FlexCHESS

Better together: how hybrid energy storage combines the best of each technology

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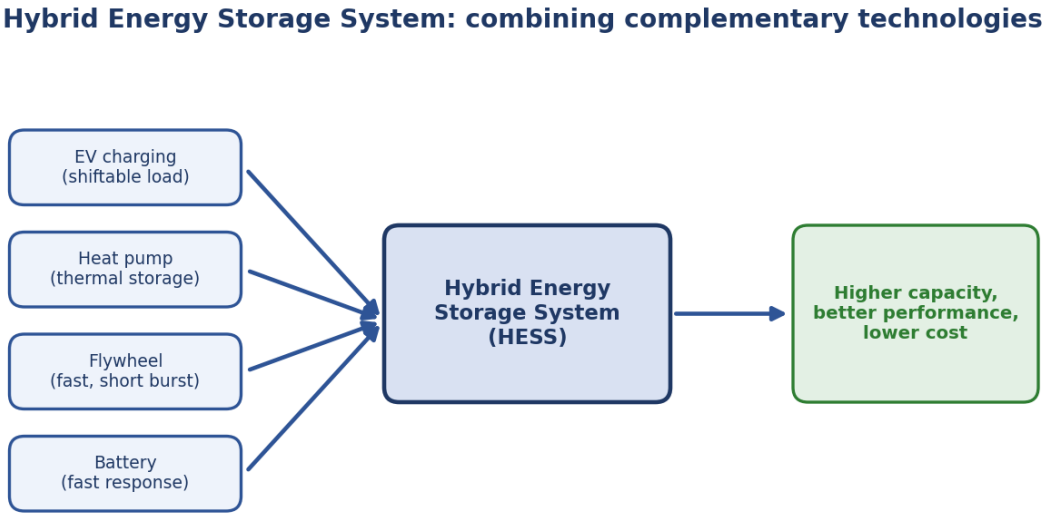

No single energy storage technology is perfect. A lithium-ion battery responds quickly but is relatively costly and degrades over time. A flywheel offers rapid response but limited capacity. A heat pump can store energy in thermal form, an electric vehicle can shift its charging, and flexible loads can be adjusted to match the grid — each with its own strengths and limitations in terms of lifespan, cost, energy and dynamic response.

The FlexCHESS project takes a simple but powerful view: rather than relying on one technology, combine several. This is the principle behind Hybrid Energy Storage Systems, or HESS.

By bringing together different sources of storage and flexibility — batteries, electric vehicles, heat pumps, flexible appliances and distributed renewable generation — a hybrid system can deliver higher capacity and better performance than any single component working alone. One technology can cover for the weaknesses of another: fast-responding assets handle sudden changes, while slower, higher-capacity resources manage longer-term needs. The result is a storage solution that is more capable, more resilient and, importantly, more cost-effective.

Making this work in practice requires two things. First, the different technologies — often from different manufacturers, using different communication standards — need to talk to one another. FlexCHESS addresses this through a common solution and protocol, and through its low-cost CHESS-plug, which connects existing appliances and devices into a shared system. Second, the combined system needs intelligent management. FlexCHESS uses a real-time digital twin and a decision-support system to decide, moment by moment, how best to use

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each resource — balancing goals such as maximising battery life, minimising cost and reducing carbon emissions.

The art of a hybrid system lies in matching each technology to the task. Fast-responding assets such as batteries handle sudden swings, while thermal storage in heat pumps or shiftable electric-vehicle charging cover longer periods at lower cost. FlexCHESS coordinates these through a single management layer, using a real-time digital twin to balance competing objectives and a Virtual State of Charge indicator to keep track of the flexibility available across the whole system.

The pay-off is a hybrid system that behaves like a single, dependable asset while drawing on a diverse mix of technologies. For consumers and energy communities, this means access to flexibility markets with the equipment they already have, and the prospect of new revenue from resources that would otherwise sit idle. For the grid, it means more flexibility to integrate renewable energy.

Across its five pilot sites, FlexCHESS tested exactly these combinations in real conditions — showing that, when it comes to energy storage, the whole really can be greater than the sum of its parts.

References and further reading

- FlexCHESS project — CORDIS, European Commission
- International Energy Agency (IEA)
- The European Green Deal — European Commission

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