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Electric Vehicle Safety: An Overview

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ABSTRACT

This paper examines some of the potential dangers associated with electric vehicles, as well as how European Union and UN type-approval procedures lessen the risks to users. It does so by highlighting any regulatory loopholes as well as the international initiatives now ongoing to remedy them. The main focus of this research paper is on vehicle dangers, with some thought given to how they are likely to be exploited by the general population. Infrastructure-related hazards, such as vehicle charging or battery exchange, are often excluded since they are likely to come under a different regulatory framework.

Keywords: Electric, vehicle, safety, overview, battery

I. INTRODUCTION

Greenhouse gas emissions from the transportation sector are among the highest in the world. To keep global warming at 1.5 degrees Celsius beyond preindustrial levels, the decarbonization of the transportation sector has become an essential aspect of the global climate change mitigation strategies cleaner types of transportation, such as electric vehicles (EVs), are now universally regarded as essential to limiting the amount of greenhouse gases emitted into the earth's atmosphere. As a result, electric vehicles have yet to take off as a mass market choice. Batteries for electric vehicles are the most expensive component of the vehicle, and making them more affordable will assist overcome the cost barrier to their widespread adoption. Electric vehicle (EV) battery cost reduction is the primary objective of this research, which examines a variety of possible approaches [1].

In 2017, transportation emitted more carbon dioxide than any other industry on the planet (approximately 8 Gt of CO2). 1 Private and commercial road transportation accounted for three-quarters of the total emissions from the transport sector. This shows how much carbon dioxide emissions may be reduced by using electric mobility. Pure EVs, REEVs, and hybrid EVs are all examples of E-mobility [2].

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Cities are becoming more densely populated, especially in emerging countries with large populations, and governments have the issue of providing transportation services while also lowering greenhouse gas emissions. As a result, it is imperative to develop policies that are financially and environmentally sustainable to remove impediments to the broad adoption of e-mobility and to rebuild the transportation system. Policymakers are still grappling with the challenges of emerging technology and a growing EV market, but one of the biggest obstacles to the adoption of EVs is the high total cost of ownership [3].

II. Literature Review

Traditional internal combustion engine (ICE) vehicles compete with electric vehicles (EVs) since they are now more economical and convenient to refuel because of the widespread availability of refuelling infrastructure. In general, traditional automobiles provide good performance and cost-efficiency for their owners. Efforts to increase the performance and lower the cost of EVs are being made all the time, including the establishment of charging infrastructure and the provision of financial incentives for research and development, manufacture, and adoption. Most of these efforts focus on the batteries, which account for over half of the cost of an EV [Kochhan, et al., 2014]. This means that a more affordable battery will play an important part in US's efforts to increase the use of electric vehicles [4].

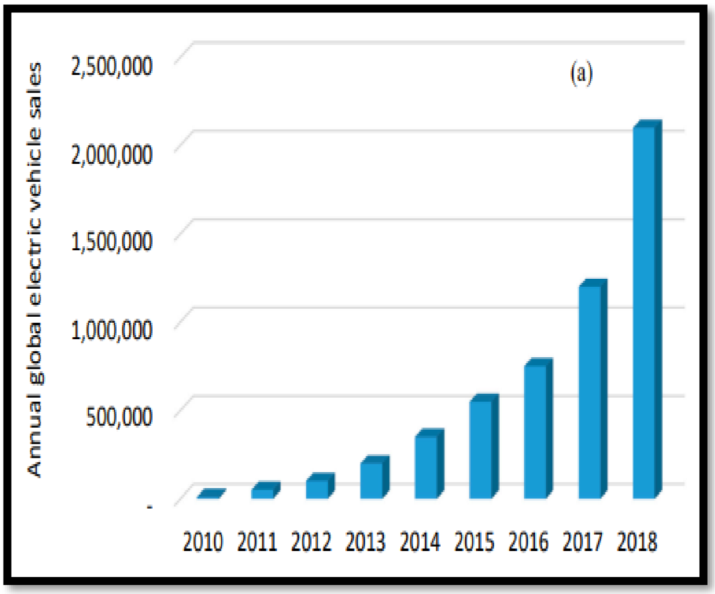

Fig. 1 (a) Annual global electrical vehicle scales

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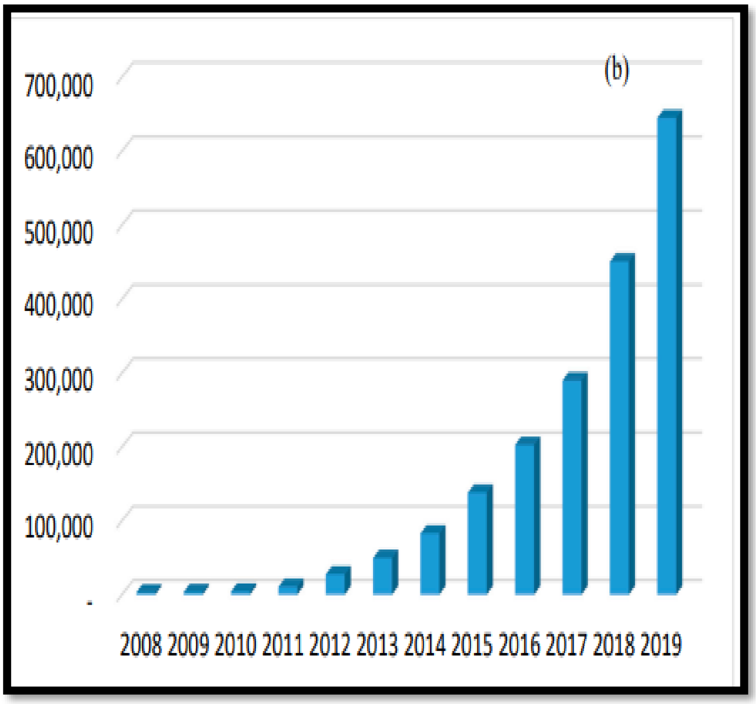

Fig. 1 (b) Total number of battery vehicle

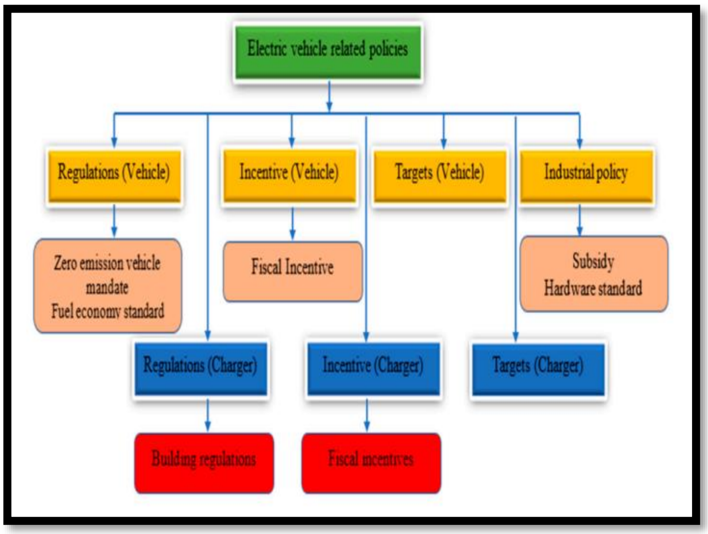

Fig. 2 Policies for electrical vehicle

Fast-growing US has ambitious climate change mitigation goals in place. To satisfy the demands of an expanding population while also decreasing greenhouse gas emissions, the transportation sector must accelerate the development and implementation of electric mobility across all segments, including private vehicles, public transportation, railroads, mass transit, and freight. Car manufacturing has become an important industry in US [5].

Because of the abundance of competent workers and the local automotive component manufacturing ecosystem, automobiles can be produced at a low cost for both the domestic and worldwide markets. However, making the switch to electric mobility will necessitate more government assistance. One area that requires immediate attention is the production of batteries, as lower battery costs are a prerequisite for a faster shift to electric mobility. As part of sustainability transitions, the shift to electric transportation is a critical aspect of the shift from traditional and prevalent socio-technical systems to more sustainable ones. As a result, in order to ensure its success, market systems and institutions will need to be able to accommodate the rapid pace of technological development [Lehmann, 2010; Twomey, 2012; Weber &Rohracher, 2012]. It is the goal of this study to educate policymakers about the complexities of the situation by focusing on the affordability of EV batteries and the probable areas that require rapid intervention [6].

When it comes to transportation, electric vehicles (EVs) are changing the game because they're seen as a credible alternativeto conventional automobiles. EVs are paving the way for a cleaner and greener future in the face of ever-increasing automotive pollution. However, there is a roadblock in the form of money. The obvious next question is why lithium-ion batteries are so pricey. For this reason, these batteries are more expensive to produce. Here are the reasons why electric vehicle batteries are so expensive [7].

- Lithium, cobalt, and nickel are among the rare earth metals that are needed for electric vehicle batteries.
- To be utilised in an electric vehicle’s batteries, metal must be heavily mined and processed.
- The cost of an electric car's battery pack is between 30 and 40 percent of its total cost.

The high cost of lithium-ion batteries is a major obstacle for automakers in their quest to make EVs competitive with conventional vehicles in terms of price. There are other factors at play as well. The cost of electric vehicles is pushed up by a number of other issues.

Electric vehicle safety standards in India

In 1966, the Automobile Research Association of India (ARAI), better known as ARAI, was founded. The automotive industry partnered with the Indian government to create India's premier R&D institution.

India's Ministry of Heavy Industries, Government of India, has established the autonomous ARAI. As a Scientific and Industrial Research Organization (SIRO), it has played a critical role in the development of safe, low-pollution, more efficient, and dependable automobiles [8].

ARAI has set some Standards for Electric Vehicles & Chargers which are as follows:

- **AIS-038**

A vehicle's unique electric power train requirements and its safety standards are covered by this set of requirements for a Rechargeable Electrical Energy Storage System.

- **AIS-039**

It aids with the measurement of electric vehicle energy use.

- **AIS-040**

It's a range test for the electric cars.

- **AIS-041**

It discusses the workings and benefits of the maximum 30-minute power, which is used to assess the net power of an electric car.

Fire Safety in Electrical vehicle

The independent, non-profit Insurance Institute for Highway Safety recently conducted crash tests on the 2021 Volvo XC40 Recharge and the 2021 Ford Mustang Mach-E and found that battery cut-off technology, along with other systems, was working as intended to prevent the deadly crumpling of the vehicle's passenger containment space.

Shock safety in Electrical Vehicle

Electric vehicles are just as safe as cars with combustion engines, according to accident researchers and insurance firms. The electric vehicle's high-voltage system does not pose any risk of electric shock when driving or recharging, contrary to popular belief [9].

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Battery Management System

In order to ensure that the battery's safety is not compromised, the Battery Management System (BMS) plays a key role. It keeps track of the SOC and overall health of the battery pack (SOH). An onboard battery management system (BMS) monitors the voltage and individual battery cells in order to prevent overcharging. Temperature can be used to set the maximum charge or discharge current limit for a battery management system (BMS) [10].

Charging safety

When it comes to EVSE installations, the biggest danger is fire. While a multitude of factors can contribute to a fire, the charger's most likely location is a facility with out-of-date electrical wiring and power supply. Wiring should be compatible with both Level 1 and Level 2 chargers and the EVSE's charging requirements, regardless of which type of charger it is. Wall-mounted AC chargers like the basic 32A model require a voltage range of 110V-240V and a charging power of 32A, for example. While charging a vehicle, an AC power source or grid must be available for the charger to connect to, in order to ensure that the AC power can safely and effectively be transferred from the charging system to the vehicle. The charger could overheat and fail if it doesn't have the required electrical support. The temperature sensor in BizLink's 32A Wall-Mount EVSE detects overheating, unlike typical AC EV chargers [11].

GFCI (Ground Fault Circuit Interrupter) failure is another EVSE risk. Due to their design to prevent electrical shock, standard EV chargers are connected by a GFCI outlet to their power supply. There are, however, reports that show GFCI breakers fail at an alarmingly high rate in some regions of the world due to a combination of factors including lightning strikes, ageing, and wear, and inadequate inspection policies. Therefore, it is critical that the GFCI to which the EVSE will be attached is thoroughly inspected before installation to ensure that it does not already have any existing damage [12].

III. Background Information

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Several elements of the manufacturing, use, and sale of electric vehicles have advanced significantly in the recent decade, including their use of new technologies. New jobs and initiatives relating to electric vehicles have also grown significantly, as a result of expanded research activities. An overview of some of the most important issues linked to EVs that have been previously discussed in the literature is provided here. The most significant disparities between this poll and others are also underlined [13].

There are a number of studies that have looked at the evolution of electric vehicles over time, classified them based on their design and engine characteristics, or examined the impact they have on electrical infrastructure.

To further categorise automobiles, they perform a categorization based on their powerplant configurations. And last but not least, they look at the effect of charging EVs on the electric grid. Similar to this, various article examines how electric vehicles (EVs) can affect electricity grid productivity, efficiency, and capacity. Electric vehicles are also discussed in terms of their financial and environmental impact. Electric vehicle charging technologies are reviewed and their impact on power distribution systems are examined. They also look at coordinated and non-coordinated charging methods, delayed loading and intelligent charging planning [14].

According to charging techniques, they examine the economic benefits of vehicle to grid (V2G) technology. The utilisation of renewable energy sources (such as wind, solar, and biomass) and their integration into the field of electric vehicles is another issue that has been addressed in many works. An overview of electric vehicles and renewable energy sources is provided. Some of the work presented here focuses on the interaction between electric vehicles (EVs) and renewable energy sources in order to lower energy costs, while others focus on improving energy efficiency or reducing emissions. (iii) The suggestions that are primarily concerned with reducing emissions. According to the environmental impact of hybrid and battery electric vehicles (HEVs and BEVs) has been studied extensively (BEVs). There are 51 environmental evaluations of the two vehicles' lifespans included in this study (i.e., BEVs and HEVs). The authors of this paper consider a variety of factors in their research, including greenhouse gas emissions, power generation, transmission, and distribution, car manufacture, battery production, and battery lifespan. According to a larger use of PHEVs can be achieved if the right deployment of daytime charging stations is followed by effective charging regulation and management of the infrastructure. To their credit provide a comprehensive picture of the new economic model that electric vehicles represent, taking into account both one-way and two-way flows of energy (in which EVs themselves can provide energy to the electrical grid). In order to do this, they investigate a variety of EV charging options,

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including both unidirectional and bidirectional systems. These vehicles are also being investigated for their potential to store energy produced by renewable sources [15].

Other authors have concentrated on the many ways for charging EVs that have been presented. In both unidirectional and bidirectional charging, Tan et al. [16] re-evaluate the advantages and difficulties of vehicle technology to the grid (V2G). In addition to the benefits, they consider the drawbacks, such as battery degradation and the hefty initial investment. Lastly, to complete the compilation of V2G optimization strategies, they group them by technique (e.g., genetic algorithms (GAs) and Particle Swarm Optimization (PSO), as well as by the objectives: I operation costs, carbon dioxide emissions; (j), profit; (k), support for renewable energy generation; and, l, power loss........ Hu et al. [17] propose a revision and classification of approaches for the intelligent charging of electric vehicles, however this time, the focus is on fleet operators, as opposed to the prior work. They focus on battery modelling, charging and communication protocols, and driving patterns, among other things. They offer these works.

Finally, they demonstrate a variety of control mechanisms and mathematical algorithms for EV fleet management. The charging infrastructure for PHEVs and BEVs is discussed in Rahman et al. [18] as a means of addressing a variety of issues. The many charging systems in diverse locations, such as homes, apartment complexes, and shopping malls are also evaluated. They're all evaluated.

Some studies have looked at the various difficulties and potential benefits that EV integration in the smart grid can offer because of the vast EV deployment. With an eye toward renewable energy intermittency, Yong et al. [9] investigate the impact of EV deployment from the vehicle-to-grid perspective. Internet of Energy researchers Mahmud et al. [19] cover all aspects of electric vehicle charging, energy transfer and grid integration with distributed energy resources (IoE). With regards to autonomous driving and future linked EVs, Das et al. [20] recently published an assessment of how these technologies would impact EV charging and grid integration.

Battery management and health and lifetime estimations are also crucial EV charging challenges because they have a direct impact on battery lifespan. A survey of recent advances in Big Data analytics provides a basis for data-driven battery health estimations. More particularly, they discuss their pros and disadvantages in terms of practicality and cost-effectiveness. Further research suggests the use of machine learning to predict the ageing of lithium-ion batteries using Gaussian process regression (GPR). For this reason, there are various ways that focus on enhanced fault detection algorithms, as battery problems might have a negative impact on performance. In general, the majority of studies on EVs have concentrated on: I the influence of EV charging on electric demand, (ii) the use of renewable energy sources in the charging process, and (iii) the proposal of novel methods for optimising the charge of electric vehicles, including grid solutions. The market for electric vehicles is now in flux, and this article focuses on the current scenario, as well as the batteries, their technology, and charging techniques. The multiple charging methods and connectors described by these standards, in addition to a comparison, are all shown on this page for your perusal. Finally, we talk about the difficulties that EVs confront and the research directions that we believe ought to be explored further.

IV. Life Cycle Cost Analysis

The total cost of ownership over the course of an asset's useful life, referred to as the "lifecycle cost," allows for a more accurate comparison of costs and benefits. By factoring the time value of money, the'realistic appraisal' obtained through LCC analysis is bolstered. Product lifetime cost analysis is a useful tool for finding high-cost components in the product's lifecycle, as well as for comparing competing goods (19). The AS/NZS 4536:1999 Standard, on which the LCC procedure is based, specifies six steps in the LCC process: analysis plan, model development, model analysis, analysis documentation, findings review, and implementation & update (implementation and update.

The LCC is as follows for an electrical car:

Total LCC = Acquisition cost + Sum (Operating Cost for a given year + Scheduled maintenance cost+ Unscheduled maintenance cost + Car disposal cost

Unites Kingdom used these cost variables for automotive lifecycle analyses. But many other studies, including this one, did not include the "Unscheduled Maintenance Cost" category because of the restricted availability of first-hand data that restricts the accuracy of time and cost forecast. Unscheduled car repairs are therefore not included in this paper's analysis.

As far as battery costs go, they are the most significant contributor to today's high price of electric vehicles. Estimated retail price for a standard EV Lithium-Ion battery is 300$/kWh. This translates to an additional A$7,200 for the Nissan Leaf's 24 kWh battery, which is a huge increase in price. The cost of battery production is, however, lowering as the specific energy of the batteries continues to rise. Because of escalating environmental and energy concerns, it is hoped that as EVs become more popular, the enormous volume of battery production would further drop the costs per unit [20].

Aside from the assumptions and scope of each model, it is vital to remember that the entire life cycle cost of an EV is strongly dependent on these factors. While some earlier studies have shown that electric vehicles (EVs) are not practical in the near future, others have shown that they can save a large amount of money. For example, a study shows that EV home recharging and the absence of replacement or repair costs result in such favourable cost savings. When the EV range was surpassed, it was anticipated that a replacement ICEV would be available. However, the expenses of pollution and public charging infrastructure were not included in the calculations. In UK, if the societal costs of pollution are factored into the life cycle cost of an EV, research found that EVs can reduce air pollution by up to 50%.

V. LCC model development

The functional unit used in this analysis is one kilometre, which was driven by a 2011 Nissan Leaf in US's metropolitan region of NSW. "Cradle to grave" study means that all costs involved with the vehicle's purchase, operation and disposal will be included in this evaluation method.

It is estimated that a 2011 Nissan Leaf will last for 200,000 kilometres, or around 20 years at a rate of 10,000 kilometres each year. An average registered vehicle in US has a 10-year-old vehicle age and a 14,000-kilometer-per-year vehicle mileage [16]. The change is necessary since EVs are likely to survive longer than ICEVs due to their lower availability of range and lower annual mileage of 10,000km combined with sufficient maintenance. An estimated A$7,300 [17] is expected to cover the cost of a new battery for some vehicles with existing owners. Prices for the vehicle have been in 2014 USn Dollars since it was purchased in 2014. In this analysis, an interest rate of 7% has been applied in accordance with the advice of the NSW Department of Treasury and Finance [21].

However, this analysis assumes that the energy consumption during operation is 0.137kWh/km due of its simplicity, even though geographical considerations have an enormous impact on this. Additional 20% of energy is required because of the assumed solo charging method's losses. This is taken into account in the level 2 charging procedure.

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VI. Consumer LCC Model

It depicts the framework of the base case consumer LCC model for this study based on the above scope and assumptions

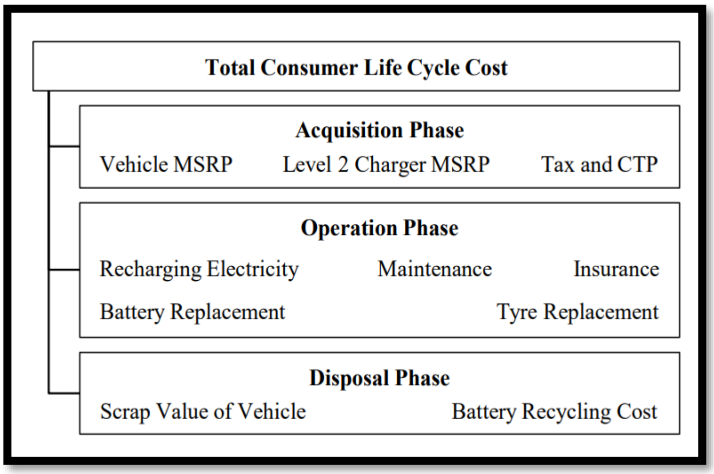

Fig. 5 Base case consumer LCC framework

Acquisition phase

The Nissan Leaf's purchase price is made up of three parts. In order to get a sense of the vehicle's MSRP, the Sydney postcode was entered and the base configuration was selected. This equates to a total of 42250 dollars. A Level 2 standalone charger, which includes installation and a three-year user guarantee, is included in the $2740 price tag. As required by law, registration, third-party insurance (CTP), and stamp duty levies have also been incorporated, and data from the Roads and Maritime Services (RMS) website has been used. Additional costs of $2415 will be incurred due to this change [22].

Operation phase

There are two ways to estimate how much electricity is needed to recharge an electric vehicle each year: the average energy consumption per kilometre (0.137kWh/km) and the charging inefficiency of 20%. 80 percent off-peak charge and 20 percent peak charging have been set for the base case to represent the possibility that consumers will take advantage of time-based tariff options. Off-peak electricity is currently priced at 16.522 cents per kWh, while peak electricity is 35.046 cents per kWh, according to the local energy retailer.

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Additionally, the base case model assumes that electricity tariffs will rise in line with historical averages in US, which is around 72% per five years [20].

VII. Estimating the Cost of Battery

- Type: I

Type: Mid-range Car Battery
Total Cost of Battery Pack= $8550
Total No. of Cells = 240x2
Cell Capacity and Chemistry: 25 Ah, NMC622-G

This battery is designed for entry-level passenger automobiles and has a 240-kilometer range and a 155-watt-hour-per-kilometer energy demand. The battery pack contains 44 kWh of energy and has a maximum output of 55 hp. The design is best suited to hatchbacks and compact sedans, with a volume of 198 L and a mass of 309 kg. The final battery pack's cost is 48.3% comprised of positive active material, formation cycling, testing, and sealing procedures, module hardware, separators, and negative active material and electrolyte [7,10,14].

Type: II

Type: Low-range Car Battery
Total Cost of Battery Pack= $12324
Total No. of Cells = 360x2
Cell Capacity and Chemistry: 27Ah, NMC622-G

Compared to a mid-range automobile battery, this one has 50% more cells;thus, its design is relatively comparable. The battery pack has a capacity of 74 kWh and can go up to 400 kilometres on a single charge. It has a maximum power output of 103 horsepower. The design would be appropriate for sedans due to the increased volume and bulk. Over half of the total price of this battery is made up of the same cost components as those used in the mid-range automobile battery previously mentioned.

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Type	Component	Cost
Electric vehicle power train	Battery Pack	**$8000**
	Thermal Management	**$225**
	Power distribution model	**$295**
	Inverter	**$523**
	Electric drive module	**$1080**
	DC converter	**$134**
	Controller	**$46**
	Control module	**$84**
	High voltage cable	**$302**
	On board charger	**$205**
	Charging cord	**$135**
Conventional Power train	Power train	**$5800**
Other direct	Vehicle assembly	**$11900**
Indirect cost	Depreciation, amortization	**$3200**

Type: III

Type: Premium: Premium Car/ SUV Battery

Total Cost of Battery Pack= $18305

Total No. of Cells = 560x2

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Cell Capacity and Chemistry: 30Ah, NMC622-G

For this type of vehicle, the battery has been built to have a larger storage capacity and a significantly higher power output, but at a greater volume and mass penalty. With a capacity of 124 kWh and a range of 485 kilometres between charges, this battery is built for long-distance travel. All of the other components, such as separators and testing and sealing processes as well as electrolyte and module hardware, combine to account up a third of the overall cost [22].

VIII. Authentic data to validate the cost model for the schedule launching in 2026

Fossil fuels are becoming increasingly scarce. It's a very worrying issue. It's time for the world to make a gradual shift to electric cars. There is a lot of work that needs to be done. Tesla and Porsche are two of the world's most well-known manufacturers of electric vehicles. Battery technology advancements in recent years have helped increase the use of electric vehicles. Purchasing an electric car could be a wise decision for consumers in the long run [25].

Electric car cost of different part in Year 2026

The quality of the drive, the low noise levels, and the ease of use are all excellent. In the United States, a year of gas-guzzling might cost anything from $1500 to $2500. On the other hand, the cost of driving an electric vehicle is $500. Electric vehicles are better than gasoline-powered ones. Electric vehicles have low upkeep costs as well. They're easy to keep up. Electric cars also have a high efficiency of converting electrical energy into mechanical energy. 60 to 70 percent of the electricity needed to power an electric vehicle. Internal combustion engines, on the other hand, are only able to achieve efficiency levels of 18-22 percent [26].

IX. Ranking of Strategies and Recommendation

Their influence on reducing costs, investment required, and time to produce returns have been evaluated using these eight methodologies. For this activity, experts from various fields of study assessed these criteria based on their relative importance and then ranked these tactics in relation to the criteria they were ranking them against. In spite of the fact that these tactics are not mutually exclusive, it is crucial to grasp their relative relevance. Using the analytical hierarchy process (AHP), the study ranks the tactics based on their effectiveness [27]. An issue is defined as a hierarchy in AHP. Here, the problem's structure can be summarised as follows.

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Standardization and the growth of auxiliary sectors rank above cell manufacturing and increasing the availability of crucial cell components. Three of the top four goals are focused on expanding domestic cell and battery packaging production, which is in line with the widespread belief that doing so will lower the price of batteries. AHP's consistency ratios can't account for the consistency of expert responses, but the availability of crucial raw materials and cell manufacture are both given high priority. In order to avoid the introduction of substandard batteries into the market, standardisation can be a very inexpensive policy area. Providing a fair and competitive market for everyone will function as a barrier to entrance and stimulate investment. End users will be helped in their decision-making by standards, and concerns about the safety of batteries and electric vehicles will be alleviated [28-29].

The formation of a market and the assurance of demand, on the other hand, will be critical in motivating investment. In order to create demand for electric vehicles, financial aid to end-users and bulk procurement, charging infrastructure, and awareness about EVs are critical [30-35].

No high priority is given to promoting reverse logistics (battery recycling and secondary use). This is the exact opposite of what was said in Chapter 4 about these possibilities, which showed that they might greatly lower the battery costs. Such possibilities are crucial in the long run, but their immediate influence on cost is not large because the value chains and demand necessary for the profitability of such projects are not yet in place. Similarly, new business models for battery as a service and demand aggregation for government use are both viable choices.

Comparison on the Cost Analysis and Strategy

6.1.1 Comparison on Cost

Phase	Indian Cost (in Indian Rupee)	US Cost
Acquisition phase		
Manufacturer's suggested retail price (MSRP)	3,291,697.50	$39990
standalone charger, including installation and 3-year user warranty	213,473.40	$3000
Roads and Maritime Services (RMS)	188,152.65	$2,352.70

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Operational Phase		
Battery replacement cost	599,907.00	$7,300
Individual battery's cost	401,002.77	$5500
mandatory annual registration	27,891.78	$433
CTP	61,159.35	$720
comprehensive insurance fee	110,242.65	$1299.06
Disposal phase		
battery recycling equates	107,048.34	$1470

1dollar=77.91 rupee

6.1.2 Comparison on Strategy

	India		**US**	
Strategy	**Priority**	**Rank**	**Priority**	**Rank**
Incentivizing cell manufacturing	26%	1	24%	1
Improving the availability of critical cell components	13%	2	15%	2
Standardization	17%	3	19%	3
Development of ancillary industries for pack components	11%	4	12%	4
Incentivizing reverse logistics, reuse for stationary usage	11%	5	9%	5
Demand aggregation	8.5%	6	7.5%	6
Dedicated battery research institute	7.5%	7	7.41%	7
Battery as a service	8%	8	7.4%	8

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Conclusion

The high cost of EV batteries is preventing India from making the transition to an electric transportation system. Since the new vehicles that will propel India's development must be both affordable and environmentally benign, it is essential for the country's emerging economy to proceed with caution during this transition. This dichotomy revolves around batteries. Batteries are extremely complex in terms of their components and chemistries, their integration with vehicles, and their utility at the end of their life. Cheap batteries are critical for making the shift from fossil fuel-powered vehicles to those powered only by electric motors as smooth as possible. Uses the Argonne National Laboratory's Bat Pac v3.1 programme to estimate the cost of EV batteries for various applications. Batteries based on NMC622-G are cost disaggregated for six different vehicle types: two-wheelers, three-wheelers, midsize automobiles, long-range cars, sport utility vehicles (SUVs), light commercial vehicles (LCVs), and buses. Materials, acquired products (battery jacket, terminal, conductor, connectors, etc.), pack integration, and manufacture make up the overall cost of a battery (building, labour and capital equipment). For 3-wheelers and SUVs, battery materials might cost anywhere from 23% to 49% more. With regard to purchasing items and pack integration for buses and two-wheelers correspondingly (from 18% to 28% for buses and 28%-29% for two-wheelers), the manufacturing ranges from 17% to 35% for both types of vehicles. Additionally, policy assessments of other countries' policies helped find ways to cut costs in addition to the data provided by the answers to the aforementioned questions.

Financial assistance has been a priority for the governments of the United States, the United Kingdom, and Germany in their efforts to promote domestic manufacturing and the connections that go along with it. In India, central and state policies have also included similar rules (Andhra Pradesh and Karnataka). In the UK procurement has had a significant impact on the acceptance of electric vehicles. There has been an emphasis on offering incentives such as exemptions (parking fees, toll charges and registration fees, for example) and direct financial incentives for EV comers in nearly all programmes. Cell manufacture and the growth of related ancillary businesses are clearly the focus of the country. Because of this, current policies (at the federal and state levels) emphasise incentives for manufacturing. However, the availability of essential raw materials and assurances of demand will play a crucial part in the success of present programmes. However, despite the current incentives for electric vehicle purchasers in the country, the required number of sales falls far short of

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the aim. Investors have also been hampered by a lack of demand, a lack of standards, and a lack of vigilance in the enforcement of current restrictions.

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