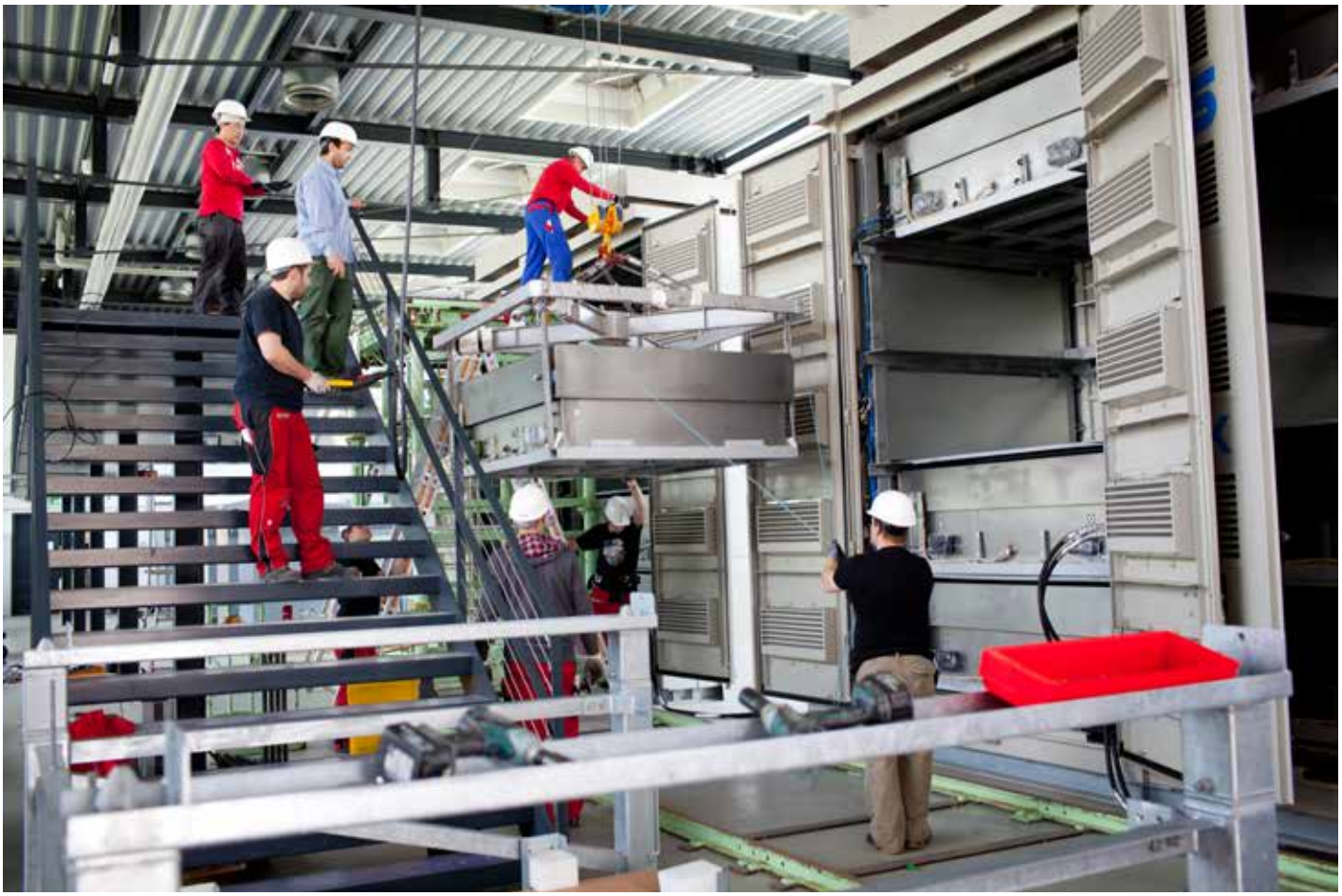
O&M in storage: optimisation and maintenance

Battery storage | Operations and maintenance is becoming an important subset of the fast-maturing solar industry but is not yet as clearly defined in the less developed storage business. Andy Colthorpe reports on how efforts to get the most out of battery systems are focused on optimising assets to provide maximum value across a range of markets



Credit Younicos

In solar PV, operations and maintenance (O&M) is big business. In mature markets such as the UK and Germany, where the booming construction phase of the utility-scale PV segment has quietened down, providing cleaning, security, monitoring, forecasting and a whole range of other services has breathed new life into the industry. Analysis firm IHS has forecasted that in North America alone, the O&M market will be worth a billion dollars by 2020, while GTM Research claimed in 2016 that the global utility-scale solar PV O&M market for that year was close to 182GW in total.

Operations and maintenance, in the sense we would apply the term as a service industry segment of solar, simply does not exist for battery storage systems. Third-party maintenance of large-scale battery storage systems is unheard of, with fault repair the responsibility of system integrators and manufacturers. This means the maintenance aspect is more a question of troubleshooting as and when necessary, and while different project developers or system providers have different strategies to do this, it's generally a simple case of automated fault-finding and cloud-based alerts.

O&M in energy storage is primarily about maximising the value of batteries across multiple value streams

O versus M

Adriana Laguna, low carbon technology manager with UK distribution network operator (DNO) UK Power Networks, is responsible for overseeing O&M for the Smarter Network Storage project, a 6MW/10MWh large-scale front-of-meter battery system that has been trialling the use of energy storage for peak shaving and grid services. Laguna says that maintenance of even such a large plant is mostly restricted to a six monthly check up to ensure optimal performance.

These include "the calibration of the batteries to identify the battery degrada-

tion levels, software upgrades, inspection and relevant work on the power conversion system and all connected electrical equipment such as the Uninterruptible Power Supply (UPS) systems installed on site," Laguna says.

Similarly, Phil Hiersemenzel, communications director at storage system integrator Younicos, says that a lot of maintenance is "software updates and things like that", adding that while this makes it seem like a routine set of activities, where projects are remotely monitored and problems fixed either remotely or on-site, it remains a vital part of the project's lifecycle.

"I think it's very important that you have it (maintenance), it ensures the availability of your asset and maximises that so it's very important. But not all important things are sexy!"

Meanwhile, it's in the 'O' of O&M that we find some of the most interesting activity going on – in other words in the operation of a battery storage plant, determining what it actually does, what services it provides, when it exports to or charges from the grid, whether it 'stacks' one or more services on top of each other for diversified and multiple revenue streams, can ultimately determine what the energy storage system earns in economic terms, which stakeholders it benefits and how long it will be capable of doing so.

"From the start point with the battery there are a lot more permutations of things happening," says David Hill, director of business affairs and corporate management at UK demand response aggregator and latterly battery energy storage operator Open Energi.

"The strategy is very different to solar – because solar's just on one strategy: export when you can and get as much subsidies as you can, or if it's subsidy-free you're still looking for a contract with an off-taker to take everything at a certain price. Whereas the economics of a battery mean you're trying to operate within as many different types of market as possible to recover the capital invested."

The price of lithium-ion batteries has dropped drastically since they were first made commercially available at the beginning of the 1990s. But although the price drops in some ways mirror the downward trajectory seen in solar panel pricing, batteries are still a relatively expensive asset. This means deploying a battery for time-shifting solar production, or for backup power alone, is not hugely economically viable, outside of certain territories such as islands and remote areas with existing high electricity prices, fossil fuel import costs and/or lack of reliable grid power, where solar can be made dispatchable and immediately more competitive with a battery attached.

> "The economics of a battery mean you're trying to operate within as many different types of market as possible to recover the capital invested"

Luckily, the versatility of batteries as a kind of 'Swiss Army Knife' for the grid means that they can provide multiple 'stacked' services – which mean a 'stack' of revenues can be accrued as well. Open Energi is responsible for the day-to-day operations – but not maintenance – of Europe's first commercially installed Tesla Powerpack, a 500kW system in England co-located with an existing solar farm. As Hill points out, it's the commercial strategy of a project that defines the O&M of a battery storage asset.

A balancing act

The key crux of O&M for battery energy storage systems is the balance between extracting maximum economic value from the asset and extracting use from it, ensuring the battery does not wear out. With the emphasis on the former, Hill says that for energy storage installations in the UK and many other territories, the most lucrative use of the battery is in frequency regulation markets, in Open Energi's case to keep frequency of power in the grid as close to 50Hz as possible. On top of frequency response contracts, commercially installed batteries commonly also provide peak demand reduction services to reduce grid power consumption onsite, while they can potentially also be used in capacity markets and for energy trading. All of these uses will have different operating parameters and economically optimal windows, but the key thing is not to overdo any of them or bring them into conflict.

"What you're trying to do is maximise the value over a period of time, because that battery will have been bought with some sort of understanding of a return on investment (ROI) or an IRR. It might require four to five years under that strategy to pay off the capital and you've probably signed it on a deal of 10-15 years so what you want to do is make sure that battery last 15 years, basically," Hill says.

"The main issue there is degradation. Every single time you charge and

Credit S&C Electric

The UK's Smarter Network Storage battery projectin Leighton Buzzard has been able to play a role at local and national levels

discharge the battery, it degrades the lithium-ion cells."

So a battery has to be used carefully and within the parameters defined by the battery or whole storage system manufacturer/integrator. As Hill points out, flexibility is often built into the batteries by manufacturers who might oversize them deliberately to give the operator a little room to breathe, while for his company's part, building on its experience in demand response, Open Energi automates the running of its plants as much as possible.

"We've built our whole R&D team around real-time machine-learning control algorithms that can optimise many different types of assets in relation to a range of constraints… We've developed a lot of sophisticated software that can optimise output against a range of constraints, be it state of charge, throughput on the battery, a physical connection from the field, all these different things."

The other aspect of this balancing act is the type of contract entered into when a project is delivered. For instance, in the case of the Smarter Network Storage project, Adriana Laguna says that as a grid-scale trial project, the battery is "primarily designed to support the local distribution network during periods of high electricity demand and keep the lights on" in the local area.

"Operationally, during these time-windows the technical considerations are a priority over the economic considerations, as the plant cannot be utilised for the provision of other high-value services and can stay idle for a prolonged period of time.

"Nevertheless, the last two years of operating the SNS, we have identified synergies between providing local network relief and reducing congestion at a national level complementing both technical and economic considerations," Laguna says.

O&M for a commercial fleet

Larsh Johnson and Gabs Schwartz, chief technical officer (CTO) and marketing director respectively of US intelligent commercial energy storage provider, Stem, agree that energy storage O&M is far more about 'O' than 'M'.

> "The [energy storage] industry is also 10 years behind solar in terms of market penetration, and so even though maybe at some point we will see separate, independent O&M providers, I don't see that happening for the next 10 years"

"Storage, compared to almost any other energy technology, is not really a hardware-based value proposition. Once the storage system is there, it's basically just an empty battery that has the capability of storing a certain amount of energy, "Schwartz says.

"What makes it valuable is the operation of it, pretty much second by second every day, for the entire life of the asset – a smart brain if you will, telling it exactly when to charge and discharge in order to provide its intended value; you can call that the 'O' of the O&M but we think of it as the entire business that we're in."

While to the end customer, the greatest value of Stem's systems is in reducing the demand charges that can make up as much as 50% of a commercial or industrial energy user's bills, the company's systems could be providing five or six different services "throughout a 24-hour day or 30-day monthly period". While this core function remains the system's priority, if a system was only reducing demand charges, it could be idle as much as 85% of the time, Johnson says. For some of the rest of that time it can be supporting the grid with ancillary services, alleviating grid constraints or trading in capacity or wholesale markets. Stem has two teams that take care of the bulk of the 'O', albeit running as many automated processes as possible.

"We have a network operation centre that's monitoring and using our software tools to detect any issues that require some kind of maintenance or field visit or any kind of tuning or adjustment of the system; that's sort of an operational team," Johnson says.

"At the same time we also have a data science group. Their job is to be looking at the data coming back and using data science techniques to mine that for clues as to how we can continue to improve the operations and then they use that to enhance or redevelop our algorithms to accommodate that new learning that they've come through from monitoring and observing the systems over the several million operating hours."

Stem has also made a name for itself in aggregating its fleets of installed behind-the-meter systems. Johnson and Schwartz say that this has several benefits from an operational standpoint, both technically and economically.

"Here's the benefit of having a large fleet – you have diversity in the system and so, what we see is the diversity in the different sites allows us to configure the system and set the rules and use the artificial intelligence processes to continually improve the way we optimise value across these multiple sites and in our offerings. As we do that, we're taking advantage of the fact that not all fleet participants are in the same place doing the same thing at the same time. That gives us a lot of flexibility around what we do. We typically

see 80%+ state of charge across the entire networks and so we're able to use that flexibility," Johnson says.

A question of maturity?

One other obvious difference is the maturity of the respective 'parent' industries. While batteries have been around for over a hundred years in their modern form, their use for stationary storage and solar storage is relatively new. To put it bluntly, solar has more than 10 years of experience as a 'mainstream' industry, with mass manufacturing and scaled deployment. From the ground-mount boom of the early 2000s, to markets that are now maturing, offering O&M as a standalone service has grown as an industry in its own right. Everything from the use of novel brushes and robots for panel cleaning to cloud-based security can quite legitimately be bundled into the provision of O&M, often by a third party to developers or project owners.

For instance, as detailed in *PV Tech Power* Volume 8, solar O&M has grown up to the point that trade association Solar Power Europe created an O&M 'taskforce' in 2015, to create quality benchmarks for the provision of these services, and to standardise approaches where feasible. Similarly, Sandia Labs and the National Renewable Energy Laboratory have drawn up a series of best practice documents for the US market along with the Sunspec Alliance.

In contrast, no such documents exist for energy storage – as yet, although best practice guidelines such as DNV GL's GRIDSTOR are starting to emerge. More critically, in terms of the differences between solar and energy storage O&M, maintaining and operating an energy storage system, be it grid-scale or commercial, is rarely contracted or sub-contracted to a third party. Younicos' Phil Hiersemenzel says that with the differences in configuration and applications each battery system is used for, the level of knowledge of each system required means that it is perhaps better left to the various project partners and the battery manufacturers themselves – at least for now.

"One difference between batteries and solar is that in solar it's a lot more of a commodity – batteries are a commodity too, but they're more specific in terms of what each battery looks like. The [energy storage] industry is also 10 years behind solar in terms of market penetration, and so even though maybe at some point we will see separate, independent O&M providers, I don't see that happening for the next 10 years. Batteries are being deployed in too specific ways.

"If you do it smartly, you can leverage batteries to do many things. But that also means you need to make sure they behave as they should and that in turn implies that you have people who have knowledge of the actual system. It could be a third party but they will have to spend a lot of time gaining the knowledge that the people who installed the system already have." ■

Credit SMA

Battery O&M requires in-depth knowledge of individual systems