Wind power is set to play pivotal role in the world's future energy supply enabled by New Breakthroughs

World signed the COP21 climate deal in Paris, that implies a steadily rising penalty on carbon emissions. During the recent climate conference in Paris, 70 countries highlighted wind as a major component for their emissions-reduction schemes. "By 2020, wind power could prevent more than 1 billion tonnes of carbon dioxide from being emitted each year by dirty energy – equivalent to the emissions of Germany and Italy combined," said Sven Teske, Greenpeace senior energy expert.

The demand of wind power is predicted for big growth in the future, Wind power will account for 14% of the world's primary energy supply – one percentage point above solar PV – by mid-century. Wind will also provide 36% of world electricity generation by 2050, with two-thirds of this generation coming from onshore projects, according to the company's Energy Transition Outlook report, which was released in sep 2017.

Wind is a emerging as a reliable and inexpensive source of renewable energy. Globally, the average cost of wind is $83 per megawatt-hour compared to averages for coal and gas being $84 and $98 respectively. "In the USA, gas is slightly cheaper than wind but this is the only large economy where that is the case. As a comparison, solar photovoltaic energy averages $122 globally for each MW-hour," said Giles Dickson who is CEO of the European Wind Energy Association (EWEA). Wind power's costs will tumble by 16% as capacity doubles over the next 33 years, while the cost of solar PV is set to fall by 18% over this timescale.

The global wind power leaders as at end-2015 are China, United States, Germany, India and Spain.

The World’s First Floating Wind Farm Is Now Producing Energy

Floating wind farms far out at sea hold a lot of promise for future energy generation. Wind turbines can be packed too densely far out in the sea than on land or near the coast, as the drag effect that causes less wind to flow is less pronounced far in the sea. That means it’s possible to extract six megawatts per square kilometer rather than the 1.5 achieved on land using the same turbines. Analysis , to the extent that three million square kilometers of floating wind turbines could supply the entire world’s current energy demand.
Hywind Scotland, situated in Buchan Deep, is the world’s first floating wind farm, with its five six-megawatt turbines now generating electricity. On shore, a one-megawatt-hour lithium battery also helps smooth its potentially erratic supply of electricity to the grid. It’s also a concept that’s catching on elsewhere, with a scheme similar to the Scottish project under consideration in California.

The project, which is a collaboration between the Norwegian oil firm Statoil and Masdar Abu Dhabi Future Energy, makes use of turbine towers that are 253 meters tall, with 78 meters of that submerged in the North Sea. Each tower is tethered using three cables that are anchored to the seabed.

Buchan Deep project cost a total of $263 million to complete. It currently receives $185 per megawatt-hour of subsidies from the British government, on top of the $65 per megawatt-hour it earns for the wholesale price of the electricity it creates. In other words, it’s damned expensive. Statoil says that it hopes floating wind farms could produce energy for between $50 and $70 per megawatt-hour by 2030.

Harnessing wind energy high up in the sky

“Wind turbines on the Earth’s surface suffer from the very stubborn problem of intermittent wind supply,” said KAUST atmospheric scientist Udaya Bhaskar Gunturu, in a release put out by the university. This has led researchers and energy companies worldwide to look upwards and explore the possibility of the strong and reliable winds at high altitudes.

Flying a wind turbine on a kite – with the electricity being delivered to the ground through its tether – may seem an unlikely scenario, but several companies worldwide are already testing prototype systems.

Tethered kites could potentially offer the flexibility to vary the altitude of the turbines as wind conditions change. Current technology would most likely allow harvesting wind energy at heights of two to three km, but there is also a lot of wind even higher than that. The researchers found that the most favourable regions for high-altitude wind energy in West Asia are over parts of Saudi Arabia and Oman.

Commercial tankers using sail power to navigate the seas could be the wave of the future.

Norsepower Oy Ltd, a Finnish engineering and technology company in partnership with Maersk Tankers, The Energy Technologies Institute and Shell Shipping & Maritime, announced in March the installation and testing of Flettner rotor sails onboard a Maersk Tankers vessel.

The project, which will be the first installation of wind-powered energy technology on a product tanker vessel, would provide insights into fuel savings and operational experience. The rotor sails will be fitted during the first half of 2018,

before undergoing testing and data analysis at sea until the end of 2019.

Maersk Tankers will supply a 109,647 ton Long Range 2 product tanker, which will be retrofitted with two 98 feet tall by 16 feet in diameter Norsepower Rotor Sails. The design would look like narrow smoke stacks. Combined, these are expected to reduce average fuel consumption on typical global shipping routes by 7-10 percent.

The Norsepower Rotor Sail is a modernized version of the Flettner rotor – a spinning cylinder using the Magnus effect to harness wind power to propel a ship. Each Rotor Sail is made using the latest intelligent lightweight composite sandwich materials. When wind conditions are favorable, the main engines can be throttled back, providing a net fuel cost and emission savings, while not impacting scheduling.

Tuomas Riski, CEO of Norsepower, said in a release: “As an abundant and free renewable energy, wind power has a role to play in supporting the shipping industry to reduce its fuel consumption and meet impending carbon reduction targets.”

Challenges of Wind power

The intermittency and variability of the wind resource, and hence of wind turbine output, pose challenges to the integration of wind power generation to the existing electricity network. Intermittent generation will be evident at site level, but due to geographical diversity will reduce when generation is considered over larger areas (such as country or regional level). Hence, the intermittency of wind generation can be reduced significantly if the power outputs of wind farms over a specific area are aggregated together.

University of Delaware researchers report in a new study that offshore wind may be more powerful, yet more turbulent than

expected in the North Eastern United States. The findings, published in a paper in the Journal of Geophysical Research: Atmospheres, could have important implications for the future development of offshore wind farms in the U.S., including the assessment of how much wind power can be produced, what type of turbines should be used, how many turbines should be installed and the spacing between each.

The paper's main finding is that atmospheric conditions around Cape Wind are predominantly turbulent, or unstable, which is in stark contrast to prevailing data from European offshore wind farms in the Baltic Sea and the North Sea. Explaining how wind can be stable, unstable or neutral is a tricky business, Archer says." When the atmosphere is stable, winds are smooth and consistent (think of when a pilot tells airline passengers to sit back and enjoy. When the atmosphere is unstable, it is similar to turbulence experienced by airline passengers during a flight—the wind is choppy and causes high winds from above and slow winds from below to crash into each other and mix together, causing a bumpy and unpredictable ride for the air current." Neutral conditions hover in the middle, with an average amount of turbulence and wind speed variation.

An expert in designing offshore wind farms, Archer says the findings may have implication on how future offshore wind farms in the region are designed. "The advantage of these turbulent conditions is that, at the level of the turbines, these bumps bring high wind down from the upper atmosphere where it is typically windier. This means extra wind power, but that extra power comes at a cost: the cost of more stress on the turbine's blades," explains Archer. "If you have increased turbulence, you're going to design a different farm, especially with regard to turbine selection and spacing. And guess what? Even the wind turbine manufacturing standards are based on the assumption of neutral stability," Archer says.

Tech innovations could cut offshore wind energy costs by a third by 2030

The levelised cost of energy from offshore wind farms in Europe could be reduced by as much as a third by 2030 if a range of technological innovations such as larger turbines and more efficient rotors are deployed.That is the conclusion of a new report released last week by sustainable energy technology investor KIC InnoEnergy and technical consultancy BVG Associates. The study used KIC InnoEnergy's offshore wind cost model to analyse the extent to which 51 innovations could help cut the cost of wind energy through changes to design, hardware, software or processes.

The changes included the introduction of mass-produced support structures for use in deeper water with larger turbines, using bespoke vessels and equipment capable of operating in a wider range of conditions, and the use of more upfront investment in wind farm development to improve site investigations and engineering studies.

Two-thirds of the estimated cost savings were found to be achievable through just nine areas of innovation, such as improvements in blade aerodynamics and optimising the layout of arrays. The innovation with the largest potential impact on cost reduction was increasing turbine size from 4MW to 10MW, the analysis found, since using fewer turbines leads to significant savings in the cost of foundations, construction, and operations.

Technologies

A wind turbine's blades convert kinetic energy from the movement of air into rotational energy; a generator then converts this rotational energy to electricity. The wind power that is available is proportional to the dimensions of the

rotor and to the cubing of the wind speed. Theoretically, when the wind speed is doubled, the wind power increases by a factor of eight.

Turbines have aerodynamic ‘smart’ blades made of carbon composite with wireless sensors, and can ‘pitch’ in and out of the wind in response to shifts in air flow. “There has been a huge leap forward in technology even over the last couple of years. They are pushing the boundaries of energy capture,” said Cian Cornroy from the offshore experts ORE Catapult in Glasgow. “They are using new metals in the generators that cut the need for servicing. There are cameras to relay digital data through cloud computing that can reset the turbines. You have to be bullish,” he said.

Direct-drive eliminates the gearbox, and could be crucial in removing the limiting size and weight of future turbines of 10 MW and beyond. Hybrid drive systems have simpler and more reliable gearing than conventional solutions with three stages of
gearing, while having a similar generator size.

Remote electronic controls are continually being incorporated into turbine design. In addition to pitch control and variable speed operation, individual turbines and whole farms may perform wind measurements remotely, using turbine-mounted technology such as lidar (LIght Detection and Ranging) and sodar (SOnic Detection and Ranging). The real-time data realised from remote sensing will optimise wind production as turbines constantly pitch themselves to the incoming wind

The reliability of a wind turbine in generating power is indicated by the availability of the turbine, which is the proportion of time the turbine is ready for operation. Onshore turbines typically have availabilities of 98%, while offshore turbine availabilities are slightly lower (95-98%) but are improving due to better operation and maintenance

In 2015, a paper from the Department of Energy (DOE) suggested that increasing rotor diameter and height is the best way to access more power from wind turbines, even in areas with lower wind speeds.

A study was conducted by researchers from Berkeley Lab, the National Renewable Energy Laboratory (NREL), University of Massachusetts, found that wind power cost could be reduced by 24 to 30 percent by 2030 based on the advances in turbine technology that are either projected or already being seen today. Those experts said that by 2030, both onshore and offshore wind turbines will get bigger, leading to additional cost reductions and smoother energy generation.

In 2015, onshore wind turbines averaged a hub height of 82m, a rotor diameter of 102m, and a power output of 2 MW. In 2030, experts on average suggest that onshore wind turbines will have a hub height of 115m, a rotor diameter of 135m, and a power output of 3.25 MW.

Offshore, the story is more dramatic. Where today’s turbines have a hub height of 90m, a rotor diameter of 119m, and a power output of 4.1 MW on average, 2030’s offshore wind turbines will measure 125m and 190m in hub height and rotor diameter, respectively, and output an insane 11 MW on average—each.

Wind Lens

The Wind Lens is the brainstorm of researchers at Kyushu University that would generate more than traditional wind power using a unique design. The Wind Lens focuses airflow just like a lens focusing light.

The circle made up of the turbine blades has a ring that curves inward, and this directs the flow of air, and accelerates the speed. The team leader states that by using an

inlet shroud, diffuser and brim in the inward ring, these cause the air to be drawn in more quickly. This means that it generates more power. The researchers have claimed that using this new wind turbine technology will allow turbines to triple their output, while even reducing the noise that the turbines cause.

Wind Lens holds great promise for Japan as a source of green renewable energy. Since Japan is an island, it will be able to make full use of offshore wind farms, since that is where researchers feel the new technology will perform the best. The Wind Lens can float on platforms shaped like hexagons, and at sea will not be subject to large waves or tsunamis, since these achieve their destructive power only upon nearing a shoreline.

The Vortex Bladeless Micro Wind Turbine

The startup Vortex Bladeless is developing a micro wind turbine shaped like a pole-like structure without blades or other moving parts. Vortex Bladeless relies on an aerodynamic phenomenon called vorticity, in which wind flowing around a structure creates a pattern of small vortices or whirlwinds. When these mini-whirlwinds get large enough, they can cause a structure to oscillate, and turbine converts this mechanical energy into electricity.

However, the individual structure will only oscillate at particular frequencies. The Vortex have developed a “magnetic coupling system” that results in broadening the range of frequencies and allows maximization of generation of energy. The microturbine can automatically vary rigidity and “synchronize ” with the incoming wind speed, in order to stay in resonance without any mechanical or manual interference.

The plus side is turbine’s ultra-slim silhouette that could

enable it to fit into all sorts of tight spaces where larger turbines can’t, however the main point of contention is the cost effectiveness of micro wind turbines. The initial product line consists of two models, a 1-megawatt Gran and a 4-kilowatt Mini. France’s Eiffel Tower recently got a full on green makeover, including a pair of high visibility vertical micro wind turbines embedded in the tower itself.

Wind Farm

A wind farm is a group of wind turbines in the same location used to produce electricity. A large wind farm may consist of several hundred individual wind turbines and cover an extended area of hundreds of square miles, but the land between the turbines may be used for agricultural or other purposes. A wind farm can also be located offshore.

The wind farm technology has also become very sophisticated and efficient, world’s biggest offshore wind farm is to be built 75 miles off the coast of Grimsby, at an estimated cost to energy bill-payers of at least £4.2 billion. The giant Hornsea Project One wind farm will consist of 174 turbines, each 623ft tall generating 1.2 gigawatt capable of powering one million homes.

GE bringing industrial Internet to wind farms

General Electric Co. has announced a new wind farm technology that will improve output by 20 percent – providing the wind power industry with $50 billion in added revenue. “It’s a huge breakthrough for renewable energy and specifically wind power,” Bolze told the Times Union during a telephone interview. “The world wants more wind power. Same wind, 20 percent more electrical output. That’s huge.”

Steve Bolze, the CEO of GE Power & Water, said the new product – called the Digital Wind Farm – has been in development for the past 18 months and combines the company's two-megawatt wind turbines with GE modeling software, sensors and the industrial Internet, which allows machines to exchange data, or "talk" to one another.

Integral to achieving all this has been the development of more precise, accurate, robust, and responsive wind energy forecasting algorithms, Grid-scale batteries built into the turbines and real-time wind turbine networking, and power management. Industrial internet communicates with grid operators, to predict wind availability and power needs, and helping to manage wind's variability and provide smooth, predictable power.

Breakthrough Magnetic Alloy Could Lead To Cheaper Cars, Wind Turbines

Scientists have created a promising new magnetic material that could lead to cheaper cars and wind turbines. The new magnetic alloy is a viable alternative to expensive rare-earth permanent magnets, the U.S. Department of Energy and Ames Laboratory reported. The material could eliminate the need for one of the "scarcest and costliest" rare Earth elements, dysprosium, and replace it with abundant cerium.

The alloy is composed of neodymium, iron and boron "co-doped "with cerium and cobalt. Recent experiments demonstrated the cerium-containing alloy boasts intrinsic coercivity (the ability of magnetic material fight demagnetization) that is even greater than dysprosium's containing magnets of high temperatures. This material is also between 20 and 40 percent cheaper than magnets containing conventional dysprosium.

"This is quite exciting result; we found that this material

works better than anything out there at temperatures above 150 [degrees Celsius],” said study leader Karl A. Gschneidner. “It’s an important consideration for high-temperature applications.” Past attempts to use cerium in rare-earth magnets were unsuccessful because the element reduces the Curie temperature (the temperature at which an alloy loses its magnetic properties). This new co-doping method coupled with cobalt allowed the scientists to substitute cerium for dysprosium without reducing the magnetic properties of the material.

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