Hybrid Energy Systems

P. Sravanthi[1], B. Tarangini[2], G. Anitha[3], R. Guna Sekhar[4],
B. Santhosh[5], Dr. N. Sambasiva Rao[6]

P. Sravanthi[1], Student, Department of EEE, NRI Institute of technology, Andhra Pradesh, India

B. Tarangini[2], Student, Department of EEE, NRI Institute of technology, Andhra Pradesh, India

G. Anitha[3], Student, Department of EEE, NRI Institute of technology, Andhra Pradesh, India

R. Guna Sekhar [4], Student, Department of EEE, NRI Institute of technology, Andhra Pradesh, India

B. Santhosh[5], Student, Department of EEE, NRI Institute of technology, Andhra Pradesh, India

Dr. N. Samba Siva Rao[6] , Professor and Head ,Department of EEE, NRI Institute of technology, Andhra Pradesh, India

ABSTRACT

Battery systems are mainly designed in terms of charge/discharge power and energy capacity. Hybrid Battery Energy Storage Systems (HBESS) which are made of several kinds of batteries can reduce system volume and cost. In this paper, power and energy management algorithms and costs estimation method for HBESS are described. The validity of the algorithms is confirmed by simulations using charge/discharge power demand waveforms of a wind farm. By using this algorithm, it is estimated that in some cases up to 36% of battery cost can be reduced, compared to single-type BESS. Furthermore, the algorithms are demonstrated on a test 200kW system in our laboratory consisting of two kinds of lithium-ion battery: high power type for hybrid vehicles, and high energy type for stationary applications.

1. INTRODUCTION

A hybrid energy system combines two or more systems and connects them to provide the most energy and power possible, as well as enough chilling, warming, and hot water for residential buildings and industrial uses. The installation of the greatest renewable sources can take the place of the combustion of fossil fuels in renewable energy systems (RESs). There are numerous RESs available, with each kind performing best under specific climatic circumstances, but because the supply of any energy source is unpredictable, the performance of the entire system may be affected. The demands of the end-user might not all be met by a single RES.

A hybrid energy system combines two or more systems and connects them to provide the most energy and power possible, as well as sufficient chilling, warming, and hot water for residential buildings and industrial uses.

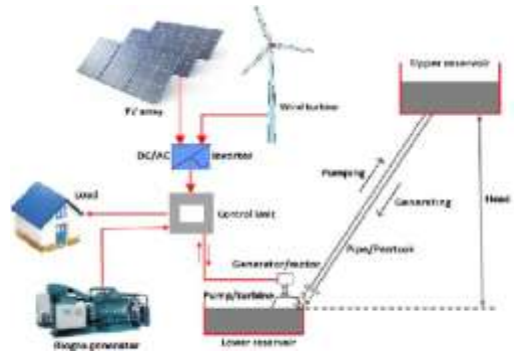

Fig -1: schematic diagram of hybrid energy system

2.Designing a Hybrid Energy System:

Hybrid systems share several electric power supplies and are coupled by a controller for parallel distribution to load feeders. They are complicated energy systems with numerous sets of variables. The primary issues are suitability and dependability with regard to the processing unit, the processed and unprocessed parameters, and the system size. The number of computations and iterations necessary in a given processing time to evaluate the best outcome depends on the size of the hybrid system. In order to examine frequency mismatching and voltage stability difficulties in preparation, a hybrid system also includes feedback (closed and open) systems that are required for the desired output, with real and reactive power management across a restricted range. In addition, when the number of resources that are tied together and have distinct operational characteristics (such as wind and hydro), after which the numerous problems with each resource's ability to provide quality power are assessed. In hybrid systems, there are a number of what are termed to as "power conditioning devices," which use FACTS devices with power electronic interfaces to control the real and reactive power controls and offer the correct result with regulated outputs. The different permutations of energy sources that can be developed into a system with suitable sustainability indices depend on the accessibility of the resources and the availability of enough acreage to build the intended hybrid system. Due to its various advantages, RES has also become more significant in hybrid systems. The Kyoto Protocol, a key agreement between developing and developed nations, states that emissions of greenhouse gases and other hazardous gases should be avoided or decreased in return for wealthy nations paying developing nations carbon credits priced at dollars per unit. Researchers are able to create simulation models of hybrid systems that reflect environmental and social factors thanks to these kinds of agreements and proactive knowledge sharing between these two country types around the world. share increases. These variables aid in making accurate modelling designs for hybrid RE systems.

3. Classification of Hybrid Energy Systems:

Hybrid energy systems can be configured up in a wide variety of ways, and they respond to various climatic factors differently. They are classified into the following categories:
• Wind-solar hybrid system
• Diesel-wind hybrid system
• Wind-hydropower hybrid system
• Solar-fuel cell hybrid power system
• Solar-thermal hybrid system

3.1 Wind-solar hybrid system:

Although hybrid systems are complicated and have a number of problems, they were created with the demand and supply for a specific type of land in mind. Due to their abundance in nature and dependency, researchers modelling hybrid systems use renewable energy sources like solar and wind power. However, both of these systems are intermittent in nature and are unable to satisfy the load duration curve and to cater for such load equally. As a result, neither energy source can be used individually because neither can afford the capital expenses involved. In contrary, integrated systems cause voltage to sag and rise for an extended period of time and have difficulties with power quality. Systems combining wind and solar can be used only in areas with a limited population or in coastal regions where the load is predictable and stable in advance. A typical hybrid solar-wind system is shown in a schematic.

Hybrid solar-wind systems must take in to the account a number of factors, including solar irradiance, solar direction, average wind speed, total output anticipated, average temperature, and terrain suitability [18]. In order to ensure that, should any component ever fail, the backup systems can meet the bare minimum demands (base load) and that the grid-connected mode is available since both systems are predictable, both systems must be tested in both islanding mode and grid-connected mode. When hybrid systems are developed with energy needs in mind, grid codes for that region must be reviewed. In order to ensure voltage stability, hybrid systems must work together and conform to the grid code batteries to store energy input in order to improve economic aspects.

3.2 Diesel-wind hybrid system:

There are two diesel-wind approaches that can be used: the first is to run a diesel engine continuously, and the second is to run it periodically on a time scale of 4 out of 5 or on an intermediate basis, as needed. Machines with a power load are essential components. An energy storage battery device, a diesel engine, and an electronic controller. Figure 2 shows a schematic of a typical hybrid diesel-wind system.
The main goal of a diesel-wind hybrid system is to use both systems economically so that deliverables, in aspects of output and efficiency, are cost-effective and optimization can be actually achieved with a minimum number of iterations. At the same time scale, both parts of the model operate as peak power. When electricity is necessary due to security and economic reasons, such diesel-wind hybrid systems are employed in distant places and for smaller populations on an island or in isolated regions.

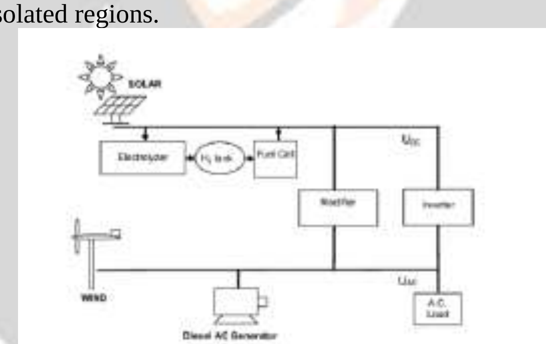

Fig.2: Schematic diagram of diesel wind hybrid system

3.3 Wind-hydropower hybrid system:

Large-scale electricity generation frequently uses this kind of system. Such hybrid systems are extremely uncommon since hydropower is constrained by certain specifications, such as the need for a water catchment area (dam and reservoir), and wind is also restricted by the availability of a specific wind speed, which can vary from location to location. Both systems (hydropower and wind) are site-specific and are subject to a variety of limitations that cannot be removed by adding an additional alternative energy source. The combination of a base power plant and a peak power plant, with the hydropower serving as the base power plant and the wind power plant operating as the peak power plant, is the most advantageous aspect of this type of hybrid power system systems that work well together. However, both energy sources could operate in peak mode in a pumped-storage plant, there would still be space restrictions. A typical variable - speed wind plant is shown in a schematic.

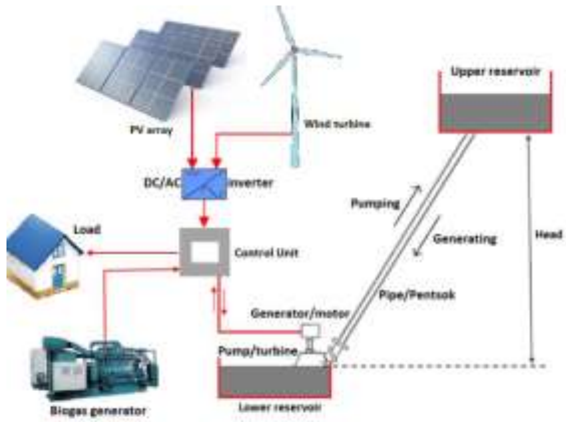

Fig.3 Schematic diagram of Wind-hydro power hybrid system

3.4 Hybrid Fuel Cell-Solar System:

A hybrid fuel cell-solar system's input power varies continually over time because of the way the sun's irradiance changes. A solar photovoltaic (PV) cell, a proton-exchange membrane fuel cell, and power conditioning devices make up this hybrid system. The system needs to be built so that it can function constantly in a variety of weather situations. A PV cell generates electricity to satisfy consumer demand. The particle barrier fuel cell is utilized to keep the system reliable when there are any issues with generation caused by low solar irradiation. Because it is a hybrid system, each system drives the other by acting as a catalyst. The fuel cell-solar system's lesser complexity is a massive benefit, but it has the disadvantage that decreased reliability indices It also has a negligibly negative effect on the environment. The power conditioning unit functions as a rectifier and bidirectional power converter, converting AC power into DC power and vice versa. As a result, the power conditioning unit functions as the hybrid PV and fuel-cell system's brain. This hybrid system increases system voltages overall and decreases the amount of time the fuel cell is used. A hybrid memory fuel cell-solar system appears on a schematic.

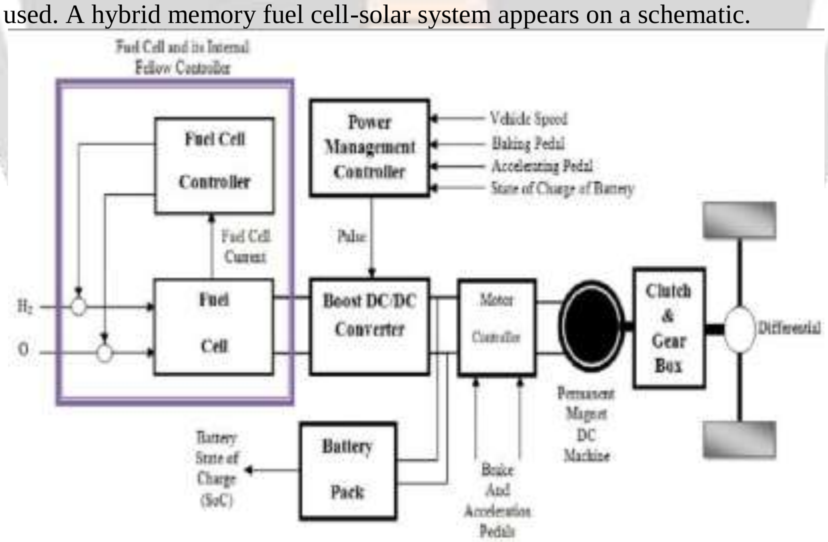

Fig-4 schematic diagram of hybrid fuel cell solar system

3.5 Solar thermal hybrid system:

Combining a solar PV and a thermal system allows for the operation of another hybrid system. Variable amounts of solar irradiation and the temperature of the plate in this system can improve overall system performance. Both thermal and electrical efficiency are provided by this. These efficiencies specify how well the system performs in various climatic situations. The most recent technologies make extensive use of optical concentration techniques, which can be applied to solar thermal systems to produce energy storage system for industrial applications. These systems work best together, but one big flaw is that the conversion technology is remote, constrained, and difficult for the end user to utilize. Additionally, the technologies employed first from investor perspective unfriendly to users Various applications make use of the well-known concentrating solar thermal systems, including parabolic trough collectors, linear Fresnel reflector systems, main receiver systems, and dish systems. A hybrid solar-thermal system is shown in schematic form.

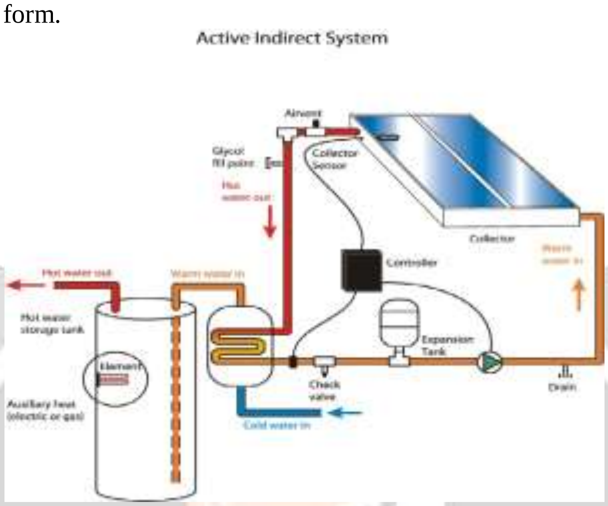

Fig-5: Solar thermal hybrid system

4.CONCLUSION:

Installation of a hybrid energy system is beneficial for system performance in a range of climatic situations. Additionally vital are distant residential and commercial uses. Alternative energy sources are required to keep the supply of electric power constant because occasionally only one system can function effectively. In addition, it has been discovered that producing electric power from hybrid energy is simple and environmentally safe. The operational systems last longer than other standard available energy sources. In this way, hybrid systems can offer future power generation solutions that are more expense and more efficient.

7. REFERENCES:

[1] Md. Ibrahim, A. Khair, and S. Ansari, "A review of hybrid renewable energy systems for electric power generation", *International Journal of Engineering Research and Applications,* vol. 5 no. 8, pp. 42-48, 2015.

[2] W. Sparber, K. Vajen, S. Herkel, J. Ruschenburg, A. Theur, R. Fedrizzi, and M. D Antoni, "Overview on solar thermal plus heat pump systems and review of monitoring results", In: *Proceedings of ISES Solar World Congress,* Germany, September 2011.

[3] P. Ganguly, A. Kalam, and A. Zayegh, "Solar-wind hybrid renewable energy system: Current status of research on configurations, control, and sizing methodologies", *Hybrid-Renewable Energy Systems in Microgrids,* Woodhead Publishing Series in Energy, pp. 219-248, 2018.

[4] P. Ganguly, A. Kalam, and A. Zayegh, "Solar-wind hybrid renewable energy system: Current status of research on configurations, control, and sizing methodologies", *Hybrid-Renewable Energy Systems in Microgrids,* Woodhead Publishing Series in Energy, pp. 219-248, 2018.