CLEAN ENERGY TECHNOLOGY

Technology innovation underpins the growing role of energy storage in a lower emission and more reliable energy system

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Energy storage is a crucial enabling technology for a lower emission and more reliable energy system

2021 will be a record year for the energy storage industry as installations exceed 10 GW for the first time, increasing from 4.5 GW in 2020. As a critical component of the energy transition, energy storage systems are needed to help balance intermittency of renewable generation, provide a cost-effective and low-emission source of critical capacity, and empower customers to manage their energy demand.

Despite the uncertainty caused by current economic challenges, there has been an even stronger focus on mitigating climate change. This has stimulated the power sector's transition from fossil fuels to cleaner energy sources – driven by both policy and an influx of fresh capital.

Policy makers across the world continue to pivot towards taking greater climate change action outlining plans for greenhouse gas (GHG) emission reduction. In the United States, President Joe Biden signed the "Executive Order on Tackling the Climate Crisis at Home and Abroad," recognizing the urgency of the climate crisis and the need to put the United States on a path to achieve net-zero emissions by no later than 2050. Mainland China's momentous 2020 pledge to become net zero by 2060 sets 26% of today's GHG emissions on a path toward eradication. In Europe, the European Commission will start reviewing its renewables target, its carbon market and possibly consider a carbon border tax in 2021.

This policy drive, but also continued cost declines will be the foundation for continued growth in the deployment of renewable energy resources, with annual gross additions reaching almost 300 GW by 2024. The increase in intermittent renewable generation, coupled with the electrification of transport, drives emission reduction action. At the same time, it creates an ever more urgent need for critical system flexibility and "peaking" capacity.

Lithium-ion (Li-ion) batteries today provide the most cost-effective energy storage resource deployable at scale. In the long-term, 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. If energy storage fails to be integrated across the energy system, clean energy goals will not be met.

The global energy storage market will begin significant multiyear growth in 2021 as the technology begins to form a core component of power grids in developed markets, and new opportunities in developing markets continue to emerge. As markets mature and technology costs continue to decline, hybrid solar-plus-storage projects will become a natural combination underpinning growth. Favorable policies and new tender schemes will also drive the market.

Improving technology and continued cost reduction, will unlock significant growth not just in the next few years but lay the foundation for a long-term acceleration in deployment. Energy storage still faces many challenges in reaching mass adoption. These can be best addressed through innovative technology solutions to make storage system more intelligent and operations more robust.

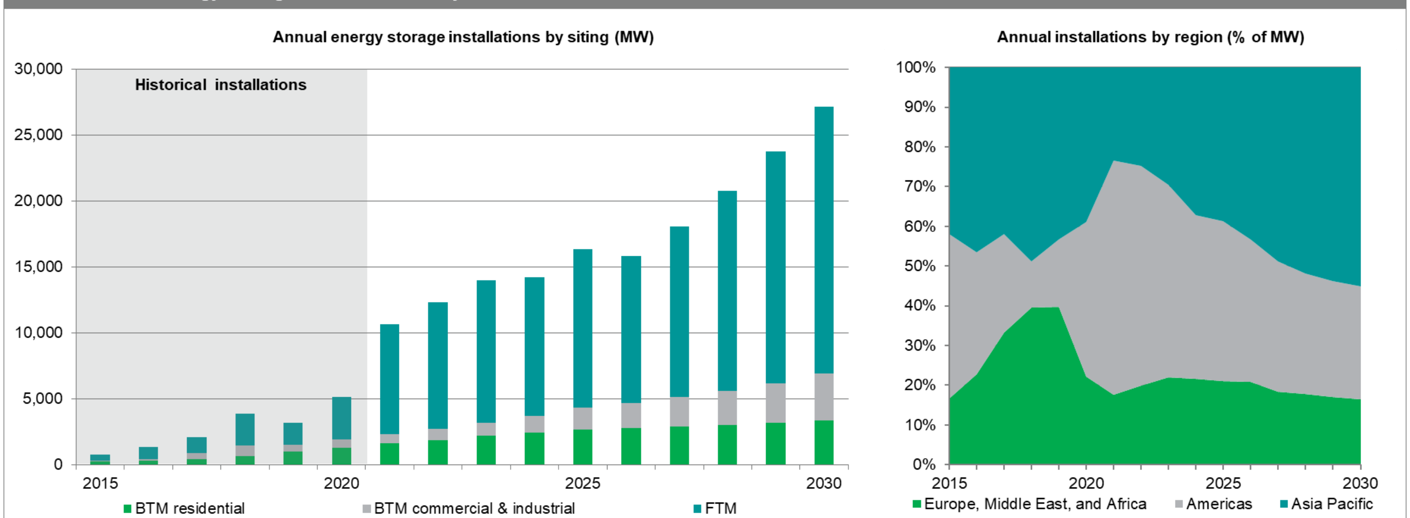
Battery energy storage – a fast growing investment opportunity

2021 will be a record year of growth as the market size exceeds 10 GW in annual installations for the first time. Over the coming decade annual installations will exceed 27 GW by 2030. In the short-term, the United States will continue to extend its dominance of the global market, gaining market share until 2023. The market will continue to be driven by the federal investment tax credit, recent regulatory reforms, increasing competitiveness of battery energy storage with conventional generation as a capacity resource, as well as states supporting storage markets by providing guidance in utility procurement processes and legislating energy storage targets, mandates, and incentives.

However, from 2025, aggressive decarbonization plans in mainland China will lead to rapid growth in the region, driving Asia Pacific to account for 44% of annual installations by 2030. A further sign of a maturing industry is the number of geographies where annual installations exceed 100 MW, which will increase from 9 in 2020 to 17 in 2022.

Mainland China's momentous 2020 pledge to peak carbon dioxide emissions before 2030 and become net zero by 2060 sets 26% of today's GHG emissions on a path toward eradication. Non fossil fuel generation will be the main driver to meet incremental energy demand over the next decade. IHS Markit forecasts that the share of solar PV and wind power against total generation capacity will increase from 23% in 2020 to almost 40% by 2030. During the 14th Five-Year Plan period, the market size will increase as more favorable policies are released – both nationally and at regional level – and the support for electrochemical energy storage deployments gradually increases. Up to now, 18 provinces in mainland China, including Shanxi, Ningxia, Qinghai, Inner Mongolia, and Guizhou, have released energy storage plans, policies or guidelines.

Grid-connected energy storage forecast summary



Note: BTM = behind the meter; FTM = front of the meter.
Source: IHS Markit

With energy storage being deployed on both sides of the meter – either in front-of-the-meter (FTM) in the grid and colocated with generation assets or behind-the-meter (BTM) at an end-customer site – growth over the coming decade will be underpinned by the FTM segment. Accounting for around 30% of annual installations over the coming decade, opportunities across the FTM segment are diversifying.

While frequency response markets will continue to saturate in established markets, they will still have a role to play in some emerging markets, especially those in the early stages of their development. Frequency response will drive the first commercial battery installations in the Philippines, Taiwan, Italy, and the Nordics, with installations targeting 2021–22. However, solar-plus-storage is becoming a major driver for market growth.

In contrast to the diminishing role of frequency response markets, renewable colocation – in particular solar-plus-storage hybrid plants are seeing a rapid uptake, highlighting the long-term natural synergy between the two technologies. In the past six months, 1.3 GW of tenders have been announced or awarded for storage which will be colocated with solar PV, while recent policy changes in the US such as the extension of the Investment Tax Credit (ITC) will further accelerate growth.

Solar-plus-storage is becoming a natural combination for future deployment

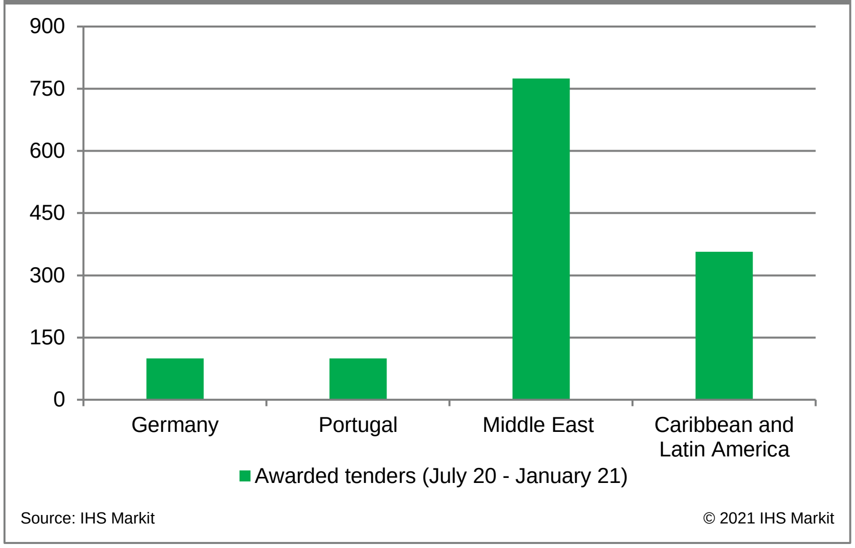
IHS Markit predicts that 3.8 GW of storage colocated with solar will be completed in 2021 compared with 0.9 GW in 2020. IHS Markit predicts that energy storage colocated with solar will account for 47% of global FTM installations until 2030. With solar PV becoming the lowest cost source of generation in many regions, and PV installations rebounding following the pandemic impasse, annual solar installations are predicted to grow by over 30% in 2021. There are now 18 markets globally that have +1GW cumulative solar installations, compared to just six a decade earlier. The increasing penetration of intermittent solar generation will further amplify the need for more system flexibility and transmission and distribution reinforcement, highlighting the role of energy storage to ensure resilience in the system.

In the United States, near-term growth in the solar-plus-storage market segment will track the federal investment tax credit (ITC) schedule, meaning that energy storage projects colocated with solar will continue to receive a reduced tax burden through to 2025. Meanwhile, the long-term trajectory, remains very positive with installations growing strongly from 2026 onwards based on economic competitiveness with conventional resources.

Curtailment of wind and solar power generation has plagued China's power grid with the rapid development of new generation capacity. These renewable integration projects have received significant support from the government to investigate the potential of storage to help increase consumption of renewable power. A growing number of provinces either mandate or encourage storage colocation of renewables and energy storage, to firm output with dedicated battery storage assets.

Elsewhere, the significant uptick in procurement of solar-plus-storage through tenders in the last six months has become evident as energy storage is now a central part of energy system planning in markets looking to rapidly decarbonize their electricity networks. So far, large procurements are mainly in emerging markets for energy storage, such as Chile and Israel, which launched a tender for up to 609 MW / 2.4 GWh of solar-plus-storage. There are also signs that this approach may be also used at a higher scale by more developed markets (such as France, Germany, and Spain) in the coming years. Tender sizes would likely be much larger in these cases and could lead to a significant upside to the forecast.

New solar-plus-storage tenders awarded or announced in the six months to January 2021 (MW)



Pairing solar with storage systems enables synergies both from a technical and cost side, as well as increasing output from solar PV plants. Energy storage resources co-located with solar PV generally have lower installation and maintenance costs. Lower installation costs may arise from shared inverters, when DC-coupled, shared land, shared point of interconnection, and other shared EPC costs. DC coupled systems provide a strong solution when applications are focused on shifting solar generation and cost advantages are imperative. AC-coupled systems remain generally preferred where greater dispatch flexibility and maximum capability to participate in ancillary services is needed. Co-locating energy storage can also make use of energy that would otherwise be curtailed or "clipped," resulting in greater plant output and "free" charging. Solar PV located in congested areas of the network may be curtailed during times of excess solar production - colocated storage can capture this energy and discharge it later.

Overcoming the remaining barriers to energy storage uptake

Despite the rapid development of energy storage markets in recent years, barriers remain across the globe hindering mass adoption across different markets and a wider range of applications. The multi-facetted challenges faced by energy storage can be summarized into three key areas:

- **Policies and regulatory frameworks** in many markets remain inadequate to foster uptake of storage and fail to recognize the value storage provides across the energy system, while at the same time not creating a level playing field for storage to compete with other assets.

- Despite **cost declines for Lithium-ion batteries** of more than 75% since 2012, capital and levelized costs (especially when paired with renewables) are not yet competitive with other forms of flexible, dispatchable forms of generation in many markets. However, as costs continue to drop – driven by the scaling of the industry – new applications and new geographic markets are quickly becoming accessible.

- Technologically, lithium-ion battery energy storage systems still face some **safety challenges, short lifespans, and require careful design and management of battery capacity and performance**, as well as complex O&M routines.

- Alternative technologies – such as Flow batteries, or mechanical storage technologies – will have to play an increasing role as the need for long-duration storage becomes imminent. However, **many alternative technologies still lack a proven track record**, bankability, and clear performance guarantees.

Li-ion price reduction remains important, but will hinge on the automotive industry more than ever

Despite the rapid growth of the grid-connected battery energy storage market, it will account for only a minor share of global demand for Li-ion batteries. In 2021, the automotive and transport sector will account for 80% of Li-ion battery demand – a figure that is set to rise to 90% by the middle of the decade. As a result, the availability of batteries and technology trends for the energy storage sector will be heavily impacted by the dynamics of the automotive sector and the pace of the uptake of electric vehicles (EVs).

The energy storage industry has increasingly adopted LFP (lithium iron phosphate) batteries in recent years due to their lower cost and better safety track record, as well as an abundant supply – in comparison to the main alternative, NMC (lithium nickel manganese cobalt), which has been favored for EVs. In the stationary energy storage market, developers have increasingly considered LFP following several battery fires in recent years. Although most of the previous safety issues can be addressed with improved regulatory standards and processes, an abundance of caution has incentivized a market shift from NMC back to LFP.

Despite some short-term challenges, IHS Markit expects LFP to be the dominant technology in the stationary energy storage sector – accounting for around 70% of total deployment in 2030. With spare capacity, outside specific Tier 1 suppliers, the energy storage industry needs to quickly broaden their supplier base and make use of the ample LFP capacity established in mainland China.

Potential supply challenges for Li-ion batteries do represent a glimmer of opportunity for alternative (non-lithium) battery technologies, such as flow batteries. However, today's cohort of alternative technology providers remains challenged to quickly scale up to provide a contender with proven reliability and performance at a competitive cost.

Innovative technology solutions will enable broader cost reduction and performance improvements

The energy storage industry is rapidly maturing looking to also tackle wider technological challenges and continue to innovate. While much focus continues to lie on the actual battery technology, energy optimization, enhanced operation and improving system intelligence are also critical to improving safety and performance of battery energy storage systems.

Improving performance will also play a role in future cost reduction. Rather than just focusing on reducing hardware capital costs, there is a stronger push to use intelligent software to both drive down lifetime costs, by enhancing performance and extending lifetime of batteries, and to boost revenues, by using intelligent energy management systems that enable batteries to tap into multiple different revenues.

Such improvements can be achieved through deploying battery pack–level energy optimizers can help minimize capacity loss from mismatch across battery packs in the rack, and thus increase available system capacity and increase the system's lifespan. In addition, pack-level optimization improves the system availability by circumventing potentially damaged or underperforming packs to avoid affecting adjacent packs and the wider system, enhancing both performance and safety.

Using smart rack-level optimizers, the capacity of racks can be balanced during the charging and discharging process, eliminating the parallel mismatch between each rack within the system. Therefore, ensuring every rack can be fully charged and discharged, as well as independently operated.

Finally, using a smart cooling design is important to minimize temperature increases ensuring safe operation and to extend the battery lifetime. This can be achieved by using a smart cooling system and distributed air-conditioning that provides even-cooling across individual racks and packs, to reduce difference in cell performance. Integrating smart software that also considers battery operation or environmental changes can offer real-time optimization of the cooling strategy to ensure safe, efficient and reliable long-term operation of the system.

Intelligent software controls are also playing a critical role, not just to ensure safe and optimal operation of the battery itself, but also help maximize an asset's ability to capture multiple revenue streams as new applications and value drivers become accessible. New advanced solutions, such as artificial intelligence (AI) and cloud-base battery management systems (BMS) can be used to monitor and automatically optimize performance. Applying such systems will also improve the safety of battery energy storage systems through smart internal short circuit analysis predicting potential fire hazards by identifying sudden internal short-circuits in real time and accurately locate derivative internal short-circuits. This would help enhance the safety of energy storage systems by moving from passive to active protection.

AI technology can be used to predict battery state of charging, forecast battery health and degradation, and optimize initial battery system design to help develop the correct configuration and augmentation schedule. Combining intelligent temperature control strategies and AI solutions to predict and optimize battery performance will over the system's lifetime provide critical costs savings. Simultaneously a linked-up advanced energy management and revenue optimization approach will help maximize returns against increasingly complex revenue streams.

Ultimately, energy storage is a crucial component to the energy transition, and represents a significant and growing opportunity, but continuous technology evolution on both the hardware and software side is needed to optimize performance, ensure safety and drive down system and lifetime costs.

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IHS Markit offers Clean Energy Technology, a global service providing comprehensive market intelligence of the important technologies shaping the energy transition. The service includes a continuous flow of data, forecasts, insight and analytics tools to track and understand how technologies develop and their impact on the industry. Robust and detailed demand forecasts are combined with in-depth analysis of the supply chain to provide a comprehensive view of industry developments and key players.