GLOBAL WIND ENERGY OUTLOOK | 2016

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GLOBAL WIND ENERGY OUTLOOK | **2016**

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FOREWORD

The Global Wind Energy Council is pleased to present this 6th edition of the Global Wind Energy Outlook, looking at the future of our industry out to 2020, 2030 and ultimately to 2050. What happens in the energy sector in that time frame is not only of vital concern to the wind industry, but to all humankind. In the next critical 5-15 years we will answer the question as to whether or not we as a species will have responded to the existential threat of climate change, or whether we spend the second half of this century trying to cope with the disaster we have caused.

With new markets developing rapidly across Africa, Asia and Latin America; unprecedented policy stability in the US market; strong and continued commitment from India and China; and the rapidly dropping prices for wind power both on and offshore - on the whole things look very good for the industry. With the Paris Agreement about to enter into force, the climate regime may finally become the major driver for the development of renewable energy that it should have been for at least the last 20 years. But of course much could go wrong…history rarely follows the smooth curves in this and other reports. But at least now the direction of travel is the clearest it has ever been.

Since 1999, the Global Wind Energy Outlook and its forerunners have presented scenarios looking at the long term future of the industry[1]. In the early days, they were considered to be pie-in-the-sky wishful thinking. However, what actually occurred was that the industry generally met or exceeded the totals in those early reports. Of course we didn't predict the dramatic rise in China, and we expected North America to be much further ahead than it is now. But on the whole, we were pretty close, far closer than the official national and international agencies looking at technology development, whose forecasts until relatively recently were ridiculously low-ball. But of late there is something of a convergence, although the *GWEC Advanced Scenario*, the successor of the original *Wind Force Scenario*, is still far and away the 'brightest' picture of the wind industry's future. It should be noted that the industry tracked the Advanced Scenario up through 2009, but then as the financial crisis struck and markets were essentially flat through 2013, real installations slipped towards the Moderate Scenario track; but with spectacular growth in both 2014 and 2015, the industry is back on the Advanced Scenario track.

1 http://www.inforse.dk/doc/Windforce10.pdf
https://www.greenpeace.de/sites/www.greenpeace.de/files/greenpeace_studie_windforce_12_1.pdf
http://greenpeace.org.br/energia/pdf/windforce12.pdf
http://www.offshorecenter.dk/log/bibliotek/WF12-2004_eng.pdf

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In 2006, the current format was adopted where we measure our scenarios against the central scenario in the IEA's World Energy Outlook (WEO) – formerly the *Reference Scenario*, and now the *New Policies Scenario*; and run all production scenarios against a baseline demand model from the IEA as well as another more efficient demand forecast. This year, we have also included the IEA's *450 Scenario*, developed in the aftermath of the Copenhagen Climate Summit in 2009, which has become a regular feature of the WEO. In conjunction, and viewed against two different projections of electricity demand growth, they provide a range of plausible futures for the development of the sector.

The GWEC Moderate and Advanced scenarios have evolved collaboratively over the years between the Global Wind Energy Council, Greenpeace International and the German Aerospace Centre (Deutsches Zentrum fur Luft-und-Raumfahrt – DLR). These scenarios for the future of the wind industry have contributed to an ongoing series of broader studies on global sustainable energy pathways up to 2050 conducted by DLR and Greenpeace International in collaboration with a number of industry associations including GWEC. For this latest iteration, our prime analyst has moved to the Unversity of Technology, Sydney – Institute For Sustainable Futures.

WHAT HAPPENS IN THE ENERGY SECTOR IS NOT ONLY OF VITAL CONCERN TO THE WIND INDUSTRY, BUT TO ALL HUMANKIND

Thanks to the IEA for providing us with their latest projections for wind energy development as of June 2016. We have extrapolated their scenarios out to 2050 and made adjustments to make all the scenarios fully commensurate, and any errors that may have resulted from that process are all our own. In the past, we used the IEA reference scenario to show how far apart we were...but that has all changed and our scenarios are getting closer and closer all the time...great minds think alike!

PREFACE

In 2016, wind power continued to push the boundaries of what many thought was possible.

On 15 May, a combination of wind and solar provided Germany with nearly 100% of its power needs. On a stormy day in August, wind turbines in Scotland generated more electricity than the entire country used on that day. Denmark now produces more than 40% of its electricity from wind turbines. And in the US, which now produces 2.5 times more wind energy than it did 5 years ago, recent polling found that 70% of registered voters view wind energy favourably.

This dramatic shift – in policy and practice – towards renewable energy sources like wind is largely being driven by one overarching consideration: cost.

Wind turbine prices have fallen by almost a third since 2009. Onshore wind is now one of the most competitive sources of electricity available with some projects now delivering electricity for as little as 4 US cents per kWh. Compared to onshore wind, nuclear power costs three times more to produce in the Americas and energy from new coal-fired or gas-fired power plants costs up to 30% more in Europe, the Middle East and Africa.

And wind power costs are expected to decline even further. With the right policies in place, IRENA research finds that average electricity costs could decrease by 35% for offshore wind and 26% for onshore wind by 2025.

The fact remains that wind is one of the least-cost options in many markets for new power generation, and this is even before factoring in environmental and health costs. IRENA estimates that doubling the global share of renewables by 2030 would save up to $4.2 trillion dollars annually thanks to avoided expenditures on air pollution and climate change.

But it's not just cost that is driving the wind boom. There are four other key environmental and social challenges that point to renewables like wind as a smarter energy solution:

1. **Jobs** – Renewable energy employs more people per unit of electricity than oil or gas. More than 1 million people worldwide are employed by the wind industry alone, a 5% increase over last year. Wind employment in the US rose by 21% in 2015 – 12 times faster than overall job creation in the US economy. If we double the global share of renewables by 2030, renewable energy employment would exceed 24 million people worldwide.

2. **Water** – Water is an essential ingredient in the energy production process. In the EU for example, energy production accounts for 44% of total water use. During power generation, solar power withdraws 200 times less water than a coal power plant to produce the same amount of electricity. Wind power requires no water. IRENA analysis finds that doubling the share of renewable energy, in particular solar PV and wind, could reduce water withdrawals in the power sector as

IT'S NOT JUST COST THAT IS DRIVING THE WIND BOOM

Adnan Z. Amin
Director-General
International Renewable Energy Agency (IRENA)

much as 52% in the UK, 37% in the US, 32% in Australia, 28% in Germany and 12% in India.

3. **Public health/air pollution** – Doubling the share of renewables would also decrease harmful emissions from pollutants such as ammonia, particulate matter, volatile organic compounds, and sulphur dioxide by 82%, 33%, 27% and 12% respectively, saving up to 4 million lives per year by 2030. The largest air pollution savings would come from the power sector, mainly due to reduced coal use. China, India, Indonesia and the USA would accrue the greatest health savings, along with all developing countries thanks to the reduced use of traditional biomass.

4. **Climate change** – The energy sector accounts for more than two thirds of global greenhouse gas emissions. As such, energy must be our priority in bringing down CO_2 emissions. Renewable energy can deliver half of all emission reductions needed to keep temperature rise below 2°C while energy efficiency measures can deliver the other half. Renewables and efficiency are the only technologies that can be deployed fast enough and at sufficient scale to meet the target set in Paris.

More and more countries around the world are now seeing that choosing renewables, like wind, is not only the most economic pathway, but also the most socially and environmentally advantageous. It would create more jobs, save millions of lives from reduced air pollution and set us on a pathway to limit global temperature rise to two degrees as agreed in Paris.

The wind industry has come a long way, but still more has to be done. World wind power generation capacity reached 435 gigawatts at the end of 2015, which is only 7% of total global power generation capacity. To push this figure higher, governments should implement a range of measures and support schemes like feed in tariffs, renewable portfolio standards in combination with auctions, and production tax credits. As shares of wind continue to increase, countries must also take steps to create power systems that can integrate large amounts of variable wind energy, exploring smart grids, storage technologies and other grid management mechanisms.

The recent ground-breaking achievements of wind and other renewable energy sources have proven that we have yet to truly tap into their full potential. With the right support policies in place that boost investment, foster innovation and spur further development, renewables can deliver the clean energy future we need, in record time.

GWEC has been a strong collaborator with IRENA since the beginning, and this report, the latest in a series that goes back to 1999, provides valuable insights at what the future holds for wind power. We look forward to continuing our collaboration with GWEC in the coming years.

1

GLOBAL STATUS OF WIND POWER

The global wind industry had another record year in 2015, with annual installations topping 63 GW. Overall, by the end of 2015, there were about 433 GW of wind power spinning around the globe, a 17% increase over the previous year; and wind power supplied more new power generation than any other technology.

China, the largest overall market for wind power since 2009, maintained its leadership position and installations in Asia led global markets again, with Europe in the second spot, and North America closing the gap with Europe, in third place. The majority of wind installations globally were *outside* the OECD once again and this trend is likely to continue.

The global wind industry is present today in more than 80 countries, of which 28 countries have more than 1 GW installed, including 17 in Europe; 4 in Asia-Pacific (China, India, Japan & Australia); 3 in North America (Canada, Mexico, US); 3 in Latin America (Brazil, Chile and Uruguay); and 1 in Africa (South Africa).

Eight countries had more than 10 GW installed, including China (145,362 MW); the US (74,471 MW); Germany (44,947 MW); India (25,088 MW); Spain (23,025 MW); UK (13,603 MW); Canada (11,205 MW); and France (10,358 MW). In 2016 Brazil joined the 10GW club.

China's cumulative wind power installations (145 GW) at the end of 2015 are more than all European Union countries combined (141.6 GW).

2015 was a big year for the big markets – China, the US, Germany and Brazil, all of which set new records. But there is also a lot of activity in new markets around the world; Guatemala and Jordan each added their first large commercial wind farms, and South Africa became the first African market to pass the 1 GW milestone. New markets are emerging across Africa, Asia and Latin America, which will provide the major growth markets for the next decade.

Asia is the world's largest regional wind market with an overall total installed capacity of 175.8 GW.

In terms of annual installations China maintained its leadership position in 2015 by adding 30.8 GW of new wind power capacity to the grid, the highest annual number for any country ever.

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Observers continue to be surprised by the astonishing track record for growth of the wind sector in China over the last decade. However, the Chinese wind power market may see a slowdown in 2017. Curtailment remains a major challenge in China. China's National Energy Administration and State Grid are working to solve the transmission bottlenecks and other grid issues, and the situation is expected to improve over the medium term.

India's wind energy installations totalled 25,088 MW at the end of 2015, keeping the Indian wind power market firmly in the top five rankings globally.

Outside of China, Asia will be led by India, but new markets such as Indonesia, Vietnam, the Philippines, Pakistan and Mongolia are developing quickly.

The United States is the single largest market in terms of total installed capacity after China. The US market added 4000 new turbines for a total of 8,598 MW in 2015, and its total installed capacity reached 74,471 MW.

Wind energy accounted for almost 31% of all new generating capacity installed in the US over last 5 years. Wind energy provided more than 31% of the electricity in Iowa, 25% in South Dakota, and 12% or more of the generation in a total of nine states.

The five year extension and phase out of the PTC provides the greatest degree of long term policy stability the US wind industry has ever seen. This, combined with a broader range of customers, and an on-going "wind rush" driven by technological improvements is setting the stage for more years like 2015 in the US.

Canada's total installed wind capacity stood at 11.2 GW at the end of 2015 making it the seventh largest market globally. Canada's new wind energy projects (1,506 MW) in 2015 represent over $3 billion in investment.

Mexico installed an impressive 713.6 MW of new capacity to reach a total of 3,073 MW by the end of 2015.

Across Europe there are now 147.7 GW installed, out of which 141.6 GW are in the EU. Wind power installed more than any other form of power generation in 2015, accounting for 44.2% of total 2015 power capacity installations.

However, the overall EU installation levels mask significant volatility across Europe; 47% of all new EU installations in 2015 took place in Germany and 73% occurred in the top four markets, a similar trend to the one seen in 2014. This is unlike previous years when installations were less concentrated and spread across many more healthy European markets.

Germany remains the EU country with the largest installed capacity (44.9 GW), followed by Spain (23 GW), the UK (13.6 GW), France (10 GW) and Italy (9 GW). Sweden, Denmark, Poland and Portugal each have more than 5 GW installed.

Weakened legislative frameworks, on-going economic crises and austerity measures implemented across Europe continue to hinder growth of the wind power industry. The year ahead is likely to be difficult but the broader investment shift away from fossil fuels could boost the European renewables sector.

Beyond the EU, Turkey is the largest market in Europe with a cumulative installed capacity of 4,694 MW at the end of 2015.

Latin America and the Caribbean has a total installed capacity of 12.2 GW. Post the Paris Agreement at COP21[1], the demand for clean energy bolstered by concerns for energy security and diversity of supply will promote the growth of wind power in Latin America and the Caribbean.

Brazil leads the Latin American market with installations of more than 10 GW and continues to be the most promising onshore market for wind energy in the region out to 2020.

1 http://unfccc.int/files/meetings/parisnov2015/application/pdf/parisagreementenglish_.pdf

Uruguay will generate more than 30% of its power from wind by the end of 2016 and had a total installed capacity of over 845 MW at the end of 2015, but has now surpassed the 1,000 MW mark.

Chile's total installed capacity now stands at just over 1 GW; Panama added 235 MW in 2015 to reach 270 MW; and Costa Rica added 70 MW of new capacity to reach a total of 268 MW. Honduras saw its total installed capacity reach 176 MW. Guatemala for the first time added wind power to its energy mix in 2015, with a 50 MW project.

Argentina added 8 MW of new capacity in 2015 to bring its total installed capacity up to 279 MW. The Caribbean reached a total installed capacity of 250 MW across various island states.

The Pacific region saw its total installed capacity rise to just over 4.8 GW by the end of 2015. Australia, the biggest wind market in the region, brought its total installed wind capacity up to 4,187 MW.

Samoa added 550 kW of new wind power capacity in 2015. This was the first wind project in the Pacific Island nation.

The Africa and Middle East region saw 953 MW of new capacity additions in 2015, bringing cumulative capacity for the region up to 3,489 MW. Africa's wind resource is best around the coasts and in the eastern highlands, but until 2014 when the South African market took off, it was in North and East Africa that wind power has been developed at scale.

At the end of 2015, over 99% of the region's total wind installations were spread across ten countries – South Africa (1,053 MW), Morocco (787 MW), Egypt (810 MW), Tunisia (245 MW), Ethiopia (324 MW), Jordan (119 MW), Iran (91 MW), Cape Verde (24 MW), Kenya (19 MW), Israel (6.25 MW) and Algeria (10 MW). New projects are expected to come online in Egypt, Ethiopia, Kenya, Morocco, Tanzania and South Africa in 2016.

OFFSHORE WIND ENERGY

The global offshore wind industry took a big step forward in 2015, installing more than 3.4 GW across five markets globally, bringing total offshore wind capacity to over 12 GW.

At the end of 2015, more than 91% (11,034 MW) of all offshore wind installations were located in waters off the coast of eleven European countries. The remaining 9% of the installed capacity is located largely in China, followed by Japan and South Korea.

Globally, the UK is the largest offshore wind market today and accounts for over 40% of the installed capacity, followed by Germany in the second spot with 27%. Denmark accounts for 10.5%, Belgium for almost 6%, Netherlands for 3.5% and Sweden for 1.6%. Other European markets including Finland, Ireland, Norway, Spain and Portugal make up about 0.5% of the market. The largest market outside of the European waters is China, which accounts for approximately 8.4% of the global market.

However, other countries are setting ambitious targets for offshore wind and development is starting to take off in some of these markets. Japan, South Korea and Taiwan have put actual turbines in the water. Construction is now complete on the first commercial offshore project in the US, and it will be commissioned before the end of 2016. The GWEC-led FOWIND consortium is developing an offshore wind roadmap for India.

Onshore wind power has become the least cost option when adding new capacity to the grid in an increasing number of markets, and prices continue to fall. Also, we have recently seen record low prices in the offshore wind sector. Given the urgency to cut CO_2 emissions, clean our air and decrease reliance on imported fossil fuels, wind power's pivotal role in the world's future energy supply is assured.

2

GLOBAL WIND ENERGY OUTLOOK SCENARIOS

WIND POWER SHAPING THE ENERGY TRANSFORMATION

The Global Wind Energy Outlook (GWEO) explores the future of the wind energy industry out to 2020, 2030 and up to 2050. We use the International Energy Agency's New Policies Scenario from the World Energy Outlook as a baseline; and for this edition we have included the IEA's 450 Scenario, as the climate consequences of different energy pathways have once again risen up the international political agenda. We have updated two scenarios especially for this publication: the GWEC Moderate Scenario and the GWEC Advanced Scenario.

The GWEC Moderate and Advanced Scenarios have evolved collaboratively over the years between the Global Wind Energy Council and the German Aerospace Centre (Deutsches Zentrum fur Luft-und-Raumfahrt – DLR). These scenarios for the future of the wind industry have contributed to an ongoing series of broader studies on global sustainable energy pathways up to 2050 conducted by DLR and Greenpeace International in collaboration with a number of industry associations including GWEC. The *Energy [R]evolution scenario*, or *2°C Scenario*, has become one of the benchmarks in international energy scenario discussions, utilized by the IPCC, IEA and others.[1]

For this edition of the GWEO, our lead analyst has moved to the University of Technology, Sydney – Institute for Sustainable Futures. We continue to compare all scenarios with two different projected energy demand futures: the demand projections used in the IEA's World Energy Outlook, and a lower, *Efficiency Scenario* developed by DLR as an update of the original Efficiency scenario used for these studies.

The upheaval in electricity markets around the globe and the wild swings in policy both in favor of and against renewable energy deployment make predictions about the future of this or any other industry challenging. However, it is also the case that as wind power plays a more and more central role in most future energy scenarios, that the various scenarios from industry, the IEA and others all begin to converge. Here we present four scenarios for each of the 10 IEA-defined regions as well as global totals, looking towards 2020 and 2030 – with

1 See http://www.energyblueprint.info

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longer-term projections out to 2050. A brief description of the underlying assumptions and orientation of each scenario is listed below.

1. IEA NEW POLICIES SCENARIO

The IEA's New Policies Scenario (NPS) is based on an assessment of current directions and intentions of both national and international energy and climate policy, even though they may not yet have been incorporated into formal decisions or enacted into law. Examples of this would include the emissions reduction targets adopted in Paris in 2015, the various commitments to renewable energy and efficiency at national and regional levels, and commitments by governments in such fora as the G-8/G-20 and the Clean Energy Ministerial. The New Policies scenario is now at the center of the IEA's World Energy Outlook analysis; and we have extrapolated it out to 2050 for comparison purposes.

2. IEA 450 SCENARIO

The 450 Scenario (450), first introduced in the IEA's World Energy Outlook in 2010, sets out an energy pathway consistent with the goal of having about a 50% chance of limiting the global increase in average temperature to 2 °C, which would require the concentration of greenhouse gases (GHG) in the atmosphere to be limited to around 450 parts per million of carbon-dioxide equivalent (ppm CO_2-eq) in the long-term. The basis of the 450 Scenario is, however, different. Rather than being a projection influenced by policy actions, it deliberately selects a plausible energy pathway to achieve the desired goal. Near-term policy assumptions for the period to 2020 draw on measures that were outlined in the WEO Special Report on Energy and Climate[2].

3. GWEC MODERATE SCENARIO

GWEC's Moderate Scenario (MS) has many of the same characteristics as the NPS, taking into account all policy measures to support renewable energy either already enacted or in the planning stages around the world, and at the same time assuming that the commitments for emissions reductions agreed by governments at COP21 (Paris, 2015) will be implemented, although on the modest side. At the same time it takes into account existing and planned national and regional targets for the uptake of renewable energy in general and wind energy in particular, and assumes that they are in fact met.

Through the period out to 2020, the MS is very close to our annual five-year market forecast[3], based on industry orders and planning as well as intelligence from our global network about new and emerging markets. After 2020 it is difficult to make a precise forecast given the current set of global uncertainties, but at that stage we assume that an even broader range of governments will begin to respond to essential asks of national energy security and long-term price stability offered by wind energy. Further, the cost of wind continues to come down and the price of conventional generation continues to go up.

4. GWEC ADVANCED SCENARIO

GWEC's Advanced Scenario (AS) is the most ambitious, and outlines the extent to which the wind industry could grow in a best case *Wind Energy Vision.* It assumes an unambiguous commitment to renewable energy in line with industry recommendations, the political will to commit to appropriate policies and the political stamina to stick with them. Further, it does NOT assume massive new-build nuclear or a large take up of carbon capture and storage technologies, as is the case in the IEA scenarios.

The AS also assumes that governments enact clear and effective policies on carbon emission reductions in line with the now universally agreed objective of keeping global mean temperature rise below 2°C above pre-industrial

2 https://www.iea.org/publications/freepublications/publication/WEO2015SpecialReportonEnergyandClimateChange.pdf
3 http://www.gwec.net/wp-content/uploads/2014/04/Market-Forecast-for-2016-2020-1.jpg

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temperatures. Wind power is critical to meeting the first objective in that battle - which is getting global emissions to peak and begin to decline before the end of this decade.

PROJECTIONS FOR ELECTRICITY DEMAND DEVELOPMENT

While it is useful to calculate the production from global wind power installations, it is also instructive to put it in the context of global electricity demand, and thereby determine what percentage of the world's growing demand for electricity can be met by wind. As was the case in past GWEO publications, we have compared each of the four supply scenarios against two different demand scenarios. The first is that used by the IEA for the New Policies Scenario in the 2015 World Energy Outlook, and the latter an *Energy Efficiency* Scenario, originally developed by the Ecofys consultancy, later updated by researchers at the University of Utrecht[4], and updated once again by the authors of the Energy [R]evolution, 2015 edition[5]. The study includes the implementation of best practice existing technologies and a certain share of new efficiency technologies, while using the same assumption for population and GDP growth over the period as the IEA, and assuming no structural economic changes beyond those in the IEA scenarios. It does not foresee lifestyle changes or loss in comfort levels, nor does it foresee 'stranded' assets, i.e., the early retirement of inefficient installations in favor of more efficient ones – which is very conservative given that such early retirement is already beginning to happen and seems likely to increase substantially.

4 http://www.energyblueprint.info/fileadmin/media/documents/2012/UU_Demand_projections_for energy_revolution_2012_30_3_12.pdf
5 See http://www.greenpeace.org/international/Global/international/publications/climate/2015/Energy-Revolution-2015-Full.pdf, p. 61

BY 2050, GWEC'S ADVANCED SCENARIO FORESEES GLOBAL WIND INSTALLATIONS REACHING 5,806 GW

This Energy Efficiency demand projection only taps a portion of the potential for energy savings and increased efficiency which is available to us now. However it is an indicator of what can be done at low or no cost, and results in 'savings' against the NPS scenario of 4.5% of demand by 2020, 8.7% by 2030, 9.2% by 2040, and 13.2% by 2050. It should be noted that in this exercise as well as in the rest of the IEA scenarios we have extrapolated the IEA scenarios from 2040 to 2050.

GLOBAL SCENARIO RESULTS

The IEA's NPS shows the global wind market returning to 2014 levels in 2016 and then gradually decreasing and stabilizing at about the 2010 market level after 2020, and only growing very slightly from that level out to 2030. **The IEA 450 Scenario** also sees the market returning to 2014 levels in 2016, dipping to 2012 levels by 2018 and then recovering to 2014 levels by the end of the decade, reaching 2015 levels again in 2022/12. This is in line with recent low-carbon energy developments and a more optimistic interpretation of the implementation of the INDCs[6] contained in the Paris Climate agreement in December 2015.

The GWEC scenarios paint a picture of two different futures:

GWEC's Moderate Scenario reflects a world which carries on more or less the way it has for the past decade, with wind power continuing to gain ground but still struggling against heavily subsidized incumbents; without a comprehensive or cohesive carbon market, and with those that exist at very low prices. Policy instability decreases, but is still a factor, although the competition in OECD markets for a larger share of a stable or dwindling pie is intense.

GWEC's Advanced Scenario shows the potential of wind power to produce more than a third of global electricity demand by the end of the scenario period, where there is a strong international political commitment towards meeting climate goals and national energy policy is driven by the need for enhanced energy security, price stability, job creation and the need to conserve our precious fresh water resources. Which future shall it be?

CAPACITY GROWTH

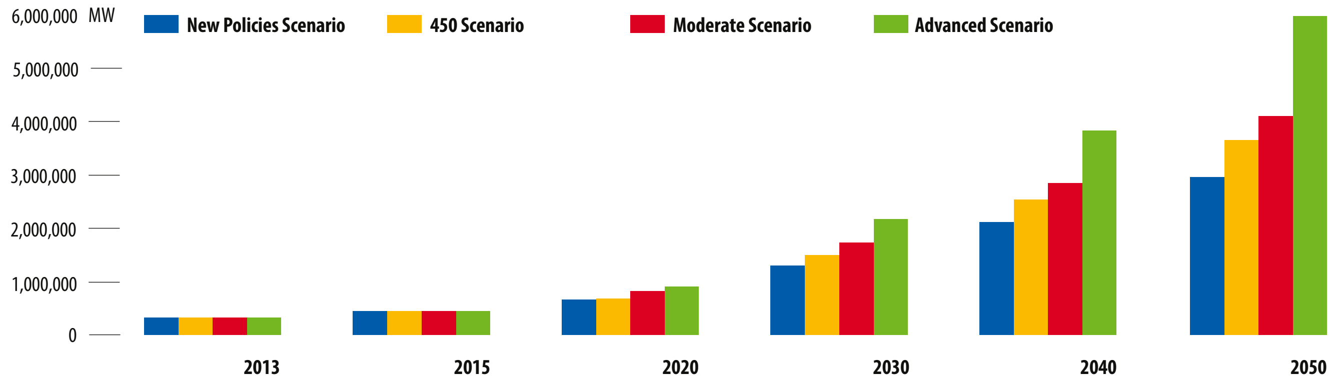
ASSUMPTIONS ON GROWTH RATES

Growth rates in the Global Wind Energy Outlook scenarios are based on a combination of historical trends, current and planned policies, information on new and emerging markets for wind energy, and relevant assumptions on the direction of overall climate and energy policy.

The cumulative market growth figures are a useful way to look at the industry over the longer term. In the IEA scenarios, the NPS shows 12% growth in 2016; dropping to 7% by 2020 and then like the MS retains annual growth in the range of 6-7% out to 2030. The 450 scenario has growth rates dropping less,

6 Intended Nationally Determined Contributions (INDCs) is a term used under the United Nations Framework Convention on Climate Change (UNFCCC) for reductions in greenhouse gas emissions that all countries that signed the UNFCCC were asked to publish in the lead up to the 2015 United Nations Climate Change Conference held in Paris in December 2015. http://www4.unfccc.int/Submissions/INDC/Submission%20Pages/submissions.aspx

GLOBAL CUMULATIVE WIND POWER CAPACITY



	2013	2015	2020	2030	2040	2050
New Policies Scenario						
MW	318,354	432,656	639,478	1,259,974	2,052,583	2,869,611
TWh/a	714	868	1,569	3,311	5,394	7,541
450 Scenario						
MW	318,354	432,656	658,009	1,454,395	2,458,757	3,545,595
TWh/a	714	868	1,614	3,822	6,462	9,318
Moderate Scenario						
MW	318,354	432,656	797,028	1,675,624	2,767,351	3,983,995
TWh/a	714	868	1,955	4,404	7,273	10,470
Advanced Scenario						
MW	318,354	432,656	879,446	2,110,161	3,720,919	5,805,882
TWh/a	714	868	2,157	5,546	9,779	15,258

holding at about 8% for most of the rest of the decade, increasing to 9% after 2025, and then tapering off again after 2030.

The MS starts with about 15% annual growth in 2016, tapering off gradually to 11% by 2020, and then stabilizes at about 7% over most of the next decade out to 2030. In the AS, annual growth rates start off well below the historical average at 15%; remain steady in the middle of this decade and then taper off to 13% by the end of the decade, dropping to 6% by 2030.

It is worth noting that cumulative market growth figures will inevitably drop over time in almost any scenario as the size of the market grows; although even small percentage increases a decade out from now will mean a large actual increase in the quantity of wind power deployed.

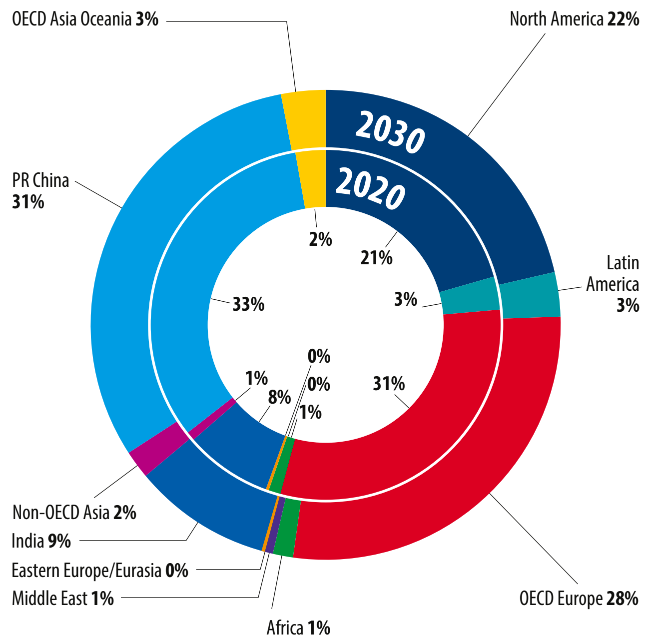
SCENARIO RESULTS

The IEA New Policies Scenario projects that annual wind energy markets will match the stellar results from 2014 and cross the 50GW mark in 2016 as well; and then shrink to just under 38 GW/annum by the end of the decade. It then projects an increase to near 2015 levels in the middle of the next decade, gradually decreasing to a net of 43 GW/annum by 2030 and essentially stays in the mid-30s in terms of GWs installed per annum, remaining flat for the rest of the period out to 2050 in net terms. On the basis of this, cumulative installed capacity would still reach 639 GW by 2020, and 1,260 GW by 2030. The latter is almost 300 GW higher than the NPS projections two years ago. By 2050, NPS foresees global wind installations reaching 2,870 GW.

The 450 Scenario also sees 2016 at 2014 levels, but is substantially higher than NPS installations out to 2020, for a total of 658 GW. It then projects a marked increase in installations with cumulative installed capacity reaching 1,454 GW by 2030, which is almost 200 GW higher than the NPS projections. By 2050, this scenario foresees global wind installations reaching 3,546 GW.

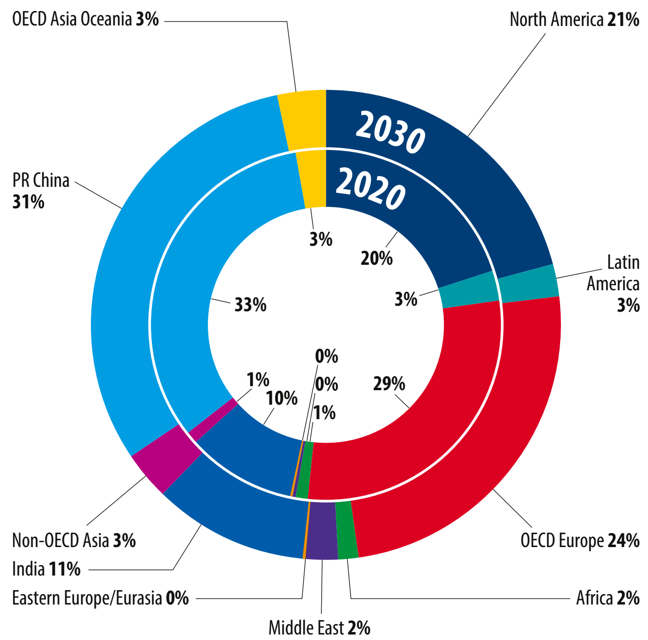
The GWEC Moderate Scenario follows the lines of our short term market projections

REGIONAL BREAKDOWN: NEW POLICIES SCENARIO



	2020	2030
North America	126,961	252,784
Latin America	18,749	36,196
OECD Europe	186,878	323,091
Africa	6,575	15,908
Middle East	1,072	8,009
Eastern Europe/Eurasia	668	1,117
India	50,063	111,938
Non-OECD Asia	5,213	21,796
PR China	201,178	364,801
OECD Asia Oceania	15,322	34,598
Global Total / MW	**639,478**	**1,259,974**

REGIONAL BREAKDOWN: 450 SCENARIO



	2020	2030
North America	131,659	303,322
Latin America	18,913	35,830
OECD Europe	190,855	355,769
Africa	7,207	23,005
Middle East	1,501	30,124
Eastern Europe/Eurasia	722	1,982
India	67,098	155,736
Non-OECD Asia	6,411	49,250
PR China	216,806	452,081
OECD Asia Oceania	16,836	47,295
Global Total / MW	**658,009**	**1,454,395**

prepared for our annual market update out to 2020[7], with annual market size reaching almost 80 GW/annum by 2020 for a total installed capacity of 797 GW. We expect robust growth in the period after 2020. By 2030 total installed capacity would reach nearly 1,676 GW. By 2050, this scenario foresees global wind installations reaching 3,984 GW.

The GWEC Advanced Scenario maintains ambitious growth rates throughout this decade, assuming that a broad, clear commitment to the decarbonisation of the electricity sector emerges quickly with the ratification of the 2015 Paris Climate Agreement. Annual market size would top 100 GW by the end of the decade, bringing total installed capacity to just over 879 GW by 2020, and to 2,110 GW by 2030, which could only occur with comprehensive and robust climate action globally and essential political will to tackle the climate challenge. By 2050, this scenario foresees global wind installations reaching 5,806 GW. This is almost 3,000 GW higher than the current baseline scenario of the long-term NPS projections for the wind sector.

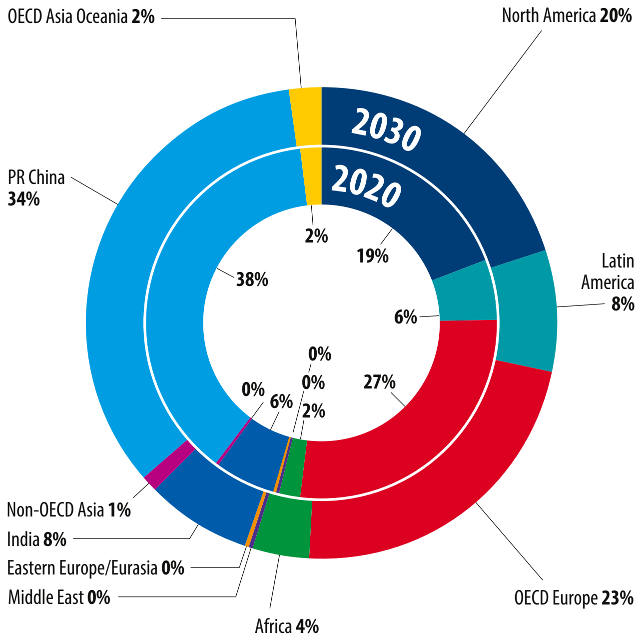
7 http://www.gwec.net/wp-content/uploads/2014/04/Market-Forecast-for-2016-2020-1.jpg

PRODUCTION AND SHARE OF ELECTRICITY SUPPLY

ASSUMPTIONS ON TURBINE CAPACITY

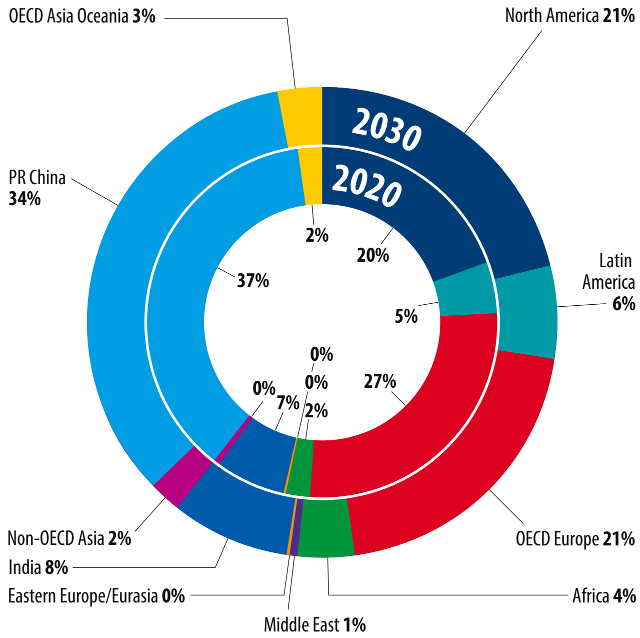
The rated output, rotor diameter and average height of wind turbines have steadily increased over the years, although the average size of turbines varies substantially by country and region. This trend is expected to continue as larger and more efficient machines are developed for the

REGIONAL BREAKDOWN: MODERATE SCENARIO



	2020	2030
North America	149,120	318,390
Latin America	42,997	129,491
OECD Europe	207,955	358,554
Africa	16,805	60,852
Middle East	777	4,995
Eastern Europe/Eurasia	644	1,895
India	44,734	116,257
Non-OECD Asia	2,344	14,842
PR China	291,439	541,577
OECD Asia Oceania	13,364	32,887
Global Total / MW	**797,028**	**1,675,624**

REGIONAL BREAKDOWN: ADVANCED SCENARIO



	2020	2030
North America	165,181	413,970
Latin America	38,203	124,494
OECD Europe	227,217	398,691
Africa	18,337	72,229
Middle East	1,017	10,234
Eastern Europe/Eurasia	650	2,835
India	56,297	163,473
Non-OECD Asia	4,296	41,659
PR China	313,061	666,500
OECD Asia Oceania	17,242	57,084
Global Total / MW	**879,446**	**2,110,161**

offshore industry, and larger and more efficient turbines are developed to extract the most energy from new sites as well as for repowering old sites, many of whose turbines are nearing their design lifetimes of 20 years. The need for substantial and increased repowering has been built into the GWEC scenarios, becoming a significant factor after 2025. It also should be noted, however, that there is a trend to install smaller rated machines on taller towers with longer blades in lower wind speed areas closer to demand centers, which opens up new areas for commercial wind development, often in areas close to load centers where the power is needed most.

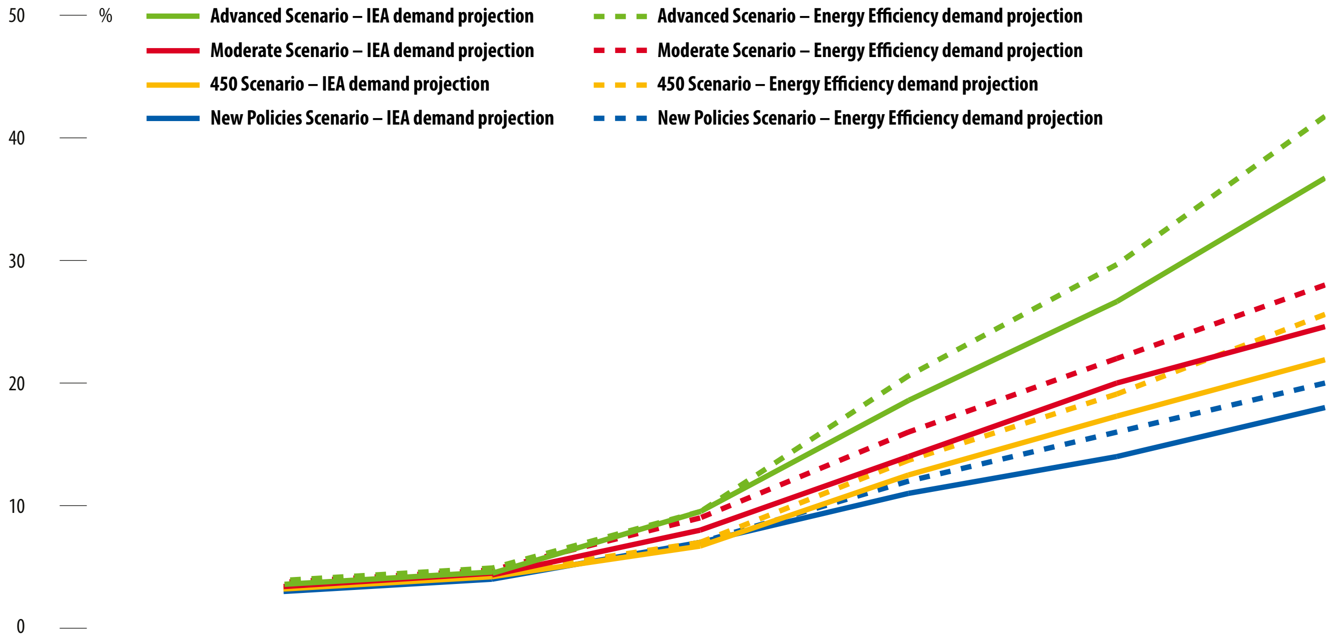
ASSUMPTIONS ON CAPACITY FACTORS

The capacity factor of a wind turbine or a wind farm refers to the percentage of the nameplate capacity that a turbine will deliver in terms of electricity generation over the course of a year. This is primarily governed by the wind resources in the particular location, but is also affected by the efficiency of the turbine, its suitability for the particular location, the reliability of the turbine, how well the wind project is managed, and whether or not it is subjected to curtailment by the grid operator[8]. Generally speaking capacity factors have increased, but are impacted by both curtailment and inter-year wind resource variability.

Average capacity factors vary widely from region to region. As mentioned above, there is also an increased emphasis on developing new turbines for new locations with lower wind resources.

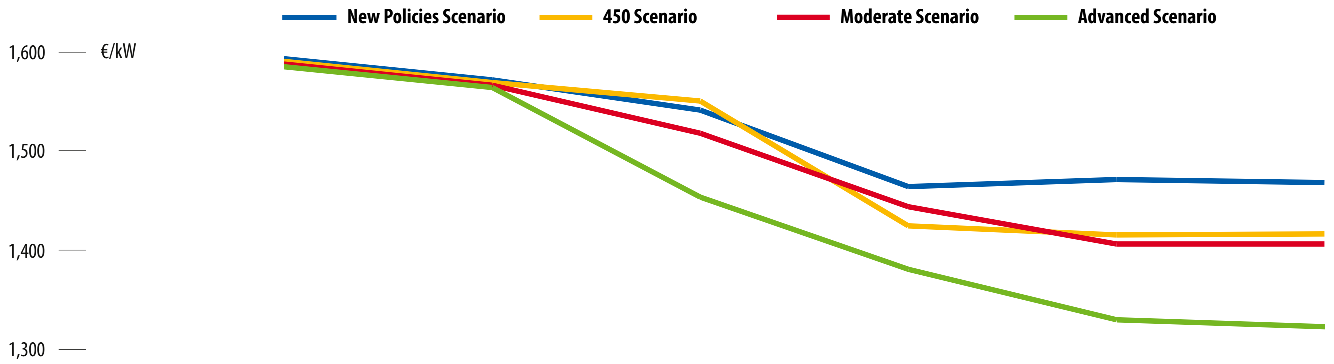
8 For example, a 1 MW turbine operating at a 25% capacity factor will deliver 2190 MWh during a year; a 2 MW turbine operating at a 35% capacity factor will deliver 6132 MWh during a year, etc.

WIND POWER SHARE OF GLOBAL ELECTRICITY DEMAND



	2013	2015	2020	2030	2040	2050
New Policies Scenario						
IEA demand projection	3%	4%	7%	11%	14%	18%
Energy Efficiency demand projection	3%	4%	7%	12%	16%	20%
450 Scenario						
IEA demand projection	3%	4%	7%	13%	17%	22%
Energy Efficiency demand projection	3%	4%	7%	14%	19%	25%
Moderate Scenario						
IEA demand projection	3%	4%	8%	14%	20%	25%
Energy Efficiency demand projection	3%	4%	9%	16%	22%	28%
Advanced Scenario						
IEA demand projection	3%	4%	9%	18%	26%	36%
Energy Efficiency demand projection	3%	4%	9%	20%	29%	41%

SPECIFIC COSTS (€/kW)



	2013	2015	2020	2030	2040	2050
New Policies Scenario	1,592	1,571	1,541	1,465	1,472	1,469
450 Scenario	1,592	1,571	1,550	1,426	1,417	1,418
Moderate Scenario	1,592	1,571	1,518	1,445	1,408	1,408
Advanced Scenario	1,592	1,571	1,452	1,379	1,328	1,321

© Bent Nielsen and Danish Wind Industry Association

These 'low wind speed' turbines generally are on taller towers with smaller generators and larger blades, and operate with a higher capacity factor. India is one of the key markets for such machines.

However, for the GWEC scenarios we have left the average global capacity factor at 28% for the period out to 2030, increasing to 30% after that date for the rest of the scenario period. The reality is that it will probably be greater than that. For the regional scenarios, however, we have used capacity factors slightly higher than the global average in OECD North America, Latin America, Africa and OECD Asia Pacific; and slightly lower in India and China, reflecting the current situation in those markets.

SCENARIO RESULTS

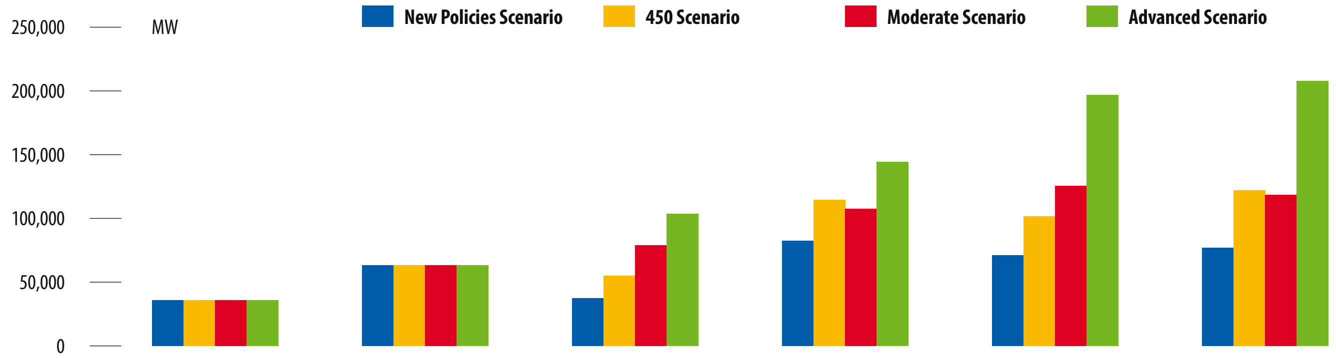
INVESTMENT

The capital cost of turbines has been decreasing, precipitously in some markets over the past several years, both in adjusted and in absolute terms. Of late, this has been largely the result of market forces, but at the same time, continuous design refinements and experience with mass producing an increasing number of the same or similar turbines have decreased the cost of the technology itself. The other major factor, commodity prices, has contributed to the decrease in prices, although the industry is susceptible to price spikes, particularly for steel and copper. Significant regional variations are seen, as both competition and other underlying market factors affect the final costs. Further inter-annual variations as a result of market forces, commodity prices and the rate of inflation can have an impact, which is beyond the scope of the scenarios discussed.

Total project costs are a more complex story, as many administrative and regulatory factors come into play, as well as the highly variable costs of labor, permitting and development in different markets.

The development of installed project costs in the GWEC scenarios assumes gradually decreasing costs in absolute terms, reflecting the projected growth of the industry. Regardless, the growth of the wind power industry is attracting increased investment. Last year almost €110 billion was invested in new wind power development, of which

TOTAL INSTALLED COST, INVESTMENT AND EMPLOYMENT



	2013	2015	2020	2030	2040	2050
New Policies Scenario						
Annual Installation MW	35,787	63,350	37,370	82,428	70,955	76,955
Cost € / kW	1,592	1,571	1,541	1,465	1,472	1,469
Investment € billion /year	57	100	58	121	104	113
Employment Job / year	606,076	1,029,681	696,841	936,232	1,080,374	1,316,408
450 Scenario						
Annual Installation MW	35,787	63,350	54,962	114,494	101,525	121,998
Cost € / kW	1,592	1,571	1,550	1,426	1,417	1,418
Investment € billion /year	57	100	85	163	144	173
Employment Job / year	606,076	1,029,681	931,654	1,385,182	1,370,137	1,682,231
Moderate Scenario						
Annual Installation MW	35,787	63,350	79,005	107,488	125,397	118,604
Cost € / kW	1,592	1,571	1,518	1,445	1,408	1,408
Investment € billion /year	57	100	120	155	177	167
Employment Job / year	606,076	1,029,681	1,290,079	1,374,111	1,469,931	1,866,633
Advanced Scenario						
Annual Installation MW	35,787	63,350	103,423	144,165	196,748	207,879
Cost € / kW	1,592	1,571	1,452	1,379	1,328	1,321
Investment € billion /year	57	100	150	199	261	275
Employment Job / year	606,076	1,029,681	1,634,721	2,426,331	3,588,875	4,202,612

almost €67 billion was in developing and emerging economies[9].

In the NPS the costs remain roughly static over the period out to 2030. Capital costs per kilowatt of installed capacity were considered to have averaged €1,571 in 2015. For the NPS they don't change significantly over the scenario period, ending up at €1,465/kw in 2030. In the 450 Scenario the prices reach €1,550/kW in 2020 and €1,426/kW in 2030.

In the MS prices drop to about €1,518/kw in 2020 and to €1,445/kw by 2030; and in the Advanced Scenario, with rapid scale up, costs drop more rapidly, down to €1,452 by 2020 and to €1,379 by 2030.

In the NPS, the annual investment decreases to €57.6 billion in 2020, and then slowly rises to €121 billion in 2030. The 450 scenario sees annual investment levels fall below the 2015 levels to €85 billion in 2020, and then over the next ten years double to €163 billion annually by 2030.

In the MS, annual investment increases to nearly €120 billion by 2020 and to €155 billion per year by 2030. Finally, in the AS, annual investments are around €150 billion by 2020, and then rise to €199 billion in 2030.

9 http://fs-unep-centre.org/sites/default/files/publications/globaltrendsin-renewableenergyinvestment2016lowres_0.pdf

EMPLOYMENT

The International Renewable Energy Agency's (IRENA) annual review of jobs in RE sector stated that nearly 1.1 million people were employed by the global wind power industry at the end of 2015[10]. Driven by favorable policies and declining technology costs, rising deployment of renewables in Asian markets kept driving the regional shifts in job numbers from traditional OECD markets.

The assumption this report continues to make, which is verified by such studies as do exist, is that for every new megawatt of capacity installed in a country in a given year, 14 person/year of employment is created through manufacturing, component supply, wind farm development, construction, transportation, etc. While there is quite substantial regional variation, this seems to work as a global average. As production processes are optimized, we project that this level will decrease to 13 person/year of employment per new megawatt installed by 2020, and to 12 person/year of employment by 2030.

In addition, 0.33 person/year of employment per MW of installed capacity are judged to be needed for operations and maintenance work at existing wind farms. Again, there will be substantial regional variations, but this seems to work as a global number.

The wind industry creates a large number of skilled, semi-skilled and unskilled jobs, and this has taken on an increasing political as well as economic importance. The macro-economic effects of the development of the wind power sector as well as the renewable energy sector as a whole is increasingly a factor in political decision making on future energy choices.

Given the assumptions, and on the basis of existing numbers available, the global wind industry employed about 1.1 million people, as of the end of 2015.

10 http://www.irena.org/DocumentDownloads/Publications/IRENA_RE_Jobs_Annual_Review_2016.pdf

THE WIND INDUSTRY CREATES A LARGE NUMBER OF JOBS, AND THIS HAS TAKEN ON AN INCREASING POLITICAL AS WELL AS ECONOMIC IMPORTANCE

Under the NPS, this number would drop to 696,000 jobs in the sector and slowly rise towards 936,232 jobs by 2030. Under the 450 Scenario, this number would stay roughly the same out to 2020 and grow strongly to reach nearly 1.39 million jobs by 2030.

In the MS the global wind sector sees 1.29 million by 2020, and nearly 1.4 million by 2030.In the AS, employment numbers near 1.6 million jobs, and reaches 2.4 million by 2030.

CO_2 REDUCTION

Wind power's environmental benefits include the elimination of local air pollution and nearly zero water consumption. However, the greatest benefit is wind power's contribution to reduction of carbon dioxide emissions from the power sector, which is the single largest anthropogenic contributor to the global climate change problem.

Wind energy technology has an extremely good energy balance. All of the CO_2 emissions related to the manufacturing, installation,

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servicing and decommissioning of a turbine are generally 'paid back' after the first 3 to 9 months of operation. For the rest of its 20-year design lifetime, the turbine operates without producing any of the harmful greenhouse gases that are already disrupting life on earth.

The benefit obtained from wind power in relation to CO_2 emissions depends entirely on what sort of power plant it displaces. If it displaces hydro or nuclear power, the benefit is small; but if it replaces coal or gas, then the benefit is enormous.

Emissions from fossil fuel plants range from around 500g CO_2 /kWh up to 1200g CO_2/kWh or more for the dirtiest fuels. On the basis of the current electricity distribution, we have calculated that 600g CO_2 /kWh is a good average number to characterize the savings generated by wind power, although the regional variations will be significant.

Annual reductions in CO_2 from existing wind power plants were about 521 million tonnes in 2015. Under the NPS, this is expected to rise to 941 million tonnes annually by 2020 and up to 1,987 tonnes per year by 2030. Under the 450 Scenario, this is expected to rise to 968 million tonnes annually by 2020 and up to 2,293 tonnes / annum by 2030.

The MS implies savings of over 1.17 billion tonnes of CO_2 /annum by 2020 and more than 2.6 billion tonnes by 2030; while the GWEO AS would result in savings of nearly 1.29 billion tonnes of CO_2 per year by 2020, and 3.3 billion tonnes/annum by 2030.

Over the long-term the AS will bring almost double the savings in CO_2 annually. In 2050 the AS is foreseen to bring about 9.2 billion tonnes of CO_2emission reduction annually. In comparison the 450 Scenario forecasts annual CO_2emission reduction of 5.6 billion tonnes.

AVOIDED CO_2 SINCE 2006

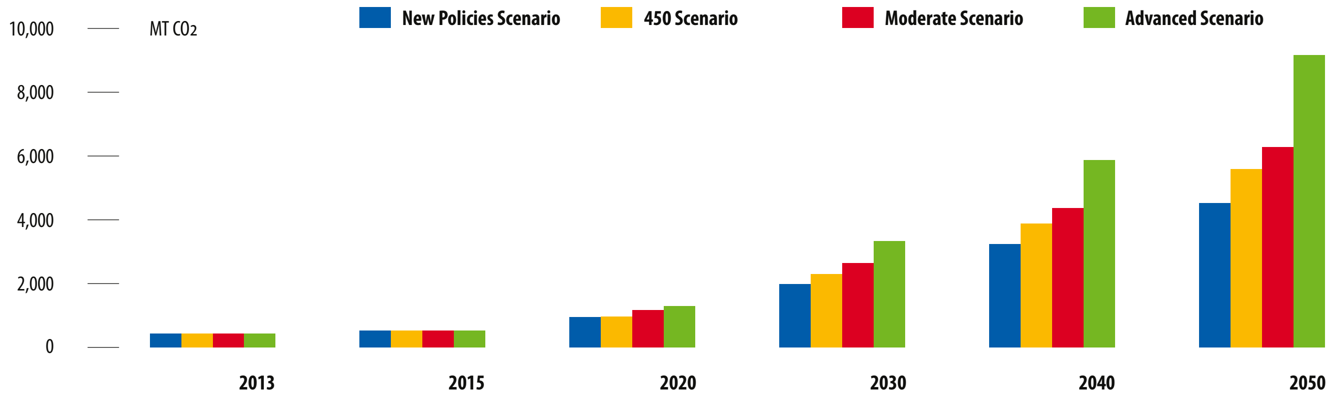
In cumulative terms, the NPS has wind power saving nearly 7.2 billion tonnes by 2020, and more than 21 billion tonnes by 2030. In cumulative terms, the 450 Scenario has wind power saving nearly 7.3 billion tonnes by 2020, and nearly 23 billion tonnes by 2030.

The MS results in nearly 7.9 billion tonnes in cumulative savings by 2020, and 26.4 billion tonnes of CO_2 savings by 2030. The AS yields cumulative CO_2 savings of 8.2 billion tonnes by 2020, and 30.7 billion tonnes by 2030.

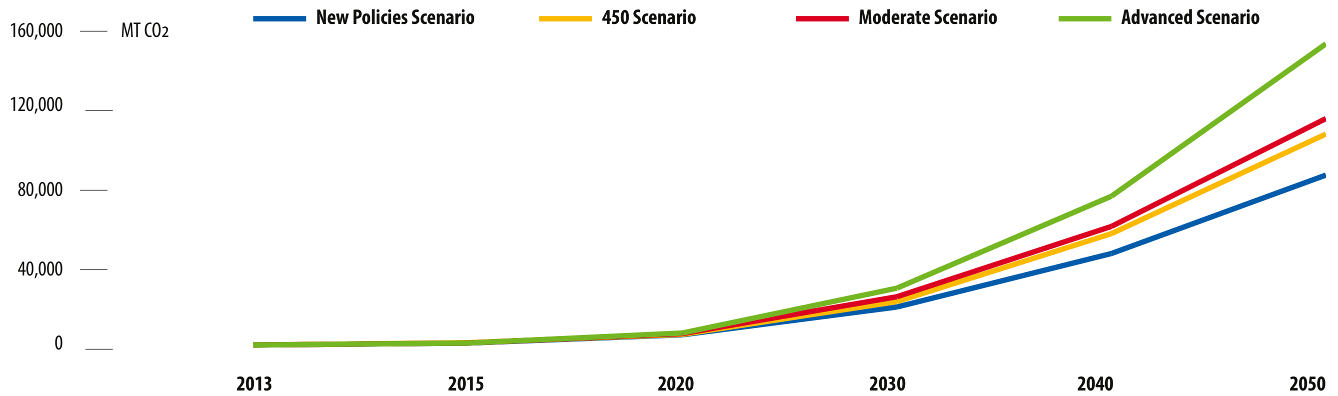
These are significant reductions across all scenarios, but the critical issue here is not just the total volume of reductions, but the speed at which these savings are achieved, as GHGs are long-lived gases, and the imperative is for early emissions reductions to achieve the greatest benefit.

Wind power's scalability and its speed of deployment makes it an ideal technology to bring about the early emissions reductions which are required if we are to keep the window open for keeping global mean temperature rise to less than 2°C above pre-industrial levels.

ANNUAL CO2 EMISSIONS REDUCTIONS



CUMULATIVE CO2 EMISSIONS REDUCTIONS



ANNUAL AND CUMULATIVE CO2 EMISSIONS REDUCTIONS (MT CO2)

	2013	2015	2020	2030	2040	2050
New Policies Scenario						
Annual CO_2 savings	428	521	941	1,987	3,237	4,525
Cumulative CO_2 savings	2,112	3,105	7,247	21,223	48,137	87,610
450 Scenario						
Annual CO_2 savings	428	521	968	2,293	3,877	5,591
Cumulative CO_2 savings	2,112	3,105	7,279	22,730	54,687	102,639
Moderate Scenario						
Annual CO_2 savings	428	521	1,173	2,642	4,364	6,282
Cumulative CO_2 savings	2,112	3,105	7,850	26,393	61,770	116,043
Advanced Scenario						
Annual CO_2 savings	428	521	1,294	3,327	5,867	9,155
Cumulative CO_2 savings	2,112	3,105	8,153	30,702	76,953	153,634

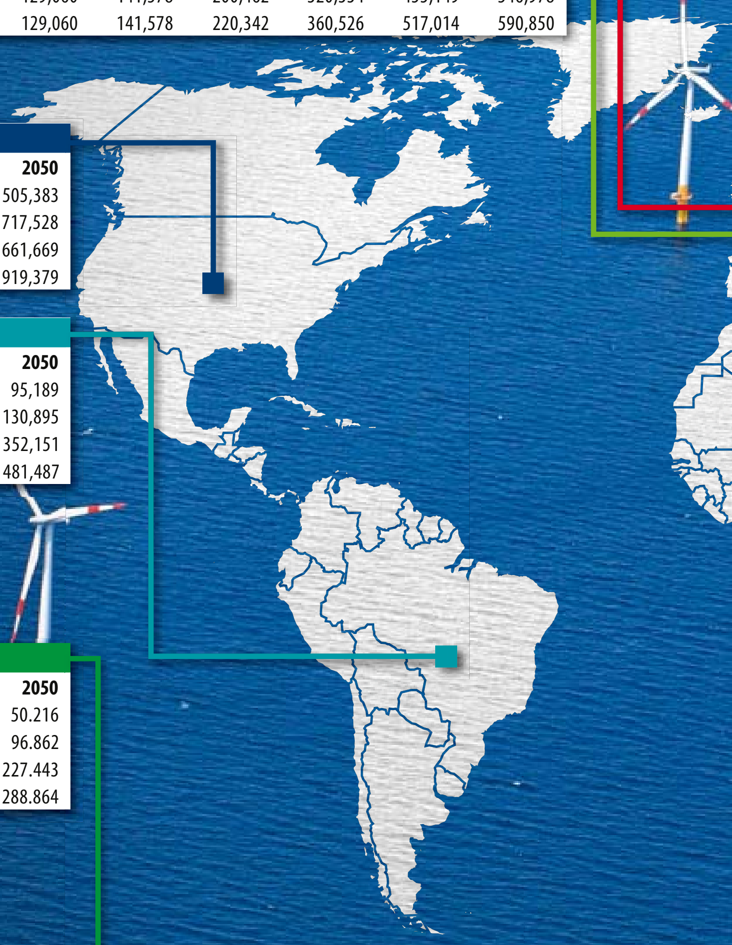
REGIONAL BREAKDOWN OF CUMULATIVE CAPACITY UP TO 2050

OECD EUROPE

Total Capacity in MW	2013	2014	2015	2020	2030	2040	2050
New Policies Scenario	119,810	132,155	145,416	186,878	323,091	476,388	607,085
450 Scenario	119,810	132,155	145,416	190,855	355,769	549,187	741,833
Moderate Scenario	119,810	132,155	145,416	207,955	358,554	512,002	641,939
Advanced Scenario	119,810	132,155	145,416	227,217	398,691	567,937	703,724

EU 28

Total Capacity in MW	2013	2014	2015	2020	2030	2040	2050
New Policies Scenario	117,472	129,060	141,578	180,755	311,273	455,984	578,681
450 Scenario	117,472	129,060	141,578	182,105	328,938	499,517	665,616
Moderate Scenario	117,472	129,060	141,578	200,462	320,334	455,149	546,978
Advanced Scenario	117,472	129,060	141,578	220,342	360,526	517,014	590,850



NORTH AMERICA

Total Capacity in MW	2013	2014	2015	2020	2030	2040	2050
New Policies Scenario	70,640	77,935	88,749	126,961	252,784	377,743	505,383
450 Scenario	70,640	77,935	88,749	131,659	303,322	492,384	717,528
Moderate Scenario	70,640	77,935	88,749	149,120	318,390	491,120	661,669
Advanced Scenario	70,640	77,935	88,749	165,181	413,970	643,214	919,379

LATIN AMERICA

Total Capacity in MW	2013	2014	2015	2020	2030	2040	2050
New Policies Scenario	4,747	8,568	12,220	18,749	36,196	66,425	95,189
450 Scenario	4,747	8,568	12,220	18,913	35,830	82,150	130,895
Moderate Scenario	4,747	8,568	12,220	42,997	129,491	234,631	352,151
Advanced Scenario	4,747	8,568	12,220	38,203	124,494	276,050	481,487

AFRICA

Total Capacity in MW	2013	2014	2015	2020	2030	2040	2050
New Policies Scenario	1.493	2.426	3.262	6.575	15.908	31.254	50.216
450 Scenario	1.493	2.426	3.262	7.207	23.005	56.557	96.862
Moderate Scenario	1.493	2.426	3.262	16.805	60.852	128.905	227.443
Advanced Scenario	1.493	2.426	3.262	18.337	72.229	157.411	288.864

Africa Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Democratic Republic of Congo, Cote d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Reunion, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, United Republic of Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe

Eastern Europe/Eurasia Albania, Armenia, Azerbaijan, Belarus, Bosnia-Herzegovina, Croatia, Serbia and Montenegro, the former Republic of Macedonia, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan

EU 28 Austria, Belgium, Bulgaria, Croatia, Republic of Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom

India India

Latin America Antigua and Barbuda, Aruba, Argentina, Bahamas, Barbados, Belize, Bermuda, Bolivia, Brazil, the British Virgin Islands, the Cayman Islands, Chile, Colombia, Costa Rica, Cuba, Dominica, the Dominican Republic, Ecuador, El Salvador, the Falkland Islands, French Guyana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Montserrat, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, St. Kitts and Nevis, Saint Lucia, Saint Pierre et Miquelon, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago, the Turks and Caicos Islands, Uruguay, Venezuela

Middle East Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates, Yemen

Non-OECD Asia Afghanistan, Bangladesh, Bhutan, Brunei, Cambodia, Chinese Taipei, Cook Islands, East Timor, Fiji, French Polynesia, Indonesia, Kiribati, North Korea, Laos, Macao, Malaysia, Maldives, Mongolia, Myanmar, Nepal, New Caledonia, Pakistan, Papua New Guinea, Philippines, Samoa, Singapore, Solomon Islands, Sri Lanka, Thailand, Tonga, Vietnam, Vanuatu

North America Canada, Mexico, United States

OECD Asia Oceania Australia, Japan, South Korea, New Zealand

OECD Europe Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom

PR China People's Republic of China including Hong Kong

EASTERN EUROPE / EURASIA

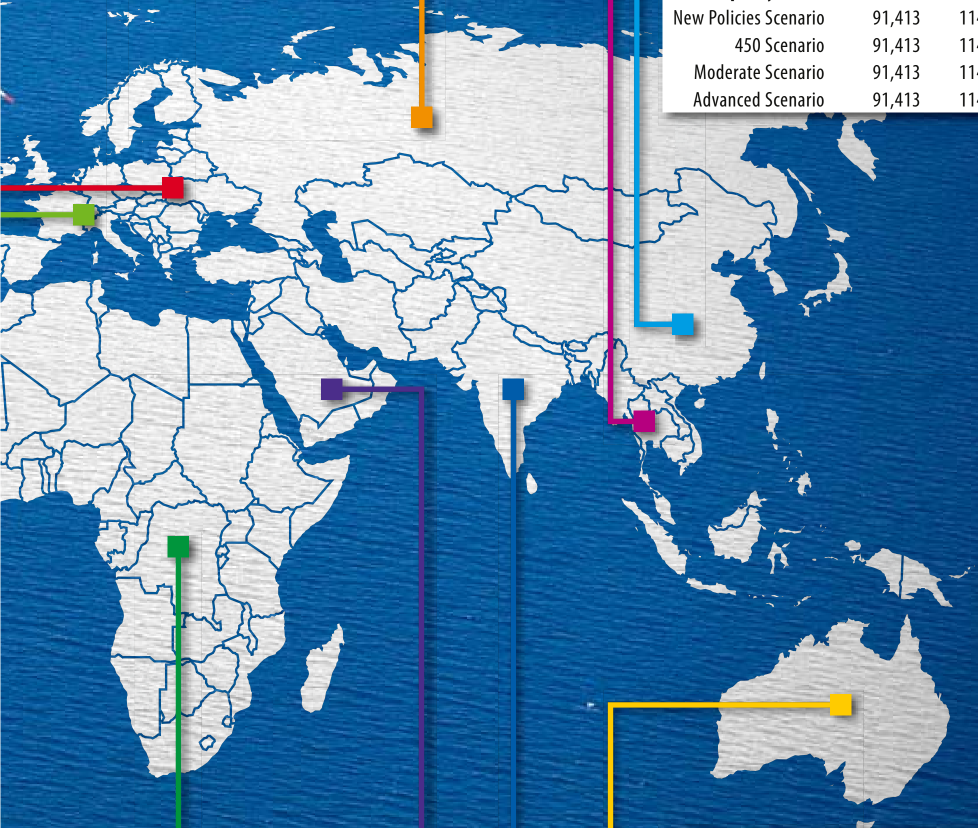
Total Capacity in MW	2013	2014	2015	2020	2030	2040	2050
New Policies Scenario	390	516	533	668	1,117	2,204	3,201
450 Scenario	390	516	533	722	1,982	4,551	7,149
Moderate Scenario	390	516	533	644	1,895	5,247	10,824
Advanced Scenario	390	516	533	650	2,835	7,454	14,163

NON-OECD ASIA

Total Capacity in MW	2013	2014	2015	2020	2030	2040	2050
New Policies Scenario	562	861	861	5,213	21,796	58,854	114,834
450 Scenario	562	861	861	6,411	49,250	111,702	204,530
Moderate Scenario	562	861	861	2,344	14,842	49,388	124,912
Advanced Scenario	562	861	861	4,296	41,659	146,439	371,895

PR CHINA

Total Capacity in MW	2013	2014	2015	2020	2030	2040	2050
New Policies Scenario	91,413	114,609	145,362	201,178	364,801	600,590	794,013
450 Scenario	91,413	114,609	145,362	216,806	452,081	735,458	1,010,198
Moderate Scenario	91,413	114,609	145,362	291,439	541,577	868,779	1,150,189
Advanced Scenario	91,413	114,609	145,362	313,061	666,500	1,189,629	1,789,753



OECD ASIA OCEANIA

Total Capacity in MW	2013	2014	2015	2020	2030	2040	2050
New Policies Scenario	7,098	7,846	8,695	15,322	34,598	60,494	90,842
450 Scenario	7,098	7,846	8,695	16,836	47,295	82,575	130,944
Moderate Scenario	7,098	7,846	8,695	13,364	32,887	68,136	128,583
Advanced Scenario	7,098	7,846	8,695	17,242	57,084	107,808	187,579

MIDDLE EAST

Total Capacity in MW	2013	2014	2015	2020	2030	2040	2050
New Policies Scenario	99	99	216	1,072	8,009	41,573	101,051
450 Scenario	99	99	216	1,501	30,124	89,366	147,344
Moderate Scenario	99	99	216	777	4,995	16,085	35,147
Advanced Scenario	99	99	216	1,017	10,234	42,623	96,128

INDIA

Total Capacity in MW	2013	2014	2015	2020	2030	2040	2050
New Policies Scenario	20,150	22,465	25,088	50,063	111,938	184,838	256,789
450 Scenario	20,150	22,465	25,088	67,098	155,736	254,827	358,314
Moderate Scenario	20,150	22,465	25,088	44,734	116,257	227,137	372,830
Advanced Scenario	20,150	22,465	25,088	56,297	163,473	294,184	452,197

GLOBAL TOTAL

Total Capacity in MW	2013	2014	2015	2020	2030	2040	2050
New Policies Scenario	318,354	369,596	432,656	639,478	1,259,974	2,052,583	2,869,611
450 Scenario	318,354	369,596	432,656	658,009	1,454,395	2,458,757	3,545,595
Moderate Scenario	318,354	369,596	432,656	797,028	1,675,624	2,767,351	3,983,995
Advanced Scenario	318,354	369,596	432,656	879,446	2,110,161	3,720,919	5,805,882

3

THE FUTURE OF WIND

All analyses of the global energy picture today say that the wind industry has a 'bright future'. Having experienced double digit cumulative growth for nearly twenty years, wind is unique among modern manufacturing industries, to the point where the fastest growing job in the United States is 'wind energy technician'.

But how bright? Left to its own devices, market forces alone would generate steady growth for the sector, due to its low cost, speed of deployment and the stability it brings to power prices. Of course, energy markets are never left to their own devices. Public policy, tax policies, subsidies and clean air, water and climate legislation and regulation, among others, have a dramatic effect on what the power markets look like, which technologies are favored, and how the system is forced to adapt.

There are two overarching questions which will have more than anything else to do with the rate and scope of wind power's expansion out to 2020, 2030 and to 2050: 1) Will humanity once and for all join forces to combat the existential threat of climate change? The Paris Agreement gives hope that this might be the case. The discourse in the current US presidential election campaign does not; 2) Is there some miraculous technological breakthrough just around the corner that will transform the power sector without the need for wind, solar and other existing technologies? It doesn't seem likely, but it can never be ruled out.

Answering those two questions is far beyond the scope of this report, or of the wind (or any other) industry. But this report is the best look at the future of wind energy based on what we know and what we can reasonably expect to happen. History viewed in retrospect rarely looks like that, but we shall see.

WHAT HAS CHANGED?

WIND HAS BECOME A MAINSTREAM POWER SOURCE

Wind provides ~4% of global electricity supply and is growing rapidly. Wind supplied more than 40% of Denmark's total power generation last year, 23% in Portugal and Ireland, ~20% in Uruguay, 19% in Spain, and 15% in Germany. The US state of Iowa sourced 31% of its electricity from wind in 2015, South Dakota 25%, Kansas 24%, Oklahoma 18% and 10% in Texas;

© Puget Sound Energy

and South Australia was around 40%. In 2015, wind was the largest single source (nearly 50%) of all increase in electricity generation globally.

PRICES HAVE FALLEN DRAMATICALLY

Wind is the cheapest way to add capacity to the grid in a large number of markets, becoming the utility option of choice. Very low prices across South America and Africa and in the United States are becoming the new normal, as both the technology and the industry matures and becomes more competitive. In the US, the cost of wind energy has dropped by more than 65% in the past 6 years.[1]

WIND IS THE CHEAPEST WAY TO ADD CAPACITY TO THE GRID IN A LARGE NUMBER OF MARKETS, BECOMING THE UTILITY OPTION OF CHOICE

INTEGRATION

With the increasing penetration of wind power in a larger number of markets, differing experiences have shown that managing large penetrations of variable renewables (wind and solar) can be handled without threatening the stability of the power system, and indeed, in many cases it enhances it, as the system is less vulnerable to the failure of a single large source[2]. Increased interconnection, improved forecasting and facilities for demand management only increase possible penetration levels. As the Portuguese Secretary of State for Energy pointed out a couple of years ago: *"We recently had a situation where we were getting more than 90% of our power from wind alone. And you know what happened? Nothing."*

GLOBAL SPREAD

As a look at our country by country breakdown[3] shows, wind has moved far beyond the 'traditional' markets in North America, Europe and (more recently) China and India: Brazil, Mexico, Chile, Peru, Uruguay and Argentina; South Africa, Ethiopia, Egypt and Morocco; and Iran, the Philippines, Indonesia, and Vietnam are now the new markets to watch. For four out of the last five years the majority of new installations have taken place *outside* the OECD, and that is expected to continue.

WHAT HASN'T CHANGED?

HUGE SUBSIDIES TO FOSSIL FUELS AND NUCLEAR

This is many times the support given to renewables. How many times depends on what you include. Estimates for annual fossil fuel subsidies range from a low of $US 5-600 million/annum, up to more than $US 5 *trillion* according to the International Monetary Fund, which includes the damage to climate, human health and the biosphere[4]. While there have been some moves for subsidy reform in some countries, the basic picture hasn't changed.

INTERNATIONAL POLICY IN THE ENERGY SECTOR

Despite the change in rhetoric, international financial institutions are *still* spending more money supporting fossil fuels than they are

1 https://cleantechnica.com/2016/06/16/us-wind-industry-highlights-66-drop-costs-wind-generated-electricity/
2 https://www.windpowerengineering.com/policy/awea-interim-ceo-rob-gramlich-addresses-house-committee-on-energy-power/
3 http://www.gwec.net/wp-content/uploads/2012/06/Global-Installed-Wind-Power-Capacity-MW-–-Regional-Distribution.jpg
4 https://www.imf.org/external/pubs/ft/wp/2015/wp15105.pdf

Fukushima 7MW floater
in Nagasaki
© FukushimaFORWARD MHI

renewables, with the World Bank leading the charge[5]. But why should we surprised, since their ultimate decision making body is composed of national government representatives whose own governments are doing the same thing?

DETRACTORS PROMOTE MYTHS

Mostly financed and promoted by incumbent energy interests, gainsaying the positive benefits of wind power and other renewables has become almost as large a business for internet cranks and trolls and unapologetic fossil fuel industry shills as climate skepticism; and with as little underlying truth. They are too numerous to go into here, but useful industry rebuttal can be found at these links[6].

AMBIGUITY AND INSTABILITY OF GOVERNMENT POLICY

The steady growth and development of the renewable energy sector relies upon stable and predictable government policies. It is still the case that far too many governments talk out of both sides of their mouths (see subsidies, above) and make rapid and sometimes retroactive policy changes which are very damaging to the sector. In the worlds of IEA (then Chief Economist) Executive Director Fatih Birol: **"But while variability of renewables is a challenge that energy systems can learn to adapt to, variability of policies poses a far greater risk."**[7]

SO WHAT DO WE KNOW ABOUT THE FUTURE?

Without attempting to answer the unanswerable questions about human response to climate change and technological miracles, there are some key developments which seem very likely to occur in the wind industry over the coming decades. How fast and how far they go will depend on the broad commitment to a clean energy system globally.

5 http://blueandgreentomorrow.com/2016/09/22/bottom-class-two-faced-world-bank-climate-change-scorecard/
6 http://www.ewea.org/uploads/pics/Windpower_Myths.png; http://www.distgen.co/top-10-wind-energy-myths-busted/; http://www.aweablog.org/fact-check-awea-represents-american-wind-power/
7 https://www.iea.org/newsroomandevents/pressreleases/2015/october/renewables-to-lead-world-power-market-growth-to-2020.html

Crossroads Wind Farm
in Canton, Oklahoma
© Russell Gold

COSTS CONTINUE COMING DOWN

While there has been much written about the precipitous drop in the price of solar PV, less has been written about the drop in wind prices. While the recent record low prices for wind in auctions in Peru, Morocco and Mexico will not be replicable everywhere in the short term, we can expect prices to continue to come down, and unlike solar, they were already low to begin with.

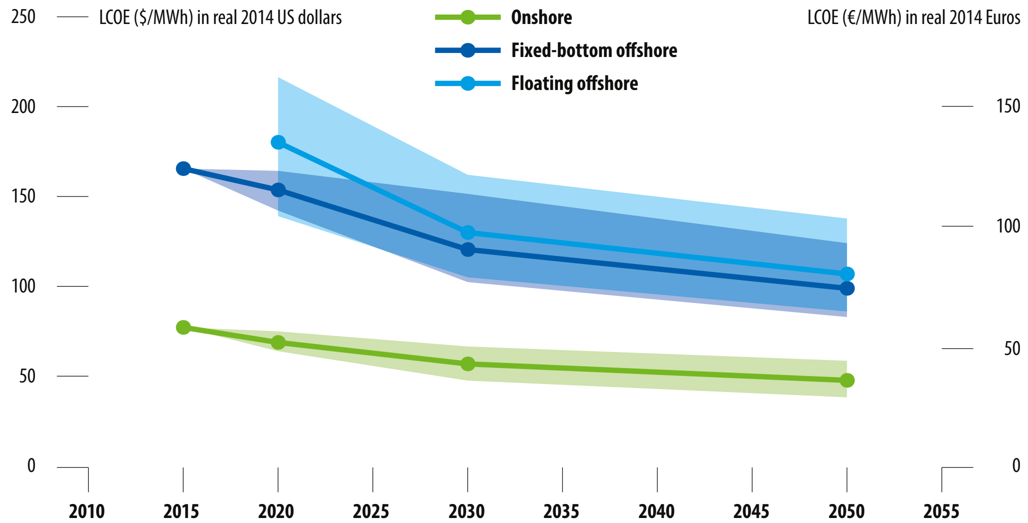
Although it may seem like wind and solar are in a 'race' to get the lowest cost, as will be seen below, at a certain point, that is no longer the question. There is plenty of room for both technologies in most systems for the foreseeable future, and the local resource, demand curve and system characteristics will determine the relative amounts of each technology that are optimal in each system.

Recently the Lawrence Berkeley National Lab, NREL and others published an *Expert elicitation survey on future wind energy costs** in the journal *Nature*, under the auspices of IEA Wind. Although the data for the study was collected prior to the record low auction results in the onshore sector over the past year and in the offshore sector in the last couple of months, (and much of it before the dollar dramatically increased in value against the Euro 18 months ago) the study reinforces the trends that we are experiencing and that we expect to see as the industry matures.

The study identified five main drivers for cost reductions: CapEx, OpEx, cost of financing, turbine performance and project design life. Larger turbine size, larger rotor diameters and higher hub heights are obviously key factors,

* http://go.nature.com/2cjOYWC

MEDIAN LCOE SCENARIO



Lines/markers indicate the median expert response for the **median LCOE scenario**
Shaded areas show the 1st-3rd quartiles of expert responses.

*Source: Berkeley Lab**

but improved operation, siting and improved financial conditions for wind projects also play a role. The study reinforces the trends that we are experiencing and that we expect to see as the industry matures.

While prices for onshore wind have been competitive in an increasing number of markets, the recent drop in offshore prices is also encouraging. The record low prices in the Dutch auction for 700 MW at the Borssele site near the Belgian border in the beginning of July 1016 - less than €73/MWh, which if you add the cost of transmission would be somewhere in the low to mid 80s. The next tender for another 700 MW is now open for bids which will close on 29 September and be awarded around the end of this year.

Vattenfall has just won the bid for 350 MW of Danish nearshore projects at a price just over €60/MWh. Granted, these projects are close to shore, but still it's a positive sign. How soon will prices <€100/MWh be 'normal'? Time will tell, but it seems inevitable.

* http://newscenter.lbl.gov/2016/09/13/experts-anticipate-significant-continued-reductions-wind-energy-costs/

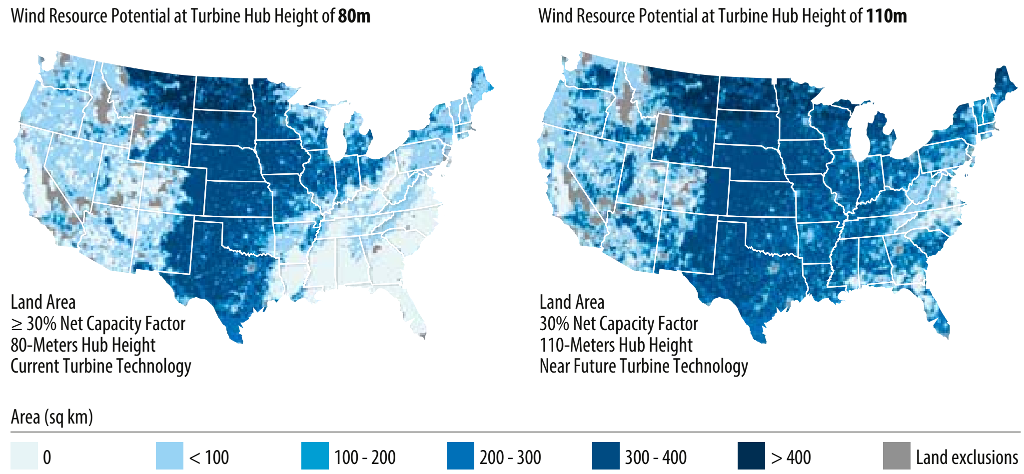
TECHNOLOGY CONTINUES TO IMPROVE

A significant portion of the cost reductions are coming through technology improvements, which are generally evolutionary rather than spectacular, although I can tell you that standing next to one of the new 8 MW machines seems pretty spectacular. But technology, scale and management improvements to extract the maximum amount of energy from a column of moving air continues.

In the past several years we have seen the widespread deployment of so-called 'low wind' machines, and the deployment of Class II and III turbines in wind regimes which might have formerly seemed most suited for Class I machines. Particularly in places like Brazil, Morocco and Egypt, the steady winds and relatively mild climate mean using a Class II or III machine means higher capacity factors and a lower cost of energy.

The deployment of turbines on taller towers with longer blades and downrated generators with lower cut-in speeds means that maximum extraction of energy at high capacity factors in modest wind regimes closer to load centers has now become economical. The impact of

NEW TECHNOLOGY MEANS MORE DEVELOPMENT IN MORE REGIONS



- New technology can reach higher and steadier winds, making wind energy development possible in new regions of the country
- Longer blades can capture more wind energy

Source: NREL/AWS Truepower

this can be seen in the dramatic increase in the area of the continental United States where wind power becomes economic.

For some years experiments have been proceeding with the use of nacelle mounted LiDAR units both for the purposes of ensuring that turbines are performing up to their rated power curves, and more importantly, to maximize energy yield by providing a series of 'snapshots' of the wind some hundreds or thousands of meters in front of the turbine, allowing in particular for yaw optimization.

In a recent breakthrough, Dong Energy announced that it is now ready to deploy its first-of-kind 'Dual Doppler'[8] radar, which will map the wind resource across an entire swath of ocean, for instance, enabling optimization of the design, siting and operation of offshore wind farms, reducing wear and tear and providing another source of short term forecasting for the production of the power plant – which is what offshore wind farms will increasingly 'look like' to the system operator.

And of course we can expect machines to get bigger. One of the reasons for the recent reductions in tender prices for offshore wind is the availability of the new range of 7 and 8 MW machines – the bigger and more powerful the machine, the fewer expensive foundations and support structures are required, thereby lowering the cost of energy. A 2011 study[9] demonstrated that with existing materials machines of up to 20 MW could be constructed. While such behemoths are not yet economic, it will probably not be long before we'll see 10, 12 and 15 MW machines – and if there are fundamental limits, they're not yet clear. As materials science continues to advance, who knows how large offshore machines will be in 20 years' time?

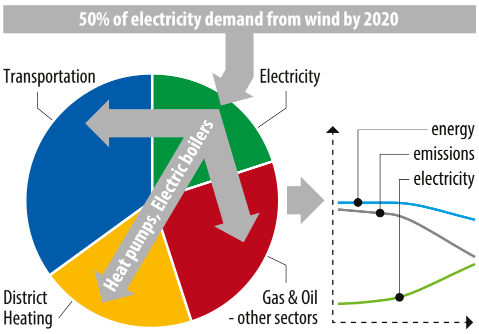
THE TRANSFORMATION OF THE POWER SECTOR

To get to zero emissions in the power sector first, and then to a totally emissions free energy system, it is clear that electricity is going to play the dominant role. As well as providing power for an increasing number of services, it is expected that electricity will take over much of the transport sector as well as some substantial portion of heat production.

8 http://cleantechnica.com/2016/09/23/worlds-first-advanced-offshore-wind-power-radar-system-now-operational/
9 http://www.ewea.org/fileadmin/ewea_documents/documents/upwind/21895_UpWind_Report_low_web.pdf

Now that wind and solar power have become so cheap, and are so universally available, we need to figure out how to make a system dominated by these two technologies work. The Danish transmission system operator Energinet.dk puts it thusly:

Coherent and flexible energy systems



Source: Energinet.dk

This is for the Danish energy system: good interconnections, no hydro, not much solar but lots and lots of wind – well over 100% of total demand on occasion.

But of course, every system is different, every country's natural resource endowment is different; it's level of interconnectedness with neighboring systems is different, dispersion or compactness of the population/demand; pattern and flexibility of demand, etc.

But what is required is a careful analysis and planning for each country/region, and a market which rewards and prioritises carbon-free emissions, but at the same time rewards the flexibility in both supply and demand which will allow maximum utilization of zero emission (and zero marginal cost) but variable renewable sources.

Finally, there is the much-discussed question of storage. Storage is always a hot topic of conversation in countries without much RE penetration, but much less so in countries that do. Storage is, as of today, the most expensive and last option for integrating variable renewables, but it may be necessary in some places in the future. But that is unlikely to be the case soon: Boris Schutz of 50HZ, a major German utility, told this year's *Energiewende* conference that "storage only becomes an issue, in Europe at least, when we get to penetration levels of 70-80% of variable RE".

At the end of the day, countries will find their own way. We recently have news of Portugal running on 100%[10] renewable electricity for 4 consecutive days in May 2016, and Uruguay did the same for six straight days in September 2016. But of course the leader is Costa Rica, which was 100% renewable in the electricity sector for 285 days in 2015[11].

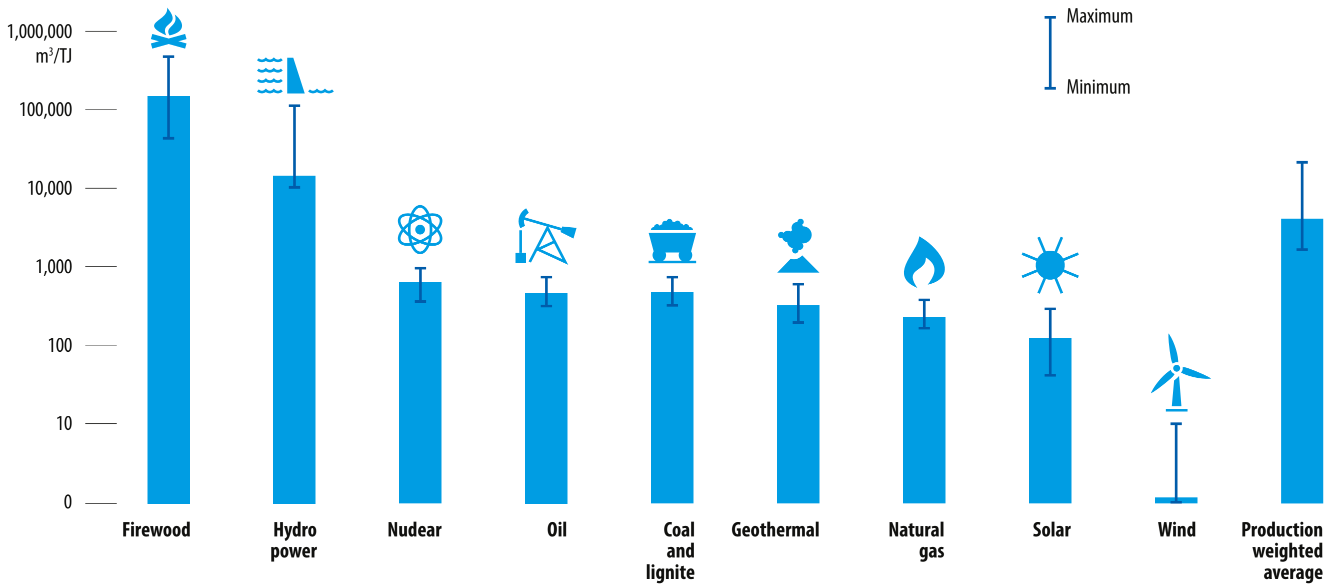
DRIVERS FOR WIND ENERGY DEPLOYMENT:

As this report documents, wind power is an increasing contributor to CO_2 reduction, and will be more so in the future. The sector also attracts billions in investment and has created over a million jobs worldwide, and those numbers are set to rise dramatically. But there are a number of other key drivers for wind deployment, which will apply to differing degrees in different countries over time.

WIND POWER IS AN INCREASING CONTRIBUTOR TO CO_2 REDUCTION, AND WILL BE MORE SO IN THE FUTURE

10 https://www.theguardian.com/environment/2016/may/18/portugal-runs-for-four-days-straight-on-renewable-energy-alone
11 http://www.ecowatch.com/costa-rica-powers-285-days-of-2015-with-100-renewable-energy-1882135438.html

AVERAGE WF RELATED TO ELECTRICITY AND HEAT PRODUCTION



	Firewood	Hydro power	Nudear	Oil	Coal and lignite	Geothermal	Natural gas	Solar	Wind	Production weighted average
Operation	400	15,100	610	440	440	340	240	50	0.2	2,410
Construction	0.4	0.3	0.3	1.1	1.1	2.1	1.1	90	1.1	1.0
Fuel supply	156,000	0	68	55	54	0	6	0	0	1,830

Average consumptive WF per unit of electricity and heat produced ($m^3 TJ_e^{-1}$) for the period 2008-2012. Note that the scale is logarithmic. The ranges shown reflect minimum and maximum values per energy source. The values in the table represent the WF (m^3 TJ-1) for the three main stages of the electricity and heat production chain.

Source: http://waterfootprint.org/media/downloads/Mekonnen-et-al-2015.pdf

Wind also helps us to combat another global crisis: **the water crisis.** Water shortage and stress are among the major impacts of worsening global climate change, and our profligacy with this precious resource is a serious problem even without the threat of climate change. While both the characterization of the problem and its potential solutions are different in each case and vary widely by geography, the (thermal) power sector is a very large consumer. If you're a policymaker in a water-stressed country or region, the chart above is instructive.

Air pollution kills over 6 million people per year, and globally is the fourth largest threat to human health. Especially in the rapidly growing economies of Asia, urban air pollution has become a chronic problem. We read a great deal about the problems in Beijing and Delhi, but the problem is actually worse in many smaller cities across Asia and in some parts of Africa.

Energy production is by far the largest source of air pollution. Policymakers looking to do something about the fact that their capitals and major industrial cities are becoming uninhabitable, would do well to consider a recent report on energy and air pollution from the IEA[12]. It goes without saying that wind, solar and most other renewables contribute virtually zero to air pollution, and are potent tool to fight this worsening crisis.

Finally, wind power and other renewables enhance a country's **energy security**. While that may seem like less of an issue now when fossil fuel prices are at decadal lows, just a few years ago the money pouring out of oil importing states was crippling many developing economies and causing major headaches for the rest. Every kilowatt-hour of electricity generated by wind power can displace an equivalent amount

12 https://www.iea.org/publications/freepublications/publication/weo-2016-special-report-energy-and-air-pollution.html

of imported fossil fuel whether it is directly for power, for electric mobility or for heat. Renewable energy is by definition indigenous, and at least in a practical sense, will not be depleted within any time frame that matters.

Macro-economic security is enhanced with better energy security, and this is not limited to purely financial matters, as fossil-fuel exporting nations have often in the past and will no doubt in future use the dependence they generate in consuming countries for political purposes. Insulating national economies from this dependence continues to be a driver for renewable energy development.

CONCLUSION

Since the oil embargoes of the 1970s, the emergence of climate change as a global threat in the late 1980s and through to the negotiations in Paris last December, there has been much talk on the sidelines of the role renewable energy can play to solve a number of the crises facing us. But that was always going to be 'some time' in the future, when costs come down. Well, the future is now, and the cost issue is all but gone. It is merely now a question of summoning the political will to put together the programs and policies which will enable the smoothest transition to a global energy system based on renewable energy, led by wind.

This is necessary in order to meet challenge of climate change, to preserve our precious fresh water resources, make our cities livable again, and create new industries, new jobs and greater security for our citizens and our economies. Will we choose to do so? It's up to us.

Wind turbine installed on the Eiffel Tower in Paris © Urban Green Energy

Year	Global Cumulative Capacity [GW]	Global Annual Growth Rate [%]	Annual Installations [MW] incl. Repowering	Capacity factor [%]	Production [TWh]	Wind power penetration of world´s electricity in % (IEA demand projection)
NEW POLICIES SCENARIO						
2013	318		35,787	28	714	3
2015	433	0	63,350	28	868	4
2020	639	6	37,370	28	1,569	7
2025	888	7	58,917	28	2,179	
2030	1,260	7	82,428	30	3,311	11
2035	1,679	6	98,089	30	4,413	
2040	2,053	4	70,955	30	5,394	14
2045	2,469	4	92,502	30	6,489	
2050	2,870	3	76,955	30	7,541	18
450 SCENARIO						
2013	318		35,787	28	714	3
2015	433	0	63,350	28	868	4
2020	658	8	54,962	28	1,614	7
2025	968	8	81,162	28	2,374	
2030	1,454	8	114,494	30	3,822	13
2035	1,998	7	126,392	30	5,251	
2040	2,459	4	101,525	30	6,462	17
2045	2,983	4	127,724	30	7,839	
2050	3,546	3	121,998	30	9,318	22
MODERATE SCENARIO						
2013	318		35,787	28	714	3
2015	433	0	63,350	28	868	4
2020	797	11	79,005	28	1,955	8
2025	1,182	7	76,810	28	2,900	
2030	1,676	7	107,488	30	4,404	14
2035	2,169	5	111,800	30	5,701	
2040	2,767	5	125,397	30	7,273	20
2045	3,386	4	123,975	30	8,897	
2050	3,984	3	118,604	30	10,470	25
ADVANCED SCENARIO						
2013	318		35,787	28	714	3
2015	433	0	63,350	28	868	4
2020	879	13	103,423	28	2,157	9
2025	1,430	9	113,247	28	3,507	
2030	2,110	7	144,165	30	5,546	18
2035	2,813	6	154,752	30	7,394	
2040	3,721	6	196,748	30	9,779	26
2045	4,758	5	212,535	30	12,504	
2050	5,806	4	207,879	30	15,258	36

Wind power penetration of world´s electricity in % (Efficiency demand projection)	CO_2 reduction (with 600g CO_2/kWh) [annual MT CO_2]	Avoided CO_2 since 2006 [cumulative MT CO_2]	Total installed Costs [€/kW]	Investment [€1,000/year]	Jobs total
3	428	2,112	1,592	56,973,015	606,076
4	521	3,105	1,571	99,523,313	1,029,681
7	941	7,247	1,541	57,578,304	696,841
	1,307	12,981	1,497	88,205,229	1,059,044
12	1,987	21,223	1,465	120,789,259	936,232
	2,648	33,076	1,453	142,529,204	971,001
16	3,237	48,137	1,472	104,415,628	1,080,374
	3,894	66,216	1,464	135,382,490	1,184,300
20	4,525	87,610	1,469	113,032,568	1,316,408
3	428	2,112	1,592	56,973,015	606,076
4	521	3,105	1,571	99,523,313	1,029,681
7	968	7,279	1,550	85,217,140	931,654
	1,424	13,393	1,506	122,221,625	1,374,438
14	2,293	23,730	1,426	163,260,361	1,385,182
	3,151	33,076	1,417	179,151,043	1,415,916
19	3,877	54,687	1,417	143,903,203	1,370,137
	4,703	76,449	1,417	181,039,230	1,496,486
25	5,591	102,639	1,418	172,996,031	1,682,231
3	428	2,112	1,592	56,973,015	606,076
4	521	3,105	1,571	99,523,313	1,029,681
9	1,173	7,850	1,518	119,959,286	1,290,079
	1,740	15,419	1,525	117,117,490	1,388,753
16	2,642	26,393	1,445	155,351,075	1,374,111
	3,421	41,884	1,429	159,774,659	1,297,268
22	4,364	61,770	1,408	176,545,253	1,469,931
	5,338	86,511	1,408	174,543,061	1,636,049
28.3	6,282	116,043	1,408	166,981,343	1,866,633
3	428	2,112	1,592	56,973,015	606,076
4	521	3,105	1,571	99,523,313	1,029,681
9	1,294	8,153	1,452	150,213,585	1,634,721
	2,104	17,031	1,433	162,230,756	1,944,062
20	3,327	30,702	1,379	198,838,088	2,426,331
	4,436	50,603	1,361	210,693,492	2,785,432
29	5,867	76,953	1,328	261,332,230	3,588,875
	7,502	111,152	1,318	280,111,058	3,907,964
41	9,155	153,634	1,321	274,520,745	4,202,612

GWEC is the international trade association representing the global wind industry. The members of GWEC represent over 1,500 companies, organisations and institutions in more than 80 countries, including manufacturers, developers, component suppliers, research institutes, national wind and renewables associations, electricity providers, finance, insurance companies and law firms.

GWEC works at the highest international political level to create a better policy environment for wind power. GWEC and its members are active all over the world, educating local and national governments and international agencies about the benefits of wind power.

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 i.e. UNFCCC, the IEA, international financial institutions, the IPCC and IRENA. 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 and South Africa.

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

University of Technology, Sydney (UTS) is a dynamic and innovative university in central Sydney. One of Australia's leading universities of technology, UTS has a distinct model of learning, strong research performance and a leading reputation for engagement with industry and the professions. With a total enrolment of over 40,000 students, UTS is one of the largest universities in Australia.

The Institute for Sustainable Futures (ISF) is a university research institute based on the Sydney downtown campus. Our mission is to create change towards sustainable futures by conducting independent project based research for Australian and international clients.

Our researchers come from varied backgrounds, including engineering, architecture, management, economics, science, the social sciences, international studies and political studies.

The **ISF** vision for sustainable Energy Futures is one in which energy is clean, affordable and accessible to all, where energy systems and services support a high quality of life and in which people and communities are empowered. We develop inspiring pictures of energy futures in which the economy thrives on innovative ideas and technologies, focusing on modern and cutting edge energy use and supply systems. The ISF views the energy system holistically and work on improving every part of it, from financing and business models, to policy and regulation, to technology analysis. Our research areas in regard to renewable energies are:

- Visualising future energy infrastructure
- Empowering new energy market participants
- Transforming through data and information
- Renewable energy market research
- Energy scenarios for countries, regions, communities, cities and islands

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