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Green Fuelling for the Electric Vehicles – A Simple and Cost-Effective Model

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ABSTRACT
The automobile industry in India has taken a major role in the growth of the Indian economy. In India, we find different modes of transportation either in the form of public transportation or in the form of private transportation. It has come to the conclusion that without the transportation service nothing can be done and if for some reason the transportation service is stopped then the life of Indians is unimaginable as well as the impact of the above problem is going to hit the entire nation. The major challenge in the automotive industry is the fuel that our country needs to import from others. The resource of the fuel is getting emptied day by day. Now it has come to a situation where we have to go for such an automobile industry which uses the alternative fuelling system. Today a lot of research work is going on electric vehicles and the Indian system is planning to switch over to the electric vehicles. This paper introduces a new model for charging electric two-wheelers using solar energy. The paper contains the different types of two-wheelers and their charging system is studied. After studying the charging system of the two-wheelers the common charging system for all those types is proposed. This solar charger is considered as a solar fuelling center where the two-wheeler gets the shelter during the sunny day as well as the battery system can be charged during the parking time.

Keywords: Sustainability, Electric vehicle, Solar charger, Vehicle parking

1. INTRODUCTION:
The Indian automobile industry is one of the major industries contributing to the Indian economy. Different types of automobiles are introduced in the market in order to cater to the needs of the customers. There are various segments in the automobile industries like two-wheelers for the city/local ride, three-wheelers for commercial use, cars, buses, different types of goods carriers, etc. catering to the needs of the customers [1]. Major segments of vehicles are two-wheelers and four-wheelers [2]. The reason for the above segment is two-wheelers are affordable so that almost everyone from the middle-class family is owning these vehicles. Even due to the

various financial assistance the four-wheelers started coming to every house. Thus, day by day the number of vehicles is increasing.

Due to a greater number of vehicles moving on the road there will be traffic jams as well as the pollution caused by these vehicles. The vehicles consume petrol or diesel and exhaust the most dangerous elements like CO, Nitrogen Oxide, hydrocarbons, etc. polluting the environment. As the number of vehicles increase, day by day the consumption of petrol or diesel also increases. The source of this fuel is very limited in such a way that one day the availability of the fuel may not be there [3]. Keeping all the negative aspects of the present vehicle in mind the R&D department has started working on electrical versions of two-wheelers, three-wheelers, four-wheelers and heavy vehicles [4]. The advantage of these vehicles includes zero noise pollution, zero environmental pollution, very less fuel (electricity) cost [5]. The key factor in the electrical vehicle is the DC motor as well as the battery backup which stores the energy. The amount of power storage and the amount of power consumption decides the mileage of the vehicle [6]. Another challenging factor is the speed of the vehicle. The electrical version of the vehicle has a limitation of the maximum speed as well as the distance covered per charge. The number of people that can be accommodated in the vehicle is also a limitation. Another major limitation is the time taken to recharge the battery backup. The battery takes a minimum of 6 to 8 hours for the complete charge [7]. All these drawbacks of the electric vehicle could not win in the market. Even due to the hike in the price made the customers not to buy the electrical vehicles.
Recently there is a revolution taken place in the battery backup. The new version of the battery backup is Lion (Lithium Ion) battery [8]. The lithium-ion battery has the following advantages [9].

- Fast recharging (80% charge in an hour)
- High energy density
- Eco-friendly
- Lightweight and compact
- Low Maintenance
- More charge cycles
- Low self-discharge rate.

The above-mentioned advantages make the Lithium-ion batteries more suitable to the electrical vehicles. Thus, by adopting the new battery backup the weight of the electric vehicle reduces as the major weight of the vehicle is the battery bank, speed is increased, less time for charging. By introducing Lithium-ion batteries, the new versions of electric vehicles are coming to the market with a fast-charging facility, long-distance travel and more accommodation inside the vehicle. The new battery technology has brought tremendous changes in the vehicle market and the government of India is showing more and more interest in the electrical version of the vehicle. The fuelling section for the electrical version is now the challenge for the electrical vehicles. The normal power range of electrical two-wheelers is nearly 1.5 KW and that of the four-wheeler is nearly 21.5 KW [10]. A separate charging point for the vehicles to charge the battery is required for either two-wheelers or four-wheelers. For two-

wheelers, a conventional charging point is sufficient whereas for the four-wheeler a separate heavy charging point with a separate line is required [11].

Solar energy for charging the two-wheeler can be an alternative solution. Solar charger for 1.5KW battery can be designed as alternative free energy for charging the two-wheeler as the charging rate of two-wheeler is less than that of the four-wheeler [12]. The solar charging system contains solar panel, charge controller and battery backup which stores solar energy so that solar energy can be used day and night also [13]. The challenging factor for setting up the solar energy is the cost of the solar panel, the efficiency of the solar panel, efficiency of the charge controller and the battery backup. Presently the rate of the solar panel is reducing day by day so that it is economical to set up the solar charging system. The challenge of improving efficiency can be done by cleaning the dust particle over the panel, improving the efficiency of the charge controller [14].

2. OBJECTIVES:

The objective of this paper is to propose a simple and cost-effective model of the solar fuelling system for an electric two-wheeler in the working environment wherein the two-wheeler gets a shelter as well as the fuelling point during the day time.

3. METHODOLOGY:

The methodology includes

- Study the electric two-wheeler vehicle
- Propose a fuelling point design using solar energy
- Analyse the performance of the proposed model.

3.1 Study the Electric two-wheeler:

For the design of the solar fuelling centre, the performance of the electric two-wheeler is studied. Here the Hero Electric scooter is taken as a sample as this company's electric scooters have already entered the market.

The Hero electric has different versions of ER series, E2 series, E5 series which are operating either at 48V or at 72V. The vehicles use Lithium-Ion batteries inside. The current rating of the batteries is as shown in table 1.

Table 1: Different versions of the Hero electric vehicle with specifications

Sl. No.	Version	Battery capacity	Motor Power	Charging time (full)	Mileage	Maximum speed
1.	Optima ER	48V/28AH X 2	550W/1200W BLDC Hub Motor	4-5 Hrs	110KM/charge	42KM/H
2.	Nyx ER	48V/28AH X 2	600W/1300W BLDC Hub Motor	4-5 Hrs	100KM/charge	42KM/H
3.	Optima LA	48V/28AH	250W BLDC Hub Motor	8 Hrs	50KM/charge	25KM/H
4.	Nyx E2	48V/28AH	250W BLDC Hub Motor	4-5 Hrs	50KM/charge	25KM/H
5.	Optima E5	48V/28AH	600W/1200W BLDC Hub Motor	4 Hrs	55KM/charge	40KM/H
6.	Nyx E5	48V/28AH	600W/1200W	4 Hrs	50KM/charge	40KM/H

			BLDC Hub Motor			
7.	Photon	72V/28AH	1000W/1500W BLDC Hub Motor	4-5 Hrs	80-110KM/charge	45KM/H

The chargers for the above electric two-wheelers are of two types one with the following specifications

- Output Voltage 48V with 2.7A. The charging power requirement is 130W
- Output Voltage 72V with 2.7A. The charging power requirement is 200W

3.2 The Proposed Model:

The model contains a small rooftop as a shelter for the two-wheeler having a solar panel at the top of the roof facing the sun, a charge controller and a small inverter that converts the input DC into 240V ac. The diagrammatic representation of the model is as shown in figure 1.

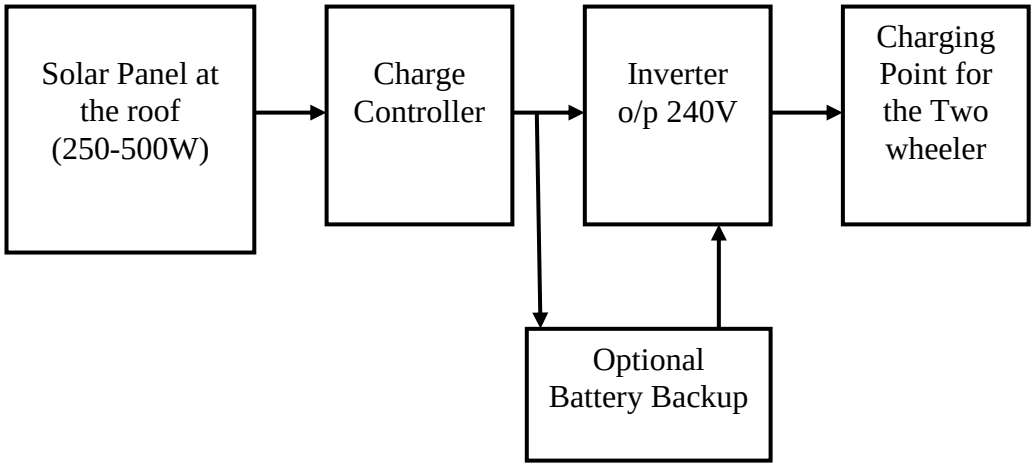

Figure 1: Proposed Solar Electric Two wheeler Charging station

3.3 Description of the Model:

The model uses a solar panel at the top of the shelter. The power capacity depends on the wattage of the panel. From the above two types of chargers, it is very clear that the maximum power of the panel required is not more than 500 W. The panel depending on the sunlight gives the output voltage ranging from 2V to 31.14V with the current ranging to 17A. The power ranges from 0W to a maximum of 408W. The daily solar power production will be shown in the following table 2.

Table 2: Daily solar power production of 250W/500W Solar Panel

Sl. No	Panel	Max. Current	Max. Power	Duration	Daily Power Production
1.	250W	8.5A	204W	4Hrs	816W
2.	500W	17A	408W	4Hrs	1632W

The charger needs an instantaneous power of either 130W or 200W in peak hours i.e. 9 AM to 3 PM. The need for the two-wheeler charger is fulfilled by the solar panel. The charge controller is used to balance the incoming variations in DC.

The output of the charge controller is given to an inverter. An optional battery backup can be installed. This battery will store the energy whenever there is no two-wheeler getting charged. Without the battery backup also, the unit works fine. The total cost of the solar fuelling unit is shown in table 3.

Table 3: Cost Table

Sl. No	Unit	Price
1.	Solar Panel (500W)	Rs. 15000
2.	Charge Controller	Rs. 2000
3.	Inverter	Rs. 2500
4.	Optional Battery	Rs 12000
4.	Aluminum roof	Rs. 5000
Total		Rs 36500 with Battery Backup Rs 24500 without battery Backup

Thus, a Solar fuelling system for electric two-wheelers can be designed within Rs. 25000.

4. ANALYSIS:

The battery capacity of the two-wheeler is 48V with 1.344 KW or 72V with 2.01KW which runs a distance of 50KM to 110Kms. A two-wheeler which is moving inside the city may cover a distance of 20KM to 40KM a day. So, a single solar fuelling unit can charge a minimum of 3 to 4 vehicles in a day. Depending on the distance covered and the amount of charge required this count may increase. This model absolutely a free energy model where solar energy can be converted into electrical energy and run a vehicle.

4.1 Advantages:

(1) Only Initial investment is required and then the fuel is absolutely free for the vehicle.
(2) If the vehicle is charged daily then more than 4 vehicles can be refuelled per day from a single fuelling unit.
(3) The recharging unit provides a shelter which can be used for various purposes.
(4) Suitable for parking places in the office.

4.2 Benefits :

(1) Pollution-free green fuel
(2) Zero Noise vehicle
(3) No environmental degradation
(4) The low average cost for long term

4.3 Constraints :

(1) Seasonal Constraint due to irregular solar energy. This above model is not useful during the rainy season as the availability of the sunlight is not as per the requirement.
(2) Educating people to adopt this technology

4.4 Disadvantages :

(1) Cost of the battery for the vehicle which reduces the commercial set up. If the cost of the battery is reasonable commercially, we can charge hundreds of batteries and when a vehicle comes for the refuelling just remove the empty battery and fix the completely charged battery which is practically not possible. This is actually the requirement of the customers as they need not wait for the complete recharge.
(2) Regular Maintenance of the solar panel

5. CONCLUSION:

The model is suitable for electrical two-wheelers and can be extended for the four-wheelers by adding more solar panels. The cost for the four-wheelers solar fuelling unit will be too high instead one can use the conventional electrical supply for charging the solar battery. The model can fuel 3 to 4 two-wheelers in a day. This simple, low-cost model can be adopted in the offices where the employees charge their electric two-wheelers during their office hours. The parking roof can be covered with the series of solar panels and using proper inverter systems many charging points can be fixed so that the two-wheelers can fuel their vehicles with green energy.

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