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WHITE PAPER

Deep Flexibility: Designing Energy Storage for Electricity Markets in Transition

Fluence Advancion Deployment

by Dr. Marek Kubik

Summary

Many global markets first saw the introduction of energy storage through contracted or merchant plants providing frequency regulation. However, as project developers, utilities and system operators alike become increasingly aware of the versatility of energy storage, and additional storage assets are introduced onto the system, the use cases and the revenue opportunities change.

A key question now facing investors, project developers and end users is why should a flexible asset be constrained by inflexible operating conditions? This white paper focuses on the frequency regulation market in the United Kingdom (U.K.) as an example of the hidden risks that arise out of a narrow design developed to minimize up-front capital costs.

In particular, it explores the often-overlooked potential of systems designed for "deep flexibility," that is, with the ability to follow shifting value streams into the more varied opportunities of merchant markets.

Why should a flexible asset be constrained by inflexible operating conditions?

Leveraging over a decade of experience in delivering energy storage systems in changing markets, Fluence has three principles, discussed in this paper, for helping our customers stay ahead of changing trends:

- Leading technology
- Customized, flexible warranties
- Repowering and augmentation potential

Huge Savings: Faster than the blink of an eye

Batteries can respond to frequency disturbances from 0% to 100% output around 1,000 times faster than a typical fast-ramping gas peaker. In fact, batteries begin to respond to a dip in frequency faster than a human eye can blink.

Third-party research has shown that 1-megawatt (MW) of battery storage can displace almost 10 MW of conventional fossil fuel generation for flexibility needs.[1]

In the U.K., the introduction of batteries since the beginning of 2017 has reduced firm frequency response (FFR) prices by 75%, resulting in estimated savings of £144.5m per year[2] for consumers.

The Opportunity

The deployment of utility-scale battery storage for frequency regulation is now well-established across transmission networks in many countries, including the United States, Australia, Chile, Germany, Netherlands, Italy and the United Kingdom. In the U.S., one of Fluence's parent companies AES was the first to have energy storage used for frequency regulation in the PJM Interconnection service territory—way back in 2008.

In the U.K., the first transmission-connected battery providing frequency regulation went online in 2015 in the All Island Single Electricity Market, followed swiftly by National Grid's 200 MW Enhanced Frequency Response (EFR) tender in 2016. By December 2018, the EFR market was saturated, with almost 670 MW of battery storage seeking to get contracts in a market that needs between 450 MW and 650 MW at any given point.[2]

CASE STUDY

U.K. Power Reserve

In 2018, Fluence and UK Power Reserve (UKPR), the U.K.'s leading flexibility provider, announced plans for the world's largest contracted portfolio of lithium ion based battery energy storage,[3] a 120MW/120MWh fleet of projects that, when complete, will be able to quickly adjust to changing business cases and capture future opportunities.

The projects are being built on Fluence's three principles of deep flexibility, enabling UKPR to follow shifting value streams into the more varied opportunities of merchant markets.

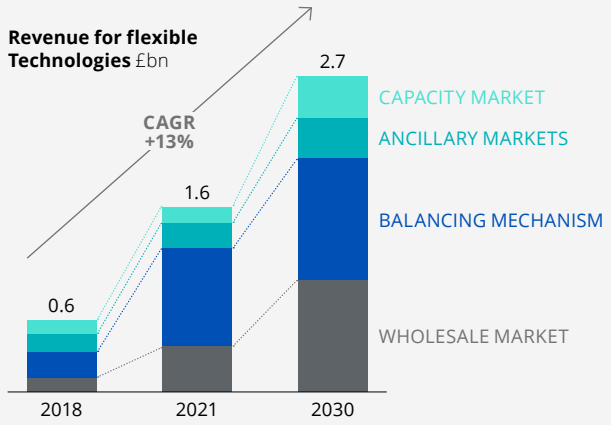
At the same time, as the frequency regulation bucket fills up, more opportunities and challenges will emerge. If a battery is designed and defined only with the services of today in mind, it will at best miss opportunities in the future, or at worst become economically disadvantaged as rules, incentives and signals change.

Without systems designed for "deep flexibility"—that is, with the ability to follow shifting value streams into the more varied opportunities of merchant markets—assets can become commercially stranded. Specifically, tight performance warranties around individual applications can leave assets trapped in shallow, saturated services. To respond to this issue, Fluence developed the cutting-edge technology and creative solutions that can provide its customers with additional upside potential and help mitigate downside risks that result from a transforming energy industry.

Without "deep flexibility" - to follow shifting value streams into more varied opportunities - assets can become commercially stranded.

Batteries have already proven themselves competitive for other grid support services in the U.K., such as Fast Reserve, Short-Term Operating Reserve and the Balancing Mechanism. According to Aurora Energy Research,[4] the U.K. is moving toward a multibillion-pound market for flexible technologies, which will grow fast, but be slower to saturate as the market size is larger. Aurora is projecting market growth of 450% for the flexibility technologies in the U.K.—worth more than £2.7 billion—over the next 12 years (equivalent to a 13% compound annual growth rate).

FIGURE 1: **The Growing Size of Flexibilty Markets for Energy Storage**



Source: Aurora Energy Research

For example, National Grid's System Needs and Product Strategy (SNAPS) promises new system services and products that will recognize characteristics and capabilities of flexible assets in ways never envisaged in existing products. These innovations will encompass changes to potentially recognize faster response speeds, more aggressive droop characteristics and "digital inertia" as the levels of synchronous generation fall on the grid and more non-synchronous forms of power, such as wind and solar, are introduced, along with high-voltage, direct current transmission lines.

The Solution

The key to this shifting market is the ability to future-proof the investments of energy storage asset owner-operators and provide the deep flexibility they need to navigate untapped merchant opportunities.

Fluence's decade of experience and fifth-generation energy storage design incorporates three strategic principles designed to support deep flexibility:

Leading, Open Architecture Technology and Superior Performance

Fluence operates deliberately on "open architecture" principles,[5] specifically:

- Fluence energy storage technology is component- and company-agnostic, enabling different battery cells, chemistries and even suppliers to operate within a single installation and as part of a cohesive platform. Each supplier goes through a certification process, and technology advancements can be integrated as they become available. This ensures the solution is always the right fit for both the market and application and can evolve over time.
- The company also leverages competition to create efficiencies. A large and growing base of key components is now available for advanced energy storage. By providing a path to common and accessible approaches, Fluence can leverage its global leadership in energy storage solutions to drive down costs and use this expanding manufacturing base for new and established suppliers.

Fluence's Advancion energy storage platform has third-party, independently verified capabilities far exceeding National Grid's existing service requirements. These systems have demonstrated initial response speeds of less than 150 milliseconds,[6] effectively future-proofing them for evolving system needs. The platform allows key parameters to be customized and continue to function seamlessly, even with changes to service characteristics such as deadband settings or ramp rates. Scheduling tools and standard protocols offer straightforward interfaces for energy traders to dispatch and operate the assets.

Customized, Flexible Warranties

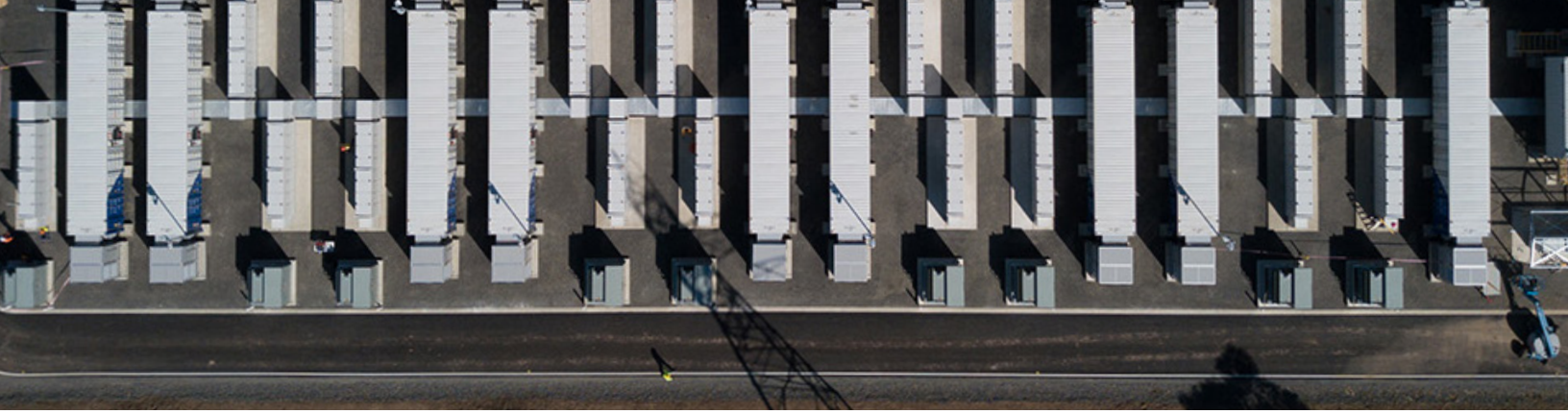
Energy storage assets are only as flexible as their performance guarantees. Fluence has been able to strike a balance between supporting long-term performance—up to 20 years—while also allowing complete flexibility to use the system outside of operating parameters. In this way, the system can be leveraged to capture near-term revenue opportunities or to adapt to usage patterns as market conditions change.

Energy storage assets are only as flexible as their performance guarantees.

Through a series of adjustment formulas, Fluence stands behind the performance of the asset even if the power profile, the energy throughput or the expected state of charge varies throughout the asset's life. Even in cases where the desired system use materially changes, Fluence can work with customers to analyze the impact on their system and help incorporate any necessary design changes. This gives our customers the flexibility to tailor their business case but be assured that Fluence will be with them come what may on their storage journey.

Repowering and Augmentation

Repowering and project augmentation options for projects are a main concern for many asset owners. Fluence's long and deep experience in energy storage solutions means we have seen projects through their full life cycles and adopted various augmentation and repowering strategies. We have dealt firsthand with assets operating more than 10 years, as well as with changing use cases and service requirements. We have even relocated and reconfigured systems in different markets multiple times. Coupled with our flexible warranty, our customers have the assurance that if they do have to adapt a system, they have an experienced partner to advise them on the best possible strategy to prolong asset life.



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Conclusion

Transforming the 100-year-old electricity system requires different companies and stakeholders to work together. New services and offerings will arise where they didn't exist before. New partnerships and businesses will deliver ever greater value to customers. A network of collaboration and innovation that goes far beyond technology is being created. Fluence and our customers will continue to be a leading force in that network, working together to design the deeply flexible storage systems that can continuously adapt to meet the new opportunities and challenges of our changing energy system.

Endnotes

[1] Everoze Partners Ltd 'Batteries: Beyond The Spin' October 2017. Available online: http://info.fluenceenergy.com/everoze-report-digital-inertia-ireland-island

[2] Calculation based on Cornwall Insight, Energy: 2030, January 2019 Issue. FFR prices have declined from £40/MW/h to £10/MW/h between January 2017 and January 2019. With an average procurement volume of 550MW this is saving National Grid and consumers £144.5m per year vs pre battery levels.

[3] Goldman, S. UK Power Reserve and Fluence Expand Partnership to Record-Breaking 120MW Battery Energy Storage Portfolio, 4th October 2018. Available online: http://blog.fluenceenergy.com/ukpr-fluence-battery-energy-storage-portfolio-2

[4] Aurora Energy Research, U.K. Battery Storage and Flexibility Conference, 31st October 2017, East Wintergarden, Canary Warf, London.

[5] Zahurancik, J. June 22nd 2017. If You Want to Go Far, Go Together – Lessons Learned in 10 Years of Energy Storage. Available online: http://blog.fluenceenergy.com/if-you-want-to-go-far-go-together-lessons-learned-in-10-years-of-energy-storage.

[6] Brogan, P. V., Best, R., Morrow, J., McKinley, K., Kubik, M.L, Effect of BESS Response on Frequency and RoCoF During Under Frequency Transients. IEEE Transactions on Power Systems. Vol 34: Issue 1. January 2019. DOI: 10.1109/TPWRS.2018.2862147.

[7] Navigant Research Leaderboard: Utility-Scale Energy Storage Systems Integrators: Assessment of Strategy and Execution for 12 Energy Storage Systems Integrators. Available online: https://www.navigantresearch.com/reports/navigant-research-leaderboard-utility-scale-energy-storage-systems-integrators

ABOUT FLUENCE

Fluence, a Siemens and AES company, is the global market leader in energy storage technology solutions and services, combining the agility of a technology company with the expertise, vision and financial backing of two well-established and respected industry giants. Building on the pioneering work of AES Energy Storage and Siemens energy storage, the company's goal is to create a more sustainable future by transforming the way we power our world. Providing design, delivery and integration, Fluence offers proven energy storage technology solutions that address the diverse needs and challenges of customers in a rapidly transforming energy landscape.

The company currently has more than 2.1 gigawatts of projects in operation or awarded across 22 countries and territories worldwide. Fluence topped the Navigant Research utility-scale energy storage leaderboard in 2018 and was named one of Fast Company's Most Innovative Companies in 2019.

To learn more about Fluence, please visit fluenceenergy.com.