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Emission, Mitigation and Estimation through Solar Based Ev Charging Station

Mohit Bansal, Kailash Sharma

Abstract ***The paper investigates how we can utilize the renewable source of energy (i.e. solar energy) to charge an EV. Transportation plays a vital role in day to day life. In India, pollution is increasing day by day. Carbon footprints for India are alarming and it can only be reduced with use of renewable energy uses. India's more than 3/4th of fuel consumption is met by imports from other countries. To boost EVs in Indian market, Solar charging is best method for charging because of two reasons, first no carbon footprints and other is no dependency on grid for power meet. Increasing charging station will be the foremost need of an EV user and it can be employed at various places like- offices, malls hospitals etc. This paper presents an idea about how can solar energy can be used for charging an EV and also gives a comparison chart for EV user and Non-EV user. In addition, a survey was conducted to provide people's opinion on solar EV charging station. Vehicle to Grid (V2G) method will show power can be supplied to grid from a charged EV. At last its advantages for environment and society are concluded.***

Keywords: Solar Energy, Charging station, Carbon footprints, EV.

I. INTRODUCTION

India's economic condition is changing drastically, as the government is taking so much efforts in making the electric mobility more affordable and economical. The fourth largest automobile market of the world need some changes in automotive market. India have been strongly dependent on conventional vehicle for so long and the climatic condition for India is also changing drastically. The national capital is not even safe for fresh breathing and the population density is on peak. The carbon emission of India is also increasing day by day, and these days people are suffering from various breathing problems. Out of 20 most polluted cities in the world 15 cities are of India, Gurugram and Ghaziabad being on the top of the list. The most favorable alternative for this replacement of conventional vehicles with electric vehicles. The 2nd most populated country in the world is India and it is expected to cross China by the end of year 2030. India first electric vehicle is Mahindra's Riva (e2o), India is expanding its electric market as more business investor are contributing to market growth.

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***** Correspondence Author
Dr. Mohit Bansal*, Electrical & Electronics department, GL Bajaj Institute of Technology & Management, Gr. Noida, India E-mail: moh.bansal@gmail.com
Kailash Sharma, Electrical & Electronics department, GL Bajaj Institute of Technology & Management, Gr. Noida, India E-mail: Kailash.sunshine@gmail.com

1.1 Carbon emission comparison

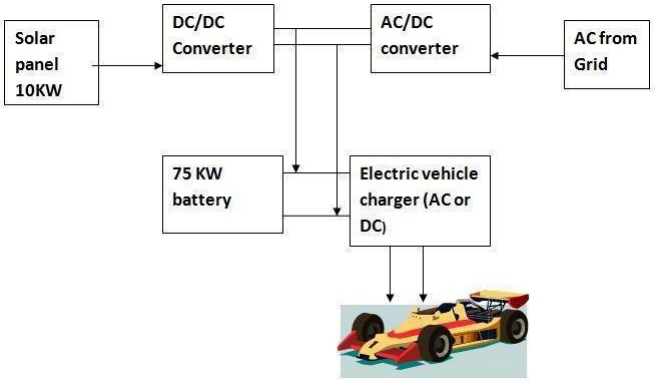
Let's assume a vehicle runs annually 10000 km and according to its mileage on different fuels [1]. Total number of liters of fuel required to travel the same distance is calculated and then CO_2 emission rate is multiplied by the number of liters. Hence total number of kgs of CO_2 production is given in the Table 1. It is imperative from the data that there is almost negligible carbon emissions due to E-Vehicles.

Table. 1 carbon emission from different fuels

Fuel type	Petrol	Diesel	Electricity
Energy req.	500 Ltr	357 Ltr	793kwh
Co2 emission	2347g/ L	2667g/L	660.6g/kwh
Annual Rate (CO2)	1173.5 kg	952 kg	52.38 kg

II. SOLAR EV CHARGING STATION

The demand for EV is increasing day by day as the fuel (petrol, diesel) cost is increasing. India is importing more than 3/4th of its fuel requirements from other countries. As we know that solar energy abundance in nature is not limited, around 430 quintillion (430*10^18) joules of energy reach the upper atmosphere. Almost 30 percent of it reflect back and only 70 percent enter into the atmosphere. China has largest consumption of solar, it has largest generating capacity of 130 gigawatts. India has been ranked 5th in solar harvesting in the world with power of 28.28 GW in march 2019.The power generation for charging is possible in infrastructure like offices, malls, hospitals etc [2].



[1, Fig. 1]: Block diagram representation

A generation model for the charging infrastructure is shown in Fig. 2, here a storage battery of 75kW is used and the model is grid connected. The primary source of power for charging is PV generation and backup supply is taken from grid. There are basically three types of charger available in the market like level 1(residential), level 2 (commercial), level 3 (DC fast charging).

III. DESIGN MODEL OF CHARGING STATION

1.2 Solar irradiance

Power generation of PV module does not only depend upon the sunlight's radiation, it's also depends upon angle between solar panel and Sunrays. Maximum generation will occur only when sun rays is perpendicular to surface of solar panel and Maximum density of light on the surface is equal to that sunlight. If the angle between a fixed surface of PV module and the sun is continually changing, the power density on a fixed PV Module is less than that of the incident sunlight. The total amount of solar radiation is incident on surface of PV module which is perpendicular to the module surface [4].

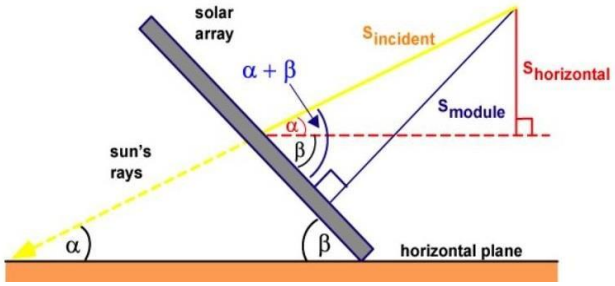


Fig. 2: Block diagram representation

As per fig. 2, the incident radiation on a tilted surface (S_{module}) is given by the solar radiation measured on the horizontal surface ($S_{horizontal}$) or radiation of sun measured in the perpendicular to the sun ($S_{incident}$). The equation relating S_{module}, $S_{horizontal}$ and $S_{incident}$ are:

$$S_{horizontal} = S_{incident} \sin\alpha \qquad (1)$$

$$S_{module} = S_{incident} \sin(\alpha+\beta) \qquad (2)$$

where α is the angle of elevation, β is the tilted angle of the module measured from the horizontal surface. The angle of elevation has been given as:

$$\alpha = (90 - \emptyset + \delta) \qquad (3)$$

Where $\emptyset$ is the latitude and δ is the angle of declination is given as:

$$\delta = 23.45^\circ \sin\left[\frac{360}{365}(284 + d)\right] \qquad (4)$$

Where **d** is the per day of the year

From the above equations, we get the relationship between S_{module} and $S_{horizontal}$ can be determined as:

$$S_{module} = \frac{S_{horizontal} * \sin(\alpha+\beta)}{\sin\alpha}$$

1.3 Production at various tilt angle

Since the sun is kept moving and earth surface seems to be stationary with respect to sun, then there are two method of tracking the sun rays. Tilted position PV module and Dual axis tracker PV module, both have some advantages but dual axis tracker of PV module is too costly. A simulation of both method of power generation in a day is done and the results are plotted in the graph as shown in Fig. 3.

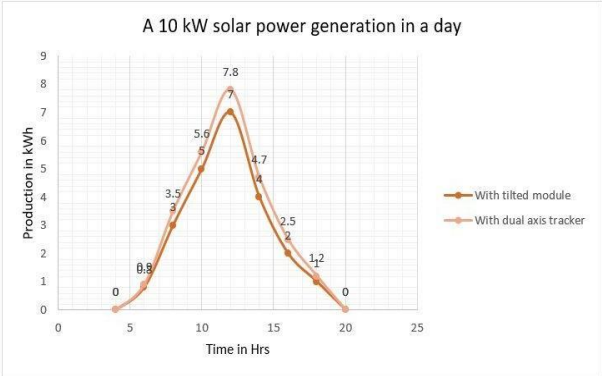


Fig.3 Solar generation in kwh in a day

The graph indicates the generation from these two methods of tracking sunrays. Dual axis tracker generation is slightly higher than tilted tracking of PV module.

IV. TYPES OF CHARGER

There are three types of charger, such as level 1, level 2, level 3. These chargers are of different rating and power capacity, the time consumption for charging an EV always depends on the power level of charger. The third level charger is DC fast charger and it can fully charge an EV in 30-40 minutes [6]. All the power including current and voltage rating of chargers are given in the Table 2. The different charging connectors are shown in Fig. 4.

Table. 2: Various types of EV charger

Types	Power supply	Charger power	Charging time Approx.
Level 1 Residential AC chargers	120/230V AC and 12A to 16A (single phase)	1.44kW to 1.92kW	12Hours
Level 2 Commercial AC Chargers	208/240V AC and 15A to 80A (single/split phase)	3.1kW to 19.2kW	6-7 Hours
Level 3 DC Fast chargers	300-600V DC And max. current 400A (poly phase)	120kW to 240kW	30-40 minutes

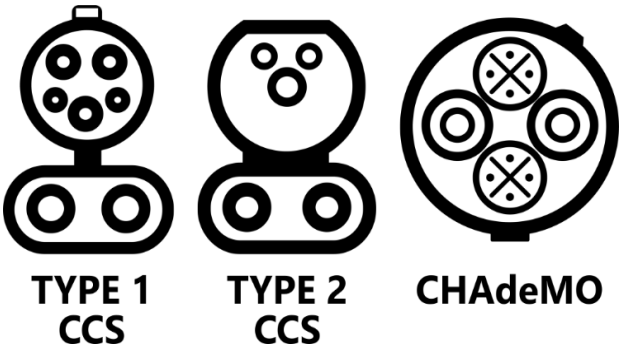


Fig. 4 Charger connectors in different level of charging

V. PERFORMANCE AND ENVIRONMENTAL EFFECT

The total cost estimation for the project is around 10 lakhs it includes all the three level chargers, panels and other required equipment. Financial breakdown is shown in the figure 5 that also includes the cost of depreciation and maintenance. The total cost estimation for the project is around 10 lakhs that includes all the three level chargers, panels and other required equipment.[5]

The system will be produced cost of charging approx. Rs 3/kWh means total saving of Rs 6/unit. It can also be used as business model, as it takes only high initial cost but depreciation and maintenance cost are low. We can save up to 90 percent of carbon emission with the employment of solar powered EV charging station. Reducing carbon footprint will make the environment and society comfortable and all the living organism can survive. The PV panels are set up on the rooftop of the buildings, we are considering a 10 kW PV panel which can generate approximately 45-50 units of electricity daily.

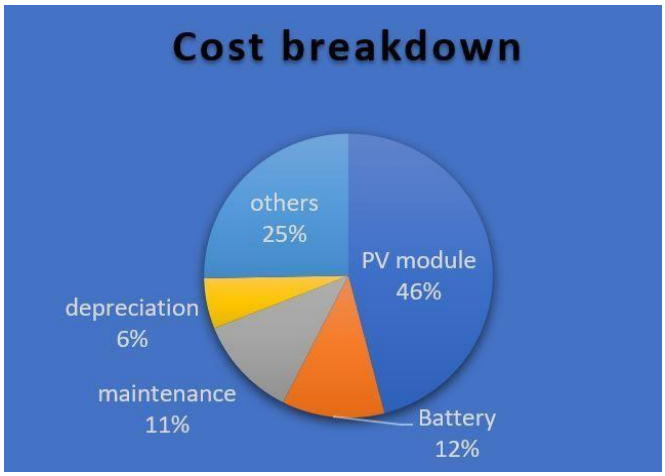


Figure. 5 Cost break-down of the system

VI. CONCLUSION

It is concluded from our review that the solar based charging stations shall increase in the near future. At that point there will be decline in vitality request from the framework. At last the carbon discharge will diminish and contamination will be less. The vitality hole among request and supply of power will be decreased and day by day utilization of power will be given to everybody. As India is developing, so that it will help in development of the economic growth, as number of charging station will be installed than the interest for purchasing EV will increased and also the increment of the assembling units. It will make a more prominent number of openings for work and reinforce the economy.

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AUTHORS PROFILE

Dr. Mohit Bansal is currently working as Professor and Head of Department of Electrical & Electronics Engineering at G.L. Bajaj Institute of Technology & Management, Greater Noida. He completed his Ph.D. in the area of renewable energy systems from Indian Institute of Technology Roorkee in 2015. Earlier, He did his Masters in Energy and Environmental Management from Indian Institute of Technology Delhi in 2008. He completed his graduation in Electrical Engineering from Aligarh Muslim University, Aligarh in 2002. He has around 20 research papers in various international/national journals/ conferences of repute. He is a Member of IEEE, Life Member of Institution of Engineers India, Life Member of Indian Society of Technical Education and Life Member of Solar Energy Society of India. His research interests include Renewable Energy Systems, Hybrid Systems and Distributed Generation.

Kailash Sharma is an Assistant Professor in the department of Electrical & Electronics Engineering at GL Bajaj Institute of Technology & Management, Greater Noida, UP, India. He received his B.E. degree in Instrumentation and Control Engineering from Rajasthan University, Jaipur in 2007 and M. Tech degree in Electronics and communication Engineering from Manav Bharti University, Solan, H.P. in 2012.His research interest includes Electrical and Electronics instrumentation and control Engineering. He has contributed 07 Research papers in Reputed International Journals and 06 Research papers in International Conferences proceedings.