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Simulation of Hybrid Solar-Grid Based EV with IGBT & Fuzzy Logic Controlled Battery & Solar Optimization

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Abstract: As fossil fuels become scarcer and more expensive, society's attention will naturally shift to electric vehicles. To avoid indirect reliance on thermal or nuclear power, electric vehicles will also need to utilise renewable energy sources. Higher torque on demand, fast acceleration, and greater power are all features of an IC engine that can be seen as a detriment to the widespread adoption of electric vehicles. A grid-solar hybrid electric vehicle design that efficiently and successfully tackles these problems is the focus of this study. In order to achieve the same efficiency as IC Engine cars in terms of row power, acceleration, torque, etc., the suggested system uses a more powerful 3 q induction motor with FOC (Field Oriented Control) or vector control. The system also has a smart electronic PWM switching technology that allows for the priority use of Root solar energy and the derivation of energy shortage from the battery while the car is in operation. The vehicle's battery can be charged from the sun using the on-board solar panels, and any excess power can be stored in the switching system.

Keywords: -Electric vehicle, Grid-Solar Hybrid, Field Oriented Control, Vector Control, Intelligent Electronic Switching.

I. INTRODUCTION

Electric vehicles (EVs) are automobiles that are propelled by one or more electric motors or kinetic energy. Sustaining an electric car requires a system of electric power gatherers to draw electricity from the environment and store it on board. Gold may convert gasoline into electricity when used in conjunction with a battery or a generator. Transportation on rails and roads, waterways, the air, and the sea can all be covered by electric vehicles.

The first EVs appeared in the nineteenth century, when they were used to power One reason why engine vehicle drive suppliers are so popular is that they bring a level of convenience and ease of use that was previously unattainable with older fuel automobiles. In spite of the fact that the internal combustion engine (ICE) has been the standard for powering automobiles for the past century, electric propulsion has remained the primary focus for other types of transportation, including trains and smaller vehicles of various sizes. Namly Any motor vehicle propelled by one or more electric motors is said to be an electric vehicle (EV). Wheels or propellers operated by revolving motors, or on account of pursued vehicles, straight engines, can provide forward motion. Automobiles, trains, trucks, planes, and even boats can all be powered by electricity.

Battery-powered electric vehicles (EVs) can use electricity as a source of transportation fuel. The batteries used in electric vehicles are used to store the electricity used to power the vehicles' motors and other electrical components. The electricity is sent to an electric motor that spins the wheels. EVSs have a limited capacity for storing energy, which can be restored by connecting them to an external power source. Unlike their petroleum-powered counterparts, electric vehicles may draw their power from a wide range of renewable and nonrenewable resources like tidal power, solar power, and wind energy. or a combination of the above. Regardless of how it is generated, electricity is sent to the car via wires strung above the road. Other methods of energy transfer, like as inductive loading and remote energy exchange, are also possible. An individual piece, steering wheel-mounted supercapacitor, gold energy component, allows for on-board power storage. Ignition-powered vehicles often rely on a few number of energy sources that are largely limited to petroleum derivatives that are not renewable. Power may be redirected back to the battery while braking (regenerative braking), which is a major advantage of electric automobiles and electric crossovers (V2G). At the turn of the new millennium, rising concerns about the environmental impact of oil-based transportation infrastructure, coupled with the peak oil price, sparked renewed interest in electric transportation systems. To that end, automobiles may Crossover electric vehicles and spotless electric vehicles, both of which are powered by renewable energy sources, are growing in popularity. Zero-emissions electric vehicles have the potential to significantly reduce urban pollution. Reduced emissions of substances that deplete the ozone layer are contingent on the method of producing electricity. Using an electric vehicle would lead to a 30% reduction in carbon dioxide emission with the current mix of US energies. It has been estimated that, given the current energy mixes in different countries, such emissions would be reduced by 40% in the UK, 19% in China, and as little as 1% in Germany. Automobiles that run solely off of electricity are known as electric battery vehicles (BEVs). Gathering electric vehicles have generally inadequate ranges between charges and reviving, despite the fact that they commonly provide great acceleration and maximum satisfactory speed. This is because electric vehicles' batteries have a lower control capacity than gasoline products. Have potentially crucial times. Still, electric cars are incredibly practical modes of transportation that can be economically revitalised in a single night, making them ideal for everyday use as opposed to lengthy trips. Other methods of energy storage that can provide more gold and faster reloading lines are areas of exploration. Because of urban pollution, reduced reliance on imported oil, and rising gas prices, the shift to electric vehicles is inevitable. While the term "electric vehicle" can refer to any vehicle powered by an electric motor, the term "electric car" typically refers to vehicles powered by electric engines and designed for use on public roads. Electric vehicles with motors fueled by other sources are typically referred to by a different term; for example, an electric vehicle powered by sunlight is called a Solar vehicle, while an electric vehicle powered by a gas generator is a form of cross breed vehicle. Therefore, TIC is installed in an electric vehicle. An electric vehicle battery is what you name the source of energy for your car that comes from a battery that is readily available in your area (BEV). Most of the time, when people talk about "electric cars," they're referring to pure electric battery vehicles like the Revai and the GM EV1. Batteries or other energy storage devices are used to provide constant access to the electrical energy that powers the engine in an electric vehicle (EV). Electric vehicles should have their batteries swapped out by hooking up to an electrical outlet. While some EVs are equipped with their own charging ports, others must be tethered to an external pile. However, the power from the mains is used by both types. Although power generation can contribute to air pollution, electric vehicles are considered zero-emission vehicles since their engines do not produce exhaust or other emissions. The major automakers do not now provide any low-control electric vehicles to the public. However, many businesses are already producing all-white NEVs (neighbourhood electric vehicles). These compact automobiles are commonly employed for Light Transport and local delivery. It can only be used on restricted-access areas like college campuses, airport terminals, and visitor zones, or for rough-terrain services when speeds exceed 35 mph. The Energy Policy Act of 1992 disqualifies NEVs from credit armadas since, due to their speed limits, they are not considered light vehicles. The Requirements and Regulations of the Federal Government. However, its versatility in transporting people through restricted areas makes it useful in a number of contexts. Electric bikes and motorcycles are two more types of electric vehicles that find useful niche uses. Vehicles having forward-facing ignitions: One of the main goals of EVs is to reduce the price gap between them and conventional internal combustion engine cars (ICEVs) in development, manufacturing, and maintenance.

Objective of Proposed Work

1. 3-phase induction motor control using IGBT inverter using vector control/ FOC (field oriented control).
2. Solar grid duel charging with priority to solar charging.
3. Solar power subsidized when vehicle running to enhance real time on battery.
4. Detection of complete vehicle system in MATLAB Simulink with vehicle motor /solar power generation, battery & power electronic circuitry.
5. 3 phase grid charging interface to expedite the charging in conjunction with solar panels.
6. Implementation of running & breaking condition using MOSFET driver.
7. Roof top solar system for charging vehicle anywhere in parking & subsidization battery power when vehicle running.

II. Proposed Work

FOC (Field oriented control) / Vector control of AC Induction Motor.

Even a simple control like the V/Hz process has limitations on its practical application. More mind-boggling control conspiracies should be linked, in order to control the acceptance engine, for better one-of-a-kind execution to be achieved. Due to the microcontroller's scientific processing power, advanced control procedures can be implemented; these processes use numerical modifications to isolate the AC enlistment engine's torque generation and polarisation capacities. The term "rotor flux arranged control," or simply "Field Oriented Control," is commonly used to refer to this type of independent regulation of torque and polarisation (FOC). The "V/Hz" technique, used for nonstationary control, has practical limitations. An enlistment engine's scalar control approach can be used to generate torque fluctuations. Therefore, the more widespread control conspire is necessary for Induction Motor to achieve higher powerful performance. Advanced control procedures can be implemented to uncouple the torque generation and the charge capacities of an AC enlisting engine with the help of the scientific preparing capacities given by the miniaturised scale controllers, computerised flag processors, and FGPA. Flux oriented control refers to the practise of isolating torque and polarisation flux (FOC).

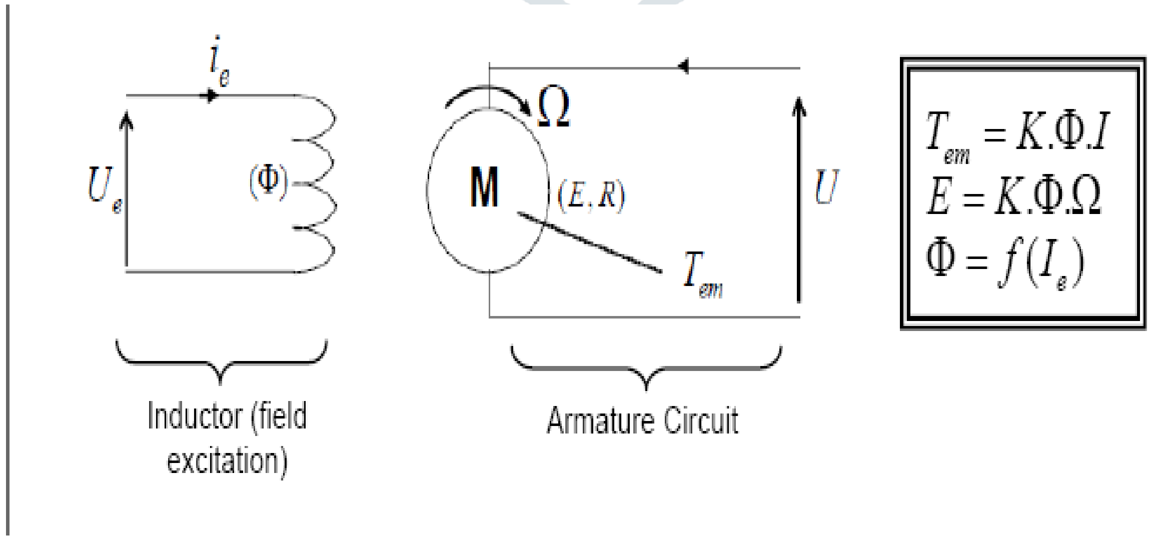

Fig 1 FOC

Flow Chart of Photovoltaic Priority Battery Charging Using PWM Based Grid Subsidization.

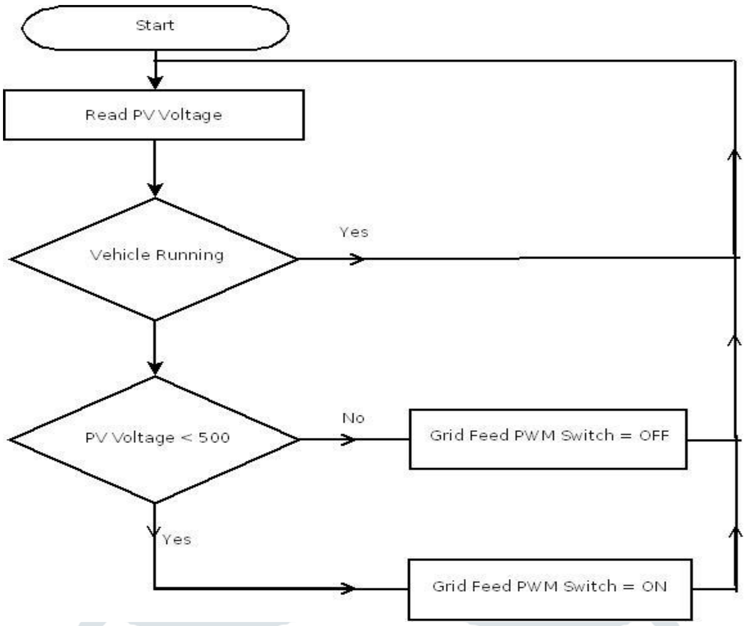

Fig.2: Flow Chart Of Photovoltaic Priority Battery Charging Using PWM Based Grid Subsidization.

This function read photovoltaic voltage and than checks, wether the vehicle is running or not. If vehicle is running than battrycan not be charged andcontrolls looped back to start. If the vehicle is holted than the function checks for photovoltaic voltage are less than 500 DC. If not than according to priority to renewable energy, Grid energy is not required, the PWM output driving grid feed MOSFET is kept OFF , Otherwise is photovoltaic voltage is less than 500volt DC, than to maintain steady changing of battry,looping in grid power becomes mondatoryand thus, PWM output driving grid feed MOSFET is turned ON.

Photovoltaic Priority Vehicle Running Using PWM Based Battery Subsidization.

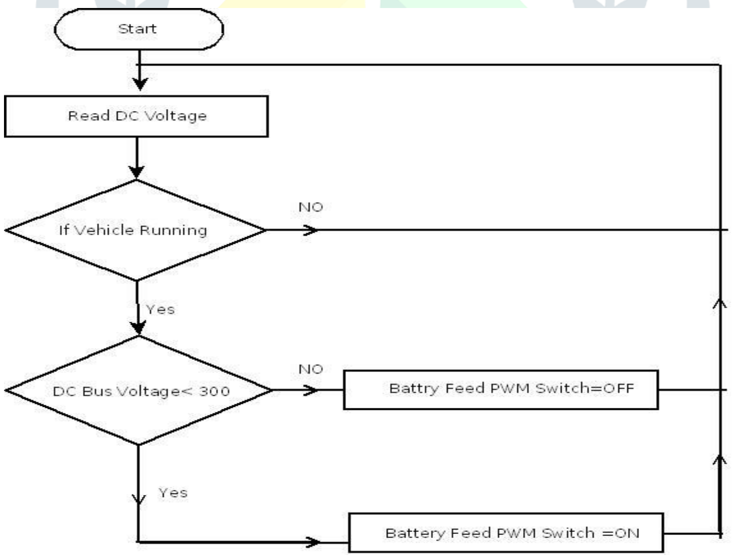

Fig.3: Photovoltaic Priority Vehicle Running Using PWM Based Battery Subsidization.

In This function reads DC voltage than checks, wether the vichele is running or not. If vichele is running than battrycan not be charged andcontrolls looped back to start.If vichele is holted than the function checks for DC Bus voltage to be less than 300 volt DC. If not then according to priority to renewable energy, Grid energy is not required, the PWM outout driving grid feed MOSFET is kept OFF, otherwise is photovoltaic voltage less than 300volt DC, than to maintain steady changing of battry, looping in Grid power becomes mondatoryand thus PWM output driving grid feed MOSFET is turned ON.

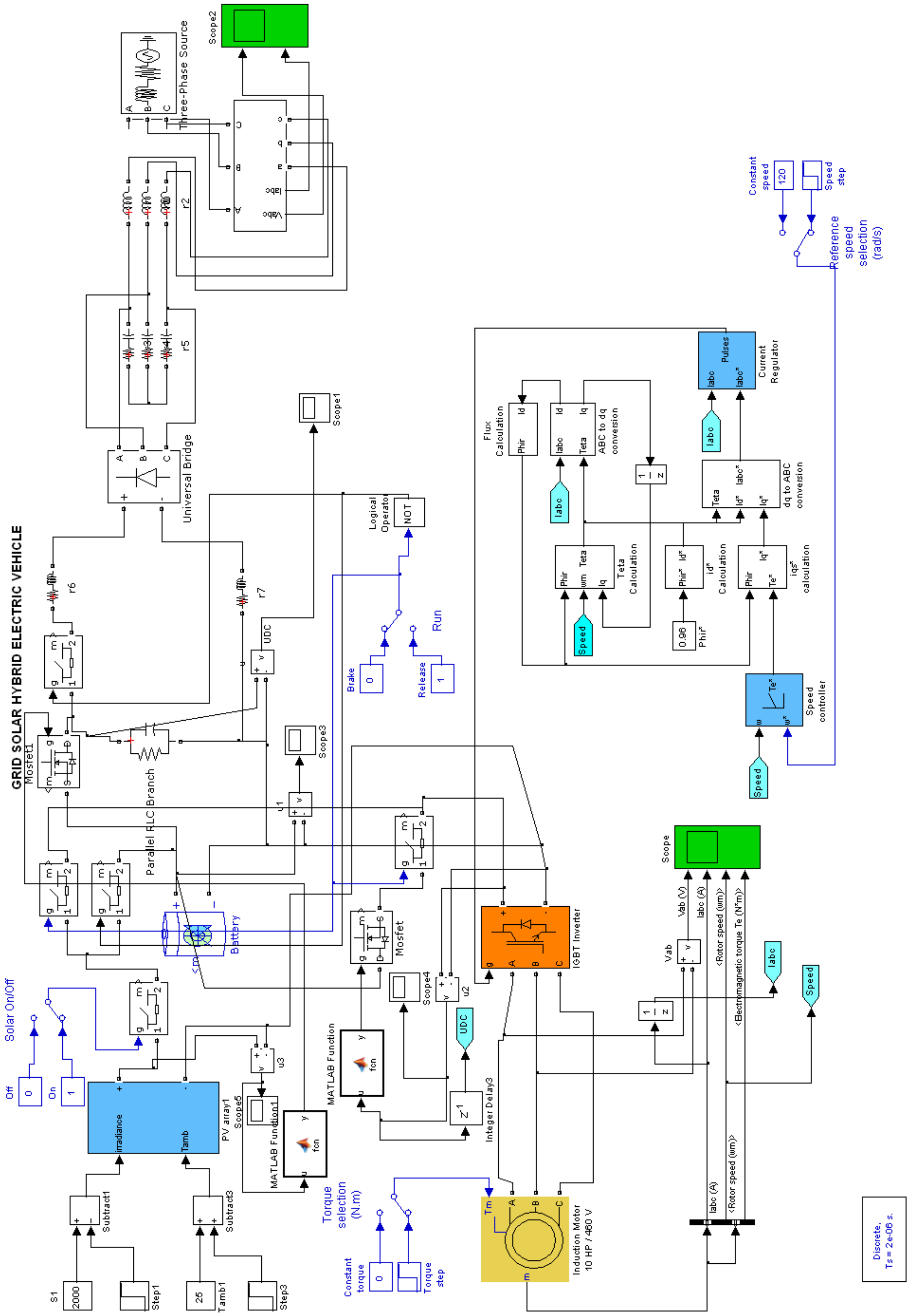

Fig.4 system architecture

III. Simulation & Result Analysis

Simulation parameter

Simulation Parameters and its value are show in Table 1.

Table 1 Simulation Parameters

S.No.	Parameter	Value
1	Simulation Type	Discrete
2	Solve Type	Tustin
3	Sample Timer	Ts
4	Simulation Timer	8 sec

Motor Parameter

Motor parameters which are used in this project and its value are show in table 2.

Table 2 Motor Parameters

S. No.	Parameter	Value
1	Power	10HP
2	Voltage	460 V
3	Frequency	60 Hz
4	Type	3 Phase Asynchronous Machine Squirrel cage
5	Stator Resistance	0.087 Ohm
6	Stator Inductance	0.8 mH
7	Rotor Resistance	0.228 Ohm
8	Rotor Inductance	0.8 mH
9	Mutual Inductance	34.7 mH
10	Inertia	1.662 J(Kg.M^2)
11	Friction Factor	0.12 F(N.M.S)

Initial Switch Settings

In this project we used 4 switches. This table shows the Switch name and its ON/OFF position and its initial conditions.

Table 3 initial switch setting

S. No.	Switch Name	Position (OFF)	Position (ON)	Initial Condition
1	Solar On/Off	Solar Panel Disconnect	Solar Panel Connect	ON
2	Break/Release	Break	Release	OFF
3	Reference Speed Select red/sec	Constant Speed (120)	Speed step	Speed Step(120rad/ sec, 160rad / sec)
4	Torque Selection (N-M)	Constant Torque	Costume Torque	Torque (0,200@1.85)

Solar Panel Parameter Change

Solar parameters show in table 3 and its value which is varies with time. Irradiance at Starting is 2000 and after 3sec it's reduced by 200 and its value after 3sec is 1800. Second parameter is Ambition Temperature at starting value is 25 degree Celsius and after 2sec its reduced by 5 degree Celsius and its value is 20 degree Celsius.

Table 4 Solar panel parameters change

S. NO.	Parameter	Time	Value
1	Irradiance	0 sec	2000
2	Irradiance	8 sec	1600
3	Ambition Temperature	0 sec	25 degree Celsius
4	Ambition Temperature	8 sec	20 degree Celsius

Various Switching of Parameters

at starting solar panel is ON then Torque is 0 N-m and speed select is 120rad/sec after 0.711 solar panel is OFF than torque is 0N-m and speed is 160rad/sec. After 1.652sec break is release other parameters are same. At 1.85sec solar panel is ON break is release and torque is change and vale is 200N-m and speed is same. At 2.958 solar panel is OFF Torque is 200N-m and speed is reduce and value is 120rad/sec.

Table 5 Various Switching of Parameters

S. NO.	Time (Sec.)	Solar Panel	Break/Release	Torque	Speed Select
1	0	ON	Break	0 N-m	120 rad/ sec
2	1	ON	Break	0 N-m	160rad/sec
3	2	OFF	Break	0 N-m	160rad/sec
4	3	OFF	Release	0 N-m	160rad/sec
5	4	ON	Release	0 N-m	160rad/sec
6	5	ON	Release	200 N-m	160rad/sec
7	6	ON	Release	200 N-m	120rad/sec
8	7	ON	Break	200 N-m	120rad/sec
9	8	OFF	Break	200 N-m	120rad/sec

Induction Motor Running Parameters

Induction motor Running Graph is show in fig. and we find the value of voltage Vab(volt) , Current Iabc(Amp.), Rotor speed(WM) and Electrostatic Torque (N-m) at different time intervals. These find out values are show in the table.

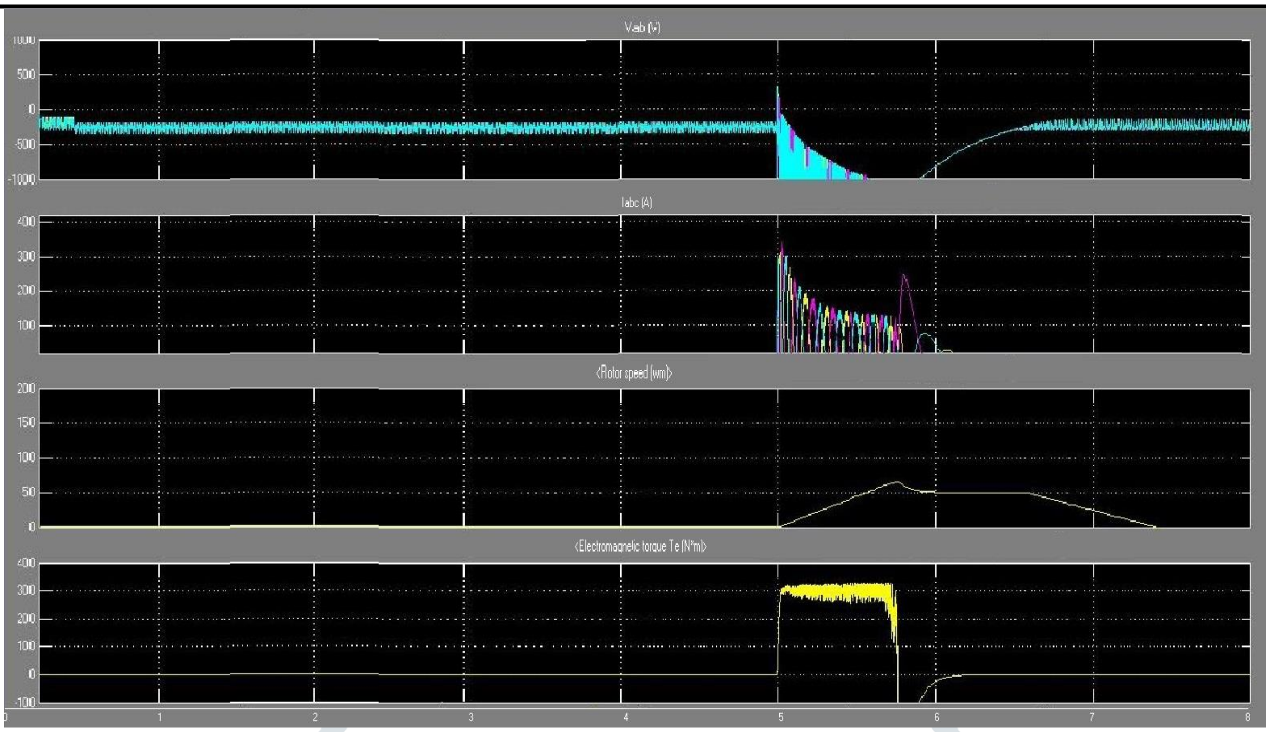

Fig. 51Induction Motor Running Parameters

Table 6 Induction Motor Running Parameters

S. NO.	Time (Sec.)	Vab (V)(Avg.)	Iabc (Amp.) (Avg)	Rotor Speed (WM) (Avg.)	Electrostatic Torque (N-m)
1	0 -1	0	0	0	0
2	1-2	-250	0	0	0
3	2-3	-250	0	0	0
4	3-4	-250	0	0	0
5	4-5	-250	0	0	0
6	5-6	-550	150	40	260
7	6-7	-300	0	45	0
8	7-8	-250	0	4	0

Solar / Battery Voltage

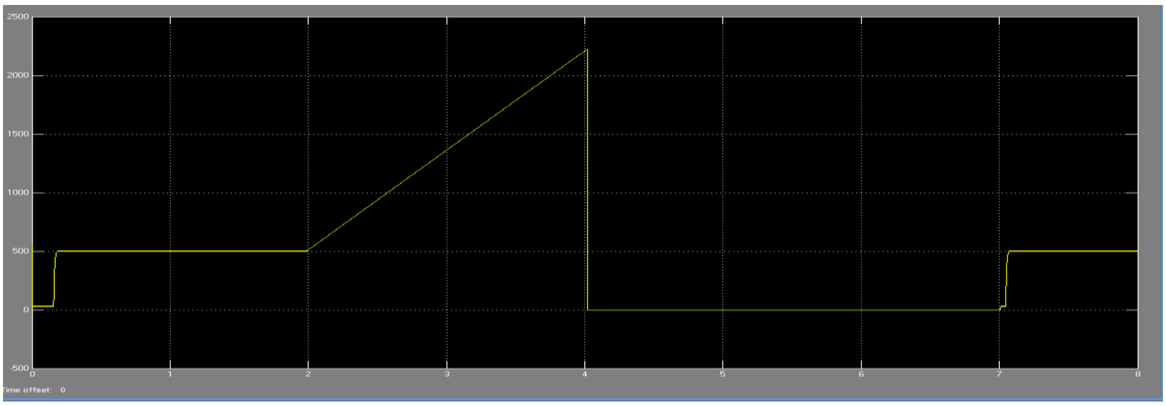

Fig. 6 Solar Voltage and Time Graph

When Project is run we find out the different solar voltage and battery voltage at different time intervals. This is show in fig. and its value show in table.

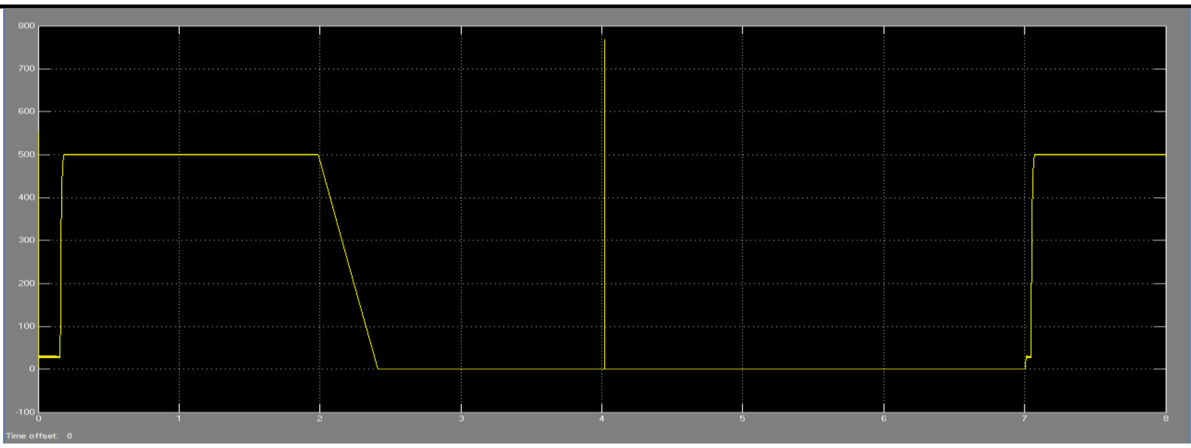

Fig. 7: Battery Voltage and Time Graph

Table 7 Solar/Battery Voltage

S. No.	Time (Sec.)	Solar Voltage (V)	Battery Voltage (V)
1	0	50	50
2	1	500	500
3	2	500	500
4	3	1400	0
5	4	2250	770
6	5	0	0
7	6	0	0
8	7	500	500
9	8	500	550

Main Voltage and Current

Fig. shows the Graph between current Iabc and time Variation in current according to time is show in the table.

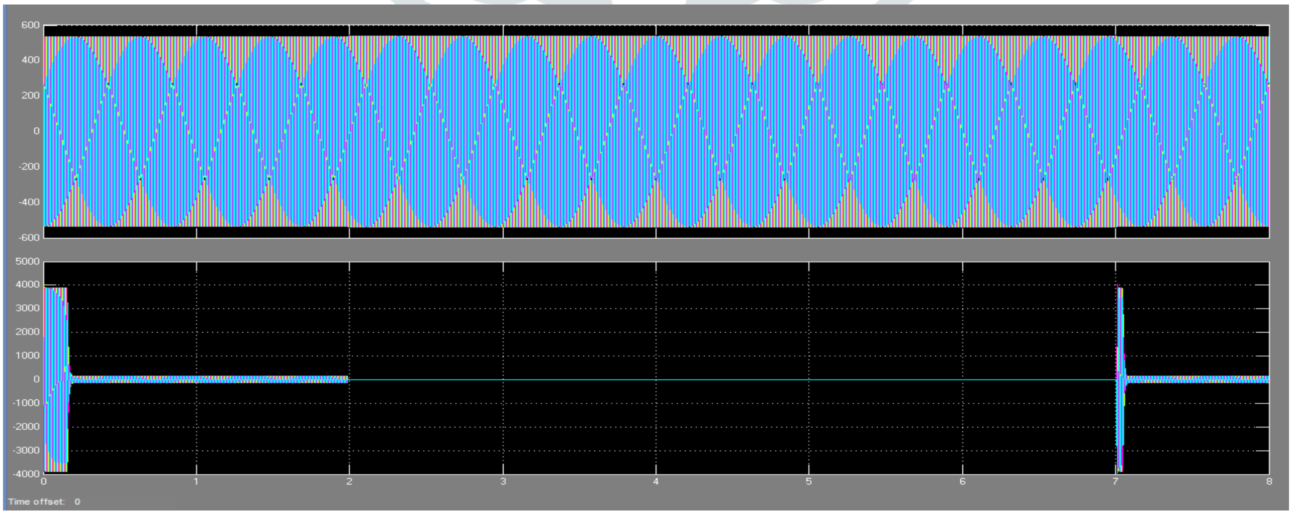

Fig. 8 Current Iabc and Time Graph

Table 8 Main Voltage and Current

S. No.	Time (Sec.)	Vabc (V)	Iabc (Amp.)
1	0	520	3900
2	1	260	100
3	2	260	0
4	3	260	0
5	4	260	0
6	5	260	0
7	6	260	0
8	7	260	3900
9	8	260	100

IV. CONCLUSION & FUTURE SCOPE

Conclusion

For a public transportation system that is both economical and gentle on the environment, nothing beats an electric vehicle. The charging of vehicles is coordinated generally. Hybrid electric vehicles that make use of both renewable energy generated on-board and grid power can reduce power losses and voltage fluctuations by smoothing out the grid's peak power demand. Also, using FOC / vector control and employing a high-power Induction motor in low-power consumption mode in default settings and high-torque mode where burst power is necessary helps increase public acceptability of EVs.

The suggested EV benefits greatly from this method's enhancements to its controllability, responsiveness, and efficiency. The utilization of solar energy to offset the energy needs of driving a car is also illustrated. Game charger technology that uses solar energy to subsidies battery power for running EVs can extend battery life and derive endurance per charging cycle.

Future Scope

Better overall efficiency can be achieved in grid solar hybrid EVs through the use of solar photovoltaic systems and power converters with higher energy efficiencies. Electronic control cards/Boards for grid solar hybrid EVs can be made cheaply by deploying efficient and sophisticated electronic switching and control systems using DSPs (Digital signal Processing). Moreover, the systems can enable real-time monitoring and diagnostic capabilities, which fit in with smart Grid / Smart city applications.

More than 2% of all recent light car sales in the United States have involved a half-and-half transaction. Assumptions based on past trends indicate that by 2012, more than one in twenty new vehicles manufactured in the United States and Canada will use a hybrid drivetrain that combines gas and electricity. Increases in both natural and administrative heft are expected to make the European market much more nimble. Nissan Renault SA and Nissan Motor Co. believe that by 2020, 10 percent of all vehicles will be electric, and they are planning for this by making a significant investment in R&D. Germany's major automakers are investing €360 million ($60 million) to develop state-of-the-art lithium-particle batteries for use in the country's borderless vehicle fleet (Project LIB 2015). The goal of the German government is to have 1 million EVs and PHEVs on the road by 2020, which would represent 2.2% of the total fleet in the country. Being active now is a fascinating choice.

Table 9: comparison between proposed works and base paper

S.No.	Parameters	Base paper	Proposed work
1	Paper title	Solar PV Charging Station for Electric Vehicles IEEE-2020	Simulation of Hybrid Solar-Grid Based EV With IGBT & Fuzzy Logic Controlled Battery & Solar Optimization
2	FOC/ Vector control	Yes	NA
3	Solar/ Grid dual charging	Yes	Yes
4	Solar Power priority Charging	No	Yes
5	Solar Power Subsidization When Vehicle running	No	Yes
6	Complete vehicle system depicted[Basic running W/O Aux Electric & Mechanical]	No	Yes
7	Roof Top Solar System for Grid Interfaced Charging	No	Yes

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