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A Review on Solar, Wind & Grid Connected Fact Device Design and Noise Estimation

Shubhanshu khare, Prof. A. K. Sharma
Department Control system (Electrical),
JEC, Jabalpur,MP,India

Abstract- The world is witnessing a change-over from its present centralized generation to a future with greater share of distributed generation. Hybrid energy systems are inter-connected with wind power, photovoltaic power, fuel cell and micro-turbine generator to generate power to local load and connecting to grid/micro-grids that decrease the dependence on fossil fuels. The hybrid system is a better option for construction of modern electrical grids that includes economic, environmental and social benefits. An overview of different distributed generation technologies has been presented. This paper puts forward a comprehensive review of optimal sizing, energy management, operating and control strategies and integration of different renewable energy sources to constitute a hybrid system. The feasibility of the different controllers such as microcontroller, proportional integral controller, hysteresis controller and fuzzy controller are presented. The controller is a closed loop feedback mechanism used for power regulation which achieves zero steady state error and the output signal generated from the controller produces desired output response.

Keywords- Distributed generation, Renewable energy sources, Energy management system, Superconducting magnetic energy storage, Maximum power point tracking technique and photovoltaic.

I. INTRODUCTION

Rapid depletion of fossil fuels has necessitated an urgent need for alternative sources of energy to cater the continuously increasing energy demand. Another key reason to reduce our consumption of fossil fuels is the growing global warming phenomena. Environmentally friendly power generation technologies will play an important role in future power supply.

The renewable energy technologies include power generation from renewable energy sources, such as wind, PV(photovoltaic), MH(micro hydro), biomass, ocean wave, geothermal and tides. In general, the key reason for the deployment of the above energy systems are their benefits, such as supply security, reduced carbon emission, improved power quality, reliability and employment opportunity to the local people. Since the RE resources are intermittent in nature therefore, hybrid combinations of two or more power generation technologies, along with storage can improve system performance. Nowadays, there is a great concern on dependence on fossil fuel and environmental issues. This has led to more research in the energy sector to reduce the dependence on fossil fuels and to protect the environment. Two strategies that can be followed to reduce dependence on fossil fuel [1]. The first strategy is based on reducing energy consumption by applying energy savings programs. A second strategy is to achieve this goal consists of using renewable energy sources. Moreover, Inaccessibility of the grid power to the remote places and the lack of rural electrification have prompted for alternative sources of energy [SD7]. Renewable resources and clean alternative energy power generation technologies have attracted much attention and concern because they have several advantages such as, less dependence on fossil fuel, availability of the resources which are free of cost, and lower harmful emissions to the atmosphere (i.e. environmental friendly). Renewable energy sources, such as wind, solar, micro hydro (MH), biomass, geothermal, ocean wave and tides, and clean alternative energy sources, such as fuel cells (FCs) and micro turbines (MTs), have become better alternatives for conventional energy sources [2, 3].

However, in comparison to conventional energy sources, renewable energy sources are less competitive due to their uncertainty, intermittency due to dependence on weather, and high initial cost. Recently, extensive research on renewable energy technology has been conducted worldwide which resulted in significant development in the renewable energy materials, decline in the cost of renewable energy technology, and increase in their efficiency.

II. RESEARCH MOTIVATION

To overcome the intermittency and uncertainty of renewable sources and to provide an economic, reliable, and sustained supply of electricity, a modified configuration that integrates these renewable energy sources and uses them in a hybrid system mode is proposed by many researchers.

The energy from renewable resources is available in abundance but intermittent in nature, hybrid combination and integration of two or more renewable sources make best utilize of their operating characteristics and improve the system performance and efficiency. Hybrid Renewable Energy Systems (HRES) are composed of one renewable and one conventional energy source or more than one renewable with or without conventional energy sources, that works in standalone or grid connected mode [1].

Hybridization of different alternative energy sources can complement each other to some extent and achieve higher total energy efficiency than that could be obtained from a single renewable source. Multi source hybrid renewable energy systems, with proper control, have great potential to provide higher quality and more reliable power to customers than a system based on a single source. Due to this feature, hybrid energy systems have caught worldwide research attention.

III. SOLAR ENERGY

Solar panels is also known as modules and it contains photovoltaic cells made of silicon that transforms incoming sunlight into electricity. ("Photovoltaic" is basically electricity from light — photo = light, voltaic = electricity.) Solar photovoltaic cells are made of a positive and a negative silicon film placed under a thin slice of glass. As the photons of the sunlight strikes on silicon cells, the electrons ejects from the film. The electrons which are negatively charged are attracted to one side of the silicon cell, this creates an electric voltage that can be collected and channeled.

The solar photovoltaic array is formed by collecting the current by wiring different solar panels. Fused array combiner is an electrical box in which multiple strings of solar photovoltaic array cables terminate; it is depending on the size of installation. Contained within the combiner box are fuses which are designed to protect the individual module cables, as well as the connections which delivers power to the inverter. The electricity produced at this stage is DC and must be converted to AC using inverter which is suitable for use in home or business.

Solar system could be categorized into two types:

- Line-independent systems: These are established in absence of line electricity to provide electricity The DC current is obtained in this system which is stored in accumulator
- Line-dependent systems: These systems do not required any DC-Batteries, since the energy is served to the demand with the help of an inverter. Line electricity is being in use in case of insufficient sun beam.

IV. WIND ENERGY

The energy of wind is converted into useful form (usually electric current) is called wind energy. Wind turbine converts the wind power into useful electric power. Electric generator used inside the turbine converts the mechanical power into the electric power. Wind turbine systems are available in ranges from 50W to 2-3 MW. The energy produced by wind turbines depends on the velocity of wind acting on the turbine. Wind power is used to feed the energy production as well as consumption demand, and transmission lines in the rural areas.

Wind turbines can be classified depending on the physical features (dimensions, axes, number of blade), generated power and so on. Power production capacity can be classified in four subclasses.

- Small Power Systems
- Moderate Power Systems
- Big Power Systems
- Megawatt Turbines

V. HYBRID ENERGY

Hybrid systems use more than one energy resources that can be renewable or non-renewable. Integration of systems (wind and solar) has more impact in terms of electric power production. Such systems are known as "hybrid systems". Hybrid solar and wind applications are implemented in the field, where entire year energy is to be consumed without any chance for an obstacle. It is possible to have any combination of energy sources to supply the energy in the hybrid systems, such as oil, solar and wind or others. This project is somewhat similar with solar power panel and wind turbine power of course; it is only an add-on in the system. Solar panels and small wind turbines depend on environmental conditions. Therefore, neither solar nor wind power is used alone.

A number of renewable energy experts say to have a satisfactory hybrid energy resource if both wind and solar power are integrated within a unique system. In the summer time, when sun beams are strong enough, wind velocity is relatively less. In the winter time, when sunny days are relatively shorter, wind velocity is high. Efficiency of these renewable systems show also differences throughout the year. In other words, it is needed to compensate these two systems with each other to get the continuous of the energy production in the system.

VI. LITERATURE REVIEW

Presently, scientists and engineers around the globe have been supporting the utilization of renewable energy resources. Science these are abundant, though dilute and variable, locally available, almost and don't contaminate the environment, simplicity in onsite generation. Since, it

is dilute and variable in nature, many complexities exist in conversion, condition, control, coordination etc.

They are utilized as a standalone system serves many applications i.e. lighting system, water pumping for irrigation, traffic control etc. But it is costly, unreliable, and requires individual conditioning and controlling units. In this challenging atmosphere, Hybrid Energy System (HES) is one of the feasible solutions to harvest energy from renewable energy resources.

1. Overview of Hybrid Renewable Energy Systems:
Hybrid energy system usually comprises of two or more renewable energy sources combined in such a way to provide an efficient system with uninterrupted power supply. In other words it can be said that hybrid energy system is a combination several (two or more) energy sources with appropriate energy conversion technology connected together to feed power to local load/grid. Since, it is categorized as a distributed generation system hence there is no unified standard or structure. It is beneficial in terms of reduced line and transformer losses, reduced environmental impacts, relived transmission and distribution congestion, increased system reliability, improved power quality, and increased overall efficiency.

2. Types of Hybrid Renewable Energy Systems:
Biomass-wind-fuel cell: consider a load of 100% power supply and there is no renewable system to fulfill this need, so two or more renewable energy system can be combined. For example, 60% from a biomass system, 20% from a wind energy system and the remainder from fuel cells. Thus combining all these renewable energy systems may provide 100% of the power and energy requirements for the load, such as a home or business [3] .

3. Completely Renewable Hybrid Power Plant:
Completely Renewable Hybrid Power Plant (solar, wind, biomass, hydrogen) a hybrid power plant consisting of these four renewable energy sources can be made into operation by proper utilization of these resources in a completely controlled manner.

4. Hydro-wind:
A wind-hydro system generates electric energy combining wind turbines and pumped storage. The combination has been the subject of long-term discussion, and an experimental plant, which also tested wind turbines, was implemented by Nova Scotia Power at its Wreck Cove hydro electric power site in the late 1970s, but was decommissioned within ten years. Since, no other system has been implemented at a single location as of late 2010 [5].

5. Photovoltaic-Biomass:
This is a combination of biomass gasifier and solar photovoltaic cells and the system is currently under research phase. Advantages and Limitations Hybrid Energy Systems employs a wide range of primary energy sources, for frequent renewable sources generation as the stand alone system for rural electrification where grid extension is not possible or uneconomic.

Design and development of various HES components has more flexibility for future extension and growth. Number of generation units can be increased with demand so as to assure consistent operation with existing system. If there is excess generation than demand, it can be feed in to grid which leads to revenue generation. Since many sources are involved in power generation, its stability, reliability and efficiency will be high. Running cost of thermal plant and atomic plant is high. Majority of the renewable source based electricity generation has minimum running cost also abundant in nature. While limitations of hybrid renewable energy systems can be explained as under.

6. Maximum power extraction:
When different V-I characteristics voltages are connected together, one will be superior to other. In this circumstance, extracting maximum power is difficult for a constant load.

7. Stochastic Nature of sources:
These distributed sources are site specific and diluted. So, the design of power converters and controllers has to be so designed to meet the requirement. Complexities in matching voltage and frequency level of both inverted DC sources like PV system, fuel cell, etc controlled AC sources like wind, hydro, etc. Because in case of these sources V-I characteristics depends on atmospheric condition, which is varying time to time. Forecasting of these sources is not accurate. Coordination: In order to get reliable power, these systems can be connected to a utility grid. Often frequency mismatch arises between both systems. Hence it leads instability of the overall system.

Energy Conversion Technology: Sun is the primary sources of all energies. It is available in many ways like oil, coal, wind, hydel, sunlight. In modern era we are generating electrical energy from these sources directly or indirectly. So far, there is no unique viable method is used for conversion and utilization. Power Quality: A wide range of power electronics converters are involved in power conditioning of hybrid energy system from source to user. These power converters generate many harmonic components in the transmission which causes large scale disturbances to the load/power distribution system.

8. Strengths in using a hybrid system:
- Hybrid systems can reduce reliance on fossil fuels and increase the share of renewable energy resources, including intermittent ones, thus increasing the eco-efficiency of energy production and energy security.
- Hybrid systems can reduce energy costs in the long run by offsetting fossil fuel use with renewable production.

- Setting up isolated grids can help provide modern energy access to remote areas and avoid the cost of expensive transmission and distribution lines from the central grid. Particularly in poor areas using diesel gensets, for which fuel price fluctuations can mean no electricity for a period of time, hybrid systems can help provide more reliable modern energy access.

VII. IMPLEMENTING STRATEGIES

Provide a net metering option in which a transmission grid encourages the development of hybrid energy systems, particularly in commercial applications: Net metering is a major financial incentive for small power producers because they can sell excess generation from renewable energy sources back to the grid at a retail – rather than wholesale – rate. Net metering requires advanced meters that communicate in real time. The production and use of smart meters is growing in China, and several ASEAN countries are beginning to follow suit. Although widespread use is a long-term vision, using smart meters with hybrid projects may provide a useful learning experience for utilities and power producers.

Introduce a feed-in tariff: Such an incentive can encourage the maximizing of renewable energy production in hybrid systems. The higher rate paid by the feed-in tariff is paid out relative to kWh of renewable production. Subsidize the capital costs or provide soft loans for hybrid power systems to expand their use: For example, in India there is an upfront capital subsidy of up to 200,000 rupees (US$3,800) or 80 per cent of the project cost (whichever is the lower) for hybrid power projects built by community groups and government bodies. For private companies and individuals, the subsidy is lower – up to 125,000 rupees (US$2,400) or 50 per cent of the project cost. The highest subsidy, up to 240,000 rupees (US$4,600) or 90 per cent of the project cost, is allotted for non-electrified islands to promote electrification.6 The low cap encourages small-scale development.7 Mobilize funding: Governments can seek out funding from the Clean Development.

Mechanism under the Kyoto Protocol, rural development banks and other development organizations to upgrade diesel genset systems to hybrid systems or build new hybrid systems to provide modern energy access to rural areas.

VIII. ISSUES WITH HYBRID RENEWABLE ENERGY SYSTEMS

Though a hybrid system has a bundle of advantages, there are some issues and problems related to hybrid systems have to be addressed:

- Most of hybrid systems require storage devices which batteries are mostly used. These batteries require continues monitoring and increase the cost, as the batteries life is limited to a few years. It is reported that the battery lifetime should increase to around years for the economic use in hybrid systems.
- Due to dependence of renewable sources involved in the hybrid system on weather results in the load sharing between the different sources employed for power generation, the optimum power dispatch, and the determination of cost per unit generation are not easy.
- The reliability of power can be ensured by incorporating weather independent sources like diesel generator or fuel cell.
- The stability issue. As the power generation from different sources of a hybrid system is comparable, a sudden change in the output power from any of the sources or a sudden change in the load can affect the system stability significantly.
- Individual sources of the hybrid systems have to be operated at a point that gives the most efficient generation. In fact, this may not be occur due to that the load sharing is often not linked to the capacity or ratings of the sources. Several factors decide load sharing like reliability of the source, economy of use, switching require between the sources, availability of fuel etc. Therefore, it is desired to evaluate theschemes to increase the efficiency to as high level aspossible.

IX. FUTURE TRENDS AND LIMITATIONS

The renewable technologies have come a long way in terms of research and development. However there are still certain obstacles in terms of their efficiency and optimal use.

Following are the challenges faced by the designer.

- The renewable energy sources, such as solar PV and FCs, need innovative technology to harness more amount of useful power from them. The poor efficiency of solar is major obstruction in encouraging its use.
- The manufacturing cost of renewable energy sources needs a significant reduction because the high capital cost leads to an increased payback time.
- It should be ensured that there should be minimal amount of power loss in the power electronic devices.
- The storage technologies need to increase their life-cycle through inventive technologies.
- These stand alone systems are less adaptable to load fluctuations. Large variation in load might even lead to entire system collapse.
- The renewable technologies have a vast scope in terms of research and development. However there are certain obstacles in terms of their efficiency and optimal use. Following are the disadvantages or limitations of a hybrid system.
- The renewable energy sources, such as solar PV and FCs, need modern technology to harness more amount of useful power from them. The less efficiency of solar is major disadvantage in encouraging its use.

- The manufacturing cost of renewable energy sources need to be reduced because the high money cost leads to an increased payback time.
- It should be ensured that there should be least amount of power loss in the power electronic devices.
- The storage technologies need to increase their lifecycle through modern technologies.
- These stand alone systems are less preferable to load fluctuations. Large variation in load might even lead to entire system collapse.

IX. CONCLUSION

This paper gives an overview of hybrid renewable energy systems (HRES). Various aspects such as methodology, unit sizing and optimization, storage and energy flow management, are specifically reviewed. Future trends as well as challenges are also presented in the paper. The presented literature review facilitates interested researchers in design and power management of HRES.The available power from the renewable energy sources such as wind, solar source is extremely dependent on environmental conditions such as wind and water velocity, radiation, and ambient temperature etc.

To overcome deficiency in the solar and wind system, we integrated them and produce hybrid energy. Parallel hybrid system can be preferred due to higher efficiency and also due to more supplying capacity than the other configurations of grid system. Switched hybrid system also has more efficiency but it has several limitations. Out of the convertible and end use energy storage system convertible are the preferred ones. Out of the convertible batteries are most efficient. The major factors to be considered for batteries are its capacity, discharging rate, size and the material used

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