ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

IJARCCE

International Journal of Advanced Research in Computer and Communication Engineering

PCON-2019

National Conference and Seminar on Innovations in Engineering & Technology

Govt Polytechnic College, Palakkad

Vol. 8, Special Issue 1, January 2019

Feasibility of Electric Vehicles in Kerala

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Abstract: This study analyzes the behaviour of the energy efficiency of an Electric Vehicle (EV) in Kerala (India), considering factors such as environmental conditions and traffic conditions. The data of each sample contains different variables of interest, which are then analysed by correlation to obtain those that affect the energy performance of the EV. The measured data of electric consumption have been used to quantify the emissions of CO_2 and pollution of the vehicle. With this information, the energy consumption of electric vehicles of different types was determined under controlled operating conditions.

Keywords: Greenhouse Gas Emissions (GHGs), Hybrid Type Vehicles (HEV) or Electric Vehicle (EV)

I. INTRODUCTION

Electric vehicles (EVs) are widely considered as a promising solution to reduce air pollution in cities and a key player to face global warming. Currently, a major technical challenge of EVs is to improve their autonomy, because batteries still need to overcome fundamental commitments in terms of energy density, useful life, costs, and safety concerns. To determining the performance of an EV, it is necessary to know the energy efficiency of conventional as well as to promote the massification of EV charging stations to have sufficient infrastructure for this new transportation alternative. The objective of this work is to determine the efficiency of an EV under real operating conditions and compare its behaviour. The study explores the main elements that influence energy consumption and their impact on the efficiency of the EV. Now, the petroleum based road transportation sector in India is responsible for a good share of country's Greenhouse Gas Emissions (GHGs). 87% of India's CO_2 equivalent emissions of the transport sector come from road transport. Diesel exhaust contains pollutant that cause respiratory irritation, heart diseases, lung cancer, causing substantial health risk to those who frequently exposed to diesel exhaust. The only way to address these issues is to migrate from existing conventional diesel vehicles to pure electric vehicles. Meanwhile, the country has seen an increase in infrastructure of renewable energy resources such as solar and wind on account of improved competitiveness of renewable energy technologies. Keeping these developments in view, the Govt. of India launched the 2020 plan of the National Mission on Electrical Mobility wherein government plans to create a potential demand for 5 to 7 million electric vehicles, including buses, light commercial vehicles, two-wheelers and three-wheelers, as well as electric cars.

The main drawback of BEVs resides in batteries, which are still too expensive, too bulky and heavy due to their low energy density. Moreover, they have an unsatisfactory life cycle and require long recharging times.

II. POLICY ON ELECTRIC MOBILITY IN KERALA

Electric vehicles (EV) or e-mobility is another step forward, Kerala, Known for its environmental sensitiveness, bio diversity and tourist attractions wishes to maintain its texture and ensure a sustainable development for its people. The transition to electric vehicles is a natural choice for the State in line with its development ethos. The number of vehicles on the road will get reduced with the introduction of modern shared transport systems like the air-conditioned Electric Bus and e-Auto rickshaw. They will provide comfortable and fatigue free ride, with no polluting gases, and much reduced vibration and noise. This will attract vehicle owners to move to shared mobility. An air-conditioned bus is only 10% more costlier than the regular EV bus. Large scale introduction of 3-wheelers (e-autos) can be made economically viable using battery swapping for the e-autos becoming similar or less compared to petrol autos. The State Government plans to ensure a robust infrastructure for electric vehicles, that includes adequate power availability, network of charging points, and favorable power tariff. KSEBL will provide quality power for 24x7 throughout the year for a rate variable based on time of the day and season of the year.

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The development of e-mobility must be integrated to the State's manufacturing ecosystem, particularly for the EV components. Kerala has developed a large number of start-ups and some of this talent pool is expected to be utilized for the e-mobility initiative. To embrace electric mobility as a tool to promote shared mobility and clean transportation and ensure environmental sustainability, pollution reduction, energy efficiency and conservation and to create an ecosystem for manufacturing.

A. EV population targets
2022: 1 million EV's on the road
2020: Pilot Fleet of 200,000 two-wheelers, 50,000 three wheelers, 1000 goods carriers, 3000 buses and 100 ferry boats.

B. Investment Targets
1. Component Manufacturing: Attract investments and create employment opportunities around Power Electronics, Battery pack assembly, Battery Management System (BMS), Electric Motors, Accessories and skilled areas like IT and R & D etc.
2. Electric Vehicle manufacture in the long term: Create an enabling ecosystem of skilled manpower, infrastructure, R&D centers, favourable regulations and initial volumes through Government programs.
3. Centers of Excellence (CoE): in the EV value chain; build world class training/skilling centers for EV professionals with niche skills for the global EV industry

Table. I Registered Vehicle in the State 2016 Economic Review

		Kerala	TVM	ERKM	KZHKD
Goods	3 W	419857	36478	69643	34296
	4 W	136938	12188	17124	13984
Buses	Stage	42707	13247	4074	3630
	Contract	64051	10251	9945	3802
4Wheeler	Cars	2070635	278468	336445	155605
	Tax less	107567	9027	17276	9729
3Wheeler	Autorickshaw	610235	70689	58271	51449
2Wheeler	Scooter/ Motor cycle	6472302	834151	1004232	639437
Tractor/Trailer	Tractor	14213	741	2117	434
	Trailer	699	143	147	35
Others		232609	25211	39996	14987
	TOTAL	**10171813**	**1290592**	**1559270**	**927388**

III. ENERGY CONSUMPTION OF ELECTRIC VEHICLE

The road transport sector consumes around 49.70% of oil derivatives worldwide and is responsible for 24% of CO2 global emissions.

Fig.1 Comparison among different types of electric vehicle

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In year 2015, land transport demanded 87% of the total fuels in this sector, where 71% of these fuels were consumed in light-duty gasoline vehicles (1 to 3 passengers) and 20% in light-duty diesel vehicle. It is well known that the thermodynamic efficiency of both Otto and Diesel engines is low (i.e., up to 40% and 45%, respectively, for large engines). Therefore, more than half the fuels consumed in the transport sector is lost due to the inefficiency of engines. In order to determine the energy efficiency of the different alternatives of vehicles available in the market, it is necessary to have the same unit of comparison. In different studies, fuel consumption is indicated in Miles Per Gallon (mpg) or litres per 100 kilometers travelled (l/100km). For establishing comparison on consumption between conventional vehicles and Hybrid Type Vehicles (HEV) or EVs, the energy used in the first ones is determined by the calorific value of the fuel, so that the consumption can be expressed in (kWh/100km). In this sense, by way of comparison, Fig. 1 groups different vehicle models from conventional fuels with oil derivatives, through hybrids to fully electric. In Fig. 1, it is shown that a clear reduction in energy consumption is possible when EV vehicles are used.

These external impact factors can be classified into the following categories: 1) factors related to traffic conditions that indirectly influence the dynamic parameters of the vehicle, such as speed and acceleration; 2) factors related to infrastructure such as the angle of inclination of the road, the roughness of the road surface; 3) environmental factors such as external temperature and wind speed; and 4) driving behaviour factors such as driver aggressiveness, brake pressure, and driving mode selection. The Heating, Ventilation and Air Conditioning (HVAC) of the cabin space also consume important amounts of main battery power. Thus, heating and ventilation must be handled properly; otherwise, EVs will not succeed in an economic study on storage systems for EV is presented. The price trend of these storage systems (Lithium, Cobalt, rare earths, among others), nowadays is in the order of Rs7150/ kWh, and it is estimated that they will present a decrease in their price until reaching Rs 4950 / kWh in 2025.

IV. PRODUCTION AND DEMAND OF ELECTRICITY IN KERALA

The Kerala State Electricity Board (KSEBL) is looking at EV population as an option for generating demand during the off-peak hours. It would mean cheap electricity for EVs and load balancing for the grid. In Kerala nearly 80% of the demand is the variable load from the domestic sector is unpredictable because a variation in atmospheric temperature can spike the power consumption. KSEBL will participate in the e-mobility development for ensuring a firm and optimally high base load on the grid attractive power tariffs.

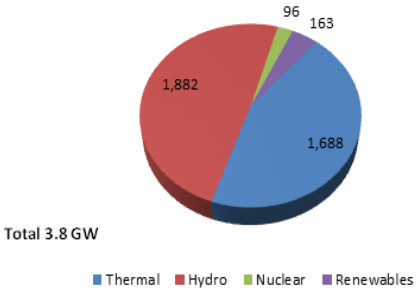

Fig.2 Installed Capacity

Table. II Demand of Electricity in Kerala in 2018

Installed Capacity	3.8GW
Maximum Energy consumption per day in Kerala	68MU

Table. III Energy Consumption of Different EVS in 2022

Vehicle	**Number**	**Avg. Km/day**	**Apprx. Units/day for charging**	**Total Units**
2 Wheeler	640000	20	0.4	256000
3 Wheeler	61000	50	1.2	73200
4 Wheeler	210000	40	1.6	336000
Bus/Others	10000	80	3.2	32000
				0.69MU

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From the table III, it is observed that the electricity production has to be increased by 1% in Kerala for achieving 1 million Electric vehicles in 2022.

V. CATEGORIES OF VEHICLE

Electric Vehicles with battery packs of below 120V is considered as Light EV, and in India they include the two-wheelers, three-wheelers and some car models also.

A. Two wheelers

- e-Scooters with a built in 50KM range battery (suitable for charging at home) with provision for additional 50KM range extension battery (that could be swapped at public stations as and when required).
- e-scooters with two swappable batteries (as in international models like Gogoro etc.).
- e-Bikes to leverage the tourism potential of the state in the coastal and hilly destinations.

B. Three wheelers

Currently, Auto-rickshaws in the State have base price of Rs. 1.40 to 1.70 Lakhs with a running cost in the range Rs. 1.30 to 1.40 per KM. converting these as e-autos can be made Revenue Neutral, if the EV battery is addressed as a separate component from the base EV. The cost of an e-Auto without battery can be in the range of Rs 1.40 to 1.70 lakhs, with sufficient assured numbers to enable the auto manufacturers to go for adequate supply tie ups. It would be necessary to provide promotional incentives wherever possible in the form of concessions in road tax, toll fee, parking fee etc. A policy decision has to be taken to give new/renewed permit only for e-autos leading to a gradual ban on ICE autos. Schemes would be devised to procure 15,000+25,000+50,000 e-autos year-wise from 2019 onwards, which could attract local manufacturing. In order to enable the State to realize the transition to e-Autos, there is a need to start manufacturing facility within the State. For this, discussions have already initiated on the revival of Kerala Automobiles Ltd (KAL) which will be taken forward.

C. Four Wheelers

Electric Cars can be introduced for government use and as modern, eco-friendly taxi cars. Technologically the optimal solution would be to have electric cars with built in batteries with hire-able 'Range extension batteries' of different capacities for different models of EV.

- Built in batteries could be charged at home over night and could run for about 80-100 KM distance daily, which would be the normal demand of the car owners, Whereas the range extension batteries could be hired for longer drives.
- There could also be a number of DC fast charging stations as well as swapping stations for range-extension batteries established in strategic locations in the cities and along the national highways and state highways.
- It would also be possible to provide the public the list and geographic location of all available swapping stations over as mobile app accessible to all.

Once the availability of sufficient electric vehicles and charging-swapping stations are in place, State may also take up certain environmentally fragile locations-like munnar-and mandate to convert all four wheelers as electric vehicles, enforcing them as pollution free EV zones. Small Cargo carriers would be another category that may be converted to EVs through policy mandates.

D. Heavy Electric Vehicles/Electric Buses

Electric Vehicles with a battery pack of more than 500 Volts is considered as Heavy EV. Buses are the first preference for conversion to e-vehicle regime, due its large impact on the on-road vehicle population, potential to reduce pollution and promote shared mobility. Buses, primarily for public transport shall be of 9 meter and 12 meter length, with an average driving range of 50 KM to 100 KM. The Bureau of Indian Standards is developing standards for the following types of Bus Battery charging options, as India specific solutions.

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VI. BATTERY AND CHARGING SYSTEM

A. Fixed battery system

Buses are expected to charge at the bus depots using 3-phase AC connections dedicatedly connected to each parked bus. In addition, small top up charging done on route. This system is currently under consideration in Kolkata.

B. Replaceable Battery Systems

Battery Swapping at Bus Depots/Terminals to cater to trip lengths of up to 35 KM. A battery pack that provides 50 KM range could be adopted for use across the State. This option is being closely watched as there are no large scale deployments of it and the robotic arm or battery switch systems is presently under demonstration stage.

C. Automated Bus Charging Systems

This is an emerging option, currently being deployed and evaluated in Northern Europe. It involves deployment of pantograph-charger (or "Docker") at the Bus terminal every time the bus returns to the terminal. The battery size can be configured depending upon the system configuration.

VII. ENVIRONMENTAL IMPACT OF ELECTRIC VEHICLE

India's CO_2 emissions grew by an estimated 4.6% in 2017, despite a turbulent year for its economy. Measured per person, India's emissions are still very low – at only 1.8 tonnes of CO_2 per capita – which is much lower than the world average of 4.2 tonnes. But those emissions have been growing steadily, with an average growth rate over the past decade of 6%. With India being the world's fourth largest emitter of CO_2, it is important to understand what the country's emissions are currently and where they might be headed. Given India's early stage of economic development, low per-capita emissions and its large population, there is significant scope for its emissions to increase. India's pledge under the Paris Agreement is to reduce the carbon intensity of its economy by 33-35% by 2030, compared to 2005 levels. Given projections of very strong economic growth over this period, emissions are expected to grow significantly.

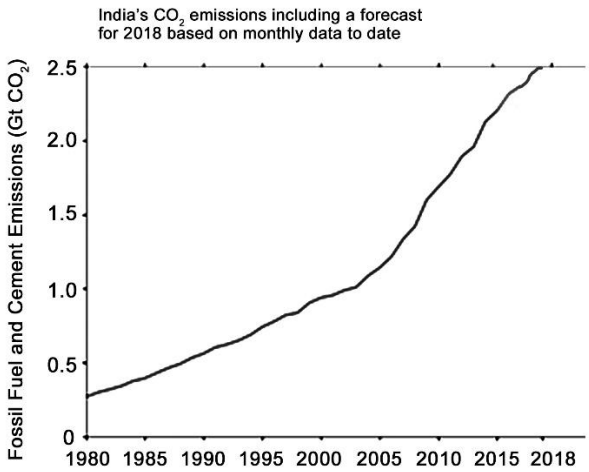

Fig.4 Indian CO_2 emissions are currently forecast to grow by 2.5% in 2018

VIII. CONCLUSION

In the near future, as the battery technology becomes cheaper, fossil fuels becomes costlier, electric vehicle technology becomes cost effectives, more government subsidies and tax benefits for EV vehicles, charging stations, CO_2 emissions law more stringent. It is a natural expectation that the EV methodology will become popular and economically viable. This can happen by bridging the cost margin between the existing Diesel vehicles and the EV's. The authors in this paper have attempted to identify and quantify the emissions of CO_2 and energy consumption of electric vehicles in Kerala and thus making the vehicle mission mobility plan of Kerala, a reality.

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BIOGRAPHY

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