IMAP | India

Electric Vehicles Industry Landscape / 2017

In this issue

An electric vehicle is driven by an electric motor using electrical energy stored in rechargeable batteries instead of an internal combustion engine that is used to drive a conventional petrol/diesel driven vehicles. Electric vehicles are classified into all-electric and hybrid classes. Plug-in Hybrid Electric Vehicle(PHEV) is a vehicle which runs on both petrol & electricity.

Electric vehicles have regenerative braking, which captures the vehicle's kinetic energy while braking, and converts it into electricity, which charges the electric motor and hence increases the efficiency of the vehicle. In conventional IC Engine vehicles, this energy is lost as heat due to friction with the ground.

EVs convert about 59%–62% of the electrical energy from the grid to power at the wheels. Conventional gasoline vehicles only convert about 17%–21% of the energy stored in gasoline to power at the wheels.

Electric vehicles are quiet due to lack of engine noise. In fact, many countries have legislations which require electric vehicles to have warning sounds designed to alert pedestrians to the presence of electric drive vehicles travelling at low speeds.

Electric Vehicles

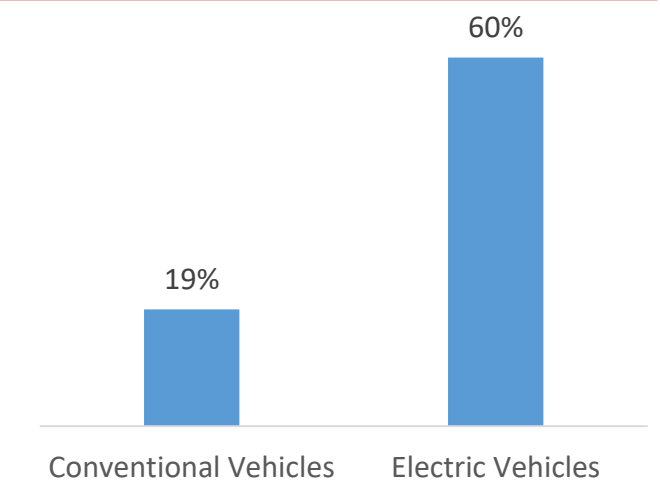
- Energy efficient
- Regenerative braking
- No tile pipe emissions
- Fewer moving parts
- No engine noise
- Cheaper fuel
- Lower maintenance costs

Electric generators and motors are eco-friendly even if electricity generation is done using conventional sources because, electricity generation is generally done in the most energy efficient and cleanest possible manner for a given fuel even accounting for losses in producing electricity from some fuel, transmitting it over power lines, recharging a battery with it, and feeding it out of the battery to the motor, you still can go a lot farther by burning a given amount of fuel to generate electricity for an electric car than by using it directly in an internal combustion engine.

Japan already has more electric car charge points (40,000) than petrol refuelling stations(35,000).

Stanford economist Tony Seba, in his report "Rethinking Transportation 2020-2030", predicted that EV battery ranges will surpass 200 miles over the next 2-3 years and electric car prices in the US will drop to $30,000, and by 2025, all new vehicles would electric. Eventually, by 2030, people will stop driving all together and switch to self-drive electric vehicles due to practically zero marginal costs incurred in EVs.

Energy efficiency* comparison



* Energy efficiency for a vehicle engine is the energy output, divided by the energy input

Over 750,000 electric cars were sold worldwide in 2016. The EV regions are USA, China, Norway, Japan and Netherlands.

Norway has incontestably achieved the most successful deployment of electric. EV have a market share of 29%. China accounted for over 40% of the electric cars sold in the world, overtaking USA to account for the largest portion of global car stock and annual electric vehicle sales.

As the number of electric vehicles on the road has continued to increase, private and publicly accessible charging infrastructure has also continued to grow, with an annual growth rate of publicly available charging points of 72% in 2016 across the world.

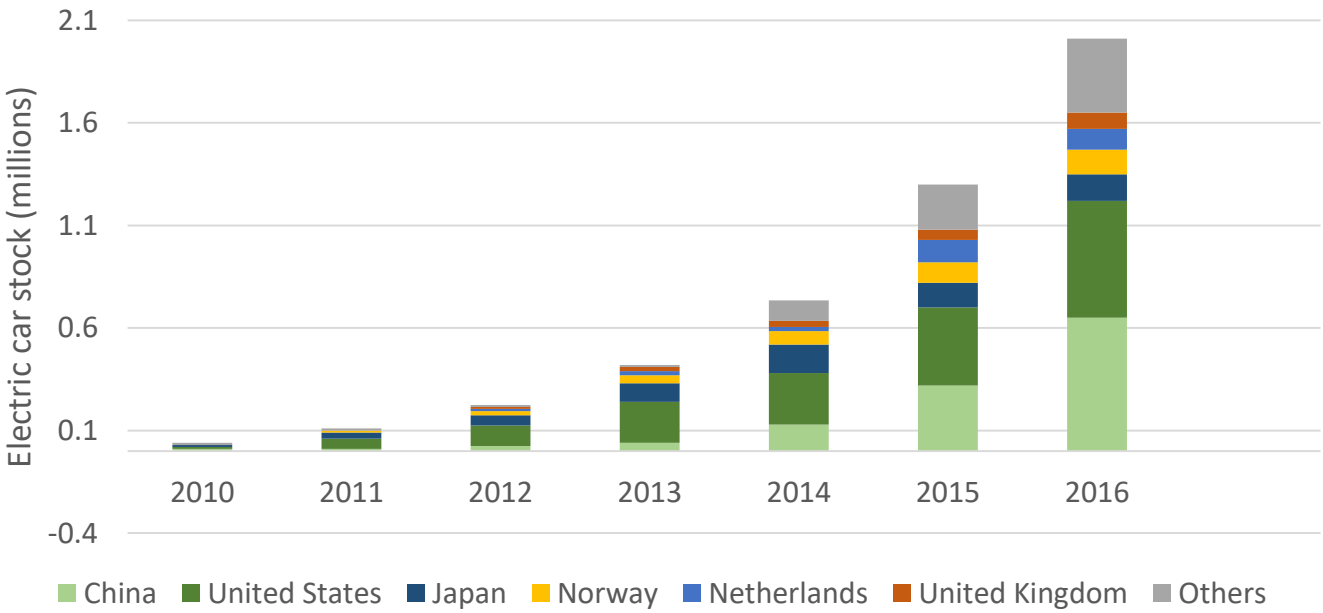
Currently, it is undeniable that the electric vehicle market uptake is largely influenced by the policy environment targeting both the deployment of electric cars and charging infrastructure.

Policy support will remain indispensable at least in the medium term for lowering barriers to electric car adoption. As electric car sales keep growing, governments will need to reconsider their policy tools.

Electric Vehicle charging could also have a sizeable impact on the loads applied to the grid at certain times & locations, with consequences for adequacy and quality of power supply, the risk of cost increases for consumers and negative feedback on transport electrification prospects.

So far, industry, governments and early adopters have succeeded in demonstrating that electric vehicles can deliver the practicality, sustainability, safety and affordability characteristics expected from them.

Evolution of global electric car stock



Source: IEA

China overtook the United States to become the country with the largest electric car stock, registering as many as 352,000 new electric cars in 2016, compared to only 159,000 cars registered in the US during the same time period. With more than 200 million electric two-wheelers, 3 to 4 million low-speed electric vehicles and more than 300,000 electric buses, China is also by far the global leader in the electrification of other transport modes.

The high popularity of e-bikes in China may be accredited to their low prices ($125 to $375) and low maintenance costs. The average daily operating cost of an e-bike is just 21 cents per day, which is 20 times cheaper than the operating cost of a car in China. Legally, e-bikes are held under the same regulations as bicycles in China, which means that riders don't need a license, any training, insurance, or even a helmet to operate one.

Electric cars in China enjoy an exemption from acquisition tax and the excise tax, normally based on engine displacement and price. The value of incentives is in the range of $6000 to$10000 to purchase electric cars.

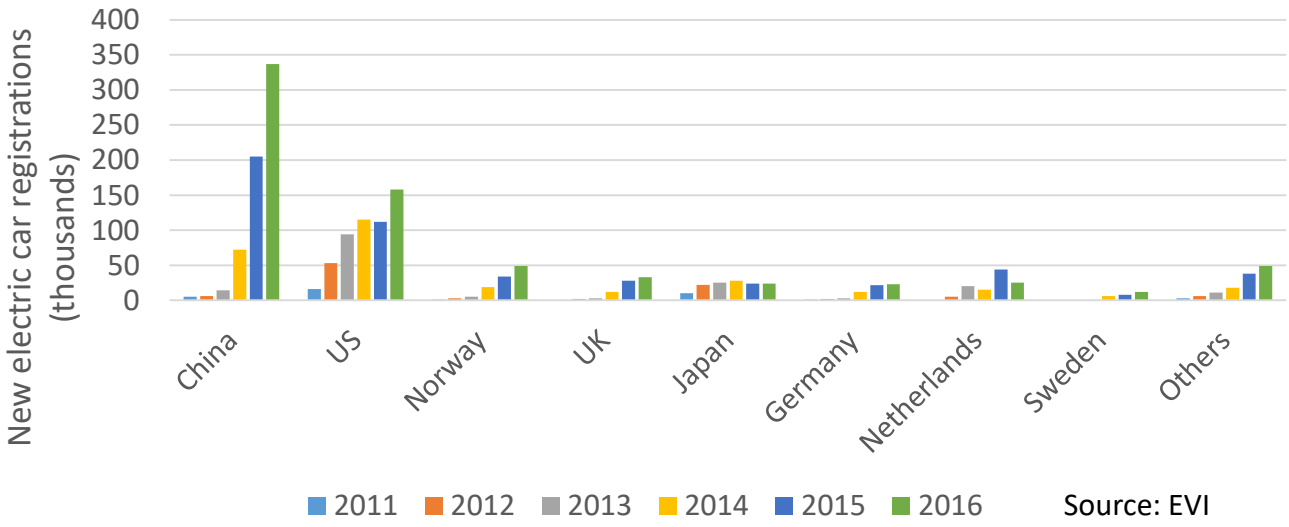
Also, gasoline powered motorcycle are banned or restricted in over ninety major Chinese cities. The justifications for these bans included relieving traffic congestion, improving safety and reducing air pollution and were imposed on all motorcycles, regardless of their power sources, and since electric bikes are categorized as non-motor vehicles they were exempt from the bans.

The relatively small sizes of e-bikes leads to higher flowrate on roads and efficient parking, even as Chinese cities become more and more packed with personal automobiles.

The Chinese Government's goal is to have five million battery-electric and plug-in hybrid electric cars on the road by 2020, while also producing one million such vehicles annually by 2020.

However, electricity produced in China is not completely eco-friendly. As of 2016, 57.2% of electricity produced in China comes from coal.

EV sales in a selection of countries



Source: EVI

The adoption of plug-in electric vehicles in the United States is actively supported by the American federal government, and several state and local governments. As of December 2016, cumulative sales in the US totalled 570,187 highway legal plug-in electric vehicles.

The U.S. market share of plug-in electric passenger cars increased from 0.14% in 2011 to 0.90% in 2016.

US EV sales jumped by 37% in 2016. By the year-end, there were about 30 different EV offerings, with total sales of 159,139 vehicles. More than half of these EV sales took place in California, driven by the state's zero-emission vehicle(ZEV) mandate, which requires that a certain percentage of an automaker's sales must be ZEVs.

The states of Washington, Oregon and California together organised an extensive network of DC fast-charging stations, the West Coast Electric Highway, which connects the three states through stations along major roadways located every 40-80 km.

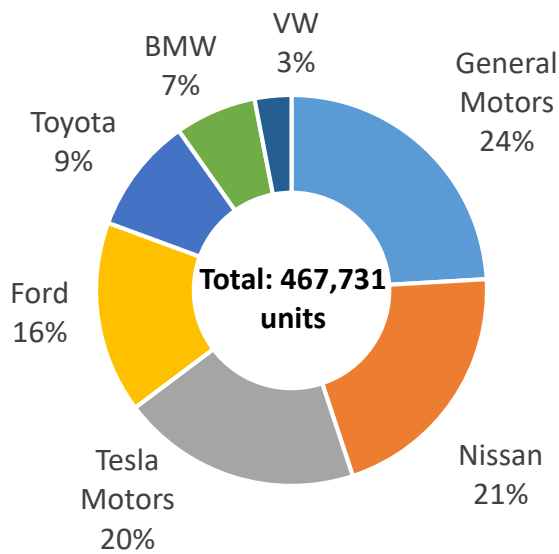
President Barack Obama pledged US$2.4 billion in federal grants to support the development of next-generation electric vehicles and batteries.

The federal government grants tax credits of upto $7500 for new qualified plug-in electric drive motor vehicles. This will be phased out after 200,000 units per manufacturer are sold for use within the country.

Around 40 states govts have established incentives and tax or fee exemptions for BEVs and PHEVs, or utility-rate breaks, and other non-monetary incentives such as free parking and high-occupancy vehicle lane access regardless of the number of occupants

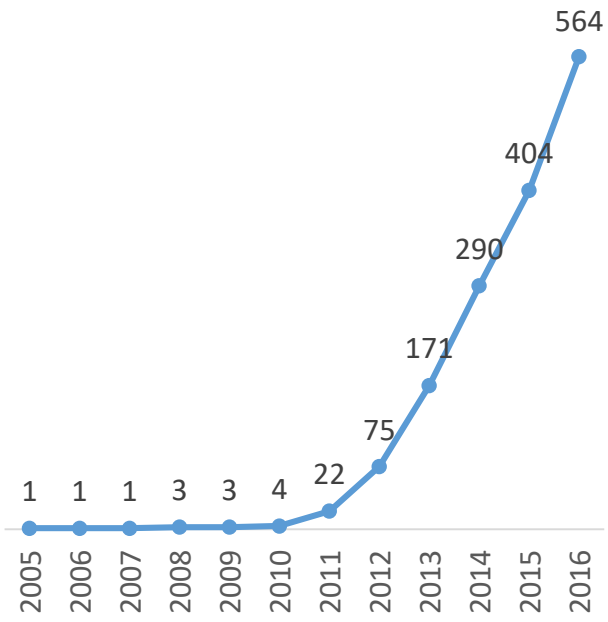
As part of the Paris agreement in 2015, the Federal government had set targets to reduce its own carbon footprint 30% by 2025, and acquire 20% of all new passenger vehicles as zero emission (all-electric or fuel cell) or plug-in hybrid by 2020, and 50% by 2025.

EV sales in USA (till Aug '16)



Source: hybridcars.com

Electric car stock in the US (thousands)



Source: IEA

9 of the 16 members in the Electric Vehicle Initiative are from Europe. In terms of policy support and market acceptance Norway and Netherlands lead the way.

Norway has the highest per capita number of all-electric vehicles in the world: more than 135,000 in a country of 5.2 million people. In 2016, EVs constituted nearly 40% of the nation's newly registered passenger cars.

The country intends to phase out all fossil fuel-powered automobiles by 2025.

Since 98 % of Norway's electricity comes from hydropower, the country's burgeoning EV fleet leaves almost no carbon footprint.

Electric vehicles are exempt from acquisition tax, the annual road tax, toll payments, and can use bus lanes. Battery Electric Vehicles (BEVs) are exempt from the 25% VAT on car purchases. Until 2016, electric cars were completely exempt from paying public parking fees. These measures taken by the government provide a highly favourable environment for electric vehicle uptake.

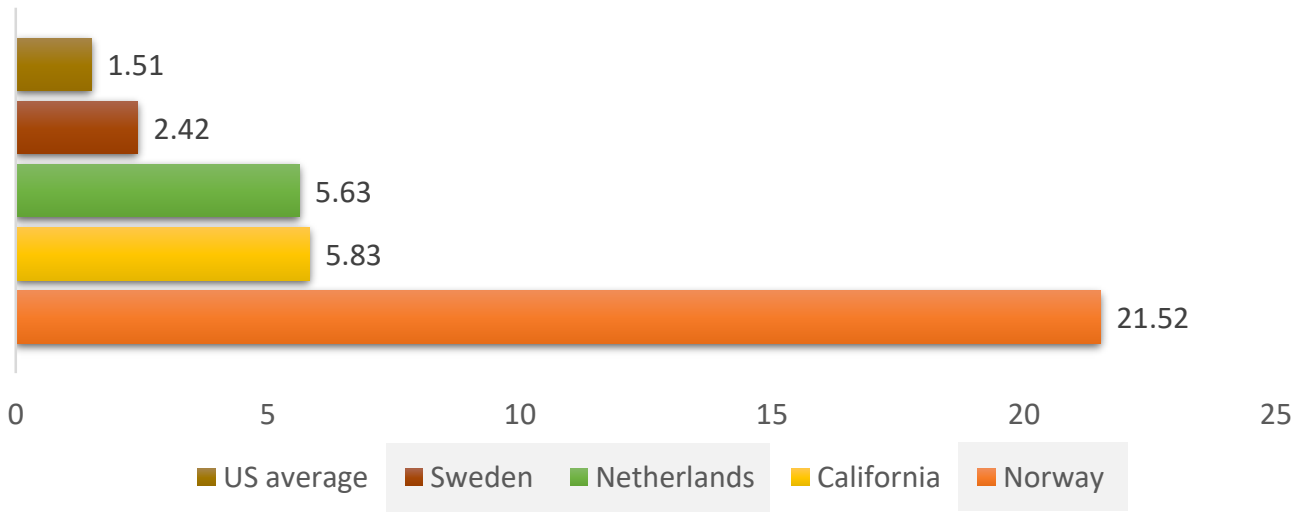
The Dutch government set a target of 15,000 to 20,000 electric vehicles with three or more wheels on the roads in 2015, which they ended up achieving in 2013. They have set targets to have 200,000 electric vehicles by 2020 and 1 million vehicles by 2025 on the roads.

As of Dec 2016, there were 113,636 highway legal light-duty plug-in electric vehicles registered in the Netherlands.

Zero-emission cars are exempt from registration tax, while plug-in hybrid vehicles are subject to a differentiated carbon emission based taxation scheme. ZEV owners pay 4% income tax on the private use of a company car, while the rate for PHEVs are likely to increase to 22% in 2017. Free charging is also offered in public parking spaces.

Dutch politicians have voted through a motion calling on the country to ban sales of new petrol and diesel cars starting in 2025. The motion has only passed through the lower house of the Netherlands' parliament, and would need to pass through the Dutch senate to become legally binding.

Concentration of plug-in electric cars registered per 1,000 people (as of July '16)



Source: hybridcars.com

The table below shows the various policy measures undertaken by respective Central Governmental Agencies across the world. Given the nascent stage of the industry, the most vital facilitator for the EV industry comes from strong Governmental support, such as that seen by the growth of EVs in China, USA, Norway and the Netherlands

	No policy
	Targeted policy
	Widespread policy
	Nationwide policy
	General fuel economy standard, indirectly favouring EV deployment

	EV purchase incentives				EV use and circulation incentives				Tailpipe emission standards		Market share of electric cars in 2015
	Rebates at registration/sale	Sales tax exemptions (excl. VAT)	VAT exemptions	Tax credits	Circulation tax exemptions	Waivers on fees (e.g. tolls, Parking, ferries)	Electricity supply Reductions/exemptions	Tax Credits (Company cars)	Fuel economy standards/regulations including elements	Road vehicles tailpipe pollutant emissions standards	
Canada										Tier 2	0.4%
China										China 5	1.0%
Denmark										Euro 6	2.2%
France										Euro 6	1.2%
Germany										Euro 6	0.7%
India										Bharat 3	0.1%
Italy										Euro 6	0.1%
Japan										JPN '09	0.6%
Netherlands										Euro 6	9.7%
Norway										Euro 6	23.3%
Portugal										Euro 6	0.7%
South Korea										Kor 3	0.2%
Spain										Euro 6	0.2%
Sweden										Euro 6	2.4%
United Kingdom										Euro 6	1.0%
United States										Tier 2	0.7%

Source: EVI

Technology learning, R&D and mass production of batteries for Electric Vehicles has led to rapid cost declines and performance improvements in the past decade and hold the promise of continuing to progressively reduce technology costs in the near future. Development of battery technology will determine the pace of growth of EVs across the World

Battery cost estimates monitored by United States Department of Energy (US DOE) show that costs fell from about USD 1000 per kWh in 2008 to USD 250 per kWh in 2016.

The US DOE has set a target of reaching battery costs of USD 125 per kWh by 2022 to achieve cost-competitiveness of Electric Vehicles relative to vehicles using conventional engines in the United States. Meeting this target implies achieving an additional 50% cost decrease in the next six years, corresponding to a 10.9% cost decrease every year between 2017 and 2022. This target seems realistic in regard to the improvements already seen in previous years.

Some original equipment manufacturers have announced even more ambitious cost estimates for Battery Electric Vehicles:

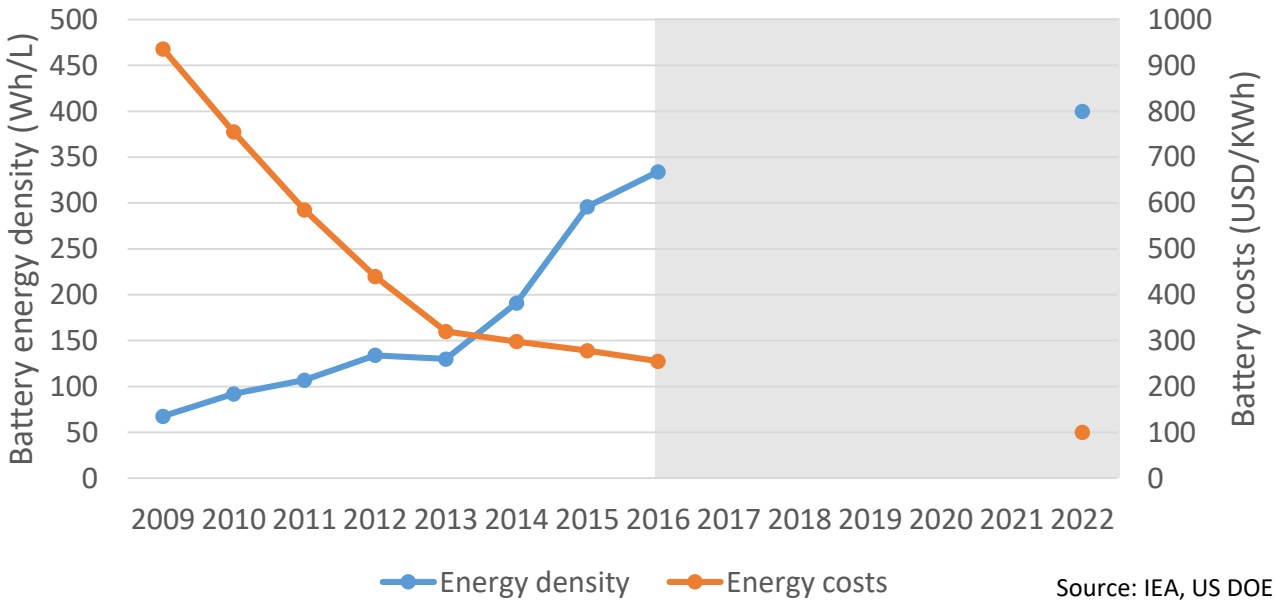
- GM announced that battery costs for its 2016 Chevrolet Bolt had fallen to USD 145 per kWh by Oct '15 and it hopes to reduce them further to USD 100 per kWh by 2022

- Tesla aims to break the USD 100 kWh mark by 2020

Battery costs have been cut by a factor of four since 2008 and are set to decrease further. In parallel, battery energy density needs to increase to enable longer ranges for lower prices. Technological progress and economies of scale are critical to move towards parity with conventional ICEs.

The chart below shows the evolution of battery density and cost over the past 8 years along with the 2022 targets for battery cost and energy density:

Evolution of battery energy density and cost development and 2022 estimate



Source: IEA, US DOE

The Indian auto industry is one of the largest in the world. The industry accounts for 7.1 per cent of the country's GDP. The production of automobiles increased at a CAGR of 9.4% over FY06-16. The Two Wheelers segment with 81 per cent market share is the leader of the Indian Automobile market owing to a growing middle class and a young population. India has overtaken China to emerge as the world's biggest market for two-wheelers, with a total of 17.7 million two-wheelers sold in 2016, compared to China's 16.8 million units sold in the same period.

While at two wheelers is dominated by conventional models, like in the case of China 10 years ago, India is set to transition to a majority electric vehicle two wheeler fleet within the next 5-10 years.

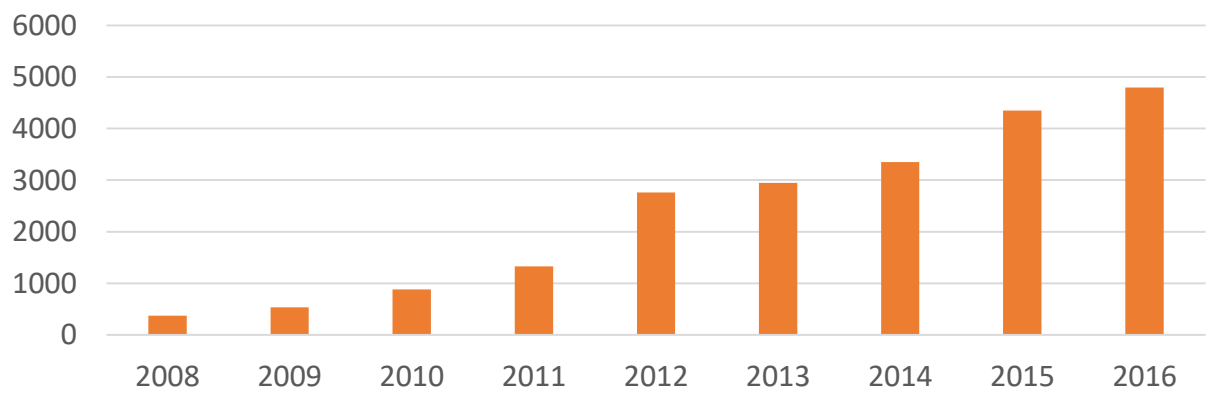
India can save up to 64 per cent of anticipated passenger mobility-related energy demand and 37 per cent of carbon emissions by 2030 by moving to a all electric fleet, a vision which is shared by the Government.

A report released by NITI Aayog said that India can reduce its annual diesel and petrol consumption by 156 million tonnes by 2030 saving a total of INR 3.9 lakh crore ($60 billion) per year by adopting a shared, electric and connected mobility future.

Given the nascent stage of the industry, there are a limited number of participants relative to those manufacturing conventional vehicles. This list is increasing as favorable policies and rapid technology advances in Electric Vehicles is developing a strong platform for growth.

Key Electric Vehicle / hybrid OEMs	
Mahindra	Ather Energy
Maruti	Okinawa
Toyota	Tork Motors
Nissan	Hero Electric

Electric car stock in India



Faster Adoption of Manufacturing of Hybrid and Electric Vehicles

- In 2015, the Government of India launched the FAME Scheme, under which electric two wheelers will be subsidized
- The total outlay for FY17 was Rs 535 crore versus Rs 260 crore in FY16; Two wheelers accounted for approximately 19% of the total outflow from FAME in FY 2016-17
- The outlay under the scheme is weighted toward providing consumer incentives instead of R&D; India stands to gain from technological advances made globally already

Other Incentives

- In addition to FAME, the Central government and State governments provide tax incentives that treat hybrid and electric vehicles preferentially over conventional technologies

GST Rates

- The GST Council has set a tax rate of 12% for electric vehicles as against a 28% rate for petrol and hybrid variants, clearly signaling the government's intent to move India towards electric vehicles

The government has set ambitious plans for moving to an all electric vehicle country by 2030

- **Demand side incentives** – focused to create demand through incentivizing consumers
- **Supply side Incentives** – focus to create supply of affordable vehicles into the market
- **R & D** – focus to create technology capability to achieve localization and domestic manufacturers
- **Charging Infrastructure** – focus to create conducive environment for mass adoption of Electric Vehicles

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