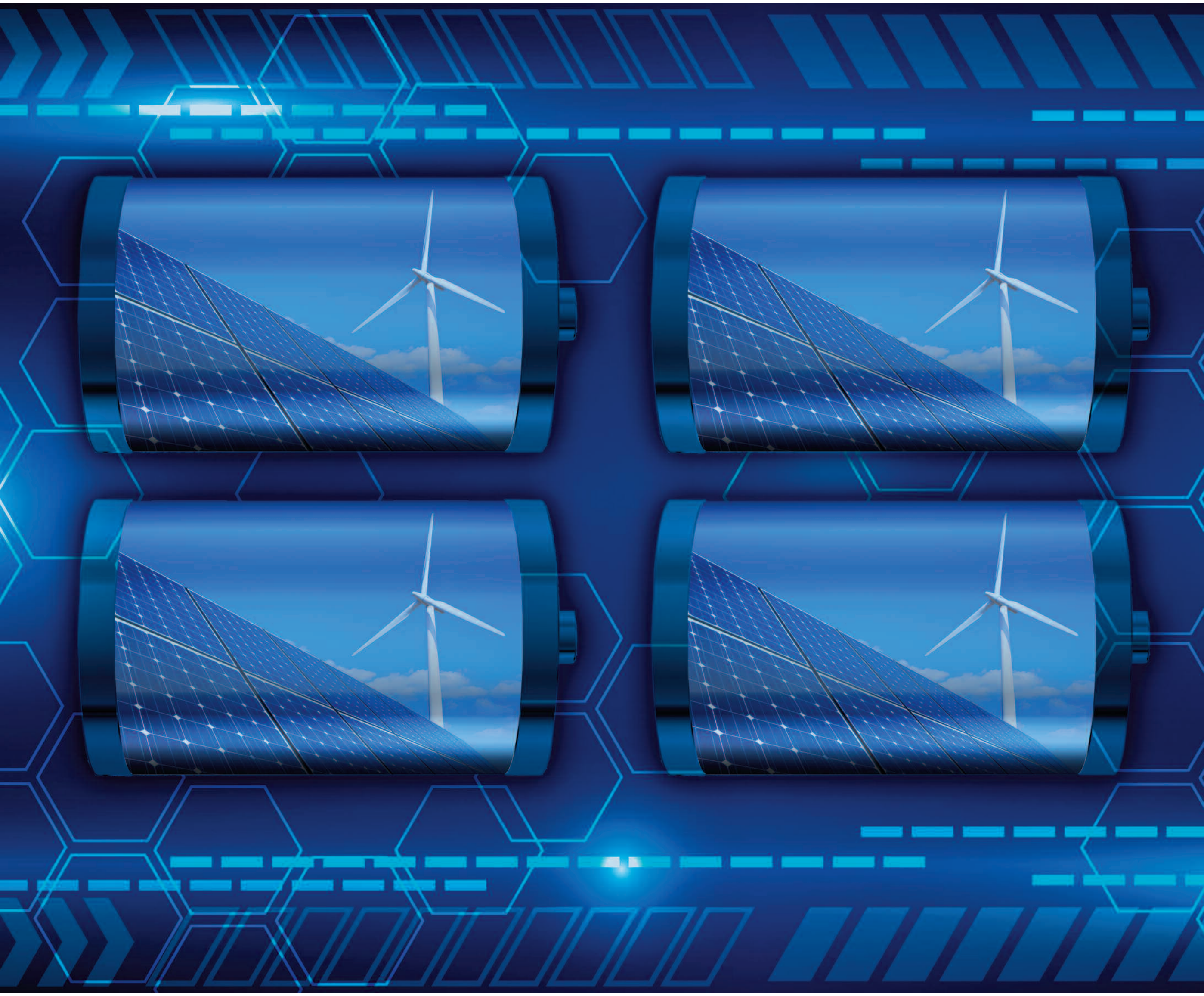
GEODE POSITION PAPER - ENERGY STORAGE

Functions of Electricity Storage for the Grid



GEODE
The Voice of local Energy
Distributors across Europe

GEODE Working Group Smart Grids

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1. Energy storage role in the energy system

Energy storage technologies absorb and store energy so that it can be released when required. Historically storage has often provided back-up power for commercial and industrial applications. A good example of energy storage is hydropower, where rainwater and melting snow is stored in reservoirs and released through a generator when electricity is needed. Fossil fuels such as coal, oil and natural gas are also forms of energy storage, having stored energy for millions of years. The use of fossil fuels has given us ready access to electricity (for example, via coal-fired power stations), heat (domestic gas boilers) and transport (petrol). Europe already today has huge amounts of storage capacity installed, especially from hydropower: in Sweden and Norway alone more than 70 TWh of hydropower storage is available.[1]

However, as we reduce the use of fossil fuels, while increasing renewable energy sources (RES) new forms of energy storage will be required to support DSOs in integrating these renewables. This increase in RES particularly affects the distribution networks where a lack of flexibility in the grid is creating constraints against integrating large amounts of RES – this is the main focus of this briefing.

Storage could have multiple uses related to balancing demand, supply and grid management.

These include amongst others:

- **Maintaining reliable electricity supplies** for national, regional, local and household electricity systems, by ensuring that electricity supply matches demand.
- **Helping to avoid or postpone costs for electricity network reinforcement** by increasing the cost-efficiency of electricity supply.
- **Managing variations in heat supply and demand.**
- **Replacing conventional transport fuels with electricity** stored in batteries or low-carbon fuels. Such approaches can produce lower greenhouse gas emissions and air pollution.
- **Helping to optimize self-consumption of customers** (e.g. PV) in order to reduce their energy bill.

[1] (70 TWh of hydropower storage = app 10 000 000 000 Tesla wall packs at 7 kWh).

2. What are the benefits of storage for DSOs?

- New connections of RES to the MV and LV grid increase the need for system services – such as storage – to balance and operate the distribution network.
- Energy storage may prove to be a cost-effective option for reinforcing the network, as a complement to cables/lines and other investments in the electricity grid, allowing the DSO to save a significant amount on network reinforcement costs.
- Storage can reduce the demand at peak hours on transformers or control the reactive energy and voltage by phase.
- Energy storage also offers an opportunity to manage interruptions in electricity supply.
- Storage facilities can be used to lower the grid losses and to ensure and improve quality and security of supply.
- More effective and/or efficient achievement of DSO core functions.
- Additional option for efficient grid management (i.e. local balancing for voltage and reactive power, to improve local power quality, fast and super chargers for e-mobility).
- Storage will help reduce high peaks and load shedding in the distribution grid, avoiding or decreasing the need for new and larger transformers and further network investments required to cope with new challenges (e.g. EV chargers).

3. DSOs role in storage

Energy storage should be integrated at different levels of the electricity system including the distribution grid and at customer level.

Energy storage that is connected to the grid will allow storage operators to supply the grid with excess energy when available and needed and can thereby give added value to the whole grid.

DSOs can make use of several functions of storage for a reliable grid operation such as capacity management, maintaining grid balance and peak load shaving, reactive power compensation, reduction of harmonics, asymmetries management, congestion management and the use of fluctuating RES feed-in as well as grid management with regard to the upstream grid.

An active DSO is key to optimize the benefits of energy storage.

In order to maximize these effects, GEODE believes that the following principles should apply:

- If storage as a networks' asset is necessary to operate the grid, the same regulatory framework should be provided for all system operators (DSO/TSO) for handling their operational challenges.
- **DSOs should be allowed to use, own and operate storage – connected to the distribution grid in order to fulfil their core activities and to guarantee the security and quality of supply in their area of responsibility.**
- The objective of DSOs when operating storage facilities must be to support the grid operations and not to be a commercial actor in the electricity market.
- The decision on whether to invest in cables/lines, to buy services in markets or invest in storage should be made on financial grounds, selecting the most efficient and profitable technology.
- Market actors should be able to offer energy storage services both to the grid and to the market – this would be reasonable due to the different functions storage can fulfill. A storage installation which has to be used to 100% either for the grid or the market might be uneconomical – while storage which can offer its services to both the grid and the market could be cost effective.
- The DSO should be responsible for the connection and integration of storage to the grid when it is operated by other actors.
- The ancillary services needed to operate the grid are normally delivered by the wholesale market to the TSO. Markets should be extended to also serve the DSO with the same services. This would require geographical bids.
- There is a need for coordination between TSOs, DSOs and potentially other market parties (aggregators) on market offerings to storage providers to ensure that services can be 'stacked' on occasion rather than permanently competing. This will help improve the economics for storage.

- For efficient grid management and to facilitate Demand Response activities, the DSO in agreement with the owner of the storage should be allowed access to commercial storage.
- **DSOs should be able to buy relevant flexibility services.** If a service is only required for a few hrs/year, it might be more efficient and economically reasonable to procure this service rather than investing in an asset. A precondition is that the required service is available on the market. The DSO should be able to "secure" storage capacity for times when it is needed, to interested parties for active flexibility and load management.

Other actors on the electricity market will be active in storage on commercial terms. Customers should be allowed to have their own storage close to the production unit and act as prosumers. This will help to optimize the self-consumption rate and at the same time the impact of distributed generation on the grid. Therefore, decentralized storage has the potential to minimize grid losses, facilitate a more efficient use of locally produced electricity and even out peak loads, which in total will provide a more efficient use of the grid.

Utilities and aggregators also will be interested in owning and/or having access to the services of energy storage operators.

4. Requirements for storage availability for DSO grid optimisation purposes

DSOs operate at a local level. Thus, DSOs' needs for storage are also local. In order to be able to use energy storage as a cost-effective option for reinforcing the network, DSOs need to be able to rely on the availability of storage at specific points on the network, perhaps the availability of a specific storage facility.

To obtain the largest societal gains from storage, it may not be appropriate to limit the use of a storage facility to a single party. However, if a storage facility is operated by market parties and used for market purposes, DSOs cannot use the same storage facility for network optimisation without a clear definition of the situations when the storage will be available for DSO use. The DSOs may require priority to use this storage in certain specified network situations.

The management of storage could usefully follow the general principle that market actors can act freely as long as the distribution grid is not put at risk – e.g. the traffic light grid status is green. In all other situations priority access to flexibility services, such as storage, is crucial for the DSOs to fulfil their core tasks being the party responsible for grid stability and secure grid operation.

A prerequisite necessary for the DSO to fulfil its role as market facilitator and for the introduction of a traffic light scheme is to increase the monitoring ability and controllability in the medium and low voltage distribution grid.

There should be no restrictions placed on market actors on what they use storage for. However, it has to be distinguished when storage is required for grid operation or when it has a commercial use.

Also, there should be no restriction on who should own or operate storage, as long as the neutrality of DSOs and proper functioning of markets is guaranteed. Restricting possibilities on ownership or operation could hamper the emergence of innovative solutions and limit the development of suitable market models.

5. Barriers and challenges

A mix of energy storage solutions as part of flexibility services is needed, tailored for each region and system architecture. There are still several barriers and challenges to be overcome before storage solutions can be efficiently integrated into the energy system at distribution level.

The **main challenges** for the increased deployment of storage are:

- **Technological:** new technologies are still in the laboratory. Slow progress due to the sometimes weak business case and other related uncertainties.
    - In a short term flexibility market, the DSO must operate a fully digitalized network at those locations where flexibility is needed to balance the grid.
    - Further investments in R&D are needed (e.g. impact of converters on the power quality due to storage).

- **Market issues:** there are no market signals to incentivize the building of storage. Lack of innovation in the Power Exchange Market. New business models, e.g. for geographical bidding have to be developed.
  - **Potential conflicting interests between DSOs and other market actors** regarding services offered by storage operators. Therefore, more coordination is necessary. A purely market oriented storage operation might lead to problems in the distribution grid. GEODE's view is that the monitoring of the grid in combination with a traffic light system might be necessary.
    - Need to create a regulatory framework that allows the use of services of storage by all market actors, taking into consideration unbundling requirements.
    - Need to create coordinated processes for business models for multiple uses of battery capacities by different market actors.
    - If the DSO uses storage services it should be a pre-condition that the required service in the DSO's network area is also made available to the market.
- **Economic:** The benefits are closely related to location. At the same time storage-technologies are expensive.
  - Profitability with today's low electricity prices and high investment costs is hard to secure.
  - In many European countries, most of the cost for electricity comprises taxes and levies, which are fixed. That affects the customer's incentives to invest in storage, since only a small part of the electricity costs can be reduced by the technology.
- **Strategic:** Lack of regulation to bridge the market and political aspects including a review of network tariffs structures towards more capacity based tariffs, where appropriate.
  - Storage is often installed by consumers who wish to become as self-sufficient as possible (e.g. PV on the roof of buildings and storage to store excess production). As a consequence, the energy taken from the grid is reduced and grid is used just as back-up. Eventually, the "bill" for the grid infrastructure has to be paid by those customers who are not able to invest in storage or decentralized generation. Therefore, the grid tariff structure has to be modified to be cost reflective and to allow for fair cost allocation. A more capacity based grid tariff could be the best option.
- **Legislation:** lack of regulatory regime and/or unclear roles (DSO, generator, supplier).
  - Need to create a market model where DSOs can operate storage to fulfil their core activities, without affecting the markets (e.g. not creating an imbalance for any supplier).

6. How should storage be financed from a grid perspective?

From a grid perspective, storage should be seen as an alternative to traditional grid investments that allows the DSO to postpone or even avoid grid investments. Therefore, the ability to finance storage through grid fees is recommended.

If the storage is approved as part of the capital invested in the network, the costs of electricity storage and the network-reinforcement are comparable, and the network operator can select the most economic of these options. Storage facilities should be treated like any other grid connection.

7. Regulatory Framework

Decisions to invest in the deployment of adequate storage capacity will depend on the development of the whole energy system and the regulatory framework for the DSO.

In most European countries there is no clear regulation on decentralized storage, and only in few of them there is any regulation for storage in place. National legislation treats storage either as generation – e.g. storage from the customers – or as an electricity end-user load or both. The regulatory framework must address barriers preventing the integration of storage into the market and grid. It should guarantee a level playing field vis-à-vis other sources of generation and flexibility.

GEODE supports a regulatory framework for storage that allows the use of all technical options for a storage facility, both for markets and networks (DSO and TSO).

8. Conclusions

- Decentralised storage will play an important role from a market and grid perspective (for a better connection of RES to the grid, for balancing and optimizing the grids and for future customer needs).
- Storage is a tool for DSOs in order to manage flexibility.
- DSOs should be allowed to use, own and operate storage, in order to fulfil their core activities and to guarantee the security of supply in their area of responsibility.
  - There should be no restrictions on market actors on what they use storage for. It has to be distinguished between storage required for grid operation or when it has a commercial use.
  - There should be no restriction on who should own or operate storage, as long as the neutrality of DSOs and proper functioning of markets is guaranteed.
- DSOs should be able to obtain access to commercial storage to fulfil their network requirements and to facilitate Demand Response activities (e.g. by a contract between the storage owner and the DSO). For practical reasons the end user's storage capacity should be known by the DSO.
- DSOs should be able to buy relevant flexibility services – in this case storage services.
- If storage as a network owned asset is necessary to operate the grid, the same regulatory framework should be provided for all system operators (DSO and TSO).
- The regulatory framework must address barriers preventing the integration of storage into the market and grid. Allowing the use of all the technical options storage can provide services to the market and to the networks (DSO and TSO).
- It should be possible to finance storage through grid fees when it is an economic alternative to traditional grid investments.
- The grid tariff structure has to be reviewed to become more cost reflective and allow fair cost allocation. Increasing grid tariffs, for those who are not able to invest in self-generation (in combination with storage), should be avoided – the grid is more and more used as back up only. A more capacity based grid tariff could offer the best option.
- It is important to support more R&D in storage solutions that include interaction between the different energy carriers.

9. RECOMMENDATIONS

A regulatory framework must be developed where DSOs are allowed to use, own and operate storage connected to the distribution grid in order to fulfill their core activities and to guarantee the security and quality of supply in their area of responsibility.

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A regulatory framework addressing the barriers currently preventing the integration of storage into market and grid has to be developed.

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The same regulatory framework should be provided for all system operators (DSO and TSO), if storage as a network asset is necessary to operate the grid.

ANNEX I

What types of storage are available or under development?

Conventional and new energy storage technologies are emerging from laboratories and demonstration projects into actual deployment across the power grid. Energy storage needs and patterns of access are changing. However, research is still needed to enable the wider application of both new and mature technologies and to understand the optimal commercial framework. Below is a list of storage technologies, both mature and new:

- Hydropower
- Pumped hydro
- Compressed air energy storage (CAES)
- Batteries
- Flow batteries
- Flywheels
- Super conducting magnets
- Supercapacitor
- Latent heat thermal energy storage
- Power-to-Heat (P2H)
- Cold energy storage
- Pumped heat electricity storage
- Power-to-Gas (P2G, hydrogen or methane production)

ANNEX II

List of acronyms

DSO - Distribution System Operator

TSO - Transmission System Operator

ICT - Information and Communications Technology

PV - Photo Voltaics

LV - Low voltage

MV - Medium voltage

RES - Renewable Energy Sources

R&D - Research and Development

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