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ENERGY MANAGEMENT STRATEGY OF A RENEWABLE ENERGY BASED ELECTRIC VEHICLE

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ABSTRACT

The usage of charging the electric vehicles using renewable energy souces [RES] has been increasing. The strategy is based on the premise of considering constraints and the principle of minimizing the operation cost of the charging stations considering the factors like solar irradiance utilization rate, real-time electrical energy price, battery loss and the combination of these renewable energy sources into the charging infrastructure has an important role to decrease the environmental effects and to enhance the efficiency of charging station. A grid connected electric vehiclecharging station powered by the renewable soucres i.e, photovoltaic solar systems and pack of batteries as storage system, is evaluated and analyzed. Due to the non linear characterstics of RES, there is a persistent need to add an energy storage system [ESS] to store electrical energy. The proposed EMS supply the continues charging to the electric vehicles even during night times (when sun irradiance is not available). This supervision is tested the charging system under different sun irradiance conditions considering the cost of the energy transmission and state of charge of the battery.

Keywords: electric vehicle , charging , solar pv array,management.

INTRODUCTION

There has been tremendous growth in usage of Plug–in electric vehicles (PEVs) and plug-in hybrid electric vehicles during recent years due to reasons like cost effectiveness, reduction in non-renewable energy supplies like gasoline, diesel, biogas etc. Charging of these PEVs & PHEVs using renewable energy sources (RES) further reduce the greenhouse gas emissions. Since there is an uncertainty in the availability of renewable energy it is not possible to provide continuous charging to Electric Vehicles using RES alone.

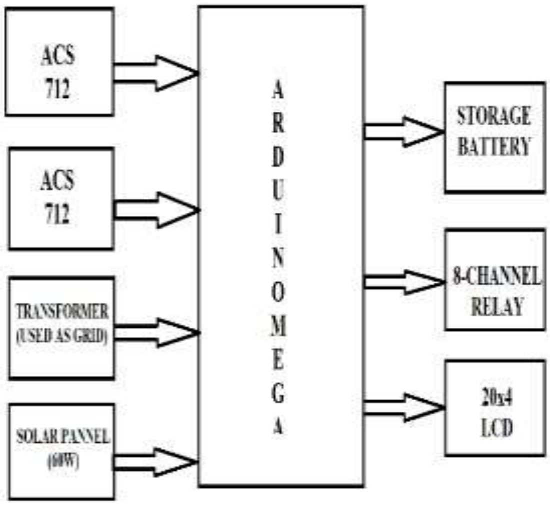
Using a grid connected Charging station powered by PV system and ESS is a solution to the above problem [1]. The combination of these renewable energy sources into the charging infrastructure has an important role to decrease the environmental effects indirectly at the power generation plants and to increase the efficiency of the charging system. Due to the non linear characterstics of RES, there is a important need to add an ESS, which has an important role in the incorporation of electric vehicle charging station (EVCS). The photo voltaic power is known as the maintance free source of energy to support the grid utility thanks to the decreasing tendency on the prices of the PV panels [2]. Furthermore, the PV system, in terms of fuel cost and labour cost is approximately maintenance free [3]. The use of the PhotoVoltaic power to supply the electric vehicles is improved by the advancement in the power conversion technologies [4]. One of the important challenges for the EVCS while charging the electrical vehicles, particularly the public ponit, is making the charging duration as short as possible. There are many standand companys in the world that work to describe the electrical characteristics of electrcal vehicle charging stations i.e., the Society of Automotive Engineering (SAE), CHAdeMO association and International Electro technical Commission (IEC). The after some time they develop the four modes of charging of electric vehicles basing on the type of the charging rate of EV, the level and the type of voltage, the mode of communication between the Electrical Vehicles and the control strategies and the presence of the protection devices and location of it.

These fast-charging station (FCS) present two topologies normalized by the IEC 61851-1, the first is tied to a common AC bus supplying all the AC-DC converters, on the other hand, the second is tied to the common DC bus which consists of various types of DC-DC chargers. The Experimental studies showed that the second topology is the best option due to the less number of the conversion stages, the nature of loads and fluent integration of ESS or RES generation. Apart from that, the continous charge of a electrical vehicles can cause an increase in the peak demand of power on 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 facilitates the extension of the charging system and the medium voltage direct current (MVDC) network by adding new element such as other sources of energy (ESS, RES) or new EVs, since the EMS does not need to be changed. Also adoption of decentralized strategy doesn't need a communication interface [5]. 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 of power [6]. 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[7]. 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. However, this approach would produce a short lifetime of the EV 's battery and other unsolved problems.

Proposed Block diagram

Table 1 Comparison of current EV charging station technologies

	Conventional Charging Stations	Solar Powered Charging Stations	Solar Powered Charging Stations with Energy Storage	Proposed Solar Powered Charging Stations with Energy Storage
Cost	Low	Medium	High (bat. Cost)	High (bat. Cost)
Impact on Grid	High	High	Medium	Low
Energy Management	No	No	Yes	Yes
Solar/Load Projection	No	No	No	Yes
Market Share (present)	High	low	Very low	Very low (nearly zero)



Fig(1): Block diagram Of Renwable Based EV Charging Station

A. Solar energy :

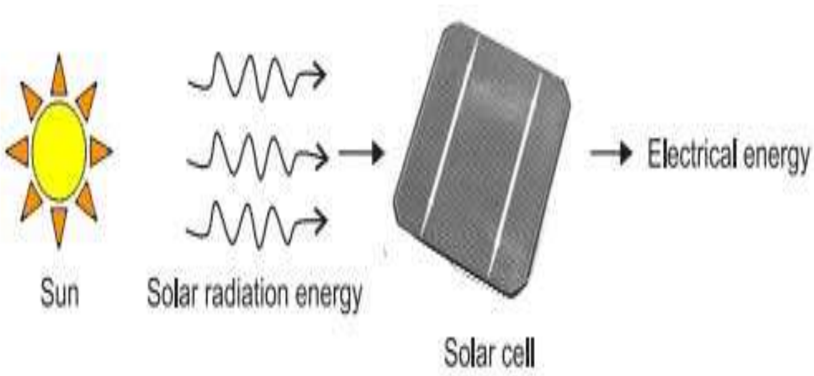
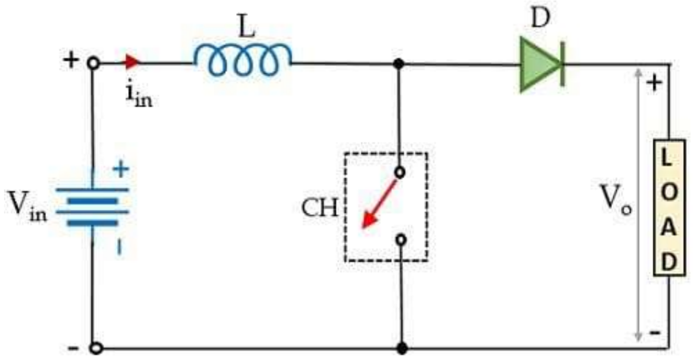


Fig (2): Solar power Generation

Generation of electrical energy by using solar energy depends upon the photovoltaic effect in some specific materials. There are certain materials that can produce electrical energy when these are exposed to direct sun light. This effect is seen in combination of two thin layers of semiconductor materials. One layer of this combination will have a depleted number of electrons. When sunlight strikes on this layer it absorbs the photons of sunlight ray and consequently the electrons are excited and jump to the other layer. This phenomenon creates a charge difference between the layers and resulting to a tiny potential difference between them. The unit of such combination of two layers of semiconductor materials for producing electric potential difference in sunlight is called solar cell. Silicon is normally used as the semiconductor material for producing such solar cell. For building cell silicon material is cut into very thin wafers. Some of these wafers are doped with impurities. Then the un-doped and doped wafers are sandwiched together to build solar cell and metallic strip is attached to two extreme layers to collect current. Conductive metal strips attached to the cells take the electrical current. One solar cell or photovoltaic cell is not capable of producing desired electricity instead it produces very tiny amount of electricity hence for extracting desired level of electricity desired number of such cells are connected in both parallel and series to form a solar module or photovoltaic module.

B.Booster Converter



Fig(3): Boost Converter

Boost converters are essentially a step-up power converter that take in a low voltage input and provide an output at a much higher voltage. A block diagram of an ideal dc/dc boost converter is shown in the figure above, an ideal boost converter is lossless in terms of energy, so the input and output power are equal. In practice, there will be losses in the switch and passive elements, but efficiencies better than 90% are still possible through careful selection of system components and operating parameters such as the switch frequency. The internal operations of a boost converter can be thought of as a charge storage and transfer mechanism. There are two states, on and off.

Different methods for achieving a DC/DC Boost Converter

To build this boost converter that meets the teams' specifications the team needs the power stage that will provide the 12V output from a 3.3V input. This circuit will be the daughter board of the design. To set the desired frequency for this converter the teams need to design a pulse width modulation (PWM) circuit up to 20MHz to drive the boost converter. A third circuit is needed to compensate for any variation in the output. This stage is called the error amplifier or control loop and monitors the output for a constant V_{out}. These three different stages make up the design for a high frequency DC/DC boost Converter with a control loop.

C. Lead acid battery

Nowadays, the most competitive type of battery is Lead acid battery due to its highest energy efficiency level, its density of power and its lightweight also its compactness. In addition to that, it allows the fast-charging ability and provides. A wide range of operating temperature, also it is characterized by its long-life cycle, low self-discharge and it does not have a memory effect.

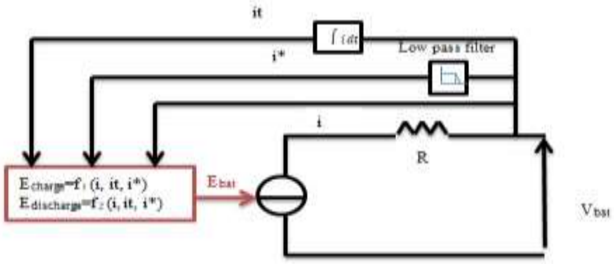
$$V_{bat} = E_{bat} - R_{int} \times I_{bat}$$

$$E_{bat} = E_0 - K\frac{Q}{i_t - 0.1Q} i^* - K\frac{Q}{Q - i_t} i_t + Ae^{(-B\,i_t)}$$

Where E0 is the voltage of no-load battery (V), K represents the polarization voltages (V), Q is the capacity of battery (Ah), A is the amplitude of the exponential zone (V), B is the exponential zone time constant inverse (Ah-1), V_{bat} is voltage of battery (V), I_{bat} is the current of battery (A), and '∫ i dt'is the charge supplied and drawn by the battery (Ah).

The SOC is the most important parameters of the battery which must be controlled to avoid an extra-charge or a deep battery discharging. Its expression is presented in the following. equation:

$$SOC(\%) = SOC_0(\%) - 100 \times \left(\frac{\int i_{bat}\, dt}{Q} \right)$$



Fig(4): Standard battery model

RESULTS

Fig(5): Reweable based Ev charging station

Fig(6): Overview of Kit

Fig(7): Charging of EV vehicle

1.Electrical vehicle is charged through solar PV panel produced power.
2.Excess power of the solar PV panel produced power is stored in the storage battery.
3.During nighttime electrical vehicle is charged through storage battery since sun irradiance is not available.
4. When storage batteries are discharged the electrical vehicles charged through grid

Conclusion

In this paper, a working model is designed to provide continuous charging to the electrical vehicles during peak demand. The power will be generated by the solar PV module, and it used to provide charging to the electrical vehicles, excess will be stored in the battery. During night-time electrical vehicles are charged by battery or grid.

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