

Solar PV – User Guide for Generators

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1. Introduction

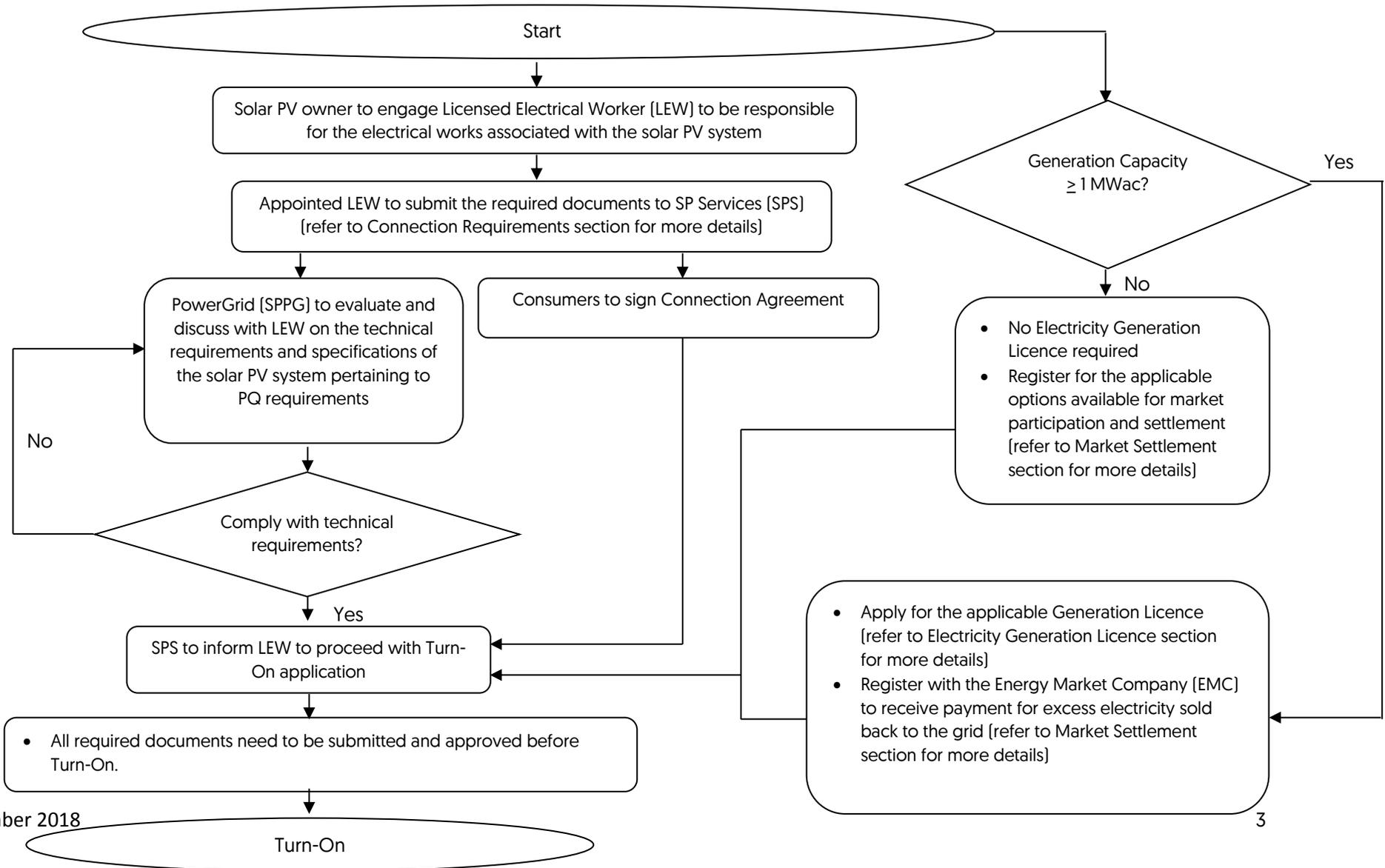
This section provides information applicable to solar PV generators who install solar PV systems to inject all electricity generated into the grid (e.g. solar farm).

A brief summary of the relevant processes can be found in the flow chart below. Please refer to the following sections for more information.

For more information on the policy and regulatory framework for solar, please refer to EMA's [website](#).

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Figure 1: Overview Process for Solar PV Generators



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2. Electricity Generation Licence

The electricity licensing requirements for solar PV systems will be based on the aggregate of the Alternating Current (AC) inverter capacities (“installed generation capacity”) at the point of connection¹ to the grid.

Any person who engages in the generation of electricity with a solar PV system with installed generation capacity of 1 MWac or more but less than 10 MWac is required to apply to EMA for a Wholesaler (Generation) Licence. For installed generation capacity of 10 MWac or more, he has to apply for a Generation Licence.

All relevant licenses should be obtained before any turn-on of solar PV installations.

A summary of the licensing requirements is shown in the table below.

Table 1: Licensing Requirements for Solar PV System

Installed Capacity of Solar PV System	Connected to the Power Grid?	Type of Licence*
Below 1 MWac	Yes	Exempted
	No	
1 MWac or more but less than 10 MWac	Yes	Wholesaler (Generation) Licence
	No	Exempted
10 MWac or more	Yes	Generation Licence
	No	

* An Electrical Installation Licence may still be required.

Application for the wholesaler or generation licence can be made on EMA’s website: http://www.ema.gov.sg/Licensees_Electricity_Licences.aspx

3. Electrical Installation

An electrical installation refers to any electrical wiring, fitting or apparatus used for the conveyance and control of electricity in any premises. A solar PV system installed within such premises forms part of the consumer’s electrical installation and should comply with the requirements stipulated in the Electricity Act (Cap. 89A), the Electricity (Electrical Installations) Regulations and the Singapore Standard CP5 Code of Practice for Electrical Installations.

All electrical work for an electrical installation, including a solar PV system, must be undertaken or carried out by a Licensed Electrical Workers (LEWs). Such electrical work

¹ The point of connection refers to the point at which the solar PV system is connected directly or indirectly to SP PowerAsset’s substation.

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includes new wiring, rewiring and extensions which have to be tested before the supply is turned on. When consumer needs any electrical work to be done at his premises, he is advised to check that the person whom he intends to engage to undertake or perform the electrical work has a valid electrical worker licence issued by the Authority.

It is an offence for a person:

- i. To carry out or caused to be carried out any electrical work unless he holds a valid electrical worker licence; or
- ii. To engage knowingly any person who is not a licensed electrical worker to carry out any electrical work.

For more details, you may wish to refer to [ELISE website](#) for the list of LEW and [SP Group website](#) for the preferred PV partners of SP Group.

Electrical Installation Licence

LEW will need to apply for an Electrical Installation Licence for the installation if the usage or operation of an electrical installation exceeds 45 kVA of approved load for non-domestic purposes. Electrical installations are licensed to ensure that owners/users of certain electrical installations engage a LEW to take charge of and maintain their electrical installations for reason of safety.

A grid-connected solar PV system is also categorised as an electrical installation. A new solar PV system will be covered under the [existing electrical installation licence](#) upon connection to the installation by the LEW taking charge of the electrical installation. If there is no existing electrical installation licence, the LEW shall apply for electrical installation licence for his solar PV system.

Safety requirements

Currently under the electrical installation licensing scheme, the consumer's appointed LEW is required to carry out safety inspection and certification of the electrical installation, including the solar PV system, according to the conditions specified under the electrical installation licence.

Solar PV systems require regular inspection and maintenance to ensure that the system remains efficient and safe for operation. In most cases, equipment manufacturers will provide maintenance guidelines for their specific components. It is important to ensure that the maintenance requirement is carried out according to the recommendation and certified by the LEW.

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4. Connection Requirements

If you intend to connect and operate your solar PV system in parallel to the power grid, your appointed LEW will have to complete the online Application Form and submit the following documents to SPS via Singapore Power (SP) eBusiness Portal:

- Document Checklist and Declaration of Compliance to SP Powergrid's (SPPG) Technical Requirements
- Application for Net Export Rebate Form
- Letter of Consent
- PQ Compliance Report
- Inverter(s) Specifications
- Solar panel(s) Specifications
- Inverter(s) Type Test Reports (Harmonics, Flicker, DC Injection)
- Single Line Diagram (from PV system to Point of Common Coupling (PCC)
- PSO Data Form (only applicable for solar PV systems 1 MWac and above)
- Certificate of Compliance (only applicable for licensed installation who are eligible to appoint their LEW to commission the solar PV system)
- Commissioning Declaration (only applicable for licensed installation who are eligible to appoint their LEW to commission the solar PV system)

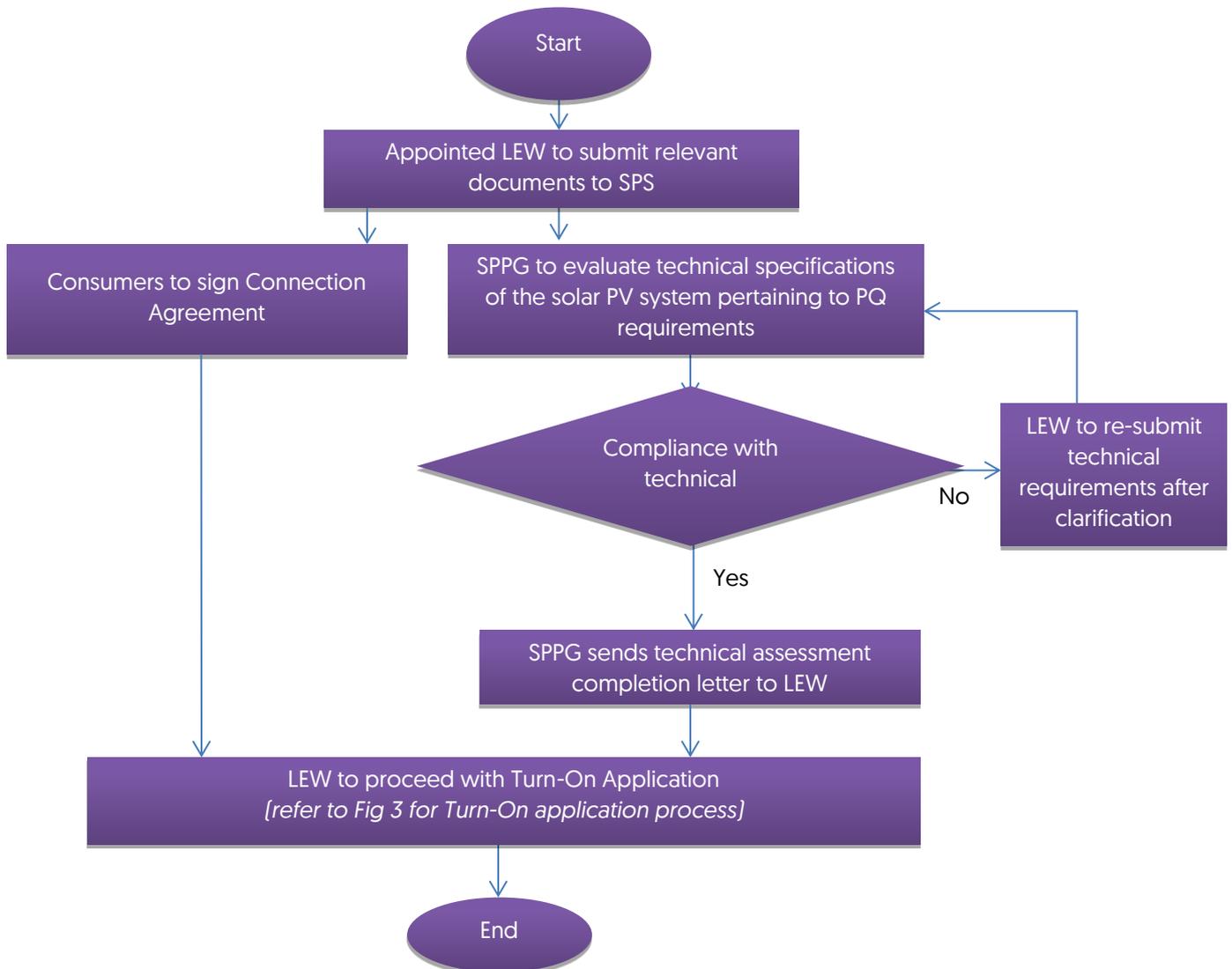
Thereafter, your appointed LEW will have to consult SPPG on the connection scheme and technical requirements.

You will need to sign a Connection Agreement with the Transmission Licensee for the generation connection to your PV generation facility.

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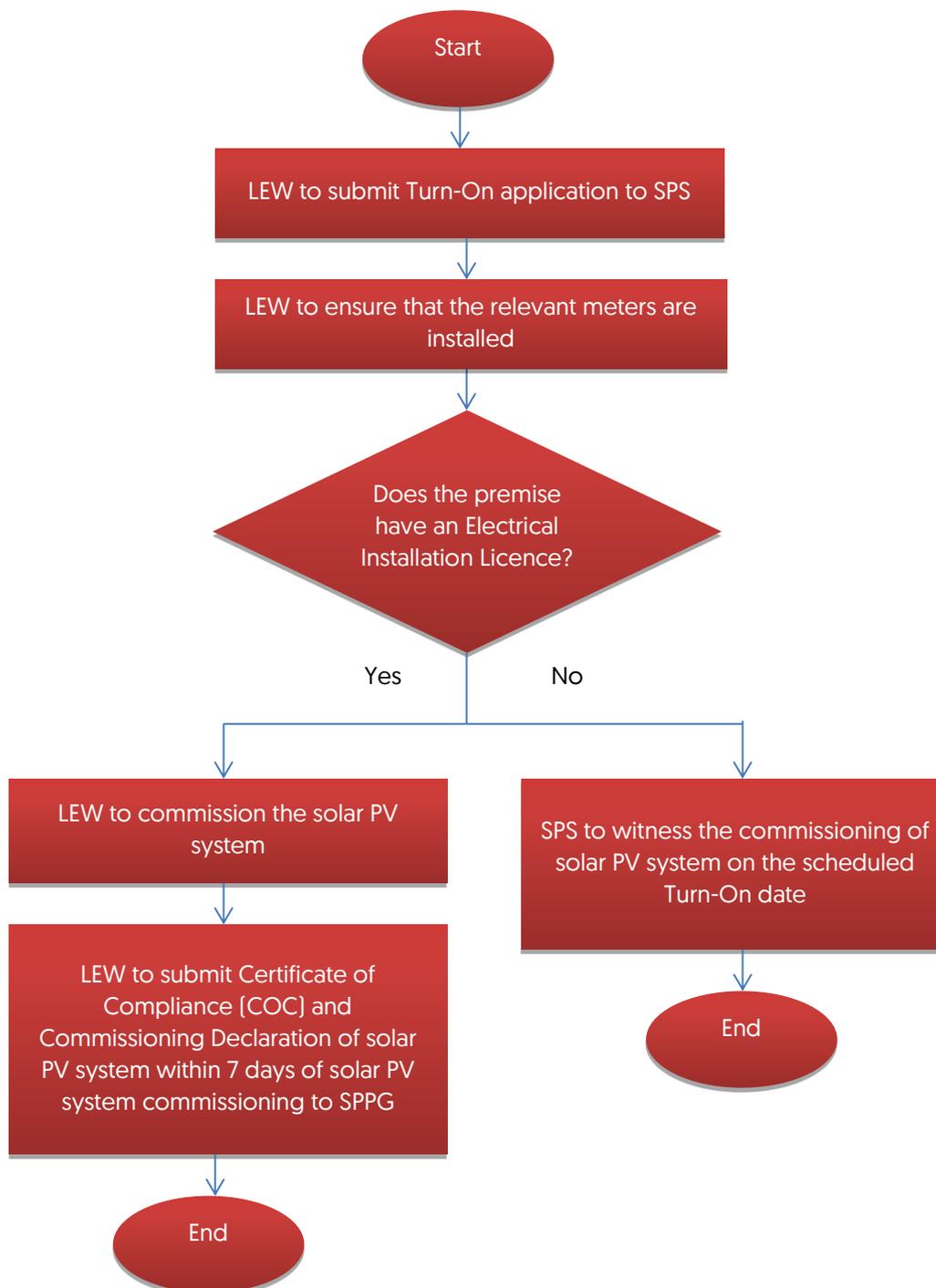
The simplified connection and turn-on application process for solar PV generators are illustrated in Figure 2 and 3.

Figure 2: Application Process for Solar PV Generator Connection



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Figure 3: Turn-On Application Process for Solar PV Generator Connection



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5. Market Settlement

Similar to other commercial generators, a standalone solar PV generator is required to register with the [Energy Market Company \(EMC\) as Market Participant \(MP\)](#); and to register their Solar Generation Facility, in order to receive payment for export of electricity into the grid. They will be paid nodal price for the selling of solar electricity back to the grid, and are subjected to the applicable market charges.

The required registration documents can be found below.

Market Participant Registration

- [MP Registration form](#)
- Signed [PSO-MP Agreement](#) and Generation Facility Operating (GFO) Agreement with PSO (if applicable)

Generation Facility Registration

- The [Generation Facility Registration form](#) (which includes PSO Standing Data Form for IGS)
- Approved Connection Agreement from SP PowerAssets
- Signed [MSSL-MP Agreement](#)

All the documents should be approved before the solar PV system is turned on.

A summary of the market payments and charges for such installations can be found in the table below.

Table 2: Market Payment and Charges for Standalone Solar PV Generators

Applicable Payments / Charges	Description
Energy Payment / Charges	
Energy Generation	Nodal Price (to be paid based on net export)
Energy Consumption	Uniform Singapore Electricity Prices (USEP) + Hourly Energy Uplift Charge (HEUC) (to be charged based on net import)
Reserves Charges	
Spinning Reserves	Only applicable for solar PV systems more than 10 MWac (subject to change based on the New Pricing Mechanism Framework)
Regulation Reserves (i.e. AFP)	Half-hourly AFP (to be charged based on gross generation and gross consumption)
Non-Reserves Market Charges	
EMC Fees	Yearly revised EMC Fees (to be charged based on net import or net export)
Power System Operator (PSO) Fees	Daily revised PSO Fees (to be charged based on net import or net export)
Market Support Services (MSS) Charge	Yearly revised MSS Charge (to be charged based on net import only)

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Applicable Payments / Charges	Description
Monthly Energy Uplift Charge (MEUC)	Monthly revised MEUC prices (to be charged based on net import only)
Grid Charges	
Use of System (UOS)	Yearly revised UOS Charge (to be charged based on import channel)
Uncontracted Capacity Charge (High-Tension & Above Network only)	Cost is dependent on type of backup required

6. Intermittency Pricing Mechanism

Given the intermittent nature of solar PV, reserves from conventional power sources are required to ensure system stability. For example, cloud cover or shadows may cause solar PV output to drop quickly, which requires the need for reserves to make up for the shortfall. Without the back-up through reserves sources, consumers are exposed to the risk of power disruptions, which happened in other countries with large amounts of intermittent generation.

To ensure the sustainable growth of solar, a balance has to be struck between the benefits of solar generation and the intermittency costs it imposes on the system. Hence, it is appropriate to consider a mechanism, Intermittency Pricing Mechanism (IPM), to allocate the fair share of reserves costs to solar.

Upon its implementation, the IPM will apply to all IGS, except for certain groups which the EMA had previously indicated that would not be subject to the IPM. The groups include:

- a. Residential consumers with embedded solar PV systems below 1 MWac; and
- b. Non-residential consumers with embedded solar PV systems connected to the system on or before 31 January 2018, unless (i) they retrofit their IGS systems such that re-commissioning by SP PowerGrid would be required in the process; or (ii) 25 years from the commissioning date of their existing IGS systems, whichever occurs earlier.

More details on the IPM can be found in EMA's [Consultation Paper](#).

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7. Monitoring Requirements

With the expected increase in solar PV systems in Singapore, the Power System Operator (PSO) would need to manage the intermittent nature of such sources to ensure that the security and reliability of the power system is not compromised. Most importantly, PSO also needs to ensure that sufficient reserve capacity is available to respond to sudden fluctuations in solar output.

Hence, PSO shall require solar PV systems with an installed capacity of 1 MWac and above at each site/facility to provide the Active Power output (AC-side) of its solar PV system(s), sampled at one-minute intervals and solar irradiance from sensor installed in close proximity to the PV panels.

For more detailed technical requirement, please contact EMA at EMA_PSO_EMS@ema.gov.sg.

Localised Network Limit

As there may be physical constraints of each network ring, there could be a limit to the amount of solar PV systems that the network circuit can support. Therefore, depending on the limitations in that area, the permissible capacity of solar PV systems in each location may differ. Hence, parties who wish to invest in solar PV systems should check if there are possible network constraints in their preferred locations, before making their investment decisions.

8. Decommissioning Requirements

If you intend to decommission the entire solar PV system installed in your premises any time after they have been connected to the Transmission System, your appointed LEW will have to complete the decommissioning form and submit to SP PowerGrid Ltd at least 30 days in advance before the intended decommission commences.

However, if the intent is to revise the solar PV capacity installed in your premises any time after they have been connected to the Transmission System, your appointed LEW will have to complete the online Application Form and submit the following documents to SPS via Singapore Power (SP) eBusiness Portal:

- Document Checklist and Declaration of Compliance to SP PowerGrid's (SPPG) Technical Requirements
- Application for Net Export Rebate Form
- Letter of Consent
- PQ Compliance Report
- Inverter(s) Specifications
- Solar panel(s) Specifications

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- Inverter(s) Type Test Reports (Harmonics, Flicker, DC Injection)
- Single Line Diagram (from PV system to Point of Common Coupling (PCC))
- PSO Data Form (only applicable for solar PV systems 1 MWac and above)
- Certificate of Compliance (only applicable for licensed installation who are eligible to appoint their LEW to commission the solar PV system)
- Commissioning Declaration (only applicable for licensed installation who are eligible to appoint their LEW to commission the solar PV system)

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9. PV Directory

For enquiries on the following matters pertaining to solar PV systems, you may wish to contact the following:

Energy Market Authority (EMA)	
Matters on:	Contact Information
Electricity Licences	Economic Regulation & Licensing Department Email: ema_enquiry@ema.gov.sg Tel: 6835 8000
Electrical Installation Licence Licensed Electrical Workers (LEWs)	Electricity Resilience & Regulation Department Email: lei_ema@ema.gov.sg Tel: 6835 8000
Policy and Regulatory Framework	Policy Department Email: ema_ppd@ema.gov.sg Tel: 6835 8000
Monitoring Requirements	Energy Management Systems Department Email: EMA_PSO_EMS@ema.gov.sg Tel: 6835 8000
Energy Market Company (EMC)	
Matters on:	Contact Information
Market Registration Market Payment / Charges	Market Administration Email: MPRegistration@emcsg.com Tel: 6779 3000
SP PowerGrid (SPPG)	
Matters on:	Contact Information
Technical Clarification regarding Connection to the Grid	Asset Management & Projects Department Email: DERenquiries@spgroup.com.sg Tel: 6916 8888
SP Services (SPS)	
Matters on:	Contact Information
Application for Connection to the Grid and Market Settlement with SPS	Electrical Installation Section Email: install@spgroup.com.sg Tel: 6916 7200