Grid-connected energy storage: implementation and risk management

Grid storage | The advent of grid-scale energy storage means a whole raft of new technical, safety and risk-mitigation requirements for the industry to understand. Martijn Huibers, PhD and Paul Raats, MSc of DNV GL report on guidance designed to help stakeholders get to grips with this fast-emerging sector

Credit: AES

GRIDSTOR is intended to support the growth of the grid-scale storage sector

The world of energy is changing at breakneck speed, whether you appreciate it or not. Even the most passionate climate change deniers cannot deny the simple facts of the energy transition. Obviously, the growth of photovoltaics has been exponential for the last decade, owing to technological progress and decreasing costs. Wind power, especially offshore wind, is thriving as well, with prices dropping decades faster than industry expert forecasts even a few years old.

With the shift in the energy mix towards variable renewable generation comes an increasing need for flexibility. Which combination of flexible resources is best suited for a particular (small- or large-scale) power system is strongly dependent on among other things the local generation and demand profiles as well as properties of the grid. Grid-scale energy storage is one booming option. It has been widely compared to where PV was 10 years ago, storming the market due to maturing technologies and steady cost reductions. Grid-connected storage systems can serve several applications in the power system, often simultaneously: primary reserve, peak shaving, arbitrage, black start capabilities, ramp rate control, grid investment deferral and more.

Utility-scale energy storage is catching the attention of power grid stakeholders. Utilities, where allowed by law, are now integrating them into their grids (or at least running demonstration projects), project developers are building them, investors are financing them, insurers are asked for policies, manufacturers and system integrators are ramping up production. And as energy storage has been around for at least a century (depending on the type), the technologies are considered matured and their risks are clear and well-mitigated. Or are they?

Risk mitigation

As with many other energy transition issues, things are not that simple; there are several complicating factors. Recent years have seen rapid technological advances, raising the possibility of risks and a lower system-level maturity. Even if only one component has evolved, the behaviour and risk profile of the entire system can be quite different. Furthermore, the scale of grid-connected storage systems being installed nowadays is quite different. Issues emerge for tens-of-megawatts systems that are not present or not relevant for (kilo-)watt-scale systems. For example, grid-scale lithium-ion batteries have different safety requirements (e.g. cooling, fire extinction) and different energy management systems than the lithium-ion cells that have been used in consumer electronics for years. Lastly, the grid-scale storage market itself is rather young. Experienced suppliers and end users exist, but a significant number of players have only comparatively recently moved into the field and are lacking knowledge to a certain extent. Consequently, designs and mitigation measures may not always be optimal, and conversely buyers are not always aware of what to ask for or pay attention to.

So why not rely on standards, the tried-and-tested way to mitigate risks, improve quality and prove compliance? Indeed, there is no shortage of standards, guidelines and other guidance documents out there – in fact, as many as 200 were identified worldwide that may apply to grid-scale energy storage components, systems or projects. It is understandable that stakeholders in an emerging market, including regulators and authorities, have trouble choosing which ones could, should or must be applied. Currently, there is no single comprehensive standard that covers all relevant aspects.

Enter GRIDSTOR. In 2015, the energy storage industry had realised the situation described above and a consortium of eight industry stakeholders (and 36 reviewing parties) cooperated in a joint industry project to resolve it. The product of their efforts was documented through "DNVGL-RP-0043; Safety, operation and performance of grid-connected energy storage systems", also referred to as GRIDSTOR. The document is a comprehensive recommended practice (RP) intended to be the one-stop go-to document for all stakeholders, issued by DNV GL and publicly available online [1]. It references existing standards and similar documents as much as possible, while adding additional or new recommendations in case topics are not or inadequately covered elsewhere. The general approach is technology-agnostic, with technology-specific content wherever needed, for example on safety issues like fire suppression and safe system design. All project phases are covered, from feasibility to decommissioning.

Market response to publication of the RP has been overwhelmingly positive, with industry players picking it up and using it as an independent risk mitigation tool. In 2016, a new consortium with 14 members formed to update and fine-tune GRIDSTOR and to add or expand upon topics such as micro-grids, cyber security, conformity assessment, warranties and decommissioning; publication is scheduled for this September.

All things to all people

The ways in which GRIDSTOR is supporting grid-connected energy storage business depend on who is using it. Every stakeholder has its own interests, expertise, risk focus and risk appetite. For example, utilities are using the document as a manual and as a guide for procurement. Investors value it as an independent and industry-supported foundation for due diligence. And last but not least, developers of solar-plus-storage projects can find support for technology selection, dimensioning and benefit stacking. These examples are examined in more detail below.

Utilities are generally experienced in implementing projects for their assets, but energy storage systems may be new to them. Therefore, in all phases they may not have an overview of key issues to investigate or address, and minor or major risks to mitigate. GRIDSTOR can then be used as a manual of sorts. By reading carefully through all applications, project phases, definitions, technology-specific issues etc. relevant to the project at hand, the utility is able to absorb the knowledge required for the project as it is being set up and run. For example, correct formulation of employer's requirements is facilitated, including key system and component specifications as well as carefully defined and relevant KPIs. Furthermore, standards with which compliance could or should be requested are easily selected and safety issues can already be discussed and incorporated early on in the project. During construction and installation, Factory Acceptance Testing (FAT) and Site Acceptance Testing (SAT) can be done in a more reliable way.

Investors are moving into the grid-connected energy storage market too. Some invest in stand-alone storage systems, other already have a portfolio of solar or

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wind projects to which storage is added. In all cases, the Recommended Practice is being used as a foundation for the due diligence process typically executed before investment decisions. If upon careful assessment the project or system(s) are found to be in line with GRIDSTOR recommendations, the investor can have confidence that risks are sufficiently identified and mitigated. If certain aspects are not compliant, the investor has an independent reference as a solid basis to convince the other party about the issues and how to address them.

System sizing

Developers of solar PV plants are more and more faced with challenging interconnection requirements, including for example conditions for maximum allowed power ramp rates and frequency control. These requirements can encourage the integration of storage into the PV plant, where the storage device is only used for a small portion of the 8,760 hours make up a full year. In such occasions the business case for the PV plant investment would improve when the storage capacity could be deployed for multiple applications, often referred to as 'benefit stacking'. The recommended practice provides insight in and guidance on the 20 fundamental applications of grid-connected energy storage in the power system.

Incorporating a storage device into a PV plant, whether by necessity or by choice, also implies selection of the correct storage technology and involves a sizing effort for the storage system. GRIDSTOR addresses electrical, electrochemical and mechanical storage technologies, and elaborates on the parameters essential for sizing storage devices to be connected to the grid.

For the consumer-oriented mass market of energy storage (photovoltaic storage, home energy storage etc.) rough sizing rules exist, mainly based on the size of the installed PV system and depending on the region the storage system will be installed in. For industrial applications, such rules do not exist yet. Although a general classification of the storage application is possible, the requirements resulting from the application of the storage device vary significantly depending on the properties of the grid where the device will operate. In many cases this hinders the transfer of a business case from one application to another with slightly different surrounding conditions, and thus requires running the dimensioning process for the new application.

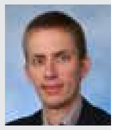
The question whether actual risks have been identified and mitigated with the help of GRIDSTOR can be answered with a resounding 'yes':

- incorrect determination of battery degradation, leading to shorter lifetime and lower capacity than anticipated, as well as warranty disputes
- definitions of key parameters being unclear or not applicable to the project, leading to performance not matching application requirements
- business cases being based on another application
- unclear guarantees and unenforceable conditions for replacement
- inadequate or absent fire suppression systems

And the list goes on. Fortunately, in these and many more cases, the recommendations the industry itself is providing through GRIDSTOR have been able to prevent and/or resolve serious issues. With all industry stakeholders being able to rely on independent risk mitigation, the grid-scale energy storage market is accelerated, in turn further enabling other energy transition technologies – like photovoltaics, just to name one. ■

An updated and expanded version of GRIDSTOR is scheduled for publication by September 2017.

Authors



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References

[1] See the GRIDSTOR landing page at www.dnvgl.com/services/gridstor-recommended-practice-for-grid-connected-energy-storage-52177/ or the general site for all DNV GL service documents at www.dnvgl.com/rules-standards/.