A Review Article Hybrid Power System with Integration of Wind, Battery and Solar PV System

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Abstract- **As the race for global industrialization begin late in 18th century, the developing technology made humans to depend on energy, so as the energy crisis begins, in this modern era, electricity become a most essential need of human beings, from household to industrial work. So, the purpose of the project is to generate electricity without using non-renewable resources and pollution. Since, renewable standalone energy generation systems have disadvantages, which need to be overcame by hybrid systems. Wind and solar energy have being popular ones owing to abundant, ease of availability and convertibility to the electric energy. This work covers realization of hybrid energy system for multiple applications, which runs under a designed circuitry to utilize the solar and wind power. And a designed circuitry for more efficient results, and inverters to convert the electrical energy as per demand.**

Keywords- **Hybrid Energy; Solar System; Wind Energy; Renewable Energy; Clean Energy; Electrical Energy Generation.**

I. INTRODUCTION

The Conventional sources of energy are rapidly depleting. Moreover the cost of energy is rising and therefore photovoltaic system is a promising alternative. They are abundant, pollution free, distributed throughout the earth and recyclable. The hindrance factor is its high installation cost and low conversion efficiency. Therefore our aim is to increase the efficiency and power output of the system. It is also required that constant voltage is supplied to the load irrespective of the variation in solar irradiance and temperature.

PV arrays consist of parallel and series combination of PV cells that are used to generate electrical power depending upon the atmospheric conditions (e.g solar irradiation and temperature). So it is necessary to couple the PV array with a boost converter.

Moreover our system is designed in such a way that with variation in load, the change in input voltage and power fed into the converter follows the open circuit characteristics of the PV array. Our system can be used to supply constant stepped up voltage to dc loads.

As electric distribution technology steps into the next century, many trends are becoming noticeable that will change the requirements of energy delivery. These modifications are being driven from both the demand side where higher energy availability and efficiency are desired and from the supply side where the integration of distributed generation and peak shaving technologies must be accommodated [1].

Today electrical power demand is very much increasing. So to generate the required power, resources used for this purpose are also increase. Hence proper utilization of power is required whenever surplus power is available. This can be achieved by storing the surplus power through batteries in the form of DC and this stored energy can be re- utilized by the conversion device called it as "INVERTER" by converting DC power into AC power.

The renewable energy sources have been tremendously increasing its production, out of all those renewable energy sources solar is popular and it needs an inverter for the conversion.

The multilevel inverters are the advancement in power electronics. Now-a-days multilevel inverters in literature are updating according to the high power capability.

Hence, multilevel inverters are capable of having good voltage spectrum and low voltage stress devices. Power electronic inverters are becoming popular for various industrial drives applications. In recent years, inverters have even become a necessity for many implementations such as motor controlling and power systems [1].

A multilevel inverter not only achieves high power ratings, but also enables the use of renewable energy sources. Renewable energy sources such as photo voltaic, wind, and fuel cells can be easily interfaced to a multilevel inverter system for a high power and Medium power application. Multilevel inverters have been mainly used in medium or high power system applications, such as static reactive power compensation and adjustable-speed drives [2-4].

II. GENERAL INFORMATION REGARDING MICRO GRID

Power systems currently undergo considerable change in operating requirements mainly as a result of deregulation and due to an increasing amount of distributed energy resources (DER). In many cases DERs include different technologies that allow generation in small scale (micro sources) and some of them take advantage of renewable energy resources (RES) such as solar, wind or hydro energy.

Having micro sources close to the load has the advantage of reducing transmission losses as well as preventing network congestions. Moreover, the possibility of having a power supply interruption of end-customers connected to a low voltage (LV) distribution grid (in Europe 230 V and in the USA 110 V) is diminished since adjacent micro sources, controllable loads and energy storage systems can operate in the islanded mode in case of severe system disturbances. This is identified nowadays as a micro grid.

Figure 1.1 depicts a typical micro grid. The distinctive micro grid has the similar size as a low voltage distribution feeder and will rare exceed a capacity of 1 MVA and a geographic span of 1 km. Generally more than 90% of low voltage domestic customers are supplied by underground cable when the rest is supplied by overhead lines. The micro grid often supplies both electricity and heat to the customers by means of combined heat and power plants (CHP), gas turbines, fuel cells, photovoltaic PV(AC/DC SMART GRID)) systems, wind turbines, etc.

The energy storage systems usually include batteries and flywheels [2].The storing device in the micro grid is equivalent to the rotating reserve of large generators in the conventional grid which ensures the balance between energy generation and consumption especially during rapid changes in load or generation [3].

From the customer point of view, micro grids deliver both thermal and electricity requirements and in addition improve local reliability, reduce emissions, improve power excellence by supportive voltage and reducing voltage dips and potentially lower costs of energy supply. From the utility viewpoint, application of distributed energy sources can potentially reduce the demand for distribution and transmission facilities. Clearly, distributed generation located close to loads will reduce flows in transmission and distribution circuits with two important effects: loss reduction and ability to potentially substitute for network assets.

In addition, the presence of generation close to demand could increase service quality seen by end customers. Micro grids can offer network support during the time of stress by relieving congestions and aiding restoration after faults. The development of micro grids can contribute to the reduction of emissions and the mitigation of climate changes. This is due to the availability and developing technologies for distributed generation units are based on renewable sources and micro sources that are characterized by very low emissions [4].

III. TECHNICAL CHALLENGES IN MICRO GRID

Protection system is one of the major challenges for micro grid which must react to both main grid and micro grid faults. The protection system should cut off the micro grid from the main grid as rapidly as necessary to protect the micro grid loads for the first case and for the second case the protection system should isolate the smallest part of the micro grid when clears the fault [3].

A segmentation of micro grid, i.e. a design of multiple islands or sub micro grids must be supported by micro source and load controllers. In these conditions problems related to selectivity (false, unnecessary tripping) and sensitivity (undetected faults or delayed tripping) of protection system may arise. Mainly, there are two main issues concerning the protection of micro grids, first is related to a number of installed DER units in the micro grid and second is related to an availability of a sufficient level of short-circuit current in the islanded operating mode of micro grid since this level may substantially drop down after a disconnection from a stiff main grid.

In [3] the authors have made short-circuit current calculations for radial feeders with DER and studied that short-circuit currents which are used in over-current (OC) protection relays depend on a connection point of and a feed-in power from DER. The directions and amplitudes of short circuit currents will vary because of these conditions. In reality the operating conditions of micro grid are persistently varying because of the intermittent micro sources (wind and solar) and periodic load variation. Also the network topology can be changed frequently which aims to minimize loss or to achieve other economic or operational targets.

IV. LITERATURE REVIEW

D.S. Chaudhari: The solar photovoltaic is considered to be the one of the most promising energy source in many applications, due to its safety and high reliability.

Residential that uses solar power as their alternative power supply will bring benefits to them. In order to increases the efficiency of system during rapid changing environmental conditions; system will adapt some Maximum Power Point Tracking (MPPT) methods. This paper presents a review on various MPPT methods for variable environmental conditions (i.e. variable temperature and irradiation level), their difficulty while tracking and how those difficulties can be overcome efficiently by the other techniques.

Apart from all the methods, an open circuit and slope detection tracking technique is found to be an efficient technique with respect to tracking speed and accuracy. This technique can avoid the unnecessary amount of power loss and therefore maintaining the power efficiency.

Pawan D. Kale: These modern days that consume a lot of energy e.g. fuel-oil, gas, coal etc. that will deplete in its source one day so, much of the focus have been given on the topic of renewable energy. Renewable energies are energy that can be renewed or have no worries of depletion. For instance wind, thermal, bio-mass and solar energy are some of the examples for renewable energy [1].

Solar energy is one of the main renewable energy sources that are widely used in power generating application. Solar energy is an unlimited resource available in nature and set to become important in longer terms for providing heat energy and electricity to the user. This kind of energy resources does not create much pollution as the conventional power sources moreover it has the potential to be the major energy supply in future [1], [5].

In the last decade, there was a consistent development in the worldwide market of photovoltaic PV system. By the end of 2008, 13 GW of energy had been generated by the installed PV systems throughout the world. Out of the total system installed 6% were standalone systems, 33% were grid-connected centralized systems, and 61% were grid-connected distributed system. In 2008 alone, photovoltaic systems which generate up to 5.56 GW energy were installed. This represents the growth in PV systems increased by 1.5 times as compared with the previous year.

Ghislain Remy: This paper presents a review of maximum power point tracking (MPPT) techniques for photovoltaic systems PV. After a brief introduction of the key factors for the power extraction of photovoltaic panel, a review of the commonly used MPPT techniques is presented and detailed with an overall approach. Then, a comparison of the main industrialized ones is discussed for a photovoltaic system. In the last part, the pros and cons of each of the considered MPPT techniques are presented.

The reduction of the fossil energies and uranium reserves make renewable energies more and more important (Hydro-electricity, Wind turbines, Solar panel). Furthermore, these energies offer a good opportunity to reduce the global-warming effect.

Among them, the photovoltaic systems' manufacturing process has been improving continuously over the last decade and photovoltaic systems have become an interesting solution. Precisely, photovoltaic systems are constituted from arrays of photovoltaic cells, choppers (mainly buck-boost or boost DC/DC converter), MPPT control systems and storage devices and/or grid

connections. To improve the efficiency of such systems, various been performed [1]-[4]. But, as solar energy is diffuse (less than 1 kW/m2), and photovoltaic cell efficiency is theoretically limited to 44%, efforts need to be strengthened on the energy transfer.

Mohamed Azab: In this paper a new maximum power point tracking algorithm for photovoltaic arrays is proposed. The algorithm detects the maximum power point of the PV. The computed maximum power is used as a reference value (set point) of the control system. ON/OFF power controller with hysteresis band is used to control the operation of a Buck chopper such that the PV module always operates at its maximum power computed from the MPPT algorithm. The major difference between the proposed algorithm and other techniques is that the proposed algorithm is used to control directly the power drawn from the PV. The proposed MPPT has several advantages: simplicity, high convergence speed, and independent on PV array characteristics. The algorithm is tested under various operating conditions. The obtained results have proven that the MPP is tracked even under sudden change of irradiation level.

M.S.Sivagamasundari: Energy especially alternative source of energy is vitalfor the development of a country. In future, the world anticipates developing more of its solar resource potential as an alternative energy source to overcome the persistent shortages and unreliability of power supply. In order to maximize the power output the system components of the photovoltaic system should be optimized. For the optimization maximum power point tracking (MPPT) is promising technique that grid tie inverters, solar battery chargers and similar devices use to get the maximum possible power from one or more solar panels. Among the different methods used to track the maximum power point, Perturb and Observe method is a type of strategy to optimize the power output of an array.

In this method, the controller adjusts the voltage by a small amount from the array and measures power, if the power increases, further adjustments in that direction are tried until power no longer increases. In this research paper the system performance is optimized by perturb and observe method using buck boost converter. By varying the duty cycle of the buck boost converter, the source impedance can be matched to adjust the load impedance to improve the efficiency of the system. The Performance has been studied by the MATLAB/Simulink.

Saleh Elkelani Babaa: Maximum power point tracking (MPPT) controllersplay an important role in photovoltaic systems. They maximize the output power of a PV(AC/DC SMART GRID) array for a given set of conditions. This paper presents an overview of the different MPPT techniques. Each technique is evaluated on its ability to detect multiple maxima, convergence speed, ease of implementation, efficiency over a wide output power

range, and cost of implementation. The perturbation and observation (P & O), and incremental conductance (IC) algorithms are widely used techniques, with many variants and optimization techniques reported. For this reason, this paper evaluates the performance of these two common approaches from a dynamic and steady state perspective.

Ting-Chung Yu: The purpose of this paper is to study and compare three maximum power point tracking (MPPT) algorithms in a photovoltaic simulation system. The Matlab/ Simulink is used in this paper to establish a model of photovoltaic system with MPPT function. This system is developed by combining the models of established solar module and DC-DC buck-boost converter with the algorithms of perturbation and observation (P&O), incremental conductance (INC) and hill climbing (HC), respectively. The system is simulated under different climate conditions and MPPT algorithms.

K.Ramani: This paper deals with new hybrid multilevel inverter fed induction motor drive. It focuses on asymmetrical topologies, the general function of this multi-level inverter is to synthesize a desired voltage from several separate dc source. This hybrid topology has more advantageous of industrial applications. In conventional methods, the need of converters to supply the cells of reversible multilevel converters increases the cost and losses of such inverters. The proposed method introduces 27 levels Inverter fed Induction Motor drive.

With the use of high level inverter, resolution is increase and also the harmonics is highly reduced. An improved new hybrid 27 level multilevel inverter structure is proposed. Basic new hybrid inverter scheme is to get the better sinusoidal output compared with low level inverters. The asymmetrical multilevel inverter is used to obtain a high resolution. By this method decrease the input voltage and get better efficiency in a 27 level multi-level inverter structure. The asymmetrical hybrid technique is used to improve the level of inverter and extends the design flexibility and reduces the harmonics.

Mr. Azad T: This paper proposes a New Hybrid 27 Level Multi Level Inverter withCascaded H Bridges which can drive a Single phase Induction motor. It uses an asymmetrical voltage source topology and it produces different voltage levels from separate dc sources. This hybrid topology has got more applications in the industrial world. In conventional multi-level inverters, the use of converters for providing asymmetrical voltage sources increases its losses and cost. The proposed inverter provides a 27 level voltage output with a THD less than 5%. With this method we can reduce the harmonics and increase the efficiency.

Melba Mary Paul Raj: Photovoltaic power generation is a promising alternative source of energy and has many advantages than the other alternative energy sources like

wind, solar, ocean, biomass, geothermal, and so on. In photovoltaic power generation, multilevel inverters play a vital role in power conversion. The three different topologies, diode-clamped (neutral-point clamped) inverter, capacitor-clamped (flying capacitor) inverter, and cascaded H-bridge multilevel inverter, are widely used in these multilevel inverters. Among the three topologies, cascaded H-bridge multilevel inverter is more suitable for photovoltaic applications since each photovoltaic array can act as a separate direct current source for each H-bridge module.

In this paper, a single-phase cascaded H-bridge five-level inverter for grid-connected photovoltaic system using proportional–integral controller is presented. Sinusoidal pulse width modulation technique was used for eliminating the harmonic distortion. The cascaded control strategy enables tracking of the maximum power point of distinct photovoltaic strings and allows independent control of the direct current-link voltages.

The performance of single-phase cascaded H-bridge five-level inverter with respect to harmonic content and number of switches is simulated using Matlab/Simulink. A hardware prototype is developed to verify the performance of the developed system. The results of hardware are compared with the simulation results. The proposed system offers improved performance over conventional two-level inverters.

The popularity of distributed generation systems is growing faster from last few years because of their higher operating efficiency and low emission levels. Distributed generators make use of several micro sources for their operation like photovoltaic cells, batteries, micro turbines and fuel cells. During peak load hours DGs provide peak generation when the energy cost is high and stand by generation during system outages. Smart grid is built up by combining cluster of loads and parallel distributed generation systems in a certain local area. Smart grids have large power capacity and more control flexibility which accomplishes the reliability of the system as well as the requirement of power quality. Operation of Smart grid needs implementation of high performance power control and voltage regulation algorithm [1]-[5].

To realize the emerging potential of distributed generation, a system approach i.e. Smart grid is proposed which considers generation and associated loads as a subsystem. This approach involves local control of distributed generation and hence reduces the need for central dispatch. During disturbances by islanding generation and loads, local reliability can be higher in Smart grid than the whole power system. This application makes the system efficiency double. The current implementation of Smart grid incorporates sources with loads, permits for intentional islanding and use available waste heat of power generation systems [5].

Smart grid operates as a single controllable system which offers both power and heat to its local area. This concept offers a new prototype for the operation of distributed generation. To the utility Smart grid can be regarded as a controllable cell of power system. In case of faults in Smart grid, the main utility should be isolated from the distribution section as fast as Necessary to protect loads. The isolation depends on customer's load on the Smart grid. Sag compensation can be used in some cases with isolation from the distribution system to protect the critical loads [2].

The Smart grid concept lowers the cost and improves the reliability of small scale distributed generators. The main purpose of this concept is to accelerate the recognition of the advantage offered by small scale distributed generators like ability to supply waste heat during the time of need. From a grid point of view, Smart grid is an attractive option as it recognizes that the nation's distribution system is extensive, old and will change very slowly. This concept permits high penetration of distribution generation without requiring redesign of the distribution system itself [3].

The Smart grid concept acts as solution to the problem of integrating large amount of micro generation without interrupting the utility network's operation. The Smart grid or distribution network subsystem will create less trouble to the utility network than the conventional micro generation if there is proper and intelligent coordination of micro generation and loads. In case of disturbances on the main network, Smart grid could potentially disconnect and continue to operate individually, which helps in improving power quality to the consumer [5].

With advancement in DGs and Smart grids there is development of various essential powers conditioning interfaces and their associated control for tying multiple micro sources to the Smart grid, and then tying the Smart grids to the traditional power systems?

Smart grid operation becomes highly flexible, with such interconnection and can be operated freely in the grid connected or islanded mode of operation. Each micro source can be operated like a current source with maximum power transferred to the grid for the former case. The islanded mode of operation with more balancing requirements of supply-demand would be triggered when the main grid is not comparatively larger or is simply disconnected due to the occurrence of a fault.

Without a strong grid and a firm system voltage, each micro source must now regulate its own terminal voltage within an allowed range, determined by its internally generated reference. The micro source thus appears as a controlled voltage source, whose output should rightfully share the load demand with the other sources. The sharing should preferably be in proportion to their power ratings, so as not to overstress any individual entity [6].

The installation of distributed generators involves technical studies of two major fields. First one is the dealing with the influences induced by distributed generators without making large modifications to the control strategy of conventional distribution system and the other one is generating a new concept for utilization of distributed generators.

The concept of the Smart grid follows the later approach. There includes several advantages with the installation of Smart grid. Efficiently Smart grid can integrate distributed energy resources with loads. Smart grid considered as a 'grid friendly entity" and does not give undesirable influence to the connecting distribution network i.e. operation policy of distribution grid does not have to be modified. It can also operate independently in the occurrence of any fault. In case of large disturbances there is possibility of imbalance of supply and demand as Smart grid does not have large central generator. Also Smart grid involves different DERs. Even if energy balance is being maintained there continues undesirable oscillation [1].

For each component of the Smart grid, a peer-to-peer and plug-and-play model is used to improve the reliability of the system. The concept of peer-to-peer guarantees that with loss of any component or generator, Smart grid can continue its operation. Plug-and-play feature implies that without re-engineering the controls a unit can be placed at any point on the electrical system thereby helps to reduce the possibilities of engineering errors [1].

The economy of a country mainly depends upon its electric energy supply which should be secure and with high quality. The necessity of customer's for power quality and energy supply is fulfilled by distributed energy supply. The distribution system mainly includes renewable energy resources, storage systems small size power generating systems and these are normally installed close to the customer's premises.

The benefits of the DERs include power quality with better supply, higher reliability and high efficiency of energy by utilization of waste heat. It is an attractive option from the environmental considerations as there is generation of little pollution. Also it helps the electric utility by reducing congestion on the grid, reducing need for new generation and transmission and services like voltage support and demand response. Smart grid is an integrated system. The integration of the DERs connected to Smart grid is critical. Also there is additional problem regarding the control and grouping and control of DERs in an efficient and reliable manner [2].

Integration of wind turbines and photovoltaic systems with grid leads to grid instability. One of the solutions to this problem can be achieved by the implementation of Smart grid. Even though there are several advantages associated with Smart grid operation, there are high transmission line

losses. In a Smart grid there are several units which can be utilized in a house or country. In a house renewable energy resources and storage devices are connected to DC bus with different converter topology from which DC loads can get power supply. Inverters are implemented for power transfer between AC and DC buses.

Common and sensitive loads are connected to AC bus having different coupling points. During fault in the utility grid Smart grid operates in islanded mode. If in any case renewable source can't supply enough power and state of charge of storage devices are low Smart grid disconnects common loads and supply power to the sensitive loads [3].

V. CONCLUSION

Developing hybrid systems is one of the most convenient and effective solution for producing electricity as compared to non-renewable energy resources. It is not only less costly but also it does not cause any harm to the environment. Another thing is that it can be used to generate electricity in hilly areas, where it is quite difficult to transmit electricity by conventional methods. Depending on the requirement its setup can be decided. All the people in this world should be motivated to use non-conventional resources to produce electricity in order to make them self-reliable to some extent. Long life span, less maintainence is some of its plus point. It just requires some high initial investment.

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