Growing The Battery Storage Market 2018

Exploring Four Key issues

From the Producers of the Energy Storage World Forum

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DUFRESNE – ENERGY STORAGE WORLD FORUM
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This white paper is sponsored by the 12th Energy Storage World Forum and the 6th Residential Energy Storage Forum, which will both take place in Rome from 14th – 18th October 2019.
What Developments Are Needed To Grow The Battery Storage Market Going Forward?

Battery storage has grown significantly over the last few years. Electrochemical storage is now pushing the 1 GW mark up from a few hundred megawatt just a few years back.¹ Key regions, such as Europe, South Korea and the US, are leading growth. Massive investments predominantly in lithium-ion batteries are driving down costs while project developers are continuously getting better at designing and building customised storage systems. These developments are being driven by more favourable markets and regulation, improving system costs, increased access to finance and a need to upgrade ageing grid infrastructure. At the same time, battery storage is still only a small part of the total power market and there is substantial room for further deployment. Navigant expects a total installed grid-scale battery capacity of 14 GW by 2023. This number is staggering as it does not include projections for residential or commercial and industrial (C&I) both of which have sizable market potentials. This white paper takes a look at four of the key issues still to be addressed if the battery storage market is to reach its projected potential in the 2020s. The issues were identified by delegates of the Energy Storage World Forum 2017 (http://energystorageforum.com) in Berlin and represent a peek in to the top issues on the battery storage agenda going forward. In turn these include:

1. **Continuing to build trust from traditional lenders and increasing the bankability of storage projects.** A key focus here is increasing the length of warranties, developing appropriate codes, standards and regulations (CSR) and the role EPCs can play by providing integrated solutions and ‘fully wrapped’ warranties.

2. **Opening up markets to energy storage, increasing revenue certainty and reducing cost.** Energy storage can offer a number of applications to the power system. Markets and regulations therefore need to open up to storage while the industry continues its focus on cost reductions.

3. **Unlocking new geographic markets for battery storage.** The large majority of battery projects are found in a handful of countries. Overcoming barriers to deployment in these markets, such as a lack of access to finance, can pave the way for markets with vast deployment potential.

4. **Developing the C&I market segment.** The C&I market segment is only recently being explored by project developers and constitutes a significant growth opportunity. Key factors such as increasing energy bills and price volatility could drive market growth going forward. Developing hybrid storage systems with the ability to respond to a wide variety of needs is also a key for unlocking future C&I growth.

“This report takes a look at a few of the key issues still to be addressed if the battery storage market is to reach its projected potential in the 2020s.”
Issue 1: Increasing “Bankability” And Trust From Traditional Financiers

While batteries are considered more bankable now than in the industry’s early years, there is still work to be done to attract low cost capital from the financing community in particular for residential but also for grid-scale projects. “Bankability” refers to how credible a storage project’s overall economic viability is considered by traditional lenders. Unproven technologies are often funded by investors willing to accept higher levels of perceived risk for a higher return. Once lenders have confidence in the technology to deliver a predicted revenue stream, that technology can access a larger pool of capital in the form of debt and equity. To this end a project generally has to undergo a rigorous independent assessment including detailed analysis of the economics as well as of the project’s technology, manufacturing, engineering and construction aspects.

While there are a number of considerations that go into the technology assessment, the length of warranties, maturity of the supply chain, product support infrastructure and the existence of codes, standards and regulations are essential. The economic assessment generally focuses on estimated costs and revenues and to what degree real-life financial performance can perform on par, or above, with financial models. As an example, the ‘Jake’ and ‘Elwood’ battery storage projects in Chicago were the first debt and equity financed utility scale projects in North America funded in 2015. This was accomplished through a robust warranty provided by a single OEM while certainty on the project finances was secured through a hedge on frequency regulation prices.

Manufacturing And Engineering: Guaranteeing Performance And Ensuring Reliability In The Storage Asset

Warranties

How do warranties affect bankability? The longer a manufacturer can guarantee the operation and reliability of a battery system the less risky it will seem to lenders. Different types of warranty are product warranty e.g. a guarantee that the storage asset should operate free of any defects for a certain number of years and performance warranty e.g. a guarantee of a certain capacity and availability over the lifetime of the system. Extended warranty options guaranteeing up to 10 years is common in today’s market although the specifics of the warranty can differ and certain parts (e.g. inverters, transformers and switchgears) can be covered for

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**Figure 1: Ensuring storage**

<table>
<thead>
<tr>
<th>Is the manufacturing and engineering reliable?</th>
<th>Are the project’s finances secure?</th>
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<tbody>
<tr>
<td>• What warranties are available</td>
<td>• What financial returns can be expected based on the revenues and costs</td>
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<tr>
<td>• What quality and control systems are in place</td>
<td>• What are the risks associated with the costs and revenues and what steps could be taken to mitigate these risks</td>
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<td>• How mature is the supply chain and its actors</td>
<td>• How reliable are the simulation tools used</td>
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<td>• Does the technology have sufficient operational hours to support manufacturer claims</td>
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**FIGURE 1: ENSURING STORAGE**
more or less time. In general, project developers seek to be protected at least for the duration of the contract term it has negotiated with a counter party. For residential systems some vendors currently offer up to 15-year warranties although the average warranty period is around 7 years.\textsuperscript{2}

The Role Of Vendors And EPCs In Guaranteeing ‘Fully Wrapped’ Warranties

Vendors and engineering, procurement and construction (EPCs) companies can play an important role in ensuring bankability by providing one-stop shop solutions for lenders. Due to the complexity of storage projects, having one provider to manage the sourcing and integration of system components can reduce costs and avoid overlaps or gaps in the construction phase hence invoking confidence in the lender. These warranties are so-called ‘fully wrapped warranties’ in which the developers guarantee a single warranty on an entire project. For example, a fully wrapped warranty was considered a key ingredient for the successful financing of Renewable Energy Systems’ (RES) 300 kW battery system provided to Western Power Distribution in the UK in 2015. This approach is becoming increasingly common in today’s market as developers now have enough data and experience with Li-ion projects to do so.

There are a number of additional ways vendors and EPCs can increase bankability. Tim Mueller, Chief Technology Officer at Belektric, said his company protects lenders against low storage system performance by using tried and tested inverters from their established PV business as well as designing and manufacturing containers for the storage system themselves hence relying on a closed quality control system.\textsuperscript{3} They are also working with a few large established battery suppliers such as Samsung, which are now able to provide performance warranties of up to 20 years on their Li-ion cells – well above the industry standard of 10 years. In general, EPC companies work with qualified suppliers of lead acid and Li-ion batteries, which have a more established track record (see Figure 2).
In their entirety CSR covers the rules and regulations that govern the design, construction, installation, commissioning and operation of storage systems. From an investor point of view,
they are crucial as they provide an industry benchmark for a project and a certain level of guarantee that a project is following best available guidelines. One problem to date has been that battery technology has developed much faster than CSR with a wide variety of configurations, chemistries and applications at different locations in the power system. Many CSR are also national or regional, while manufacturers and developers tend to operate internationally. As the number of stakeholders in the sector grow, input to CSR development and modification becomes crucial to convey to traditional lenders that the industry is capable of safe and reliable operation.

A number of initiatives over the last years have produced CSR for the standard battery chemistries including lead acid and Li-ion. In Europe these standards have been developed by the International Electrotechnical Commission (IEC) and cover technical features, testing and system integration. However, newer battery chemistries lack the required standards and according to the IEC work is underway to develop these with a focus on:

- Terminology
- Basic characteristics of storage systems and their components including capacity, power, discharge time, lifetime and standard unit sizes
- Protocols and security standards for communication between components
- Interconnection requirements
- Mechanical and electrical safety
- Guidelines for implementation

In 2016 IEC published a standard (IEC 61427-2) for a methodology to compare and test different battery chemistries in four different grid-scale applications. Once the necessary codes and standards have been developed, organisations such as DNV GL play a key role in carrying out the testing and certification required to prove the safety and reliability of a project.

“Developing comprehensive and ‘wrapped’ warranties, alongside appropriate codes, standards and regulations is an important step towards increasing confidence from traditional lenders.”

Project Finance: Using Advanced Tools To Accurately Simulate Revenue

In addition to having confidence in the technology, lenders must also have confidence in the project’s finances. Energy storage is unique due to its ability to capture a number of revenue streams across the energy system. This can be positive for the lender, as it can increase profitability, but it can also add complexity both to the operational demands on the storage asset as well as to the tools used to predict future revenue streams. For example, the profitability of a grid-connected storage asset offering ancillary services, load shifting and capacity depends on a number of factors including:
• Price volatility
• Existing generation mix and changes to generation/demand profiles over time
• Availability of competing flexibility options (e.g. other storage, demand-side resources, flexible thermal plant)
• Grid capacity and congestion in a given area
• Prices of ancillary services offered
• Price of capacity
• Availability of storage asset to successfully deliver under all contracts
• Weather patterns
• Any other factors (including all cost elements)

A C&I storage asset will also be affected by non-power market related factors such as changes to labour force, building additions or changes to manufacturing equipment. A requirement to better understand such future complex revenue streams is to apply advanced simulation models using real-life historical market data. Typically it takes several years of historical data to produce robust results. For C&I sites it is generally harder to get hold of reliable data although it is possible to obtain this; in particular in Europe where data on consumption patterns is collected through EU-driven energy efficiency initiatives. Project developers are clear that simulation tools are not able to substitute for real-life operational data, which is why market deployment and testing out in the field is crucial for any storage asset. As mentioned by Rosario Polito, Head of Innovation and Storage at Terna (Italian TSO), at the Energy Storage World Forum in 2017, there are still important lessons to learn from actual field operation of storage assets.

**Making Energy Storage Bankable: Key Points**

- Increasing the bankability of battery storage projects is key to enable access to a larger pool of finance including debt and equity thereby allowing more rapid and cost-effective deployment
- Lenders must have confidence in both the technology and the finances of a project
- Improved warranties and standards and certifications are key to inspire confidence in lenders
- Codes, standards and regulations (CSR) exist for traditional chemistries but are lacking for more novel ones
- Advanced simulation tools based on real-life data should be used to estimate future revenue streams
Issue 2: Improving Battery Storage Economics: Improving Revenue Certainty And Achieving Cost Reductions

Several aspects of making a project bankable are to a large extent within the control of developers and owners. Providing warranties and adhering to codes and regulations can be guaranteed through rigorous quality assurance, project management and experience with the technology out in the field.

What developers cannot provide a warrantee on is the market and regulatory landscape that govern whether storage assets are able to monetize their services. To date, the vast majority of services storage can provide to the system are inaccessible and allowing storage providers access to these, alongside achieving cost reductions in the technology itself, is necessary to pushing storage deployment further. Industry and policy makers on both EU and national level will therefore need to work closely together to ensure action on these areas.

Opening Up Markets And Ensuring Longer-Term Revenue Certainty For Storage

The European Association for Storage of Energy (EASE) identified 34 different applications for energy storage in the electricity sector spread out across generation/bulk services, ancillary services, transmission and distribution support and customer energy management services. For the time being, most grid-scale business models rely on single use cases (e.g. frequency regulation or renewable capacity firming) with few additional revenue streams. Accessing the multiple applications available to storage could therefore significantly improve overall revenues. Using the battery for a single revenue stream also means the battery is underutilised and that payback times are longer than necessary. For the time being however there are a number of market, regulatory as well as technical questions that need to be addressed and uncertainty on revenue is one of the key barriers to further deployment mentioned by storage developers (see Figure 3).

Lack Of Appropriate Markets For Valuing And Defining Storage

Lack of appropriate market mechanisms sometimes means that although storage provides a value somewhere in the system (e.g. by shifting and reducing peak load) there is no formal means of valuing and monetising on that service for the storage owner. For example, deploying a battery on a congested point of the network may mean that the network operator could be
spared additional investment in transmission and distribution upgrades. However, there is no formal mechanism for the storage operator to capture this generated value. In general, the mechanisms that do exist (e.g. arbitrage or peak demand management) tend to undervalue the service provided to the system as a whole. This often leads to a situation in which the costs of storage are privatised while the benefits are socialised.

Furthermore, as energy storage can both charge and discharge it sits both on the generation and demand side of the value chain. This has, to date, caused confusion regarding appropriate definitions, which again has knock-on effects around who can own storage assets and which markets storage can legally bid into. For example, in the EU storage has been classified as generation thereby excluding transmission and distribution network operators from owning and developing batteries for use in for example transmission investment deferral as well as in energy markets.

Over the last few years, however, steps have been taken to address these barriers. The UK energy regulator (Ofgem) has proposed modifying the existing generation license to accommodate storage as a subset of generation. The changes would deal with the issue of ‘double charging’ in which storage assets are taxed for both electricity consumption and production. Due to a pressing need to integrate increasing levels of renewables, Italy has also made progress on allowing Terna, the Transmission System Operator, to own and operate batteries which has led to Italy being one of the leading battery storage markets in Europe. Work is currently also on going to include a unique definition for energy storage in the new EU Electricity Directive from November 2016 which under certain circumstances may allow ownership of storage devices by transmission and distribution operators.

Lack Of Access To Markets Or Prohibitive Market Regulations Holds Storage Deployment Back

Even if there is an actual market mechanism for the value provided by storage, some EU countries are not open for competition or do not allow storage assets to compete. System services such as frequency control in Italy for example are not market based, while other markets such as Spain impose large size requirements and other regulatory barriers that preclude storage assets from participating. Large size requirements above the 10 MW mark are generally prohibitive for storage developers if aggregation of multiple resources is not allowed. In many European countries (e.g. Estonia, Ireland, Italy, Poland and Portugal) there are still several types of ancillary markets from which aggregated load is prohibited such as primary, secondary and tertiary reserve markets. Industry should therefore closely watch what action is being promoted to change these regulatory restrictions.

For example, France, Belgium, Switzerland and the UK have all moved to open up ancillary markets to aggregated resources. This point was further addressed in the renewed electricity directive, and by doing so the European Commission set the first steps towards more inclusive market structures. It has been suggested that these initiatives must now be implemented using secondary legislation such as the Network Codes, which are the set of rules drafted by the ENTSO-E and govern the terms and conditions under which flexibility providers such as storage
will be able to participate in electricity markets. The outcome of these developments will be formative for the EU storage market going forward.

Markets Do Not Provide Long Term Revenue Certainty

Even if there is a way of valuing energy storage services and the asset has access to these mechanisms, there is little in the way of guarantees for investors who are interested in a long-term revenue stream for the duration of an asset’s life. Storage assets have economic lifetimes of >10 years and developers would like to see contracts covering that lifetime. At the moment, however, most ancillary contracts tend to be short-term or on an ad hoc basis because grid operators do not want to expose themselves to the risk of oversubscribing and overpaying for a service.

The Firm Frequency Response (FFR) market in the UK for example is run as a monthly tender that hardly provides revenue certainty for a storage developer. The new Enhanced Frequency Response (EFR) provides more certainty via four-year contracts, but this still means storage owners are faced with several years of uncertainty. A similar dilemma exists for capacity markets although storage operators in the UK proved themselves capable of landing 15-year contracts in National Grid’s 2016 December auction.

One solution would be to increase the contract length for ancillary services but this would not meet the risk requirements of the grid operator regarding oversubscription. Alternatively, the industry could move away from the idea of longer contract lengths, and instead move towards a purely merchant trading platform for flexibility on which all technologies compete on an equal footing. Fast response resources like batteries would likely do well in these markets. However, financing terms would probably not be as competitive compared with those projects with longer contracted revenues – as a result this solution would likely push up the overall supply cost.

Technical Requirements For Revenue Stacking Can Be Challenging

Market and regulatory aspects are not the only challenge to building stronger revenue streams. Different technical requirements from each market can place stringent demands on the software and hardware of the battery leading to risks that the asset may not deliver its service as contracted. As mentioned by Dr. Johannes Werhahn at the Energy Storage World Forum 2017, the optimization of multiple applications, together with intelligent forecasting, is one of the key focus areas for power utility E.ON going forward. Due to this increased interest from developers, improvements in software and control systems are now rendering revenue stacking more feasible, as the storage asset is able to handle multiple operational patterns with more ease than before. The traditional approach for managing battery assets is to deploy a plant controller that interacts with the batteries and a separate power control system (PCS) that interacts with the battery management system (BMS). Project developers are now developing software based plant controllers that allow direct control between the battery, PCS and BMS hence making advanced control and optimisation of revenue streams more manageable. As software systems develop it will therefore be crucial for vendors, EPCs and other stakeholders to have a thorough understanding of their capabilities and impacts on revenue generation.
Examples of these types of systems are currently being used in the Oncor microgrid project in Texas and a number of other systems in Europe and the US. For example, EDF’s 49 MW West Burton battery storage project in the UK was the cheapest bid in the Enhanced Frequency Response (EFR) auction due, in part, to its use of revenue stacking with the UK capacity market. The utility-owned WEMAG project in North Germany also recently announced a capacity expansion to enable the provision of black start services in addition to frequency regulation.

“As software systems develop it will be crucial for vendors, EPCs and other stakeholders to have a thorough understanding of their capabilities and impacts on revenue generation.”

Reducing The Cost Of Storage

In addition to opening up markets and making revenue streams more robust, cost reduction is one of the key ways of increasing the competitiveness of battery storage against other technology options. Driven primarily by increased manufacturing in the electric vehicle and consumer sectors, the manufacturing cost of lithium batteries has fallen dramatically over the last few years. Costs of $273/kWh are now being reported by some manufacturers, which represent a 73% price reduction since 2010. While still too expensive for certain storage applications, such as load levelling and arbitrage, these reductions have allowed the majority of storage deployment to date focusing on niche applications in e.g. frequency regulation and peaker replacement. But how low are battery costs expected to go? BNEF predicts that prices for lithium-ion batteries may fall as low as $73/kWh in 2030, which could open up the market to other revenue streams. The US Department of Energy (DOE) has announced an interim price target of $125/kWh by 2020.

“Driven primarily by increased manufacturing in the electric vehicle and consumer sectors, the manufacturing cost of Li-ion batteries has fallen dramatically over the last few years.”
Despite the attention given to manufacturing costs, batteries comprise roughly 60% of an installed battery system. The remaining costs comprise of hardware (20% - inverters, transformers etc.), development and soft costs (11% - profit, customer acquisition, interconnection etc.) and EPC (9% - control system, testing and commissioning etc.). Project developers were reporting total installed costs of less than $500/kWh in 2016, which is ahead of estimates from, for example, the EPRI which suggested prices of $350-500/kWh by 2020.

To better understand the competitiveness of storage it is helpful to also discuss levelised cost. Levelised cost is traditionally used for fossil or renewable power plants to gauge the price at which a specific project would need to sell their output at in order to breakeven over the lifetime of the project. Because storage is a highly versatile technology that is sized for a number of different applications the costs will also vary considerably depending on the technical parameters of the battery system. The total electricity charged, stored and discharged over the lifetime of the asset is also closely related to the type of application(s) the system is optimized for. The most recent Lazard Levelised Cost of Storage 3.0 analysis provides insights into the cost trends of storage per application and shows that the overall trend in the industry is towards cost reductions for most applications. These are driven by the development of more cost-effective batteries, better system integration and longer battery lifetimes.

Further cost reductions in battery manufacturing will continue to be driven by mass production and economies of scale through the electric vehicle industry. Estimates now suggest that automotive battery pack production volumes of over 200,000 will cost less than $200/kWh. Improved and scaled-up manufacturing processes are therefore key to unlocking further cost reductions. Research and development also continues to have a significant role to play. Current
emphasis in Li-ion research focuses on developing high-energy silicon anodes (4200 mA h/g) to replace current graphite anodes (372 mA h/g) may pave the way for significantly higher energy densities and reduced cost per capacity. Further reductions could, for example, also come from the individual hardware components, system integration and the balance of plant costs.

### Improving Battery Storage Economics: Key Points

- **Storage can provide >30 services to the power system.** Market and regulatory frameworks need to open up to storage and allow full participation across energy, capacity and ancillary markets.
- **Battery manufacturing costs have come down 73% from $1000/kWh to $273/kWh since 2010** - mainly driven by economies of scale and developments in the electric vehicle industry. This is still too expensive for arbitrage and load levelling applications but has opened up the market to large-scale niche applications such as frequency regulation.
- **Further cost reductions are likely to come from continued increases in manufacturing scale, R&D efforts and in balance of system components.** BNEF predicts a price of $73/kWh in 2030.
Issue 3: Unlocking New Geographic Markets For Storage

To date, battery storage deployment has been concentrated in a handful of developed economies in North America, East Asia & the Pacific and Europe & Central Asia. The leading countries are the United States, South Korea, Japan and a number of European countries including Germany, the United Kingdom and Italy. In total, around 96% of installed projects exist in these countries.\textsuperscript{24} The remainder 4% are in China and South America, predominantly in Chile. The Middle East & North Africa, South Asia and Sub-Saharan Africa only have negligible amounts of battery storage.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{installed_power_region.png}
\caption{Installed rated power by region}
\end{figure}

This uneven distribution of projects around the world means that there is significant room for growth outside of the main markets. The opportunity is particularly pronounced in many developing countries where power systems are less advanced and countries may choose to ‘leap frog’ over the traditional development path chosen by other countries in favour of market and technical arrangements more suitable for today’s energy technologies. Several of these countries are also endowed with generous solar resources, which if developed and combined with cost-effective storage can deliver cheap and low-carbon base load electricity. Another driver is the need to upgrade an ageing grid infrastructure at the same time as electricity demand is expected to grow.

These drivers combined with learning from the more advanced regions are therefore creating an environment ripe for further storage deployment. In South Africa, the country’s main utility Eskom estimates a need for 2 GW of energy storage on its networks to accommodate a target of 18 GW of renewables by 2030 and recently opened a testing facility to assess different storage options.\textsuperscript{25} As part of the testing facility’s activities, the US Trade and Development Agency (USTDA) announced in September 2017 that they intend to fund the capital cost for a flow battery provided by US company Primus Power. The battery will be developed by local
developer Solafrica Energy. USTDA also recently (July 2017) announced a partnership with Kenyan renewable developer Xago Africa and US battery storage developer Alevo to fund a 40 MW solar PV plant with integrated Li-ion storage. The rest of Sub-Saharan Africa is expected to predominantly deploy remote power systems due to the lack of a well-developed grid infrastructure. Power Africa, another USTDA funded project, aims to develop 25 solar microgrids across Nigeria including grid infrastructure, smart metering and storage systems.

Latin America and the Caribbean are considered attractive markets for energy storage development, also because of their large-scale growth ambitions for solar PV. The major markets in Latin America, Chile, Argentina, Mexico and Brazil, have or are in the process of deregulating their power markets thereby paving the way for independent power producers and merchant storage developers. In 2015 Bolivia deployed a 5 MW solar project connected with a 2.2 MW battery that supplies 54,000 inhabitants in a nearby town. The project was funded by the state-owned electricity company as well as with a grant from the Danish Corporation for Development in Bolivia. The Caribbean is expected to deploy battery systems for remote power applications and there are already several projects underway including an 8 MW lithium-ion system on the Dominican Republic. In 2017, EDF installed 5 MW of battery storage for frequency support on Guadeloupe and storage developers are expecting increased deployment over the next years. For example, French storage developer Quadran is expecting a four-fold increase in its own storage deployment on the French Caribbean islands between 2018 and 2023 (50 MWh to 200 MWh).

In East Asia and the Pacific, China is expected to be the leader in storage deployment. The state-owned utility State Grid Corporation of China is currently opening up for competition from non-state power providers. China also has aggressive concentrated solar targets (10 GW by 2020) although this will likely benefit thermal storage rather than batteries. In addition to China, the Philippines has 100 MW of lithium-ion batteries in the pipeline and last year AES installed a 10 MW battery in the country.

South Asia’s energy storage market is expected to be dominated by India. Ambitious renewable energy policies, such as Narendra Modi’s target of 100 GW of solar PV by 2022, could make India the largest solar PV market in the world and pave the way for associated storage deployment. As with other regions, India’s storage deployment will also be driven by population growth and investments in an ageing grid infrastructure. One of the more positive recent developments was a July 2016 tender in which hundreds of megawatt of solar PV was procured which included the mandate to develop 5 MW/2.5 MWh of storage for every 50 MW of solar PV.

These and other developments show that there are recognised benefits that storage can provide to emerging markets. However, a number of barriers to further deployment of storage need to be dealt with. These include:

- Markets tend to be vertically integrated and regulated leading to a lack of competition and remuneration mechanisms for storage assets. The process of deregulation, such as
that seen in Latin America and China, therefore needs to continue with further open
dialogue between policy makers and the investment community.

- Limited local experience and knowledge with storage can increase costs and supply chain risks. To date this has been a significant barrier to solar PV deployment in India. Knowledge transfer from more advanced regions should therefore take place to build up local expertise.
- Access to affordable financing is hard due to projects not being seen as bankable by traditional financiers. In some regions this is often exacerbated by political and economic instability. Grant funding and capital injection from national and international agencies, such as that seen from the Danish Corporation for Development in Bolivia and USTDA’s involvement in Africa, could therefore step in to close parts of the funding gap.

Unlocking new geographic markets for storage: key points

- The vast majority (96%) of battery storage is found in a handful of countries including United States, South Korea, Japan and leading European countries such as Germany and the UK
- A number of factors are driving storage development outside of these regions including increasing levels of renewable penetration and an ageing grid infrastructure. In countries where grid connection is poor there are strong prospects for storage to contribute to remote power systems
- Barriers still remain which include access to affordable finance, lack of local expertise and political instability in some regions
Issue 4: Developing New Commercial And Industrial Applications

The key markets for battery storage globally have to-date been grid-scale and residential. Of the currently 952 MW of operational battery storage projects, an estimated 41 MW could be classified as commercial and industrial (C&I). However, favourable policy and technological advances have led to C&I receiving more attention from project developers over recent years, in addition to other more novel storage forms such as vehicle-to-grid (see Figure 6). Favourable policies include energy efficiency standards, carbon reduction initiatives and increasing peak demand charges. In addition, reductions in feed-in-tariffs for solar PV has created an incentive for C&I customers to maximise self-consumption.

![Operational Grid-Scale Vs C&I Battery Storage](image)

**Figure 5: Operational grid-scale versus C&I battery storage**

Energy storage now offers a number of value propositions to C&I customers:

- **Bill management**: reduction of peak demand charges by shaving peak load and flattening the load profile throughout the day. Storage in combination with on-site renewables could also create a hedge against volatile electricity prices
- **Increased grid independence**: higher self-consumption of on-site renewables leading to energy bill savings and lower carbon footprint
- **Ancillary services**: additional business revenue through provision of ancillary services such as frequency response and voltage control
- **Arbitrage and energy market bidding**: the development of optimised control and software systems may unlock new sophisticated revenue streams that allows participation across markets including energy as well as ancillary and capacity markets
McKinsey recently found that battery storage for certain C&I sectors and applications is already economically viable. However, a number of barriers remain to be overcome before C&I deployment can be realised on a large scale. These include:

- Lack of knowledge of energy storage systems and their benefits amongst C&I customers
- Lack of appropriate markets to properly remunerate the benefits of storage to the system
- Unique building load profiles requiring customised higher cost solution for each customer. This exacerbates already relatively high upfront costs.

Stefan Schauss, Director of Business Development at Wärtsilä, says that, “the question is that you do get a different setup with C&I and even when you get a sizeable C&I segment there is a lot of special analysis for the business case to be done. Once you have that solution there is slightly different sizing of the system that is needed – you have to look at it case by case”.

Other developers generally agree that C&I projects are more complex than grid scale. However, addressing these issues by finding more customisable solutions means that the market could grow by orders of magnitude over the next few years. As previous Energy Storage World Forum events have revealed, multiple companies are targeting the sector and C&I storage projects such as the Amsterdam Innovation Arena, using 280 repurposed Nissan Leaf batteries for back-up power and load shifting, are expected to yield both significant cost and carbon savings.

Navigant estimates a total of 9 GW of C&I storage by 2025, being driven by strong growth in China and India. Bloomberg New Energy Finance (BNEF) predicts that by 2021 C&I behind the
meter will account for 50% of installed capacity globally (10 GW). Growth is also expected from other market commentators who see a total of 500-600 MW C&I storage by 2021 in Germany and UK alone. The sectors most likely to experience high demand for storage projects are retail, agriculture, water and waste treatment plants and industrial processes with a constant demand for power.

Innovation efforts are currently focusing on flexibility by developing hybrid systems with high power and energy ratings combined with sophisticated control systems. An example of such a hybrid system is using fast-response ultracapacitors for high power applications combined with a battery for load levelling such as that used by Duke Energy in North Carolina to support a 1.2 MW solar installation. A recent EUR 4 million EU funded project is also testing Europe’s largest combined flywheel and battery storage system to provide frequency regulation. Further research and development of these systems may therefore cater to C&I needs, which could use several hours of backup storage while also bidding into ancillary markets as a secondary revenue option. While the sector is still far off the estimated 9-10 GW, an improving business case, continued R&D and interest from project developers will likely drive this sector going forward.

Unlocking New C&I Applications: Key Points

- Only an estimated 4.3% of current battery storage deployment could be classified as C&I
- Increasing and volatile energy bills coupled with a desire for more self-consumption are currently key drivers for the sector
- The C&I space is generally viewed as more complex requiring more customised solutions than grid-scale projects
- Research and development into hybrid systems that can cater to a wide variety of customer needs will likely make the sector more accessible
Summary

The need to deploy storage to help integrate variable renewables around the world is becoming increasingly obvious. This report has reviewed four of the key areas in need of further work as identified by industry delegates at the Energy Storage World Forum in 2017. Overall, these areas represent issues that should be dealt with in close cooperation between policy makers, industry and other stakeholders in order to unlock significant growth and value in the battery storage market going forward over the next decades. Specific action points are suggested in Figure 6 below.

Continuing to make battery storage projects bankable will ensure greater access to lower cost finance, while opening up markets to fairly remunerate storage will improve its economics and ultimately improve the value storage can provide to the power system. Regulators need to take steps to ensure ancillary markets are competitive and that regulations do not unfairly prohibit storage assets from competing with traditional generation assets. The massive cost reductions seen over the last few years are likely to continue, driven by scale and R&D, which may make storage competitive in a larger number of applications. Demand from commercial and industrial customers is likely to grow from a desire to increase self-consumption and reduce exposure to increasing energy bills; however, developers need to find customisable and cost-effective solutions to those projects that are generally considered more complex than grid-connected batteries. Another untapped area for growth is that of developing economies who only very recently started considering batteries to manage variable renewables, population growth and an ageing grid infrastructure.

Progress on each of these areas could set the storage industry on track to meet the ambitious deployment targets estimated by market observers over the next decade. These, and other, topics will be explored in more detail by top industry leaders and delegates at the 11th Energy Storage World Forum May 14-18th 2018 in Berlin (http://www.energystorageforum.com)

![FIGURE 6: ACTION POINTS FOR INCREASING BATTERY STORAGE DEPLOYMENT](image-url)
References

This white paper is sponsored by the 12th Energy Storage World Forum and the 6th Residential Energy Storage Forum which take place in Rome from 14th – 18th October 2019. See the full programme at www.energystorageforum.com

1 US DOE Global Energy Storage Database. All operational and verified electro-chemical projects as of October 9th 2017.
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7 Ibid.
11 Italy has nevertheless managed to become a leader in storage deployment in Europe largely due to the decision to allow Terna to deploy and operate batteries.
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24 US DOE Global Energy Storage Database. All operational and verified electro-chemical projects as of October 9th 2017. Sorted by country and region.
27 Ibid.
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