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Strategy for resolving storage problem to boost renewable energy

India has one of the largest renewable energy (RE) capacity expansion programmes in the world today. In 2015, the government not only increased the country's RE targets to 175 GW by 2022, but subsequently also announced a slew of initiatives such as adoption of electric vehicles (EV) and building of smart cities to reduce India's emission intensity by 30-33% by 2030, taking 2005 levels as the baseline. However, with increasing levels of RE, Indian grid operators have often expressed strong concerns over maintaining the stability of the grid. Similarly, RE developers have also pressed for the need to improve the evacuation infrastructure to handle increasing RE; there have been instances of RE curtailment in states such as Tamil Nadu.

In the context of addressing issues related to high RE penetration and its variability, energy storage can play an important role. It can help store the excess RE or fill-in for deficit power. Storage can bridge the gap between supply and demand by shifting either generation or load, thereby solving

the problem of RE intermittency and variability. The most common form of energy storage in India, used extensively at smaller scales, is electrochemical batteries. These batteries are primarily used in the commercial and residential sectors — as back-up for Uninterrupted Power Supply (UPS) and as automotive batteries. In order to provide flexibility and balancing power to the grid, we also have large-scale, bulk-storage systems such as pumped-hydro. These systems are basically fast-acting hydro plants with storage reservoirs, connected to the central transmission infrastructure.

Pumped-hydro systems have the ability to store energy for several hours and handle large power discharges (of more than 100 MW). It also has a much longer cycle life than electrochemical batteries. The cost of storage in pumped-hydro systems is lower (Rs.0.3-0.4/kWh) than that of conventional batteries (Rs.10/kWh), as per the Central Electricity Authority's (CEA) data. On the other hand, battery energy storage systems (BESS) have the advantage of being modular and can be used for both stationary as well as portable applications. It is envisaged that with falling battery prices, these systems can offer higher economic benefits in India as compared to that in other countries. This is mostly because of the significant difference between cheap off-peak power (Rs.2–3/kWh) and expensive back-up power from diesel (Rs.16–25/kWh).

At present, about 96 GW of pumped-hydro potential exists in India. However, only about 2.1 GW of the net 4.78 GW installed capacity works in pumping mode. This is due to various technical reasons, unavailability of surplus power for long hours and commitment for irrigation needs. There are some challenges associated with the construction of new pumped-hydro systems. It takes close to 20 years to construct projects of such massive scale. Numerous environmental clearances are required, along with resettlement of human habitats around the riverbed at times. In addition, these plants are usually built close to reservoirs and rivers, far away from typical load centres like cities, thus increasing transmission losses and cost. Similarly, BESS have their own set of problems. They are currently expensive, with typical capital costs of ₹7,000/kWh onwards. Capacity degradation due to frequent cycling and thermal losses reduce the life span of BESS to less than three years in certain cases.

Thus, going forward, India can look at pumped-hydro as a long-term solution to address the need for flexible resources for balancing RE at the transmission level. This would help in reducing the variability of utility-scale solar and wind spread across large geographical areas. If the construction of pumped-hydro plants is initiated now, India would have a decent amount of balancing power to handle the high RE targets envisaged.

In addition, BESS could be considered for small-scale and decentralised applications of RE. India has a vibrant and mature lead-acid battery manufacturing capability. The government can push for R&D collaboration with other countries to improve the lifecycle of lead-acid batteries. Leapfrogging to other battery technologies such as lithium-ion batteries could be considered as well. Lithium battery costs have fallen drastically in the past few years and are expected to decrease by about 50% in next five years. A transition towards lithium will also help in the growth of EVs, as lithium batteries are extensively used by this sector.

Market mechanisms such as time of use tariff in commercial and residential sectors could be introduced to incentivise the use of storage with solar rooftop systems. This would help in shaving the peak demand for distribution companies, and more deployments will drive higher volumes and bring down storage costs. Storage coupled with RE micro-grids can electrify remote villages in the country. Energy generated could be consumed locally, hence reducing losses and costs drastically.

Therefore, while India waits for additional pumped storage capacity to be ready by the next decade, it can still leverage the use of BESS to spur growth in small-scale and decentralised RE. This will enable the country to realise its ambitious RE targets to a large extent.

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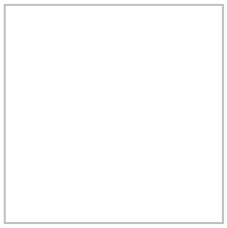

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