DC-DC INTERLEAVED CONVERTER SOLAR BASED ELECTRIC VEHICLE CHARGING STATION

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DEPT. OF ELECTRICAL ENGINERRING

1. INTRODUCTION

Pollution is the introduction of contamination of harmful materials into the natural environment. These harmful substances are called pollutants. Substances, like solid, liquid or gas, such as any form of energy grow at the rate faster than it can be disposed, decomposed or recycle called pollution. Similarly, vehicle pollution is the introduction of harmful pollutants into the environment by motor vehicles. The pollutants introduced have several effects on human health and the symptoms include cough, nausea, headache, irritation in the eye, and visibility problems. As the population increases, the purchasing power of the people also increase therefore everyone has a vehicle these days for transportation which is very bad for the environment. Over the last few decades, most vehicles have been produced. The population of vehicles was about 1.4 billion in 2020 itself. The rapid growth in vehicles means more fuel is required which results in the emission of harmful gases in the environment that causes air pollution [1]

EVs are the result of the development in battery innovation and the extension of battery charging centers trying to fulfill their energy necessities [3], [6]. An electric vehicle (EV) is a vehicle that uses one or more electric motors for propulsion. It can be powered by a collector system, with electricity from extravehicular sources, or it can be powered autonomously by a battery (sometimes charged by solar panels, or by converting fuel to electricity using fuel cells or a generator).

A charging station, also known as a charge point or electric vehicle supply equipment (EVSE), is a piece of equipment that supplies electrical power for charging plug-in electric vehicles (including electric cars, electric trucks, electric buses, neighbourhood electric vehicles, and plug-in hybrids). There are two main types: AC charging stations and DC charging stations. Batteries can only be charged with direct current (DC) electric power, while most electricity is delivered from the power grid as alternating current (AC). DC chargers facilitate higher power charging (which requires much larger AC-to-DC converters) by building the converter into the charging station instead of the vehicle to avoid size and weight restrictions.

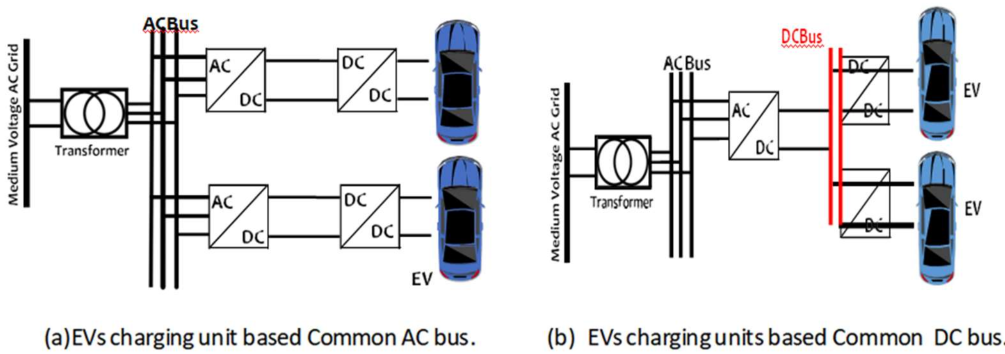

Fig 1:- charging station based on bus

2. METHODLOGY

The proposed charging architecture is chosen by highlighting the important features of EV charging- systems that primarily rely on an AC-DC bus since keeping in mind the integration of a PV-system with the power network, static Battery Storage, EV-load, & the conversion of power steps depending on the interleaved-converter as well as an AC / DC interconnected converter.

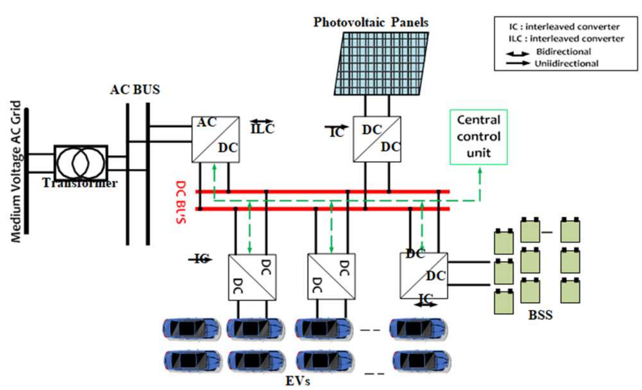

Fig 2:- EV charging station module based on micro grid

The AC / DC converter realize a DC-bus voltage 750 V in this EV-charging design . As during the inconsistent functioning, different energy converting devices simultaneously allows EV-charging and charging / discharging of Battery Storage System (BSS). An efficient cooperated charging control which focuses on the stability issues between portion executes and analyzed the combine power source- based EVs charger system, the inverter design, and the EV-charging assessments. Moreover adequate control strategy is created, permitting the recommended charging system to complete the assigned operation in different conditions. The fundamental controlling stage of the EV's DC charger system, in which the EV- chargers, AC / DC interconnected converters, localized PV-system, & BSs were tied to a single DC-bus.

3. INTERLEAVED CONVERTER

As it is simple in design, the DC / DC boost-converter is widely utilized to link the PV-panel to the DC-bus. It is employed for the battery & converter in bi-directional mode.

Fig.3 shows the Photovoltaic cells utilized in this work. The survey has discussed IBC, involving 2-ph, 3-ph, & 4-ph [17–19]. This system gives various characteristics like : reducing the volume & size of passive elements, I/P ripple-current, increasing I/P current's frequency, improving grid stability, and increasing converter's power O/P because of parallel-phases. The interleaved-topology further provides easy thermal performance.

The switching sequences of the switches may or may not overlap, causing variations in the ripple of the input current. The frequency of the input current is N times the frequency of the current in each inductance [16].

With respect to below mentioned constraints the computation of V-I ripples obtained as per the duty cycle:-

a) The coil's & capacitor's resistance are minimal.

b) Parasitic-capacitances and inductances are minimal.

c) Ideal switches are there.

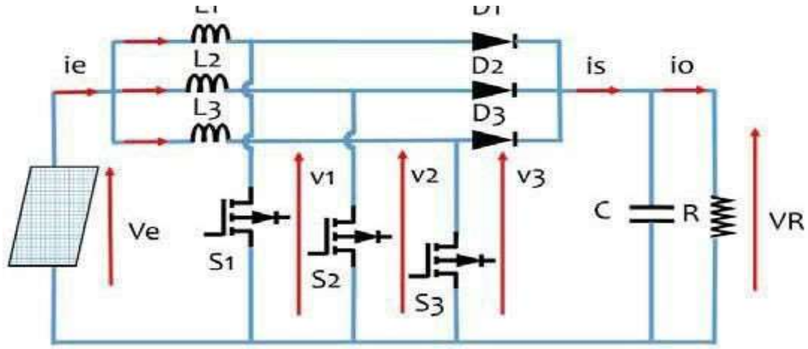

Fig 3:- Interleaved Converter

To determine the current i_e, three cases must be examined according to the value of (α)

Case 1: α < T/3

In this case, the operating state of each switch is less than T/3; the timing of conduction of the switches is given:

Fig 4:- Switches Conduction Timeline, case 1

The waveform of the current and voltages within the converter and at the load side is given:

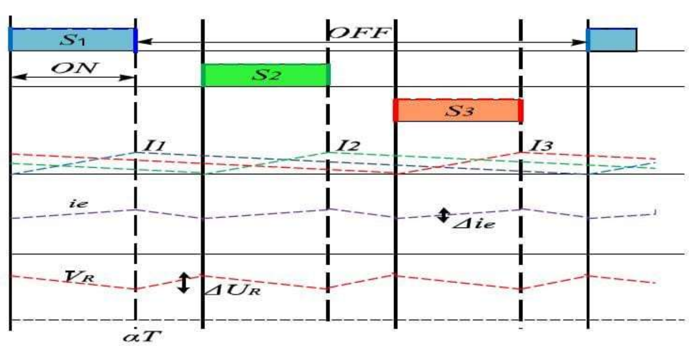

Fig 5:- Waveform of different signals, case 1.

Case 2:- (T/3) < α < (2T/3)

Each switch has a conduction time greater than T/3and less than 2T/3. The timing of switch conduction is shown:

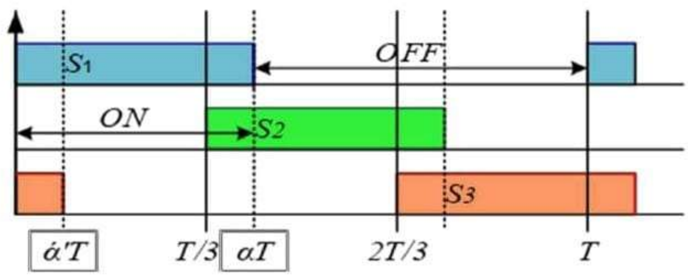

Fig 6:-Switch conduction timeline, case 3

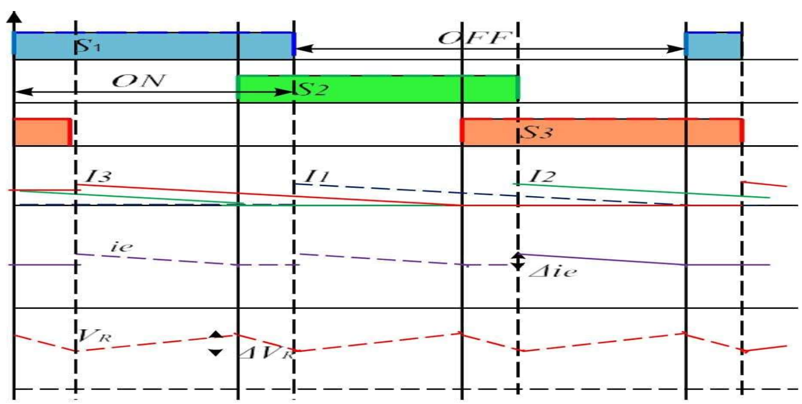

Fig 7:- Waveform of different signals case 2

Case 3: α > (2T/3)

In this case the switches have longer conduction time than 2T/3. The conduction time of the switches is given. Assuming αT is equal to (αT- 2T/3) and considering the intervals phase during the switches time. The voltages (V1+V2+V3) are alternating between 0 and VR.

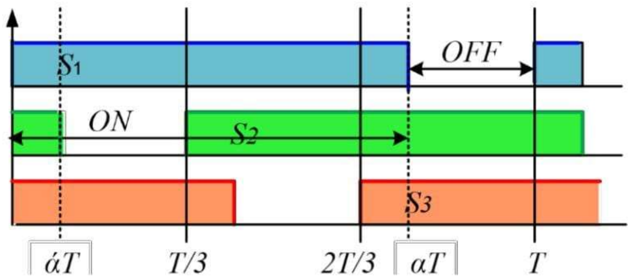

Fig 8:-Switches conduction timeline, case 3

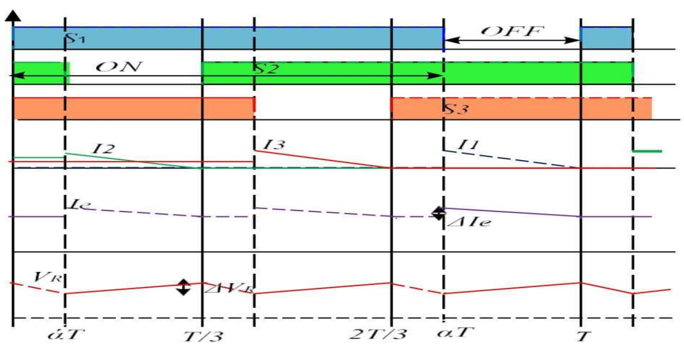

Fig 9:-Switches conduction timeline case 3

4. ENERGY MANAGEMENT OF PROPOSED EV CHARGING MODEL

This study conducts dual EV-charging point with PVs, BSS & MG. The web based approach is recommended for making the use of RES more efficiently. In order to keep the charger needs in various situations, BSs is linked to overcome the intermittency of solar. Reducing dependency on the grid is the objective of the energy-management [27].

The strategies main features are:-

- To create more RES.
- To use BSS for uncertain RES.

- In the extreme condition use of MG to fill the gap of load & generation.
- To achieve the consumption of generation the competence of EM system and inverter stage is evaluated while taking into account:

PPV ± PV Grid ± PBSS = PEV

5. RESULT AND DISCUSSION

Here EV charging-system model is M ATLAB simulated. With the objective of testing the abilities of REMS-algorithm for delivering continues charging with a stable/minimum charge under various conditions. Specially, such testing's to be done for continues charging with a fix charge:

A] During various atmospheric conditions.
B] With various BSS-SoC levels.
C] At grid with Different electricity cost.

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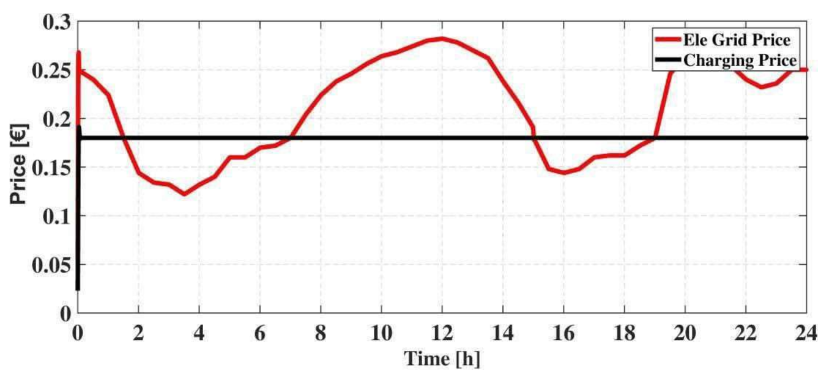

Fig 10:-Electricity grid price and EV charging price

As per [26], with a constant value of 0.17 euro / kWh, we set the charging-price to a fixed value which is smaller as compared to the avg. Price of grid-electricity at equality & below the equality terms. On the basis of the grid electricity the off peak terms are stated, since the grid-electricity cost is proportional to its load. In Figure the cost of grid-electricity is smaller as compared to the charging-price during 1:30 - 7:00 A.M. & during period 15.00-19.00 P.M. these duration's presents the off-peak of grid-side.

5.1 Charging during high PV power

The cost of grid-electricity is smaller as compared to the charging-price during 1:30 - 7:00 A.M. & during period 15.00-19.00 P.M. these duration's presents the off-peak of grid-side.

In the event of a power outage, the battery will be used to charge the EVs. In the event of insufficient combined power from both sources, grid power will be used for load maintenance. It is depicted.

The BSS and EV load is charged outside of the grid peak hours, with the load being provided by the grid under cheap price of power to ensure uninterrupted charging. The system was tested under various BSS SoC levels; if the SoC level is on the middle or high level, the charging system will operate under the charging price and grid price completely.

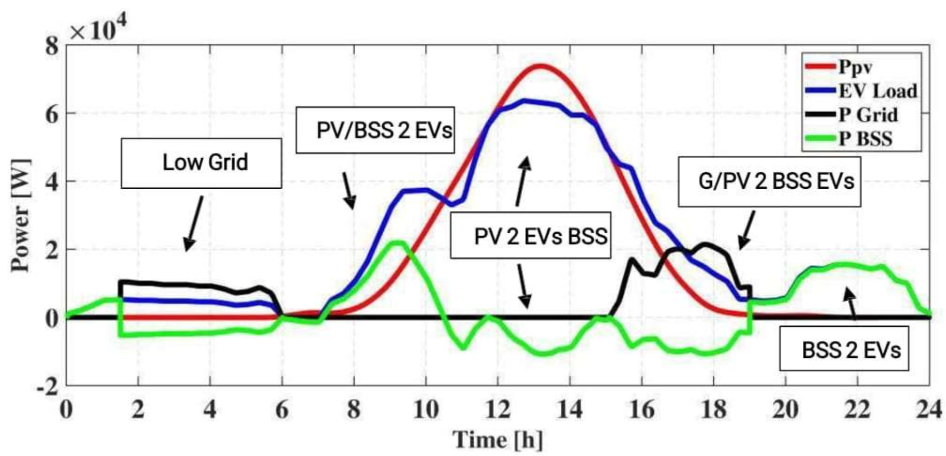

Fig 11:- Power flow of charging system components and BSS SoC at 50%

The simulation of a REMS-based PV charging system with the same EV demand profile but a different BSS SoC is established using the same PV profile. Because the BSS SoC is 85%, the demand gap is filled by BSS in addition to PV and grid in the event of a low electricity price. Extra energy is absorbed by the BSS or the grid in this instance to maintain power balance if the SoC is high. It not only lowers the operational costs of grid-side power production, but it also lowers the charging costs. The suggested REMS, in general, offer power balancing between linked sources and EV load.

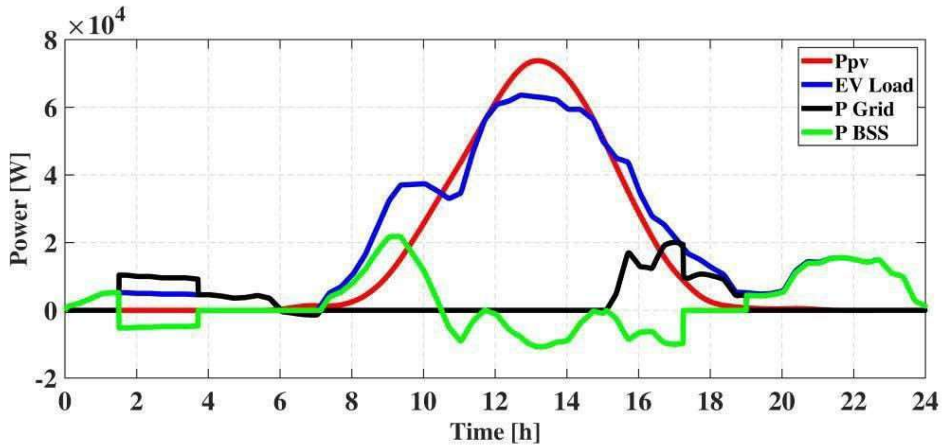

Fig 12:- Power flow of charging system components and BSS SoC 85%on clear day

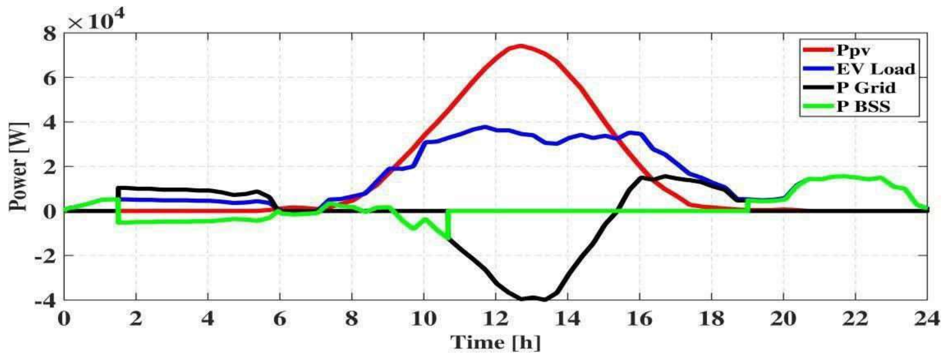

Fig 13 :-Power flow of charging system component and BSS SoC 25% on clear day.

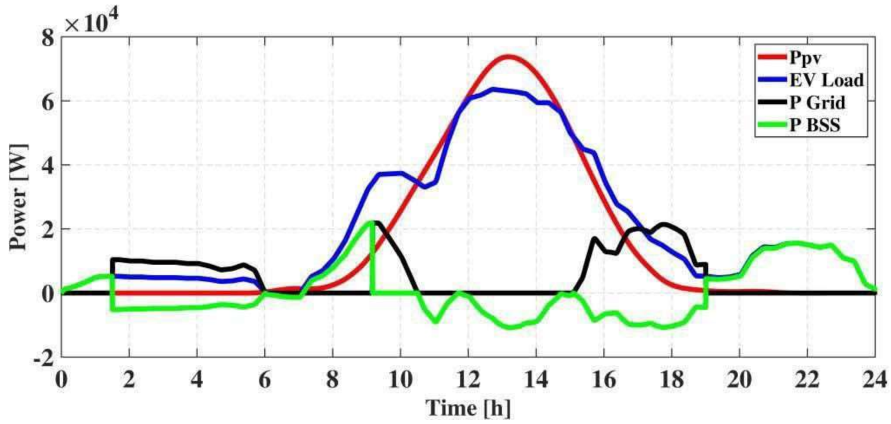

Fig 14:- PV energy to grid in case of SoC and low EVs Loads.

6. CONCLUSION

All the while multiple studies have looked into the effect of a considerable percentage of EV's with charging-stations also on security of power networks, just a tiny proportion have examined the economical advantages of running the power-grid and managing the EV's load. Under this regards, the actual enhanced EMS was already planed and developed to manage the micro grid operation, with EVs load, their aim was ever to decrease power prices, CO2 & pollutant level with raising the capacity of present RES-system. It was found that the EV-Chargers too can work as peak load clip and Gap fillers. The below mentioned factors mostly demonstrate how important the abovementioned is:-

Gap-filling & peak clipping are obtained with such a suitable EV-charge technique. Such that by decreasing the price of electricity production and delayed the creation of a new charging station which relies on power- grid as an energy source to minimize the maximum-load, smoothing of load-curve is possible.

With the investment in discharge stations and boosting the stability of the power-source, the stored power in a huge amount of EV-batteries can be applied for voltage & frequency control.

The potential of the power grid to satisfy such power sources can be enhanced, that will boost the cost effectiveness of the operating system. This may be performed by maintaining the discharging & charging of a huge amount of EVs efficiently and by co-ordination of irregular RES. Even though the power grid capability to handle irregular RES is limited, the wide adoption of EVs aids in increasing the system's efficiency.

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