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Analysis of Combination Power Generation Using Renewable Energy Sources and Its Applications

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Abstract:

In this study, we discuss effective energy management for a micro grid powered by solar PV, wind, and batteries. Both the solar fuzzy logic controller-based MPPT technique and the use of wind PMSG generators to increase power output are being studied. Bi-directional de-de converters and diode-based bridge rectifiers are used to integrate solar, wind, and battery energy sources. The efficiency with which these power converters operate will have an impact on how well a hybrid power generation performs. In this study, more precise fuzzy controllers are suggested for use with these power converters. Two situations, such as variation in RE sources with a constant load and fluctuation in load demand with constant RE sources, are examined for the proposed fuzzy controller-based hybrid micro grid. The proposed fuzzy logic controllers-based hybrid micro grid energy management approach makes stable energy management converters of power energy management. The technologies employed with solar hybrid systems for energy storage are thoroughly detailed in this chapter. Particularly discussed are several varieties of rechargeable batteries, as well as their chemical and physical compositions and electrical output properties.

Keywords: Hybrid power generation, Power Generation ,Renewable energy, Solar, Wind.

Introduction

The abundance of natural resources, the power sector is dominated by the expansion of electricity output from RE sources. Clean energy utilizing sources of renewable energy, such as sun and wind, is provided [1]. Both of this using energy from renewable source solar and wind are erratic natural power sources. Solar and wind energy sources are coupled in order to produce the power offered by the load, F[2]. RE sources are connected to the stored energy system like a battery to provide stable and dependable power to the load [3]. Power converters that combine renewable energy sources, such as solar, wind, and batteries, are essential [4]. To operate the power converters efficiently, a smart controller is needed. Since the notion of coordinated energy management for isolated hybrid micro grids or grid-connected hybrid micro grids was introduced, numerous architectures have been

proposed in the literature. Over the past two decades, many industry professionals have introduced the battery state of charge (SOC) topologies. Improved DC microgrid performance was explored in [5] by enhancing De grid voltage level with a battery-based SOC control technique.[6] created a small-scale, low-cost hybrid electronic circuit micro grid. [7] Presented a case study on the hybrid micro grid's optimization-based energy management. [8] discussed the ideal hybrid microgrid concept while taking into account variable load characteristics[9].The major goal of this project is to create a hybrid micro grid powered by renewable energy sources wind, solar PV, and batteries and operate its power converters efficiently. The following is the investigation's main goal: (i) Use fuzzy controllers to efficiently run the power converters. (i) Make the most of solar energy.

Utilizing a fuzzy MPPT control system. (iii) Regardless of how much electricity the RE source is producing, give the load a steady state voltage. To meet the load requirement, (iv) implement suitable energy management between the RE sources. (v) A constant (50V) level of regulated DC bus voltage; (vi) Proper battery operation between its state of charge (%SOC) levels. The following subsections of this text are separated as follows: Fuzzy controllers based on SECS, WECS, and battery storage systems were presented in part II. In two case scenarios where the proposed method was used, the produced load power is constant and the DC link voltage is regulated, Addressed the simulation findings. is an overview of the findings from this research.

I. HYBRID RENEWABLE ENERGY

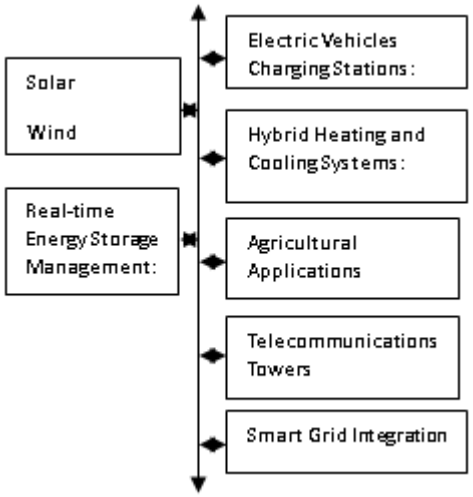

Fig. 1. Block diagram

The hybrid RE power-fed load's construction three alternative energy are combined in this design, with the DC bus connected to the rectified solar and wind power and the DC-DC boost converter. The storage device is coupled with a simultaneous DC-DC powered converter configuration to regulate the electrical voltage of a DC connection [10]. An inverter circuit was used on the load side to make it easier to supply electricity to the load. SECS, short for Solar Energy Conversion System Solar PV modules plus a boost converter make up SECS[11]. Using fuzzy logic controller (FLC)-based MPPT, the solar pv panels' maximum power is obtained. Technique. Depicts the configuration of the fuzzy controller-based SECS system[12]. The variable duty cycle to operate the boost converter is obtained by taking into account the change in PV power and PV voltage levels, whilst

the fuzzy MPPT technique maintains PV voltage close to MPP voltage[13]. When the PV power rises, the voltage is increased further; when it falls, the voltage is decreased.

II. WIND ENERGY

The WECS (Wind Energy Conversion System) A wind generator connected to a PM synchronous generator (PMSG) creates the WECS in order to convert wind kinetic energy into electrical energy[14]. An MPPT with boost converter and a diode-bridge three-phase rectifier are used to rectify the obtained ac voltage. The frequently chosen over PMSG because it requires less maintenance, has lower operating costs, and limits greater efficiency. The Fig 1 availability of wind speed may affect how the PMSG develops its power. The fuzzy controller-based WECS is structured[15]. The boost converter is successfully operated with the fuzzy controller to enhance the rectified DC voltage from the diode bridge circuit. The wind turbines kinetic energy per second is calculated as follows: The following equation can be used to Energy that moves into another form of the wind into electrical energy if the cross sectional area A of the wind turbine rotor is exposed to this wind. The rotor receives a portion of the kinetic power in P-PAV[16]. The wind also takes the remaining power with it. Coming out of the turbine. Where A- Dimensions of the rotors segment m3, P Power generated (watt), and Cp Coefficient of Power. BESS or battery energy storage system. Even load mismatch, fluctuating load, or variation in RE-generating storage elements are introduced into the micro grid to deliver continuous and stable power to the load[17]. Depicts the structure of the fuzzy controller-based BESS. The two main modes of operation for BESS are charging and discharging[18]. Similar to when load demand is higher and insufficient power is provided by RE sources, the battery can inject (operate in discharging mode) the electricity into the circuit if there is a lower load demand and more surplus power produced by RE sources. Bi-directional DC-DC converters based fuzzy controllers are used to operate the battery energy levels with great care.

III. INDUSTRIAL METHODS

Biomass Energy including bio energy in the form of biogas or bio fuels, biomass can be utilized to generate heat and power for industrial uses. Fig 2 Industrial processes can also make use of steam and solar heat. Agriculture irrigation systems can be powered by renewable energy, lowering agriculture's carbon footprint. Biogas produced from agricultural waste can be utilized for cooking and heating in rural areas. Water Desalination in dry places, fresh water can be made from saltwater or brackish water by combining renewable energy with desalination technologies. Grid Stabilization and Energy Storage when used in conjunction with energy storage technologies like batteries, renewable energy sources like solar and wind can help maintain the stability of the grid. Energy storage enables the storage of extra energy for usage during times of high demand or when renewable energy sources are unavailable[. Environmental Conservation To protect natural ecosystems and lessen environmental effect, wind and solar farms can be built on damaged land. The necessity for damaging techniques like mountaintop removal mining is diminished by renewable energy. Emergency and Disaster Relief traditional power sources are down, solar power and portable wind turbines can supply vital electricity during emergencies and natural catastrophes. Water and Wastewater Treatment water treatment facilities and wastewater treatment facilities can be powered by renewable energy, which enhances water quality and lowers operating expenses. Research and Development In the continual drive to produce cleaner and more sustainable energy solutions for the

future, renewable and alternative energy sources are essential. Depending on the resources, policies, and infrastructure that are in place, different regions adopt different renewable and alternative energy sources. These energy sources are anticipated to take on a bigger role in the global energy landscape as technology develops and costs come down. use of the output graph for renewable and alternative energy sources.

IV. Results and Discussion

The simulation results are run for the two scenarios of variable RE sources with constant load and variable load demand with variable RE sources to validate the efficacy of the suggested strategy. The simulation runtime is 70 seconds for these two cases[19].

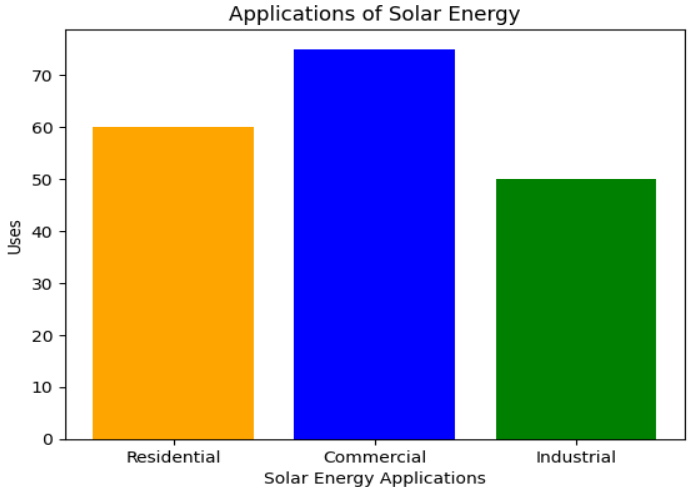

Fig. 2. Solar Energy Applications

Solar and wind energy are combined to meet the 100W load demand. Improve the micro grid system's dependability by using the battery in both charging and discharging modes. In this instance, the power generated by sun and wind varies quickly in relation to time[20]. The main goal of this scenario is to generate stable electricity for the set load even under erratic power-generating circumstances. The varying irradiance is taken into account as 1000W/m2, 800W/m2, 400W/m2, and 600W/m2 at particular times to produce variable solar electricity. The associated solar irradiance levels and developed PV power are configured.The variable wind speed is defined as 14 m/s, at specific periods to provide variable wind power. The corresponding wind speed fluctuation and accompanying wind power developed are set up. In order to balance solar-wind power generation and the battery, the required power (100W) must be reached. A source of energy is used. Fuzzy control is used to ensure that the battery charging and discharging process runs smoothly. gives the load stable power while controlling the DC link voltage at SOV. The relevant battery power, DC link voltage, and load power are set up.

TABLE I. INTEGRATED SOLAR UAV

Integrated Solar UAV Speed , Range , Solar Panel Capacity Approx				
UAV 2 - Max Speed: 100 km/h, Max Range: 250 km, Payload Capacity: 3 kg, Solar Panel Capacity: 6 m^2	UAV 2.1 - Max Speed: 90 km/h, Max Range: 220 km, Payload Capacity: 2 kg, Solar Panel Capacity: 4 m^2	UAV 1 - Max Speed: 80 km/h, Max Range: 200 km, Payload Capacity: 2 kg, Solar Panel Capacity: 5 m^2	UAV 1.1 - Max Speed: 70 km/h, Max Range: 180 km, Payload Capacity: 1 kg, Solar Panel Capacity: 3 m^2	UAV 1.2 - Max Speed: 75 km/h, Max Range: 190 km, Payload Capacity: 1 kg, Solar Panel Capacity: 4 m^2

The suggested method enables continuous power to be delivered to the load even though the RE sources only supplied variable power. In Table 1, the load power that each power source shares with respect to time is reported. When there is a surplus of power produced by renewable energy sources, the battery can be charged, and when there is a deficit of electricity, the battery can be discharged to equalize the amount of power needed by the load. In this case, the variable load is coupled to the micro grid that continuously generates solar and wind energy.

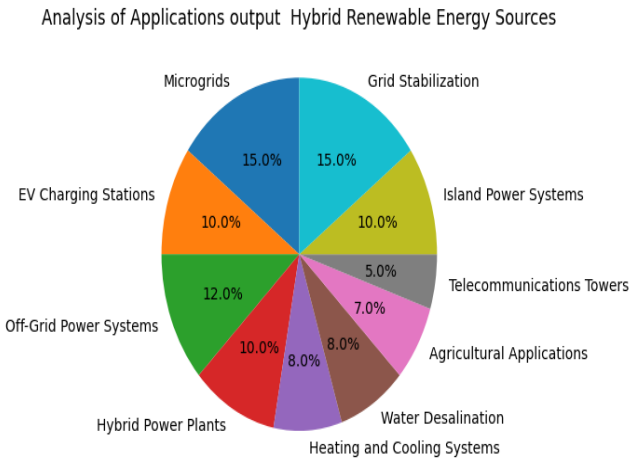

Fig. 3. Analysis of Applications output Hybrid Renewable Energy Sources

They maintained sun irradiation at 800 W/m2 to generate SSW power from the PV panels. Similarly, the wind speed is maintained at 11 m/s to generate 40 W of power from the wind. The corresponding solar irradiance, wind speed, and associated PV and wind power are set up, correspondingly. Fig 3 and 4 Battery energy is used to provide the varied power needed by the load, such as 20W, 100W, 70W, SOW, 70W, 100W, 110W, and 120W at various periods. Fuzzy control is used to ensure the battery operates successfully during charging and discharging[30]. Gives the load stable power while controlling the DC link voltage at 50V

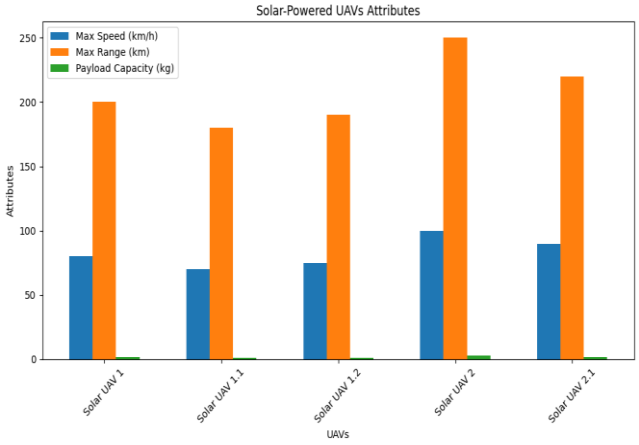

Fig. 4. Output Integrated Solar UAV Graph

Solar photovoltaic (PV) panels, which are frequently employed in residential, commercial, and utility-scale applications, produce electricity from sunshine .

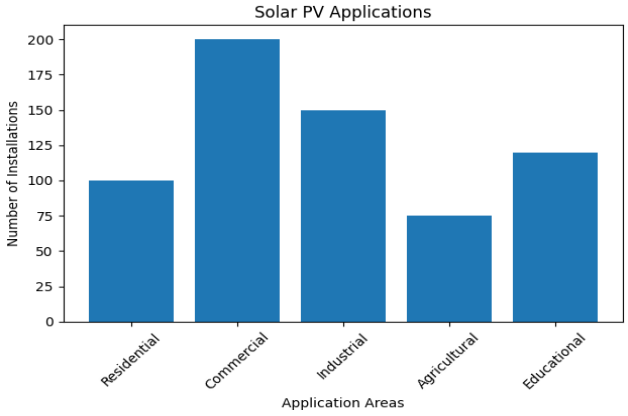

Fig. 5. Applications Integrated renewable energy branches

Wind Turbines: Used in both onshore and offshore wind farms, these machines convert wind energy into electricity Hydropower Create electricity by using hydroelectric power plants and dams to capture the energy of moving water. Heating and Cooling: Solar Thermal Systems: These systems heat water or other fluids using sunlight for industrial processes, home hot water, and space heating.

Fig. 6. Ouput kit of Renewable Energy Sources and Its Applications

Transportation: Electric Vehicles (EVs): Use electricity instead of petrol or diesel for cars to cut emissions and reliance on fossil resources. Bio fuels: Produced from organic resources such as corn, sugarcane, or algae, bio fuels can be blended with gasoline or diesel and used in conventional internal combustion. Off-Grid and Remote Power: In off-grid and remote locations where grid connections are impractical, renewable energy sources are crucial for supplying electricity. For decentralized power generation, solar cells, wind turbines, and micro-hydropower systems are frequently employed.

V. CONCLUSION

Integrating RE sources while balancing the power demand from the load is a difficult task. Energy management between hybrid power sources is not possible with the use of conventional PI controller-based power converters. Fuzzy controllers are used to operate power converters in order to solve this problem, supply the power required by the load, and maintain a consistent level of DC link voltage. According to the simulation results for both situations, varying the RE sources while maintaining a constant load and varying the load demand while maintaining a constant RE source maintained a steady DC voltage for the load.

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