



Energy transition in the power sector in Europe: State of Affairs in 2017

*Review of the Developments and Outlook
for 2018*

Dave Jones | Sandbag

Matthias Buck | Agora Energiewende

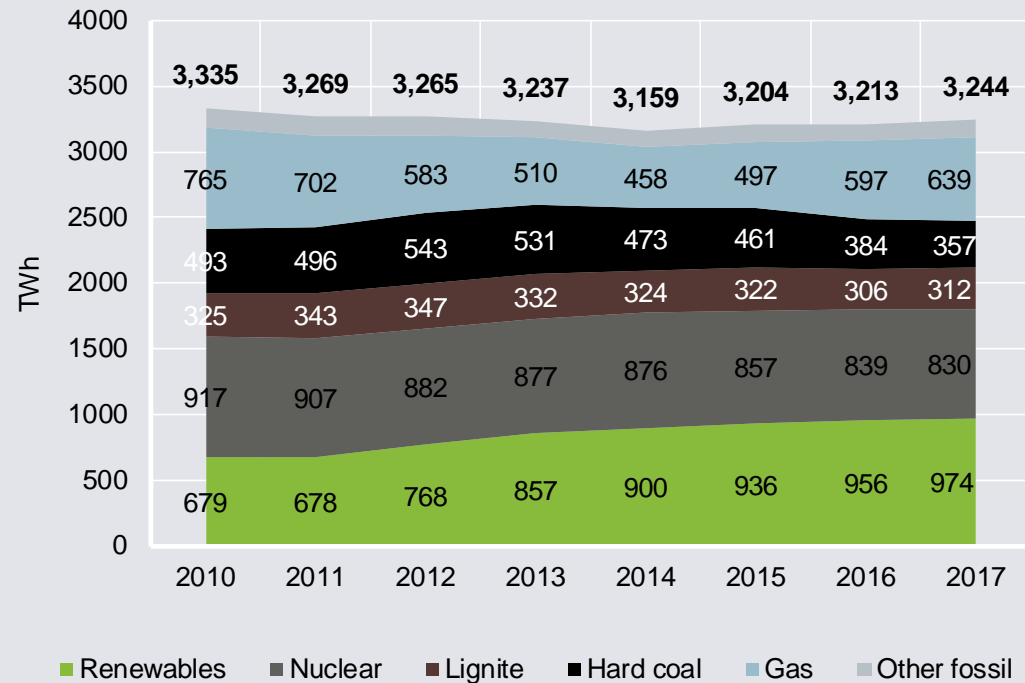
Alice Sakhel | Agora Energiewende

BRUSSELS, 30 JANUARY 2018

Key Findings

- 1 Wind, solar and biomass sharply increased in 2017, overtaking coal for the first time**
- 2 Renewables growth has become uneven – geographically and technologically.**
- 3 Electricity consumption rose by 0.7% in 2017, marking a third consecutive year of increases.**
- 4 CO₂ emissions in the power sector were unchanged in 2017, and rose slightly economy-wide.**
- 5 Western Europe is phasing out coal, but eastern Europe is sticking to it.**

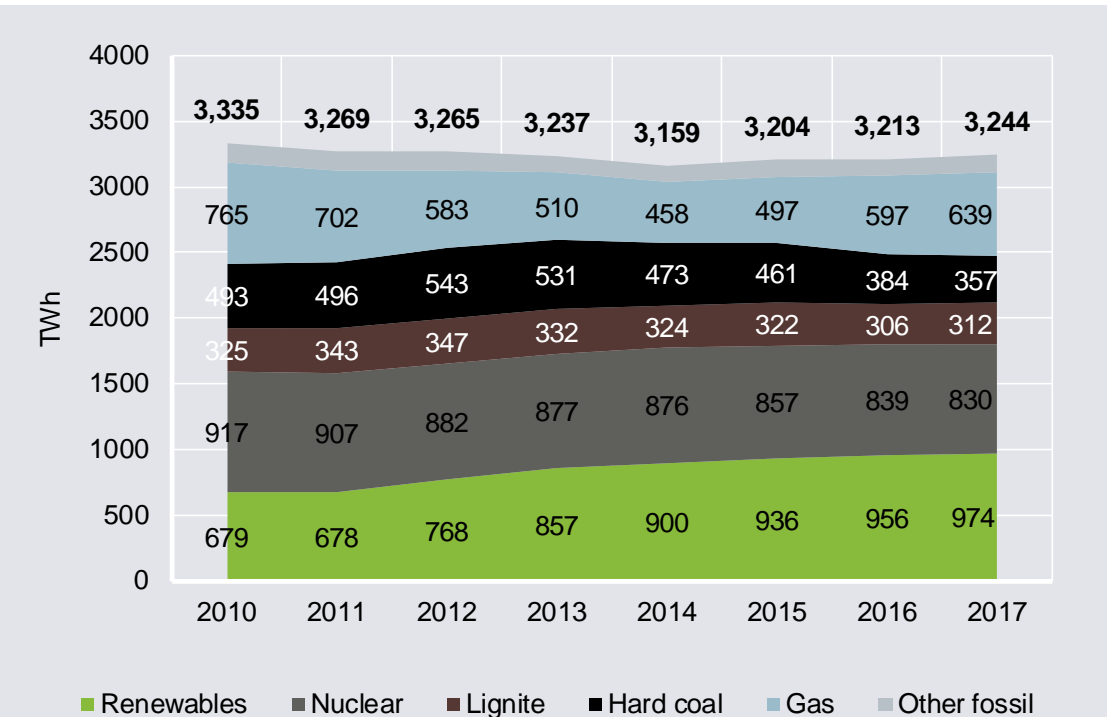
EU electricity generation, by fuel type



EUROSTAT data to 2015, 2016 and 2017 are own calculations

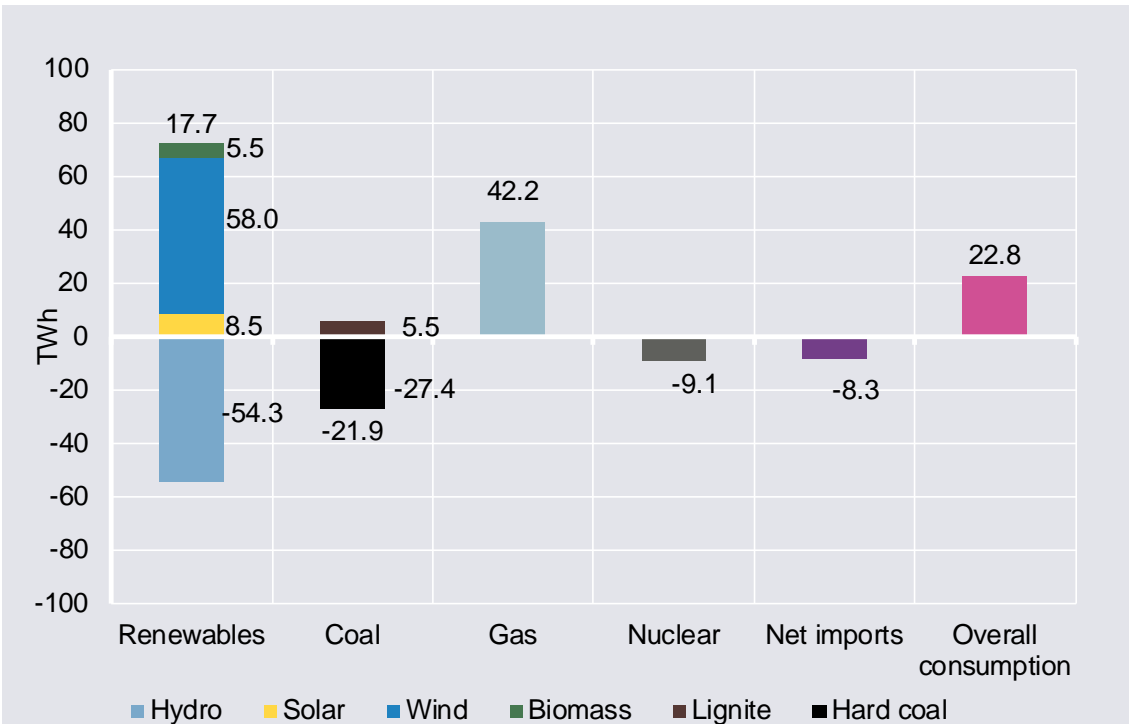
Wind displaces Coal; Gas fills in for poor year Hydro and Nuclear; Rising consumption prevents fossil generation falling.

EU electricity generation, by fuel type



EUROSTAT data to 2015, 2016 and 2017 are own calculations

Changes in electricity production and consumption (2016 to 2017)



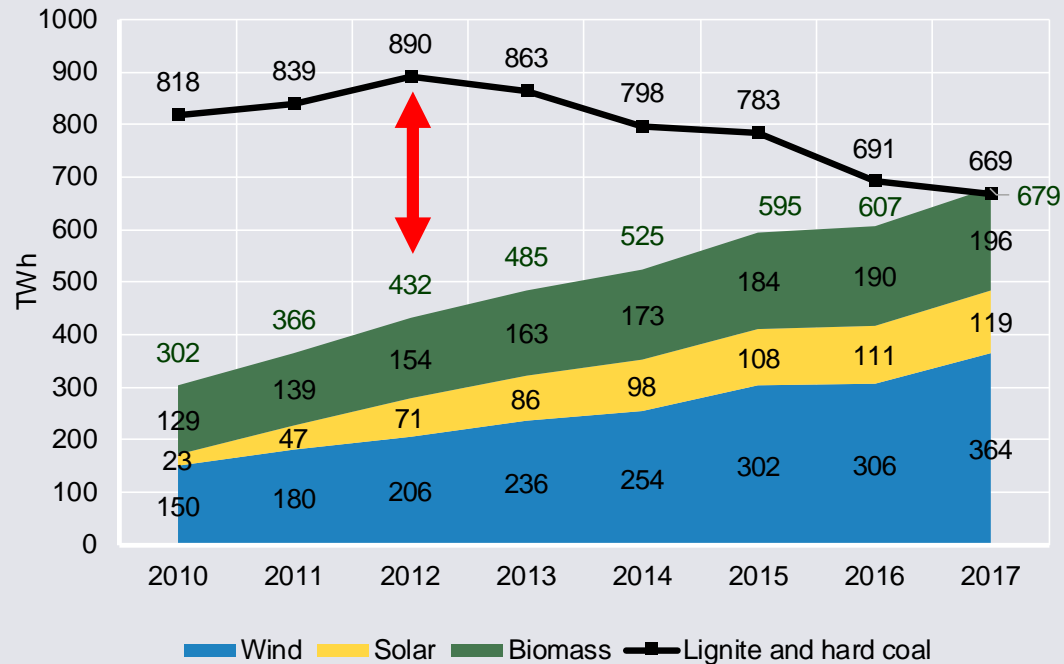
EUROSTAT data to 2015, 2016 and 2017 are own calculations

Wind, sun and biomass overtook coal in 2017!

Main reason: Surge in wind capacity with *potential* records in offshore and onshore installations

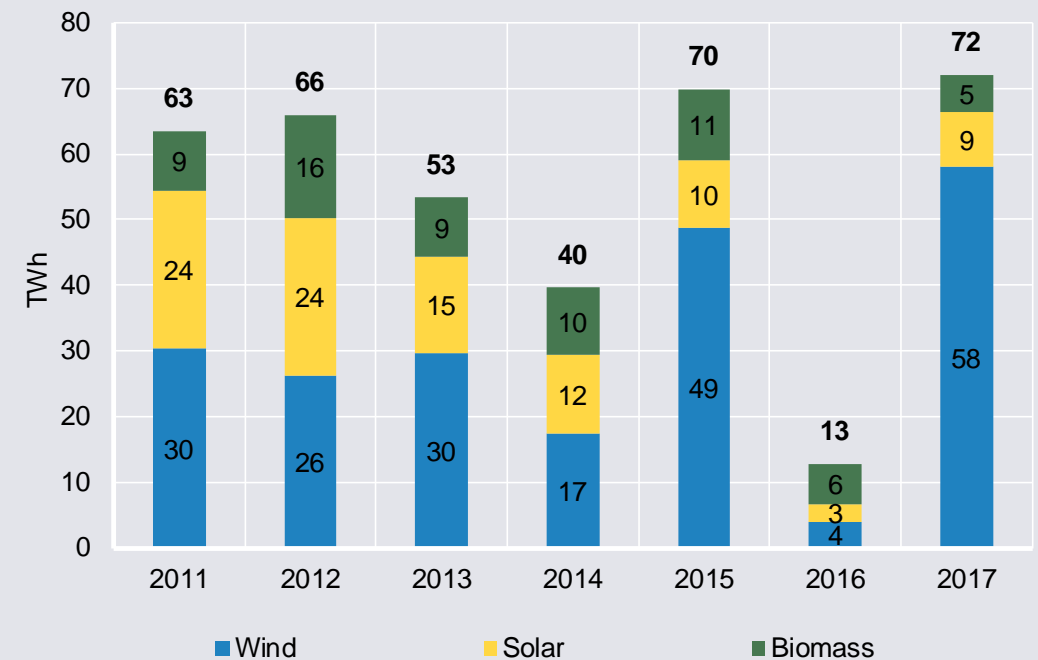


Renewables versus coal electricity generation



EUROSTAT data to 2015, 2016 and 2017 are own calculations

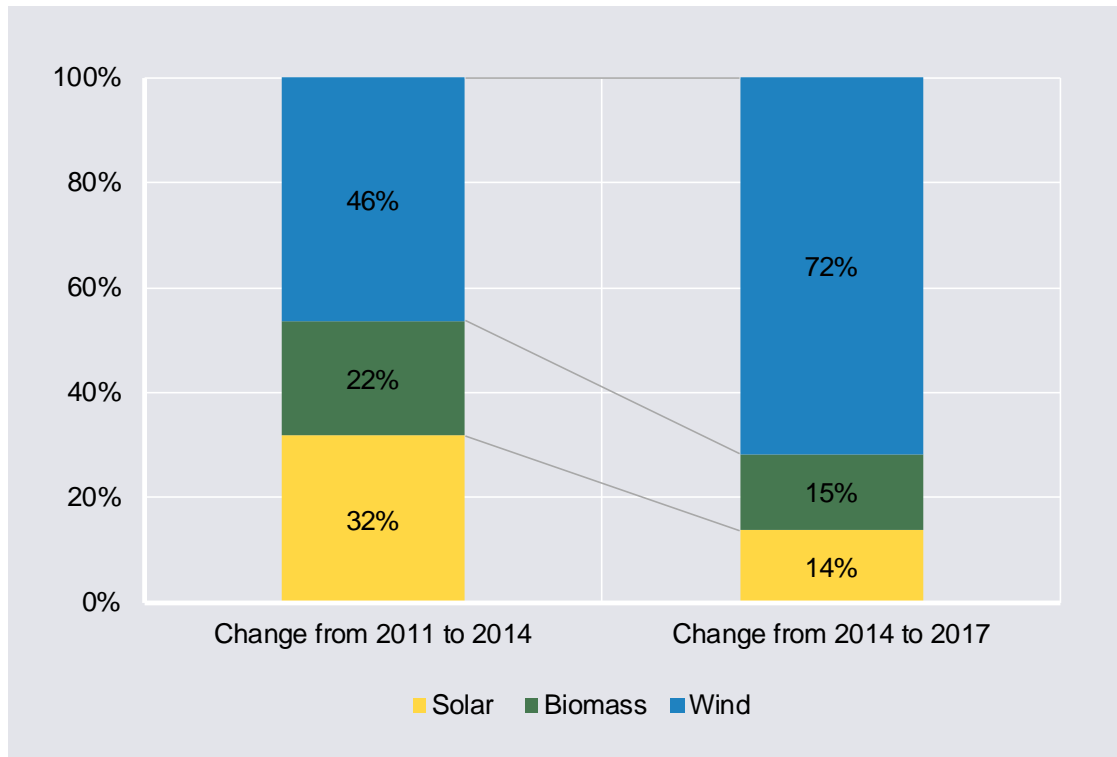
Changes in non-hydro renewables generation by country



EUROSTAT data to 2015, 2016 and 2017 are own calculations

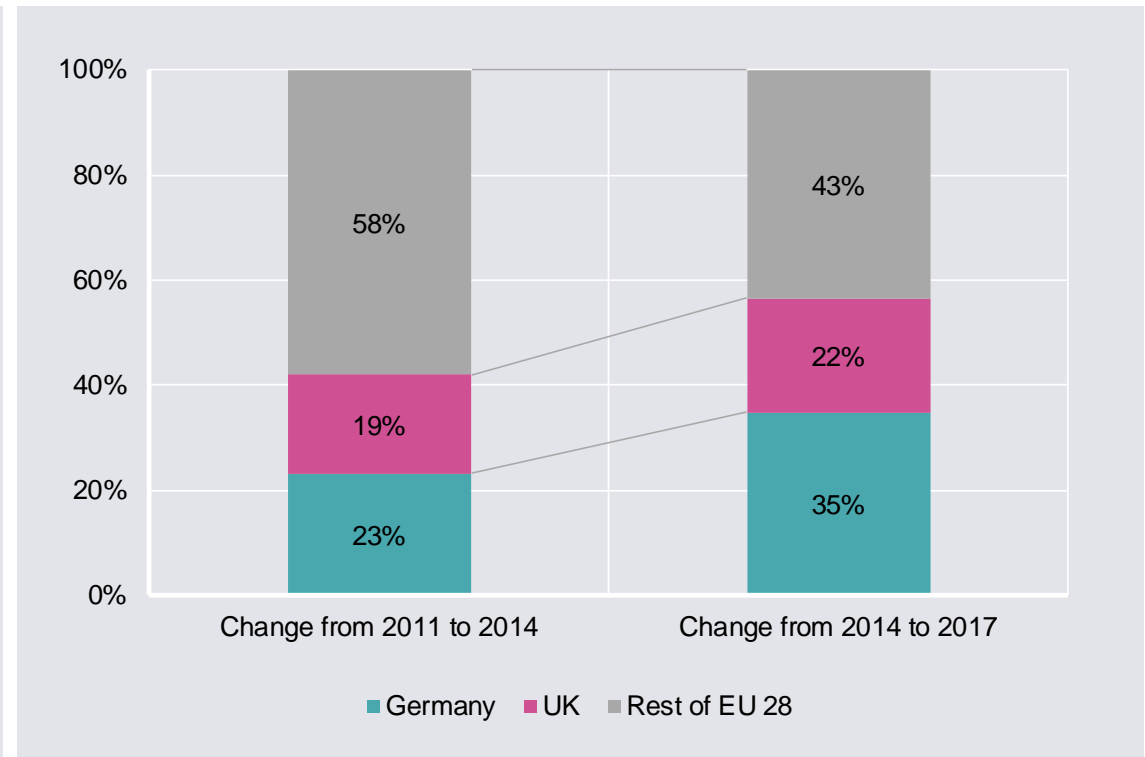
Renewables growth has got more uneven: Technologically (focus on wind) Geographically (focus on DE/UK)

Changes in non-hydro renewables generation by type



EUROSTAT data to 2015, 2016 and 2017 are own calculations

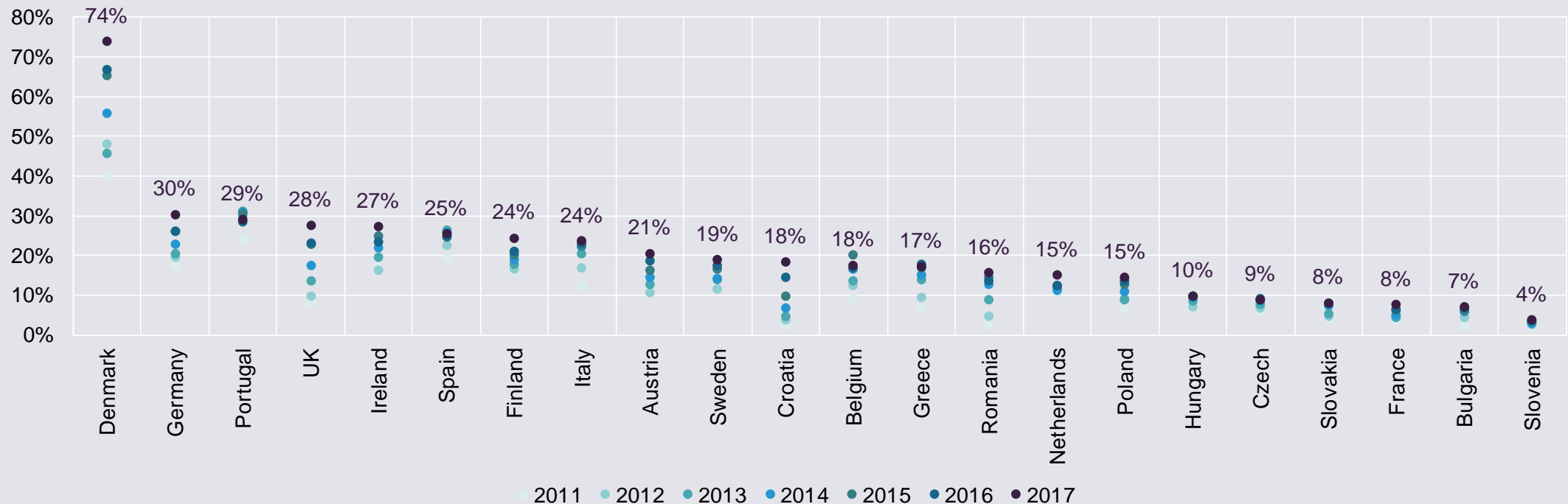
Changes in non-hydro renewables generation by country



EUROSTAT data to 2015, 2016 and 2017 are own calculations

Denmark soars to 74% wind+solar+biomass! UK is next biggest increase since 2011

Wind, solar and biomass as percentage of national electricity production

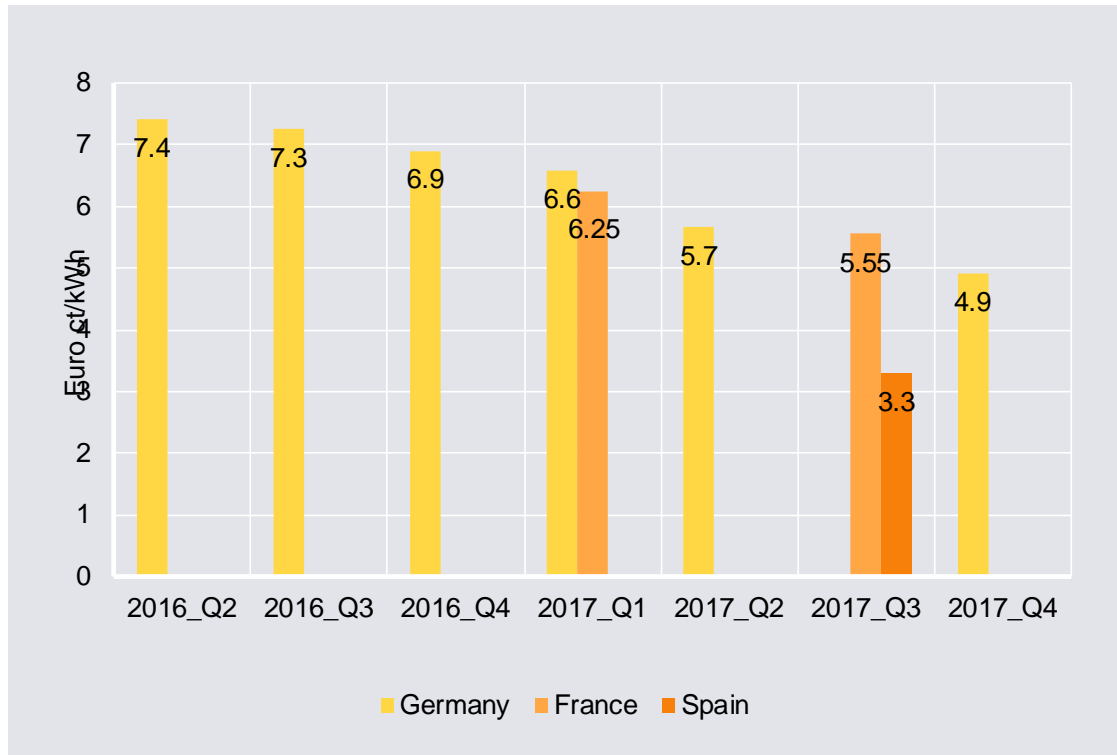


EUROSTAT data to 2015, 2016 and 2017 are own calculations; LT, LU, CY, EE, LV, M not included due to lower data quality

Where are you solar!?

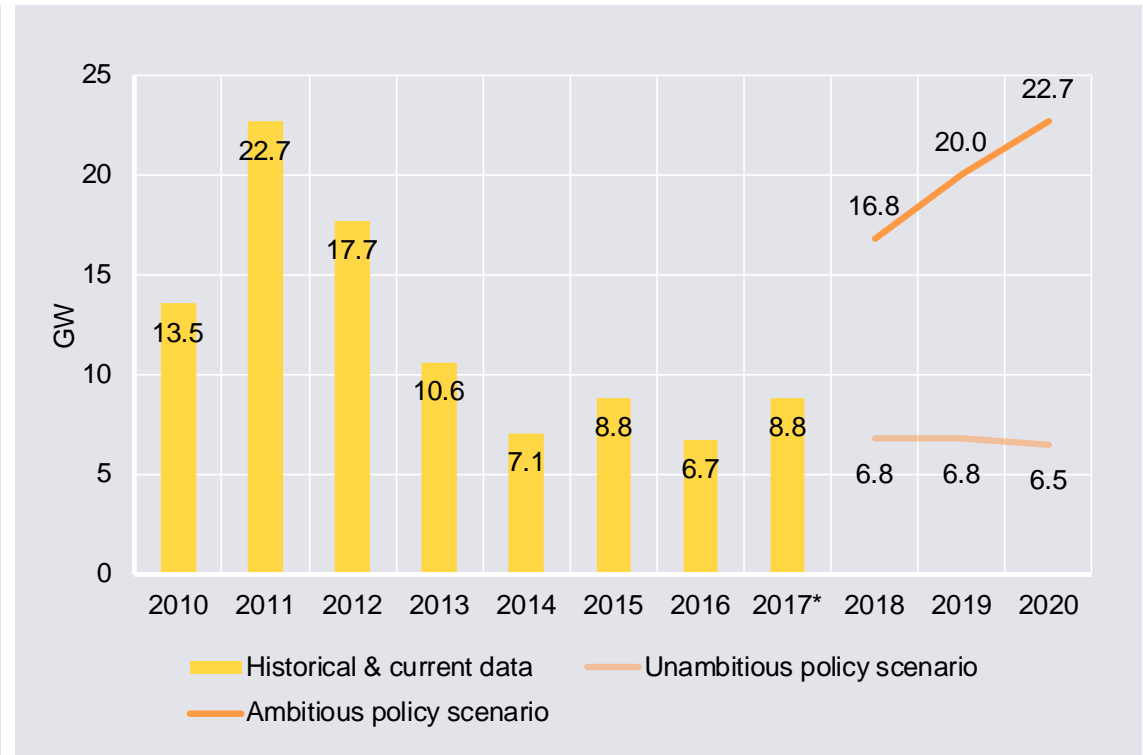
Cheaper than wholesale electricity prices + Ready to scale up

Solar PV auction results 2016-2017 (avg. prices, ground-mounted)



BNetzA 2016/2017, globalfinance.solarenergyevents.com 2017, pv-tech 2017

Annual solar PV installations



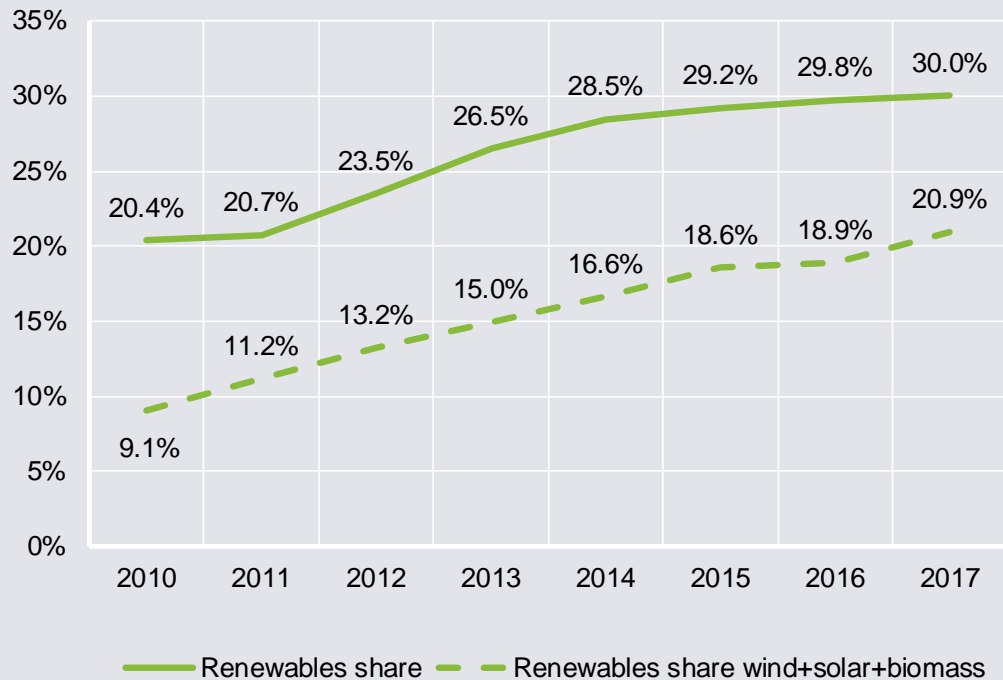
Solar Power Europe 2017, *latest forecast

30% of EU electricity from renewables!

On-trend for 27% renewables share of final energy demand by 2030; 35% possible!

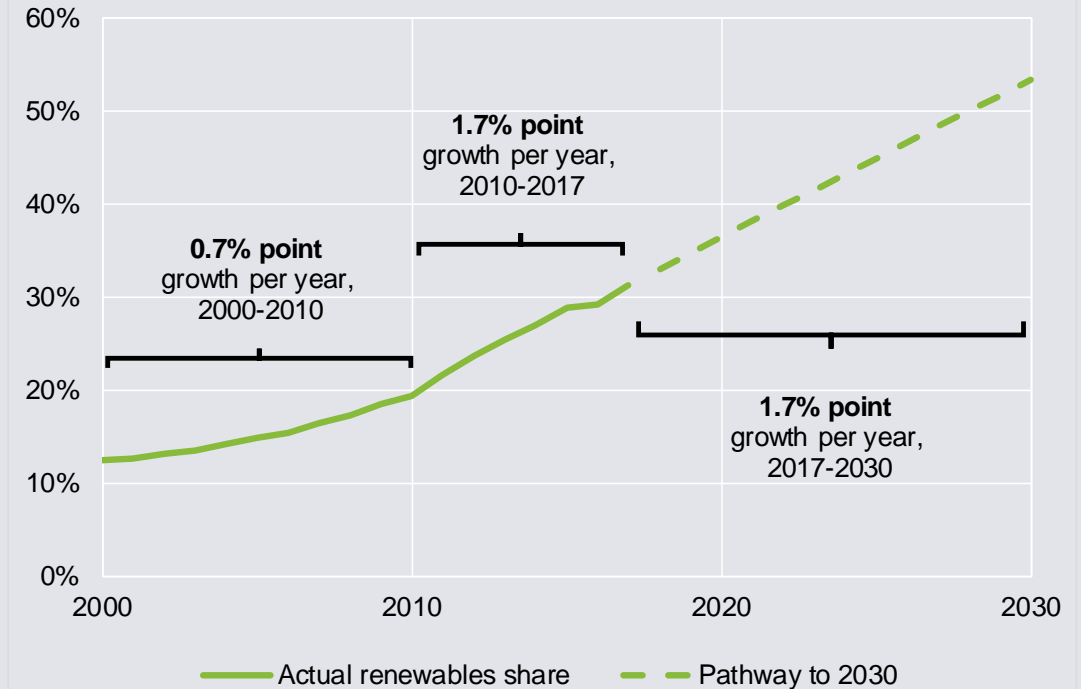


Renewables share (%) of gross electricity production



EUROSTAT data to 2015, 2016 and 2017 are own calculations

Renewables share (%) of gross electricity production: 2050 Trend



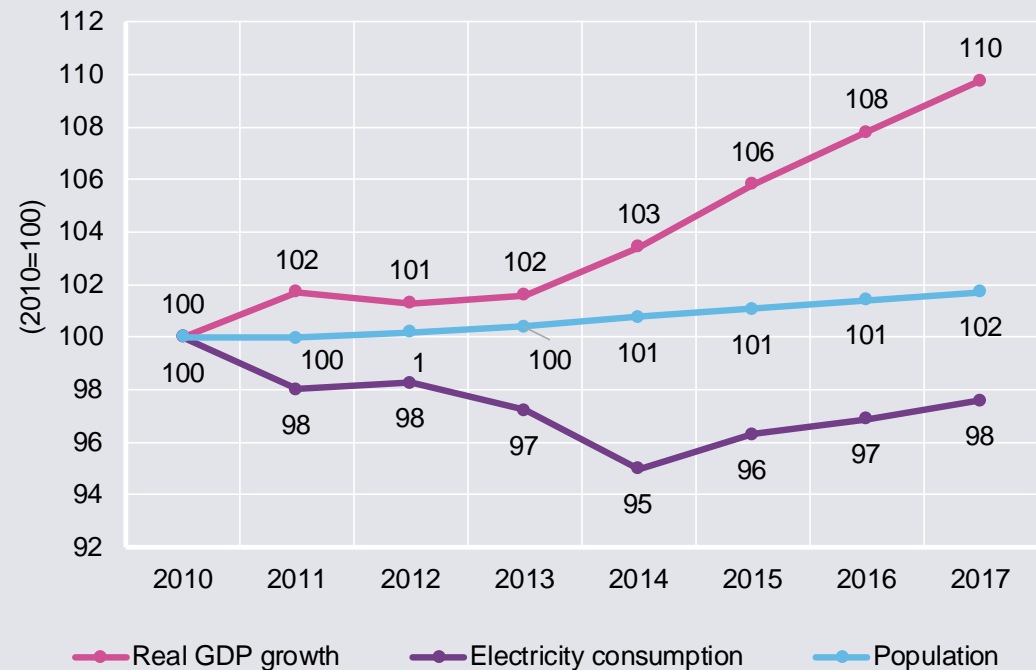
EUROSTAT (2015, 2016, 2017 own calc.), normalised hydro

Electricity consumption rises (0.7%) third year in a row

Power consumption does not decouple enough
from economic growth

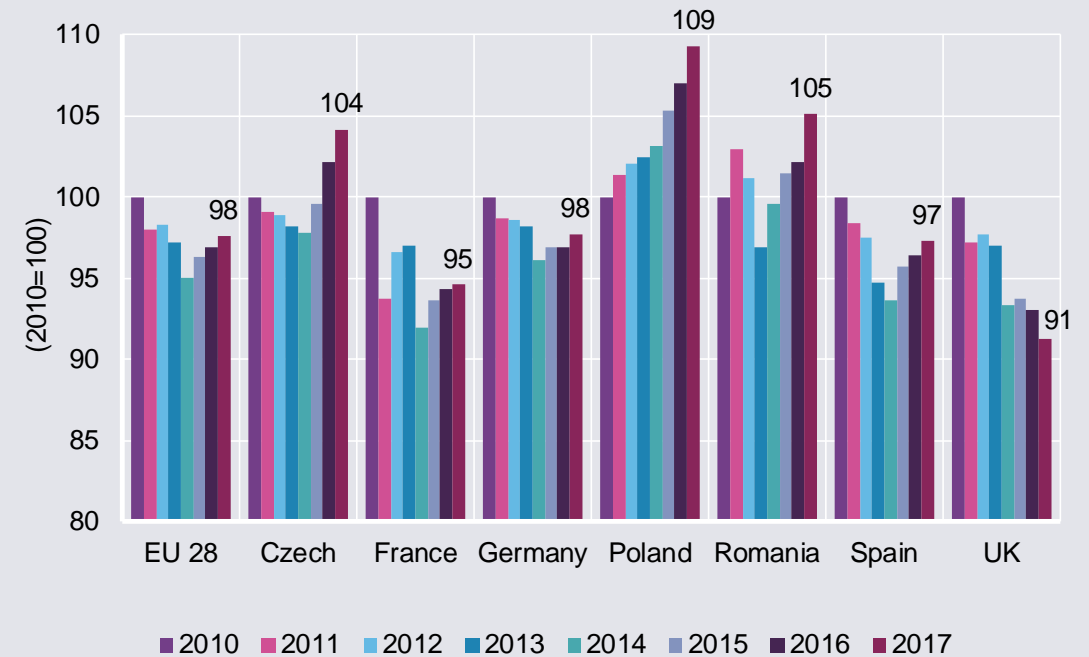


EU electricity consumption (indexed)



EUROSTAT 2018

Electricity consumption by country (indexed)



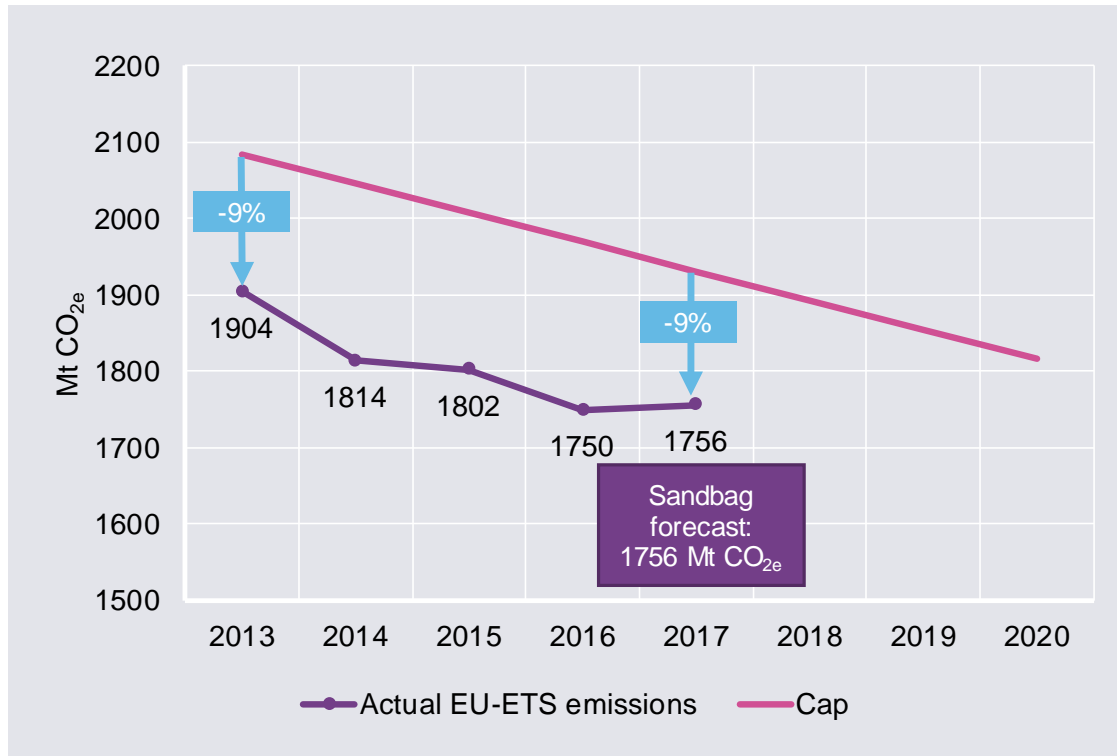
EUROSTAT data to 2015, 2016 and 2017 are own calculations

Still no scarcity in the EU ETS:

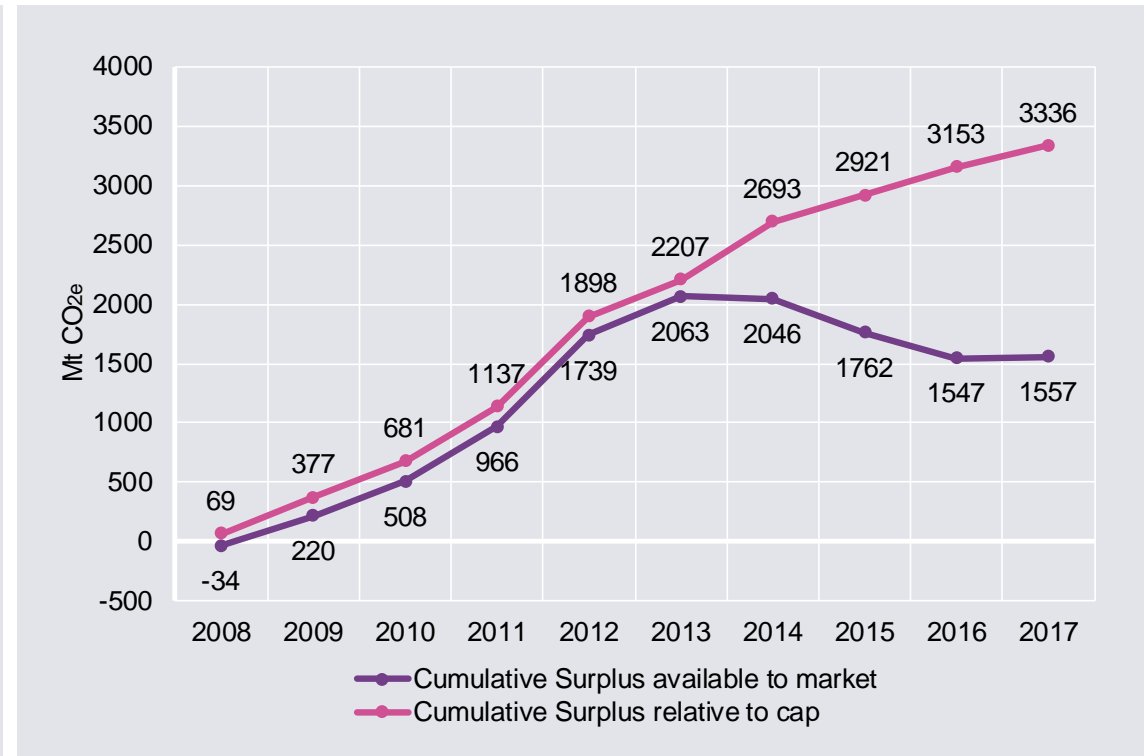
Cap 9% above actual emissions
 Cumulative surplus almost twice the annual emissions of the entire EU ETS



ETS cap 2013-2017



ETS surplus 2008-2017



Sandbag 2018

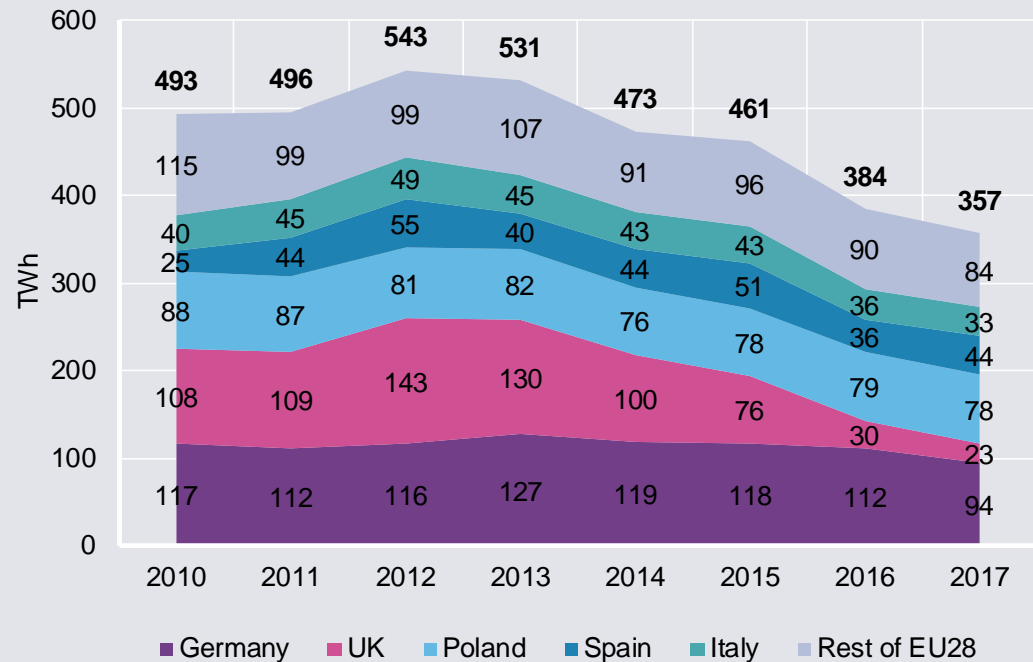
Sandbag 2018

Coal: Hard coal is falling, lignite is not

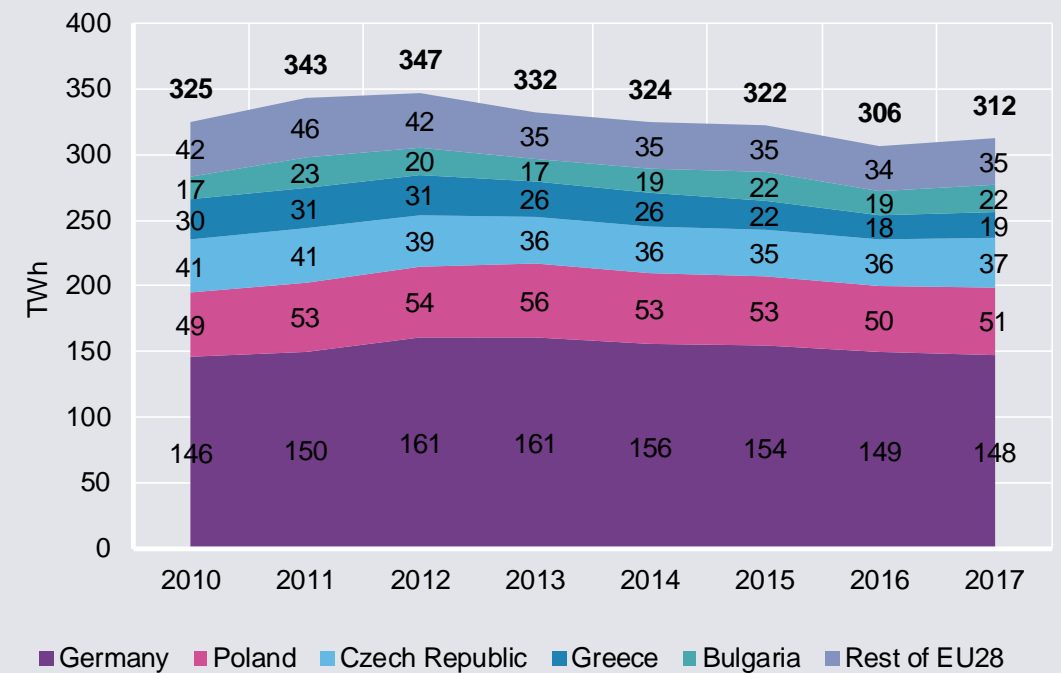
Europe's 256 coal plants

= 38% EU-ETS CO2 = 15% total EU GHG

Hard coal electricity generation (including split of top 5 countries)



Lignite electricity generation (including split of top 5 countries)

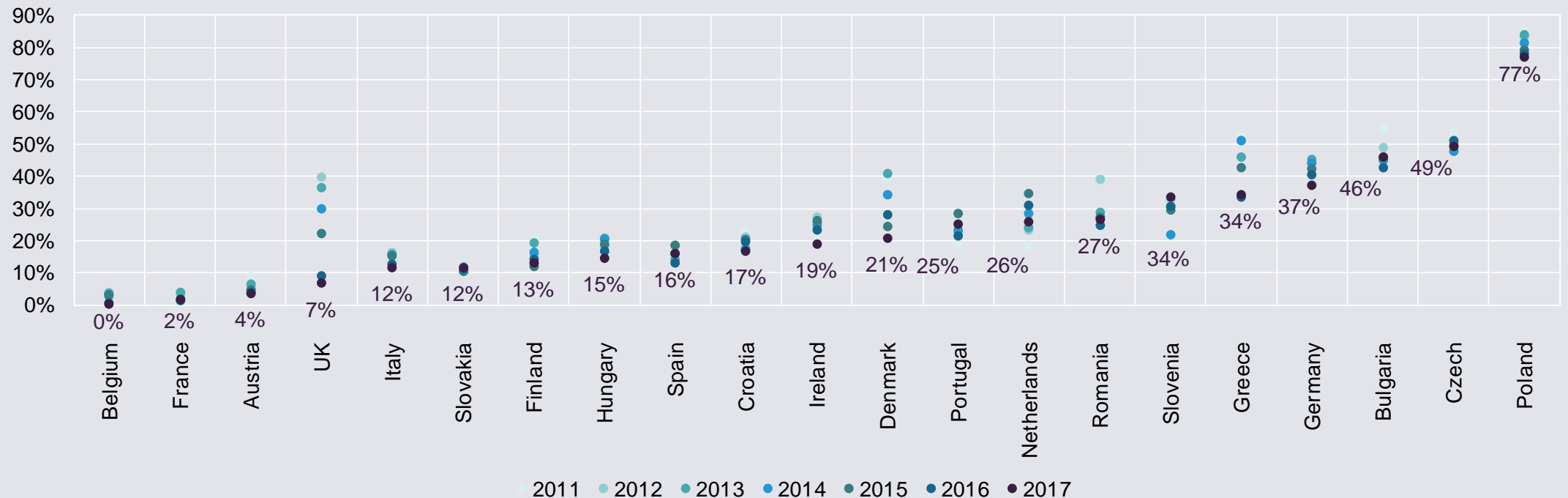


EUROSTAT data to 2015, 2016 and 2017 are own calculations

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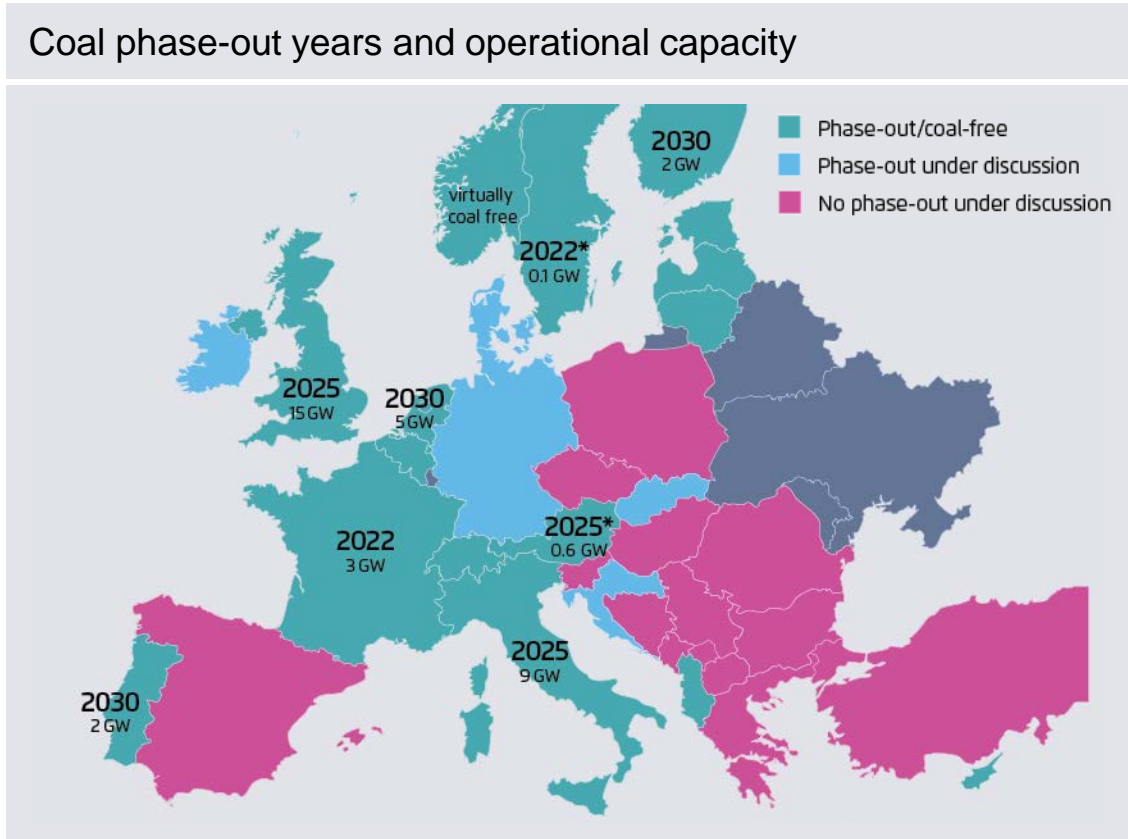
Coal 2010-17: Biggest fallers = Denmark + UK
= Biggest renewables increases (+ Gas falling!)
Germany still fourth most coal-intensive electricity...

Hard coal and lignite as percentage of national electricity production

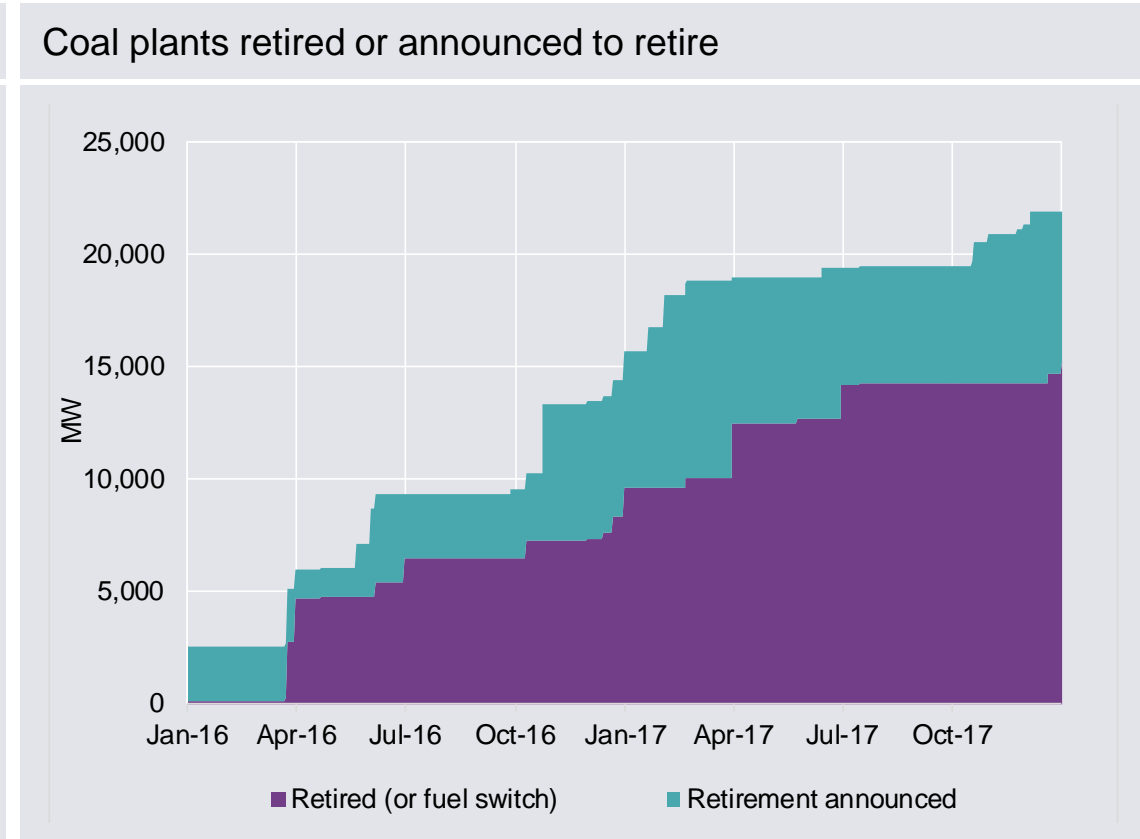


EUROSTAT data to 2015, 2016 and 2017 are own calculations; LT, LU, CY, EE, LV, M, have no coal power plants.

Coal phase-out plans: Western Europe is announcing phase-outs, Eastern Europe is not – and Germany is still discussing it.



Europe Beyond Coal campaign 2018



Europe Beyond Coal campaign 2018

Thank you for your attention!

Questions or Comments? Feel free to contact me:

dave@sandbag.org.uk |

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Sandbag is a not-for-profit climate change policy think tank based in Brussels and London.

Agora Energiewende is a joint initiative of the Mercator Foundation and the European Climate Foundation.

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Backup

Key Findings

1

New renewables generation sharply increased in 2017, with wind, solar and biomass overtaking coal for the first time. Since Europe's hydro potential is largely tapped, the increase in renewables comes from wind, solar and biomass generation. They rose by 12% in 2017 to 679 Terawatt hours, putting wind, solar and biomass above coal generation for the first time. This is incredible progress, considering just five years ago, coal generation was more than twice that of wind, solar and biomass.

2

But renewables growth has become *even more uneven*. Germany and the UK alone contributed to 56% of the growth in renewables in the past three years. There is also a bias in favor of wind: a massive 19% increase in wind generation took place in 2017, due to good wind conditions and huge investment into wind plants. This is good news since the biomass boom is now over, but bad news in that solar was responsible for just 14% of the renewables growth in 2014 to 2017.

3

Electricity consumption rose by 0.7% in 2017, marking a third consecutive year of increases. With Europe's economy being on a growth path again, power demand is rising as well. This suggests Europe's efficiency efforts are not sufficient and hence the EU's efficiency policy needs further strengthening.

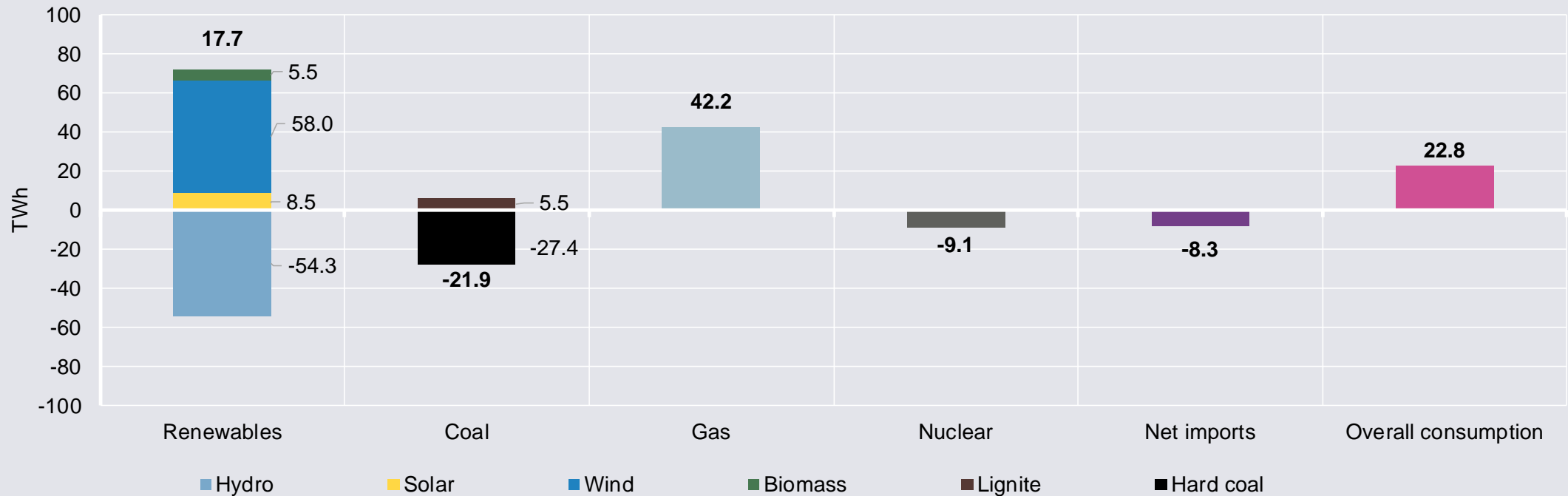
4

CO₂ emissions in the power sector were unchanged in 2017, and rose economy-wide. Low hydro and nuclear generation coupled with increasing demand led to increasing fossil generation. So despite the large rise in wind generation, we estimate power sector CO₂ emissions remained unchanged at 1019 million tonnes. However, overall stationary emissions in the EU emissions trading sectors rose slightly from 1750 to 1755 million tonnes because of stronger industrial production especially in rising steel production. Together with additional increases in non-ETS gas and oil demand, we estimate overall EU greenhouse gas emissions rose by around 1 percent in 2017.

5

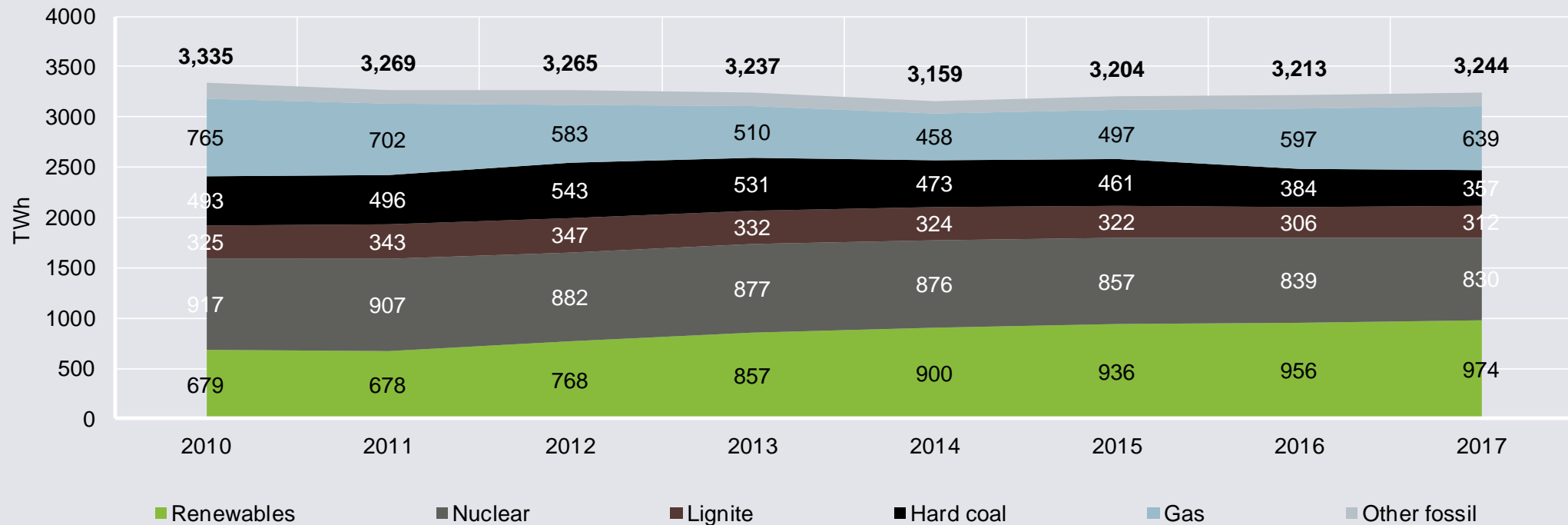
Western Europe is phasing out coal, but Eastern Europe is sticking to it. Three more Member States announced coal phase-outs in 2017 - Netherlands, Italy and Portugal. They join France and the UK in committing to phase-out coal, while Eastern European countries are sticking to coal. The debate in Germany, Europe's largest coal and lignite consumer, is ongoing and will only be decided in 2019.

Changes in electricity production and consumption, from 2016 to 2017



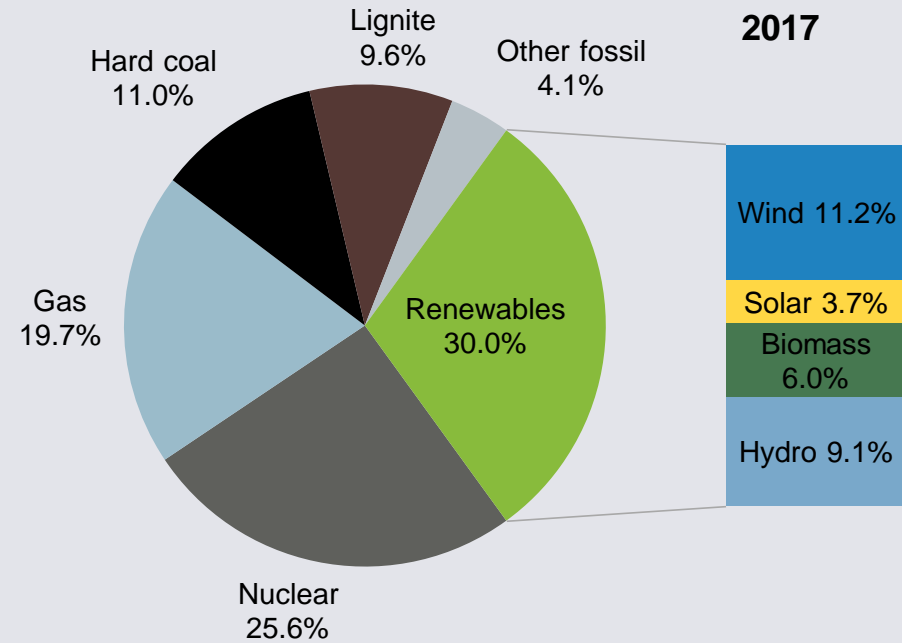
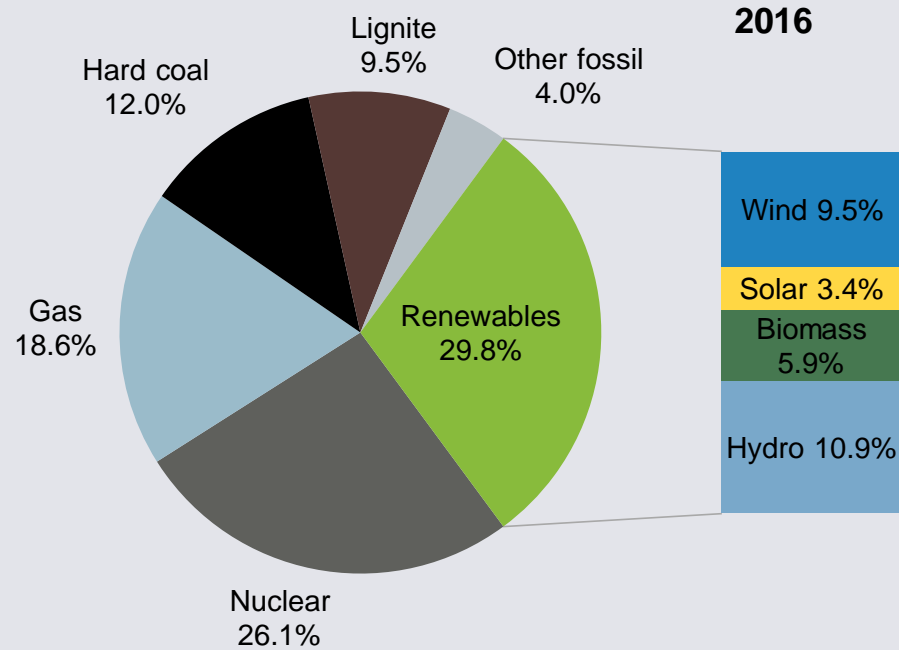
EUROSTAT data to 2015, 2016 and 2017 are own calculations

EU electricity generation, by fuel type



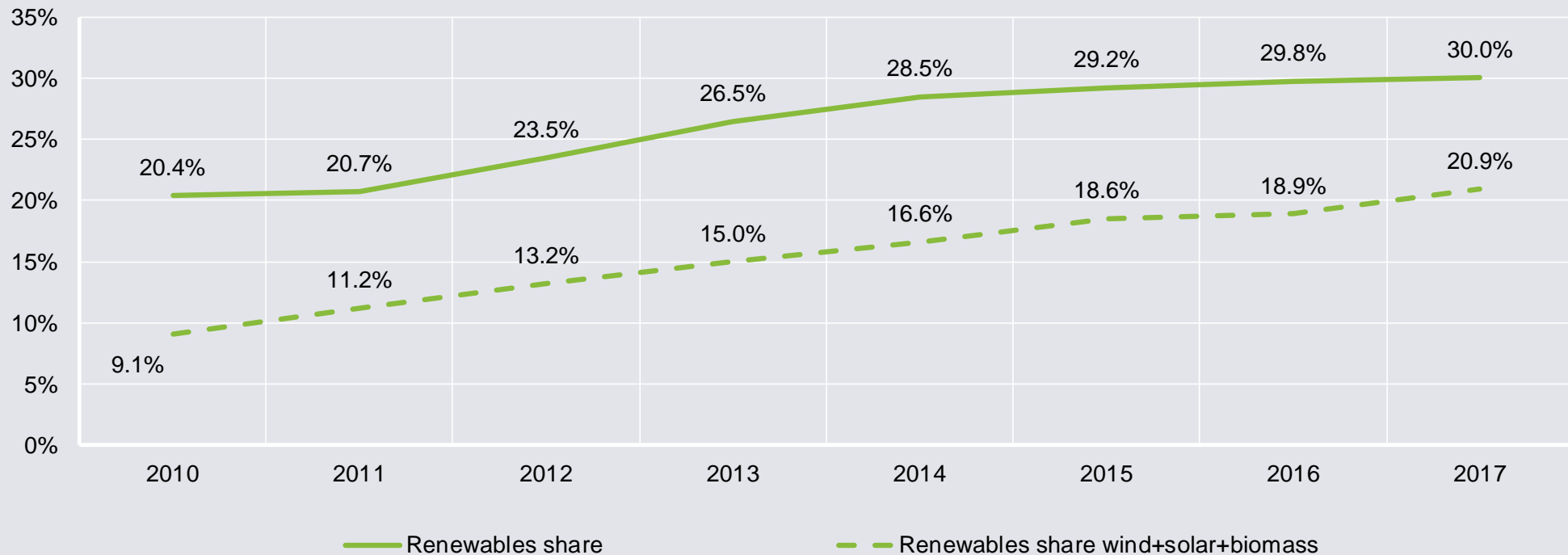
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Generation mix in 2016 and 2017



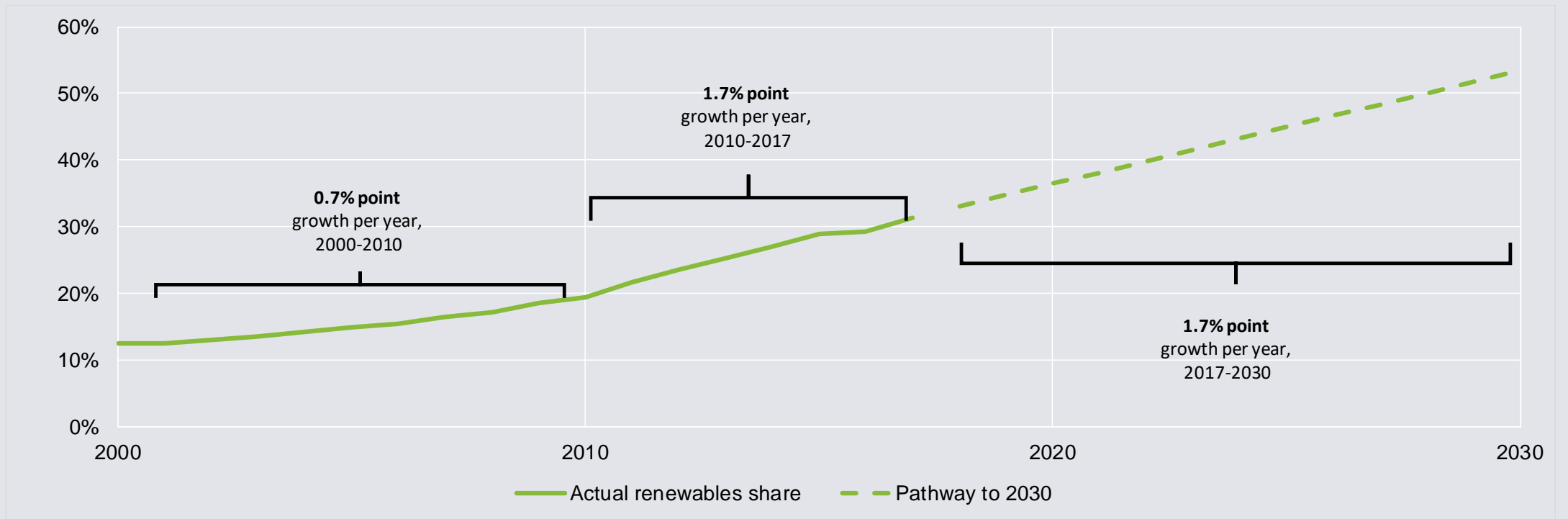
EUROSTAT data to 2015, 2016 and 2017 are own calculations

Renewables share as percentage of gross electricity production



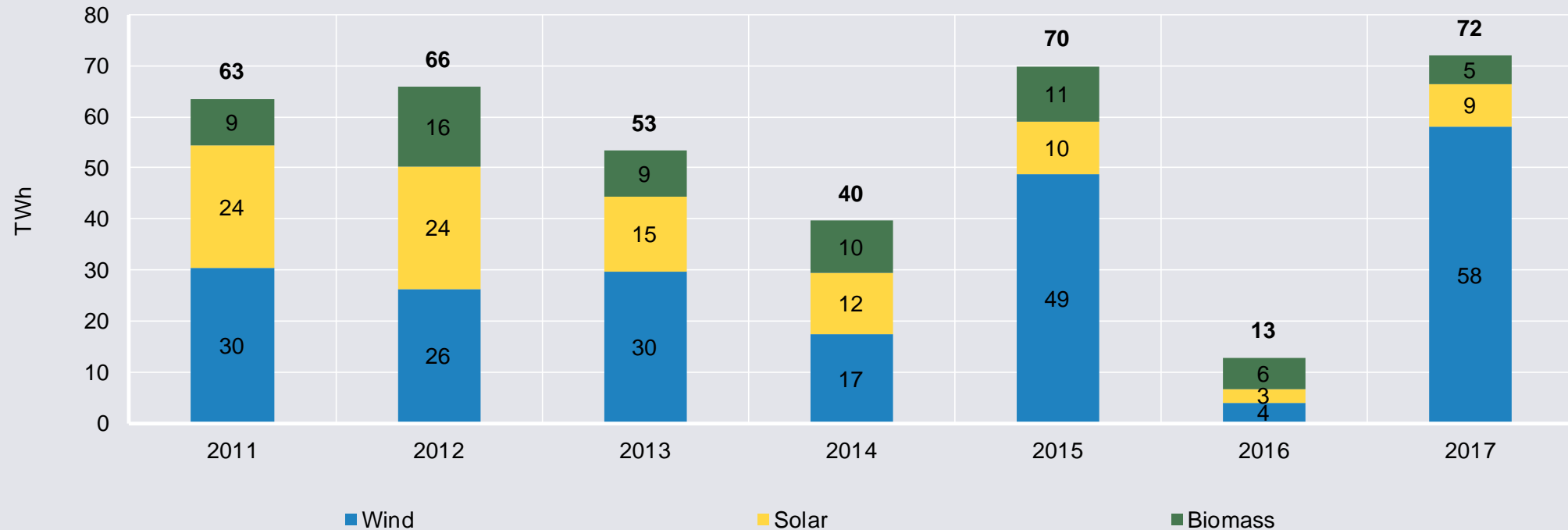
EUROSTAT data to 2015, 2016 and 2017 are own calculations

Renewables share as percentage of gross electricity production: the trend to 2050



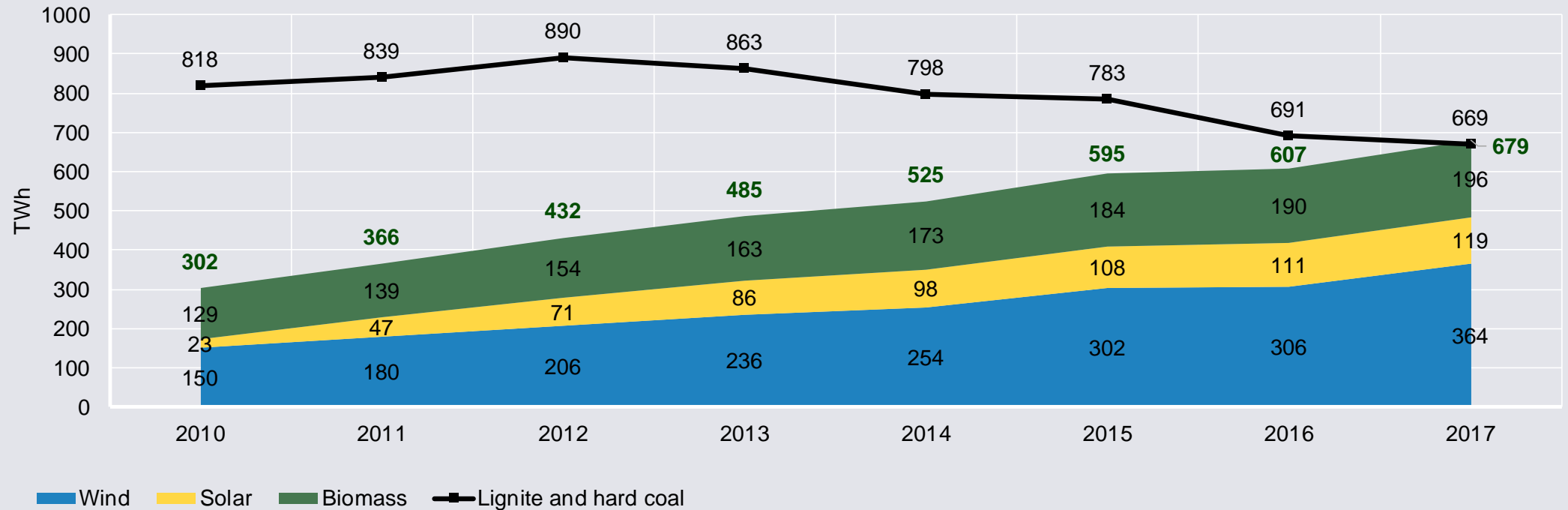
EUROSTAT data to 2015, 2016 and 2017 are own calculations, normalised hydro

Changes in renewable electricity generation



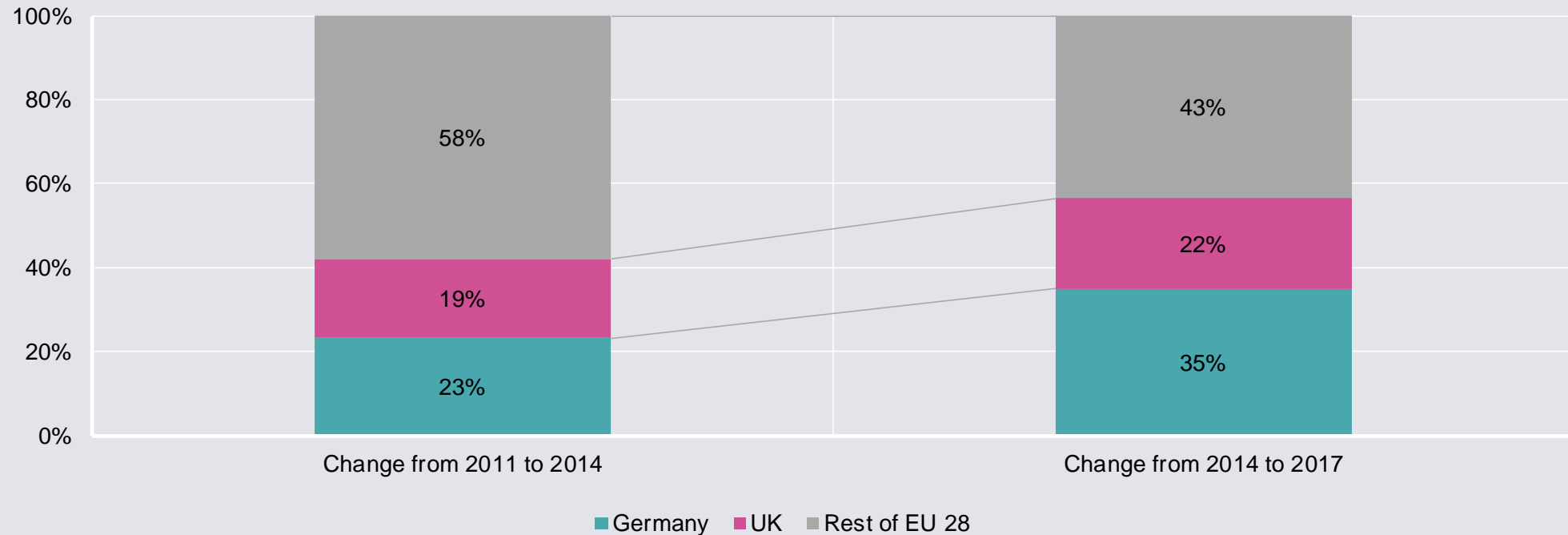
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Renewables versus coal electricity generation



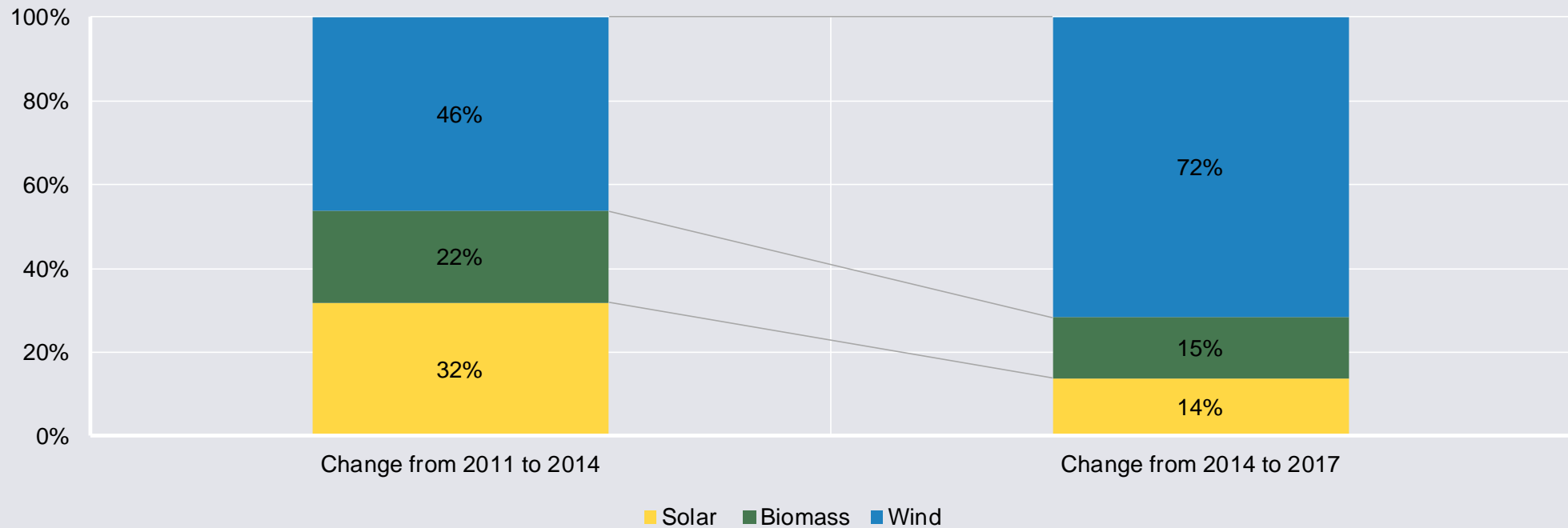
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Changes in non-hydro renewables generation by country



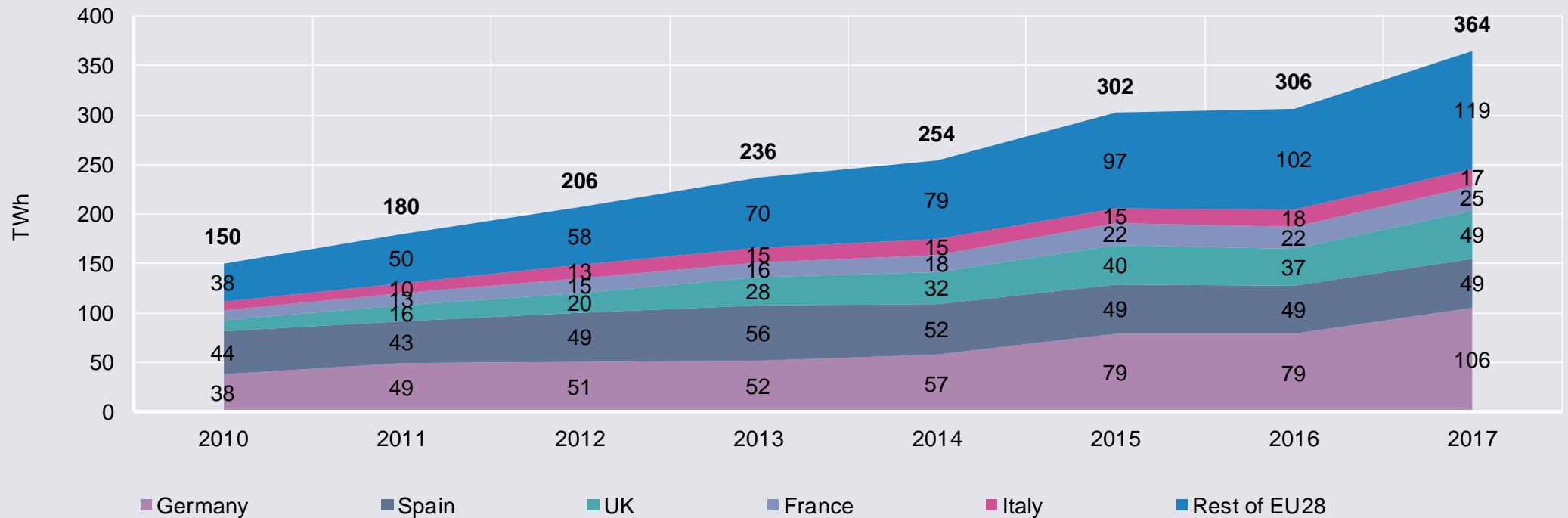
EUROSTAT data to 2015, 2016 and 2017 are own calculations

Changes in non-hydro renewables generation by type



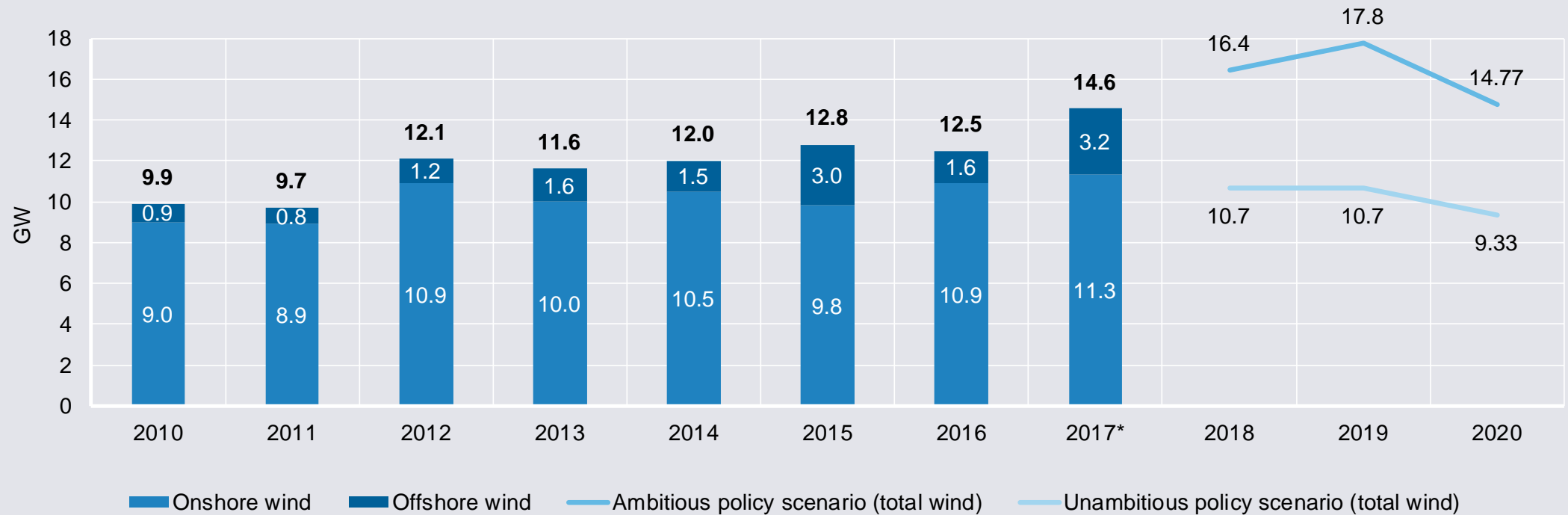
EUROSTAT data to 2015, 2016 and 2017 are own calculations

Wind electricity generation (including split of top 5 countries)



EUROSTAT data to 2015, 2016 and 2017 are own calculations

Annual wind installations



WindEurope 2017, Wind energy in Europe: Outlook to 2020, *latest forecast

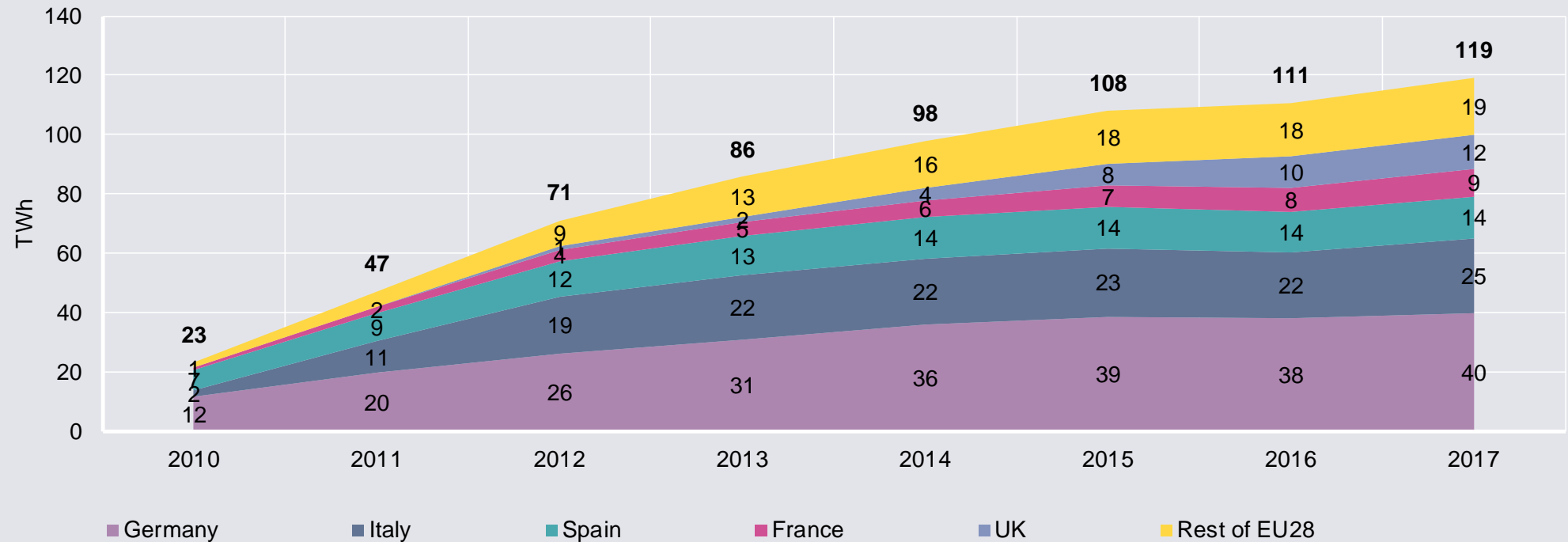
Wind auction prices

Technology	Auction	Quarter	Year of Construction	Latest Realisation	Capacity Auctioned	Result in € ct/kWh, £ p/kWh (average, weighted clearing price)
Offshore	Borssele I & II (NL)	Q3 2016	2019	Q3 2021	760MW	7.27 (15 yrs) / 8.77* (incl. grid)
	Danish Near Shore (DK)	Q3 2016	2019	2020	350 MW	6.4 (17.5 TWh) / 7.3* (incl. grid)
	Kriegers Flak (DK)	Q4 2016	2019-2020	2021	600 MW	4.99 (30 TWh) / 6.49* (incl. grid)
	Borssele III & IV (NL)	Q4 2016	2020	Q4 2021	740 MW	5.45 (15 yrs) / 6.95* (incl. grid)
	German Offshore	Q2 2017	2024	Q4 2025	1,390 MW	0.44 (20 yrs, excluding grid)
	UK Offshore	Q3 2017	2021-2022	2021-2022	860 MW	7.48* (incl. grid)
			Q3 2017	2022-23	2022-2023	2,336 MW
Onshore	German Onshore I	Q2 2017	2018-2021	Q4 2019 - Q4 2021	807 MW	5.71 (20 yrs)
	German Onshore II	Q3 2017	2019-2022	Q1 2020 - Q1 2022	1,013 MW	4.28 (20 yrs)
	German Onshore III	Q4 2017	2020-2022	Q2 2020 - Q2 2022	1,000 MW	3.82 (20 yrs)
	Spain 2017 I	Q2 2017	2019	Q4 2019	2,979 MW	4.3 (20 yrs)
	Spain 2017 II	Q3 2017	2019	Q4 2019	1,128 MW	3.3 (20 yrs)

COM 2016, EU Reference Scenario 2016, BNetzA 2016,2017, Danish ENergy Agency 2016, WindEurope 2017, 4offshore 2017

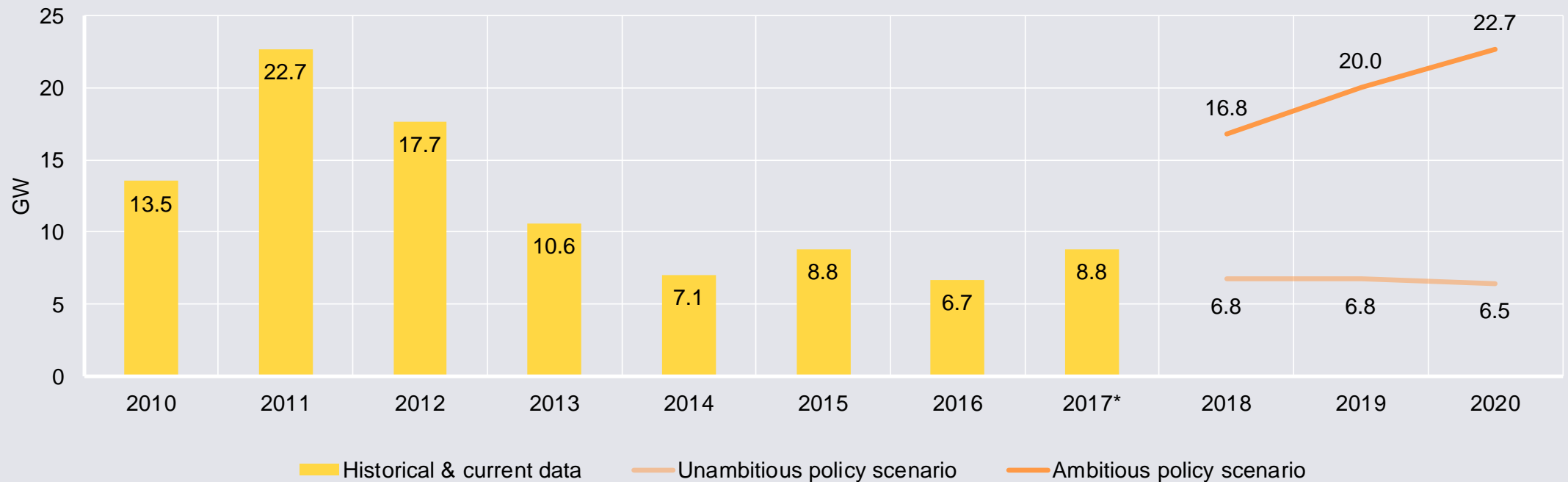
*Based on NERA Consulting 2016, IEA-RETD 2017: €0.15 added to tariff to account for development and grid connection costs. €0.09 applied to Danish Near Shore due to lesser distance from shore.

Solar electricity generation (including split of top 5 countries)



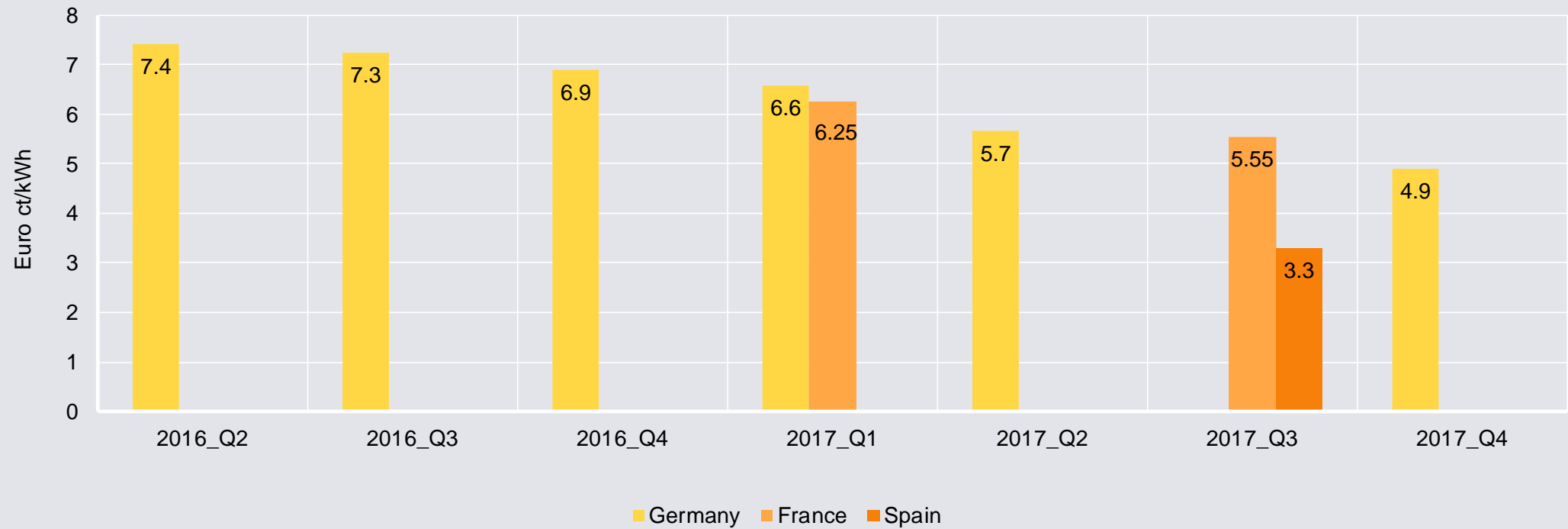
EUROSTAT data to 2015, 2016 and 2017 are own calculations

Annual solar PV installations



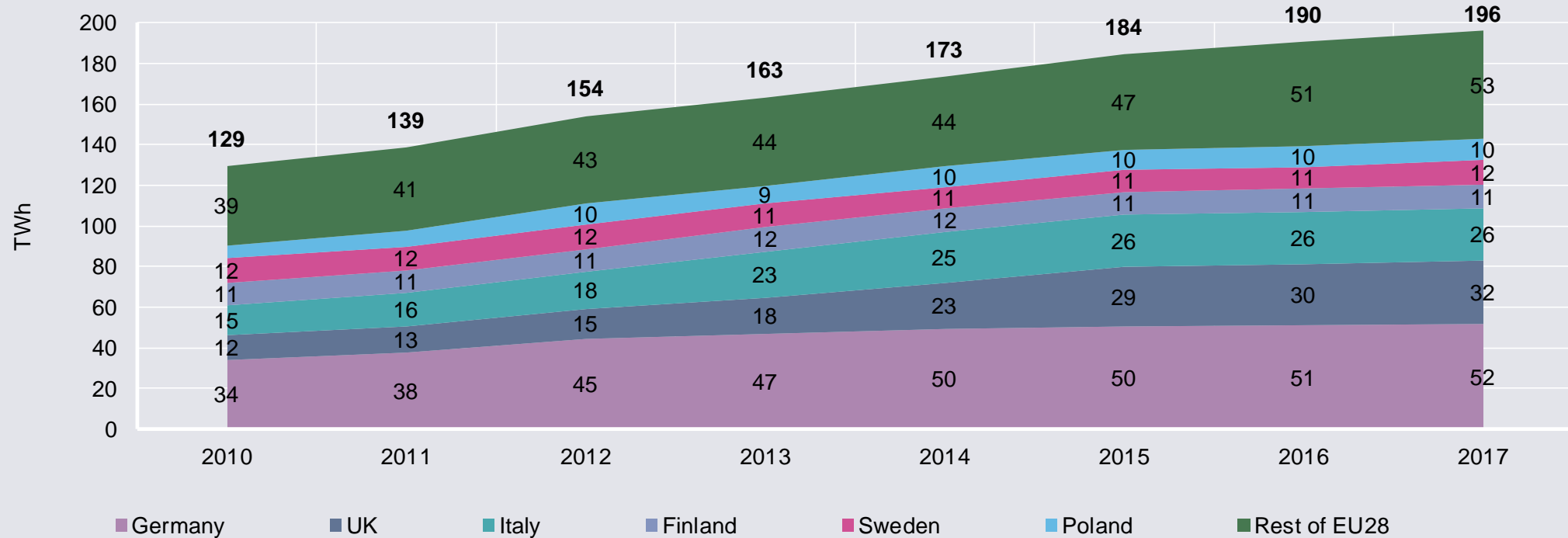
Solar Power Europe 2017, *latest forecast

Solar PV auction results 2016-2017 (average prices, ground-mounted installations)



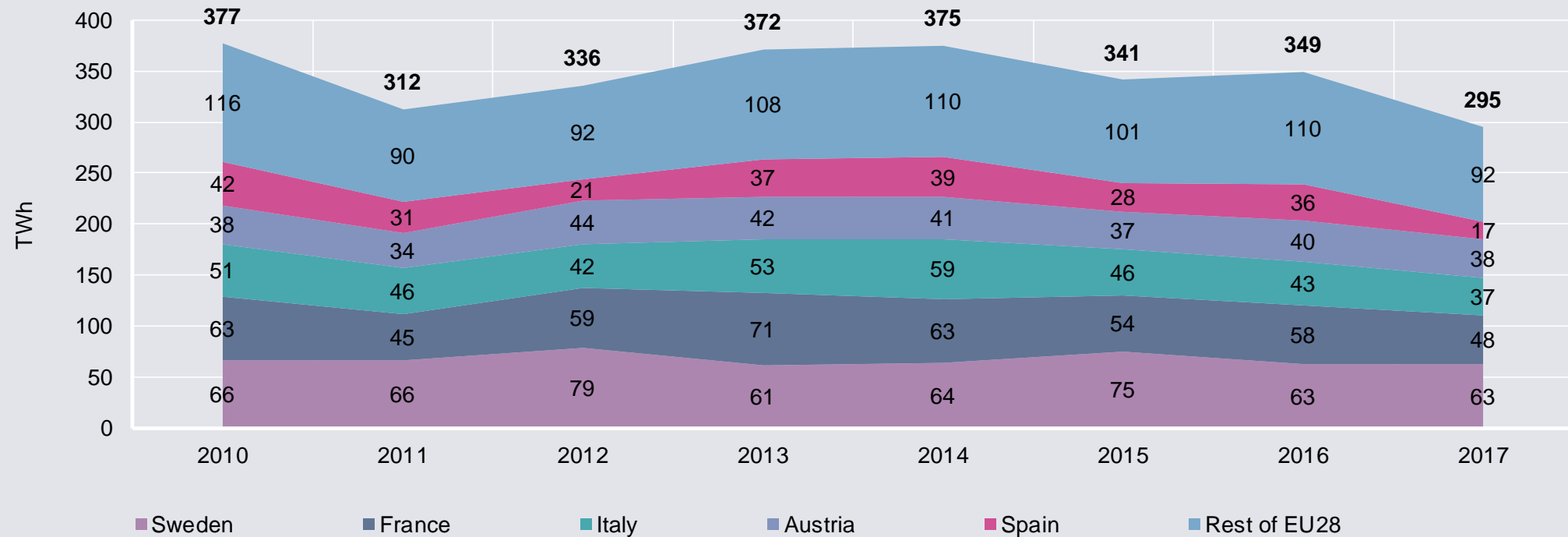
BNetzA 2016/2017, globalfinance.solarenergyevents.com 2017, pv-tech 2017

Biomass electricity generation (including split of top 5 countries)



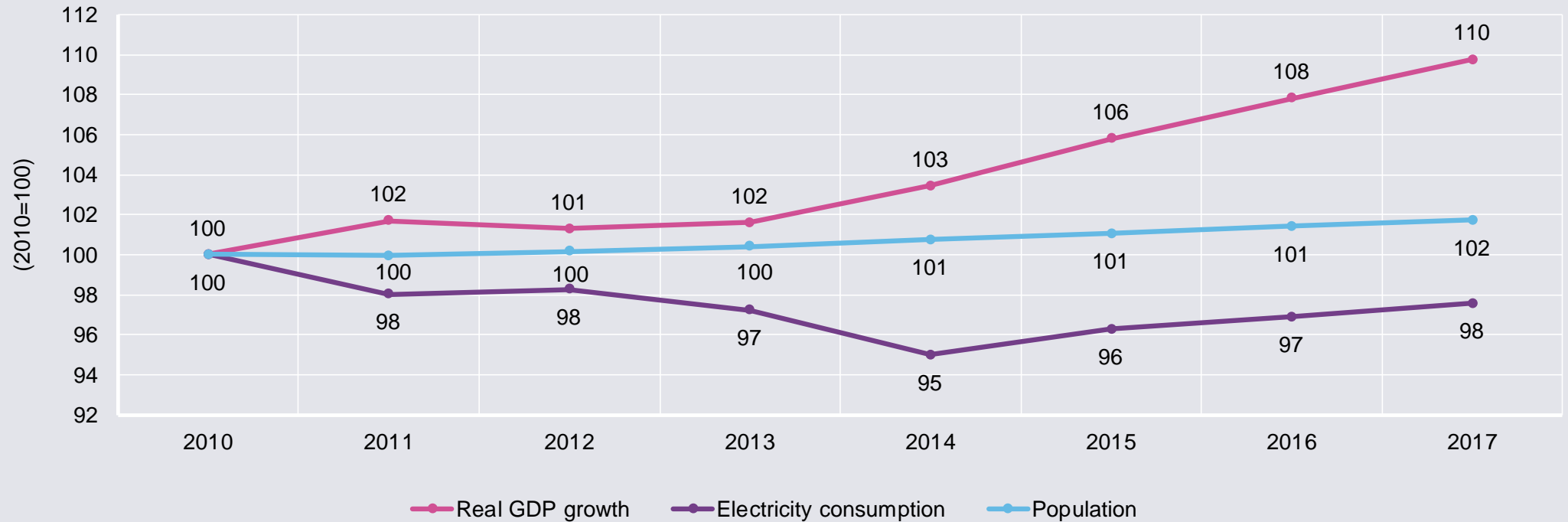
EUROSTAT data to 2015, 2016 and 2017 are own calculations

Hydro electricity generation, non-normalised (including split of top 5 countries)



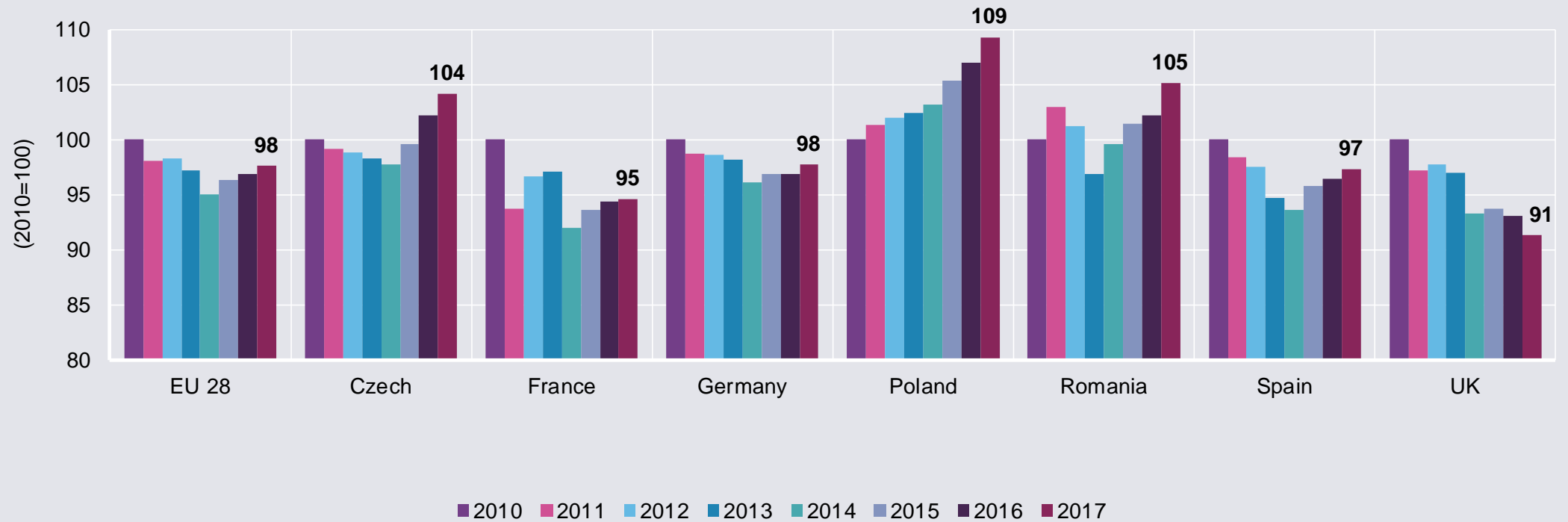
EUROSTAT data to 2015, 2016 and 2017 are own calculations

EU electricity consumption (indexed)



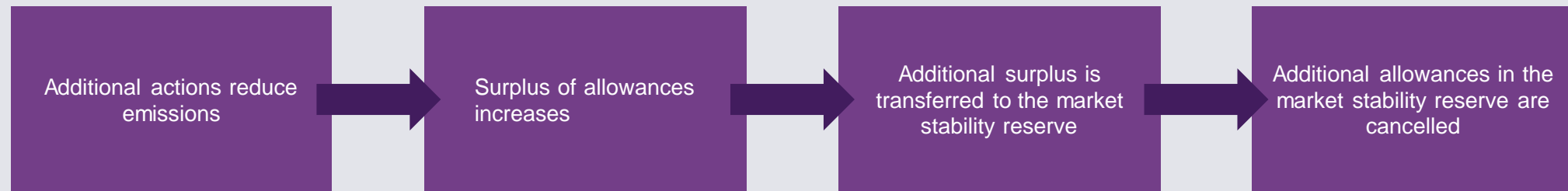
EUROSTAT 2018

Electricity consumption by country (indexed)

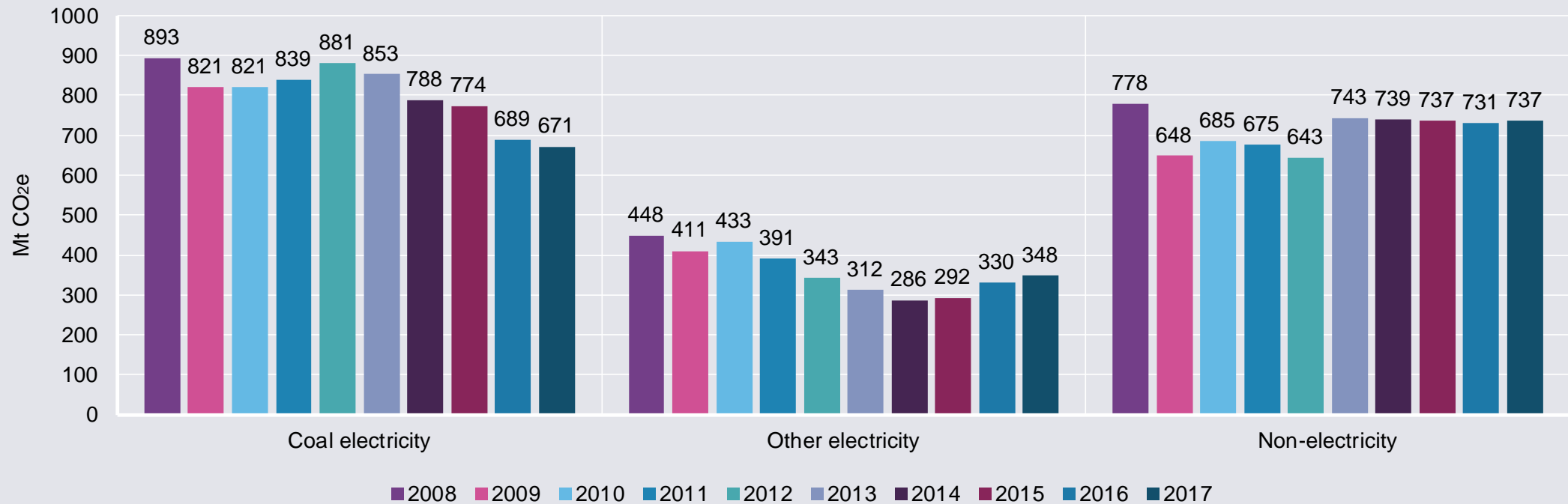


EUROSTAT data to 2015, 2016 and 2017 are own calculations

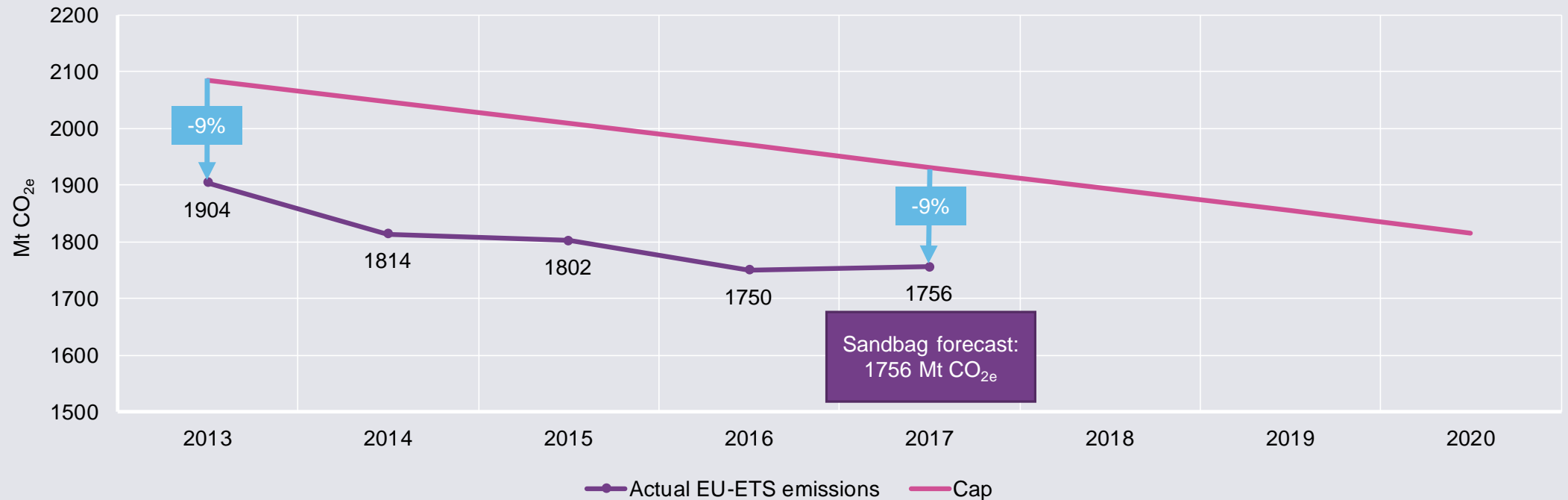
Why is the “waterbed effect” dampened?



Emissions from coal, other electricity and non-electricity sectors 2008-2017



ETS cap 2013-2017



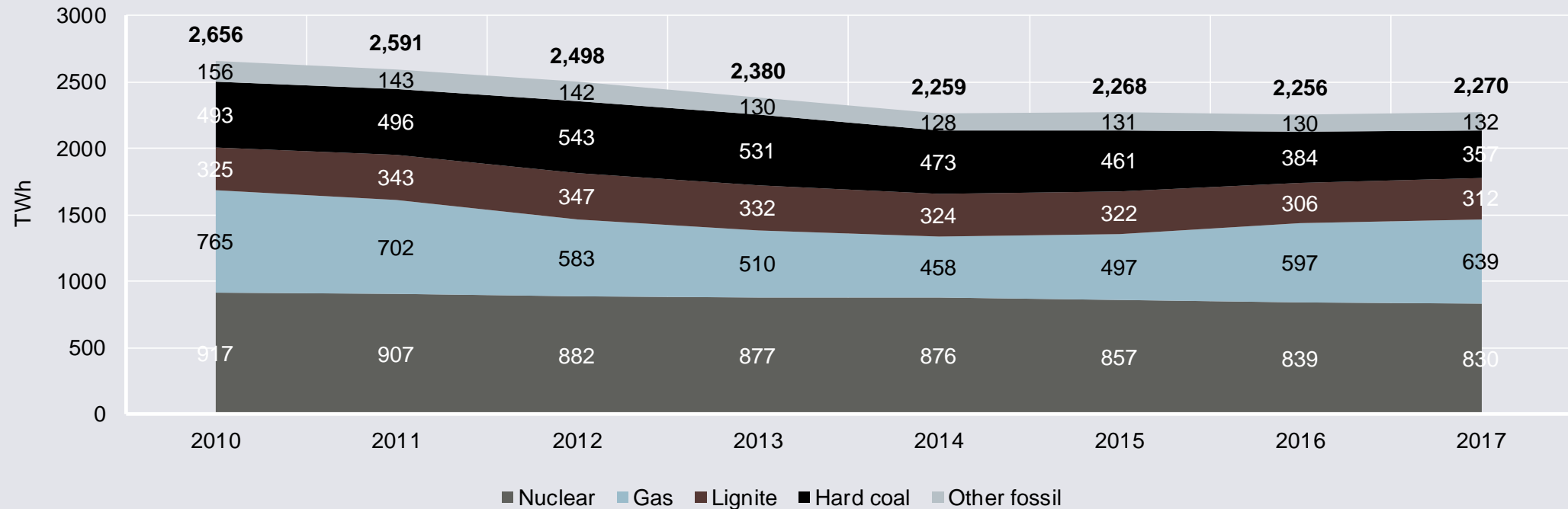
Sandbag 2018

ETS surplus 2008-2017



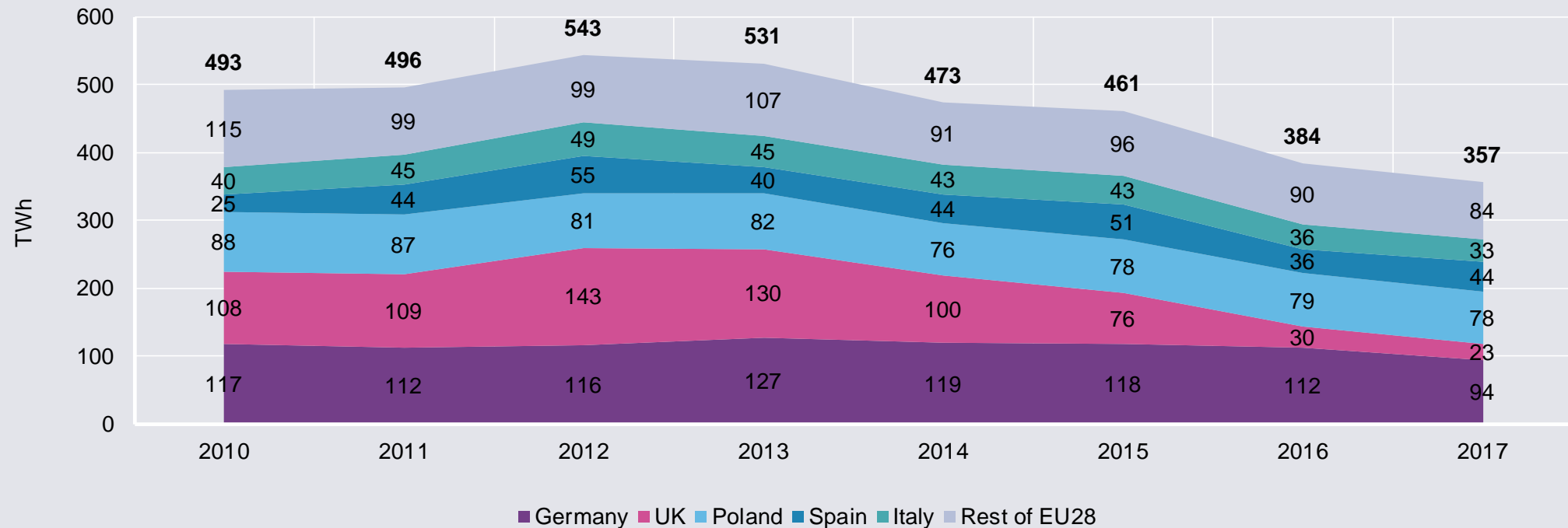
Sandbag 2018

Conventional electricity generation



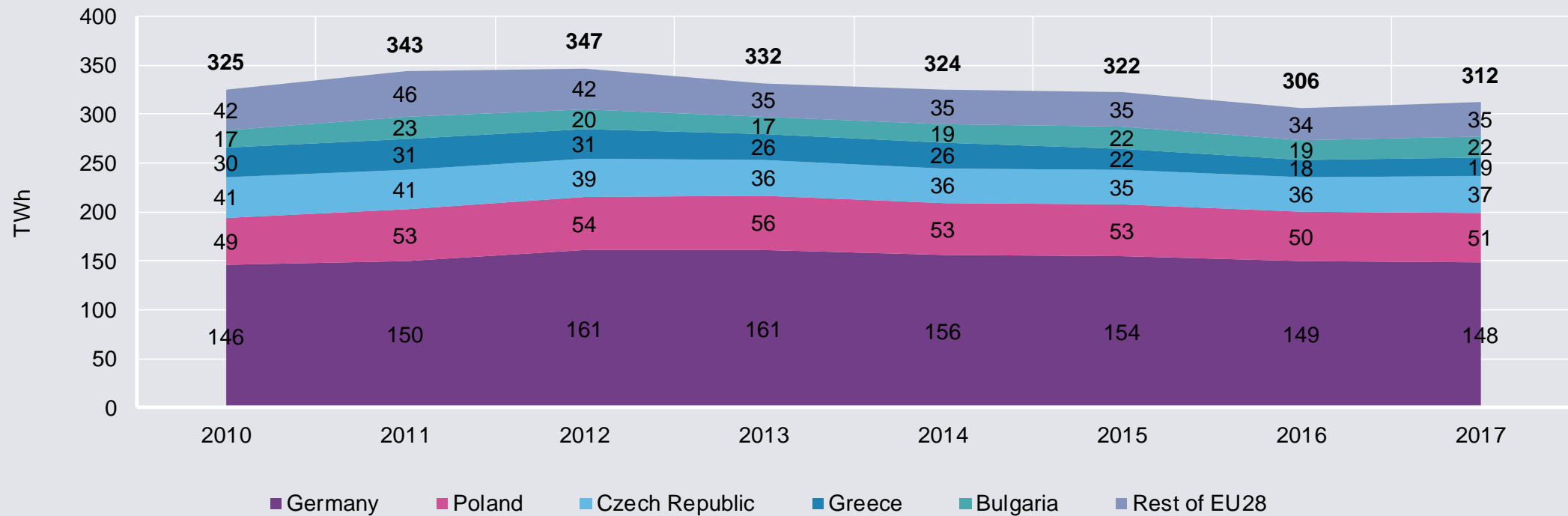
EUROSTAT data to 2015, 2016 and 2017 are own calculations

Hard coal electricity generation (including split of top 5 countries)



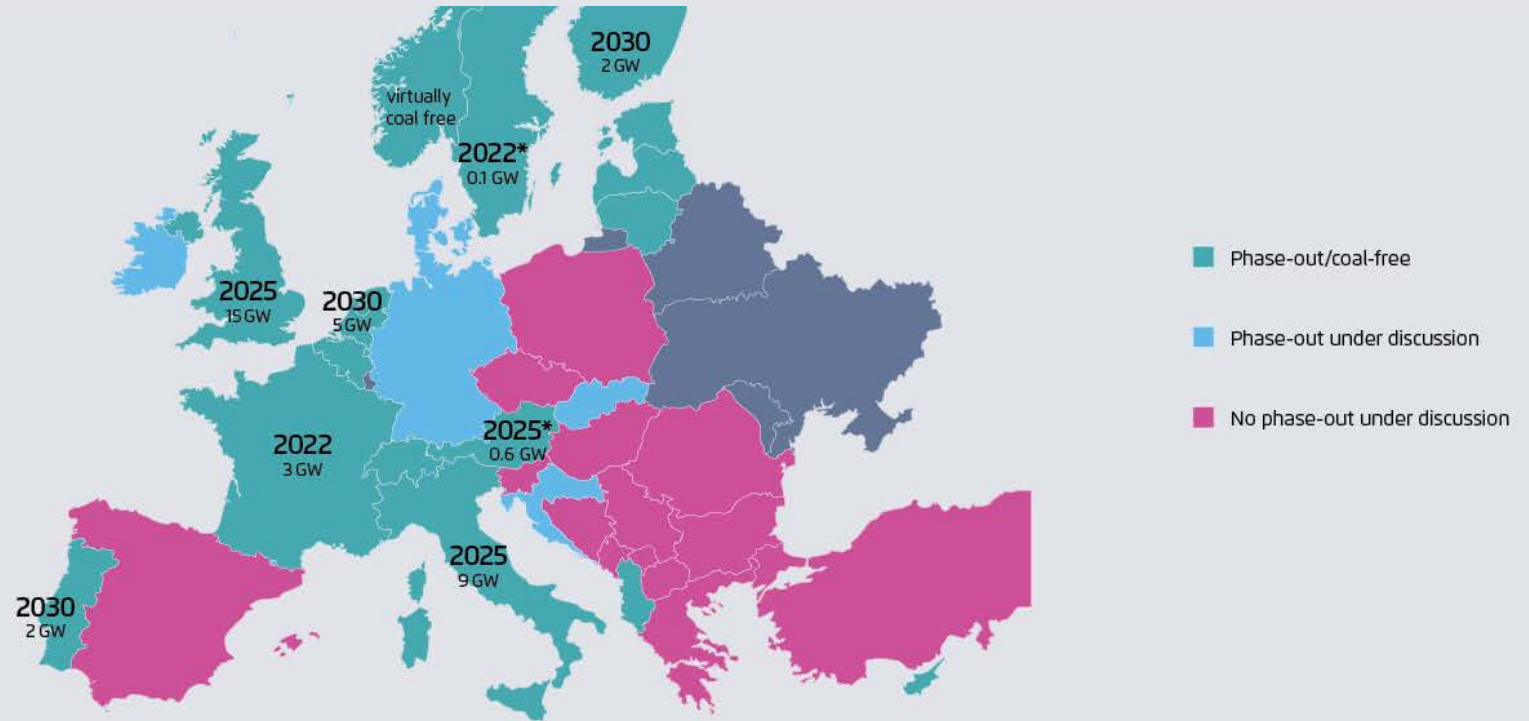
EUROSTAT data to 2015, 2016 and 2017 are own calculations

Lignite electricity generation (including split of top 5 countries)



EUROSTAT data to 2015, 2016 and 2017 are own calculations

Coal phase-out years and operational capacity



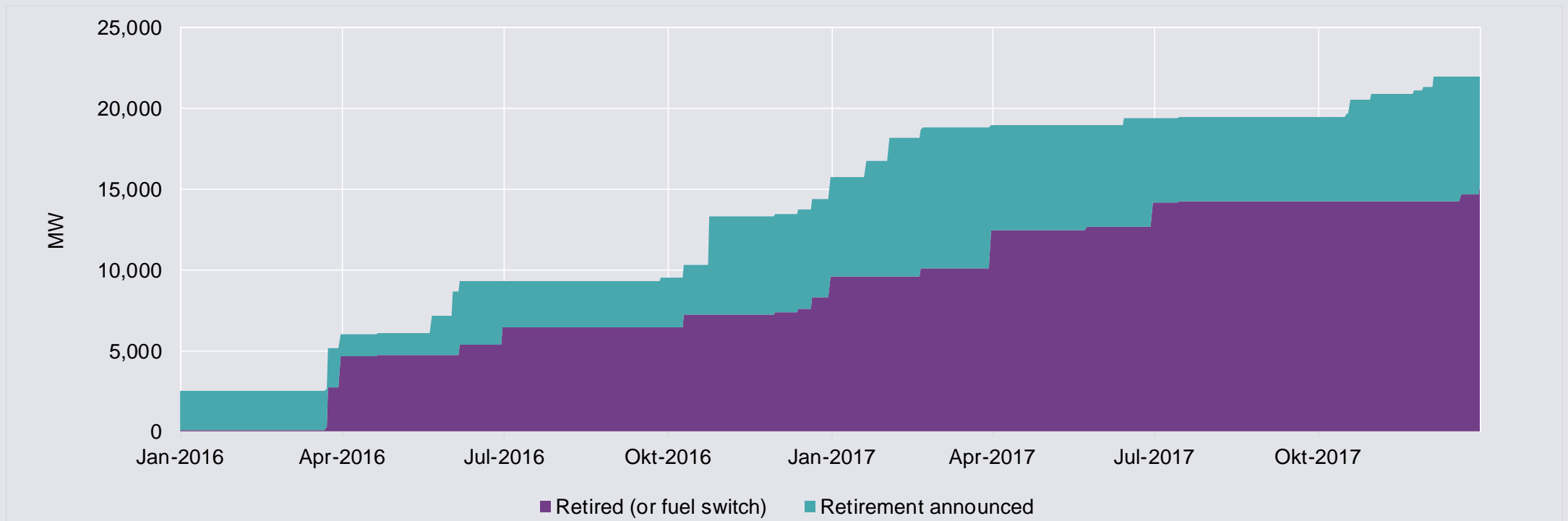
Beyond Coal campaign 2018

Retired coal plants in 2017

Country	Plant name	Coal type	Owner	Year opened	MW (gross)
Croatia	Plomin 1	Hard coal	HEP	1969	125
Finland	Kristiina 2	Hard coal	PVO	1983	242
Finland	Tahkoluoto	Hard coal	PVO	1976	225
Germany	Berlin-Klingenberg	Lignite	Vattenfall	1986	164
Germany	Ensdorf	Hard coal	RWE	1963	430
Germany	Herne 3, Marl II	Hard coal	STEAG	1966	378
Germany	Voerde	Hard coal	STEAG	1982	1522
Germany	Voerde West	Hard coal	STEAG	1971	712
Italy	Genova	Hard coal	Enel	1952	155
Netherlands	Maasvlakte	Hard coal	Uniper	1987	1207
Poland	Adamow B	Lignite	Zepak	1964	600

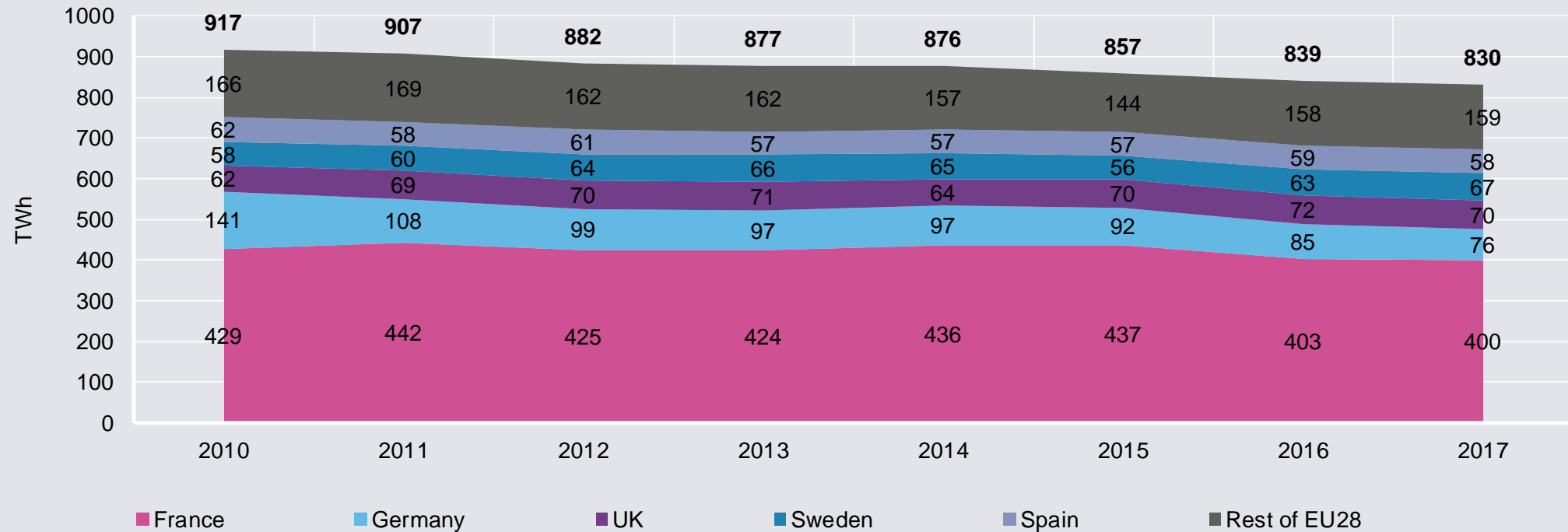
Beyond Coal campaign 2018

Coal plants retired or announced to retire



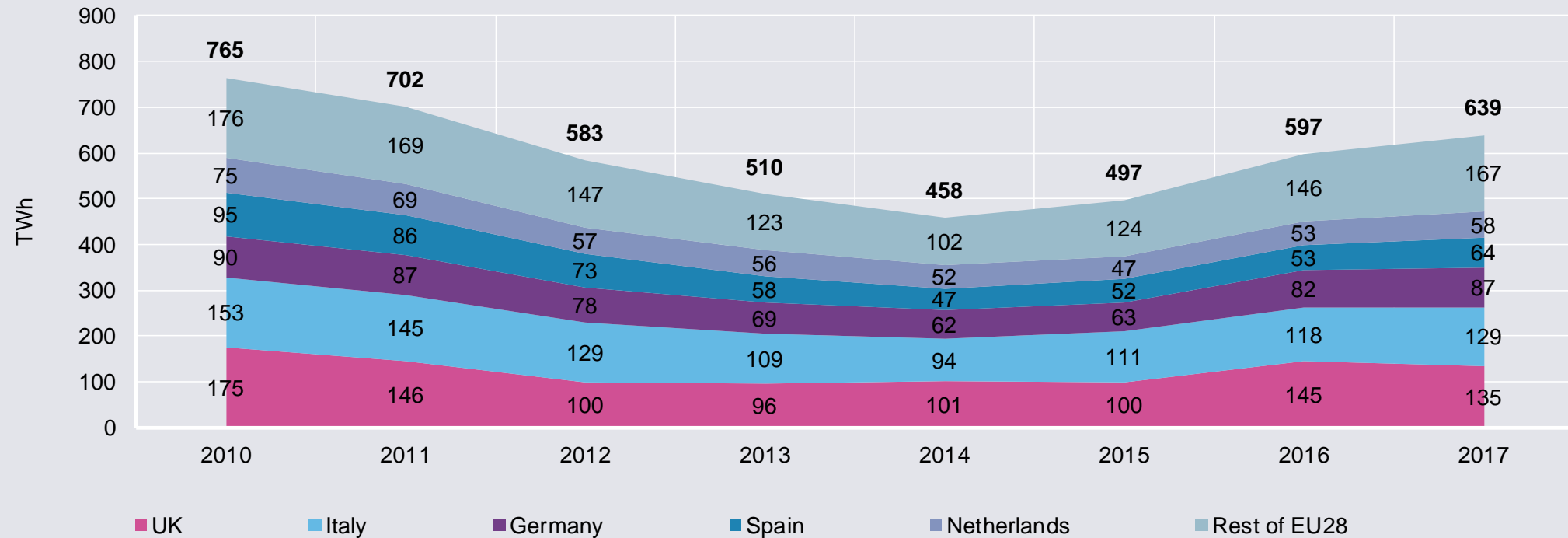
Beyond Coal campaign 2018

Nuclear electricity generation (including split of top 5 countries)



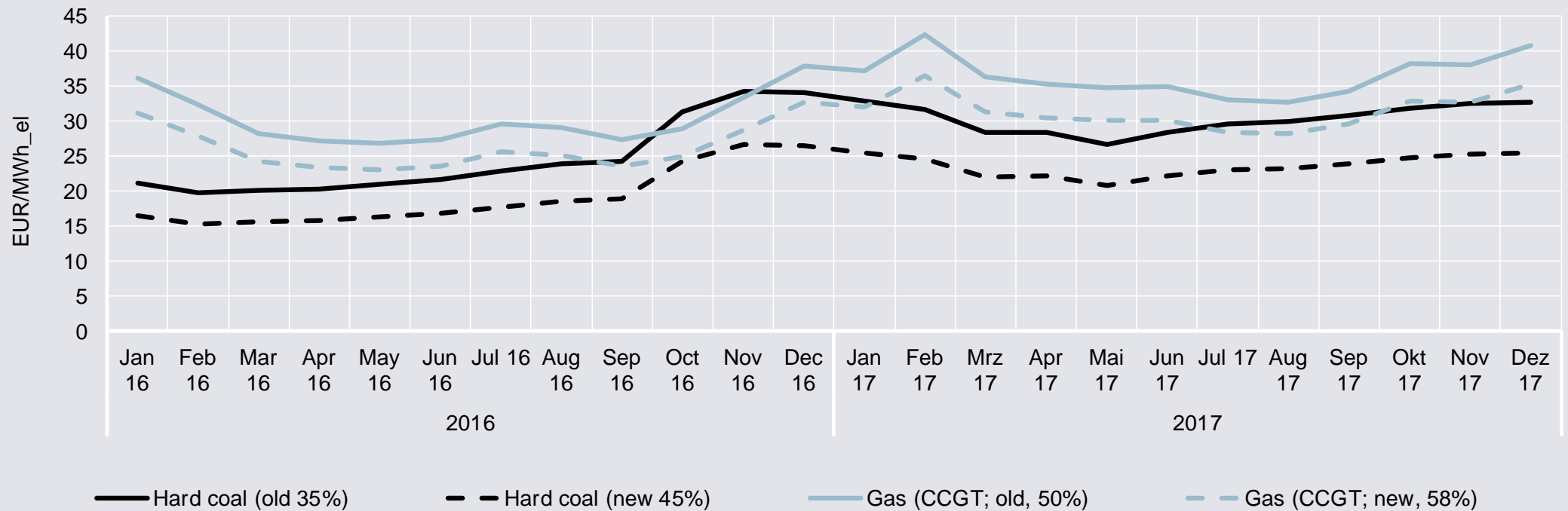
EUROSTAT data to 2015, 2016 and 2017 are own calculations

Gas electricity generation (including split of top 5 countries)



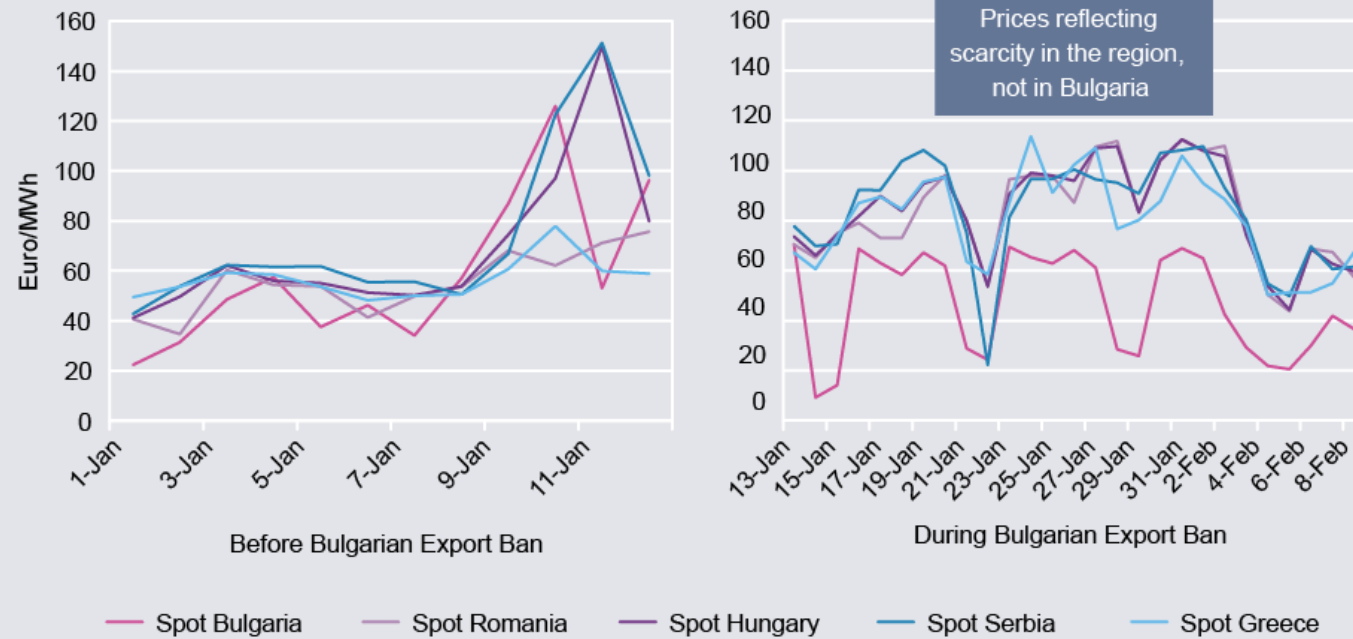
EUROSTAT data to 2015, 2016 and 2017 are own calculations

Marginal cost of standard-type power plants 2016-2017



Worldbank 2018; Bundesbank 2018, UBA 2015, DEhSt 2018 (own calculations)

Day Ahead Power Prices in South-East Europe Jan & Feb 2017



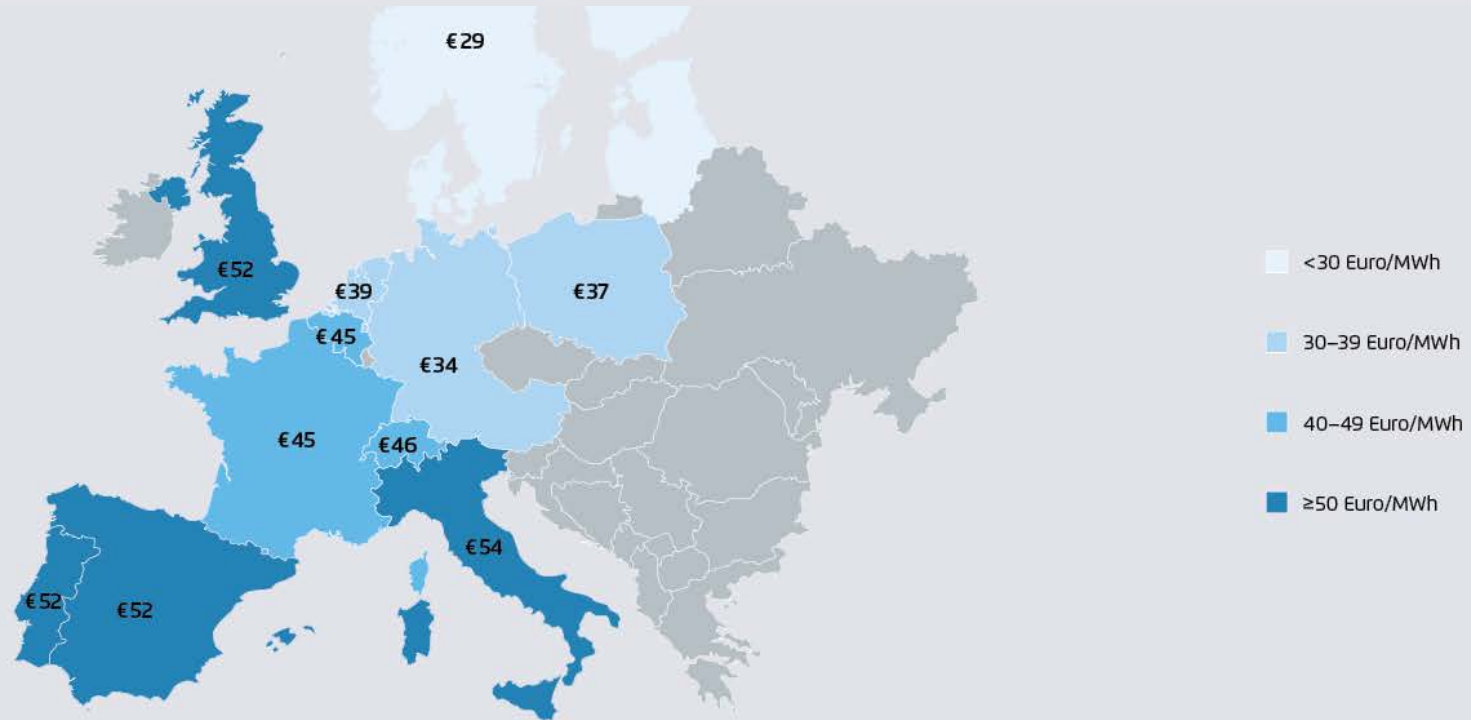
PXE 2017, SEEPEX 2017, IBEX 2017, Lagie 2017

Situation in France in January 2017

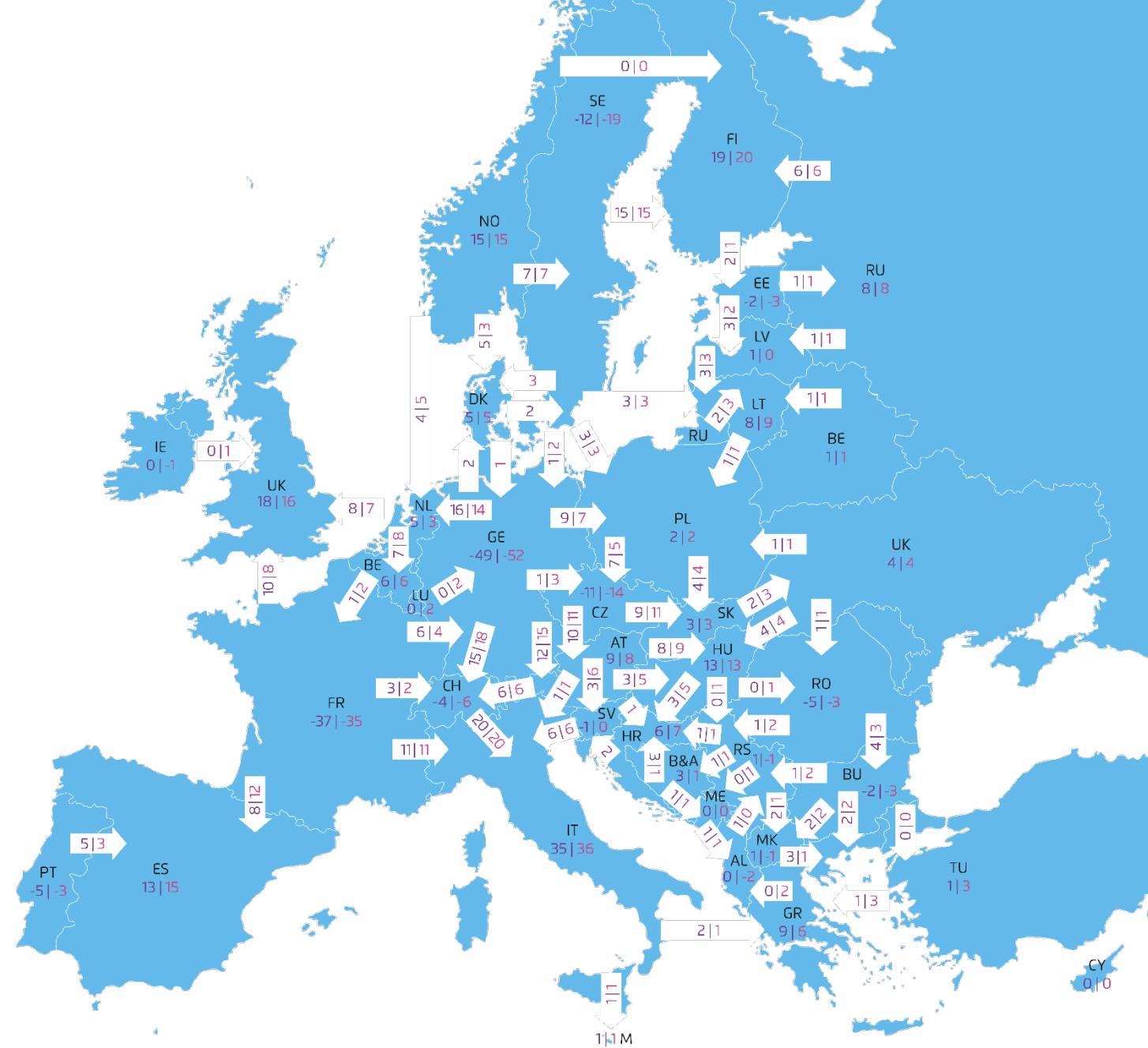
	Installed Jan. 1, 2017	20-Jan-17	25-Jan-17
Price		€122/MWh	€206/MWh
Time		10 AM	9 AM
Demand		93.7	89.6
Fuel oil	7.1	4.0	2.5
Coal	3	2.6	2.3
Gas	11.7	9.3	9.1
Nuclear	63.1	55.6	56.6
Wind	11.7	2.7	1.2
Solar	6.7	0.5	0.1
Hydro	25.4	13.7	12.7
Other	1.9	0.9	0.8
Imports		4.2	4.3
UK		1	1
Spain		2.3	2.2
Italy		-1.3	0.2
Switzerland		0.8	1.4
Belgium/Germany		1.3	0.3
Adj		0.1	-0.8

RTE France 2017, EPEX Spot 2017

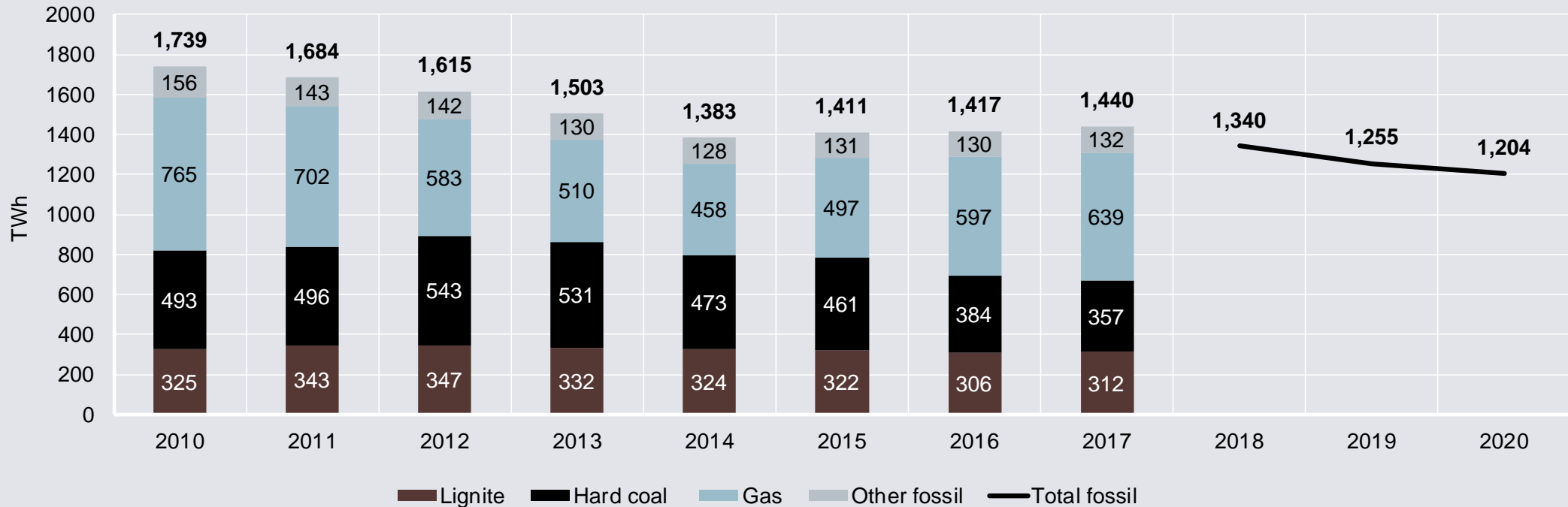
Average day-ahead wholesale electricity prices in selected countries in 2017



EPEX-SPOT 2018, Nordpool 2018, Belpex 2018, OMEL 2018, Mercato Elettrico 2018, APX 2018, POLPX 2018 (own calculations)

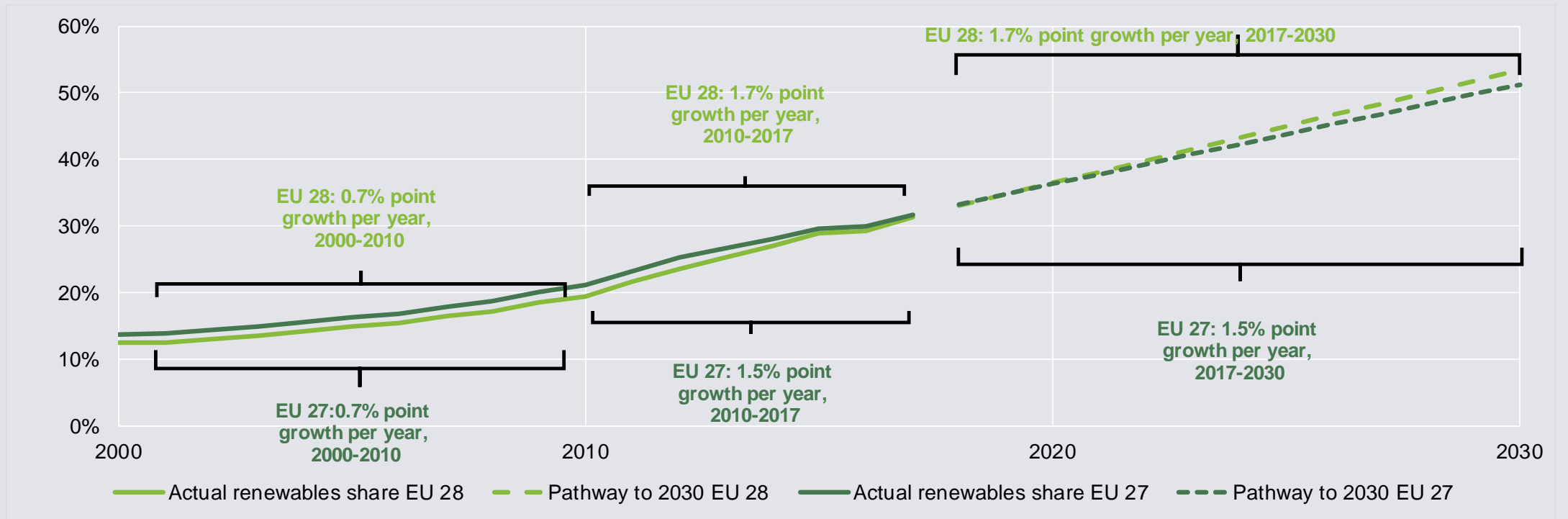


Conventional electricity generation 2010-2017 and projected total conventional generation 2018-2020



Sandbag 2018

Renewables share as percentage of total electricity production: the trend to 2050, EU 28 vs. EU 27



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Annex

Classification of fuel types

Electricity sources as used in this report	Detailed energy carriers used in EUROSTAT
Lignite	Lignite, peat, patent fuels and BKB.
Hard Coal	Anthracite, coking coal, other bituminous coal, sub-bituminous coal
Gas	LPG, natural gas liquids, gas work gas and other recovered gases
Other fossil	"Other sources", gas works, coke oven gas, blast furnace gas, other recovered gases, oil shale and oil sands, peat products, crude oil, natural gas liquids, refinery gases, LPG, Diesel oil, residual fuel oil, other oil products, industrial waste, municipal waste (non renewable).
Nuclear	Nuclear
Hydro	Hydro minus Pumps
Solar	Solar photovoltaic, solar thermal
Wind	Wind, and "Tide, Wave Ocean"
Biomass	Municipal waste (renewables), solid biofuels, biogases, bio-diesels, other liquid biofuels, and geothermal.
Net imports	Imports minus Exports
Consumption	Production minus Net imports
Production	Sum of Lignite, Hard coal, Gas, other fossil, nuclear, hydro, solar, wind, biomass.

Accuracy of last year's calculations

	Lignite	Hard Coal	Other fossil	Gas	Nuclear	Hydro	Solar	Wind	Biomass	Imports	Consumption	Production
2015 (TWh changes year-on-year)												
Jan-17 forecast by Agora/Sandbag	0	-10	2	35	-18	-36	12	48	12	-4	40	44
Eurostat actuals	-2	-12	3	39	-19	-34	10	49	11	-1	44	45
Error	-2	-2	2	4	-2	3	-2	0	-1	3	4	1
2016 (TWh changes year-on-year)												
Jan-17 forecast by Agora/Sandbag	-16	-78	1	101	-18	6	4	4	3	6	15	8
Jan-18 forecast by Agora/Sandbag	-16	-77	-1	100	-18	8	3	4	6	12	20	8
Change in forecast	0	1	-3	-1	0	2	-1	0	3	5	5	1

Own calculations

	Lignite	Hard Coal	Other fossil	Gas	Nuclear	Hydro	Solar	Wind	Biomass	Imports	Consumption	Production	CO2 (Mt)
EU28	6	-27	2	42	-9	-54	9	58	5	-8	23	31	0
Austria	0	0	0	3	0	-2	0	1	0	-1	1	2	1
Belgium	0	0	0	2	-2	0	0	1	0	0	1	1	0
Bulgaria	2	0	0	1	0	-1	0	0	0	-1	0	2	3
Cyprus	0	0	0	0	0	0	0	0	0	0	0	0	0
Czech	1	0	0	-1	4	0	0	0	0	-3	1	4	0
Denmark	0	-2	0	0	0	0	0	2	1	-1	0	1	-2
Estonia	0	0	1	0	0	0	0	0	0	-1	0	1	0
Finland	0	-1	0	0	-1	-2	0	2	0	1	0	-1	-1
France	0	3	0	5	-3	-10	1	3	1	1	1	0	4
Germany	-2	-18	0	5	-9	-1	2	27	1	0	5	5	-15
Greece	2	0	0	3	0	-1	0	0	0	-3	2	4	3
Hungary	-1	0	0	1	0	0	0	0	0	0	1	1	0
Ireland	0	-1	0	1	0	0	0	1	0	-1	0	1	-1
Italy	0	-3	0	11	0	-6	3	-1	0	1	5	4	2
Latvia	0	0	0	0	0	1	0	0	0	-1	0	1	0
Lithuania	0	0	0	0	0	0	0	0	0	1	0	0	0
Netherlands	0	-5	0	5	-1	0	0	3	0	-2	1	2	-2
Poland	1	-1	0	1	0	0	0	2	0	1	4	3	1
Portugal	0	2	0	6	0	-9	0	0	0	2	1	-1	4
Romania	1	0	0	1	0	-4	0	1	0	2	2	0	1
Slovakia	0	0	0	0	0	0	0	0	0	1	1	0	0
Slovenia	0	0	0	0	0	-1	0	0	0	1	0	0	0
Spain	0	8	0	11	-1	-19	1	0	0	2	3	0	11
Sweden	0	0	0	-1	4	0	0	2	1	-7	0	7	0
United Kingdom	0	-8	1	-10	-2	0	1	12	1	-2	-7	-4	-10
Luxembourg	0	0	0	0	0	0	0	0	0	0	0	0	0
Malta	0	0	0	0	0	0	0	0	0	0	0	0	0
Croatia	0	0	0	1	0	-1	0	0	0	1	1	0	0



Terawatt hour changes by fuel type by country in 2017 versus 2016

Source: ENTSO-E 2018 (own calculations)