

# Open season: the next steps for energy storage

**Storage** | Despite the huge strides energy storage has made, significant hurdles remain before the technology in its many guises can be claimed to have fulfilled its massive potential. Introducing a PV Tech Power energy storage special report, Andy Colthorpe assesses the key successes and ongoing challenges for this indispensable part of the future power system



The world has watched on as some of its leading regional markets, China, South Korea, Australia, Japan, parts of the US, the UK, and many parts of Europe have raced ahead in deploying energy storage in the last five years, mostly, but not only, lithium-ion batteries. IHS Markit says that the US in 2019 will deploy around 712MW, becoming the world's largest market for grid-connected batteries this year, while another research firm, Wood Mackenzie Power & Renewables, has predicted that 4.3GW could be installed worldwide during 2019.

Record-breaking figures have been reported in the US and other territories such as the UK, year-on-year. Yet from other territories reports come in of interminable delays, of hotly contested jurisdictional rights, the difficulty in overhauling not only the technical design

of the grid but the ways in which we think about energy markets too. Everyone seems certain energy storage is a key part of the decarbonised energy system, but no one seems certain when we will be able to breathe a sigh of relief that that place is assured. And of course, there's the question of whether success in these leading markets can be replicated all over the world.

In those leading regions, the rapid rise is happening both in front of and behind the meter, with economic cases that are finally starting to make sense and often – but not always – with specific policy support. And while solar industry investor and commentator Jigar Shah predicted confidently that utilities would try to take ownership of energy storage as much as they could themselves at the beginning of 2018, it seems as though 2019 was the year that this really took shape.

**Large-scale battery sites have been built in regions including the UK (pictured). But are they doing enough and should there be commercial impetus to build more?**

A quick case study of a utility in one of those 'leading regions' is municipal power provider LADWP in California, which over the next few years will deploy enough batteries to cover more storage output and capacity than its existing 1.5GW pumped hydro plant (see box, p.23). We also asked Janice Lin and Jack Chang at consultancy Strategen, itself based in California, to write about the 'challenges in the sun' California faces and some of the initiatives, both private and public, that are seeking to overcome them (see p.32).

Meanwhile in Australia, major utility AGL is now offering rebates of up to AU\$7,000 off the cost of residential ESS purchases, as well as a virtual power plant programme which benefits homeowners.

ers in some states to the tune of AU\$280 credit for a year for enrolling.

They and others are pushing ahead in areas where there may be high electricity prices and high grid congestion, falling feed-in tariffs and favourable tax regimes. Whatever the reason, circumstances have come together to reduce the risk and improve the return of procuring, owning and operating energy storage in some territories.

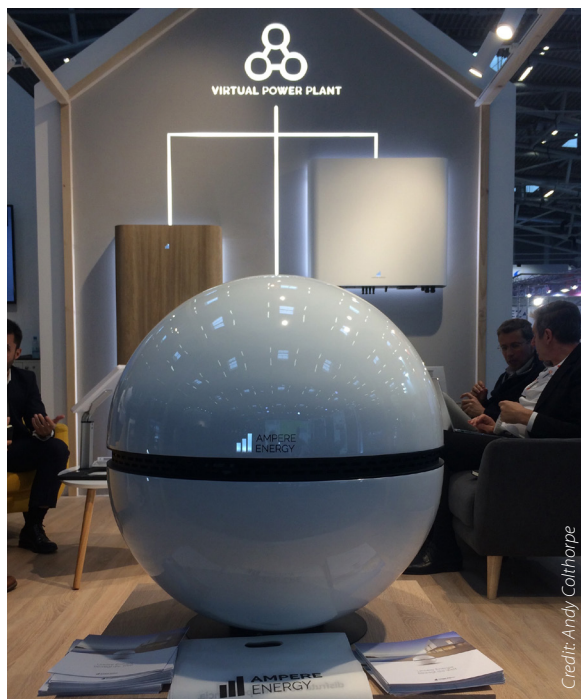
### Fear of missing out

Other utilities in other territories face totally different circumstances, such as Xcel Energy, which operates as a near-monopoly in Colorado, USA. Holding an all-resource, all-technology bid for new capacity a couple of years ago, in addition to picking out wind power projects, the utility also selected three solar-plus-storage projects, Alex Eller, analyst with Navigant Research says.

The utility hasn't done much in the way of standalone storage, because Xcel hasn't yet found "other use cases where storage was economical for distribution upgrade deferral and things like that", Eller says, and so in Colorado, where land is fairly cheap and so is electricity, it's the competitive economics of solar – now dispatchable with the addition of storage – that appeals, rather than storage in its own right. Being a vertically integrated utility, Xcel could later use the batteries at its solar-storage plants, each of which will have in the region of 50MW of batteries, for frequency regulation and other balancing services, but the main impetus is the deployment of renewables to replace fossil fuels.

It is an interesting snapshot of the wider picture across much of the US, Eller says. Many utilities now procure storage alongside solar as a low-cost generation source. Backed with PPAs, they offer the most certainty of use cases for energy storage on the US grid so far. Elsewhere, some standalone storage is deployed increasingly by municipal utilities, which have a certain degree of autonomy – in other US regions such as New England, where the regional Independent System Operator (New England ISO) has also opened up some of its markets to energy storage.

So, even with this seemingly positive picture, where in some areas electric system stakeholders of various kinds and local and even national governments are getting behind energy storage in a



**Despite futuristic concepts and design, battery energy storage is about functionality for both grid and end customers.**

big way and in other regions solar-plus-storage makes sense, will it be enough? And if, as we suspect, it might not be, what are the challenges and barriers in the road ahead?

### More to cost reduction than batteries themselves

A lot of emphasis has been placed on the cost of the batteries, which as we all know continue to enjoy a decline. Navigant's Eller has previously predicted a fall to around US\$76 per kWh by 2030, rival analyst Logan Goldie-Scott at BloombergNEF conversely says that an "average" lithium-ion battery pack could cost as low as US\$62 per kWh by that year.

Beyond the cost of the battery as well, power electronics components could still enjoy improvements in design and lowering of costs, Eller says, with much of that to centre around the standardisation of battery inverters, which the analyst says were "pretty customised" in the past.

One area Eller highlights is the growing interest in DC-coupled storage, explored in more detail in Sara Verbruggen's piece on storage system architecture later in this special report (see p.29). "[That] reduces the cost...because the DC converters are much cheaper than full grid-tied inverters are. So I think that certainly helps bring prices down," Eller says.

On the system side, there's also the

reduction in cost of software, but much of this has already been squeezed out, Eller says. Still, software is key in another vital way – the role it plays in complete system integration.

This year, product launches on the global market have included a 2.5MWh containerised solution from Saft and later a 3MWh 'Megapack' from Tesla. Offering more fully integrated, modular, all-in-one units that include the battery management system (BMS) and safety and protection features delivered in a single container from a single vendor can lower costs significantly, Eller says, noting that NEC's Energy Solutions division and Fluence are also now marketing "specific, defined products" to the market. Standardisation within individual vendor's offerings is certainly encouraging, the Navigant analyst says.

In the long term, Eller says storage companies should aim to offer more "plug-and-play" products to utilities, that will be "faster and easier to deploy" than more specialised equipment.

### The edge of profitability

Stationary energy storage systems are on the "edge of profitability in many market segments today", we hear in this special edition of the journal from Dr. Kai-Philipp Kairies, Jan Figgenger and David Haberschusz of RWTH Aachen University (see p.24).

Yet markets that reward the benefits of energy storage are drastically underdeveloped. Many in the US are looking to the bipartisan ruling FERC Order 841 from the Federal Energy Regulatory Commission, which instructs regional grid operators to open up wholesale markets to the participation of energy storage and is intended to be a game changer for the industry.

Many of the regional ISOs of the US have already responded by drafting their initial plans to comply with the Order. However, says Jennifer L. Key, a FERC lawyer with law firm Steptoe & Johnson LLP, there have been "somewhat surprising legal challenges...from both the state and public power and even parts of the utility industry dealing with jurisdictional fights over storage, between FERC and the states".

A "uniquely American problem", Key says, of dual state and federal regulation, is holding up FERC Order 841 before the details are even put on the table for discussion. A lot of the disagreement essentially stems from "whether FERC



or the state should have control over all things wholesale going on on the distribution system because a lot of storage is being connected to the distribution system – as opposed to the transmission system”, Key says. “A large swathe” of distribution system companies and state commissions have “filed for an appeal of Order 841 on jurisdictional grounds”.

“What’s interesting is that you have some states that are fully supportive of storage, that don’t mind at all that FERC is taking a lead and you have utilities and distribution system owners who don’t care who has jurisdiction; the storage that’s coming in, they’re dealing with it, they’re doing the right thing to get the storage interconnected.

“[Then] you have this whole entire pushback and it’s unclear if that’s because the states want to control the entry and use of storage,” Key says. Whether that is because individual state commissioners believe they could do it better than FERC perhaps, or believe that distributed storage could interfere with operations of their electric system somehow is also unclear, Key adds.

### Regulation, regulation, regulations

Jennifer Key and others argue that when FERC Order 841 does come to pass, it really will be a game changer partly because “it is compelling the organised markets in the US to develop and make sure that their systems whether it’s their software, or their market systems, have a place for energy storage which compensates”.

“One of the issues [Order 841] is raising is: can storage obtain enough compensation in the market, especially in markets where it’s hard for storage unless paired with something else (such as solar PV) to provide a capacity product?

“But it’s opening up, setting the rules of the organised market so that they can make accommodations as needed for storage and also the clarity of permitting storage devices to charge at wholesale [prices].”

On the subject of clarity, while the FERC Order 841 saga and in particular the recent pushback continue, in Europe, in both the UK and mainland Europe, a more basic regulatory issue continues to play out. As we hear from the continental European Association for the Storage of Energy (EASE) in this special report, so-called ‘double-charging’ remains a



Credit: Wasatch Group/Sonnen/Rocky Mountain Power

**Soleil Lofts, a 600 apartment development in Utah where Sonnen will deploy 12.6MWh of batteries in new homes**

huge, huge stumbling block for grid-connected energy storage (see p.38).

In the UK, too, a regulatory definition for energy storage has only just been proposed by the regulator, Ofgem. At present, energy storage is quite often still categorised as generation, Kirsti Massie, a UK-based lawyer with White & Case, says. Not having a dedicated definition or even a licence for energy storage, has “implications across a number of pieces.”

“If you have a generation licence it means in the UK certainly, as a transmission system operator or distribution network operator, you’re not also going to be able to own and operate storage facilities because they can’t become part of the grid because the way their licensing is structured,” Massie says.

“As a generator you’re often looking to smooth out intermittency to renewables. That’s fine but storage can do a lot more than that and it can provide grid services – it’s not just an add-on to generation. Grid services are hugely important and become increasingly important as more renewables come on the wires,” Massie says, while, as with mainland Europe, double-charging still exists.

“Also as a generator you will pay system charges when you’re charging up your battery but you’ll also pay when you’re actually discharging the power from the battery. You’re getting hit both times.”

Grid service markets are not often enough structured in such a way to take advantage of the fast-responding, low carbon generation-enabling qualities of

energy storage. As a lawyer, Massie says she looks closely at developments in the UK, Europe, the Middle East and Africa, but also works closely with colleagues in the US and Australia.

“What I’ve found very interesting is that the issues that we are talking about and that the industry and the regulator is trying to get their heads around in the UK are the same issues that you see in various markets in the US and in Australia. We’ve got a commonality of issues, in terms of questions people are trying to answer.”

### The customer will always come first

Deployed energy storage capacity around the world largely remains pumped hydro while lithium-ion is the current flavour of choice. Coming in all shapes and stackable up to hundreds of megawatts, the advantages of lithium-ion battery systems include how quickly they can be deployed and their rapidly falling cost. One of the challenges from a big picture perspective is going to be figuring out how much energy storage capacity is needed in front of the meter, providing services to the grid and capacity to utilities, and how much of it goes behind the meter, at customer sites.

These behind-the-meter sites are increasingly being aggregated to create energy trading opportunities and virtual power plants (VPPs). In much of the US, however, residential net metering for solar obviates much of the financial case for batteries in the home while in other

territories, feed-in tariffs still reward customers well for energy delivered to the grid.

"It (net metering) effectively pays the homeowner the fully delivered cost of power. So I don't think you're going to get this notion of all these distributed residential resources getting together to sell power because they'd have to give up the benefits of net metering," Jennifer Key says, with some 40 US states still running net metering programmes.

So again, there will be some specific parts of the US adopting VPP programmes earlier than others: Energy-Storage.news reported on a 12.6MWh VPP in Utah from Sonnen and utility Rocky Mountain Power across 600 apartments as this edition went to press, for example. In other global markets however such as Japan, Australia, the UK and Europe including Germany, the cutting of feed-in tariff support is inspiring homeowners with solar to 'go battery storage' too.

A recent blackout in the UK which affected one million electricity customers was responded to by frequency response assets including 6MW of aggregated residential storage, acting as a VPP, from independent utility Social Energy. To be able to do this on a grand scale and as the norm, using both large and small ESS assets, will not only require more simplified and readily accessible revenue streams for grid services, it will also require coordination of effort and engagement with the end customer.

"Decentralisation, decarbonisation is the right thing to do, but we can't forget the consumer in all of this because the consumer is fundamental," says Faisal Hussein of UK industry body Flexi ORB (Flexible Energy Oversight Registration Body).

"In our focus on decentralisation and decarbonisation, we've got to be careful that we don't leave the consumer behind."

### If the industry is ok, is that enough?

Despite some significant challenges, the adoption of energy storage as both an essential companion for renewables and as a flexibility resource for the grid in its own right appears healthy enough to suggest that in key markets adoption will only increase. Elsewhere, off grid, the economics are even better, and recent interest in microgrid companies active

## LA's big ambitions

By Janice Lin & Jack Chang, Strategen Consulting

Even in progressive California, Los Angeles stands out with its bold plans to decarbonise its power sector. The city's municipal utility, Los Angeles Department of Water and Power (LADWP), is the United States' largest publicly owned utility. LADWP is fully embracing energy storage as a critical tool for achieving the city's clean and affordable energy goals.

LADWP is already very familiar with the benefits of energy storage. It operates a 20MW lithium-ion battery storage system at its Beacon Solar Plant as well as a 1,500MW pumped hydro facility at Lake Castaic. In February 2019, LADWP announced it will not be replacing three gas-fired power plants scheduled to close by 2029. Instead, the utility will employ clean-energy alternatives such as solar and energy storage to make up for their 1,660MW of generation capacity. In July, LADWP proposed building the largest capacity utility-scale solar battery project in the country to date. The plan, submitted by developer 8minute Solar Energy, would build as much as 400MW of solar capacity and 300MW of energy storage at the historically low price of US\$19.97 per MWh. As of early August, approval is pending at the LADWP board.

These moves are aligned with the city's Green New Deal, which lays out ambitious sustainability targets and devotes billions of dollars for new infrastructure. The plan calls for increasing cumulative energy storage to as much 4,000MW by 2050 – far larger than the current target for the entire state of California (1,500MW). Driving all that energy storage demand is the city's goal to supply 55% of its electricity needs with renewable energy within six years and 100% by 2045. Much work remains but given the leadership of the city and state, Los Angeles is well poised to succeed in achieving its clean energy goals with storage.

Year	Cumulative energy storage (MW)
2021	1,524
2025	1,750
2035	3,000
2050	4,000

### LA's energy storage goals to 2050

in emerging markets from major energy companies means that energy storage for energy access is also a reality.

At Solar Media and in particular through Energy-Storage.news, we'll be looking at some of these challenges in the coming months, as well as others we have barely mentioned, including the supply chain and end of life management (although you can read about the efforts of one company, Li-Cycle in Canada, to create an effective system for battery recycling on p.45). There's also the integration of data and fire safety, the choice of technologies, whether batteries, lithium batteries, or otherwise.

We're certainly encouraged to see so much proactive discussion of how many of these problems can be solved, and for many of our readers coming from a renewable energy background, a difficult challenge is nothing new. In regulation and many other areas however, "we've got away with a sticking plaster approach so far", Kirsti Massie of White & Case says, but the existing frameworks in the UK and many other regions still need to catch up to the progress – and promise – of energy storage technology.

"Trying to shove it in an existing

framework, I think, limits the value [of energy storage]," Massie says. "You're not going to be able to take full advantage of the flexibility that storage can offer, if you're constraining it within a regulatory framework that dates way back before some of these technologies were even thought of."

As Massie says, there's been a huge amount of progress and it's certainly not a negative picture out there today for the energy storage industry. If we are to meet policy goals in reducing carbon emissions and transitioning to renewable energy, however, "energy storage inevitably is going to have to play a bigger role," Massie says.

"In order to play a bigger role, you need people who are willing to invest and to invest and develop at scale. One of the key things that then will arise, is, how are you going to finance this? If you're not able to really leverage off all of the benefits that storage can bring, the full flexibility of the storage offering, you're kind of limiting your revenue stream and that makes it more tricky and difficult to attract financing and I think will get in the way of the real, scale deployment of storage that is going to be key." ■