Review of Micro-Grid With Simultaneous DC & AC Outputs

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Abstract- *Nowadays with inadequacy in electrical energy & continuously enlarging fuel cost, it leads to investigation on the Non-Conventional energy sources. This paper presents a stand-alone hybrid Solar-Wind energy system for applications in isolated areas. The wind & solar system are connected to the common load through Boost Derived Hybrid Converter. The modeling and simulation of the hybrid system are done using MATLAB /SIMULINK. The performance of the hybrid system is evaluated under different speeds & different irradiation levels. Simulation results show that the proposed hybrid system has the potential to meet the demand of an isolated area such as Islands, etc.*

Keywords- Non-conventional energy, Hybrid energy system, Boost-Derived Hybrid Converters, Microgrid, etc.

I. INTRODUCTION

In this paper, wind and solar plants are designed to make a Micro-grid. For the local use of remote areas, Micro-grid is a good solution. As the need for energy is increasing drastically day by day, Microgrid is a good solution to meet the energy demand. The microgrid is a small scale grid that can operate separately or with other small power grid. Micro-grid is used to generate, distribute and control power in the small section. Micro-grids are designed to provide continuous power and balance customer local demand.

In the year 2012, 44.8 GW of new wind energy conversion systems were installed worldwide. The trends have been towards increasingly larger turbine sizes, culminating in the installation of off-shore wind parks that are not located too far from load centers. The energy system proposed in the paper seeks to address both issues related to electricity and transportation sectors. One potential solution to this is hybrid, Micro-grids that can be either vertically integrated with high-rise buildings as frequently encountered in urban areas [1].

In this paper, the Hybrid Converter is also designed. Hybrid Converter work as both Inverter & Chopper. Working with Hybrid Converter depends on the switching of MOSFET. The input of Hybrid Converter is DC and it gives AC & DC as output with the help of Inverter and Chopper and then it is supplied to the loads.

II. METHODS AND MATERIAL

BLOCK DIAGRAM EXPLANATION:

1) SOLAR POWER PLANT: Solar energy is one of the cleanest and greenest technologies. Although solar energy is led by a thermal power plant. It is expected that solar energy in the World will prove to be the single largest source of power. Therefore solar energy plays a dominant role in the Indian Power Scenario due to various benefits it offers over other non-conventional sources.

On average Country has 300 sunny days a year & received annual radiation of 1600-2200 kWh/m2 translating into an annual estimated potential of 6 billion GWh [1].

To harvest solar energy, the most common way is to use photo-voltaic panels which will receive photon energy from the sun & convert to electrical energy. Solar technologies are broadly classified as passive and active. Solar depending on the way they detain, convert & distribute solar energy. Solar energy is one of the cleanest and greenest technologies. Although Solar Energy in India is led by the solar thermal power plant, it is expected that solar PV in India will prove to be the single largest source of power in the times to come. It is thus no surprise that Solar Energy is & will continue to play a dominant role in the Indian power scenario due to various benefits it offers over renewable sources.

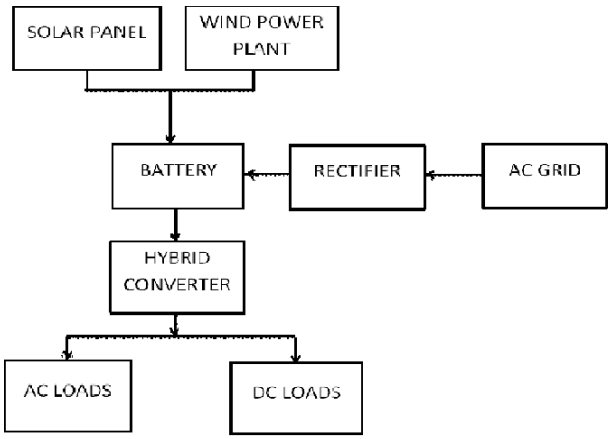

Fig No.:1 Block diagram of Micro-grid with simultaneous AC- DC outputs

***2) WIND POWER PLANT*:** A wind turbine is also called a wind energy converter; it converts kinetic energy to electrical energy. The manufacturing of wind turbines is in a wide range. Wind turbines are manufactured in two types for the vertical axis and horizontal axis. For battery charging or for power traffic warning signs the smallest turbines are used. For making a contribution to domestic power supply larger turbines are used. The array of large turbines is called wind farms. This became an important source of renewable energy and this is used by many countries to reduce the use of fossil fuel which is limited. Wind turbines can rotate either in the vertical direction of horizontal direction as per their construction

3) BATTERY STORAGE: Battery storage stored energy which generates at one time for use later whenever there is a need for energy. A device in which stored energy is known as a battery or accumulator. Battery storage power stations use for low leveling storing electrical energy at times of low demand for use during peak periods. It is designed for the purpose of discharging to a lower capacity between 50%-80% than a conventional battery. The deep cycle of our battery is C10.

Lithium-Ion solar batteries are the ideal match for solar energy storage needs. We have a Solar energy system with energy storage, the power generated when the sun is out. If the existing energy storage system for our solar system is inefficient. Typical Lead Acid Batteries used for solar energy storage have many problems including they are almost never adequate to handle generated energy storage needs, do not efficiently and effectively store generated power, do not last long, are they are very heavy and made of toxic material.

Energy is of various types, which include radiation, chemical, electrical potential, gravitational potential, latent heat, elevated temperature, and kinetic energy. There are some examples of energy storage that are rechargeable battery which is used to operate mobile phones, fossil fuel, for example, coal and gasoline which stored ancient energy, food stored chemical form of energy. There are some applications of battery storage; they are mills, homes, grid electricity and power stations, air conditioning, transport, electronics.

4) BOOST DERIVED HYBRID CONVERTER (BDHC): The foregoing system has various types of loads i.e. DC and AC loads, which are capable of being interfaced with different conventional and non-conventional energy sources. This interfacing is achieved by means of different electronic converters. With this in mind, to drive DC and AC loads concurrently from single DC input in a single step, a new technology of Boost Derived Hybrid Converter provides simultaneous DC and AC to loads from a "Single Switch Controlled Boost Converter". The hybrid converter requires a lesser number of switches to provide AC and DC output with increased reliability.

Voltage source inverter (VSI) in the hybrid converter would involve the case of deadline circuitry to prevent shoot-through. In addition, due to electromagnetic interference or other spurious noise, miss gating turns on-off of inverter switches may take place, resulting in damage to switches. Impedance Source Inverter (ZSI) reduces the problem of shoot through interference.

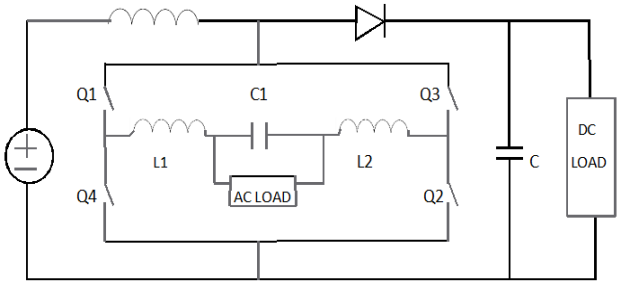

Fig No.2: Hybrid Converter

The Switched Boost Inverter (SBI), is Hybrid Converter topology, which can achieve similar advantages as ZSI with a lesser number of passive components and supply simultaneously AC as well as DC loads.

A. Operation of BDHC:

The operation of BDHC undergoes the following interrogation:

(i) Boost operation is controlled by the DUTY CYCLE (D_{st}).

(ii) Inverter operation is done by MODULATION INDEX (M_a).

B. Operating Principle:

The schematic diagram of BDHC is as shown in the figure. If the current through starting inductor (L) is maintained greater than zero, then the circuit will operate in the mode of continuous conduction.

In this new BDHC technology, the controlling of AC output has been achieved by employing a modified scheme of Sinusoidal Pulse Width Modulation (SPWM)

BDHC can be operated in three modes:

a. *Shoot-through Interval (STI*): This interval is as shown in Figure (i). This interval has been achieved by Gating ON each switch of a particular leg (either Q1-Q4 or Q2-Q3). And the duty cycle (D_{st}) of BDHC is decided on the basis of the duration of a shoot-through interval [4]. The diode D is reverse bias during this period. The inverter output current circulates within the bridge network switches. Thus, BDHC allows for additional switching states [4].

b. *Power Transfer Interval (PTI):* This interval is as shown in Figure (ii). During this interval the current is flowing through the opposite leg (Q1-Q2 or Q3-Q4) of BDHC via AC load in the converter circuit, the interval of power transfer is attained. During this, the diode D starts conducting and the DC output voltage is obtained [4].

c. *Zero Interval (ZI):* This interval is as shown in Figure (iii). This interval occurs when the inverter current circulates among the bridge network switches in not sourced. The diode D conducts during this interval.

During STI we get only DC output only when the capacitor is initially charged. In PTI we get both the outputs simultaneously. And during ZI we get only DC as output.

***5) POWER FROM AC GRID*:** An electrical grid is also known as the power grid. It is an interconnected network that starts from generating station called as producers and ends at the consumer. It consists of generating station that generates electric power, electrical substation for the purpose of the step up and step down of voltage, high voltage transmission lines which carry power from sources to demand center, distribution lines which gives the power to the individual consumer.

6) AC & DC LOADS: An AC load is any device that receives alternating current electrical power from a source in an electrical system. And DC load is any device that receives direct current electrical power from a source in an electrical system.

III. RESULTS AND DISCUSSION

The solar power plant is modeled and simulated using MatlabR2018Ra/Simulink. The integration of solar panel & wind plant, as a dc input source has been implemented and verified in MATLAB R2018a/Simulink to drive DC as well as AC loads. The analysis of different types of load is done in MatlabR2018a/Simulink.

IV. CONCLUSION

Micro-grid is an extension of the main grid providing on-site generation capable of fulfilling its local load demand. It is concluded that micro-grid is to be added to the main grid to increase the reliability, improve power quality, avoid the use of depleting fossil fuels, and reduce greenhouse emissions. The micro-grid is connected to islanded or isolated and grid-connected modes. Depending upon the requirement these renewable energy sources are connected to the main grid or operate separately. As renewable energy sources are intermitted in nature, energy storage schemes are required to store the energy. It is desirable to develop reliable micro-grid operation and effective energy storage algorithms which would enhance the performance of hybrid power systems.

REFERENCES

[1] Nisarkumar R Dave and Manish N Sinha “Simulation of Solar and Wind Power Plant Using MATLAB for Micro-Grid”, Kalpa publications of Engineering, vol.1, pp 208-213, 2017

[2] Lie Xu, Senior Member,“ Control and operation of a DC j Microgrid with Variable Generation and Energy Storage”, IEEE Trans. Power Delivery, vol.26, NO.4, Oct 2011.

[3] Prabal Pratap Singh, Subhash Chandra, Ashish Tiwari, “Study and Implementation of Boost-Derived Hybrid Converter With Simultaneous DC and AC Outputs,” IEEE Trans. On developments in Control, Automation & Power Engineering, Noida, India, May 2018.

[4] Olive Ray “Boost-Derived Hybrid Converter with Simultaneous DC and AC Outputs,” IEEE Trans. On Industry application, vol.50, NO.2, March / April 2014.