

ANNUAL MARKET UPDATE 2017

# GLOBAL WIND REPORT



**GWEC**  
GLOBAL WIND ENERGY COUNCIL

# Opening up new markets for business



Hanoi, 7 June 2018



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# TABLE OF CONTENTS

## CHAPTER ONE

|  |   |
|--|---|
| <b>THE NEXT BIG THING ...?</b> . . . . . | 9 |
|--|---|

## CHAPTER TWO

|  |    |
|--|----|
| <b>GLOBAL STATUS OF WIND POWER IN 2017</b> . . . . . | 15 |
|--|----|

## CHAPTER THREE

|  |    |
|--|----|
| <b>MARKET FORECAST 2018-2022</b> . . . . . | 27 |
|--|----|

## CHAPTER FOUR

|   |    |
|---|----|
| <b>A SNAPSHOT OF TOP WIND MARKETS IN 2017</b> . . . . . | 35 |
| Argentina . . . . .                                     | 36 |
| Australia . . . . .                                     | 37 |
| Brazil . . . . .  | 38 |
| Canada . . . . .  | 39 |
| PR China . . . . .                                      | 40 |
| The European Union . . . . .                            | 42 |
| Finland . . . . .                                       | 46 |
| France . . . . .  | 47 |
| Germany . . . . .                                       | 48 |
| India . . . . .   | 49 |
| Japan . . . . .   | 50 |
| Mexico . . . . .  | 51 |
| Netherlands . . . . .                                   | 52 |
| Norway . . . . .  | 53 |
| Offshore Wind . . . . .                                 | 54 |
| Pakistan . . . . .                                      | 64 |
| South Africa . . . . .                                  | 65 |
| Turkey . . . . .  | 66 |
| United States . . . . .                                 | 67 |
| Uruguay . . . . .                                       | 68 |
| Vietnam . . . . .                                       | 69 |
| About GWEC . . . . .                                    | 70 |

# PREFACE



**Steve Sawyer**  
Secretary General  
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**2017** was not a spectacular year in terms of global installations, but key developments marked the forward progress of the energy transformation. Driven by the improving economics of wind power, as well as solar and storage, the outlines of a future sustainable energy system are beginning to become clear.

'Hybrid' wind/solar/storage plants are now being built, able to supply clean reliable power 24/7 for most of the year; utilities are seriously experimenting with battery storage in place of peaker plants; and EV sales are booming in key markets. The development of local micro-grids, some using peer to peer power trading with blockchain technology, and more and more sophisticated market structures for matching up supply and demand at all scales are just some of the elements beginning to emerge.

Last year at this time we reported on prices in a tender in Morocco having broken through the US\$ 0.03/kWh barrier. This year, we note the record low prices in Mexico's most recent tender, having broken through US\$ 0.02/kWh. How much lower can it go? Nobody knows for sure, but costs will continue to come down, albeit probably at a slower rate than in recent years.

Overall, 52.5 GW of new wind power was installed across the globe in 2017, a slight decrease on the 2016 market of 54.6 GW, bringing total installed capacity up to 539 GW.

Behind the numbers, however, is the fact that wind energy is now operating in more and more markets on a purely commercial basis, moving away from the support schemes of old; and that transition has created policy gaps in a number of markets, as governments and regulators as well as the industry gets accustomed to the new reality. We expect these gaps to be felt in 2018 installation numbers as well, before the global market returns to growth in 2019.

China, the driver of global market growth for most of the last decade, installed 19.7 GW in 2017, more than twice as much as any other market, even though it represents a decrease on 2016's 23 GW. India had a record year, breaking the 4 GW barrier for the first time in 2017, and although 2018 is likely to be a 'gap' year, we can expect rapid growth starting in 2019.

Europe had an extraordinary year, setting new records both on and offshore. New annual market records were set in Germany, the UK, France, Belgium, Ireland and Croatia, as well as in the offshore segment, which accounted for 3,148 MW of the European total of 16,803 MW (15,638 MW in the EU).

The US installed a solid 7 GW, having dodged a bullet and survived the new tax bill largely unscathed. Canada's numbers were down, but the big news was December's auction in Alberta, with prices coming in below US\$ 0.03/kWh, and we can expect more



auctions in 2018. Mexico's newly reformed market is now ready for takeoff, and we can expect more than 1,000 MW of installations this year.

Brazil installed just over 2 GW in 2017, and it seems as if the worst of the political and economic crises are behind them, with new wind power being contracted in December's auction after a nearly 2-year hiatus, and there are two more auctions scheduled for 2018. Argentina now has a solid 3 GW pipeline with another auction coming up in the 3<sup>rd</sup> quarter of this year.

The Middle East and Africa was quiet, with only South Africa adding capacity...but the good news from South Africa is that on 4 April the PPAs for the last round of tenders were finally signed, after a delay of more than 2 years. In the Pacific, the only activity was in Australia which installed a modest 245 MW, but now has a 2.8 GW pipeline to be build out in the next few years to meet 2020 targets.

Proving that offshore wind has finally hit its stride, 2017 marked the first 'zero-bid' offers for offshore development rights, for more than 1 GW off Germany. This helped prompt the Dutch government to launch a 'subsidy-free' tender for 700 MW which was awarded in March. While it will be some years before this is the new normal, offshore going forward is economically competitive with any and all new forms of generation, at least in Europe; and this has sparked huge interest

in the technology around the globe: in the United States, Japan, South Korea, Taiwan, India, Australia and even Brazil!

This is the 13<sup>th</sup> annual report on the status of the global wind industry by the Global Wind Energy Council. It provides a comprehensive overview of the global industry at a specific moment in time; an industry now present in more than 90 countries, 30 of which have more than 1,000 MW installed, and 9 with more than 10,000. The information contained in this report – market data, profiles and analysis, have been collected primarily through GWEC's member associations and companies around the world, as well as from governments and independent analysts. We thank all our contributors and look forward to continuing our collaboration in the future.

*Brussels, 25 April 2018*

Steve Sawyer

Morten Dyrholm



**Morten Dyrholm**  
Chairman  
GWEC

# AMBITIOUS OBJECTIVES: AND WHY NOT?



**Adolfo Rebollo**  
Chief Executive Officer  
Ingeteam

**R**enewables are gaining momentum globally. At the same time, regulations and policy-driven targets of some governments will have a significant impact on the course of this global move.

Certainly, Europe wants to make headway towards a progressively decarbonised future. Europe is taking action, showing a strong commitment to the Paris Agreement. The ambitious EU binding target of 35% share of renewables by 2030 included in the latest revision of the EU Renewable Energy Directive still needs to be negotiated with the individual countries. The previous consensus in 2014 on EU Energy Strategy for 2030 set the bar at 27% minimum. The difference is significant since it doubles the pace at which deployment should take place.

International markets and auctions have driven industrial costs down over the last few years. We have witnessed a very interesting turn of events in the energy generation industry: renewables are the most competitive option for any power plant in the world. The progressive electrification of the transport and heating sectors is becoming a tangible reality that should be further enabled by efficient green energy assets. The latter may help with capped costs, and at the same time, it should be virtuously balanced by the flexible demand of these sectors. Therefore, an increased deployment pace is not only desirable but justified.

With good foresight, the current European energy strategy already included plans for electrical infrastructure reinforcement, interconnections, common trading platforms and diversification of power supply. However, the rate of deployment of renewables conditioned by the approved targets is an essential factor for fostering investments in technology development and industrial value chains. This is key to maintaining the competitive advantages achieved during the past decade.

With its common origin in the yearly allowance of the sun's radiation bestowed upon the earth, renewable energy finds unequal balances in different regions of the globe as they strive for equilibrium. Technology costs or legacies have a decisive influence on the energy mix for any particular country, but progressive convergence with the natural endowments should be expected. Equatorial regions rich in solar radiation, the tropics ideal for hybridization, and the territories in windy cold climates, all of them shall strive for the optimum combination of energy sources. In most places renewables tend to be sparse and uneven; these characteristics raise material, control and storage challenges that can be addressed through R&D developments and diverse technologies. The result shall be a new generation of smart energy assets, acting as one smart, reliable, predictable and efficient power plant, called by its own nature, to have a global scope.

As well as many governments, utilities, IPPs, and investors have progressively understood the paradigm shift and are re-positioning themselves. This has helped increase the size of renewable energy power plants and equipment volumes. Greater competition has tightened margins, driving consolidation among equipment and service providers, and making a natural selection among them, so only the strongest and fittest are still in business. As a consequence, technological diversity has been reduced and a progressive evolution has been imposed. All design architectures have a limitation on their scalability, and beyond a certain size, other revolutionary concepts become more competitive. This point of inflexion could be approaching for some technologies, particularly in power conversion systems and wind turbine designs, where material constraints are so significant. Additionally, the increasing stress for the profit of renewable power plant operations has encouraged mining historical data with advanced analytics, further digitalisation of equipment and integrated suites of modelling tools that can provide valuable insights for the optimisation of maintenance and extended life of the energy generation assets.

So, although with a strong track record, renewable energies are not yet fully mature. Their efficient exploitation requires knowledge, a committed team, technological resources, and wise strategy. Envisaging those optimal scenarios and facilitating

with our developments is a mission for companies like Ingeteam that are at the forefront of innovation. Our commitment is to search for excellence in our generation and power conversion product portfolio, to push the boundaries of electric network requirements, platform sizes, hybrid and storage interfaces, and even channelling the power to end-users with grid integrated fast electric vehicle chargers. Progressive add-on or built-in intelligence is also allowing us to provide competitive services that maximise predictability, availability and efficiency.

There is such a great opportunity to further combine diverse technologies and energy sources that the true potential of the "green revolution" is still unknown. Certainly, it will come with universally affordable energy, qualified jobs, growing decarbonised economies, and endurable energy infrastructures. Is there a better legacy for future generations? We don't think so. So let us cheer for more ambitious goals!



**Ingeteam**









CHAPTER ONE

# THE NEXT BIG THING ...?



The Philippines © GWEC

After about 100 years of research and development, testing of prototypes and some very impressive single units, the first commercial wind farm started generating electricity at Crotched Mountain in Southwest New Hampshire at the end of 1980, and the modern wind industry was born. Since then, the industry has been on a continuous search for new markets around the world. German and Danish markets started up shortly after the US, followed by Spain; and although through the rest of the decade the US remained the market leader, Europe as a whole surpassed the US early on. The first non-OECD market was India, which installed its first commercial project in 1986.

Rapid growth followed in the 1990s, led by Germany which overtook the US as market leader in 1997, and European markets broadened to include Italy, the Netherlands, the UK and Sweden, and there were the first stirrings of the markets in China, Japan, Canada and Australia. By the mid-2000s, Spain had also overtaken the US (briefly), and Canada and Portugal had entered the top 10 markets.

Everything changed after the introduction of the Chinese Renewable Energy Law in 2005,

and by the end of the decade China emerged as the global market leader, and is now double the #2 market, the US, which overtook Spain in 2007 and then Germany in 2008. The only change in the top 5 ranking since then was India moving past Spain in 2015.

At the end of the 2000s and the beginning of the new decade, new markets emerged in Brazil, Mexico and South Africa, as well as Egypt, Morocco, Chile, and a host of smaller markets in Europe, most notably Turkey and Poland. Today we have commercial wind operations in more than 90 countries around the world, 9 of them with more than 10,000 MW, and 30 with more than 1,000 MW across Europe, Asia, North America, Latin America and Africa.

Where to next? When looking back 10 years from now, what will be the big success stories from the end of this decade and the 2020s? While we don't have definitive answers to that question, there are a few key markets with enormous potential that could begin to play dominant roles in the industry by 2030, and we take a look at some of them here: Argentina, Russia, Saudi Arabia, and Vietnam.

## ARGENTINA

A century ago, Argentina was one of the richest countries in the world, and its relative economic decline has puzzled economists for decades. The country is blessed with fantastic natural wealth of nearly every description, and one of the brightest spots at the moment is the potential to develop its extraordinary renewable energy potential.

Argentina has been the 'sleeping giant' in South America since the early days of the wind industry. With enough wind power potential to supply all of Latin America's electricity needs several times over, developers have looked hungrily towards the windswept Pampas in the south of the country as something of a holy grail.

Back in the 1990s Santa Cruz Governor (later President) Kirchner was very enthusiastic about wind power's potential and instigated the first few small wind projects in Argentina. However, after the financial crisis at the end of the decade interest waned, and by the time he was elected President in 2003 wind power was largely off the radar and remained so until the election of the Macri government which took office in late 2015.

Since then, Argentina seems to have done just about everything right. Implementing newly passed legislation, the new government developed an enabling framework for the achievement of renewable electricity targets of 8% by 2017, and 20% by 2025. The full programme was launched in May of 2016, dubbed RenovAr, consisting of a series of fiscal incentives and financial support mechanisms, regulations and rules aimed at overcoming the existing barriers to renewable energy investment. The main barriers were due to the Argentine government having defaulted on its foreign debt three times since 1982, the last being in 2014 – in other words, the government had a difficult sales job to convince international investors that Argentina was a good investment destination.

However, the promises of the new government, the fact that Argentina's power market is second only to Brazil in South America, and the enormous wind (and solar) potential of the country convinced investors to take the risk. The first tender round in 2016 was oversubscribed many times, and nearly 1.5 GW of wind projects were awarded, and another 1 GW in 2017,

which, combined with the 'rehabilitation' of about 500 MW of legacy projects from the largely unsuccessful GenRen programme, has created a 3 GW pipeline which is now being built out. With another tender scheduled for later in 2018, and two international OEMs having announced plans for the establishment of manufacturing facilities, it seems that Argentina's renewable energy industry is up and running, led by wind power. It will be some time before it is in a position to challenge Brazil for wind power leadership in the region, although it should be firmly in the #2 spot in South America before 2020.

Could it all go horribly wrong? Given the country's history of political and fiscal instability, it certainly could, but confidence is growing with each milestone passed, and the recent introduction of regulations allowing for private/corporate power purchase deals adds another leg for the industry to stand on. The 2019 elections will be crucial for the programme's future, but barring any unforeseen surprises, it looks very positive for the wind sector going forward, with a market of at least 1 GW/year. With the success of the RenovAr programme to date, the 2025 target will be met and perhaps exceeded, and at some point in the not too distant future the government may need to adjust the targets upward; although in order to do so, it will have to attract substantial investment in transmission infrastructure.

## RUSSIA

The largest (nearly) blank spot on the global wind map is, ironically, the largest country in the world. 10-year-old estimates of Russian wind potential put it at something like 80,000 TWh/yr, or more than three times current total global electricity consumption. With up to date technology and measuring methods, the numbers would be no doubt be much larger. As is usually the case, the resource is not the limitation.

There have been numerous attempts to get the Russian wind industry moving, most recently from 2009 - 2011, when then-President Medvedev was making positive noises about modernizing the economy and developing the country's vast renewable energy potential: wind, solar, hydro, geothermal and biomass. Despite framework legislation enacted in 2007, however, the final step was never taken.



After the return of Vladimir Putin to the presidency all eyes were on Arctic oil, and renewables development stalled.

Now, with oil prices hovering around US\$ 50-60/barrel, it seems that there is interest again, and it would be a smart move for Russia to begin to exploit its renewable resources, rather than squandering its oil and gas at extremely low prices for domestic electricity production or at relatively low export prices.

Last year, Russia held a tender for 1.65 GW of onshore wind capacity to be built out from 2018 to 2022 – 250 MW in 2018, 300 MW in 2019, 240 MW in 2020, 400 MW in 2021 and 460 MW in 2022, although accounts of the final results differ. The tendering rules are complex, and pay too much attention to capex and not enough to the cost of electricity, in my view, but major national and international players have taken the plunge for what are apparently very attractive prices for electricity of more than US\$ 0.12/kWh.

Rosatom, the state-owned nuclear power company, has done a license deal with the Dutch turbine manufacturer Lagerwey for producing 6-900 MW of turbines in Russia. Finnish energy company Fortum, meanwhile, has just completed a 35MW project in Ulyanovsk near the upper reaches of the Volga River, which came on line in January of this year. Fortum has also signed an investment deal with RUSNANO, the technology investment company led by Anatoly Chubais, former head of RAO UES of Russia, the state-owned electricity monopoly. This consortium then concluded an agreement with Vestas in late 2017, which includes the construction of a blade factory near Ulyanovsk and has up to 1 GW at various stages of development. Many other companies including DNV GL, Siemens Gamesa Renewable Energy, GE and NRG are already active in the market.

Another tender is scheduled for later this spring for an additional total of 830 MW of wind power to be commissioned between 2019 and 2023, which brings the total pipeline up to about 2.8 GW, although some sources have higher numbers.

We've all read the stories about the difficulties of non-Russian companies operating in the country over the nearly three decades since

the end of the Cold War. The current politics do not bode well, but I have not yet heard of that getting in the way of the wind business. But with Russia, it could always come. Also, nobody knows what a post-Putin Russia will look like – it could go either way.

The tremendous resource is there, and there are enough Russian companies involved now, both state-owned and private, that I think that at least this mini-boom over the next five years is going to take place in some shape or form. What happens next is anyone's guess, but if our energy future is going to be sustainable, Russia has to be a part of it – and it could be of tremendous benefit to the country if they so choose.

## SAUDI ARABIA

The Kingdom of Saudi Arabia remains a mystery to most people. However, it is more than just members of the royal family parading around in Rolls Royces and attending OPEC meetings. There is a growing understanding of the need to address some of the fundamental structural problems in the Kingdom, and energy is high on that list.

Saudi Arabia currently burns 700-900,000 barrels of oil a day to generate electricity, and they consume a lot, particularly for air conditioning. That's the equivalent of a modest oil producing nation such as Colombia or Indonesia, or four or five times what now flows through the Trans Alaska Pipeline. At current prices, this costs the Kingdom more than US\$ 50 million/day in foreign earnings, and since it is basically given free to generators, it's a huge net drain on the economy.

Back in 2010, then-King Abdullah founded KACARE, the King Abdullah City for Atomic and Renewable Energy, whose mission was to plan for a future Saudi Arabia much less dependent on fossil fuels, focussing on the exploitation of the country's renewable resources (and nuclear). Saudi Arabia has huge solar potential of course, but there are also excellent wind resources, particularly on the west (Red Sea) coast. The plan in the first instance was for something like 9 GW of wind, 16 GW of solar PV, 25 GW of CSP and a bit of geothermal and waste to energy, alongside nuclear. However, the initiative ran into opposition from others in the royal family and from Saudi Aramco; and with the King's

health failing in the second half of 2014, the initiative ran out of political support and out of steam.

Enter the new Crown Prince Mohammed bin Salman, and his ambitious efforts to modernize the country's economy. With Energy Minister Khaled al-Falih, he established the National Renewable Energy Program (NREP) in 2016 under the Ministry of Energy with major participation from Saudi Aramco, along with what was left over from KACARE.

It appears that this effort is more likely than previous ones to get some traction – they've already awarded one solar project, and a tender for a 400 MW wind project is in the pipeline. The targets are for about 3 GW of renewables by 2020, and 9.5 GW by 2023. However, local content requirements are steep, as the new Crown Prince is adamant that Saudi Arabia should become a manufacturing and technology leader. NREP awarded the first solar project on local content over price – even though the price was very good.

Is this initiative for real? Seems to be. Are the rules clear? No. Transparency? Not a chance. However, it's a potentially big market not far from Europe and they have the ability to move quickly if necessary. It could be an exciting market, in both positive and negative ways, but not for the cautious or faint hearted.

## VIETNAM

Vietnam has some of the best wind resources in Southeast Asia, a region where much international attention is focused these days, as it is the only region where coal use is still growing, and where the Energy Revolution has not caught hold – yet.

The country's 3,500 km coastline provides rich opportunities for the industry to develop quickly in line with Vietnam's fast-growing economy, where electricity demand growth is currently at around 10%/year. Current resource estimates are for a potential of around 24 GW, but my bet is that that number will increase substantially as the industry develops.

Two things stand in the way at the moment: firstly, financing, or the lack of available local finance, which means that in addition

to the risk associated with any new market, developers need to take on substantial currency risk as well; and secondly, the PPAs on offer from Electricity of Vietnam (EVN) are not readily 'bankable' by the standards of international financiers, and therefore push the risk premiums even higher.

Having said all that, the government has ambitious plans for the sector, looking to develop 800 MW by 2020 (up from today's 197 MW), 2,000 MW by 2024 and 6,000 by 2030. However, it will need to clear some of the planning and regulatory roadblocks out of the way in order for that to happen. Will they? Well, yes, I think so, although it is likely to take longer than we expect. Then again, I would imagine that once things start to move in earnest they can move very quickly.

Another advantage Vietnam has is shallow coastal waters in and around the Mekong Delta with strong wind resources, which will make the development of the offshore sector easier, and it will come earlier in the development of the market than is usual, which could give the country extra opportunities in the region. This market probably does not have the huge potential of an Argentina or Russia, but it could become a solid addition to the Asian region in a few years' time.

## CONCLUSION

So, when we look back 10 years from now, what will we see? Are Argentina, Russia, Saudi Arabia and Vietnam the 'next big things' beyond the already established markets? All of the above? None of the above? We could also speak about Iran, Indonesia, Nigeria or the Philippines as major markets moving forward, but from where we sit today they're not likely to have the same impact, or at least not in the foreseeable future.

Argentina, Russia, Saudi Arabia and Vietnam are all potentially large enough to warrant investors shouldering the substantial risks involved – and these risks are high, especially in the case of Russia and Saudi Arabia. "High risk, high reward" as the saying goes...we'll only know in retrospect if the risks were worth taking. A number of major players think they are – let's hope they're right!





A landscape photograph showing a series of rolling hills under a sunset sky. The sky transitions from a deep blue at the top to a warm orange and yellow near the horizon. Several wind turbines are silhouetted against the sky, with some in the foreground and others receding into the distance. The foreground is dark, suggesting the ground is in shadow.

CHAPTER TWO

# **GLOBAL STATUS OF WIND POWER IN 2017**



© Vestas

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 (€ 296.8bn<sup>1</sup>) 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\$.<sup>2</sup>

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.

<sup>1</sup> Exchange rate used for USD to EUR conversion (USD1 = EUR 0.89)  
<sup>2</sup> <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     |
|--------------------------------------|----------------|---------------|----------------|
| <b>AFRICA &amp; MIDDLE EAST</b>      |                |               |                |
| South Africa                         | 1,467          | 618           | 2,085          |
| Egypt                                | 810            | -             | 810            |
| Morocco                              | 787            | -             | 787            |
| Ethiopia                             | 324            | -             | 324            |
| Tunisia                              | 245            | -             | 245            |
| Jordan                               | 119            | -             | 119            |
| Other <sup>1</sup>                   | 159            | -             | 159            |
| <b>Total</b>                         | <b>3,911</b>   | <b>618</b>    | <b>4,528</b>   |
| <b>ASIA</b>                          |                |               |                |
| 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 <sup>2</sup>                   | 70             | -             | 70             |
| <b>Total</b>                         | <b>204,281</b> | <b>24,412</b> | <b>228,684</b> |
| <b>EUROPE</b>                        |                |               |                |
| 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 <sup>4</sup>                   | 153,731        | 15,638        | 168,729        |
| Rest of Europe <sup>3</sup>          | 7,612          | 1,166         | 8,777          |
| <b>Total Europe</b>                  | <b>161,342</b> | <b>16,803</b> | <b>177,506</b> |
| <b>LATIN AMERICA &amp; CARIBBEAN</b> |                |               |                |
| 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 <sup>5</sup>               | 200            | 18            | 218            |
| Others <sup>6</sup>                  | 386            | -             | 386            |
| <b>Total</b>                         | <b>15,312</b>  | <b>2,578</b>  | <b>17,891</b>  |
| <b>NORTH AMERICA</b>                 |                |               |                |
| USA                                  | 82,060         | 7,017         | 89,077         |
| Canada                               | 11,898         | 341           | 12,239         |
| Mexico                               | 3,527          | 478           | 4,005          |
| <b>Total</b>                         | <b>97,485</b>  | <b>7,836</b>  | <b>105,321</b> |
| <b>PACIFIC REGION</b>                |                |               |                |
| Australia                            | 4,312          | 245           | 4,557          |
| New Zealand                          | 623            | -             | 623            |
| Pacific Islands                      | 13             | -             | 13             |
| <b>Total</b>                         | <b>4,948</b>   | <b>244,9</b>  | <b>5,193</b>   |
| <b>World total</b>                   | <b>487,279</b> | <b>52,492</b> | <b>539,123</b> |

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

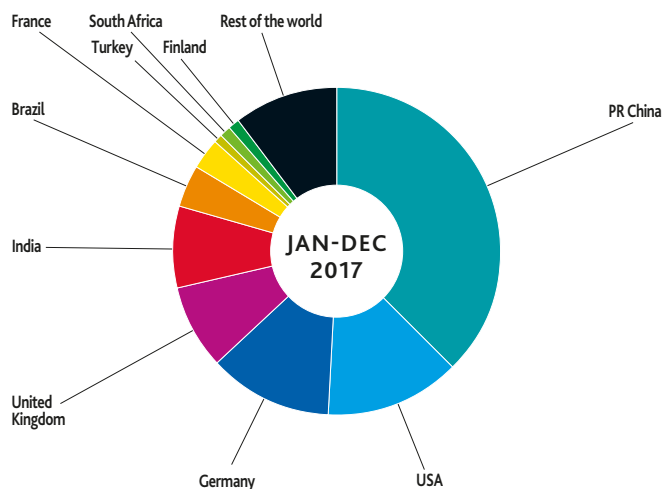
5 Caribbean: Aruba, Bonaire, Curacao, Cuba, Dominica, Guadalupe, Jamaica, Martinica, Granada, St. Kitts and Nevis

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

Note: The stats includes a decommissioning of 648.8MW



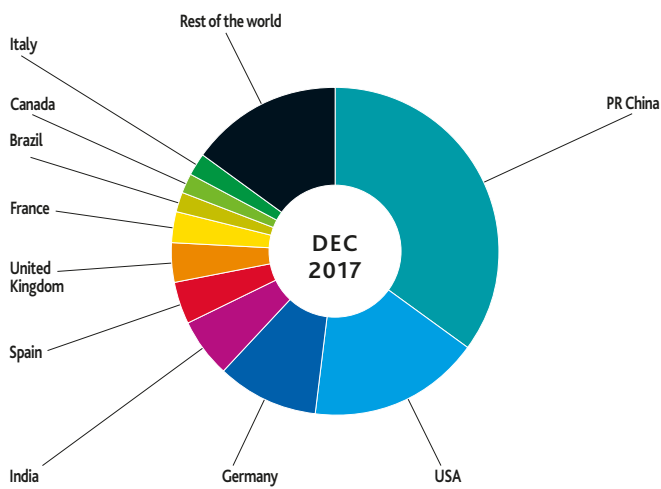
**TOP 10 NEW INSTALLED CAPACITY JAN-DEC 2017**



| 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         |
| <b>Total TOP 10</b> | <b>47,310</b> | <b>90</b>  |
| <b>World Total</b>  | <b>52,492</b> | <b>100</b> |

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         |
| <b>Total TO P10</b> | <b>456,732</b> | <b>85</b>  |
| <b>World Total</b>  | <b>539,123</b> | <b>100</b> |

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.<sup>3</sup>

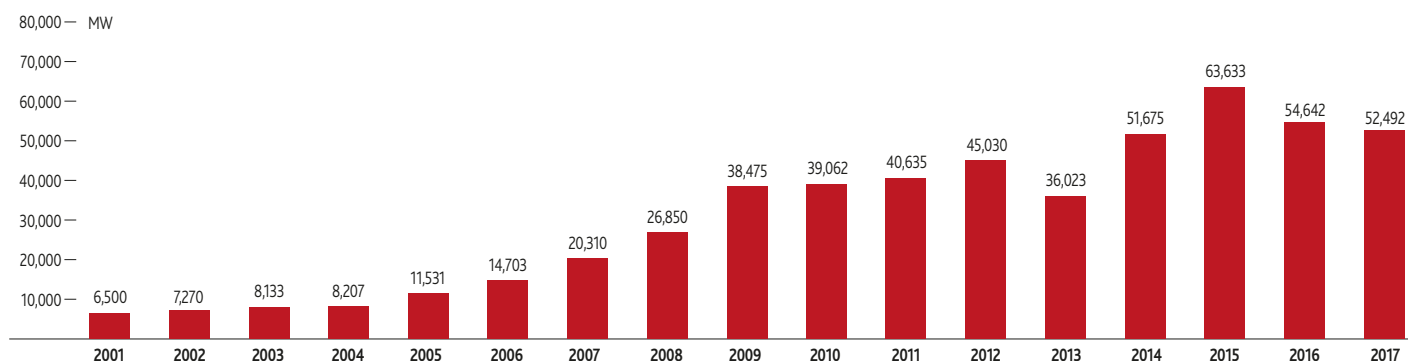
Curtailed on wind farms in China improved substantially in 2017 according to the National Energy Administration (NEA), averaging 12% across the country for the year, down from 17% in 2015.

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

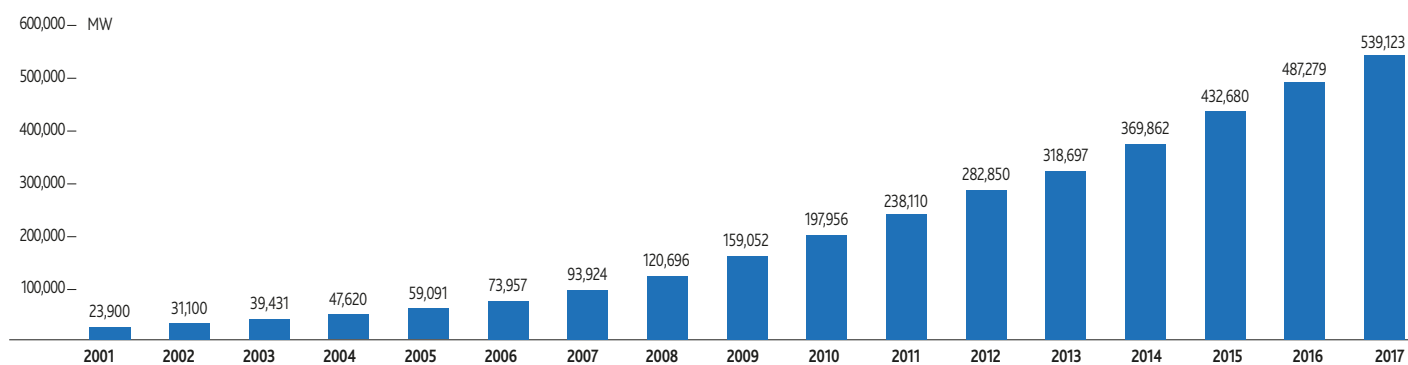
<sup>3</sup> <https://chinaenergyportal.org/en/2017-electricity-energy-statistics/>

## 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.

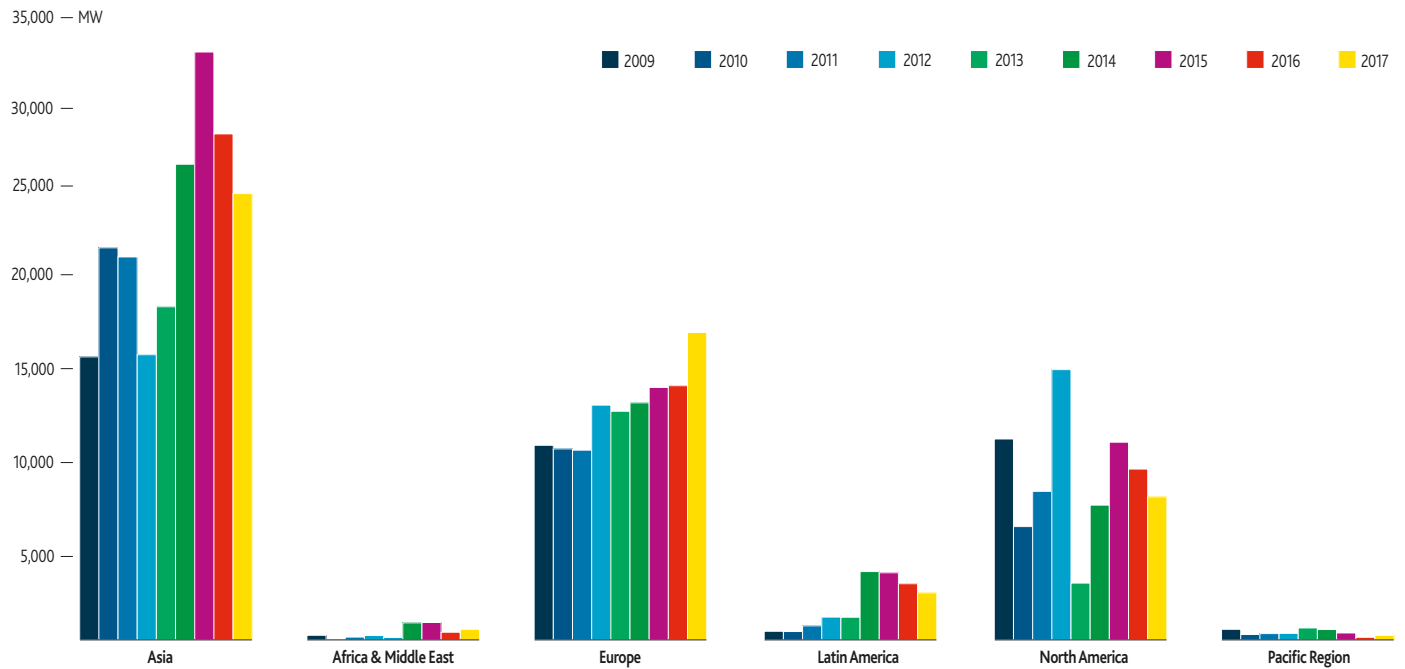
Elsewhere, **Mongolia** commissioned its second 50 MW wind farm, **Vietnam** added 38 MW, **Thailand** 24 MW, and **Taiwan** added just 10 MW as it focuses on its burgeoning offshore sector, which will start to get built out in the next few years.

### 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 2016<sup>4</sup>.

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.

<sup>4</sup> <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.









CHAPTER THREE

**MARKET FORECAST  
2018-2022**





The Philippines © GWEC

The aftermath of the global financial crisis in the previous decade resulted in average global markets of about 40 GW/annum for the period from 2009 to 2013. Breaking through the 50 GW barrier for the first time in 2014, the industry set a record of more than 60 GW due to anomalously high installations in China in 2015. In 2016 the market returned to the 'new normal' of just over 54 GW, and 2017 was in the same general range, which is also what we expect for 2018, before the industry embarks on another growth spurt in the run up to a number of 2020 targets.

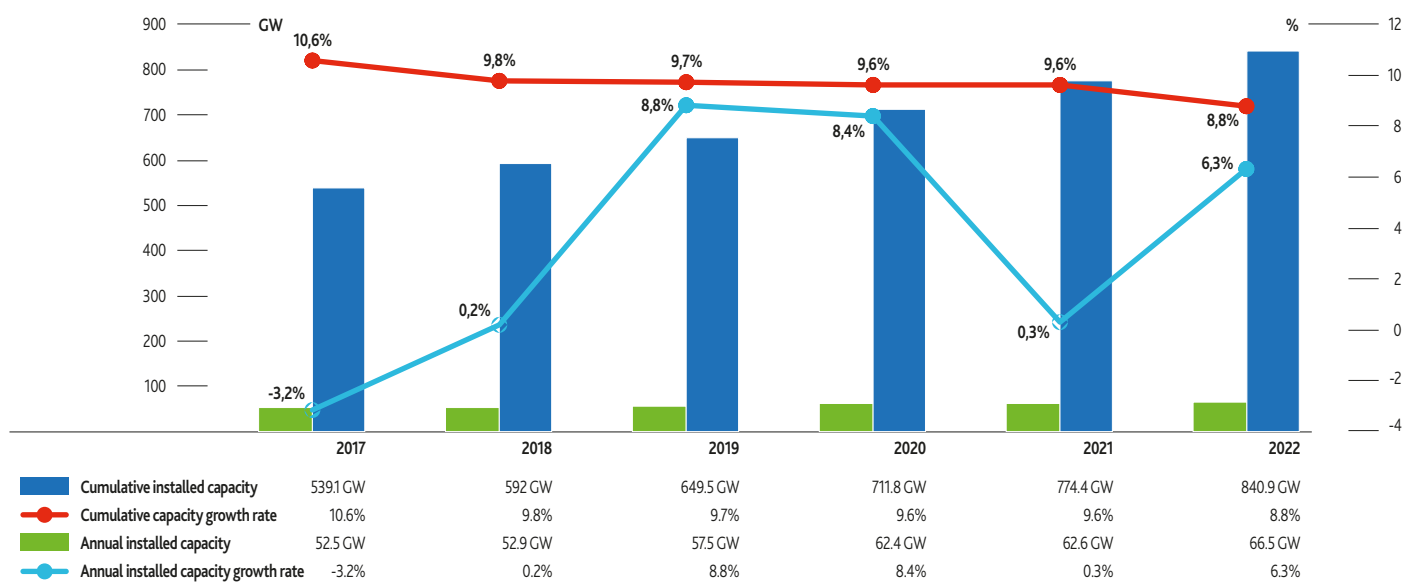
Several countries set new record high installations last year, as did the offshore sector, which installed more than 4 GW in a single year for the first time. While offshore still represented only about 8% of the global market, and only about 3.5% of global installed capacity, those numbers will increase substantially in the coming five years. It

should also be noted that those offshore MW will generate significantly more electricity than their onshore counterparts.

Germany, the UK, France, Belgium and Ireland all set new records, as did India, breaking the 4 GW barrier for the first time. China, still very much the global leader, dropped below 20 GW for the first time since 2013.

We expect the annual market to remain at roughly 2017's level for 2018 due to anticipated decreases in Germany, the UK and India. This will be balanced by increases in North America, the Middle East and Africa and Latin America. The annual market will return to growth in 2019 and 2020, breaching the 60 GW barrier once again and continue to grow, albeit at a slower pace, in the beginning of the new decade. We expect to see total cumulative installations reach 840 GW by the end of 2022.

## MARKET FORECAST 2018-2022



Source: GWEC

## MAJOR TRENDS IN 2017

### Prices continue to drop

“How much lower can it go?” is the question we are often asked. While we don’t have a definitive answer, it is clear that the downward trend will continue for both wind and solar in the coming years, although at a slower pace than we’ve seen over the past five years or so. In late 2017 we saw tender prices in Canada (Alberta) go well below € 0.025/kWh mark, and in Mexico below € 0.015/kWh. While these are outliers at present, they are also harbingers of things to come in more and more markets, where wind (and increasingly solar) are far and away the cheapest way to add new generation capacity to the grid.

Late in 2017 the Dutch government announced its first ‘subsidy free’ offshore tender, which was in fact concluded earlier this year. The winner of the 700 MW Hollandse Kust project will build the project by 2022 and will receive nothing more than the wholesale price of electricity. This follows on from the first ‘zero bids’ for more than 1 GW of offshore wind in Germany last year, although these projects will not be built out until about 2024. In both cases, the costs of building the transmission connections will be borne by the government. These developments have created a dramatic increase in the appetite for offshore outside its home base in Europe (and China) in places

as diverse as the United States, Taiwan, Korea, Japan, India, Australia and now even Brazil.

### A Market in transformation

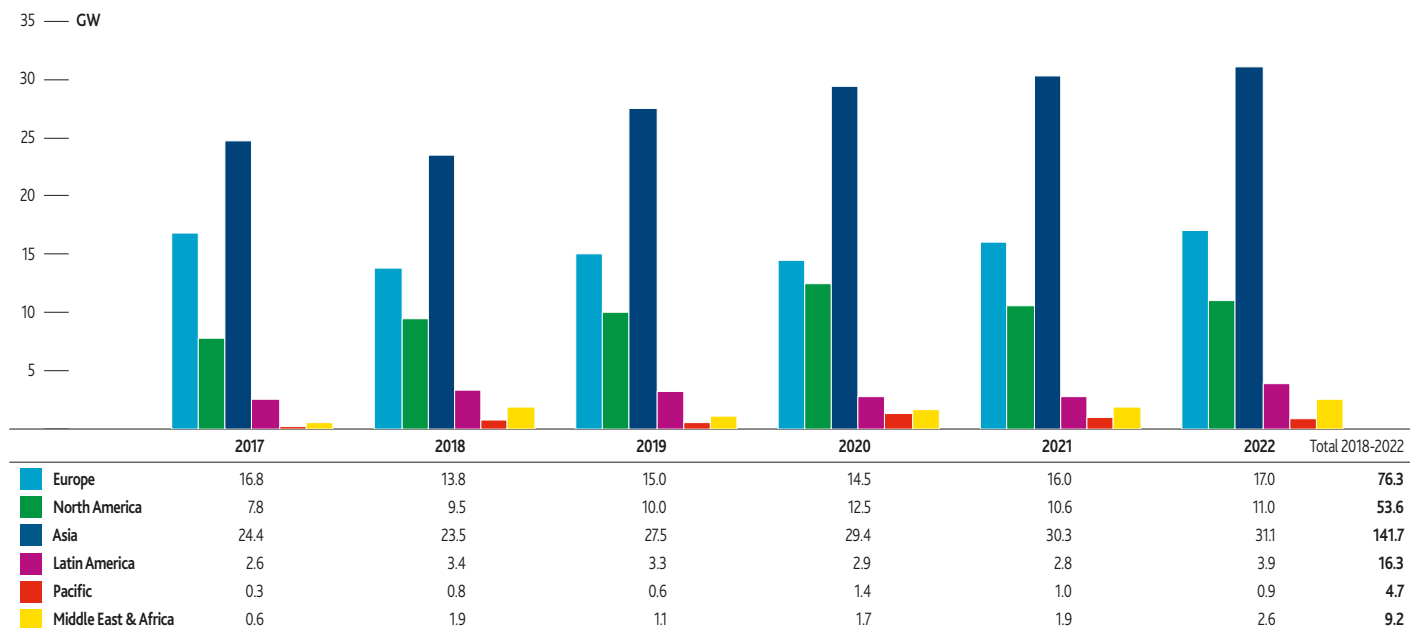
What we are seeing across the globe is a transformation of markets for wind power away from the support schemes that gave birth to the industry, with wind taking its place as a purely commercial technology, increasingly operating without subsidies or support mechanisms. Competing, one might add, with incumbents which are heavily subsidized to the tune of hundreds of billions (low estimate) to trillions of dollars per year, depending on what is included. But that is a discussion for another time.

The point is that the phrase ‘renewables are too expensive’ can now disappear forever. Whatever ideologues might have to say about it, the marketplace has spoken and we are in the process of adjustment to a direct market-driven competition for the future of the energy system. Policy will also play a role, and it should play a stronger role if we are to avoid the worst ravages of climate change. Regardless, we are in a time when it makes extraordinary sense to invest in renewables, and it makes little sense to invest in anything else.

This transformation is taking its toll on the annual market size. ‘Policy gaps’ between the new and old systems mean that some

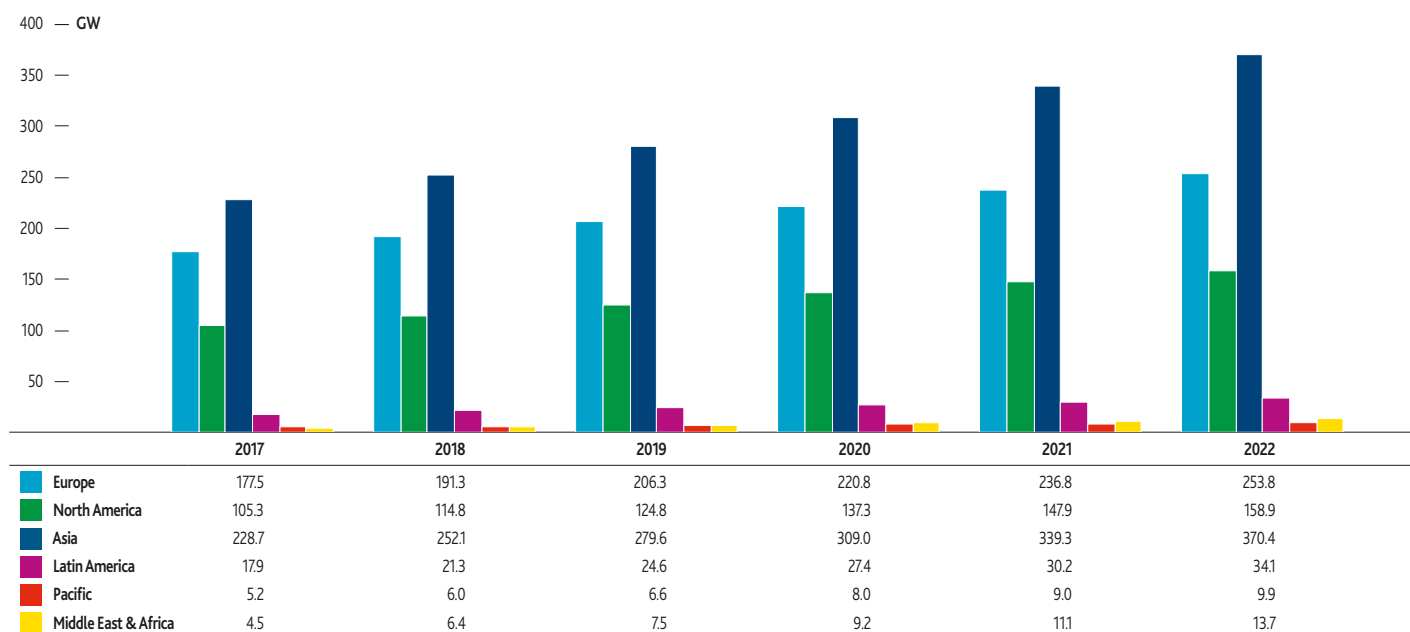


## ANNUAL MARKET FORECAST BY REGION 2018-2022 (GW)



Source: GWEC

## CUMULATIVE MARKET FORECAST BY REGION 2018-2022 (GW)



Source: GWEC

markets were on something of a bumpy ride in 2016 and 2017 and that will continue for another year or two (longer in a few markets, including the world's largest, in China) until the kinks are worked out of the new systems.

### The Future

Alongside the cratering prices for wind, solar and other technologies, other aspects of the transformation are proceeding apace. The dramatic uptake in EVs is one of them. Although it is as of yet limited to just a few markets, the rate of increase is beyond the wildest projections of just a couple of years

ago. Likewise, the precipitous drop in the price of battery storage is another game-changer. One result of that is what has been talked about for many years, but which is only now appearing in reality: wind/solar hybrid plants with battery storage. We have examples under construction in Australia and India, and we will see much more in the coming years, with the combination enabling power delivery 24/7 for most of the year.

What does all this mean for wind markets in 2018-2022? Well, from where we sit at the end of March 2018, it will mean a more or less flat market for 2018, a return to rapid growth

in 2019 and 2020, and tapering off a bit after that, following the rush to install prior to the various deadlines coming up in key markets in 2020. Will there be unforeseen surprises? Probably. Will Russia and Saudi Arabia finally begin to reach their potential and provide rapidly growing major new markets for the industry? Perhaps. What about Vietnam, the Philippines and the rest of the Southeast Asia? The only thing that we can say for certain is that the increase in the rate of change in energy markets will continue to accelerate in the coming years.

## REGIONAL MARKET DEVELOPMENT

The Asia market continues to dominate and will do so for the foreseeable future. While China continues to be by far the largest market globally, the days of dramatic annual market increase are probably over, at least for the next few years. India will play a much stronger role, although the 2018 market will disappoint. Europe is unlikely to repeat the record installation levels in 2017, but we've been looking for a downturn in Europe for the last five years at least, but it hasn't come yet, although there has been a worrying concentration in fewer and fewer markets. North America looks pretty stable for the near future, and we're expecting Mexico to start to fulfill its promise over the next few years.

Despite the fact that Brazil's political and economic woes have abated somewhat, we will feel the effect of the lack of auctions for most of the last two years over the next three years. Argentina is one of the brightest spots in the wind universe at the moment, and Chile will continue to grow, as will some of the smaller Latin American markets. As of this writing it appears that the South African hiatus is over, and there should be significant installations in North Africa in the coming years. Australia will continue to be the only significant market in the Pacific for the coming years as the fulfilment of the MRET proceeds apace.

### Asia

With 228.7 GW of installed capacity, the Asia region is the undisputed driver of the global industry. It is led by China of course, but with India growing rapidly in the coming years. The emergence of a number of new markets, albeit smaller, will add to the world-leading annual market.

While falling back from its record breaking 30GW market in 2015, China's 19.7 GW of installations led all markets by far. We expect China to remain at about that level for the coming years, with perhaps a bump in 2020. This means that the last Five-Year Energy Plan target of 210 GW of wind power by 2020 will be met at least one year ahead of time. Curtailment in China decreased from 17% to 12% last year, which is still not good, but represents a substantial step in the right direction, resulting in increasing capacity factors across the country. The Chinese offshore market had its first 1,000 MW+ year in 2017, and we expect that segment to pick up substantially over the next few years. Further, electricity market reform, the introduction of an RPS system and the replacement of the FIT with an auction system remain at the discussion stage, but one or more of them may come quickly as China's energy transition gathers momentum.

India set another new record in 2017, but 2018 is likely to disappoint due to the 'policy gap' in the transition period away from the old market incentives towards an auction-based system. However, the government seems committed to meeting its aggressive targets for 2022, which includes 60 GW of wind, up from 2017's final number of just under 33 GW.

Elsewhere in Asia, Japan and Korea will continue to grow slowly, but are being surpassed in terms of annual installations by Pakistan, in addition to an impending surge in the Philippines and Thailand, a new offshore market in Taiwan, the beginnings of a market in Indonesia, and the expectation that Vietnam will finally take off at some point in the next few years. Overall, we expect the Asian market to add 142 GW in the next five years, for a total of 370 GW by the end of 2022.

### Europe

Against the expectations of many, Europe had a record year in 2017, with several national markets as well as the offshore sector setting new high annual totals. Germany, the UK, France and others set new highs, but at least in the case of Germany and the UK these are unlikely to be repeated any time soon due to changing policy landscapes. The revival of the Spanish market and the increasing strength in France as well as some of the other smaller markets bodes well, however, and we may

see substantial installations in Russia in the coming years although it is too early to say how much.

Recent tenders in the offshore sector point to the future of the sector in Europe, although the lead times for offshore mean that these installations will only begin to be seen at the end of the next five-year period. The current pipeline indicates that offshore installations will be down a bit in 2018, pick up again in 2019 and then remain stable for the rest of the period, approximately doubling existing offshore installations by the end of 2022.

Overall, we expect Europe to proceed in line with its 2020 targets, and current discussions within the EU indicate that the overall renewable targets could be raised to 35% by 2030, which would put the industry in a much stronger position for the post-2020 market. Overall, we expect Europe to install about 76 GW of new wind power by the end of 2022, reaching a cumulative total of 254 GW.

### **North America**

After the tax deal which was struck at the end of 2015 for the extension and phase out of the Production Tax Credit in the period up to 2020, the US wind industry entered its longest ever period of policy stability. After surviving an assault on this agreement last year largely unscathed, the 2017 market was solid, and a very large (28GW) pipeline augurs well for the future of the US market, at least through 2020, and probably beyond. Increased state RPS mandates and the ever-improving economics of the sector put it in a strong competitive position, and significant action in the offshore segment means that we may see offshore adding to the US market numbers by 2022.

While the Canadian market had a modest 2017, the auction results in Alberta in December last year mean that the technology is even more attractive going forward, and at least two more auctions are planned in 2018. Although Canada is not in need of much new electricity, increasing attention to its overall climate goals will help. Mexico should have its first year installing more than 1,000 MW in 2017 (I know, I said that last year, but this year for sure!), and should proceed to take off from there which will be necessary to meet the governments targets for 2024 (35% clean electricity), 2035 (40%) and 2050 (50%).

Overall, we expect 53.6 GW to be installed in the North American region over the next five years, bringing cumulative installations up to 159 GW by the end of 2022.

### **Latin America**

After two years of falling installation numbers in the region, the good news is that Brazil is tendering for new wind power again, with 1.4 GW contracted at the end of last year, and at least two more auctions scheduled for 2018. The bad news is that the impact of two years without auctions means that this will be seen in a dip in Brazil's installation numbers over the next several years, especially in 2019-2021.

However, much of this slack will be taken up by the burgeoning new market in Argentina. With 3 GW already in the pipeline, and with another round of auctions coming up later this year, Argentina has rapidly become the second most important market in the region. This exciting new market is now starting to attract investment in manufacturing facilities from international OEMs as it builds up its domestic supply chain.

Elsewhere, Uruguay's dramatic buildout to the point where the country is all but 100% renewable in the power sector, with 35-40% of its power coming from wind, is just about over for now. However, installations in Chile will pick up over the coming years to the level of ~500 MW/year, and we will see continuing contributions from smaller markets around the continent, in Central America and the Caribbean. Overall, we expect about 16 GW of new installations in Latin America and the Caribbean in the period out to 2022, bringing the region's total to 34 GW.

### **Africa and the Middle East**

2017 was another quiet year in the region, where the only installations were 618 MW in South Africa. It appears that the stalemate with Eskom has been broken and the REIPPP projects allocated two years ago, including more than 1 GW of wind projects, can now proceed. As of April 4, the PPAs have been signed under the auspices of the new Energy Minister. We can see substantial installations in the next few years, although the fate of the country's Integrated Resource Plan for the power sector remains in limbo.



US © Ed Collier Photography

Elsewhere in the region, the transmission line for Kenya's 310 MW Lake Turkana project should be ready before the end of this year, and we expect substantial new installations from 2016's auctions in Morocco during the course of 2018. There is also a pipeline of projects in Ethiopia which we expect to at least begin construction this year; and we hope that the bottlenecks will be removed in Egypt so that country can begin to fulfill its potential as well as government targets. There are several 'first projects' beginning around the region, and the new programme for renewables procurement in Saudi Arabia shows significant promise. Overall, we expect about 9 GW to be installed in the Africa and Middle East region over the coming five years, reaching a cumulative total of 14 GW by the end of 2022.

### **Pacific**

Australia installed 245 MW in 2017, the only active market in the region at the moment. However, after several years of subdued markets, the implementation of the Mandatory Renewable Energy Target has created a pipeline of about 2.8 GW, most of which is expected to be built by 2020. What happens after that is not yet clear, but it looks


like at least three strong years for the industry going forward.

We don't see much activity in the rest of the region in the near future, and Australia will be the main market driver leading to the installations of about 4.7 GW in the Pacific region in the period out to 2022, bringing the cumulative total to about 10 GW.

So, there you have it: our projections for the next five years, as it looks at the end of March 2018. There will undoubtedly be surprises, both positive and negative, but the general trends are clear: a maturing market, with exciting new opportunities in Africa, Asia and Latin America; technology continuing to improve with decreasing prices, increased capacity factors and reliability; renewable energy penetration levels continuing to increase around the globe; and an industry in transition to one driven more and more by markets and less and less by support schemes, yet one where policy remains fundamental if we are to meet our climate and clean air and water goals. The case for wind and other renewables only gets stronger with each passing year. We'll check in again at this time next year to update both the 2018 market and see how accurate we were, and what has changed.







CHAPTER FOUR

**A SNAPSHOT OF TOP  
WIND MARKETS IN 2017**

# ARGENTINA

## KEY DATA

Total installed capacity  
**228 MW**

Wind power capacity added in 2017  
**24 MW**

Wind-generated electricity produced in 2017  
**615 GWh**

Share of wind generated electricity in total electricity consumption  
**0.2%**

People employed by the wind industry at the end of 2017  
**1,500 direct jobs and about 10,000 indirect jobs**

Number of turbines  
**147**

Leading turbine suppliers in 2017  
**Vestas, Enercon, GE**

In 2017 Argentina remained on track to achieve its renewable electricity target of 20% by 2025. Wind will be the leading technology, with a solid pipeline of nearly 3GW at the end of 2017, primarily from the RenovAr programme, although some legacy projects from the previous regime will be built out as well.

Rounds 1 and 1.5 in 2016 resulted in 22 projects receiving long term PPA contracts for a total of 1,473MW. In Rounds 2 and 2.5 in 2017 11 new projects were awarded for a total of 993MW, at an average price of US\$ 41.23/MWh, down from the average of about US\$ 56/MWh for the projects awarded in 2016.

There are now nine RenovAr projects under construction, totalling 653MW, as well as two private projects of 50 MW each.

In September, a framework for large consumers to contract for their own renewable energy supply was enacted through Resolution 281-2017. This resolution allows large power users (>300kW) to contract renewable power directly from producers, energy traders, or to self-supply in order to meet their renewable power obligations. The

Energy Ministry projects that this could lead to as much as US\$ 6 billion of investments in Argentina's energy sector over the next three years, amounting to about 4GW of generation capacity. In 2017, 250MW of new wind power was licensed under this new scheme.

While only 24MW of new wind capacity was installed in 2017, many of the projects awarded in 2016 are expected to come on line in 2018. A 3<sup>rd</sup> round of tenders is expected in the second half of 2018.

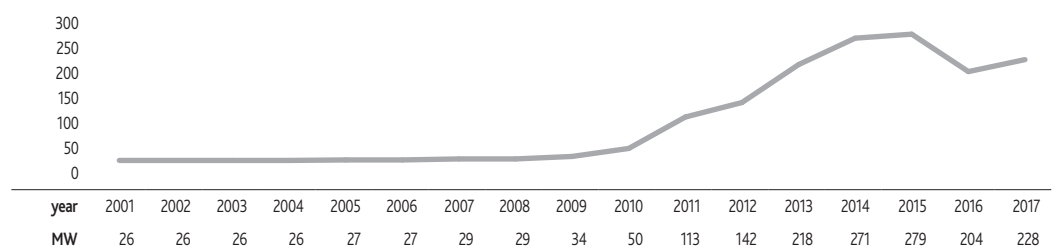
Key challenges faced by the Argentinian wind market include financing, the development of a local supply chain, logistical difficulties and expansion of the transmission grid. The government has issued a tender for enhancement of the grid infrastructure which is expected to be held in 2018.

The growing Argentinian market has started attracting manufacturing investment as well, most notably through Vestas' announcement in early 2018 of its intent to establish a nacelle assembly factory in the country, which was followed by a similar announcement from Nordex. If the market continues to develop as it has over the past two years, there will be more investments to come.



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## TOTAL INSTALLED CAPACITY



# AUSTRALIA

Australia's renewable energy industry had a genuinely transformational year in 2017. The promise of the national Renewable Energy Target (RET) finally bore fruit, with a significant number of wind projects either starting construction or proving successful in attracting financing. These projects added up to AUD\$ 6.2 billion of investment in 2017, representing a combined 2,885 MW of wind capacity – by far the biggest year in the history of the Australian wind industry. Although only one wind farm was commissioned in 2017, sixteen wind farms were under construction or financially committed at the end of the year. To date all Australian wind projects have been onshore, with the first off-shore project proposal attracting investor interest at the start of 2018.

The wind development underway across the country is largely attributable to the RET, an Australian Government policy designed to accelerate the lowest-cost form of renewable energy. The RET is designed to increase large-scale renewable generation by an additional 33,000 GWh per year by 2020 above a baseline of existing hydro projects. In early 2018 the Clean Energy Regulator, a Federal Government body, announced that there were enough projects at an advanced stage of development to build out the remainder of the RET by 2020, setting the industry up for several very active years of construction activity. As the lowest-cost form of renewable energy that can be rolled out on a large scale, wind energy is proving to be a strong contributor towards meeting this target.

State jurisdictions have enforced their own renewable energy targets. The Victorian Government legislated an auction scheme in 2017 which aims to deliver achieve 25% and 40% contributions from renewables to the state's electricity supply by 2020 and 2025, respectively. This auction is intended to

bring forward increased wind investment. The Queensland Government has also committed to a 50% target for renewable energy by 2030 to stimulate new investment in renewable generation.

The key barriers to the wind industry in Australia are the policy uncertainty currently being created by the imminent end of the RET, the rejection of the Clean Energy Target<sup>1</sup> (CET) and the lack of clarity around the National Energy Guarantee<sup>2</sup> (NEG). Having said all that, the industry is highly optimistic and looking forward to several years of record construction activity and many wind farms being commissioned before the end of the decade.

*With input from the Clean Energy Council, Australia*

- <https://www.cleanenergycouncil.org.au/policy-advocacy/energy-transformation/clean-energy-target.html>
- National Energy Guarantee (NEG) is a energy policy proposed by the Turnbull government in late 2017 to deal with rising energy prices in Australia and lack of clarity for energy companies to invest in energy infrastructure. The policy specifically targets energy companies in the National Electricity Market and large energy users to have a reliability obligation as well as emissions reduction obligations.

## KEY DATA

Total installed capacity  
**4,557 MW**

Wind power capacity added in 2017  
**245 MW**

Wind-generated electricity produced in 2016  
**12,903 GWh**

Share of wind generated electricity in total electricity consumption  
**6.7% (2016)**

People employed by the wind industry at the end of 2017  
**2,820 (2016)**

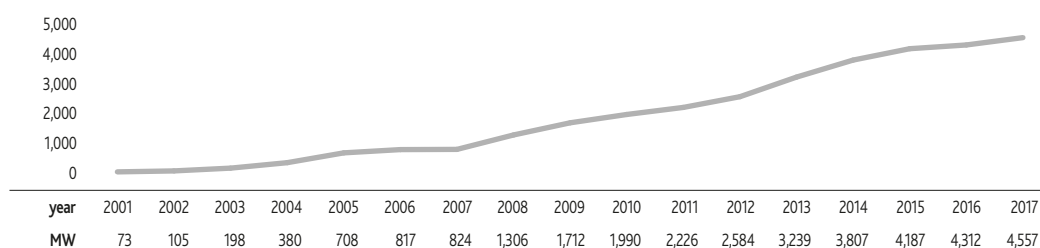
Number of turbines  
**2,184**

Leading turbine suppliers in 2017  
**GE, Vestas, Siemens Gamesa**

## PROJECT PIPELINE IN AUSTRALIA

|                              | Tech   | Location                        | Capacity (MW) |
|------------------------------|--------|---------------------------------|---------------|
| <b>Actively constructing</b> |        |                                 |               |
|                              | Wind   | Homsdale Stage 2                | 100           |
|                              | Wind   | Homsdale Stage 3                | 109           |
|                              | Wind   | White Rock – Stage 1            | 175           |
|                              | Wind   | MT Emerald                      | 180           |
|                              | Wind   | Kiata                           | 30            |
|                              | Wind   | Yaloak South                    | 29            |
|                              | Wind   | Mt Cellibrand – Stage 1         | 66            |
|                              | Wind   | Sapphire                        | 270           |
|                              | Wind   | Crookwell 2                     | 91            |
|                              | Wind   | Willogoleche Wind Farm          | 119           |
|                              | Wind   | Salt Creek Wind Farm            | 54            |
| Wind and Solar               | Hybrid | Kennedy Energy Park             | 58            |
|                              | Wind   | Silverton                       | 200           |
| <b>Financial commitment</b>  |        |                                 |               |
|                              | Wind   | Stockyard Hill Wind Farm        | 530           |
|                              | Wind   | Bodangora Wind Farm             | 113.2         |
|                              | Wind   | Lincoln Gap Wind Farm – Stage 1 | 126           |
|                              | Wind   | Coopers Gap Wind Farm           | 453           |

## TOTAL INSTALLED CAPACITY





# BRAZIL

## KEY DATA

Total installed capacity  
**12,763 MW**

Wind power capacity added in 2017  
**2,022 MW**

Wind-generated electricity produced in 2017  
**42,253 GWh**

Share of wind generated electricity in Brazil's total electricity consumption  
**7.44%**

People employed by the wind industry at the end of 2017  
**190,000**

Number of turbines  
**6,491**

Leading turbine suppliers in 2017  
**GE, Siemens Gamesa, Vestas**

After two years of drought, the Brazilian government held two new energy auctions and a transmission auction at the end of 2017. A total of 1.4GW of wind projects were contracted in the A-4 and A-6 auctions in December 2017, representing investments of over US\$ 2.5 billion. Wind power was the most competitive technology, with an average price of R\$ 98.62/MWh (around US\$ 30/MWh), well below prices for large hydropower.

Revival of the auctions was welcomed by the industry which has suffered from the country's recession that had brought new project procurement to a halt. Keeping the volume of 2GW of wind energy per year is fundamental for maintaining the supply chain, which is 80% nationalized, and brings multiple benefits and jobs to the Brazilian economy. In its *ten year energy development plan (PDE)* the government highlights wind power's important role. While 2018 may well be a politically turbulent year in Brazil due to presidential elections, the prospects for the wind sector remain strong, with two new

auctions scheduled for the year: an A-4 tender on 4 April; and an A-6 tender in August.

Brazil has some of the best wind resources in the world, exceeding the country's current electricity needs three times over. In 2017, Brazil's wind generation record was broken by producing 10% and 11% of national electricity demand in August and September respectively. In the Northeast, wind power supplied more than 60% of the electricity demand, beating all previous generation records during a time when hydropower reservoirs in the region were very low.

The transmission auction held in 2017 will help ease the problem of insufficient transmission. Regarding financing, there's an objective to strengthen the private banks, which should lead to an increase of financing possibilities in the sector. The Brazilian Development Bank (BNDES) has also decided to substitute long-term interest rates (TJLP) with a new long-term Rate (TLP), which is more aligned with market prices.

The Brazilian government's ten-year energy development plan forecasts the country to reach 28.5GW of wind capacity by 2026. Currently, there are more than 5GW of wind projects in the pipeline.

*With input from the Brazilian Wind Energy Association, ABEEólica*

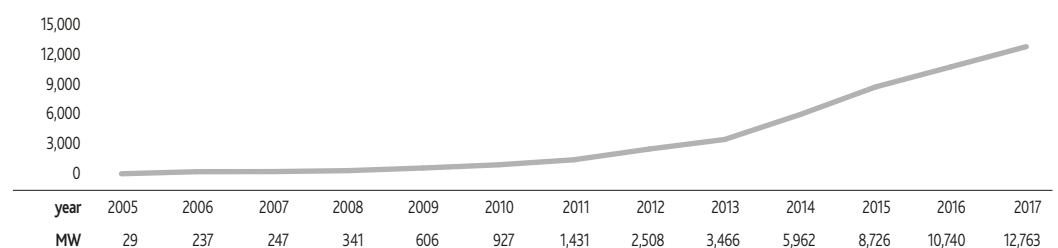
### WIND POWER PROJECT PIPELINE

| Year         | Total of Projects | Total Capacity (MW) |
|--------------|-------------------|---------------------|
| 2018         | 84                | 1,800.35            |
| 2019         | 56                | 1,291.10            |
| 2020         | 30                | 522.60              |
| 2021         | 2                 | 64.00               |
| 2023         | 51                | 1,434.93            |
| <b>Total</b> | <b>223</b>        | <b>5,112.98</b>     |



© GWEC/De Freitas Oliveira

### TOTAL INSTALLED CAPACITY



# CANADA



© CanWEA

Overall, the Canadian market saw a substantial dip in 2017, but a competitive electricity-supply auction in December in Alberta made 2017 a record-breaking year for wind energy. It yielded the lowest-ever price paid for wind energy in Canada and made wind energy the lowest-cost option for new electricity generation in the country. The auction secured 600 MW of capacity at a weighted average price of CDN\$ 37/MWh (US\$ 28.8/€ 23.4/MWh). This will help inform expectations for a 2018 auction in Saskatchewan and another in Alberta this year as well.

In Canada, the federal government remains committed to phasing out coal power, meeting its Paris Agreement obligations, and ultimately decarbonizing the economy, which will necessitate a corresponding scale-up of non-emitting electricity generation, including wind energy. However, near- and mid-term electricity surpluses in some regions, coupled with low short-term demand growth across the country are cooling investment prospects somewhat. Exporting clean wind energy to the United States remains a potential opportunity. While there is no doubt that the future for wind energy is positive, Canada's wind energy industry is entering a period of

slower growth than the rocketing expansion of the past decade.

Also in December 2017, the federal government rolled out its *Greening Government Strategy*. The plan seeks to reduce greenhouse gas emissions from government operations 40% by 2030, in part via a commitment to use 100% clean electricity in government buildings. Wind energy has the potential to play a leading role in delivering on this commitment, through new renewable energy certificates or power purchase agreements.

While wind energy will continue to grow in Canada, it is currently expected that we will also see significant growth in natural gas generation as coal is phased out and nuclear plants are refurbished. The wind energy industry is working to raise awareness of the fact that the decarbonisation of Canada's electricity grid cannot stop with coal.

The Canadian wind energy industry is looking forward to a good year in 2018, with about 600 MW of new capacity expected to come online.

*With input from the Canadian Wind Energy Association, CanWEA*

## KEY DATA

Total installed capacity  
**12,239 MW**

Wind power capacity added in 2017  
**341 MW**

Wind-generated electricity produced in 2017  
**30,081 GWh**

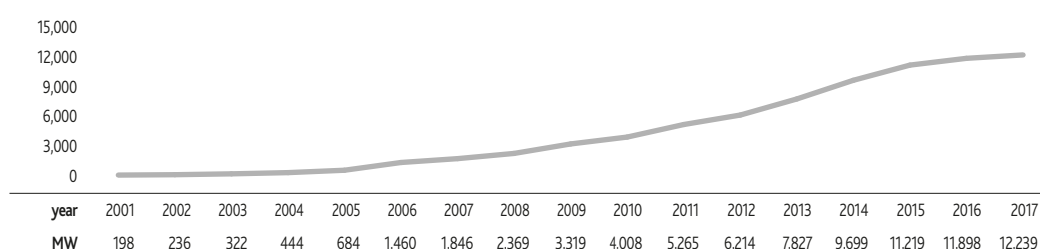
Share of wind generated electricity in Canada's total electricity consumption  
**6%**

People employed by the wind industry at the end of 2017  
**n/a**

Number of turbines  
**6,415**

Leading turbine suppliers in 2017  
**GE, Siemens Gamesa, Senvion**

## TOTAL INSTALLED CAPACITY



# PR CHINA

## KEY DATA

Total installed capacity  
**188,392 MW**

Wind power capacity added in 2017  
**19,660 MW**

Wind-generated electricity produced in 2017  
**305.7 TWh**

Share of wind generated electricity in China's total electricity consumption  
**4.8%**

Number of turbines  
**104,934**

Investment in wind power  
**RMB 64 billion**  
**(€ 8.28 billion)**

Leading turbine suppliers in 2017  
**Goldwind, Envision, Mingyang**

China again led global markets in 2017 by adding 19,660 MW of new capacity to the country's electricity grid. Although this is a 15.9% decrease on the 2016 market, it still represents 37% of global installations. This brings China's cumulative installations to 188,392 MW, an 11.7% increase from the previous year. While the numbers are strong, China's wind development is gradually slowing down, and growth is expected to be flat for the next few years out to 2020.

On the generation side, electricity produced from wind power reached 305.7 TWh in 2017, a 27% increase from 2016, enough to produce 4.8% of the national electricity supply. This shows wind and other renewables taking an increasingly important role in the country's generation mix, with fossil fuels continuing to decrease from 79% in 2012 to 71% in 2017.

## DEVELOPMENT TREND

A significant change in the regional distribution of wind projects took place in 2017. Wind installations in the Central and Southern regions increased substantially, accounting for 55% of all installations last year. Previously the majority of installations were in the three northern regions (North West, North East and Central North). To better address the serious curtailment issue, the development of wind in Central and Southern regions is prioritized in the 13<sup>th</sup> FYP over the three-northern regions. Newly added

capacity in the Central and Southern regions, with generally lower levels of curtailment, have a target of an additional 42GW by 2020, larger than the additional 35GW target for the three northern regions. This will make the Central and Southern regions the new engines of wind development in the next three years, which is opposite to the development path of the past decade. The industry has also echoed this by investing in the development of turbines suitable for class III wind. Longer blades and higher towers are becoming the norm, while development at wind sites with wind speeds of 5m/s is becoming financially feasible for most companies.

## CURTAILMENT CHALLENGE: SLOWLY IMPROVING

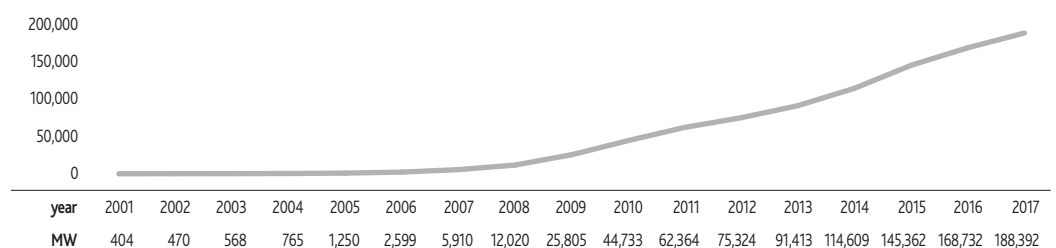
Grid curtailment is still a major challenge for the wind industry in China. However, the situation is improving, with the national average curtailment rate decreasing from 17% in 2016 to 12% in 2017. 41.9 TWh of wind electricity was curtailed in 2017, down 7.8 TWh from 2016. Curtailment remains very high in Gansu (33%), Xinjiang (29%), Jilin (21%) and Inner Mongolia (15%). In 2017, the national Energy Administration (NEA) issued an *Action Plan on Solving the Wind and Hydro Curtailment*, in which the priority purchase of renewable energy is reiterated, and attention is placed on system flexibility as a key to solve the integration issue. Clean energy heating is one of the key future areas of development in the Northern regions. Using the electricity market, where there are already an increasing number of electricity wholesale companies<sup>1</sup>, emerged as another solution for alleviating the situation.

<sup>1</sup> Electricity wholesale companies began to emerge in the past two years, helping to connect power producers and large consumers, primarily industrial users. Renewable energy is not taking a great share in this market at present, but transactions are happening. With the positive prospect for the implementation of an RPS emerging, the role of RE trading will definitely increase.

## PENETRATION RATES FOR DIFFERENT TECHNOLOGIES IN CHINA (2012-2017)

|             | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|-------------|------|------|------|------|------|------|
| Hydro       | 17%  | 17%  | 19%  | 19%  | 19%  | 19%  |
| Fossil Fuel | 79%  | 79%  | 76%  | 74%  | 72%  | 71%  |
| Nuclear     | 2%   | 2%   | 2%   | 3%   | 4%   | 4%   |
| Wind        | 2%   | 3%   | 3%   | 3%   | 4%   | 5%   |
| Solar       | 0%   | 0%   | 0%   | 1%   | 1%   | 2%   |

## TOTAL INSTALLED CAPACITY





Shanghai, China © GWEC

## SUPPORT SCHEME AND RPS

The feed-in tariff has been the main driver for wind development in China. The FIT has been financed through an RE surcharge, which is added to each kWh of electricity sold. The surcharge is then put into an RE Fund dedicated to finance the FIT and other activities related to renewables. The RE Fund has always been under pressure. In 2017, the shortfall of the RE Fund reached RMB 100 billion (€ 129.4mn/US\$ 159mn). This was not only due to wind installations, but also to soaring solar PV installations in the past two years. On this occasion, the government introduced a green certificate system, hoping that this could work as a replacement for the FIT in the future. However, an aggressive Renewable Energy Portfolio (RPS) is a prerequisite for a nation-wide green certificate market, and it must be stringently enforced to ensure sufficient demand for the certificates.

In China, establishing an RPS has been discussed for a long time and is still not settled, despite years of negotiations with

various stakeholders. However, the good news is that at the time of writing, the RPS Act has been once again circulated for comments among different government ministries. This is a good sign, and there's a higher chance for the bill to pass this time, thanks to growing pressure to find a new way to finance renewables as well as pressure to combat air pollution. In the current draft proposal, the RPS targets are divided into: 1) RE targets with hydropower; and 2) RE targets without hydro power included. The targets for provinces with high RE resources are set at 10% on average, and for the four provinces with the highest curtailment rate, the RPS target is set at 15% on average.

The Chinese market will continue to lead global markets in the coming years. With the RPS in sight and the electricity market starting to emerge, we expect the curtailment to decrease and the transition from a fossil-fuelled energy system to a clean energy system to continue and consolidate.

*With input from the Chinese Wind Energy Association, CWEA*



# THE EUROPEAN UNION

## KEY DATA

Total installed capacity

**168.7 GW**

Wind power capacity added in the EU in 2017

**15.6 GW**

Wind-generated electricity produced in 2017

**336 TWh**

Wind generated enough electricity to meet **11.6%** of the EU's total electricity demand

People employed by the wind industry at the end of 2016

**262,712**

Number of turbines

**n/a**

Leading turbine suppliers in 2017

**Vestas, Siemens Gamesa, Enercon**

© Enercon



Europe had its best year ever in 2017, with record installations both on and offshore; and with new records set in Germany, the UK, France, Belgium, Ireland and Croatia. A total of 15.6 GW (16.8 GW in Europe) of new wind power capacity was installed in the EU during 2017, of which 3,148 MW 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.

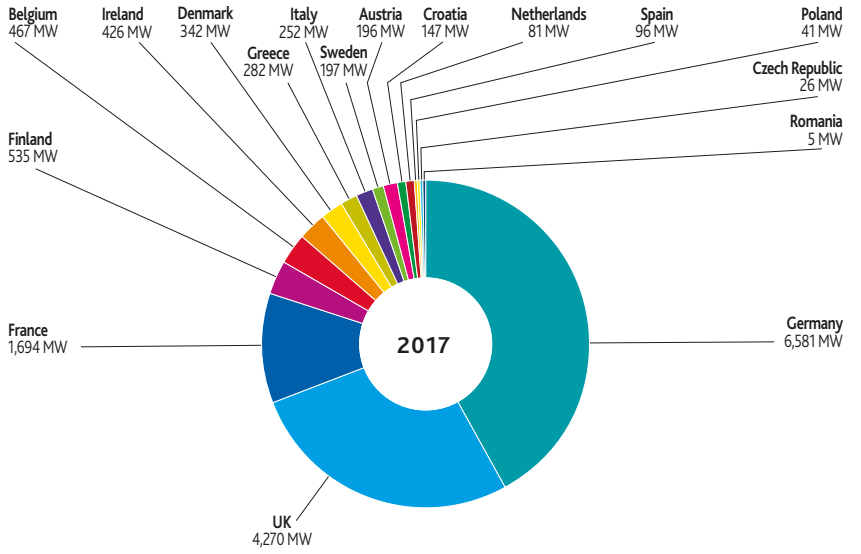
Germany installed the most wind power capacity in 2017, with 6,581 MW (a 15% increase on 2016); 19% of Germany's installed capacity was offshore. The UK came second with 4,270 MW, five times more than installations in 2016. France was third with 1,694 MW (9% growth on 2016).

Finland (535 MW), Belgium (467MW) and Ireland (426MW) followed, with additions all above 400MW. In total, 17 countries saw some new installations last year, down from 20 countries in 2016. There were no new installations in the Baltic countries. The Czech Republic had new installations (26MW) after two years of inactivity. 80% of the total new installations took place in just three countries, a considerable increase in the concentration of wind power installations compared to 2016.

Cumulatively, there are now 168.7 GW of wind power capacity in the European Union, 153 GW onshore and 15.8 GW offshore, making wind energy second only to gas in the European market. Germany remains the EU leader with 56.1 GW, followed by Spain (23.2 GW), the UK (18.9 GW), France (13.8 GW) and Italy (9.5 GW). Another four



### EU COUNTRY SHARES OF NEW WIND ENERGY CAPACITY INSTALLED DURING 2017



Total: 15,638 MW

Source: WindEurope

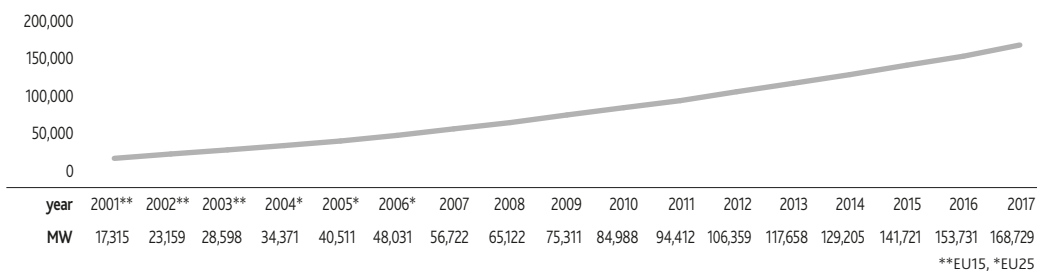
EU country with the highest penetration rate (44%), followed by Portugal (24%) and Ireland (24%). Germany registered the highest increase from the previous year, with a 25% increase in power generation. 10 out of the 28 Member States had a wind penetration rate of more than 10%.

At the end of 2016 the wind energy industry accounted – both directly and indirectly – for 262,712 jobs in the EU. It contributed € 36.1bn to the EU's Gross Domestic Product or 0.26% of the overall EU GDP. The industry remains a global net exporter with a € 2.4bn positive trade balance in products and services (€ 7.8 bn exports and € 5.4 bn imports). Over 80% of European wind energy companies have a commercial presence and manufacturing sites outside of Europe in more than 80 countries. Of the 10 largest wind turbine manufacturers in the world, five are EU-based.

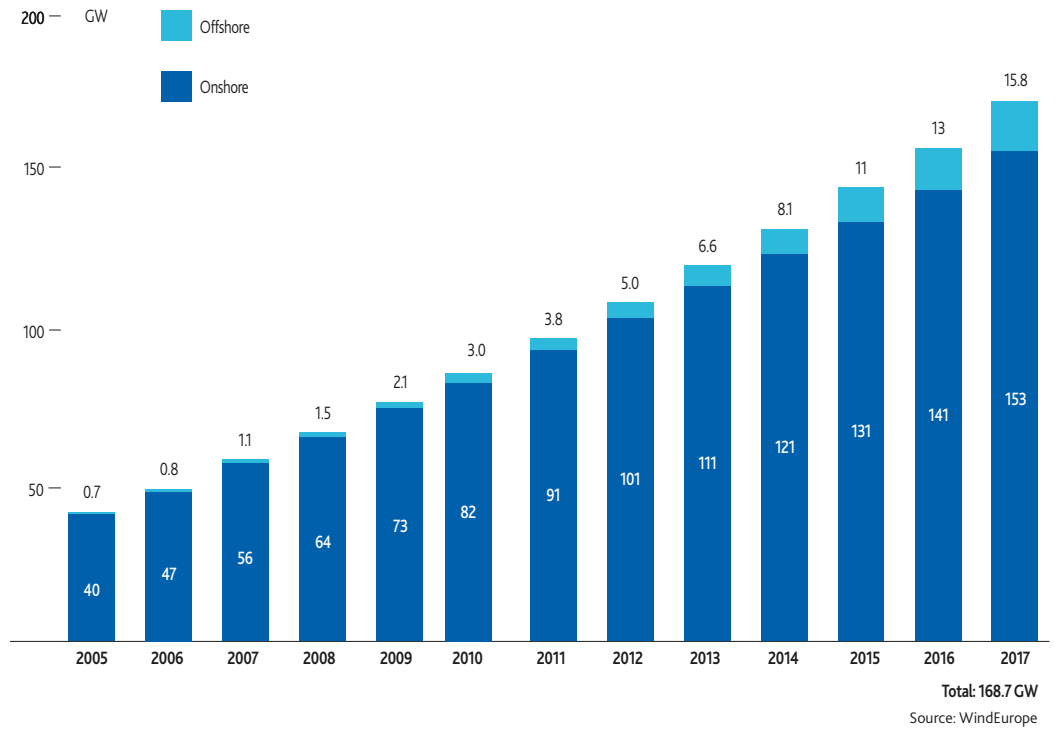
EU countries (Sweden, Poland, Portugal and Denmark) have more than 5 GW installed, and an additional seven countries more than 1 GW: Austria, Belgium, Finland, Greece, Ireland, the Netherlands and Romania.

In 2017 wind energy generated enough electricity to meet 11.6% of the EU-28's total electricity demand. Denmark was the

### TOTAL INSTALLED CAPACITY



## CUMULATIVE INSTALLATIONS ONSHORE AND OFFSHORE IN THE EU



The largest asset owners are, in alphabetical order, Accional Energia, EDF-EN, EDP Renewables, ENEL Green Power, Engie, E.ON Climate and Renewables, ERG Renewables, Iberdrola Renewables, Ørsted, RES Ltd and Vattenfall. Market leaders in wind turbine original equipment manufacturing (OEMs) are ENERCON, GE, Renewables, MHI-Vestas, Nordex-Acciona, Senvion, Siemens Gamesa and Vestas.

For many countries 2017 was a transitional year to new support schemes and tender mechanisms. A large number of projects were rushed to connect while feed-in-tariffs still applied. The first onshore wind tenders took place in Germany, Spain and France. The UK ended its Renewable Obligation Certificates (ROCs). Although some projects will continue accessing the FiT in Germany, France and Belgium; and Sweden continues with its green certificates, Europe entered the 'auction world' in 2017.

EU annual installations are expected to decrease in 2018 due to a slow-down in Germany and the UK. However, 2019 is likely to be a record year for offshore wind installations; and a massive quantity of Spanish installations are expected in 2019 as a result of the 4.1 GW awarded in the two tenders in 2017. WindEurope expects 37 GW to be installed between 2018 and 2020.

During 2018, EU Member States and the European Parliament are expected to adopt the *Clean Energy for All Europeans* legislative package, which will in large part determine the future of renewables for the decade after 2020. Long-term visibility and stable regulatory frameworks remain crucial for wind energy deployment post-2020. Only 8 out of 28 Member States have renewable energy plans post 2020. The Emissions Trading System (ETS), is still not expected to provide the market signals needed to shift investments from polluting power generation into renewable energy.

Other barriers to wind energy deployment are caused by long permitting and siting procedures in some countries due to potentially adverse interaction with civil and military aviation, and tightening regulations on setback distances and noise limits (Poland, France, the UK, Sweden and Baltic countries). Also, about 50% of the EU's current installed capacity will reach the end of its operational life by 2030. An effective repowering market will rely on the implementation of fast-track administrative procedures, among other things. Finally, the rate of build out and reinforcement of onshore grids to host an increasing capacity of wind energy, both on-and offshore, while minimising curtailment, is crucial for keeping a high pace of wind energy deployment in Europe.

*With input from WindEurope*





© iStock.com/PPAMPicture

# FINLAND

## KEY DATA

Total installed capacity  
**2,071 MW**

Wind power capacity added in 2017  
**535 MW**

Wind-generated electricity produced in 2017  
**4.8 TWh**

Share of wind generated electricity in Finland's total electricity consumption  
**5.6%**

People employed by the wind industry at the end of 2017  
**5,000**

Number of turbines  
**700**

Leading turbine suppliers in 2017  
**Vestas, Nordex, Acciona**

**2017** was another strong year for the wind industry in Finland, partly driven by a policy-induced 'rush-to-install' prior to the end of the feed-in tariff scheme at the end of November. In its *Energy and Climate Strategy for 2030* published in the end of 2016, the Finnish government announced its intention to replace the FIT system with technology neutral auctions for renewables. However, the legislation is still pending approval in the parliament. The auctions are planned to be available only for a limited amount of renewable energy capacity, while a much larger number of fully permitted wind power projects are waiting to be built.

Details of the new competition-based system are yet to be published. Before that the government ordered a study on the effect of wind power on health and on bats and birds. The results of the studies were published in June, with no new findings that would have given any reason not to proceed with wind power development.

Finland's first commercial offshore wind farm, Suomen Hyötytuuli's 40MW Tahkoluoto

project, came online in 2017. The project's ten 4MW turbines sit on rock-filled gravity-base foundations specifically designed to withstand the icy conditions of the Gulf of Bothnia. Research on offshore Arctic conditions will be conducted at the site over the lifetime of the project. The research will contribute to a growing pool of cold-climate wind power technology research conducted by leading Finnish institutes.

Currently, the key priority for the industry is ensuring that the details of the new auctioning system will support the industry effectively.

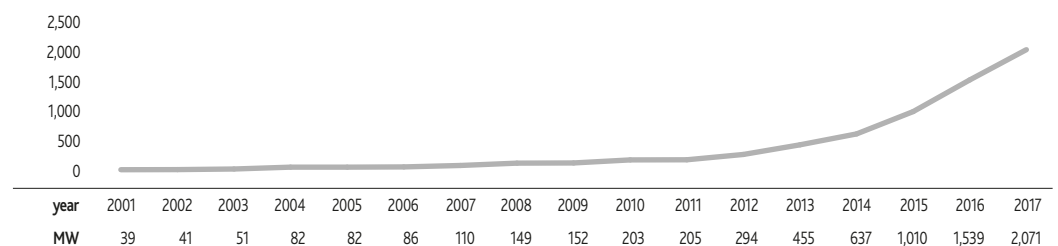
A slow down for wind development is expected in 2018, with no new capacity to be constructed in Finland. Numbers are expected to go up again towards the end of the decade. The Finnish government has a goal to produce 50% of domestic energy supply from renewable energy by 2030.

*With input from the Finnish Wind Energy Association*

Vihreäsaari wind farm, Oulu, Finland  
© wpd windmanager Scandinavia Oy



## TOTAL INSTALLED CAPACITY



# FRANCE

France had a big year in 2017, installing a record 1,694MW of onshore wind power, bringing the total to 13,759MW, enough to power 11 million French homes. The country's first onshore wind tender was launched with 500 MW awarded at an average price of € 65.4/MWh in March 2018. The French government also introduced simplifications to the legal framework in order to accelerate and facilitate deployment of wind energy.

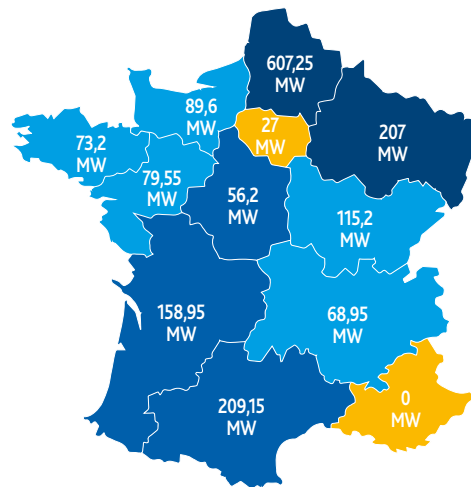
Other good news was the unveiling of France's first offshore wind turbine (a floater) on 13 October 2017. The commissioning of the 2MW Floatgen project is expected to take place in April 2018. Floatgen marks a *turning point* for floating wind as the sector prepares to enter commercial deployment.

France's multi-year energy plan (Programmation pluriannuelle de l'énergie) is currently under revision. The plan will set targets for each technology for 2023-2028. The first draft is expected to be released by the French government in June and final adoption of the plan is envisaged in December 2018.

Constraints linked to radar and aviation and for installations close to military facilities remain the main obstacles to wind development in France. Grid connection conditions have improved thanks to collaboration between the wind industry and transmission and distribution system operators. There are still some administrative rules that need to be further clarified in 2018.

The French wind industry expects to reach a new annual onshore wind record in 2018. The year should also see the adoption of the updated multi-year energy plan and the results of the ~500 MW third offshore wind tender off Dunkerque.

## INSTALLED CAPACITY BY REGION IN 2017



Source: France Energie Eolienne, 2018

By 2023, the FEE expects to reach 26 GW onshore and 3.2 GW offshore wind power respectively.

*With input from the French Wind Energy Association, FEE*

## KEY DATA

Total installed capacity  
**13,759 MW**

Wind power capacity added in the country in 2017  
**1,694 MW**

Wind-generated electricity produced in 2017  
**22.84 TWh**

Share of wind generated electricity in total electricity consumption  
**4.8%**

People employed by the wind industry at the end of 2016  
**15,870**

Number of turbines  
**6000 turbines**

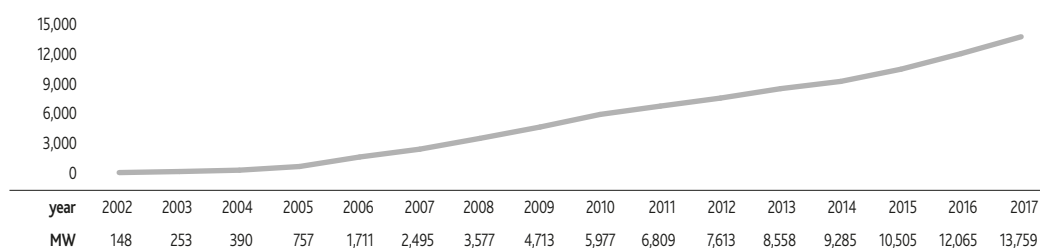
Leading turbine suppliers in 2017

**Vestas, Enercon, Senvion**



©Floatgen.eu

## TOTAL INSTALLED CAPACITY





# GERMANY

## KEY DATA

Total installed capacity  
**56,132 MW**

Wind power capacity added in 2017  
**6,581 MW**

Wind-generated electricity produced in 2017  
**105.5 TWh**

Share of wind generated electricity in Germany's total electricity consumption  
**16.1%**

People employed by the wind industry at the end of 2016  
**150,000**

Number of turbines  
**29,844**

Leading turbine suppliers in 2017  
**Siemens Gamesa, Vestas, GE**

Germany had a record year in 2017, leading all EU markets by adding 6,581 MW of new wind power, up 15% from the 2016 market. This was largely due to the end of the country's feed-in tariff regime and the entry of feed-in-premiums with auctions. Offshore installations represented a significant share of all grid-connected projects (1,247 MW). A total of € 6.7bn of investment was generated for the construction of new onshore and offshore wind farms in the course of the year. Germany's wind sector registered an enormous increase in generation in 2017, producing 104 TWh, up 25% on 2016.

In 2017, competitive renewable energy auctions were introduced in Germany by the Federal Network Agency (BNetzA). The results of the first offshore tender, held in April 2017, were considered as an important signal for the offshore market in Germany: the average awarded price came in at € 0.44 cents/kWh and the lowest offer at € 0 cents/kWh, meaning that tenders for more than 1 GW of new offshore capacity receive no more than the wholesale price of electricity. The second offshore tender will be completed in April 2018, and the roll-out of offshore wind energy

up to 2020 with 6,500 MW is progressing according to plan. By 2030 Germany expects to have 15,000 MW of offshore wind capacity.

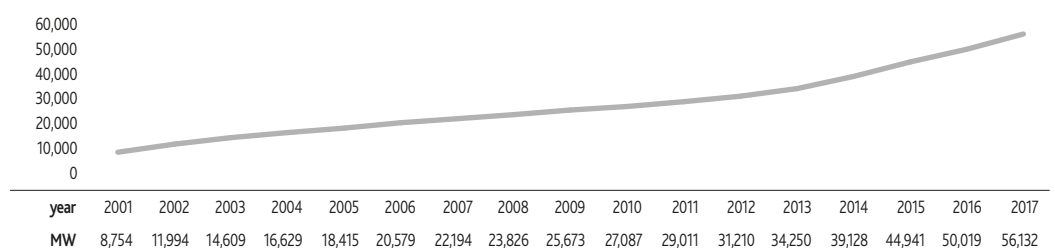
Germany is also ramping up its installed onshore wind capacity by holding tenders for 2.8 GW per year from 2017 to 2019, and 2.9 GW each year afterwards, as part of the country's move away from fossil fuels. However, the first three onshore tenders held during 2017 were dominated by so called "citizen's wind projects", which were allowed to bid without permits, and where successful, have up to four and a half years for implementation. This shortcoming was recognised by the German government and the tender design has been amended for future auctions. To avoid a dip in expansion and to meet the government's energy policy targets, the tender volume also needs to be adjusted, as planned in the Bundesrat and the coalition agreement. The German wind industry expects to see new installations of 3.5 GW in 2018.

*With input from the German Wind Energy Association, BWE and VDMA Power Systems*



Marienkoog, Niebüll

## TOTAL INSTALLED CAPACITY



# INDIA



© GWEC/Naatu

India had a record year in 2017, adding 4.15 GW, the first time the country has broken 4 GW in a single year, taking total capacity to 32.8 GW and cementing its position as the world's fourth largest wind market. The big change in 2017, however, was the shift from feed-in tariffs to competitive tendering. While installation numbers have slowed as the industry adapts to the new regime, the future looks bright with the government's commitment to install 60 GW of wind power by 2022. This will mean an average of about 7 GW/year for the four years following 2018; and at the end of this period, we should see the beginnings of an offshore wind sector emerging in the country.

To date, two auctions of 1 GW each have been completed and a 3<sup>rd</sup> auction for 2 GW is in progress. Two more bids of 2 GW each will take place in the first quarter of 2018, followed by 10 GW in 2018-19 and another 10 GW during 2019-20. Additionally, the Ministry of New and Renewable Energy

(MNRE) has asked state governments to consider feed-in tariffs for Micro, Small and Medium Enterprises (MSME) for projects below 25MW at tariffs to be determined by the states.

First assessments of offshore wind potential in India together with pre-feasibility studies for two key coastal states of Tamil Nadu and Gujarat have been conducted by GWEC led FOWIND (Facilitating Offshore Wind in India) project. Offshore wind power could play an important role in India due to the large wind resources available near centers of high-energy demand.

The key challenges faced by the Indian wind industry include the lack of a system to trade and transfer wind power from windy states to other parts of the country and insufficient grid connections.

*With input from Indian Wind Turbine Manufacturers Association, IWTMA*

## KEY DATA

Total installed capacity  
**32,848 MW**

Wind power capacity added in the country in 2017  
**4,148 MW**

Wind-generated electricity produced in 2017  
**53,726 GWh**

Share of wind generated electricity in India's total electricity consumption  
**4.35%**

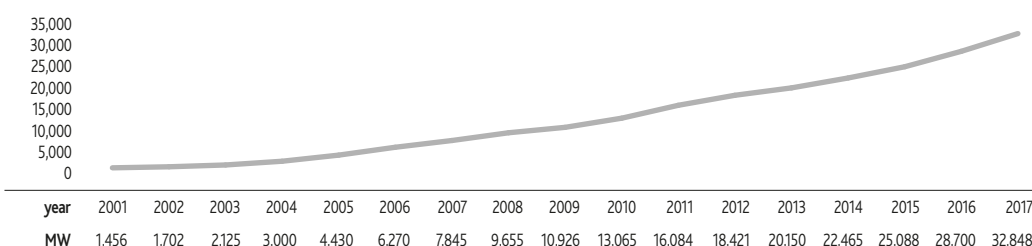
People employed by the wind industry at the end of 2017  
**0.2 million**

Number of turbines  
**32,136**

Leading turbine suppliers in 2017

**Siemens Gamesa, Suzlon, Inox Wind Limited**

## TOTAL INSTALLED CAPACITY



# JAPAN

## KEY DATA

Total installed capacity  
**3,400 MW**

Wind power capacity added in 2017  
**177 MW**

Wind-generated electricity produced in 2017  
**5,030 GWh**

Share of wind generated electricity in Japan's total electricity consumption  
**0.56%**

People employed by the wind industry at the end of 2017  
**5,000**

Number of turbines  
**2,225**

Leading turbine suppliers in 2017

**Hitachi, Enercon, Japan Steel Works (JSW)**

Japan added 177MW of new wind power in 2017, down 10% from 2016. Several large wind farms have finished the long EIA (Environmental Impact Assessment) process and come online. Cumulative installations reached 3,400MW at the end of 2017, producing about 5 TWh of electricity, which is about 0.56% of Japan's total electricity supply.

Japan's offshore wind capacity reached 64.6MW with a total of 29 turbines in Japanese waters. One further floater – the 5MW Hitachi floating turbine - came online in May 2017 as part of the FukushimaFORWARD project.

Wind development in Japan has been slow due to unclear and inconsistent policies. A new law is to be adopted in May 2018 to enable more offshore wind development, but now the government is planning to change the feed-in tariff regime into a price based auction system. While some improvements with the EIA procedure have been achieved, grid restrictions still create a barrier for wind development in Japan.

The Japanese Ministry of Economy, Trade and Industry (METI) has set a target for wind power at 10 GW (including 820MW offshore wind power) by 2030, in its future energy plan called the *Long-term Energy Supply and*

*Demand Outlook (Energy Mix Plan)* which was released in July 2015. The plan is reviewed every three years. The Japan Wind Power Association (JWPA) has requested a more aggressive target for wind power, calling for 36.2 GW by 2030, including 10 GW of offshore.

The Japanese FIT law was amended in April 2017. The FIT approval timelines have been moved earlier and feed-in tariffs will now be applied in the middle of the EIA process, 2 to 3 years prior to the project start. This can significantly improve the predictability of project profitability. At the same time, FIT approval is still subject to acquiring grid connection rights. METI has also lowered the feed-in tariffs for wind and solar over the next three years to 2020.

### FIT PRICE FOR WIND POWER (JPY/KWH)

| Type                   | FY2017  | FY2018 | FY2019 | FY2020    |
|------------------------|---------|--------|--------|-----------|
| Onshore                | 22 / 21 | 20     | 19     | 18        |
| Onshore repowering     | 18      | 17     | 16     | 16        |
| Offshore, fixed bottom | 36      | 36     | 36     | (Auction) |
| Offshore, floating     | 36      | 36     | 36     | 36        |

source: METI

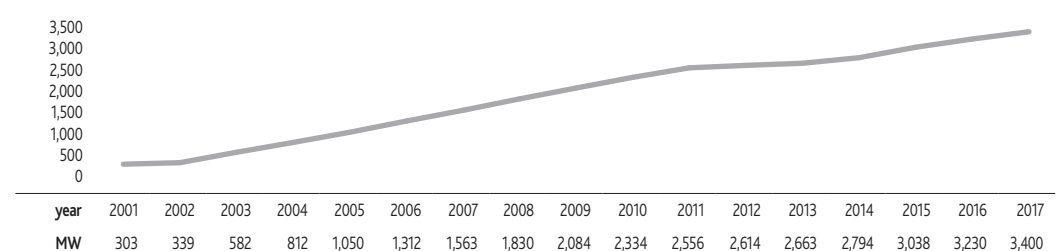
Japan expects to install about 250MW in the course of 2018.

*With input from the Japan Wind Power Association, JWPA and the Japanese Wind Energy Association, JWEA*

The 80MW wind farm, in Mie pref, with 2 MW X 40 Hitachi turbines, started operation in February 2017 © Aoyama Kogen wind farm



## TOTAL INSTALLED CAPACITY





# MEXICO

The Mexican wind industry has an aggressive target to reach 14 GW of installed wind capacity by 2022, as the government remains committed to knocking down remaining market barriers. After three clean-energy tenders that have contracted more than 2 GW of wind since March 2016, the government is now preparing the fourth tender, to be launched by the end of March 2018. Mexico ended 2017 with just over 4 GW of installed wind capacity; wind power has already attracted over US\$ 7.6bn of investment. The auctions held so far have come in at historically low prices, setting new world records and demonstrating the competitiveness of wind power in the country. Moreover, the Mexican wind market is not just about long term auctions, as there are also new regulations which allow for bilateral contracts with large private sector consumers.

As a result of the auctions, almost 50% of the country's states will have new generation projects. This helps to spread the social and economic benefits of renewable energy development to communities across the country. At present, Mexico's 46 wind farms are located in the states of Baja California, Zacatecas, Chiapas, Jalisco, Nuevo León, Oaxaca, San Luis Potosi, Tamaulipas and Puebla.

In 2017, the government published tender rules for the country's first transmission line to be built and owned by private companies, as part of its energy reform package that has opened the generation and transmission sectors to private and foreign investment. Transmission is seen as a key bottleneck for the Mexican wind market.

The Mexican Energy Ministry's forecast estimates that when taking into account both the planned demand growth and the replacement of obsolete generation centrals, a minimum of 56 GW of new capacity will be needed for the 2017-2031 period.



© AMDEE

The government has set a clean energy target for the power sector of 35% by 2024, 40% by 2035 and 50% by 2050. The Mexican wind industry expects to install about 1,180MW in 2018 from seven wind farms that are planned to come online in course of the year. By 2020, the industry expects to see more than 12 GW installed, and up to 14 GW by the end of 2022.

*With input from the Mexican Wind Energy Association, AMDEE*

## KEY DATA

Total installed capacity  
**4,005 MW**

Wind power capacity added in 2017  
**478 MW**

Wind-generated electricity produced in 2017  
**1,976 GWh**

Share of wind generated electricity in Mexico's total electricity consumption  
**About 4%**

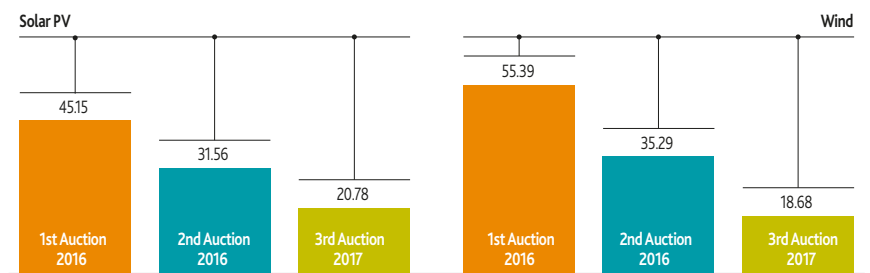
People employed by the wind industry at the end of 2017  
**1,550**

Number of turbines  
**2,140**

Leading turbine suppliers in 2017  
**Siemens Gamesa, Acciona, Vestas**

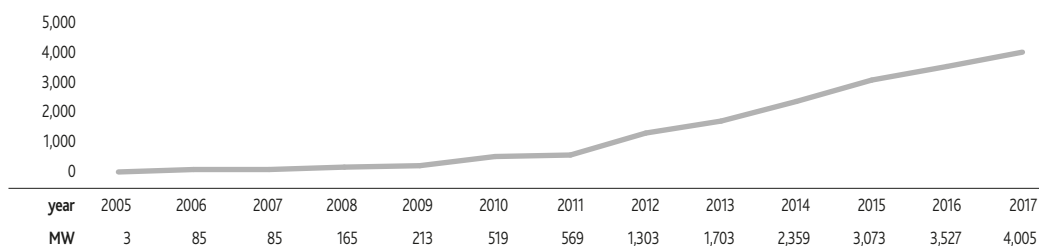
## AVERAGE AWARDED LCOE FOR SOLAR PV AND WIND

2016 & 2017 Long Term Auctions (US\$/MWh)



Source: AMDEE

## TOTAL INSTALLED CAPACITY



# NETHERLANDS

## KEY DATA

Total installed capacity  
**4,341 MW**

Wind power capacity added in 2017  
**81 MW**

Wind-generated electricity produced in 2017  
**10.6 TWh**

Share of wind generated electricity in total electricity consumption  
**~9%**

People employed by the wind industry at the end of 2015  
**10,150**

Number of turbines  
**2,294**

Leading turbine suppliers in 2016  
**Siemens Gamesa, Enercon, Lagerway**



First Dutch offshore windfarm © Guido Hommel, NWEA

Although 2017 was a quiet year for wind development in the Netherlands, the country has some ambitious plans in the works. The Dutch government has set a target of 6,000MW of onshore wind power by 2020 and 4,500MW of offshore wind by 2023, up from current 4,341MW of which 1,118MW is offshore. Negotiations have also started over renewable energy targets for 2030. The Dutch Wind Energy Association (NWEA) calls for reaching 15 GW of onshore and 18.5 GW of offshore wind energy by 2030.

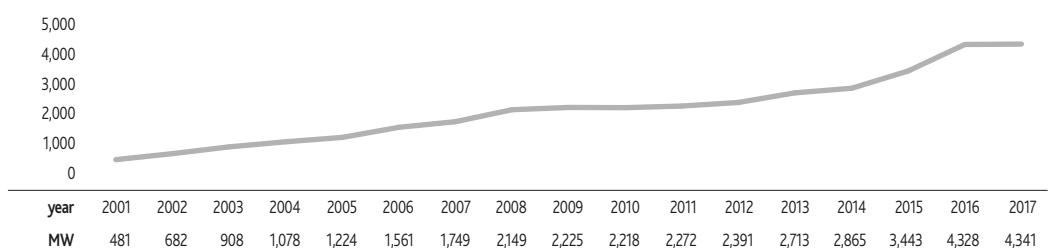
With its five offshore wind farms, the Netherlands currently is the fifth largest offshore wind market in the world. At the end of 2017, the Netherlands launched a landmark zero-subsidy offshore wind tender to build the 700MW Hollandse Kust Zuid project, which has now been awarded to Vattenfall. The tender has been labelled as a *game-changer* for the sector because it means that the bidders will rely solely on wholesale electricity prices without financial aid from the government.

The ambitious plans don't stop there. The Dutch grid operator TenneT (with Denmark's Energinet) has a plan to build an island which would act as a power hub for vast offshore wind farms. The power hub would send electricity over a long-distance cable to the UK and the Netherlands and possibly later to Belgium, Germany and Denmark. The proposal is seen as an innovative answer to industry's challenge of continuing to make offshore wind cheaper. TenneT envisages the project involving windfarms with a capacity of 30 GW, more than twice today's total installed offshore wind power in Europe. The next steps for the plan will come during 2018 in the shape of a roadmap published in the Netherlands.

Key barriers to wind development in the Netherlands are lack of sufficient grid infrastructure, both on- and offshore and public opposition in some areas.

*With input from the Netherlands Wind Energy Association, NWEA*

## TOTAL INSTALLED CAPACITY



# NORWAY

Norway's wind industry had its all-time record year in 2017 with 324MW of new wind power installed, as the country is moving towards ending the joint renewable energy support scheme with Sweden. This coincides with the first large corporate wind power deals, setting the scene for Norway to become a major wind-powered corporate PPA market in the Nordics. To date, Norsk Hydro is buying power from wind farms in Fosen to supply the company's technology pilot at its Karmøy plant; the international giant Alcoa's Norwegian arm has made a deal to purchase power from the Kvitfjell and Raudfjell wind farms to power its aluminium plant in Mosjøen; and Google buys output from the Tellnes wind farm to power its data centers in Europe.

Until recently, Norway has put offshore wind development on hold, claiming the technology was too expensive. Now, following the sharp fall in offshore costs, the government wants to take another look at offshore wind, using demonstration projects, particularly for floating technology. One or two areas will soon be opened for offshore wind development, and the state-owned enterprise Enova is ready to receive applications for technology development and demonstration projects.

Lack of strategy and targets for new wind power development has been one of the key barriers in Norway, following the decision not to continue Norwegian participation in the green certificates scheme. However, in 2017 the Norwegian Water Resources and Energy Directorate (NVE) started preparing

a *National Framework for Wind Power*, which is expected to be published in 2018. The national framework will provide data on areas where conditions for wind energy development are most favourable, and will also be utilised as a national knowledge base for wind energy.

In 2018, the first part of the landmark 1,000.8 MW Fosen wind farm is expected to be completed, with the planned grid connection of the 255MW Roan project. The Fosen wind farm consists of six onshore sites and once completed, it will be Europe's largest onshore wind farm.

The Norwegian wind industry expects to install about 450MW in 2018, and to reach up to 4 GW by 2021.

*With input from the Norwegian Wind Energy Association, NORWEA*

## KEY DATA

Total installed capacity  
**1,162 MW**

Wind power capacity added in 2017  
**324 MW**

Wind-generated electricity produced in 2017  
**2.85 TWh**

Share of wind generated electricity in Norway's total electricity consumption  
**1.9%**

People employed by the wind industry at the end of 2017  
**n/a**

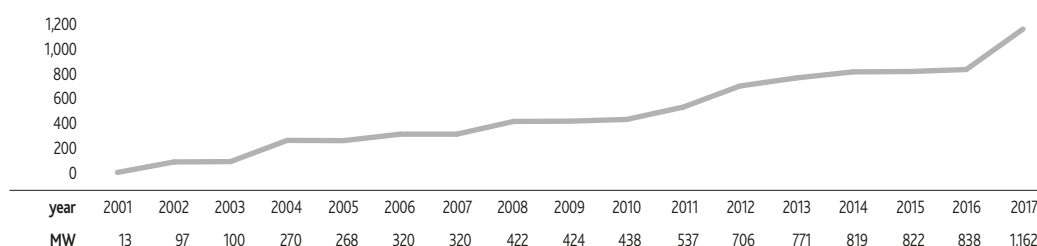
Number of turbines  
**466**

Leading turbine suppliers in 2017  
**Siemens Gamesa, Senvion, Vestas**



© Valsneset Trønder Energi

## TOTAL INSTALLED CAPACITY





# OFFSHORE WIND



Hitachi 5MW floating offshore wind turbine  
© FukushimaFORWARD

**2017** was a spectacular year for the offshore wind sector: the cratering prices with first zero bids for offshore in Germany; and a full 'zero subsidy' tender in the Netherlands; larger and larger turbines whose size boggles the mind; a plan for building an offshore wind island with more than twice today's total installed offshore wind power in Europe; and the number of markets expanding rapidly – including newcomers India, Australia, Brazil and Turkey. The rapid maturing of the technology has meant that offshore wind is taking shape as a mainstream energy source.

A historical record of 4,334 MW of new offshore wind power was installed across nine markets globally in 2017. This represents a 95% increase on the 2016 market. Overall, there are now 18,814MW of installed offshore wind capacity in 17 markets around the world.

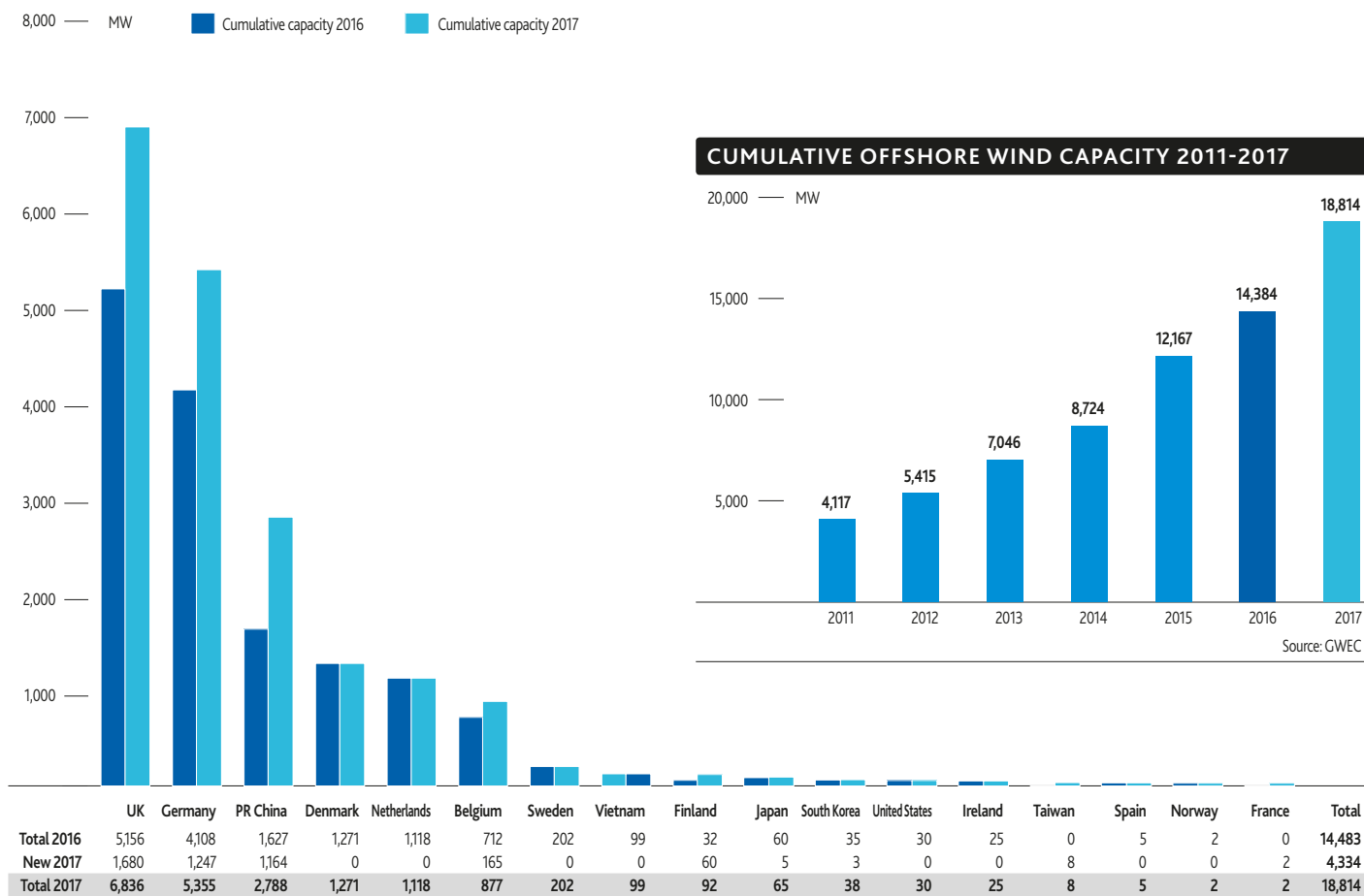
At the end of 2017, nearly 84% (15,780MW) of all offshore installations were located in the waters off the coast of eleven European

countries. The remaining 16% is located largely in China, followed by Vietnam, Japan, South Korea, the United States and Taiwan.

The UK is the world's largest offshore wind market and accounts for just over 36% of installed capacity, followed by Germany in the second spot with 28.5%. China comes third in the global offshore rankings with just under 15%. Denmark now accounts for 6.8%, the Netherlands 5.9%, Belgium 4.7% and Sweden 1.1%. Other markets including Vietnam, Finland, Japan, South Korea, the US, Ireland, Taiwan, Spain, Norway and France make up the balance of the market.

The spread of the offshore industry beyond its northern European home to North America, East Asia, India and elsewhere has begun. The first US offshore wind farm came online in 2016, China's offshore wind industry has finally taken off, and Taiwan has an ambitious programme lined up. The number of countries planning pilot projects or full-scale

## GLOBAL CUMULATIVE OFFSHORE WIND CAPACITY IN 2017



development of commercial-scale offshore wind farms is rapidly growing.

Meanwhile, offshore wind had its first 'subsidy-free' bids for offshore projects in Germany and an entire subsidy free tender in the Netherlands, with winners 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.

The reasons for this are many: the maturing of the industry, the improvement and maturation of the technology and management thereof, growing investor confidence, and the introduction and deployment of a new generation of turbines, with enormous swept area and tremendous output.

## RECORD YEAR FOR EUROPEAN OFFSHORE WIND

The European offshore wind industry had an all-time record year adding 3,148 MW in 2017, corresponding to 560 new offshore wind turbines across 17 wind farms. This is double the size of the 2016 market and represents a 13% increase on the previous record set in 2015. During 2017, fourteen projects came online, including Europe's first floating offshore wind farm. 2017 also saw Final Investment Decision (FID) on six new offshore wind projects to be installed in the coming years. The new investments total € 7.5bn and cover 2.5 GW of capacity.

Just over half of all capacity (53%) brought online in 2017 was in the United Kingdom, including the commissioning of the first floating offshore wind farm: Hywind, in Scotland. The second largest market was Germany with 40% of overall European capacity, largely realised through the commissioning of the Veja Mate and Wikinger projects.

### SUMMARY OF WORK CARRIED OUT AT EUROPEAN OFFSHORE WIND FARMS DURING 2017

| Wind Farm                           | Capacity connected in 2017 (Mw) | Country | Status                   |
|-------------------------------------|---------------------------------|---------|--------------------------|
| Race Bank                           | 498                             | UK      | Partially grid-connected |
| Dudgeon East                        | 402                             | UK      | Fully grid-connected     |
| Walney 3 (Extension Phase 1 - West) | 256                             | UK      | Partially grid-connected |
| Burbo Bank Extension                | 200                             | UK      | Fully grid-connected     |
| Rampion                             | 179                             | UK      | Partially grid-connected |
| Galloper                            | 72                              | UK      | Partially grid-connected |
| Blyth                               | 42                              | UK      | Fully grid-connected     |
| Hywind Scotland                     | 30                              | UK      | Fully grid-connected     |
| Veja Mate                           | 402                             | Germany | Fully grid-connected     |
| Wikinger                            | 350                             | Germany | Fully grid-connected     |
| Nordsee One                         | 332                             | Germany | Fully grid-connected     |
| Nordergründe                        | 111                             | Germany | Fully grid-connected     |
| Sandbank                            | 52                              | Germany | Fully grid-connected     |
| Nobelwind (Belwind II)              | 165                             | Belgium | Fully grid-connected     |
| Pori Tahkoluoto 2                   | 36                              | Finland | Fully grid-connected     |
| Kemi Ajos 1+2                       | 24                              | Finland | Fully grid-connected     |
| Floatgen                            | 2                               | France  | Fully grid-connected     |

Belgium represented 5% of the total share and Finland commissioned its first offshore wind farm specifically designed for icy conditions at Pori Tahkoluoto 2. Moreover, France's first offshore wind turbine, the 2 MW Floatgen demonstrator came online. In Denmark, 5 MW were decommissioned at Vindeby. Overall in 2017, work was carried out across 26 wind farms including grid connections, wind turbine erections and foundations installed.

In cumulative terms, Europe now has a total installed offshore wind capacity of 15,780 MW. This corresponds to 4,149 grid-connected wind turbines across eleven countries.

The UK has the largest offshore wind capacity in Europe, with 6,836 MW, followed by Germany (5,355MW) and Denmark (1,271MW). The Netherlands is in fourth place with 1,118MW, and Belgium fifth with 877MW. Combined, the top five EU countries represent 98% of all grid-connected offshore wind installations in Europe.

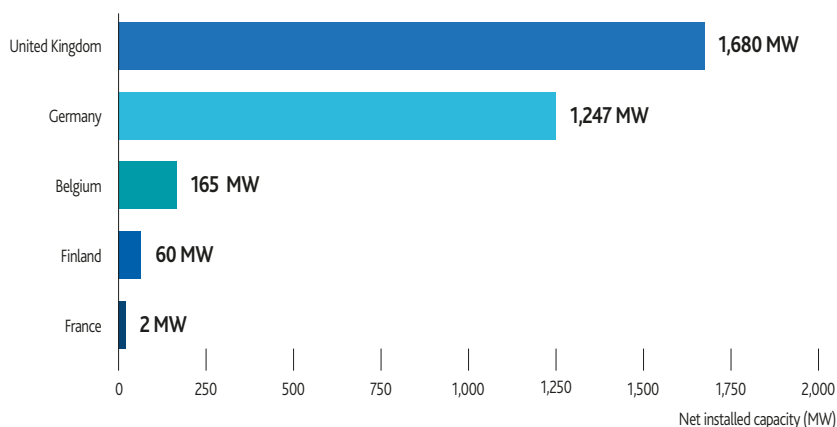
Installations in the North Sea account for 71% of all offshore wind capacity in Europe. The Irish Sea has 16% of installed capacity, followed by the Baltic Sea with 12% and the Atlantic Ocean 1.2%.

Siemens Gamesa Renewable Energy is the leading offshore wind turbine supplier in Europe with 64% of the total installed capacity. MHI Vestas Offshore Wind (18%) is second, followed by Senvion (8%) and Adwen (6%). The top 4 represents 96% of the total number of turbines connected.

In terms of ownership, Ørsted is the largest owner of offshore wind power in Europe with 17% of cumulative installations at the end of 2017, a slight increase from last year. E.ON is the second largest owner with 8% of installed capacity, followed by Innogy (7%), Vattenfall (7%), and Northland Power (4%). The top five owners represent 42% of all installed capacity in Europe, a slight decrease compared to the end of 2016.

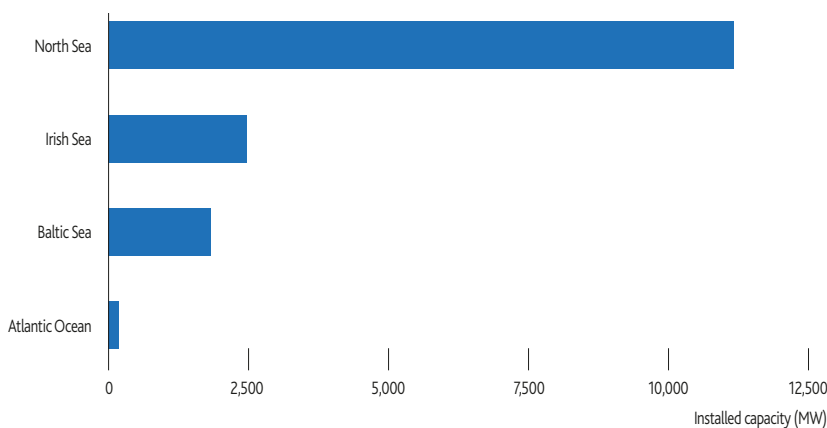
The average installed offshore wind turbine grid-connected in 2017 was 5.9 MW, a 23% increase over 2016. The average size of a grid-connected offshore wind farm in 2017 was 493 MW, 34% larger than the previous year. The average water depth of offshore

### ANNUAL OFFSHORE WIND CAPACITY INSTALLATIONS PER COUNTRY



Source: WindEurope

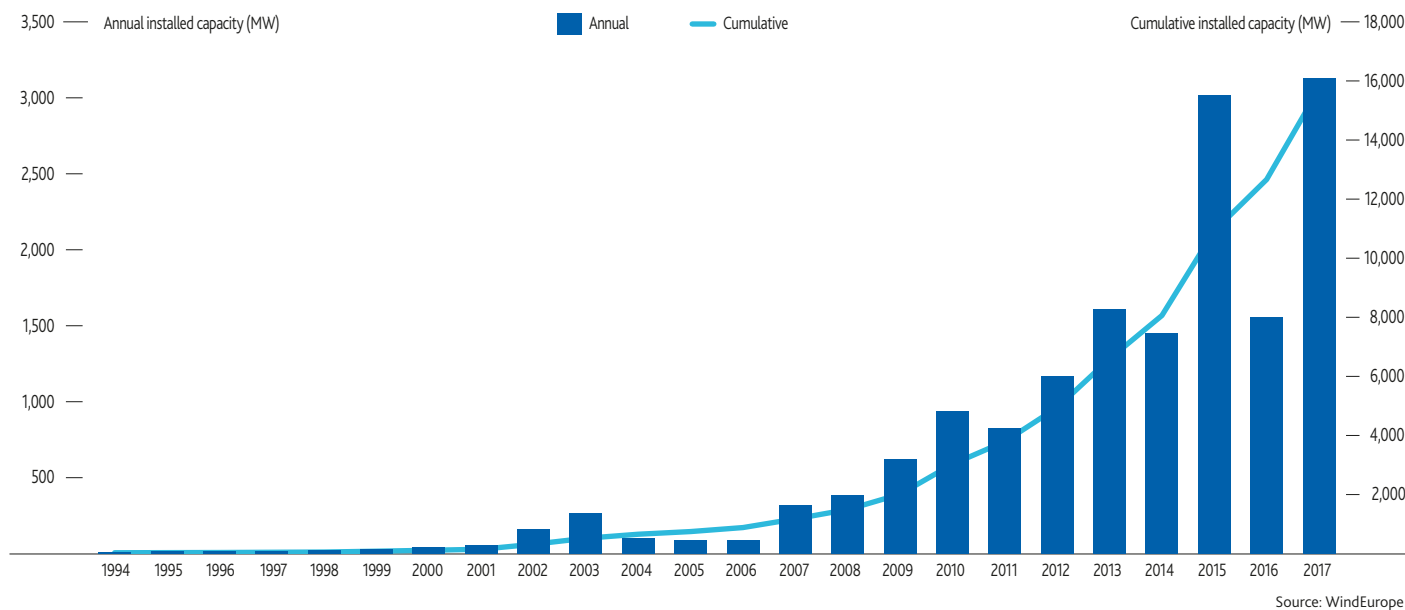
### NET ANNUAL INSTALLATIONS BY SEA BASIN (MW)



Source: WindEurope



## CUMULATIVE AND ANNUAL OFFSHORE WIND ENERGY INSTALLATION IN EUROPE



wind farms where work was carried out in 2017 was 27.5 m, slightly less than in 2016 (29.2 m). The average distance to shore for those projects was 41 km, a small decrease on the previous year (43.5 km). Hywind Scotland, the first floating offshore wind farm in the world, has an average water depth more than twice (95-120m) that of the bottom-fixed offshore wind farms where work was carried out in 2017.

### Outlook for 2018 and beyond

Looking ahead, projects expected to achieve FID in 2018 are estimated to have a combined capacity of 3.9 GW. This includes a number of projects in the UK, Denmark and the Netherlands, as well as floating offshore wind projects in Portugal and France. Financing needs could top € 9bn based on disclosed transaction costs.

In 2019 Europe expects to see another record year for offshore wind power. This is mainly due to the delay of consenting Round 3 projects in the UK in 2016. There are 400 MW currently under construction, which are expected to be connected to the grid throughout 2018. Germany will connect turbines from Merkur and Borkum Riffgrund projects in 2018 and Belgium will connect turbines in the Rentel and Norther wind farms. Winning projects of recent tenders in Denmark and the Netherlands are expected

to start to connect capacity towards the end of 2018.

However, the number of grid-connected projects are expected to fall towards 2020 as EU member states will reach the end of their National Renewable Energy Action Plans (NREAPs) under the current Renewable Energy Directive, which covers the period up to 2020. However, significant construction activity will continue. By 2020 WindEurope expects a total European offshore wind capacity of 25 GW. The offshore market will concentrate mainly in the UK, with 3.3 GW of new grid-connected capacity in the period between 2018 and 2020, followed by Germany with 2.3 GW, Belgium with 1.3 GW, the Netherlands with 1.3 GW and Denmark with 1.0 GW.

### CHINA OFFSHORE FINALLY TAKING OFF

With all the focus on the dramatic success in the offshore sector in Europe, it's worth noting that China's offshore industry is finally taking off. 1,164 MW of new installations in 2017 brought the cumulative total to 2,788, putting China in third place globally, behind the UK and Germany.

The new installations in 2017 are spread across 18 offshore wind farms, and nine of them (totalling 968 MW) are in Jiangsu Province, which continues to be the major focus of offshore development. There were



© Alpha Ventus

four projects totalling 65 MW in Fujian Province, and the remaining five were spread across Guangdong, Zhejiang and Hebei Provinces. The market leaders in terms of turbines were Shanghai Electric (50%), followed by Goldwind (18%), Envision (17%) and CSIC (9%).

Unlike China's onshore targets, which have been regularly exceeded, we have come to expect the offshore targets not to be met, especially the very ambitious ones set nearly a decade ago. Now, however, it seems the industry is on track and it will easily meet the

national 2020 target of 5 GW, probably well ahead of time.

In addition to the national target, Jiangsu has set itself a 2020 target of cumulative installations of 3,500 MW, Guangdong has a 2020 target of 2,000 MW, as does Fujian province. These alone would exceed the national goal.

The Offshore FIT was set three years ago at RMB 0.85/kWh for near shore, and RMB 0.75/kWh for inter-tidal. In the past two years, the development of the offshore has been mainly focused on near shore development, where previously the focus was on inter-tidal projects.

#### JAPAN INSTALLS ANOTHER FLOATER IN 2017

Despite Japan's favourable conditions and abundant offshore wind potential, the sector has developed at a slow pace. Japan added 5MW in 2017, which brought the country's total installations to 65MW, spread over 29 turbines and 11 projects. Japan has been experimenting with both fixed and floating foundations, with the floating installations accounting for 16MW in two projects.

A feed-in tariff for offshore wind has been set at JPY 36/kWh. However, the Japanese Ministry of Economy, Trade and Industry (METI) has proposed moving to a new system of auctions for fixed foundation offshore wind. The current level of FIT will be maintained for floating projects up to a cumulative total of 820MW, after which the auction system will be applied for all projects.

The next floating turbine is expected to come online during summer 2018 at Kitakyushu as NEDO's (New Energy and Industrial Technology Development Organization) new national project. The 3.5MW two bladed turbine is designed by Germany's Aerodyn, using a moon-pool type foundation from France's IDEOL.

There are a further 12 GW of offshore wind projects currently under various stages of development, of which 22 projects totalling 5,079MW are at an advanced stage. The remaining 7 GW of projects are at pre-EIA (environmental assessment) stage and waiting for a 'proposal rush' for a transmission auction which will be organised by Tohoku Electric

Power Co. The first commercial project is expected to start operation in 2021.

Although Japan's *Port and Harbor Act* was amended to better enable offshore wind development, the amendments only apply to limited areas of Japan's coast, leaving the majority of waters surrounding Japan outside the legislation's scope. The lack of clear rules has been the subject of increasing industry frustration and calls for reform. As a result, the government now designates special zones for offshore wind development in a new law on the promotion of offshore wind power in general common sea areas, which is expected to enter into force in September 2018.

After that, it will take about a year to prepare detailed rules for the bidding system, meaning that the first auctions for offshore wind in the general common sea area are likely to be held in 2019. At least five areas including Aomori, Akita and Nagasaki are expected to be nominated, with a 30-year lease for the winners.

While the new bill will reduce investment risk, uncertainties still remain in the grid connection and EIA process. Some conflicts may arise when bid winners for offshore sites and for grid connection are different. The Japanese Wind Power Association (JWPA) has requested that the Japanese government apply a so-called *centralised system*, which is in use for example in the Netherlands. Another concern is METI's intention to introduce a price based auction system for the fixed bottom type offshore wind development for general common sea areas after the new law takes force. This is likely to cause another type of business risk due to PPA price uncertainty. JWPA has also requested to maintain the FIT for fixed bottom offshore wind sites.

Japan's wind industry has a target to reach 10 GW of offshore wind by 2030.

### TAIWAN'S AMBITIOUS TARGET SET AT 5.5 GW BY 2025

Taiwan has become one of the offshore wind power hotspots in Asia. International offshore developers and OEMs are attracted by the government's generous feed-in tariff and strong wind resources, as well as the government's ambitious targets and policies to promote the clean energy industry.

#### OFFSHORE WIND POWER IN JAPAN AT THE END OF 2017

| Type         | Location    | Distance (km) | Depth (m) | Rated (MW) | No. of WTG | Total (MW) | Start operation |           |
|--------------|-------------|---------------|-----------|------------|------------|------------|-----------------|-----------|
| Fixed        | Hokkaido    | Setana Port   | 0.7       | 13         | 0.6        | 2          | 1.2             | Dec. 2003 |
|              | Akita       | Akita Port    | 0.1       | -          | 3.0        | 1          | 3.0             | Feb. 2015 |
|              | Yamagata    | Sakata port   | 0.05      | 4          | 2.0        | 5          | 10.0            | Jan. 2004 |
|              | Ibaraki     | Kamisu        | 0.04      | 4          | 2.0        | 7          | 14.0            | Feb. 2010 |
|              |             | Kamisu        |           | 4          | 2.0        | 8          | 16.0            | Feb. 2013 |
|              | Chiba       | Choshi*       | 3.1       | 12         | 2.4        | 1          | 2.4             | Mar. 2013 |
| Fukuoka      | Kitakyushu* | 1.4           | 14        | 2.0        | 1          | 2.0        | Jun. 2013       |           |
| Floating     | Nagasaki    | Fukuejima     | 5.0       | 100        | 2.0        | 1          | 2.0             | Apr. 2016 |
|              | Fukushima   | Iwaki city    | 20        | 120        | 2.0        | 1          | 2.0             | Dec. 2013 |
|              |             | Naraha*       |           |            | 7.0        | 1          | 7.0             | Mar. 2016 |
|              |             |               |           |            | 5.0        | 1          | 5.0             | May 2017  |
| <b>Total</b> |             |               |           |            |            | <b>29</b>  | <b>64.6</b>     |           |

\*National projects

#### OFFSHORE WIND PROJECT PIPELINE IN JAPAN

| Type       | Location             | Area              | WTG (MW) | No. of WTGs | Total (MW)  | Start Operation |       |
|------------|----------------------|-------------------|----------|-------------|---|-----------------|-------|
| Fixed      | Hokkaido             | Wakkanai port     | Port     |             | 10  |                 |       |
|            |                      | Ishikari new port | Port     | 4.0         | 24  | 96              | 2020~ |
|            | Aomori               | Mutsuogawara port | Port     | 2.0         | 40  | 80              | 2019~ |
|            |                      | Mutsu             | Gen.     |             |   | 800             |       |
|            |                      | Yokohama          | Gen.     |             |   | 80              |       |
|            |                      | Tsugaru           | Gen.     |             |   | 1,000           |       |
|            |                      | Tsugaru East      | Gen.     |             |   | 480             |       |
|            | Akita                | Noshiro port      | Port     | 3.3-6.0     | 20  | 100             | 2021  |
|            |                      | Happo Noshiro     | Gen.     |             |   | 180             |       |
|            |                      | Akita port        | Port     | 3.3-6.0     | 14  | 70              | 2022  |
|            |                      | Akita North       | Gen.     | 3.3-5.0     | 120   | 455             | 2023  |
|            |                      | Yurihonjo         | Gen.     |             |   | 1,000           |       |
|            | Yamagata             | Sakata port       | Port     |             |   | 15              |       |
|            | Toyama               | Toyama            | Gen.     |             |   | 75              |       |
|            | Ibaraki              | Kashima port      | Port     | 5.2         | 36  | 187             | 2021  |
| Yamaguchi  | Yasuoka, Shimonoseki | Gen.              | 4.0      | 5           | 60  |                 |       |
| Fukuoka    | Kitakyushu port      | Port              |          |             | 220   |                 |       |
|            | Kitakyushu           | Gen.              |          |             | 300**   |                 |       |
| Nagasaki   | Saikai Enoshima      | Gen.              |          |             | 240   |                 |       |
| Floating   | Fukuoka              | Kitakyushu*       | Gen.     |             | 1   | 3.5             | 2018  |
|            | Nagasaki             | Fukuejima         | Gen.     | 2.0-5.0     | 10  | 22              |       |
| Test Field | Niigata              | Awashima          | Gen.     |             |   |                 |       |
|            | Nagasaki             | Kabashima         | Gen.     |             |   |                 |       |
|            |                      |                   |          |             | Planned projects (location defined)               | 5,079           |       |
|            |                      |                   |          |             | Grid connection request (locations are disclosed) | 7,000           |       |
|            |                      |                   |          |             |   | <b>12,000</b>   |       |

\*National projects  
\*\*Estimated by JWPA

Taiwan's initial offshore wind target of 3 GW by 2025 was quickly exceeded by over-subscription of projects proposed by developers, which led to an upward adjustment of the target in 2017 to 5.5 GW by 2025. The target of 520MW by 2020 was maintained, while the target for 2030 was raised to 10-17 GW.



The adjusted target is closely linked to a mixed-tariff system. Projects fitting into the original 3 GW capacity target will stay within the FIT regime; the submission of projects to qualify for the 3 GW list is expected to be finalised by end of March. The remaining projects amounting to 2.5 GW will have to compete to sell power at a lower price in a tender held by the national utility Taipower. Taiwan's feed-in tariff is one of the highest in the world. Developers can either choose NT\$ 5,740 (\$ 187/€ 175) per MWh for 20 years, or NT\$ 7,108/MWh (US\$ 244.2/€ 198.2/MWh) for the first 10 years and NT\$ 3,459/MWh (US\$ 118.9/€ 96.4/MWh) for the following ten.

Taiwan's major development hotspot is located off Changhua County, where the 128MW Formosa project is located. There is a great deal of activity laying the groundwork for future development, and nearby Taichuang Harbour is becoming a main port to provide support for offshore development. Taipower has signed a deal to build what it says will be Southeast Asia's largest offshore wind port facility in Taichung. State-controlled Taipower will invest about \$ 100m in the facility in a link up with Taiwan International Ports, according to the Taiwanese government, which is pursuing an ambitious offshore wind expansion programme. Siemens Gamesa has also signed an MOU to set up an offshore wind supply chain at Taichuang Harbour.

#### **SOUTH KOREA READIES FOR OFFSHORE WIND EXPANSION**

South Korea aims to triple the share of renewables in the country's power mix by 2030 which translates to adding about 47 GW of new wind and solar capacity, according to the government's latest draft policy roadmap.

The East Asian nation will also cut back the shares of coal and nuclear in its electricity supply – although not as sharply as expected – under the Ministry of Trade, Industry and Energy's (MOTIE) draft of the *Eighth Basic Plan for Electricity Supply and Demand*, which provides Korea's power development roadmap for the next 15 years.

According to the plan, renewables will account for 27.3% of Korea's total power capacity in 2030, increasing nearly threefold from 9.7% this year. The share of renewables

in power generation will increase accordingly from 6.2% now to 20% in 2030.

Although the draft does not mention specific sector targets, analysts have estimated that South Korea will be looking to reach 5 GW of onshore wind by that date, about five times the total in place now, and balloon its offshore base to 13 GW from a negligible level now.

MOTIE's plan aims to reduce complex steps for renewable projects to seek permits. It also promises to build transmission infrastructure "preemptively", including grid connections and substations to spur wind and solar development.

Coal and nuclear will still account for 60% of Korea's power generation under the roadmap. The new targets to cap coal and phase out nuclear are less ambitious than those previously advocated by the newly-elected President Moon Jae-in, who had pledged to ditch all nine new coal projects and eight reactors to be built in the coming years.

The surge of renewable energy will help South Korea to cut 237 million tonnes of GHG emissions and limit particulate pollution, according to the roadmap.

Besides laying out power generation targets, the plan also proposes measures to limit consumption increases. It estimates power demand growing by only 1.3% by 2030.

#### **US OFFSHORE DEVELOPMENT LED BY NEW YORK**

While there were no new offshore installations in the US in 2017, a lot of activity took place, ensuring solid development for the next few years. There are ambitious plans at the state level up and down the East Coast, and great interest from European manufacturers, developers and investors in this potentially huge new market segment.

At the time of writing this report, GE announced the world's first 'double-digit' turbine, the Haliade-X 12MW. Other manufacturers are expected to follow soon to develop the next generation of huge offshore turbines.

In terms of the development plan, the north-eastern states are still the hotspot



China © Siemens Gamesa

of offshore wind development in the US. The high wholesale electricity price, high electricity demand along with the state governments backing for the renewable energy industry are the main drivers of offshore wind development. The states on the forefront of offshore wind power development are Rhode Island, New York, New Jersey and Massachusetts.

New York State has become the new climate leader in the US, after California, with a series of government measures and targets being introduced to boost the clean energy industry. An offshore wind target has been set at 2.4 GW by 2030. In January 2018, New York State also released its long-awaited *Offshore Wind Master Plan*, encompassing 20 in-depth studies on a variety of factors that will affect the state's ability to reach its 2.4 GW offshore wind target by 2030.

Rhode Island is home to the first US offshore wind farm, the 30MW Block Island project which was completed in 2016. The state now plans to issue a request for proposals (RFP) for up to 400MW of renewable energy, including offshore wind, in the course of 2018. Rhode Island has a target to reach 1 GW of renewable energy by the end of 2020.

The offshore wind industry in Massachusetts is driven by the state's RPS requirement especially for offshore, where utilities that serve Massachusetts are required by law to procure 1.6 GW of offshore wind capacity by 2027. A new lease sale for two additional areas off the coast of Massachusetts for commercial wind energy development is scheduled for the end of September 2018 by the US Bureau of Ocean Energy Management (BOEM).

# PROJECTIONS FOR OFFSHORE WIND DEVELOPMENT GLOBALLY OUT TO 2030

BY OUR MEMBER BVG ASSOCIATES

Offshore wind has reached maturity in Europe, both technically and commercially. It is now seen as an attractive investment opportunity for pension funds, investment houses and banks. Costs have fallen decisively, with committed projects scheduled to start generating in the early 2020s likely to produce at a levelised cost of energy (LCOE) below € 70/MWh (at 2017 prices), including the cost of offshore to onshore grid connection.

This has led to increased confidence in the deployment offshore wind around the world. We now forecast 120GW total installed capacity by 2030, with an installation rate of over 10GW per year being achieved before then.

Much of this growth will come in Europe, building on the established capability and proven low cost. We will also see significant capacity in China and US, with smaller but significant volumes in Japan, Taiwan and S Korea.

By 2030, LCOEs below € 60/MWh will be achieved by many newly installed offshore wind farms, which could be well below the average wholesale power price in many electricity networks, driving higher levels of deployment and the spread to currently uncharted waters.

Floating offshore wind has seen the first multi-turbine demonstration project (Statoil's Hywind in 2017), but floating is likely to remain a niche sector throughout the 2020s. It will become cost-competitive (or nearly so) by the end of the decade, giving it strong potential in the 2030s, especially through enabling new markets.

Early deployment of floating offshore wind projects needs support mechanisms in multiple markets specifically targeted at enabling commercial-scale floating deployment. France and Japan are the most likely candidates, assuming governments are able to see clear long-term benefits.

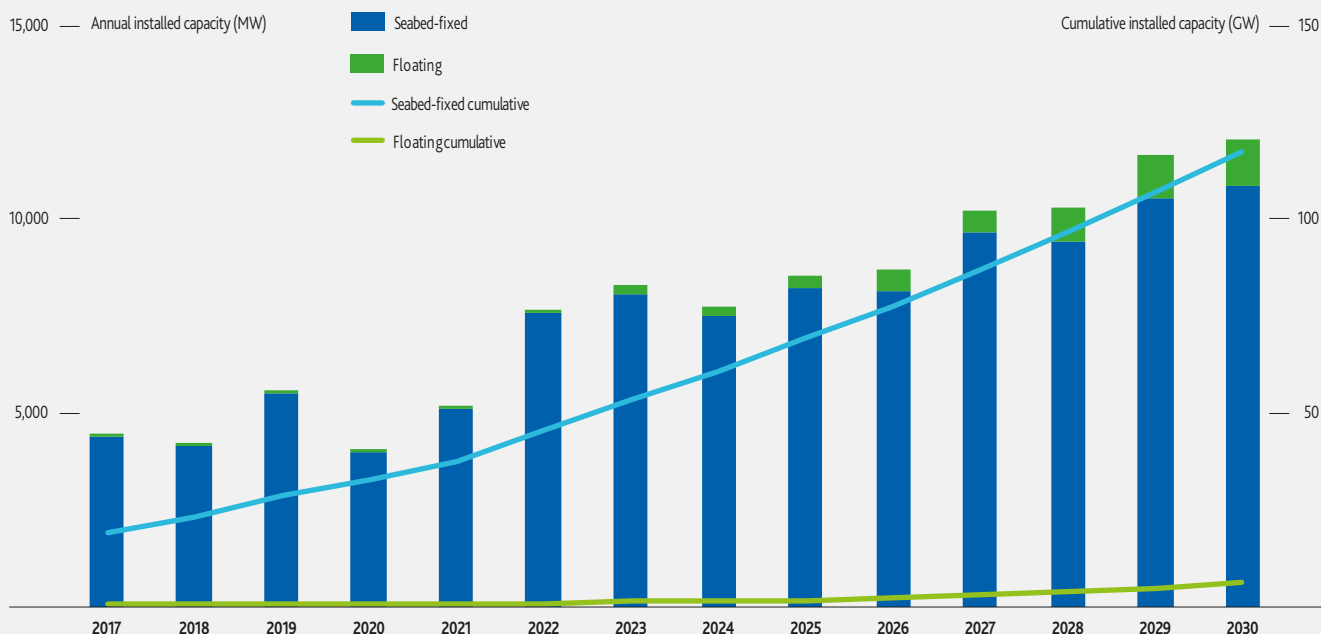
On this basis, we expect floating deployment to exceed 500MW a year by 2026, increasing to over 1GW a year by 2030 to give a total installed capacity of over 5GW by 2030, 5% of the offshore market. In addition to France and Japan, commercial floating projects are also likely in Korea, Taiwan, the UK and the US by 2030.

Floating offshore wind projects will tend to use the same turbine suppliers as bottom-fixed, with balance of plant provided by a mix those involved in bottom-fixed operations and others. The majority of installations will be in locations not suitable for fixed-bottom technology.

If cost reductions are achieved quicker than currently expected and floating becomes cost effective much faster, the market could really 'take off' with up to 12GW installed by the end of 2030, setting the 2030's up for substantial further global offshore wind deployment.

For more information: [www.bvgassociates.com](http://www.bvgassociates.com)

## PROJECTIONS FOR OFFSHORE WIND DEVELOPMENT GLOBALLY OUT TO 2030



Source: BVG Associates



In New Jersey, the state government has an ambitious offshore wind target, led by Governor Phil Murphy who signed an executive order for a 3.5 GW by 2030 state-wide offshore wind target. This order aims at filling in the gaps of the renewable energy certificate (OREC) programme which was delayed and shook investor confidence in the past years in New Jersey.

However, offshore wind development is not only limited to the North East. In March, Avangrid won North Carolina's offshore lease auction, and there is great industry enthusiasm under the new federal administration which has promised a lighter regulatory process and faster project timelines to boost the offshore wind sector.

## UPCOMING MARKETS

### India prepares for its first demonstration projects

The GWEC-led FOWIND<sup>1</sup> (Facilitating Offshore Wind in India) project prepared a roadmap for offshore wind power in India. The project focused on assessing the two key coastal states of Gujarat and Tamil Nadu. As a part of the project a LiDAR unit was deployed off Gujarat in the Gulf of Khambhat at the beginning of November 2017. These first offshore measurements will be critical for the future of the sector. Further, FOWIND's pioneering efforts have paved the way for another private LiDAR unit to be deployed in the Gulf of Kutch (also Gujarat) and India's National Institute for Wind Energy (NIWE) plans to deploy a LiDAR in the most promising zone in Tamil Nadu later in 2018. Offshore wind resource assessment is underway, and will need to verify the current estimates of about 35 GW of potential off Gujarat and around 30 GW off Tamil Nadu.

It appears that the next steps going forward will be:

- A call for OEMS to contribute to NIWE's 'test field' which will be established in Tamil Nadu on a spit of land that sticks out into some of the best offshore wind in India at Dhanushkodi. This is envisaged to be a demonstration facility along the lines of the Danish site at Østerild, and will coincide

with NIWE's placement of a LiDAR in the same region.

- Autumn of 2018 – a request for proposals for a demonstration project of somewhere between 500 and 1000 MW in the Gulf of Khambhat in Gujarat. It is expected that a feed-in tariff/PPA structure will be utilised for this project, although it is not known what the level will be.
- Autumn of 2019 – a request for proposals for a demonstration project of between 500 and 1000 MW off Tamil Nadu in the Gulf of Mannar (south of Dhanushkodi) in our Zone A.

If this all moves forward, then we will be looking at tendering for offshore projects in the year or two following this.

India has the world's 4<sup>th</sup> largest onshore wind market with a total installed capacity of close to 33 GW. However, India has an acute need for large-scale, clean and indigenous energy generation to fuel its rapidly growing economy. Offshore wind power could play a very important role in India due to the large wind resources available near centers of high energy demand.

### Vietnam takes steps forward

Vietnam's first near-shore/intertidal wind project, the 99.2MW Bac Lieu wind farm, is the first offshore wind farm in the Mekong Delta region, and came online in stages from 2013-2015. Another nearshore wind project, the 800MW Phu Cuong wind farm, also located in Mekong Delta, is now gearing up. The first phase, the Phu Cuong 1 Wind Farm (170 MW), is expected to reach financial close in 2018.

In 2018, new projects, both onshore and offshore, are being developed in Soc Trang Province, which is emerging as the next hot spot for wind development in Vietnam.

Despite slow progress to date, the Vietnamese wind market has started attracting world leading turbine manufacturers and investors. Vietnam may become the next gigawatt sized wind market in Asia, once the regulatory and financial conditions are corrected, which may come during the course of 2018.

<sup>1</sup> [www.fowind.in](http://www.fowind.in)

# PAKISTAN

## KEY DATA

Total installed capacity  
**789 MW**

Wind power capacity added in 2017  
**199 MW**

Wind-generated electricity produced in 2017  
**1,719.7 GWh**

Share of wind generated electricity in total electricity consumption  
**1.48%**

People employed by the wind industry at the end of 2017  
**5,000**

Number of turbines  
**488**

Leading turbine suppliers in 2017  
**GE, Nordex, Goldwind**

Lower technology prices have led Pakistan's government to increase the share of wind and solar in the power mix of the country. 2017 saw a major shift in the wind energy sector with the decision to develop new wind power projects through competitive bidding instead of feed-in tariffs. Based on available grid infrastructure in the country, the government has set a target for adding 1,200 MW of wind power by 2020. The share of wind energy is intended increase in line with future power demand growth.

Pakistan is beginning to reap the benefits of Chinese investment in renewable energy infrastructure, with the opening of the first wind power projects constructed as part of the huge China-Pakistan Economic Corridor (CPEC). Just under 200MW of wind capacity was added during 2017 at sites located at the so-called *Gharo-Jhampir wind corridor* in Sindh province, which, according to the Pakistan Meteorological Department, has the potential for 11,000 MW of wind power development.

In addition, the International Finance Corporation (IFC) plans to finance three 50MW wind power projects in the Gharo-Jhampir wind corridor. The World Bank has started mapping Pakistan's wind potential, looking at wind corridors in Punjab as well.

The Pakistan Government has initiated the development of solar-wind hybrid projects. The scheme combines solar with wind power at existing wind farms to increase project capacity factors and maximise the use of the existing grid. The key barrier to wind development in Pakistan is the insufficient grid capacity and transmission capabilities in the country. The government is working to address this issue in order to harness Pakistan's rich wind resources and move toward decarbonising the energy sector.

For 2018, the wind industry is expecting to install 400MW of new wind capacity.

*With input from Alternative Energy Development Board, Government of Pakistan*

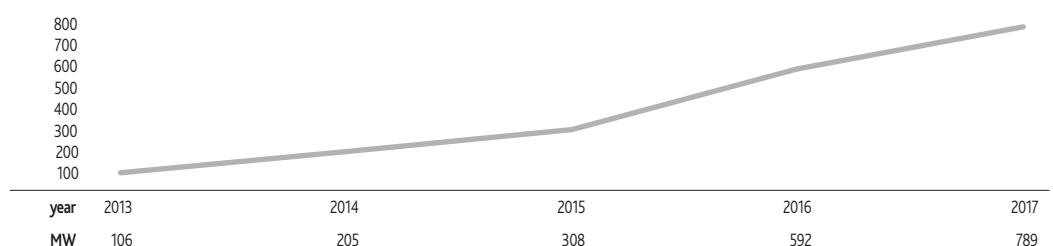
### INSTALLED CAPACITY BY PROJECT AT THE END OF 2017

| Name of Project  | Capacity (MW) | Location              | Completion Date |
|--|---------------|-----------------------|-----------------|
| 1 FFC Energy Limited                                   | 49.5          | Jhampir, Dist. Thatta | 16 May, 2013    |
| 2 Zorlu Enerji Pakistan (Pvt.) Ltd                     | 56.4          | Jhampir, Dist. Thatta | 26 Jul, 2013    |
| 3 Three Gorges First Wind Farm Pakistan (Pvt.) Limited | 49.5          | Jhampir, Dist. Thatta | 25 Nov, 2014    |
| 4 Foundation Wind Energy – II Ltd.                     | 50            | Gharo, Dist. Thatta   | 10 Dec, 2014    |
| 5 Foundation Wind Energy – I Ltd.                      | 50            | Gharo, Dist. Thatta   | 11 Apr, 2015    |
| 6 Sapphire Wind Power Company Ltd                      | 52.8          | Jhampir, Dist. Thatta | 22 Nov, 2015    |
| 7 Yunus Energy Ltd.                                    | 50            | Jhampir, Dist. Thatta | 16 Sep, 2016    |
| 8 Metro Power Company Ltd.                             | 50            | Jhampir, Dist. Thatta | 16 Sep, 2016    |
| 9 Tapal Wind Energy Pvt. Ltd.                          | 30            | Jhampir, Dist. Thatta | 7 Oct, 2016     |
| 10 Tenaga Generasi Ltd.                                | 49.5          | Gharo, Dist. Thatta   | 11 Oct, 2016    |
| 11 Master Wind Energy Pvt. Ltd.                        | 52.8          | Jhampir, Dist. Thatta | 14 Oct, 2016    |
| 12 Gul Wind Energy Ltd                                 | 50            | Jhampir, Dist. Thatta | 18 Oct, 2016    |
| 13 Hydro China Dawood Power Pvt. Ltd. (CPEC)           | 49.5          | Gharo, Dist. Thatta   | 5 Apr, 2017     |
| 14 Sachal Energy Development Pvt. Ltd. (CPEC)          | 49.5          | Jhampir, Dist. Thatta | 18 Apr, 2017    |
| 15 United Energy Pakistan Pvt. Ltd (CPEC)              | 99            | Jhampir, Dist. Thatta | 16 Jun, 2017    |
| <b>Total</b>   | <b>788.5</b>  |                       |                 |

### NEW CAPACITY ADDED IN 2017

| Name of Project                          | Capacity (MW) | Commission date |
|--|---------------|-----------------|
| 1 Hydro China Dawood Power Pvt. Limited  | 49.5          | April, 2017     |
| 2 Sachal Energy Development Pvt. Limited | 50            | April, 2017     |
| 3 UEP Wind Power Pvt. Limited            | 99            | June 2017       |
| <b>Total capacity added in 2017</b>      | <b>198.5</b>  |                 |

### TOTAL INSTALLED CAPACITY



# SOUTH AFRICA

The South African renewable energy sector has been through challenging times while waiting for more than two years for the conclusion of PPAs which were stalled by a long-running dispute with the country's state owned power utility Eskom. This has delayed investments of 58 billion rand and the creation of 15,000 jobs. The good news is that South Africa's very successful procurement programme is moving forward again under its new President, and wind and other renewables will play an increasing role in South Africa's energy future.

The South African Department of Energy established the Independent Power Producers Procurement Programme (IPPPP) in 2010 to procure renewable and non-renewable power from IPPs. Electrical generation capacity from IPPs is procured according to ministerial determinations as procurement targets, which is also aligned to South Africa's *Integrated Resource Plan for Electricity (IRP)*. The total ministerial determinations to date for wind is equivalent to 6,360 MW, of which 3,357.3 MW has been procured to date. No new policies related to wind development have been introduced. A key barrier facing the implementation of wind IPP projects has been

to conclude the Power Purchase Agreements (PPAs) of 12 wind projects (1,372.8 MW) from Bid Window (BW) 4 of the REIPPPP with the national electric utility, Eskom.

Despite this, a total of 618 MW of new wind power capacity was added to the grid in 2017, bringing cumulative capacity to 2,085MW. The development of South Africa's wind industry has taken place within a relatively short period of about five years, placing South Africa among the leading new wind markets globally. South Africa has excellent wind resources and upscaling renewables development in the country has become a necessity, as renewable energy is the only source of new power that can be deployed fast enough to help ease South Africa's chronic electricity shortages.

Now that the PPAs are signed, the South African renewable industry can begin the task of recovery and to resume the trajectory of growth that this much-admired programme was well on track to realising back in 2015.

*With input from the South African Wind Power Association, SAWEA*

## KEY DATA

Total installed capacity  
**2,085 MW**

Wind power capacity added in the country in 2017  
**618 MW**

Wind-generated electricity produced in 2017  
**5,046 GWh**

Share of wind generated electricity in South Africa's total electricity consumption  
**2.15%**

People employed by the wind industry at the end of 2017  
**n/a**

Number of turbines  
**961**

Leading turbine suppliers in 2017  
**Siemens Gamesa, Vestas, Nordex**

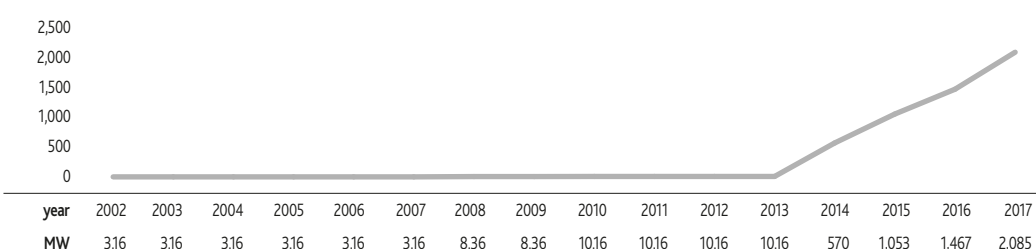
## PROJECT PIPELINE IN SOUTH AFRICA

| Project             | MW              |
|---------------------|-----------------|
| Nxuba               | 138.9           |
| Garob               | 135.93          |
| Oyster Bay          | 140             |
| Soetwater           | 139.4           |
| Karusa              | 139.8           |
| Golden Valley       | 117.72          |
| Wesley-Ciskei       | 32.7            |
| Kangnas             | 136.7           |
| Copperton           | 102             |
| Perdekraal East     | 107.76          |
| Excelsior           | 31.9            |
| Roggeveld           | 140             |
| Klawer              | 5               |
| Hopefield Community | 5               |
| <b>Total</b>        | <b>1,372.81</b> |



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## TOTAL INSTALLED CAPACITY





# TURKEY

## KEY DATA

Total installed capacity  
**6,857 MW**

Wind power capacity added  
in the country in 2017  
**766 MW**

Wind-generated electricity  
produced in 2017  
**17,755 GWh**

Share of wind generated  
electricity in total electricity  
consumption  
**6.12%**

People employed by the wind  
industry at the end of 2017  
**n/a**

Number of turbines  
**2,913**

Leading turbine suppliers in  
2017  
**Nordex, Vestas,  
Enercon**



© GWEC/Kocak

Turkey added 766MW in 2017, bringing the country's total wind power capacity to 6,857MW. 2017 marked a turning point for Turkey's wind industry: in December, 2.11 GW were issued preliminary licences for 67 wind projects by Turkey's electricity transmission operator Teias. This completed a round which had started in June 2017 with the assignment of 710MW of so called pre-licences, issued to projects meeting specific criteria and participating in grid capacity auctions. In addition, the country's first wind tender was held in August, where 1 GW of onshore wind capacity was allocated under Turkey's YEKA renewable energy programme. Recently Turkey's energy and natural resources ministry also announced its plans to start offshore wind development to boost the country's renewable energy capacity. The ministry has identified potential zones for the country's first offshore wind tender.

Siemens Gamesa won the 1 GW capacity in the winner-takes-all auction in August as part of a consortium along with Turkish infrastructure company Kalyon

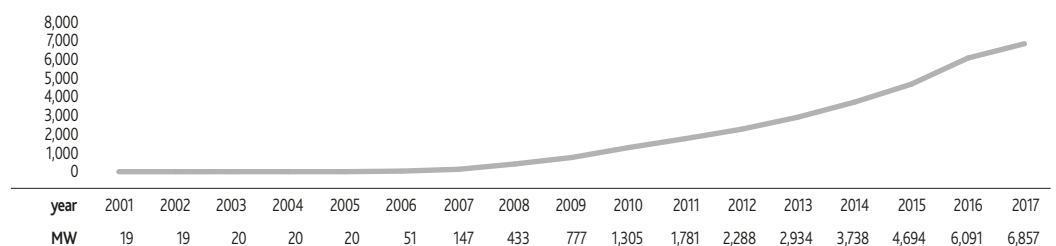
Enerji and Turkish wind energy investor Turkerler Holding. The agreement includes the possibility of a 15-year PPA at the consortium's winning bid price of US\$ 3.48 cent/kWh, and a commitment to build a minimum of 700 MW of extra wind projects by 2022. The Consortium will also build a local nacelle factory to meet local content requirements.

After finalizing the tenders and YEKA project, Turkey's wind capacity is expected to grow by around 4 GW in the next three to four years. However, the country needs private investment to meet its growing demand; there will be an investment and capacity gap between 2018 and 2019.

In 2018, there will be a second YEKA tender. There are currently more than 30 projects amounting to 800MW under construction. Turkey's national target for wind power is set at 20 GW by 2023.

*With input from the Turkish Wind Energy Association, TUREB*

## TOTAL INSTALLED CAPACITY



# UNITED STATES



© Toby Smith

The US wind industry installed 7,017 MW of new capacity in 2017, solidifying wind's position as the number one source of renewable electricity generation capacity in the country. Economics are driving the sustained growth in the US wind energy sector as the cost of wind power continued to fall – down 67% since 2009. Today, in many parts of the country, wind is the lowest-cost source of new electricity generation<sup>1</sup>. This value proposition has propelled 8% annual growth over the past five years, resulting in over US\$ 50 billion in new investment.

Federal tax reform dominated the US domestic policy agenda in the latter half of 2017, with implications for the US wind industry. Despite various attempts to alter the structure of the Production Tax Credit (PTC) and Investment Tax Credit phase down, the provisions emerged intact in the final tax bill. The multi-year phase down of the federal incentives continues to provide the predictable business environment necessary for sustained domestic supply chain operations and industry growth.

In the offshore wind market, a number of states announced plans for substantial

deployment. In 2017, New York committed to developing 2.4 GW of offshore wind by 2030, Massachusetts issued its first solicitation for 400 to 800 MW of offshore wind, and Maryland awarded offshore renewable energy credits for the first time to two offshore projects. At the end of 2017, there were 14 proposed offshore wind projects in various stages of development representing over 12,500 MW of potential capacity.

Combining the multi-year PTC extension with recent RPS increases and falling technology costs, the US wind industry expects robust growth to continue in 2018 and beyond. As of the end of 2017, more than 28,668 MW of wind capacity were under construction or in advanced development across 28 states. Rapid action to qualify wind projects for the 100% or 80% PTC propelled strong pipeline growth over the past two years, including significant utility announcements to directly own wind power capacity. The growing pool of utilities, corporations, and cities seeking to procure additional wind energy points to solid growth in the sector.

*With input from the American Wind Energy Association, AWEA*

<sup>1</sup> Lazard, Levelized Cost of Energy v11.0, 2017a

## KEY FACTS

Total installed capacity  
**89,077 MW**

Wind power capacity added in 2017  
**7,017 MW**

Wind-generated electricity produced in 2017  
**250 TWh**

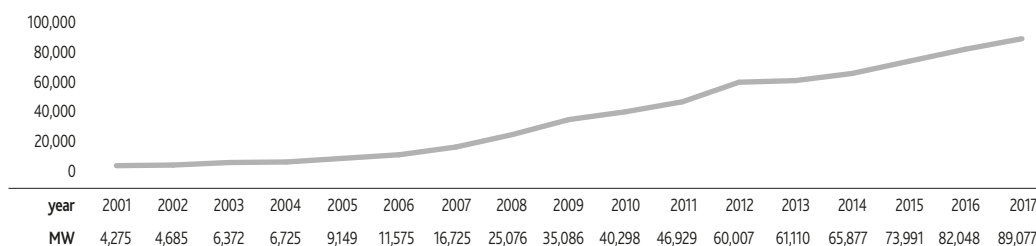
Share of wind generated electricity in the US's total electricity consumption  
**6.3%**

People employed by the wind industry at the end of 2017  
**105,500**

Number of turbines  
**54,430**

Leading turbine suppliers in 2017  
**Vestas, GE, Siemens Gamesa**

## TOTAL INSTALLED CAPACITY



# URUGUAY

## KEY DATA

Total installed capacity  
**1,505 MW**

Wind power capacity added in the country in 2017  
**295 MW**

Wind-generated electricity produced in 2017  
**3,767 GWh**

Share of wind generated electricity in Uruguay's total electricity consumption  
**30%**

People employed by the wind industry at the end of 2017  
**450**

Number of turbines  
**750**

Leading turbine suppliers in 2017  
**Vestas, Siemens Gamesa, Enercon**

Thanks to Uruguay's aggressive and successful energy policy, the country is now nearly 100% renewable in the electricity sector, with more than 30% coming from wind. Uruguay has prioritized ramping up renewable energy in its energy mix with the aim of reducing risks from droughts, enhancing the country's energy security and doing its part in the fight against climate change. Uruguay went from having almost no wind power in 2007 to double digit penetration in less than a decade. Between 2010 and 2014, a total of 1,500 MW of wind power was awarded as a result of competitive tenders. Uruguay has shifted its role from an importer of electricity to exporting surplus energy to its neighbors.

The Uruguayan electrical system's historical consumption peak is under 2,000MW. 295MW of new wind was installed in 2017, which brought the country's total capacity to 1,505MW, and Uruguay has nearly completed the build-out of its wind sector. One more wind farm has come on line in 2018, and that will be all until overall circumstances change. Uruguay's National Energy Authority has suggested adding more solar PV in the system, thanks to the fall in prices and its very good complementarity with wind energy. However, the main challenge is lack

of demand. Transformation of the transport sector by integrating electric vehicles could boost demand, enabling new investments in the wind sector, but the process is very slow and no significant changes are expected until 2022.

Another focus of the government is to improve demand management and development of energy storage to better manage the surplus of renewable energy. When the electric mobility sector grows, more renewable energy will be needed in the system and the EV fleet could contribute to increased storage capacity and increased system flexibility.

Trading renewable energy with the neighbors has proved to be more complicated than was assumed. While successful energy exchange agreement was concluded with Brazil, exchange with Argentina has yet to take off - further negotiations are still needed.

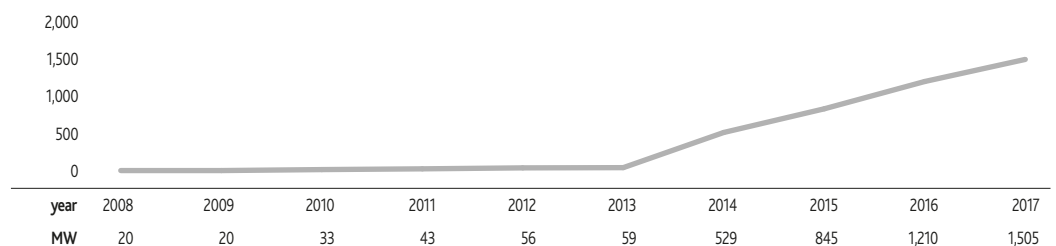
Meanwhile, the Uruguayan wind industry focuses on working on end of warranty inspections and O&M activities.

*With input from the Uruguayan Wind Energy Association, AUDEE*



© Siemens Gamesa

## TOTAL INSTALLED CAPACITY





# VIETNAM

Vietnam's wind market is still at the early stages, with an overall capacity of 197 MW, up 38 MW from 2016. However, Vietnam is considered to have some of the best wind resources in Southeast Asia. Located in the monsoon climate zone, and shaped by the country's more than 3,000 kms of coastline, Vietnam has ideal conditions for wind power development. A study conducted by the World Bank has found that 8.6% of Vietnam's total land area has high to very high potential for large scale wind development, with average wind speeds exceeding 7m/s. The overall onshore wind potential has been estimated at 24 GW.

In order to harness this potential, a feed-in tariff of US\$ 7.8 cents/kWh for onshore wind (offshore US\$ 9.8 cents/kWh) was introduced in 2011. This was however considered too low by the industry given local conditions. The government now intends to revise the tariff with an aim of making it more realistic. Once the new FIT kicks in, if at reasonable level, wind development in Vietnam is expected to boom.

However, some additional barriers to wind development remain, including:

- More transparent policies and mechanisms are needed to make wind projects bankable.
- The approval process is complex and lacks clarity.
- Poor grid infrastructure.
- Difficulty related to overlapping land use clearance.
- Lack of reliable resource data.
- Lack of expertise, knowledge and skilled workforce.

The Vietnamese government has set a target for wind development at 800MW by 2020, 2,000 MW by 2025 and at 6,000MW by 2030.

According to Vietnam's *Renewable Energy Development Strategy* for 2016 - 2030, the country will promote onshore wind power until 2030 and study potential offshore developments as of 2030.

## WIND POWER PROJECTS IN VIETNAM

Vietnam has five wind farms in operation with a total capacity of 197 MW:

- The first 30MW wind farm in Viet Nam, located in Binh Thuan province
- Cong Ly (99.2MW), a nearshore project in Bac Lieu province
- Phu Lac (24MW) in Binh Thuan province
- Huong Linh (30MW), in Quang Tri province
- a 6MW diesel-wind hybrid project on Phu Quy island, in Binh Thuan province
- Dam Nai (8MW) in Ninh Thuan province

In addition, there are more than 50 projects in the pipeline under different phases of development.

*With input from Binh Thuan Wind Energy Association, BWEA*

## KEY FACTS

Total installed capacity  
**197 MW**

Wind power capacity added in 2017  
**38 MW**

Wind-generated electricity produced in 2017  
**n/a**

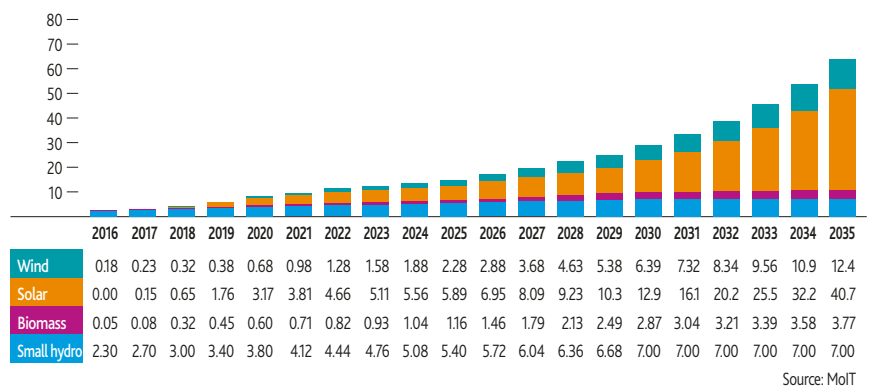
Share of wind generated electricity in Vietnam's total electricity consumption  
**n/a**

People employed by the wind industry at the end of 2017  
**n/a**

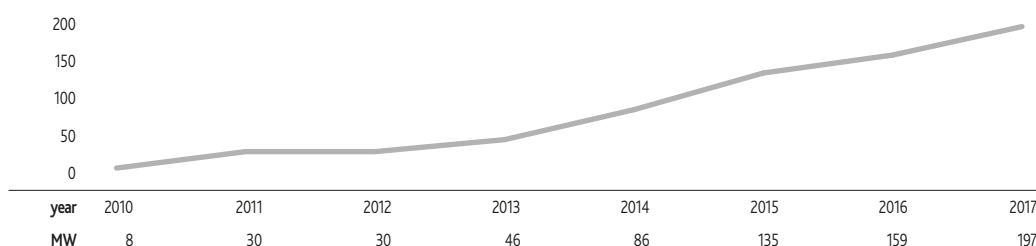
Number of turbines  
**115**

Leading turbine suppliers in 2017  
**GE, Vestas, Fulender**

## OUTLOOK FOR RENEWABLE ENERGY DEVELOPMENT UP TO 2030



## TOTAL INSTALLED CAPACITY



# OPENING UP NEW MARKETS FOR BUSINESS

GWEC is a member-based organisation that represents the entire wind energy sector. The members of GWEC represent over 1,500 companies, organisations and institutions in more than 90 countries, including manufacturers, developers, component suppliers, research institutes, national wind and renewables associations, electricity providers, finance, insurance companies and law firms. Our mission is to ensure that wind power establishes itself as the answer to today's energy challenges, providing substantial environmental and economic benefits. GWEC works with national and

international policy makers and industry associations to help open new markets for wind power. GWEC has a proven track record of success in helping to build the wind power industry in emerging markets around the world, including Argentina, Brazil, China, India, Mexico, Mongolia, South Africa, and Vietnam.

**"GWEC is really well placed to open new wind markets, driving new business for the wind industry..."**

Morten Dyrholm, Group Senior Vice President,  
Marketing Communications and Public Affairs, Vestas

## GWEC MEMBERSHIP BENEFITS

GWEC has a proven track record of success in building the wind power industry in emerging markets around the world by working with powerful stakeholders. GWEC puts people in touch with people in order to drive business in emerging markets. Here is an overview of our membership benefits:

### Market-making: We help you open up new wind markets

- Support on policy, regulatory, system, grid, planning, awareness-raising
- Local seminars & other tailor-made events
- Setting up local wind associations
- Sharing of best-practices
- Co-host events with members
- Speak at members' events

### Consultancy services: We know the challenges facing our members

- Advice on how to do business in markets

### Networking: We facilitate dialogues

- Invitations to events and conferences
- Match-making
- Introduction to key companies in emerging markets

### Information & Intelligence: We help you stay updated

- Bi-annual Global Wind Energy Outlook
- Yearly Global Wind Reports
- Country Reports
- Monthly Newsletter
- Webinars
- Windlog (members' only bi-monthly newsletter)

### Visibility: We provide branding opportunities

- Speaking slots at GWEC events (incl. webcasts)
- Sponsor packages
- Listing on GWEC website
- Discount with GWEC media partner
- Logo on website landing page
- Advertising on GWEC communication channels (bannering, video, posts)

### Influence the development of the industry:

- Join our Board

Find out more about GWEC's policy work, publications, events and other membership benefits on our website.



[www.gwec.net](http://www.gwec.net)

# MOVE AHEAD INTO NEW MARKETS AND JOIN GWEC TODAY!

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# Opening up new markets for business

“Contributions by global pioneer members across the wind value chain and its capilarity through an internationally recognized reputable voice of the sector (GWEC), supports Siemens Gamesa to operate efficiently in new markets. GWEC’s help is invaluable in advocating change to policies, positioning the relevance of wind and capturing new market trends.”

Jon Lezamiz, Global Public Affairs Director, Siemens Gamesa Renewable Energy

“GWEC is an important facilitator and promoter for growth of wind energy globally.”

Ditlev Engel, CEO, DNV GL – Energy

“GWEC does a great job promoting the interest of the global wind industry and opening up new markets for business.”

Adolfo Rebollo, CEO of Ingeteam

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