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A Review on Integration of Wind Turbines in Distributed Generation Power System

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ABSTRACT

Wind power is one of the mostly used renewable source of energy generated in recent decades. To be systems that are directly connected to the grid system, it is important to use the high voltage and get the high voltage converted from the turbine. Energy storage is needed to operate the electrical system efficiently. These storage areas are continuously controlled to coincide with the generation and operation of the system and, thus, to maintain the electrical frequency in prescribed limits. They are usually provided with standard integrated composite units such as hydraulic or thermal power plants. With the continuous depletion of these generating plants for non-synchronous power plants (e.g. wind and solar) the rate of saturation of the synchronization power in the system decreases. Speed instability of wind presents the incredible difficulty of planning the wind power available in advance. For this reason, the purpose of this paper is to introduce the techniques developed in recent years and, as such, provide a control solution that mimics the conditions of various wind turbines.

KEYWORDS: *Maximum power point, batter energy storage system, battery energy storage, renewable energy, frequency control*

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I. INTRODUCTION

The countries all over the globe are passes through continuous energy fluctuations. Recently Germany and other European countries, as well as other countries such as China, India, USA, Brazil and Canada, have made great efforts to reduce their dependence on fossil fuels, moving away from the hydrocarbon platform and establishing a renewable energy planet [1]. Promoting the incorporation of renewable energy sources, especially wind energy, into electricity mixes, is one of the strategies used to achieve this goal and to reduce greenhouse gas emissions [2-4]. According to the Intergovernmental Panel on Climate Change (IPCC), global warming is a reality and human activities are responsible for causing an estimated warming of 1.0ºC above pre-industrial levels, a figure that could reach 1.5ºC between 2030 and 2052 [5]. To address the environmental challenges posed by global warming, energy production from renewable sources should be increased as a precautionary measure, not only for energy security, but also for promoting a healthy environment. Wind resources are considered an attractive energy resource because it is renewable, clean, legal in society, economically competitive and environmentally friendly [4,7,16]. Thus, the outlook could increase future wind energy participation, to at least 18% of global energy by 2050 according to the International Energy Agency (IEA, 2018). The Global Wind Energy Council revealed that in 2017 total output was 11% higher than the end-of-year total of 487 GW, and global output remained above 50 GW in 2017. In addition, according to the Global Wind Energy Council, "Besides that, renewable energy technologies have been completely sold, excluded; to compete effectively in the market against surplus-backed securities and land tenants". Among the developing countries as a source of renewable energy are 30 countries with more than 1 GW of installed capacity and nine countries with more than 10 GW, including China, USA, Germany, India, Spain, UK, France, Brazil and Canada. [4,7,16]. The changing air conditioning, despite the lack of wind power, poses a number of challenges when integrating wind power into the electrical grid, since higher costs may be involved in the construction of wind farms as well as pre- and post-exploration studies. In contrast to conventional power sources, wind speed varies both temporally and temporally, producing fluctuations in wind power output [23]. Climate variables such as wind direction, temperature, pressure and humidity, among others, have an impact on wind power production [23]. So, it is a combination of spirit.

The biggest obstacle to wind power is our inability to predict and control wind. Recent weather forecasting has improved the situation, but it is still a problem. When there is a wide variation in wind speed, it is necessary to obtain the correct speed, which produces maximum power. To achieve this goal the controller is required to track high power output without wind speed [7]. Blade pitch control is an effective way to improve the aerodynamic response of the wind energy conversion system. Installation angle controller support simultaneous rotation of stories, with standalone or shared actuators. The angle used for wind speeds lower than the nominal value is zero, and the angle increases when the wind speed exceeds the maximum speed [8], [9]. In the wind engineer's control system, the techniques used to control the particle's effectiveness play a key role, and the pitch angle is important to reduce the limit for seizures in strong wind conditions. If the wind exceeds the set point in the wind turbine, it is necessary to disconnect the wheel from the network or change the installation of the blades to stop the transition, because high-speed winds can damage the building. Simultaneous mobility can be used to limit energy production in dynamic cycles, but each bend has the added advantage of reducing the fatigue loss caused by cyclic loading on computers [11]. Various control techniques, such as proportional-integrated (PI) [12], [13] and rational logic (FL) [14], [15] or mixed methods [16], have been used for pitch angle control. Research has been enhanced by flexible control that is consistent with dynamic system performance in various aspects of power generation and safety [17]. The literature review highlights the tendency of controlling pitch angle through the technology system, with various authors supporting the becoming of a more simple problem over time, and its solution depends on data extraction or weather forecasting. In addition to the difficulties in complex mathematical models. The purpose of this work is to introduce an update of expert systems developed in recent years and to provide a control solution that simulates the conditions of various wind turbines. Building a professional control system is not just about dynamic system performance, we need to expect a control response in every particular situation. The more system variants are considered, the more information available for decision making, the more efficient the system is, and the greater the impact on power generation. That is why the professional management system is based on human knowledge and knowledge and provides a way to find solutions, with good control over its variables and adequate control of the database system. In other words, it is a regulatory model of professional experience in this area.

II. Review of European Grid Codes regarding participation in frequency control

Frequency Control is a particularly challenging task for islanded power networks as they do not have access to high energy storage in a grid-connected network. Therefore, the demand for wind power plants is much stronger in these networks than the continental grid. However, increased energy efficiency will lead to critical needs in grid network. In line with this, this section for the first time provides definitions and names for different types of energy conservation. Second, it is reflected in the timescales of the power generation of selected areas of grid codes.

2.1. Interpretation and definition of energy conservation

Energy conservation can be defined as the additional active energy (positive or negative) that can be brought about by a production unit to respond to the energy imbalance in the network between reproduction and consumption. Four different levels of reserve can be described: immediate, basic, basic and reserve [11]. This term is widely accepted; but nomenclatures may differ from country to country. The following content provides a description of each energy source. Immediate energy conservation refers to the physical stability effect of all connected synchronous generators due to their inertia. In the event of a decrease in generation on the network, the stored energy is accelerated due to this stability and hypnotic effect. Their electrical power is Pelect rapidly increasing, which is annoying by the electronic imbalance in the generator set according to $P_{mech} - P_{elec} = J\omega_g \frac{d\omega_g}{dt}$ (1)

P_{mech} being the developed mechanical power by the generator, J is the moment of inertia referred to the generator shaft and ω_g is the mechanical speed of the generator (the electrical rotational speed of the generator ω_r is deduced from the number of poles p and ω_g as:

$$\omega_r = \omega_g \frac{p}{2} \quad (2)$$

As a result of the power imbalance, the speed of the electric current decreases. These reductions are also common in the system. The rate of change of frequency (ROCOF) depends on the number of available power points and thus on the system inertia [3]. Low levels of system inertia, e.g. High levels of ROCOF, which can provoke logical load distribution, generating units and transmitting (used to avoid island travel [5]), thus affecting the system's frequency stability. In studies related to the energy system, it is standard practice to describe the constant inertia H. The fixed inertia, in seconds, determines the time at which a unit generating energy can provide limited energy using only the kinetic energy stored in its rotating parts. It can be expressed mathematically as part of a period of infinite machine speed (in seconds): $H = \frac{1}{2}\tau_{acc} = \frac{1}{2} J \frac{(\omega_g^{nom})^2}{P_{nom}^{total}}$ (3)

The normal speed (rad/s) of the generator is represented by ω_g^{nom} and its power by is the nominal mechanical generator speed in rad/s, whereas the generated power in (kW) is termed as P_{nom}^{total}, moment of inertia is referred as J and has unit as kg m^2 , referred to the generator shaft. More important think is that grid isolated wind energy conversion system does not have the inertial support of grid and it has to cope up the variabilities it itself. Still, it is not possible with a squirrel-cage asynchronous generator, since they deliver an internal environmental reaction due to interaction to the grid [17]. Basic backup is proposed to be an additional network power that can be operated spontaneously and localized by the manufacturer's controller after a few seconds of the imbalance between demand and supply on the network [11]. The aim of the primary conservation is to rapidly measure the energy consumed and produced in the system and thus stabilize the frequency to a certain extent. These used backups are usually done automatically by the droop frequency controllers of the generating units, building what is called the optimal frequency control. Primary backup should be posted until power deviation is completely cleared by secondary or tertiary stocks. For the purpose of harmonizing energy conservation-related appointments, by ENTSO-E, which is the Association of Distributors of Transmission System (TSOs) on the European continents, described sources classified as frequency storage. [10]. Prior to the publication of this document, in ENTSO-E's "Operational Handbook" [11], this final grade was designated as the primary storage area. The present document considers the above publication (due to its complete and undesirable character) to show ENTSO-E recommendations regarding system frequency control and energy storage levels. The secondary endpoints operate to restore the estimated frequency of the program, releasing the primary storage locations, and restoring the active power exchange between control points at their satellite points [11]. They work with TSOs by changing the set points of the power of the generating units within each control point. In June 2012, ENTSO-E proposed a restoration of the standard word description of the designated areas [10]. Lastly, the purpose of the conservation of heights (or replacing them with the final ENTSO-E application [10]) is to replace the archives and return the frequency to the estimated value if the amount was previously disallowed. In addition, they are used for economic power transmission [9], taking into account system constraints such as the current limits of transmission lines. These preservatives are performed manually and in-house at the TSO control centers in the event that continuous activation of secondary sites or awaits response to expected imbalances [11]. General rules and technical recommendations regarding storage capacity and their associated performance are set out in ETSO-E's "Operational Handbook" [11]. In addition to these general guidelines, the specific rules for the provision and maintenance of grid frequency control must be determined by TSOs in its Grid Codes.

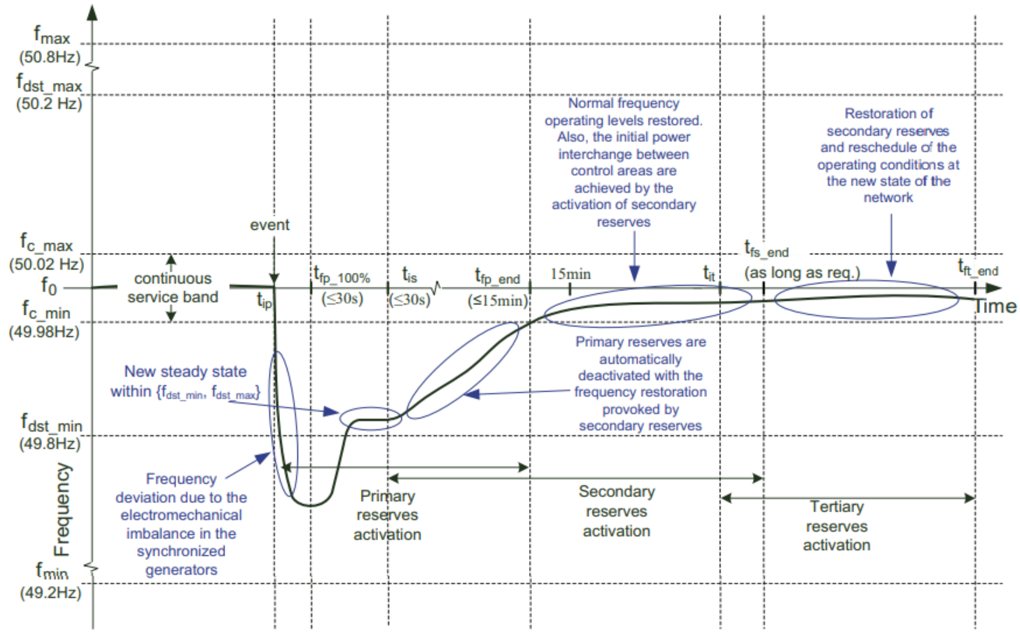

Fig.1. Conceptions and definitions of time frames and frequencies

2.2. Arrangement sequence of power reserves for frequency control

Figure 1 presents the performance of the system frequency criterion in the wake of the sudden lack of network generating power with all the levels of power involved. Other annotations in their application are included according to [11]. In the case of the generator coming to the network, the system frequency starts to decrease and thus the instantaneous reserves of the units that generate synchronization help to restore the balance of power in the network due to the strong impact of inertia. Subsequently, as soon as a certain level of frequency is reached, the basic energy savings are activated; the power of the generator to drive increases. As the correlation between the developed voltage and input voltage to the generator is found, the frequency of the system stops decreasing, e.g. Frequency nadir is available. Next, an additional increase in primary storage capacity speeds up the generator sets and the frequency of the system increases to a whole new level with its estimated value. The elemental tendency of the primary dynamic droop has a significant influence on the nadir of the frequency and the degree of elasticity of the solid [1,16]. In this sense, it can be concluded that the slow movement of the ruler to the unit producing power, lowers the average nadir.

- Reinforcement of secondary sites is followed by repeated levels of operational efficiency and therefore performance in storage of primary storage facilities. The repositories are in effect until they are completely replaced by high storage areas. A proper description of the parameters presented in Fig. 1 are organized as follows: [11]:
- fmin and fmax: the minimum and maximum expected immediate speed after an observational event (loss of generation or load loss) assumes predefined program conditions.
- fdst_min and f dst_max: the minimum and maximum intensity of the frequency. They describe the frequency tolerance band of a continuous state system after an incident, taking into account the predefined programming conditions. With the exception of this downtime, all available startup reserves remain active. This means that the droop controllers of all units that provide the basic resources must be set up to shoulder all of their final contractual obligations.
- fc_min and f c_max: Frequencies of the dead-frequency band to activate the start locations. These limits specify the time period in which basic services may be maintained. This frequency deviation is usually related to the accuracy of the frequency and intensity of the controller. However, a large dead group was also allowed according to the TSO.
- Tip, Tissue and Tit: The first time to activate primary, primary and maximum retention activations from the time of receipt of an event.

- tfp_50% and tfp_100%: Maximum operating time of 50% and 100% of the base amount used since the event acquisition, respectively.
- tfs_100% and tft_100%: Maximum operating time of 100% of secondary and maximum final revenue from event acquisition.
- tfp_end, tfs_end and tft_end: Minor influence of primary, secondary and tertiary factors.

III. OTHER TECHNICAL ISSUES ARISING FROM INTEGRATION OF DGS

3.1. System stability

A standard power system is a high-speed multidisciplinary system whose dynamic performance is influenced by a variety of installed devices and their controls [17 - 19]. Errors or distortions will cause variations in power flow, rotor angles and bus voltages that can lead to possible problems of rigidity. Stability is a major topic in the design and design of a power system, including protection [20-25]. The integration of large numbers of DGs into functional devices essentially introduces some behavioral and regulatory mechanisms that need to be studied. Simple voltage-behind-the-impedance models that have been used for DGs are not sufficient in such studies. Understanding the behavior of energy generating units is essential to the robustness of the power system. At the time of the fault, the ignition units must provide enough current-rotation to ensure the correct operation of the protective equipment. Following improper recognition, generating units should recover and provide reactive power as quickly as possible without unnecessary oscillations, and continuously, provide reactive power, or reduce the use of reactive power, in order to support rapid gas recovery [27]. Traditionally, stability has never been an issue at distribution levels as the network was considered to be relatively ineffective, and energy sources are represented by simple Therein model models [13,18]. Errors in the distribution network were considered to have no effect on the behavior of the generating units in the distribution system [18]. However, first, because of the increasing contribution of DGs to network security, the termination of a large number of DG units following system interruption or error, according to current practice, will result in significant imbalances between generation and demand leading to system mistrust. Second, the high penetration of DG, especially PV, has the effect of reducing the effective inertia system which results in a decrease in the efficiency of the solid system [20,26]. Traditionally, a power system is required to have sufficient internally charged power that can be called immediately to stabilize power in the event of unusual circumstances. Stability requires real and effective power and control [27]. How can DGs add inertia to the energy system in a topic under general discussion. PV, for example, may need to provide equal inertia for electrical means by using stored energy to conserve system energy [27]. Wind generators can also provide equal inertia by releasing the kinetic energy stored in the rotating parts of the wind turbines through a revolutionary device called “synthetic inertia” [28]. Integration of the CSP-based thermal generation provides the opportunity to integrate synchronization equipment into the energy mix and improve the system inertia [28]. However, at present, only utilityscale CSP systems are integrated through the distribution system. Research is needed to develop informal forms of integration at the distribution level. Programs like these will introduce significant inertia and the stockpile of the distribution system that are essential to success on the island. Most of the strategies from the literature are proposed to protect the integrated DG distribution system to try to address the issue of communication between protection devices but not to mention the impact of protection strategies on the system's robustness and robustness [27]. Significant research has been done on the problem of robustness but from a regulatory perspective, developing control strategies that help maintain the system stability of the integrated DG distribution system [30]. The issue of resilience also needs to be looked at from a security perspective and any proposed security plan needs to be evaluated in relation to the robust response and resilience of the system. The problem of rigidity is complicated by the combination of DGs.

IV. Conclusions

Power generation is a widely researched issue over the past 20 years and much attention has been given by researchers around the world for short forecasts and related problems, leaving a gap especially in review and analysis focused on mid- and long-term forecasts. This is what the current article is talking about, with SLNA and bible analysis. Traditional distribution protection fails in its function when a large number of DGs are integrated into the distribution system. DGs affect the size of the short circuit and the flow direction, reduce transmission sensitivity and cause protection to lose interaction. Various protection strategies have been suggested by many researchers to protect the integrated DG distribution systems that have been reviewed. To a large extent the proposed protection strategies apply to networks with specific structures or topologies, or are designed for specific DG technologies due to the temporal behavior of DGs. The proposed techniques need to be developed and optimized for the use of a standard DG distribution system. Distribution level stability is now an important topic due to high expected DG penetration, and protection systems need to be tested against the dynamic response and system stability. These findings are lacking with the currently proposed strategies. The system of protection employed should also make adjustments to the operation of the island to improve the reliability of the supply. This ability is not reflected in the currently proposed solutions.

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