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EFFICIENT ENERGY MANAGEMENT IN MICROGRIDS UTILIZING RENEWABLE ENERGY SOURCES

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ABSTRACT- The major goal of this project is to create a power management system that governs the energy requirements and power transmission of a fully integrated green energy system, with a focus on solar and wind power. Control systems and highly reliable storage systems are essential to ensure that the entire system runs smoothly and consistently. The frequency and voltage of the line-side converter can be controlled by indirect vector control with droop characteristics. Fluctuations in frequency result from changes in the battery's energy status, particularly during the charging and discharging operations. Despite the lack of wind energy, the system continues to function. An Intelligent Power Management System (IPMS) is designed to handle changes in power demand and supply by establishing a dependable control algorithm for the entire system and regulating unpredictable power. This allows for the testing of various power supply and power needs via a power system. Simulations have shown that the IPMS can reliably meet demand by utilizing batteries and intermittent renewable energy sources such as wind and solar power.
Keywords- Control system, IPMS, PV, Systems Power Energy.

1. .INTRODUCTION

In many isolated places of the world today, diesel engines are the only source of power. It is expensive and spreads quickly when using these energy sources. To alleviate these challenges and better meet people's requirements, we need to generate a lot of power in the area. The author has a separate PV setup with a self-contained windmill. However, a self-sufficient machine with a single energy source requires a significant amount of storage and PE components that work with it. This is typically required for converters that use solar electricity to charge and discharge batteries. Nevertheless, the due date It is more expensive and heavier due to its complex construction. Furthermore, converting in phases makes the system less efficient.

When two or more hybrid power sources are combined, the system becomes more reliable and does not require as much BES. Hybridization works best with both solar and wind energy. Action patterns that occur on a regular basis throughout the year are well documented. Say kind things. It has been presented independently by several different writers. To maximize the benefits of this combination, use a hybrid solar and wind configuration. The permanent magnet synchronous generator is most commonly employed in small windmills. Even for more expensive machines, a PMSG can be built without gears. SCIG can produce machines at a lower cost than other firms since they do not have to limit the speed to achieve the MPPT.

Some contributors also built SCIG engines and wind-solar hybrid systems. Furthermore, once speed control is established, a complete conversion is required. Many writers are writing on solar and self-sufficient applications. Wind power has been employed in industry, with one example being a dual power induction generator (DFIG). Low-power converters can be utilized to power the DFIG Variable Speed Process. This is an example of a microgrid renewable energy system (REGS) powered by wind and equipped with a solar-powered light source. Diode characteristics combined with a PV system that monitors high power points and includes numerous DC-DC converter inputs for conversion

We examine at how effectively the DC converter works and how many power sources may be used simultaneously.[3]

Other photovoltaic (PV)-based totally autonomous energy systems, such as PV solar arrays and batteries, are frequently used to regulate the power generated [6] from various energy sources and offer clients with consistent energy in the appropriate form. Three different DC-to-DC converters may have been utilized previously. This study demonstrates how to employ a remoted dc/dc 3-port converter (TPC) for PV to reduce the cost of the energy gadget while increasing its energy density [9]. A battery energy storage system (BESS) is added to the hybrid device to help keep energy levels stable as wind, sun, and freight change [10, 11].

A DC-DC enhance converter regulates the utilization of low-voltage PV and battery backups to extract the maximum energy from a solar PV array while also adjusting the output DC voltage. It accomplishes this by utilizing perturbation and statement high-voltage advantage converters. This minimizes the impacts of parasitic capacitance and partial shadowing at the PV source. Many distinct battery units can be linked together in series without necessarily being connected in series. This prevents problems like overcharging and deep draining, which reduce the battery's life.

The suggested manipulation methods are demonstrated using MATLAB/Simulink, and their overall performance is evaluated in real time when there are stable, unstable, linear, and nonlinear masses, as well as when the weather changes.[4] Because of its tiny size, the area of wind power that has received the greatest attention recently has been distributed generation employing small wind turbines (200 kW power plants). You can add extra power sources to your system as needed because they all connect to the same power line.

A lot of emphasis has been dedicated to the development of active and reactive power controls, as well as dump power controls. Consider how a stand-alone hybrid power system that combines both wind and solar energy works to increase system reliability and energy conversion efficiency. The results demonstrated that the system could accurately adjust the flow of energy under various loads and weather conditions.

They also demonstrated that the amplitude and phase of the proposed hybrid system's AC output voltage were accurately adjusted. If Microgrids (MG) are the general concepts investigated in a number of studies [3], global energy consumption will have increased by more than 25% by 2040. Green energy sources, which are growing increasingly popular, are expected to account for approximately 40% of global energy consumption. The fundamental cause for the unreliability of green energy sources is a mismatch between supply and demand [2].

Energy is brought closer to its users by reimagining energy systems, energy storage, renewable energy sources, and distributed generation (DG). This energy is derived from renewable sources.[12] PV DC microgrids exhibit significant time variation and nonlinearity. As a result, classic dual voltage and current regulation systems based on PI[14] controllers will be unable to effectively restrict changes and effects of DC bus voltage, even if the system's dynamic response is increased. The voltage and frequency of the road facet converter are regulated by diagonal vector control in the Droop property [15].

It adjusts the frequency reference based on the battery's energy level and slows the rate at which it charges or discharges. This strategy remains effective even when there are no wind energy sources nearby. Every wind and solar energy block has a function called maximum power point tracking (MPPT) incorporated into its operation. There is no need for more electricity because the device's power source recharges the battery. For various conditions, a Simulink or MATLAB model is created.

2. TOPOLOGY STRUCTURE

Figure 1 shows a schematic drawing of the REGS device micro mesh that was provided. The approach is intended for areas that can accommodate the most people. 15 kW on average and 5 kW on average. With solar blocks, REGS can manage up to 15 kW of wind power. The incubator can operate at 20% power, which is sufficient to power both power blocks for a day. If there aren't enough wind energy sources, the circuit breaker will protect the system, as seen in the image. The CC side RSC and LSC connect to the HV side of the solar system, which stores energy in batteries. The LSC controls both the cycle rate and the voltage of the machine. This is the wind energy absorption rotor that powers the DFIG. Mechanical power has a value based on

$$Pm\ 0{:}\ 5Cp\pi r2\rho V^{3}_{w} \quad (1)$$

Here, r and Vw represent the precise radius and speed of the wind that the wind machine is facing. The generator in the suggested configuration can generate 17 kW of power at a wind speed of 12 m/s. A current from outside the DFIG powers the stator and rotor. The DFIG clearance (Pag) grade is related to not accounting for losses at the greatest wind speed. The unit's electrical power threat is assumed to be equal to the maximum power of the entry, which is an air gap. RSC delivers all of the magnetism power that a wind rotor requires when in operation. With the appropriate quantity of DFIG power, 15 kW of wind energy may be converted into electricity.

$$Pe=Pag / (1+|S_{pmax}|) \quad (2)$$

To connect the load and stator poles to the LSC, a zigzag transformer is employed. The LSC is also neutral for single-phase loads on the 415 volt side. The voltage on the LV side of the zigzag, Vrmax, is likewise selected. So, the transformer's HV coil, stator, and load voltage ratio of 415/125 V remain constant. The internal resistance Rin could be a direct current power source with a capacitor Cb. It's connected in series. The battery is also connected to an additional RB resistance, allowing it to relax on its own. The open cell voltage (VOCC) and DC voltage indicate how many cells are in the circuit. NC VDCM equals VOCC°3þ. RC filters are utilized in the stator connection to reduce voltage waves and frequencies below the fundamental frequency. In addition, the switching frequency must be matched in half.

Table 1: Technical details of solar block.

Open circuit voltage of PV cell, Vocc	0.64 V
Open circuit voltage of a module (voc)	23.04V
MPP voltage of PV cell, Vmpc	0.5223V
MPP voltage of module (Vmp)	18.83V
Short circuit current of module (Isc)	8.69A
MPP current of module (Imp)	8.04A
A Module Power Rating µIsc µVoc	151Wp
Pv modules in the solar block	0.04%/oC
String open circuit voltage (SOCV)	-0.36%/oC
	11 strings each are having 9 PV modules
	207.36V

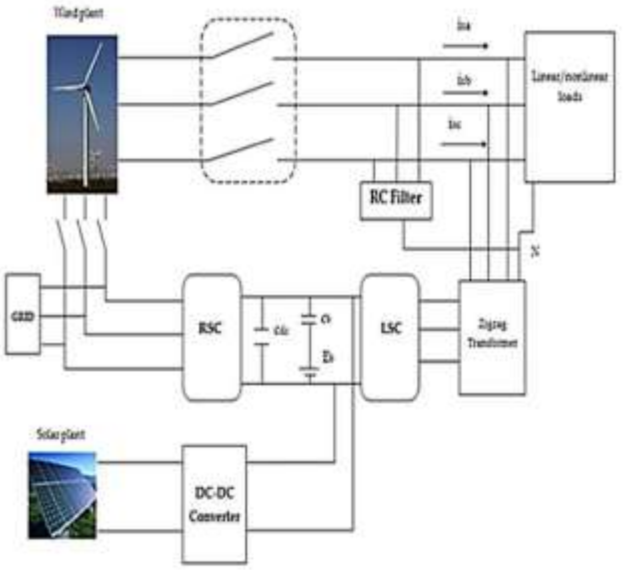

Figure 1: Schematic diagram of a hybrid microgrid of renewable energy sources

3. CONTROL STRATEGY

DC-DC converter with built-in SMPPT logic for variable resistance solar converters that harvest energy from the sun. When the solar system is operational, SMPPT converts to MPP in an intelligent manner, giving us control. Onshore wind turbines only need to generate energy 60-70% of the time to stay operational when there is no wind. Figure 2 shows the control approach. I*qs is comprised of two pieces. When the wind machine is operational, the first portion, iqs1, displays the DFIG's current power. Iqs2 is the second half used when the DFIG stator is not connected to the load terminal. To connect the generator to the filter, you need a particular quantity of reactive power, known as DC I*ds. If you look at the text below, you'll notice that the I*qs and I*ds numbers assist keep the voltage and frequency stable during indirect vector control..

$$I^*_{ds}=I_{ds(k-1)}+K_{pv}(v_{err(k)}-v_{err(k-1)})+K_{iv}v_{err(k)}dt \quad (3)$$

$$I^*_{qs}=I^*_{qs1}+I^*_{qs2} \quad (4)$$

The RSC controls the turbine speed, allowing the gadget to operate within the MPP. It also provides the engine with the necessary energy to power the magnets. The concept depicted in Figure 3 consists of the orthogonal manipulation, the straight rotor thing currents Iqr, Idr, and the transition viewpoint h slip. Field Oriented Vector Control (FOVC) links the device's magnetization electricity to the Idr. Kp and Ki have to do with the advantage provided by the PI pace controller. These fluctuations in wind speed enable MPP to be contained and voltage spikes to be managed when demand is low and production is high. Using the two circuits, k1 and k2, one may determine how much okay costs.

$$\theta_{slip}=\int_0^t (w_e^* - (\tfrac{p}{2})w_r)dt$$

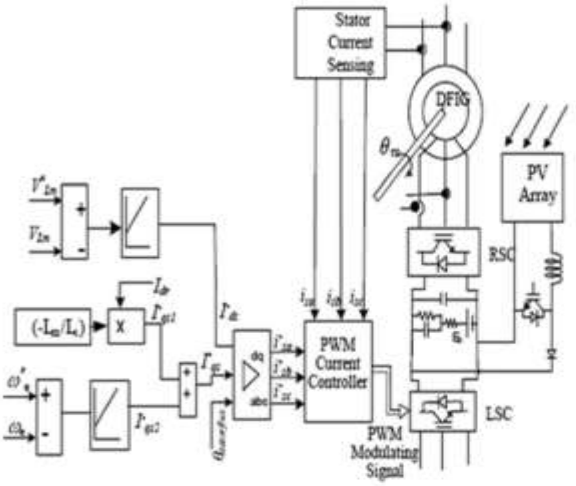

Figure 2: Control strategy of LSC

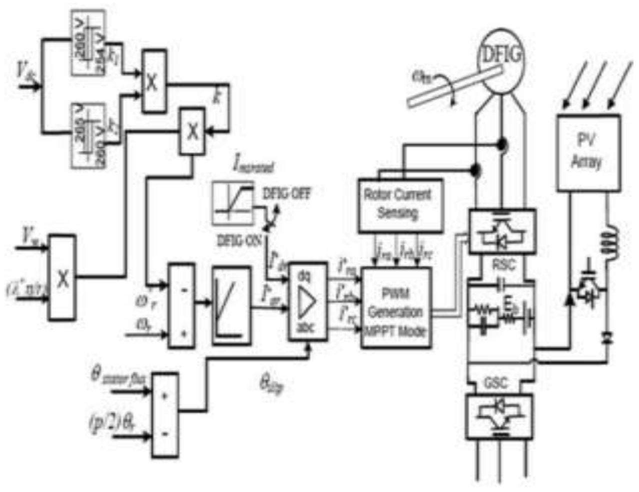

Figure 3: Control strategy of RSC

4. SIMULATION RESULTS

Case-A: System performance at cut in and cut out of wind power

Figure 4 depicts that 10kW and 6kVAR loads are applied before they begin.Any power source derived from the sun or wind. At time t = 0.05 s, the wind power generator is moving at a speed of 7 meters per second. As a result, the device's power will fluctuate briefly. Windmill at t = 0.5 second. The wind speed decreases after increasing from 7 m/s to 8 m/s at t = 1.0 second. The performance of the rotor control is maintained at its peak. The WMPPT method was utilized to determine the rotation speed. or The windmills turn off at time t = 1.4 seconds.

Case-B: System performances at cut in and cut out of solar power

When there is no solar or wind power, the machine will start with 10kW and 6kVAR loads. As illustrated in Figure 5, we employ a solar setup that emits 800 W/m2 of light at t = 0.05 s. At t = 0.34s, the light level reached 900W/m2, then at t = 0.52s, it decreased to 800W/m2. Every shift in direction takes t = 1.08 seconds, after which the solar system comes to a stop. The device's power changes in noticeable ways.

Case-C: System performances at unbalanced and nonlinear load

Figure 6 illustrates that the nonlinear tool behavior is not balanced. To accommodate the unequal nonlinear demand, a sufficiently large microgrid is required. The load receives two kW of linear power and eight kW of nonlinear energy. At t = 3.25 seconds, the a-section load will be removed from the community. At t = 3.46 s, the b-section load will perform the same. The results show that the tool can provide the most power even when the load is not flat or linear.

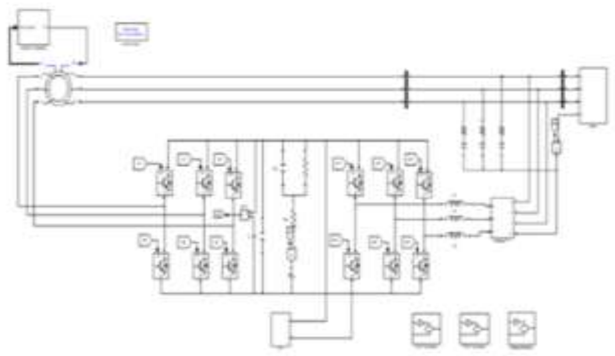

Figure 4: Performance of a system at constant load and cut-in and cut-out of wind power

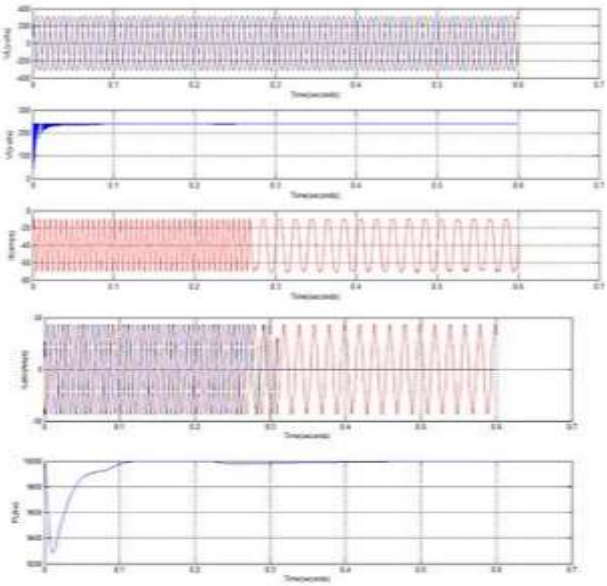

Figure 5: System performance at unbalanced and non-linear load

5. CONCLUSION

The proposed REGS microgrid technology proved to be effective. It is in a remote location and does not require a large amount of home load. REGS, with the use of blocks intended to gather energy from the sun and wind, can provide power while using the most renewable energy possible. The apparatus is designed to function totally on its own. The study also shows the sizes of the key sections. It instructed the system on how to adjust the input state for various types of load profiles. Regardless of the load terminal state, the power quality remains satisfactory. How dependable is the SIMULINK/MATLAB findings approach.

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