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Simulation of Electric vehicle charging Station Using Matlab

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Abstract—*In order to electric vehicle (EV) adoption , there is a strong need for designing and developing charging stations that can accommodate different customer classes, by their charging preferences, needs, and technologies. This paper focuses on an EV charging network equipped with different charging technologies. Such stations can answer the requirements to offer remarkable amounts of energy in similar time duration to the time that a vehicle that gets filled with petrol. Regarding to the charge demand and limitations of the technology, we have studied and offered optimized plan of fast charging stations. For this aim, storage system is hired in the optimal charging station to store the low price electrical energy during off-peak hours and uses this energy to recharge electric vehicles during on-peak hours. For various storage systems the cost per KWH to store electricity is calculated and then compared with each other. Based on this comparision, the optimal storage system is selected and then the optimal capacity for the storage system is determined. Design guidelines and modeling are explained in Matlab/Simulink. Simulations are performed in Matlab/Simulink to illustrate the behavior of the station.*

Keywords—EV-Electric Vehicle, KWH-Kilo Watt Hour, MATLAB-Matrix Laboratory.

I. INTRODUCTION

This paper deals with the design of a grid friendly ultrafast electric vehicle charging demonstrator. High charging power and short charging times impose peaks to an electricity distribution system, which necessitates over-dimensioning of the grid connection. A calculation methodology for energy storage elements is proposed and their interconnection possibilities to an ultrafast EV charging spot is discussed. To emphasize the situation, a comparision between a small fuel efficient family car and its electric counterpart is drawn in table 1.

II. TYPES OF CHARGER

1. Private Charger :- The home private chargers are generally used with 230V/15A single phase plug which can deliver a maximum of about 2.5KW of power. Thus, the vehicles can be charged only upto this rate

2. Public Charger :- For charging outside the home premises: the electric power needs to be billed and payment needs to be collected. Further, the charges may depend on state of grid.

III. CLASSIFICATION OF CHARGERS

Type of public charger can be classified as :

1. Bharat EV AC charger (BEVC-AC001)

2. Bharat EV DC charger (BEVC-DC001)

3.1 Bharat EV AC Charger (BEVC-AC001) :-

AC input to the vehicle which has on-board chargers is given by public metered AC outlet (PMAO). This charger is of 230V single phase AC supply with a maximum output of 15A and maximum power of 3.3KW. This type of charger are slow chargers and requires more time to charge battery.

Under AC charging there are two categories of charging.

a) Normal AC charging

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b) Fast AC charging

3.1.1 Normal AC charging :-

Electric 2-wheelers, 3-wheelers and 4-wheeler vehicles in India has on-board charger that charge at rate of around 2.5KW to 3KW. These AC 2.5KW or 3KW Chargers could fast charge a 2-wheeler (for a battery with an energy density of 2KWh) in an hour’s time; 4-wheeler or larger vehicles with batteries of 12 KWh or more will be charged in five to six hours.

3.1.2 Fast AC Charging :-

Global electric cars like the Nissan Leaf or the Tesla have on board chargers with higher power ratings. This enables AC charging at a faster rate, from 7.7 kw to 22 kw.

Different AC connectors used for charging purposes are shown below :-

3.1.2.1 Indian e-rikshaws connector :-

IEC 60309 Industrial Socket is used by the indian e-rikshaws. This is according to the Bharat EV standard.

Fig.1 Connector 1

3.1.2.2 Electric cars connector :-

IEC 62196 Type 2 connector used by Indian and Global EV's electric cars.

Fig. 2 Connector 2

3.1.2.3 E-Scooters connector :-

Simple 3 pin connector coupled with a 15 Amp plug used in Indian e-Scooters.

Fig.3 Connector 3

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3.2 Bharat EV DC charger (BEVC-DC001) :-

In this method of charging, DC current is sent to the electric car's battery directly via the DC charge port.Fast charging's faster charge rate (usually 50 kiloWatts or more outside India) can supply 100 or more km's of range per hour of charging. A significant fast charging network available should make electric cars more attractive than otherwise, and lead to higher adoption rates. As per Bharat DC Charging Specifications, Power rating of fast chargers are

- 10kW/15kW/30kW/50kW or even higher capacity.

Voltage rating at which fast charging has to be carried out

- 48V/72V for Indian electric cars like the Mahindra e2o Plus P8, Mahindra e-Verito and upcoming Tata electric cars
- Up to 750V or even higher used by global electric cars like Nissan Leaf and others.

Two types of DC chargers are as follows :-

a. Level 1 DC chargers

b. Level 2 DC chargers

a) Level 1 DC chargers :-

Public DC Chargers at output voltage of 48V / 72V, with power outputs of 10 kW / 15 kW with maximum current of up to 200A. As per the Bharat EV specs, these will be called Level 1 DC Chargers.

b) Level 2 DC Chargers :-

Public DC Chargers at output voltage up to 1000V, with power outputs of 30 kW / 150 kW. These will be called Level 2 DC Chargers.

- DC connectors used :-

i. Chademo :– Nissan and other Japanese companies like Mitsubishi

Fig.4 Connector 4

ii. SAE Combo Charging System (CCS) :– (BMW, GM, VW, and other carmakers)

Fig.5 Connector 5

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iii. GB/T connector :- BYD among other Chinese companies use this. Mahindra and Tata electric cars also use this standard.

Fig.6 Connector 6

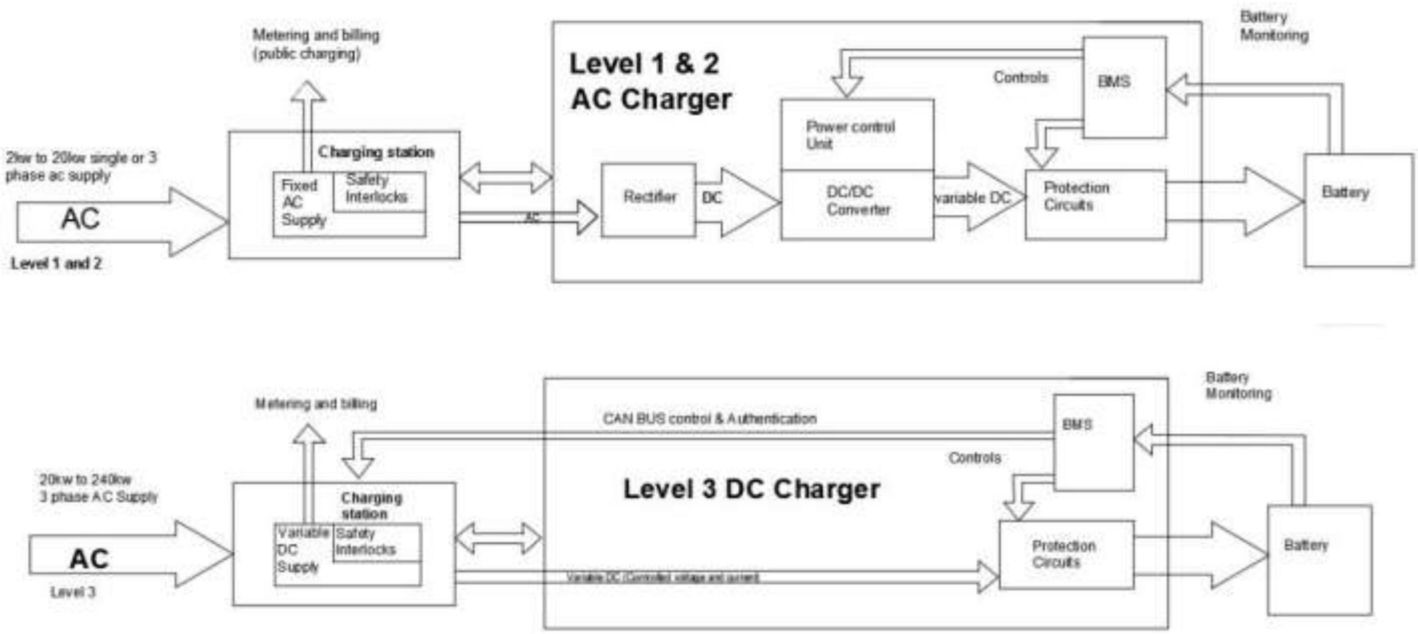

Fig.7 Block diagram of normal and fast charging

IV. CONCLUSION

This paper present's a fast charging station with a flywheel energy storage system. The storage system stores the low price electrical energy during off peak hours and uses this energy to recharge electric vehicles during the on peak hours, so it will be possible to shift the EV load from the peak to the valley periods. By modeling the problem as a multi stage stochastic programming a realistic representation of the problem is created where multiple uncertain scenarios are used with the goal to achieve reliable result in the control process than in the goal to achieve reliable results in the control process than the deterministic control representation. A fast DC charging station with dynamic load control is presented. The charging station is able to control the rate of charging of the PEV's while maintaining the PCC voltage. This feature is highly desirable when the charging station has high number of fast charging slots and is connected to a highly loaded or to a weak AC grid.

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