Energy storage in electricity grids

In brief

- The shift towards greater use of renewable energy necessitates more dedicated storage in electrical power systems to provide short-term flexibility.
- Electricity storage facilitates the decoupling of electricity supply and demand, and can be used to provide a wide range of ancillary services.
- The future deployment of dedicated electricity storage in Austria and the EU will be strongly influenced by future policies for electricity market design, system operating rules, technology investments, and involvement of consumers and prosumers.

What is it about?

The current deployment of dedicated electricity storage on the grid in the EU is dominated by pumped hydroelectric energy storage (PHES). Nevertheless, the deployment of lithium-ion batteries is growing quickly, and growth is also expected with regard to the deployment of other energy storage technologies. At least two EU member states (Germany and the UK) have recently started to procure more dedicated storage for deployment on their electricity grids, and an even greater share can be expected until 2030 in the entire EU grid. Against this background, two key technology developments justify the attention of innovation and energy policymakers.

(1) As variable renewable energy sources (wind energy and photovoltaics) have become more widespread, more storage systems can be connected to transmission and distribution grids. This allows for short-term flexibility and advantages when competing with other options such as flexible generation, grid reinforcement, demand-side management and load reduction. (2) Small storage systems will be installed on distribution grids as consumers (mainly householders) have started to invest in photovoltaic systems and battery systems for their own consumption of energy. Many different electricity storage technologies have been researched, developed and piloted over the past several decades, with several potentially competing options still being developed. Pumped hydroelectric energy storage and possibly lithium-ion batteries also appear to be ready for large-scale deployment in grid-connected applications in the EU over the next few years.

Source: wikimedia.org/wikipedia/commons/thumb/8/8b/Pumpspeicherwerk_R%C3%B6nkhausen_FFSN-4446.jpg

Pumped hydroelectric energy storage is the most widely used and proven electricity storage technology today.

PHES power plants are currently in operation in the 28 EU member states (EU28) plus Norway and Switzerland, totalling more than 48 gigawatts. Worldwide, PHES power plants with a total output of approximately 170 gigawatt are in operation. There is scope for increasing the output from many existing PHES plants, and several new sites could be used in the EU, leading to estimates that, in the EU, up to approx. 75 GW of PHES could be deployed by 2030.

Battery technologies have already proven successful in both transmission and distribution grid-connected applications. Research in this area is ongoing, with a particular focus on reducing costs and improving the performance of batteries. Worldwide, major investments are being made to create new plants for the mass production of lithium-ion batteries.

Basic data

Project title:	Valuing dedicated storage in electricity grids
Project team:	M. Ornetzeder (in an international consortium led by Prof. M. O'Malley)
Duration:	2015-2017
Funded by:	EASAC – European Academies Science Advisory Council

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Key results

The value of dedicated storage on an electricity grid is system-dependent. The roles and opportunities for electricity storage and its competitors grow as the electricity systems grow, in particular as the use of variable renewable energy sources increases. The same storage technology can offer several different services to the grid, and have different advantages in different situations. The business case for investing in storage becomes more attractive when one specific storage system can viably compete in more than one role per market at the same location (multiple uses with value stacking).

Storage adds value to electricity grids by contributing to the growing demand for flexibility (including congestion management), which results from increasing levels of variable renewable generation (notably wind energy and photovoltaics) on electricity grids. In addition, dedicated storage adds value to electricity grids by contributing to balancing, reserves, network capacity and generation adequacy.

Battery for local storage of solar power in a private home

Currently, storage is widely acknowledged as an expensive option, but its costs are falling and its value is improving. There are many conflicting claims and projections for current and future costs of the different storage technologies, and many ongoing research projects aim at reducing costs. Amongst the different storage technologies, it is clear that batteries presently have the highest cost reduction potential, and their costs are falling fast, partly as a result of the economies of scale that accompany their growing use, especially in transport applications. In contrast, the costs of other storage technologies are coming down more slowly. Nevertheless, for future large-scale applications, PHES in particular can offer good value for money in suitable locations.

Future research on a wide range of storage technology options is ongoing, but new storage technologies are not expected to be commercially deployed in grid-connected applications on a large scale before 2030.

What to do?

Future policy options for the electricity sector must ensure efficient and stable operation of the electricity grids with the lowest possible cost to consumers. At the same time, the share of variable renewable electricity continues to grow in response to a continuing drive to reduce carbon emissions.

Against this background, the future deployment of dedicated electricity storage in Austria and the EU will be strongly influenced by future policies for electricity market design, rules and regulations governing the operation of the systems, technology investments, and involvement of consumers and prosumers. These are the main policy options to ensure that storage is used effectively:

- Electricity market design should deliver price signals (locational and temporal) that will encourage investment in the most cost-efficient flexibility options on both transmission and distribution grids.
- Electricity market design should address the emerging challenge of more photovoltaic and battery systems being installed by householders on distribution grids.
- Electricity market design should be technology neutral, which means that it should not create barriers to the deployment of potentially valuable systems and technologies (including storage).
- More research and development is needed, particularly with a focus on cost reduction of storage technologies and socio-economic monitoring of demonstrations and innovation programmes, and of prosumer markets.

Further reading

EASAC (ed.) (2017) Valuing dedicated storage in electricity grids, EASAC policy report 33
easac.eu/fileadmin/PDF_s/reports_statements/Electricity_Storage/EASAC_Electricity_Web_low_res_30_June.pdf

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