
ENERGY

From sunlight to storage: building a grid that never sleeps

Solar energy production, particularly through photovoltaic (PV) panels, faces a significant challenge due to the intermittent nature of sunlight. The sun isn't available continuously, except briefly at certain latitudes during specific seasons, so solar power alone can't reliably meet electricity demand. PV systems can generate power in cloudy conditions, but output varies throughout the day and across seasons, making it difficult for utilities to depend solely on solar.

Large-scale energy storage has only recently gained prominence in the renewable energy sector. Unlike more visible technologies such as solar panels and wind turbines, storage systems like battery farms often operate quietly in the background. As a result, discussions around renewables tend to focus on generation, while the vital role of storage in balancing supply, supporting grid resilience and enabling consistent delivery is often overlooked.

Energy storage as a key element of the renewable energy transition

According to the DNV Energy Transition Outlook (ETO) 2024, battery storage, PV and solar are growing faster than expected. Battery costs continue to fall, with a 14% drop in 2024 alone, making around-the-clock solar and storage increasingly accessible.

Energy storage strengthens grid stability by maintaining supply regardless of weather or demand shifts. These advancements are critical to building more efficient, reliable renewable systems. Battery Energy Storage Systems (BESS) and other hybrid models help reduce fossil fuel reliance, particularly during peak demand, supporting emission reductions and a transition to a low-carbon future.

'The future grid runs on energy storage and hybrid systems,' says Juan Carlos Arévalo, CEO of GreenPowerMonitor, a DNV company. 'With falling battery prices, now is the time to capitalize on this tipping point.

'We are committed to driving innovation to meet the needs of both our customers and the industry. By advancing storage systems and reducing reliance on fossil fuels during peak periods, we contribute to meaningful carbon reductions.'

How battery energy storage systems work and their expected future

Storage power plants like BESS are crucial for matching supply and demand, ensuring grid stability. These systems capture excess energy from sources such as solar and wind, storing it in large batteries. This energy can then be released when generation falls or demand rises, helping smooth out fluctuations and ensure reliability.

The DNV ETO 2024 anticipates that long-duration storage technologies, including flow batteries, compressed air and gravity-based systems, will begin scaling during the 2030s.

BESS storage and the technology typically included

A BESS stores electricity from renewable and traditional sources in rechargeable batteries, typically drawing from surplus generation such as excess solar output. This stored energy is then dispatched when needed.

Beyond the batteries themselves, BESS includes essential components for integration into the grid. Key design considerations include power capacity, measured in MW or kW, which determines the rate of energy input or output, and energy storage capacity, measured in MWh or kWh, which defines the total energy the system can hold. These specifications vary by application and are central to system performance. BESS installations range from compact units to large-scale facilities covering entire industrial zones.

BESS systems typically incorporate a range of technologies working together to ensure safe, efficient and reliable operation. Inverters convert direct current (DC) to alternating current (AC), while sensors continuously monitor performance and system health, supplying data for optimisation.

Control units manage how the batteries charge, discharge and regulate energy flow. Battery modules group individual cells to operate collectively, and cooling systems, using either air or liquid, maintain optimal operating temperatures. Battery Management Systems (BMS) ensure safety and efficiency by tracking key metrics such as voltage, temperature and state of charge. Finally, Energy Management Systems (EMS) coordinate energy use based on real-time demand, supply availability and operational goals.

Phasing out fossil fuel backups in renewable energy

Phasing out fossil fuel backups in storage and hybrid systems is ambitious but achievable. National climate plans, including the Paris Agreement's NDCs, are increasingly incorporating fossil fuel phase-out strategies.

Battery technologies such as lithium-ion and sodium-ion are becoming more efficient and affordable. Hybrid systems use predictive algorithms and smart grids to balance supply and demand. AI helps forecast both energy demand and renewable output, improving how stored energy is scheduled and deployed.

Other measures include demand response programs that encourage users to shift consumption to times of high renewable availability. Converting fossil fuel plants into renewable or storage hubs also aids the transition and avoids asset stranding.

Examples of regulations and challenges affecting energy storage systems

European Union: The EU's Electricity Market Design Directive defines energy storage as a unique asset class, removing deployment barriers. It ensures fair grid access and promotes open competition for balancing services. The REPowerEU initiative is also accelerating solar and wind growth, creating opportunities for storage.

China: Under its 14th Five-Year Plan, China targets 30 GW of energy storage by 2025. Provincial targets may exceed this, positioning China as a global leader in storage.

United States: The Inflation Reduction Act introduced a 30-50% Investment Tax Credit for standalone storage, aimed at accelerating renewable adoption.

The energy storage industry holds strong potential to fast-track renewables and support sustainability. Despite challenges, such as upfront costs, regulation, investment gaps and technological constraints, each also presents an opportunity for innovation and growth.

Energy storage and hybrid systems at GreenPowerMonitor, a DNV company

GreenPowerMonitor (GPM), part of DNV, is helping meet market demand using its 110 GW under management, data science

Juan Carlos Arévalo

expertise and a team of over 5,000 energy specialists from DNV's advisory teams.

GPM's storage and hybrid solutions include the Energy Management System (EMS), which optimises battery performance, extends asset lifespan and supports overall grid reliability. Alongside this, the Hybrid Energy Management System (HEMS) enables seamless coordination between PV systems and BESS, enhancing efficiency, lowering operational costs and ensuring regulatory compliance.

Juan Carlos Arévalo adds: 'At GPM, we recognise that the energy transition is dynamic and demands constant innovation. As part of DNV, we bring deep expertise in renewable energy management and the flexibility to adapt to evolving industry needs. We are committed to collaboration, especially in BESS and hybrid projects, to help drive the sustainable growth of the energy sector.'

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