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Economics

DATA-DRIVEN ESTIMATION OF THE SUSTAINABILITY OF ELECTRIC VEHICLES IN INDIA

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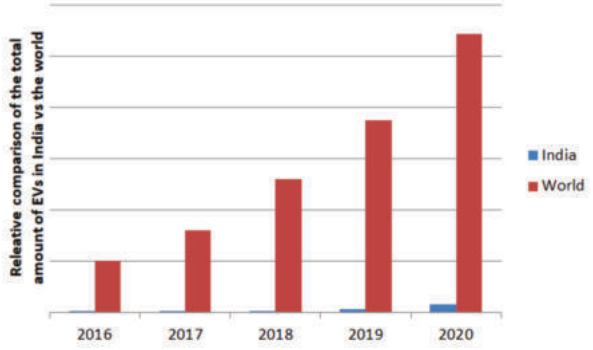
ABSTRACT India, a rapidly developing economy, has started to see the advantages of electric vehicles over traditional gasoline cars. The government has optimistic future plans on being more 'EV-centric' and less dependent on fuel powered vehicles. To do so, it is important to determine whether India will be able to sustain an electric vehicle infrastructure large enough to effectively support its population. This paper considers factors such as carbon emissions and energy use to determine the requirements for an effective rollout of electric vehicles in India.

KEYWORDS :

Growth Of Global And Indian Markets For EVS

The number of electric vehicles across the globe is growing exponentially. Starting with developed economies like the U.S and Germany, the concept of electric vehicles has been employed by other countries as well, resulting in the total number of EVs to grow by approximately 450 percent in the last five years. Tempted by advantages like lower fuel emissions and decreased noise pollution, India is among several other countries with an objective of having a large EV fleet in the coming decade. Although the number of electric automobiles in India has risen by over 1200 percent since 2015 - with a record 45 percent increase in fiscal year 19-20 itself - India currently holds only 1 percent of the global market penetration of electric vehicles.



The bar chart compares the total number of electric vehicles in India and the World from 2016 to 2020. It can be reasonably inferred that there will continue to be significant growth in the EV industry in India as well as in the global markets. [1][2][3][4]

The Indian Government aims to be 30 percent electric by 2030. Reports by the Indian Energy Storage Alliance (IESA) predict that in seven years' time, India would sell more than six hundred thousand electric vehicles yearly, implying drastically growing demand for electric vehicles in the near future.

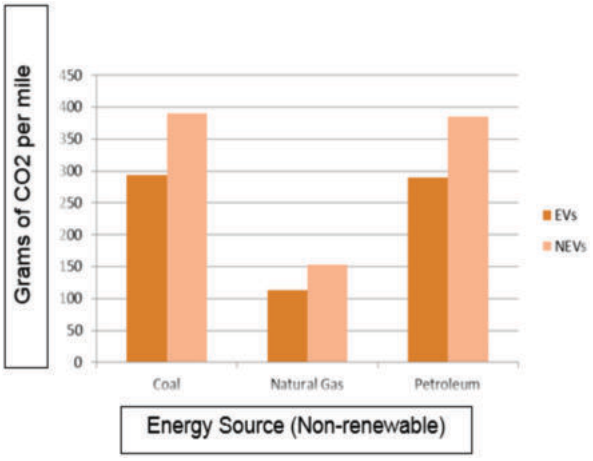
Charging Infrastructure

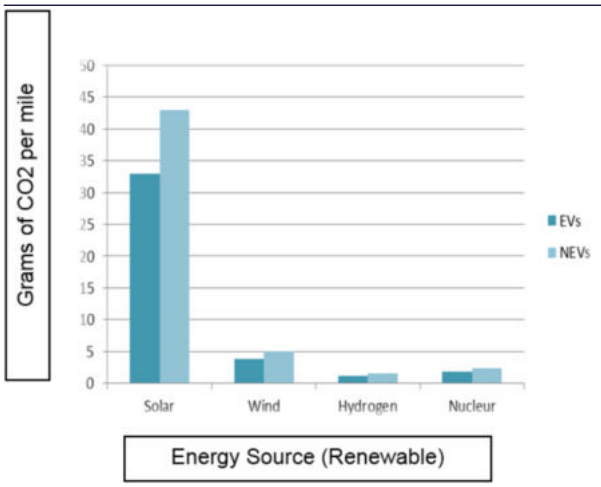
A major drawback of electric vehicles is to build an effective network of charging stations. Building charging stations that offer fast charging, and are easy to locate is vital to electric vehicle owners. This is hard to do in a densely populated country like India, because large charging locations would be hard to set up in accessible locations. The Society of Manufacturers of Electric Vehicles (SMEV) claims that there are 1800 charging stations across India as of March 2021. Union Minister Nitin Gadkari stated that the government intends to have approximately 70 thousand charging stations very soon. These kiosks will be located inside already existing petrol pumps and therefore eliminating the need to build charging stations separately for electric vehicles; a cost effective way of introducing a charging infrastructure for EVs in India. Taking into consideration the projected growth and demand of electric vehicles in India, an article by Grant Thornton Bharat-Ficci says that there would have to be 400000 charging stations across the country by 2026. To analyze the necessary requirements for charging electric vehicles, it is important to consider which source of energy should be used to provide electricity for electric vehicles. In this case, solar energy is the most effective due to its high abundance and easy maintenance when compared to other energy sources like wind or hydrogen. Charging stations would need a combination of both AC (slow charging) and DC (fast charging) kiosks to better utilize solar energy. On average, AC and DC would together be able to provide 50-60 kW of electricity in five sun hours. So per day, around 2-4 electric vehicles would be able to charge themselves for 50 – 100 miles (depending on DC or AC) per charging system. A charging station contains several of these charging systems. Approximately 100 gasoline cars visit one petrol pump a day. For electric vehicles, the number would be much lower because the process is longer (around 10 – 40 depending on the region) so at least 10 charging systems in every charging station. The number of charging systems required would be much greater if the location of the charging station is in a relatively busier area. To that end, different regions may also require different types of charging stations; essentially, there are two types of charging stations: Off- Grid and On- Grid. [5]

Off-grid is not connected to the main electrical utility grid, and therefore can be used independently in rural areas as well. Since it is independent of the main grid, even if the grid is down the off-grid station can continue to supply electricity. This added benefit comes with the cost of more expensive equipment and restricted access to electricity - in India, policies related to off-grid charging are still developing. On the other hand, on-grid charging provides sufficient access to electricity and is also cost-effective and easy to install. Even if the main grid malfunctions, electricity supply can remain unchanged through the use of backup batteries. Since India is still in the primary stages of the launch of electric vehicles, setting up off-grid charging stations to satisfy rural demand is unnecessary; hence, a majority of on-grid charging infrastructure would be more suitable. [6][7]

CO2 emissions

On average, a gasoline vehicle needs 0.4kWh of energy per mile, compared to the 0.3 kWh for electric vehicles.





The two graphs compare the amount of CO2 given out (in grams) for every mile an electric vehicle and a non-electric vehicle need to travel. The first diagram compares non-renewable sources and the second, renewable. [8][9][10]

In 2020, the total CO2 emissions by non-electric vehicles in India were approximately 1.50 gigatons. This shows the urgency of having more electric cars and also more sustainable energy sources like solar power. The graphs show the huge difference in carbon dioxide produced not just between electric vehicles and gasoline cars, but also between traditional energy sources like coal and more sustainable energy sources like wind and hydrogen.

CONCLUSION

According to the government of India's Energy Efficiency Services Limited, there would need to be 8 million public charging stations for approximately 80 million electric vehicles. This estimation considers both DC and AC type chargers. As of 2020, total electric vehicles in India are roughly 20 million. For an average of five sun hours per day, solar charging would generate 15 kW of DC power and 100kW of AC power. Taking a lower bound average, a reasonable assumption would be that a solar energy powered charging station can generate 50kW everyday using a combination of AC and DC.

Average Supply =((AC + DC))/2 = (15+100)/2 = 57.5 (Lower bound = 50)

As per DataLabs by Inc42, to sustain 1 million electric vehicles (with average battery size being 30 kWh), India would need 15 million kWh of electricity per day and 2 million charging stations.

=> Since the ratio of electric vehicles to electricity needed is 1 million: 15 million kWh

=> 80 million = 1200000MWh

=> Since we are taking an average of 5 sun hours, total power = 1200000/5=240000MW

=> 1 Charging station gives an average of 57.5 kW

=> 1 MW is 1000 kW therefore 240000MW = 2.4 x 108 kW

=> Total number of charging stations = (Total Energy needed)/(Energy per charging station) = 2.4 x 108 / 50 = 4.8 million charging stations. This number would be lower as we take into account the fact that all electric vehicles will be in major metropolitans and hence, in the same areas, so one charging station would be able to supply electricity to much more electric vehicles. Hence, the prediction of 2 million charging stations is reasonably accurate. [11]

To meet the long term consumer demand of 80 million EVs, India would need to supply at least 50 - 60 million charging stations. Another factor to consider here is efficiency. State-owned charging stations run at 50% efficiency which would result in traffic congestion and hence, a need for a bigger charging network. The two primary solutions to this are either increasing government spending or privatizing the supply of charging stations. Nevertheless, India is unlikely to meet its goal of having a third of the transportation market to be electric due to the small number of charging stations compared to the considerable number of consumers in the country. Major changes in policies regarding government spending, renewable energy uses, privatization, and electric vehicle restrictions would need to be implemented to ensure a faster and successful introduction of charging stations which can meet the exponentially growing consumer market.

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