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Stability analysis in smart grid with renewable energy sources

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ABSTRACT

Electricity is most versatile and widely used form of energy. With the fast development of world, the conventional fossil energy sources are rapidly declining and ever increasing consumer demand is rising. So the renewable energy has become the alternative source of fuel. To deliver the growing demand for power as well as providing a stable and sustainable supply of electricity is a heavy stress on today's grid. The growing worldwide population is dynamic and will create even greater increase in demand for electricity. To rectify this Smart Grid pays way to deliver the Growing demand for power and to minimize the increased complexity of power grids. Smart Grid integrates modern technologies and renewable energy resources in to future power grid in order to supply more efficient and reliable electric power. It aims in describing the development of stable operation of power grid during the integration of different renewable energy sources with the power grid. The main advantage of the proposed system are best intelligence, auto balancing, self-monitoring of power grid that accepts any source and transforms it into consumer end use. The proposed method integrates the renewable energy sources like wind, solar power and supplies the power to the load. In addition the load can also be supplied by the AC grid. If the supply from the renewable energy sources not meets the demand, the load can fetch power from the AC grid. If the power produced by renewable energy sources is more than load demand, it can be connected to grid in further. These control actions are done with the help of controller which uses Model Predictive Control (MPC) technique.

Index Terms: Alternative Source, Demand, Integration Renewable Energy, Smart Grid, Stable Operation.

INTRODUCTION

The world has been changing revolutionary towards a higher efficiency in many aspects due to the fast pace advancements of communication technologies. Conventional power networks across the globe are undergoing transformation towards Smart Power Grids (SPGs) incorporating advanced monitoring and controlling strategies. Smart grid is defined as the integration of power communications and information technologies for an improved electric power infrastructure serving loads while providing for an on-going evolution of end use applications. Near-real-time awareness of system possible through a smart grid will enable power companies to greatly improve system reliability and redundancy. These days in order to improve the power quality and power supply reliability, constructing strong smart grid has become the trend of power grid development. Power systems are designed to maintain the acceptable voltage profile develop throughout a network under normal operating conditions.

In a distribution network, uncertainty and variability associated with renewable energy resources, such as solar power and wind power can easily cause power fluctuations, voltage instability and frequency deviations. The transmission system serves as a vital link between the generating

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station and consumers. With the phenomenal increase of power in recent times, the length of transmission lines have been continuously increasing to deliver power to consumers. Also transmission lines traverse harsh terrains and thus effective communication between substations has been a challenge. The above mentioned problems can be rectified by means of smart grid which support worldwide distributed energy resources by organizing, bidirectional transmission of power and real time information, alternating renewable generation and supply/demand balancing within the distributed networks. Such that with the adoption of new technologies makes consumer to monitor and routinely control energy use and provides opportunities for consumers to contribute in the market to meet demand. Integration of distributed power sources are renewable energy such as Fuel cells, Photovoltaic cells, Wind turbine, hydro generators etc. can provide the needs like stability in power, grid efficiency improvement, increase the use of the Plug-in EVs, support customer in changing their energy usage patterns, by reduction in power consumption and saving money.

PROJECT BACKGROUND

The nation's economic growth depends heavily on reliability and eminence of its electric power supply. The demand on Global energy is expected to grow by 65% over the next 30 years subjected to three major factors:

- Population growth,
- Rate of Gross Domestic Product (GDP) and
- Energy intensification.

These things will be able to cause a significant increase in GHG emissions associated with climate change. Secured, reliable and affordable energy sources are fundamental for maintaining economic stability and development. Increasing energy demand rise a challenge to energy security poses increased dependence and reliance on markets of global energy. In particular in the industrialized world, holds an important and pro-active role in providing solutions to security of supply and to reduction of GHG emissions with economically feasible solutions. Achieving this transition, the power industry has only increased several challenges for the power system. Innovative power system architectures at various levels in power system involving both new technologies and new ways of managing the network to ensure balance fluctuations in energy demand and supply are incorporated.

In practical, renewable energy sources which continued to cultivate strongly in all end-use segments, delivering close to 19% of global electricity supply in 2011, and expected to procure 40% and 78% of the global power supply from all sources by 2040 and 2050 as per recent market policy. It will play an important role in advancing development by improving the access of millions to energy, whilst helping ensure energy security, and mitigating the existential risk of climatic change by reducing emission. In India the power market is characterized with poor Demand Side Management (DSM) and consequences on technical and non-technical aspects with response to lack of proper infrastructure and awareness. In order to overcome these preventable challenges, the innovative power system architecture with incorporation of RES can acknowledge reduction in line losses to overcome prevailing power shortages, achieve the reliability of supply, power quality improvement and its management, safeguarding revenues, preventing theft etc.

PROBLEM STATEMENT

With the growing demand of electrical power, Quality of Service (QoS) i.e. quality in the service and continuity of supply has been the utmost primacy for all major power utility sectors across the world, prior to the global market strategy. More power electronics is also a key technology to build the smart grid technology in an eventual way by adding new DC grids and AC Var sources at the T&D level, serve as backbones and additional stability pillars to existing grids. In addition it has inevitable benefits, Smart Grid technology does have some burgeoning issues in both technical and non-technical aspects. Researchers and power engineers are encroached to eliminate these key issues for the proper and sound implementation of the technology across a large network. Such approach is being initiated under the department of R&D in partnership with numerous world-class

institutes and multi-national companies in a due course of time.

PROPOSED METHODOLOGY

The proposed method integrates the renewable energy sources like wind, solar power 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.

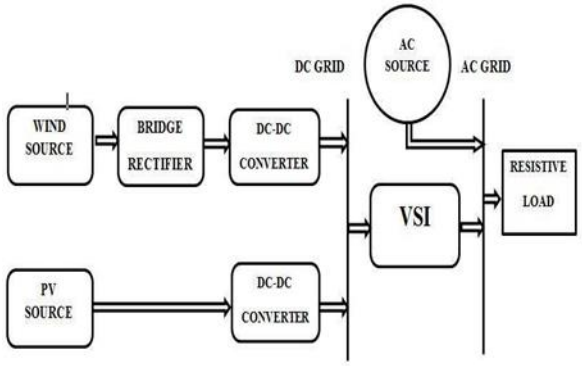

Fig 1. The Block Diagram of Proposed Methodology

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. The MATLAB model of the proposed model is shown as Fig. 2.

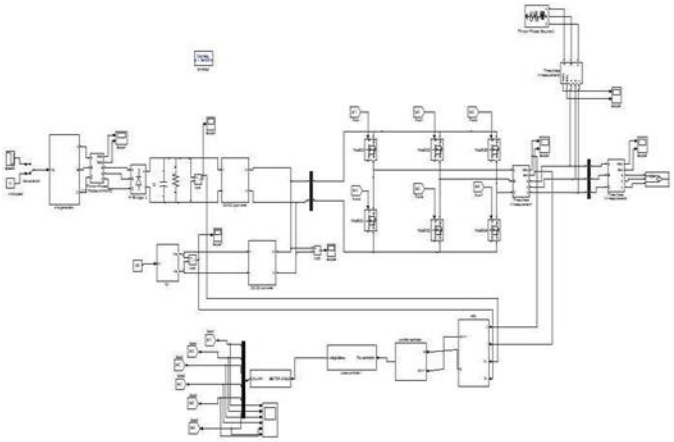

Fig 2. Proposed Simulink Model

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. In case if it fails, the load is supplied by the AC grid. These operations are performed with the help of Model Predictive Controller algorithm (MPC).

RESULTS ANALYSIS

The following are the output of simulation of proposed methodology. The output waveform of wind system shown in fig. 3 is a variable AC output of the simulation of wind system.

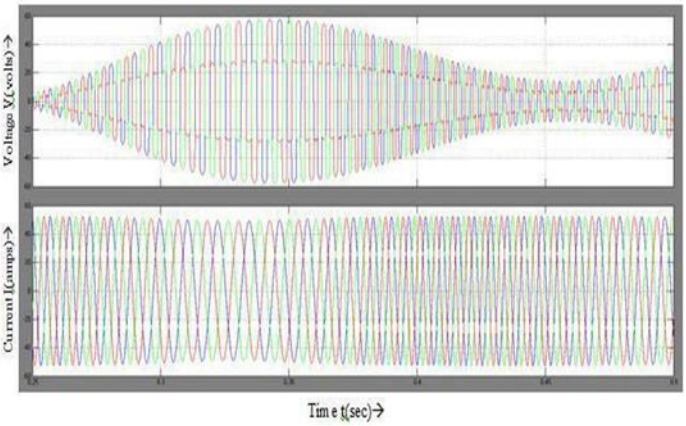

Fig. 3. The Output Waveform of Wind System

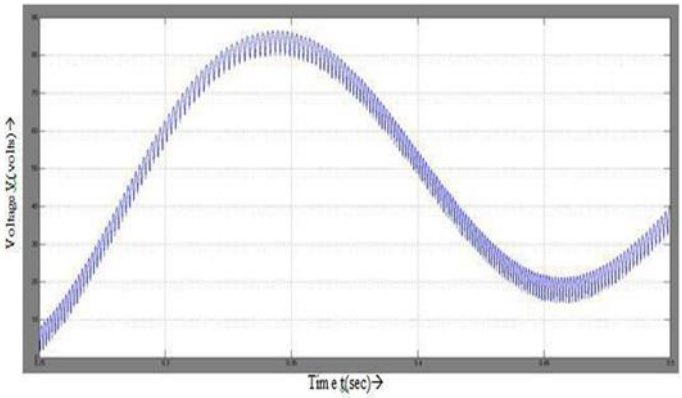

Fig. 4. Output of Wind System after Rectification

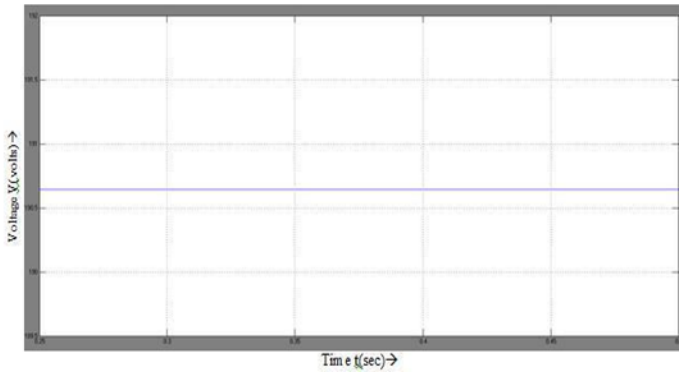

Fig 5. The Output of Solar PV panel source

The output of solar PV panel is shown by Fig. 5. The solar PV panel produces DC output which can be converted to AC by means of Inverter. The output waveform of AC source is shown as Fig. 8.The following is the output waveform of AC source i.e. the source from grid.

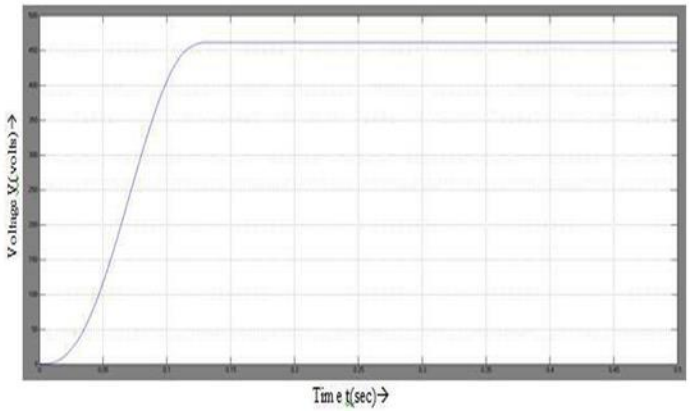

Fig. 6. The Output of DC-DC Converter

The output waveform of Renewable energy sources i.e. wind and solar system are shown as Fig. 7. This is the sum of the outputs of renewable energy sources.

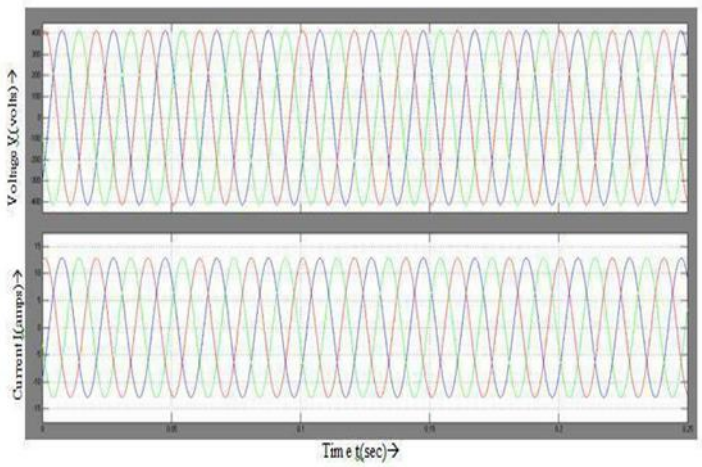

Fig. 7. Inverter Output of Renewable Sources

The output waveform of wind system after rectification is shown as Fig. 4. The wind system produces variable AC output, which is converted to DC by use of rectifier.

The output waveform of AC source is shown as Fig. 8.The following is the output waveform of AC source i.e. the source from grid.

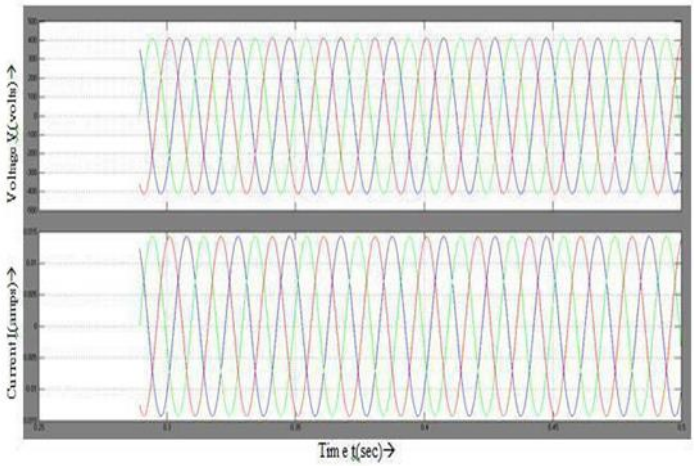

Fig 8. The Output Waveform of AC

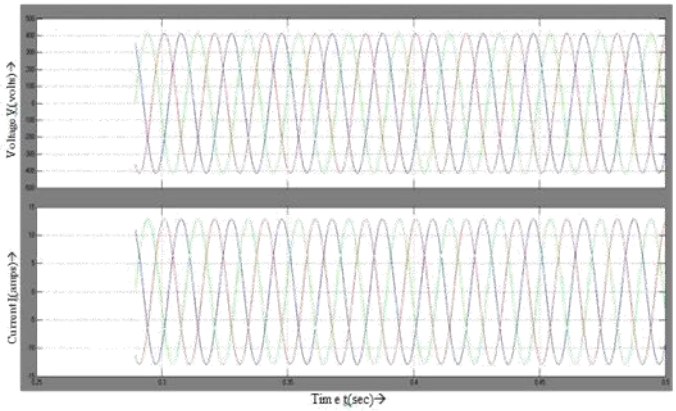

Fig 9. Result Waveform

The total output of the AC grid is shown by Fig. 9. Here the total output indicates that the sum of output from renewable energy and AC source. It can also be said that the waveforms of load demand.

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 add 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.

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.

FUTURE SCOPE

As the report only had pulled the grid connection requirement for wind power generation and Photo Voltaic (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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