SIMULATION OF HYBRID ELECTRIC VEHICLE CHARGER IN WORKPLACE

KUNDRAJULA SAI VISHWA
PG Scholar
Dept of EEE
TKR Collection of Engineering and Technology (Autonomous)

ADERLA ANJAIAH
Assistant professor
Dept of EEE
TKR Collection of Engineering and Technology (Autonomous)

Dr. K.RAJU
Associate professor
Dept of EEE
TKR Collection of Engineering and Technology (Autonomous)

ABSTRACT

Electric vehicles are promoted in large numbers by government of India to reduce environmental pollution and climatic change. Major anxieties while introducing electrical vehicles is their driving range and initial cost. Enough number of normal, medium and fast charging stations and battery swapping stations are to be planned and installed for smooth conveyance of electrical vehicles. This paper deals with a normal charging station implemented at a workspace. A solar power plant is used as the major source of electrical energy. An alternate connection to the station storage battery is used for importing/exporting the electrical power at times of deficient/excess solar power generation. The performance of the system is verified with MATLAB/Simulink.

INTRODUCTION

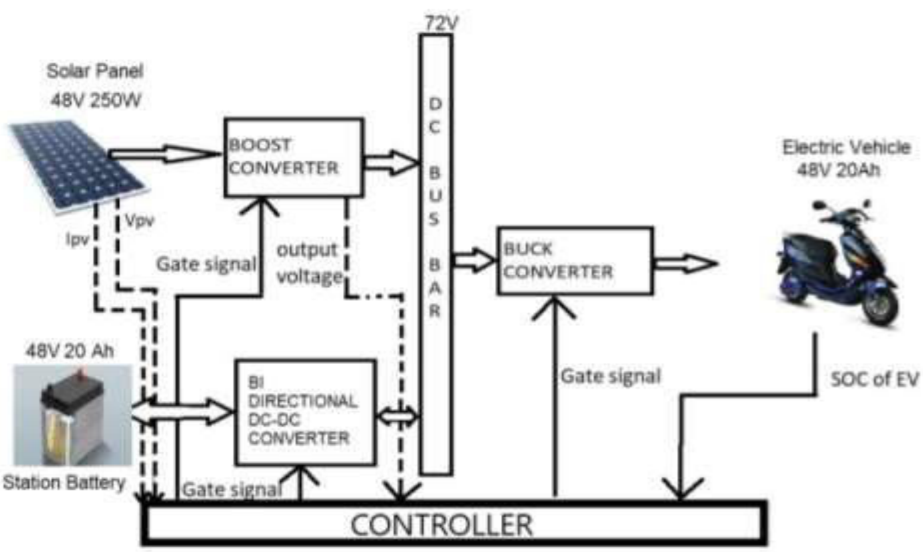
An electric vehicle (EV) is one that operates on an electric motor, instead of an internal-combustion engine that generates power by burning a mix of fuel and gases. Therefore, such as vehicle is seen as a possible replacement for current-generation automobile, in order to address the issue of rising pollution, global warming, depleting natural resources, etc. Though the concept of electric vehicles has been around for a long time, it has drawn a considerable amount of interest in the past decade amid a rising carbon footprint and other environmental impacts of fuel-based vehicles. In India, the first concrete decision to incentivise electric vehicles was taken in 2010. According to a Rs 95-crore scheme approved by the Ministry of New and Renewable Energy (MNRE), the government announced a financial incentive for manufacturers for electric vehicles sold in India. The scheme, effective from November 2010, envisaged incentives of up to 20 per cent on ex-factory prices of vehicles, subject to a maximum limit. However, the subsidy scheme was later withdrawn by the MNRE in March 2012.

In 2013, India unveiled the 'National Electric Mobility Mission Plan (NEMMP) 2020' to make a major shift to electric vehicles and to address the issues of national energy security, vehicular pollution and growth of domestic manufacturing capabilities. Though the scheme was to offer subsidies and create supporting infrastructure for e-vehicles, the plan mostly remained on papers. While presenting the Union Budget for 2015-16 in Parliament, then finance minister Arun Jaitley announced faster adoption and manufacturing of electric vehicles (FAME), with an initial outlay of Rs 75 crore. The scheme was announced with an aim to offer incentives for clean-fuel technology cars to boost their sales to up to 7 million vehicles by 2020.

In 2017, Transport Minister Nitin Gadkari made a statement showing India's intent to move to 100 per cent electric cars by 2030. However, the automobile industry raised concerns over the execution of such a plan. The government subsequently diluted the plan from 100 per cent to 30 per cent. In February 2019, the Union Cabinet cleared a Rs 10,000-crore programme under the FAME- II scheme. This scheme came into force from April 1, 2019. The main objective of the scheme is to encourage a faster adoption of electric and hybrid vehicles by offering upfront incentives on purchase of electric vehicles and also by establishing necessary charging infrastructure for EVs.

Plug–in electric vehicles (PEVs) which comprise all electric vehicles and plug-in hybrid electric vehicles provide the chance to modify the transportation energy demands from petroleum to electricity. Although, the impact of charging the electric vehicles (EVs) via the electrical grid, especially during the peak demand period cannot be neglected, it cause many problems such as harmonics, voltage outages and fluctuations [1]. The use of charging stations integrated with distributed generation based on renewable energy sources (RES), to boost the power generation, can be a viable solution to mitigate this problem [2]. In addition, the combination of these distributed energy sources into the charging infrastructure has an important role to decrease the environmental effects and to enhance the efficiency of the charging system. Due to the stochastic nature of RES, there is a persistent need to add an energy storage system (ESS) which has a crucial role in the incorporation of electric vehicle charging station (EVCS). The photovoltaic (PV) power is known as the most competitive source of energy to support the grid utility thanks to the persistent decreasing tendency on the prices of the PV panels [3]. Furthermore, the PV system, in terms of fuel and labor is approximately maintenance free [4]. The use of the PV power to supply the EVs is improved by the advancement in the power conversion technologies [5]. One of the important challenges for the EVCS, particularly the public ones, is making the charging duration as short as possible.

There are many standards organizations in the world that work to define the electrical characteristics of EVCS i.e. the Society of Automotive Engineering (SAE), CHAdeMO association and International Electro technical Commission (IEC). The latter develops four modes of charging basing on the type of the charging rate, the level and the type of voltage, the mode of communication between the EVs and the CS and the presence of the protections and its location.

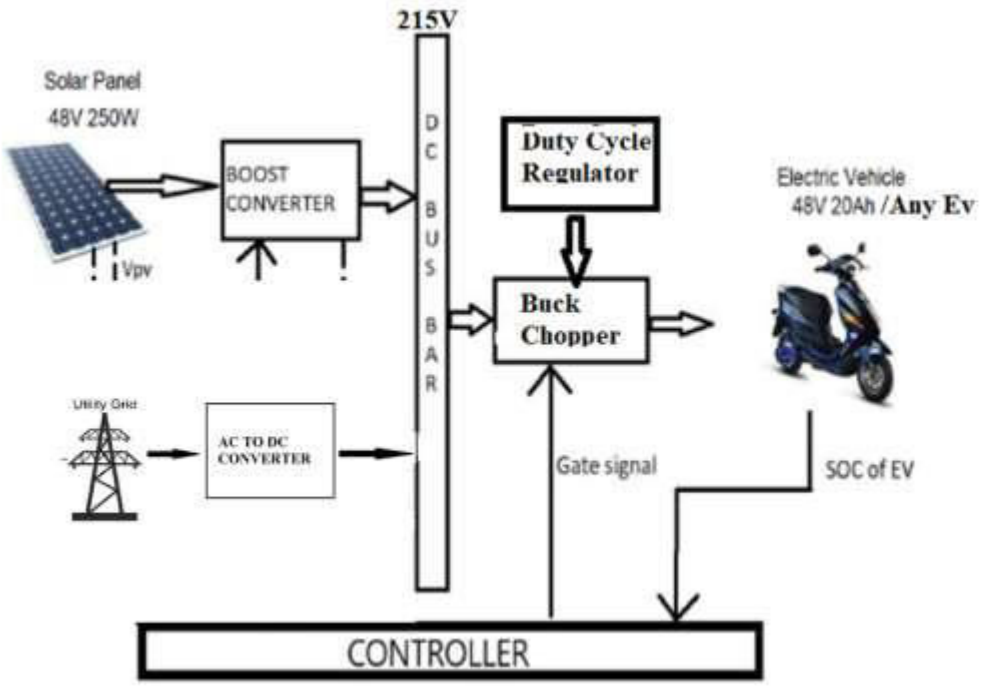


These fast charging station (FCS) present two topologies normalized by the IEC 61851-1, the first is tied to a common AC bus suppling all the AC-DC converters ,on the other hand, the second topology is based on a common DC bus which feed the various DC-DC chargers. Experimental studies showed that the second architecture is the best option due to the reduced number of the conversion stages, the nature of loads and fluent integration of energy storage systems or distributed generation. Apart from that, the synchronous charge of a fleet of EVs can cause an increase in the peak power demand to the utility grid. Dealing with a fleet of EVs at different poles of charging needs a study on appropriate management strategy, so two ways have been suggested, i.e. centralized or decentralized management strategy. The latter strategy, applied to the EVCS, is based on local controllers, and each source of energy works independently from the others, in addition to that the energy flow management between the sources of energy is accomplished without the necessity of communication interface between the energy sources or between the energy management system (EMS) and sources of energy. It facilitate the extension of the charging system and the medium voltage direct current (MVDC) network by adding new element such as others sources of energy (ESS, RES) or new EVs, the EMS does not need to be changed. Also, comparing these two strategies, it was concluded that the adoption of the decentralized strategy represents the most feasible option thanks to the benefit of not needing a communication interface [8]. In our study, a PV-grid charging station is studied to maximize the use of the photovoltaic power whenever it possible and to use the grid or/and the ESS as a buffer system when the solar irradiance is unavailable or there is an excess of power [9], This strategy allows the buffer‘s connection taking into account the energy transmission cost (ETC) and the state of charge of the battery (SOC). The proposed approach promotes the smart grid concept by combining the RES with the utility grid [10]. In order to get more revenues, Vehicle to Grid (V2G) technology can be also integrated where EVs owners can realize a balance of demand between charging and discharging modes [11]. However, this approach would produce a short lifetime of the EV‘s battery and other unsolved problems.

The combination of solar energy and **electric vehicle (EV) charging** is the key in drastically reducing our dependence on fossil fuels. Electricity comes from a variety of sources and it’s crucial that electric vehicles will be powered by renewables. Electric cars are becoming immensely popular and coming years we expect nearly anyone who owns a solar energy system will install a **solar charging station** at its workplaces.

Conventional approach disadvantages

- DC bus voltage is up to 72 volts if any higher voltage EV is came to charging station it is impossible to fed EV
- In the existing approach output is constant I,e 48V so than voltage vehicle charging is not possible
- If solar and battery storage is over than EV station output is ZERO
- Cost of BESS is very high mostly 40% of the total PROJECT cost
- Battery energy storge system is having Aging effect

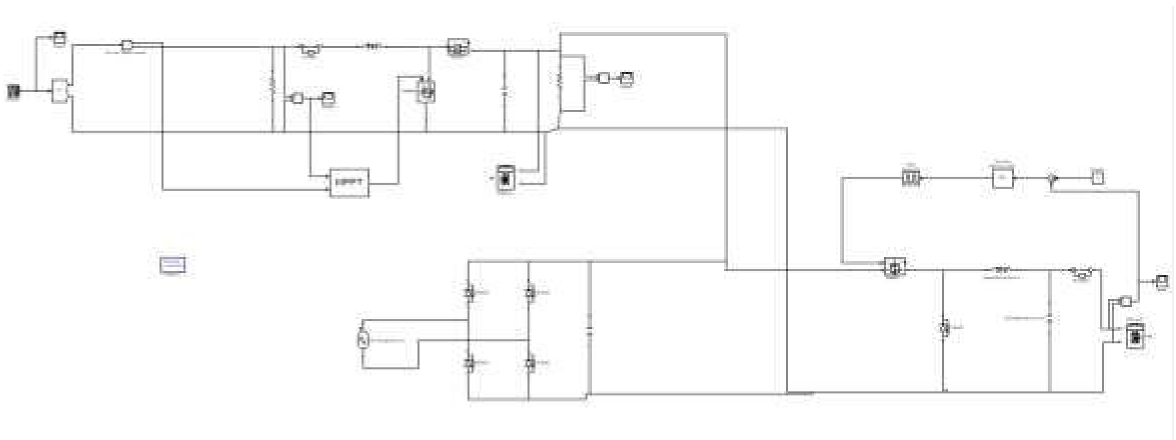


Proposed system

Proposed approach disadvantages

- DC bus voltage is up to 215 volts mostly all EV s in the market came into this voltage level.
- In the proposed output is not constant I,e 12v to 215 Voltage vehicle charging is possible
- If solar is zero than also EV station output is exists
- No BESS cost.
- Battery energy storge system is not presented so Aging effect

PROPOSED SIMULATION RESULTS



Proposed circuit configuration

- DC bus voltage is up to 215 volts mostly all EV s in the market came into this voltage level.
- In the proposed output is not constant I,e 12v to 215 Voltage vehicle charging is possible

- If solar is zero than also EV station output is existing
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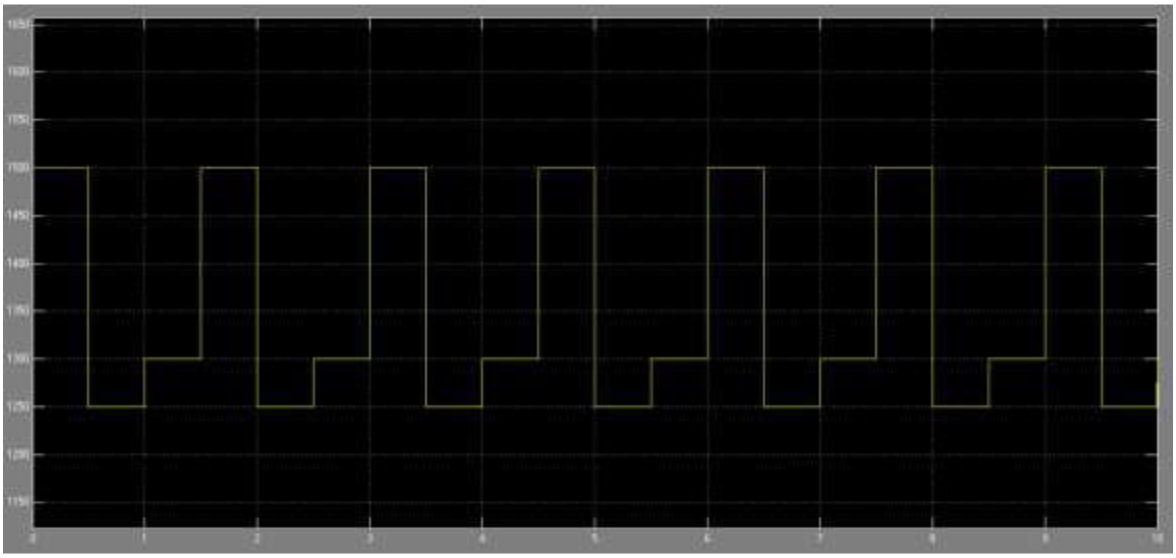
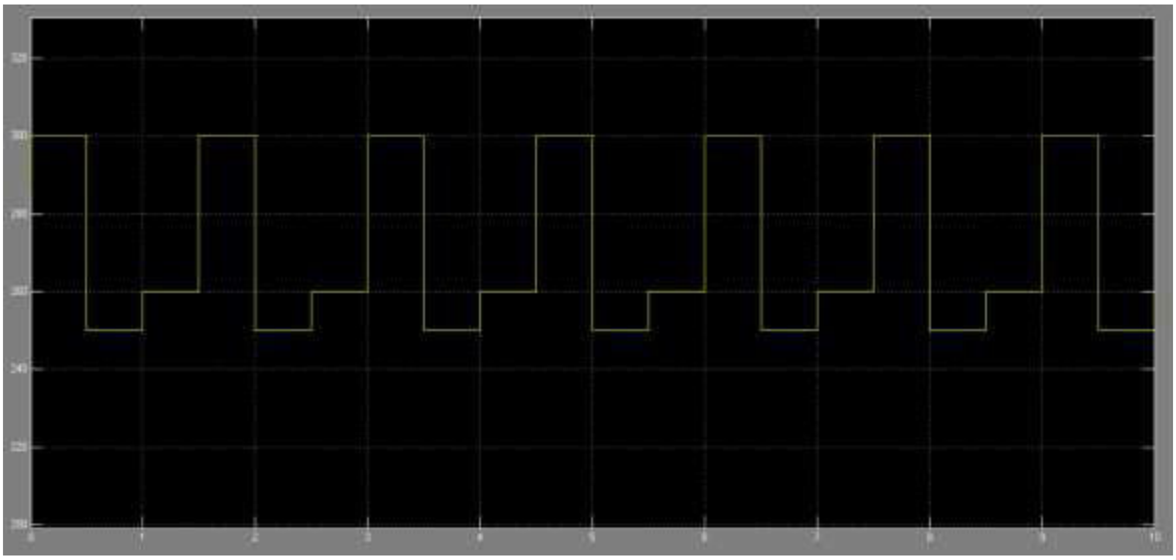
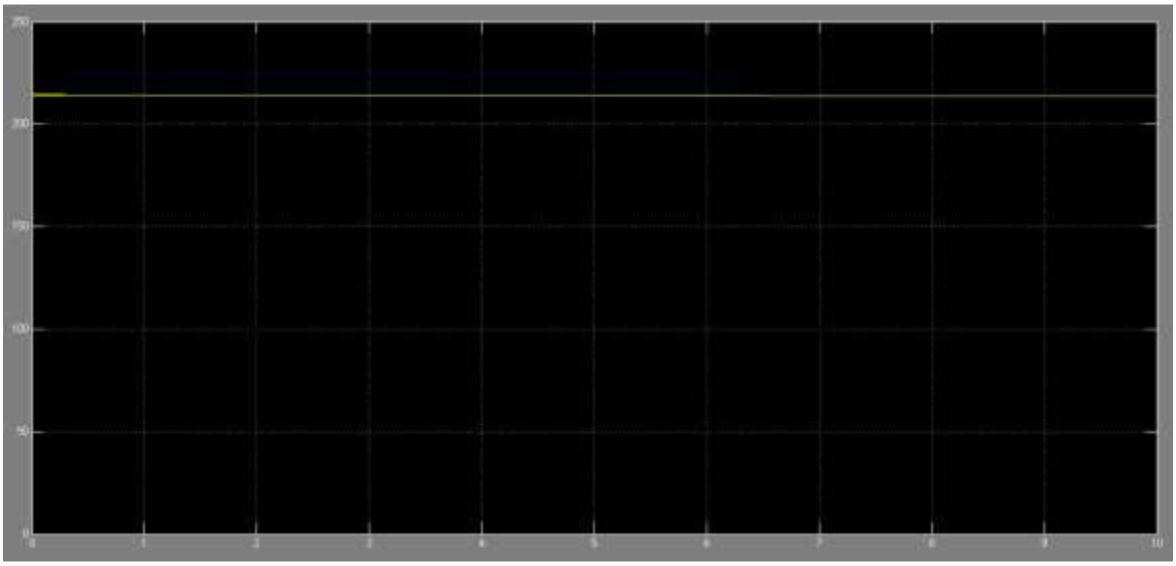


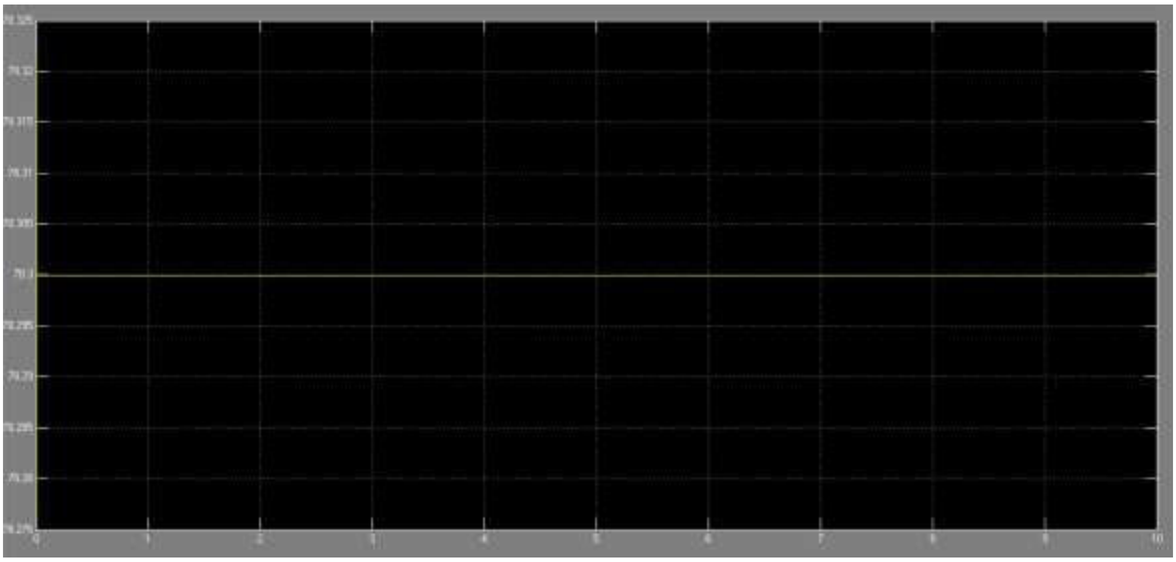
Irradiation vs time



Solar output voltage vs time



Dc Bus voltage vs time



Battery voltage vs time

CONCLUSION

The solar EV charging station controller is implemented in MATLAB and control desk and its effectiveness is tested under different solar power generation and battery power requirement. It is found that the power supplied by the solar panel depends on the load across it at a specific irradiance and temperature. Constant current charging is employed so that the vehicle batteries can be charged. Grid connection may be added to the system to account for the cases where both the solar energy and station battery SOC are insufficient.

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