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Study on Integration of Wind and Solar Energy to Power Grid

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ABSTRACT
Nowadays Renewable Energy plays a great role in power system around the world. It is a demanding task to integrate the renewable energy resources into the power grid .The integration of the renewable resources use the communication systems as the key technology, which play exceedingly important role in monitoring, operating, and protecting both renewable energy generators and power systems. This paper presents about the integration of renewable energy mainly focused on wind and solar to the grid.
KEYWORDS- Communication Systems, Grid, Renewable Energy, Solar Power, Wind Power.

I. INTRODUCTION

In this paper, it reviews some communication technologies available for grid integration of renewable energy resources. Since most renewable energy sources are intermittent in nature, it is a important task to integrate a significant portion of renewable energy resources into the power grid infrastructure mainly the electricity flow takes place in one direction from the centralized plants to consumers.

When compared to large power plants, a renewable energy plant is having less capacity. But as emerging resources renewable energy should be taken into account. By achieving the integration as shown in Fig.1 we can improve monitoring techniques, protection, optimization and the operation. And also two way flow of electricity can be employed.

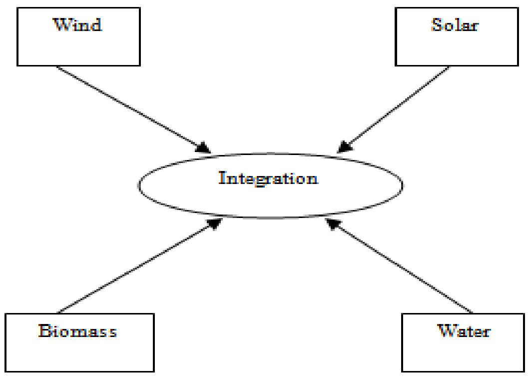

Fig. 1 Renewable energy integration

II. WIND POWER INTEGRATIONN

The idea of grid integration connected Wind Turbine Generation Systems have been developed in the last decades to MW size power generation units with advanced control .The power output is not only based on the incoming wind speed but also based on system requirements. In contrast with the past, the WTGS technological developments [1] enable wind farms to be operated according to the Virtual Power Plant (VPP) concept, thus providing necessary support to the primary activities.

Wind energy has become an increasingly significant portion of the generation mix. Large scale wind farms are normally integrated into power transmission networks so that the generated electric power can be delivered to load centers in remote locations whereas the Small scales wind farms can be integrated into power distribution networks to meet local demands.

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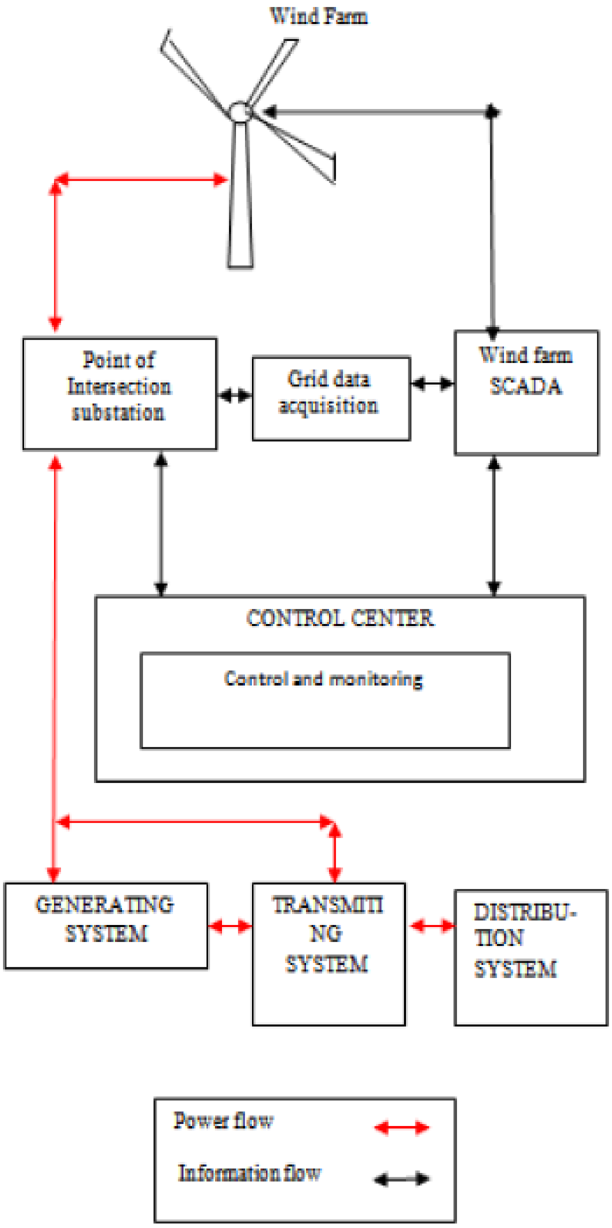

Fig. 2. Grid integration of a wind farm

Communication systems are the basic tool that transmits the measured information and control signals between wind farms and power systems. A Proper communication system can explore the wind potentials and facilitate farm controls, helps in peak load and providing voltage support for power systems. Fig. 2 shows the grid integration of the wind farm. It can be seen that a modern power system is composed of communication networks. Energy flows through the power grid to meet customer demand, while information flows through the communication system to monitor the system status, control the dynamic energy flows presented in the grid, and transfer the information collected from an internet of smart devices for sensing and control across the power grid. From the wind farm the data are given to control center through the SCADA communication where the control, monitoring, operation is done and connected to transmission system.

III. GRID CODES OF WIND INTEGRATION

Grid operators, both in transmission and distribution, have developed grid codes for connecting WTGS and the wind turbine manufacturers have responded to these requirements by developing advanced functionalities in the field of WTGS control and electrical system design Essential grid code requirements are discussed below

A. Frequency control

Several grid codes require the participation of wind farms in primary and secondary frequency control, including frequency response capability and limitation of both ramp rates and active power output. The requirements are expected to become stricter at higher wind power integration levels in order to avoid exceed power gradients of conventional power plants responsible for primary and secondary frequency control. Some operators also require that WTGS should stay connected and in operation at a wider frequency band in order to contribute to frequency restoration and stable power systems operation.

B. Voltage control

The individual WTGS have to control their own terminal voltage to a constant value by means of an automatic voltage regulator, allowing that modern wind farms have capability to control the voltage at the Point of Common Coupling (PCC) to a pre-defined set-point of grid voltage. Expanded reactive power capabilities can bring advantages for system operators because it offers the possibility of better balancing the reactive power demand.

C. Fault Ride-Through capability

WTGS must remain connected during and after severe grid disturbances, ensuring fast restoration of active power to pre-fault levels as soon as the fault is cleared and inject reactive current in order to support the grid voltage during disturbances and to provide fast voltage recovery after fault clearing.

IV. SOLAR ENERGY INTEGRATION

The first application of photovoltaic power was as a power source for space satellites. Mostly the photovoltaic modules are used for utility-interactive power generation. Grid connected solar systems are typically classified as three categories: residential, commercial, and utility scales. Residential scale is the smallest type of installation and refers to all installations less than 10kW usually found on private properties.

The commercial capacity ranges from 10kW to 100kW, which are commonly found on the roof of a commercial building. Utility scale is designed to the installations above 100kW, which are traditionally ground-based installations on fields. In this technique using integrate communication systems [4] - the photovoltaic panel, voltage, current and temperature of each module was collected and the information is sent to the monitoring interface.

The solar power monitoring [3] can be classified as three categories: system level, string-level, and module-level. Fig. 3 shows the three-level monitoring based on wireless communication systems. The system will monitor the status of solar modules, solar strings, and solar inverters based on the IEEE 802.15.4-2003 ZigBee standard. Either star or mesh topology can be used. With this wireless monitoring capability, each solar module status is visible.

V. WIND AND SOLAR ENERGY INTERGRATION

The combination of wind and solar energy leads to reduced local storage requirements. The combination of complementary and multilevel energy storage technologies, where a super capacitor or flywheel provides cache control to compensate for fast power fluctuations and to smoothen the transients encountered by a battery with higher energy capacity.

Micro grids or hybrid energy systems have been shown to be an effective structure for local interconnection of distributed renewable generation, loads, and storage. Recent research has considered the optimization of the operation on one hand and the usage of dc to link the resources on the other .A schematic of the dc micro grid with the conventions employed for power is given in Fig. 4.

The dc bus connects wind energy conversion system (WECS), PV panels, multilevel energy storage comprising battery energy storage system (BESS) and super capacitor. The WECS is connected to the dc bus via an ac–dc converter. PV panels are connected to the dc bus via a dc–dc converter. The BESS can be realized through flow battery technology connected to the dc bus via a dc–dc converter. It is connected close to the LV–MV transformer to reduce losses and voltage drop and it is connected to main grid.

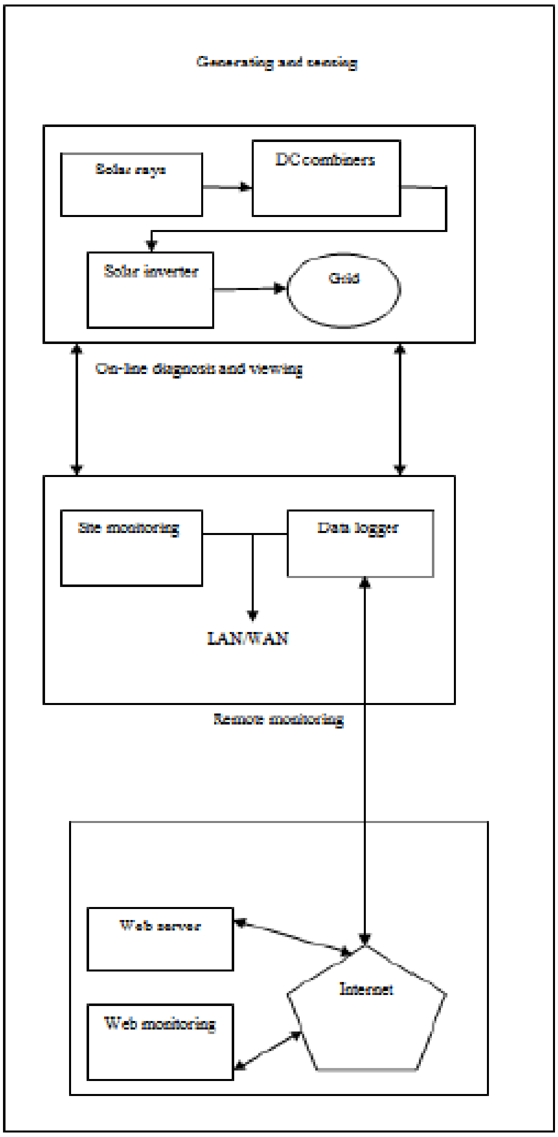

Fig. 3. Three-level monitoring of photovoltaic Power systems based on wireless communication

VI. ADVANTAGE OF WIND AND SOLAR – HYBRID SYSTEM

The major advantage of the system is that it meets the basic power requirements of non-electrified remote areas, where grid power has not yet reached. The power generated from both wind and solar components is stored in a battery bank for use whenever required. A hybrid renewable energy system utilizes two or more energy production methods, usually solar and wind power. The major advantage of solar / wind hybrid system is that when solar and wind power productions are used together, the reliability of the system is enhanced.

Additionally, the size of battery storage can be reduced slightly as there is less reliance on one method of power production. Wind speeds are often low in periods (summer, eventually) when the sun resources are at their best. On the other hand, the wind is often stronger in seasons when there are less sun resources. Even during the same day, in many regions worldwide or in some periods of the year, there are different and opposite patterns in terms of wind and solar resources. And those different patterns can make the hybrid systems the best option.

An hybrid wind-solar electric system demands an higher initial investment than single larger systems: large wind and solar PV systems are cheaper than smaller systems. But the hybrid solution is the best option whenever there is a significant improvement in terms of output and performance - which happens when the sun and the wind resources have opposite cycles and intensities during the same day or in some seasons.

VII. GRID CONGESTION

Power grid congestion is a situation where in the existing transmission and/or distribution lines are unable to accommodate all required load during periods of high demand or during emergency load conditions, such as when an adjacent line is taken out of service or damaged by a storm, it also reflects a decrease in efficiency.

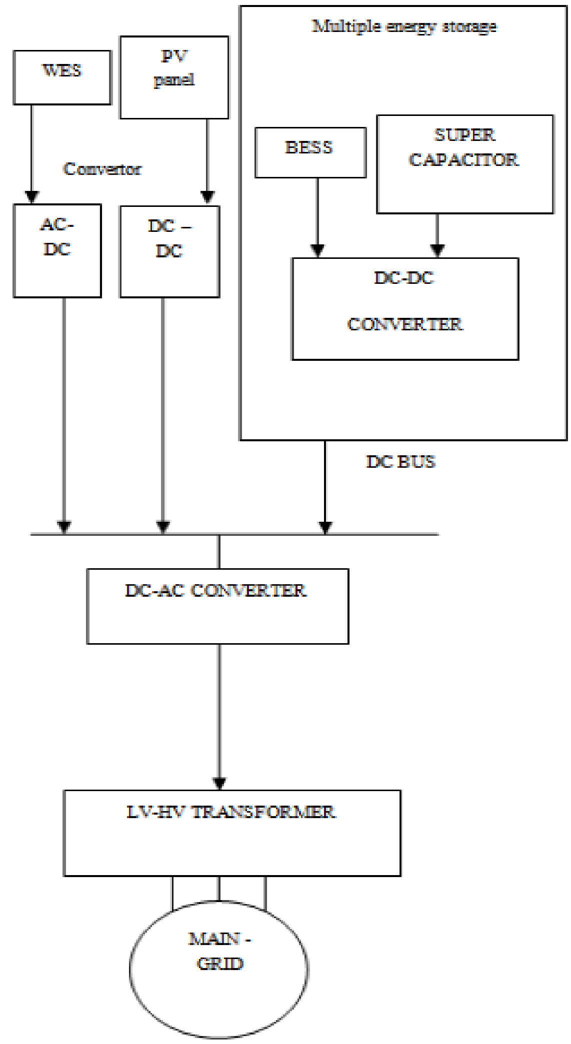

Fig. 4. Wind and Solar Integration

Under high load conditions, line losses escalate exponentially. If lines are congested and operating at or near their thermal limits, they would also be exhibiting significant line losses during high load conditions.

There have been cases when wind farms are forced to shut down even when the wind is blowing because there is no capacity available in the lines for the electricity they create. Without adequate transmission to transport power from "renewable" rich areas (like Arizona) to densely populated areas, it is only cost effective to use renewable sources in certain areas of the country. While building new infrastructure would certainly help, smart grid technologies can also help utilities alleviate grid congestion and maximize the potential of our current infrastructure.

Smart grid [2] technologies can help provide real-time readings of the power line, enabling utilities to maximize flow through those lines and help alleviate congestion. As smart grid technologies become more widespread, the electrical grid [5] will be made more efficient, helping reduce issues of congestion. Sensors and controls will help intelligently reroute power to other lines when necessary, accommodating energy from renewable sources, so that power can be transported greater distances, exactly where it's needed. Relieving grid congestion can be achieved in several ways:

- By adding new transmission lines
- By building new electric generating capacity near load centers
- By reducing the demand for electricity in congested areas through greater use of energy efficiency and conservation.

VIII. CONCLUSION

Two-way communications are the fundamental infrastructure that enables the accommodation of distributed renewable energy generation. In this paper, we reviewed communication technologies available for the grid integration of renewable energy resources. The concept of wind and solar integration is been discussed, which gives better output, reduce the losses and provides better monitoring ,control and operation is achieved with help of power electronics devices like converters and also with communication technologies. Distinct characteristics in integration of renewable energy resources pose new challenges to the communication systems, which merit further research.

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