

EV Retrofitment Market

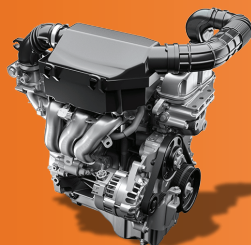
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Authors

Lead Author- Saswat Das, Jyoti Gulia

Contact Us

E : contact@jmkresearch.com

M : +91-7428306655

A : 212A, Suncity Trade Tower, Sector 21, Gurugram, Haryana 122016

W : jmkresearch.com

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Introduction

The retrofitting of ICE vehicles into EVs has been a topic of interest for some time. As the EV industry expands globally, a large number of aging ICE vehicles, still in good condition, face disposal due to evolving emission norms and government efforts to reduce pollution. Retrofitting offers a solution, particularly for transport sector vehicles, allowing them to remain operational.

The feasibility of retrofitting varies significantly across various vehicle segments and use-cases.

Retrofitters often provide services for a limited range of vehicle models because each model's retrofitment kit is distinct and needs to go through a costly, separate homologation process.

The industry's growth has been limited by challenges like costly certifications, lack of affordable access to financing/insurance, low consumer awareness and confidence, etc. The e-retrofitment market, primarily led by startups and small firms, is still in its early growth phase. It currently has established centres only in major cities and industrial hubs like Delhi NCR, Bangalore, Hyderabad, and Pune.

This white paper explores India's EV retrofitment market and examines the costs, market dynamics, feasibility, and potential challenges associated with this transition.



Retrofitting Process

An e-retrofitting kit generally consists of key components such as a traction motor, battery, inverter, wiring harness, connectors, state of charge indicators, a vehicle control unit, and on-board chargers.

Table 1: Key Components replaced in the retrofitment process

ICE	EV
Engine	Electric Motor
Fuel Tank	Electric Battery
Fuel Pipe	Motor controller
Exhaust	Wire harness
Engine Accessories	Charging socket

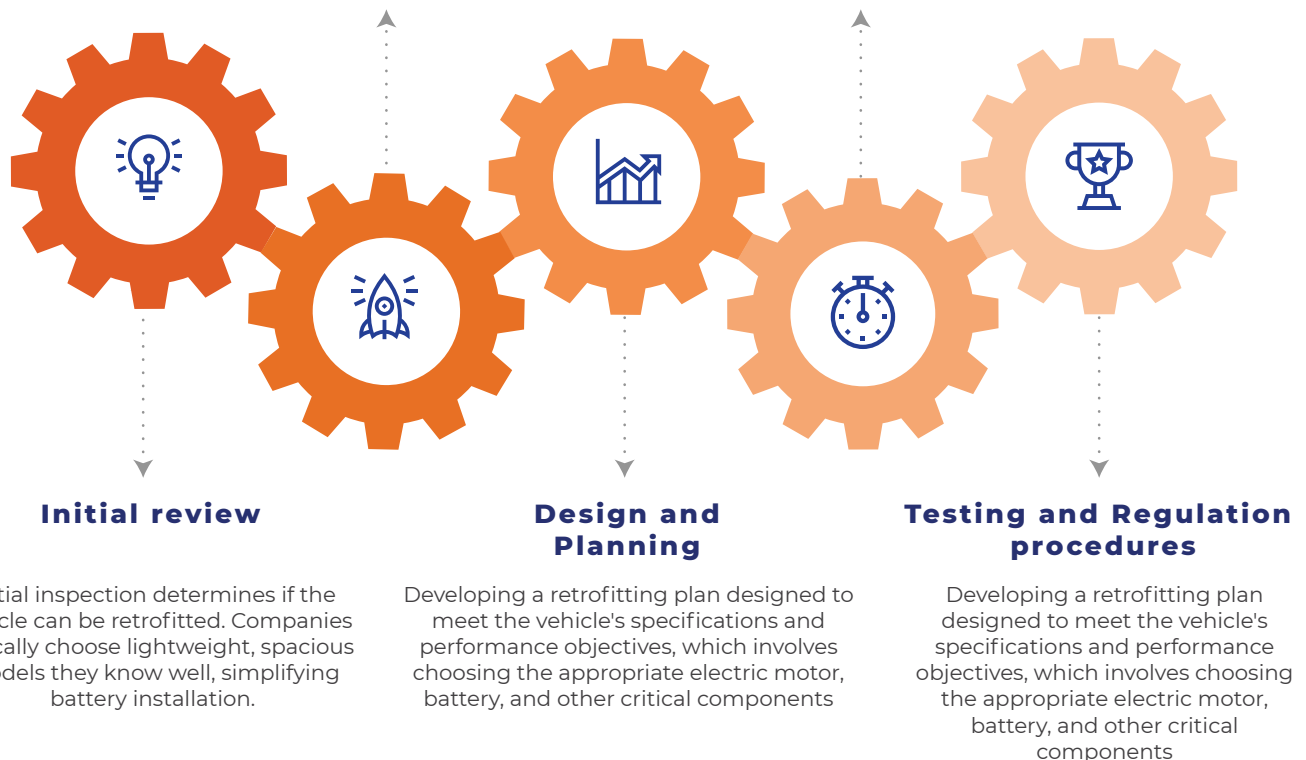
In the retrofitting process, the fuel tank, engine, fuel pipes, exhaust system and engine accessories are replaced with a battery, controller, and motor. Engineering challenges arise in selecting the appropriate sizes for the battery and motor, as well as ensuring effective integration of the motor with the existing vehicle's transmission system. According to India's Automotive Industry Standards 123 (AIS 123), the ideal weight difference between the original and retrofitted vehicle should be around 10%.

Removing Thermal ICE Components

After the initial assessment, the vehicle's thermal components like the engine, fuel tank, and exhaust system are removed, freeing up space for the new electric parts.

Installing /customizing EV components

EV components, such as the electric motor, battery, lithium cells, and power controller, is installed. Component sizes vary based on the vehicle's space, performance needs, and weight.



EV Retrofitment: Commercial Vs. Personal

While retrofitting ICE vehicles to EVs offers benefits like lower upfront costs and extending vehicle lifespan, it often costs 60-70% of a new EV due to the high price of batteries, which make up around 50% of a new EV's cost. When factoring in assembly, disassembly, and other components, the price difference with New EVs is minimal, making retrofitting less attractive for individual buyers. Additionally, retrofitted vehicles lack warranties and often show signs of wear, making retrofitted EVs a less appealing option for individual consumers.

Cost Efficiency of Bulk Retrofitting makes it an attractive proposition for Commercial Players

Retrofitting is particularly advantageous for commercial and institutional buyers who benefit from economies of scale. These buyers typically convert ICE vehicles in bulk, where the smaller price difference between retrofitted vehicles and new EVs becomes less of a barrier. The cumulative savings from retrofitting in bulk make it a more cost-effective option for them.

Dominance of Three-Wheelers in the Commercial Retrofitting Market and the Rise of Battery Subscription Models

Three-wheelers make up most of the retrofitting activity in the commercial market. Few retrofitters have also tried a battery subscription/swapping business in the two- and three-wheeler categories to lower the initial cost of the retrofitted vehicle.

Key Market for Personal segment : Luxury and Vintage Vehicle Owners

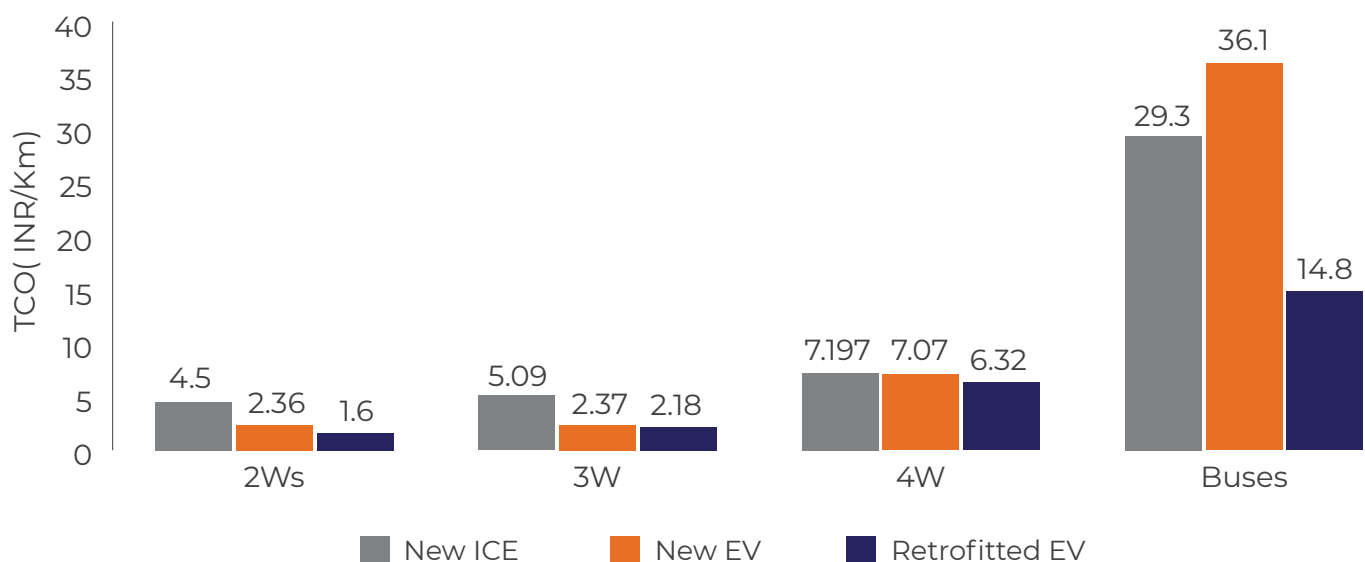
The primary customers for individual vehicle retrofitment are owners of high-end luxury or vintage vehicles. These owners aim to bypass government-mandated scrappage rules, if their vehicles' chassis meet the required fitness standards.

TCO Analysis Across EV Segments

This section aims to illustrate how the total cost of ownership (TCO) serves as a key metric for evaluating the economic advantages of retrofitting vehicles. The graphs below highlight the anticipated economic benefits across four segments of retrofitted electric vehicles: buses, trucks, three-wheelers (3Ws), and four-wheelers (4Ws).

Total cost of ownership for retrofitted EVs are generally lower than those of new ICE and EV vehicles across all segments, and cost savings are especially significant in larger vehicle categories, such as buses. For buses, retrofitting can reduce the total cost of ownership (TCO) by 60% compared to purchasing new electric models, making it an attractive option.

Figure 1: TCO Analysis of retrofitted EVs over a 10 year Period



Factors influencing viability of EV retrofitting

In India, EV retro fitment is most practical for 2-wheelers (2Ws) and 3-wheelers (3Ws) due to their simpler retrofitment process, smaller battery requirements and the growing availability of battery-swapping options. Currently, retrofitting 4-wheelers (4Ws) faces more obstacles, including higher costs, technical complexity, and limited-service providers.

Table 2: Key factors influencing the retrofitment process

Factors influencing viability of EV retrofitting	Two-Wheeler	Three-Wheeler	Four-Wheeler
Investment and Technical Complexity	Viability: High Cost of Retrofitting Kit: >Rs 50,000 Retrofitting 2Ws typically requires simpler modifications because of their smaller batteries, motors, and fewer internal components, resulting in lower technical complexity and investment, making it a cost-effective option	Viability: High Cost of Retrofitting Kit: Rs 1-2 lacs Retrofitting 3Ws is also quite straightforward due to their simpler and more consistent structure across different models, along with sufficient internal space for batteries and controllers. This makes the retrofitting process both technically and financially feasible.	Viability: Low Cost of Retrofitting Kit: >Rs 5 lacs Retrofitting 4Ws entails increased technical complexity and a higher investment due to their advanced systems and power needs. The kits require, advanced motors, and larger batteries, raising both costs and technical demands.
Homologation costs for EV retrofitment companies	Viability: Low Homologation for 2Ws is the least expensive among segments, but varying requirements for weight, mileage, and top speed necessitate separate homologation for each customized kit. This results in higher costs as individual expenses accumulate across multiple kits.	Viability: Moderate 3Ws have lower homologation costs due to their simpler design, standardized kits, and common commercial use.	Viability Low Homologation costs of 4Ws are higher due to their complexity, varied models, and strict regulations. The need for separate homologation for each model increases expenses, which may deter manufacturers from offering affordable retrofitting solutions.

■ Viability: High

■ Viability: Moderate

■ Viability: Low

Factors influencing viability of EV retrofitting

	Two-Wheeler	Three-Wheeler	Four-Wheeler
Extent of localization due to high EV adoption	Rising demand for electric two-wheelers has boosted local production of key EV components allowing retrofitting companies to source parts affordably within India. This reduces import reliance, cuts costs, and makes retrofitting solutions more accessible to consumers.	The increased adoption of electric three-wheelers in India has accelerated the growth of a local supply chain for EV components. This enables retrofitting businesses to source components locally, lowering retrofitting costs for ICE vehicles. As demand for electric three-wheelers grows, the ecosystem expands, further reducing retrofitting costs for fleet operators.	Electric four-wheeler adoption is rising but trails behind that of two- and three-wheelers due to higher costs, longer charging times, and limited charging infrastructure. Consequently, retrofitting ICE four-wheelers is less common and cost-effective compared to 2Ws and 3Ws..
Standardization in Retrofitting Kits	India's two-wheeler market includes numerous models, each varying in design, structure, speed, mileage and weight distribution, making it challenging to create standardized retrofitting kits that can work across multiple models without adjustments.	Three-wheelers are mainly used for commercial transport, like rickshaws and goods delivery, with predictable usage patterns. This consistency enables retrofitting providers to standardize battery sizes and power setups, reducing the need for customizations.	The wide range of 4W models in India—including hatchbacks, SUVs, electric vans, and fleet vehicles—creates obstacles for standardization. These vehicles have diverse power and battery needs, which complicates the development of standardized retrofit kits.

Source: industry consultations

EV Retrofitment Market Trends

Emergence of " battery as a service" (BaaS) model

The BaaS model eliminates the need for an upfront battery purchase, the costliest EV component. Instead, users pay a subscription or rental fee, such as monthly or per-use charges, lowering retrofitting costs by avoiding direct battery ownership.

Retrofitting a two-wheeler with BaaS model can cost as little as 25% of a new electric two-wheeler, making it a budget-friendly alternative.

Increasing use of Leasing Models for Retrofitted Four-Wheelers

An EV leasing model for retrofitted four-wheelers is proving effective in making EV adoption more affordable, especially since retrofitting four-wheelers can be costlier than two-wheelers due to larger

batteries and complex powertrains. By leasing, customers avoid the substantial upfront retrofitting costs and instead pay a fixed monthly fee, which is often cheaper than a car loan or full purchase. This approach can reduce the initial expense to around 20-30% of the total retrofitting cost annually, making EVs accessible to a broader audience.

Rising demand for Hybrid Electric Retrofits in India's Pre-owned Car Market

The concept of hybrid electric retrofits for cars has gained traction due to increased demand for hybrid options, especially after pollution concerns in cities like Delhi, and a limited supply in the second-hand car market. This approach involves equipping pre-owned cars with retrofit EV systems. This unique model stands out in the domestic market, reshaping green vehicle solutions. These hybrid retrofit systems offer the advantages of both ICE and EV modes.

Key Players in EV Retro fitment segment

Most participants in the EV retrofitting market are start-ups, alongside a few established OEMs and auto component manufacturers. EV retro fitment players can be classified into four main categories

- 1. Pure-play EV retro fitment service providers:** These providers focus exclusively on retrofitting, substituting ICE components with electric powertrains, batteries, and control systems.

Table 3: Dedicated EV retro fitment service providers

Company	Headquarter	Vehicle Segment	Overview
	Gurgaon	4Ws-passenger cars, light commercial vehicles	Loop Moto offers EV conversion kits and retrofitting services for a wide range of vehicles available in India. Their compact electric powertrain features lithium-ion batteries, a battery management system, and other key components needed to convert ICE vehicles into EVs.
 GoGo AI	Mumbai	2WS	The retrofit kit is designed for over 50 popular two-wheeler models in India, including more than 45 models from Hero Honda, Hero Motocorp, Honda, and Scooter India. It is also compatible with five variants of the Honda Activa.

- 2. Original Equipment Manufacturers (OEMs)** As the original manufacturers of the vehicle, OEMs possess a deep understanding of its design, structure, and performance. This expertise allows them to provide high-quality retrofit kits that benefit from strong brand recognition.

Table 4: Original Equipment Manufacturers (OEMs)

Company Name	Headquarter	Vehicle Segment	EV category
 3EV Industries Pvt Ltd.	Banglore	3WS	3ev offers micro-mobility solutions tailored to local communities, including services for passengers, small-parcel deliveries, and freight.
 Zero 21	Hyderabad	3WS	The company manufactures electric auto rickshaws, including models like Chalo, Smart Mule X, Smart Mule Passenger, and Teer. They also offer EV retrofitting kits.
Zuink Retrofit	Bengaluru	2WS	Bounce began as Wicked Ride, a rental service for high-performance motorcycles. It later shifted its focus to app-based scooter rentals and rebranded as Bounce. Owned by the EV-maker Bounce, Zuink Retrofit provides retrofitting services converting petrol scooters to EVs.

Source: Company Websites, News articles

- 3. Automotive component manufacturers:** These companies produce vital EV components, such as batteries, electric motors, and power control modules. They already possess expertise in certain parts necessary for EV retrofit kits. Their decision to enter the retro fitment market is motivated by the opportunity to expand their manufacturing capabilities and improve their overall auto component expertise. By doing so, they aim to establish themselves as significant players in both the EV retrofit and auto component markets, creating synergy between the two segments enhancing profitability and broadening market opportunities

Table 5: Automotive component manufacturers

Company Name	Headquarter	Vehicle Segment	EV category
Northway Motorsport	Pune	4Ws- passenger cars, light commercial vehicles	Operates as an EV division of Hemank Auto Parts Pvt Ltd. The company specializes in EV retrofitting and powertrain development, serving a broad customer base from private owners to fleet operators.

Table 5: Automotive component manufacturers

Company Name	Headquarter	Vehicle Segment	EV category
Precision Camshafts	Solapur	4Ws- light commercial vehicles	Precision Camshafts Limited (PCL), a leader in camshaft manufacturing for over 30 years, has entered into EV retrofitting with support from its Dutch subsidiary, EMOSS, a supplier of electric powertrains to European companies
Mecwin India	Mumbai	2W,3W and 4W	Mecwin India, a manufacturer of EV motors, solar pumps, and green propulsion solutions, entered the EV retrofitting sector in 2022 through a ₹15 billion partnership with Raipur-based Tatva Group.

Source: Company Websites, News articles

- 4. EV service providers.** These providers engage in various EV services, such as developing battery solutions, building charging networks, operating EV cab fleets, and have also entered the EV retrofitting business.

Table 6: EV service providers

Company Name	Headquarter	Vehicle Segment	EV category
Race energy	Hyderabad	2Ws & 3Ws	RACEnergy is a top retrofit solution provider in India, specializing in manufacturing electric powertrains and battery swapping stations.
Green-Tiger Mobility	Bengaluru	2Ws	The company is committed to developing the EV ecosystem through retrofitment and innovative mobility solutions, aiming to enhance customer experience and promote sustainability. Its mobility division focuses on designing, conceptualizing, and implementing advanced solutions, delivering high-quality indigenous products to support the expanding EV market.
Do-real motors	Gurugram	4Ws	The company began as a dedicated EV retrofitment enterprise with the goal of transforming ICE-powered vehicles into electric. Over time, its focus expanded to include EV battery manufacturing, refurbishing and upgrading existing battery packs, and prototyping two-wheelers, three-wheelers, and four-wheelers for OEMs.

Source: Company Websites, News articles

Investments and Partnerships

Following investments highlight the growing confidence in India's EV retrofit market, as companies focus to convert existing ICE vehicles to electric powertrains and strengthen the nation's green mobility infrastructure.

Table 7: Investments and partnerships

Company	Headquarter	Vehicle Segment	Category	Investments
Sun Mobility	Bengaluru	Small Format Electric Vehicle - 2W, 3W & 4W	EV service provider	In March 2024, Sun Mobility and Indian Oil Corporation (IOC) announced to have formed a joint venture, backed by IOC's \$78 million investment to focus on converting ICE vehicles to compact electric formats using a Battery-as-a-Service (BaaS) model.
Kalyani Powertrain	Pune	Electric Trucks	Auto-component player	In June 2024, Kalyani Powertrain partnered with Bluwheelz and Revfin to introduce retrofitted electric trucks in India, aiming to convert truck fleets to electric vehicles over the next five years.
Volektra	Ahmedabad	2Ws and 3Ws	Pure play EV retrofitment	In 2022, Auto Ignition Ltd. invested ₹100 crore in a partnership with Volektra from Germany to create electric retrofitting solutions in India. In July 2024, Ecozen, supported by Thinkuvate and Growthfactory, invested in Volektra to develop affordable and eco-friendly EV retrofitting kits for two- and three-wheelers.
Omega Seiki Mobility	New Delhi	Buses and Trucks	OEM	In June 2022, OSM announced plans to establish a retrofit facility near Chandigarh with a \$25 million investment. Through its new subsidiary, OSM Retro, the company aims to first convert 1.0-1.5-ton trucks, then expand to 3.5-6.5-ton trucks, and later include minibuses.

Company	Headquarter	Vehicle Segment	Category	Investments
Pepper Motion	Mumbai	Buses and Trucks	Pure play EV retrofitment	In November 2023, Pepper Motion invested ₹4,640 crore in Punganur, Chittoor district. The facility aims to retrofit diesel buses and trucks and manufacture new vehicles, with a battery production capacity of up to 20 GWh.

Source: Company Websites, News articles

Exits from the EV retrofitment space

key players such as E-trio, Cell propulsion etc have exited from the EV retrofitment space and have transitioned toward becoming full-fledged Original Equipment Manufacturers (OEMs). This shift often follows naturally, as retrofitment service providers build expertise in EV powertrain technology, making it a strategic and profitable next step to manufacture complete vehicles. Given that an EV primarily consists of the powertrain and chassis, once a service provider masters powertrain development, adding chassis manufacturing becomes less challenging and enables broader market opportunities.

Table 8: Players Who Have Exited the EV Retrofitment Space

Company	Headquarter	Vehicle Segment	Overview
E-trio	Telangana	3W & 4W	Founded in 2017, Etrio is an EV manufacturer focused on electrifying cargo fleets for logistics applications. The company offers a variety of electric vehicles in both three- and four-wheeler segments, with payload capacities ranging from 350 kg to 700 kg.
Cell Propulsion	Bengaluru	Buses & Trucks	Cell Propulsion offers cost-effective EV solutions for intra-city commercial vehicle fleets, including buses and trucks, all with zero noise emissions.
Altigreen Propulsion Labs	Bengaluru	3Ws	Altigreen, based in Bengaluru, manufactures advanced electric three-wheelers for India's last-mile transportation sector, focusing on research, design, and production.

Source: Company Websites, News articles, industry consultations

Regulatory landscape for retrofitted EVs in India

The regulatory environment for retrofitted electric vehicles (EVs) in India is developing, with the government implementing various measures to regulate, encourage, and support the growth of EV retrofitment.

Below is an overview of the key elements of the regulatory framework:

Regulatory Framework	
Regulatory Sections Reference	The Automotive Industry Standards (AIS-123) and the amended Central Motor Vehicle Rules (CMVR 115G) permit the conversion of existing vehicles to electric. These regulations focus on key areas like battery safety, motor efficiency, and ensuring the structural integrity of the vehicle after the retrofitting process.
Governing Bodies	The Ministry of Road Transport and Highways (MoRTH) is responsible for enforcing and interpreting the Central Motor Vehicles Rules (CMVR) and the Motor Vehicle Act, which establish the legal guidelines for the registration, fitness, and lifespan of transport vehicles, including EVs and retrofitted EVs, in India.
Homologation policy	Vehicles converted to electric powertrains must go through a homologation process, which involves rigorous testing and certification. This is conducted by authorized agencies such as the Automotive Research Association of India (ARAI), the International Centre for Automotive Technology (ICAT), or other approved testing centres to ensure that the retrofitted vehicles meet safety, performance, and environmental standards.
GST Rates	New electric vehicles (EVs) benefit from a favorable 5% Goods and Services Tax (GST) rate, but retrofit kits lack a dedicated GST provision. Instead, each component is taxed at rates over 18%, which discourages the adoption of retrofitting as a practical alternative.

State-wise regulations and standards

Currently, there is no national-level program offering central incentives for e-retrofitting. All Indian states and five Union Territories have introduced electric vehicle (EV) policies to promote vehicle electrification. However, among these, around eight states, including Delhi, Assam, Chandigarh, Rajasthan, Telangana, Tamil Nadu, Goa, and Kerala, have incorporated provisions specifically for e-retrofitting.

Table 10: State-wise provisions

States	Policy Period	Incentives Provided
 Assam	2021-2026	3W : 15% of Retro fitment cost capped at INR 15,000
 Chandigarh	2022-2027	Cart: 15% of the cost (up to ₹10,000) for the first 1,000 vehicles registered during the policy period. Auto: 15% of the cost (up to ₹15,000) for the first 1,000 vehicles registered during the policy period. Goods carrier (L5N): 15% of the cost (up to ₹15,000) for the first 1,000 carriers registered during the policy period.
 Delhi	2022-2027	The retrofitting program targets diesel vehicles over 10 years old and petrol vehicles over 15 years old. Eight certified retrofitting kits have been approved, along with authorized conversion centers. However, there are no incentives offered for this program. According to Delhi government rules, diesel vehicles under 15 years can be retrofitted but must be retired after reaching 15 years. Diesel vehicles older than 10 years require re-registration for retrofitting. Petrol and CNG vehicles over 15 years can also be retrofitted if re-registered with a valid fitness certificate, while commercial vehicles are ineligible for retrofitting after 15 years

 Goa	2021-2026	Registered owners of EVs can receive a purchase incentive for converting old ICE vehicles using a retrofitting kit, subject to RTO approval. The incentive will be based on battery capacity or capped at the applicable state subsidy, whichever is greater.
 Tamil Nadu	2023-2027	2 wheelers up to INR 15000/vehicle for first 30,000 vehicles 3 wheelers up to INR 20,000/ vehicle for first 15,000 vehicles Vehicle cap period is 2023-2025
 Telangana	2020-2030	3W : Rs 15,000/vehicle for first 5,000
 Rajasthan	2022-2027	3W (e-rickshaw, e-cart, e-goods carrier and e-auto) 15 per cent of retrofitting cost (including taxes), up to Rs 10,000 vehicles for 3,000 vehicles 4W (personal cars, taxi, commercial vehicle, light goods vehicle 15 per cent of retrofitting cost (including taxes), up to Rs 15,000/vehicle for 2,000 vehicles Bus 15 per cent of retrofitting cost (including taxes), up to Rs 250,000/ vehicle for 2,000 vehicles
 Kerala	2022	INR 15,000 per vehicle for three-wheelers

KEY CHALLENGES

Affordable Financing

- The conventional loan options for both traditional and retrofitted vehicles, which are structured around the tenures and interest rates for internal combustion engine (ICE) vehicles, are not well-suited to electric vehicle (EV) customers.
- EVs have a distinct lifecycle compared to ICE vehicles, as the battery operates on a separate life and performance cycle, independent of the vehicle's body and chassis. This mismatch in financial terms makes it difficult for EV buyers to afford loans based on ICE vehicle standards.
- Even when loans are available, financial institutions often impose high interest rates, low loan-to-value ratios, short repayment terms, or strict repayment schedules making the terms unfavourable for borrowers

Securing Insurance

- Insurance companies assign a high-risk factor to electric vehicles (EVs) due to the relatively new nature of the technology, which is not yet fully understood. This uncertainty leads to the application of insurance premiums that are higher than necessary.
- The limited historical data in the emerging market for retrofitted vehicles further complicates this task. Insurers rely heavily on historical data to forecast claims frequency and severity, but the lack of sufficient data in this area makes accurate predictions challenging, potentially leading to higher premiums or reluctance to provide coverage
- The early stage of the retrofitting market complicates matters for insurers, as the 'law of large numbers'—which suggests that selling more policies improves claims predictability—is hindered by the market's limited reach and unpredictability.

Limited Scope of Implementation

- Despite some state governments offering financial incentives for retrofitting, the market has yet to scale significantly.
- In most states, retrofitting remains limited to small vehicles like three-wheelers
- While retrofitting larger vehicles like buses and trucks is possible, it is still a small, niche segment.

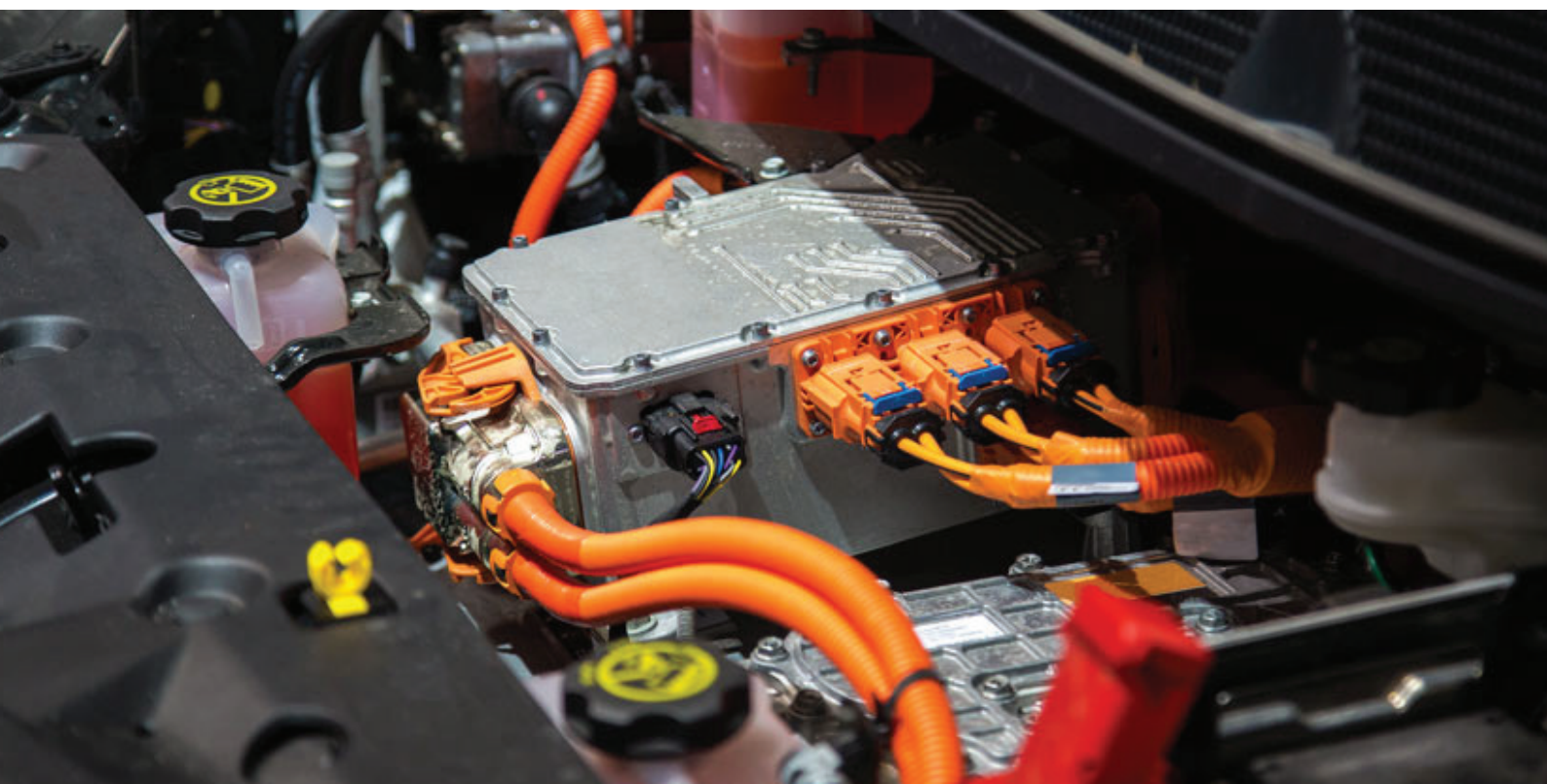
Conclusion

Although EV retrofitting is in its nascent stages in India, its importance is growing. The EV retrofit market should be seen as a critical part of India's journey towards net-zero goals, alongside sectors like charging infrastructure, EV component market, etc. This is becoming more evident as various players, including charging infrastructure manufacturers, OEMs, fleet owners, logistics providers, and auto component makers, enter the market. These sectors are interconnected, supporting and enhancing each other. As the BaaS (Battery as a Service) ecosystem and domestic EV component market develop, retrofitting costs will decrease, making EV retrofitting more viable across all vehicle segments.

Currently, EV retrofitting is more viable for the commercial segment than the personal segment due to higher returns, better utilization rates, and the cost benefits of retrofitting in bulk. Total cost of ownership for retrofitted EVs are generally lower than those of new ICE and EV vehicles across all segments, and cost savings are especially significant in larger vehicle categories, such as buses and four-wheelers.

EV retrofitting is most popular in three-wheelers (3Ws) compared to two- and four-wheelers, due to standardized usage patterns, lower homologation costs, and a stronger presence in the commercial sector. The predictable use of 3Ws in transport and cargo allows for more standardized kits, unlike the varied models of 2Ws and 4Ws, which raise homologation expenses. New models like Battery-as-a-Service (BaaS) is cutting costs by over 75% from new EV prices, as the costly battery is offered via subscription.

Key players are increasingly entering India's EV retrofit market, particularly targeting the commercial segment with investments from logistics firms, EV charging providers, and financiers. Some companies are moving toward becoming full-scale OEMs, as this approach is profitable in the EV three-wheeler space. On the regulatory side, though there's no central incentive, eight states, including Delhi, have specific policies on e-retrofitting. Delhi's policy, which permits vehicles older than ten years to operate with EV kits, has been pivotal in spurring growth in the EV retrofitting sector. However, challenges persist in financing and insurance, as existing loan standards for internal combustion vehicles do not align well with EV retrofitting needs. Lack of sufficient data for risk assessment leads to higher insurance costs for retrofitted EVs.



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JMK Research & Analytics

E: contact@jmkresearch.com

M: +91-7428306655

A: 212A, Suncity Trade Tower,
Sector 21, Gurugram, Haryana
122016

W: www.jmkresearch.com