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Abstract: This short note outlines how energy storage systems are becoming a core component of modern low carbon electric power systems. Challenges and opportunities are identified, while we also discuss mechanisms being put in place to favour the emergence of economically-viable grid-connected energy storage systems.

Résumé : Cette courte note examine comment les systèmes de stockage d'énergie joueront un rôle de plus en plus prédominant dans les réseaux électriques décarbonés. Nous y identifions les défis techniques ainsi que les occasions d'affaires reliés au déploiement de ces systèmes. De plus, nous discutons certains des mécanismes mis en place afin de favoriser l'implantation de systèmes de stockage d'énergie qui soient viables économiquement.

Historically, electric power systems have been developed with the assumption that energy storage systems (ESS) were either too expensive or technically inadequate to play a major role in electric power systems. The poor energy conversion efficiencies of most legacy storage technologies and centralized, generation-driven utility planning have clearly been major barriers, which held back wider deployment. Aside from classic pumped-hydro storage power stations (such as the Sir Adam Beck Complex in Niagara Falls and the well-known Dinorwig power station in Wales), often built to help manage nighttime load in power systems with significant power nuclear generation capacity, grid-side energy storage has had limited scope and range of applications up until now.

With the ongoing deployment of increasingly variable, intermittent, distributed and, most importantly, low carbon power generation from the sun and the wind, energy storage systems are finally gaining ground in the power industry. This evolution is also coupled with significant progress in battery technology as well as in less conventional technologies, like compressed air energy storage.

Today's ESS serve three main purposes in assisting power system operators and planners integrate more renewable energy sources (Figure 1).

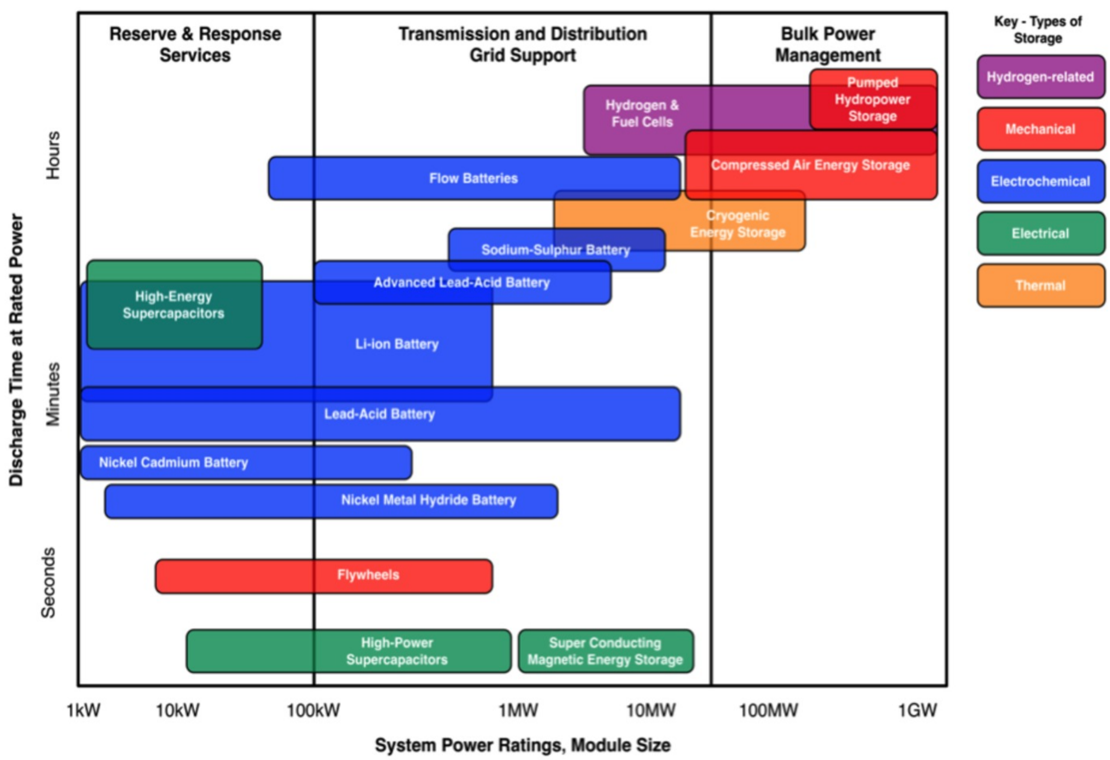

Figure 1: Energy storage application and technology map (Source: Centre for Low Carbon Futures, UK)

First, ESSs can assist with reserve and response services. In such cases, the storage technologies involved are able to help grids ride through fast-acting disturbances like major wind and solar power ramps, and when large numbers of wind turbines shut down quasi-simultaneously in high wind conditions.

In addition, ESSs are essential to provide bridging power in timescales of 10 to 60 minutes to assist with grid management and support. For these applications battery technologies dominate. Typical roles for storage here will involve short-term wind power generation balancing, network congestion relief and operating reserve provision.

Over longer time scales (beyond 1 hour), ESSs are tasked with bulk energy movements potentially spanning several hours. Applications here would include profit-driven energy arbitrage (i.e., buying and storing electricity when it is cheap and reselling it when its price is high) and intra-day energy shifting with the goal of reducing peak demands.

The main challenges for grid-side energy storage technologies at the moment and for the years to come are very similar to those encountered by the solar photovoltaics and wind power generation industries over the last decade. Its main goal is to reduce manufacturing costs. At the same time, in the case of batteries, it is essential that manufacturers can roll out battery packs with potential for more charging/discharging cycles and less performance degradation due to repeated cycling.

In the Canadian context, two principal business cases for grid-connected storage have emerged. The first one is associated with improving the greenhouse gas emission performance and operating costs of power generation in off-grid communities and mining operations. Here, energy storage can be used, in combination with local wind power generation, as a partial substitute to local diesel-fired generation. Glencore's Raglan nickel mine in Northern Quebec with its 3 MW wind turbine, 1.8 MW diesel units and a hydrogen-based storage system is a great example of such a hybrid diesel-wind-storage system.

Another business opportunity is certainly within the Ontarian power market with its near zero (or even negative) energy prices at nighttime and very high prices during the day. Here storage operators can reap the benefits from the inherent inflexibilities of nuclear power and from the fact that the Ontario electricity market does not have a lot of spare generation capacity at peak times.

Last but not least, just like with all the other now mature renewable energy generation technologies out there, energy storage technologies will most likely benefit from some regulatory stimulus. This is why several jurisdictions in North America–e.g., in Ontario, and in the state of California–have launched energy storage mandates to stimulate further technological development, get actual field deployments and attract investors. In California the energy storage mandate launched in 2014 was a great success with multiple bidders overshooting the mandate's target. The world is now watching to see if the exercise will deliver its promises as deployments are starting.