Utilization of Renewable Energy Resources to Enhance the Energy of EV Station

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***Abstract-* Demand for electric vehicles (EVs) is growing steadily, which causes a number of big problems. One of the biggest problems is that there aren't enough charging stations. Nations are working to speed up the growth of renewable energy sources that can be used to power charging stations. This is to reduce the damage that carbon emissions do to the environment. Battery switching stations (BSSs) that are powered by photovoltaic cells (PV) use the traditional integration of renewable resources that are used to provide electricity for electric vehicles (EVs). The charging strategy of PV-based battery storage systems has a big impact on the availability, cost, and carbon footprint of the switching service (BSSs). In this study, an optimal charging method is proposed to. Cat-and-mouse optimization is used to figure out how much the battery should cost based on how many cars can park there, how much power the PV system can produce, how much load is connected to the PV system, and how many electric cars are available (EVs). By keeping the BES at the best speed for charging and discharging the battery, the battery will last longer.**

Keywords- Electric vehicle, Solar, Wind, Grid

1. INTRODUCTION

The increasing popularity of electric vehicles (EVs) can be attributed to the depletion of fossil fuels and the growing concern over greenhouse gas emissions and their impact on the environment. Electric vehicles can be connected to the power grid and charged using either on-board or off-board chargers [1]. Research has demonstrated that the implementation of coordinated electric vehicle (EV) charging can mitigate adverse impacts, such as heightened peak load, that may arise from the integration of a substantial number of EVs into the power grid. Extensive research has been conducted in the technical literature regarding the aforementioned effects. The findings indicate that the adverse impact of EV charging on the power quality of low-voltage electricity distribution grids is the root cause. Electric vehicles (EVs) have the potential to contribute to the electric grid by providing both active and reactive power, regardless of their connection status to the grid. The rationale behind this is that electric vehicles possess the ability to retain energy and function as a means of transferring power from the vehicle to the grid, commonly referred to as vehicle-to-grid (V2G) technology. This phenomenon can occur regardless of whether the electric vehicle is connected to its battery or not. The operation of V2G reactive power results in the exposure of the battery of an electric vehicle to a ripple current component of switching frequency for an extended duration, which is considered unfavourable. A significant concern regarding V2G reactive power compensation pertains to the potential depletion of the battery and resultant power conversion losses due to the persistent operation of the power converter [2]. According to the authors, it is recommended that the electric vehicle's battery should not be linked to the charging system when the vehicle is not actively utilising power from the public power grid. Disconnecting the battery from the charger may reduce the potential for V2G reactive power correction to cause harm to the electric vehicle's battery. However, the present study did not examine the significant impacts of disengaging the battery from the electric vehicle charger. The aforementioned factors encompass dynamic performance, capacitor dimensions, and the regulation of capacitor voltage. Electronic power inverters play a crucial role in the battery storage systems utilised by electric vehicles (EVs). The topology of the boost inverter is a differential inverter topology for a single phase, which integrates the functions of boosting and inverting into a solitary power conversion stage. The nomenclature commonly used to refer to this configuration is the boost-inverter arrangement.

2. RELATED WORK

V.V. Subrahmanya et. al. 2021, The present research showcases a novel bidirectional DC-DC converter with zero-current switching, designed for application in dual voltage automotive systems. An enhancement has been made to the hard-switched DC-DC converter through the incorporation of an additional auxiliary resonant network. This network comprises two auxiliary switches, two resonant inductors, and two capacitors. This represents an improvement over the previous iteration. The aforementioned converter has the capability to transfer power between low and high voltage levels bidirectionally. This represents one of its functional characteristics. The implementation of dual auxiliary resonant networks enables the achievement of soft-switching operations for both the turn-on and turn-off phases, specifically zero-current switching (ZCS) techniques. Moreover, the auxiliary switches are capable of ZCS turn-on/turn-off operations with minimal additional losses. The aforementioned topology confers numerous advantages, however, the two most salient benefits are reduced switching loss and increased efficiency, as documented in reference [3]. This study presents an analysis of operating principles and design simulations to demonstrate the validity of the theoretical analysis. The simulation of the converter's design involves the utilisation of a 100/350V/500W converter system operating at a switching frequency of 75 kHz.

Evgeni Malev et.al. 2021 In a wind-solar complementing system that is geographically dispersed on a large scale, there is a lack of information exchange between the subsystems, which poses a significant obstacle to achieving synchronised optimisation. The utilisation of distributed model predictive control is implemented in the entirety of the wind-solar complementing system with the aim of optimising and regulating the power balance of the system while simultaneously maintaining stable voltage levels, as stated in reference [4]. The utilisation of a multi-port bidirectional DC-DC converter is recommended for the wind-solar complementary system as a solution to address the issue of power flow in the wind, photovoltaic, and battery subsystems that arises from the use of multiple single-port bidirectional DC-DC converters. According to reference [3], implementing this approach would result in a reduction in both the quantity and expenses associated with DC-DC converters. The findings of the study indicate that the suggested approach of distributed model predictive control can be effectively employed in the context of a wind-solar system featuring a multi-port DC-DC converter, which serves as a supplementary power source to solar energy. In contrast to conventional control methods [5], the utilisation of this approach yields a significantly elevated level of optimisation while concurrently ensuring the continued safe and dependable operation of the system.

3. PROPOSED WORK

Electric drive vehicles, commonly referred to as EDVs, employ the fundamental concept of vehicle-to-grid power transfer to supply electricity to the grid during stationary periods. The EDV has the potential to function as a battery-electric vehicle, a fuel cell vehicle, or a plug-in hybrid car, among other possibilities. Plug-in hybrid electric drive (HEV) vehicles are capable of functioning in all modes of operation. Electric vehicles (EDVs) possess the ability to store energy in the form of a battery and utilise power converters to generate 50 Hz AC voltage, which is identical to the voltage utilised for powering residential and commercial establishments. These vehicles can be powered by batteries, fuel cells, or a combination of petrol and electricity. The transmission of electrical energy from automobiles to power grids is commonly referred to as "vehicle-to-grid" (V2G). Electric drive vehicles (EDVs) that are equipped with additional connections to enable the charging of their batteries from power lines are commonly referred to as Grid-to-Vehicle (G2V) systems. The utilisation of a single-phase bidirectional AC-DC converter facilitates the conversion of alternating current voltage to direct current voltage. During battery depletion, the buck-boost DC-DC converter transitions into boost mode. During the charging process, the battery enters the buck mode as indicated by reference [7]. The system's functionality was demonstrated through the successful charging and discharging of the battery.

4. MATLAB SIMULATION

When parked, an electric car adds to the power grid in the same way that a solar panel does. "Vehicle-to-grid power" is the name for this kind of power transfer. The EDV could be a car that runs on batteries alone, a car that runs on fuel cells, or a plug-in hybrid vehicle. Plug-in hybrid electric drive vehicles (EDVs) can go forward or backward. Even if they are powered by batteries, fuel cells, or a combination of the two, their batteries and power converters store enough energy to provide the 50 Hz AC voltage that our homes and businesses use. Even if they are a mix, this is still true. V2G is the process of hooking up vehicles to power lines so that electricity can flow from the car to the power lines (Vehicle to Grid). In this case, EDV batteries can be charged by plugging them into power lines. This is known as "G2V." (Grid to Vehicle). As an alternative to it needs to make sure that its grid power generation meets the needs of driving while also meeting the time-critical "dispatch" needs of the electric distribution system. PHEVs get power from the grid so they can drive with less fuel. When it comes to how well PHEV cars work, the battery makes a big difference. Show in figure 1 matlab Simulink mode

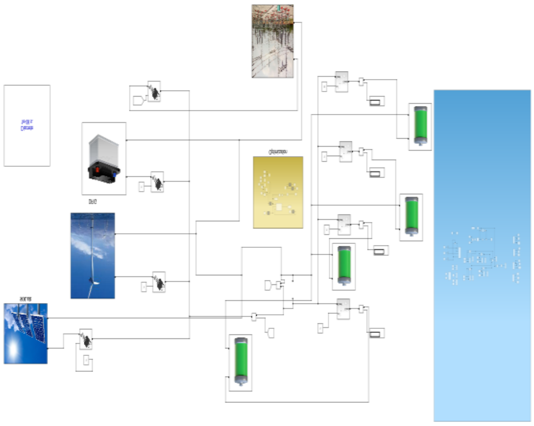

Figure 1: MATLAB Simulink mode

Modules

- Solar power
- MPPT Algorithm
- Boost converter
- Wind turbine
- Grid
- Bidirectional converter
- Battery
- PWM Switching

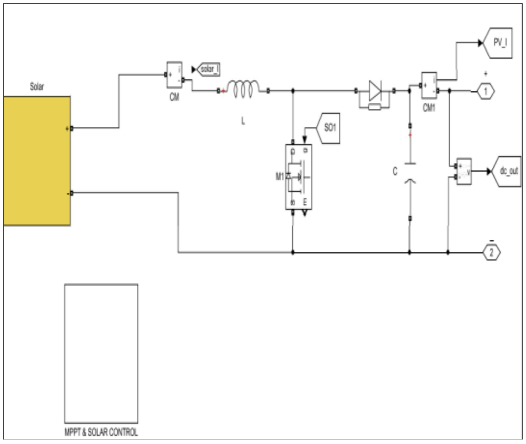

Figure 2: Solar Subsystem

Most wind and solar energy conversion devices are made using a method called "Perturb and Observe." In a solar photovoltaic (PV) system, the voltage and current of the PV output are checked at two different times that come right after each other. The power is figured out for two different times that come after each other. dP/dV stands for the ratio between the change in power and the change in voltage. The duty cycle is changed so that it matches the impedance better. Listed below are the steps of the algorithm.

Algorithmic steps:

Step1: Measure the two consecutive values of voltages and currents of solace PV

Step 2: Calculate the powers P(n) and P(n-1)

Step 3: If the powers are increasing, then decrease the duty cycle

Step 4: If the powers are decreasing, then increase the duty cycle

Step 5: Go to step 1

Wind Turbine

This block has a model of a wind turbine with a blade that can tilt in different directions. The wind speed, the speed at which the blades turn, and the pitch angle all affect the coefficient of performance, or Cp. Cp is a way to measure the power of a machine (beta). When beta is equal to zero, Cp is at its highest possible value. If you look at the power characteristics display on a wind turbine, you can see how it works when it is tilted at different angles of attack. First, you'll need to figure out how much faster the generator is running than its base speed. The speed of any generator, whether it is synchronous or not, is called its "sync speed," even if it is not synchronous. It is the main speed that a generator works at. When there is no load on a permanent-magnet generator, it runs at what is called its "base speed.

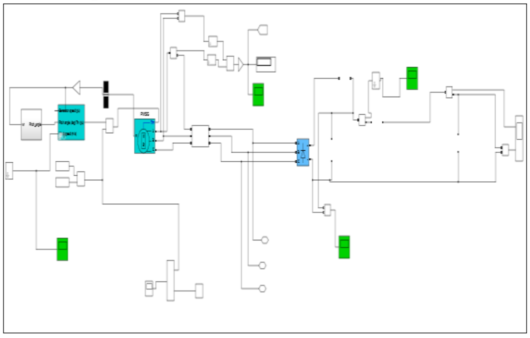

Figure 3: Wind Turbine Model

In this study, the grid-interfaced DFIG-based WECS is suggested as a way to smooth out the power. When trying to guess where the rotor is, the method of rotor position computation is used [4]. The work stands out because GSC is in charge of it (Grid Side Converter). So, the authors have shown beyond a reasonable doubt that their control algorithm can send regulated electricity to the grid. Another important part of DFIG-based WECS that helps smooth out power is the BESS selection. By looking at the difference between the traditional DFIG and the recommended DFIG, you can see how the power changes when the wind speed goes up. Tests have shown that the method works well to control how much electricity DFIG generators make, even when the wind speed changes.

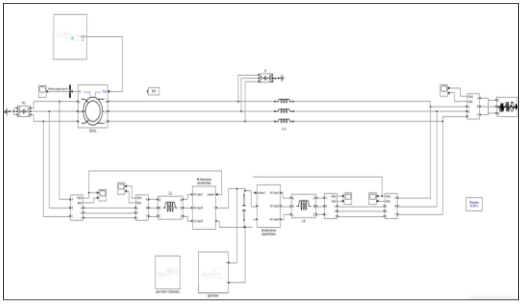

Figure. 4: Proposed Simulink model

Figure 4 shows a diagram of the proposed DFIG-based WECS that would connect to the grid. The BESS gets power from the two VSCs that are connected back-to-back through their DC connectors. In this case, there is no middleman between the stator and the grid. RSC is controlled and regulated within a reference frame that is based on voltage. The d-axis of the reference frame that is spinning in sync has been moved so that it lines up with the voltage axis (Enhanced Phase Locked Loop). The way to figure out where the rotor is is used here so that an estimate can be made of where it is. The GSC was made so that it could supply the grid with the electricity that had to follow rules. The BESS is used to store any extra energy that is made when the power generated is more than the power that is regulated. If the amount of energy generated is less than what is set to be generated, the BESS will send any extra energy back into the grid. Figure 6 is a picture of the control algorithms.

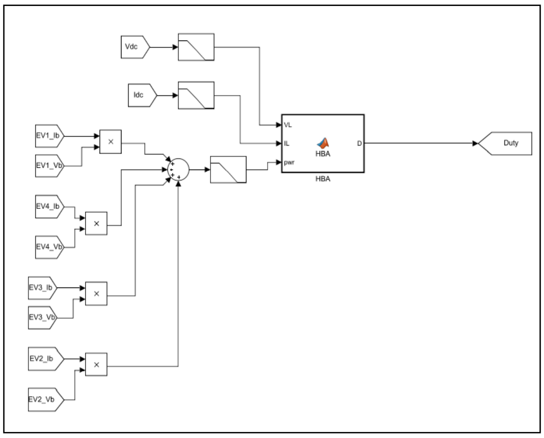

Figure 5: Optimization with HBA

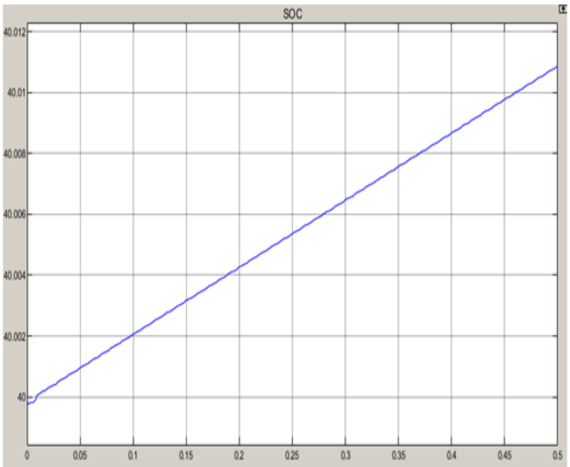

Figure 6: SOC charging at 40%

In the simulation 4 SOC condition check to check the SOC of the battery in the first case If soc between 0 to 25% , it will charge showing in fig 5.6

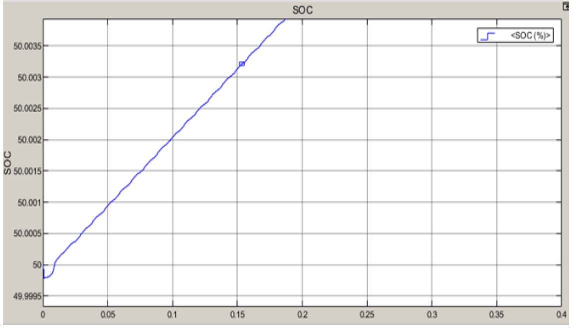

Figure 7: SOC charging at 50%

In the third case If soc between 50% to 90%, it will charge showing in fig. 8

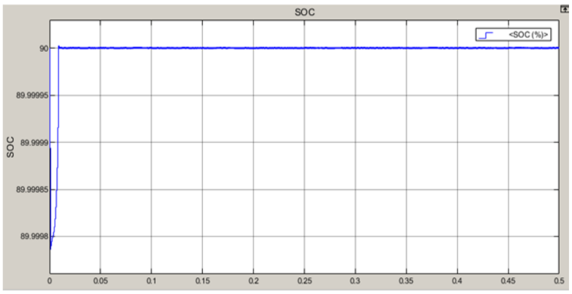

Figure 8: SOC charging at 90%

In the third case If soc between 50% to 90%, it will charge showing in fig 8

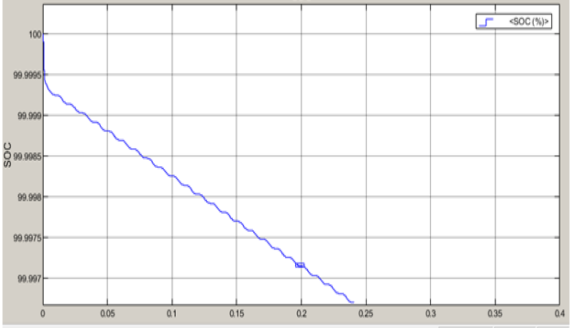

Figure 9: SOC discharging at 100%

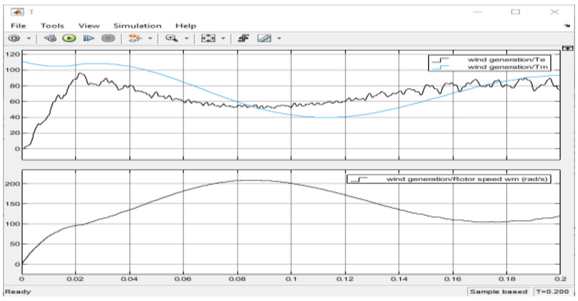

Figure 10: Te, Tm, Wm

Fig10 showing the Te electrical torque, Tm electrical torque, Wm rotor speed

The inverter board is made up of two single-phase inverters, and it can make PWM voltages from a source of constant dc voltage. Also, the inverter board can be turned around.it had to use an inverter. The three-phase voltage that was made was sent to the grid with the help of a controlled circuit breaker and a step-up transformer. The PWM was set to switch 12 times per second. During the simulation, 40 amps and 230 volts were sent through the grid.

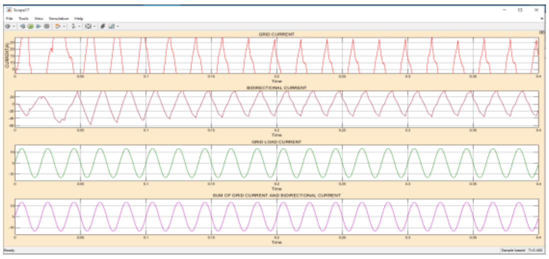

Figure 11: grid voltage, bidirectional current and sum of grid current and bidirectional current

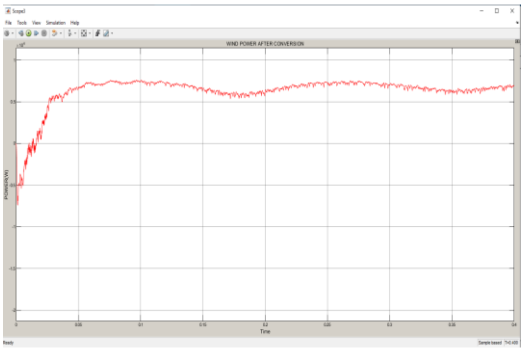

Figure 12: wind power after conversion

5. CONCLUSION

The converter being evaluated has effectively provided alternating current to and from the power grid while maintaining a power factor of 1 and minimal current harmonics. The aforementioned result has led to an elongated lifespan for both the converter and battery, as well as a decreased probability of grid voltage distortion. Moreover, it enables interactions between vehicles and the grid, commonly known as vehicle-to-grid (V2G), which possess the capability to improve the efficiency of the grid. The converter being examined has effectively conveyed alternating current to and from the power grid while preserving a power factor of one and generating negligible current harmonics. The aforementioned result has led to a prolonged lifespan of both the converter and the battery, in addition to a decreased probability of grid voltage distortion. In addition, it enables interactions between vehicles and the grid, commonly referred to as vehicle-to-grid (V2G), which possess the capability to augment grid efficiency. The current that is injected during power delivery to the grid displays a phase difference of 180 degrees, which suggests a reverse direction with respect to the voltage of the grid. The continuity of the correlation between the zero crossing of the grid voltage and the injected current is observed in this scenario. The data presented illustrates the simulated results of the loading of the DC voltage bus. Notwithstanding the presence of transient voltage fluctuations resulting from abrupt load changes, the converter adequately maintains a voltage level of 380V across the DC bus while supplying or receiving the requisite current.

The development of batteries with higher capacities is expected to facilitate the adoption of faster and more efficient charging methods, as well as more advanced wireless charging techniques. The creation of a unique connector that can be universally applied has the potential to provide benefits for the integration of electric vehicles. It is anticipated that the integration of electric vehicles (EVs) will have a substantial influence on the advancement of Smart Cities in the forthcoming years. The significance of implementing charging strategies that are diverse and customizable to cater to the individual needs of users cannot be overstated. It is essential for forthcoming Battery Management Systems (BMS) to consider the emerging situations resulting from the introduction of new batteries and the demands of Smart Cities.

6. REFERENCES

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