

Wind Power in Germany in 2014

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Scope, Main Findings and Conclusions

- ❑ This document presents the results and some analysis of wind power development in Germany up to the end of 2014 with comparisons with other renewable electricity production in 2014 in Germany and with other European countries in 2013
- ❑ Information from the new RE power plants register published monthly by BNETZA since August 2014 is very precious and the selection of wind turbines with minimum power of 100 KW and reliable data from this register show that for new commissioned wind turbines there is a clear increase in rotor diameter, hub height and more important, also of the specific area ratio **Su** (in m²/kW) which is in favour of higher average annual capacity factors
- ❑ From data of decommissioned wind turbines in this register, their average number of years of operation was 17.7 years, with a minimum of 10 years and a maximum of 25 years.
- ❑ According to EWEA data, Germany was N°1 in 2014 for installed wind power and new power with annual growth rates of 14.3 % and 63 % and represented 30 % of EU installed power and 45 % of new capacity. Net wind power changes in 2014 were + 4,386 MW onshore and + 529 MW offshore (source: Deutsche Windguard) with a total of 39.1 GW at end of 2014.
- ❑ From provisional data on wind power production in 2013 provided by ENTSO-E, Germany was the 2nd wind energy producer in the European Union, but with a capacity factor of only around 18 % (full-load hours Nh = 1,557 hours/year).
- ❑ With a provisional estimate of more than 52 TWh in 2014, wind power contribution was the highest within renewables in Germany. With 1.2 TWh in 2014 from 1 GW, offshore wind production was only 2.3 % of total wind energy.
- ❑ Share of variable but predictable production from [Wind + PV] is now 55 % of the total renewable share of electricity production of 27.3 % in 2014.

References

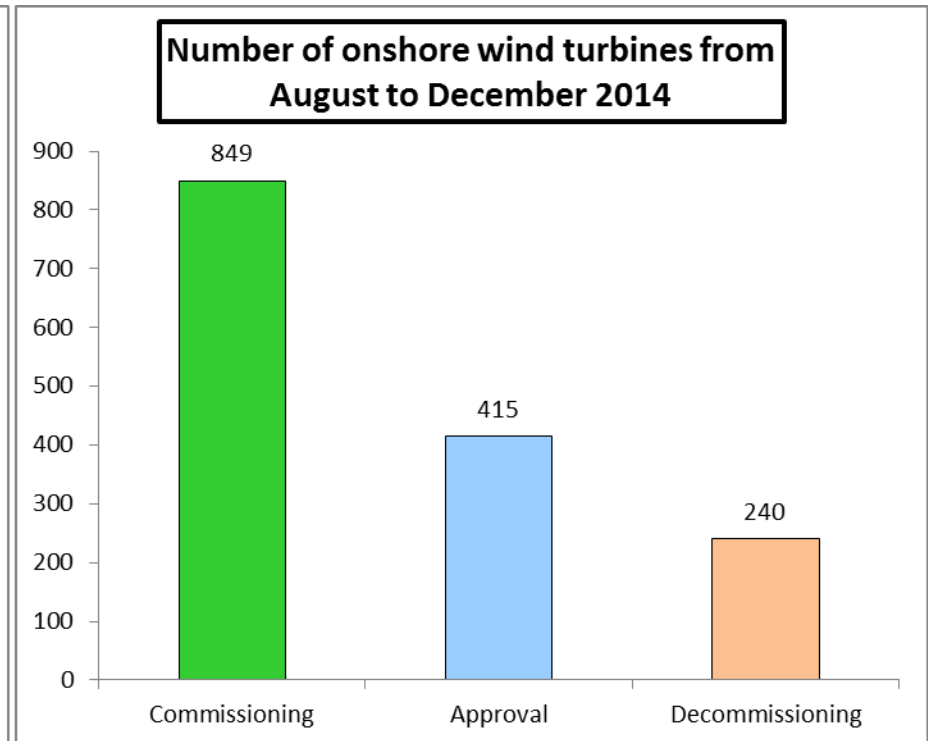
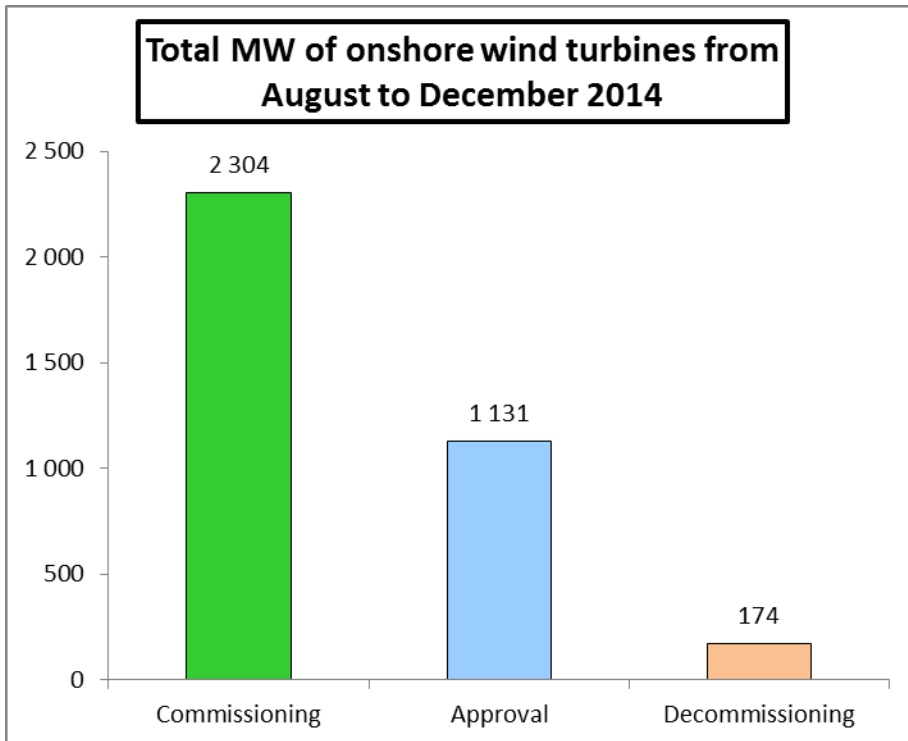
Refer to preceding analysis and conclusions on renewables and electricity in Germany:

- **“Analysis of PV installations and contribution in Germany in 2014”**, on line February 2015 and downloadable at: <http://www.renewablesinternational.net>
- **“ Towards 100 % renewable electricity and then 100 % of renewable energy: who will lead among Denmark, Germany, Norway and Sweden ?”**, on line January 28, 2015, and downloadable at: <http://www.renewablesinternational.net/targets-and-fulfillment-in-scandinavia-and-germany/150/537/85029/>
- **« Electricity in Germany up to 2014 with a focus on the production and the share from renewables »**, on line January 22, 2015, and downloadable at: <http://www.renewablesinternational.net/germanys-largely-unsung-success-with-efficiency/150/537/84829/>
- **« Comparing the main indicators for population, GDP, energy, CO2 and electricity of Japan, Germany, United Kingdom and France »**, on line January 7, 2015, and downloadable at: www.renewablesinternational.net/main-indicators-for-japan-germany-uk-and-france/150/537/84454/
- **“Analysis of Wind, Solar PV and Conventional Power Production in Germany up to May 2014”**, on line in June 2014 and downloadable at: www.renewablesinternational.net/german-power-market-update-up-to-may-2014/150/537/79689/
- **“Analysis of Onshore and Offshore Wind Production and Productivity in Germany from January to May 2014”**, on line in June 2014 and downloadable at: www.renewablesinternational.net/field-converter-plagues-german-offshore/150/435/79679/
- **“Updated Analysis of Electricity Production from Renewables in Germany in 2013”**, on line May 2014 and downloadable at: www.renewablesinternational.net/overview-of-german-renewable-electricity-from-1990-2013/150/537/79182/
- **“Analysis of 13 years of successful PV development in Germany under the EEG with a focus on 2013”**, online March 4, 2014 and downloadable at: www.renewablesinternational.net/german-pv-history-2000-2013/150/452/77299/
- **“Analysis of the Global Electricity Production up to 2013 With a Focus On the Contribution From Renewables”**, on line July 14, and downloadable at: www.renewablesinternational.net/world-electricity-production-in-2013/150/537/80167/
- **“Wind and Solar PV Production in Germany in 2013 and comparisons with 2012”**, online January 3, 2014 and downloadable at: www.renewablesinternational.net/german-and-french-wind-solar-in-2013/150/537/75771/

**Some wind turbines
characteristics from the
BNETZA RE power plants
Registry**

Characteristics of a selection of 1504 onshore wind turbines (P ≥ 100 kW) entered into the RE power plants register from August to December 2014

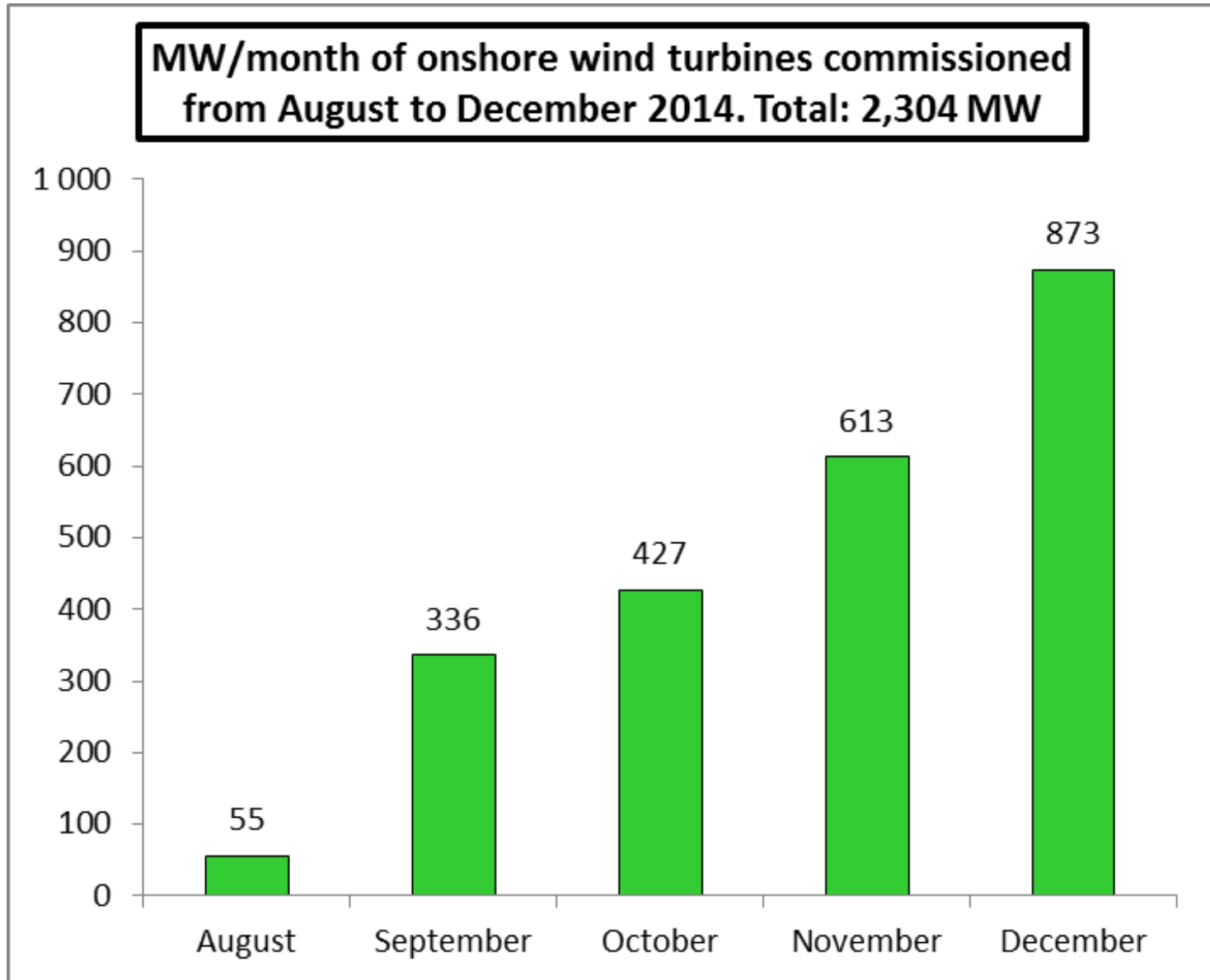
Onshore 8-12/2014	Put in operation	Approval	Decom- missioned	Net increase
MW	2 304	1 131	174	2 130
N WT	849	415	240	609
Pm (kW)	2 714	2 724	726	



Commissioning from August to December 2014 of 849 selected onshore wind turbines ($P \geq 100$ kW). Total 2,304 MW

Onshore 8-12/2014	P (kW)	D (m)	S (m ²)	Su (m ² /kW)	Ps (W/m ²)	H hub (m)
Total	2 304 319		7 020 012			
Maxi	6 150	154	18 627	4,524	598	149
Average	2 714	101	8 269	3,048	350	117
Mini	800	48	1 810	1,673	221	50

More commissioned onshore wind power was registered at the end of 2014



Approval from August to December 2014 of 415 selected onshore wind turbines. Total: 1,130 MW

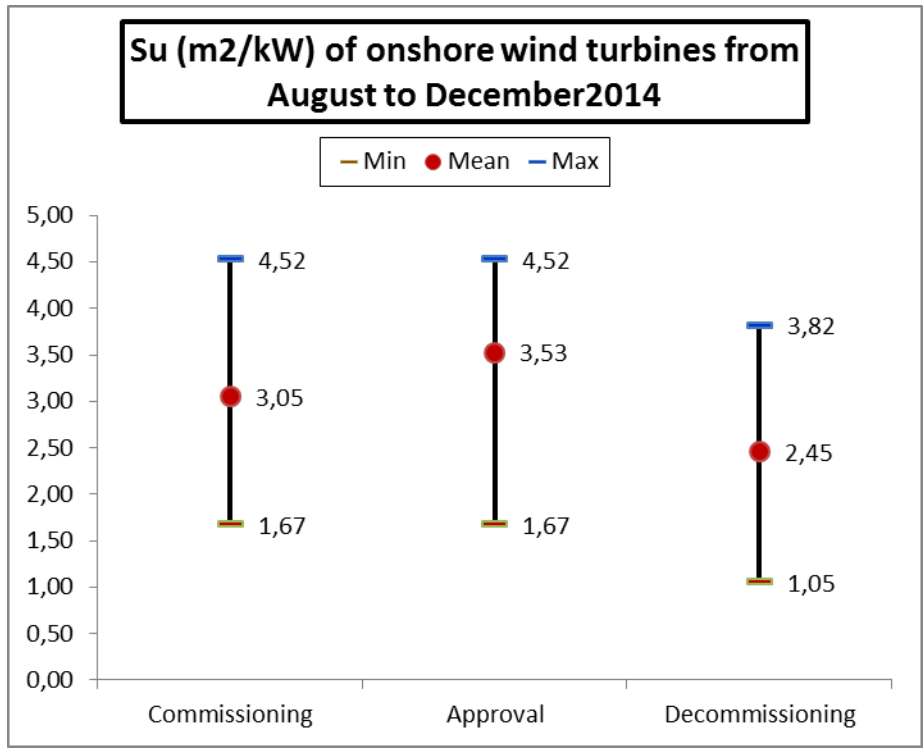
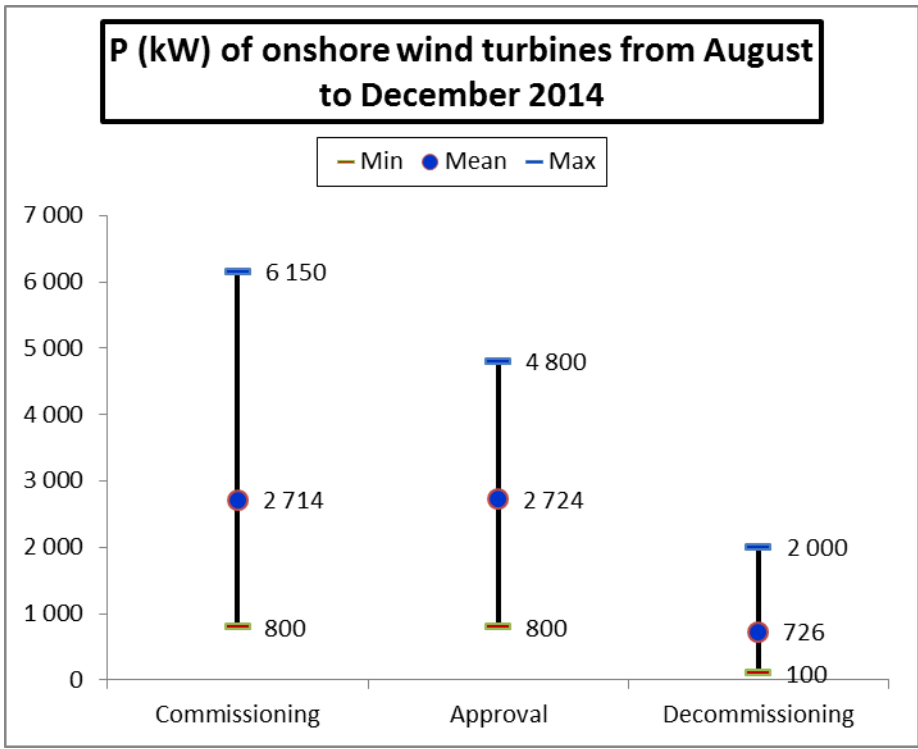
Aug - Dec 2014	P (kW)	D (m)	S (m ²)	Su (m ² /kW)	Ps (W/m ²)	H hub (m)
Total	1 130 630		3 946 607			
Maxi	4 800	131	13 478	4,524	598	149
Average	2 724	109	9 510	3,526	299	126
Mini	800	53	2 198	1,673	221	59

Decommissioning from August to December 2014 of 240 WT selected onshore wind turbines installed from 11/1/1990 to 30/4/2004. Total 174 MW, decommissioned after 10 to 25 years of operation (average 17.7 years)

Aug-Dec 2014	P (kW)	D (m)	S (m ²)	Su (m ² /kW)	Ps (W/m ²)	H hub (m)
Total	174 175		3 959			
Maxi	2 000	71,0	1 682	3,817	955	78
Average	726	44,0	154	2,454	418	53
Mini	100	14,0	154	1,047	262	0

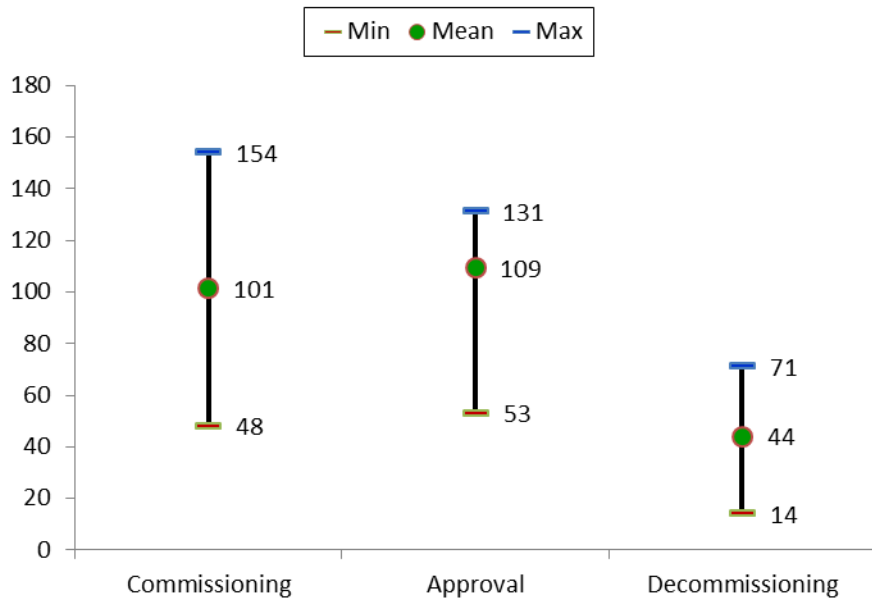
Number of years of operation	
Maxi	24,90
Average	17,73
Median	17,25
Mini	10,26

There is a clear shift towards larger S_u (m^2/kW) ratios from commissioned to approved wind turbines (an increase of mean value of +16 %), leading to a very small increase in average power from wind turbines

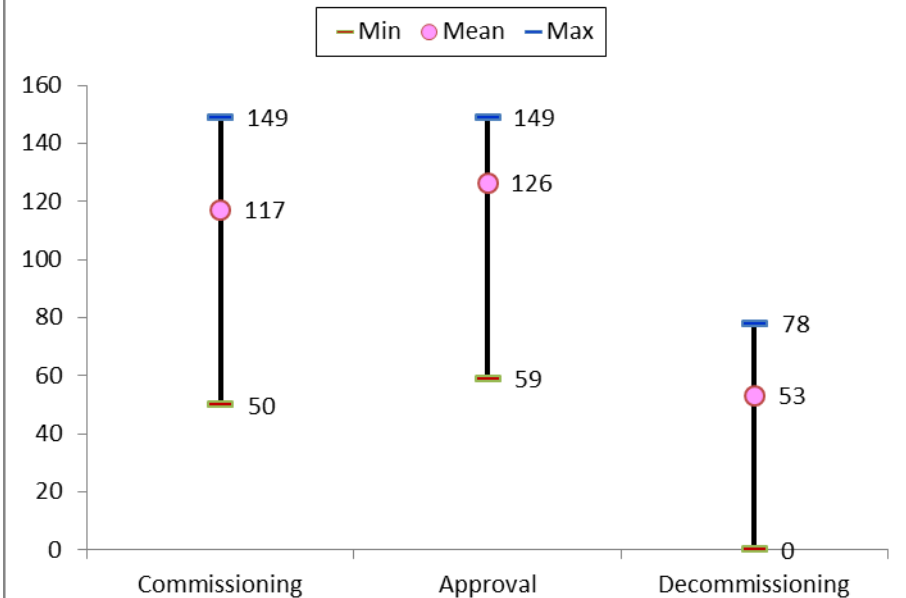


There is an increase in average and minimum values of the diameter and the hub height from commissioned to approved wind turbines

D (m) of onshore wind turbines from August to December 2014



H hub (m) of onshore wind turbines from August to December 2014



**Commissioning of 86 offshore wind turbines from August to November 2014.
Total 320 MW**

Offshore 8-12/2014	P (kW)	D (m)	S (m ²)	Su (m ² /kW)	Ps (W/m ²)	H hub (m)
Total	320 700		971 992			
Maxi	6 150	126	12 469	3,142	493	96,5
Average	3 729	120	11 302	3,064	330	89,0
Mini	3 600	116	10 568	2,027	318	87,0

Wind power in Germany and in EU in 2014

Germany was N°1 in 2014 in EU for installed wind power and new power with annual growth rates of 14.3 % and 63 % and represented 30 % of EU installed power and 45 % of new capacity. Data from EWEA

Rank	Country	MW at end 2014	%MW at end 2014	Cumul. %MW	%change 2014/2013
1	Germany	39 165,0	30,4%	30,4%	14,3%
2	Spain	22 986,5	17,9%	48,3%	0,1%
3	UK	12 440,3	9,7%	57,9%	16,1%
4	France	9 285,0	7,2%	65,1%	12,6%
5	Italy	8 662,9	6,7%	71,9%	1,2%
6	Sweden	5 424,8	4,2%	76,1%	23,8%
7	Portugal	4 914,4	3,8%	79,9%	3,9%
8	Denmark	4 845,0	3,8%	83,7%	0,8%
9	Poland	3 833,8	3,0%	86,6%	13,1%
10	Romania	2 953,6	2,3%	88,9%	13,6%
11	Netherlands	2 805,0	2,2%	91,1%	5,0%
12	Ireland	2 271,7	1,8%	92,9%	10,9%
13	Austria	2 095,0	1,6%	94,5%	24,4%
14	Greece	1 979,8	1,5%	96,0%	6,1%
15	Belgium	1 959,0	1,5%	97,6%	17,6%
16	Bulgaria	690,5	0,5%	98,1%	1,4%
17	Finland	627,0	0,5%	98,6%	39,6%
18	Croatia	346,5	0,3%	98,9%	32,9%
19	Hungary	329,2	0,3%	99,1%	0,0%
20	Estonia	302,7	0,2%	99,4%	8,1%
21	Czech Rep.	281,5	0,2%	99,6%	5,0%
22	Lithuania	279,3	0,2%	99,8%	0,2%
23	Cyprus	146,7	0,1%	99,9%	0,0%
24	Latvia	61,8	0,0%	99,9%	0,0%
25	Luxembourg	58,3	0,0%	100,0%	0,0%
26	Slovenia	3,2	0,0%	100,0%	39,1%
27	Slovakia	3,1	0,0%	100,0%	0,0%
28	Malta	0,0		100,0%	

Rank	Country	dMW 2014	%dMW 14	Cumul. %dMW	%change 2014/2013
1	Germany	5 279,2	44,8%	44,8%	63,0%
2	UK	1 736,4	14,7%	59,5%	-16,3%
3	Sweden	1 050,2	8,9%	68,4%	52,4%
4	France	1 042,0	8,8%	77,2%	65,4%
5	Poland	444,3	3,8%	81,0%	-50,3%
6	Austria	411,2	3,5%	84,5%	33,3%
7	Romania	354,0	3,0%	87,5%	-49,0%
8	Belgium	293,5	2,5%	90,0%	6,5%
9	Ireland	222,4	1,9%	91,9%	-35,3%
10	Finland	184,0	1,6%	93,4%	12,7%
11	Portugal	184,0	1,6%	95,0%	-8,0%
12	Netherlands	141,0	1,2%	96,2%	-52,2%
13	Greece	113,9	1,0%	97,2%	-2,0%
14	Italy	107,5	0,9%	98,1%	-75,4%
15	Croatia	85,7	0,7%	98,8%	5,5%
16	Denmark	67,0	0,6%	99,4%	-90,4%
17	Spain	27,5	0,2%	99,6%	-84,3%
18	Estonia	22,8	0,2%	99,8%	117,1%
19	Czech Rep.	14,0	0,1%	99,9%	75,0%
20	Bulgaria	9,4	0,1%	100,0%	32,4%
21	Slovenia	0,9	0,0%		-60,9%
22	Lithuania	0,5	0,0%		-96,9%
23	Hungary	0,0	0,0%		
24	Cyprus	0,0	0,0%		
25	Latvia	0,0	0,0%		
26	Luxembourg	0,0	0,0%		
27	Slovakia	0,0	0,0%		
28	Malta	0,0	0,0%		

Wind Power	MW end 2014	% change	dMW 2014	% change
Total EU 28	128 752	9,7%	11 791	3,8%

From provisional data on wind power production in 2013 provided by ENTSO-E , Germany was 2nd wind energy producer, but with a capacity factor of only around 18 % (full-load hours Nh = 1,557 h/year)

Rank	Country	GWh 2013	%GWh in 2013	Cumul. % of GWh
1	Spain	54 709,0	24,9%	24,9%
2	Germany	50 782,0	23,1%	48,1%
3	UK	18 027,0	8,2%	56,3%
4	France	15 839,0	7,2%	63,5%
5	Italy	14 821,0	6,8%	70,2%
6	Portugal	11 749,0	5,4%	75,6%
7	Denmark	11 029,0	5,0%	80,6%
8	Sweden	9 891,0	4,5%	85,1%
9	Poland	5 689,0	2,6%	87,7%
10	Netherlands	5 574,0	2,5%	90,3%
11	Romania	4 597,0	2,1%	92,4%
12	Ireland	4 550,0	2,1%	94,4%
13	Belgium	3 563,0	1,6%	96,0%
14	Greece	3 392,0	1,5%	97,6%
15	Bulgaria	1 260,0	0,6%	98,2%
16	Finland	774,0	0,4%	98,5%
17	Hungary	694,0	0,3%	98,8%
18	Lithuania	600,0	0,3%	99,1%
19	Estonia	553,0	0,3%	99,4%
20	Croatia	494,0	0,2%	99,6%
21	Czech Rep.	475,0	0,2%	99,8%
22	Cyprus	228,0	0,1%	99,9%
23	Latvia	120,0	0,1%	100,0%
24	Luxembourg	80,0	0,0%	100,0%
25	Slovakia	2,0	0,0%	100,0%
26	Malta	0,0	0,0%	100,0%
27	Austria	na	na	na
28	Slovenia	na	na	na

Rank	Country	MW mid 2013	GWh 2013	Nh 2013 h/y	CF 2013 %
1	Belgium	1 330,8	3 563	2 677	30,6%
2	Portugal	4 629,7	11 749	2 538	29,0%
3	Sweden	3 981,8	9 891	2 484	28,4%
4	Denmark	4 484,5	11 029	2 459	28,1%
5	Ireland	1 899,2	4 550	2 396	27,3%
6	Spain	22 871,6	54 709	2 392	27,3%
7	Croatia	220,4	494	2 241	25,6%
8	Lithuania	270,9	600	2 215	25,3%
9	Netherlands	2 531,0	5 574	2 202	25,1%
10	Hungary	329,1	694	2 109	24,1%
11	Finland	368,5	774	2 100	24,0%
12	Romania	2 252,3	4 597	2 041	23,3%
13	Estonia	274,5	553	2 015	23,0%
14	France	7 933,0	15 839	1 997	22,8%
15	Latvia	60,9	120	1 970	22,5%
16	Poland	2 942,8	5 689	1 933	22,1%
17	Greece	1 807,5	3 392	1 877	21,4%
18	UK	9 680,0	18 027	1 862	21,3%
19	Bulgaria	677,6	1 260	1 860	21,2%
20	Czech Rep.	264,1	475	1 799	20,5%
21	Italy	8 338,0	14 821	1 778	20,3%
22	Germany	32 619,6	50 782	1 557	17,8%
23	Cyprus	146,9	228	1 553	17,7%
24	Luxembourg	58,2	80	1 376	15,7%
25	Slovakia	3,1	2	ns	7,5%
26	Malta	0,0	0	0	0,0%
27	Austria	1 530,4	na	na	na
28	Slovenia	1,2	na	na	na

Wind Power	MW mid 2013	GWh 2013	Nh 2013	CF 2013
Total EU 28	111 507	219 492	1 968	22,5%

Onshore wind power development in Germany

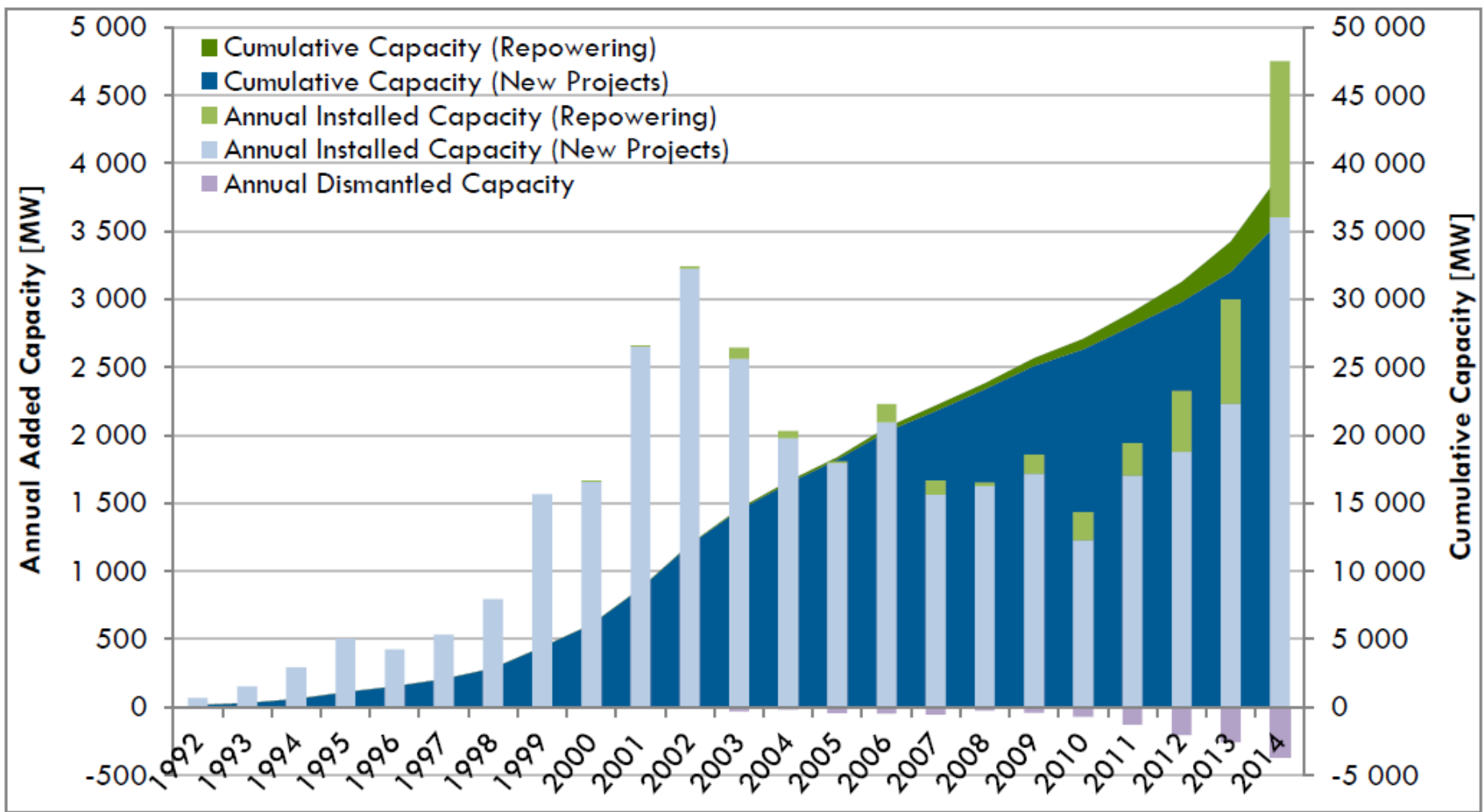


Figure 1: Development of the Annual Installed and Cumulative Capacity (MW) of Land-Based Wind Energy in Germany incl. Repowering and Dismantling, Status: 31st December 2014

Source: "2014 Status of land-based wind energy development in Germany", Deutsche Windguard on behalf of BWE and VDMA

Offshore Wind power in Germany and in EU in 2014

Rank	Country	MW	% of total	Cum. %	N turbines	kW/turbine
1	UK	4 494	55,9%	55,9%	1 301	3 454
2	Denmark	1 271	15,8%	71,7%	513	2 478
3 →	Germany	1 049	13,0%	84,7%	258	4 066
4	Belgium	712	8,9%	93,6%	182	3 912
5	Netherlands	247	3,1%	96,7%	124	1 992
6	Sweden	212	2,6%	99,3%	91	2 330
7	Finland	26	0,3%	99,6%	9	2 889
8	Ireland	25	0,3%	99,9%	7	3 571
9	Spain	5	0,1%	100,0%	1	5 000
10	Portugal	2	0,0%	100,0%	1	2 000
	Total EU 28	8 041	100,0%	100,0%	2 486	3 235

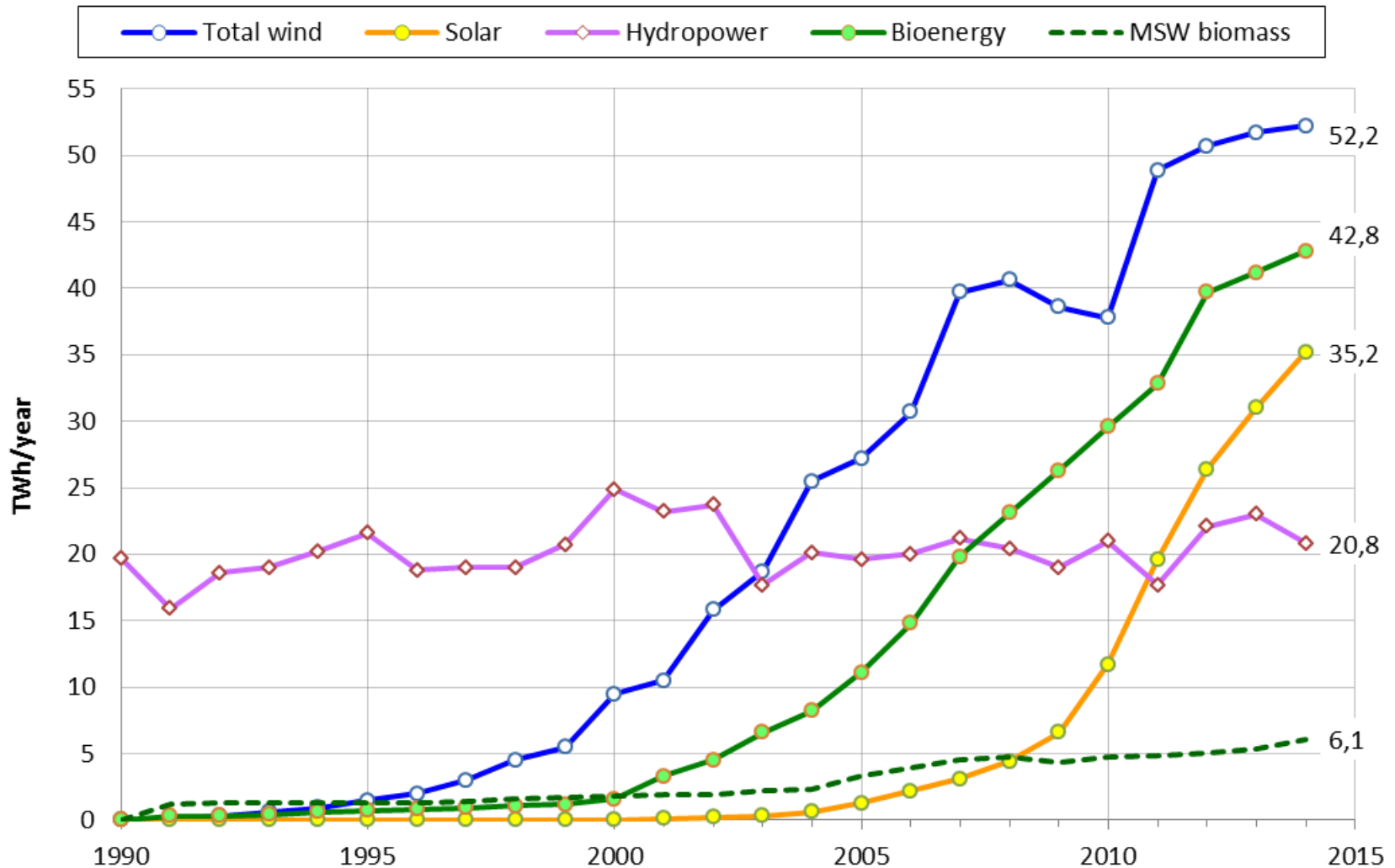
**Wind power contribution
within electricity from
renewables in Germany on
1990-2014**

Wind power contribution is the higher within renewables. With 1.2 TWh in 2014 from 1 GW, offshore wind production was only 2.3 % of total wind energy

Electricity from Renewables in Germany(TWh/year)

Total 2014: 157.4 TWh; 27.3 % of demand; 25.3 % of production.

Data from AGEB, december 12, 2014

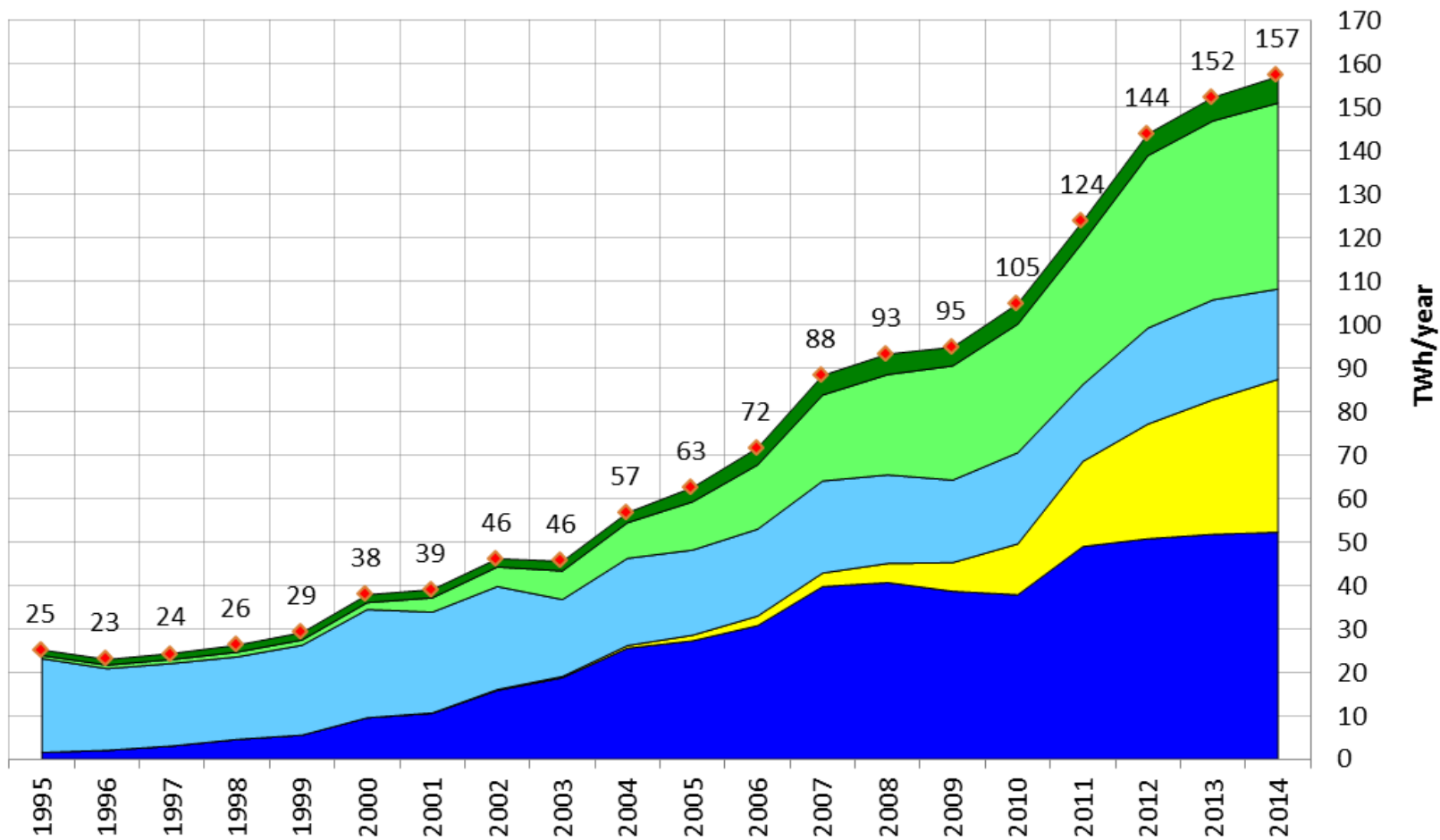


Renewable electricity production (157TWh) is 3.5 times more than in 2003 and 2014 wind power production has nearly doubled in ten years

Electricity from renewables (TWh/year)

Total 2014: 157.4 TWh; 27.3 % of demand; 25.3 % of production. Data from AGEB, dec. 12, 2014

■ Total wind ■ Solar ■ Hydropower ■ Bioenergy ■ MSW biomass ◆ Total RE

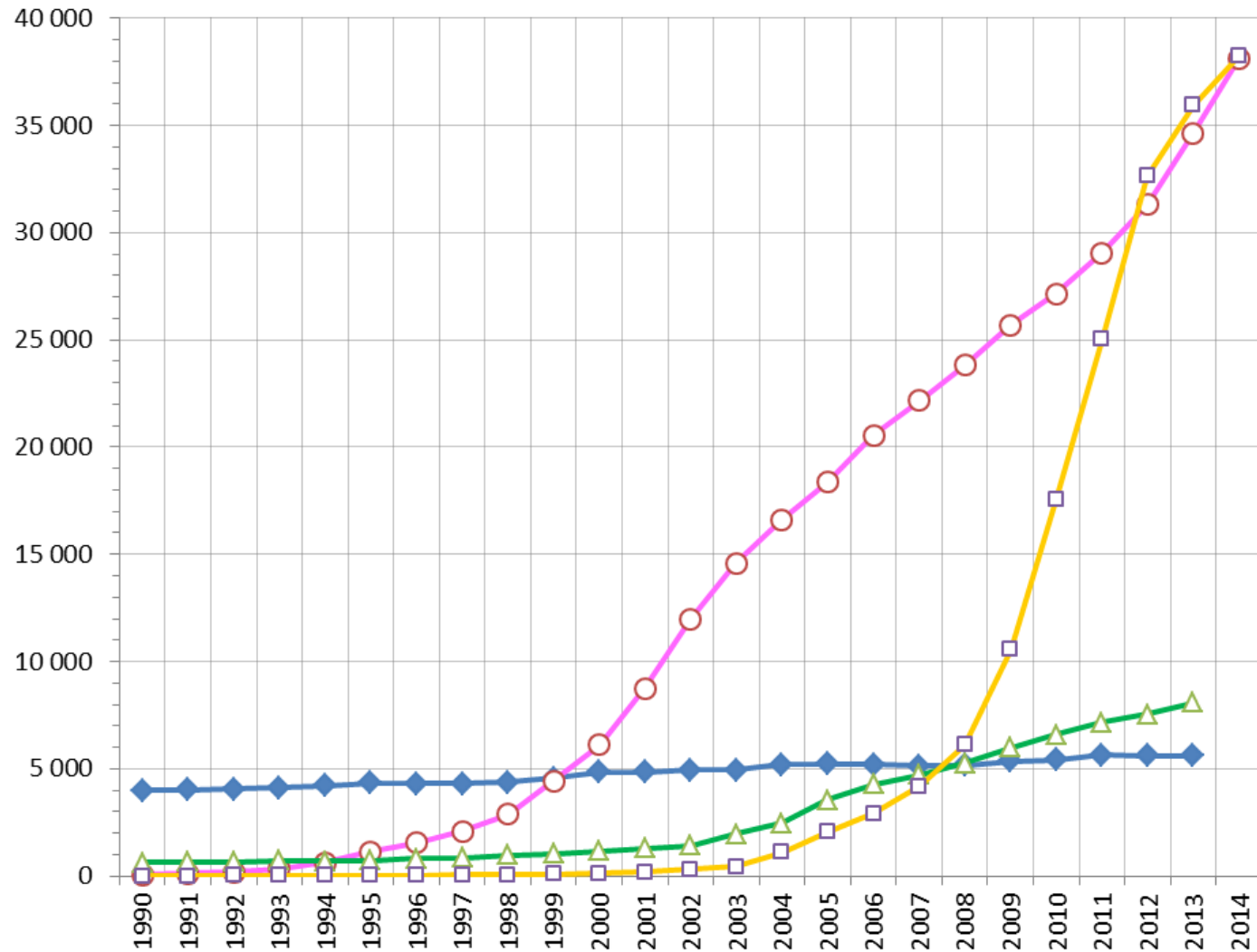


Renewable power in operation at the end of year (MW)

RE installed power in Germany (MW)

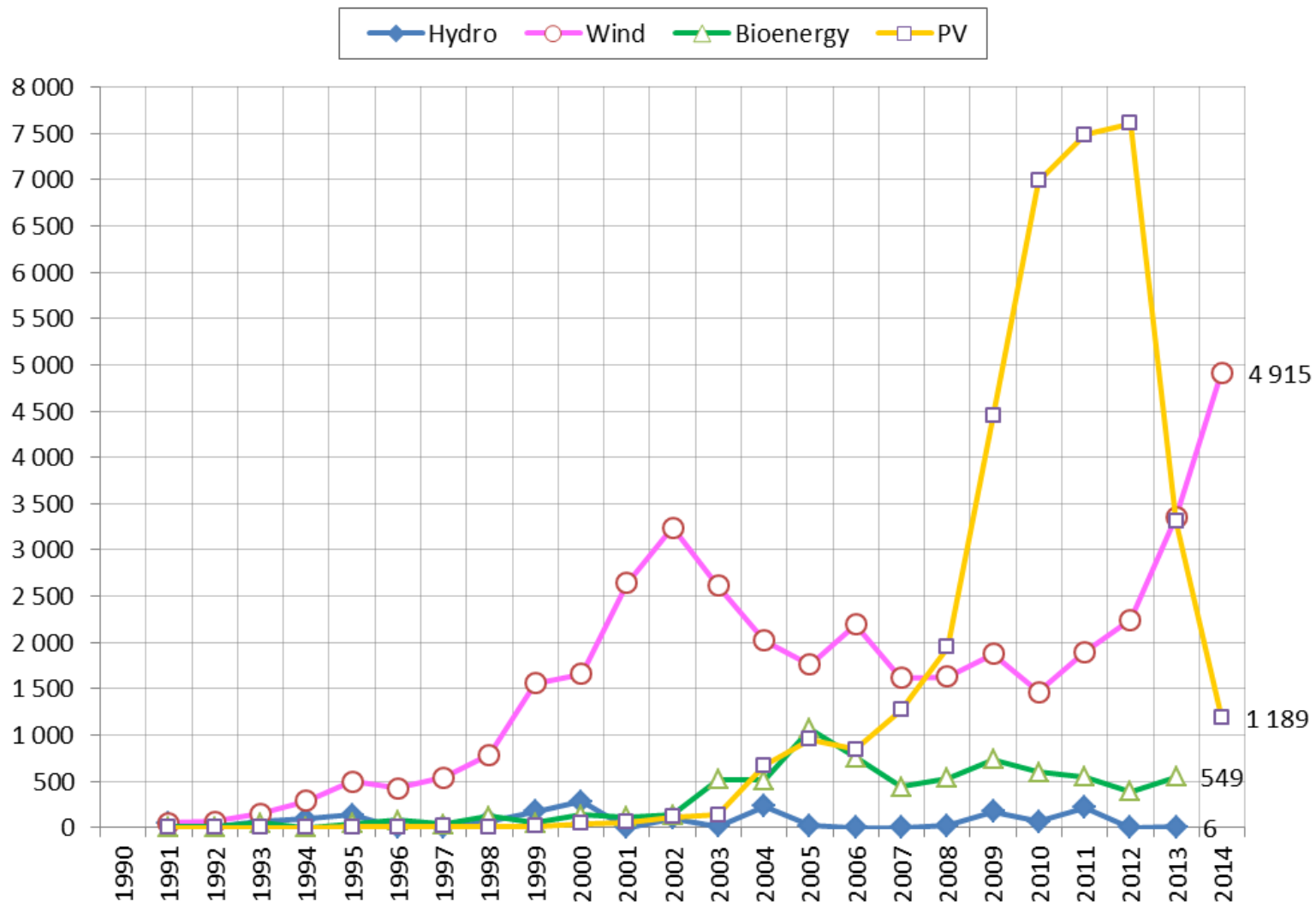
Source of data: AGEE-Stat. Total end 2013: 84.3 GWe

Hydro Wind Bioenergy PV



Net wind power changes in 2014 were + 4,386 MW onshore (+ 4,750 new and - 364 dismantled) and + 529 MW offshore (source: Deutsche Windguard)

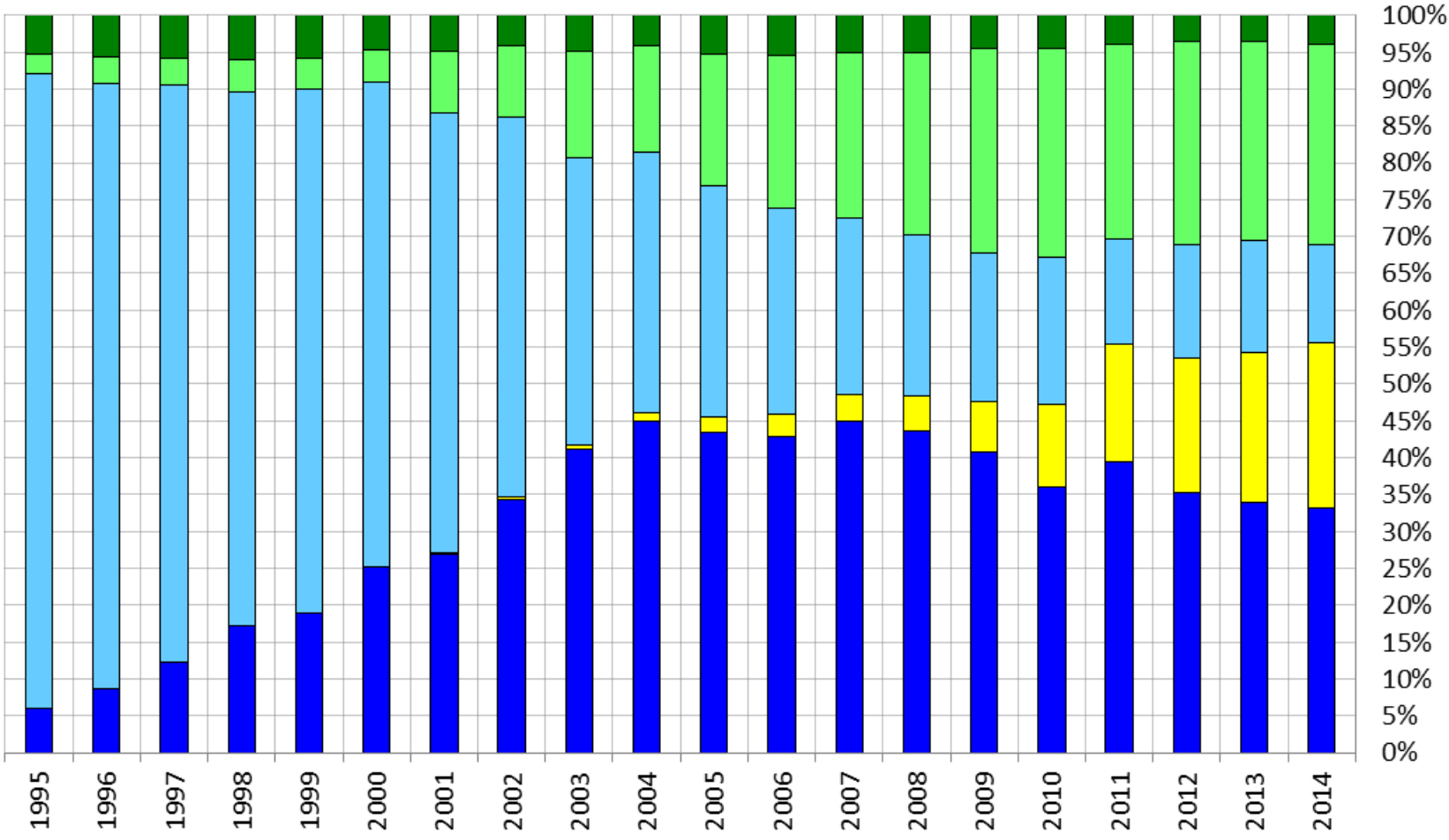
Net RE installed power per year in Germany (MW/year)
 Source of data: AGEE-Stat, EWEA, BNETZA. Total in 2013: 7,235 MW



Share of variable but predictable production from [Wind + PV] is now 55 % of the total renewable share of electricity production of 27.3 % in 2014

Share of electricity from renewables (%)
 Total 2014: 157.4 TWh; 27.3 % of demand; 25.3 % of production.
 Data from AGEB, december 12, 2014

■ Total wind ■ Solar ■ Hydropower ■ Bioenergy ■ MSW biomass



Renewables production is now higher than from lignite, coal, gas, nuclear and the decrease in nuclear and gas is compensated by renewables and not lignite and coal

Electricity production in Germany(TWh/year)

Total production 2014: 610 TWh. Total demand: 577 TWh.

Data from AGEB, december 12, 2014

