# Introduction of Intelligent technology for generation of electricity as source of energy for next generation

Joshua Kim

Seoul International School, 388-14 Bokjeong-dong, Sujeong-gu, Seongnam-si, Gyeonggi-do, South Korea
joshua.kim17@stu.siskorea.org

**Abstract:** In the late 19th century, extensive research by many physicists and chemists like Alexander Graham Bell, Thomas Edison, Galileo Ferraris, William Thomson, Joseph Swam and Nikola Tesla, have strengthen the concept of electricity as an essential tool for modern life. This rapidly let to Second Industrial Revolution, where industries ranging from iron, steel, chemical, maritime automobiles and many other started depending on electricity as primary source of power. Thus, electricity soon became an indispensable part of economic growth by powering every realm of life like business, medicine, education, agriculture, infrastructure and communication. Moreover, human and economic growth depended heavily on energy supplies and transformation systems that can generate inexhaustible amounts of electricity. However, our economic and social growth is under constant pressure due to constraints on methods of electricity production. Therefore, there is a need for extensive research, development and implementation to uncover the newer ways of sustainable electrical power generation. Here, we discuss various constraints and requirement for better resources and research and development for making clean and affordable source of energy by investigating the power of next generation wind turbines.
[Joshua Kim. **Introduction of Intelligent technology for generation of electricity as source of energy for next generation.** *N Y Sci J* 2016;9(11):65-68]. ISSN 1554-0200 (print); ISSN 2375-723X (online). http://www.sciencepub.net/newyork. 10. doi:10.7537/marsnys091116.10.

**Keywords:** Intelligent technology, generation of electricity, source of energy, next generation

## 1. Introduction

Though batteries are versatile and handy source of electricity, they are small and can carry extremely low amounts of energy. In order to supply electricity to cater the large industrial demands, we need reliable and more consistent sources of energy, for which batteries are not enough, that can be transmitted continuously over conductive transmission lines. In the last decade, due to extensive demand of electricity pressurized by our economic growth, we have used most of our fossils fuels. Primarily burning of fossil fuels along with nuclear reactions and harvesting kinetic energy from wind or flowing water, powers the electro-mechanical generators that can convert this kinetic energy into electrical energy. However, due to decrease in fossils fuels, today almost 80% of the energy is supplied by harnessing kinetic energy from flowing water or winds. These generators employ basic electromagnetic principles that conductor links to changing magnetic fields leading to induction of potential difference, which is essentially electrical energy. Electricity generated using this method have been used to enhance our economic and social growth, however even today 1 billion people, which is one out of five people, lack access to this modern electricity and live their life in constant darkness. Moreover, despite of advancements in the generation and transmission technologies over the years, still almost 3 billion people rely on burning of wood, charcoal or animal waste to suffice their basic needs of cooking and heating. Therefore, these alarming situations across the world clearly mean that there is a need for more reliable and effective measures of generations and implementation of newer sources of energy.

## 2. Method

In order to spread awareness and call for inventions United Nations Framework Convention on Climate Change (UNFCCC), which started in 1992 and most recently the Paris Agreement of 2015 address and focuses on need of alternate and cleaner sources of energy. United nations has adopted 17 goals to transform our world and out of which Goal number 7 is to ensure clean, reliable, affordable, sustainable and modern energy for all (SDGs). It targets that by year 2030; there will be universal access of affordable and modern energy for all. It also aims to enhance international cooperation wherever required to facilitate access to clean energy research and technology and promote investment in energy infrastructure building and efficient utilization of cleaner fossil fuels. This extensively important goal aims to change the face of the world energy resources and will require cleaner and affordable sources of energy production like wind power. Harnessing of wind power has seen tremendous growth in technology, making it more sophisticated and efficient, cutting down costs by nearly 80% (NCWE). From the period 2004 to 2013, the total installed capacity of wind power stations across the world went up from 48GW to 318GW, an increase of more than 550% (REN21). Moreover, with around 125 years of contributions from inventive minds, wind technology is now in an advanced state of maturity and commercialization, that need support from people, industries and government to be implemented efficiently for making it our best bet for the immediate future.

The basic design of wind turbine always consist of blades that function as a wind capture device and are mounted on, either a vertical shaft (called Vertical Axis Wind Turbines) or a horizontal shaft (called Horizontal Axis Wind Turbines). Rotation of the shaft is caused by lift created due to oncoming winds pushing the aerodynamically shaped blades. The other end of this shaft is connected to an electric generator which, when rotated, creates electricity by electromagnetic induction. In order to control over-speeding and to monitor the system, there is an automated braking and control system that is connected through electronic circuits and can be operated by using a computer interface. The whole system is mounted on a tower, typically a rigid structure that provides stability to the system and can be moved to re-orient the turbine towards wind direction. A typical modern-day wind-power-system generates electricity that can electrify an entire municipality of 500-600 average homes. Modern wind power systems have very large wind turbines blades lengthening up to 150ft and towering up to 200ft high. Moreover, hundreds of these are laid out in an open field, known as 'wind farm' that covers an area of several hundreds of square miles. The use of wind energy to generate is one of the cleanest and sustainable ways to generate electricity. However, the wind turbines still face some of the greatest challenges like building of more innovative and optimized designs that would be cost-effective, durable as well as highly efficient. Various approaches have been taken to improve productivity of the wind turbine itself like increasing the output by making larger scale turbines that generate more power and optimizing the aerodynamic design of blades, electrical design of generators and other components to reduce energy losses and increase the efficiency of power conversion. Moreover, improving configuration and layouts of wind farms to increase wind harvest, optimizing site selection, and tackling problems of intermittency has also contributed a lot to advance the current wind turbine mediated power generation. Efforts to improve control systems using advanced methods of data capturing and data modeling and improved prognosis and health monitoring have also made great contributions.

## 3. Results

A lot of research has been invested in order to increase the efficiency of wind-turbines, by focusing on engineering longer, stiffer and more aerodynamically sound blades that can bear the structural as well as aerodynamic load during operations. To achieve this, Sandia National Laboratories (SNL) have invested their resources to develop Segmented Ultralight Morphing Rotor (SUMR) that have longer and segmented blade which are capable of morphing its shape, in order to reduce the aerodynamic load on the blade during operation (Ichter et. al., 2012). During high wind pressures these SUMR blades can change their shape and align themselves in the direction of the wind which makes them less vulnerable to damage blades, however, under low wind pressure conditions the blades fan out to capture maximum wind energy. The largest blades currently in operation are the Vestas 164 that generates 8MW with 260ft long blades, however, SUMR blades would be longer than 650 ft. and will be capable of generating at least 50-MW power. Moreover, SNL is also researching on development of floating wind turbines, to follow the developments in the oil industry leading to floating oil-rigs (Bloomberg). Also, GE has come up with light and stiff carbon fibers to make blades light weighted and architecturally sound, which would enable in construction of bigger and better blades (Wood, K.). Moreover, in order to provide with taller towers at wind plant sites and reduce costs of transportation, National Renewable Energy Laboratory (NREL) of the United States has pioneered a spiral welding process that would build taller steel towers onsite itself, using steel pipes which are much easier to transport (Cortell et al., 2014).

The wind hitting the blade hub is recently being harvested by ecoROTR turbine developed by GE, where wind at the hub is deflected to the blades, leading to significant increase in overall power (GE Reports, 2015). To improve gearbox reliability and lifespan, while reducing size and weight, NREL has developed of new gearbox by replacing journal bearings with roller bearings (Halse, C., and Keller, J., 2014). On the other hand, Siemens has come up with a completely gearless design for its 7 MW turbine. Absence of gears reduces the mass of the turbines drastically, thus enabling Siemens to invest its resources to build taller wind turbines (Seimens Industry). Another approach is to develop intelligent wind turbines that have on-blade sensors that can monitor loads and actively control the operation to reduce loads, increase lift and thereby decrease operating and maintenance costs. Intelligent wind turbines is actively being analyzed by GE with prototype of wind turbines that have sensors which can gather and analyze temperature, misalignments or vibrations in real time and relays feedback to a network that makes configuration adjustments to improve efficiency for peak power generation. Measuring wind speeds can contribute to optimizing efficiency of wind turbines. Carbon Trust is deploying Light Detection and Ranging (LIDAR) technology to transform the current wind measurements on wind farms (Carbon Trust). It has great implications on every wind farm as almost 45% of the wind farm overall project cost accounts for wind measurements. NREL is concentrating on making super smart intelligent wind farms where wind flows are optimize to increase the output of the plant as a whole system, instead of turbine-by-turbine basis. It aims to optimize the power output of the entire farm, i.e. steering a turbine in the next row might decrease the power output slightly for that particular turbine, but increase production of an entire subsequent row (Fleming et al., 2013).

**4. Discussions**

Power generation in wind turbines depends heavily on the wind, which is extremely intermittent. It does not blow all the time, and also does not blow the same way all the time. And depending on the blow of the wind, electricity is either generated or not generated in the wind farms, which makes it difficult to power the electric grid that requires consistent and smooth electricity. In order to bridge this gap, GE is innovating a short-term, grid-scale battery storage system paired with a smart system that analyses trends and is able to predict when power will be needed and when the wind will be blowing (GE company, 2013). Moreover, Predictable Power App allows operators to know how much and when energy can be expected (GE-Energy). Therefore, excess of electricity that cannot be utilized by the electrical grid is stored in these batteries that can be used to electrify grid when no wind is blowing, ensuring a consistent and smooth supply of electricity.

These innovations and various others by GE, Siemens, NREL, SNL and many others have revolutionized the field of generation of electricity by wind turbines. They have changed the basic picture of wind turbines to more sophisticated and technologically evolved next generation wind turbines forming large wind farms and generating thousands of Megawatts of electricity. These measures will ensure that any form of wind whether reliable or not can be harnessed by our super intelligent wind turbines to generate a steady and reliable electrical energy. As more of these next generation turbines hit the grid, the reliability of renewable energy increases, making it a feasible backbone to the electric grid. Some estimates that global installed wind capacity could grow to 2,000 GW by 2030 and meet almost 19 percent of global electricity demand and ensuring the sustainable development goals of United Nations. With these innovations wind energy industry will certainly help us to get there and provide a clean, bright and well-lit future for the coming generations.

**Acknowledgements:**

Author is grateful to Dr. Shukhrat Muradov for research and academic support to carry out this work.

**Corresponding Author:**
Joshua Kim
388-14 Bokjeong-dong, Sujeong-gu,
Seongnam-si, Gyeonggi-do, South Korea
E-mail: joshua.kim17@stu.siskorea.org

**References**

1. Bloomberg. The Oil Industry Can Teach Offshore Wind Farms How to Stay Afloat - Bloomberg. (n.d.). Retrieved from http://www.bloomberg.com/news/articles/2016-05-17/new-california-gold-rush-beckons-wind-developers-off-coast.
2. Carbon trust. Carbon Trust launches world's largest technology trial to create 3D wind maps for offshore wind farms. (n.d.). Retrieved from https://www.carbontrust.com/about-us/press/2016/02/carbon-trust-launches-world-s-largest-technology-trial-to-create-3d-wind-maps-for-offshore-wind-farms/.
3. Cotrell, J., Stehly, T., Johnson, J., Roberts, J. O., Parker, Z., Scott, G., & Heimiller, D. (2014). Analysis of Transportation and Logistics Challenges Affecting the Deployment of Larger Wind Turbines: Summary of Results. United States. doi:10.2172/1123207.
4. Fleming, P., Gebraad, P., van Wingerden, J. W., Lee, S., Churchfield, M., Scholbrock, A., & Moriarty, P. (2013). The SOWFA Super-Controller: A High-Fidelity Tool for Evaluating Wind Plant Control Approaches.
5. GE Company. (2013) GE Power & Water Renewable energy. Brilliant Battery applications. https://www.gerenewableenergy.com/content/dam/gepower-renewables/global/en_US/documents/GEA30652-Battery-Apps-FS_R2.pdf.
6. GE-Energy. Shifting the winds in your favor. https://www.gerenewableenergy.com/content/dam/gepower-.renewables/global/en_US/documents/Shifting-The-Winds-Infographic-Big.jpeg.
7. GE Reports, 2015. How Does a Wind Turbine Work? With GE's New ecoROTR, Better than Ever - GE Reports. Retrieved September 29, 2016, from http://www.gereports.com/post/120795016210/how-does-a-wind-turbine-work-with-ges-new/.

8. Halse, C., and Keller, J., (2014). NREL Next Generation Drivetrain Mechanical Design and Test Plan. *2014 American Wind Energy Association (AWEA) Windpower Conference and Exhibition.* http://www.nrel.gov/docs/fy14osti/61599.pdf.
9. Ichter, B., Steele, A., Loth, E., & Moriarty, P. (2012). Structural Design and Analysis of a Segmented Ultralight Morphing Rotor (SUMR) for Extreme-Scale Wind Turbines. 42nd AIAA Fluid Dynamics Conference and Exhibit. doi:10.2514/6.2012-3270.
10. NCWE – North Carolina Wind Energy. (n.d.). Retrieved September 29, 2016, from http://wind.appstate.edu/wind-power/wind-turbines.
11. REN21 Report – Renewable Energy Policy Network for the 21st Century. (2014) 10 Years of Renewable Energy Progress. Retrieved September 29, 2016, from http://www.ren21.net/Portals/0/documents/activities/Topical%20Reports/REN21_10yr.pdf.
12. Siemens Industry. Siemens Industry presents new gearless Direct Drive Wind Generator. Technology platform solution offers maximum flexibility, reliability and efficiency https://www.siemens.com/press/pi/IDT2012094045e.
13. UNFCCC – United Nations Framework Convention on Climate Change. The Paris Agreement - main page. Retrieved September 29, 2016, from http://unfccc.int/paris_agreement/items/9485.php.
14. Wood, K. (n.d.). Wind turbine blades: Glass vs. carbon fiber. Retrieved September 29, 2016, from http://www.compositesworld.com/articles/wind-turbine-blades-glass-vs-carbon-fiber.

11/15/2016