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Integration of Renewable Energy Sources in Smart Grid

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ABSTRACT:The complexity of the power grid, in addition with the ever increasing demand for electricity, creates the need for efficient analysis and control of the power system. Smart grid technology is the best key for an efficient use of distributed energy resources. The smart grid is the future solution for the techniques and strategies of production and the interaction of all the components of power grid. Noting the climate change becomes an important topic of concern, the whole world is currently facing the ever increasing price of petroleum products, coal etc. and also the renewable energy power systems have reduced cost, giving opportunities for renewable energy systems to address electricity generation. However, the integration of renewable energy systems (RESs) in smart grids (SGs) is a challenging task, mainly due to the intermittent and unpredictable nature of the sources, typically wind or sun. The Smart Grid uses two-way flow of electricity and information to create a widely distributed automated energy delivery network, considered as the next generation power grid. It allows a better exploitation of renewable energy sources and a reduction of the customers' energy consumption costs with both economic and environmental benefits. The grid flexibility and resilience can be improved through the active participation of distribution system operators (DSOs) and electricity supply/demand that, according to their preferences and costs, respond to real-time price signals using market processes. This paper presents the study of integrating renewable energy in smart grid system and the concept of smart grid plays a crucial role and can be successfully applied to the power systems.

KEYWORDS: Alternative Source, Fuel Cell, Integration, power demand, Renewable Energy, Smart Grid, Solar Energy(PV), Stable Operation, Wind Energy.

I.INTRODUCTION

The Smart Grid is the integration of the twentieth century traditional electrical power grid with the most recent 21st telecommunication and information technologies. These kind of integration enables efficient resource utilization to optimize energy consumption, install and manage distributed energy sources, as well as to exchange the generated power. It can also be said as , the power flow and communications will be in two-ways. Most of the utility companies around the globe started to install renewable energy sources such as solar and wind energy nearby the consumption sites. The residential home owners also started to install smart home appliances and renewable energy resources in their premises to generate and consume electrical power efficiently. The smart grid concepts emerged as a fast growing research and development topic in the last few years, Smart grid users communicate in two-way directions by utilizing several wired and wireless communication protocols such as Zigbee, WiFi, Homeplug, power line carrier, GPRS, WiMax, LET, Lease line, and Fibers. Several software packages were updated and many are being developed to accommodate the new grid operation, maintenance and management such as, distribution management system (DMS), geographic information systems (GIS), outage management systems (OMS), customer information systems (CIS), and supervisory control and data acquisition system (SCADA). The smart grid evolution results in recent enabling technologies have emerged to reduce the number of communication protocols and handle big amounts of data. One of the most recent enabler for the smart grid is Internet of Things (IoT).

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Now a Days, the integration of large amounts of renewable energy systems (RESs) with the grid is widely studied by many researchers, but only few of them address these problems in connection with a consumers' potential participation to the electricity market or analyse the additional balancing costs due to intermittent and partially predictable availability of RESs. On the other hand, continuous changes of power system generation capacity impose significant energy reserves, imported energy, and the use of efficient storage systems, thus higher costs.

II.COMPARISON OF TRADITIONAL GRID VERSUS SMART GRID

Traditional grid includes centralized power generation, and at the distribution level unidirectional power flow and weak market integration. Centralized and distributed power generations produced considerably by renewable energy sources are included in smart grid. They integrate distributed and active resources (i.e. loads, generation, storages and electricity vehicles) into energy markets and power systems. Smart grid is the electricity network that smartly integrates producers and consumers to efficiently deliver electricity which is sufficiently capable and coverage area accessible, safe, economic, reliable, efficient, and sustainable. Smart grid development tends to be driven by one of the two principal visions for enhancing electric power interactions for both utilities and end use customers. The fast growing installations of non-conventional energy resources require a coordinated and joint effort from the planning stage all the way down to the electronic devices basically used for power generation, distribution, storage purpose and consumption.

III.OBJECTIVES

The utilization of renewable energy sources in smart grid system has been increasing in recent years. The question for cleaner, green and more reliable energy sources has considerable implications to the existing power transmission and distribution system. The power is generated in bulk and distributed to the large load centers via the transmission lines, traditionally. The transformation of power was always one way, which is from the utilities to the consumers. The renewable energy sources cannot support the entire grid by themselves immediately for future. So the main grid acting as auxiliary power sources have to be connected to thus reducing the overall burden on the primary power generation units. The renewable energy sources could also be employed to serve load units totally isolated from the main grid. The objectives of the proposed methodology are as follows:

- To integrate the various renewable energy sources
- To deliver the growing power demand
- To minimize the increased complexity of power grids
- To increase the effectiveness of power grid
- Energy production cost minimization

IV.PROPOSED METHODOLOGY

The proposed method integrates the renewable energy sources like wind, solar power, Fuel Cell and supplies the power to the load. The load is supplied by integrated renewable energy source i.e. the supply from wind and solar PV. In addition the load can also be supplied by the AC grid. Fig. 1 shows the block diagram of proposed methodology.

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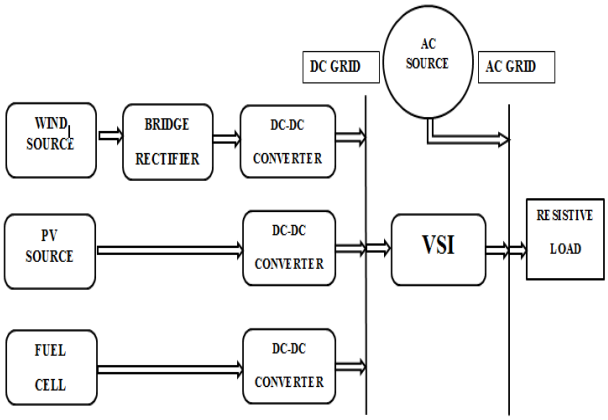

Fig. 1 Block Diagram of Proposed Methodology

The end users need not only be passive consumers in Distributed generation (DG), but they can be active suppliers to the grid. DG is an alternative which is not only gathering momentum but can also playing an important role in meeting the ever increasing power demands by using an alternative source of energy like photovoltaic, wind, fuel cells, etc.. The need of integrating the renewable energy into power system is to minimize the environmental impact on conventional plant. Smart grid plays a major role here. The main objective of smart grid is to promote active customer participation and decision making as well as to create the operation environment in which both utilities and consumers can interact with each other. The users can influence utilities by providing DG sources such as photovoltaic modules or energy storage devices at the point of use, and reacting pricing signals in smart grid. Additionally, utilities can improve reliability through the demand response programs, adding DG or energy storage at substations, and providing control automation to the grid.

V. SIMULATION OF PROPOSED METHODOLOGY

The MATLAB model of the proposed model is shown as Fig. 2. It consists of renewable energy sources like wind and solar PV system addition to the AC source. The load is supplied mainly by the renewable energy sources. Incase if it fails, the load is supplied by the AC grid. These operations are performed with the help of Model Predictive Controller algorithm (MPC).Here, wind source is connected to bridge rectifier and the outputs of bridge rectifier are connected to the DC-DC buck boost converter. The other sources solar and fuel cell are connected to DC-DC buck boost converter. Finally, the three sources are connected to the DC grid. Then DC source is connected to the Voltage Source Inverter. The output of VSI and AC source are connected to AC grid. Through AC grid the load takes the supply according to need.

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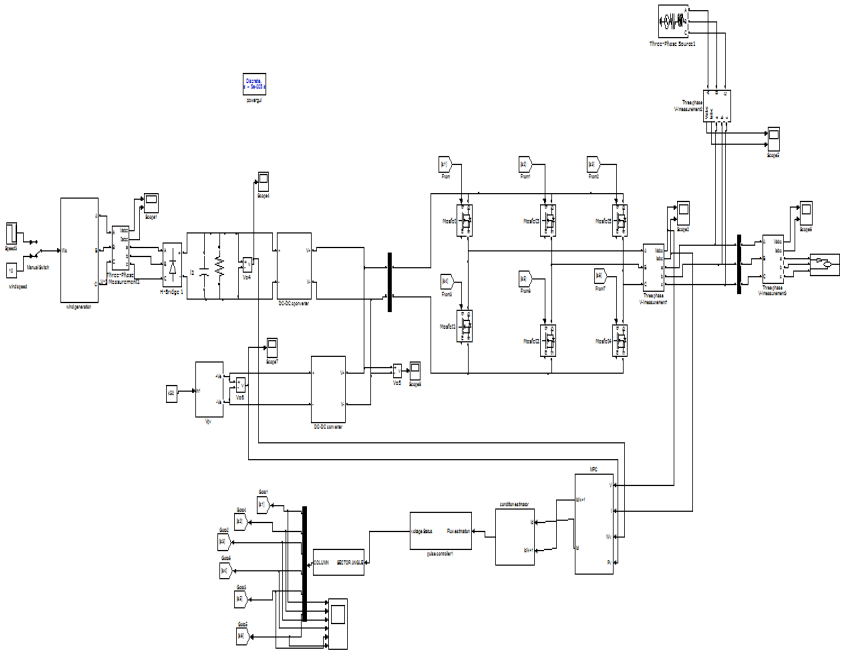

Fig. 2 Proposed Simulink Model

The load here considered is a resistive load. If the supply from the renewable energy sources not meets the demand, the load can fetch power from the ac grid. The load can also be supplied by both renewable energy source (solar, wind) and the AC grid. If the power produced by renewable energy sources is more than load demand, it can also be connected to grid further. These control actions are done with the help of controller which uses Model Predictive Control (MPC) technique which switches the power supply to the grid. A variable AC output will be produced by the wind source and the Dc output will be produced by the solar PV panel. The variable AC output from wind source is converted to DC supply by a three phase bridge rectifier. The DC supplies from both the renewable energy sources are fed to a DC-DC converter. The DC-DC converter here used is a buck boost converter. The buck boost converter will step up (i.e.) boost the output if the supply is less and it will step down the output if the supply is more. The controller fetches the input data like current, voltage produced by renewable energy sources, both DC-DC converter output, Voltage Source Inverter output(VSI), AC grid output, need of load. The control actions like switching the source of supply to load are done with the help of Model Predictive Controller algorithm technique according to the controller inputs.

VI.CONCLUSION

In India energy generation and consumption are on high growth rate. The change of climate also concerned due to emission combined with resource and infrastructure constraints are dampers. With nearly 40 % of population deprived of grid electricity, so the present installed power capacity may have to be doubled by the end of this decade to meet the need of energy and its growing population and expectations of a high GDP growth economy. Now a days, an electricity disruption such as a blackout can have a domino effect—a series of failures that can affect banking, communications, traffic, and security. This is a particular threat in the winter, when home owners can be left without heat. The smart grid will give additional benefit to our electric power System and make it better prepared to address emergencies such as severe storms, earthquakes, large solar flares, and terrorist attacks. Due to its two-way interactive capacity, the Smart Grid will allow for automatic rerouting when equipment fails or outages occur. These will minimize outages and minimize the effects when they do happen. Market of power in India is generally characterized by the poor demand side management and response for lack of proper infrastructure and awareness.

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Smart Grid Technology can intuitively overcome these issues. In addition to that, it can also reduce in line losses to overcome prevailing power shortages, improve the reliability of supply, power quality improvement and its management, safeguarding revenues, preventing theft etc.. Integration of RES is expected to play significant influence on the operation of the power system for sustainable energy in future. There are certain Grid codes which are set up to specify the relevant requirements for efficient and secure operation of power system for all network users and these specifications have to be met in order to integrate wind turbine into the grid. In addition, Micro grids are creating new smart grid technology requirements in the areas of automation, management and control of alternative energy sources with energy storage devices. With this, the report may guide future policies which to lead Indian power system to take several steps to implement Smart grid with RES integration. In this connection, the report should act as advocate to bring forth the significance and fortification of Smart Grid philosophy and implanting it on the basis of proposed ideology in Indian subcontinent.

VII. FUTURE SCOPE

As the report only had pulled the grid connection requirement for wind power generation and PhotoVoltaic (PV). Which has been planned to stretch upon to the study of hydro energy, fuel cell and its grid connection planning in Indian scenario. Also, few more work related to micro grids and hybrid energy with energy storage system is premeditated to complete by near future. Upon the final result of the entire study, the further research perspective would deliberately act as an advocate to discover the rank and strategy of nation's development in energy and power with respect to current and future energy demand. Currently, the nation ranks to be 4th largest in installed power generation capacity using RES and 3rd largest in investment and implementation of smart grids, which will be a trend setter for emerging economies to pursue "green" and sustainable energy.

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