Simulation of Integrating Solar Photovoltaic Energy Sources in Smart Grid applications

Bharathy Priya D\textsuperscript{1}, Dr. A. Sumathi\textsuperscript{2}

Research Scholar, Anna University, Adhiyamaan College of Engineering, Hosur, Tamilnadu, India

Professor and Head, Department of Electronics and Communication Engineering, Adhiyamaan College of Engineering, Hosur, Tamilnadu, India

ABSTRACT: Smart Grid is an electrical Grid that communicate with us to manage our electricity consumption by creating network of communications that will control computers automation. It helps in utilizing energy conversion, reduction in cost, increase in reliability and more efficient. In Smart Grid applications, Solar and Wind energy production play an important role in Integrating Renewable Energy resources. Smart Grid technology enables by adding Sensors and Software’s to the existing system that gives utilities and individual information to help them understand and react to changes quickly. Simulation results of solar photovoltaic energy systems are presented using MATLAB Simulink.

KEYWORDS: Solar Photovoltaic energy systems, Wind energy, Smart Grid, MATLAB Simulation

I. INTRODUCTION

Smart Grid is a modern electric power systems that used for communication network, sensors, automation. Smart grid is to promote active consumer participation and decision making as well as to create the operation environment in which both utilities and electricity users influence each other. Integrating modern digital electronics technology into the electrical power grid enables the utility to detect, monitor and respond digitally to any changes, thus making it a smarter version of the grid.

Benefits of Integrating Renewable energy system

Smart grid technology helps to Integrating both small and large facilities. Renewable Generation will reduces the need for investments in grid reinforcement infrastructure, that will controls and operational metrics. Distribution level facilities provide energy security to limit the extent of a system disturbance and allow for faster recovery, grid technologies such as Advanced Meter Infrastructure, Advanced Electricity Pricing, Demand Response and Distribution Automation Resource Forecasting, Smart Inverters, Distributed storage, Bulk power Technologies, also allow diverse and changing mix of Renewable energy system on the grid.[1]

Necessary for Integrating Renewable Energy Sources

- Advanced sensing systems, communicating and controlling method functionalities in the power grid’s operation, for the purpose of enhanced efficiency, reliability, security and reduce in emission.
- Powergrids allows to support a greater percentage of variable renewable energy resources.
- More effectively and lowcost.
- As integrating renewable energy system increases, more advanced control system will be required to maintain reliability.[2]
- Reduce barriers in integrating renewable energy resources.
II. SMART GRID SOLAR PV RENEWABLE ENERGY SYSTEMS

Renewable energy resources and distributed generation systems are receiving support and their shares in generating electricity are rapidly rising. Lots of sensors and controls are used to re-route power to other power lines that is required from renewable energy resources, so that power can be transported to a greater distance whenever it is needed. Smart grid delivers electricity from suppliers to consumers using digital technology through control automation continuous monitoring and optimization of distribution system in order to save energy, reduces consumer cost and improve reliability. Smart Grid technology is to provide flexibility that need to integrate variable generation in characteristics of renewable resources such as Wind or Photovoltaic.

Solar Photovoltaic Smart Grid System

The Integration of systems into the electrical power grid with several technical problems like instability, energy quality degradation, signal parameter fluctuation and mismatch between loan supply and demand. Integrating decentralized renewable energy generators in co-generation seems to be the backing solution for the above stated problem.

Interleaved Dc-DC converter reduce the ripples in PV current without requirements of sizable or high switching frequency. The DC voltage on the inverter side of the DC-DC converter is normally maintained to be constant by the inverter control. The MPPT algorithm is used to find continually a PV array DC voltage which extracts the most power from the PV array while the cell temperatures and operating conditions of the module change. In P&O method, the terminal voltage of the PV array is perturbed in one direction and if the power from the PV array increases, then the operating voltage is further perturbed in the same direction. Filter is placed at the output to minimize harmonics fed into the power system. In some designs a transformer is also employed at the output of the inverter to ensure no DC is injected into the grid.

![Block Diagram of Solar PV Grid System](image-url)
Functionalities of Smart Grid
The main functionalities of Smart Grid in Renewable energy systems are

- Low cost reliable and quality with energy supply that can be archived through peak demand management, demand response control (with smart meters/AMI) and solar roof tops.- From the consumer perspective of view
- Customer satisfaction with a margin of profit for continuous improvement of services for uninterrupted and secured energy delivery, that can be achieved by reducing energy losses, improving metering, billing and collection (MBC), outage reduction, efficiently using the asset (with AMI/DMS/OMS and IT Systems)- From the Distribution perspective of view.
- Reliable and quality and secured generation and transmission to end customers through /Service Providers, that can be achieved using efficient energy dispatch systems, mix of generation (conventional and renewable)(SCADA/EMS, WAMPAC/, IT system)- From the Transmission and Generating companies perspectives of view.

Features of a Smart Grid Technology

Figure 2 shows the key features of Smart Grid Technology. The key options of Grid technology are as follows:

- Enables participation by shoppers.
- Enables new product list, services and markets.
- Anticipates and responds to system disturbances in an exceedingly self-correcting manner.
- Operates resiliently against physical and -attack and natural.
- Provides power quality that meets a range of needs required by our new digital economy.
- Accommodating all generation and storage Integrating systems, monitoring merging, controlling, protection, maintenance, EMS, AMI etc.
- Having Plug-in and Play system features for work equipment and ICT based solutions.

Figure 2: Smart Grid Technology Features
III. LITERATURE SURVEY

Survey of integrating renewable energy system in smart grid application based on the characteristics as follows: merits and demerits of smart grid concept methods, optimization of renewable energy in smart grid system, pricing and forecasting strategy are as follows:

- In this paper, discussed about smart grid concept and applications with respect to designing, size and optimal placement of the energy mix, small scale test implementations in order to choose the best strategy to its implementation, voltage stability, overall system integration rate, global losses and many other factors which help economical and technical [7].
- Discussed key features of the smart grid by performing the smart demand response dispatching, survey of potentials and benefits when enabling technologies such as energy controllers, smart meters and communication systems. Implicitly promotes the reliability and sustainability of the power supply and lowering the peak demand.[5].
- Discussed solutions of the connection and the integration of renewable energy sources in the electric grid and their architectures.[3]
- Smart grid application for renewable energy distributed generation, merits and demerits of renewable energy distributed generation is discussed in this paper.[12]
- Modeling of PV system, controller method used in PV and simulation of grid connected solar system is discussed in this paper[2].
- Discussed the issues of renewable energy sources from engineering’s, energy supply and related environmental problems like global warming, health and economic perspectives [6].
- Improved power grid systems such as smart infrastructure system, the smart management system, and the smart protection system are discussed in this paper [8].
- Discussed the tools that are available for PV system design and sizing, problem arising from the system sizing and PV contribution to the load [13], [14].
- Discussed that the renewable energy sources provide reliable and comparatively low cost electricity services[9]
- Discussed about the allocation of renewable energy sources in smart grid system and optimal reactive power injection in order to improve the voltage stability of the system and the penetration level of renewable energy sources.[10]

IV. MATLAB SIMULINK RESULTS

Figure 3. Shows the Matlab Simulink circuit for grid connected solar photovoltaic systems for three phase home appliances. Figure 4. Shows the Simulink result of Inverter output voltage which is connected to the Grid for energy distribution systems such as Industry, home etc. requirements.
Figure 3: MATLAB Simulink circuit for Grid connected Solar Photovoltaic system

Figure 4: Simulation results for output voltage of the inverter.
This paper discussed the key role of smart grid technology in renewable energy system which has a demanding and role in the future efficient power generation and distribution. Smart Grid technology used in various energy distribution systems, development in low cost smart meters. Integrating renewable energy sources is expected to be significant influence on the operation of the powersystem for sustainable energy in future work that involves - Distributed renewable interconnection technologies with advanced practicality. Integrating of renewable energy sources with load and storage, Electric power system technologies, controls and operations that enable high penetration of distributing renewable energy sources, models for renewable energy systems that allow them to be included in various planning and analysis tools.

### REFERENCES


[11] Steve G , Kelly Crandall, “chapter 1-Smart grid is a lot more than just technology”, science direct, smart Grid, integrating Renewable, Distributed and efficient energy, pp3-28, November 2012


### V. CONCLUSION