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Social, Economic and Environmental Impact of Electric Vehicles in India

REVIEW PAPER

ABSTRACT

This study gives a general overview of the social, economic, and environmental impacts of electric vehicles (EVs) in India. The growing threats of global warming, excessive petrol dependence, ever increasing prices of fuel, and driving trends are just a selection of reasons which have accelerated the development of EV since the transport sector also represents a critical percentage of greenhouse gas emission. The aim of this study is to compare and analyze the development of the EV market and the government support in making the trend and accelerating it to save the nation and the world from pollution in India. Electric vehicles have huge potential from a user perspective. In the coming years, EVs will have a very important role in smart transportation and smart cities, along with shared mobility, mass transport, etc. Therefore, more efforts to facilitate the charging process and to improve batteries are needed. In a thrust towards incentivizing new age technologies and reducing its carbon emissions to net-zero by the year 2070, India is aggressively promoting the adoption of EVs. India aims to switch 30% of private cars, 70% of commercial vehicles, and 80%of two and three-wheelers to EVs by the year 2030. Increase percentage of renewable energy in the electricity mix and prevent air pollution caused from battery manufacturing. The recommended policies can be accepted by any market globally for reducing air pollution through increased adoption of electric vehicles. The environmental considerations of electric mobility challenges exist in terms of environmental impacts generated by the rising demand for electric vehicles.

Keywords: *electric vehicle; charging Infrastructure; rechargeable battery; Smart Grid; IC engine*

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INTRODUCTION

Electric vehicles (EVs) are growing in popularity in India, and they are cleaner and more efficient (*Sivakumar et al 2018*). The market growth, however, is still considered a problem: end users consider several factors such as costs of purchasing and operating as well as performance, but there is also a need for government and policy inputs. EVs operate within a broader energy and transportation ecosystem. Unless we understand the Indian-use cases, limitations, and opportunities, we risk ambitious targets that remain aspirational. Even at today's low oil prices, running a diesel sedan can cost about Indian Rupee (Rs) 3.8 km^{-1} versus Rs 5.5 for petrol. The cost of for EVs depends on electricity price, which varies significantly. At Rs 7 kWh^{-1} of power, they cost only about Rs 1.1 km^{-1}.

EVs are expensive, primarily because of the battery. However a drop in EV battery prices can become a game changer. Without fast-charging infrastructure, fast-charging an EV requires more power compared to household's 15 A sockets, which can only offer about 3 kW of power. Thus 35 kWh will take almost 12 hours to charge, which inevitably has "range anxiety". Hence, widespread and company-agnostic public charging infrastructures become a key policy choice (*EY Global 2016*).

The power grid is also a key stakeholder in the EVs ecosystem. The worst-case scenario is consumers coming home after work and plugging in at the same time, which is the grid's demand peak. One solution is a variable rate for electricity bill for consumers attempting to charge EVs based on time of day, but this is not the norm for most users in India particularly in the household. Otherwise, commercial users attempting to charge EVs on subsidized residential power prices (*Tongia 2017*). There are other ways like including dedicated charging spots and discounted or

free parking. The long-run goal just to make vehicles electric but to reduce personal driving (*Tongia 2017*).

Impacts

Our roadways, which are under threat from extremely high levels of pollution, require a vehicular revolution. With the advances in electric vehicle technology, there is a chance for India to leapfrog into an age of clean and efficient mobility. The leading EV manufacturers like Tesla Inc.,Toyota Motor Corp and Nissan have expressed their interest in the Indian market. The Suzuki Motor Corp., the parent of India's largest car maker Maruti Suzuki India Ltd, formed a joint venture with two Japanese firms, Denso Corp. and Toshiba Corp., to produce lithium-ion batteries for EVs in India. This came after the introduction of the FAME "Faster Adoption and Manufacturing of Hybrid and Electric Vehicles" program of the government in 2015 to promote hybrid and electric vehicles (*Ganesh 2016*). The transport ministry looks into renting electric cars for its officials and pushes for the same for public transportation.

Vehicle emissions can be divided into two general categories: air pollutants, which contribute to smog, haze, and health problems; and greenhouse gases (GHGs), such as carbon dioxide and methane. Conventional vehicles with an internal combustion engine (ICE) produce direct emissions through the tailpipe, as well as through evaporation from the vehicle's fuel system and during the fueling process. Conversely, all-electric vehicles produce zero direct emissions. Plug-in hybrid and electric vehicles (PHEVs) produce zero tailpipe emissions when they are in all-electric mode, but they can produce evaporative emissions.

When using the ICE, PHEVs also produce tailpipe emissions. However, their direct emissions are typically lower than those of comparable conventional vehicles. Well-to-wheel emissions include all emissions related to fuel production, processing, distribution, and use. In the case of gasoline, emissions are produced while extracting petroleum from the earth, refining, distributing the fuel to stations, and burning it in vehicles. In the case of electricity, most electric power plants produce emissions, and there are additional emissions associated with the extraction, processing, and distribution of the primary energy sources they use for electricity production.

Challenges

In 2013, the Department of Heavy Industries (DHI) of India launched the National Electric Mobility Mission Plan (NEMPP) 2020. This envisions to sell six to seven million electric and hybrid vehicles by 2020 to reduce India's dependency on crude oil imports and to reduce carbon emissions. The recent crisis of air pollution across Indian cities is well documented. A World Bank study noted that air pollution cost India nearly 8.5% of its GDP in 2013. The initiative to switch completely to an electric vehicle will obviously face many social and political challenges. All climate actions that require disruptive socio-technical transitions will face hurdles. The expected resistance will come from established industries and institutions. The good news for India's transition to all-electric vehicles is that charging stations have already popped up in states such as Karnataka and Maharashtra due to their early adoption of electric vehicles for government fleets. The cost of batteries and battery charges have seen a significant global reduction while charging speeds as well as battery quality have gone up (*Ganesh 2016*). Companies like Tesla are already salivating at the idea of capturing the Indian electric car market share. While most of the socio-technical transition plans focus on policies and incentives to drive adoption and innovation towards the new technologies, much less attention is paid towards strategies to dismantle the old technologies. The so-called 'creative destruction' to destabilize the old structures is as critical as the innovation and adoption of the new (*Murtugudde 2017*).

For example, manufacturing and marketing, labor, education/training and research and development that support petrol and diesel vehicles cannot simply be wished away by 2030 (*Dhawan et al. 2017; Sivakumar et al. 2018*). Simultaneously driving the innovation for manufacturing, training a new workforce, or retraining much of the existing workforce, mental models to drive large-scale adoption of electric vehicles as well as the infrastructure for electricity production, charging stations, smarter grids, and better and cheaper batteries as well as their recycling. The planned transition to electric vehicles may offer a golden opportunity for local and state governments with policies and subsidies to transition out of using petrol and diesel vehicles (*Murtugudde 2017*).

For example, diesel vehicles are now the main mode of food transportation including grains. This means that the transition to electric vehicles ensures that food prices are not affected adversely, especially for the poor.

The Government of India is working on a policy which aims for the state buses to be converted into EV with aid from private investment. The India Energy Storage Alliance (IESA) analyzes the traffic patterns and identifies cities and routes that are most suited for

introduction of electric buses in India. There is also a need to scale up the rollout target by launching 10-25 vehicle pilots. The cost of the electric buses can be brought down immediately rather than waiting for the cost of storage to drop. The government is currently considering an option of battery swapping along with the installations of new charging stations to address the lack of charging infrastructure.

Currently, batteries nearly at 50% is the largest component in the cost of an electric vehicle. But the cost has been rapidly declining with advances in technology. With India's passenger car ownership expected to grow manifold over the next 15 years, this is the moment to change the trajectory of how these vehicles will be powered.

Batteries are identified as a problem material in the waste stream. Batteries are made from a variety of chemicals to power their reactions. Some of these chemicals, such as nickel and cadmium, are extremely toxic and can cause damage to humans and the environment. Both disposable and rechargeable batteries are classed as hazardous waste; they are placed in steel drums encased in concrete within secure landfills so that air and water can't corrode the battery casings.

Renewable energy advances and its large-scale adoption can combine with novel battery technologies, smart grid, increased electric vehicle demand with supportive policies and subsidies, as well new business models may work as a game-changer for the transition to electric vehicles. Thus, India need not rely simply on bans and regulations to enforce the transition to electric vehicles. It can adopt a strategic mix of policies, incentives, regulations, and subsidies to drive a smooth and equitable transition. Investments in science and technology education will also need to drive innovations and entrepreneurship to support such transitions, as well as train a globally aware workforce. This workforce will continue to exploit the green markets as well as it has cashed in on IT and other outsourcing. The switch to electric vehicles can thus be a golden opportunity (*Murtugudde 2017*).

Union Minister of Road Transport and Highways, Nitin Gadkari, put the automotive industry on notice through some tough talk recently about Centre's target to achieve 100% e-mobility by 2030 (*Dhawan et al. 2017; Vidhi and Shrivastava 2018*). Instead, focus should be given to the intent behind his statements and to this government's seriousness to promote battery electric vehicles (BEVs) in the long term. BEVs constituted less than 0.1% of all cars in use globally at the end of 2016 (*Walawalkar et al. 2017*). By this measure, expectation hugely outweighs achievement so far. However, there is no denying that this sector continues to receive significant investment globally and looks like becoming the default technology for future zero emissions per Company Social mobility.

Discussions about the dawn of the electric car age should bear the above figure in mind, as well as the one billion IC cars in use. Hence, for policymakers in India to completely discount the importance of IC engines, would be a step in the wrong direction. Going full electric for its huge fleet of vehicles in a little over a decade for a country as economically diverse as India would be an enormous task, no matter what the Government's intentions or the industry's willingness. No doubt, the challenges for India to achieve its BEV target have been widely discussed. Even so, it is important to point these out again.

Bigger Challenges

One of the biggest challenges for electric vehicles is price and this becomes a more imperative concern for India. The purchase cost of any BEV will have to be comparable or only slightly higher than an IC powered vehicle for the highly price-conscious Indian buyer. The battery cost would have to significantly come down over the medium-term, which means it would have to be made locally. In this regard, the recent joint venture between Suzuki Motor Corporation, Toshiba Corporation and Denso Corporation to set up a lithium-ion battery unit in India could play a significant role.

On the technology front, the Indian components industry would have to come on board to supply many of the electrical parts for BEVs. This could be an opportunity for the vendor industry to adapt, upgrade and scale up for the EV future by investing heavily in their operations.

Moreover, charging stations would be required across the width and breadth of the country to allow easy adoption of electric vehicles. This process has already started with the government inviting bids for 4,000 charging stations in Delhi NCR (National Capital Region). The industry would have to make enormous investments to prepare for such a paradigm shift, and it simply would be disastrous if this or any future government were to change direction.

Overall, a convergence of government policy, cost reduction, local technology up gradation and charging infrastructure would be needed for India to achieve a measure of success in the EV space.

Way Forward

Electric cars are 100% eco-friendly as they run on electrically powered engines. It does not emit toxic gases or smoke in the environment as it runs on a clean energy source. They are even better than hybrid cars as hybrids running on gas produce emissions. According to a US-based website, EV batteries convert 59-62% of energy into vehicle movement, while petrol-run vehicles only convert 17-21%, making EVs more efficient. Besides, EVs are quiet and smooth as there is no exhaust system, providing a good driving experience.

The major benefit of electric cars is the contribution that they can make towards improving air quality in towns and cities. With no tailpipe, pure electric cars produce no carbon dioxide emissions when driving. This reduces air pollution considerably.

Big EV Charging Infrastructure in India

The first step towards nationwide electric vehicle charging infrastructure in India was recently taken by the government when an agreement was signed between a Finland-based company and a government-owned infrastructure developer in India. The agreement covers planning, designing, investing, and operating the charging infrastructure using a cloud-based system. A company has developed Fortum Charge and Drive to meet these demands, paving the way for the more widespread and efficient use of electric vehicles. Fortum has set up a 22 kW charging station at NBCC premises on a pilot basis. This will likely be tested once the first batch of EVs are delivered to government institutions later this year. Fortum and NBCC plan to set up more than 150 charging stations across the country over the next 12–18 months. This rapid expansion will be necessary, as the government has just ordered 10,000 electric vehicles through a public tender (*Saurabh 2017*).

India's transportation minister warned Indian carmakers that he would ensure policies are created to push them to make electric vehicles. India plans to stop sales of vehicles that use fossil fuels by 2030 (*Saurabh 2017; Sivakumar et al. 2021; Vidhi and Shrivastava 2018*).

Apart from cars and private vehicles, the Indian government is also looking to significantly expand electric vehicles in public transportation. Electric buses will soon play in India and the government has come out with a long-term policy for states and cities to develop infrastructure friendly to the growth of electric vehicles (*Saurabh 2017*).

CONCLUSIONS

Due to the dynamic development in recent years, it is difficult to get an overall perspective on the development of EV. Companies are challenged with a magnitude of consequences such as changes of value chains or radical innovations changing the market drastically. It shows that the user must gain experience with the electric vehicles so that perceived negative aspects like price or range can be opposed by some positive experiences of everyday usability. For a successful market launch standard, such as terms of structure and protection, the charging plug, the communication infrastructure between the vehicles, power stations, infrastructures, and network operators, are essential.

Electric vehicles have great potential from a user perspective. But due to existing weaknesses in comparison to competitive technologies, e.g., about the range, it should be analyzed how the customers will accept new mobility concepts, which combine electric vehicles with other services. The environmental considerations of electric mobility target primarily the eco-balance. Challenges exist in terms of resource requirements and by the environmental impacts generated by a rising demand for electric vehicles.

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