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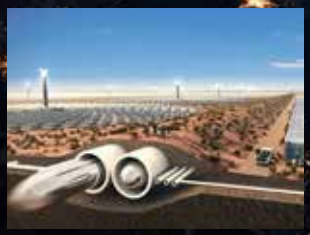

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INTRODUCTION

Welcome to this special report from Energy-Storage.News, proudly brought to you by Solar Media and all of us at the site.

After a few years of being the true realm of the pioneering and courageous early adopter, the energy storage industry is coming of age rapidly and we've taken the opportunity to look at some of the regions where this change is already apparent.

From the UK's front-of-meter auctions being followed by a wave of behind-the-meter activity; investigating three of North America's leading regions from high level perspectives; Australia's race to deploy both standalone and solar-plus-storage solutions at scale; India's ambitions across manufacturing and electrification for the masses; Europe's continent-wide shift to clean energy; experiences of working with lithium batteries in Africa, there's all this and plenty more to read about.

Taking stock of what's going on in the energy storage industry is a breath-taking exercise and while there are regions where we'd like to have had more time to focus on, we think you'll find more than enough to consider in these digital pages.

I'd certainly recommend you follow Energy-Storage.News and the other Solar Media sites, be sure to take a look at the calendar for Solar Energy Events and if you're active in the UK market, Solar Media Market Research could be for you. Don't forget also to check out PV Tech Power, Solar Media's quarterly technical journal for the downstream solar PV industry, which includes a special section powered by ESN.

We'd like to thank our readers and all those who have helped us to support the industry, without doubt among the most exciting, dynamic and potentially future-shaping in the world.

Andy Colthorpe
Editor | Energy-Storage.News

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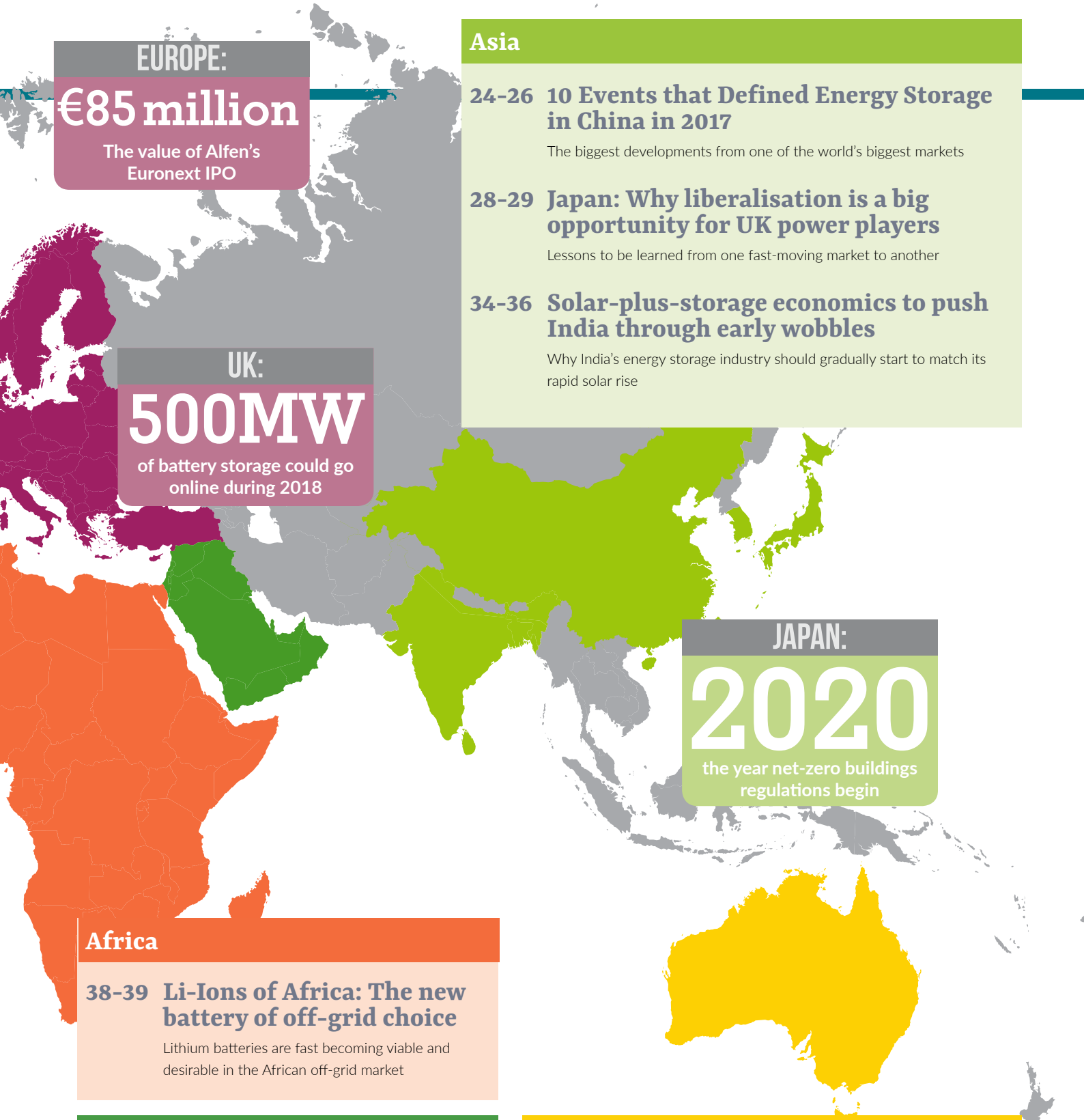

Asia

Africa

Middle East

Australia

NEWS ROUNDUP:

Some recent news from around the world of energy storage

Credit: PJM Interconnection

PJM Interconnection is investigating the benefits of energy storage for New Jersey with the Public Utilities Board

USA

New Jersey sets '600MW in three years' goal

In April, New Jersey became the latest US state to set itself targets for the deployment of energy storage, with newly passed legislation calling for 600MW of the technology within three years.

A bill, S2314/A3723, was passed as one of three sustainability and low carbon measures for the state going forward, calls on the New Jersey Public Utilities Board to analyse the costs and potential benefits of energy storage as well as making revisions for community solar, energy efficiency, peak demand reduction and solar renewable energy certificate programmes.

Florida Power & Light announces 74.5MW / 40MWh solar-plus-storage project

US utility Florida Light & Power (FPL) has followed up the US' first DC-coupled grid-scale battery system with the March announcement of a solar-plus-storage project pairing 10MW / 40MWh of energy storage with an existing 74.5MW PV plant.

The output of FPL's Babcock Ranch Solar Center in Charlotte County, installed in 2016, will be made dispatchable with the addition of the battery. The solar-plus-storage plant will also be used to mitigate peaks in network demand.

Arizona proposes 3GW target and 'Clean peak standard'

Andy Tobin of the state of Arizona's regulator, the Corporation Commission, presented a grid modernisation plan that includes a goal to generate 80% of Arizona's power from renewable sources by 2050, a commitment to review the existing Renewable Energy Standard and Tariff (REST) policy, to use renewables to mitigate peaks, establishing a 'Clean Peak' standard and to deploy 3,000MW of energy storage to "leverage low priced energy during the day". A final vote is expected on the proposal by the beginning of next year.

Virginia hydroelectric plant gets 4MW advanced energy storage

Advanced battery energy storage will be integrated into a hydroelectric plant in Virginia, by US energy storage system integrator Greensmith in a project that was announced in October 2017.

Greensmith, perhaps best known for its software solutions and control systems, is majority-owned by Wärtsilä following a US$170 million takeover deal. Greensmith has signed an agreement with investor-owned utility American Electric Power (AEP) to add a 4MW energy storage system to two hydroelectric plants, Buck and Byllesby, which have both been in operation for more than 100 years.

Massachusetts sets 200MWh 'aspirational target'

In July last year, Massachusetts, via its Department of Energy Resources (DOER), set an "aspirational" 200MWh energy storage procurement target for electric distribution companies.

DOER said that after consideration of stakeholder comments, it was "adopting an aspirational 200MWh energy storage target for electric distribution compa-

nies to procure viable and cost-effective energy storage systems". The distribution companies have until 1 January 2020 to do so.

Southeast Asia

Hoppecke providing lead acid battery to Singapore solar-diesel hybrid

Singapore-based clean energy provider Sunseap Group contracted German energy storage firm Hoppecke Asia Pacific in April, to bring storage to Sunseap's hybrid off-grid solar system at a tennis academy in Singapore.

In 2016, Sunseap donated a 15kW solar system to the academy as part of its corporate social responsibility programme. Hoppecke's 17kWh advanced sealed lead acid battery will help Tanglin Academy further reduce its carbon footprint. The collaboration will serve as a testbed for Sunseap to launch hybrid off-grid energy solutions on a commercial scale in the future.

Philippines town hails arrival of Tesla battery

The first solar-plus-storage microgrid in Asia to use Tesla's Powerpack energy storage system, designed to end power reliability issues for a Philippines community, was completed in April.

The launch of 'Solar Para Sa Bayan', an initiative by Solar Philippines founder Leandro Leviste to bring cheaper, more reliable power to areas poorly served by utilities, realised the project utilising 2MW of PV panels manufactured by his company, 2MWh of Tesla's Powerpack lithium-ion industrial and grid-scale battery storage and 2MW of diesel backup.

It is designed to supply reliable power 24 hours a day, over the entire year, at 50% less than the full cost of the local electric supply. Local energy supply will no longer have to be subsidised by the state by over half a million US dollars annually.

Credit: Solar Philippines

Proud villagers in Paluan, Philippines, with a banner that reads 'NO MORE BROWNOUTS!'

South Korea

Hyundai's big in-house project

Various companies in the Hyundai engineering and industrial construction group will work together on a 65MW solar PV plant with 130MWh of co-located battery energy storage in Seosan, South Korea.

Local news reported that Hyundai Engineering and Construction awarded 100 billion Won (US$94 million) of contracts to two affiliates, Hyundai Heavy Industries Green Energy and Hyundai Electric & Energy Systems, both part of Hyundai Heavy Industries.

UAE and South Korea sign strategic partnership

Masdar, the Abu Dhabi Future Energy Company, has signed a memorandum of understanding (MOU) with the Korea Energy Agency (KEA) for renewable energy collaboration and investment between South Korea and the UAE.

Masdar and KEA aim to establish a strategic partnership to encourage renewable energy investment in Korea and to develop a number of renewable energy projects using solar, wind, energy storage, floating solar power and waste-to-energy technologies, among others.

LG Chem, Samsung SDI identified as market leaders

A February 2018 study from Navigant Research into the strategy and execution of various lithium-ion battery providers in the utility-scale energy storage industry identified Korean companies LG Chem and Samsung SDI as "leaders" of a rapidly-growing sector.

Companies in the "contenders" category just below that are China's BYD and Japan's Panasonic and Toshiba, another South Korea-headquartered company, Kokam, along with Saft (France) and Leclanche (Switzerland). In a third and final 'challengers' category, are Canada's Electrovaya and Chinese company CATL.

Germany

Pro-renewables voices expect German coalition to support clean energy

Speakers at Energy Storage Europe were confident, despite a few reservations, that Germany's new government which granted Chancellor Angela Merkel a fourth term in office from mid-March, will be good for the environment and for renewable energy.

Dr Simone Peter, president of the Germany Federal renewable energy association (BEE) and Thorsten Herdan, a politician and director general for energy at the Federal Ministry of Economy and Energy both voiced their optimism that support for the ongoing Energy Transition ('Energiewende') away from fossil fuels and nuclear would continue.

Enel in first Germany storage project

A subsidiary of Enel is jointly developing a large-scale lithium-ion battery system project with wind power developer ENERTRAG, in what will be the multination-

al utility's first energy storage project in Germany.

Enel Green Power Germany, a local division of the Italy-headquartered company holds a 90% stake in a special purpose vehicle (SPV) created for the project, with ENERTRAG holding the remaining 10%. Located in Cremzow, Brandenburg, it will be a 22MW lithium-ion battery system. The first 2MW phase is pencilled for completion in April this year, while the remaining 20MW will be deployed and connected by 2018's end.

Bosch JV in frequency regulation project

German utility company EnBW and engineering firm Bosch completed a frequency-stabilising battery storage system in Baden-Württemberg in April that is expected to be the first of many in a joint venture between the two.

The pair created Kraftwerksbatterie Heilbronn in February as a JV vehicle for executing the 5MW / 5MWh project in Heilbronn. It uses 768 lithium-ion battery modules and is used for primary control reserve – maintaining the frequency of the local grid within acceptable boundaries.

Fraunhofer ISE opens centre for market-oriented R&D

More than €30 million is being invested to create a new competence centre for batteries and energy storage systems in Freiburg, Germany.

Fraunhofer ISE (Institute for Solar Excellence), one of the group's founders, announced in March. Fraunhofer ISE is collaborating with VDE, the Association of German Electrical Engineers and another Fraunhofer group institute, Fraunhofer Institute for High-Speed Dynamics, Ernst-Mach-Institute (Fraunhofer EMI).

Europe

Alfen makes Europe inroads before stock exchange listing

In late 2017, Alfen completed the first grid-scale storage system in the Czech Republic and rapidly followed that up with a 1MW project in Belgium. Then, in March of this year, CEO Marco Roeleveld rang the bell at Amsterdam's Euronext Stock Exchange as the Dutch system integrator and energy storage technology provider went public. The company made an initial public offering (IPO) of €85 million (US$105.76 million).

Dutch EV charge network trial for Leclanché

Energy storage battery and system maker Leclanché is piloting the use of stationary energy storage to support fast charger networks for electric vehicles (EVs) in Holland.

The Swiss company signed a deal with EV charging equipment manufacturer Fastned, which has installed over 60 charging stations in the Netherlands that promise a full charge in 20 minutes. Fastned wants to expand across Europe.

7.5MWh PCR battery in Switzerland

Swiss utility and power distribution company EKZ (Elektrizitätswerke des Kantons Zürich) is building a grid-balancing and renewables integrating 18MW / 7.5MWh energy storage system, appointing NEC Energy Solutions to execute the project.

The project will dwarf previously developed battery storage systems in Switzerland – EKZ previously installed a 1MW / 500kWh Dietkon, Zurich using LG Chem batteries in 2012. The new facility will provide primary control reserve (PCR) frequency regulation, to the grid and will be used on a commercial basis.

Credit: Fraunhofer ISE

Fraunhofer ISE is opening a new battery competence centre in Germany

ONTARIO'S ELECTRICITY COSTS ARE SKYROCKETING AND ENERGY STORAGE CAN HELP

Author: David Hebert
David Hebert is director of East Coast sales at EnerNOC, an Enel Group Company

Large businesses in Ontario have experienced a drastic increase in electricity costs in the past decade. In Toronto and Ottawa, for example, electricity costs grew 53% and 46% from 2010 to 2016, compared to an average increase of 14% in other Canadian cities over that period, according to a report released in October by the Fraser Institute. Last year, large industrial organisations in the province paid nearly three times as much for electricity as counterparts in Montreal and Calgary, the report added.

However, this increase in total electricity costs has coincided with a steady decline in hourly energy prices. The Fraser Institute's report shows that while the total commodity cost for electricity has grown from about 8¢/KWh (US$0.06) in 2005 to nearly 12¢/KWh in 2016, the hourly Ontario energy price has declined from roughly 9¢/KWh to less than 2¢/KWh.

What's behind Ontario's rising electricity costs?

The primary driver of increased electricity costs in Ontario is the Global Adjustment (GA) charge, passed onto Ontario customers' electricity bills to cover energy providers' costs of providing adequate generating capacity and conservation programmes.

To help improve grid reliability, the Ontario government established long-term fixed price agreements for power aimed at helping project developers secure funding for new generation resources and maintain existing nuclear and hydro infrastructure. These contracts guaranteed fixed revenue streams by covering the difference between the Hourly Ontario Energy Price (HOEP) and the contract rate. However, the HOEP - set by supply and demand on the market - has declined steadily over the past decade. As a result, GA charges have increased dramatically from less than 2¢/KWh in 2008 to about 10¢/KWh in 2016 to make up the difference between wholesale electricity prices and the prices established in the agreements. The GA charge is the largest line item on most Ontario customers' electricity bills, up to 70% for some.

Credit: Wikimedia / Taxiarchos228

The opportunity: How Ontario businesses can gain control of costs

Thanks to a recent policy change, more businesses in Ontario can start to gain control of the GA's impact on electricity costs.

Since 2010, Ontario businesses that qualified for the Industrial Conservation Initiative (ICI) have been assessed an annual GA rate based on each building's demand at the top five annual peak demand hours for Ontario's grid. If you can predict when peak demand is likely to occur and temporarily reduce demand for that period, you can reduce your GA charge.

In 2017, Ontario expanded eligibility for the ICI, previously limited to buildings with a peak demand of 5MW or higher, to include all buildings with a peak demand of 1MW or greater, as well as those in select industries with a peak demand of 500kW or greater.

However, while expanding ICI eligibility opened this opportunity, it did not address the two main challenges to capitalising on it: accurately predicting when peak demand will occur and reducing demand significantly without disrupting building operations.

With insight into Ontario grid trends, businesses can set alerts when system peak is most likely to occur on the grid and seamlessly transition a portion of their building's load onto an energy storage system. The building will experience no difference in energy consumption, but its GA charges will decrease as if it did. This opportunity is substantial - businesses that reduce their peak demand factor by 1MW stand to save more than $500K in GA charges in the following year.

Contact the author at **sales@enernoc.com**
www.enernoc.com

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Unlocking the Financial Value of Behind-the-Meter Energy Storage

While many commercial and industrial (C&I) enterprises are drawn to the sustainability and resilience advantages of energy storage, the technology is becoming increasingly valuable for its ability to create financial value by supporting multiple demand-side management strategies.

One of the most important benefits of a well-designed and optimized energy storage system (ESS) is the opportunity for "stacking services," i.e. leveraging the same equipment, system, or process to deliver multiple benefits that maximize the financial impact. Some examples of these services include:

- **Demand response:** Businesses can leverage an ESS to create revenue by participating in demand response programs, while minimizing energy curtailment required at the site level.
- **Time-of-use charge management:** An ESS can enable businesses to avoid daily peak prices by reducing grid demand in line with energy providers' time-of-use periods.
- **Demand charge management:** With an ESS, businesses can reduce costly demand charges that account for a significant amount of annual energy costs by reducing demand at the right time.

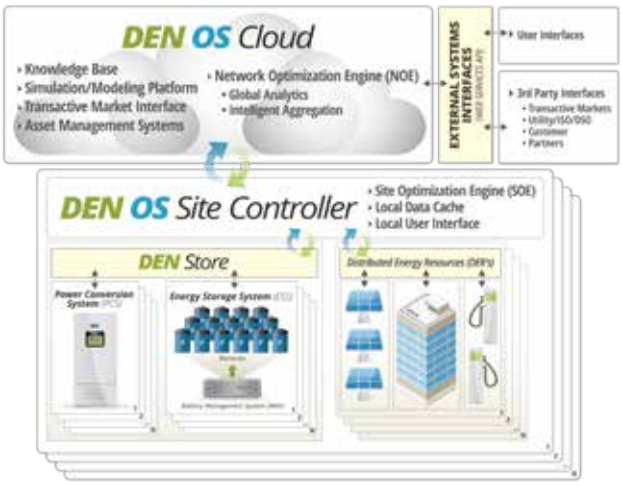
Value stacking means not only leveraging these kinds of services, but optimizing the deployment of an ESS to get the most possible value out of them. While these are just a few examples of services that businesses can leverage, they can enable some organizations to create hundreds of thousands of dollars in value every year—if they are managed properly.

Understanding the Challenges of Value Stacking

Traditionally, ESS controllers have implemented these demand-side management strategies on an individual basis. To date, the obstacle to stacking multiple value streams has been compatibility. According to the Energy Storage Association:

"Benefits must be both technically and operationally compatible if they are to be stacked. A combination of benefits is technically compatible if the storage system has all technical characteristics necessary to perform as needed when used for all targeted benefits. Benefits are operationally compatible if no operational conflicts arise when used for the respective benefits."

For example, on a given day, an ESS may be able to perform renewable energy firming while also helping to manage time-of-use charges and participate in demand response programs, but the amount and timing of each maneuver would depend on cloud cover, the building's operational schedules and load requirements, and other factors on that specific day. Without an intelligently optimized approach, this could result in missed financial opportunities and negative impacts on battery performance or operating life.



If this sounds complicated, that's because it is. A good analogy is determining the best altitude to fly a passenger jet from Seattle to New York, which requires balancing considerations like passenger ride quality, fuel consumption, safety, and time of arrival. At the same time, the calculation must also account for how the winds change throughout the flight path and react while maintaining the balance of the other considerations.

In the same way, buildings need to leverage all available demand-side value streams while accounting for other variable factors, such as changing electrical loads and battery degradation, in order to optimize the value of their ESS assets.

The Key to Value Stacking: Real-Time Optimal Control

An ESS platform with real-time optimal control is capable of continually balancing participation in multiple value streams simultaneously—especially when they may compete with one another—while also considering the impact on battery degradation.

EnerNOC's Distributed Energy Network Optimization System (DEN.OS) is a real-time optimal control platform that analyzes information on all aspects of the building's energy situation—tariffs, incentives, demand response programs, battery chemistry and sizing, etc.—while also learning the building's energy consumption patterns. Armed with this data, DEN.OS plans and automatically executes a control strategy that deploys the ESS to deliver the maximum total economic value from all available value streams while extending battery life—ensuring optimal return on investment in an ESS.

The days of deploying energy storage systems for only one purpose are ending. With today's evolving rate structures, market demands, and incentive programs, system ROI has become a more complex and economically beneficial calculation, based on the value of stacked services. Only true real-time optimal control, such as that provided by the DEN.OS platform, can facilitate effective energy storage optimization.

Douglas Staker, Vice President of Global Sales, EnerNOC, an Enel Group Company, deropportunity@enernoc.com | www.enernoc.com

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For further information on our Americas series, Contact Leon Walton, lwalton@solarmedia.co.uk

NEW YORK, NEW ENERGY GOALS

Edward Burgess is director at Strategen Consulting, helping to lead the utility and government consulting practices

At the beginning of 2018, New York Governor Andrew M. Cuomo unveiled the state's Clean Energy Jobs and Climate Agenda, New York's latest step in its ongoing clean energy leadership, further strengthening existing policies such as the 50% Clean Energy Standard. The Agenda strengthens New York's commitment to decrease greenhouse gas emissions by addressing small, highly-polluting peaking plants, adding significant offshore wind capacity and increasing overall system resiliency.

It also included the largest energy storage mandate of any U.S. state at the time, 1.5 GW by 2025. This target is consistent with recent analysis conducted by Strategen on the critical role storage will play in New York's energy future. The target represents a bold step forward, however there is much more work to be done to see it realised and to create a sustainable, scalable market for energy storage.

Benefits of Energy Storage

Within the next five years, the generation zone that serves New York City will have 2,860MW, or 30%, of its generation fleet reach retirement age. Many of these resources are very old peaking power plants without any pollution controls. If these plants retire due to operational challenges or environmental restrictions, it may lead to reliability issues at both local and ISO (independent system operator) levels. In addition, these peaking plants are some of the most polluting plants on the power system, located in dense urban areas with environmental concerns. The ageing fleet represents a massive opportunity to not only help meet local capacity needs, but to reduce ozone-forming pollution and reduce greenhouse gas emissions (GHGs).

Credit: Wikimedia / Chensiyuan

As the penetration of renewable energy increases, storage aid the power grid in more cost-effectively achieving the Clean Energy Standard. One example is under scenarios with high wind penetrations, to help avoid curtailments. Because wind generation profiles do not always align with peak demand periods, energy storage can be used to store excess wind energy rather than curtailing it and then dispatched that energy during system peak hours. This can help alleviate transmission congestion and aid local capacity requirements simultaneously.

Storage can also help create a more resilient grid, helping to provide backup power to safeguard against future storms. The examples above demonstrate that energy storage can provide numerous environmental, location specific, and resiliency related benefits. Energy storage can provide a large suite of services, but despite its strengths for New York, the path to market is not totally clear and certain regulatory barriers remain.

Barriers to energy storage in New York

For front-of-the-meter applications, storage assets have the opportunity to generate revenues in wholesale markets from products such as energy arbitrage, capacity, and ancillary services. These revenues can be significant in some cases - particularly in local capacity zones like New York City and Long Island - but may

Credit: Andrew Cuomo's office.

NY Governor Andrew Cuomo with former SolarCity CEO Lyndon Rive

not be sufficient to finance projects without additional long-term revenue certainty.

The same requirements for certainty have been true with other resource types, such as wind and solar, that commonly enter into long PPA contracts with additional revenues from the likes of RECs (Renewable Energy Certificates) and PTCs (Production Tax Credits). Even natural gas plants have typically only been constructed in recent years on the basis of long-term contracts. Energy storage is no different from these other resources and will likely need some form of contract or revenue certainty for large projects to be financeable.

For behind-the-meter projects, demand-charge management as well as participation in demand-management programmes such as the Brooklyn-Queens Demand Management program ("BQDM") have led to attractive storage deployment opportunities. However, this deployment has been stymied by lack of approval from local jurisdictions over fire safety concerns, despite the industry's track record in this domain.

Potential paths to a sustainable market

Currently, NYSERDA (New York State Energy Research and Development Authority) is developing a storage roadmap to outline the comprehensive suite of programs and policies that can ensure storage will be deployed at the right place and right time, in a manner that works for developers and meets New York's policy goals.

It is worth discussing a few of the options here:

1. One promising pathway is to establish a program to compensate storage for the non-market benefits it provides to the energy system, similar to the way renewable energy credits ("RECs") compensate renewable energy resources for their benefits. Under this model, a Flexible Capacity Credit or "FleCC" could be provided to storage resources based on benefits such as avoided GHG emissions (via arbitrage), avoided renewable energy curtailments, and storm resilience, among others.

2. Hybrid procurement of renewable energy resources with storage is another option with large potential given the significant renewable procurements that will be required to fulfil climate goals. Recent RFPs issued by NYSERDA score renewable energy bids based on a number of attributes, including "Operational Flexibility and Peak Coincidence." This includes explicit consideration of energy storage resources. If NYSERDA selects a sufficient amount of renewable energy resources that are paired with storage and can provide operational flexibility, it may be able to mitigate future integration costs.

3. For BTM resources, the NY PSC (Public Service Commission) has been working on creating a tariff that recognises the values that DERs bring to the grid, the Value of Distributed Energy Resources (VDER) tariff. Over the last several months, several decisions have advanced VDER for solar PV. At present, energy storage is not eligible for participation in the tariff. However, NY PSC Staff has proposed that energy storage soon be allowed to obtain revenue for providing demand response and locational values, along with capacity values in some instances.

4. Finally, utilities are being required to establish more standardised and transparent planning frameworks that account for the various services DERs provide through Distribution System Implementation Plans (DSIPs). An integral process being developed through DSIPs is for Non-Wire Alternatives (NWAs). NWAs are non-traditional solutions for providing grid services using DERs. The potential for energy storage to be incorporated into NWAs is vast, given the flexibility and wide range of services it provides.

ENERGY STORAGE AND THE CALIFORNIA SUN

Alex Morris, VP, Strategen Consulting and director of policy and affairs, California Energy Storage Alliance (CESA)

Credit: Tesla

California is home to manufacturers and tech companies including Tesla

California has added energy storage to the electric grid via multiple approaches, including a behind-the-meter incentive programme and utility-led energy storage procurements. Energy storage is widely expected to play roles in helping California meet its ambitious renewable and climate goals, which currently include a 50% Renewable Portfolio Standard (RPS) by 2030, and a fully-developed greenhouse gas 'cap and trade' program which will reduce greenhouse gas (GHG) emissions by 40% from 1990 levels by 2030.

The California energy storage market was kickstarted by the energy storage procurement framework established in AB2514 (2010, Skinner), which led to an energy storage procurement target of 1,325MW by 2020 for the California investor-owned utilities (IOUs). This work compelled key electric industry stakeholders to understand how to model, procure, and operate energy storage projects.

California also has the largest behind-the-meter energy storage incentive programme in the world, the Self-Generation Incentive Program (SGIP), which incentivises deployment of energy storage at customer sites and which has helped establish a rapidly developing behind-the-meter energy storage industry.

The state's more recently built energy storage has focused on electrochemical, thermal and mechanical storage, including the use of batteries, ice-storage, flywheels, etc but it is also using well established pump-hydro storage, exploring compressed air and potentially hydrogen storage too, while the state is a leading market for EVs, exploring grid uses from these vehicles. Additionally, California successfully deployed energy storage to support electric grid operations in the dense Los Angeles load area so that reliance on electric generation from gas fleets could be reduced, in part due to a major natural gas leak from a storage facility.

As of April 2018, California's IOUs have collectively procured over 770MW of energy storage resources, from large, utility-scale systems to behind-the-meter, customer-sited systems. AB2514 was instrumental in demonstrating a number of innovative use cases and positioning energy storage resources to become a mainstream part of California's electric toolkit.

The present: Energy Storage as Local Capacity

Much of the energy storage procured to date under AB2514 is already delivering critical reliability value as certain legacy resources are being retired or decommissioned. Additionally, the unplanned moratorium on the aforementioned Aliso Canyon natural gas storage facility limited the availability of gas fuel to several peaker plants in Southern California and posed a reliability risk. Energy storage resources were expeditiously procured within eight months to deliver urgently needed local capacity.

The decommissioning of the 2,000MW San Onofre Nuclear Generating Station (SONGS) led to another major local capacity deficiency in Southern California, with over 260MW of energy storage resources procured to provide this local capacity cleanly. Similar situations are arising with the state considering energy storage alternatives to gas generators. Energy storage is not being procured just to meet a procurement target but also to address real and urgent grid needs.

The near future: Multiple-use applications, distribution deferral, & microgrids

Several new market 'frontiers' are emerging. New transmission and distribution planning frameworks and cost recovery mechanisms are being developed, whereby

energy storage resources are capable of deferring or avoiding traditional grid investments, such as substation upgrades, while also delivering other grid services, in order to deliver more cost-effective resources without sacrificing service reliability. California grid agencies are not only testing the capabilities of energy storage resources for these use cases, but are also exploring compensation, sourcing, and evaluation mechanisms to understand how utilities can be incentivised to procure more 'non-wires alternatives' such as energy storage.

Additionally, California utilities and policy-makers are actively considering how energy storage resources can enhance grid resilience or support the provision of clean and reliable electric service in disadvantaged communities. Resiliency in particular has been a major area of focus after costly and harmful wildfires affected grid operations in 2017. Recent legislation (AB 2868, Gatto, 2017) authorises each California electric IOU to propose new programmes and investments to deploy energy storage systems to provide grid resiliency, with a focus on low-income and disadvantaged communities. Up to 500MW of such energy storage projects could be deployed.

Finally, to unlock the full value of energy storage resources, California leads the nation in developing the frameworks and rules around enabling multiple-use applications, where energy storage resources can be configured to provide multiple services to the grid or to customers in a given period. These multi-use frameworks focus on eligible 'revenue-stacking' and could lead to more cost-effective energy storage resources being procured and operated.

The long-term: Integrated Resource Plans

California is increasing reliance on Integrated Resource Planning (IRP) - long-term plans drawn up by utilities and approved by regulators - to direct solutions that support grid needs and goals while meeting greenhouse-gas (GHG) reduction goals. For the first time in any formal rulemaking process in the United States, the California Public Utilities Commission completed a major modelling exercise to identify the optimal electric resource mix for the state to achieve its renewable, GHG, reliability, and disadvantaged community goals. To decarbonise its grid to meet its 2030 goals, the IRP models estimated that 9,000MW of utility-scale solar and 1,100MW of utility-scale wind resources be procured by 2030. To reliably and cost-effectively integrate a portfolio reaching close to a 60% RPS by 2030, the IRP modelling recommended the procurement of 2,000MW of energy storage resources incremental to already statutorily required or planned energy storage. Moreover, the IRP modelling may underestimate the need for energy storage due to certain limitations of the models used.

One of the newer pressing questions is the role of gas generators, which have been historically needed in major and congested electric grid load pockets. These face worsening economic conditions due to competition from renewables and from California's GHG and disadvantaged community goals. Energy storage resources are increasingly viewed as potential replacement or enhancing resources for these gas generators. These issues are arising across California, including two recent solicitations.

For more information on energy storage in California, contact the California Energy Storage Alliance (CESA) at www.storagealliance.org

Credit: Flickr / Earthworks

Aftermath of the gas leak at Aliso Canyon

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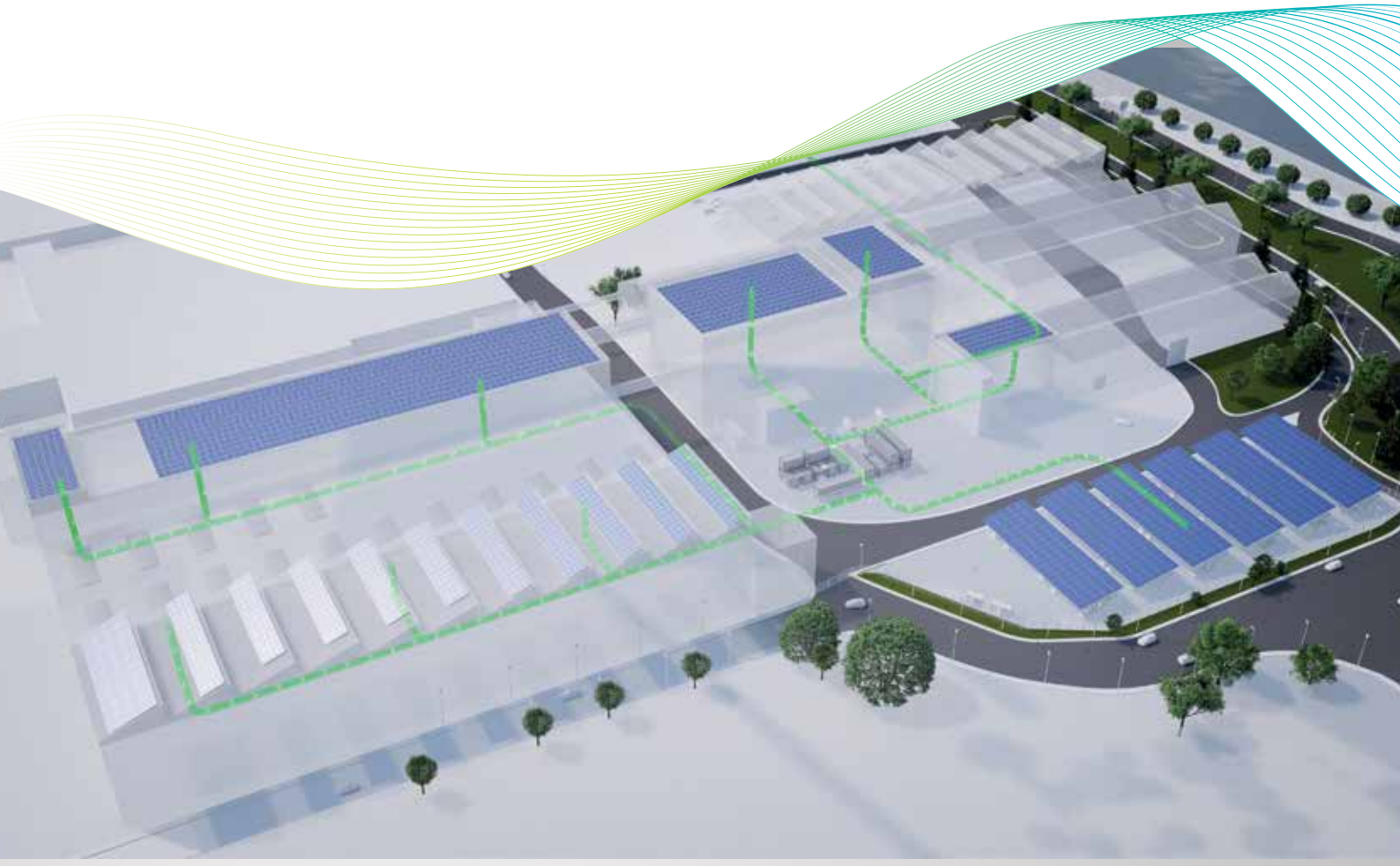

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HOW DOES THE UK ALREADY HAVE AN 8GW ENERGY STORAGE PIPELINE?

Lauren Cook, analyst, Solar Media Market Research

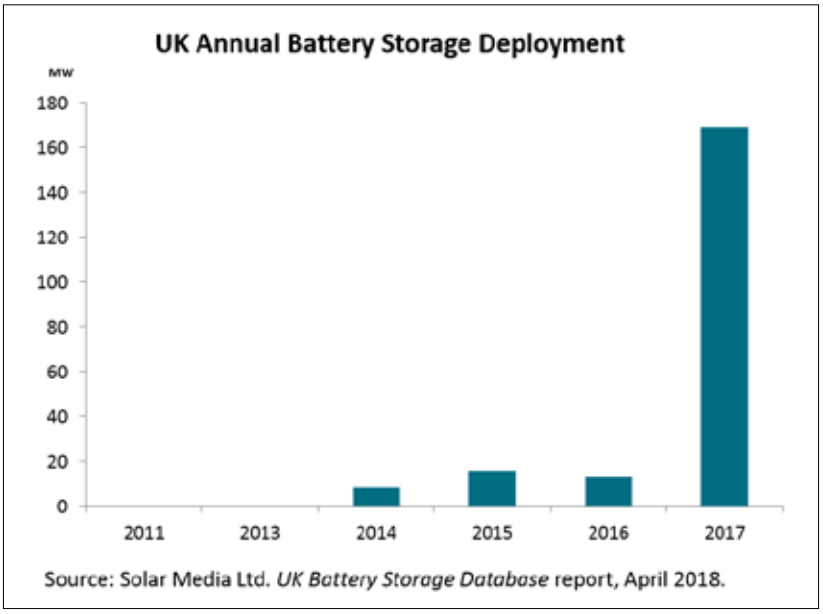
So far in 2018 we have seen the installed capacity of large-scale energy storage reach 350MW in the UK. These projects are part of the pipeline that developed over the past couple of years, following the initial enhanced frequency response (EFR) auction in 2016. Since then we have seen the pipeline grow a huge amount, from 2.5GW at the beginning of 2017 to over 8GW by the end of the year. Figure 1 shows how annual deployment was low up until 2017, made up of one-off projects. However, it grew to around 170MW in 2017 and Solar Media Market Research predicts annual installations could reach around 500MW in 2018. To date the majority of batteries installed in the UK have been short duration batteries, designed to provide fast response for a short period of time, i.e. frequency response. This is due to a number of reasons, including costs and revenue streams available.

Drivers: Auctions kickstarted the front-of-meter action

As the pipeline has grown, we have seen the business models and revenues being targeted by these projects evolve. The market was kicked off by the EFR auction in 2016, quickly followed by the pre-qualification window for the 2016/2017 Capacity Market, this saw 200MW projects winning EFR contracts and 500MW of projects winning T-1 and T-4 Capacity Market contracts, 5 projects won both capacity market and EFR contracts.

Projects which were successful in the 2017 T-4 Capacity Market which did not win the 4 year EFR contract began looking for contracts providing firm frequency response (FFR) which could take them up to the start date of the capacity market contract. Energy storage began applying to provide FFR services in 2017 and the majority of energy storage projects active in the scheme are submitted using aggregators. As more energy storage projects entered the FFR process we saw contract prices fall, meaning that projects that would previously have used it to make up a percentage of their overall revenue will need to find an alternative revenue stream to make up the shortfall.

The 2017/2018 Capacity Market saw a huge influx of battery storage projects, evident from the increasing number of projects submitted to local authority planning from around the middle of last year. Capacity Market registers revealed that over 6GW of battery storage projects had entered, with just over half pre-qualifying and ultimately just 380MW winning T-1 contracts and 400MW winning T-4 contracts. The CM process in 2017 was overshadowed by changes which saw the de-rating of a half hour battery fall from 96% to 18% reducing the revenue potential for the project dramatically.



Source: Solar Media Ltd. *UK Battery Storage Database* report, April 2018.

Opportunities and uncertainties from National Grid

National Grid currently procures over 20 services, all with the aim of balancing the grid and ensuring security of supply, plus procuring new capacity annually through the capacity mechanism. Currently these are procured separately, each with their own conditions that must be met, National Grid is currently reviewing the procurement of these processes. This means that

Credit: E.On

E.On's 10MW Blackburn Meadows project, the first completed UK EFR battery system.

aside from the current lack of clarity around which services can be provided by storage and how, there is also uncertainty going forward as the processes will change.

The changes to the de-rating of energy storage projects in the CM caused a huge amount of uncertainty throughout the process and has been stated as one potential reason why projects pulled out before the auction and has caused uncertainty for battery storage going forward.

Emerging business models

This evolving market for storage has strengthened the case for using aggregators and virtual power plants (VPPs). As projects begin to enter different markets at different times it becomes important to have a platform from which you can control the batteries' commercial operations. We now see several aggregators actively participating in the National Grid procurement across a range of services. As we see storage looking for other revenue opportunities, developers and aggregators will be looking for ways to participate in providing services previously reserved for large generators. One example of this is the balancing mechanism, where a generator bids for what they are willing to be paid to either be taken offline or to export to the grid. National Grid has said that they expect new technologies such as electricity storage to offer opportunities going forward and will be consulting on different aspects of the schemes.

Although there has been a lot of activity in large grid-scale projects, the sector has also struggled with uncertainty as changes made to the CM and a lack of clarity around regulation, which have damaged the business case. This has conversely led to an increase in interest in behind-the-meter (BTM) storage. These projects are still able to provide services to National Grid but also provide financial benefits to the property owners, in the form of energy cost savings and energy security.

Many of these projects will be providing both BTM and front-of-the-meter (FTM) services, including frequency response. The energy cost savings will make up a large proportion of the business model, meaning that a smaller percentage of the overall revenue will need to come from external contracts which may vary. There is a huge opportunity to use storage on commercial properties and with high energy users and there are lots of companies developing business models to take advantage of these opportunities. These types of projects are often sold as a service, so the installer or an aggregator will be responsible for the commercial operations of the battery.

Trends in battery storage and what they mean for the UK

Globally there has been a shift towards longer duration batteries. This has been driven by business models and applications. As in the UK one of the first commercial cases for using battery storage was to provide short term services such as frequency response which required the batteries to respond very quickly, but operate for a short period of time, up to half an hour. However, utilities and network operators are beginning to look how batteries can be used for reserve power and capacity to reinforce the grid and offset generation coming offline.

For more information on Solar Media Market Research email: marketresearch@solarmedia.co.uk

EUROPE'S AMBITIONS AND CHALLENGES

Patrick Clerens, secretary general, European Association for the Storage of Energy (EASE)

What are we expecting to see for 2018, and what would you hope to see this year?
We will continue to see more and more deployments of energy storage technologies across Europe, particularly in front of the meter, but also behind the meter. Hopefully we will see an agreement on the final "Clean Energy for All Europeans" package that contains supportive policies for energy storage, a major step forward for the industry. We also hope to see more discussions about energy storage business cases, how to monetise flexibility services, the role of storage in supporting the decarbonisation of transport, and efforts to improve investment security.

What will be the biggest challenges to face the industry for 2018?
The biggest challenge for the industry in 2018 continues to be the uncertainty about the role of storage in the EU regulatory framework and, as a result, the lack of long-term investment security. Another challenge is to further clarify the different applications storage can provide as well as how to monetise these different services. On the R&D side, the biggest challenges are to deliver continued performance improvements and cost reductions across all storage technologies.

What changes would you like to see – perhaps at policy or industry level – that could improve the prospects for deployment of energy storage in a cost-effective and transformative way?
The most important support policymakers can provide is to remove regulatory barriers which prevent the development of a flourishing market for flexibility services and for storage. Energy storage should be recognised as the fourth element of the energy system, alongside generation, transmission/distribution, and consumption. This would prevent energy storage from being classified as either generation or consumption, or both. It would also allow for a clear framework specific to energy storage, clarifying the unwarranted double charging, including levies and taxes, on energy storage devices and the ownership of energy storage facilities.

Additionally, policymakers should ensure that the procurement of all energy and ancillary services is market-based and that the prequalification and other criteria do not discriminate against storage technologies. Furthermore, policymakers should continue investing in research, development and demonstration (RD&D) projects, not only to support research into technologies themselves, but also address grid integration challenges and identify how to monetise and create a market for services storage can provide.

What are some of the most exciting developments that could have a big impact on the energy storage market this year and in the near future?
Policy and regulation is our main focus as EASE and will be an exciting area to follow. We see more and more initiatives recognising the fundamental importance of storage in the EU energy system. Whether it's the Clean Energy for European Islands forum, the High-Level Battery Alliance, or the ETS Innovation fund, we see storage becoming more and more central to the EU's policies in all areas. More and more players are also realising that energy storage is the make or break technology for a decarbonised energy system by 2050. Discussions are being held for a huge initiative on energy storage, which could propel Europe to the global forefront.

Feldheim Regional Regulating Power Station (RRKW), colourfully decorated and co-located with wind turbines

Credit: LG Chem

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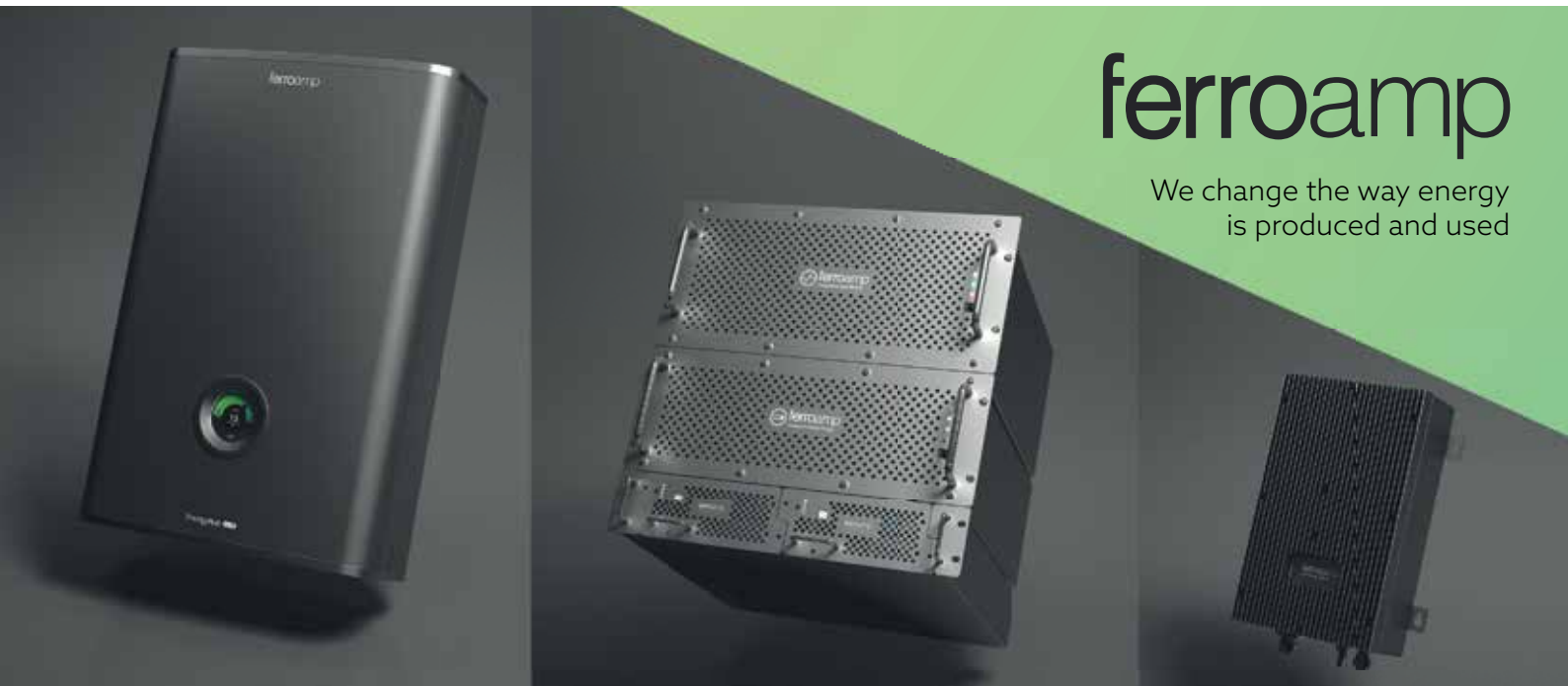


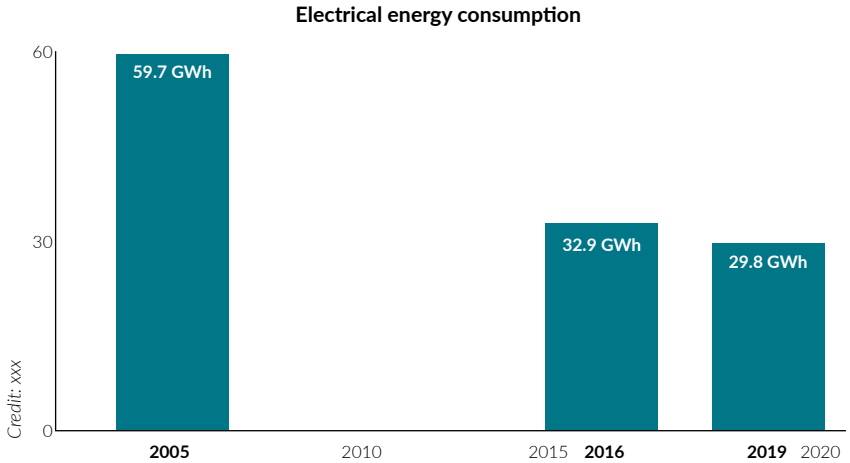
SCANDINAVIA'S REAL ESTATE AS A 'LIVING LABORATORY'

Jonas Tannerstad is head of the Electricity and Automation Unit at Örebrobostäder (Öbo), a Swedish property and real estate group.

Örebrobostäder (Öbo) is Sweden's fourth largest property owner, with a good track record in energy efficiency work. In 2007, the municipality of Örebro decided that Örebro Properties would reduce its electricity consumption by 25% and district heating by 15% by 2015, compared with 2005 consumption. In addition, the goals would be achieved within existing budget frameworks. Each measure would meet the return requirement corresponding to the internal rate. The target for electricity consumption was exceeded with 38% reduction by 2015. Now, we have tightened the target and the goal now is to reduce the consumption by -50% to 2019.

A big part of this work has been about making the houses energy efficient and smart by themselves. Together, collaborative houses can contribute to aggregated services in a new energy market. In the future, we will be able to offer services previously reserved for energy companies.

Instead of houses being passive end users of energy, they are transformed into active parts of an energy system. They will use energy storage systems, and across several houses the systems can interact, so the power grid 'sees' them as a giant battery. ÖrebroBostäder together with sustainability group InnoEnergy is testing local energy production together with energy storage in our development project.



CODES and LIFE

Öbo and Örebro are being used as a living lab to test concepts and the ability to merge research, industry, entrepreneurs and markets. The CODES (Control and Optimisation of Distributed Energy Storages) project has attracted great interest and demonstrated that real estate can be considered as flexible energy resources against the energy system.

The system enables smart control of batteries in residential buildings. The aim of the project is to investigate and combine services from batteries to achieve the best financial results. ÖBO will contribute 7 properties where the project's battery system is implemented and tested.

The EU sees solutions like CODES, as key parts of future smart cities. We are now very pleased and grateful that the EU has noted and confirmed the project application (LIFE) made and where we want to develop the concept of smart cities. We have recently been notified that the project application has been approved and that we receive a funding of 1,1 million Euros for this project. In the technical roadmap we developed for the project, we will evaluate how to build a smart city, where the houses become flexible power resources in a future energy market.

We are now planning to expand the work on energy storage and plan to install DC power networks. We see photovoltaics, energy storage, DC Power networks and vehicle-to-grid functionality as key components in our future projects.

Contact the author: obo@obo.se

SOLAR & STORAGE FINANCE ASIA

26-27 JUNE 2018
SINGAPORE

This event will connect financiers and investors in solar PV, energy storage and microgrids with developers in the Asia Pacific region.

Key agenda topics for 2018 summit

- Regional investment strategy for PV from debt and equity providers: expected returns, attracting lower cost of capital, secondary market activity, quality assurance and deal flow predictions for 2017-2018
- Understand the private PPAs marketplace: creditworthiness, offtakers' key drivers, floating to fixed rates, offsite versus onsite
- How to structure bilateral agreements in pre-FiT countries
- Energy storage business case: revenue stacking, retrofits and the impact on pre-existing PPAs, export/import charges and TSO/DSO perspectives
- How to attract finance to island microgrid solutions combing PV, diesel gen-sets and BESS

Key 2017 speakers included:

SENA
Kessara Thanyalakpark,
Deputy Chief Executive Officer

SUNSEAP GROUP
Lawrence Wu,
Founder & Director

ARMSTRONG ASSET MANAGEMENT
Andrew Affleck,
Founder

INFRACO ASIA
Allard Nooy,
CEO

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marketing@solarmedia.co.uk

10 EVENTS THAT DEFINED ENERGY STORAGE IN CHINA IN 2017

By China Energy Storage Allliance (CNESA) staff

In 2017, China's energy storage industry began to heat up. October marked the release of the first national-level policy on the energy storage industry, and the energy storage market took big steps towards commercialisation. Based on long-term industry tracking, CNESA's research department has gathered together the top ten energy storage events to occur in China in 2017.

1. The release of the "Guiding Opinions on Promoting Energy Storage Technology and Industry Development" clarifies key goals for the next 10 years of energy storage development

On October 11, 2017, the Chinese government released "Guiding opinions on promoting energy storage technology and industry development". The policy, the first of its kind for China's energy storage industry, focuses on current issues related to energy storage technology and development, such as identifying gaps in policy support, research demonstrations, standardisation, and other issues. The policy proposes an energy storage development goal for the next 10 years and five major tasks for China's energy storage development. The policy certifies energy storage's place in the energy revolution and its use as a key strategy for a clean, low-carbon modern energy system.

Credit: BYD

The likes of BYD are active in both stationary storage and e-mobility sectors

2. The "Workplan for the Improvement of a Subsidy (Market) Mechanism for Ancillary Services" encourages energy storage equipment to provide ancillary services

The National Energy Administration released the "Workplan for the Improvement of a Subsidy (Market) Mechanism for Ancillary Services" in response to new challenges in operations management for electricity systems. The workplan seeks to improve and develop the subsidy (market) mechanism for ancillary services, and formulates a detailed, multi-stage development goal and key tasks. The policy continues the "Grid-Connected Power Plant Ancillary Services Management Interim Measures" from 2006, serving as another important outline for the promotion of ancillary services nationwide. The workplan puts forth an increase in ancillary services according to need, encouraging energy storage equipment and demand-side resources to provide ancillary services and permits third parties to participate as providers in ancillary services.

3. Shanxi Province begins initial trials of energy storage for peak shaving and frequency regulation ancillary services

The Shanxi Energy Regulatory Office released the "Notice on Encouraging Energy Storage in Peak-Shifting and Frequency Regulation Ancillary Services in Shanxi Province". The notice is the country's first administrative regulation focused on energy storage for ancillary services. In order to ensure that energy storage will be able to participate in the ancillary services market smoothly, the notice includes a workplan for programme management, power pricing policies, grid dispatch strategies, and other areas.

Credit: Narada Power

Narada Power is one of the homegrown companies accelerating China's energy storage market

Shanxi province's trial period for energy storage in ancillary services will consist of peak shaving and frequency regulation services utilizing both integrated and independent energy storage facilities. Initial peak shaving trial units are set for a total capacity not to exceed 300,000MW, while initial frequency regulation trial units are set for a total capacity not to exceed 120,000MW.

4. Grid-integrated energy storage sees support through Jiangsu Province's release of the "Customer-side Energy Storage Grid Integration Management Regulations"

State Grid Jiangsu Electric Power Co. released the "Customer-side Energy Storage Grid Integration Management Regulations". The policy provides regulations for grid integration of customer-side energy storage systems connecting to the grid at 3,500V or less and a storage power rating of 20MW or less. Customer-side storage systems with high voltages require local company control centres to conduct necessary grid integration tests and configurations. Lower or medium voltage customer-side energy storage systems require city/county company customer managers to be responsible for organising the appropriate department to conduct the necessary grid integration tests and configurations.

5. Energy storage enterprises increase deployment of industrial and commercial storage projects, with Jiangsu, Beijing, and Guangdong becoming hot spots

According to statistics from CNESA's project tracking database, Jiangsu, Beijing, Guangdong were 2017's hot spots for planning, constructing, and implementation of new energy storage projects. These three areas are notable for their developed economies, numerous industrial and commercial parks, and heavy power use. Industrial and commercial users in these areas also engage in large degree of energy arbitration, and can make use of load shifting for electricity price management. Narada, Sunwoda, Clou, and ZTT represent the key companies that have continued to increase deployment in the above three regions, both through increased activation of projects and the continuous release of contracts and construction plans for projects at 100MWh and above.

6. Local ancillary service markets continue to open, encouraging energy storage to be an independent market player

According to statistics from CNESA's policy tracking database, following the lead of the special market reform trials for ancillary services in the northeast region beginning at the end of 2016, Shandong,

Fujian, Xinjiang, and Shanxi each released their own marketization trials and operations regulations for ancillary services in 2017. Each area has created its own peak shaving and frequency regulation market trading mechanism based on their unique power generation and load needs. Each area has also defined an equal role for market players, including power generation companies, power sellers, and power users. Energy storage can provide ancillary services to power systems as an independent market player, or integrate with power generators at the generation side to share market benefits.

7. Problems in the use of renewable energy peak shaving become more apparent, energy storage's flexibility for generation-side applications continue to attract attention

Due to the limited peak shaving abilities of power systems, lags in the planning and construction of transmission channels, and other reasons, problems in China's use of renewable resources has become an increasingly urgent issue. As a result, the flexibility of energy storage applications for generation-side applications became an area of increased interest in 2017. Construction began on large-scale integrated "resource bases" combining wind, solar, water, thermal, and energy storage. Power generators and energy storage enterprises also teamed together to explore solar-and-storage models, wind-and-storage models, and dispatch solutions, with Huaneng's solar-and-storage project in Qinghai, Beikong Renewable Energy's Energy Storage plant in Yangyi, Tibet, and the Yellow River wind-and-storage farm project in Qinghai serving as examples of renewable energy generation-side storage projects either in operation or under construction.

8. EV battery recycling programmes take off, second-life battery markets begin to form

With China's EV sales continuing to climb, a large number of batteries will soon face retirement. The State Council's release of the "Manufacturer Extended Responsibility Plan" extends responsibility to EV manufacturers and establishes a system for the use of recycled batteries. According to CNESA statistics on second-life battery markets, in 2017, new energy vehicle enterprises, energy storage system aggregators, EV manufacturers, PACK and BMS enterprises, battery recyclers, and other industry chain members have all increased efforts to create a second-life energy storage market. The establishment of second-life trial programmes at the megawatt level in industrial and commercial parks, China Tower Co.'s release of an EV recycling bidding programme, and other trends have created popularity for second-life energy storage markets.

9. Four energy storage technologies receive national support and become key research focuses for 2018

The Ministry of Science and Technology's release of the "Smart Grid Technology and Equipment" special guidelines in 2018 reveals five technology focuses. These include the use of large-scale renewable integration, flexible large-scale energy internet, diversified customer supply and demand interaction, multi-resource distributed energy supply and microgrids, and smart grid foundations. In total, 23 key research tasks have been created. In 2018, the key energy storage technology research areas include technologies for scaling applications of second-life EV batteries, foundational research on high safety long-life solid state batteries, research of megawatt-scale flywheel energy storage key technologies, and research of liquid metal battery storage technologies.

"Due to the limited peak shaving abilities of power systems, lags in the planning and construction of transmission channels, and other reasons, problems in China's use of renewable resources has become an increasingly urgent issue."

10. The first batch of new energy microgrids and energy internet demonstrations are released, energy storage plays a critical support role

In 2017, China's National Development and Reform Commission and the National Energy Administration each released the "New Energy Microgrid Demonstration Programmes List" and the "'Energy Internet-and-Smart Energy' Demonstration Projects List," respectively. 28 new energy microgrid demonstration projects and 56 energy internet demonstration projects were included on the lists. Out of the 28 projects, 25 are focused on electric energy storage or heat energy storage. Of the energy internet projects, the majority are energy storage facilities. Energy storage has already become a critical technology for the support of new energy microgrids, the energy internet, and other new energy applications.

The CNESA research department conducts continuous tracking of energy storage industry development both in China and around the world. A comprehensive summary and analysis of the 2017 energy storage industry's projects, manufacturers, and policies are available in CNESA's "Energy Storage Industry White Paper 2018," published in April 2018.

JAPAN: WHY LIBERALISATION IS A BIG OPPORTUNITY FOR UK POWER PLAYERS

Silvestros Vlachopoulos is a part of Delta-ee's Distributed Power Service research team, supporting a wide range of research and consulting projects. Silvestros has a background in electrical engineering and PV.

Liberalisation of the Japanese energy market is a process which started more than a decade ago, initially for industrial and then commercial customers. More recently, residential customers are free to select their supplier in electricity (since 2016) and gas (since 2017). The final stages of the process are planned to be finished in two landmark years, 2020 for electricity and 2022 gas, after which retail prices will be fully liberalised.

One of the most significant changes Japan's energy market has seen since the process began has been the increase in market players and competition. Before deregulation there were just 10 electric utility companies, operating as regional monopolies, whereas now there are more than 400 new entrants ranging from gas companies to telcos.

Another emerging trend has been the increasing number of partnerships between electric and gas utilities as well as between energy and non-energy companies. Finally, the increase in competition has brought the need for new customer offerings. Previously, gas and electric utilities were solely focused on supply whereas now competitive tariffs and new services are being offered as a way to keep existing and acquire new customers.

Credit: Solar Frontier

Japan could lean on UK experiences

Japan's transition towards a liberalised energy market, coupled with government strategic decision for the support of renewable energy, can potentially create opportunities for UK companies. The UK was the first country in the world to privatise its electricity market in 1990, making it an early pioneer of market liberalisation. Overall the level of opportunity will depend on the relative difference of maturity between the two countries in each certain segment of the energy market. For instance, fuel cell deployment is more advanced in Japan compared to the UK, where the sector is still relatively new, meaning there will be less obvious opportunities for UK companies.

On the other hand, there are segments in which UK companies are a few steps ahead in terms of experience, mostly because of earlier developments with market deregulation and renewable energy regulation. Services around electricity system flexibility (such as demand side response and energy storage), renewable energy generation and the use of digital technologies within the energy system are segments where the UK has a higher or similar level of maturity, emerging as interesting targets for a market entry in Japan.

Frequency regulation and smart controls

Electricity system flexibility is an inevitable global trend in energy systems, as we move towards an electricity grid with increasing levels of intermittent renewable generation. The importance of flexibility will be higher in Japan compared to other countries. This is because the Japan lacks interconnection with other countries that could provide some energy to balance the system in times of need. Moreover, there is an absence of a single national grid; Eastern Japan uses a 50Hz frequency transmission system, whereas Western Japan uses 60Hz.

Consequently, there are limitations to the amount of energy that can be exchanged between the two systems. On top of these drivers, as part of the electricity market reform, a capacity and a real-time electricity exchange market will open in 2020. This will lead companies to capture value from demand side response and flexibility services. In the UK this market was established already a decade ago; hence there is already a big number of companies active in this sector, ranging from start-ups to large utilities, offering innovative services around flexibility.

As far as energy storage is concerned, besides the aforementioned drivers for flexibility, developments are further boosted by government support for batteries. More specifically, there is a subsidy programme in Japan which has been active since 2017 that covers up to 1/3 of the equipment cost and up to 1/2 of the installation cost of batteries for homes and businesses. Furthermore, there is an upcoming regulation for net-zero energy buildings from 2020.

There is already evidence of partnerships and Virtual Power Plant projects announcements around trialling energy storage: Moixa & TEPCO, Stem & Mitsui and Sunverge and TEPCO; the latter has already lead to dozens of energy storage unit installations. Overall, we see a lot of future potential for the storage sector in Japan, however at the moment the market has just started to develop. Experience from now-leading markets, such as Europe and Australia, suggests that a few years will be needed for the market to grow significantly following the introduction of positive policy. And after all, the net-zero buildings regulation will start from 2020.

Renewables continue to play vital role

Renewable energy generation will see a lot of developments within the next decade in Japan, as the government's goal is to increase the share of renewables from around 15% currently to 24% by 2030. This long-term goal is mainly driven by Japan's need for self-efficiency and energy security, as it is currently highly dependent on imports – more than 90% of its primary energy supply is imported. There is growing PV uptake in Japan, especially since the Fukushima disaster.

Digitalisation of energy is another trend which is evolving prominently as innovative digital technologies emerge and the world progresses towards creating an Internet of Things (IoT). This is an area that spreads widely among segments from smart grids and energy management systems (EMS) to data analytics and cyber security. In Japan, the integration of digital technologies is already evident with the smart meter rollout which is expected to be completed by 2024. In addition, the government has shown support for the use of EMS as a way to improve building energy efficiency and it has specifically set the target of having approximately 10,000 home energy management systems (HEMS) installed in households by 2024. The UK's capability in this sector has been driven a lot by competition in the energy market and it is developing significantly quickly. Many of the current leading players in EMS technologies and connected home offerings are UK companies.

Direct entry into the Japanese market is still considered very difficult, due to a number of barriers ranging from language to limited understanding of customers. A safer route would be to use a facilitator such as British Embassy Tokyo, or consulting companies such as Japanese company ABeam Consulting. Here at Delta-Energy & Environment, we are supporting European heating appliance manufacturers in building relationships with fuel cell developers in Japan.

Contact the author: info@delta-ee.com

THE AUSTRALIA DIARIES: PROMISES AND PROOF

It's not just that Australia has more than a million solar rooftops and it's not just the way energy and the environment have become a critical part of national political debate. It's all of those things and a lot more. At Energy-Storage.News, we've tracked progress as advanced battery systems have become big news Down Under.

Tesla-Neoen's Hornsdale project, completed in 100 days.

Credit: Neoen-Tesla

2015

As the market took off

APRIL: Diesel prices increased approximately 5% per annum in Australia from 2005 to 2015, with many remote areas paying more than AU$2.50 (US$1.95) a litre for delivered diesel fuel.

Hydro Tasmania created King Island Advanced Hybrid power station by integrating an Ecoult UltraBattery storage system, capable of 3MW of power contribution and storing 1.6MWh of useable energy, into the local network.

JULY: The biggest solar-plus-storage project in Australia to date was announced by German developer Juwi at DeGrussa Copper-Gold Mine in Western Australia, with support from public bodies including the country's Clean Energy Finance Corporation (CEFC). The project deployed 10.6MW of solar and a 6MW battery, added to 19MW of existing diesel. Energy at mines can constitute approximately 30% of operating costs.

Clean energy groups warned that feed-in tariffs (FiTs), determined regionally across Australia would begin expiring the following year, handing a boost to batteries. LG Chem launched a 6.4kWh battery storage system at around US$1,000/kWh to the residential market, following the likes of Panasonic.

AUGUST: ARENA's investigations into the economic value of 'virtual power plants' began to emerge with the publication of a study prepared by technical services company AECOM.

ARENA pledged AU$400,000 support for utility company Ergon Energy to trial a 'virtual power plant' model, aggregating 33 solar PV and storage systems across residential rooftops in Queensland.

DECEMBER: Tesla Powerwalls went on sale through utility Origin Energy. News outlets reported the price at around AU$16,500 (US$11,900) for a bundle that included Trina Solar panels and SolarEdge inverter.

2016

FEBRUARY: AGL Energy invested US$20 million in manufacturer Sunverge, as Australia's biggest utility set up a fund worth ten times that to help meet climate change commitments.

MARCH: Berlin-based smart energy storage provider Qinous won a contract for a project at an Aboriginal community in northern Australia, which had relied on diesel until the 800kW/1,987kWh lithium-ion battery-plus-solar-plus-diesel project came along.

A hybrid off-grid project from renewables firm Energy Developments Limited's (EDL) including 4MW wind, 1MW solar and a 1MW/250kWh battery system in South Australia reached financial close. The project, alongside EDL's existing 3.9MW diesel power station, would provide the town of Coober Pedy with up to 70% clean energy over its lifetime.

APRIL: A trial using 1.1MWh of lithium-ion battery storage in two centralised containers to harness power from more than 100 rooftop solar systems was installed in a Western Australian, Alkimos.

MAY: AGL and Sunverge's partnership led to the announcement of a 5MW / 7MWh virtual power plant in Adelaide, South Australia. The AU$20 million (US$15.4 million) project uses 1,000 customer-sited batteries.

SA Power Networks issued around 100 Tesla Energy and Samsung SDI batteries in Salisbury, South Australia. Participants receiving financial assistance for system purchases and a minimum of AU$500 in savings annually on their electricity bill.

AUGUST: Multinational developer Conergy announced plans to build a 10.8MWac solar PV plant combined with 1.4MW/5.3MWh of lithium-ion battery storage near the remote town of Lakeland, Australia. ARENA pledged AU$17.4 million in funding for the AU$42.5 million project.

OCTOBER: ARENA committed up to AU$18 million (US$13.7 million) funding to build the first phase of the AU$120 million (US$91.5 million) solar-wind-storage project by Windlab and Eurus, Kennedy Energy Park. It was designed with 19.2MW of solar PV, 21.6MW of wind and 2MW of battery storage, near Hughenden in North Queensland.

The national Clean Energy Council's guidelines on battery installation became mandatory.

FLASHPOINT! DECEMBER: Perhaps the single most significant event in energy storage development to that point in Oz, and it didn't even involve energy storage and it didn't happen in December. Blackouts across South Australia crippled businesses and left homes without power in September, affecting 1.7 million residents. While initial reports blamed renewables, by December when the picture was clearer, it looked more certain than ever that energy storage could bring resilience to the state's networks.

Credit: Juwi

Workers at Juwi's solar-plus-storage project for DeGrussa mine.

2017

FEBRUARY: Prime Minister Malcolm Turnbull, Tony Abbott's successor, announced that energy storage was "long neglected" in Australia and would be a priority for his government in 2017.

APRIL: The Australian Energy Market Commission (AEMC), proposed five minute settlement in the electricity spot market, likely to favour flexible resources such as energy storage, replacing an existing 30-minute rule.

AEMC is responsible for rulemaking and market development in the National Electricity Market (NEM) covering eastern and southern Australia. AEMC determined that as of 2021, the five minute rule would be introduced.

Queensland-based developer SolarQ proposed a 350MW(AC) solar plant combined with as much as 4,000MWh of lithium-ion battery storage in Gympie, Queensland. Estimated to cost AU$2 billion, the proposal was linked to plans to ramp up the Lower Wonga PV project to 800MW(ac) within four years.

Then, the state of Victoria opened a tender for two 20MW battery systems, with local government investing AU$25 million into a range of energy storage projects.

MAY/JUNE: The Finkel Report from Australia's chief scientist Dr Alan Finkel recommended in June that after 2020, wind and solar projects should be required to pair with energy storage capacity or dispatchable generation plants to enhance the security of the power system.

Renewable energy investor Lyon Group launched an innovative utility-scale solar-plus-storage market services tender to cover 640MWh of storage across three major projects in Victoria, South Australia and Queensland. This included one project in northwest Victoria pairing 250MW of solar with an 80MW / 160MWh battery storage system.

OCTOBER: At the end of the month, ZEN Energy, via its chairman, billionaire Sanjeev Gupta, approved a 1GW plan for dispatchable renewables aimed at South Australia's commercial and industrial sector.

NOVEMBER: Lincoln Gap, the country's first "unsubsidised large-scale grid-connected battery", 10MW / 10MWh co-located with a 212MW wind farm in South Australia, was offered a financing commitment from CEFC. CEFC will provide AU$150 million in debt financing.

TALKING POINT! NOVEMBER: Tesla completed its 129MWh battery system at Hornsdale, South Australia, in 100 days as promised by CEO Elon Musk. Tesla worked with French developer Neoen, which has been involved in several of Australia's big renewables and energy storage projects.

Tesla CEO Elon Musk famously ended up promising to deliver the 100MW / 129MWh project within 100 days of contracts being signed or deliver it for free. The clock started ticking on 29 September when a grid interconnection agreement was signed with transmission network provider ElectraNet and approved by the Australian Energy Market Operator (AEMO). Tesla switched from its usual battery cell supplier Panasonic to Samsung SDI to expedite deliveries and construction.

DECEMBER: A 250-home 'virtual big battery' was switched on in Canberra, Australia.

Reposit and project partner ActewAGL, a joint venture formed by utilities including major AGL, said that homes involved were about to "synchronise their battery systems to sell energy back to the grid". GridCredits, a system developed by Reposit Power allows customers' energy to be sold back into the market or used to perform grid or network services.

2018

JANUARY: French renewable energy developer and independent power producer Neoen, which together with Tesla recently delivered the 100MW / 129MWh grid-supporting battery system in South Australia, signed a "support agreement" with local authorities for its next big project in the country.

Bulgana Green Power Hub near the town of Stawell will allow local commercial grocery producer Nectar Farms to increase its share of renewable energy dramatically, while selling 85% of the power generated to the grid. Original plans called for 20MW / 34MWh of energy storage with 204MW of wind energy, which would enable the whole system to deliver sustainable "baseload" power.

In the middle of the month the Australian Capital Territory, the country's federal district and home of national capital Canberra, pledged to support the planned roll-out of 36MW of customer-sited batteries by funding a further AU$3 million (US$2.39 million) in rebates.

FEBRUARY: A trial began for what could be the world's biggest virtual power plant. Tesla is supplying "up to" 50,000 home storage systems, starting with 600 homes this year. The VPP could include 250MW of solar energy and 650MWh of battery storage capacity additions over about four years.

Almost immediately after the Tesla VPP announcement, South Australia said it was considering two new grid-scale projects and a sizeable commercial and industrial (C&I) installation. Plans were for a 300MW / 1350MWh pumped hydro plant at a decommissioned quarry near Adelaide, the 21MW / 26MWh Snowtown North Battery Energy Storage System Project, at a 44MW solar farm, as well as a 2.5MW PV system, 4.2MWh lithium-ion battery system and a 2.5MW generator project in South Australia Produce Market in Pooraka.

MARCH: Jay Weatherill, premier of South Australia was defeated in state elections which voted his Labor Part out of power and ushered in the Liberals. However, just before his exit, Weatherill announced a deal for a 140MWh battery system to be built by ZEN Energy. The State Government's Renewable Technology Fund is thought be loaning SIMEC Zen Energy around AU$10 million for the project. The battery paired with solar is being constructed at Whyalla, a steelworks which Gupta's family companies bought and saved from being closed down.

Yet another VPP project came about later that month. Simply Energy, the Australian retail arm for ENGIE, will aggregate 6MW of Tesla household batteries together with 2MW of demand response at commercial premises in Adelaide. ARENA is once again supporting the project.

SOLAR-PLUS-STORAGE ECONOMICS TO PUSH INDIA THROUGH EARLY WOBBLES

Tom Kenning, Deputy editor, PV Tech

Combining energy storage with solar in India has got off to a shaky start, with multiple tender cancellations and an ever more frustrated industry. Moreover, for one of the most mature PV markets in the world, the south Asian nation cannot lay claim to having an equally advanced transmission network. In fact with more than 60GW of renewable energy now connected to the grid, India must take its head out of the sand and work just as hard on upgrading and extending transmission infrastructure as it does on deploying wind and solar.

Energy storage has to play a key part in this shift of focus, particularly with its capabilities in grid-balancing. However, the first set of storage tenders have so far done little but aggravate developers. Nevertheless, interest is still building rather than fading, given the vast long-term opportunity at hand, but the breakthrough areas of deployment might unexpectedly have to come via the private sector rather than government-led procurement programmes.

Confidence was hit earlier this year, when what was hailed as India's first successful large-scale solar-plus-storage auction on the Andaman Islands was scrapped even after the project award was made. The industry maintained some eagerness, with the original auction winner, major Indian solar EPC firm Mahindra Susten, claiming that despite the unfortunate development, it was still keen to work closely with government on this technology for which the economics are continuously and rapidly improving.

Mahindra had won the 20MW solar and 28MWh storage project on the Andaman and Nicobar Islands via an auction held by state-run coal and power firm NLC India. It was acclaimed as a major breakthrough for the Indian PV and energy storage industry and came in at a price far lower than what the government had predicted. However, the award was canned and has now been re-tendered by NLC for two separate 10MW solar projects with the storage component significantly reduced to just 8MWh overall.

"We are keen to work closely with government to develop a robust solar-plus-energy storage facility in the islands and other possible places," says Manish Singhal, head, business development of Mahindra Susten. "Battery prices are continuously falling, making its economics better and when coupled with solar power, the combined energy solution can be a true 24/7 green power option to protect the sensitive flora and fauna of Andaman and Nicobar."

Nevertheless, the sector was irked by the government's ability to meddle with the tender. Various explanations or rumours about what had caused the scrapping have been floated.

Vishwanathan Iyer, a leading expert in the renewables industry, says: "It is understood that the Ministry of Power is keen on exploring alternative sources of power generation in the Andamans – quite likely an LNG-fuelled power facility of around 30MW – whose LCOE is probably expected to be around INR 9-9.5/Unit, which might have been a key factor resulting into re-calibration of the storage tender."

Back in 2017, the first two major large-scale solar and storage tenders floated by Solar Energy Corporation of India (SECI) were also cancelled. The tenders at Pavagada Solar Park in Karnataka (200MW solar) and at Kadapa Solar Park in Andhra Pradesh (100MW solar) were to be coupled with 5MW/2.5MWh of battery storage each. They had been delayed due the sudden drop in solar prices across India, but after the hiatus, SECI could not get states to sign back-to-back PPAs for these projects at the originally discovered tariffs. Therefore, they had to be withdrawn. A smaller tender in the Andaman and Nicobar Islands issued by India's largest utility NTPC had also been scrapped.

With industry's mood still eager but fragile, it was looking for a robust return but the next Andaman tender saga turned out to be yet another let-down. Thus, the most important takeaway from the second Andaman cancellation has to be not only what kind of message it sent to the industry but also how the industry has responded.

Credit: ABB

A recently deployed a solar-plus-storage microgrid in Gujarat

Projects 'stuck due to mixed signals'

Rahul Walawalkar, president and MD of Customized Energy Solutions and executive director of the India Energy Storage Alliance (IESA), is keen to point out that there are now additional tenders being released by government as well as private parties. However, he says the way the Andaman tender was cancelled was lacking in transparency and logic.

"Flip-flops from various government agencies on large-scale renewable energy integration projects – and mixed signals from the Ministry of New and Renewable Energy (MNRE) – have resulted in the majority of the 100MWh of grid-scale energy storage project RFPs released during 2017, getting stuck. IESA is now working closely with all the policy-makers and, perhaps most importantly, it anticipates that most of these projects can move forward in 2018."

Walawalkar has also praised the rising opportunities available for this technology in the private sector in India.

"While we concur with IESA on the opportunities available in the private sector, we believe it is still early days for storage in terms of rapidly evolving technology. Hence at least utility-scale projects, being capital intensive in nature, will require some support from government to help the early adopters of the sector grow and evolve," says Mahindra's Singhal. "Events like the scrapping of the NLC tender after it is opened – that too at a price which is significantly lower than government estimates – do not give comfort to players who are looking to enter [the] Indian storage market and the government should be cautious about taking such decisions."

Sticking the knife in further, the viability and suitability of solar and storage on the Andaman Islands was demonstrably clear. The Andaman and Nicobar Islands government has to ship fuel for 1,200 kilometres and burn it on inefficient diesel gensets, says Walawalkar. Where such generators are used, there is an opportunity to improve efficiency by increasing loading of the generators for certain hours and shutting them down for other times where solar and storage can meet demand. These benefits mean the solar-storage project should ultimately go forward, but the delay is very disappointing, adds Walawalkar.

"It basically seems like a minor roadblock. [...] Everyone who has looked at the technical merits of the project has concluded that solar-plus-storage is the best option, so what is disappointing is the ability of MNRE to randomly change direction," says Walawalkar.

With the NLC retender now out, Iyer notes: "It will be thought-provoking to observe the action in the fresh bid round. Especially, in the background of developments and falling costs in the global energy storage market and also the rising interest of foreign players in India in the wake of the newly announced intention of the government of India to seed an Energy Storage Mission."

Indeed the Ministry of New and Renewable Energy (MNRE) and NITI Aayog (the National Institution for Transforming India), buoyed by the success of the National Solar Mission (NSM), which has catapulted India into the third largest PV market in the world,

Credit: PV Tech

India needs energy storage to match its renewables ambitions

has now formed an Expert Committee on energy storage with a goal of releasing a 'National Energy Storage Mission' during 2018.

Other Opportunities

Furthermore, in spite of the tricky start to government-led tenders, the IESA is very optimistic about opportunities for solar-plus-storage projects in India.

There is still plenty of positivity in the industry, claims Walawalkar, with many government projects still expected to move forward, rising private sector opportunities as mentioned earlier, and SECI's consultation on a 160MW solar-wind-storage hybrid in Andhra Pradesh. A similar but smaller pilot hybrid project is being planned in Kerala. Just in Andaman and Nicobar, there are also another 4-5 other solar-plus-storage projects being executed for the military engineering services (MES).

However, Walawalkar warns: "It is very difficult to put the expectation on most tenders anymore, but we are very confident that on the private side things will now take off this year."

For the Andhra Pradesh hybrid project, AP Solar Energy Corporation, AP Nedcap and APTransco are planning to tender a project involving 120MW of solar, 40MW of wind and 20-40MWh of storage in Q1 2018, explains Bharat Reddy, deputy general manager, SECI. The storage element will be technology agnostic. SECI is providing some investment with backing from the World Bank and the plant will be located inside a new solar park in Anantpur and it will be by far the largest such system in India.

Meanwhile, the Kerala-based technology demo would be located at Ramakkalmedu, including 3MW of solar, 4MW of wind, and battery storage, says Dr Harikumar Ramadas, director of the Agency for Non-Conventional Energy and Rural Technology (ANERT). Deliberately situated in a tourist zone, there are plans to launch a training centre on site, allowing the public to view the system and witness the performance evaluations and studies.

Solar storage PPAs

Elsewhere, the private sector is seeing bulging interest with the weight of foreign and domestic companies like CLP India, ReNew Power, 8minutenergy, CleanMax Solar, and Vikram Solar among others getting on board. Walawalkar claims that all the major solar players in India are now taking storage seriously.

Corporate rooftop solar specialist CleanMax Solar for example has started offering solar-plus-storage on a PPA-basis where they are ready to invest in a project on behalf of customers and sign a PPA with that customer, adds Walawalkar. Other companies such as major Indian PV developers and EPCs like Hero Future Energies and Sterling &Wilson are also looking to make a similar offer.

While Mahindra Susten is itself planning several other projects in the next few months, it is also considering a technology partnership with foreign solar storage technology companies to sharpen its capabilities and offer the service in other geographies.

Singhal says: "While solar with storage tenders in India will come up in a big way going ahead, there are some very big projects coming up in the Middle East, Australia and the US."

Home or away, India is likely to become a larger force in the energy market.

NOMINATIONS DEADLINE: 31 MAY 2018

SOLAR POWER PORTAL

Energy Storage NEWS

AWARDS 2018

GALA DINNER AWARDS CEREMONY

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LI-IONS OF AFRICA: THE NEW BATTERY OF OFF-GRID CHOICE

Andy Colthorpe, Editor, Energy-Storage.News

While it would be a mistake to generalise across a continent, it might surprise some to hear that lithium-ion is considered affordable even for smaller projects in Africa. Focusing on communities with little to no access to electricity besides perhaps from expensive diesel generators and replacing kerosene used for lighting, we spoke with two US-headquartered providers of energy access.

Off Grid Electric is a startup which offers home solar-plus-storage for residential customers, who lease the products on a pay-as-they-go basis, in Tanzania, Rwanda, Ghana and the Ivory Coast. Powerhive conversely installs larger, community-scale solar-plus-storage microgrids, selling the power on a kWh-basis in Kenya, where it has operated for six years, with Rwanda and Nigeria on the horizon for this year and next.

What sort of technologies are you using in Africa?

Joshua Pierce, co-founder and CTO, Off Grid Electric: Anything from individual light sources like solar lanterns, all the way up through low voltage solar home systems.

We provide what I would characterise as aspirational modern energy systems for off-grid and weak grid consumers. Low voltage DC-only solar home kits that include the appliances, energy storage and the solar. All of our systems include energy storage and we use lithium iron phosphate batteries for that application. Exclusively.

Rik Wuts, co-founder and VP for business development, Powerhive: We are basically a full-on utility. We build an actual power plant, we build the distribution network, we do metering and we sell power on the kWh in the end. We can power productive loads. It's exactly the same electricity you have in your house, 240V AC electricity.

We basically use predominantly solar power, we have AC-coupled systems and we currently are using flooded lead acid batteries, which is the cheapest technology available, from a relatively good brand - we use Trojan Batteries. We are in the process of migrating to lithium-ion. We'll be working with a big Chinese vendor.

Credit: Powerhive

Powerhive delivers 240V AC power from its minigrid projects.

You have both selected lithium batteries, albeit in the future in Powerhive's case. Some people might be surprised to see them considered affordable in a developing market. What's behind their selection?

JP: When we started Off Grid (in 2012) we selected lithium from Day One. Even though the price was between US$400 and US$500 per kWh. Today we're seeing prices approaching US$200 per kWh with projections for it to go below that. When you look at the use profile of the lithium chemistry versus the lead acid and customer lifetime value, for a company like ours that is a lease-to-own essentially, the economics begin to very quickly swing in favour of lithium over cheaper chemistries that have shorter lifecycles or other potential issues.

Off Grid Electric provides an 'Energy Ladder', starting with small home installations for light and phone charging.

Credit: Off Grid Electric.

We chose lithium iron phosphate for some very specific reasons. Firstly, this is one of if not the most common small-scale modular lithium chemistries available today. The 18650 lithium phosphate cell, thanks primarily to the Chinese EV industry and similar industries, is an extremely common platform. It's highly flexible and it balances energy density with cost and high cycle life. The safety of lithium iron phosphate was also a critical factor for us.

Another benefit is that we talk about providing what's called an 'Energy Ladder', where consumers can start with a relatively small system and upgrade over time. This is not necessarily easy to do with other types of energy storage.

RW: Lead acid batteries are cheap to buy but expensive to maintain. They're very finicky. You have to refill them all the time with water, you have to always be checking the voltages and if you run them on too high temperature for a day the capacity goes back dramatically. They don't last very long and they are really hard to manage.

Lithium-ion is more of a closed system with inbuilt power management and air-conditioning, all that kind of stuff. It's a little bit more heavy on the wallet initially but it lasts much longer and you have basically no maintenance. If it's twice as expensive upfront and it's going to last three times as long and has no maintenance, there's a clear case there.

What about the argument that while lead acid is more toxic than lithium, it is still more widely recycled in the supply chain. How does lithium do from a sustainability perspective?

JP: The common argument is that lead acid is a highly recyclable product for which it can be economically viable to recycle and repurpose raw materials. That's true. However there has to be an effective recycling supply chain. I would argue, having operated in multiple African environments and lived in Africa myself, that that supply chain is not nearly as robust as it is in other places in the world. Where the impact is the worst, is on the most vulnerable populations.

The other thing I would say is, go to a rural village and yes, lead acid batteries will eventually make it out of the ecosystem, but not before they've done their damage. I've seen countless piles of dead lead acid batteries. That is a resource people will use until there's nothing left in it. They'll use it in their car until it won't start their car. Then they'll use it in their business, then they'll use it in their house for lights. It's amazing how resourceful people are but then that battery may sit and corrode and pollute the local groundwater, which is what children drink. I've seen it time and time again.

RW: There is already a supply chain for doing that for lithium actually because of the computer industry. Every laptop, every cell phone has a lithium-ion battery obviously. So there is already, even in Kenya there's that supply chain. It's actually harder for us with lead acid because we have to ship it back to the vendor, who's on another continent. So it's actually going to be easier doing it with lithium-ion where there's much more savvy systems around that than there is with lead acid technology. •

HYPER-REALITY: BRINGING FAST, SUSTAINABLE TRANSPORT TO THE MIDDLE EAST

Colin Rhys is creative director at high-speed sustainable transport system Virgin Hyperloop One, currently focusing on developing a route in the United Arab Emirates.

Hyperloop is a new mode of transportation that moves freight and people quickly, safely, on-demand and direct from origin to destination. Passengers or cargo are loaded into the vehicle and accelerate gradually via electric propulsion through a low-pressure tube. The vehicle floats above the track using magnetic levitation (maglev) and glides at airline speeds for long distances, due to ultra-low aerodynamic drag. Virgin Hyperloop One systems will be built on columns or tunnelled below ground to avoid dangerous grade crossings and wildlife. It's fully autonomous and enclosed, eliminating pilot error and weather hazards. It's safe and clean, with no direct carbon emissions.

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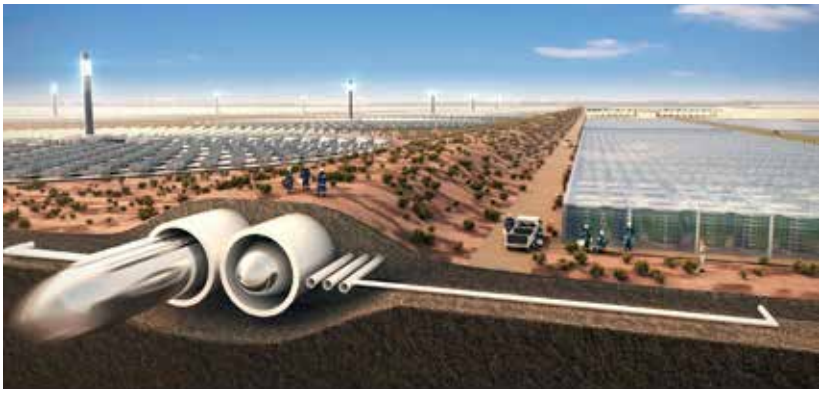
The transport sector has a major role to play in developing solutions to the unprecedented challenges our planet faces. We are committed to building a new mode of transport that's efficient, fast, clean and brings the widest benefits to the most people.

We have the lowest carbon footprint per passenger mile travelled, in comparison to other modes of transportation. We have achieved this by addressing both operational and embodied carbon.

Our system will be powered by renewable energy, with storage and solar pivotal to the technology, aligning with our commitment to reduce operational carbon. Virgin Hyperloop One can draw power from whichever energy sources are available along the route - and unlike other rail transport, it only requires energy to a portion of the track.



Credit: Virgin Hyperloop One

Energy storage is key to efficiency increases

Specific energy use will depend on system requirements and the terrain. Our system will generate more energy than it consumes and surplus energy can be stored and used as an uninterrupted source of power for critical infrastructure and services. Overall efficiency increases mean lower prices, less emissions and more reliable power.

Material innovation is also key to our sustainable vision. We are using low embodied carbon materials for all components, including our hyper-route, portal and pods. We are disrupting carbon intensive supply chains, while locally sourcing recycled construction materials.

While the first route in the world is likely to be in the GCC (Gulf Cooperation Council) region, the ultimate goal is to connect the world. We are working with organisations to study potential routes, holding discussions with governments and organisations to progress the first projects. In all such projects we will be using solar energy and energy storage.

Our project says a lot about the interested government's clean energy opportunities and ambitions. UAE Vision 2021 aims to reduce emissions, enhance environmental sustainability, preserve natural resources and shift towards a sustainable lifestyle. We are working with the UAE government to achieve sustainable development that does not harm the environment, current or future generations.

The future is in renewable energy and we have designed a system with that in mind. Our solar energy capabilities will provide incomparable benefits in comparison to conventional modes of transport. Sustainability is integral to our system.

For more information on Hyperloop contact Harry AH Amos, Kestrel Global Limited harry.amos@kestrelglobal.ae

Energy Storage NEWS

After a couple of record-breaking years, Navigant Research predicts the global market will grow 47% again this year, while in the US alone, the market for **energy storage grew by 284%** in 2016, according to the Energy Storage Association.

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