ÖAW AUSTRIAN ACADEMY OF SCIENCES

ITA INSTITUTE OF TECHNOLOGY ASSESSMENT

IMPLICATIONS OF ELECTRICITY STORAGE

In brief

- Along with several other options, storage systems for electrical energy are considered as a key technology of the energy transition.
- In the future, the greatest storage requirements will be in the area of long-term storage (storing across seasons and years).
- Consequences, risks and potential for conflicts are manifold and largely depend on respective technologies and forms of application.
- A lack of storage facilities is currently not an obstacle to the expansion of renewable energy sources in the electricity sector.

What is it about?

Storage systems for electrical energy are considered as one of the key technologies of the energy transition. They allow for a temporal decoupling of supply and demand and can thus contribute to further integration of environmentally-friendly wind and solar energy. However, the spread of new technologies or the construction of large-scale plants not only offers opportunities for society, but is also associated with uncertainties and possibly undesirable consequences and risks. This is also the case with electrical energy storage systems.

In general, there are four technologies for the storage of electrical energy, with the option of generating electrical energy again after storage: mechanical storage (e.g. pumped storage hydroelectric power plants), electrochemical storage (e.g. batteries), electrical storage (e.g. capacitors), and chemical storage (e.g. hydrogen/fuel cells). There is a wide range of different applications for which the above-mentioned technologies are used. The following six forms of application are currently considered particularly relevant for Austria: pumped storage, stationary battery at home with photovoltaic (PV) system, virtual large-scale storage (pooling), battery power plant, industrial battery storage system as well as mobile applications in the field of electric vehicles.

Source: shutterstock.com, petrmalinak

Battery storage for sustainable energy

However, from a security of supply perspective, storage facilities are only one option amongst many. In the long term, it is likely that all options for more flexibility will have to be exhausted if the aim is the far-reaching decarbonisation of the entire electricity sector. More flexibility refers to consumption and demand not having to coincide at every location at any given time. In addition to the expansion of storage facilities, grid expansion and modernisation, flexible generation or demand-side load management are also an option. The most significant future demand in the storage sector will be for long-term storage (across seasons and years). From today's point of view, only chemical storage materials (e.g. hydrogen, synthetic methane) can be considered for this purpose.

BASIC DATA

Project title:	Zwischenspeicher der Zukunft für elektrische Energie
Project team:	ITA: Ornetzeder, M., Bettin, S., Nentwich, M.; AIT: Wasserbacher, D., Schaper-Rinkel, P.
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Key results

Consequences, risks and possible conflicts arising from further expansion of storage technologies are very diverse and depend largely on the technologies and the associated forms of application.

Pumped storage facilities are well established and widely used. The environmental, economic and societal consequences are considerable, but largely known. New types of consequences are unlikely to emerge. Measures to minimise risks are required by law. Risks and other implications are assessed and evaluated on a project-by-project basis (EIA process). Despite adequate opportunities for participation, social conflicts cannot be ruled out in the future either.

Pumped storage power plants to store electricity

Internationally, **battery storage systems** have been used to balance electricity grids for a long time; in Austria, however, they were introduced only recently. The enormous technical progress in the field of lithium-ion technology has been of great importance in this respect. Market research predicts strong global growth. Considerable risks of this technology exist in production (e.g. raw materials) and disposal (e.g. recycling), and are strongly linked to the products used and their distribution dynamics. PV battery systems, for example, which are mainly used in the private sector, have to be considered with caution: whilst hardly any positive environmental effects have been observed to date, mass distribution is associated with certain risks (e.g. financial risks for operators, behaviour in the event of fire).

Power-to-gas (P2G) as an electricity storage technology is only at the cusp of industrial use. Assessing the consequences and risks is therefore still clouded in uncertainties – at the same time, however, there are still many design options. Chemical storage has the key advantage of enormous potential for long-term storage. The disadvantage of this technology, however, is the high cost due to low overall efficiency. P2G is only ecologically advantageous if electricity from renewable sources is used to produce the chemical energy carrier.

What to do?

Together with several other options, storage technologies are an important element on the way to a decarbonised power supply. In order to identify possible negative consequences, risks and possible conflicts at an early stage, and minimise them as much as possible, the following points, amongst others, must be considered:

- The lack of storage facilities is currently not an obstacle to the expansion of renewable energy sources in the electricity sector. Many, often more cost-effective options for flexibility are available.
- Existing and planned pumped storage facilities in Austria already offer enormous capacities. Approval procedures with high process quality are of great importance for further expansion.
- In the case of battery technologies, a wide range of consequences, risks and social conflicts can be seen during the various life cycle phases. Consequently, batteries should be addressed as an issue in the context of comprehensive sustainable recycling management.
- Based on negative experiences in Germany, the consequences and risks of PV battery systems should be investigated more thoroughly. Financial support for such systems should be linked to clear energy and environmental policy criteria.
- Chemical storage facilities are currently considered the only option for closing the foreseeable seasonal flexibility gap. However, the technologies required for this purpose still have significant technical and economic disadvantages. Potential risks associated with large-scale plants have not been clarified either.

Further reading

Ornetzeder, M.; Steffen, B.; Wasserbacher, D. (2019) Zwischenspeicher der Zukunft für elektrische Energie Endbericht. Bericht-Nr. ITA-AIT-9; ITA/AIT: Wien; im Auftrag der Parlamentsdirektion. epub.oeaw.ac.at/ita/ita-projektberichte/ITA-AIT-9.pdf

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