The advantages of Behind-the-Meter Energy Storage with rooftop photovoltaics

In early September, India's peak daytime electricity demand stood at 241 GW, a record high. The solar market in India plays a crucial role in meeting this ever-increasing demand, especially the rooftop photovoltaic sector which has enormous untapped potential. The Government of India aims to have 40 GW of rooftop photovoltaics (RTPV) installed capacity by March 2026.

However, high penetration of variable renewable energy (RE) sources at the end-user level will pose challenges such as mismatched supply and demand and grid stability/flexibility, leading to grid stability and outages. Using an energy storage system (ESS) alongside RTPV could help overcome these issues in the electricity system.

The distributed solar and behind-the-meter (BTM) energy storage system linked to a utility's distribution network can meet a consumers energy needs, act as a backup during grid failures, reduce electricity bills, and provide grid services to distribution companies (DISCOMs).

Advantages for Consumers

According to our analysis, consumers who install RTPV with BTM ESS can reduce their reliance on expensive power-producing facilities while benefiting from reduced electricity bills to the tune of 75%. Electricity can be generated during solar hours and excess energy can be stored for later use.

Adding BTM storage with RTPV systems also ensures backup power during grid outages, avoiding potential costs related to poor quality and reliability of power. BTM ESS with RTPV is a considerably more cost-effective power backup solution (INR 11/kWh) than diesel generators (INR 16–18/kWh).

Recently, the Ministry of Power (MoP) announced the introduction of time-of-day tariffs (ToD) for all consumers by 2025 through an amendment to the Electricity (Rights of Consumers) Rules, 2020. This initiative could also prove to be beneficial for BTM consumers. With ToD tariff, different rates for energy consumption are specified for various time periods in a day instead of the same rate being applied throughout the day. TOD tariffs will be determined based on the grid’s peak and off-peak conditions and associated expenses.

Conventionally, utilities must expand capacity during on-peak periods to keep up with the increased demand. As a result, the real-time cost of providing power increases, which can be offset by an increase in ToD tariff rates. Hence, ToD tariffs can incentivise residential, commercial, and industrial consumers to increase their BTM PV and ESS capacity to partially fulfil demand and reduce reliance on the electricity grid.

The excess energy stored in an ESS can be sold to the grid during peak hours (high-priced instances), providing an additional revenue stream to consumers. In addition, a BTM ESS increases the utilisation of on-site green energy generation, reducing carbon emissions and environmental impacts.

Benefits for DISCOMs

BTM ESS with RTPV offers numerous benefits to DISCOMs, too. One of the primary benefits for DISCOMs is grid stabilisation. The intermittency of distributed RTPV can strain the grid infrastructure, leading to outages and instability.

By integrating storage systems at the consumer level, excess solar energy can be stored during peak

generation periods and released during high-demand hours. This mitigates grid fluctuations and reduces strain on traditional power sources, contributing to greater grid reliability. This will be further reinforced if future TOD tariffs encourage consumers to shift their usage patterns and reduce peak demand, thereby avoiding costly infrastructural upgrades by minimising distribution network congestion.

For DISCOMs, this approach lessens the need for expensive peak power procurement, resulting in cost savings. Increased reliance on distributed energy resources also reduces transmission losses and enhances grid resilience against potential disruptions.

Incorporating BTM ESS with distributed solar energy is a transformative step towards a greener and more robust energy ecosystem for DISCOMs. The collaboration will enhance grid stability and empower consumers to actively participate in sustainable energy practices while significantly reducing operational costs for DISCOMs.

Challenges and Way Forward

The main challenges in implementing BTM ESS with RTPV are high upfront battery expenses and flat tariff rates that do not reflect the true costs of the power system. To reduce the high capital cost of batteries, the Government of India has employed a production-linked incentive subsidy scheme and is setting up Advanced Chemistry Cell (ACC) storage plants. This will bring down the cost of batteries in the near future.

Further, to reduce the capital cost of BTM battery storage, the Government and stakeholders should provide reasonable incentives as these systems could support the grid. Policymakers should incentivise the adoption of BTM ESS, offering financial benefits such as tax credits or reduced electricity tariffs. Additionally, innovative financing models could be introduced to make such systems more accessible to a wider range of consumers, including low-income households.

Currently, central financial assistance (subsidy) is provided to residential electricity consumers for the installation of RTPV. This scheme should be extended for BTM ESS consumers because of the benefits it can provide to the grid.

By embracing BTM ESS with RTPV, DISCOMs can foster a symbiotic relationship with consumers, encouraging sustainable energy practices and reducing carbon footprints. This transition will benefit the power system and individuals economically and contribute significantly to collective efforts in combatting climate change.

[This piece was written exclusively for ETEnergyworld by Dr Ammu Susanna Jacob and Sourabh Metre. They are researchers working in the area of energy storage at the Center for Study of Science, Technology and Policy (CSTEP), a research-based think tank]