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A New Hybrid Solar-Wind Charging Station for Electric Vehicle Applications and Its Simulation

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Abstract: Electric vehicles play a vital role in energy saving and emission reduction of harmful greenhouse gases. electrical vehicles dispersion into the vehicles market has not been up to the mark because of less value effective and these vehicles have to be compelled to be compelled to recharge once in sixty-five to seventy klick drive. The novel hybrid vehicle charging station carries with it fully totally different sources like PV systems, wind systems, the AC provide, batteries area unit used as a main energy storage system, kind DC little grid permanently energy delivery.

Thus, grid offers decent quality of power to 3 totally different hundreds notably 110-volt AC single-phase output ,100 v DC output. The grid is at 230 V rms with fifty cps connected isolator in relation to the DC bus. The three-part output of the grid is regenerated to the rippled DC by utilization of DBR (Diode Bridge Rectifier). The regenerated DC voltage is fed to graphic symbol device that might be a DC-DC device, making the rippled DC to constant DC with the use of a buck device, this paper justifies comparative performance hybrid charging station mistreatment buck and letter convertor to stabilize the DC voltage. planned system analysis in MATLAB Simulink.

Keywords: Charging station, DC grid, Electric vehicle, MATLAB Simulink

I. INTRODUCTION

Any A new Hybrid charging Station machine is planned for the clever power delivery. The planned charging Station machine is connected with the 230V AC electricity provide, and integrates the renewable power reasserts of wind electricity and electrical phenomenon (PV) electricity, additionally to the electrical automotive along. additionally, the planned DC grid machine adopts the battery. Hence, the planned DC micro-grid machine cannot best supply the excessive exceptional electricity for three styles of DC and AC masses, however, to boot acquire several distinctive functions and traits for clever power delivery. This paper can gift part dialogue of the machine configuration, machine manage approach for clever power delivery, and consequently the corresponding simulation overall performance. planned machine includes the following four subsystems, specifically the AC deliver module, the standby module, the renewable module, the garage module, the output load module,

The AC deliver module presents the 230V AC electricity provide for the 170V DC micro-grid. Actually, through adopting the duplex AC/DC device, the DC micro-grid power can also be fed once more to the AC electricity aspect. The renewable module accommodates the wind electricity and PV electricity provide, which could be reworked to the DC 170V through the DC/DC and AC/DC device. For the PV electricity branch, the most issue chase (MPPT) manage is employed to draw in the most sun power through calibration the duty cycle of the DC/DC device. For the wind electricity branch, a current magnificence of permanent-magnet (PM) brushless gismo is also accustomed seize the alternative energy for the micro-grid machine.

The output load module consists of three styles of masses, specifically the 110V single-section AC load, 48V DC load, and consequently the 100V DC load, which could additionally to boot cowl most commonplace place appliances. Moreover, the spoken communication module connects all of the inverters, converters, and corresponding electricity alerts through the computers. Therefore, the planned DC small grid machine are capable of do the clever and versatile cap potential to perform the clever power delivery. one amongst the disputes in DC electricity structures is to create bound the electricity within the machine keep balanced forever for dependable and economical operation. It will end up to be advanced notably in conditions whereby the machine receives affected by essential disturbances evolving from one-of-a-kind sections within the machine. additionally, to introducing safety schemes in Hybrid Vehicle Charging Stations, it's miles crucial to recollect coordinated and optimized operation with the manage machine. However, it's currently not been drastically investigated in most of the protection schemes. during this paper, a coordinated improvement and manage theme is planned whole} totally on random load profile additionally to on-the-spot machine disturbance info.

The aim is to supply coordination among machine safety on the controller stage and a stronger stage improvement to create bound the machine stays optimized in any respect factors of operation despite the disturbances. so as to place into impact and validate the planned approach, a DC-primarily based mostly completely deliver board electricity machine (SPS) is taken into account. the electrical distribution machine on board a deliver got to be capable of supply elementary options which incorporates electricity generation, distribution, manage, electricity conversion, power garage and utilization. typical SPSs are self-contained and appoint radial distribution architectures, however, zonal distribution structures have gotten appealing because it could supply higher reconfigurations capabilities. Recent improvement of SPSs is trending nearer to the thought of incorporated electricity machine (IPS), that's appeared as a large-scale, on-board small grid incorporating clever methods for assembly loading wishes with dynamically matching people capability.

Moreover, DC- primarily based mostly completely IPS has been investigated to update the normal AC SPS because it could convey higher operational overall performance and management capabilities.

II. CONTROL TECHNIQUE

A. PWM Technique

The pulse width modulation technique is generally used for the conversion of DC to AC waveforms. A full bridge inverter with six IGBTs can be used to convert DC to three phase AC. Each phase has to be phase shifted to each other by 1200 and has to be in synchronization with the grid to which it is being connected. The pulses are to be given to the IGBTs are generated with a reference or fundamental waveform compared with a triangular waveform.

The fundamental waveform has the frequency of the grid and the triangular or carrier waveform has higher frequency to create a modulation signal. The diagram of the fundamental and the carrier waveform are shown below Six pulses are formed by applying NOT gates to the three pulses produced by the comparison of the fundamental and carrier waveforms. The generated pulses are fed to the VSI (Voltage source Inverter) with G1G2G3G4G5 and G6 switches. A simple construction of VSI is shown in fig.

The rating of IGBT is taken as:
Internal resistance Ron = 0.001 Ω
Snubber resistance Rs = 100 kΩ
Snubber capacitance Cs = 1F

Due to the impedance load the load current gets ceased during sudden switch OFF of the IGBT switch and generate high voltage peaks in the output voltage. To avoid this an anti-parallel diode is attached to the switch (IGBT) so that the inductor current from the impedance load can pass through the diode.

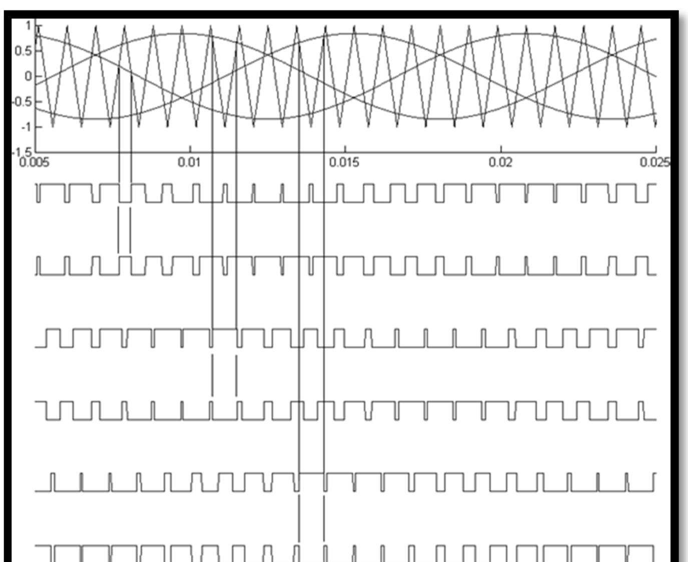

Fig.1: Generation of pulses with respect to reference fundamental waveforms.

The higher the carrier frequency the lower the harmonics developed by the inverter. To eliminate the minimum harmonics, we also use LC filter to filter the higher order harmonics from the three phase AC voltage waveforms. The three sinusoidal fundamental waveforms are generated as -

$$Va = Vm \sin \omega t$$
$$Vb = Vm \sin(\omega t + 2\pi /3)$$
$$Vc = Vm \sin(\omega t - 2\pi /3)$$

Where Vm = maximum voltage i.e., amplitude of sinusoidal waveform which is ‘1’

The modulation index in PWM waveform is controlled by controlling the amplitude of the fundamental waveform. By reducing amplitude of the sinusoidal wave, the space between the pulse is increased reducing the amplitude of the PWM waveform. The phase of the reference wave considered decides the phase of the PWM waveform.

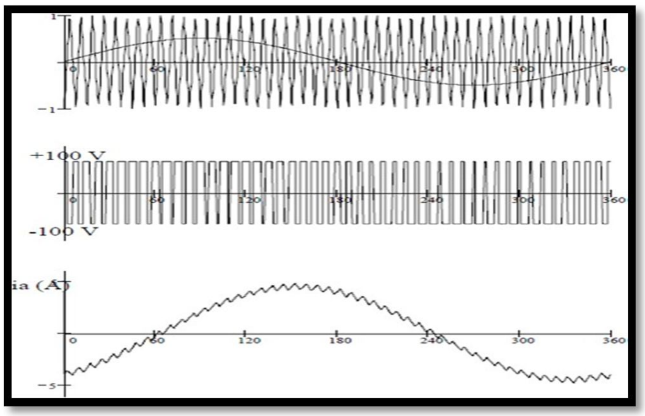

Fig.2: Effect of Change in Amplitude of Sinusoidal Waveform

B. Modeling of PVA

For efficient renewable power generation PVA is used to generate power from solar irradiation. As the load demand is increasing day by day the power generation also has to be increased, but due to the traditional way of power generation is causing global warming. Due to this the efficiency of the PVA has to be increased by adding silicon surface on the panel. And also employ MPPT techniques to track maximum power during any irradiation and atmospheric conditions. The design of PVA is done in MATLAB with Simulink block, with mathematical representation.

Voltage of PVA completely depends on solar irradiation (Sx) and ambient temperature (Tx). PVA (Photo voltaic array) is a combination of series and parallel solar cells arranged in an array to generated the required voltage and current. Each series combination of cells can be considered as photo voltaic module. Increase in series cells increases the voltage and increase in parallel cells increases the current capacity. Formulation for voltage of each cell is given below.

$$V_C = \frac{AkT_c}{e} ln\left(\frac{I_{ph} + I_o - I_c}{I_o}\right) - R_{sc}I_c$$

Where,
k = Boltzmann constant (1.38 × 10−23J/K).
Ic = cell output current, Amp.
Iph= photocurrent
Io = reverse saturation current of diode
Rs= series resistance of cell
Tc = reference cell operating temperature
Vc = cell voltage, V.

The Boltzmann constant and the reference temperature have to be in same units i.e., either Celsius or Kelvin. The mathematical modeling of the above equation can be constructed using Simulink blocks is as below in fig.

The above design is for a single cell voltage, in order to increase the voltage of the PVA the cell voltage has to be multiplied to a desired value considering each cell voltage as 0.4 V. So, the number of series connected cells (Ns) can be calculated as:

$$N_s = \frac{V_0}{0.4}$$

To get each cell current, the total current output from the dependable source has to be divided by number of parallel connected cells (Np). Therefore, parallel connected cells are considered as –

$$N_p = \frac{I_o}{I_{cell}}$$

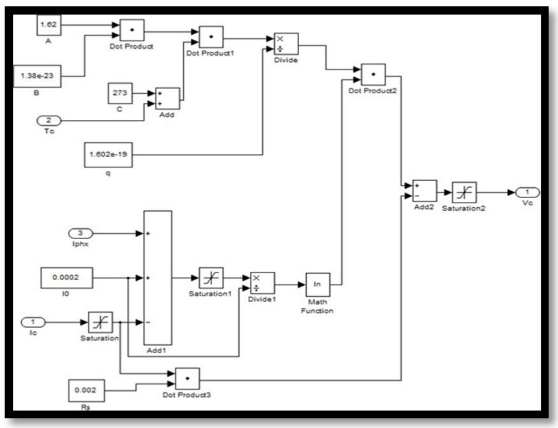

Fig.3: Simulink model of Vc

The representation in Simulink is taken as -

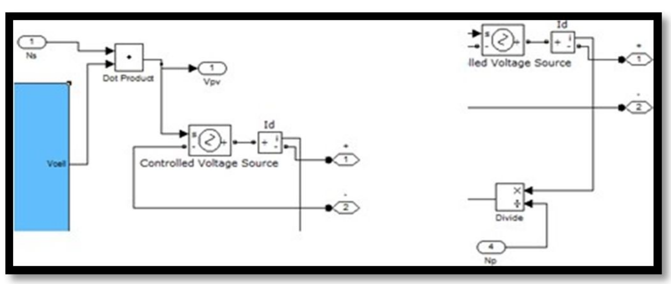

Fig.4: Simulink modeling of Ns & Np

For the calculation of Vcx (cell voltage) and Iphx (Photocurrent) we need correction factors C_{TV}, C_{TI}, C_{SV}, C_{SI}. The formulation is given as –

$$V_{CX} = C_{TV} C_{SV} V_C$$

$$I_{phx} = C_{TI} C_{SI} I_{ph}$$

The correction factors are given as -

$$C_{TV} = 1 + \beta_T (T_a - T_x)$$

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$$C_{TI} = 1 + \frac{\gamma_T}{S_C}(T_x - T_a)$$

$$C_{SV} = 1 + \beta_{T\alpha S}(S_X - S_C)$$

$$C_{SI} = 1 + \frac{1}{S_C}(S_X - S_C)$$

Where,
$\beta T = 0.004$ and $\gamma T = 0.06$
Ta = reference temperature
Tx = ambient temperature
Sc = reference solar irradiation
Sx = ambient solar irradiation.

The values of Tx and Sx changes depending upon the Sun rays which change continuously and unpredictably. The effect of change in solar irradiation varies the cell photocurrent and also the cell voltage (Vc). Let us consider the initial solar irradiation is Isx1 & the increase of the irradiation is Isx2 which in turn increases the temperature from Tx1 to Tx2, photocurrent from Iphx1 to Iphx2. The mathematical modeling of the correction factors in Simulink is given below:

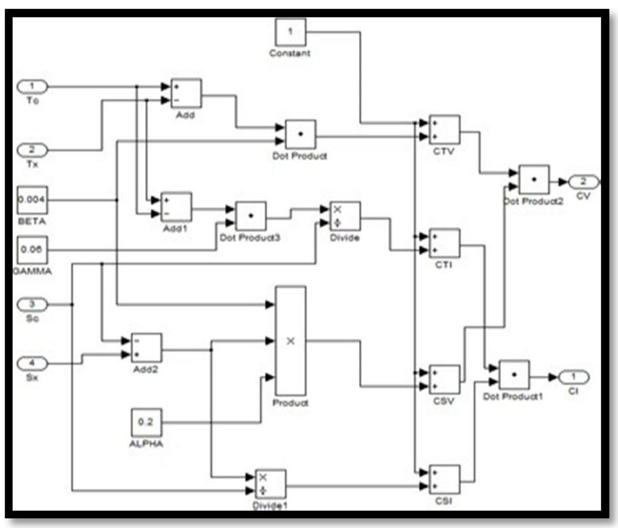

Fig.4: Simulink Modelling of Proposed Test System

Depending upon the solar irradiation and temperature the values of CV & CI are calculated which is fed to Vc block to get the cell voltage value as shown below:

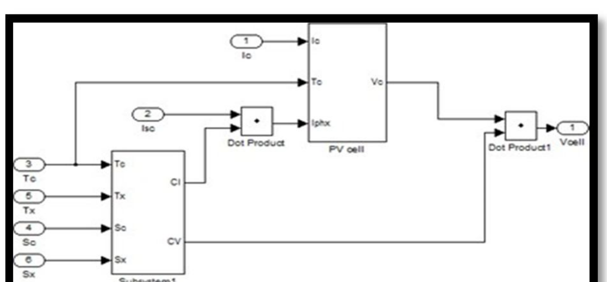

Fig.5: Combined diagram of CV, CI & Vc Mathematical Models.

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The total system diagram of the PVA with all the mathematical formulation are put into a subsystem to make it clear and understandable. The output of the Vc multiplied with the Ns constant block defining the total voltage of the combined cells of the PVA is fed to the voltage-controlled voltage source block so as to generate the required voltage. A diode is connected in series at the positive terminal of the PVA to avoid reverse currents passing into the PVA. To reduce the ripples a capacitor can be added later after the diode in parallel as the capacitor doesn't allow sudden change of voltages dV/dt. The complete PVA module with internal block construction is shown in the fig. below

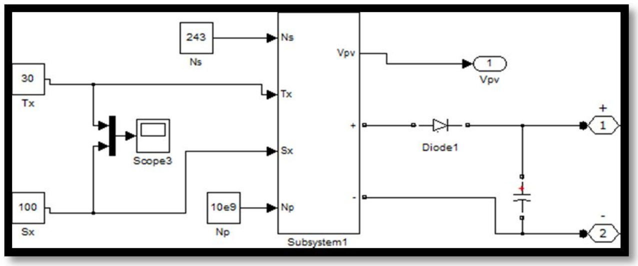

Fig.6: Complete diagram of PVA

III. METHODOLOGY

Exiting device with star entirely totally charging stations to be had for electrical vehicles. analysis is presently current. once coming up with sun energy station many different factors area unit taken into consideration: created neck of the woods, annual sun insolation, tilt perspective of modules, wide range of sun modules, close temperature, shading, seasoner cooling of modules. The wide range of sun modules directly determines the performance of a sun energy station. a large wide range of modules can boom their operating space [9]. star modules convert sun radiation directly into strength via an electrical phenomenon impact. this can be a silent and swish procedure that does not need motion of components. The physical phenomenon impact may be a semiconductor impact whereby sun radiation getting access to the semiconductor photocells creates the motion of electrons. electrical phenomenon cells convert sun strength into DC. the number of sun radiation falling at the world will currently not rely upon act. Even though this parameter is taken into thought while preferring the neck of the woods of the energy plant, handiest sun entirely} totally Charging Station Not satisfy all demand therefore layout hybrid charging station for electrical power-driven Vehicles. The distinctive functions and traits of the projected DC micro-grid for charging of vehicles device could also be summarized as follow:

The DC micro-grid instinctively possesses the excessive unbiased operation ability. Even while not the AC energy deliver, the DC grid will nevertheless perform healthily. It way, if a twist of fate takes place withinside the AC energy deliver, this grid will combination and distribute the energy in step with the wants. It will be showing neatness offers for electric car charging. By integration the renewable strength module, garage strength module, standby strength module, and AC deliver module along, the projected micro-grid device will do clever and bendy strength transport for the load sides. It approaches that the grid will distribute the energy via approach of suggests that of optimizing the renewable strength, AC energy deliver, and garage strength module. Since the DC energy link inherently has not the harmonic issue, the DC micro-grid will attain a higher fine energy than the standard AC grid device.

IV. MODELLING AND ANALYSIS

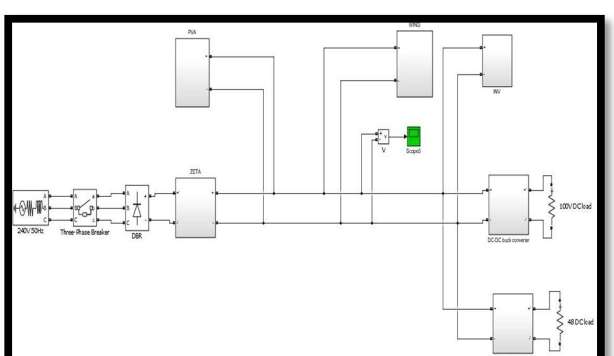

Fig.7: Simulink Modelling of Proposed Test System

The grid is at 230Vrms with 50Hz related to a isolator in reference to the DC bus. The Three section output of the grid is transformed to rippled DC through using DBR (Diode bridge rectifier) The transformed DC voltage is fed to ZETA converter that's a DC-DC converter, making the rippled DC to steady DC with using a greenback inductor.

The MOSFET transfer offer withinside the ZETA converter switches in line with the obligation ratio given through the PI controller for which the center is given from the mistake fee of the reference and measured output DC fee of the ZETA converter. It a closed loop manipulate machine with comments PI controller circuit and the switching frequency of the ZETA converter is 45kHz.

The transformed DC voltage shape the ZETA converter is fed to the DC bus in which all of the different modules are related. On the weight aspect we've got 3 loads, one AC load which needs to be 110Vrms and 50Hz. Second 100V DC load, and 1/3 is 48V DC load.

The AC load includes a PWM inverter using Simple sinusoidal PWM approach changing DC to PWM AC with 110Vrms 50Hz output in flip related to a AC load.

The 100V DC load is attached to a DC-DC greenback improve converter with MOSFET switches every working with NOT operation. The switching frequency is 20kHz and the obligation ratio is 0.2 The 48V DC load is attached to any other DC-DC greenback-improve converter with MOSFET switches every working with NOT operation.

The switching frequency is 20kHz and the obligation ratio is 0.1In each the DC-DC greenback improve converters while the MOSFET Q1 is OFF Q2 is ON charging the inductor. After a cycle of term 50usec the MOSFET Q1 is ON and Q2 is OFF and the fee gift withinside the inductor discharges thru the MOSFET Q1.

V. RESULTS

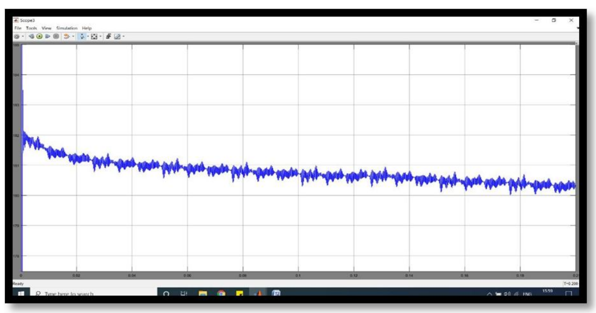

Fig. 8: DC Link Voltage at PCC with Buck Converter.

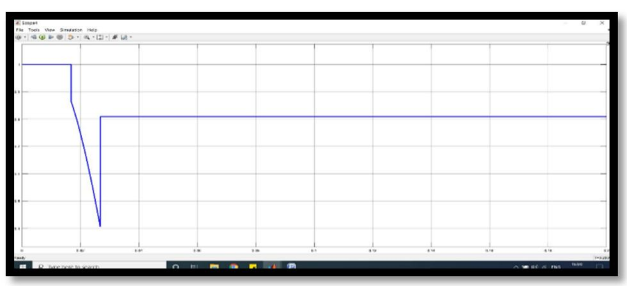

Fig. 9: THD of AC Load with Buck Converter

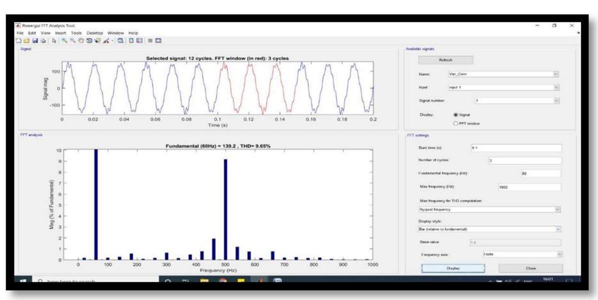

Fig. 10: Power Factor of Three Phase Source with Buck Converter.

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In the model there are three loads connected in which the first load is an AC load with inverter and other two loads are low voltage DC loads. The low voltages (100V and 48V) are generated using conventional buck converters.
The simulation is run out for 0.1sec and voltages of all devices are recorded in graph using GUI environment available in MATLAB. All graphs are plotted with respect to time.

VI. CONCLUSIONS

In Proposed Hybrid cars charging station. As visible withinside the given graphs and FFT evaluation contrast of the proposed take a look at machine with Buck converter and Zeta converter related to the three-segment grid, it's miles clean that the take a look at machine with Zeta converter has higher overall performance in comparison to standard Buck converter. The ripple withinside the DC hyperlink voltage at PCC is much less in Zeta converter withinside the variety of underneath 1% in conjunction with advanced strength element of the three-segment supply maintained above 0.96. Whereas with Buck converter the strength element of the supply is 0.8.
The THD of the AC load voltage is likewise advanced from 9.65% to 6% with Zeta converter decreasing the harmonics withinside the voltage waveform. All the graphs are represented with time described evaluation the usage of Powergui block to be had in MATLAB Simulink environment.

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