

BATTERY SWAPPING: India's Opportunity for Global Dominance



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BATTERY SWAPPING: India's Opportunity for Global Dominance

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Foreword

**Mr. Anurag Jain,
Secretary,
DPIIT
& Chairman,
Invest India**



Decarbonisation of the transport sector is critical to net zero ambitions worldwide. As the 4th largest automotive market in the world, India has the opportunity to lead this global transition from traditional ICE powertrains to a more efficient and decarbonised Electric Vehicle (EV) technology. In line with India's commitments, a shift to green vehicles is well on track as reflected in growth of EV sales. H1 of calendar year 2022 has seen EV sales YoY growth of 333%. Penetration of 2 Wheelers EV in key markets like Delhi is already upwards of 10% in the year 2021-2022, up from 1.6% in 2019-2020. Electric 3 Wheelers are consistently selling more than their conventional powertrain counterparts on a pan India basis.

The first National Electric Mobility mission was launched in 2012. Efforts of government to promote the manufacturing & adoption got a push with the FAME scheme, one of its kind globally, with an outlay of INR 10,000 Cr (\$1.35 Bn). The scheme has supported extensively in the growth of the industry by providing direct subsidy to the customer and ensuring minimum quality standards of the vehicles being sold.

The Government of India is ensuring that EV policies embrace all forms of technology, taking cognizance of the fact that each use case has its own set of requirements. The recent draft battery swapping policy published by Niti Aayog is a step in the same direction. It allows the customer experience to be more time and cost efficient while taking up less space leading to enhanced throughput. This new policy along with numerous other production linked incentives to promote the "Make in India" philosophy will ensure India's dominance in this global transition to clean mobility.

Preface – Invest India

Mr. Deepak Bagla
MD and CEO,
Invest India



India has been charting a path towards self reliance for long, but it has gotten a renewed focus since 2020 through a historic initiative known as 'Atmanirbhar Bharat'. As part of the Hon'ble Prime Minister's vision of Atmanirbhar Bharat, the government has launched a series of reforms and incentives that highlight the India opportunity to the global investor community and make the Indian market easily accessible to foreign investors. 'Atmanirbhar Bharat' has already showcased the success of the Indian market and its attraction to foreign investors. India attracted the highest ever total FDI inflow of USD 84.83 Bn during the financial year FY22 despite the pandemic and a global decline in FDI.

Invest India, the world's most awarded investment promotion agency, is helping propel major initiatives to position India as the world's fastest growing major economy. Invest India's facilitation efforts reflect the country's growth priorities. As we work across over 40 umbrella sectors, we have witnessed a remarkable rise in global interest in India.

The Automotive industry is one of the most acknowledged manufacturing successes

which India has seen. The Indian auto sector has cumulatively received ~ USD 25 Bn in FDI over the last two decades contributing to over 5% of India's total FDI. On the PE & VC front, Indian electric vehicle industry has seen an 8X YOY jump from \$181 Mn funding in 2020 to \$1.7 Bn funding in 2021. As a consequence of the two PLI Schemes (Auto & ACC), we are expecting the electric vehicle industry to invest over \$ 12 Bn in the next five years. In fact, our Auto & EV team is playing an active role in the grounding of investments worth over \$4.5 Bn. India has immense potential to lead the world of battery swapping by bringing in 'Made in India' sustainable & scalable innovative solutions. In line with the budget speech of Hon'ble Finance Minister- Niti Aayog is coming up with the Battery Swapping policy soon.

We look forward to working with you in your India journey.

Scan to know more about Invest India:



Preface – NRI India

Mr. Vineet Jain
Partner,
Automotive Industry
Consulting Group,
NRI Consulting & Solutions India Pvt Ltd



Recent innovations in BESS (Battery Energy Storage System) technology has been a fillip to newer business models in the EV industry. ‘Battery as a Service’ is one such new business in the Indian EV industry. In the recent Union budget, Finance Minister Nirmala Sitharaman expressed the government’s aim to establish a policy for battery swapping and specify interoperability standards. Subsequent to the announcement, NITI Aayog has published a draft battery swapping policy.

We expect the BaaS business model to attract remarkable participation by the industry players. Battery as a Service is yet to take off even in the most advanced economies. Indian society is a potpourri of numerous lifestyles and hence it provides an avenue for multiple business models to try their luck. BaaS service works under the principle of mutual collaboration across different stakeholders and often with the users themselves. Success of new business models such as BaaS require cooperation from the Central and State administrative bodies, ensuring the presence of well-defined policy and guidelines and handholding by the government at various levels of the value chain.

India has an opportunity to lead the world in adoption of battery swapping technology and it is upon all the stakeholders to seize upon this opportunity.

At NRI Consulting & Solutions, we have been supporting our clients in the automotive, infrastructure, energy and finance domains to come together and co-create sustainable yet profitable solutions. We have supported global as well as domestic ecosystem players in taking on the disruptive trends in mobility. In this report we have tried to crystallize our learnings from various projects spanning strategy, planning and implementation in the form of POCs and rollouts. India is serving both as a test bed and a global base for rolling out solutions. We invite interested players to come to India and explore the new market opportunities emerging out of innovative models like BaaS and create global solutions for the future.

Executive Summary

India, recently surpassed Germany to become the **4th largest automotive market globally**. As one of the fastest growing large economies in the world, it presents itself a unique **opportunity to become a world leader in battery swapping**. The government's recent push towards battery swapping as a complement to fixed charging through the draft battery swapping policy indicates the same.

EV industry is an extremely dynamic industry and the Govt of India doesn't want to stifle innovation by prioritizing any one technology over another. The government's viewpoint is to stay technology agnostic when it comes to any part of the EV value chain be it the vehicle powertrain, or battery chemistrieor EV infra (fixed charging & swapping).

Through this report, we intend to **explore the need for battery swapping, various nuances involved in setting up a swapping network in India along with the pertaining regulatory requirements**. This report evaluates how India has the potential to dominate the battery swapping market globally. Capitalizing on its global position as the 2nd largest two-wheeler manufacturer and the largest when it comes to three wheelers, high density of e-commerce companies and last mile delivery services, price sensitive nature of Indian consumers, Central and State Government's push towards EV adoption acts a catalyst towards building a sound EV infra ecosystem in the country.

Public and private stakeholders across the value chain are enthusiastic about the opportunities and are **exploring a variety of business models for battery swapping**. The operational ecosystem for battery swapping typically involves local DISCOMs, land agencies, Vehicle OEMs, battery manufacturer, fleet operators, etc. in addition to the battery swapping operator.

The battery swapping ecosystem is nascent and there are **immense opportunities for introducing solutions to tackle the existing challenges**. An attempt in this regard has been made through NITI Aayog's Draft Battery Swapping Policy which proposes on reducing tax rate differential of batteries & EVSE, backs fiscal incentives, prioritizes metro cities for swapping network and also advocates for interoperability. Setting up a battery swapping business in India requires interaction with different central government and state government bodies. **Some of the key compliances have been covered in the report.**

Basis our interaction with various stakeholders across the ecosystem and study of multiple battery swapping models, we have listed some key factors that contribute to the success of a battery swapping business; these primarily include:

- Compatibility across vehicles segments and stations
- Dense network of swapping stations
- Efficient battery utilization for higher throughput
- Ensuring battery health management for higher ROI per battery unit
- R&D focused approach
- Seamless customer experience to ensure higher retention rate

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Key success factors & future of battery swapping

Glossary

Technical Terms

OEM	Original Equipment Manufacturers of end-products like chargers, batteries, vehicles, etc.
EV	Electric vehicle including both fixed and swappable battery vehicles
Battery Swapping Station (BSS)	Where EV can get its discharged/ partially charged battery replaced by a charged battery
Battery Swapping Operator (BSO)	Agency that operates a battery swapping station, which may not necessarily be the OEM
Public BSS	Where any EV, privately or commercially owned, can get its discharged/ partially charged battery replaced by a charged swappable battery
Captive BSS	Exclusively for EVs owned/ under control of the BSS owner, and is not accessible to other EVs with swappable and compatible batteries
Battery Charging	Where discharged/ partially discharged electric batteries for EVs are re-charged battery (can be co-located at site same as BSS)
Public BCS	Where only swappable batteries dispensed at 1 or more public BSS are re-charged
Captive BCS	Exclusively for the swappable batteries of EVs owned/ under control of the BCS owner, and is not made available for charging other batteries
ACC	Advanced Cell Chemistry which includes new generation cells that store electrochemical/chemical energy
Interoperability	Compatibility of EV batteries with different EV models and with the Electric Vehicle Supply Equipment (EVSE) provided in different BCS

Business Terms

CAPEX	Capital Expenditure (Land, equipment, vehicle cost, etc)
OPEX	Operational Expenditure which is incurred during business operations
B2B	Business to Business transaction
B2C	Business to Consumer Transaction
MaaS	Mobility as a Service
BaaS	Battery as a Service
DODO	Dealer Owned Dealer Operated

DOCO	Dealer Owned Company Operated
COCO	Company Owned Company Operated
Franchise Model	A mode of business expansion wherein an independent business owner is allowed to own and operate a BSS
Outsourcing	Hiring of a 3rd party to perform certain tasks
USP	Unique Selling Proposition which enables a brand to differentiate from other brands
PSU	Public sector undertakings are bodies in which the Government of India has a Financial or Controlling Interest is established by the government
O&M	Operation and Maintenance (of a product)
Pilot	An initial small-scale implementation of a larger project
Proof-of-concept (PoC)	Evidence demonstrating the feasibility of a project through a pilot implementation

Others

FAME	Faster Adoption and Manufacturing of Electric Vehicles
MNRE	Ministry of New and Renewable Energy
Dealer	Property dealer or land owner in the context of this report
Infra	Infrastructure, which includes civil and electrical infrastructure
OMC	Oil Marketing Company (such as HPCL, BPCL, IOCL)
PESO	Petroleum and Explosive Safety Organization
DISCOM	Distribution Company (such as BESCO, Tata Power, etc) which provides electrical distribution infra.
ARAI	Automotive Research Association of India
AIS	Automotive Industry Standards issued by the Ministry of Road Transport and Highways (MoRTH)
BIS	Bureau of Indian Standards which are technical standards issued by the Ministry of Consumer Affairs (MCA)
NOC	No Objection Certificate which states that the certifying agency does not object to the covenants of the certificate
L, M, N Category	Vehicle categories set by MoRTH including 2W,3W and 4W passenger and goods vehicles

01

State of the Charge: Current status of Battery Swapping



Battery Swapping in India- At a Glance

As the 2nd largest 2W and largest 3W producer globally, India presents one of the largest target market for battery swapping

1 Million+
Number of Swaps

Players such as Bounce, Sun-Mobility and Battery Smart are performing thousands of swaps every day

10+
Number of Companies

Startups, Oil companies, Conglomerate businesses, PSUs, OEMs are all entering the battery swapping space



A total of 19 states have adopted EV policies. The policies promote battery swapping adoption

\$100+ Million
Private Investment

Investments through funding in start-ups as well as partnerships with OEMs

Stakeholder Perspective

Stakeholders whom we interviewed, are extremely bullish on the opportunity battery swapping presents

Tailwinds for Battery Swapping



gogoro

“Rapid urbanization, road infrastructure development and a push for decarbonisation provide tailwinds to clean mobility sector. Lower upfront costs and faster turnaround times provide an edge to battery swapping over fast chargers.”

**– Kaushik Burman,
Managing Director, Gogoro India**

Battery Swapping's edge over fixed



“Battery swapping requires less space giving it an edge over fixed charging. Vehicles do not need to dock to recharge their batteries resulting in more vehicles being serviced per hour. Further, the goal should be a swap station every kilometre so that consumer does not have to go long distances to recharge, similar to the strategy followed for setting up a fuel station. We believe swapping brings convenience and customers will eventually realise that in absolute terms. Convenience cost paid by consumers for swapping vis-a-vis home charging will be insignificant”

**– Sanjeev Gupta,
Executive Director, Corporate Strategy, IOCL**

Retrofitment opportunity



RACEnergy

“We are converting existing ICE 3W to E-3Ws through retrofitment. Retrofitment provides reduced upfront cost and reduced TCO. The market for retrofitment is 10x larger than new-vehicle one. Further, it is faster to retrofit than to manufacture. Drivers are also aware of the solution after diesel to CNG retrofitment.”

**– Arun Sreyas,
Co-founder, RACEnergy**

Government support



“Telangana government has started allocating land next to existing charging stations to swap operators. First 50 locations will be allotted to swap operators by July end. The allotment will be done on a revenue-sharing basis. Operators can apply through single window mechanism and that will take care of all approvals”

**– Sujai Karampuri, CEO, T Works,
Government of Telangana**

Business challenges



“CESL has shifted their role from supplier contracting to selecting charge point operators. We have zeroed in on 1545 locations with land partners. Partners include metro stations, parking lots, oil marketing companies. We invite companies to come up with their battery swapping stations.”

- N Mohan, Head (EV Charging Infra),
Convergence Energy Services Limited

Government initiative



“Although battery swapping is a CAPEX intensive business, just a large amount of cash influx is not enough, having technology to manage a large network is necessary. We appreciate the government’s initiatives on safety regulations, subsidy benefits, and GST parity. However, interoperability may result in reduced incentives for operators to continue innovation in battery design and offer great customer service”

- Pulkit, Khurana,
Co-Founder, Battery Smart

Implementation challenges



“Subsidized electricity for battery swapping is difficult to acquire. Charging vs swapping confusion exists since all regulations refer only to charging. As local shop owners and fuel stations are both partners – documentation for subsidized meters is often difficult to get from the partners.”

- Anil G,
Co-Founder and COO, Bounce

Unique Proposition



“Battery swapping system is a unique proposition which brings down initial buying price of vehicle which will accelerate the growth of Electrification in small mobility 3W and 2W in future. Also no separate charging time required for vehicle as it is only swapping time which is rather quick”

- Jayakumar G,
Group President & MD, Valeo India

Benefits of Battery Swapping

Uniquely suited to Indian conditions as it provides benefits on maintenance, cost, range, time, real estate etc.

End Users

- Lower downtime

Compared to fixed battery system which on an average takes 4-5 hours to fully charge, average time for swapping is less than three minutes.

- No replacement cost of batteries

Battery life of a typical 2/3 wheeler averages between 4 -5 years. Given the fluctuating raw material prices and extreme weather conditions sometimes leading to faster degradation of batteries, not owning the battery presents as a more feasible option to the price sensitive Indian consumers.

- Lower upfront cost

While TCO of an electric 2W is lower, consumers still have to pay a premium compared to its ICE counterpart during the upfront purchase. However, BaaS allows the consumer to save upto 40% by opting only for the vehicle.

- Lower stress on grid

Better distributed load management - Batteries from swap stations can be charged during non-peak hours. Vehicle users of fixed batteries on the other hand normally charge their vehicles late in the evening after their working hours thus, leading to immense stress on the grid.

Charge Point Operators

- Lower space requirement

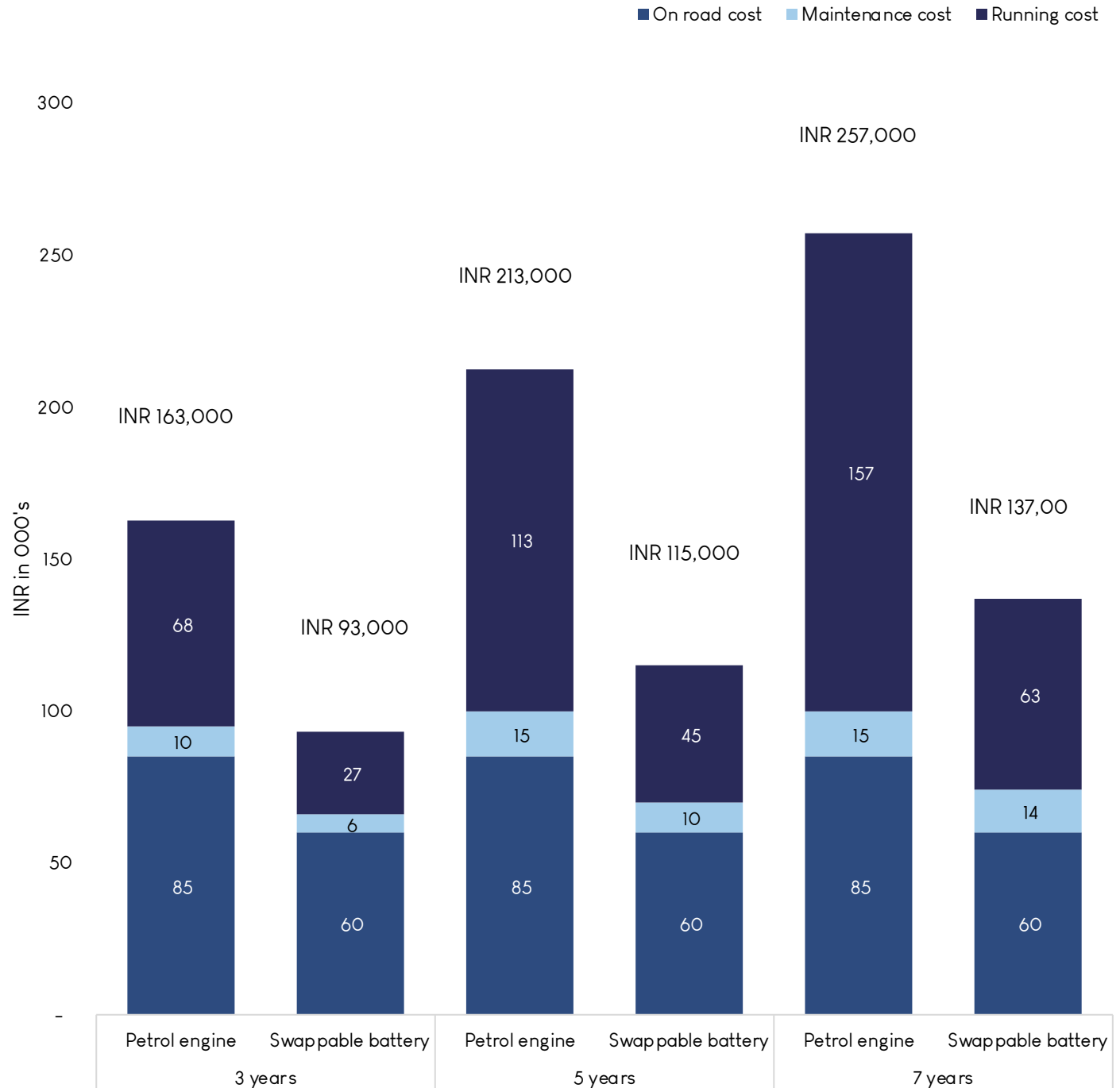
Space required for same number of cars is more for fixed charging since the vehicles need to be parked for the entire duration. A typical swap station is like an ATM machine- covers ~20% real estate area of a typical charging station. Throughput in terms of number of vehicles leaving the station with charged batteries can go upto 5X in a swap station vs a charging station

Vehicle OEM and Dealer Partners

- Additional revenue stream

Swapping service can be bundled with the vehicle and OEMs can generate revenue from number of swaps carried out during the entire life of the vehicle

Total Cost of Ownership (TCO) Analysis



Points for consideration during calculation

Comparison between a 100 CC petrol Scooter v/s equivalent E2W with swappable battery

- Daily running – 30 km
- Fuel cost – INR 100/L
- Running cost of swapping scooter – INR 1/Km
- This calculation does not account for resale value
- Maintenance costs for ICE scooters – INR 3000/year
- Maintenance cost for EV scooters – INR 2000/year

Challenges and Way Forward

The swapping ecosystem is nascent and there are opportunities for introducing solutions to tackle the existing challenges

Challenges

CAPEX investment

Establishing swapping stations requires a high capex investment including maintaining an immense inventory of battery packs

Business profitability

Due to high CAPEX, break even point takes longer to achieve, making it non-profitable in short term

Battery quality and safety risks

It may be challenging for BSOs to maintain consistency in age, quality and range of battery. Lithium batteries have high risk of fire without proper thermal management, and recent automotive battery fires have raised user concern

Way Forward

Mature financing

It is expected that the market will mature gradually to have a variety of financing options available through banks, government grants, private equity and venture capitalists. Financing through sales leaseback models



Interoperability

Mass adoption of swapping is expected to result in high utilization and monetization of battery assets. One of the ways to achieve this is battery interoperability across vehicle OEMs and vehicle segments

Updated safety standards

Until Dec '22, the AIS 156 and AIS 038 Rev 2 standards which cover both electric vehicles and batteries have not been mandated. As a result many manufacturers continue to follow the older AIS 048 standard. Shifting to AIS 156 at the earliest is required

02

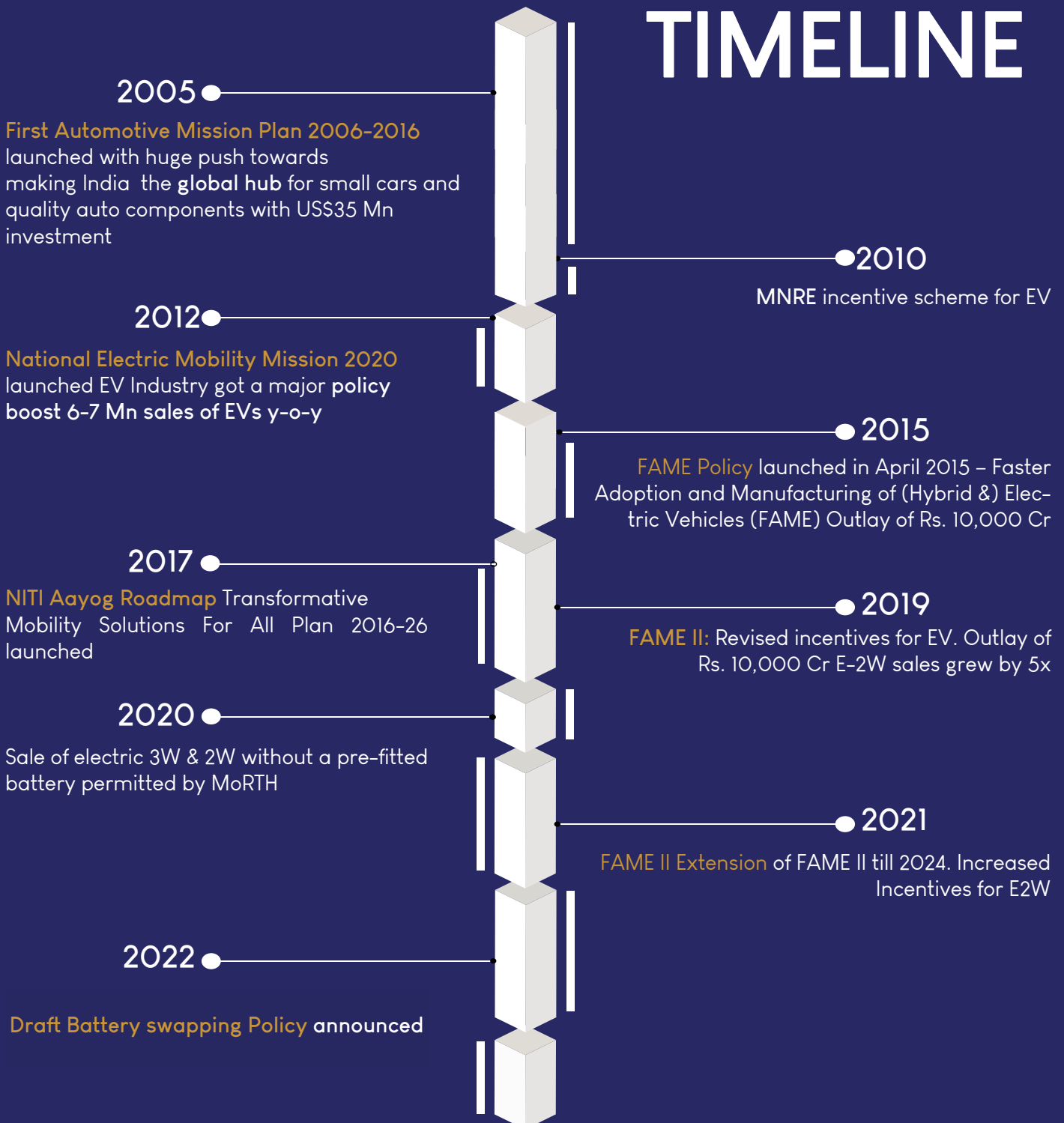
The Policy Push: Government Support in Battery Swapping



Evolution of EV Policy framework

Progressive EV policies have ensured accelerated adoption in the last decade; New battery swapping policy is expected to spur further growth

TIMELINE



NITI Aayog's Battery Swapping Draft Policy: Key Highlights

Policy proposes reducing tax rate differential of batteries & EVSE, backs fiscal incentives, prioritises metro cities for swapping network

Key Highlights

- Reduce difference between tax rates on Li-ion batteries and EV Supply Equipment (EVSE) which are at 18% and 5% respectively (subsequently implemented through GST council order in July '22)
- Offer the **demand-side incentives** under new/existing schemes for EV purchase to EVs with swappable batteries eligible under this policy
- Rollout of BSS in phased manner; **prioritize metropolitan cities** with population 4 Million+ for development of battery swapping network in 1st phase
- Each BSS should serve **at least 2 EV OEMs**. Set up battery swapping stations at locations like retail fuel stations, public parking areas, malls, etc.
- Require state governments to ensure that public battery charging stations are **eligible for power tariffs** at concessional rates
- Single **window clearance** to facilitate documents submission, issue trade licenses, approve allocation of public land & grant electricity connections

Eligibility

Batteries using ACC with performance equivalent/ superior to EV batteries supported under FAME-II scheme & are BMS enabled

Operating Period

Till 31st March, 2025

Perspective on Interoperability

Owing to the merits and demerits of interoperability of EV batteries, the subject faces range of opinions on form, function and integration

Advantages

Consumer centric approach

- It provides **options to customers** to select from multiple BSOs. Customer will not be tied down to a single operator and will have an option to change the BSO if not happy with the service
- This will **promote healthy competition** amongst BSOs and foster innovation
- This also provides **flexibility to the customers** to change city and location without worrying if their existing BSO is present in the new location or not

Increased safety

- Standardisation helps in promoting **minimum safety standards**. Consumers have peace of mind that standards are being followed irrespective of the BSO, location etc.

Ease in future upgradation

- Customers will have an option of choosing a higher capacity / better battery pack based on various options present in the market

Concerns

Increases development lead time

- Engineering **change management becomes tedious** as each change will require additional testing and approvals. **Testing lead time increases** due to the increased change time

Load on regulatory authorities

- This will result in requiring regular certifications to be conducted by the regulatory authorities
- Approvals are expected to be required at regular intervals
- Hence, more time and resources are needed for regulatory authorities such as ARAI

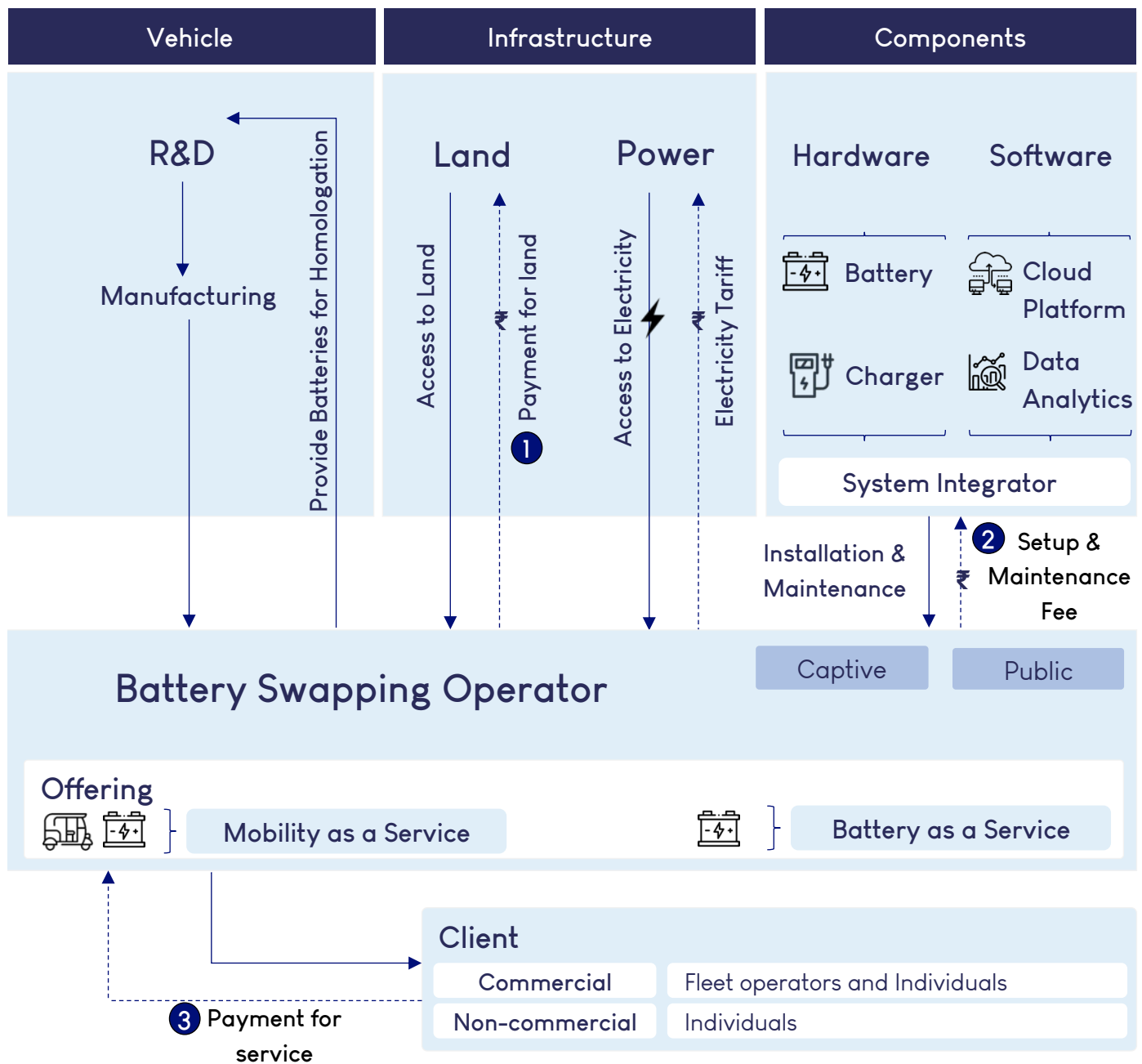
03

Business Models: Strategies for sustainability and scalability



Battery Swapping - Operational Ecosystem & Monetization

Basic overview of a swappable ecosystem

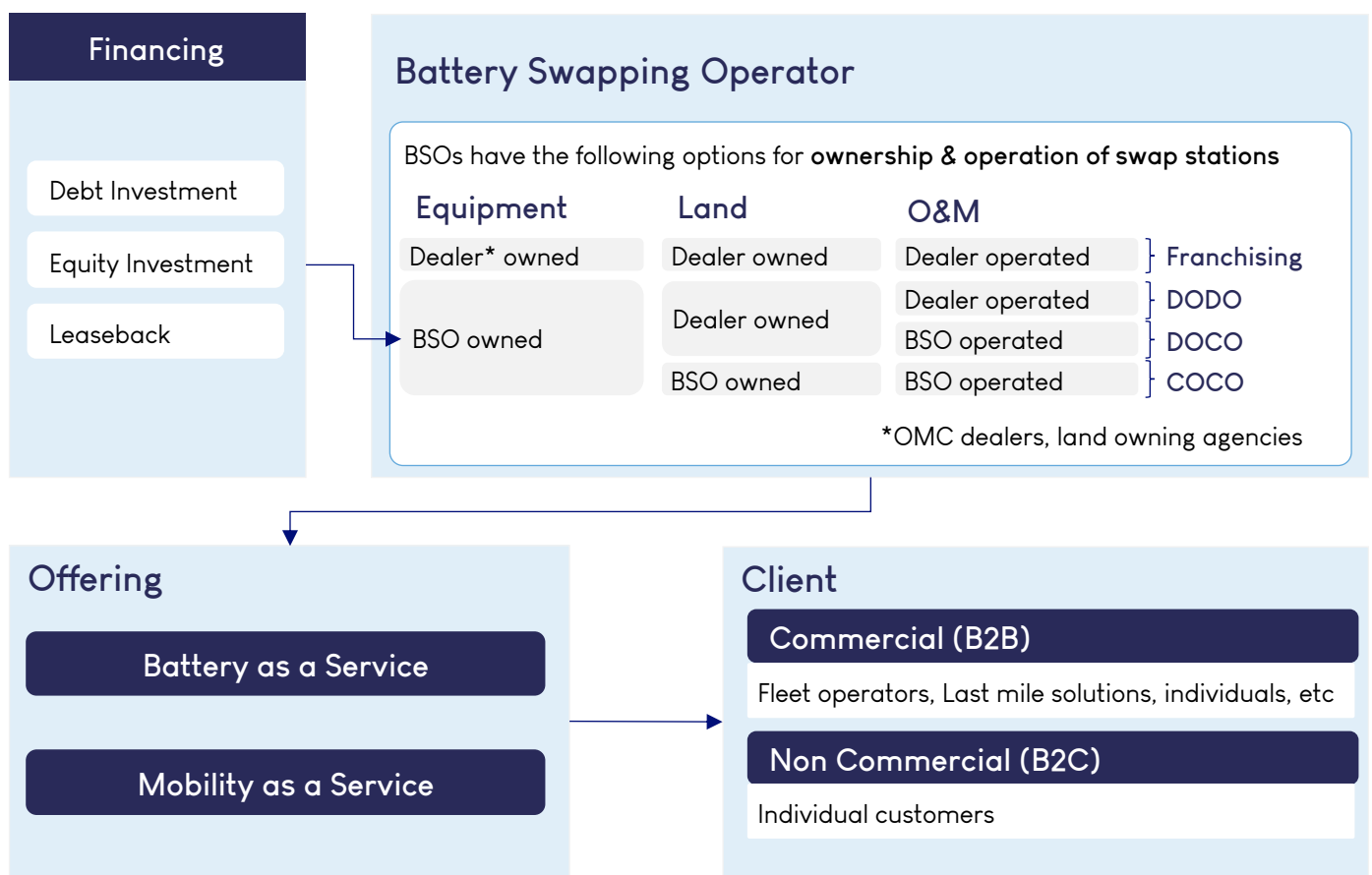
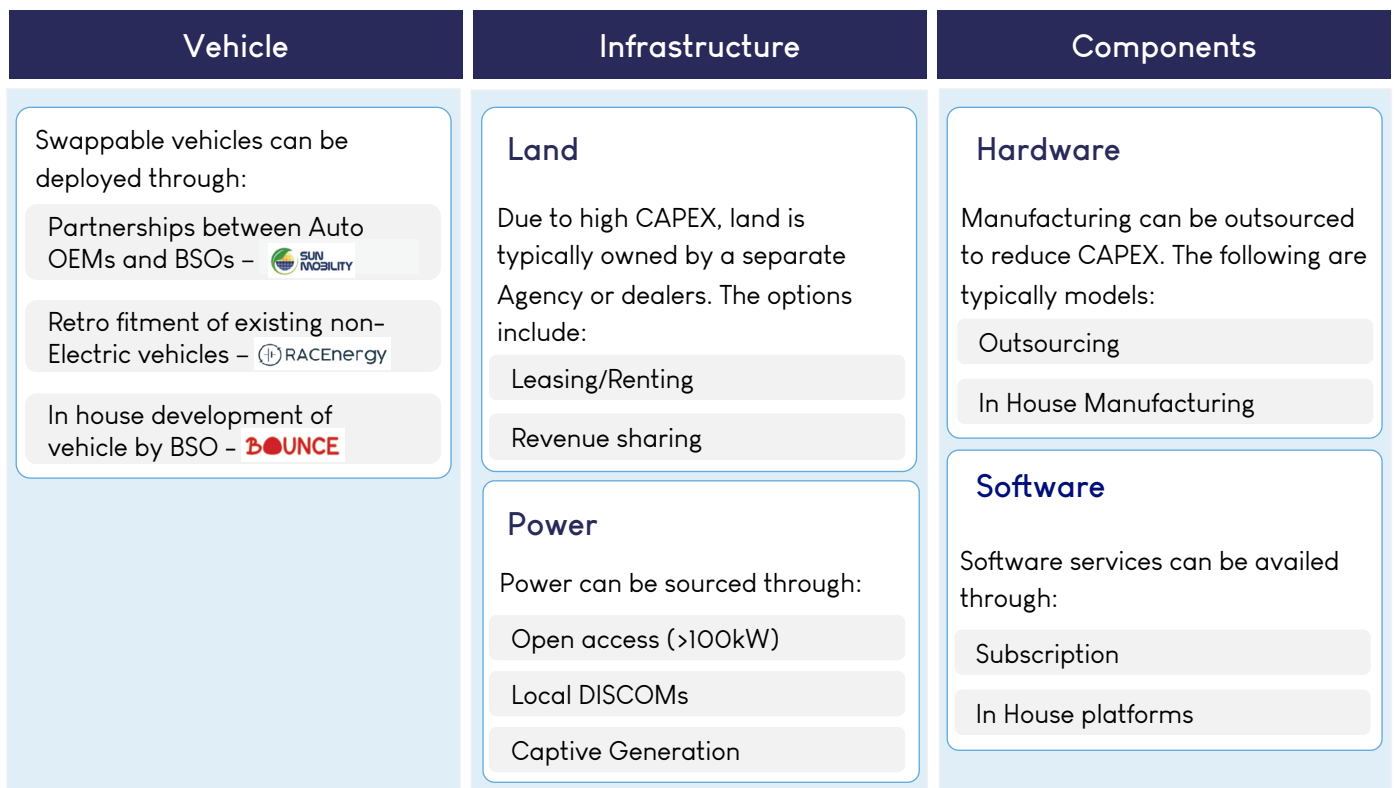


Monetization

- Land owner:** Revenue can be generated through renting, leasing, adopting a revenue sharing model or a franchise model (to ease CAPEX).
- Software provider:** Revenue can be earned through subscription fees or adopting a revenue sharing model.
- BSO:** Charge customers on a per-swap basis or basis energy consumed to take into account current battery health. In MaaS, vehicle is also offered on subscription.

Battery Swapping – Business Model options




Players in the value chain opt for different business model alternatives



 Available Options

Battery Swapping- Classification by ownership and operations

BSOs can reduce CAPEX & OPEX through franchising and dealer operated stations or opt for fully owned and operated stations

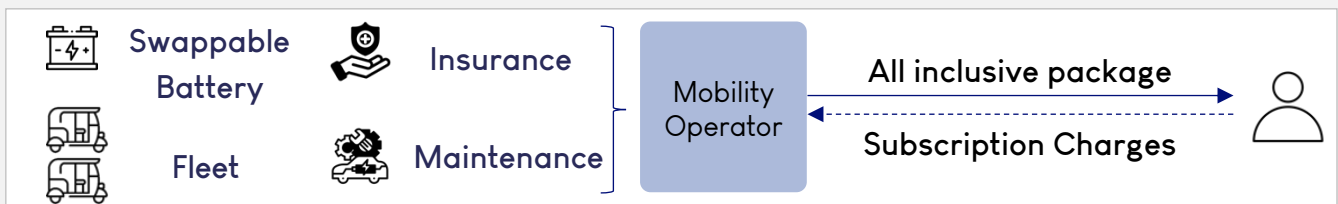
		BSO Ownership				Details
		Land	Charger	O&M	Battery	
Asset Light models	Franchising	✗	✗	✗	✓	<ul style="list-style-type: none">Franchising involves complete 3rd party ownership of the swap station including the chargers, O&M and the landThis model provides lowest CAPEX and OPEX for a BSO <div></div>
	DODO	✗	✓	✗	✓	<ul style="list-style-type: none">In Dealer Owned Dealer Operated stations, while the equipment is still owned by the BSO, the Dealer or the land owning agency provides land and O&M supportThis model would require CAPEX on the charger and batteries for the BSO <div></div>
	DOCO	✗	✓	✓	✓	<ul style="list-style-type: none">In Dealer owned Company Operated stations, the BSO owns the charger and batteries and also takes care of its O&MThis model involves both CAPEX and OPEX for the BSO
	COCO	✓	✓	✓	✓	<ul style="list-style-type: none">This model involves fully owned and operated stations by BSO and hence highest in terms of CAPEX and OPEXSuch models can be followed for flagship stations
Asset Heavy models						

Battery Swapping - Classification by service offering

Battery swapping players in the market broadly provide 2 types of services: BaaS and MaaS which differ in terms of the included products

Mobility as a Service (MaaS)

MaaS offering bundles the battery with the vehicle along with other services like insurance and maintenance to provide the user a holistic solution in subscription model. MaaS enables clients, typically in the B2B segment to reduce assets under control of the business owners.



Pros

- Increases customer base as MaaS opens up players looking for asset light solutions

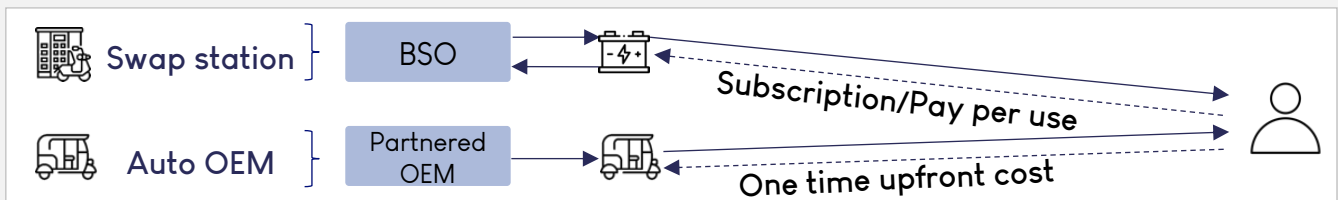
Cons

- As MaaS players end up owning the vehicle, CAPEX and inventories increase
- Requires high vehicle utilization to ensure ROI

Players: **BOUNCE** 

Battery as a Service (BaaS)

BaaS only provides the Battery to the user on subscription or pay per use/charge model, offered typically in the B2C segment, where the user or fleet operator owns or leases their own vehicle or fleet respectively.



Pros

- Lower CAPEX for the BSO compared to MaaS as vehicle ownership is on the user

Cons

- Smaller B2B customer base

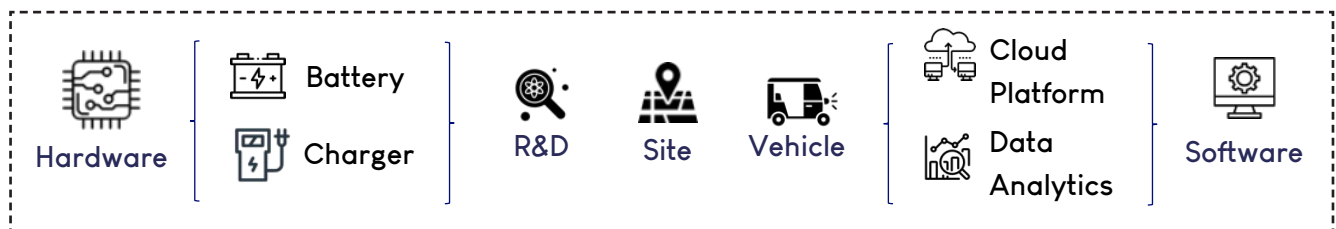
Players:  **BatterySmart**

Battery Swapping - Classification by control over customer experience

BSOs have the option to either vertically integrate across the value chain or form partnerships to reduce CAPEX

Vertically integrated

Vertical integration is a strategy that allows a company to streamline its operations by taking **direct ownership** of various stages of its supply chain rather than relying on external contractors or suppliers.



Pros

- Gives operator control over the entire supply chain
- Negligible reliance on external companies for product delivery
- Seamless customer experience

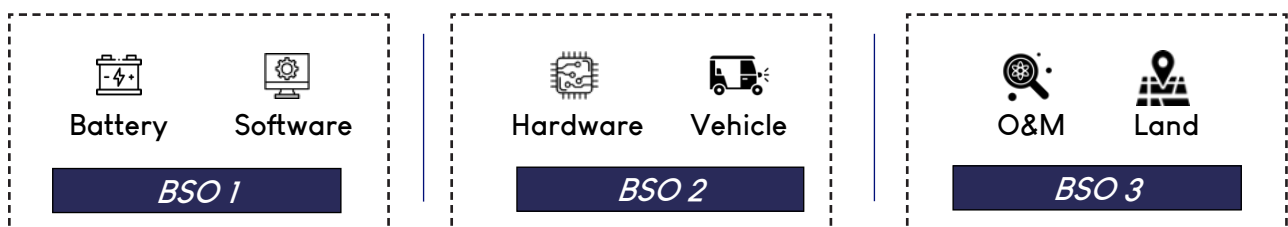
Cons

- Requires a high CAPEX
- Limits avenues to collaborate on a single point of value chain

Partnership-based

In a partnership-based model the company either **outsources** or **enters in a partnership** with a **third-party** in multiple parts of the supply chain. Generally, the company has complete ownership over one aspect of the supply chain which is their **USP**. In the below scheme:

- BSO 1: Owns only the battery and the software platform while the charger is outsourced
- BSO 2: Owns the hardware (battery + charger) and vehicle while the software platform is outsourced
- BSO 3: A typical land agency or franchise player that owns land, charger and O&M



Pros

- Low CAPEX
- Allows operator to focus on one aspect, making it their USP

Cons

- Lack of control over value chain, subject to external factors

 Direct ownership of BSO

Successful global business models: Case of a 2W operator

Vertical integration enabled a 2W operator to capture over 90% domestic market share

About the Company:

A Taiwan-based two-wheeler battery swapping player, that started with a vision of becoming a technology provider ended up developing fully integrated EV solutions. Currently, it holds around a market share of over 95% of the country's total EV sales and a customer retention rate of close to 100 percent. It has its presence in the world's top 3 2W markets which accounts for close to 500 million scooters running on the road.

Key Stats (2015 - 2022):

- 465,00 daily users
- 350,000 daily swaps
- 275 million swaps till date,
- 10000 + swapping racks across 2200 locations
- 1 million batteries in circulation
- 40 SKUs running in Taiwan itself with their powertrain solutions

Offerings:

Besides having their own scooters running on the road, they offer three solutions based on the requirements of their partners

- **Power train solutions** – The partner company can take the tailor-made powertrain and launch their own vehicles based on the market segment they wish to target.
- **Interface kits** – These kits allow their partner

companies to utilise the swapping network while using the powertrain of their choice.

- **App suite** – These acts as the HMI between the smarts of the scooter and the robust backend which the company's swapping network is running on.

Subscription Plans:

Users can subscribe to batteries for as low as 10 USD per month

- **Flex** – Pay per kWh
- **Fixed** – User selected predetermined payment plan based on estimated consumption
- **Fleet** – Commercial plan

Key Takeaways:

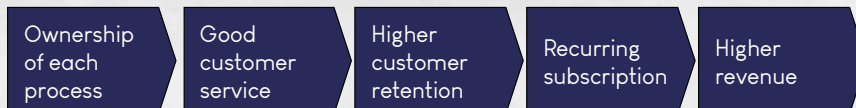
- User centric BaaS model, **targets 4 major concerns of the user – Time, Range, Safety and Affordability**. The company has always prioritised user experience to ensure maximum satisfaction
- **Full vertical integration** – Connected vehicles, Powertrain technology, Smart Batteries and Consumer app and network software
- **Scalability** – Partnerships with global OEMs by providing powertrain solutions
- **Recurring revenue** – >54% of company total revenue through BaaS subscribers. They have an industry leading customer retention rate of close to 100 percent

Partnerships established:

- OEMs – Partners with OEMs to leverage their local expertise in their home country and leverage their sales and distribution network
- Contract Manufacturers – Leveraging economies of scale to support their global ambitions
- OMCs and State agencies – To leverage their extensive real estate presence across the country
- Vehicle aggregators – B2B market penetration

Key insights:

- Complete vertical integration has allowed the company to have close to 100% customer retention rate



- By providing **different subscription plan** allows the company to acquire a wider customer base (Better financial sense)
- Local partnerships leading to ease of doing business
- Manufacturing partner to help the company focus on the core business



Successful global business models: Case of a 3W operator

Extensive pilot study helped a 3W in streamlining their business plan for India

Profitability Assessment:

- Conducted TCO benchmarking
- Initial upfront cost reduced
- Cost per charge estimated between Rs 50-60, half of the fuel price of what ICE motors would require to travel the same distance

Challenges Tackled:

- Lead Acid batteries have a limited range of up to 80 kms, 12 hours of charging
- Vehicles are expensive because of battery which lasts only 6-9 months
- Looked at EV as a whole, within that micro-mobility – E-2W, E-3W. L5 would have taken OEM integration

Pilot setup:

- Pilot setup was done with E-rickshaw fleet in Gurgaon by retrofitting existing (with 100 Kg lead Acid batteries)

Pre-Pilot:

The company enabled telematics and studied vehicle usage, driving behavior, location heat map and stops data for 3 months before the pilot

Pilot:

- Pilot was sustained for almost a year after this and added fixes and enhancements. They developed a clear roadmap for features based on this experience, especially the retail segment (Driver cum Owner of commercial vehicles as opposed to fleet) which was the bigger opportunity.

Commercial Launch:

- Commercial Launch was first carried out for 3Ws, then 2Ws. Currently, the company has 65 Swap Points across 14 cities in India, 400,000+ rides and over six million kms powered

Partnerships, Technology & Scaling:

Partnerships with OEMs, Power companies, OMCs, and technology companies

Future Direction:

Started with Mobility-as-a-Service (MaaS) in 2021, aiming to onboard more than 1 Million vehicles by 2025, partnered with Amazon

Successful global business models: Case of a 4W operator

Strategically locating swapping stations along highways helped a 4W operator in higher customer adoption

About the firm

One of the only companies venturing into the infamous 4-wheeler battery swapping, it has successfully established its name in the last **6 years** with **1000 plus active swapping stations** in two countries.

Key stats

- 1000+ fully automated swapping stations
- Allows for battery sizes anywhere from 70 kWh to 130 kWh
- Swapping time of less than 3 minutes
- 800,000 swaps completed to date
- 200,000 vehicles delivered

Key takeaways

1. **Battery asset management company** – In order to adopt asset-light financial model – the company has partnered with 3 other firms in equal partnerships, one of them being one of the largest lithium-ion cell manufacturers.
2. **Basket of charging options** – Swapping network working complimentary with their fast-charging public network. The battery swapping stations are primarily located along the highways to ensure lesser downtime for customers during long distance travel while offering comprehensive fast and slow charging solutions for their customers within city limits



State-level efforts to promote battery swapping: Case study of Telangana government

The Telangana government has started to strategically push towards battery swapping implementation in the state, with 50 swapping stations already in pilot

- Telangana government plans to set up a total of **500+ charging stations** under FAME 2. With an immediate plan for 138 charging stations with atleast 5 guns in each charging station (both fast and slow) out of which 118 EVCS stations will be set up in Hyderabad 10 in Warangal and 10 in Karimnagar for which the state has allocated the locations to central implementing agencies selected by DHI
- **156 EVCS stations** set up by both private and TSREDCO are already functional in Hyderabad
- The Government of Telangana is in process to establish 120 EV charging points of DC fast chargers in Hyderabad
- Government is planning to install **600 EVCS and BSS across Telangana**. Preference will be given to CPOs who are setting up battery swapping stations alongside fixed charging stations
- A pilot of **50 battery swapping stations** is under process and will be allotted to stations operators within this year for which a tender will be issued
- The government has also launched the first state **EV app** – TS EV to facilitate a smoother transition for EV adoption
- The state government will give the land on a revenue-sharing model to the battery swapping operators and ensure a special electricity tariff to ensure cost benefit for the consumers
- Operators can apply through the single window portal being set at TSREDCO up by the government to facilitate allotment of land, electricity connection requests or any other forms of NOC

04

Regulatory Requirements: Compliances for setting-up battery swapping stations



Government Stakeholders – Central Level

The following ministries and departments play a role in EV policymaking at the central government level

Authorities/ Ministries	Scope of Work	EV pertaining activities	Relevant body/ departments
NITI Aayog	Thought Leadership and Policymaking	Developing policies for adoption of electric vehicles, Battery Swapping policy	Transport Department
Ministry of Road Transport & Highways	Industry Standards & Incentives	AIS, EV promotion through green plate licenses and no registration caveats	Automotive Research Association of India
Ministry of Heavy Industries		PLI for ACC, PLI for Auto and Auto components, Indigenization of xEV parts	Department of Heavy Industries
Ministry of Consumer Affairs	Standards and Certifications	Development of the activities of standardization, marking and quality certification of batteries through BIS	Bureau of Indian Standards
Ministry of Science & Technology	Research & Development	Developing indigenous charging standards, Conducts workshops, stakeholder discussions, R&D, etc.	Department of Science & Technology
Ministry of Power	Charging Infrastructure, Standards & Deployment	Policy drafting, regulations related to public & private CI and station location, subsidies on power tariff	<ul style="list-style-type: none"> Central Electrical Authority Central Electricity Regulatory Commission
Ministry of Housing & Urban Affairs		By-laws amendment on parking space reservation for CI	Town and Country Planning Organization
Ministry of Commerce and Industry		Determining industrial policy such as PESO, etc	Petroleum and Explosives Safety Organization

Government Stakeholders – State level

The following departments play a role in EV policymaking at the state government level

Departments	EV Initiatives	
1 Industries Department	<ul style="list-style-type: none">• Disbursement and Op. Guidelines issuance of supply-side incentives*	
2 Transport Department	<ul style="list-style-type: none">• Disbursement and Op. Guidelines issuance of demand-side incentives• E-3W purchase subsidy• Early bird, vehicle scrappage incentives provision• Fleet electricification	
3 Energy Department	<ul style="list-style-type: none">• Disbursement of charging infra incentives• Ensure implementation of charging infra development by ULBs	
4 Urban Development Department	<ul style="list-style-type: none">• Ensure implementation of charging infra development by ULBs	<ul style="list-style-type: none">• Identify land locations with govt./land-owning agencies for charging infra installation at concessional rentals
5 Urban Local Bodies (ULBs)	<ul style="list-style-type: none">• Encouraged to offer property tax rebates to residential owners installing pvt charging infra• Prepare charging infra plan for cities	
6 DISCOM	<ul style="list-style-type: none">• State Nodal Agency• Operational guidelines issuance for disbursement for EV charging infra incentives• Concessional tariff provision for charging + swapping infra	

* incentives for EV related manufacturing and R&D facilities (vehicle/battery assembly, component/cell/electronic parts mfg., etc.)

Compliance and Procedures

Preparation of application as per the following compliance processes to be followed for BaaS setup in India

Order	Type	Compliance Process	Relevant Authority
1	Equipment	Component level ARAI certification	ARAI (Automotive Research Association of India)
	Electrical	Obtain electricity connection	DISCOMs functioning in site location
3	Fire	Obtain NOC	Fire & Safety Department (State Government)
4	Storage/ Transportation	No specific approval	-
5	Location based approval (Fuel Outlets)	PESO approval required	Petroleum & Explosive Safety Organization (PESO) (Central Government)
6	Location based approval (other locations)	No specific compliance procedure	-

Regulatory Requirements – Product Compliance

From 27 December 2022, AIS 156 will become mandatory for safety requirements with respect to safety requirements of motor and battery; New standards for battery swapping to be published soon

AIS 156 Standard Document

Scope:

Specific Requirements for L Category Electric Power Train Vehicles: Part 1 for the vehicle and Part 2 for the Rechargeable Electrical Energy Storage System (RESS)

Requirements:

- Protection against Electrical Shock
- Protection against water effects
- Functional safety
- Additional test for REESS vehicles
- Vibration Tests
- Mechanical Tests
- Fire Resistance
- Over charge and Discharge

AIS 048 Standard Document

Scope:

Traction (driving power) batteries used for battery operated vehicles of L, M & N category as defined in AIS-053, containing automotive vehicle types terminology

Requirements:

- Vehicle Test
- Short Circuit Test*
- Overcharge Test*
- Mechanical Test
- Vibration Test*
- Shock Test

New Battery Swapping Standards (Under development)

Scope:

- Battery standard (Dimension, connector etc.)
- Communication protocol (battery to vehicle, swapping station, and back end)
- Public charging stations

The Ministry of Road Transport and Highways has mandated amended AIS 156 and AIS 038 Rev.2 standards from October 1, 2022. The amendments include additional safety requirements related to battery cells, BMS, on-board charger, design of battery pack, thermal propagation due to internal cell short circuit leading to fire. Vehicle and component level standards will still be applicable over and above these.

*Fire and safety related tests

Regulatory Requirements – Electricity Connection

Ministry of Power, Central Electricity Authority & State level Electricity boards are the governing authorities for electricity guidelines in India

Inquiry about "Current laws and regulations for similar equipment"

For electrical issues:

- a Who should be the related ministry/department?
- b Which laws and regulations shall be applied?
- c What kind of application process should be taken? Do the application/approval processes above vary from state to state? (Do the suppliers/operators need to get approval from both central and local government?)

Responsible Ministry/ Department

Central level:

- Ministry of Power (MoP)
- Central Electricity Authority (CEA)

State level:

- State Electricity Boards (Eg. KPCTL) & Department of Electrical Inspectorate

Applicable laws & regulations

- Central level regulation: Electricity Act, 2003 by Ministry of Power
- State level regulations: Respective State electricity boards have their own electricity regulations derived from Electricity Act, 2003
 - The Electricity (Karnataka Amendment) Act, 2013

Application process*

- **Offline process** which involves submission of various documents such as electrical installation drawings to **respective DISCOMs. O&M companies/electrical consultants** can help in such application & approvals
- Application process varies from State to State as the governing Electricity boards are different
- Approval is required only from the respective state level electrical authorities

Regulatory Requirements – PESO Approval

Swapping units can be setup in a fuel station if it is at least 6m away from fuel dispensers; 1 time approval for all units would suffice

PESO Electric Charging Infrastructure Guidelines

Versions dated Dec 18 & July 20



- Swapping Station needs to be set up outside extent of three zones of hazardous area (Zone-O, 1 & 2) i.e. 6 m away from fuel dispensing unit
- Electrical Wiring for the swapping station needs to be laid underground
- Battery swapping stations needs to be provided with appropriate hydrocarbon detectors to cut off power supply if hydrocarbon vapors are detected in the vicinity and adequate firefighting facilities shall also be provided
- Battery swapping station needs to be clearly demarcated and appropriate display board to be provided

Approval process involves a station layout approval and an electrical equipment approval

	Station Layout Approval	Electrical Equipment Approval
Purpose	For any change/new installation in the licensed area	To confirm if any new equipment being installed is safe, flame free and doesn't cause any hazard
Responsibility	OMCs	Equipment Manufacturer / OMCs
Approval from	PESO Regional Office	PESO Head Office
Requirement	Multiple (For every Petrol Pump)	Single Approval is required for electrical equipment setup across multiple locations
Timelines	1 day* (More days might be required in case any further clarification is required by PESO offices or in case field visit by officials is required)	10-90 Days

05

Conclusion: Key success factors & future of battery swapping



Key Success Factors

The success of a battery swapping business relies on simultaneous success of several inter-linked factors

1



Compatible Vehicles

- Battery swapping business requires same set of batteries to be widely compatible across multiple vehicles and applications to ensure higher throughput and lower downtime.
- The higher the number of compatible vehicles, the **greater the demand for BSO's batteries**

2



Station Network

- Battery swapping business requires a dense and wide network presence to support swapping operations
- This **alleviates customers - range anxiety**, making them prefer such a BSO

3



Battery Utilisation

- BSOs need to manage their battery inventory efficiently to account for the existing demand but also avoid high CAPEX costs due to idle batteries in circulation.
- This can be done through effective data study of consumer utilisation pattern.

4



Battery Health

- Swappable batteries undergo a higher number of charge cycles which requires maintaining the battery health by monitored charging and discharging
- This ensures that the battery capacity is effectively utilised over its lifetime, hence **providing a greater return on investment from each battery unit**

5



Research and Development

- Battery swapping business is expected to experience frequent changes in battery technology such as fast charging, new chemistries, safer batteries, etc.
- Being at the forefront of R&D can help BSOs select the right battery technologies for the purpose of their business, **otherwise they may face a risk of technological obsolescence**

6



Customer experience

- BSOs should focus on providing a seamless customer experience in order to increase customer retention rate eventually leading to higher recurring revenues.
- This can be achieved through vertical integration, prompt after sales support services etc.

Conclusion

Battery swapping is expected to move beyond 2W and 3W to industry-agnostic Energy as a Service applications

We envision a future where battery swapping is an **integral part of our mobility**

The immediate tangible benefits of the battery swapping technology is apparent. However, a more important and exciting benefit is the broad potential of the technology to realise a green and sustainable future

- **Battery as a Service (Automotive):** In future, the application areas shall not be limited to only the 2W and the 3W segment. Larger vehicles such as 4W and buses/trucks shall also find utility in battery swapping
- **Energy as a Service (Industry-agnostic):** In future, the same set of batteries shall be used as a fuel for wide application areas such as for power back-up, micro-grids, water pumps, etc.

This future will be a possibility with coordination among various stakeholders

- **The government** shall continue to provide a **level playing field** among technologies, such as fixed battery and swappable battery. This will allow innovation and the survival of the fittest
- **The regulators** shall continue to **guard against safety risks and market concentration** threats by allowing a level-playing field for the new players and the old
- **The players** shall continue to **collaborate to increase the size of addressable market** rather than playing a zero-sum-game in the existing market

In future, the battery swapping stations will be as ubiquitous as petrol pumps currently. This will remove the infrastructure constraints to customer adoption of battery swapping. And **the adoption of battery swapping will simply boil down to the customer preference for ownership and maintenance of the battery**

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