RENEWABLE SOURCES-GRID INTEGRATION CHALLENGES

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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.*

Key words: grid, renewable sources, mitigation, power quality, grid integration.

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 centers. 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,distributionandutilization.

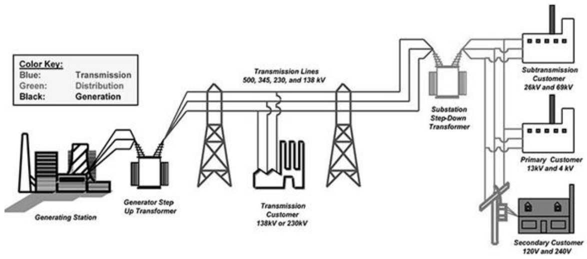

Fig.1 General Schematic -Electricity grid

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 centers 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.

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 centers. 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 center is also called as substations and substations are allotted to each region for reliability of supply. It is called as load dispatch center (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. SMART GRID

The existing electricity grid is unidirectional in nature. It converts only 1/3 rd of fuel energy into electricity without recovering the waste heat. Almost 8% of its output is lost along its transmission lines, while 20% of its generation capacity exists to meet peak demand only (i.e., it is in use only 5% of the time). In addition to that, due to the hierarchical topology of its assets, the existing electricity grid suffers from domino effect failures.

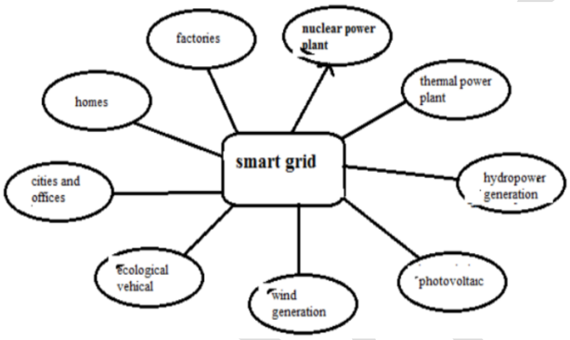

Fig. 2 Smart grid

Table1.Comparison of traditional and smart grid

Traditional grid	Smart grid
Electric machinery	Digital
One-way communication	Two-way communication
Centralized power generation	Distributed power Generation
A small number of sensors	Full grid sensor layout
Manual monitoring	Automatic monitoring
Manual recovery	Automatic recovery
Failures and power outages	Adaptive and Islanded
Few user options	More user options

Due to the challenge of the energy shortage and 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. At present, the initial investment cost of the RES-GGS is still high and the competitive edge of the RESGGS is reduced. Therefore, how to enhance the power extraction ability and increase the utilization rate of the RES is a key [2]. India is considering renewable energy resources (RES) like solar and wind as alternative for future energy needs. As on March 31, 2012 the grid interactive power generation from RES is 24914 MW i.e. around 12.1 % of the total installed energy capacity. Further Ministry of New and Renewable Energy (MNRE), Government of India is targeting to achieve 20000 MW grid interactive power through solar and 38500 MW from wind by 2022. However there are various issues related to grid integration of RES keeping in the view of aforesaid trends it becomes necessary to investigate the possible solutions for these issues. Integration of renewable energy sources to utility grid depends on the scale of power generation. Large scale power generations are connected to transmission systems where as small scale distributed power generation is connected to distribution systems. There are certain challenges in the integration of both types of systems directly. This paper presents the some issues and challenges encountered during grid integration of different renewable energy sources with some possible solutions [9]. A number of factors are contributing to increases in renewable energy production. These factors include rapidly declining costs of electricity produced from renewable energy sources, regulatory and policy obligations and incentives, and moves to reduce pollution from fossil fuel-based power generation, including greenhouse gas emissions. While not all renewable energy sources are variable, two such technologies – wind and solar PV – currently dominate the growth of renewable electricity production. The production from wind and solar PV tries to capture the freely available but varying amount of wind and solar irradiance. As the share of electricity produced from variable renewable resources grows, so does the need to integrate these resources in a cost-effective manner, i.e., to ensure that total electricity production from all sources including variable renewable generation equals electricity demand in real time. Also, a future electric system characterized by a rising share of renewable energy will likely require concurrent changes to the existing transmission and distribution infrastructure.

III. RENEWABLE SOURCES AND GRID INTEGRATION

The electricity grid to accommodate higher percentage of renewable energy would need large quantities of conventional back up power and huge energy storage. These would be necessary to compensate for natural variations in the amount of power generated depending on the time of day, season and other factors such as amount of sunlight and wind at any given time.

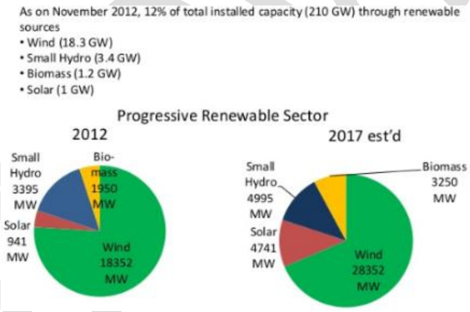

Fig. 3 India's renewable scenario

Since today electricity grid cannot handle this variability, the cost of adopting the renewable energy sources is much more expensive than it should be. Renewable energy technologies (RETs) - hydropower, biomass, wind and solar photovoltaic – have been successfully demonstrated over the years. Currently, the total shares of all renewable for electricity production make up for about 19%, a vast majority (83%) of it being from hydroelectric power. Power generation through the use of biomass offers a viable and long-term solution to grid electrification; however it is inefficient use, biomass resources presently supply only about 20% of what they could if converted by modern, more efficient, available technologies. In recent years, interest in biomass as a modern energy source, especially for electricity generation has been growing worldwide. Wind power has emerged as the world's fastest energy growing source. The decentralized and locally available nature of wind energy makes it particularly attractive to grid electrification. Solar PV uses and applications have been justified and strongly recommended for grid electrification. The current cost of PVdevices, though lower than a decade ago, is still too high to provide power to compete the conventional electric supply. This paper aims to study the opportunities and challenges of integrating renewable energy in smart grid system. The concept of smart grid renewable energy system and its applications are presented. [4]

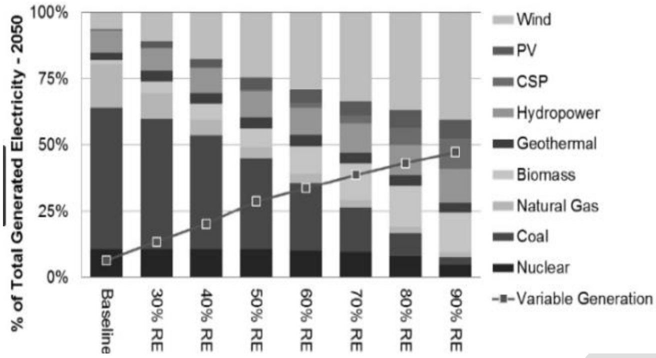

Fig. 4 contribution of renewable for future

Benefits and barriers of smart grid renewable energy

1) Enabling renewable energy resources to accommodate higher penetration with cost effective while improving power quality and reliability.
2) Integrating consumers as active players in the electricity system; savings, achieved by reducing peaks in demand and improving energy efficiency, as well as cutting greenhouse gas emissions.
3) Voltage regulation and load following enables reducing cost of operations based on marginal production costs [4].

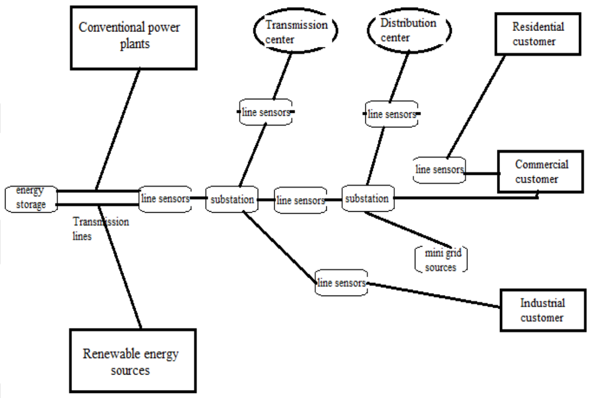

Fig.5 Renewable and grid integration

IV. GRID INTEGRATION CHALLENGES WITH RENEWABLE SOURCES AND THERE MITIGATION

Following points explains the details regarding mainly wind and solar sources out of all renewable sources and there impacts on grid operation. Hence grid integration is the practice of developing efficient ways to deliver variable renewable energy (RE) to the grid. It will be mitigated by using

1) New RE generation,
2) New transmission,
3) Increased system flexibility,
4) Planning for new RE infrastructure.

1) Wind and 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 nighttime. 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.

2) Impacts to Fossil-Fueled Generators: 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-fueled 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.

3) Communication issues: it becomes important for the system operator to communicate with the load centers 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 nonrenewable 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.

5) More reserves are needed at the time of no operation of wind and solar as per the weather: toconsider the weather parameters is beneficial when the renewable are integrated with the grid. Accordingly the reserves and its capacity will be designed from other sources. This definitely needs preplanned economic planning.
6) More transmission network and better planning needed:
7) Grid services (e.g., inertia response) from wind/solar or other equipment come at added cost like marginal costs, revenues and related tariff.
8) Existing conventional generators needed, but run less, affecting cost recovery
9) Achieving power systems with high RE requires an evolution in power system planning [6]
in short addition of RE sources needs planned system operation, current and future market scenarios, storages, flexibility in generation and proper network of communication and infrastructure. Faster Scheduling to Reduce Expensive Reserves Broader balancing areas and
10) geographic diversity can reduce variability and need for reserves
11) Increase Thermal Plant Cycling

Following are some key takeaways for use of RE in grids
1) Wind and solar increases variability and uncertainty
2) A wide variety of systems worldwide show 10%+ annual RE penetrations achievable
3) There are no technical limits: investments in flexibility and transmission will enable higher penetration levels of RE
4) Often the most cost effective changes to the power system are institutional (changes to system operations and market designs) [6]

V.CONCLUSION

Integration of renewable sources to the grid is beneficial and efficient thing to generate as well as transmit the power to the load centers. Due to this, utilization of conventional sources can be reduced which is advantageous for environment, cost, location, availability, and transport point of view. Also the sustainable energy and its reserves will become the essential parameter in nation’s economical growth scenario. Hence the inculcation of natural sources for energy generation, due to their enormous benefits is the need of hour

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