

Communications

Smart Charging Method for Domestic Electric Vehicles Chargers

Navod L. Bandara,^a Poorna P. Rajanayake,^a Akila E. Jayasinghe,^{a,*} and Akila Wijethunge^b

^a Department of Engineering Technology, Faculty of Technology University of Jaffna, Ariviyal Nagar Kilinochchi 44000, Sri Lanka

^b Department of Materials and Mechanical Technology, Faculty of Technology, University of Sri Jayewardenepura, Homagama 10200, Sri Lanka

Email Correspondence: akilaj@univ.jfn.ac.lk (A. E. Jayasinghe)

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Electrical vehicles (EV) are a type of vehicle which operates by an electric motor instead of internal combustion. As the demand for EVs are increasing the demand for charging facilities also will be increasing. The research carried out introduces a smart domestic EV charger system with improved functionality while addressing the challenges associated with the implementation of EV charging stations and systems. Minimizing waste of energy, use of sophisticated technology to overcome the application of the old technologies, minimize wastage of time and finally to minimize the environment pollution are achieved using maximum energy management and effective charging with suggested smart charging methods. The mode for EV charging during the off-peak time according to the demand curve and another mode is for EV charging with renewable energy and grid supply is suggested. The smart hybrid charging system will provide the users with a solution to energy crisis and consumption and the time and capital will be saved with an easy, simple, convenient, and reliable operation.

In the modern world, Electrical Vehicles (EV) are ever more appealing where the reduction of the emission of carbon pollution is a huge and at the same time a growing concern for almost all the people throughout the world. Other than that, the high cost of fuel & the limitations of fuel sources the electric vehicles are being which saves the conventional fuels. As the process of Internal Combustion Engine (ICE) engine is more complex and combustion engine necessarily has many more parts and takes up much more space than an electric engine. Also, the considerably high number of moving parts in the fuel vehicle, today's generation has a preference of choosing EVs. The less

maintained necessity & the low impact on the environment are the main reasons for the choice of EVs. The EVs in the market can only travel between 100 km to 160 km per a single charge. And it takes some time to recharge their battery using the charging system [1].

Generally, there are two main ways of charging EVs namely the conductive method and inductive method. In the conductive method, EV and electricity providers are connected directly using the charger cable. Most industries and users consider conductive method systems as it is a system that is cheap and at the same time efficient. Inductive charging is a method [2] of charging EVs using electromagnetic fields. The charger induction coil is used to create an alternating electromagnetic field within a charging base, and a second induction coil placed in EV is the portable device that absorbs power from the electromagnetic field and converts it back into electric current to charge their battery. In the present conductive method to charge EVs is widely used as it is cheap and the time efficient. There are three major types of EV chargers according to the power provided to the battery from the grid, level 1, level 2, level 3 (Fast charging). SAE J1772 is a standard connector and receptacle that is used in EV chargers under the level 1 and level 2 stages [2]. The connector in IEC 61851 is a charger connector that is used for charging EVs under fast charging methods. Level 1 chargers are working at 120 V AC supply and does not require installation of additional charging equipment. Level 2 chargers are designed and manufactured according to SAE J1772 standard, and they can work with 3.3 kW to 6.6 kW power range. Fast chargers are designed and manufactured according to IEC 61851 standards, and they can work with 30 kW to 50 kW power range.

The limitations of non-renewable energy sources lead to the human to consider and evaluate more about renewable energy sources. Photovoltaic (PV) grid-connected systems are being used widely for EV charging. EVs can be charged domestically at workplace or in a public place and most EV users do more than 80% of their charging at home and it is a low expensive option rather than using the workplace and public charger [3]. The European project Mobile Energy Resources in Grids of Electricity (MERGE) examine the effect of residential EV battery charging on electricity demand of six European countries. Two EV charging regimes are considered: dumb charging (EV owners would plug-in their EVs as soon as they return home from the last daily trip) and smart charging (a valley filling approach is adopted) [4]. Based on the demand curve of a country a smart charging can be used to charge the EVs considering the time of use tariff in order to minimize the electricity cost of the consumer. This study provides the solution for smart energy management with optimum power consumption based on the renewable source availability with time, which manages

the low cost and less losses in the domestic charger by introducing a smart EV charging device. Further the device suggested will be IoT enabled device to operate in the optimum power management.

The smart EV charging device implemented has four main units namely Power system, Control system, Power management system, Inverter system as illustrated in Figure 1. The power system unit has two main input power inputs into the system, one from grid supply and another from renewable energy sources. A switched-mode power supply (SMPS) is used to carry out the switching mechanism. The function of the system is rectifying the 230 V supply into 12 V 10 A / 50Hz.

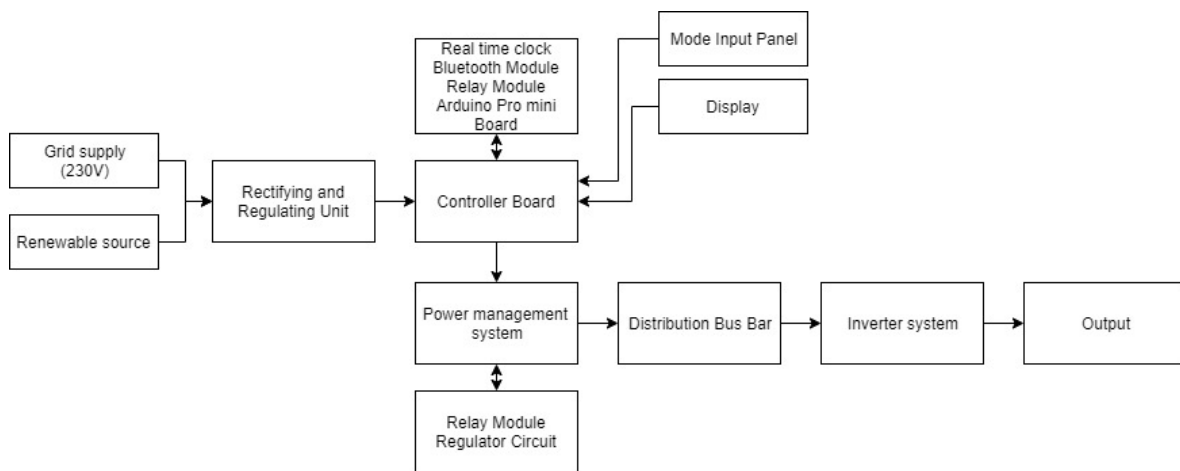


Figure 1. Block diagram of Smart Hybrid Domestic Charger

The generation voltage can be transferred to the intermediate battery bank or directly charges the EVs through an inverter circuit. The function of the control unit is to deliver all the operational signals to other units according to user requirements. The control board consists of Real-time clock modules, Bluetooth module, Relay module, Arduino pro-mini-board, and other necessary electronics components. Power management systems consist of a relay module, regulator circuit, and protection circuit. In the inverter circuit, DC power is connected to a transformer through the center tap of the primary winding.

The implemented smart EV charging device is shown in Figure 2.



Figure 2. Implementation of Smart Domestic Charger for EVs

Direct mode, Hybrid mode, and Off-peak mode are the three modes of operation in smart domestic charger systems. In hybrid mode, electric vehicles are being recharged by renewable energy and grid supply. In off-peak mode, based on the demand curve, a particular time can be used to charge the EVs. In direct mode, EVs can be charged battery at any time. The suggested smart EV charger will operate in all three above mentioned modes based on the availability of solar energy, tariffs of grid and solar energy and charging level of the EV. As the device will be IoT enabled, it has easy access to all the related yet important information regarding the charger displayed on the screen, stored in the cloud. Moreover, the data will be analyzed to achieve maximum energy management and less cost required for the charging.

Conflicts of Interest

The authors declare no conflicts of interest.

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