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Renewable Energy Sources and their Integration with Electronic System

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Abstract: *Day by day the society is to rely mostly for the generation of power on renewable energy sources because of the crisis of availability of conventional sources like coal, diesel, etc Renewable are natural sources which are available easily and abundantly. These sources include sun, wind, biomass, biogas, tidal and water to generate the electricity. Their main advantages over conventional sources are easy availability, free of cost, no transportation problems, non-pollutants and, abundance in amount and many more. Due to the challenge of the energy shortage, environmental pollution and because of its advantages of consuming no fossil fuels, infinite reserves, and harmlessness for the environment, the renewable energy source grid-connected generation system (RES-GGS) has attracted more and more attention. But many challenges are there in interfacing these sources with grid due to their variable nature as per the season shift, variation in characteristics for different times and days of the year, base load power generation, and penetration issues. This paper emphasizes on the challenges in grid integration of these sources and their mitigation to make them efficient throughout the year for energy generation.*

Keywords: Grid, Renewable Sources, Grid Integration, Mitigation, Multilevel Converter Topology.

I. INTRODUCTION

The reliable supply of electric power is a critical element of our economy. The new operating strategies for environmental compliance, when combined with our aging transmission and distribution infrastructure, challenge the security, reliability, and quality of the electric power supply. Hence the designing and proper integration of renewable sources without a stress on existing grid infrastructure is an important point for the utility as well as consumers [7]. Before going to take a knowhow related to grid Integration challenges with renewable sources it is important to know about the grid of the electric supply system. Grid in electrical terms is a network of synchronized power providers and consumers that are connected by transmission and distribution lines and operated by one or more control centres. The power grid is nothing but the transmission system for electricity. Many believe the electric power system is undergoing a profound change driven by a number of needs. There's the need for environmental compliance and energy conservation. We need better grid reliability while dealing with an aging infrastructure. And we need improved operational efficiencies and customer service [7]. Electrical power travels from the power plant to your house through an amazing system called the power distribution grid. Since large amounts of energy cannot be stored, electricity must be produced as it is used. The power distribution grid must respond quickly to shifting demand and continuously generate and route electricity to where it's needed the most. ELECTRICITY GRID WORKING Grid is a complex and important system, and one of the most impressive engineering feats of the modern era. It transmits power generated at a variety of facilities and distributes it to end users over longer distances. It provides electricity to buildings, industrial facilities, schools, and homes. And it does so every minute of every day, whole of the year. Our nation's electricity grid/supply system consists of four major components Generation, transmission, distribution and utilization. approaches.

Generation: This is the major component of a grid. It uses the conventional sources like coal, diesel, hydro and nuclear for the electricity generation as well non-conventional sources like solar, wind, biogas, biomass, tidal etc. It is mainly located at far away distances from the load centres to avoid the air and noise pollution as well to avoid all the inconvenient and troublesome things caused during the generation process. AC generators (3 phase alternators) are used for generation. Power generated is in MW or KW as per load side requirement.

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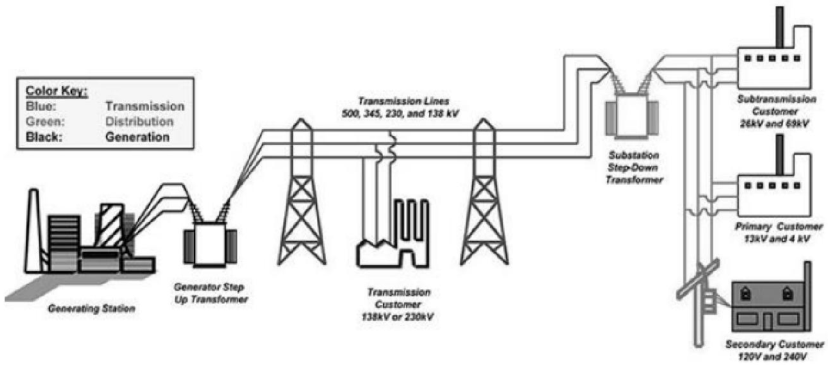

Fig. 1 General Schematic -Electricity grid

Transmission: This includes transmission lines which carries the power to different locations of loads and connects generation point with consumers. Depending on the distance and load voltages like low voltage, high voltage, very high, extra high and ultra-high, lines are classified to short, medium, long transmission lines. They are mounted on transmission towers or poles with proper grounding. They are either overhead or underground. Typical transmission voltages are 110KV and in some cases as high as 765KV. Transmission voltages can be lowered or increased by using step down or step up transformers.

Distribution: Transmitted power is distributed as per requirement using distribution centres. The distribution network is simply the system of wires that picks up where the transmission lines leave off. These networks start at the transformers and end with homes, schools, and commercial loads. Distribution centre is also called as substations and substations are allotted to each region for reliability of supply. It is called as load dispatch centre (LDC) and it is region wise. LDC's are equipped with SCADA system for proper functioning.

Consumers/load: The transmission grid comes to an end when electricity finally gets to the consumer, allowing you to turn on the lights, watch television, or run your dishwasher. The patterns of our lives add up to a varying demand for electricity by hour, day, and season, which is why the management of the grid is both complicated and vital for our everyday lives .The electricity grid has grown and changed immensely since its origins in the early 1880s, when energy systems were small and localized. During this time, two different types of electricity systems were being developed: the DC, or direct current, system, and the AC, or alternating current, system .Hence the grid should be

Reliable: Since the grid is an enormous network, electricity can be deployed to the right places across large regions of the country. The large transmission network allows grid operators to deal with anticipated and unanticipated losses, while still meeting electricity demand.

Flexible: The electricity grid allows a power system to use a diversity of resources, even if they are located far away from where the power is needed. For example, wind turbines must be built where the wind is the strongest; the grid allows for this electricity to be transmitted to distant cities.

Economic: Because the grid allows multiple generators and power plants to provide electricity to consumers, different generators compete with each other to provide electricity at the cheapest price. The grid also serves as a form of insurance – competition on the grid protects customers against fluctuations in fuel prices.

II. LITERATURE SURVEY

This section focuses on the review of the recent developments of power-electronic converters and the state of the art of the implemented PV systems. PV systems as an alternative energy resource or an energy-resource complementary in hybrid systems have been becoming feasible due to the increase of research and development work in this area. In order to maximize the success of the PV systems, a high reliability, a reasonable cost, and a user-friendly design must be achieved in the proposed PV topologies. Several standards given by the utility companies must be obeyed in the PV-module connection.

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Nowadays, the standards EN61000-3-2 [29], IEEE1547 [30],and the U.S. National Electrical Code (NEC) 690 [31], and the future international standard (still a Committee Draft for Vote-CDV) IEC61727 [32] are being considered

These standards deal with issues like power quality, detection of islanding operation, grounding, etc. They define the structure and thefeatures of the present and future PV module Market Considerations Solar-electric-energy demand has grown consistently by20%–25% per annum over the past 20 years, which is mainly due to the decreasing costs and prices. This decline hasbeen driven by 1) an increasing efficiency of solar cells;

2) manufacturing-technology improvements; and 3) economies of scale. In 2001, 350 MW of solar equipment was sold to add to the solar equipment already generating a clean energy. In2003, 574 MW of PV was installed. This increased to 927 MWin 2004. The European Union is on track to fulfilling its own target of 3 GW of renewable electricity from PV sources for2010, and in Japan, the target is 4.8 GW. If the growth rates ofthe installation of PV systems between 2001 and 2003 could be maintained in the next years, the target of the European Commission's White Paper for a Community Strategy and Action Plan on Renewable Sources of Energy would already be achieved in 2008. It is important to notice that the PV installation growth-rate curve in the European Union exactly mirrors that of wind power, with a delay of approximately12 years. This fact predicts a great future for PV systems in the coming years

III. METHODOLOGY

The integration of renewable energy sources in power systems poses challenges but can be addressed through various solutions. Intermittency and variability can be managed through energy storage systems and improved forecasting models. Grid stability and flexibility can be achieved through advanced grid management techniques and the deployment of flexible resources. Upgrades and expansion of grid infrastructure are necessary to accommodate renewable energy flow. Supportive regulatory frameworks, market design adjustments, and cross-border integration can facilitate integration [6]. Lastly, public acceptance and community engagement play a crucial role in ensuring successful integration. By implementing these solutions, the transition to a renewable energy-based power system becomes more feasible and sustainable. By addressing these challenges and leveraging the solutions, countries can transition towards a more sustainable, secure, and resilient energy future. The integration of renewable energy is a crucial step in achieving global climate goals and fostering a greener and more sustainable world.

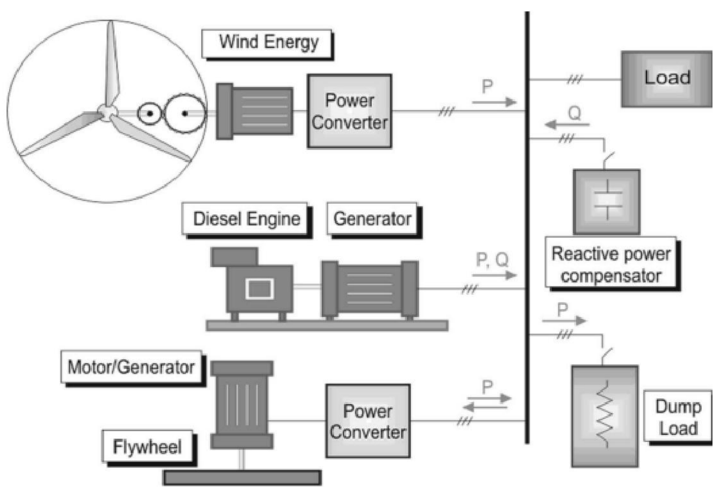

Fig. 2.Typical compensation system for renewable energy applications based on flywheel energy storage

A. Wind & Solar Power Variability

The variation in solar energy output during the course of the day and the year is highly predictable, because the movement of the sun is very well understood. An additional, less-predictable source of variability, however, is the presence of clouds that can pass over solar power plants and limit generation for short periods of time. Cloud cover can result in very rapid changes in the output of individual PV systems, but the impacts on the electric grid are minimized when solar projects are spread out geographically so that they are not impacted by clouds at the same time. In this way, the variability from a large number of systems is smoothed out. For large photovoltaic (PV) plants, cloud cover typically affects only a portion of the project at a given time while the clouds travel through the system. Compared to solar, wind energy is less predictable, but still subject to daily and seasonal weather patterns. Often wind energy is more available in the winter or at night-time. The uncertainty and variability of wind and solar generation can pose challenges for grid operators. Variability in generation sources can require additional actions to balance the system. Greater flexibility in the system may be needed to accommodate supply-side variability and the relationship to generation levels and loads. System operators need to ensure that they have sufficient resources to accommodate significant up or down ramps in wind generation to maintain system balance. Another challenge occurs when wind or solar generation is available during low load levels; in some cases, conventional generators may need to turn down to their minimum generation levels. Solar power that is connected to the distribution system has similar impacts as that connected to the bulk power system; however, there are differences. Transmission-level solar power plants provide real-time generation data to power system operators; whereas distributed solar power plants do not. That makes it difficult for a system operator to know whether an increase in net load is because of increasing demand or decreasing solar generation. Another difference is the way the solar generation reacts to faults or voltage excursions.

B. Impact to Fossil-Fuelled Generator

The presence of additional wind and solar power on electric grids can cause coal or natural gas–fired plants to turn on and off more often or to modify their output levels more frequently to accommodate changes in variable generation. This type of cycling of fossil-fuelled generators can result in an increase in wear-and-tear on the units and a decrease in efficiency, particularly from thermal stresses on equipment because of changes in output. Costs of cycling vary by type of generator. Generally, coal-fired thermal units have the highest cycling costs, although combined-cycle units and many combustion turbines, unless specifically designed to provide flexibility, can have significant costs as well. Hydropower turbines, internal combustion engines, and specially designed combustion turbines have the lowest cycling costs. For coal plants in particular, the impacts can include increased damage to a boiler as a result of thermal stresses, decreased efficiency from running a plant at part load, and increased fuel use from more starts and difficulties in maintaining steam chemistry and NOX control equipment.

C. Communication Issues:

It becomes important for the system operator to communicate with the load centres of particular region to maintain the uninterrupted and reliable service in terms of base load, maximum load, and load factor. But in case of integrated sources it becomes difficult to do communication as per their varying nature of generation as per weather. As well that much efficient communication devices and network is to install which matches the requirements of both conventional and non-conventional sources. This needs the extra cost. 4) Balancing between use of renewable and non-renewable sources requires more flexibility: Which source is to use from conventional and non-conventional as a base load and peak load is the important point because at a time when both are in use there should be the flexibility to control and operate the real-time data by both as per need.

IV. CONCLUSION

The integration of renewable energy sources into power systems is vital for achieving a sustainable energy future. However, it presents challenges related to intermittency, grid stability, energy storage, and policy frameworks. By implementing advanced forecasting techniques, diversifying energy sources, deploying energy storage systems, and establishing supportive policy frameworks, these challenges can be addressed. The successful integration of renewable energy sources into power systems will contribute to a cleaner, more reliable and sustainable energy supply. Continued research, technological advancements, and collaboration among stakeholders are necessary to overcome these challenges and fully harness the potential of renewable energy in power systems. By embracing advanced forecasting, grid-friendly technologies, energy storage solutions, demand-side management, system flexibility, and supportive policies, power systems can successfully integrate renewable energy sources and drive the transition towards a cleaner

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and greener energy landscape. Continued research, technological innovation, and collaborative efforts will be instrumental in achieving a resilient and sustainable power system for future generations.

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