

# INNOVATING ENERGY

## Charging India's e-mobility revolution

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## EDITOR'S NOTE

Dear readers,

India's electric mobility aspirations have galvanized an entire ecosystem comprising two-, three-, and four-wheel vehicle OEMs, battery manufacturers, and charging equipment & infrastructure providers.

According to the IEA Global EV Outlook `19, India will witness its share of electric mobility rise to approximately 30 percent by 2030.

Today marching from nascency to fruition, electric mobility will need a key catalyst: giving consumers a reason to switch. Electric mobility's foremost consumer benefit is savings on fuel costs. This, in turn, needs an abundance of charging infrastructure.

Towards enabling consumers to access these benefits, the rapid scale-up of EV Charging Infrastructure (EVCI) across the country is critical. At EESL, we have been partnering with Urban Local Bodies, institutions, and state governments to establish public charging stations. Our engagements with them have always put forward a win-win proposition: Electric mobility will not only help reduce the cost of mobility, but also support environmental sustainability.

These benefits, complemented by our proven demand aggregation model, have made EVCI establishment more attractive. We believe that with access to sufficient charging stations, consumers will look forward to adopting electric mobility. These stations will also support the electrification of our public transport fleet.

Equally important is acknowledging and responding to the impact of the COVID-19 pandemic on India's electric mobility ecosystem. With the gradual reopening of our economy, a special focus must be given to e-mobility to keep its growth in the fast lane. A collective push from the government, OEMs, charging infrastructure providers, financial institutions, and active consumer appetite for electric mobility will be vital. Conducive policies and new technological innovations that can bring down the cost of EVs and EVCI will play a key role. All these efforts will be vital to realise the benefits of e-mobility - increased energy security and lower carbon emissions - on a national scale.

In this comprehensive newsletter, we touch upon many viewpoints pertaining to the electric mobility ecosystem as it is today, how it will respond to immediate imperatives like the COVID-19 pandemic, and the journey ahead. It will explore industry-relevant topics like battery swapping, Li-ion batteries, charge point management solutions, and building a thriving EV charging infrastructure in India. The newsletter will also look at EESL's efforts in building a robust electric mobility ecosystem and the future of e-mobility in India and across the globe.

As always, we welcome your feedback and inputs.

Regards,

**Amit Kaushik**

**Business Unit Head (Growth)**

Energy Efficiency Services Limited



## **Rahul Walawalkar**

### **President**

India Energy Storage Alliance

## **Decoding Indian EV ecosystem**

India's market potential and ecosystem for electric vehicles (EVs) will play a significant role in determining the future of our mobility systems. IESA's analysis estimates that the market will have around 77 million EVs between now and the year 2030. The Government of

India has announced its e-mobility plans, and the National Mission for Transformative Mobility (NMTM), with the guidance of NITI Aayog, aims to provide impetus to the entire e-mobility ecosystem, which includes EV manufacturers, charging infrastructure development companies, battery manufacture and storage, fleet operators, service providers, and more.


As the crucial catalyst in carbon-free mobility, the installation of electric charging infrastructure was traditionally restricted to licensed distribution companies and utilities. Today, most charging stations are either owned by government utilities and Public Sector Undertakings (PSUs) on pilot mode or are provided as a free service by automobile companies. Apart from these pilot projects, Energy Efficiency Services Limited (EESL) and state distribution companies have floated some tenders to install charging stations across India. Now, however, as part of the anticipated EV policy, charging infrastructure could be allowed to be built through a service model. This will attract new players to the field, open new business models, and accelerate EV adoption.

Standardisation and interoperability are key requirements for efficient pan-India charging infrastructure. The Department of Heavy Industries' Bharat standards already propose a common standard for charging and payment mechanisms. To ensure interoperability, standardization should also be observed across battery sizes, plug technologies, and other aspects without hampering existing systems. Software will play a major role in convenient charging and last-mile connectivity and will encourage people to opt for plans that are compatible with multiple service providers. This will help utilities and service providers map the supply and demand from EVs and provide suitable incentives.

Depending on how charging infrastructure is created and policies are developed, there may or may not be a need for substantial new generation capacity. For instance, if 100 GW of solar capacity is added by the year 2022, it is expected that India will have a net load curve with enough capacity for taking on additional load during the afternoon. If we can have sufficient public charging facilities for charging EVs during the day, it can solve the problem of low net loads when maximum solar energy is produced.

Many of the components required for charging or swapping stations are currently imported. There is a huge opportunity for local tools-and-components-makers to design and manufacture them in India. Even local component suppliers of the automobile industry could diversify into manufacturing components for EVs.

India has a vast talent pool but lacks R&D facilities and proper direction for manufacturing components and electronics for the EV sector. There is a need for a special incubator to nurture early-stage EVs and electronics



and energy storage technology startups, and to provide them with suitable facilities for accelerating their journey from laboratory to commercialization. IESA has been working on the creation of such an incubator for the energy storage sector, in line with the Government's Atal Innovation Mission. It is also working with the Skill India Mission and various academic partners to identify skill and training gaps in this area.



**N Mohan**  
**Deputy General Manager and**  
**(Head EV - Charging Infrastructure)**  
 Energy Efficiency Services Limited

## India's Emerging Electric Vehicles Charging infrastructure Outlook – Striding Towards Economies of Scale

*How adequate infra can boost adoption of E-mobility in India?*

Adequate EV charging infrastructure has been the key for the uptake of Electric Vehicles. As per the IEA, in 2018, the global EV fleet stock crossed the 5.1 million mark up by 2 million since 2017, strongly backed a global push for charging infrastructure which crossed the 5.2 million mark across all segments worldwide.

After much deliberation, it was concluded that Electric Vehicle Charging Infrastructure (EVCI) should be the first priority before widespread EV penetration. It has been proved that the availability of a strong network of Electric Vehicle Supply Equipment (EVSE) in a country has been three times more effective than providing rebates and subsidies on the purchase of an electric vehicle<sup>1</sup> From a demand standpoint, both public and home charging infrastructure are critical to promote EVs. Adequate EV charging infrastructure relaxes the range anxiety for users and the technological improvements leading to decreasing charging times are improving the convenience factor for the EV users. A major role is played by the public charging infrastructure providing the “on-the-go” charge which if, widely available and feasible can be a game changer for the uptake of EVs. International Council on Clean Transportation (ICCT) estimates that the leading electric vehicle markets of Norway and the Netherlands have more than 10 times as many public charge points per capita as average markets, and leading markets in California and China had three to five times the average.<sup>1</sup> Globally, the public charging infrastructure has grown at a staggering CAGR of 84% in the last decade with more than 100% YoY growth rates between 2009-2012 and 2013-2014 averaging around 180% YoY growth between 2010-2018.

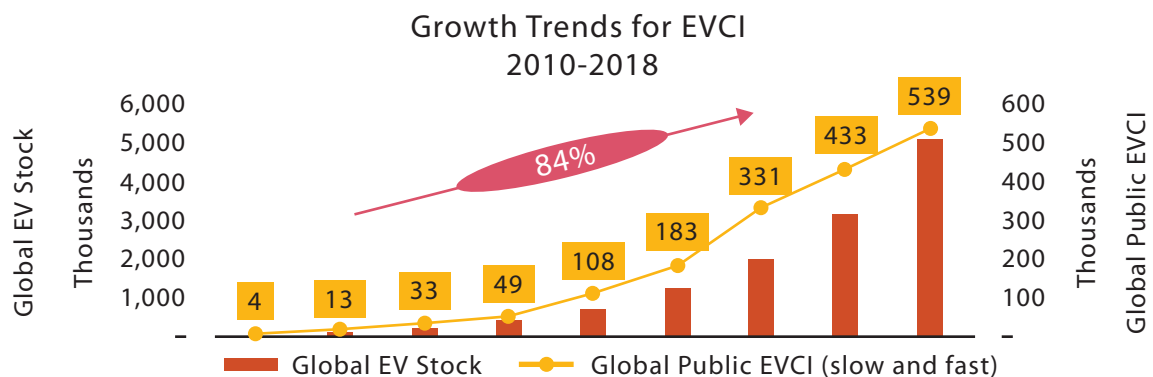


Figure 1: How the global markets are shaping up?<sup>2</sup>

<sup>1</sup> Yu, Li, & Tong, 2016

<sup>2</sup> IEA, PwC Analysis

India is an emerging electric mobility market and as the world's fourth largest automotive market we are gradually becoming the focal region in Electric mobility. A strong government push towards clean mobility coupled with an increased public awareness about sustainability and environment, India's move towards electric mobility is a concept whose time has arrived. There are roughly 200 million vehicles which currently ply India's roads, of which less than one percent are electric vehicles. As per IEA Global EV Outlook '19, the projected share of EVs in India will achieve a dominant share of ~30% by 2030.<sup>3</sup> India's EVSE installations are at a nascent stage, with around 352 publicly accessible chargers (slow and fast) in India till 2018. It is estimated that by the year 2030, India's publicly accessible EVCI will cross 400,000 mark.

India Public EVSE (slow and fast)

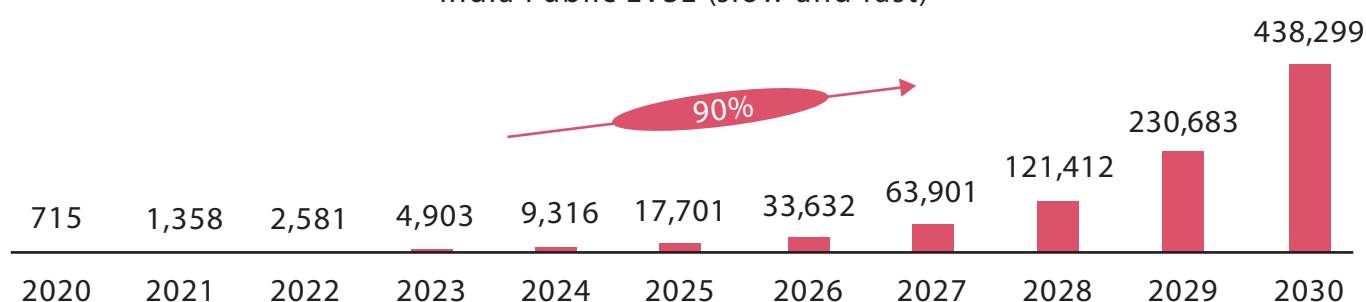


Figure 3: India Public EV Charging Infrastructure Growth Trend <sup>4</sup>

Since, 2013 when 'The National Electric Mobility Mission Plan (NEMMP) 2020' was launched, charging infrastructure development has come a long way ahead. The Government of India's policy direction is clear that Charging infrastructure development should precede penetration of Electric Vehicles. Business models have been simplified to promote private sector participation through the clarification provided by the Ministry of Power that EV Charging will be considered as service, and guidelines and standards have been issued by Ministry of Power and statutory authorities, 'Model building bylaws (MBBL) and Urban Regional Development Plans Formulation and Implementation (URDPFI) Guidelines' have been amended by Ministry of Housing and Urban Affairs, and market development and ecosystem development activities are being led by EESL.

Though we have achieved considerable feats, there are still various grassroots aspects to be resolved. Application approvals, land access, grid connectivity, and regional regulatory hurdles are some of the grassroots operational challenges affecting the commercial feasibility and project turn around. In times to come, if EVCI projects have to achieve substantial scale, various application processes will need to be streamlined and standardised. DISCOMS will need to establish single window digital application processes to fast track EVCI applications. Electricity costs are estimated to be about 60-70% of the end-user charging tariff and State Electric Regulatory Authorities can help develop feasible EV tariff mechanisms. Efficient processes have to be developed for location siting and grid load planning. Technology integration will play a major role here in terms of identifying right locations and conducting extensive load planning simulations for the sites.. DISCOMS should assist charging point installers in conducting grid load studies and supporting in an efficient utilisation of upstream infrastructure, reducing the need for adding redundant infrastructure increasing commercial strains. Additionally, various state authorities in sync with EVCI State Nodal Agencies can help assist in aggregation of viable land sites through initial location assessments and establishing standardised revenue sharing mechanisms to access land.

<sup>3</sup> IEA – GEO – 2019

<sup>4</sup> IEA; PwC Analysis

At EESL we are actively conducting bulk procurement and demand aggregation to bring down supply costs. Our focus is towards holistic city level ecosystem development and hence we have partnered with local city municipalities, DISCOMs, Metro Rail Corporations, Oil Marketing Companies and City Development Authorities for locational assessments and setting up of charging infrastructures across Cities pan India.

EESL undertakes detailed assessment of various parking locations in the city to install Public EV Charging Stations (PCS), procure the required chargers, and install the chargers at different parking locations. The city municipality or land-owner earmark the parking sites for EVs. In lieu of this, EESL shares a part of revenue with the city municipality or land-owner.

On the demand side to improve charger utilisation levels, we have forged successful partnerships with EV fleet operators who are prominently based on EESL EVCI ecosystem. To enhance digital visibility and promote customer attraction, all the EESL's Public Charging Stations are operated through a mobile app developed specifically to integrate Network Service Provider (NSPs), e-mobility Service Provider (MSPs) and Charging Point Operators (CPOs).

Our primary purpose is to develop the EVCI ecosystem from nascency to economies of scale. Our vision is to scale our operations pan India with deployment of more than 10,000 Chargers by 2025. We are the first organisation in the country to deploy Electric Vehicles (EVs) and Public Electric Vehicle Charging Stations (PCS) on a large scale. We have recently closed procurement of 200 Fast DC chargers and procurement of about 1020 Chargers is underway. By the end of 2019, we had deployed, more than 470 captive chargers and 84 Public EV Charging Stations across India. We have taken initiatives to create charging hubs across the country and will be establishing about 1020 PCS by March 2021 across 14 Cities under the FAME II scheme. A testament to the efficacy of our initiatives to deploy Electric Vehicles (EVs) and Public Electric Vehicle Charging Stations (PCS) in India, we received the prestigious ISGF Innovation Award in the 'EV and EVSE Rollouts' category. This award is a recognition of our concerted efforts towards building a thriving EV ecosystem in the country.

The future of EVCI growth in India is dominantly positive, we are hopeful of achieving the global EVCI penetration growth rates and we firmly believe with the emerging supply side, strong government push, increasing demand and grassroots level tweaks EVCI sector will definitely propel EVs to achieve 30% share by 2030.





**Garrett Fitzgerald**  
**Manager and India Power Sector Lead**  
Rocky Mountain Institute


## **Preparing DISCOMs for electric vehicles as distributed energy resources**

The electric vehicle (EV) market is one of the most rapidly growing sectors in the global economy. In India, the EV market is in early stages of electrification, propelled largely by central and state government policies and accelerated by the declining costs of lithium batteries and ever-improving vehicle technology. Converting India's existing vehicle fleet to electric will add terawatt-hours of new demand to the grid and require thoughtful, timely planning to minimize costs and maximize benefits for DISCOMs and customers. If managed correctly and planned proactively, this new large and flexible load will support long-term revenue growth and improve the efficiency of DISCOM operations. However, if the new demand is not met proactively, DISCOMs will be challenged by large numbers of interconnect requests and little control over the new load, resulting in a lost opportunity for demand-side management and a slowdown in new revenue growth.

If the EV market growth scenarios presented in NITI Aayog and Rocky Mountain Institute's 2019 report 'India's Electric Mobility Transformation' come to fruition over the next decade, Indian DISCOMs will serve about 10 TWh per year of EV load by 2030. However, meeting this new load will not necessarily require massive investments in grid infrastructure if some early and thoughtful planning is put into it.

A simple analysis indicates that, if daily EV charging across India in 2030 is spread evenly over 24 hours, the total EV energy demand will be 10 GW. Alternatively, if the same energy requirement is spread over only four hours (assuming all vehicles are charging during the same four-hour window), the additional peak demand will be over 60 GW. While neither scenario is a likely representation of how vehicles will charge from the grid, it does demonstrate the wide range of power demand, and emphasizes the need for encouraging charging patterns that benefit the local grid while meeting customer needs.


Planning for, and deploying, adequate charging infrastructure to serve both commercial and private vehicles in a manner that meets the needs of vehicle owners/drivers and provides DISCOMs with load flexibility can be accomplished by using a diverse range of charging technologies and by including effective price signals from DISCOMs. A robust network should make use of slow- and high-speed chargers; AC and DC chargers; battery-swapping and conventional charging; workplace and home charging; and dedicated and public chargers. If EV owners can be provided with an assortment of options to meet their various charging needs, and an appropriate price signal, they will be able to choose when, where, and how to charge. If designed properly, such a price-based choice will give DISCOMs greater influence over how EVs interact with the grid. It is important that all types of chargers be equipped with some level of intelligence that enables load management and responds to price signals.



The first step in planning for an EV future is to build capacity among key stakeholders and ensure that all parties have the knowledge required for productive planning discussions and that they understand the trade-offs and constraints that each group faces. In order to benefit from the demand flexibility of EV charging, DISCOMs, regulators, OEMs, and charge-network operators should collectively understand the forces driving adoption and work together to shape technical aspects and market development in a way that encourages a flexible charging system. Pilot projects that demonstrate how EV load profiles can be shaped in a way that minimize grid infrastructure costs, maximize consumption of renewables, and meets customer needs through time-of-day pricing and aggregated demand response programs, must be prioritized and highlighted among DISCOMs.

There is no better time than now for DISCOMs and other stakeholders to prepare for EV-readiness. DISCOMs across India are in various stages of rolling out smart meters, testing time-of-day rates, building out Demand-Side Management (DSM) programs. It is important that DISCOMs develop EV-readiness plans that are aligned with, and support, ongoing and future Smart Meter implementations. DISCOMs must embrace the growing EV market and be proactive, not reactive, in seizing the opportunity.

However, they cannot do it alone; they need the support of regulators and policymakers. Moreover, they must engage with sectors that have historically been siloed from their own – automobile and transportation. DISCOMs with early experience in EV-readiness and EV planning are encouraged to share the lessons they have learned, including missteps, early and often. The success of the transition to electric mobility over the next decade will require a good deal of coordination, patience, and adaptation.





## Anirudh Arun

COO

Blu Smart Mobility


## Ramping up charging infra for leveraging electrification of fleet


### Summary

As electrification of fleets accelerates across India, driven by both environmental and price advantages, the requirement for EV Charging will rise rapidly. EV Charging for fleets will continue to have unique challenges and different requirements, as compared to the charging of Personal Electric Vehicles.

Blu-Smart has already set up 169 fast- and slow- chargers in Gurugram alone and is expected to double this number in the next four months. The biggest resistance to faster growth of EV Charging in India is the availability of a combination of land and load at suitable locations.

### What it takes to set up an EV charging station for fleets

 Petrol Pump	
Turnover time	3-5 minutes/car
Space Requirements	Low
Other Requirements	None

 EV Charging Station	
Turnover time	45-90 minutes/car
Space Requirements	High
Other Requirements	200-800 kW load

The availability of a combination of real-estate (land) and electric power (load) at suitable demand hotspots for fleets – like malls, office-complexes, residential areas, airports, and railway stations – can help accelerate the electrification of fleets in India's mega-cities.

### Maximizing time of fleet vehicles on road

Unlike Personal Mobility vehicles, which normally are driven on road for 1-4 hours per day, Fleet Vehicles are required to be on the road, carrying passengers, in excess of 10-12 hours per day in order to be profitable. Thus, the Slow Charging cycles of these vehicles would have to be carefully planned, and a majority of the “refuelling” of these will happen through DC Fast Chargers.

These chargers need to be utilised in such a manner that their effective usage on a daily basis makes them economically viable. Excessive utilisation of these chargers is also not viable as this leads to discharged vehicles waiting in queue, for their turn to charge.



## Charger Utilization



### Orange Zone

>55% Cars queue up for charging

### Green Zone

35-55% Ideal for Charger Unit Economics as well as Cars on Road

### Red Zone

<35% Charger has negative Unit Economics

DLU Smart - Accelerate on Electric Mobility



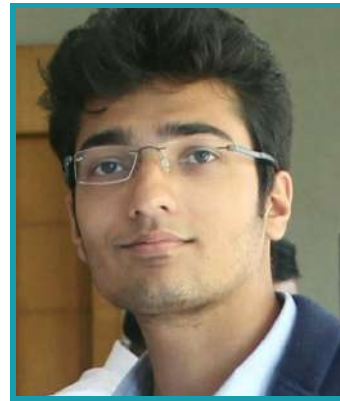
## Way Forward for EV Fleets in India

As thousands of fleet vehicles go electric, it is only understandable that charging infrastructure will have to be ramped up swiftly. Fleet companies continue to explore different charging models including distributed public charging, dedicated captive charging in hubs and various combinations of these two models.

Various arms of the government, as well as energy service behemoths such as EESL are playing a pivotal role in accelerating the electrification of fleets in India's mega-cities. Further governmental interventions and policy tailwinds would be helpful in accelerating India's shift to clean, connected, and shared mobility.



**Pradeep Singhvi**  
Associate Director  
PwC



**Tanmay Nag**  
Consultant  
PwC

## Sustaining EV momentum during COVID and beyond

What does COVID-19 entail for the industry? How will the global interlinks shape up? How do we sustain and emerge strong?

### LOOKING INTO THE PAST: STRONG GROWTH and THE HAPPIER TIMES

We picked up four key trends from the International Energy Agency (IEA)'s Global EV Outlook 2019 (GEO '19), and they tell us a story of 7-digit vehicle/charger stocks and double-digit growth rates.

5 MILLION ELECTRIC VEHICLES	5.3 MILLION CHARGING POINTS
63% UP SINCE 2017	44% UP SINCE 2017
107% CAGR	84% CAGR
118% AVERAGE YOY GROWTH BETWEEN 2010-18	180% AVERAGE YOY GROWTH BETWEEN 2010-18

#### *What's leading the growth?*

Electric mobility is an impactful tool in our initiatives towards climate change, energy efficiency and environment conservation. It is estimated that by 2040, EVs are expected to displace 6.4 MMbpd<sup>1</sup> of oil demand. EVs efficiencies are more than 35% from well to wheel (W2W), 50% higher than the ICE vehicle well-to-wheel efficiency of close to 22%,<sup>2</sup> and thus are on their way to displacing 540Mt CO<sub>2</sub>-eq of W2W emissions in 2030.<sup>3</sup> In the last decade, electric mobility emerged fully, going beyond being a concept. It has

<sup>1</sup> BNEF

<sup>2</sup> TU Delft

<sup>3</sup> IEA EV30@30

begun making economic sense for consumers to shift from ICE, in-turn creating demand for suppliers to develop better products and develop economies of scale and reduce upfront costs. Coupled with the noble causes, the availability of efficient and economic products in the markets, government push, consumer awareness and availability of charging infrastructure has pushed the strong growth trends for electric mobility across the globe.

## **PRESENT: INTERLINKED ECONOMIES, COVID-19 AND TROUBLED WATERS**

The COVID-19 (Coronavirus) outbreak has created unprecedented scenarios globally, with rising cases creating an overwhelming impact on the healthcare systems and bringing nations to a near complete economic halt. Consequently, the world has been put under a stress test. Disruption to business and economic activities is likely to continue for many months to come. COVID-19 has unleashed a devastating blow to the global economy, bringing almost all economic activities to a standstill, creating large holes in public and individual incomes, and disrupting supply chains while choking off demand.

The effect is evident on the electric mobility supply chains as well. From rare-earth elements for batteries to power electronics and vehicle assemblies, electric mobility has evolved through global supply chains. In present times, majority of production facilities across supply chains remain closed or are not able to attain full production capacity.

In global trade, China has been the leading exporter with more than US\$2.5T in 2019. The global dominance of China extends to the electric mobility sector as both a supply and demand powerhouse. As per 2018 estimates, Chinese lithium production was at 8,000 metric tons<sup>4</sup>, and lithium reserves were estimated to one million metric tons.<sup>4</sup> Coupled with a strong power electronics market, Chinese entities control nearly half of global lithium production and 73%<sup>4</sup> of the electric battery production capacity estimated to around 230 GWh in 2019.<sup>5</sup> In 2018, China had a total of 2.3 million EVs, around 45%<sup>6</sup> of the global electric cars on the road and by 2030 it is estimated that China could account for and supply upwards of 60%<sup>7</sup> of the world's EVs.

Due to the nationwide lockdown and social distancing measures, battery production across China is going to take a hit in both supply and demand - a fall of 26GWh<sup>8</sup> in production capacity is expected in 2020. Leading battery manufacturing players CATL and BYD are faced with a high probability of production delays and resuming of full-scale productions. Tesla's Gigafactory in Shanghai has hinted of possible supply shortages for the US, the UK and Australia. China exports an estimated US\$70bn<sup>8</sup> worth of car parts and accessories worldwide and has estimated a production shortfall of 1 million vehicles.<sup>8</sup> Hubei's capital city Wuhan, the epicentre of the coronavirus outbreak, is a key production base for automotive manufacturing. The sales of various OEMs have been down by 60-80%.<sup>8</sup>

With most of the supply being concentrated in China, the demand for Electric Vehicles and Charging Infrastructure has been spread out across the USA, Europe and the Asia Pacific. As observed in most global markets, the global interlinkages in the times of an economic standstill can create supply chain breaks, logistical delays and premature demand terminations.

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<sup>4</sup> Forbes <https://www.forbes.com/sites/rpapier/2019/08/04/why-china-is-dominating-lithium-ion-battery-production/#33218beb3786>

<sup>5</sup> BNEF, Reuters

<sup>6</sup> IEA GEO 2019

<sup>7</sup> Goldman Sachs

<sup>8</sup> <https://www.power-technology.com/comment/covid-19-electric-vehicle-production/>

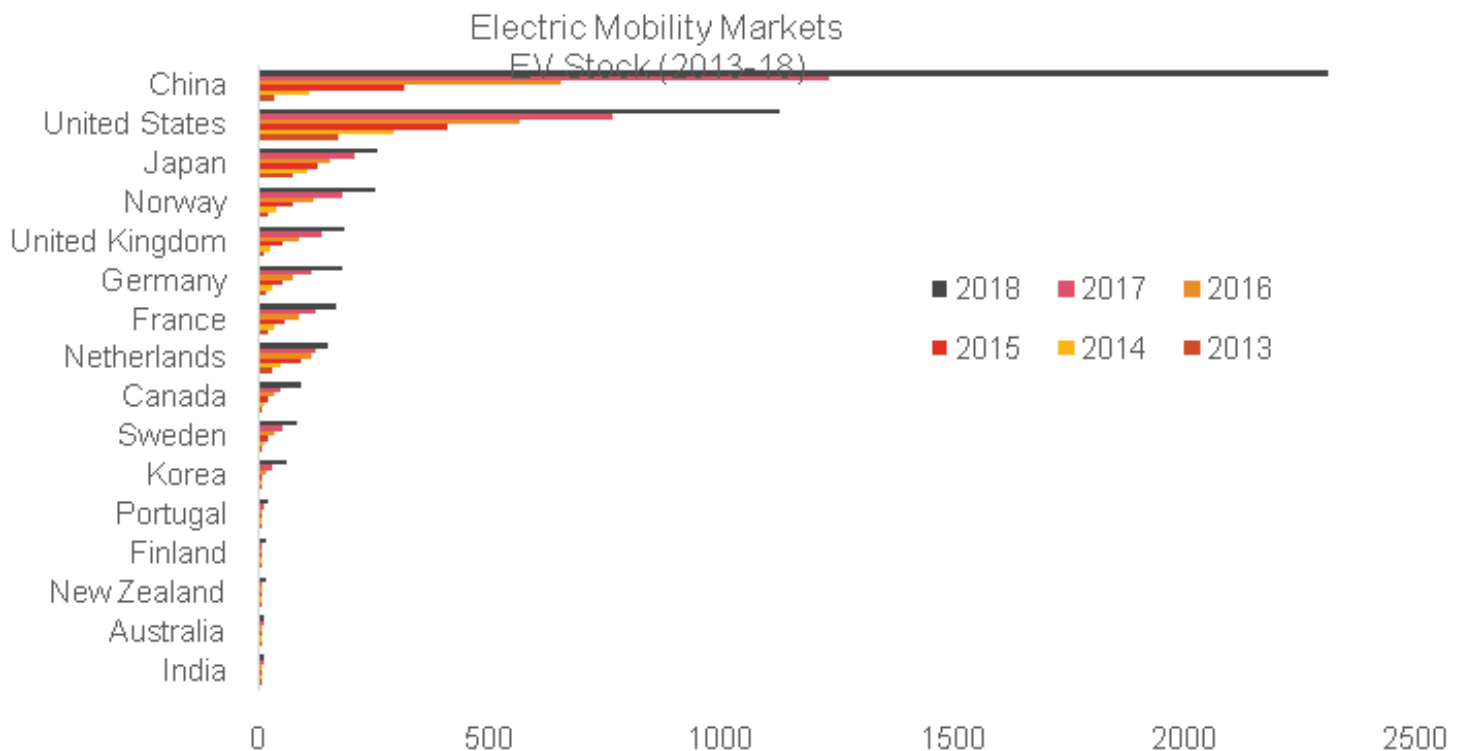


Figure 1: Global Electric Mobility Markets (2013-18)<sup>5</sup>

### Impact on Electric Vehicle Charging Infrastructure

Across the Electric vehicle charging infrastructure value chain, we see manufacturing, sales/retail, installations and operations bearing the major impact of the economic lockdown. Maintenance and field services will have a moderate impact. Digitally enabled billing and value-added services will have low to minimal impact.

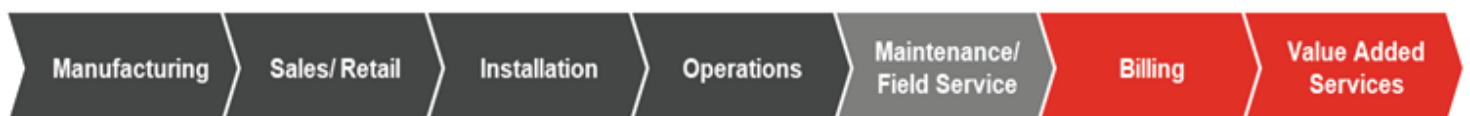


Figure 2: Impact on EVCI Supply chains

In India's context, the majority of the EVSE components (i.e. hardware) to set-up the charging infrastructure are imported from China and assembled in India. With the halt in production centres across India and China, manufacturing will be primarily impacted and will take the longest to recover. A key turnaround factor will be the buffer capacity of components with Indian OEMs.

Along, with manufacturing, we see that retailing/sales will be affected due to inter-country and inter-states logistical challenges. Herein, enough buffer capacity of components amongst manufacturers will determine the installations turnaround time once the lockdown is lifted in the demand locations.

Operations would be significantly affected as the utilisation levels of the chargers will go down to almost nil in the absence of individual and fleet vehicles. This will cause financial strains and may significantly affect the operations of firms operating on thin cash flows.

Maintenance/field service is expected to be moderately affected considering the required on-ground staff would be available immediately post lock-down is lifted. We see some initial delays due to the unavailability of skilled labour in the light of labour migrations.

Digitally enabled services of billing and value-added services would remain unimpacted in principle but being complementary to the primary operations would be of little importance.

## **FUTURE: DEVELOPING RESILIENCE AND THE NEW WORLD ORDER**

Ray Dalio (Co-Chairman, Bridgewater Associates) describes the current environment as the emergence of a 'new world order'. The world post-COVID-19 will be a very different one from the one today. We will find new ways to adapt, conduct business and interact. We will pivot from models such as 'Asset light' and 'Core offshore manufacturing' models to the models offering improved resilience with an inward approach. Innovation will start to take a centre stand (notice an increasing number of hackathons and emerging ideas in the current times) as nations will increasingly focus on becoming self-reliant. We understand that not every nation has the right resources and trade is a crucial factor of the prosperity in emerging markets, hence, globalisation and interlinked supply chains will gradually re-emerge post an initial downward trend. New technologies, changing consumer preferences and fragmented supply chains will define the new world order.

### ***How can the EV and EVCI industry prepare for the New World Order?***

## **UNDERSTAND AND ASSESS THE RISKS**

*"To know thyself is the beginning of wisdom" - Socrates*

Stakeholders across the value chain should develop a realistic point of view on the technological, regulatory landscapes and consumer preferences. Stakeholders have to be agile and dynamic in understanding emerging implications. A re-look on the supply chains, business models and markets are necessary to bring out all the red flags.

## **GO BACK TO THE CAPITAL STRUCTURE DRAWING BOARD**


*"With money in your pocket, you are wise, and you are handsome, and you sing well too." - Yiddish Proverb*

With business continuity as the priority, stakeholders need to assess if they have the financial flexibility to remain strategically nimble. Substantial debt burdens may make it more difficult to invest in life-critical projects and potential unicorn projects that will pay off in the long run.

## **GO DIGITAL. NOW!**

*"There is no alternative to digital transformation. Visionary companies will carve out new strategic options for themselves — those that don't adapt will fail." – Jeff Bezos*

In the current phase of remote working, we all have realised the importance of digital technologies. The question essentially is - How do I improve my operational efficiencies, or How do I reach that new market, or




How do I engage my end users? There is a purpose behind every innovation and it's the right time for stakeholders to ask these questions and realign their digital strategies.

## **DECIDE ON THE BEST PATH FORWARD**

*"Change is the law of life and those who look only to the past or present are certain to miss the future" - John F. Kennedy*

Post COVID-19, stakeholders will have about 1 to 2 years' horizon until when the global markets start recovering and maturing. This is the right time for a new strategy, pivot plan or transformation. Possible strategic moves can include adding software or advanced electronics capabilities, either organically or through acquisitions, joint ventures or partnerships, or planning to exit lines of business that may see slower growth as EV adoption.





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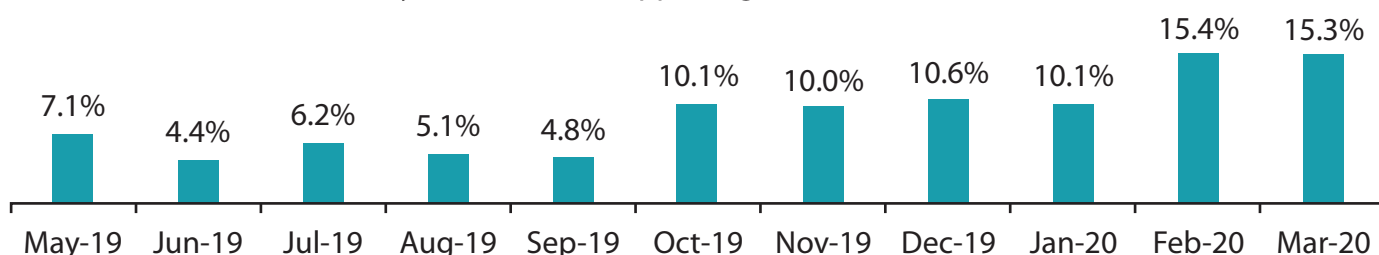
## ChargeD: Charger Monitoring Dashboard for Electric Vehicles

As the electric vehicles (EVs) market evolves in India, it is important to capture data for reporting and analytics that will help monitor the utilisation of initial public chargers. This data will provide significant insights to stakeholders such as charging station operators, utilities, etc. and help in better planning, implementation, and scaling up of public charging stations for EVs in India.

The United States Agency for International Development (USAID), through its bilateral program with the Ministry of Power, Smart Power for Advancing Reliability and Connectivity (SPARC), supported EESL in designing its public charging interventions, including developing such an analytical platform for EVs. The “ChargeD” dashboard will help track and review key performance parameters of public charging stations. Useful insights for ChargeD is assisting EESL in reviewing its business model and pricing strategy for EV public charging station business. The use of the EV analytics dashboard is multiple and the benefits to stakeholders are immense.

### ChargeD: Key Initial Trends on Utilisation of EV Chargers

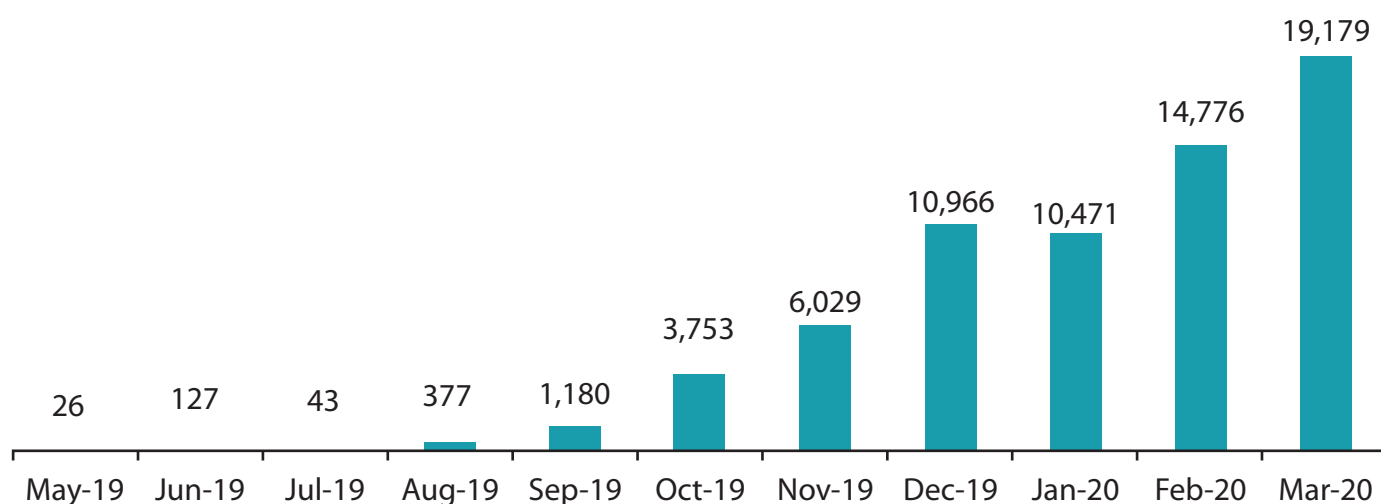
- a) Monthly utilisation of chargers<sup>1</sup> touched 15% in Feb 2020 with accumulated energy consumption of over 100,000 units (May-19 to Mar-20) supporting ~ 6 lakh clean kilometres<sup>2</sup>.



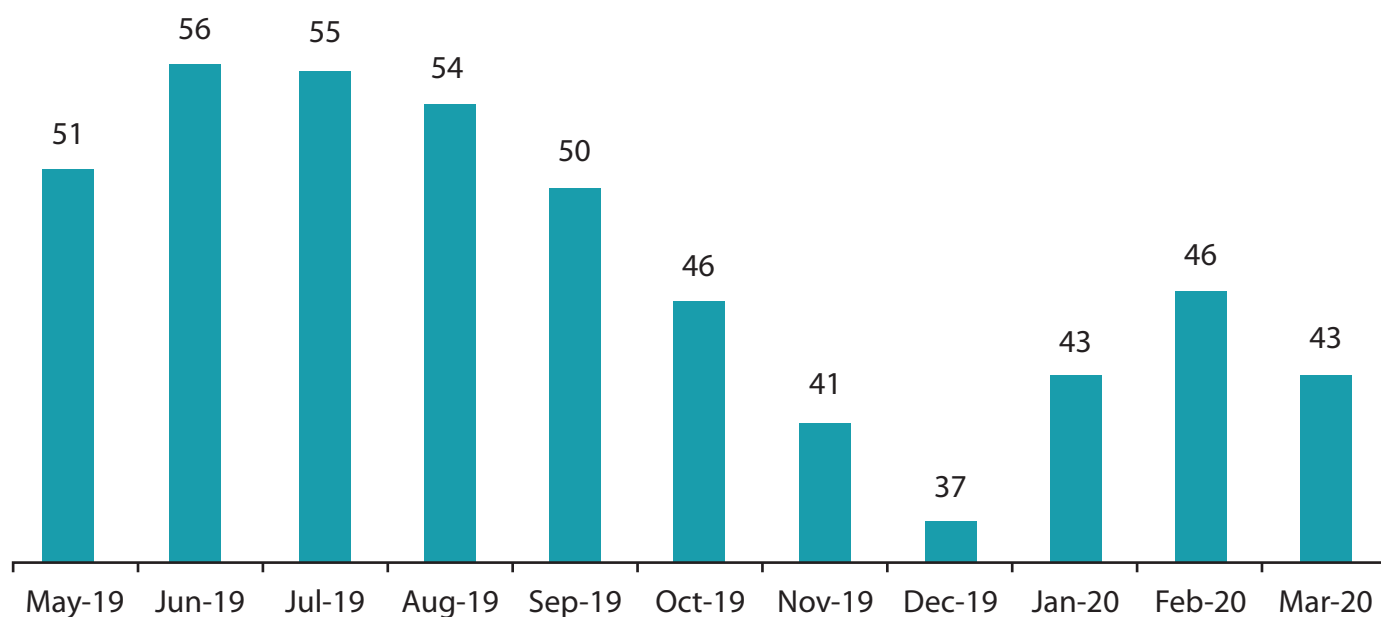
<sup>1</sup> Measured as utilisation of chargers when online

<sup>2</sup> Assuming a mileage of 6 km per kWh

- b) Utilisation by cab aggregators, one of the biggest beneficiaries of public charging stations, is increasing by ~90% on a monthly basis; this is critical and also serves as a testimonial to EESL's efforts in forging win-win partnerships with aggregators such as Lithium, BluSmart, etc. With easily available charging stations, cab aggregators will focus on operations of EVs without any "range-anxiety".

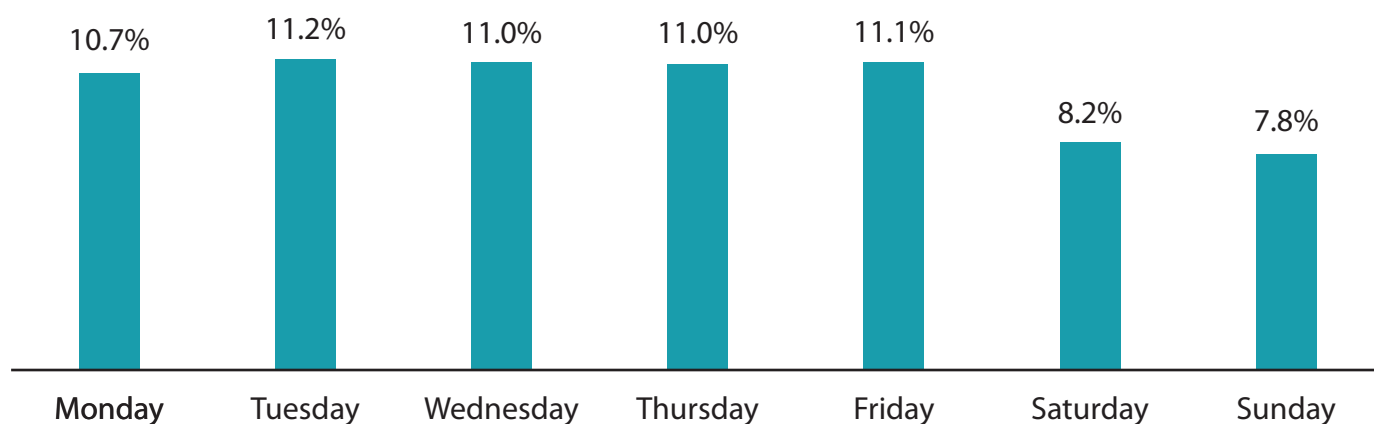


- c) The range anxiety has decreased from 52 km (May 2019) to 43 km (March 2020)<sup>3</sup>. This is a positive development as range anxiety is often quoted as one of the key barriers to mass adoption of EVs.



<sup>3</sup> Computed using the average minimum state of charge of battery at which EVs come to utilise the PCI. Assuming a mileage of 6 km per kWh and EV with battery capacity of 18 kWh (Based on models available in the market and vehicles compatible with DC001 chargers).

d) Chargers are being utilised the most during weekdays. This is line with the utilisation trend of commercial cars that are utilised mostly during the working days.



#### Indicative Benefits to Stakeholders

Stakeholder	Benefit
Power distribution utility	<ul style="list-style-type: none"> <li>a) Load management</li> <li>b) Insights to introduce dynamic tariffs/time-of-day tariff</li> </ul>
Charger operator/vendor	<ul style="list-style-type: none"> <li>a) Overall level of utilisation of chargers</li> <li>b) Utilisation of chargers basis different time-of-day, location of a city, day-of-week, etc.</li> <li>c) Consumption pattern of different consumer categories</li> <li>d) Option to generate non-tariff revenue such as advertisement revenue</li> </ul>
Land-owner	<ul style="list-style-type: none"> <li>a) Better visibility of revenue from land</li> <li>b) Potential revenue generation option from advertisement near the land</li> </ul>



## **Vinit Mishra**

### **Leader**

EY P&U (Digital)

## **Significance of Analytics Tools in EV charging infrastructure business**

The global e-mobility market is undergoing a transition from Range anxiety to Experience anxiety, while witnessing a consistent rise.

A key segment of this evolving ecosystem is the Electric Vehicle (EV) charging infrastructure market which has started to gather exponential momentum. Building and operating an EV charge station is complex and requires strategic planning. From a technical perspective, the electric grid load should be meticulously managed, with further attention to charge point availability and optimised utilization. On the business end, care must be given to enhancing the customer experience and maximising the return on investment.

Intelligent analytics tools play a pivotal role in mastering the complexities of the EV charging infrastructure business. Deriving insights from data is the key for EV infrastructure operators to unlock the several benefits, across the entire lifecycle of their charge station portfolio. From planning, deployment and installation of charge points, to the operation and maintenance (including cyber security, third party vendor and field force management), data analytics play a major role in ensuring efficiency, productivity and profitability. Also, business-centric operations such as customer relationship and experience management are driven by analytics on feedback and consumer behaviour.

There are significant benefits to building an optimised charger portfolio and grid infrastructure, with enhanced customer experience, supported by good analytics. For example - insight-informed operations of the public chargers guarantee return on investment for the chargers themselves. Simultaneously, utilities can tap into the full potential of Vehicle-to-Grid (V2G) applications to manage grid congestion; this flexibility will be invaluable as intermittent generation resources such as wind and solar create an increasingly volatile grid. Finally, the ability to maintain and improve the positive experience for the end customer is paramount – and it is also essential to driving adoption of EV within the mobility market.

The international management and technology consultancy Ernst & Young provide their clients with an innovative tool called EY UtilityWave. The tool, built on a proprietary Microsoft Azure platform, aligns market insights and best practices alongside legacy systems, new IoT devices and other sources of data. It then produces data visualizations as well as data for operational excellence to empower Charge Point Operators (CPOs) to derive measurable performance improvement outcomes for utilities and their customers. Exemplary use cases are:

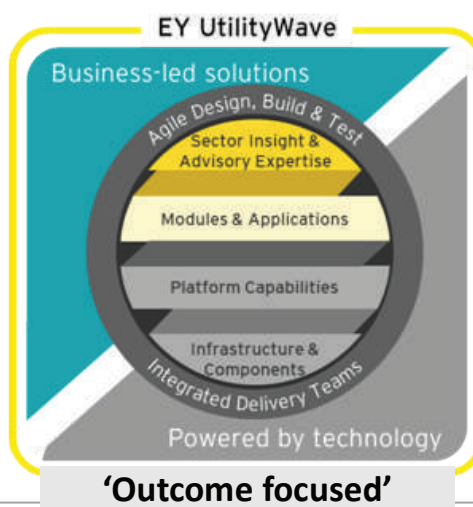
- Analytics powered by Machine Learning to capture data from smart (connected) devices, to detect EVs on the network and monitor usage

- Geographical forecasting of EV charging capacity demand to intelligently inform planning management for the construction and installation of public and private EV charging stations
- EV charging station utilization analysis to optimise return on assets, customer analysis and private and commercial user analysis
- Monitor Back-office operations such as revenue forecasting, cost to serve analysis and complaint management, to achieve operational excellence

### ‘Business led’

#### Market leaders in Digital Grid advisory

EY brings unparalleled insight and expertise to work alongside clients to understand their specific business needs to tailor the solution, involving them every step of the way.



### ‘Technology powered’

#### Proven, scalable & secure cloud technology

EY leverages technology, with a platform built on the market-leading Microsoft Azure, to accelerate the deployment of customised client solutions.

**Deliver turnkey solutions** – Fully integrated teams combine business and technology skills and turbo-charge the design, build, operate, and transfer cycle.

**Deliver quick results** – EY uses agile delivery methods focused on rapid development cycles to test/validate often and build incrementally.

**Value-driven** – EY uses flexible commercial models and price based on value that is tailored to the context of clients.



**Sumit Ahuja**  
**Founder & Director**

ElectreeFi - Next Generation IoT Platform for Evs

## **Effective charge point management solution: Fostering swift adoption of EVs**

Most people understand the advantages of EV mobility; negligible pollution; long-run cost savings; fuel availability at home and office, and low maintenance. So, what are the biggest impediments in the adoption of EVs in a country like India? Various studies identify four factors that together act as the biggest roadblock to EV adoption: range anxiety; negligible charging infrastructure; lack of choice of EV models; and the initial cost of an EV.

With OEMs now focusing towards a robust EV strategy, the market can anticipate more EV launches.

The Hyundai Kona, MG ZS EV, Tata Nexon EV and the launches of Audi e-tron, Mahindra eKUV 100, BMW i3, to name a few, in the coming months are a testament to this fact. As the number of EV models and their volumes increase, the cost of EVs is sure to come down.

That still leaves us with two important issues to tackle. We firmly believe that technology can play a role in alleviating customer anxiety and concerns, thus enabling faster EV adoption. Not only can technology be an enabler for seamless ICE to EV transition, but it can play a very important role for the Charging Infrastructure Providers for running their EV Charging Stations. When the growth comes technology will further help the energy management companies and the utilities.

The core technology for managing the EV ecosystem is a Cloud-based Charge Point Management Solution (CPMS). It is a powerful tool for the entire ecosystem: the EV owner; the Charging Infrastructure Provider (CIP), EV Fleet Operators, and the Energy Management Companies/Utilities.

Charging infrastructure providers use CPMS extensively to manage and operate EV Charging Stations in an unmanned way, thus considerably reducing the maintenance and operations cost. This makes it a powerful asset for a business that needs to be highly optimized to earn revenues.

CPMS provides a way to remotely manage charging infrastructure through a central command centre, thus reducing the need for the manual workforce. Extensive features (given in Table 1.0 below) give total control in the hands of the CIP to run business operations effectively and efficiently. Such a system would thereby encourage CIPs to deploy more EV Charging Stations without worrying about their operational needs. The EV owners are also likely to benefit from the CPMS - these benefits are outlined in Table 1.0 below.

This system provides a hassle-free charging experience thus enabling the transition to EV in a seamless way.

**Table 1.0: Features of a Charge Point Management Solution**

Charging Infrastructure Providers	End User Capabilities
Asset Management and Control (including Asset Servicing)	Find, View Live Availability Status, Direction and Navigation to EV Charging Stations
Pricing Management including GST	Reserve a Charging Slot
Charging Station Management	View/Provide Reviews and Customer Feedback
Users, Roles, Permissions Management	Digital Payments
Invoicing/Billing including integration with backend financial systems	Charging Transactions History along with Invoices
Integration with Parking Systems	Trip Planning
Corporate Management	Premium Subscriptions
Integration with Fleet Operators	Remote Charging
Reporting and Analytics	Multilingual along with extensive system preferences

Similarly, this system works in a seamless fashion for an EV fleet operator, by guiding EV drivers to plan and manage their EV charging needs at public locations and EV hubs. In addition, the system generates charging reports and analyses charging data, thereby presenting a powerful analytics architecture. This can ultimately help various ecosystem stakeholders in furthering the efficient use of the charging infrastructure, and enabling effective time and cost utilisation.

Such systems communicate to the charging station, through a standard protocol Open Charge Point Protocol (OCPP). A standardized protocol enables the Charging Infrastructure act as a shared one; in addition to one's own stations, the application shows stations from all other operators as well, using a standardized inter operator protocol known as the Open Charge Point Interface protocol (OCPI).

The CPMS' integration capability with third-party systems is a well-defined process. Two-way data exchange can happen synchronously, thus allowing this system to be tightly coupled with existing organizational systems.

We believe that once such systems are widely in use, they will help in automating the entire ecosystem, benefiting all the stakeholders run operations flawlessly, thus enabling faster EV adoption.



**Nitish Arora**  
**Research and Policy Lead**  
OLA Electric Mobility Pvt Ltd

## Battery Swapping to charge India's EV dreams

Transitioning to cleaner mobility solutions is critical for achieving Indian's Nationally Determined Contributions wherein India has pledged to improve the emissions intensity of its GDP by 33 to 35 percent below the 2005 levels by 2030. In India, the transport sector contributes close to 10% of the total national GHG emissions, with road transport contributing about 87%<sup>1</sup>. Electrifying the road transport sector has the highest energy savings potential of around 40% in 2030, which is largely driven by ambitious adoption of electric vehicles and a shift from private to shared modes.

However, the uptake of EVs has been slower than expected. On the one hand, high upfront costs, lack of charging infrastructure, and uncertain performance of a battery-powered vehicle continue to hold back rapid adoption of e-mobility for private users; on the other, while commercial/shared use cases are potential early adopters given that the low operating costs provide more compelling economics, these use cases could not afford any downtime spent on charging.

Given this, battery swapping seems to be a silver bullet that could help India move faster on its EV agenda.

### Value Proposition of swapping over “park and charge” solutions

Battery swapping helps in eliminating the wait time of charging by mimicking the experience of fuel pumps. It optimises Total Cost of Ownership (TCO), reduces the requirement of scarce resources such as land, acts as demand responsive units for Discoms, and is an enabler for smart grid, among others.

**It provides upfront affordability key for mass adoption** even after FAME II incentive upfront costs continue to remain quite high for 2Ws and 3Ws. The prime reason why the e-rickshaw segment has seen scale adoption even with no FAME benefit is **because it has low upfront cost by using cheap lead acid batteries, even though the TCO is poor.**

**Optimal asset utilization:** Separating battery and vehicle allows maximum utilization of battery and vehicle over its lifetime. For instance, the private use case would end up only using 600-700 cycles over a seven year period. Also restricts the user to upgrade to better and new technologies overtime (by tying a vehicle to a particular battery).

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<sup>1</sup> MoEFCC

**Innovating in India and for the world:** Separating battery from the vehicle allows for greater innovation and holds the potential for ramping up the EV charging infrastructure and brings in size and scale effect in India's EV market.

**Bringing in the size and scale effect:** Swapping allows for right sizing of the battery. This would relatively reduce the average subsidy amount per vehicle as vehicles can do with smaller packs in swapping compared to fixed batteries. It implies that more vehicles can be supported with a given FAME II budget.

### **Ola Electric Gurgaon journey**

A great example is Ola Electric, which started its state-of-the-art battery swapping infrastructure to power a fleet of 2Ws and 3Ws in Gurgaon with the aim to minimize the charging time of batteries and optimize efficiency. This technology has helped in reducing the wait time associated with charging models, allowing for increased run-time and has improved the earnings of our driver partners by 40%. Ola has been able to convert 50% of Gurgaon's e-rickshaw fleet using fixed batteries to swappable batteries. This initiative has been running for the last 15 months and has powered over 8.34 million clean kilometers.

### **Policy levers for scale deployment**

The following policy levers would translate EV dialogue into action, accelerate the adoption of electric vehicles in India and take India closer to its 2030 EV targets.

Battery Swapping is another form/technology for charging electric vehicles, all incentives (EV tariff, capital subsidy etc) applicable to charging stations should be extended to swapping stations. Here, both FAME II and Ministry of Power charging infrastructure guidelines should incorporate Swapping.

Another booster could be reduced and consistent GST on EVs, Batteries, and Charging-Swapping Station Services. Since Battery and chargers used for automotive use case are essentially automotive components, GST rates should remain consistent across EVs as a whole and its components (batteries, chargers, bulk chargers) etc. Presently, GST on an EV with a fixed battery is 5% but if the consumer adopts a swapping solution the Glider (EV without battery) will be at 5% but the battery would be taxed at 18% although the same is tagged to the Glider. GST on charging and swapping service is taxed at 18%. A significant input cost in this service is electricity, which does not fall within the ambit of GST. Hence a reduced rate of GST on charging and swapping services would offer the much-needed fillip to adoption of the electric mobility ecosystem in the country. Considering India is a small vehicle dominated market, battery swapping in these segments presents a leapfrogging opportunity that could catalyse the uptake of electric vehicles in India.



**Dhivik A**  
**CEO**  
Go GreenEoT

## Lithium Batteries- where did it begin and where is it safe?

### HISTORY

The first battery came into being when Otto von Guericke constructed an electrical machine using a large sulfur globe which, when rubbed and turned, attracted feathers and small pieces of paper. Guericke was able to prove that the sparks generated were electrical in nature. Though, the first practical use of static electricity was the “electric pistol” that Alessandro Volta (1745–1827) invented.

In 1802, William Cruickshank designed the first electric battery for mass production, which resembles the flooded battery that we have today.

In 1859, the French physician Gaston Planté invented the first rechargeable battery based on lead acid, a system that is still used today. Until then, all batteries were primary, meaning they could not be recharged.

In 1899, Waldmar Jungner from Sweden invented the nickel-cadmium (NiCd) battery, NiCd was the only rechargeable battery for portable applications. In the 1990s, environmentalists in Europe became concerned about the harm incurred when NiCd is carelessly disposed.

SONY commercialised Lithium Batteries in 1991. Besides powering cellular phones, laptops, digital cameras, power tools and medical devices, Li-ion is also used for electric vehicles and satellites. The battery has a number of benefits, most notably its high specific energy, simple charging, low maintenance and being environmentally beneficially.

### LITHIUM CELLS

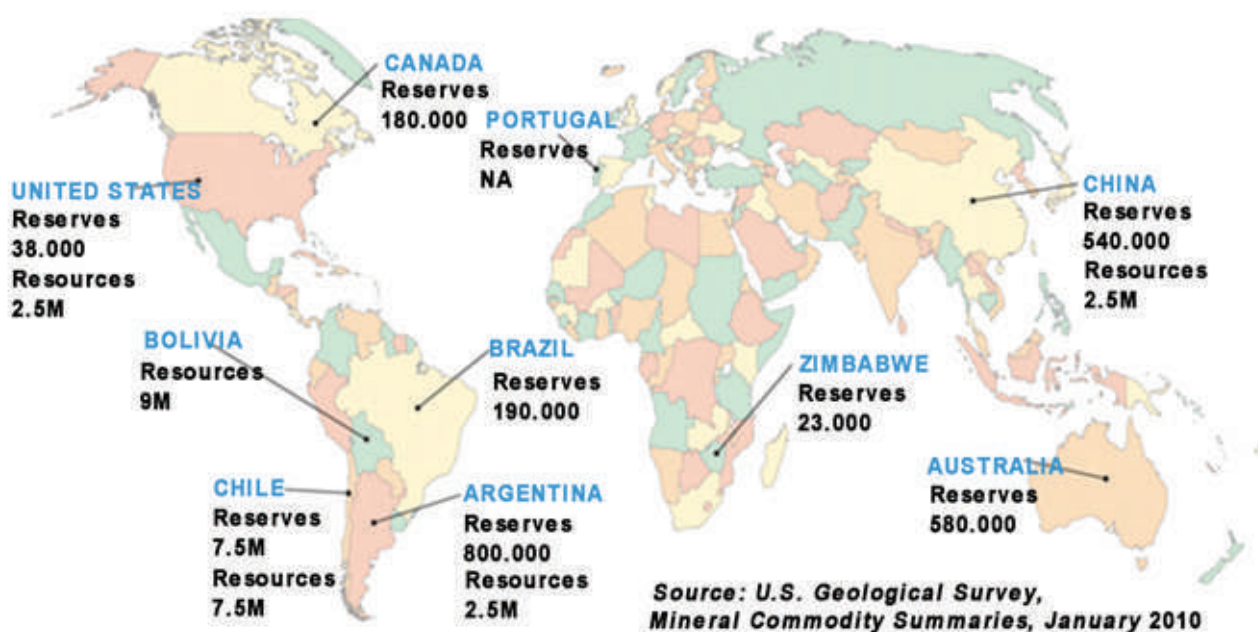
Lithium ion cells come in different packages viz. Pouch, Cylindrical and Prismatic. Also, they come in various chemistry as well. The uses of each is tabulated below:

Chemical Name	Material	Abbreviation	Application
Lithium Cobalt Oxide	LiCoO <sub>2</sub>	LCO	Cellphones, Laptops, Cameras
Lithium Manganese Oxide	LiMn <sub>2</sub> O <sub>4</sub>	LMO	Power Tools, EV, Medical
Lithium Iron Phosphate	LiFePO <sub>4</sub>	LFP	Power Tools, EV, Medical
Lithium Nickel Manganese Cobalt Oxide	LiNiMnCoO <sub>2</sub>	NMC	Power Tools, EV, Medical
Lithium Nickel Cobalt Aluminum Oxide	LiNiCoAlO <sub>2</sub>	NCA	EVs, Grid Storage
Lithium Titanite	Li <sub>4</sub> Ti <sub>5</sub> O <sub>12</sub>	LTO	EVs, Grid Storage

Electric vehicle makers are focusing on two chemistries: nickel-cobalt-aluminum (NCA) and nickel-cobalt-manganese (NCM or NMC). With very little focus on LFP, it is being pushed over to other countries, since there is high supply of the same in China.

Car and battery makers are reducing the amount of cobalt they use because it is one of the most expensive parts of a battery and there is a shortage of the commodity. Cobalt is mainly used to make the cathode in lithium-ion batteries. Benchmark Mineral Intelligence predicts that by 2026, NCM batteries will account for about 70 per cent of the total lithium-ion battery market. Right now, most EVs use the NMC622 battery technology, which stands for six parts of nickel to one part each of manganese and cobalt, but there's a drive towards the NMC811 battery technology. NCM811 and NCA have very similar cathode chemistries and the battery market is already pushing towards adopting these technologies. NCM chemistries are more widely used today and there is already a shift towards 811, but this is posing a challenge to producers in terms of lifecycle, so the shift will be more gradual with 622 the target for most in the near-term and gradually working towards 811 over the next one to three years.

## IS LITHIUM AVAILABLE. HOW MUCH GOES INTO ONE CELL.



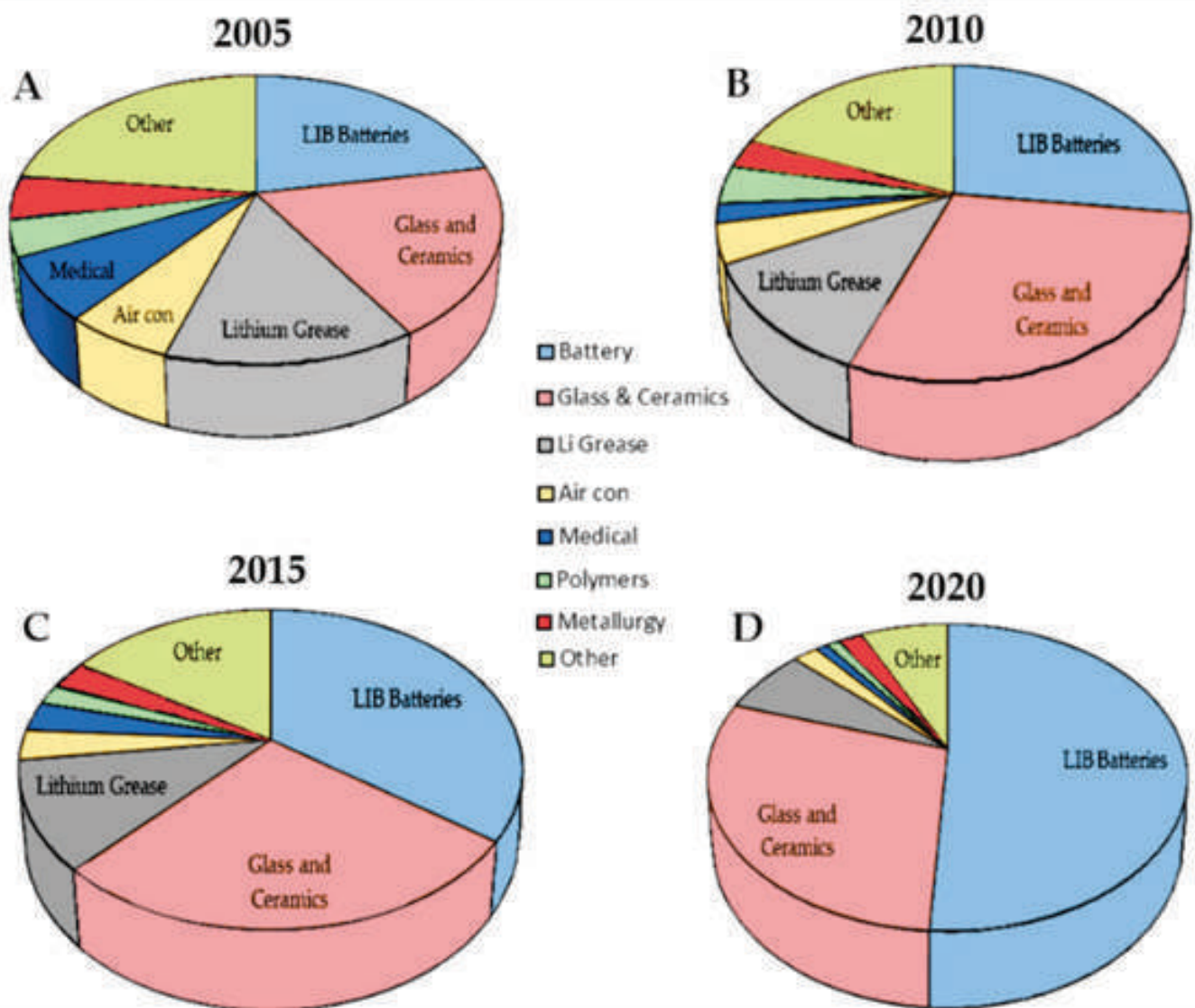
About half the world's known reserves are located in Bolivia. According to the USGeological Survey, Bolivia's Uyuni Desert has 5.4 million tonnes of lithium. If we take the 2019 production number and increase it to 50,000 metric tons per year demand, then with the current reserves of 13.5 million tonnes plus Bolivian reserves totaling 19 million tonnes, we have enough reserves for 380 years ( $19 \text{ million} / 50,000$ ). Even if we use 100,000 metric tons of annual demand, the reserves would last 190 years.

According to a 2011 study conducted at Lawrence Berkeley National Laboratory and the University of California, Berkeley, the currently estimated reserve base of lithium should not be a limiting factor for large-scale battery production for electric vehicles, as the study estimated that 1 billion 40 kWh Li-based

batteries could be built with current reserves. Another 2018 study by researchers from the University of Michigan and Ford Motor Company found that there are sufficient lithium resources to support global demand until 2100, including the lithium required for the potential widespread use of hybrid electric, plug-in hybrid electric and battery electric vehicles. The study estimated global lithium reserves at 39 million tons, and total demand for lithium during the 90-year period was analysed at 12–20 million tons, depending on the scenarios regarding economic growth and recycling rate.

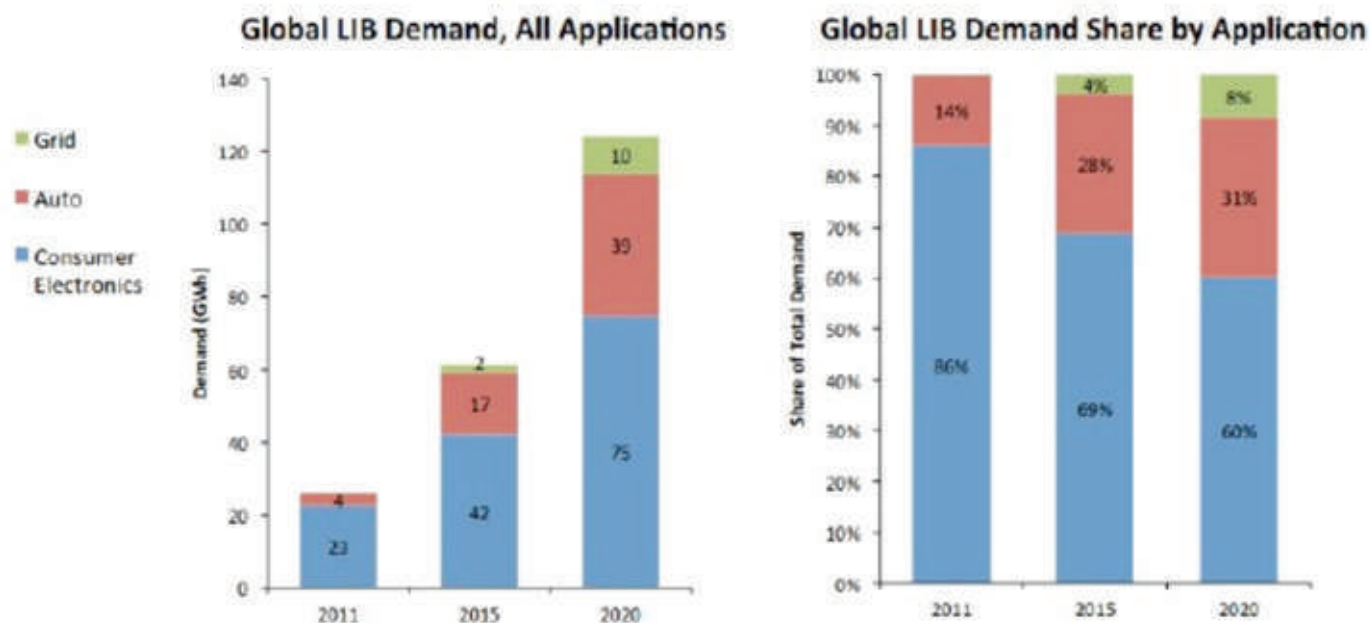
The image below shows usage of Lithium as a mineral.

Percentage lithium use in each of the main lithium using industries in 2005.  
(B) Lithium use in 2010, (C) lithium use in 2015, and (D) lithium projected use in 2020.



The usage of Lithium Ion Cells as per application is shown in figure below.

## Consumer Electronics Represent the Majority of Demand for LIBs



## SUPPLY OF LITHIUM CELLS

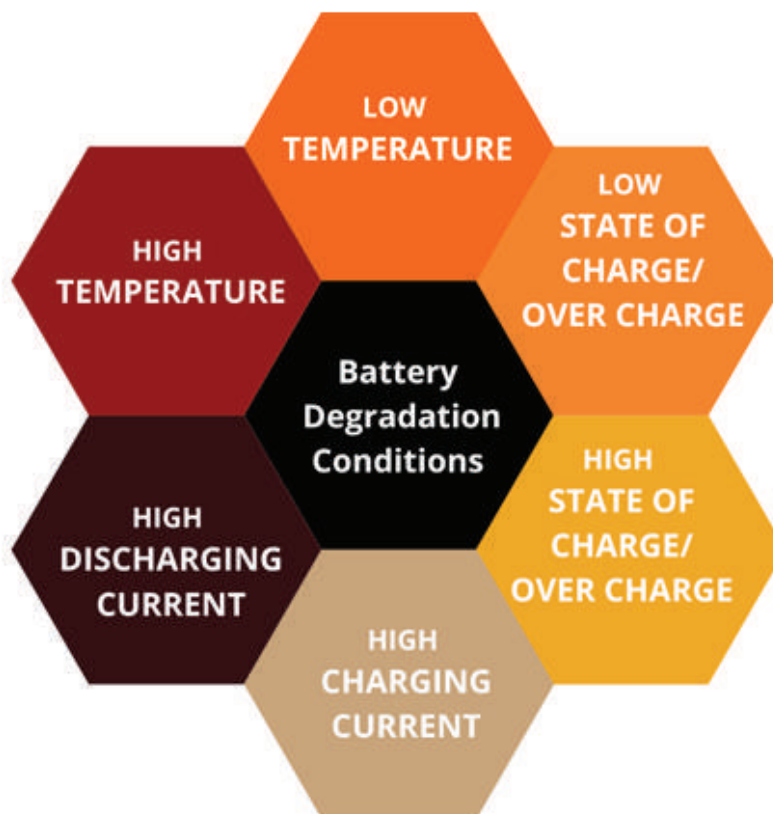
Asia currently dominates Lithium Ion Battery (LIB) cell production with a robust upstream supply chain, from processed materials to complete cells. In 2015 BNEF came out with a study on all countries, which have commissioned Lithium Battery cells production.

	Fully Commissioned ( MWh )	Partially Commissioned ( MWh )	Under Construction (MWh )	Announced MWh
China	16,704	3,576	18,730	12,847
Japan	10,778	-	1,200	-
Korea	16,059	-	-	-
US	3,770	-	1,200	35,000
KU	1,798	-	-	-
Rest of the World	2,440	-	-	564
Total	51,549	3,576	21,130	48,412

Disclosed Capacity: Existing + Partially Commissioned + Under Construction + Announced capacity = 125 GWh. That is the amount of cells that the world is looking at procuring as in 2015.

## LIMITATION OF LITHIUM BASED BATTERIES

Rechargeable lithium-based cells require careful "care and feeding" in both their electrical and mechanical aspects. Electrically, they have to be charged along a specific profile, with the charge rate and mode (constant current and voltage) monitored and adjusted, and their discharge profile must be within specific limits as well. Going outside the boundaries will have detrimental effects, ranging from reduced capacity and run time (unpleasant but not dangerous) to overheating (very undesirable). The following safety mix should be of prime importance in building battery packs.



Finally, what we need to understand is the fact that it is easy to make a battery pack. However, a 1KWh of battery pack would be approximately 6-7kgs and is like a ticking time bomb if it's not safely charged and safely discharged. It becomes important to choose the right cells and the right BMS. In my opinion getting the cells right computes to 15% of the entire job and getting the BMS right is 10% of it. Getting the packing and packaging right is 30%, but what is extremely important is getting the thermal effect right, which constitutes 45% importance to making the right pack. This is where we as engineers have a strong contribution to make to win this space for India.

**G.Raghavan**  
**Consultant (Energy Storage)**  
Trident Power solutions

## Importance of recycling of lithium ion batteries

Lithium ion batteries are a family of rechargeable batteries in which lithium ions move from negative electrodes to positive electrode during discharge and in the reverse order while charging. Lithium batteries feature higher voltage, greater energy density and longer life with improved safety, through the usage of electronics like Battery Management System(BMS). Lately, the usage of Lithium battery has gained traction, covering diverse applications in portable equipment, electric vehicles, energy storage systems, load leveling, frequency regulation and grid stability among others.

In view of the fast-paced adoption of lithium batteries, it is natural that recycling of lithium cells assumes importance. More so, with the Government of India enacting stricter laws for recycling and smelting. While lead acid is a time-tested storage energy source, recycling capabilities have matured and recovery rate of 95 % is not uncommon. This is because the basic materials are majorly lead, with small quantities of antimony and calcium plastics, apart from sulphuric acid.

The average life of lithium ion batteries is 4-8 years, depending on the battery chemistry, usage and application. The battery is supposed to have reached its end of life (for a particular application) when it reaches to 80 % of its original capacity. However, it can still be used for other applications, especially those that require much less capacity, which is why it is extensively used in second life. Many renewable energy sources do not offer a constant and reliable power source and are subject to weather conditions. To ensure reliability, energy storage devices are viewed as a solution to store energy. This can be done during periods of over-production and delivered when required. The main goal of the second life of batteries is to provide affordable, portable, safe, sustainable, replicable, versatile and reliable, in-time energy source. For example, 3 fast EV chargers connected to a peak 70 KW grid require additional 20 KW of power for a short period to sustain the charging. This is accomplished by using second life batteries instead of increasing power generation.

Apart from using these in their second life, it is also important to recycle lithium ion batteries. Battery waste is extremely heterogeneous and problematic to treat consistently via hydrometallurgical means. Consequently, research in LIB recycling is intensive, including solvent extraction and chemical precipitation.

The three different battery recycling technologies are as follows, with the first two currently being in operation while the third is in emerging/ experimental stage.

### **(a) Pyrometallurgical process**

The Pyro Metallurgical process is a high temperature smelting process usually involving two steps- LIBs are first burned in a smelter where compounds are broken down and organic material such as plastics and separators are burned away, generating new alloy through carbon reduction. Afterwards the metals are further separated to recover pure metals like Cobalt, Nickel, Copper. Lithium is entrained in the slag fraction to be recovered by

further processing. The advantages of pyro metallurgical process are:

- Simple and mature process
- Sorting and size reduction not necessary
- The output consists of elemental blocks that can be reused

### **(b) Hydrometallurgical process**

In this process, the material recovery is achieved by aqueous chemistry via leaching and subsequent concentration and purification. Advantages are:

- Lower CO<sub>2</sub> emission
- Solvent extraction has the advantage of short reaction time with high purity yield
- Lower temperature operations
- High purity metals are generated
- Most constituents are recovered

### **(c) Direct recycling process**

A few years back Accurec developed the Vacuum Thermal Recycling (VTR) process, in combination with pyro metallurgical and hydro metallurgical process. Here, the spent LIB is first treated mechanically (disassembled to remove electronic parts and plastics) after crushing, classification and sorting. Al, Cu, and steel are recovered by sieving and magnetic separation followed by air separation. Other metals are extracted through further metallurgical process.

Thus, proper and safe recycling of Li-ion batteries is of paramount importance and the above methods can be used to accomplish the same.

## #EESLSpirit captures twitter to lead #UjalaPrakashPathKa

EESL organised a Twitter campaign to recognise our on-ground unsung heroes who work tirelessly 24x7 to illuminate street lights while #IndiaFightsCorona



By Smruti Ranjan Tripathy from Odisha



By Rahul Pant from Uttarakhand



By Mrigender Pratap Singh from Aligarh (UP)

Winners of #UjalaPrakashPathKa Twitter Campaign	
Rank	Winner's Name
First	<b>Ashish Kacchap</b> from Jharkhand
Second	<b>Prem Puri</b> from Bihar
Third	<b>Rahul Pant</b> from Uttarakhand
Runner- Up	<b>K. N. Hemant</b> from Hyderabad
Runner- Up	<b>Mrigender Pratap Singh</b> from Aligarh (UP)
Runner- Up	<b>Rahul Dev Gautam</b> from Rajasthan
Runner- Up	<b>Smruti Ranjan Tripathy</b> from Odisha
Runner- Up	<b>Aditya Vashishth</b> from Ghaziabad (UP)



By Rahul Dev Gautam from Rajasthan



By Ashish Kacchap from Jharkhand



By Aditya Vashishth from Ghaziabad (UP)



By K. N. Hemant from Hyderabad