

PV Energy to Smart Microgrid System Based on Reactive Power Sharing using DC-DC Interfacing Converter

Sanjeev Kumar^{1*}, Prof. Ashish Bhargav²

M. Tech. Scholar, Department of Electrical Engineering, Bhabha Engineering Research Institute, Bhopal¹

Assistant Professor, Department of Electronics and Communication, Bhabha Engineering Research Institute, Bhopal²

Abstract: - Currently the utilization of Renewable Energy (RE) as a source of power generation is increasing. Penetration of renewable energy source on a large scale will greatly affect the quality and reliability of electric power systems, due to the intermittent renewable energy sources. Therefore it is necessary to develop a technology to compensate the intermittent energy resources. The smart grid or microgrid technology has the ability to deal with this intermittent characteristic especially while these renewable energy resources integrated to grid in large scale, so improved the reliability and efficiency of that grid. These sources modeling and simulation is performed for optimal power flow based on power flow chart for demand-side management. The designed system fulfills realistic operation for the power system, based on fundamentals. The constraints are lively for synchronizing of voltage, frequency and waveform at the PCC for grid integration with RES. Also, these are beneficial for the switching of protective devices through remote monitoring and control. Finally, with these features, the developed system testing are conceded for linear, nonlinear and dynamic loading. These results are proximate to the specified tolerance at different universal morals.

Keywords:- Renewable Energy Sources (RES), Photovoltaic, Battery, Smart Grid, Microgrid

I. INTRODUCTION

Indonesia has high renewable energy potential. Based on data from the Ministry of Energy and Mineral Resources (KESDM), Indonesia's renewable energy potential for electricity reaches 443 GW, where solar energy is the greatest potential, namely 4.8 KWh m⁻² or equivalent to 207 GWp, but only 78 MWp has been utilized. While the potential for wind energy at wind speeds of more than 4 m s⁻¹ is 60 GW with an installed capacity of 3.1 MW [1, 2], while the national electrification ratio until September 2019 has only reached 98.86 %, where the lowest electrification ratio is mostly in rural areas rural areas that are difficult to reach [3, 4]. The conventional grid system is arguably outdated, in order to catch up with the fast growing demand for electrical energy. Global climate change is getting worse every year, this makes electric power industry scientists competing to create innovative systems to replace the existing electricity grid. Development of renewable energy is one of the seven national focuses and is included in one of the national research agendas. On the other hand, the use

of a system that implements a smart or smart grid system is a promising development in the future, hence it can increase energy use effectively. In a smart grid system, all variables from the power plant to the end user side will be monitored and controlled continuously. This means that all systems must have complete control [5–8].

The technology that is being intensively developed now is the Smart grid or smart power grid system, according to the United States Department of Energy (DoE), that the smart grid is an integration of sensing technology, control methods, and communication on the existing power system. From this definition, one of the main parts of the Smart Grid system is to have a functioning communication system, so that all variables from the generation side to the end user side can be monitored in real-time and then a communication medium that can send real-time data is required. One of the communication media commonly used is the internet. Also, the communication technology that is being developed intensively at this time is the Internet of Things (IoT), where this system allows all things to be connected together in internet services so that it allows users to monitor in both directions [9].

Due to the uncertainty of the availability of wind and solar energy, one of the most vital factors in the optimal size of a renewable energy-based smart microgrid system is the reliability of the system built to meet energy load requirements. The data collected must be compatible with providing sufficient resolution. The main contribution of this paper is to use a technical assessment of energy availability in relation to the power generated to find out the performance of PV panels, wind turbines, battery storage, and power imported from the grid to the system which will ensure a reliable energy supply, as well as the technical feasibility of smart microgrid system.

II. SOLAR PV STAND-ALONE SYSTEM

A simple *stand alone PV system* is an automatic solar system that produces electrical power to charge banks of batteries during the day for use at night when the suns energy is unavailable. A stand alone small scale PV system employs rechargeable batteries to store the electrical energy supplied by a PV panels or array.

Stand alone PV systems are ideal for remote rural areas and applications where other power sources are either impractical or are unavailable to provide power for lighting, appliances and other uses. In these cases, it is

more cost effective to install a single stand alone PV system than pay the costs of having the local electricity company extend their power lines and cables directly to the home as part of a grid connected PV system.

A stand alone photovoltaic (PV) system is an electrical system consisting of an array of one or more PV modules, conductors, electrical components, and one or more loads. But a small-scale PV system does not have to be attached to a roof top or building structures for domestic applications, they can be used for camper vans, RV's, boats, tents, camping and any other remote location. Many companies now offer portable solar kits that allow you to provide your own reliable and free solar electricity anywhere you go even in hard to reach locations.

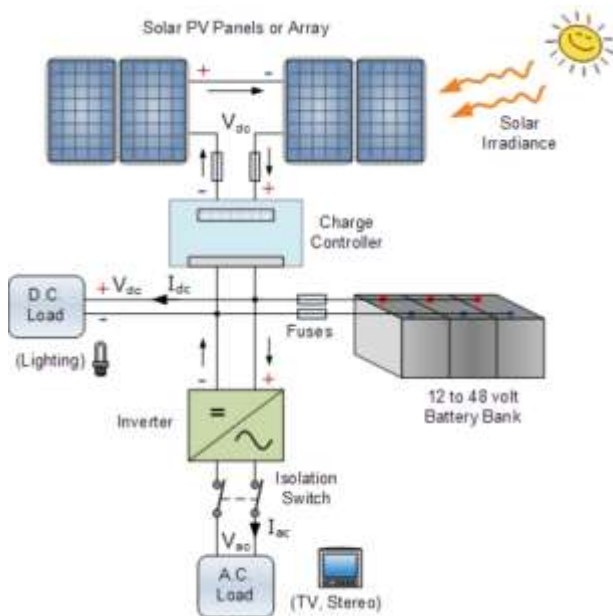


Fig.1: Solar PV stand-alone power system

III. SMART GRID

Microgrids are modern, small-scale versions of the centralized electricity system. They achieve specific local goals, such as reliability, carbon emission reduction, diversification of energy sources, and cost reduction, established by the community being served. Like the bulk power grid, smart microgrids generate, distribute, and regulate the flow of electricity to consumers, but do so locally. Smart microgrids are an ideal way to integrate renewable resources on the community level and allow for customer participation in the electricity enterprise. They form the building blocks of the Perfect Power System.

Here at the Galvin Electricity Initiative's Microgrid Hub, you will find a comprehensive set of resources on microgrids, collected from our partners and from across the web. Use the navigation system at the left to browse through all of our microgrid materials, and if you have suggestions for additional content, please let us know. If you are a member of the media seeking

information on microgrids, be sure to view our press kit in addition to the other resources.

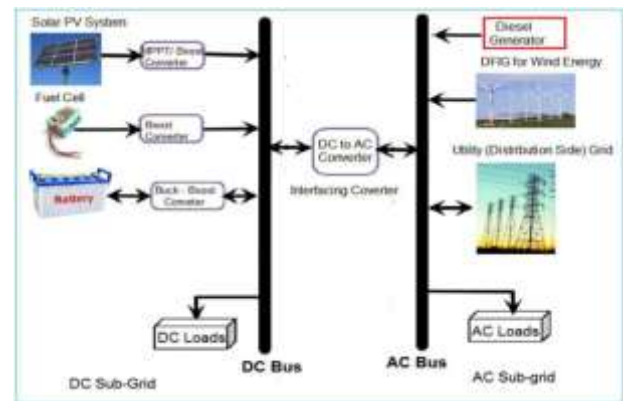


Fig.2: RES for grid integration

As climate change results in more extreme weather, power outages will become more common. An area like Puerto Rico, which hurricane season often affects, is a prime example of where microgrids should integrate. Islands and rural areas can stop relying on the larger power grid as their only source of electricity and instead operate on their own when they need to.

Cities are also starting to use this technology, though. Brooklyn, for instance, started a smart microgrid initiative to generate local solar energy. With parent company LO3 Energy leading the initiative, Brooklyn is looking to provide smart microgrid energy to as many residents as possible. In a city, this step is new — energy typically comes from standard grids that use fossil fuels or natural gas. Now, smart microgrids are changing that dynamic.

The use of smart microgrids also helps to mitigate any grid disturbances during outages. This mitigation helps with energy storage, which can then reduce the cost of electricity capacity for any location that uses these grids. As the microgrid's smart servers optimize generation, it can disperse the energy efficiently to all buildings within its reach.

Microgrids will continue to expand with these benefits. As it reaches remote or distant locations, more cities will start to pick up on the necessity. With fewer outages come fewer repairs. With more energy efficiency comes more sustainability and more money saved.

IV. METHODOLOGY AND RESULTS

The RES with modern authenticity is imparting for grid integration as a portion of a smart grid. In this chapter, expertise for RES like solar PV, wind energy, along with storage battery (fuel cell) with advanced features of grid integration is applied for monitoring and control of power system parameters. The system behavior is controlled by DSP as per the requirement of load and in which energy is supplied through RES with grid interconnection.

Technologies have been developed to harness this energy to fulfill this demand. These sources were

individually used to supply the load. Each source has its own set up to harness energy convert into electricity and supply to the load. But the drawback of such a method is that they are not reliable and load get often interrupted which causes varieties of problems. To overcome the discussed difficulties the DSP controller has been adopted to take into consideration various energy sources. These can generate and supply an uninterrupted approach through a designed three-phase inverter. The algorithm has been developed for transit between the energy sources as per their availability such as harness the maximum amount of energy generated from RES.

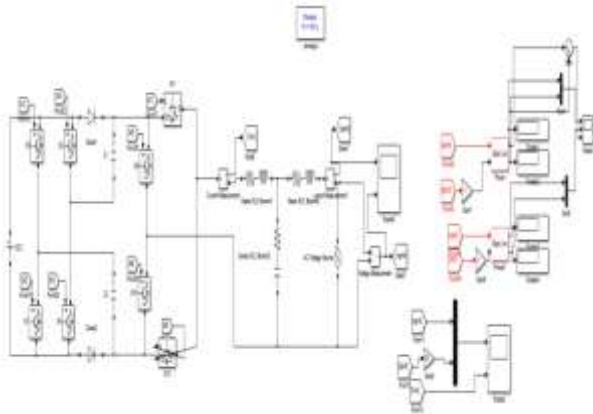


Fig.3: Simulation Model of Proposed Methodology

A grid connected photovoltaic system is becoming increasingly important for the solution in renewable energy. This work proposed as a PV to grid connected system.

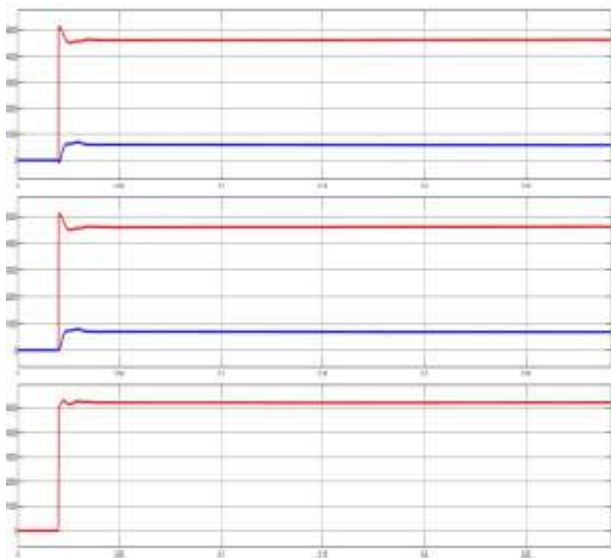


Fig. 4: PV power and current with respect to voltage

This work processed in two stage where, stage one is the DC-DC boost converter with MPPT (Maximum power point) tracking and second stage is the five-level inverter. For this stage proposed a new five-level inverter topology which is reduce the switched count and other parameters. After this stage levelled output passes

through designed LCL filter which gives AC output and connected to grid.

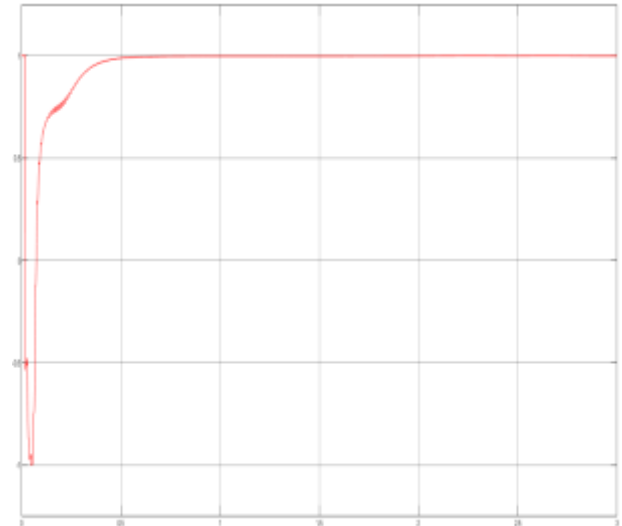


Fig. 5: Unity Power factor at the grid side

Power quality describes the importance of the issues found in any electrical system; these issues are depended on the perspective of the end-user network. But it is repeatedly detected that there is a deviation in sinusoidal voltage and current waveforms. This distortion is nothing but the harmonics and the reason for the concern at different stages in electrical power systems.

V. CONCLUSION

The smart grid distribution system developed through power electronics will support to utilize RES and operate in an automated way. The whole configures both communication network and power line network has successfully achieved in session to work in the mode of master-slave towards the fulfillment of dynamic loading on demand-side management.

Hence it is concluded that the proposed designed and developed pilot model shows consistency in the results and having the evidence of successful integration of RES into the grid thus called Smart Grid. It is expected that when a large scale RES integrates is future of the world large scale development of this pilot model will be, an integrated part for all smart grid operation purposes. The simulation results shows that the standard deviation of the utilization factors of the inverters with the proposed approach is significantly less than that achieved with conventional Proportional Nominal Apparent Power Sharing (PNAPS) method.

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