GRID CONNECTED ELECTRIC VEHICLE CHARGING STATION USING RENEWABLE ENERGY SOURCE

A Project report submitted in partial fulfilment of the requirements for the degree of

B. Tech in Electrical Engineering

By

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ACKNOWLEDGEMENT

It is my great fortune that I have got opportunity to carry out this project work under the supervision of **(Grid Connected Electric Vehicle Charging Station using Renewable Energy Source/Prof. Dr. Shilpi Bhattacharya)** in the Department of Electrical Engineering, RCC Institute of Information Technology (RCCIIT), Canal South Road, Beliaghata, Kolkata-700015, affiliated to Maulana Abul Kalam Azad University of Technology (MAKAUT), West Bengal, India. I express my sincere thanks and deepest sense of gratitude to my guide for his constant support, unparalleled guidance and limitless encouragement.

I wish to convey my gratitude to Prof. (Dr.) Debasish Mondal, HOD, Department of Electrical Engineering, RCCIIT and to the authority of RCCIIT for providing all kinds of infrastructural facility towards the research work. I would also like to convey my gratitude to all the faculty members and staffs of the department of Electrical Engineering, RCCIIT for their whole hearted cooperation to make this work turn into reality.

I would also like to thank TEQIP-II, RCCIIT for financial support to perform this project work.

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CERTIFICATE

To whom it may concern

This is to certify that the project work entitled (**Grid Connected Electric Vehicle Charging Station using Renewable Energy Source)** is the bona fide work carried out by **(Dibyajyoti Sarkar (11701618008), Sagnik Das (11701617045), Asamanya Ganguly(11701617068))** , a student of B.Tech in the Dept. of Electrical Engineering, RCC Institute of Information Technology (RCCIIT), Canal South Road, Beliaghata, Kolkata-700015, affiliated to Maulana Abul Kalam Azad University of Technology (MAKAUT), West Bengal, India, during the academic year 2020-21, in partial fulfillment of the requirements for the degree of Bachelor of Technology in Electrical Engineering and that this project has not submitted previously for the award of any other degree, diploma and fellowship.

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Contents:

ELECTRIC VEHICLE

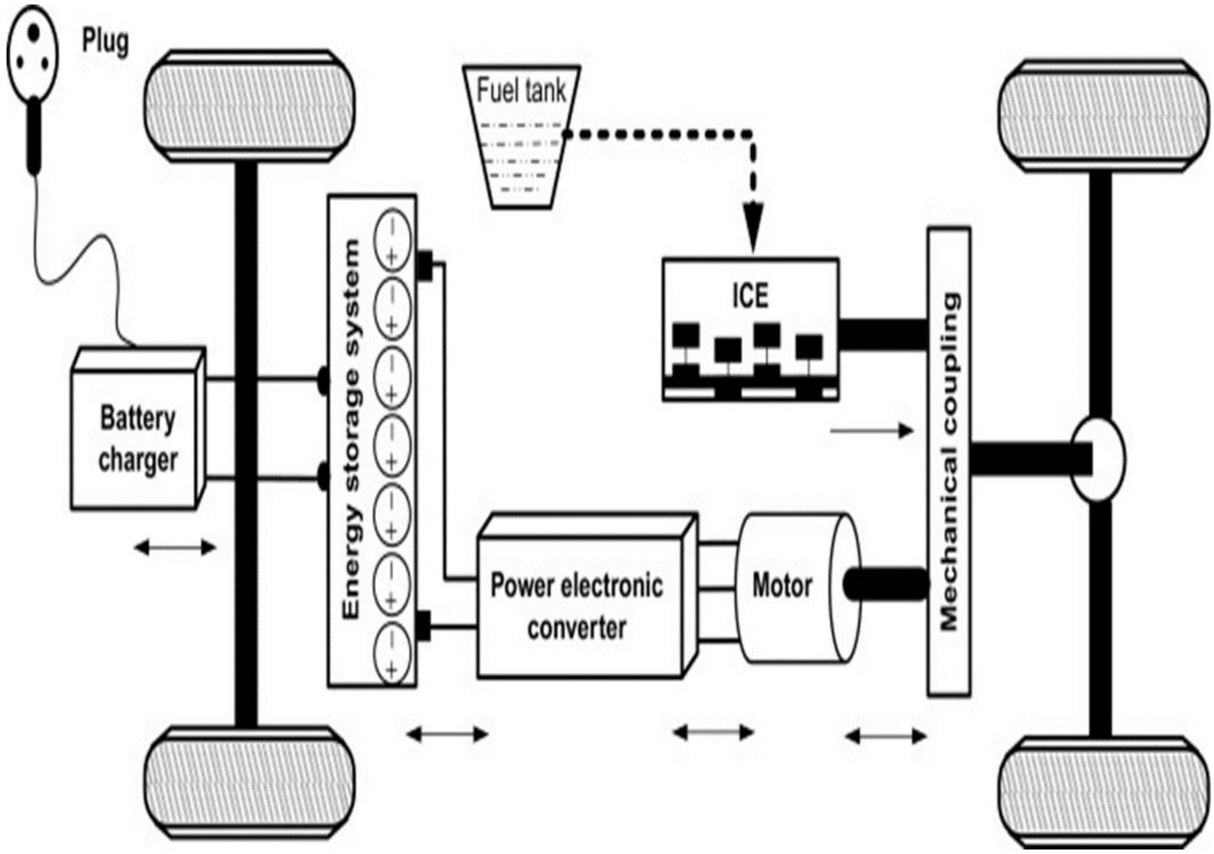
An electric vehicle (EV) is a vehicle that uses one or more electric motors or traction motors for propulsion. An electric vehicle may be powered through a collector system by electricity from off-vehicle sources, or may be self-contained with a battery, solar panels, fuel cells or an electric generator to convert fuel to electricity. EVs include, but are not limited to, road and rail vehicles, surface and underwater vessels, electric aircraft and electric spacecraft.

EVs first came into existence in the mid-19th century, when electricity was among the preferred methods for motor vehicle propulsion, providing a level of comfort and ease of operation that could not be achieved by the gasoline cars of the time. Modern internal combustion engines have been the dominant propulsion method for motor vehicles for almost 100 years, but electric power has remained commonplace in other vehicle types, such as trains and smaller vehicles of all types.

Commonly, the term EV is used to refer to an electric car. In the 21st century, EVs have seen a resurgence due to technological developments, and an increased focus on renewable energy and the potential reduction of transportation's impact on climate change and other environmental issues. Project Drawdown describes electric vehicles as one of the 100 best contemporary solutions for addressing climate change.

Government incentives to increase adoption were first introduced in the late-2000s, including in the United States and the European Union, leading to a growing market for the vehicles in the 2010s. And increasing consumer interest and awareness and structural incentives, such as those being built into the green recovery from the COVID-19 pandemic, is expected to greatly increase the electric vehicle market. A pre-COVID 2019 analysis, projected that Electric vehicles are expected to increase from 2% of global share in 2016 to 22% in 2030. Much of this market growth is expected in markets like North America and Europe; a 2020 literature review, suggested that growth in use of electric vehicles, especially electric personal vehicles, currently appears economically unlikely in developing economies.

SIMPLE WIRING DIAGRAM OF ELECTRIC VEHICLE



AIM:

The recent scenario depicts that world is struggling with several burning issues, most significantly global warming and energy crisis, the adoption of Electric Vehicle with cutting edge technologies may prove beneficial in partially eradicating real-word difficulties.

In this presentation we have made an effort to introduce an all-new innovative approach towards integrated intelligent hybrid power model considering both renewable and conventional power sources primarily to feed the EVs. A smart integrated controller circuit has been designed to set up a network consisting of multiple energy sources, storage, charging infrastructure and finally existing grid to establish uniform reliable bi-directional flow of energy. The above-proposed dynamic model has been characterized to optimize the flow of energy between generating station and loads through intelligent energy switching between sources based on its demand schedule. Moreover, a special feature has been instigated i.e. GPS based mobile charging van service for real-time emergency backup; in addition, surplus power can be utilized by distributing to remote areas in turn empowering with independent power autonomy. Cost optimization has been achieved using an evolutionary algorithm which has been numerically validated with respect to real-time demands.

This may significantly reduce the burden and dependence upon fossil fuels and may set a path towards green circular economy and move towards a sustainable future.

OBJECTIVES:

1. To promote and harness energy-efficient renewable energy as a major field in the energy sector.

2. To reform Indian automobile industry policies for a better sustainable green future.

3. To provide effective scope for low-cost EV charging station running primarily on renewable sources.

4. To enhance reliable and flexible charging infrastructure through revolutionary charge carrier vans.

5. To supply dynamic power to the remote areas at affordable rates under adverse circumstances.

Benefits of Electric Vehicles:

Cheaper to run

- The cost of the electricity required to charge an EV is around 40% less than the cost to use petrol for a similar sized vehicle driving the same distance. The cost will be lower if charged from solar PV system or at free charging stations.

Cheaper to maintain

- A Battery Electric Vehicle (BEV) has fewer moving parts than a conventional petrol/diesel car. Servicing is relatively easy, less frequent and overall cheaper than a petrol/diesel vehicle.
- All EV batteries degrade. Most car manufacturers warrant EV batteries to not degrade below a certain level for around eight years.
- Plug-in Hybrid Electric Vehicles (PHEVs) also have a petrol or diesel engine that needs servicing, so a PHEV will cost more to maintain than a BEV.

Better for the environment

- Less pollution: Driving an EV helps to reduce harmful air pollution from exhaust emissions. An EV has zero exhaust emissions, but still creates a degree of greenhouse gas emissions when it is charged from the electricity grid.
- Renewable energy: If you have a solar PV system and charge your EV during the day, you can reduce your greenhouse gas emissions even further. Another way is to purchase Green Power from your electricity retailer. Then, even if you recharge your EV from the electricity grid, your electricity is coming from renewable energy sources.

Problems with Electric Vehicles:

- Range of cars: EV have less range over ICV. Though there have been claims of EV providing a range of 300 miles, under safe parameter
- Charging Time: It takes around 20 hrs. To charge through 120V supply and 7hrs through 240V supply. With fast charging, it still takes around 30 minutes.
- Infrastructure: A study carried out by Nielsen in 2017 showed that the number of gas charging station is almost three times than the EV charging station. There is only 1 charging station for 16 EV.
- The number of charging stations are very less and have been installed very far off from one another which also creates a lot of problems.

CHARGING STATION

An **electric vehicle charging station**, also called **EV charging station**, **electric recharging point**, **charging point**, **charge point**, **electronic charging station** (**ECS**), and **electric vehicle supply equipment** (**EVSE**), is a machine that supplies electric energy for the recharging of plug-in electric vehicles—including electric cars, neighbourhood electric vehicles and plug-in hybrids.

Some electric vehicles have converters on board that plug into a standard electrical outlet or a high-capacity appliance outlet. Others use a charging station that provides electrical conversion, monitoring, or safety functionality. These stations can support faster charging at higher voltages and currents than residential EVSEs.

Charging stations provide a range of heavy duty or special connectors that conform to the variety of standards. For common DC rapid charging, multi-standard chargers equipped with two or three of the Combined Charging System (CCS), CHAdeMO, and AC fast charging has become the *de facto* market standard in many regions.

Public charging stations are typically on-street facilities provided by electric utility companies or located at retail shopping centres, restaurants and parking places. They can be operated by various private companies.

CHARGING STATION TYPES

- Residential charging stations: An EV owner plugs into a standard receptacle (such as NEMA connector in the US), recharging the vehicle overnight. A home charging station usually has no user authentication, no separate metering, but may require wiring a dedicated circuit to have faster charging. Some portable chargers can also be wall mounted as charging stations.

- Charging while parked (including public charging stations) – a private or commercial venture for a fee or free, sometimes offered in partnership with the owners of the parking lot. This charging may be slow or high speed and often encourages EV owners to recharge their cars while they take advantage of nearby facilities. It can include parking for an organization's own employees, parking at shopping malls, small centres, and public transit stations. Typically, AC Type1 / Type2 plugs are used.

- Fast charging at public charging stations >40 kW, capable of delivering over 60-mile (100 km) of range in 10–30 minutes. These chargers may be at rest stops to allow for longer distance trips. They may also be used regularly by commuters in metropolitan areas, and for charging while parked for shorter or longer periods. Common examples are J1772, Type 2 connector Type 3 connector, combined charging system, CHAdeMO, and Tesla Superchargers.

- The battery can charge in under 15 minutes. A specified target for CARB credits for a zero-emission vehicle is adding 200-mile (300 km) to its range in under 15 minutes. In 2014, this was not possible for charging electric vehicles, but it is achievable with EV battery swaps.

CHARGING TIME WITH TABLE

The charging time depends on the battery capacity and the charging power. In simple terms, the time rate of charge depends on the charging level used, and the charging level depends on the voltage handling of the batteries and charger electronics in the car. The U.S.-based SAE International defines Level 1 (household 120 V AC) as the slowest, Level 2 (upgraded household 240 V AC) in the middle and Level 3 (super charging, 480 V DC or higher) as the fastest. Level 3 charge time can be as fast as 30 minutes for an 80% charge, although there has been serious industry competition about whose standard should be widely adopted. Charge time can be calculated using the formula: Charging Time [h] = Battery Capacity [kWh] / Effective Charging Power [kW]. The effective charging power can be lower than the maximum charging power of the socket or charging station due to limitations of the vehicle, charging losses (which can be as high as 25%), and also vary over time due to charging limits applied by a battery management system or a charge controller.

Charging time for 100 km of BEV range

Power Supply	Power	Voltage	Max. Current	Charging Time
Single Phase	3.3 KW	230 V AC	16 A	5–6 hours
Single Phase	7.4 KW	230 V AC	32 A	2-2½ hours
Three Phase	11 KW	400 V AC	16 A	1½-2 hours
Three Phase	22 KW	400 V AC	32 A	44–55 minutes
Three Phase	43 KW	400 V AC	63 A	22–28 minutes
Direct Current(DCFC)	50 KW	400 – 500 V DC	100 – 125 A	19–24 minutes
Direct Current(DCFC)	120 KW	400 – 500 V DC	300 – 350 A	8–10 minutes

COST

Costs vary greatly by country and the available power suppliers. In 2017, Tesla gave the owners of its Model S and Model X cars 400 kWh of Supercharger credit. Afterwards, drivers using Tesla Superchargers have to pay per kWh. The price ranges from $0.06 to $0.26 per kWh in the United States. Tesla superchargers are only usable by Tesla vehicles.

Other charging networks are available for non-Tesla vehicles. The Blink network of chargers has both Level 2 and DC Fast Chargers and charges separate rates for members and non-members. Their prices range from $0.39 to $0.69 per kWh for members and $0.49 to $0.79 per kWh for non-members, depending on location. The Charge Point network has free chargers and paid chargers that drivers activate with a free membership card. The paid charging stations' prices are based on local rates (similarly to Blink). Other networks use similar payment methods as typical gas stations, in which one pays with cash or a credit card per kWh of electricity.

SAFETY

There are two main types of safety sensor:

- Current Sensors which monitor the power consumed, and maintain the connection only if the demand is within a predetermined range. Sensor wires react more quickly, have fewer parts to fail and are possibly less expensive to design and implement. Current sensors however can use standard connectors and can readily provide an option for suppliers to monitor or charge for the electricity actually consumed.
- Additional physical "sensor wires" which provide a feedback signal such as specified by the undermentioned SAE J1772 and IEC 62196 schemes that require special (multi-pin) power plug fittings.

Charging Stations in India:

Here we some of the charging station manufacturers in India.

- **TATA Power** – it is also one of the most prominent manufacturers of EV charging stations in the country. TATA's EV charging network covers an area of 9 states including Delhi, Hyderabad and Mumbai, with about 300 charging points across 40 cities including: Mumbai, Delhi, Bangalore, Hyderabad, Pune, Chennai, Ahmedabad, Chandigarh, Lucknow, Kolkata and Vishakhapatnam.
- **CHARZER** – a start-up based in Bangalore which offers portable Kirana chargers of 3.3 KV for small shop owners, restaurants, malls, societies etc. at an affordable price of Rs. 15,000 only.
- **Delta Electronics India –** is India's leading EV Charging manufacturer in terms of sales and offers a wide variety of charging equipment including DC Quick Charger and AC EV charger. It also provides a Site Management System for parking lots, working places, residential buildings and more.
- **Fortum India –** is a Finnish clean energy company with activities in more than 40 countries. It has to its credit the first public charging station for Indian Oil in Hyderabad.
- **Mass-Tech** – It has to its credit the completion of the installation for DC Fast Charging Station in Mumbai, in partnership with TATA motors.

Simulation of grid connected EV charging station with renewable energy source:

Abstract:

The configuration of grid connected EV charging station which is integrated with renewable energy system. This is a solar PV rooftop system and act as a backup system for meeting power demand of an EV charging station which help to reduce stress on grid. Renewable energy sources is an best solution for production of energy as an local generation of power which help charging station run economically as it collaborate with grid connected charging station at off peak period the power is taken by grid for operation of station and at that time the solar pv system charges the backup batteries which are connect to station for supplying power to charge EV's at peak hours .As well as the backup battery bank which charge whole day with Solar PV system can be used for battery swapping for EV's .MATLAB/SIMULINK is used to simulate the grid connected EV charging station with renewable energy sources which help to obtain results of simulation model .

Introduction:

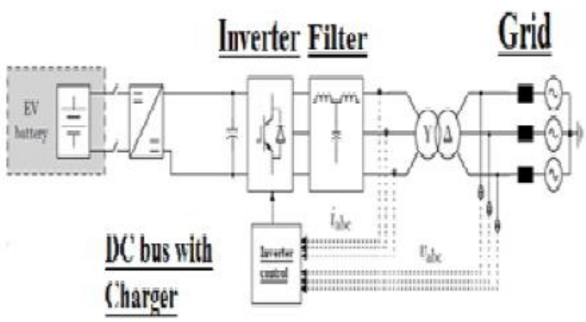
The present senior of worldwide is that global warming is increasing day by day one of the main reason for global warming is emission of carbon by conventional vehicle .one of the best solution proposed over the conventional vehicle that is electrical vehicle owing there advantages they are zero carbon emission, reduction of greenhouse gases, **eco-friendly**, consumption of fossil fuels is zero. EV is a perfect solution for energy crises which required negligible amount of conventional energy sources which is able to make balance between energy resources. The charging station plays an key role in EV technology to remove the limitations of charging of EVs, charging station location should be short accessible area, the charging time of EV should ne reduces and perfect battery management solutions should be implemented for long driving range. Integrating renewable energy sources with EV charging station with will help to meet power demand of EV charging station. In renewable energy sources solar PV system is more famous due its arability, reliability, low maintenance and it can setup easily .By integrating the solar with EV charging station is an prefect combination for reducing stress on grid and locally generated power by solar PV system can easily charge the backup batteries and which can be utilized at peak hours of grid so that charging station can run economically in peak hours.

SYSTEM DETAILS:

In an EV charging station, main components are inverter with interface with grid an RCL filter, transformer and a DC bus feed and battery chargers.

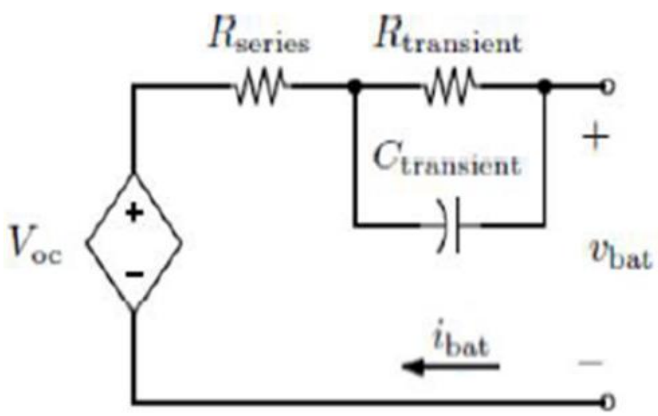
1. Inverter with interface with grid an RCL Filter

The picture shows an inverter is connected to grid with RCL filter and Inverter is controlled by control of inverter which use reoffered value from grid at the end DC off board charger with battery is shown.



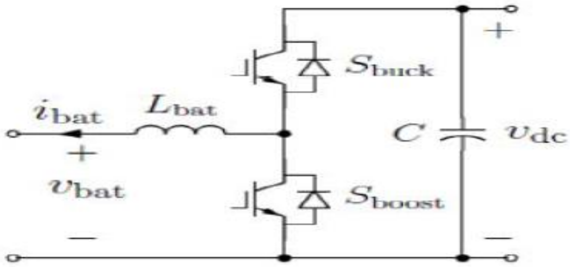
2. EV battery

The Thevenins equivalent circuit is used to represent the battery module where Voc=open circuit voltage which depends upon short circuit current and R series is used for V-I characteristics whereas Transient t response of battery is shown by RC parallel circuit. Battery is a heart for an EV which pumps power all over the EVs for the activities.



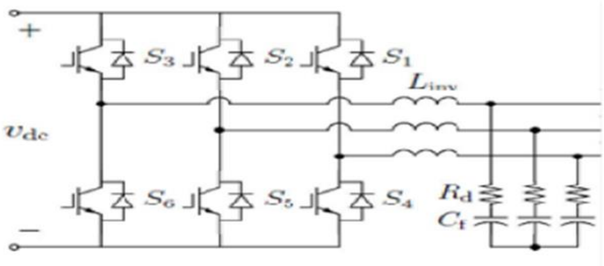
3. Battery charger

A Battery charger having a bi-direction convertor with power electronic s/w which operated complimentary to each other with respective control signals. In a convertor a buck boost operation is carry out, Buck-Boost depend upon the switching of the power electronic s/w. A boost action occurs at the left side voltage Vbat, when lower s/w is operated or triggered and buck mode is activated when upper s/w is operated.



4. Three phase inverter

The inverter is connected between sources and battery charging module and its control is done by inverter control system which provide gate pulse to trigger s/w of invertor and RCL filter is also connected with invertor.



5. RCL filter

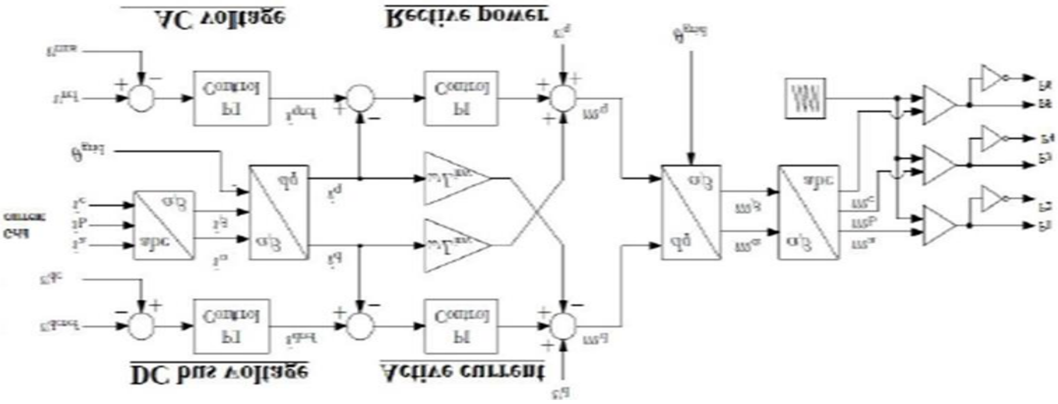
The passive filter is implemented to reduce harmonics which cause disturbance in line current and voltage which result to poor power quality and make an impact on system. RCL filter is connected between source and invertor.

6. Control system

Control system is an key aspect in a modelling of an any system it keep eye on working of system at different phases and adjust the input value according to system requirement to get proper desirable results.

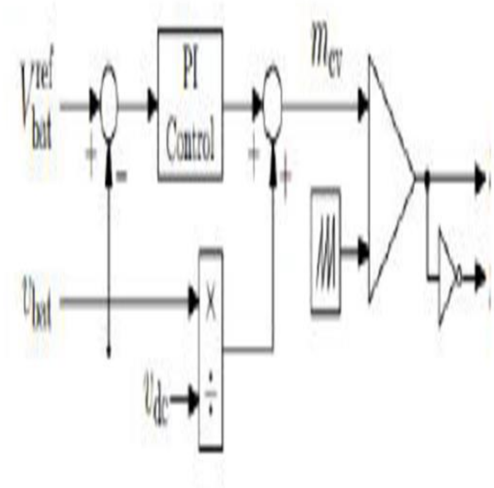
6.1 Inverter control

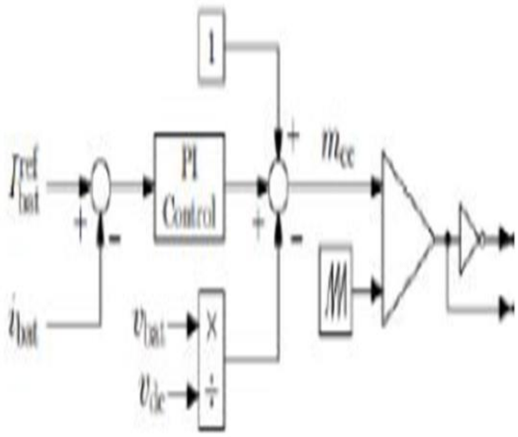
Invertor is utilized to power exchange between AC grids to DC bus. The control strategy implemented is cascaded control in sq. frame and PWM generator is used to give a gate pulse for s/w of invertor which help to maintain DC bus voltage. The cascade control have an inner current loop and outer voltage loop .Phase locked loop (PLL) is used to synchronization with grid voltage.



6.2 Battery control

Two controls are proposed for battery charge control one is constant current and another is constant voltage, whereas constant current is an initial stage of charging.

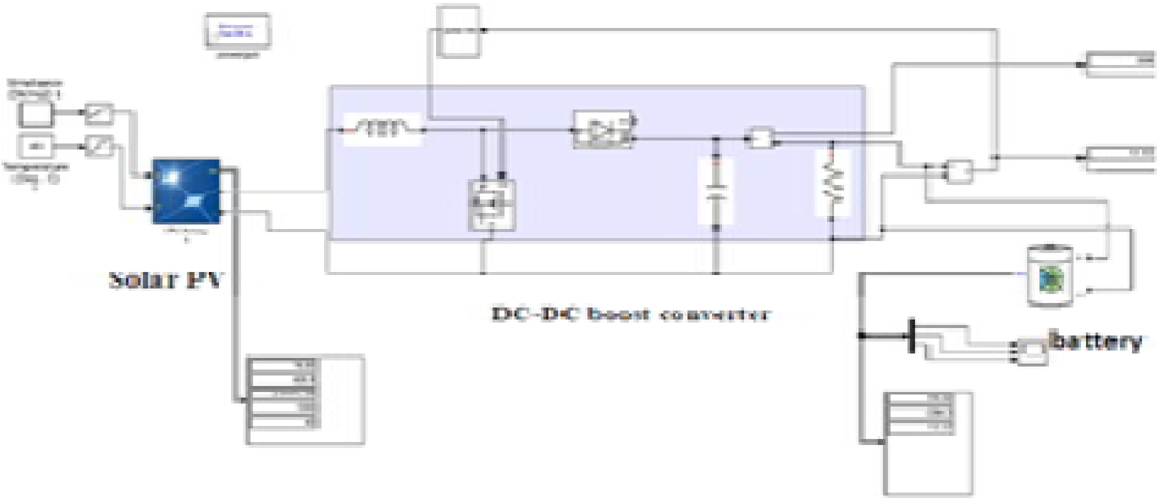




Simulation Models:

1. Simulation of solar pv with boost converter

The solar PV is use for charge the backup battery with help of boost converter .The solar PV module use in simulation is 1kw, Sun power SPR-X20-255with specification in the Table.3.The solar PV output is boosted and applied for charging process of battery .A Li-ion battery of 24V is utilized which will act as backup system to charging station.



2. Simulation of EV charging station

The MATLAB simulation of EV charging station is represent in fig 11 ,where whole station is connected grid sources of 11KV where power is feed to transformer , filter ,inverter and battery charging unit that is boot charger and functions of EV charging is carried out.

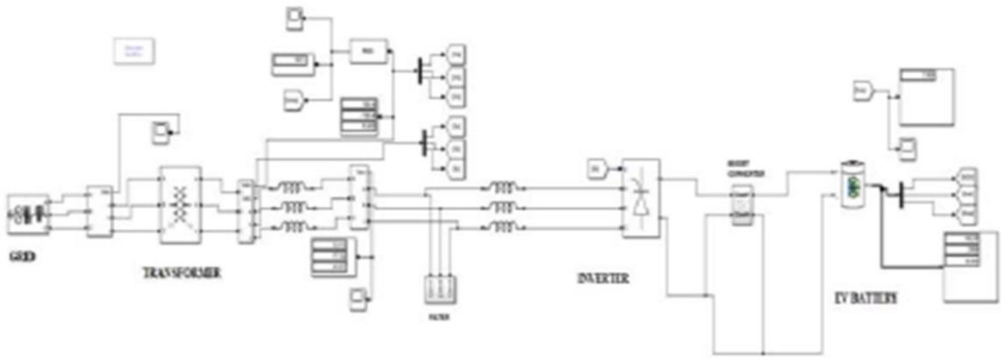


Figure 11: Simulation model of Grid connected EV charging station.

RESULTS AND OBSERVATION

The output of the proposed system mostly focusses on two parts:

1. Charging and discharging at battery end
2. Inverter output signal under charging.

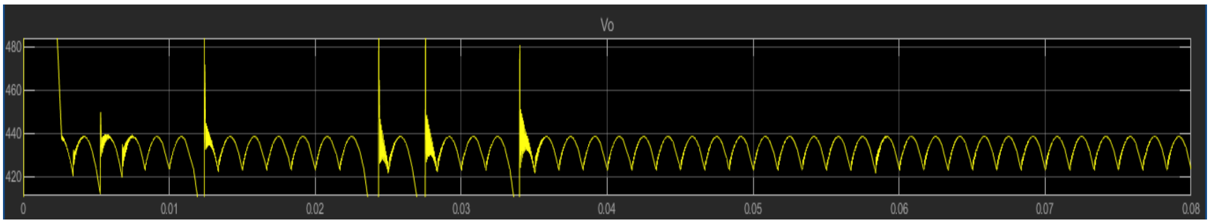
The battery end charging and discharging: The Input to the device is fed from a 440V AC supply and varying output DC voltage is obtained by varying the smoothing capacitor connected in parallel with the circuit.

PARAMETER	RATINGS(Farads)	OUTPUT VOLTAGE (Volts)
Capacitor	1 µF	423.4
Capacitor	5 µF	422.7
Capacitor	10 µF	424.0
Capacitor	50 µF	427.2
Capacitor	100 µF	438.0

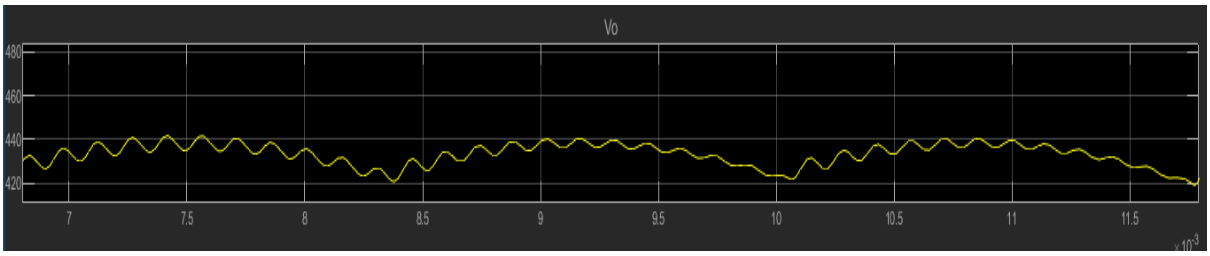
Table 1.1: Capacitor Rating vs. Output Voltage

The output voltage graph changes a lot with the change in the capacitor value. Y- Axis Voltage vs. X- Axis Time

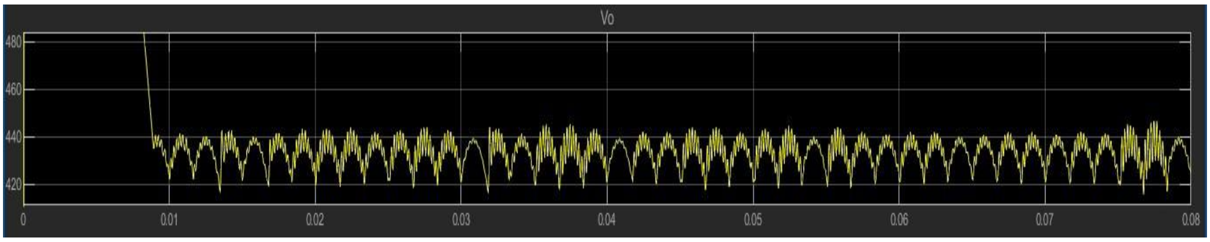
1µF Smoothing Capacitor



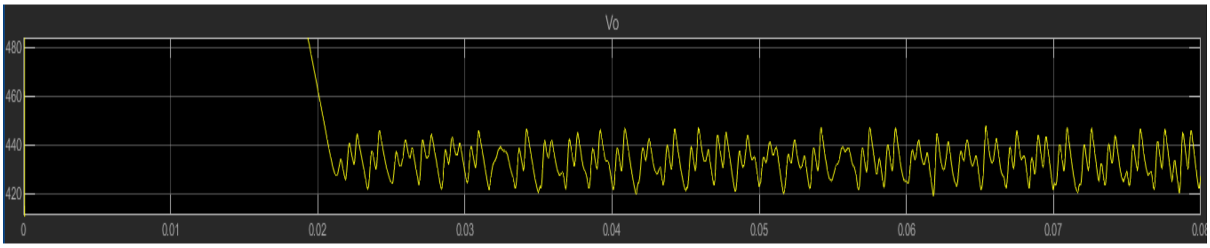
5µF Smoothing Capacitor



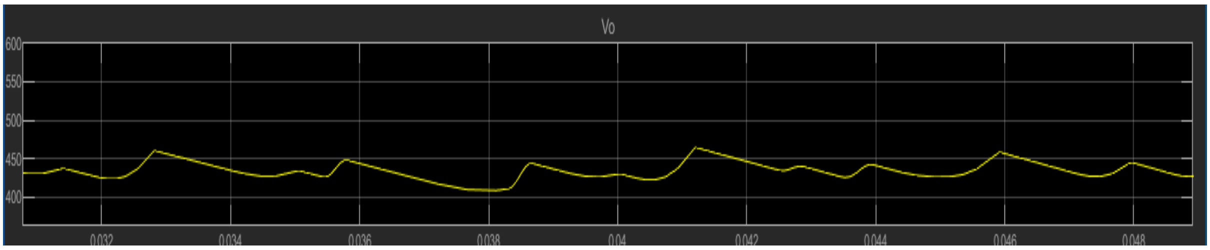
10µF Smoothing Capacitor



50µF Smoothing Capacitor



100µF Smoothing Capacitor



OBSERVATION

The output voltage smoothens by increasing the capacitor value. The output voltage and current harmonics of the output waveform is given by,

$(I_s)_n = \Sigma_{n=1, 3, 5}^{\infty} (4I_O/n\pi) \cos(\alpha n/2) \sin(n\omega t - n\alpha/2)$

Thus, becomes **inversely proportional** to the capacitor value, whose increment reduces the output harmonics.

However, there are two important parameters to be considered while choosing a suitable smoothing capacitor and these are its **Working Voltage**, which must be higher than the no-load output value of the rectifier and its **Capacitance Value**, which determines the amount of ripple that will appear superimposed on top of the DC voltage. Too low a capacitance value and the capacitor have little effect on the output waveform as in the case of 1micro-farad capacitor is observed. But if the smoothing capacitor is sufficiently large enough (parallel capacitors can be used) and the load current is not too large, the output voltage will be almost as smooth as pure DC.

INVERTER OUTPUT FOR CHARGING

The Inverter is fed from a 220V DC supply, keeping the value of LC elements fixed, Simulink results of output voltage, output current and source current is obtained. The output hence obtained is filtered using a LC filter and the harmonics are eliminated. Specifications under stander testing condition: - **Frequency: 50Hz Inductor: 36mH Capacitor: 470µF.**

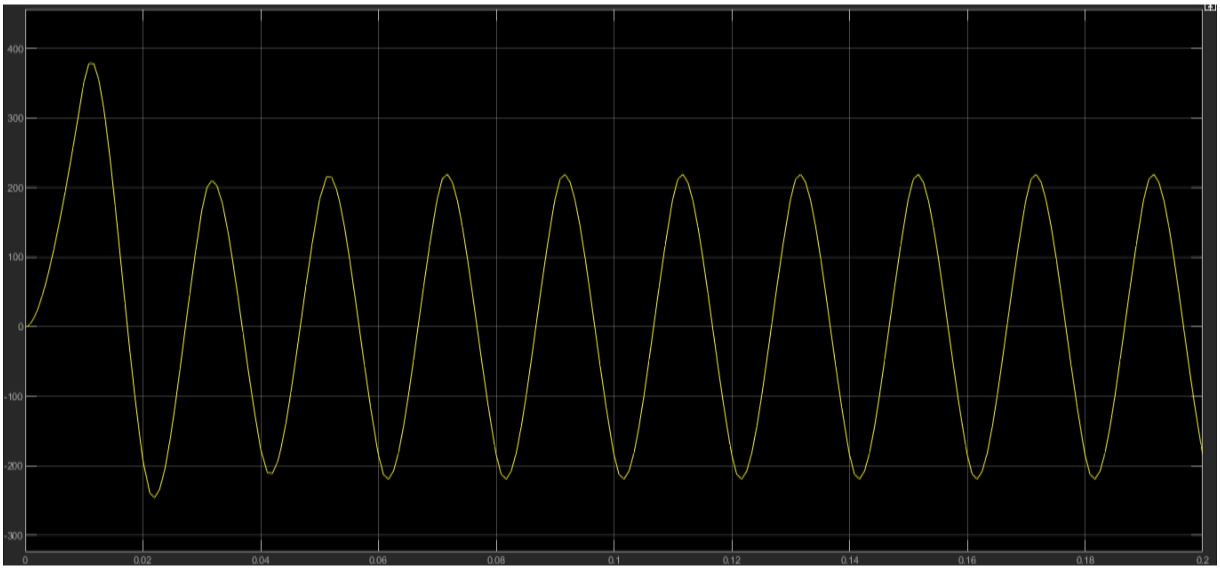


Fig 1: Output Voltage of the Inverter

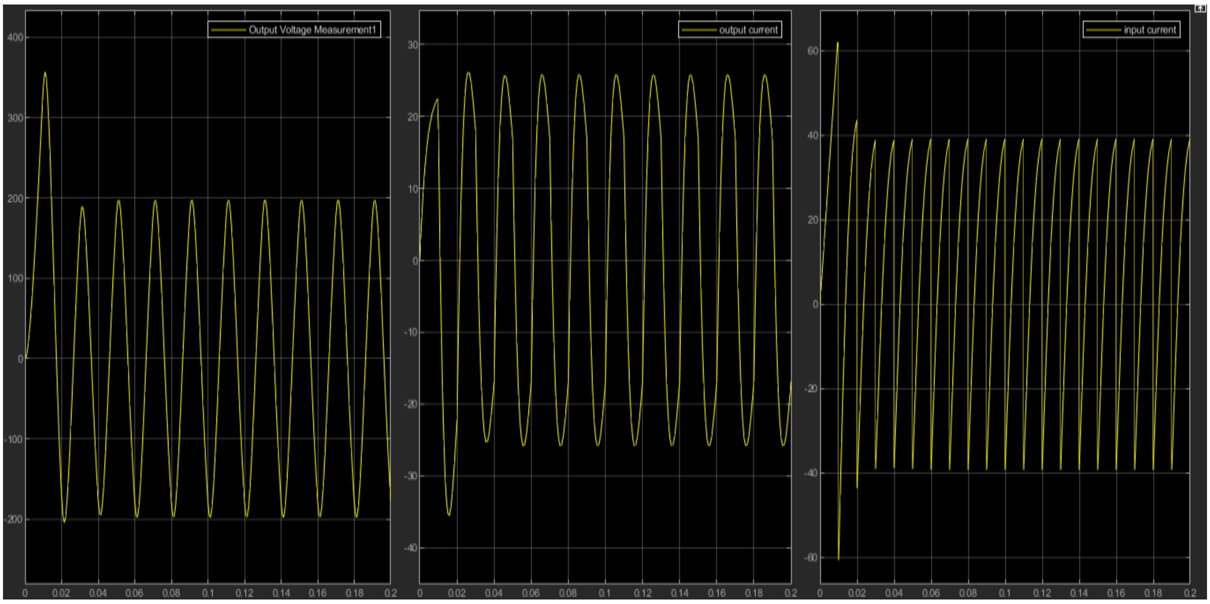


Fig 2: Output Voltage, Output Current, Input Current of the Inverter

OBSERVATION

By fixing the value of Capacitor and Inductor, the frequency of the output current and output voltage can be changed. From the above Simulink results we can observe, the frequency of the output voltage **increases** while the output current **decreases** guided by harmonics governed by the LC filter.

It is known that with the increase in the capacitor value decreases the output waveform harmonics and hence the LC filter alongside the inverted produces a close by ideal AC input for the charging station hub. The SCR firing angle (α) is changed to meet desired output load requirements for EV charging.

FINAL OUTPUT

A standard EV charging station are of **three types.** Level 1 and level 2 charging is on **AC** while Level 3/Fast charging is **DC** based charging mainly implemented in European countries.

Parameters	Level 1	Level 2	Fast Charging
Voltage	120 V	220 – 240 V	200 – 450 V
Maximum Current	16 A	80 A	200 A
Current Type	AC	AC	DC
Power	1.4 KW	7.2 KW	50 KW
Maximum Output	1.9 KW	19 KW	150 KW
Charging Time	12 Hours	3 Hours	20 Minutes

Table 1.2: Charging Station Ratings

Special emphasis has been given to Level 2 charging type.

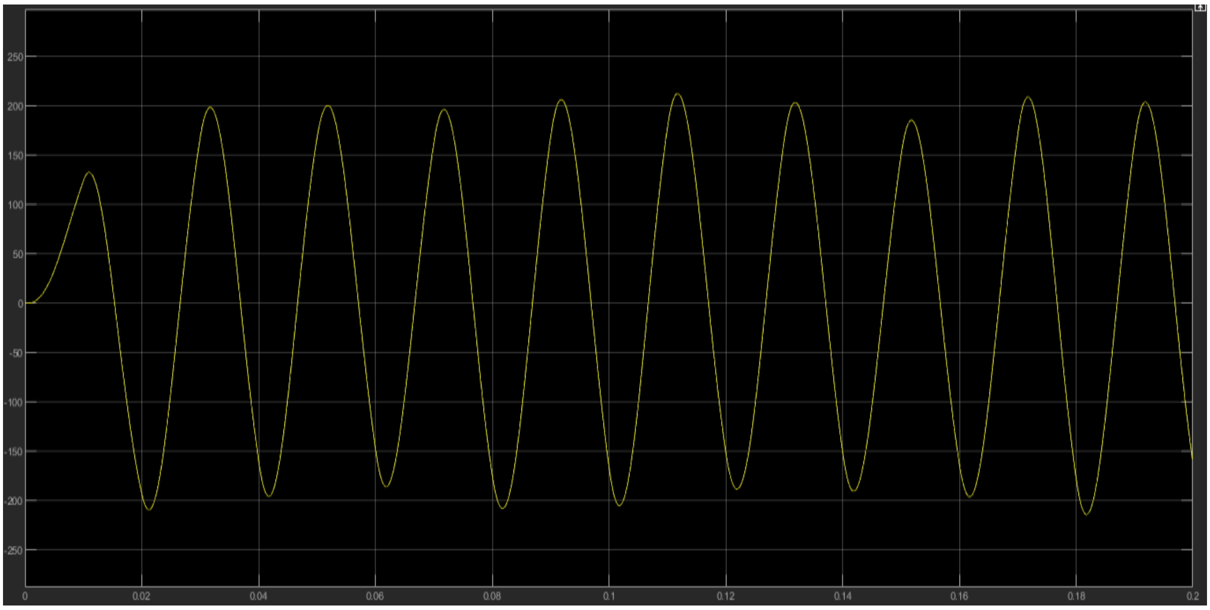
Load Capacity if the Batteries are used replacing DG Sets.

Location	Home	Store	Restaurant	Convention Centre	Workplace
Power	3.6 KW	7.2 KW	10 KW	12 KW	15 KW

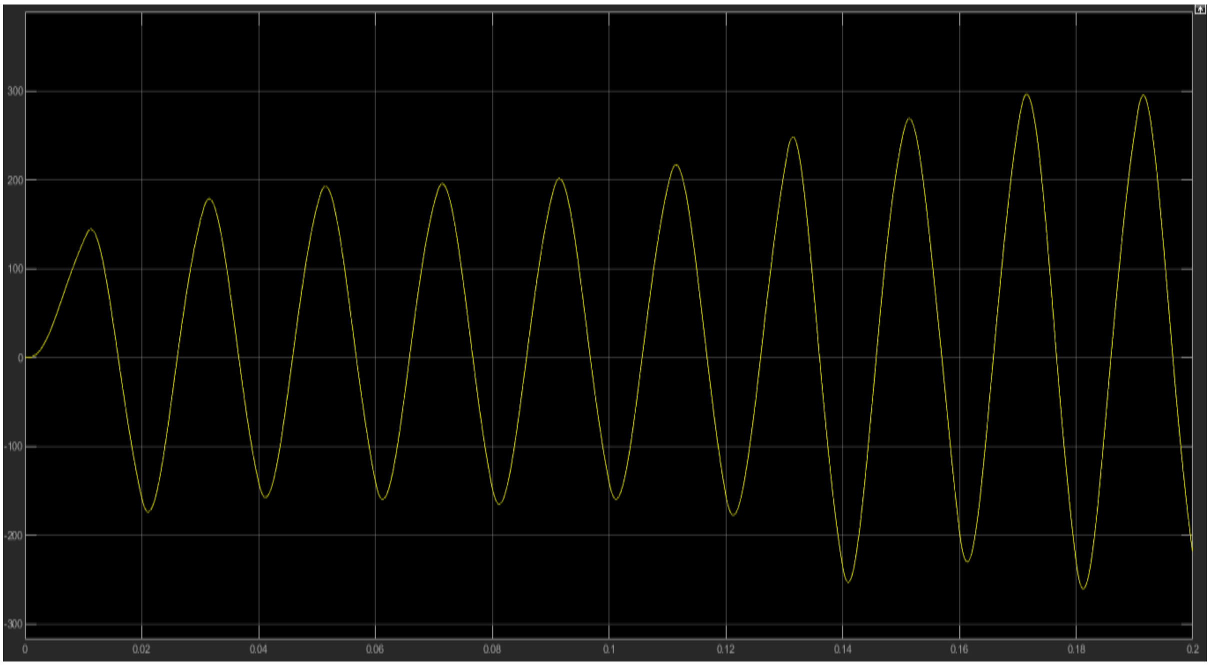
SIMULATION RESULTS

The load requirement variation is maintained by changing the firing angle (α) and the harmonics and output frequency is governed by the values of L & C alongside the inverter. The output Voltage waveforms for different loads has been demonstrated as follows:

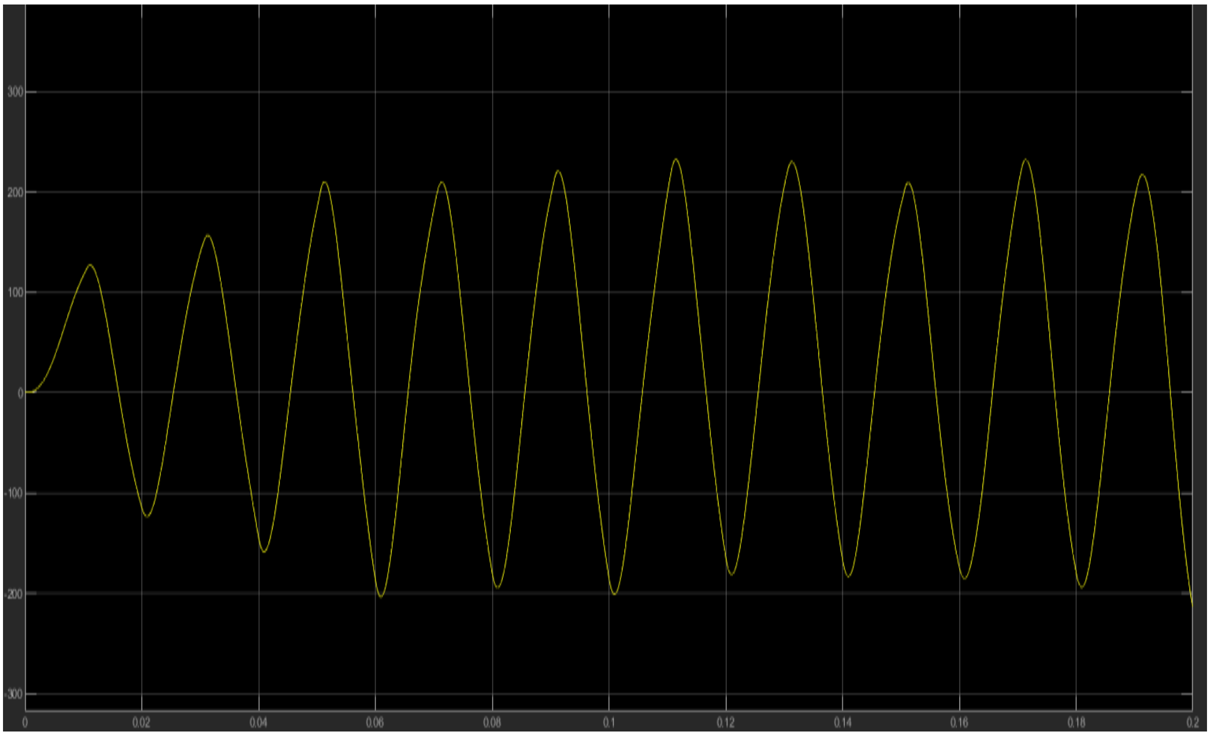
3.6 KW Load



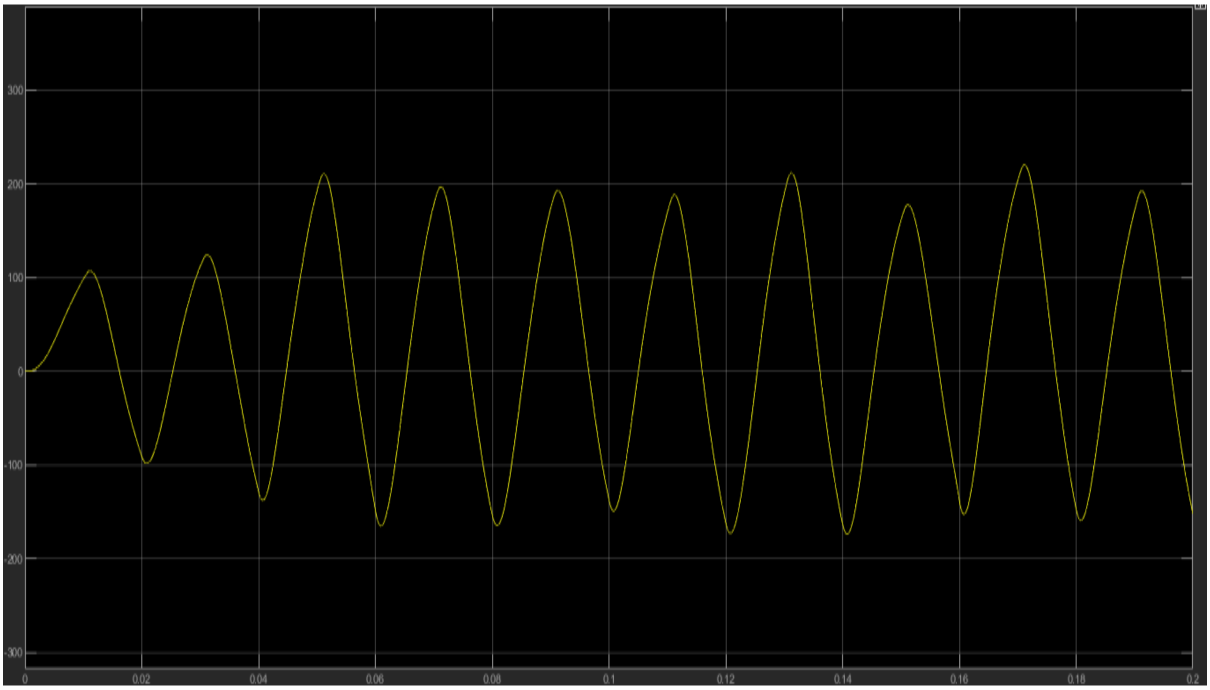
7.2 KW Load



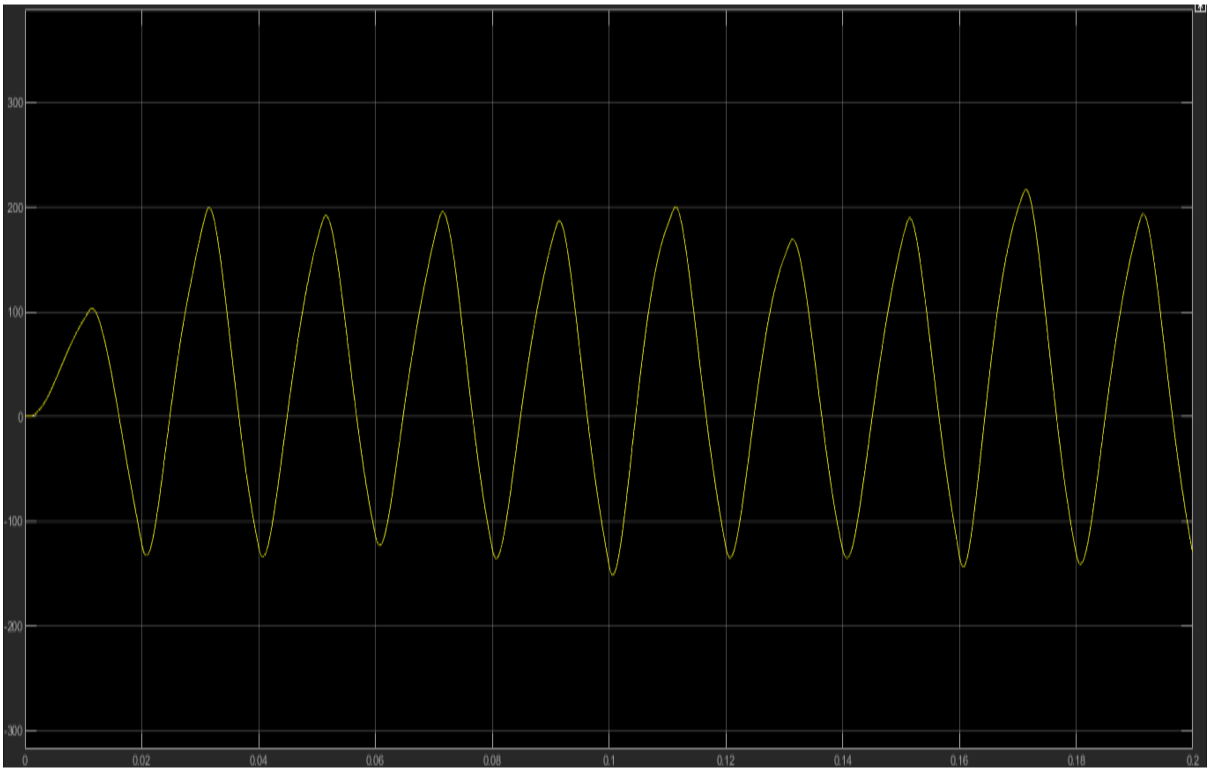
10 KW Load



12 KW Load



15 KW Load



Conclusion of our project:

- With these we come to following fact that no of expected vehicles doubling on the road in the near future the need for this alternative energy is very evident and has promising returns.
- Important to produce vehicles that do less, have a longer range use less energy.
- Lower our toxic emissions and localize greenhouse effects.
- Increase the overall energy efficiency of vehicles.

Reference:

- www.wikipidea.org
- Senger, R., M. Markel, and J. Nelson, "Validation of advisor in a series of Electric Vehicle," SAE paper 981133, 1998.
- Wipke Anderson, Samuel Johnson, "Future perspective of EV," IJOART paper, 2008.
- Donald MacArthur,Brooker pegotty, "Electrical vehicle A sustainable view," IJSER paper 2011 [4] Stevenson Parker", EV– A green vision for coming generation,"IEEE Xplore, 2010