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Optimizing Power Utilization In Electric Vehicle Charging Stations Through 75 Bus Energy Management System

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Abstract: - *The rapid growth of electric vehicle (EV) adoption necessitates efficient power utilization strategies within charging stations. This thesis presents an innovative approach to optimizing power utilization in EV charging stations through the implementation of a 75-bus energy management system. The system leverages a combination of renewable energy sources, including solar and wind power, alongside grid energy to enhance the sustainability and efficiency of EV charging processes. Key components of the system include intelligent scheduling for vehicle charging and discharging, accurate state-of-charge (SOC) estimation for vehicle batteries, and the management of bi-directional power flows between vehicles and the grid.*

Through extensive simulations and real-world data analysis, this research demonstrates significant improvements in energy efficiency and cost savings. The 75-bus system effectively balances energy supply and demand, reduces reliance on grid power during peak times, and mitigates the variability and uncertainty associated with renewable energy sources. Additionally, the study explores the potential of using advanced forecasting techniques and load scheduling to further enhance system performance.
Keywords: - Electric Vehicle Charging Stations, Power Utilization Optimization, 75-Bus Energy Management System, Renewable Energy Integration. Intelligent Charging Scheduling, State-of-Charge Estimation, Bi-directional Power Flow, Smart Grid Technology, Energy Efficiency

I. INTRODUCTION

Carbon dioxide emissions have increased due to the widespread use of fossil fuels from rapidly depleting conventional energy sources, which eventually results in the glasshouse gas effect. The escalating effects of glasshouse gases from conventional internal combustion engines (IC) paved the way for the fast growth of pollution-free electric vehicles in the automotive industry (EV). Professor Sibrandus Stratingh of the University of Groningen in the Netherlands created a small scale electric car in 1835 after Anyos Jedlik created an electric motor for a model car in 1828. The car was powered by non-rechargeable batteries. General Motors President Rick Wagoner unveiled the "Impact," a two-seat electric vehicle, later that year at the Los Angeles Auto Show. The Mitsubishi i-MiEV was released in Japan in 2009, and this marked the beginning of the modern era of highway electric vehicles. In 2008, Tesla Motors released the Tesla Roadster in California. With the introduction of competitive EVs by Nissan, BMW, Renault, Ford, Volkswagen, and Chevrolet, there are now eight available EVs.

Since traction batteries can handle high power and energy demands while occupying little space and weight, they are frequently used in electric vehicles. In order to advance EV battery technology, a lot of research is being done [Young et al., 2013]. Until recently, only lead acid batteries were used in electric vehicles. Nickel batteries, which have a high power density and dependability, have largely replaced lead acid batteries in EVs because of their low specific energy and short cycle life. On the other hand, nickel batteries generate a lot of heat at high temperatures and have a high rate of self-discharge. Lithium batteries are now prefered because of their high power density, light weight, and small size. Low specific energy, subpar thermal capabilities, and chemical leakage are all overcome. Korth Pereira Ferraz et al. (2018); Chen et al. (2012). Additionally, the wide operating temperature range, low self-discharge rate, long life cycle, and fast charging capability all contribute to its increased use in the EV industry. Lithium titanate and lithium ferrophosphate batteries are the most popular types of lithium batteries. The lithium ferrophosphate battery has superior thermal stability when fully charged and is unlikely to be inadvertently overcharged. The lithium titanate battery can be quickly recharged and has a wide operating temperature range.

The use of EVs is constrained by their inability to charge batteries, high cost, and brief lifespan [Beretta, 2010; Chan and Chau, 1997]. A 240 V or 400 V outlet is necessary for the AC Level 2 charging method, which is a semi-fast charging method. Using 208/415 volts, AC Level 3 charging is a three-phase fast charging technique. The charging station's DC fast charging method is designed for both public and commercial use.

On-board and off-board chargers are the two different types of EV battery chargers. A single off-board charger is installed, but the entire vehicle has an on-board charger. For on-board chargers, there are limitations in terms of size, weight, available space, and price (Aggeler et al., 2010; Haghbin et al., 2010). This charger can be integrated with electric vehicle motor drives, with the motor winding serving as filter inductors or an isolated transformer, to get around these restrictions (Thiringer et al., 2010; Thimmesch, 1985; Rippel, 1990). The two types of charging systems are conductive and inductive. Direct contact between the charger inlet and the EV connector is made possible by the conductive system. Magnetic power transfer occurs in an inductive system. [Chang and Liaw, 2009]. Level 1 and level 2 AC charging techniques use static and dynamic inductive chargers, respectively. A secondary inductor is used in the vehicle and a primary inductor is used at the charging station to create a static charger, which is a stationary inductive charger. When the primary paddle is inserted into the vehicle's charge port, a magnetic circuit is created and power is transferred. An electric vehicle (EV) charging system known as a dynamic charger transmits power from a stationary primary inductor buried beneath the road's pavement to a secondary inductor installed in a moving vehicle.

II. PROPOSED METHOD

Electric vehicles (EVs) are currently regarded as one of the most efficient modes of transportation due to their lack of tailpipe emissions. Given the benefits of electric vehicles, there are currently 3 million on the road and 100 million are anticipated by 2030 [1]. On the other hand, the proposed plan calls for massive electrical energy and charging infrastructure. Additionally, the electricity used to charge EVs must come from renewable and sustainable sources in order for them to be sustainable. On the other hand, generating electricity from fossil fuels does not reduce emissions; instead, it merely transfers them from vehicles to power plants. As a result, producing electricity from renewable energy sources can completely eliminate emissions while also being good for the environment. Solar PV-based generation is the most practical option for EV charging among the various renewable energy sources available, including solar PV arrays, wind energy, hydro energy, and fuel cell-based energy. This is because it is available almost everywhere, whether the region is rural or urban.

There are many different electrical bus system designs, but which one you choose will depend on the voltage of your system, where your substation is located in the electrical power system, how flexible you need the system to be, and how much it will cost.

A conductor or group of conductors known as an electrical bus bar collects and distributes electricity from incoming feeders to outgoing feeders. In other words, it is a type of electrical junction where all electrical currents, both incoming and outgoing, converge. The result is that the electrical bus bar concentrates electricity in one place.
A circuit breaker and an isolator make up the bus bar system. When a fault arises, the circuit breaker trips, making it simple to detach the busbar's problematic portion from the circuit.
The electrical bus bar can be found in a number of different shapes, including cross-sectional, round, and rectangular. In power systems, the rectangular bus bar is a common sight. Electrical bus bars are manufactured using copper and aluminium.
The Main Elements to Take into Account When Selecting a Particular Bus-Bar Arrangement Scheme
1. System simplicity.
2. Simple maintenance of various equipment.
3. Reducing downtime during maintenance.
4. Provision for future extension as demand grows.
5. Optimizing the bus bar arrangement scheme selection so that it maximises system return.

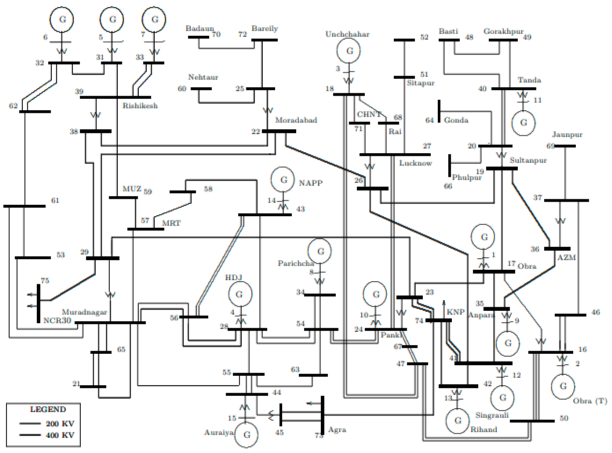

Fig.1 75-bus UPSEB system

Figure 1 depicts the IEEE - 75 bus test system. The cost and emission coefficients of the generator, as well as the load, shunt capacitor data, and transmission lines, are all provided. The IEEE-75 bus system cost coefficients are slightly modified to incorporate nonsmooth fuel cost functions with ramp rate coefficients. The data is based on a 100 MVA base.

III. RESULT

The simulation results obtained from simulation using MATLAB/Simulink platform. In this figure 5.1 are showing the proposed model in which we are using solar and wind in renewable energy, and on the other side we are doing diesel generator, in the proposed model we have built a charging station in which to power management and charge 5 electrical vehicles. We are using 75 bus model in proposed system to manage source and load.

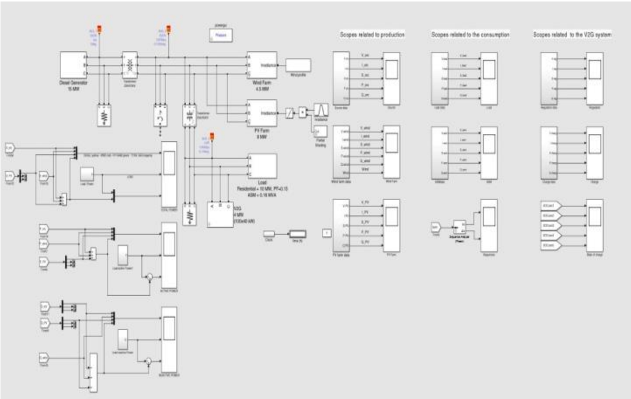

Fig.2 Proposed Model

Figure2 also shows the output of the proposed model like total power generation in the model and active and reactive power. This model basically designs for 24x60x60 power generation for the charging station.
Figure 3 shows the proposed model of 75 bus system. In this different model is connected to each other.

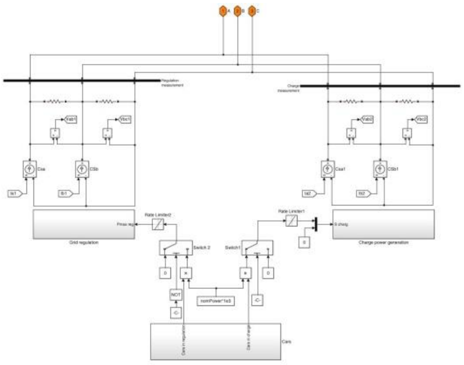

Fig.3 Model of Proposed Bus System

Figure 3 is show power management of charging station also show charging station section where we are charge 5 EV's in one time.

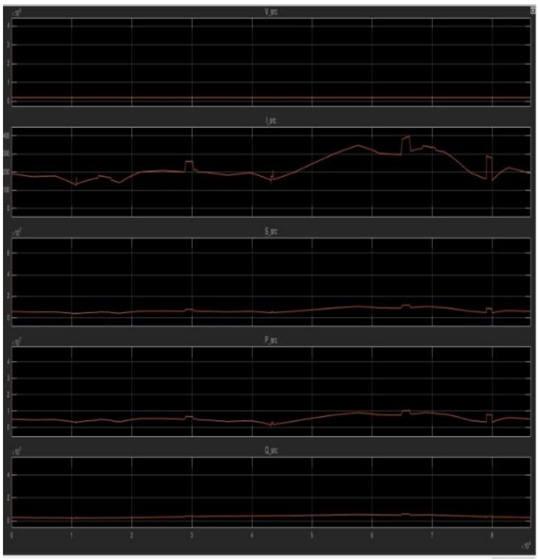

Fig.4 Wave form of voltage, current and power

Figure 4 shows the result waveform of voltage, current and power. In this figure first waveform of voltage source is a rms value, second waveform of current source of rms value, third waveform of electrical switches and then last waveform of power.

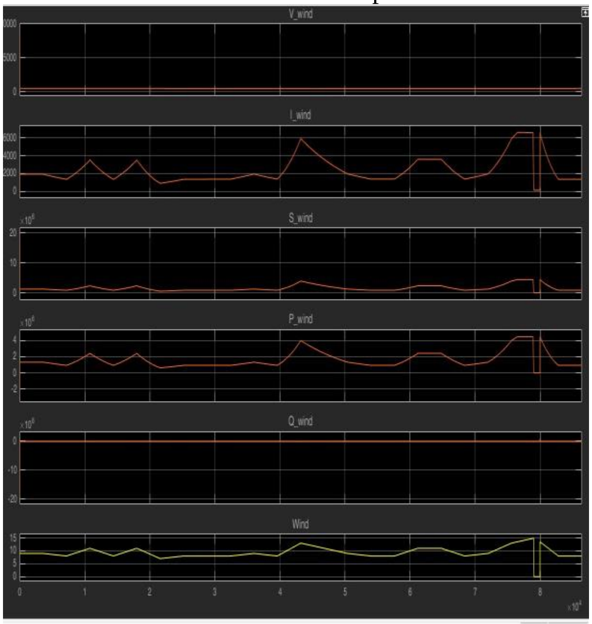

Fig.5 Waveform of Wind voltage, current and wind power

Figure 5 shows the waveform of voltage, current, power, electrical switches and wind power.

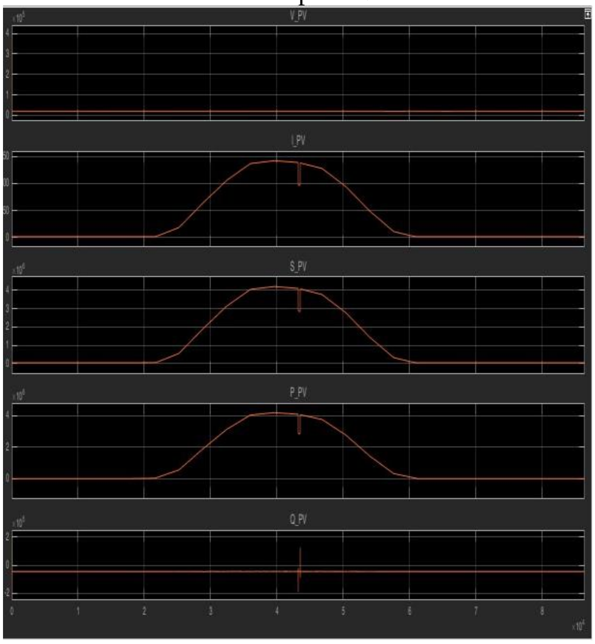

Fig.6 waveform of solor cell of voltage, current and power

Figure 6 shows the result waveform of photovoltaic cell of voltage, current and power with respect to time.

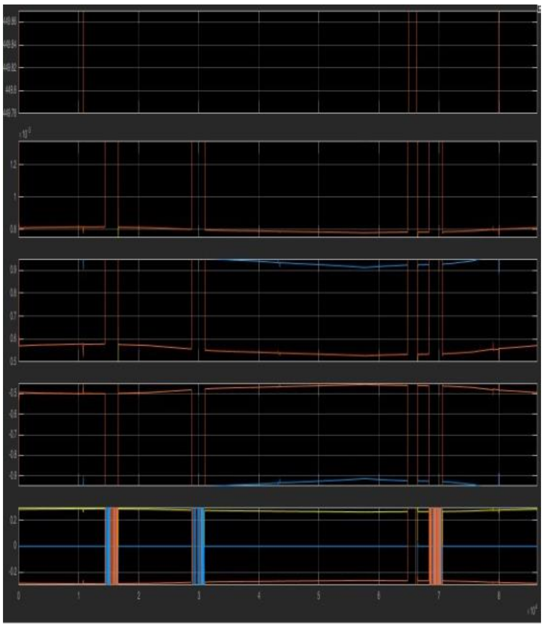

Fig.7 output of state of charge

Figure 7 shows result output waveform of state of charge. Battery controller waveform.

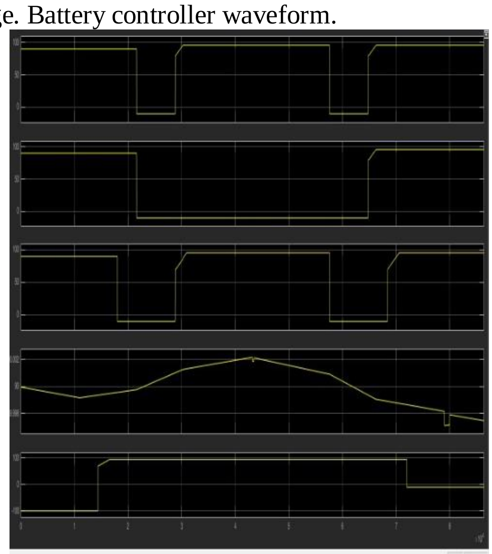

Fig.8 wave forms of active power

Figure 8 shows result waveform of active power of total generation power.

IV. CONCLUSION

The development of the hybrid renewable energy system is ongoing. Voltage and current waveforms are seen in MATLAB simulations. These systems are more dependable and stable than single-source systems, according to the simulation results. It is used in grid-connected systems as well as off-grid areas. In an Indian 75-bus power system, the optimal power flow problem is resolved using differential evolution. Differential evolution has a number of advantages over other contemporary heuristics, including modelling adaptability, certain and quick convergence, and reduced computational time. It is possible to draw the conclusion that this charging station, with the provided control, is capable of utilising different energy sources very efficiently and providing consistent and affordable charging to EVs.

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