IHS Markit

ENERGY STORAGE NORTH AMERICA

Clean Technology & Renewables

Global Grid Transformation

ESNA 2019: Enabling the transition to a low-carbon, resilient and affordable power grid through energy storage

Introduction

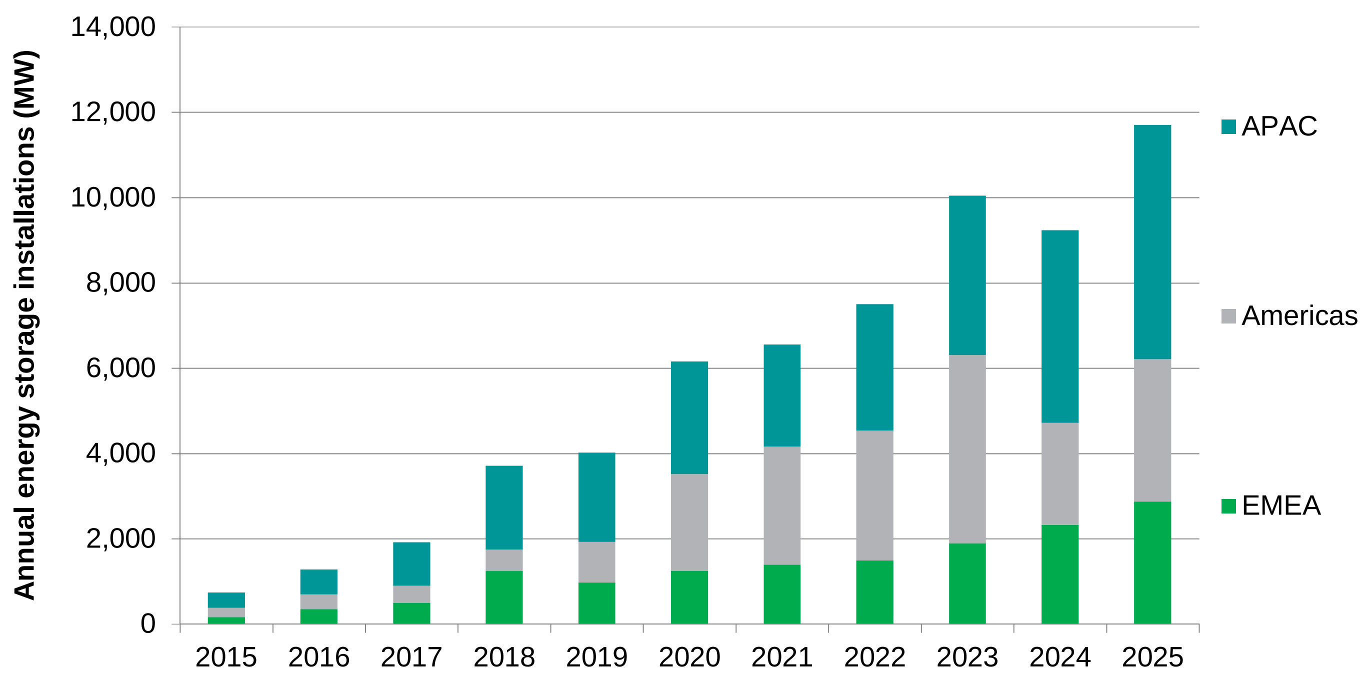
This is a report from the Global Grid Transformation (GGT) conference track at Energy Storage North America (ESNA) 2019, which took place in early November in San Diego, California. The event brought together key stakeholders from over 35 countries to exchange ideas, share success stories, and brainstorm on key challenges, with a focus on **promoting a low-emission, resilient, and affordable power grid.**

IHS Markit worked together with ESNA to prepare this white paper, providing thought leadership and a summary of the discussion at the event. Through enabling industry collaboration, IHS Markit and ESNA hope to highlight key challenges and aim to provide **actionable insights to delegates and readers**.

A globalizing energy storage market is opening **unprecedented growth opportunities** for a relatively young industry. As shown in the graph below, IHS Markit predicts that annual global installations of stationary energy storage will grow from less than **3.7 gigawatts (GW) in 2018 to more than 11.7 GW annually in 2025**, reaching cumulative installations of 63.7 GW / 174 gigawatt-hours (GWh)[1].

ESNA 2019 highlighted the benefits of **global collaboration**, as international participants came together to discuss four of the key topics that are leading the conversation in the energy storage industry. Participants openly shared challenges, differing regulatory approaches, and views on key actions to ensure energy storage is best positioned to facilitate the **transformation of our energy systems to being low-carbon, resilient, distributed and economic**.

Global annual grid-connected energy storage installations by region



Excludes: Pumped Hydro, Hydrogen, thermal and gravity energy storage
Source: IHS Markit

[1] Data based on IHS Markit Grid-connected Energy Storage Market Tracker; excludes Pumped Hydro, Chemical and Thermal energy storage.

Highlights from the Global Grid Track

Energy storage is incredibly diverse and offers a tremendous amount of value in supporting the transformation of our energy systems to being low-carbon, resilient, distributed and economic. The discussions during the ESNA Global Grid Track highlighted the following:

- It is necessary to create **market-based incentives and reform tariff structures** to enable energy storage to capture its **full value**.
- **Resilience** is becoming a major issue. Regulators need to accelerate the development of frameworks and revenue streams that **value the role storage plays in enabling more resilient electricity networks** – something that will be crucial in the long-run due to the intermittency of renewable generation and increasing catastrophic weather events.
- **Technology diversity** is needed to address the multi-facetted challenges our future energy system is facing. Lithium-ion batteries are a great technology suitable for many of the challenges we see today. However, we must **incentivize technology diversity** to support the long-term decarbonization of the power sector and creating resilient electricity networks, as well as enabling non-battery powered alternative transport.
- There is broad recognition and consensus that **longer duration storage will be needed**. As demand and renewable energy penetration increases, **bulk energy shifting becomes a necessity**.
- In enabling the transition of our energy system, an opportunity exists to **incorporate energy storage with existing infrastructure across sectors** – such as hybridization or re-using thermal assets with green hydrogen – to optimize and ensure affordability.

The ESNA Global Grid Transformation track focuses on developing on actionable outcomes designed to make an impact in advancing the energy storage industry. The following sections will provide insights into the individual sessions, before summarizing key action items.

Decarbonizing the Power Sector and Maintaining Reliability: Solutions for Multi-Day and Seasonal Storage

With more than half of the states in the United States adopting renewable energy goals, and states such as California targeting 100% clean energy by 2045, the need for storage and especially long-duration bulk storage is becoming more pressing. This is evidenced by ever increasing amounts of curtailed renewable electricity. For example, in the first five months of 2019, the California Independent System Operator curtailed 630,864 MWh of wind and solar generation, compared with 287,057 MWh in the same period in 2018. Finding ways to better match the supply of abundant low-cost renewable generation with demand throughout the year will require longer duration storage, including multi day and seasonal storage. Without significant deployment of long duration storage, clean energy policy goals will not be met.

Today, multi-day and seasonal storage is achieved via the storage of fossil fuels – such as natural gas in the gas pipeline and in underground caverns. This same infrastructure can also be utilized to store renewable energy, in the form of compressed air or hydrogen made from renewable energy. The big challenge will be to find ways to compensate developers for storing renewable energy for long durations including multi day and seasonal time periods. Within this, it will be crucial to price in the value of zero carbon reliability – a cleaner alternative to utilizing fossil fuels for the same purpose.

To successfully navigate this transition, pathways to increase coordination are needed, particularly since the solutions span not only silos within the power sector, but adjacent sectors such as the gas sector. It will be crucial to include these new longer duration storage solutions in ongoing planning efforts and to develop market-based incentives such as long-term contracts for renewable reliability and resiliency. This can work in unison with specific incentive tools such as an Investment Tax Credit for standalone energy storage, which is currently under consideration in Congress. While such market and direct incentives would also be favorable in existing markets, they have a pivotal role in enabling the accelerated development of long-duration, bulk storage.

> ***"Just to meet policy goals in the next five years, we are going to need significant amounts of long-term storage"***
>
> Laura Nelson, Executive Director, Governor's Office of Energy Development, Utah

Lithium-ion batteries, which today account for approx. 90% of installed battery energy storage capacity, work very well for time shifting energy within a shorter duration. Lithium-ion batteries are becoming feasible for up to 8 hours of storage. However, beyond that costs become prohibitive and technology characteristics less favorable, highlighting the need for alternative technologies. These solutions may include alternative battery chemistries, mechanical and thermal technologies, as well as 'green' hydrogen produced through renewable energy. Policy makers and regulators should thus incentivize a wide range of technologies and foster cross-industry collaboration to drive their deployment.

To accelerate the development of long-duration, bulk storage across industries, forming a specific multi state, multi-jurisdictional task force could address the convergence of gas and power sector via renewable hydrogen storage. As part of this the delegates of the Global Grid Track identified the following priorities:

- Ensure that long duration solutions, including multi-day and seasonal solutions are properly integrated into ongoing integrated resources planning efforts
- Devise compensation mechanisms so that energy storage can be compensated for reliability and resilience, including both centralized wholesale market solutions as well as distributed solutions.
- Devise new wholesale and retail tariffs so that green hydrogen can be made from renewable electricity via electrolysis.
- Create hydrogen injection standards so that 'green' hydrogen or methanated green hydrogen can be injected into the existing gas infrastructure.
- Demonstrating use of renewable hydrogen to displace natural gas in thermal units (existing thermal generation can combust hydrogen with natural gas up to an allowable blend) and compensating these plants for their lower carbon footprint.

Energy Storage: Where the Power Sector & Transportation Meet

IHS Markit expects global battery EV[2] sales to reach up to 40 million per annum by 2030, from less than 2 million in 2018. Already, e-mobility is driving investment across the automotive industry, with automakers committing more than $300 billion of investment into alternative modes of transportation. Simultaneously the increase in EV ownerships is creating new challenges for power systems and distribution networks.

EV charging is changing customers' demand patterns, increasing overall system demand and shifting peaks. The more serious impact will however be at a local network level, where grid infrastructure is inadequate to deal with growing customer peaks – especially in the commercial sector – and the deployment of ultra-fast charging stations. Especially as medium and heavy-duty vehicles begin to be electrified, tens of MW of additional demand on a single node are expected in the foreseeable future. Simultaneously EVs require a change in user and driving behavior, with a lack of education and incentives exaggerating the challenges.

Encouragingly, operators of EV charging points and operators deploying vehicle capacity into energy markets, are already seeing that EV can be an active tool to manage these issues. Already EV charging is supporting the grid by countering the duck curve, through smoothening demand and driving behavior meaning vehicles are on the road during high load periods. Early commercial projects driving vehicle-grid-integration with smart charging and bi-directional vehicle-to-grid (V2G) are supporting local networks.

EVs in the aggregate can be a smart demand resource, as well as serve as a virtual power plant of distributed energy storage asset. To accelerate this, regulators need to create a level playing field for aggregated EV battery storage capacity to participate in real-time electricity and ancillary services markets. Competitive markets will allow industry to find the lowest cost, highest-value solution to provide critical grid flexibility. While enabling EV to provide system value, it is crucial to develop new retail rates that incentivize the system-beneficial behavior and creates additional value for the customer. Automotive OEMs have a crucial role to collaborate with the power sector to advance regulatory proceedings and enable vehicles to have the necessary onboard capabilities.

As new value is created for customers and at the system level, it is paramount to educate customers. There should never be a negative impact on a customer's mobility needs. Thus, customers need to fully understand the impact on them, their running costs and the full value they receive, all while operators of these assets need to minimize intrusion. Generally, and especially as rate structures change, customers need to understand how the costs of an EV are being reflected on their monthly power bill.

To reduce the impact of EV on the power system and advance their roles as a flexibility resource, it is critical to address the gap in customer education, developing cost reflective time-of-use rates, allowing participation in real-time energy markets and developing propositions for the diverging needs of commercial and personal-use customers.

[2] Including pure battery EV and plug-in hybrid EV, based on IHS Markit EV demand scenarios

Rebuilding in the Wake of Disaster

Hurricane Maria devastated infrastructure and caused long-term supply challenges in Puerto Rico, and wildfires in California have in part been blamed on distribution network failures and led to subsequent widespread outages. As climate-change is increasing the frequency and strength of natural disasters, this has elevated the critical role that energy storage plays in not only providing resilience, but also supporting the rebuilding in the aftermath of natural disasters.

While it is almost impossible to achieve complete resilience against all forms of natural disaster, there are several obvious and effective solutions increasing resilience – one of those being energy storage. Energy storage can provide resilience at many different levels, and through proper system planning provides a holistic solution:

- Initially securing critical facilities such as hospitals and emergency services through uninterrupted power supply (UPS) and back-up power, with on-site generation ensuring continued operation.
- Energy storage as part of microgrids can support the islanding of whole communities.
- In the home, solar plus storage – if designed accordingly – helps customers keeping the lights on, even over long periods of outage.
- Battery energy storage and thermal storage solutions prevent food and other perishables from going off.

Energy storage can thus support resilience across the power system, but one of the crucial challenges is how to best optimize storage and other resources and how to create value streams for providing such resilience services. In addition, it should be considered how to price wider economic losses caused by natural disasters into valuing energy storage. Storage paired with solar or other on-site generation creates the capability for critical facilities and end-customers to be self-sufficient and through that provides a rapid solution to restore power in the wake of disaster. Thus, incentivizing solar and storage, but also potentially mandating that distributed solar and storage installations are capable of islanding, will accelerate uptake.

As energy storage can provide critical resilience across the power system, it will be crucial to create a framework that values this resilience provided. To achieve this, the value of resilience that different resources can provide, should be built into Integrated Resource Plan (IRP) valuation and planning models. To support the business case for isolated microgrids that can be islanded, these should receive additional value for supporting critical infrastructure in the case of an outage which can reduce local economic losses. At the same time the planning of network topologies to identify and enable islanding in critical locations could provide optimal outcomes. The total losses from the PG&E power shutoffs in Northern California were estimated to be up to $2.5 billion, with local businesses hit hard.

Thermal Fleet Retirement & Replacement

Natural gas-fired power plants provided over a third of US electricity generation in 2018, a share that is expected to increase in 2019 and beyond as coal plants retire. It is undoubtedly a vital resource in keeping the power system both reliable and affordable. As power systems transition to a low-carbon, high-renewable resource fleet, it is important to be forward thinking and incent the appropriate procurement of resources to manage grid variability. Today's gas plants can play that role to an extent, but rising penetrations of wind and solar will require even faster and more flexible resources to balance them.

Fortunately, hybridization of battery technology with gas-fired generation offers just such a solution. Integrating battery storage allows gas generators to quickly ramp to maximum output and to be turned down immediately without incurring maintenance costs—enabling a much wider range of flexibility compared to turbines that are common today. In addition, hybridization allows gas turbines to run more efficiently while they cycle, reducing operating cost, water consumption, and emissions, and enables them to provide vital operating reserves while they are offline (i.e. emissions-free reserves). In many respects, battery-gas hybrids are greater than the sum of their parts—achieving the hyper-flexibility of battery technology across a wider operating range, all while maintaining the reliability attributes of conventional thermal asset.

““From a regulatory perspective, we don't care where the storage is located so long as it meets the purpose it is trying to meet. If storage wants to start dating a gas plant, that's great that it chooses to couple that way, but we still consider the storage as an individual [regardless of who it is hanging out with…]”.”

Molly Tirpak Sterkel, Program Manager, Infrastructure Planning and Permitting at California Public Utilities Commission

How might this integration play out in practice? Initially, short duration batteries can be added to improve the performance of existing gas plants that are needed for reliability. Over time, the storage duration can be expanded—capitalizing on the modular nature of Li-ion batteries—so that the gas-fired component of the plant only turns on in the event of a multi-day or seasonal need. Importantly, only a subset of the gas fleet needs to be hybridized to realize many of the benefits. By dramatically increasing the flexibility of part of the thermal fleet, the remaining group can avoid most of the ramping it would otherwise be required to do, resulting in more efficient operations and lower maintenance costs.

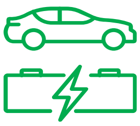
There are challenges to realizing this vision however, that go beyond simply adding more renewables to the grid. Even in cases where hybridization may make economic sense today, plant owners are unlikely to undertake expensive retrofits without long term investment certainty—they need to know that the flexibility they are paying for now will have market value down the road. To create this certainty, both the storage and gas communities need stronger collaboration with regulators so that regulators can understand the value of hybrids and create mechanisms to reward it. In addition, regulators need to explicitly allow repowering of newer thermal units for the addition of energy storage. Finally, hybrid battery-gas resources need to be explicitly modeled in resource planning efforts—as California has recently done with its 2019 Integrated Resource Planning efforts.

As we move towards a more sustainable future, energy storage will improve the stability of the grid by enabling a variety of existing assets, including generators (gas and renewables), to operate more cost-effectively and with greater functionality.

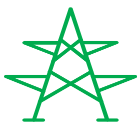
Conclusions and Action Items

With renewable energy targets becoming more aggressive, and decarbonization driving the electrification across the transport sector the need for energy storage is becoming more pronounced. Especially considering the growing need for greater reliability and resilience, long-duration energy storage and new technologies will play an increasing role.

The need for long-duration bulk storage intensifies as renewable penetration grows. Compensating energy storage for the resilience and reliability value it provides and including these resources in ongoing planning models will be crucial. Technology diversity and accelerating innovation are needed to develop future solutions.



E-mobility is driving investment across the automotive industry, but EV uptake creates new system and local network challenges. To reduce their impact, EV need to be used as a flexible resource with access to wholesale and ancillary services markets.



Natural disasters are intensifying highlighting the lack of resilience in many power grids. Deployment of energy storage across different segments will help strengthen resilience, while ensuring fast response in the wake of disaster.

As power systems transition, faster and flexible resources are required. This can be achieved by hybridizing gas-fired generation with energy storage, reducing emissions while ensuring reliability.

To enable and accelerate this transition, policy makers and regulators need to work closely with industry. Direct incentives will be needed to support new entrants and technologies building a track record through demonstrators that allows them to participate in ongoing utility procurements. More importantly it is pivotal that market frameworks accurately value the capabilities of energy storage assets through:

- Tariff structures that reward flexibility and encourage re-purposing of existing infrastructure
- New approaches to resource planning that involve diversity of storage solutions
- Establishment of technology neutral incentives
- Ability to recognize and monetize the value of energy storage for reliability and resilience purposes, including use of energy storage for multi-day and seasonal storage to shift abundant low-cost renewable energy

Finally, industry and multi-sector collaboration need to be incentivized, busting through jurisdictional and regulatory barriers. Perhaps, creating an application specific taskforce that curs across jurisdictions, regions and sectors.

About Energy Storage North America

Energy Storage North America (ESNA) is the largest dedicated conference, exhibition and networking event covering all applications of grid storage in North America. ESNA connects utilities, developers, energy users, policy makers and other key stakeholders from around the world to advance understanding and deployment of energy storage, and ultimately build a cleaner, more affordable and more resilient grid November 10-12, 2020 in San Diego, CA, USA. www.esnaexpo.com

Prepared by:

IHS Markit

Julian Jansen, Research & Analysis Manager

Sam Huntington, Associate Director

Prepared for:

ENERGY STORAGE NORTH AMERICA

@EnergyStorageNA

#ESNA2018

www.esnaexpo.com

With support from:

STRATEGEN

In collaboration with:

INTERNATIONAL TRADE ADMINISTRATION

For more information www.ihsmarkit.com

Americas
T +1 844 301 7334
E technology_us@ihs.com

Emea
T +44 (0) 13 44 32 81 55
E technology_emea@ihs.com

Apac
T +60 042913763
E technology_apac@ihs.com

About IHS Markit

IHS Markit (NYSE: INFO) is a world leader in critical information, analytics and expertise to forge solutions for the major industries and markets that drive economies worldwide. The company delivers next-generation information, analytics and solutions to customers in business, finance and government, improving their operational efficiency and providing deep insights that lead to well-informed, confident decisions. IHS Markit has more than 50,000 business and government customers, including 80 percent of the Fortune Global 500 and the world's leading financial institutions. Headquartered in London, IHS Markit is committed to sustainable, profitable growth.