ENERGY STORAGE SYSTEMS FOR SINGAPORE

POLICY PAPER

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CONTENT

ENERGY STORAGE SYSTEMS FOR SINGAPORE

1 Executive Summary

1.1 Energy Storage Systems ("ESS") is a game-changing technology that potentially has significant benefits for Singapore. ESS's unique characteristic is that it can allow energy produced at a particular time to be captured and used later. This can unlock various opportunities for the energy market and system, such as integrating higher levels of intermittent generation sources ("IGS") such as solar, providing market support services, and deferring costly grid investments to meet short term peak electricity demand. Hence, the Energy Market Authority ("EMA") intends to support ESS development by providing clarity on EMA's vision and regulatory framework for ESS deployment in Singapore.

1.2 In October 2016, the EMA published a consultation paper to review the regulatory framework for ESS to ensure that the relevant regulations keep pace with the development of ESS technologies. Taking into account industry feedback, we have concluded that the existing regulatory and market framework is fit-for-purpose and already allows ESS to participate in our energy, regulation and reserves markets.

1.3 The EMA has also launched complementing initiatives to drive new opportunities. For example, the EMA awarded the Energy Storage Grant Call in June 2016 to develop cost-effective solutions that can be effectively deployed in Singapore. The EMA-SP ESS Test-Bed awarded in October 2017 would implement Singapore's first utility-scale ESS to better understand the feasibility of deploying grid-level ESS technologies in Singapore's hot and humid environment.

1.4 Through these efforts, the EMA seeks to catalyse ESS deployment in Singapore and promote industry innovation. As the costs of ESS fall overtime and become commercially viable, this ensures that we are poised to capture the benefits and opportunities to build a more resilient energy system, increase market competition and enhance the vibrancy of our future energy landscape. We will also continually review the landscape and monitor developments to ensure that our regulations are continuously updated to recognise the fast-paced advancements in ESS.

2 Background

2.1 ESS is viewed as a game-changing technology that can bring multiple benefits to the power system and consumers. Its unique ability to capture energy produced at a particular time to be used later can facilitate the integration of distributed generation sources and IGS, increase system efficiency and rapidly respond to power fluctuations within networks to ensure system stability and reliability. ESS also has the potential to allow grid operators to defer capital-intensive grid infrastructure investments and provide benefits to consumers. Against this backdrop, it is necessary to have a forward-looking regulatory approach that enables Singapore to reap the potential benefits of ESS.

2.2 ESS is a particularly important technology that can help electricity grids to integrate renewable and intermittent energy sources and ensure reliable electricity supply. Globally, the cost of generation from renewables has been declining due to improvements in technology and economies of scale in production. The International Energy Agency ("IEA") indicated that in 2016, renewables accounted for almost two-thirds of net new power capacity globally, largely driven by growth in solar photovoltaics ("PV") capacity[1]. In Singapore, the share of solar PV installed capacity has also increased steadily over time from 0.4 MWp in 2008 to 162 MWp as at end 2Q 2018 (see Figure 1 below). This can be expected to increase further due to greater cost reductions throughout the solar PV value chain, and increase in consumer demand for low-carbon electricity. Singapore has also announced plans to raise the adoption of solar energy to 350 MWp by 2020 and 1 GWp beyond 2020.

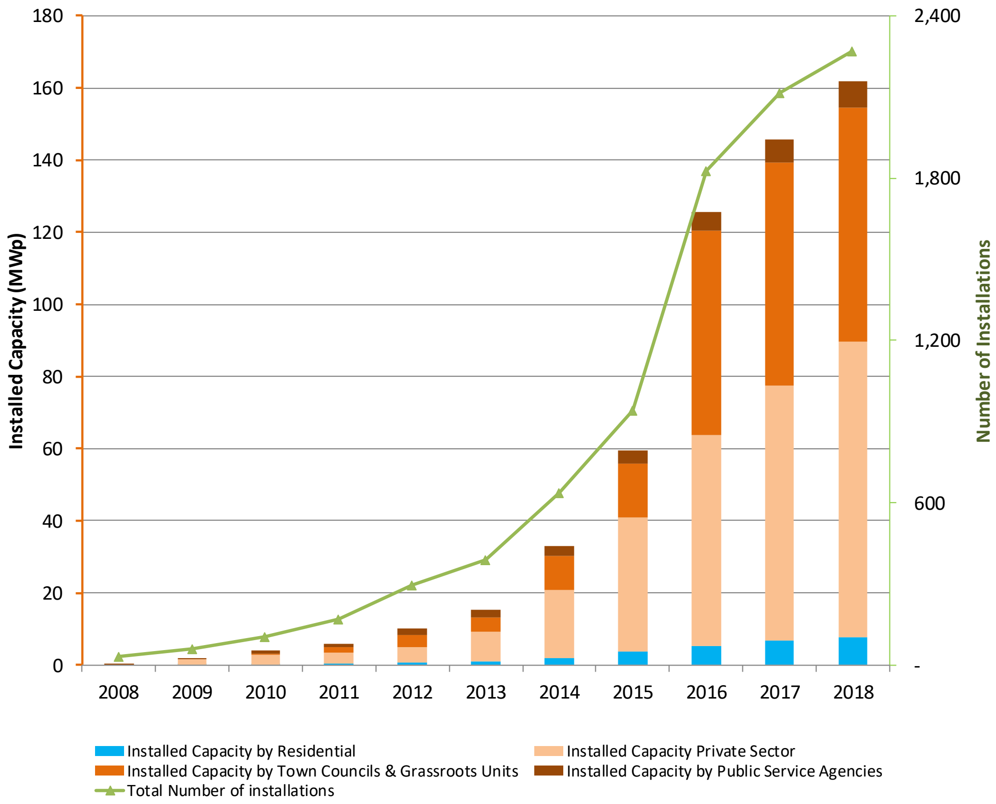

Figure 1: Solar PV capacity growth in Singapore

[1] Renewables 2017, International Energy Agency.

2.3 IGS produce variable power output and integrating increasing shares of such energy sources into energy grids will become a critical challenge for power system operators and regulators globally. Insufficient backup reserves or lack of system flexibility to cater for the unexpected loss of IGS output when weather conditions change could lead to severe power system outages. Countries with significant share of renewables in their energy mix are therefore seeking solutions to manage intermittency and provide greater flexibility in the power system, while maintaining system security and reliability. These can include both supply-side and demand-side solutions, such as introducing more ESS, flexible generation sources with faster response and demand response.

2.4 In October 2016, the EMA launched the consultation paper on Policy Framework for Energy Storage Systems to seek views on the following areas: (i) the possible ESS business models applicable in the Singapore context; (ii) the regulatory and market frameworks to support ESS deployment; and (iii) the possible options for the electricity grid operator to utilise ESS. We had received feedback from 15 participants ranging from generation companies ("gencos"), retailers, ESS vendors, and the grid operator. The EMA has incorporated this feedback into our responses, as set out in this paper.

3 Energy Storage Systems for Singapore

3.1 ESS has unique characteristics as it can act as both a load and a generator, allowing it to time-shift energy by charging and storing energy, and discharging the energy later when required. Depending on the technology and characteristics, ESS can provide short or sustained response. The main types of ESS technologies include[2]:

Table 1: Description of main ESS technologies

ESS Technology	Description
Pumped Storage Hydro (PSH)	Water is pumped from a lower reservoir to a reservoir at higher elevation during off-peak periods. Subsequently, when energy is needed, the water is allowed to flow back down to the lower reservoir through a turbine and generate electricity in the process.
Flywheel Energy Storage	Flywheels are mechanical devices that spin at high speeds, storing electricity as rotational energy. The energy is released later by slowing down the flywheel's rotor, releasing quick bursts of energy (i.e. releases of high power and short duration).
Compressed Air Energy Storage	Air is compressed and stored in underground caverns or storage tanks. The air is released later to a combustor in a gas turbine to generate electricity during peak periods.
Chemical Batteries	Chemical reactions with two or more electrochemical cells enable the flow of electrons. These include lithium-based batteries (e.g. lithium-ion, lithium polymer), sodium sulphur, and lead-acid batteries.
Flow Batteries	Electricity is produced by dissolving two chemical components in an electrolyte separated by a membrane (e.g. vanadium redox flow battery).
Thermal Energy Storage (TES)	Thermal energy is stored by heating or cooling a storage medium so that the stored energy can be used later for heating or cooling applications and power generation.

[2] Technology Roadmap Energy Storage, International Energy Agency, 2014

Benefits of ESS

3.2 ESS brings benefits to our energy system as it can provide multiple services throughout the energy value chain.

3.2.1 Integrate higher levels of IGS. ESS can be co-located with IGS such as wind and solar to address intermittency by providing localised ramping during periods of fluctuating output. The ESS would partially or fully absorb the intermittency of the IGS by charging and discharging accordingly, thus limiting the intermittency effect. Projects in other jurisdictions where this has been successfully demonstrated include:

(a) Notrees Battery Storage Project (Texas, United States)[3]: The 153 MW wind farm is paired with a 36MW/24MWh Li-ion battery storage system to optimise power delivery and provide frequency regulation service in the Electric Reliability Council of Texas ("ERCOT") market.

(b) PNM Prosperity Energy Storage Project (New Mexico, United States)[4]: The 500kW solar PV installation is co-located with a 500kW battery to smooth variable output and a 250KW/1MWh battery for peak shifting.

3.2.2 Provide market services. ESS can provide in-front-of-the-meter[5] services such as frequency regulation, and spinning reserves. One example is the Hornsdale Power Reserve in Jameston, South Australia[6]. The 315 MW Hornsdale wind farm is co-located with a 100MW/129MWh battery. It participates in all competitive energy and ancillary services markets and also receives fixed payments to provide critical grid reliability services.

3.2.3 Provide end-consumer services. ESS can be installed behind-the-meter[7] within consumer premises. For example, the ESS could be used to avoid peak electricity prices by arbitraging the price of electricity during off-peak and peak periods, as well as used to provide uninterruptible power supply (UPS) services.

3.2.4 Defer or replace grid infrastructure. ESS can help to defer the cost of building new transformers and substations by meeting short term peak load demand. This may be more cost-efficient than building new infrastructure which needs to be oversized and the additional capacity may not be required immediately. In the EU, some countries such as Belgium and Italy have allowed transmission network operators to utilise ESS for grid support services. However, other countries like the UK require entities involved in transmission system operation activities to be separated from other market activities, which

[3] Case Studies: Battery Storage, IRENA, 2015

[4] Case Studies: Battery Storage, IRENA, 2015

[5] In-front-of-the-meter refers to providing services to the network.

[6] Lessons from Tesla's World-Beating Battery, Bloomberg New Energy Finance, 2018

[7] Behind-the-meter refers to providing services to end-consumers.

effectively prevents transmission system operators from owning any form of energy storage.

3.2.5 Provide voltage regulation service. ESS is capable of absorbing or producing reactive power to regulate the local network voltage and provide voltage support to maintain the local network voltage within the operating range.

Limitations of ESS

3.3 There are economic and technical factors to consider for ESS deployment.

3.3.1 Cost. At the moment, ESS face higher costs relative to other technologies which makes commercial viability challenging. The commercial viability of ESS will be dependent on market forces and ability to leverage on multiple revenue streams. However, the costs of ESS are falling. (e.g. Li-ion battery pack prices have fallen almost 80% since 2010 to about US$200/KWh in 2017). Furthermore, ESS co-located with solar may improve economics. For example, the Bloomberg New Energy Finance (BNEF) projects that the payback periods for residential PV and ESS in Australia will equalise with new CCGTs between 2023 to 2030[8].

3.3.2 Losses. ESS technologies will incur net energy losses from the charging and discharging process. As ESS technologies have different levels of efficiencies, this results in varying levels of energy losses. Hence, ESS technologies with higher efficiencies will be naturally incentivised for adoption and participation in the market.

3.3.3 Technical Limitations. ESS can be used to provide fast or sustained response. For fast response, the ESS will need to be able to ramp up/down its power output quickly and will be dependent on the power output and ramp rate. For sustained response, this will depend on the energy storage capacity and efficiency of the ESS.

3.3.4 Safety. ESS may pose safety concerns. For example, some types of ESS such as lithium-ion batteries may pose fire hazards due to thermal runaway. The US National Fire Protection Association is currently reviewing fire safety standards for ESS and has published a draft version of Standard for the Installation of Stationary Energy Storage Systems (NFPA 855) for public consultation. Mechanical forms of ESS such as flywheels could also result in safety concerns due to the stored rotational energy if not properly and safely controlled. Hence, these ESS technologies may need to be further researched and investigated to ensure that safety is not compromised.

3.3.5 Future Concentration Risk. Currently, ESS is most widely used in other markets to provide frequency regulation and spinning reserves. If ESS proliferates in Singapore and provides the same services, there is a need to watch for potential concentration risk if conventional power plants (such as CCGTs) are replaced by a few large ESS to provide reserves.

[8] New Energy Outlook 2018, Global Key Messages Presentation, Bloomberg New Energy Finance.

4 Efforts to Facilitate Adoption of Energy Storage Systems

Global Initiatives to facilitate ESS adoption

4.1 The adoption of ESS is increasing. Globally, commissioned ESS projects are expected to reach 125GW/305GWh by 2030, as countries increasingly turn to ESS for grid level and behind-the-meter applications. Out of this, about 56% of ESS installations will be behind-the-meter[9]. For instance, some countries have facilitated ESS adoption through various policies:

Table 2: Country examples of policies to facilitate ESS adoption

Country	Examples of actions taken
United States	The Federal Energy Regulatory Commission ("FERC") issued a final ruling on energy storage in wholesale markets ("Order 841") requiring market operators to ensure energy storage can participate in energy, capacity, and ancillary services markets.
Australia	The Australia Energy Market Commission ("AEMC") ruled that network operators can procure behind-the-meter ESS services through a third party or ring-fenced affiliate. This has led to a growing market for behind-the-meter ESS where retailers and network operators are partnering with technology vendors to aggregate behind-the-meter ESS to offer services.
United Kingdom	ESS has been identified by the UK government as one of "eight great technologies" for the UK. The National Grid also launched the Enhanced Frequency Response ("EFR") tender and awarded 201 MW of contracts to ESS. Going forward, there are plans to simplify the market design for frequency regulation improvement which will increase ESS capacity demand.
South Korea	The government is promoting ESS deployment for renewable integration and commercial and industrial ("C&I") sectors. It has modified the Renewable Portfolio Standard ("RPS") to support ESS installation for wind and solar. It has also launched an electricity retail rate discount to encourage behind-the-meter ESS for C&I sectors.

[9] 2017 Global Energy Storage Forecast, Bloomberg New Energy Finance.

Singapore's Initiatives to facilitate ESS adoption

4.2 Though adoption of ESS in Singapore is still nascent, we are facilitating the adoption of ESS through ongoing efforts to prepare for an ESS-ready future. Singapore has also rolled out initiatives to encourage the industry to adopt ESS solutions.

4.2.1 In August 2015, EMA and Energy Market Company ("EMC") implemented a rule change in the electricity market to allow ESS to participate in the regulation market[10]. The participation of batteries would contribute to the diversity of regulation providers, and enhance competition and efficiency in the Singapore Wholesale Electricity Market ("SWEM").

4.2.2 The EMA awarded $15 million to six projects under the Energy Storage Grant Call in June 2016 to develop cost-effective energy storage solutions that can be deployed in Singapore.

4.2.3 In October 2017, the EMA and SP awarded S$17.8 million to two Singapore-led consortiums, CW Group and Red Dot Power, to implement Singapore first utility-scale ESS. The ESS technologies deployed, redox flow and lithium-ion batteries, will be evaluated for their performance under Singapore's hot and humid environment. The test-bed will also help to establish the standards and guidelines for ESS deployment. In addition, the Technical Standards Working Group was formed under Enterprise Singapore's Singapore Standardisation Programme to track and monitor International Standards in ESS (e.g. fire safety, and communication/control protocols), and to establish local technical guidelines for ESS deployment in Singapore.

4.2.4 The EMA has also announced in October 2018 that it will implement the Intermittency Pricing Mechanism ("IPM") for IGS to ensure that reserve costs are fairly allocated to all generation types. Singapore's approach to IGS adoption is to price energy right so as to ensure steady and sustainable growth, and long term benefits to consumers. The IPM will create the price signal that encourages IGS consumers to adopt solutions to manage intermittency and their reserves cost, including ESS[11].

4.3 The EMA recognises that ESS can potentially be used to defer grid expansion and/or enhance the reliability of the grid network. For example, during periods of peak demand, ESS can be deployed to ease the network constraint via peak load shaving, by charging during the off-peak periods and discharging during the peak periods. This could potentially be a more cost-effective option of upgrading grid infrastructure to meet demand compared to the current option of building new transformers and substations, thus bringing net benefits to consumers. In Italy, network operators are allowed to own and operate battery storage if it can be shown that it is the most cost-efficient solution as opposed to building new grid

[10] Provision of Regulation by Batteries, Notice of Market Rules Modification, EMC. https://www.emcsg.com/f1380,101679/EMC321-EMA-JO.pdf

[11] For more information, please refer to Final Determination Paper on Intermittency Pricing Mechanism for Intermittent Generation Sources in the National Electricity Market of Singapore, 30 October 2018. https://www.ema.gov.sg/cmsmedia/Final%20Determination%20Paper%20-%20Intermittency%20Pricing%20Mechanism%20vf.pdf

infrastructure[12]. In Belgium, network operators are allowed to own and operate batteries if they do not alter the competitive functioning of markets[13].

4.3.1 Locally, the EMA would first need to assess and determine if the use of ESS for grid applications would bring net benefits to consumers, and determine what would be the most cost-effective solution (e.g. upgrading infrastructure, procuring ESS services from third party providers, or owning/operating ESS directly).

4.3.2 The EMA also recognises that there could be conflict of interest if the grid operator ("SP Power Assets" or "SPPA") owns and operates ESS assets for grid applications. EMA will explore and implement appropriate measures to address any conflict of interest to safeguard consumers' interests, which may include ensuring that the most-cost effective solution is procured, and the ESS capacity is right-sized.

4.3.3 The EMA will work with SPPA to assess the effectiveness of ESS in providing grid support services and benefits to consumers, as well as testing the controls to safeguard consumers' interests. If there are indeed proven benefits to consumers and potential conflicts can be addressed, the EMA may consider allowing the ESS to be used by SPPA, either as a service that they procure from third parties, and/or as an equipment under SPPA's Transmission Licence on a case-by-case basis. The current Transmission Code will also be subject to review to ensure that it is fit for purpose for ESS to be used as grid infrastructure.

4.4 We envisage that ESS will be increasingly adopted in Singapore for multiple applications, as costs decline. ESS can be used to (i) integrate higher levels of solar PV and manage variable output as solar adoption increases, (ii) shift peak load and arbitrage electricity prices, (iii) provide ancillary services to the market for frequency regulation and backup reserves, (iv) as an alternative that enables deferment of traditional grid investments to meet periodic peaks in demand[14], thus driving efficient grid investments, and (v) provide voltage regulation services .

4.5 Looking ahead, electric vehicles ("EV") and EV charging infrastructure will also be potential key pieces for the ESS landscape in Singapore. For example, EVs may be able to discharge electricity into the grid during peak demand periods i.e. Vehicle-to-Grid ("V2G"), and to draw electricity for charging when system demand and electricity prices are low. On the other hand, a high concentration of EVs may also increase the localised peak in housing estates. This may necessitate additional grid infrastructure in the absence of ESS. We are seeing growing interest from industry to integrate EV infrastructure into our electricity grid. As EV uptake is still nascent, EMA will monitor developments and ensure our market framework is ready to accommodate such business models.

[12] Italian decree law 93/11, Art. 36, par.4

[13] Belgian Electricity Act, Article 9(1)

[14] This is currently under test-bedding and will need to be proven.

5 Regulatory and Market Frameworks for Energy Storage Systems in the National Electricity Market of Singapore

5.1 Licensing Requirements for ESS

5.1.1 The EMA has reviewed the licensing requirements for ESS. Under the current regulatory framework, the type of licence required depends on the type of service that is being provided. As ESS is able to provide different services, the EMA will apply the existing licensing treatment to ESS depending on the type of services provided. There are two broad categories of licences that are applicable to ESS:

(a) **Generation or Wholesaler Licence:** The ESS acts as a generator and is required to be licensed under a wholesaler or generation licence depending on its name-plate capacity[15]. As all generators less than 1 MW do not require a licence, similar treatment will apply for ESS with capacity of less than 1 MW.

If ESS is paired with IGS, the aggregate of the Alternative Current ("AC") capacities of both the ESS and IGS inverter at the point of connection[16] to the grid will be used to determine the threshold for licensing requirements[17]. This is consistent with how the EMA treats conventional generation sources. Currently, the existing wholesaler and generation licence conditions are applicable for ESS.

If the ESS is participating specifically in the Interruptible Load or Demand Response schemes only, it can choose to apply for a Wholesaler licence.

(b) **Electrical Installation Licence:** Electrical Installation Licence is required for all non-domestic electrical installation with approved load exceeding 45kVA. The Electrical Installation licence for the electrical installation shall cover the embedded ESS if it has a ESS capacity of not more than 1MVA.

5.1.2 As ESS technology advances, the EMA will continue to review licence conditions to ensure that sufficient regulatory controls are in place to maintain safety and technical reliability of ESS, while supporting innovations that benefit both businesses and consumers.

5.2 Market Participation and Settlement

5.2.1 Currently, as a generator, ESS is allowed to participate in the market to provide energy, regulation or reserves. In 2015, the EMA and EMC implemented a rule change in the electricity market to allow ESS to participate in the regulation market. At this point, the EMA

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[15] Any person who engages in the generation of electricity with a generating unit having a name-plate capacity of between 1 MW or more but less than 10 MW, is required to hold a wholesaler licence; and any person who engages in the generation of electricity with a generating unit having a name-plate capacity of 10 MW or more, is required to hold a generation licence.

[16] The point of connection refers to the point where the facility is connected to the SPPA's substation.

[17] For more information, please refer to the Final Determination Paper on Enhancements to the Regulatory Framework for Intermittent Generation Sources in the National Electricity Market of Singapore, 1 July 2014. https://www.ema.gov.sg/cmsmedia/Consultations/Electricity/Proposed%20Modifications%20to%20the%20Transmission%20Code/1July2014Final_Determination_Intermittent_Generation_Sources_-_1_July_2014_Final_.pdf

has assessed that no further rule changes are required for participation in the energy and reserves market. Similar to conventional generators, ESS will need to prove that it is fully dispatchable[18] and can continuously generate at its scheduled output throughout the entire half-hour dispatch period for energy and reserves.

5.2.2 Moving forward, under the existing Market Rules, ESS is required to be registered as a Market Participant ("MP")[19] if it is at least 1 MW, or if it wants to be paid for any energy injected into the grid if it is less than 1 MW. To register as a MP, interested parties are required to submit relevant documents to EMC[20].

5.2.3 There will be no changes to the minimum offer requirement of 0.1 MW in the market. Under the current Market Rules, aggregation of multiple ESS units within the same site is already allowed upon compliance with technical requirements for dispatch by PSO and market registration by EMC.

5.2.4 On market settlement[21] for providing energy, regulation and reserves, ESS will receive the same type of payments as conventional generators as illustrated below:

(a) **Energy payments:** For a standalone ESS which charges from and discharges all electricity into the grid for price arbitrage, it will be paid the prevailing half-hourly nodal price for the electricity injected to the grid, and pay the prevailing half-hourly nodal price for the electricity withdrawn from the grid, less the applicable market charges. For embedded ESS paired with IGS located within the same premise as the load (i.e. behind the same point of connection to the grid), net settlement of energy will be done within each half-hourly trading interval. For example, if total energy consumption is 50 kWh and total ESS/IGS generation is 100 kWh, the facility will be paid the prevailing half-hourly nodal price based on the net injection of electricity of 50 kWh, less the applicable market charges.

(b) **Regulation payments:** ESS will receive the same half-hourly payments for providing regulation as conventional generators.

(c) **Reserves payments:** ESS will receive the same half-hourly payments for providing either primary or contingency reserves as conventional generators.

5.2.5 On charges for market settlement, both generators and loads are subject to reserve charges to ensure the reliable supply of electricity to consumers and the secure operation of the power system. ESS acting as either a generator or load will be subject to the same

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[18] As per the market rules, dispatch means the act of receiving an instruction as to the level of a registered facility's physical operation required in a given dispatch period, and operating in accordance with such an instruction.

[19] For contestable consumers with embedded ESS capacity below 10 MW who participate only in the energy market, they can register under the Enhanced Central Intermediary Scheme (ECIS) with SP Services and be paid at prevailing half-hourly average nodal prices.

[20] For more information, please refer to EMC's Guide to Participation in the Singapore Wholesale Electricity Market for an overview of the procedures and requirements for registration as a Market Participant. The guide is available at: https://www.emcsg.com/f143,68842/EMC_Registration_Guide.pdf

[21] For the purpose of market settlement, ESS is required to install 2 revenue-class meters to measure total generation (i.e. generation meter (s) – M1) and net withdrawal from the grid (i.e. consumption meter – M2).

reserve charges. There are two broad categories of reserves: regulation and spinning reserves:

(a) **Regulation Reserve:** This refers to the amount of generation capacity needed to balance the minute-to-minute variations in electricity consumption of all loads and small variations in generating units' output. The cost of regulation reserve is recovered from all loads and the first 5 MWh of each generation facility in each half hour period on a "gross" basis. Given that the nature of ESS allows it to switch continuously between charging from and discharging to the network even within the half-hour trading period, gross settlement[22] for regulation reserves will apply. For example, if the ESS withdraws 2MWh of energy and injects 3MWh of energy within a particular trading period, the ESS will be charged 5MWh for regulation reserves.

(b) **Spinning Reserve:** This refers to the amount of generation capacity required to correct large imbalances in the system due to significant reduction in generating units' output. The cost of spinning reserve is recovered from all generation facilities scheduled, including ESS (less the first 5 MWh of each facility, which is allocated the cost of regulation reserve) operating in that half-hour through a methodology that varies according to the scheduled/forecasted generation output based on its Reserve Responsibility Share[23].

5.2.6 On non-reserve market charges[24], ESS acting as either a generator or load will be subject to the same non-reserves charges based on gross generation and gross consumption. In the case where the ESS fulfils the requirements[25] for embedded generators, such non-reserves charges will be settled on a net basis[26].

[22] To be consistent with the treatment for embedded IGS, net settlement of regulation reserves will apply for all residential consumers and non-contestable consumers with embedded ESS capacity less than 1 MW. For more information, please refer to EMA's Final Determination paper on Enhancements to the Regulatory Framework for IGS in the NEMS, 25 July 2017.
https://www.ema.gov.sg/cmsmedia/Consultations/Electricity/Determination%20paper%202017%20-%20Enhancements%20to%20the%20regulatory%20framework%20vf.pdf

[23] For more information, please refer to EMA's consultation paper on Intermittency Pricing Mechanism for Intermittent Generation Sources in the NEMS, 1 August 2017.
https://www.ema.gov.sg/cmsmedia/Consultations/Electricity/Intermittency%20Pricing%20Mechanism%20Consultation%20Paper%20_1%20Aug.pdf

[24] Non-reserve market charges refer to Energy Market Company (EMC) fees, Power System Operator (PSO) fees, Monthly Energy Uplift Charges (MEUC) and Market Support Services (MSS) fees.

[25] For more information, please refer to EMA's information guide for embedded generation, February 2014.
https://www.ema.gov.sg/cmsmedia/Consumers/Embedded%20Generation/GuideforEG.pdf

[26] For more information, please refer to EMA's decision paper on the review of policy on direct supply of electricity by generating sets to onsite loads, 5 July 2010.
https://www.ema.gov.sg/cmsmedia/Consultations/Electricity/4c319fca8c79a5_July_2010_EMA_s_Assessment_and_Decision.pdf

5.3 Grid Charges

5.3.1 Grid charges will be levied on ESS when it is acting as a load as per the current grid charge structure, either on a fully variable (Low Tension) or fixed-variable (High Tension and above) basis. This is the same treatment for all loads with embedded generators today.

5.4 Transmission and Metering Codes Requirements

5.4.1 The EMA has determined that ESS will follow the existing Transmission and Metering Codes requirements.

5.4.2 For ESS used to provide grid support services, the EMA will review the Transmission Code in conjunction with the ongoing ESS testbeds to assess if there is a need to include additional performance requirements.

5.5 Creation of ESS Registry

5.5.1 All electrical installations, including ESS, are required by EMA to be operated and maintained by Licensed Electrical Workers ("LEW") to ensure that installations are safe for use. As part of the commissioning procedures, the LEWs appointed by ESS owners are required to submit installation details, such as the type of ESS, name-plate capacity (kW/ KWhr) and installation location to SPPA.

5.5.2 All details collected will be recorded in an ESS Registry maintained by SPPA which will be used to track ESS installations and assess the level of ESS in the system and its impact on the grid. This is important for the purpose of ensuring power system stability, both at the localised level as well as the system level. LEWs will be required to inform SPPA before they disconnect or retrofit any grid-connected ESS installations. This ensures that information in the ESS Registry is up-to-date.

6 Conclusion

6.1 There are benefits for ESS deployment in Singapore and ESS could help Singapore to move towards a low-carbon and more flexible energy system. ESS can help to (i) integrate higher levels of IGS, (ii) avoid network constraints and defer grid investments, (iii) provide market support services, and (iv) provide services to end-consumers.

6.2 Based on the existing policy and regulatory framework, ESS can already participate in the energy, regulation and reserves market today. In addition, the EMA will continue to monitor developments in other jurisdictions and see how lessons can be applied to Singapore, such as the use of ESS as fast-response reserves. EMA will continuously update our regulatory framework to harness the benefits of fast-changing ESS technologies.

- End -