Simulation of Photo-Voltaic Power Charging Station for Electric Vehicles

Surabhi Singh, Anup Kumar, Nitin Kumar

***Abstract*— Environmental issues and increasing fuel costs have come up with evolution and commercialization of Electric Vehicles. The electric car charger using power electronic technology is a typical high power nonlinear device, so the vigorous promotion of electric vehicle charger will seriously affect the power quality of power grid. Thus this is an important problem which must be considered by the construction of charging station .Before construction of electric vehicle charging station, it is necessary for engineers to analyze and simulate the impact charging station and its operation made on the grid .At the same time, engineers need to know that whether charging station construction requirements meet the national standard. So the results of analysis and simulations can provide the reference for the construction of charging stations, for whether the charger stations need to configure appropriate governance such as harmonic suppression and reactive power compensation device.**

The article aims at the simulation study of photo-voltaic electric vehicle charging station, illustrating mainly from the PV array, charger and charging station aspects. Then it states how to use MATLAB simulation software to model and analyze.

***Index Terms* -Electric Vehicle, Photo-Voltaic, MATLAB, Charger.**

I. INTRODUCTION

With the ceaseless advancement of charging vehicle, the quantity of electric vehicles is expanding. So energy utilization of charging and releasing organization which electric vehicle charging offices framed will be exceptionally enormous. Hence the effect on the framework is additionally progressively can't be disregarded.

From one perspective, the electric vehicle charging load has certain haphazardness in reality. That may prompt increment of the pinnacle power load, so there is the need to expand power lattice limit. Some electric force transmission and dissemination organization won't convey their energy needs. Then again, the symphonious that electric vehicle charging gear created will likewise influence the force nature of nearby force network. Subsequently, under the wide application prospect in electric vehicle, how to appropriately finish the plan of the electric vehicle charging station, and how to quantitative survey the colossal energy utilization influences that foundation network brought has become the focal point of numerous power laborers.

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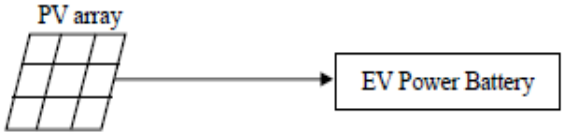
To make the design of electric vehicle charging and releasing offices more logical and levelheaded, so the development of the electric vehicle charging and releasing offices won't influence the typical activity of the force framework. It should be concentrated profoundly and completely in the plan and the energy utilization the executives.

There are several possible ways for photo-voltaic (p-v) to charge electric vehicles. The energy distribution ways shows as followed figure. The series of steps will prepare an overview of the systems components, complete system efficiency in keeping with pre-determined input parameters and several ways of classification of Energy from Photovoltaic to Charging Station. The block-diagram of the EV PV public charging station is presented in figure 1.



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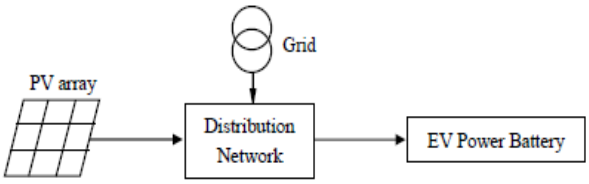

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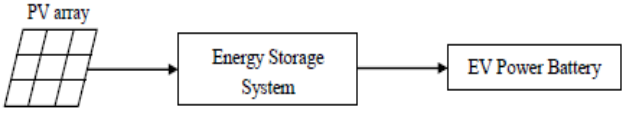

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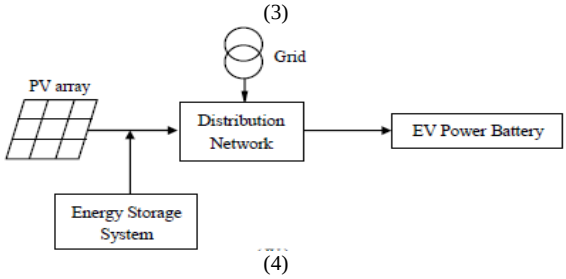

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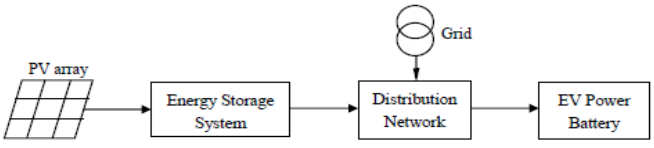

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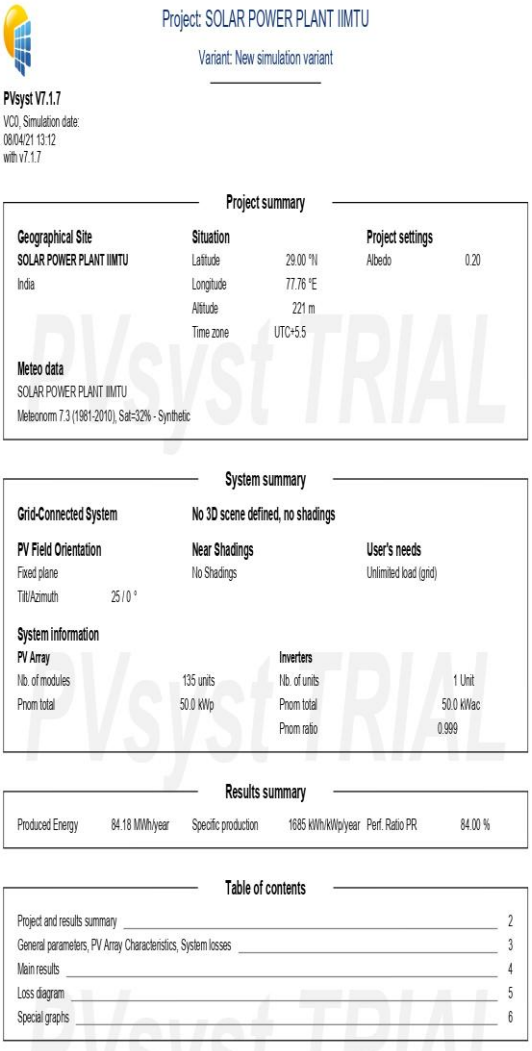
Fig1:- Modes Classification of Energy from Photovoltaic to Charging Station

II. PV SYSTEM Design

To evaluate the power and energy generated by a 50 kWp PV array in the India, an accurate measurement of weather data is required. For this purpose, the meteorological data from the MITEONORM is used, which has a resolution of 1 min. Global horizontal irradiance (SGHI), Diffuse Horizontal Irradiance (SDHI), Direct Normal Irradiance (SDNI) and ambient temperature (Ta) are obtained from MITEONORM for the years 2020. A 50 kWp PV array was modeled in MATLAB using 135 modules of VIKRAM SOMERA vsm370 modules rated at 370W. They are connected in 9 parallel strings having 15 modules in series having a combined installed power of 49950 W.



Project: SOLAR POWER PLANT IIMTU

Variant: New simulation variant

PVsyst V7.1.7

VC0, Simulation date: 08/04/21 13:12 with v7.1.7

Project summary

Geographical Site	Situation		Project settings	
SOLAR POWER PLANT IIMTU	Latitude	29.00 °N	Albedo	0.20
India	Longitude	77.76 °E		
	Altitude	221 m		
	Time zone	UTC+5.5		

Meteo data

SOLAR POWER PLANT IIMTU

Meteonorm 7.3 (1981-2010), Sat=32% - Synthetic

System summary

Grid-Connected System	No 3D scene defined, no shadings	
PV Field Orientation	**Near Shadings**	**User's needs**
Fixed plane	No Shadings	Unlimited load (grid)
Tilt/Azimuth 25 / 0 °		

System information

PV Array		Inverters	
Nb. of modules	135 units	Nb. of units	1 Unit
Pnom total	50.0 kWp	Pnom total	50.0 kWac
		Pnom ratio	0.999

Results summary

Produced Energy 84.18 MWh/year Specific production 1685 kWh/kWp/year Perf. Ratio PR 84.00 %

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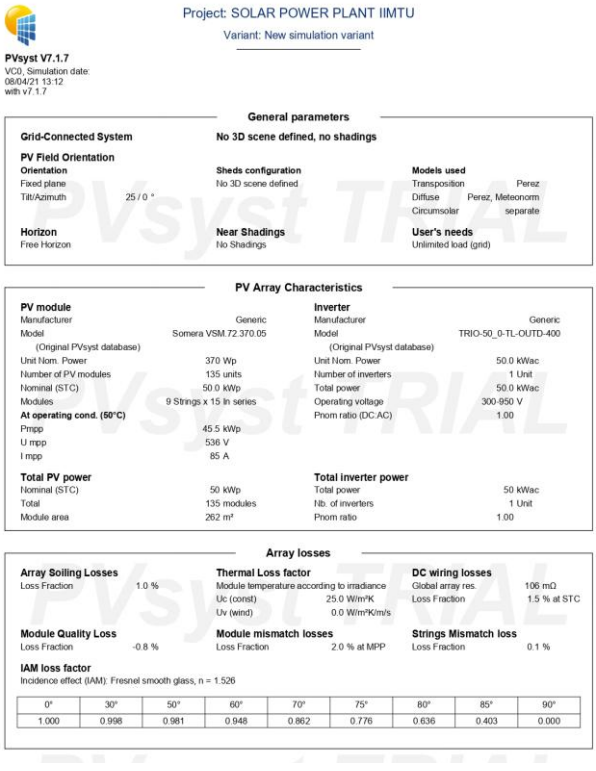

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VC0, Simulation date: 08/04/21 13:12 with v7.1.7

General parameters

Grid-Connected System	No 3D scene defined, no shadings	
PV Field Orientation		
Orientation	**Sheds configuration**	**Models used**
Fixed plane	No 3D scene defined	Transposition Perez
Tilt/Azimuth 25 / 0 °		Diffuse Perez, Meteonorm
		Circumsolar separate
Horizon	**Near Shadings**	**User's needs**
Free Horizon	No Shadings	Unlimited load (grid)

PV Array Characteristics

PV module		Inverter	
Manufacturer	Generic	Manufacturer	Generic
Model	Somera VSM.72.370.05	Model	TRIO-50_0-TL-OUTD-400
(Original PVsyst database)		(Original PVsyst database)	
Unit Nom. Power	370 Wp	Unit Nom. Power	50.0 kWac
Number of PV modules	135 units	Number of inverters	1 Unit
Nominal (STC)	50.0 kWp	Total power	50.0 kWac
Modules	9 Strings x 15 In series	Operating voltage	300-950 V
At operating cond. (50°C)		Pnom ratio (DC:AC)	1.00
Pmpp	45.5 kWp		
U mpp	536 V		
I mpp	85 A		
Total PV power		**Total inverter power**	
Nominal (STC)	50 kWp	Total power	50 kWac
Total	135 modules	Nb. of inverters	1 Unit
Module area	262 m²	Pnom ratio	1.00

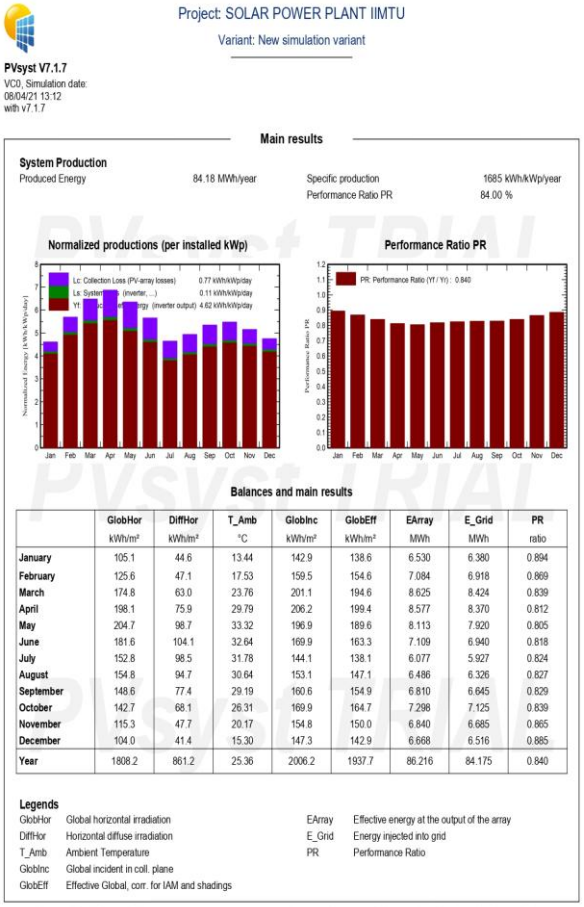
Array losses

Array Soiling Losses	Thermal Loss factor	DC wiring losses
Loss Fraction 1.0 %	Module temperature according to irradiance	Global array res. 106 mΩ
	Uc (const) 25.0 W/m²K	Loss Fraction 1.5 % at STC
	Uv (wind) 0.0 W/m²K/m/s	
Module Quality Loss	**Module mismatch losses**	**Strings Mismatch loss**
Loss Fraction -0.8 %	Loss Fraction 2.0 % at MPP	Loss Fraction 0.1 %

IAM loss factor

Incidence effect (IAM): Fresnel smooth glass, n = 1.526

0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	0.998	0.981	0.948	0.862	0.776	0.636	0.403	0.000



Project: SOLAR POWER PLANT IIMTU

Variant: New simulation variant

PVsyst V7.1.7

VC0, Simulation date: 08/04/21 13:12 with v7.1.7

Main results

System Production

Produced Energy 84.18 MWh/year Specific production 1685 kWh/kWp/year

Performance Ratio PR 84.00 %

Normalized productions (per installed kWp)

Performance Ratio PR

Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	PR ratio
January	105.1	44.6	13.44	142.9	138.6	6.530	6.380	0.894
February	125.6	47.1	17.53	159.5	154.6	7.084	6.918	0.869
March	174.8	63.0	23.76	201.1	194.6	8.625	8.424	0.839
April	198.1	75.9	29.79	206.2	199.4	8.577	8.370	0.812
May	204.7	98.7	33.32	196.9	189.6	8.113	7.920	0.805
June	181.6	104.1	32.64	169.9	163.3	7.109	6.940	0.818
July	152.8	98.5	31.78	144.1	138.1	6.077	5.927	0.824
August	154.8	94.7	30.64	153.1	147.1	6.486	6.326	0.827
September	148.6	77.4	29.19	160.6	154.9	6.810	6.645	0.829
October	142.7	68.1	26.31	169.9	164.7	7.298	7.125	0.839
November	115.3	47.7	20.17	154.8	150.0	6.840	6.685	0.865
December	104.0	41.4	15.30	147.3	142.9	6.668	6.516	0.885
Year	1808.2	861.2	25.36	2006.2	1937.7	86.216	84.175	0.840

Legends

GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_Grid	Energy injected into grid
T_Amb	Ambient Temperature	PR	Performance Ratio
GlobInc	Global incident in coll. plane		
GlobEff	Effective Global, corr. for IAM and shadings		

A. Integrating local storage in EV–PV charger

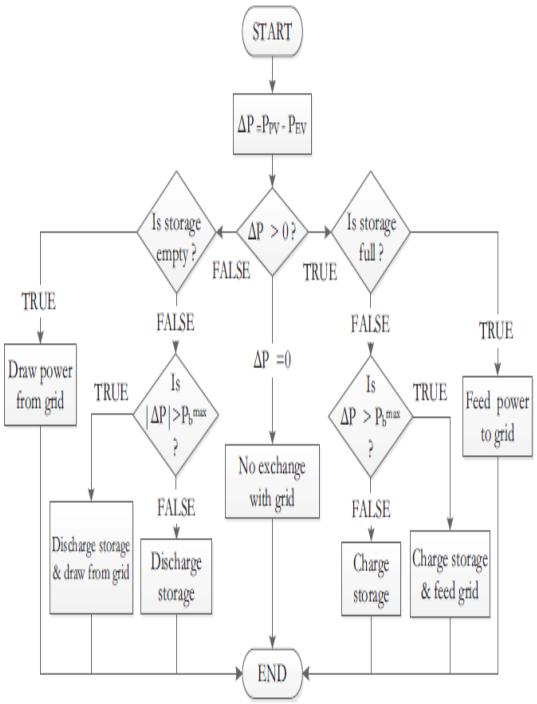


Fig2:- State diagram for operation of EV–PV charger with local storage.

III. Simulation of Photo-Voltaic Power Charging Station

The electric car charger using power electronic technology is a typical high power nonlinear device, so the vigorous promotion of electric car charger will seriously affect the power quality of power grid. Thus this is an important problem which must be considered by the construction of charging station .Before construction of electric vehicle charging station, it is necessary for engineers to analyze and simulate the impact charging station and its operation made on the grid .At the same time, engineers need to know that whether charging station construction requirements meet the national standard. So the results of analysis and simulations can provide the reference for the construction of charging stations, for whether the charger stations need to configure appropriate governance such as harmonic suppression and reactive power compensation device.

The article aim at the simulation study of photo-voltaic electric vehicle charging station, illustrating mainly from the PV array, charger and charging station three aspects. Then it states how to use MATLAB simulation software to model and analyze.

A. PV ARRAY

For any given temperature and radiation parameters, PV array model equation can be determined according to I-V curve of the PV cells. PV array modeling process is as shown in the figure below.

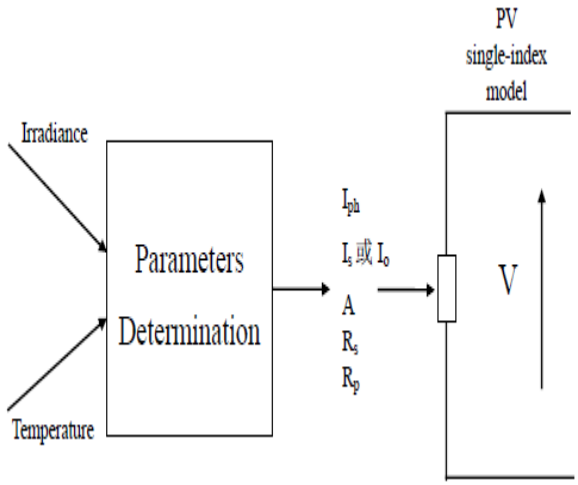


Fig3:- PV Modeling Procedure

B. CHARGING SET

Hf charger general structure diagram is as follows. Among them, three-phase alternating current (ac) Ua, Ub, Uc are obtained through transformer from the three-phase grid. They can provide power for charger. High frequency DC to DC converter frequency is more than 20 kHz. Here, as well as having isolation effect, it can reduce the volume of equipment such as transformer and filter. At the mean time ,it can also improve the filtering effect and efficiency of charger.

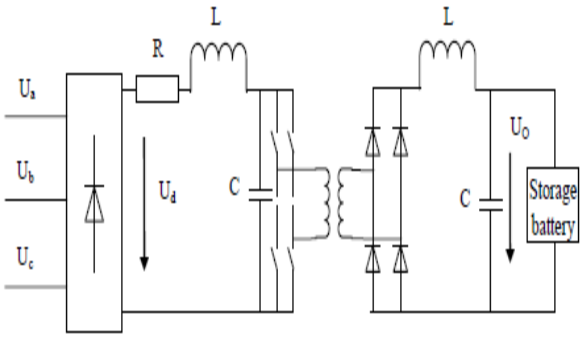


Fig4:- Hf Charger General Structure Diagram

IV. MALAB simulation and Results

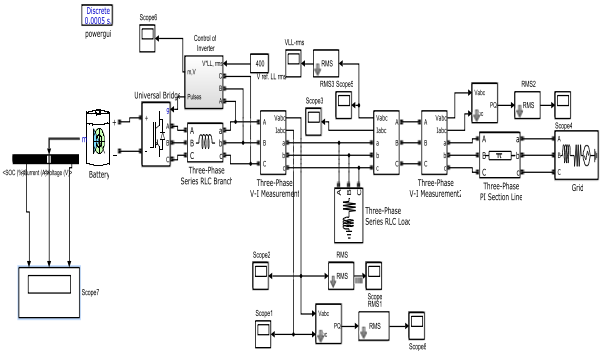


Fig5. Simulation of grid connected battery

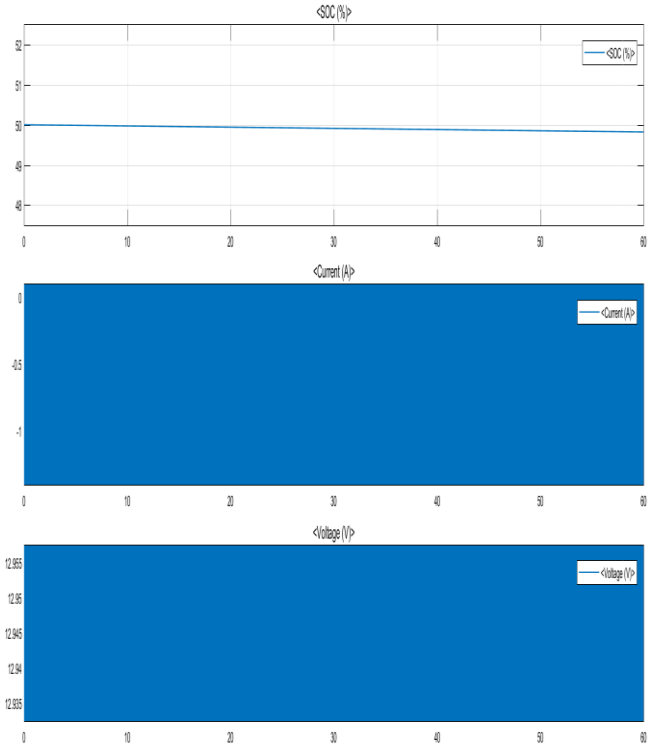


Fig6. battery discharging

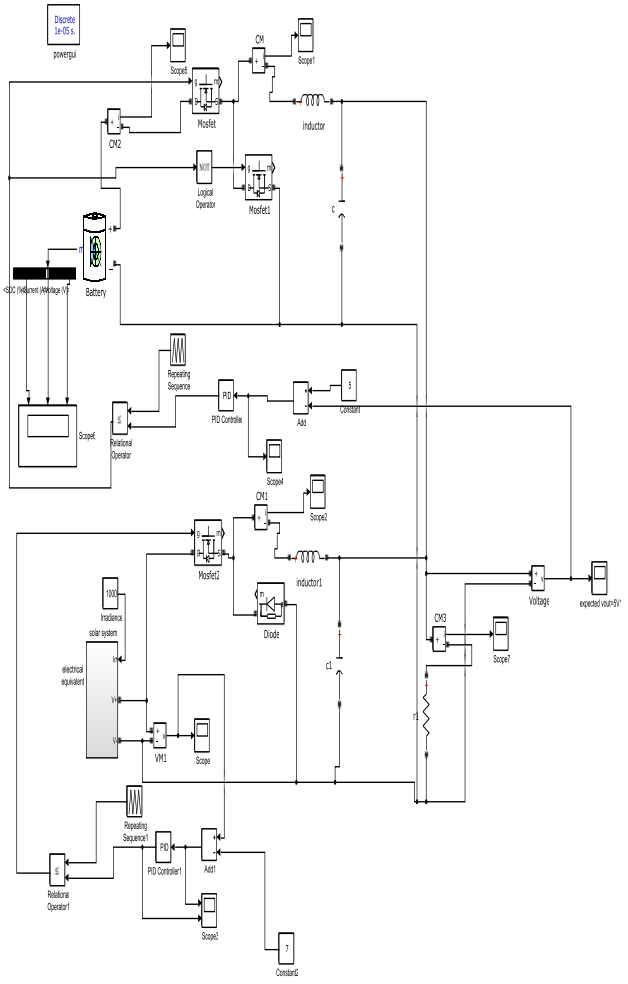


Fig7. Simulation of solar PV and battery charging

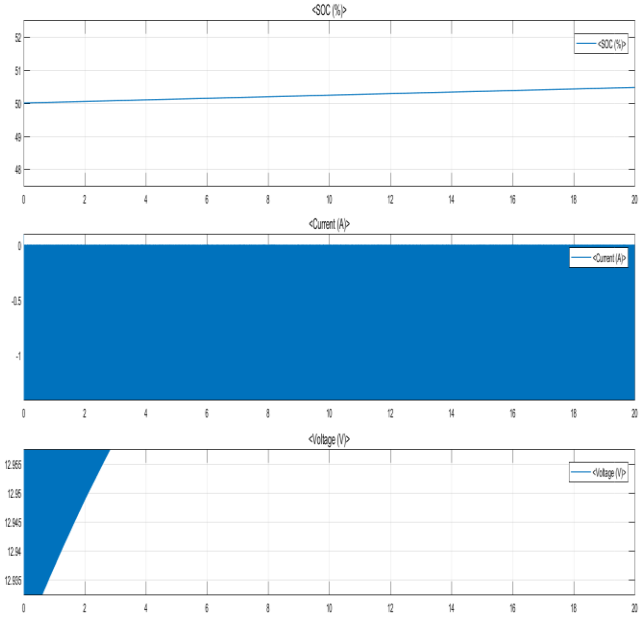


Fig8. Battery charging for 20 second (SOC: 50 to 50.5)

V. CONCLUSION

Work environment charging of EV from sunlight based energy gives a practical passage to transportation later on. It gives an immediate usage of the PV power during the day and endeavors the sun based expected roofs of structures. In this report, the PV framework plan and dynamic charging for a sun based energy fueled EV charging station for India is explored.

Electric vehicle charging stations not just need to add energy to electric vehicles, just as act electric vehicles and framework interface .So the electric vehicle charging station development is the way in to the flow industrialization of electric vehicles .Based on two heading the photovoltaic and electric vehicle charging station, the proposal takes the electric vehicle accusing stations of photovoltaic force supply as guide to examine the plan, recreation and investigation of the charging station .In the paper, it presents the fundamental plan of two sorts of charging stations, and brings up that it is vital to reenact the charging station activity through the MATLAB/Simulink programming ahead of time. That will bode well before development of the charging station real, making the charging station more helpful, arranging and sensible.

Sustainable power is clarified with its different Equipment utilized in station design .The control technique utilized in bidirectional inverter is additionally show in paper for appropriate downplaying .The sun oriented PV framework is used with the station for monetary and specialized angles whereas reinforcement battery's give arrangement power interest in top long periods of station which effectively decreases weight on lattice and trading of battery office can likewise made accessible on station. Charging of EV is effectively minded out with their outcome addressed with various battery types which help to examine and comprehend the accusing rate conduct of their particular synthesis.

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