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Global Grid Transformation

ESNA 2018: Australia, Europe, Americas

Facilitating the advancement of the energy storage industry

Introduction

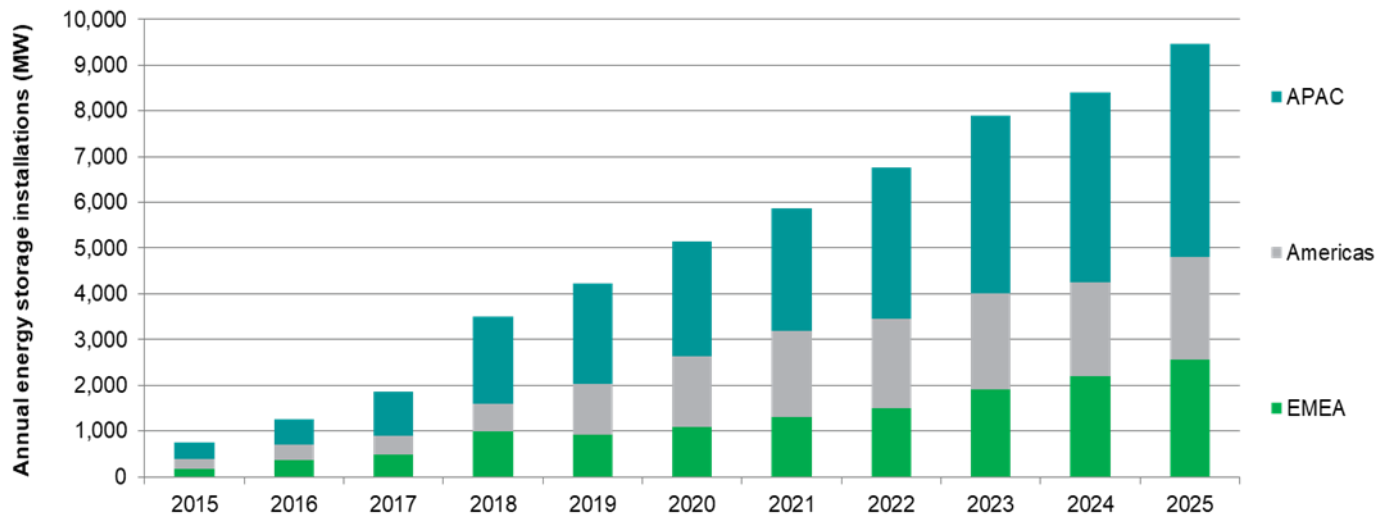
This is a report from the Global Grid Transformation (GGT) conference track at Energy Storage North America (ESNA) 2018, which took place in early November in Pasadena, California. The event brought together key stakeholders from Australia, Europe, and the Americas to exchange ideas, share success stories, 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 a recap of the most important points faced today by the energy storage industry, including how various markets are developing and how stakeholders can identify and target growth opportunities for energy storage.

A globalizing energy storage market is opening unprecedented growth opportunities for a relatively young industry with the capability to cover diverse geographies following a wave of industry consolidation in 2016 and 2017. IHS Markit predicts that annual global installations of stationary energy storage will grow from less than 2 gigawatts (GW) in 2017 to more than 9 GW in 2025, reaching cumulative installations of 56 GW /141 gigawatt-hours (GWh). The range of energy storage technologies and innovation creates a diverse toolkit to tackle a host of challenges created by the transformation of the energy sector. At the same time, growth is creating challenges for all stakeholders:

- Integrators are facing supply constraints when procuring Li-ion batteries, while also looking for bankable alternative technologies.
- Policy makers and regulators are developing new frameworks to enable and accommodate such growth.
- Financiers are searching for firm revenue streams and attractive returns.
- New, alternative technologies are being brought to market (especially for long-duration energy storage), but often struggle to secure capital and project contracts.

At ESNA 2018, participants came together for three concurrent roundtable discussions on each region, followed by joint sessions on wholesale market design and distributed energy storage. Participants openly shared challenges, differing regulatory approaches, and views on how to best integrate energy storage into their region's future energy needs.

Global annual grid-connected energy storage installations by region



Notes: Includes all types of battery energy storage, flywheels. Excludes chemical energy storage, pumped-hydro energy storage, thermal energy storage, hydrogen, capacitors, underground CAES.
Source: IHS Markit

Main discussion topics

The key discussion topics? emerging from the various roundtables and panel discussions cut across all regions and countries, showing that companies, policy makers, and regulators strongly benefit from the type of exchange and cross-border collaboration showcased at ESNA.

A major challenge identified by participants from all regions was the lack of a clear definition of energy storage resources within regulatory frameworks in terms of asset class, technology inclusion, and remuneration. This affects ownership structure and can hinder procurement by utilities.

IHS Markit estimates global solar photovoltaic (PV) additions to reach 103 GW in 2018, growing to annual additions of 152 GW in 2022. The continued growth, especially of utility-scale solar, is creating new challenges for transmission and distribution (T&D) infrastructure, as well as for the supply and balancing of electricity. Spirited debates during the conference revolved on determining the best approaches to integrate and reward energy storage as a pivotal tool to mitigate these challenges.

The continued rise of distributed energy resources (DER) has created a class of electricity "prosumers"—customers who now generate and consume their own electricity. At the same time, the digitalization of the energy sector is enabling aggregation of distributed energy storage assets as part of Virtual Power Plants (VPP) and demand response contracts, allowing customer-sited assets to potentially participate in wholesale and flexibility markets. The key question remains how to intelligently control and optimize such assets, while simultaneously ensuring that the value they provide is rewarded.

Key insights from roundtable discussions

The following section will provide an overview of the key discussion points raised for each region, highlighting the diverse roles that energy storage will play within each region's future energy system, as well as the major learnings and outcomes that emerged during the discussions on future wholesale market design and the integration of DER.

Australia

Rooftop solar installations in Australia have reached high levels of penetration, and demand for utility-scale solar is increasing rapidly. The challenges created by the intermittency of renewables are heightened by the closure of baseload assets and high gas prices, making new conventional flexible generation uneconomical. This presents a prime opportunity for energy storage. At ESNA 2018, market influencers held intense discussions on the challenges faced by Australia—and how to capitalize on the resulting opportunities created for energy storage.

Distributed energy storage

With more than 7.6 GW of rooftop solar installed to date in Australia, IHS Markit expects high additions to continue—albeit at a slower growth rate—across both the country's residential and commercial segments. In some Australian states, residential PV penetration has reached significant levels; for example, close to 40% of homes in Queensland have installed PV systems to date. Meanwhile, in South Australia, Victoria, and the Australian Capital Territory, incentive programs for small-scale storage installations and high electricity costs have driven uptake of residential energy storage systems to maximize solar self-consumption.

This is creating challenges for both energy suppliers, who are losing customers, and grid operators, who are facing issues around load and generation forecasting as well as displacement of incumbent energy infrastructure.

Despite these challenges, distributed energy storage is creating the opportunity to move away from a traditional view of electricity customers. Already, Australian utilities and regional governments are looking to develop and incentivize aggregation as part of Virtual Power Plants to provide:

- Optimization of a bi-directional flow of electricity against a range of ancillary services
- Appropriate financial rewards for DER and end-customers to provide such services
- A framework that incentivizes energy storage to unlock the market value

Despite this positive outlook, steps are still needed to advance the development of distributed energy storage to provide such additional value. Moreover, connection and technical standards require updating, inverters need to have smart capabilities, and the regulatory framework must allow for aggregated DER to participate in wholesale and ancillary services markets.

Utility-scale PV amplifies the need for utilizing storage

Demand for utility-scale PV in Australia is increasing rapidly, with annual installations growing from approximately 600 megawatts (MW) in 2017 to 3.4 GW in 2018. In the past three years, the utility-scale solar market was driven by the country's Renewable Energy Targets and auctions held by the Australian Renewable Energy Association (ARENA), an independent agency of the Australian government charged with managing the country's renewable energy programs. But going forward, the market will increasingly be based on power purchase agreements (PPA) and merchant projects.

Because of the PV market's rapid growth, the biggest challenge for the country will be the increasing bottlenecks emerging around grid connections. With many grid-connection points reserved for solar PV projects, the development of large-scale projects will decrease significantly. Yet energy storage can be a feasible option to develop larger projects by utilizing an existing grid connection. Additionally, the movement toward a merchant solar market could create opportunities for storage to provide wholesale arbitrage.

Energy market integration of front-of-the-meter energy storage

Across Australia, the closure of baseload assets is heightening the need for storage, as intermittent renewables make up a greater share of the energy mix. At the same time, opportunities for new flexible gas-generation plants are limited, owing to the high price of natural gas. Challenges have been amplified especially in South Australia given the deep penetration of centralized and decentralized renewable generation; as well as in Western Australia, where a sparse population across a vast territory is driving the decentralization of energy generation and supply through microgrids.

At present, Australia's market operators are considering the introduction of a new scheme to recognize and maximize the value of storage systems. The developments across the Australian energy sector, as outlined throughout this section of the whitepaper, are not only causing more capacity reserve challenges but are also leading to increasing deployment of battery energy storage targeted at lucrative frequency regulation markets.

The provision of frequency regulation with battery energy storage system is considered the low-hanging fruit. But as in other international markets, it is an opportunity quickly exhausted due to relatively limited market requirements. In Australia this situation is amplified, as shown by the prominent 100 MW Hornsdale Power Reserve project. While the project has been considered a success in proving the capability of storage to rapidly restore system frequency, it has also uncovered some fundamental issues in the Australian energy market. The higher performance achieved by the project, for instance, has led to a significant drop in frequency regulation pricing, because speed of response is not adequately compensated in the Australian energy market.

Europe

Grid-connected energy storage installations in Europe will grow from 455 MW in 2017 to 905 MW in 2018. After a short period of intense growth, which was led by the exploitation of short-term opportunities in frequency regulation markets in Germany and the United Kingdom, the market will stabilize before reaching more than 1.8 GW of annual installations in 2025.

Unlike other regions, the European market is more dependent on the growth of behind-the-meter energy storage, based on a particularly strong residential and an emerging commercial and industrial market. The short-term deceleration, often observed once frequency regulation markets are saturated, is allowing policy makers and regulators to catch up and develop the necessary frameworks to allow effective energy storage integration.

An expert panel of key stakeholders—including trade associations, utilities, aggregators, and policy makers—took on the challenge to debate a hugely diverse region, looking to draw out similarities and cross-border learnings.

Different system approaches create a complexity across European markets

The pivotal considerations when assessing the market across Europe are the differences in market structures and potential approaches regarding the future integration of energy storage.

- Germany remains a very centrally controlled system, despite the continuous growth of renewables and DER. Under current considerations, it appears that regulators are favoring traditional infrastructure investments over the support of distributed energy storage and flexibility. Panelists at ESNA highlighted that the current unclear and outdated regulation needs to catch up to enable future energy storage resources to provide systemic benefits outside the provision of frequency regulation.
- In the United Kingdom, the "Future of Balancing Services" strategy outlines how energy storage and other DER will be able to contribute to a wider range of ancillary services, reducing barriers to market participation. Additionally, distribution network operators are evolving and are looking to directly procure local network services.

- In Austria, a significant installed base of Pumped Hydro Energy Storage is reducing the need for additional resources, with some limited opportunities for providing frequency regulation and to potentially reducing operational cost of existing hydro turbines.
- Elsewhere, opportunities continue to evolve in diverse ways from the development of fast frequency regulation tenders in Ireland, to solar-plus-storage development as part of tender programs in the French islands and overseas territories, as well as direct incentives for behind-the-meter energy storage in the Czech Republic.

The European Union's clean energy package is explicitly considering energy storage as part of a new wholesale market design. The plan, currently under discussion, aims to provide greater clarity around how energy storage is defined, and more importantly, looks to solve whether system and network operators can own and operate energy storage assets, especially when these may be participating in wholesale and ancillary services markets.

Sector coupling and the role of new technologies

One of the main discussion topics throughout the European roundtable discussion was the role of sector coupling and alternative energy storage technologies, other than batteries. In this regard, the European discussion differed from that of other roundtables at ESNA 2018. Specifically, panelists looked to highlight the following opportunities:

- As the build-out of charging infrastructure for electric vehicles (EV) accelerates, many network operators are increasingly worried about the impact of EV charging on distribution networks. To this end, energy storage is being tested as the key resource to support the effective integration of fast-charging infrastructure without infrastructure becoming significantly constrained in the process.
- To achieve the European Union's target to cut greenhouse gas emissions 40% by 2030, the decarbonization of heat remains the key outstanding challenge. Panelists highlighted the need to advance power to heat and thermal storage technologies to accelerate progress.
- To accelerate technology diversity and the advancement of non-battery energy storage, the creation of technology neutral regulatory frameworks and incentive programs was highlighted as a necessity across European market.

Americas (Mexico and South America)

To date, less than 200 MW of battery energy storage has been installed across Central and South America.

IHS Markit predicts that more than 1.4 GW of new grid-connected energy storage will be installed across the region between 2018 and 2025, with the front-of-the-meter segment dominating.

The Americas roundtable brought together a range of participants from Mexico—including CENACE, the country's national energy regulator—together with utilities and regulators from the United States. While discussing the wider challenges across Central and South America, the roundtable primarily focused on developing the Mexican energy storage market and what could be learned from experiences in California and across the United States.

In Mexico, a combination of high energy prices, insufficient or constrained transmission infrastructure, and a high penetration of renewable generation is creating a strong mix of fundamental drivers for energy storage. This combination is strongest in Baja California Sur and on the Yucatan peninsula, which form ideal test beds for developing and understanding the potential of different energy storage solutions. However, despite a strong set of market fundamentals, the lack of market rules and financing is holding back the industry. Participants during the roundtable agreed that to advance the industry in Mexico and across the region, a simpler approach is needed to deploy assets and better understand the technology's capabilities and to pilot new regulatory development.

Integration of utility-scale solar

IHS Markit expects cumulative utility-scale PV installations in Mexico to exceed 3.1 GW by the end of 2018, with total installations across all segments to surpass 3 GW p.a. over the next two years. Driven by a host of policy incentives including renewable energy auctions, clean energy certificates, and increased direct supply via PPAs for commercial and industrial users, the Mexico market is expected to remain relatively stable.

During the discussions at ESNA 2018, participants noted the excellent solar resources in Mexico, but drew attention to the challenges caused by the recent exponential growth of solar PV installations:

Country snapshots: Central and South America

- **Mexico – Significant deployment of utility-scale solar PV is leading to grid constraints in several regions, especially in Baja California Sur. Regulators and policy makers have started to develop a new regulatory framework for storage.**
- **Puerto Rico – Ramp-rate restriction on PV systems created a short-term opportunity for battery energy storage. Following Hurricane Maria, energy storage is seen as a crucial resource to increase resiliency.**
- **Chile – After years of stagnation, in one of the earliest markets for battery energy storage, future regulation on ancillary services could make Chile one of the most attractive markets in the region.**
- **Brazil – Funded research and development pilots form most of the market opportunity.**
- **Caribbean islands – Projects are being developed across several countries to reduce reliance on fossil fuels and increase energy independence.**

- CENACE expressed concern about an intensifying "duck curve", which will create significant need for time-shifting intermittent solar generation.
- Additionally, in several regions—especially Baja California Sur—limited transmission system capacity and poor interconnection are leading to grid congestion and potential constraints around absorbing further PV capacity. Energy storage is seen as a necessary solution to enable the further growth and build-out of utility-scale solar in those areas.

Meanwhile, it is important to also allow and encourage other applications and models to flourish—for example, the use of renewables and storage to provide dispatchable renewable capacity to be bid into wholesale markets, guaranteeing long-term PPAs; and even considering the hybridization of existing thermal generators with energy storage. Participants highlighted that encouragement should come in the form of developing ancillary services market rules and products as an additional value stream for such projects.

Energy storage as a transmission asset

Constrained transmission infrastructure is posing one of the greatest challenges for the Mexican power sector. While it can in part be linked to the increase in renewable generation, several other issues amplify the challenges faced:

- Growing congestion across the transmission system, especially in poorly interconnected areas that are seeing significant renewable uptake
- Mexico's electricity demand is expected to grow at 4-5% p.a. The increasing load is putting further stress on T&D infrastructure
- Insufficient T&D infrastructure, and the need for additional investment

Energy storage can provide a valuable resource to overcome these challenges and enable long-term growth of renewables, while ensuring reliability and cost-effective grid expansion. Most importantly, energy storage can be deployed quickly as an alternative to a costly investment into major transmission upgrades.

During the roundtable, participants also said energy storage can be attractive, not in spite of—but because—energy storage is a more flexible asset with a shorter investment horizon. Put simply, a battery storage system provides more flexibility than a transmission asset with a 30-year lifespan. By deploying battery storage, system operators can re-evaluate needs as—and when—load and generation profiles change over time.

The main challenge outlined during the discussion at ESNA 2018 was how to allocate costs for storage as a transmission asset. While in some cases the transmission value may be sufficient, in most cases supplementary value streams are needed. Such value could come from wholesale or ancillary services markets, which may often lead to clashes on the utilization of a storage asset against different value streams, raising questions over optimum control strategies.

Procurement of energy storage

Finally, participants from Mexico looked to the United States to better understand the best practices in energy storage procurement. Even in more mature markets such as California, it can be difficult to develop energy storage projects on merchant revenues alone, especially when stacking multiple revenue streams. Hence, storage needs to be considered in comprehensive resource planning, including an evaluation of whether energy storage procurement should be rate-based or facilitated through the appropriate market rules.

In a nascent market such as Mexico, and across Central and South America, there is value in moving forward simply with commercially significant initial projects to test and evaluate the diverse capabilities of energy storage as a tool to overcome challenges of renewable intermittency, constrained T&D infrastructure, and integration of DER. This will allow local stakeholders to become more familiar with the technology's functionality, and it can be used also to pilot the development of new regulation and market rules. As suggested by participants of the roundtable, a promising approach could be for energy regulators, CENACE, and the World Bank to craft the specifications, financing and procurement package for a new commercially significant energy storage project. Working together with the state-owned utility, CFE, to develop the project and rate-base the asset to enable immediate deployment would help stabilize the grid and facilitate increasing penetration of renewable energy.

Such a project would aid current efforts in drafting new framework regulations in integrating energy storage. A major demonstration project would facilitate comprehensive planning and the consideration of energy storage as an alternative solution. Only through experimental testing will stakeholders be able to understand the definition of jurisdictional roles, grid modeling and planning, safety considerations, and local job training requirements.

The roundtable discussion concluded by identifying Baja California Sur (BCS) as an attractive starting point particularly because a high voltage undersea transmission cable connecting BCS to the mainland is already being considered; effectively establishing the cost target for energy storage and renewables to beat. The Yucatan peninsula was also identified as a high priority area, where many of the challenges outlined throughout this summary are amplified.

Best practices in wholesale market design

During this session regulators, energy market operators, and utilities came together to exchange perspectives and key learnings to advance the integration of energy storage within wholesale markets.

While in the United States FERC Order 841 is removing major barriers for storage to participate in wholesale markets, many other countries and regions still struggle to define energy storage within their regulatory frameworks and to enable appropriate valuation and reward structures.

While a definition of energy storage assets is being developed at present at a European Union-level and in the United Kingdom, this remains inherently difficult because of the various technologies involved and their differences in performance and potential value.

Key challenges

- **Defining energy storage within regulatory texts remains challenging due to the difference in technologies, making it difficult to develop robust parameters for performance comparison.**
- **Utility ownership of energy storage can potentially distort market dynamics. At the same time, the topic of who should control the operation of assets remains divisive.**
- **Market regulators and system operators must develop the appropriate frameworks to adequately value the diverse energy storage capabilities and speed of response for providing ancillary services.**
- **The lengthy timing of regulatory changes puts the market design at risk of being left behind by advances in the energy storage industry.**

Defining energy storage as an asset class will subsequently impact the ability of utilities to own and operate energy storage assets. This could distort market dynamics, especially where energy storage assets also participate in wholesale electricity markets. Additionally, in the case of distributed behind-the-meter storage, a utility may have an unfair advantage in accessing customers and selling energy directly to existing electricity customers.

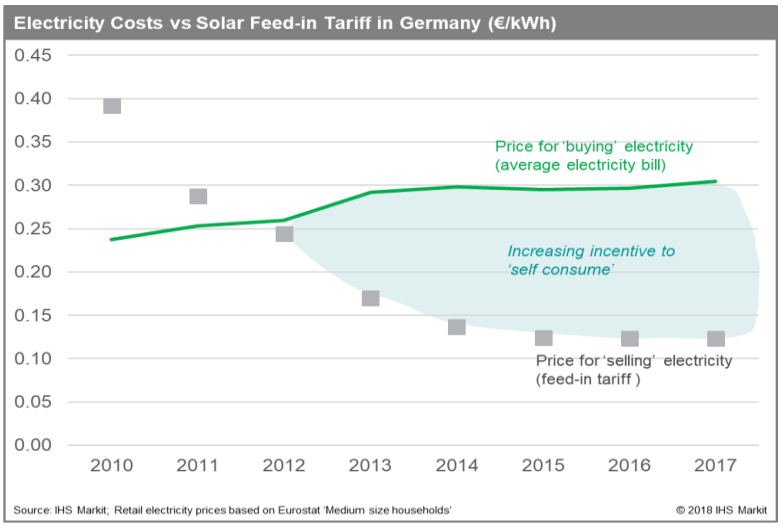
Aligned with the ownership challenge is the question of who should manage the state of charge and operational optimization of a storage asset, so that critical balancing services could be provided. System operators are arguably best-positioned to optimize storage assets from a resource management standpoint, while ensuring that the speed of response provided by storage assets is utilized in the most effective way. Simultaneously, where energy storage provides services to both the system and distribution network operator, there may be a conflict of interest when left to the asset owner to self-manage the energy storage system.

To ensure optimum performance within a future decarbonized, resilient, and affordable power grid, it makes sense to allow system operators to exercise some control over energy storage assets. Given the significant variations in energy market design, the ownership debate should be resolved at a regional level. In some cases, however, local utilities are best-positioned to own and operate storage assets. And in other markets, such as Europe, the procurement of local network services through network operators may be necessary to ensure competitiveness within the energy markets.

Integrating distributed energy storage

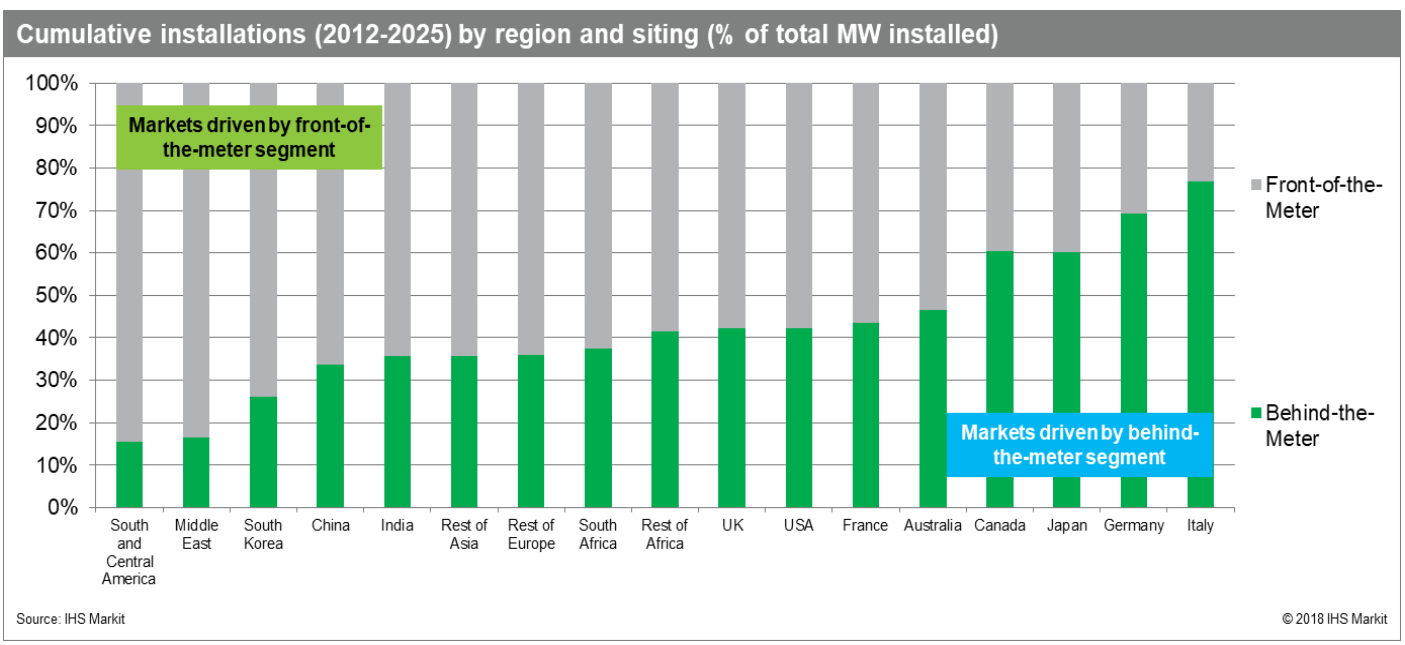
In many countries, it is now significantly cheaper to generate solar power than to buy power from an energy supplier. As the price of electricity has increased sharply for many end-customers, the cost of generating power from rooftop solar has decreased dramatically.

Simultaneously, other DER have also declined in price, and both commercial and industrial customers are taking advantage of attractive energy service offerings. As part of this shift, energy storage is being increasingly used to maximize self-consumption of self-generated power, as well as to save on energy costs through peak shaving and time-of-use optimization.



With behind-the-meter installations accounting for more than a third of global battery storage installations in 2018, the rise of distributed energy storage will continue. By 2025, IHS Markit predicts annual behind-the-meter installations of 4.8 GW. The digitalization of the energy sector is enabling the aggregation of distributed energy storage assets as part of a VPP and demand-response contracts, allowing customer-sited assets to potentially participate in wholesale and flexibility markets. The key question remains how to intelligently control and optimize the assets, while simultaneously ensuring the value that they provide is rewarded.

With the goal of electrification being to make life simpler, it will be unlikely that most people want to be re-educated to learn about the electricity system. Therefore, the concept of optimizing distributed storage assets within the energy system should be simple for the customer to understand and come about without disruption to their business or home. This leads to the challenge of whether system operators need to optimize distributed storage assets, and what type of market access is given to aggregators. Ultimately, the discussion at ESNA concluded with the view that utilities in the future must be able to interface with an innovative, fast-moving market and become a dynamic actor.



About Energy Storage North America

Energy Storage North America (ESNA) is the largest conference and expo for grid-connected energy storage in North America. In collaboration with the Global Energy Storage Alliance and the World of Energy Storage, ESNA 2019 will bring together the largest and most diverse group of global policymakers, utilities, commercial, and industrial customers, as well as storage industry stakeholders, for energy storage site tours, networking, workshops, and learning sessions—all with a focus on building the grid of the future. November 5-7, 2019 in San Diego, CA, USA. www.esnaexpo.com

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