POWERING SMART, ELECTRIC, EFFICIENT MOBILITY

EV MANUFACTURING SPECIAL

EMobility+

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COVER STORY

THE UNSTOPPABLE RISE OF EV MANUFACTURING IN INDIA

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Shri. F.R. Singhvi,

President at **Automotive Skills Development Council and JMD at Sansera Engineering Ltd.,** emphasizes proactively building a strong knowledge base, practical experience, a growth mindset, and well-rounded soft skills - ASDC.

Vivek Gosain

Head of Manufacturing Engineering for the Passenger Vehicles Business Unit at **Tata Motors**, discusses how lean, agile, flexible, and sustainable manufacturing is the future of automotive manufacturing.

Read the full interview to learn about their vision, and approach to innovation

MUST READ

TECH STORY

Smart Mobility Solutions: The Role of AI and IoT in Manufacturing Indian Electric Vehicles

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IN CONVERSATION

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BUSINESS NEWS

INVESTMENT

Ather Energy Attracts ₹286 Crore In New Funding From Key Investor

Ather Energy, the electric scooter manufacturer, secured ₹286 crore (USD 34 million) in funding from its founders and Stride Ventures through a combination of debt and equity.

EXEDY Invests In Omega Seiki To Enhance Electric Mobility In India

EXEDY has announced its investment in Omega Seiki Pvt. Ltd., a Delhi-based company specializing in electric mobility solutions. This strategic partnership aims to develop electric vehicles featuring EXEDY's advanced electric drive units, including motors and continuously variable transmissions (CVTs). The collaboration is set to enhance the adoption of electric vehicles in India, contributing to the nation's carbon neutrality goals.

Euler Motors To Expand To 40+ Cities With ₹200 Crore Series C Investment

Euler Motors will use its recent capital infusion to expand its pan-India presence and servicing infrastructure, aiming to establish a footprint in over 40 cities by FY25. The company successfully closed its Series C funding round, raising an additional ₹200 crore and bringing the total for this round to ₹570 crore. This funding came from existing investors such as British International Investment, the UK's development finance institution, and impact investor, Blume Ventures, as well as new investor Piramal Alternatives India Access Fund.

Detroit, Varanasi, and Venice Chosen to Host Toyota Mobility Foundation's $9 Million Sustainable Cities Challenge

The Toyota Mobility Foundation has announced Detroit, Varanasi, and Venice as the host cities for its $9 million Sustainable Cities Challenge. This global initiative aims to foster healthier, safer urban environments and enhance sustainable mobility through innovative solutions. Chosen from a pool of over 150 cities across 46 countries, these three cities will each receive $3 million in funding to address their unique mobility challenges. Innovators worldwide are invited to submit their proposals, with the best solutions to be tested and implemented in real-world scenarios.

Marking system -THERMOMARK ROLL 2.0

Complete identification solution consisting of a printable label and a suitable protective laminate (EML-PR 29X9R/CHARX) for outdoor use. The AC charging cables can be labelled as per customer required specification (e.g., company logo). The label geometry was specifically adapted to the design of the AC charging cables to provide customers with a high-quality solution in terms of both appearance and technology. Thermomark Roll 2.0 thermal transfer printer marks labels, signs & heat shrink sleeves supplies in rolls directly on-site and can be used in all area of industrial marking .

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ON THE ROAD TO SUSTAINABILITY INNOVATIVE PARTNERSHIPS DRIVE EV GROWTH

Tata Motors Joins Forces With Bajaj Finance To Boost Dealer Financing Options

Tata Motors Passenger Vehicles (TMPV) and Tata Passenger Electric Mobility (TPEM) have partnered with Bajaj Finance Ltd., a subsidiary of Bajaj Finserv Ltd. This collaboration is set to extend supply chain finance solutions to dealers of both passenger and electric vehicles under Tata Motors. The MoU for this initiative was signed by the CFO of Tata Passenger Electric Mobility Ltd. Director of Tata Motors Passenger Vehicles Ltd., and CBO of Bajaj Finance Ltd. Tata Motors continues to lead the Indian automotive market with its innovative offerings in both internal combustion engine (ICE) and electric vehicle (EV) segments.

CHARGE ZONE Secures $19 Million Investment To Accelerate Expansion Of EV Charging Network In India

CHARGE ZONE, India's EV charging network, secures $19 million from British International Investment. This funding will help expand its high-speed charging network, targeting 1,500 super-charging stations in 18 months and over 10,000 by 2027, contributing to its goal of one million charging points by 2030.

Mahindra & Mahindra Ltd. Pumps ₹12,000 Crore Into MEAL For EV Expansion

Mahindra & Mahindra Ltd., a leading Indian automaker, has announced a massive investment of ₹12,000 crore (US$1.5 billion) in a new subsidiary, Mahindra Electric Automobile Limited (MEAL). MEAL will focus on the development and production of electric vehicles, a rapidly growing segment of the automotive industry.

BEENEXT Leads $2 Million Pre-Seed Investment In ProsParity To Transform Electric Vehicle Financing In India

ProsParity has secured $2 million in pre-seed funding from a consortium of global institutional investors, including BEENEXT, Sparrow Capital, All In Capital, DeVC, and Huddle Ventures. Notable angel investors have also joined this funding round. The raised funds will be allocated towards developing proof of concept, enhancing technology infrastructure, and expanding origination networks, with an initial focus on Central India.

Zypp Electric Secures $15 Million In Series C1 Funding, Plans Major Expansion

Zypp Electric has successfully launched its Series C funding round, raising $15 million. This round was spearheaded by Japanese major ENEOS. The Series C1 funding includes $15 million in equity, part of an ongoing $50 million round divided into $40 million in equity and $10 million in debt. The equity funding saw participation from prominent investors, including ENEOS and existing backers such as 9unicorns, IAN Fund, Venture Catalysts, WFC, and others.

ELECTRIC DREAMS PIONEERING THE SHIFT TO CLEAN TRANSPORTATION

SMBC Provides Green Financing Of ₹300 Crore For GreenCell Mobility's UP Electric Bus Project

GreenCell Mobility has secured over ₹300 crore in Green Financing from Sumitomo Mitsui Banking Corporation (SMBC) of Japan for its electric bus initiative in Uttar Pradesh. According to the terms outlined in the agreement, SMBC has provided GreenCell Mobility with a long-term Project Finance facility for its project involving 350 electric buses in Uttar Pradesh. This ₹3.07 billion facility aims to support the deployment of 9-meter fully-equipped AC electric buses across 8 cities in UP, as outlined in a company statement.

Tube Investments' TI Clean Mobility To Secure ₹580 Crore From GEF Capital Partners

Tube Investments of India (TII), a subsidiary of the Murugappa Group, announced that its division TI Clean Mobility has entered into a definitive agreement to secure ₹580 crore from GEF Capital Partners LLC, a private equity firm. The agreement, signed by TI Clean Mobility Pvt Ltd (TICMPL) on May 6, 2024, with South Asia Growth Invest III LLC and South Asia EBT Trust III (collectively GEF), involves raising the capital through equity and compulsorily convertible preference shares (CCPS), as per a regulatory filing.

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At the forefront of India's Public transport sector lies Prawaas 4.0, a pivotal event in multimodal transport discussions. Following it's success in the first 3 editions, Prawaas 4.0 promises a deeper impact. It brings together leading bus and car operators from across India, focusing on nine crucial segments: Intercity, Intracity, School Bus, Employee Transport, Tour Operators, MaxiCabs, Tourist Cabs, PPP-SPVs, & Critical Care.

Under the theme "**Towards Safe, Smart & Sustainable Passenger Mobility,**" Prawaas takes a big stride forward by integrating new segments such as Metro & Light Electric Vehicles. With a mission to revolutionize India's Public Transport sector, Prawaas facilitates discussions among Operators, Manufacturers, STUs, Policy Makers, Regulators, sector experts and media, paving the way for innovative solutions and collaborations. Join us as we drive towards a future of safe, smart, & sustainable mobility for all.

Towards SAFE SMART SUSTAINABLE Passenger Mobility

HIGHLIGHTS OF PRAWAAS 4.0

- **36** STATES & UTS OF INDIA
- **1500+** INDUSTRY DELEGATES
- **6000+** BUS & CAR OPERATORS
- **100+** EXPERT SPEAKERS
- **200+** LEADING EXHIBITORS
- **10000+** BUSINESS VISITORS

EVENT SPECTRUM

- TRADE EXHIBITION
- CONFERENCE WORKSHOPS / MASTERCLASS
- CEO CONCLAVE
- POLICY MAKERS ROUND TABLE
- AWARDS & CELEBRATIONS
- B2B PARTNERING

- BOCI INDUSTRY LEADERSHIP RECEPTION
- BOCI YUWA
- PIT STOP

Lead HVAC Partner: Eberspächer | Supported By: BITLA | Media Partner: EMobility+ | Local Host Associations

EXHIBITION TARIFF

Category	INR/sqm	USD/sqm
Raw Space	₹ 12000 /-	USD 185
Shell Space	₹ 13000 /-	USD 200

Plus 18% GST

Be A Partner I Book A Booth
Block Your Seat I Be At Prawaas

INVESTMENT

Relux Electric's Charging Station Expansion Gets ₹250 Crore Boost

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Atul Greentech's Electric Three-Wheeler Expansion Fueled By ₹32.50 Crore Funding

Atul Greentech Private Limited, the subsidiary of Atul Auto Limited specializing in electric three-wheeler manufacturing, has successfully raised ₹32.50 crore ($4.1 million) through various fundraising endeavors. This financing has led to the company being valued at Rs. 950 crore ($121.3 million). Among the investors in this funding round are Atul Auto Limited, notable investor Vijay Kedia, foreign portfolio investor Nav Capital VCC – Nav Capital Emerging Star Fund, and the Mahendra Patel family.

Roadcast And Mufin Green Finance Collaborate To Revolutionize Electric Vehicle Leasing in India

Roadcast, a leading SaaS-based logistics automation platform in India, has announced a partnership with Mufin Green Finance, the country's first listed NBFC dedicated to electric vehicle (EV) financing. In this collaboration, Mufin Green Finance will lease GPS-enabled 3W electric vehicles (3WEVs) equipped by Roadcast. This strategic partnership aims to revolutionize India's electric vehicle (EV) market by integrating advanced IoT systems into the 3WEVs leased by Mufin Green Finance.

Mobility and Energy Solutions Startup Matel Secures $4 Million Series A Funding from Transition VC and Gruhas

Matel, a homegrown mobility and energy solutions company, has secured $4 million in a Series A funding round led by Transition VC. The round also included investments from Gruhas and Haresh Abichandani, the founder of Millenium Semiconductor. Steer Advisors served as the exclusive transaction advisor for this funding round.

Transition VC Leads $4M Series A Funding Round for Matel, Accelerating Sustainable Electric Drivetrain Development

In a significant stride towards revolutionizing electric mobility, Matel, a pioneering homegrown mobility, and energy solutions company, has secured $4 million in a Series A funding round. Transition VC spearheaded the investment, joined by Gruhas and Haresh Abichandani, Founder of Millenium Semiconductor. The transaction advisory was exclusively facilitated by Steer Advisors.

PHF Leasing Diversifies Electric Vehicle Loan Portfolio, Including New Financing Options for Electric Cargo Vehicles And Used E-Rickshaws

PHF Leasing Limited, a Deposit accepting Non-Banking Financial Company (NBFC) headquartered in Jalandhar, Punjab, has significantly expanded its Electric Vehicle (EV) Loan portfolio. The company registered with the Reserve Bank of India since 1998, has introduced new loan products catering to the purchase of Electric Cargo vehicles in the L5 Category, Electric two-wheelers, and Used E-Rickshaws.

POLICY

India's Ministry Of Heavy Industries To Finalize Draft Guidelines For New EV Policy Aimed At Attracting Global Automakers

The Ministry of Heavy Industries plans to issue draft guidelines for India's new electric vehicle (EV) policy, aiming to attract global automakers like Tesla. The policy requires fresh investments for incentives, not considering previous ones. Vinfast's USD 500 million investment in Tamil Nadu awaits policy finalization. The government approved the Scheme to Promote Manufacturing of Electric Passenger Cars in India, with a 120-day application window for firms committing to a USD 500 million greenfield investment.

Ministry Of Heavy Industries' Electric Vehicle Taskforce Initiates Battery Swapping Policy Consultation In India

The Ministry of Heavy Industries plans to issue draft guidelines for India's new electric vehicle (EV) policy, aiming to attract global automakers like Tesla. The policy requires fresh investments for incentives, not considering previous ones. Vinfast's USD 500 million investment in Tamil Nadu awaits policy finalization. The government approved the Scheme to Promote Manufacturing of Electric Passenger Cars in India, with a 120-day application window for firms committing to a USD 500 million greenfield investment.

TENDER

Chennai's Metropolitan Transport Corporation Invites Bids For 100 Electric Buses

The Institute of Road Transport's Central Purchase Unit has opened a tender for supplying, operating, and maintaining 100 low-floor AC electric buses and charging solutions in Chennai. The project, worth ₹2.5 crores, aims to upgrade the city's public transport and promote sustainability. Bids are due by June 17, 2024.

CESL Invites Bids For Electric Car Fleet Management Tender In India

Convergence Energy Services Limited (CESL), a government of India enterprise, seeks bids for managing its electric car fleet, promoting electric mobility. Bid submission closes on May 14, 2024. The application fee is ₹25,000, with an EMD value of ₹55,00,000.

PARTNERSHIP

PURE EV and Pragmatic Design Solutions Ltd (PDSL) Join Forces To Revolutionize Electric Mobility With High-Performance 2-wheeler

In a significant move towards advancing electric mobility, PURE EV, India's prominent electric 2-wheeler scooter OEM, has announced a strategic joint venture with Pragmatic Design Solutions Ltd (PDSL) based in the UK. With over 70,000 customers and a commitment to pushing the boundaries of electric mobility, PURE EV's collaboration with PDSL aims to cater to the evolving needs of consumers both domestically and internationally.

Revfin Partners With Kalyani Powertrain Ltd And Bluwheelz To Launch Retrofitted Electric Trucks In India

In a significant move towards sustainable mobility, Revfin, India's leading digital lending platform, has announced a strategic partnership with Kalyani Powertrain Ltd (KPTL), the electric mobility arm of Bharat Forge Ltd, and Bluwheelz, a provider of sustainable logistical solutions. This collaboration aims to introduce retrofitted electric trucks to the Indian logistics sector, marking a pivotal shift towards greener transportation.

Driving Efficiency: Zepto And Battery Smart Unveil Partnership For EV Expansion

Battery Smart, a prominent battery-swapping network for electric two and three-wheelers, has revealed a partnership with Zepto, an e-grocery and quick commerce service. This collaboration will provide Zepto's EV delivery partners access to Battery Smart's extensive network of over 1,000 battery-swapping stations across more than 30 cities, enabling rapid two-minute battery swaps. The partnership aims to help Zepto deploy 10,000 new electric vehicles to its fleet in the fiscal year 2024-25.

PARTNERSHIP

Quantum Energy and Green Drive Mobility Join Forces To Propel EV Adoption In Last-Mile Delivery

In a significant move towards sustainable transportation, Quantum Energy Limited, a prominent electric vehicle (EV) original equipment manufacturer (OEM), has announced a strategic partnership with Green Drive Mobility, a leading innovator in electric mobility solutions. This collaboration marks a pivotal step in accelerating the adoption of electric vehicles for last-mile delivery and connectivity services across India.

Lectrix EV Partners With Jumppers to Electrify India's Last-Mile Delivery With 500 Electric Vehicles

In a groundbreaking move towards sustainable logistics, Lectrix EV, a leading name in India's electric two-wheeler sector, has announced a strategic partnership with FYC TECH PVT LTD, known as Jumppers. This collaboration will see Lectrix EV supply 500 electric vehicles to Jumppers, significantly bolstering their capacity to meet the surging demand for eco-friendly delivery services.

Incharz And 3ECO Partner To Establish Nationwide EV Charging Stations For Cargo Vehicles

Incharz, an EV charge point operator, has entered into a Memorandum of Understanding (MoU) with 3ECO, a producer of L-3 and L-5 cargo vehicles and an EV cargo fleet operator, to establish exclusive EV charging stations for 3ECO's fleet throughout India. This initiative aims to create a nationwide EV charging network, strategically positioned to meet the needs of 3ECO's vehicles.

Neuron Energy Partners with Hexall Motors For Groundbreaking Double Front Wheel Electric Vehicle

Neuron Energy, a leading manufacturer of lithium-ion batteries for electric two-wheelers and three-wheelers, has announced a strategic partnership with Hexall Motors. This collaboration marks a significant milestone in the electric vehicle (EV) industry, featuring the launch of Hexall Motors' innovative L5 category vehicle with a patented double front wheel design, the first of its kind in the world.

Motovolt Mobility Partners with FuturElectra to Deploy 2,000 Electric Scooters in India

Motovolt Mobility partners with FuturElectra to launch 2,000 M7 electric scooters in India, promoting sustainable urban mobility and efficient last-mile logistics. The M7, featuring a 166 km range, LFP cell chemistry, and IP67 certified battery, aims to revolutionize deliveries with its reliability and eco-friendly design.

ZEVO and Zen Mobility Partner to Revolutionize Last-Mile Deliveries in India

ZEVO and Zen Mobility partner to enhance last-mile delivery in India using Zen Mobility's Zen Micro Pod, an EV designed for congested urban roads. With a 150kg payload and 120 km range, the vehicle will improve delivery efficiency and reliability for services like Zomato and Swiggy.

Magenta Mobility And Switch Mobility Forge Alliance To Boost Electric Vehicle Deployment

Magenta Mobility, a provider of integrated electric mobility solutions, and Switch Mobility, the electric vehicle division of the Hinduja Group, have entered into a Memorandum of Understanding (MoU) for the procurement of 500 SWITCH IeV4 (Intelligent EV) over two years.

PARTNERSHIP

DGI and EVage Motors Forge Strategic Partnership to Revolutionize Electric Truck Market in India

In a groundbreaking move poised to reshape the landscape of sustainable mobility in India, DG Innovate and EVage Motors have announced a strategic joint venture. This partnership aims to accelerate the commercialization of DG Innovate's Pareta electric drive system while bolstering EVage's position as a leading player in the electric truck market.

Statiq and Cube Stop Forge Alliance To Fuel India's EV Revolution on Highways

In a bid to accelerate the adoption of electric vehicles (EVs) and bolster the EV charging infrastructure along India's highways, Statiq, the nation's leading EV charging network, has joined forces with Cube Stop Highway Rest Areas. This collaboration marks a pivotal step towards fostering sustainable mobility solutions across the country.

New Joint Venture Between VECV And iTriangle Infotech To Revolutionize Telematics In Trucks And Buses

VE Commercial Vehicles Limited (VECV), a key subsidiary of Eicher Motors Limited, has announced a partnership with iTriangle Infotech Private Limited (iTriangle) to deliver automotive-connected solutions. Under this partnership, VECV will own 51% of the joint venture company (JV Co), while iTriangle will hold the remaining 49%. According to the company's exchange filings, "Upon finalization of the Joint Venture Agreement, AMSPL (Aquila Mobility Solutions Private Limited) will become a JV Co with VECV and iTriangle."

Stellantis And Leapmotor Set To Electrify Indian Market With EV Launch In 2024

Stellantis and Leapmotor have established Leapmotor International to introduce Leapmotor's electric vehicles globally, starting with India in late 2024. With a €1.5 billion investment, the joint venture aims to leverage Stellantis' network to expand Leapmotor's sales, offering advanced BEVs like the C10 and T03 models to Indian consumers.

OTHER

NSE Indices Introduces Nifty EV & New Age Automotive Index

NSE Indices Limited has launched the Nifty EV & New Age Automotive Index, India's first Electric Vehicle Index, to track companies in the EV ecosystem. With a base date of April 2, 2018, and a value of 1000, it offers new investment opportunities, aligning with India's Make in India initiative.

Ola Electric Files Patent For Removable Battery, Revolutionizing EV Technolog

Ola Electric has filed a design patent for a removable cylindrical battery with a grab handle, intended for its upcoming electric three-wheelers. Unlike fixed batteries in its current scooters, this swappable battery is primarily for commercial use, similar to those used by Hero's Vida, Bounce, Yuma Energy, and Honda.

NCRTC Rolls Out First Electric Vehicle Charging Point In Ghaziabad

NCRTC has launched its first EV charging station at Sahibabad RRTS station, Ghaziabad, offering fast and slow charging for various electric vehicles. Users can pay via a mobile app. More stations will follow, aligning with NCRTC's solar policy to produce 11 MW of solar power for non-traction uses within five years.

Jupiter Electric Mobility Receives ARAI Approval For JEM TEZ Electric Vehicle

Jupiter Electric Mobility (JEM), a subsidiary of Jupiter Wagons, received ARAI approval for its Battery Operated Light Commercial Vehicles, including the JEM TEZ, capable of fast charging in 20 minutes and a 127 km range. Production starts soon, with plans to expand into Medium and Heavy Commercial Vehicles and buses.

Accelerating Electric Mobility:

THE UNSTOPPABLE RISE OF EV MANUFACTURING IN INDIA

Electric vehicles (EVs) are no longer just a futuristic concept but a rapidly growing reality, and India is making significant strides in this direction. With increasing concerns about pollution, climate change, and the depletion of fossil fuels, the shift to electric mobility is not only desirable but also necessary. India, one of the world's largest automotive markets, is accelerating its efforts to become a major hub for EV manufacturing.

The Indian government has played a crucial role in this transformation. The National Electric Mobility Mission Plan (NEMMP) 2020, launched in 2013, was a pivotal step in promoting electric vehicles. This plan aimed to support the faster adoption of EVs by offering financial incentives, developing necessary infrastructure, and encouraging local manufacturing. Following this, the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme was introduced in 2015. This scheme has been instrumental in providing subsidies for electric two-wheelers, three-wheelers, and buses, thereby boosting the market for EVs.

Policy measures have been crucial in creating a supportive environment for EV manufacturing in India. The government has reduced the Goods and Services Tax (GST) on EVs to 5%, compared to the 28% on internal combustion engine vehicles. Additionally, there are income tax rebates for individual EV buyers and incentives for setting up manufacturing units and charging stations. The phased manufacturing program (PMP) encourages the local production of critical components, helping reduce costs and promote domestic innovation.

India's push towards electric mobility is also driven by its vibrant startup ecosystem. Startups across the country are developing innovative solutions for electric vehicles, from designing advanced batteries to creating efficient charging infrastructure. Companies like Ather Energy, Ola Electric, and Revolt Motors are leading the way in producing electric two-wheelers that are both high-performing and affordable. These startups are not only contributing to the growth of the EV market but also creating jobs and driving economic growth.

The traditional automotive industry in India is also adapting to this new era of mobility. Major automakers like Tata Motors, Mahindra & Mahindra, and Hero Electric are investing heavily in EV technology. Tata Motors, for instance, has launched several electric models like the Nexon EV, which has received a positive response from consumers. Mahindra & Mahindra is focusing on electric SUVs and commercial vehicles, while Hero Electric is expanding its range of electric scooters.

A significant factor in the rise of EVs in India is the development of charging infrastructure. The availability of convenient and reliable charging stations is crucial for the widespread adoption of electric vehicles. The government, along with private players, is working on setting up a robust network of charging stations across the country. Energy companies like Tata Power and Indian Oil are partnering with EV manufacturers to establish charging points at strategic locations.

Despite these positive developments, the EV industry in India faces several challenges. The high cost of batteries, limited range, and lack of charging infrastructure in rural areas are significant hurdles. However, ongoing research and development efforts are addressing these issues. Advances in battery technology are leading to cost reductions and improved performance, while the expansion of the charging network is making electric vehicles more practical for everyday use.

Moreover, the environmental benefits of electric vehicles cannot be overstated. With India being home to some of the most polluted cities in the world, the adoption of EVs can significantly reduce air pollution and improve public health. Electric vehicles produce zero tailpipe emissions, which means cleaner air and a reduction in greenhouse gases. Additionally, EVs are quieter, contributing to lower noise pollution in urban areas.

In conclusion, the rise of electric vehicle manufacturing in India is an unstoppable trend driven by government support, innovative startups, and the traditional automotive industry's commitment to change. While challenges remain, the benefits of electric mobility, including reduced pollution and enhanced energy security, make it a vital part of India's future. As the country continues to develop its EV ecosystem, it is well on its way to becoming a global leader in electric mobility.

BRIDGING GAPS AND EMBRACING INNOVATION: A VISIONARY APPROACH TO AUTOMOTIVE DESIGN

Ramkripa Ananthan

Head of Design
Ola Electric

KEY HIGHLIGHTS

- Keeping it simple, focusing on evolving customer needs and solving the problem with the best use of technology define Kripa's design philosophy.
- Core competencies and collaboration are key, turning challenges into opportunities in automotive design.
- AI and VR/MR enhance creativity and efficiency, improve the quality of design and speed to market.

Can you describe your design philosophy and how it has evolved over your 27+ years in the automotive industry?

Mine is more a capability than a philosophy- my capability is bridging the gap between what the customer truly desires and what the product can actually deliver. Over the years, my capability has evolved in that I am getting better at decoding customer needs and, maybe because of that, at product design. At Ola Electric, we are cutting away at the clutter and focusing on capturing the essence of the category (of product). My philosophy now is about keeping it simple, focusing on the rapidly changing customer needs, and solving the problem with the best technology has to offer.

As an outstanding woman leader in the automotive sector, what unique challenges and opportunities have you encountered, and how do you see the role of women evolving in automotive design and leadership in the coming years?

To answer the question, I need to write a book! What's fascinating about having worked in this industry for so long is that when I started, our industry was nascent - I got the opportunity to develop teams, organization structures, capabilities, processes, portfolios of products, equipment, and infrastructure. I have not dedicated sufficient time to understanding whether my gender posed any specific challenges. In technical areas, I am confident that what the industry needs is people with core competencies who are excellence oriented, hardworking, and committed. In automotive design, it is essential for leaders to be collaborative; development timelines are long, and having a common goal is essential for speed of delivery. Automotive design is complex with many systems having to work in perfect unison; again, the only way to achieve success is by working closely with your colleagues and turning challenges into opportunities for product differentiation and not compromises.

What role does user feedback play in the design and development of new models at Ola Electric?

Customer feedback is critical for creating successful products, and its role varies depending on the phase of product development. Ahead of defining the product, we would like to get insight about the customer - what makes them tick, what gives their life meaning, what's the zeitgeist, and what do they want in their products; during the early stages of design and development, we would like feedback on the product being defined - the design, performance, and features. We are using Virtual Reality tools to get this feedback in early stages of design. While I am making this sound quite discrete, customer feedback is almost continuous; designers need to be in a state of deep empathy always.

How do you approach designing a seamless customer experience from the vehicle's exterior to its in-car UI/UX and associated apps?

Customer experience nowadays is much before and beyond the product; it is essential to be in sync with brand architects, marketing, and service teams to have a cohesive narrative from when the customer becomes aware of the product till well after purchase. In product design, we have a well crafted design brief that is part of the narrative, with which the whole team aligns. In a complex product like a vehicle, aspects like exterior design, interior design, UI/ UX, CMF will be contributing to different attributes of the brief yet make sense as a whole.

> Goal is to bridge the gap between what the customer truly desires and what the product can actually deliver. My journey in the automotive industry has been about responsiveness to a customer's evolving needs

> In automotive design, success hinges on collaboration. Leaders must foster teamwork, ensuring that the intricate systems within a vehicle harmonize to deliver an exceptional product.

How do you leverage advanced technologies like AI, IoT, and automation in your design process? How do you see the design of electric vehicles evolving in the next five to ten years?

We have just started using AI to augment design, and we see immense potential in increasing the range of creative solutions. Currently, we are using it as an ideation tool, in making presentations, and in some processes in digital modeling. The scope for automation is little in design as every exercise is unique. However, we do make bespoke tools inhouse to aid in evaluating and improving comfort and ergonomics. The big difference in recent years has been the inclusion of VR/ MR in every step of automotive design. We are able to improve the quality of design and speed to market significantly using VR/ MR as we have less need to make physical models and prototypes. There is a close relationship between electric, shared, autonomous, and connected vehicles. We will see more autonomous and connected car features shaping the design of electric vehicles in the future.

How does Ola Electric address sustainability in its design practices and material selection?

Young designers like to think at a system level and are invested in a sustainable future. At Ola Electric, we encourage designers to think about efficiency at all times, be minimal, be reductive. We focus on light-weighting, on less parts, less processing. Our journey on sustainable materials is in early stages but we are looking at increased recycled content, at reduced energy usage through the entire lifecycle of the part and at end of life. Using VR in the design process properly reduces iterations and the need for more multiple physical properties too; thereby reducing waste.

How do you balance the desire for personalized design with the need for scalable manufacturing?

Currently, our focus is on scale. In the future, extensive accessories are the way to enable personalisation, for comfort, utility, specific functionality, and enhanced performance. In digital areas, like our app and on our screen, we provide personalisation. One of the advantages of an electric vehicle is the ease of personalisation - we can have personalised drive modes, comfort modes, routes, etc. without affecting scale of manufacturing.

How can young designers stay innovative and relevant in the rapidly evolving field of EV design? What legacy do you hope to leave behind in the automotive and electric mobility sectors?

Designers will always be relevant if they have true empathy for customers. Envisioning many viable alternative futures is a way of being able to come up with innovative solutions. Designers need to be abreast of technology in materials and processes at all times to be able to leverage them in their designs. A portion of your day has to be kept aside for tracking trends across the world and in adjacent fields. I think having a sense of wonder, of being able to see beauty around you makes you a better designer. I enjoy what I do. A good legacy for me would be to have inspired people to love design, to enjoy their work, and life, to aspire for excellence.

SETTING NEW BENCHMARKS IN AUTOMOTIVE MANUFACTURING EXCELLENCE

Vivek Gosain

Head-Manufacturing Engineering for Passenger Vehicles Business Unit,

Tata Motors

KEY HIGHLIGHTS

- My experience with top automotivecompanies has shaped my flexible and customer-focused approach at Tata Motors.
- We enhance manufacturing with Industry 4.0 and IoT by first optimizing and then digitizing our processes for better efficiency.
- We enhance manufacturing with Industry 4.0 and IoT by first optimizing and then digitizing our processes for relationships.

How has your experience in different areas like plant operations, manufacturing engineering, and new product development shaped your management style at Tata Motors?

I have had a unique opportunity to work with Automotive majors-Honda Cars, General Motors, and SAIC's MG Motor over the last 28 years. I have had accomplishments in setting up Greenfield plants right from Concept stage to commissioning stage and to steady stage operations, have executed brownfield expansion projects, launched new models in ICE and EV powertrains, have also set up Supplierpark for Tier 1 suppliers.

I have had exposure to Multi culturalenvironment working with Multinationals and Indian companies and have evolvedinto forming my own work ethics which rest on the pillars of Flexible in thinking, being creative, having an Owner's mindset and walking the straight line. My mantra is demonstrating CARS behavior (Customerand Product focus, Accountability, Risk taking and Speed).

Tata Motors is a Company that has a very rich legacy of its own. It has had its own share of ups and downs, although, post Covid 19, Tata motors has been cruisingon a fast lane. Volumes of 25000 units per month have gone up to 55000 per month. I am proud to be part of this growth story, having executed Capacity creation in our vehicle and Powertrain plants besides launching CNG variants of Altroz and Punch models,MCE versions of Nexon and Harrier/ Safari.

I have applied the right mix of short-term and long-term approach, thereby being frugal yet modularin planning and spending to tackle Business uncertainties. Besides building teams of the future, I have been busy in developing an Ecosystem which is future ready, Digital,simplified yet effective, and exceeds Quality, productivity, and Cost deliverables.

At R&D front also, whetherit is Body and Chassissystems, or vehicleelectronics, of Autonomous features (ADAS), been engaged in ensuring that we have a competitive edge over Competition in these technologies. There have been many firsts since I joined Tata Motors-Twin cylinder technology for our CNG vehicles, BNCAP compliant vehicles etc.. and many more vehicles with Unique features to hit the market over next few months.

How is Tata Motors leveraging Industry 4.0 and IoT technologies to enhance manufacturing processes?

At Tata Motors, we are committed to a business-first philosophy in leveraging Industry 4.0 and IoT technologies. Our priority is solving complexmanufacturing-related problems throughthese advanced technologies. By harnessing Industry4.0 and IoT, we are achieving significant improvements in efficiency, quality, and flexibility.

We follow a "first Lean, then Digitalize" approach. This means we first standardize our processesand eliminate waste, then utilizeIndustry 4.0 and IoT technologies to make our operations transparent, agile, and data-driven. These advancements not only enhanceour manufacturing processesbut also providea competitive edge in the automotive industry through improvedresource management, predictive maintenance, and data-driven decision-making.

How do you handle supply chain disruptions, especially concerning critical EV components like batteries?

In electric vehicles, the key components are the E drive of Electric motor which is alternate to Engine in ICE vehicles.Then we have Battery pack, which comprises of Cells in cluster form; this is alternate to the Fossilfuel used in ICE vehicles and then we have DC-DC Converter. It converts the higher voltage DC current into lower voltage DC current that is used to power the smaller EV accessories.

Among all the unique components of EV, the Battery packs have always been critical from Supply chain perspective. The battery packs are sourced from Tata AutoComp systems ltd. Which has a JV with China's Guoxuan. Though, currently, battery pack capacity is a challenge meeting our Electric vehicles demand, however, to secure healthy supply we have kicked off our own battery pack Giga factory at Sanand, Gujarat under the name - AGRATASwhich is a global batterybusiness within the Tata Group.Derived from the Sanskrit word 'Agra', the world's oldest language, our name stands for leadership and moving forward. Combined with 'Gravitas', it reflects our ambition to be purpose driven, pioneering power for future generations. We have enteredour industrialization phase, building world-class giga factoriesin India and the UK, and unlocking green growth opportunities for global customers in the mobility and energy sectors.

Regarding non EV specific components, unlike rest of the Industry playersin India, for the Semiconductor based parts, during Covid times, while the whole world was facing major semiconductor shortages our supply chain team took right actions by creating a pool of Chips and then ensuringsteady supplies at JIT basis, we, thereby, didn't face major supply disruptions, now the semiconductor shortages are behind us hence,we are getting the supplies as per the demand.

To summarize, Tata Motors maintains a highlydynamic approach towards our supply chain through active camaraderie with our supplier partners.

What do you think about the future of car manufacturing with Industry 4.0 and digital transformation?

Automotive manufacturing is becomingincreasingly complexdue to the constant shift in customer demands. Consequently, lean, agile, flexible, and sustainable manufacturing is the future. A connected value chain will be the backbone of automotive manufacturing, where the demand cycle, manufacturing cycle, and supply cycle work seamlessly together.

Industry 4.0 and digital transformation technologies will enable real-time data capturing and information processing for agile, data-driven decisions. Successfully integrating these advancements will likely distinguish industry leaders from laggards. In this context, the future of automotive manufacturing is incredibly promising, with the industryset to be the torchbearer for digital transformation and Industry4.0 in the near future.

How do you balance the need for high-quality manufacturing with the pressures to reduce costs and increase efficiency?

As I mentioned that over last 4 years, we have more than doubled our capacities which has been realized thru migration towards high level of automation in our plants. That said, the decision to Automate is taken keeping payback in terms the Return on Investment thru increased Productivity, process repeatability, better Quality and de-skilling of operation from Manual thru automation.

Our Weld shops are fully automated with state of the Art Robots and handling systems, our Paint shops have adapted latest technologies in processes in CED and spray painting area, we are transforming our coating technology from Mediumsolid to High solid Painting which besides from perceived quality is an enabler towards our Sustainability responsibility. We have error proofed our Vehicle assemblyprocesses through smart Poka yoke and we are challenging conventional vehicle assembly processes from quantum of assembly time perspective. Conventionally, vehicle assembly plants are people intensive, this is also being challenged by us and we plan to big-time migration towards automation in these areas too.

We are eliminating variances in terms of the Machine and equipmentinfrastructure thru standardscommon for equipmentselection and for spare management, similarly we have dedicated team of subject matter experts who takes care of high end equipment's, similarly by adoptingproper preventive maintenance techniques our team ensure the availability of equipment's for production thereby increasing efficiency.

What key advancements are needed in manufacturing to support future electric vehicle growth, and how might they develop?

The Electric vehiclesfrom our portfolioare derived from our ICE architecture, thereby,some compromises in terms of Body structure are required for both ICE and EV variants thereby increasing Body mass given durability requirements. Our future architectures are designed for EV dedicatedly, thereby achieving efficient Body design.

Mostcritical advancements requiredfor manufacturing of Electric vehiclesis to maximize common Bill of Process(BOP) and Bill of equipment (BOE) and minimizeimpact of the deviations to cycle times on common workstations.

At Tata Motors, we are already taking these initiatives for efficient manufacturing, which is fungiblebetween ICE and Electric vehicles.

Key Themes	Key Focus Areas
• Leadership in Sustainability	Drive Sustainable Mobility Solutions-Net Zero and Circular Economy, EV & alternatefuels, Energy Transition, Innovative Mobility Solutions, Risk Management
• Momentum for Growth with Financial Fitness	Product Portfolio expansion through a segment-specific approach, Network Capability & Reach, LeverageDownstream & International Business, Benchmark Competitiveness - Value accretion, Fix Cost, DMC/Margin, Capex efficiency and Cash flow management.
• Superior Customer Experience	Enhance CustomerExperience, Focus on Product Quality& Service for good customersatisfaction, Fostering Innovation & Technology Incubation, Product Attribute Leadership, Reliable & Innovative 'Products and Services' that customers aspire for, Building Brand Salience amongstStakeholders
• Accelerate and Leverage Digitalisation	Business Products, Focus on Operational & Process efficiency, Better Stakeholder Experience driven through data, Digital and AI/ML, Data Quality, Use of Digital& AI/ML
• Future Ready Organisation	Benchmark People Processes - People Engagement with focus on Empathy for customer, Capacity & Capability, Leadership Pipeline & Intrapreneurship, Talent Management, Organizational Culture & Effectiveness, Diversity & Inclusion, Learning & Sharing,Safety Commitment &Outcomes
• Ecosystem Management (Manufacturing, Suppliers & Partners)	Operational Technology & Excellence, Manage Product Quality & Service, Capacity enhancement and resilient supply network to maximize demand fulfilment capabilities. Strategic Partnerships with Suppliers, ChannelPartners, and Startups

How does Tata Motors ensure that its manufacturing processes align with customer expectations for EV performance and reliability?

Our strength is our sensitivity towards our customers. Following are the enablers for the same.

- Obsessed with Customers. Builds customer trust, confidence, and loyalty. Processes and measures are largely "outside-in". Customer First. Customerstake the example of the organization as role models in Customer centricity.
- Strategies are market driven and sensitive to Customer requirements
- Marketing initiatives are more Customer driven.Reward mechanisms for delighting Customers
- Innovates product offerings and services to exceed customerexpectations.
- The companyproactively captures the voice of the customeracross all markets& products, including customer desires and marketplace potential, and leverages in-depth knowledge of customers by segments. Customers are long-standing brand ambassadors; they constructively criticize for a better partnership.
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- ComprehensivelyListens to current,former, and potential customers.Collects and disseminates actionable information on engagement, satisfaction, and dissatisfaction for action and continuous improvement across all stages of the life cycle of customer engagement.
- Resolves through effective systems all customerrelated complaints promptly and eliminates the causes. Refines and innovates customersupport and communication.
- The results reflect offerings with superior value as viewed by customers and the marketplace.

Tata Motors' EV manufacturing: Adaptations, challenges in scaling up, and quality assurance methods?

Given the novelty of EV production platform, its not surprising that manufacturers encountering plant capacitychallenges. These challenges are addressed by adding new stations for Electric Vehicle specific operations in body shell welding, paintingprocess, especially in the under body,and in Powertrain assembly and vehicle assembly lines such as E drive vs Engineassembly,fuel tank vs battery decking,our ECU flashing programs for ICE vs Electric vehicles, common vs unique testingprocesses. Fuel dispensing vs Battery fast charging, commonization of ADAS testing processes and other EOL testing processes. There are some challenges as well, like managing complexities, adding facilities in the existing lines for battery storage systems, and online decking of batteries, etc.

JSW MG MOTOR INDIA COMMITMENT TO RENEWABLE ENERGY AND ECO-FRIENDLY INITIATIVES

Ravi Mittal

Director-Manufacturing
JSW MG Motor India

KEY HIGHLIGHTS

- MG Motor India's Halol facility uses advanced technologies and Lean manufacturing for efficient EV production.
- They optimize supply chain operations with data-driven strategies to ensure timely delivery of parts.
- MG Motor India prioritizes sustainability with over 60% renewable energy use and various eco-friendly initiatives.

Can you share with us some insights into MG Motors' manufacturing strategy in India, particularly concerning electric vehicle (EV) production?

Since our inception in India, we have been consistently focusing on innovation, technology, and a customer-centric approach. Today, our state-of-the-art manufacturing facility in Halol, Gujarat, has an annual production capacity of 1,00,000 plus vehicles providing employment to 6,000 direct and indirect employees, with diversity at Shop floor as one of the strengths, which is currently at 36%.

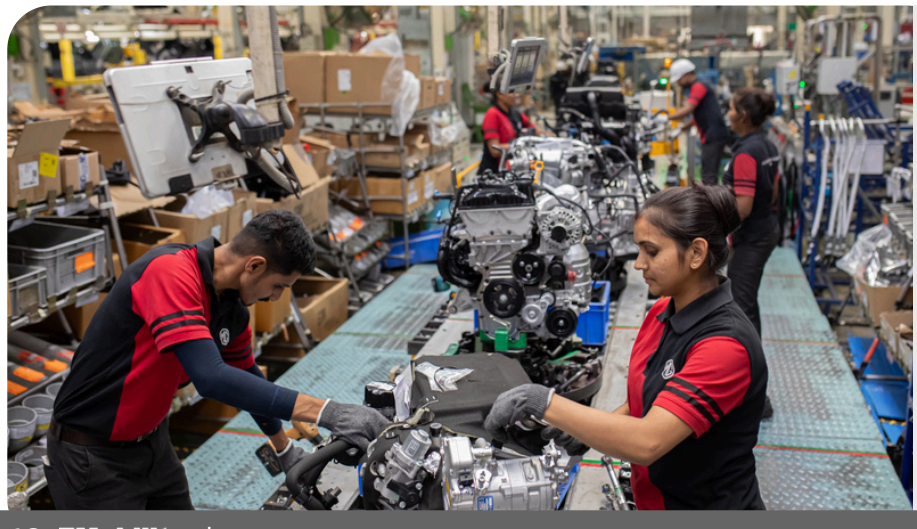
With the rapid progression of technology and shifting global dynamics, the manufacturing sector is undergoing profound transformations, and so is JSW MG Motor India. We brought in operational efficiency through the implementation of **Lean manufacturing principles** and **the integration of smart factories.** Digital twining tools, real-time data analysis for bottleneck identification, and the deployment of advanced sensors, cameras, AR/VR, and other emerging innovations are leveraged to eliminate human errors.

The automotive industry is also witnessing a rapid increase in sophistication, automation, agility, and efficiency. Manufacturers in the automotive sector are gradually transitioning from conveyorized manufacturing processes to assembly on Automated Guided Vehicles (AGV), providing the flexibility to manufacture multiple variants simultaneously. With the new phase of growth for JSW MG, the company will be focusing on introducing advanced technologies and best sustainable practices in its manufacturing operations.

What are the key challenges you've encountered in scaling up EV manufacturing operations in India, and how have you addressed them?

One of the critical aspects of EV manufacturing is to ensure the facility gets the right parts at the right time to deliver right vehicles to the customers. The complete cycle chain starting from the supply of raw materials to the suppliers, manufacturing of Parts & products, to distribution of goods to consumers, forms the complex automotive supply chain.

Adopting the right supply chain planning strategy using historical data, inventory management and market intelligence data to understand the changing demand, the manufacturers optimize/reduce costs, improve customer service, and support the business goals. The automotive supply chain has also become significantly more globalized, meaning that it is becoming difficult to keep track of where all the materials are coming from. Hence, it becomes important for us to work towards increasingly open and visible IT environments, with increased integration across the complete value stream.



> Being the second-largest EV seller, currently EVs contribute about 30% to MG's sales in India, highlighting our commitment to promoting sustainable transportation and shaping the future of manufacturing in the EV sector.

Sustainability is a growing concern in the automotive industry. How does MG Motor India incorporate eco-friendly practices into its manufacturing processes?

Being a responsible corporate citizen, we are also mindful of utilizing the environmentally friendly materials and implementing the sustainable initiatives at our manufacturing plant from renewable resources. We are one of the few pioneering passenger car manufacturers to use wind-solar hybrid power at its manufacturing unit in Halol in partnership with CleanMax – A leading renewable energy company in India.

JSW MG Motor India has been a strong advocate for creating a sustainable automotive industry in India, being at the forefront of implementing sustainability initiatives like:

- Zero Discharge Plant that utilizes 100% of treated water
- Usage of Cleaner fuel (PNG) in all processes
- Zero landfill site - 100% disposal of Hazardous Waste in cement plan
- Miyawaki Forest–3000 Plants
- 12 Recharge Wells
- Green coverage-Over 22% of land with 10,000 trees planted

With the increasing demand for EVs, how does MG Motor India ensure the quality and reliability of its electric vehicles during the manufacturing process?

Customers these days expect enhanced value for their money, encompassing both the product and associated services. The purchasing decision is no longer solely revolve around price sensitivity; rather, it also encompasses a commitment to quality and reliability. At JSW MG India, focus on offering customer delight with quality and reliability are paramount. Quality focus extends beyond the manufacturing to encompass complete process chains, commencing from raw material selection and processing, logistics, packaging, to digitized inspection and analysis, culminating in the final quality experience at the customer receiving point through our most advanced and superior quality products.

Our MG ZS EV, India's first pure-electric internet SUV and MG Comet - The Smart EV have undergone through more than 35 stringent battery safety tests to ensure maximum safety for every possible condition. The batteries of both the EVs have been designed to comply with IP69K and IP67 rating respectively.

As the automotive industry transitions towards electric mobility, what role do you see MG Motor India playing in shaping the future of manufacturing in the EV sector?

We have prioritised the development of EV infrastructure prior to introducing the ZS EV, our second model launched in 2020. The move highlighting its dedication to promoting sustainable transportation in India. As an early mover in the EV space, we focused on establishing a robust infrastructure for EV charging well in advance of introducing our second vehicle, the MG ZS EV, India's first fully-electric internet SUV. Being the second-largest EV seller, currently EVs contribute at about 30% to MG's sales in India.

From convenience and ownership point of view, we ensure end-to-end charging solution to our EV customers. And, towards this, we have been installing chargers at our EV customers' residence, leading apartments, condominiums, and societies, major highways across the country. Under the MG Charge initiative and with our partners we have successfully installed more than15,000 public and home EV chargers. Additionally, the company has collaborated with BPCL, Jio-BP and HPCL to establish charging stations at various touchpoints across India. MG also partnered with Exicom, Tata Power, ATTERO, UMICORE, TES AMM SUPER and LOHUM for second-life and recycling of EV batteries.

JSW MG is also committed to create awareness programmes for customers and potential EV owners. One of them is EVPEDIA, the first-of-its-kind EV Education platform that aims to provide comprehensive and accessible information to educate a diverse audience and promote the adoption of EVs in India. JSW MG forged into a strategic partnership with Shoonya — Zero Pollution Mobility campaign led by NITI Aayog, along with notable industry leaders from the electric mobility sector in India.

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ENSURING A SMOOTH & SAFE RIDE: WHY VIBRATION AND SHOCK TESTING IS ESSENTIAL FOR EVS

Tarang Kinetics

The electric vehicle (EV) revolution is in full swing, promising a cleaner and more sustainable future. However, unlike their gasoline-powered counterparts, EVs face unique challenges in terms of ensuring a smooth and safe ride. Vibration and shock testing come to the forefront here, playing a critical role in guaranteeing the robustness and passenger comfort of these innovative vehicles.

Beyond Engine Rumble: Sources of Vibration and Shock in EVs

- **Road Imperfections:** Bumps, potholes, and uneven surfaces are a constant reality. These imperfections transmit vibrations through the suspension system, ultimately reaching the cabin and creating a bumpy ride.
- **Electric Drivetrain:** The electric motor and inverter, the heart of an EV's propulsion system, generate vibrations due to their rotating parts. While quieter than an engine, these vibrations can be felt at specific frequencies, impacting comfort.
- **Battery Pack:** The battery pack, often the heaviest component in an EV, is susceptible to movement during sudden accelerations, decelerations, or sharp turns.
- **External Shocks:** From potholes to road debris, EVs encounter unexpected shocks that can potentially damage components or compromise passenger safety.

The Necessity of Vibration and Shock Testing

- By simulating real-world driving conditions, vibration and shock testing provide invaluable insights for engineers.
- **Enhanced Passenger Comfort:** Excessive vibration and shock can lead to fatigue, discomfort, and even motion sickness. Testing helps identify and mitigate these issues, leading to a smoother and more enjoyable driving experience.
- **Improved Durability and Reliability:** Constant exposure to vibrations and shocks can lead to wear and tear on various EV components. Testing helps identify potential weak points, allowing engineers to strengthen these areas and ensure the vehicle can withstand everyday use.
- **Battery Safety:** Lithium-ion batteries, the mainstay of EVs, are sensitive to both vibrations and shocks. Testing helps ensure the battery pack and its connections can handle these forces without compromising safety or performance.
- **Noise Reduction:** Vibrations often translate into unwanted noise. By minimizing vibrations through testing, engineers can create a quieter cabin experience for passengers, particularly important in EVs where engine noise is absent.

Types of Vibration and Shock Testing for EVs

- **Vibration Testing:** This involves subjecting the EV to controlled vibrations across a range of frequencies. Two main methods are employed:
- **Sine Sweep Testing:** This method gradually increases the frequency of vibrations, allowing engineers to identify resonant frequencies where vibrations are amplified. By pinpointing these frequencies, they can modify components or add dampeners to reduce unwanted noise and vibration.
- **Random Vibration Testing:** This method simulates the random vibrations experienced during real-world driving. It helps assess the overall response of the EV and its components to a broad spectrum of vibration frequencies.
- **Shock Testing:** This test simulates sudden impacts that an EV might encounter, such as hitting a pothole or curb. By exposing the vehicle and its components to these controlled shocks, engineers can ensure they can withstand such forces without damage or compromising safety features.

Standards and Regulations

EV manufacturers must adhere to industry standards set by organizations like ISO and SAE. These standards define acceptable vibration and shock levels, ensuring EVs meet safety and performance requirements. As EV technology advances, these tests will remain crucial for creating a smoother and more resilient future of electric transportation.

Fig: Vibration Test Machine

Ready to Elevate Your Testing?

Contact Tarang Kinetics for assistance with your application, send e-mail to info@tarangkinetics.com

MODELING AND SIMULATION ARE KEY TO DEVELOPING FUEL CELL ELECTRIC VEHICLES

Introduction

One potential way to help reduce greenhouse gas emissions and slow down climate change is by replacing internal combustion engine vehicles with electric vehicles. Electric vehicles also offer the advantage of reducing pollutant emissions in densely populated areas, thereby improving air quality for citizens. Electric vehicles powered by wind electricity have very small greenhouse gas emissions during operation. However, there are substantial emission levels during the manufacturing stage of these vehicles.

Fuel cell electric vehicles offer several advantages compared to battery-powered electric vehicles. They can achieve a higher energy density (especially for heavy vehicles); higher efficiency, if the comparison is made assuming that the electricity for charging the batteries is produced using hydrogen; and they do not require capacity to deliver very high power from the electric grid when refueled, compared to the recharge of the battery-powered vehicles.

The main limitations of fuel cells for electric vehicles are the manufacturing cost, limited service life, and relatively low power density [1].

The Design Limitations

The three limitations mentioned above all boil down to the microscopic design of the active layer in the oxygen-reducing gas diffusion electrode: the cathode in the fuel cell. There are surely other aspects that are important, but the design of the active layer is paramount.

The catalyst used in the active layer is platinum. The platinum loading of the active layer determines the lower limit for the manufacturing cost. We can reduce the manufacturing cost of almost everything else in the fuel cell, but it is harder to lower the cost of platinum. It is therefore necessary to develop active layers that require a very-low-catalyst loading without reduced performance.

Service life is limited by different degradation mechanisms, such as proton reduction, platinum dissolution, carbon corrosion, the formation of radicals that attack the membrane electrolyte in the active layer, adsorption of impurities on the catalyst sites, and accumulation of impurities in the pore electrolyte [2]. Changes of hydrophobicity in the cathode's active layer may cause flooding of the cathode.

The limitation in power density is mainly caused by the limited catalytic activity of the cathode: the oxygen electrode. This activity can be increased by a higher catalyst loading. However, this also means a higher cost and a shorter service life since a higher catalyst loading requires a higher current density. (Part of this limitation can be worked around by using several fuel cell stacks in parallel.)

The Active Layer

In order to improve the design of the active layer for vehicle fuel cells, engineers and scientists have to understand the fundamental transport phenomena, electrode kinetics, thermodynamics, electrolyte chemistry, and catalytic surface activity involved in the charge transfer reactions in this layer at the microscopic level.

Let us look closer at the transport and reaction processes that may occur in the active layer in a fuel cell electrode. We can consider a proton exchange membrane fuel cell (PEMFC), which is the strongest fuel cell candidate for use in electric vehicles. The reactions at the anode and cathode are the following:

The electrons released at the anode are conducted by the electronic conducting electrode material to the outer circuit. In the outer circuit, the electrons are conducted over a load and then to the cathode. The protons (hydrogen ions) are transported in the electrolyte and the separator to the cathode. At the cathode, the protons react with oxygen from the cathode gas, electrons are received from the external circuit, and water is formed.

Figure 1 shows a schematic drawing of the processes at the anode's active layer. Note that the active layer contains the anode material with the catalyst (blue), pore electrolyte (green), and gas-filled pores. The pore electrolyte comprises proton-conducting polymer that has been infused into the porous electrodes. Hydrogen from external gas channels is transported in the gas-filled pores and dissolved in the pore electrolyte. It is then transported through a thin film of pore electrolyte to the active catalyst site (white dashed circle, Figure 1) and oxidized to produce hydrogen ions (protons) at the active site. The electrons released in the oxidation are conducted through the anode material to the outer circuit.

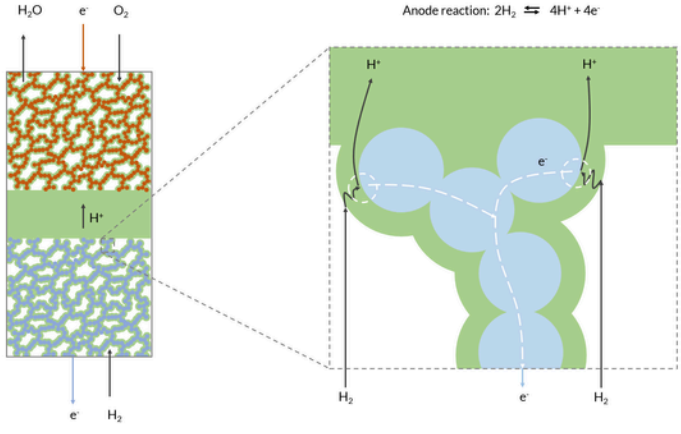

Figure 1. The processes that occur in the active layer in a PEMFC anode.

Once the hydrogen ions have migrated to the cathode, they may react with oxygen at the active sites at the cathode; see Figure 2. Oxygen is transported through the gas-filled pores in the cathode and through a thin film of pore electrolyte before it reaches the active sites. At the active site, oxygen and protons receive electrons, over the active circuit and through conduction in the cathode electrode material, to produce water. The reaction at the active site depends on the local electrode potential in relation to equilibrium, the local oxygen concentration, and the local water activity. The formed water molecules can be transported out of the cathode as vapor or as liquid water. Precipitation of liquid water in the gas-filled pores may occur depending on the pore structure and on the local water vapor partial pressure.

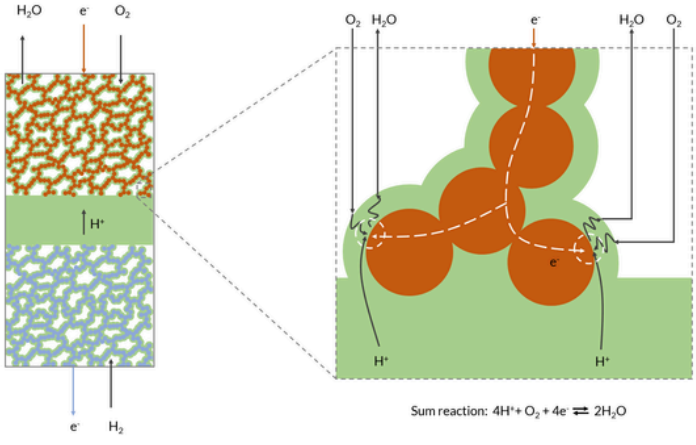

Figure 2. The transport and reaction processes that occur at the cathode.

The migration of hydrogen ions from the anode to the cathode also depends on the water content of the membrane. Each hydrogen ion drags a few water molecules over the membrane electrolyte from the anode to the cathode.

So, there are transport processes in the gas phases in both electrodes, transport in the pore electrolyte, transport of water and protons in the membrane, and kinetic expressions for the charge transport relations at the active sites. We may also add processes that describe the deterioration of solid particles, for example, through oxidation. The model equations describing these processes are coupled and depend on each other.

The solution of the model equations reveals the losses in the different reaction and transport processes. For example, if water precipitates in the gas-filled pores at the cathode, the transport of oxygen gas through the gas-filled pores is slowed down dramatically. If the model predicts a deterioration of the particles, for example, by oxidation that causes them to detach from the pore electrolyte or the rest of the electrode material, then the electrons cannot be transported to and from the active sites, causing losses in performance.

The contribution of the different processes to the losses in the cell are difficult to estimate experimentally. Here, combining models with experiments is a great help. The key to understanding the losses in the cell is the fact that the different processes occur at different time scales.

The transport processes in the pore electrolyte and in the gas-filled pores, the conduction of ions, the conduction of electrons, and the charge transfer reactions all occur at different time scales. Transport in the pore electrolyte is several orders of magnitude slower than transport in the gas-filled pores. Ionic and electronic conduction are speedy processes. Charge transfer reactions can be slow (cathode) or relatively fast (hydrogen) but are relatively fast compared to the transport in the pore electrolyte. Transient techniques, such as current interrupt and impedance spectroscopy, can be modeled and then compared to and validated using experiments. The contribution of the different losses can also be followed over time for different operating conditions during the aging of a cell.

The principle of impedance spectroscopy is quite simple. An average voltage (V0) is applied with a small sinusoidal perturbation over time. As a consequence, a corresponding sinusoidal current is obtained as a response to the voltage perturbations; see Figure 3.

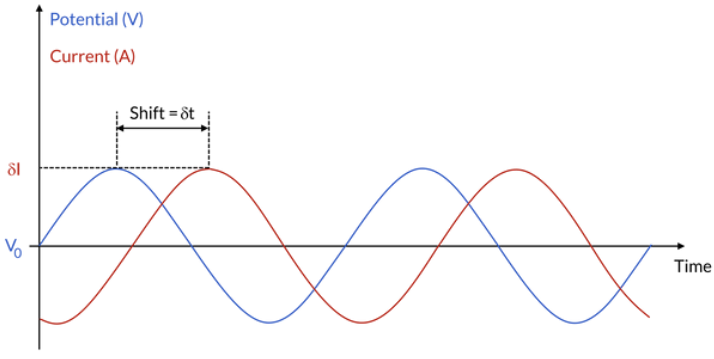

Figure 3. A perturbation in electrical potential over the cell results in a current response.

The current response may have a shift in time (δt) compared to the voltage. A shift can be caused by processes that delay the response of the current to the sinusoidal perturbation in voltage. For example, at low frequencies, slow processes such as mass transport may be responsible for such a shift while fast processes may be able to follow the voltage perturbations perfectly. At high frequencies, slow processes will only "see" the average voltage; they will not be able to respond to the voltage perturbations. Instead, fast processes, such as the reaction kinetics, will be responsible for the shift in the response at high frequencies. Additionally, the amplitude of the response (δI) may also vary at different frequencies.

By sweeping over different frequencies, the method can separate processes with different time constants. The time shift and the current response's amplitude to the voltage perturbation are reflected in the complex impedance, where a shift in time is reflected in the imaginary part of the impedance. The absolute value of the impedance reflects the proportionality of the response.

For a fuel cell, the impedance response gives insight into several fuel cell properties and processes. At high frequencies, short-time-scale processes such as capacitance, electrochemical reactions, and local resistances affect the impedance. On the other hand, at low frequencies, phenomena such as the diffusion in the pore electrolyte contribute to the impedance. Frequency sweeps can be carried out at different polarizations of the fuel cell to investigate phenomena at different loads. The combination of modeling impedance spectroscopy and parameter estimation with experimental data can then provide accurate descriptions of transport and reaction properties in fuel cells during operation at different loads. Over time, the models and experiments may reveal the source of deterioration of a cell. This implies that the proper actions in design and material selection can be taken in order to increase performance and slow down deterioration.

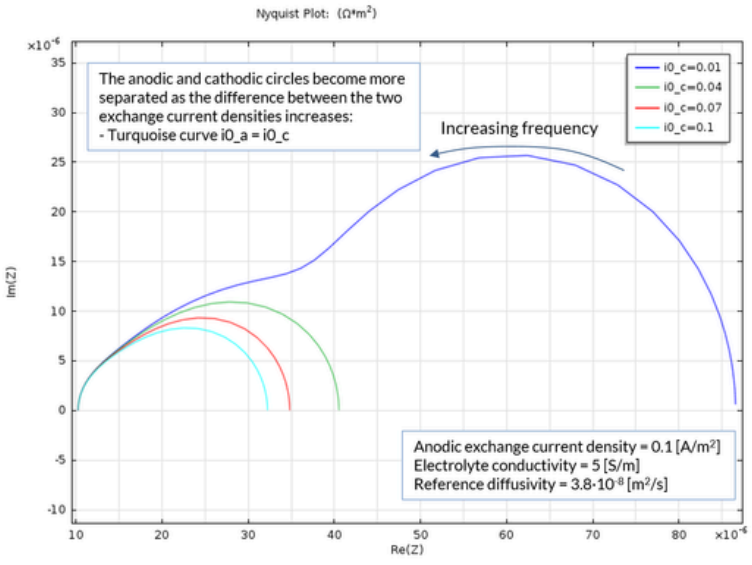

Figure 4. Results from an impedance spectroscopy simulation of a fuel cell unit cell. The activity of the cathode catalyst is varied in four different frequency sweeps.

Figure 4 shows a so-called Nyquist plot of the results from a high-fidelity model of a fuel cell unit cell. This is a small experimental cell where the conditions can be controlled very accurately. The model shows the effect of the reaction kinetics at the active sites of the cathode. As the catalyst deteriorates, the cathodic semicircle grows (so the impedance grows). However, there is no change at very high frequencies since the kinetics are not able to react to very fast perturbation. The ohmic losses in the cells are constant. In this way, it is possible to separate other losses too, such as ohmic or transport losses.

Modeling and simulations offer a very effective, unique way of studying the processes. As mentioned above, it is very hard to measure the phenomena that occur in the active layer during operation. Instead, these phenomena can be modeled in detail and their impact at the macroscopic level can also be modeled in so-called multiscale models [2]. Experiments can be designed in order to verify the implications of the microdesign.

One example is the connection of physics-based models for impedance spectroscopy with measurements as shown in Figure 4. This allows scientists and engineers to separate processes in different time scales, such as diffusion (slow) and current conduction (fast). Studying what limits the response to perturbations at different time scales may reveal which process limits the performance at the microscale [3, 4, 5].

Once the processes are understood, more direct methods may be used. An example is the innovation of using ordered porous structures in the active layer to lower tortuosity. Ordered structures may increase the transport of reactants, improve access to the catalyst surface, and yield a uniform current density distribution in the active layer [1, 6]. The results may be improvements in performance without requiring a higher platinum load or causing the accumulation of water or harmful byproducts that may deteriorate the performance of the active layer over time.

Modeling and simulations are not only useful for exploring new ideas. Once a good design has been innovated, mathematical models can be used to optimize design further and operational parameters. This development is evolutionary and can be made almost automatic by gathering data from operation.

The Fuel Cell Unit Cell and Fuel Cell Stack

Each microscopic part of a fuel cell is affected by the configuration of each cell and of the whole fuel cell stack. This implies that the microscopic details cannot be studied in isolation. They have to couple to the macroscopic factors that may impact a cell. The simulation shown in Figure 4 treats a hydrogen channel and an oxygen channel in a fuel cell unit cell, with the electrodes and the membrane in between, as shown in Figure 5.

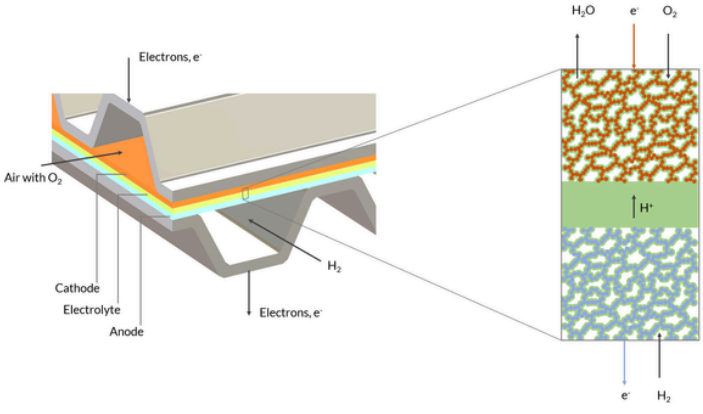

Figure 5. A unit cell model may consider a part of the membrane-electrode assembly as well as the metallic plates that serve as the current collectors and feeders.

Each unit maybe part of a stack connected to an external circuit; see Figure 6. The units may be equipped with straight parallel channels (Figure 6) or serpentine channels (Figure 7). Modern fuel cells, like in the Toyota Mirai® automobile [7], may also have a more complex structure for the oxygen (air) gas feed. Here, a louver-like structure allows for water to flow down with gravity, away from the cathode, while oxygen can flow upward. In this way, the transport of liquid water in the oxygen electrode is enhanced, which also enhances the transport of oxygen to the active layer. Liquid water in the porous electrode hinders the transport of oxygen and may also cause flooding. In addition, the use of a thinner membrane allows for back diffusion of water from the cathode to the anode, which also eliminates the need of humidifying the anode gas and lowers the risk of flooding. Toyota, with this design, has considerably enhanced the performance and simplified the design of their fuel cell [7]. Figure 8 shows a schematic drawing of what this louver structure may look like.

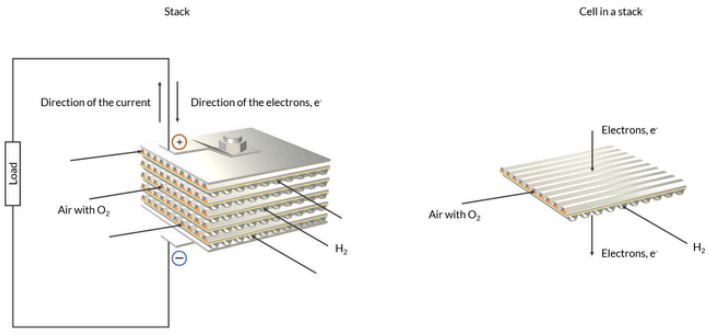

Figure 6. Left: Stack with crossflow configuration, i.e., the oxygen and hydrogen channels run in a 90-degree angle relative to each other. Right: One cell in the stack. Figures 1, 2, 5, and 6 illustrate going from the microscale to the stack scale.

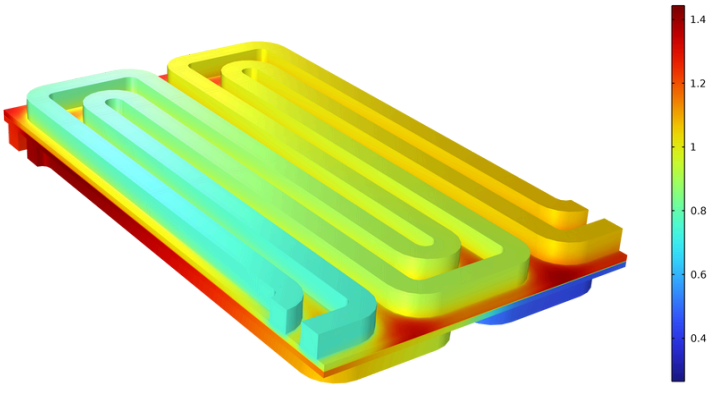

Figure 7. Relative humidity in a section of a serpentine channel PEMFC, in contrast to the straight channel configuration in Figure 6. The section is small enough to include all of the relevant transport and reaction processes in the fuel cell in a high-fidelity model.

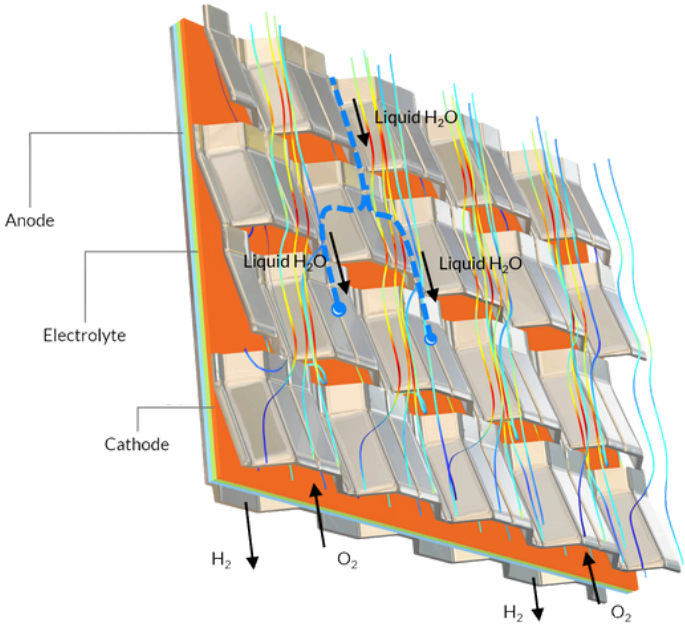

Figure 8. A louver-like structure allows for water to flow down and oxygen (air) to flow up. In this way, the transport of liquid water away from the cathode is enhanced and does not obstruct the transport of oxygen in the electrode [7].

High-fidelity models can be coupled and incorporated in models of a fuel cell unit cell; a stack; and a whole system, including the electric drivetrain of the vehicle (the load in Figure 6). This requires using fitted lumped models and reduced models that are automatically updated using detailed models when a new range of operation is encountered. In this way, modeling and simulations can also be used to determine the state and remaining service life of a fuel cell system [3].

Concluding Remarks

The development of fuel cells and the design of the active layer will continue to lead to lower platinum loads, longer service life, and increased power density. To a great extent, this will be due to the understanding, innovation, and optimization tools offered by modeling and simulations. These tools will also allow for an optimal combination of fuel cells, batteries, and supercapacitors in order to deliver energy and power density at a low cost and with maximum service life. Modeling and simulations will continue to be important in the work of reducing greenhouse gas emissions and other pollutants from cars, buses, and trucks.

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AUTHORED BY: Ed Fontes and Henrik Ekström, COMSOL

QUALITY AND EFFICIENCY: EKA MOBILITY'S BLUEPRINT FOR SUPPLY CHAIN EXCELLENCE

Umezawa Nobuyoshi

Chief Strategy Officer
EKA Mobility

KEY HIGHLIGHTS

- EKA Mobility aims to become a global leader in Commercial EVs by expanding facilities, implementing lean manufacturing, and vertically integrating production.
- EKA Mobility is poised to leverage India's growing EV market with tailored products and efficient production, supported by favorable government policies.
- EKA ensures quality components through rigorous supplier evaluation, long-term partnerships, and exploring vertical integration.

What are the key strategic goals for EKA Mobility over the next five years in terms of EV manufacturing?

EKA Mobility aims to strengthen its position as a prominent player in the rapidly growing Indian EV manufacturing sector to meet evolving market demands. So, over the next five years, expanding & streamlining operations while minimizing waste will be a top priority. Our vision is to become a global volume leader in Commercial Electric Vehicles.

By expanding our facilities and implementing lean manufacturing principles we will enhance our operational efficiency, reduce costs, and improve overall productivity in EKA's EV manufacturing plants.

To align seamlessly with the lean factory setup, we will be adopting a modular design approach for EV products which will help facilitate easier assembly and customization of vehicles.

Moreover, EKA will be vertically integrating production facilities rather than adopting the horizontal integration model, setting it apart from traditional automotive industry practices. By vertically integrating the production of key EV components, EKA Mobility aims to enhance quality control, reduce dependency on external suppliers, and achieve greater cost efficiency.

So rather than outsourcing components and relying on complex global supply chains we aim to own as many aspects of production as possible, from raw materials to final assembly.

Owning the entire production process will give us more flexibility to innovate and adapt to evolving market demands. The company can rapidly prototype, test, and implement new technologies or design iterations without relying on external partners, thus fostering a culture of innovation and agility.

To capitalize on emerging opportunities and broaden our customer base, we also have plans to expand our presence in India, beyond existing locations such as Chakan and Indore. This will also include establishing a stronger foothold in international markets.

> EKA Mobility prioritizes customer input and feedback in the design and development of its vehicles, ensuring that its EVs align closely with consumer needs and preferences.

What opportunities do you see in the Indian market for the growth of EVs, and how is EKA Mobility positioned to capitalize on these opportunities?

The global automotive industry is undergoing a significant shift towards electric vehicles (EVs), and India stands at the forefront of this transformative change redefining mobility and sustainability. With the government's ambitious plan to introduce 800,000 buses over the next 5-7 years, coupled with favorable policies, this positions India to emerge as one of the largest markets for electric buses globally, second only to China. This surge in demand is attracting significant interest from private players keen on transitioning to electric vehicles.

In particular, Intercity coaches, offering a range of 300 to 500 kilometers, have great potential, especially with favorable financing terms along with the government's commitment to providing electricity at a standard rate of 5 rupees per kilowatt-hour. These factors can fuel rapid growth and drive significant advancements in the Indian EV segment.

Electric small commercial vehicles (SCVs) are another area witnessing accelerated growth, where fleet companies are leading the charge in electrifying their fleets at an accelerated pace.

The Indian government has started initiatives like the National Electric Mobility Mission Plan (NEMMP) and the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme, to encourage the adoption of electric vehicles and to expand the 'Make in India' ecosystem.

Additionally, various production-linked incentive schemes have been introduced to encourage domestic manufacturing of EVs and their components. These schemes offer financial incentives to manufacturers based on their production volume and investment in the sector. By promoting local manufacturing, these incentives not only reduce dependence on imports but also create employment opportunities and contribute to the growth of the domestic EV industry.

EKA Mobility aims to leverage these opportunities by offering products tailored to customer needs in terms of total cost of ownership (TCO) and features. By ensuring the right production capacity, EKA aims to meet the increasing demand efficiently and effectively while also delivering vehicles with shorter lead times.

How does EKA Mobility manage its supply chain to ensure the availability of quality components for EV manufacturing?

We rigorously evaluate and qualify our suppliers based on stringent criteria's such as quality standards, reliability, capacity, and technological capabilities. This process ensures that suppliers meet EKA's standards for quality and performance, thereby minimizing risks and ensuring the availability of high-quality components for EV manufacturing.

EKA Mobility views its suppliers as strategic partners and fosters long-term relationships with them. This collaborative approach enables EKA to work closely with suppliers to align goals, share expertise, and drive mutual growth.

By treating suppliers as our partners, we ensure consistent supply, quality, and value from them.

We are also exploring opportunities for vertical integration of EV components where there are supply or technology gaps. By bringing certain manufacturing processes or component production in-house, we can enhance efficiency, quality control, and cost-effectiveness. Vertical integration allows EKA to have greater control over critical components such as powertrains or batteries, ensuring reliability and performance in its electric vehicles.

How does EKA Mobility address consumer concerns and preferences regarding electric vehicles?

EKA Mobility prioritizes customer input and feedback in the design and development of its vehicles. By working closely with customers, EKA ensures that its EVs are tailored to meet specific requirements such as passenger capacity, load body capacity, and intended applications. This customer-centric approach ensures that EKA's vehicles align closely with consumer needs and preferences.

We also interact directly with potential customers, including fleet companies, founders, and management teams. By creating direct communication channels, the team at EKA can gain deeper insights into customer concerns, preferences, and pain points related to EV adoption.

Whether it's modifying vehicle specifications, incorporating specific features, or offering alternative configurations, EKA ensures flexibility to meet the unique requirements of different customers and applications.

Also, let's not forget reliable after-sales support and services, which we offer to ensure a positive ownership experience for customers.

What policy changes would you advocate for to further support the growth of the EV industry in India?

To begin with we can start to penalize the import of fully built chassis - which is the 'skeleton' of the vehicle plus the running gear. This can greatly encourage domestic manufacturing of EVs and its components, fostering the growth of the local EV industry and reducing dependency on imports.

Another thing we can work on is reducing interest rates when it comes to financing E-buses. For private and State Transport Undertakings (STUs), the interest rates should be 1-2% less than ICE buses.

When we prioritize Lending Status for E-Bus financing it can make it easier to access financing for electric buses, enabling fleet operators to transition to cleaner and more sustainable transportation options.

Our policies should also facilitate long-term financing and investment in EV infrastructure, such as charging stations and electric buses, by providing tax benefits and other incentives.

Proposing government tenders for the construction of charging infrastructure for charge point operators, with concessions on taxes or subsidies for the initial 3-4 years, can be a beneficial move to catalyze the development of EV charging infrastructure in India.

Additionally, providing concessions on taxes or subsidies for the initial years of operation incentivizes private investment in charging infrastructure by reducing financial risks and improving the viability of charging point businesses. This encourages participation from a diverse range of stakeholders, including businesses, entrepreneurs, and investors, in building out the EV charging network.

By selecting highways and cities based on recommendations from industry bodies like BOCI (Bus and Car Operators Confederation of India) or STUs (State Transport Undertakings), the government can ensure that charging infrastructure is strategically located in areas with high EV demand and usage. This targeted approach maximizes the impact of infrastructure investments and addresses range anxiety among EV users by providing convenient access to charging stations.

Furthermore, private bus operators should be allowed to establish premium bus services for paying customers within cities.

Mandating metro systems to integrate feeder bus services and providing electricity at the same subsidized rate as the metro can also be beneficial. Integrating feeder bus services with metro systems expands the reach and coverage of public transportation networks, particularly in areas not directly served by metro lines.

Implementing a fixed price of Rs 5 per kilowatt-hour (kWh) of energy cost for electric vehicle charging across India promotes uniformity and transparency in electric vehicle charging rates nationwide. It can simplify the charging process for EV owners, eliminating confusion about pricing variations across different regions or charging stations.

A fixed price may also make electric vehicle charging more affordable for consumers, particularly when compared to the cost of conventional fuels like petrol or diesel.

Mandating corporations, based on their profitability and turnover, to allocate a minimum of 25% of their staff transport fleet to electric buses can drive innovation and investment in electric vehicle technology. This can promote sustainable practices and long-term cost savings.

Strengthening Corporate Average Fuel Efficiency (CAFE) norms can drive innovation, accelerate electric vehicle adoption, reduce emissions, and position India as a leader in environmental sustainability and energy efficiency.

How important is user experience in the design of your electric vehicles, and what measures do you take to ensure it?

User experience is at the forefront of all our design efforts at EKA Mobility. Whether it's our buses or trucks, we've infused a design theme centered around happiness and friendliness, creating vehicles that feel welcoming and engaging for passengers and drivers alike.

To ensure excellence in user experience, we've established a dedicated Centre of Excellence. Here, we meticulously study benchmark vehicles and draw inspiration from similar products, focusing on aspects like human-machine interface (HMI), ergonomics, and the flow of information on the dashboard.

Another key focus for us is the maintenance of our vehicles. We recognize the importance of making maintenance tasks easier, more efficient, and cost efficient. This not only reduces the total cost of ownership for our customers but also ensures that our vehicles remain reliable and in optimal condition throughout their lifespan.

Additionally, we are actively developing an internal command center, aiming to elevate our service standards and provide a superb experience for our customers. By centralizing monitoring, diagnostics, and support functions, we can proactively address issues, optimize vehicle performance, and deliver timely assistance, further enhancing the overall service experience.

At EKA Mobility, our commitment to user experience, maintainability, and service excellence drives everything we do, ensuring that our vehicles not only meet but exceed the expectations of our customers.

How does EKA Mobility plan to evolve and adapt to future trends and technological advancements in the EV space?

At EKA Mobility, we are closely monitoring three key areas of technology advancements: powertrain, power electronics, and battery, particularly in terms of cell technology. By keeping our vehicle architecture open, we ensure flexibility to accommodate these evolving technologies, allowing us to stay ahead of the competition. Specifically focusing on battery cells, we have advisors and subject matter experts guiding us, and we maintain constant communication with cell suppliers to incorporate changing trends such as sodium-ion, silicon anode, or solid-state batteries into our designs.

Furthermore, our commitment to innovation is driving the team at EKA to develop highly efficient and lightweight powertrains, with plans for implementation by December 2024.

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PURE EV: TRANSFORMING THE ELECTRIC VEHICLE LANDSCAPE WITH SUSTAINABLE INNOVATION AND SAVINGS

Rohit Vadera

CEO
PURE EV

KEY HIGHLIGHTS

- PURE EV boasts over 150 IP filings and 2 billion kilometers driven by consumers, highlighting its innovation and reliability.
- The company has saved consumers over $60 million and captured 20% of India's e-motorcycle market.
- PURE EV ensures sustainable manufacturing with battery recycling, component refurbishing, and renewable energy use.

PURE EV has made significant strides in the electric vehicle sector since its inception. Can you share the journey of PURE EV and what inspired you to enter the electric mobility space?

PURE EV (Power Using Renewable Energy) is leading the transition to sustainable energy sources with a strong focus on innovation and environmental stewardship. The company has made significant strides in the electric vehicle industry, specifically with electric two-wheelers and high-performance lithium batteries under the brands "PURE EV" and "PURE Lithium." This commitment to green technology has positioned PURE EV at the forefront of the electric mobility revolution.

With over 150 intellectual property filings, PURE EV is recognized as one of the top three innovators in its industry. The impressive mileage achieved by PURE EV's consumers, who have collectively driven 2 billion kilometers to date, demonstrates the reliability and efficiency of its vehicles. On average, a PURE EV consumer travels 46 kilometers per day, underscoring the practicality and everyday usability of these electric vehicles. More than 35,000 of these vehicles have surpassed 30,000 kilometers each, further solidifying the brand's reputation for durability and performance.

The economic impact of PURE EV's products is equally noteworthy. The company has enabled its consumers to save more than $60 million, illustrating the significant cost benefits of switching to electric mobility. In terms of market reach, PURE EV has sold 75,000 vehicles across India and Southeast Asia, capturing approximately 20% of the e-motorcycle market in India.

Financially, PURE EV is on a strong footing with BB+/A4+ credit rating and the only EV 2W upstart to maintain EBITDA positive since 4 years and has backing of country's leading investors.

One of PURE EV's key strengths is its operation without exposure to subsidy uncertainties or policy fluctuations, providing a stable and predictable business environment. Additionally, the company leverages the global ancillary ecosystem and advanced technologies, positioning itself to grow and thrive even as local infrastructure continues to develop.

Looking to the future, PURE EV is poised for exponential growth, targeting a 10X expansion over the next three years. By continuously harnessing its innovative capabilities, robust manufacturing processes, and strategic market positioning, PURE EV is set to lead the charge in the electric mobility revolution. PURE EV is not just an OEM; it is a movement towards a sustainable, economically viable, and technologically advanced future

Electric two-wheelers are gaining significant popularity worldwide. What key market trends and technological advancements do you believe are driving this surge, and how is PURE EV positioning itself to capitalize on these trends?

We acknowledge the significant market trends and technological advancements driving the surging popularity of electric two-wheelers worldwide. This trend is multifaceted, rooted firstly in a global shift towards environmental sustainability. Consumers are increasingly seeking cleaner transportation options, aligning seamlessly with our commitment to providing eco-friendly mobility solutions. Secondly, the rapid urbanization sweeping across cities worldwide has intensified issues of congestion and pollution, making electric two-wheelers an increasingly attractive choice for urban commuters seeking efficient and environmentally responsible transportation.

Furthermore, advancements in battery technology and electric drivetrains have played a pivotal role in enhancing the performance and range of electric two-wheelers, making them more practical and appealing to a broader audience. These technological strides, combined with supportive government incentives and regulations promoting electric vehicle adoption, have created a conducive environment for growth and innovation in the electric mobility sector.

At PURE EV, we are strategically positioned to capitalize on these trends through a comprehensive approach. Our focus on continuous innovation and research enables us to develop cutting-edge electric two-wheelers that address the evolving needs and preferences of consumers. Additionally, our diverse product range caters to various market segments, ensuring that we meet the diverse preferences of our customers. Through strategic partnerships, customer education initiatives, and a steadfast commitment to quality and customer satisfaction, we are dedicated to leading the transition towards a cleaner, greener future powered by electric mobility.

Design plays a crucial role in consumer adoption of electric two-wheelers. Can you share some of the latest trends and innovations in design that PURE EV is incorporating into its products to enhance both aesthetics and ergonomics?

PURE EV is at the forefront of integrating cutting-edge design trends and innovations to enhance both aesthetics and ergonomics in its electric two-wheelers, ensuring a superior user experience. One of the key trends is the emphasis on streamlined, futuristic aesthetics that appeal to modern consumers. PURE EV's designs feature sleek lines, aerodynamic shapes, and contemporary color palettes, all of which contribute to a visually appealing product. Additionally, advanced materials are being utilized to reduce weight without compromising on strength or durability, thereby enhancing both the look and performance of the vehicles.

Ergonomics is another critical focus area for PURE EV. The company employs user-centric design principles to ensure comfort and ease of use. This includes adjustable seats, handlebar positions, and footrest placements that cater to a wide range of rider physiques, promoting better posture and reducing fatigue during longer rides. Moreover, PURE EV incorporates intuitive interface designs with digital dashboards that provide clear, real-time information to riders, enhancing both safety and convenience. These innovations collectively ensure that PURE EV's electric two-wheelers not only look sophisticated but also deliver a highly ergonomic riding experience.

Furthermore, PURE EV is leveraging smart technology to enhance the overall user experience. Features such as integrated GPS, Bluetooth connectivity, and mobile app compatibility allow riders to seamlessly connect their devices, access navigation, and monitor vehicle performance through their smartphones. This blend of aesthetic appeal, ergonomic design, and advanced technology ensures that PURE EV's products meet the evolving needs and preferences of today's consumers, positioning the brand as a leader in the electric two-wheeler market.

As an expert in EV manufacturing, what strategies has PURE EV implemented to enhance manufacturing efficiency and scalability to meet the growing demand for electric vehicles?

The electric vehicle (EV) sector is expanding rapidly, driven by consumer demand for readily available products with minimal waiting times. At PURE, we utilize a Just-in-Time (JIT) approach through efficient forecasting of vehicle demand. This forecasting incorporates various factors, including geography, seasonality, trends, and consumer behavior insights. PURE gathers input from dealers, industry experts, and consumers through nationwide market research. This helps the company in planning the manufacturing, procurement and warehousing efficiently.

How does PURE EV ensure that its manufacturing practices are sustainable and environmentally friendly? What initiatives have you taken to minimize the environmental impact of your production processes?

In the modern era, the importance of sustainable practices in manufacturing cannot be overstated. At PURE EV, we are deeply committed to integrating sustainability into every facet of our two-wheeler production process. We recognize that responsible waste management is crucial for the environment and have implemented comprehensive initiatives to address the various types of waste generated during manufacturing. Our sustainable practices are designed to minimize waste and reduce the environmental footprint of our operations, ensuring a healthier planet for future generations.

One of our key initiatives is battery and cell recycling. We collaborate with certified recycling companies specializing in the safe and efficient recycling of batteries and cells. PURE EV is one of the first companies to offer a battery buyback program, ensuring that degraded or unused batteries are either reused or recycled. This not only facilitates resource recovery by extracting valuable metals such as lithium, cobalt, and nickel but also ensures the safe disposal of hazardous components. Additionally, our commitment to renewable energy is exemplified by the solar plant established within our factory premises, which uses refurbished cells and provides 40% of our power.

Moreover, we have developed in-house capabilities to refurbish all essential components, ensuring that motor windings, controllers, and casings are maximized for reuse. These components are entrusted to specialized recycling firms that adhere to stringent environmental standards, ensuring that metals and other materials are repurposed, significantly lowering the demand for new raw materials. Our sustainable packaging solutions further demonstrate our commitment to the environment. We have implemented an innovative circular system where carton boxes used in our operations are sent to companies that transform them into new, usable boxes, reducing waste and conserving natural resources.

Our painting processes are also optimized for efficiency and environmental benefit. By using advanced, highly efficient liquids, we ensure precise coating with minimal overspray, significantly reducing paint wastage and lowering VOC emissions. Beyond our internal efforts, PURE EV actively promotes sustainable practices within the industry. We engage with industry peers through forums and alliances to share best practices and innovative solutions, and we raise awareness about the economic and environmental benefits of sustainability.

Our dedication to sustainability is not just a compliance measure but a core aspect of our business philosophy. By integrating these sustainable practices into our operations, we aim to lead by example and inspire a wider adoption of environmentally responsible manufacturing processes within the industry. At PURE EV, we believe that our proactive approach to waste management and sustainability will contribute to a greener future and drive positive change across the manufacturing sector.

The EV industry heavily relies on a robust supply chain for components like batteries and motors. How does PURE EV manage its supply chain to ensure efficiency and reliability?

The company has strategically implemented backward integration and diversification to address supply chain fluctuations. For example, by manufacturing its own battery packs, the company ensures availability as needed and maintains control over the quality and performance of this critical vehicle component. For other powertrain components, the company maintains an open supply chain with both domestic and international suppliers, reducing the risk of supply chain disruptions.

> At PURE EV, we believe that economic viability and environmental responsibility go hand in hand, leading to substantial savings for our consumers and a cleaner planet.

Said by CEO, PURE EV.!!

TRANSFORMING AUTOMOTIVE LEADERSHIP: A 35-YEAR JOURNEY OF INNOVATION AND SKILL DEVELOPMENT IN THE EV ERA

Shri. F.R. Singhvi

President at Automotive Skills Development Council
JMD at Sansera Engineering Ltd.

KEY HIGHLIGHTS

- From Chartered Accountant to Automotive Innovator: A Journey of 35 Years in Leadership and Technological Advancement.
- ASDC Revolutionizes EV Training with Advanced Technologies to Meet Growing Industry Demands.
- Enhancing India's EV Workforce: Policy Changes and Public-Private Partnerships for Skill Development.

With over 35 years of experience, can you share some pivotal moments in your career that have influenced your approach to leadership and innovation in the automotive sector?

By qualification, I am a Chartered Accountant who transitioned into an automotive sector joining my friend Sekhar. Over the past 35 years, I have witnessed our company's growth from the first purchase order to its current level of growth and it being listed in the stock market. In managing the company, we considered all stakeholders, including investors, customers, employees, and suppliers, and society at large. Over time, we made significant technological advancements, starting with the development of our own CNC machines, respecting the company's needs and paving the way for a future with automated machines incorporating AI and other technologies.

While running the company, our focus has always been on maintaining quality in life, products and relationships. We believe in not limiting ourselves to one segment; we have expanded into the aerospace and defence sectors. One challenge we often face is a shortage of skilled professionals for modern challanges. I have been actively involved in ACMAand its activities over 2 decades. I have been chairman of HR Committee, Aerospace and Defence committee, Pillar 3 of ACMA and, now I have been given the responsibility of heading ASDC our Auto sector skill council formed by SIAM, ACMA,FADA and NSC of India.

How is ASDC incorporating new technologies and innovations in its training programs to keep pace with the evolving EV landscape?

EV industry has spurred a new demand for skilled professionals, ranging from engineers and designers to technicians and service providers. As the industry evolves, the need for such expertise continues to grow. This surge in demand will not only creates jobs but also will enhance the capabilities in our country to become a global player not only in manufacture of EV vehicles but also in the area developing EV infrastructure. To address these needs, ASDC offers comprehensive various training programs at different levels of employment in various sections of the EV industry which, include manufacturing, maintenance, repairs, charging infrastructure, sustainability, etc., ASDC provides both entry-level training and opportunities for upskilling and reskilling existing professionals. Their curriculum, refined with input from over 300 industry experts, ensures relevance and rigor.

ASDC also leverages advanced technologies to enhance training. Simulators offer a safe, controlled environment for practicing EV diagnostics and repairs, while simulation tools and virtual reality (VR) technologies help trainees understand complex EV systems without risk. These innovative approaches ensure that trainees gain practical, hands-on experience in a risk-free setting.

What policy changes do you believe are necessary to further support the development of skills for the EV sector in India?

To bolster skill development for India's EV sector, encouraging public-private partnerships in skill related activities is essential to leverage resources and expertise effectively. Standardizing EV curricula across educational institutions, including ITIs, colleges, and universities, with input from industry experts, will ensure relevant and up-to-date training. Providing financial incentives to companies that invest in workforce training can significantly enhance skill development.

Awareness campaigns are crucial to attract talent to the EV sector, while integrating advanced technologies like virtual reality (VR) in training programs will enhance the learning experience. Expanding training infrastructure and mandating apprenticeship programs will offer students practical, hands-on experience. Additionally, supporting research and development in EV technologies within educational institutions will foster innovation and keep the sector at the cutting edge.

Long term policies, aligned with the evolving needs of the EV industry, will provide stability and confidence to the Industrialists to invest and will generate employment. We also need to ensure that the workforce remains adept in the latest technologies driving the growth and advancement of India's EV industry.

How does ASDC integrate cutting-edge technologies, such as Industry 4.0 and IoT, into its training programs to prepare the workforce for the future of automotive manufacturing?

ASDC integrates cutting-edge technologies like Industry 4.0 and IoT (Internet of Things) into its training programs to prepare the workforce for the future of automotive manufacturing in several innovative ways. Firstly, ASDC incorporates theoretical knowledge of Industry 4.0 principles, such as automation, data exchange, and smart manufacturing, into its curricula. This ensures that trainees understand the fundamentals of advanced manufacturing processes. Secondly, ASDC provides hands-on training using IoT-enabled equipment and machinery. Trainees learn how to operate and troubleshoot interconnected devices, sensors, and machines, gaining practical experience in managing smart manufacturing systems.

Moreover, ASDC utilizes simulation software and virtual reality (VR) technology to create immersive training environments. Trainees can practice real-life scenarios in a risk-free virtual setting, enhancing their skills in problem-solving and decision-making. Additionally, ASDC offers specialized courses and workshops focused on emerging technologies in automotive manufacturing, such as additive manufacturing (3D printing), robotics, and predictive maintenance systems. This ensures that the workforce is equipped with the latest skills and knowledge required by the industry.

By integrating Industry 4.0 and IoT technologies into its training programs, ASDC ensures that the workforce is prepared to embrace the future of automotive manufacturing, where interconnected systems and data-driven processes play a central role in driving efficiency, productivity, and innovation.

> Leading ASDC and integrating new technologies into our training programs has been a transformative experience, illustrating the critical role of skilled professionals in the evolving EV landscape.

What steps is ASDC taking to ensure that the Indian automotive workforce, particularly in EV manufacturing, remains competitive on a global scale?

ASDC's dedication to remaining at the forefront of industry progress is underscored by these initiatives, ensuring the continual relevance of our curriculum and arming employees with the most current skills. Through collaborations with diverse partners, we've launched programs aimed at enhancing the expertise of existing personnel within the automotive sector.

ASDC's commitment to staying updated on technological and industry advancements ensures that our curriculum remains pertinent, equipping employees with the latest skills. Collaborations with esteemed organizations such as Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and Research Triangle Institute (RTI) India have led to the development of a comprehensive institutional capacity and skills development program for electric mobility.

Automotive Skills Development Council (ASDC) offers 46 e-learning courses covering various aspects of the auto industry, including EV basics, automobile technology, EV charging, and wheel balancing. These courses are accessible online, providing flexibility for learners, and some are complimentary through partnerships with organizations like Eicher and Toyota.

ASDC has entered into partnership with many universities to bring in industry related practical course into college curricula , whereby a student can take up these as elective subjects and be better prepared before being employed. This will minimise the gap of industry related knowledge in students.

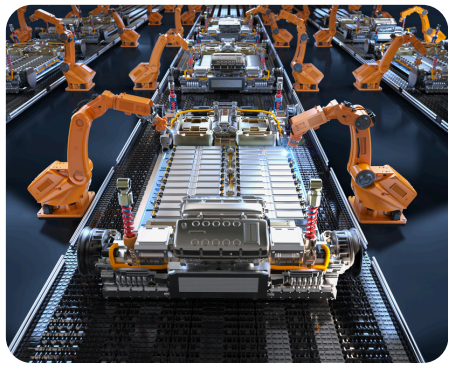
Moreover, ASDC has partnered with leading companies like Hero in the automotive and EV sectors to develop training programs aligned with global standards and best practices. These collaborations ensure that the workforce receives training that meets the requirements of international markets.

How can young professionals and students best prepare themselves to meet the demands and opportunities in this rapidly growing sector?

The surging EV sector beckons young professionals and students with a world of opportunity. To navigate this exciting landscape, a proactive approach is essential. Building a strong foundation is key. Explore EV-specific courses, certifications, or degrees in electrical, mechanical, or automotive engineering with an EV focus. Consider training programs offered by organizations like ASDC.

Next, bridge the theory-practice gap. Seek internships with EV companies, startups, or research institutions. This hands-on experience will equip you with the latest technologies and forge valuable industry connections. Don't underestimate the power of networking – connect with established professionals to gain insights and explore potential career paths.Actively follow industry publications, attend conferences, and participate in online forums to stay apprised of the latest EV trends and innovations. Embrace lifelong learning and be adaptable – the ability to continuously upskill yourself will be key to staying competitive in this dynamic field.

Furthermore, demonstrate your commitment to sustainability. As EVs champion the fight against climate change and air pollution, environmental consciousness will set you apart. Explore fresh ideas, participate in hackathons, or even consider venturing into EV entrepreneurship. Finally, remember that soft skills are an essential complement to technical expertise. Hone your communication, problem-solving, and teamwork abilities to make yourself even more attractive to potential employers. By proactively building a strong knowledge base, practical experience, a growth mindset, and well-rounded soft skills, young professionals and students can position themselves for success in the electrifying world of EVs.



POWERING GROWTH: MANUFACTURING INSIGHTS AND TRENDS IN INDIA'S ELECTRIC TWO-WHEELER MARKET

Prashant Vashishtha

Chairman & Managing Director
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KEY HIGHLIGHTS

- Government incentives and technological advancements drive India's electric two-wheeler market growth.
- Consumer acceptance of electric two-wheelers is rising due to environmental awareness and financial accessibility.
- Manufacturers address battery technology and range anxiety to enhance performance and consumer confidence.

What are the current market trends driving the growth of the electric two-wheeler segment in India?

In my experience, several converging trends and focused efforts are driving the growth of India's electric two-wheeler segment. For instance, the rising environmental awareness among consumers is steering them towards more sustainable and smarter transportation options such as electric two-wheelers. Similarly, government incentives to curb emissions, notably through older policies like the FAME II and new initiatives like the Electric Mobility Promotion Scheme 2024 that provide substantial financial subsidies are helping make electric two-wheelers more affordable and attractive to the broader consumer segment.

In addition, rapid technological advancements in battery and motor efficiencies continue to enhance the performance and reliability of these vehicles, aligning them more closely with traditional fuel-powered alternatives in terms of functionality and convenience. Above all, the increasing cost of petrol and diesel is positioning electric two-wheelers as a cost-effective alternative, adding to their appeal and accelerating the EV market's growth in India.

How has consumer perception and acceptance of electric two-wheelers evolved in India in recent years, and what factors contributed to this shift?

In recent years, we have witnessed a drastic change in consumer perception and acceptance of electric two-wheelers in India. In my experience, not one but several factors that align with the country's broader economic and industrial growth have contributed to this change. For instance, factors such as rising income levels, increasing urbanization, enhanced purchasing power of the middle class, and growing awareness about the environment have facilitated greater consumer spending on advanced technologies, including EVs.

Additionally, government initiatives such as the National Electric Mobility Mission Plan and incentives under schemes like FAME II and EMPS 2024 have also played pivotal roles in making electric two-wheelers more financially accessible and appealing. For instance, the electric two-wheeler segment saw a remarkable 33.3% year-on-year growth in sales in the fiscal year 2023-24, underscoring an impressive surge in EV adoption.

Moreover, the expanding production capabilities, as highlighted by the robust production figures in the auto industry, ensure that supply can meet the growing demand for electric two-wheelers. In the first quarter of 2024, electric two-wheelers were nearly 62% of total EVs sold, demonstrating their market dominance.

This comprehensive support system, coupled with an increased focus on sustainability and the availability of more reliable and efficient electric vehicles, has significantly shifted consumer attitudes towards favoring electric two-wheelers over traditional petrol or diesel-driven vehicles.

Can you discuss the regulatory landscape surrounding electric two-wheelers in India? How do government policies influence market dynamics and industry development?

The regulatory landscape in India for electric two-wheelers is significantly shaped by government policies aimed at accelerating the adoption of electric vehicles as part of a broader initiative to reduce carbon emissions and promote sustainable transportation. These policies play a key role in influencing market dynamics and driving industry development.

For instance, we have already seen how government initiatives like the FAME Scheme have been instrumental in making FAME-compliant electric vehicles, including two-wheelers, accessible to the public. Moreover, the government's decision to reduce Goods and Services Tax (GST) on electric vehicles from 12% to 5%, compared to higher rates for traditional combustion vehicles, has helped position EVs as a financially attractive option. Even State-level initiatives complement these efforts by offering additional subsidies, waiving road tax and registration fees, and fostering local networks of manufacturing hubs.

Similarly, initiatives like the Production Linked Incentive (PLI) Scheme for Automobiles continue to help EV manufacturers set up production facilities in India. This is helping not only build local expertise in EV technology but also create job opportunities and reduce the cost of vehicles through the local sourcing of components. The entire push towards electric mobility supported by a robust network of advanced charging infrastructure continues to drive technological advancements and innovation within the automotive and ancillary industries, such as charging infrastructure, batteries, and components. Hence, this supportive regulatory framework remains indispensable in transforming market dynamics and promoting industry-wide innovation and development.

What are the key challenges faced by electric two-wheeler manufacturers operating in the Indian market, particularly in terms of production, distribution, and adoption?

Most electric two-wheeler manufacturers in India face several challenges that impact their production, distribution, and adoption efforts despite the sector's growth and supportive government initiatives. One of the major challenges prevalent in the production stage is the high cost of technology, especially batteries, and advanced electronics. While they are pivotal in manufacturing electric two-wheelers, they considerably increase the initial cost compared to conventional vehicles. Another challenge is the heavy dependency on imports for critical components such as batteries and other high-tech electronics, which is making manufacturers vulnerable to supply chain disruptions and fluctuations in global markets.

Notably, the inadequate charging infrastructure also continues to restrict the practical usability of electric two-wheelers, especially for long-distance travel, leading to range anxiety among potential customers. This further aggravates a significant consumer population who remain hesitant about the reliability of electric vehicles compared to their petrol counterparts. Collectively, these challenges continue to hamper the overall adoption rate in the country. However, joint efforts on the part of the manufacturers, investors, and government can help address such concerns and accelerate India's electric two-wheeler vehicle adoption rate.

How is the infrastructure for electric vehicle charging evolving in India, and what impact does it have on the growth of the electric two-wheeler market?

The infrastructure for electric vehicle charging in India is rapidly evolving, playing a crucial role in shaping the growth trajectory of the electric two-wheeler market by addressing the rampant issue of range anxiety. This development is significantly influenced by government initiatives and private sector investments, which are aimed at enhancing the accessibility and convenience of using electric two-wheelers.

The Indian government has been proactive in facilitating the development of EV charging infrastructure through various policies and incentives. Programs such as the FAME Scheme included provisions for setting up charging stations across India. Additionally, several state governments have launched their initiatives to support public charging station installations, offering subsidies and incentives for their development. Such policy-driven approaches have been crucial in supporting the widespread adoption of electric two-wheelers.

Private companies, including startups, are also investing in the deployment of charging stations across strategic locations, such as malls, parking lots, and residential complexes. This expansion has helped increase the availability of charging options and enhanced their accessibility, which are key factors in consumer adoption.

Thanks to such focused efforts, more charging stations are becoming accessible to consumers, in turn, making them more confident in the usability of electric two-wheelers. This accessibility makes electric two-wheelers a more viable option, encouraging wider adoption. As the charging infrastructure continues to improve, it is expected to boost electric two-wheeler sales, supporting India's goal of becoming a leader in electric mobility and sustainability.

What demographic segments within India show the highest interest in electric two-wheelers, and how are manufacturers tailoring their offerings to meet diverse consumer needs?

In India, various demographic segments are showing increasing interest in electric two-wheelers, influenced by distinct needs and preferences. However, young professionals and students, especially millennials and Gen Z, are particularly drawn to electric two-wheelers for their eco-friendliness, modern technology, and cost-effectiveness. This group, primarily located in urban areas, values sustainability and advanced features such as connectivity and smart tech integration. As a result, manufacturers like us feel encouraged to offer stylish, high-tech sustainable models to cater to the rising demand. Another keen segment includes urban commuters of all ages who seek efficient and economical transportation solutions to navigate congested city traffic. For them, manufacturers emphasize ease of use, reliability, and the economic benefits of lower operating costs.

Families and older adults, looking for safe and accessible transportation options, represent yet another demographic with specific needs such as comfort and ease of maintenance, which the EV manufacturing segment addresses by designing user-friendly models with comfortable seating and minimal upkeep requirements.

Today, more manufacturers are expanding their focus to target last-mile commuters and delivery businesses by offering robust models designed for durability and extended range, catering to the demands of continuous operation and heavier loads. This why by factoring in the niche demand for different customer groups electric two-wheeler manufacturers are refining their offering to capture a broader market segment.

How do Indian electric two-wheeler manufacturers address concerns related to battery technology, range anxiety, and overall performance to enhance consumer confidence?

Most Indian electric two-wheeler manufacturers, including us, follow a proactive stance towards addressing consumer concerns regarding battery technology, range anxiety, and overall performance to build trust and drive adoption. For instance, significant investments are being made in battery technology to improve energy density and efficiency, extending both the life and range of batteries. Most modern electric two-wheelers are equipped with lithium-ion batteries, which are superior in terms of weight and life cycle compared to older types. Additionally, improvements are being made to lower charging time and enhance rider experience.

To further mitigate range anxiety, manufacturers are enhancing battery capacity and integrating advanced battery management systems into their vehicles. Such a feature offers riders real-time data on battery health and available range, allowing them to plan their trip better and ensure efficient battery usage. Similarly, performance improvements are being prioritized across segments. For instance, many Made in India electric two-wheelers now feature more robust motors and optimized drivetrains that improve torque and acceleration, positioning them as viable competitors to traditional petrol-driven vehicles and international brands.

Beyond technological advancements, manufacturers are striving to build consumer trust through robust warranties and transparent after-sales services, particularly for batteries and other essential components. Such measures address worries about the durability and upkeep costs associated with electric two-wheelers. These strategies are helping Indian manufacturers like us to enhance consumer confidence and foster the growth of the electric vehicle sector in India. However, we continue to count on government support and industry innovation in fields like charging infrastructure to help address challenges that hinder consumer experience.

DRIVE DOWN EV PRICES: 4 TIPS FOR LOCAL BATTERY MANUFACTURING SUCCESS

ROHAN SHRAVAN

Founder & CEO

Tresa Motors

Over time, people have become more conscious of their vehicle choices, increasingly considering electric vehicles (EVs) as alternatives to internal combustion engine (ICE) vehicles. However, the upfront cost of EVs remains a barrier, with batteries comprising almost 50% of the expense, making them pricier than conventional ICE vehicles. Thus, reducing EV prices necessitates cutting battery costs.

So, what's the solution? Indigenization holds the key, where manufacturing EV batteries locally can lower prices, making EVs more accessible and accelerating the transition to sustainable transportation solutions.

Here are a few suggestions on how local players and the government can play a significantly role in reducing prices through various mechanisms:

- **Cut Costs, Boost Quality:**

  Local manufacturing of EV batteries can significantly reduce production costs due to the elimination or reduction of import duties, transportation costs, and potential delays in shipping and customs. Lower production costs can directly translate to lower prices for the end consumer. Indian startups like Tresa Motors focus on R&D to develop everything in-house, including their battery packs, which most companies typically outsource. They aim to collaborate with local players to drive the "Made in India" promise forward.

- **Manufacture Locally:**

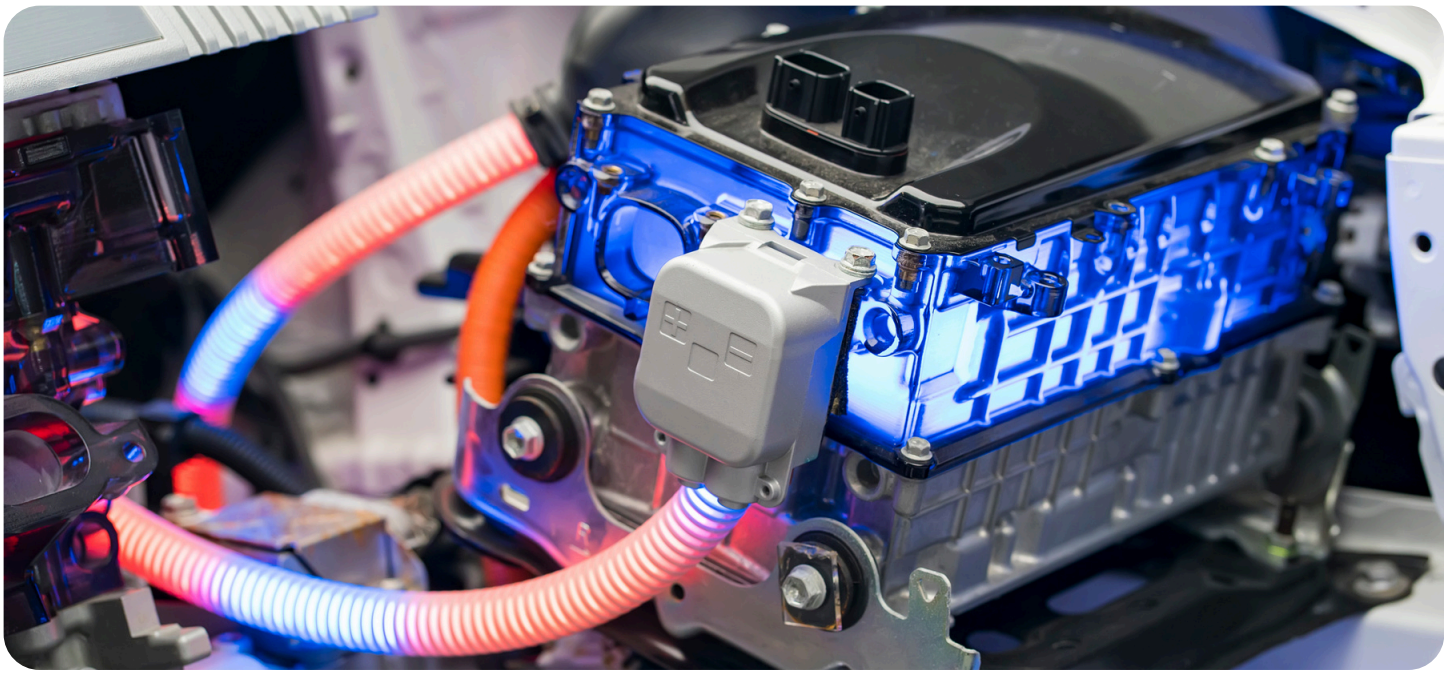
  Establishing local manufacturing facilities can lead to economies of scale, where the cost per unit decreases as production volume increases. As the domestic industry matures, companies can streamline their operations, invest in more efficient technologies, and negotiate better deals with suppliers, further driving down costs.

- **Encourage and welcome Government Incentives and Subsidies:**

  Governments often provide incentives for the development and indigenization of critical technologies like EV batteries. These may include tax breaks, grants, or subsidies that reduce the overall cost of battery production. Such incentives make it financially viable for companies to invest in local manufacturing, ultimately lowering prices for consumers. The new EV policy aligns with the vision of promoting sustainable mobility solutions and contributing to the 'Make in India' initiative by easing import duties for a limited number of EVs, encouraging global manufacturers to establish manufacturing facilities in India and promoting a robust ecosystem for electric vehicles in the country.

- **Collaborate and Compete:**

  Local EV players can collaborate with global giants, acquire technical know-how, and enhance their capabilities in areas such as battery manufacturing, charging infrastructure, and component localization. The establishment of a local battery manufacturing industry can increase competition, driving down prices. As more players enter the market, competitive pressure can lead to more efficient production methods, innovation, and ultimately, lower prices for consumers. This will invite more players to enter the market, further stimulating competition and innovation.



EMPOWERING LOCAL INNOVATION: ROLE OF STARTUPS IN INDIA'S EV REVOLUTION

India's progress cannot rely solely on IT or software-related innovation. While software is crucial, focusing exclusively on this sector is insufficient, especially as work shifts from India to ASEAN countries. Our lack of homegrown giants like Microsoft or Google suggests a contentment with following Western companies and a belief in their tech superiority.

Situation is similar in Electronics, Healthcare and many other spaces as well.

Since liberalization 33 years ago, many entrepreneurs have gone abroad, brought back technology, and started manufacturing without owning it, benefiting Western companies and limiting our innovation potential.

Historically, we have not been leaders in manufacturing, often adopting Western or Eastern technologies and taking pride in using German or Japanese tech. The "Make in India" initiative has seen success over the last decade, and growing resentment against China has led to a shift towards a China +1 or China +2 strategy. However, companies still primarily view India as a manufacturing hub. But who owns the IP?

Today, it's China +1. In 20 years, it could be India +1, and then the focus may shift to Africa. This cycle will continue unless we start inventing, owning IP, and developing our own technology. Otherwise, today India as manufacturing hub would shift to Latin America or Africa as manufacturing hub, what would we do then?

Leaders in technology need to set benchmarks and explore new territories rather than just copying others. Even if we choose to emulate, we should do so cost-effectively and innovatively.

While we continue to develop mass manufacturing capabilities, China has excelled, becoming the world's factory by taking significant risks and venturing into new territories and from making the technology to actual owner of technology. Example - Their advancements in EV technology exemplify their comprehensive approach, whereas India still debates how to acquire and commercialize such technology.

Innovation is crucial. Advanced countries have invested heavily in inventions and innovations rather than merely adopting others' technologies. Startups should focus on building and investing in long-term strategies instead of just seeking venture capital and inflating growth potential.

Legacy automobile companies in India are too focused on internal combustion engine vehicles, adopting a wait-and-watch policy. This provides an opportunity for startups to find niche or competitive plays, creating new segments or markets.

So it brings us how to Empower Local Innovation :

- **Avoid Direct Competition with Large Companies:**

  Large companies understand legacy businesses well and can scale up faster.

- **Innovate Locally:**

  Don't merely bring Western or Eastern technology and localize it.Innovate within the local for local and local for global context.

- **Build Niche Segments:**

  Develop specialized products and focus on building intellectual property (IP) to create entry barriers.

- **Invest in Market Research:**

  Focus on long-term market research to build solutions that are hard to match.

- **Understand Customer Pain Points:**

  Create products that address unique customer needs and engage with customers early to refine the product.

- **Persistent Innovation:**

  People like change but don't adopt it easily. Be persistent and lead the market.

Just as brands like Tata and Mahindra have been embraced due to their strong product lines, startups must focus on creating robust and innovative products. Adopting the "Vocal for Local" sentiment can catalyze this shift, ensuring that India does not just remain a manufacturing hub but evolves into a centre of innovation and technology ownership.

ALOK DAS

Co-Founder
QARGOS

EMPOWERING INDIA'S AUTOMOTIVE INDEPENDENCE: BUILDING A SELF-SUFFICIENT EV MANUFACTURING ECOSYSTEM

India stands at the cusp of an electric mobility revolution that promises to reshape our automotive landscape. As a rapidly growing market for electric vehicles (EVs), India has a unique opportunity to chart its course towards automotive self-reliance and reduce its dependence on imported fossil fuels.

The transition to EVs is not just an environmental imperative but a strategic economic necessity. India's burgeoning urban population, coupled with rising disposable incomes, has fueled an insatiable demand for personal mobility solutions. However, our reliance on imported crude oil has rendered us vulnerable to global price fluctuations and supply disruptions.

Achieving self-sufficiency in EV manufacturing is a multifaceted challenge that requires a concerted effort from all stakeholders – policymakers, industry leaders, and consumers alike. The Indian government has recognized this imperative and unveiled a comprehensive EV policy aimed at fostering domestic manufacturing capabilities.

At the heart of this policy lies the development of a robust domestic supply chain for critical EV components, particularly lithium-ion batteries. The Production-Linked Incentive (PLI) scheme for Advanced Chemistry Cell (ACC) batteries is a commendable step in this direction, offering fiscal incentives to attract investments in domestic battery manufacturing.

Lithium-ion batteries are the heart of modern EVs, accounting for a significant portion of their cost and performance. India's current dependence on imported batteries not only exposes us to supply chain vulnerabilities but also limits our ability to innovate and drive down costs effectively.

To capitalise on the opportunities presented by the EV policy, we must foster a thriving ecosystem of domestic battery manufacturers, leveraging India's rich reserves of critical minerals and abundant skilled labour. By establishing state-of-the-art battery manufacturing facilities, we can not only meet the growing demand for EVs but also unlock new opportunities for research, development, and innovation.

Collaboration between industry, academia, and government is crucial to nurturing this ecosystem. Investment in cutting-edge research and development centres can catalyse breakthroughs in battery chemistry, cell design, and manufacturing processes, propelling India to the forefront of global EV innovation.

Beyond battery manufacturing, a self-sufficient EV ecosystem requires a robust domestic supply chain for other critical components, including motors, power electronics, and charging infrastructure. The government's efforts to promote localization of supply chains and encourage private sector investment in EV infrastructure are crucial enablers in this regard.

By reducing our reliance on imported fossil fuels and embracing the electric mobility revolution, we can enhance our energy security, mitigate environmental challenges, and position India as a global leader in sustainable transportation solutions.

The path ahead is challenging, but the rewards are immense – a cleaner environment, reduced import dependencies, and a thriving domestic industry that generates skilled employment opportunities. With visionary government policies, collaborative efforts, and unwavering commitment from all stakeholders, we can unlock India's true potential in the electric mobility era and propel our nation towards a more self-reliant and sustainable future.

PRATIK KAMDAR

CEO & Co-Founder
Neuron Energy

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BATTERY TECHNOLOGY TRENDS

Insights For Indian EV Manufacturers

The Indian electric vehicle (EV) market is poised for significant growth, driven by government initiatives, rising fuel prices, and increasing environmental concerns. However, range anxiety – the fear of running out of power before reaching a charging station – remains a major barrier to mass EV adoption. Here, battery technology plays a pivotal role. This column explores key trends in EV battery technology that hold immense potential for Indian EV manufacturers.

A core focus lies in developing batteries that store more energy in the same physical space. This translates directly to extended range and improved vehicle performance. Lithium-ion batteries, the current workhorse, are witnessing a steady increase in energy density, with projections of a 5-7% annual improvement. This trend is expected to continue, allowing Indian manufacturers to offer EVs with a more compelling driving range.

This revolutionary technology promises significant leaps in energy density, charging speed, and safety. Solid-state batteries use a solid electrolyte instead of a liquid one, enabling faster charging times, and potentially reducing anxieties around long journeys. Additionally, they offer better thermal stability, minimizing fire risks. While still under development, solid-state batteries are a game-changer, and Indian manufacturers who can integrate this technology early stand to gain a competitive edge.

As environmental consciousness takes center stage, the focus is shifting towards eco-friendly battery materials. This includes ethically sourced lithium and exploring alternative elements like sodium. India, with its abundant reserves of aluminum – a key component in some battery chemistries – can position itself as a leader in sustainable battery production.

A particularly promising alternative to lithium-ion batteries, sodium-ion technology boasts advantages like lower costs, wider availability of raw materials, and faster charging capabilities. While energy density might be slightly lower, sodium-ion batteries are well-suited for budget-friendly EVs and applications requiring frequent charging cycles. This technology aligns perfectly with India's cost-conscious market and its push for domestic battery production.

As the EV market expands, so will the need for efficient battery recycling processes. Developing a robust recycling infrastructure will not only address environmental concerns but also ensure a steady supply of critical raw materials. Additionally, exploring "second-life" applications for used batteries in stationary energy storage systems can further enhance sustainability and economic viability.

The Indian government is actively fostering innovation in battery technology through schemes like the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) and the Production Linked Incentive (PLI) scheme for advanced cell chemistry. These initiatives provide crucial financial and technical support for Indian manufacturers to invest in research and development, propelling the domestic EV battery industry forward.

The Indian EV market presents a unique opportunity for domestic manufacturers to leverage the latest battery technology trends. By focusing on enhanced energy density, exploring alternative materials, and prioritizing sustainability, Indian companies can not only cater to the evolving needs of the Indian consumer but also emerge as global leaders in the EV battery space. Embracing these trends will be instrumental in overcoming range anxiety, reducing costs, and propelling India towards a cleaner and more sustainable transportation future.

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Lifecycle Assessment Of EVs ENVIRONMENTAL IMPACTS and SUSTAINABILITY METRICS

Electric vehicles (EVs) are widely considered a cleaner alternative to traditional internal combustion engine (ICE) vehicles, primarily because they produce no tailpipe emissions. However, to comprehensively evaluate their environmental benefits, it is essential to conduct a lifecycle assessment (LCA). An LCA examines the environmental impacts of a product from its creation to its disposal. This column explores the lifecycle assessment of EVs, highlighting their environmental impacts and sustainability metrics.

The lifecycle of an EV can be divided into several stages: raw material extraction, manufacturing, use, and end-of-life. Each of these stages has distinct environmental impacts that must be considered to obtain a holistic understanding of the sustainability of EVs.

Raw material extraction is the first stage and involves mining and processing the materials needed for EV components, particularly the battery. Lithium-ion batteries, the most common type used in EVs, require materials such as lithium, cobalt, nickel, and manganese. The extraction and processing of these materials can have significant environmental impacts, including habitat destruction, water pollution, and high energy consumption. Cobalt mining, in particular, has been associated with severe human rights issues, including child labor in certain regions.

The manufacturing stage encompasses the production of the vehicle and its components. This stage is energy-intensive, especially the production of the battery, which can account for a substantial portion of the total energy consumption and greenhouse gas (GHG) emissions associated with EV manufacturing. Research indicates that the production of an EV generally results in higher GHG emissions compared to an ICE vehicle, mainly due to the battery.

The use stage of an EV's lifecycle, however, often offsets the higher emissions from the manufacturing stage. EVs produce zero tailpipe emissions, meaning they do not emit pollutants such as nitrogen oxides (NOx) and particulate matter (PM), which are harmful to human health and the environment. The environmental benefits during the use stage are highly dependent on the electricity mix used to charge the EV. In regions where electricity is primarily generated from renewable sources, the GHG emissions associated with EV use are significantly lower than those of ICE vehicles. Conversely, in areas reliant on coal or other fossil fuels for electricity, the benefits are reduced but still present.

The end-of-life stage involves the disposal or recycling of the EV and its components. Batteries pose a particular challenge due to their hazardous materials. Effective recycling processes are essential to recover valuable materials and minimize environmental impacts. Currently, the recycling infrastructure for EV batteries is still developing, but advancements are being made in this area. Second-life applications, where batteries are repurposed for energy storage in residential or industrial settings, also offer a sustainable solution.

Sustainability metrics are used to quantify the environmental impacts and benefits of EVs throughout their lifecycle. These metrics include GHG emissions, energy consumption, water usage, and resource depletion. Life Cycle Assessment (LCA) tools, such as the GREET (Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation) model, help researchers and policymakers evaluate these metrics. Studies using LCA tools generally conclude that, despite higher manufacturing emissions, EVs have a lower overall environmental impact compared to ICE vehicles over their entire lifecycle, particularly when powered by renewable energy.

Another important sustainability metric is the carbon footprint, which measures the total GHG emissions associated with a product. The carbon footprint of an EV is typically lower than that of an ICE vehicle over its lifetime, especially as the electricity grid becomes greener. Additionally, the use of renewable energy in both manufacturing and charging can further reduce the carbon footprint of EVs.
Water usage is another critical metric. The production of batteries, especially lithium extraction, can be water-intensive. Sustainable water management practices are necessary to mitigate the impacts on local water resources.

In conclusion, a lifecycle assessment reveals that while EVs have higher environmental impacts during the raw material extraction and manufacturing stages, they offer substantial benefits during the use stage, particularly in terms of reduced GHG emissions and air pollution. Effective recycling and advancements in battery technology are crucial for enhancing the sustainability of EVs. Overall, EVs present a more sustainable alternative to ICE vehicles, especially as the energy grid transitions to renewable sources. Understanding these impacts through comprehensive LCAs is vital for making informed decisions and promoting the broader adoption of sustainable transportation solutions.

Policy Framework For Sustainable EV Manufacturing:

IMPACT ASSESSMENT AND INDUSTRY PERSPECTIVES

The transition to electric vehicles (EVs) is a cornerstone of global efforts to reduce carbon emissions and combat climate change. In India, the government is actively promoting EV adoption through a comprehensive policy framework designed to foster sustainable EV manufacturing. This column explores the policy framework for sustainable EV manufacturing in India, its impact assessment, and industry perspectives.

India's commitment to EVs is rooted in its National Electric Mobility Mission Plan (NEMMP) 2020, launched in 2013. This initiative aimed to enhance national energy security, mitigate adverse environmental impacts from transportation, and create an indigenous manufacturing base for electric mobility. The Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme, introduced in 2015, is a key component of this mission. FAME focuses on providing financial incentives for EV purchases, developing charging infrastructure, and supporting technology development.

The FAME II scheme, launched in 2019 with an outlay of ₹10,000 crore, extends these efforts by offering subsidies for electric two-wheelers, three-wheelers, four-wheelers, and buses. It also emphasizes the establishment of charging infrastructure across urban and rural areas. The scheme aims to support 1 million electric two-wheelers, 500,000 electric three-wheelers, 55,000 electric cars, and 7,000 electric buses.

The Production Linked Incentive (PLI) scheme for Advanced Chemistry Cell (ACC) Battery Storage, approved in 2021, incentivizes domestic battery manufacturing. This scheme aims to attract large-scale investments in battery manufacturing, crucial for reducing the cost of EVs and enhancing their adoption. By promoting local production of battery cells, the PLI scheme reduces reliance on imports, thereby fostering a sustainable and self-reliant EV industry.
Moreover, the Indian government has reduced the Goods and Services Tax (GST) on EVs from 12% to 5% and on chargers from 18% to 5%. Income tax rebates are also offered on loans taken for purchasing EVs. These measures aim to make EVs more affordable and attractive to consumers.

The policy framework also includes mandates for automakers to produce a certain percentage of electric vehicles. This push is complemented by state-level policies providing additional incentives such as road tax exemptions, registration fee waivers, and subsidies for EV buyers. States like Maharashtra, Gujarat, and Delhi have announced comprehensive EV policies to promote manufacturing and adoption.

Impact assessment of these policies indicates significant progress but also highlights challenges. The financial incentives under FAME II have accelerated the adoption of electric two-wheelers and buses, particularly in urban areas. However, the uptake of electric four-wheelers has been slower due to higher initial costs and limited model availability. The establishment of charging infrastructure has seen substantial growth, yet there is a need for a more extensive and reliable network to support long-distance travel and rural adoption.

From an industry perspective, these policies have been largely positive. Automakers and battery manufacturers are investing heavily in EV technology and production facilities. Companies like Tata Motors, Mahindra & Mahindra, and Hero Electric are expanding their EV portfolios, while startups like Ather Energy and Ola Electric are driving innovation in the two-wheeler segment. The PLI scheme has attracted significant interest, with major players committing to setting up battery manufacturing plants in India.

However, industry stakeholders also highlight several challenges. The high cost of raw materials, particularly for batteries, remains a significant barrier. The development of a robust supply chain for critical minerals like lithium and cobalt is essential. Moreover, the recycling and disposal of EV batteries pose environmental and logistical challenges that need addressing.

Collaboration between the government and private sector is crucial for overcoming these hurdles. Public-private partnerships can facilitate the development of charging infrastructure and battery recycling facilities. Research and development in alternative battery technologies, such as solid-state and sodium-ion batteries, are essential for long-term sustainability.

In conclusion, India's policy framework for sustainable EV manufacturing is comprehensive and forward-looking, aiming to transform the automotive landscape and promote green mobility. The impact of these policies is evident in the growing adoption of EVs and the expansion of manufacturing capabilities. However, addressing the challenges related to raw material supply, battery costs, and infrastructure development is crucial for sustaining this momentum. With continued support and collaboration, India is well-positioned to become a global leader in sustainable electric mobility.

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Strategies For Scaling EV Production In India:
LESSONS FROM INDUSTRY LEADERS

As India aims to electrify its roads, scaling up electric vehicle (EV) production is a crucial step towards achieving sustainable transportation. Let's delve into the strategies employed by industry leaders, learning lessons from their experiences in navigating the complexities of the Indian market.

Localization Is Key:

Industry leaders understand that to scale EV production efficiently, localization is paramount. Setting up manufacturing plants within India allows companies to reduce costs associated with imports and tailor products to suit local preferences. Mahindra & Mahindra, for instance, has been a pioneer in localizing EV production, manufacturing vehicles like the Mahindra eVerito entirely in India.

Investment in R&D:

Another vital strategy is investment in research and development (R&D) to innovate and improve EV technology. By investing in R&D, companies can develop more efficient batteries, motors, and charging systems, making EVs more appealing to consumers. Tata Motors, for example, has heavily invested in R&D to enhance the performance and range of its electric vehicles.

Strategic Partnerships:

Collaboration is key to success in scaling EV production. Industry leaders are forming strategic partnerships with technology firms, battery manufacturers, and even competitors to share expertise and resources. This collaboration accelerates innovation and streamlines supply chains. For instance, Tata Motors has partnered with LG Chem to develop lithium-ion battery packs for its EVs, leveraging LG Chem's expertise in battery technology.

Focus on Charging Infrastructure:

A robust charging infrastructure is essential to support the widespread adoption of EVs. Industry leaders recognize the importance of investing in charging infrastructure to alleviate range anxiety and encourage consumers to switch to electric vehicles. Companies like Hero Electric are not only manufacturing EVs but also investing in building charging stations across the country to facilitate EV adoption.

Government Support:

Government policies and incentives play a crucial role in scaling EV production. Industry leaders advocate for supportive policies that incentivize EV adoption, such as tax incentives, subsidies, and infrastructure development grants. The government's Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme, which offers incentives for EV manufacturing and adoption, has been instrumental in driving growth in the EV sector.

Adapting to Market Dynamics:

Flexibility and adaptability are essential traits for scaling EV production in India. Industry leaders continuously monitor market trends and consumer preferences, adapting their strategies accordingly. For example, Ola Electric initially focused on electric scooters but later diversified its portfolio to include electric two-wheelers and three-wheelers in response to evolving market demands.

In conclusion, scaling EV production in India requires a multi-faceted approach, encompassing localization, innovation, collaboration, infrastructure investment, government support, and market adaptability. By learning from the strategies employed by industry leaders, manufacturers can navigate the challenges of scaling EV production and contribute to the growth of sustainable transportation in India.

UNVEILING THE CURRENT LANDSCAPE OF EV MANUFACTURING IN INDIA

Electric vehicles (EVs) have emerged as a pivotal component in the global effort to reduce carbon emissions and combat climate change. In India, the EV manufacturing landscape is rapidly evolving, reflecting a blend of government initiatives, technological advancements, and growing consumer interest. This column delves into the current state of EV manufacturing in India, highlighting key developments, challenges, and future prospects.

India's EV sector has seen significant growth in recent years, driven by a combination of policy support and market dynamics. The Indian government has played a crucial role in promoting EV adoption through schemes like the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) initiative. Launched in 2015, FAME aims to incentivize the production and purchase of electric vehicles. The scheme has undergone multiple phases, with FAME II focusing on supporting the development of EV infrastructure and providing subsidies for electric two-wheelers, three-wheelers, and buses.

One of the standout players in India's EV market is Tata Motors, which has made substantial strides in the electric car segment. Tata Motors' commitment to EVs is part of a broader strategy to lead the market in sustainable transportation solutions. Similarly, Mahindra Electric, a pioneer in the Indian EV industry, continues to innovate with models like the eVerito and e2o Plus, catering to both personal and commercial segments.

In the two-wheeler segment, India's market is witnessing a boom with companies like Ather Energy, Ola Electric, and Hero Electric at the forefront. Ather Energy, known for its Ather 450X scooter, combines advanced technology with robust performance, appealing to urban commuters. Ola Electric, leveraging its vast ride-hailing network, has entered the EV space with ambitious plans, including the establishment of a large-scale manufacturing plant in Tamil Nadu. Hero Electric, with its extensive dealership network, remains a key player, offering a range of electric scooters to meet diverse consumer needs.

Despite these advancements, the Indian EV manufacturing landscape faces several challenges. One of the primary hurdles is the high cost of EVs, driven by expensive battery technology. Lithium-ion batteries, the most common type used in EVs, significantly contribute to the overall cost of the vehicle. To address this, the Indian government is promoting research and development in alternative battery technologies, including solid-state and sodium-ion batteries, which could potentially reduce costs and improve efficiency.

Another significant challenge is the lack of adequate charging infrastructure. While urban areas have seen a rise in the number of charging stations, rural regions lag behind, limiting the adoption of EVs in these areas. To tackle this, both government and private players are investing in expanding the charging network. Companies like Tata Power and Reliance are setting up charging stations across the country, aiming to create a comprehensive and accessible charging infrastructure.

Moreover, the EV supply chain in India is still developing. Many components, especially advanced electronics and battery cells, are imported, making the manufacturing process dependent on global supply chains. The government's push for the 'Make in India' initiative aims to localize the production of EV components, encouraging domestic manufacturing and reducing dependency on imports.

Looking ahead, the future of EV manufacturing in India appears promising. The government's target of achieving 30% electric vehicle penetration by 2030 is ambitious but attainable with sustained efforts. Policies supporting innovation, research, and infrastructure development are crucial. Additionally, consumer awareness and education about the benefits of EVs will play a significant role in driving adoption.

In conclusion, the EV manufacturing landscape in India is at a transformative stage. With strong policy support, increasing investments, and growing consumer interest, India is poised to become a significant player in the global EV market. Addressing the existing challenges and leveraging opportunities will be key to shaping a sustainable and efficient transportation future for the country.

Charging Infrastructure Expansion:

ENABLING SEAMLESS EV ADOPTION ACROSS INDIA

Electric vehicles (EVs) are becoming an increasingly vital part of the global transition towards sustainable transportation. In India, the government and private sector are working together to foster the growth of EVs as a solution to rising pollution levels, fluctuating fuel prices, and the pressing need for energy security. However, one of the primary challenges to widespread EV adoption in India is the development of robust charging infrastructure. This column delves into the expansion of EV charging infrastructure and how it is crucial for enabling seamless EV adoption across the country.

The Indian government has been proactive in promoting electric mobility through various policies and initiatives. The Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme, launched in 2015 and extended subsequently, aims to boost the EV market by providing financial incentives for purchasing EVs and establishing charging stations. Under FAME II, significant funds have been allocated specifically for setting up charging infrastructure across urban and rural areas.

Developing an extensive network of charging stations is essential to alleviate range anxiety among potential EV buyers. Range anxiety, the fear of running out of battery power before reaching a charging station, is a significant deterrent to EV adoption. By ensuring the availability of convenient and reliable charging options, users can be more confident in their decision to switch from traditional internal combustion engine vehicles to EVs.

Public and private sector partnerships are pivotal in the expansion of charging infrastructure. Several energy companies, automakers, and startups are investing in building and operating charging stations. For example, Tata Power has been actively installing EV chargers across key locations in cities and along highways. Similarly, Indian Oil Corporation is setting up EV charging points at its fuel stations, leveraging its vast network to provide easy access to charging facilities.

Fast-charging technology is another critical component in enhancing the charging infrastructure. Fast chargers can significantly reduce the time required to recharge an EV, making long-distance travel more feasible and convenient. With the advent of ultra-fast charging stations capable of recharging a vehicle in a matter of minutes, the issue of lengthy charging times can be effectively addressed. The installation of these high-speed chargers along major highways and in urban centers is crucial to support the growing number of EVs on the road.

Home charging solutions are also gaining traction, offering EV owners the convenience of charging their vehicles overnight. Manufacturers are increasingly providing home charger installations with the purchase of an EV, ensuring that users have a reliable and hassle-free way to charge their vehicles. Furthermore, the government is encouraging the installation of charging points in residential complexes and office buildings, promoting accessibility and convenience.

Technological advancements play a significant role in the development of an efficient charging infrastructure. Smart chargers, equipped with features such as remote monitoring, dynamic load management, and integration with renewable energy sources, are becoming more prevalent. These smart charging solutions help optimize energy usage, reduce grid impact, and provide users with real-time information on the charging status and availability of nearby charging stations.

Standardization and interoperability of charging stations are crucial for creating a seamless EV charging experience. The Bureau of Indian Standards (BIS) has been working on developing standardized charging protocols to ensure compatibility across different EV models and charging networks. This standardization helps avoid the fragmentation of the charging infrastructure and makes it easier for EV users to access a wide range of charging options.

In addition to government and corporate efforts, community-based initiatives are emerging as a powerful tool for expanding the charging network. Local communities and resident welfare associations are increasingly installing shared charging stations within their premises, fostering a collaborative approach to building a sustainable transportation ecosystem.

Despite the significant progress, challenges remain. The high cost of installing charging infrastructure, land acquisition issues, and the need for grid upgrades to support increased electricity demand are some of the hurdles that need to be addressed. However, ongoing research and development, coupled with supportive policies and incentives, are paving the way for overcoming these obstacles.

In conclusion, the expansion of EV charging infrastructure is a cornerstone for the seamless adoption of electric vehicles in India. By addressing range anxiety, promoting public and private sector collaboration, leveraging technological advancements, and fostering community-based initiatives, India can build a robust and accessible charging network. This development is essential not only for encouraging more people to switch to EVs but also for achieving the broader goals of reducing pollution, enhancing energy security, and fostering sustainable growth.

The Future Of EV Supply Chains In India: INVESTMENT RISKS AND REWARDS

The future of electric vehicle (EV) supply chains in India presents a complex landscape of investment risks and rewards, influenced by both global trends and domestic policy initiatives. As India aims to become a major player in the EV market, understanding the dynamics of supply chain management, including sourcing raw materials, manufacturing components, and assembling vehicles, is crucial for investors and industry stakeholders.

One of the critical components of the EV supply chain is battery manufacturing. Lithium-ion batteries, essential for EVs, require a steady supply of lithium, cobalt, and nickel. India's limited reserves of these critical minerals pose a significant risk. To mitigate this, Indian companies are seeking to secure long-term contracts and invest in mining operations overseas, particularly in resource-rich countries like Australia and Chile. This strategy, while potentially reducing supply chain vulnerabilities, also exposes investors to geopolitical risks and fluctuations in global commodity prices.

Localization of manufacturing is another focal point for India. The government is encouraging the development of domestic EV manufacturing capabilities to reduce import dependence and create jobs. However, building a localized supply chain requires substantial investment in infrastructure, technology, and skilled labor. Companies like Tata Motors, Mahindra & Mahindra, and Ola Electric are leading the charge, but they face challenges such as high initial capital expenditure and the need for continuous innovation to stay competitive.

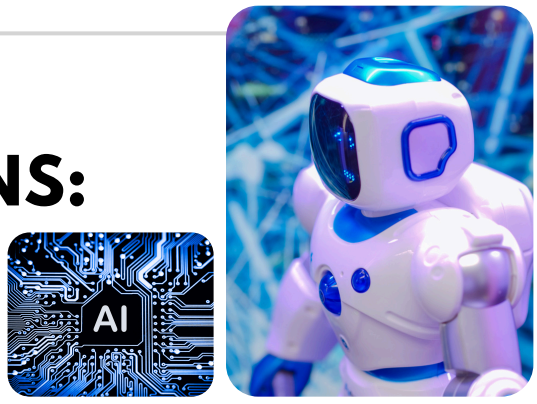
The charging infrastructure is a crucial element of the EV supply chain that demands significant attention. A widespread and reliable network of charging stations is necessary to alleviate range anxiety and boost consumer confidence in EVs. This sector offers lucrative investment opportunities, but it is fraught with challenges including regulatory hurdles, land acquisition issues, and the need for substantial upfront investment. Collaborative efforts between the government, private sector, and public utilities are essential to overcoming these barriers.

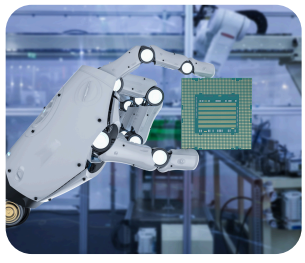
Technological advancements and innovation are vital for the growth of the EV supply chain. Investments in research and development (R&D) for battery technology, power electronics, and vehicle design are critical. India has the potential to become a hub for EV innovation if it can leverage its strong IT and engineering sectors. However, this requires a conducive environment for startups and established companies to collaborate and innovate, which involves addressing issues related to intellectual property rights, funding, and market access.

From a financial perspective, the EV market in India offers both high rewards and significant risks. The potential for high returns is driven by the expected rapid growth of the EV market, supported by favorable government policies and a growing consumer base. However, investors must navigate risks such as policy uncertainty, technological obsolescence, and the volatility of global supply chains. Diversification and strategic partnerships are essential strategies to mitigate these risks.

In conclusion, the future of EV supply chains in India is poised for growth, underpinned by supportive policies and increasing consumer demand. However, realizing this potential requires addressing significant challenges related to raw material sourcing, manufacturing capabilities, charging infrastructure, and technological innovation. Investors willing to navigate these complexities may find substantial rewards, but they must be prepared for the inherent risks that come with a rapidly evolving industry. The key to success lies in strategic planning, robust risk management, and fostering a collaborative ecosystem that supports sustainable growth in the EV sector.

SMART MOBILITY SOLUTIONS: THE ROLE OF AI AND IOT IN MANUFACTURING INDIAN ELECTRIC VEHICLES





Smart mobility solutions are revolutionizing the way we think about transportation, and India is at the forefront of this change with its focus on electric vehicles (EVs). The integration of Artificial Intelligence (AI) and the Internet of Things (IoT) in the manufacturing of Indian electric vehicles is playing a crucial role in shaping a sustainable, efficient, and intelligent transportation ecosystem.

AI and IoT technologies bring numerous benefits to the EV manufacturing process, enhancing everything from production efficiency to vehicle performance and user experience. These technologies are particularly important in addressing the unique challenges and opportunities present in the Indian market, such as high population density, varied urban infrastructure, and the need for cost-effective solutions.

AI in manufacturing is transforming how electric vehicles are produced. By using AI algorithms, manufacturers can optimize production lines, predict equipment failures, and reduce downtime. Predictive maintenance, powered by AI, allows for real-time monitoring of machinery and anticipates when parts need replacing, thus avoiding unexpected breakdowns. This not only improves the efficiency of the manufacturing process but also significantly cuts costs and enhances productivity.

Moreover, AI is instrumental in quality control. Traditional methods of quality assurance are often time-consuming and prone to human error. AI-based systems, however, can inspect components with greater precision and speed. Machine learning algorithms analyze data from sensors and cameras to detect defects or irregularities in real time, ensuring that only high-quality parts are used in the assembly of EVs. This leads to better reliability and performance of the final product.

IoT, on the other hand, connects various parts of the manufacturing ecosystem through a network of sensors and devices, enabling seamless communication and data exchange. In the context of EV manufacturing, IoT facilitates the integration of supply chain components, from raw materials to finished products. For instance, smart sensors track the inventory levels of materials and automatically place orders when supplies run low, ensuring that production is not halted due to shortages.

Additionally, IoT enables real-time monitoring of the entire production process. By collecting data on temperature, pressure, and other critical parameters, manufacturers can maintain optimal conditions for producing high-quality components. This data-driven approach allows for greater control and precision in manufacturing, leading to improved efficiency and reduced waste.

The integration of AI and IoT extends beyond the manufacturing floor to the EVs themselves, enhancing their functionality and user experience. Smart electric vehicles equipped with AI can offer features such as autonomous driving, predictive maintenance, and personalized user settings. These vehicles can learn from the driving habits of their users and optimize performance and energy consumption accordingly.

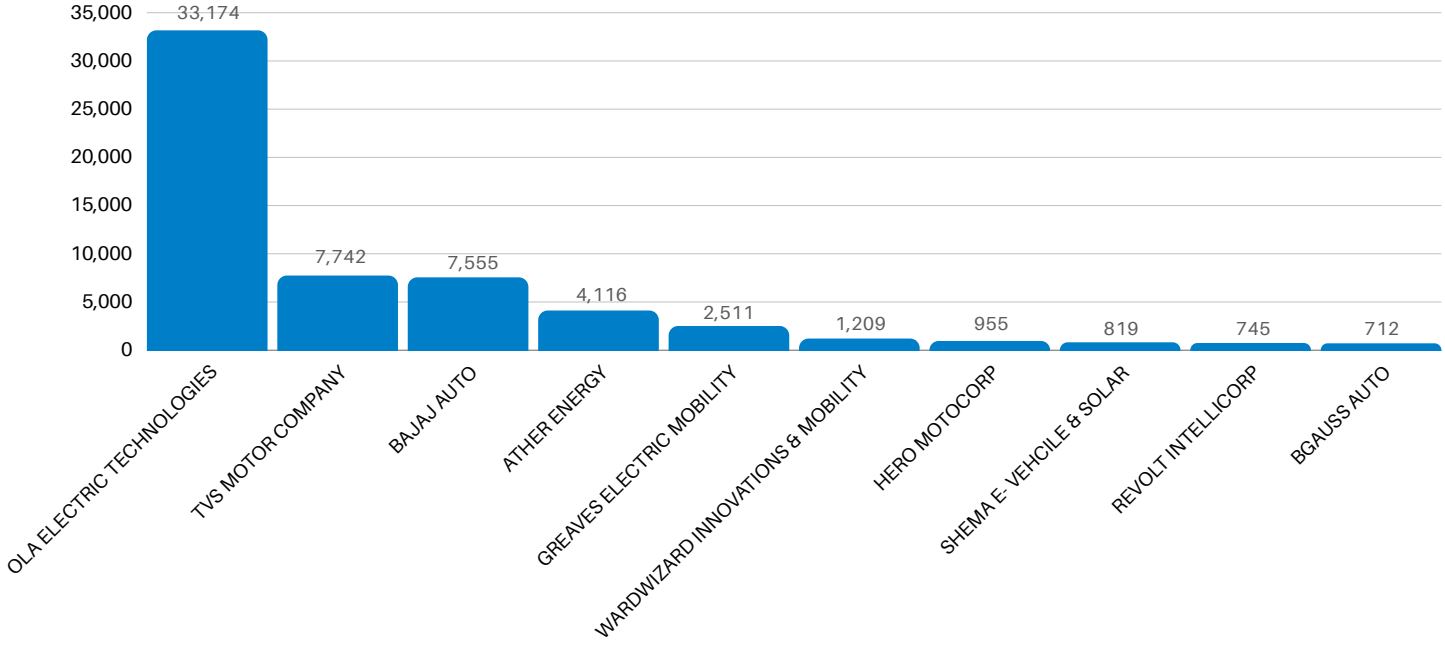
IoT connectivity in EVs enables advanced telematics services, such as real-time tracking, remote diagnostics, and over-the-air (OTA) updates. This connectivity ensures that the vehicles remain up-to-date with the latest software improvements and security patches, enhancing their longevity and performance. Furthermore, IoT can facilitate the development of smart charging infrastructure, allowing EVs to communicate with charging stations to optimize charging times and reduce energy costs.

In India, the adoption of AI and IoT in EV manufacturing is supported by various government initiatives aimed at promoting smart mobility and sustainable transportation. The Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme, for example, provides incentives for the development and deployment of electric vehicles and related technologies. This policy support, combined with the country's growing tech ecosystem, creates a favorable environment for the integration of AI and IoT in the EV industry.

The collaboration between tech companies and automakers is also crucial in advancing smart mobility solutions. Partnerships between Indian automotive giants like Tata Motors and Mahindra & Mahindra and technology firms specializing in AI and IoT are driving innovation and accelerating the adoption of these technologies in EV manufacturing.

In conclusion, AI and IoT are playing a transformative role in the manufacturing of electric vehicles in India. By enhancing production efficiency, ensuring quality control, and enabling smart features in EVs, these technologies are key to developing a sustainable and intelligent transportation system. As India continues to invest in smart mobility solutions, the integration of AI and IoT will be essential in overcoming the challenges and maximizing the opportunities in the EV sector.

TOP EV TWO WHEELER SALES IN INDIA, APRIL 2024



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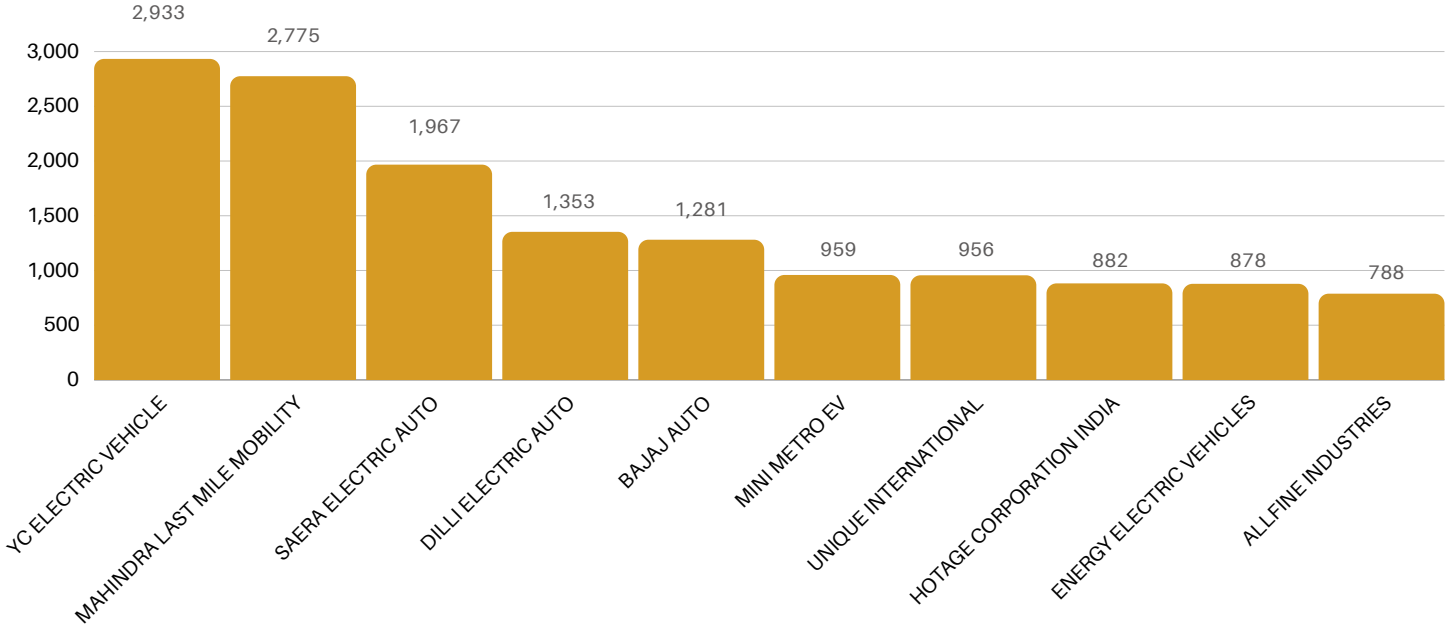

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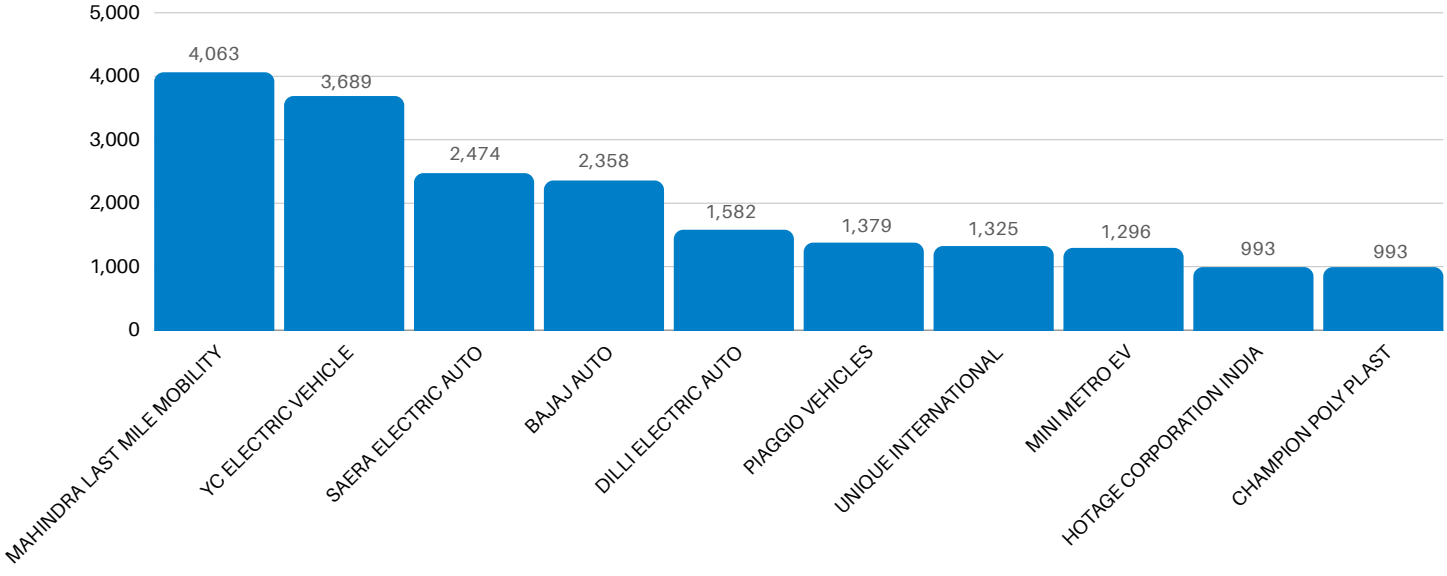

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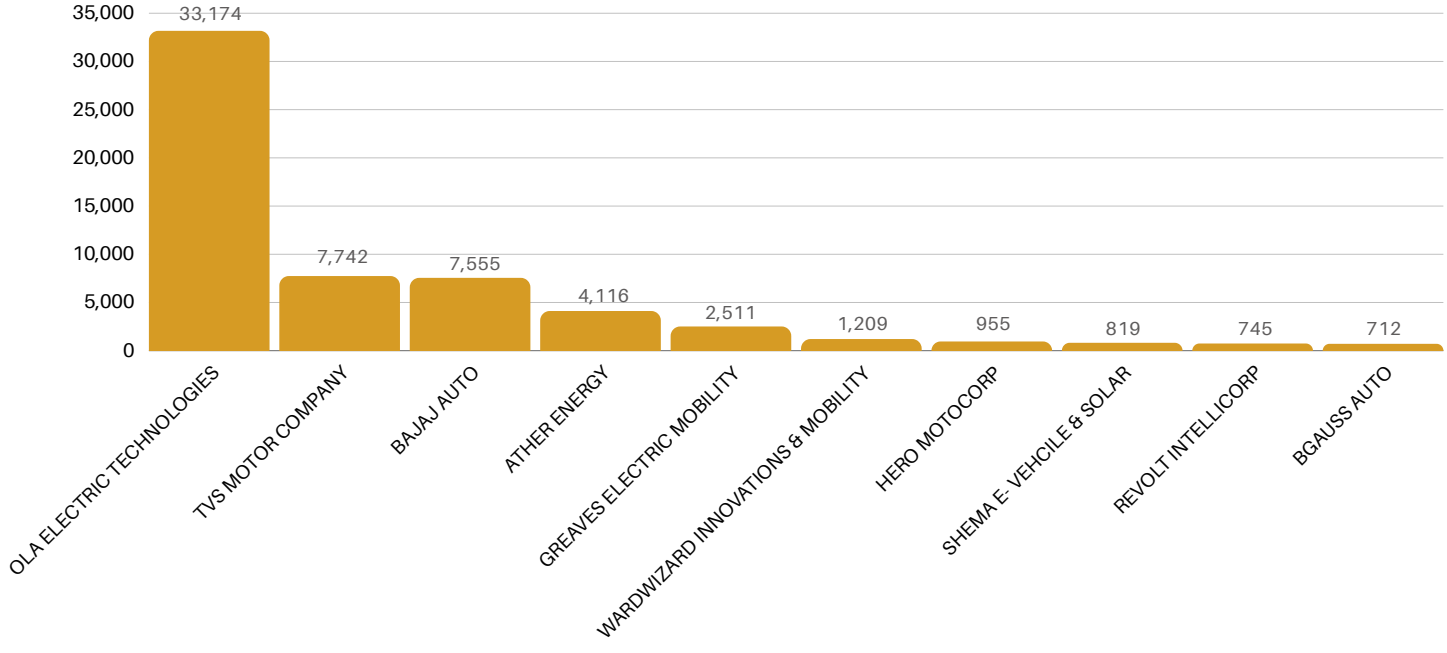

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