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Energy Oil & Gas and Utilities

Alternate Energies
BESS - Stationary Storage

August 2021

Agenda

Acronyms

Acronyms	Description
AC	Alternate Current
BESS	Battery Enabled Storage Systems
BoS	Balance of System
C&I	Commercial and Industrial Customers
CAGR	Compounded Annual Growth Rate
DC	Direct Current
DG	Diesel Gensets/Generator
DISCOM	Distribution Company
ESS	Energy Storage Systems
GENCO	Generation Company
GWh	Giga Watt hour
IPP	Independent Power Producers
ISO	Independent System Operator

Acronyms	Description
KfW	Kreditanstalt für Wiederaufbau (German funding agency)
LFP batteries	Lithium Iron Phosphate
NCM batteries	Nickel Manganese Cobalt
NREL	National Renewable Energy Laboratory
OEM	Original Equipment Manufacturers
PLI	Performance Linked Incentive
PV	Photovoltaic
R&D	Research & Development
RE	Renewable Energy
RTO	Regional Transmission Organization
T&D	Transmission & Distribution
TCO	Total Cost of Ownership

Foreword

The aftereffects of COVID-19 pandemic have been wide and large. The pandemic has already affected the economy severely. Although the recovery is going to be a long-drawn and hard-fought process, Indian economy is resilient and shall bounce back.

This report is intended to provide, various industry stakeholders including business leaders, an overall perspective on the key trends in the energy storage market and emerging opportunities as the economy was on the path of recovery post the last year lockdown. However, since then the market has witnessed up and down swings and the second wave has curtailed the energy storage push to a certain extend.

While our report is fairly COVID-19 agnostic and speaks about the trends and directions in the energy storage market, we have discussed the use cases for energy storage at a stationary battery enabled storage system level. We discuss about the various electricity storage technologies globally and the application of battery enabled Stationary Storage system.

Further we discuss about within batteries how lithium ion batteries are the key energy storage batteries currently and how their chemistries are evolving, particularly in case of NCM and LFP battery chemistries and how their price movement is determining the overall price for energy storage in the future and subsequently the overall cost of electricity.

We also talk about the evolving business models for energy storage across utility and end users and the various policies and directions by the government overall. Finally, we do highlight the barriers which are slowing the growth of stationary BESS in India.

We, at Praxis, look forward to continuing the discussion with our friends across sectors and exchanging notes as the situation evolves.

Madhur Singhal
Managing Partner & CEO

Aryaman Tandon
Managing Partner & Co-Founder

Key takeaways

Stationary Storage market

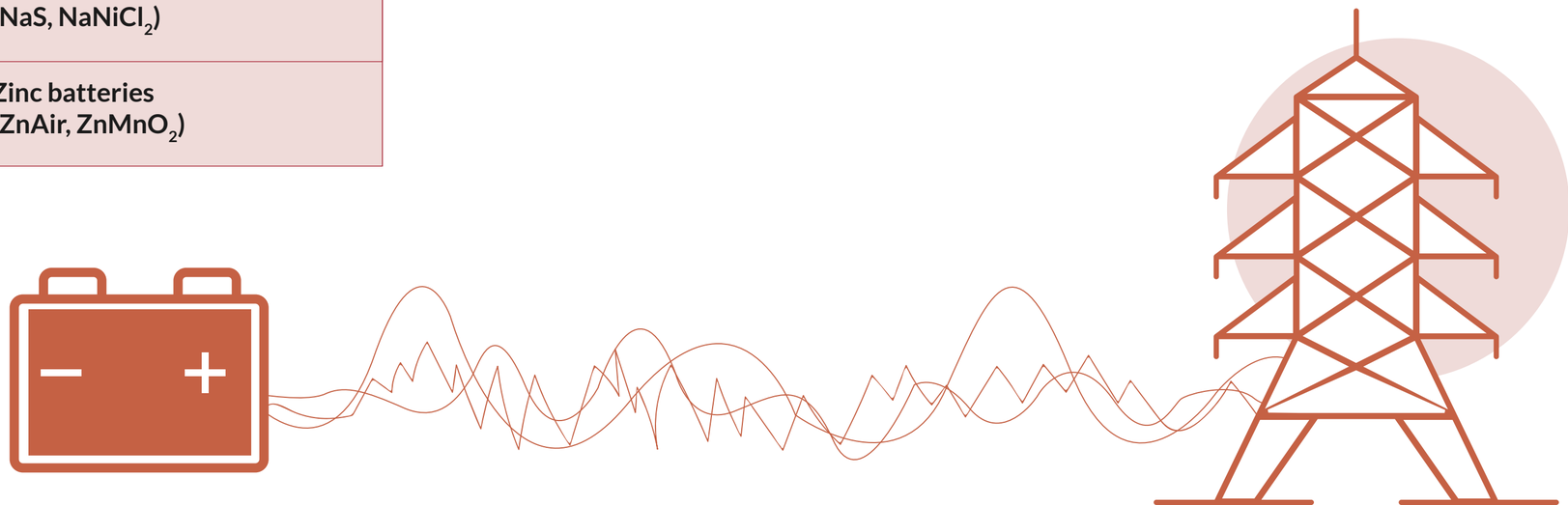
- India is expected to lead the battery storage market over the next 10-15 years due to robust solar energy generation integration and strong end-customer demand
- TCO for both Li-ion chemistries (LFP and NCM batteries) are expected to witness a significant decline over the next decade
    - LFP batteries: Solar power + BESS tariff for electricity stored in LFP batteries are expected to range between INR 7.0 – INR 7.7 by 2030
    - NCM batteries: Solar power + BESS tariff for electricity stored in NCM batteries are expected to range between INR 7.8 – INR 8.7 by 2030
- Both utility-scale and end-consumer models exist globally for battery storage; Utility-scale models target grid and large C&I customers
- BESS has a strong use case to minimize DG electricity; Falling battery prices have the potential to create a strong case to replace grid electricity with solar + BESS in the future

Introduction

There are 5 major categories of energy storage technologies globally; Li-ion batteries under BESS is one of the most used technologies of energy storage

Mechanical energy storage	Electrochemical or BESS	Thermal energy storage	Electrical energy storage	Chemical (hydrogen) energy storage
Pumped Hydro Energy Storage (PHES)	Lead Acid Batteries, advanced Lead Acid Batteries	Sensible molten salt, Chilled water	Super capacitors	Power-to-power (fuel cells)
Compressed Air Energy Storage (CAED)	Lithium batteries (LCO, LFP, NMC, NCA, LTO)	Latent ice storage, Phase change materials	Superconducting magnetic energy storage (SMES)	Power-to-gas
Flywheel Energy Storage	Flow batteries (Vanadium redox, ZnBr)	Thermochemical storage		
	Sodium batteries (NaS, $NaNiCl_2$)			
	Zinc batteries (ZnAir, $ZnMnO_2$)			

Most used technology



Sources: India Smart Grid Forum, Praxis analysis

Introduction

Applications for Li-ion based Battery Enables Storage Systems (BESS) across the spectrum

BESS applications (for Li-ion batteries)

Industrial application

Stationary Storage

Electricity grid

Telecom towers

Commercial & Industrial (C&I)

Invertors

UPS

Mobility storage

EV charging infra

Battery swapping

Consumer application

Smartphones

Laptops

Personal care & other consumer products

Power tools

Tablets

Stationary Storage

Invertors (Residential)

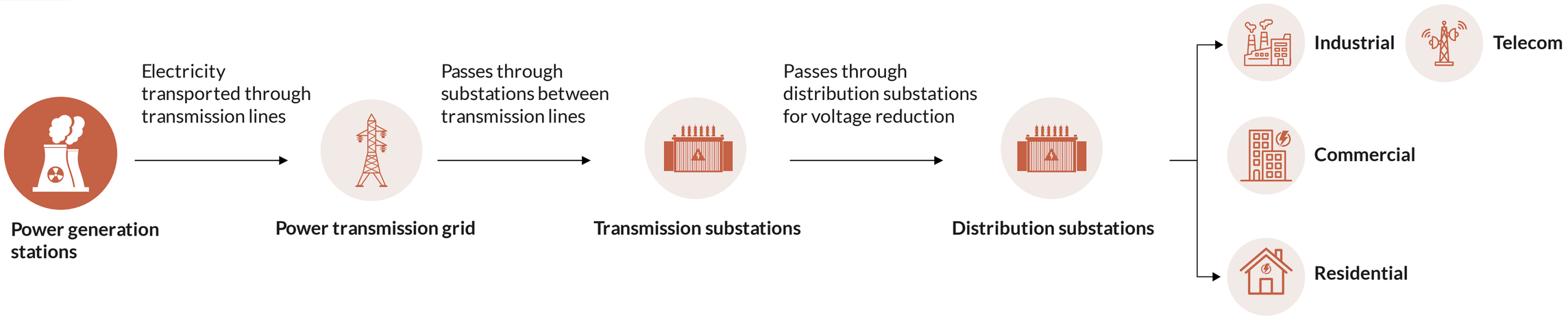
UPS (Residential)

Sources: India Smart Grid Forum, Praxis analysis

Report focus area

Introduction

Stationary Storage have application across Grid, C&I and residential categories, hence growing demand from these categories would increase Stationary Storage capacity



	Generation	Transmission and distribution	Residential, C&I end users
Asset owner	• State generating companies • Private companies (IPPs)	• Transmission companies (public and private) • Distribution companies (public and private)	• End customers (C&I, residential, etc.)
Key applications and uses	• **Capacity firming:** Maintain intermittent power output • **Load leveling:** Store power during off-peak hours and deliver during on-peak hours • **Frequency regulation:** Charge/discharge in reply to increase/decrease in grid frequency • **Spinning reserve:** : Provide seconds-scale reserve to respond to outages	• **Voltage support:** Protect against sharp increase or drop of voltage in grid • **Grid congestion reduction:** Smoothen out the power transmission from peak to off-peak • **T&D capex deferral:** Maintenance of adequate T&D capacity and defer the need for upgrade/capacity addition	• **Demand charge reduction:** Lower charges due to lower grid electricity demand • **Backup power:** Adequate backup for power cuts • **DG use minimization:** Decreased diesel consumption for DG • **Decreased** diesel consumption & diesel usage • Ability to **store solar-generated electricity** for later use

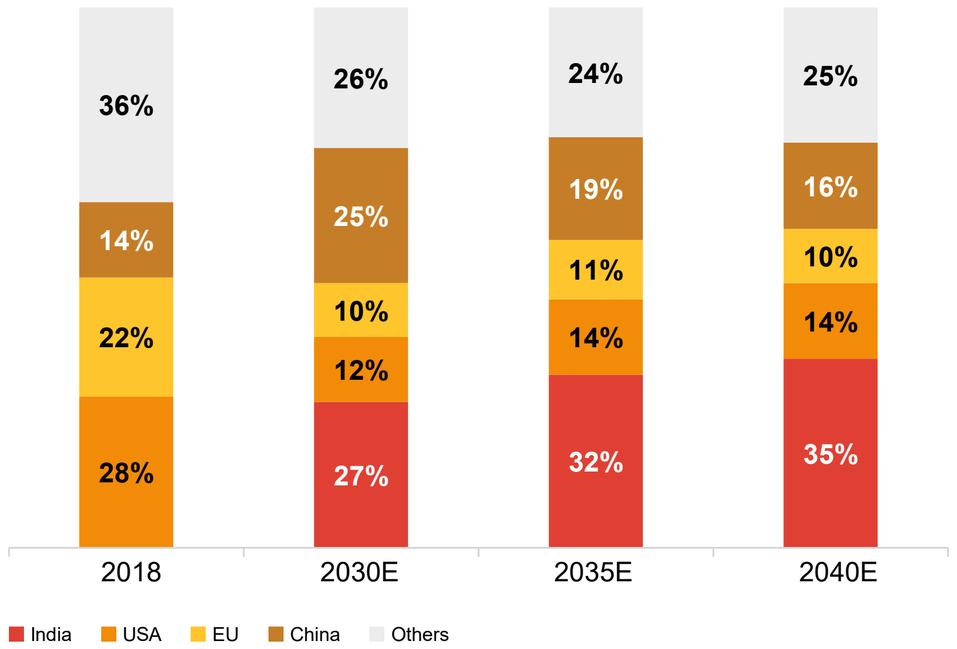
Sources: Secondary research, Praxis analysis

Indian and global trends

India is expected to lead the battery storage market over the long term on the back of robust solar energy generation targets and strong end-customer demand

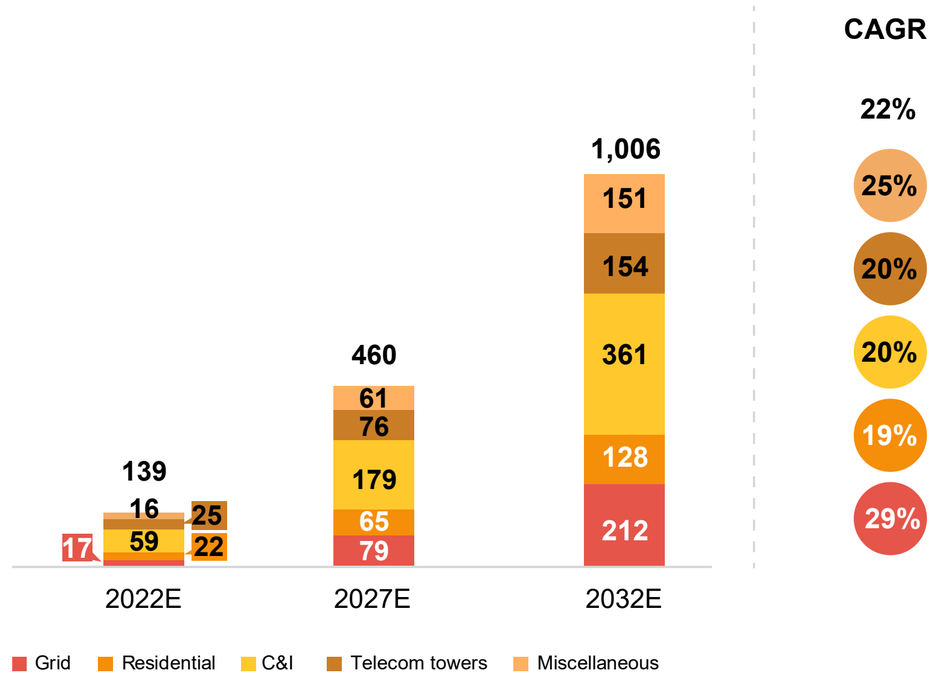
India is expected to contribute to 35% of the total global battery deployment for energy storage by 2040

Share of major countries in battery storage deployment



Stationary energy storage requirement is expected to grow 9X over 2022-32, at 22% CAGR

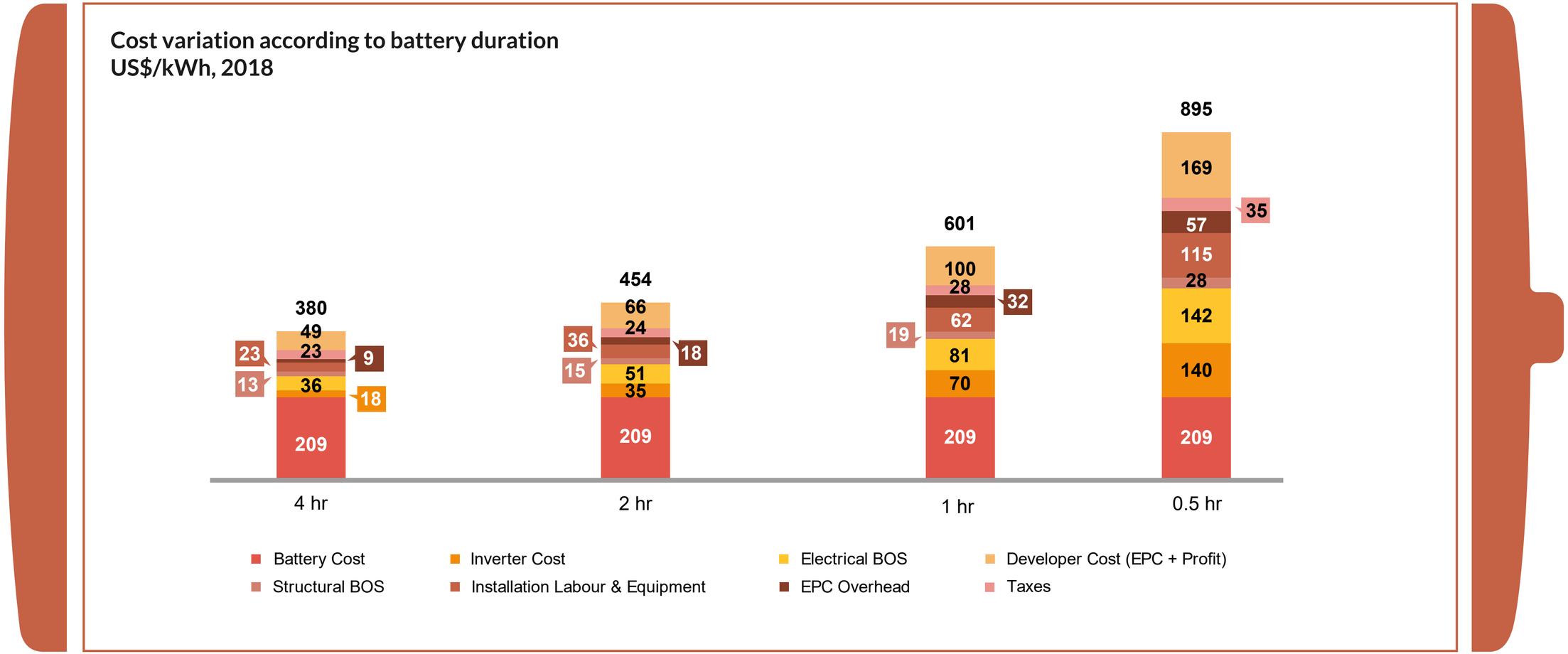
Stationary energy storage estimates across end-uses in India
GWh



Notes: Miscellaneous includes railways, rural electrification, HVAC application; Residential includes invertors and UPS; C&I include, DG sets, invertors and UPS
Sources: IEA, India Smart Grid Forum, Praxis analysis

Cost economics

Li-ion batteries cost vary as per the usage requirements – Cost economics witness significant increase while moving from 4hr battery to 0.5hr battery

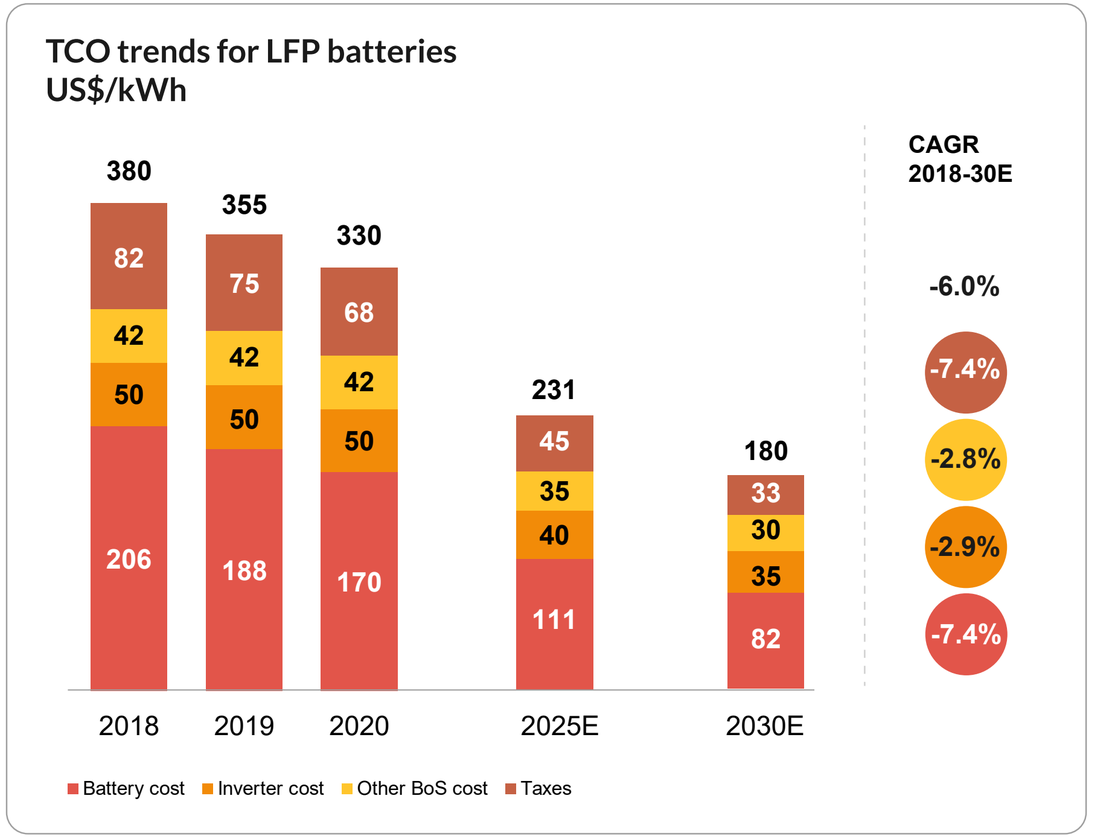


Sources: NREL, Secondary research, Praxis analysis

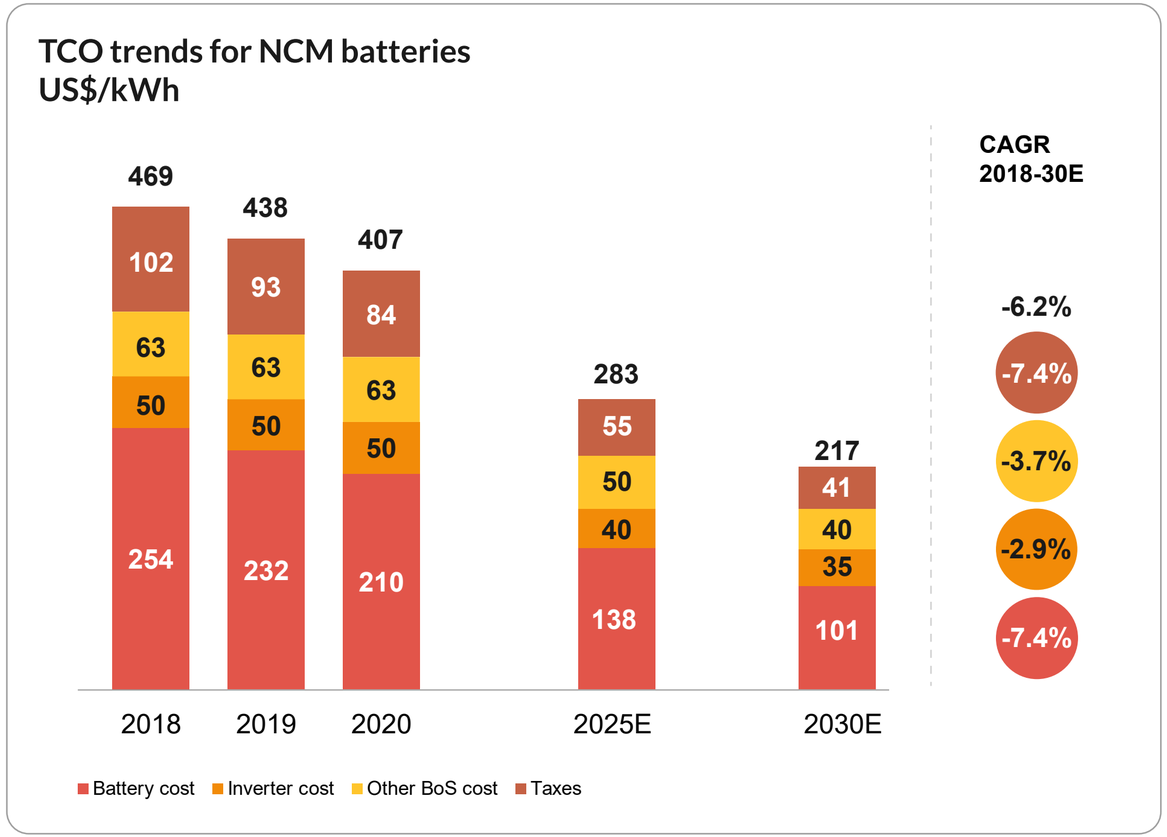
Cost economics

TCO for both Li-ion batteries (LFP and NCM) are expected to witness a significant decline over the next decade

TCO of LFP batteries is expected to decline from US$ 380/kWh to US$ 180/kWh



TCO of NCM batteries is expected to decline from US$ 469/kWh to US$ 217/kWh



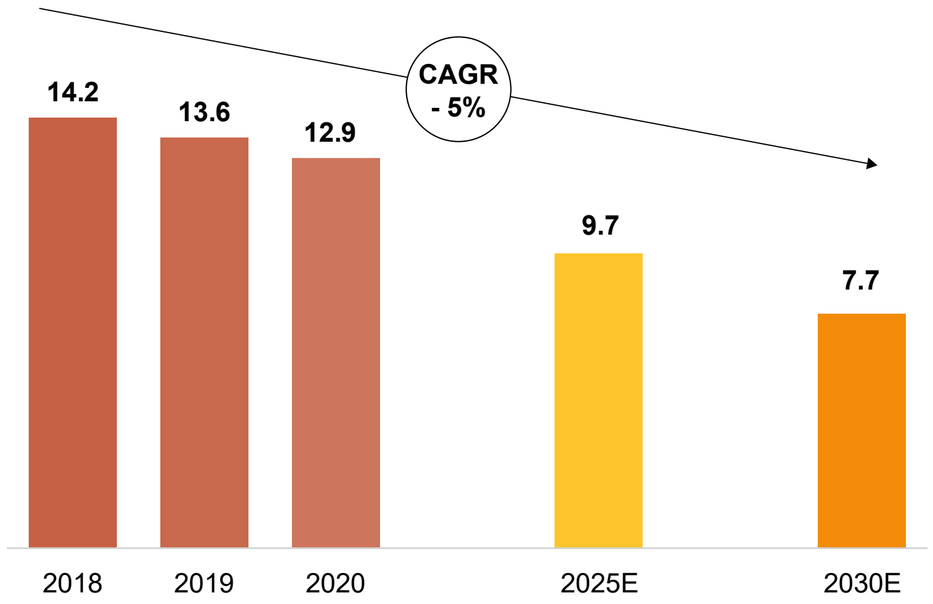
Notes: TCO- Total cost of ownership; Analysis based on NREL data for battery cost; tax rate is assumed to be constant for the calculations.
Sources: NREL, secondary research, Praxis analysis

Cost economics

LFP batteries: Solar + BESS tariff for electricity stored in LFP batteries is expected to range between INR 7.0 – INR 7.7 (US$ 0.09 – 0.10) per unit by 2030

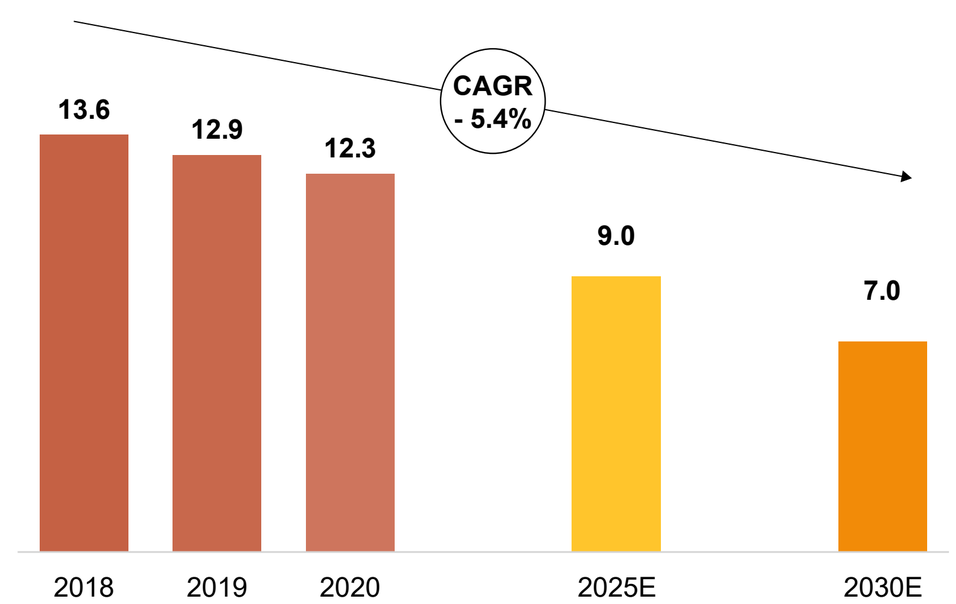
In the base case scenario, electricity tariff for LFP batteries is expected to reach INR 7.7/kWh by 2030

Base case: Solar + BESS tariff for electricity stored in LFP batteries
INR/kWh



In the aggressive case scenario, electricity tariff for LFP batteries is expected to reach INR 7.0/kWh by 2030

Aggressive case: Solar + BESS tariff for electricity stored in LFP batteries
INR/kWh



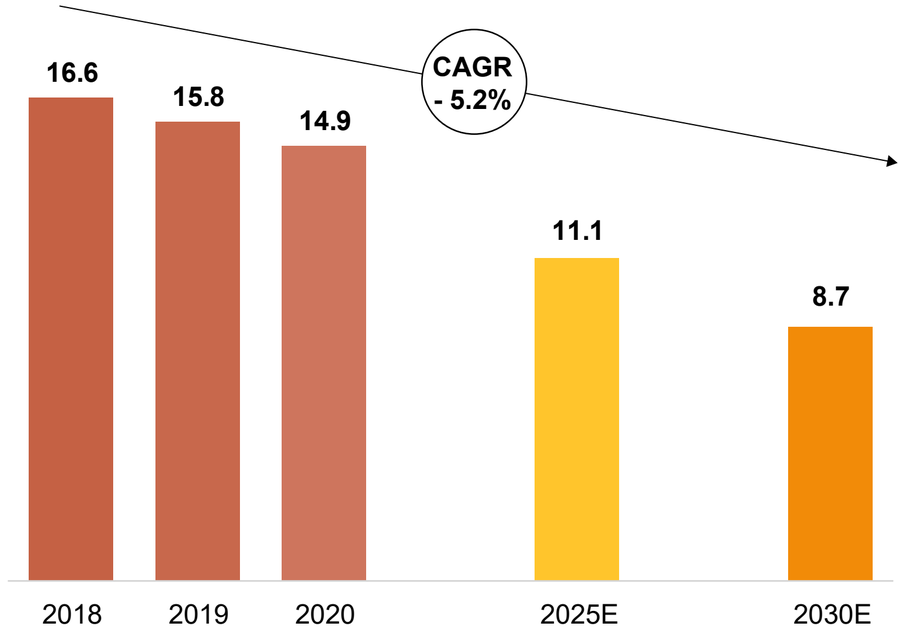
Note(s): Base case is made on NREL battery price projections and aggressive case is based on BNEF battery price projections; tax rate is assumed to be constant for the calculation; Solar electricity cost is assumed to be INR 3.5, INR 3 and INR 2.5 in 2018-20, 2025 and 2030 respectively
Source(s): NREL, BNEF, Praxis analysis

Cost economics

NCM batteries: Solar + BESS tariff for electricity stored in NCM batteries is expected to range between INR 7.8 – INR 8.7 (US$ 0.10 – 0.12) per unit by 2030

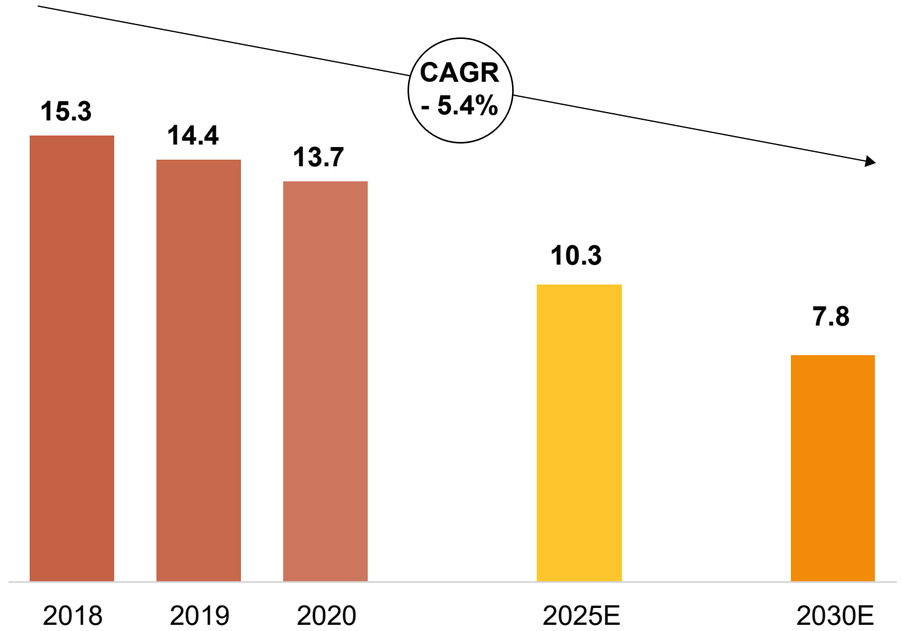
In the base case scenario, electricity tariff for NCM batteries is expected to reach INR 8.7/kWh by 2030

Base case: Solar + BESS tariff for electricity stored in NCM batteries
INR/kWh



In the aggressive case scenario, electricity tariff for NCM batteries is expected to reach INR 7.8/kWh by 2030

Aggressive case: Solar + BESS tariff for electricity stored in NCM batteries
INR/kWh

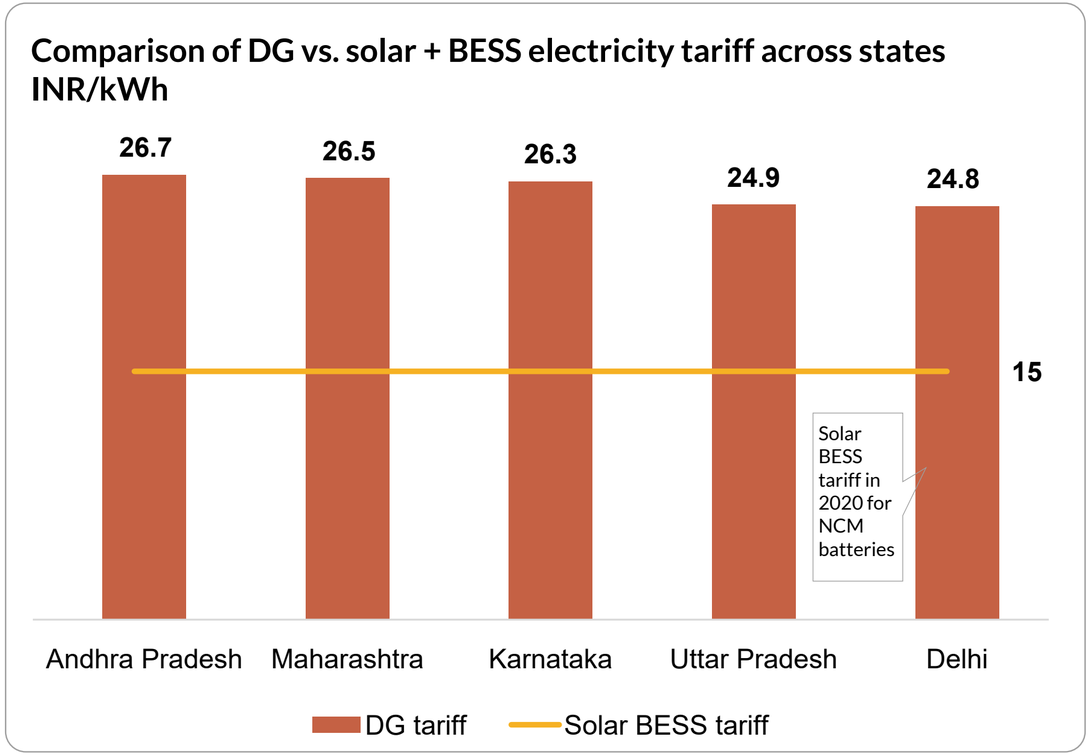


Note(s): Base case is made on NREL battery price projections and aggressive case is based on BNEF battery price projections; tax rate is assumed to be constant for the calculations; Solar electricity cost is assumed to be INR 3.5, INR 3 and INR 2.5 in 2018-20, 2025 and 2030 respectively
Source(s): NREL, BNEF, Praxis analysis

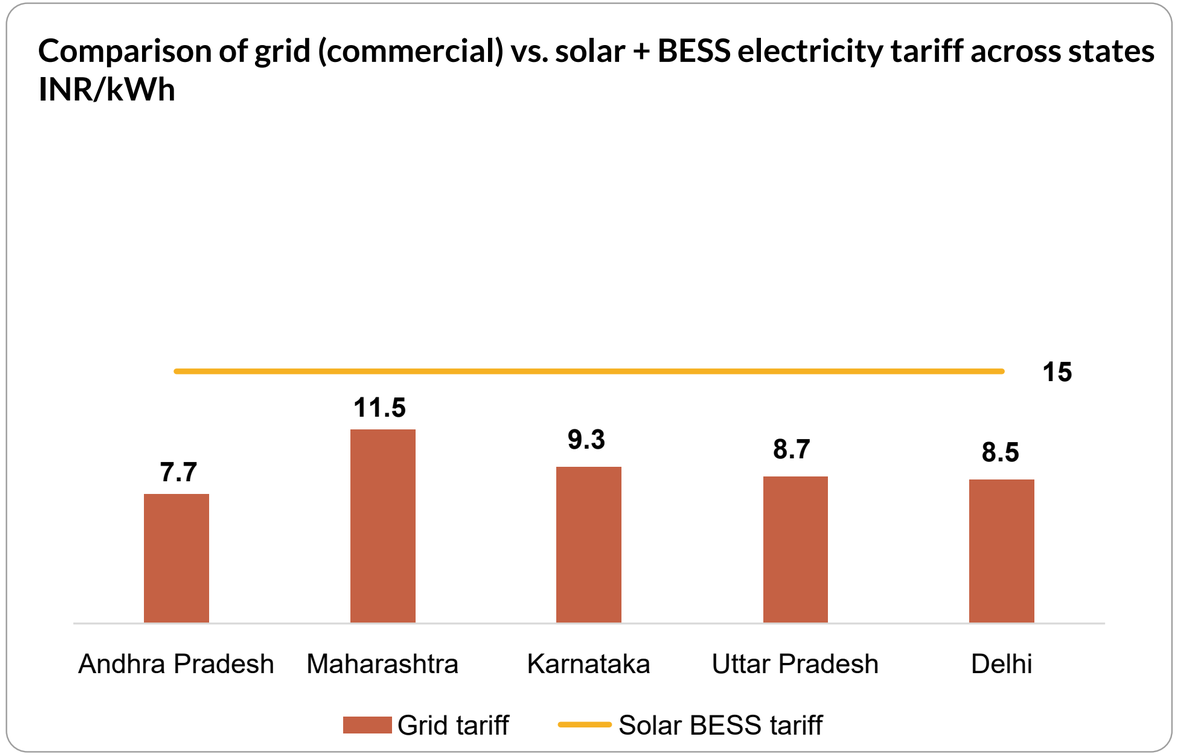
Use case comparison

BESS has a strong use case to minimize DG electricity; Falling battery prices has the potential to create a strong case to replace grid electricity with solar + BESS in the future

Solar BESS electricity has the potential to significantly minimize DG usage due to its lower cost



Solar BESS electricity is still 2X costlier as compared to grid electricity



Note: Diesel prices considered for 10/01/21; 1 litre of diesel generates 3 units of electricity; Grid tariff taken for highest slab for commercial users
Source: Tariff orders of State Electricity Distribution companies, Secondary research, Praxis analysis

Renewable integration to grid along with Government support to push BESS growth; high capex and tariff are the key challenges faced

Challenges

High tariff charges: The current cost of battery storage is high and with a longer payback period resulting in low adoption of stationary battery storage and hence tariffs are higher. Commercial scale applicability is yet to be achieved.

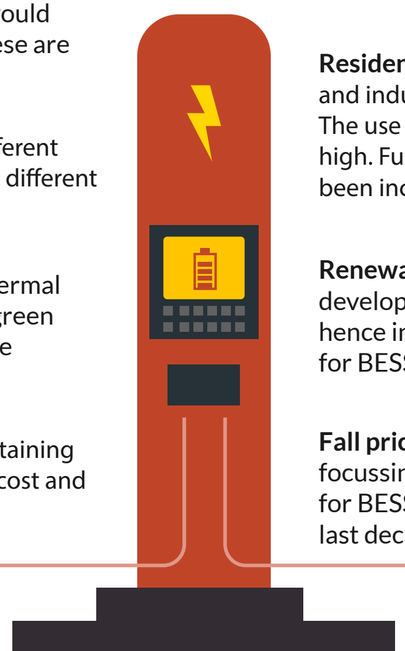
High Capex for setting up Stationary Storage: There is a high initial cost required to set up a BESS which can impact the growth of BESS adoption.

Battery duration: The BESS storage duration ranges from 30mins to 4hrs, however in cases of power failures beyond 4hrs BESS may not make sense as well as would be costly. While there is a focus to increase the duration to 6hrs and 8hrs, these are still not on a commercial scale resulting in the need for redundancies.

Lack of standardization: On account of diverse technical requirements and different policy processes there is a lack of standardization within BESS. Each supplier has different tech specs which can be a hindrance to scale.

Charging BESS with thermal power: The prospects of charging BESS with thermal power would reduce the usage of BESS as energy storage is perceived to be green and in cohorts with renewable energy. This would have ESG issues and reduce investments in BESS.

Performance & safety: Various safety & security measures are needed for maintaining battery storage in C&I as well as residential areas which would mean additional cost and measures to be taken adding to existing procedures needed to be followed.



Opportunities

Energy storage benefits: The BESS can help on various aspects such as demand charge reduction, back-up power requirement, frequency regulation, grid congestion reduction, T&D Capex deferral, spinning reserve, decrease in diesel usage.

Government incentives and policy support: Central and State Governments are introducing policies and tenders for solar and wind energy along with the BESS component for the grid. Private players are focusing on pilot stage projects for BESS such as Tata Power.

Residential and C&I market: The usage of BESS to replace diesel gensets in commercial and industrial segments along with the residential segment is gaining significant traction. The use case makes commercial sense today with the cost of diesel being at an all-time high. Further within the UPS and Inverter market, usage of Li-ion batteries in BESS has been increasingly replacing the Lead Acid Batteries.

Renewable energy integration: With more and more renewable energy development, the grid is expected to see higher usage of renewable energy and hence intermittent power supply which can cause grid fluctuations. Hence the need for BESS is of paramount importance.

Fall price of BESS: With Giga scale factories envisaged globally and India also focussing on moving towards greener power and hence need for BESS, the price for BESS has been coming down, it has come down by 90% from the start of the last decade. This shows promising signs for greater adoption of BESS.

Sources: Secondary research, Praxis analysis

Business models

Both utility-scale and end-consumer models exist globally for battery storage; Utility-scale models target grid and large C&I customers

	Utility-scale model	End-use customer model		
	GENCO/IPP/DISCOM owned	**Third-party owned and operated**	**End-user owned**	**Energy management contract**
Asset owner	• GENCO/IPP/DISCOM	• Private third-party operators	• Commercial and industrial establishment/residential	• Energy management company
Customers	• Grid • DISCOMs	• Commercial and industrial establishments • Residential areas	• Commercial and industrial establishments • Residential areas	• Commercial and industrial establishments
Key features	• Long-term PPAs with customers • Option to transfer the power to grid during any time (based on congestion in the grid)	• No upfront capex for the end-customer • Customers pay fixed monthly fee over the per kW consumption	• Asset completely owned by the end customer	• Energy storage is a part of the overall long-term energy management contract
Business and revenue models	• Capex • Opex model	• Opex model • Lease model	• Capex model	• Opex shared savings model • Opex lease model
Benefits	• GENCOs can delay the capex cost for setting up new power plants • Additional revenue stream for GENCO/IPP • Improved grid reliability and performance through better management of T&D congestion	• Reduced requirement of inverters/DG sets for the end customer • Avoidance of load fluctuation	• Reduced requirement of inverters/DG sets for the end customer • Avoidance of load fluctuation	• Higher energy savings potential realized by ESCO for their customers, leading to increased revenue potential
Risks	• Lower PPA tariffs may impact long-term profitability • Restriction on open-access for C&I customers in some states	• Asset owner can prioritize grid over the end-customer if it gets a better deal	• Capex and opex to be borne by the end consumer (with no practical experience of maintaining such systems)	• Higher risk for ESCO due to upfront capex

Sources: PSR India, Secondary research, Praxis analysis

Policy measures

Governments globally are evolving their energy storage policies to support the industry; India needs to advance in terms of fiscal incentives compared to developed countries

Country	Policy measure	Description
 India	• National Energy Storage Mission	• The Government of India has created the draft National Energy Storage Mission to promote energy storage
	• National Tariff Policy	• Mandatory procurement of RE power for DISCOMs • Waiver on inter-state transmission charges for RE power transmitted through the grid to promote open access for large end customers
	• National Programme on Advanced Chemistry Cell Battery Storage	• The Government approved INR 18,100 Crore PLI scheme for building manufacturing facilities for battery storage in India. The plan is to set up a 50 GWh manufacturing capacity
 USA	• Frequency regulation	• Each grid operator changes its regulation tariffs to pay resources based on the actual amount ofregulation service each resource provides to the grid, i.e. 'pay-for-performance'
	• RTO/ISO participation	• Removal of all existing barriers for storage to participate in markets administered by RTO/ISO
	• Tax incentive	• Investment tax credit expands to all energy storage systems, enabling more widespread deployment of energy storage
 Germany	• KfW funding program	• Low-interest loans and repayment subsidies for new solar PV installations, which incorporate a fixed battery storage system, and for the retrofit of such systems to solar PV installations • Up to 100% of investment cost is available as debt for players interested in setting up such plants

Sources: PSR, Secondary research, Praxis analysis

Barriers

Growth of advanced ESS requires a stimulus to reduce manufacturing cost and reliance on imports of raw materials

Barrier	Description	Impact
Reliance on imports	• Lack of raw material deposits for elements such as lithium etc. makes India significantly dependent on imports to support the battery manufacturing industry	◕
Higher manufacturing cost	• Due to lower economies of scale, the overall per battery manufacturing cost is higher in India as compared to countries with a higher manufacturing base • Lack of incentives for manufacturers to set up units, however now with the PLI scheme in place this should ease out and witness more capacities coming up.	◑
Restriction on open access	• Only end consumers with sanctioned load of 1MW and above are eligible to procure power through open access route • Few states try to limit purchase through open access to protect state-owned DISCOMs	◑
Estimation of energy storage requirement	• Over-estimation or under-estimation of energy storage requirements leads to under-achievement of desired results in planned energy storage projects	◑
Lack of skilled workforce	• Lack of skilled workforce in advanced battery manufacturing, as traditionally India has manufactured mainly Lead Acid Batteries • Comprehensive training and re-skilling of workforce required	◔
Lack of secondary market for batteries	• No comprehensive framework for reuse and recycling of advanced energy storage technologies, leading to the absence of a secondary market for batteries	◔
Standards and testing	• Lack of defined standards and testing protocols for local use of advanced energy storage technologies	◔

Low ○ ◔ ◑ ◕ ● High

Source : Secondary research, Praxis analysis

Energy & Utilities – our capabilities

We work on wide range of strategic areas within the Energy & Utilities through our Praxis vertical

Macroeconomic evolution

- Sector perspectives
- Potential trends and sectoral impact
- Policy change and impact

Strategy and transformation

- Portfolio strategy
- Growth strategy
- ‘Net zero’ focus
- Go-to-market strategy

Growth and scale-up

- Micro-market evaluation
- End use segment growth (commercial & industrial)
- Adjacencies and new business opportunities (energy storage, charging infrastructure, green hydrogen etc.)
- Geographical expansion

Cost and performance excellence

- Economics improvement
- Capex improvement
- Operational and process Excellence
- Predictive maintenance forecasting

Customer loyalty and experience

- Customer loyalty and NPS improvement
- Value proposition improvement
- Retention management and churn reduction
- Sales acceleration

Investment advisory

- Commercial due diligence on targets
- Operational due diligence
- Exit thesis development
- Post deal value creation - 100 day plan

Enablement and implementation

- Change management
- Post merger integration
- Program management Office

Organization productivity

- Organization role span design
- Employee NPS & people value creation
- Attrition defence
- KPI cascade & performance management

Sources: India Smart Grid Forum, Praxis analysis

Specific practitioner expertise

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60%
lower costs

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team members

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30%
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40
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she/he ratio

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- Unique ‘Uber-like’ Domain Partner led model- scaling aggressively
- Differentiated on Objectivity, ‘Roll up the sleeves/Get-it-done’ orientation and Value-for-money delivery model

Connect with us

We will be happy to share perspectives

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