



WESTFÄLISCHE
WILHELMS-UNIVERSITÄT
MÜNSTER

ENERGIE DER ZUKUNFT
Kommission zum Monitoring-Prozess

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The German Energy Transition and the Future of Renewables

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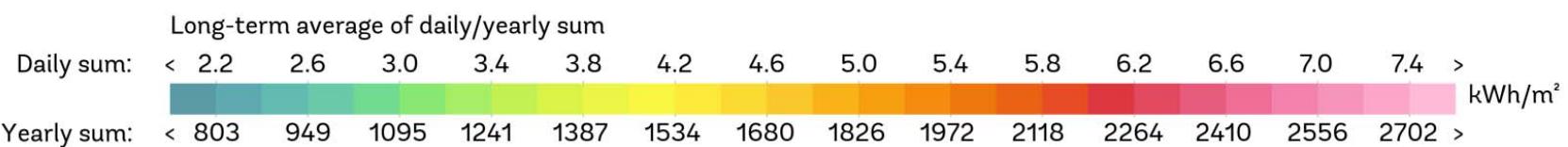
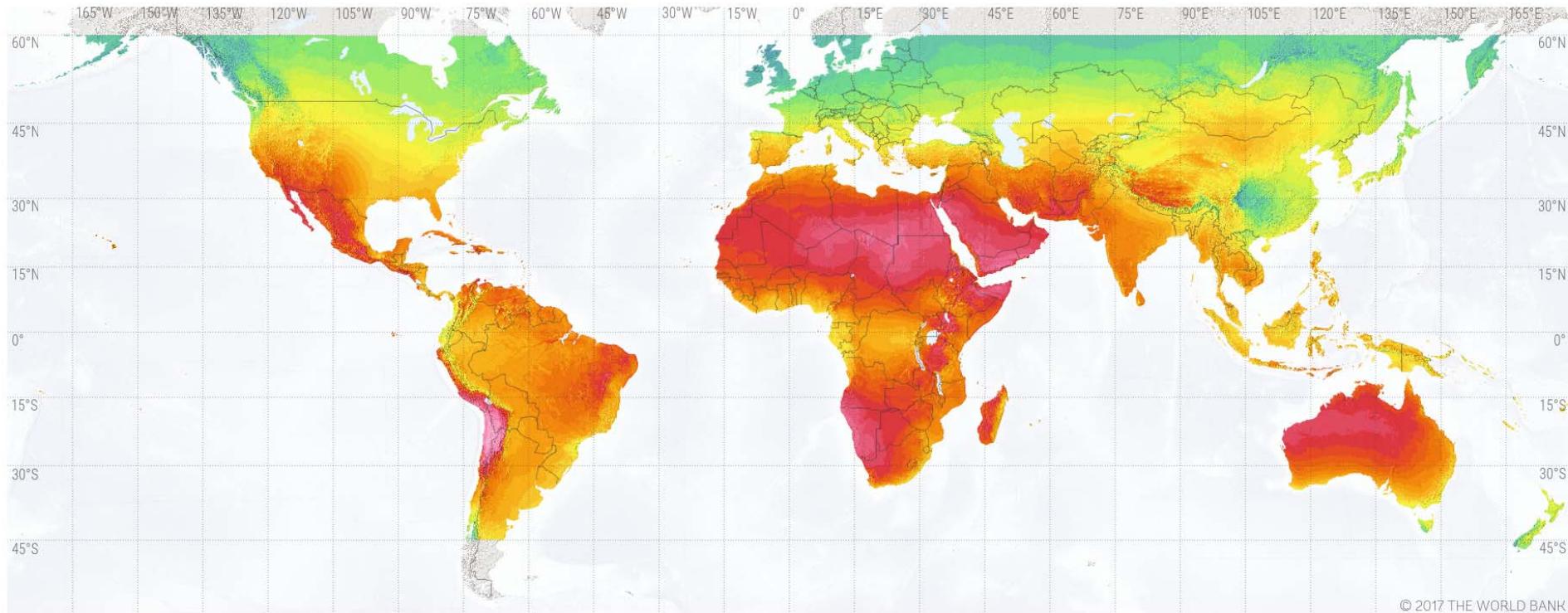
SOLAR RESOURCE MAP GLOBAL HORIZONTAL IRRADIATION

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ESMAP
Energy Sector Management Assistance Program

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ENERGY OF THE FUTURE

Commission on the Monitoring Process

Monitoring the Energy Transition

<http://www.bmwi.de/Redaktion/EN/Artikel/Energy/monitoring-implementation-of-the-energy-reforms.html>

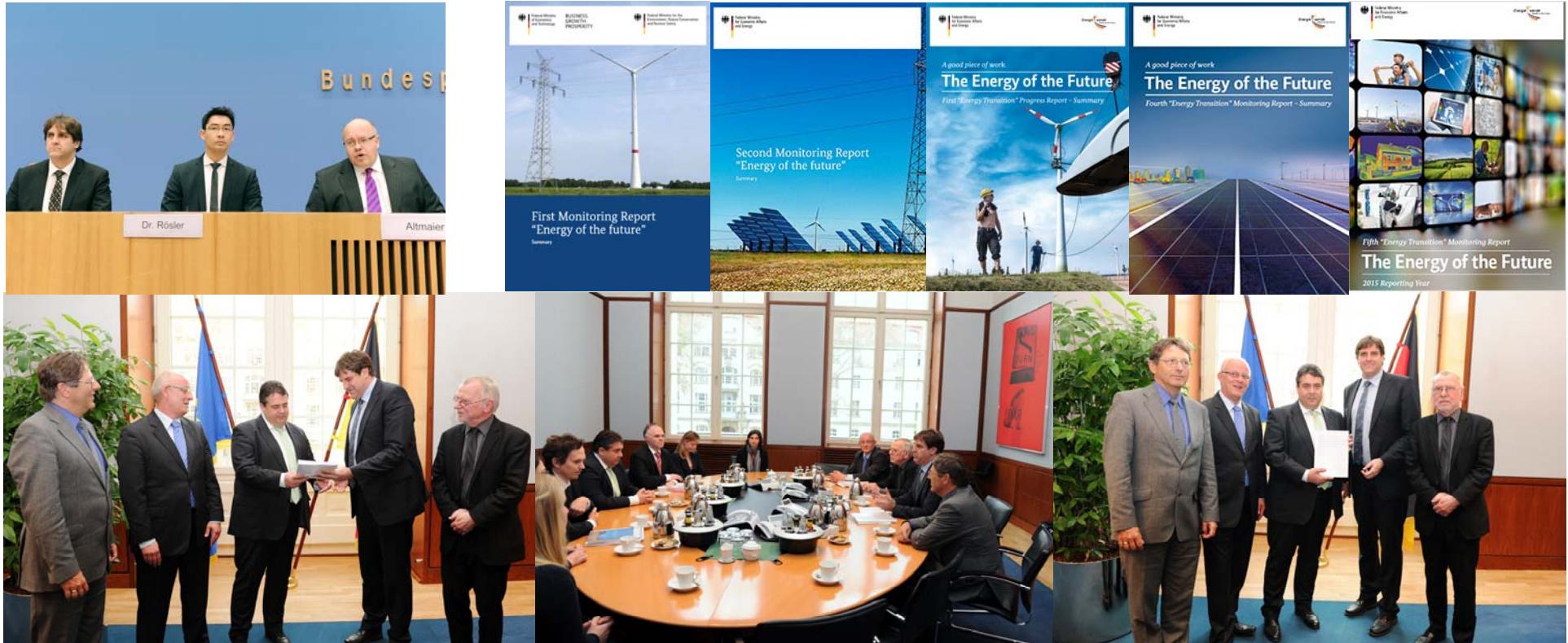
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Status of the German energy transition

Dimension	Lead indicator
Mitigating climate change	Reduction in greenhouse gas emissions
Renewable energy	Increase in the share of renewable energy in gross final energy consumption
Energy efficiency	Reduction of primary energy consumption
Security of supply	Expansion of transmission grids
Affordability	End-user spending on electricity in terms of GDP
Public acceptance	General approval of goals of energy transition

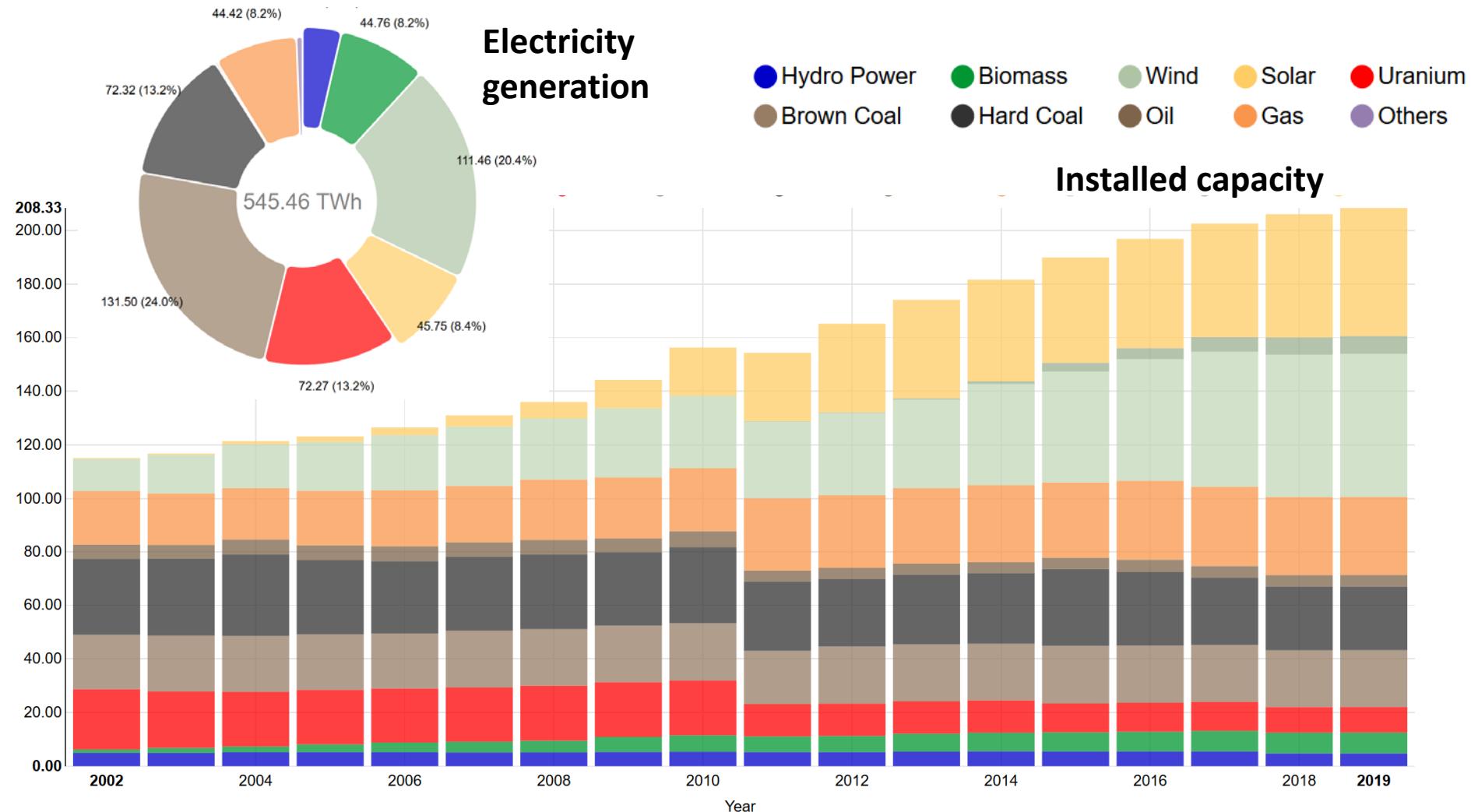
Target attainment: ● likely ○ uncertain ■ unlikely

Source: Löschel et al (2019)

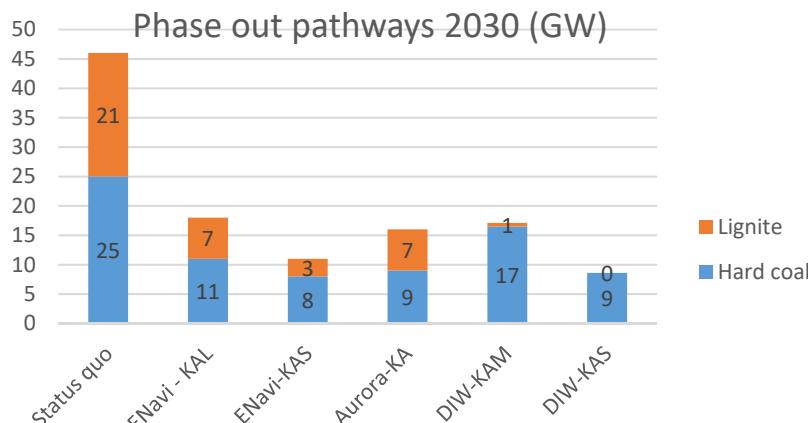
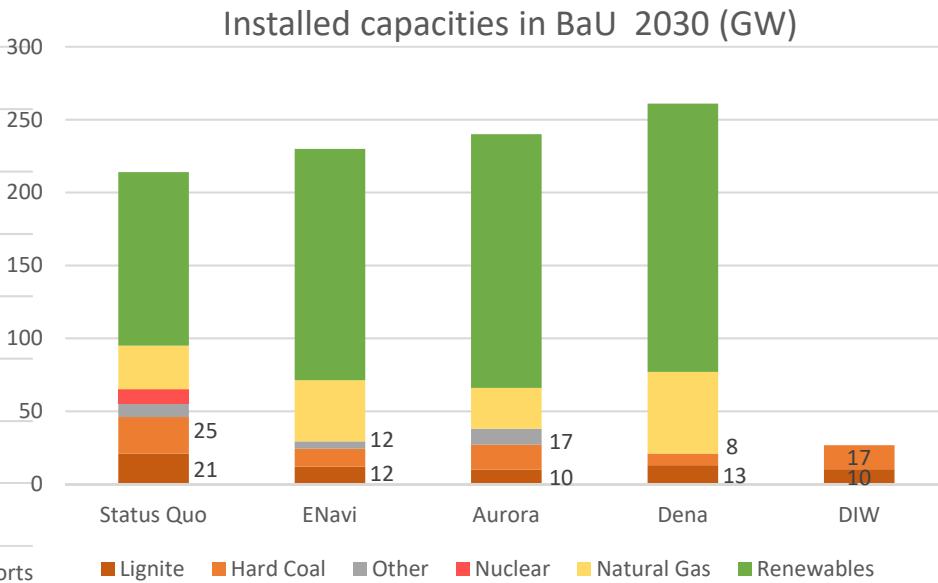
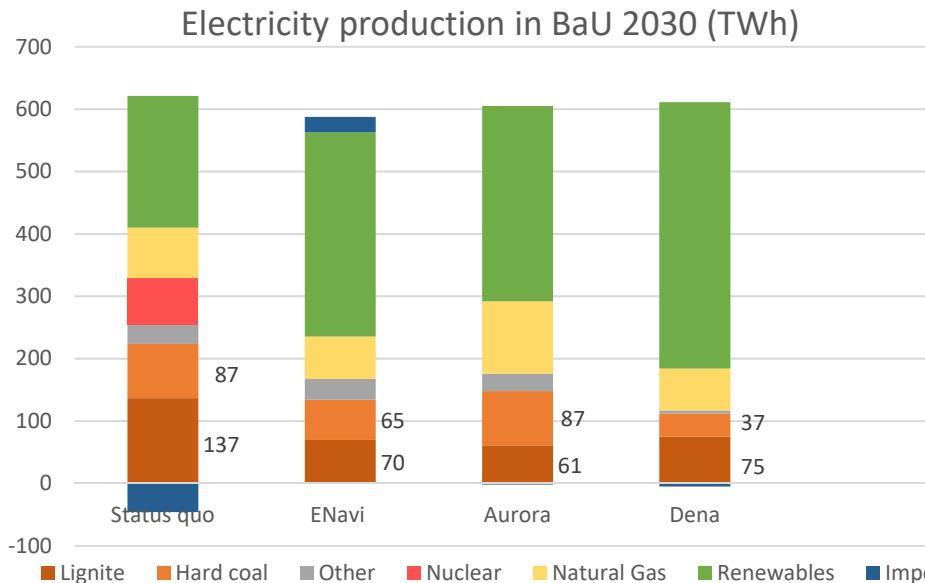
Renewable support effective

- renewable Energy Sources Act (EEG): long term fixed technology specific feed-in tariffs with privileged access to market and obligation for network connection: 20,5 GW ('04) to 117 GW ('18) with 46 GW PV, 53 GW Wind onshore, 6 GW Wind Offshore, 5 GW Hydro, 8 GW Biomass
- EEG 2014: reduction in FIT + targets for capacity increase per year
 - wind onshore: 2,5 GW MW (net → 3-5 GW gross,)
 - wind offshore: 6,5 GW by 2020 (15 GW 2030)
 - photovoltaic: 2.500 MW (gross), biomass: < 100 MW (gross)
- EEG 2016: bidding system for renewable investments from 2017 onwards (quantity based), not PV < 750kWp
- 2018: goal enshrined in the coalition agreement of about 65 % by 2030
- better synchronization of renewable energies and grid capacities
 - limit expansion of wind power in some areas
- tenant Electricity Act involves tenants directly and sets PV impulses, wind cooperations

Electricity generation in Germany



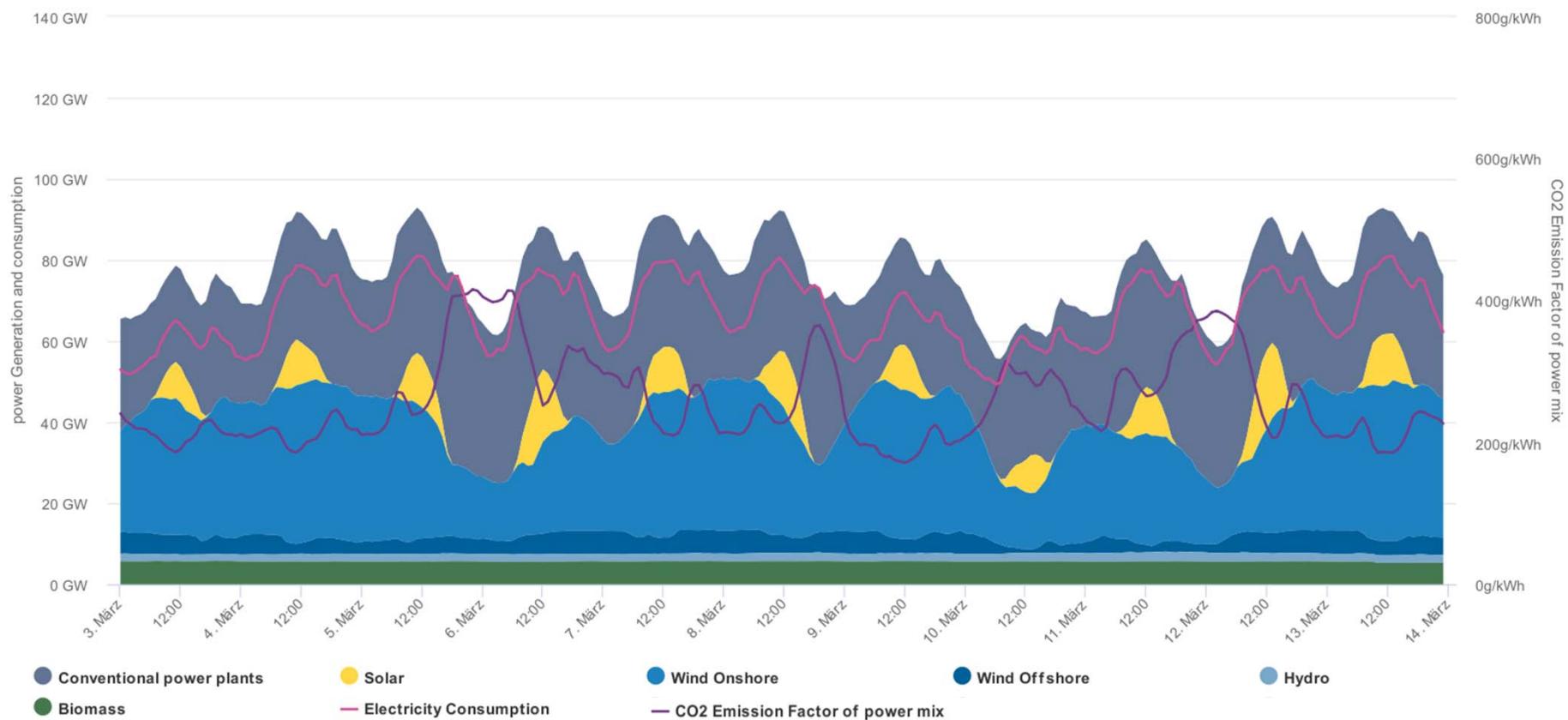
Electricity generation in 2030 (BaU)



- substantial economic phase out of coal based electricity generation
- renewable increase to 55 %, but targets missed (50+)
- additional reduction necessary to achieve 2030 target
- Germany to become net importer

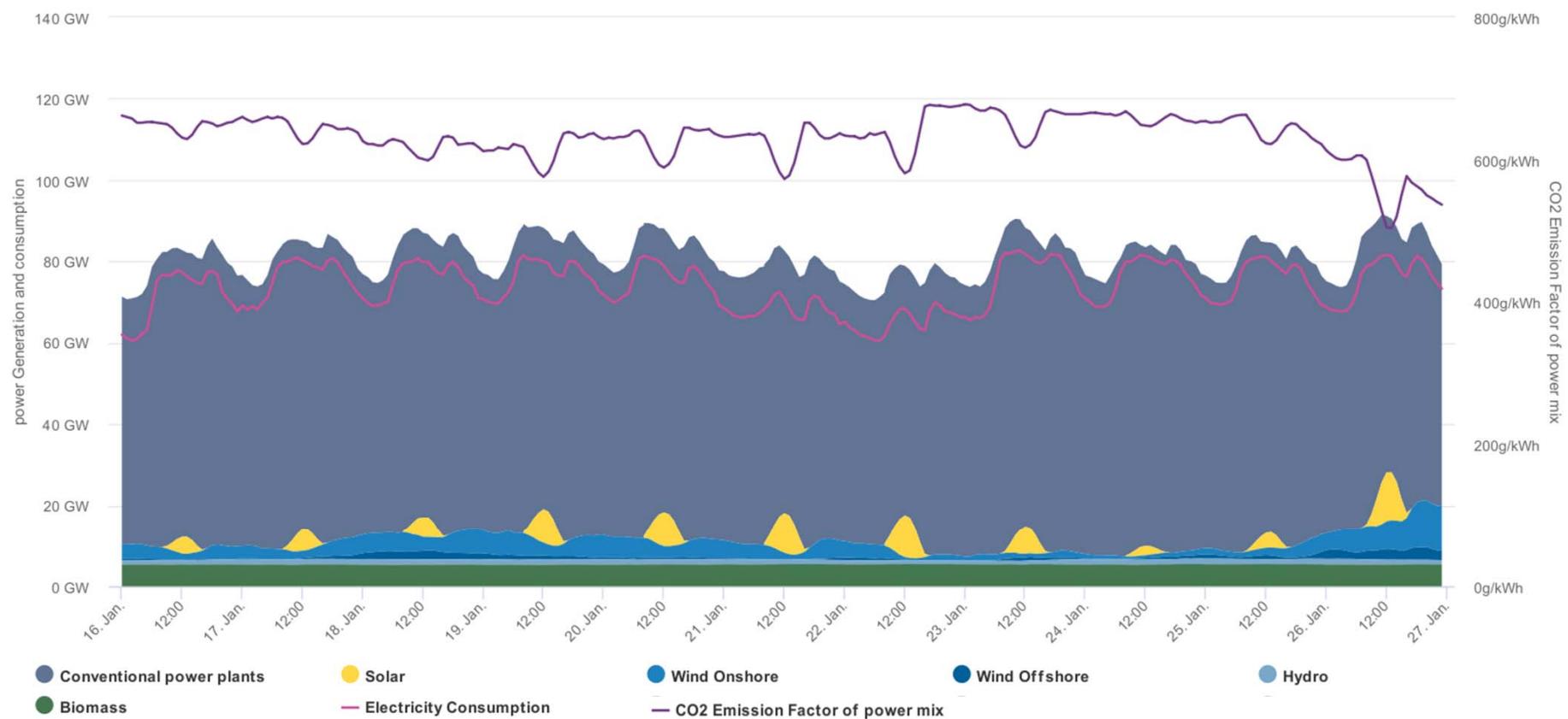
Renewables in 2019

In calendar week 10 2019 around 70 % of electricity consumption covered by renewables

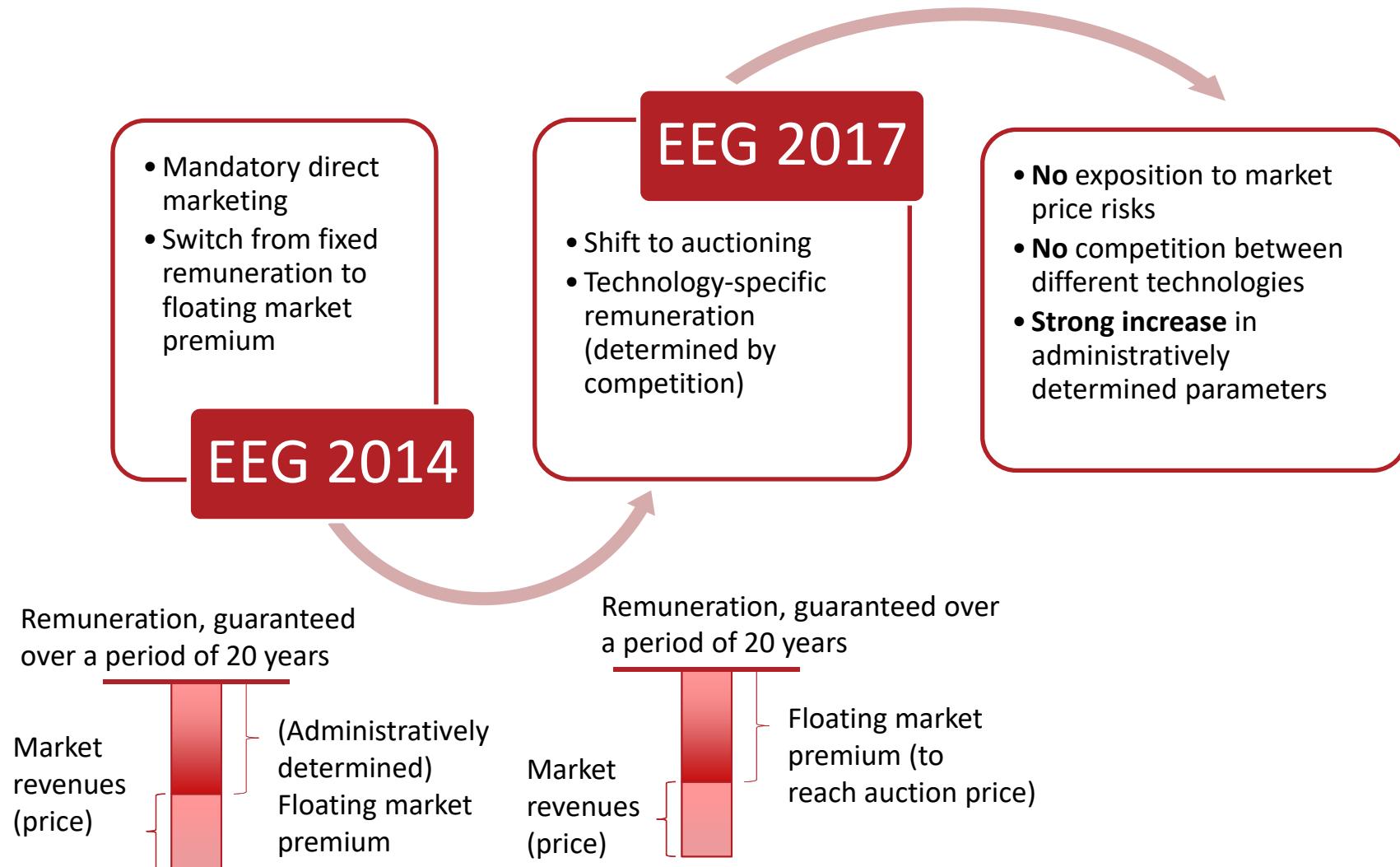


Integration of renewables into system

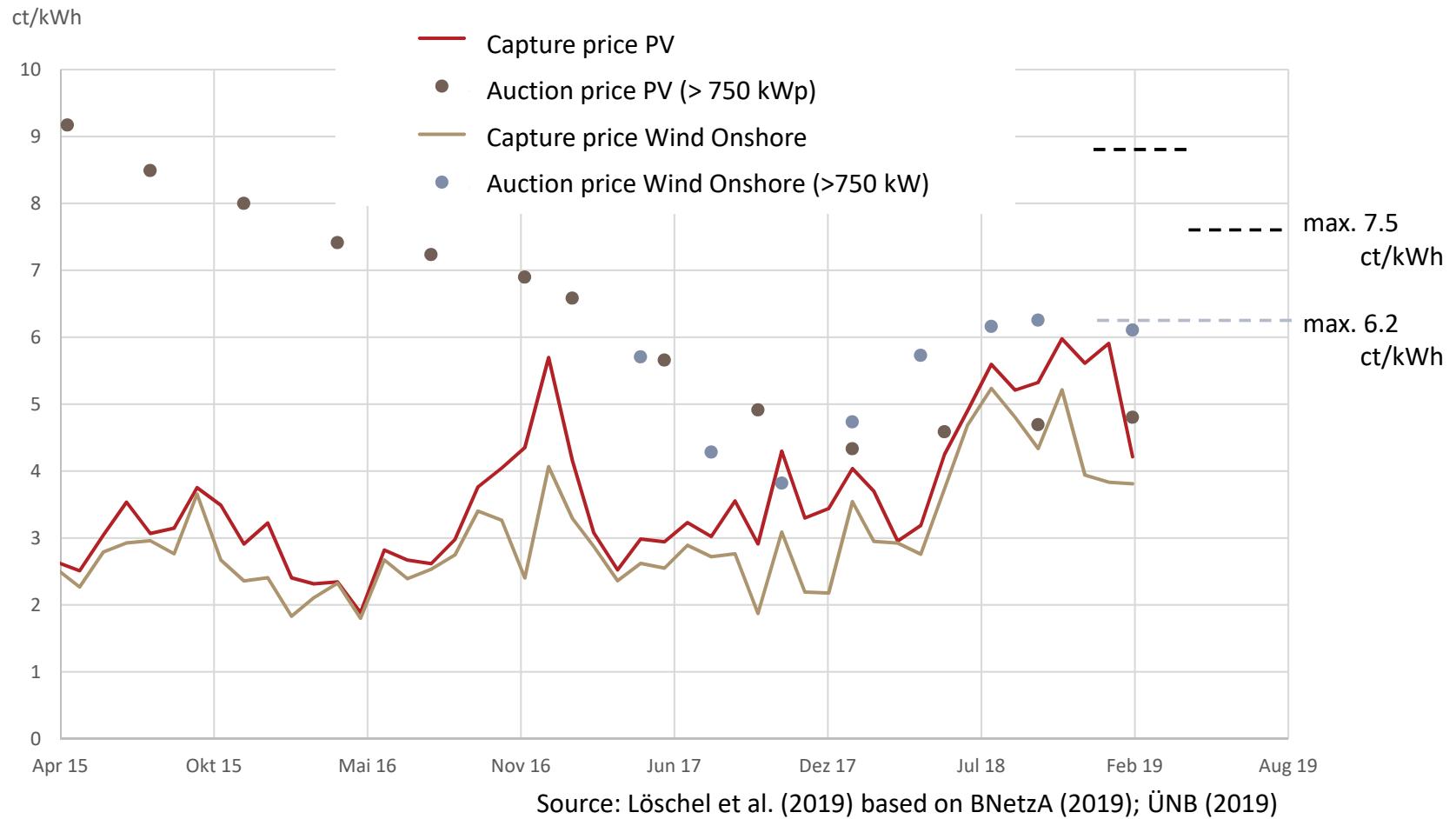
Electricity generation and load: 16.1.2017 – 26.1.2017.



Development of support system

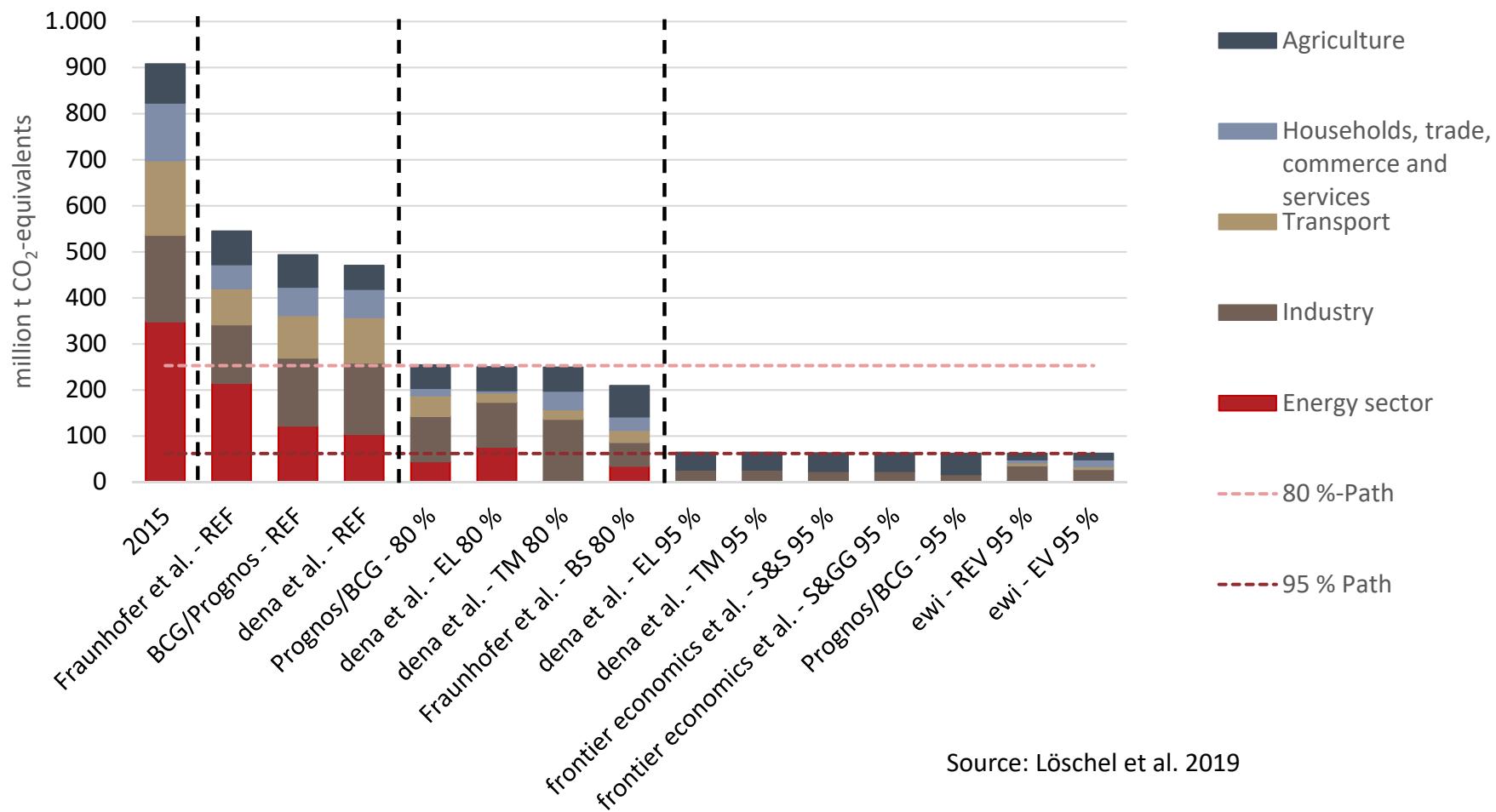


Renewable auctions and capture prices



GHG Emissions in 2050

Sectoral GHG emissions in 2050 (and comparison with 2015 as a base year)



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Electricity generation in 2050

Net electricity generation in 2050 according to different scenarios

TWh	BCG/Prognos – REF	BCG/Prognos – 80 %	BCG/Prognos – 95 %	ewi – REV 95 %	ewi – EV 95 %
Photovoltaics	90	100	114	192	192
Wind offshore	151	188	258	139	113
Wind onshore	194	208	215	373	372
Gas (Synthetic gas from PtG)	49	47	48 (syn gas)	84 (syn gas)	61 (syn gas)
Other	136	83	80	87	72
Total	620	626	715	875	811

Source: Löschel et al. 2019

Electrification in 2050

Selected technologies for sector coupling in 2050

Attribute	BCG/Prognos – REF	BCG/Prognos – 80 %	BCG/Prognos – 95 %	ewi – REV 95 %	ewi – EV 95 %
heat pumps [million units]	4	14	16	13	6
Electric cars and light-duty vehicles [million units]	14+1	26+2	33+2	33+2	33+2
truck overhead line [km]	0	4,000	8,000	N/A	
Synthetic fuels [TWh]	0	0	268	170-177	188-207
Synthetic fuels and combustibles [TWh]	0	0	383	448	634
Synthetic fuel imports [TWh]	0	0	340	402	585

Energy Transition - Status quo and challenges

- substantial gaps in 2020/2030: climate target and efficiency
- climate policy options
 - coal phase out as a relatively cheap option, but implementation costly
 - CO₂ pricing and energy tax reform (electricity tax, FIT, ...)
- renewable policies to be developed further (tech, grid, market price risk)
→ increase in renewable alone not sufficient to achieve CO₂ targets
- sector coupling necessary in long run (electricity, heat, transport): electrification and Power to X (hydrogen, green gas, synthetic fuels)
- grid extension as a bottleneck (also in EU): grid charges, market splitting
- comprehensive review of the coal exit measures and their implementation in 2023, 2026 and 2029

Thank you.

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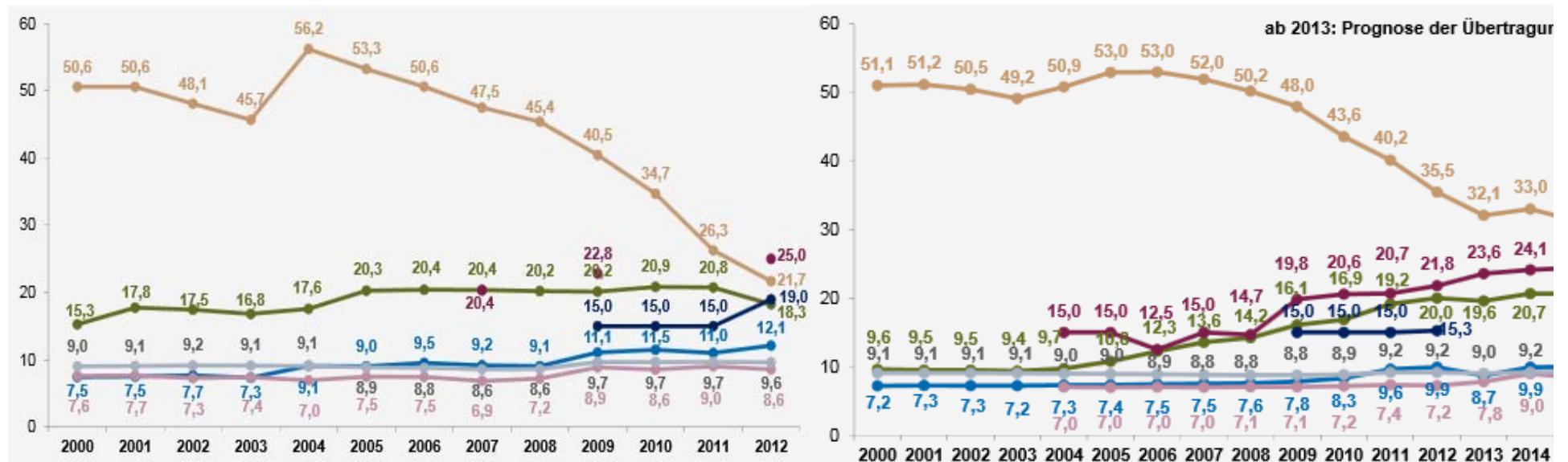
Monitoring the Energy Transition

<http://www.bmwi.de/Redaktion/EN/Artikel/Energy/monitoring-implementation-of-the-energy-reforms.html>

Google: energy monitoring germany bmwi

Renewable support effective, but not efficient

- Feed in tariffs (new installations) average feed in tariff

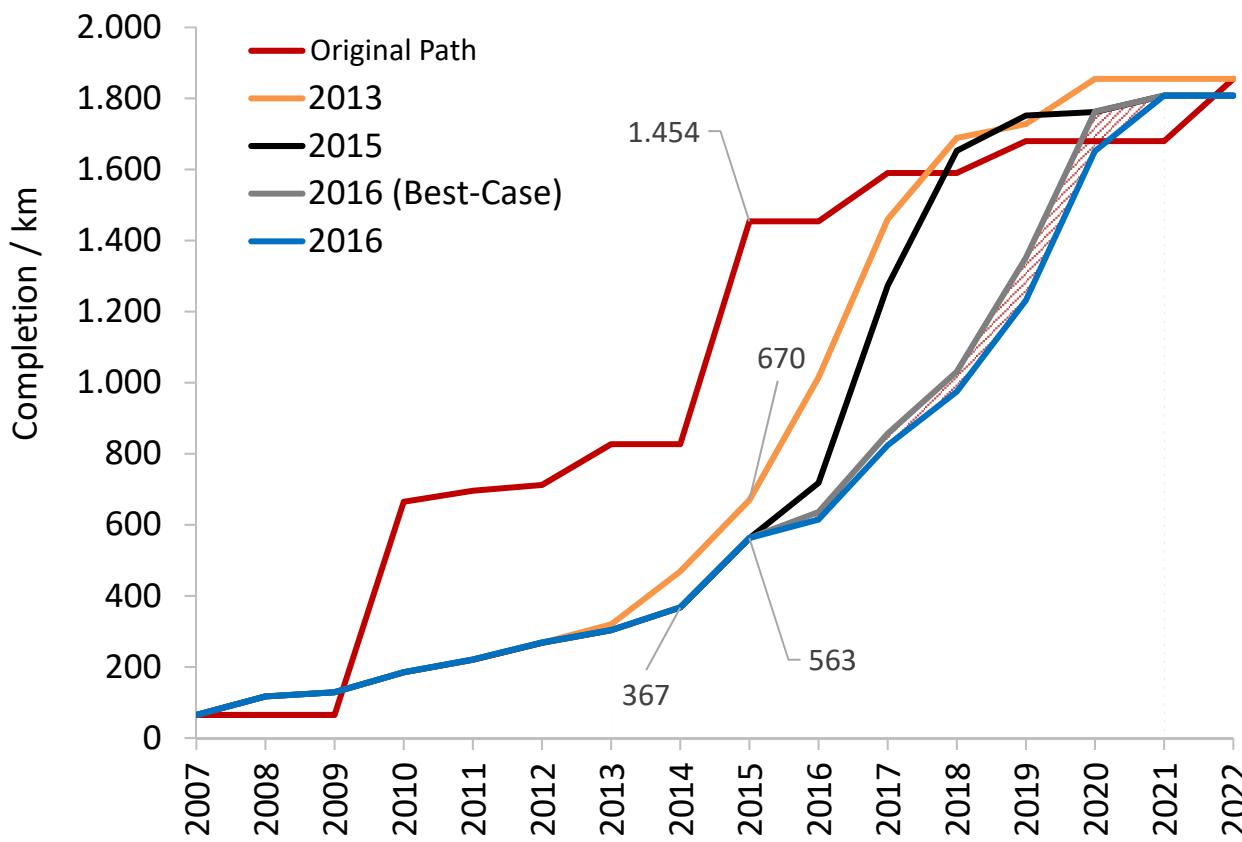


2014: Biomass 15 ct, Wind offshore 19 ct, Wind onshore 9 ct, Photovoltaik 12 ct
e.g. 1.2.2015 PV rooftop <10kWp 12,56, <500kWp 10,92, open space 8,70



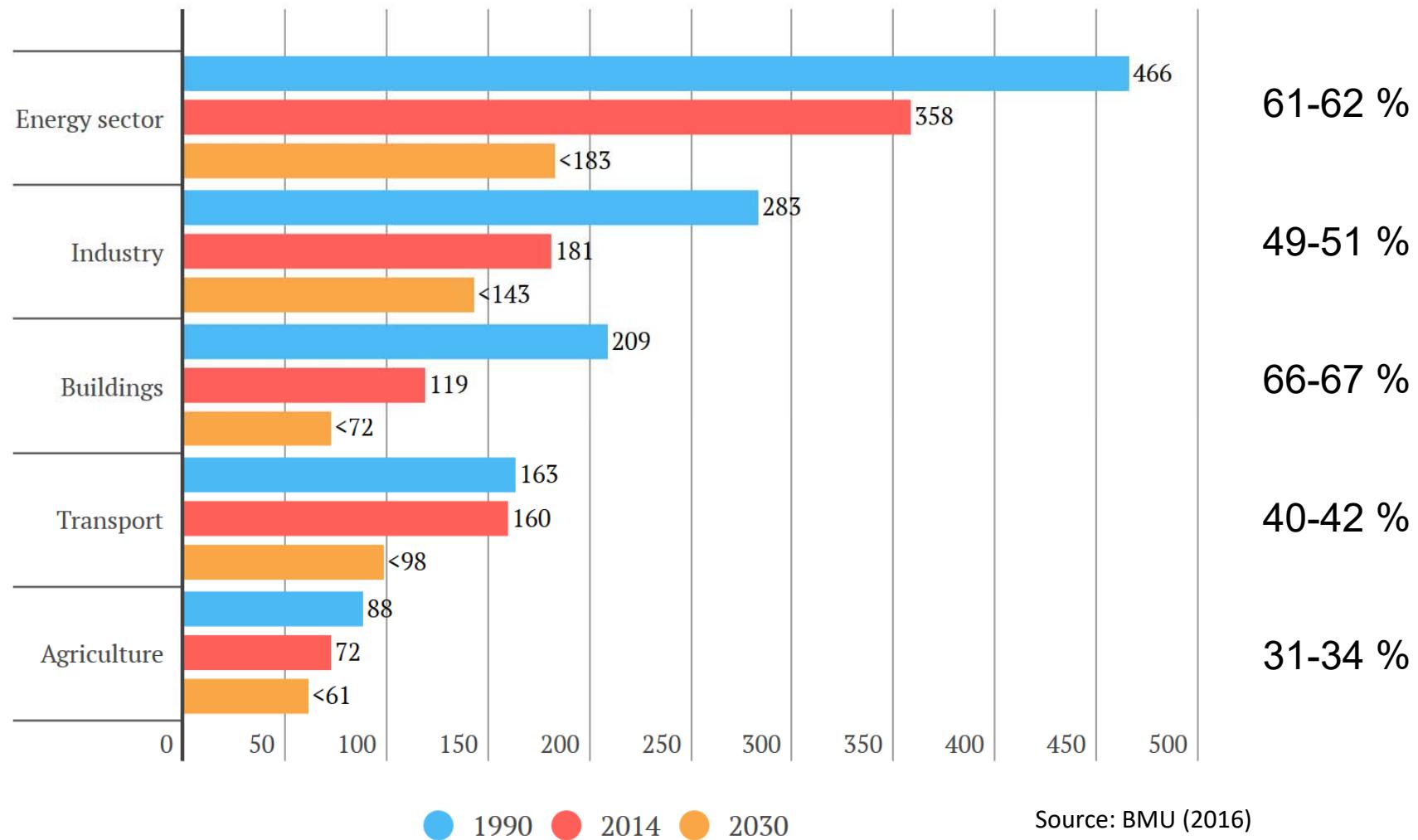
Expand the grid

Necessary grid extension (transmission and distribution) because of local and temporal intermittency as well as increasing average distance



- By the end of 2015 563 km had been completed (107 km less than forecasted in 2013, and 891 km less than originally intended)
- The situation is similar with respect to projects of the Federal Requirement Plan

Climate Action Plan 2050 and 2030 targets



Perspective 2050

Decomposition of the drivers of energy emissions in the overall system 2015-2050

