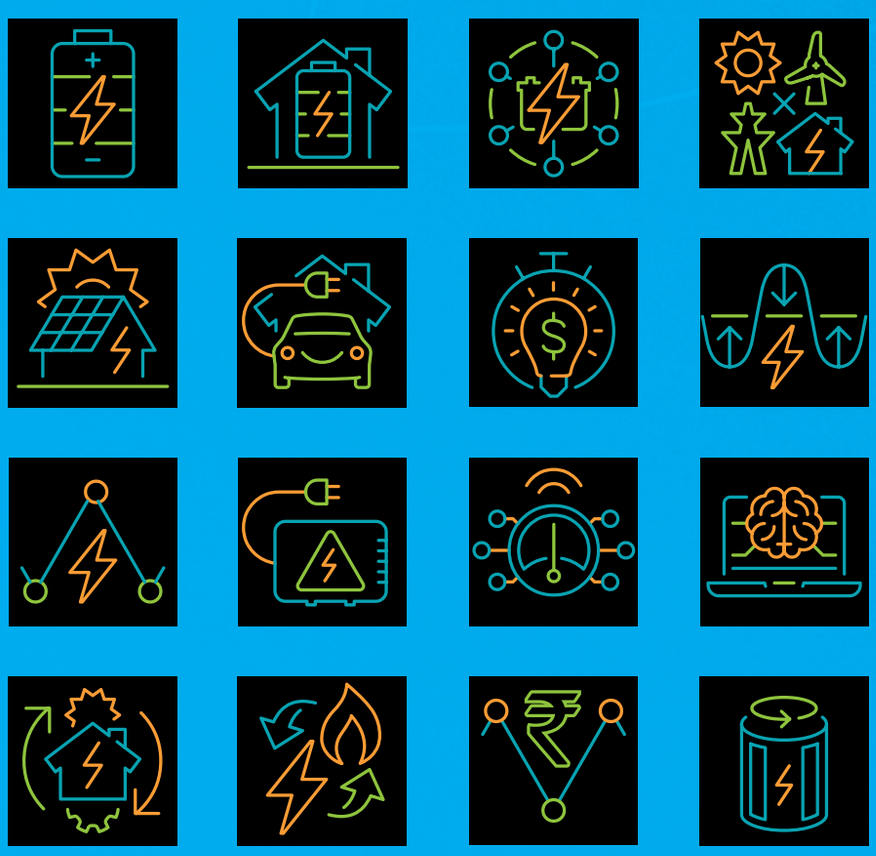
FICCI

# BATTERY STORAGE

## The Next Big Energy Frontier



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# Contents


**Foreword**

**01** **Introduction: India as the Fastest Growing Energy Market**
**05** Emerging Distributed Energy Systems
**09** Merging Transport Electrification

**Message from Mr. Manoj Kohli,** Executive Chairman, SB Energy (Softbank Group)

**11** **Indian Energy Storage Market Today**
**12** Drivers of Energy Storage
**13** Readiness of Indian Ecosystem

**Message from Mr. Mahesh Babu,** CEO, Mahindra Electric

**17** **Applications and Business Models for Energy Storage**
**18** Business Models

**Message from Mr. Sanjeev Aggarwal,** Founder, Managing Director & CEO, Amplus Solar

**21** **Battery Chemistry and Challenges of Indian Market**
**23** Battery Performance and New Technologies
**24** Challenges for Uptake of Energy Storage

**27** **India as a Manufacturing Hub for Energy Storage**
**28** Manufacturing the Battery
**29** Deployment of the Battery

**31** **Battery Recycling and Disposal: Repurposed Batteries**
**32** Battery Repurposing
**33** Battery Recycling
**33** Battery Exchange Platform

**35** **Quality and Risk related to Battery Storage**

**39** **Key Areas that will Impact and Enable Energy Storage in India**
**40** Way Forward

**43** **Imprint**






# Foreword

India's commitments under the Paris Agreement have set it on the path of achieving 175 GW of renewable energy by 2022. Having already crossed the 80 GW mark, India is now one of the cheapest producers of renewable energy in the world, especially solar.

In addition, Government of India's programme for promoting electric vehicles will lead to millions of vehicles drawing from distribution grids. Mass adoption programmes are underway for promoting decentralised electric systems to power street lighting, water pumps, domestic cooking and heating systems. Given this renewable energy generation and usage pattern, reliable energy storage systems will become increasingly important.

The Government of India, in March 2019, launched the "Transformative Mobility and Energy Storage Mission" to promote clean, connected, shared, sustainable and holistic mobility initiatives. Under the mission, a phased roadmap to implement battery manufacturing at Giga-scale will be considered with an initial focus on large-scale module and pack assembly plants by 2019-20, followed by integrated cell manufacturing by 2021-22.

Thus, to achieve the renewable energy targets and energy storage demands in the coming years, it is important to develop an ecosystem which promotes battery manufacturing in the country. The purpose of this paper is to identify the current scenario of energy storage in India along with the key barriers to its proliferation. In addition, it states the benefits of adopting energy storage and initiatives that can be taken to minimise the associated risks in promoting India as a manufacturing hub of the country.

The three key themes have been highlighted to provide a big picture for energy storage – demand creation, investment and collaboration, and indigenous manufacturing. The policy and regulatory initiatives that can help in demand creation, investment risks and business models that can be adopted by Indian market, material sourcing, battery technologies, manufacturing and deployment of batteries, and recycling.

This knowledge paper has been prepared realising the need of India given the increasing share of renewable energy and proposes a way forward to promote India as a hub of energy storage ecosystem for both service and manufacturing side.

With this initiative, we hope to accelerate the conversation around demand creation measures that will be necessary for the industry to succeed and the regulatory reforms needed for the proliferation of distributed energy systems.



**Mr. Manish Sharma**
President and CEO, Panasonic India and South Asia
Co-Chair FICCI Energy Storage Committee

# Introduction:
# India as the Fastest Growing Energy Market



The global electricity demand has grown by 3% a year, accounting for 19% of total final consumption today compared to just over 15% in 2000. The significant growth demand arises from the developing economies accounting for around 85% of this increase. India estimating for almost 6% of the global electricity demand is at the epicenter of this growth and is now the third-largest electricity market in the world. India's total generation is expected to grow at a rate of 3.9% compared to a global 1.6% CAGR and is expected to account for ~8% of the global electricity generation by 2025.[1]

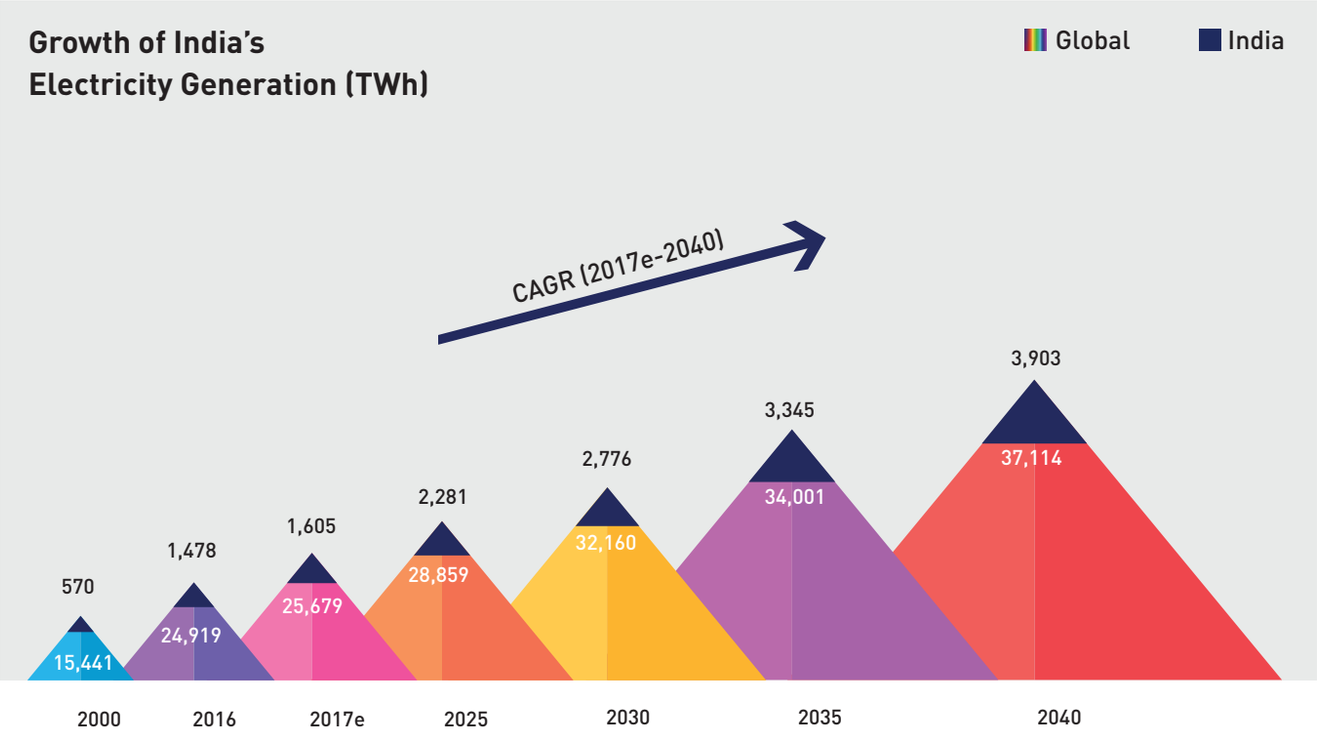
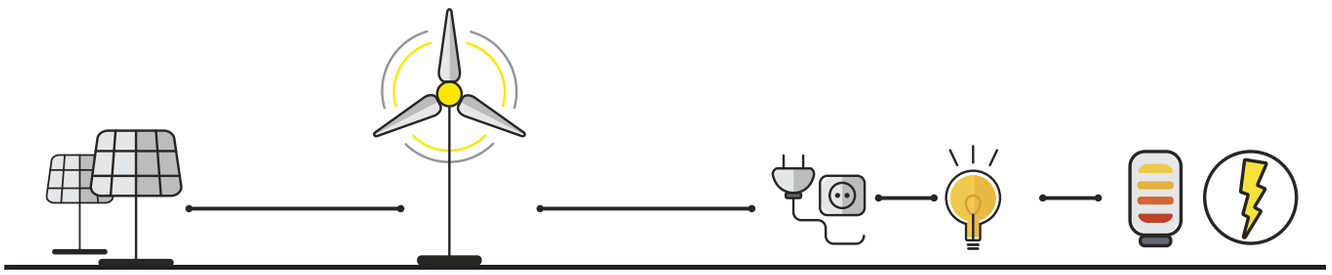



Figure 1: India as one of the largest growing electricity markets in the world (2000-40) [3]

As India attain the 3.9% electricity generation growth rate and transcend towards becoming the fastest growing energy economy globally, the need for incorporating zero emission renewable energy sources will be of paramount importance towards a sustainable growth. It is expected that by 2025, India's power generation will account to 1,130 Mt of $CO_2$ emissions estimating to around 11% of the global power sector emissions.

Led by the global emission reduction targets India's power generation emissions is expected to witness a negative rate of -3.9% compared to a rate of negative-6% globally. Renewable energy sources in India can witness a growth potential of 10% forming 34% of the total power generation by 2025 further rising to 66% by 2040.



[1] IEA- Global Energy Outlook 2018

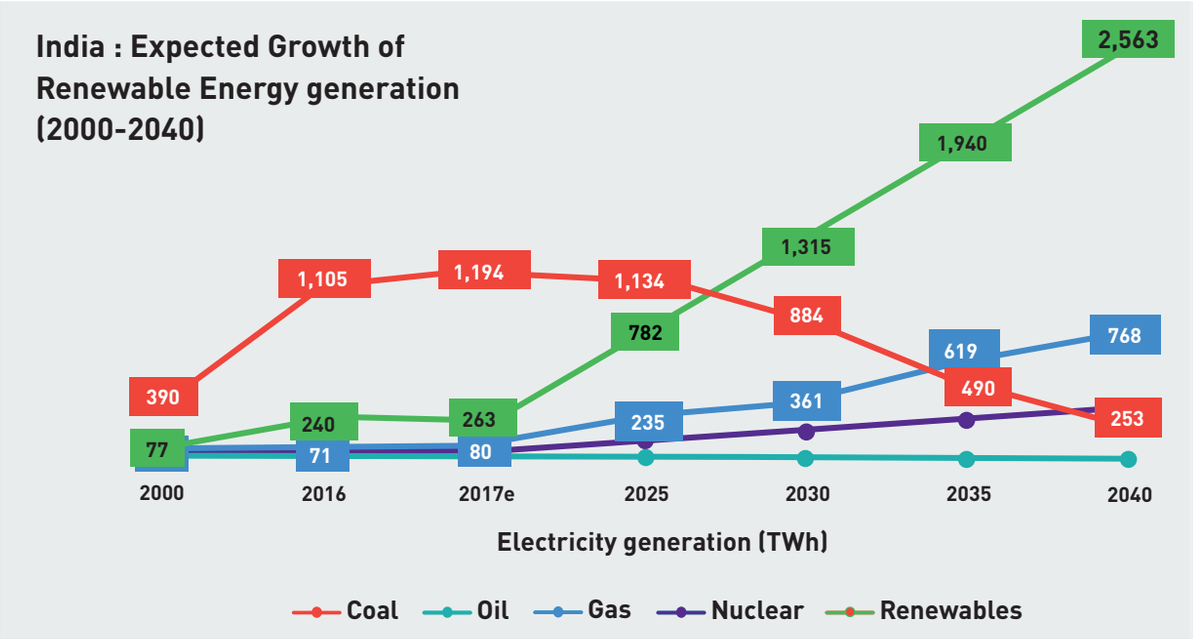



Figure 2: Government of India renewable energy adoption targets[3]

Globally, India has one of the largest renewable energy (RE) deployment programs with an ambitious target of 175 Gigawatt (GW) of installed capacity by 2022, of which solar will have the largest component at 100 GW, followed by wind, biomass, and small hydro at 60 GW, 10 GW, and 5 GW, respectively.[2]

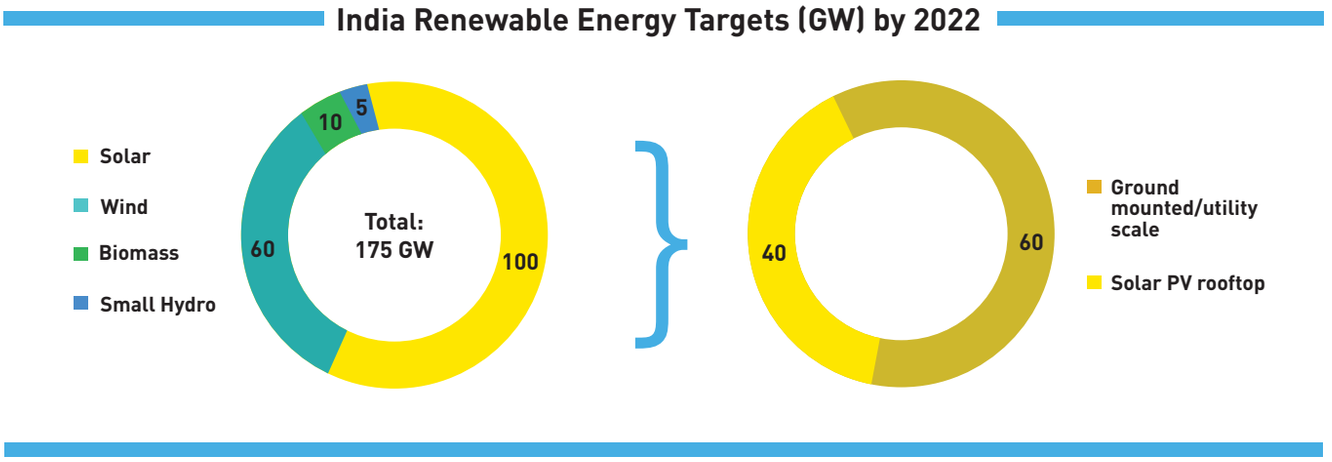



Figure 3: Government of India renewable energy adoption targets [4]

Today, as the competitiveness of renewable power generation options is increasingly becoming evident, electricity storage will play a crucial role in enabling the next phase of the energy transition. Along with promoting renewable power generation, it will allow sharp decarbonisation in key segments of the energy market. As variable renewables grow to substantial levels, electricity systems will require greater flexibility. At very high shares of VRE, electricity will need to be stored over days, weeks or months. By providing these essential services, electricity storage can drive electricity decarbonisation and help transform the whole energy sector.[3]

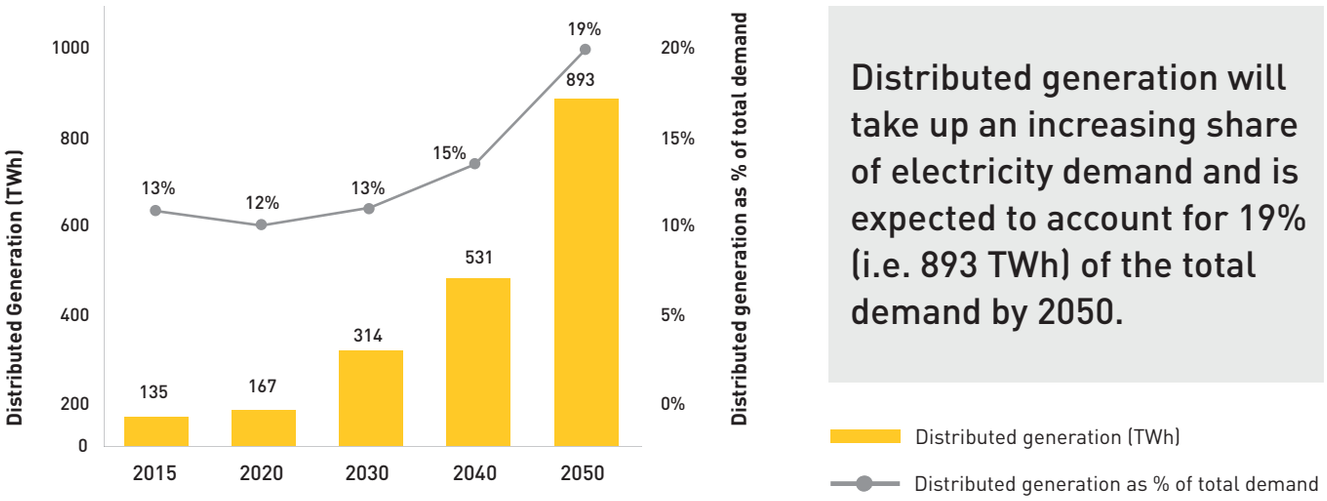
[2] MNRE – https://mnre.gov.in/physical-progress-achievements

[3] IRENA - https://www.irena.org/publications/2017/Oct/Electricity-storage-and-renewables-costs-and-markets



## Emerging Distributed Energy Systems

With the rapid uptake of renewable energy systems, we are witnessing the birth of a new distributed energy ecosystem which is transitioning closer to the end user and is increasingly augmented by digital technologies. Distributed generation will take up an increasing share of electricity demand and is expected to account for 19% (i.e. 893 TWh) of the total demand, which is expected to reach around 4700 TWh by 2050




Distributed generation will take up an increasing share of electricity demand and is expected to account for 19% (i.e. 893 TWh) of the total demand by 2050.

Figure 4: Growth trends of Distributed Generation (TWh)[5]



## Microgrids

MNRE's draft national policy for mini-grids and microgrids issued in 2016 aimed to deploy up to 500 MW of capacity in the next five years, to serve ~200 million people living in energy scarcity. This policy was drafted to benefit states with a low electrification ratio such as Bihar, Uttar Pradesh, and Odisha. To encourage energy service companies (ESCOs) in project development, the ministry has categorized private developers/operators as Rural Energy Service Providers (RESPs). The RESPs will be obligated with special incentives and privileges. The proposed microgrids will have the capability to produce less than 10 kW power, while the mini-grids will be designed to generate 10 kW or more power using renewable energy. The microgrids and minigrids that produce more power will get interconnected and linked to a main grid to transfer the extra power generated. The establishment of a relevant policy provides market and regulatory certainty for all stakeholders within the microgrid segment.[4]

### **Microgrids:** Key projects in India

| Project name | Location | Rated power (kW) | Project developer/owner |
|---|---|---|---|
| Tata Power-MIT Microgrid Project, Purnia, Bihar, India | Bihar | 1000 | Tata Power Solar, MIT |
| SunEdison 159 kW Solar PV Microgrid Project, MP, India | Madhya Pradesh | 159 | SunEdison, Rural Electrification Corp. (REC), MP Urja Vikas Nigam State Agency |
| Chief Ministers Official Residence Microgrid Project, Bihar | Bihar | 125 | Optimal Power Solutions |
| Sundarbans Village Microgrid Project, West Bengal, India | West Bengal | 120 | Tata Power Solar |
| Dharnai Microgrid Project, Bihar, India | Bihar | 100 | Greenpeace India |
| KPCL Mandya Karnataka Microgrid Project, Karnataka | Karnataka | 100 | KPCL |
| Andaman Island Indian Coast Guard Microgrid Project, Andaman, India | Andaman | 75 | Optimal Power Solutions |
| Gram Oorja Microgrid Project, Jawhar, Palghar, Maharashtra | Jawhar | 38 | Gram Oorja |
| Kalkeri Sangeet Vidyalaya Microgrid Project, Karnataka, India | Karnataka | 14 | SELCO |

**Source: GlobalData, DOE6 I Rated power refers to the storage part in most projects**

Though the government has shown significant progress on rural electrification in recent years through grid extension, a large number of rural households still have no access to electricity. The India Energy Storage Alliance (IESA) recently launched the Microgrid Initiative for Campus & Rural Opportunities (MICRO). The main objective of this initiative is to reduce electricity cost from microgrids in India by 20–30% within 2019.

Microgrids is a huge opportunity that can be realized quickly and easily by channelizing the investment in focus areas. Some of the government subsidies for rural electrification and other initiatives to fund microgrid projects in India are listed below:

- MNRE: 30% subsidy on project cost
- Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY)
- Some projects are partially funded by non-profits and social venture capital, foreign aid such as USAID that invested in Mera Gao Power, and funding from World Bank and Asian Development Bank

[4] **Global data, Microgrids, Update 2018**



## Rooftop solar in India

Despite the favorable policy environment, slow rate of RTS adoption can be attributed to several market challenges faced by different stakeholders. For consumers, high upfront cost and lack of access to finance are critical challenges. For developers, small size of rooftop systems, fragmented distribution of installations and payment risks result in high transaction costs. Furthermore, delays in regulatory approvals and high cost of debt financing are critical challenges for developers. Credit worthiness of developers and consumers is a major concern for financiers. In addition, small size of RTS projects results in high transaction costs due to which financiers are reluctant in RTS financing. As early adopters of RTS will be high end consumers, DISCOMs face a major risk of revenue loss. As the conventional business offerings are ineffective in addressing these challenges, there is a need for innovative business models making RTS a viable option for all stakeholders. Furthermore, interventions though incentive mechanism/ schemes can also be explored to increase adoption.

## Rooftop solar policy in India

In February 2019, the government approved the second phase of grid-connected rooftop solar program for achieving cumulative capacity of 40 GW from such projects by March 2022. The program will be implemented with total central financial support of INR 118.14 bn ($1.66 billion). Phase-II consists of two components:

**Component A** in which 4 GW of grid-connected rooftop solar PV projects will be developed in the residential sector with CFA. For this, a CFA of INR66 bn ($0.94 bn) is proposed. Total CFA of INR49.50 bn ($0.71 bn) has been allocated to be given as an incentive to DISCOMs, INR6.6m ($0.094m) has been allocated as CFA to be given as capacity building charge, and INR1.98 bn ($0.028 bn) has been allocated as CFA to be given as service charge.

**Component B** through which incentives will be provided to DISCOMs. For component B, the incentive will be based on additional grid-connected rooftop solar PV capacity installed over and above the base level. Incentives will be limited for the first 18 GW of grid-connected rooftop solar PV projects.

Year-wise Fund Requirement for Component A and Component B (INR & $)

| Year | Fund required for Component A | Fund required for Component B | Total Fund Requirement |
|---|---|---|---|
| 2019-20 | 858 crore ($0.12bn) | – | 858 crore ($0.12bn) |
| 2020-21 | 1716 crore ($0.24bn) | 742.5 crore ($0.10bn) | 2458.5 crore ($0.35bn) |
| 2021-22 | 3432 crore ($0.48bn) | 148.5 crore ($0.02bn) | 4917 crore ($0.69bn) |
| 01 April, 2022 to 31 December, 2022 | 858 crore ($0.12bn) | 2722.5 crore ($0.38bn) | 3580.5 crore ($0.50bn) |
| **Total** | **6864 crore ($0.96bn)** | **4950 crore ($0.70bn)** | **11814 crore ($1.66bn)** |

Table 1: Year-wise Fund Requirement for Component A and Component B under phase-II of rooftop solar policy[5]

[5] https://mnre.gov.in/sites/default/files/schemes/Notification-20082019-184419.pdf

In the Phase-II Program CFA for the residential sector has been restructured with availability of 40% CFA for Rooftop systems (RTS) up to 3 kW capacity and 20% for RTS system capacity beyond 3 kW and up to 10 kW. For Group Housing Societies/Residential Welfare Associations (GHS/RWA), CFA will be limited to 20% for RTS plants for supply of power to common facilities, however, the capacity eligible for CFA for GHS/RWA will be limited to 10 kW per house with maximum total capacity upto 500 kW, inclusive of RTS put in individual houses in the GHS/RWA.

These policies will have a positive impact on rooftop solar and will help in altering consumer behaviour for faster adoption. Further, battery storage can be coupled up with rooftop solar for providing uninterrupted power and incentivising customers by implementing peak/ non-peak tariffs.

## Emerging Transport Electrification

A push for global emission reduction has further enabled the transition of transportation sector from conventional fossil fuel-based mobility towards electric mobility solutions. It is expected that electricity as a transport fuel source will grow fastest at a rate of 11% accounting for 10% of the total energy mix for transportation by 2040. Whereas, conventional oil will witness a negative trend of -3% though accounting for more than 60% of the total energy mix.

| | 2025 | 2030 | 2040 | CAGR |
|---|---|---|---|---|
| **Oil (Mole)** | 2,404 | 2,193 | 1,668 | -3% |
| **Electricity** | 66 | 118 | 293 | **11%** |
| **Biofuels** | 200 | 284 | 393 | 5% |
| **Other Fuels** | 117 | 233 | 354 | 5% |
| **Total** | **2,848** | **2,829** | **2,708** | |

Table 1: Sustainable Development Scenario (SDS) -Transportation Sector Energy mix[6]

**Electricity as a transport fuel source will grow fastest at a rate of 11% accounting for 10% of the total energy mix for transportation by 2040**

With such a projected growth in distributed energy systems and electric mobility, demand for energy storage is perceived to be huge in the future.



[6] IEA – Global Energy Outlook 2017 – Sustainable development Scenario (SDS)





# Message

The entire renewable industry is fully committed towards recently announced Hon'ble Prime Minister's vision of enhancing the target of 175 GW of renewable capacity by 2022 to 450 GW in the coming years. Integration of Energy Storage System with renewable generation sources (Wind & Solar) is of utmost importance to realize the full potential of RE sources and provide affordable & sustainable "Round The Clock" power to 1.3 billion population of the country.

With expected fall in prices of storage batteries and improvement in efficiency, the energy storage market segment is set to replicate the exponential growth seen by solar industry in last decade. In addition to this, with a push towards reduction of emission caused due to fossil-based transportation and adoption of electric vehicles across the globe, Electric Vehicle market will pose a major demand for utilization of high efficiency and affordable batteries.

The paper rightly highlights the interventions to be made on demand, supply and facilitation side so as to provide a macro environment for ease of adoption of storage batteries.

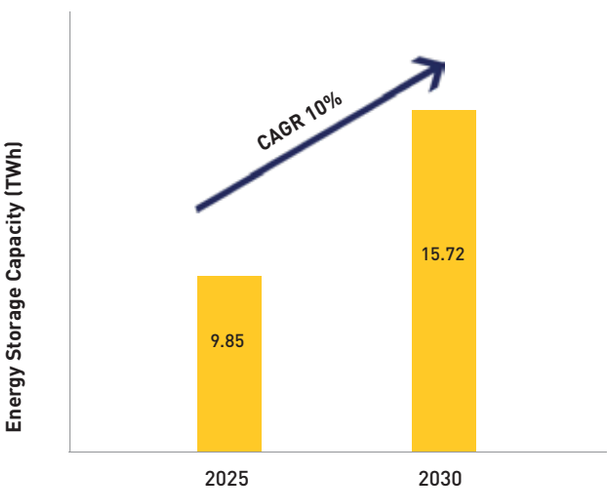
With proper tapping of key raw materials of battery storage and initial government support in form of subsidies, India can establish itself as the global manufacturing hub of storage batteries and can lead the next big energy transition across the world.

**Mr. Manoj Kohli**
Chairman, FICCI Renewable Energy CEOs Council and Executive Chairman,
SB Energy (SoftBank Group)

# Indian Energy Storage Market Today



The push for distributed energy systems and electric mobility has led to a significant demand in the energy storage applications. Globally, it is expected that energy storage will account for ~16 TWh by 2030[7]. Though India's energy storage market is at a nascent stage, it is expected to grow upwards of 2 TWh by the year 2030.




Though India's energy storage market is at a nascent stage, it is expected to grow upwards of 2 TWh by the year 2030.

Figure 5: Global Battery Storage Demand

## Drivers of Energy Storage

Government's ambitious renewable energy target will drive the development of energy storage systems. Renewable energy installed capacity[8] as on 30th September 2019 is:

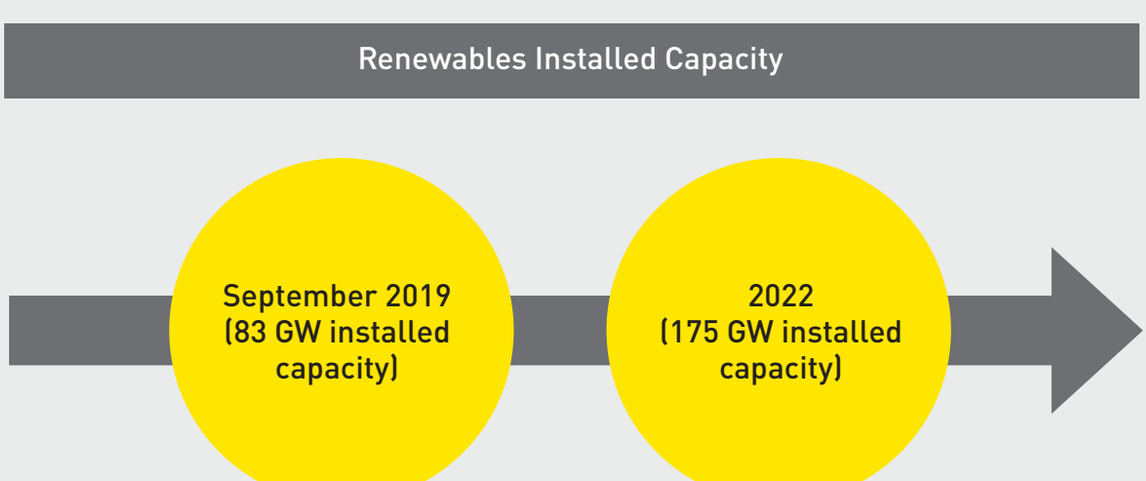



Figure 6: India's Renewable Energy Target

[7] https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Oct/IRENA_Electricity_Storage_Costs_2017.pdf

[8] https://powermin.nic.in/en/content/power-sector-glance-all-india

Energy storage could play a pivotal role in enabling renewable penetration without overreliance on transmission corridors that could require huge capital investments and underutilization of such assets due to variable nature of renewable energy resources. An example of this application is the tender released by Solar Energy Corporation of India to set up two different systems with aggregate capacity of 14 MW solar with battery storage capacity of 42 MWh, in Leh and Kargil. In such remote areas, these projects can help in providing opportunities of utilising clean energy and reducing the dependence on the grid.

**"With the country's focus on renewable energy and electric mobility, energy storage solutions are set to play a crucial role in scripting the sector's success. While the sector is at a nascent stage, a number of initial policy interventions have been made, with more expected. Key to this would be ensuring demand creation measures, introducing reforms for the power sector and measures to co-opt consumers, suppliers and the entire energy value chain. This will be essential for India to lead the way towards renewable energy and mitigating the risks of climate change."**



**Mr. Manish Sharma**
President and CEO, Panasonic India & SA

Also, increased power sector disruptions have resulted in urgent need for flexibility in India and energy storage technology is best placed to provide this flexibility across the value chain. Arguments supporting this viewpoint are:

> **Load following generating stations - Thus far used in for balancing the demand fluctuation in the Indian power system**
- Hydro plants with un priced fuel are traditionally used, however peak demand in India is unmet in many instances.
- Peaking stations with high variable costs are used for rescue.
- Furthermore, gas stations not optimally used due to un-economical gas purchase.

> **Advent of higher share of renewables - High variability and intermittency**
- Load following stations capacity addition can solve. However, addition of new hydro & gas renders time consuming and un-economical.
- Below technical limits, flexibility of coal plants is not possible.

> **Decentralized market structures**
- Grid disciples - Frequency between 49.95 Hz and 50.05 Hz.
- Load serving entities are severely affected due to these grid discipline rules.
- Restrictions on overdraw and underdraw.
- Lack of regional balancing principles and generation supply sharing market mechanism.

> **Apart from this, Government is pushing for increased EV uptake in next decade, resulting in exponential demand of energy storage technologies.**

## Readiness of Indian Ecosystem

The push for distributed energy systems and electric mobility has led to a significant demand in the energy storage applications. Globally, it is expected that energy storage will account for ~16 TWh by 2030. Though India's energy storage market is at a nascent stage, it is expected to grow upwards of 2 TWh by the year 2030.

| Application | Market driver | Current battery market |
|---|---|---|
| **Telecom** | • Almost 40% telecom towers face load shedding for >12 hrs/day<br>• Government mandate to use batteries as part of hybrid system for powering towers | • Telecom operators have started importing batteries from players like Panasonic, Saft, Coslight, etc |
| **Automotive** | • Government's focus on electric vehicles<br>• Rising pollution levels | • EV market in India is dominant by startups across vehicle categories and services. Established players such as TATA, Mahindra, Hero, Bajaj, MG Motors and Hyundai have entered the market with EV variants.<br>• India has also emerged as one of the largest market for E-3W (3-4 kWh) with around 2 million units in operation. |
| **Power Backup (Industrial & Commercial** | • Falling cost of batteries<br>• Real estate space costs<br>• Rising fuel costs | • Li-on battery storage systems have started to replace legacy storage technologies (lead-acid) that have been deployed over the years with DG sets being used as emergency power back-up |
| **Renewable integration** | • Government target of 175 GW of renewable energy by 2022[9]<br>• Incentives by national/state governments | • Government has announced plans to support demonstration projects |

Table 2: High Demand Application Areas in India



[9] https://www.saurenergy.com/solar-energy-news/mnre-clarifies-december-2022-deadline-175-gw-target

Thus, the demand for energy storage in India is already significant and is increasing at a rapid pace. However, despite this strong demand, energy storage business models are not mature enough in the country.

## Renewable Energy and Battery Integration: Examples in India

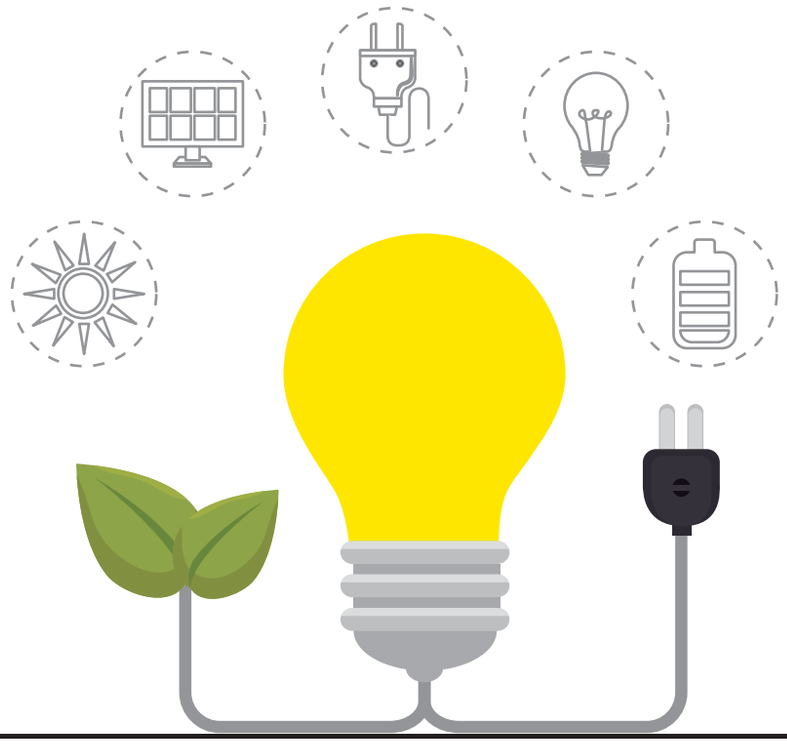
**Solar Energy Corporation of India - 1200 MW ISTS-Connected Solar PV with 3600 MWh Storage in India**[10]

> **Overview:**

In February 2019, SECI floated a tender for an aggregate 1,200 MW of wind/solar/wind-solar hybrid projects with Inter-State Transmission System (ISTS) along with 3600 MWh energy storage, throughout India. The projects are on a 'build-own-operate' basis. SECI would enter into PPAs with successful bidders for a period of 25 years. Power procured is provisioned to be sold to the different buying utilities of India.

> **Key Applications/Benefits:**

Protection of loads against sharp drop of voltage in the grid; deferred need for transmission and distribution upgrade.



[10] https://seci.co.in/show_whats_new.php?id=823

## Panasonic Energy Solutions Division provided a comprehensive Li-ion based Energy Storage Solution to replace VRLA batteries

- In 2014-15, Panasonic installed a comprehensive high-energy density Li-ion based Energy Storage Solution (ESS) to India's leading telecom tower company in approximately 2,500 sites
- The ESS led to substantial reduction in overall OPEX at their Telecom sites
- An in-built data log feature in the ESS ensured remote performance monitoring and diagnostics
- Substantial reduction in CO2 emissions resulting from substantial reduction in use of DG sets, thereby saving fuel cost
- Increased reliability and performance as compared to VRLA-based solutions

## ACME installed Li-ion based Energy Storage Solution for Tower Vision

> **Overview:**

In 2015, ACME installed its first Li-ion based Energy Storage Solution for a leading telecom tower company, Tower Vision. The installation has been done by ACME under its exclusive and strategic agreement with Korean energy storage system giant to manufacture and market lithium ion based energy storage solutions in telecom, buildings, solar power, defence sectors and other allied industries.

> **Key Applications/Benefits:**

Eliminate diesel generators; cut down on the carbon footprint; increase energy efficiency; savings in fuel costs; improve uptime; increased reliability.





# India's promising Energy Storage Market

Electrical energy storage is potentially the next big industry in India and is expected to witness an exponential growth in the next two decades. Some estimates also say that world's electrical energy storage market is expected to double between now and 2030. Out of this, 50% is expected to be installed in USA, Japan and India alone.

There can't be a better time for the energy storage market to grow, given our own country's fast growing demand for energy and heavy dependency on fossil fuels to fulfil it. Oil import bills and severe pollution crisis are compelling people to evaluate cleaner sources of energy for which energy storage will be a key component. We are on track to achieve a target addition of 175 GW of renewable energy installed capacity by 2022. The Indian government has also taken on an ambitious target of adding 450 GW (equivalent of charging 21 million electric cars) of renewable energy in terms of installed capacity by 2030.

India's policy on adopting electric vehicles in the next decade has the potential to create a $300 billion market for EV batteries says a study done by Niti Aayog and RMI. Assuming 30% penetration of EVs by 2030, the additional demand from EVs will be just 4-5% of the overall electricity demand and this can be supported by adding renewable sources to the grid and making electric vehicles truly 'green'.

In addition, Indian government's Phased Manufacturing Program will see India becoming a global hub for electric vehicles and this will include battery manufacturing. With the rise in demand for EVs, the cost of batteries is expected to further reduce significantly. Many private and public enterprises are already working towards development of EV components and charging solutions to accelerate the adoption of 'made in India' EV components. A lot of start-ups are also coming up with innovative energy storage solutions. Start-ups and their ideas are essential for a nascent industry like energy storage. Start-ups can work with mature organizations to take their ideas to scale.

It's just matter of time for global cell manufacturers to enter India. We are already witnessing several companies assembling modules and Li-Ion pack in India. With appropriate policy support and through the Make in India initiative, India will take on the likes of China, Germany, USA, Taiwan and South Korea in Li-Ion manufacturing.

The EV industry alone will make India a lucrative field for used batteries which have the potential to be used in second life application as energy storage. The India Energy Storage Alliance (IESA) expects India to have over 300 GWh of energy storage opportunity within the country by 2025, making it one of the highest in the world. This note only makes for a compelling business case but also a great sustainability initiative for organisations to explore.



**Mr. Mahesh Babu**
CEO, Mahindra Electric

# Applications and Business Models for Energy Storage



ESS has different applications from power generation to end customers and thus have multiple business models in accordance with its application. The applications can be divided into three levels:

1. **Energy storage at Generation level**
2. **Energy storage at Transmission and Distribution level**
3. **Behind the Meter energy storage**

Level wise description of each application is given below.

| | Application | Purpose | Benefit |
|---|---|---|---|
| Generation | **Capacity firming** | Maintain the intermittent power output from RE at a firm level for a period | Smooth the output and control ramp rate (MW/min) to eliminate rapid voltage and power swings on the electrical grid |
| | **Load levelling** | Store power at off-peak and deliver it at on-peak | Reduce the load on less economical peak-generating facilities |
| | **Frequency regulation** | ESS is charged or discharged in response to an increase or decrease in grid frequency | Improve power quality |
| | **Spinning reserve** | Provide seconds-scale reserve to respond to generation or transmission outage | Eliminate the need to have back-up generators |
| Transmission & Distribution | **Voltage support** | Protect loads against sharp drop of voltage in grid | Maintain voltages within the acceptable range |
| | **T&D deferral** | Maintain adequate T&D capacity to serve load requirement | Defer the need for the upgrade |
| Behind the Meter | **Peak shaving** | Reduce peak demand | Avoid installations of additional capacity |
| | **Energy arbitrage** | Charge at off-peak, discharge at on-peak | Save on electricity bills |

Table 3: Application of Energy Storage

## Business Models

Globally, storage services for the grid can be acquired through several business models. These business models range from contracting for services only without owning the storage system to outright purchase. The specific option chosen depends on the varying needs and preferences of the owner as well as on opportunities in the country's power market.

| Utility-scale | End use customer (C&I) | End use customer (Residential) |
|---|---|---|
| • Utility owned<br>• IPP owned | • Utility owned<br>  > Grid asset<br>  > Smart-grid asset<br>• IPP owned<br>• ESCO owned<br>• Vendor/third party owned | • Customer owned<br>• ESCO (with aggregator) owned<br>• IPP owned<br>• Utility (LSE) owned<br>• Part of utility program |

Table 4: Ownership Options for Storage System

ESCO = Energy service company, IPP = Independent power producer, LSE = Load-serving entity





Since, Indian energy storage market is at nascent stage, there is not a variety of business models which are in practice. However, at global scale, there are various business models being followed. These models can be adopted by India, in phases, as the domestic market evolves. These phases would be in accordance with the size of the plant and hence, can be categorised into following three:

**Phase 1 – Utility-scale business model**
**Phase 2 – End use customer (C&I) business models**
**Phase 3 – Residential ESS business models**

## Phase 1: Utility-scale business model

- Merchant Model: Storage plant owners and operators can participate in competitive electricity market, thus, unlocking new revenue streams. The merchant (often an IPP that would own multiple generation assets) can also establish a power purchase agreement with a utility, or directly with other electricity end users, to provide services at specific times.

- Utility Owned: Utilities can invest in energy storage to defer the cost of electrical T&D upgrades needed to meet growing electricity demand. ESSs can help improve grid reliability by managing T&D congestion and improving T&D performance, allowing utilities to increase the lifespan of infrastructure assets and to avoid purchasing additional equipment.

- Capacity Contract: Capacity contracts would involve utilities procuring energy storage-as-a-service from providers that can offer reliable load reduction, typically in a set geographic location where there are capacity constraints.

## Phase 2: End use customer (C&I) business models

- Vendor/Third-Party Owned: The vendor/third-party owned model can include a wide range of agreements between vendors and their customers. The two leading third-party owned business models are power purchase and power efficiency agreement plans. In a power efficiency agreement, the customer can get a set power efficiency projects implemented by the vendor through contractual arrangement. On a global scale, these models have allowed a growing number of C&I customers to benefit from energy storage without incurring significant upfront expenses.

- Transactional Sale: The transactional sale business model is a more traditional sale of an ESS to end-use customers. This model can be popular among customers with more complex building systems that have a dedicated energy and facility management staff.

- Holistic Energy Management: Several leading C&I ESS providers can enter the market by offering more holistic energy management services, as opposed to offering ESSs exclusively. Many of these firms would include energy service companies (ESCO) that offer long-term energy management contracts to their customers.

## Phase 3: Residential ESS business models

- Full Utility Ownership and Control: The full utility ownership and control model will have no upfront cost, and customers will pay monthly fees for backup power. The utility will manage the ESS remotely, and the need of the grid will be prioritized over customer needs.

- Full Customer Ownership and Control: In the full customer ownership and control model, the customer pays the full cost of the system with no utility control. The system is managed onsite by the customer or a third party, and the software prioritizes customer needs over grid needs.

- Hybrid: The utility may control the system at certain times, and priorities can vary by program. Upfront costs may be shared between the customer and the utility.





# The Energy Storage for India

With all the buzz going around energy storage these days, be it for Stationary storage or for EVs, very often than not, it is claimed to be the holy grail of renewable energy.

Owing to the intermittency and unpredictability in solar and wind generation, high degree of flexibility in the demand and generation sources is needed for effective operation of the electricity grid for absorbing renewable energy beyond a critical proportion in the energy mix. Battery Energy Storage System (BESS) serves both the purposes – flexible load as well as flexible source. This dual flexibility not only can be used at grid generation level applications like in transmission & distribution network operations, but also in multiple end-user level applications like for Commercial & Industrial (C&I) clients. This dual nature of both load & source enables BESS to provide multiple services to C&I users like peak load management to reduce the contract demand charges, energy usage shift to utilize the benefit of time-of-day tariff structure or to install higher capacity of solar PV, diesel abatement for higher reliability at reduced expenses etc.

However, mass uptake of any technological solution beyond the demonstration level happens when it brings in commercial advantage either versus an incumbent technology or versus an opportunity lost. This can be seen in the case of advanced energy storage systems, where the uptake has been growing steadily year-on-year with major chunk limited to geographies like USA, Australia & Europe driven by suitable grid tariff levels & structures, relatively clearer regulatory policies and fiscal incentives by government which enhances the commercial value proposition of BESS.

In the Indian landscape, although BESS has strong commercial value proposition under certain scenarios, lack of suitable regulatory policies or fiscal incentives for BESS added with significantly high upfront capital costs diminishes the adoption by prospective users. It is at this point where Opex / BOOT (Build, Own, Operate & Transfer) model will play a significant role in the early adoption of this technology.

However, BOOT model of BESS comes in with its own set of challenges. Unlike solar PV projects where the evaluation metrics are straight forward with commercial metric being solar PV tariff pegged against grid tariff, and performance metric being electricity units generated which off-set the grid units; BESS project metrics are complex owing to its innovative and versatile features/use cases. In addition, due the multitude of applications served with the same BESS asset, structuring the legal contract for BOOT model requires due amount of consideration to bring it to a saleable and scalable point.

Hence, building the right Opex/BOOT Model for BESS with due weightage given to technical, financial & legal structuring will be the foundation for mass scale deployments of BESS solutions in India & abroad. At this stage and time, Amplus, having done early Opex/BOOT projects in BESS, is a step ahead in understanding and framing the model to place the bits in place and scale up the Opex/BOOT offering as the infliction point in BESS cost is reached in near future.



**Mr. Sanjeev Aggarwal**
Founder, Managing Director & CEO, Amplus Solar

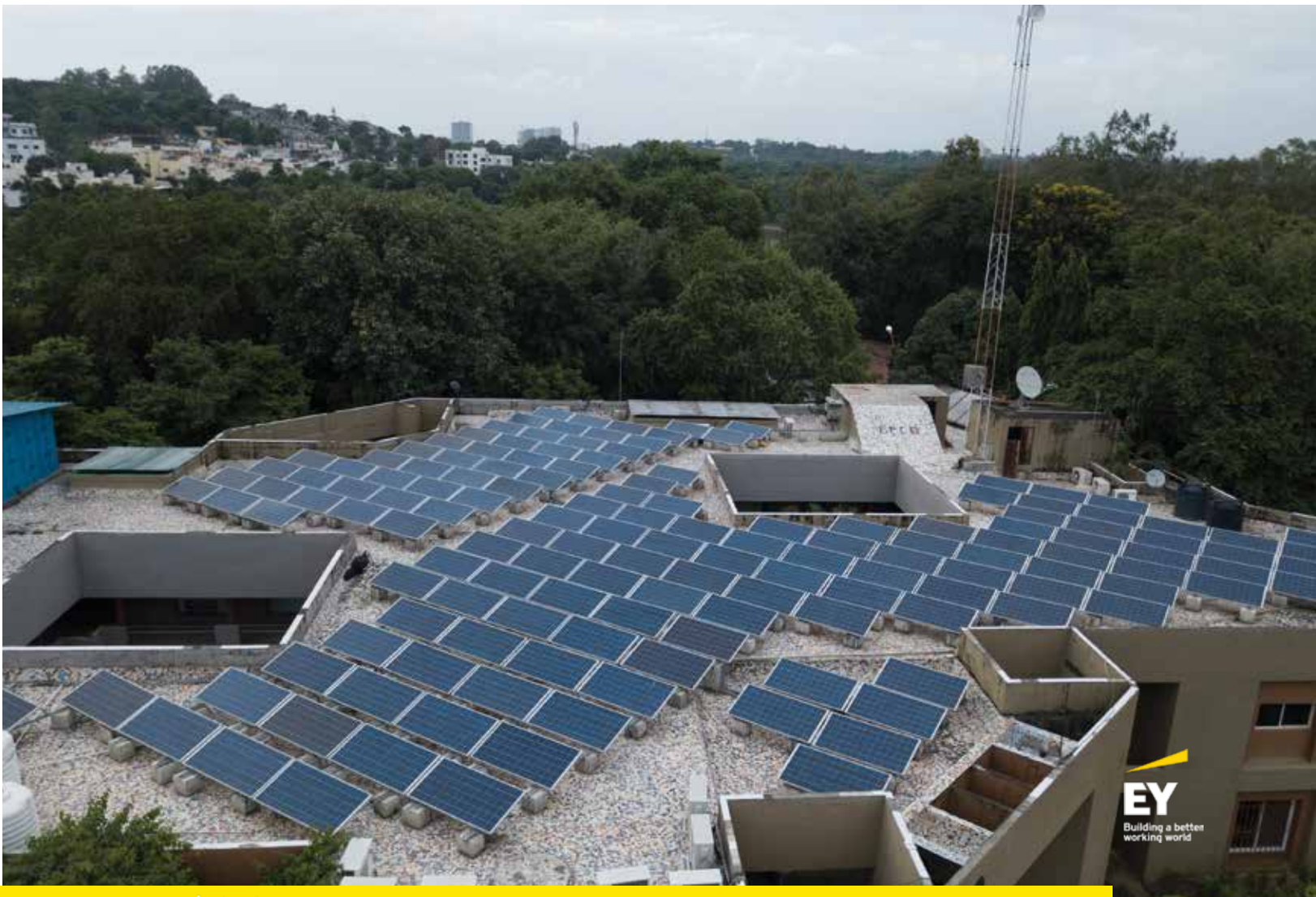
# Battery Chemistry and Challenges of Indian Market



Various battery technologies have been developed at the global level, suitable for both stationary applications and transportation markets. It is observed, that lithium-ion batteries have high power and energy density, along with competitive cycle and calendar life, which justifies their use and consideration for a wide variety of applications spanning from electric mobility to off-grid application.

| Lithium-ion | Lead acid | High-Temperature | Flow Batteries | Nickel-based Batteries |
|---|---|---|---|---|
| Lithium Cobalt Oxide (LiCoO2) | Valve-regulated lead-acid battery (VRLA) | Sodium Nickel Chloride (NaNiCl) | Vanadium redox battery (VRFB) | Nickel Cadmium (NiCd) |
| Lithium Manganese Oxide (LiMn2O4) | Flooded Lead acid (FLA) | Sodium–sulphur Battery (NaS) | Zinc bromine flow battery (ZBFB) | Nickel metal hydride battery (NiMH) |
| Lithium Nickel Manganese Cobalt Oxide (LiNiMnCoO2 or NMC) | | | | Nickel–iron battery (NiFe) |
| Lithium Iron Phosphate (LiFePO4 or LFP) | | | | |
| Lithium Nickel Cobalt Aluminum Oxide (LiNiCoAlO2 or NCA) | | | | |
| Lithium Titanate (Li4Ti5O12) | | | | |

Table 5: Lithium-ion Battery Chemistries



With a 97% global market share for 2018, lithium-ion technology will leap-frog the erstwhile popular sodium-sulphur, nickel and lead-acid based storage systems, which will soon make up less than 1% of the market share by MWh. Intense price competition and a price-sensitive consumer has led manufacturers to develop new chemistries and improved processes, resulting in cheaper storage solutions with higher energy densities. It is predicted, by 2030, lithium-ion batteries would be priced as low as $74/kWh.

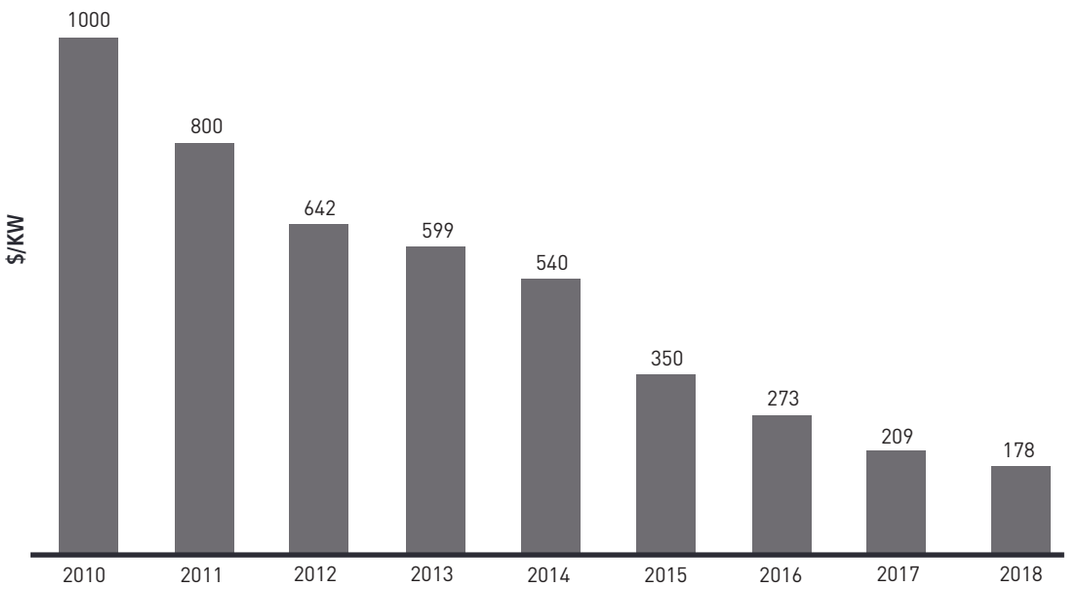



Figure 7: Decrease in the Li-ion battery cost (2010-2018)[11]

**Lithium-ion technology will leap-frog the erstwhile popular sodium-sulphur, nickel and lead-acid based storage systems, which will soon make up less than 1% of the market share by MWh.**

Apart from lithium-ion, there are many more better performing batteries with new technologies in research phase.

## Battery Performance and New Technologies

Currently many types of new battery innovations are being researched in the market considering the performance factors and cost of the researched product. Here are a few examples giving a broad brief of some new projects in research:

### 1. Liquid Electrolyte Batteries

**a. New nickel, manganese and cobalt (NMC) Li-ion batteries**

- Current ratio - 60% Nickel to 20% Manganese to 20% cobalt (6:2:2).
- Research is ongoing to change composition of cathode material ratio to 8:1:1 for the quantity of Nickel (80%) to Manganese (10%) to Cobalt (10%).
- Main focus - Reduce the amount of expensive Cobalt and add more Nickel to minimize cost.

[11] Bloomberg New Energy Finance (BNEF)

b. Silicon Anode and Nickel Rich Cathode Battery

- Silicon-alloy anode is combined with a nickel rich cathode to reduce anode composition in the battery.
- Battery could have 30% less cost and a much higher energy density as compared to the conventional Li-ion Batteries making them of great potential in the battery market.
- Amount of Li and Co would effectively reduce making them an even better choice to manufacture in India.

### 2. Solid State Batteries:

- Use a solid electrolyte which is a conductive chemical mixture that allows flow of the current between the anode and cathode.
- Because of the solid electrolyte, the battery will have a smaller size with higher energy density, longer lifespan, and increased safety.
- Theoretically, it can store twice as much energy as a lithium-ion battery.
- Most liquid electrolytes present in the Li-ion battery are flammable. Thus, solid state batteries are believed to be much safer in this regard.

### 3. Metal-Air Batteries:

- Uses a metal (preferably Zinc) for the anode and air (which is drawn in from the environment) as the cathode and usually a liquid electrolyte.
- Oxygen is abundant, free, and doesn't require a heavy casing to keep it inside a battery cell. So, in theory, the battery can be of ultra-lightweight, and have a long-lasting regenerative cathode.
- Battery can have the potential of giving a very high energy density that may even be comparable to gasoline.
- Main components of anode and cathode are Zinc (India is 4th Largest in the World Zinc reserves) and Air (abundant in Atmosphere) respectively.

Even with such a favourable trend of Li-ion batteries and new technologies for adoption of energy storage, there are some challenges that Indian market has to face.

## Challenges for Uptake of Energy Storage

### 1. Demand risk

Government schemes like FAME I & II have helped to create an emerging market for energy storage solutions, but more policy interventions are required to unlock demand across all applications.

### 2. Low mineral reserves

India does not have reserves of some of the most important Li-ion components including lithium, cobalt, nickel, nor, for that matter, of the copper used in conductors, cables, and busbars.

### 3. Cost of battery technologies

Consumers and solar installers in solar photovoltaic segment are highly cost sensitive. The back-up system (batteries) could increase the upfront cost of a solar system by up to 50% along with additional maintenance and replacement cost associated with batteries.



### 4. Lack of cost-effective cell manufacturing know how

The cell manufacturing contributes to about 30% - 40% of the cost of the battery. International partnerships will be needed for cell manufacturing.

### 5. Early stage battery manufacturing industry

India has no major producers of EV batteries at present and lacks state-of-the-art facilities of both sufficient capacity and capability.

### 6. Maintenance requirements and performance of battery system

Batteries require regular maintenance and replacement after every few years. Also, battery performance is very unreliable and largely depends on usages. Shortfall in battery performance is directly blamed on solar companies. To avoid such situation, companies prefer to install grid integrated solar systems without battery backup.

### 7. Improving power availability scenarios

One of the important challenges to improving the penetration of battery technologies is the improving power availability scenario in existing markets. National statistics suggest that the overall deficit in electricity supply is seeing a significant drop.

### 8. Lack of coordination among stakeholders

Key stakeholders in the battery manufacturing ecosystem include material suppliers, battery manufacturers, vehicle manufacturers, research institutes, and think tanks. Coordination among these parties is a must to define technology pathways, align investment strategies and timing, and guide policies to help achieve India's 2030 EV target. The absence of this coordination is a key barrier to streamlining efforts by different industries and organizations in building India's battery manufacturing supply chain.

### 9. High technology risk

Due to evolving technological changes, demand uncertainty and high investments required in setting up battery manufacturing units.

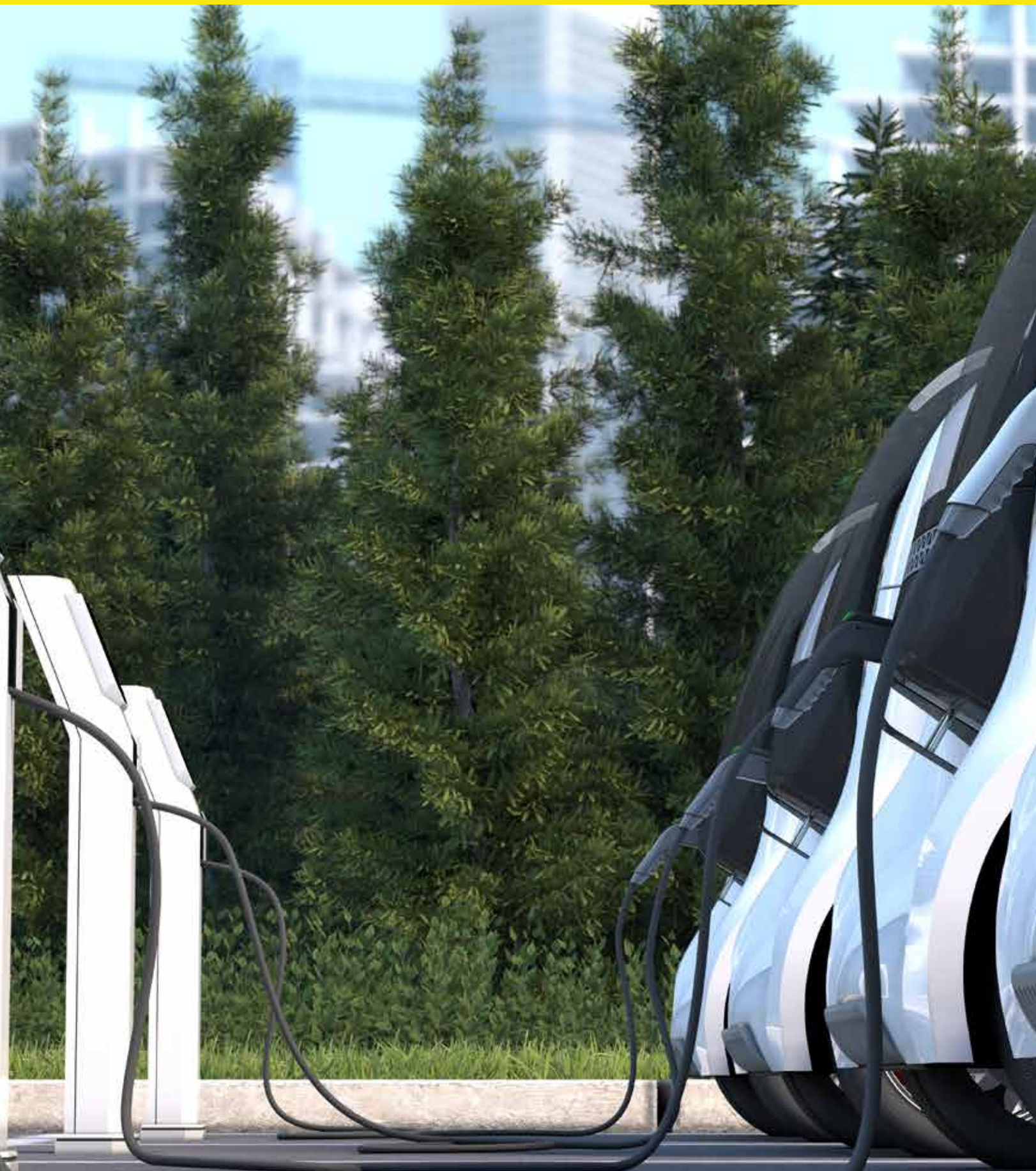
### 10. Recycling for material recovery and second use life

EV batteries have a shelf life of less than 10 years, and after 8-10 years of usage, are not considered fully functional to power an EV. Also, India doesn't have any policy framework or mechanism for battery recycling and second use market

Although, there are many barriers for adoption of energy storage in the country, there is an opportunity for the country to foray into a new segment in energy sector by addressing these challenges and leveraging the drivers of energy storage in the country to become an energy manufacturing hub.



# India as a Manufacturing Hub for Energy Storage



The share of renewable energy in the global energy system is increasing rapidly, electricity storage will grow in tandem as EVs decarbonise the transport sector, solar power is deployed at increasing scale. Simultaneously, falling battery costs will open new economic opportunities for storage technologies to provide various grid and mobility services and boost the economic value of using distributed batteries to increase the self-consumption. Economic value can be realised across the energy storage value chain here represented in two simplified segments –

1. **Manufacturing the battery**
2. **Deployment of the battery**

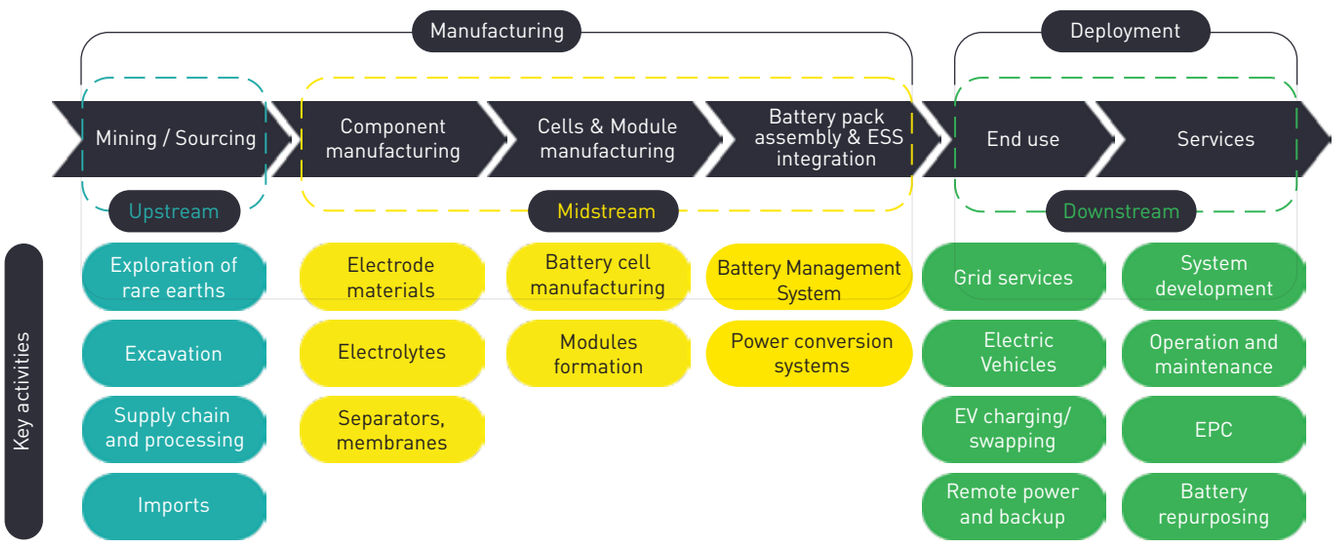



Figure 8: Energy Storage Value Chain

## Manufacturing the Battery

The manufacturing part consists of the first four parts of the value chain i.e., mining/sourcing, component manufacturing, cells and module manufacturing, and battery pack assembly and ESS integration.

Currently, in India, lead acid batteries are primarily manufactured and used for majority of applications. The main reason being easy availability of raw materials in the country. However, the market is shifting towards lithium ion due to its better performance. But, there is a major barrier in terms of raw materials needed for its manufacturing. India has scarce or no known sources of a major constituent i.e. Lithium. Hence, the country has to depend on its imports. Also, there are almost no capabilities for manufacturing of lithium ion batteries in the country. India is heavily dependent on China, Taiwan and Japan for import of these batteries, especially for applications in portable electronics.



With plans to add 175 GW renewable energy generation capacity by 2022 and shift 30% fleet to electric vehicles by 2030, the demand for battery storage is expected to be at 300 GW. Government of India is planning to set up 50-GWh battery manufacturing in India with attractive financial incentives for helping the country achieve 30% electric vehicles by 2030 target. The subsidies that GoI is planning to offer to companies setting up a plant includes minimum alternative tax at 50% the current rate and import and export duty waivers or cuts for eight years. The annual subsidy outgo on this is estimated to be INR700 crore. Indigenous manufacturing of batteries will make the country self-sufficient in addressing demand of batteries for electric vehicles and other consumer electronics.

As per the expected timelines, the government will invite bids by December 2019 and award contracts subsequently. Companies will be given contracts based on their financial position, production capacity, scale-up plan and the extent of localisation. Niti Aayog will seek proposals from states to identify locations for plants and on providing duty waivers and exemptions to the battery manufacturers. The states will be asked to provide favourable policy framework including reduction in GST rate, easy land acquisition, concessional electricity, single-window clearance and environmental clearance.

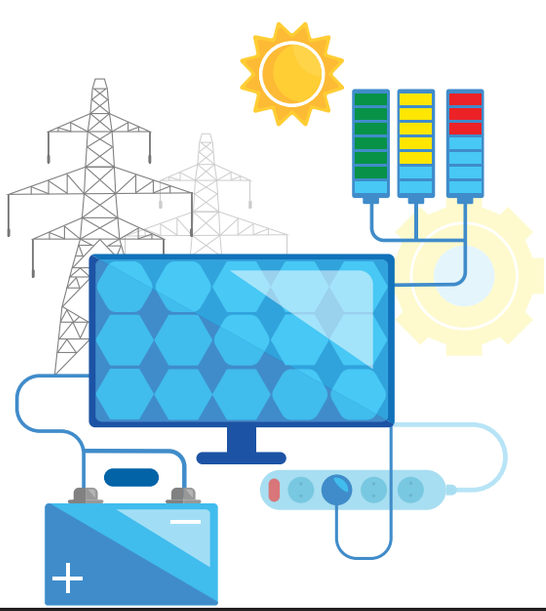
After the identification of best proposals, Niti Aayog will invite bids from companies to set up the plants at identified locations. According to the expected timelines, Niti Aayog will have to conclude the bidding within six months from Cabinet approval. As per the proposal, the companies will have to set up the manufacturing facilities by 2022, following which they will get the incentives for eight years till 2030. This clause is being pushed to ensure early setting up of the manufacturing base. Number of locations to be identified will range from minimum of five locations and maximum of 20.[12]

In addition, India has recently signed a Memorandum of Understanding (MoU) with Bolivia for the development and industrial use of lithium to produce lithium-ion batteries. As part of the MoU, Bolivia will support supplies of lithium and lithium carbonate to India, as well as joint ventures between the two countries for lithium battery production plants in India.

## Deployment of the Battery

The deployment part consists of the last two steps of the value chain i.e., end use and services.
In energy storage deployment segment, India has not progressed much and most of the projects are of pilot scale. The deployment of battery can be divided into three key system and customer-oriented segments:

1. **Generation**
2. **Transmission and distribution**
3. **Behind the meter**



[12] https://economictimes.indiatimes.com/news/economy/policy/subsides-soon-to-make-batteries-in-india/articleshow/70526760.cms

At generation level, a lot of energy storage tenders have been issued by different government bodies. Some of the major tenders are given below: -

| Date | Organisation | Nature of Project | Capacity | Location |
|---|---|---|---|---|
| March 2018 | Neyveli Lignite Corporation | Solar PV with BESS power plant | 20 MW (8 MWh) | Andaman & Nicobar Islands |
| August 2018 | Solar Energy Corporation of India | Solar-Wind Hybrid plant with BESS | 160 MW | Andhra Pradesh |
| March 2019 | Solar Energy Corporation of India | Solar PV with BESS | 14 MW (42 MWh) | Leh & Kargil |
| April 2019 | Rajasthan Electronics & Instruments Limited | Solar PV with BESS | 1.7 MW (1 MWh) | Andaman & Nicobar |
| May 2019 | Solar Energy Corporation of India | Floating Solar PV plant with BESS | 20 MW (60 MWh) | Lakshadweep |

**Table 6: Tenders and Generation Level in India**

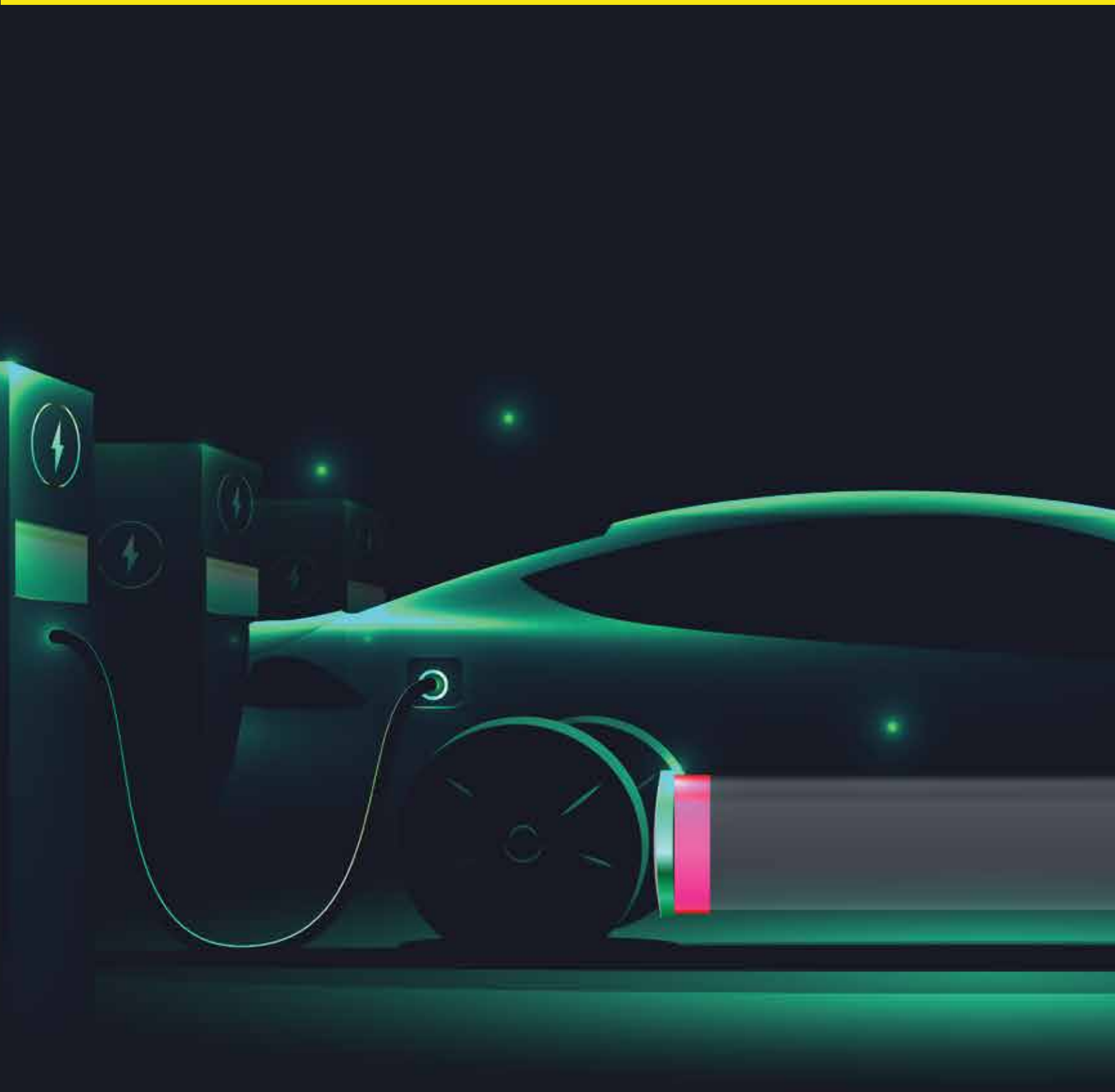
At transmission and distribution level, the progress is not as much as compared to that at generation level. However, activities of issuance of some tenders and pilot programmes are present in the country. For example, in February 2019, SECI issued a tender for a 1.2 GW inter-state transmission system across India, which was oversubscribed by 0.9 GW. Also, Tata Power Delhi Distribution Ltd. has installed 10 MW energy storage system at its sub-station.

At behind the meter level, the country has not progressed much. Also, there are currently no known tenders or pilot programmes at this level.

Thus, considering the as-is scenario of Indian market, a considerable attention is needed in battery manufacturing and deployment segments. Also, after manufacturing and deploying the battery, there is another area which needs to be addressed which is battery recycling.



# Battery Recycling and Disposal: Repurposed Batteries



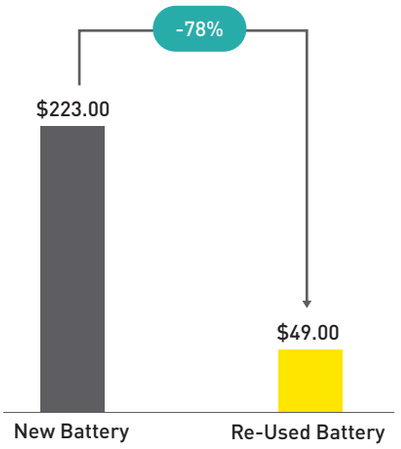
Battery lifecycle management is fast emerging as a lucrative business opportunity. It is driven primarily by the anticipated EV demand, shortage of or restricted access to critical minerals, increasing regulatory push, and useful capacity left in used EV batteries.

Industry participants are exploring both repurposing and recycling to derive value over the lifecycle of a battery to both lower upfront EV costs as well as develop new revenue streams.

## Battery Repurposing

The deployment part consists of the last two steps of the value chain i.e., end use and services.
In energy storage deployment segment, India has not progressed much and most of the projects are of pilot scale. The deployment of battery can be divided into three key system and customer-oriented segments:

1. **Generation**
2. **Transmission and distribution**
3. **Behind the meter**




Estimated cost of a re-used battery is 78% less than a new battery.

Table 7: Cost Comparison - New vs Re-used Battery

**Key applications for second-life batteries include:**

- Renewable energy storage: Used EV batteries are ideal for storing electricity from solar panels and wind turbines and allowing its usage when needed.
- Grid stabilization: Handling load shifting when there is high peak demand.
- Power back-up: Back-up power supply and improving power quality inside residential or commercial buildings.
- Portable/Mobile Charging Solutions: Stored energy can be leveraged to offer EV charging services in locations where constructing a high-power connection would be very costly.

## Battery Recycling

Recycling refers to the extraction of high-value minerals from existing battery cells after their useful first, second or third lives. The rising stockpile of lithium-ion (Li-ion) batteries from EVs, solar rooftops and other storage applications has necessitated battery recycling, as Li-ion poses the risk of personal injury, property damage and environmental damage if not properly recycled or disposed.

It is expected that 11 million tonnes of Li-ion batteries to be discarded by 2030 creating an untapped market opportunity of USD 11.8 billion by 2022 and thereby controlling extracted rare earth minerals.

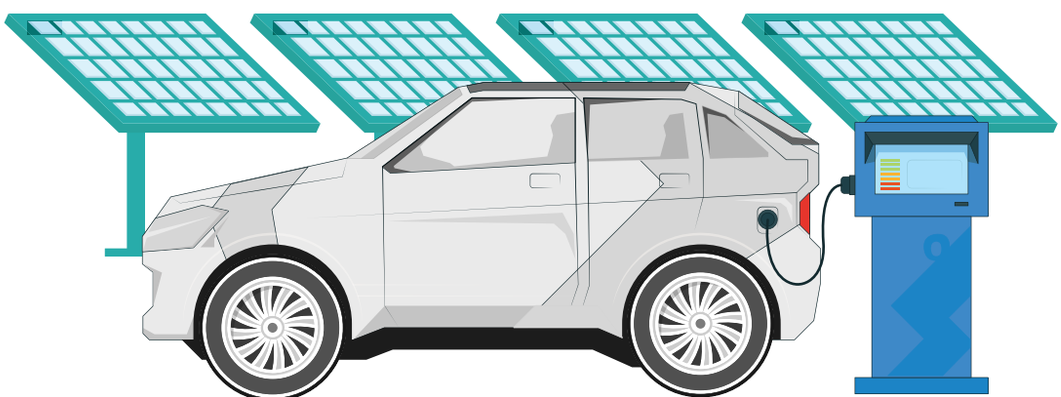
**It is expected that 11 million tonnes of Li-ion batteries to be discarded by 2030 creating an untapped market opportunity of USD 11.8 billion by 2022.**

## Battery Exchange Platform

Repurposing of battery driven by inventory management technology solutions such as blockchain can lead to development of a battery exchange platform, wherein, the battery is circulated amongst various stakeholders in different life phases and is controlled through a centrally managed platform. Battery exchange platform has a potential to launch new and adjacent services:

- Subprime loan and guarantee-for-sale-at-price based on certain re-use profitability.
- Insurance services for used batteries.
- Subscription model, Battery as a Service.
- Trade service of surplus electric power by monitoring the distribution and usage status of distributed battery storages in real time.
- Secure large volume of batteries as recycle materials and trade(bid) with best price in market to recyclers.

Thus, there are various opportunities in energy storage segment for Indian market. However, to gain maximum benefits, some strategies and initiatives are needed. The next section discusses about some of the recommendations to help this segment evolve in the country.





# Quality and Risk related to Battery Storage



## Quality

Quality is directly related to the lifecycles of the battery. To ensure quality of battery storage, right cost must be matched with the right price at the time of procurement and regulations need to be in place to prevent dumping of poor-quality battery packs from other countries.

Currently, international players are dumping low-quality battery packs for electric vehicles (EVs) in India, it is similar to the way rejected solar modules were sold here at a discount when solar PV picked pace in India.

In previous years, to prevent dumping of solar equipment, stringent quality norms were introduced, and Government ordered that all substandard equipment should be destroyed. Requirement of similar norms for battery storage needs to be established to prevent influx of Chinese low-quality battery packs. Therefore, it is important to develop domestic standards and to ensure that consumers are protected.

Hence, to start the process of setting quality standards, battery energy storage system (BESS) was brought under the purview of the solar photovoltaics, systems, devices, and component goods (Requirement for Compulsory Registration under the BIS Act Order 2017) which was implemented on April 16, 2018.

The government is trying to catch up with quality issues and is setting up testing guidelines to ensure all products sold meet established standards. As batteries are of varying sizes, ratings, and types, each category of batteries is to be grouped when submitting samples to test labs and will be granted approval for the series (group) of products based on testing of representative models.

As per MNRE guidelines, the information regarding the material of the battery containers, the separator used, and the type of sealing adopted (in the case of sealed batteries) and the overall dimensions should be provided by the manufacturer while submitting the batteries for testing. The short-term tests like capacity test, retention of charge, and others will be performed on all ratings included in the series.

Among the product range of cells and batteries from a manufacturer, the representation model of that particular cell and battery will be tested. The highest rated capacity sample will be subjected to all tests (including endurance tests), and the qualifying product will be issued test reports to all samples covered in the series. For cells and batteries to be considered in the same series, the manufacturer has to submit an assurance to the test lab that all the models have been manufactured with no change in the grid alloy composition, grid purity, grid thickness, ingredients used in the electrode preparation, method of preparation and the thickness of the electrodes and quality systems followed for manufacturing.

India is currently finalizing plan to build Tesla-style giga factories to develop its own domestic battery manufacturing ecosystem. This involves multiple incentives such as concessional financing options, friendly tax regimes and a suitable basic customs duty safeguard, that will ensure quality of battery packs.

# Risk

## 1) Sourcing of Raw Materials

Today, the demand for Li-ion batteries is much more than those of other battery technologies like lead acid or nickel metal hydride. This is mainly because of li-ion battery being much more energy dense compared to other technologies. Thus, nowadays, Li-ion cells are widely used in automotive, laptops, cameras and other electronics equipment.

Owing to the recent policy push by the government, India has started venturing into manufacturing of Li-ion batteries. Graphite, which is an active anode material for Li-ion, is easily available in the country. In fact, 12.5% of graphite in the world is mined in India. However, it is the scarcity of other key materials which pose a risk sourcing to the nation.

Lithium, the core element of the battery, has no known sources in India. Thus, there is no option but to import it from lithium rich countries like Chile, Argentina, Bolivia, Australia, Zimbabwe, Portugal, Brazil, United States and China. In fact, India has recently signed a Memorandum of Undertaking with Bolivia for import of lithium. However, these imports can be a very costly affair.

Another major raw material for which India must depend on imports is cobalt. Cobalt is abundantly found in Congo in Africa, which is the world's largest producer of the mineral. However, India hasn't yet started any investment in the countries like Congo.

Thus, to propel the battery manufacturing business in India, big players in the country must acquire lithium and cobalt mines in various countries.



## 2) Technology

There are a number of new technologies currently in the research & development stage or concept stage, including hydrogen fuel cells and aluminium-air batteries. While these technologies show great potential, they have not reached economic viability and commercialization yet. The falling lithium-ion manufacturing costs and the current investment in infrastructure provide lithium-ion batteries with considerable first mover advantage as of now, however, other technologies can pose a challenge in the long run.

## 3) Safety and recovery of elements

Batteries which depend on certain lithium-ion battery chemistries, fire hazards are associated with them due to high energy densities coupled with the flammable organic electrolyte. This creates new challenges for use, storage, and handling. Various studies have shown that physical damage, electrical abuse such as short circuits and overcharging, and exposures to elevated temperature can cause a thermal runaway. This refers to rapid self-heating from an exothermic chemical reaction that can result in a chain reaction thermal runaway of adjacent cells.

To avoid such situations, failure scenarios, including thermal runaway should be considered during design and testing so that a failure is not catastrophic. Battery packs should be maintained at manufacturers' recommended operating temperatures during charging or discharging and other guidelines including those related to storage, charging and discharging, and disposal should be followed strictly.

It is widely known that recycling reduces the impact of batteries at end-of-life. The non-recycling of batteries is not only a health and environmental hazard but also an economic loss as recycling of these precious materials could help avoid mining, which is otherwise costly. Thus, it becomes imperative to recycle batteries and recover the raw materials. However, improper recycling of both - lead acid battery, which is manufactured in India at large scale, and lithium ion batteries, which are used in most applications globally - also poses a risk.

Lead is toxic, and it produces harmful smoke and dust particles during smelting process. To keep these toxic particles in control, pollution control plant is required. But, this plant can be a very costly affair. Thus, there is a growing number of backyard and small operators in the country, who rely on polluting technologies. Also, these smelters supply lead at a lower price as compared to authorised smelters, thus, harming their business. Apart from polluting the environment, cattle death cases, near unlicensed lead smelting units, are very common.

In case of lithium ion batteries, extraction of lithium through traditional smelting leads to formation of a mixed by product. Extracting lithium from the by product is complicated and an expensive process. Also, lithium ion batteries pose fire hazard and are known to have caused multiple fires in trash dumps and landfills, due to improper handling and recycling. Another challenge in its recycling is lack of maturity in technologies for extraction of critical elements from li-ion batteries.
Thus, to address these risks, government can come out with clear guidelines and incentives for recycling of each battery technology.

# Key Areas that will Impact and Enable Energy Storage in India



## Way Forward

The future outlook of energy storage in India would be determined by a systematic coordination in the Supply, Facilitation and Demand side interventions. Global and regional alliances towards solving supply chain linkages, Government's policy clarity and Demand side market mechanisms would be crucial for the energy storage market uptake.

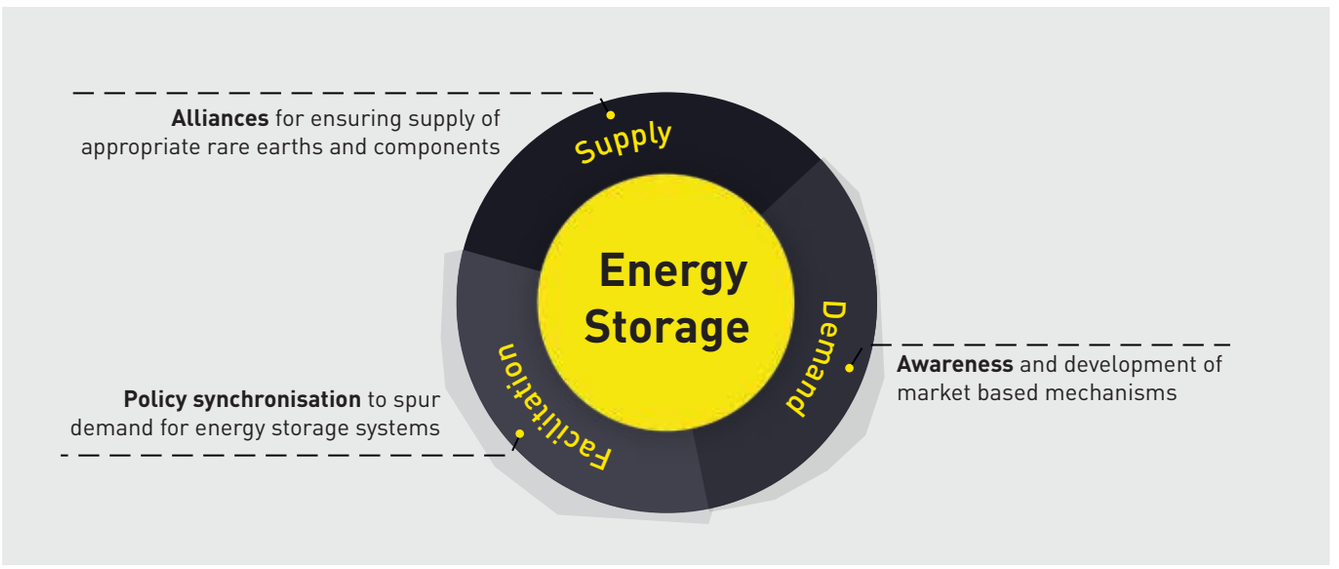



Figure 9: Solving the supply, facilitation and demand puzzle

### Demand side interventions

To make energy storage an attractive business opportunity, initial focus should be on demand creation. Government can introduce various incentives to promote large scale adoption of energy storage. Some incentives are as follows:

- **Differential tariff**: DISCOMs may charge higher rates during time of peak demand and lower rates at the time of low electricity demand for all segments. This tariff structure can motivate people to use batteries to store energy during non-peak hours and utilise the stored energy during peak hours to save their expenses.
- **Tax incentives:** Incentives such as property tax reductions, corporate tax reductions, etc. can be provided to consumers who use energy storage systems.
- **Awareness creation:** Awareness drives and workshops can be conducted for potential consumers to apprise them about the benefits and monetary savings a consumer can make by adopting energy storage. In addition, this measure can be very effective in rural areas which regularly face long power outages.
- **Incentives to promote faster adoption:** Government can introduce schemes (similar to FAME for electric mobility) offering several incentives and benefits to promote faster adoption of energy storage. Furthermore, public sector organisations can promote energy storage by setting up pilots for their offices.
- **Licence exemption:** The setting up of grid scale storage can be exempted from licence requirement. This would enable the creation of independent storage service providers (ISSPs) to deploy large-scale solutions.

## Facilitation side interventions

Energy storage can act as a business opportunity for DISCOMs. Stored electricity can help DISCOMs handle peak demands with ease and defer the transmission and distribution infrastructure upgrades. However, financial health of most utilities is not good in India. Thus, they need monetary support from government to invest in this opportunity.

One way in which government can provide financial help is by setting up a fund for accelerating the deployment of grid scale energy storage projects by DISCOMs in the early years. The government in turn can be benefited as they can explore learnings from these projects, which can help market adoption by addressing technology, policy and commercial risks.

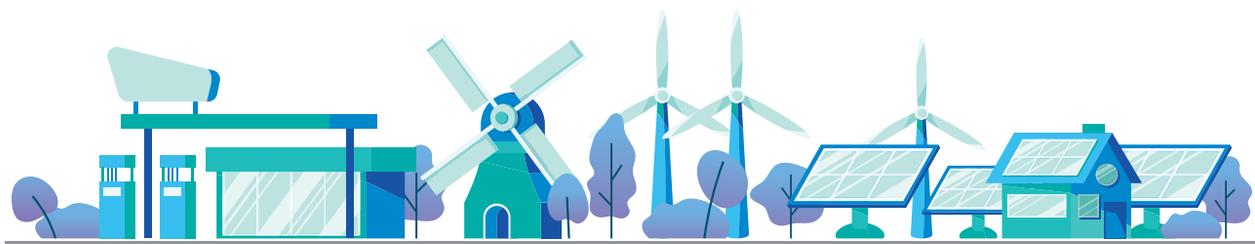
Another barrier for adoption of energy storage by DISCOMs is lack of rules and regulations as well as incentives to set up energy storage systems. Therefore, there is a need of a revised Regulatory Framework for DISCOMs. There are several measures which can be taken by the government in this regard. Some of the measures are as follows:

- Revised Electricity Act: Since, there is no section on energy storage in the Electricity Act, there is a need of an updated Act which defines energy storage.
- Clarification on licence requirement: CERC / SERC can introduce some guidelines to provide clarification about requirement of licence for setting up energy storage systems.
- Monetary incentives: Government can introduce incentives such as monetising the value of firming/smoothing of solar power, ramp rate control, peak shifting, demand response etc.
- Creation of interconnection standards: There is a need to create grid interconnection standards for the use of storage on a stand-alone basis and as part of generation, transmission and/or distribution assets.
- Inclusiveness in policy making: An integrated approach among the concerned ministries such as Ministry of New Renewable Energy (MNRE), Ministry of Power (MoP), Ministry of Heavy Industries and Public Enterprises (MHIPE), Department for Promotion of Industry and Internal Trade (DPIIT), Ministry of Finance (MoF), etc., is necessary for policy making on energy storage for grid services and EVs.
- Conduct studies to motivate DISCOMs: Government can conduct some studies to build confidence among DISCOMs towards energy storage. Some examples of such studies are:
  - Evaluation of the cost and environmental impacts of conventional thermal power plants and their comparison with the use of energy storage for providing flexibility to the grid.
  - Impact of meeting rooftop solar targets on system cost for DISCOMs to determine the possible role of storage.

## Supply side interventions

Energy storage is a dynamic sector involving multiple stakeholders from the governments, utilities, mining, OEMs and technology integrators. One of the key barriers to energy storage in India is the early stage of battery manufacturing due to which the country is dependent on imports. One other way to reduce this dependence is to source the essential elements like cobalt and lithium from outside country reserves and use them to manufacture home-made Li-ion batteries. Supply chain linkages will be required amongst various entities to ensure an unbroken value chain in India that can supply the market with all the batteries it needs. The Government will leverage international relations to secure reserves of rare earths, Battery and automobile OEMs are integrating for electric mobility, technology integrations will enable newer business models such as battery-as-a-service.

Challenges associated with additional custom duties on import of materials may increase the cost of manufacturing, thus, making the batteries much more expensive.



## Other areas that can further impact battery storage market in India are:

### 1. Research to innovate existing Battery Technology

To diminish dependence on foreign import of Li-ion batteries, an innovation in the manufacturing technology that requires less amount of elements like Lithium and Cobalt at the base level to produce the product is required.

For this to happen a platform needs to be established for the Indian companies to invest more in the Research and Development (R&D) sector.

### 2. Initiatives from the Government

Here are some of the Proposals which government can introduce to make battery more appealing to the targeted stakeholders:

**i. Growth Proposals**

Government could show support to the new Battery technologies coming up in the market.

- Solid State Batteries: Main problem is their mass production at an attractive price point. So, there could be steps taken to lower the price by subsidies.
- Metal–Air Batteries: Government could lower the price of the raw basic raw materials like zinc to decrease the cost of production and hence promoting research of these batteries.
- Liquid electrolyte batteries: Since they need lesser quantity of Li, Co, the companies researching on them can be provided with facilities like land concessions to speed up their research.

**ii. Sales of researched battery technology**

The sales of the researched battery developments could be taken up by the government so that the new companies investing in the research don't have to worry about their product not being sold in the market.

### Conclusion

Government's facilitation and regulatory maturity of the market will influence the value and utility of storage systems. In fact, regulatory policies may supersede technological advancements in terms of influencing storage adoption. The government will act as an anchor to address the diverse stakeholder nature of the energy storage systems and will set targets for adoption. Government may further facilitate the sector through financial incentives.

The demand side interventions will be driven through the evolving market paradigms. Earlier, as the utilities were vertically integrated, there was no need for a separate mechanism for regulating the grid stability through ancillary services. As we move forward, it is becoming more important that with the growth of renewables and changing demand patterns, a functional ancillary market mechanism be put in place which can focus on stabilising the national grid at a 50 Hz frequency, rather than having a band within which the frequency oscillates. CERC recognizes this fact and is currently working on revising the Ancillary market mechanism in India to meet these newer challenges, however, Battery Storage needs to be an integral part of new regulations to provide frequency control and other services. Also, Government should revise relevant provisions under Electricity Act, to make sure it doesn't act as a hindrance in proliferation of Battery Storage.



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