



A Review on Electric Vehicles: Technologies and Challenges

Mr. Chethan Raj K¹, Mr. Mahabub Basha S^{2*}, Dr. K Saketh Reddy³

^{1, 2, 3} Assistant Professor, Department of Commerce & Management, IIBS, Bangalore

*Corresponding Author

Mr. Mahabub Basha S

Assistant Professor, Department of Commerce & Management, IIBS, Bangalore

Article History

Received: 29.09.2023

Accepted: 02.10.2023

Published: 13.10.2023

Abstract: As a consequence of this attention, many technical problems are tackled and addressed. Therefore, efforts and studies aimed at incorporating EVs powered by renewable energy sources are a current realistic alternative for addressing climate change and accelerating energy transition. Current trends suggest that the usage of internal combustion engines will decrease as a result of this service in the coming months. The current state and projected growth of the electric vehicle (EV) industry worldwide is analysed. The efficiency of electric vehicles is determined by how well its power electronics converters and energy storage devices are linked. The high initial cost and lengthy charging time of EVs are the main obstacles to wider adoption.

Keywords: Electric vehicles, energy transition, global market.

Introduction

The difficulties encountered by the EV manufacturers are increasing in tandem with the quick pace at which electric cars are being adopted in India for both domestic and commercial usage. Yet, in spite of difficulties, answers may be found. The Cover Story describes the technical hurdles that electric vehicle manufacturers must overcome and goes into detail on the solutions that are being rapidly implemented throughout production lines.

There are two sides to India's burgeoning electric car market. There has been both a rise in the popularity of electric minibuses and other forms of public transportation and a surge of reports of electric motorcycles catching fire. However, it's important to remember that India is steadily progressing towards acceptance of EVs, as the country proclaimed its intention to transition to an electric mobility economy by 2030 in 2016. Additionally, the government has stated its intention to increase the percentage of EVs from the existing share of less than 1% to roughly 30% by 2030 in a communication between the Ministry of Road Transport and Highways and NITI Aayog.

By the year 2030, it is anticipated that India will have over 200 million electric motorcycles and scooters on its streets. In addition, the projections indicate that the count of electric cars will reach 34 million, and electric buses will amount to approximately 2.5 million during the same period. The transition from ICE to batteries and electric motors is challenging for the EV manufacturing industry to concentrate on. It's undeniable that this poses a problem, but producers and distributors are working hard to solve it. Original equipment manufacturers (OEMs) have been forced to change their attention from diesel and petrol to batteries in response to new restrictions aimed at reducing global carbon emissions. Almost every original equipment manufacturer (OEM) has now announced public intentions for EVs.

To have motors

Traction motors are essential in any electric vehicle with wheels, including cars, trucks, and tractors. It's for this reason that several

car manufacturers including BMW, Ford, GM, and Volkswagen want to start building their own engines in-house. In order to meet the high demand for its electric motors, Ford, for example, is investing \$150 million in an expansion of its Van Dyke gearbox plant in Sterling Heights, Michigan, USA. General Motors is also adopting a vertically integrated strategy, with its modular Ultium Drive power train series consisting of three interchangeable motors. Adam Kwiatkowski, GM's Executive Chief Engineer for Global Electrical Propulsion, stated in an interview, "As with other propulsion systems that are complex, capital-intensive, and contain a great deal of intellectual property, we are always better off making them ourselves."

Fabrication by robots

What would occur if an increasing number of manufacturers transition from making traditional gasoline and diesel vehicles to manufacturing electric ones? For instance, as original equipment manufacturers (OEMs) and suppliers ramp up electric vehicle (EV) production, they will employ a greater number of robots not only for assembling the motor but also for smaller parts and subassemblies. Rotor assembly, with its many difficulties caused by precise tolerances, is a good candidate for automation. Robots are used for picking, winding, and shaping coils or windings in rotor and stator assembly applications. In an interview with a prominent journal, Patrick Matthews, who serves as the Global Power Train Group Manager at ABB Robotics, emphasized the various tasks that robots can perform in the assembly process. These tasks encompass linking components, applying pressure to the rotor shaft, conducting welding operations, employing adhesives, and fastening the body through bolts. Matthews also underscored the critical role played by automated glue injection into magnet housings to ensure the magnets' secure retention, even when subjected to exceptionally high rotational speeds exceeding 15,000 rpm. Robots are used for regular quality control and assembly inspection to ensure electric motors are built to exacting standards.

Taking it easy

Drive range is mostly determined by the vehicle's weight. If you can shed 10% of the vehicle's mass, you'll see an 8% increase in MPG. Unlike internal combustion engine (ICE) power trains, electric drive trains and batteries add a lot of weight to a vehicle. To offset the additional mass introduced by electric power trains, automakers are using cutting-edge lightweight materials for car construction. Up to half the weight of an automobile may be cut by switching to lightweight materials like magnesium and aluminium alloys or carbon fibre for the body and chassis. Manufacturers must use these materials in a strategic manner to reduce vehicle weight without compromising safety.

Battery capacity and composition also have a role in determining a vehicle's drivable range. Current electric vehicles are often modified versions of conventional internal combustion engine cars. These non-native EVs have smaller batteries in order to accommodate the current design, which is a result of the packaging discrepancies between internal combustion engine (ICE) and electric power train. To better handle electric power trains and to facilitate high-volume manufacturing, manufacturers are moving to modular native EV platforms. Native EV platforms allow for battery packs up to 25% bigger, increasing driving range, and enabling adaptable power train layouts.

Difficulties in Production

The availability and cost of materials required in the production of EVs and hybrids provide obstacles despite the numerous economic and environmental advantages of these cars. As per a study conducted by The Energy and Resources Institute (TERI), there is a projected surge in the overall material demand, anticipated to elevate from a mere 0.005 million tonnes to nearly 1.6 million tonnes. This forecast holds true under the condition that the present lithium battery chemistry persists, and no significant technological advancements occur in the manufacturing of powertrains for compact four-door vehicles. Among the various resources that India imports, such as copper, lithium, permanent magnets, and related minerals and components, the cost of these imports has demonstrated a consistent upward trajectory over time.

One of the most crucial inputs towards the production of batteries for electric cars, lithium is mostly found in Chile, China, Argentina, and Australia. Mining for cobalt, which is used in EV battery production, is a major industry in the Democratic Republic of the Congo. The rare earth materials necessary to create the permanent magnets in synchronous motors are almost exclusively produced in China. The paper issues a caution that the lack of suitable resource interventions could result in heightened imports of essential materials essential for producing various components of electric vehicles, such as batteries and powertrains. This, in turn, could result in an escalation of our import expenditure.

Stimuli for Growth

Despite the material and technological hurdles that the EV industry must now overcome, there are some clear triggers, such as:

- Batteries, a crucial component of electric vehicles, are advancing at a rate that has surprised experts.
- Increasing regulatory pressure at the federal, state, and local levels is prompting early adoption of what is widely seen as the industry standard.

- Both established automakers and upstarts are pouring money into electric vehicle (EV) development programmes and startup businesses.
- The expanding availability of recharging stations for electric vehicles (EVs) is lowering the barriers to entry for the EV market.

Changes and Answers

Experts in the field believe that the problems plaguing EV production may be resolved by integrating the physical and digital worlds in the form of a "digital twin" of the product and its manufacture. Ideas from the "factory of the future" may inspire real-world efficiency gains via the use of digital twins of the production process and infrastructure. These digital twins have the potential to acquire physical asset performance data from produced commodities and industrial facilities. By collecting, assessing, and merging data from smart, linked field objects and manufacturing equipment into product design as actionable information, a closed-loop decision environment is established for continuous optimisation.

Along the product and manufacturing lifecycle, this all-encompassing digital twin ties together mechanical, electrical, and software domains with several digital threads. Closed loop performance engineering is made possible by data analytics, the cloud, and the Internet of Things (IoT), and it drives the constant improvement of design, production, and operation. In addition to cutting down on battery production costs and improving coordination across extensive supplier networks, a digital twin of this scope also helps manufacturers plan and execute manufacturing processes for innovative lightweight designs and modular vehicle platforms.

Fabrication of Batteries

The success of electric vehicles depends on lowering the price of batteries. By bridging the gap between battery design and production, integrated digital technologies may enable battery manufacturers create batteries at a competitive price. Engineers can improve cell design and performance from the get-go with the help of cutting-edge battery design and simulation technologies. The battery modules and final package provide the framework in which the cell shape may be designed and tuned. Next, engineers may analyse battery cells, modules, and packs in a digital manufacturing setting, paving the way for more adaptable and efficient methods in cell, module, and pack assembly. This satisfies the market's need for reduced production costs and increased productivity throughout the whole battery manufacturing value chain.

Facts on the ground

Frequent reports continue to surface, demonstrating the growing embrace of electric vehicles (EVs). Concurrently, the EV manufacturing sector is advancing into novel phases, conducting assessments to ensure the cost-effectiveness and environmental sustainability of EV operations. Recently, GreenCell Mobility unveiled 'NueGo,' India's pioneering inter-city electric mobility coach brand, with ambitious plans to serve up to 24 cities across the nation. The firm has declared that they would deploy seven hundred and fifty air-conditioned (AC) electric buses along major thoroughfares between major cities in southern, northern, and western India.

The business plans to deploy 100 electric buses throughout Madhya Pradesh and 200 across Delhi NCR, avoiding 56,154 tonnes of gross CO₂ emissions during the lifespan of the vehicles. In response to this development, Ashok Agarwal, the Managing Director and CEO of GreenCell Mobility, commented that there has been a growing acceptance of electric buses in India. Various cities with state governments have initiated the process of electrifying their bus-centric transportation systems. He also noted that the government of India's program, Faster Adoption and Manufacturing of Electric Vehicles in India (FAME) Phase - II, has played a crucial role in expediting this transition.

Olectra Greentech Limited, meantime, has made significant progress towards its goal of extending the range of products it offers in India by beginning field tests of its 6 x 4 heavy-duty electric tipper. Olectra Greentech, a world leader in electric bus production, is expanding into truck production, with a prototype based on its heavy-duty electric tipper platform now undergoing testing. The Olectra tipper, India's inaugural vehicle of its kind, boasts an impressive single-charge range of 220 kilometers. Equipped with a robust bogie suspension tipper capable of handling gradients exceeding 25%, it is exceptionally well-suited for traversing uphill highways.

Manufactured en masse, this vehicle will roll off the production line at the company's cutting-edge facility located just outside Hyderabad. K V Pradeep, Chairman and Managing Director of Olectra Greentech, expressed, "As pioneers in India's electric mobility sector, Olectra Greentech has embarked on rigorous trials for heavy-duty tippers." The fact that this is India's first vehicle of its kind fills us with immense pride and joy. With the escalating cost of fossil fuels, electric trucks are poised to revolutionize the industry. This revolutionary caravan is loaded with cutting-edge amenities.

Governmental Efforts

The target for electric car sales in 2030 in at least some nations includes India. In a bid to align policies with this objective, the national government has introduced numerous measures aimed at nurturing and advancing the electric vehicle (EV) ecosystem. These initiatives encompass the Faster Adoption and Manufacturing of Electric Vehicles (FAME II) program and the production-linked incentive (PLI) scheme. 350 new EV fast-charging stations have been erected around the nation in places including Chandigarh, Delhi, Jaipur, Ranchi, and Agra as part of the government's FAME II initiative. The Ministry of Power has also mandated that charging stations be installed every 25 km along both sides of major roads, spaced at 3-kilometer intervals. There are already 70,000 gas stations in the nation, and work is ongoing to provide charging stations for electric cars at 22 percent of those locations. As new business models arise, these advancements will attract investors, producers, and operators.

The high price of lithium-ion battery-powered cars has been helped by the FAME II stimulus, which has contributed to the expansion of EVs. To further boost trust among lithium-ion battery producers, the government has implemented PLI programmes. The recent decision to permit full Foreign Direct Investment (FDI) through the automatic route in India's car industry is another positive step towards the sector's bright future. According to projections made by the Energy Storage Alliance, the value of India's electric vehicle industry would increase from its current level of 25,000 crore to

50,000 crore by 2025. Many high-powered, long-range EVs designed to transport people and commodities will be introduced to the market in the near future.

Connectivity and artificial intelligence for EVs

Electric cars have the potential to revolutionise urban transportation, but their widespread adoption depends on a confluence of variables that have already been discussed. Improvements in range, speed, power, and comfort have all been made in recent years, making EVs a more viable option for consumers shopping for a new car. While the initial investment is more, the price difference between the electric and combustion engine versions is narrowing thanks to government subsidies and tax breaks.

But there are other factors that are as important and need to be enhanced to pave the way for electric automobiles. One major issue is the insufficient presence of EV charging facilities. Presently, a significant number of countries lack an extensive network of charging stations, which certainly deters prospective buyers. Our opinion is that more work has to be done to enhance the current charging infrastructure.

For electric cars to be more appealing to consumers, the time needed to fully charge their batteries must be drastically cut. It is our hope that advances in vehicular communications and Artificial Intelligence (AI) can help speed up the transition to new modes of transportation that are less harmful to the environment and more sustainable in the long run. Through wireless communication networks, automobiles could be furnished with a communication system enabling both vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) connections.

Algorithms based on artificial intelligence will make cars smarter and usher in a plethora of new possibilities that will completely alter the face of transportation in the near future. Several AI-based solutions concerning various EV aspects are available. These include more efficient routes, smarter charging methods, and improved thermal management of batteries. Present a fresh approach to energy-efficient routing that makes use of machine learning. Their method can estimate how much energy will be used on the various stretches of road that make up the existing or projected routes used by vehicles.

The combined utilization of communications and AI is expected to usher in innovative solutions. These solutions will have dual objectives: (i) simplifying battery charging procedures by enabling advanced features such as pre-booking charging slots, automatic power distribution optimization, and context-driven adaptive charging, and (ii) enhancing power generation capabilities to meet the escalating electrical demand on the grid. This will be achieved through predictive power requirement assessments in real-time and in-depth mobility analysis, among other methods. Therefore, we are on the cusp of the introduction of the idea of Internet-connected electric vehicles (IoEVs), which will not only revolutionise the way we travel but also provide novel opportunities for study and development in a wide range of fields.

Conclusion

In the near future, achieving dominance in all six domains with a single battery technology will prove challenging. It is crucial to find equilibrium between battery performance, durability, affordability, and safety considerations. To optimise the

mechanical, thermal, and electrical components of the battery system in EVs, an accurate and efficient system-level study is necessary. Computer simulation, because to its adaptability and efficiency, may significantly speed up the process of systematic battery design. In particular, atomic-scale simulations might aid in the selection of essential battery materials, while continuum-scale simulations and machine learning could assist shorten design cycles and optimise the system's layout.

The enhancement of the electric vehicle market share will not solely rely on advancements in battery technology. The availability of charging stations and any government laws are other important considerations. If the government implements the right rules, the electric vehicle industry will thrive, and charging stations will alleviate buyers' anxieties. Demand for EVs may be stimulated and accelerated via the joint efforts of manufacturers, battery suppliers, power providers, and governments.

References

1. Basha, S. M., & Ramaratnam, M. S. (2017). Construction of an Optimal Portfolio Using Sharpe's Single Index Model: A Study on Nifty Midcap 150 Scripts. *Indian Journal of Research in Capital Markets*, 4(4), 25-41.
2. Basha, M., Singh, A. P., Rafi, M., Rani, M. I., & Sharma, N. M. (2020). Cointegration and Causal relationship between Pharmaceutical sector and Nifty—An empirical Study. *PalArch's Journal of Archaeology of Egypt/Egyptology*, 17(6), 8835-8842.
3. Krishnamoorthy, D. N., & Mahabub Basha, S. (2022). An empirical study on construction portfolio with reference to BSE. *Int J Finance Manage Econ*, 5(1), 110-114.
4. JagadeeshBabu, M. K., SaurabhSrivastava, S. M., & AditiPriya Singh, M. B. S. (2020). Influence of social media marketing on buying behavior of millennial towards smart phones in bangalore city. *PalArch's Journal of Archaeology of Egypt/Egyptology*, 17(9), 4474-4485.
5. Mohammed, B. Z., Kumar, P. M., Thilaga, S., & Basha, M. (2022). An Empirical Study On Customer Experience And Customer Engagement Towards Electric Bikes With Reference To Bangalore City. *Journal of Positive School Psychology*, 4591-4597.
6. Reddy, K., SN, M. L., Thilaga, S., & Basha, M. M. (2023). Construction Of An Optimal Portfolio Using The Single Index Model: An Empirical Study Of Pre And Post Covid 19. *Journal of Pharmaceutical Negative Results*, 406-417.
7. Shaik, M. (2023). Impact of artificial intelligence on marketing. *East Asian Journal of Multidisciplinary Research*, 2(3), 993-1004.
8. Krishna, S. H., Vijayanand, N., Suneetha, A., Basha, S. M., Sekhar, S. C., & Saranya, A. (2022, December). Artificial Intelligence Application for Effective Customer Relationship Management. In *2022 5th International Conference on Contemporary Computing and Informatics (IC3I)* (pp. 2019-2023). IEEE.
9. Basha, M., Reddy, K., Mubeen, S., Raju, K. H. H., & Jalaja, V. (2023). Does the Performance of Banking Sector Promote Economic Growth? A Time Series Analysis. *International Journal of Professional Business Review: Int. J. Prof. Bus. Rev.*, 8(6), 7.
10. Ahmad, A. Y. A. B., Kumari, S. S., MahabubBasha, S., Guha, S. K., Gehlot, A., & Pant, B. (2023, January). Blockchain Implementation in Financial Sector and Cyber Security System. In *2023 International Conference on Artificial Intelligence and Smart Communication (AISC)* (pp. 586-590). IEEE.
11. Reddy, K. S. (2020). RISK MANAGEMENT AND AGRICULTURAL INSURANCE.
12. Venkat, M. V. V., Khan, S. R. K., Gorkhe, M. D., Reddy, M. K. S., & Rao, S. P. (2023). Fostering Talent Stability: A Study on Evaluating the Influence of Competency Management on Employee Retention in the Automotive Industry. *Remittances Review*, 8(4).
13. Reddy, K., Reddy, K. S., Lokesh, G. R., & Ashalatha, D. (2023). A Study on Factors Influencing Organic Food and Purchase Intentions of IT Professionals. *resmilitaris*, 13(2), 3544-3552.
14. Reddy, K. S., & Ranganathan, S. Shoppers' Perceived Value in Organized Retailing during Pandemic and Pre-Pandemic. *RVIM Journal of Management Research*, 5.
15. Reddy, K. S., & Ranganathan, S. Factors Influencing Customer Satisfaction in Bangalore Shopping Malls: Before & During COVID-19 Pandemic. *RVIM Journal of Management Research*, 26.
16. Lokesh, G. R., & Kotehal, P. U. A Study on the Effect of Electronic Payment Systems on Small Business in Urban Bengaluru.
17. Taj, M., Gunday, I., Navya, M. K., & Basha, M. A Study on Consumers Awareness in Rythu Bazars with Reference to Andhra Pradesh.
18. Jaggaiah, T., & Kethan, M. Analyzing the Effect of Macroeconomic Variables on National Stock Exchange: Evidence from India.
19. Basha, S. M., Kethan, M., & Aisha, M. A. (2021). A Study on Digital Marketing Tools amongst the Marketing Professionals in Bangalore City. *JAC: A Journal of Composition Theory*, 14(9), 17-23.

20. Isac Gunday, D. M. K. (2023). A study on consumer perception towards fast food retail outlets with reference to bengaluru karnataka. *Journal of Pharmaceutical Negative Results*, 418-424. with Reference to Bangalore City. *Journal of Corporate Finance Management and Banking System (JCFMBS)* ISSN: 2799-1059, 3(01), 23-34.
21. Kethan, M., & Rajasulochana, A. L. (2023). An Empirical Study on the Factors Influencing Usage of Mobile Payments