Hybrid and Electric Vehicles in India: Current Scenario and Market perspective

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Abstract

World market is using Conventional fuel vehicle mainly on petrol and Diesel but in Asia, China and India now emphasising on alternative fuel option i.e. Electricity. China is the world leader and quiet successful in adopting Hybrid and electric vehicles. Through this study we come to know about the scenario of Indian market. Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) scheme from the Central Government was launched in March, 2015. Indian government has introduced the electricity as new source of fuel for all type of vehicles to address the issues of National energy security, vehicular pollution and growth of domestic manufacturing capabilities. Under this scheme government announced different incentives to reduce India's dependence on foreign energy imports. The present Research work is an effort to study the different aspects of FAME scheme. Market incentive given by government on electric vehicles, other facilities such as fuel station and fuel efficiency of these vehicles is main focus of this article. The secondary collected has been systematically analyzed by using descriptive statistics. This study reviewed the impact of FAME after studying the penetration of electric vehicles in market and improvement in facilities.

Keywords: Hybrid and electric vehicle, fuel, battery, incentive, technology.

Introduction

India aims to have over 3 million Electric Vehicles [EVs] by 2030 from the present number of approximately 1500 electric vehicles in use[1]. In India, automobile exhaust is currently one of the biggest sources of pollution in cities. Through initiatives like Hybrid and Electric Vehicles, the government is not only looking to lower the levels of pollution in urban areas,

but is also hoping to reduce traffic congestion by promoting multimodal public transport[2]. Cost concern and facilities have prevented manufacturers from introducing Hybrid Electric Vehicle (HEVs) and Battery Electric Vehicle (BEV) technologies in India until recently, but this seems poised to change following the introduction of incentives to foster the penetration of these vehicles.

Table 1. Components and Outlay under FAME Scheme

Component of scheme	2015-16	2016-17
Technology platform (Including testing infrastructure)	Rs 70 crore	Rs 120 crore
Demand incentives	Rs 155 crore	Rs 340 crore
Charging infrastructure	Rs 10 crore	Rs 20 crore
Pilot projects	Rs 20 crore	Rs 50 crore
IEC/ Operations	Rs 05 crore	Rs 05 crore
Total	Rs 260 crore	Rs 535 crore
Grand total		**795 crore**

Source: Gazette of India, Ministry of heavy industry and public enterprises, 2015

In FY 2015-16, hybrid and electric passenger vehicles constituted approximately 1.3% of all passenger vehicle sales in India, up from essentially zero in FY 2012-13[1]. Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) scheme from the Central Government was launched in March, 2015 to foster hybrid and electric technology in India[3]. As outlined in Table 1, the scheme earmarks funds under several components for a two-year period across FY 2015-16 and FY 2016-17. Demand incentives, which are available as a direct subsidy on the retail price of eligible vehicles to consumers, are the most significant component of the scheme[3].

Since hybrid and electric technologies are inherently more fuel efficient than conventional technologies. The recent announcement from the government clarifying that there will be no need for separate licences for charging stations comes as a huge relief to the EV industry with many citing that the positive announcement will create a level playing field for different stakeholders in the sector and foster the adoption of EVs in the country[5]. They play an important role in reducing India's dependence on foreign energy imports as well as in achieving climate and air quality benefits resulting from reduced fuel consumption.

Objectives of the Study

1. To study the use of the demand incentive allocations under the FAME scheme for FY 2015-16, based on vehicle segment and technology.
2. To examine the fuel-efficiency benefits of models currently registered under the FAME scheme.
3. To examine the relative contribution of all incentives considered, including demand incentives from FAME, in making hybrid and electric technologies cost-competitive in the Indian market.

It is important to note that because consumers do not always make purchasing decisions using structured cost-comparison methods, the objective of this analysis is not to comment on what the "correct" level of incentives should be, but rather to help readers understand the relative

contribution of various incentives in making hybrid and electric technologies cost-competitive with conventional options on the market.

Further, because the overall goal of such incentives is to influence the market in favour of socio-economic outcomes such as domestic energy security and climate change mitigation, this analysis also aims to inform readers on such contextual benefits available through hybrid and electric technologies. For perspective, crude oil imports constitute more than 30% of India's primary energy supply[6] and the majority of this oil consumption is from refined petroleum products used in the transport sector[4].

Market incentives in place

The FAME scheme offers a subsidy on retail price of different Vehicle segments. Subsidies are available for two-wheelers, three-wheelers, light-commercial vehicles, buses, and for retrofit kits[3]. A summary of the available demand incentives across vehicle segments is outlined in Table 2.

Table 2. Range of Demand Incentives Available Across Vehicle Segments and Technologies under FAME Scheme

Vehicle Segment	Mild Hybrid INR	Strong Hybrid INR	Plug-In Hybrid INR	Battery-Operated Electric INR
TwoWheelers	1,800 – 6,200	----------	13,000 – 18,000	7,500 – 29,000
ThreeWheelers	3,300 – 7,800	----------	25,000 – 46,000	11,000 – 61,000
Passenger Cars	11,000 – 24,000	59,000 – 71,000	98,000 – 1,18,000	76,000 – 1,38,000
LightCommercial Vehicles	17,000 – 23,000	52,000 – 62,000	73,000 – 1,25,000	1,02,000 – 1,87,000
Buses	30,00,000 –41,00,000	51,00,000 – 66,00,000	----------	----------

Demand incentives are also available for retrofit kits across all vehicle segments and technologies for up to 15% to 30% of kit price depending on the amount of fuel consumption reduced, as well as price of the kit[21].

The subsidy from the FAME scheme is not the only incentive mechanism that impacts the market for hybrid and electric vehicles in India. In the national FY 2016-17 budget, the Central Government of India exempted hybrid and electric vehicles from infrastructure cess[4].

Automobile industry body Society of Indian Automobile Manufacturers (SIAM) has proposed a host of fiscal as well as non-fiscal incentives including reduction of tax on electric vehicles to 5% from the current 12% if the government is to realise its objective of attaining 100% electric mobility in the intra-city public transport sector and 40% e-mobility among individual users by 2030. In non-fiscal incentives, the industry has advocated that power tariff for charging electric vehicles be 50% of existing domestic tariff rate for home and workplace charging to enhance utilisation of EVs. SIAM has also said that all electric vehicles be exempted from paying toll charges, all electric vehicles used for commercial purposes be fully exempt from state entry taxes and all electric two-wheelers and passenger vehicles used for personal purposes be exempt from parking charges. Manufacturers are passing on some or all of these benefits to the consumer, which should encourage greater sales of hybrid and electric vehicles.

Approach and key incentives

Fuel-efficiency evaluation: Fuel efficiency benefits are evaluated in terms of fuel-consumption reductions of registered hybrid and non-electric models under the FAME scheme, in comparison with their non-hybrid or non-electric base models or appropriate reference benchmarks from the segment. Further, for passenger cars, fuel-consumption levels of the registered models are also evaluated in perspective of India's recently implemented fuel-consumption standards for passenger cars that are to be enforced from FY 2017-18[5], as well the proposed passenger car fuel-efficiency labelling program. Life-cycle greenhouse gas (GHG) emissions are also estimated for a five-year use period for all passenger cars eligible for subsidy under the FAME scheme and their base models[21].

Fuel Efficiency and Life Cycle Emissions Evaluation of Vehicles Registered under FAME Scheme

PASSENGER CARS

In the passenger car segment, there are one gasoline-based strong hybrid model from Toyota, two battery electric vehicle models from Mahindra & Mahindra and two diesel-based mild hybrid models from Maruti Suzuki that are currently eligible to receive demand incentives under the FAME scheme[6]. A summary of the specifications and fuel consumption of these models is presented in Table 3.

Table 3

Vehicle	Segment	Technology	Curb Weight (kg)	Length (mm)	Displacement (cc)	Price Range (INR Lakhs)	Gasoline Equivalent Fuel Consumption (liter/100 km)	Life-Cycle CO2e Emissions (Tonnes/5 years)
Maruti Ciaz SHVS	Midsize	Mild Hybrid (Diesel)	1,115	4,490	1,248	8 to 10.5	3.98	6.73
Maruti Ertiga SHVS	Utility Vehicle (UV1)	Mild Hybrid (Diesel)	1,235	4,265	1,248	7.5 to 9.5	4.55	7.71
Toyota Camry Hybrid	Premium	Strong Hybrid (Gasoline)	1,635	4,850	2,494	28 to 32	5.22	8.12
Mahindra e2o	Mini	BatteryOperated Electric	830	3,280	NA	4.5 to 7.5	0.86	5.06

Mahindra eVerito	Midsize	BatteryOperated Electric	1,140	4,277	NA	9.5 - 10	1.47	9.94

Source: As per fuel economy values under test conditions certified by Automotive Research Authority of India.

There are a few imported units such as the Toyota Prius (gasoline-based strong hybrid) and the BMW i8 (gasoline-based plug-in hybrid) also available on the Indian market, however demand incentives under the FAME scheme are available only to vehicles manufactured (assembled) in India. The Maruti Ciaz SHVS and Ertiga SHVS are based on lead-acid batteries, while the Toyota Camry Hybrid, Mahindra e2o, and Mahindra eVerito are based on advanced lithium ion battery technologies. Mahindra also recently announced the launch of the luxury EV brand Automobili Pininfarina with plans to introduce an electric hyper car by 2020[5].

Utilization of demand incentives under FAME scheme for year 15-16

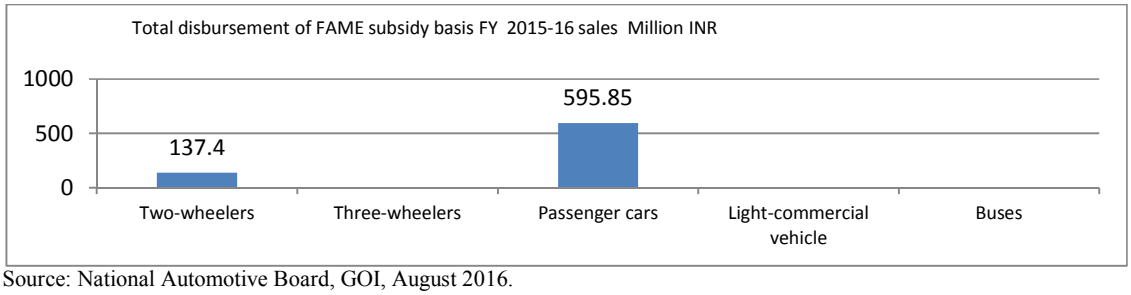
Passenger car and two wheeler models appear to be taking advantage of the FAME scheme although it incentives are for all vehicle segments. Hyderabad-based Goldstone Group, which sells electric buses in India in collaboration with China's BYD, is investing Rs 500 crore to set up its second manufacturing facility, in Karnataka and also completed trials of its electrical buses in Delhi, Bengaluru, Hyderabad, Rajkot and Chandigarh[5].

Table 4. Number of Models Currently Eligible under FAME Scheme and Unit Sales for FY 2015-1620

Vehicle Category	Mild Hybrid Eligible Models (Units sold)	Strong Hybrid Eligible Models (Units sold)	Plug-In Hybrid Eligible Models (Units sold)	Battery-Operated Electric Eligible Models (Units sold)
Two-Wheelers				24 (17,836)
Three-Wheelers				
Passenger Cars	2 (33,394)	1 (911)		2 (790)
LightCommercial Vehicles				
Buses				
Retrofitment kits				

Source: Department of Heavy Industry, 2016.

A summary of the registered models under the FAME scheme is outlined in Table 4. Based on the sales data for the above models for FY 2015-16, the outflow from demand incentives under the FAME scheme for FY 2015-16 is presented in Table 4 and stands underutilized at 47% of the allocated among Passenger cars constituted 81.3% of the total demand incentive utilization in FY 2015-16; two-wheelers were the remaining 18.7%.



Source: National Automotive Board, GOI, August 2016.

Within the outflow to passenger cars, 73% of the funds were utilized by mild hybrid cars, 11% by strong hybrid cars, and 16% by battery-operated electric cars. All the two-wheelers registered under the scheme are battery-operated electric models[6]. There are no eligible models registered under the scheme across other vehicle segments. Going forward, hybrid buses hold potential to gain significantly under FAME, as the allocations available cover a significant portion of the technology costs.

Fuel Efficiency Evaluation

The fuel consumption for the eligible models under the FAME scheme all come well under the 2017-18 standard limit of about 5.5 gasoline equivalent[5] liters/100 km (or 130 g/km when expressed in terms of CO2 emissions). All of the above models also fall under the 5-star fuel efficiency label as per the star labelling methodology proposed by the government's Bureau of Energy Efficiency (BEE). Efficiency gains of the registered hybrid and electric models under the FAME scheme compared with their base models are presented in Table 5. Sales of hybrid and electric passenger cars in India in FY 2015-16 resulted in fuel-consumption reductions of approximately 2.97 million gasoline equivalent liters[5].

Emissions for electric models are due to electricity consumption from the Indian grid (including transmission and distribution efficiencies), while for the gasoline- and diesel-based models, the majority of the emissions are on account of fuel consumption during vehicle operation. The current electricity mix in India is coal based, however India has announced its intent to reduce the carbon intensity of its grid by scaling up renewable power generation capacity from 36 GW in 2015 to 175 GW by 2022[8], as per India's Intended Nationally Determined Contribution (INDC) under the United Nations Framework Convention on Climate Change. This is expected to result in an abatement of an estimated 326 million tonnes of CO2e per year.

Further, it is reported that the efficiencies of power generation[9] as well as transmission and distribution[10] in India are significantly lower than global averages, and improvement of efficiencies in the power sector have also been recognized as a priority in the INDC[11]. Thus, it is important for government to build up market for electric mobility in a parallel timeframe as the renewable energy footprint and energy efficiency of India's power sector will undergo transformational improvements.

Table 5

Technology	Hybrid/Electric Model (BEE Fuel Efficiency Star Rating)	Non-Hybrid/Non-Electric Base Model (BEE Fuel Efficiency Star Rating)	Gasoline Equivalent Fuel Consumption Reduction over Base Model
Diesel-Based Mild Hybrid	Maruti Ciaz VDI SHVS (5-Star)	Maruti Ciaz VDI (5-Star)	7%
Diesel-Based Mild Hybrid	Maruti Ertiga VDI SHVS (5-Star)	Maruti Ertiga VDI (4-Star)	15%
GasolineBased Strong Hybrid	Toyota Camry Hybrid (5-Star)	Toyota Camry AT 2.5 L (2-Star)	32%
BatteryOperated Electric	Mahindra E-Verito D2 (5-Star)	Mahindra Verito D2 (4-Star)	68%
BatteryOperated Electric	Mahindra e2o (5-Star)		

Source: Bureau of Energy Efficiency (BEE).

Two wheelers

There are 24 two-wheeler models registered to receive demand incentives under the FAME scheme and all are battery-operated electric.

Vehicle	Maximum Speed (kmph)	Curb Weight(kg)	Price (INR Thousand)	Gasoline Equivalent Fuel Consumption (l/100 km)	Life-Cycle CO2 e Emissions (tonnes/ 5 years)
Ajanta J-500 Plus	25	Not Available	35.00	0.32	1.90
Ampere V48	25	85	37.27	Not Available	No data
Ampere V60	25	100	47.92	Not Available	No data
Avon Escoot 207	24	Not Available	33.50	Not Available	No data
Avon E Mate	24	Not Available	45.00	Not Available	No data
Breeze Lite	25	Not Available	Not Available	Not Available	No data
Yo Electron ER	25	84	30.00	0.23	1.36
Yo Explor	25	86	34.76	0.27	1.58
Yo Spark	45	114	47.13	0.45	2.66
Yo Exl ER	55	138	51.81	0.70	4.11
Hero Maxi	25	75	35.49	0.18	1.08
Hero Zion	25	Not Available	Not Available	Not Available	No data
Hero Optima Plus	25	82	40.19	0.18	1.08
Hero E-Sprint	45	106	47.69	Not Available	No data
Hero Photon	45	111	48.49	Not Available	No data
Hero Cruz	25	75	42.89	0.18	1.08
Hero Wave	25	Not Available	Not Available	Not Available	No data
Hero Wave DX Extra Mile	25	Not Available	48.19	0.19	1.14
Hero Optima DX	25	Not Available	Not Available	Not Available	No data
Hero NYX	25	Not Available	39.19	0.18	1.08
Lohia OMA Star	25	89	35.50	0.32	1.90
Lohia OMA Star DX	25	Not Available	41.50	0.24	1.42
Lohia Genius	25	89	32.50	0.28	1.63

Source: Gazette of India, Ministry of heavy industry and public enterprises, 2015

*All listed models are based on conventional lead-acid batteries.

One of the models is based on conventional lead-acid battery technology, while one low-speed electric model (Hero Optima Dx Li) based on advanced lithium ion battery technology[8]. Nineteen of the 24 models are low-speed scooters with maximum power output of less than 250 watts and maximum speed of 25 kilo meters per hour[8]. However, the Hero Optima Dx Li has yet to be launched in the market[12]. Lithium-based batteries have a higher energy density than lead-acid batteries (thus being lighter for a given capacity and increasing efficiency), have a longer life cycle (> 2,000 charges) than lead-acid batteries (300 to 400 charges), and are capable of fast charging (up to 80% charge in 30 minutes) compared with lead-acid batteries (7-8 hours for a full charge). Further, lead-acid batteries are also associated with higher environmental risks on account of potential lead leakage that may occur in the recycling and disposal process. However, lithium-based batteries have a higher upfront purchase cost than lead-acid batteries. For example, it is reported that the Hero Optima Dx Li is likely to be priced upward of INR 60,000 in Delhi[13], while the average cost

of lead-acid-based low-speed scooters in Delhi is about INR 30,000. A summary of the available specifications and fuel consumption data of the registered models available on the market is presented in Table 6.

Table 6

	Maximum Speed (kmph)	Maximum power Output(W)	Gasoline Equivalent Fuel Consumption (l/100 km)	Life-Cycle CO2 e Emissions (tons/5 years)
Low-Speed Electric Scooters	25	250	<0.51	<3.04
High-Speed Electric Scooters	45-55	1500-1800	<0.82	<4.86
Honda Activa 3G	82	5966	1.5	2.33

Source: Bureau of Energy Efficiency (BEE).

The above models are part of an all electric two-wheeler series from the manufacturers, and do not have corresponding non-electric base models. In this case, the top-selling two wheeler scooter in the Indian market, the Honda Activa 3G, is considered as a reference benchmark.

As electrical energy consumption values were not available for all the registered two wheelers under the FAME scheme, it was not possible to compute the gasoline equivalent fuel consumption values for all of the models. However, the FAME scheme caps the maximum energy consumption from low- and high-speed electric two-wheelers at 5 kWh/100 km and 8 kWh/100 km, respectively, as eligibility criteria to receive demand incentives under the scheme. These energy consumption limits are used as a perspective for comparison against the non-electric reference benchmark.

A summary of the maximum fuel consumption for electric two-wheelers under the FAME scheme compared with the Honda Activa 3G is presented in Table 6. Electric scooter manufacturers in India do not disclose energy consumption data. It is interesting to note the differences between electric scooters on the Indian market and electric scooters in China, which is the global leader in electric two-wheeler manufacturing and use[15]. While lead-acid batteries are still the most prevalent battery type in both markets, Chinese regulations promote low-weight, low-power, low-speed design, with a view toward passenger safety and reduced environmental impacts[15]. The general penetration of electric two-wheelers in China is attributed majorly to government restrictions on gasoline-powered scooters in certain cities as well as access to a well developed bicycling infrastructure that provides safe driving lanes[19].

Other Incentives

It is also important to consider other incentive mechanisms that significantly impact cost of ownership at a consumer level. It will help in understanding the contribution of FAME in bringing down the costs of hybrid and electric technologies in the Indian market,

Table 7

Vehicle Category	Central Excise

	Duty
Length < 4m, gasoline/LPG/CNG, and engine capacity < 1200 cc	12.5%
Length < 4m, diesel, and engine capacity < 1500 cc	12.5%
Length < 4m, gasoline/LPG/CNG, and engine capacity > 1200 cc but < 1500 cc	24%
Length > 4m and engine capacity < 1500cc	24%
Length > 4m and engine capacity > 1500cc	27%
Length > 4m, engine capacity > 1500cc, and ground clearance >170mm (SUVs and MUVs)	30%
Buses	12.5%
Trucks	12.5%
Three wheelers	12.5%
Two wheelers	12.5%
Hybrid cars	12.5%
Electric Cars, Buses, Two Wheelers, Three Wheelers	6%

Source: Gazette of India, Ministry of heavy industry and public enterprises, 2015.

Central excise duty

Central Excise Duty in India is an indirect tax levied on all goods manufactured in India. The duty is paid by manufacturers, who pass that cost on to consumers. As outlined in Table 7, hybrid and electric vehicles are subjected to reduced central excise duty rates compared with the tariffs for conventional technologies.

Central infrastructure cess

In form of additional excise duty an infrastructure cess was put in place for passenger vehicles in India in 2016, to be paid by manufacturers. Hybrid and electric vehicles are exempt from this cess. It is expected that manufacturers of non-exempt vehicles will pass on the incidence of this tax to consumers.

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Conclusion (FAME scheme)

The majority of FAME scheme utility has gone to mild hybrid passenger cars and two wheelers and the relative contribution from the scheme is currently playing a small role in keeping hybrid technologies cost-competitive with base models. Thus, there is potential to realign allocations to focus more on electric technologies compared with hybrid, particularly for passenger cars, including increased emphasis on supporting aspects such as creation of public and privately owned charging infrastructure.

Further, it is important to understand that, from a consumer perspective, there is a difference between owning electric (and plug-in hybrid) and hybrid technologies. While hybrid ownership is similar in experience to owning a conventional internal combustion engine-based technology, electric technologies call for a significant shift in driving habits. For example, consumers will have to schedule travel routes and distances based on vehicle range and availability of charging points. Thus, expecting a shift to electric technologies from consumers will likely require substantially greater investments in charging infrastructure, including subsidies for home-based and workplace charging stations

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