EDSO for smart grids

European Distribution System Operators for Smart Grids

Integrating electricity storage in distribution grids

May 2016

Introduction

Since the start of mass-electrification, the electricity industry has been expected to invest in increased generation and, increased transmission and distribution capacity to make sure that electricity generation would meet peak demand. However, the deployment of distributed renewable energy sources (DRES) is leading to a change of philosophy: demand should also adapt to generation and constraints, and consumers should be incentivised to become more flexible.

Electricity storage is a bridge between these two approaches, as it helps generation to match any sudden demand surge, and also can store energy when generation is abundant but demand is low. Electricity storage commonly exists under the form of pumped-hydro storage, but the limited number of areas suited for this type of technology are preventing its further development. Other promising energy storage technologies are turning other utility-scale electricity storage into a more realistic prospect, at least in the medium to long term.

Electricity storage, understood in this paper as "*the intake and stocking of electricity in different suitable energy forms where the release of energy in the form of electricity, occurs at a controlled time, at the same connection point where it was first absorbed*" is a promising technology, both for market players and for network operators, and potentially for small consumers in the future.

This paper looks into the potential of electricity storage to be integrated into distribution system planning and operations, and the changes required to the current regulatory frameworks.

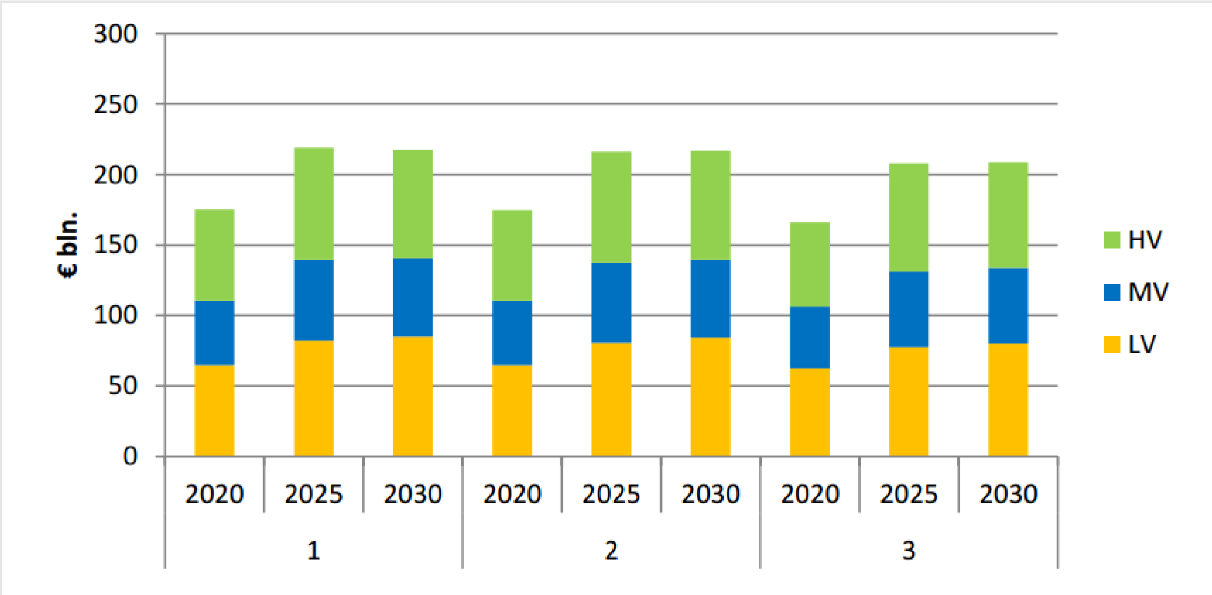
Key messages

- DSOs should be allowed to procure system flexibility services from existing electricity storage facilities. DSOs should also be able to deploy and operate their own electricity storage facilities, if necessary. In the latter case, the energy storage facilities should be integrated in the DSO's regulatory asset base and their cost should be recovered through network tariffs.
- As demonstrated in current R&D projects, electricity storage can support network operations, but its economic viability remains the main obstacle for commercial deployment, together with the lack of a clear regulatory framework.
- EU regulatory certainty should come in the revision of the Third Energy Package, through a clear definition of electricity storage. In the interim, NRAs should take stock of existing European initiative to develop their own set of rules.

1. What could DSOs use electricity storage for?

With the increasing installation of RES, heat pumps, electric vehicles and aggregators, DSOs will have to reinforce their networks to cope with more volatile electricity consumption and generation. The continuous reinforcement and renewal of electricity networks will require significant investments according to a study[1] produced on request of the European Commission in 2014: EUR 170b by 2020, and 215b by 2030.

Cumulative distribution reinforcement cost in the main scenarios (EU-28, EUR bn)



To better control costs, rationalise investments, and keep the current levels of quality of service, DSOs are investigating alternative solutions guaranteeing the same quality of service as grid reinforcement. In this context, electricity storage could be used by DSOs to:

- Smooth generation and consumption peaks to increase the capacity of existing networks (saving investments);
- Enhance power quality (reactive power, voltage);
- Limit losses;
- Perform local balancing.

A previous EDSO paper on the role of DSOs in tomorrow's electricity market already identified a number of system needs and potential system flexibility services that DER, including storage, could deliver to DSOs:

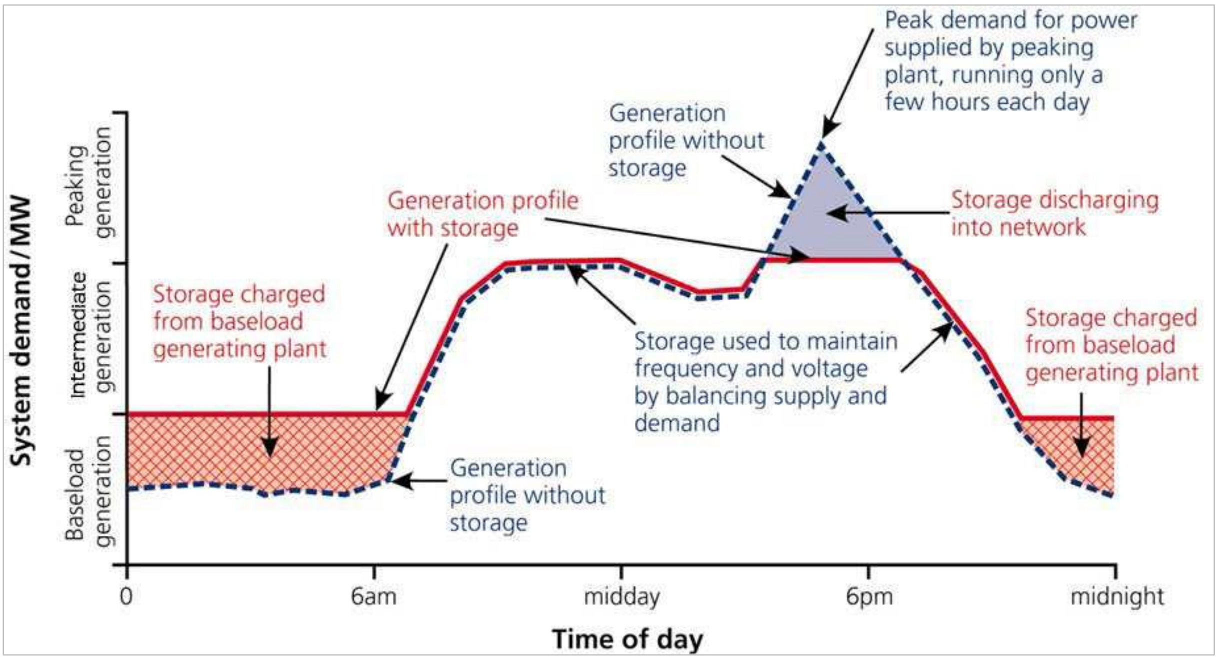
[1] Imperial College London, NERA Economic Consulting, DNVGL, « *Integration of Renewable Energy in Europe* », June 2014

Potential system flexibility services to be procured by DSOs

System Need	Potential Service	Procurement mechanism
Congestion management to keep the system running within security standards	Generation adjustment	Market / bilateral agreement
Voltage control	Active and Reactive power provision	Grid code
Investing efficiently in distribution grids	Peak shifting and peak shaving	Market / Bilateral agreements / auction / Grid codes

The use of such services has been tested in several demonstration projects across Europe. Among them, the "Smart Storage Unit" project conducted by the Dutch DSO Enexis, was used to study the potential of electricity storage for peak shaving. A 230 kWh electricity storage facility was built in a district where most houses were equipped with solar panels. As shown in the figure below, batteries were charged in the early morning when the network is not stressed, and/or when PV production was high and demand low. Electricity was then injected back into the local network during the evening in order to cover the electricity consumption spike that usually occurs when consumers go back home. This experiment enabled Enexis to reduce peak demand by 15%.

Peak shaving experiment in the Smart Storage Unit project



Other projects, such as GRID4EU, Greenlys, Sustainable, and Smart Grid Évora, have also shown the technical value of storage for system operations. As further refinement of storage technologies are expected in the near future, the regulatory framework should not prevent DSOs to avail of these technologies.

2. Who should own and operate electricity storage facilities?

Electricity storage facilities should be built and operated by multiple companies in a competitive environment, in the same way generation power plants are owned and operated today. Depending on the technology used and on commercial and regulatory incentives, electricity storage facilities could be used for market-driven purposes (e.g., portfolio optimisation, trading), for the provision of system services to transmission system operators and/or for the use by distribution system operators.

As for DSOs, they should be allowed to procure systems flexibility services from market players, either via organised markets (similar to balancing markets on the transmission level, where TSOs procure reserve capacity for frequency response via auctions/tenders), bilateral contracts or competitive tendering.

Taking into account the fast development of electricity storage technologies, DSOs should also be able to deploy electricity storage on their own, if necessary. In that case, the electricity storage facility should be included in the regulatory asset base of the DSO and its cost should be recovered through network tariffs.

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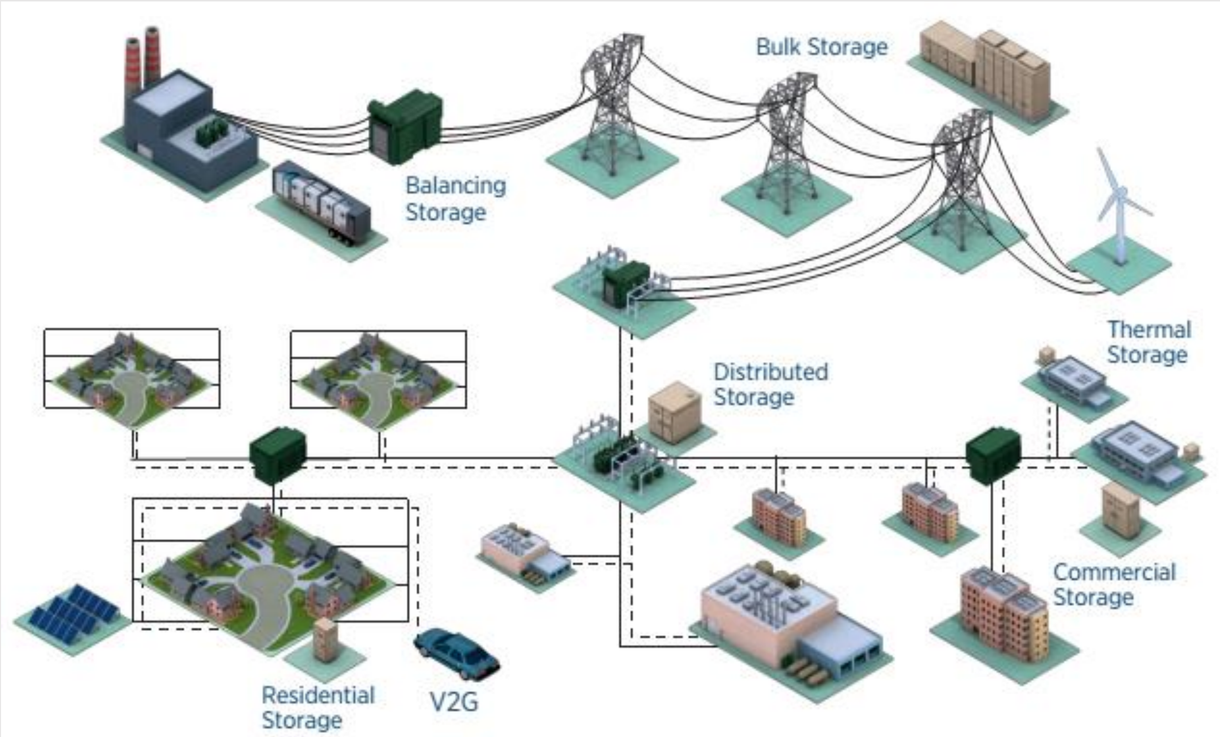
3. Where in the grid should energy storage be connected?

As energy storage can be useful for market parties and network operators, different forms of energy storage will continue to co-exist in the future, serving different purposes. Two main types could be distinguished:

- **Centralised, – large-scale - storage,** already used in the form of pumped-hydro, which is dispatched as any generation power plant and bids on wholesale markets and complementary services markets managed by TSOs;
- **Distributed, – medium and small scale – storage**, connected to the medium and low voltage networks, or connected to the consumer facilities.

As the figure below shows, it is not possible to pinpoint an ideal connection point for every type of energy storage. The best connection point will depend on the technologies consider, their price, where the grid needs support and where energy storage can deliver the most benefits.

Potential locations and applications of electricity storage in the power system



Source: International Renewable Energy Agency, "*Renewables and electricity storage: A technology roadmap for REmap 2030*", June 2015

4. Should storage facilities pay energy taxes and network tariffs?

Taxes and fees based on the end-consumption of electricity were designed to charge every unit of electric energy (kWh) only once, which is why they are linked to the end-consumption and not – for example – electricity trading. Charging taxes and levies on storage (i.e. electricity taken from an electricity grid and re-injected later into the same electricity grid) would violate this principle as the same energy would be charged twice, once when stored in the energy storage facility and once when consumed by the final consumer. In this context, EDSO encourage NRAs to apply fair taxes on storage not to jeopardise its economic viability.

Network tariffs are a distinct issue. In today's regulatory framework, grid users are charged differently: generators usually pay a limited share of the total network charges (if any), while consumers bear the brunt of them. Such differences, which correspond to local context and regulators' objectives are necessary.

Electricity storage facilities should not be taxed twice. As for network tariffs, the decision to charge electricity storage facilities should be left to the national regulator.

5. What are the barriers to electricity storage deployment?

Two main barriers exist today for electricity storage: its lack of economic viability, and the lack of a clear regulatory framework.

- **Economic viability**

The exact cost of electricity storage depends on the technology used and the purpose of the storage facility installed. Currently both the energy density and the dimensions of the batteries are decreasing, which is an indicator that the price will decrease as well. Nonetheless, the situations under which installing batteries would be more cost efficient than grid reinforcement are still rare. Two pilot projects, one in the Netherlands and one in Germany, illustrate this fact.

In 2010 in the Netherlands, Enexis studied the possibility to substitute electricity storage for network expansion. The base scenario was the installation of a 5km long, 10kV power line, representing a traditional investment of €350.000. With a 60-year lifetime and no maintenance, its cost was €6.000/year. The investment for the storage facility used in this pilot (400 kW, with a storage capacity of 230 kWh) was, back in 2010, about €600.000 and its depreciation time was estimated to be 10 years, hence a cost of €60.000/year.

The current price for the same facility is now estimated to be in the range of €150.000-200.000, which represent a cost of €15.000-20.000/year. The business case for this type of storage could become positive in 3-5 years from now. This remains a rough estimate, but where new power lines are hard to install, and the extra capacity needed is limited, the business case for energy storage could become positive soon.

A second example from Germany shows that storage assets can be beneficial if a grid reinforcement is only required for a certain period. In an on-going project managed by Westnetz, a subsidiary of RWE, an investment in a 5 km 10-kV-system was required to solve local voltage and load issues in rural grids with high PV feed-in. This reinforcement would have been required for 4 years only due to a planned redesign of the grid and its connection to a nearby higher voltage grid. It was shown that a storage system with 250 kW, 1 MWh and costs of about € 1,000,000 was more beneficial than the investment in new cable from a welfare point of view.

- **Lack of a clear regulatory framework**

The use of energy storage by grid operators is limited at present because unbundling requirements – or their current interpretation by NRAs -- do not allow TSOs and DSOs to directly own or control energy storage facilities.

The Third Energy Package is not clear on this matter, but in the interim, there are some interesting national developments on energy storage regulation underway[2].

[2] « Energy Storage: Which Market Designs and Regulatory Incentives Are Needed? », SQ Consult, Fraunhofer Institute for Systems and Innovation Research ISI and Universitat Politècnica de Catalunya for Policy Department A: Economic and Scientific Policy, European Parliament (August 2015).

Italy has stated in the decree law 93/11, Art 36, paragraph 4 that the TSO and DSOs can build and operate batteries provided this investment is justified through a cost/benefit analysis that shows that the energy storage system is the most efficient way to solve the problem identified (e.g. compared to the build of new line). Remuneration from the storage asset should not be higher than the (measurable) cost of alternative solutions.
In addition, Italian network regulator (AEEGSI) passed a Decision on Provisions related to the Integration of Energy Storage Systems for Electricity in the National Electricity System (Decision 574/2014/eel of 10 November 2014) defining network access rules for energy storage.

In Ireland and Northern Ireland, EirGrid and SONI are developing a programme ("DS3"), due to start in 2017, which will allow energy storage companies to provide grid services via a system of competitive bids.

In Belgium, Elia has been allowed to use energy storage for balancing upon the following conditions:

1. the electricity is generated for balancing purposes only, with an explicit prohibition for commercial purposes;
2. the stored electricity is called upon as a last resource;
3. under the form of negotiated drawing rights;
4. to the limit of the power needed for ancillary services;
5. upon the prior approval of the regulator;
6. after having completed all relevant procedures for calling upon the market.

EU regulatory certainty should come in the revision of the Third Energy Package, through a clear definition of electricity storage. In the interim, NRAs should take stock of existing European initiative to develop their own set of rules.

EDSO for Smart Grids is a European association gathering leading electricity distribution system operators (DSOs), cooperating to bring smart grids from vision to reality.
www.edsoforsmartgrids.eu