Reviewing India's National Mission on Electric Vehicles

GANESHPRASAD PAVASKAR

In 2010, the Ministry of New and Renewable Energy proposed a 20% subsidy for electric vehicles through a scheme called the Alternate Fuels for Surface Transportation Programme. This resulted in a big leap in sales of electric vehicles, mostly in the e-bikes segment. However, this initial spurt in sales was followed by a slump. This article analyses why electrical vehicles have not taken off in India, and suggests alternatives.

In January 2013, the Government of India introduced an ambitious National Electric Mobility Mission Plan (NEMMP) through the Department of Heavy Industry (DHI) to revamp the electric vehicle (EV) segment further. This plan has identified a demand potential of 60–70 lakh EVs on the road by 2020. This target is classified into the two-wheeler (2W), three-wheeler (3W), four-wheeler (4W), buses, and light commercial vehicle (LCV) segments. The targets for each segment are mentioned in Table 1.

After the introduction of NEMMP, many modern and noise-free Hero e-bikes and Yo e-bikes were expected on the road. However, multiple news reports suggest that the introduction of NEMMP has been counterproductive. Sales of 2W EVs have dropped by more than 80% and this led to the shutdown of 75% of 2W EV manufacturers. This industry witnessed peak annual sales of 1,10,000 units of 2W EVs in 2011–12.

In 2010, anticipating a lucrative 4W EV market in the near future, Mahindra & Mahindra bought a majority stake in the Reva Electric Car Company. They launched a new and better EV model, named e20, in March 2013. Initially, they hoped to sell 1,000 vehicles per year with a subsequent rise in sales. However, as of March 2015, they have sold only about 500 units.

Evidence suggests that the implementation of NEMMP has failed to create a positive impact on EV sales because of the withdrawal of the 2010 subsidy scheme and delays in the release of new NEMMP subsidies. This is a classic case of the Gartner's Hype Cycle in technology, which was seen not only in India but also across the world. What it says is "Initially, expectation about a technology from consumers and the industry grows much faster than its maturity, later the expectation reaches a peak and then falls until the technology matures." In India, a peak in expectation was seen in 2012 and later expectations went down which is evident from the drop in sales. However, Hype Cycle also predicts that the expectation will pick up again in the future after the technology

Table 1: Old (2010) and New (2013) Schemes for Electric Vehicles in India

EV Type	Targets		Subsidies		Total Investment
	AFSTP (2010)	NEMMP (2013)	AFSTP	NEMMP–FAME	NEMMP
	No of Vehicles	No of Vehicles	20% of Price (₹)	(₹)	(₹)
2W	1.3 lakh	35–50 lakh	Up to 5,000	1,800–29,000	10,000 crore
3W	266	20,000– 30,000	Up to 60,000	3,300–61,000	700 crore
4W	840	14–16 lakh	Up to 1 lakh	11,000–1.38 lakh	8,000 crore
LCVs	–	30,000–50,000	Up to 4 lakh	17,000–87 lakh	1,600 crore
Buses	–	2,600–3,000	Up to 4 lakh	30–66 lakh	1,200 crore
Demand incentive total expenditure				14,000 crore	
Additional support under new scheme					
Battery R&D				1,000 crore	
Other R&D				500 crore	
Power infrastructure				5,000 crore	
Charging infrastructure				1,200 crore	
Total expenditure necessary for NEMMP					₹ ~ 21,500 crore

Ganeshprasad Pavaskar (*ganeshpavaskar@gmail.com*) is with the Center for Study of Science, Technology and Policy, Bengaluru.

matures. Recent sales figures suggest that EV sales have gone up in recent months.

FAME, India

In July 2014, the new government formulated a ₹14,000 crore demand-side incentive plan under NEMMP to meet the proposed targets. Since April 2015, these incentives are being provided in the form of discounts on EVs under a detailed scheme titled "FAME, India" (Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India), which is based on NEMMP. The discount amount is about one-third of the difference between the price of an EV and a comparable petrol vehicle. An estimated expenditure budget of ₹795 crore has been allocated for two years (2015–17) by DHI. According to the scheme, these discounts will be reimbursed to the dealer in 60–90 days. DHI is flexible in the disbursement of the subsidies, if sales exceed targets. They are also ready to provide higher amounts of subsidies for battery electric buses as compared to the amounts mentioned in the FAME document. In order to do this, they are looking for proposals from state and municipal transport corporations for battery electric bus deployment.

Battery Electric Vehicles vs Hybrid Electric Vehicles

The NEMMP targets are further classified into Battery Electric Vehicles (BEVs) and Hybrid Electric Vehicles (HEVs) segments. An HEV has a conventional internal combustion engine propulsion system plus an electric propulsion system consisting of a battery and a motor. This makes HEVs heavy and expensive. Therefore, the prospect of high penetration of HEVs looks bleak in the 4w segment and is zero in the 2w segment. The HEV segment, at best, can be expected to have a small share in the form of buses or LCVs. The other segment type is BEV. It has only the electric propulsion system consisting of a battery and an electric motor that propels the vehicle. Future 2w and 4w EV segments can expect to be dominated by BEVs. In this article, references made to EVs belong to the BEV category. However, some of the issues discussed apply to both BEVs and HEVs.

An analysis for big consumer targets from NEMMP, which are 2w and 4w EVs, is presented here. Highest selling EVs are compared with similar vehicles in the petrol segment. The vehicles chosen for the analysis are Hero e-bikes and Honda Activa in the 2w segment and Mahindra e20 and Maruti Suzuki Alto in the 4w segment. Table 2 presents a comparison of various features, which will be helpful to not only policymakers and researchers but also to consumers to take informed decisions. This analysis of India's BEV sector shows that the challenges faced by this sector not only lie with NEMMP but also with technology, infrastructure, and associated costs. Challenges and solutions for each factor analysed have been mentioned later in the article.

In the consumer EV segment, the lower limits of these subsidy ranges provided in the "FAME, India" scheme (₹1,800 per 2w EV and ₹11,000 per 4w EV) are too low to attract potential consumers. Buyers of Hero e-bikes and Mahindra e20 can avail subsidies worth ₹7,500–₹10,000 and ₹1 lakh, respectively. In addition to these demand-side subsidies, the government will also endorse research and development (R&D), supply-side incentives, and power and charging infrastructure development, as mentioned in Table 1, by 2020.

NEMMP has set a huge target to deploy 48 lakh 2w EVs and 15 lakh 4w EVs by 2020. However, accomplishing these targets, based on current valuations in NEMMP, may not be possible because the current expenditure estimates do not match subsidy calculations. A subsidy of ₹1 lakh per 4w EV will require a total outlay of ₹15,000 crore; the present allocation of ₹14,000 crore will not be sufficient to achieve the sales targets of various EV segments identified in the plan. In order to overcome these concerns, first the government needs to re-estimate the NEMMP targets to bring them in sync with more accurate expenditure estimates. Second, the time frame of the plan should be extended to enable the creation of a sustainable EV industry.

Assessment of BEVs for EV Mission

BEVs are zero emission vehicles. If we use clean renewable sources such as solar, wind, etc, we will be able to charge BEVs without an iota of greenhouse gas being released. They curb noise pollution by being much quieter than conventional vehicles. They also have low maintenance requirements. Their fuel economy seems to be on the higher side as compared to fuel-based vehicles. They can assist in energy security with lower reliance on fossil fuels in the future as India is increasing its renewable energy share in electricity generation. Despite BEVs having significant environmental and other benefits, their sales numbers are minuscule. Why is that?

BEV sales are inherently plagued by challenges in three areas—technology, infrastructure and costs.

Battery Technology

Battery is the heart of a BEV; a battery solely provides the energy required to propel the vehicle. Hero e-bikes and Mahindra e20 use lead acid batteries and lithium-ion battery, respectively. Currently, the best battery technology, which delivers high energy and high power, uses lithium. India has a scarcity of lithium and will have to rely on expensive imports to sustain a growing BEV industry. Lead acid batteries, on the other

Table 2: Comparative Analysis of EVs and Petrol-based Vehicles in India

Two-wheeler		Vehicle Segment	Four-wheeler	
Hero e-bikes	Honda Activa	Vehicle Type	Mahindra e-20	Maruti Suzuki Alto
50–80	240–320	Range (km)	77–120	500–800
3.5 hours	< 5 min	Charging/refuelling time	5 hours	< 5 min
25–45	82	Top speed (km/hr)	81	140
Low	Moderate	Acceleration	Moderate	Good
15,000	–	Battery life (km)	50,000	–
1.6	–	Battery life (years) +	5.5	–
35,000–50,000	55,000–65,000	Price (₹)	7,50,000–8,50,000	3,50,000–4,50,000
7,500–10,000	–	Subsidy (₹)	1,00,000	–
0.1–0.2	1.3–1.8	Electricity/fuel cost (₹/km)	0.5	3–4.5
1.2–1.8	2.0–2.5	Cost of ownership (₹/km)	10–12	8.5–10
14,000	21,000	Cost of ownership (₹/year)	1,10,000	90,000
Low	Moderate	Maintenance	Low	High

+ If driven 25 km/day.

hand, are inexpensive and easily available but have performance limitations.

Current battery technology is not mature enough to allow BEVs to compete with fossil fuel-based vehicles. The energy storage capacity (kWh/kg) of batteries is 100 times less than that of petrol or diesel. Hence, BEVs provide low range per charge, with Hero e-bikes and Mahindra e20 promising only 50 km–80 km and 77 km–120 km per charge, respectively. The solution presently being used involves the installation of a big battery pack. However, this increases the weight and cost of a vehicle significantly.

Another technical deficiency of BEVs is that their speed and acceleration is lower than conventional fuel-based vehicles because of the low power capacity (kW/kg) of batteries. The top speed of Hero e-bikes and Mahindra e20 is 25 kmph–45 kmph and 81 kmph, respectively. Some technical reports suggest that the current speed and acceleration of BEVs are enough for city use. However, people still desire fast bikes and cars. Moreover, achieving higher speeds in a BEV from a regular battery pack reduces the range and life of the battery.

The installation of supercapacitors along with the battery in BEVs can solve this problem and ensure better reliability and longevity of existing batteries. Supercapacitors are a type of electrochemical capacitors that use a physical process to store energy, unlike other electrochemical batteries, which use a chemical reaction. They have very high-power capacity; they can charge and discharge very quickly unlike other batteries, thereby making them indispensable for faster BEVs. However, they are an expensive technology. In the future, they can be made with graphite (carbon), which can be manufactured from organic wastes like coconut shell, hemp, etc, to make them cheaper. Researchers are working on developing a hybrid capacitor, which has lead oxide electrodes and supercapacitor electrodes in the sulphuric acid electrolyte, that is, it resembles lead acid battery but has better performance. These kinds of low-cost, advanced battery-capacitor hybrid technologies can revolutionise the BEV industry in the future.

Alternate battery technologies, such as room temperature sodium-ion batteries and magnesium-ion batteries should be explored extensively through R&D. To address technological challenges in EVs, collaboration of local academic institutes with industry is of foremost importance.

Infrastructure for Charging

Charging-related issues are another reason behind people's scepticism towards BEVs and they are driving away customers. Lead acid batteries take eight hours and lithium-ion batteries take one to five hours to charge, which is much longer than the time needed to refuel a vehicle. India is also battling with issues of infrequent and insufficient power supply. The government has to set up additional power generation infrastructure in order to make EVs more attractive. It has been estimated that if India were to achieve the NEMMP targets, the added electricity required to run BEVs would be about 1GW.

Range anxiety is another big concern. If a battery gets completely discharged in the middle of a journey, one will not be able to recharge it in minutes like filling petrol, thereby stranding the user. A strategic charging network infrastructure can eliminate this problem and will enable the use of BEVs in long-distance drives.

Upcoming smart grids in India can play a significant role in improving the charging infrastructure. Smart grids can help in optimising electricity needs at peaking demand hours for utility purpose and for BEV charging. They can provide information on grid network, empty slots for charging, usage and cost statistics. Bosch has already set up a similar kind of network (in Germany) with a mobile application, which provides information about locations, latest status and empty slots for charging. Robust infrastructure and communication facilities should be explored for Vehicle to Grid (V2G) integration, which can provide excellent demand response services by limiting the charging rate of EVs or by delivering electricity into the grid.

In terms of time requirement, an innovative solution for quick recharging is battery swap, which is equivalent to refuelling a vehicle.

Cost of EVs

The prices of BEVs are a major concern for prospective customers. The cost of the battery in BEVs accounts for nearly half of the total cost of a vehicle, thereby making long-range 4W BEVs three times more expensive than regular 4W BEVs, which are expensive than similar petrol-based 4Ws. For example, in the US, a 300 km–50 km long-range 4W BEV costs around $75,000, whereas a 100 km normal-range 4W BEV costs $25,000. Nevertheless, e-bikes cost less than their petrol counterparts because they have small, low performance lead acid batteries with very small range and speeds. Hero e-bikes and Mahindra e20 are priced at about ₹35,000–₹50,000 and ₹7.5–₹8.5 lakh, respectively, without subsidies. Buyers of Hero e-bikes and Mahindra e20 can avail subsidies worth ₹7,500–₹10,000 and ₹1 lakh, respectively.

The good news is that technology costs are slowly coming down, but remains unaffordable for the average middle-class Indian. The price of a lithium-ion battery was $1,000/kWh in 2007, which reduced to $300/kWh in 2015. When the price of lithium-ion battery goes below the benchmark value of $150/kWh, it will lead to a potential paradigm shift in EV adoption. Incentives such as discounts, low-cost finance, tax credits, etc, can make BEVs more viable, thereby promoting higher adoption of EV technology. As their market penetration increases, their cost will reduce simultaneously because of synergy between economies of scale and developments in technology. Solar energy in the energy industry has gone through a similar experience. Once the industry and the market are set up, private investors can take over to create a sustainable and competitive industry. In turn, the government will be able to generate tax revenues from the established industry in the future.

The low resale value of BEVs is also a major challenge in the EV market; old BEVs are undesirable because of battery replacement issues and uncertainty of the future of the BEV market. Majority of BEV batteries have a two–five year lifespan and battery replacement cost is a major hidden component, which increases the Total Cost of Ownership (TCO) significantly. The results of a TCO analysis, along with certain assumptions, have been shown in Table 2.

Creative solutions like developing and implementing a business model for leasing batteries in BEVs can lower overall prices. This new model will also insure consumers

from issues related to the performance, life, and recycling of the battery.

Other Policies

Public awareness is another important aspect that requires attention in order to boost EV sales. Today, only a small segment of the society, with a drive for sustainability and environmental awareness, purchase EVs. The government, non-governmental organisations, and policy think tanks should create awareness programmes to inform society about the potential benefits of EVs. The government can regulate polluting vehicles with stricter Bharat Stage emission standards and through policies like the National Auto Fuel Policy. Furthermore, "gamification" of sustainability, thereby incentivising consumers for the greater use of EV, may achieve better EV adoption. Providing opportunities for technology demonstration and municipal rollouts of EVs such as a recently announced fleet of 25 buses by Himachal Road Transport Corporation may attract more consumers.

In India, policies such as the Atal Mission for Rejuvenation and Urban Transformation, National Heritage City Development and Augmentation Yojana and Smart City Mission can support the adoption of BEVs by converging targets of these different schemes with NEMMP to create synergistic alliances. The National Green Tribunal, which works mostly in environmentally sensitive areas, should work over the broader area of EV deployment. The "Make in India" programme can be a sound guiding principle to enable domestic manufacturing and export of EVs and related components. The National Manufacturing Policy can also aid in the same. Going forward, NEMMP has to progress in synergy with various national policies, such as the National Urban Transport Policy, National Action Plan on Climate Change, National Solar Mission, National Mission on Sustainable Habitat and National Mission for Enhanced Energy Efficiency.

Conclusions

The article presents major issues affecting the EV industry and provides few solutions; however, solutions and numerous other issues need to be analysed in detail. An in-depth but quick and revised study of various EV industry related sectors, which include R&D, supply chain development, novel services and market behaviour, is important to understand and address challenges. Auto manufacturers and consumers are demanding more clarity on policies, with a robust action plan. On the policy side, the NEMMP objectives can be accomplished with re-estimated targets and time frames, strong and innovative policy frameworks and appropriate schemes and regulations. A systematic and sustainable action plan is essential to create an environment conducive for EV manufacturing and usage.