



BATTERY SWAPPING: A PROMISING FUTURE FOR ELECTRIC VEHICLES

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SUMMARY | BATTERY SWAPPING: A PROMISING FUTURE FOR ELECTRIC VEHICLES

Rising temperatures, rising sea levels, floods and climate change in general has become a cause of global concern in the last decade. To combat climate change, the Government of India (“Gol”) has been proactively campaigning about its climate goals. With the aim to achieve net zero emissions by 2070¹ and 100% shift from Internal Combustion Engine (“ICE”) vehicles to electric vehicles (“EVs”) by 2030, the Gol has taken various steps to promote mass electrification of transportation and push for a shared, electric, and connected mobility future.² A detailed analysis of the incentives and policies issued by the Gol and various state governments and the legal landscape governing manufacturing of EVs has been covered in our previous articles on this topic, titled 'Electric Vehicles: Driving India Towards Sustainability'³ and 'Legal Landscape Governing Manufacturing of Electric Vehicles And Batteries'⁴.

In order to enhance the demand for EVs, manufacturers of EVs and its components have been trying to make EVs affordable, easy to charge and economically viable.⁵ Battery swapping has emerged as one of the biggest solutions to the shortcomings of traditional EVs. It has been reported that batteries consist of 40% to 50% of the EV's cost, with a switch to EVs without a battery this cost is eliminated, thereby making EVs more affordable. In addition to making it more affordable, primarily, battery swapping is a noteworthy solution for the lack of fast paced development of charging infrastructure in India. With leading market players advocating for this change, battery swapping has the potential of becoming an alternative that is adequate, affordable, accessible, and reliable. We have dealt with the distinguishing aspects of battery swapping infrastructure and battery charging infrastructure in greater detail in later part of this article.

The objective of this article is to undertake a comparative analysis of the different approaches adopted in various jurisdictions towards successful implementation of battery swapping services and examining the key features of the draft battery swapping policy (“Policy”) published by Niti Aayog on April 20, 2022 to implement such a service model.⁶

Further, emphasis is drawn on other measures, incentives and schemes introduced by both the Gol and the state governments to promote a complete battery swapping ecosystem in India to attract potential investment and mass adoption.

¹ Press Release available at <https://pib.gov.in/PressReleasePage.aspx?PRID=1795071#:~:text=The%20Government%20of%20India%20has,held%20in%20Glasgow%2C%20United%20Kingdom.>

² Minal Pathak and Shaurya Patel, The speed bumps in India's electric vehicle that no one's talking about, available online at <https://economictimes.indiatimes.com/industry/renewables/the-speed-bumps-in-indias-electric-vehicle-ride-that-no-one-is-talking-about/articleshow/88144625.cms?from=mdr> last accessed on July 20, 2022

³ Saurav Kumar, Swathi Sreenath and Ritvika Thakur, Electric Vehicles: Driving India towards sustainability, available online at <https://www.mondaq.com/india/rail-road-cycling/1146374/electric-vehicles-driving-india-towards-sustainability>

⁴ Saurav Kumar, Swathi Sreenath, Ritvika Thakur and Shreya Chaturvedi, Legal landscape governing manufacturing of electric vehicles and batteries, available online at <https://www.mondaq.com/india/waste-management/1169402/legal-landscape-governing-manufacturing-of-electric-vehicles-and-batteries>

⁵ Dr. Irfan Khan, Battery Swapping for electric vehicles and ways to lead the change, available online at <https://www.livemint.com/auto-news/battery-swapping-for-electric-vehicles-and-ways-to-lead-the-change-11652604393940.html> last accessed on July 20, 2022

⁶ Battery Swapping Policy dated April 20, 2022 issued by Niti Aayog, available online at https://www.niti.gov.in/sites/default/files/2022-04/20220420_Battery_Swapping_Policy_Draft.pdf

GLOBAL TRENDS – BATTERY SWAPPING IN CHINA, JAPAN, AND U.S.

Despite initial resistance, countries are now actively switching to battery swapping to accelerate adoption of EVs. Set out below is a summary of the current position in respect of battery swapping in China, Japan, and U.S.

- **China:** Battery swapping is in its nascent stages in China whereas it hasn't really taken off in other parts of the world.⁷ China's State Council announced the New Energy Vehicle Industry Development Plan (2021-2035) on October 20, 2020 ("Plan") with an aim to ensure development of the new energy vehicle industry.⁸ Under the Plan, the Chinese government is looking forward to developing a public charging network with focus on fast charging. Further, it also provides financial support to the businesses' involved in the construction of charging stations. Amongst the companies in the swapping business, companies like Nio and Aulton New Energy have built 1,400 battery-swap stations nationwide and plan to grow the number to 26,000 by 2025.⁹
- **Japan:** The Japanese government's goal is to achieve carbon neutrality by 2050. It is aiming to transition to 100% EV by 2035.¹⁰ Original Equipment Manufacturers ("OEMs") in Japan namely, ENEOS Holdings, Honda Motor, Kawasaki Motors, Suzuki Motor and Yamaha Motor have collectively established a new company called Gachaco Inc. to ensure production of swappable batteries meeting the same standards and set up effective replacement systems to swap batteries.¹¹ The newly incorporated company will develop necessary battery as a Service ("BaaS") platform infrastructure to provide the swapping service to electric 2W users,¹² thereby combating one of the common hurdles to the widespread adoption of EVs in the country. The aim is to manufacture mutual-use swappable batteries that can be swapped in the Two-Wheelers ("2Ws") produced by all the OEMs forming part of the consortium.
- **U.S.:** Tesla, one of the biggest EV manufacturers in the world had introduced swapping stations in the US back in 2013.¹³ The company had to shut down the swapping stations within a few years due to low-cost recovery. This led to the innovation of super chargers which would decrease the otherwise high downtime for EVs. However, recently battery swapping has witnessed immense demand in the U.S..¹⁴ Ample, a start-up based in California, U.S., engaged in developing battery swapping technologies has produced battery modules that can handle battery packs of different cars and low-cost swapping stations. Batteries that can accommodate a range of vehicle, eliminates the requirement of a standard battery pack required to be

⁷ Anjani Trivedi, The promise and pitfalls of an EV battery swapping pathway, available online at <https://www.livemint.com/opinion/columns/the-promise-and-pitfalls-of-an-ev-battery-swapping-pathway-11658085503475.html> last accessed on July 21, 2022.

⁸ State Council, Notice on printing and issuing the development plan for the new energy vehicle industry (2021–2035), available online at http://www.gov.cn/zhengce/zhengceku/2020-12/31/content_5575906.htm

⁹ Paul Lienert, Nick Carey and Norihiko Shirouzu, Inside China's electric drive for swappable car batteries, available online at <https://www.reuters.com/business/autos-transportation/inside-chinas-electric-drive-swappable-car-batteries-2022-03-24/> last accessed on July 21, 2022.

¹⁰ Available at <https://www.trade.gov/market-intelligence/japan-transition-electric-vehicles>

¹¹ Mohan K Ramanujam, Gachaco Starts EV battery swapping service in Japan, available at <https://paultan.org/2022/03/30/gachaco-starts-ev-battery-swapping-service-in-japan/> last accessed on July 21, 2022.

¹² Available at <https://www.automotiveworld.com/news-releases/agreement-reached-to-standardize-swappable-batteries-for-electric-motorcycles/>

¹³ Available at <https://www.popsoci.com/science/electric-car-battery-swap/>

¹⁴ Jeniece Pettitt, Why battery swapping may finally become a part of EV charging infrastructure in the U.S., available online at <https://www.cnbc.com/2021/05/29/how-ample-is-bringing-battery-swapping-to-the-us.html> last accessed on July 21, 2022

maintained by OEMs while producing 2Ws in order to ensure that the batteries being produced fit into the vehicle.

Global trends suggest a move towards battery swapping as a new solution. As observed, different countries have used different business models of battery swapping to overcome the prevalent shortfalls in the EV landscape. With the release of the Policy, the Gol has also joined other jurisdictions in promoting a switch to battery swapping. This move should be further backed by state governments to ensure deeper penetration of electric 2Ws and three-wheelers (“3Ws”) in India. The Finance Minister of India, Mrs. Nirmala Sitharaman had during the 2022-23 budget announcement, introduced BaaS as a new business model to accelerate sustainable mobility solutions.¹⁵ This model aims at resolving the space constraint faced in setting up charging stations in urban areas by providing a recharging facility akin to the refueling facility available for ICE vehicles. The key feature of this model is discussed in the next section of the article.

KEY FEATURES OF THE POLICY

The Gol had announced the introduction of the Policy in its union budget for the financial year 2022-23, with the intent to strengthen the EV industry and catalyze large scale adoption of EV. The Policy would also enable in recognizing ‘battery’ or ‘energy’ as a service and help in further developing the EV infrastructure and increasing the use of EVs in public transportation. It is pertinent to note that the Policy focuses on 2Ws, 3Ws, light electric power train vehicles (“LEV”) among the lightweight category vehicles and E-Rickshaw/ECart and is intended to promote swapping of batteries with Advanced Chemistry Cells (“ACC”), to reduce battery cost.

The key objectives of this Policy are:

- Offering flexibility to EV users by developing battery swapping as an alternative to time taking charging facilities;
- Providing technical guidelines, standards and principles required to enable interoperability within the battery swapping ecosystem;
- Addressing regulatory and financing challenges faced by manufacturer or/and service providers;
- Encouraging co-operation among various market players like battery providers, battery OEMs, EV OEMs, lending institutions, etc. thereby forming an ecosystem that can provide integrated services to the customers;
- Providing for a better lifecycle management of batteries, including both maximum usage and recycling.

This policy is valid from the date of its public notification till March 31, 2025, post which Ministry of Power (“MoP”) is authorized to review, revise, and extend its validity.

¹⁵ Express Drives Desk, Union budget 2020: EV industry welcomes measures recognizing battery as a service, available online at <https://www.financialexpress.com/auto/electric-vehicles/union-budget-2022-ev-industry-welcomes-measures-recognising-battery-as-a-service/2422609/>, last accessed on July 22, 2022.

We have set out below, particulars of some of the key features of the Policy:

S.No	Key Features	Brief Particulars
1.	Technical and operational standards for batteries	<ul style="list-style-type: none"> • Technical and performance standards to be approved/adopted by concerned agencies to ensure safe operations and flexibility in operating with different battery types; • Battery Management System (BMS) will be enabled in all ACC batteries; • Batteries to be equipped with advanced features like IoT-based monitoring system, remote monitoring etc.; • Additional standard and specifications for batteries to be notified later to support a phased manner transition to battery swapping; • A Unique Identification Number (UIN) to be assigned to batteries and battery swapping stations; • Batteries to be tested as per Automotive Industry Standards 156 and 036, testing protocols and relevant regulatory standards; • OEMs to seek approval from Automotive Research Association of India (ARAI) to accept interoperable swappable batteries.
2.	Standards for Battery charging and swapping infrastructure	<ul style="list-style-type: none"> • MoP to develop and approve the standards for battery charging and battery swapping stations; • Electric Vehicle Supply Equipment (EVSE) used at swapping stations should be tested and certified by National Accreditation Board for Testing and Calibration Laboratories (NABL) or agency appointed by the central nodal agency for battery swapping; • Charging infrastructure for electric vehicles – guidelines and standards released by MoP in 2022 to be followed; • Guideline and protocols issued by Central Electricity Authority are to be followed.
3.	Data Sharing	<ul style="list-style-type: none"> • Emphasis on data sharing agreements among major battery providers; • A non-restrictive guideline with respect to classification and usage of collected data will be developed; • Information about the type of batteries available for swapping, use of swapping mechanism, performance of batteries etc. will be provided by battery providers to the customers in a standard format.

4.	Battery as a Service (BaaS) Model	<ul style="list-style-type: none"> • Users will purchase EVs without battery and shall acquire battery on a subscription basis; • Battery providers may work with battery OEMs to develop batteries and operate swapping stations; • Multiple distinct solutions from relevant market players to be taken into consideration for maintaining technical and operational standards; • Ecosystems to be open to other market players to foster flexibility and choice for EV users; • Users are allowed to detach swappable batteries and charge it elsewhere using appropriate measures.
5.	Direct financial support	<ul style="list-style-type: none"> • Existing incentives for EV purchase to be extended to batteries covered under this Policy; • MoP to produce a mechanism for disbursement of subsidies, • Battery providers to receive subsidies, provided they meet the technical and operational requirements under this Policy; • Subsidies to be linked with UIN of EVs to avoid double-dipping; • Scheme to specify minimum duration of contract to be signed by EV users and battery providers; • State governments to provide additional financial aid in the form of subsidies.
6.	Indirect financial support	<ul style="list-style-type: none"> • Electricity consumed by swapping stations to be charged under time-of-day tariff regime to reduce operating expenditure; • Public entities and governments (both GoI and state governments) to provide land for establishing swapping/charging stations on a revenue sharing basis; • State governments to ensure power supply to swapping stations at concessional rates; • Goods and Services Tax (GST) may at a future date reduce tax rates.
7.	Implementation in a phased manner	<p>Swapping stations to be set-up in urban areas in the following phases:</p> <ul style="list-style-type: none"> • <u>Phase I (1st and 2nd year)</u>: All metropolitan cities with a population greater than 4 million; • <u>Phase II (2nd and 3rd year)</u>: All major cities with population greater than 0.5 million.

8.	Nodal agencies responsible for rollout of swapping stations	<ul style="list-style-type: none"> • Central Nodal Agency – rollout of EV charging infrastructure; • States and Union territories – implementation and governance of the entire ecosystem; • Transport departments – easing registration process; • Municipal Corporations – land allocation permission; • Energy department – supply of power; • State electricity regulatory commissions – concessional tariff rates for electricity supply.
9.	Re-use and Re-cycling of Batteries	<ul style="list-style-type: none"> • Regulation on minimum battery performance and durability requirements; • Standards for re-use of batteries to be developed; • Battery providers to be encouraged to develop a power bank using swappable batteries after their end-of-life; • Improper disposal of batteries in landfills or scrap is prohibited; • Battery management rules to be notified with respect to end-of-life handling of batteries; • Collection and re-processing of batteries will be tracked as per provisions of Draft Battery Waste Management Rules, 2020.
10.	Single window portal	<ul style="list-style-type: none"> • A single window portal to be set up by concerned authorities to facilitate submission of all required documents, issue trade licenses, approve allocation of public land and to grant electricity supply connections in relation to battery swapping business.
11.	Grievance Redressal	<ul style="list-style-type: none"> • On behalf of the ecosystem, battery providers will be the primary point of contact between the players in the battery swapping ecosystem and will be responsible for channeling monetary compensation to EV owners in case of grievances. The Policy is silent on the types of grievances covered. Any of the relevant market player can be liable to pay compensation. Battery providers are merely a medium for addressing and facilitating grievances raised by customers.

BATTERY SWAPPING VS. BATTERY CHARGING

Basis the key objectives of the battery swapping ecosystem mentioned above, further is a pros and cons analysis of swapping vs. charging, as a service and the relevant difference between both the infrastructures.

- **Time:** One of the main objectives of the Policy as mentioned above is increasing consumer flexibility by reducing the long recharging time required by traditional EVs. Battery swapping provides a quick alternative as it involves replacement of discharged batteries with pre-charged batteries. Reports suggest that it takes a minimum an hour or two to charge an EV.¹⁶ It takes minutes for swapping versus an hour for charging.
- **Cost:** Battery swapping aims at eliminating the upfront cost incurred while purchasing an EV by providing battery as a service on a subscription basis. This will further lead to opening the market for other players like battery providers. EVs with batteries are expensive to purchase thereby creating a need for the government to announce purchase as well as manufacturing incentives on a regular basis.
- **Space:** The plug-in chargers used at charging stations are slow and capable of charging only one vehicle at a time. On the other hand batteries can be stacked up and charged together for swapping. Charging batteries and swapping the discharged batteries requires lesser space in comparison to charging stations charging one vehicle for hours.¹⁷ This makes swapping stations more effective and less capital-intensive in terms of the infrastructure required.
- **Range Anxiety:** Range anxiety is primarily fear of a vehicle owner that they might run out of charge before reaching the destination. This anxiety arises due to lack of proper charging infrastructure. Battery swapping helps address this issue as swapping stations is easier, faster, and more convenient to establish and less time consuming. However, this will prove to be beneficial only upon successful implementation of the BaaS model in India.¹⁸
- **Sustainability:** The Policy aims towards providing a better life-cycle management of batteries by focusing on both maximum usage and recycling. Batteries charged for swapping can also be used to power the swapping station in case of any power interruptions.¹⁹ In case of an EV with battery, once the battery is dead it has to be degraded and the vehicle has to be refitted with new battery, adding on to the generation of e-waste.²⁰

¹⁶ Venkat Rajaram, To swap or not to swap: What's best for electric vehicles, available at <https://economictimes.indiatimes.com/industry/renewables/to-swap-or-not-to-swap-whats-best-for-electric-vehicles/articleshow/88543602.cms?from=mdr> , last accessed on August 01, 2022.

¹⁷ Gerald Ollivier, Shyam Srinivasan and Shyamasis Das, A greener future: Thoughts on India's proposed battery swapping policy, available online at <https://blogs.worldbank.org/endpovertyinsouthasia/greener-future-thoughts-indias-proposed-battery-swapping-policy>, last accessed on August 01, 2022.

¹⁸ Available at https://www.business-standard.com/podcast/automobile/what-is-range-anxiety-and-how-does-it-affect-ev-buyers-122051600045_1.html, last accessed on August 09, 2022.

¹⁹ Available at <https://www.financialexpress.com/auto/electric-vehicles/rechargeable-battery-vs-battery-swapping-in-electric-vehicles/2467989/>, last accessed on August 01, 2022.

²⁰ Ananth Iyer, EV Battery Tech : Charging vs Swapping, available online at <https://www.team-bhp.com/news/ev-battery-tech-charging-vs-swapping> , last accessed on August 01, 2022.

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- **Innovation:** OEMs claim to be using different technologies for efficient battery than their competitors. Swapping aims at standardization of battery packs thereby eliminating innovation. This will further attract resistance from OEMs.

The shortcomings of battery swapping are mentioned in detail in the next section.

POTENTIAL HURDLES IN ESTABLISHING A SWAPPING ECO-SYSTEM

Undoubtedly, the Policy is seen as a move in the right direction by industry experts and stakeholders. However, it comes with certain challenges. One of the issues in introducing swappable batteries is adoption of standardized batteries applicable to all EVs. In order to swap discharged batteries with a charged one at any swapping station, it is important for all EVs produced by OEMs to use a standard battery back and connector to charge the battery. In the absence of standard batteries or battery modules adapting to all size and models, swapping stations will be able to cater to vehicles only with a specific type of battery pack.

This standardization comes with its own set of challenges. Along with the technical difficulties in standardizing plethora of battery specifications already existing in the market, standardization is also highly criticized by OEMs. News reports suggest that vice president of a leading energy company had linked standardization of batteries for personal vehicles to decrease in innovation.²¹ Battery standardization along with interoperability is crucial for BaaS model to become effective. In case of unstandardized swappable batteries, swapping stations will not be able to offer services to all kinds of EVs. Unlike a petrol pump, swapping stations will then cater only to a specific brand of batteries. However, the Policy is silent on the mechanism for standardization. Standards and protocols in manufacturing swappable batteries are yet to be provided. This creates a need for extensive research in this field especially given the rise in incidents of EVs catching fire. Swapping involves multiple market players like OEMs (EV manufacturers), battery manufacturers, service providers and network operators. The success of battery swapping ecosystem in India is heavily dependent on the smooth co-ordination and communication between the above-mentioned key players.

Further, the Policy currently does not extend to four wheelers. However, it is important to note that BaaS ecosystem in India covers the mass market of 2Ws and 3Ws batteries which captures the bulk of the EV market share and in comparison, to four wheelers are easier to swap.

Further, the applicable GST for BaaS is around 18% which in a developing sector may be substantially higher. At the least, the Government could consider having parity with battery charging and reduce it to the applicable GST chargeable on electricity in case of battery charging.

Having said that, one cannot ignore that the battery swapping industry is growing rampantly both in India and globally. Various BaaS models are prevalent in the Indian battery swapping industry. For instance, Sun Mobility, a leading electric energy infrastructure and service provider based in India, has been acting both as a battery manufacturer and network provider as it offers both smart batteries and swapping services.²² Whereas, Bounce Infinity, a swapping service provider has recently

²¹Prathik Desai, Hurdles seen in mass adoption of EV battery swapping technology, available at <https://www.deccanherald.com/business/hurdles-seen-in-mass-adoption-of-ev-battery-swapping-technology-1078152.html> last accessed on July 21, 2022.

²² Available at <https://www.sunmobility.co.in/>

launched its own range of electric 2Ws.²³ Further, Battery Smart is an integrated platform that aims at connecting various players in the EV space.²⁴ It primarily provides swappable batteries to e-rickshaws on a subscription basis for a replacement charge per battery at a nominal rate at its own swapping stations.²⁵ Sheru, a tech start-up also provides e-rickshaw owners to swap batteries at their retail stores with a pay- per-use policy.²⁶ It is pertinent to note that battery swapping industry is still developing and with technological advancements newer and more efficient models will emerge.

CONCLUSION

Battery swapping is globally seen as the ultimate solution to overcome the shortfalls of the traditional EVs. It allows for replacement of the discharged batteries for charged ones thereby providing flexibility to recharge the batteries separately. Unlike a traditional EV wherein the owner cannot use the vehicle until it is charged, battery swapping allows for reduction in both downtime and space required for setting up charging stations. In order to promote the implementation of the Policy, the Ministry of Road Transport and Highways had earlier on August 12, 2020, allowed registration of EVs without pre-fitted batteries. The BaaS model emphasizes on buying EVs without batteries as it makes the production of EVs less expensive, resulting in reduced cost of an EV. This is most likely to act as an incentive for vehicle users as high cost in comparison to traditional vehicles is one of the biggest hurdles in mass adoption of EVs. The one-time cost to be incurred in purchasing a swappable battery is eliminated by providing batteries on a subscription basis for the during the lifetime of the Vehicle. Ease in registration requirement fosters mass production of battery swappable EVs and swappable batteries.

In addition to production of EVs without batteries and production of batteries setting up swapping stations, providing batteries and maintenance services represent a huge economic opportunity for India. It presents itself as a lucrative area of investment to both foreign and domestic investors. With policy support from the GoI and active involvement of private players, vast network of swapping stations can be set-up. This will lead to increased adoption of EV as it will address the issue of lack of charging infrastructure for EVs in India.

The Policy coupled with GoI sponsored incentives, strong coordination between multiple players, detailed standards on interoperability has the potential of helping India achieve its long-term climate goals. Further, increased purchase incentives and awareness about the benefits of battery swapping will attract more consumers, leading to large scale switch to EVs.²⁷

²³ Available at

https://bounceinfinity.com/home.html?utm_source=google&utm_medium=search&utm_campaign=INTCBrandSearch&campaignid=15501962536&kw=bounce%20infinity%20electric%20scooter&qclid=EA1aIQobChMI84y-jMWL-QIVxw0rCh3lkgJeEAAYASAAEgJblfD_BwE

²⁴ Available at <https://www.batterysmart.in/aboutus>

²⁵ Available at <https://auto.economicstimes.indiatimes.com/news/auto-components/battery-smart-announces-one-million-swaps-powering-30-million-emission-free-km/89617736>

²⁶ Available at <https://sheru.se/>

²⁷ Available at <https://www.livemint.com/news/india/india-has-found-a-way-towards-mass-electrification-swap-batteries-11657859978788.html>

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