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RE-ENERGIZE ELECTRIC VEHICLES USING WIND ENERGY

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Abstract: In the twenty-first century, Wind energy applications are expanding significantly faster than those of other renewable resources such as solar, geothermal, and so on. As the third key source of energy, it replaces non-conventional fuels such as oil and chemicals. Wind power is the most quickly developing and promising renewable energy source.
Our research is focused on placing low-cost Vertical Axis Turbines on highways in order to provide an alternate means of charging our Electric Vehicles in the future that will not interfere with the traditional grid. Variable-speed wind turbines, in addition to producing more energy than constant-speed turbines, reduce power fluctuations and improve reactive power delivery. The main purpose is to use as much wind energy as possible to maximize power output, hence highways were chosen. The produced power is delivered to EV charging stations and may then be used to recharge Electric Vehicles.
Electric cars will soon replace traditional automobiles in order to achieve a pollution-free future. We are utilizing Wireless Power Transfer technology, which has advanced in recent years and offers a wide range of possible applications. WPT is a method for transmitting electrical power without the use of a direct connection. The WPT operates on the same core concept as a conventional transformer: inductive power transfer. WPT may be utilized in both static and dynamic charging systems for electric cars. Wireless power transfer may naturally provide galvanic separation, automated charging, and minimized battery size.
This work validates MATLAB simulations of a WECS with PMSG and variable-speed wind turbine, as well as wireless power transfer.
***Keywords: WECS, VAWT, PMSG, WPT, STATIC AND DYNAMIC WIRELESS CHARGING, EV'S.**

1. INTRODUCTION:

As one of the primary energy sources, wind power is predicted to play a larger role in reaching carbon neutrality by 2050. WIND EXPO brings together a diverse spectrum of wind power production technologies, from wind turbines to wind farm building, maintenance, and operation, as well as offshore wind technology, among others. The event helps the growth of the wind energy sector by serving as a well-established commercial platform for the newest technology, information, and people. Japan Wind Power Association is a co-organizer of the event (JWPA).

2. WIND POWER:

Wind power is a renewable energy source. It is non-polluting, infinite, and reduces the need for fossil fuels, which are the source of greenhouse gases that contribute to global warming. Moreover, wind energy is a "native" energy since it is accessible almost everywhere on the planet, which helps to reduce energy imports while also producing wealth and local jobs. For these reasons, wind energy generation and effective utilization contribute to long-term growth. Wind energy is an alternative to traditional power. Wind turbines may be used to generate electricity from wind energy. The wind turbine converts the kinetic energy of the wind into rotational energy, which is subsequently utilized to generate electricity. This energy might be utilized to power electric automobiles. The vertical axis wind turbine, on the other hand, is appropriate for such places due to its capacity to capture wind energy from any direction. This makes the VAWT nearly maintenance-free

and contributes to lower wind turbine maintenance costs. This will also significantly reduce the VAWT's start-up wind speed.
Wind power has evolved considerably technologically, and installation prices have decreased significantly. During the last decade, the cost of onshore wind turbines has dropped by 37%, and the cost of lithium batteries for power storage has dropped by 85%. Wind energy already accounts for more than 3% of worldwide power consumption, and this percentage is predicted to rise to 5% by 2020. Longer term (by 2040), wind energy might cover 9% of worldwide power demand and more than 20% of demand in Europe, according to the International Energy Agency.
Wind generating capacity in the globe was 400,000 MW at the end of 2015, according to preliminary estimates from consulting firm Navigant/BTM, which predicted that this would expand by more than 45% by 2025, to surpass 600,000 MW.

3. WIRELESS POWER TRANSFER:

Electric vehicles (EVs) will play an increasingly crucial role as governments throughout the world strive to meet their various decarbonization objectives. With 2.3 million EVs sold in Europe in 2021, EV sales were up 109% over the previous year. There is now a higher requirement for more efficient EV charging infrastructure to guarantee that this growth rate continues and that decarbonization objectives are met. Wireless EV charging would revolutionize the car business by increasing charging efficiency. Although plugging in your EV is simple, wireless EV charging is more convenient since it allows the user to charge their EV without leaving the car.
The entire EV charging procedure has been streamlined, resulting in a far improved end-user experience. The driver just aligns the car with the ground transmitter pad, and charging begins immediately. The technique is especially suitable for electric buses & electric cars, which are critical electrification prospects. Wireless charging reduces operating costs, allowing for more cheap vehicles with smaller batteries, and extending battery life. When compared to typical public charging devices, wireless EV charging technology is more interoperable, convenient, and difficult to vandalize. To make payments, the user never needs to get out of the EV and deal with multiple connectors, bulky wires, or deal with a not-so-friendly user interface.
Numerous international organizations, including the Society of Automotive Engineers (SEA), the International Electro-technical Commission (IEC), and the Institute of Electrical and Electronics Engineers (IEEE), are collaborating to create a global standard for wireless EV charging. Plug-in charging has a maximum efficiency of 94 to 94.5 percent, while the newest SEA wireless charging standards have shown an efficiency of 90~92 percent, essentially erasing that major obstacle in wireless charging adoption.

4. LITERATURE SURVEY:

In 2021, Istanbul Technical University designed and installed wind turbines in the streets of Istanbul to generate electricity using the wind generated by the traffic. The vertical turbines that have been installed along the roads are known as ENLIL and the University has developed this with Devecitech, a tech firm in Istanbul.
Various literature foretells the need for wind energy-based electricity generation. A detailed analysis is carried out on the production of electricity with the help of a wind turbine. A study was brought out on a HAWT designed for the ambient conditions of the Nigerian University. It is found that the maximum obtainable power was 322W at a wind speed of around 10m/s from the completion of the study. This convinces us that a VAWT is more appropriate for lower wind speed zones.
Helix Wind Turbine Use on Pakistani Highways, which has one of the largest highway networks in South Asia. According to the wind map of Pakistan roads, wind power production has a strong potential along the Makran coastal Highway, the Motorway from Lahore to Islamabad, and national highways. The average car passing rate on highways is 16 and 22, with heavy traffic using the leftmost lanes. The effect of wind turbulence caused by passing automobiles was measured to be 0.6-0.9 m/s for low traffic and 0.8-1.1 m/s for high traffic. As a result, if suitable measures are made, Pakistan has a strong potential for electricity from wind power.
The Korea Institute of Science and Technology has designed a wireless charging system with an output power of 27 kW, an air gap of 20 cm, and a maximum system efficiency of 74% using a serial/serial (S/S) compensation architecture. Juan L. Villa of the University of Zaragoza and colleagues employed this compensatory architecture to create a wireless charging system with a power output of 2 kW, an air gap of 15 cm, and a maximum system efficiency of 82%.
A survey of the literature on current developments in stationary and dynamic WPT utilized for EV charging is provided by Gil and Taiber (2014). This article identifies technological and infrastructure challenges to the switch from fixed to dynamic wireless charging by discussing power constraints, electromagnetic interference laws, communication problems, and interoperability.
Israeli company Electron Wireless has been working on wireless charging on the move for some time. In the next few months, the first official tests are planned in Tel Aviv, with the installation of charging plates under the asphalt of a 2 km stretch of road, on which an electric bus will be able to recharge on the move. The wireless charging of the electric truck on a public roads is a significant milestone in the commercialization of wireless electric road technology.
A wireless charging device based on MIT magnetic resonance technology was created by the Joshua R. Smith research team at Intel Seattle Labs in August 2008. Appliances like laptops and PDAs may be charged with it. Within a 1m radius, it has a 60W wireless energy transmission capacity with a 75% efficiency.

5. WIND POWER CALCULATIONS:

There are numerous technical calculations and equations involved in understanding and building wind turbine generators, however, the layperson should not be concerned with most of them and should instead memorize the following crucial information:

A wind generator's power output is proportional to the area swept by the rotor; so, twice the swept area, and the power output will double. Wind generator power production is related to the cube of wind speed. Kinetic Energy = 0.5 x Mass x Velocity^2, where mass is measured in kilograms, velocity is measured in meters per second, and energy is provided in joules. Because air has a known density (approximately 1.23 kg/m^3 at sea level), the mass of air hitting our wind turbine (which sweeps a known area) per second can be calculated as follows: Velocity (m/s) x Area (m^2) x Density (kg/m^3) = Mass/sec (kg/s). As a result, the power (i.e. energy per second) in the wind hitting a wind turbine with a specific swept area may be calculated by simply plugging the mass per second calculation into the usual kinetic energy equation provided above, yielding the essential equation:

Power = 0.5 x Swept Area x Air Density x Velocity^3, where Power is given in Watts
(i.e. joules/second), the Swept area in square meters, the Air density in kilograms per cubic meter, and the Velocity in meters per second.

The equation for wind power(P) is given by P= 0.5 x ρ x A x Cp x V^3 x Ng x Nb
where, ρ = Air density in kg/m^3, A = Rotor swept area (m2).
Cp = Coefficient of performance
V = wind velocity (m/s)
Ng = generator efficiency
Nb = gearbox bearing efficiency.

6. BLOCK DIAGRAM:

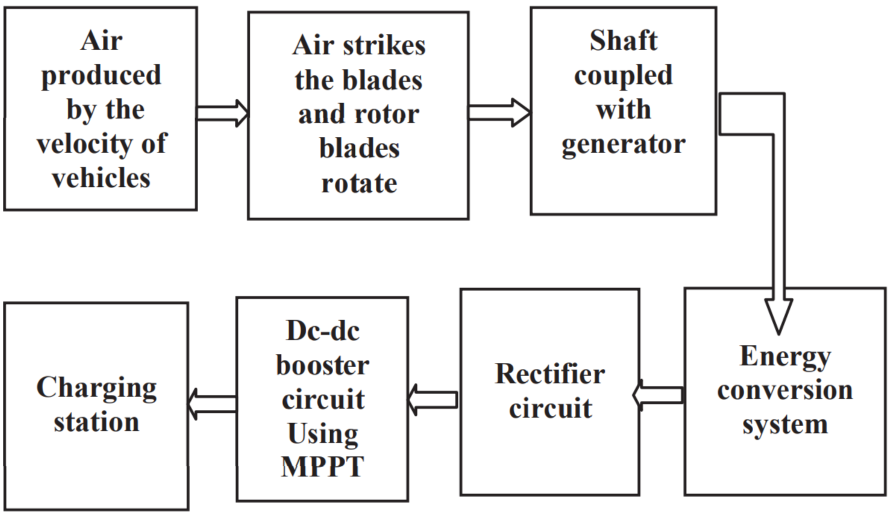

Figure: Block Diagram of Wind Power Generation

The block diagram depicts how the project concept operates. It is made up of a vertical-axis wind turbine, a PMSG (generator), a rectifier, a DC-DC boost, and a charging outlet. Because of the speed of the vehicle (average of 12 m/s), some pressured air is created whenever cars drive on both sides of highways. This compressed air impacts the turbine's rotor blades, causing the turbine to spin. The turbine shaft is linked to the generator (PMSG). The generator produces alternating current in three phases. The generator's output is converted to DC via a rectifier, and this supply is then enhanced using a DC-DC booster based on MPPT and delivered to charging ports.

7. MPPT ALGORITHM:

The main idea behind MPPT is to get the most available power out of a wind inverter by operating it at the most efficient voltage (maximum power point). i.e., MPPT examines the output of the Wind Inverter, compares it to the voltage of the battery, and then determines what is the best power that the Wind Inverter can provide to charge the battery and converts it to the best voltage to get the greatest current into the battery. It may also power a DC load that is directly linked to the battery.

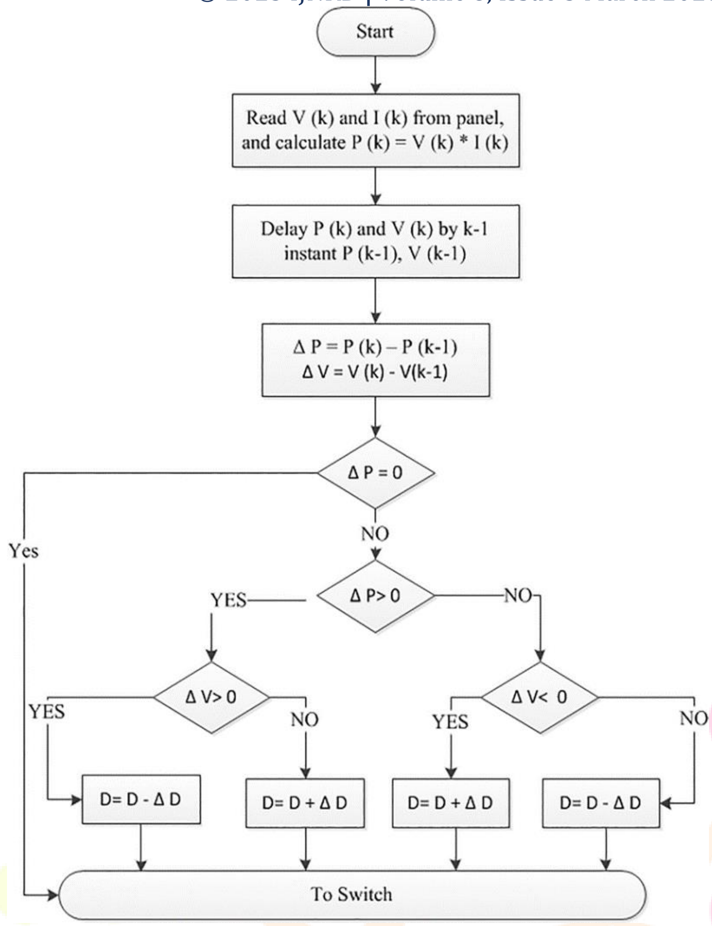

Figure: Perturb & Observe Technique

8. SIMULATION OF WIND POWER GENERATION:

The diagram consists of the full simulation module which consists of the Wind turbine system, PMSG (generator), Rectifier, DC-DC booster based on MPPT, and charging port.

When it comes to simulation the turbine is the first component. We have given pitch value, generator speed, and wind speed inside the wind turbine block. When simulated, the negative torque produced by the turbine is given to the PMSG. PMSG will convert mechanical energy to electrical energy. The output of PMSG is a 3-phase AC supply. This is converted to DC using a rectifier. Then the output voltage is boosted using a DC-DC booster, and then the output is supplied to the charging stations

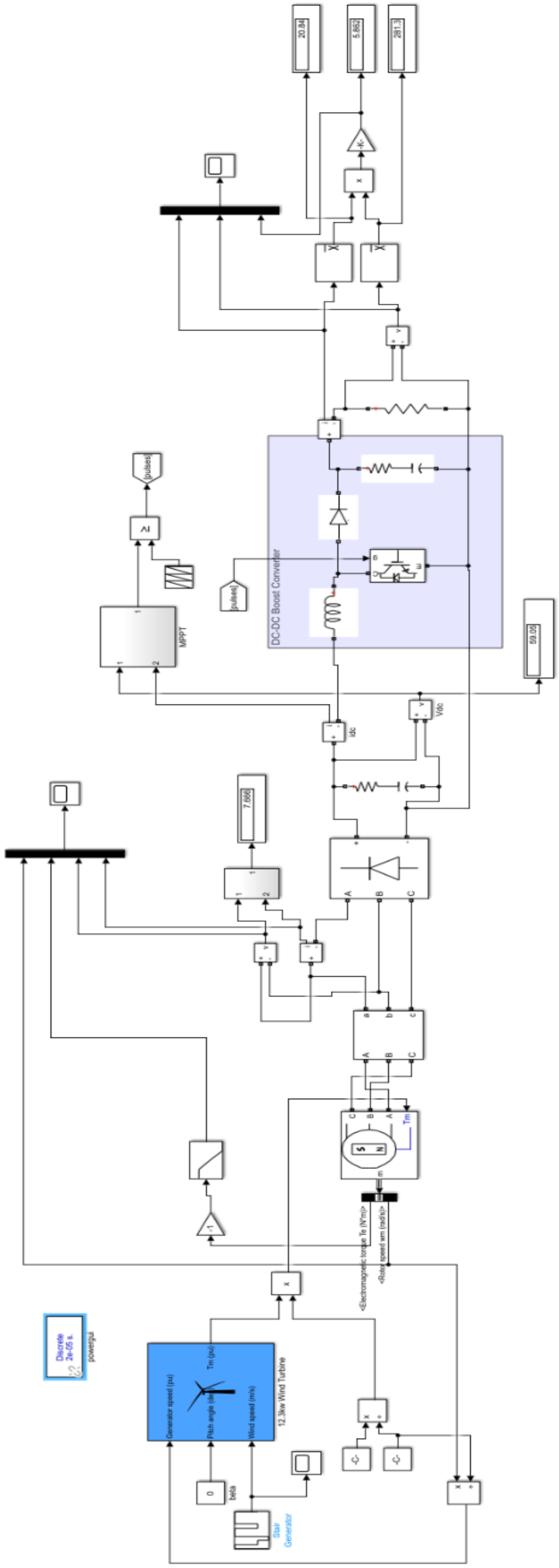

Figure: Simulation of Wind power Generation

SIMULATION RESULTS:

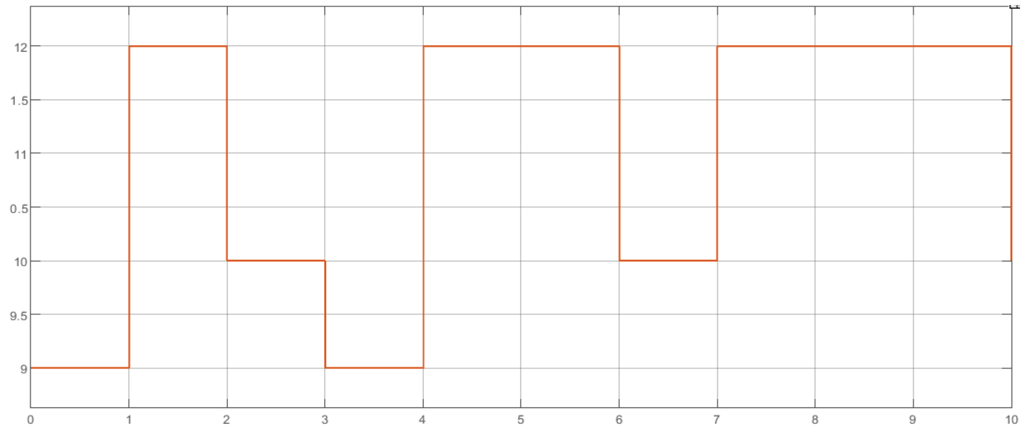

Figure: Variable wind speed

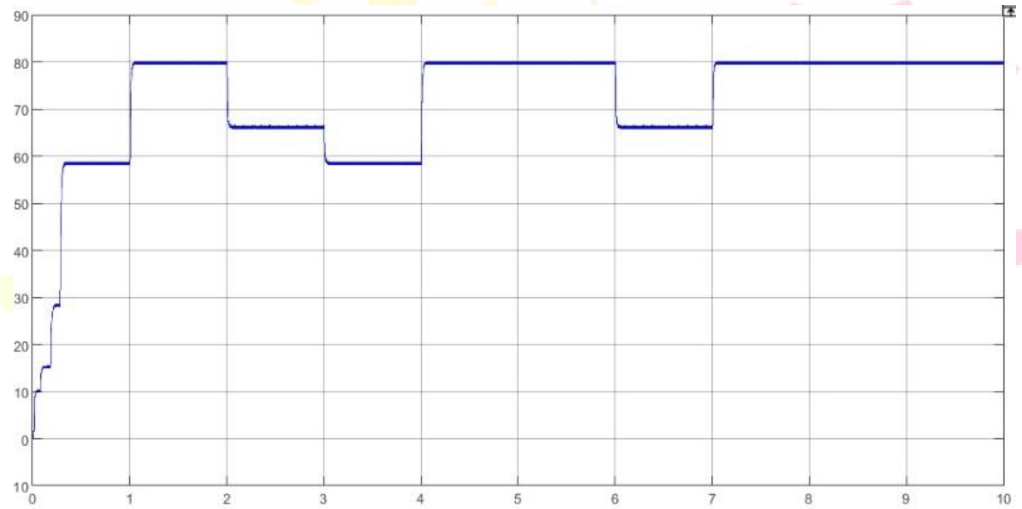

Figure: Electromagnetic Torque

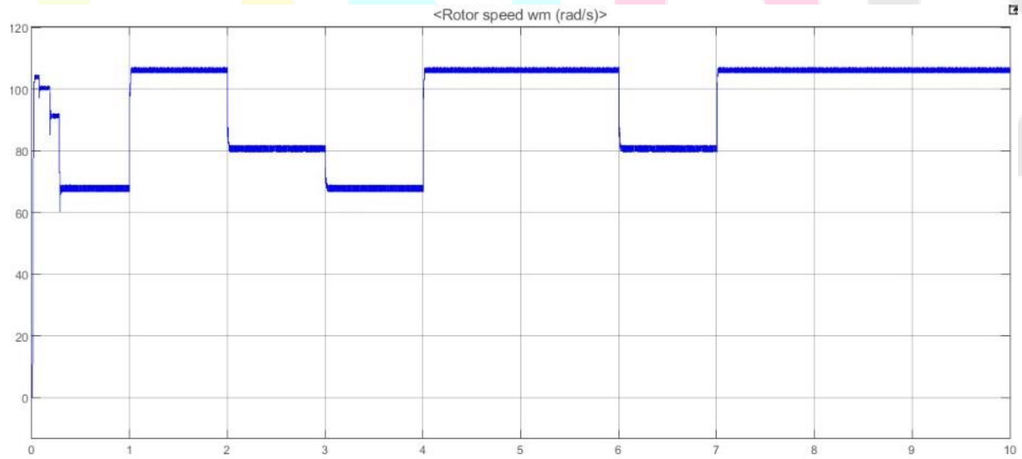

Figure: Rotor Speed

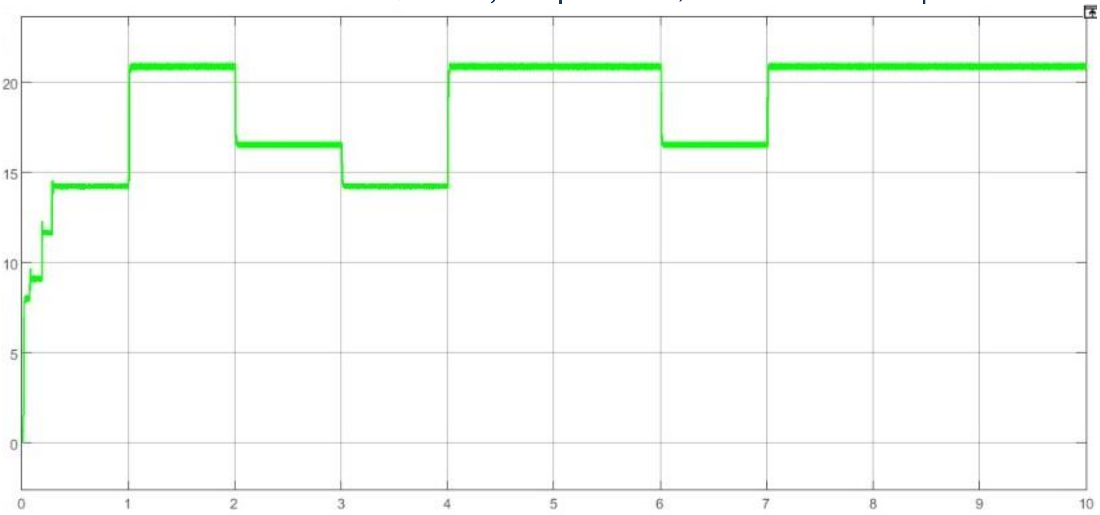

Figure: DC Current

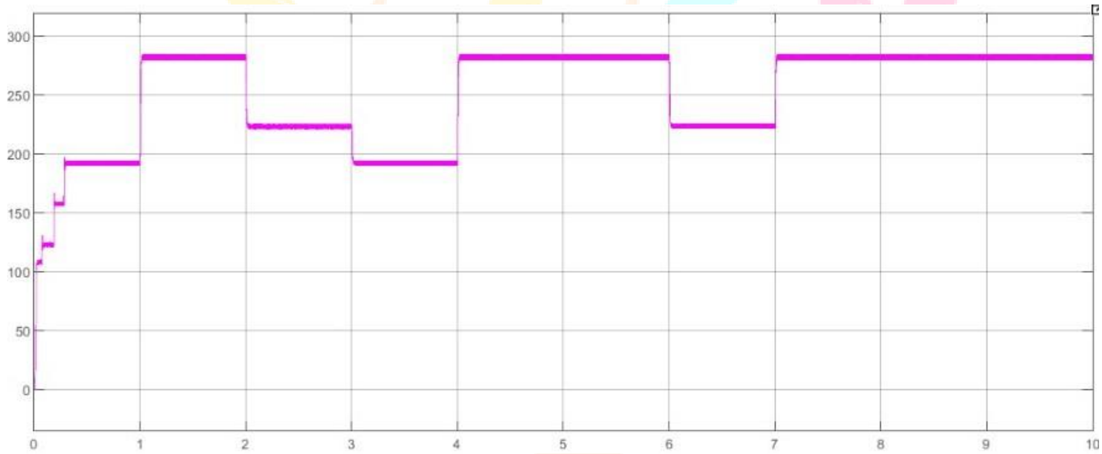

Figure: DC Voltage

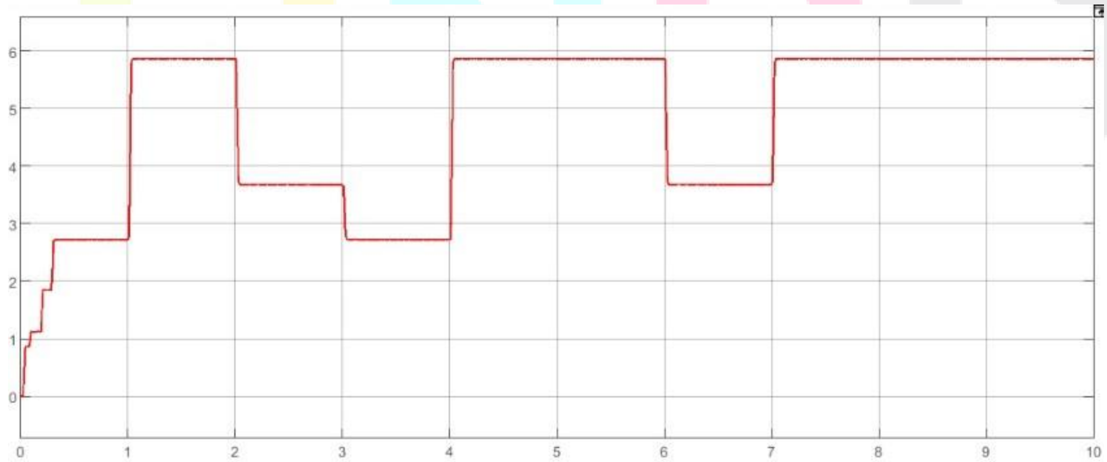

Figure: DC Power

9. WIRELESS CHARGING TECHNOLOGY:

Wireless charging system working principle: The power frequency AC is converted into DC by a rectifier circuit and then converted into 20kHz high-frequency AC by an inverter. After the primary compensation network causes the coil loop to resonate, the high-frequency alternating current in the transmitting coil creates an alternating magnetic field in the space. Correspondingly, the AC voltage is induced in the receiving coil, and the receiving coil loop resonates through the compensation network of the secondary side. Finally, the high-frequency AC in the receiving coil is converted into DC by the rectifier circuit to charge the EV. In addition, the efficiency of the electrical power transmission, medical and environmental influence of electromagnetic waves, and improvement of the facile high-speed charging, safe security, and energy storage density is essential limits that should be considered when WPT is designed for EVs.

Resonant wireless charging is the most cost-effective and efficient wireless charging technology. It is an enhanced form of inductive wireless charging. When a transformer's primary and secondary coils are adjusted to the same resonant frequency, electrical energy from the main coil is transmitted to the secondary coil at a much quicker pace. When the coils are in resonance, electrical energy is transferred even if the magnetic field between them is minimal. Despite the long distance between the coils, electrical power is delivered if the resonance frequency of both coils is matched. In a resonant inductive charging system, compensation networks are added on both sides in series and parallel to match the resonance frequency at the transmitter and receiver coils. The method of resonant inductive wireless charging improves the power transfer efficiency and provides a high-quality factor. It has the same cost benefits as inductive charging, plus it provides higher efficiency, lower losses, and enables faster charging.

10. WPT-SYSTEMS FOR CHARGING EVs:

The fundamental components of a WPT system for EV charging. It is made up of two major subsystems, one of which is situated beneath the road surface and the other in the vehicle's underbody. The first subsystem consists of an energy source, a rectifier and a high-frequency inverter, a primary compensation network, and a primary/transmitter coil. In EVs, the secondary/receiving coil and secondary compensation network form a resonance circuit that sends power to a high-frequency rectifier, filter, and battery. An air gap separates the subsystems. The distance between the two systems is determined by vehicle type, ground clearance, and road conditions such as pavement thickness. Typically, the air gap is less than 0.4 m.

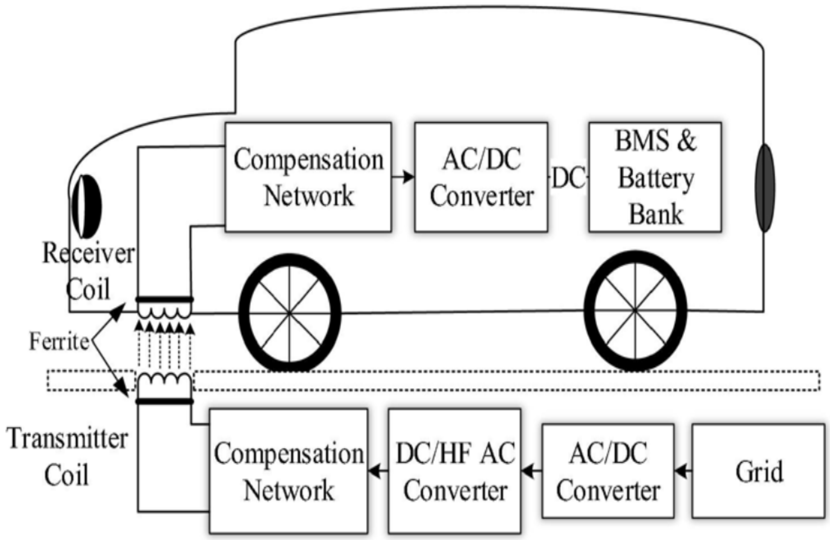

Figure: block diagram of wireless charging of EVs

11. SIMULATION OF WIRELESS POWER TRANSFER:

The figure depicts the whole simulation model of a system's wireless charging.

The Ac 230v 50Hz Supply is acquired from the Grid for simulation. The AC is then transformed into DC by a rectifier circuit, which is subsequently converted into high-frequency AC at 20kHz by an inverter. The high-frequency alternating current in the transmitting coil generates an alternating magnetic field in space after the primary compensation network causes the coil loop to resonate. In turn, the AC voltage is induced in the receiving coil, and the receiving coil loop echoes across the secondary side compensation network. Lastly, the rectifier circuit converts the high-frequency AC in the receiving coil into DC to charge the EV's batteries.

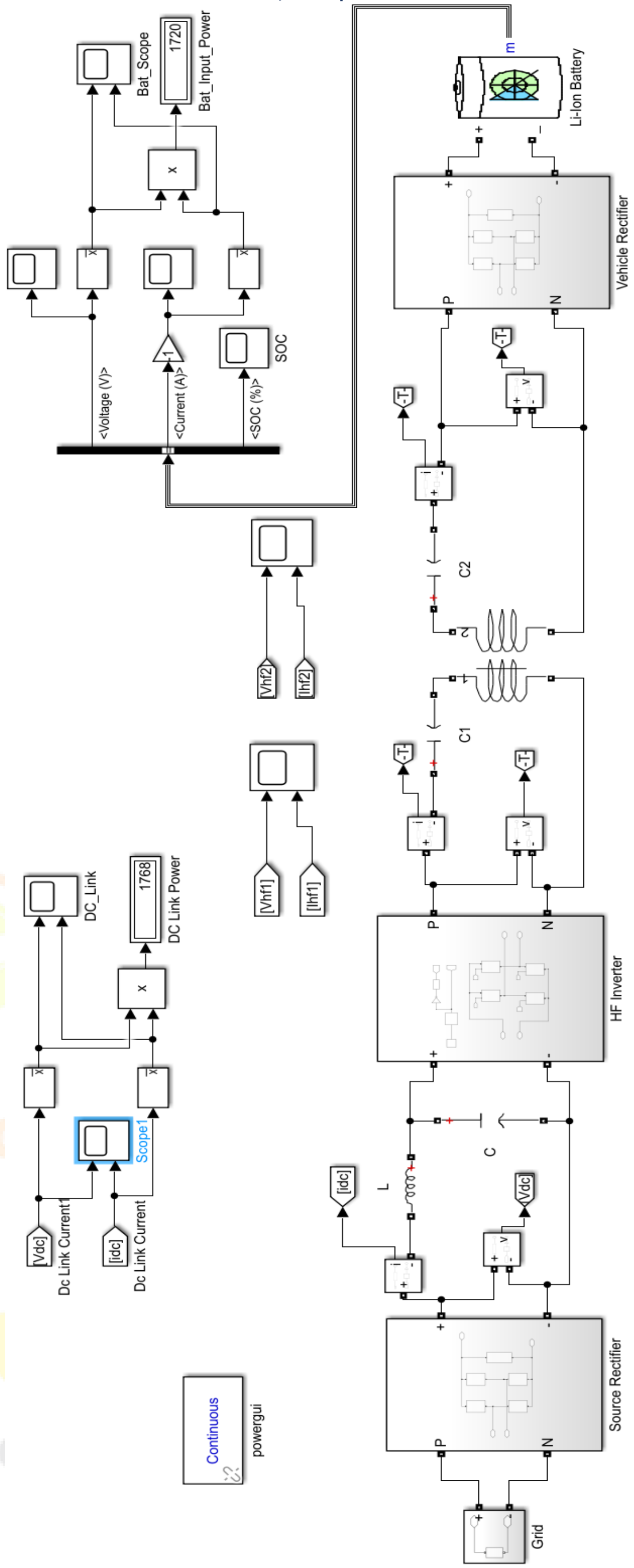

Figure: Simulation of Wireless Power Transfer

SIMULATION RESULTS:

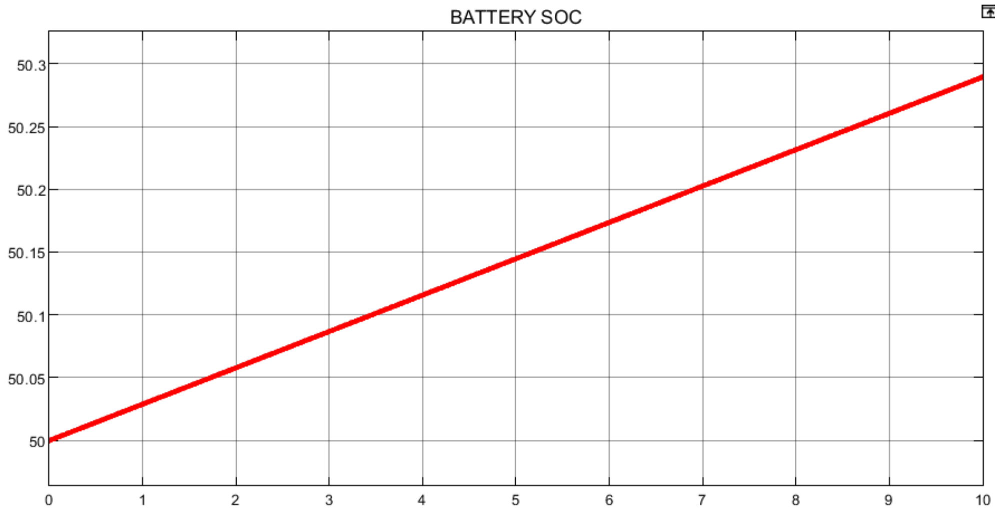

Figure: State of Charging (SOC of Battery)

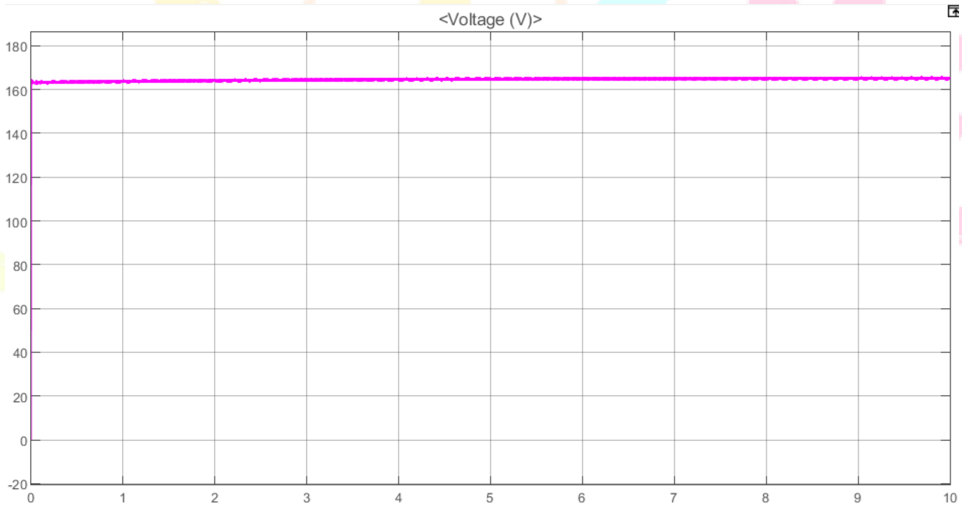

Figure: Voltage during Charging

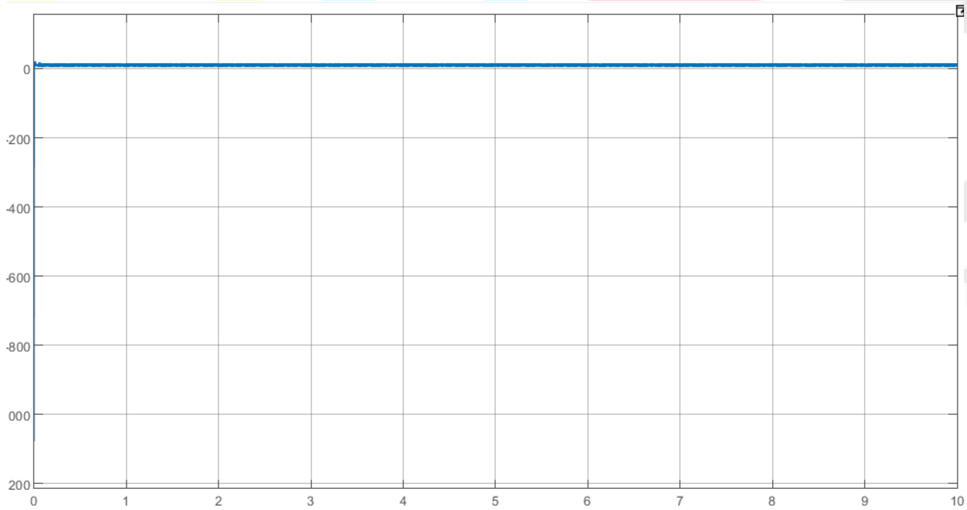

Figure: Current during Charging

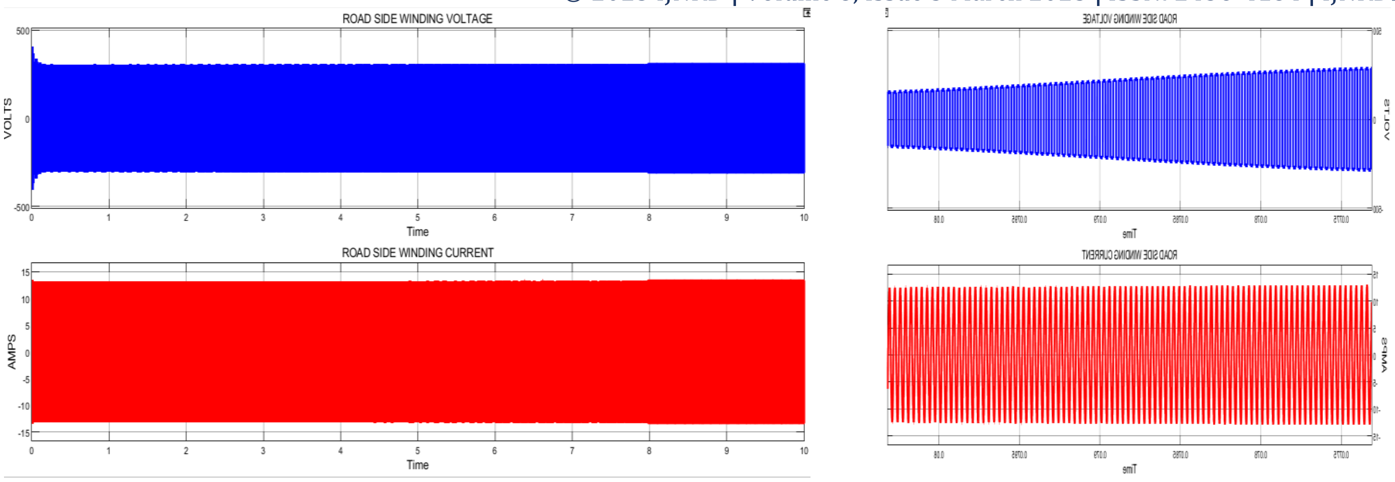

Figure: Transmitter Coil Voltage and Current

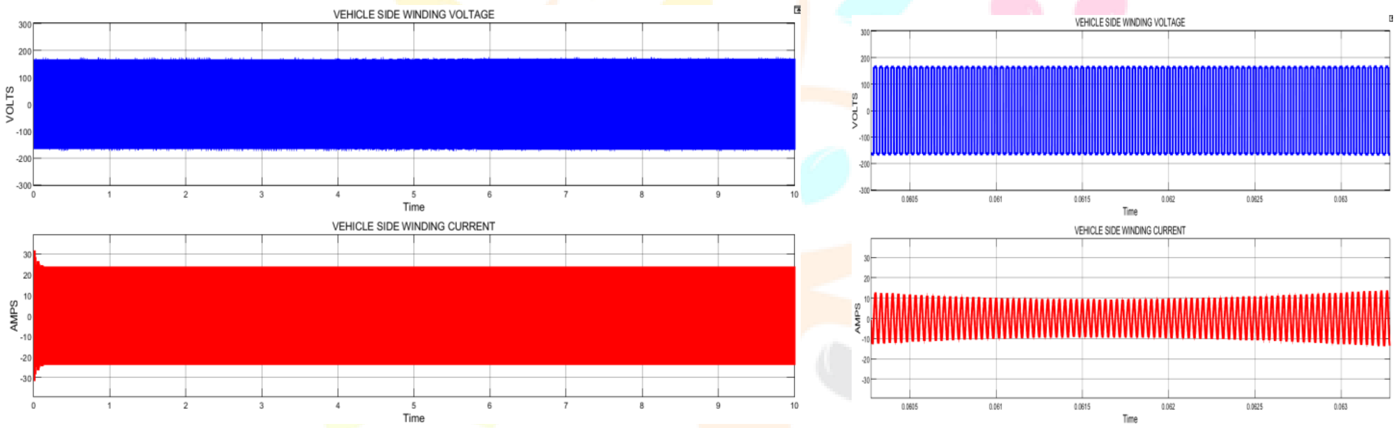

Figure: Receiver Coil Voltage and Current

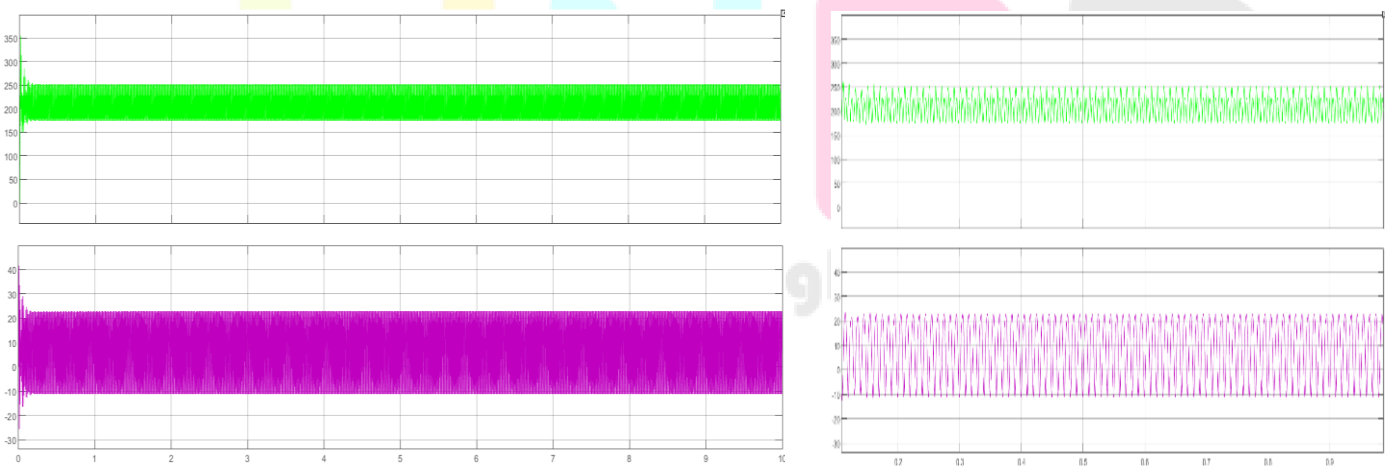

Figure: DC Voltage and Current (at source Rectifier)

CONCLUSION:

This proposed form of a vertical-axis wind turbine on highways will be an excellent source of renewable energy. With this strategy, all national roadways may be used to generate power while avoiding the usage of nonrenewable energy sources. The wind energy is stored in the grid, and the AC power is retrieved from the grid and to recharge the electric vehicle through wireless power transfer technology. The design of the two magnetically connected coil resonators allows for charging the electric vehicle with any voltage capacity. WPT was studied utilizing inductive coupling, which has several features such as distance between coils, turns ratio, and coil area. The charging system may adjust the corresponding current and voltage levels for the load. The proposed design is examined, and the results are acquired through simulations. WPTS is better suited for short-distance transmission; the ideal distance is up to twice the coil's size. Because it nearly entirely tackles the issue of power shortage, the simulation results lead to the conclusion that this project can be expanded up to a level of mass production. This study contributes to a better knowledge of wireless EV charging on the track for high resonant frequency utilizing RIPT and has the potential to be increased for future research in this area.

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