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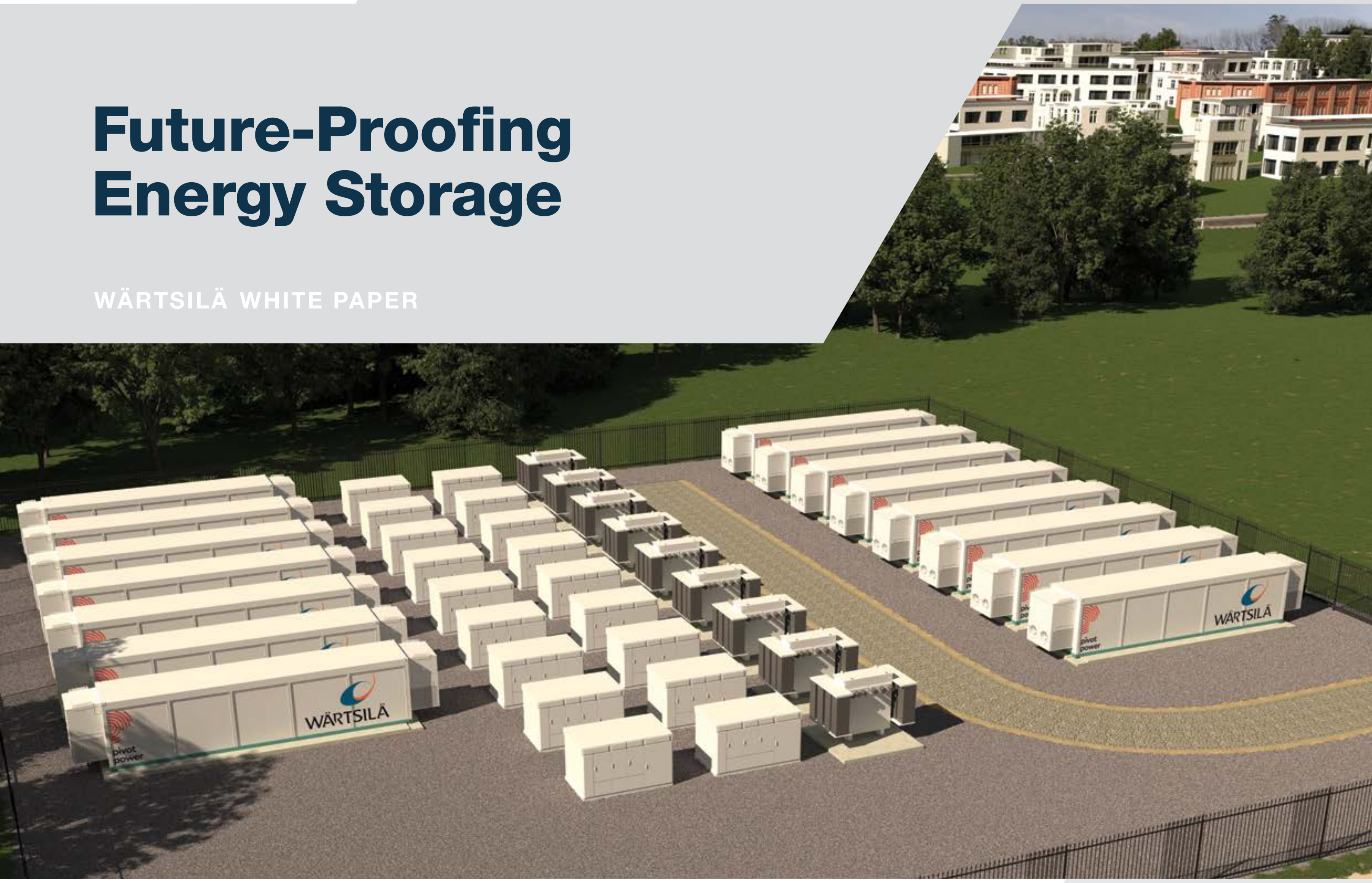
Future-Proofing Energy Storage

WÄRTSILÄ WHITE PAPER



Ready for tomorrow, future-proof your investment

Energy storage has reached a turning point as a mainstream grid-reliability resource. The United States achieved another year of record deployments in 2016, and forecasts show continued rapid expansion of the energy storage industry. At the same time, the investment case for storage is still difficult due to risks of limited technology track record and business cases that rely on uncertain revenues. Due to rapidly changing grid dynamics and the long life required of storage assets, energy storage owners must future-proof their investments today.

To future-proof energy storage, storage developers must employ technology and project engineering specifically designed for flexibility. Future-proofing also requires commercial agreements and analytical expertise to optimise the operational value of energy storage.

In this white paper, Wärtsilä Energy Storage and Optimisation (ES&O) lays out the requirements involved in future-proofing energy storage. We then describe our approach to future-proofing energy storage projects in two significant markets: the United Kingdom and California, USA. With changing dynamics in these markets and others, storage owners will be successful only if they future-proof their energy storage investments.

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Introduction

Energy storage became a mainstream grid planning tool in recent years. In late 2015, the Aliso Canyon natural-gas storage facility in Southern California experienced a significant leak that put the grid at risk of power outages. In 2016, storage industry leaders installed three large lithium-ion (Li-ion) battery systems totaling 70 MW / 280 MWh to mitigate the power capacity shortage caused by the Aliso Canyon leak. After the projects were completed, California Public Utilities Commissioner Michael Picker said, "I was stunned at the ability of batteries and the battery industry's ability to meet our needs. This was something I didn't expect to see until 2020. Here it is in 2017, and it's already in the ground."[1] Kevin Payne, the CEO of Southern California Edison, one of California's large investor-owned utilities affected by the Aliso Canyon crisis, added that the commercial delivery of Li-ion battery storage in response to the crisis "validates that energy storage can be part of the energy mix now."[2]

In addition to playing a high-profile role in the Aliso Canyon crises, energy storage systems (ESS) reached critical scale in grid deployments. For this paper, **we define ESS to include all forms of stationary battery storage, including Li-ion and other electrochemical and flow batteries.** We exclude large-scale infrastructure storage, such as pumped hydro and compressed air. This convention is followed by all the figures cited in this paper unless explicitly defined otherwise. Platts reported that as of Q2 2017, the installed base of ESS in the United States was 565.5 MW, and approximately one third of the capacity was deployed in the past year.[3]

Future-proofing: the process of anticipating the future and developing methods to minimise the effects of shocks and stresses of future events.

While the total ESS market is growing, the MWh installed total is growing faster than MW installed, which indicates an increase in the average battery storage system duration. The reason is that as ESS costs decrease, longer-duration ESS projects become cost-effective, which opens further markets for ESS. While the largest projects in 2014 and 2015 were for short-duration ancillary services markets, the largest projects in 2016 were for longer duration capacity markets. We expect the trends of increased installations and longer system durations to continue. Both trends support a rapidly growing installed base of ESS.

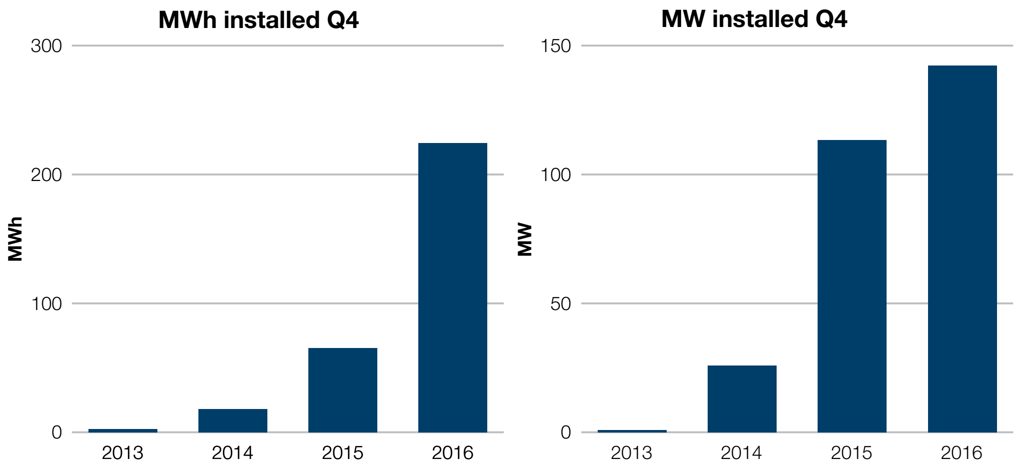

Figure 1. US battery storage installations by MW and MWh. *Source: GTM Research Q1 2017 U.S. Energy Storage Monitor.*

In terms of MWh of ESS installed, the market is forecasted to roughly double in size year over year until 2019 and then continue growing at an annual rate of about 35 to 40 percent.[4] The U.S. ESS market size was $320 million in 2016 and forecasted to rise to $3.3 billion by 2022.[5] Globally, the ESS market size was $1.5 billion in 2016 and forecasted to rise to $7 billion by 2025.[6]

While the ESS market is growing rapidly, a significant barrier to growth is financing risk. ESS assets are built to last ten years or longer, and storage investors need ESS assets to deliver over the expected lifetime to realize pro forma project returns. However, long-term performance data for grid-scale ESS does not exist. In addition, many markets for ESS face uncertainties that make revenue forecasting a difficult task.

1) Tesla, Greensmith, AES Deploy Aliso Canyon Battery Storage in Record Time, Greentech Media, http://bit.ly/2iuJMBD, Jan. 2017.
2) Ibid.
3) US electricity storage facilities' power rating tops 565 MW at end of Q2, Platts, http://bit.ly/2gaRorZ, Aug. 2017.
4) GTM Research, U.S. Energy Storage Monitor: 2016 Year in Review and Q1 2017, March 2017.
5) GTM Research, U.S. Energy Storage Monitor: 2016 Year in Review and Q1 2017, March 2017.
6) IHS Markit, Grid-connected energy storage market tracker – H1 2017, July 2017.

Risks to ESS Owners

Risk 1: The Track Record of Grid-Scale ESS Projects Is Short

The U.S. Department of Energy (DOE)'s Energy Storage Database shows that the median operating lifetime of grid-scale battery energy storage systems is 4 years and 9 months.[7] Globally, there are only 14 grid-scale ESS projects that have at least ten full years of operating history. In addition, many of these systems have been run as pilot programs, designed to test multiple applications rather than operating full-time as mission-critical resources like the systems being deployed today. Finally, major equipment vendors release new energy storage products every 12-18 months, meaning that past performance may not be indicative of future results.

Among ESS projects that have been operational for multiple years, the track record is mixed. Developers and utilities have piloted multiple battery technologies and are discovering the strengths and limitations of various storage technologies. For example, to accelerate the progression of grid-scale storage, the DOE invested in an early project in the Electric Reliability Council of Texas (ERCOT) market to demonstrate the capability of advanced lead acid battery technology to provide renewable firming and frequency regulation. The DOE's interest was to obtain technical and economic data from the project to prepare for future deployments. Once installed, operators found that the most lucrative application for ESS was Fast-Responding Regulation Service (FRRS), a pilot program in ERCOT designed to take advantage of the capability of fast-responding resources, such as ESS, to mitigate grid frequency deviations. Unfortunately, advanced lead acid batteries turned out to be a poor fit for the use case and experienced extreme degradation, which necessitated replacement years before the expected end of system lifetime.

Another storage system using advanced lead acid batteries in Hawaii caught fire.[8] A third system, also in Hawaii, exhibited significant degradation after two years.[9] Media reports in recent years have also documented failures affecting flow batteries, sodium-sulfur batteries, and flywheels.[10] [11] [12] Li-ion battery systems, which make up the vast majority of battery systems today, have more positive preliminary performance results. However, with a limited install base, investors do not have the long-term field data to prove that such systems will perform positively in all project conditions.

Risk 2: Market Revenues of ESS are Uncertain

ESS assets have a usable lifetime of 10 or more years depending on the ESS technology and usage profile. However, many of the key electricity market services that ESS provide are procured with short-term contracts. Other key market services are procured on a completely merchant basis via day-ahead bidding. Whereas wind and solar assets traditionally generate revenue for investors via long-term power purchase agreements, ESS projects often generate revenue via ancillary services and capacity markets, which do not always offer long-term contracts. The market value and procurement mechanism for these market services will change in unknown ways over the life of the ESS asset.

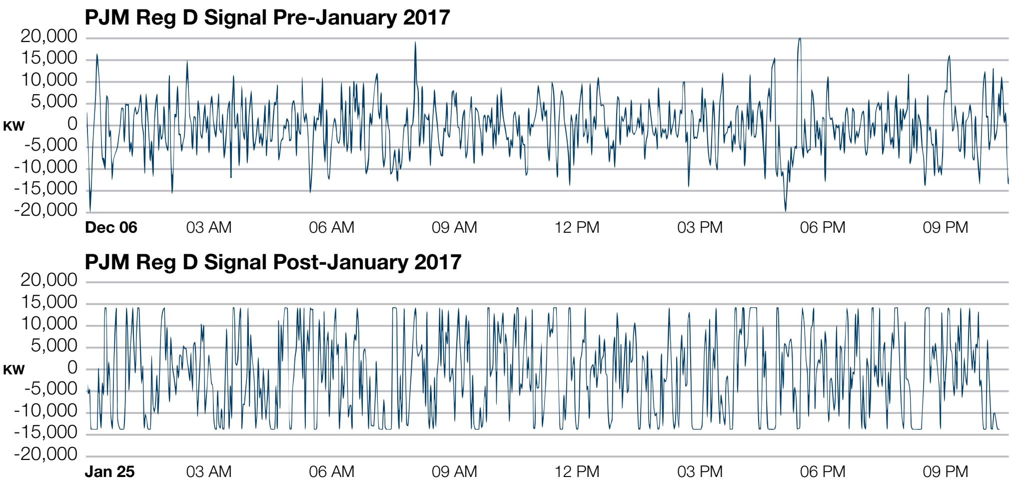

Figure 2. PJM's 2017 signal change increased ESS energy throughput by over 50% and changed the energy neutrality condition from 15 minutes to 30 minutes.

7) Includes electrochemical batteries with installed capacity greater than 1 MW
8) Battery Room Fire at Kahuku Wind-Energy Storage Farm, Greentech Media, http://bit.ly/2xh3MLd, Aug. 2012.
9) The Risks of Novel Batteries Wearing Out Before Their Time, Greentech Media, http://bit.ly/2xwTxSm, July 2015.
10) Redflow Halts Delivery of Residential Flow Batteries Due to 'Unexpected Product Failure Modes', Greentech Media, http://bit.ly/2wL3zSy, April 2017.
11) Exploding Sodium Sulfur Batteries From NGK Energy Storage, Greentech Media, http://bit.ly/2xhp3EA, Nov. 2011.
12) Injuries Reported In Explosion At Poway Business, KPBS, http://bit.ly/2vaAoJo, June 2015.

The PJM Reg D market is a cautionary tale. PJM is a Regional Transmission Organisation serving 165 GW of customer load across 13 states in the Northeast US. [13] In 2012, PJM instituted performance-based regulation, an ancillary service, through a new automatic generation control signal called Reg D.[14] The Reg D signal recognised the benefits that fast-responding ESS could bring to PJM ratepayers. The Reg D signal had no ramp rate limitations but was designed to be energy neutral over a period of 15 minutes, recognising both the advantages and limitations of ESS when paired with traditional regulation resources. The faster response time of ESS allows a grid operator to reduce the total MW of ancillary services procured, providing cost savings for customers. With Reg D, PJM was able to reduce its regulation procurement target by 30%, from 1% of peak load to 0.7% of peak load. From 2012 to 2016, over 250 MW of ESS capacity was installed in PJM, equivalent to a capital investment of approximately $200 million.

As more ESS capacity entered the market, PJM encountered some operational and market design challenges. A contentious stakeholder process to reform the market stalled, and PJM unilaterally changed the Reg D signal characteristics in January 2017. The new signal targeted energy neutrality over a 30-minute period and required an incremental energy throughput of greater than 50% that of the previous Reg D signal.

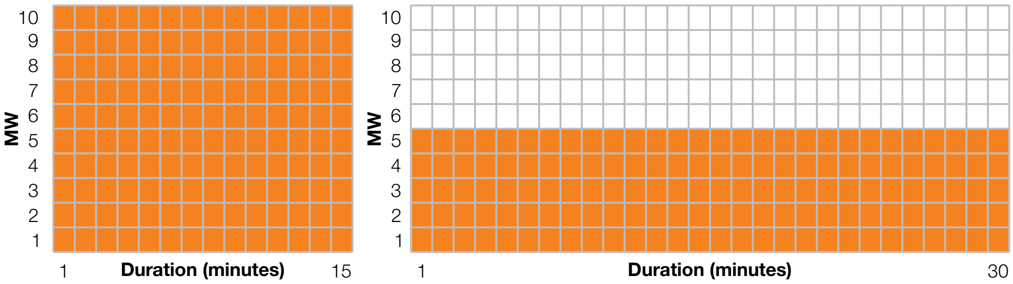

Figure 3. Indicative illustration that ESS capacity drops from 10 MW to 5 MW as ESS duration requirement increases from 15 minutes to 30 minutes.

These changes adversely impacted all ESS projects in PJM. An ESS project designed to provide a fixed amount of power for 15 minutes cannot maintain its power capacity or increase energy throughput without affecting battery performance, warranty terms, and even safety considerations. A 10 MW system built for a 15-minute duration has 2.5 MWh of usable energy capacity. If a 30-minute duration is required, then the system's power capacity must be limited to 5 MW so it can continue to yield the same 2.5 MWh of energy capacity. Most PJM battery system operators responded to the Reg D signal changes by simply cutting power in half and reducing system availability. However, since revenue is based on capacity and availability, these operational changes reduced investor revenue by greater than 50%.

Wärtsilä ES&O, by contrast, made software and physical site changes to maintain a high system availability and keep the rated capacity of our systems greater than 50%. We did this by re-evaluating all the tradeoff decisions that go into ESS operation. For example, because the Reg D signal change increased energy throughput, we reduced ESS temperature, which decreased degradation but also decreased round-trip efficiency. Because the signal change modified the energy neutrality condition, we modified our state-of-charge management algorithm, which impacted energy throughput and system performance. These changes were enabled by future-proofing with a flexible controls architecture, which we will discuss next. While future-proofing saved Wärtsilä customers millions of dollars in PJM, other PJM systems faced tremendous losses. Investors looking at the experience of the PJM merchant market for Reg D will use caution when entering into future merchant markets for ESS.

Faced with a limited track record of the ESS installation base as well as market uncertainty, **how can an ESS investor mitigate risk?** The only option is to future-proof current ESS investments to plan for changes in the future.

Energy storage projects can be future-proofed by:
1) installing a flexible controls architecture
2) planning the right way for battery capacity augmentation
3) tracking ongoing operation with a flexible warranty
We see flexibility as the number one factor.

13 PJM Electric Regions, Federal Energy Regulatory Commission, http://bit.ly/2ivtuZ3, accessed Aug. 2017.
14 "Performance-Based Regulation: Year One Analysis", Regulation Performance Senior Task Force PJM Interconnection, October 12, 2013.

Strategies to Future-Proof ESS

Strategy 1: Employ a Flexible Architecture

There are two primary controls architectures for an ESS Energy Management System (EMS): PLC-based and PC- based.

A programmable logic controller (PLC) is a hardened industrial computer, designed originally for assembly lines. PLCs are "hard" systems in that they are programmed for a specific task, and they accept limited inputs and outputs to accomplish the task. In the context of an energy storage EMS, PLCs are typically designed by inverter manufacturers and coded for a specific inverter and battery technology. Modifications are possible, but they take significant time and effort and typically require an engineer onsite for months at a time. This makes the cost of PLC modification relatively high.

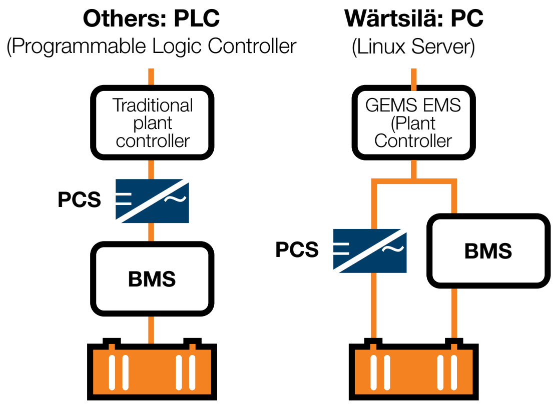

Figure 4. The PC-based approach communicates directly with PCS controller and BMS to abstract all technology characteristics and enable technology-neutral architecture.

To develop future-proof energy storage systems, storage developers should harness technology and project engineering tailored specifically for flexibility. Future-proofing also demands commercial agreements as well as analytical expertise to enhance the operational value of energy storage.

A personal computer (PC)-based controller is built on multi- purpose industrial servers and is controlled by software. The PC-based architecture facilitates complex operation and optimization and allows for updates to be delivered faster and at lower cost. Wärtsilä's GEMS controls platform is designed with a technology-neutral architecture, meaning that the same controls platform can be used with any battery and inverter technology with minimal configuration. Wärtsilä tests all software modifications on a virtual machine that replicates the technology characteristics of each piece of hardware. Updates are performed only after the software has been fully debugged in a lab environment, and are then installed remotely via a secure VPN and require only five minutes of downtime.

The PC-based **flexible architecture** enables various degrees of flexibility that each contribute to ESS future-proofing. In PJM, the flexible architecture allowed Wärtsilä to react quickly to adverse changes in the market. In other cases, the flexible architecture has enabled Wärtsilä to easily repurpose ESS assets when market changes allowed for incremental value. A table of case studies demonstrating the capability of a PC-based architecture is shown below. Many of these deployments are technically feasible on a PLC, but would have been much more complex and costly, negating the commercial case for deployment.

Capabilities enabled with a flexible PC-based architecture	Example Wärtsilä Energy Storage and Optimisation deployments		
	Date	Location	Description
Repurposing of existing ESS asset	2011	California	50 kW ESS sold from initial owner to secondary owner and repurposed for new use case with remote software update
Dual battery operation	2015	Virginia	60 kW ESS (50 kW flow + 10 kW electrochemical), unified control platform
Co-optimisation of multiple generation assets	2015	Puerto Rico	1 MW ESS + 2 MW solar, unified control platform
Flexible augmentation plans (one controller optimising the output of batteries with different vintages and performance characteristics)	2016	California	20 MW, augmentation pre-planned for 2021

Strategy 2: Design for Flexibility

One solution for dealing with technology and market uncertainty is to design for ESS flexibility with an **augmentation plan** over the ESS project lifetime. In an augmentation plan, additional battery capacity is added to the project site. The augmented battery capacity can be used to supplement planned battery capacity losses due to battery degradation, or to provide incremental capacity if future market conditions support a larger system.

While augmentation plans make sense in concept, few installed energy storage systems today have been planned for augmentation. As such, there is no long-term track record of augmented battery storage systems. In addition, there are different schools of thought about how to safely and effective augment ESS projects. Wärtsilä is one of the few market participants to have installed an ESS that has been planned for augmentation, and Wärtsilä's position is that there is a right way and a wrong way to design for flexibility with an augmentation plan.

Original Installation

Hypothetical system of 4 inverter banks, each with 3 battery racks at date of installation.

Battery Rack-Based Augmentation

Under rack-based augmentation, a new battery rack is added at the end of battery banks.

Inverter-Based Augmentation

Under inverter-based augmentation, old racks from Inverter 1 are redistributed to banks behind Inverters 2, 3 & 4. All new racks are in one bank feeding Inverter 1.

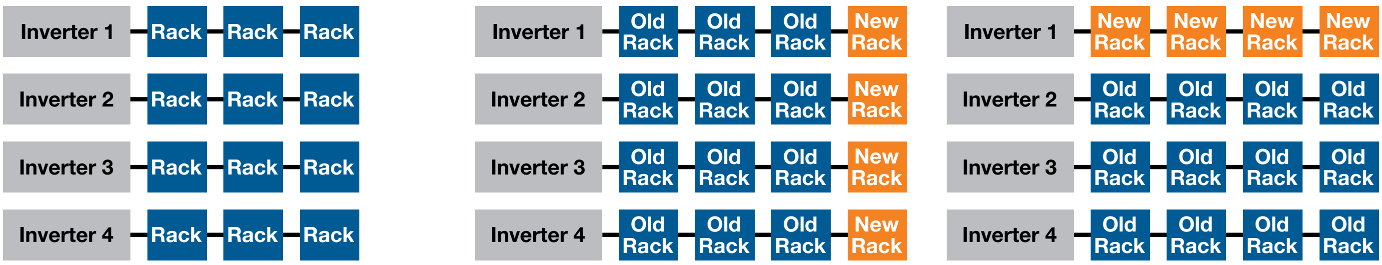

Figure 5. Hypothetical augmentation scenarios. The charts assume a central inverter design, which is representative of most operating energy storage systems.

The right way to design for flexibility is to plan the ESS layout for inverter-based augmentation. This design requires leaving sufficient space for additional battery racks, and designing wiring and cable trays for the future state of the system where som e racks have moved and additional racks are added. With an inverter-based augmentation, batteries will be wired in parallel only with other batteries of the same vintage. The older batteries will have a similar state of health, and therefore they will have similar resistance and current output profiles. The new batteries may have different characteristics, benefitting from higher performance, lower cost, and a smaller footprint, and thus requiring a smaller initial capacity than batteries from the original deployment. A second augmentation may be possible, but it depends on system size and the number of original batteries and central inverters.

The wrong way to design for flexibility is to assume that battery rack-based augmentation will be possible. The appeal of battery rack-based augmentation is that, in theory, it could be less costly. Battery rack-based augmentation would allow an ESS owner to add the minimum incremental storage capacity necessary, conduct multiple augmentations, and eliminate the labor from moving previously installed racks at the time of augmentation. However, battery rack-based augmentation renders a system unsafe to operate. As batteries age and degrade, their internal resistance increases. When new batteries are installed in parallel with old batteries, the new batteries will operate at higher currents than the old batteries. These higher currents will exceed the current limitation of the conductors, over current protection devices, switches, and contactors in the power path. Therefore, battery rack-based augmentation is not a feasible approach to future-proofing energy storage.

An alternative is rack-based inverter design. In this scenario, racks are wired in parallel on the AC side of the inverter rather than the DC side. A rack-based inverter configuration allows for more design flexibility for future augmentation but can be less cost effective. **The selection of the right approach is dependent on the degree of flexibility desired by the system owner.**

Strategy 3: Track Ongoing Operations for Flexibility with Warranty

Li-ion battery warranties are complex. Warranty terms differ by battery vendor and model. Typical terms include:

- Annual energy throughput
- Peak DC charge/discharge rate
- Daily average DC charge/discharge rate
- Average daily temperature
- Maximum temperature deviation across measurement points
- Common mode noise level (voltage)
- Common mode noise level (current)

If one or more of these conditions are violated, or if the system is operated in a different manner than modeled, the system owner faces a reduction in warranted usable energy. Many of the battery warranty conditions have a direct correlation to battery usage and system revenue, which leads to tradeoff decisions regarding how the system is used. Is it better for a battery storage owner to operate the system aggressively and chase additional revenue, or operate it conservatively to maintain a higher warranted usable energy over time? The only way for system owners to make informed decisions is to track all values using dashboards and analytics. These are core functions of the GEMS platform.

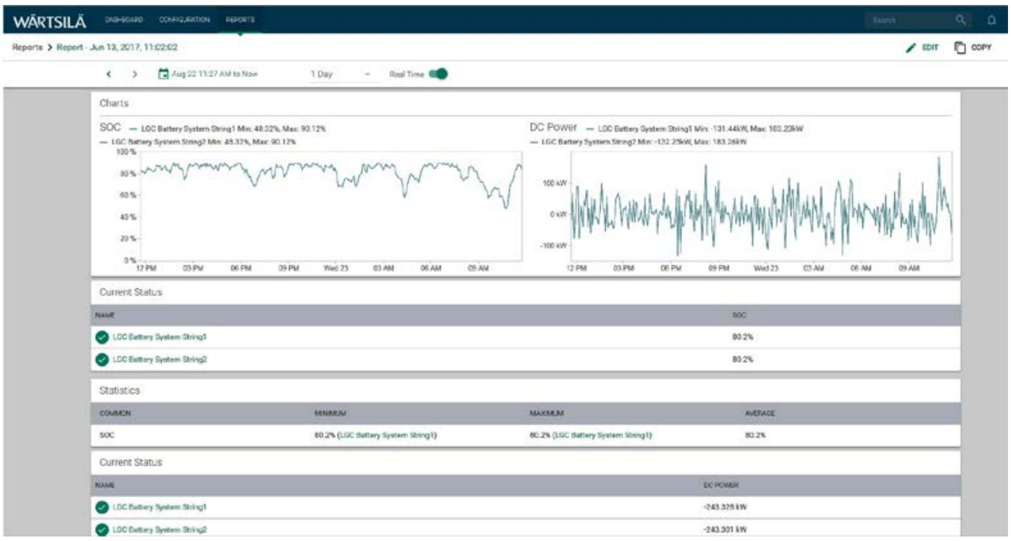

Figure 6. GEMS dashboard tracks values associated with warranty compliance; provides analytics as well as full data export capability (csv).

An incorrect approach is to track battery warranties is to rely on the battery management system (BMS). The BMS does not track all warranty conditions, so if a warranty claim arises, the BMS is not sufficient to ensure warranty compliance. Without an energy management system to track all energy storage performance data, the system owner is not protected in event of failure. In addition, tradeoff decisions regarding changes in battery operation within the terms of the battery warranty are not possible.

Case Studies of Future-Proofing ESS

Case Study 1: UK National Grid

MARKET OVERVIEW

The United Kingdom is poised to become one of the largest ESS markets in the world. National Grid, the UK grid operator, has announced its intention to procure ESS for grid balancing services through its Enhanced Frequency Response (EFR) and dynamic Firm Frequency Response (dFFR) market products. National Grid has awarded four-year EFR contracts for 201 MW of ESS capacity, and dFFR contracts ranging from a period of months to two years for more than 100 MW of ESS capacity.

The UK has a need for incremental resources for balancing services due to multiple market drivers. These drivers include increased wind penetration, retirement of large synchronous coal- fired generation, and limited interconnection capacity with neighboring grids. According to Julian Leslie, head of electricity network development at National Grid, "At the moment we are spending around £1 billion a year [on balancing services] and ever-increasing, and I think personally by the next five years or so that will be £2 billion a year."[15] While there is certain to be future need for balancing services beyond the short-term contract terms of EFR and dFFR, ESS investors have no certainty regarding the structure of future balancing service market products or their future price levels.

MARKET UNCERTAINTY

ESS owners that win EFR or dFFR contracts face uncertainty in evaluating what the market for balancing services in the UK will look like after the expiration of their contract terms. In addition, many ESS projects that are providing EFR and dFFR are "value-stacking" by also bidding into the UK capacity market. Contract terms in the capacity market last up to 15 years. As of this writing, capacity in the UK required an energy duration of 30 minutes for ESS, but UK regulators have signaled an intention to lengthen the energy duration requirement.[16] As in the case of PJM Reg D, an increase in energy duration requirement of capacity would have an adverse impact on system revenue, so prospective owners need to plan for flexibility in their current installations.

FUTURE-PROOFING APPROACH

For National Grid EFR and dFFR projects that are participating in the capacity market, Wärtsilä offers an ESS design with spacing and cabling pre-planned to modify battery storage duration at a future date. Wärtsilä developed a 10 MW / 5 MWh system with spacing and cabling pre- planned for conversion to 10 MW / 20 MWh in the future. Before and after the conversion, the system will maintain a set of five 2 MW inverters. The change comes from adding three storage containers with batteries to increase the energy rating. By increasing the energy rating, the system can expand from providing 10 MW in 30-minute increments to provide 10 MW in 2-hour increments. The flexibility of the GEMS platform also enables a mix of high-power battery cells from the initial design with high-energy cells in the future design to minimise cost and plant footprint at initial deployment and after augmentation.

Lastly, the Wärtsilä EFR/dFFR system design benefits from a flexible warranty that adjusts according to system throughput. Through a competitive procurement, superior warranty terms from the battery vendor were secured for this project. The GEMS platform displays and tracks all battery performance elements related to revenue and warranty through a GEMS dashboard. The dashboard provides insight to the ESS owner about system management and assurance to the battery vendor that warranty terms will be honored. This warranty available to Wärtsilä UK projects is unique because it provides an incremental value when the system owner chooses to conserve the batteries.

Until now, many investors have perceived the risks in the UK ESS market to be too high. The ESS investment case depends heavily on revenue generation coming after National Grid's current contracted revenue period. With the combination of intelligent software, careful planning, and warranties that address customer needs, system owners can future-proof their investments in the burgeoning UK battery storage market.

15) Balancing demand 'could cost National Grid £2bn', The Telegraph, http://bit.ly/2vb0LyN, June 2016.
16) Government plans changes to capacity market rules for batteries and unproven DSR, the energyst, http://bit.ly/2gaVZdJ, July 2017.

Case Study 2: California Independent System Operator (CAISO)

MARKET OVERVIEW

The California Public Utilities Commission requires distribution utilities to procure capacity commitments of at least 115% of their peak loads. This requirement is met though bilateral Resource Adequacy (RA) contracts between utilities and generation owners. For limited energy resources such as ESS, RA contracts are defined to require four hours of discharge duration at rated capacity. Most grid-scale ESS projects in California are four-hour systems because RA is the most lucrative revenue stream in California. The RA rules also require generators to bid into the CAISO market during most hours of the day so that CAISO knows these assets are online and available. For ESS, the most lucrative secondary revenue stream available in the CAISO market is typically frequency regulation. Therefore, the ESS assets deployed in California are four-hour systems, but are used most of the year for frequency regulation, a use case which requires shorter duration storage solutions in other markets.

MARKET UNCERTAINTY

While many California ESS assets have signed RA contracts for ten years with utility off-takers, CAISO frequency regulation is an entirely merchant market revenue stream. Frequency regulation could be highly lucrative or near worthless in the future. RA contracts have fixed capacity requirements, so an energy storage owner must plan to meet the fixed capacity requirement over the life of the ten-year contract either by oversizing the system for ten years of planned degradation or by planning for an augmentation of energy storage capacity. However, if frequency regulation values go up or down, the energy storage owner may wish to utilise the ESS differently, leading to an increase or decrease in degradation. Given the uncertainty of ESS usage in California and the requirement for fixed capacity in 10-year contracts, an augmentation plan and flexible warranty provide significant incremental value to a storage owner.

Figure 7. 20 MW / 80 MWh ESS in California with planned augmentation and flexible warranty.

FUTURE-PROOFING APPROACH

For California RA systems, Wärtsilä offers an augmentation plan, which it has put into place in a 20 MW / 80 MWh project deployed in California in 2016. Under this plan, GEMS will track the warranted capacity of the batteries and display trend values over time. At the same time, our team designed for flexibility with a planned inverter-based augmentation at approximately Year 5 of the system. If the owner chooses to run the system more aggressively for more revenue, this augmentation can occur sooner with more batteries augmented. Likewise, if the owner chooses to run the system less aggressively due to unattractive market conditions, the augmentation can be delayed or even skipped to reduce cost as much as possible. By tracking the battery's flexible warranty, GEMS enables the system owner to make tradeoff decisions for various market conditions. This flexible approach provides the investor with more confidence that merchant revenue is attainable, which boosts returns and allows for competitive bidding in RA tenders.

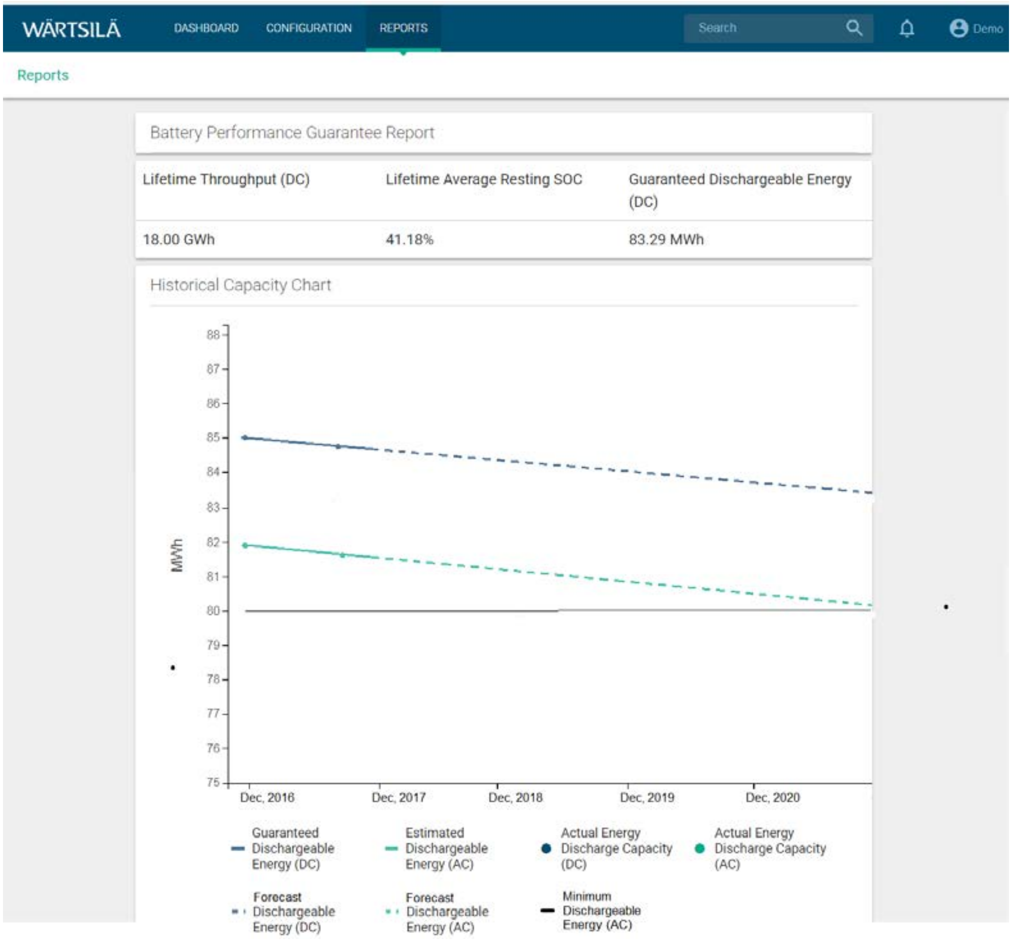

Figure 8. GEMS Analytics Dashboard showing forecasted battery capacity warranty based on battery usage scenario.

Conclusion

In the United Kingdom and California, two early and significant markets for energy storage, **success for storage owners is only possible if investments are future-proofed.** In both markets, investors must plan to future-proof energy storage to take advantage of revenue streams that are not contracted. These revenue streams are uncertain, so a flexible system design is necessary to be confident that the revenue streams are attainable. In the UK, the revenue risk includes frequency response revenue in the years after an EFR or dFFR contract has expired, as well as future changes in the capacity market. In California, the risk includes frequency regulation revenue, which augments revenue from a bilateral capacity contract. In both markets, storage owners that do not assume additional merchant revenue in their project pro-forma will be unable to compete in solicitations for long-term contracted revenue. Once projects are built, the measures taken to future-proof ESS will make the difference between realising revenue expectations and being left with stranded assets.

Wärtsilä has built software technology and engineering philosophy with flexibility in mind. Regardless of the changes that come to battery storage technology or energy storage market revenue, our systems will be equipped with the flexibility to achieve optimal results for storage owners.

WÄRTSILÄ ENERGY BUSINESS IN BRIEF

Wärtsilä Energy leads the transition towards a 100% renewable energy future. We help our customers unlock the value of the energy transition by optimising their energy systems and future-proofing their assets. Our offering comprises flexible power plants, energy management systems, and storage, as well as lifecycle services that enable increased efficiency and guaranteed performance. Wärtsilä has 72 GW of installed power plant capacity in 180 countries around the world.

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