e-News for power industry leaders
Edition 42 – February 2026

The Potential Roles of Energy Storage in Power Systems

Technical Brochure (TB) 970 prepared by Working Group (WG) C1.51, examines the potential roles of energy storage in modern power systems, particularly in the context of global decarbonisation. As electricity systems transition toward higher shares of wind, solar, and hydro generation, managing intermittency and maintaining reliability become central challenges. TB 970 explores how grid-scale energy storage can balance supply and demand, enhance system stability, and support the reliable integration of renewable energy. The TB provides a useful reference on the current state of energy storage globally. The Australian members of the WG were Jonathan Dennis, Steve Richardson and Phil Southwell.

The brochure begins by placing energy storage in a historical context. While humanity has long stored tangible resources such as grain and water, electricity presents a unique challenge because it is produced and consumed instantaneously. Large-scale direct storage of electricity is not currently feasible; instead, electricity must be stored indirectly through other forms of energy. Ideally, storage technologies should be affordable, compact, highly efficient, scalable, durable, fast-responding, and long-lived. However, no existing solution fully meets all these criteria, requiring system planners to make trade-offs.

TB 970 categorises non-CO_2-emitting storage technologies into five groups:

- **Electric**, including supercapacitors and inductors, which are well suited for very short-duration, rapid-response applications.
- **Electrochemical**, primarily batteries, varies widely in performance depending on materials. Considerable research is continuing with flow batteries currently showing promise for longer-duration utility applications.
- **Mechanical** encompassing pumped hydro, compressed air, and gravity systems.
- **Thermal** capturing heat or cold for later use, often integrated with industrial processes.
- **Chemical** focusing mainly on hydrogen and its derivatives, which can substitute for fossil fuels and produce water as the primary combustion by-product.

The TB compares these technologies using common metrics such as cost, efficiency, capacity, durability, scalability, siting requirements, and life expectancy.

Applications of storage are grouped into three broad categories:

- **System-wide applications** provide core grid functions, including buffering supply and demand, firming renewable generation, supporting stability, supplying short-circuit current, and enabling black start.
- **Balancing generation with load and frequency-control applications** including frequency regulation, spinning and operating reserves, ramp-rate control, and inertial response. Most inverter-based systems can respond within milliseconds, which may reduce reserve requirements and improving efficiency. Mechanical storage can provide a natural response.

Electromechanical, thermal and chemical sources can provide synthetic inertia and can respond more quickly than conventional sources.

- **Location-based applications** can support system operation, reduce transmission congestion, increase effective capacity, and support industrial and commercial users in managing peak demand and power quality.

Implementation challenges are significant. Storage complicates system analysis by introducing new uncertainties and multi-use operational modes. Inverter-based systems require careful specification, verification, and maintenance. Planning must account for limited energy capacity, charging constraints, efficiency losses, and auxiliary consumption. Transmission visibility, especially regarding state of charge of batteries, presents operational difficulties. The integration of distributed storage, electric vehicles, and vehicle-to-grid (V2G) systems adds further complexity. Investment decisions must weigh storage against generation and transmission alternatives, considering lifespan and decommissioning impacts, including battery disposal. Market frameworks also play a decisive role; storage will only develop where market rules allow revenue streams aligned with system needs. Existing grid codes and market designs may disadvantage storage and require adaptation.

Drawing on utility case studies across battery, flywheel, gravity, pumped hydro, compressed air, and thermal storage, TB 970 concludes that storage is already embedded in modern power systems. Its flexibility enables at least nine key services, from supply-demand balancing to black start capability. The brochure recommends further work on comparative economic and environmental analysis, updated planning methodologies, V2G integration, and coordinated transmission-distribution planning to fully realise storage's potential in a decarbonised grid.

The TB is free for members and €220 for non-members.