

## Impact of electric passenger cars in India: A review

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### Abstract

India, like any other country, in the world is concerned about increasing air pollution arising out of CO<sub>2</sub> emissions from use of cars and vehicles. The government has been promoting use of electric vehicles and is likely to announce a full proof policy. However, several factors such as cost of production, growing prices of battery and environmental concerns arising out of battery waste are likely to be elements that will lead to limits to growth of e-cars (electric cars or electric vehicles) in the country. In this paper, a study has been made regarding projection of growth of electric vehicles (EV) and the causes that may hinder such a growth. Results show that leading car manufacturer is apprehensive about keeping the price of car in the range affordable by the Indian customers; companies worldwide are concerned about economic viability and technical feasibility of recycling battery waste; the battery charging infrastructure and the damage that the environment is also likely to sustain due to mining of lithium and cobalt.

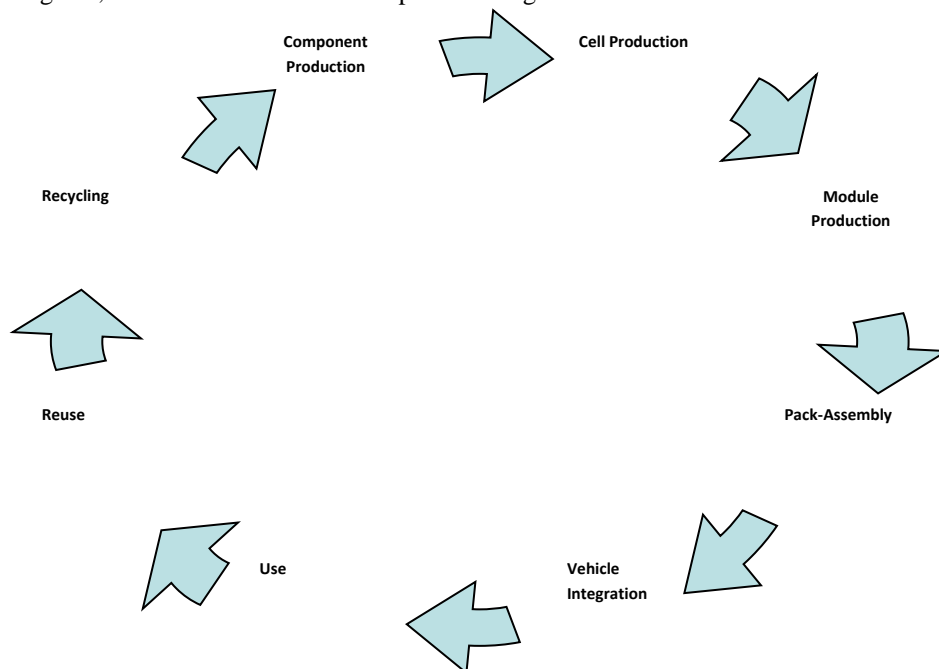
**Keywords:** Electric Vehicles, Passenger Car, Growth, Cost, Cobalt, Environment, Limits to growth.

### Introduction

The Government of India recently stressed on introduction of electric cars in India. It appealed car makers to roll out electric cars in Indian roads (Saluja, 2017). The Union Minister of Road Transport indicated that a fool proof policy on the lines of “Transport for London (TfL)” will be introduced and an MOU is proposed to be signed with TfL (Vashisht, 2018). This is expected to have manifold benefits such as reduction in carbon oxide gases, reduction in crude oil imports

and in turn enhance health condition of the citizens and reduce outflow of foreign reserves (through reduction in imports). Another important aspect would be also the fluctuating crude prices.

According to BCG (Boston Consulting Group, 2010), the value chain of electric battery involves seven stages. These are the production stages associated with component, cell, and module; pack – assembly, vehicle integration, use, reuse and recycling as illustrated in Fig. 1.



**Fig. 1: Stages in Electric Car Battery Value Chain**

Each of these stages requires exclusive planning. The component production that require metals such as Lithium and Cobalt need to be accessed on a continuous basis. Battery producer major such as Tesla have reported to be looking for Cobalt mines (Insideevs, 2018), though the major source have been Congo. Questions have been also raised regarding the cost to human life in mining Cobalt. The mining is done using hand and is affecting lives of inhabitants of Congo (Frankel, 2016). Tesla has over 300 suppliers across the globe for their product and many these suppliers are single source of supply. Stoppage of supply may lead to supply chain disruption. The key raw materials include aluminium, steel, nickel, copper and cobalt. The company has been experiencing price fluctuations of these raw materials (CSI Market, 2017). The stages of cell and module production followed by pack assembly are dependant on plant's production capacity. The use of battery driven cars is dependent on availability of charging stations, capacity of charging vehicles (that is, number of charging points per station) and time to charge per car. The government of India planned to procure electric cars through the nodal body called Energy Efficiency Services Ltd. (EESL). However the procurement process is getting delayed due to lack of infrastructure to charge the battery. The car supply will be made by companies namely, Tata motors Ltd., and Mahindra and Mahindra Limited through EESL. The country plans to integrate the charging stations with the present re-fuelling stations. However, it is required to be studied the constraints in using the current re-fuelling pumps. This is so because all pumps are not having similar layout and can afford to provide adequate charging stations.

The reusability depends on the plant capacity to extract the costly minerals and cost of such extraction.

The report stress that the lithium ion technologies have under focus as could be seen from the increase in patents in this field. The patents increased from 26 percent in 2005 to 62 percent in 2008. The characteristics of lithium ion battery can be assessed across six dimensions. These are the safety, life span, cost, performance, energy-storage and state-of-charge measurement. Another challenge of lithium ion battery is that of charging infrastructure. Re-use and re-cycling are the areas that have not been given much thought as most of the effort is reduction of cost of car and its usability. The report stresses that the challenges for the car makers lay in bringing down the cost, increasing the

driving range and cutting down the charging time. Niti Aayog, India's apex planning body opined that the country needs big plants to make electric car batteries. Industrial houses such as Reliance, Adani, JSW, the Hero Group of Companies and Mahindra and Mahindra have shown interest in setting up such plants in India (PTI, 2017). Honda, a Japanese car manufacturing company has planned to setup its own battery manufacturing plant in India. The car manufacturer aims at having 65 percent share of its production in electric cars, hybrid cars, plug-in hybrid cars and fuel-cell powered cars. Out of this, 15 percent would be pure electric cars (Mukherjee, 2017).

However, there are flip sides of uncontrolled growth in use of battery for electric cars. Or rather there could be limits to growth of e-cars in India. In this paper an analysis has been made to study the impact of e-cars in India. The study aims at exploring the factors that govern the dynamics of e-car usage in India. A statistical analysis has been carried out to project the growth of electric passenger cars and its impact studied to identify the limits to growth of e-cars.

#### Share of Passenger Cars in India

Around 72 million passenger cars travel the roads of the world as on 2016 and India's share is around 5% (OICA, 2018). The sales have been increasing over the years. Table 1 shows the total passenger car sales during the period 2005-2006. Figure 2 illustrates the trend in sales.

**Table 1: Total passenger car sales during the period 2005-2006**

Year	Sales
2005	454,07,298
2006	479,55,259
2007	508,34,531
2008	499,78,237
2009	496,54,985
2010	558,18,570
2011	578,39,953
2012	609,36,407
2013	634,29,200
2014	657,08,230
2015	663,14,155
2016	694,64,432

Source: <http://www.oica.net/category/production-statistics/2016-statistics/>

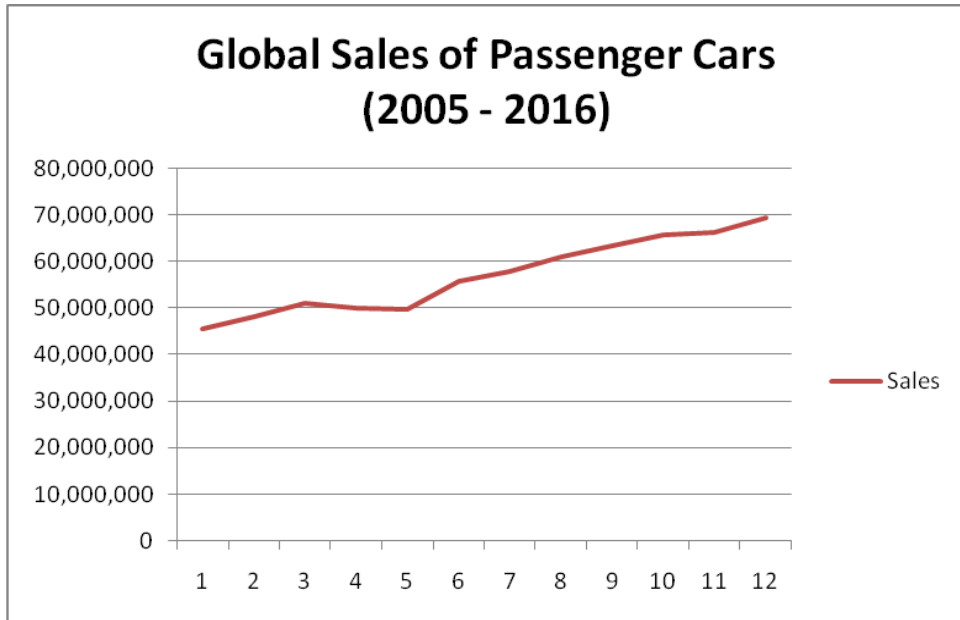
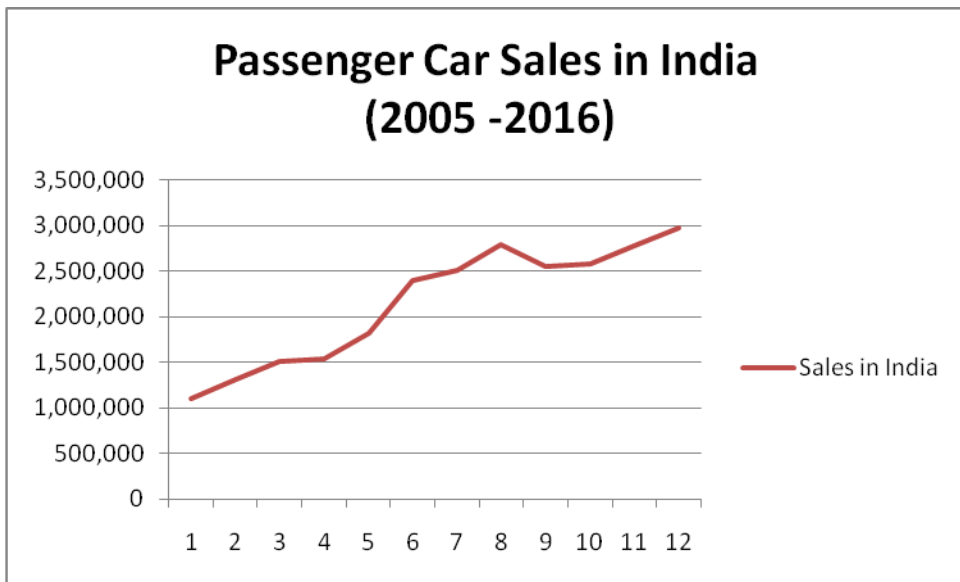


Fig. 2: Trend in global passenger car sales

The sales of passenger cars have been also growing in India (Fig. 3).



Source: <http://www.oica.net/category/production-statistics/2016-statistics/>

Fig. 3: Trend of passenger car sales in India

In year 2015 the CO<sub>2</sub> emissions has been around 130 CO<sub>2</sub>/km for passenger cars in Europe (Fontaras et al., 2017). The cars in India too opt for European standards. However CO<sub>2</sub> emissions depend on several factors such as vehicle characteristics (weight, aero dynamics, auxiliary systems), vehicle driver (driving skills and style of driving), traffic condition and weather conditions (Fontaras et al., 2017). In India city roads are congested, vehicles are not properly maintained and driving skills are not consistent, hence the CO<sub>2</sub> levels tend to have an increasing trend. Thus electric cars are certainly going to benefit the country.

**Analysis**

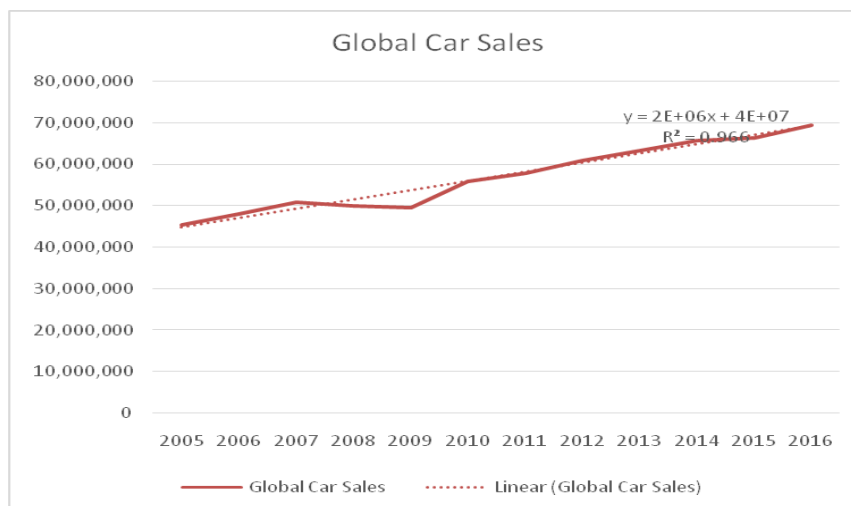
The below table 2 shows the sales of Passenger cars and Electric vehicles (EV) from 2005 to 2016

**Table 2: Sale of Electric Vehicle**

Year	Global EV Sales	Global Car Sales	% Share of EV
2005	1890	4,54,07,298	0.004162327
2006	320	4,79,55,259	0.000667289
2007	460	5,08,34,531	0.000904897
2008	2460	4,99,78,237	0.004922142
2009	2220	4,96,54,985	0.00447085
2010	6780	5,58,18,570	0.012146495
2011	47580	5,78,39,953	0.082261478
2012	118060	6,09,36,407	0.193742962
2013	203660	6,34,29,200	0.321082404
2014	323420	6,57,08,230	0.492206227
2015	547120	6,63,14,155	0.825042557
2016	753170	6,94,64,432	1.084252733

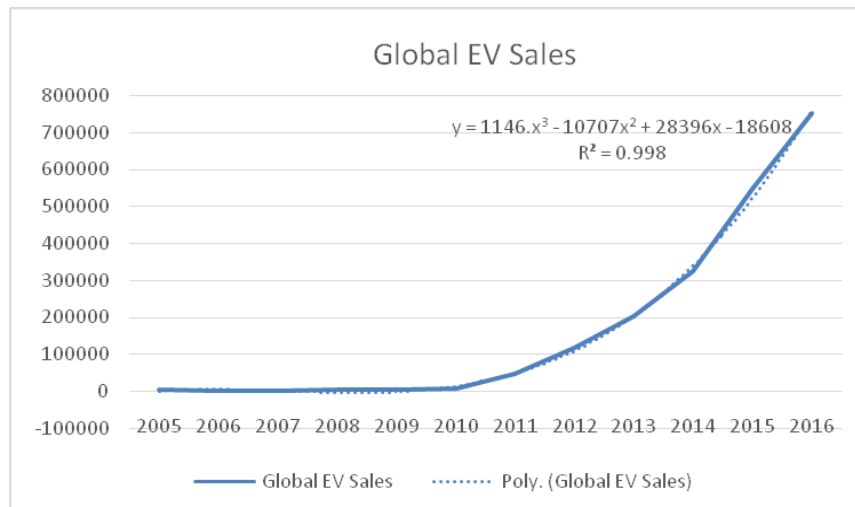
Source: Bloomberg: <https://about.bnef.com/electric-vehicle-outlook/>

The trend of global sales of car is as shown below (Fig. 4). The car sales show a linear rising trend.



**Fig. 4: The sales trend with the trend line equation**

The trend of global electric vehicle sales along with trend equation is given below (Fig. 5). The sales have gone up exponentially since 2011.



**Fig. 5: Global sales trend=d of electric vehicles (EV)**

By analyzing the past trends, we have attempted to project the sales of both EVs and the total passenger cars and the numbers is as given in the below (table3).

**Table 3: Projection of Electric Vehicle sales**

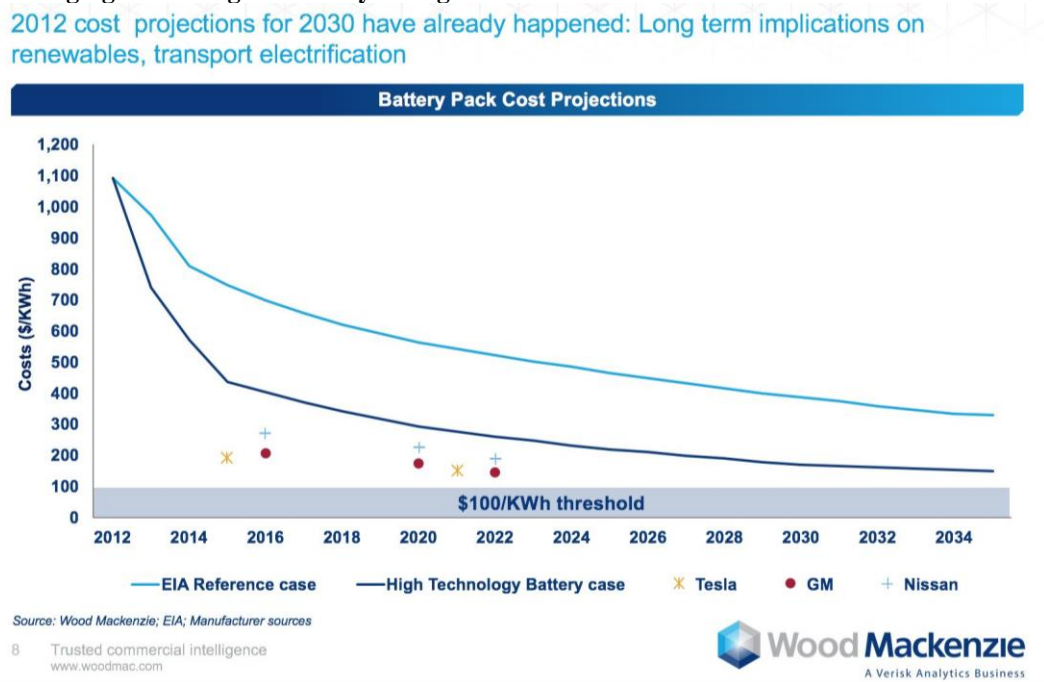
Year	Projected Global Car Sales	EV Projected	% Projected Share of EV
2005	44693279.88	227.5	0.000509025
2006	46920884.39	4528	0.009650287
2007	49148488.91	1172.5	0.002385628
2008	51376093.43	-2960	-0.005761435
2009	53603697.95	-990.5	-0.00184782
2010	55831302.47	13960	0.025003895
2011	58058906.99	48770.5	0.084001754
2012	60286511.51	110320	0.182992841
2013	62514116.03	205487.5	0.32870576
2014	64741720.55	341152	0.526943055
2015	66969325.07	524192.5	0.782735229
2016	69196929.59	761488	1.100465013
2017	71424534.11	1059917.5	1.483968378
2018	73652138.62	1426360	1.936617221
2019	75879743.14	1867694.5	2.461387483
2020	78107347.66	2390800	3.060915614
2021	80334952.18	3002555.5	3.737545637
2022	82562556.7	3709840	4.493368602
2023	84790161.22	4519532.5	5.330255816
2024	87017765.74	5438512	6.249886967
2025	89245370.26	6473657.5	7.25377404
2026	91472974.78	7631848	8.343281738
2027	93700579.3	8919962.5	9.519644987
2028	95928183.82	10344880	10.78398401
2029	98155788.33	11913479.5	12.13731732
2030	100383392.9	13632640	13.58057305
2031	102610997.4	15509240.5	15.11459872
2032	104838601.9	17550160	16.74016983
2033	107066206.4	19762277.5	18.45799731
2034	109293810.9	22152472	20.26873417
2035	111521415.4	24727622.5	22.17298122
2036	113749020	27494608	24.17129221
2037	115976624.5	30460307.5	26.26417835

2038	118204229	33631600	28.45211232
2039	120431833.5	37015364.5	30.73553181
2040	122659438	40618480	33.11484273

Source: Bloomberg-<https://about.bnef.com/electric-vehicle-outlook/>

This was done using the TREND Function for passenger cars as it followed a linear trend of growth during 2005-2016 while Polynomial regression of order 3 was employed to project EV sales till 2040. It must be noted that this is a pure statistical projections without considering the factors like falling prices of lithium ion batteries, government subsidies etc. The trend shows increase in years ahead as it has been based on past trends. However past trend may not be repeated as there are limitations with regard to sourcing of raw materials, production capacity, charging infrastructure, recycling and environmental concerns. Government may soon announce policy regarding recycling and disposal of used battery.

**Graph 1: Emerging Technologies: Battery storage**



The above projection shows decrease in cost of battery pack, however, on need to consider the doubling of cost of cobalt over past one year.

**Results and Conclusion**

It is projected that in 2040 the share of EV will be 33.11% of total passenger car sales. This goes in line with the projections of various agencies such as Bloomberg who predicted around 35% to 54 % share of EVs in 2040 (Bloomberg, 2017).

The vehicles with Internal Combustion Engines which constitute more than 98% of the share would be reduced to 66% or even lesser in the wake of new innovative and sustainable technologies.

This would mean that dependence on crude oil would reduce greatly and would go a long way in the

sustaining the environment for future generations. Besides, the cost of lithium ion batteries are likely to drop by 70% by 2030 (Bloomberg, 2017). However Bloomberg (2017 b) also reported that the price of lithium and cobalt have doubled over the last one year. It prescribes mining batteries is much profitable than mining ground for the metals. Companies, such as Tesla and Toyota Motor Corp., are considering 10% recycling of the battery. Thus price of cobalt will be key to growth of electric cars (Douglas, 2017). India is a price sensitive market and hence increase in price of cars is likely to dither the customers and may lead to drop in

drop in electric cars. Maruti Suzuki, India's leading car manufacturer apprehends its inability to keep the price of car in the affordable range of Indian customers (0.5 to 0.6 million INR) (Doval, 2018). Besides there are environmental concerns (Gardiner, 2018) with regard to lithium battery waste. It is estimated that the boom of e-car sales will leave around 11 million tonnes of spent lithium batteries to get recycled. The lithium ion batteries are expected to produce toxic gases when damaged and in addition mining of cobalt and lithium, being finite in availability, will lead to water pollution and other environmental consequences. The problem is aggravated with the fact that the cost of fully recycling a battery is falling toward €1 per kilo, the value of the raw materials that can be reclaimed is only a third of that (The Guardian, 2017).

The government of India apart from announcing its policy on use of electric cars, should also consider laying down guidelines for import of raw materials, reusability, recycling and disposal of used battery. It should identify the extent of such cars that can be registered keeping in mind the infrastructure available for charging and the ways and means to dispose of old fuel cars.

The car and battery industry on the other hand should invest in research and development to find out substitute of lithium and cobalt. A global convention may be held to prevent monopoly of holding rights, in hands of few manufacturers or suppliers, to mine scarce metals such as cobalt. At the same time the companies should adopt right practices avoiding child labour, illegal mining, resorting to right medical and health practices and compensating duly to the mine workers.

All these will make the industry sustainable but is likely to raise the cost at least in the short and midterm.

#### Scope for future research

A multiple regression can be carried out on factors affecting the rapid rise in sales of EVs such as battery prices, Government subsidies, availability or capacity of charging stations and other factors identified in this study. The impact on the environment as a bad output may also be considered for further analysis.

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