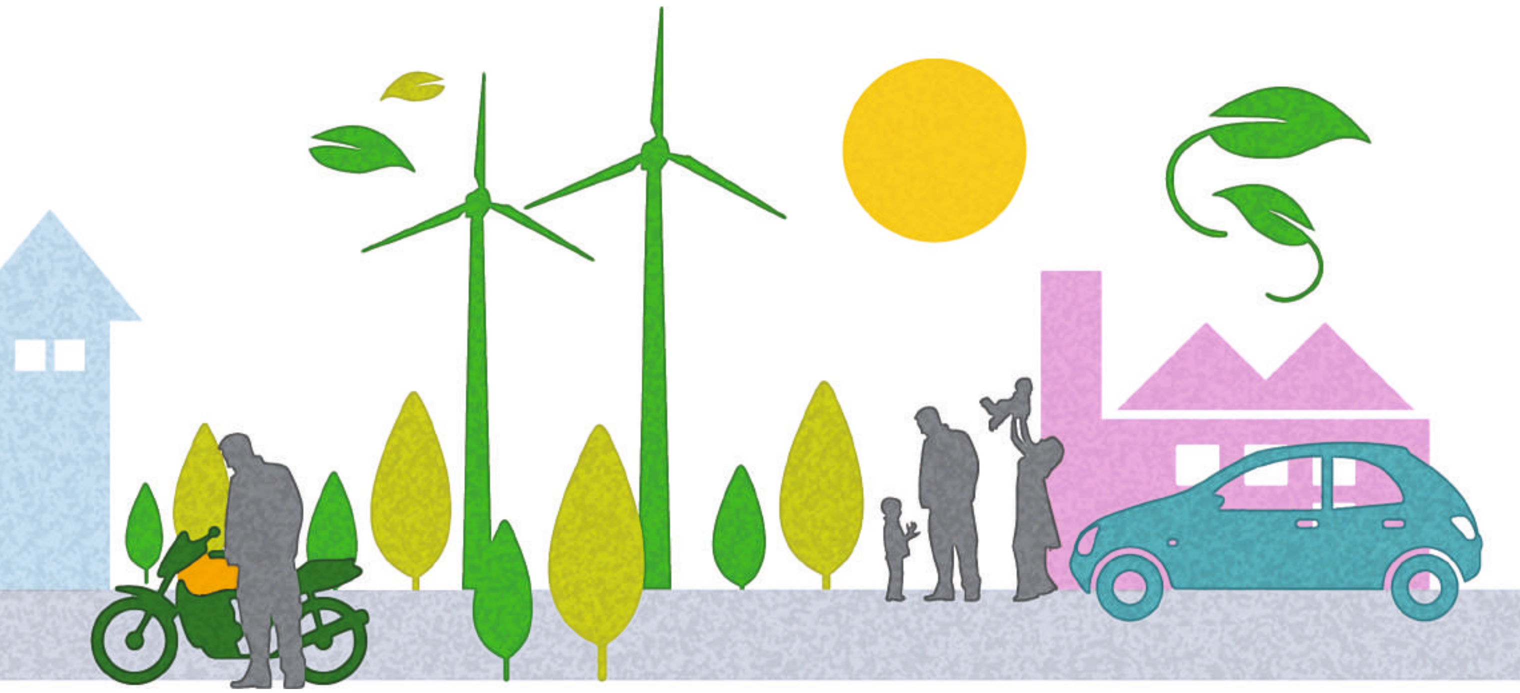
National Electric Mobility Mission Plan 2020



सत्यमेव जयते

Department of Heavy Industry
Ministry of Heavy Industries & Public Enterprises
Government of India

Vision Statement

"To encourage reliable, affordable and efficient xEVs that meet consumer performance and price expectations through Government - Industry collaboration for promotion and development of indigenous manufacturing capabilities, required infrastructure, consumer awareness and technology; thereby helping India to emerge as a leader in the xEV Two Wheeler and Four Wheeler market in the world by 2020, with total xEV sales of 6-7 million units thus enabling Indian automotive Industry to achieve global xEV manufacturing leadership and contributing towards National Fuel Security."

From the Desk of Hon'ble Minister for Heavy Industries and Public Enterprises

Shri Praful Patel, Hon'ble M (HI&PE)

The Indian automotive industry has made tremendous progress in the last decade. India has today emerged as the 6th largest vehicle manufacturer globally with the automotive industry contributing approximately 21 % to the country's excise duty collection.

2. This sector is important for economic growth and development because of its high contribution to the national GDP, employment generation and as it meets the needs of the logistics and transportation industry, which is the life line of the economy. The growth of the auto industry which, at present, contributes 22% to the manufacturing GDP will be critical for realizing the target, envisaged in the new Manufacturing Policy, of increasing the share of manufacturing in overall economy to 25% by 2022.

3. Continued high level growth of the Indian economy and the transportation sector is must for improving the lives of millions of Indians. However, with growth also comes the responsibility of meeting the associated challenges of fast depletion of traditional energy sources, rising energy costs, increasing oil import bill and the impact of mobility on the environment. It is, therefore, essential that we now invest in interventions that can help mitigate these challenges.

4. Exemplary Industry – Government partnership, clarity and joint ownership of the future vision through Automotive Mission Plan (AMP) 2006-16 have been instrumental in shaping the successes achieved so far. All forecasts point to the vast untapped potential that still exists for the Indian automotive industry. It is our duty to take steps to not only realize this potential but more importantly shape the future direction of the auto industry so as to promote and achieve sustainable growth. In-depth primary data based study conducted jointly by the Government and the Industry indicates the existence of high latent demand for environmentally friendly electric vehicle (xEV) technologies exists. However, strong upfront & continued support by Government would be essential to realize this demand. I believe that encouraging the faster adoption of xEVs (hybrid & electric vehicles) and their manufacture in India is a wise investment that we need to make for our future generations.

5. A common future roadmap for the National Mission for Electric Mobility (NMEM), on the lines of the AMP 2006-16, was essential to steer and synergize the efforts of all the stakeholders. I am very pleased that my Department, in consultation with all other stakeholders in and outside of Government, has prepared this comprehensive document: **'National Electric Mobility Mission Plan (NEMMP) 2020'** which will guide our flagship program in the future. I am confident that the continued proactive support of the Government and the combined efforts of all stakeholders shall enable us to realize the potential latent demand for electric vehicles by 2020. I would like to complement all those who are instrumental in giving shape to this vision document.

(Praful Patel)

New Delhi, August, 2012.

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Abbreviations

ACMA	Automotive Component Manufacturers Association
AFST	Alternate Fuels for Surface Transport
AMP	Automotive Mission Plan
ASDC	Automotive Skills Development Council
BEE	Bureau of Energy Efficiency
BEV	Battery Electric Vehicle
BHEL	Bharat Heavy Electricals Limited
BIS	Bureau of Indian Standards
BRIC	Brazil, Russia, India & China Group
CAGR	Compound Annual Growth Rate
CAR	Collaborative Automobile R&D
CDM	Clean Development Mechanism
CEM	Clean Energy Ministerial
CMVR	Central Motor Vehicle Rules
CNG	Compressed Natural Gas
CPCB	Central Pollution Control Board
CSIR	Council of Scientific & Industrial Research
DHI	Department of Heavy Industry
DIPP	Department of Industrial Policy & Promotions
DRDO	Defence Research & Development Organisation
DRT	Department of Road Transport
DSM	Demand Side Management
DST	Department of Science and Technology
ER-EV	Extended Range-Electric Vehicle
EVs	Electric Vehicles
FGD	Focused Group Discussion
GDP	Gross Domestic Product
GoI	Government of India
GW	Giga Watt
HEV	Hybrid Electric Vehicle

HG	High Gas
I&C	Inspection & Certification
IC	Integrated Circuit
ICE	Internal Combustion Engine
IEA	International Energy Agency
ITS	Intelligent Transport System
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
JVs	Joint Ventures
KPTCL	Kalpataru Power Transmission Corporation Limited
KW	Kilo Watt
LCVs	Light Commercial Vehicles
LPG	Liquid Petroleum Gas
MEML	Mahindra Eco Mobiles Ltd
MNES	Ministry of Non-conventional Energy Sources
MNRE	Ministry of New and Renewable Energy
MoEF	Ministry of Environment & Forests
MoF	Ministry of Finance
MoP	Ministry of Power
MoRTH	Ministry of Road Transport & Highway
MoUD	Ministry of Urban Development
MW	Mega Watt
NAB	National Automotive Board
NAPCC	National Action Plan for Climate Change
NATIS	NATRiP Implementation Society
NATRiP	National Automotive Testing and R&D Infrastructure Project
NBEM	National Board for Electric Mobility
NCEM	National Council Electric Mobility
NEMMP	National Electric Mobility Mission Plan
NMCC	National Manufacturing Competitiveness Council
NMEEE	National Mission for Enhanced Energy Efficiency
NMEM	National Mission for Electric Mobility
NMSH	National Mission on Sustainable Habitat
NPV	Net Present Value
NSDC	National Skill Development Corporation
NSM	National Solar Mission

OEMs	Original Equipment Manufacturers
PHEV	Plug-in-Hybrid Electric Vehicle
PMSM	Permanent Magnet Synchronous Motor
PPP	Public-Private Partnership
PSU	Public Sector Undertakings
R&D	Research & Development
SG	Sub Group
SIAM	Society of Indian Automobile Manufacturers
STU	State Transport Undertaking
SUV	Sports Utility Vehicle
SMEV	Society of Manufacture of Electric Vehicle
TIFAC	Technology Information, Forecasting and Assessment Council
TSC	Technical Standing Committee
USD	United States Dollar
VAT	Value Added Tax
VKT	Vehicle Kilometer Travelled
WG	Working Group
WG-R&D	Working Group for Research & Development
WG-DS	Working Group for Demand Supply
WG-Infrastructure	Working Group for Infrastructure
xEVs	Full Range of Electric Vehicles
2W	Two Wheeler
3W	Three Wheeler
4W	Four Wheeler

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Foreword

The Indian automotive industry is today amongst the fastest growing automotive industries globally. It is expected that, by 2020, the annual demand for passenger vehicles, commercial vehicles and two wheelers in India will be 10 million, 2.7 million and 34 million units respectively, thereby making India the third largest vehicle market in the world.

2. In an "as is" case scenario, the increase in vehicular population will lead to sharp rise in demand for fossil fuels and have an undesirable impact on the environment. As per International Energy Agency (IEA) estimates, globally the transportation sector accounts for 30% of worldwide energy consumption and is the 2^{nd} largest source of CO_2 emissions contributing to 20% of Global GHG. Three quarters of the projected increase in oil demand in future will be from transportation sector with the highest growth from China and India.

3. India depends largely on oil imports to meet its energy needs. The percentage of oil imported by India has risen from 57% in 1997 to 85% in 2010; this is likely to reach 92% of the total demand by 2020. High import dependence along with continuously increasing prices of oil poses a serious challenge for India's future energy security.

4. As economic development is indispensable, it is crucial that strategies for mitigating adverse impact of growth are adopted. The National Mission for Electric Mobility (NMEM) has National energy security and growth of domestic manufacturing capabilities in full range of electric vehicle technologies as its two inter-related key objectives. The NEMMP 2020 lays the vision and provides the roadmap for achieving significant penetration of efficient and environmentally friendly electric vehicle (including hybrids) technologies (xEVs) in India by 2020, thereby helping to achieve the NMEM objectives. NEMMP 2020 implementation will involve finalization and roll out of comprehensive array of interventions involving all stakeholders, both in and out of the government.

5. The Department is fully confident that objectives and targets set forth in NEMMP 2020 shall be realized and help the Indian Automotive Industry achieve a paradigm shift for strong, continuing sustainable growth. I would like to place on record the appreciation for tremendous work done by the officers of the Department, industry representatives and experts who have identified the priorities and various interventions that have gone into the finalization of the mission document. The Mission Plan would be a useful blueprint for the future to provide the joint vision of the Government and the Indian Automotive Industry in this very important initiative.

(S. Sundareshan)
Secretary, Department of Heavy Industry,
Government of India

New Delhi, August, 2012

Preface

The Department of Heavy Industry (DHI), which is the nodal department in Govt. of India for the automotive sector, has taken a number of initiatives aimed at accelerating the growth and development of Indian automotive industry. This includes the 10 year vision roadmap for the automotive industry, viz, Automotive Mission Plan (AMP) 2006-16.

2. The National Mission for Electric Mobility (NMEM) is amongst the most significant recent initiatives taken up by the Department. The genesis of NMEM was the recommendations from Prime Minister's Group on Technology for fast tracking the introduction and manufacture of full range of electric vehicles, including hybrids, in the country. Based on detailed stakeholder consultations and an in-depth study, the Government had approved the taking up of this initiative on a National Mission mode, along with setting up of a high level apex structure in the form of National Council for Electric Mobility (NCEM) and National Board for Electric Mobility (NBEM).

3. In order to assess the present day ground realities, the future possibilities for introduction of electric mobility in the country, for setting the Mission targets and for finalizing the roadmap for NMEM, a detailed study based on consumer feedback and extensive stakeholder consultations has been undertaken. The study was carried out with a reputed consultant, as the knowledge partner, who brought with them extensive knowledge of developments around the world. The study took advantage of wide-ranging deliberations and consultations involving all stakeholders from Government, Industry, academia and research associations. The study findings were presented to the NBEM, in their second meeting held on 3rd Jan, 2012, wherein the broad general principles, guidelines and framework for finalizing the National Electric Mobility Mission Plan (NEMMP) 2020 were approved. It was also decided that three Working Groups in the areas of R&D, infrastructure, and demand generation would be set up and their additional suggestions, if any, would also be incorporated.

4. The NEMMP 2020 is the National Mission document providing the vision and the roadmap for the faster adoption of xEVs (full range of hybrid and electric vehicles) and their manufacturing in the country. We believe that with the commitment and support of all stakeholders, 6-7 million units of new vehicle sales of xEVs, along with resultant fuel savings of 2.2 – 2.5 million tonnes can be achieved in 2020. In order to operationalize the NEMMP 2020, various schemes, interventions, policies and projects will be finalized and approved for roll out by the NBEM/NCEM. These will be based on the approach enunciated in NEMMP 2020. In order to expedite this process, the collaborative structure of various Working Groups and Sub-Groups will be effectively utilized, so as to ensure maximum participation of all stakeholders at all stages.

5. I would like to gratefully acknowledge the guidance, support and encouragement received from the Hon'ble Minister for Heavy Industries & Public Enterprises, Shri Praful Patel and Secretary, Department of Heavy Industry, Shri S Sundareshan. I would also like to thank my colleagues from Government, senior

representatives of industry, academia and automotive research institutes who have invested a great deal of their time and effort in finalizing NEMMP 2020. I am confident that this initiative shall greatly contribute to the future energy security of India, mitigate the impact of transportation on the environment and also help in strengthening the Indian automotive industry for its continued sustainable growth.

(Ambuj Sharma)

New Delhi, August, 2012

Joint Secretary, Department of Heavy Industry,
Government of India

NEMMP 2020

1. BACKGROUND

Chapter 1

1.1. Broad overview of the Indian Automotive Industry.

1.2. The need for electric mobility.

1.3. Past efforts and present status of electric mobility in the country.

1.4. Global scenario.

Chapter 1 – Background

1.1 Broad overview of the Indian Automotive Industry.

1.1.1. The Automotive Industry globally is one of the largest industries and because of its deep forward and backward linkages with the rest of the industry, it has a strong multiplier effect and is one of the major drivers for economic growth.

1.1.2. With the gradual liberalization of the automobile sector in India since 1991, the number of manufacturing facilities has grown progressively. The Indian automotive industry produces a wide variety of vehicles: passenger cars, light, medium and heavy commercial vehicles, multi-utility vehicles such as jeeps, two wheelers that include scooters, motor-cycles and mopeds, three wheelers, tractors and other agricultural equipments. The Indian automobile industry is dominated by two wheelers, which account for 75% of the total vehicles sold in the country. In the passenger car segment, India is mainly a small car market.

1.1.3. In view of the huge potential of the automotive sector, the Government of India jointly with the industry prepared a ten year strategic vision plan for the industry - the Automotive Mission Plan 2006-16 (AMP 06-16) which was formally released by the Hon'ble Prime Minister in January, 2007. The AMP 06-16 lays down a 10 year roadmap for the automotive industry covering every aspect of its growth ranging from broad direction on fiscal policies, emissions, safety and globalization in terms of technical standards, enhancing competitiveness, skill development, testing and homologation, Research & Development, etc.

Release of AMP2006-16 by Hon'ble Prime Minister of India

AMP 2006-16

1.1.4. The Automotive Mission Plan 2006-2016, envisages that by 2016, India will emerge as the destination of choice in the world for the design & manufacture of automobiles and automotive components. The output of India's automotive sector is targeted to reach $145 billion by 2016 with doubling of the contribution of the sector to the National GDP from around 5% in 2006 to 10% in 2016 and additional employment generation opportunities for 25 million people in the entire value chain. As on date, the automotive industry is on track to meet most of the AMP targets for 2016. The AMP document captures the expectations and responsibilities of all the stakeholders for a common end objective and is a shining example of how Government – Industry collaborative approach can transform an industry sector. The approach and ethos of AMP has been adopted even more rigorously for developing the NEMMP 2020 document.

1.1.5. Today, the automobile sector in India is aptly described as the next sun rise sector of the Indian economy. This sector has been growing at a CAGR, in excess of 15% over the last 5-7 years. In fact, in the last ten years, the volumes, exports and turnover have increased by 3.8, 19.6 and 6 times respectively. The contribution of this sector to the National GDP has risen from 2.77% in 1992-93 to close to 6% now. At present, the installed capacity of the four wheeler industry (comprising passenger vehicles and commercial vehicles) is over 4 million units and two & three wheeler industry is over 15 million units with an investment of over Rs 80,000 crores. The industry has developed in clusters which have large number of companies with their vendor base. The major automotive hubs being in Pune region (Maharashtra), NCR region, Pithampur (MP), Chennai, and Uttaranchal. Gujarat is emerging as the latest major automotive hub.

1.1.6. At present India has 19 manufacturers of passenger cars & multi utility vehicles, 14 manufacturers of commercial vehicles, 16 of 2/3 wheelers and 12 for tractors besides 5 manufacturers of engines in India. This includes virtually all the major global OEMs (Original Equipment Manufacturers) as well as home grown companies. In 2010-11, India surpassed France, UK and Italy to become the 6th largest vehicle manufacturer globally. Today, it is the largest manufacturer of tractors, second largest manufacturer of two wheelers, 5th largest manufacturer of commercial vehicles and the 4th largest passenger car market in Asia. During 2011-12, India exported 2.9 million vehicles to more than 40 countries which included 0.5 million passenger cars and 1.94 million two wheelers. Today, the automobile industry in India provides direct and indirect employment to 13.1 million people. The production of vehicles and exports is given in **Table 1 & 2** below:

Table 1 - Production of vehicles (in numbers)

Category	*2006-07*	*2007-08*	*2008-09*	*2009-10*	*2010-11*	*2011-12*	*5-yr. CAGR (%)*
Passenger Vehicles	*1,545,223*	*1,777,583*	*1,838,593*	*2,357,411*	*2,982,772*	*3,123,528*	*15.11*
Commercial Vehicles	*519,982*	*549,006*	*416,870*	*567,556*	*760,735*	*911,574*	*11.88*
Two Wheelers	*8,466,666*	*8,026,681*	*8,419,792*	*10,512,903*	*13,349,349*	*15,453,619*	*12.79*
Three Wheelers	*556,126*	*500,660*	*497,020*	*619,194*	*799,553*	*877,711*	*9.56*
Grand Total	*11,087,997*	*10,853,930*	*11,172,275*	*14,057,064*	*17,892,409*	*20,366,432*	*12.93*

Source: *SIAM data.*

Table 2 - Export of Vehicles (in numbers)

Category	*2006-07*	*2007-08*	*2008-09*	*2009-10*	*2010-11*	*2011-12*	*5 year CAGR (%)*
Passenger Vehicles	*198,452*	*218,401*	*335,729*	*446,145*	*444,326*	*507,318*	*20.65%*
Commercial Vehicles	*49,537*	*58,994*	*42,625*	*45,009*	*74,043*	*92,663*	*13.34%*

Category	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	5 year CAGR (%)
Two Wheelers	619,644	819,713	1,004,174	1,140,058	1,531,619	1,947,198	25.73%
Three Wheelers	143,896	141,225	148,066	173,214	269,968	362,876	20.32%
Grand Total	1,011,529	1,238,333	1,530,594	1,804,426	2,319,956	2,910,055	23.53%

Source: *SIAM data.*

Recent performance of the sector

1.1.7. In 2010-11, the total turnover of the automotive Industry stood at USD 73 Billion (Rs 3, 27,300 crores)[1] of which the turnover of the vehicle industry was USD 53.1 billion[2] (Rs 2, 39,000 crores) with a 26% growth on year to year basis. The turnover of the auto component industry, in 2010-11 was USD 40 Billion (Rs. 1,79,320 crores approx.)[3]. The export of vehicles and auto components during 2010-11 stood at USD 6 Billion and 5 Billion respectively. In 2010-11, the contribution of the automotive industry to the Manufacturing GDP and the excise duty was at 22% and 21% respectively.

1.1.8. The global recession of 2009 impacted the global automotive industry in a big way. Demand in traditional global automotive markets has declined and remains sluggish. However, the demand from emerging economies continues to be high with India becoming the second fastest growing automotive market after China. The global economic downturn of the recent past has firmly shifted the centre of gravity of the automotive industry to the east. It is predicted that the future growth of automotive industry will primarily come from the emerging economies which include the BRIC nations viz. Brazil, Russia, India and China along with Thailand, Iran and Mexico.

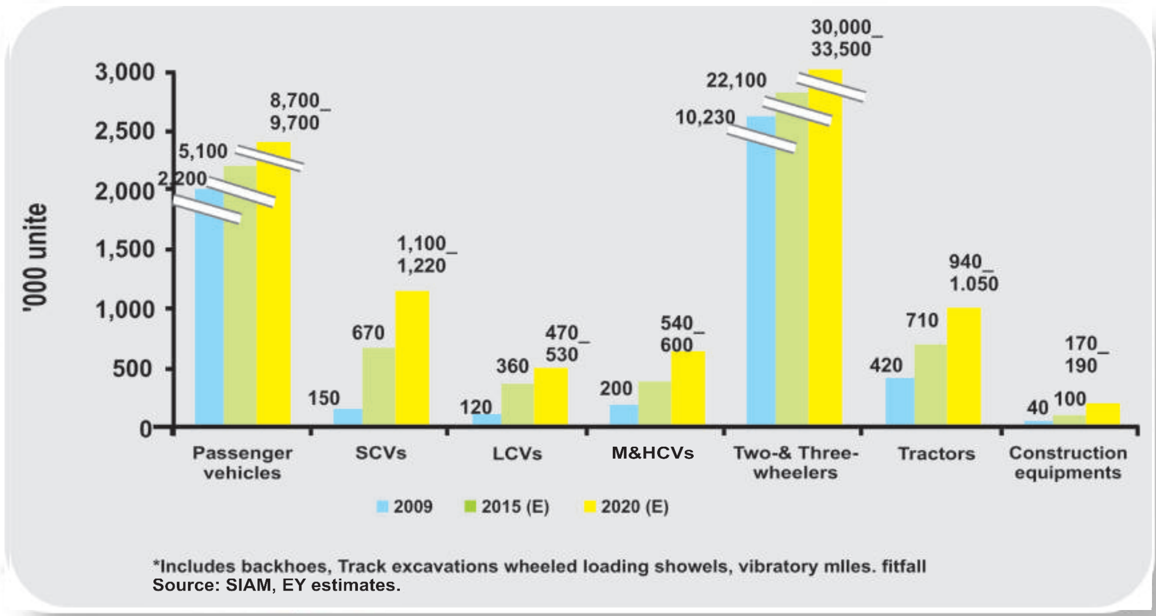
1.1.9. In 2010-11, the total global demand of passenger vehicles was 73 million units, of which the volume in India was 2.4 million units (4%). It is estimated that by 2020, Asia, Pacific and Africa region will witness a demand of 54 million passenger vehicles out of a total global demand of 108 million units (50%), of which the demand from India will be 10 million units (8%)[4]. Further, in 2020, the market / production for commercial vehicle, tractors and two wheelers in India is expected to reach 2.7 million, 1 million

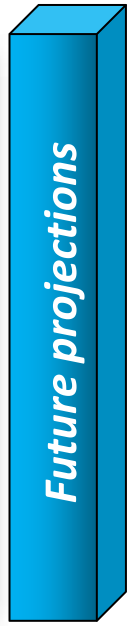
[1] SIAM Data.
[2] This also includes a portion of turnover of auto component industry.
[3] ACMA Data.

[4] J D Power, E&Y)

and 34 million units respectively, thereby making India the third largest vehicle market in the world **(Exhibit-1)** This will translate to an overall industry turnover of USD 162 billion, with the component industry attaining a turnover of USD 113 billion. However, for this potential to be fully realized, a lot of effort, both by the industry and the Government, will be required.

Exhibit 1 - Vehicle production – 2020 projections





1.2. The need for electric mobility.

1.2.1 Globally, automotive industry is passing through a paradigm shift. The past century has been the era of internal combustion engine (ICE) primarily on account of the ease of use, availability and low-cost of fossil fuels. The shift to electric mobility has become necessary on account of fast depletion of fossil fuels, rapid increase in energy costs, impact of transportation on the environment and concerns over climate change.

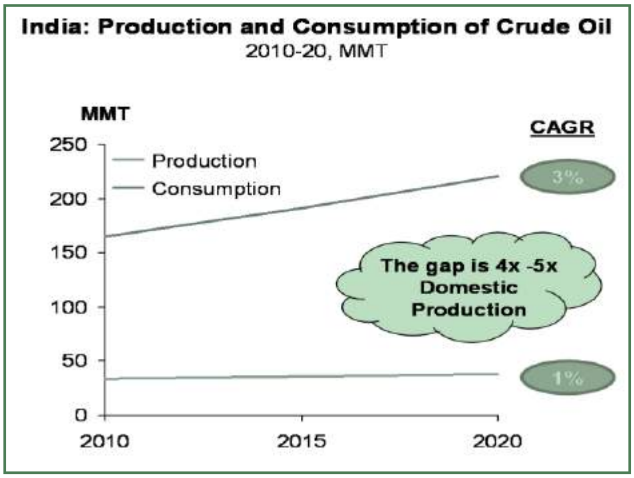
1.2.2. As per IEA report of 2009, fossil fuel based transportation is the second largest source of CO2 emissions globally. From 2006 to 2030, the global energy consumption is likely to rise by 53% and about three quarters of the projected increase in oil demand will come from transportation. World over these concerns are driving Governments and automotive industries alike to invest heavily towards developing vehicles based on alternate propulsion systems including electric mobility.

1.2.3. For emerging economies like India, the urgency to find viable alternatives for sustainable mobility is also accentuated by rapid economic development which is accelerating the demand for transportation. As a result of sustained high GDP growth, India's primary energy consumption is expected to increase by 70% in the next ten years[5]. The gap between domestic crude oil production and consumption is widening.

[5] *MoPNG*

This coupled with hardening of the crude prices is leading to increase in the trade deficit. This poses a serious challenge to India's energy (fuel) security. Therefore, all measures need to be taken for lessening the dependence on fossil fuels for the country's energy requirements. The projected production and consumption of crude oil for India up to 2020 is given in **(Exhibit 2).**

Exhibit 2 – Crude oil gap for India



1.2.4. The transportation sector alone accounts for about one-third of the total crude oil consumption and road transportation accounts for more than 80% of this consumption. Therefore, the Government will need to focus on this sector and partner with industry for investing in sustainable mobility solutions for the future. Transportation energy use and its impact on the environment including green house gas emissions are determined by a number of factors. These can be broadly classified in four distinct yet interrelated set of factors that include **(i)** vehicle efficiency **(ii)** vehicle use and distance travelled **(iii)** the type of fuels or energy sources used in transportation **(iv)** overall system efficiency of the infrastructure.

Approaches for environmental impact mitigation

1.2.5. Each one of these factors are important and the various interventions relating to them will need to be adopted as a part of a multi-pronged strategy for increasing transportation efficiency levels & mitigation of the adverse impact of transportation sector on the environment and climate change. Some of the interventions within this broad classification of factors include the following:

Vehicle efficiency

1.2.5.1 This includes improvements in fuel efficiency of both “new vehicles” and “on road vehicles”. In addition to achieving higher efficiencies through improvements in traditional ICE vehicles by better designs for lowering rolling resistance, aerodynamic drag and light weighting etc, much higher gains can be made through greater adoption of xEVs. Simultaneously, it is also essential to address the huge “on road vehicle” population in India. This will be possible through introduction of a vigorous pan India Inspection and Certification (I&C) regime. In addition, recent developmental testing results for retro fitment hybrid kits for cars in India by the industry indicate that fuel efficiency gains of 25-30% are possible. These solutions will also need to be supported and adopted.

Vehicle use

1.2.5.2. Vehicle usage and distance travelled includes broad level interventions like better designed cities for minimizing the need for travel, development of mass public transportation for intra-city travel, shift to public transportation from private vehicle use, etc.

Type of fuel

1.2.5.3. Interventions related to type of fuel are aimed at lowering dependence on fossil fuels and gradual shift to cleaner and low carbon energy sources such as advanced bio-fuels, a greater adoption of electric vehicles fed on renewable energy sources, etc.

Infrastructure

1.2.5.4. Overall system efficiency of the infrastructure: System efficiency improvements in infrastructure through better roads, traffic management and use of Intelligent Transport Systems (ITS), etc are also important.

National approach needs to focus on greater adoption of xEVs.

1.2.6. In India, a lot of work needs to be done in all these areas. In fact, the National Action Plan for Climate Change emphasizes the need for introduction of rapid mass transportation system for major cities and greater shift towards public transportation including Railways. However, given the fact that the present level of vehicle penetration in India is amongst the lowest in the world, at 11 cars and 32 two wheelers per thousand persons, there is a very high head room for off take of personal vehicles. This coupled with the challenges of time and resources associated with roll out of comprehensive mass transport systems and given the aspirational aspects associated with owing vehicles, it is imperative that the National approach for energy security and for mitigation of the impact of mobility on environment and climate change also focuses strongly on the greater adoption of xEVs (full range of electric vehicles from mild hybrids to pure electric vehicles). These vehicles can provide significant contribution in enhancing energy (fuel) security and sustainable mobility.

1.3. Past efforts and present status of electric mobility in the country.

1.3.1. The first electric three wheeler - Vikram SAFA was developed by Scooters India Ltd, Lucknow in 1996 and approximately 400 vehicles were made & sold. These vehicles ran on a 72 volt lead acid battery system. In 2000, BHEL developed an 18 seater electric bus. Its power pack consisted of an AC induction Motor and a 96 Volt lead acid battery Pack. Some 200 Electric vans were built and run in Delhi, with monetary support from MNES. The major concern with these vehicles was their poor consistency, low life and very high cost of the battery.

1.3.2. Mahindra & Mahindra Ltd. launched its first electric 3 wheeler in 1999 and also launched a new company, MEML, based in Coimbatore, in 2001, to make and sell electric vehicles named Bijlee. In 2004, MEML was closed down due to lack of demand. Mahindra again started making electric vehicles at Haridwar plant in 2006 and continues to produce electric vehicles as per market demand. Bajaj Auto Ltd, Pune had also demonstrated their 3 Seater electric Rickshaw in 2001. The vehicle used advanced PMSM drive system. However, this product has not been commercially launched.

1.3.3. In 2001, REVA, Bangalore entered the EV sector in the Car category with a vehicle developed by an American company (Amerigon) and built with a state-of-the-art battery management system. Some 3200 cars have been sold worldwide including approx 1500 cars that have been sold in India, mostly in Bangalore City.

Reva NXR

Very recently, other manufacturers, including TATA motors, Maruti Suzuki India showcased their demonstration vehicles during Commonwealth Games held in 2010 at New Delhi.

1.3.4. High battery cost and lack of charging infrastructure remains a major concern area for mass adoption. Recently, car manufactures in India including TATA motors, General Motors, Hero Motocorp, and TVS have announced their xEV rollouts and have also showcased their vehicles.

1.3.5. In the two wheeler segment, Hero cycles collaborated with UK based Ultra Motor to launch a series of bikes in 2007. Other companies such as Electrotherm India, TVS Motor, Hero Electric etc are also manufacturing and selling electric two wheelers. Some other players who have entered this space and launched e-bikes include Atlas, Avon Cycles and Chennai based TI Cycle. These bikes are usually charged at the domestic supply voltage and therefore, require no special adapter. Batteries, Motors and other electrical kits for these vehicles are imported from China and other countries whereas, mechanical design and assembly of these bikes is done here. However, despite an installed capacity close to half a million units; the high cost of electric two wheelers remains the major hurdle due to which the average capacity utilization in the industry remained quite low. However, recently the off take of these vehicles has picked up on account of subsidy scheme launched by the Government of India and concessions given by some state governments.

BEV Two Wheeler

1.3.6. The Government of India has been supporting electric mobility efforts in the country. The Department of Heavy Industry (DHI), being the nodal Department for the automotive sector, has been funding research, design, development and demonstration projects and also spearheading the electric mobility initiative in the country. In the recent past (2010-12), Ministry of New and Renewable Energy (MNRE) has also incentivized the purchase of electric vehicles through its Alternate Fuels for Surface Transportation Program (AFSTP) scheme which had an outlay of Rs 95 crores. The incentive was provided to OEMs that gave at least one year warranty and were setting up at least 15 service stations across India.

1.3.7. In addition, the Department of Science and Technology (DST), has a funding scheme for all industries, including automotive industry. The Council for Scientific and Industrial Research (CSIR) is also active and R&D on lithium-battery technology for xEVs is ongoing at the Central Electrochemical Research Institute, Karaikudi. Furthermore, certain state governments like the Delhi Govt. are also providing demand side subsidies in addition to VAT and road tax waiver. Owing to these various programs, xEV 2 wheelers have reportedly witnessed growth of 20% and Reva recorded a three-fold rise in average monthly sales. However, these initiatives remain largely fragmented & short-term.

1.3.8. The various initiatives taken in the country to promote electric mobility could not yield the desired results mainly due to higher cost of EVs, challenges in battery technology, limited range of EVs, lack of infrastructure and consumer mindset. In addition, the past efforts also did not have the desired level of synergy, continued top level support & ownership both in the government and industry. As such, most of the efforts undertaken fizzled out since they were isolated in nature, lacked collaborative approach and did not tackle all the issues holistically. In order to achieve the potential, a more systematic and collaborative approach is required with a clear long term roadmap.

1.4. Global scenario

xEV definitions

1.4.1. Various alternate powertrain technologies are available today – Hybrid Electric Vehicle (HEV), Plug-in Hybrid Electric Vehicle (PHEV), Extended-Range Electric Vehicle (ER-EV) and Battery Electric Vehicle (BEV). In the NEMMP 2020 document these are collectively referred to as xEVs. HEVs have both internal combustion and electric drives, which work in tandem leading to higher fuel efficiency. If the battery is used only when vehicle is started or stopped, for regenerative braking and limited electric motor assist, it is classified as mild hybrid. Whereas, full Hybrids have full electric launch assist and motor drive. PHEVs and Extended Range EVs (ER-EV) can run on batteries alone for a significant length and have ICE backup. BEVs run solely on batteries.

Global scenario

1.4.2. Across the world, Governments are playing a key role in facilitating greater adoption of electric mobility through use of the following five main levers of public policy to influence the early adoption of xEVs **(i)** Demand incentives **(ii)** Supply side incentives for spurring manufacturing **(iii)** Power & Charging Infrastructure **(iv)** Research & Development incentives **(v)** imposition of stringent fuel efficiency norms.

1.4.3. Different nations have followed different strategies for promoting xEVs. While US has been primarily focusing on both demand and supply side incentives, with Government directly subsidizing private initiatives, Japan and France have been focusing on supporting charging infrastructure of xEVs with more limited support on demand and supply side incentives. In contrast, China has a very comprehensive and large scale program for adoption for e-mobility – and plans to spend tens of billions of dollars, primarily to support PHEVs and BEVs (lately, there is talk for support to HEVs also). This is summarized in **(Exhibit 3)** on the following page.

1.4.4. A deeper analysis of the strategies adopted by different countries reveals that

1.4.4.1. USA aims to have 1 million PHEVs by 2015 and has been focusing on both demand and supply side incentives and has also been directly subsidizing private initiatives, which includes USD 2.5 Billion grant for battery development and USD 2.4 Billion loan to OEMs for xEV production

1.4.4.2. China plans to have 5 million xEVs by 2020 and has earmarked USD 15 billion over next three years for R&D on vehicles and components, USD 4.4 billion over next 10 years on pilot projects and USD 5 billion for half million public chargers

1.4.4.3. Japan has targeted 2 million xEVS by 2025 and has earmarked USD 250 million over next three years R&D on vehicles and components and

1.4.4.4. France aims to have 2 million BEVs and PHEVs by 2020 with an investment of USD 380 – 430 million for battery investment and pilot projects for vehicles and USD 2 billion public investment for recharging network of 1 million recharging points by 2015. Further the French companies and government also plan to buy 100,000 electric vehicles.

Exhibit 3 – E-mobility models

E-Mobility Models: Comparison of Select Countries

Lever	US	China	Japan	France
R&D	✓✓✓	✓✓✓	✓✓	✓✓
Supply Side	✓✓	✓✓✓	✓	✓
Demand-side Incentives	✓✓✓	✓	✓✓	✓✓✓
Infrastructure	✓✓	✓✓✓	✓✓	✓✓✓
Proposed Investment	>$5 B	> $20 B	>$1.7 B	>3.5 B

Note: Japan's investment is from 1998-2014
Source: ICCT, Booz & Company analysis

Global demand

1.4.5. The total global demand for four wheelers and two wheelers, which at present is 45 million and 43 million units, is expected to increase to 70 million and 76 million units respectively by 2020. Two wheeler segment already have a high penetration level for electric variants, mainly in China. The demand for xEV two wheelers is expected to remain high with majority of demand expected to come from Asia Pacific region (95%) with

China expected to generate maximum demand.

1.4.6. The Global demand projection for four wheeler xEVs has a high degree of uncertainty as demand and supply sides along with the xEV technology are all quite immature. Furthermore, as the future technology and price evolution is not clear, precise forecasting is difficult. It is expected that penetration of xEVs in the passenger 4 wheeler vehicle space will be significant. The detailed global xEV demand forecasts are dealt within **Chapter 4.**

Technology developments

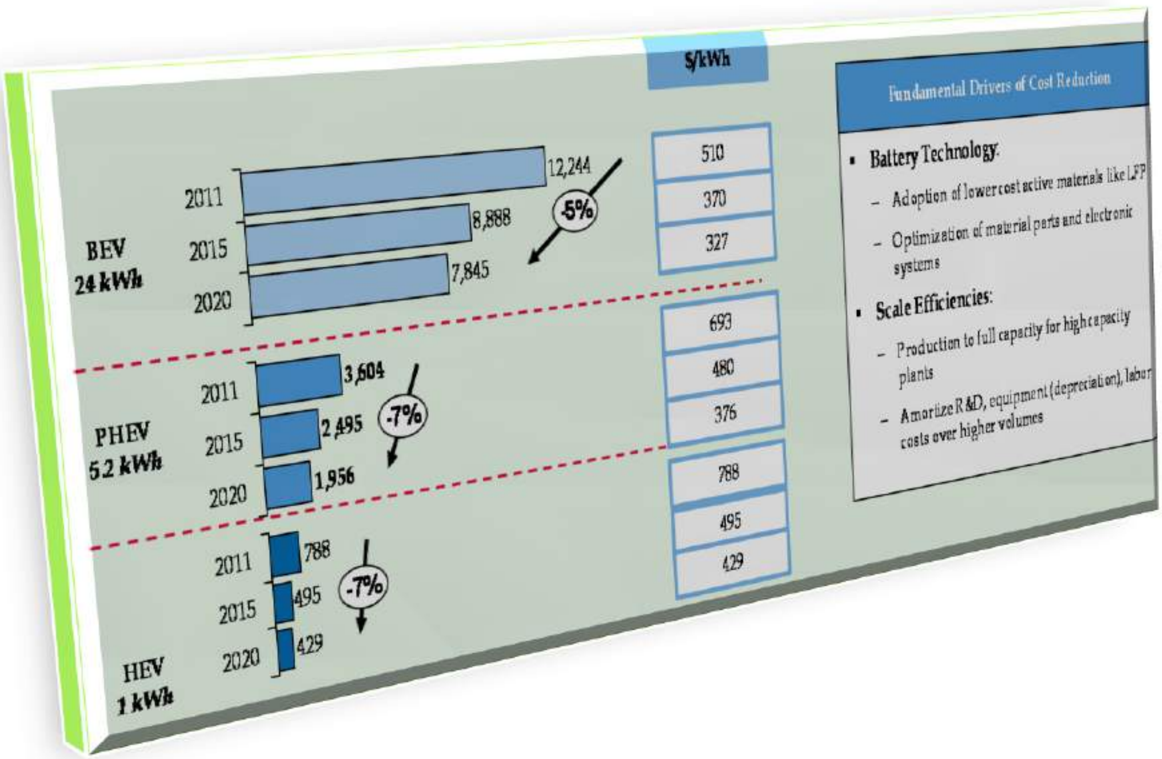
1.4.7. In view of the increasing focus on xEV research, promising developments across all dimensions of xEV powertrain have been seen. These include significant progress in the area of engine downsizing (HEV/PHEV), development of non rare earth material motors and research in battery and battery management systems around chemistry, stability, performance, smart charging, etc. In the area of controllers too, better cooling and power management techniques have been developed and a higher level of control integration is being envisaged. These cumulative efforts have led to significant performance improvement and cost reduction in xEVs. This is likely to continue and lead to a favorable cost evolution for xEVs in the future.

1.4.8. At present Lithium-ion batteries are the preferred choice for usage in xEVs. They have high energy density and low discharge rates, and hence are able to deliver sustained high performance. These batteries have low maintenance cost and a long lifespan. However, their high price continues to be the main barrier to their widespread usage.

1.4.9. It is expected that technology innovation and scale of production will be the important levers that will together impact almost 90% of the lithium-ion battery cost. From the technology standpoint, cost could be reduced by identifying cheaper raw materials and safe chemistries for automotive usage. Furthermore, manufacturing processes could be automated and streamlined to improve quality and yield. It is expected that favorable developments in these areas could bring down Lithium ion battery costs from the current levels of $ 500-800 / kWh to $ 325-430 /kWh by

2020 **(Figure 1).** In the BEV segment, this would tantamount to a 5% y-o-y decrease, while for HEV and PHEV, the decrease could be up to 7%. The favorable battery cost evolution would lead to significant global sales penetration of xEVs. However, despite the reduction in price of Li ion batteries in the future, as far as India is concerned, it is expected that the Li ion battery costs are likely to remain higher than the customer expectations. This is borne out from a comparison of the expected willingness of the consumer to pay price premium for Li ion batteries with the expected cost evolution of these batteries up to 2020.

Figure 1– Expected Li – ion Battery price evolution



Note: *Assume technology impacts cost of active materials and other parts like electronics reducing cost by ~50% by 2020; scale effects impact equipment (depreciation), labor, R&D costs; scale based on estimated global uptake of respective powertrain systems and market share of lead battery manufacturer; 2011 costs based on JRC/ Duke estimates*

Source: *MIT Technology Review, JRC, JD Power, Argonne National Lab, Deutsche Bank, Expert Interviews, GoI– Industry study*

NEMMP 2020

2. RECENT DEVELOPMENTS

FIRST MEETING OF

NATIONAL BOARD FOR ELECTRIC MOBILITY

11th JULY, 2011

Chapter 2

2.1. National Mission for Electric Mobility (NMEM).

2.2. Setting up of the National Mission targets and the roadmap for the future.

Chapter 2 – Recent Developments

2.1. National Mission for Electric Mobility (NMEM).

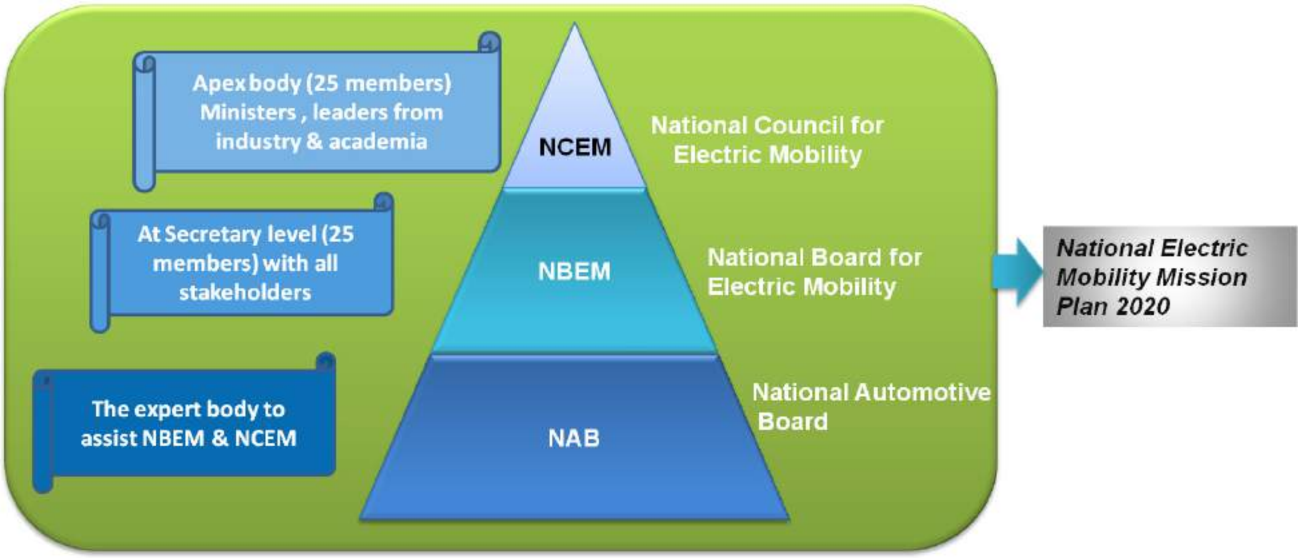
2.1.1. Government of India has recognized the fact that at present the barriers to greater adoption of Electric Vehicles (EVs) are immense. Given the importance of the initiative, the Government has decided to launch the National Mission for Electric Mobility (**NMEM**). The adoption of the mission mode approach is intended to provide this initiative the desired high level of ownership (both in Government and the Industry), continued government intervention/support, continued long term commitment from all stakeholders and a synergized - holistic approach to the complex issues involved with the program.

2.1.2. As a first step, an enabling mechanism has been set up for speedier decision making and for ensuring greater collaboration amongst various stakeholders. This consists of empowered bodies at the apex level in the form of National Council for Electric Mobility (**NCEM**) and the National Board for Electric Mobility **(NBEM)**. The Council comprises of Ministers from the key Central Ministries/Departments, eminent representatives from the industry and academia. The NCEM is chaired by the Hon'ble Minister for Heavy Industries & Public Enterprises. The composition, roles, responsibilities and functions of the Council are in **Annexure I.** The Council will be aided by a 25 member National Board for Electric Mobility comprising of secretaries of stakeholder Central Ministries/Departments with representation from industry and academia. The composition, roles, responsibilities and functions of the Board are in **Annexure II.**

2.1.3. The National Council and the National Board will be serviced initially by the NATRiP Implementation Society (NATIS) and later by the National Automotive Board (NAB), once set up. NAB will comprise of domain and technical experts and shall be the nodal agency for all ongoing and new initiatives of the government for the automotives sector. This mechanism is intended to provide a common platform for all initiatives; enable fast decision making, encourage industry-academia-government collaboration, and also approve and monitor all allocations that are made from the Government of India for development of xEVs. The roles, responsibilities and functions of the NAB are in Annexure III.

2.1.4. The NMEM structure will ensure synergies between the efforts being made by different agencies, help avoid duplication of efforts and also enable prioritization of allocation of resources by the Government. The enabling structure approved by the Government is depicted as (**Exhibit 4**).

Exhibit 4 – National Mission for Electric Mobility Structure



2.2. Setting up of the National Mission targets and the roadmap for the future.

NEMMP 2020

2.2.1. Earlier, while seeking the approval of the Union Cabinet for the initiative, Department of Heavy Industry had undertaken a detailed study for the possible interventions. Although, this involved focus group discussions, expert opinions etc, the exercise remained largely based on secondary data sources like international studies, literature reviews etc. In order to finalize the National Hybrid / Electric Mobility Mission Plan viz. NEMMP 2020, the Department of Heavy Industry in collaboration with the Industry commissioned a rigorous study based on primary research with M/s Booz & Company as the knowledge partner.

2.2.2. The objective of the exhaustive study was to help establish the possible road map, crystallize mission objectives, targets and milestones to be achieved by 2020 along similar lines of Automotive Mission Plan: 2006-2016. The study was undertaken with the active involvement of all key stakeholders including the concerned key Ministries of the Government of India, automotive industry associations, industry experts, automotive testing agencies etc. For this purpose, a steering committee comprising of representatives of all key stakeholders was constituted which guided and closely monitored the study. In addition, a number of workshops were also conducted during the course of the study.

2.2.3. The findings of the study have been considered by the National Board for Electric Mobility in their second meeting held on 3rd January, 2012. The board agreed on the broad principles and the framework that can be the basis for finalizing the National Electric Mobility Mission Plan 2020 (NEMMP 2020). These decisions have been fully incorporated in the NEMMP 2020.

2.2.4. The National Electric Mobility Mission Plan 2020 (NEMMP 2020) is intended to provide the future roadmap, establish common set of priorities, broad principles and framework for promoting the adoption of the full range of electric mobility solutions for India, which can enhance national fuel security, provide affordable and environmentally friendly transportation and enable the Indian automotive industry to achieve global manufacturing leadership.

Future roadmap

2.2.5. The NEMMP 2020 will be the basis for guiding all the future initiatives, schemes, policies and other interventions of the government for electric mobility. It will also help shape the future priorities of the industry. While the 2020 levels of xEV penetration projected by NEMMP 2020 is being adopted as the National goals, the various specific formulations provided by the study including the level of demand incentives, their duration, total investment required etc are being taken as an indicative estimate which will be fine tuned during the process of formulating the various specific schemes and interventions. The various schemes and interventions for demand creation, xEV R&D, xEV infrastructure, etc will be approved and rolled out separately as per Govt. rules. A mechanism for continued review, monitoring and mid-course corrections is intended to be an integral part of the NEMMP 2020.

NEMMP 2020

3. DEVELOPING THE ELECTRIC MOBILITY MISSION PLAN 2020

National Mission for Electric Mobility

Chapter 3

Chapter 3 – Developing the Electric Mobility Mission Plan 2020

3.1. The Indian automotive market – a unique market.

3.1.1. The Indian automotive market is quite distinct from automotive markets in other countries. This is both on account of the automotive market composition and also in terms of the consumer preferences and level of infrastructure development.

Indian automotive market

3.1.2. The Indian automotive market is dominated by two wheelers. The sales and on road population of two wheelers is almost 75% of the total vehicles sold/ vehicles on the road. In other words, the sales of two wheelers are almost five times the sales of passenger cars and sports utility vehicles (SUVs).

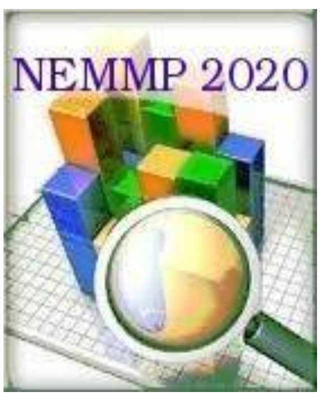
3.1.3. Within the passenger car segment, the sale of small cars (of length less than four meters and having engine capacity less than 1200 cc for petrol engines and less than 1500 cc for diesel engines) is approximately 75% of the total sale of passenger cars. In comparison, the sales of small cars in China, US and UK were 59%, 28% and 10% respectively of the total passenger car sales in 2010.

3.1.4. The present structure of the Indian automotive market is partly due to Government policies such as lower excise duty for smaller cars. It is also on account of the fact that the Indian consumer is highly value conscious and affordability plays a vital role in consumer buying decisions. This is an important aspect that needs to be kept in mind for developing a strategy for faster adoption of xEVs in India.

3.1.5. In addition, at present India has an average power deficit of 8-10%, has lack of sufficient road infrastructure and has high levels of traffic congestion. In view of the uniqueness of the Indian automotive market, products and solutions from other markets cannot be replicated in India. Customized solutions are required to match the consumer preferences, electricity supply and market realities. Similarly, the strategy for supporting electric vehicles in India has to be uniquely tailored taking into account the ground realities of India.

3.2. Methodology - I *(Consumer survey and stakeholder inputs).*

3.2.1 Given the uniqueness of the Indian automotive market and its eco-system; it is essential that the strategy and the solutions that are adopted for greater adoption of electric vehicles in India are tailor made to suit Indian conditions and ground realities.

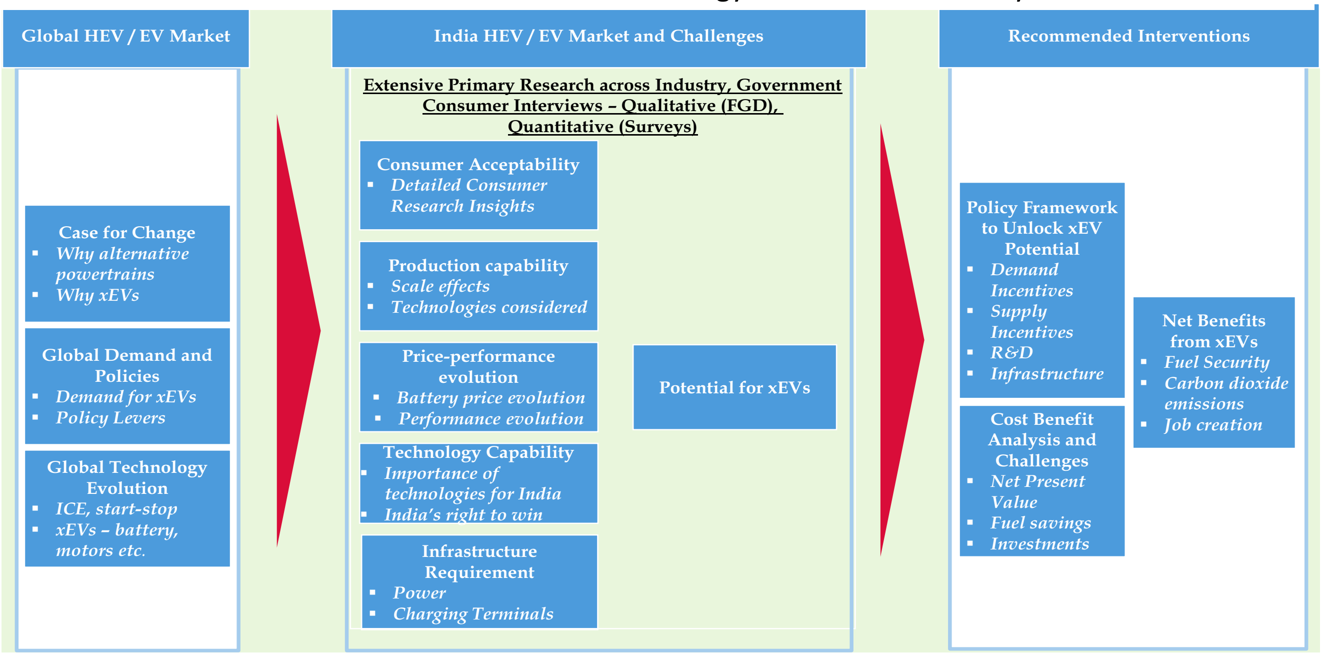


3.2.2. The study jointly conducted by the Department of Heavy industry (DHI) and the industry has given an in-depth understanding of the issues involved, challenges ahead and has also given an estimate of the possible latent xEV demand in India, consumer preferences, barriers to adoption and effective drivers for uptake of hybrid and electric vehicles in India.

Primary data research

3.2.3. This study involved extensive field level consumer surveys based on direct interviews through administered questionnaires. Several rounds of focused group discussions and interactions with key stakeholders were also conducted covering all major cities and demographic profiles during May, 2011 – Oct, 2011. The methodology followed in the study is given in **(Exhibit 5)** on the next page:

Exhibit 5 – The broad methodology followed in the study



Source: GoI– Industry study.

3.2.4. The initial stage of the study focused on scanning and gaining an understanding of global HEV / BEV vehicle market in terms of global demand, policy levers used by various governments to promote xEVs, and how the technology is evolving globally in critical areas such as ICE technology development, developments in start-stop technology, as well as all xEV components like batteries, power electronics, electric motors etc. This has provided the basis to benchmark with the global scenario and also identify potential issues. Greater emphasis was placed on understanding the cost and price evolution of batteries.

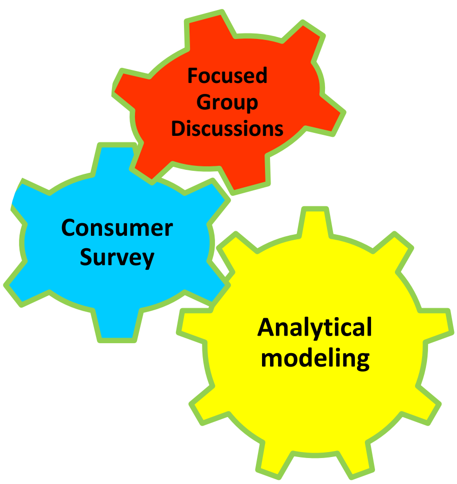
3.2.5. For an in-depth understanding of the Indian scenario and future possibilities, detailed interactions were held and inputs of various key stakeholders including the various Ministries/ Departments, State Governments, State Transport Undertakings (STUs), Power Utilities, Consumers, Industry (OEMs, component manufacturers and dealers), Industry Associations, Experts, Automotive Testing Institutes, Academia, Research Institutes, etc were taken.

3.2.6. The consumer survey covered 7000 respondents across 16 cities, including the tier 1, tier II and tier III & IV cities and 12 focus groups across the nation covering all vehicle segments. In addition, 200 interviews were conducted covering all automotive stakeholders including the Government (Central Ministries & Departments, State Governments etc), Industry (both OEMs and suppliers), Research Institutes and Associations etc.

3.2.7. The consumer survey captured various important aspects such as technology awareness and preference, preferred attribute levels (price, mileage, top speed etc.), perception of alternative technology compared to conventional technology, major drivers and barriers to adoption etc. Additionally, a questionnaire was floated with the survey and a conjoint analysis was performed to capture the sensitivity of consumer preference to parameters like price, running cost, recharge time and range, to obtain a true insight into consumer preferences for these attributes. Preference and sensitivity variation with demographic parameters like age, occupation, education etc. was also considered. The interaction with the key stakeholders in the industry helped in the understanding of the existing production capabilities, price-performance evolution of xEVs, and technology capability within the country, along with the potential for xEVs.

3.2.8. These inputs have provided the basis for possible scenarios for level of penetration of electric mobility in the country (upto 2020), the key interventions required from the Government and the Industry, the possible levels of investments required and the likely return on these investments.

3.3. Methodology – II *(Models used).*



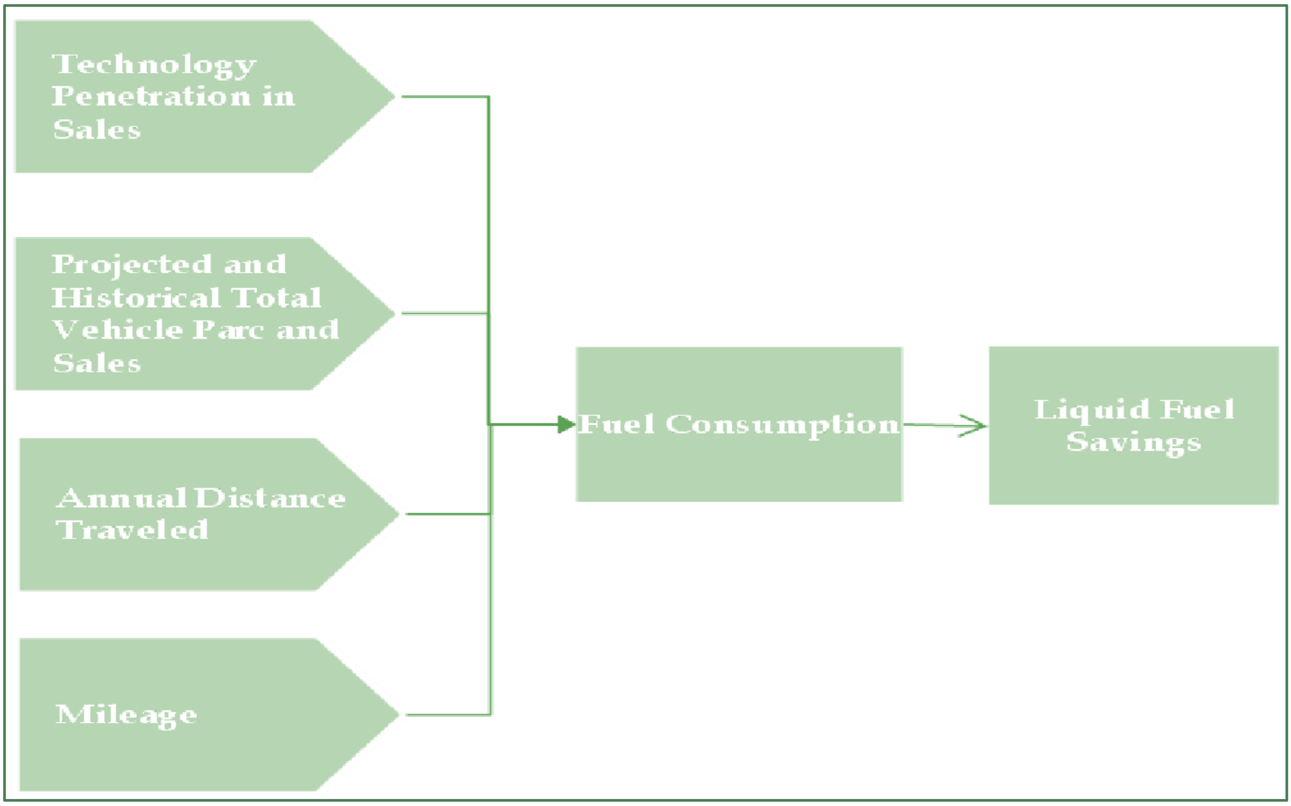
Analytical models used

3.3.1. A number of analytical models have been used for arriving at the projections for the net fuel savings, relative economies of all power trains in the future, the likely penetration of different technologies and likely savings in the carbon dioxide emissions.

Fuel savings

3.3.2. The fuel saving from xEVs was calculated by using inputs on the expected vehicle segment sales by 2020, penetration of different technologies in vehicle sales, vehicle kilometers travelled by each segment and its future evolution etc. This is depicted in (**Exhibit 6**) below.

Exhibit 6 – Fuel saving calculations



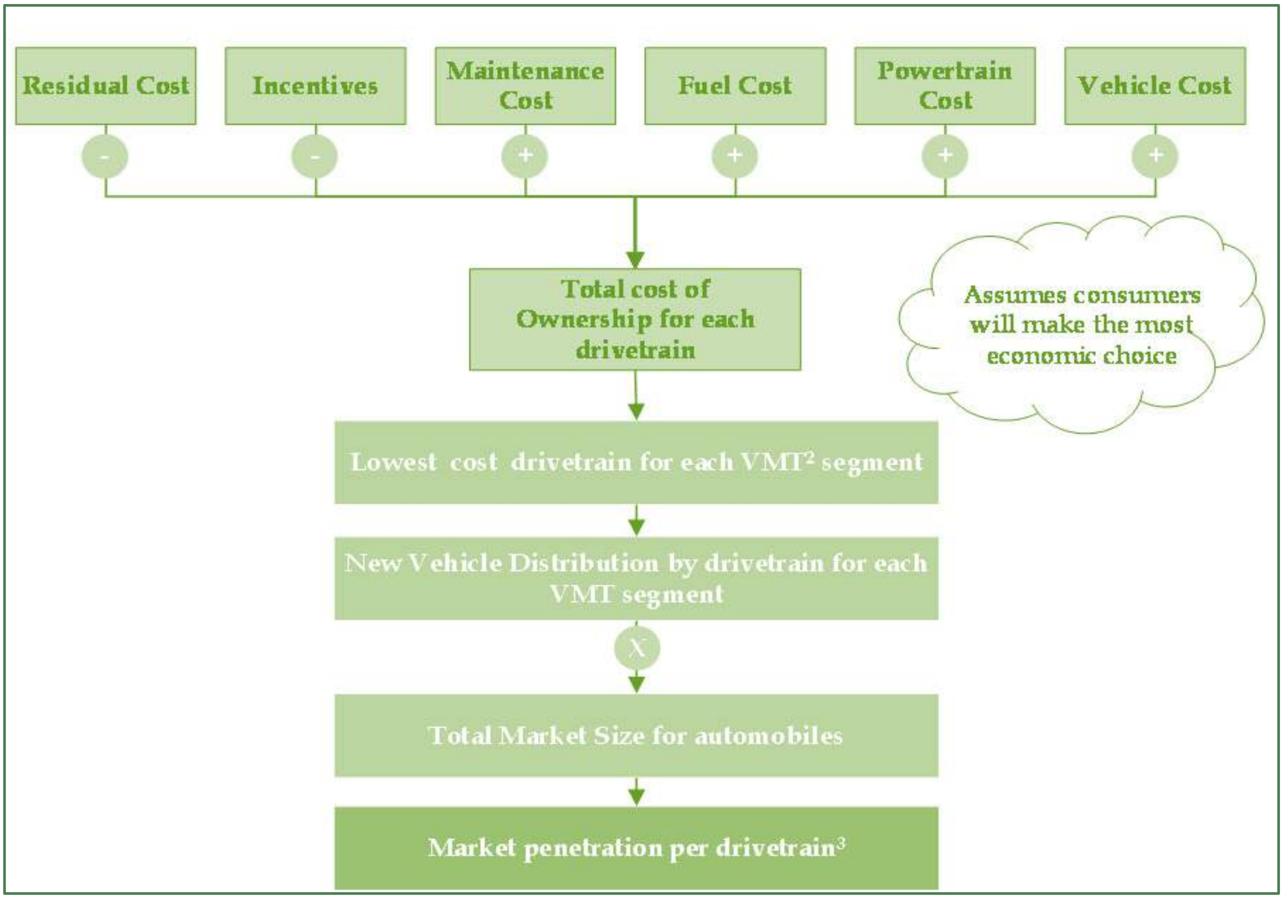
***Note**: Retrofits are assumed to have 80% of the fuel efficiency gain compared to OEM produced HEV / PHEV, Fuel efficiency of ICE : 2w – 65 kmpl, 3w – 38 kmpl, 4w – 12 kmpl (petrol), Premium Bus – 2.4 kmpl, LCV – 18kmpl*

***Source:** OEM Interviews, Secondary Research, GoI– Industry study.*

Total cost of ownership

3.3.3. The Total Cost of Ownership (TCO) model has been used to arrive at relative economics of all the powertrains, and the likely penetration of each (**Exhibit 7).** In order to arrive at the total cost of ownership of a specific vehicle segment (2w, 4w etc.) and of the specific drivetrain technology (HEV/PHEV/BEV etc.), the acquisition cost comprising of vehicle and powertrain cost, running cost, maintenance cost and incentives were considered. From the total cost of ownership, the lowest cost drivetrain for each vehicle segment (based on kilometers travelled) was identified. Further, based on the assumption that consumers will make the most rational economic choice, the distribution of drivetrains in incremental sales was calculated leading to total market size for automobiles and penetration per drivetrain.

Exhibit 7 – Total cost of ownership model



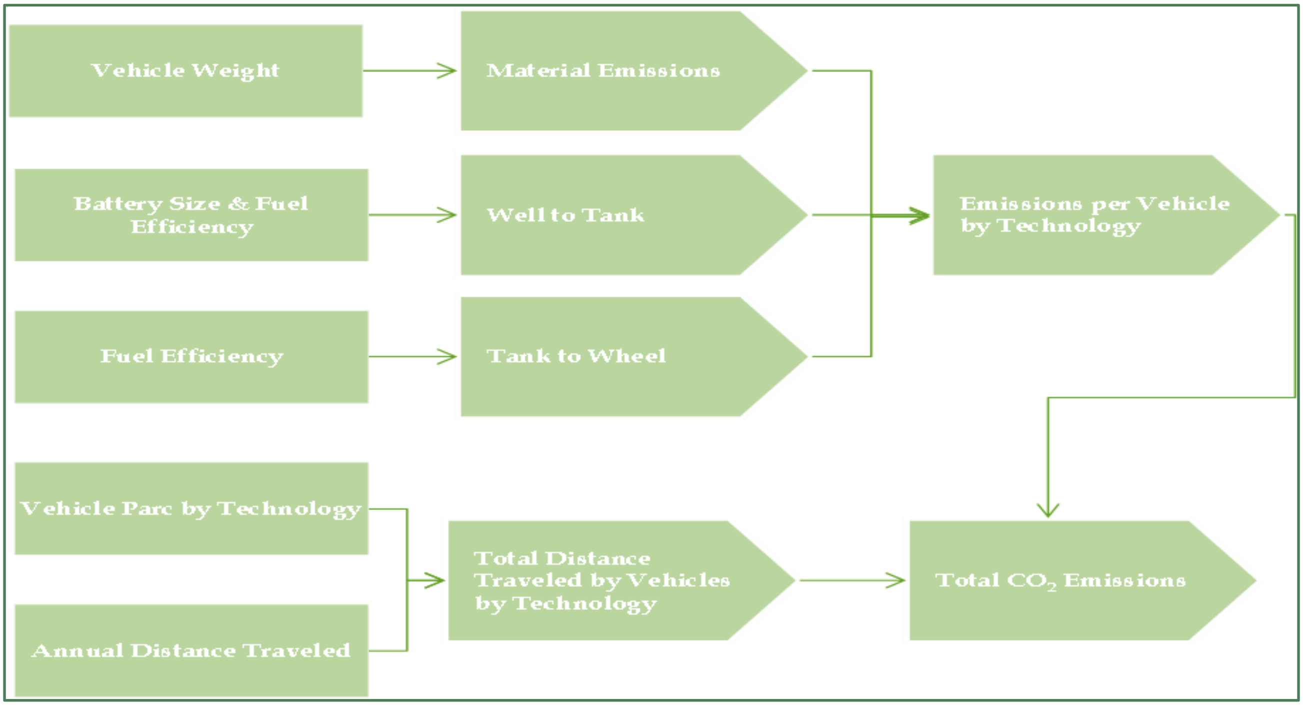
Note: *Price in 2011 refers to expected price if OEMs bring the commercial product to the market based on current price and performance,*
2) VMT refers to the Total Vehicles Miles Travelled (annual distance travelled in km)
3) The Market penetration is adjusted with a market inertia factor to reflect consumer hesitance while shifting to new xEV technologies
Source: *GoI– Industry study*

3.3.4. For estimating the carbon dioxide emissions and likely savings arising out of adoption of xEV solutions, the carbon dioxide emissions model was used (**Exhibit 8**). The total CO_2 emission calculations involved the calculation of emission per vehicle per kilometer by vehicle technology. This has three components – the *tank to wheel*

CO_2 *emissions*

emission which depends on the fuel efficiency of the drivetrain; the *well to tank emission* which is a function of battery size in addition to fuel efficiency; and the *material emissions* which are dependent on the vehicle weight. The total emission used is the combination of these three components. The three components were individually computed and the total emission per vehicle per kilometer was multiplied with annual average vehicle kilometer driven and total parc to get total emissions. Comparison of emissions of the high gas/HEV scenario and high gas/HEV/BEV scenario with status-quos gave the emission reduction in case of each one of these scenarios.

Exhibit 8 – Carbon dioxide emission model



Source: GoI– Industry study.

3.4. Summary of the projections for latent demand by 2020.

Global projections

3.4.1. It is projected that the total global demand for four wheelers and two wheelers, which at present is 45 million and 43 million units, is expected to increase to 70 million and 76 million units respectively by 2020. It is also expected that the current level of penetration of electric (includes hybrid & PHEV) four and two wheelers which at present is 2% and 38-40% respectively may shift to 7-19% and 34-36% [6] respectively by 2020. This will translate to 5-13 million electric 4W and 27 million electric two wheelers by 2020.

3.4.2. Further, it is estimated that the total potential demand for the full range of electric vehicles in India (mild hybrids to full electric vehicles) will be in the range of 5-7 million units in new vehicle sales by 2020. This will include 3.5-5 million pure electric two wheelers (BEVs), 1.3-1.4 million HEV vehicles (4W, buses, LCVs) and 0.2-0.4 million other pure electric vehicles (4W, buses, LCVs). However, it is also clear that on its own these levels of penetrations are not expected to be achieved and will therefore require government support to spur industry investments. The level of penetration that is possible in 2020 is depicted in **Table 3** below. The basis for the latent demand projections made for India by 2020, the essential requirements to realize the potential, the various strategies that can be adopted are covered in detail in **Chapter 4** – Demand Creation.

Potential demand for India – 2020

Table 3 – xEV potential demand by 2020

Vehicle / Technology Segment	*Potential for xEVs (M Units)*
BEV 2W	*3.5 – 5*
HEV Vehicles (4W, Bus, LCV)	*1.3 – 1.4*
Other BEV Vehicles (3W, 4W, Bus, LCV)	*0.2 – 0.4*
Total	*5-7*

[6] *The slight reduction for the electric two wheelers projected for 2020 is on account of the decreasing trend for electric two wheelers seen in China.*

3.5. Barriers to adoption of electric mobility.

Barriers

3.5.1. Globally significant barriers to larger and faster adoption of electric mobility exist. These are mainly on account of higher cost of acquisition, challenges relating to batteries (these include issues relating to price, range, performance etc), consumer acceptability, performance standards of xEVs in comparison to traditional IC engine based vehicles (range, speed, acceleration etc), lack of charging infrastructure etc.

3.5.2. These barriers can be clubbed into four broad areas which need to be overcome. As far as India is concerned, various issues in these areas include **(i)** Consumer Acceptability – this includes issues relating to low consumer awareness, current price – performance gap etc. **(ii)** Technology Development – the existing low level of R&D in this area in the country, limited current capabilities etc are some of the concern areas. **(iii)** Manufacturing Investments – includes the limited domestic manufacturing capabilities and non-existent supply chain. **(iv)** Lack of xEV related Infrastructure.

3.5.3. In order to overcome these barriers, creation of market for xEVs through greater consumer acceptability will have to be the starting point. This will need to be taken up in right earnest and includes addressing issues related to higher price of acquisition of electric vehicles and various other demand generation measures. Demand incentives should be accompanied by measures for spurring localization of manufacturing and greater investment in R&D and technology acquisition. The efforts for addressing the infrastructure related issues will need to be addressed continuously from the very beginning of the road map.

3.6. Assessment of ease of implementation for different vehicle segments.

3.6.1. An assessment of the various vehicle segments with respect to the ease of implementation / introduction of xEVs has been carried out based on an assessment of the current capabilities, the existing price performance gap and the level of investments required. This is based on the data generated during the course of the study and is depicted in **Table 4** on the next page.

Table 4 – Analysis of the ease of implementation of electric mobility plan

Analysis		Four Wheelers	Two Wheelers	Buses	Three Wheelers	LCVs
Ease of Implementation	**CAPABILITIES**	Low to Moderate	Moderate to High	Moderate	Moderate	Low
	PRICE PERF. GAP	Moderate to High	Low to Moderate	High	High	High
	INVESTMENT	Significant investments required by OEMs	High investment needed as volumes are high.	Moderate	Moderate	Moderate
	Overall	***Low to Moderate***	***Moderate to High***	***Moderate***	***Moderate***	***Low***

Source: GoI – Industry study

xEV implementation

3.6.2. Table 4 shows that introduction of xEVs in the LCV segment is likely to be the most difficult, the ease of introduction of xEVs in case of four wheelers will be low to moderate. Two wheelers followed by buses and the three wheeler segments are the most amenable vehicle segments for introduction of xEVs. In addition, views of the industry in this regard were also taken into account. As per the interactions with various vehicle manufacturers (OEMs), the order of ease of roll out of xEVs for various vehicle segments is buses, followed by two wheelers and three wheelers, with four wheelers being the most difficult.

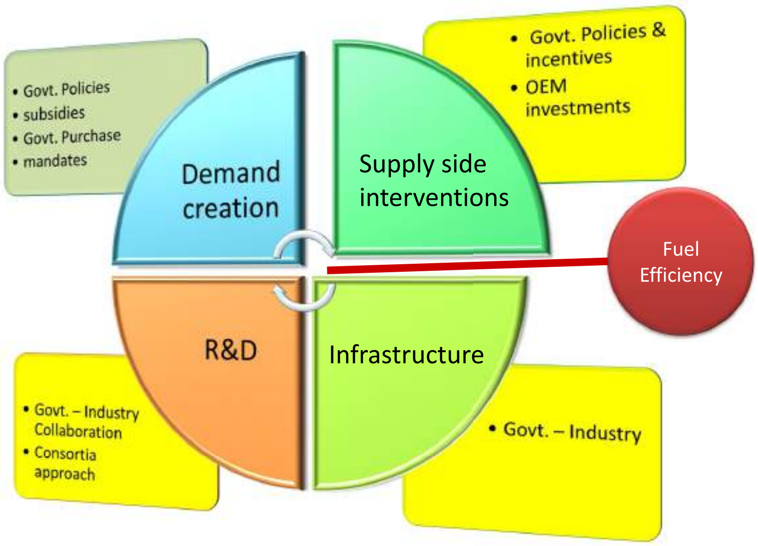
3.7. Essential ingredients for realizing the potential latent demand.

Levers for xEV adoption

3.7.1. In view of the nascent nature of the xEV market, lack of manufacturing eco system in India and the significant existing barriers for adoption of xEVs, the role and support of the government will be critical. This will involve closer working of all stakeholders, especially the government and the industry. As such, Government- industry collaboration would be essential

3.7.2. The important interventions, schemes and instruments of government policy that are required to support the growth of the hybrid / electric vehicle market can be classified into five broad areas of demand and supply related interventions, research and development support, infrastructure investments and fuel efficiency measures. Interventions in these areas will need to be used effectively and leveraged.

Figure 2 – Levers to support xEV adoption.



3.7.3. These areas are dealt in detail in subsequent chapters, however, briefly some of the possible interventions in these areas include:

3.7.3.1. Demand Generation: This includes a host of measures including mandating xEV in government fleets and public transportation for creating assured demand. Promoting the sale of xEVs by bridging the higher acquisition costs of xEVs through a host of possible measures such as cash incentives, tax incentives and peripheral benefits such as road tax exemption etc.

3.7.3.2. Supply related interventions to encourage domestic manufacturing: The supply side interventions are aimed at creating the manufacturing eco system for xEVs through greater domestic value addition. This can be achieved by linking demand incentive from the Government to a certain minimum level of localization of xEV components along with a phased increase in local value addition as a qualifying precondition for manufactures. In addition, various other incentives, such as accelerated depreciation, tax holidays etc can also be used to encourage and strengthen the local manufacturing capabilities. Further, as domestic capabilities increase over time, the current special dispensation of low import duty structure on critical xEV components can be harmonized with the general auto component import duties to give fillip to local manufacturing as against direct imports.

3.7.3.3. Research & Development: For developing the domestic xEV manufacturing eco-system and lowering of costs in future, it is essential that research and development programs be aimed at promoting India

specific solutions and greater localization of xEVs be encouraged and funded. The R&D effort will require investments from both the government and the automobile industry. As a part of this initiative, consortium building approach or direct grant models can be examined, as some of the funding mechanisms to support and ensure a strong local R&D base yielding tangible results. To this effect, it would be necessary to define measurable output indicators for R&D.

3.7.3.4. Infrastructure Support: The xEV roll out will require augmentation of existing infrastructure of Power Generation & Transmission and also setting up of Charging Infrastructure for xEVs. The requirement of additional power generation on account of xEVs is not expected to be very high. However, significant Charging Infrastructure would be required to be set up particularly for buses. While, in case of buses, charging stations can be located in the bus depots, for other vehicle segments, charging stations will need to be set up in apartment complexes, malls, parking garages, workplaces, public buildings, etc.

3.7.3.4.1. For charging infrastructure, the aim will be to develop this as a commercially viable business opportunity that attracts private investment. The government will need to facilitate this activity by taking a number of measures that include mandating charging infrastructure in public buildings, introducing standards for charging equipment, amending building laws to mandate provision for charging outlets, providing speedier access to land for setting up of charging infrastructure, allowing private retailing of power, uninterrupted electricity at reasonable costs for xEV recharge, speedy clearances and by undertaking pilot projects for testing the efficacy of the various charging infrastructure models that can be adopted.

3.7.3.4.2. The pilot xEV charging projects will be taken up in the early adopter areas or cities and will not only involve identifying suitable pilot stage cities but also key target transport groups for electrification like fleet operators, public transportation companies, operators of feeder buses to the metro system etc.

3.7.3.5. Fuel Efficiency: Higher fuel efficiency is one of the important outcomes expected from the initiative. However, given the present level of maturity of the xEV market, taking into account the impact of xEVs in arriving at fuel efficiency norms can be done only at a later stage once these technologies have attained economic viability, greater penetration and acceptance. At that time, more stringent fuel efficiency norms can be an important lever of government policy to support xEV growth.

3.7.3.6. Creating awareness about xEV technologies among the consumers is also an important initiative that will be required to be taken up. The details of the strategy proposed for each of these levers is dealt in detail in subsequent chapters.

3.8. NEMMP 2020 stakeholders and their roles.

The key NEMMP 2020 stakeholders

3.8.1. It is clear that in order to realize the latent demand for xEVs, all stakeholders including the Government and the industry will need to provide continued long term support and commitment to this initiative. The Central Government is one of the key stakeholders for this initiative with DHI, DST, NMCC, MNRE, MoRTH, MoP, MoUD, MoF, MoEF, and DIPP being the main concerned Union Ministries. In view of the existing limitations on both demand and supply side, the Government will be required to commit continued & sustained support for creating a critical market size for xEVs through bridging higher acquisition costs (to the extent agreed upon) for an optimal number of xEVs of different segments for an agreed duration.

3.8.2. In addition to bridging the higher acquisition costs of xEVs another barrier that currently exists for pure electric vehicles on account of range limitation (maximum distance driven per charge) also needs to be addressed. As such, Government's continued support for kick starting xEV infrastructure and R&D creation will be essential. The creation of adequate charging infrastructure, development of battery swap and fast charging as viable business models coupled with improvements in range, performance, charging time, and cost reductions through R&D efforts are expected to play a key role in addressing this issue.

3.8.3. In order to effectively administer the various schemes and for achieving the desired outcomes, the Government will also have to ensure the development of electric vehicle performance, quality and safety parameters/standards. This will include issues relating to vehicle and battery performance, durability & warranties, driving range, charge time, energy efficiency of vehicle, standardization of technical characteristics like battery characteristics, motor specifications etc. In addition, the facilities required for testing and homologation will also need to be set up.

3.8.4. These ground realities would necessitate mid to long term stable Government policies, schemes and pilot projects to be approved and launched in the start off phase itself. The Government will also need to co-ordinate efforts for international collaboration in the area of growth of electric mobility and also for R&D activities in this field.

Government policies

3.8.5. The various important mechanisms/ policies that can be used by the Government to help shape the outcomes of this initiative include **(i)** *Permissive legislations:* Use of legislation framework, laws, both central and local to shape what mode and vehicle types will be allowed to ply in various areas **(ii)** *Operational regulations:* Use of legislation framework and regulations, both central and local aimed at setting up safety regulations, emission regulations (environmental regulations), vehicle performance standards, charging infrastructure standards, standards for inspection & maintenance, etc. **(iii)** Instruments of Fiscal policy measures and trade related policies as tool for shaping the market, export-import. **(iv)** Manufacturing policy aimed at encouraging investments **(v)** Specific policies aimed at incentivizing the manufacture and earlier adoption of electric vehicles through demand creation incentives. **(vi)** Schemes and pilot projects for facilitating Infrastructure creation (vii) Policy for facilitating Research, Development and Demonstration.

3.8.6. The State Governments, local bodies, municipalities are also important stakeholders and will have a key role to play in effective adoption and roll out of electric mobility through host of measures like road tax incentives, mandating charging infrastructure in building byelaws, enabling private parties to sell electricity, earmarking certain areas for electric vehicles only, selective levies like parking fees etc.

3.8.7. These measures by the Government are expected to substantially de-risk the large private investments required and thereby create the environment and provide confidence for realizing the xEV demand by 2020.

3.8.8. The main stakeholder industries for this initiative include **(i)** Automobile industry, **(ii)** Auto component industry, **(iii)** Battery manufacturers, **(iv)** Motor manufactures, **(v)** Power utilities, **(vi)** Renewable energy companies like Suzlon, **(vii)** Public transport companies and fleet operators both for freight and passenger. The de-risking and conducive environment created by Government policies and other interventions should encourage the automotive companies to make the investments required for creating the manufacturing eco-system (supply chain) and for undertaking significant product development activities. The role of the power utilities and oil dispensing companies would also be important.

3.8.9. The automotive R&D institutes, R&D centers in other related areas, academia and the Industry will be required to collaborate in their research efforts in a more effective manner so as to have faster and desirable outcomes. In addition to facilitating the roll out of the NEMMP 2020, collaborative R&D is one of the other important activities/areas to be taken up by the National Automotive Board (NAB) being created under the Department of Heavy Industry. The NAB will play a key pivotal role in this regard. The xEV R&D strategy elaborated in **Chapter 5** lays strong emphasis on effective R&D networks and collaboration as the way forward.

3.8.10. Acquiring a better understanding of the consumer needs and key factors/strategies that will best influence a change in consumer purchase behavior, individual travel behavior pattern etc is also very important. These insights can be used not only by the industry for their marketing strategy but also by the Government for developing the most appropriate policies. In addition, consumer education and awareness will also be critical.

Upfront stable long term Government policies, investments, schemes and key interventions for xEV infrastructure and R&D will contribute significantly for providing confidence and de-risking the investment decisions of the private sector. The industry will in turn, need to make the committed level of investments required for creating the manufacturing eco-system and undertake product development for realizing the xEV demand by 2020.

3.8.11. For success, the Government will have to be the catalyst to ensure that collaboration between all these stakeholders becomes a reality. The industry will be required to make viable business models and understand well the consumer preferences and vehicle usage patterns by different segments for effective targeting and also for the right product design and specifications.

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NEMMP 2020

4. DEMAND CREATION

Chapter 4

4.1. Current status and present demand incentives for xEVs.

4.2. The potential global demand for xEVs in 2020.

4.3. Three possible scenarios of demand projection for India.

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4.11. Key stakeholders, roles and responsibilities.

4.12. Review, monitoring & course correction mechanism.

Chapter 4 – Demand Creation

4.1. Current status and present demand incentives for xEVs.

4.1.1 The past efforts and the current status of the xEV market in India has been summarized in **Para 1.3.** The most recent demand generation incentive program in India for xEVs, namely the Alternate Fuels for Surface Transportation Program (AFSTP), was run by the Ministry of New and Renewable Energy (MNRE). This program provides demand incentives for all xEVs, amounting to a total of Rs 95 crore between 2010 and 2012. This was available to OEMs giving at least 1 year warranty and setting up 15 service stations across India. The contours of this program are summarized in **Table 5** below.

Table 5 - Physical targets & central financial assistance (FY 2011 and FY 2012)

	Type of Vehicle	Physical (units) FY11	FY12	Assistance per vehicle
2W	Low Speed	20,000	80,000	Rs. 4,000/- or 20 % ex-works cost of vehicles whichever is less
	High Speed	10,000	20,000	Rs. 5,000/- or 20 %
3W	7 seater	100	166	Rs. 60,000/- or 20 %
Passenger Car	4 seater	140	700	Rs. 1,00,000/- or 20 %
Bus/Mini Bus	>10 seater	-	-	Rs.,4,00,000/- or 20%

4.1.2. In addition, some State Governments have also been providing incentives for electric vehicles. For instance, the Delhi Government provides **(i)** a 15% subsidy on the base price, **(ii)** 12.5% exemption of VAT and **(iii)** Refund of road tax and registration charges

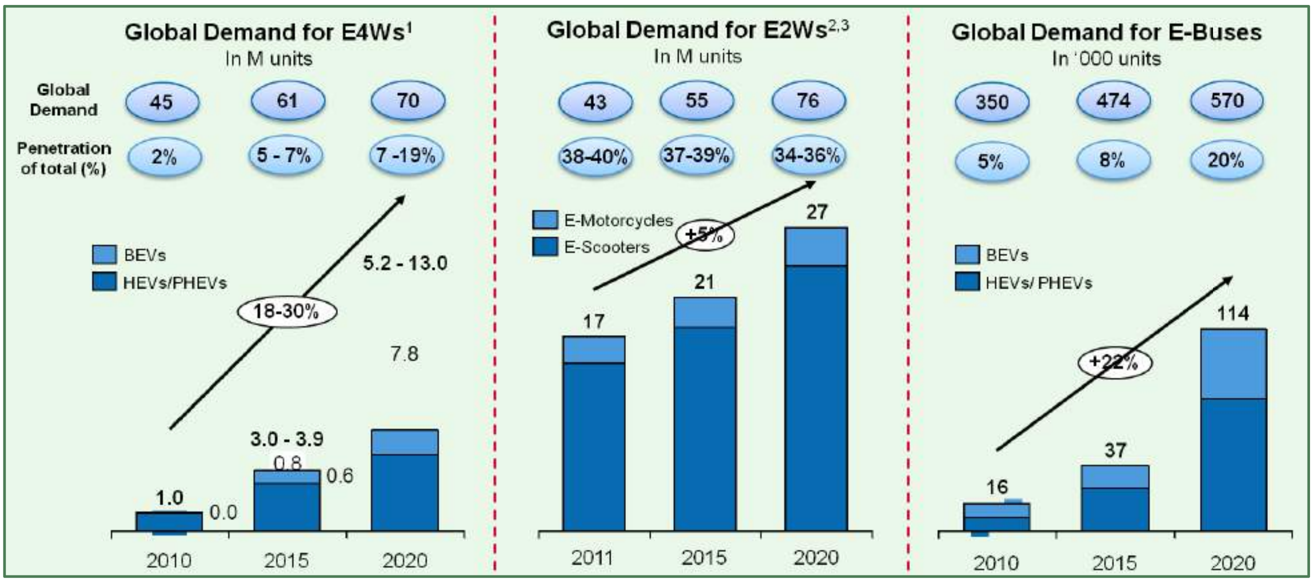
State Governments

4.1.3. The two most important drawbacks highlighted by the industry that need to be improved in the earlier and existing xEV demand incentive schemes are **(i)** lack of continuity of the incentive policy/scheme for sufficiently long duration that is necessary to give confidence to the industry for committing large investments for setting up domestic manufacturing facilities. Currently the existing schemes are extended on year to year basis without any assurance on their total duration and budget. As a result, the manufacturing/value addition in the country is currently restricted to assembly operations with critical components being imported. **(ii)** Simple and effective incentive delivery mechanism that allows for the incentive to reach the intended beneficiaries quickly and efficiently. Current schemes leave a lot of scope for improvement for this. As such, the learning from efforts made so far highlight the importance of having upfront commitments on total size (number of vehicles covered and amount of incentive per vehicle), duration of a demand incentive policy/scheme and an efficient incentive delivery mechanism for the scheme to be effective in faster adoption of xEVs, for spurring domestic investments and for creation of domestic xEV manufacturing eco-system.

4.2. The potential global demand for xEVs in 2020.

4.2.1. The global demand for xEV four wheelers are expected to grow at a CAGR of 18-30% in the next eight years and four wheeler xEVs are expected to capture 7-19% of global 4W incremental sales by 2020. Therefore, based on different technology scenarios, the sales of four wheeler xEVs is expected to range between 5 million and 13 million units by 2020. This is depicted in **(Exhibit 9)** below.

Exhibit 9 - Potential global demand for xEV 4W by 2020



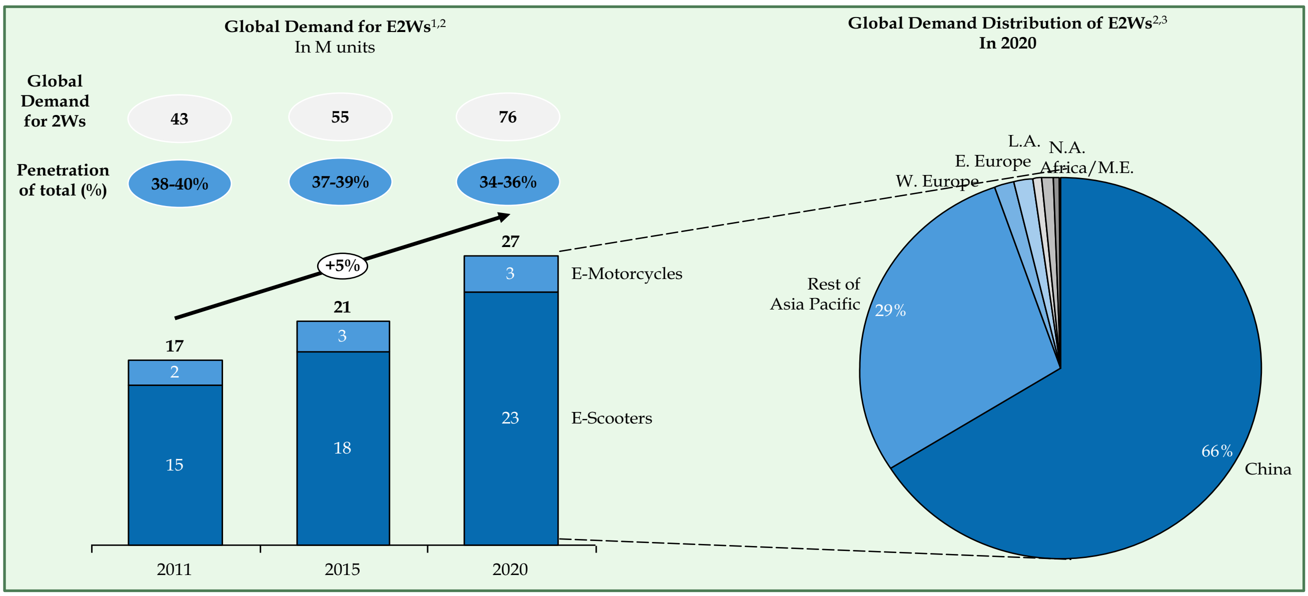
Sources - JD Power - Drive Green 2020, JD Power - Global Engine &Transmission Forecast, Deutsche Bank - Electric Cars Plugged In 2.

4.2.2. Given their strong focus on emission control and liquid fuel savings, US and Europe are expected to have the greatest penetration of four wheeler xEVs. Japan which has made significant technological breakthroughs is also expected to have a significant number of 4W xEV units by 2020.

4.2.3. The two wheeler segment is at an advantage compared to other vehicle segments as there is already a significant adoption of electric two-wheelers in China, pushing the global xEV two wheeler penetration to close to 40%. While the current penetration of electric 2 wheelers in China is close to 75%, it is expected to decline to 68% by 2020, mainly on account of safety concerns and change in licensing rules. Notwithstanding this, the current xEV two wheeler global demand projection of 17 million units is expected to rise to 27 million units by 2020, maintaining a 5% CAGR (**Exhibit 10**). The majority of demand is expected to come from Asia Pacific (95%). China is expected to have a maximum demand, accounting for about two-thirds of the total global demand.

4.2.4. The global xEV bus sales are expected to grow at 22% CAGR reaching ~ 1.1 – 1.2 lakh units in 2020. The penetration is also expected to rise from the current 5% to 20% in 2020. It is expected that 45% of the total global xEV bus sales in 2020 will be from China. The penetration of electric bus in China is expected to rise from the current 4% to about 24% in 2020.

Exhibit 10 – Global demand forecast – 2W



Sources – SIAM, JAMA, FAMI, AISI, Global insight, Datamonitor, Pike research, Govt. Industry study.

Global scenario

4.2.5. In summary, it is expected that the current level of penetration for electric four and two wheelers (including hybrid & PHEV) which at present is at 2% and 38-40% respectively may shift to 7-19% and 36-34% respectively by 2020. This will translate to 5-13 million xEV 4W and 27 million electric two wheelers by 2020. The likely global xEV demand by 2020 is summarized in **Table 6** below.

Table 6 – Global 2020 xEV demand summary

(units in Millions)

Vehicle segment		2W	4W Range		Buses	Total
Global xEV projections 2020	**Numbers**	27	5	13	0.12	32.12 - 40.12
Total vehicles 2020	**Numbers**	76	70	70	0.57	147
Global penetration of xEV	**%**	35.5%	7%	19%	20%	

4.3. Three possible scenarios of demand projection for India.

Projections for India

4.3.1. In case of India, three most likely future scenarios of vehicle demand projection have been considered for the purpose of analysis and outcome development. These are:

4.3.1.1. Scenario 1 - Status-quo: – This scenario assumes that there is no change in the current state of fuel mix and the penetration patterns of the respective vehicle segments remain similar to the current pattern i.e. – high ICE penetration and marginal CNG penetration.

4.3.1.2. Scenario 2 - The High Gas and High HEV: – Here significant government focus on CNG and xEV through investments and incentives has been considered. This scenario underlines a strong xEV focus to substitute IC engine technology. Here a substantial CNG penetration of about 30-35% and significant Hybrid penetration of 10-15% has been assumed by 2020 for vehicles other than 2W. The BEV penetration has been taken to be low, reaching about 2% in 2020. However, in view of the ease of deployment of BEV two wheelers, 15% penetration in sales by 2020 is taken in this scenario.

4.3.1.3. Scenario 3 - High Gas, High HEV and High BEV: - This is one step ahead of the high gas/HEV scenario and takes into account a strong focus on BEVs in addition to CNG and HEV. Here the BEV penetration is assumed to increase to 5%

in 2020 (by sales) across most vehicle segments, while capturing 15% of 2-wheeler market.

4.3.2. In addition, estimates of the likely impact of these penetration levels on future liquid fuel consumption have been made for both the High Gas/High HEV and High Gas/High HEV/High BEV scenarios in order to estimate the possible savings by 2020 and also the likely cost – benefit analysis for the initiative. This has been taken up in greater detail in **Chapter 8**.

4.4. Important findings of the Government – Industry study.

4.4.1. In-depth study comprising of an extensive ground level consumer survey based on direct interviews and administered questionnaires was carried out. The study included several rounds of focused group discussions covering all major cities and demographic groups and interactions with key stakeholders were also conducted. The Joint Government – Industry study provided an understanding of the consumer preferences, and the likely effective divers for adoption of hybrid and electric vehicles in India. This study forms the basis for arriving at the latent xEV demand projections for India.

4.4.2. As already detailed in **Chapter 3**, the field survey for four and two wheeler vehicle segments involved more than 1800 consumers across 16 cities, while that for buses and three wheelers entailed 170 interviews of bus fleet owners across 11 cities and 1600 consumers respectively to understand their preferences. The interviews with bus fleet owners were extensive and 75%-80% of bus population in tier 2, 3 and 4 cities and 40%-50% bus population in tier 1 cities were covered.

4.4.3. The Focus Group Discussions (FGD) with potential consumers provided several significant insights, such as **(i)** currently there is a limited understanding of xEV technologies amongst the consumers. **(ii)** Consumers are willing to pay a premium of 10-20% for HEVs justified by their lower operating costs; however the premium should be recoverable in 2-3 years. **(iii)** Highest preference has been expressed for HEVs, followed by PHEVs and BEVs – due to lack of charging requirement, higher range, lack of battery replacement, availability of an IC engine as a backup to the electric engine etc. **(iv)** Consumers appeared to be more receptive to PHEVs and BEVs, if

Focus Group Discussions

there is an acceptable range and if the necessary charging infrastructure is available. **(v)** Charging aspects was cited as being important and most respondents preferred public charging infrastructure and lower charging time. The charging time anxiety was higher for two wheelers and three wheeler owners. **(vi)** Environmental benefits of xEVs did not appear to be an important buying criterion for consumers.

Industry feedback

4.4.4. The insights gained from the OEMs, research institutes and component suppliers indicates that **(i)** the low demand for xEVs in Indian market is due to high price, low performance, lack of infrastructure and low awareness. **(ii)** HEVs seem to be preferred due to higher range and no charging issues as compared to PHEVs and BEVs. **(iii)** Amongst the various vehicle segments, the easiest uptake of xEVs will be for buses, two wheelers followed by four wheelers and three wheelers.

TCO model

4.4.5. Demand Projections based on Consumer survey, FGDs, TCO analysis: Based on extensive consumer surveys, focus group discussions, interactions with different stakeholders, including OEMs and Total Cost of Ownership (TCO) analysis model, the study has made estimations for the possible latent demand projections for xEVs by 2020. These are summarized below.

Four wheelers

4.4.5.1. Consumer research has revealed that overall there is a high latent demand for xEV cars (4W) and that 25-30% of surveyed consumers would prefer a xEV to traditional ICE four wheelers (4W) provided price & performance expectations are suitably met. Amongst the xEV four wheelers, the higher preference is for HEV (~14-15%) followed by PHEV (~9-10%) cars and least for BEV cars (~5%). The main barriers inhibiting adoption of 4W BEVs are poor pick up, low top speed and issues relating to battery replacement.

4.4.5.2. Projections based on the total cost of ownership (TCO) analysis for 4Ws indicate that with suitable incentives being provided; the four wheeler xEVs will have significant latent demand by 2020. The likely potential demand for 4W will be in the range of ~ 1.6-1.7 million units by 2020. In this projection, it is assumed that the scale effects will come into play in 2020 and lead to 10% reduction in acquisition price. Within 4W xEVs, mild hybrid and full hybrid EVs can have a latent demand of ~20% by 2020 due to their lower acquisition and operating costs. The 4W HEVs are likely to have a latent demand of ~4% by 2020 and 4W BEVs can have a latent demand varying from 2.5% -5% based on cost. It is also clear that on its own, the xEV potential for 4Ws in India will not be reached by 2020 unless consumer expectations are met. The study indicates that demand side incentives would be critical. In addition, technology and infrastructure improvements would also be required for realizing the latent demand for 4W xEVs.

Two wheelers

4.4.5.3. Consumer research indicates that although electric two wheelers have much higher acceptance, yet poor pick up, low top speed and battery replacement issues continue to be the main barriers to higher adoption of xEV 2W. The demand projections based on TCO analysis indicate significant latent demand for BEV two wheelers which is projected to rise from 2% at present to ~16% by 2020. This corresponds to ~5 Million units by 2020 constituting 16% of the total future projected demand of 32 million two wheelers. Depending upon the future petrol prices, it is estimated that the latent demand could be in the range of 20% for BEV scooters and 15% for BEV bikes by 2020 to as high as 21% in a more aggressive scenario. Further, consumer research also indicates that there is a higher preference for battery operated 2Ws (~55-60%).

Buses

4.4.5.4. Higher preference has been expressed for hybrid buses by consumers compared to PHEV and BEV buses. The key barriers for early adoption of xEV buses include pick up, battery replacement and charging time. In order to harness the existing latent market potential leading to increased xEV adoption, incentivizing both consumers and manufacturers would be required. The demand side incentives can push up demand thus enabling the OEMs to achieve scale thereby reducing the production costs and make the buses more affordable. It would therefore be preferable to front load the incentives to drive early adoption and then phase out the incentives. By 2020, the likely potential demand for xEV buses will be in the range of 2300 - 2700 units.

LCVs

4.4.5.5. Consumer survey indicates that the key barriers which may inhibit the adoption of xEV LCVs include poor pick up, low top speed and high battery replacement costs. In case the demand incentives and other enabling conditions are met, it is expected that by 2020 HEV and BEV LCVs may achieve a penetration level of 8% and 4% respectively. In volume terms, this translates to 81,000 units and 35,000 units of HEV and BEV LCVs respectively.

4.4.5.6. Pick up and top speed emerged as the top two key barriers

Three wheelers

inhibiting adoption of three wheeler xEV technologies along with battery replacement cost. It is expected that with demand incentives, latent demand for 3W BEVs can be more than 2% by 2020.

4.4.5.7. *The Impact of technology and economies of scale on demand:* It is expected that Improvements in technology and global scale effect will bring down lithium ion battery costs by about 5-7% YoY in future, thereby translating to price level of $325 - $ 430/kWh by 2020. However, these prices would still remain higher than equivalent price expectation of the Indian consumer ($ 210-275/ kWh) leading to a higher acquisition cost than consumer expectation. This aspect has been taken into account while arriving at the likely xEV demand projections for India by 2020.

4.4.5.8. The projections for possible xEV latent demand in India along with the Global projections for 2020 are summarized in **Table 7 & 8**:

Table 7 - India and global xEV demand projections for 2020 (Nos in Millions)

Vehicle seg./ country		**2W**	**4W Range**		**Buses**	**Total Range**	
India xEV projections 2020	***Numbers***	***4.8***	***1.6***	***1.7***	***0.002***	***5***	***7***
penetration of xEV India	*%*	*15.0%*	*17.8%*	*18.9%*	*-*	*14-16%*	
Total vehicle Sales India	***Numbers***	*32*	*9*	*9*	*-*	*43*	
Global xEV projections 2020	***Numbers***	***27***	***5***	***13***	***0.12***	***32.12***	***40.12***
Global penetration of xEV	*%*	*35.5%*	*7%*	*19%*	*20%*		
Total vehicles 2020	***Numbers***	*76*	*70*	*70*	*0.57*		
India Share as per above	*%*	*17.8%*	*12.8% - 30%*		*-*		

Graph 1 – Projected 4W xEV share in 2020

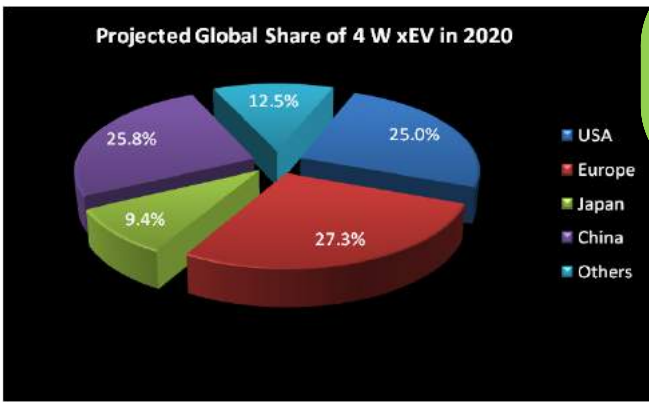


Table 8 - Projected Global Share of 4W xEV

Country	*4 W Nos in Mn*	*% Share*
USA	***3.2***	*25.0%*
Europe	***3.5***	*27.3%*
Japan	***1.2***	*9.4%*
China	***3.3***	*25.8%*
Others	***1.6***	*12.5%*
Total	***12.8***	*100.0%*

Barriers

4.4.5.9. The summary of the vehicle segment wise barriers for adoption of xEVs, as indicated in preceding paras, is summarized in **Table 9**. It must be remembered that this feedback is in context of the comparisons that consumers made in the performance of traditional IC engine vehicles with xEVs. In addition, it must also be appreciated that the current consumer understanding of xEVs is also limited. However, these barriers relating to performance will need to be overcome by ensuring that xEVs that are introduced in the market meet certain specified minimum requirements.

Table 9– Vehicle segment wise matrix of key barriers to xEV adoption.

Range	**4**	**4**	**4**	**4**	
Charging time			**5**	**5**	**3**
Battery replacement	**3**	**3**	**3**	**3**	**2**
Low top speed	**2**	**2**	**2**	**2**	**4**
Low pick up	**1**	**1**	**1**	**1**	**1**
	4W	2W	3W	LCV	Bus

Source: GoI – industry study. Note: Numbers indicate priority with 1 representing the highest ranking.

Other important findings of the study

4.4.6. The other important findings of the study in regard to **(i)** Key consumer purchase criterion for xEV. **(ii)** Sensitivity analysis across four key parameters of price, running costs, recharging time and range. **(iii)** City wise variations in xEV demand. **(iv)** Consumer preference for incentive type. **(v)** Possible niche usage areas for xEVs are summarized as follows.

Key consumer purchase criteria

4.4.6.1. Consumers have expressed maintenance cost, battery cost, pickup, top speed and charging time as major factors considered while buying xEV two wheelers and four wheelers. In case of LCVs top factors considered while buying xEV LCVs are pick up, maintenance costs and running costs. The top factors indicated by consumers while buying three wheeler xEVs were maintenance costs, range and running costs. Maintenance costs, pick up, running costs and availability of spares are important to 60% consumers and therefore emerge as the key factors considered by consumers while buying xEV buses. A summary of the key consumer purchase criteria for different vehicle segments is captured in **Table 10** on the next page:

Table 10– Vehicle segment wise matrix of key consumer purchase criteria.

Spares					4
Range				2	
Running cost			3	3	3
Charging time	5	5			
Top speed	4	4	5	4	
Pick up	3	3	1	5	2
Battery Cost	2	2	4		
Maintenance cost	1	1	2	1	1
	4W	2W	LCV	3W	Bus

Source: GoI – industry study. Note: Numbers indicate priority with 1 representing the highest ranking.

Sensitivity analysis across key parameters

4.4.6.2. Sensitivity analysis across four key parameters of price, running cost, recharge time and range was conducted as a part of the conjoint analysis on consumer feedback received from various cities. This gives a good understanding on the extent of the impact that any changes to these parameters are likely to have on the consumer preference. Therefore, this helps in identifying the parameters of maximum impact in each of the vehicle segments. This analysis reveals the following:

4.4.6.2.1. In case of 4W, the consumers are highly sensitive to price and running cost of HEV cars; with greater preference for lower acquisition costs. This implies that cash incentives and fuel efficiency can serve as effective levers to increase the adoption of 4W HEVs. Therefore, OEMs should also focus on improving fuel efficiency for HEVs, and spreading awareness of the same. Similarly, in case of 4W PHEVs and BEVs lowering of acquisition cost can be effective in stimulating demand. The face to face consumer interviews validated the efficacy of acquisition cost based incentives and battery subsidies for 4W xEVs.

4.4.6.2.2. Similar to the 4W segment in case of 2W also, consumers are most sensitive to acquisition price. In addition, consumers have also shown sensitivity to recharging time. This indicates that incentives on BEV 2W is likely to be effective in boosting demand. The adoption of fast/quick chargers is also likely to help generate demand.

4.4.6.2.3. In case of LCVs, in addition to acquisition price, consumers have shown sensitivity to running costs. As such cash incentive on acquisition costs is likely to be effective. Further, lower charging time is also important and will lead to an increase in latent demand in case of PHEVs.

4.4.6.2.4. Like most other segments, in bus segments also consumers have expressed sensitivity around acquisition price. Hence, cash incentives would be effective and will be essential to generate demand. Moderate sensitivity was also observed for running costs and recharging time for PHEVs. Setting up fast or rapid charging stations for buses could be a good lever in promoting xEV adoption in buses.

4.4.6.2.5. Acquisition price remains the major concern in the three wheeler segment as well. Running cost, charging time and range are also areas of major concern to consumers. These concerns can be mitigated through roll-out of fast and rapid charging terminals and public charging infrastructure.

4.4.6.2.6. The summary of the outcome of the sensitivity analysis for the various vehicle segments across the four parameters is given in **Table 11.** This clearly indicates that gains through higher fuel efficiency and demand incentives will be the key levers for higher xEV off take.

Table 11– Sensitivity analysis matrix for different vehicle segments.

Parameters		HEV	BEV				HEV	BEV	Critical Area	Effective Levers for Intervention
	Range		2	4	4				Battery Size	Battery cost
	Re-charge Time			2	3	3		3	Charging infrastructure	
	Run Cost	2		3	2	2	2	2	Fuel Efficiency	Fuel Efficiency
	Price	1	1	1	1	1	1	1	Acquisition Cost	Demand Incentive
		4W	4W	2W	3W	LCV	Bus	Bus		

Source: GoI – industry study. Note: Numbers indicate priority with 1 representing the highest ranking.

City wise variations

4.4.6.3. Consumer feedback from 16-18 cities reveals that there are significant variations across cities. An analysis of the responses received across various cities reveals that in case of xEVs, four wheelers and LCVs have higher uptake in Tier 1 and 2 cities as compared to the Tier 3 and 4 cities. In case of LCVs, Tier 1 and Tier 3 cities have shown a higher preference for HEV than BEV/PHEV. In case of 3W, higher preference has been expressed in tier 2 and tier 4 cities. As far as the battery operated two wheelers is concerned, there is a high latent demand for these vehicles specifically in tier 2 cities followed by tier 1 cities. The respondents in tier 1 and 2 cities have also cited highest preference for low maintenance cost and high mileage. The tier wise breakup shows that in the bus segment, HEVs are most preferred and that HEVs have the highest preference in tier 2 and 4 cities; while PHEV and BEV buses are most preferred in tier 4 cities. State Road Transport

Corporations in cities like Bangalore and Delhi have evinced interest in xEV buses.

Consumer preference for type of incentive

4.4.6.4. In case of 4W, consumer interviews indicate that cash/tax subsidies would be the preferred (58% respondents) mode of demand incentive for adoption of 4W xEVs. The cash or tax incentive can be given directly to an OEM or to the consumer either directly or routed through the OEM. Subsidy on batteries emerged as the second most favored route (56% respondents). However, battery subsidies may not be required in the near term as the advent of Li – ion batteries in cars delays the replacement of batteries to 7-10 years after purchase. Lower preference has been indicated for other peripheral benefits such as dedicated toll lanes, toll discounts etc. In case of *two wheelers*, low/no tax and low cost of batteries have been cited as the most important motivators for adoption of xEV 2 W by the consumers. In case of *three wheelers*, the preferred form of incentives indicated was low/no tax, retro fit kit availability and free/reduced cost of permits. For LCVs, consumers indicated no/low tax and availability of low cost batteries as the preferred incentive modes. In case of buses, surveys indicate that cash support, toll discounts and low cost batteries are the most preferred incentive. Further, as in the case of 4W also, it is also expected that with the use of lithium ion batteries in buses, battery replacement may be required in 5-7 years. As such the replacement of batteries is not expected to be a barrier in future, therefore, upfront acquisition costs only need to be supported. The consumer preference for type of incentive is summarized in **Table 12** below.

Table 12 – Vehicle segment-wise matrix of consumer preference for incentive.

Toll Discount					**2**
Others	**xEV Kits**	**Electricity cost**	**xEV Kits**	**xEV Kits**	
Free Parking	**3**	**3**	**4**	**4**	**5**
Subsidy on Batteries	**2 (56%)**	**2**	**5**	**2**	**3**
Cash/Tax Subsidies	**1 (58%)**	**1**	**1**	**1**	**1**
	4W	2W	3W	LCV	Bus

Source: GoI – industry study. Note: Numbers indicate priority with 1 representing the highest ranking.

However, it must also be remembered that the incentive delivery mechanism that is adopted should be simple and effective that allows the incentive to reach the intended beneficiaries quickly and efficiently. As already indicated, the existing/earlier schemes leave a lot of scope for improvement in this regard.

4.4.6.5. Possible niche area of usage/ applications for xEVs: In case of the various vehicle segments, the xEV variants lend themselves to niche area applications/usage. Some of these include:

4.4.6.5.1 The premium bus segment (low floor A/C) can be a target for xEVs buses, as price points are high (Rs. 1-1.3 Crore for xEVs compared to Rs. 60-70 Lakhs for ICE bus). However, prices for xEV high floor bus would be very high as compared to a high floor ICE bus (~Rs. 70-80 Lakhs compared to Rs. 25-30 Lakhs for ICE). Hence, xEV adoption in low floor buses (like DTC buses) may be more viable.

4.4.6.5.2 Small buses used for last mile connectivity for metro stations will also be highly amenable for xEVs due to their usage pattern.

4.4.6.5.3 xEV LCVs can be used in niche applications such as airport pick-ups, transportation within factory premises etc. Rapid charging stations may need to be established to increase adoption of such vehicles.

4.4.6.5.4 Low speed 3W BEVs can be used in pockets with high traffic, small campus and small towns.

4.5. Demand incentive structure and other recommendations.

Essential requirements of a demand incentive scheme

4.5.1. Essential requirements of a demand incentive scheme: Designing an effective demand incentive scheme will not only require identification of the optimum quantum of incentives for various vehicle segments based on a sound rationale but also the comprehensive criteria based on which these incentives can be structured and distributed. This can be done on the basis of qualified vehicle parameters, time / volume (phasing) considerations and degree of localization conditions. The *vehicle parameters* include **(i)** battery size **(ii)** technology **(iii)** minimum performance criteria. In case of *time/volume phasing*, issues like yearly based volume caps for incentives (maximum number of vehicles to be covered segment wise), desirability of mandating of certain minimum portion of incentives to be earmarked for a particular technology within a vehicle segment (say BEV within the 4W segment), the final phasing out of incentives can be examined and incorporated as a part of the demand incentive scheme that is adopted.

4.5.1.1. Conditions of minimum quality, durability, homologation and safety standards for xEV vehicles will need to be mandated as an essential qualifying criterion for demand incentives. Further, localization criterion will also be required to be inbuilt in the scheme as a measure to ensure that demand incentives are matched with minimum xEV component indigenization to create the xEV manufacturing eco system within the country. Certain additional requirements can also be considered for entitling a manufacturer to qualify for incentives such as minimum level of in-house R&D spend on xEV.

Demand incentive strategy

4.5.1.2. The linkage of demand incentive decisions to issues like battery size, technology and minimum performance criteria (i.e. vehicle parameters) for different vehicle segments constitutes the specific demand incentive strategy for that particular vehicle segment. The prescribed strategy for different vehicle segments will differ substantially depending upon various conditions. This has been taken up later in detail.

Boundary parameters

4.5.1.3. The criteria of **(i)** time / volume i.e. phasing **(ii)** minimum localization conditions **(iii)** assured minimum quality, durability and safety standards etc constitute the essential qualifying parameters that a manufacturer will need to meet in order to be eligible for demand incentives. These parameters can be collectively termed as the qualifying or boundary parameters. As in the case of demand incentive strategy; the boundary conditions will be unique for different vehicle segments.

Demand assurance measures

4.5.1.4. It is also to be kept in mind that in certain vehicle segments cash incentives alone may not be effective enough for promoting localization of xEV, as xEV component supply chain may not come up unless there is a sufficient demand volume which is assured upfront. As such, in the initial years, the strategy of linking localization of xEVs to demand incentives may need to be supplemented with some level of demand assurance measures in certain cases. In addition, the feasibility of putting in place assured demand measures will also need to be evaluated as in case of certain vehicle segments this may not be possible. The possible means of achieving demand assurance can be through procurement of xEV vehicles for Central and State Government vehicle fleets, mandating of xEVs in certain areas/locations etc. In case of low floor intra city buses, since most of the intra-city bus fleets are operated by Government owned State Transport Undertakings (STUs), a certain share of new bus purchases by STUs can be mandated to be xEVs, with Government support being provided on similar lines to procurement of low floor buses through the Jawaharlal Nehru National Urban Renewal Mission (JNNURM). This may however not be feasible for high floor buses on account of very high cost differential between the xEV bus and the traditional IC engine bus. Similarly, it may also be possible to mandate certain XEV four wheelers in Government purchase. The cumulative demand generated across various vehicle segments, some of which also includes assured demands can provide the required volumes for component suppliers to invest in setting up local manufacturing units. An assessment of the demand assurance measures for various vehicle segments is given in **Figure 3** below.

4.5.1.5. A comprehensive demand incentive scheme will comprise of the various elements discussed in preceding paras. This is depicted in **Figure 4** on the next page. The quantum of incentive [A], the parameters for deciding their distribution/gradation amongst the various vehicle segments & technologies [B], the minimum qualifying criterion/ boundary parameters that need to be insisted upon [C], and the supplementing demand assurance measures [D] for some of the vehicle segments together constitute the necessary elements required for a comprehensive demand incentive scheme. This is at the core of the NEMMP 2020 strategy that will drive faster adoption and also provide impetus to manufacturing of xEVs in the country.

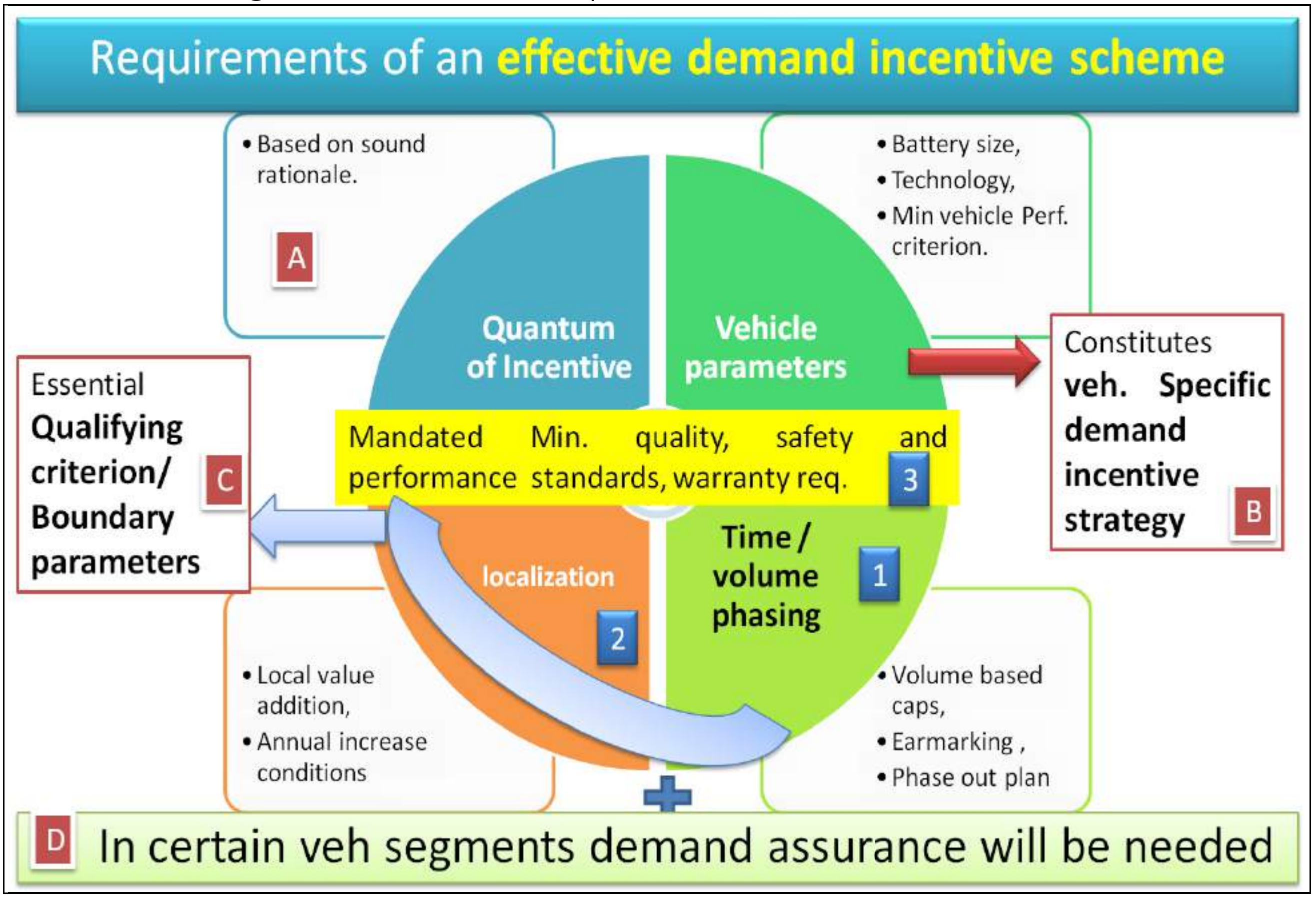
Comprehensive demand incentive

Figure 3 – Demand assurance measures – vehicle segment wise assessment

Vehicle Segment	Two Wheelers	Three Wheelers	Four Wheelers	Buses	LCVs
Demand (2020)	4.8 million	20,000-30,000	1.4-1.6 million	2600-3000	30,000-50,000
Assessment of mandates required	**Sufficient Demand, no mandates required**	**Insufficient Demand, similarity with 2W will drive localization; free additional permits will be useful.**	**Insufficient Demand, mandate like govt. vehicle fleet procurement may be required.**	**Insufficient Demand, mandate like procurement by STUs would be required coupled with pilot projects.**	**Insufficient Demand, City fleet could be mandated to be xEV starting 2015.**

Source*: GoI – industry study.*

Figure 4: Elements of a comprehensive demand incentive scheme



Source: GoI – Industry study.

Government – Industry study recommendations

4.5.2. Government Industry recommendations: Based on extensive interactions with all stakeholders including industry and consumers and relying upon key findings, the indicative levels of demand incentives required for different vehicle segments have been proposed in the Government – Industry study. In addition, various possible formulations for gradation & distribution of demand incentives across various technologies; within various vehicle segments and the other boundary (essential) conditions for qualifying for incentives have also been suggested. These recommendations provide a robust framework for framing of a comprehensive demand incentive scheme which will be approved separately by the NBEM and NCEM during the roll out phase of the plan. The findings from the Government – Industry study are summarized as follows.

4.5.3. As far as the demand incentive strategy for four wheelers; the Government – Industry study has

Possible demand incentive strategy for different vehicle segments.

proposed that given the higher battery size; more incentives should be given to PHEVs and BEVs as compared to HEVs. Within the BEV's, it is suggested that higher incentive can be allocated to high performance BEVs. In the study, high performance has been defined in terms of the pickup and top speed of the vehicle. Further deliberations will be required to define the optimum and most effective performance parameters.

4.5.3.1. In case of two wheelers, the strategy is centered on higher incentive for higher battery size and within the same battery size higher incentive allocation is recommended for better performing two wheelers in terms of higher speed and durability. It is also proposed by the Government – Industry study that in the initial years (2012-2014), higher quantum of demand incentives for certain types of two wheelers can be kept which can be reduced during the later phase (2014-2017).

4.5.3.2. The demand incentive strategy for buses is proposed to be based on higher incentive for larger battery size (i.e. higher incentives for PHEVs and BEVs) with front loading of incentives, in terms of volumes (first 900, next 750 and so on), to drive early adoption and then a phase out. In addition, demand assurance by mandating a share of new sales in the public intra city buses, especially in the low floor category, and metro feeders to xEV buses would be conducive to adoption of xEV buses. As this is still a nascent technology in India, before full scale commercialization, pilot projects can be conducted for hybrid/electric buses in cities such as Delhi, Mumbai, and Bangalore for monitoring the benefits and the commercial viability. In addition, the establishment of fast and rapid charging stations at bus depots may be required for BEV / PHEV buses.

4.5.3.3. With respect to LCVs, the incentives are proposed to be based on battery size (higher incentive amount to BEVs) with a portion of incentive earmarked for BEVs.

4.5.3.4. The Government – Industry study also recommends the distribution of incentives based on technology type as an important constituent of the demand incentive strategy.

Incentive distribution criterion for diff. tech.

4.5.3.4.1. At present, in relative terms, as HEVs have much higher market acceptability, these are easiest to roll out and have fewer issues to be addressed. In case equal treatment is given to all technologies, it may so happen that most of the demand incentives are consumed by products using this technology which may limit the subvention available for demand creation of other technologies.

4.5.3.4.2. Therefore, the possible formulations suggested for splitting the demand incentives within different vehicle segments amongst different technologies (HEV, PHEV and BEV) are as under:

4 W

i. The Government - industry study proposes that the incentive for 4W can be split as 75-90% for mild/full HEVs and PHEVs and balance 10-25% be reserved for BEVs. This may help in bolstering BEV demand by preventing domination by HEVs and PHEVs. In addition, it is also proposed that suitable incentive can also be applied for approved retrofit solutions.

Buses and LCVs

ii. In case of buses, it is proposed that 75%-90% of the demand incentives can be reserved for HEVs/PHEVs and 10-25% for BEVs. In case of LCVs, the study has proposed an incentive ratio of 80-70% by volume for HEVs/PHEVs and 20-30% for BEV. These recommendations will need greater deliberations before finalisation.

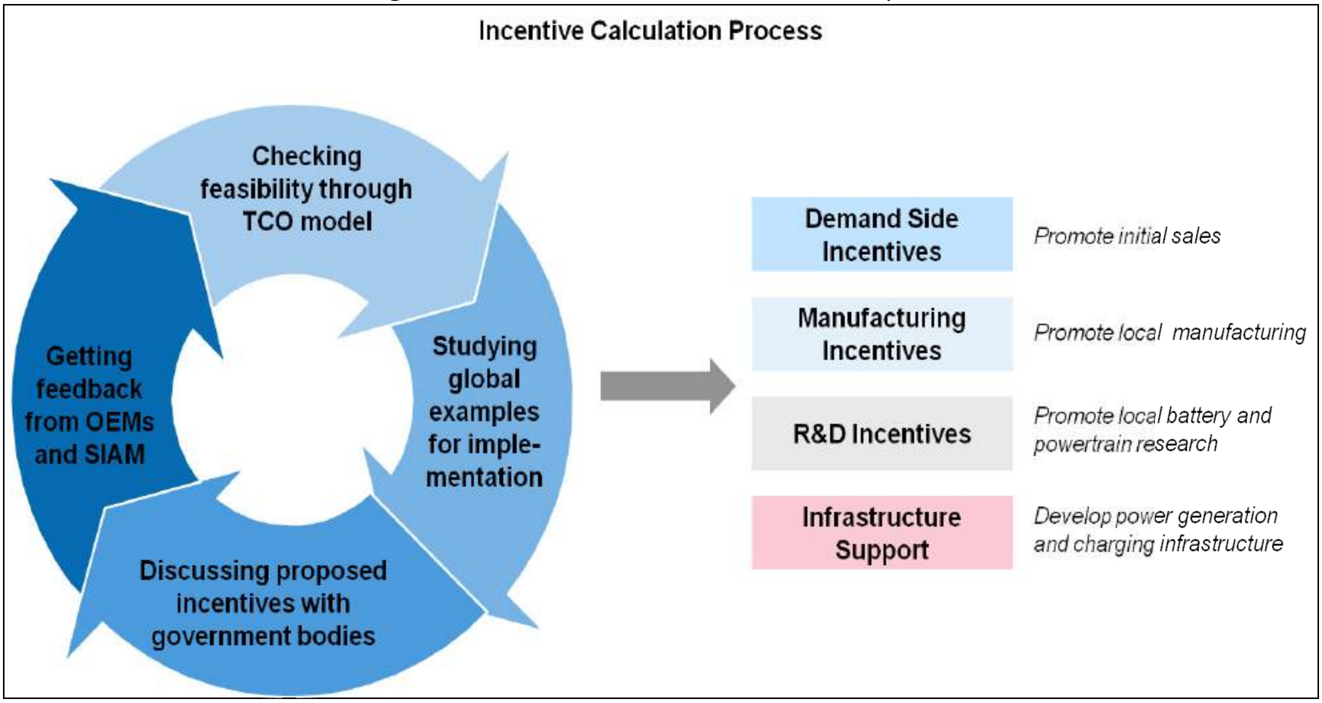
4.5.3.4.3. While the agreed upon fundamental approach is not to favor any particular technology through policy, however, in order to allow popularization and development of PHEVs and BEVs, the desirability of reserving a certain portion of demand incentives for these technologies will be examined during the formulation of the comprehensive demand incentive scheme. Further, associated issues relating to possible non utilization of "reserved portion" of incentives for these technologies and whether these "non-utilized" incentives will be rolled over to subsequent years or will be allocated to other technology products, will also need to be addressed.

4.5.3.5. The possible strategies as recommended in the Government – Industry study will be further refined to arrive at the optimum demand incentive strategy for each vehicle segment during the finalization of a specific policy on demand incentives to be approved by the NCEM during the initial roll out phase of the NEMMP 2020.

Level of incentives

4.5.4. The level of demand incentives for the different vehicle segments were calculated using an iterative process with inputs from the total cost of ownership (TCO) model, OEMs, Government, consumer and global perspectives. This is depicted in **Figure 5** on the next page. A two pronged approach was used wherein on the demand side, the TCO model was used along with vehicle kilometers travelled (VKT) to work out the demand penetration for different technologies in different VKT segments. This assumed that the consumer would make the most rational economic decision while making a purchase and gave an estimation of the demand levels that can be achieved for different technologies. On the supply side; inputs were taken from the OEMs and global perspectives on the expected penetration levels and minimum scale required for xEVs to become self sustaining. This provided the estimate of the demand levels that are required/ needed to be achieved. The gap between these two estimations was used to arrive at the level of incentive that would be required for different vehicle segments. The level of incentives proposed in the study for various vehicle segments, which can be considered subject to the prescribed boundary/qualifying conditions are summarized in the following paragraphs.

Figure 5 - Incentive calculation method adopted



Source: Govt – Industry study

4 W

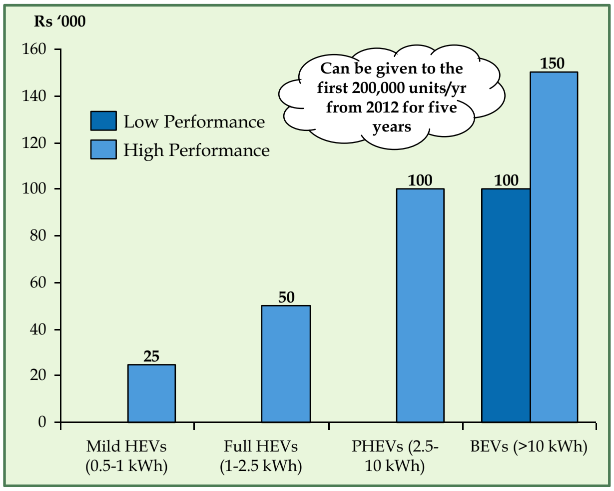
4.5.4.1. The proposed level of demand incentives for four wheeler xEVs based on type of technology and within the pure electric technology (BEVs), the incentive level based on performance standards are as follows.

- Rs. 25K for mild HEVs
- Rs. 50K for full HEVs
- Rs. 1 Lakh for PHEVs

- Rs. 1 Lakh for low-performance BEV, Rs. 1.5 Lakh for high-performance BEV.

The possible performance criterion for differential incentive in case of pure electric four wheelers includes top speed, pick up and range. This is depicted in **(Exhibit 11)** below.

Exhibit 11 - Proposed demand incentive structure for 4 wheelers.



Source: GoI – industry study.

However, as indicated earlier, the incentive strategy will need to be further deliberated and refined.

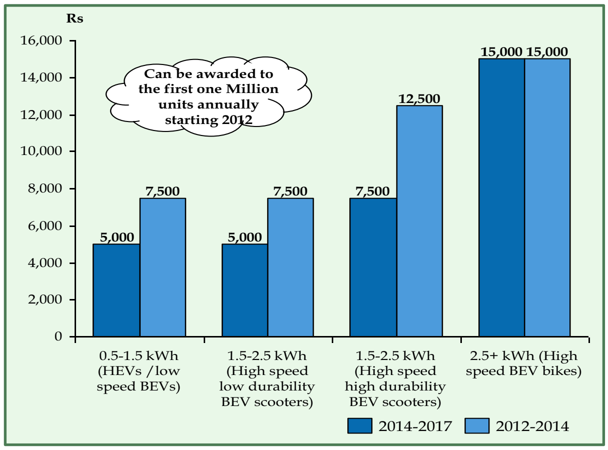
Two wheelers

4.5.4.2. The level of demand incentives for two wheelers that can perhaps be considered, along with the possible allocation criterion, is indicated as under:

- Rs. 5 – 7.5K per HEV / low speed BEV (0.5 – 1.5 kWh)
- Rs. 5 – 7.5K per high speed, low durability BEV (1.5 – 2.5 kWh)
- Rs. 10 – 12.5K per high speed, high durability BEV (1.5 – 2.5 kWh)
- Rs 15,000 per high speed BEV motorbike (+ 2.5 kWh)

It is proposed that higher level of incentives would be given upfront in the initial years (2012-14) for faster early adoption of xEV 2W which will help bring down the costs through scale and higher domestic value addition. This can be followed by phase II of lower level of incentives. This is depicted in **(Exhibit 12)**.

Exhibit 12 - Proposed demand incentive structure for two wheelers.



Source: GoI – industry study.

Here also differential incentives, varying with the type of vehicle, time and volume can be considered.

Buses

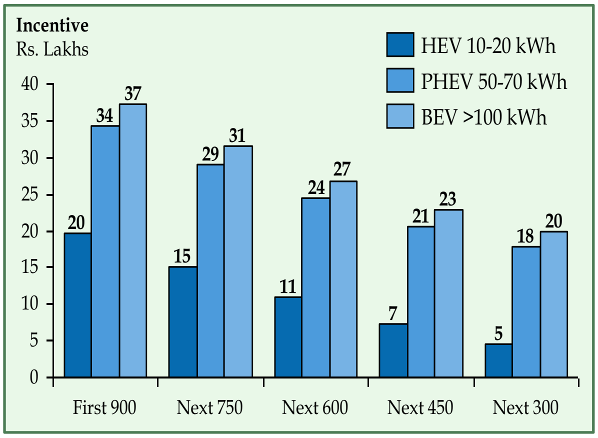
4.5.4.3. In case of the bus segment, the possible demand incentives proposed for low floor urban buses are:

- Rs. 20-5 lakh for HEV (decreasing annually)

- Rs. 34-18 Lakhs for PHEVs
- Rs. 37-20 Lakhs for BEVs

The demand incentive structure for buses is given in **(Exhibit 13)**.

Exhibit 13 – Proposed demand incentives for xEV Buses



Source: GoI – industry study

In addition, as STUs purchase ~22,000 buses per annum, of these ~ 50% or 11,000 buses are intra-city. As already indicated, a proportion of this annual procurement can also be mandated to be hybrid buses based on city tier (high for tier 1 cities) to create initial assured demand. However, as the economic rationale and operating performance of these buses needs to be fully established, pilot projects should be conducted for hybrid / electric buses in the initial take off years, benefits of which can be monitored closely before full-scale roll-out.

3 W

4.5.4.4. In case of three wheelers, it is suggested that xEV in this segment can be incentivized through the following measures:

- Free permits and incentives of Rs 10,000 per BEV 3Ws can be given to 20,000 units every year from 2012 for 5 years.
- Mandate low speed BEVs in public transportation in certain areas of cities with high traffic, with small campuses, small towns etc to create initial demand for OEMs.

4.5.4.4.1. During deliberation on the demand incentives for three wheelers, the results from a recent detailed three wheeler consumer survey conducted by a manufacture were also deliberated. As per this, it appears that market acceptability of xEV three wheelers would require higher performance standards (range, top speed etc). In such a scenario the incentives levels may need to be increased to offset the higher costs. In terms of the agreed upon approach, this aspect would be examined and a decision would be taken at the time of finalizing the demand incentive scheme.

LCV

4.5.4.5. In case of LCVs, the Government – Industry study proposes that:

- Incentives of Rs 50,000 per vehicles for HEV (0.5-3 KWh) and Rs 100,000 per vehicle for BEV (> 7 Kwh) be given to the first 50,000 units per year from 2013 for five years.

- Mandating of xEVs in Government fleet, specific cities can be considered.

NBEM decision - study recommendation to be taken as indicative

4.5.4.6. The NBEM in their second meeting decided that the report findings on quantum of demand subsidy will be taken as the indicative starting point and the WG on Demand & Supply (WG-DS) will use these inputs to recommend the specific incentive levels etc for the approval of the NCEM. It was also decided that in order to make the scheme more effective, the incentive delivery mechanism should be made as simple as possible. As such micro examination and finalization of the incentive levels will be undertaken in the roll out phase.

Essential qualifying conditions

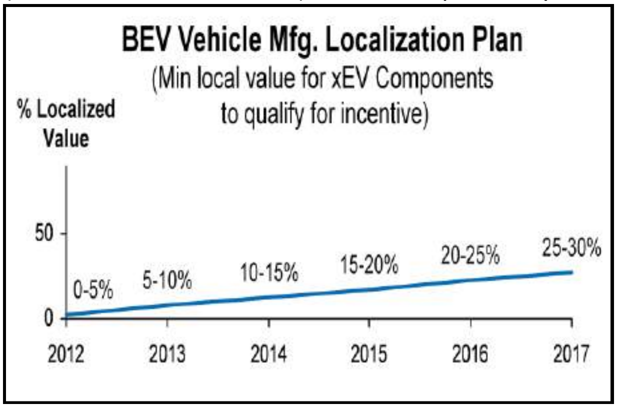
4.5.5. Essential qualifying conditions/boundary parameters for grant of demand incentives: As indicated in Para **4.5.1.3**, the criterion of **(i)** time / volume i.e. phasing. **(ii)** minimum localization conditions. **(iii)** assured minimum quality, durability, homologation and safety standards constitute the essential qualifying parameters or boundary parameters based on which incentives can be given. The NBEM approved that the essential conditions required for qualifying for incentives as also the other set boundary parameters should be included in the demand incentive scheme. It was also decided that the specific conditions and parameters should be framed based on the possible formulations given in the Government – Industry study. As per the Government – Industry study, the recommendations in respect of these criteria for different vehicle segments are given in subsequent paras.

Localization commitments (phasing of localization)

4.5.5.1. In order to promote local manufacturing and sourcing, demand incentives need to be subject to firm industry commitments on the minimum level of localization of xEV components in the vehicle. A minimum threshold percentage of localized value needs to be specified for each technology with an agreed upon annual increase of domestic value addition coinciding with the next five years of demand subvention (at the level of at least 5% increase annually). This will vary between different vehicle segments depending upon various conditions. Bill of

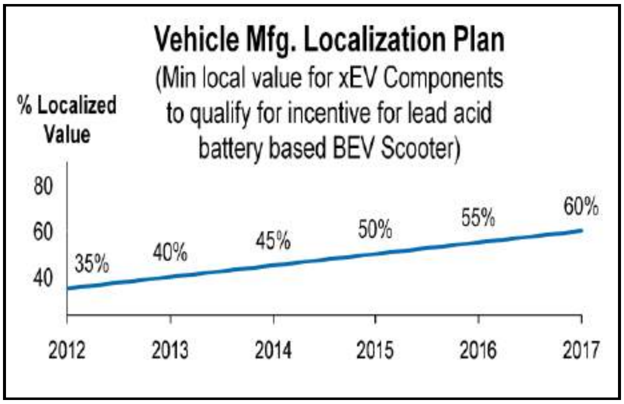
Material can serve as the basis for evaluation of this criterion being met. As per the Government – Industry study the proposed localization conditions for different vehicle segments are illustrated in **(Exhibit 14 to 18).**

Exhibit 14 – Proposed phasing of localization (domestic value addition) for 4 W as per study.



Source: GoI – Industry study. Note 2012 = start yr of scheme.

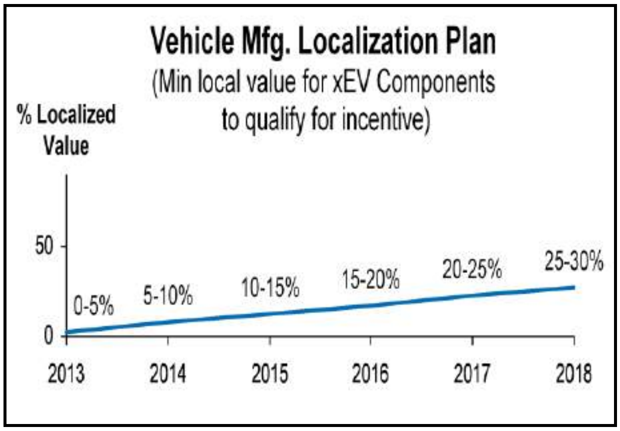
Exhibit 15 – Proposed phasing of localization (domestic value addition) for 2W as per study.



Source: GoI – Industry study. Note 2012 = start yr of scheme.

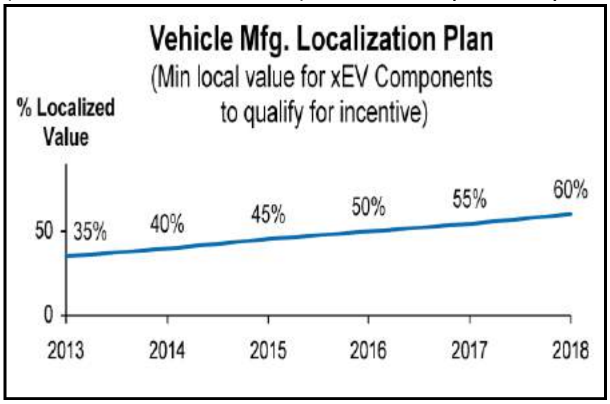
This essential qualifying requirement has been agreed in principle to be incorporated in the final demand incentive scheme; however, the level of localization and extent of annual increase will be further examined in detail.

Exhibit 16 – Proposed phasing of localization for buses as per study.



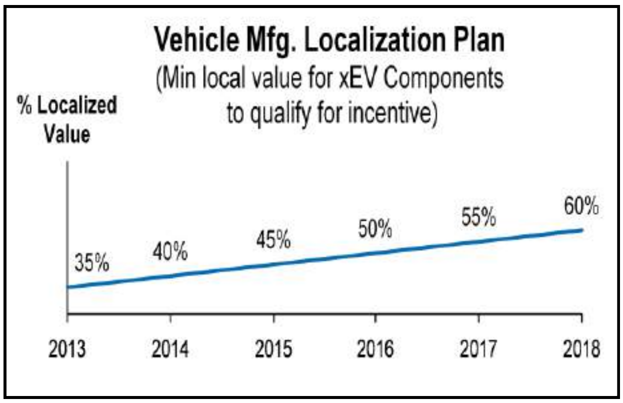
Source: GoI – Industry study. Note 2012 = start yr of scheme.

Exhibit 17 – Proposed phasing plan for localization (domestic value addition) for LCVs as per study.



Source: GoI – Industry study. Note 2012 = start yr of scheme.

Exhibit 18 - Proposed phasing plan for localization (domestic value addition) for 3 W as per study.



Source: GoI – Industry study. Note 2012 = start yr of scheme.

Furthermore, in view of the need for encouraging local manufacturing and assembly, no incentives would be provided for completely built imported xEV vehicles. Further, the current import duty benefits for xEV components will also need to be phased out and aligned with normal auto component tariffs over a period of time (for instance, 5 years) to promote indigenous manufacturing.

Volume caps

4.5.5.2 The study has recommended annual volume caps for the demand incentives in each of the vehicle segment before the final phase out year. It is proposed that the Incentives can be made available to the first 200,000 four wheelers per year, the first 1 million two wheelers, 20,000 three wheelers and the first 50,000 LCV units every year. In case of non utilisation of full incentives for any vehicle segment, the option of carrying this over to the next year or allocating the unutilised balance to another segment in the same year will also need to be included during the roll out of the scheme. Further, regular review mechanism will also be set up for assessment of the impact of this market creation initiative.

4.5.5.3 The incentives for xEVs are proposed to be phased out in five years for the various vehicle segments.

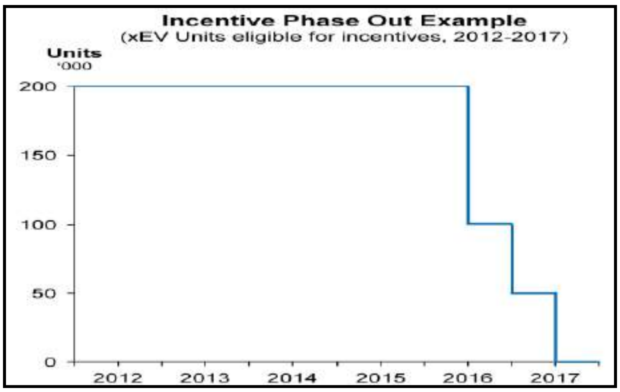
Phase out

However, in case, it is seen that the industry or a particular vehicle segment becomes self-sustaining within the pre-defined period, the incentives can be withdrawn earlier. Also, in case of non-attainement of the desired volumes by the end of the incentive period, a review would be done to consider further continuation of the scheme. The proposed phase out of the incentives as per the Govt. – Industry study for different vehicle segments is given hereunder:

Four wheelers

4.5.5.3.1. In case of four wheelers, it is envisaged that the incentives will be gradually phased out from the sixth year with 100,000 units supported in the first half and 50,000 units in the second half of the sixth year. Following this the incentives will be withdrawn. This is depicted in **(Exhibit 19)**.

Exhibit 19 – Proposed likely phase out plan for 4W demand incentives.

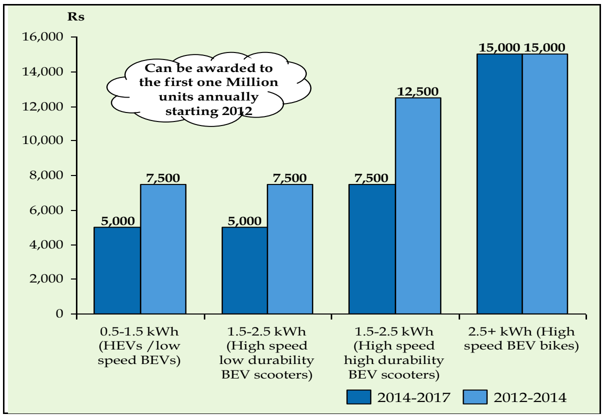


Source: GoI – Industry study. Note 2012 = start yr of scheme.

Two wheelers

4.5.5.3.2. In case of two wheelers, it is proposed that in the initial years i.e. 2012 - 2014; higher level of incentives ranging from Rs 7500 – Rs 15000 (depending on vehicle type) can be given to boost demand. The initial higher offtake is likely to lower cost of production owing to scale effect and localisation; so as to enable the level of incentives in subsequent years i.e. 2014-2017 to be decreased. This is illustrated in **(Exhibit 20).**

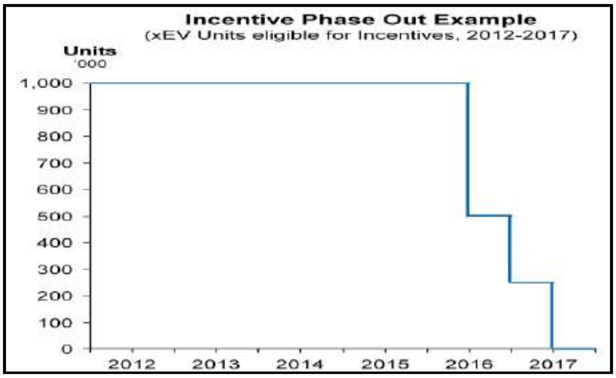
Exhibit 20 – Proposed phased lowering of demand incentive for two wheelers



Source: GoI – Industry study.

In addition, as in case of other vehicle segments, it is also proposed that in 6th year, incentives can be given to 500,000 two wheelers in the first half and 250,000 units in the second half, after which they may be withdrawn. This is depicted in **(Exhibit 21)**.

Exhibit 21 – Proposed likely phase out plan for 2W demand incentives**.**



Source: *GoI – Industry study. Note 2012 = start yr of scheme.*

3 W

4.5.5.3.3. The study proposes that the incentive for three wheelers will also be phased out after five years i.e. by 2017 by restricting the incentive to 10000 vehicles in H1 - 2017 and 5000 in H2 - 2017.

LCV

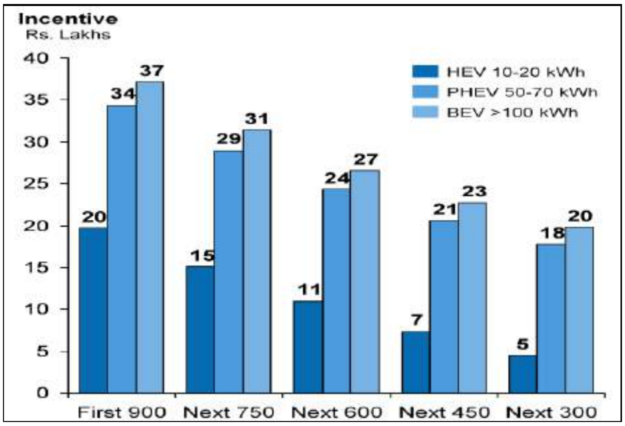
4.5.5.3.4. In case of LCVs, the incentive can eventually be phased out after five years from 2013 (25,000 units in first half of 2018 and 12,500 units in the second half of 2018).

Bus

4.5.5.3.5. The introduction of xEV buses can be done on pilot project basis, for cities such as Delhi, Mumbai, Bangalore etc, wherein the benefits and adoption by consumers can be monitored so that issues, if any, can be addressed before full scale commercialization. It is estimated that incentive to about 3000 buses should provide enough scale to OEMs to bring down the costs by 20-25%. Therefore, the proposed Incentives can be made available to the first 3000 buses starting from 2013, subject to localization, quality and minimum performance standards etc, and then these can be withdrawn. In case of demand incentives for buses, it is also proposed that the level of incentives should continue to decline with increasing volumes as depicted in **(Exhibit 22)**.

4.5.5.3.6. For all segments, the actual yearly caps, start year, phase out, etc will be finalised during final scheme approval.

Exhibit 22 – Proposed likely phase out plan for bus demand incentives.



Source: GoI – Industry study. Note 2012 = start yr of scheme.

Quality, safety and performance criteria

4.5.5.4 The demand incentives to be provided to xEVs will also be subject to set quality & safety standards, performance criterion and warranty requirements approved by authorized automobile testing institutions. The performance standards may include parameters like fuel efficiency, range, minimum battery life, minimum top speed, min passenger carrying capacity, etc. It has been decided in the NBEM that these requirements will be insisted upon and the specific details in this regard will be finalized as a part of the demand incentive scheme.

4.5.5.5. In order to enforce the quality, safety and performance standards, regulations and standards will be set up on priority in areas where these do not currently exist. In addition, the testing infrastructure required to enforce these standards will also be set up. An assessment in this regard will be made by the WG on demand.

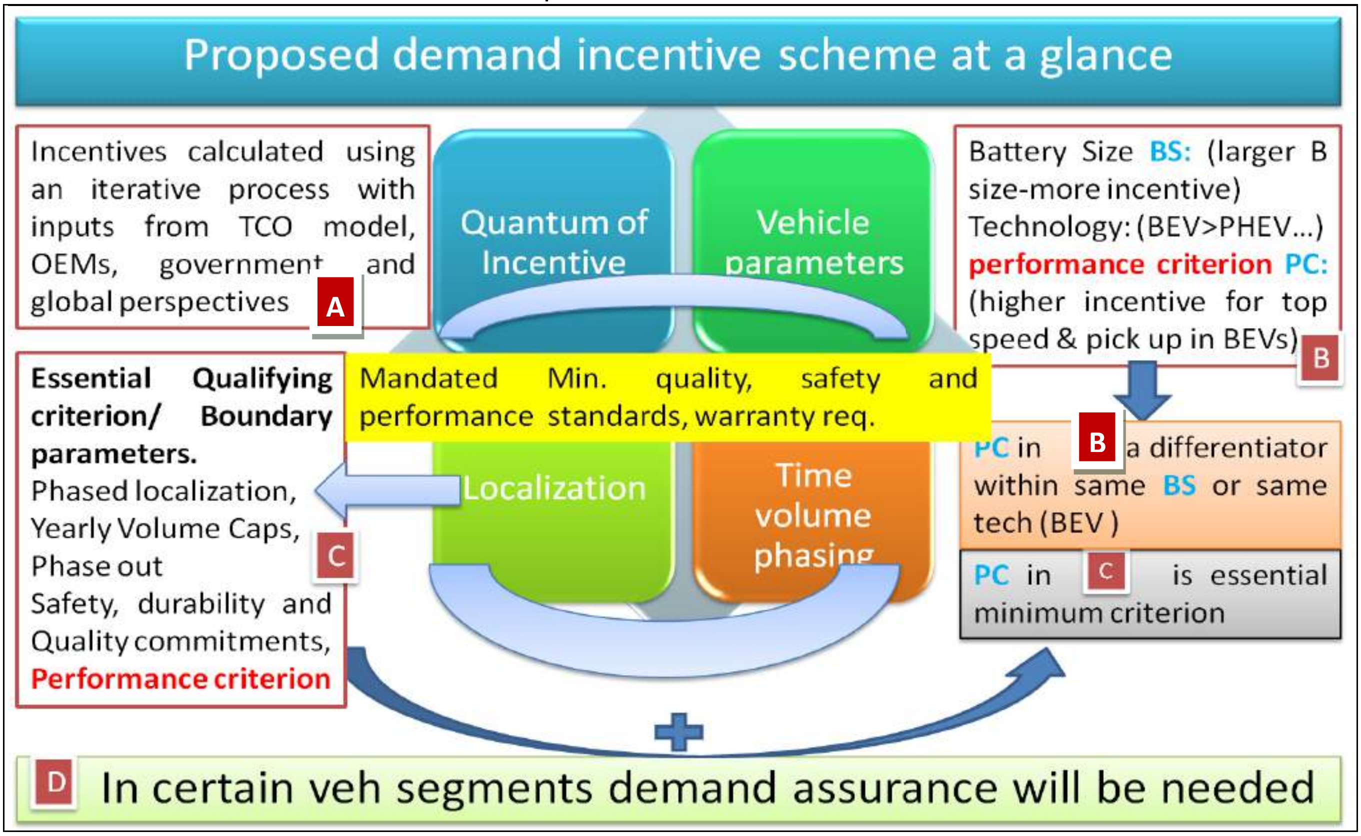
Total demand side incentives

4.5.6. While projecting the total demand incentive levels, the study has considered two scenarios – HG/HEV and HG/HEV/BEV, with the second scenario having higher penetration of BEVs (pure electric vehicles). The range of investments required for the demand generation for the HG/HEV scenario is Rs 12,250 crores – Rs 12,600 crores and that for the HG/HEV/BEV scenario is Rs 13,500 – Rs 13,850 crores. The summary of the total demand generation incentives suggested for the different vehicle segments for the next five years is summarized in **Table 13**. This is an indicative assessment of the level of

Government support that will be required for spurring demand generation for xEVs.

4.5.7 The overview of the possible demand incentive scheme as proposed by the joint Government – Industry study is depicted in **(Exhibit 23)** below. The WG –Demand & Supply, created by the NBEM, will help further detail and refine the proposed demand incentive scheme for the consideration of the NBEM/NCEM.

Exhibit 23 – Proposed demand incentive scheme



Source: GoI – Industry study.

Table 13 – Total investment proposed for the next 5 years - *(Rs Crores)*

Area	*4W*		*2W*	*3W*		*Buses*		*LCV*		*Total*	
	HG/ HEV	*HG/HEV/BEV*	*HG/ HEV*	*HG/ HEV*	*HG/HEV/BEV*	*HG/ HEV*	*HG/HEV /BEV*	*HG/ HEV*	*HG/HEV/BEV*	*HG/ HEV*	*HG/HEV /BEV*
Demand Incentives	*4900 -5000*	*5600-5700*	*5200-5300*	*400-500*	*700-750*	*500-550*	*500-550*	*1200-1300*	*1500-1550*	*12,250 -12,600*	*13,500 -13,850*

Source: GoI – Industry study. Note: These are indicative estimates. For higher performance three wheelers (range, speed and load capacity) the demand incentives will be higher.

4.6. Scope, coverage & phasing of demand incentives.

4.6.1. The different vehicle segments have dissimilar levels of implementation difficulty and pose distinct challenges for introduction of xEVs. The total funds needed for meeting the demand incentive requirements for different vehicle segments varies significantly. The outcome (benefits) from introduction of xEV in each vehicle segment is also quite different. As such, it needs to be decided whether the introduction of electric vehicles needs to be supported for all vehicle segments at the same level or if different priorities are to be allocated to various vehicle segments based on pre determined criterion. Further, it also needs to be examined whether or not different priorities need to be accorded to different technologies in each of the vehicle segment. **Table 14** below provides a summarized assessment of the vehicle segment wise variation of **(i)** demand incentive requirements calculated on the number of xEV to be provided incentive in each vehicle segment for full duration of the program, **(ii)** ease of implementation (introduction) of xEVs and **(iii)** the projected net benefits from introduction of xEVs based on the realization of the potential demand by 2020.

Table 14 – Assessment of xEV introduction implications.

		Four Wheelers	*Two Wheelers*	*Buses*	*Three Wheelers*	*LCVs*
Total demand incentives	*HEV*	*4900-5000*	*5200-5300*	*500-550*	*400-450*	*1250-1300*
	HEV/BEV	*5600-5700*		*500-550*	*700-750*	*1500-1550*
Ease of Implementation	*Overall*	*Low to Moderate*	*Moderate to High*	*Moderate*	*Moderate*	*Low*
NPV of benefits (Net Benefits)	*HEV*	*4800*	*28,000*	*3300*	*1200*	*1500*
	HEV/BEV	*7100*		*3700*	*1700*	*3000*

Source: GoI – Industry study.

4.6.2. An assessment of the ease of implementation and preferred areas for xEV introduction, based on consumer feedback, OEM feedback and the outcome of the government – industry study, is summarized in **Table 15**. From this, it is seen at present that both consumers and OEMs prefer hybrid and mild hybrid technologies. The OEMs view that the implementation of xEV will be easiest for buses, two wheelers, three wheelers followed by four wheelers. The vehicle segments and technology favoring introduction of electric vehicles is also depicted in the matrix below with a higher no of √.

Table 15 – Vehicle segment wise assessment of xEV introduction implications.

Priority Segment	**Two wheelers**	**Four wheelers**	**Three wheelers**	**Buses**
Priority Tech.	**1** 2	**3** 4	**3** 3	**2** 1
Mild Hybrid		√√		√√
Hybrid		√√		√√√
Plug in Hybrid		√		√√
Pure Electric	√√√	√√	√√	√√

- OEMs

- Consumer

4.6.3 Based on the data indicated at **Table 14** and **Table 15,** an assessment of the possible macro level implementation scope options can be made. The various options can be worked out based on broad decisions like **(i)** if all the vehicle segments are to be taken up immediately or only the most promising ones be supported initially, **(ii)** similarly, a choice needs to be made regarding the technology to be adopted, (HEV, PHEV, BEV) and its phasing, **(iii)** in case, it is decided to take up all segments immediately and also to support all technologies, then it will need to be decided if equal priorities is to be given to all the vehicle segments and technologies or otherwise. Of the various permutations possible, the three possible options deliberated by the NBEM are indicated in **Figure 6** on the next page.

Figure 6 - Options for scope of demand incentives

4.6.4. The NBEM during the second meeting decided that neither any specific vehicle segment nor any particular technology should be excluded from the scope of the NEMMP 2020. It was also decided that the vehicle segment and technology priorities along with incentive criterion (battery size etc) & incentive type would be worked out by WG-D&S and proposed to NBEM/NCEM for consideration and approval. The methodology proposed should be linked to outcome achievement.

Phasing

4.6.5. *Phasing during next five years:* The phasing of the demand incentives for the next five years and the degree of localization as indicated in the Government – Industry study for the various vehicle segments will be fine tuned by the WG-D&S. The decision taken by NBEM for linking time limits for demand incentives to achievement of outcome will be also taken into account as a part of the comprehensive demand creation policy which will be submitted for approval of NBEM/NCEM.

4.7. Demand incentive scheme – the way ahead.

4.7.1. In terms of the Government decision taken during the approval for the National Mission for Electric Mobility (NMEM), all interventions, schemes, policies, initiatives are to be approved by NBEM and NCEM, irrespective of the Ministry/agency entrusted with the implementation of the scheme, initiative, intervention. This is essential to ensure synergic working by various agencies to the common end objective.

4.7.2. As a number of agencies and organizations will be involved, the NBEM in its second meeting decided to set up a Working Group on demand & Supply (WG-D&S) comprising of all concerned stakeholders. This working group has been mandated to also look into issue related to demand incentive scheme, supply side incentives and hybrid retro fitment kits. The micro detailing for the initiative, including schemes, timelines, milestones, and specific decisions will be developed with the help of the WG-D&S.

4.7.3. During the first meeting of the WG-D&S held on 22nd -23rd February, 2012, it was decided that the study, being an extensively researched document will be the basis for the finalization of a comprehensive demand incentive scheme/policy. The various issues relating to **(i)** validation of the quantum of demand incentives, **(ii)** setting up of simple yet effective vehicle parameters for gradation of/differential incentives between different vehicle segments and technologies, **(iii)** validation and fine tuning of the qualifying criterions/boundary parameters and **(iv)** detailing of the demand assurance measures will be undertaken through various sub groups of the WG-D&S.

4.7.4. The exercise for validation of the incentive levels as proposed by the study will also involve monetizing the proposed incentives for different vehicle segments on year to year basis. The evaluation of the various options for the vehicle parameters, qualifying parameters (boundary conditions) and performance parameters will include developing a formulation that allows for flexibility of approach, use of innovation to achieve mission objectives and incentives for higher achievement of key mission objectives of fuel efficiency, localization and greater investment in R&D. This would require the scheme /policy to be technology agnostic on a broad level thereby allowing adoption of various technology pathways.

4.7.5 The WG-D&S also made certain important suggestions that will be considered while framing the demand incentive policy. Some of these include;

4.7.5.1. The existing incentive schemes are extended on year to year basis without any assurance on their total duration and budget. Certainty of the duration and quantum of the incentive policy/scheme is essential to give confidence to the industry for committing large investments for setting up domestic manufacturing facilities. Further, the incentive delivery mechanism should be simple and effective that allows for the incentive to reach the intended beneficiaries quickly and efficiently.

4.7.5.2. The capacity and firm commitment of the industry to be able to supply the required number of xEVs would be adequately captured.

4.7.5.3. The mission should encourage the development of new vehicle types/designs instead of mere conversion of heavy IC engine based vehicle designs. Mass reduction (light weighting) and energy efficiency should therefore be encouraged.

4.7.5.4. The incentives should be a percentage of the price differential with the balance being met from the benefits accruing from lower operating costs and economies of scale. Public transportation (Buses and three wheelers) should be given higher priority in view of their larger benefit to the society.

4.7.5.5. Since xEVs have higher weight as compared to ICE vehicles mainly due to battery, the optimum battery sizes for different xEVs should be specified upfront. Further, a detailed and effective definition of minimum quality, durability and warranty requirements for xEVs should also be prescribed.

4.7.5.6. The generation of renewable energy is highly variable depending on external conditions like wind, light etc. In view of the intermittent availability of renewable energy, buffer storage and decentralized power generation from alternate fuels needs to be promoted. NMEM can be an important initiative to provide the means for buffer storage (xEV batteries) and the use of renewable energy at remote locations. Therefore, NMEM should also be seen as an important intervention that can promote renewable energy. Renewable energy generation efforts should be linked to the NMEM.

4.7.6. The draft demand incentive scheme/policy will be finalized by a core group headed by Department of Heavy Industry and consisting of members from MNRE, NMCC, Planning Commission, MoF etc. The representatives of industry associations will also be co-opted. The inputs from the working group on demand will be considered while finalizing the draft scheme/policy. The draft scheme/policy will be considered and approved by the NBEM/NCEM.

4.8. Retro fitment kits for hybrid vehicles.

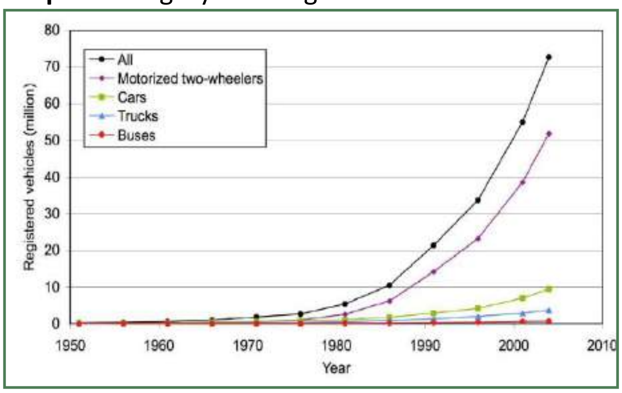
4.8.1. The key objectives of the NMEM are to ensure national energy security and also to encourage manufacturing. For this, the main focus is on new xEV vehicle sales through encouraging fast adoption of xEVs and their manufacturing in the country. The vast fleet of "on the road" vehicles will also need to be made more energy efficient. The population of "on the road vehicles" in India is estimated to be over 100 million. A snapshot of the total number of registered motor vehicles in India from 1951-2009 is given in **Table 16** and is also depicted in **Graph 2**. This only reflects the cumulative number of vehicles registered in India, as accurate data on the number of vehicles that have gone off the roads is not readily available.

Table 16 – Total number of registered motor vehicles (in thousands)

Year	All vehicles	Two wheelers	Cars, jeeps & Taxis
1951	306	27	159
1981	5391	2618	1160
1991	21374	14200	2954
2001	54991	38556	7058
2009*	114951	82402	15313

Source: MoRTH; Note: the number of vehicles taken off the roads is not captured.

Graph 2 Category wise registered vehicles in India



Source: MoRTH

4.8.2. However, as per the estimates made by the Central Pollution Control Board (CPCB), the age profile of the "on road" vehicles in India is depicted in **Table 17** on the next page. As per this, in the case of two wheelers, with the existing population of around 52 million, nearly 50% two wheelers are less than 5 years old and about 27% are 6-10 year old. In case of cars also, around 50% of existing 7 million cars are less than 5 years old, while 30% are between 6-10 years old. The numbers of two and four wheelers which are more than 10 years old are 23% and 20% of the total population of these vehicles respectively. Similarly, 42% of the on road LCV population is more than 10 years old. However, as per CPCB estimates 60% of air pollution is caused by vehicles that are more than 10 years old. These comprise about 30% of the total vehicle population.

Table 17 – Age profile of the "on road vehicles" in India

Sr. No	Vehicle Type	Population (In Millions)	< 5 yrs (%)	6-10 yrs (%)	11-15 yrs (%)	16-20 yrs (%)	20-25 yrs. (%)	> 25yrs (%)
1	2- wheelers	52	48.7	27.2	14.3	7.8	1.8	0.3
2	Cars	7	50.3	29.5	12.9	6.0	1.1	0.2
3	LCV	2	36.8	21.5	26.5	11.3	3.2	0.8

Source: Status of vehicular pollution control program in India – CPCB, March,2010

4.8.3. The "on the road" vehicles tend to have much lower fuel efficiency levels and emission performance owing to various factors. In view of their vast population and large scope or improvements, the "on the road" vehicles need to be specifically targeted for improving their fuel/energy efficiency and emissions as the likely impact would be huge.

4.8.4. Encouraging higher fuel/energy efficiency amongst the "on the road" vehicles can be done through several means that include introduction of a robust pan India inspection & certification (I&C) regime, phasing out of old and obsolete vehicles (fleet modernization) and also through retrofitting existing liquid fuel (IC engine) driven vehicles with HEV kits that improve their fuel efficiency levels significantly.

4.8.5. Although hybrid retro fitment kits are available, globally these have not gained popularity owing to various reasons. USA also provides a tax credit of 10% of conversion cost, subject to maximum of USD 4000 for converting a vehicle to plug in hybrid or electric vehicle.

Retro fitment hybrid kits

4.8.6. HEV retro fitment solutions for vehicles are also being developed in the Indian market, trials of which indicate up to 30% fuel savings. These fuel efficiency gains have also been certified by recognized automotive testing agencies in their labs. India has a unique strength in IT, low cost manpower and given the wide acceptance amongst Indian consumers for LPG/CNG kits, it is felt that the HEV retro fitment kits are also likely to become widely accepted in the Indian market. The main barrier for adoption will be their high acquisition costs. The other challenges that will need to be addressed include ensuring an effective implementation mechanism that ensures quality, safety and durability of the retro fitted vehicle.

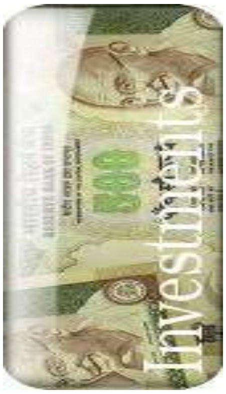
4.8.7. In order to popularize these kits, the interventions that would be essential include (i) demand incentives for the initial years till the industry attains scale and maturity with required conditions such as those kept for new vehicles, (ii) Ensure that quality, safety standards and performance parameters are strictly followed/met through setting up of the required standards and also by having an effective roll out mechanism.

4.8.8. The incentive scheme for hybrid retro fitment kits would require identification of the block of vehicles that can be targeted and prioritized, the level of support required, its duration, yearly volume caps, phasing out plan, and localization criterion to be met etc. In addition, the quality, safety standards and performance criterion will need to be set up through the concerned agencies (CMVR-TSC under DRT for safety standards and other automotive regulations etc) along with the infrastructure required to test these regulations/standards. Further, evaluation of possible business models involving battery lease, implementation of the scheme through authorized and qualified franchises etc will also be examined. These constitute the essential prerequisites for the scheme to promote hybrid retro-fitment kits to be considered and approved by the NCEM/NBEM.

4.8.9. The NBEM has given an in principle agreement for taking up & promoting retro fitment hybrid kits for existing "on road vehicles". For this purpose, the Board also directed that the setting up of regulations & minimum performance and safety standards should be fast tracked. It was also decided that the WG on Demand & Supply will recommend to the NBEM/NCEM (through NAB) the agreed upon mechanism for implementation of HEV retro fitment initiative and also the possible subsidies / incentives that can be given for this purpose.

4.8.10. The work for setting regulations, quality and safety standards for hybrid retro fitment kits has already been initiated through a panel under the AISC/CMVR-TSC which is being coordinated by ARAI. This exercise is likely to be finalized within 3-4 months. The WG-DS in its meeting held on 22nd February, 2012 decided to set up a sub group under the chairmanship of DHI to develop the scheme for incentivizing hybrid retro fitment kits and are for recommending the implementation strategy (to ensure safety, quality, durability etc) for its roll out.

4.9. Source of Government funding & incentive delivery mechanism



4.9.1. The investments indicated for demand incentives in the NEMMP 2020 takes into consideration all the vehicle segments along with the level of incentives proposed, both in terms of quantum and number of vehicles to be covered. Demand creation will be the key to achieving xEV potential as the present acquisition cost of xEVs is much higher and needs to be bridged appropriately to ensure creation of minimal market size that is viable for the industry to invest in product development and for creation of local manufacturing facilities. As indicated earlier also, the actual level of demand incentives, the demand incentive strategy along with the qualifying criterion/ boundary conditions to be adopted will be recommended to the NCEM as a part of the comprehensive xEV demand creation policy document.

Funding source

4.9.2. During the stage of seeking approval of the Government for the NMEM, it was indicated in **Para 4.4.2.** that "…….the resources requirements for undertaking these initiatives for promoting electric mobility pertaining to different departments will continue to be undertaken by the concerned Ministries through their respective budgetary allocations for these programs. In case of new programs, schemes, projects, initiatives etc. the approval of the Government will be taken separately once these are approved by the NCEM. The additional resource requirements are proposed to be met from various sources such as the funds for technology development, propagation of renewable energy sources, climate change mitigation, automobile Cess etc."

4.9.3. The implementation of various schemes that are approved by the NBEM/NCEM will be taken up by NAB which in partnership with the existing agencies involved in these activities.

4.9.4. Further, during the inter-ministerial consultations at the time of seeking cabinet approval, some Ministries had also suggested the creation of a specific fund for various projects, schemes etc to be taken up under this initiative. This possibility will also be explored and taken up by DHI for various other initiatives/schemes including the initiative for funding retro fitment kits for hybrid vehicles.

Incentive type

4.9.5. Form of Incentives to be considered: Consumer preference for the form of incentive (tax breaks, excise duty concessions, direct cash subsidies, subsidies on batteries etc) in case of various vehicle segments has been covered in **Para 4.4.6.4.** It emerges that cash/tax incentives are the most preferred mode. A brief analysis of the various incentive channelizing options that can be used is given in **Figure 7** below. The optimum formulation will be proposed in the demand incentive scheme/policy. In addition, it will also be ensured that the incentive delivery mechanism that is used is simple and effective thereby facilitating the incentive delivery to the intended beneficiaries in a quick and efficient manner.

Figure 7 – Various possible options for channelizing demand incentives

	Cash Incentive to OEM	Tax Incentive to OEM	Cash Incentive to Consumer, Claimed by OEMs	Tax Incentive to Consumer
Features	▪ Direct cash incentive given to OEM ▪ Can be given for exports	▪ Tax exemption given to OEM	▪ Direct cash incentive given to consumers ▪ Registration copy can be proof of sale	▪ Tax exemption given to consumer
PROs	▪ Centralized process, easier to monitor sales	▪ Centralized process, easier to monitor sales ▪ Lesser implementation issues	▪ Consumer gets full benefit of incentive Preferred option	▪ Consumer gets full benefit of incentive
	▪ Govt. needs to monitor whether incentive passed on to consumer	▪ Govt. needs to monitor whether incentive passed on to consumer ▪ Time lag between sales and reimbursement	▪ Difficulty in administration for govt. ▪ **Can be streamlined if incentive is claimed by OEM** ▪ **Process should be expedited by govt.**	▪ De-centralized and difficult to monitor sales ▪ One year time lag between sales and reimbursement

Source: GoI – Industry study

4.10. Implementation structure and mechanism.

Implementation, monitoring & review

4.10.1. As per the approval of the Government NATRiP/NAB (once set up), being the technical advisor and secretariat to assist the NBEM/NCEM, will facilitate in the formulation and approval of the various schemes for demand creation. In addition, NATIS/NAB will also spearhead the implementation and roll out of the various interventions for demand creation in close coordination and collaboration with the various agencies and organizations involved in these areas. The WG-D&S and various sub-groups constituted under it shall assist NATIS/NAB, in carrying out these responsibilities.

4.10.2. The monitoring and review of specific programs, projects, schemes and impact of policies will also be under taken through NATIS/NAB with the help of the WG-D&S.

4.11. Key stakeholders, roles & responsibilities.

4.11.1 The study clearly brings out that high acquisition cost is one of the major barriers for the early and faster adoption of xEVs in India. The generation of demand for xEVs is also an essential precursor for xEV manufacturing eco-system to be created in the country. Given the importance of making transportation sector more fuel efficient and lesser dependent on fossil fuels as a vital element of the efforts aimed at national energy security and lowering the carbon intensity of the economy, the role of the Government in popularization of xEVs and their manufacture in India will be critical, especially in the initial phases.

4.11.2. It is clear that in the early stages Government support for creation of demand for xEVs through demand based incentives will be essential. Once the comprehensive xEV demand creation policy is approved by the NCEM, the xEV demand incentive scheme will be rolled out through the approved mechanism of NCEM/NBEM/NAB. However, in order to achieve desired results and create the manufacturing capabilities within the country the firm commitment of the industry for investments in research & development efforts, setting up the supply chain, product development and adequate after sales facilities is also essential.

4.11.3. As such the xEV demand creation policy and the scheme for incentivizing the hybrid retro fitment kits that will be submitted for the approval of the NBEM/NCEM will adequately capture these commitments from all stakeholders. The scheme will not only clearly spell out targets for demand incentives (in terms of no. of vehicles and quantum of incentive), but also the commitments for localization, volume caps and gradual phase out, quality and performance standards that need to be met by the manufacturers as the qualifying conditions & boundary parameters. The assurance of the industry about its readiness for meeting the projected demand and other commitments regarding localization (domestic value addition), phase out of the incentive scheme, quality, safety, durability and other performance criterion will also be captured upfront.

4.11.4. In addition, the various automotive testing centers will be upgraded by setting up the required testing infrastructure and develop competencies for being able to test and validate that the quality, safety and performance requirements have been met. The Government, industry and the academic institutions will collaborate so the required trained manpower is available in the entire value chain i.e. to meet the requirements from R&D, manufacturing, maintenance etc.

4.12. Review, monitoring & course correction mechanism.

4.12.1. The implementation structure for this initiative i.e. NCEM and NBEM at the apex level and the NAB/NATIS along with the WG-D&S and its sub groups at the working level shall review and monitor the roll out of this program and the various projects and schemes that are implemented under it. The course corrections, if required, shall be decided at the appropriate level as per the delegation that is agreed upon.

4.12.2. The progress of various initiatives shall be submitted as regular agenda item in all the NBEM/NCEM meetings. The review at the apex NCEM level is planned to be held at least once a year, while that at the NBEM level will be taken up 3-4 times in a year as per requirements. The NAB/NATIS and WG-D&S will conduct monthly reviews. The lead agency for this activity shall be NAB/NATIS.

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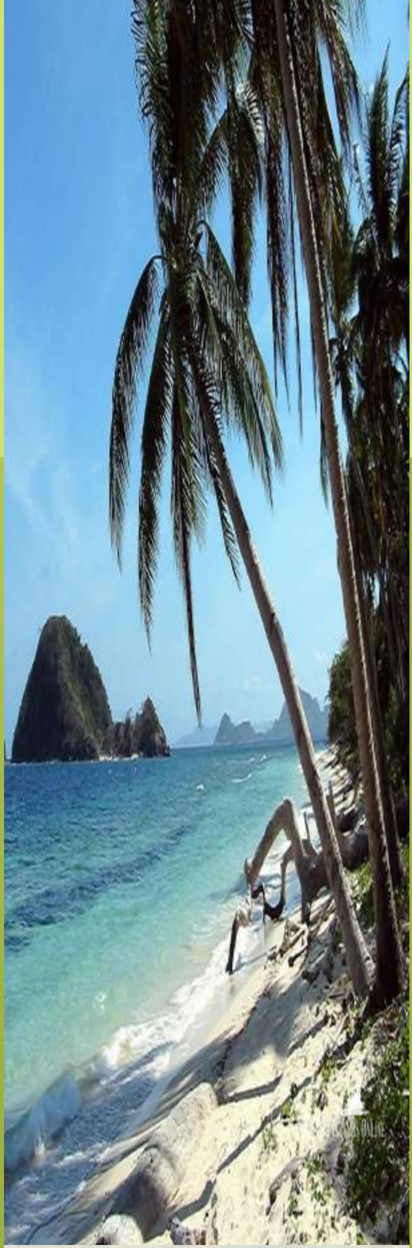
NEMMP 2020

5. RESEARCH & DEVELOPMENT

Chapter 5



Chapter 5 – Research & Development

5.1. Introduction and global scenario.

5.1.1. Regulations, demand incentives and technology innovation are expected to drive xEV emergence. The biggest concern for xEVs today relates to battery technology. The need for high energy density, improved battery life, concerns over safety and reliability have resulted in extensive research in basic battery chemistry. Battery management systems are also being developed to achieve higher level of integration and reliability. In addition, a lot of work is being done in the areas of acceleration assist, optimization from downsizing of engines, regenerative energy and overall system optimization to improve efficiency of xEV powertrains. The ongoing extensive research efforts are expected to lead to major breakthroughs that will help in bridging the price-performance gap thereby boosting the global demand for xEVs.

5.1.2. The ongoing global R&D efforts in xEV can be broadly classified in the following areas.

Battery unit

5.1.2.1. Battery is the most important part of the xEV powertrain, both by function and by value. Currently, the battery cost is approx 40-50% of the total manufacturing cost of a BEV car. As such significant research and development is being aimed at developing cost effective battery solutions. The ongoing battery research efforts worldwide are focused around cell chemistry seeking improved power density, thermal management, lifespan and stability at a reasonable price.

Battery Management System

5.1.2.2. Battery management system is the electronics which binds the cells together into a battery pack. It manages the rechargeable battery by monitoring its state, protecting the battery, controlling its environment, and balancing it. BMS development focus is largely concentrated on providing flexible compatibility with a range of cell chemistries and battery architectures.

Power Electronics

5.1.2.3. Power Electronics (motor controller) refers to the control system that provides energy to the motor from batteries. Controller research is mainly focused on providing a greater level of integration, enhancing thermal control and eliminating external signal conditioning.

xEV powertrain system integration

5.1.2.4. In xEV, powertrain research initiatives are focused towards developing more efficient xEV powertrain. This includes research in the areas of dual operation mode of motor-generator module in hybrids and plug-in hybrids for providing acceleration assist, downsizing of IC engine, overall system optimization including regenerative energy optimization etc. On the motor front, the ongoing efforts are mainly aimed at developing products which are not based on rare earth materials. Lately, a lot of research is being conducted globally for xEV powertrain integration mainly in the areas such as system integration, thermal management etc. The OEMs/Govt. organizations across the world are complementing the research conducted in various xEV sub-systems by developing, demonstrating and testing fleet of xEV vehicles which would allow collection of real world performance of such systems/vehicles.

5.1.3. Brief scan of the global research efforts: The ongoing R&D efforts in the leading automotive nations are summarized below:

5.1.3.1. In United States, battery cell research is the primary focus amongst component suppliers and OEMs have focused on xEV transmission system research. Additionally, national labs and academic institutions are also conducting research at various levels of the xEV powertrain. OEMs like GM and Ford have significant patents on transmission systems.

5.1.3.2. Japan has focused its R&D efforts mainly on battery cells and has achieved the world leader status in Lithium ion battery research and development. In Japan, research is mostly driven by OEMs and suppliers. Battery suppliers like Sanyo, GS Yuasa, NEC etc. have extensive intellectual properties in lithium ion chemistry around electrolytes, electrode material, charging/discharging methods etc. OEMs like Toyota and Nissan also hold numerous battery and BMS patents. Motor and transmission system are the other areas where Japanese OEMs hold significant patents. Honda, Toyota and Nissan combined hold more than 350 patents on alternate transmission systems and more than 220 patents in electric motors.

5.1.3.3. South Korea's focus is also largely around battery and BMS research. LG Chem and SBLiMotive (JV between Samsung and Bosch) are leading research and manufacturing efforts on Lithium ion batteries in Korea. Efforts are directed towards developing customized battery packs for different xEVs. Among OEMs, Hyundai-Kia holds intellectual property in xEV powertrains in areas like dual clutch transmission and 4-wheel drive. In addition, some academic institutions like Korea Advanced Institute of Science and Technology also hold patents on Lithium battery anode materials.

5.1.3.4. China has recently started focusing on basic research in the xEV space especially in the area of lithium-ion batteries. Academic institutions like Jia Tong University and Tsinghua University have patents around cathode materials, hydraulic brake regeneration, fault simulation systems etc. Chery has worked on high capacity lithium-ion batteries and high voltage power management. BYD holds a large number of patents in lithium-ion batteries. SAIC and Chery hold significant patents in BMS both individually, and through their collaborative ventures. In electric motors, Chery has focused on torque management and power distribution controller.

5.2. The current status of R&D in India, priority & focus areas for xEV R&D.

5.2.1. At present, the Indian OEMs and component manufacturers have limited R&D capabilities across all key xEV components. OEMs like TVS (with 5-7 patents), Mahindra Reva (with 10 patents), Tata Motors and Hero Electric (1 patent each) have made some progress on xEV components like battery, power electronics and electric motor. Indian component manufacturers have no patents as yet and foreign OEMs and manufacturers carry out most of the R&D in their home country.

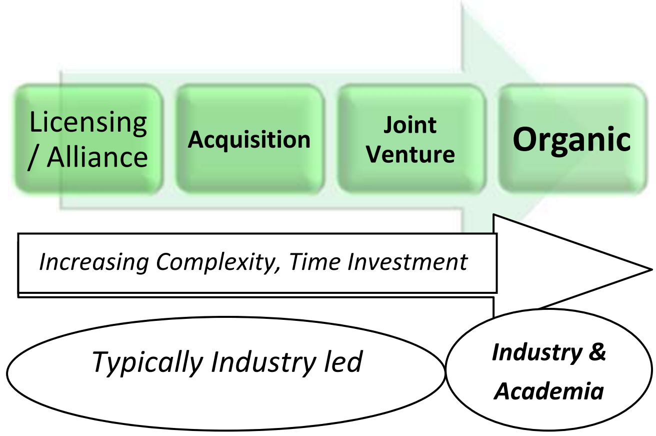
5.2.2. In order to be globally competitive, it is essential for the Indian companies to reach capability levels comparable to US, Japan, China and Korea. Globally, Japan, United States and Korea have strong capabilities in lithium batteries. Japan leads with ~5500 patents for battery cells and BMS and Korea and US follow suit with ~2500 and ~2000 patents respectively. Japan and United States are also strong in transmission systems with the major players applying for ~373 patents in Japan and ~239 patents in US. These patents are spread across local and international universities, national labs, OEMs and suppliers.

5.2.3. In areas of R&D, battery is the most important area and within batteries, cell materials and electronics are the most research intensive areas. The electrodes and the electrolyte within the cell together constitute one of the highest cost segments for lithium ion batteries leading to considerable research in these areas. For instance, Sanyo has been granted 134 patents on optimizing lithium ion battery performance. This includes 84 patents on electrolytes, 26 on electrodes and 15 related to the electronics.

Building R&D capability

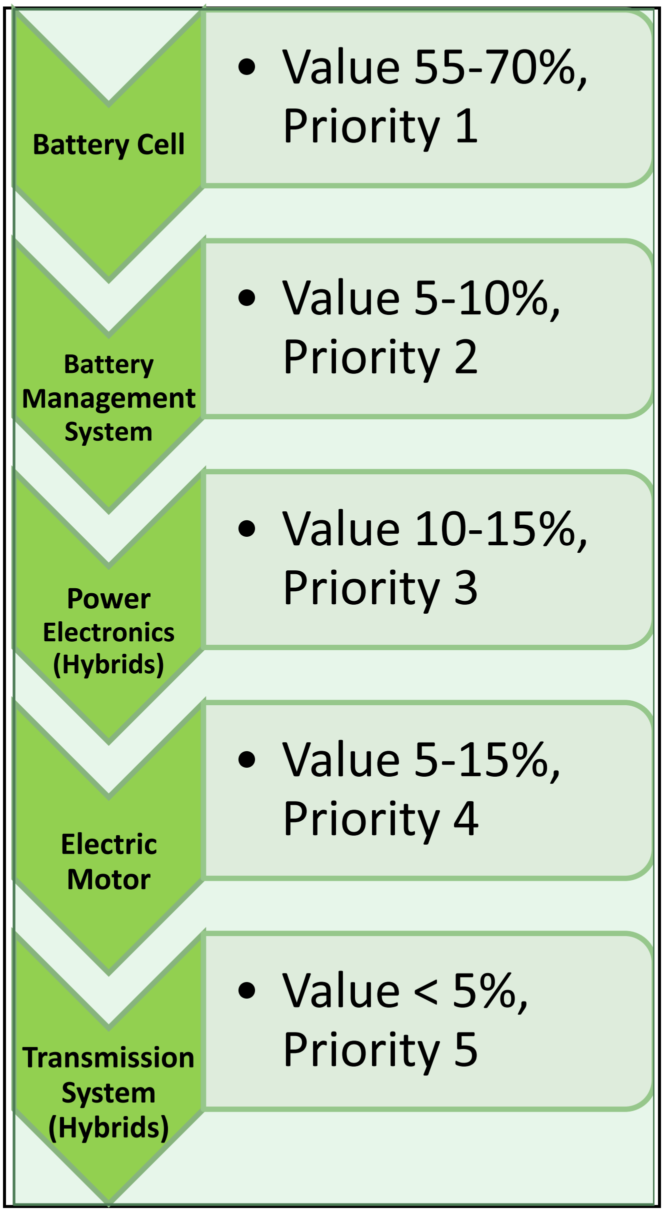
5.2.4. Based on priorities, internal capabilities, competitive intensity and investment needs, there are a range of technology strategies that can be used to attain global standards. R&D capability can be built via multiple routes including licensing/ alliances, acquisitions, joint ventures, and organic development (**Exhibit 24**). Licensing technologies from other entities and forging alliances is the least complex route with much less investment in terms of time and money. This is typically industry led. At the other end of the spectrum, organic in-house development calls for significant time and monetary investment. This is typically led by academia and smaller groups within large industrial houses.

Exhibit 24 – Building R&D capabilities.



5.2.5. The in-depth study undertaken jointly by DHI & Industry indicates that high priority R&D areas for India include battery cell technologies which will drive affordability and adoption. As per this study, battery cells and battery management systems form the highest priority areas, as they have a great impact on cost and performance of xEVs. It is expected that localized battery systems customized for Indian weather and traffic duty cycles will yield better performance. The next priority is accorded to xEV Powertrain system integration, transmission systems (Hybrid), electric motors and power electronics (especially for HEVs/ PHEVs). Localized power electronics can yield better performance at a lower cost and low cost motors by use of non-rare earth magnets can also be an important area of technology developed. To achieve the desired efficiency and performance from xEV vehicles, optimized xEV powertrain integration is an important R&D area as well. The technology priority areas for R&D are summarized in **(Exhibit 25)**.

Exhibit 25 – Technology priority areas.



"Right to win" R&D areas for India

5.2.6. In addition, to these priority R&D areas, it is essential and important to identify the areas where in India has a higher chance of success i.e. "India's right to win R&D areas". An evaluation of the current capabilities in the country, investments required and global competitive intensity helped determine the areas where R&D efforts in India are expected to yield better outcomes. From this comparative analysis, it emerges that India has a "right to win" in R&D areas of battery management systems, power electronics, xEV powertrain system integration and electric motors for xEVs (**Exhibit - 26**). While battery cell is a high priority area, high investments and global competitive intensity translate to a lower right to win for India. BMS, power electronics, electric motors and xEV powertrain system integration are highly attractive areas as current expertise in technology and manufacturing is high and investments required are also low- to- moderate.

Exhibit 26 – "Right to win" R&D areas for India.

	BMS	Power Electronics	Electric Motor	Transmission	Battery Cell
India's Right to Win	High	High	High	Moderate	Low
Area Priority	2	3	4	5	1
Value in xEV	5-10%	10-15%	5-15%	<5%	55-70%

Source: GoI– Industry study.

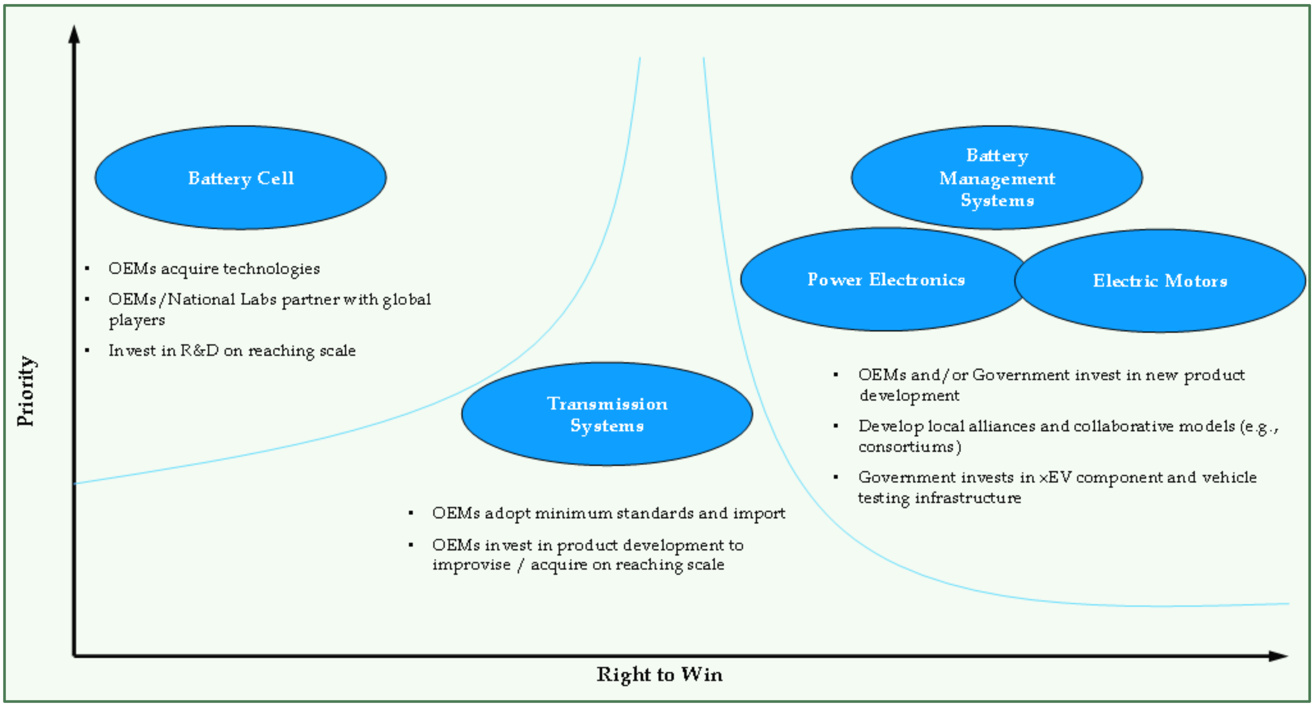
5.3. R&D strategy.

R&D strategy for India

5.3.1. The analysis of the R&D priority areas and the right-to-win evaluation for the country as indicated in the preceding pages provides an insight into the different technology strategies that can be adopted for various xEV components. The optimum strategy for the high priority but hard-to-develop components like battery cells would be through the acquisition of technologies and partnering with global players.

5.3.2. The moderate priority and higher right to win areas like battery management systems, power electronics, electric motor technologies and xEV powertrain system integration can be developed by organic investment and local consortia. Whereas for the low priority – moderate difficulty areas like transmission, OEMs/ Manufacturer can work towards improvising on global product development activities by acquiring companies. The possible xEV R&D strategies for different broad areas are depicted in **(Exhibit 27)** on the next page.

Exhibit 27 – xEV technology Strategies



Source: GoI– Industry study.

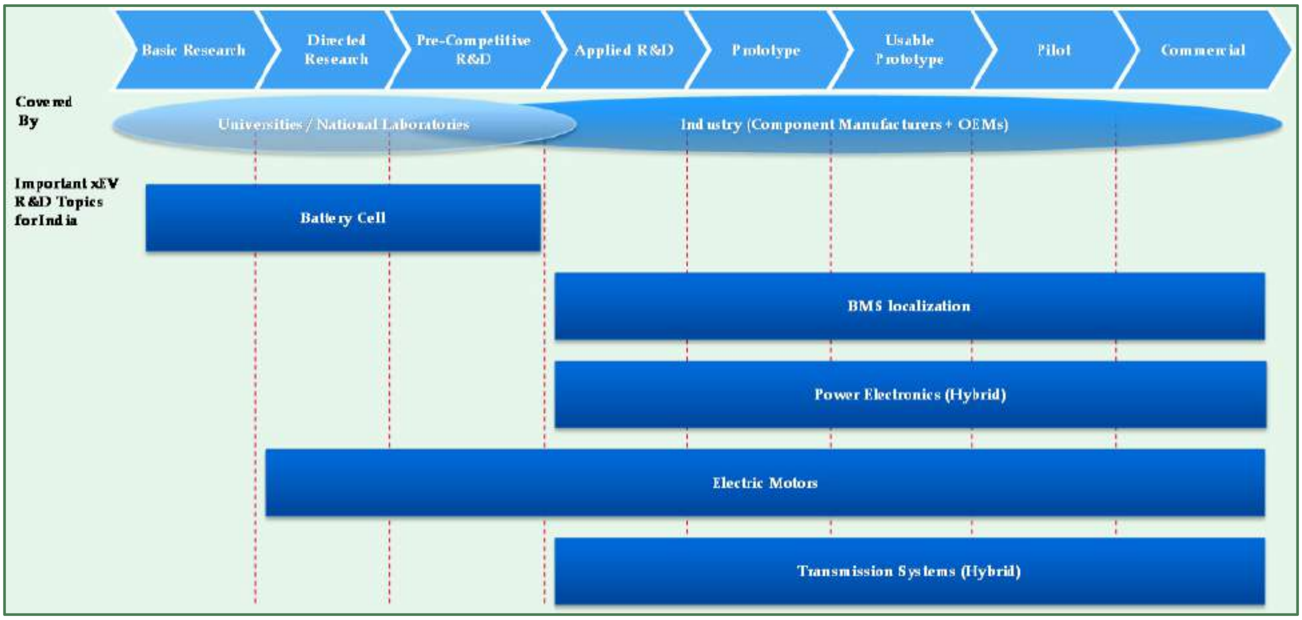
5.3.3. The xEV technology strategies as depicted in **(Exhibit 27)** above will be the blue print to be followed by all the stakeholders for the xEV R&D initiative. In addition, in view of their positive impact across all technologies, traditional areas of automotive R&D that have high potential for increasing energy efficiency like light weighting, reduction of rolling resistance in tyres, downsizing of engines etc will also be given high priority. The funding for these areas will continue to be taken up through the existing schemes like the R&D funding from automotive Cess funds provided by DHI etc.

5.3.4. These strategies can be implemented through OEMs, universities and national labs (**Exhibit 28**). Universities and national labs can take the lead on nascent technologies like battery cells and electric motors. For more mature areas like BMS, power electronics, xEV powertrain integration and electric motors OEMs/component manufacturers with support from the Government can take the lead in new product development.

5.3.5. The R&D effort for xEV will require considerable continued support &

nurturing from the Government. This initiative will be taken up as a collaborative effort between the Government – Industry and the R&D agencies (automotive & others) with clear common roadmap for better synergy and outcomes. The Government funding to the national labs, academia and industry will be through multiple routes including consortia and R&D grants as required. The consortia models to be adopted and mechanisms that are built around the philosophy of fairness, equal opportunity and transparency will be developed and approved by the NCEM for adopton, effective roll out and implementation of this initiative.

Exhibit 28 – xEV R&D implementation



Source: GoI– Industry study.

5.4. Priorities, fund requirements and phasing.

5.4.1. Due to presence of mature software and electronic industry, players in electrical machines, low to medium financial investment required and low global competitive intensity, India has higher R&D "right to win" in battery management system, electric motor and power electronics and xEV powertrain system integration compared to other R&D areas. In line with the efforts made together by Government organizations and OEMs globally, India should also focus on promoting prototype development and fleet testing of xEV vehicles. This will allow

India to develop its own knowledge base of performance of xEV vehicles on actual road conditions and therefore allowing tuning of these technologies specific to India requirements.

5.4.2. The organic in-house product development of battery management systems, power electronics and improvising transmission technologies will require targeted investment from OEMs and manufacturers. However, electric motor and battery cell technologies are more nascent, and therefore, R&D in this area will require Government assistance.

Funds required for R&D

5.4.3. Based on a detailed assessment undertaken during the course of the xEV study, it is estimated that the Government will need to invest ~ Rs 200 crores each for the 4W, 2W and buses, with a matching level of investment from OEMs to support battery cell alliances and technology acquisition including infrastructure for battery recycling.

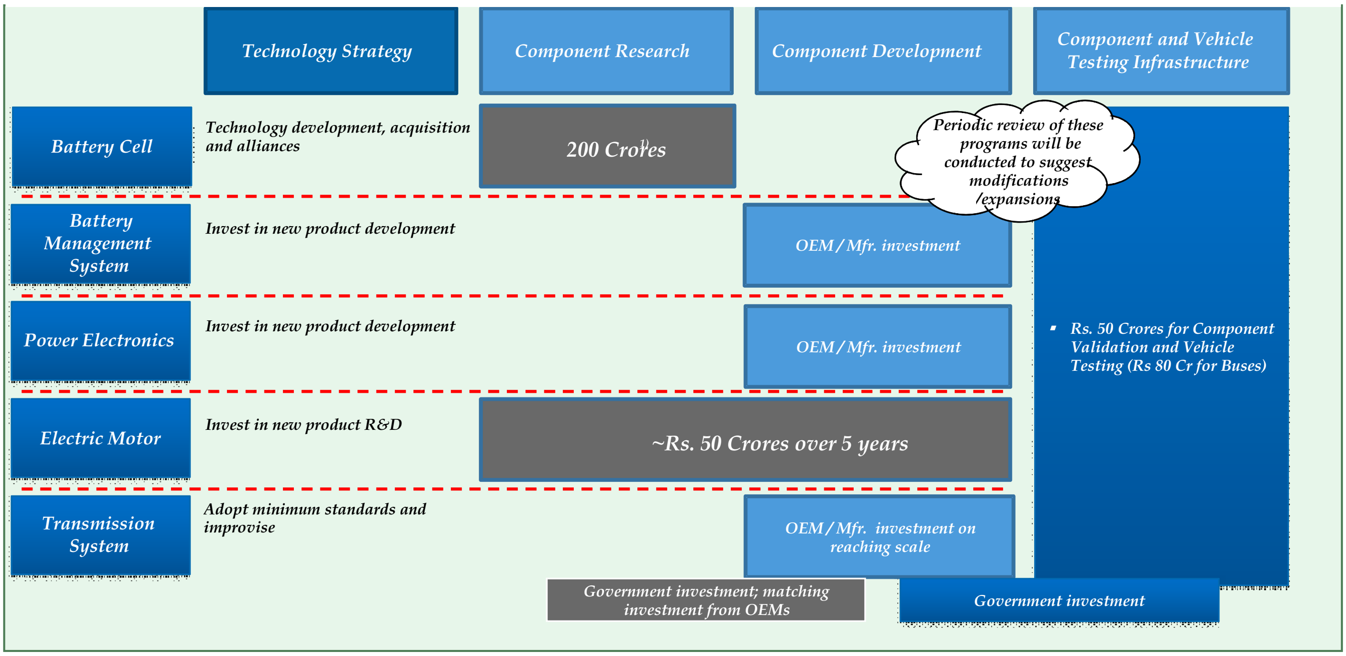
5.4.4. Similarly, funding to the tune ~Rs 50 crores each for 4W, 2W and bus segments, over next five years is required to be made for research and new product development of electric motors by both Govt. and OEMs. In addition, the Government will also need to invest ~ Rs 50 crores for 4W & 2W and ~ Rs 80 crores for buses to develop component validation and vehicle testing facilities. This is an initial indicative estimate. All public funding for setting up of component and vehicle testing and validation infrastructure will be made in existing and upcoming automotive testing facilities in the country so that this is in the public domain and that these facilities are available to all companies alike.

5.4.5. No separate R&D investments for the 3W and LCV vehicle segments are proposed as there are likely to be significant overlaps and possibility of application of R&D outcomes from a particular vehicle segment in other segments also.

5.4.6. Accordingly, as per initial estimates, an overall investment for 4W, 2W & buses will be in the range of Rs 500 - 600 crores spanning over the next 5 year period. Since there is considerable overlap, this will also take care of the R&D requirements for 3W and LCVs. As such the total level of investment for xEV R&D is projected to be in the range of Rs 1600 - 1800 crores over the period of next five years. This includes investments from OEMs also. The R&D investment for 4W, 2W and buses is depicted in **(Exhibit 29)** on the next page.

5.4.7. The total estimated support required from Government will be in the range of Rs 930 crores and includes Rs 180 crores for setting up of the required component and vehicle testing infrastructure. As this is an initial estimate, it is proposed that a frequent periodic review of these programs will be conducted to review progress and incorporate course corrections, modifications or expansions. The R&D spent on other areas that have potential for increasing energy efficiency across all technologies like light weighting etc will also be supported through the existing schemes. The summary of the likely R&D investments required is given in **Table 18** below and the proposed segment wise & R&D area wise investments is given in **Table 19** on the next page:

Exhibit 29 – Research investment for 4W, 2W and buses



Source: *GoI-Industry study.* ***Note:*** *above depiction is common to 4W, 2W and buses with the only difference that in case of bus segment, the expenditure on setting up of testing infrastructure will be Rs 80 crores instead of Rs 50 crores.*

Table 18 – Vehicle segment wise R&D spent for 5 years (Rs in crores)

Area	***4W***		***2W***	***3W***		***Buses***		***LCV***		***Total***	
	HEV	***HEV/ BEV***	***HEV***	***HEV***	***HEV/ BEV***	***HEV***	***HEV/ BEV***	***HEV***	***HEV/ BEV***	***HEV***	***HEV/ BEV***
R&D Investment	*500 - 600*	*500 - 600*	*500 - 600*	*-*	*-*	*500 - 600*	*500 - 600*	*-*	*-*	*1500 - 1800*	*1500 - 1800*

Source: *GoI-Industry study.* ***Note:*** *These are approximate estimations for the likely range of investments required. The R&D expenditure for both HEV and HEV/BEV options is the same. It is assumed that investments in 4W, 2W and Buses will also facilitate 3W and LCVs.*

Table 19– Vehicle segment wise & R&D area wise expenditure

	Component Research (CR)					Component Development (CD)					Component and Vehicle Testing Infrastructure				
R&D Area	***4W***	***2W***	***3 W***	***Bus***	***LCV***	***4W***	***2W***	***3 W***	***Bus***	***LCV***	***4W***	***2W***	***3W***	***Bus***	***LCV***
Battery Cell	*200**	*200**		*200**							*50*	*50*	*-*	*80*	*-*
Battery Mgmt System						***OEM/Manufacture Investment***									
Power Electronics						***OEM/Manufacture Investment***									
Electric Motor	*Rs 50 Cr each from Govt. & industry for 4W, 2W and Bus segment for component research and development*														
Transmission						***OEM/Manufacture Investment***									
Total	***225****	***225****		***225****		***25****	***25****		***25****		**50**	**50**		***80***	

*Note: (i) These are approximate estimates (ii) * indicates matching investment from both government and Industry. For sake of simplicity, Rs 50 Cr for motors has been equally split between CR & CD. Therefore, for 4W the investment for CR is Rs 200 Cr + Rs 25 Cr from Govt. & industry both i.e. Rs 450 Cr. and Rs 50 Crore for Component development. Source: GoI – Industry study.*

Sources of Government funding

5.4.8. In terms of the Industries Development (Regulation) Act, 1951, the automotive industry has also been notified by the government, in 1983, for the purposes of levy of automotive Cess to be used for the growth and development of the automotive industry. Accordingly, a Cess on automobiles (1/8th of 1%) is levied and collected along with excise duty collections. This is made available to the Department of Heavy Industry for the various initiatives for the automotive industry. In 2010-11, it is estimated that the automotive cess collected was in the range of Rs 225 crores. This is being used to fund pre-competitive automotive R&D projects and other schemes of the automotive sector. It is planned that the requirement of funds for building new facilities, and also for meeting a portion of R&D expenditure would be met from the head of automotive Cess through higher budgetary allocations to DHI.

5.4.9. The Department of Science and Technology will also partner in funding the electric mobility R&D program from their budget allocations. Similarly, funding from other departments under various existing schemes will also be explored. In addition, the feasibility of setting up of an exclusive electric vehicle technology development fund to support xEV technology development on continual basis will also be explored.

5.4.10. In terms of the Government decision (Cabinet decision), all funding of various R&D programs by the Government will be through the empowered mechanism of NAB/NBEM/NCEM. Accordingly, all projects to be funded will be initially evaluated by a suitable mechanism set up under NATRiP/NAB before being considered by NBEM/NCEM. The award, monitoring and outcome evaluation of the projects will also be done through the same structure.

5.4.11. The proposed phasing of Government expenditure is indicated in **Table 20** hereunder. It is also possible that higher level of front loading of R&D investments may need to be done. However, as this is an initial estimate, the exact funding level as also the optimum phasing of expenditure will be examined by the WG-R&D and submitted for consideration of NAB/NBEM/NCEM. In case of any shortfalls in outflows during the initial years on account of delays in finalization of project proposals etc; the balance unspent amount will be carried over to subsequent years. In addition, the progress of the R&D initiative and the review of phasing of the expenditure will be done on a regular basis by NCEM/NBEM.

Table 20 – Phasing of R&D expenditure

	2012-13	**2013-14**	**2014-15**	**2015-16**	**2016-17**	Total
For testing infrastructure	**60**	**90**	**30**	**-**	**-**	**180**
For xEV R&D Projects	**50**	**100**	**150**	**200**	**250**	**750**
Total for xEV	**110**	**190**	**180**	**200**	**250**	**930**

5.5. Key stakeholders, roles and responsibilities.

5.5.1. As indicated earlier, xEV R&D activities in India are at present minimal, fragmented and involve multiple agencies and various Ministries. There is insufficient coordination and synergy amongst the various efforts being undertaken by different arms of the Government. The collaboration between Government R&D labs, industry, Government departments and academia is not sufficient. Therefore, it is imperative that all Government funded/aided R&D projects and other activities are put on a single platform through the NAB/NBEM/NCEM. All resource allocations made from GoI will be through this one common platform

5.5.2. Further, this intervention need is to be taken up as a collaborative effort between the Government – Industry and the R&D agencies (automotive & others) with clear common roadmap for better synergy and outcomes.

5.5.3. The role of the Government will be to help provide the resources for taking up of R&D in key identified areas through incentives, R&D grants, directly taking up R&D projects, acquisition of technology and possible sourcing of required expertise. In addition, the Government will also need to catalyze, help in creation of collaborative mechanism, bring all stakeholders on board and help de-risking of industry efforts in this direction. The other important role of the Government includes integration and coordination of investment and research/technology within various Government organizations.

5.5.4. The industry will need to match the Government in terms of commitment and resource allocations for R&D in the area of xEV. In fact, the roadmap provides for significant R&D investments by the industry.

5.5.5. The various Government labs, automotive testing centers will be geared up to develop competencies, commit resources and collaborate with the industry, other labs and academia for taking up the various xEV related R&D projects and complete these as per fixed timelines with desired outcomes.

5.6. Implementation structure and mechanism.

Implementation structure & mechanism

5.6.1. A single platform of NCEM/NBEM has been created by the Government to achieve greater synergy through common vision, roadmap, and priorities amongst all stakeholders involved in promoting electric mobility. As such and in terms of existing Government approval, the R&D strategy, roadmap, implementation models to be used and all the R&D initiatives/projects to be taken up through Government support will be approved through the mechanism of NAB, NBEM and NCEM.

5.6.2. The existing structures, agencies and organizations currently having expertise in this area, such as NATIS and its constituent centers, etc will be the implementation agencies of the Government. Further, NATIS/NAB will also assist the NBEM/NCEM in the xEV R&D project approval, review and monitoring process.

Collaborative approach

5.6.3. The xEV R&D initiative will be taken up on a collaborative approach with NATIS/NAB and the existing automotive R&D centers under it jointly playing the pivotal role in partnership with TIFAC/DST. While TIFAC/DST will focus on technology foresight and project nucleation, NATIS/NAB, DHI will focus on project implementation with certain degree of overlap for smooth functioning.

5.6.4. The existing collaborative R&D model used by CAR (Collaborative Automotive R&D) program under TIFAC/DST for forming project consortia may be used for which key stakeholders including the industry, academia and other research institutes will be taken on board. In addition, the Government – Industry study has also proposed a number of other possible consortia models that can be explored and adopted in case these are approved by the NBEM/NCEM.

5.6.5. DST has also shown keen interest in focusing its resources and labs for undertaking the effort in shape of a much bigger R&D program which will include a number of specific projects and may also involve acquiring of technology, if required. As such, in addition to the automotive testing and R&D labs, other labs under DST will also be involved as per requirement.

5.6.6. While the study has identified the broad areas where R&D efforts need to be made, however, a more detailed exercise will be undertaken with DST and the industry to identify the specific R&D projects, their budgets, outcomes and timelines. Further, the existing automotive regulations relating to xEVs are also being reviewed by the various panels set up under the CMVR-TSC that is administered by the DRT, Government of India.

5.6.7. The current and the upcoming level of automotive testing infrastructure in the country is planned to be further augmented. This will be required not only for R&D purposes but also for testing vehicles as per the new regulations and standards that will be introduced (e.g. test equipment for e-motors and battery test beds, etc.). The ongoing automotive testing and R&D infrastructure up-gradation project (NATRiP), under DHI, will be therefore, expanded to cover these newer areas. As per the estimations made in the study, the level of investment required for this is in the range of Rs 180 crores. However, these estimates still require further detailing, fine-tuning and approval by NCEM/NBEM. Once approved, these investments can be clubbed with the current ongoing up-gradation exercise under the NATRiP project. DHI & NATRiP will be the implementation agencies for the up-gradation of existing automotive testing and R&D facilities. In addition, wherever required, other facilities and labs under DST, CSIR, DRDO will also be partnered with.

WG-R&D

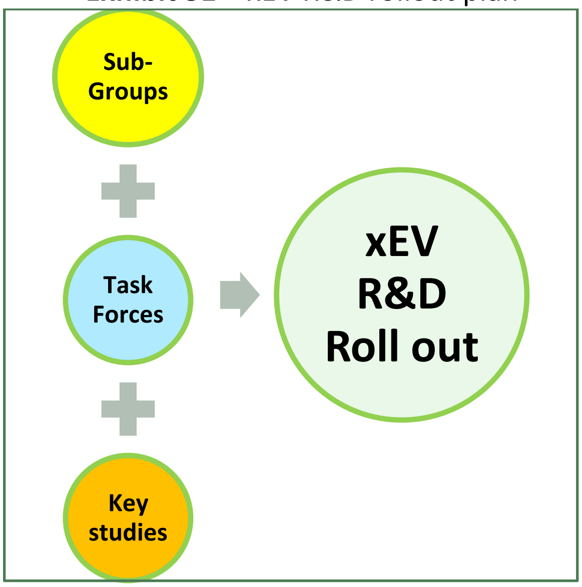
5.6.8. In view of the enormity and complexity of the task, the large number of stakeholders involved, it was felt that a Working Group (WG) comprising of all the key stakeholders should be constituted to help in the micro detailing and roll out/implementation of this initiative. For this purpose, the WG on R&D has been set up by the NBEM in its second meeting. The WG-R&D will not only undertake the initial detailing of the R&D initiative but will continue to function for the implementation phase also. Three Sub-Groups have also been set up under the WG-R&D. The composition of the various working groups, including WG-R&D, is given at **Annexure-IV**. Additional members, as per requirement, will also be co-opted to these groups.

Roll out model

5.6.9. The WG-R&D during its first meeting deliberated on the various important pre-requisite activities that need to be taken up immediately for the roll out of the xEV R&D interventions. This includes setting up of the necessary enabling rules, guidelines and policies. In addition, identification of specific R&D projects to be taken up, project detailing including the resources required, R&D project prioritization and phasing also needs to be completed and approved by the NBEM/NCEM. In order to achieve these tasks the WG-R&D constituted three sub-groups, four task forces and commissioned eight studies/reports. The responsibility, mandate and timelines for completion of work have been agreed upon by all the stakeholders. Most of the studies/reports will be carried out by TIFAC/DST and three of the task forces will also be lead by DST. NATRiP/NAB will coordinate the functioning of the Working Group on xEV R&D (WG-R&D) and its sub groups, task forces etc. The xEV R&D roll out/ implementation model that is being used is depicted in **(Exhibit 30** and **31)** on the next page.

Exhibit 30 - The xEV R&D roll out model

Exhibit 31 – xEV R&D rollout plan



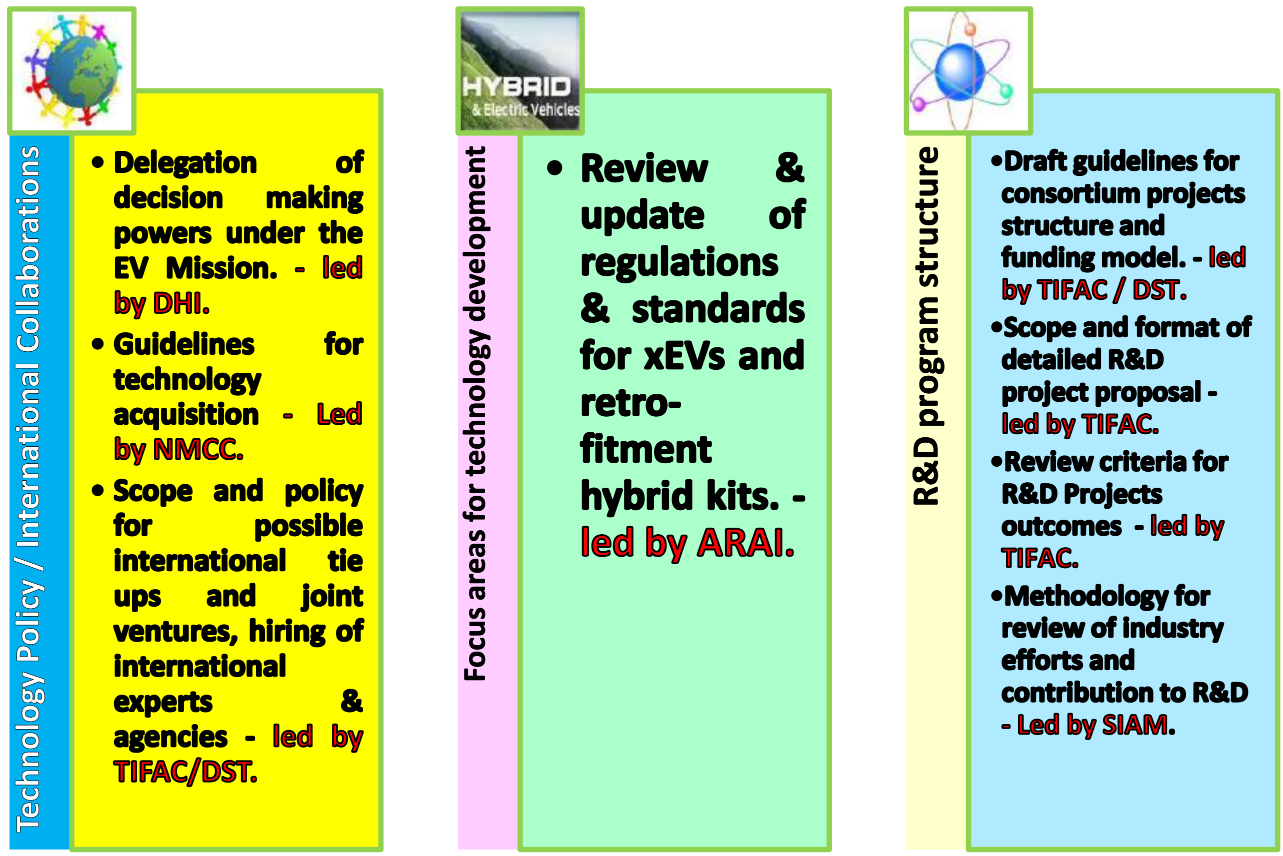
Sub Groups

5.6.10. Three sub-groups have been constituted in the area of BMS & batteries, Power electronics and motors and testing infrastructure, human resources & efficient technologies. The broad mandate of these groups is to identify and propose the various projects that can be taken up and their prioritization. This includes details like project outcomes, lead agencies, resource requirement, optimum methodology (consortia, grant based etc), timeline and monitoring mechanisms.

Studies /reports

5.6.11. The eight study reports commissioned by the Working Group on R&D will provide the key inputs for policy decisions and program formulation under the EV Mission. These are without exception first time efforts. The models for technology development that will be developed as a result of these studies will also set a precedent for further such efforts at developing cutting edge industrial technology in the country. In order to ensure that the "right view" is formulated in all these subject areas, a high level participation from the stakeholder agencies will be encouraged. These reports can be clubbed in three broad areas **(i)** Technology Policy / International Collaborations, **(ii)** Focus areas for technology development, **(iii)** R&D program structure. This is depicted in **Figure 8** below:

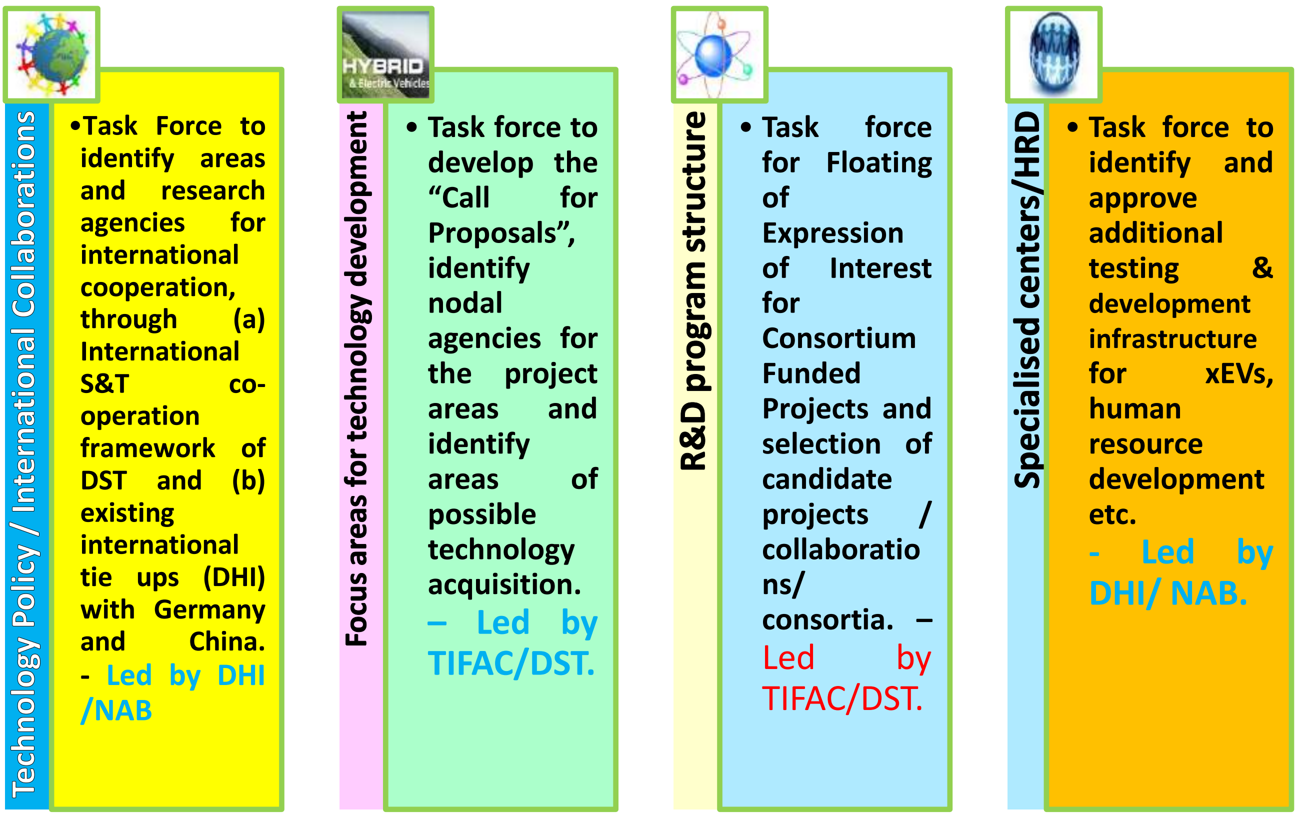
Figure 8 – Study areas for the xEV R&D initiative roll out



Task Forces

5.6.12. Four task forces have also been constituted as standing bodies for the duration of the National Mission on Electric Mobility. These will submit quarterly reports to the NAB/NBEM through the Working Group on R&D. The mandate of these task forces will include the commissioning of specific survey reports and co-opting additional members from time to time, and holding specific inter-agency consultations. The Secretariat support and administrative expenditure will be provided by the lead agencies, as part of the EV Mission activities. These task forces can be categorized in four broad areas on similar lines to the three broad study areas as depicted in **Figure 9** below:

Figure 9 – Task forces for the xEV initiative roll out.



5.7. Review, monitoring & course correction mechanism.

5.7.1. The implementation structure for this initiative i.e. NCEM and NBEM at the apex level and the NAB/NATIS along with the Working Group on R&D (WG-R&D) and its sub groups at the working level will review and monitor the roll out of this program and the various projects and schemes that are implemented under it.

5.7.2. The review, monitoring and course correction mechanism for xEV R&D initiative will be on same lines as the mechanism adopted for review of xEV demand initiatives. The report on the progress of various xEV R&D initiatives will be submitted as an agenda item in all the NBEM/NCEM meetings. The review at the apex i.e. NCEM level is proposed to be held at least once a year, while that at the NBEM level will be taken up 3-4 times in a year as per requirements. The review at NAB/NATIS and WG-R&D level will be held at once in a month as per requirements. The lead agency for coordinating the reviews will be NAB/NATIS.

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NEMMP 2020

6. SUPPLY INCENTIVES

Chapter 6

6.1. Introduction.

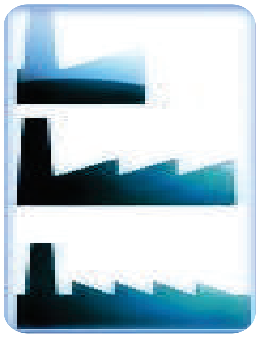
6.2. Manufacturing strategy.

6.3. The way ahead.

6.4. Implementation strategy, funding, review, monitoring & course correction mechanism.

Chapter 6 –Supply Incentives

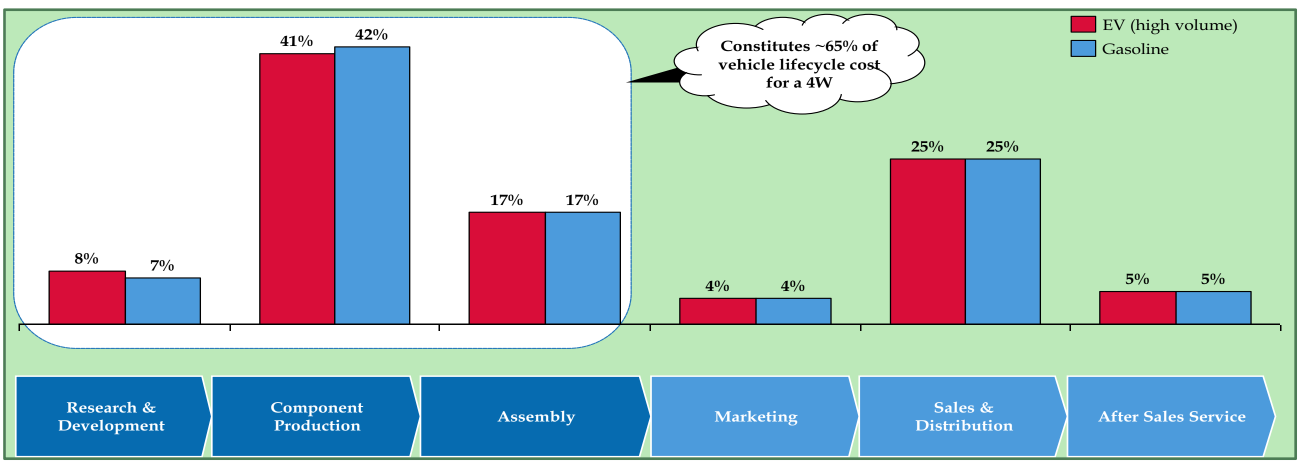
6.1. Introduction.



6.1.1. Encouraging development and manufacture of xEVs and their components in India is one of the prime objectives of the NMEM. This is not only with a view to develop the domestic manufacturing capabilities which is in line with the Government objective of increasing the contribution of manufacturing sector to the national GDP thereby resulting in large scale employment generation, but equally important is the fact that higher level of localization is also critical for the faster adoption of electric vehicles in the country. This is due to the fact that larger value addition in India will not only help drive down the costs of xEVs but will also allow for more robust components and vehicle to be developed given the unique conditions of India. This fact is supported by the manner in which the Indian automotive industry has developed in the recent past.

6.1.2. The importance of R&D and production activities can be seen by the fact that almost two-thirds of the 4W xEV value is created in R&D and production (**Exhibit 32**). This is similar to gasoline 4W vehicles where ~60% of the value arises from component production and assembly and ~7-8% from research and development.

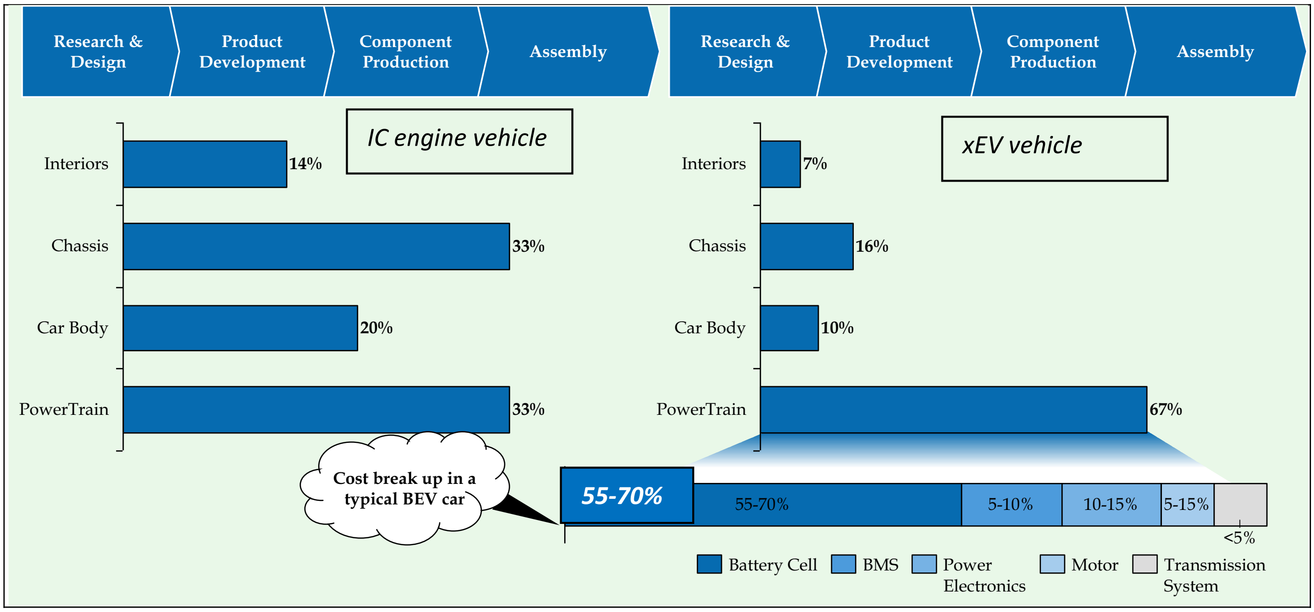
Exhibit 32 - Vehicle lifecycle cost for industry – breakup by supply chain elements



Source: GoI- Industry study.

6.1.3. In contrast to the traditional ICE vehicles where chassis and powertrain each contribute to 33% of the costs, in 4W BEVs, the chassis contributes only 16% and powertrain ~67% of the cost of the vehicle. Within the powertrain, the battery pack and power electronics dominate, contributing to ~55-70% and ~10-15% of the cost respectively. Consequently, these assume paramount importance while determining areas of focus for R&D and production **(Exhibit-33)**.

Exhibit 33 - Cost of manufacturing for ICE and battery electric vehicles

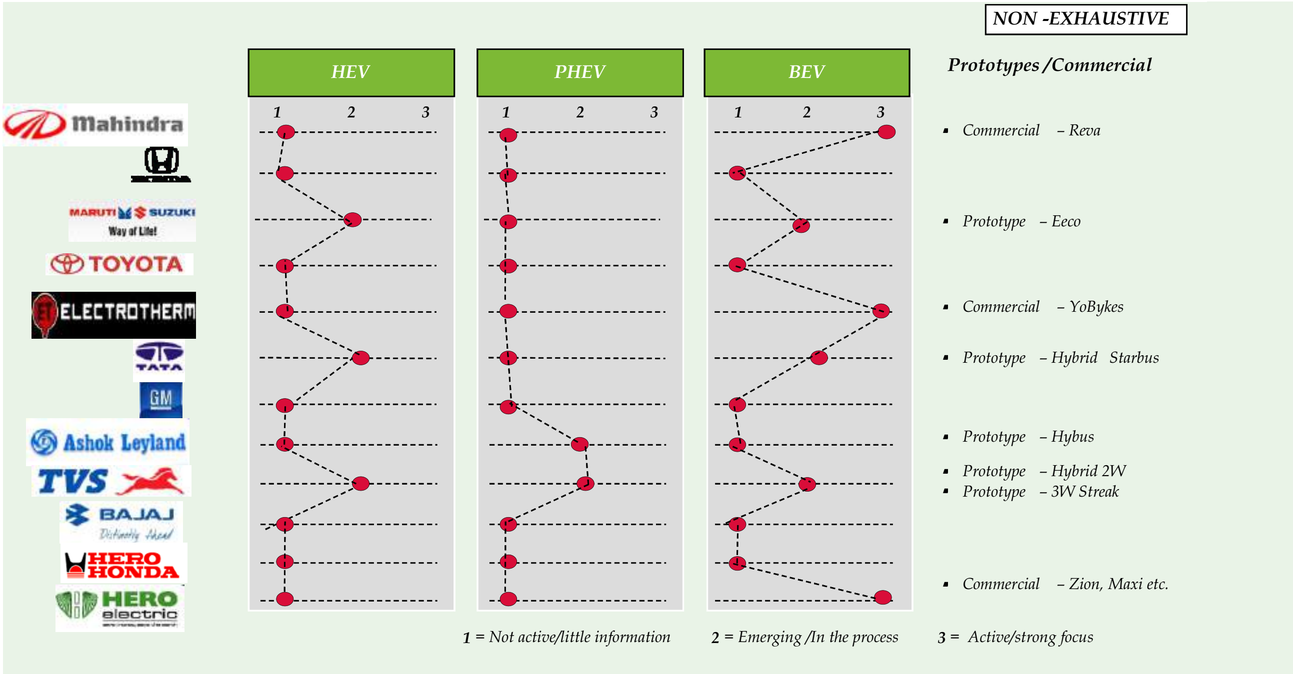


Source: GoI-Industry study. Note: Analysis for sub-compact battery electric vehicle, Source: Nomura, Argonne National Laboratory, Booz & Company analysis

Current scenario

6.1.4. Currently, domestic capabilities in xEV power train and component development and manufacturing are low. This is depicted in **(Exhibit 34)** on the next page. A few OEMs in India have initiated efforts for developing their xEV manufacturing capabilities. While firms like Mahindra (Reva) and Maruti Suzuki have made progress in the four-wheeler xEV space, much of the technology and products are still imported. Most of the components for the electric two wheelers being sold in India are also imported, with only assembly activities taking place in India. The local component manufacturing capability in India across major xEV sub-systems is also very limited. (**Exhibit 35**) Interviews with OEMs reveal that battery technology in India is nascent with no manufacturing capabilities in the country for lithium-ion cells.

Exhibit 34 – OEMs development activities in various power trains in India



Source: GoI-Industry study.

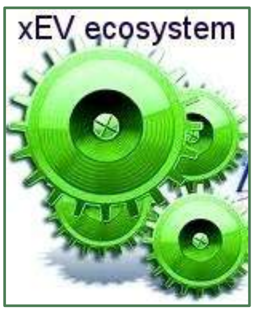
Exhibit 35 – Status of xEV component supplier in India

NON-EXHAUSTIVE

	Battery	BMS	Transmission System	Electric Motors	Power Electronics	Comments
AMARA RAJA	✘	✘	✘	✘	✘	
EXIDE TECHNOLOGIES	✓	✘	✘	✘	✘	• Lead – acid batteries for electric 2W
SB LiMotive	✘	✘	✘	✘	✘	
BHARAT FORGE / KPIT Cummins	✘	✓	✘	✘	✘	• BMS solution for HEV • Electronic control unit
BOSCH	✘	✘	✘	✘	✘	
Crompton Greaves	✘	✘	✘	✓	✘	• Special drive motors • Traction motors
Kirloskar	✘	✘	✘	✓	✘	• Manufacture e-motors for Reva

Source: GoI-Industry study.

6.1.5. There have been numerous initiatives by the Government and also the industry to develop electric vehicle market in the country. However, most of these have not been able to fully yield the desired outcomes on account of various factors. Besides the challenges associated with the issues of technology and required infrastructure, the main barrier is the huge difference in the acquisition cost of the xEV as compared to the counterpart IC engine vehicle. Therefore, despite the fact that the operational cost of an electric vehicle is much lower than that of the IC engine vehicles, for the consumer this is still not significant enough to offset the higher acquisition cost of the xEV and as a result, the off take of xEVs remains low. The sharp dependence/ co-relation between the acquisition price of xEV and the demand of xEVs is also demonstrated by the fact that whenever there has been any demand creation initiative for xEVs by the Government (central or state), the off take of xEVs has shot up tremendously. This has also been seen in respect of both the electric two wheelers and four wheelers (Reva) during the recent demand creation scheme of MNRE.

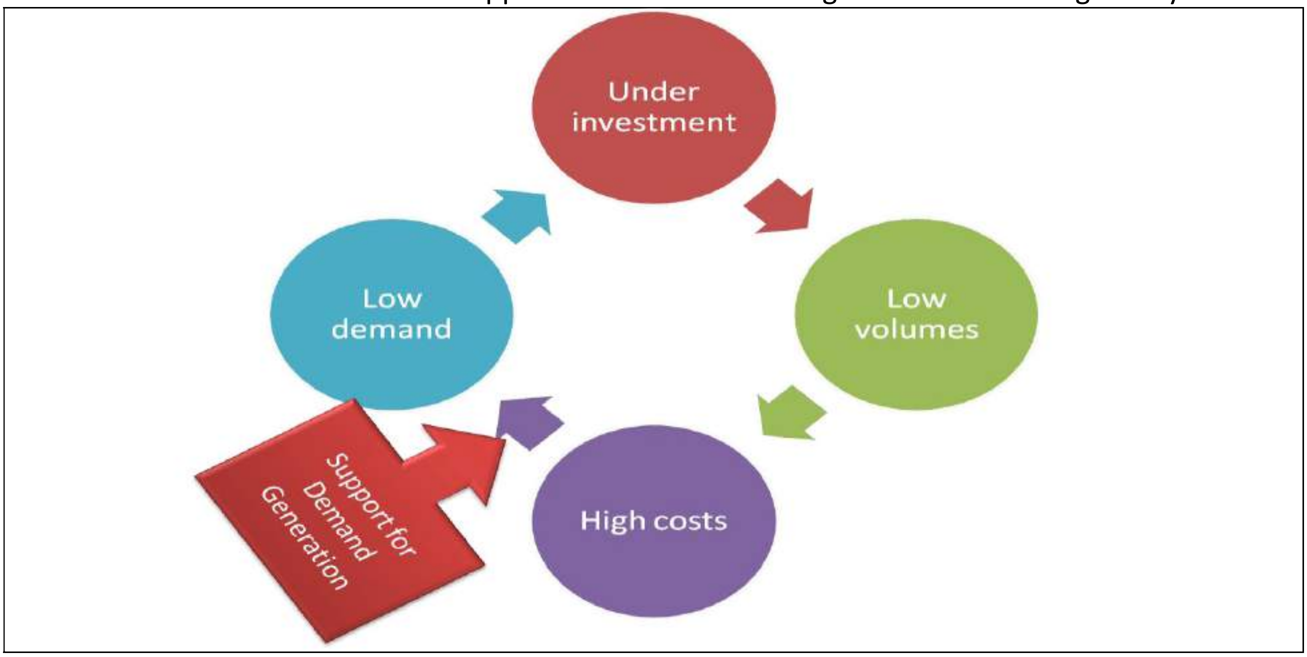


6.1.6. In order to develop a sustainable xEV industry eco system, it is essential to bring down the higher initial acquisition cost of xEV vehicles because it is neither feasible nor sustainable to envisage a scenario wherein demand creation support by the Government continues to be provided endlessly. The lowering of the acquisition costs through lesser manufacturing costs can happen mainly through **(i)** economies of scale associated with much higher volumes**, (ii)** lowering of costs through technological developments, **(iii)** higher degree of localization. Therefore, in the near future significant investments by automotive industry are essential to build scale and also benefit from localization to drive down the costs of xEVs. However, the existing low and uncertain demand for xEVs has contributed to significant under investments for specialized xEV components thereby leading to higher cost of manufacturing. The high manufacturing costs has in turn resulted in low demand thereby leading to a vicious cycle that needs to be broken. This is depicted in **(Exhibit 36)** on the next page. In order to break this cycle, it is essential for the industry to make the necessary investments for building the xEV manufacturing eco system and scale. However, a conducive environment has to be created that permits significant investment de-risking for the industry through necessary assurance for **(i)** a much larger demand for these vehicles then what is at present, **(ii)** the continuity and certainty about the minimum demand volumes in the future, **(iii)** commitment and support from the Government especially in the initial phases (infancy) of this industry, **(iv)** stability of Government policies through an agreed upon medium to long term plan.

Demand incentives are critical for developing manufacturing ecosystem

6.1.7. It is therefore, essential for the Government to support demand creation in the initial phases through narrowing the price difference between the IC engine and xEV vehicles. Demand creation strategy as discussed in earlier chapter is the key to creation of the xEV manufacturing eco system in the country. The other essential pre-requisite conditions include **(i)** the demand created has to be significant in size, **(ii)** the demand creation scheme needs to be continued for a minimum pre-defined period, **(iii)** the vision, strategy and the roadmap for electric mobility initiative has to be clearly defined and owned by all stakeholders. These enablers are expected to provide the confidence and give significant de-risking comfort to the industry for investing significantly in the creation of the xEV manufacturing base in the country. Therefore, the demand creation support to be provided by the Government needs to be seen as an "investment" with a strong linkage to creation of local xEV manufacturing capabilities rather than a subvention scheme.

Exhibit 36 – Demand creation support essential for creating xEV manufacturing eco-system



6.2. Manufacturing strategy.

6.2.1. The Indian auto component industry mainly comprises of small and medium sized companies. Although the Indian Automotive Industry has been growing at impressive rate for the past few years and has attained sufficient scale and maturity, there are specific areas of concern that needs to be addressed. These include the increased competition from companies based in other low cost countries, lack of adequate capacities and design capabilities, disadvantages of higher transactional and infrastructural costs in India, lower productivity and shortage of skilled manpower. Overall, the Indian auto component industry is facing challenges from cheap imports. In 2010-11, India was a net importer of auto components worth USD 5 billion. This trade deficit has been increasing over time and the amount of exports and imports of auto components is summarized in **Table 21** below:

Table 21 – Export – import data for auto components

	2006-07	2007-08	2008-09	2009-10	2010-11
Exports % Growth	2.67 8	3.52 32	3.80 8	3.80 -	5.00 32
Imports % Growth	3.60 45	5.22 45	6.80 30	8.16 20	10.00 23
Import as % of Turnover	24	29	37	37	33
Exports as % of Turnover	18	20	21	13	17

6.2.2. The Department of Heavy Industry has been supporting the growth of the Indian auto component sector through various programs like the ACMA-UNIDO cluster development program and is also working on various new initiatives like the Automotive Skills Development Council, developing an Auto Component Technology Development fund etc. These initiatives will need to be augmented and efforts to improve the competitiveness of the Indian auto component supply chain will be the essential pre-requisite for developing an efficient and competitive indigenous xEV component supply chain.

6.2.3. Meeting the domestic demand for xEVs will necessitate strengthening of the local manufacturing and supply base. The development of the local xEV supply chain is sought to be achieved through a phased approach for gradually building the domestic manufacturing capabilities for the various vehicle segments. In addition, this strategy will also involve the essential requirement of linking Government support for demand creation to firm commitments by the industry to reach pre-defined levels of domestic value addition in terms of the percentage value of the local xEV components used in the xEV. This will help create, to a large extent, the required impetus for the supply side investments and commitment from the industry for creating the xEV supply chain. The committed level for localization is also proposed to be gradually increased in a phased manner during the period wherein demand incentives continue to be provided.

6.2.4. In addition; in order to encourage manufacturers having higher level of localization content, the possibility of having distinguishing/gradation localization criterion for getting higher level of demand incentives (in terms of quantity of vehicles covered or the amount of incentive provided) can also be explored. Further, the possibility for range of other enablers to fast track investments will also be seen.

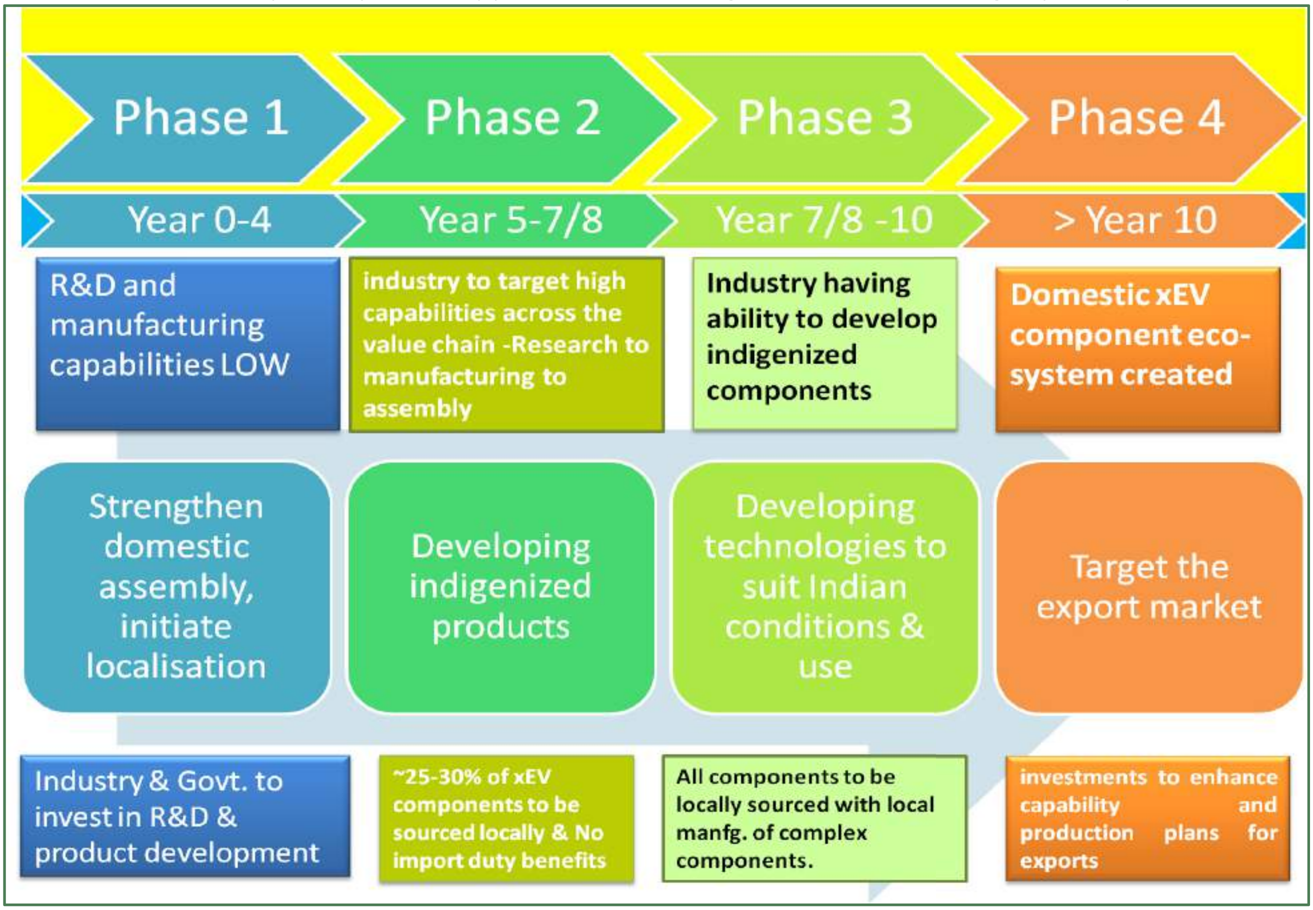
6.2.5. As per the joint Government – Industry study, a three/four-phased approach spread over next ten years, depending upon the vehicle segment will be adopted to build the manufacturing capability for xEVs in India. The phased manufacturing strategy for xEVs and four wheelers is depicted in **(Exhibit 37 and 38)** on following pages. Although the phased – ten year approach is common to all vehicle segments, however, in view of the different levels of off take of xEVs in various vehicle segments, the number of phases and the timelines of the various phases vary slightly across different vehicle segments.

Phased approach

6.2.6. In case of the four wheelers, the first stage of development from (0-4 years) would involve strengthening of the domestic assembly. During this phase, the industry will develop high capability in manufacturing with local assembly of xEVs using imported or local components. Simultaneously, the local sourcing can also be increased translating to moderate capabilities on this front. Further, the industry and Government will also initiate investments in R&D and product development centers as the current capabilities in these areas are quite low in the country.

6.2.7. The second stage from the next 5-8 years will involve developing indigenized products. By this time, it is expected that the R&D and industry product development centers would have attained moderate capabilities for developing indigenized components (BMS, transmission system, electric motors etc.). At this point, the country will target ~25-30% of xEV components in terms of value to be sourced locally. In order to support the reasonably developed local supply chain, during this phase the customs duty exemptions for xEV components will also be phased out completely.

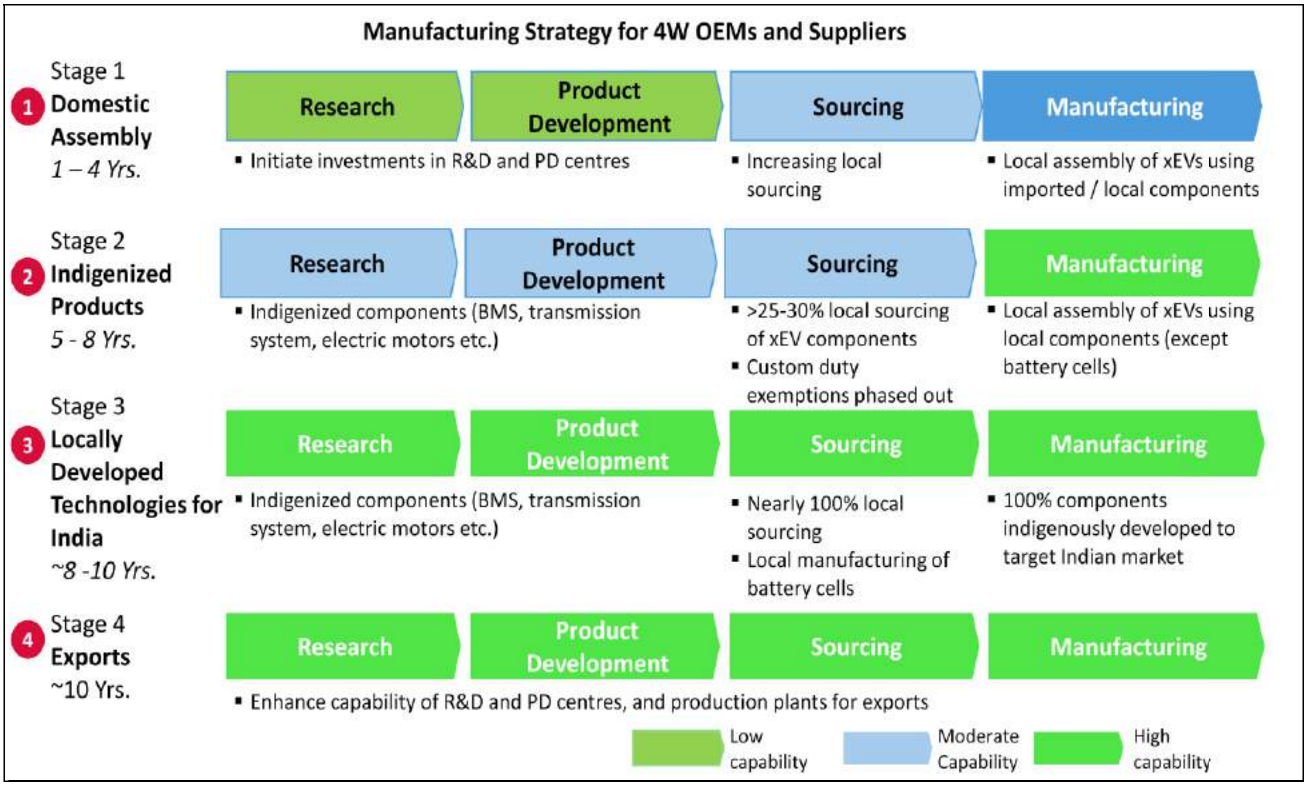
Exhibit 37 - Ten year 4-phased approach for building xEVs manufacturing capability in India.



Source: GoI-Industry study.

6.2.8. During the third phase for 4W xEVs, 8-10 years from now, the focus will be on developing technologies to suit Indian conditions and usage. In this period, industry should have developed high capabilities across the value chain from research to assembly and manufacturing. During this phase, nearly 100% of the components would be locally sourced including local manufacturing of complex components like battery cells. In the final stage (>10 years), the target will be on the export market. This will require suitable investments to enhance capability of R&D, product development centers and production plans for exports.

Exhibit 38 – Phased approach to encourage manufacturing of xEV four wheelers



6.2.9. As far as the other vehicle segments (two wheelers, buses, three wheelers LCVs etc) are concerned; a similar approach with three phases will be adopted. The focus of phase one from year 1 to 4 will be on local assembly with investments being made for R&D and product development. During phase 2, from year 5 to 7, it is envisaged that the efforts will involve developing indigenized products with the level of indigenization reaching 60% for 2W and LCVs and 25-30% for buses. The focus of R&D and product development will be to develop indigenized components such as BMS, transmission system, electric motors. During this phase, in order to promote local components, the customs duty exemption will be completely phased out. During the last phase, i.e. from year 7 to 10, the emphasis will be on locally developing technologies for India and exports. The phase wise approach for these vehicle segments is summarized in **Table 22** on the next page.

Table 22 – Phase wise approach for promoting xEV manufacturing in India

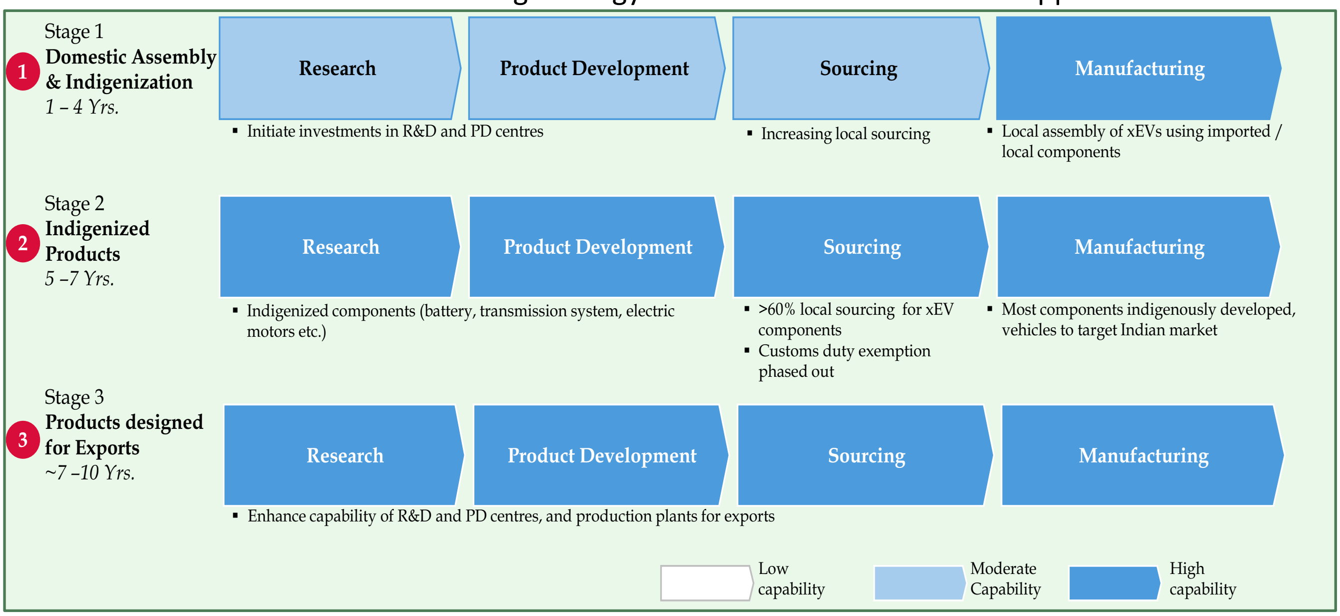
Phase & duration	Two/three Wheelers	Buses	LCVs
First Phase (Yr 1 - 4)	The local assembly of xEVs using imported or locally manufactured components can be fully strengthened. Direct and indirect incentives to increase local sources along with investments in R&D and product development will help this segment mature.	The focus will be on developing capabilities in local assembly of xEVs using imported or locally manufactured components. Investments in R&D and product development will be initiated to build capabilities in indigenized components.	Develop capabilities in local assembly of xEVs using imported or locally manufactured components. Investments in R&D and Product Development will be initiated as well.
Second Phase (Yr 5 -7)	The industry is likely to develop indigenized products and have high capabilities across the value chain. Research and product development focus will be placed on indigenized components including battery, transmission system, electric motor etc. Moving down the value chain, the target should be to source >60% of the xEV components locally with the customs duty exemption being completely phased out. It is expected that most components will be indigenously manufactured with vehicles localized to suit the Indian market.	Having developed the local assembly of xEVs, the focus will be on developing indigenized components. R&D focus should aim to build indigenized components such as BMS, transmission system, electric motors. At least 25-30% xEV components should be locally sourced and the custom duty exemptions be completely phased out, to increase localization.	The focus will be on developing indigenized products. R&D will focus on indigenized components such as BMS, transmission system, electric motors. By this time, at least 60% xEV components should be locally sourced and the custom duty exemptions be phased out completely.

Phase & duration	Two/three Wheelers	Buses	LCVs
Third Phase (Yr 7 -10)	During this phase, the industry will need to enhance capabilities to be globally competitive and focus on exports.		
	This will involve enhancing capabilities of R&D, product development centers and production plants to supply in the Indian market as well as for exports.		
	Capabilities will need to be developed across the value chain with indigenously developed components, local manufacturing of battery cells and nearly 100% local sourcing.		

Note: The phased approach for spurring 3W manufacturing is identical to the other vehicle segments indicated above.

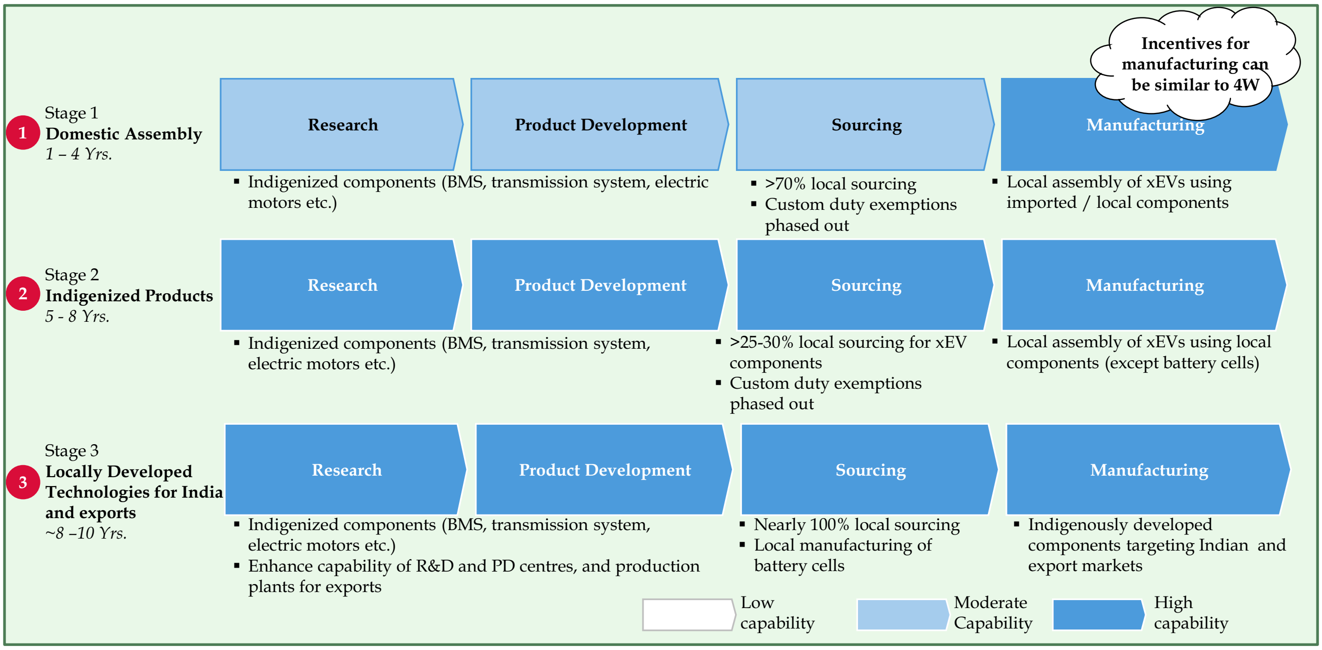
6.2.10. In addition, a host of other possible incentives for encouraging investments like tax holidays to OEMs and component manufacturers, possibility of green field xEV plants to be included and thereby qualify for the consequent benefits in the National Manufacturing and Investment Zones as proposed in the National Manufacturing Policy, duty exemption for capital equipment used by OEMs for xEV assembly, soft loans etc would also be explored to facilitate building of domestic capabilities. The phased approach for promoting manufacturing in various vehicle segments is depicted in **(Exhibits 39 to 41)**.

Exhibit 39 - Manufacturing strategy for two-wheeler OEMs and suppliers



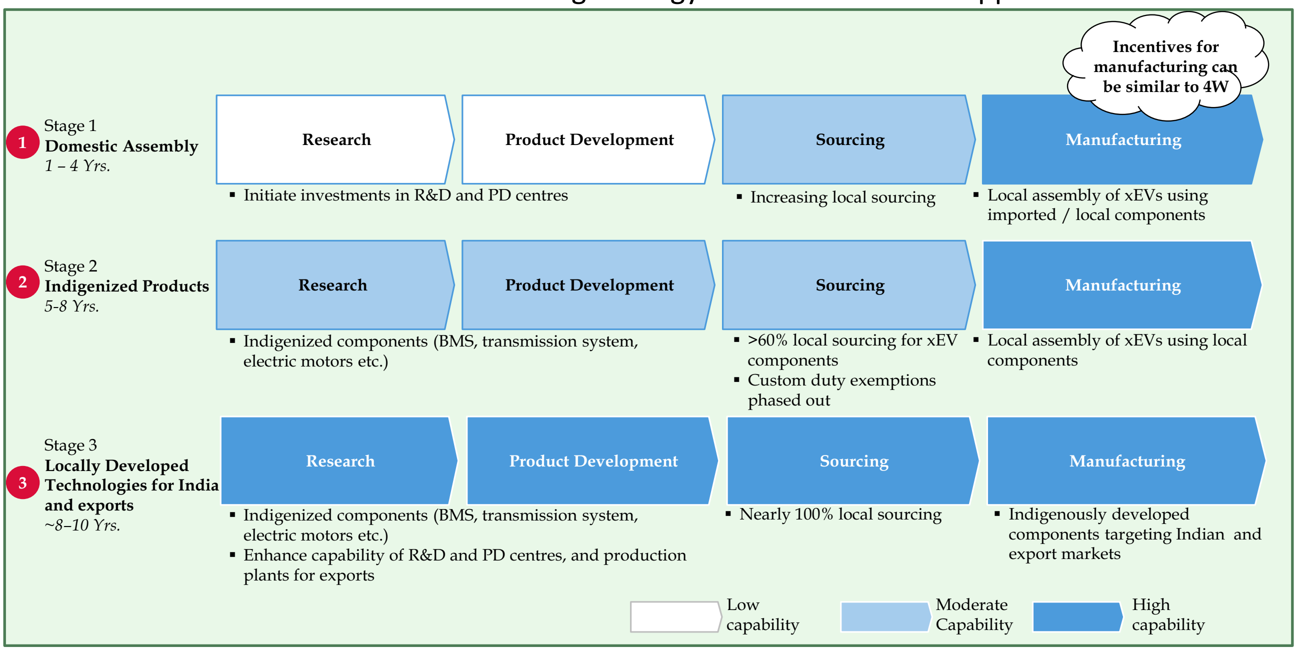
Source: GoI – Industry study.

Exhibit 40 - Manufacturing strategy for bus OEMs and suppliers



Source: GoI – Industry study.

Exhibit 41 - Manufacturing strategy for LCV OEMs and suppliers



Source: GoI – Industry study.

6.3. The way ahead.

6.3.1. The broad contours of the manufacturing strategy were agreed during the second meeting of the National Board for Electric Mobility. It was decided that the support provided by the Government for demand creation of xEVs will be linked with a firm commitment from the industry to make investments for phased increase in the degree of localization of xEVs as an essential eligibility criterion for demand generation support. This along with a fixed time frame window for the Government support for demand creation constitutes the two key elements of the demand creation strategy that will have a significant catalytic impact for creation of the xEV manufacturing ecosystem in the country. The NBEM also mandated that the specific micro issues and other possible investment incentives will be examined and recommended by the Working Group on Demand & Supply for consideration by the NBEM and NCEM.

6.3.2. The Working Group on Demand & Supply during their first meeting recommended that in addition to the manufacturing strategy as agreed by the NBEM, the following activities and initiatives indicated in **Table 23** below, that are aimed at enhancing the competitiveness and capabilities of the automotive component industry currently under consideration of the Department of Heavy industry, would be augmented and expedited. These would help strengthen the Indian auto component sector, especially the tier 3 & 4 level, that would also facilitate the capacity of the Indian auto component industry to take up local manufacture of the components related to electric mobility.

Table 23 – Activities and initiatives under consideration of DHI

Sr. No.	Activity
1.	ACMA – UNIDO capacity building program phase III.
2.	Creation of a modernization/automotive development fund.
3.	Skill development through the Automotive Skills Development Council.

6.3.3. In addition, other important issues like the mandatory registration of the small xEV two wheelers and development & enforcement of quality, homologation and safety standards and performance criterion for xEV components, both domestic and imported, would be taken up at the earliest with the Department of Road Transport for taking the lead. A number of studies, for further fine tuning and improving the strategy for spurring domestic manufacture of xEV components, will be taken up immediately. The areas of study along with the details of the lead agencies and members are indicated in **Table 24** below:

Table 24 – Studies to be undertaken.

Sr No.	Study Area	Agencies
1	Assessment of areas of xEV component manufacture where India can be globally competitive,	Lead agency: ACMA Gr members: NMCC, DHI, DIPP, other Industry associations
2.	Analysis of the various manufacturing incentives, their efficacy and the optimum incentive strategy for xEV component manufacture.	Lead agency: ACMA Gr members: NMCC, DHI, DIPP, other Industry associations
3.	Human resource gaps and competencies required to be created for supporting xEV manufacture and after sales support in the country.	Lead agency: SIAM Gr members: ASDC, NATRiP, DHI, NMCC, other Industry associations, NSDC

6.4. Implementation strategy, funding, review, monitoring & course correction mechanism.

6.4.1. The implementation of the various recommendations will be done by NAB in coordination with various nodal Ministries /Departments and agencies. The funding requirements wherever required will be made through augmentation of existing allocations or through allocations for new schemes as may be the case. The Working Group on Demand & Supply will be a permanent structure with representation from all stakeholders to support NATIS/NAB for proposing various schemes/initiatives, regularly reviewing & monitoring progress of various initiatives and decisions and for recommending course corrections, if required, for the consideration and decision of the NBEM and NCEM.

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NEMMP 2020

7. xEV INFRASTRUCTURE

Chapter 7

Chapter 7 – xEV Infrastructure

7.1. Introduction.

7.1.1. The limitations of current xEV batteries with regard to their energy storage capacity and the slow pace of charging significantly restricts the usage pattern of electric vehicles (EV, PHEV and range extended EVs) and the preparation time required for their use. Only HEV is autonomous as it depends only on the fossil fuel stored in its fuel tank. These limitations not only necessitate the need for widespread availability of public charging infrastructure but also facilities for fast and rapid charging. In view of the fact that “range anxiety” is one of the key concerns of the consumer, the greater adoption of pure electric vehicles is closely linked to development of the required public charging infrastructure.

7.1.2. The charging infrastructure broadly includes level 1 terminals, level 2 terminals (fast chargers) and level 3 terminals (rapid chargers). The typical time taken for charging by these chargers is 6-8 hours, 3-4 hours and less than 30 minutes respectively. These chargers also vary substantially in their costs; therefore, the charging terminals need to be created as per the requirement of the location. While level 1 charging terminals are appropriate at residences/office buildings/parking lots etc, the level 2 charging terminals are more suited for areas where vehicle is likely to be parked for shorter but substantial duration of time like commercial areas (shopping malls), Airport/ Railway stations and also some at parking lots. The rapid chargers are best suited to be located at convenient locations like petrol pumps etc. A mix of these public charging points needs to be established on a pilot basis to evaluate consumption pattern and the optimal type and location mix for the different charging terminals.

7.1.3. The extent of linkage between the availability of public xEV charging infrastructure and adoption of xEV varies between different vehicle segments, for different usage patterns (average vehicle kilometers travelled). For instance, electric two wheelers are less dependent on public recharging infrastructure for their off take as compared to electric four wheelers. Further, within the two wheeler segment; the consumers whose average vehicle mileage is lower are less impacted by the non availability of public recharging infrastructure, as they can recharge their vehicles at home just like their mobile telephones. In addition, the fleet operators like the state run intra-city bus services have a totally different and unique recharging infrastructure requirement for their electric bus fleet. It is therefore, necessary that the public charging infrastructure strategy and planning has to be unique to match the context in which it is being set. World over countries are investing heavily in setting up extensive recharging infrastructure.

Global trends

7.1.4. As infrastructural support is essential to develop a strong electric vehicle market, countries across the world are providing subsidies to strengthen the electric vehicle charging infrastructure. This includes support for charging stations and battery swapping stations. Some of the significant efforts made globally for setting up public charging infrastructure are as follows:

7.1.4.1. America has allocated around USD 400 million to set up 15,000 charging stations in 15 cities across the country, including cities like Chicago and Los Angeles. Joint ventures between OEMs, infrastructure developers and utility companies have been developed to deploy the xEV charging networks.

7.1.4.2. China is also following a public-private-partnership model for electric vehicle charging infrastructure deployment. The state utilities companies in China have been investing in charging infrastructure and have also set up Joint ventures with battery manufacturers for this purpose. China has allocated USD 4.4 billion for conducting pilot projects over the next 10 years and earmarked USD 5 billion for deployment of more than 500,000 public chargers.

7.1.4.3. In order to achieve the target of 2 million xEV vehicles by 2025, Japan has made significant investments in infrastructure development in addition to providing moderate R&D support and incentives. The Japanese Government has plans to set up 15,000 charging stations in Japan by 2015. Subsidy is being provided for the establishment of Clean Energy Vehicles refueling facilities. In addition, the government is also funding demonstration projects for low-pollution vehicles including car-sharing and station car. Japan is also collaborating with US and PPPs for Okinawa smart-grid pilot project. Moreover, there are collaborative experiments in the area of battery swapping, e.g. Better Place has started setting up battery swapping stations for electric taxis.

7.1.4.4. France has targeted a cumulative adoption of 2 million xEVs by 2020. In order to achieve this target the government is providing customer incentives and developing public charging infrastructure. Extensive plans for investments of approx USD 2 billion for establishment of a recharging network of 1 million charging points by 2015 have been chalked out. France is also following a PPP model for infrastructural development wherein the state utilities, OEMs and battery suppliers collaborate through joint ventures. Furthermore, there are also JVs between foreign electric companies and local investment firms.

7.1.5. At present, India faces a power deficit situation with demand for power outstripping generation. In addition, the amount of transmission and distribution losses are amongst the highest in the world, averaging 26% of total electricity production, with some States having losses as high as 62%. Two of the major problems facing the grid are poorly planned distribution network and frequent overloading of system components.

7.1.6. Further, as far as India is concerned, currently very little or no efforts have been made for roll out of public charging infrastructure for electric vehicles. More importantly, in order to overcome the existing scenario of power deficit, India faces the twin fundamental challenges of rapidly increasing the installed power generation capacity and significantly improving the power transmission and distribution network. It is therefore, essential to keep these facts in mind while deciding on the future strategy for electric vehicle charging infrastructure for the country.

7.2. Study findings for infrastructure requirements.

7.2.1. In view of the existing power generation and transmission scenario in India, an in-depth estimation of the additional power generation infrastructure requirements and the charging infrastructure that will be needed to support the level of penetration of xEVs being proposed by 2020 has been made in the joint Government – Industry study. In addition, consumer feedback on the issue of recharging infrastructure was also obtained in the study.

7.2.2. As per the extensive consumer survey carried out as a part of the Government – Industry study; the findings pertaining to consumer perception of xEV compared to a traditional ICE vehicle, the key barriers to xEV adoption and consumer sensitivity analysis relating to xEV charging infrastructure are summarized in **Table 25**. These findings are an important input for further developing the xEV charging infrastructure strategy for the country.

Table 25 - Key xEV charging infrastructure related findings from the consumer survey.

Vehicle Segment	Perception of xEV compared to ICE (Range)	Key Barriers for adoption	Sensitivity
Four Wheelers	xEV worse than ICE - **46%**	Range – **46% (4th)** Charging time – **41% (6th)** Charging infra – **31% (10th)**	For PHEVs – Acquisition price > recharge time in sensitivity analysis. **Inference:** Pilots can be conducted for public fast charging terminals to monitor adoption of xEVs before complete roll out.
Buses	xEV worse than ICE - **39%**	Charging time – **56% (3rd)** Charging infra – **45% (7th)** Range – **33% (4th)**	**Recharge time** is the 3rd most important parameters as per sensitivity analysis. **Inference:** Moderate sensitivity observed for recharge time for PHEV and BEV buses indicating the need to set up fast and rapid recharging stations.
Two Wheelers	BEV scooters worse than ICE - **46%** BEV bikes worse than ICE - **46%**	Range – **e-scooters - 46% (4th), e-bikes – (48%) (4th)** Charging time – **e-scooters - 46% (5th), e-bikes – 43% (5th)** Charging infra – **e-scooters - 30% (10th), e-bikes – 29% (10th)**	**Recharge time** and **range** are the 2nd and 4th most important parameters as per the sensitivity analysis. **Inference:** Typical changes to re-change time translates to significant variations in consumer preference for BEV bikes and scooters, while the consumers are relatively agnostic to changes in range of the vehicle.
Three Wheelers	xEV worse than ICE - **46%**	Range – **50% (4th)** Charging time – **50% (4th)** Charging infra – **42% (8th)**	**Recharge time** is the 3rd most important parameters as per sensitivity analysis.

Source: GoI– Industry study.

7.2.3. For supporting the xEV demand and supply capabilities, sustainable infrastructure is critical. As per the Government – Industry study, a vehicle segment wise assessment of the additional power required to meet the demand for electricity from xEV vehicles by 2020 and the investments needed for the additional power generation capacity and charging infrastructure has been made. As far as two wheelers are concerned, the size and battery capacity used in 2 wheelers is small. Hence BEV two wheelers can be charged at home and as such significant investments in public charging infrastructure will not be required. However, given their huge volumes, infrastructural support in terms of additional electricity generation would be required. It is estimated that an additional 600 MW power requirement would be needed to support the energy requirements for the electric two wheelers by 2020.

7.2.4. In case of the four wheeler segment, it is predicted that adequate charging facilities will be required to support xEV demand and uptake. It is estimated that by 2020, 150-225 MW of extra power generation capacity and investment of Rs 750-1000 crores for charging infrastructure may be required to support the 4W xEV potential (**Exhibit 42 & 43)**. In a scenario assuming high uptake of CNG and HEVs, 150MW of extra power generation may be required in 2020 assuming 20% peak charging. This translates to ~175,000 charging stations including fast chargers, level 1 chargers and rapid chargers involving an investment of Rs 750 crores. In the alternate scenario assuming high CNG, HEV and BEV uptake, the 2020 power requirement rises to ~225MW. The higher off-take of BEVs would necessitate ~227,000 charging stations to be established by 2020 involving investment of Rs 1000 crores.

Exhibit 42 - Infrastructure requirement for xEV four-wheelers

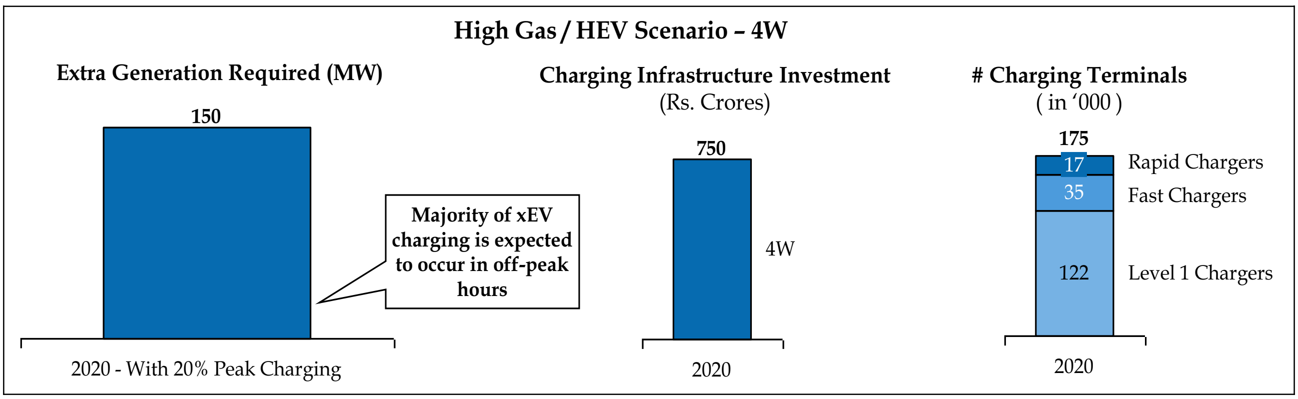
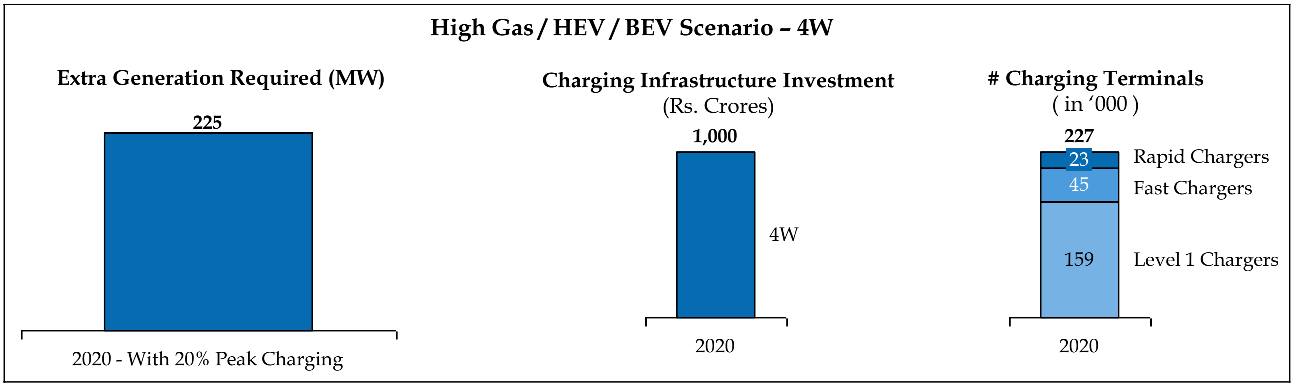


Exhibit 43 - Infrastructure requirement for xEV four-wheelers. (Part II)



Note: Price per charging station – Rs. 2,25,000 ($5,000) for fast charging (10% of stations), Rs 36,000 ($800) for level 2 charging (20% of stations), Rs.18,000 ($400) for level 1 charging (70% of stations). Charging station efficiency = 18 hours per day. Source: GoI–Industry study.

7.2.5. Based on the two off-take scenarios, an estimated 2-4 MW of extra power generation would be needed for meeting the requirement from xEV buses. The corresponding charging infrastructure would require an investment of Rs 10-20 crores to build 300-500 charging terminals (**Exhibit 44 & 45**). For xEV buses, the State Transport Undertakings (STUs) can establish charging stations at bus stands/Depots and at metro stations for feeder buses. Rapid charging points, which enable quick charging (5-10 minutes), can also be created at prominent bus stops to eliminate the need for large batteries. However, rapid recharging points cost five times the cost of Level-1 charging stations (~$22,000 per terminal), as such these may not be viable on a large scale. Pilot stage roll out will be required to work out the economics of the recharging infrastructure for buses.

Exhibit 44 - Infrastructure requirement for High Gas / HEV scenario for buses

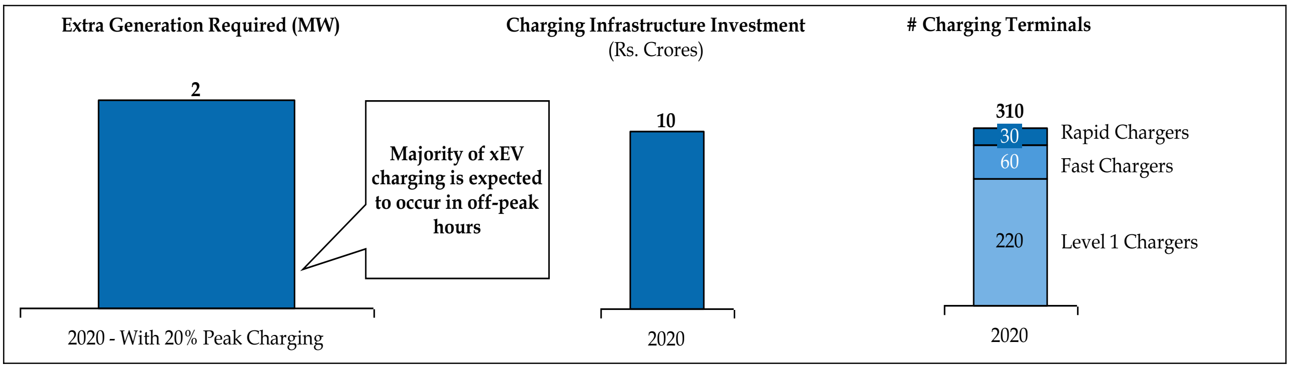
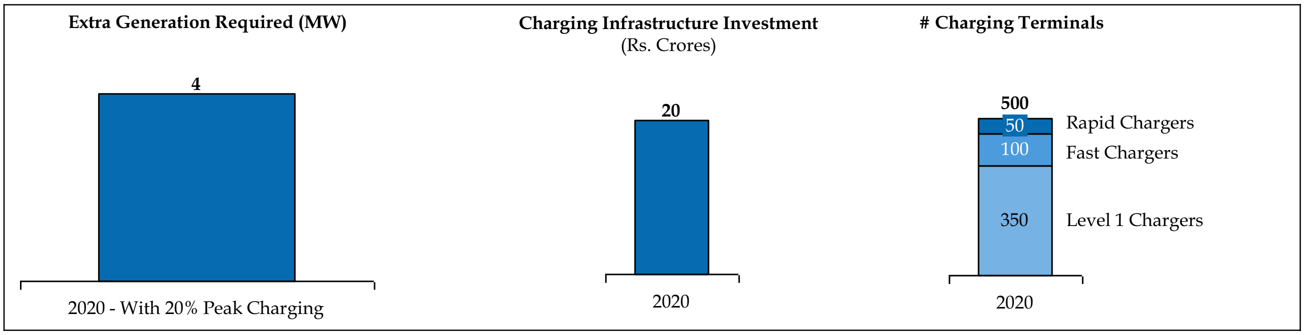


Exhibit 45– Infrastructure requirement for High Gas / HEV/BEV scenario for buses



Note: Price per charging station – Rs 10,00,000 ($22,000) for fast charging (10% of stations), Rs 4,50,000 ($10,000) for level 2 charging (20% of stations), Rs 2,00,000 ($4,400) for level 1 charging (70% of stations). Charging station efficiency -18 hours/day; majority of xEV charging is expected to occur in off-peak hours. Source: GoI– Industry study.

7.2.6. In order to support the battery charging requirements of the electric three wheelers, incremental 10-15 MW of electricity generation would be required, based on the two scenarios of HEV/ BEV penetration of 3 wheelers. This would entail investments of Rs 50-75 crore for charging infrastructure involving 11,000 – 18,000 charging terminals (**Exhibit 46 & 47**).

Exhibit 46 – Infrastructure requirements for High Gas/ HEV scenario for 3W

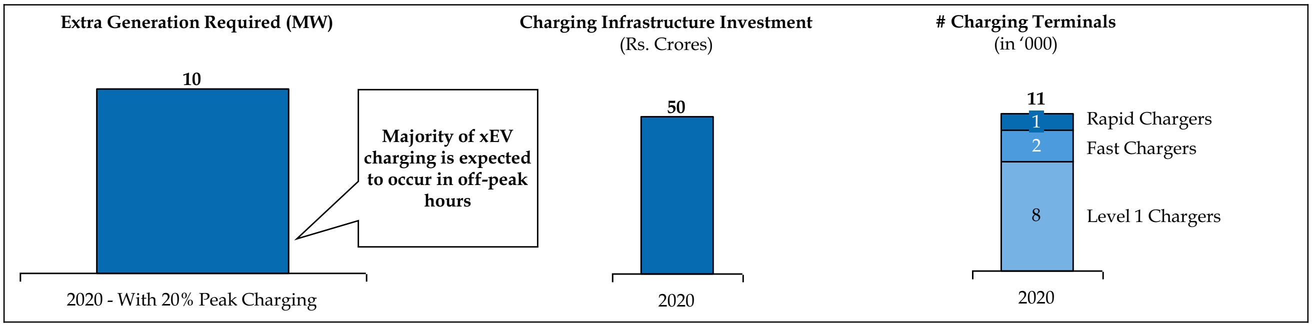
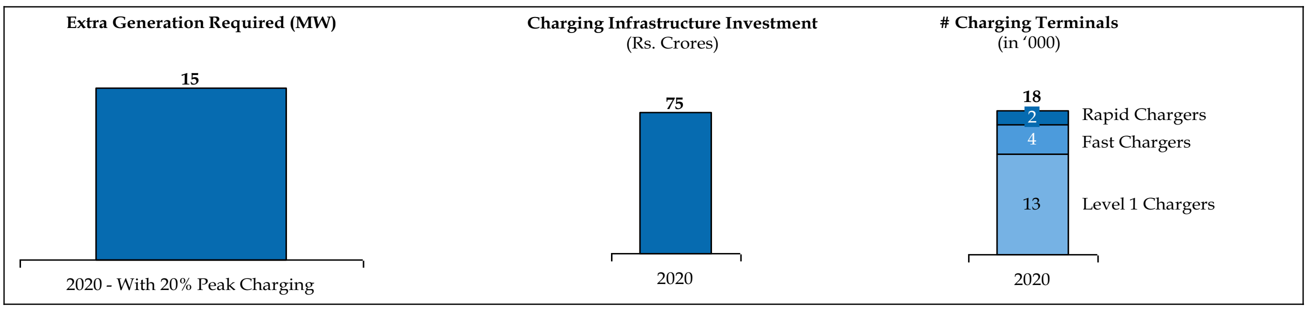


Exhibit 47 – Infrastructure requirements for High Gas/ HEV/BEV scenario for 3W



Note: Price per charging station – Rs 2,25,000 ($5,000) for fast charging (10% of stations), Rs 36,000 ($800) for level 2 charging (20% of stations), Rs 18,000 ($400) for level 1 charging (70% of stations). Charging station efficiency = 18 hours per day. Source: OEM Interviews, GoI– Industry study.

7.2.7. As far as the LCVs are concerned, in the High Gas/ HEV Scenario, an additional 10 MW of power generation capacity will be required. For this penetration level, it is estimated that 18,000 charging terminals would be needed at an investment of Rs 75 crores (**Exhibit 48**). In the High gas/ HEV/ BEV scenario for LCVs, it is estimated that 20 MW of additional power generation will be required with charging infrastructure investment of Rs 120 crores comprising of 27,000 charging terminals (**Exhibit 49**).

Exhibit 48 – Infrastructure requirements for High Gas/HEV scenario for LCVs

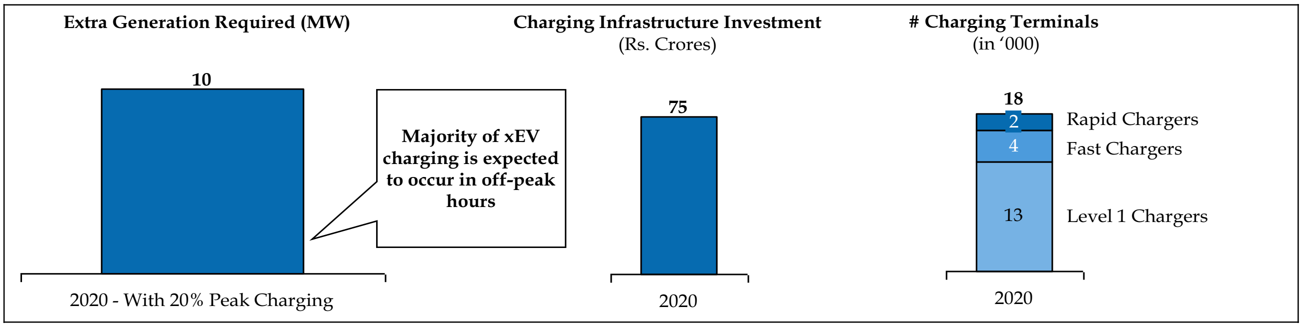
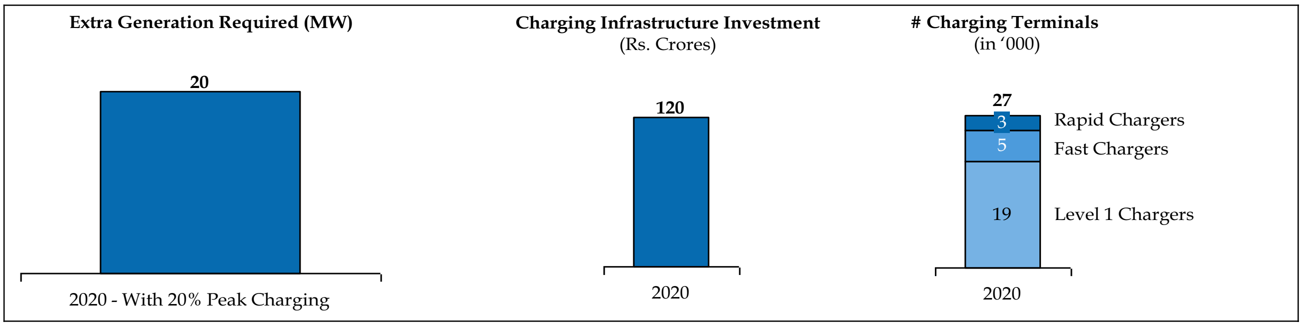


Exhibit 49 – Infrastructure requirements for High Gas/HEV/BEV scenario for LCVs



Note: Price per charging station – Rs 2,25,000 ($5,000) for fast charging (10% of stations), Rs 36,000 ($800) for level 2 charging (20% of stations), Rs 18,000 ($400) for level 1 charging (70% of stations). Charging station efficiency = 18 hours per day. Source: OEM Interviews, GoI– Industry study.

7.2.8. The projections of the Government – Industry study gives a good estimate that can be used for framing the broad strategy and in the initial take off stage of the program. However, as these estimates are indicative, for specific programs and projects, additional inputs from detailed infrastructure studies will also be required to supplement these findings.

7.3. xEV charging infrastructure strategy.

7.3.1. The Government – Industry study indicates that **(i)** moderate investments in xEV charging infrastructure would be required by 2020 to achieve the potential for xEVs in India. **(ii)** The requirement of additional power generation capacity in India to support the projected electric vehicle penetration levels is not expected to be very high. As per KPTCL, it is estimated that for 1 million BEV cars with ~10-20 kWh battery size, the additional power requirement will be about 1 GW generation, which over the total installed base is not very high. As per the Government – Industry study, it is expected that less than 1 GW of extra power generation capacity would be required[7] in order to achieve the xEV potential for India by 2020.

Pilot projects

7.3.2. The xEV charging infrastructure can be a self sustaining viable business opportunity, if adequately facilitated by the Government. As such, most of the investments in charging infrastructure can be made by the private sector provided the initial investments for pilot projects and setting up of the required framework is done by the Government. It is therefore, recommended that the Government investments in the charging infrastructure should be restricted to the initial off take period including the pilot programs to evaluate the level of impact of public charging stations (e.g., parking stations, malls etc.) on xEV adoption and for working out the commercial viability of charging stations so that these can then be developed as a viable business models to be adopted for full roll out. Similarly, in case of buses also, these investments should be made in pilot programs first, before rolling out on a larger scale.

xEV infrastructure lead time

7.3.3. Given the current status of xEV charging infrastructure in the country and the likely levels of infrastructure investment required, need to initially undertake pilot projects, lead time required for setting up infrastructure and the likelihood for amendments/modifications in building byelaws and other laws by various Governments (central, state and local); there is likely to be a significant gestation time before adequate electric vehicle public charging infrastructure can be rolled out.

[7] *Assuming 20% of electric vehicles charge during peak power load periods*

Way forward

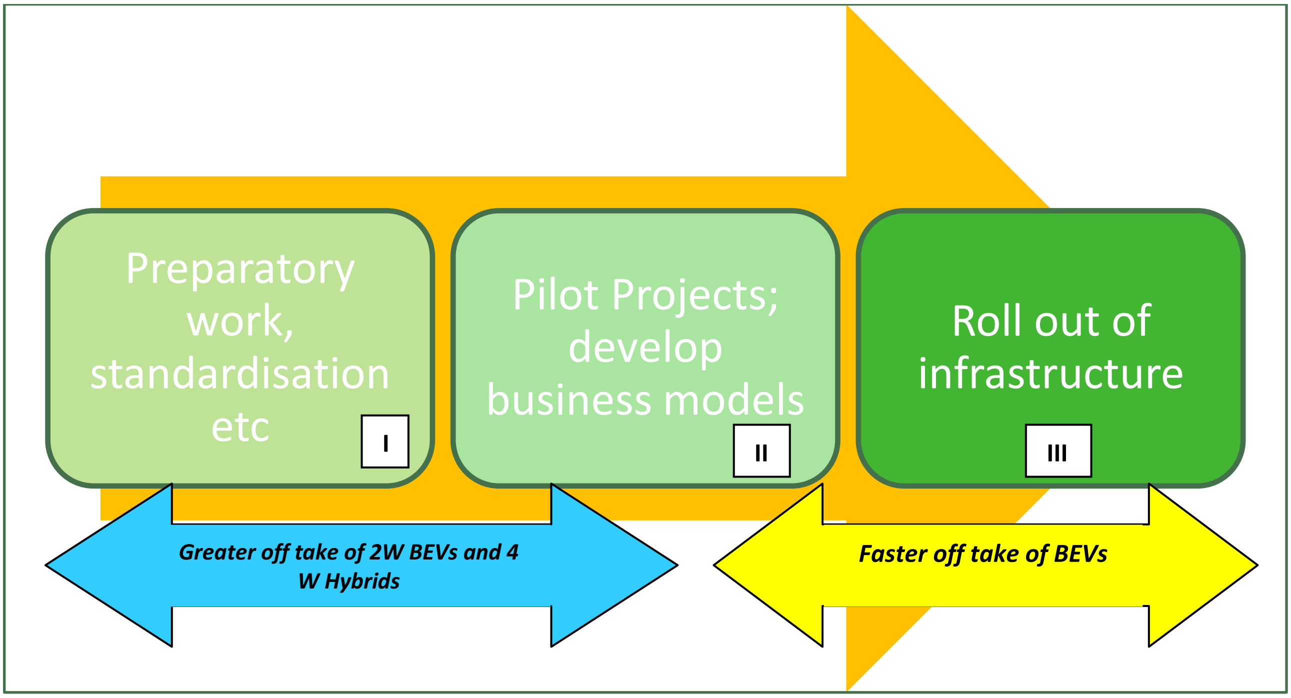
7.3.4. An effective way to get around this bottleneck without impacting the fast adoption of xEVs, especially the short run, will be to propagate faster initial adoption of electric vehicles for limited range usages and greater adoption of technologies (hybrids, PHEVs) that have lower dependence on charging infrastructure. The intervening time can be used to gradually roll out the infrastructure after which the scope of electrification of mobility can be expanded. During this phase, various aspects of an effective recharging infrastructure strategy will need to be examined, evaluated and essential requirements identified, planned and put in place.

7.3.5. Besides ensuring availability of reliable, regular electricity supply and adequate xEV charging infrastructure; the Government will need to ensure standardization of batteries and recharging related components, as this is an essential ingredient for a successful roll out of recharging infrastructure. A comprehensive public xEV charging infrastructure will require greater participation of the power utilities and oil marketing companies along with the battery suppliers and vehicle manufacturers. In addition, the role of Government would also be critical in helping to develop innovative energy delivery models for xEVs. This is quite important, as these can help decouple the battery costs from the upfront vehicle purchase cost which could enable EVs to be sold at more competitive prices thereby resulting in higher sales.

Phased roll out

7.3.6. Based on the above strategy, a phased roll out of the xEV charging infrastructure is proposed to be adopted. This is depicted in **(Exhibit 50)** on the next page.

Exhibit 50 – Strategy for xEV infrastructure



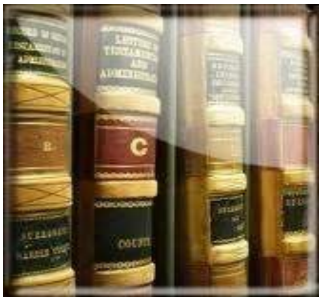
Phase I

7.3.7. The strategy of xEV infrastructure roll out involves a three phased approach. The Phase I (first year) – or the initial preparatory phase will involve achieving immediate to short term objectives. This will entail greater detailed and in-depth evaluation of various options, prioritization and putting in place the required framework, enabling policies, charging infrastructure standards, laws and undertaking detailed studies that will facilitate the roll out of the optimum xEV infrastructure. The various activities to be taken up immediately include:

7.3.7.1. Introduction of standards for vehicle to grid interface, components, batteries and other charging infrastructure. This is essential not only for ensuring minimal quality and safety standards but also to enable early achievement of economies of scale for different components. This activity can either be spearheaded by the CMVR/DRT process or through BIS. Efforts for standardization will also include assessment of the testing infrastructure requirements, identification of testing and certifying agencies and putting the testing infrastructure in place.

7.3.7.2. Evaluation of various strategies followed worldwide that includes assessment of the efficacy in the Indian context of providing subsidies for charging equipment, streamlining the charging installation permitting process, etc for possible adoption in India.

7.3.7.3. Assessment of the changes to the legal framework required for facilitating xEV infrastructure roll out: For day time recharging, public recharging infrastructure at petrol pumps, office locations, shopping centers, parking lots, mass transport terminals, streets, etc. will be required. Furthermore, modification to the electricity act will also be needed for allowing charging stations to sell power. This will necessitate enabling legislation, modification to the relevant laws and also perhaps legal mandates for private charging infrastructure. Currently, a number of countries have passed such laws mandating recharging infrastructure, in fact most recently San Francisco Building Authority has mandated recharging points in all new and refurbished buildings. Therefore, an assessment of the modifications required in the legal framework will need to be made.



7.3.7.4. Carrying out studies for the impact assessment of xEV charging on the micro grids and possibility of using xEV to power /stabilize the grid and act as an energy storage medium in remote areas powered by renewable energy.

7.3.7.5. Assessment of the various possible incentives for setting up of recharging infrastructure that may include tax breaks, grants, soft loans etc.

7.3.7.6. Evaluation of various strategies/models that can be used for designing optimal recharging infrastructure and also to decouple the cost of batteries from the purchase of EVs: The cost of batteries and setting up of public charging infrastructure are amongst the most important limiting factors that needs to be resolved for greater off take of electric vehicles globally. It is estimated that the average cost of the Li-ion battery would need to be at USD 300-400 per KW hour from the present USD 500 per KW hour to for pure economics of EV to be near par with ICE vehicles. Some studies indicate that the breakeven point between EVs and ICE vehicles, on a “Life cycle cost of ownership” basis, without any subsidies may be reached by 2017. The various activities that can be undertaken in this regard include:

7.3.7.6.1. Assessment of the optimal battery capacity or range required through scientifically analyzing and understanding the consumer behavior and vehicle usage pattern for all the different segments in different settings.

7.3.7.6.2. Preliminary evaluation of possible new innovative energy delivery business models like battery leasing, battery swapping etc that take out the cost of battery from the acquisition cost of the electric vehicle/ hybrid vehicle or help reduce battery ownership costs for xEV consumers. For instance, the battery swap model can potentially also be designed in such a way so as to recover both electricity cost as well as battery capital cost through the battery swapping charges on an incremental basis.

7.3.7.6.3. In addition, other innovative electric charging business models, e.g. smart metering and grid powering from batteries will also need to be examined and developed. Even for home recharging oriented system, the cost of batteries could be bundled into the daily cost of recharging thereby allowing consumers to pay for the batteries over longer period of time.

7.3.7.6.4. Li ion batteries that can no longer be used for automobile application still retain as much as 80% of storage capacity. This makes these batteries attractive for alternate use like storage of energy generated from renewable sources (wind, solar etc) and also for meeting power backup needs in case of power failure. Therefore, such batteries can return significant value to the original user. A viable business model for this can be easily built up. In addition, after the second use, once the battery finally reaches its end of life, recycling processes and infrastructure needs to be built to derive maximum economic value and also mitigate environmental impact. In fact if targeted properly, India with its traditional advantages of lower labor costs can perhaps suit this industry well to even serve the end of life and recycling requirements of other countries.

7.3.7.7. Design of pilot projects and finalizing the DPR and outcomes of the projects.

Phase II

7.3.8. The second phase involving medium term objectives/activities (Phase II – Year 1 - 3): The activities in the medium time frame would build on the initial basic work done and include deeper impact assessment studies & programs, pilot projects, xEV infrastructure consortium building activities, development of possible business models, etc. The indicative list of possible activities that need to be taken up during this phase includes the following:

7.3.8.1. The finalisation of the guidelines and specifications for mandating charging infrastructure requirement for new constructions. This may initially be started with Government and public buildings/infrastructure and then expanded to cover commercial and residential buildings subsequently. This activity will also involve carrying out modifications to the existing legal framework and also for making the necessary new laws, where these do not exist, to facilitate roll out of xEV infrastructure.

7.3.8.2. Roll out of xEV charging infrastructure on a pilot project mode in various cities with optimal number and mix of different type of chargers arrived at through the insights gained from studies on consumer behavior and vehicle usage pattern in various cities for different vehicle segments. An assessment of the project outcomes will be undertaken. This will allow the associated business/economic models to be tested and if necessary for their recalibration, so that these can then be used during the full roll out of the xEV charging infrastructure.

7.3.8.3. Testing of the various possible strategies/models for designing optimal recharging infrastructure and for decoupling the cost of batteries from the purchase of EVs. This will include detailed evaluation of various possible business models like battery leasing, battery swapping, grid powering, etc. for their feasibility of use and enabling structures required.

7.3.8.4. Developing the infrastructure and business models for reuse and recycling of Li ion batteries.

7.3.8.5. Developing strong linkages between the electric mobility initiative with the national renewable energy generation efforts: In case the energy generation is not clean and transmission losses remain high, the environmental benefits of shifting to electric mobility cannot be fully realized, therefore, in order to get the full environmental benefits of electric mobility, quality of power generation as also the efficiency of power transmission and distribution needs to be addressed in a holistic manner. In addition, in the long run to make BEV/PHEVs even more effective; batteries in BEVs/PHEVs can also be used for storage of energy and also for load balancing of the grid i.e. feeding electricity back to the grid when the BEVs/PHEVs are not in use. Therefore, electric mobility and renewable energy generation can potentially strongly complement each other. As such the efforts on mobility side will have to be adequately married with strong linkages with renewable energy generation e.g. solar recharging of BEVs/PHEVs, wind recharging of BEVs/PHEVs, biogas based recharging of BEVs/PHEVs etc.

Consortium approach

7.3.8.6. Exploring the feasibility of consortiums for providing energy solutions for xEVs: The setting up of the xEV charging infrastructure needs to be kept in the private domain or through PPP model as viable business models. The role of the Government needs to be restricted to facilitating, monitoring and oversight activities. There is very strong possibility of synergies in providing the energy supply solution for xEVs by the oil sector, power utilities and renewable energy generation companies. For these companies, this activity would constitute forward linkages with strong possibility of good business models. For power utility companies and oil marketing companies, this model can be linked to the existing network that they have. For the renewable energy generation companies, this would also provide opportunities especially in remote area recharging locations etc. At the same time recharging business would also be equally attractive for the battery manufactures for which this will mean good forward linkages. A consortium approach between the oil marketing companies, power utilities, renewable energy generating companies, battery manufactures, automobile companies and finance companies needs to be explored and facilitated for recharging infrastructure.

7.3.9. Final phase involving medium to long term objectives (Phase III – 3rd Year to 2020): The medium to long term objectives will include **(a)** Ensuring availability of reliable and regular electricity supply, **(b)** Making available adequate recharging facilities with convenient access, **(c)** Development of EV charging as a viable business entity, **(d)** Well established and synergic linkage between xEV charging infrastructure with renewable energy generation infrastructure, **(e)** Development of public recharging infrastructure that includes opportunities for rapid recharging through either setting up of optimal number of fast recharging centers or by use of batteries swapping stations that allows quick replacement of discharged battery packs with charged ones.

Phase III

7.3.10. The roll out of the xEV charging infrastructure, interventions and the various schemes will be done through NAB in partnership with the concerned infrastructure Ministries/Departments. Accordingly, the Ministry of Urban Development, Ministry of Road Transport & Highways and Ministry of Power will be actively involved along with the other stakeholder Central Government Ministries, State Governments/ Union Territories, Local Governments, the automotive industry, Power & Oil marketing companies and the testing agencies. The Working Group on Infrastructure (WG-Infra) which has been constituted will be a permanent body with representation from all the stakeholders for developing key interventions and making recommendations for the consideration of the NBEM/NCEM. In addition, WG-Infra will also assist NATIS/NAB in monitoring the progress of the roll out of xEV charging infrastructure interventions along with related issues and recommend course corrections, if required, for the consideration of the NBEM/NCEM.

7.4. Resource requirements and funding.

Investments

7.4.1. In terms of the assessment made by the joint Government-Industry study, the amount of total investments needed for setting up the required infrastructure up to 2020 (both power and charging infrastructure), vehicle segment wise, is summarised in **Table 26** on the next page**.** From this, it can be seen that the major portion of the investment required towards infrastructure development is slated to be for the setting up of the additional power generation capacity to meet the demand from projected population of electric vehicles by 2020. Significant investments for new power generation capacities are already being made by the PSUs and private sector. It is therefore, expected that the additional new capacities required to meet xEV demand will also come from normal investments for capacity augmentation by the private sector and PSUs. Government support will be required for electric vehicle charging infrastructure only in the initial stages during the phase when pilot project roll out and business model development takes place. Subsequently, the investments for recharging infrastructure are also expected to come from the private sector as viable business ventures.

Table 26 – Assessment of the segment wise investments required for xEV infrastructure.

Area	4W		2W	3W		Buses		LCV		Total	
	HG/ HEV	HG/ HEV/BEV	HG/ HEV	HG/ HEV	HG/ HEV/ BEV	HG/ HEV	HG/ HEV/ BEV	HG/ HEV	HG/HEV/BEV	HG/ HEV	HG/ HEV/ BEV
Additional Generation Capacity **(MW)**	150 – 225		600	10 - 15		< 5		10 – 20		775 – 865	
Power Infrastructure **(Rs Cr)**	700-800	1200-1300	3300 - 3400	40-50	75-85	5-10	20-30	55-65	90-100	4100 - 4325	4685 - 4915
Charging Infrastructure **(Rs Cr)**	700-800	950-1000	-	40-50	70-80	5-10	10-20	70-80	115 - 125	815 - 940	1145-1225

Source: GoI. – Industry study.

7.4.2. As in the case of funding of the demand generation measures, it is proposed that the Government funding for the initial pilot projects, studies etc will be taken up through NAB in partnership with the existing mechanisms and agencies currently undertaking this. Therefore, the partner Ministries/ Departments will integrate these additional financial resource requirements in their planning and budgeting exercise.

Given the integrated – one platform approach being followed through the setting up of the NCEM/NBEM, this should not pose a major problem. However, since during the inter-ministerial consultations at the time of seeking Cabinet approval, some Ministries had also suggested the creation of a specific fund for various projects; schemes etc to be taken up under this initiative. This aspect will also be examined and taken up with Planning Commission and Finance Ministry, if required.

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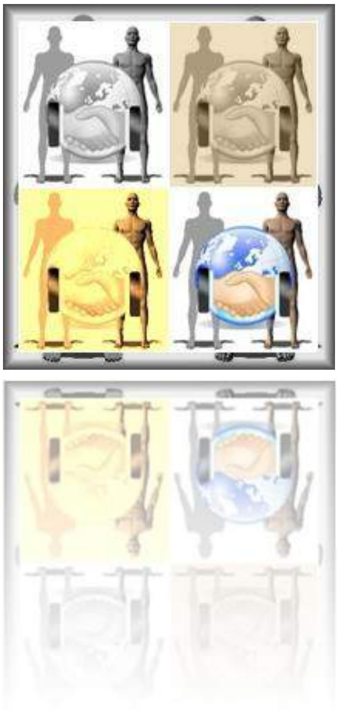
NEMMP 2020

8. THE ELECTRIC MOBILITY MISSION PLAN 2020

Chapter 8

Chapter 8 –The Electric Mobility Mission Plan 2020

8.1. Introduction "Electric mobility an investment for the future".



8.1.1. In order to achieve the potential demand of xEVs for 2020, all stakeholders of the plan will need to work in unison and harmony. A number of interventions criss-crossing various broad areas of consumer acceptability, technology development, setting up of the manufacturing eco system and xEV infrastructure will be required to be taken up involving large number of stakeholders representing various arms of the Government, automotive testing and R&D organizations and a much wider spectrum of industry. The shift towards electric mobility will also involve significant issues relating to "change management" for all the stakeholders including the consumers, most of whom are not familiar with these products. For industry, this shift represents technologies, products, business models, competitive landscape and competencies that are completely new that need to be developed in their supply chain, employees and channel partners. The Government will have to assume the role of a collaborator, facilitator, adopt new concepts and have a much faster & flexible decision making

High level growth of the Indian economy and the transportation sector is inevitable and also essential for improving the lives of millions of Indians. However, the consequence of this will be significant increase in fossil fuel imports and impact on the environment. It is therefore, essential that we invest today in areas and interventions that can help mitigate these future challenges. Encouraging the faster adoption of xEVs and their manufacture in India is a wise investment for our future generations.

Shri Praful Patel, Hon'ble Minister (HI&PE)

approach in its working. As such, the outcomes of NMEM will also depend upon how successfully the consumers, industry and the Government are able to manage this “change” as it impacts them.

8.1.2. As indicated earlier also, the role of the Government will be critical in supporting the creation of demand and acceptability of xEVs, spurring collaborative R&D efforts and enabling the required infrastructure to take shape. For this purpose, the xEV demand generation scheme is planned to be more robust both in terms of size and duration so that it meets the twin objective of bridging the existing gap in acquisition price of xEV in comparison to the normal ICE vehicle and for creating the manufacturing ecosystem for these technologies to become viable. Along with demand incentives, Government support for R&D and electric vehicle infrastructure will facilitate creation of affordable xEV solutions which can meet consumer expectations. This is essential for realizing the potential demand for these vehicles by 2020 which will translate to huge savings in liquid fuel consumption and emissions. The Government-Industry study indicates that these savings will be large enough to result in significant positive Net Present Values (NPV) for all vehicle segments. As such the financial resources committed by the Government for this initiative are investments for the future.

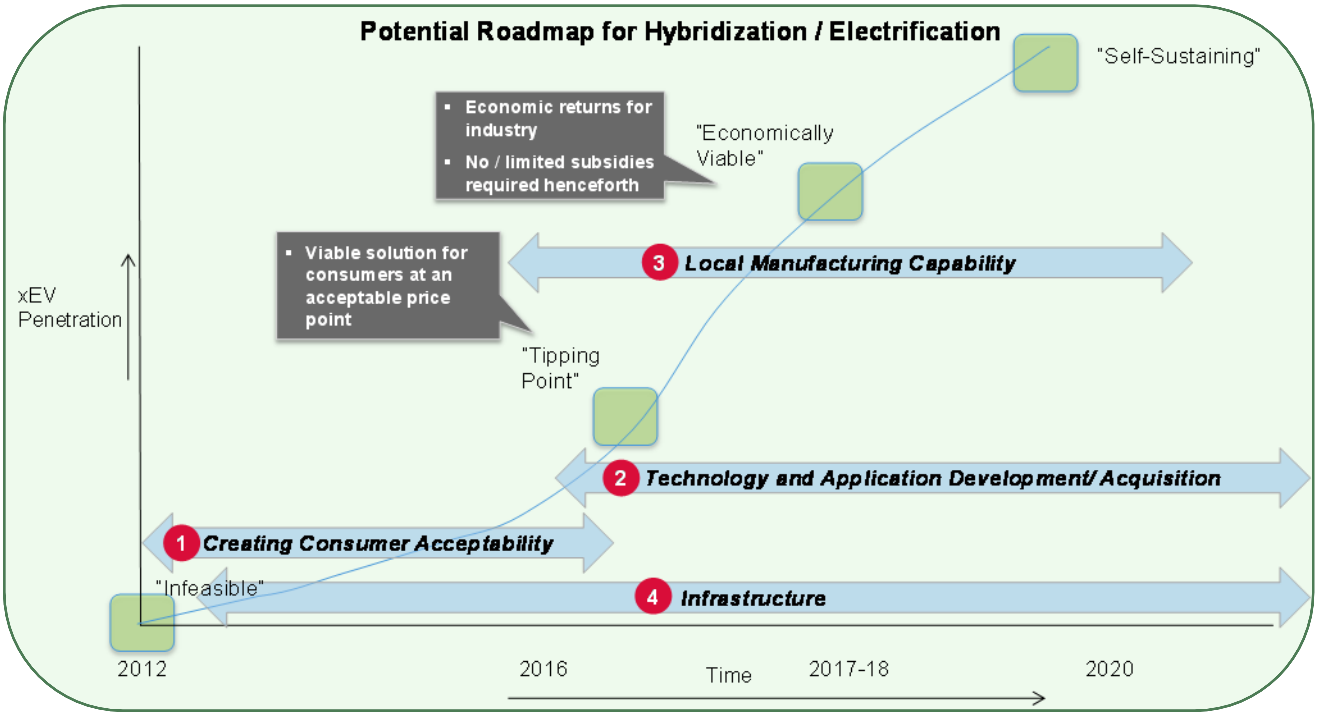
8.2. Roadmap for the plan.

8.2.1. The approval of the Government to take up this initiative on mission mode approach through the NMEM is a strong signal for the firm commitment and high priority accorded to this initiative by it. The setting up of the NCEM and NBEM has put in place the enabling single high level platform representing all stakeholders for deciding and taking up of the various activities under this mission. The continued apex level support from Government and industry leaders will be vital for the various stakeholders to manage the changing paradigms better. In this backdrop, the NEMMP 2020 is intended to provide the single common roadmap, priorities and end objective targets for all the stakeholders. This enabling structure will also provide the strong framework for rolling out the multitude of interventions, schemes,

policies and projects under this mission. The roadmap for the NMEM is depicted as **(Exhibit 51)** below

8.2.2. The National Mission for Electric Mobility roadmap captured in the NEMMP 2020 document entails starting with creation of consumer acceptability and development of infrastructure for these solutions. In addition, the xEV technology will need to be developed/ acquired to promote localization. These efforts are expected to lead to development of viable solutions in the market for consumers at acceptable price points. The Govt. support for initial xEV demand creation, infrastructure and R&D efforts is expected to encourage OEMs to make the required investments for local manufacturing. This will make the xEV market economically viable beyond which incentives shall not be needed. The creation of the local manufacturing eco-system will be boosted through the firm localization commitments that will be kept as pre-conditions for manufactures to qualify for the demand incentives.

Exhibit 51 – The potential roadmap for hybridization/electrification.



Source: GoI– Industry study.

8.2.3. Further, up front efforts are also required to put in place the necessary standards, test procedures and testing infrastructure in the initial phase itself as this is the essential starting requirement for developing the industry and generating a viable mechanism for providing incentives. It will be essential for all the stakeholders, particularly the Government and the industry to support this long term roadmap in order for the xEV potential to be realized.

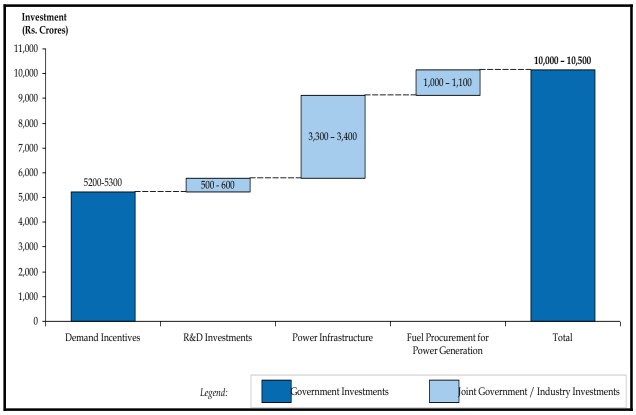
8.3. Broad investment implications.

Investment

8.3.1. As per the estimates of the Government – Industry study, the total investments on the four broad areas of intervention, for both the industry and Government, required for achieving the xEV potential by 2020, will be in the range of Rs 20,200 crores to Rs 21,100 crores for the HG/HEV scenario and Rs 22,400 crores to 23,300 crores for the HG/HEV/BEV scenario. The total level of investment varies with the type of scenario and the HG/HEV/BEV scenario with higher penetration of pure electric vehicles will necessitate larger investments. The HG/HEV i.e. the High gas/ High Hybrid vehicles scenario has hybrids and pure electric sales penetration of 10-15% and 2% respectively. The High gas/High Hybrid and High pure electric i.e. HG/HEV/BEV scenario assumes the hybrids and pure electric sales penetration levels of 10-15% and 5% respectively.

8.3.2. The total investments required for the largest vehicle segment i.e. two wheelers is expected to be in the range of Rs.10000 - 10500 crores over the next eight years. Given the impetus required to create an initial demand and achieve sufficient scale for self-sustainability, nearly 50% of the investment is towards demand-side incentives. Although R&D and product development investments constitute a smaller fraction (~5%), they are fundamental to the long term success. Remaining ~45% needs to be dedicated to developing the power infrastructure and financing the fuel costs. This is depicted in **(Exhibit 52)** on the next page.

Exhibit 52 – Total investment required for supporting the electric 2W



Source: GoI– Industry study.

8.3.3. For other vehicle segments, the total investment required will be approx. Rs 7000-Rs 9000 crores, Rs 1100 – 1300 crores and Rs 1400 – 1800 crores for the 4W, bus and LCV segments respectively.

8.3.4. The majority of investments by the Government will be mainly for demand creation i.e. Rs 12,250 to Rs 13,850 crores. The Research and Development investments of Rs 1500-1800 crores will involve Government support to the extent of Rs 980 crores and includes the setting up of the testing and R&D infrastructure. The balance requirements will be met by the industry. As far as the infrastructure related investments are concerned, it is expected that most of these will come from the industry and the Government will need to invest manly during the initial pilot project stage for the charging infrastructure. The summary of the various interventions suggested in the study for different areas relating to demand generation, research & development, infrastructure, etc along with the approximate range of corresponding investments required during the next eight years for different segments of vehicles is summarized in **Table 27.** The corresponding level of investments required for the different vehicles segments is given in **Table 28**.

Table 27 - Total investment proposed for the next 8 years (Rs in Crores)

Area	***4W***		***2W***	***3W***		***Buses***		***LCV***		***Total***	
	HG/ HEV	***HG/HEV /BEV***	***HG/ HEV***	***HG/ HEV***	***HG/HE V/BEV***	***HG/ HEV***	***HG/HE V/BEV***	***HG/ HEV***	***HG/HE V/BEV***	***HG/ HEV***	***HG/HEV /BEV***
Demand Incentives	*4900-5000*	*5600-5700*	*5200-5300*	*400-450*	*700-750*	*500-550*	*500-550*	*1250 - 1300*	*1500 - 1550*	*12,250-12,600*	*13,500 -13,850*
R&D Investment	*500-600*	*500-600*	*500-600*	*-*	*-*	*500-600*	*500-600*	*-*	*-*	*1500-1800*	*1500-1800*
Power Infrastructure	*700-800*	*1200-1300*	*3300-3400*	*40-50*	*75-85*	*5-10*	*20-30*	*55-65*	*90-100*	*4100-4325*	*4685-4915*
Charging Infrastructure	*700-800*	*950-1000*		*40-50*	*70-80*	*5-10*	*10-20*	*70-80*	*115-125*	*815-940*	*1145-1225*

Area	4W		2W	3W		Buses		LCV		Total	
	HG/ HEV	HG/HEV /BEV	HG/ HEV	HG/ HEV	HG/HE V/BEV	HG/ HEV	HG/HE V/BEV	HG/ HEV	HG/HE V/BEV	HG/ HEV	HG/HEV /BEV
Total*	7200-7300	8700-8800	10000-10500	500-600	800-900	1100-1200	1200-1300	1400-1500	1700-1800	20200-21100	22400-23300

** Includes amounts for fuel procurement for power generation (approx. figures). These are indicative estimates.*

Source: GoI– Industry study.

Govt. Funded

Govt. & Ind. Funded

Table 28 – Vehicle segment wise investments.

Sr. No.	Segment	Investments required
1	Four wheelers	Rs 7000 – Rs 9000 Crores,
2	Two Wheelers	Rs 10,000 – Rs 10,500 Crores,
3	Buses	Rs 1,100 – Rs 1,300 Crores.
4	Light Commercial Vehicles	Rs 1,400 – Rs 1,800 Crores.
5	Three Wheelers*	Rs 500 – Rs 900 Crores.
6	Total	Rs 20,000 – Rs 23, 500 Crores.

* *These are indicative estimates.* Additional studies indicate that the investment levels for xEV three wheelers may be larger in order to support higher performance vehicles (range, speed, load capacity). *Source: GoI– Industry study.*

8.4. Assessment of the likely benefits of the initiative.

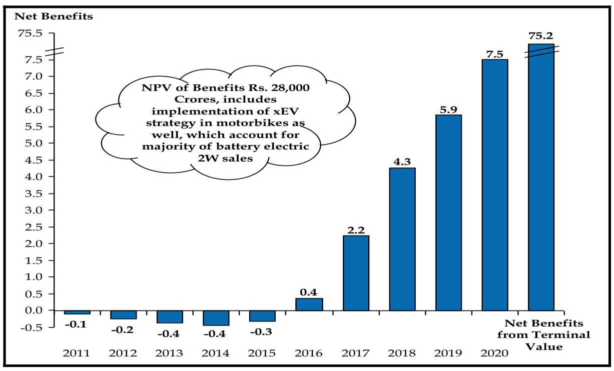
8.4.1. Greater adoption of full range of electric vehicles, as one of the key interventions by the Government, for ensuring future energy security for the country and the manufacturing of electric vehicles in the country are the two prime end objectives for the NMEM. It is expected that by achieving the targeted sale penetration levels for xEVs by 2020, the electric mobility initiative is likely to not only result in significant savings in liquid fuel consumption thereby lowering the petroleum import bill but will also result in mitigation of impact of mobility on the environment. There are likely to be significant reductions in emissions and also net decrease in CO_2 emissions on a "well to wheel" basis.

8.4.2. The support and direction from the Government is likely to facilitate a vibrant manufacturing eco-system for electric vehicles to be created in the country and the Indian automotive industry will be able to compete globally. This will ensure greater value addition in the country, spur manufacturing and generate significant additional employment. In 8-10 years from now, as OEMs in India develop capabilities, they can also consider exports to markets outside India. It is projected that through local manufacturing of xEVs, at least 60,000 – 65,000 additional jobs can be generated by 2020, over and above the jobs created by growth of manufacturing for conventional vehicles. In addition, 180,000 – 200,000 jobs are also likely to be created in new related services.

8.4.3. The growth of automotive manufacturing in the country is credited with introduction of large number of new concepts, efficient shop floor and management practices like Just in Time (JIT) etc which have benefited many other manufacturing sectors in India. The development of domestic manufacturing eco system for xEVs will also have a large cascading beneficial impact of larger domestic manufacturing. For instance, development of motors, batteries, controllers, etc. will definitely benefit many other segments and not only contribute to manufacturing growth in many other areas but also help contribute towards improvement in energy efficiency in those sectors. For example, there can be instant transfer of capabilities and many technologies for manufacture of more efficient and cheaper appliances that use motors. As such creation of the xEV domestic capabilities and supply chain will lead to much wider impact on growth of manufacturing sector and energy efficiency in the Indian economy.

8.4.4. As per the study, the uptake of ~ 4.8Mn BEV two-wheelers is estimated to result in fuel savings of 4.9MT till 2020. This will translates to net benefits with NPV of Rs. 28,000 crores from now to 2020. Further, decrease in transmission losses and technological improvements are likely to result in BEVs with emissions of only ~29g CO_2/km/vehicle in 2020. As such, in the aggressive off take scenario, adoption of two-wheeler BEVs can potentially reduce two-wheeler CO_2 emissions by ~3% in 2020. The year wise net benefits from adoption of electric two wheelers are given in **(Exhibit 53)**.

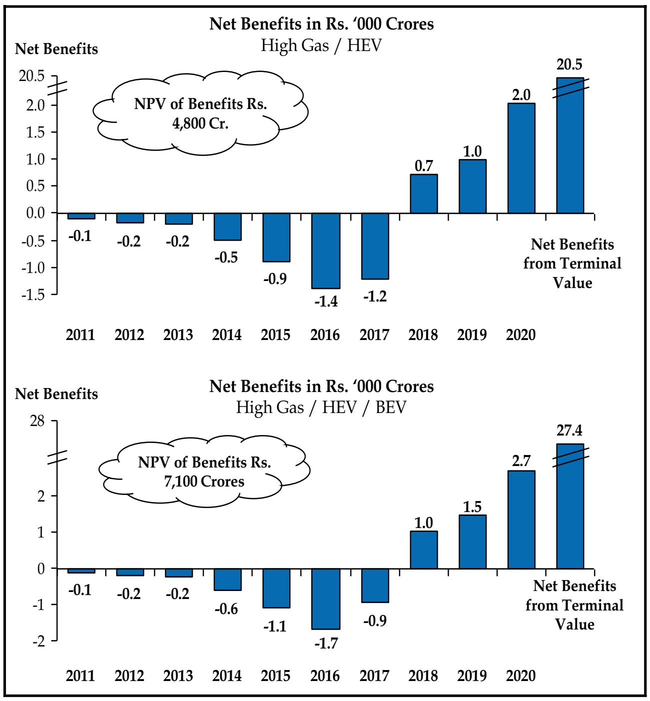
Exhibit 53 - Net Benefits from Adoption of xEV Two-Wheelers (in Rs 000 crores)



Note: *Assumed terminal multiple: 10%. Hurdle rate for NPV calculation: 12%.* ***Source:*** *GoI– Industry study.*

8.4.5. For 4W, with evolution of technology, PHEVs and BEVs are expected to have ~35+% and ~45+% lower well-to-wheel emissions respectively as compared to contemporary gasoline engines in 2020. Cleaner electricity generation with improved fuel mix is expected to help lower CO_2 emissions further. Adoption of xEVs will help achieve liquid fuel savings in the range of ~1.1 MT – 1.6 MT till 2020. Cumulative net benefits are estimated to have NPV of ~Rs.4800- 7100 crores. While initial investments translate to negative returns in the near term, positive benefits are expected from 2018 onwards. This is depicted in **(Exhibit 54)**.

Exhibit 54 - Net benefits of xEV four-wheeler adoption (in Rs 000 crores)



***Note:** Terminal multiple of 10 is used. NPV calculation uses hurdle rate of 12%. **Source:** GoI – Industry study.*

8.4.6. The reductions in CO_2 emissions as a result of the projected shift to xEVs have been calculated using the well to wheel approach. As per this, the CO_2 emissions on account of emissions related to materials (production), electricity generation (well to tank), and fuel efficiency (tank to wheel) have all been considered. It is estimated that, for all vehicle segments, achieving the potential demand for xEVs by 2020 could help result in potential reduction of 1.3% - 1.5% in CO_2 emissions, compared to status quo scenario by 2020.

8.4.7. On the whole, it is estimated that in 2020, the total new vehicle sales of 6-7 million xEVs will result in total liquid fuel savings to the tune of 2.2 – 2.5 MT. The vehicle segment wise possible savings in the liquid fuels in 2020 is given in **Table 29**. The projected fuel savings is on account of higher penetration of xEVs only and does not include the possible liquid fuel savings due to the higher penetration of CNG vehicles. This level of fuel savings translates to savings of Rs 13,000 – 14,000 crore by 2020. The cumulative liquid fuel savings over the next 8 years are expected to be 7-8 MT.

The bulk of these fuel savings (>50%) would come from battery electric two wheelers. Four wheelers are also expected to account for 20–25% of these fuel savings, followed by buses, light commercial vehicles and three wheelers in decreasing order of fuel savings. The assumptions pertaining to penetration levels of xEV, future total vehicles sales, average distance travelled, fuel efficiency achieved etc used for arriving at the fuel saving scenario is summarized in **Table 30**.

Table 29 - Level of fuel savings in 2020

<table>
<tr><th>Segments</th><th>2W</th><th>4W</th><th>BUS</th><th>LCV</th><th>3W</th></tr>
<tr><td colspan="6">xEV Vehicle Sales in 2020 (‘000 units)</td></tr>
<tr><td>HEV / PHEV</td><td>-</td><td>1275</td><td>2</td><td>120</td><td>-</td></tr>
<tr><td>BEV</td><td>4800</td><td>170-320</td><td>0.3-0.7</td><td>30-50</td><td>20-30</td></tr>
<tr><td colspan="6">Fuel Savings due to xEVs in 2020 (Million Tonnes of Liquid Fuel)</td></tr>
<tr><td>Fuel Savings</td><td>1.4</td><td>0.4-0.65</td><td>0.16-0.19</td><td>0.09-0.16</td><td>0.06-0.09</td></tr>
</table>

Table 30– Major assumptions for calculating fuel savings

<table>
<tr><th colspan="2" rowspan="2"></th><th colspan="3">% Penetration (2020)</th><th colspan="2">Sales (Million)</th><th colspan="2">% Mileage improvement over ICE</th><th rowspan="2">Annual Mileage improvement</th></tr>
<tr><th>HEV</th><th>PHEV</th><th>BEV</th><th>2011</th><th>2020</th><th>HEV</th><th>PHEV</th></tr>
<tr><td rowspan="2">2W</td><td>High HEV</td><td colspan="2" rowspan="4">NA</td><td rowspan="2">15%</td><td rowspan="2">11.8</td><td rowspan="2">32</td><td rowspan="2">30%</td><td rowspan="2">40%</td><td rowspan="10">2%</td></tr>
<tr><td>High HEV/BEV</td></tr>
<tr><td rowspan="2">3W</td><td>High HEV</td><td>2%</td><td rowspan="2">0.5</td><td rowspan="2">1</td><td rowspan="2">25%</td><td rowspan="2">40%</td></tr>
<tr><td>High HEV/BEV</td><td>3%</td></tr>
<tr><td rowspan="2">4W</td><td>High HEV</td><td rowspan="4">11%</td><td rowspan="4">4%</td><td>2%</td><td rowspan="2">2.5</td><td rowspan="2">8.5</td><td rowspan="2">24%</td><td rowspan="2">65%</td></tr>
<tr><td>High HEV/BEV</td><td>4%</td></tr>
<tr><td rowspan="2">Bus</td><td>High HEV</td><td>2%</td><td rowspan="2">0.004</td><td rowspan="2">0.014</td><td rowspan="2">32%</td><td rowspan="2">40%</td></tr>
<tr><td>High HEV/BEV</td><td>5%</td></tr>
<tr><td rowspan="2">LCV</td><td>High HEV</td><td rowspan="2">8%</td><td rowspan="2">-</td><td>2%</td><td rowspan="2">0.3</td><td rowspan="2">1.5</td><td rowspan="2">20%</td><td rowspan="2">35%</td></tr>
<tr><td>High HEV/BEV</td><td>4%</td></tr>
</table>

Source: GoI– Industry study. Note; Assumptions for Fuel efficiency (FE) for ICE: 2W - 65kmpl, 3W -38 Kmpl, 4W – 12Kmpl (petrol), Premium Bus – 2.4 Kmpl, LCV – 18 Kmpl.

8.4.8. The potential savings associated in case latent demand for xEVs in 2020 is realized and is summarized in **Table 31**.

Table 31 – Summary of potential savings

	High Gas /HEV	**High Gas/ HEV/ BEV**
Annual Crude Oil Savings over status quo scenario	**~ Rs 13,000 Crores**	**~ Rs 14,000 Crores**
Reduction in CO2 emissions over status quo scenario	**~ 1.3 %**	**~ 1.5 %**

8.4.9. It is estimated that the total cumulative net benefits from xEV initiative would be in the range of Rs. 39,000 – 43,000 Crores. The vehicle segment wise cumulative benefits in terms of the cumulative fuel savings (up to 2020) and Net Benefits have been worked out and are summarized in **Table 32** below.

Table 32 – Vehicle segment wise savings

Vehicle Segment	**2 Wheelers**		**3 Wheelers**		**4 Wheelers**		**Bus**		**LCV**	
Scenario	**High HEV**	**High HEV/ BEV**	**High HEV**	**High HEV/ BEV**	**High HEV**	**High HEV/ BEV**	**High HEV**	**High HEV/ BEV**	**High HEV**	**High HEV/ BEV**
Cumulative liquid fuel savings in MT (up to 2020)	**4.9**		0.2	0.3	1.1	1.6	0.5	0.6	0.3	0.5
Net Benefits (NPV in Rs Crores)	**28,000**		1,200	1,700	4,800	7,100	3,300	3,700	1,500	2,700

Source: GoI– Industry study.

8.5. Segment wise cost – benefit analysis and ease of implementation.

8.5.1. In order to analyze the amenability of the off take of electric mobility technologies for the various vehicle segments would require an assessment of the ease of implementation of electric mobility for these vehicle segments, investments required to achieve the potential demand by 2020 and the likely benefits on achieving the demand potential. An analysis matrix summarizing the total investments required vehicle segment wise, level of likely fuel benefits by 2020, the ease of implementation, and the Net Present Value (NPV) of benefits (Net benefits) for each vehicle segment is given in **Table 33**.

8.5.2. As per this, it can be seen that the electric two wheelers have the highest potential demand by 2020, offer the maximum fuel savings (in case of the potential demand being achieved), and have the maximum net present value on the investments. As such, the two wheeler segment appears to be the most amenable to introduction of electric mobility technologies. In addition, as the Bus and the three wheeler segment cater to public transportation, their usage (average vehicle kilometers traveled) and passenger transported intensity is very high. As such the desirability of introduction of electric mobility solutions for these segments is also high.

Table 33 – Summary of cost – benefit analysis for different vehicle segments and ease of implementation.

Analysis		*Four Wheelers*	*Two Wheelers*	*Buses*	*Three Wheelers*	*LCVs*
Total Investments - next 8 years (Rs Crores)	HEV	7,200-7,300	10,000-10,500	1100-1200	500-600	1400-1500
	HEV/BEV	8,700-8,800		1200-1300	800-900	1700-1800
Fuel Benefits	*HG/HEV (fuel saving by 2020)*	*1.1 MT*	*4.9 MT by 2020*	*0.5 MT*	*0.2 MT*	*0.3 MT*
	HG/HEV/BEV (fuel saving by 2020)	*1.6 MT*		*0.6 MT*	*0.3 MT*	*0.5 MT*

Analysis		*Four Wheelers*	*Two Wheelers*	*Buses*	*Three Wheelers*	*LCVs*
Ease of Implementation	*CAPABILITIES*	*Low to Moderate*	*Moderate to High*	*Moderate*	*Moderate*	*Low*
	PRICE PERF. GAP	*Moderate to High*	*Low to Moderate*	*High*	*High*	*High*
	INVESTMENT	*Significant investments required by OEMs*	*High as volumes are high.*	*Moderate*	*Moderate*	*Moderate*
Total additional direct new jobs	*Numbers*	*26000-30000*	*22,000*	*1150-1200*	*1200*	*7200-8000*
NPV of benefits (Net Benefits)	**Rs Crores**	**4800-7100**	**28,000**	**3300 - 3700**	**1200-1700**	**1500-3000**

8.5.3. As a part of the Government – Industry study, inputs from consumers, OEMs and the Government were taken in terms of their preference for the various electric mobility technologies and the prioritization of different vehicle segments. As per the feedbacks from the OEMs; the vehicle segment preference ranking (indicating the perceived ease of adoption for xEVs) was buses, two wheelers, three wheelers and four wheelers. For different xEV technologies both the consumers and OEMs preferred the mild hybrid and hybrid technology solutions (other than for two wheelers). This is summarized in **(Exhibit 55)**. The preferred (higher adoption possibilities) technology and vehicle segments as per the analysis of the data summarized in **Table 30** has also been captured and incorporated in **(Exhibit 55)**. The most amenable cells for xEV adoption in the "vehicle segment – technology matrix", as per this data, is represented with **√√√** and **√√** & **√** indicates decreasing priority segments.

Exhibit 55 – xEV technology and vehicle segment prioritization.

Priority Segment	Two Wheelers	Four Wheelers	Three Wheelers	Buses	LCVs
Priority Technology	1* ②	3* ④	3* ③	2* ①	?
Mild Hybrid		√√		√√	√
Hybrid		√√		√√√	√√
Plug in Hybrid		√		√√	
Pure Electric	√√√	√√	√√		

OEM preference

Consumer preference

Source: GoI– Industry study. Note: * - ranking as per the study data.

Scope & coverage

8.5.4. As already highlighted in **Para 4.6.4.**, the NBEM during their second meeting decided that neither any specific vehicle segment nor any particular technology should be excluded from the scope of the NEMMP 2020. As such, as far as possible a technology agnostic approach coupled with market driven vehicle segment prioritization is proposed to be followed. It was also decided that based on these broad principles, the initial vehicle segment and technology priorities along with incentive criterion (Battery size etc) & incentive type would be worked out by WG on demand and proposed as a policy formulation to NBEM/NCEM for consideration and approval. In addition, the policy would include the provision for annual market based feedback, impact assessment and mechanism for review of the options so that continuous improvement and fine tuning can be undertaken for achieving mission objectives.

8.5.5. As such, the NMEM does not propose creation of any permanent linkage to any particular technology pathway. This is essential to allow India and the auto industry the flexibility to innovate and adopt the optimal and most promising solutions as they emerge in the market. This approach will also not restrict the industry to focus their efforts only on power train alone but also to explore and invest in other equally important areas like light weighting, lowering rolling resistance of tyres, alternate fuels, fuel cell technologies, etc. This approach recognises the fact that technological breakthroughs will continue to happen in the future and many of the technological solutions available today may not necessarily emerge as the solutions of choice in the long term. In this scenario, many of the technologies available today may just prove to be bridge technologies and not the end game.

8.6. E-mobility strategy.

8.6.1. In terms of the "in principle" agreement of the NBEM to the likely levels of allocation of Government support/ resources to the various areas of intervention; the relative importance of the different levers of Government policy and hence the e-mobility strategy for India is depicted in **Table 34**. As per this, the main focus will be on demand side incentives for creating consumer acceptability and hence higher off take of xEVs. This is must for creating the optimal level of demand that enables setting up of the xEV manufacturing eco-system in India within five years. This is an essential requirement to drive down the manufacturing costs over a period of time through economies of scale and localization benefits. This coupled with general lowering of costs through technological developments is intended to create a self sufficient and viable xEV vehicle industry segment in the country that does not depend upon Government support to bridge the acquisition gap between the xEVs and the traditional ICE vehicles. In addition, Government support for R&D and xEV infrastructure development, albeit at a lower quantum, will also be provided. As a result, it is expected that India will be able to realize the NEMMP 2020 targets and achieve significant road transportation related liquid fuel savings and environmental benefits.

Table 34 – The e-mobility strategy for India – a comparison.

Lever	US	China	Japan	France	India*
R&D	√√√	√√√	√√	√√	√
Supply Side	√√	√√√	√	√	√√**
Demand-side Incentives	√√√	√	√√	√√√	√√√
Infrastructure	√√	√√√	√√	√√√	√
HEV / PHEV / BEV Incentives	Incentives for HEVs phased out Incentives for PHEVs & BEVs based on battery size	Only road tax deduction for HEVs Max. subsidy for BEVs, lesser for PHEVs	Equal incentives for all xEV technologies	Incentives for HEVs < 50% compared to PHEVs / BEVs	Under consideration
Proposed Investment	**>$5 B**	**> $20 B**	**>$1.7 B**	**>$3.5 B**	**$ 2.7 -$ 3 B**

*Source: GoI– Industry study. Note: Investments indicated include investments already made and announced. Japan's investment is from 1998 to 2014. * Based on the study recommendations ** For supply side incentives; primarily deep linkages between demand incentives and firm commitments by OEMs to pre-agreed localization levels is envisaged. In addition, some incentives may also be considered. Exchange rate used: 1 USD =Rs 50.*

Government preferred option

OEM preferred option

8.6.2. The total likely investment for the initiative is in the range of Rs 20,200 to Rs 23,300 crores (USD 4-4.5 billon[8]). This includes the investments in R&D and xEV infrastructure that are likely to be made by the private sector. The level of total Government investment, taking into account both the scenarios (HEV and HEV/BEV) is expected to be in the range of Rs 13,500 to Rs 15,250 crores (USD 2.7–3.05 billion). **Table 34** also depicts the proposed level of investment in comparison to those made abroad and the different approaches adopted by various countries on the relative emphasis given to the various policy levers as a part of their e-mobility strategy. The preference to different policy levers as indicated by the responses received from the various Government and OEMs representatives during the Government – Industry study is also captured in **Table 34**. The level of investment for R&D is based on a detailed analysis of the existing eco-system and capabilities. It is expected that the level of R&D investments envisaged, which is considerably less than the demand creation incentives, will suffice the resource requirement for the efforts in R&D areas where India has a "right to win"

[8] *Note: Exchange rate used is 1USD = Rs 50.*

8.7. Linkages.

Create inter – program synergies and linkages

8.7.1. The Government of India has already taken a number of measures for shifting to sustainable development models through greater emphasis on renewable energy sources, cleaner environment and initiatives aimed at mitigating the adverse impact of economic growth on environment and climate change. This includes the National Transport Policy, Renewable Energy Generation Programs and the National Action Plan for Climate Change (NAPCC). The NAPCC includes eight National missions including the National Solar Mission (NSM), National Mission for Enhanced Energy Efficiency (NMEEE), National Mission on Sustainable Habitat (NMSH) and National Mission for Strategic Knowledge for Climate Change.

8.7.2. NAPCC is by far the most important overarching guiding policy for climate change mitigation strategies of the country. Since one of the most important outcomes of the NMEM is reduction in CO_2 emission from the transport sector,

NAPCC

ample care has been taken to ensure that the NMEM is fully aligned to the NAPCC. Some of the important principles adopted in the NAPCC that are relevant and have also been imbibed in the NEMMP 2020 include – "**(i)** Achieving national growth objectives through a qualitative change in direction that enhances ecological sustainability, leading to further mitigation of greenhouse gas emissions. **(ii)** Devising efficient and cost-effective strategies for end-use demand side management. **(iii)** Deploying appropriate technologies for both adaptation and mitigation of greenhouse gas emissions extensively as well as at an accelerated pace. **(iv)** Engineering new and innovative forms of market, regulatory and voluntary mechanisms to promote sustainable development. **(v)** Effective implementation of programs through unique linkages with civil society and local government institutions and through public – private partnerships."[9]

8.7.3. In view of the projected large potential reduction in CO_2 which is a key outcome of the NMEM, the inclusion of

[9] *Source: National Action Plan on Climate Change.*

NMEM as the ninth National Mission under the NAPCC will be explored for developing the required effective and strong linkage between the two efforts. The NAPCC already specifies that the various national missions will be institutionalized by the respective Ministries and will be organized through inter-sectoral groups which include in addition to the related Ministries, Ministry of Finance and Planning Commission, experts from industry and academia. This institutional framework/structure already exists for NMEM through the NCEM and NBEM.

8.7.4. In addition, better integration with other relevant missions that are already a part of the NAPCC will be done. These include:

NSM

8.7.4.1. The National Solar Mission (NSM) seeks to increase the solar energy generation in the country. 20,000 MW of electricity generation is targeted for 2020. As already detailed in **Chapter 7**, in order to achieve maximum benefits, the NMEM and NSM need to be synergized and renewable energy generation sources be linked to the off take of xEVs in the country.

NMSH

8.7.4.2. National Mission for Sustainable Habitat (NMSH) approved by the government seeks to promote sustainability of habitats through various measures including modal shift towards public transportation, improving access to goods and services through integrated urban planning and fuel conservation through fuel efficiency standards & shifting from fossil fuels to natural gas, renewable and alternate fuels including xEVs. As far as the transportation is concerned, the NMSH builds on the National Urban Transport Policy (NUTP) of 2006 released by the MoUD. The NUTP also lays emphasis on greater shift towards mass public transport solutions and non motorized modes. The expansion of Metro Rail Transportation Systems in Delhi and other cities and BRTS are part of this program. While these efforts (NMSH & NUTP) will definitely lead to lowering of the energy and CO_2 intensity of transportation sector, the extremely low penetration levels of personal vehicles (cars and scooters) in India, which are amongst the lowest globally, along with the inadequate public transportation solutions available is likely to result in continued high demand and off take of personal vehicles in the future. Therefore, a linkage between these initiatives is necessary and will be put in place.

8.7.4.3. National Mission for Enhanced Energy Efficiency (NMEEE) being implemented by the Ministry of Power (MoP) and Bureau of Energy Efficiency (BEE), as a part of NAPCC, lays emphasis on energy conservation and efficiency, particularly through Demand Side Management (DSM) and estimates that 15% energy saving is possible through these measures. The NMEEE recognizes that enhanced use of energy efficient products and technologies is often constraint by their higher first costs (acquisition costs) as compared to less efficient products and that the first cost bias needs to be overcome to initiate market transformation towards their preferential acquisition. NMEEE also proposes leveraging international financing instruments like the Clean Development Mechanism (CDM) for promoting energy efficient products. Since, there is significant similarity in the issues facing these two initiatives, the two missions need to be effectively linked so that efforts made under the NMEM can gain from the experience and learning of the NMEEE. This includes examining the possibility of replicating the various models and frameworks used in NMEEE to supplement their efforts to create energy efficiency market for the greater off take of xEVs. In addition, it also needs to be seen if the efforts through the NMEM can be structured in a manner that allow for CDM framework to be used for financial gains arising out of the carbon emission savings.

NMEEE

CEM

8.7.5. As a part of linking NMEM with the efforts of the country for cleaner energy, electric vehicles (mobility) has already been included as an area of engagement by India in the multi lateral Clean Energy Ministerial (CEM) discussions. The 4th round of meeting is being hosted by India in 2013.

8.7.6. Significant off take of xEVs will also lead to a large population of used batteries being generated. As such issues relating to recycling will need to be examined and optimal solutions integrated in the various schemes of the NMEM at the outset itself. This is not only to mitigate the possible "end of life" environmental impact, comply with the environmental laws but

Recycling

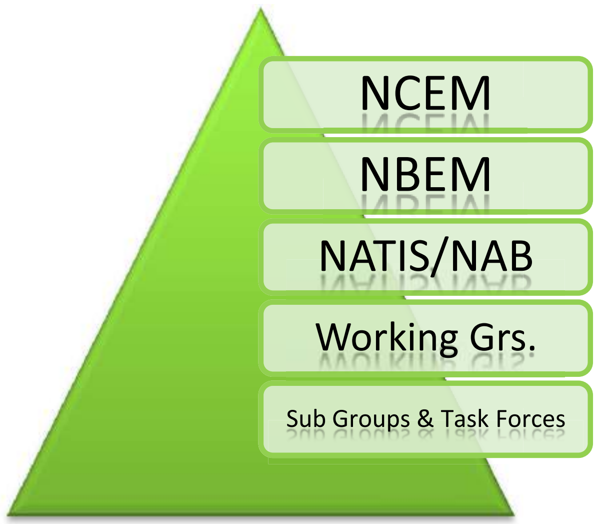
also to exploit this as a business opportunity to extract the maximum possible residual value of batteries and other components. The leveraging of the “End of life” value of such sub systems and assemblies will also allow lowering of the total cost of ownership of xEVs thereby positively impacting the upfront acquisition of these vehicles.

8.8. Implementation mechanism.

8.8.1. NEMMP 2020 will include a large number of interventions in the broad areas of demand support/creation, setting up of the manufacturing eco system (supply chain), Research and Development and xEV Infrastructure. The various policies, schemes, projects, etc are proposed to be designed by involving all stakeholders through the mechanism of the three Working groups (WGs) set up by the NBEM. Given the enormity and complexity of the task, constitution of various sub groups (SG) under the WGs is also implemented. All concerned Ministries, Industry representatives, R&D Centers and experts from the academia will be adequately represented on these WGs and their SGs.

8.8.2. The suggestions and formulations of the WGs will be examined by NATIS/NAB (once set up) and recommendations made to the NBEM and NCEM for consideration and approval. The functioning of various WGs and SGs will be coordinated by NATIS/NAB, which has been approved by the Government to be the technical advisor and secretariat for NBEM & NCEM. This structure (**Figure 10**) will also be used for monitoring and assessment of the outcomes of the various interventions.

Figure 10 – NEMMP 2020 Implementation structure



8.8.3. During the first meeting of the three working groups constituted by the NBEM to examine specific issues and to go into micro detailing for the development of the various interventions; a number of sub-groups have been constituted for the various specific critical areas. The immediate task before these bodies is to assess the ground realities in case of the various interventions and assess the resources required, suggest prioritization of these interventions, establish and put in place the various enabling guidelines, framework, policies and schemes that are essential for roll out and implementation of the NEMMP 2020. In addition three task forces in the area of R&D have been constituted and a number of studies to be commissioned. The list of the various sub-groups is given in **Table 35** below.

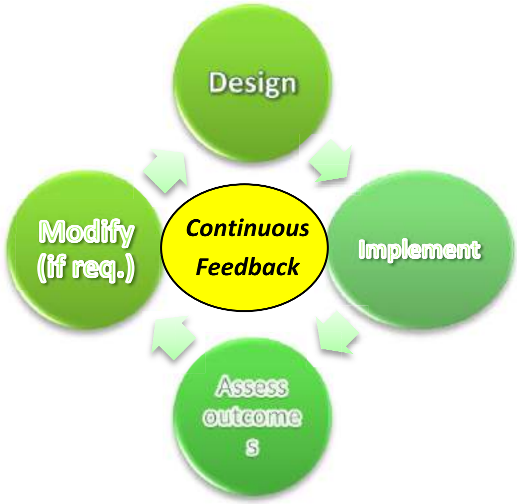
Table 35 – List of Sub Groups set up under the Working Groups

Sub-Groups under Working Group on R&D	
Sr. No	***Domain Area of Sub Group***
1	Sub Group on BMS & Battery
2	Sub Group on Power Electronics and Motors
3	Sub Group on testing infrastructure, human resources, energy efficiency technologies (light weighting etc.)
Sub-Group under Working Group on Infrastructure	
Sr. No.	***Doman Area of Sub Group***
1	Sub Group on technology and standards (SG-T&S)
2	Sub Group on infrastructure roll out (SG-IRO)
Sub-Group under Working Group on Demand & Supply Incentives	
Sr. No.	***Doman Area of Sub Group***
1	Core Group for finalizing the demand incentive scheme (CG-DI)
2	Sub Group on validation of level of demand incentives. (SG-VDI)
3	Sub Group on vehicle parameters & qualification criteria. (SG-VP&QC)
4	Sub Group on demand assurance policy. (SG-DAP)
5	Sub Group on incentive delivery and monitoring mechanism (SG-ID&MM)
6	Sub Group for promoting hybrid retro-fitment kits (SG-RFT)

8.8.4. In view of the fact that faster approval and decision making will be essential for successful roll out of the NEMMP 2020; various methodologies to enable this will be explored including greater empowerment of NBEM and NCEM and adoption of simpler processes.

8.8.5. The various schemes, projects, policies that are adopted as a part of the NMEM are planned to be designed to be adaptive and evolve/ improve dynamically through the design-implement-assessment feedback loop. That is, the various schemes, projects, policies etc will include provision for continuous periodical impact/outcome assessments through appropriate mechanisms including studies, assessment reports etc. The periodicity of the reviews will be decided depending upon the kind of intervention to be assessed. NATIS/NAB (once set up) will coordinate these efforts along with other stakeholders and lead agencies that are identified for different issues. The various working groups that have been set up will provide the necessary inputs for designing of the policies, programs etc. These inputs will be provided to NBEM and NCEM not only for periodical program assessment, cost – benefit analysis but also to incorporate the required modifications to the various programs, projects, schemes and policies that are being assessed.

Figure 11 - Dynamic system based on continuous feedback loop



8.8.6. The implementation of the various interventions that are approved by the NCEM will be taken up through the concerned nodal Ministries, existing agencies mandated for those activities and agencies approved by the Government along with the active involvement of all stakeholders. It will be ensured that new structures and agencies are used only where it is inescapable so that no replication takes place.

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NEMMP 2020

ANNEXURES

Annexures

Annexure I – Composition, roles, responsibilities & functions of NCEM.

Annexure II – Composition, roles, responsibilities & functions of NBEM.

Annexure III – Roles, responsibilities & functions of NAB.

Annexure IV – Composition of various working groups.

Annexure I

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Ministry of Heavy Industries and Public Enterprises
(Department of Heavy industry)

NOTIFICATION

New Delhi dated 27th May, 2011

1.(i) No. ______ In pursuance of the decision of the Cabinet in its meeting held on 31st March, 2011 for the launch of the "**National Mission for Electric Mobility"** and for setting up of National Council for Electric Mobility (NCEM) and National Board for Electric Mobility (NBEM) to propagate electric mobility and manufacture of electric vehicles (including hybrid vehicles) and their components, the Central Government hereby constitutes the "**National Council for Electric Mobility (NCEM)"** with the following members, namely:-

1)	Minister (Ministry of Heavy Industries & Public Enterprises)	Chairman
2)	Minister (Ministry of Power)	Member
3)	Minister (Ministry of New & Renewable Energy)	Member
4)	Minister (Ministry of Urban Development)	Member
5)	Minister (Ministry of Road Transport and Highways)	Member
6)	Minister (Ministry of Petroleum & Natural Gas)	Member
7)	Deputy Chairman, Planning Commission	Member
8)	Minister (Ministry of Science & Technology)	Member
9)	Minister of State (Ministry of Environment & Forests)	Member
10)	Minister of State (Finance)	Member
11)	Chairman, National Manufacturing Competitive Council	Member
12)	Principal Scientific Advisor to the Prime Minister	Member

Nominated Members:

Five members of eminence and expertise from the area of automobile industry, academia and research & development:-

13)	Mr. Anand Mahindra- Vice Chairman & MD, Mahindra & Mahindra Ltd.	Member
14)	Dr. Surinder Kapur - Chairman Sona Group of Industries Ltd.	Member
15)	Dr. V.K Saraswat - Secretary, Department of Defence Research and Development, DG, DRDO and Scientific Advisor to Defence Minister	Member
16)	Prof. V.S Ramamurthy, Director, National Institute of Advanced Studies, Bangalore	Member
17)	To be nominated later	Member
18)	Secretary, Department of Heavy Industry	**Member Secretary**

(ii) The Chairman, NCEM may also co-opt additional members including members from the state governments or union territories, as required, from time to time.

(iii) **Tenure of members:** The nominated members will have a tenure of two years on the council, or until further Government order, whichever is earlier. These members can be re-nominated for additional terms, if needed.

2. **Functions & powers of National Council on Electric Mobility**: The functions and powers of the Council would be as under:

a) To finalise and approve the short term and long term objectives of the mission program on electric mobility, its quantifiable outcomes and the milestones along with roles and responsibilities of the various stakeholders.
b) Consider and recommend/approve overall broad policy guidelines, required fund requirements and governance models and strategies for promoting electric mobility and for encouraging manufacture of electric vehicles in the country.
c) To approve the key interventions, projects and incentives required, prioritize these interventions, projects. Approve the nodal agency/ministry for its implementation and finalise the short term and long term road map for these interventions/projects.
d) To consider and recommend to the government any legislation, act or notification or amendment to an existing legislation, act or notification for promoting electric vehicles and their manufacturing in India.
e) To consider and recommend to the government the additional resources required for promoting EV and their manufacturing in India including finalizing the resource requirements for the five year plans.
f) To consider and approve projects and schemes to be taken up with the help of the state governments.
g) To synergize the efforts being made by various Ministries, industry, academia and research institutes.
h) To consider, approve funding of and monitor the various electric mobility related R&D projects and pilot projects.
i) To consider and approve mechanisms, collaboration, business models and possible government incentives/interventions in funding for technology acquisition, acquisition of technical expertise and for entering into agreements with leading R&D centres globally to facilitate availability of technology to the domestic industry.
j) To monitor, review the various projects, schemes and interventions and propose the mid-course corrections, additions and closure of parts and whole of any particular programme/scheme, if any.
k) The NCEM shall be the final authority to resolve the differences of opinion amongst various ministries, if any.
l) In the matters falling within the domain of State Governments/Local bodies and directly related to them, their views and concerns will also be taken into account.
m) Any other role that is assigned to it.

3. The National Council for Electric Mobility would meet periodically, to discharge the above functions. The NCEM will be assisted by the NBEM.

4. Presently, NATRiP Implementation Society (NATIS) and subsequently, National Automotive Board (proposed), after its formation, would function as technical advisor and secretariat of the NCEM and NBEM.

[File No. 12(89)/2009-AEI]

(Ambuj Sharma)
Joint Secretary to the Government of India

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Annexure II

To be published in Gazette of India (Extraordinary) Part I of Section 1

Ministry of Heavy Industries and Public Enterprises
(Department of Heavy industry)

NOTIFICATION

New Delhi dated 27th May, 2011

1.(i) No. ___ In pursuance of the decision of the Cabinet in its meeting held on 31st March, 2011 on launch of the **"National Mission for Electric Mobility"** and for setting up of National Council for Electric Mobility (NCEM) and National Board for Electric Mobility (NBEM) to propagate electric mobility and manufacture of electric vehicles (including hybrid vehicles) and their components, the Central Government hereby constitutes the **"National Board for Electric Mobility (NBEM)"** with the following members, namely:-

1)	Secretary (Department of Heavy Industry)	**Chairman**
2)	Secretary (Department of Economic Affairs)	Member
3)	Secretary (Department of Revenue)	Member
4)	Secretary (Ministry of Power)	Member
5)	Secretary (Ministry of Road Transport and Highways)	Member
6)	Secretary (Ministry of Urban Development)	Member
7)	Secretary (Ministry of New & Renewable Energy)	Member
8)	Secretary (Ministry of Environment & Forests)	Member
9)	Secretary (Department of Industrial Policy & Promotion)	Member
10)	Secretary (Ministry of Petroleum and Natural Gas)	Member
11)	Secretary (Ministry of Science & Technology)	Member
12)	Secretary, Planning Commission	Member
13)	Joint Secretary, National Manufacturing Competitive Council	Member
14)	CEO, NATRiP/Chairman, National Automotive Board (proposed)	Member
15)	President, Society for Indian Automobile Manufactures (SIAM)	Member
16)	President, Automobile Component Manufacturers Association of India (ACMA)	Member
17)	President, Society of Manufacturers of Electric Vehicle (SMEV)	Member
18)	President, Battery Manufacturers Association	Member

Nominated Members:

Six members of eminence and expertise from the area of automobile industry, academia and research & development:-

19)	Mr. Vikram Shreekant Kirloskar, Chairman & Managing Director, Kirlokar Systems Limited	Member
20)	Mr. Chetan Maini, Chief of Technology & Strategy Officer and Deputy Chairman, Mahindra REVA Electric Vehicle Company Limited	Member
21)	Mr. Mukesh Bhandari, Chairman & CTO, Electrotherm Ltd.	Member
22)	Dr. Arun Jaura, Vice- President of Technology, India Engineering Centre – Eaton Corporation	Member

23) Prof. H. P Khincha, Professor, Electrical Engineering Department, Indian Institute of Science, Bangalore — Member

24) To be nominated later — Member

25) Joint Secretary (in-charge automobile division) — **Member Secretary**

(ii) The NBEM may also co-opt additional members including members from state governments or union territories as required, from time to time.

(iii) Tenure of the members: The nominated members will have a tenure of two years on the Board or until further Government orders, whichever is earlier. These members can be re-nominated for additional terms, if needed.

2. **Functions & powers of National Board on Electric Mobility:** The main functions and powers of the Board shall include:

a) To examine, formulate and propose the short term &long term plan and contours of the mission program on electric mobility, its objectives, quantifiable outcomes and roles and responsibilities of the various stakeholders.

b) To propose and recommend policy guidelines and government interventions and possible strategies for promoting electric mobility and for encouraging manufacture of electric vehicles in-the country.

c) To analyse and propose the key interventions, incentives and projects required, propose the prioritizations of the interventions and recommend the nodal agency/ministry for its implementation and propose the short term and long term road map for these interventions/projects.

d) To examine and propose to the National Council the introduction of any legislation, act or notification or amendment to an existing legislation, act or notification for promoting electric vehicles and their manufacturing in India.

e) To evaluate and recommend to the NCEM the projects, schemes, studies, interventions and initiatives for the 12th five year plan and the fund requirements for the same.

f) To expedite the standardization of electric vehicle charging systems and charging infrastructure.

g) To hold regular deliberations to ensure synergy amongst the efforts of the various stakeholder Ministries, industry, academia and research institutes. Coordinate and resolve bottlenecks, if any.

h) To formulate strategies and give directions to various ministries and other stakeholders for implementing the decisions of the NCEM.

i) To ensure and report compliance of action for the various decisions taken by NCEM.

j) To Coordinate and resolve differences of opinion amongst various ministries, if any.

k) To examine, recommend and monitor and review electric mobility related R&D projects and pilot projects.

l) To evaluate and propose various mechanisms and possible business models for popularizing electric mobility.

m) To explore and recommend possible collaborations and tie ups for technology acquisition, obtaining technical experts and exploring possible agreements with leading R&D centres globally to facilitate availability of technology to the domestic industry.

n) To monitor, review and report the progress of various projects, schemes and interventions and also suggest mid course corrections, if any, to the NCEM. Recommend the additions, modifications and closure of parts and whole of any particular programme/scheme, if any.

o) The Board may as deem fit also constitute Sub-Committees for looking into the various specific aspects.
p) Any other role that is assigned to it.

3. The National Board for Electric Mobility (NBEM) would meet periodically, to discharge the above functions and shall assist the NCEM.

4. Presently, NATRiP Implementation Society (NATIS) and subsequently, National Automotive Board (Proposed), after its formation, would function as technical advisor and secretariat of the NBEM.

[File No. 12(89)/2009-AEI]

(Ambuj Sharma)
Joint Secretary to the Government of India

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Annexure III

Role, responsibilities and functions of NATIS/NAB.

The proposed roles, responsibilities and functions of NATIS/NAB are enumerated below:

a) NATIS/NAB shall be the repository of technical, domain expertise and data on all aspects of EV and their manufacturing and shall be the technical advisor and secretariat for both the Council and Board

b) To provide the expert advice to the National Board for the formulation, of the overall short term and long term plan of the program, its objectives, and quantifiable outcomes.

c) To evaluate and appraise the various project proposals, possible interventions, incentives, possible government policies, schemes, etc for promoting electric mobility and for encouraging manufacture of electric vehicles in the country. Make recommendations and give expert advise to the National Board and the Council in this regard;

d) Prepare recommend pilot feasibility studies and detailed project reports on various initiatives for the consideration of the National Board and the Council.

e) Select and appoint consultants, experts, implementation agencies for various projects/pilot schemes to be undertaken.

f) To coordinate with various agencies, industry and academia for collaborative R&D initiatives in various selected research and development projects. These projects will be jointly carried out with the help of various testing centres which have these existing facilities, academicians and Deptt. of Science & Technology.

g) To optimally utilize the available facilities of its centres, liaison and enter into collaborations with other R&D centers, labs in India and aboard for implementing the approved R&D projects and studies for EVs.

h) To evaluate and advice the Board and the Council on the various possible new business models for popularizing electric mobility and EV manufacturing in India.

i) To monitor and report the progress of implementation of various projects and schemes from time to time and suggest corrective action if required.

j) To assist in any other way i.e. required for smooth functioning of National Board and the Council.

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Annexure IV

Composition of the Working Groups on Demand & Supply, Research & Development and Infrastructure

<table>
<tr><th>Demand & Supply</th><th>R&D</th><th>Infrastructure</th></tr>
<tr>
<td>

Government:
DHI,
MoF (DoR, DoE)
Planning Commission, DIPP
MNRE, DRT, NMCC
Industry:
SIAM, ACMA, SMEV
Shri Chetan Maini (Mahindra Reva), Shri I.V. Rao (MUL), Shri K Srikanth (Toyota), Shri Pandit (KPIT), Shri P. Sachadeva (Mahindra Reva), Shri Jayendra Parikh (Ashok Leyland), Dr. Rao Chalasani (General Motors), Ms. Sulajja Firodia Motwani (Kinetic Motor), Shri A. Srinivas (Mahindra & Mahindra), Shri A.S. Puri (Tata Motors)
Chair: Joint Secretary, Automotive Sector, DHI
Member Secretary: Shri Vikram Gulati, Director (Operations), NATRiP

</td>
<td>

Government:
DHI,
DST, TIFAC
MoF (DoR, DoE)
Planning Commission,
DRT, NMCC
MNRE
Industry:
SIAM, ACMA, SMEV
Prof Khincha (IISC), Shri Chetan Maini (Mahindra Reva), MD, Electrotherm, Shri I.V. Rao (MUL), Shri K Srikanth (Toyota), Dr Arun Jaura (Eaton Corp), Shri Kartik Gopal (Mahindra Reva), Shri Jayendra Parikh (Ashok Leyland), Dr. Rao Chalasani (General Motors), Ms. Sulajja Firodia Motwani (Kinetic Motor), Shri A. Srinivas (Mahindra & Mahindra), Shri S. Ravishankar (Tata Motors),
R&D organizations: CSIR, DRDO, ARAI, NATRiP (iCAT)
Chair: Joint Secretary, Automotive Sector, DHI
Member Secretary: Shri Vikram Gulati, Director (Operations), NATRiP

</td>
<td>

Government:
DHI,
MoUD, MoP
MoF (DoR, DoE)
Planning Commission, DIPP, MoPNG
MNRE, DRT, NMCC
Industry:
SIAM, ACMA, SMEV
Shri Kartik Gopal (Mahindra Reva), Shri P. Sachadeva (Mahindra Reva), Shri Jayendra Parikh (Ashok Leyland), Dr. Rao Chalasani (General Motors), Ms. Sulajja Firodia Motwani (Kinetic Motor), Shri I.V. Rao (MUL), Shri R. Chandramouli (Mahindra Reva), Shri S. Ravishankar (Tata Motors), Shri K Srikanth (Toyota)
R&D organizations: ARAI,
Chair: Joint Secretary, Automotive Sector, DHI
Member Secretary: Shri Vikram Gulati, Director (Operations), NATRiP

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</tr>
</table>

Source: Minutes of 2nd meeting of NBEM circulated vide OM No. 12 (89)/2009-AEI dated 01.02.2012

NEMMP 2020

NEMMP 2020

National Mission For Electric Mobility

NATIONAL MISSION FOR ELECTRIC MOBILITY

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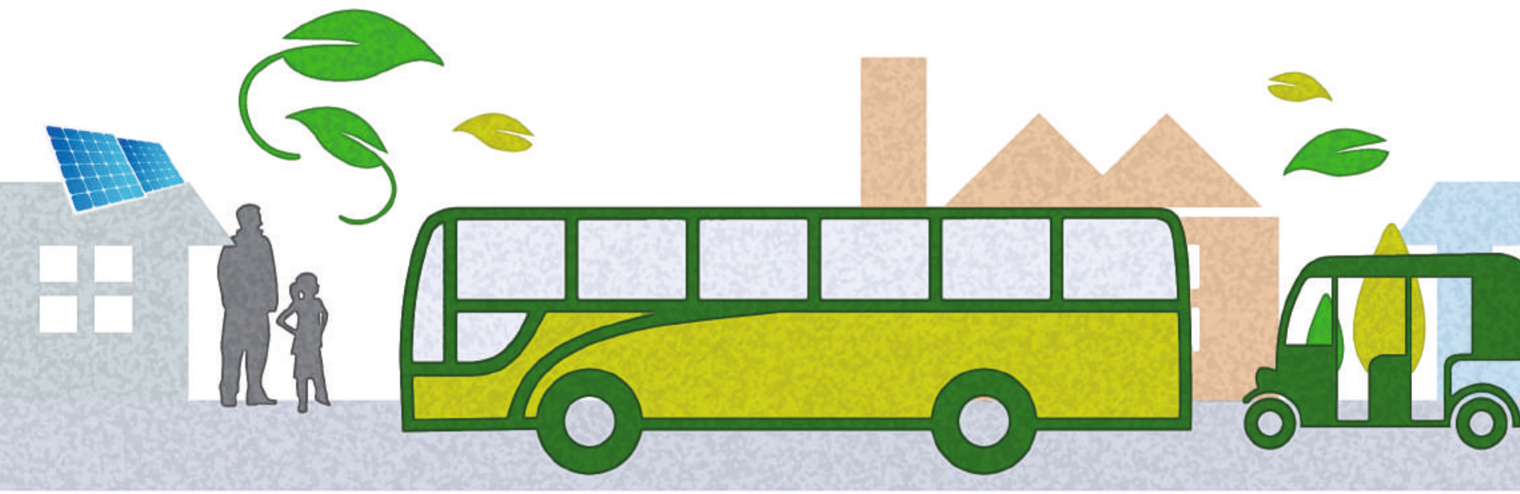
As on August 2012

"The National Mission for Electric Mobility is an investment for our future generations"

Electric mobility can transform the automotive & transportation sector by reducing the dependence on fossil fuels which is currently the single predominant source of primary energy for the sector, increasing the energy efficiency of vehicles and by providing the means to achieve the ultimate objective of shifting to a new transport paradigm that is highly efficient, cleaner and compatible with sustainable renewable energy future. The National Mission for Electric Mobility has the national energy security, mitigation of adverse impact of transportation on the environment and creation of a strong domestic manufacturing base as its key objectives. The National Electric Mobility Mission Plan 2020 seeks to put in place a full array of interventions on a scale that can catalyze the emergence of a viable electric vehicle manufacturing eco-system in the country by 2020.



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Department of Heavy Industry
Ministry of Heavy Industries & Public Enterprises
Government of India