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Energy storage – Changing and charging the future in Asia

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Introduction

What is happening now

Energy storage is picking up pace as renewables did a decade ago. It is perhaps the crucial missing piece of the puzzle to bring about greater penetration of renewable energy and accelerate the smooth global transition to clean energy.

With developed nations already striving to be big storage players in the industry, new energy storage projects are now seen to be sprouting in emerging markets, primarily driven by the rapidly falling energy storage costs. Indeed, it has been estimated that approximately 80GW of energy storage capacity is expected to come from developing countries from the existing 2GW today.[1]

Moving in parallel, the Paris Agreement on climate change represents a concerted international movement towards adopting clean energy. The Agreement came into force on 4 November 2016 and aims to keep global warming below 2°C above pre-industrial levels. It is thus expected that investments, including government support, will be increasingly channeled into renewables and energy storage innovation, which will in turn further drive down the storage costs. Investment in grid-scale battery storage is reported to have already passed the billion dollar mark in 2016.[2]

Future of energy storage

A common trend amongst the reports on energy storage is that the rate at which storage is being deployed poses a challenge to the traditional grid system within the next five years. In other words, we may be looking at a hybrid between a decentralised power system and the existing central design and dispatch system.

As the demand for electricity goes up and with increasing renewable sources in the energy mix, what is clear now is that utilities must now be alive to the impending integration of energy storage for it is the trending solution to increase the flexibility of the grid to meet with the daily cyclical demands.

1 World Bank Group, Energy Storage Trends and Opportunities in Emerging Markets, 2017.
2 IEA, World Energy Investment, 2017.

Main drivers of energy storage

Renewable energy has been dominating the conversation for the past few years. In 2016, the spending on renewables was a staggering $297 billion.[3] As countries continue to meet their aims of decarbonisation with high penetration of renewable sources, the grids will need to ensure the security of energy supply. Existing physical infrastructure may not be well-suited to manage the increased influx of renewables as they already have difficulty with delivering existing online electricity to the rapidly growing populations. Storage systems integrated in the grid will thus allow for storage and ready dispatch of energy when demand peaks. This integrated system gives the much needed flexibility as renewable sources such as solar and wind offer variable energy streams to match real time fluctuating demands.

The falling cost of storage technology has been driven partly by the recent boom in the electric vehicle industry where a large amount of investment is being channeled into energy storage innovation. It has been reported in 2016 that storage costs may further drop for about 70% over the next 15 years.[4] Similarly, Moody's has indicated that cost of batteries have declined more than 50% since 2010.[5] This will further accelerate the scaling up of energy storage as they become more economical.

Energy storage is also seen as complementary to the progressively modernised grid. There have been plans to transform the grid into a smart platform to process data on energy usage and demand to better balance the energy supply and optimising power flow in the grid so as to be more efficient and cost effective.[6] Energy storage comes in as an enabling tool to respond accordingly to the data analytics and increase the reliability of the smart electricity grid.

3 *Ibid.*

4 World Energy Council, World Energy Resources Report 2016, E- storage: Shifting from cost to value 2016, 2016.

5 Moody’s, Declining battery prices could lead to commercial and industrial customer adoption in 3-5 years, 24 September 2015.

6 Financial Times, DeepMind and National Grid in AI talks to balance energy supply, 12 March 2017.

Types of energy storage

Technologies

Energy storage technology assumes diverse forms, ranging from traditional storage such as pumped hydroelectricity to modern lithium-ion battery storage. Common technologies include:

(a) Flywheel energy storage: energy is stored by accelerating a high-speed rotating mass (i.e. a flywheel). The speed of rotation represents the amount of kinetic energy stored within the flywheel system, which is later reduced or decelerated to generate electricity to be transmitted, capable of responsive energy dispatch;

(b) Compressed air: excess energy from generation can be diverted to compress air typically in underground tanks and store energy in the form of potential energy. Energy is later released to generate electricity by turning the turbines;

(c) Hydrogen gas battery: energy is stored in the form of hydrogen gas through electrolysis (separating water into hydrogen and oxygen elements). When needed, the hydrogen gas would be fed to natural gas power plants or fuel cells to generate electricity;

(d) Pumped hydroelectric: excess energy is used to pump water to higher elevation and be stored in the form of gravitational potential energy. During high demand, the stored water is released to turn turbines, which in turn generate electricity; and

(e) Chemical battery: this includes lithium ion and lead-acid battery, where energy is stored in the form of chemicals using their unique chemical properties and later released in the form of electric current.

Storage types

Other than be deployed on the grid to integrate renewables into the energy mix, energy storage systems may be installed at the customer's sites or as an isolated remote power system in areas where large-scale electricity grids do not serve.

There is a myriad of factors to consider when determining how energy storage systems should be deployed. This includes location, grid needs, local regulations, cyclical demand pattern, and customer type. It remains to be seen how the list of factors will expand in the future especially with the growth of smart electricity grids.

(a) Utility-scale or grid-scale: As alluded to above, challenges posed to existing grid calls for utilities to adopt disrupting energy storage technologies. Energy storage systems are expected to be installed on transmission or distribution networks to assist the grid operators in addressing system imbalance caused by changes in supply. This departs from the conventional method of modifying output from power plants by engaging reactive energy supply (in some cases, sub-second response) to ensure smooth grid operation.

(b) Behind the Meter ("**BTM**"): BTM energy storage systems are installed behind the customer's utility meters to help manage costs on the side of the commercial or residential customers. Apart from feeding energy generated from renewable sources back into the grid to enjoy feed-in tariff, consumers can now choose to reduce their electricity bills by storing excess energy onsite through the installation of BTMs. This is not necessarily at odds with utility scale energy storage as it may help to balance the grid by storing excess energy at the customer end to resolve issues of over back-feeding of electricity into the grid.

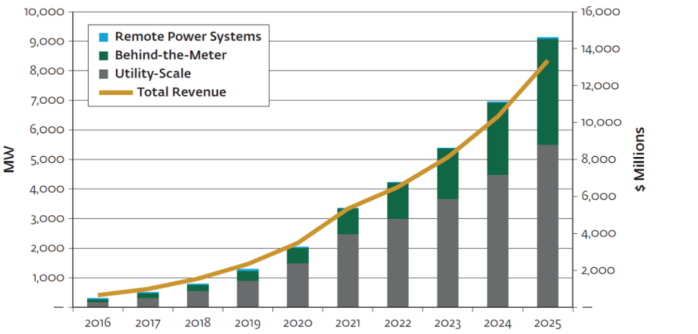
(c) Remote Power Systems: Where centralised electricity networks are unable to reach remote communities, isolated remote power systems can facilitate the transitioning to renewable energy sources in such communities. Larger remote energy systems are more commonly known as microgrids, while the smaller ones are nanogrids. Similar to grid-scale energy storage systems, remote power systems assist in load management and optimisation of resources. However, in terms of interface issues, it may be less risky for remote power system to integrate with the existing power systems.

Storage in Asia

East Asia

As the largest power producer in the world, **China**, with its 1.4 billion citizens, is positioned to be the energy storage giant in Asia. Indeed, China is expected to possess over 9 GW of energy storage capacity by 2025.[7]

Projected Annual Stationary Energy Storage Deployments, Power Capacity and Revenue by Market Segment, China: 2016–2025



(Source: Navigant Research)

While pumped hydro accounts for the majority of China's energy storage capacity, 2016 saw an exponential growth in electrochemical energy storage deployments by 299% to 101.4 MW (mainly in lithium-ion and lead acid batteries) situated primarily in the northwest and east-central regions.[8] Significantly, a 200 MW vanadium redox flow battery storage facility to be built in the city of Dalian was approved by the National Energy Administration in April 2016. More recently, the first modularised battery energy storage power plant went online in Suzhou. The plant aims to reduce the load in the main grid by discharging during peak periods.[9]

There has been a flurry of Chinese policies in the recent years placing energy storage on the agenda. In 2016, the Outline of the Economic and Social Development Thirteenth Five-Year Plan of the People's Republic of China puts energy storage among the top national strategic projects. Similarly, the "Energy Technology Revolution Innovation Action Plan (2016-2030)" studies the development of energy storage technologies, and the "Made in China 2025 – Energy Equipment Implementation Plan" emphasised the importance of sustained development of energy storage technologies in China.[10] In 2017, the importance of energy storage as part of China's long-term planning goals was again highlighted in Document 1701, "Guidance on the Promotion of Energy Storage Technology and Industry Development", a joint publication between the China National Development and Reform Commission and the National Energy Commission.

In the aftermath of Fukushima disaster in 2011, **Japan** has been moving away from nuclear and fossil-fossil energy and turning their attention on safe renewable sources. The 2014 Fourth Strategic Energy Policy expressly outlines the importance of boosting the local energy storage industry and plans to acquire 50% of the world's storage battery market share by 2020.[11] The Ministry of Economy, Trade and Industry of Japan has rolled out several subsidy programs, such as the Stationary Lithium-ion battery program with a budget of ¥21 billion and the Battery-integrated stand-alone renewable energy generation program with a budget of ¥30 million.[12]

In April 2016, the National Institute of Technology and Evaluation launched the National Laboratory for Advanced Energy Storage Technologies in the Osaka's Bay Area, being Japan's first testing and evaluating facility for large-scale battery energy storage systems. Its aim is to help develop safety standards for energy storage systems.[13] In October 2017, Japan launched its first microgrid system equipped with energy storage cells to power 117 homes in Zone D4 of Smart City Shioashiya Solar-Shima. Each of the homes will have a

7 World Bank Group, Energy Storage Trends and Opportunities in Emerging Markets, 2017.
8 China Energy Storage Alliance, Energy Storage Industry White Paper 2017, 2017.
9 https://www.prnewswire.com/news-releases/the-first-modularized-and-pre-installed-battery-energy-storage-power-plant-in-china-has-been-put-into-operation-300548267.html
10 China Energy Storage Alliance, Energy Storage Industry White Paper 2017, 2017.
11 EU-Japan Centre for Industrial Cooperation, The Energy Storage Landscape in Japan, September 2016.
12 *Ibid.*
13 http://www.nite.go.jp

solar power generator (4.6kW) and a storage cell (11.2kWh).[14]

Southeast Asia

Momentum for energy storage systems is also building up in Southeast Asia. In **Philippines**, where there are more than 7,000 islands, there is great potential for the deployment of energy storage systems. With the introduction of the Philippine Renewable Energy Act of 2008, the Philippines Energy Plan 2012 – 2030 and Energy Regulatory Commission Regulations, energy storage looks to be on the agenda to integrate renewable energy into the grids. The present state of affairs in the archipelago nation proved to be unsatisfactory due to its current reliance on imported diesel fuel for its mini grids leading to unplanned outages. This translates into opportunity for renewable energy and energy storage as a stabiliser to the grids and indeed, companies such as AES[15], Solar Philippines[16] and Manila Electric Co.[17] are already in the advanced stages of developing battery storage projects in Philippines. In 2016, AES completed the first grid-scale battery energy storage in Southeast Asia and has plans to build more storage facilities across Philippines that can store up to 250 MW. Solar Philippines received approval in 2017 for a 150 MW solar power project equipped with a 50MWh battery in Concepcion and has plans to build a micro grid system in Mindoro equipped with energy storage battery.[18]

Similar to Philippines, **Indonesia** aims for electrification of isolated communities scattered across the archipelago nation. With more than 17,500 islands, reports have indicated that small, remote mini grids equipped with storage technologies could enable the electrification of isolated communities.[19] Aligned with Indonesia's renewable energy targets,[20] a microgrid pilot project was implemented in Sumba Island where a hybrid microgrid is designed to fully power the island with renewable energy. In late 2013, a 400 kW flow battery energy storage system was commissioned to integrate renewable energy into the Sumba Island microgrid and to improve power quality and stability within the system.[21] Building on to this model, Perusahaan Listrik Negara, Indonesia's state-owned electricity company, entered into a memorandum of understanding with Caterpillar Inc. to build hybrid microgrid projects (equipped with energy storage facilities) in 500 remote islands in Indonesia.[22] Solar plants with storage capabilities are considered to be suitable to serve remote communities for it eliminates the need for frequent refueling of feedstock which in turn translates to lower operational cost.

Battery storage has been in an infancy stage in **Thailand** for the past few years and has recently picked up pace. The Thai government has indicated that there are plans to include energy storage in its national renewable development plan (Power Development Plan:2015–36) to promote energy storage in parallel with renewable energy growth to address potential blackouts and issues with the national grid. Additionally, the Ministry of Energy has launched "Energy 4.0", a policy which sets out a clear framework on promoting energy storage systems. In 2016, the Energy Policy and Planning Office under the Ministry of Energy provided funds of about US$23 million as research grant to fund research and development in energy storage systems.[23] As of

14 http://news.panasonic.com/global/topics/2017/50883.html
15 http://aesenergystorage.com/2015/12/18/aes-breaks-ground-on-first-battery-based-energy-storage-facility-in-the-philippines-at-masinloc-zambales/
16 http://cleantechies.com/2017/04/30/philippines-approves-30-megawatts-solar-storage-project-to-assess-grid-impact/
17 https://www.doe.gov.ph/meralco-reboots-venture-battery-energy-storage
18 https://www.energy-storage.news/news/solar-philippines-working-on-asias-largest-solar-diesel-battery-micro-grid
19 PwC, Powering the Nation: Indonesian Power Industry Survey 2017, May 2017.
20 Presidential Regulation No. 22 of 2017 concerning the National Energy Master Plan provides that renewable energy supply in the primary energy mix for 2025 is 23%.
21 IFC, Energy Storage Trends and Opportunities in Emerging Markets, 2017.
22 http://www.thejakartapost.com/news/2016/01/25/bringing-renewable-energy-life-indonesia-solar-and-beyond.html
23 Dr. Weerawat Chantanakome, Thailand's Energy 4.0 in EPPO ASEAN Energy Forum – ASEAN Sustainable Energy Week, 8 June 2017.

March 2017, there are a total of 32 research projects in relation to energy storage systems approved with a planned disbursement of US$9.6 million. Alongside the research agenda, the Ministry of Energy launched Thailand's first 300MW hybrid PPA scheme to encourage the supplementary role of energy storage systems to renewable energy. In particular, the 20-year PPA requires a fixed and continuous output during the day which clearly points towards the opportune adoption of energy storage systems by renewable energy developers.

While the pace to implement utility scale energy storage has been slow in **Malaysia**,[24] investors are aware that there are opportunities for development of large scale energy storage projects in the country. Indeed, Malaysian companies are seen partnering with foreign experts to develop energy storage systems in Malaysia.[25] [26]

Singapore has begun to turn its attention to energy storage systems and has established a S$25 million Energy Storage Programme to develop technologies that will stabilise Singapore's power system by using energy storage to facilitate higher penetration of renewable energy.[27] In October 2017, the Energy Market Authority and the SP Group (Singapore's utility) awarded two Singapore consortiums to launch Singapore's first utility-scale energy storage system.[28] With S$17.8 million in grants, the consortiums will deploy an aggregate capacity of 4.4 MWh of redox flow and lithium-ion batteries in the two test-beds in northern and northeastern parts of Singapore. The trial is expected to run for three years.

24 Energy Commission of Malaysia, Towards a World-Class Energy Sector (Energy Malaysia, Volume 7, 2016). Discussions are underway to implement a national energy storage system in Malaysia.

25 Sunway Berhad, the Malaysian conglomerate, is collaborating with Comtec Solar Systems Group, a Chinese company, to develop large scale battery systems for both residential and commercial clients.

26 In April 2018, Cypark Resources Berhad is reported to be collaborating with German-based 21st Century Clean Energy GmbH & Co KG on energy storage projects.

27 https://www.ema.gov.sg/Energy_Storage_Programme.aspx

28 EMA, Energy Storage Test-Bed Media Release, 23 October 2017.

Crystal ball gazing – Opportunities and obstacles in Southeast Asia going forward

As can be seen, the integration of energy storage systems in Southeast Asia is imminent as the region continues to build up its renewable energy capacity. Even though the conventional energy sources are expected to dominate the energy mix to support the growing population[29] and urbanisation in Southeast Asia, renewable energy sources will begin to play a bigger role given their incremental growth to alleviate dependence on conventional energy sources – occupying a larger proportion of the energy mix.[30]

As mentioned, energy storage is seen to be facilitating the transition to renewable energy in islands and rural areas in Southeast Asia. It is expected that current trends will continue to eliminate the need of having spinning reserves. More than just storage, energy storage systems provide ancillary services[31] to smooth out discrepancies between generation and load.

Government support in the region is now on the rise to push for energy storage adoption alongside traditional grid investments. Pilot testing projects have been increasing to integrate utility scale energy storage systems and these are strong and positive indicators for investors.

However, it remains to be seen how smooth the transition to energy storage will be in Southeast Asia. Notwithstanding a positive shift in government policies, the regulatory environment lags behind in such emerging technology. The regulatory uncertainties (including licensing regimes or tax consequences) pose as a challenge to equity investors and debt funders, on top of the obstacles in the emerging markets. For example, there may be tax or regulatory implications if the energy storage system draws electricity from the grid for storage.

Unfamiliarity with the structuring of energy storage projects and the interplay with grid networks is also a challenge. The structure of the project will largely depend on how parties intend to utilise the energy storage system within the project. The usual approach often takes the form of using the traditional PPA model to assimilate both the generation source and the co-located energy storage facility such that they are a single unit with a single revenue stream. Parties have to appreciate the unique features that come with the integration of energy storage such as the ancillary services energy storage systems provide, as well as the need to account for renewable energy credits.

Where energy storage facility is structured as a separate project from the generation source (in some cases, standalone energy storage facility), revenue streams generated from services provided by the energy storage facility are separate. Potential revenue streams from such services include load shifting, peak shaving, frequency response, etc.

A significant barrier to entry for energy storage remains the lack of familiarity with storage technology and project structures among the investors, regulators and financiers in the region. To this end, strong government support will go a long way to overcome challenges.[32]

Ultimately with lower costs and continued technological breakthroughs, sustainable energy will soon take the centre stage. The potential in Southeast Asia alone is huge given the increased government support and we expect to see the incremental transition to storage energy picking up speed with the presence of political will.

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29 According to the ASEAN Centre for Energy (ACE), population will increase to 715 million by 2025 while economic growth is expected to grow on an average of 5% annually. This will contribute to a rapid industrialization and urbanization of the ASEAN nations, leading to a strong growth of 4% in energy demand annually from 2014 to 2025, while electricity demand will double over the same period.

30 ACE expects renewable energy to contribute 17% of ASEAN's fuel mix in its reference case for analysis by 2025, while aspiring to a more ambitious 23%.

31 Ancillary services include frequency support, voltage support, and system restoration.

32 See the Sumba Island case study above.

Our storage experience

A selection of our experience includes

- An investor in connection with an **Energy storage project** to develop and operate one of the world's largest stationary battery storage systems. Our advice included advising on the terms of the corporate structure, financing (including the involvement of ECA financing), EPC contract and O&M terms
- **Mecanova** on the development of a 50MW solar thermal plant in Spain, including the structuring of unique performance guarantees for both field and storage efficiencies
- The **largest institutional landowner** in the State of Hawaii in connection with the development of solar and energy storage facilities
- A battery storage manufacturer in connection with a master supply and development agreement for the sale and development of **utility scale battery storage systems**
- A battery storage project developer in connection with the development of **utility scale battery storage projects** in the United States and Canada
- **Exelon** in connection with an equity investment in a portfolio of 100 fuel cell projects
- A **fuel cell developer** in connection with a US$131m financing of a portfolio of fuel cell projects
- A major energy company in connection with the development of a **combined heat and power fuel cell product offering** for commercial and industrial customers
- An independent power producer in a number of **energy storage projects** in New York
- A major energy company in connection with the development of a **fuel cell-powered microgrid** to provide emergency back-up power for a municipality

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