

Analyzing the Future of Automobiles

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BACKGROUND

The global and Indian automobile sectors are at a pivotal point, driven by increasing environmental concerns and the urgent need for sustainable solutions. In this case study we have done comprehensive analysis of the comparative advantages and challenges of Battery Electric Vehicles (BEVs) over the Green Fuel vehicles and Hybrid Vehicles. We explore the environmental impact, cost-efficiency, market dynamics, and strategies employed by major automobile manufacturers. The goal is to provide a detailed understanding of the current landscape and predict future trends.

“

In order to have clean air
in cities, you have to go
electric.

Elon Musk

”

Agenda

1

Evaluate the environmental benefits and drawbacks of BEVs, Green Fuel vehicles, and Hybrid Vehicles.

2

Compare the cost structure and efficiency, including purchase price, maintenance, and operational expenses.

3

Investigate market trends and consumer preferences in India and globally, identifying key players and their strategies.

4

Examine strategies and innovations of leading manufacturers, focusing on R&D investments, partnerships, and technological advancements.

5

Predict future trends and provide strategic recommendations for investment in BEVs, Green Fuel vehicles, and Hybrid Vehicles.



Why EV ?

EV is the future but the question arises what are the things that EV have, besides it runs on electricity, that makes it a favourable option. An interesting fact about EV is that in 1888 first electric car was launched but it failed at that time. So, what technological and environmental impact will it make now that makes it a favourable option in today's time.

COMPARISON

Green Fuel Vehicles

An automotive battery, or car battery, is a rechargeable battery that is used to start a motor vehicle. Its main purpose is to provide an electric current to the electric-powered starting motor, which in turn starts the chemically-powered internal combustion engine that actually propels the vehicle.

Hybrid Vehicles

Hybrid vehicles combine electric car technology with that of traditional cars. A hybrid vehicle utilizes a 12-volt lead-acid battery and gasoline like a traditional vehicle while also pulling energy from an electric battery. The vehicle can switch seamlessly between power sources, so the driver isn't even aware of the transition.

BEV

A battery electric vehicle (BEV), pure electric vehicle, only-electric vehicle, fully electric vehicle or all-electric vehicle is a type of electric vehicle (EV) that exclusively uses chemical energy stored in rechargeable battery packs, with no secondary source of propulsion.

Battery Pa
ck

COMPARISON

Green Fuel Vehicles

In a car, a transmission, or a gearbox, acts as the medium that transmits power generated by the engine to the wheels via a mechanical system of gears and gear trains. A transmission allows a person to apply power to a vehicle in a controlled manner, without which, the car would not efficiently move.

Hybrid Vehicles

The transmission system in a hybrid electric vehicle (HEV) coordinates power flow between the internal combustion engine, electric motor, and wheels. It uses a transmission control unit and complex electronics to switch between power sources based on driving conditions to optimize efficiency.

BEV

Electric cars also have a type of transmission, but they'll usually only have one gear, meaning no gear shifts are needed. The key difference between ICE and electric cars is that the electric motor in an EV provides instant power and torque to go the top speed without gear shifts.

**Transmissi
on System**

COMPARISON

Green Fuel Vehicles

Brakes use friction of brake shoes and drums to convert kinetic energy developed by the vehicle into heat energy. When we apply brakes, the pads or shoes that press against the brake drums or rotor convert kinetic energy into thermal energy.

Hybrid Vehicles

Regenerative braking is a simple process used by self-charging hybrid cars. It allows them to recharge their batteries using braking power. During the process of regenerative braking, kinetic energy that may otherwise be wasted is converted into electrical energy. This is then returned to the battery.

BEV

Regenerative braking captures the kinetic energy from braking and converts it into the electrical power that charges the vehicle's high voltage battery. It also slows the car down, which assists the use of traditional brakes. Electric motors, when used in reverse, function as generators and will then convert mechanical energy into electrical energy. Vehicles propelled by electric motors use them as generators when using regenerative braking, braking by transferring mechanical energy from the wheels to an electrical load.

Braking System

ENVIRONMENTAL BENEFITS OF EV

Minimized Resource Depletion

When considering the production process, EVs are far less resource-intensive than traditional vehicles, which gives them a huge environmental advantage. EVs' simpler mechanics, in contrast to petrol or diesel vehicles, is the reason for this resource efficiency.

Less Harmful Fluids

Electric vehicles offer a significant environmental advantage by eliminating the use of fossil-based products like motor oil used in petrol and diesel vehicles. Unlike ICE vehicles, EVs do not need various lubricants and fluids that can cause environmental hazards.

Eco-Friendly Materials

The electric vehicles importance lies not only in their operational benefits but also in the use of eco-friendly materials. While many manufacturers use recycled materials in smaller components, EV manufacturers lead the way by integrating these materials into the vehicles structure.

Increase in Clean EV Battery

Electric vehicle technology continues to make remarkable developments in reducing carbon footprints linked with their batteries. Over the past few years, the carbon trace of EV batteries has decreased significantly. Now, it is at 2 to 3 times lower than previous levels.

Impact on the environment

POSITIVE IMPACTS

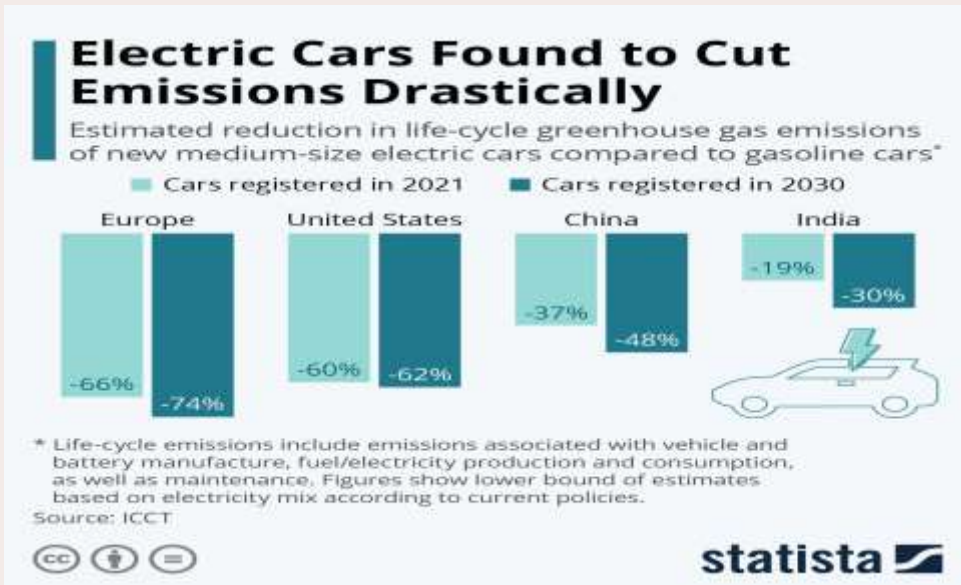
- EVs have no tailpipe emissions that contribute to air pollution.
- EVs are relatively quiet, so they do not contribute to noise pollution.
- EVs do not use engine oil, which is generally bad for the environment.
- EV brake pads are different so they “don’t corrode, crumble, and fail prematurely” thus requiring expensive maintenance.

POSITIVE IMPACTS

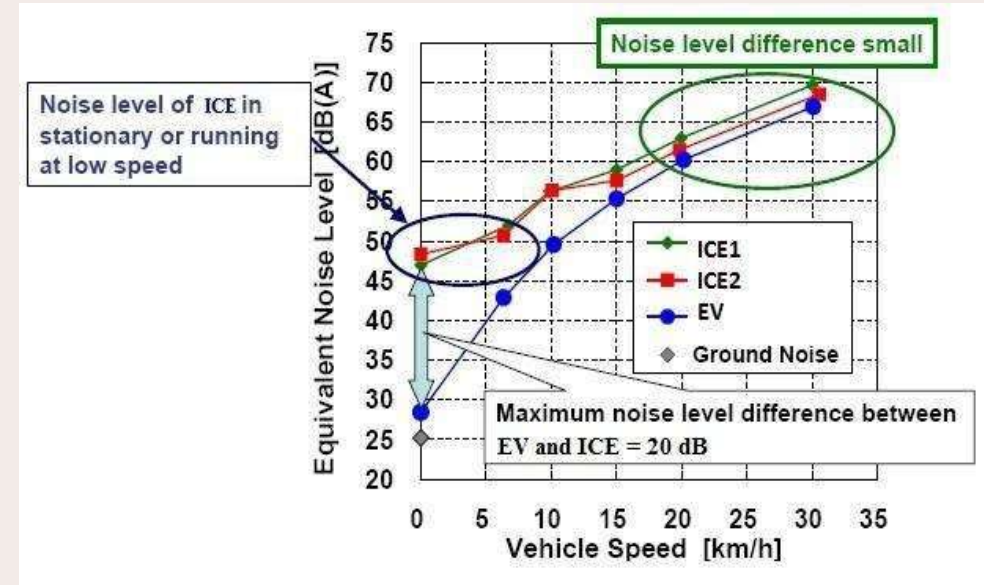
- EV manufacturers traditionally try to use eco-friendly materials whenever possible.
- EV chargers, when powered by renewable energy sources, have less impact on the environment and its natural resources than traditional gas stations. No transportation is required to get the “fuel” to the chargers, unlike a gas station’s need to transport fuel.

ENVIRONMENTAL BENEFITS OF EV

Zero Tailpipe Emissions



Reduced Noise Pollution



Impact on the environment

NEGATIVE IMPACTS

- EV chargers generally rely on electricity from power plants, which still use fossil fuels. This could be problematic in states like California where the energy grid is already being pushed to its limit during the hot, summer months, so residents will be forced to experience more rolling blackouts.
- EV battery production can adversely impact the environment, such as a loss of biodiversity, air pollution and decreased freshwater supply.
- EV battery recycling methods are still in their early stages, but they are not specifically designed to be recycled.
- EV tires wear out faster due to the heavier weight and increased torque of the vehicle. Expected lifespan on EV tires is only between 30,000 to 40,000 miles. This means you'll be buying tires more often and thus contributing to increased emissions.

NEGATIVE IMPACTS

- EV batteries consist of materials like nickel, lithium, cobalt and others, which are energy-intensive to mine. These minerals are also often mined in regions with a poor environmental record. Take, for example, the lithium mining currently happening in Argentina. According to Time, Argentina accounts for 21% of the world's lithium reserves and plans are already in place to open 13 more mines (in addition to the two already in production). Many worry the mining could cause massive destruction, corrupt an already fragile ecosystem and pillage the country's natural resources all in the name of "green progress".

Overview of Electric Vs Petrol Car Ownership Costs



In recent years, the automotive sector has seen a notable shift towards electric vehicles (EVs). This change is driven by a variety of factors, including environmental consciousness, technological advances, and government incentives. It is often said that an electric car is more affordable to maintain as compared to a conventional car. But is it true? And what factors affect the running costs of an electric vehicle? In this guide, we'll calculate the cost of owning an electric and green fuel car in India.

Factors Affecting Total Ownership cost of car

Several factors influence a car's total ownership cost (TOC), irrespective of the fuel type. Be it an electric car or a petrol/diesel car; one has to account for several factors. In this section, let's take a look at the factors that determine the cost of ownership of a vehicle.

1. Vehicle price

It's the upfront cost of the vehicle. In other words, it's the amount one pays to the dealer for purchasing the car. It also includes the registration costs and additional costs related to the vehicle, such as accessories, extended warranty packages, etc.

2. Car insurance cost

It is the premium you pay to insure the vehicle. The new car insurance premium depends on the vehicle's price or value and the chosen coverage. The insurance cost also fluctuates as per the vehicle's age and overall mechanical condition.

3. Fuel price

It is the price you pay to purchase fuel for your car. For example, the cost of a litre of petrol/diesel or a unit of electricity (charging cost) is considered as the fuel price.

4. Maintenance cost

It is the money you spend on maintaining the car. It includes service costs, parts replacement costs and other miscellaneous costs related to vehicle maintenance.

5. Fuel efficiency

It is the distance travelled by the vehicle on a litre of fuel or a full charge in the case of electric cars. The fuel economy depends on various factors such as type of vehicle, engine capacity, driving style, driving environment and road conditions.

6. Driving distance

It is the total distance you drive in a day, month or year. The driving distance plays a significant role in determining the running cost. Because the more distance you drive, the more costs you incur.

Calculating the vehicle ownership cost



The overall ownership cost of a car can be calculated using the already-mentioned factors. To keep things simple, we will consider the approximate numbers for insurance, maintenance, and fuel costs. The vehicle we will consider for this calculation is the Tata Nexon compact SUV (Sports Utility Vehicle). The fact that it is available in petrol, diesel and electric variants makes it a comprehensive comparison. So, without further ado, let's jump into the business end of this article.

Ownership cost of an electric car

To calculate the running cost of an electric car, let's assume that you are purchasing the Tata Nexon EV Prime XM base variant. The following table will give you more clarity on the costs involved in the EV purchase.

| | |
|---|--|
| Tata Nexon EV Prime XM variant on-road price | Rs. 16 lakhs |
| Car insurance cost | Rs. 65,000 (included in the on-road price) |

Since the EVs are exempted from registration charges, you need not pay any registration fees during the vehicle purchase.

Once you have made the purchase, the next aspect to look for is the fuel price, driving range, charging cost and maintenance cost.

- The Tata Nexon EV Prime delivers an ARAI-certified range of 312 km on a full charge.
- Let's assume that you drive a distance of 10,000 km per year.
- For a full charge, the Nexon EV Prime consumes 20 units of electricity and let's consider an average cost of Rs. 7 per unit of electricity.
- Hence, the electric SUV will consume 641 ($10,000 \times 20 / 312$) units of electricity to cover a distance of 10,000 km.
- So, the total fuel cost (electricity cost) for the first year stands at Rs. 4,500 (641×7).
- An electric car does not comprise complex mechanical components. Hence, the service and maintenance costs will be on the lower side.
- Let's assume the service/maintenance costs for the first year stands at Rs 3,000.
- So, the EV ownership cost for the first year stands at Rs. 16,07,500 ($16,00,000 + 4,500 + 3,000$).

Ownership cost of an electric car

Here's a table with the costs involved in EV ownership for five years.

| Cost | 1st Year | 2nd Year | 3rd Year | 4th Year | 5th Year | Total Cost for 5 years |
|------------------|-------------|------------|------------|------------|------------|------------------------|
| Insurance cost | Rs. 65,000* | Rs. 62,000 | Rs. 57,000 | Rs. 53,000 | Rs. 48,000 | Rs. 2,20,000 |
| Maintenance cost | Rs. 3,000 | Rs. 5,000 | Rs. 6,000 | Rs. 8,000 | Rs. 8,000 | Rs. 30,000 |
| Charging cost | Rs. 4,500 | Rs. 4,500 | Rs. 4,500 | Rs. 4,500 | Rs. 4,500 | Rs. 22,500 |
| Total Cost | Rs. 7,500 | Rs. 71,500 | Rs. 67,500 | Rs. 65,500 | Rs. 60,500 | Rs. 2,72,500 |

**The 1st year insurance cost is included in the vehicle's on-road price. Hence, we have excluded it from the above calculation.*

1.Total ownership cost of an electric car for 5 years

We know all the costs incurred in 5 years of owning the Tata Nexon EV Prime. We need to add all the expenses to get the overall ownership cost.

TOC = On-road price + Insurance cost + Service/Maintenance cost + Charging cost

TOC = 16,00,000 + 2,20,000 + 30,000 + 22,500

Total Ownership Cost = Rs. 18,72,500

Ownership cost of a petrol car

For a fair comparison, let's assume you purchase the Tata Nexon XE Petrol (base variant). We will consider similar factors such as the vehicle price, fuel, service, and insurance cost to calculate the running cost.

- The on-road price of the Nexon XE stands at around Rs. 9 lakhs, and it includes the insurance (Rs. 40,000) and registration charges.
- Let's assume that you drive a distance of 10,000 km per year.
- The petrol variant of the Nexon delivers an ARAI-certified fuel efficiency of 17 kmpl.
- Hence, the vehicle consumes 590 litres (10,000/17) of fuel in a year.
- Considering the average cost of petrol as Rs. 100 per litre, the fuel cost for the first year comes to Rs. 59,000 (590x100).
- Next, the service and maintenance cost for a vehicle in this segment can be estimated at Rs. 9,000 for the first year.
- Putting up all the costs, the ownership cost of the Nexon petrol for the first year stands at Rs. 9,68,000 (9,00,000 + 59,000 + 9,000).

The table below denotes the insurance, maintenance and fuel costs for five years.

| Cost | 1st Year | 2nd Year | 3rd Year | 4th Year | 5th Year | Total Cost for 5 years |
|------------------|-------------|--------------|--------------|--------------|--------------|------------------------|
| Insurance cost | Rs. 40,000* | Rs. 36,000 | Rs. 32,000 | Rs. 28,000 | Rs. 25,000 | Rs. 1,21,000 |
| Maintenance cost | Rs. 9,000 | Rs. 10,000 | Rs. 12,000 | Rs. 14,000 | Rs. 16,000 | Rs. 61,000 |
| Fuel cost | Rs. 59,000 | Rs. 59,600 | Rs. 60,200 | Rs. 60,800 | Rs. 61,400 | Rs. 3,01,000 |
| Total Cost | Rs. 68,000 | Rs. 1,05,600 | Rs. 1,04,200 | Rs. 1,02,800 | Rs. 1,02,400 | Rs. 4,83,000 |

The 1st year insurance cost is included in the vehicle's on-road price. Hence, we have excluded it from the above calculation.

Ownership cost of a petrol car

Ownership cost of a petrol car
for 5 years

With all the costs available at
our disposal, we can go ahead
and calculate the ownership
cost for five years by using the
following method.

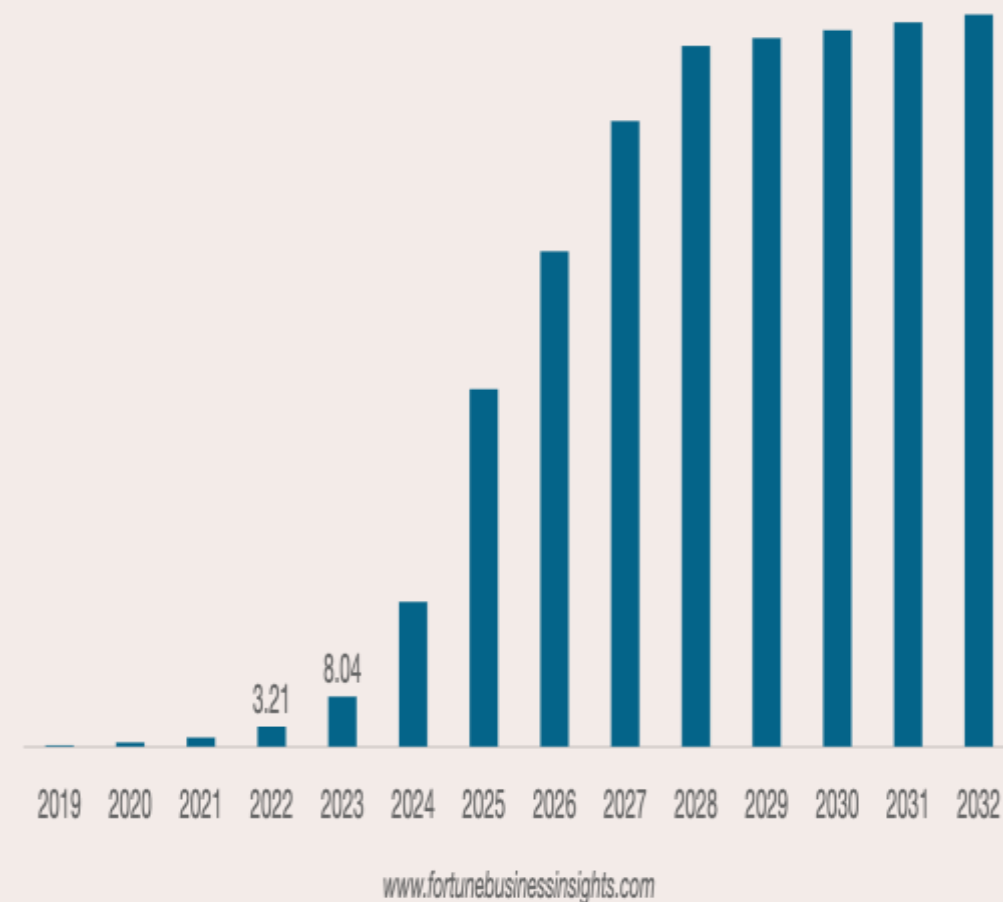
| |
|--|
| $\text{TOC} = \text{On-road price} + \text{Insurance cost} + \text{Service/Maintenance cost} + \text{Fuel cost}$ |
| $\text{TOC} = 9,00,000 + 1,21,000 + 61,000 + 3,01,000$ |
| $\text{Total Ownership Cost} = \text{Rs. } 13,83,000$ |

Trend Of EV Market In India

India Electric Vehicle (EV) Market Size, 2019-2032 (USD Billion)

The India electric vehicle market size is projected to grow from USD 3.21 billion in 2022 to USD 113.99 billion in 2029, growing at a compound annual growth rate of 66.52 per cent, according to a report by Fortune Business Insights. This meteoric rise is indicative of the Industry's potential to transform the automotive landscape in the country. The Industry has recorded strong growth in the past few years and is supported by the Government's implementation of favourable policies and programs. According to a joint report by GameChanger Law Advisors and Speciale Invest, the Indian EV battery market is also set to skyrocket, from \$16.77 billion in 2023 to an impressive \$27.70 billion by 2028.

India has set an ambitious target of increasing the share of EV sales to 30 per cent in private cars, 70 per cent in commercial vehicles, 40 per cent in buses, and 80 per cent in two-wheelers and three-wheelers by 2030. In absolute numbers, this is estimated to translate into an impressive target of 80 million EVs on Indian roads by 2030. The country also aims to achieve 100 per cent local production of EVs under the 'Make in India' initiative.

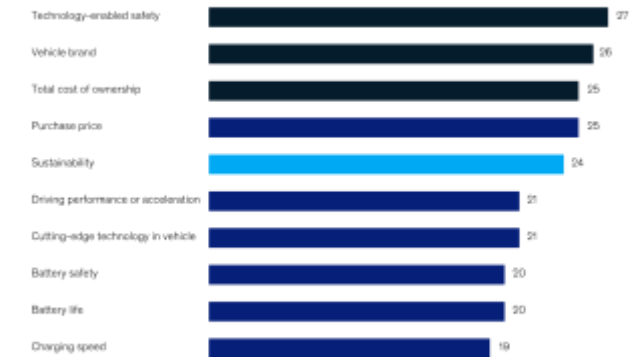


Consumer Of EV

- Consumer sentiment suggests the transition to electric cars will gain momentum. The vast majority of people are eyeing EVs for their next car purchase, with a clear preference for full battery electric vehicles (49 percent) over plug-in hybrid electric vehicles (21 percent). These preferences align closely with our research on electric two-wheelers, which showed that 86 percent of consumers would consider buying an EV compared to 69 percent who would consider an ICE vehicle. A number of factors are contributing to this appetite for EVs, with potential purchasers noting the impact on the environment (67 percent), lower total cost of ownership (26 percent), and reduced engine noise (26 percent) as the biggest benefits of driving an EV.
- Indeed, an overall concern for sustainability is influencing Indian consumers' desire for EVs, with sustainability being the number one priority in car-buying and mobility-usage habits. In fact, sustainability is increasingly influencing consumer decisions across the board in India: 75 percent of Indians are starting to change (or have already changed) their behavior and consumption patterns based on sustainability considerations. Of these changes, engaging with and becoming more loyal to sustainable brands (27 percent), positively advocating for sustainable products and services (23 percent), and trying sustainable products and services more often (20 percent) are the most common
- Sustainability is among the top five criteria people factor in when considering a car, along with safety, brand, and costs). The desire for zero-carbon vehicles is also evident in the dominant two-wheeler market, in which this preference was one of the top three purchase criteria.

For their next car purchase, consumers are considering safety, brand, and total cost of ownership, followed by sustainability.

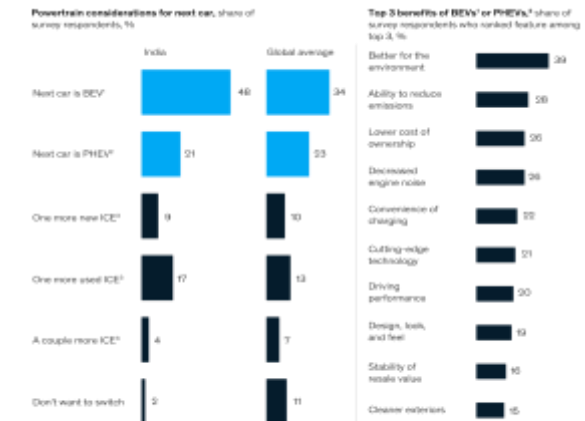
Key purchase criteria for next private car, share of car considers, %



Source: McKinsey India Mobility Consumer Survey, December 2022 (n = 1,980)

McKinsey & Company

Most Indian consumers say the next car they purchase will be electric.



*Note: Figures may not sum to 100% because of rounding.
*BEV = battery electric vehicle, PHEV = plug-in hybrid electric vehicle.
*New car purchase only.
Source: McKinsey India Mobility Consumer Survey, December 2022 (n = 1,980)

McKinsey & Company



Innovation In EV'S

- Innovations are happening aplenty globally along the entire electric vehicle value chain. In India too, there are innovations and R&D efforts, though by global standards one should say that the Indian efforts are likely to be less impactful to fundamental EV technologies.
- Automotive manufacturers globally are investing heavily in research and development to produce in a range of EV innovations – all the way from use of different battery chemistry to advanced BMS solutions for battery battery management to more effective ways to charge electric vehicles in far lesser time.
- While India is a late starter in the EV ecosystem space, here are some initiatives taken by India are briefed in detail in the following sections (Click on each section for more details).
 - **Technologies and Innovations in EV Industry – Better Batteries, Lighter Cars, Faster Charging** – This post provides a global overview of research and innovations in the EV sector for batteries, vehicles themselves and for EV charging solutions.
 - **Innovations in Battery Management System – BMS Technology Trends – Charging, Intelligence, Analytics** – The battery management system plays a critical role in ensuring high battery performance while at the same time ensuring that the battery degradation is minimal, thus ensuring a long life for the battery. Unsurprisingly, there are a number of research and innovation efforts worldwide in the domain of battery management systems. This post provides an overview of these research and innovation efforts.
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- Research Trends Li-ion Anode/Cathode Material – NMC, LFP, NCA Chemistries for Lithium-Ion Batteries – For at least until 2030, Li-ion batteries will be the mainstay of electric vehicle batteries. But within this genre, a number of different chemistries are being evaluated at the cathode and anode. This post provides details on the international research and innovation trends for the various Li-ion battery chemistries.
- Fuel Cell Research Effort in India – R&D in Fuel Cells – IISc, IITs, VSSC – Fuel cells represent an emerging and exciting energy storage technology, both for stationary electricity storage as well as for electric vehicles. Even though the field is nascent, there are already fuel cell based electric cars and even electric vans operating in different parts of the world, though in limited numbers. In India, a number of academic research efforts are ongoing in the fuel cell domain. This post provides details of these research efforts from prominent research and academic institutes.
- EV Battery Innovations – New Anode/Cathode Chemistry, BMS, Nanotech for Electric Vehicle Batteries – Batteries are the most critical technology in the context of electric vehicles. Not surprisingly, a large number of research efforts are being undertaken globally to arrive at better and cheaper batteries. Many of these efforts go far beyond Li-ion batteries and into entirely new chemistries and battery technologies. This post provides a detailed scan of the innovations happening world over across the entire battery value chain.
- Innovative EV Companies in India – Pioneering Indian Startups in Electric Vehicles – Batteries, Scooters, BMS... – Until 2017, one would have been hard-pressed to find an Indian startup operating in the electric vehicle industry. Since then, this field has exploded and attracted very high interest from startups and entrepreneurs. Startup interest in e-mobility has not been restricted to vehicles alone, but has ranged all the way from electric bicycles to power electronics for EV charging stations. This post provides a detailed list and profiles of startups operating in the Indian electric vehicle domain.

Strategies Of TATA And Tesla

Tesla and TATA both are pioneers at Global and Indian market respectively in EV sector. Both have some amazing strategies to capture the market .

Strategies of TATA

Market Development: The company is focusing on market development by addressing barriers to EV adoption. This includes improving **charging infrastructure**, addressing total cost of ownership (TCO) concerns, ensuring residual value, offering a variety of models, and catering to various use cases.

Charging Infrastructure: Tata Motors is collaborating with charge point operators to set up almost 22,000 chargers in the coming years. This initiative aims to provide adequate charging infrastructure to support EV users.

Solar Rooftop Integration: The company is working with solar rooftop companies to promote the idea that having a rooftop solar setup makes an EV more economically viable. This integration of solar power is expected to enhance the appeal of EVs.

Market Expansion: Tata Motors plans to expand its presence in the EV market by exceeding **sales targets**. Despite missing the target of 100,000 units in FY24, the company is confident about surpassing this figure in the current year.

Strategies OF TESLA

1. Superior technology

Tesla's electric motors are superior compared to the company's competitors. Tesla motors are equipped with proprietary magnets, making them not only smaller, but also cheaper and more efficient than competitors'

2. Supercharger Network

The average American drives 29.8 miles (47.7 km) per day. At first glance, this range is sufficiently covered by an EV. But the average can be misleading. Despite the low average, there are circumstances where the driver drives very long distance – exceeding the range coverage of EVs. As such, about 95% of driving needs can be satisfied by an EV, but **most consumers require 100% of their driving needs to be met (including long distance trips 1-2 times per year)**. The fear of not being able to drive long distance using an EV is called range anxiety, and is the number one reason consumers cite to be the barrier to adopting EVs on a wider scale.

Recognizing this, Tesla has developed a network of superchargers. Superchargers are electric charging stations that can *fast charge* (50% charge in about 20 minutes) Teslas. They use a proprietary connector, which means other EVs cannot use Tesla's network.

3. Vertical Integration

Tesla's organizational structure and its approach to vertically integrate where possible are what make its technology superior. Unlike other car companies, Tesla develops and produces most of the *core* components in-house. In contrast, established car companies (OEMs) such as Ford, GM and others have an ecosystem of third party suppliers that comprise of three tiers (*Figure 5*). **This makes fast technology innovation and iteration difficult.**



Investment Recommendation

- As of now In india most of the ev vehicles that consumer buys is either two or three wheelers that is because of its low maintainence cost besides the upfront cost is high.
- In case of 4 wheelers the cost increses significantly for both green fuel vehicles and EV .In general only upper and upper middle class can afford the a 4 wheeler of any type
- As the economy grows and gdp per capita of India increases we gonna see people buying more and more 4 wheelers
- So the 4 wheelers sales will increase in upcoming years but percentage of ev cars will remain low with steady increase but after 4 to 5 ears when India will developed a good infrastructure for ev cars also, then sales pf ev will gain speed and after 10 to 12 years ev cars will be significant portion of sales for 4 wheelers
- So for the investment purpose look for companies having a good sales of 4 wheelers and are also currently investing a good amount in EV technology and infrastructure

APPENDIX

- Benefits of Electric Cars on Environment | EV & Petrol Cars
 - [EDF Energy](#)
 - <https://www.edfenergy.com › energywise › electric-cars-...>
- The Key Components of an Electric Vehicle
 - [DataOne Software](#)
 - https://vin.dataonesoftware.com › vin_basics_blog › elec...
- Overview of Electric Vs Petrol Vs Diesel Car Ownership Costs
 - [Acko](#)
 - <https://www.acko.com › Car Insurance › Articles>
- The Strategy Behind TATA.ev
 - [The Hard Copy](#)
 - <https://thehardcopy.co › case-study-tata-ev>
- **Tesla Company – Business Strategy Analysis**
 - [Vested Finance](#)
 - <https://vestedfinance.com › blog › tesla-strategy-analysis>

Thank you

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