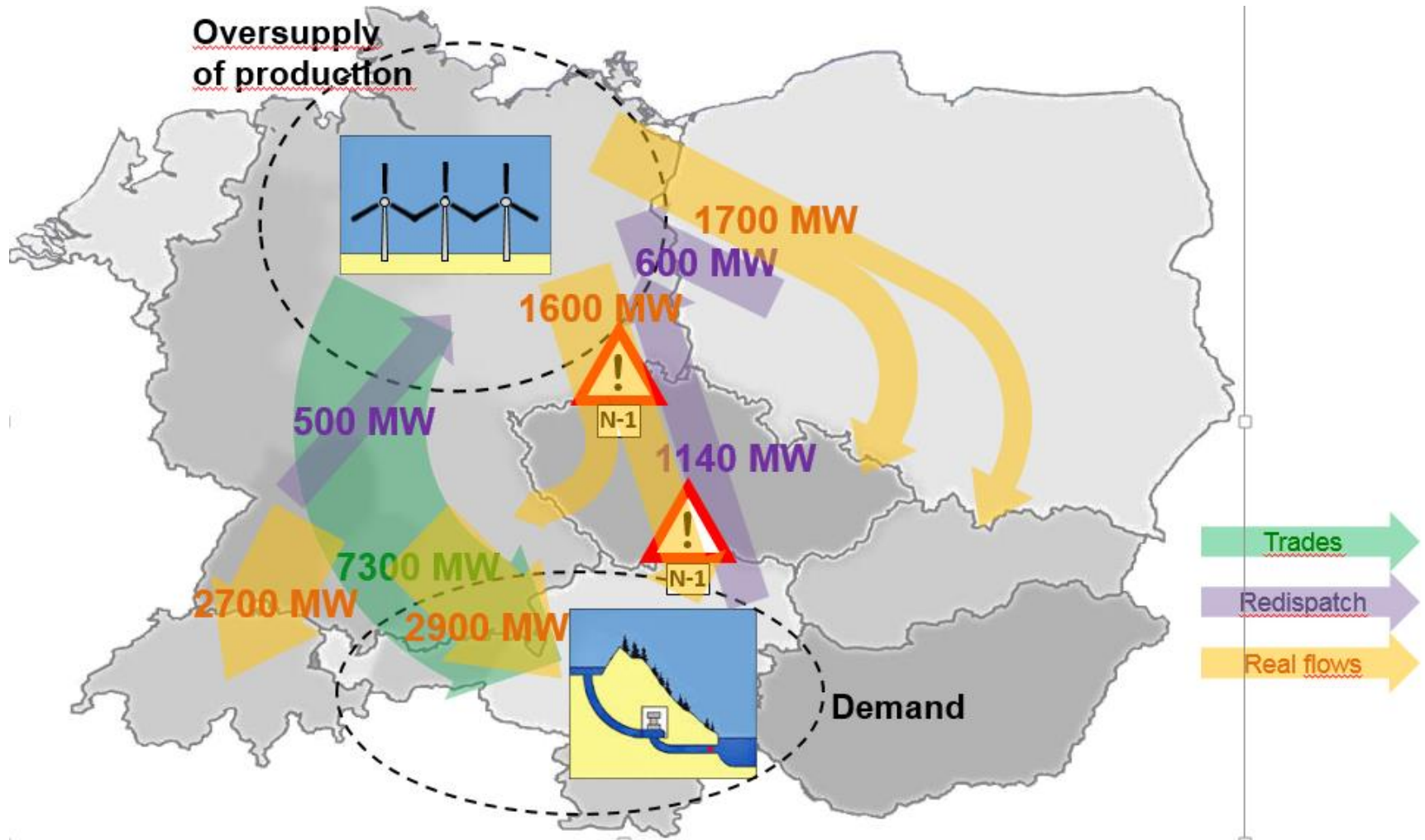
- Profit from Energiewende – import of cheaper electricity.



Impact on government

- Nuclear energy as a baseload source of energy questioned.
- Nuclear is planned to replace decommissioning of 14 GW (out of 24 GW total) in 2030.

Trades and flow of electricity 2014/2015



Sources

- BMWi (2015): Making a success of the energy transition.
- Clean Energy Wire
- Černoch et.al.(2017): Energiewende and the Energy Security of the Czech Republic and Poland