Design and Optimization of Electric Vehicle Using V2G Network

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***Abstract*—Transportation field has drastically increased on a big scale over the years, as a result of this crude oil use or electricity generation, green gas emissions have compellingly increased. The transportation industry has evolved as a compelling source, accounting for 27 percent of total emissions of the greenhouse gases. An outcome of this scenario various measures has been taken place to reduce the emissions, which pose seriously health dangers. Electric Vehicle's (EV) are the one that run on electricity and were initially introduced in the year 1832-1837. The first commercial electric vehicle was introduced and built in the year 1902 by a company called "Studebaker vehicles," but it was similar in most of the aspect. Therefore because of high speeds and superior performance, electric trains have proven in the journey of success. Electric vehicles on the other hand, have been in use for the past two decades, with significant manufacturing by businesses such as Tesla and Nissan. Electric vehicles may not outperform traditional vehicles in terms of performance, but they offer a significant environmental benefit. As a result, Electric vehicles are predicted to grow from a 2 percentage of the market share in 2016 to a huge 45 percentage by 2050, resulting in a 59 percent reduction in greenhouse gas emissions. The goal of this system is to create an effective EVs model that can function as both source and the load, it can also be described as V2G (Vehicle to Grid). These electric vehicles put pollutants while simultaneously improving grid performance. To avoid collisions in charging units or power utilization, a pool of these vehicular networks is employed with appropriate scheduling and queuing.**

Keywords— Electric Vehicle, EV Charging, Micro Grid, V2G, Internet of things.

1. INTRODUCTION

Plug-in Hybrid Electric Vehicles (PHEV) when connected, the hybrid electric vehicles battery can also be recharged through external power. In simple terms, a Plug-in Hybrid EVs is a vehicle that has both an internal combustion engine and a motor that work together to push the vehicle. An electric vehicle that relies solely on its battery will not be able for providing the requisite range and performance. As a result, hybrid power usage principles aid in maintaining the range and performance[1].

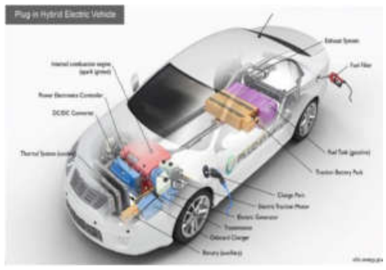

Figure. 1: Key components of a PHEV

The auxiliary batteries present in the car assists in turning on a car's ignition engine. The charge ports at the same time allow the car to be charged from an external source. DC/DC converters convert high voltage traction battery power to low voltage power[2]. which is used to power the car's electrical components. While braking, an electric generator generates electricity and transfers that into a battery pack that is the electric vehicles. Taking into the consideration of the battery's energy. To exhaust gases from the engine, a three-way catalyst-enabled exhaust system is added. A gasoline fuel tank holds the required fuel until it is needed. When the battery runs out, the Internal combustion engine, which injects is positioned as an external source to switch over into the combustion chamber and ignites it using a spark plug[3]. A typical PHEV has an onboard charger for charging the traction battery.

1.1.LOAD DEMANDSAND OPTIMISED SCHEDULING

Load demands are important to both consumers and suppliers of energy because there is an increased number of commuters and use of EVs. Mostly, load demands are highest in the morning as significant users commute to work, and the demand increases in the evening as users return. Therefore, load needs are a factor which needs to be important in finding the charging and discharging times of various EVs. Load demands are important both to the consumers and suppliers of energy because of the increased number of commuters and the use of electric vehicles. Typically, load demands are highest in the morning as significant users commute to work, and demand increases in the evening as users return. These load needs are factor which needs to be important in the charging and discharging times of various EVs. The theoretical plotting also includes the current, torque and operations of EV.

1.2. Non-Intrusive modelling

A Non-Intrusive Load Monitoring is a Training-Free of EVs Charging with Less Sampling Rate is designed to estimate the power consumption in the charged vehicles plugged into the grid containing other Power consuming entities like Air conditioner or entire House load. As the name suggests, the load estimation for the grid due to charge and discharge of the PHEV and running of the household load and Air conditioner is non-intrusive i.e., no training algorithm is used, and the power is used in naïve methods.

1.3. V2G SYSTEMS

In most of the circumstances, an electric vehicle is seen not only as a load but also it is a basement of energy, returning power to the grid. Vehicle to Grid, or V2G, is a network of EVs that can return some energy to the grid. Therefore, may be taking place during business hours or at night. Current energy systems can now balance more renewable energy using V2G. It is critical to promise the V2G network is secure. Users can signal when they want to unplug and when the battery is fully charged. This project creates a V2G model that combines a PV grid model with different renewable energy grids to create 5 separate user profiles. A total of 100 EVs account are taken, with 20 from each profile.

2 Experimental Work

The Graphical user interface is created in MATLAB which works as project's gateway, and it employs callback methods to access and simulate the models, as well as to run the scripts and plot the results. Figure 2 depicts the project gateway for all of for all aspects of the project All of these components are accessible with a single click via the GUI.

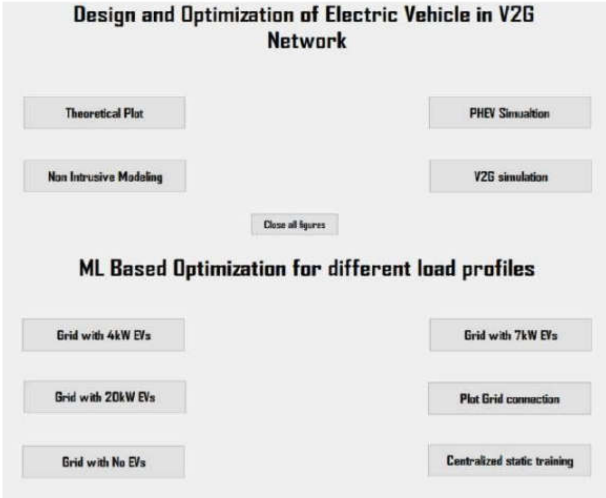

Figure 2: Project Gateway

The load demand plays an important part in vehicle scheduling and adjusting the grid load capacity to fulfil these demands. This block considers load demand for 24 hours, with 15- minute samples, for a total of 96 samples each day. Two alternative grid schedule techniques are utilized to illustrate the demand at each sample. The load demand is shown in Figure 3. During optimum scheduling, two methods are used: Disorderly charging load and orderly charging load, during peak hours, the grid capacity is rapidly expanded to accommodate the higher demands for the Electric vehicle Network due to chaotic charging load. As previously stated, 96 different kinds of samples are taken into consideration when plotting, although only 24 samples are presented in the table owing to space constraints. We can see from the data that demand is fairly high during peak hours (8 am-11 am). The system needs to meet the high load demands during these hours the uses will extra distribution nodes, making energy usage more expensive during non-peak hours.

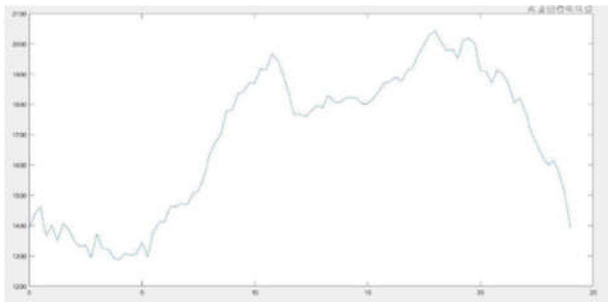

Figure3 Load demand for 24 hour time period in EV

Simulink is used to create a model with a 24-hour simulation time that includes V2G technology as well as renewable energy sources such as wind energy, a PV system, and a diesel generator as shown in figure 4. The microgrid is made up of four major components: a diesel generator that serves as the main power source; a PV farm that is paired with a wind farm to provide renewable energy; and a battery storage system. A V2G system is installed close to the grid's load, which is the last portion of the system. During a low-consumption day in the spring or fall, the microgrid's size corresponds to about a thousand families. In the default model, there are 100 electric vehicles, implying a 1:10 ratio between automobiles and residences. The diesel generator is used to counteract the power outage.

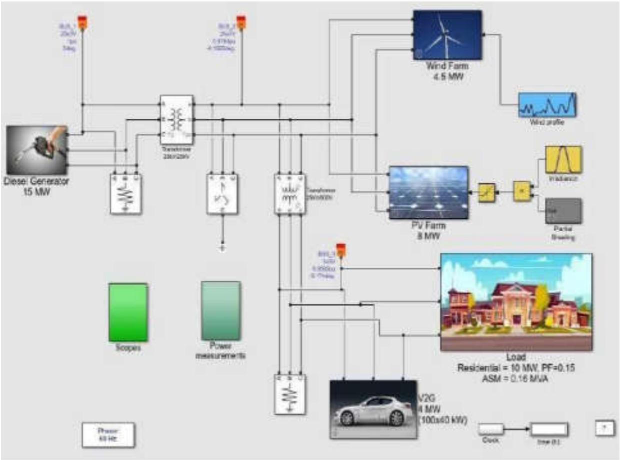

Figure4: V2G System Model

3. Hardware Setup.

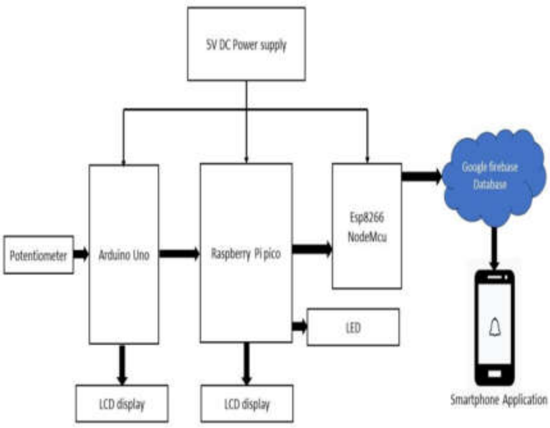

Figure 5: Block Diagram

Arduino Uno with 20*4 lcd display is used to represent grid system whose demand can be varied using a potentiometer connected with Arduino. Raspberry pi Pico with 16*2 LCD display is known to show electric vehicle charging/discharging status. Esp8266 Node mcu board it can be used to provide wifi capability to the model for connecting with firebase database to send Realtime V2G notification to EV user via Android application as shown in figure 5. Once the grid demand reaches peak level a request in the form of notification will be send to the plugged in EV user to allow V2G energy transfer, once the user accepts the request vehicle display will show discharging status to simulate V2G transfer. And the mobile notification provided by the app details will allow the user to allow the User to accept to provide the electricity back to grid and the process will continue.

4 Results

The V2G model was created in MATLAB Simulink and ran for 24 hours to see how a system of sources could successfully use the electricity from the V2G-enabled vehicles. To improve precision, the V2G was equipped with a Machine Learning system based on a linear regression model, in which the vehicles were educated with various data sets to predict whether or not to return power back to the grid. A voltage, current, and transformer profile were all measured during the optimization process for various distinct configurations. The whole algorithm was designed in ANN Network. This work aims to design and construct an electric car incorporating V2G technology, which allows the vehicle to return energy back togrid. Understanding load needs is needful for the development of algorithms that allow the grid to set itself up to satisfy these demands at the lowest possible cost. With the Monte Carlo simulation criteria, two alternative models were employed to create this optimal scheduling as shown in figure 6.

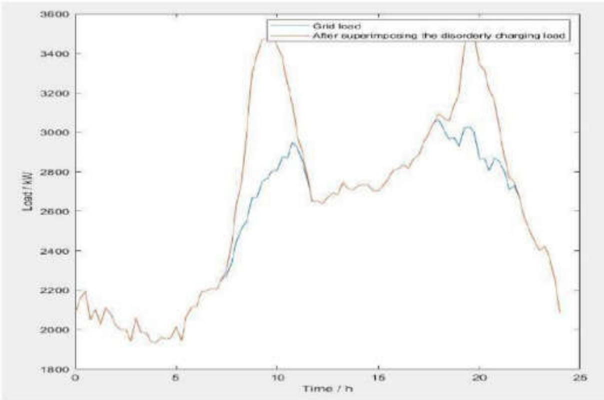

Figure 6: Comparison of grid load with disorderly charging load superimposition

The conclusion made from this graph is that the grid is now capable of producing twice the amount of electricity required during peak hours. However, because more distribution networks will be utilized to meet these demands, this will put a lot of strain on the grid and raise costs during peak hours as shown in figure 7

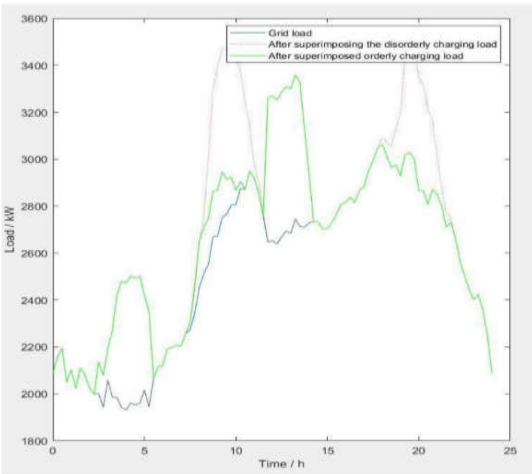

Figure 7: Comparison of grid load with orderly charging load

The hardware setup is as shown below in the figure 3.3, a knob with potentiometer is provided to vary the demand of Grid system which is shown below in Grid display, once the demand reaches the peak level an IoT based real time notification is sent to the user (Figure 8) user can either accept or reject the request. If user accepts the request, then V2G transfer will be initiated and the indicator LED will change its color to green (Figure 9) and once the demand decreases the system will switch back to G2V state where again vehicle will charge using grid power. As the notification is sent through IoT cloud the speed at which notification is sent/received depends on the Network speed shown in figure 10.

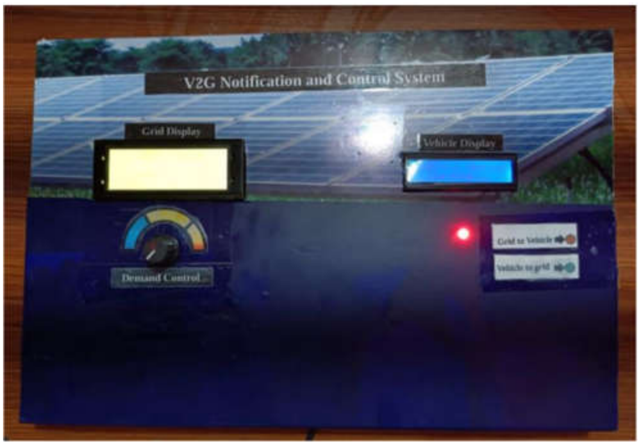

Figure8: The Hardware setup (showing G2V)

Figure 9: the Hardware setup (showing V2G)

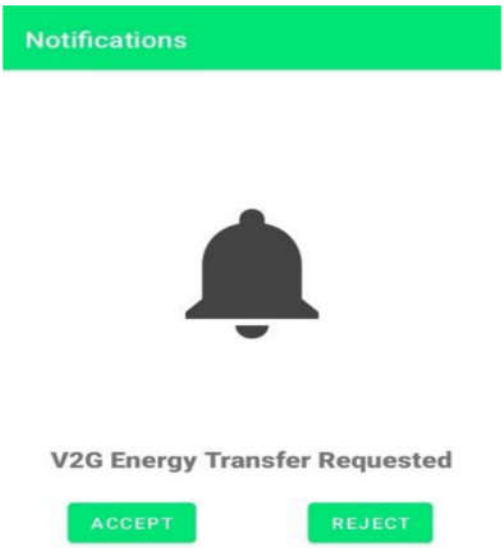

Figure10: Notification sent through app

I. CONCLUSIONS

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