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HIERARCHICAL ARCHITECTURE OF MICROGRID

[1]Urvi Vasavada, [2]Shivani Rathod, [3]Dixita Prajapati

[1,2,3] *Vadodara Institute Of Engineering, Vadodara, India.*

Abstract— *The advent of micro grid has enticed a lot of interest in the research of distribution generation thereby bringing into existence an intelligent electrical generation networks. It ensures security, reliability, stability, and sustainable of energy. Micro grid may include both renewable and non-renewable energy sources. It has been proven to possess the promising potential of providing clean, efficient, and reliable power. The energy sources include solar photovoltaic, wind, fuel cell, micro turbine, bio- mass micro hydro. Various architecture of a micro grid are available and are developed the factors dependable upon availability of renewable resources, geographical location, load demand. For effective and efficient operation unlike main grid, it needs to employ special and control this is so because of combination of conventional and renewable energy sources.*

Keywords—*solar energy; wind energy; microgrid*

I. INTRODUCTION

DG resources used in systems by using different types of renewable energy sources available. Today there are different technologies of renewable energy sources and each of them has specific characteristics and positive and negative points. Of them Solar energy, fuel-cell technology and biomass are more into practice. Meanwhile the most important and common source of renewable energy is the wind energy. This is since wind energy has some special advantages in comparison with rest of renewable sources. Use of wind energy is convenient, comes cheap and it's globally accessible in the world. In the mean time there are certain disadvantages for wind systems that should be considered too. The main one is that the wind speed and situation of weather predictions is not easily forecasted and hence presence of energy will face a big question mark. There are some limitations on the maximum and minimum of the wind speed for generating electricity which are provided by operators and these boundaries should be met to provide a better situation for wind energy generations. Because of this, power systems cannot rely on wind generation solely and there should be back serves for the systems using wind generation to support them in case of calm weather. Often these back up services are provided with another sort of renewable energy source and the main back up for these services can be considered as solar to provide a hybrid system of wind and solar systems.

There are multiple reasons that why this systems are used today. In brief it could be stated that main reasons for increase in use of renewable energy sources is increase of worries about climate change and increase of temperature in the world. Another main reason is increase in energy demands and acceleration of energy consumptions in the world and the final reason is that fossil fuels are forecasted to reach an end in near future and this will make energy providers to look towards new replacements for conventional fossil fuels systems. To provide a comparison between renewable sources and fossil fuel sources, it should be noted that about 1 kg of CO2 is saved by using each kW/h of energy generated by renewable. Energy resources like oil, gas, coal, etc. providing the main sources of today energy in the world and this should be changed in near future using renewable sources. The high level of CO2 emissions can have dangerous effects on weather and environment and can result in changes in environment. For these reasons, renewable sources should be developed further and be used in the world as a replacement source. A microgrid is a modern distributed power system using local sustainable power resources designed through various smart-grid initiatives. It also provides energy security for a local community as it can be operated without the presence of wider utility grid. Microgrid technology generally represents three important goals of a society such as reliability (physical, cyber), sustainability (environmental considerations), and economics (cost optimizing, efficiency). The “distributed generation” (DG) term refers to power generation located at or near the consumption sites. By comparison to “central generation”, DG can eliminate the generation, transmission, and distribution costs while increasing efficiency by removing elements of complexity and interdependency. In many cases, distributed generators can provide lower generation costs, higher reliability, and increased security not realized via traditional generators. For instance, Pike Research has identified 3.2 gigawatts

(GW) of globally existing microgrid capacity [1-4]. The North America leads to global microgrid generation with 2,088 MW operating capacity according to the report [3]. On the other hand, Europe holds the second rank with 384 MW installed microgrid capacity while Asia Pacific follows with 303 MW of operating capacity. The installed microgrid capacity in the rest of world is around 404 MW. If each power user (building/company/hospital/market) cares about reliable power and keep their desire to back up

energy source like generation/battery/diesel engine that would be the most expense power system. In a microgrid system, backup resources are unnecessary because a single user does not have to supply a general load during critical consumption periods. One billion dollars of energy consumption can be conserved by managing a few hundred-summer peak hours by shifting or eliminating loads. Therefore, reliability is a major justification for microgrid operation [1]. Microgrids could also prove economically viable in the southwestern US. The sustainability is another most important factor for considering this new technology, but less so, in the US; it is more necessary in China where a great deal of environment issues is emerging nowadays. The microgrid could tackle the energy crisis since the transmission losses are greatly reduced. Additionally, a microgrid provides significant reduction in generation costs while providing reliable and sustainable energy to loads. The cyber security issue is addressed as well due to the localized nature of the system. Microgrid technology is suitable for regions with an underdeveloped transmission infrastructure, such as remote villages where an islanded microgrid would be the most advantageous kind of power network [4]. Microgrids that are similar to a conventional grid structure in terms of power generation, distribution, transmission, and control features are assumed as a minor model of actual grid form. However, microgrid technology differs from a conventional grid owing to the distance between power generation and consumption cycles as a microgrid is installed near the load-sites. Microgrids also integrate with distributed generation plants such as combined heat and power (CHP), and renewable energy plants powered by solar energy, wind power, geothermal, biomass, and hydraulic resources [4, 5]. Although the power rate of microgrids is limited to a few MVA, it is relative to its application area and grid type. Power parks refer to interconnection of several microgrids that are installed to meet higher power demands where increased stability and control opportunities are necessary. Moreover, the interconnection of renewable sources and a microgrid contributes to decreased environmental emissions [3, 7]. In a macrogrid (conventional grid application), only one-third of the fossil fuel consumed is converted to electricity; the remainder is dissipated as heat energy. A microgrid, on the other hand, can communicate with consumers and thus manage demand and supply easily. About 5-7% power is lost along transmission lines in a macrogrid whereas, in a microgrid, all the power stays at the distribution level. Another projected point is that a 20% of generation capacity exists to meet peak demand of 5% time for utility grid where it has a “domino effect failure” can lead to a blackout. In North America, in 2003, more than a hundred power plants were forced to stop power generation due to the cascading effect of failing plants. One feature of a microgrid is independent operation during widespread failure or during fluctuation of power (intentionally or unintentionally), or even for costoptimization purposes. In reality, microgrid has black start facility if it is required due to any sort of disaster [6-8]. This study will briefly describe the components, structure and types of microgrids. The paper presents an introduction to microgrids by assembling several comparisons, components, and control methods that are independently examined in current research. It is intended to lead the researcher to examine the real-world application of a microgrid, and provide insight for potential improvements. Additionally, the comparison of microgrids in several regions with varying parameters will allow a conclusion on the design requirements for a particular microgrid application scenario with specific, available resources. It also tabulates all necessary

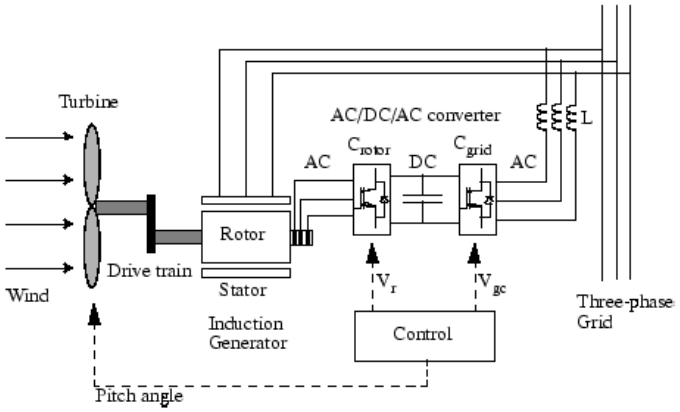
information about microgrids, and then proposes a standard microgrid for optimal power quality and maximized energy harvest. Finally, it focuses on removing knowledge gaps related to power systems in light of a future trend and potential improvements.

A. Wind Energy

In the past decade use of wind energy is increased significantly. The newer generations of wind turbines can generate electricity for both domestic and industrial purposes and it is improving as design and considerations of wind turbines are improving which can decrease generation costs as well. The main problem is frequent changing in the wind speed and this is varied both geographically and by seasonal changes in the same place. This also varies based on the height of wind turbines. Wind power offers green energy as a new source of energy for most domestic purposes at a cost competitive rate in comparison with ordinary sources of energy. Another problem of

wind sources is that they need to occupy some land and it needs wide areas which are not always accessible easily. Though, Investments in wind energy is more beneficial in comparison with other sources of energy. On the rating of wind sources, it should be stated that low generation wind turbines that are considered as small sources and are usually between five to forty kWs and are used in domestic usages while bigger turbines which are in between of 100 to 400 kWs are generating power for industrial purposes.

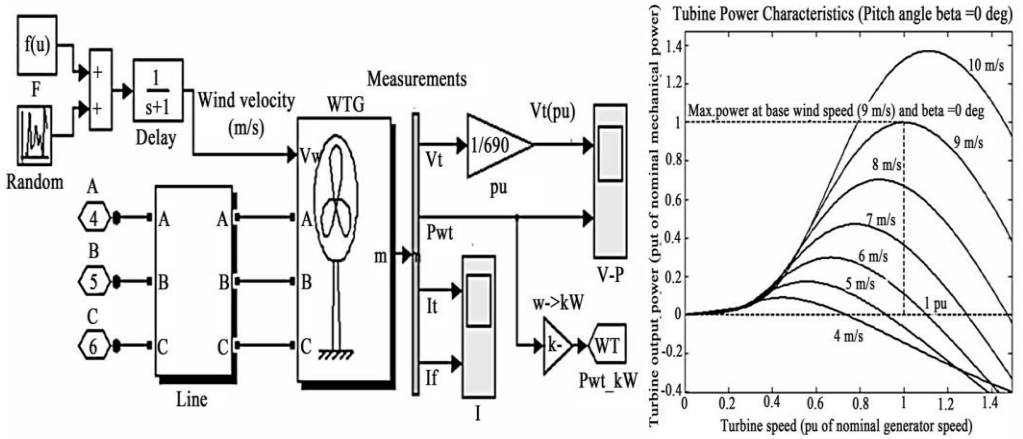
have the duty of changing the DC power (including both current and voltage) to AC power which can be used in purposes of real usages in domestic or industrial section. DC converters have the duty of changing amplitude of voltage in photovoltaic (Solar) systems.



B. Solar Energy

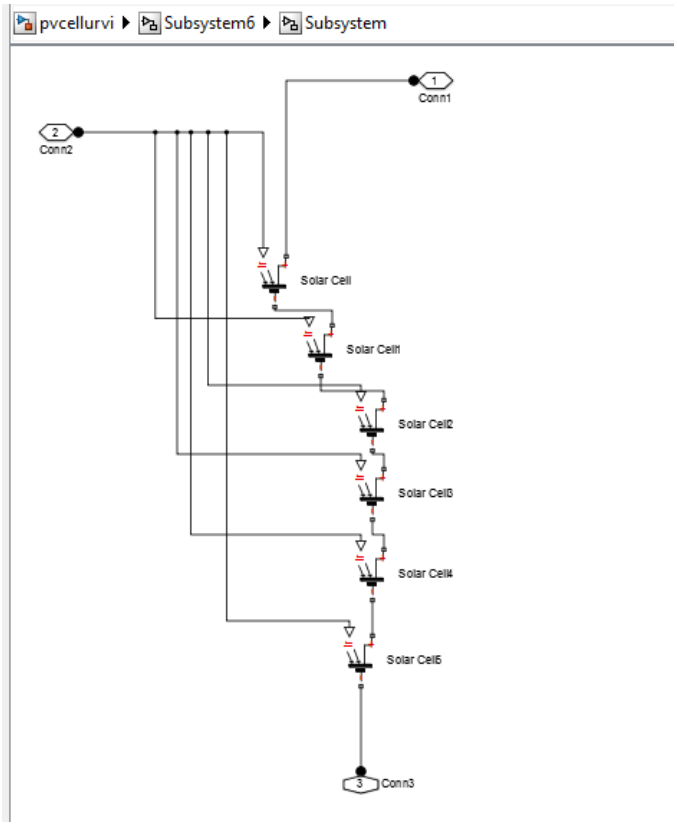
Solar systems are getting more economical and hence they are getting widespread due to increase in cost of electricity generated by ordinary power plants. The solar systems can be implemented on the roof of houses and industries and they can even be used in surface of the materials used to build the building surface itself. In cases the energy generated is not used in the local loads, it can be sold to grid (when the hybrid systems are grid connected) and the national network can pay back the generators the costs of energy used already by costumer by importing energy from main grid in terms of feed-in-tariffs. Although the efficiencies of solar systems are relatively high, but since there are certain limitations on amount of power generated by them, hence the final output energy is not considerable yet in comparison with other sources of energy. These limitations are pretty clear. Non- presence of light in half of day, limited capacity of batteries for saving extra energy in day and presence of clouds is a very important context that should be considered in positioning of installation and may result in reduction of energy generated.

Technologies used in PV panels are also enhanced. Reflections of panels are reduced and this will consequently increase the absorption of photons and hence energy generation. In addition, materials used in photovoltaic cells are also improving and this causes better generation of electricity for a constant level of radiation of photons. Nowadays cells do not need to be directly in front of sun. Although direct sun can increase the energy generation, but cells can provide sufficient amount of energy by indirect light too. Pitch of the cells in the installation point matters. For the countries above tropical line (Most of Europe, Asia and North America) cells should face toward south and based on the farness of country from tropical line, facing angle increase. For instance in UK the sufficient pitch angle in PV panels is around 40 degrees southward.

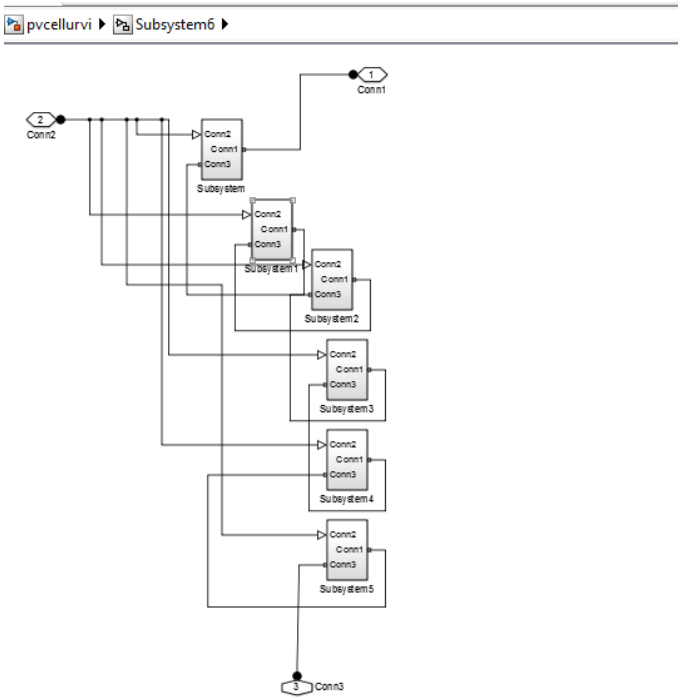


II. COMBINED WIND AND SOLAR CONSIDERATIONS

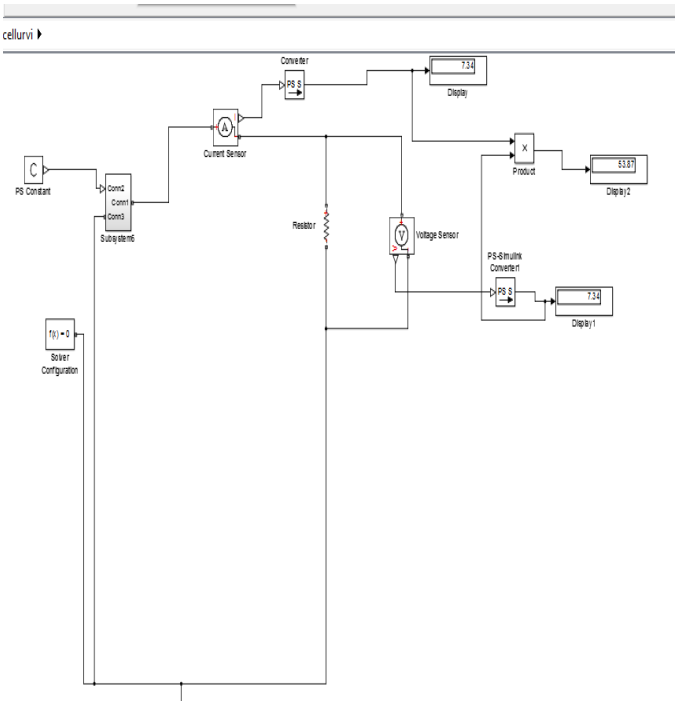
We have combined the Solar energy and Wind energy as a combined DG.To integrate the solar energy we have supposed the modeling of the solar cell. In that solar cell we have made a series and aparallel combination of the solar cell in case of increase in generation. For the simulation purpose we have taken thirty six cells. In which six are series with the six parallel cells.



We have combined the cells in parallel combination.



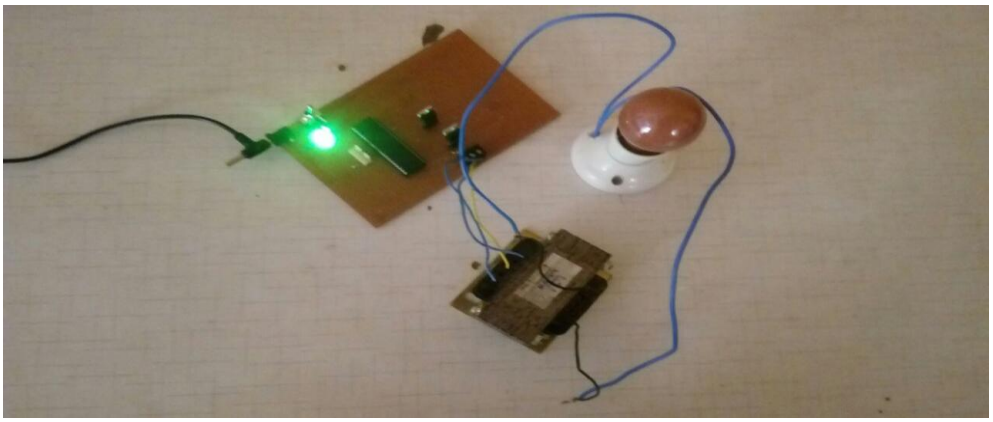
This will lead to the output of the system as a watt.



III. RENEWABLE ENERGY AS A DGS

Hybrid DGs are produced by connections of wind and photovoitaic sources to provide a more stable power source. These Solar cells are getting very efficient everyday and have the ability to generate a relatively high amount of energy and some parts of this energy is saved in batteries and UPS units to be used in darkness situations or in cases there is no wind blowings. On the other hand, Wind energy is of most environmental friendly energy sources available and this energy is provided by rotation of wind turbines and generation of the necessary power. In below you may see the schematic for the connection of wind and solar photovoltaic cells together to form the necessary system for this connection. Wind energy never finishes and it has no CO2 generation (at least when it is into practice, the only CO2 consideration for wind turbine is in the level of manufacturing of blades and turbine). Expansions of uses of wind energy are negligible as climate change and CO2 generations are increasing every day. Efficient design of larger and more efficient blades in turbines are of hot engineering topics today, as well as improvements in transmissions and turbine parts at comparable lower prices possible. Production of electricity is economical if the money invested comes back. In the wind section, capital cost should be considered well in advance which is the cost of building of plants and its grid connecting. In addition, running cost should be considered well which is the maintenance and expenses of applications in wind turbines. Hopefully wind is free and no price is paid for fuel section. The main problem of wind plants is covering capital costs. This could be where public or private sectors come into effect and they can cover for capital costs. The negligible fact is that wind energy is relatively not expensive and is getting more economical and raising funds for it is getting easier. In the mean time, cost of traditional energy technologies is rising and wind becomes economical.

Distributed Generation technologies are use described as micro-generators (Mostly renewable sources) in power systems. These systems can be implemented in sections of distribution system in the power line. It can be connected to a far local system to feed the local loads or it may be connected into the network grid to supply the rest of energy that conventional electrical power systems have not been able to compensate. DG technologies may operate with renewable energy sources or fossil-fuel generator inline. Based on design considerations, DG unit should feed all or parts of consumers requirements [8]. DG is usually connected to systems by using energy sources to provide a better energy security level and mitigate the risk of climate change that is occurred due to increase in use of fossil fuels. As it is seen in below network, a simple standard IEEE power system including six buses is provided to do a simple simulation over DG impact on power systems. It is seen that presence of DG sources in network causes lower system power loss and improved voltage.



CONCLUSION

From the experimented and calculated results we have obtained the solutions for the grid connections. We have calculated and obtained the solar energy generation with the output of 100 Watts.
This topic is currently being concerned by the alarms on global warming, pollution and carbon footprint emissions. Microgrid systems facilitate remote applications and allow access to pollution-free energy and gives impetus to the use of renewable sources of energy. Moreover, in an event of a power grid failure, a microgrid is one of the best alternatives. Renewable energy systems help to generate clean and sustainable energy as the demand for energy continues to rise. Nevertheless, there are several challenges that need to be tackled to facilitate
the RES that could be used to complete prospective. Renewable resources are widely distributed and due to the intermittent nature of power, such a new distributed system can be provided by various generation approaches to obtain the maximum potential energy of the sources. This survey paper has been dedicated to describe the microgrid term and the conceptual components are sketched for the different research fields. The possible research directions have been projected which are essential for future development of microgrid. Centralized and decentralized hierarchical controls of microgrids have been explained with the MAS decentralized control offers several advantages for example plug&play capability. The communication system, stability and control issues of microgrid have been presented. Finally, the possible feature of future microgrid has been illustrated with the growth of world distributed generation market.

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