

CHAPTER TWO

GLOBAL STATUS OF WIND POWER IN 2017





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The global wind power market remained above 50 GW in 2017, with Europe, India and the offshore sector having record years. Chinese installations were down - 19.66 GW - but the rest of the world made up for most of that. Total installations in 2017 were 52,492 MW, bringing the global total to 539,123 MW. The annual market was in fact down 3.8% on 2016's 54,642 MW; and the cumulative total is up 11% over 2016's year-end total of 487,279 MW.

The offshore segment had a record year with 4,334 MW of installations, an 87% increase on the 2016 market, bringing total global installations to 18,814 MW, and representing a 30% increase in cumulative capacity. Offshore is still only about 8% of the global annual market, and represents about 3.5% of cumulative installed capacity, but it's growing quickly.

Beyond the statistics, however, is the fact that wind power is in a rapid transition to becoming a fully commercialized, unsubsidized technology; successfully competing in the marketplace against heavily subsidized fossil and nuclear incumbents. The transition to fully commercial market-based operation has meant that the industry is going through a period of adjustment and consolidation. Also, some governments have left 'gaps' in the transition. The global 2017

numbers reflect that, as will installations in 2018.

Total new investment in clean energy rose to US\$ 333.5bn (€ 296.8bn¹) in 2017, up 3% over 2016, but still lower than the record investment of US\$ 348.5bn (€ 324.6bn) in 2015. According to BNEF, China alone accounted for 40% of total investment with US\$ 133bn (€ 118.7bn); and the Asia Pacific region as a whole invested US\$ 187 billion, over 57% of the total. Total investment in wind amounted to 107 billion US\$.²

Cratering prices for both onshore and offshore wind continue to surprise. Markets in such diverse locations as Morocco, India, Mexico and Canada range in the area of US\$ 0.03/kWh, with a recent Mexican tender coming in with prices below US\$ 0.02. Meanwhile, offshore wind had its first 'subsidy-free' bids in a tender in Germany last year, with tenders for more than 1 GW of new offshore capacity receiving no more than the wholesale price of electricity. Overall, offshore prices for projects to be completed in the next 5 years or so are half of what they were for the last five years; and this trend is likely to continue.

¹ Exchange rate used for USD to EUR conversion (USD1 = EUR 0.89)
² <https://data.bloomberglp.com/bnef/sites/14/2018/01/BNEF-Clean-Energy-Investment-Investment-Trends-2017.pdf>

GLOBAL INSTALLED WIND POWER CAPACITY (MW) – REGIONAL DISTRIBUTION

	End 2016	New 2017	Total 2017
AFRICA & MIDDLE EAST			
South Africa	1,467	618	2,085
Egypt	810	-	810
Morocco	787	-	787
Ethiopia	324	-	324
Tunisia	245	-	245
Jordan	119	-	119
Other ¹	159	-	159
Total	3,911	618	4,528
ASIA			
PR China	168,732	19,660	188,392
India	28,700	4,148	32,848
Japan	3,230	177	3,400
South Korea	1,031	106	1,136
Pakistan	590	199	789
Taiwan	682	10	692
Thailand	609	24	633
Philippines	427	-	427
Vietnam	159	38	197
Mongolia	50	50	100
Other ²	70	-	70
Total	204,281	24,412	228,684
EUROPE			
Germany	50,019	6,581	56,132
Spain	23,075	96	23,170
UK	14,602	4,270	18,872
France	12,065	1,694	13,759
Italy	9,227	252	9,479
Turkey	6,091	766	6,857
Sweden	6,494	197	6,691
Poland	5,807	41	5,848
Denmark	5,230	342	5,476
Portugal	5,316	-	5,316
Netherlands	4,328	81	4,341
Ireland	2,701	426	3,127
Romania	3,024	5	3,029
Belgium	2,378	467	2,843
Austria	2,632	196	2,828
Finland	1,539	535	2,071
Rest of EU	5,294	455	5,745
EU-28 ⁴	153,731	15,638	168,729
Rest of Europe ³	7,612	1,166	8,777
Total Europe	161,342	16,803	177,506
LATIN AMERICA & CARIBBEAN			
Brazil	10,741	2,022	12,763
Chile	1,424	116	1,540
Uruguay	1,210	295	1,505
Costa Rica	319	59	378
Panama	270	-	270
Peru	243	-	243
Argentina	204	24	228
Honduras	180	45	225
Dominican Republic	135	-	135
Caribbean ⁵	200	18	218
Others ⁶	386	-	386
Total	15,312	2,578	17,891
NORTH AMERICA			
USA	82,060	7,017	89,077
Canada	11,898	341	12,239
Mexico	3,527	478	4,005
Total	97,485	7,836	105,321
PACIFIC REGION			
Australia	4,312	245	4,557
New Zealand	623	-	623
Pacific Islands	13	-	13
Total	4,948	244,9	5,193
World total	487,279	52,492	539,123

Source:GWEC

1 Algeria, Cape Verde, Iran, Israel, Kenya, Libya, Mozambique, Nigeria

2 Azerbaijan, Bangladesh, Sri Lanka

3 Belarus, Faroe Islands, FYROM, Iceland, Liechtenstein, Norway, Russia, Switzerland, Serbia, Turkey, Ukraine

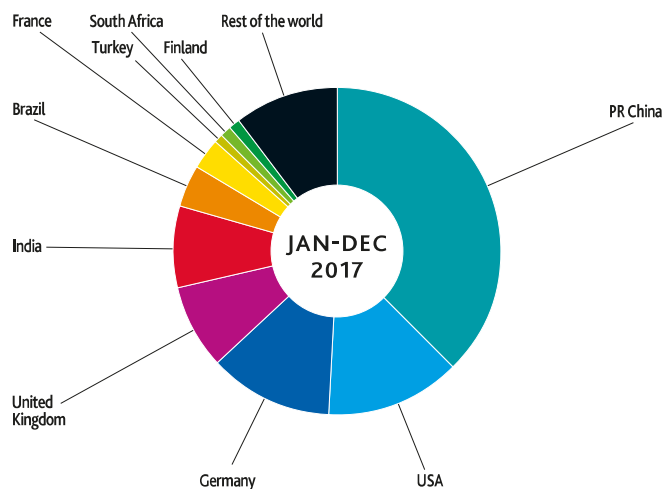
4 Austria, Belgium, Bulgaria, Cyprus, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, UK

5 Caribbean: Aruba, Bonaire, Curacao, Cuba, Dominica, Guadalupe, Jamaica, Martinica, Granada, St. Kitts and Nevis

6 Bolivia, Colombia, Ecuador, Guatemala, Nicaragua, Venezuela

Note: The stats includes a decommissioning of 648.8MW

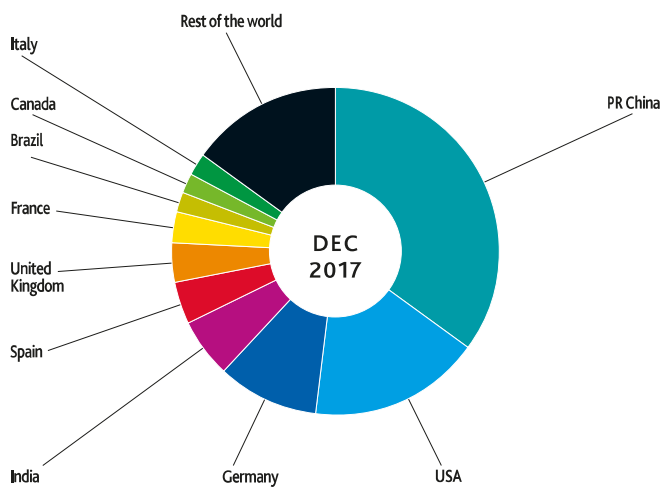
TOP 10 NEW INSTALLED CAPACITY JAN-DEC 2017



Country	MW	% Share
PR China	19,660	37
USA	7,017	13
Germany	6,581	12
United Kingdom	4,270	8
India	4,148	8
Brazil	2,022	4
France	1,694	3
Turkey	766	1
South Africa	618	1
Finland	535	1
Rest of the world	5,182	10
Total TOP 10	47,310	90
World Total	52,492	100

Source: GWEC

TOP 10 CUMULATIVE CAPACITY DEC 2017



Country	MW	% Share
PR China	188,392	35
USA	89,077	17
Germany	56,132	10
India	32,848	6
Spain	23,170	4
United Kingdom	18,872	4
France	13,759	3
Brazil	12,763	2
Canada	12,239	2
Italy	9,479	2
Rest of the world	82,391	15
Total TO P10	456,732	85
World Total	539,123	100

Source: GWEC

The technology continues to improve, opening up many areas for onshore wind development which were previously not commercial.

More sophisticated power electronics, better planning and overall management have contributed to increased reliability as well as price reductions. Offshore, the size of the machines continues to boggle the mind, and we will have 1X MW machines in the not too distant future. Indeed, on 1 March GE announced its long-awaited next-gen design, the 12 MW Haliade-X, with a rotor diameter of 220 m, which could come into commercial operation as early as 2021. It might not be too far into the next decade before we're talking about 2X machines for massive floating offshore installations in the deeper waters of the outer continental shelf.

Today, wind is the most competitively priced technology in many if not most markets; and the emergence of wind/solar hybrids, more sophisticated grid management and increasingly affordable storage begin to paint

a picture of what a fully commercial fossil-free power sector will look like.

China, the largest overall market for wind power since 2009, retained the top spot in 2017. Installations in Asia once again led global markets, with Europe in the second spot, and North America in third.

Once again in 2017, as has been the case since 2010 (except for 2012), the majority of wind installations globally were outside the OECD.

By the end of 2017 there were 30 countries with more than 1,000 MW installed: 18 in Europe; 5 in Asia-Pacific (China, India, Japan, South Korea & Australia); 3 in North America (Canada, Mexico, US), 3 in Latin America (Brazil, Chile, Uruguay) and 1 in Africa (South Africa).

Nine countries have more than 10,000 MW of installed capacity, including China, the US, Germany, India, Spain, the UK, France, Brazil and Canada.



India © Siemens Gamesa

China will cross the 200,000 MW mark in 2018, adding another milestone to its already exceptional history of renewable energy development since 2005.

ASIA: RECORD YEAR FOR INDIA

For the ninth year in a row, Asia was the world's largest regional market for new wind power development, with capacity additions totalling 24.4 GW. China's wind market reached 188 GW by the end of 2017, reinforcing China's lead in terms of cumulative installed wind power capacity.

In terms of annual installations **China** maintained its leadership position, although the annual market dropped about 16% compared to last year, adding 19.7 GW of new capacity.

In 2017, wind power generation reached 305.7 TWh, an increase of more than 26%

compared with 2016, and accounts for about 4.75% of total Chinese power generation.³

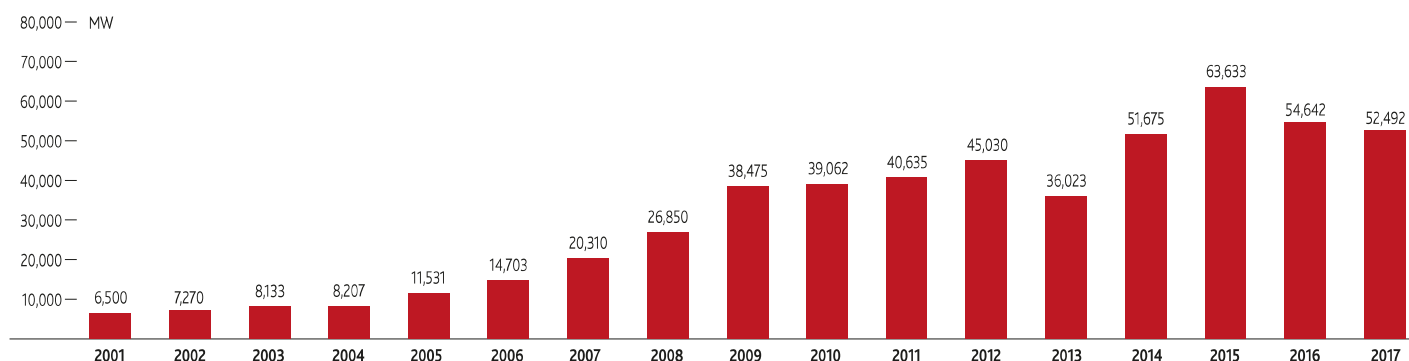
Curtailed on wind farms in China improved substantially in 2017 according to the National Energy Administration (NEA), averaging 12% across the country for the year, down from 17% in 2015.

On-going curtailment of electricity generation is a challenge for wind power projects. However, the NEA and State Grid are working to solve the transmission bottlenecks and other grid issues, and the situation is improving.

India had a record year in 2017, with 4,148 MW being added to the grid, the first time the country has broken 4 GW in a single year, cementing its place as the second largest market in Asia, fifth in 2017 installations, and in solid fourth place in the global cumulative rankings. 2018 will be an off year as the

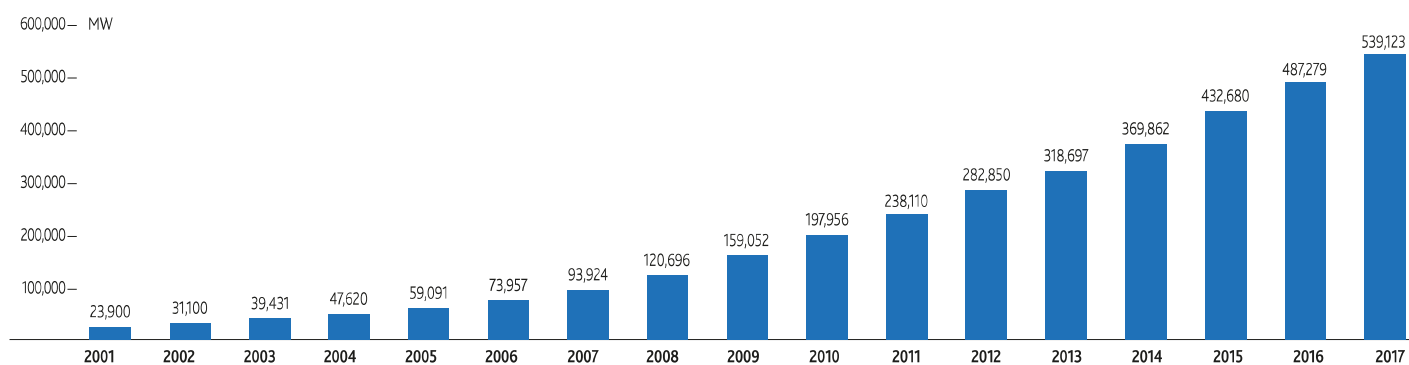
³ <https://chinaenergyportal.org/en/2017-electricity-energy-statistics/>

GLOBAL ANNUAL INSTALLED WIND CAPACITY 2001-2017



Source: GWEC

GLOBAL CUMULATIVE INSTALLED WIND CAPACITY 2001-2017



Source: GWEC

switch from the old regime to an auctioning system has left a 'policy gap'.

However, 2019 and beyond are expected to see a dramatic increase in the Indian market, as the government seeks to meet its targets of 175 GW of renewable capacity by 2022, with 60 GW of that coming from wind. With cumulative installations standing at 32,848 MW at year-end 2017, that will mean an average of about 7 GW/year for the four years following 2018. At the end of this period, we should see the beginnings of an offshore wind sector emerging in the country.

As for the rest of Asia, it's a long way down to third place, occupied by **Pakistan** with 199 MW. **Japan** installed 177 MW for cumulative installations of 3,400 MW, while we continue to wait for the end to the stranglehold on the grid by the vertically integrated utility monopolies. **South Korea** added 106 MW, as we wait to see any effect of the new government's pledge to dramatically increase the country's share of renewables in the power mix, with a presumed focus on the offshore sector.

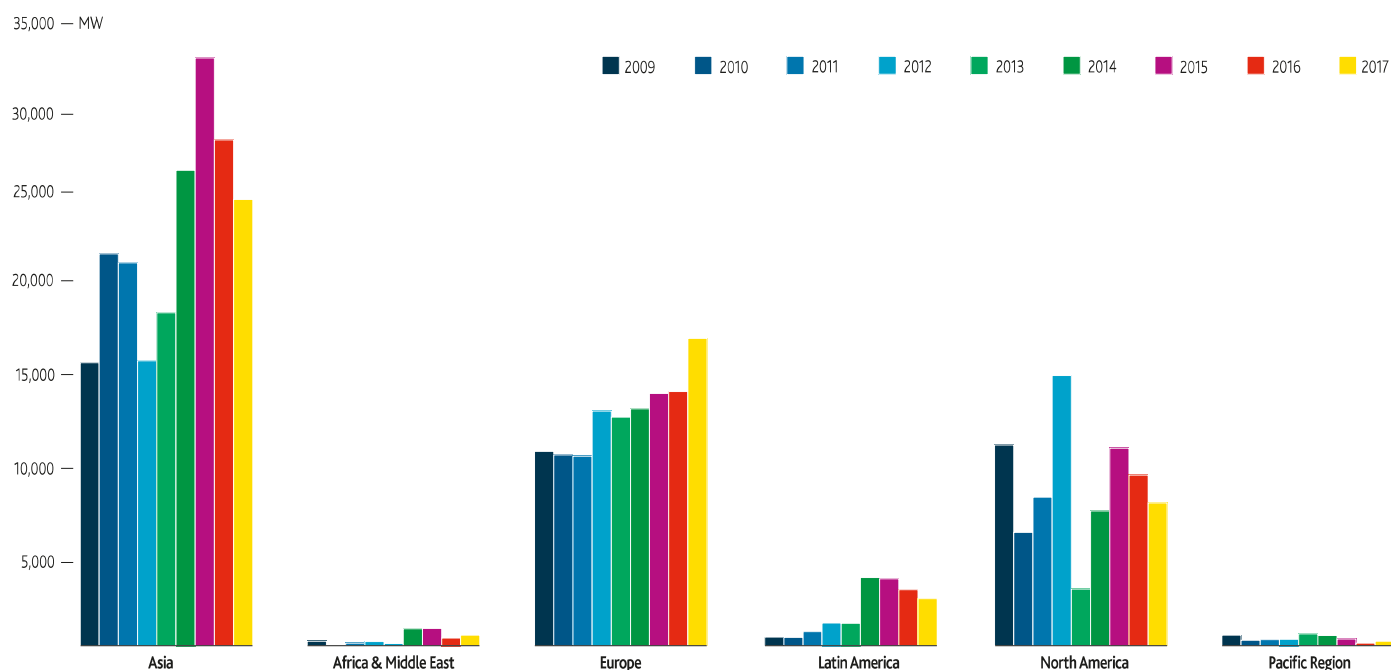
Elsewhere, **Mongolia** commissioned its second 50 MW wind farm, **Vietnam** added 38 MW, **Thailand** 24 MW, and **Taiwan** added just 10 MW as it focuses on its burgeoning offshore sector, which will start to get built out in the next few years.

NORTH AMERICA: STRONG GROWTH CONTINUES IN THE US

The **US** is the second largest market in terms of total installed capacity after China. The US was also second in terms of the annual market, with 7,017 MW of new capacity added in 2017, solidifying wind's position as the number one source of renewable electricity generation capacity in the country. Although the policy environment is relatively stable at the moment, the main driver for the wind industry is economics, with the price of power from new wind installations having dropped 67% since 2009.

Total installed capacity at the end of 2017 was 89,077 MW, and the 250 TWh generated by

ANNUAL INSTALLED CAPACITY BY REGION 2009-2017



	2009	2010	2011	2012	2013	2014	2015	2016	2017
Asia	15,507	21,481	20,981	15,624	18,252	26,058	33,962	27,721	24,412
Africa & Middle East	251	153	8	131	240	934	953	418	618
Europe	10,660	10,466	10,393	12,862	12,524	12,988	13,831	13,926	16,803
Latin America	471	459	771	1,248	1,240	3,744	3,678	3,078	2,578
North America	11,008	6,208	8,137	14,807	3,112	7,382	10,829	9,359	7,836
Pacific Region	578	294	345	358	655	568	381	140	245

Source: GWEC

the fleet represented 6.3% of total US power production, up from 5.5% in 2016⁴.

Texas leads all states with 22,637 MW of wind power at the end of 2017, followed by Oklahoma (7,495 MW), Iowa (7,308 MW), California (5,609 MW), Kansas (5,110 MW), Illinois (4,332 MW), Minnesota (3,699 MW), Oregon (3,213 MW), Colorado (3,104 MW) and Washington (3,075). Of the forty-one US states with commercial wind operations, 18 have more than 1,000 MW. Iowa leads all states in terms of penetration, getting 36% of its electricity from wind power.

In **Canada** just 10 new projects totalling 341 MW of new wind capacity came online in 2017, Canada's lowest total in many years. Canada's total installations are just over 12.2 GW, making it the ninth largest market in terms of cumulative installations; delivering 6% of the country's electricity, enough to supply 3 million Canadian homes.

The big news, however, was the result of a tender in Alberta in December, where 600 MW of new wind power was procured at the very low price of CDN\$ 37/MWh (€ 0.023/kWh; or \$ 0.028/kWh), setting a new benchmark for a second auction expected in Alberta in 2018, as well as one in Saskatchewan.

There are now 295 wind farms made up of over 6,400 wind turbines operating in Canada, bringing economic development and diversification to rural communities through land lease income, property tax payments, ownership revenue and community benefits agreements.

Mexico installed 478 MW of new capacity to reach a total of 4,005 MW by the end of 2017, supplying about 4% of the country's electricity. Mexico's Energy Reform has introduced tendering for wind power and other renewables, the latest of which resulted in the record low price of US\$ 0.017/kWh for one project.

⁴ <https://www.eia.gov/tools/faqs/faq.php?id=427&t=3>



Finland © H. Holttinen

In addition to wind farms procured through the tendering process, new regulations were implemented in 2017 which set out rules for direct purchase of wind power by private/corporate consumers, giving developers an alternative to the highly competitive auctions.

Expectations for 2018 are for a market exceeding 1,000 MW for the first time, as the newly tendered projects get built out, with installations expected to rapidly increase in subsequent years in pursuit of Mexico's target of 35% clean electricity by 2024.

EUROPE: NEW RECORDS ABOUND

Both the EU and Europe as a whole set new records in 2017, with new record high installations for the offshore sector, as well as in Germany, the UK, France, Belgium, Ireland

and Croatia. 15.6 GW (16.8 GW in Europe) of new wind power capacity was installed in the EU during 2017; 3,148 MW of that was offshore. Annual onshore installations increased by 14%, while offshore installations doubled. Overall, the volume of new installations was up 25% on the 2016 market.

In 2017, **Germany** led all markets with 6,581 MW (a 15% increase on 2016); 19% (1,247 MW) of Germany's installed capacity was offshore. The **UK** was second with 4,270 MW, five times more than installations in 2016, with more than a third (1,680 MW) offshore. **France** came third with 1,694 MW (9% growth on the previous year).

Finland just missed setting a new record with 535 MW, but new highs were set in **Belgium** (467 MW) and **Ireland** (426 MW). In total, 17 countries saw some new installations

last year, down from 20 countries in 2016, reflecting a worrying concentration of the market in fewer countries, with 80% of the total new installations in just three countries.

The new cumulative total at the end of 2017 for the European Union is 168.7 GW (177.5 GW in Europe as a whole) of wind power capacity, 153 GW onshore and 15.8 GW offshore, making wind energy second only to gas in the European market. Germany retains the number one spot with a cumulative total of 56.1 GW, followed by Spain (23.2 GW), the UK (18.9 GW), France (13.8 GW) and Italy (9.5 GW). Sweden, Poland, Portugal and Denmark (and non-EU member Turkey) have more than 5 GW installed. An additional seven countries have more than 1 GW: Austria, Belgium, Finland, Greece, Ireland, the Netherlands and Romania.

In total, wind energy generated about 336 TWh in 2017, representing about 11.6% of the EU's electricity demand, supporting more than 260,000 jobs and attracting € 36.1 billion in investments.

As in many other parts of the world, the European wind industry is in a period of transition from the old support schemes to one based on competitive tendering of one form or another. While this is a healthy development for the sector as a whole, there are a number of issues, key among them being the 'policy gaps' created in the transition, where developers and manufacturers lay idle while the industry and regulators adapt to the new system.

For these reasons, as well as anticipated dips in the markets in Germany in the UK, EU installations are expected to be down a bit in 2018, including in offshore. However, 2019 will see a major rebound in offshore installations, as well as a major surge in the Spanish market due to the buildout of projects awarded in 2017's tenders.

Uncertainty remains about the post-2020 environment for the climate and energy question in Europe, as EU institutions continue to struggle over the legislative package which will set the framework for European energy policy over the next decade. However, final agreement on the package is expected during the course of 2018. While there has been some movement to 'fix' the

European emissions trading scheme, it is still not at a level which will drive investment away from carbon-intensive generation.

LATIN AMERICA AND THE CARIBBEAN: BRAZIL CONTINUES TO LEAD

For the second year in a row, installations in the Latin America and Caribbean region dropped, from 3,078 MW in 2016, to 2,578 MW in 2017, bringing cumulative capacity up to 17,891 MW. However, it is expected that the market will pick up again in 2018 due to new installations in Argentina.

Despite the hiatus in tenders for new capacity, **Brazil** once again dominated the market, with its 2,022 MW accounting for more than three quarters of the installations in the region. Brazil's total at year end 2017 was 12,763 MW, and it has subsequently passed 13 GW. Although 1.4 GW was procured in tenders late in 2017, there will be a slowdown in the coming years as the 2-year drought in auctions works its way through the system, although some of this may be made up by the private market.

Uruguay installed 295 MW in 2017, nearly completing the build-out of its wind sector – one more plant has come on line in 2018, and that will be it until overall circumstances change. With its cumulative capacity of 1,505 MW of wind, Uruguay is now very nearly 100% renewable in the electricity sector with somewhere between 35 and 40% coming from wind.

Chile added 116 MW to bring total capacity up to 1,540 MW; and **Costa Rica** added 59 MW for a total cumulative installed capacity of 378 MW. **Honduras** added 45 MW for a total of 225 MW, and **Argentina** added just 24 MW, but that is just the calm before the rapid buildout of its nearly 3 GW pipeline over the coming few years.

Overall prospects for the region going forward are excellent. With Brazil's economic recovery, the industry is back on track towards the minimum 2 GW/year market necessary to maintain its supply chain. Argentina is set to boom in the coming years, and in addition to substantial build-out in Chile due to recent tenders, and some of the smaller Central American and Caribbean states, there are stirrings of a potentially substantial new market in Colombia.

PACIFIC

The region saw its total installed capacity rise to 5,193 MW last year, on the strength of the **Australian** market's addition of 245 MW. Australia's cumulative capacity now stands at 4,557 MW.

New Zealand and the rest of the Pacific did not add any new wind power capacity in 2017.

AFRICA AND THE MIDDLE EAST

While there was a lot of activity in Africa and the Middle East in 2017, the only installations were in South Africa, bringing the regional total up to 4,528 MW. **South Africa** installed 618 MW of new capacity, for a cumulative total of 2,085 MW.

We can look forward to a much more diverse 2018, with Kenya's Lake Turkana project finally slated to come on line this year, and the build-out of 2016's tenders in Morocco are expected to be largely completed during the course of the year. In addition, we may see the first construction in Egypt since 2015. Finally, of course, we are expecting big things from Saudi Arabia's new programme, but how much that will yield, and when, only time will tell.

The big news however, was the pledge by the new South African government to honour the tenders from 2015/2016. Having fought off a last-minute court challenge, on 4 April the new Minister of Energy presided over the signing of the outstanding PPAs, including for more than 1.3 GW of wind energy. We expect the return of the South African market to full health in the coming year.

At the end of 2017, over 99% of the region's total wind installations were spread across ten countries – South Africa, Morocco (787 MW), Egypt (810 MW), Tunisia (245 MW), Ethiopia (324 MW), Jordan (119 MW), Iran (91 MW), Cape Verde (24 MW), Kenya (26 MW), Algeria (10 MW) and Israel (6.25 MW).

2017: A TRANSITION YEAR

In 2017, the global wind industry continued with installations above 50 GW. After five years of essentially flat markets from 2009-2013 due to the global financial crisis, installations crossed the 50 GW mark in 2014



mark, and have stayed over 50 GW for the last four years, with the anomalous Chinese market in 2015 pushing the total over 60 GW. Globally, cumulative installations passed 500 GW in 2017, ending the year at about 540 GW.

Wind power is increasingly the most competitive way of adding new power generation to the grid in an increasing number of markets, even competing against heavily subsidized incumbents; and for the first time we can say that this now includes offshore, with 'subsidy-free' winning bids in Germany's offshore auction in 2017, followed by a Dutch 'subsidy-free' tender, which has just (20 March) been awarded for two projects to be built out by 2022.

Wind is a mature technology, with proven reliability and cost competitiveness. It is more



Blade transportation © Siemens Gamesa

and more often the technology of choice for utilities, and has also dominated the surging corporate PPA market, where savvy companies look to both provide a hedge against potentially wildly fluctuating fossil prices, and at the same time reduce their carbon footprint – not to mention ‘greening’ their image with increasingly vigilant consumers.

Wind is making a rapid transition from a technology reliant on ‘support’ in most markets, to one where it stands on its own economically, even without any kind of financial benefit for the major rewards society reaps from its deployment in terms of clean air and carbon-dioxide emissions reductions. Hopefully we’ll get there one day. But in the meantime, the industry will have to struggle with shifting policy regimes and the inevitable gaps that accompany them and do our best to

take it to the next level – annual installations of 60, 70, or even 100 GW/year. This will be necessary to meet the Paris targets and secure a sustainable energy future on a planet left habitable for succeeding generations.

2017 saw a concentration of installations in a smaller number of markets in Europe, Africa, and Latin America, reversing a trend for a diversification of markets that has marked the industry’s growth over the last decade. That needs to change, and there are solid signs that it will in 2018, but we shall see.

There is still an acute need around the world for new power generation, which is clean, affordable, indigenous, reliable and quick to install. Wind power is leading the charge in the transition away from fossil fuels; and continues to blow away the competition on price, performance and reliability.