A Hybrid Solar -Wind Power Generation System : Challenges and Prospects

[1]Sandeep Ushkewar, [2]Jagdish More

[1,2,]Assistant Professor
[1,2]Electrical Engineering Department,
[1,2] SVKM's Institute of Technology, Dhule, India

Abstract : The extension of the grid cannot currently reach the rural areas where there are no electrified residents since the link is not economically viable nor supported by the major players. Additionally, conventional energy options, such fuel-based systems, are gradually being dropped from rural development agendas due to the rise in oil costs and the intolerable effects this energy source has on its consumers and the environment. Using "hybrid power generation using solar and wind energy," this issue can be solved.

IndexTerms **– Solar Energy , Wind Energy , Converters**

I. INTRODUCTION

Many are looking at sustainable energy alternatives to protect the planet for future generations as worry over global warming and the depletion of fossil fuelsupplies grows. Other than hydropower, solar and wind energy have the most potential to satiate our energy needs. Wind energy is capable of producing significant amounts of electricity when used alone, but it is highly unpredictablebecause it might appear one minute and disappear the next. Similar to this, solarenergy is there all day long, but the amount of solar irradiation varies due to the sun's intensity and the unpredictability of the shadows created by clouds, birds, trees, etc. Both wind and photovoltaic systems have the inherent flaw of being intermittent, which renders them unstable. Nevertheless, by merging these two sporadic sources and by The efficiency and dependability of the system's powertransfer can be greatly increased by using multi-phase power tracking (MPPT) algorithms [1-2]. The alternative energy source can make up the difference if onesource is unavailable or not enough to fulfil the demands of the load. There have been numerous hybrid wind/PV power systems proposed and explored in works. To perform MPPT control for each of the renewable energypower sources, the majority of the systems described in the literature use a separate DC/DC boost converter coupled in parallel in the rectifier stage. It hasbeen recommended to use a more straightforward multi-input structure to combine the sources from the DC-end and yet achieve MPPT for each renewable energy source. The suggested construction combines the buck and buck boost converters. Systems described in the literature need passive input filters [3-4].

II. SOLAR WORKING PRINCIPLE

To understand how solar panels transform solar energy into electrical energy, wealso need to understand how solar cells function. The devices that convert solar energy into electrical energy by utilising the photovoltaic effect are known as solar cells or solar photovoltaic cells. Numerous real-time applications, including remote telecommunication systems, street lighting systems, residential lighting systems, and railway signalling systems, utilise these cells.A silicon P-type layer that is in contact with a silicon N-type layer makes up a solar photovoltaic cell. The N-type substance's electrons permeate into the P- type material. The N-type material has more electrons than the P-type materialdoes because its holes can accommodate more electrons. In light of the sun energy's influence, these As a result, the P-N junction is where these electrons and holes combine. This combination results in the creation of a charge and an electric field on either side of the P-N junction. This development of an electric field leads to the creation of a system that resembles a diode and encourages charge flow. This is known as drift current, and it balances the diffusion of electrons and holes. The depletion zone, also known as the space charge region,is where this drift current occurs since it lacks mobile charge carriers there. Thus, these solar photovoltaic cells operate as reverse bias diodes at night or in complete darkness. In most cases, the voltage of a solar panel's open circuit (when the battery is not attached) is higher than the voltage of the panel itself. Consider a 12 volt solar panel, for instance, which, in good sunlight, may provide an output voltage of roughly 20 volts. However, once a battery is connected to the solar panel, the voltage lowers to 14 to 15 volts. Silicon and other commonly used semiconductor materials are utilised to make solar cells. An array of solar panels is used in the solar photovoltaic (SPV) effect, a processthat transforms solar energy into DC electricity. Battery storage, direct DC loadfeeding, or indirect AC load feeding are all possible uses for this DC electricity.with the use of an inverter that converts DC power to 120-volt AC power [3].

III. WORKING OF WIND POWER PLANT

One of the renewable energy sources, wind energy, can be used to power generators and wind turbines to produce electricity. There are several benefits to employing wind energy, including the ability to generate electricity with wind turbines, generate mechanical power with windmills, pump water with wind pumps, and more. Electricity can be produced as a result of the large wind turbines rotating with the wind. When a generator is connected to the electricity grid, the minimum wind speed required is known as the cut in speed, and when it is disconnected from the grid, the highest wind speed required is known as the cut off speed. Typically, wind turbines operate in the speed range between the cut-in and cut-off speeds [5-6].

a. Wind Turbine

A wind turbine is a fan with three blades that rotates as a result of wind flow, and its axis of rotation must coincide with the direction of the wind flow. A gearbox is referred to as a high-precision mechanical system since it is utilised to mechanically shift energy from one device to another. The two most common forms of wind turbines are those with a horizontal axis and those with a vertical axis. There are more types of wind turbines. The illustration depicts the many components of the wind turbine generator system.

b. Wind Turbine Generator

Because a wind turbine is connected to an electrical generator, the latter is known as a wind turbine generator. There are various types of wind turbine generators, and these generators can be directly connected to the electrical grid, loads, or batteries depending on a variety of factors. There are typically four categories.

A.The squirrel cage induction generator can be used to supply AC or DC loads by using the proper converters, or it can be linked directly to the power grid.

B.The electrical grid is connected to a generator and an AC to DC to AC converter.

C. A wound rotor induction generator with rheostat-controlled speed that can be used to maintain desired outputs and is connected to the power grid or batteries.

D. A power grid-connected twin feed induction generator whose speed may be adjusted using back-to-back converters

DFIG double fed induction generator with a wound three phase stator and rotor. Due to the three phase AC signal provided to the rotor windings, an AC current is induced. The rotor begins to rotate as a result of the mechanical force generated by wind energy, creating a magnetic field. The frequency of the AC signal delivered to the rotor windings and the rotor speed are proportional to one another. AC current is created in the stator winding as a result of a steady magnetic flux travelling through them.

IV. WORKING OF HYBRID SOLAR AND WIND POWER PLANT

Wind and solar energy are complementary to each other, which makes the system to generate electricity almost throughout the year. The main components of the Wind Solar Hybrid System are wind aero generator and tower, solar photovoltaic panels, batteries, cables, charge controller and inverter [7].

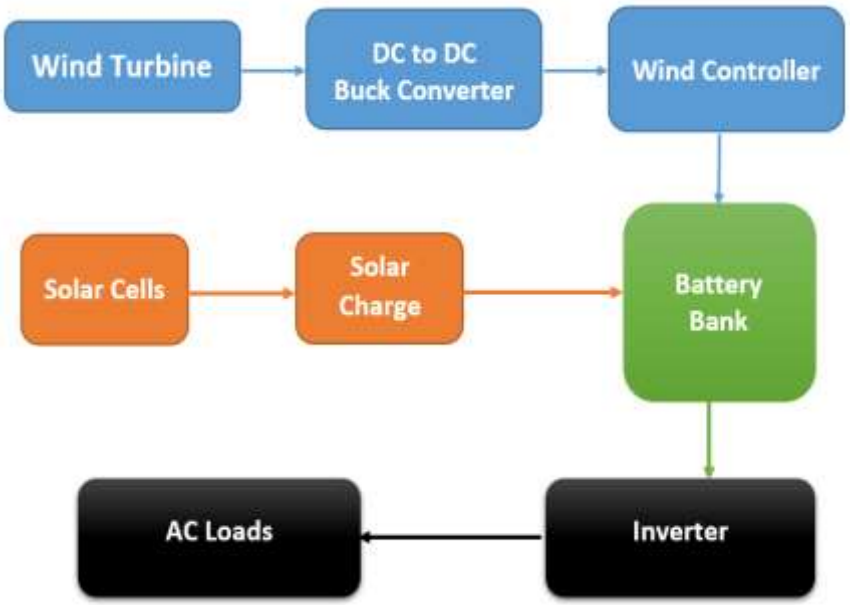

Fig. 1 Block Diagram of Solar and Wind Hybrid System

V. Conclusion & Future Perspectives

Currently, one of the best options for supplying electricity in dispersed locations or at specific distances from the grid is renewable energy, if not the only one. Indeed, by improving the security of the energy supply, reducing greenhousegases and other pollutants, and by creating local employment that improves overall social welfare and living conditions, renewable energy sources are already helping to realise significant economic, environmental, and social goals.In order to provide "high quality" community energy services to rural areas at the most affordable price, hybrid systems have proven to be the bestalternative optimum social and environmental advantages at the lowest possible cost. Infact, developing nations can reduce their CO2 emissions while boosting consumption due to economic growth by utilizing renewable energy.

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