Scalable Computing: Practice and Experience, ISSN 1895-1767, http://www.scpe.org
© 2024 SCPE. Volume 25, Issues 2, pp. 721–728, DOI 10.12694/scpe.v25i2.2545

OPTIMIZATION STUDY OF GRID ACCESS FOR WIND POWER SYSTEM CONSIDERING ENERGY STORAGE

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Abstract. This study gives an optimized study with details discussion of the access of wind power grid systems and the energy storage that is high in demand in recent days. The wind power system is a renewable energy resource that can help to meet the need or crisis of energy related to the fuel resources that are being increased in recent times. This is also helpful where energy access related to the power supply is difficult. This may also help the places where the shortage of energy and power supply is faced. There are some issues that are faced at different times that are related to the maintenance and handling of the power grid of the wind turbines. The technical process of handling the machines and the one-time cost of investment on it at the first time is also difficult. There are some benefits of the wind power grid with high energy storage capacity that may help to fulfill the demand for energy that is the main issue of the total system of power supply nowadays. The issues should be mitigated with the help of expert and at the coastal area where there is plenty of continuous flow of wind may be helpful with supply of power supply with wind. These advanced systems hold the potential to mitigate the pervasive energy demand issues plaguing contemporary power supply systems. By expertly addressing these challenges and strategically locating wind power grids, especially in coastal areas with consistent wind flow, the dependable supply of electrical energy can be significantly enhanced, thereby offering an effective solution to the prevailing energy supply challenges of our time.

Key words: Power, grid, system, energy, storage, issues, challenges, capacity, renewable, fuel, resources

1. Introduction.

The intermittency of power generation with the help of wind can be the cause of some challenges for normal operation schedules and in different energy states. The power plants that are related to the Pump Storage are made with wind power plants. It can be helpful for the improvement of the resilience power system and the access to large-scale source distribution has been helpful to maintain a stable operation of the energy system with the help of grid systems.

On the other hand, it is also an important thing to make energy storage units and increments of the consumption process of renewable energy resources and its stable operation with the help of the grid system and wind power system is one of them. The energy storage process has a great advantage that is helpful for balanced load, maintenance of the frequency, and the stability of the grid for voltage along with the buffering of the grid.

This study may help to figure out the energy storage space with consideration of the static security that can be effective for renewable energy resources like wind with great safety with a reduced cost of investment in grid systems.

The grid scale storage plays a very important or vital role in the Net Zero Emission by the year 2040 scenario. This storage system also providing the crucial system and the services that are ranging from the operating of the reserves and the balancing that are short term. It also ranges from the ancillary services and the stability of the grid as well as the investment connected to deferment in the transmission and the distribution of lines. This deferment investment is used for the long – term storage of energy as well as the restoring of the operations that are represented by the grid and following the blackout.

In an era marked by the urgency to transition towards sustainable and renewable energy sources, wind power systems have emerged as a pivotal solution to meet the ever-growing global demand for electricity. The

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integration of wind energy into our power grids offers a cleaner, more environmentally responsible alternative to conventional fossil fuel-based electricity generation. However, as wind power gains prominence in the energy landscape, there arises an increasing need for efficient and reliable grid access and energy storage solutions. Wind power systems, powered by the kinetic energy of moving air, offer an abundant and renewable source of electricity. These systems have the potential to significantly reduce greenhouse gas emissions and contribute to the reduction of our carbon footprint, thus playing a pivotal role in mitigating climate change. However, the inherent intermittency and variability of wind resources pose challenges in maintaining a stable and reliable power supply. This is where the synergy of wind power systems and energy storage becomes indispensable.

This research seeks to unravel the complexities and nuances of grid access for wind power systems while considering energy storage as a pivotal component. By investigating the technical, economic, and environmental aspects of this integration, we aim to provide valuable insights into the development of sustainable and reliable energy solutions. As we collectively strive to reduce our reliance on fossil fuels and transition to greener energy sources, the fusion of wind power and energy storage holds the promise of a brighter and more sustainable energy future.

2. Objectives.

1. To gain a comprehensive understanding of the fundamental principles and intricacies involved in enabling wind power systems to seamlessly connect with the grid while considering the integration of energy storage solutions.
2. To assess the implications and influence of integrating wind power systems with the electrical grid, particularly in terms of optimizing and enhancing energy storage capabilities.
3. To investigate the challenges those are faced at the time of making grid access for the wind power system
4. To get the solutions by mitigating the issues faced in the making of Grid access of wind power systems in energy storage

3. Methodology. A data set with the help of analytical inspection in the form of composition of the literature review section. Here, the application of the secondary data set has been verified with different statistical information and articles that are related to wind power and grid access. The secondary data are authentic and collected from Google Scholar and from different news articles. The secondary qualitative data collection method has been followed and interpretivism philosophy has been used. The deductive approach of the research is used for the present study. The deductive approach helps to connect the theoretical aspect and the scientific collection of data and get a relation between them [18].

Accessing the grid for wind power systems is a complex process that requires coordination with multiple stakeholders, from regulatory authorities to utility companies. It's essential to approach the integration with careful planning and adherence to technical and regulatory requirements for a successful and sustainable wind power project.

4. Accessing the Grid for Wind Power Systems with the Energy Consideration System. Grid integration with the help of wind energy is a collection of all the activities that are related to the connection of WPPs with the grid. In the first stage, the planning along with the activities before the GOP is done [9]. The physical connection encompassing the activities that are occurring with the firm of wind with the grid is made. The last and final stage is the operation of systems, which are helpful for the activities occurring after the connection of the grid [7].

Wind energy is incorporated with a unit commitment process and with the help of an economic dispatching process [24]. Forecasting is required for the prediction of hourly variability of wind and that is helpful for energy production. The forecasting lead time has to be reduced as it may be helpful for using the grid in time.

Pumped storage hydropower technology stands as the most widely adopted energy storage method, with significant potential for further expansion across various regions [12]. Batteries, on the other hand, have demonstrated remarkable scalability and are integral to grid-scale energy storage solutions. Over recent years, battery technologies in conjunction with grid-scale storage systems have consistently exhibited substantial market growth and development [7]. In addition to these, alternative storage technologies, such as gravity-based storage and compressed air energy storage, play a comparatively smaller role within the contemporary

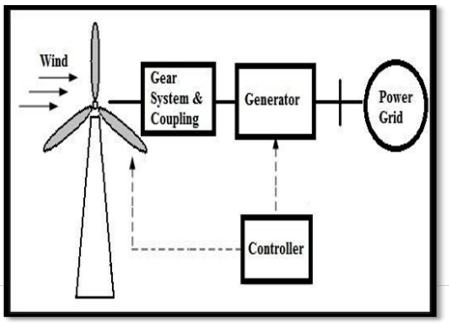

Fig. 4.1: Diagram of wind turbine system

landscape of energy storage systems.

Moreover, the term hydrogen that is detailed separately or differentially is a developing or the growing technology [8]. It is demonstrated as the growing technology that has the additional potential for the seasonal storage related to the renewable energy [13]. While the approaches are still made or projected the development and the growth in the system of the storage capacity or possibility of the gird-scale are not presently on the track in connection with the net zero emissions that need a great hard work and efforts.

4.1. Impact of Winf Power Plant and Grid System for Energy Storage. Integration of new power plants can create an impact on the grids that exist and on the incumbent generators. The impact of the multiple time of scale can be described as an hour to hour, day to day, and seconds to second [4].

The impacts of the wind power on the in the system of the grid is mainly depends on the large expansion of the level of the penetration related to the wind energy, the generation mixture of the electricity in the system of the grid-scale, and the size and accuracy of the grid. The expansion of the penetration of the wind-energy at the moderate or the lower level is the matter of the capital investment or the cost.

These issues of the cost are highlighted by numerous regional and national integration studies. This integration of the capital and cost that are highlighted are modest fairly. The low or the moderate penetration levels of the wind energy in the power system operation of the power system are hardly impacted. In recent years 2022, the supply of the power of the wind is less than that of 6 per cent demonstrated by the overall demand of electricity.

There are various establishments of the control procedures and the system reserves that are available for the dealing with variety of the sully and demand that are moderate in dealing with additional variability the lower penetration of the wind energy. This lower penetration of the wind energy levels up an around 30 per cent that are describes depending on the nature of the significant system. In order to get the higher penetration in the level of the wind energy that represents some changes or transformation in the system and the procedures of operations that are required for the accommodation for the further penetration of the winds.

The impacts of the power of the wind energy on the grid power system could be categorized in the long and the short term affects. The long term effects are mainly related to contribution of the wind power that is provided to the adequacy and its capability in order to meet reliably with the problematic situations. Therefore the effects that are short-term are usually caused by the balancing of the system at the time operational scale.

Locally, the wind power plants mostly interact with the voltage of the grid, similarly to any other stations that are related to the power. This context includes the quality of the power, the state steady voltage deviations and the control of the voltage at vor the near the sites of the wind farms and this all must be taken into considerations. The power of the wind provides the control of the voltage and the active power or frequency control. The wind power plants might reduce the distribution and the transmissions losses when applied through as generations that are embedded.

1. Wind power plants can create an impact on the voltage level and the flow of power in different networks. This may be beneficial for the system that is near the load centers and for the low penetration level areas [26].

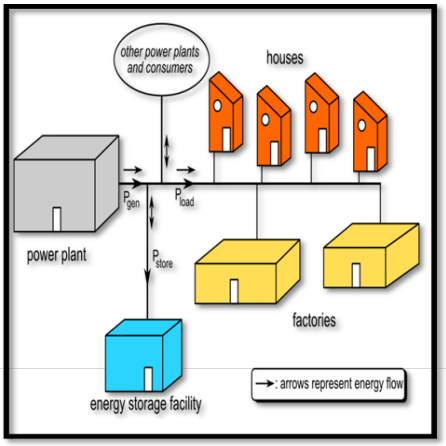

Fig. 4.2: Grid energy storage system

2. Wind power plants may help at the time of low voltage time which can help to improve the up gradation of the transmission and distribution features of current. Connecting with the remote area and sometimes, the pressure of the area that is high in demand of electricity and voltages may be helpful with the help of a wind grid system [23].
3. Wind power has a requirement of measuring and regulating the control and technology generation with a great penetration level in the local area network.
4. If there is the absence of sufficient current and power exchange between the regions and countries that may be helpful with the supply of wind generation and supply [20].
5. Wind power plays an important role in maintenance and stability that contributes to helping the total system with the security of the voltage supply
6. The power plants of the wind can influence the level of the frequency and distribution of the energy in the all the networks. It also supports and benefits the system In the voltage at the time of faults that during the low voltage. This wind plants the reactive power that are able to control all the systems that are installed at the end of the long lines which are radical. This radical lines benefits the system since they support the quality of the voltage as well as the part of the grid.
7. The power of the winds plays a very crucial and vital role in the management of the accuracy and efficiency of the system of the grid as well as the production of the power and storage of the power. It also impacts the security or the safety of the supply of the power in the system of the electricity.

4.2. Challenges faced by the Wind Integration and making Grid Access for the Wind Power System. The main primary challenge that is associated with the wind firm is the intermittent nature of winds at different times. Conventional power plants are made and they can give a constant source of voltage that is estimated for distribution [16]. Wind first generated the voltage as per the availability of winds which is highly variable. Therefore, the power generation is uncertain at different times. The quality of the power and voltage is also uncertain as it is dependent on the flow and speed of the winds [25]. The stability of the voltage and the need for it at different times is stable but the wind is not stable the whole time.

Hence, the voltage stability within the wind grid system exhibits fluctuations. Additionally, the construction and installation costs of power plants are notably high, demanding extensive space [2]. Investing such significant capital in a domain characterized by unpredictable wind patterns and power output is not always economically feasible. Furthermore, the grid-related equipment and technologies necessitate expert handling due to their complexity.

There is a lack of technological skills among people to handle the wind grid [17]. The lack of constant current and voltage supply, uncertainty of the amount of the voltage, and the issue those are being faced at the time of making the voltage switch [13]. With the help of wind creates issues to store the current and using it

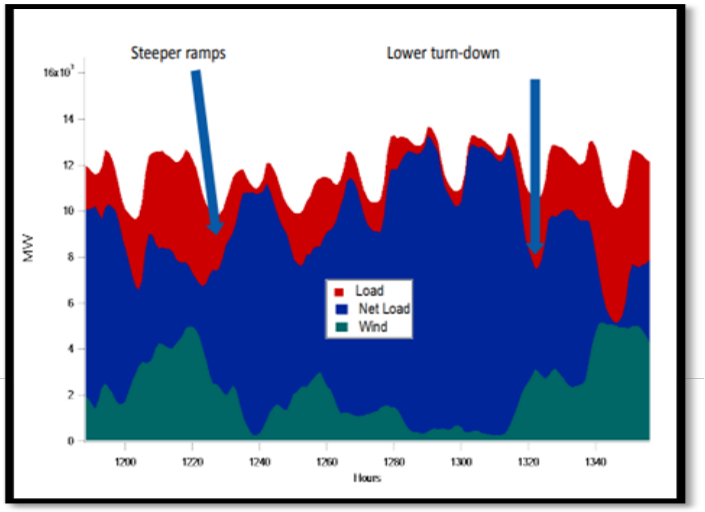

Fig. 5.1: Wind energy has a requirement of flexibility from the generators that are remaining

with the help of renewable energy resources this crisis time of merely. Therefore these challenges are affecting the wind grid power in a great way [5].

4.3. Solutions for mitigating the Issues faced in making of Grid Access of Wind Power Systems in Energy Storage. The industry of electricity is going under processing changes worldwide with the help of implementation of the new generation, distribution, and transmission. With the help of consideration, national and regional markets should be the main target for making growth in renewable energy sources [15].

Technologies of new generation on a wider scale can help to mitigate the significant challenges that are faced in the grid system of wind power. In different regions, wind integration issues may be faced over the time of installation of the wind power mills. Sometimes there should be changed the fuel box of the electricity generation process system should be changed in the integrations [14]. There should be invested different technical professionals who have the knowledge about the total process of power grid handling and access in a great way. Training should be provided to the people who are willing to access this system of renewable energy resources [6]. To cut the cost of installation, a huge amount should be given subsidies from the Government to encourage people to use this grid and access it. The awareness of renewable energy resources should be helpful among the people to get interstate and to use it at different times that are useful for power consumption [22].

5. Results.

5.1. Energy storage for the application of grid. Energy storage can be the asset that may be one of the most valuable assets of the grid system [19]. This can be helpful for the provision of the management of a load of power, quality of power, and uninterrupted power supply that can help to increase the efficiency of the demand of power supply and to get a more sustainable energy system [21].

There are different types of energy storage systems that are suitable for grid-scale applications. Locations of different places are facing the issues. On the other hand, the capacitors used for wind turbines are most effective for conservation of the power and energy [1].

The cost imposed in the total system for renewable energy resources in the market and balancing it with the help of increments of concern of policymakers. The techniques of use and analysis should be assessed in the early stage of the development of the grid power-making stage [11]. The type of approval of the total certification system can also help to mitigate the barriers that are hampering the total process. Storage capacitors should be high technologies that may help to conserve the charges and power [10]. This may help to enhance the energy storage increment that should be used in the time of shortage of power supply or voltage shortage.

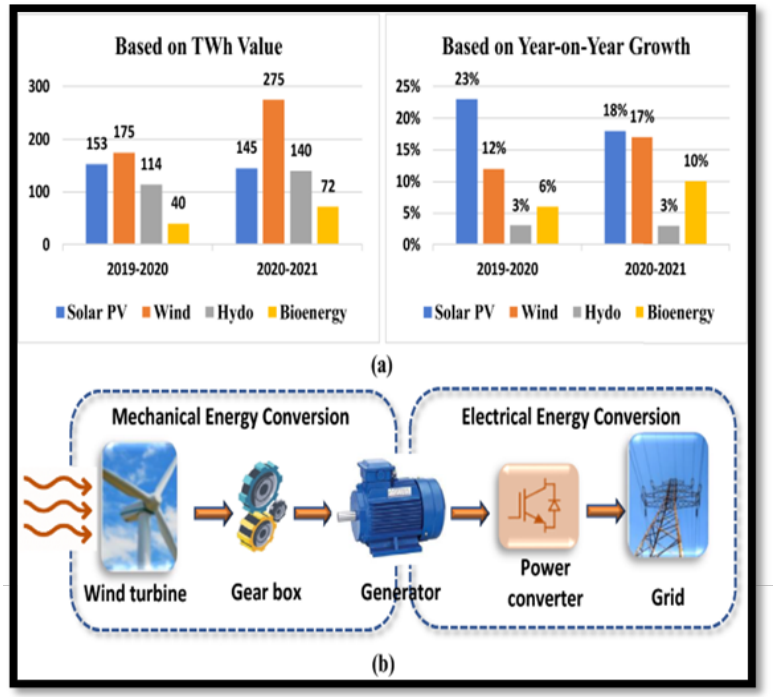

Fig. 5.2: Recent trend of wind energy system

5.2. Benefits of wind power energy through grid access. The presence of solar power and an electric grid can create an impact on the natural gas and fire plants by modifying the level of output of variable generation. Fossil fuel generators are non-renewable energy resources that may be finished in the near future [25]. Wind power energy is a clean resource of renewable energy that may be used in the future without fear of being finished.

With the help of wind turbines, the energy is harnessed using the mechanical and technical way with the help of spin generators for creating electricity [3].

Wind energy is an abundant and inexhaustible resource, and it does not pollute the air by burning any fuel. In the United States, the largest energy resource of renewable energy is the supply of wind energy continuously [8]. It helps to become less reliable on renewable energy resources. Wind energy has a great help of 329 million metric tons of carbon emission on an annual basis which is equivalent to 71 million of car emissions that can be the cause of acid rains and greenhouse gasses [12].

As per the basis of lands and regional basis, wind energy and its cost are competitively low in comparison with the other resources. It may be a great cost-saving technical process in the future to get more energy and power and voltage [6]. Wind energy can be implemented in the village or remote areas also as the coastal area may be helpful with the flow of wind. Island communities are other places where the supply of fuel energy is not easily available, but the resources of the wind are plenty and this may be helpful for the place to get the energy supply [4].

The power plants of the wind might need the additional development or growth in the distribution and the transmission of the infrastructure that are related to the grid system. In relation to the case when any of the power plants are connected to the system of the grid.

In order to show connection with the high resources that are remote that includes the off-shore or the air or the wind that are very large in the regions that are remote as well as the centers of the load. The new radical's lines that are need to be constructed for the building of the pipe lines for the gas and oil. This building of the pipeline will maximizing the effects and shows the smooth impacts on the geographically distribution of

the winds. The supply of the power of the wind required many techniques and approaches for regulating and maintaining control similarly any other technology that are related to the generations. This management is necessary for the reduction of the challenges and the issues also increase the power of the firm and include the additional tramission of the energy and power. The absence of the sufficient and the intelligent and the well maintained and the management of the power of the supply and wind and exchange of the power between the countries and the regions are also done through the grid system of the power.

The grid system of the power is describes as the combination or the mixtures of the non-management system that usually demands the production of the of the power that might results in the maintain the efficiency and the frequency of the power supply of the winds where they are constrained.

6. Conclusion. In conclusion, wind energy grids represent a crucial component of the modern power storage system, offering the ability to capture and store energy for future use, thereby reducing our reliance on finite fossil fuel resources. Through a comprehensive examination of data collected at various intervals, it becomes evident that the application of energy storage, facilitated by wind energy grids, plays a pivotal role in sustaining a continuous and reliable power supply in regions where traditional sources may fall short. This integration of power grid systems and energy storage, driven by wind energy, underscores its significance as a catalyst for the advancement of innovative technologies. These technologies, in turn, are poised to meet the surging demand for efficient and sustainable power supply systems, ushering in a brighter and more environmentally responsible energy future.

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Edited by: Sathishkumar V E
Special issue on: Scalability and Sustainability in Distributed Sensor Networks
Received: Aug 26, 2023
Accepted: Oct 29, 2023