JMK Research & Analytics

Navigating INDIA'S **BATTERY SWAPPING** Ecosystem

October 2024

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Based on our in-depth sector experience, strong industry network in the Indian sustainability market, we provide key insights and detailed industry information that helps our clients develop successful business models and market strategies.

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INTRODUCTION

Electric Vehicles (EVs) in India rely on two primary charging methods: Conductive and Battery Swapping, each tailored to different applications.

Conductive charging involves direct electricity transfer from a charging station to the vehicle, while battery swapping replaces a depleted EV battery with a fully charged one at designated stations. Battery swapping stations, acting as aggregators, are essential for used batteries and supply fully charged replacements to EV owners.

Battery swapping is emerging as a crucial solution, especially in India's price-sensitive market. **With over 1 million battery swaps occurring daily, this approach addresses economic and operational challenges, particularly in the electric two-wheeler (E2W) and three-wheeler (E3W) markets.**[1]

Key drivers of increasing usage of battery swapping in certain cases and segments in India is mainly driven by following factors:

Operational Efficiency:

Battery swapping enhances operational efficiency for both commercial and personal vehicles by minimizing downtime. For fleet operators, this translates to increased productivity, allowing vehicles to remain in operation longer. For personal vehicle users, reduced charging times mean more convenience and usability, especially in urban settings where time is often of the essence.

Cost Reduction and Affordability:

The battery swapping model allows for the decoupling of battery ownership from the vehicle purchase, significantly lowering the upfront costs associated with electric vehicles (EVs). This financial flexibility not only makes EVs more affordable for commercial fleet operators but also encourages personal users to consider electric options without the burden of high initial investments.

Standardization of Battery Technology:

The movement toward standardizing battery designs and interfaces is gaining momentum within the industry. Achieving interoperability allows for seamless swapping across different vehicle models, enhancing user convenience and driving further adoption of battery swapping technology.

This whitepaper delves into the growing significance of battery swapping as a pivotal technology in the Indian EV ecosystem.

[1] **NRI**, BATTERY SWAPPING: India's Opportunity for Global Dominance, September 2022

Feasibility of Battery Swapping

Personal Vs. Commercial Usage

Battery swapping technology has gained traction as a potential solution for the challenges associated with electric vehicle charging, such as long wait times and range anxiety. However, the feasibility of implementing battery swapping systems varies significantly between commercial vehicles and personal passenger vehicles.

Commercial fleets, which often operate under predictable schedules and high utilization rates, are more suited to battery swapping. In contrast, the personal vehicle segment faces unique challenges that hinder the widespread adoption of battery swapping.

This table outlines the key factors that highlight why battery swapping is not as feasible for personal vehicles compared to commercial ones.

Factor	Personal Vehicles	Commercial Vehicles
Utilization Rate	• Low to moderate daily usage, Inconsistent charging needs	• High daily usage, Constant energy demands
Battery Standardization	• Diverse models with various battery sizes and specifications • Lack of standardized batteries	• Fleets often have similar or identical vehicles • Easier to standardize battery types across fleets
Infrastructure Investment	• High costs, difficult to justify by personal use frequency • Requires numerous swapping stations for distributed use	• Centralized infrastructure can serve fleet vehicles at designated hubs • Cost more easily distributed across fleet operations
Swapping Frequency	• Less frequent need, personal charging is flexible	• High swapping frequency for continuous operation
Charging Flexibility	• Private vehicle owners can charge at home or office with slow/fast charging options • Home charger is more convenient	• Fleets often need rapid turnaround times, so swapping is faster than charging for commercial operations
Operational Efficiency	• Downtime not critical for personal owners	• Minimizes downtime, critical for fleet operations

Source: Industry articles, JMK Research

Segment wise feasibility

As the electric vehicle market evolves, battery swapping has emerged as a promising solution for addressing challenges related to charging time, infrastructure constraints, and operational efficiency. However, the feasibility of battery swapping varies across different vehicle segments. Factors like infrastructure availability, investment costs, and economies of scale are crucial in determining the viability of this solution for each segment.

Aspect	Electric Two-Wheeler	Electric Three-Wheeler	Electric Car	Electric Bus
Battery Size and Standardization	Compact, easy to swap manually; Easily standardized	Medium-sized, Moderately standardized	Larger, more complicated to swap; Low standardization; variety of models	Very large, complex infrastructure needed; Very low standardization
Infrastructure Requirements	High: Simple infrastructure, small swap stations can be easily installed	Moderate: Requires more space and equipment compared to E2W, but manageable	Low: Requires larger, complex swap stations, which are not commonly available yet	Moderate: Requires large, specialized swap stations, mostly limited to select urban centers
Cost & Investment	Low: Minimal investment in basic swapping stations. Battery rental models reduce upfront costs for users	Moderate: Higher costs for infrastructure and battery management systems, but cost-effective for commercial operators	High: High infrastructure costs for swapping stations and advanced battery management systems	Very High: Heavy investment required in both the infrastructure and advanced equipment to swap large batteries efficiently
Feasibility Status	High	Moderate to High	Low	Low

Source: Industry Articles, JMK Research

Business Models in Battery Swapping

The battery swapping market in India is a nascent yet rapidly evolving industry. Key players in the industry primarily operate under two prominent business models: Battery as a Service (BaaS) and Mobility as a Service (MaaS).

Parameters	Battery as a Service (BaaS)	Mobility as a Service (MaaS)
Definition	BaaS offers users' access to a battery on a subscription or pay-per-use/charge basis. Customers pay for the energy used by them	MaaS provides both the vehicle and battery, along with additional services such as insurance and maintenance, all bundled under a subscription model
Segments	Common in **B2C (business-to-consumer)**	Common in **B2B (business-to-business)**
Pros	• Customers end up paying as per the us_ age. Users can switch to different battery types or capacities based on their needs, offering flexibility in vehicle range and performance • Lower CAPEX for the Battery Swapping Operator (BSO) compared toMaaS as vehicle ownership is on the user	• MaaS offers businesses like Zomato several advantages, particularly when the entire vehicle ecosystem is managed by a Battery Swapping Operator (BSO) • MaaS eliminates the need for businesses to invest in fleet ownership, maintenance, and management
Cons	• Might be uneconomical for users that resort to charging of batteries at home • Smaller B2B base	• As MaaS players take ownership of vehicles, their capital expenditure (CAPEX) and inventories increase • Requires high vehicle utilization to ensure Return On Investment (ROI)
Players	SUN MOBILITY, VOLTUP SMART SWAPPING, yuma Power your move, Battery Smart, RACE energy, chargeup	SUN MOBILITY, gogoro

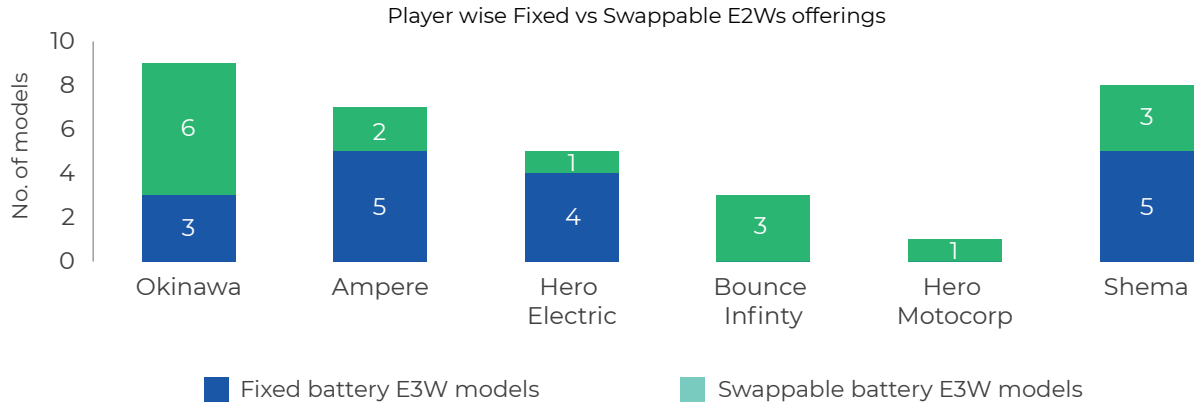
Source: Industry Articles, JMK Research

Key Trends in Battery Swapping Market in India

As the battery swapping market in India continues to develop, several key drivers and trends are emerging that are shaping its growth and influencing the strategies of industry players:

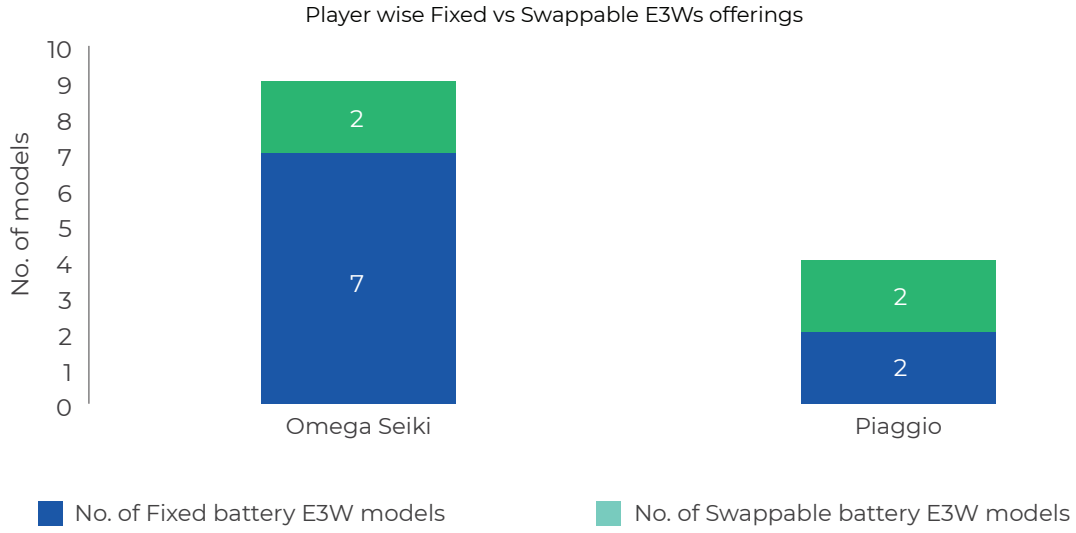
1. Operational Efficiency driving Commercial players to Adopt Battery Swapping in E2W and E3W segment

While personal-use E2Ws primarily charge at home, there is a growing trend among manufacturers to introduce new models designed for battery swapping. For commercial E2W applications, fleet owners and businesses involved in last-mile delivery services prefer swapping because it reduces vehicle downtime caused by fixed charging. This approach optimizes operational efficiency and enhances profitability by allowing businesses to keep their vehicles on the road for longer periods without interruptions.



Source : Company Websites, JMK Research

The E3W passenger segment primarily relies on fixed charging methods. However, the E3W cargo market is gradually shifting towards swappable battery options, as this significantly reduces downtime for fleets and businesses. Among the top players in the E3W segment, only Piaggio and Omega Seiki offer products with swappable batteries.



Source: Company Website, JMK Research

2. Strategic Focus on Tier 1 Cities

Major battery swapping companies have initially concentrated their efforts on establishing swapping stations in Tier 1 cities like Mumbai, Delhi, Chennai, Bangalore, and Pune. This strategic focus is driven by the dense population, significant EV adoption rates, and a strong demand from last-mile delivery services. The concentration of fleet businesses in these cities further enhances the appeal of battery swapping as a solution.

3. B2B Focus and Fleet Partnerships

There is a concerted effort among companies to invest in expanding the battery swapping station network, making it more accessible for both personal and commercial vehicle users. This growth in infrastructure alleviates range anxiety and supports broader EV adoption, encouraging more users to consider battery swapping as a viable option.

4. Retrofitting ICE Vehicles to Electric Swappable models

Companies like RACE Energy and SUN Mobility are boosting demand for battery swapping by retrofitting internal combustion engine (ICE) two- and three-wheelers into electric vehicles. This allows fleet operators to convert their existing vehicles to EVs without purchasing new ones, reducing upfront costs while improving efficiency. SUN Mobility, for example, has partnered with BluWheelz to offer retrofit kits that convert Tata ACE vehicles from ICE to EV, making the shift to electric swappable models more accessible and cost-effective.

Policy Measures for Battery Swapping

Most incentives under the FAME scheme have primarily focused on fixed charging solutions, with no support allocated for battery swapping at the national level. On the other hand, several state policies have emerged that provide fiscal support specifically for battery swapping initiatives. Below are the key national and state-level policies pertaining to battery swapping:

1. National Level

The Indian government released a **Draft Battery Swapping Policy in June, 2022**. Following are the key highlights of the draft policy:

- This policy is targeted at supporting the adoption of battery-swapping, primarily for Electric scooters, Motorcycles and E-Rickshaw/E- Cart.
- The Draft Battery Swapping Policy 2022 aims to advance the adoption of battery swapping technology for electric vehicles by offering substantial support for the development of Battery Swapping Stations (BSS) and promoting the Battery-as-a-Service (BaaS) model, which can reduce upfront vehicle costs for consumers.
- It includes incentives for establishing BSS infrastructure at strategic locations and financial support for both BSS setup and the broader battery swapping ecosystem.
- Additional support is directed towards public transport and commercial fleets to adopt battery swapping solutions, with funding for R&D in advanced battery technologies and the establishment of pilot projects to test the technology's viability.
- Furthermore, a regulatory framework for battery swapping operators will be developed, covering licensing, operational guidelines, and compliance requirements.

The Ministry of Power recently issued **"Guidelines for Installation and Operation of Battery Swapping and Charging Stations,"** outlining key frameworks to promote battery swapping technology as an alternative for powering EVs. These guidelines define essential components such as Battery Charging Stations (BCS) and Battery Swapping Stations (BSS), specifying their relevance for battery providers, station operators, and fleet users.

The guidelines also incorporate several clauses from the **"Guidelines for Installation and Operation of Electric Vehicle Charging Infrastructure-2024"**. This includes:

- Allowing BSS and BCS to utilize existing electricity connections with or without requesting an increase in connected load for charging swappable batteries. Additionally, the guidelines endorse the deployment of liquid-cooled swappable batteries for larger vehicles like buses and trucks.
- Safety standards, provisions for quick battery replacement, and tariff-related measures are also addressed to ensure compliance with existing electrical regulations and support the broader development of EV infrastructure in India.

2. State Level

State Name	Incentives for Battery Swapping
Andhra Pradesh (June 2018)	• Capital subsidy of 25% on first 50 battery swapping stations on fixed cost (excluding battery inventory cost) up to INR 10 lakhs • Promotes the sale of power from Vehicle to the grid for battery swapping stations • External Infrastructure subsidy of 50% of the cost of infrastructure up to INR 2 crores for external infrastructure, include battery swapping stations • 100% reimbursement to be provided on SGST accrued to the state for firms involved in battery swapping until 2024 • Land allocation would be facilitated for setting up battery swapping stations
Delhi (August 2020)	• Land will be provided for battery swapping at a bare minimum rental lease • Swapping stations will be set up by inviting energy operators • Facilities such as power banking and open access will be provided for Battery Swapping stations which have been integrated with Renewable Energy
Karnataka (September 2017)	• (a) Battery swapping stations (2W/3W)- 25% capital subsidy for first 100 stations up to INR 3 lakh (b) Battery swapping stations (cars) - 25% capital subsidy for first 50 stations up to INR 5 lakh (c) Battery swapping (buses) - first 50 stations – up to INR 10 lakh
Kerala (March 2019)	• 25% capital subsidy of fixed capital investment for up to INR 10 lakhs for the first 50 Battery swapping stations
Madhya Pradesh (November 2019)	• 25% capital subsidy of fixed capital investment for up to INR 10 lakhs for the first 50 Battery Swapping stations

Source: Policy Documents, JMK Research

Key Players

The battery swapping industry in India is rapidly evolving, with key players leading the charge. Prominent companies such as SUN Mobility, Gogoro, Battery Smart, RACE Energy, Charge Up, and Bounce Infinity, among others, each operate with distinct business models. These companies cater to various sectors and customer segments, ranging from electric two-wheelers and three-wheelers to commercial vehicles, reflecting the diverse needs of the market.

Company	No. of Battery Swapping Stations	Business Model	Vehicle segments catered to	Investment Raised (USD Millions)	Clients/ Partnerships
Battery Smart	1,400+	BaaS	E2Ws / E3Ws	183.6	zomato, Eveez, Zypp Electric, Hero Electric The smart move, Quantum eScooters
SUN Mobility	650	BaaS / MaaS	E2Ws / E3Ws/ LCVs	233.3	Piaggio, Bluwheelz, IndianOil, amazon, Bounce Infinity Zedex, zomato, Terra Motors
ChargeUp	360	BaaS	E2Ws / E3Ws	9.7	zomato, Hyderabad Metro Rail, LOHUM, HP
VoltUp	150	BaaS	E2Ws / E3Ws		BSNL, HP, Bharat Petroleum energising lives
Yuma Energy	125	BaaS	E2Ws		yulu, MAGNA
Bounce Infinity	64	BaaS	E2Ws	234.2	SUN MOBILITY, Bharat Petroleum energising lives
Gogoro	Global player based out of Taiwan. Aims to establish 1000 stations by 2024	BaaS / MaaS	E2Ws	480	Hero, HP, Zypp Electric, Uber Eats
RACE Energy	30	BaaS	E2Ws / E3Ws	7.1	Hyderabad Metro Rail, LOHUM, HP, Hala Rentals
Esmito	NA	BaaS	E2Ws / E3Ws	2.65	NEXZU, Jio, bp, EVTRIC, BOUNCE

Source: Company Websites, Industry Articles, JMK Research

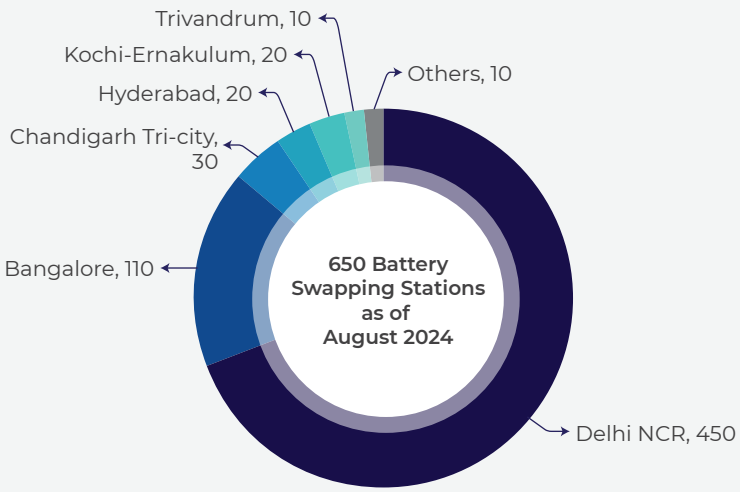
CASE STUDY

SUN Mobility

SUN Mobility, based in Bangalore, India, is a prominent player in the battery swapping industry. With a footprint spanning **20 cities** across the nation, the company serves customers in the E2W, E3W for both goods and passenger transport, and light commercial vehicle (LCV) segments. SUN Mobility provides batteries primarily in two capacities—**1.55 kWh** and **2.1 kWh**—and supports its operations with over **650** swap stations located throughout India.

SUN Mobility's plan is to expand its network to 10,000 stations and support over 1 million electric vehicles by 2028.

SUN Mobility swap station distribution across India



Source: SUN Mobility, JMK Research

SUN Mobility has strategically chosen the Delhi NCR region as a focal point for its initial growth, capitalizing on strong support from the Delhi state government. The company employs a cluster-wise expansion strategy, pinpointing high-demand areas to establish swap stations in optimal locations.

The company has primarily 2 business models:

1. **Battery as a Service (BaaS)** - SUN Mobility charge customers only for the energy they consume, rather than the entire battery pack. The current cost stands at **INR 40.7 per kWh**, inclusive of 18% GST. Added advantage of SUN Mobility's swap stations is the interoperability of batteries across all vehicle form factors, ensuring that customers have access to flexible options regardless of their electric vehicle type. Through a network of OEM partners such as **Piaggio Vehicles, Hero Electric, Omega Seiki Mobility, Shema Electric and Solar (SES), Warivo Electric, Bounce Infinity, Fujiyama, etc.,** the company has integrated their battery swapping technology solutions with their vehicle platforms across various vehicle models.

2. **Mobility as a Service (MaaS)**- SUN Mobility provides a comprehensive Mobility-as-a-Service (MaaS) solution to partners like **Zypp Electric, Bounce Infinity, and Amazon.** Their MaaS model includes electric vehicles, energy infrastructure, maintenance, financing, insurance, and data integration, all on a pay-per-use basis. It allows fleet operators to choose from various two- and three-wheeler models, leveraging a shared energy infrastructure for fleet electrification.

*Existing fixed battery vehicles and ICE vehicles can also be retrofitted with SUN Mobility's battery swapping retrofit kits, thereby giving users access to the battery swapping network.

Other Key Take Aways:

- The battery swapping model has proven to be particularly beneficial for fleet operators, especially those using E2Ws for commercial purposes and E3Ws for loading operations. Fleet operators can minimize downtime, enhancing the efficiency of their operations, making this model attractive to over **50** fleet operators who have already partnered with SUN Mobility.
- SUN Mobility has partnered with both **Piaggio and Omega Seiki** which have E3W offerings in swappable category. This makes SUN Mobility capture more than 80% swapping market in the E3W segment.
- Average Waiting Time - For every five customers reaching at Swap Station, three are able to receive a battery instantly, while the remaining two face an average waiting time of about five minutes.

KEY CHALLENGES

Battery swapping is gaining momentum in the country. However, several key challenges must be overcome to establish effective and scalable swapping stations:

High Initial Investment:

Setting up a battery swapping station for electric two-wheelers (E2W) or three-wheelers (E3W) requires a substantial initial outlay. This high upfront cost covers expenses related to batteries, chargers, and other necessary infrastructure. The large capital investment required poses financial challenges for businesses and stakeholders aiming to invest in and expand battery swapping networks.

Lack of Policy Support

The development and implementation of battery swapping infrastructure are significantly hampered by the absence of comprehensive and supportive policies. Without clear regulatory frameworks and incentives from governments, the progress of battery swapping systems faces considerable obstacles. Policymakers need to establish supportive frameworks, including standardized practices, financial incentives, and safety regulations.

Compatibility, Standardization and Interoperability

A major challenge for battery swapping systems is achieving compatibility, standardization, and interoperability across diverse electric vehicle (EV) models. Currently, the lack of uniformity in battery design—varying in size, shape, and connection interfaces—complicates the development of a universal swapping system. For battery swapping to be effective, industry-wide standardization is crucial, yet achieving consensus among manufacturers on standardized battery formats and swapping mechanisms is challenging. Moreover, ensuring interoperability between different brands and models requires seamless integration of both physical and software systems. Without these standards and compatible technologies, the effectiveness and adoption of battery swapping infrastructure could be severely limited.

Battery Ownership and Management

In a battery swapping model, determining who owns the batteries—the vehicle owner or the swapping service provider—can complicate financial and operational arrangements. If the swapping provider owns the batteries, they must manage inventory, ensure the quality and safety of each battery, and handle repairs and replacements, which adds logistical and financial burdens. Conversely, if vehicle owners retain ownership, they face potential issues with battery maintenance and lifecycle management, including ensuring compatibility with the swapping infrastructure. Balancing these ownership and management responsibilities in a way that supports both efficient service operations and customer satisfaction is a critical and challenging aspect of implementing battery swapping systems.

Logistics and efficiency

Pose significant challenges for battery swapping systems, as they require a well-coordinated infrastructure to operate smoothly. Establishing and maintaining swapping stations involves considerable logistical planning to ensure that batteries are readily available, charged, and efficiently managed. The need for a continuous supply of fully charged batteries, coupled with the rapid turnover of used batteries, necessitates a robust and well-organized distribution network. Additionally, the efficiency of the swapping process itself must be optimized to minimize downtime for vehicle users, which requires sophisticated technology to handle battery swapping quickly and accurately.

CONCLUSION

Battery swapping in India is poised for significant growth, particularly in the B2B segment, with potential expansion into the B2C category as OEMs introduce more compatible models. Currently dominated by electric two-wheelers (E2Ws) and three-wheelers (E3Ws), the market is expected to extend into heavier vehicle segments as technology advances.

Battery Swapping Operators primarily operate under Battery-as-a-Service (BaaS) and Mobility-as-a-Service (MaaS) models, providing accessible solutions for businesses. Initially focused on Tier 1 cities, there are clear plans for expansion into Tier 2 and Tier 3 cities as EV adoption increases.

While few companies, such as SUN Mobility and Battery Smart, hold substantial market shares, the entrance of new startups will foster competition and innovation.

Future success of this market will depend on collaboration between government and industry stakeholders, with partnerships with fuel stations potentially enhancing infrastructure.

Ultimately, in the B2C segment, consumer preferences regarding battery ownership will influence the choice between battery swapping and traditional charging, while in the B2B sector, particularly for last-mile delivery, battery swapping is likely to gain traction due to its profitability. These factors signal a promising future for battery swapping in India's evolving EV ecosystem.

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EV ONLINE DASHBOARD

Registrations 01
Overall EV count registered and bifurcation as well as further analysis of different types of EVs - E2W, E3W, E-Car, E-Buses. Yearly as well as monthly capture available

Models 02
Existing and recently introduced models of all vehicle types with information on range, charging time, ex-showroom prices, top speed, battery type etc.

E2W Player Profiles 03
Company description, month-wise registrations, models, dealership network, investments/JVs/partnerships

Investments & JVs/Partnerships 04
Related information captured basis vehicle type, deal type, and company type

Tenders 05
~50 tenders with status of all announced (2019 onwards) and awarded tenders and Expression of Interest

Policies 06
All State-announced/notified/drafted EV policies in consolidated form as well as for different vehicle segments, charging infrastructure, and manufacturing. This includes targets to be achieved and incentives offered as part of state policies and FAME-I, FAME-II

Value-chain 07
Batteries' and charging infrastructure-related all relevant information captured here

Market Share/ Projections 08
Market share data available for Segments/OEMs/Li-Ion Batteries (LIB)/Charge Point Operators (CPOs). Likewise, projections available and continuously updated for segment-wise market shares and LIB/LIB end-use shares.

	DELIVERABLES	PARTNERS				DETAILS
		Platinum	Gold	Silver	Associate	
DATABASE PORTAL	EV Portal Annual Subscription	✓	✓	✓	✓	Access to unlimited subscribers for our EV online Dashboard
	EV Daily/ Weekly/ Monthly Newsletters	✓	✓	✓	✓	–
	Monthly Excel Tracker	✓	✓	✓	✓	Every month 3 Excel Trackers will be shared 1. Sales (OEM wise, State wise, city wise) 2. Product Models launched 3. Investments & Deals tracker
REPORTS	Access to Paid Reports	All Reports	Any 4 Reports	Any 2 Report	–	7 paid reports will be published in a year • E2W Market Annual Update • E3W Market Annual Update • E-Bus Market in India • E-Cars Market in India • Charging Infra Market Trends • LiB Manufacturing Landscape • LiB Recycling Market
EVENTS	Delegate passes for Physical Conferences	5 Passes	3 Passes	2 Passes	1 Pass	–

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