

# Energy Storage: Pumped Storage to Take High Ground in Near Term

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## Synopsis

- Given the new renewable purchase obligation (RPO) and energy storage obligations (ESO) norms, there is an increased impetus on capacity augmentation of energy storage systems (ESS). Assuming 4 hours of storage per GW, India requires ~12 GW storage capacity in FY24, which is likely to increase further to ~70 GW by FY30.
- The industry would necessitate ~Rs. 14 lakh crore incremental debt financing for the installed Renewable Energy (RE) capacity to reach 425 GW, pumped storage projects (PSP) capacity of 19 GW and battery-enabled storage solutions (BESS capacity) of 42 GW by 2030
- Levelized cost of storage from PSP remains competitive at Rs. 4.81 per unit as against Rs. 11.64 per unit from BESS
- Assuming round-the-clock supply of RE, the landed cost from PSP is ~Rs. 4.74 per unit as against Rs. 6.59 per unit from BESS. Significant technological advancements, cost economies and financing stimulus are needed to uplift BESS.

## RPO and ESO targets to provide impetus for incremental RE adoption - Storage to assume a key role

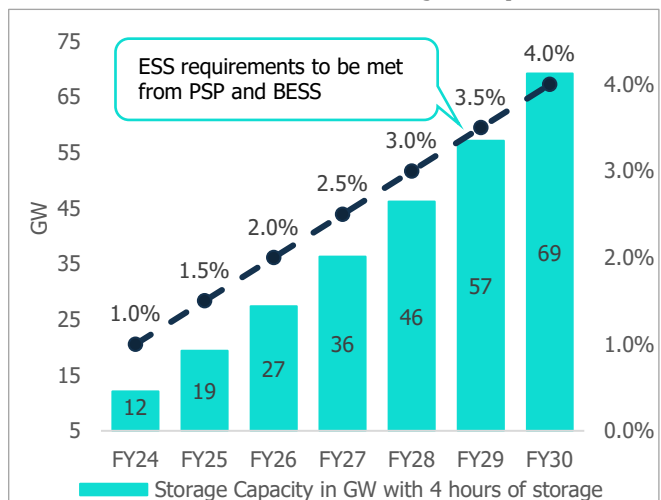
In October 2023, the Ministry of Power (MoP) notified the RPO targets for the designated customers up to March 2030. The sub-segments of the new RPO targets consist of wind, hydro, a new component of distributed renewable energy (RE) and Others. Only the procurement from wind and hydro projects commissioned post-March 2024 would be eligible to meet the respective sub-segment targets. For a project to comply with the requirement of distributed RE, its capacity must be less than 10 MW. Previously in July 2022, MoP had introduced energy storage obligations (ESOs) as a separate component and all the obligated entities must ensure sourcing of some RE wherein there is an involvement of storage component. The ESO targets have been kept at 1% for FY24 and a linear increment of 0.5% has been mandated till FY30.

**Exhibit-1: MoP defined RPO trajectory**



Source: MoP, CareEdge Ratings

**Exhibit-2: MoP defined ESO trajectory**



Source: MoP, CareEdge Ratings

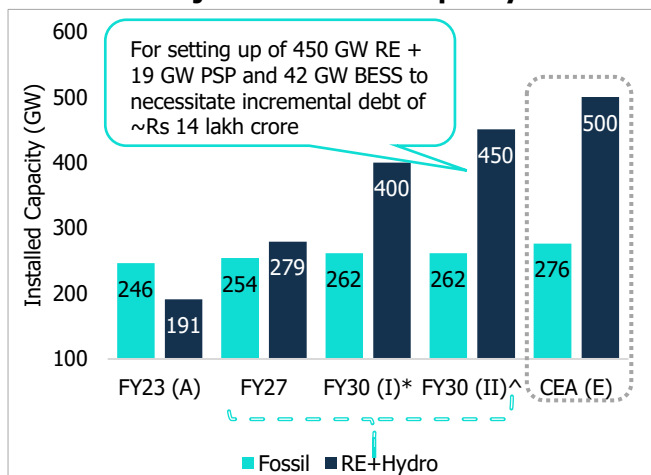
According to CareEdge Ratings' analysis, the nation necessitates approximately 12 GW of storage capacity, with an assumption of 4 hours of storage per GW for FY24. This requirement is projected to escalate to approximately 70 GW by FY30. The augmentation of Renewable Purchase Obligation (RPO) targets and the introduction of Energy Storage Obligation (ESO) targets are initiatives that bode well for the achievement of a cumulative non-fossil fuel-based capacity installation of 500 GW by 2030. These measures provide the essential momentum for integrating storage solutions into the overall energy mix.

**RE contribution in the overall energy generation profile to exceed 35% by 2030**

As depicted through Exhibit 3, India had an installed power capacity of 435 GW as of the FY23 end. The same comprised fossil fuel-based capacity of 246 GW and others at 191 GW. Exhibit 4 reflects the contribution of these two sources in the overall generation mix. Fossil based capacity has higher PLFs and thus contributed 77% of the overall generation, whereas RE + Hydro comprised the remaining 23%.

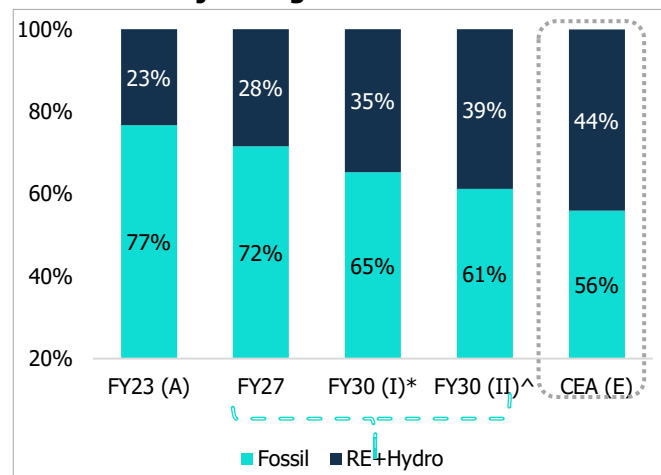
CareEdge Ratings forecasts the future capacity as well as generation mix till FY30. Key assumptions being (i) non-fossil fuel capacity to increase in a phased manner and reach 400 GW in case 1 and 450 GW in case 2 (ii) growth in energy demand at a CAGR of 6%. We expect the nameplate non-fossil fuel-based capacity to overtake fossil fuel capacity by FY27 in either case. Further, the share of non-fossil fuel generation is expected to exceed 35% of the overall generation, even with an installed non-fossil fuel-based capacity of 400 GW. Further as per CEA, by 2030 India will require ~19 GW of pumped storage projects (PSP) and ~42 GW of battery-enabled storage solutions (BESS).

**Exhibit-3: Projected installed capacity**



Source: CEA, MoP, CareEdge Ratings

**Exhibit-4: Projected generation mix**



Source: CEA, MoP, CareEdge Ratings

As per CareEdge Ratings, the overall capex assuming 425 GW of RE + storage would be ~Rs. 19 Lakh crore and necessitate incremental debt funding of ~Rs. 14 lakh crore.

**PSP & BESS: The Key enabling technologies that will aid integration of variable RE in the grid**

Two leading technologies viz. PSP and BESS have emerged as the mainstream mediums for energy storage. Exhibit 5 highlights the key characteristics of both technologies. BESS on a relative basis has a shorter gestation period of ~1-2 years as compared to 5+ years for a PSP.

BESS has (i) lower land requirements, (ii) is agnostic to the project site characteristics and (iii) can also be utilized for distributed generation. Yet batteries are exposed to disposal related challenges whereas PSPs offer a sustained and much cleaner alternative. PSPs on the other hand have (i) a longer project life, (ii) accepted worldwide as an established technology and are (iii) more cost-competitive. However, these projects are customary to witness escalations given the longer gestation periods and exposure to varying commodity prices. Besides, PSPs are also exposed to rehabilitation and resettlement related challenges as they require contiguous parcels of land for setting up.

#### Exhibit-5: PSP Vs BESS

Parameters	PSP	BESS
Gestation period	Longer 5-7 years	Shorter 1-2 years
Land Requirements	Higher	Lower, Modular in nature
Topography	Dependent on site characteristics	Agnostic
Duration & Discharge	Longer 6-8 hours	Shorter 3-4 hours
Efficiency	75-80%	85-90%
Project Life	40+ years	7-12 years
Levelized Cost of Storage	Rs 4-6 per unit	Rs 11-12 per unit
Suitability for Distributed Generation	No	Yes
Track Record	Proven globally	Relatively new

Source: Industry, CareEdge Ratings

#### Key supportive policies for energy storage

The government has issued several ESS policies to promote energy storage and attract investments in this space. The PSP framework was released in April 2023 and primarily focuses on land allocation, simplification of project approvals and possible benefits that can be extended by the state and central government towards the development of a PSP. Similar to the guidelines applicable for a plain vanilla wind and solar project, the government has formulated guidelines to ensure standardisation of key terms across various tenders requiring firm and dispatchable renewable energy (FDRE). In September 2023, the Government launched a viability gap funding (VGF) scheme for development of 4 Gwh of BESS by FY31. The scheme targets bringing down the levelized cost of storage (LCoS) the current high of ~ Rs 11 per kWh to Rs. 5.50-6.60 per kilowatt-hour (kWh).

#### Exhibit-6: Supportive policy initiatives for storage

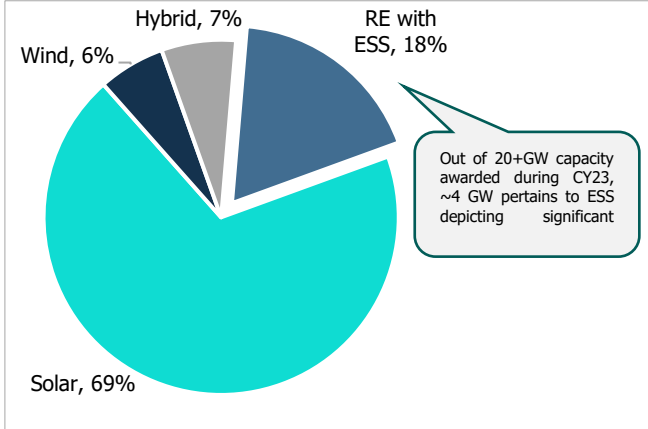
PSP	FDRE	VGF-BESS
No upfront premium for project allocation	Trading Margin of Rs 0.07 per unit for the intermediary, in line with the prevailing policy for Wind/ Solar projects	Initial outlay of Rs. 9,400 crore including budgetary support of Rs 3,760 crore
Simplification of project approval process including environmental clearances	PPA for a minimum period of 20 years	Financial support of upto 40% of the capital cost
Monetary benefits in the form of reimbursement of SGST, stamp duty, various cess and ISTS charges	100% power to be offered from RE, of which, 5% could be from green sources/bilateral agreements	Envisaged development of 4 GWh of BESS by FY31
No obligation to supply free power to the home state & eligible for participation in HP-DAM	Penalty for not meeting the stipulated availability shall be equal to 1.5x of no. of units not supplied	85% of the envisaged development to be made available to discoms
No upfront premium for project allocation		To bring levelized cost between Rs. 5.5 - 6.6 /unit

Source: MoP, MNRE, CareEdge Ratings

**Increase in share of ESS Tenders in CY23**

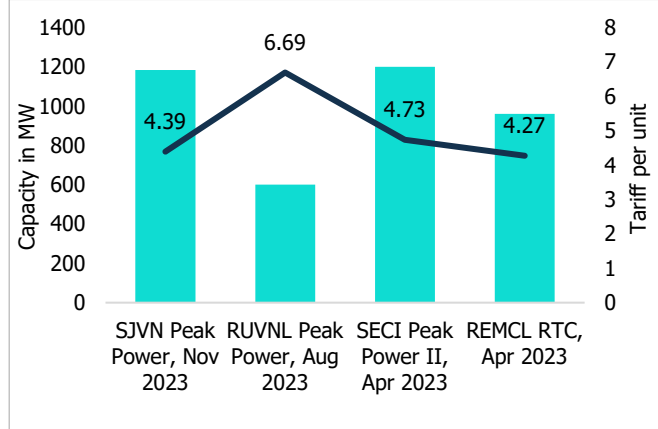
It has been observed that the proportion of tenders wherein storage is a part of the overall requirements has been increasing. The same is also reflected by the fact that out of 20+ GW capacity awarded during CY23, ~4 GW pertains to ESS.

**Exhibit-7: Type of RE Bids**



Source: CareEdge Ratings

**Exhibit-8: Bid Results Of Prominent ESS Tenders**



Source: CareEdge Ratings

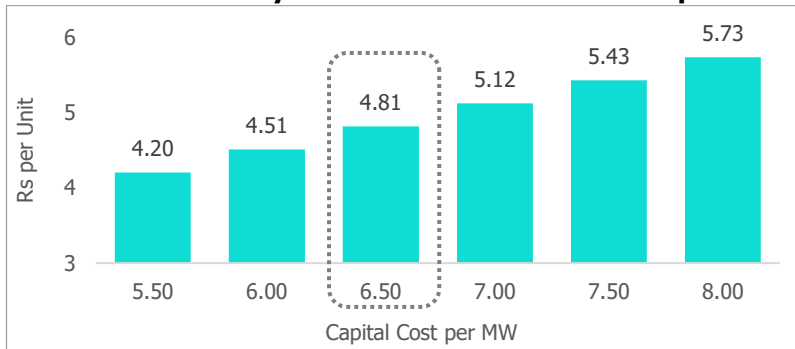
The four key ESS bids awarded last year are shown in Exhibit 7. The determined tariff was sub Rs. 5 per unit in three bids whereas the determined tariff in one bid was Rs. 6.69 per unit. The determined Tariff was higher in RUVNL bid primarily on account of the following reasons:

- Relatively weaker counterparty as compared to central offtakers
- Higher energy requirement during the peak hours i.e. 3 hours in a day in RUVNL tender as against 2 hours a day in other tenders
- Higher penalties for non-fulfilment of energy during peak hours with penalties in RUVNL bid being ~2.5x the PPA tariff into the shortfall units whereas the other tenders have a penalty of 1.5/2.0x the PPA tariff

**PSP & BESS – Comparison of financial viability**

CareEdge Ratings has attempted to illustrate the movement in the cost of storage in Rs. per unit at various cost levels for a project. Assuming a capex of Rs. 6.5 crore per MW which is to be funded in a debt-equity ratio of 75:25, for a PSP plant having a storage capacity of 6 hours, the levelized cost of storage excluding the cost of input power comes out to be ~Rs. 4.8 per unit. If the capital cost increases to Rs. 7.5 crore per MW, the levelized cost of storage would increase to ~Rs. 5.5 per unit.

**Exhibit-9: Sensitivity of levelized cost of PSP to capital cost**



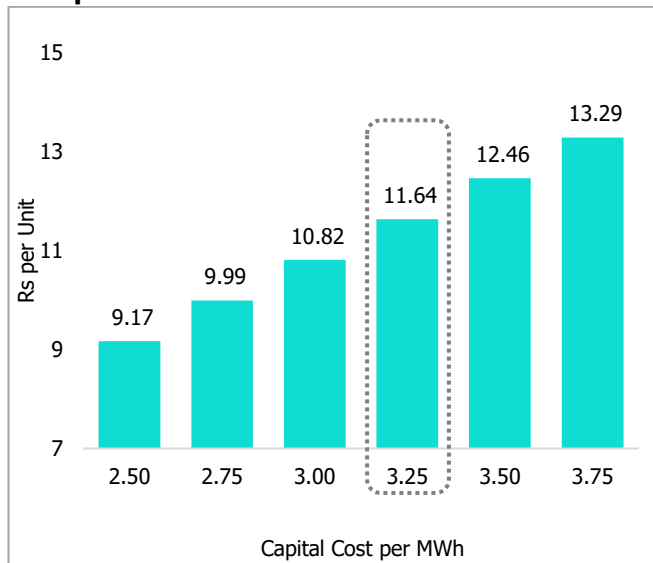
Source: CareEdge Ratings

**Assumptions**

Particulars	Value
Project Capacity (MW)	100
Capex per MW (Rs. Crore)	6.5
Debt: Equity	3:1
Interest Rate	9.5%
Debt Tenure post CoD (Years)	20
Return on Equity	15%
Storage (Hours)	6
Round Trip Efficiency	75%
O&M (Rs lakh per MW)	12
Annual Escalation	5%
Project Life (Years)	40

Exhibit 10 represents an illustration of movement in cost of storage in Rs. per unit at various levels for project cost for BESS. CareEdge Ratings has assumed a battery capacity of 400 MWh with an average operational cycles per day of 1.5 to facilitate a relative comparison with a 100 MW PSP offering 6 hours of storage. The capital cost of the battery-driven project has been assumed at Rs. 3.25 crore per MWh. The number of cycles in a battery has been assumed at 6000 cycles and augmentations to the overall battery at the end of every 5 years have been taken given the storage requirements are applicable for a tenor of 25 years. Further BESS capital cost has been assumed to decline by 5% annually. The levelized cost of storage excluding the cost of input power comes out to be ~Rs. 11.6 per unit.

**Exhibit-10: Sensitivity of levelized cost of BESS to capital cost**



Source: CareEdge Ratings

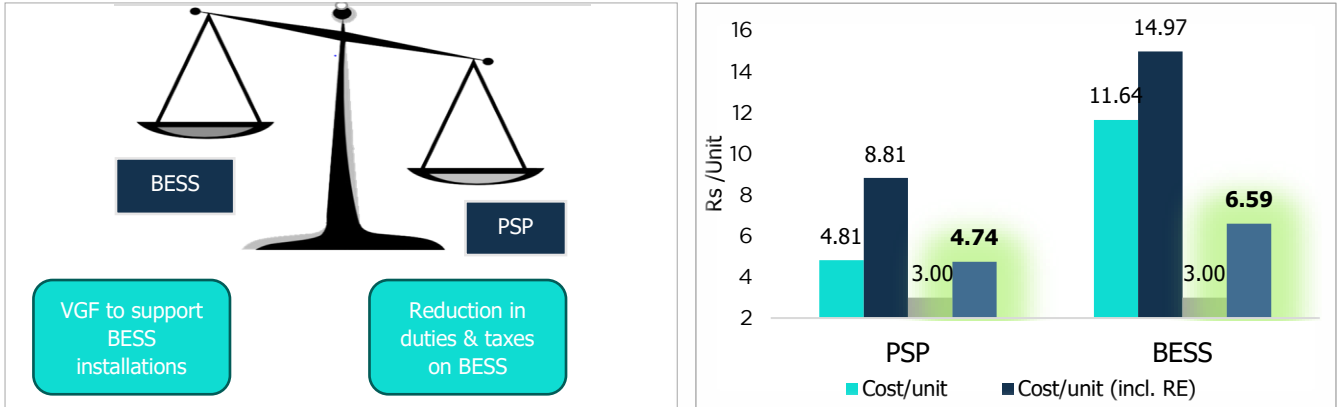
**Assumptions**

Particulars	Value
Project Capacity (MWh)	400
Capex per MWh (Rs. Crore)	3.25
Debt: Equity	3:1
Interest Rate	9.5%
Debt Tenure post CoD (Years)	25
Return on Equity	15%
O&M (Rs lakh per MW)	2
Annual Escalation in O&M	5.0%
Project Life (Years)	25
Number of Cycles (2-hour) used for Battery/day	1.5
Battery Cycles Required (Number)	13,687
Cycles of a Battery used annually (Number)	547
Cycles in a battery (Number)	6,000
Cycles Required from Augmentation	7,687
Total Capacity Required for Augmentation (MWh)	512
Number of Augmentations	5
Augmentation Capacity (MWh)	102
Decline in battery cost (CAGR)	5.0%

**PSP – The preferred solution today**

Assuming that the requirement is to supply 20 hours of RE power in a day i.e. CUF requirement over 80% annually, which is to be met through a combination of variable RE (VRE) and storage component, a relative comparison between PSP and BESS has been done. It has been assumed that power from ESS will be supplied for 6 hours a day and VRE will be used for the remaining 14 hours. The levelized cost from PSP comes to be ~ Rs. 4.7 per unit whereas the levelized cost from BESS comes to be ~Rs. 6.6 per unit. Thus, at present, especially if one has to provide storage for longer durations, PSP is preferable from a cost standpoint.

**Exhibit-11: Comparison between PSP and BESS on financial viability**



Source: CareEdge Ratings

However, the balance can change if there is an–

- Introduction of VGF/ other capital incentives on BESS beyond the existing VGF
- Reduction in duties and taxes on batteries

Moreover, PSPs given their longer gestation are prone to witness time and cost overruns. This coupled with a reduction in battery prices can swing the balance between both technologies.

**CareEdge Ratings View**

“The introduction of several policy measures by the government including RPO & ESO targets, guidelines for promoting PSPs and introducing VGF for BESS indicates that the government is serious about achieving 500 GW non-fossil fuel capacity by 2030 while also ensuring grid stability. The investor interest in this segment also remains buoyant with multiple large groups winning capacities in various storage auctions. However, from a financial viability standpoint, the country needs to cover some distance as BESS which is modular in nature is not as cost effective as PSPs and the latter has its inherent challenges including dependence on location, high gestation period etc,” said Sabyasachi Majumdar, Senior Director, CareEdge Ratings.

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