

White Paper on Electric Vehicles

Adopting Pure Electric Vehicles: Key Policy Enablers

SIAM

Society of Indian Automobile Manufacturers

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India is World's 2nd largest 2W market, 5th largest PV market and 7th largest CV market

Global experience shows the need for having known the country's market dynamics and create suitably a conducive environment through strong and stable policies

India has started late on the electrification path and needs a strong policy to catch-up and move rapidly towards the stated goal.

Automotive industry globally is at the cusp of a major transformation. Growing concerns for environment and energy security clubbed with rapid advancements in technologies for powertrain electrification, increasing digitalization, evolution of future technologies and innovative newer business models and ever-increasing consumer expectations are transforming the automotive business. One of the key facets of such a change is the rapid development in the field of electric mobility which might transform the automotive industry like never before. With an ambition to be among the top 3 in automobile manufacturing by 2026 (as per the Automotive Mission Plan 2016-2026), Indian auto industry needs to consider an innovative and pragmatic approach to ride this transformation wave. E-mobility by far is the greatest opportunity for the Indian industry to participate and emerge amongst the top in the globalized automotive world.

Countries across the globe have adopted policies of long-term which were aligned with each nation's ecological goals towards decarbonization of the industrial activities. Each country's approach has been based on their market environments, per capita income, purchasing power and strategic needs & goals.

Logically, electrification policies for the auto-sector have been largely around bridging the viability gap of electric vehicle technologies vis-à-vis conventional vehicles, enabling charging infrastructure, creating public awareness and acceptance of electric vehicle technology. This has been done keeping in mind the evolutionary nature of the electric vehicle technology and the significant and sustained investments required both from the industries and the governments. Today, with continued efforts of more than a decade, many major economies such as US, China, The Netherlands, Norway etc. have promoted electrification of vehicles through various fiscal and non-fiscal incentives and have now gathered momentum in terms of demand, charging infrastructure and manufacturing eco-system. Such countries are perhaps more ready with pure electric vehicles to achieve their regulatory and strategic targets.

India has started late on the electrification path and needs a strong policy to catch-up and move rapidly towards the stated goal of hundred percent pure electric technology regime. Pure electric vehicle penetration currently remains quite low in India, ~0.1% in PVs, ~0.2% in 2Ws and practically nil for commercial vehicles due to several reasons including significant affordability gap and low level of consumers' acceptance (i.e. lack of demand), low level of electric vehicle manufacturing activities (i.e. lack of supply), lack of comparable products (especially in the 2W category), non-existent public charging infrastructure etc. All these issues typically are like a "hen or egg" situation. However, it may be expected that with a concerted policy and a sufficient time for such a policy to bear fruits, all these aspects could be well taken care of.

Government of India has set out a desirable and ambitious roadmap for pure electric vehicles with a transformative solution of shared-connected-electric mobility, wherein, 100% public transport vehicles and 40% of private vehicles can become all electric by 2030. This vision needs to be expanded to have a future of all electric vehicles.

India's Vision

All new vehicles to be 100% pure electric by the 100th year of India's independence

In 2013, Government of India launched a National Electric Mobility Mission Plan 2020. Under the mission plan, the FAME India Scheme (a scheme for faster adoption and manufacturing of hybrid & electric vehicles), was launched in FY-2015 for 2 years as Phase-1 (now extended until 31st March 2018). A phase-in approach will be needed to bring policy changes in the FAME Scheme to promote electric vehicle technology. Therefore, the FAME scheme should be extended until 31st March 2020 as per the original plan to keep the momentum going and the proposed new measures should be phased-in over the next 2-3 years for a smooth transition to the next level.

Taking cognizance of the advancements in the electric vehicle technology, markets development globally and a dire need to reduce energy demand and decarbonization of the auto sector in India, NITI Aayog's transformative mobility report of 2017 has set out a desirable and ambitious roadmap for pure electric vehicles, wherein, it is said that if India adopts a transformative solution of shared-connected-electric mobility, 100% public transport vehicles and 40% of private vehicles can become all electric by 2030. This vision needs to be expanded to have a future of all electric vehicles.

In this regard, the Indian auto industry commits itself to fully support the Government for an ambitious goal of electric mobility by expanding it further to seek a goal of a fully electric vehicle regime in a phased manner with the following vision to align with the objective of the India Energy Security Scenario 2047:

"The Society of Indian Automobile Manufacturers (SIAM), along with its automobile manufacturers, aims to achieve new vehicle sales in the country to be hundred percent pure electric vehicles (battery electric and fuel cell vehicles) on the hundredth anniversary of India's independence (2047), with a following roadmap:

- **All new vehicle sales for intra-city public transport fleets to be pure electric vehicles by 2030;**
- **Forty percent of new vehicle sales in the country to be pure electric vehicles by 2030;**
- **Sixty percent of new vehicle sales in the country to employ greener technologies like hybrids & other alternate fuels by 2030; To ensure smooth phasing in of pure electric vehicles and to sustain the transition to cleaner fossil fuel vehicles, the IC engine upgradation must continue over the next decade or so. Progressively cleaner fossil fuel vehicles would be an essential stepping stone in this journey towards hundred percent pure electric;**
- **Finally, all new vehicle sales to be pure electric vehicles by 2047.**

In the process, the Indian automobile industry also aims to become a leading global hub for design, manufacture and export of pure electric vehicles supporting the 'Make in India' initiative."

Partnership of trust between Industry and Govt. is the essence. The road ahead will need full conviction, hundred percent commitment and total perseverance.

Investments will run into thousands of crores for the auto industry towards creating a sustainable market place and a robust manufacturing eco-system for electric vehicles.

The paper focuses on aspects related to pure electric vehicle technology putting the nation's interest in the forefront for meeting the social and ecological needs of the country.

Challenges notwithstanding, the vision towards hundred percent pure electric regime is the raison d'etre for seeking a policy for the country.

To make sure that this vision is realized, the industry, government and various stakeholders will need to collaborate and invest. Most importantly, the long-term plan for the country for such an endeavor will have to be implemented with full conviction, hundred percent commitment and total perseverance. As the electric vehicle technology is evolving rapidly, it could be possible that transition to hundred percent electric vehicle regime might evolve earlier than envisaged in the stated vision. Therefore, the policy will need to be necessarily adaptive while at the same time must not bring sudden changes so as to allow outcomes in a planned manner and to ensure that the necessary transformation takes place with the minimum of disruption which may have socio-economic impact in terms of industrial growth, employment and livelihood of people in the auto industry.

Auto industry will invest with a proper business case even with a certain degree of risk around market readiness of electric vehicles. In not so distant future, such investments are likely to turnaround the electric vehicle scenario in an opportunity. Such investments will run into thousands of crores for the auto industry towards creating a sustainable market place and a robust manufacturing eco-system for electric vehicles. Already, many automobile manufacturers and auto component manufacturers in India have launched or announced their plans to develop electric vehicles and related components. Businesses, including the public-sector companies, will be looking at setting-up the entire supply chain including cell manufacturing in the country.

Towards this, the white paper suggests appropriate policy interventions needed for creating a sustainable manufacturing ecosystem of electric vehicles to achieve the stated vision. For its sheer size, complex market profile and different vehicle segments, a technology agnostic roadmap driven by market forces is always a preferred route for the automotive industry, however, this paper focuses on aspects related to pure electric vehicle technology vehicles putting the nation's interest in the forefront for meeting the social and ecological needs of the country.

As the electric vehicle technology is evolving rapidly, the white paper has refrained from any future projections on technology development, costs and demand. However, we have analyzed that mass adoption of electric vehicle will ultimately depend upon two major attributes – Buyer's Preference (determined by affordability, performance and durability) and User Friendliness (ease of charging and ease of upkeep). In the following section, the paper would briefly highlight some of the key challenges that are present today with respect to the adoption of electric vehicles for the various vehicles segments. As such, the vision towards hundred percent pure electric regime is the raison d'etre for seeking an e-mobility policy for the country.

Adoption of Electric Vehicles - Gap Analysis

The single major factor for slow penetration of electric vehicles is their high price which is around 2 to 2.5 times more than a comparable conventional vehicle. The other important concern of EVs is their range per charge.

It is important to understand the consumers' outlook and concerns as to why growth of market for electric vehicles has been sluggish. In the following sections, we briefly explain what the gaps are today for the electric vehicles vis-à-vis conventional vehicles.

The single major factor for slow penetration of EVs is their high price which is around 2 to 2.5 times more than a comparable conventional vehicle. The other important concern of EVs is their range per charge. To offer a higher range, higher battery capacity in the vehicle is needed which lead to increase in the EV price roughly proportionately and increases the price gap. At the same time, however, EV offer a significant advantage on operating cost (running plus maintenance cost) which could be as low as 1/4th of that of a conventional vehicle.

As compared to a personal vehicle, commercial vehicles like taxi fleets, bus fleets, 3-wheelers run 4 to 5 times longer distance per day. Therefore, for such higher mileage vehicles savings on operating cost will pay-back the initial high purchase price faster than low mileage vehicles. Attractive power tariff can play a significant role to offset capital cost of buying EV with lower operating cost at faster pace.

Most of the personal vehicle buyers consider upfront purchase price, fuel efficiency, maintenance and service cost, comfort features as the key buying criteria. However, commercial vehicle buyers consider capex plus opex cost economics as the most important buying criteria.

In India, affordability index is lower than developed economies due to lower per capita income. Therefore, manufacturers will have to offer medium range electric vehicles so that the cost of the vehicles remain affordable for the masses. This would in turn would need more frequent charging, especially for commercial fleets where the vehicle would run for upto 200~250 kilometres per day. Charging infrastructure for fleet application would require more of fast charging stations to minimise the turnaround time of the vehicles. For personal vehicles where the usage would be up to 50 kilometres per day, slow chargers at home, workplaces, opportunity places like shopping malls, cinemas etc. would be adequate.





	ICE Vehicle	Electric Vehicle*
		
Range	~300 miles per refuel (~480 km)	~100 miles per charge (~160 km)
Time to Refuel	5 minutes 	35~40 minutes (Fast Charging) 8 hours (Slow Charging) 

Figure 1: ICE versus EV vehicle

It is a complex scenario of multiple factors. Based on this broad narrative, the gap analysis for various segments are provided in the following sections.

Two-Wheelers



Majority (84%) of the 18 million two-wheelers sold annually in India have engine capacity between 100 and 125 cubic capacity. This segment is popularly known as the commuter segment.

Out of only 210,000 electric 2Ws on the road, more than 98% are low powered electric two wheelers. Being low powered, these are not covered under CMVR.

It would be necessary that comparable or near equal electric 2-wheelers are developed to penetrate and create a sustainable marketplace.

Today, more than 18 million gasoline 2-wheelers i.e. scooters and motorcycles, are sold annually in India.

Majority (84%) of the 18 million two-wheelers sold have engine capacity between 100 and 125 cubic capacity. These two wheelers are available in the range of Rs 60,000 – 90,000 (both scooter and motorcycle). This segment is popularly known as the commuter segment.

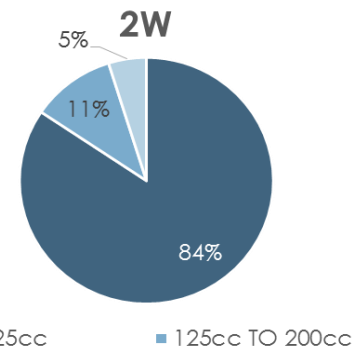


Figure 2: Share of 2W based on engine capacity

Currently, in India, the total vehicle parc of electric 2-wheelers is about 210,000. Out of these, more than 98% are low powered and low speed variants (maximum power not exceeding 250 Watts and maximum speed not exceeding 25 kilometers per hour). These vehicles are deemed as non-motorized vehicles and are thus exempted from various requirements under the Indian Central Motor Vehicle Rules (CMVR) viz. type approval, conformity of production, registration plate, driver's license etc. These low speed electric 2-wheelers by their basic design have limited performance like drivability, acceleration, gradeability etc. Even today, price of such low speed electric 2-Wheeler (before incentive) is in the range of Rs 30,000 - 50,000 which is quite low as compared to the conventional gasoline 2-wheeler. Still, because of sub-par performance as stated above, such low speed electric 2-Wheelers have not been accepted by the consumers at large. At best, such electric 2-wheelers would remain a niche segment and might not enable large scale penetration into the market to replace the conventional 2-wheelers.

It would be necessary that comparable or near equal electric 2-wheelers are developed to make an impact for a sustainable marketplace and achieve economies of scale for the creation of a robust manufacturing eco-system. The table below (Table 1) provides specifications for a near comparable electric 2-wheeler with a 100~125 CC gasoline engine 2-wheeler.

Electric Vehicle		Internal Combustion Engine	
Acceleration	0-20kmph in 4sec	Acceleration	0-20kmph in 1.1 sec
Gradeability	7deg min	Gradeability	7deg min
Range	60 km @ IDC (Min)	Range	600 km
Max speed	60 kmph (Min)	Max speed	80 kmph
Energy Efficiency	5 KWh/100km	Energy Efficiency	60-70 km/l
Warranty	3 Yrs / 30000 km	Warranty	3Yrs / 30000 km

Table 1: Specs of a comparable electric 2-wheeler with a 100~125 CC gasoline 2W

While this is technically possible, the relative cost becomes significantly higher (1.5 to 2 times) as compared to a conventional gasoline 2-Wheeler. The chart below (Figure 3) provides an image on price gap of a near equal performance electric 2-wheelers vis-à-vis a gasoline 2-wheelers.

The price gap is highest in the 100-125 cc segment, which is the mass segment

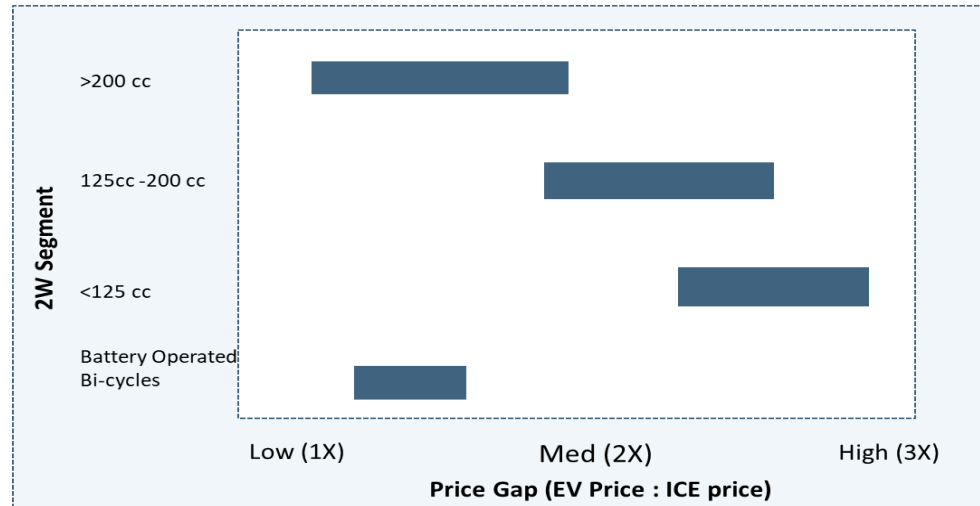


Figure 3: Price gap in 2W segment

We have done a viability analysis of a comparable electric 2-wheeler vis-à-vis a gasoline 2-wheeler with different battery prices as a variable (starting from current cost at around 300 USD/Kwh down to 73 USD/Kwh). Two scenarios are analysed – commercial application (150~200 Km/day) and personal mobility (30~50 Km/day). The Figure 4 indicates that an electric 2-wheeler is not economically comparable (at capex level) even if the battery price falls to 73 USD/Kwh, however, the TCO viability could be achieved in 2 to 5 years at different battery prices for a commercial application. However, in personal mobility use, due to shorter commuting distance, the payback within 3 to 4 years is only possible when the battery price falls to 73 USD/Kwh.

TCO in 2Ws will be attractive only if battery prices come down to ~100 USD per Kwh

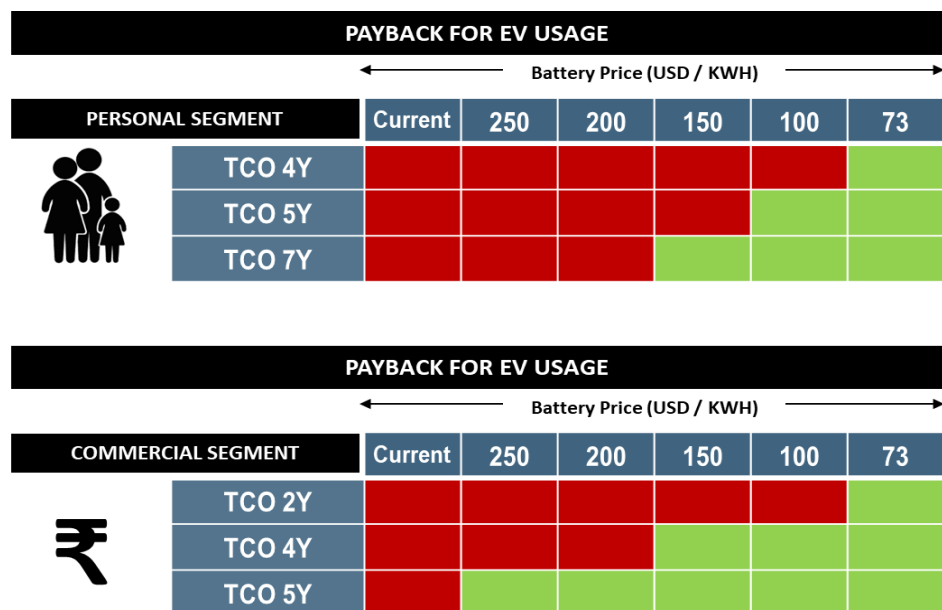


Figure 4: TCO attractiveness for 2W segment



Three-Wheelers

India is world's largest market for Three wheelers. These 3-Wheelers or Auto-Rickshaws are being used seamlessly in tandem with public transportation and for intra-city good movement. Majority (78%) of the Passenger 3Ws are configured for less than 4 seats and another 21% have more than 4 seats configuration (Figure 5).

At current cost levels, any electric 3W with near equal performance to IC engine will be at least twice in price. Moreover, limited range and inadequate charging infrastructure will lead to downtime resulting in revenue loss. For 3-wheelers, battery swapping may be encouraged to strengthen the possibility of overcoming range limitations in inner cities. SIAM could play a pivotal role in defining standard specs for swappable batteries for 3 – wheelers.

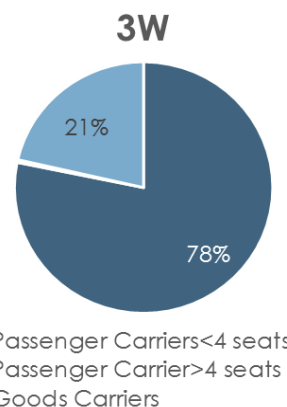


Figure 5: Break-up of India's 3W

At current cost levels, any electric 3W with near equal performance to IC engine will be at least twice in price. Moreover, limited range and inadequate charging infrastructure will lead to downtime resulting in revenue loss. For 3-wheelers, battery swapping may be encouraged to strengthen the possibility of overcoming range limitations in inner cities.

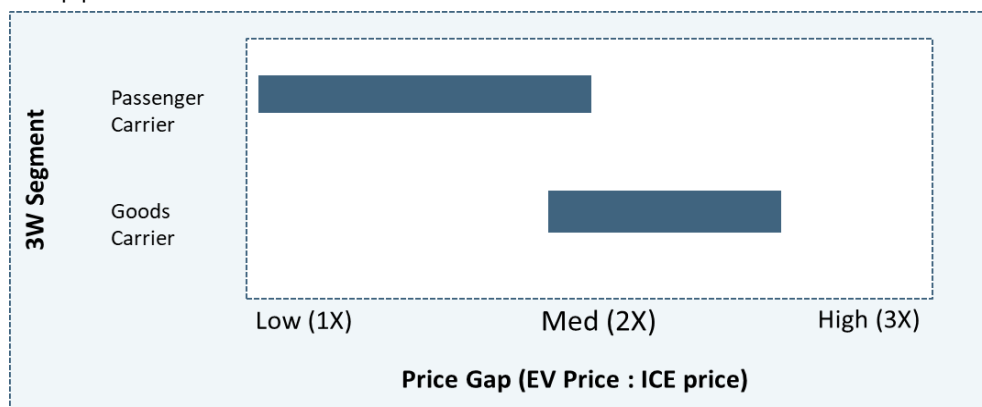


Figure 6: Price gap in 3W segment

The current TCO (Figure 7) would become positive if the battery prices fall to below USD 100 per KWH.

3W TCO will be attractive only when the battery price falls below 150 USD per KWH

PAYBACK FOR 3W EV USAGE							
		Battery Price (USD / KWH)					
COMMERCIAL USE		Current	250	200	150	100	73
₹	TCO 3Y						
	TCO 5Y						
	TCO 7Y						

Figure 7: TCO attractiveness for 3W segment

With phased mandates in cities over time, 3-wheelers could be one of the biggest opportunities to move to pure electric vehicle technology. With such a policy measure, the vision for 100% electric vehicles for public fleets in 2030 would be achievable for 3-wheelers.

Passenger Cars, Vans & Utility Vehicles



Majority (99%) of the passenger cars sold in India belong to the small or mid-size segment (Figure 8).

Due to the addition of incremental EV powertrain components such as battery, traction motor, control unit and charging point, the initial increase in the purchase price of an equivalent EV over an entry level sedan is ~70%. Due to the moderate mileage clocked by PVs for personal use (40 to 50 km per day), electric cars are rendered unviable even for a 7 years ownership period. This scenario holds true even if the battery costs fall to 50 USD/Kwh.

Passenger Cars

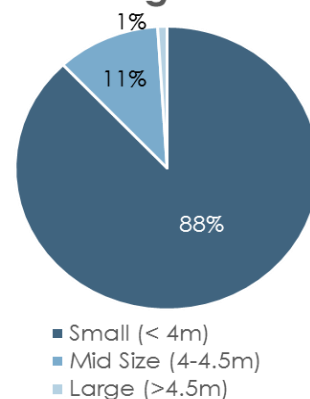


Figure 8: Break-up of India's Car sales

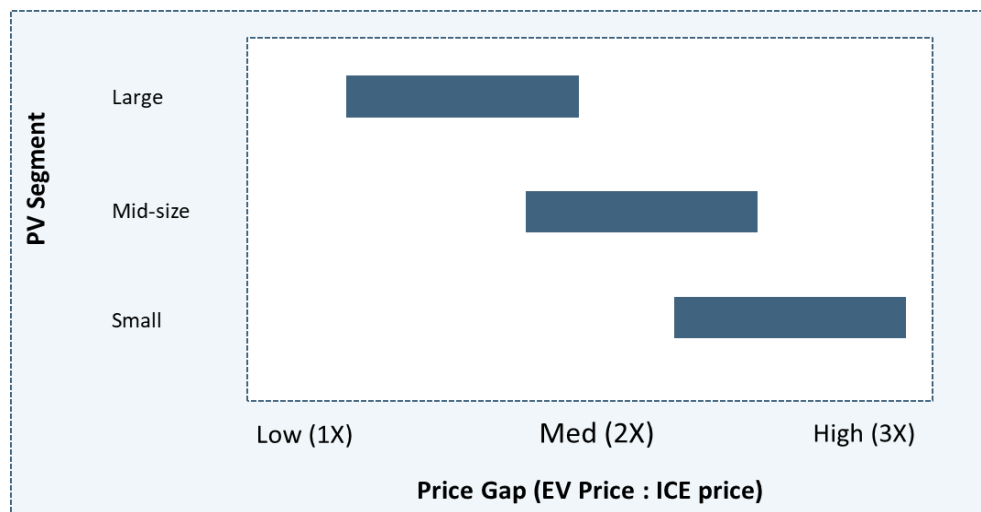


Figure 9: Price gap in PV segment

For the fleet application, due to longer commuting (~200 km per day), the viability gap reduces substantially. If the battery price falls below 150 USD per Kwh, fleet operators can recover the additional investments by 4 years (Ref. Figure 10).

For personal usage, battery prices must come down below USD 75 per Kwh to make TCO attractive

PAYBACK FOR EV USAGE							
		Battery Price (USD / KWH)					
PERSONAL SEGMENT		Current	250	200	150	100	73
	TCO 4Y						
	TCO 5Y						
	TCO 7Y						
FLEET SEGMENT		Current	250	200	150	100	73
	TCO 4Y						
	TCO 5Y						

Figure 10: TCO attractiveness for Passenger Vehicle segment



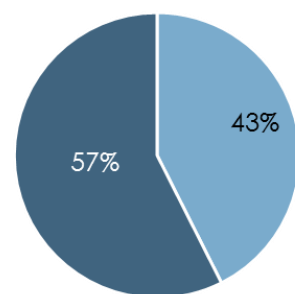
Current viability gap for electric buses is 1.7~2.5 times than a regular diesel or CNG bus

Buses

Majority of the buses sold in India belong to the 7.5-12 tonnes category. Of all the buses sold, ~7% are run by the STUs.

Buses employ a larger battery pack (optimal capacity at around 120 Kwh) leading to higher increase in the initial capex of 1.7~2.5 times a diesel bus. With bigger battery, there could be a weight penalty in terms of payload and lead to inefficiency. However, with smaller battery, there would be an operational gap for meeting daily mileage requirement of around 250 Kms per day. Therefore, an optimal electric range per charge, which is proportional to the battery capacity in the vehicle, is an important requirement.

Bus Sales



■ 7.5 to 12 tonnes
■ 12 to 16.2 tonnes

Figure 11: Break-up of India's Bus Market

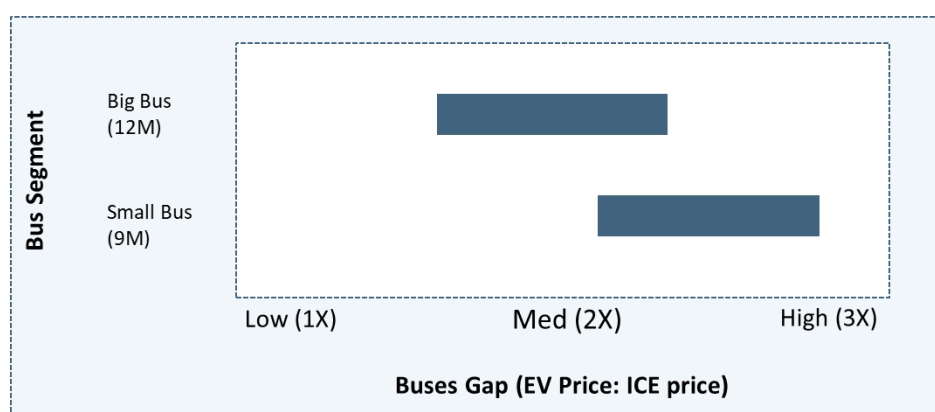


Figure 12: Price gap in Bus segment

For buses, cost of battery replacement in the middle of life impacts negatively on the TCO

In other vehicles segments, where life of a battery is expected to be 10 years or more and would be good for the lifetime of a vehicle. However, in the bus segment with today's battery technology, the life of the battery may not be more than 5~6 years due to strenuous operating conditions in the city and the need for fast charging at regular intervals. Cost of replacement of batteries in the middle of the life of the bus will have a direct impact on the TCO for buses.

At the current price level, for an electric bus with 120 Kwh of battery pack and with power tariff of Rs 7 per kwh, the viability gap is estimated at around Rs 4,00,000~500,000 per annum for 10 years of operation. A battery replacement cost that will incur midway at around 5th year) will increase the viability gap at that point of time. With power tariff at preferential rates, the viability gap per annum can be reduced.

To bring operational convenience of running longer distance per day, operators and vehicle manufacturers could also consider battery swapping as one of the possible mechanisms. Battery swapping in buses, to replace a discharged battery with a charged battery, could be as low as 10 to 15 minutes. Further, spare batteries for swapping could have a longer life span if such batteries are subject to slow and climatic controlled charging at a swapping station. With additional spare batteries to be available for swapping, commercial feasibility for such a mechanism are to be kept in mind.

SIAM could be the focal point for consultations with the bus manufacturers to collectively define common battery specifications that can be leveraged to adopt the swapping model efficiently and effectively.

Policy Measures and Recommendations

While the policy may be evolving, the most critical part is that gestation time be in-built, and the policy measures be sustained over time to bear fruits

The policy should aim at improving affordability and acceptance of electric vehicles to create market demand

To achieve the stated vision, it would be critical to bridge the above gaps for each vehicle segment as well as for different types of users. Therefore, a multi-pronged, segment and customer specific policy will be needed. **The policy should collectively aim at improving affordability and acceptance of electric vehicles by:**

- (1) bridging the viability gap,**
- (2) enabling charging infrastructure buildout,**
- (3) encourage domestic manufacturing,**
- (4) creating public awareness and**
- (5) other enablers**

It may be noted that automobiles have product development gestation of minimum of 3 years and product manufacturing life-cycle of around 8 to 10 years. Therefore, it is important to understand the level of effectiveness of each policy measure and acceptability of the policy measures from a long-term implementation perspective.

In this respect, a mix of policy measures which are equitable, implementable and can be sustained on a long-term basis with minimum fiscal burden and maximum impact and outreach is given in Table 2. It may be noted that various policy measures have different level of impact on the market and their criticality. The policy measures which result in acceptance of electric vehicle technology are the most critical.

The recommendations in the white paper are made based on impact and criticality of policy measures and which can be implemented on a longer-term as an integrated policy. With all such measures, there will be a cumulative effect to help create an EV eco-system.

Policy Measure	Mechanism
Creating Eco-system	Charging Infrastructure, Domestic Manufacturing etc.
Fiscal Measures	GST, Income Tax Credit, Road Tax, Low Interest Loan, Accelerated Depreciation etc.
Demand Aggregation	Taxi Fleets, 3-Wheelers, Buses etc.
Business Model	Vehicle Leasing, Battery Leasing, Battery Swapping etc.
Regulatory Provisions	Permits, EV Only Eco-Sensitive Zones etc.
Demand Incentive	FAME India, Direct Benefit Transfer etc.

Table 2: Policy Measures & Mechanisms

(1) BRIDGING THE VIABILITY GAP

While it is expected that viability gap will reduce over time due to technology evolution and reduction in battery prices, till then, a policy push is must to reduce the viability gap

While it is expected that viability gap will reduce over time due to technology evolution and reduction in battery prices, till then, a policy push will be required to bring affordability of EVs. Demand incentives or cash subsidies can at best be a short-term measure to kick-start the process. However, tax rebates and other fiscal & non-fiscal measures can be sustained over a longer term and will have a greater impact and outreach. For next few years, there will be a need for all such measures to collectively bridge the gap and make EVs a preferred choice for the consumers. Our proposal on fiscal and non-fiscal measures to promote pure electric vehicles are tabulated below:

Fiscal Measure	Vehicle Segment	Purchaser	Proposal
GST	All	All	GST rate for EV may be brought down from 12% to 5%
Road Tax	All	All	Road tax be fully exempted. Motor Vehicle Act can act as an enabler
Interest Rate of Finance	All	All	Favorable treatment similar to priority sector lending should be considered for electric vehicles.
Income Tax Deduction	All	Individual	One-time income tax deduction of 30% of vehicle price from total taxable income to individual purchasers, who have <u>NOT</u> availed any bank finance for the purchase. A maximum vehicle price of Rs 25 Lakhs may be considered (the same is used to define SUVs as per SIAM classification)
Income Tax Deduction	All	Individual	For individuals who have availed bank finance to purchase a personal EV, income tax deduction of up to Rs 1 lakh on the interest component for loans taken may be given every year during the tenure of the loan, like government's scheme on home loans.
Income Tax Deduction	All	Institution & Corporates	Accelerated depreciation of 40% instead of 15% on EVs be considered for income tax deduction as is being given for plant and machinery.

Table 3: Fiscal Measures

Non-Fiscal Measure	Vehicle Segment	User Type	Proposal
Power Tariff	All	All	Power tariff for charging of EVs could be 50% of the existing domestic tariff rate for home and workplace charging. Attractive power tariff rate at public charging infrastructure could be considered to enhance utilization.
Toll Charges	All	All	Toll may be fully exempted
Entry Tax	PV & Buses	Commercial	State entry taxes may be fully exempted
Parking Fees	2W, PV	Individual	Parking fees may be exempted for all personal EVs.
Demand Aggregation	All	All	Govt. purchase for demand aggregation
Phased Conversion	3W, PV & Buses	Commercial	Phased mandate of conversion of public fleets in cities (including e-commerce delivery vehicles) to electric. CNG fleets in India is an example that could be emulated with a phased plan.
Permits	3W & PV	Commercial	Permit cost may be fully exempted
2W Taxi	2W	Commercial	Electric 2-wheelers be allowed to be used as Taxis, nationwide. Motor Vehicle Act may be amended to that effect.
Leasing	All	All	Leasing of EVs could be made attractive for individual consumers.
Insurance Rate	PV and CV	Institution & Corporates	Bulk insurance at concessional rate for commercial fleets.

Table 4: Non-Fiscal Measures

Some of the clean technologies like hybrid electric and alternate fuels can play a role to achieve fuel savings and emission reduction.

These technologies should get active promotion from the government in a suitable manner

The above recommendations are aimed at bridging the viability gap for pure electric vehicles, which will constitute 40% of new personal vehicle sales and 100% of new vehicle sales for intra-city public transport by 2030 as per the stated vision.

However, that still leaves us with a balance 60% of new personal vehicle sales and inter-city buses and trucks by 2030 for which a vision needs to be expounded. It is imperative that these vehicles are encouraged to become greener by reducing fuel consumption as well as limiting the emissions to the extent possible.

Some of the greener technologies that can play a role to achieve this are hybrid electric and alternative fuels like gaseous fuels and bio-fuels. These technologies should get active promotion from the government in a suitable manner.

Alternate fuels like gaseous and biofuels are based on ICE technology and therefore, there is a lesser technology and economic viability gap. For such alternate fuels, the main policy recommendation could

Hybrid electric vehicles have the potential to reduce fuel consumption by a great extent through electrification of powertrains.

For hybrid electric technology, cost viability gap could be substantial depending on the level of electrification.

largely focus on ensuring wider availability and supply of these fuels at prices commensurate to their energy content.

Hybrid electric technologies, being deployed globally, have the added advantage of offering contemporary performance without the consumer anxiety on range as well as without a large dependence on external charging infrastructure. Hybrid electric vehicles have the potential to reduce fuel consumption by a great extent through electrification of powertrain. However, for hybrid electric technologies, cost viability gap today could be substantial depending upon the level of electrification. Higher electrification corresponds to deployment of bigger sized electric drive train components like batteries, motors etc. Therefore, for hybrid electric technologies, the main policy recommendation could largely focus on promoting higher level of electrification by bridging their corresponding price gap vis-à-vis conventional vehicles.

For all such alternate technologies also, there is a need to have a clear roadmap. In this connection, SIAM in consultation with vehicle manufacturers would formulate separate white papers.

(2) CREATING CHARGING INFRASTRUCTURE

One of the key aspects with electric vehicles is that these can be charged at many places like homes, workplaces, malls, parking spots etc. unlike conventional vehicles which cannot be refuelled without dedicated fuelling infrastructure at dedicated locations. However, proper and suitable charging infrastructure will need to be in place at such locations.

Unlike conventional vehicles which cannot be refueled without dedicated fuelling infrastructure at designated locations, one of the positive aspects with electric vehicles is that these can be charged at many places like homes, workplaces, malls, parking spots etc. However, proper and suitable charging infrastructure will need to be in place at such locations. A wide spread and easily accessible charging network will be most crucial for mass adoption of electric vehicles. As a daily practice and use pattern, it is likely that most of the times, people will have their electric vehicle charged before they will start a day. In the absence of parking places at residence, people would prefer to charge their electric vehicles at their work places.

During the day, for the city commuting, people will want to top-up the EV battery at every reasonable opportunity and place say for e.g. at shopping complex or commercial complex. We may expect that unless people have a stop-over of 2~3 hours or more, they will not want to charge at such places. However, for taxi fleets for the want of running more kilometer per day, need for public chargers (with preference for fast charging to reduce down-time) will become significant. For inter-city commuting, more of fast chargers will be needed at stop-overs on the highways to allow top-up. It may be noted that for fast charging in 30 minutes or less, electric vehicle will have to be capable for taking such high voltage or current (or both), which will increase the cost of the EV and have an impact on battery life.

As illustrated in Figure 13, availability of public charging is generally linked with electric vehicle adoption. Places with higher electric vehicle uptake tend to have more publicly available charging infrastructure (Source: ICCT).

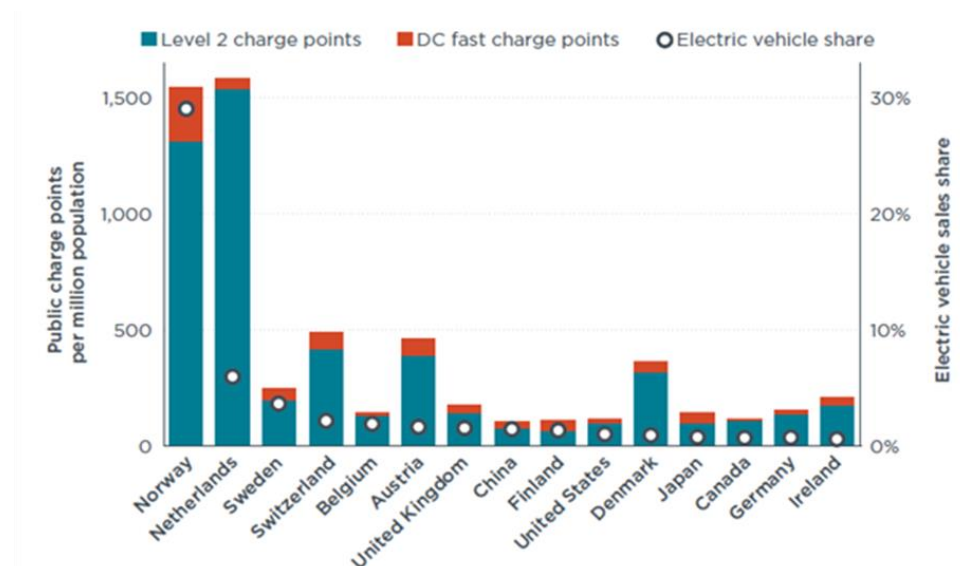


Figure 13: Electric vehicle sales share and public charge points per million population in selected leading markets

At least for today, there is no universal benchmark for the number of electric vehicles per public charge point.

Another analysis of major metropolitan areas with the highest electric vehicle shares (Figure 14) shows that there is a wide variation of number of electric vehicles per public charge point. Hence, at least for today, there is no universal benchmark for the number of electric vehicles per public charge point.

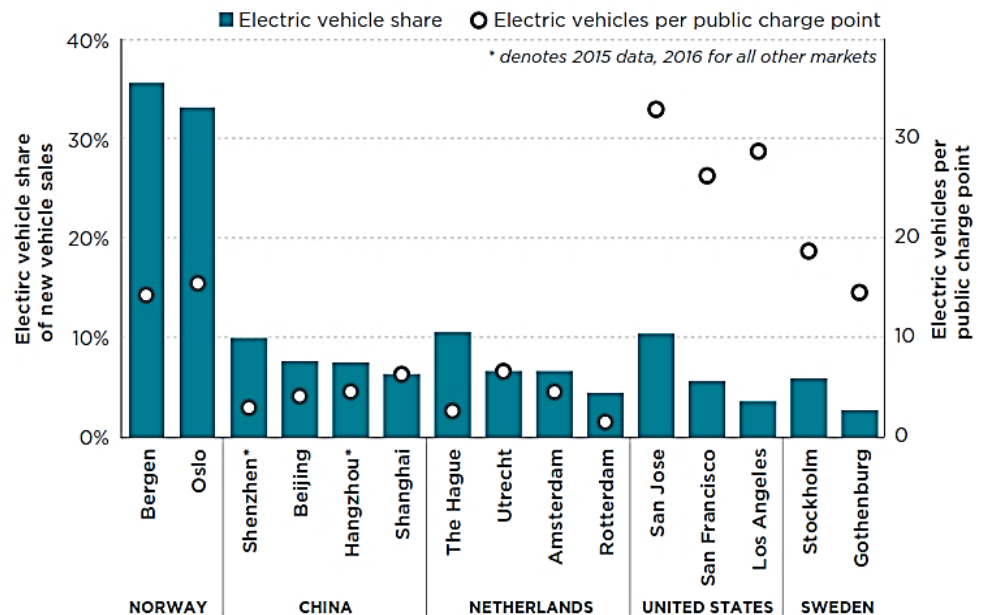


Figure 14: Electric vehicle sales share and public charge points per electric vehicle in selected leading markets

It is also noted here that deployment of public chargers is less where there is availability of parking space and access to home charging (like California), whereas it is more where there is scarcity of private charging and parking space (like Amsterdam). (Source: ICCT)

Based on use case, location and density of electric vehicles, a combination of slow and fast chargers will be required.

Different segment of vehicles (2W, 3W, PVs, CVs) may require different type of charging standard (& connector), however, the charging infrastructure, at-least at public places, should be common to the extent possible to reduce the infra cost. Based on the available duration for charging, locations like homes (residential and curb-side) and work places would be ideal for AC slow charging while places where vehicles halt for a shorter duration (less than 2 hours) like commercial complex, highways etc., fast charging would be a more suitable candidate (within city commuting, taxi will have relatively more demand for top-up as compared to a private use). Buses will need captive charging at depots which will be mostly fast charging (both AC and DC). Therefore, based on use case, location and density of electric vehicles, a combination of slow and fast chargers will be required.

Policy, regulations and standards for charging infrastructure

Early charging infrastructure will be crucial, and Govt. will need to play a leadership role.

Multifaceted and collaborative efforts would be required in promoting early establishment of charging infrastructure. Early charging infrastructure will be crucial, and Govt. will surely need to play a leadership role. Eventually, with growth in number of EVs and viable business models, businesses will be willing to set-up and operate charging infrastructure.

Various government around the world have earmarked funds for setting up of charging infrastructure (Table 5).

Country/City	Program	Budget	Mechanism of Support
Germany	<ul style="list-style-type: none"> €300 million for 10,000 Level-2 and 5,000 DC fast charging stations 	€300 million (\$285 million)	<ul style="list-style-type: none"> Subsidies for 60% of costs for all eligible businesses
Japan	<ul style="list-style-type: none"> Next Generation Vehicle Charging Infrastructure Deployment Promotion Project Nippon Charge Service government-automaker partnership 	Upto Yen 100 billion (\$1 billion)	<ul style="list-style-type: none"> Grants to local governments & highway operators Public-private partnership
Netherlands	<ul style="list-style-type: none"> "Green Deal: (curbside chargers on request) 	€33 million (\$31 million)	<ul style="list-style-type: none"> Contracts tendered to businesses on case-by-case basis
Norway	<ul style="list-style-type: none"> Enova grant scheme from 2009 onwards 		<ul style="list-style-type: none"> Quarterly call for proposal for targeted projects
United Kingdom	<ul style="list-style-type: none"> Curbside stations for residential use Highways England building DC fast charging stations along major roads in England 	BP 2.5 million (\$ 2 million) BP 15 million (\$12 million)	<ul style="list-style-type: none"> Municipalities apply for grants. Installers reimbursed Grants and tenders administered by public body
United States	<ul style="list-style-type: none"> Grants for funding public charging stations through American Recovery & Reinvestment Act 	\$15 million	<ul style="list-style-type: none"> Matching grants for local governments

Table 5: Summary of major national-level charging infrastructure programs in selected markets

The scale of such support indicates a substantial commitment of the government towards electric mobility. There are examples from various metropolitan cities around the world where municipal governments in these cities have funded many charging stations in collaboration with the utility bodies. National government bodies in countries like Netherlands, China, Germany, France etc. have funded municipalities to install charging infrastructure.

Private charging, both at home and at the workplace, will represent the majority of electric vehicle charging. Therefore, a higher priority

may be accorded to have policy measures and regulations around building private charging network (homes, multi-unit dwellings, workplaces, and other such captive places). The Table 6 provides a snap-shot of what is going on in various countries to enable home charging infrastructure:

Country/City	Program	Mechanism of Support
UK	Level 2 Charging at Homes	Incentive of up to 75% of hardware & installation cost (up to 500 Pounds)
Quebec (Canada)	Level 2 Charging at Homes	Incentive of up to 600 CAD on hardware & installation cost for 240 V Station
California	Green Building Standards Code	Regulation to have 3% of all parking spaces in commercial buildings include "make-ready" infrastructure for charging stations.
Europe	EU Directive	Directive that will require a charging point in every new or refurbished home beginning in 2019.
London	Regulation	Requires charge points at 20% of parking spaces in all new housing project as well as make-ready infrastructure for an additional 20% of spaces.
Germany	Mandate	Considering new policies to mandate charge points or make-ready infrastructure in all new building, as well as policies to streamline construction of charging stations in existing building

Table 6: Summary of schemes in various countries to enable home charging infrastructure

One of the pressing questions is how to address needs for residents living in apartments (multi-unit dwelling) and residents that do not have access to proper parking place. Investments in creating parking lots with charging points could be considered with an active policy support to take care of both providing parking and charging facilities. Workplace charging can also serve as a major resource. Research has shown that people are 20 times as likely to buy an electric vehicle if there is access to charging at their workplace.

Country/City	Program	Mechanism of Support
US	Workplace Charging Challenge	Regulation to increase workplace charging stations by 10 times by 2018 from 2013 level.
Quebec	Branché au Travail program	Funding to businesses and municipalities offering free charging to their employees
Massachusetts	The Massachusetts Electric Vehicle Incentive Program	50% of the funding (up to \$25,000) for hardware costs to employers for promoting workplace charging
UK	Workplace Scheme by OLEV	Rebates for initial purchase and installation costs
France	ADVENIR program	Goal of installing 6,300 at workplaces.
Norway	Enova Program (agency funded by oil marketing companies in Norway)	Provides funds for workplace charging infrastructure

Table 7: Summary of schemes in various countries to enable workplace charging infrastructure

Charging infrastructure requires substantial installation, operation and maintenance costs and can also incur significant costs for land procurement (in India land is a premium). Demand aggregation of home and workplace chargers (AC charging) can be a great lever to reduce prices as well as to have such charges installed at a mass level. EESL and other such government agencies can run a program for procurement of AC chargers in bulk and offer at affordable prices to individual users, RWAs and Corporates.

Governments can also support by various other strategies like providing land for setting up of charging station, subsidized electricity tariffs, collaborate with residents and property owners to install AC slow charging infrastructure in shared parking facilities and promote consumer awareness in multi-unit dwellings. Automobile industry can also collaborate with banks and power companies to form a joint venture and form a nationwide network of charging stations (including fast charging stations).

To conclude, the following measures are recommended in this regard:

- (1)** Through support and regulations, launch home, multi-units dwelling and workplace charging schemes/policies. Demand aggregation of home and workplace chargers (AC charging) can be a great lever to reduce prices as well as to have such charges installed on a mass scale.
- (2)** For corporates/employers, accelerated depreciation on such infrastructure can be provided under the tax relief. Individual users can be provided income tax relief to the extent of charging equipment cost.
- (3)** At workplaces, employers can be incentivized to allow employees charge at subsidized rate. Creation of charging infrastructure may be considered as part of Corporate Social Responsibility (CSR) to encourage investments by corporates.
- (4)** Regulations should be passed that will mandate provision of AC slow charging points in parking areas of residential buildings, workplaces spaces, shopping malls, commercial complex etc. To ensure that #NEWINDIA is built in line with the vision, "Smart Cities" need to have charging infrastructure as an integrated piece of development.
- (5)** Central Electricity Act need to be amended to allow resale of electricity by third party for facilitating setting up of charging infrastructure.
- (6)** Different segment of vehicles (2W, 3W, PVs, CVs) may require different type of charging standard (& connector), however, the charging infrastructure, at-least at public places, should be common to the extent possible to reduce the infra cost.

- (7)** Energy companies (like IOCL, HPCL, IGL etc.) may invest in providing a charging network, specially the fast charging stations at inter-city routes like state and national highways. This could also be based on renewable electricity source.
- (8)** Automotive Industry Standard - AIS 138 Part 1 (both slow charging standard and fast charging standard) is suitable for all vehicle segments as an AC charging standard and may be notified. AIS 138 Part 2 could be finalized after considering the following requirements/provisions:
- (8.1)** For 2/3 Wheelers: A new standard unified connector is being considered which could be used both for AC and DC charging to alleviate the need for two separate slots on the vehicle for AC and DC charging respectively. IEC 62196-2 Connector (commonly known as Type-2) is one of the proposals being evaluated.
 - (8.2)** For 4-wheelers with system voltage not exceeding ~ 100 V: GB/T connector, as per the specs given under BEVC DC-001 (Bharat EV Charger DC-001), is suitable.
 - (8.3)** For 4-wheelers with system voltage exceeding ~ 100 V deployment of "publicly available or public" DC fast chargers in the country the recharging points at such charging stations may be equipped at least with protocol and connector of the combined charging system CCS-2 (as described in the Annex-C of AIS 138 Part-2).
 - (8.4)** Further, the charging station / point installed by any private entity or individual for private purpose or for specified users, DC charging standard as described in Annex-A of AIS 138 Part-2 (i.e. Chademo) shall also be permissible.
- (9)** Battery swapping infrastructure for 3-wheelers and buses may be considered. Standard for battery swapping may be formulated to ensure safety and functional requirements.
- (10)** For city buses, depot & opportunity charging mechanisms need to be carefully evaluated based on techno-commercial feasibility and route planning.
- (11)** Regulations need to be put in place to ensure availability of stable and good quality power for EV charging.
- (12)** Linking public chargers with an IT network for interoperability and proper usage.

(3) ENCOURAGE DOMESTIC MANUFACTURING – MAKE IN INDIA

A world class manufacturing base with a competitive strength in terms of scale, quality, cost and technology will be a must to achieve the stated goal of pure electric regime.

70-80% of the total cost of the battery pack is the cost of constituent cells in the pack. The cell, essentially, is the highest single value item in an electric vehicle.

India today has good expertise in area of Electric Drivetrain and Power Electronics which form 30-35% of total vehicle cost

A world class manufacturing base with a competitive strength in terms of scale, quality, cost and technology for electric vehicles and their critical components will be a must to achieve the stated goal of hundred percent electric regime. The automotive industry in India i.e. the automobile and automobile component manufacturers will have the capability and the commitment to achieve this. Policy environment to encourage this aspiration will enable the Indian automotive industry to become a first rate in electro-mobility, and to move up in the value chain - to producing high technology, high quality, high performance products.

With its vast pool of skilled engineers and significant incubation centres for gestating and maturing new technologies, the automotive industry is committed to succeed. SIAM and other industry associations are enthusiastic and energised to work in that direction. These energies need to be synergised by defining the policy framework and an actionable roadmap.

The biggest bottle-neck to derive the cost down of EVs will be the battery pack or commonly called as battery. Today, a pack forms on an average 40-50% of the cost of a typical mass segment electric vehicle. Around 70-80% of the total cost of the battery pack is the cost of constituent cells in the pack. The cell, essentially, is the highest single value item in an electric vehicle.

The other major cost components of the electric powertrain are electric drivetrain viz. motor & motor controller and power electronics viz. inverter, on-board charger, DC/DC converter etc. These components form on an average 30-35% of the cost of a typical mass segment electric vehicle.

Today, Japan, Korea and China are the world leaders in cell design, development and manufacturing. AESC, BYD, LG Chem, Panasonic, Samsung, Toshiba are some of the top names in the world of cell manufacturing. These organizations also have manufacturing presence in other rapidly growing electric vehicle markets like US and Europe.

India today has a good expertise in area of Electric Drive trains and Power Electronics for non-automotive applications. This expertise can be leveraged to establish research and manufacturing in India for Automotive applications much faster with right mix of policy.

Cell and Battery Manufacturing

As soon as possible, India should set-up its own cell manufacturing set-up where even if the raw materials for such cells are imported, there would be a straight forward benefit of reduction in import value by around 30%.

Government, may be through their undertakings, can implement a two-pronged approach.

The first approach is to import cells in bulk and made these cells available to the entire industry in India at an attractive price.

The second approach is to invite established cell manufacturers to invest into setting-up a giga factory in India.

A battery pack is an assembly of cells, electronic parts (i.e. battery management & charging system) and sub-assemblies of thermal/cooling hardware. Auto industry in India is fairly matured in dealing with integration of electronic parts and such sub-assemblies. Local supply chain of such parts could be established with a fair degree of ease once the volume picks up.

However, cell manufacturing requires high investments in plant & machineries and significant minimum viable volume typically in millions of cells per annum to set-up a cell assembly line. For a given form factor of cells (i.e. cylindrical or prismatic or pouch etc.), the same assembly line could be perused with minor adaptation to make cells of different lithium based chemistries like LFP (Lithium Iron Phosphate), NMC (Lithium Nickel Manganese Cobalt Oxide), NCA (Lithium Nickel Cobalt Aluminium Oxide), LTO (Lithium Titanate) etc.

For the near future, India may not have the right to win to design and develop unique cells, a process that normally takes some years of R&D and validation. However, India can and should take the first major leap and start with a local production of battery packs with commercially available cells which will have the most significant impact on whole of the eco-system of EV manufacturing in the country. Subsequently, as soon as possible, India should set-up its own cell manufacturing facility where even if the raw materials for such cells are imported, there would be a straight forward benefit of reduction in import value by around 30%. It will reduce the cost of cell manufacturing by leveraging reduced labour and utility rates in India and will improve logistics efficiency of manufacturing in India. Commercial feasibility for setting-up such a cell manufacturing unit should not be a concern with a huge export potential even if demand from the domestic market in the initial years could be limited. With cells made locally, it can be expected that the whole battery pack would be locally produced. This will be a game changer. However, a typical Giga-factory of this kind will take 2~3 years to set-up and operationalize. India must aim to have its first giga-factory by 2020.

In this connection, we recommend a two-pronged approach towards creating a viable and sustainable supply chain for cells in India. As part of the approach, the steps mentioned below will need to be pursued concurrently for an effective and timely execution. This approach will also act as a great enabler to bridge the viability gap of electric vehicles leading to a virtuous cycle of mass adoption and sustainable manufacturing of electric vehicles.

- (1)** The first approach should be to pool demand for different kind of cells in the country to import these cells in bulk from any of the globally competitive cell manufacturer(s). Government can play a pivotal role wherein organizations like EESL can call for a global

tender and invite bidders. It will enable vehicle manufacturers and battery pack manufacturers to procure such cells possibly at a cheaper price due to the bulk procurement. Considering waiver of import duty on such cells as part of such bulk procurement tenders, the landed price could further be brought down to make it attractive for the industry. It will also ensure quality cells to be available for use in the domestic market.

- (2) The second approach, that also needs to be concurrent, will be wherein Government can collaborate and invite established national or international battery manufacturers to invest for setting-up a cell manufacturing plant in India – a Giga Factory. With cheaper operational cost in India and alleviation of import and other logistic costs, the cell price through such collaboration could possibly be lower than global prices of such cells. India must aim to have its first giga-factory by 2020. This set-up should also engage in design and development of new cells suitable for future domestic and export market. Government can provide fiscal support in the form of tax credits based on investment plan and job creation in the giga-factory. The support can also include providing land and other such measures.

Electric Drivetrain and Power Electronics

The major constituents by value of the electric drivetrain and power electronics are:

1. Motor, motor controller and Inverter
2. On board charger
3. Power distribution unit
4. DC/DC converter
5. Vehicle control unit

It will be imperative to have these components locally produce to reduce the cost of EVs and to create a sustainable manufacturing supply chain.

Each of the above part is comprising of several sub-parts or child-parts. The chart in the next page (*Source: ACMA*), shows different child parts there are in an electric power-train. Each child-part has different market potential and its ease of localization.

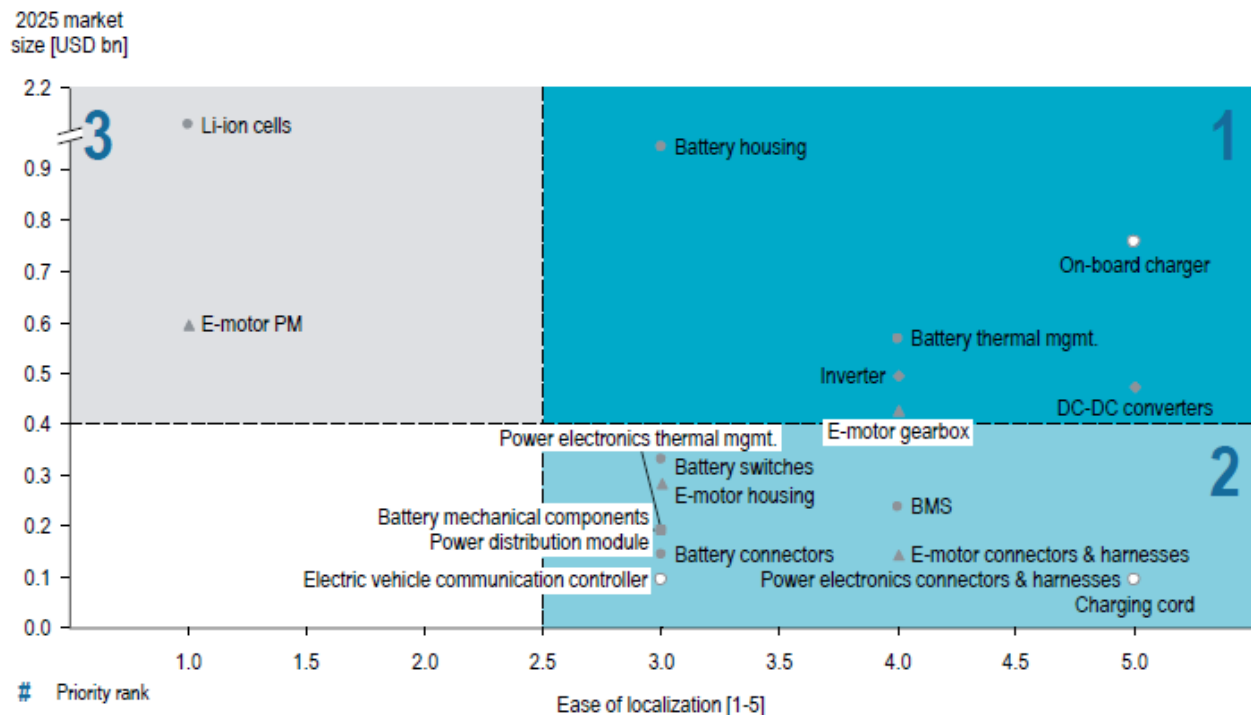


Figure 15: child parts of electric power-train components

We expect that with EV demand picking-up both globally as well as in the local market, localization will take place wherein, suppliers will acquire technology through both organic and in-organic routes. However, the challenge will be to produce components with same quality at an affordable price point and at scale.

Until then, when the volumes will not be viable for scaled manufacturing, the Indian auto industry will have to gear-up and start investing in phased manner. To enable this, a policy support will be required for the auto industry to plan calibrated investments. Following policy measures could be considered for the auto industry for industrialization and localization:

- (1) Support to local manufacturers to acquire and develop technology and collaborate globally with technology suppliers. A pool of funds may be considered for technology acquisition for multiple manufacturers in India.
- (2) Export incentives for EV manufacturers and EV component manufacturers at the rate 5% through Merchandise Exports from India Scheme (MEIS).
- (3) To encourage domestic R&D for development of EVs, 200% weighted deduction for calculations of income tax should be continued beyond 2020.
- (4) GST rate on EV components could be brought down to 12%.
- (5) Concession in electricity tariff, property taxes and tax breaks could be considered;

- (6)** Priority allotment of land and speedy execution of land allotment could be implemented under EoDB.
- (7)** Investment allowance or capital subsidy could be provided.
- (8)** R&D support to the auto-component industry, especially for MSMEs, start-ups and academia. For that, a fund for technology development and patent registration may be created in this regard.
- (9)** Concessional import duty on critical components like batteries, motors etc. should be allowed till such time domestic capacities are set-up and should be phased out over time in a planned manner.

(4) PUBLIC AWARENESS

For the technology to be known and its impression to get formed, a multi-dimensional approach is needed to create the awareness.

It will have to be around sharing government's vision, informing on products and their economic advantage, role of cities, societal and ecological merits, and much more.

Outreach program will be a learning phase for all the stakeholders including central government, state agencies, civic bodies, businesses, utilities and others. The core of it will lie in hand holding until the behavioural shift and change management take place homogeneously.

With compelling economic advantage in future, electric vehicles are expected to be the first choice for the people. Until then, we will need to create a positive outlook and momentum for this transformation. For the technology to be known and its impression to get formed, a multi-dimensional approach is needed to create the awareness. It will have to be around sharing government's vision, informing on products and their economic advantage, role of cities, societal and ecological merits, and much more.

Studies have suggested that awareness of electric vehicles is low which included familiarity with technology, lack of knowledge related to government's schemes, economic benefits etc. The studies also indicate that there is a direct correlation between knowledge of electric vehicles and its adoption.

Although the focus can be on masses, it will be a learning phase for all the stakeholders including central government, state agencies, civic bodies, businesses, utilities and others. The core of it will lie in hand holding until the behavioural shift and change management take place homogeneously. Government and corporates will need to come together to work out an entire plan around these aspects.

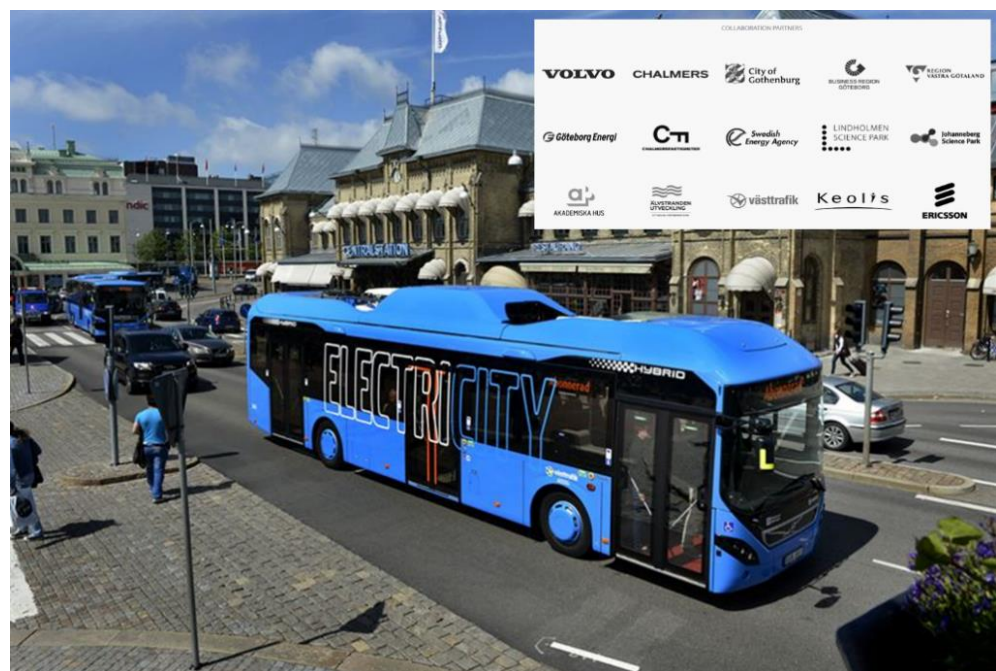
Supporting measures like exemption from entry restriction within city limits applicable to commercial vehicles, exemption from toll, access in emergency measures like odd-even, reserved parking etc. will encourage consumers to understand the merits of owning electric vehicles. There will be a need to create a wholesome experience by creating multi-modal public transportation system with electric vehicles to bring visibility on the ground.

Pilots should be considered within each state to bring these concepts into live and by involving multi-stakeholders together. NITI Aayog intention to create a Lighthouse City as a living lab for conceiving, financing and testing mobility solutions will greatly help in this direction. There will be a need to have more such lighthouse cities in different states to have a greater outreach. We suggest that Germany's Electromobility Model Regions and Showcase Regions could be evaluated in this respect.

In summary, following measures could be considered towards building public awareness:

- All activities under the umbrella of creating awareness could be brought under CSR for corporates to provide funds. City government could consider promoting electric vehicles, at-least in eco-sensitive zones and tourist destinations, to link it with Swachh Bharat Mission.

- Regular information dissemination related to government's schemes, availability of products, performance and cost comparison. Regular advertisements and signages could be considered in this respect.
- Organize public events for ride & drive experience and technology and products showcase. Automotive events like The Motor Show (Auto Expo) could be considered for such promotions. SIAM will actively support such activities in the public interest.
- Deploy electric fleets in public or mass transportation including buses, taxi fleets, corporate fleets, tourism sites etc.
- Implement regional action plan to involve civic bodies and local agencies. Projects like ElectriCity in Gothenburg are some such good case studies to be considered. It is a collaborative, cross-functional cooperation with partners from industry, the academic world and the society (see figure below).



Sustained programs will be more likely to capture a wider audience of prospective electric vehicle consumers and bring various actors up to the speed. There will be a need to have an approach that can expand and build upon on its own.

- Dedicated schemes and programs to educate on electric vehicles can be implemented for targeted consumers like fleet operators and 3-wheeler drivers.
- Sustained programs will be more likely to capture a wider audience of prospective electric vehicle consumers and bring various actors up to the speed. There will be a need to have an approach that can expand and build upon on its own through mechanisms like social media, word of mouth and low-cost information dissemination.
- Media as one of the stakeholders can support all such awareness campaigns by giving out regular news and updates.
- Last but not the least, there will be a need to have a unified platform for information sharing and creation of database. The nodal Ministry may be entrusted to this effect.

(5) OTHER ENABLERS

Battery Swapping

Battery swapping would be more relevant for vehicles built for commercial use only viz. buses and 3-wheelers, which travels comparatively a longer distance

The purpose of battery swapping or leasing is to delink battery cost from the cost of an electric vehicle to bring down the cost of the vehicle (without battery) comparable to a conventional vehicle. In the battery swapping, the additional advantage is of quick replacement of discharged batteries with charged batteries at a swapping station. This could reduce the range anxiety.

Battery swapping, therefore, would be more relevant for vehicles built purposely for commercial use only viz. buses and 3-wheelers, which travels longer distance per day as compared to a personal vehicle. From the infrastructure owner's commercial feasibility, it may be relevant to implement swapping model on fixed routes within cities to have an optimal infrastructure of spare swappable batteries and captive back-up charging facilities.

Technical and operational standard for battery swapping will act as an enabler to promote the swapping model as a safe industrial activity.

For most of the individuals, a 2W or a car is an aspiration where they take pride in owning a vehicle. Manufacturers design vehicles with unique features to meet the consumers' aspirations. Every vehicle manufacturer strives to keep up with its competitor as well as tries to differentiate from others to have a strong brand value. There is a strong relationship between a consumer and a brand. In this context, battery swapping for personal vehicles i.e. 2Ws and Cars would be challenging. With battery prices coming down, it would be possible for vehicle manufacturers to offer the vehicle as a complete package with battery as an integral part of the design and construction of the vehicle.

Globally, there have been experiments on swapping model, but a feasible operating and business model is yet to emerge at a large scale. There are technical and commercial challenges. Technical standard for battery swapping will be critical and will also act as an enabler to promote the swapping model as a safe industrial activity. With such guidelines in place, industry players could implement such measures as a viable commercial activity.

Battery Recycling

Recycling of battery materials will help source raw material locally and enhance cost effectiveness of the supply chain

Proper scrapping of batteries will not only alleviate possible environmental concerns but will also act as an enabler to source locally the chemical elements of the batteries such as Lithium, Nickel, Manganese, Cobalt, Titanium, Phosphorus etc. thus increasing the cost effectiveness of the supply chain. To incentivize recycling, following measures could be adopted:

- Demand generation by mandating minimum requirement of materials to be recycled in batteries;
- Encouraging manufacturers to develop closed-loop mechanism for batteries ensuring minimum scrapping.

COLLECTIVE MISSION

Need for a collaborative platform for policy making & implementation

Need to establish a collaborative platform for policy making and a nodal agency to coordinate and monitor activities at a pan India level

Transformation of an entire nation towards electric mobility is going to be a huge effort. It will be important that policies are framed in a collaborative manner with a long-term vision in mind. Implementation of policy measures will require close coordination at several levels and amongst various departments & ministries of the central / state government and other public & private stakeholders.

While taking firm and ambitious steps in going towards hundred percent pure electric regime, we must not lose sight of the fact that the actual production in India, of the inputs for the EVs must be ramped up in a calibrated manner, while not allowing the infrastructure for ICE vehicles to be neglected during this long transition phase. If electrification is attempted to be done too fast, it will likely have an adverse impact on local content due to increased imports, and will result in exporting jobs. Localization has to accompany or even precede the fast ramp up. Simply reducing import duty on CBUs or on SKDs may impose a high economic price on the country, if the local development and full manufacturing of electric vehicles does not happen in India, in a planned and assured manner.

For the common goal of sustainable mobility and building the nation responsibly, SIAM will look forward to proactively contribute towards this national mission.

It will be necessary to establish a collaborative platform for policy making and a nodal agency to coordinate and monitor activities at a pan India level. This shall ensure that the current momentum does not lose steam and the efforts can be sustained, thus enabling the country to achieve its e-mobility vision collectively.

Towards the common goal of sustainable mobility and building the nation responsibly, SIAM will look forward to proactively contribute in various aspects of this roadmap such as standards formulation, implementing various measures to be led by industry like CSR activities, spreading the public awareness, and not the least bring the industry together for taking up challenges as and when required.

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