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An Overview on Issues of Wind Energy Conversion Systems

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ABSTRACT: In the last ten years, wind power capacity has increased dramatically. Many loads (such as isolated settlements, islands, ships, and so forth) are not connected to the main grid. They need a stand-alone generating system to supply local electrification (which can maintain a steady nominal voltage and frequency) This research looks at wind energy conversion systems (WECs), wind energy converter system (WECs) characteristics, horizontal axis wind turbines (HAWT), vertically axis wind turbines (VAWT), and wind energy conversion system difficulties. The development of unique stand-alone generating technologies has been motivated by this necessity. First, a summary of different existing generator technologies for grid-connected operations is presented.

KEYWORDS: Connecting, Frequency Generators, Wind Energy Conversion System, Wind Turbine

1. INTRODUCTION

A wind turbine, motor, connecting equipment, and control systems are the main elements of a conventional wind energy converting systems (Li et al., 2020). Wind turbines are divided into two categories: vertical axis and horizontal axis. The majority of contemporary wind turbines have a horizontal axis with 2 or 3 blade that may operate downwards or upstream. A wind turbine may be constructed to operate at a constant or variable speed (Harish & Sant, 2021).

Adjustable velocity wind generators may generate 8 to 15% more energy than constant speed turbines, but they need control microelectronic change to give a constant frequencies and set voltages to their loads. The high-speed 3 generator are sandwiched among the low-speed turbines blade, most turbine makers have used reduction gears. For some turbines, a direct drive design, in which a generator is directly connected to

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the rotors of a wind turbines, provides great dependability, minimal maintenance, and perhaps cheap cost (Harish & Sant, 2021).

In contemporary turbine designs, some manufacturers have chosen the direct drive option (Hossain et al., 2021). Generators for wind turbines will include synchronized generator, fixed magnetic synchronized generators, and inductive generators, comprising squirrel cage and wound rotor types, at this time and in the near future.

Permanent magnetic generator and squirrel cage induced generator are often employed in low to moderate capacity wind farms due to their dependability and economic benefits. Many high-power wind turbines currently use inductive generator, adjustable speed generators, and wrapping field synchronized turbines. Devices that perform power control, soft start, and connectivity operations are known as interconnection apparatuses. Power electronics conversions are often employed as such devices.

To offer a constant output amplitude and speed with acceptable energy efficiency, most current turbines integrators are forced commutated PWM inverters (Adetokun & Muriithi, 2021). In wind turbines, It has been utilized both voltage source voltage controlled integrator and energy supply present controlled integrator. Dual Pmi (pulse width modulation) converter enable for bi-directional power transfer between the turbine and the utility grid, may provide efficient power management for some high-power wind turbines.

1.1 Characterization of wind energy adaptation scheme:

WECs may be classified in a variety of ways. The following are the most common WEC classifications:

Based on the magnitude of the electrical influence productivity:

- *Minor size (up to 2kW)*: These are suitable for distant requests. Purposes, or in regions where little power is required (Tiwari & Babu, 2016).

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- *Medium-Scale Turbines (2-100 kW)*: These turbines might be small or large. Previously, it was utilized to serve multiple customers with rated capability of fewer than 100 kW. For personal use or for use in the neighborhood.
- *Big Size (100 kW and up)*: Produce electricity for distribution via central power networks (Koay et al., 2020).

Depending on the kind of electrical energy output:

There are primarily three types of generators which are given below:

- *D.C. generators*:

Because they are costly and need frequent maintenance, D.C. generators are uncommon uses for wind/microhydro turbines for most D.C purposes, it is now more common to utilize an a.c. generator to generate a.c., which is then transformed to d.c. utilizing simple solids rectifiers (Wang et al., 2019).

- *Generators that are synchronized*:

The main benefit of The advantage of asynchronous turbines is their responsive energy. characteristics can be regulated, allowing them to be utilized to give energy that is reactive to another power system components that need it (Pande et al., 2021). A synchronous generator, normally coupled to the diesel, is standard in a stand-alone wind-diesel system. When installed to a wind turbine, synchronous generators must be carefully managed to avoid the rotor speed speeding through synchronous speed, particularly during turbulent winds. To absorb turbulence, it also needs flexibility couplings in the drive train or springs or dampers are used to support the gearbox unit. Initiation producers are relatively costly than synchronous generators, particularly at smaller sizes. Asynchronous turbines have a greater failure rate than asynchronous generating.

- *Generators of induction*:

As a standalone energy supplying source, an induction generator has several benefits over a traditional synchronous generator. The primary benefits are lower Brushless (in

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squirrel cage design), reduced size, absence of separate DC supply, ease of upkeep, and personality against high overloads and shorts connections (Yang & Chai, 2016). Furthermore, Ignition generator are weakly linked electronics, which means they are heavily damped and so can absorb slight rotor speed fluctuations and drive train transients to certain extent. Synchronous generators, on the other hand, are tightly coupled devices that need extra dampening devices like as adjustable When used in turbulence-prone wind turbines, connecting in the powertrain or placing gearbox assemblies on cushions and damper are recommended (Do et al., 2018). The main disadvantages of induction generators are reactive power usage and poor voltages stability at different speeds, however the invention of dynamic power conversions has made induction generator management easier in terms of outputs voltages and frequencies.

According to Rotational Speed of Aeroturbines:

- *System with a constant speed*:

Stationary-rapidity schemes are the most basic and extensively used configuration. They run at a continuous velocity [a form of operation known as continuous rapidity constant frequency (CSCF)]. This means that the rotational speed of the rotors is constant and governed by the frequencies of the supply grid and gear proportion, independent of the primary mover speed(Do et al., 2018). The electrical element of this arrangement is generally simple and dependable, however the mechanical parts are susceptible to greater loads and extra safety measures must be integrated into the mechanical design. The electric machine in this setup might be an induction generator (IG) and a wound rotor synchronous generator (SG). However, the squirrel cage induction generator has become the most popular. The simplicity, excellent efficiency, and minimal maintenance needs are the key reasons for its appeal. In order to achieve roughly unity power factor, a capacitor bank (usually stepwise regulated) is introduced in parallel with the induction generator to compensate for the reactive power usage of the generator. During the connection and start-up of the turbine, a soft starter is also employed to reduce psychological strain and connection among the power grid and the

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turbine. The key benefit of this method is that it is a straightforward and dependable setup. To maintain power factor, capacitors must be cut in or cutoff on a regular basis. Unwanted transients in line currents and voltage result from this random switching. The primary mover speed changes are transferred to torque pulses, which generate mechanical stress. The drive train and gearbox break down as a result of this(Tiwari & Babu, 2017). The amount of power produced by this setup is sensitive to changes in primary mover speed. Pitch management of rotor blades is essential to prevent this.

- *System with fully variable speeds:*

The web issues of continuous velocity schemes developed extra obvious as the size of the turbine increases, particularly in places with comparatively weak grids. To address these issues, contemporary generator technology is moving near adjustable-rapidity principles. The generator torque is kept constant using a variable-speed system, although the generator speed varies. Rotor speed adjustments absorb variations in the input power (Sahoo et al., 2019).

As a result, the variable-speed system includes a generator management system that can run at various speeds. The machine's variable-voltage variable frequency (VVVF) power is converted to repaired fixed voltages electricity using back-to-back power converters in this configuration. As the electric machine, the setup may use either an induction generator or a synchronous generator. The machines side conversion provides the machine with lagging excitation, The line side converter, on the other hand, maintains unity output component at the grid connection and regulates the dc link voltage. For a variable-speed system, the synchronous machine provides the simplest design. With a competent multi-pole design, it can run without a gearbox. This is an essential goal since the gearbox is a component that is prone to failure. Mechanical oscillations in the drive train are not present in this design, as they are in fixed-speed systems.) Limited Variable-Speed Systems The fundamental distinction between The difference between a doubly-fed induction generating and a squirrel-cage inducement producer is that the latter permits accessibility to the rotor windings, allowing the rotor voltage to be impressed(Pachauri et al., 2019).

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- *Limited number of variable speeds*:

The fundamental distinction between The difference between a doubly-fed inductor and a squirrel-cage induction producer is that the latter permits access to the rotors windings, allowing the rotor voltage to be impressed. The rotor circuitry or the rotors circuits might both magnetize the engine, and power can be retrieved from or provided to the rotor circuit. Induction generator speed may be controlled using one of two methods: rotor resistance control or back to back converter control. Back to back converters with a doubly-fed arrangement are the most effective strategy for restricted variable speed systems (Boopathi et al., 2020).

1.2 Horizontal axis wind turbine (HAWT):

Horizontal axis wind turbines (HAWT) have a rotating axis that is aligned to the air stream. Horizontal axis windmills may come in a variety of shapes and sizes. These may be classed as solitary, According on the amount of blade, they may be double-bladed, 3, multi-bladed, or bicycle-bladed. These may be categorised as up-wind or down-wind depending on how the blades are oriented in relation to the wind way. When the wind change directions, all horizontal axes in wind generators contain a mechanism to keep the rotor in the wind. As a consequence, the whole wind machine, as well as its towers, or the top of the wind device where the rotor is attached, must shift their location in relationship to the wind (Moradi et al., 2019). The tail vane on smaller wind turbines, such as farm windmills, maintains the rotor pointed towards the wind regardless of wind direction changes. Both tail vortices and fan tails position the rotor upwind of the tower by using wind forces. They adjust the wind turbine's orientation in response to variations in wind without the use of either people or electrical energy. Tail vanes and fantails are not required for downwind rotors. The blade instead are swept offshore, generating a narrow cone with a peak at the tower. The rotor is intrinsically oriented downwind due to the coning of the blades.

1.3 Vertical axis wind turbines (VAWT):

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Vertical axis wind turbines (VAWT) have a rotating axis that is vertical to the wind direction. These devices are also known as cross-wind axis machines. The two most frequent designs for vertical axis machinery are the Savonious rotor and the Darrieus rotor (Fathabadi, 2016). The main benefit of VAWT over traditional HAWT is that it is omnidirectional, which means it can receive wind from any direction. This simplifies their construction and removes the issue of gyroscopic forces acting on the rotor of traditional turbines when they yaw towards the wind. The generator and gear may also be mounted at ground level thanks to the vertical axis rotation. On the downside, VAWT needs guy wires to be linked to the top for support, which may restrict its use, especially in offshore locations.

1.4 Issues of wind energy conversion system(WECs):

- *Grid instability:*

A dependable grid is just as vital as the presence of high winds for the commercial utilization of wind energy. The loss of generation due to a lack of a stable grid may range from 10% to 20%, and this shortcoming might be one of the primary causes for WEGs' poor real energy production when compared to expected output in known windy locations with sufficient wind data.

- *Operation at a low frequency:*

Low frequency operation has two effects on WEG output. When the velocity is lower than 48 Hz and the wind is blowing nicely, many WEGs do not cut-in, resulting in a loss of output. Aside from this shortcoming, the output of WEGs at low frequencies is significantly decreased owing to the rotor's lower speed. Because of the low frequency operation, there might be a 5 to 10% reduction in output.

- *Consequences of a low power factor:*

Induction generator-equipped WEGs need reactive power to magnetize. In most traditional energy systems, generators also provide reactive power in addition to active power. However, instead of contributing WEGs with inductive producers provide react

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back to the grid, whereas WEGs without inducement generators receive reactive energy from the grid, putting a load on the system. To lower the grid's reactive power load, appropriate reactive power compensation [23] may be necessary.

- *Flow of energy:*

It is necessary to guarantee ensure the generation or distribution links linking them are not overwhelmed. This sort of study is required to guarantee that the addition of new generation does not overwhelm the transmission lines and other electrical infrastructure. It's important to look at both active and reactive power needs.

- *Short circuit:*

The influence of new generating sources on the network's Current electricity equipment's short accident current rating may be established.

2. DISCUSSION

Wind energy is a non-polluting renewable energy source. It has enormous potential that, if fully realized, can easily meet a country's energy needs. According to estimates, 2% of the total solar energy that falls on the globe is transformed to kinetic energy in the environment. 30% of this kinetic energy originates at the lowest 1000 meters of elevation, i.e. wind has the most kinetic energy in this lowest kilometer, which may be transformed into mechanical energy and used to produce electricity or do other useful tasks. Because the wind's energy is derived from its velocity, the device used to collect it should be able of slowing the wind.

Wind turbines and other wind energy conversion devices are used to transform wind energy into mechanical power. Wind turbines are made up of a few sails, vanes, or blades that radiate outwards from a central axis. The blades or vanes revolve around the axis as the wind blows against them. This rotating motion is put to use for certain practical purposes. Wind energy may be converted to electric energy by connecting a wind turbine to an electric generator. Winds in India are quite modest (5 km/hr to 15/20 km/hr) and fluctuate significantly depending on the season

3. CONCLUSION

In this paper, an attempt is made to discuss a variety of challenges relating to WEC power production, such as variables impacting wind energy and its categorization, generator selection, grid connection issues, Wind-diesel autonomously hybrid energy installations, reactive power regulation of wind systems, environment elements of power production, and the newest trend in wind power production from off-shore locations are only a few of the topics covered. Wind power now supplies around 0.4 percent of the world's energy. EWEA (European Wind Energy Association) estimates that wind power production will account for about 12% of global energy supply by 2020, which will need considerable political commitment. By 2020, the global wind energy sector is expected to construct 1200, 000 MW, necessitating the global exploitation of existing wind potential as well as the generation of electricity from off-shore locations.

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