# A Review on Different Types of Wind Generation

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**ABSTRACT**
*This research paper is review of different type of wind power generation techniques. Power generation and utilization via wind energy is done by human since 3200 BC. A small introduction about the wind energy followed by Characteristics was taken in this review. Comparison of different type of wind generation system is presented which help in adopting the system as per need. Modelings of wind power plant were also taken into considerations accomplishing different simulation software to model.*

***Keywords***-PWM, Gear Ratio, IG, PSCAD

## I INTRODUCTION

Renewable Energy is now buzz again in this decade due to price hike of fossils and nuclear disasters of present few years. As renewable technology and its impacts are not very new, but recent advancements are driving with political wills and policy support boosted this endeavors. In present era researchers were focusing on cultivating energy more from sustainable non-polluting sources, of which major concentration were on, Wind, Hydro, Solar and Biomass. From the advent of human evolution it is dependent on Sun energy, and it is real driving force of life on our planet. Sun whose energy is source of life, but also driving winds, flow of Oceans' currents. The impact of solar energy radiations along with rotation of earth creates the wind systems round the globe which decides the wind flow patterns. Patterns of wind flow are important to tap this energy, for utility analysis, which is provided by every Nations weather forecast centers. In recent years direction of wind flow is changed due to climatic change this causes real worry for Wind Systems installed in past, as they are now becoming absolute. History of Wind power harnessing, from the evidences of 3200 BC, which is used to sail ships; Persians use Wind Mills for pumping water and grain grindings, for the first time in history at 1891 Denmark generated electricity by the use of wind generators.

Since the invention of Wind Electric Generators, there is amendments' in its design as per the continuous process of design thinking and advances in electrical technology and machining facility capability enhancements. Now a day's 2 MW and higher rating single Wind Generators are available and in working, also Tidal waves and Wind Generations were common in coastal areas in North and South Americas, also in European Nations, but not prominently utilized in South East Asia.

## II CHARACTERISTICS OF WIND TURBINE GENERATORS (WTGS').

As wind is available in abundant around the globe but it doesn't mean that it is utilizable from everywhere, from the height of ground level to the 10 meter height above on one square meter area minimum wind speed is calculated as per KWh generation capability. In India maximum wind speed is 20-25 Kmph in potential areas utilized for generation whereas yearly average is 9-17 Kmph. For establishment of grid interactive wind power generation, wind farms required 12 hectare/MW, with area having wind power density greater than 200 W/m$^2$. With the advancement in manufacturing cost of generation were reduced and changes in used materials due to availability of advance lightweight materials. WTGs' were designed and developed based on few characteristics which are as follows:

(i) Power Flow Analysis of an Induction Machine.
(ii) Gear Ratio
(iii) Torque versus Speed of Induction Machine.

**(a) Classification of Wind Turbines-** Wind Turbines are main constituents of Wind Energy Generation system, which is classified as Horizontal Axis Turbine and Vertical Axis Turbine. Design of wind turbines are dependent on the Drag and Lift phenomenon. Utility of wind turbine depends on the wind penetration and density at the place where wind farms are planned to be installed. Different type of rotors which are in operations are as follows:

(i) Multiblade Rotor
(ii) Propeller Type
(iii) Savonious Type
(iv) Darrieus Type

**(b) Squirrel Cage Induction Generator (SCIG)-** Harnessing energy from wind is not as simpler as other renewable energy as, the complexity lies in the speed of wind which is not constant all the time. Due to this non-uniform availability of wind energy on the basis of annual average wind speed wind farms are installed and height of installation is dependent. Due to this Asynchronous generators are used to generate electricity in wind farms popularly known as

SCIG. In this construction Wind Turbines are having gear box arrangements, by the gear ratio arrangements asynchronous speed is transmitted to the generator which generate electricity in grid tied farms. Figure 1. Represents the topology of SCIG based wind generation system.

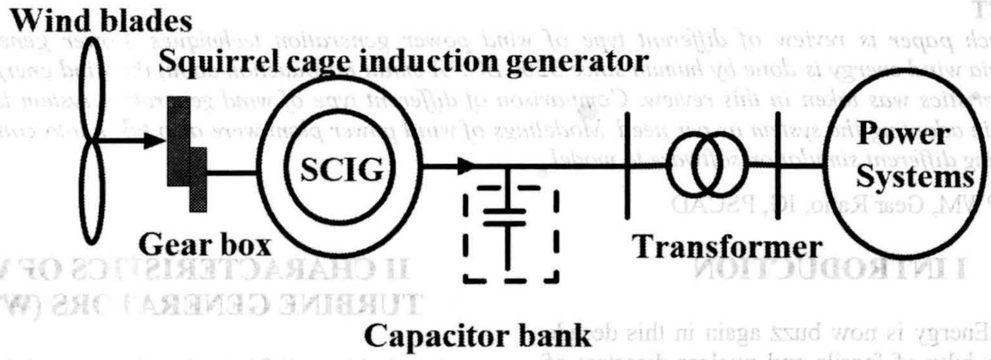


**Fig. 1 SCIG Topology**

**(c) Doubly-Fed Induction Generators (DFIG)-** As the SCIG is having its simplicity but the generation of reactive power externally is invincible in its adoption for large system, so a modification which then termed as DFIG. In figure 2, DFIG is shown, both active and reactive powers are decoupled and generation of power can be adjusted by PWM converters. Due to this stability of system is improved along with other parameters which can be controlled as and when required.

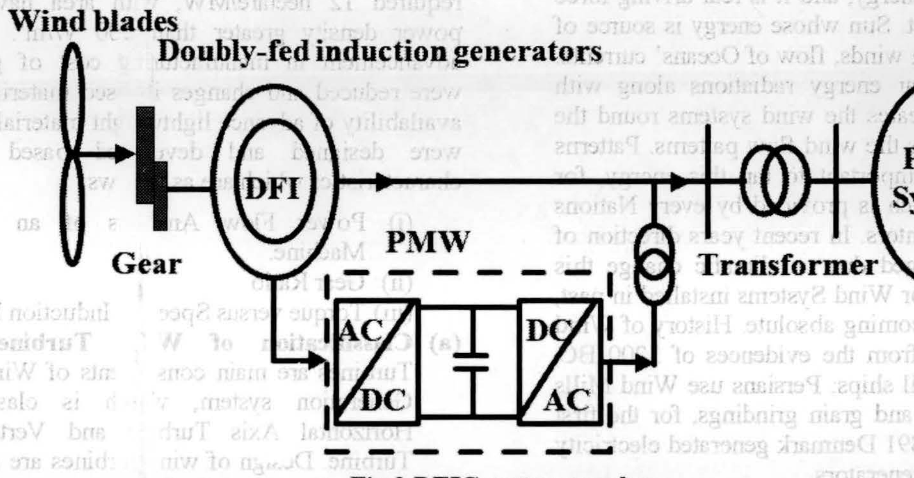


**Fig.2 DFIG system topology**

**(d) Direct Driven Permanent Magnet Wind Power Generators (DDPMG)-** This type of generators are adopted for large scale energy generation in MW scale as they are light in weight and free from wear and tear due to robust construction. This is new topology to be used in new age wind energy generation farms. In figure 3. DDPMG is shown in which cascaded connection of converter with grid interface is observed.

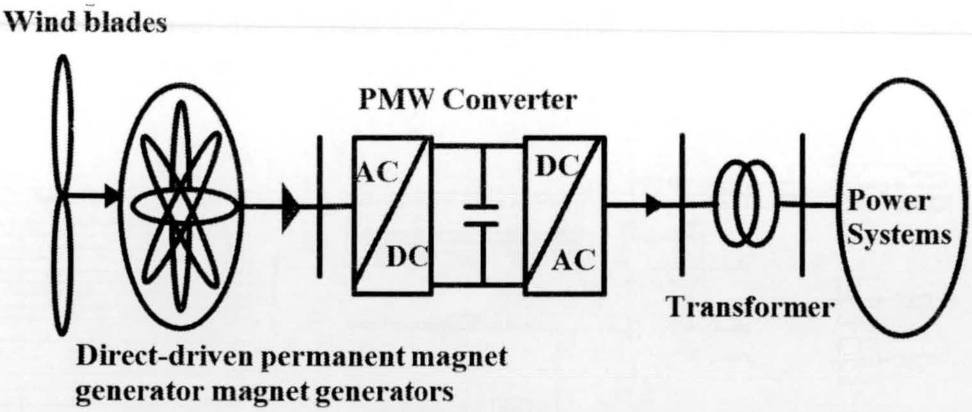


**Fig. 3 DDPMG system topology**

(e) **Performance comparisons-** Wind Energy Generation is done by its different topology which used worldwide were discussed in this section. Every technology having its Pros and Qons which lead to adaptation of some other technological advancement or rearrangements in existing facilities, comparison of above discussed wind energy generation schemes are presented in Table-1.

**Table 1**
**Comparison of different WTGs**

| S.No. | Advantages | Disadvantages |
|---|---|---|
| **SCIG** | Simple in construction, Robust and electrically efficient system having less maintenance, Converters are not required. | Generation in Asynchronous speed is complex; gear ratio is complex, aerodynamically inefficient system with noises. |
| **DFIG** | Aerodynamically efficient systems, Noises are reduced. | This system requires complex gear ratio and box for the speed feed adjustment. Due to introduction of converters and feedback it is costly. |
| **DDPMG** | Mechanical Stress were reduced, Gear box is eliminated | Size of generator is increased, very costly, large rating converters are needed |

## III POWER SYSTEM SMALL SIGNAL STABILITY

As power systems is interconnection of different generation source also containing different sink nodes from where power is used by end user. The ability of electric utility to remain in synchronism is termed as stability, where due to variation of rotor angle any disturbances which introduce in systems are small signal. Due to continuous operation of power system, transient of small levels are common, but dynamics stability is prone to major failures, and this is due to contiguous degradation of generator system. In wind energy generation system, small signal stability plays a great role as the speed of rotor for power generation is not constant thus variable throughout the generation period. Due this dynamic stability and permanent wears will create errors in operation and control on mechanical adjustment and electrical adjustment both contexts.

Small Signal stability can be analyze using this two popular mathematical analysis in power systems context:

(i) Eigen Value

(ii) Frequency Domain

## IV MODELING AND SIMULATION

With the advancement of technology now before final installation and commission of systems its all possible outcomes and challenges were outlook by the use of specific tools. Simulation software's and specific tools help in modeling of the wind energy generation systems and grid tied designing and its impact analysis. By the use of software like MATLAB-SIMULINK, PSCAD-EMTDC and tools like PSAT helps in Mini grid and micro grid modeling. Homer and PVsyst is software which calculates the yearly wind density predictions on the basis of past data.

As wind power generation is having following integrated steps, conversion of kinetic energy of wind into rotational motion of wind turbine, which consists of gear inside and adjust the shaft power which will be connected to electric generator. As the electricity is generated it has to be fed to the grid but with proper synchronism to the utility system, so designing of systems and its testing before final commissioning helps in resolving many issues.

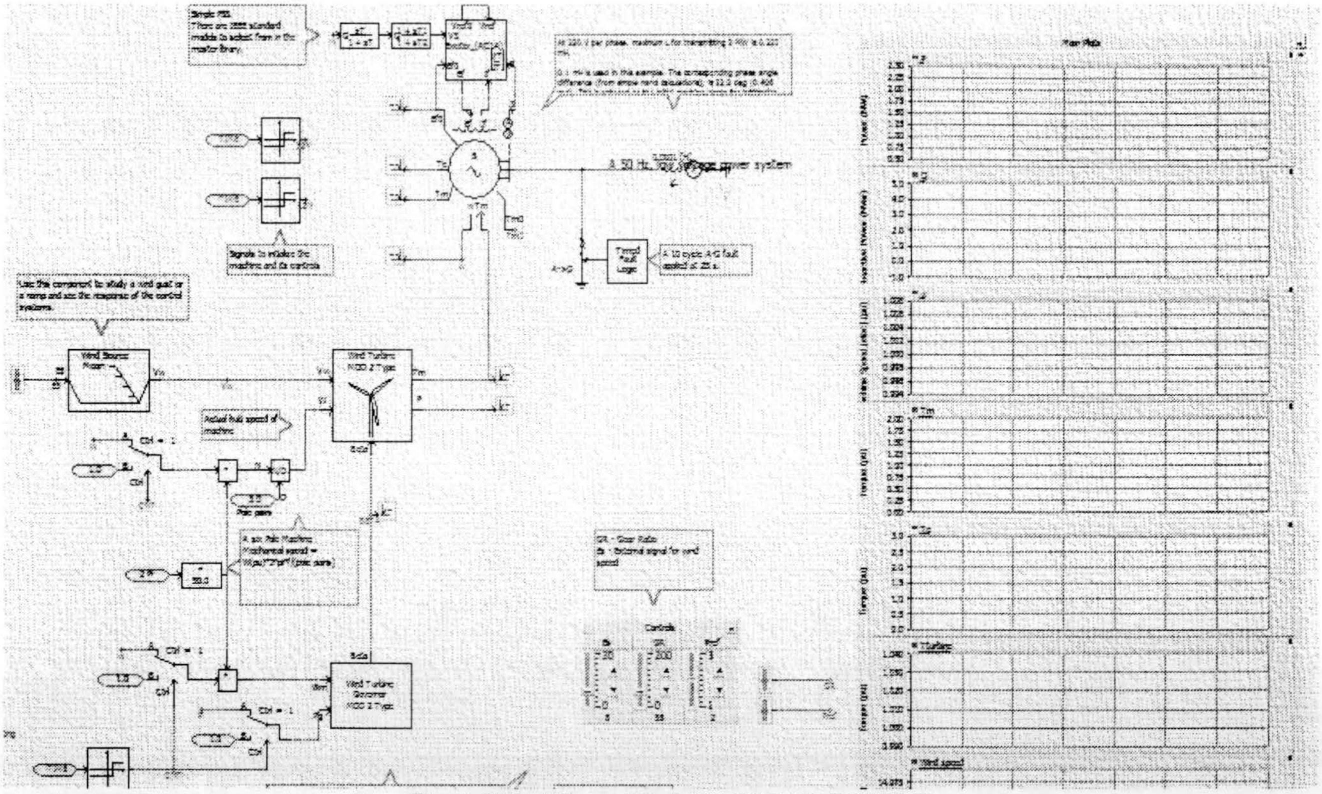

**Fig. 4: Wind Farm Model in PSCAD-EMTDC**

Now a day mathematical modeling of system, site layout and electrical stimulation of system is done using the above described software and some other specific tools. Stability analysis of system are also study and long term impact are also studied of both type of systems which are under existence and which are in row of existence. As electrical grids are complex real modeling is not possible so software modeling is utilized and popular throughout the globe.

## V CONCLUSION

This review paper presents the need of wind energy generation system. Details of different type of wind generators and their evolution. Small Signal stability is the major concern of interconnected wind farms, which is to be taken in consideration while designing the system. Now a day's microgrid and mini grid systems operations and encouragements were round the globe, thus modeling of system before installation is focused by acknowledging software.

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