Electric Vehicle: Roadmap for Upscaling in India

Suprotim De

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Abbreviations and Acronyms

ADEME	Agence de l'Environnement et de la Maîtrise de l'Energie
ASEAN	Association of Southeast Asian Nations
BEST	Brihanmumbai Electricity Supply and Transport
BEV	Battery Electric Vehicle
BMTC	Bangalore Metropolitan Transport Corporation
CAGR	Compounded Annual Growth Rate
CBU	Completely Built Up
CEA	Central Electric Authority
CMVR	Central Motor Vehicle Rules
CNG	Compressed Natural Gas
DCFC	Direct Current Fast Charge
DHI	Department of Heavy Industries
DTC	Delhi Transport Corporation
EV	Electric Vehicle
EVI	Electric Vehicle Initiative
EVSE	Electric vehicle Service Equipment
FAME	Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles
HRTC	Himachal Road Transport Corporation
ICE	Internal Combustion Engine
IEA	International Energy Agency
LCV	Light Commercial vehicle
LPG	Liquefied Petroleum Gas
MNRE	Ministry of New and Renewable Energy

NEMMP	National Electric Mobility Mission Plan
NGT	National Green Tribunal
OEM	Original Equipment Manufacturer
PCB	Pollution Control Board
PDS	Public Distribution Shop
PHEV	Plug-in Hybrid Electric Vehicle
ROW	Right of Way
SKD	Semi Knock Down
SMEV	Society of Manufacturers of Electric Vehicle
VAT	Value Added Tax
ZEV	Zero Emission Vehicle

Executive summary

Figure 1 : World's First Integrated Wind Power Electric Vehicle Charging Station in Barcelona (Source: https://in.pinterest.com/explore/electric-charging-stations/?lp=true)

The conventional means of transportation constitute for a majority of transport demand in today's world. While this still continue to form the backbone for human mobility, there is a lot of push towards alternative fuel powered vehicles. This also becomes essential to adopt greener and sustainable modes of transport when the environmental condition is deteriorating. Another factor that leads to adopt these are the growing concern of energy security among major economies.

Vehicular Emission and commitment to Paris Climate change has led to adoption of electrical vehicles by many major economies globally. Countries like China, U.S.A, Norway, Netherlands and Japan have seen a huge growth in the shares of electric vehicles in transportation. This was primarily due to the fact that these countries had favorable Fiscal, Financial and other policies which made electrical vehicles more competitive and cost efficient as compared to conventional fuel vehicles.

India being one of the major automobile markets however could not see a considerable growth in the adoption of electric vehicles. Previous Government policies and incentives had a little impact for upscaling electric vehicle deployment in India. Our research shows that both the consumers are skeptical for buying electric vehicle and the manufacturers hesitant to manufacture electric vehicle.

So to overcome this barrier and upscale the electric vehicle deployment we analyzed the Indian electric vehicle market. Under this we evaluated three major stakeholders of the electric vehicle value chain; the consumers, the manufacturers and the regulatory and statutory bodies. Our research helps us to narrow the challenges that each stakeholder is facing regarding the policy and incentives. A roadmap for the same is devised for addressing specific challenges. It is expected that the government will play a very major role to break the barrier and help in upscaling the electric vehicle deployment in India.

While this report gives a brief non-technical description of the different types of electric vehicles, other types of electric vehicles like two wheelers, rail and other heavy duty vehicles are not addressed.

Introduction

Electric Vehicles

In this 21st century mobility is essential part of human development which also ultimately leads to the nation's development, has seen quite a number of evolutions over the past 100 years and now coming towards electric vehicles.

Figure 2: Electric Vehicles being charged at Public Charging (source: The Economic Times, February 5, 2017)

With the advent of industrialisation and globalisation there has been an increasing trend in the rapid urbanisation of the last few decades, both for the developed and developing economies globally. The demand for transportation in the major cities has gone up considerably. Traditionally this demand is being met either by personal vehicles or by a mix of public transport facilities available. However, many cities have to battle congestion and poor air quality due to the growing numbers of personal vehicles, also most of the major economies[1] rely on imported fossil fuels and the growing demand not only creates a pressure on the trade deficit but also has implications on the energy security of the nation.

Green vehicle[2] is the new buzzword in our age and most of the people think that it is the latest technology that has been developed in the last few years, but contrary to this notion they have been present for over more than 150 years. The history of EVs dates back to 1880 when the first electric car was introduced in the German market, it was also at that time the other type of EVs such as trams and trolley buses made their debut. Interestingly the development of ICE in the early 20th century followed by the discovery of petroleum somewhat led to the decline of this technology.

Back in 1990 there was a growing concern for vehicle emission and climate change which insisted the manufacturers and the policymakers to turn their attention towards EVs. Then for the first time in history the state of California[3] in United States of America mandated to implement strict emission control for the vehicles. As a result the large auto manufacturers started to increase their commitment towards development of BEV, similar judgement was implemented by ADEME in France. This impacted the overall automobile markets as the auto manufacturers realised the likelihood of similar norms and policies being implemented by the other major economies. The IEA has coined this period as the third age[4] of EV; this period saw the mainstreaming of the lithium battery technology along with the mass debut of two new types of EV; Nissan's LEAF a full BEV and Chevrolet's Volt a PHEV.

[1] bp-statistical-review-of-world-energy-2016-full-report.pdf (Accessed on April 28,2017)
[2] https://www.epa.gov/greenvehicles (Accessed on April 28,2017)
[3] https://www.arb.ca.gov/msprog/zevprog/background.htm (Accessed on April 28,2017)
[4] https://www.iea.org/media/news/older/Issue2_Evs.pdf (Accessed on April 28,2017)

Types and Characteristics of Electric Vehicles

There are three main types of Electric vehicles which run on an electric motor and use battery as their fuel. Fuel cell vehicle is another type of EV which is currently in the developmental stages. The types of electric vehicle based on different battery technology are:

- Battery Electric Vehicle (BEV): BEVs includes a typical powerful lithium ion battery with their capacity ranging from 20kWh or more than 50kWh[5].
- Hybrid Electric Vehicle (HEV) : The battery in HEV is charged by the ICE and regenerative braking[6].
- Plug-in Hybrid Electric (PHEV):They have an ICE engine and a battery with capacity up to 40 kWh[6]

The detailed classification of the different type of electric vehicle is represented in the table below.

Table 1: Classification and Characterization of Different Types of Electric Vehicles[7]

Powertrain technologies		**Description**	**Commercial Examples**
Hybrid Electric Vehicles	Mild Hybrids (Mild HEV)	• E-motor assists engine in acceleration • Regenerative braking charges a small battery • Not all electric propulsion possible	Honda civic hybrid,Mercedes-Benz S400 blue,BMW 7-series hybrids
	Strong/Full Hybrid Electric Vehicles (SHEV)	• Can run on just ICE, just batteries or a combination • Combines E-motor and engine power that optimizes output to the wheels throughout the operating range	Toyota Prius,BMW X6 hybrid, Ford escape hybrid
	Plug-in Hybrid Electric Vehicle (PHEV)	• Both regular ICE and E-motor can be used for propulsion • Charging through regenerative braking or plug-in	Toyota Prius plug-in, Audi A1 e-tron,BYDF3DM,GM volt
Battery Electric Vehicles (BEV)		• Runs only on battery power, doesn't have ICE • Range is limited by the size of battery	Mahindra Reva and E20, Nissan Leaf, Citroen C-zero, Ford Focus, Mitsubishi i-MIEV
Fuel Cell Hybrid Vehicle (FCV)		• Fuel cell functions like a battery producing electricity • Instead of recharging must be refilled by Hydrogen.	Prototypes only

[5]low_carbon_vehicle_technology-Lytton-report (2010) (Accessed on April 15,2017)
[6]Bringing the electric vehicle to mass market-tsang,pedersen(2012) (Accessed on April 22,2017)
[7] A.T. Kearney and CII, Cost Effective Green Mobility (Accessed on April 22,2017)

Global Electric Vehicle Outlook

Governments across the global have undertaken different steps for helping electric vehicles gain a foothold in their country. These steps act as demand drivers for electric vehicles. These steps are primarily in form of financial, fiscal and policy incentives. These incentives are shown in the table below.

Table 2: Policy Incentive for Electric Vehicles in Major Economies

Country	Fiscal Incentive	Financial Incentive	Other Incentive
United States of America	• Tax credit ranges from $2500-$7,500[8] depending upon the type of electric vehicle.	-	• Conversion kit worth maximum $4000[8] for retrofitting conventional powered vehicles with electric vehicle capability.
China	• Vehicles are exempted from circulation /ownership taxes • Waiving off of the registration fees and toll tax in most of the cities.	• $5323-$9126[8] bonus for BEV depending on the battery range of the vehicle. • 35,000 RBM bonus for PHEV whose battery bonus is no less than 50 kms.	• Government intends to invest $15.21 billion[8]for development of whole industry chain of EVs. • 10 cities and 1000 vehicles program[8]
Norway	• Reduction of registration tax, Exemption from VAT and waiving off of toll tax.	• EV are exempted from purchase tax in tune of $12000	-
Japan	• Exemption from tonnage tax. • Reduction on automobile tax for EVs.	• Incentives range from $3300-$5500 typically for BEV and PHEV with maximum incentive up to $7800.	-
Netherlands	• Reduction on registration tax of hybrid vehicles. • New car leases tariff reduced from 20% to 0 % for ZEVs	-	• Dutch politicians have voted through a motion to ban sales of new petrol and diesel vehicle from 2025[9] onwards
United Kingdom	• Exemption from excise duty • Exemption from fuel benefit charge	• 35% of the cost of plug in car up to $8731.86[8] • 20% of a cost of a van up to $11642.48[8]	• Funding of £ 7,500[10] capped for installation of public charging facilities.
Germany	• Exemption from motor vehicle tax for 10 years	• Cash Inventive of € 4000[11] for pure electric car & € 3000 for hybrid car.	• Special parking place for electric vehicles
France	• Exemption of electric vehicles form company car tax[8]	• Premium of $7,111[8] for vehicles emitting 20g/km or less (cannot exceed 27% of purchasing price) • Premium of $4,515[8] for vehicles emitting between 20g/km to 60g/km(cannot exceed 20% of the purchase price)	-

[8]INFRA NOW Newsletter_Punj Lloyd Institute_ISB_Vol_1 (Accessed on April 15,2017)

[9]https://www.theguardian.com/technology/2016/apr/18/netherlands-parliament-electric-car-petrol-diesel-ban-by-2025 (Accessed on April 22,2017)

[10]Grant Scheme for the installation of plug-in vehicle charge points on the UK Government and wider public sector estate 2013 (Accessed on April 28,2017)

[11]http://www.dw.com/en/germany-sets-out-major-cash-incentive-for-electric-car-buyers/a-19266326 (Accessed on April 22,2017)

Current State of Electric Vehicle in Major Economies

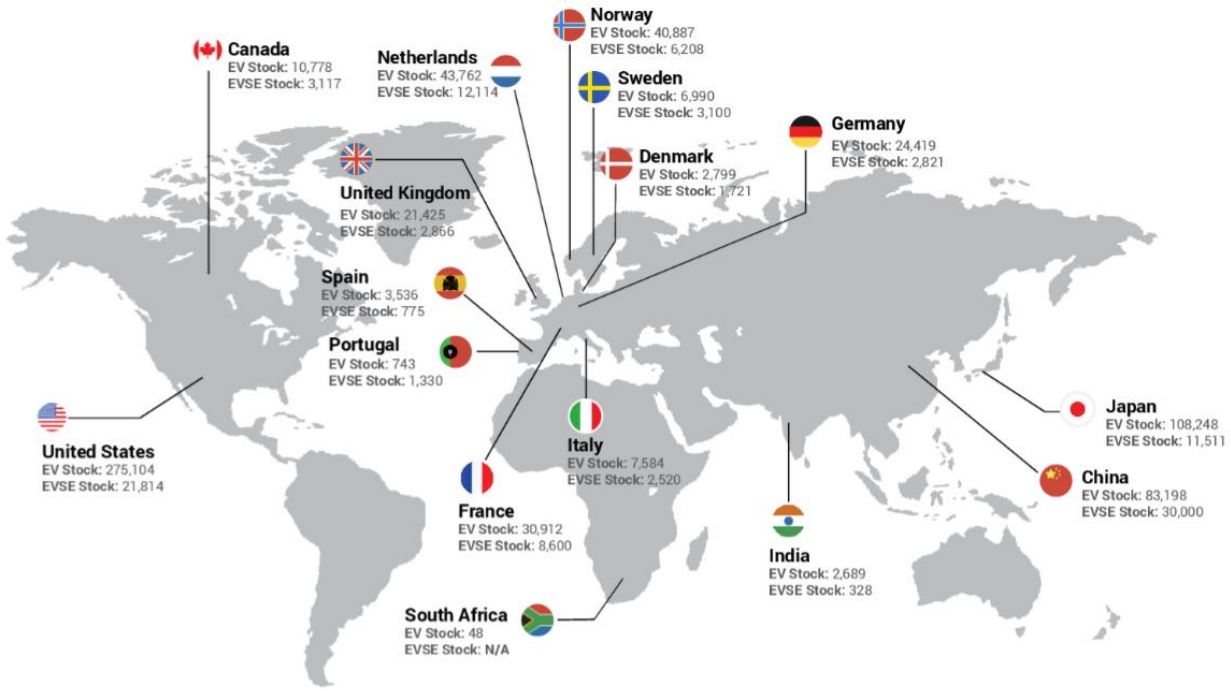

Figure 3: Electric Vehicle Stock in Major Economies (Source: Global EV Outlook, 2015)

The major economies where electric vehicle have been used widely are the United States of America, China and European Union and the Schengen region. This section entails the current state of electric vehicle in these respective economies.

United States of America: ZEV mandate which was introduced in the state of California is now being followed by 10 other states. These states have signed a memorandum to push the electric vehicle sales by mandating the automakers. United States still faces challenge of least uniformity among the states in terms of new EVs technology and registrations. This is a reason while EV market in California, Oregon, Utah and Maryland have been promising. The markets outside in other states have been challenging for EVs. Also the federal government has been relatively absent from the EV movement in the country.

China: China through their central governance developed 10 cites 1000[12] vehicle program. This program aimed at developing charging infrastructure and electric vehicle deployment through city based pilot projects. The outcome from this program has notable success both in development of new technologies and vehicles. Also major cities under this program have deployed electric vehicles in their public transport system. Currently Chinese government is considering stricter technological standards to restrict the 200[13] odd manufacturers to almost 10. This move is implemented so that domestic manufacturers adhere to international standards in terms of battery technology and charging infrastructure.

[12] Stanford social innovation review spring 2013 (Accessed on April 18,2017)

[13] https://www.bloomberg.com/news/articles/2016-08-28/most-of-china-s-electric-car-startups-face-wipeout-by-new-rules (Accessed on April 18,2017)

European Union & Schengen Region: Electric vehicles are concentrated in a few countries like Norway, Sweden, Iceland, Netherlands and Switzerland. All of these countries have policies which have made buying electric vehicle favorable for the people. Also both central and state government have helped in creating more charging stations, dedicated lanes for EVs and awareness creation for new buyers. Due to intensive public charging infrastructure the majority of the EVs sold in Europe are PHEV. European Union recently drafted a bill where every new or refurbished home has to be fitted with EV charging point. This bill which will come into effect by 2019[14] will boost the electric car market in Europe. Also the policymakers in these countries have focused on indirect consumer incentives since direct incentives are only a part of demand creation.

Country Wise Types of Electric Vehicles

In 2015, 90% of the electric vehicle sales were concentrated in the major eight electric car markets: China, the United States, the Netherlands, Norway, the United Kingdom, Japan, Germany and France. All these markets except Japan and the United States showed increase in demand. New registration with over 550000[15] vehicles was sold alone in 2015 which showed increased sales by 70 % between the year 2014 and 2015.

United States of America: There was rise of sales of electric vehicles up by 38[16]% in 2016 from year ending 2015.During this period 159,000[16] new vehicles were registered across the nation. Most of these sales came from the passenger vehicle segment. Out of the total EVs sold in US the major models sold were Tesla's Model S 18%[16] , Chevrolet's Volt 15%[16] and Tesla's Model X 11%[16]. Sales in California were about 50% of the total national sales with 60,412 units while the other 9 states with ZEV mandates accounted for another 25%.

China: The market share of electric cars was 1% for China during the period 2014-2015 which saw a threefold growth for the same. China overtook the United States as the largest maker for electric cars in 2015 with over 200,000[15] new registrations, which is more than the half of global new electric vehicle registrations. In China EVs market comprises of 2-wheeelers, cars and buses. Also in China BYD auto remained the largest manufacturer with 33[17] % market share, the domestic automakers still control about 96[18]% of the market share followed by tesla motors having 2[18] %, Porsche with 1 % and rest of the electric automakers having 1 % combined together. The Chinese company made cars are very cheaper as compared to other international players. This has helped them to gain large market share in a very quick span of time.

European Union: The three major markets in European Union for electric vehicles are Norway, Sweden and Netherlands. In 2015-16 the largest market in the European Union for electric vehicle is Norway followed by the Netherlands and Sweden. However in Norway the new cars entering the markets are BEVs whereas both the Netherlands and Sweden markets have been

[14] https://www.theguardian.com/sustainable-business/2016/oct/11/electric-car-charging-point-new-home-europe-renault (Accessed on April 18,2017)
[15] Global EV Outlook, 2016 (Accessed on March 25,2017)
[16] http://www.fleetcarma.com/ev-sales-usa-2016-final/(Accessed on March 25,2017)
[17] https://cleantechnica.com/2016/08/11/china-electric-car-sales-188-still-dominated-byd/ (Accessed on March 25,2017)
[18] https://www.theguardian.com/technology/2016/apr/18/netherlands-parliament-electric-car-petrol-diesel-ban-by-2025 (Accessed on March 31,2017)

more oriented towards PHEV. The top 5 selling BEV in the European Union in 2015 were Renault Zoe with 23.4[19]%, Nissan Leaf with 20.3[19]%, tesla Model S with 13.5[19] %, BMW i3 with 10.7[19] % and Volkswagen E golf with 7.3[19] % respectively. While the top 5 selling PHEV in the European Union in 2015 were Mitsubishi Outlander with 18.1[19] %, Volkswagen Passat GTE with 11.2[19] %, Volkswagen Golf GTE with 9.6[19] % , Mercedes c350e with 8.7[19] % and Volvo XC90 with 8.1[19] % market share respectively.

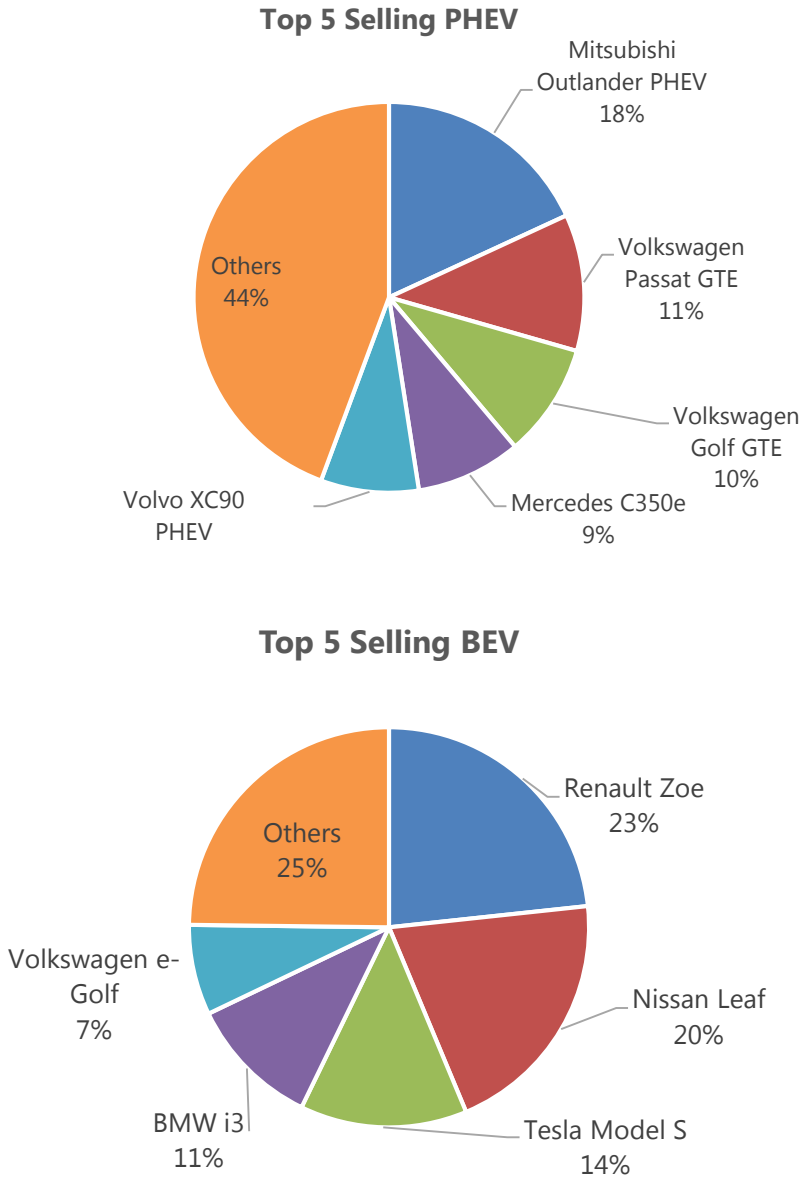

Figure 4: Top 5 most selling hybrid and electric vehicles (Source: European Alternative Fuels Observatory)

[19] http://www.eafo.eu/vehicle-statistics/m1 (Accessed on March 31,2017)

Indian Scenario of Electric Vehicle

Current Status of Electric Vehicle Deployment in India

India has a nascent market share of EVs as compared to the other 16 member nations of EVI worldwide. In 2014[20] the market share was just 0.1[20] percent among all member nations. The number of EV stock till 2015 was approx. 2689[20] units and the slow EVSE (charge infrastructure) was 328[20] units. FAME scheme became a key driver for the growth of electric vehicles in the period between 2015 and mid-2016. The BEV stock as of 2016 was approximately 4350 units while the PHEV stock was approx. 1660 units (International Energy Agency, 2016). Also new registration in this period was estimated to be 1000 (PHEV) units and 1000 (BEV) units (International Energy Agency, 2016).SMEV reported that electric vehicles sales grew by 37.5%[21] in FY 2015-16 at 22,000 units as compared to 16,000 units in FY 2014-15. Out of this 20,000 units comprised of two wheelers while only 2000 units were four wheelers.

The deployment of electric vehicles in India went through various stages in recent past. The electric vehicle deployment is governed by National Mission on Electric Mobility (NMEM) which is the pivotal body. Under this two apex bodies were constituted, where National Council on Electric Mobility (NCEM) was at the ministerial level and National Board on Electric Mobility (NCEB) was at secretary level.

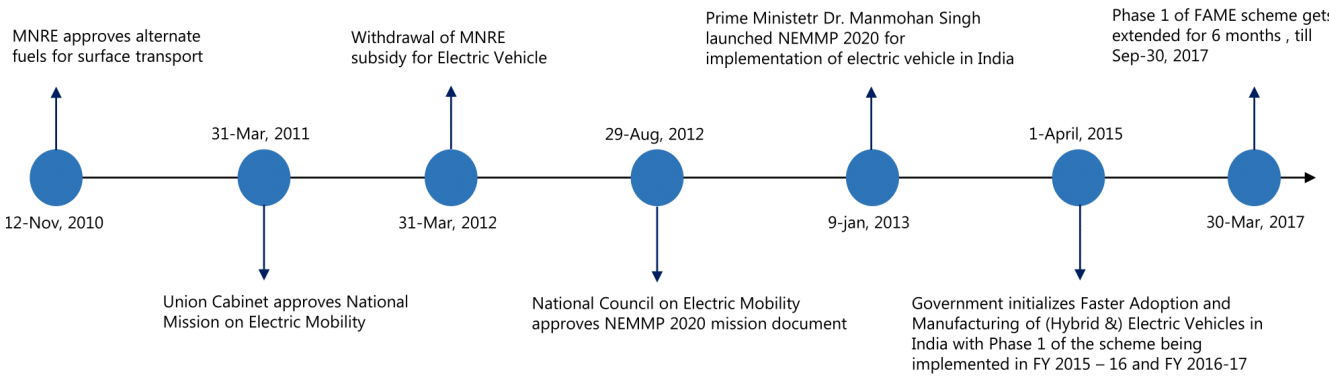

Figure 5: Initiatives taken by Indian Government for Electric Vehicle Deployment in India

The following factors have been identified as "key drivers" for accelerating the Electric Vehicle deployment in India. These factors were established after discussion with experts in the field of electric vehicles in India.

- Fluctuations in the oil prices.
- Government push for reduced CO_2 emissions and air pollutions
- Subsidy available for buying electric vehicles
- Improvement of technology and low ownership cost

[20] EVI-GlobalEVOutlook2015.pdf (Accessed on March 25,2017)

[21] http://www.smev.in/electric-vehicles-sales-grow-by-37-5-in-fy-2015-16/ (Accessed on March 25,2017)

Existing policy structure

To facilitate the aspirational target of having 6-7 million of Heavy Industries and Public Enterprises Shri Anant Geete launched a scheme for Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India also known as FAME in 2015. Other than this there is no policy for implementing EVs

FAME India Scheme, based on the Ministry of Finance's approval, came with an outlay of 795 crore under plan head for the initial period of two years i.e. phase 1 (2015-2017).

Table 3: Fund Allocation under FAME for 2015-16 and 2016-17 (in crores)

Components of the scheme	***2015-16 (in Rupees)***	***2016-17 (in Rupees)***
Technology platform (Including testing infrastructure)	70	120
Demand Incentives	155	340
Charging infrastructure	10	20
Pilot Projects	20	50
IEC/Operations	5	5
Total (Rs)	260	535
Grand Total (Rs)	795	

The scheme would be covered throughout the country in the following four areas:

a) Cities under Smart Cities Initiative

b) Major metro agglomerations- Delhi NCR,Greater Mumbai, Kolkata, Chennai, Bengaluru, Hyderabad, Ahmedabad

c) All states and other Urban Agglomerations /cities with 1 million populations (2011 census)

d) Cities of the North Eastern States

The vehicle segments which have been identified are two, three and four wheelers, cars, LCVs, Buses etc. and all forms of hybrid (mild/ strong), Plug-in and pure electric vehicle. These led to setting up of four sub groups which are vehicle system integration, motors and controllers and power electronics, batteries and battery management system and charging infrastructure. In each of these areas,centres of excellence will be set up to provide thrust and result oriented outcomes.

Key Components under Fame Scheme

This scheme also lists some demand (financial) incentive for the buyers. Vehicles under this scheme have been categorised based on the battery technologies present in them;

- Conventional battery: Battery with lead as the principle chemical element
- Advanced battery: New age batteries with Li &Ni as the primary element and etc.

The vehicles have been categorized into the proposed slabs based on their fuel efficiency. Based on these vehicle incentives have been classified into "Level 1" and "Level 2". The detailed formulation can be referred from the FAME press release and is beyond the scope of this paper

As per the proposed minimum fuel consumption improvement under FAME, the demand side incentives (Financial) for segment wise range is as follows.

BEV	(advanced battery) Scooter (Rs) 17000/- Motorcycle (Rs) 23000/- 3 wheeler CNG/HSD (Rs) 45000/- 3 wheeler petrol (Rs) 51000/- 4 wheeler(Rs) 76000/- LCV CNG/HSD (Rs) 156000/- Bus (Rs) 5100000/-	advanced battery) Scooter (Rs) 22000/- Motorcycle (Rs) 29000/- 3 wheeler CNG/HSD (Rs) 54000/- 3 wheeler petrol (Rs) 61000/- 4 wheeler(Rs) 124000/- LCV CNG/HSD (Rs) 187000/- Bus (Rs) 6100000/-
Mild HEV	(Conventional battery) Scooter (Rs) 1800/- Motorcycle (Rs) 3500/- 3 wheeler CNG/HSD (Rs) 3300/- 3 wheeler petrol (Rs) 3300/- 4 wheeler (Rs) 13000/- LCV CNG/HSD (Rs) 17000/- Bus (Rs) 3000000/-	(Conventional battery) Scooter (Rs) 2200/- Motorcycle (Rs) 4200/- 3 wheeler CNG/HSD (Rs) 4000/- 3 wheeler petrol (Rs) 4000/- 4 wheeler(Rs) 16000/- LCV CNG/HSD (Rs) 20000/- Bus (Rs) 3600000/-
	Level 1 **Minimum Incentive**	**Level 2** **Maximum Incentive**

Figure 6: Demand Side Incentive under FAME Scheme

Other policy incentives for electric vehicles apart from the mentioned in FAME scheme are:

- Registration of electric vehicles is not required and is approved by the Government of India
- Insurance and road tax are not required for electric vehicles and is approved by the government of India
- License for riding electric vehicles are exempted by the Government of India

Key Challenges

Electric vehicle deployment still remains a challenge in India. Even after FAME was implemented in 2015 these challenges still remain a roadblock. The key three challenges which are impacting market growth are:

1. Business challenges
2. Commercial challenges
3. Policy and Incentive challenges

Business challenges

One major stakeholder in implementing EV in this country will be the industry or business houses. These are consortium of auto manufacturers, OEM makers and battery makers. Both existing and new players will have different scope and scale of challenges. In this paper is restricted only to the current challenges faced.

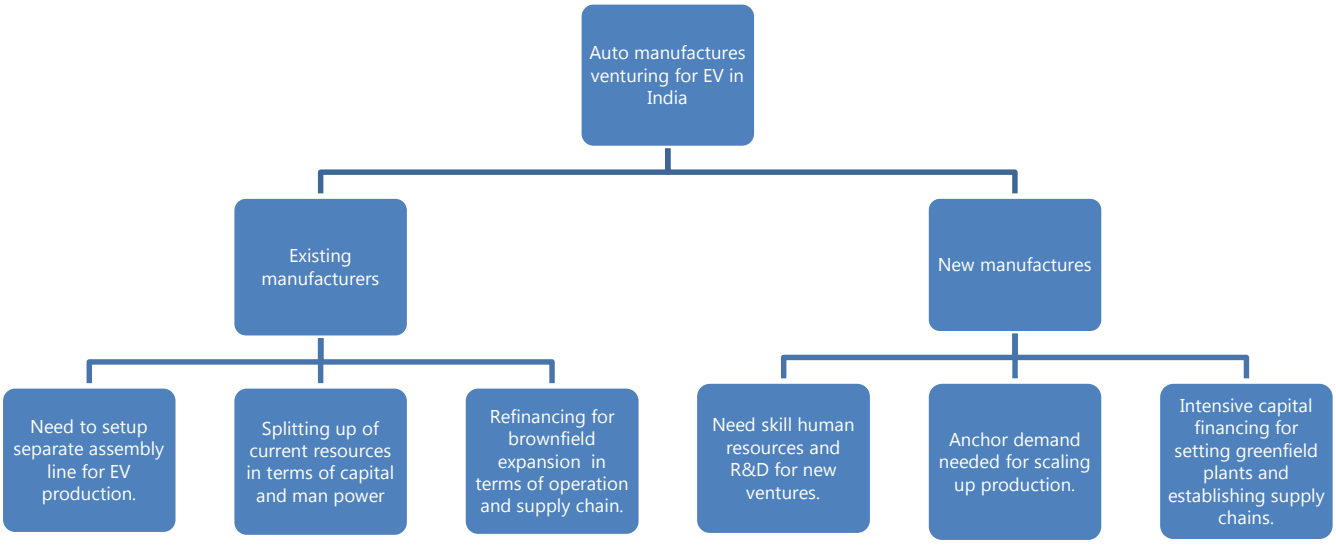

Figure 7: Current Business Challenges for Electric Vehicles in India

The incentives under FAME allocate an outlay which has not been able to create momentum among the industry players. This can be linked to the fact that there is no clear outline on policy and funding strategy aimed towards EV manufacturers. Also both new and existing automobile manufacturers have their separate concern for electric vehicles. New entrants are hesitant to invest huge capital whereas existing players don't want to have large inventories which might remain unsold.

Commercialization challenge

It is an interlinked challenge involving three stakeholders who are government, consumers and the manufacturers. Commercialization challenge has led to growth stagnation of electric vehicles in India. This involves both challenges arising from demand side and supply side of electric vehicle commercialization. While demand side challenges are more focused towards the consumer perspective, the supply side challenges are oriented towards other stakeholders. Commercialization challenges can be related to project lifecycle, this means that the challenges will start during the initiation and continue till the mid stages. These challenges will lessen in magnitude with time and when electric vehicle market reaches maturity.

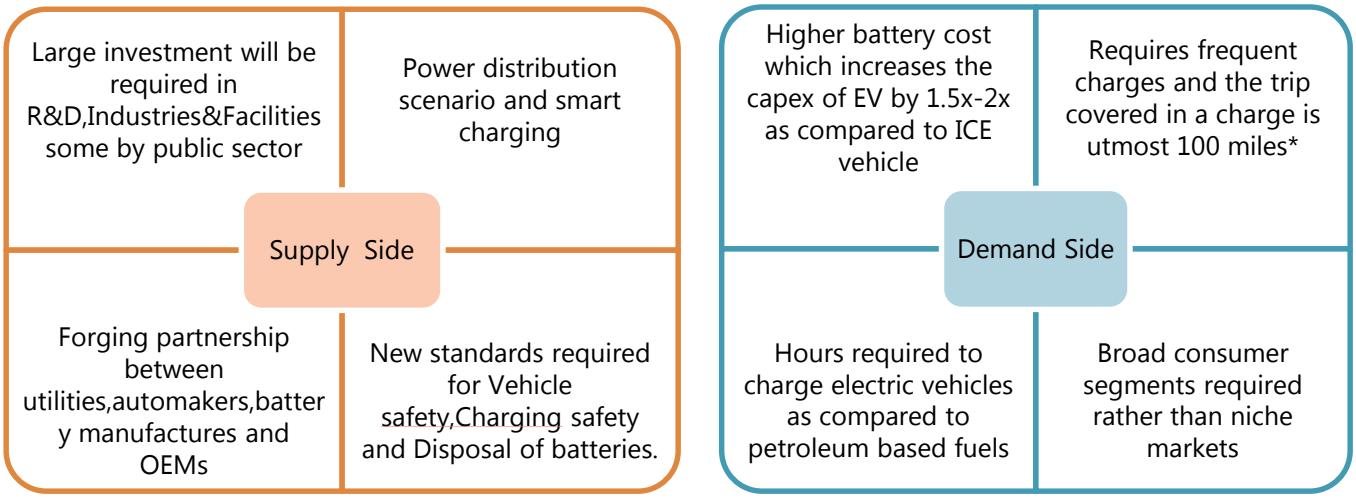

Figure 8: Commercialization Challenge of Electric Vehicle in India – Supply Side and Demand Side

Policy and incentive challenges

Earlier in 2010-2012 MNRE had implemented Alternate fuels for surface transportation program an expenditure of Rs.95[22] crore. This incentive focused only the OEMs who were provided this for electric vehicle manufacturing. This being a limited intervention incentive didn't catalyze any major vehicle or component innovation activity by the industry. These meant areas under technology, charging infrastructure and demand-supply side challenges were not covered. The drawback of this policy was that the corpus of the incentive was inadequate for a market where EVs was a new concept. Also when MNRE withdrew the subsidy due to its own liabilities the EVs sales showed a massive decline by almost 65% between FY 2012-2013.

The proposed allocation of Rs 22,000 crores[23] under NEMMP for EV deployment and development remained in the proposal stages. GOI intended to fund 13,000-14,000 crore over an 8 year timeline but these incentives couldn't materialize into any policy or mandate. Allocation under FAME scheme is only on a pilot basis hardly could create enough demand generation. The scheme failed to provide the visibility of the incentives to the common people. So these challenges have largely prevented the commercialization of electric vehicle in India. Also both consumers and the producers are at loggerheads when it comes to EV as each stakeholder is citing their own issues.

Stakeholder Analysis of Electric Vehicle

Electric vehicle development and commercialization needs various stakeholders to come to a common platform under the electric vehicle ecosystem. The ecosystem is a bird's eye view of the different tier of the value chain. Each tier represents the different stakeholders under it. The tiers are represented as follows

[22] Rajya Sabha Unstarred Question 3881 (Accessed on March 15, 2017)
[23] NEMMP 2020, Government of India Report (Accessed on March 15, 2017)

- Tier 1: Industry
- Tier 2: Consumer
- Tier 3: Statutory bodies and other agencies

Stakeholders are one of the key elements of the electric vehicle value chain. The stakeholders' will play pivotal role in the commercialization of electric vehicles. Also all stakeholders need to assess the changing landscape of EV technology. The electric vehicle ecosystem is represented in the diagram below.

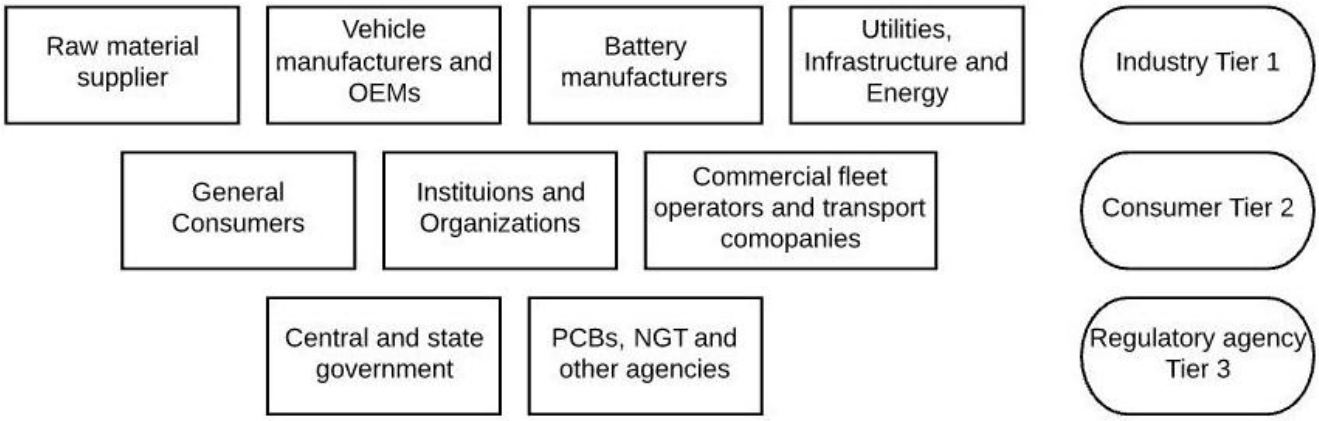

Figure 9: Stakeholders across different tiers in Electric Vehicle Value Chain

The value chain analyses the issues that is preventing each stakeholder to adopt electric vehicles. Also each of the stakeholders has unique challenges

Tier1: Industry

One of the critical elements that can shape the dynamics of the industry. The stakeholders which come under this are discussed below

- **Raw material suppliers:** The raw materials needed for manufacturing EVs are almost similar to that of a conventional vehicle. The key raw materials are required for chassis, drivetrain, suspension engine and battery manufacturing. Aluminum is widely being used as a major raw material as automakers are shifting their focus on better fuel efficiency and lighter vehicles. Prices of aluminum in India have remained flat over the last 1 year with only 2.07[24]%., although global prices fluctuated due to excess supply than demand. The consumption of aluminum is estimated to grow at 6-8%[25] per annum. The primary demand comes from the power sector while the secondary demand comes from the automobile sector. Together these sectors consume nearly 60%[26] .The key players of this industry in India are Hindalco, Nalco and Balco (subsidiary of Vedanta), all these

[24] http://profit.ndtv.com/commodity/aluminium-price_aluminium (Accessed on March 25, 2017)

[25] https://www.equitymaster.com/research-it/sector-info/aluminium/Aluminium-Sector-Analysis-Report.asp (Accessed on March 25, 2017)

[26] http://economictimes.indiatimes.com/industry/indl-goods/svs/metals-mining/aluminium-consumption-in-india-to-grow-from-3-3-million-tonne-to-5-3-million-tonne/articleshow/54738630.cms (Accessed on March 25, 2017)

firms are involved in extraction and refining of aluminum and aluminum alloys. Challenges that aluminum producers are facing are:

- Cheap aluminum imports from ASEAN specially China are preventing domestic players to invest in R&D and technological innovations for new age aluminum composites
- Primary and Secondary aluminum producers are yet to arrive at an consensus on minimum import pricing
- Another raw material required is lithium. Lithium is replacing lead for battery manufacturing due to improvement in battery technology. Lithium is concentrated in few parts of the world specially China, Chile and Australia. As prices are controlled by these major producers their range through long-term contracts has been in between $8,000 to $10,000[27] per tonne while the Chinese spot prices are as high as $20,000[28].Currently lithium carbonates and lithium ion cells are completely imported in India. Challenges that lithium carbonates and battery importers face are
- The preferential trade agreement between India and Chile has few allocations for lithium imports
- High import duty for lithium battery components in India which is around 26.50%[29]

- **Vehicle manufacturers and OEMs**: Electric vehicles have advanced in terms of propulsion and transmission technologies. Also converting existing vehicles into mild hybrids requires special type of retrofitting and kits. Indian automobile market is the fifth largest in the world with the auto component export increased at a CAGR of 11.31[30] % in the financial year 2015-16. Favourable policies such as the automotive mission plan 2006-2016 have led to the emergence of India as aglobal automotive components hub. The government has already allowed 100%[31] FDI in this sector. Also vehicle manufacturers have seen a demand growth of 9-11%[32] in FY 2016-17.Again this growth was observed from passenger vehicle sales especially in the small cars and compact utility segments. Currently only Indian automakers and OEM makers are manufacturing electric vehicles and components. Also the electric vehicles presently sold in India are largely two-wheelers and few four-wheelers. The major commercial players currently present in India are Hero electric and Electrotherm for two wheelers. Mahindra Reva a subsidiary of Mahindra and Mahindra is the only commercial four-wheeler electric vehicle maker. Other players like Maruti Suzuki and Toyota only manufacture and sell mild hybrids on a small scale. Few major automakers in the country namely Maruti Suzuki India limited, Mahindra and Mahindra Ltd, Mahindra Reva Electric vehicles private Ltd, Ford India Pvt.Ltd and Tata Motors Ltd have created a consortium to create a supplier base for electric vehicles components economically. The project code named xEV One aims to develop for hybrids and pure electric vehicles. . The government under DHI has sanctioned Rs. 22 cr for the project xEV One while the other private parties will fund Rs.4.4cr[33] for every model they make.

[27] http://blogs.ft.com/ftdata/2016/04/14/lithium-price-on-the-rise/ (Accessed on April 18, 2017)
[28] http://fortune.com/2016/06/06/lithium-price-tesla-metal-future/ (Accessed on April 18, 2017)
[29] https://www.zauba.com/customs-import-duty/lithium-battery-/india.html (Accessed on April 5, 2017)
[30] http://www.ibef.org/industry/auto-components-presentation (Accessed on April 5, 2017)
[31] http://www.makeinindia.com/sector/automobiles (Accessed on April 5, 2017)
[32] https://www.crisilresearch.com/industryasync.jspx?serviceId=7&State=null#storyId#7777700005790#sectionId#2594#newsFeedId#undefined
[33] http://www.livemint.com/Industry/kxHCpLgEYd2L9WBuwJESYJ/Car-firms-collaborate-for-electric-vehicles-cause.html (Accessed on April 18, 2017)

The issues faced by vehicle manufacturers and OEMs are

- Higher tax rate of 28%[34] on the auto-components leading to rise in counterfeit and substandard products
- 200%[35] weighted deduction on R&D expense still not been implemented by the government
- High import duty between the range of 60-100%[36] for CBUs and SKDs preventing innovations in electric vehicles

- **Battery manufacturers**: Battery is a critical component for BEVs and PHEVs as a major source of power. EV manufacturers worldwide are adopting Lithium ion batteries. Lithium-ion batteries have higher energy density as compared to traditional lead acid battery. This high energy density is an essential feature for the range of the vehicle. In India Lithium battery are still in developmental stages and those used in electric vehicles are imported from China, Taiwan, South Korea and Japan. The Indian battery manufacturers are more involved in lead acid based conventional battery and energy storage devise. The major battery manufacturers in India are Exide industries, Amara raja batteries, HBL power systems and Base Corporation. The issues faced by the battery manufacturers are:

  - High import duty on the raw materials for manufacturing of lithium batteries
  - Absence of government incentives for development of new battery storage technology

- **Utilities, Energy and Infrastructure**: These stakeholders will develop and provide the auxiliary services for electric vehicle rollout. The current statuses of these services are discussed below.

  - Electricity being the heart of the whole electric vehicle ecosystem is a challenge for a large country like India. The challenge is especially when states and cities are plagued by power outages. During the period between FY 2013-14 the power deficient was as high as -18,583[37] MU. The peak deficient during this period was -3,160[37] MU in the northern region while the overall net deficit in the country for the same was -42,428 MU which was -4.2 percent between the demands and supply. Although India achieved a power surplus of 13,252 MU[38] which was 1.1 percent of the difference between demand and supply owing to the surplus in western and southern parts. The situation is critical as most of the deficit is due to the high aggregate and transmission losses (AT&C), transmission and distribution constrains and poor financial condition of state power utilities.
  - India's energy mix generally comprises of fossil fuels which is also the major source of generation of power according to CEA report in 2016 the new capacity additions were in tune of 16,654.5 MW[38] in which the share of the thermal power was 13,440.5 MW. Utility and power companies also need to factor in alternate sources of energy i.e. renewable energy for meeting demand since the primary goal for using electric vehicle is to reduce the pollution and the greenhouse gases emission and reducing dependency on fossil fuel will be a step towards it.
  - Most of the public chargers setup till date is by Mahindra electric mobility limited. There are no other private entities that have setup EVSE on a large scale. Also there is no classification on the type of charger or EVSE that is currently

[34] http://profit.ndtv.com/news/budget/article-restore-weighted-deduction-of-200-on-r-d-expenses-auto-component-makers-body-1644670 (Accessed on April 28, 2017)

[35] http://auto.ndtv.com/news/mixed-reactions-to-union-budget-2017-from-auto-sector-1654797(Accessed on April 28, 2017)

[36] http://www.siamindia.com/economic-afairs.aspx?mpgid=16&pgid1=18&pgidtrail=20 (Accessed on April 28, 2017)

[37] Lok Sabha unstarred question number 919 (Accessed on April 18, 2017)

[38] http://www.cea.nic.in/reports/annual/lgbr/lgbr-2016.pdf (Accessed on April 18, 2017)

deployed. Similarly, price continues to be a constraint for new Level2 or DCFC charger setup. Availability of charging stations on real tie basis is also absent. The issues that need to be addressed for these services are:

- Large capital investment for replace dwindling transmission infrastructure and achieve higher plant load factor
- Setting up of real time metering for encouraging charging during off peak hours
- Involvement of government for providing legal clearances on installation of new charging stations

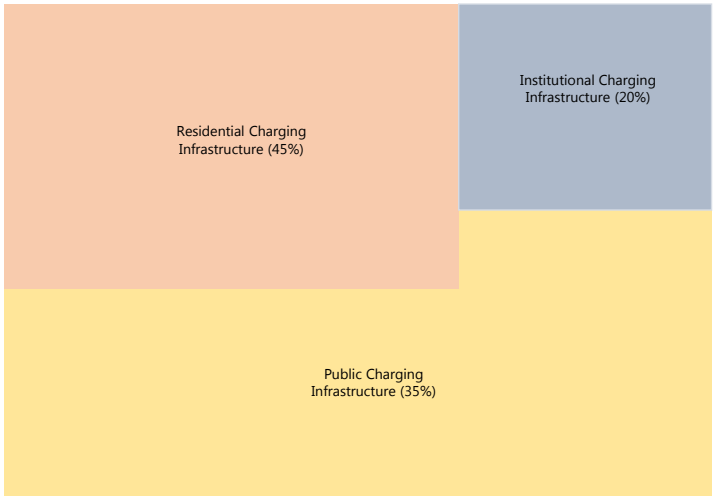

Figure 10: Assessment of necessity of charging infrastructure for residential, institutional and public usage

Table 4: Incentive provided for non-residential EVSE setup in United States

Incentive Example	***Incentive Description***	***Base EVSE unit cost***	***EVSE unit cost after incentive***
Income Tax credit (Level 1)	Income tax credit for 20 % of the cost of EVSE up to $2,500	$4,000	$3,200
Level 2 Rebate	$1,000 rebate on the purchase and installation of Level 2 EVSE	$3,000	$2,000
DCFC Rebate	$15,000 rebate for the purchase of DC fast charge EVSE	$30,000	$15,000

Tier 2: Consumers

They are important element when it comes for electric vehicle commercialization and deployment. Consumers will shape the dynamics of this emerging technology. This tier is broadly classified into three stakeholders. These are general consumers (people using personal vehicles), institutional consumers and state run public transports or commercial operators. The stakeholders are discussed below

- **General consumer:** They are the most important stakeholder around which the EV concept revolves. The transition of electric vehicle has been more observed in the 2wheerler segment in India. As mentioned earlier out of the total sales of 22,000[21] electric vehicles 20,000 came from two wheelers. Another important segment is small cars and compact utility. Hero electric and Electrotherm are the major manufacturers of electric two-wheelers in India. Also, Mahindra Reva is the only manufacturer of EV in India. Other manufacturers like Toyota and Maruti Suzuki have mild hybrids present in the Indian

markets. Since Mahindra Reva is currently the only available EV it is observed that there is large gap in the Indian market for passenger vehicles. Also lack of available models from Indian and international automakers have led to slowdown for EV among people. Although the running cost of electric vehicle is low as compared to conventional vehicles but the high upfront cost has acted against the customer sentiments. The cost benefit analysis was done for the electric vehicles with respect to conventional vehicles showing the result. The key issues faced by the consumers are:

- Upfront price of the vehicle and battery replacement cost
- Presence of public charging infrastructure causing range anxiety among EV owners
- Lack of continued subsidy provided by the government to EV owners
- Lack of awareness among the people regarding electric vehicle

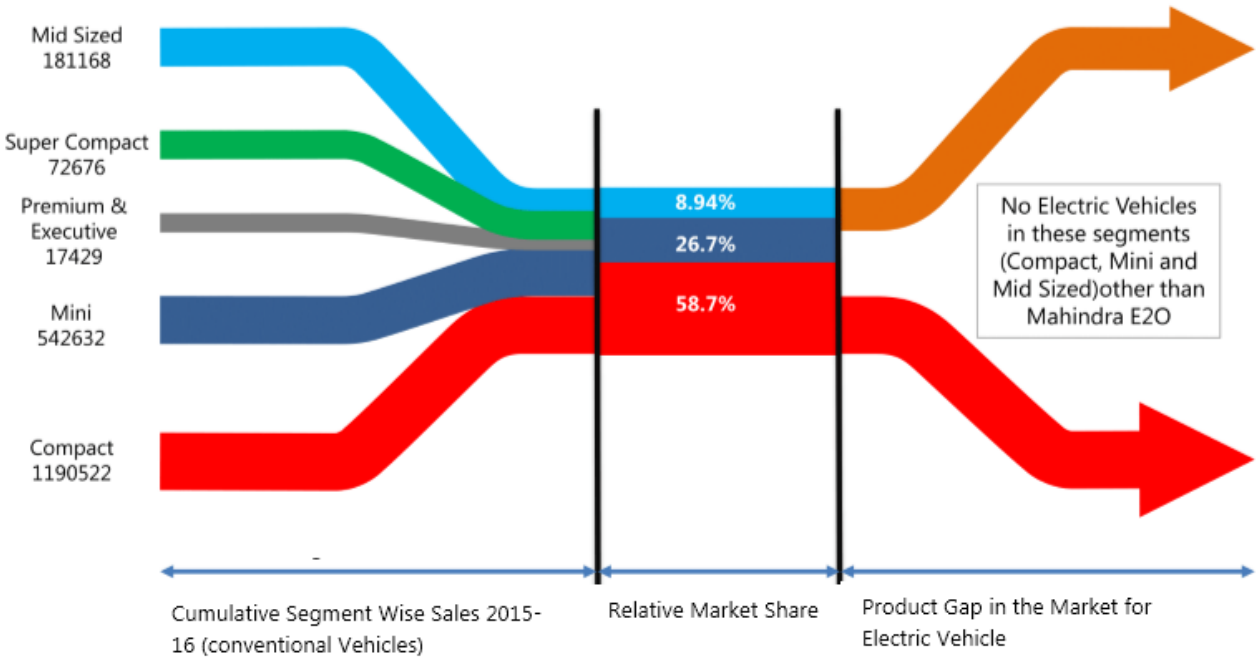

Figure 11: Product Gap in Electric Vehicles as compared to Conventional Vehicles

- **Institutions, SEZ: These stakeholders include offices, IT parks, schools and others.** They have important role in both developing electric vehicle charging stations in their premises and also promoting employees to buy EVs. The institution usually provides financial assistance for the employees buying EVs. It also provides free charging facility for the employees. The EVs used in the institutions and others are mostly BEV and PHEVs. In Bangalore similar initiative has been taken by SAP labs. The firm has provided green allowance for EV buyers and pays 75%[39] of the car EMI. It also has installed free charging stations in the campus for the EV owners. Other major institution like Bangalore International Airport Limited (BIAL) has setup several

[39] http://economictimes.indiatimes.com/industry/auto/automobiles/fostering-electric-vehicle-ecosystems-for-india/printarticle/29921296.cms (Accessed on April 21, 2017)

charging stations on the premises with assistance from Mahindra. It also provides discount on the parking for electric vehicles. This stakeholder will play an important role in installation of public charging station. Currently the number of community/public charging station is 218[40] in India.

A large part of these are basic chargers. The number of fast chargers' setup in India is represented by the table below.

Table 5: City Wise Number of Free and Paid Charging Points[41]

City	Free charging points	Paid charging points
New delhi	23	-
Bangalore	16	-
Kolkata	18	-
Pune	12	-

The key issues faced by these stakeholders are

- No financial assistance from state or central government for setting up charging infrastructure
- Inadequate number of charging points giving rise to charge rage
- Commercial fleet operators and transport companies: Traditionally commercial fleet operators including cab aggregators and transport companies mostly ply diesel vehicles. Few of them use CNG and petrol vehicles for shorter trip lengths. Other ride hailing services Other ride-hailing services are those who have service level agreements with BPO and ITES industries for catering the transportation needs of the employees, most of the company cab fleet is made up of multi-utility vehicles like Toyota Innova, Mahindra Xylo, Chevrolet Enjoy etc. powered by diesel drivetrain and provide pickup and drop facilities within a radius of 25-30kms inside city limits. Currently no such electric vehicle is present in this segment. The two models by Mahindra especially Reva and eVerito are present in the compact and subcompact cab segments. Lithium cab a non-app based cab service based out of Bangalore is the only operator of electric cabs in India. Their operation is based around B2B model where the corporates pay user charges in form of rents. Also users and cab operators together have setup charging infrastructure inside the office premises. Other car rental companies like CARZONRENT and ZOOMCAR have deployed electric vehicles on a self-drive basis. These are currently present on a very small scale and are presently available in New Delhi, Mumbai and Bangalore only. Although cost benefit analysis shows EV cabs are cheaper to run as compared to conventional cabs, lack of charging infrastructure makes it difficult for B2C operations. Another important segment is transport companies comprising of public and private transport. This segment is purely depended on electric buses. Electric buses are imported from BYD a Chinese based company since there is no commercially available Indian manufacturers. Goldstone infratech ltd.is the only Indian firm who assemble BYD buses in India. Electric buses have been deployed by DTC, BMTC and BEST but only as a pilot project. HRTC is also running electric buses on a trial basis between Manali and Rohtang, followed which it will decide to commercially deploy electric buses. The issues faced by these stakeholders are:
    - High upfront cost of imported electric buses creating financial pressure for transport companies
    - Lack of available public charging stations preventing cab operations in B2C model
    - Lack of available models from Indian manufacturers

[40] http://www.pluginindia.com/charging.html (Accessed on April 21, 2017)

[41] https://www.mahindrae20plus.com/pages/charging/charging-points (Accessed on April 21, 2017)

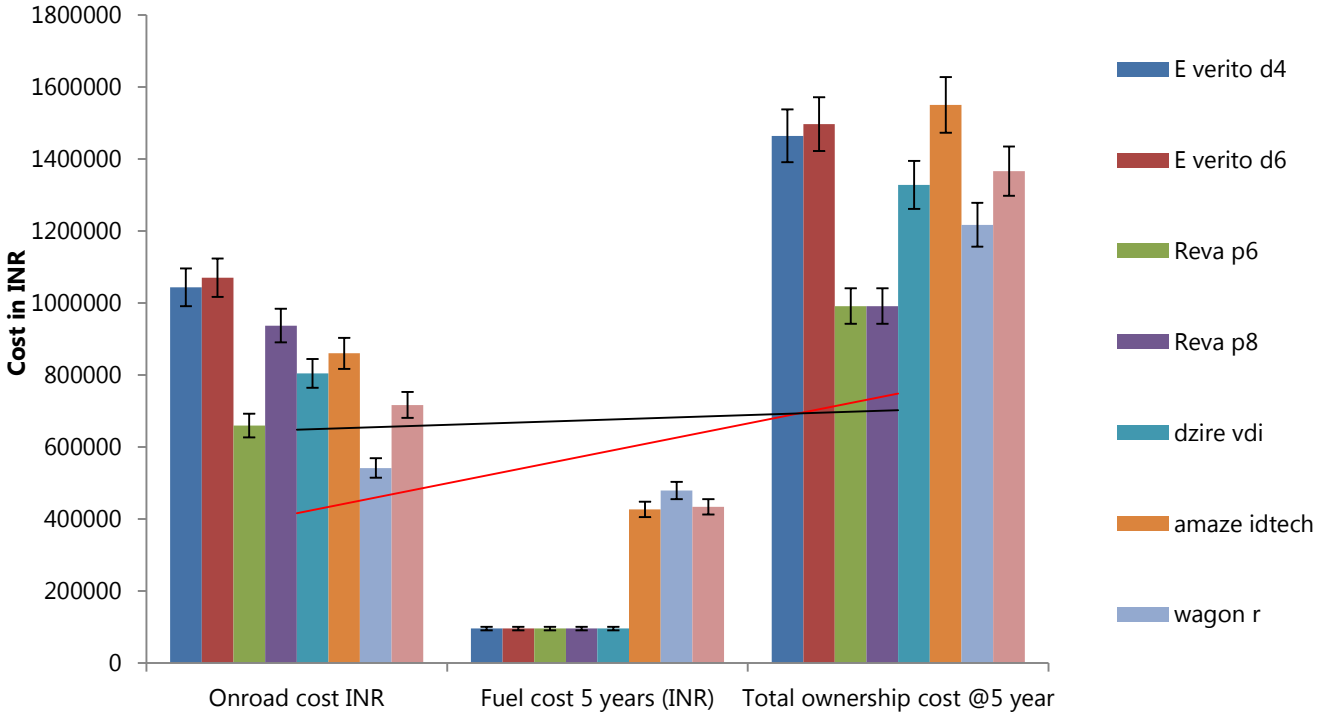

Figure 12: Cost Analysis of Vehicles under mini, compact and super compact segments[42]

Tier 3: Statutory bodies and other agencies

Government has to play a proactive role in both the demand and supply creation of EV. Also this stakeholder has to align both industry and consumer for quicker rollout of electric vehicle in India. The stakeholders under this tier are discussed below.

- **Central and state government**: Both central and state governments have an uphill task when it comes to EV deployment. Back in 2010 when MNRE came up with subsidy for alternative fueled vehicles it lacked a clear vision of the objectives that it wanted to achieve since it was done on a trial basis. Also after the withdrawal of the subsidy there was a steep decline in the purchase of electric vehicles. Also there is no clear policy for electric vehicle adoption under FAME. The FAME subsidy of 795 and FY 2016-17 is also based on pilot projects. This budget allocation which will not help to develop large scale commercialization of EV since it is insufficient for both the consumers and the manufacturers. The subsidy provided by the central government is only on the upfront cost of the electric vehicle based on vehicle specification mentioned under FAME. Some state governments like Delhi provide additional incentives along with FAME incentive for electric vehicle while others states don't have such provision. There is no subsidy provided by the government for battery replacement. Also there are no regular incentives like waiver of toll charges, road tax and parking fees provided by the state or central government to the consumers. Similarly, for the industry there is no incentive provided in terms of excise duty, import duty and VAT on sales of the vehicles. The role which central and state government has to play for EV commercialization:

[42] Prices of the vehicles have been taken from cardekho.com and respective dealers. The cost component includes on road price, fuel running cost for 5 years and total ownership cost at 5 years. *Price as on March 28, 2017

- Providing fiscal and financial incentives to both manufacturers and consumers
- Creating awareness among the consumers for EV

- **PCB, NGT and SC**.: Statutory bodies have lately been active in checking vehicular pollution in many cities in India. Even though the decisions that came till date were related to ban of old diesel vehicles and vehicles failing under latest emission standards. Recently government agencies have started levying additional pollution cess ranging from 1-4%[43] on conventional vehicles. As per current policy implementation by NGT only electric buses are allowed to run between Manali and Rohtang for public transport. Also banning sale of BSIII diesel vehicles can force consumers and manufacturers to look for alternative vehicles, which in turn can boost the EV market in India. PCB along with NGT are also considering amending battery management and handling rules 2001, amended in 2010 which will make traditional battery manufacturers to develop new age lithium batteries. The role of these statutory bodies for EV rollout would be:

  - Regulation the number of old conventional vehicles to ply on roads
  - Designating special green zones where only electric vehicles can run
  - Directing central and state government to impose tighter emission norms for conventional vehicles
  - Also implementing standard guidelines for EV specification and battery disposal

The Need for State Push

Government needs to play an important role for commercializing electric vehicles in India. Although government recognized a roadmap for EVs in form of NEMMP 2020 back in 2012 and subsequently FAME in 2015. There are still key challenges which every other stakeholder is facing thus preventing them to adopt EVs. The government role should not just limit to incentives (fiscal and financial) and regulations. It has to address the challenges of each stakeholder separately and align them along the same objective.

Government and industry: The steps that government should take so that industry takes a lead regarding EV development and deployment. This involves a comparative description of the existing issues and the recommendations for the same. This has been represented in the table below.

[43] https://capitalmind.in/2016/02/budget-2016-pay-pollution-cess-on-cars-and-even-more-on-suvs/ (Accessed on April 5, 2017)

Table 6: Industry Challenges and ways to mitigate them

Stakeholder	Key Issues	Government's Role	Current Status
Raw material suppliers	1. Cheap aluminum imports from ASEAN preventing domestic players to invest in R&D and technological innovation for new age aluminum composites 2. Primary and secondary aluminum producers yet to agree on minimum import pricing 3. High import duty for lithium battery components which is around 26.50%	1. Imposing anti-dumping duty for cheaper aluminum imports 2. MIP which is still under consideration needs to be implemented to promote indigenous R&D in aluminum sector 3. Reduction on current import duty of lithium battery component	1. Not implemented on aluminum for vehicle manufacture 2. Government yet to take final decision on MIP 3. Yet to be implemented
Vehicle manufacturers and OEMs	1. High tax rate on auto-components leads to rise in counterfeit and substandard product 2. High import duty for CBUs and SKDs preventing innovations for electric vehicles 3. Absence of weighted deduction on R&D expense	1. Lowering of tax rate for auto component makers that are related to EV manufacturing 2. Reduction on import duty for SKDs and CBUs initially to promote EV market 3. EV manufacturers should be provided weighted deduction or tax holiday for R&D	1. All components being covered under GST 2. Tax laws to change under GST
Battery manufacturers	1. High import duty for manufacturing of lithium batteries 2. Lack of incentives for development of new lithium batteries	1. Reduction on import duties for lithium ores to keep battery prices low 2. Battery manufacturers developing EV batteries should be provided incentives either in form of financial subsidy or tax breaks to promote innovations	1. No change on import duties for lithium ion battery 2. No incentive for developing electric vehicle
Utilities, Energy and Infrastructure	1. Large capital needed to upgrade existing transmission and distribution infrastructure 2. Lack of real time metering available for charging of electric vehicle 3. Lack of local bodies involvement in providing clearance for new charging station installation	1. Exemptions in corporation tax for companies installing public charging stations 2. Change in tariff metering methodology for the retail and institutional consumers 3. Providing assistance on obtaining municipal clearance and ROW for new charging station installation	1. No provision for exemption in corporation tax 2. Real time metering is still in infant stages 3. No policy for getting ROW regarding installation of charging station

Apart from the mentioned steps other incentives and regulations are also needed. These regulation and incentives will complement the existing scenario of electric vehicle in India. Some of these have been implemented by other major EV adopting nations. These are:

- Mandating existing auto manufacturers for having part of their sale come from electric vehicles
- Increasing the budget allocation for technology platform under the FAME scheme
- Implementation of sunset policy for old vehicles
- Building byelaws should mandate installation of charging points on every new building for EV

Most of these are related to the supply side for electric vehicle deployment. If these issues are mitigated they might impact the EV industry in the following ways:

- It will cheaper for the vehicle manufacturer to produce different models of EV
- The cost of lithium battery will fall which will again lower the price of the vehicle
- It will lead to innovation on better battery technology and upgraded electric vehicles
- It will lead to installation of more charging stations which will create demand for EV

Government and consumers: The steps that the government has to take for pushing the consumers to buy electric vehicles. This involves a brief comparison of the issues faced and the recommended steps that needs to be taken. It is represented by the table below.

Table 7: Challenges faced by General Consumers and Role of Government to mitigate them

Stakeholder	Key Issues	Government's Role
General consumer	• High upfront price and battery replacement cost of vehicles • Lack of public charging station for electric vehicle • Lack of continued other incentives for EV buyers • Lack of awareness among the buyers regarding electric vehicle	• Government needs to increase the subsidy cap for new vehicles and also provide subsidy during battery replacement • Local government needs to install more charging points in all public places • Government needs to provide continued incentives with respect to toll, parking and vehicle registration charges • Promotional campaigns needed for creating awareness among people • Reduction on the interest rate and prime lending rates by the government banks
Institution, SEZ	• Lack of financial assistance from government for installing charging infrastructure	• Government needs to increase the funds allocated for charging infrastructure under FAME
Commercial fleet operators and transport companies	• Lack of public charging infrastructure • High upfront cost for electric buses	• Government needs to provide additional subsidy for electric bus operators on vehicle cost and battery cost • Local government needs to setup more charging infrastructure • Additional financial and fiscal incentives need to be provided to transport companies

Other incentives and regulations also needed for the consumers to switch towards electric vehicle. Most of these incentives and regulations have been implemented by major EV adopting nation. Some of these are as follows:

- Continued fiscal and financial incentives for consumers purchasing electric vehicle
- Imposing higher tax excise duty and tax on diesel vehicles
- Restricting the registration of number of new conventional vehicles

Since these are related to the demand side of electric vehicle deployment they may have the following impact:

- Increased cost of conventional vehicles and subsidy on EV will make people switch towards EV

- Increases in demand will attract other car manufacturers for making EV which will lead to reduction of prices of vehicles through competition

Government and statutory bodies:

The role of government and statutory bodies will involve policy, regulation and incentives. These will be the key drivers for electric vehicle in India. Although the government planned for deploying 6-7 million electric vehicles a clear policy is needed to achieve this target. The policy needs to be backed along with regulations and incentives to push this EV program. A framework needs to be drafted for the same involving multiple key ministries which will fine tune existing program. It should be noted that all these implementations should involve both top-down and bottom-up approach for better optimization. The role of the government and statutory bodies and their impact on EV program is listed in the table below.

Table 8: Role of Government and Statutory Bodies for EV Program

Stakeholder	Role	Impact
Central and state government	• Provide subsidized electricity to EV owners based on real time metering and on actual usage • Pool account needed for raising funds for subsidy provided under FAME • Amendment of existing building by-laws for installing home charging sockets for new buildings • Disbursement mechanism should be formulated for battery replacement cost • Policy formulation for vehicle scrapping for personal vehicles by providing incentives	• Reduction in the operating cost of EV will attract more people to buy them • Increase in financial assistance will promote the manufactures to spend more on R&D of new vehicles and installation of more public chargers which will help to increase demand • Residential charging infrastructure will develop • Will help in reduction of the ownership cost of EV • Incentives will help people shift focus towards EV
PCB, NGT and SC	• Vehicle scrapping policy should also include the fitness of vehicle along with vehicle age as the parameter • Tighter emission control including ban on sale of conventional vehicles • Creation of restricted zones for preventing plying of commercial vehicles • Pollution cess for both buying and manufacturing of conventional diesel vehicles	• Consumers will shift their focus on buying electric vehicles • Making plying of conventional vehicle restrictive will drive both industry and consumers towards adopting EV • Price competition will work in favor of EV since conventional vehicles will become expensive following tighter emission technology incorporation

Recommendations for increasing incentive under FAME scheme: It is felt that the current allocation under the FAME scheme wouldn't be sufficient enough to upscale electric vehicle in India. Funding continues to remain a constraint when it comes to expanding the allocations under fame. Current subsidy savings from petroleum products and savings from crude oil bills can be considered in this regard. Following the fall in crude oil prices beginning in the year 2013 the government has been able to save Rs 371,564 crores with respect to import bill between FY 2013- 2016. Also subsidy savings on petroleum products like petrol, diesel, LPG and PDS kerosene between FY 2013 -2016 has been Rs. 133459 crores. A part of these savings can be used to increase the corpus of funds under FAME scheme. This increase will give a major boost to both manufacturers and consumers

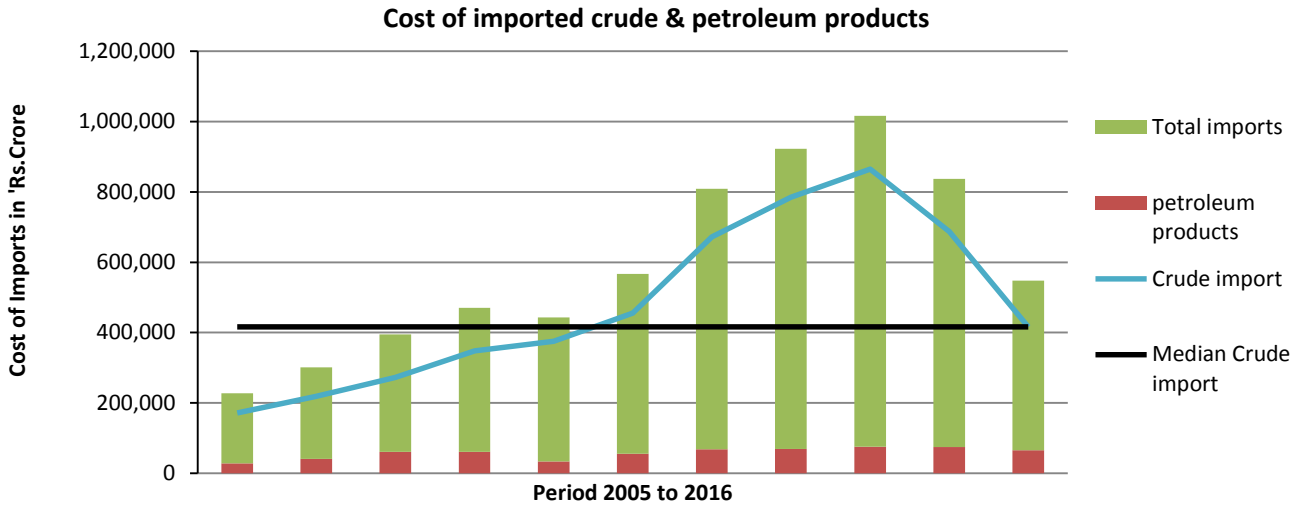

Figure 13: Savings on Import of Crude Oil and Petroleum Products[44]

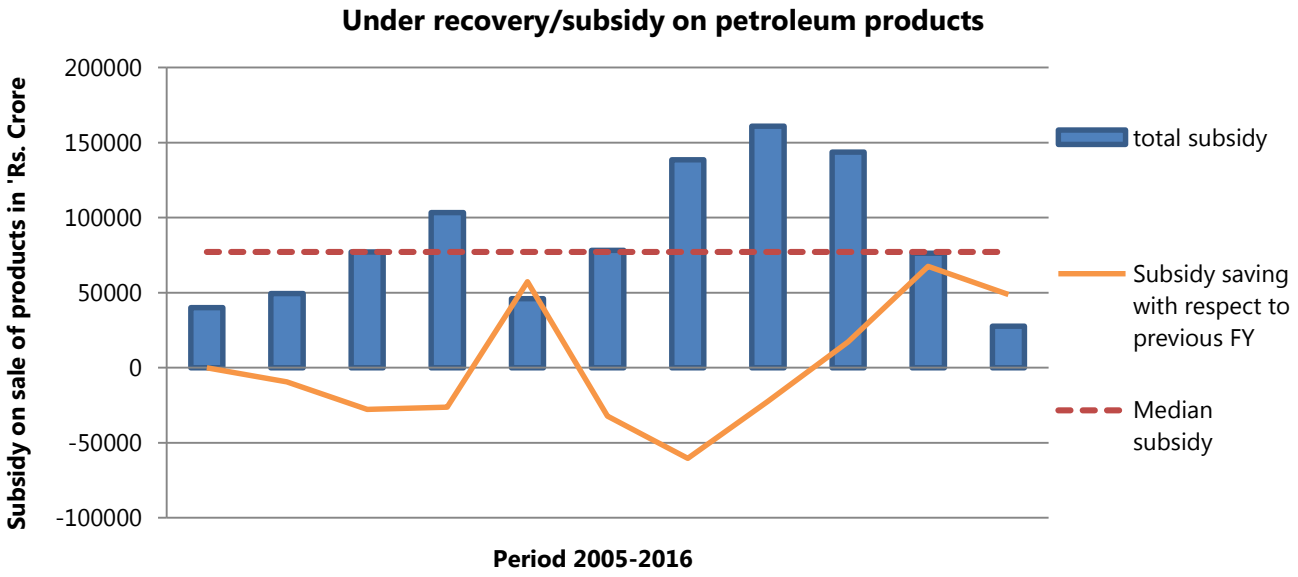

Figure 14: Under Recoveries/DBTL Subsidy on Sale of Sensitive Petroleum Products

[44] PPAC Oil and Gas Data, 2016 *Price as on April 15, 2017

References

A.T. Kearney & CII. (April 2013). *Cost Effective Green Mobility.* A.T. Kearney.

Aakash. (2016, Feburary 29). *Capitalmind*. Retrieved from https://capitalmind.in/2016/02/budget-2016-pay-pollution-cess-on-cars-and-even-more-on-suvs/

Accenture. (2015). *Electric Vehicle Market Attractiveness.* Accenture.

British Petroleum. (June 2016). *BP Statistical Review of World Energy.* BP.

Central Electric Authority. (2016). *Power Sector.* New Delhi: Ministry of Power.

Christopher Marquis, H. Z. (2013). China's Quest to Adopt Electric Vehicles. *Stanford Social Innovation Review*, pp. 52-57.

Department of Heavy Industry. (2012). *National Electric Mobility Mission Plan 2020.* Ministry of Heavy Industries and Public Enterprise.

Equitymaster. (2016, February 03).

European Environment Agency. (2016). *Elctric Vehicles in Europe.* Luxembourg: Publications Office of the European Union.

EY. (June 2016). *Electric Vehicles Adoption: Potential Impact in India.* EY.

Fortune. (2016, June 07). Retrieved from http://fortune.com/2016/06/06/lithium-price-tesla-metal-future/

Hern, A. (2016, April 18). *theguardian.* Retrieved from theguardian: https://www.theguardian.com/technology/2016/apr/18/netherlands-parliament-electric-car-petrol-diesel-ban-by-2025

International Energy Agency. (2016). *Global EV Outlook.* 2016: International Energy Agency.

Knight, B. (2016, May 18). *dw.com.* Retrieved from http://www.dw.com/en/germany-sets-out-major-cash-incentive-for-electric-car-buyers/a-19266326

Lytton, L. (March 2010). *The Potential of Low Carbon Vehicle Technology.* RAC Foundation.

Nelsen, A. (2016, October 11). *theguardian*. Retrieved from theguardian.

Office of Low Emmision Vehicles. (2013). *Grant Scheme for the installation of plug-in vehicle chargepoints on the UK Government and wider public sector.* London: Crown.

P.R. Shukla, S. D. (November 2014). *Promoting Low Carbon Transport In India.* UNEP DTU.

Pontes, J. (2016, August 11). *CleanTechnica*. Retrieved from https://cleantechnica.com/2016/08/11/china-electric-car-sales-188-still-dominated-byd/

Press Trust of India. (2017, January 04). *Profit NDTV*. Retrieved from http://profit.ndtv.com/news/budget/article-restore-weighted-deduction-of-200-on-r-d-expenses-auto-component-makers-body-1644670

Raj, A. (2016, June 15). *Livemint*. Retrieved from http://www.livemint.com/Industry/kxHCpLgEYd2L9WBuwJESYJ/Car-firms-collaborate-for-electric-vehicles-cause.html

Romei, V. (2016, April 14). Retrieved from http://blogs.ft.com/ftdata/2016/04/14/

Samir Karnik, N. S. (January 2013). *Electric Vehicles: Challenges and Opportunities in India.* Yes Bank & Teri.

Shikha Rokadiya, A. B. (December 2016). *Hybrid and Electric Vehicles in India.* ICCT.

Trigg, T. (2012). The Third Age of Electric vehicles. *The Journal of the International Energy Agency*, 30-31.

Tsang, P. (Feburary 2012). *Bringing the Electric Vehicle to the mass market.* Cambridge: RAND Europe.

Zhang, Y. (2016, August 29). *Bloomberg L.P US*. Retrieved from Bloomberg: https://www.bloomberg.com/news/articles/2016-08-28/most-of-china-s-electric-car-startups-face-wipeout-by-new-rules

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