German Energy Transition – Opportunities and challenges

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Agenda

1. Political Framework and decisions

2. Opportunities and Challenges

3. Conclusion and Outlook

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The EU Roadmap shall define a cost-efficient pathway towards carbon reductions by 2050

Pathway towards 2050 - forecasts

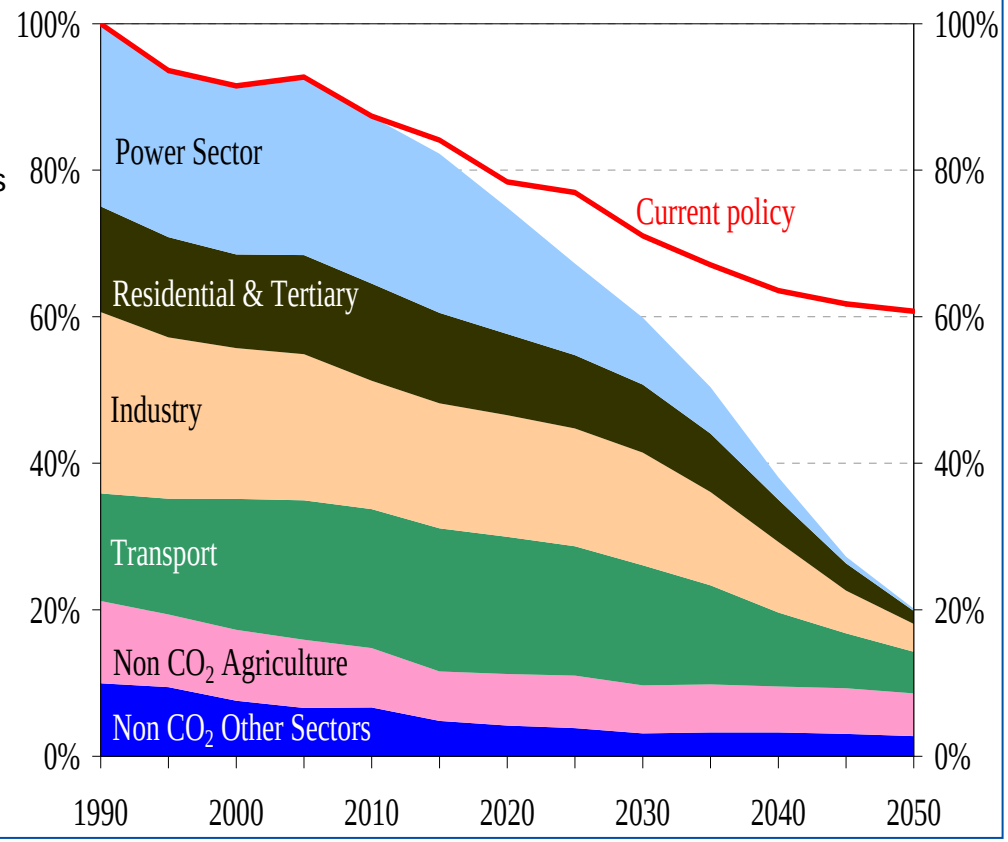
> **According to Roadmap 2050, 80% domestic reduction in 2050 could be feasible:**

- With currently available technologies
- With behavioural change only induced through prices
- If all economic sectors contribute to a varying degree & pace

> **Efficient pathway:**

- -25% in 2020
- -40% in 2030
- -60% in 2040

Source: European Commission, DG Climate Action



Political decisions taken in Germany

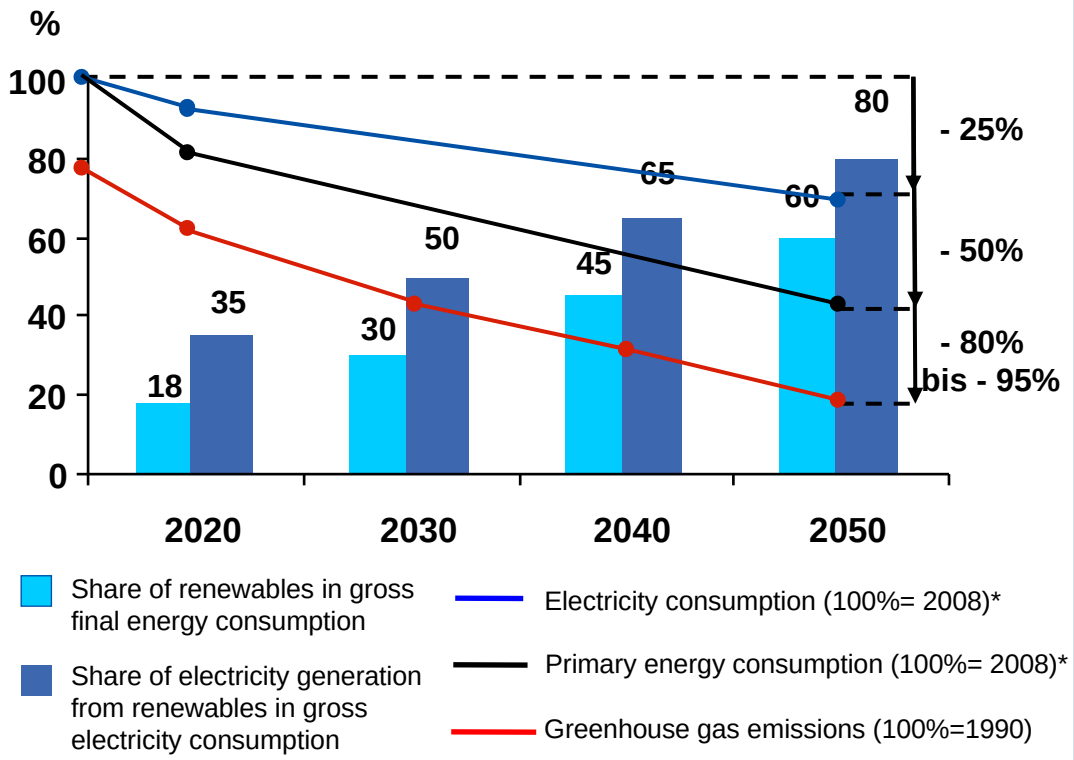
- In October 2010 the Government tabled a new Energy concept. This builds a framework towards the 2050 energy supply with ambitious targets on carbon emission reductions and increase in renewable energies.

- In March 2011 the Government decided to rethink the role of nuclear energy within the energy concept. Immediately 8 nuclear power stations were taken from the grid.

- In summer 2011 a big package of laws and legislations passed the Parliament to foster the goals of the energy concept and to close all nuclear stations by 2022.

The Energy Concept of the German Federal Government: main objectives

More renewables, less emissions



Growing share of renewables of 60% in gross final energy consumption by 2050

Growing share of renewables of 80% in gross electricity consumption by 2050 (to date 15%)

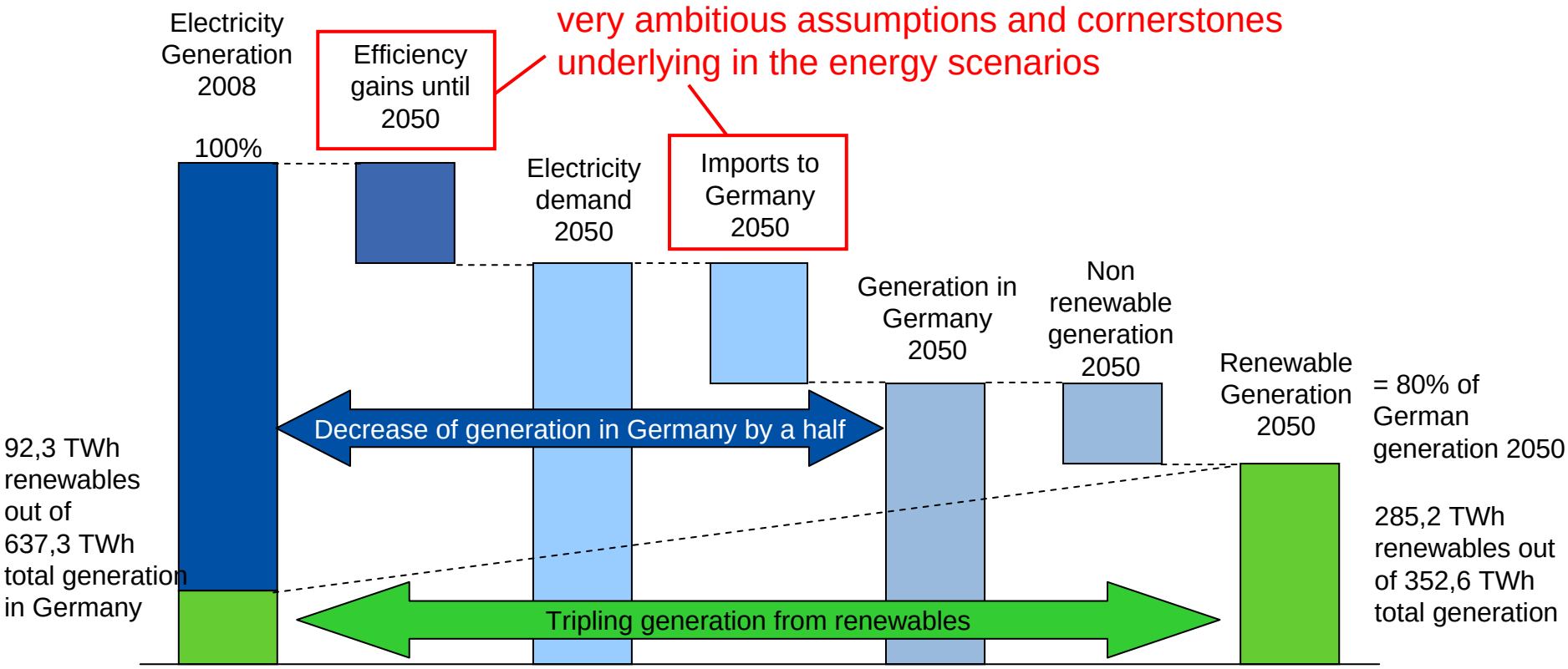
Reduction of gross electricity consumption by 25% until 2050 (baseline 2008)

Reduction of primary energy consumption by 50% until 2050 (baseline 2008)

Reduction of GHG by 80% - 95% (baseline 1990)

* Concrete data only available for the years 2020 and 2050

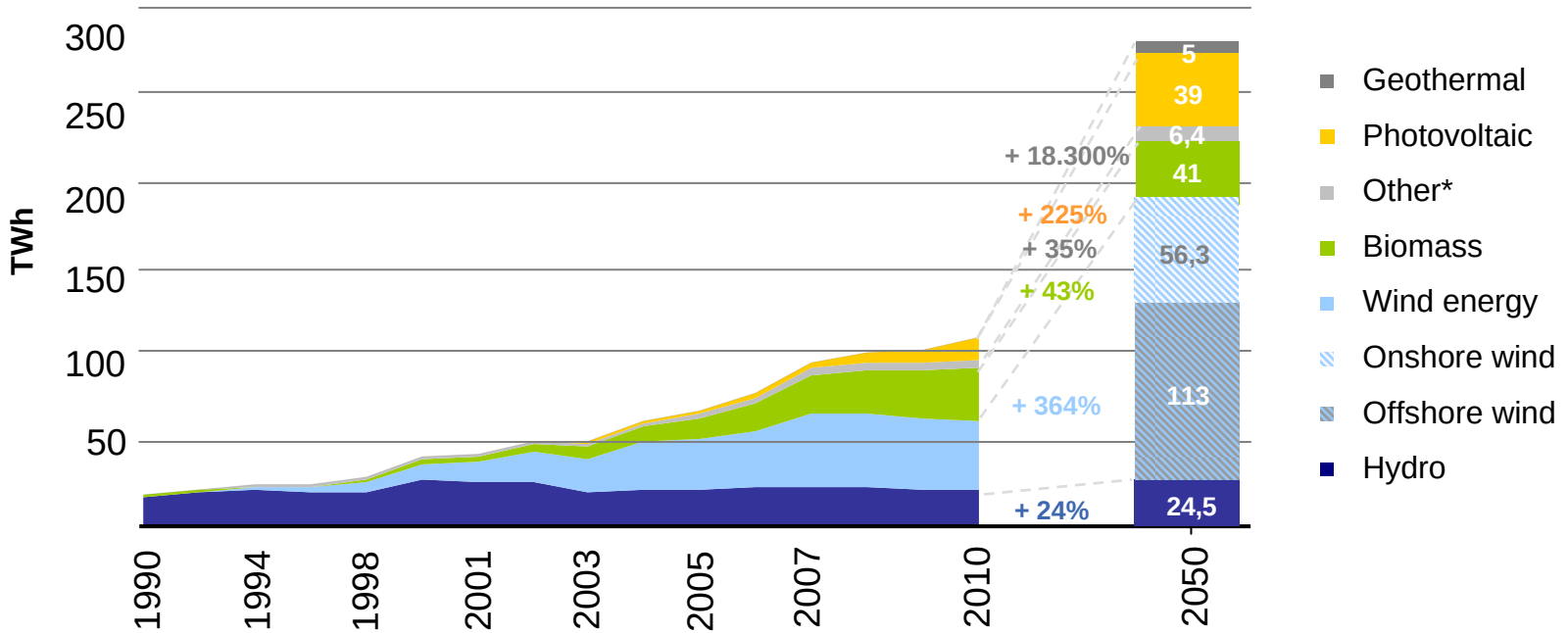
According to the energy concept the German electricity supply has to be reconstructed completely



Bruttostromerzeugung gemäß Tabelle A I-7, Szenario II A, Energieszenarien EWI, GWS, Prognos

Absolute production targets for renewables for 2050 are ambitious

Electricity generation from renewable energies 1990 until 2050 (TWh)



> Targets for hydro, biomass, on- and offshore wind are acceptable

> Photovoltaic possible, but due to inefficiency and high costs critical

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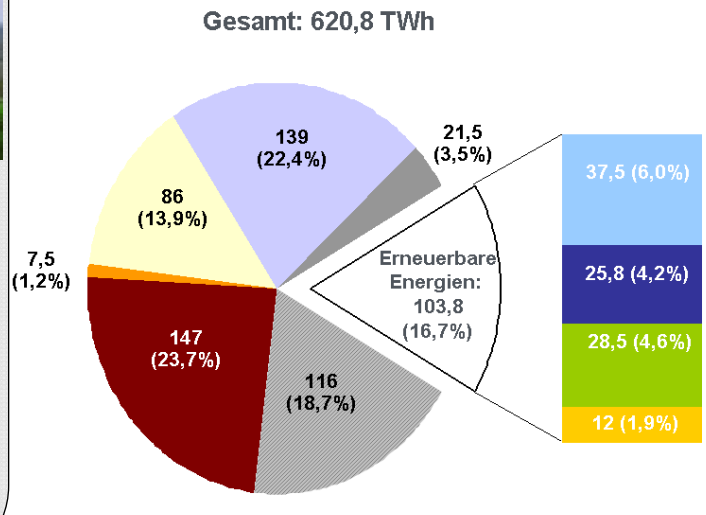
Source: Daten bis 2010: BMU; Daten 2050: Energieszenarien nach EWI, GWS, Prognos

* Andere: BMU: Biogener Anteil des Abfalls; EWI, GWS, Prognos: Biogener Müll, Klär- und Deponiegas

The Share of Renewables in Power Generation in Germany is supposed to grow from 17% in 2010 to 55% to 2030

Gross power generation by energy carriers 2010 (in TWh)



Hard coal | Pump storage | Nuclear power | Petroleum | Wind | Biomass | Geothermal[2)]
Lignite | Gas | Others[1)] | Hydro | Solar | Other Renewables[3)]

Source: BMWI; Energy scenarios 2011

1) Waste, mine gas und other non-reneables according to dthe definition of AGEB
2) Geothermal: 2,0 TWh
3) Other renewable fuels: 7,0 TWh

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Utilities focus more on renewable energies
Example: RWE founded new company with focus on wind, hydro and biomass while also supporting new technologies

Onshore Wind	Offshore Wind	Hydro	Biomass	New Technologies
				

- > Established in February 2008
- > Bundling renewables activities and competencies across RWE Group
- > Focus on capacity growth in commercially mature renewable technologies, i.e. wind, biomass and hydro
- > Research & Development and Venture Capital to drive the development of emerging technologies, e.g. solar, geothermal, marine
- > Focus on Europe: Asset portfolio of 2.4 GW in operation and 1.2 GW under construction mainly located in United Kingdom, Germany, Spain, Netherlands, Italy and Poland *

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Challenges and Solutions

Main challenges:

> Integration of fluctuating generation from wind and solar.

> Ensure security of supply.

> Ensure economical competitiveness of industry.

> Ensure payable energy for the consumer.

Possible options:

> Grid extension

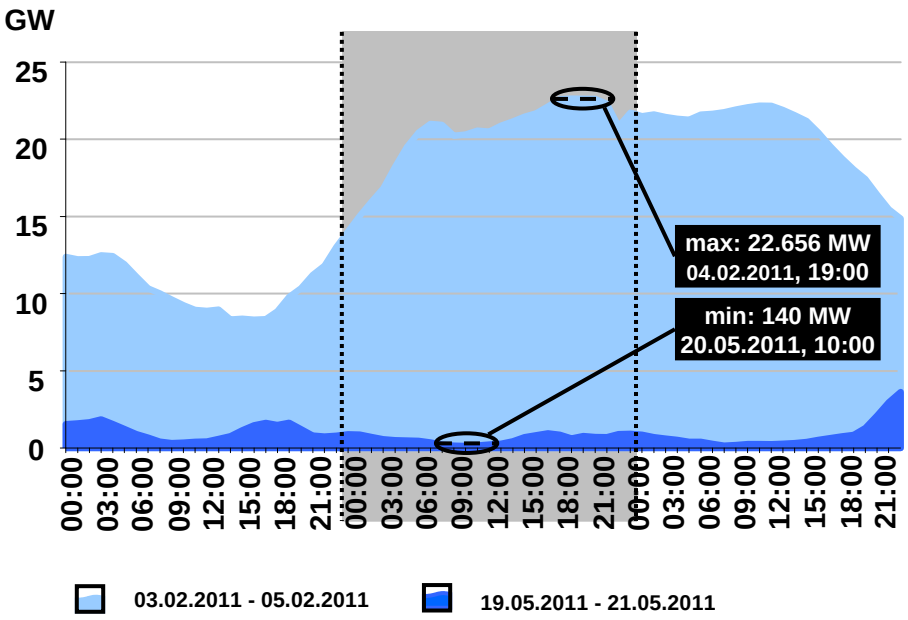
> Flexible generation with conventional power plants

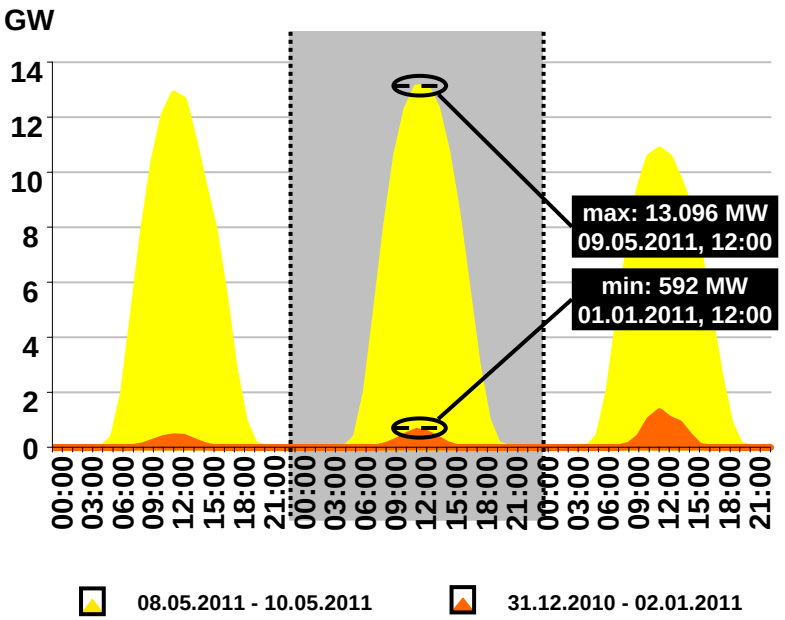
> Increase storage capacities

> Smart grids and demand side management

> Be cost effective

Discontinuous Wind- and PV-feed-in make the energy turnaround becoming a challenge



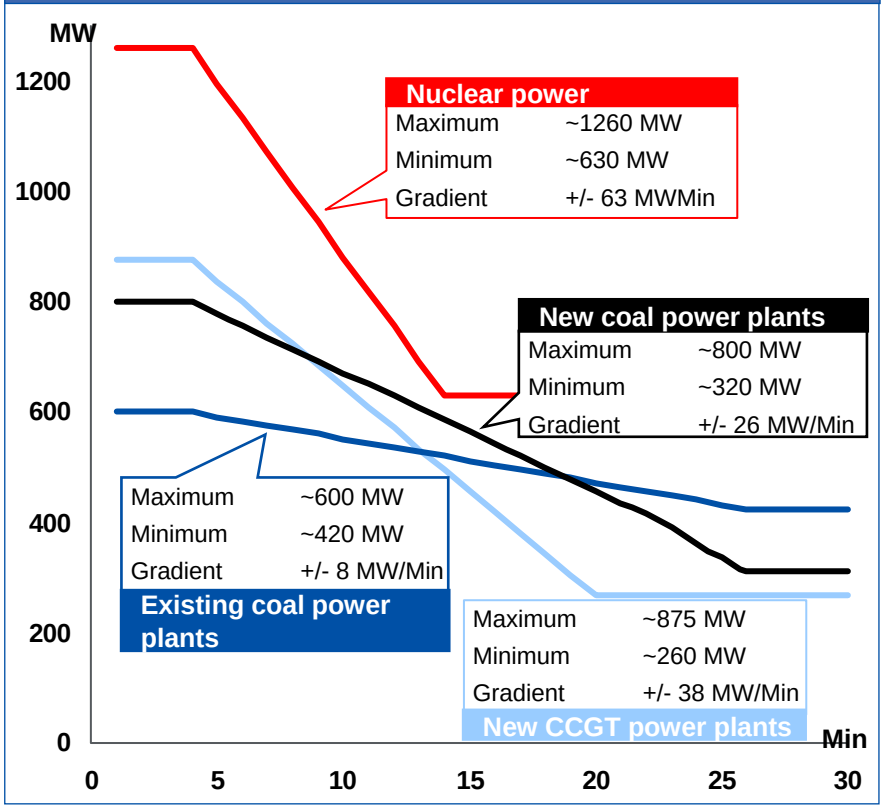


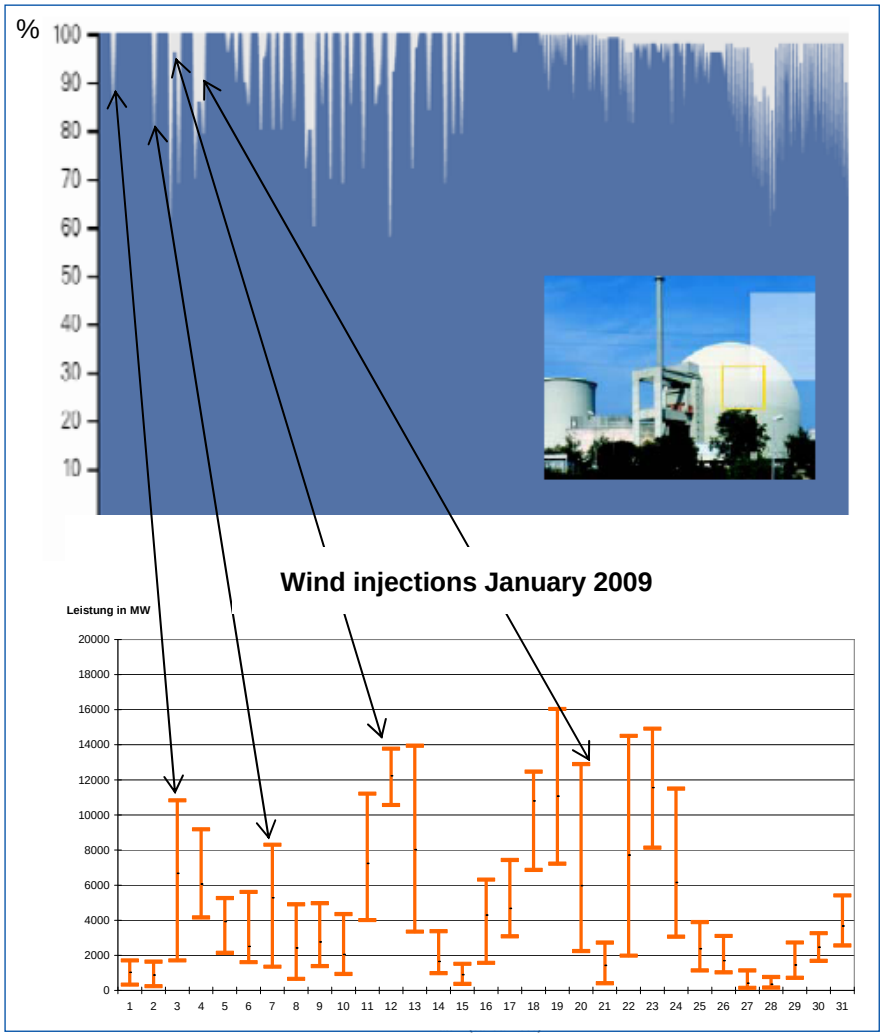
Only in the first half of 2011 variations of wind-feed-in of 23 GW and of PV-feed-in of 13 GW could be regarded.

Source: RWE Supply&Trading, MLT-VW

All existing conventional power plants contribute to integrate and balance the renewable generation

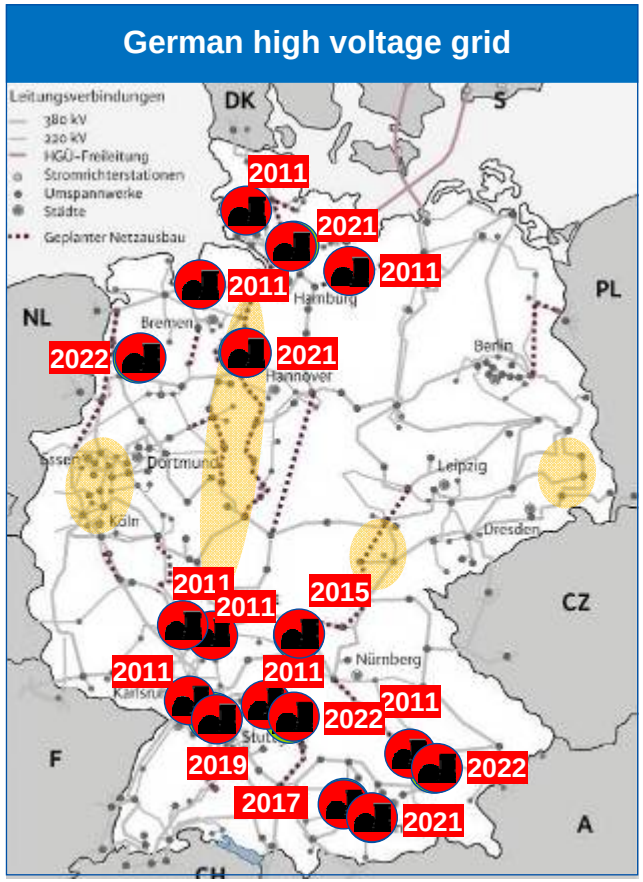
Ability of conventional power plants to change their load:





In general the high voltage grid must be extended -

especially after the shut down of the nuclear stations

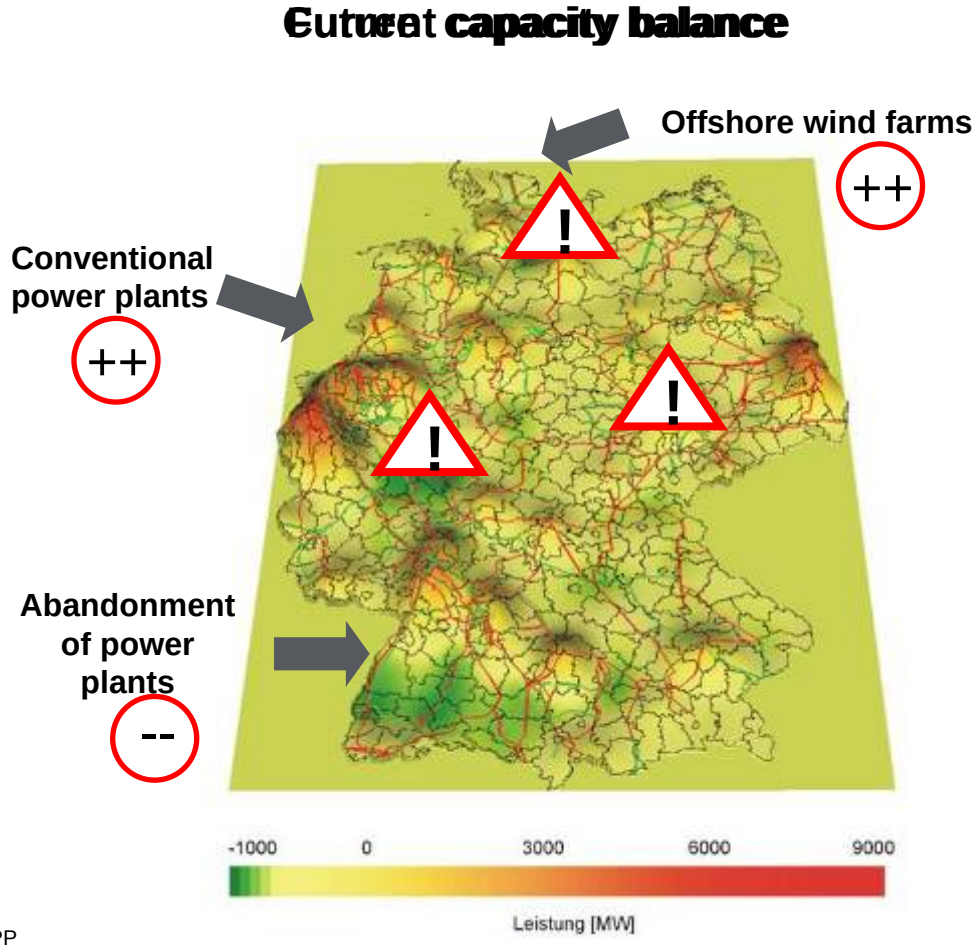


Network expansion project up to 2015 (dena)

Increased grid bottlenecks expected

Operative NPP

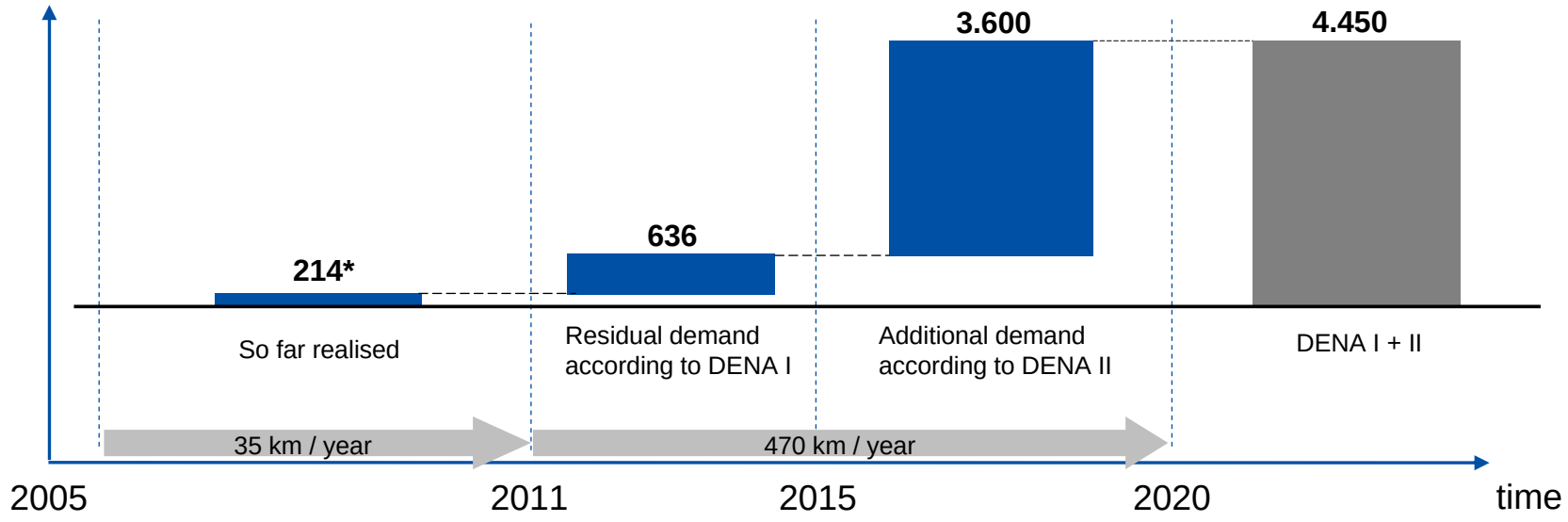
Abandoned NPP



Nuclear phase-out and more renewable energies increase regional grid bottlenecks – 4,450 km new lines are needed

Grid extension identified by DENA grid study I und II

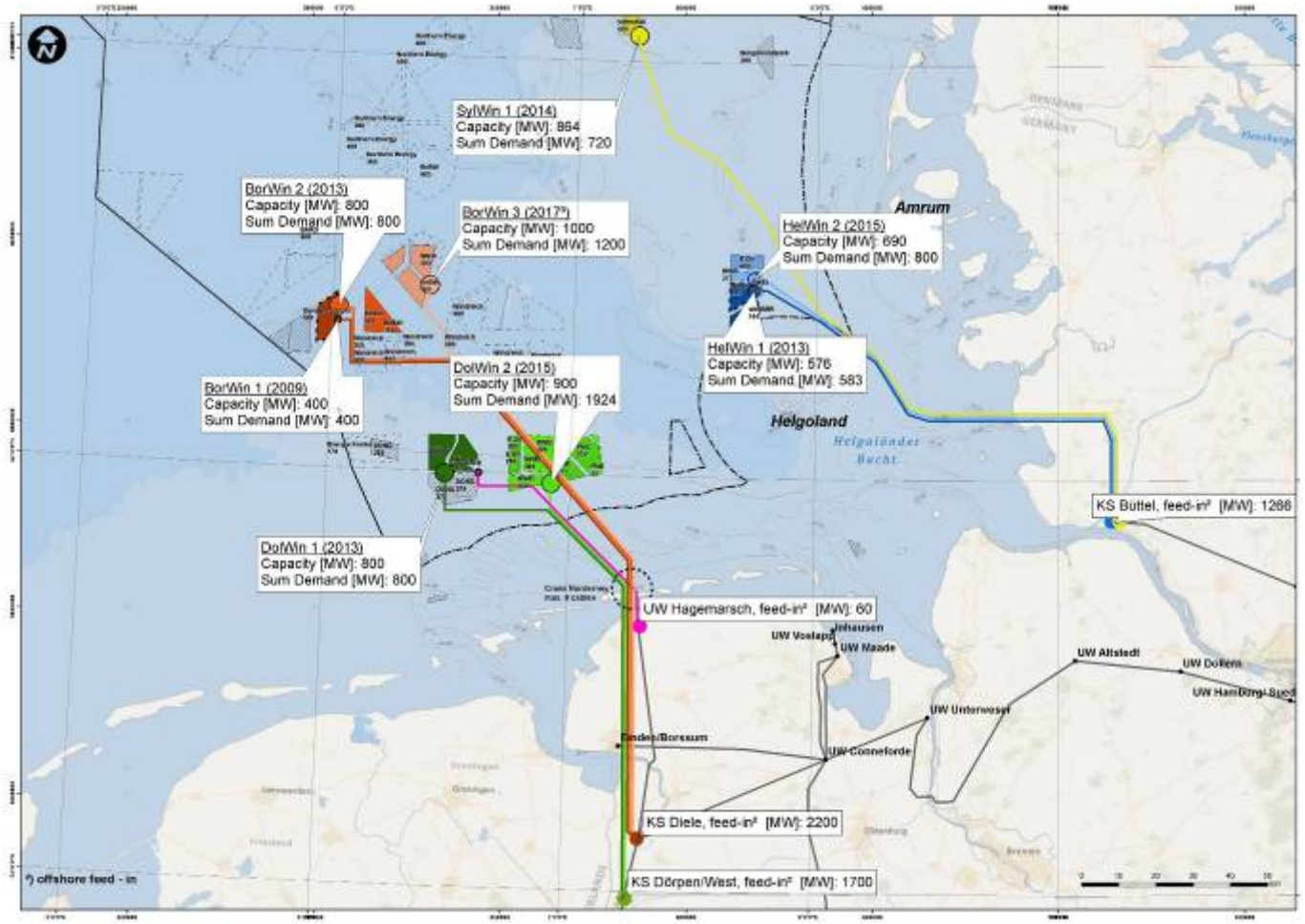
Necessary grid extension (in km)



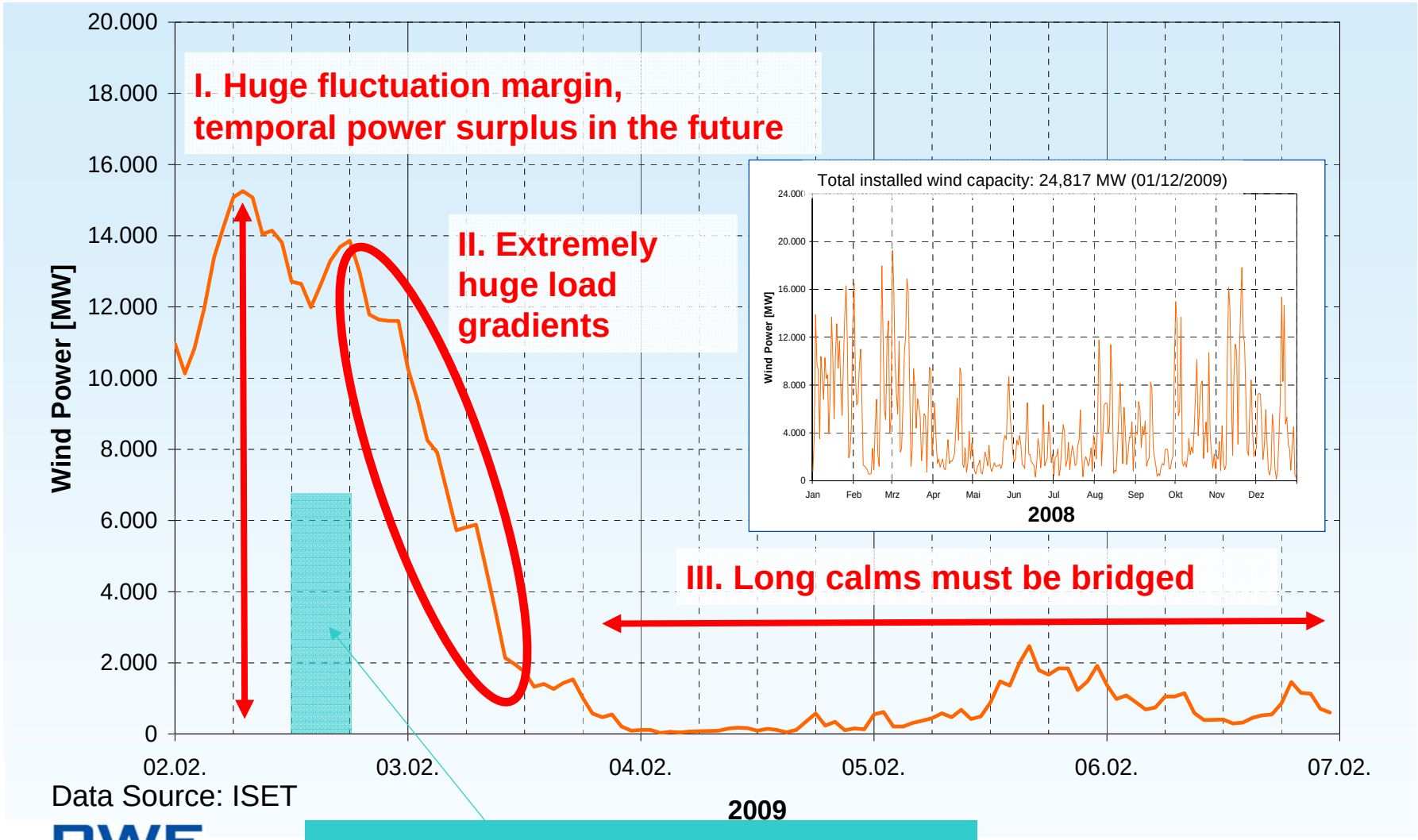
- For building 3600km of high-voltage line 12.000 masts have to be erected.
- Since 2005 the grid has been extended by approx. 35 km per year. In the coming nine years approx. 470 km per year have to be realised.

* Source: BNetzA, monitoring report 2011

Actually insufficient capacity of German North Sea grid is the main barrier for Offshore-growth



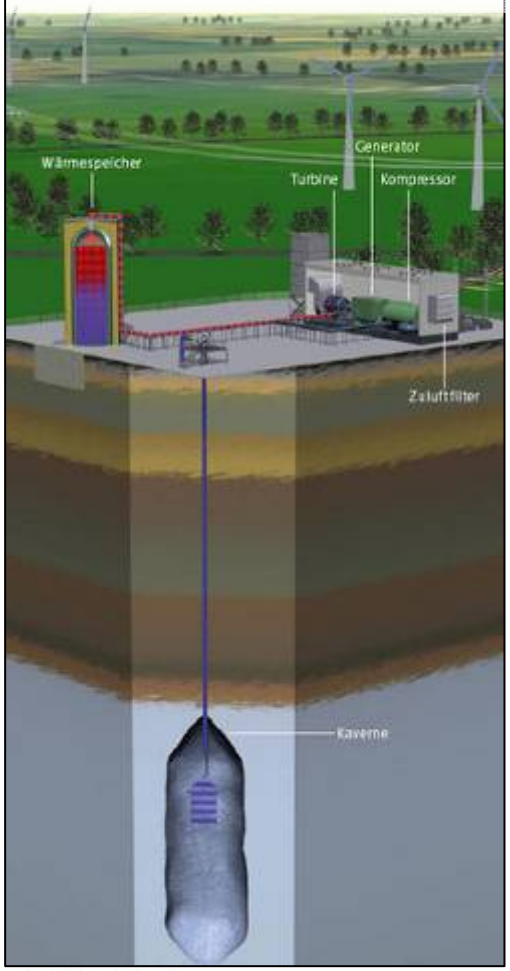
Challenge: Fluctuating generation must be integrated to keep the level of security of supply



Data Source: ISET

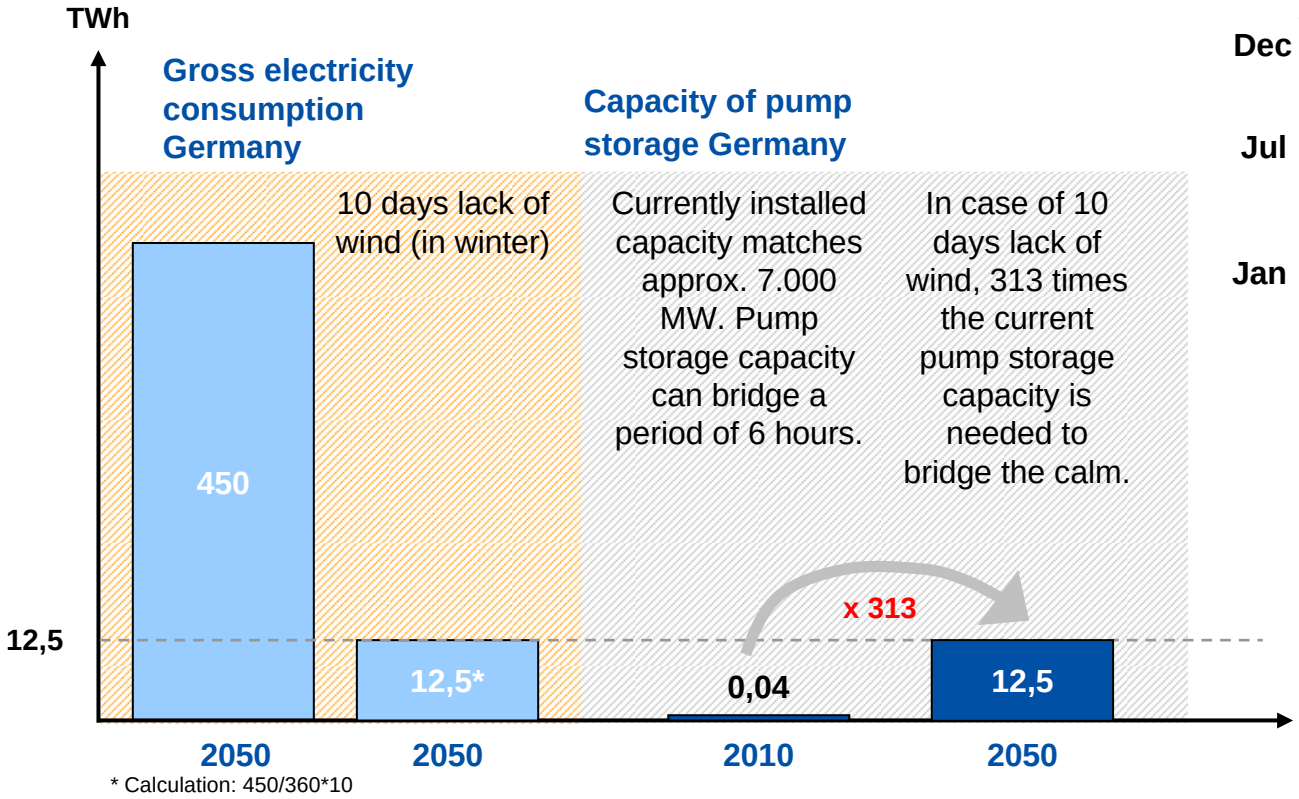
Different storage technologies are discussed

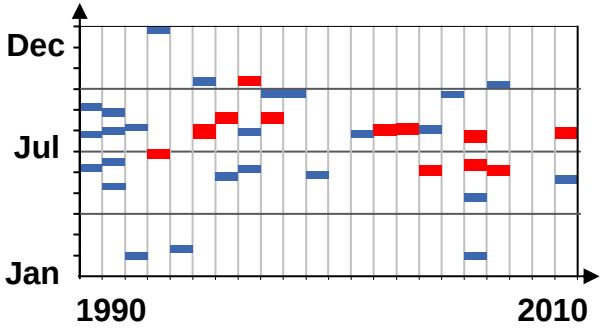
Adiabatic air storage



Pump-storage

Perspectively a 313-times enlargement of pump storage capacity (compared to today) would be necessary





Low wind period from 10-12 days

Low wind period > 12 Tagen

Low wind: Days where a wind power plant generates less then 10 % of its capacity.

High growth of pump storage capacity is necessary. Also including the potentials in Norway, Switzerland and Austria the aims are ambitioned.

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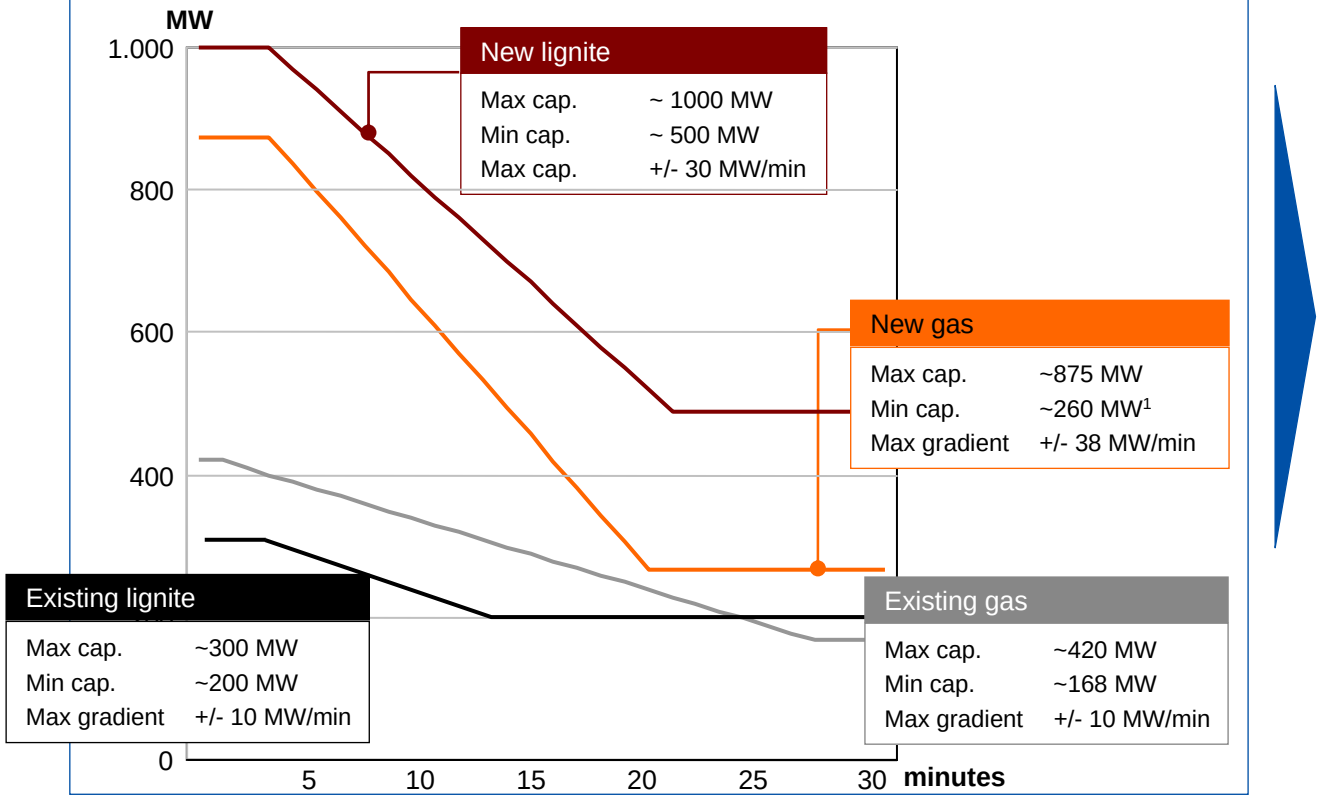
Flexible design makes new conventional power plants becoming good partners of renewables

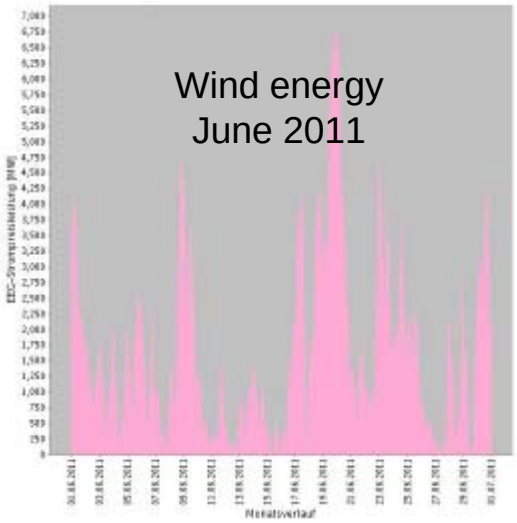
Comparison of ramp capacities (new lignite unit – old lignite unit, new gas unit – old gas unit)

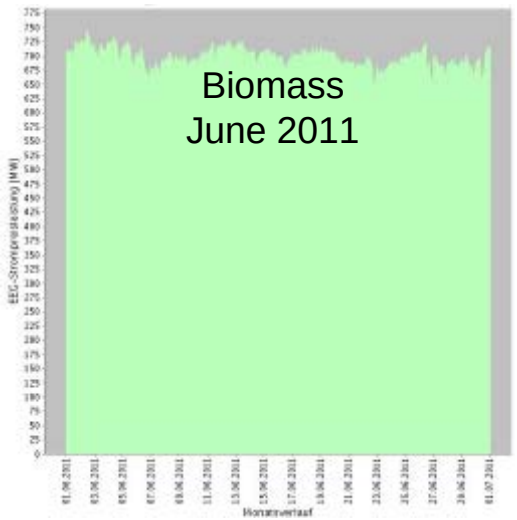


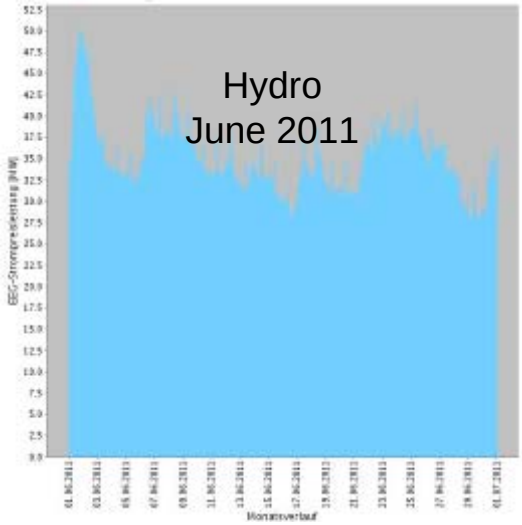
The faster a power plant is able to lower and raise its output, the more flexible it can be utilised.

1) switch-off of a turbine

Hydro and Biomass as balancing energy?
Potential in Germany is limited





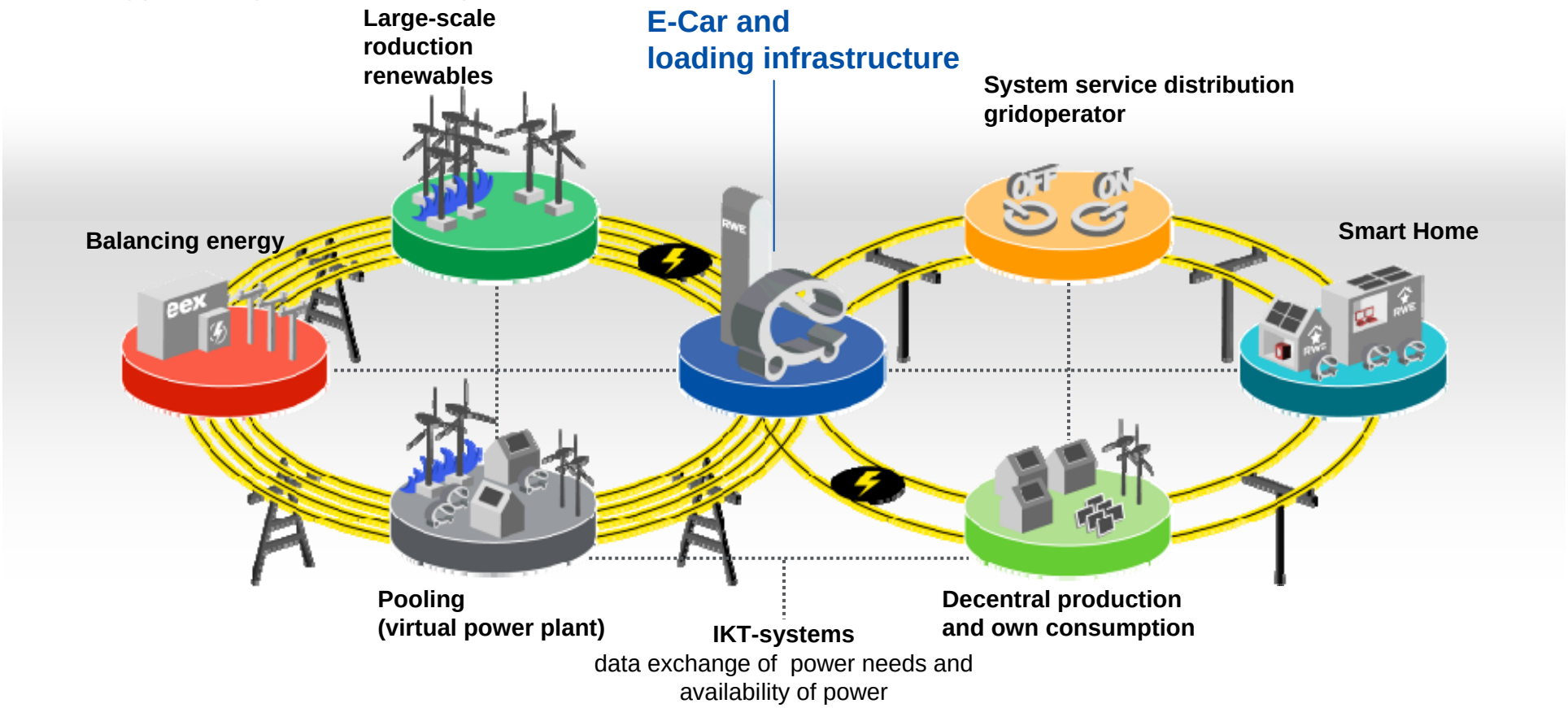


- Curbed **storage water- and pump storage power plants** are already employed as balancing energy power plants. Today the potential of hydro is nearly fully utilized.
- **Biomass** ist currently the only renewable und especially base-load capable balancing energy.
- Currently necessary incentives for selling biomass efficiently on the balancing energy market are missing.

Source: http://www.50hertz-transmission.net/cps/rde/xchg/trm_de/hs.xsl/167.htm/papp/apc_nextgen_inter_trm-prod:EEG_Energy_Input_Process_Application/

Electro mobility may play an important role in the future Smart Grid

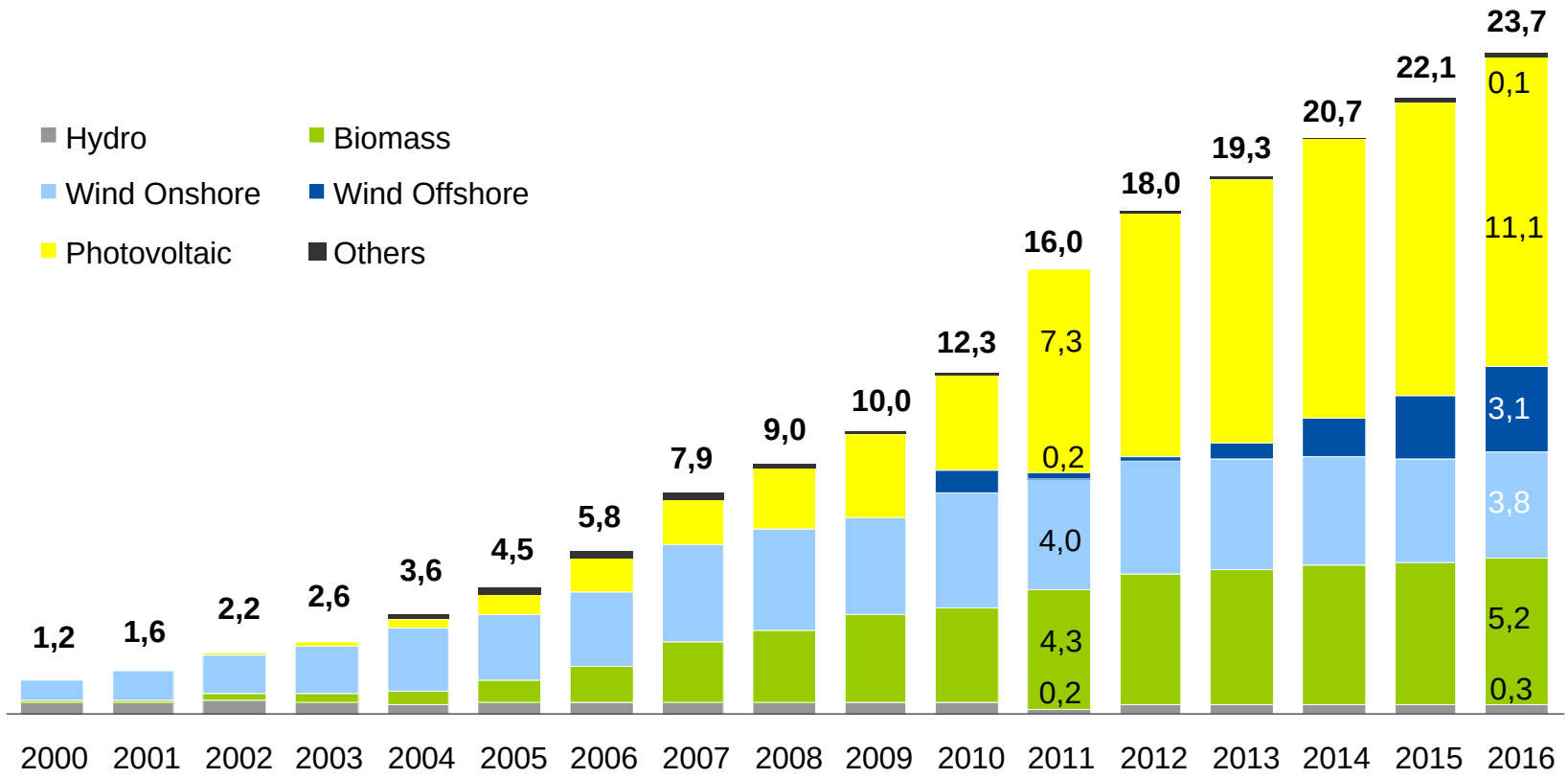
Application possibilities and potentials are numerous



Source: FTD, RWE

Costs for the support of renewable energies must be considered carefully

Feed-in costs under the German support scheme (EEG) (Gross in bn €)



Source: BMU Leitstudie 2008, EEG-Mittelfristprognose der Stromtransportnetzbetreiber (Zahlen bis 2010 stammen aus der EEG-Mittelfristprognose Stand 11.05.2009, Zahlen für 2011 stammen aus der EEG-Mittelfristprognose Stand 15.11.2010, Zahlen ab 2012 stammen aus der EEG-Mittelfristprognose Stand 15.11.2011)

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Conclusions and Outlook

- Energy transition means more then building renewable capacities.
- The entire energy a must be rebuild to secure security of supply.
- The grid infrastructure is a very crucial part in the transition process.
- All parts of the value chain (generation, transmission and consumption) are effected.
- Timing of the transition and cost challenges are important to secure economic competitiveness and public acceptance.
- Under these aspects the energy transition could be successful.

THANK YOU VERY MUCH FOR YOUR ATTENTION AND LET‘S COLLECTIVELY:

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