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DC FAST CHARGING STATION USING RENEWABLE ENERGY SOURCES

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Abstract - Global warming has led to the large adoption of Evs (Electric Vehicles) which appear to be the best replacement for IC engines. Due to the number of Evs are increased on the road, charging vehicles with conventional fossil fuel-based grids are not efficient and economical. The renewable energy-based charging station finds control for electric vehicle charging. This project describes the solar and wind energy-based charging mechanism (SWCM) to generate the power for charging the battery packs of Evs (electric vehicles). The renewable charging station consists of both the wind generator and PV (solar photovoltaic) modules. The wind energy-based charging mechanism immensely reduces the requirement of fossil fuels to generate electricity, resulting in reduced CO2 and CO-related emissions. An EV (electric vehicle) charging station integrating solar power, wind power, Grid and a BESS (Battery Energy Storage System) is designed for the current scenario. For uninterrupted power in the charging station, additional grid support is also considered without becoming an extra burden to the grid. To balance the load demand, the system is connected to the grid by the help of the single-phase bidirectional DC-AC (alternating current) inverter. The results show that the renewable charging mechanism is suitable for EV charging and it creates a pollution-free environment. tool to improve manuscript clarity meant for the referees. The final layout of the typeset paper will not match this template layout.

1. INTRODUCTION

The remarkable increase in the use of electric vehicles (EVs) has resulted in a massive rise in demand for electric energy across the globe. The global electric vehicle market has grown significantly. The number of EVs on the road in 2010 was a few hundred; this number rose to approximately three million in 2017 and approximately six million in early 2019. Electric vehicles are exciting alternatives to conventional vehicles (CVs). With zero carbon emissions during operation, the EV has the ability to reduce total climate effect and pollutant emissions significantly. As fossil fuels are phased out to a greater degree, the need for bio-fuels would also be reduced. Electric motors have an efficiency of 80–95%, making them a more appealing choice than CVs, which have an efficiency of less than 20%. EVs are also a critical element of modern transportation, because they incorporate a variety of new industrial technologies (e.g., an electric motor, a battery, and a charging facility). However, the adoption of electric vehicles is not going as well as predicted. The limited range pressure on local electricity networks because of the increasing number of electric vehicle charging points. Renewable energy sources such as wind and solar are some of the most effective solutions to bridge this deficit faced by local electricity networks, potentially supporting the EV charging infrastructure .After the announcement of the rapid development of the EV at the turn of the millennium, renewable energy-based charging infrastructure (RCI) research began with the effort of wind and solar charging infrastructure. It envisioned a charging facility that could match EV demand with renewable and direct current (DC) to improve shortcomings of conventional charging infrastructure. The traditional charging stations affect the grid's stability with issues such as harmonics, fluctuations, and voltage outages. By contrast, the RCI has several advantages, such as high efficiency, low system cost, and simple arrangement. Besides, it requires less power conversion levels than those in alternating current (AC)-based facilities. The RCI can contribute significantly to reducing carbon emissions and expanding the energy domain's penetration of renewable energy sources. Moreover, RCI has the potential to lower the cost of EV charging. However, uncertainties of the renewable sources (e.g., seasonal variations in wind speed and sun irradiance and daily randomness in cloud coverage for solar panels) and load characteristics of EVs (e.g., battery capacity, number and types of EVs, stop time, charging start time, and the initial state of charge) are serious challenges in implementing the RCI. Currently, there is an on-going considerable research work on the aforementioned topics. At the same time, other researchers are working on various aspects of implementation and operation of RCI, such as optimal planning, controlling and sizing, pricing approaches, and examination of the key factors influencing the linking of EV load directly with the RCI. For instance, few studies reviewed EV charging infrastructure research; however, they considered general technical aspects and did not concentrate on renewable energy sources. Another study reviewed the RCI studies but with the focus on the consumer preferences and interactions with EVs. To our knowledge, no study has reviewed RCI studies extensively by discussing all related research areas. This study examines recent advances in RCI technology and the latest research progress in this critical field. The paper discusses the concept of RCI from different perspectives, including appropriate renewable energy sources for RCI, sitting, optimal planning, optimal sizing, control and energy management, and renewable energy based charging pricing programs and challenges of RCI. DC fast charging using solar and wind energy is a promising technology for reducing the environmental impact of transportation. Solar and wind energy are renewable and sustainable sources of energy, and DC fast charging can significantly reduce the time it takes to charge an electric vehicle (EV). DC fast charging bypasses the on-board charger in an EV and instead delivers DC power directly to the battery. This can charge an EV battery in as little as 30 minutes, compared to several hours for AC charging. By combining these renewable sources, the station achieves enhanced reliability and efficiency in power generation. Excess energy generated during peak conditions is stored in high-capacity batteries, guaranteeing a continuous power supply for charging EVs, even during lulls in renewable energy production. The escalated demand on the electrical power has been caused by the dramatic rise of population and city urbanization. This has led to a fast depletion to the conventional energy resources such as fossil fuels. Moreover, this has also raised the event of global warming as an urgent issue to be quickly addressed. Renewable energy sources are clean, limitless, and getting more and more competitive. Their main differences from fossil fuels are their diversity, abundance, and global use, but most importantly, they don't emit any polluting or greenhouse gasses, which are the main cause of climate change. Despite their current volatility, the overall cost trend for fossil fuels is declining, while their costs are likewise declining at a sustainable rate.

2. Objectives

To harness renewable energy sources such as solar and wind power to charge electric vehicles. To provide reliable and efficient DC fast charging infrastructure for battery charging. To create a cost-effective and scalable charging station model.

3. Proposed DC Fast Charging System

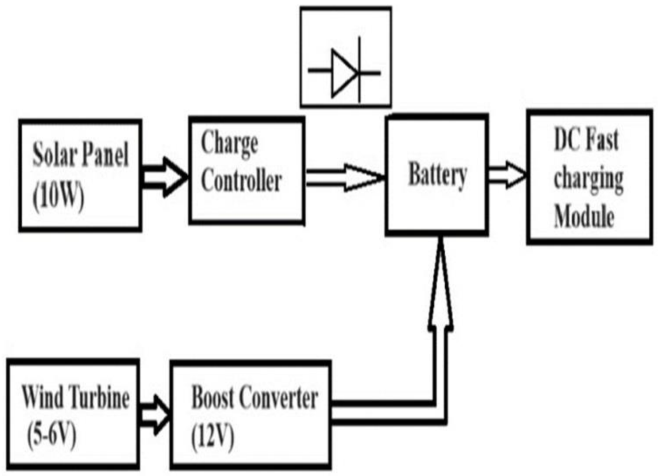

Fig 1. Block Diagram of DC Fast Charging Station

Solar Panel: The use of solar technologies is still growing in both industrialized and developing nations. A photovoltaic system, the solar panel system generates electricity by harnessing solar radiation. One essential component of the system is the solar panels. They are able to convert light into electricity by absorbing it. Solar panels are made of material that collects solar energy, or sunshine, and converts it into direct current (DC). The direct current (DC) generated by the panels is erratic and varies. This DC cannot be fed straight into a charging station.

Charge Controller: It reduces the possibility of overcharging your batteries the solar charge controller is an essential component of your PV system. The solar charge controller receives power from the solar panels and distributes it to the batteries and other connected load devices. In order to guarantee correct charging and avoid overcharging that could harm the batteries, solar charge controllers manage the voltage and current that goes from the solar panels to the batteries. In order to reduce the current flow as the battery gets closer to full charge, it also keeps an eye on the battery voltage.

Power Source: A solar battery is an electrical accumulator used in solar energy installations to store the electrical energy produced by photovoltaic panels. In an autonomous facility, installing solar panels necessitates installing a battery system to guarantee power availability. When solar panels acquire excess solar energy during the hours of maximum solar radiation, solar battery technology saves the electrical energy produced. When the electrical system requires less energy than the solar panels can produce, the excess energy is used to charge the batteries. The solar panels supply all of the energy needed.

DC Charging Device: DC In contrast to alternating current (AC) charging techniques, fast charging uses direct current (DC) power to charge electric vehicle batteries considerably more quickly. The vehicle's battery receives direct current from the charging station, which transforms alternating electricity from the electrical grid. Connecting the EV to the charging station is the first step in the charging process. The charging station connects to the car and communicates with it to figure out the right voltage and current for charging. After that, the vehicle receives the necessary power from the charging station, enabling it to charge significantly faster than it would with conventional AC power. Comparing DC Fast Charging to conventional AC charging techniques reveals a number of benefits. First of all, the time required to charge an electric car is greatly decreased by its rapid charging capabilities. Drivers who are pressed for time or who require a rapid energy boost while traveling a long distance may find this especially helpful.

Boost Converter: In essence, a boost converter is a step-up dc-to-dc converter or chopper that increases the voltage at which the input voltage is converted to an output voltage. Put otherwise, boost converters are regulator circuits that provide an output voltage that is either larger than or equal to the supplied input voltage. The idea of energy storage in an inductor underpins the boost converter's operation. An inductor's voltage drop is directly correlated with changes in the electric current passing through it. The circuit configuration functions to support the maintenance of a higher and more regulated dc output at the load. A DC chopper is a static device that allows us to take a source of constant DC voltage and convert it into variable DC voltage. It functions similarly to how an AC transformer would to adjust the dc voltage source's step size. In addition to power savings, the DC chopper has several other benefits, such as great efficiency, quick reaction, small size, effortless operation, low maintenance, and low cost.

Wind Turbine: This vertical-axis wind turbine incorporates 3 in volute spiral blades in a configuration that utilizes the mass momentum of the wind to spin the blades around a central shaft. Force is applied to the blades by the wind both entering and leaving the turbine, allowing maximum extraction of energy from the wind. The unique nature of the involutes spiral is that the wind is increasingly diverted into and out of a central vortex with no constriction in the path, only pushing the surfaces around. Other advantages to this particular design will be covered below at the base.

4. Methodology

- HARDWARE IMPLEMENTATION:
  We have implemented the DC Fast Charging Station for EV by using Renewable Energy Sources like Solar and Wind Energy.
- SOFTWARE IMPLEMENTATION:
  The simulation is carried out for real time by using Simulink, which is integrated in MATLAB.

5. Simulation Result and Discussion:

The designed charging station is simulated using MATLAB/Simulink environment. The input to the PV array is temperature and irradiance as assumed as varying. Fig. 2 shows the overall simulation diagram.

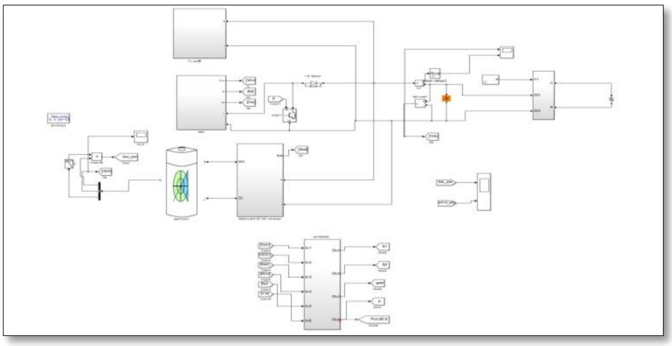

Fig 2. Simulation Circuit

The irradiance of solar panel for 1000W/m2 and temperature of 29°C is shown in fig 2. The corresponding output voltage, output current, output power and duty cycle of the converter is shown in fig 2.

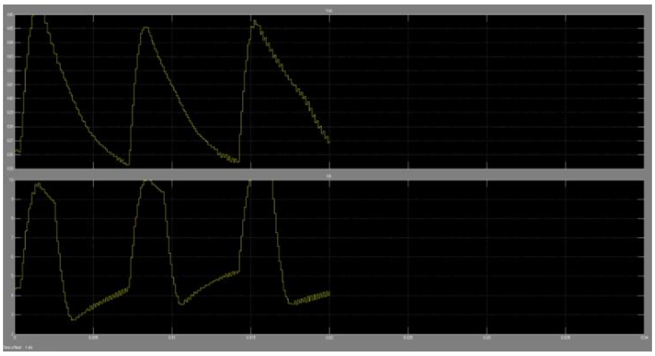

Fig 3. Solar PV voltage for irradiance of 1000W/m ^{2}and temperature of 29˚C

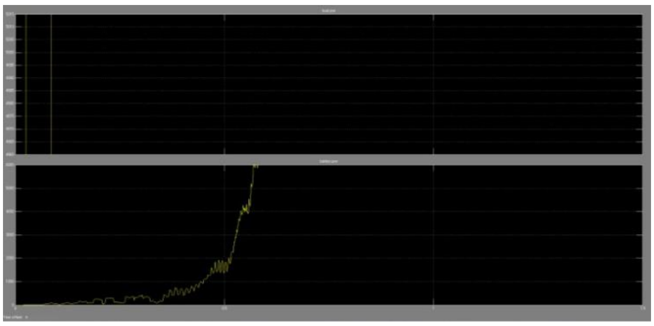

Fig 4. Waveform of Load Power and Battery Power

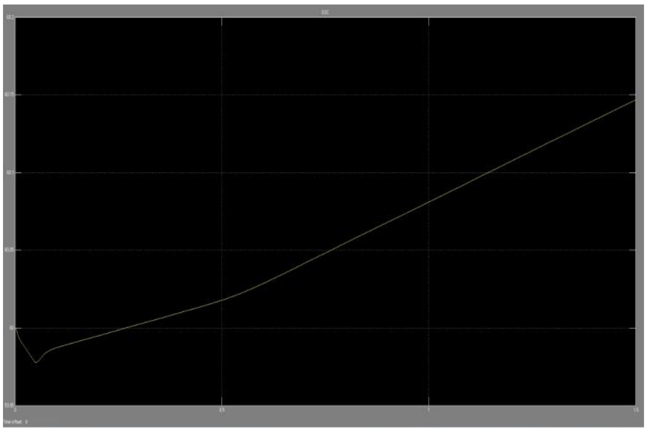

Fig 5.SOC

Fig 5 shows the state of battery charge. Always SOC is maintained at 60%. At 80% of SOC, battery's nominal voltage is 300V, which is boosted using bidirectional dc-dc converter. Thus, 330V dc bus is successfully obtained. In case of insufficiency of power from solar PV, battery is charged using fuel cell and storage battery. At time t=0.15 Sec, both the sources are feeding power to the load. Hence, the bidirectional converter charges the battery and is shown in Fig. 5. That is power flows from load to battery. Energy from the solar PV is less, the battery discharges with the help of bidirectional dc-dc converter. In all cases the output Voltage is maintained at 300V with ripple voltage of 7V.

6. CONCLUSION

EV (Electric vehicles) is expected to be one of the inevitable of our future. They will be more popular than internal combustion engine vehicles. As a first step the charging time of the EV (Electric vehicles) should be less and they should be able to cover a long distance. This is reason for the expected reason of the fast-charging stations. In order to manage and minimize the negative effects of this new load potential on the grid, usage of the local energy resources is inevitable. The EV (Electric vehicles) should be able to benefit from these sources effectively. In this study, a hybrid fast-charging system that is supplied by local renewable energy resources rather than the grid is examined. The analysis is conducted with real weather station data. It is expected that; these systems will become more widespread and applicable to the development of fast-charging stations. The PV system and battery technologies are also important to increase the implementation of this type of system. For next studies, new systems will allow the energy flow between the EV (Electric vehicles).Therefore it will minimizing the dimensions of the charging stations may be considered as an option. At last, we conclude that this system approach minimize the pollution. It will also increase the usage of EV (Electric vehicles) as it will create pollution free environment.

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