APPENDIX 1 TO THE ENHANCEMENTS TO THE REGULATORY FRAMEWORK FOR INTERMITTENT GENERATION SOURCES IN THE NATIONAL ELECTRICITY MARKET OF SINGAPORE:

RESPONSE TO FEEDBACK

1 JULY 2014

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A. Licensing

Comments/Feedback	The EMA's Response
Sustainable Energy Association of Singapore ("SEAS") The Consultation Paper refers many times to "MWp" for limits such as the current cap on total intermittent generation sources being 350MWp. We believe this is incorrect and should be expressed as 350MW or 350MWac, because MWp is a term that applies only to PV and not other generators such as wind or gas generators. MW (or MWac) is the correct unit for a generator, regardless of its technology. This is consistent with the decision under 2.1.2 to define the capacity of a PV system according to the aggregate capacity of its AC inverters. ***Sunseap, YL Integrated, Ecosys Infrastructure*** The Consultation Paper refers many times to "MWp" for limits such as the current capacity on total intermittent. We would like to suggest that IGs be look at on their AC nameplate capacity such as "MW" or "MWac". This is consistent with the decision under 2.1.2 to define the capacity of a PV system according to the aggregate capacity of its AC inverters.	The EMA agrees with this comment, and has clarified that **MWac,** or the aggregate capacity at the Alternating Current ("AC") inverters, will be used to determine the licensing threshold and the Intermittent Generation Threshold ("IGT"). We would also like to clarify that the **IGT (i.e. 600 MWac) does not constitute a cap** on the amount of Intermittent Generation Sources ("IGS") we can accommodate in our system. Instead, the EMA has recommended a "dynamic pathway" approach to manage intermittency by procuring sufficient reserves in tandem with the growth of IGS. Hence, the 600 MWac IGT is the first threshold of this "dynamic pathway" approach, below which existing reserves can be used to manage the intermittency. It is possible for the total amount of installed IGS capacity in Singapore to exceed 600 MWac.
SEAS When comparing capacities of different generators, the current regulations consider only name plate rating. But this does not give fair weight to the energy impact of each technology, which varies according to its capacity factor (CF). Consider a 1MW gas generator that operates at capacity for 7'000 hours a year, so it feeds 7'000MWh a year into the grid. A year has 8'760 hours, so	EMA does not agree with using the capacity factor to determine the licensing requirements, as the impact of a generation source on the operation of a power system depends on its generation capacity (i.e. name-plate capacity), rather than the capacity factor. Hence, licensing threshold is based on name-plate capacity and should be applied consistently to all generation types.

Comments/Feedback	The EMA's Response
the gas generator's capacity factor is 7'000/8'760 = 79.9%. In contrast, a 1MWac PV power plant (typically 1.2MWp) generates approx 1'200MWh/MWp = 1'440MWh/MWac. Its CF = 1'440/8'760 = 16.4%. For equivalent energy impact, we should apply the ratio of capacity factors. Thus a 1MW gas generator is equivalent to 79.9/16.4 = 4.9MWac of PV power plant. We can apply similar calculations to other generators such as wind turbines, biogas plants etc. We propose adjusting the MWac limit for each technology according to typical capacity factor instead of applying a flat 1MWac to all generator types. ***Sunseap, YL Integrated, Ecosys Infrastructure*** When comparing capacities of different generators, the current regulations consider only name plate rating. But this does not give fair weight to the energy impact of each technology, which varies according to its capacity factor (CF). For equivalent energy impact, we should apply the ratio of capacity factors. Thus, a 1MW gas generator is equivalent to approximately 5 MWac of PV power plant. We can apply similar calculations to other genertors such as wind turbines, biogas plants etc. We propose adjusting the MWac for each technology according to typical capacity factor instead of applying a flat 1 MWac to all generator types. ***Keppel Merlimau Cogen***	

Comments/Feedback	The EMA's Response
Name plate capacity for intermittent generation will be used by PSO for forecasting production and determination of externalities (DR scheme and Reserve Charges). Degradation of solar generation over the life of the plant typically reduces its output by 10–20%. For PSO's forecast to be accurate and for fair distribution of reserve charges, it is imperative for PSO to maintain an updated true capacity of IGs. EMA may consider using the historical 1-year actual electricity exported or generated as an indication of each IG's capacity or allow voluntary re-declaration of the capacity of intermittent generators on a need to basis, instead of fixing name-plate capacity solely to capacity of inverters.	
SEAS Some solar PV installations in Singapore are financed by third parties who are the legal owners of these systems. For the required registration and licensing with EMA, which of these two parties will be required to hold the necessary licences?	For a solar photovoltaic ("PV") system that is 1 MWac and above, the <u>owner</u> of the solar PV system would need to apply for the relevant licence from the EMA. As a clarification, in the case of solar leasing, the solar leasor will be deemed the owner of the system.
Singapore Power PowerGrid ("SPPG") We would like to inform that currently all PV systems are connected to customer's equipment within consumers premises and not directly to SPPA's network.	All existing solar PV systems' point of common coupling is at SPPG's distribution network. In some instances, the solar PV systems may export power to SPPG's distribution network.

B. Commissioning Procedures

Comments/Feedback	The EMA's Response
SPPG SPPG submits that the IG registry should be kept and maintained by the PSO for the following reasons: • SPPG does not monitor gencos' operation online. The current PV system registry kept by SPPG is merely for the purpose of recording approvals of service connections. • PSO's operations depend on the IG registry, e.g. tracking of solar installations, maintaining power system stability and allocating reserves costs. Therefore, PSO should also cover IGs as part of its current duties in monitoring gencos' operations. • This is in line with EMA's decision to adopt the "dynamic pathway" approach for setting IGT and IGL levels. Furthermore, PSO requires ready access to the registry to enable it to monitor growth of total PV installed capacity and its geographical distribution in a timely and accurate manner. Following SPPG's proposal in para 3.1.2 above, the owners and LEWs of the respective IGs should contact the PSO for any change in their IG system. The owners and LEWs should contact SPPG in the event they are disconnecting their grid-connected IGs from SPPA's system.	The EMA does not agree with this comment. As part of the commissioning process, the Licensed Electrical Workers ("LEWs") appointed by solar PV owners are required to submit installation details, such as the name-plate capacity and installation location to SPPG. In addition, the LEWs will be required to inform SPPG before they disconnect or retrofit any grid-connected solar PV installations. Hence, SPPG should maintain the Solar PV Registry and ensure that it is up-to-date. In addition, with increasing penetration of solar PV installations at the distribution level, there can be impact on power quality and safety of the distribution network. Being the distribution grid operator, SPPG has the responsibility of ensuring the safe and secure operation of the distribution network. With immediate effect, SPPG is required to (a) maintain the Solar PV Registry of all solar PV installations connected (directly or indirectly) to the distribution network (which includes the collection of the necessary information required by the EMA); and (b) submit to the EMA the Solar PV Registry on a regular basis.
Sunseap, YL Integrated, Ecosys Infrastructure Also, the interlock / inter-tripping mechanism requirement for IGs even for connection at low voltage is also an overkill since there are already anti-	The EMA has set up a joint Taskforce with SPPG to review and enhance the existing commissioning process for solar PV installations. Specifically, the

Comments/Feedback	The EMA's Response
islanding mechanism built in for all approved inverters. Most importantly, these requirements from SPPG and PSO are not even mentioned in the Handbook for Solar Photovoltaic (PV) Systems and are newly in placed requirements without any consultation from industry. These requirements represents capex cost and onerous real time monitoring cost which is more than often too expensive for any IGs (solar in particular) to bear especially if the capacity is calculated without any reference to CF. We feel that Power Grid's requirement to install interlocking / inter-tripping mechanism is redundant as all the Grid-Tied Inverters are built in with anti-islanding mechanism to isolate the PV system when there is a loss of supply from the grid. Moreover the PV systems are connected at the Low Voltage side of the electrical network. These anti-islanding mechanisms are tested and certified with international standards and are also tested on site during Power Grid's commissioning of the PV system. We would like to request EMA to consider waiving off the above-mentioned requirement.	Taskforce will - a) Streamline the existing commissioning process for solar PV installations; and b) Review and update the existing technical requirements for solar PV installations to ensure that the safety and quality of electricity supply are not compromised. On the requirements for additional safety mechanisms (e.g. inter-tripping mechanism), the EMA has worked with SPPG to assess that these would not be required if the 'built-in' safety mechanisms can meet the requisite standards.

C. Market Participation and Settlement

Comments/Feedback	The EMA's Response
Market Participation	
SEAS We…welcome proposals to streamline market registration procedures for intermittent generation (IG) sources less than 1MWac. Central forecasting by the PSO is an excellent idea to better manage distributed IG in Singapore's electricity grid.	EMA notes the comment.
Tuas Power …[T]here should not be undue impediments for the entry of small scale intermittent generation and licensing and registration requirements could be further relaxed. The current 10MW threshold is an appropriate limit for the Singapore market and therefore should be maintained in that anybody who chooses to invest anything beyond this threshold must subjected to the same market rules without exception as set out in the market design adopted for Singapore.	The EMA agrees that the regulatory framework should not be a barrier of entry for IGS as they become commercially viable. Given the intermittent nature of IGS, it is not possible to subject IGS to all rules and obligations as conventional generators. For example, it is not possible for IGS to be centrally dispatched unlike conventional generators. Hence, the EMA's approach is to put in place an enhanced regulatory framework which recognises the technical characteristics of IGS.
PacificLight Power With respect to the market registration process, PLP would request the EMA provides further details on the waivers that would be granted to intermittent generators as well as the rationale behind these waivers. We would question why an intermittent generator should be exempted from providing a security deposit knowing that these generators are also consumers of electricity.	The EMA would like to clarify that para 4.2.2 of the consultation paper lists possible options to simplify the market registration process for small IGs. To clarify, a security deposit would not be required if monies are not owed by the consumer/IGS to the Energy Market Company ("EMC"). This is similar to the security deposit requirements for other market participants.

Comments/Feedback	The EMA's Response
Provision of a security deposit reduces unnecessary credit risk which has to be borne by the market and ensures that market participants settle their electricity charges promptly. An Intermittent Generator is equally at risk of defaulting on payment as any other market participant/consumer and therefore should be treated consistently.	
Market Settlement	
SEAS Using nodal prices to determine payment for exports unnecessarily complicates matters. The nodal price concept is valid for centralised generation, where there can be measurable transmission and distribution losses between generator and consumer. But in a distributed generation model, any exports from an embedded generator are consumed on site or very close by, with no measurable T&D losses. We propose just using the USEP prices. ***Sunseap, YL Integrated, Ecosys Infrastructure*** Using nodal prices to determine payment for exports unnecessarily complicates matters. The nodal price concept is valid for centralized generation, where there can be measurable transmission and distribution losses between generator and consumer. But in a distributed generation model, any exports from an embedded generator are consumed on site or very close by, with no measurable T&D losses.	The National Electricity Market of Singapore ("NEMS") adopts nodal pricing to ensure that the true cost of delivering the electricity to each point in the grid is revealed. Nodal pricing is the outcome of a dispatch schedule which takes into consideration the physical characteristics of transmission system and the simultaneous flow of energy from different points between nodes. Hence, nodal pricing provides the price signals for efficient generation planting. While IGS generation is likely to be distributed in nature, the export into the grid affects the flow of power, which in turn affects prices across the different nodes. Therefore, IGS should be modelled by the Market Clearing Engine ("MCE"), and be paid the price which reflects the true value of its export into the grid. The exception is embedded IGS less than 1 MWac which will receive a weighted price of all the generation nodes for export into the grid. This is on the consideration that it would not be practical for the MCE to model numerous small units.
Solar Gy	

Comments/Feedback	The EMA's Response
Under clause 4.1.4, can we understand how NCC can get paid for excess energy injected into the grid, in the case they are taking HT supply from SP, as we understand there is presently no HT dual register metering scheme.	At present, non-contestable consumers ("NCC") connected at the High-Tension ("HT") network can register with EMC to receive payment for their export, based on the prevailing pool price. While the "Simplified Credit Treatment" only caters to NCCs at the Low-Tension ("LT") network now, system changes will be subsequently implemented to enable "Simplified Credit Treatment" for NCCs with embedded IGS less than 1 MWac, connected at the HT level.
Solar Gy Will all existing and new Owners of landed properties continue to enjoy payment for PV energy injected to the gird based on the dual register metering scheme?	NCCs (residential and non-residential) with IGS less than 1 MWac connected at Low-Tension ("LT") will continue to enjoy the "Simplified Credit Treatment", where they are paid the energy component of the tariff through SPS for export of excess electricity into the grid.
Energy Market Company ("EMC") If EMA decides that individual consumers with IGS are not required to register as MPs, EMA's licence conditions should reflect this and alternative settlement arrangement should be put in place to allow these consumers to be paid through other channels, via MSSL or retailers, when they inject into the grid. With reference to paragraph 4.3.3 of EMA's paper, please note that if GSFs/GRFs are not individually registered they cannot be paid nodal prices as the MCE will not determine nodal prices for them.	The EMA notes the comment. As some of the existing conditions stated out in the market rules may not be applicable to solar PV, the EMA has streamlined some of the market requirements and registration procedures for them.
Central Forecasting by Power System Operator ("PSO")	
Keppel Merlimau Cogen How would PSO factor plant availability of respective IGs be factored in the	As the majority of solar PV installations is likely to be small (< 1 MWac) and

Comments/Feedback	The EMA's Response
forecast? How would plants communicate shut-downs for maintenance or system faults to PSO? ***PV World*** The model proposed by EMA requires forecasted output of each solar PV system. It will be difficult to gather data from all the different systems on a regular basis as the generation is simpl(y) consumed within the building unless a meter is installed at every location. A simple forecasting will not be fair in the event of a shutdown period due to roof works.	distributed across the island, it is not practical to track the availability of individual solar PV installations. Hence, the EMA will be adopting a statistical approach to forecast system-wide solar PV output. In order for the PSO to manage real time system stability and to establish a robust methodology for forecasting solar PV output, solar PV owners above 100 kWac would be required to meet PSO's monitoring requirements.
Sunseap, YL Integrated, Ecosys Infrastructure Instead of installing its own weather station for each PV system, we propose that an educational / research institute can provide accurate readings from their network of precise stations deployed nationwide.	The EMA agrees with this comment. PSO will not require each solar PV system to provide weather data.
EMC If residential consumers are not included in the pricing mechanism, it would mean, presumably, that the IGS output from these consumers will not be charged reserve cost and will not be included in the IGS generation forecast by PSO. There might be some system security concern if the IGS output is under forecasted and reserve procured is insufficient.	Residential IGS will be considered in the PSO forecasting methodology. We wish to clarify that forecasting is a separate issue from the reserves charging framework for IGS.
Keppel Merlimau Cogen What is the definition of intermittent generation sources with storage facilities such that requirements to submit offers and be subjected to dispatch would	IGS integrated with technological solutions such as energy storage will no longer be classified as intermittent if they are dispatchable.

Comments/Feedback	The EMA's Response
still apply? Can EMA clarify how is such "storage facilities" defined as some PV systems would have some form of battery systems?	

D. The "Dynamic Pathway" Approach

Comments/Feedback	The EMA's Response
Dynamic Pathway Approach	
SunEdison LLC SunEdison supports removal of market entry barriers to solar PV, in particular the proposed adoption of a "dynamic pathway" in lieu of arbitrary caps on the integration of commercially viable and cost-effective intermittent generation.	The EMA notes the comment.
Localised Network Constraints	
Sunseap, YL Integrated, Ecosys Infrastructure Solar PV project implementation (from development to commissioning) can take up to 1 year during which time the network limit may be reached. We would like to recommend relevant authorities to publish details of the network limit to the public, broken down into geographical location and distribution zones and these data to further substantiate the renewable energy installation limits where such installations would not be subjected to onerous cots and monitoring expenses and capital expenditure. ***SEAS*** Solar PV project implementation (from development to commissioning) can take up to 1 year during which time the network limit may be reached. To limit risk of not connecting project to grid due to network limit we propose a two stage approach which has been implemented in other countries. Step 1: EMA confirms network availability at connection point from client	The EMA notes the comments. We are currently carrying out the review of localised network limits with SPPG. However, as the configuration of the distribution network may change from time to time, these limits would be adjusted accordingly. Potential investor in new solar PV installations should approach SPPG early so that SPPG can advise the applicant on feasibility of connection.

Comments/Feedback	The EMA's Response
inquiry Step 2: Client places non-refundable down payment (proportional to size of PV capacity) to reserve capacity allocation with a guarantee from EMA to connect at the network point. This guarantee should expire if project is not built by a reasonable deadline. This avoids network access being unproductively blocked.	
SPPG Given the intermittency nature of the IG generation sources, the raising of the IGT from 350 MWp to 600 MWp will have an impact on the system harmonics and contribute fault current to the grid system. The costs associated with the solutions to mitigate the impact of harmonics and fault current will have to be borne by the IGs based on the "causer-pay principle".	The EMA notes the comment. SPPG needs to monitor real-time status, voltages and flow of power in/out of installations with solar PV system connected to the SPPG's network.
Exemption from the Pricing Mechanism for IGS	
SEAS Opt-out date will apply only to non-residential consumers with embedded intermittent generation (IG) installed (presumably connected) before 1 Apr 2014, provided they submitted their application to SPPG prior to 1 Jan 2014. That means consumers who are evaluating an IG system between 1 Jan 2014 and the publication of EMA's final determination paper cannot properly evaluate the economics of their proposed investment, because they will not know the full terms of the market conditions.	Taking into consideration the industry's feedback on the Externalities Pricing Mechanism, the EMA intends to embark on a more in-depth study on the issue. Given this, the EMA had announced on the 28 March 2014 that the cut-off dates eligible to opt-out of the pricing mechanism will be **extended by 1 year**. Specifically, non-residential consumers can choose to opt-out, if they meet the following revised criteria – a) Installed their embedded IGS <u>prior to 1 January 2015</u> (instead of 1 January 2014); or

Comments/Feedback	The EMA's Response
We propose changing this deadline to 2 months after EMA's final determination paper is published. ***Keppel Merlimau Cogen*** On the opting out option, would pre-investments made onto projects that have not been fully implemented at the cut-off date be also eligible?	b) Submitted their application to SPPG <u>before 1 January 2015</u> (instead of 1 January 2014) and with a <u>commissioning date before 1 April 2015</u> (instead of 1 April 2014).
SEAS For point b [of section 6.1.4 in the consultation paper], we propose changing 20 years to 25 years. Most PV systems have an economic life of 25 years, consistent with PV module warranty. ***Sunseap, YL Integrated, Ecosys Infrastructure*** Under page 15 section 6.1.4 point b, we propose changing 20 years to at least 25 years. Most PV systems have an economic life of 25-35 years, which is widely available and verifiable with public literature. This is also congruent with PV module warranties and some solar leasing contracts signed for 25 years.	The economic life of PV systems has been adjusted to 25 years. Hence, for eligible consumers who have chosen to opt-out, they will be subjected to the pricing mechanism if: (a) They retrofit their IGS systems such that re-commissioning by SPPG would be required in the process, or (b) 25 years (instead of 20 years) from the commissioning date of their existing intermittent generation systems, whichever occurs earlier.
Solar Gy Under Clause 6.7.5, is a HDB flat common area meter classified under non-residential NCC? (if they have not opted to be contestable)? On the other hand, if they are classified as residential, do they have to pay reserve charge?	Energy generated from solar PV installed on the rooftops of HDB flats is used to offset the common services load (e.g. lifts, pumps etc.), which is considered non-residential load. Depending on their contestability status, such loads can be contestable or non-contestable.

Comments/Feedback	The EMA's Response
	As highlighted in the final determination paper, the pricing mechanism for IGS will only be applied to non-residential consumers (both Contestable Consumers ("CCs") and NCCs) as such consumers are in a better position to manage the commercial risks of their investments.
Pricing Mechanism Pricing Mechanism for IGS	
SEAS A pragmatic alternative is to recognise that current levels of IG (essentially PV) in Singapore make no measurable impact on the grid. They get lost in the noise of intermittent demand, and are indistinguishable from negative load. At some point, this will cease to be the case. At certain levels of PV capacity, it will have an impact on the grid. Until that threshold is reached, we suggest treating PV as a negative load, which means insulating consumers with IG from the complexity of NEMS rules, for all IG that is consumed in-house. The IGs can be simple price takers for any excess exported to the grid, minus a fair contribution to grid charges. This allows investors today to calculate their IRRs without fear that the market conditions will change in future. When a defined threshold is crossed, existing PV capacity should not have to pay any higher charges. Instead, all investors in the next tranche of PV capacity (eg the next 100MWac) will pay their share of grid infrastructure upgrades to accommodate the intermittency they impose. By that time, the cost of PV installations will have dropped slightly, enabling the newcomers to afford the infrastructure costs.	The EMA notes the comments. Aligned with the 'causer-pays' principle, IGS should bear a share of the costs to manage intermittency. It will not be fair to allow a significant amount of IGS to enter the system without charging for the impact, while making IGS that enter later bear the full costs of managing intermittency. We understand the industry's preference for a pricing mechanism that is simple and provides greater certainty. At the same time, the EMA needs to ensure that the reserves charging mechanism is fair to all generators and consumers, including future IGS consumers. The EMA will be conducting a further in-depth study, and will issue a consultation paper in Q4 2014 to seek industry feedback on the revised pricing mechanism framework.

Comments/Feedback	The EMA's Response
The same happens with each successive tranche. Eventually, new PV capacity will only be possible in combination with storage, and will only be feasible if the combined cost of PV + storage is economically viable. The advantage of this approach is twofold – ▪ Firstly, it allocates infrastructure costs more fairly to newcomers, without imposing future uncertainty on established IG capacity. ▪ Secondly, it gives the regulator time to study the true positive and negative externalities of IG and consider technological as well as market options to settle these externalities fairly. ***PV World*** So currently in Singapore, PV technology has some market and opportunity but still very fragile. Without the grant & support from government, it has little possibility to surge within a short period. So I suggest that EMA target a trigger point to start charging the reserve charges, it can be 60% of Intermittent Generation Threshold but not now. ***Sunseap, YL Integrated, Ecosys Infrastructure*** When a defined threshold is crossed, existing PV capacity should not have to pay any higher charges. Instead, all investors in the next tranche of PV capacity (e.g. the next 250 MWac up to maximum of 500 MWac) will pay their share of grid infrastructure upgrades to accommodate the intermittency they impose. By that time, the cost of PV installations will dropped slightly, allowing the newcomers to afford the infrastructure costs. The same happens with each successive tranche. Eventually, new PV capacity will only be possible in combination with storage, and will only be feasible if the combined cost of PV + storage is economically viable.	

Comments/Feedback	The EMA's Response
Reserve costs should be computed based on known factors with no impact on predecessor system installations. For example, should reserve costs be applicable in the 500 MWac tranche, such costs should be imposed on name plate capacity (i.e. Wp) and fixed on a monthly or annual basis for the duration of the economic useful life of the solar system. Such costs should not be imposed on the earlier tranche (i.e. 250 MWac tranche), which are subjected to typically higher capital expenditure costs and pre-determined costs of capital. ***Keppel Merlimau Cogen*** Keppel proposes that the implementation of pricing mechanism be postponed until the total intermittent capacity reaches a critical mass as proposed methodologies may not function meaningfully with current capacity of 12MW. Methodologies for forecasting of generation and pricing of externalities would also need to be fine-tuned with real system data as more IG capacity is introduced into the system. ***PV World*** The implementation of the reserve charges proposed in the consultation will have adverse impacts on the solar PV industry in Singapore All I know is that even if the true cost of the reserve charges is reduced from my estimates of 17% to 5%, solar will not be viable in Singapore. As mentioned above, PV technology contributes to the environment. For each 1 kWh electricity generated by PV system, it saves 0.514kg CO_2, which equals to 0.023 nos of trees. From my point of view, PV technology should not be treated the same as other technology which consumes traditional energy such as oil & gas which produced a lot of CO_2. The methodology in the consultation paper is fair to each market participants in terms of commercial benefit but not fair in terms of environmental benefit. Even the	

Comments/Feedback	The EMA's Response
reserve charges are born by market participants (power wholesaler) eventually it will go to PV system integrators because the wholesaler may not want to bear the additional cost engaged by PV system. If there is no additional regulation to clarify the responsibility of the reserve charges, PV system integrator / solar leasing companies will be the one to bear all the charges. In my opinion, since the PV technology benefits the next generation of the whole Singapore, the whole country shall be responsible for the reserve charges similar to what they did in Germany. This is the responsibility of the whole society other than a few companies'. The charges will be allocated to the Retailer, which will be passed on to the end-user which will be passed on to the owner of the solar PV system, whether it is a solar leasing company or a solar investor. Accounting will become unnecessarily complicated and add one more obstacle solar PV companies will face in order to convince building owners to go green ***Singapore Electrical Contractors and Licensed Workers' Association (SECA)*** The consultation article presents a charge that may reduce the uptake of solar in the city. Moreover, the proposals for charges are complex and difficult to understand. Some calculations of the [of the consultation paper] show a large percentage of the electricity revenue flowing into the reserve charge that prevent investors from entering into the field with little yield. ***Solar Gy*** Is the reserve charge per kW for solar PV system based on the installed nameplate rating? Is the charge a recurring monthly charge? ***Sunseap, YL Integrated, Ecosys Infrastructure*** Forcing IGs into a regulatory mould designed for conventional, centralized,	

Comments/Feedback	The EMA's Response
dispatchable generators does not bode well for the longer term good of the development of renewable energy in Singapore. But IGs have no dispatchable power and cannot participate in bidding spinning reserve. They face considerably higher risks when spinning reserve charges are allocated among such generators. Most solar PV installations in Singapore are financed by third parties who are the legal owners of these systems such as those under the Solar Leasing Scheme. Any positive or negative externalities should be imposed or paid directly to the system owner whom is registered as a Market Participant. Disproportionately high reserve costs added to the operating costs of IG sources will imply a shift away from grid parity. Potential solar system owners will be deterred and wait for revenue/tariff to increase and/or operating costs and capital expenditure to decrease further, assuming a constant cost of capital or financing costs do not change. Besides being disproportionately high charges, the whole calculation is too complex for any layman to understand. Solar installers and owners today have no clue how much such reserve costs will be incurred over the next 20-30 years. More importantly, this will prevent any investor in IG facilities from predicting his IRR, Without an informed basis, no investor can decide whether or not to install an IG system. Professional third party financiers will also not finance a non-predictable cash flow business or asset, i.e. financing will either not be available or they will sky rocket – higher risks/lower predictability equates to higher required rates of returns, e.g. bank loans vs venture capital funds. After taking into account peak shaving on an aggregated basis and should reserve costs still be applicable for a say 500 MWac tranche, such costs should only be remotely applicable during the above-mentioned 4-hour period and not over a 24-hour period.	

Comments/Feedback	The EMA's Response
EMC EMC agrees that IGS should be allocated regulation and reserve cost in accordance with the causer-pays principle. We understand that EMA is still studying the methodology on how to aggregate the output of IGS for allocating regulation and reserve costs and much of the details have yet to be finalised, specifically: a) How regulation cost allocation should be modified to take into account generator's minute-to-minute variation. This would incur significant system implementation costs, and on-going costs for EMC, PSO and MSSL to read and record minute-to-minute generation output data and allocate the regulation cost correspondingly. Consumers with IGS may also need to incur the cost to install the necessary monitoring system. However, if studies show that higher penetration of IGS indeed increases the regulation requirement, it can be considered for the additional regulation procured to be charged solely to IGS. EMA can also consider introducing other incentives to encourage the participation of energy storage devices in the system so as to reduce intermittency caused by the IGS. b) How to forecast the output from IGS and determine the equivalent POF for IGS how. We understand that due to the intermittency of the IGS, their output could deviate from its forecast output more often than conventional generators. On the other hand, due to the potential geographical diversity of solar generators, the loss of generation from IGS may not	

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be as high as 100% compared to the forced outage event of a conventional generator. Instead of using just one PoF number to indicate the reliability of IGS, a more accurate way might be a probability matrix which shows the forecast error of different magnitude and its corresponding probability. If the forecast is accurate, it is expected that large forecast error will occur rarely and thus has a very low PoF. Consequently, the reserve cost allocated to IGS will be lower. For forecast error that is less than 10MW, it can be considered that no reserve cost be allocated to IGS. We do not support the option to allow IGS to submit their respective PoF (as stated under footnote 17) to be used in the reserve cost allocation as its individual PoF would neither be able to factor in the effect of geographical diversity, nor reflective of the performance of all IGS in aggregate. To allow consumers to make a more informed decision, we would like to suggest details of the cost allocation methodology be published together with EMA's determination paper. Some more realistic numeric examples to show the cost allocation would also be helpful for consumers to assess the impact to their cost and decide if they want to opt out of the pricing mechanism. ***Senoko Energy*** Senoko supports the notion that as intermittent generation reaches a threshold more regulation and reserves may need to be procured. Based on the information in the consultation paper, it is unclear how the current cap can be increased without a corresponding increase in procurement of ancillary services. In order to comment on specific threshold or limit levels, it would be necessary to understand how the PSO will assess the intermittency risk posed by the various facilities (individually and in combination). In	

Comments/Feedback	The EMA's Response
general, it would also be useful to understand in detail how the PSO will forcast solar output and the associated probability of failure (POF). ***Tuas Power*** In respect of spinning reserve costs, arguing for aggregation on the basis that output cannot be controlled totally ignore the fact of unreliability in the first place. If there is merit in diversity, a portfolio generator should also be given the benefit of reduced charges since his other units can also increase output in response to forced outage of one of his units in his portfolio. ***YTL Power Seraya*** Changes to the Market Rules and IT systems of EMC, retailers and MSSL would be needed to effect what has been proposed and would incur costs. It has not been established that the benefits would outweigh the costs. The variation of a generator's output can be due to provision of regulation reserves service or the responding to a forced outage in the power system, that is making use of spinning reserves to make up for lost output. It would not make sense if such variation in output contributes to the generator's having to pay higher regulation reserves charges as such variation reflects responding to instructions, explicit or implicit. Payment of regulation reserves charges is on the basis of deviation from instructions where a generator is supposed to generate at a certain level but deviates from that level such as due to its technical characteristics. ***Keppel Merlimau Cogen*** Keppel wishes to clarify how the POF of individual projects be equitability determined when the generation forecast is determined by the PSO. Adopting a 'portfolio' approach for determining the POF for IGs and	

Comments/Feedback	The EMA's Response
apportioning of reserve cost based on installed capacity would discount the technical reliability of each IG project and its impact to the system. Keppel seeks clarifications on the guidelines on submission of IG's respective POFs to ensure fairness and consistency. How would reserve charges be determined for existing IGs which opt out of the proposed scheme? ***PacificLight Power*** PLP believes that the process to manage such intermittent loads might require substantial changes to market systems such as EMC's and/or SPS' systems to be able to handle the ranking, computation and settlement process. PLP would request the EMA to confirm the impact of these costs to the market and the proposed cost allocation methodology considering that key beneficiaries represent a small percentage of total generation.	
PV World The paper mentions attributing the positive externalities which solar brings about in the energy market. The idea is to equalise the reserve charges and with the peak shaving payments. Singapore's electricity prices do not fluctuate much, and hence the peak shavings payment will be marginal compared with the reserve charges. ***SEAS*** But we feel that Demand Response (DR) is the wrong tool for this. As 6.2.2 mentions, the current DR scheme requires dispatchable consumers. Including inherently non-dispatchable IG sources in the DR scheme will	After careful consideration of the comments received, the EMA will not proceed with the enhanced DR scheme for solar PV.

Comments/Feedback	The EMA's Response
make things very complicated for dispatchable consumers also trying to contribute under DR. This confuses matters with a one-sided treatment of externalities. Payment for injection has nothing to do with externalities, but recognises the market value of each kWh. And since such payment to IGs registered with EMC will be net of deductions for externalities, it should also be net of payments for positive externalities. In case a suitable solution is found to reward positive externalities, we propose it should apply to all IGs except those such as NCC accounts receiving the simplified credit treatment scheme through SPS. ***Solar Gy*** Under Clause 6.2.1, is there an option for customers with intermittent generation sources to opt for either payment for injection of excess energy to the grid or for DR payments? ***Sunseap, YL Integrated, Ecosys Infrastructure*** Payment of injection has nothing to do with externalities, but recognizes the market value of each kWh. And since such payment to IGs registered with EMC will be net of deductions for externalities, it should also be net off payments for positive externalities. No renewable contractors would want to have their renewable energy exported as they are economically worse off as prices for energy consumed is generally higher (or savings) than what is recovered from the NEMS. In case a suitable solution is found to reward positive externalities, we propose it should apply to all IGs. ***EMC***	

Comments/Feedback	The EMA’s Response
In EMA's determination paper on DR, EMA already recognised that reductions of load which would have occurred anyway under “business-as-usual” circumstances should not be rewarded with payments under the Demand Response programme. Similarly, for IGS, the generation would occur anyway as its output is not controllable. Therefore, IGS should not be rewarded under the DR scheme either. If IGS is to receive addition payments for their ability to dampen pool prices, then any peaking generators that run during peak hours should also receive additional payment because if they do not run, pool prices could reach the upper price limit of $4500 per MWh. Extending this “logic” further would mean that any generator should be compensated as the pool prices would be higher if it did not offer to produce. ***Tuas Power*** Moreover, choosing to further reward such new capacities through the Demand Response scheme through the argument that such new sources put downward pressure on prices and therefore warrant merits to consider sharing of consumer surplus arising from peak load shaving ignore the fact that all new conventional generating capacities introduced into the market will also exert downward pressure on the pool price with resulting benefits to the broader consumer base. In addition, with regards to peak load shaving, the paper appeared to have ignored the original investment of conventional generation assets that were built to serve the original peak load. A Demand Response scheme called for the load to be curtailed at very short notice. However the fact that there is intermittency of such generating sources cast doubts on the effectiveness shaving of peak load in the sense that owners do not actually have control over the output (ie can they increase their output upon command?).	

Comments/Feedback	The EMA's Response
YTL Power Seraya If intermittent generation such as solar generation is eligible for additional payments on the basis that such generation is " produced in the day which typically coincides with the system peak demand, it brings about the peak load shaving effect as it reduces the overall system demand", then non-intermittent generation would [be] based on that principle also being eligible for similar payments. We do not agree that such additional payments are justified for generation, whether intermittent or non-intermittent. Generation already receives compensation from the applicable Market Energy Price. Such additional payments would only serve to make consumers pay higher prices for electricity. To our knowledge, we are unaware of any other jurisdiction that applies such additional payments for intermittent generation. If such additional payments are justified, the question would arise as to why to our knowledge, no other jurisdiction makes such payments. ***Senoko Energy*** In general, Senoko favours removing undue barriers to the entry of solar generation to the Singapore market. However, we caution that such a policy should ensure that intermittent generation is only deployed when it is more commercially viable or suitable than an alternative technology. For example, the purported "peak shaving" benefits provided by solar should not be over compensated to the detriment of other forms of (more reliable) peaking generation or demand response (DR). To this end, Senoko does not support the proposal to use DR-style subsidies to promote the deployment of intermittent generation. Section 6.1.1 of the consultation paper claims that "intermittent generation sources such as solar energy can bring about positive as well as negative externalities. There are advantages to recognizing and pricing such externalities to incentivise the optimal level of investments and deployment	

Comments/Feedback	The EMA's Response
of such technologies in Singapore." Senoko does not agree with this analysis and the conclusions drawn from it. Externalities are impacts caused by the activity of one party on another party that did not choose to be impacted by such an activity. Clearly, those parties in Singapore that buy / sell at wholesale electricity prices have chosen such exposures instead of contracting their demand / supply at fixed rates. Therefore, to characterize solar's contribution to reducing wholesale prices as a positive externalities is incorrect. Furthermore, if one generating technology (e.g. solar) receives additional payments as a result of their capacity making the market outcome more competitive then it would be consistent to extend these payments to any generator that takes action that results in a decrease market prices. If all generators are not subject to the same incentive / payment regime, then the result will be an unlevel playing field with certain technologies being favoured over others. Ultimately this will result in biased and potentially inefficient investment decisions. In the case of subsidizing solar in this manner it could mean that more conventional (and more reliable) peaking generators are not commercially viable. The DR scheme has a penalty regime that is designed to ensure that demand responders fulfil their offers to the market to a similar standard as dispatched generators. If intermittent generators are not subject to a similarly robust dispatch regime, then it is difficult to justify why they should receive payments (implicit or otherwise) that are equivalent to conventional generators and DR. ***Keppel Merlimau Cogen*** Keppel notes that the DR scheme does not reward reductions of load which would have occurred anyway under "business-as-usual" circumstances. However, the proposed pricing mechanism to recognize positive externalities brought about by intermittent generation through the DR scheme is not	

Comments/Feedback	The EMA's Response
aligned with that as such intermittent generators' reduction in withdrawal of energy from the grid may have occurred under business as usual circumstances and may not be due to the solar output. Hence, simply enhancing DR scheme as a mechanism to pay intermittent generation sources may at this stage be premature. It may also be premature to explore enhancements to the DR scheme when its initial phase has not even been launched in the Singapore Electricity Market. Keppel seeks clarification on the treatment of a consumer with intermittent generation output and is also participating under DR scheme. ***PacificLight Power*** However they should not receive other financial payments such as a portion of any reduction in pool price as this is not commensurate with their risk. An IGS sells excess power that it does not require for its own consumption. Moreover, it has to be ascertained that a drop in pool price is the direct result of IGS' contribution before financial payments can be given.	
Sunseap, YL Integrated, Ecosys Infrastructure Intermittent generators aggregated island wide should only have to consider contingency reserves. ***SEAS*** Intermittent generators aggregated island wide should not have to consider primary or secondary reserve costs.	Given the intermittent nature of the IGS output, the reserves supporting its variations should be fast and responsive. Therefore, all classes of reserves (i.e. regulation, primary, secondary and contingency reserves) should be considered. As mentioned, the EMA is reviewing the pricing mechanism for managing intermittency, including the reserves requirements to support the growth of IGS under the "dynamic pathway" approach.

Comments/Feedback	The EMA's Response
Wartsila Wärtsilä proposes that, as a solution to reduce the cost of reserves, only the regulation and primary reserves need to be kept spinning, and a substantial part of the reserves, especially the secondary and contingency, could be met by stand-by (i.e. non-spinning) reserves. Technical solutions for providing secondary and contingency reserves from stand-by are proven and available globally, for example with modern combustion engine power plants, hydro plants and electrical storage that are able to start-up within the response time required by secondary reserves. In addition, these plants can provide competitive peaking energy to a power system. Utilization of this type of solution will require the market rules to allow generators to provide secondary and contingency reserves also from stand-by, in addition to providing them as spinning reserve. With the comfort of standby reserves, CCGTs can be relieved of the task of providing spinning reserves and can be allowed to run at optimal load and best efficiency. Additionally, stand-by reserves don't have operational cost while providing reserves and therefore they are able to provide reserves cheaper and more competitive than CCGT.	 In principle, the EMA agrees that off-line units could potentially provide contingency reserve (10 minutes response time) if these are hydro or fast-start combustion gas turbines. However, as the Singapore generation portfolio consists primarily of Combined Cycle Plants which takes hours to run-up and there is no hydro power plant, grid-scale energy storage facility or fast-start gas turbine, the option of relying on off-line units to provide secondary and/or contingency reserve is not feasible today.

E. Monitoring Requirements

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<tr><th>Comments/Feedback</th><th>The EMA’s Response</th></tr>
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Sunseap, YL Integrated, Ecosys Infrastructure

With a 16.4% capacity factor (CF), a 1 MWp system is only equivalent to a 164 kW(ac) system and imposing the many PSO system operation requirement for real-time monitoring and interlocking / intertripping mechanism on such a small system is deemed as an overkill.

Through the experience of installing one of the largest solar system in Singapore, we have faced multiple challenges posed from PSO and SPPG.

We think some of the requirements are extracted from the current requirements imposed on large scale generators and simply not feasible to be applied for IGs, especially for solar systems.

PV systems that are less than 1 MW and wish to participate in NEMS are also subjected to the strict PSO monitoring requirement. We would like to propose a waiver of the PSO monitoring for such cases but only provide per minute uploading of meter reading for settlement requirement with EMC.

Installing monitoring systems complying with PSO requirement will for such systems will unnecessarily increase the capex and opex cost of the system. For example in the case of HDB installations, most setups are less than 100 kw installed peak capacity and based on actual output, it is less than 80%% of the peak capacity at all times. We recommend that you consider the installations of those that are fulfilling these conditions to be required to do per min uploading

- More than 100 kw installations per site

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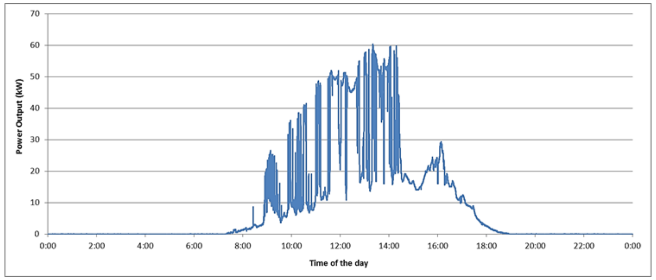
Although the solar PV capacity factor is 16.4%, solar PV output is intermittent and could fluctuate within a short period of time (an example is shown in the diagram below). To facilitate large scale deployment of solar PV in Singapore without compromising on system security, there is a need for real time monitoring so that the PSO can take appropriate response actions to manage the associated intermittency.



The PSO has reviewed and determined that solar PV installations with installed capacity of 100 kWac & above within a site would be required to provide **real time information of active power output** to the PSO. In comparison, Germany requires solar PVs with installed capacity of **30 kWac and more** to comply with its real time monitoring requirements.

Taking into consideration feedback from industry, and at the same time striking a balance between the potential costs on the solar PV owners and the security of the power system –

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Comments/Feedback	The EMA's Response
• More than 50 kw for each inverter • Exporting power PV systems are commonly made up of multiple smaller sub-systems and may consist of many inverters. There will be too many circuit breakers to monitor. In addition, monitoring the circuit breaker may not be meaningful, as the status does not correlate the performance of the PV system. The circuit breaker can be in the "on" position while the PV system is not generating any energy, for e.g. during at night. We would like to propose reduce the PSO real-time 30s monitoring requirement to 10 minutes and more. We would therefore propose to limit the implementation of the PSO requirement only to PV system above a certain capacity, e.g. 1 MW	(a) The monitoring frequency for IGS has been reduced from 30 seconds to **1 minute**. However, the PSO has assessed that it would be insufficient to set the monitoring frequency at 10 minutes (as proposed in the feedback), as this could pose significant risks to system stability as IGS deployment grows; and (b) Other real time data requirements (e.g. voltage monitoring) for IGS has been waived.

F. Others

Comments/Feedback	The EMA's Response
Information on IGS Policy	
Sunseap, YL Integrated, Ecosys Infrastructure We propose updating the EMA PV handbook to reflect these industry changes.	The EMA will be publishing a factsheet to reflect the enhancements for IGS highlighted in this final determination paper.
Energy Storage	
CPvT Energy Asia The significant growth in the importance of energy storage has been an outgrowth of two trends: 1) the accelerating pace of renewable-energy deployment and its effects on the stability and reliability of electric grids around the world; and 2) increasing severe weather events leading to an emphasis on resilient power solutions for grid optimization, resiliency and automation. Serious work is now being done on the methods to encourage the deployment of a variety of storage technologies which reduce or alleviate the effects of variability while allowing their positive attributes and benefits to be incorporated. ***EMC*** EMA can also consider introducing other incentives to encourage the participation of energy storage devices in the system so as to reduce intermittency caused by the IGS.	The EMA notes the comments. As the deployment of solar PV is expected to increase in Singapore, energy storage could be a viable option for managing intermittency, for peak shaving and for the provision of regulation reserves in our system. These have the potential to support greater deployment of IGS in Singapore, and also improve power system operation and stability.

Comments/Feedback	The EMA's Response
Government Support for Deployment of Renewable Energy	
Mr Dennis Gay Singapore needs to explore more eco friendly and renewable sou(r)ce of energy. The govt should take the lead to makes these forms of energy generation more accessible to the public consumers eg giving cash grants to reduce the costs of installing solar panels. Making it possible for consumers to sell excess electricity to national grid. Singapore should reduce its 100% reliance on imported non renewable energy sources.	The Government has several initiatives to promote the take-up of renewable energy deployment. For example, in Committee of Supply debate in March 2014, the Government announced plans to raise the adoption of solar energy in Singapore to 350 MWp by 2020. EDB will spearhead this effort by working with other Government agencies to aggregate demand for solar deployment across Government buildings and spaces under the SolarNova Programme (http://www.mti.gov.sg/MTIInsights/SiteAssets/Pages/Budget-2014/SolarNova.pdf). However, it is not likely that 100% of Singapore's energy can be sourced from renewable sources, such as solar PV generation. In particular, solar PV generation can only produce electricity during sunny hours (not as and when energy is needed) and hence, cannot be used as base-load generation.

Comments/Feedback	HDB's Response
Mr Ivan The using of solar panels does not benefit residents at all. It only helps town council to save money but we still pay high conservancy charges to them. Instead the fees may be raise because of the govt purchase of them. Pls tell me 1 good reason how resident stand to gain in the long run?	Under the current solar leasing model, the government provides little to no upfront capital for the solar PV system, with the solar leasor providing for most of the system cost. The solar PV system remains the property of the solar leasor (i.e. the government does not purchase them), and the solar leasor will operate and maintain the PV system for the entire duration of the contract (i.e. the government does not incur maintenance costs). Furthermore, the Town Councils will enjoy a guaranteed discount-off the regulated tariff for the solar energy generated.

Comments/Feedback	HDB's Response
	Overall, such an arrangement lowers the utilities costs incurred by Town Councils which in turn helps to mitigate the rising estates maintenance cost.