What can we learn from the German nuclear phase-out?

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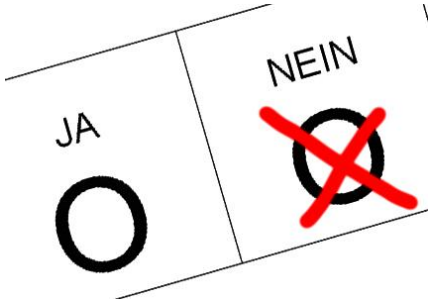
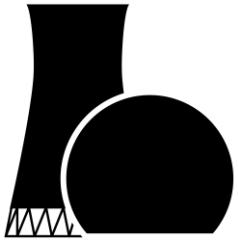
The 49th JAIF ANNUAL CONFERENCE , 12 April 2016

Political, technical and economical issues dominating nuclear energy

- No replacement of existing nuclear plants
- Green party: Shut down NPPs after 45 years
  → public vote in Nov. 2016



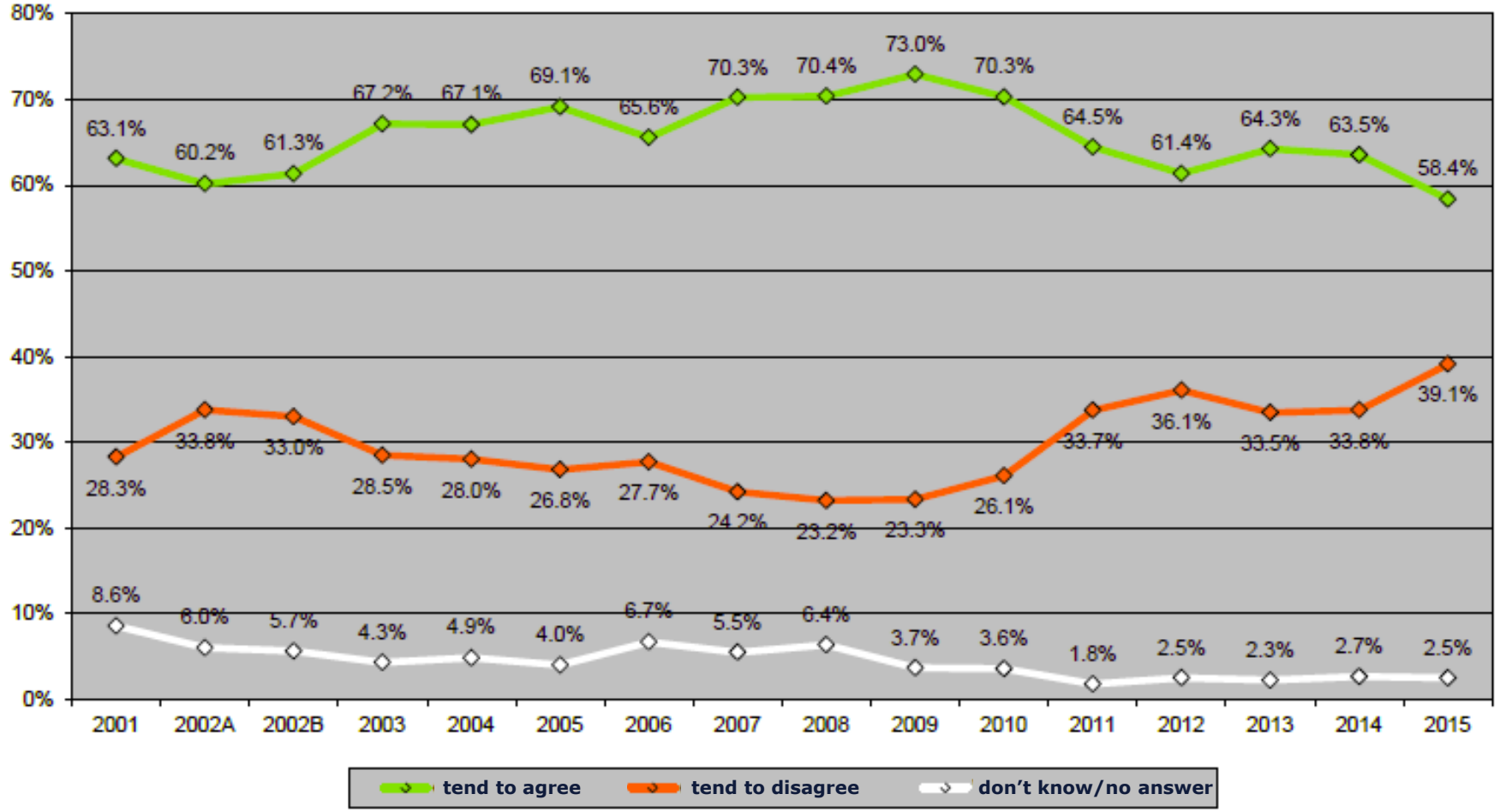
- Gösgen, Leibstadt operating normally, long outage in Beznau 2
- Beznau unit 1 in shut-down since March 2015 (RPV NDT testing results); restart not before July 2016
- BKW preparing 1st Swiss decommissioning project



- Low electricity prices
- Utilities wouldn't invest in new capacity, regardless of political nuclear phase-out

Trends in public opinion are challenging

«The existing NPP's are necessary for the security of supply.»



Source: Yearly Swiss telephone survey «Eckwertstudie»;
http://www.swissnuclear.ch/upload/cms/news/Eckwertstudie26112015.pdf

Dr. Frank Walter Steinmeier, German Foreign Minister in March 2016

"Ten years ago, hardly anyone would have thought it possible. Today, however, **we know** that the energy transition **is technically and financially feasible**"

Quote: http://bmwi.de/EN/Press/press-releases,did=757952.html Photo: Thomas Köhler/photothek.net

Sigmar Gabriel, German Minister for Economic Affairs and Energy in March 2016

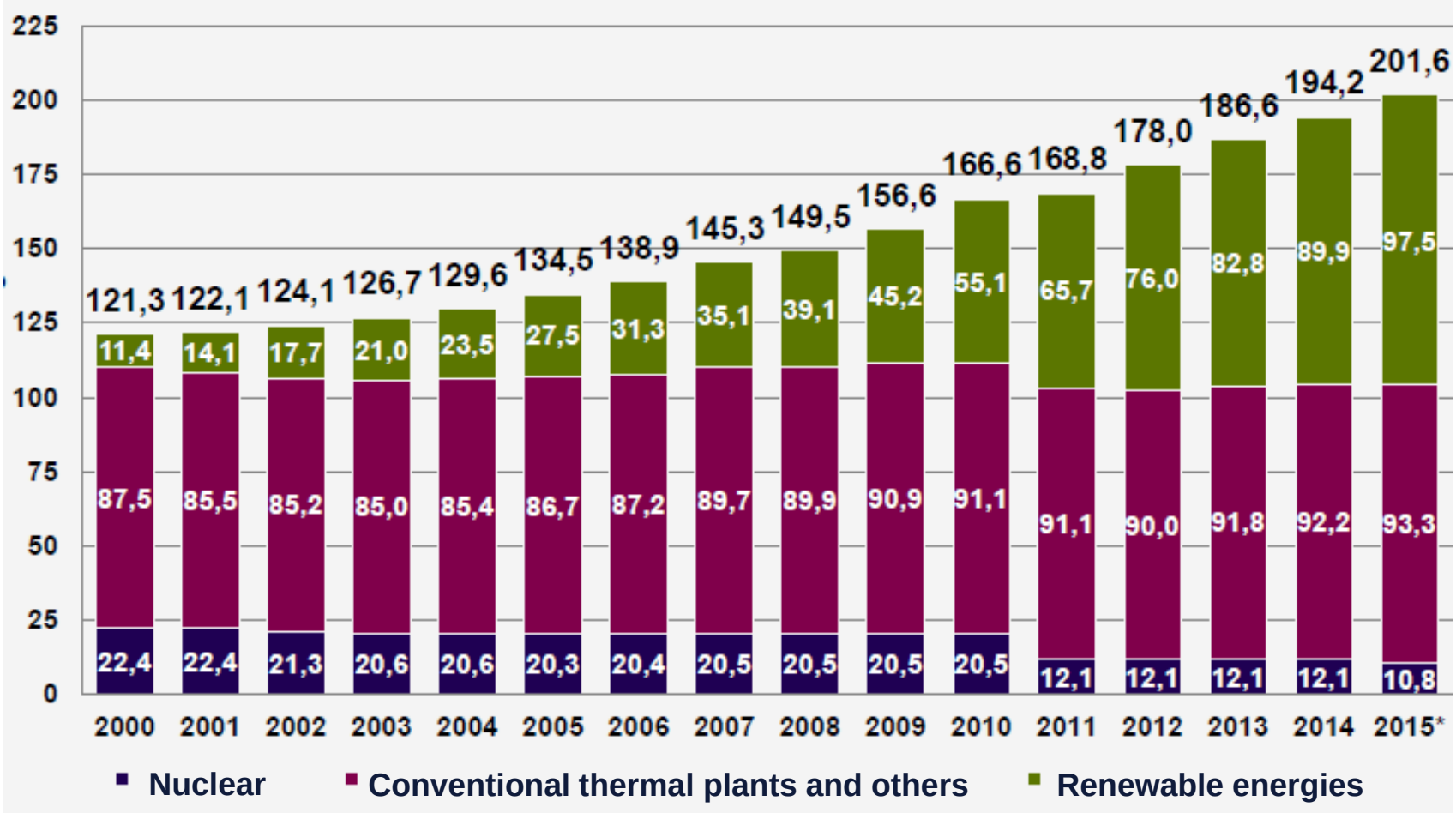
"We want to demonstrate that **sustainable energy policy** makes sense both from an **ecological** and an **economic** point of view"

Quote: http://bmwi.de/EN/Press/press-releases,did=757952.html, Photo: Dominik Butzmann, SPD

Three main issues around the German nuclear phase-out and energy transition

- **T** Technical feasibility
- **F** Financial reality
- **E** Environmental impact

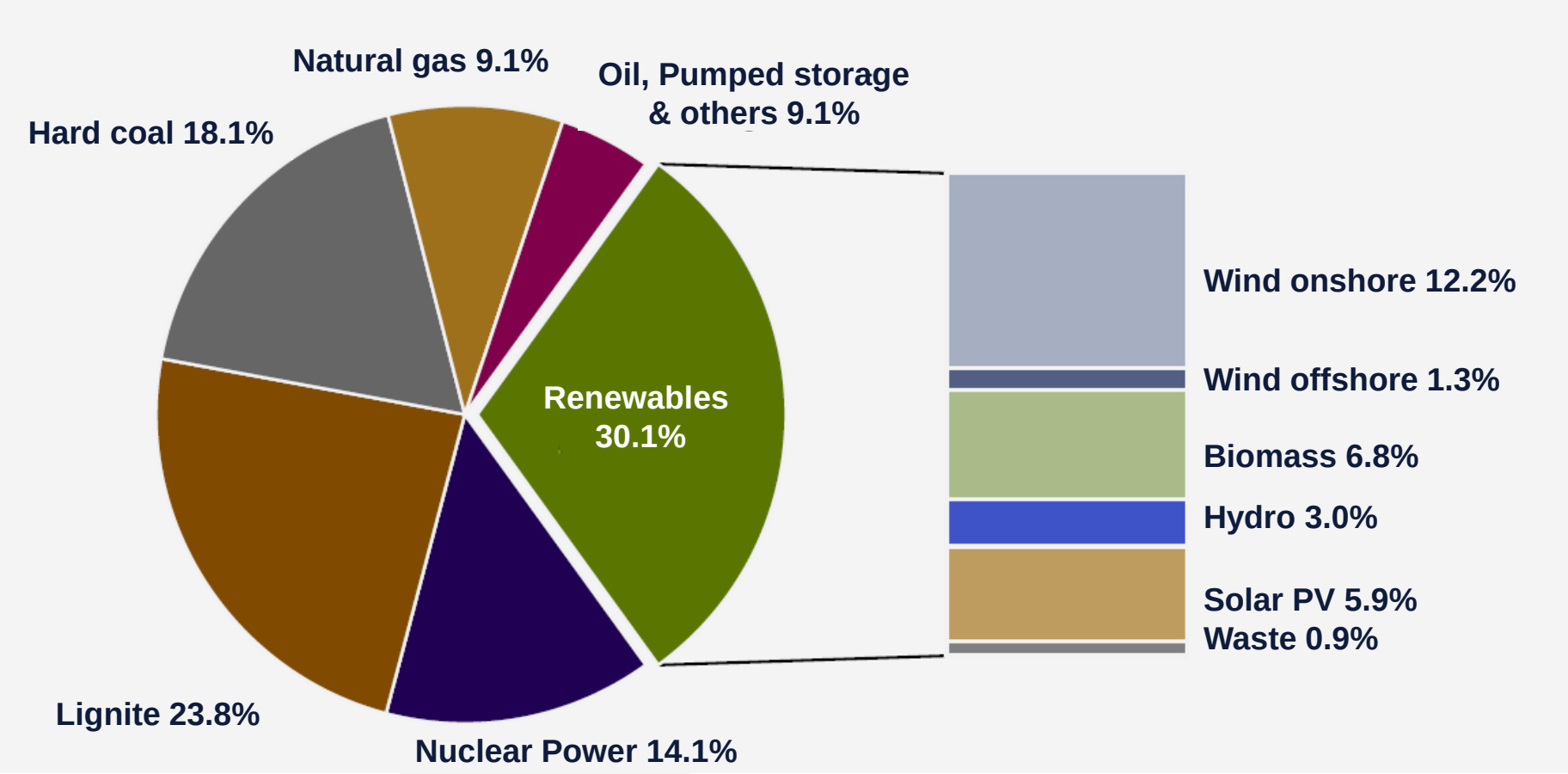
Installed generation capacity in Germany [GW]



48% renewables - 52% fossil, nuclear & others

Source: BDEW, *2015 preliminary; https://www.bdew.de/internet.nsf/res/FDFDE1F303A781EBC1257F61005AA43C/$file/160218_Foliensatz%20Energie-Info_Erneuerbare%20Energien%20und%20das%20EEG_2016_final.pdf

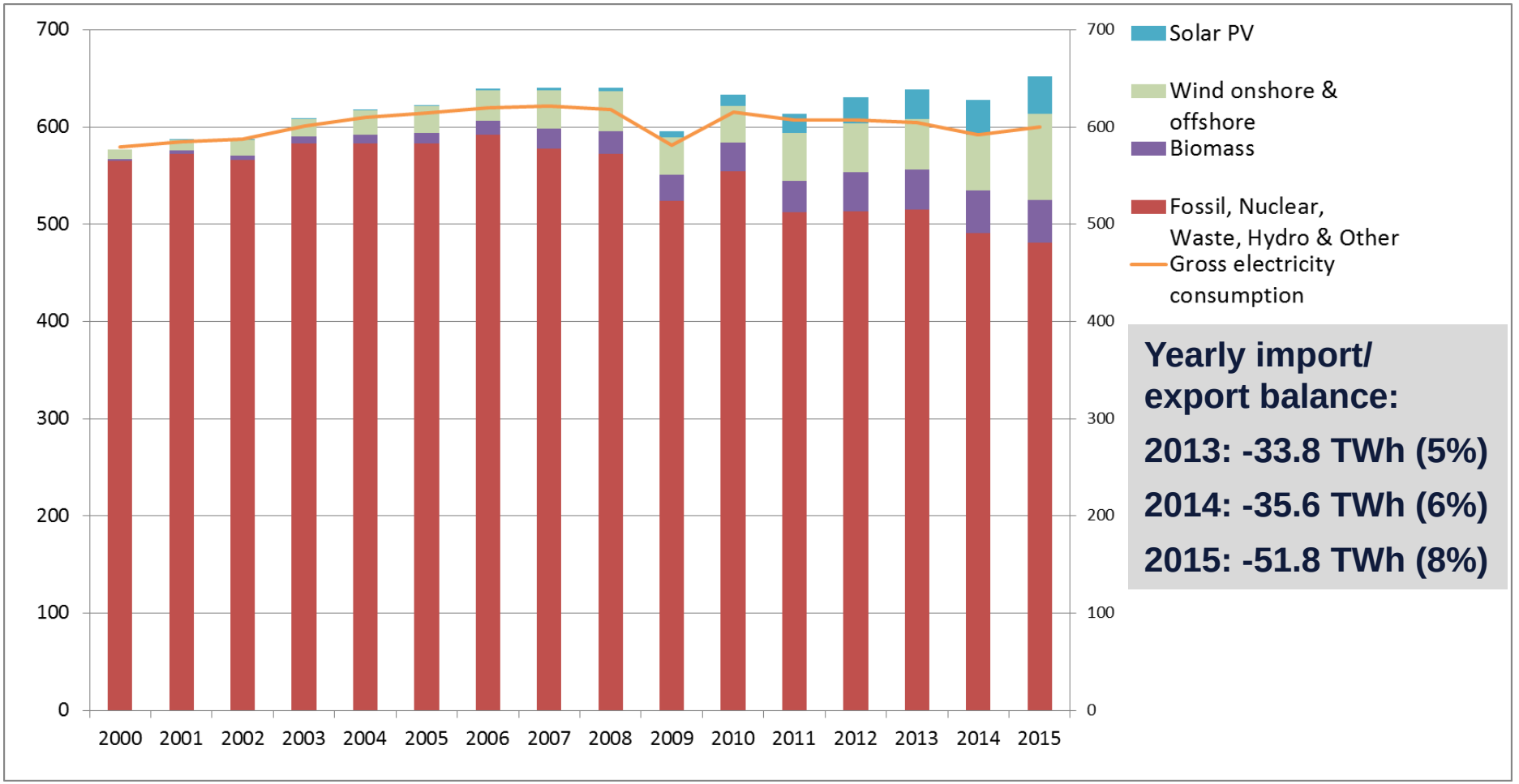
The German electricity generation mix in 2015 (gross generation: 652 TWh)



30% renewables - 70% fossil, nuclear & others

Source: BDEW

Gross electricity generation in Germany [TWh] 2000 - 2015



Yearly import/ export balance:

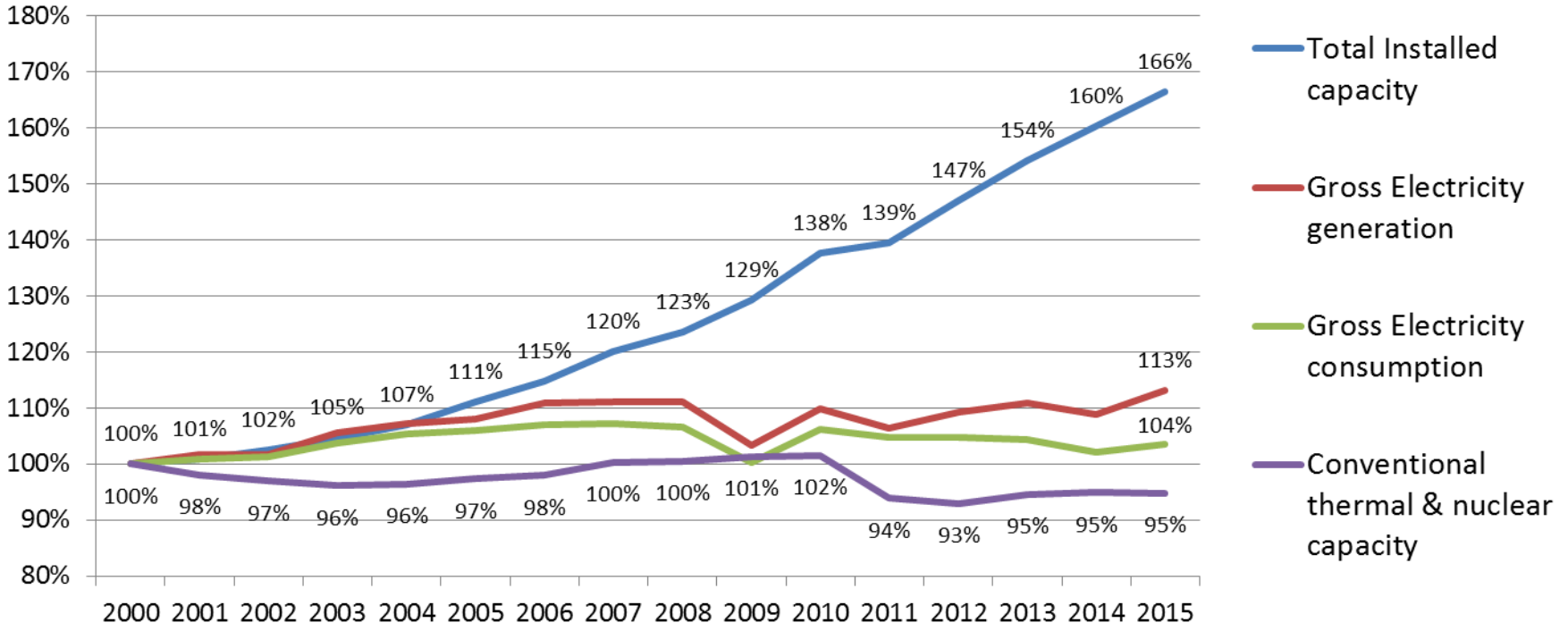
2013: -33.8 TWh (5%)

2014: -35.6 TWh (6%)

2015: -51.8 TWh (8%)

Data: AG Energiebilanzen, BDEW

Installed capacity vs. electricity generation and consumption

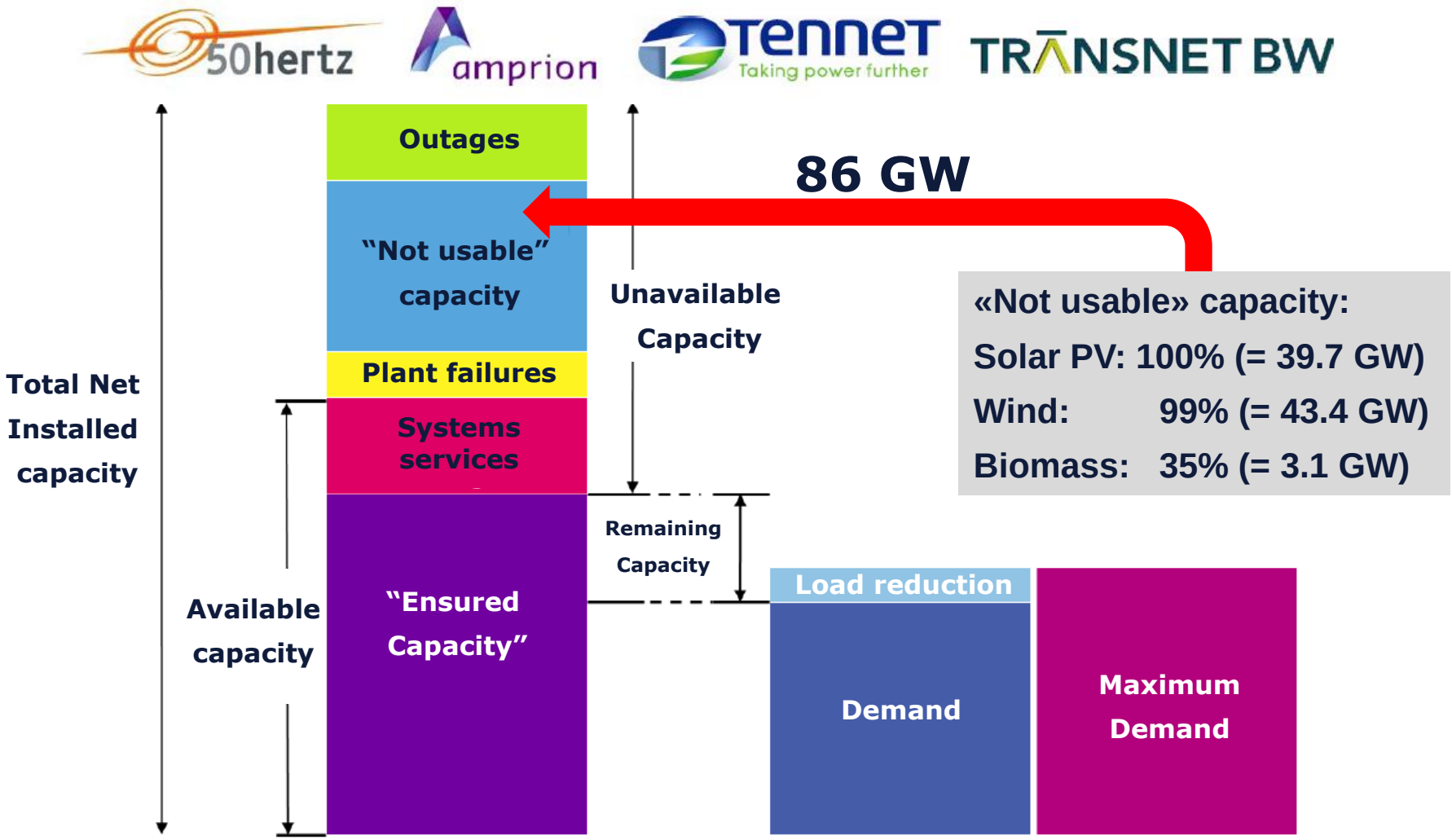


- Electricity consumption stayed the same since 2000
- Conventional thermal or nuclear capacity was not replaced

→ New renewables capacity as «add-on» to existing system

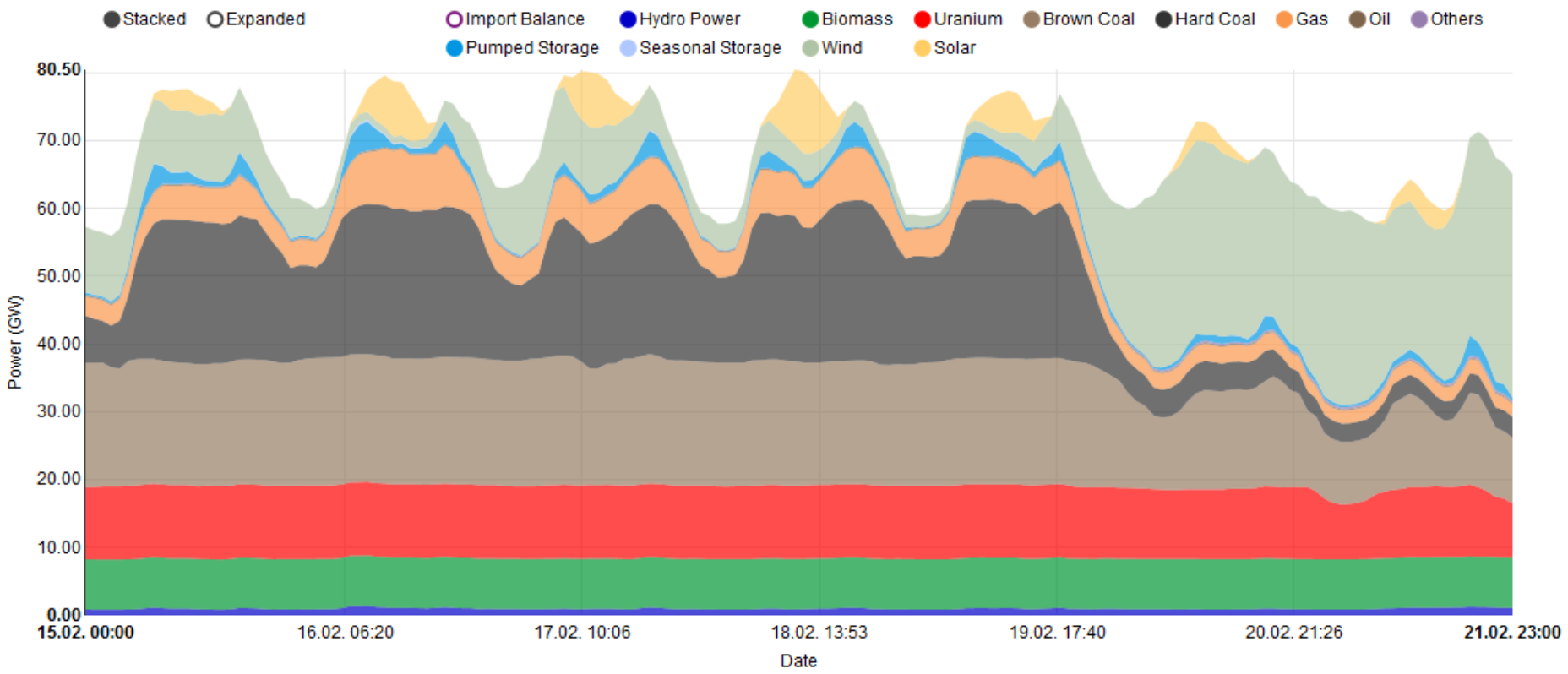
→ Load factors & fuel use of conventional plants reduced

Solar PV and Wind capacity «not usable» for the balance of supply and demand



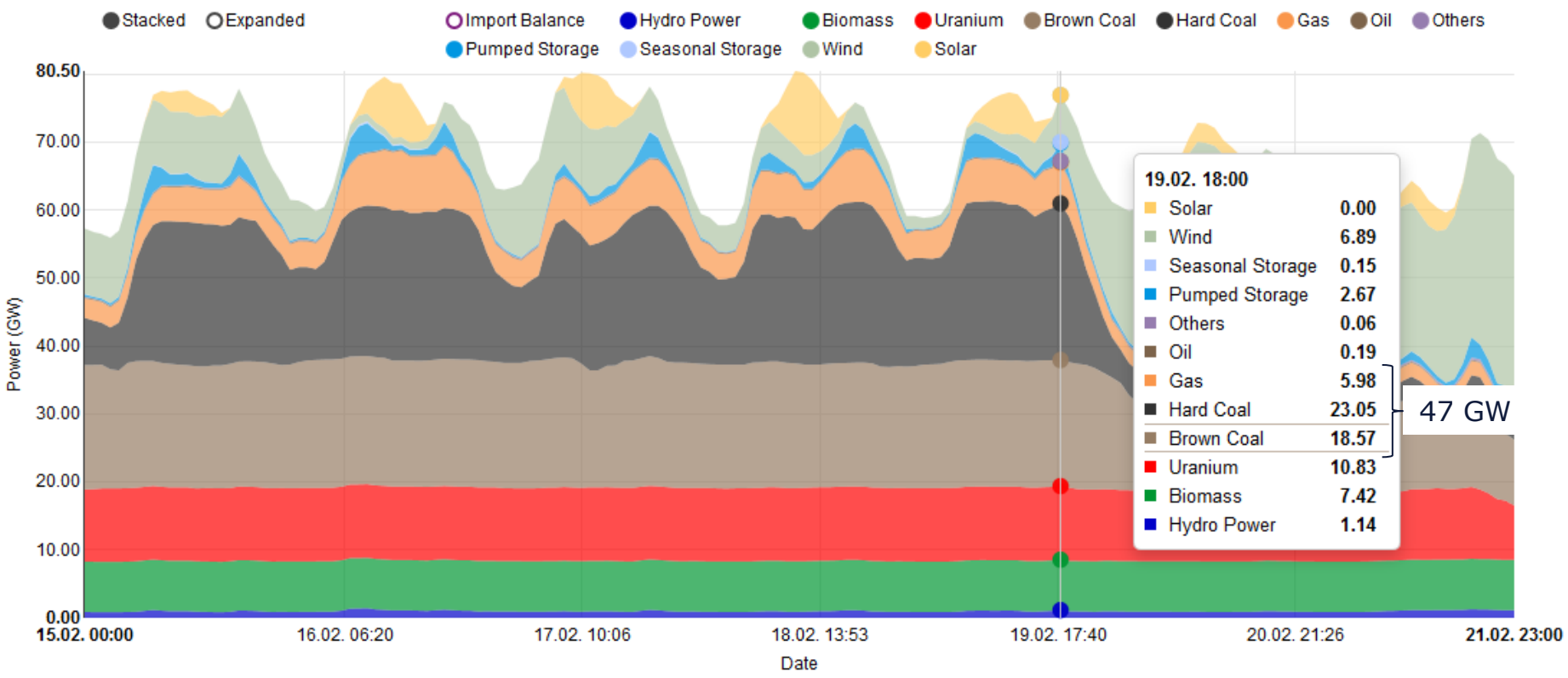
https://www.bundesregierung.de/Content/Infomaterial/BMWI/bericht-uebertragungsnetzbetreiber-leistungsbilanz-2015_753972.html

Example for «technical feasibility»: 19-20 February 2016



Source: www.energy-charts.de

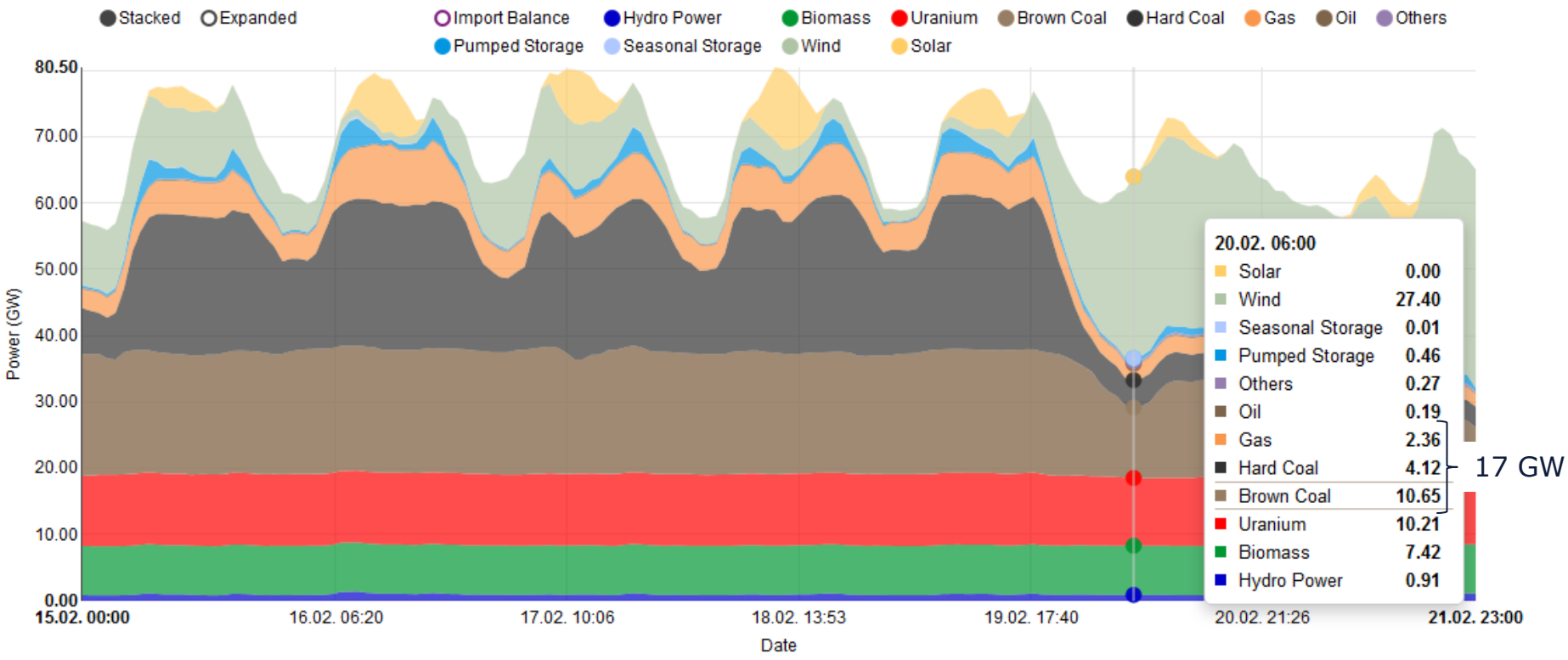
With 20GW more wind on a Saturday morning, hard coal, gas and lignite have to stop generating



Datasource: 50 Hertz, Amprion, Tennet, TransnetBW, EEX
Last update: 27 Feb 2016 23:14

Source: www.energy-charts.de

With 20GW more wind on a Saturday morning, hard coal, gas and lignite have to stop generating



Datasource: 50 Hertz, Amprion, Tennet, TransnetBW, EEX
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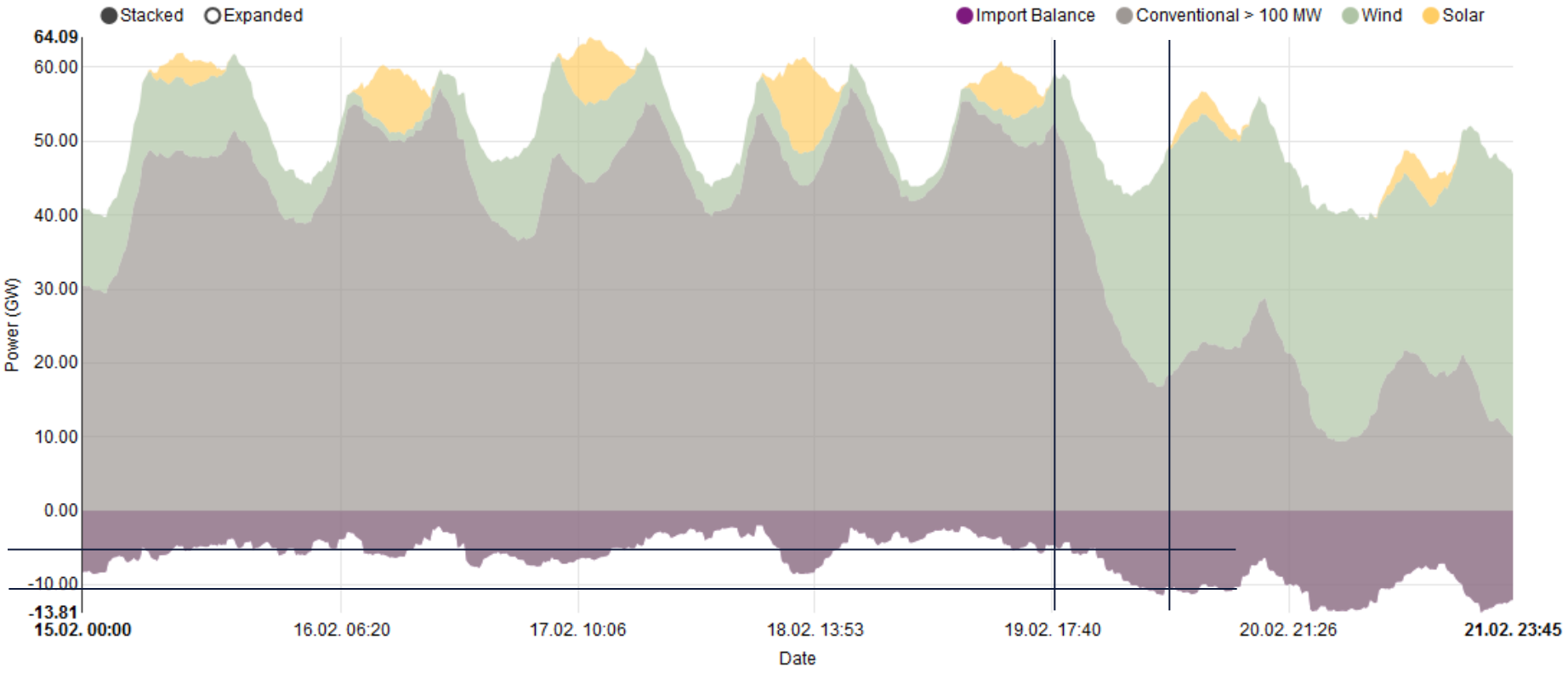
Source: www.energy-charts.de

… and 5GW are additionally exported



Datasource: 50 Hertz, Amprion, Tennet, TransnetBW, EEX
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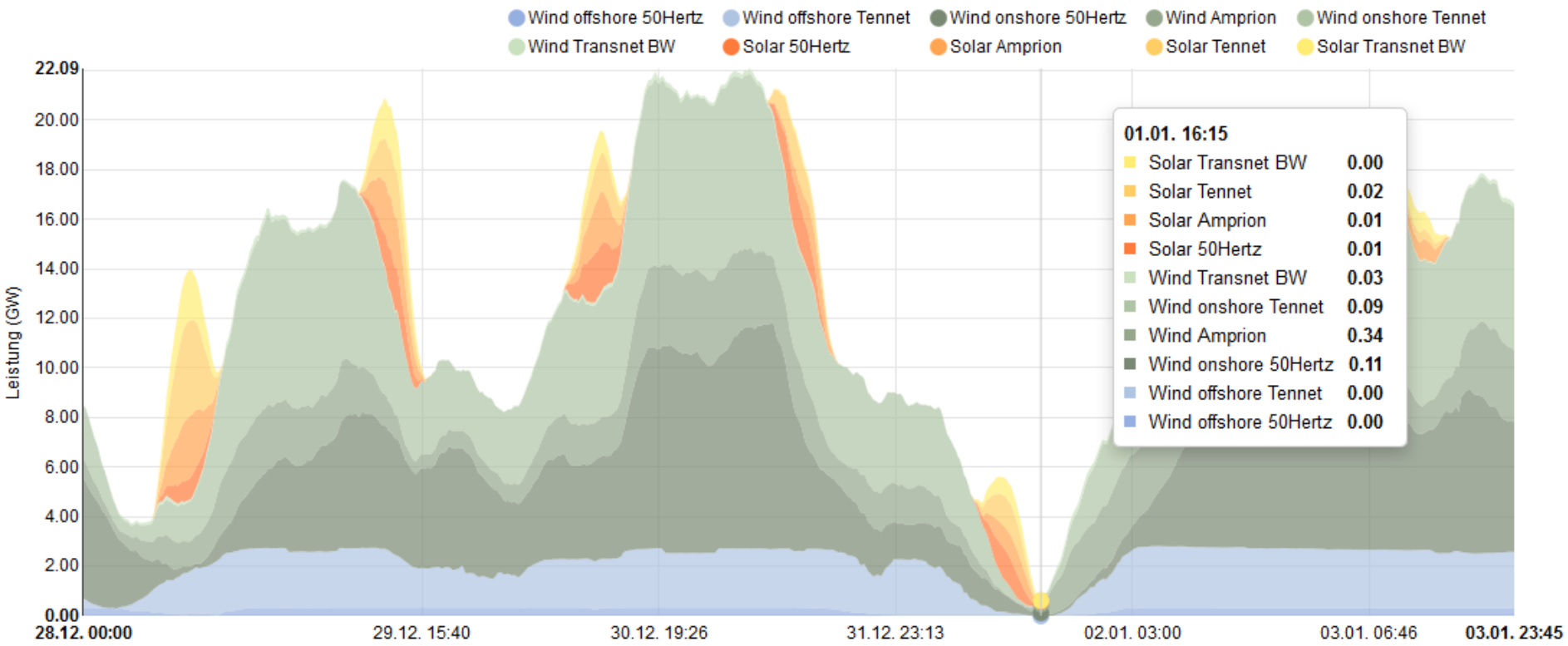
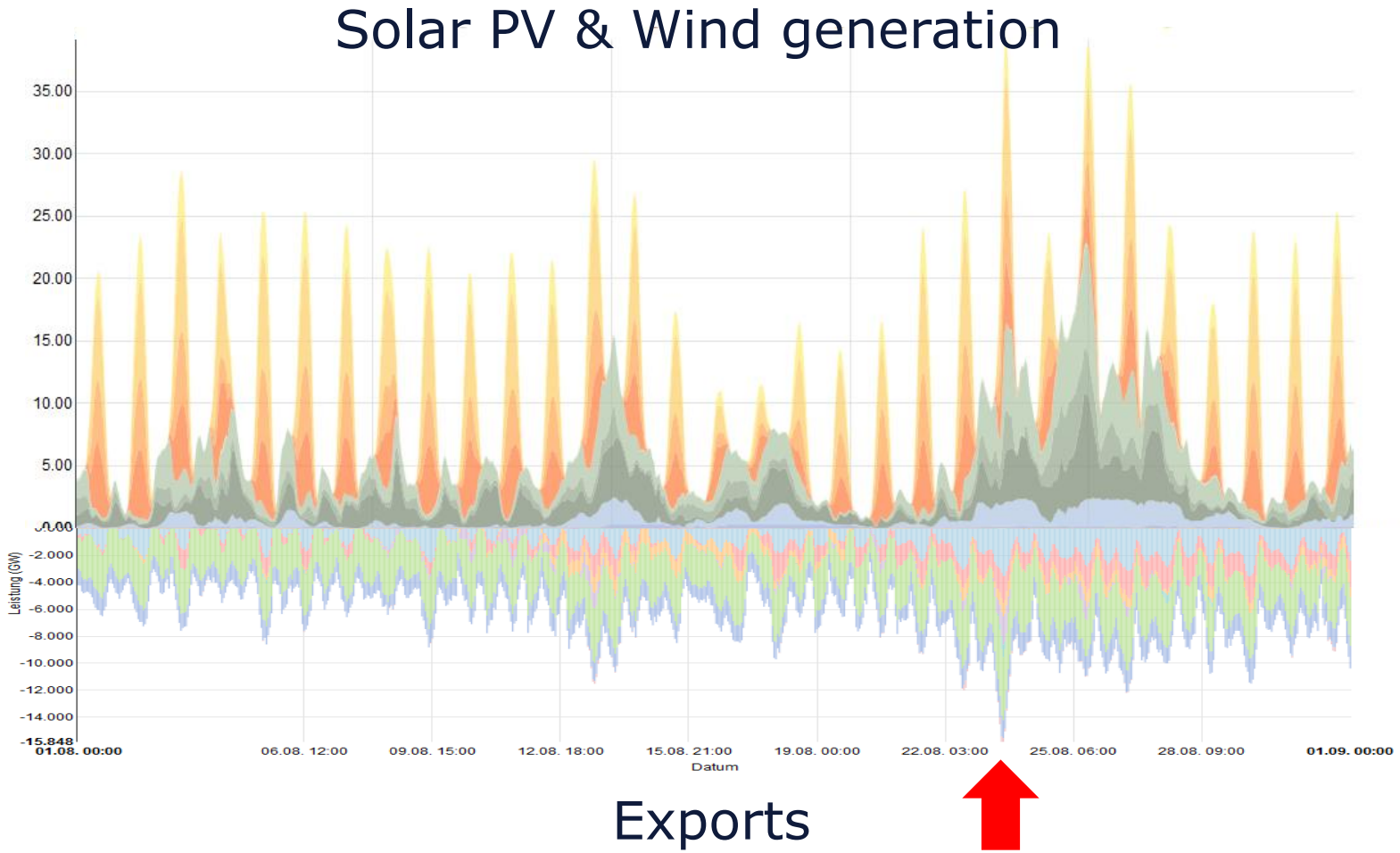
Source: www.energy-charts.de

Generation of 80 GW capacity can be almost zero – example 1 January 2016, 16:15pm



Source: www.energy-charts.de

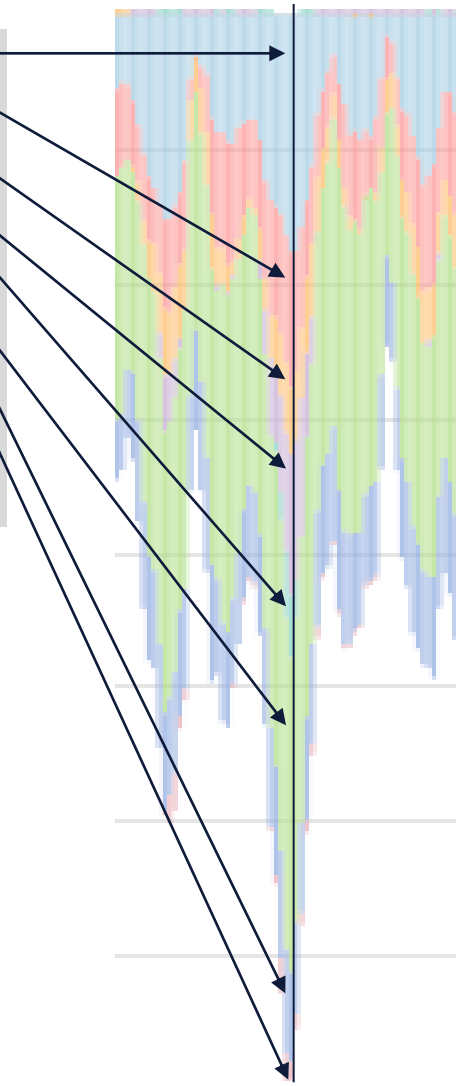
Germany «outsourcing» part of its problems to the neighbours – example: 23 August 2015, 1pm



Source: www.energy-charts.de

Germany «outsourcing» part of its problems to the neighbours – example: 23 August 2015, 1pm

Austria	-3.5 GW
Switzerland	-2 GW
Czech Republic	-1 GW
Denmark	-2 GW
France	-1 GW
Netherlands	-4.7 GW
Poland	-1.3 GW
Sweden	-0.3 GW
Total	**-15.8 GW**



Source: www.energy-charts.de

The German premature nuclear phase-out: 2500-4000 TWh of electricity to be replaced

Plant	Type	MWnet	Years shut-down before reaching 50 years [y]	Years shut-down before reaching 60 years [y]	Theoretical yearly generation with capacity factor of 85% [TWh]	Total generation "lost" compared to 50 years of operation [TWh]	Total generation "lost" compared to 60 years of operation [TWh]
Biblis A	*PWR*	*1167*	*13.8*	*23.8*	*8.7*	*120*	*207*
Biblis B	*PWR*	*1240*	*15.7*	*25.7*	*9.2*	*145*	*238*
Brunsbüttel	*BWR*	*771*	*15.8*	*25.8*	*5.7*	*91*	*148*
Isar 1	*BWR*	*878*	*17.9*	*27.9*	*6.5*	*117*	*182*
Krümmel	*BWR*	*1346*	*22.9*	*32.9*	*10.0*	*229*	*330*
Neckarwestheim I	*BWR*	*785*	*15.6*	*25.6*	*5.8*	*91*	*150*
Philippsburg 1	*BWR*	*890*	*18.9*	*28.9*	*6.6*	*125*	*191*
Unterweser	*PWR*	*1345*	*18.4*	*28.4*	*10.0*	*184*	*284*
Grafenrheinfeld	*PWR*	*1275*	*16.9*	*26.9*	*9.5*	*161*	*255*
Gundremmingen B	BWR	1284	16.6	26.6	9.6	158	254
Brokdorf	PWR	1410	17.0	27.0	10.5	178	283
Grohnde	PWR	1360	15.1	25.1	10.1	153	255
Gundremmingen C	BWR	1288	15.1	25.1	9.6	144	240
Philippsburg 2	PWR	1402	15.3	25.3	10.4	160	264
Emsland	PWR	1329	15.5	25.5	9.9	153	252
Isar 2	PWR	1400	15.3	25.3	10.4	160	264
Neckarwestheim II	PWR	1310	16.3	26.3	9.8	159	257
Total		**20480**				**2530**	**4055**

« Ce qu'on voit et ce qu'on ne voit pas » (That Which Is Seen and That Which Is Not Seen)

Frédéric Bastiat, 1801-1850

The parable of the broken window:

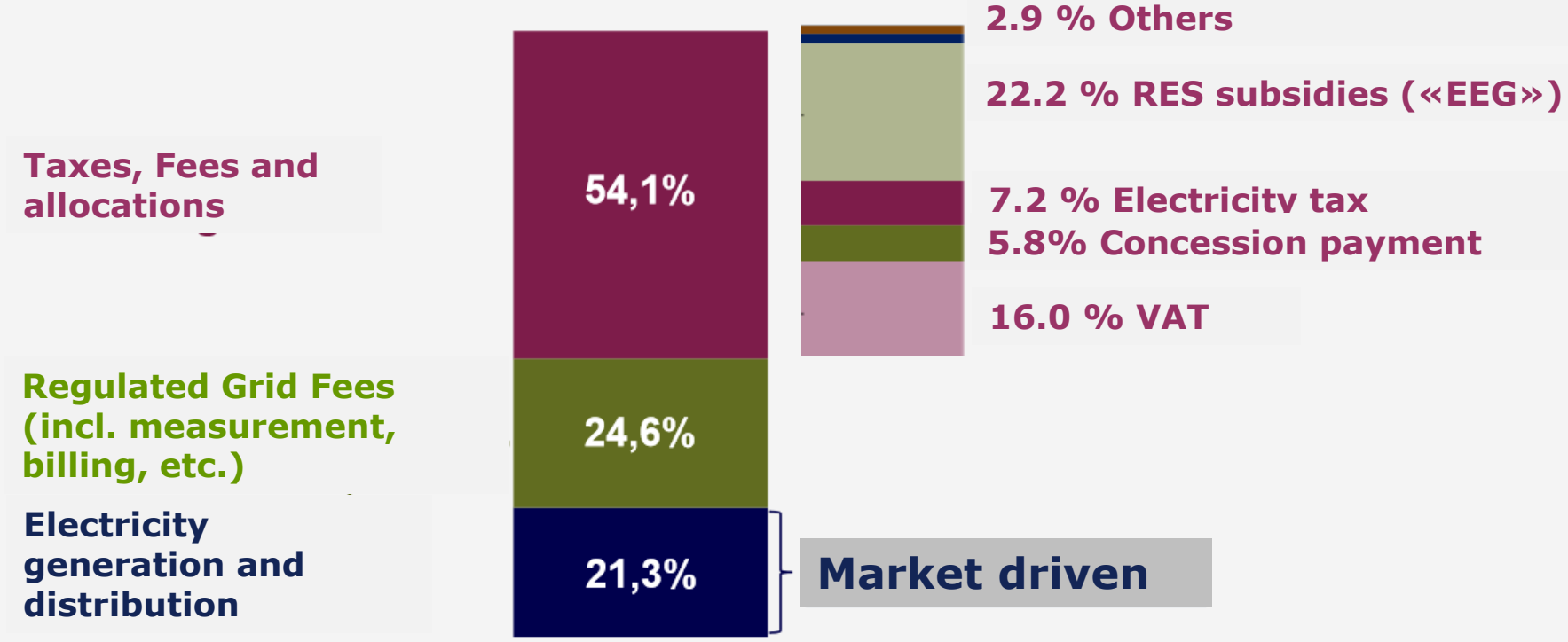
Money spent on broken windows cannot be spent on other things

→ Opportunity costs should be recognized

What do you call a system where 80% of the final price is being determined by government?

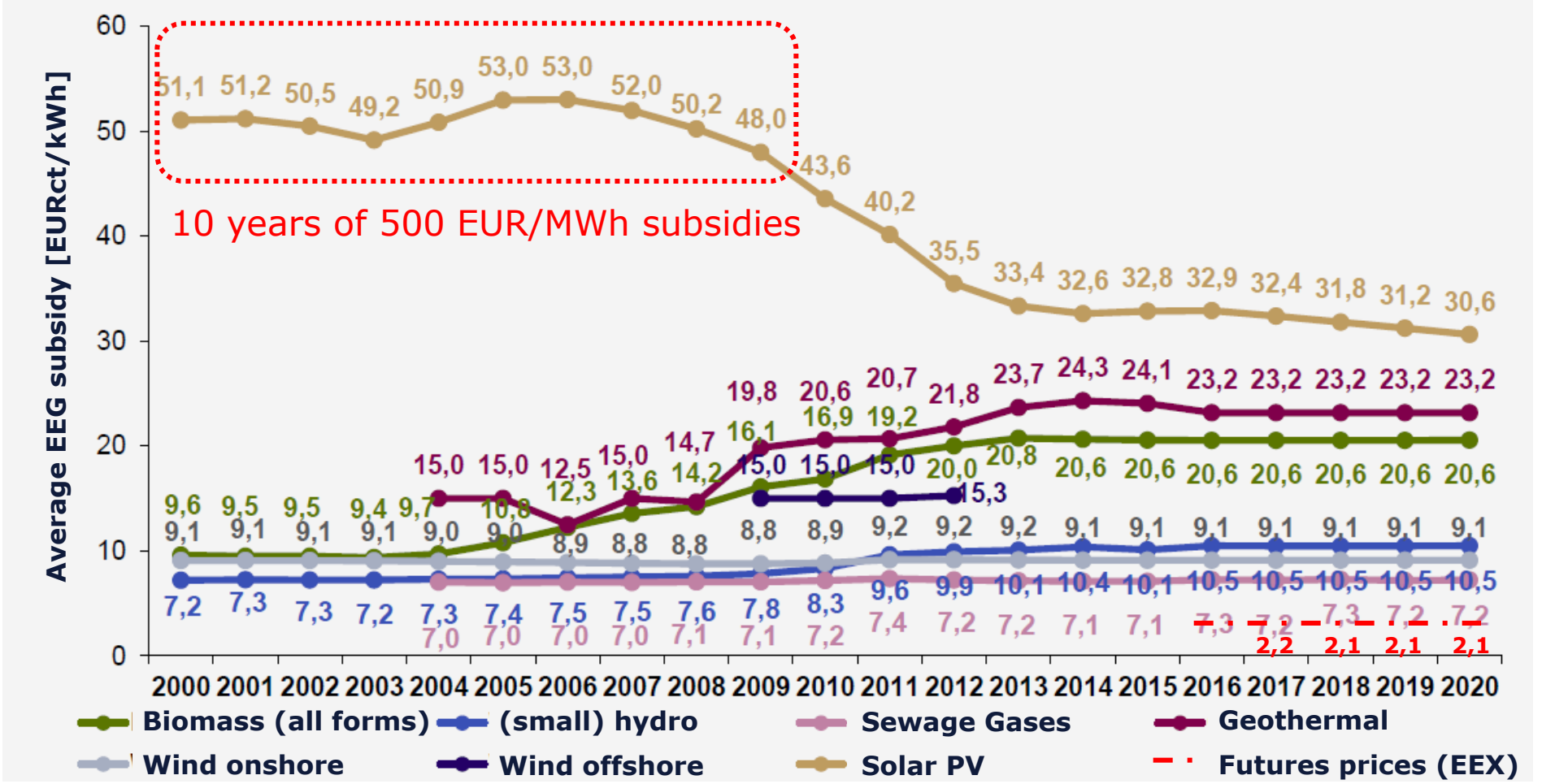
Total: 28.7 EURct./kWh, RES subsidies: 6.35 EURct./kWh

Average composition of the electricity price 2016 for a household in Germany with 3.500 kWh yearly consumption



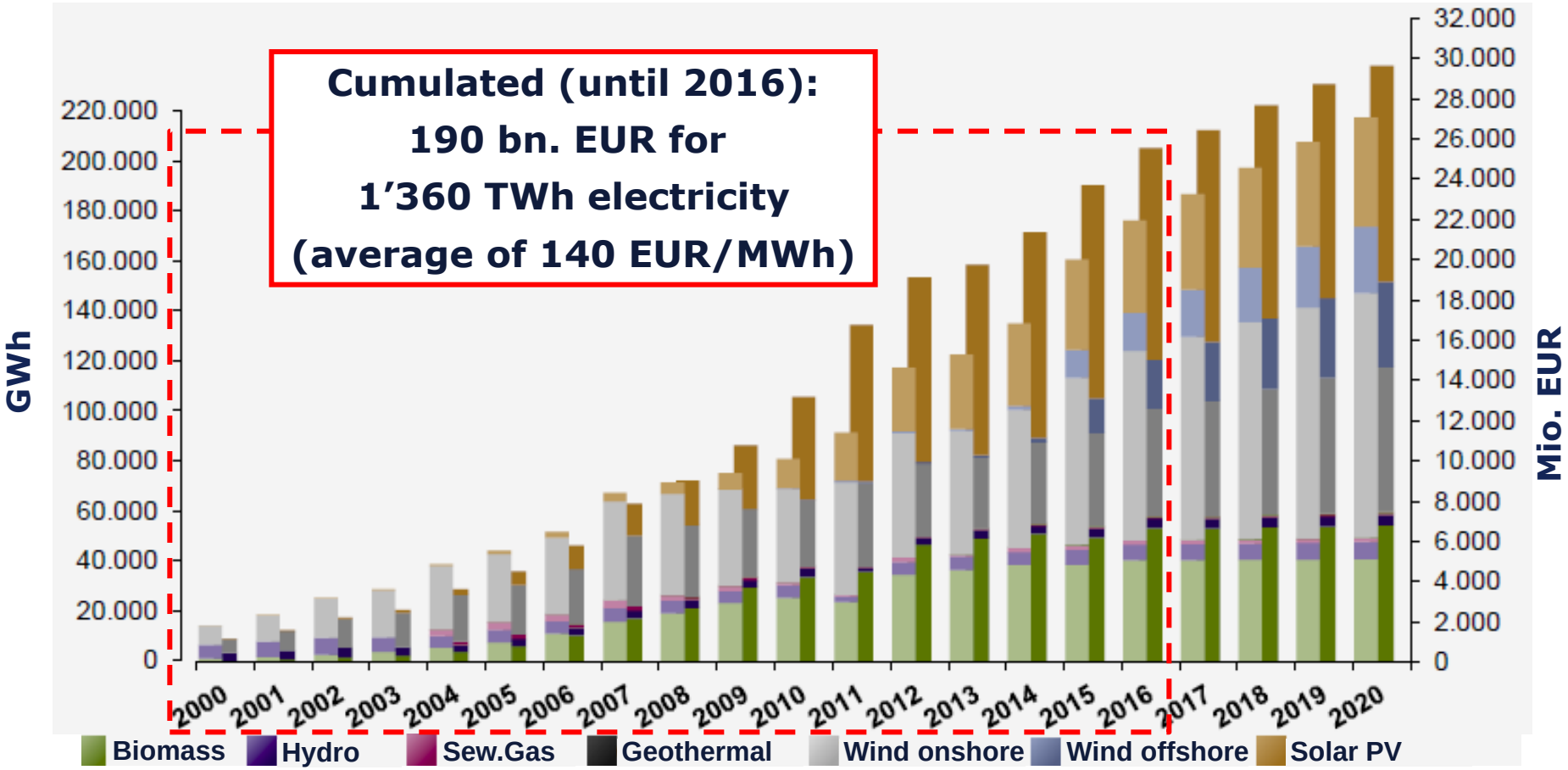
Source: graph based on BDEW

Total subsidies per new renewable technology over the total installed capacities in Germany



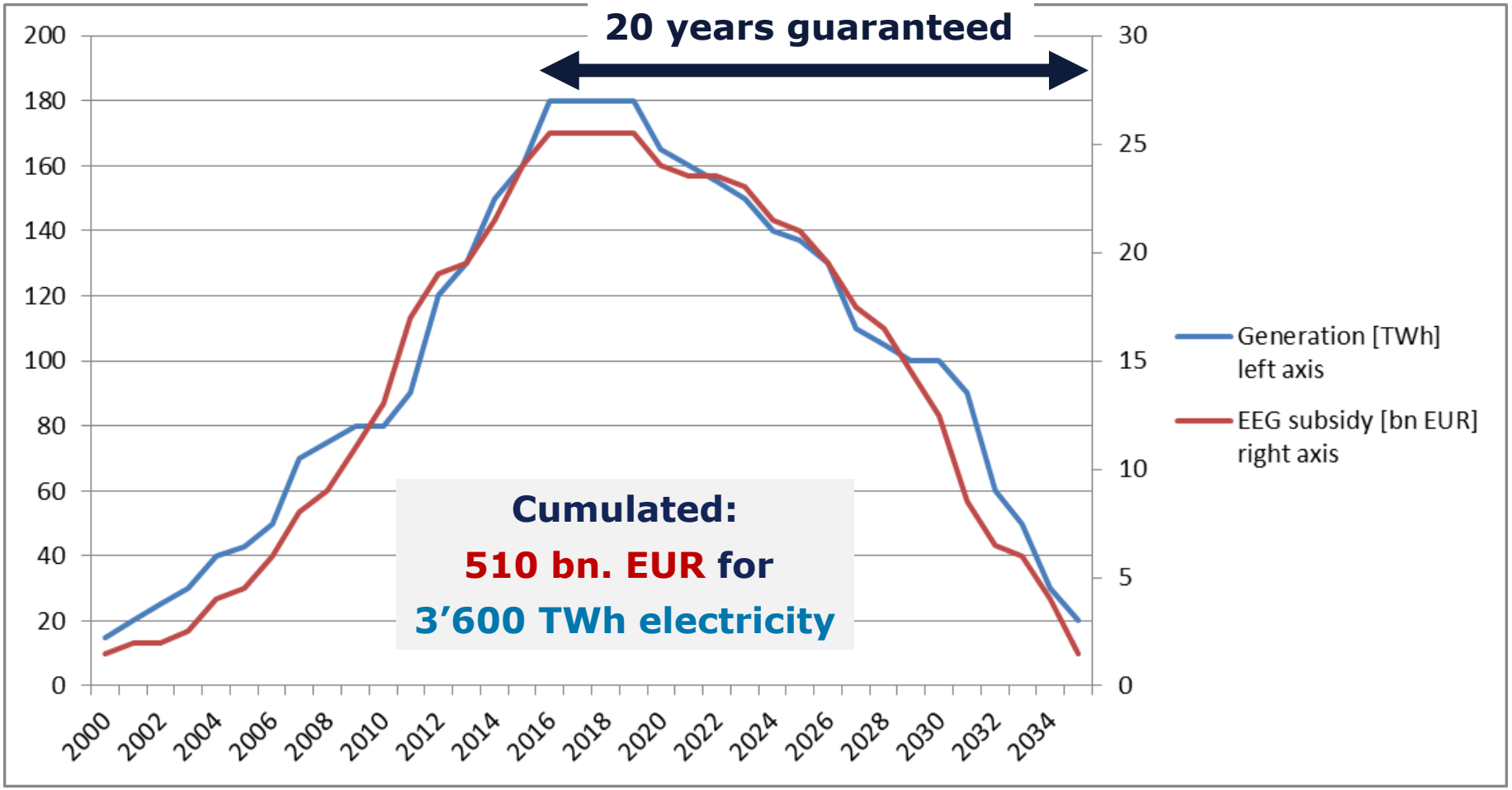
Source: graph by BDEW, remarks added by W. Denk; as of 2015: Grid operators forecast

Subsidies paid under EEG vs. Electricity produced



Source: BDEW

Estimation of subsidies paid & committed for all capacity that came online from 2000 until 2016



Source: estimation W. Denk based on BDEW data

Environmental impact of new renewables

- Materials use for plant capacity
- Visual impact (onshore wind turbines)
- Noise emissions (onshore wind turbines)
- Impact on animal life (wind turbines)
- Increase of food prices and monoculture (biomass)
- Additional grid capacity to be built
- Reducing of load factors of existing capacity is increasing environmental impact per kWh
- Dedicated smart metering capacity to be built
- Dedicated battery capacity to be built

→ New renewables have substantial environmental impact

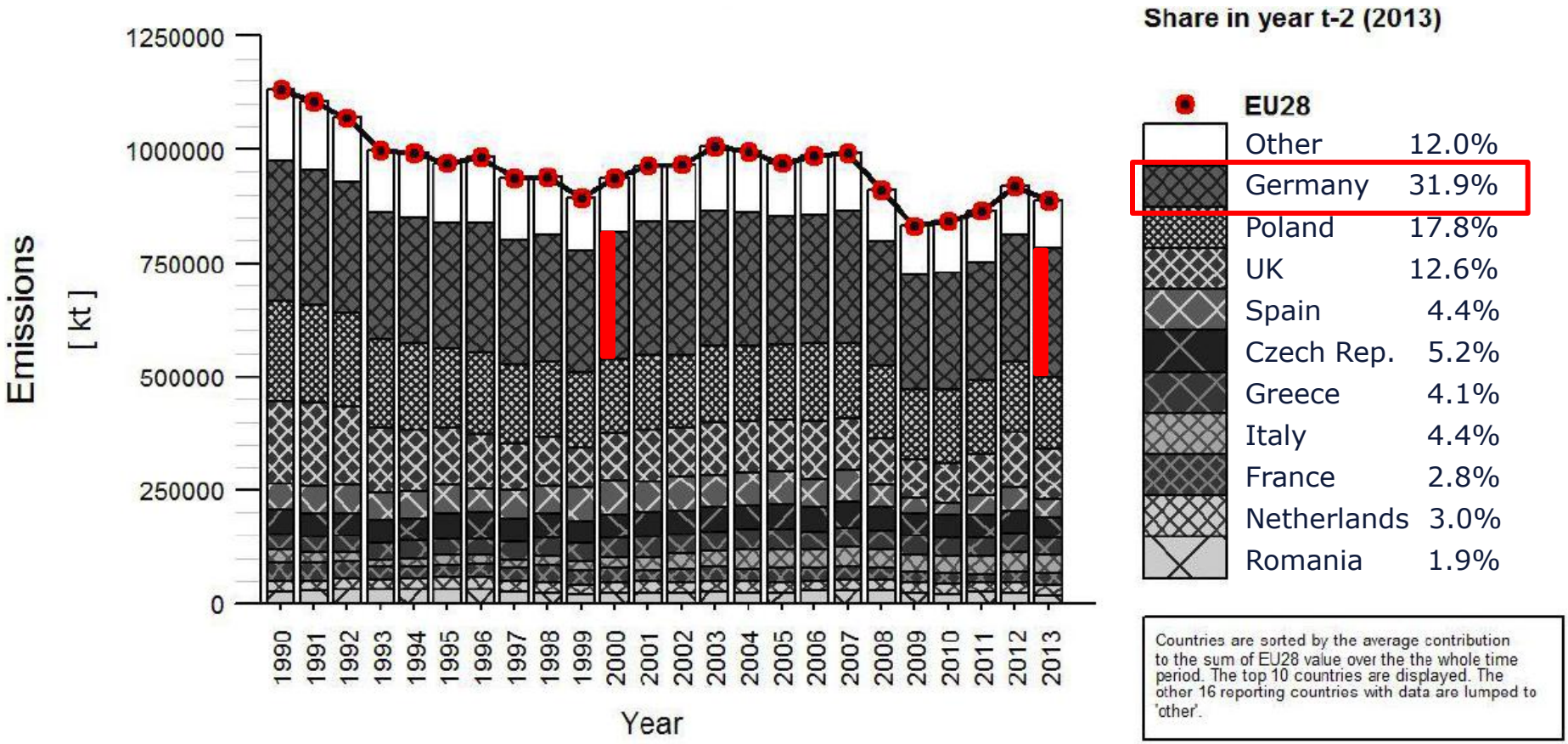
19th century Gothic style castle Braunfels, Hesse: ”It looks a bit like from a fairy tale, but it’s real!”

Source: http://www.schloss-braunfels.de/en/braunfels-castle.html

Castle Braunfels with seven wind turbines in Hohenahr (16 km away)

Source: http://www.burgerbe.de/2014/01/21/windrader-vor-schloss-braunfels/; Photo: Meinolf Schmidt

Public Electricity and Heat Production in EU-28: CO_2-emissions from solid fuels



Germany emits by far the largest amount (282 million tons)

Source: EEA Annual European Union greenhouse gas inventory 1990–2013 and inventory report 2015, 27 Nov 2015, page 92

What can we learn from the German nuclear phase-out and energy transition?

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1. None of the shut-down nuclear capacity has been replaced by solar PV or wind capacity.
2. Solar PV and Wind do not contribute to supply and demand balance of transmission grid operators.
3. The technical feasibility is not ensured and already now relies on neighbouring countries.
4. Massive subsidies have lead to a planned-economy style system with numerous unintended consequences.
5. The level of Solar PV subsidies is being reduced but is still absurdly high compared to market prices.
6. If reducing CO_2 emissions would have been a top priority, then fossil capacity should have been reduced.

Does the German energy policy «make sense both from an ecological and an economic point of view?»

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German energy policy

510 bn EUR

86 GW new renewable capacity added on top

3'600 TWh («free», random profile, dis-regarding demand)

«Broken» system, «Broken» market, CO_2-emissions high

One possible alternative

510 bn EUR

85 GW of new nuclear capacity* replacing coal & gas

38'000 TWh** («market», base-load, plannable)

System and market mechanisms intact, ultra-low CO_2

* Assuming the construction of a fleet of 57 nuclear units with (1'500 MW, 9 bn EUR per unit)

** Assuming 85% capacity factor (= 633 TWh/a) and 60 years life-time

Thank you very much!

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