Solar PV – User Guide for Non-Residential Consumers

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Solar PV – User Guide for Non-Residential Consumers

1. Introduction

This section provides information applicable to non-residential consumers with embedded solar PV systems to reduce their electricity consumption.

A brief summary of the relevant processes can be found in the flow chart in the website. 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.

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 connection[1] 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 licences 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 Systems

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 Worker (LEW). 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.

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 and for multi-metered premises. 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 forms part of the consumer's 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.

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.

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 system 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.

For High Tension and above (6.6kV and above) consumers with embedded IGS / generation, you will need to choose one of the 3 backup schemes (full or partial) required:

(1) Summation Scheme;
(2) Capped Capacity Scheme; or
(3) Extended Capped Capacity Scheme

You will need to sign a Supplemental Agreement with the Transmission Licensee to reflect your choice of backup scheme for the service connection.

For more information on each scheme, please refer to SPPG's guide on "How to Apply for Electricity Connection" available on the SP Group website (www.spgroup.com.sg).

The simplified connection and turn-on application process for solar PV systems less than 1 MWac are illustrated in Figure 2 and 3.

Figure 2: Application Process for Solar PV System Connection (less than 1 MWac)

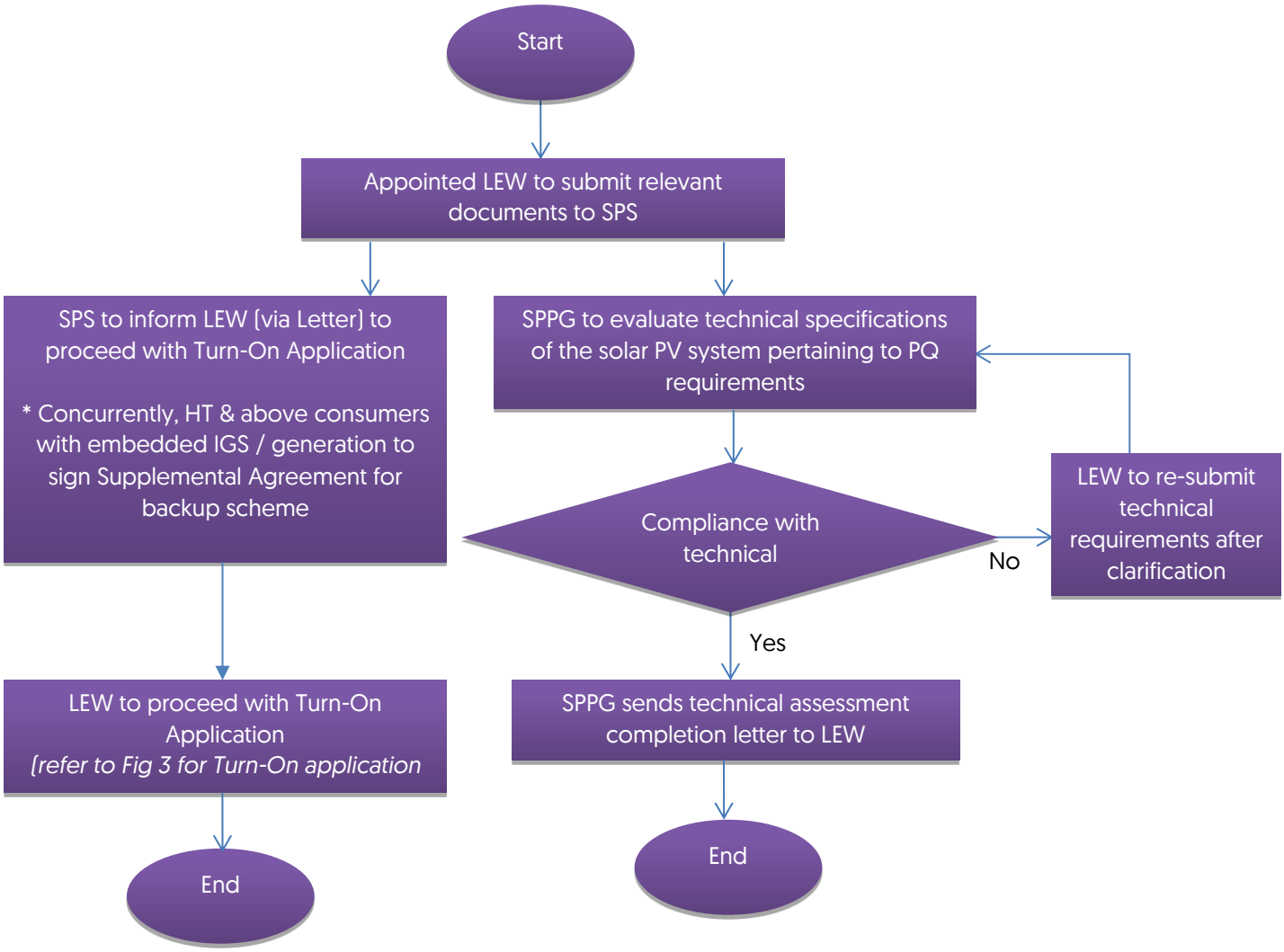
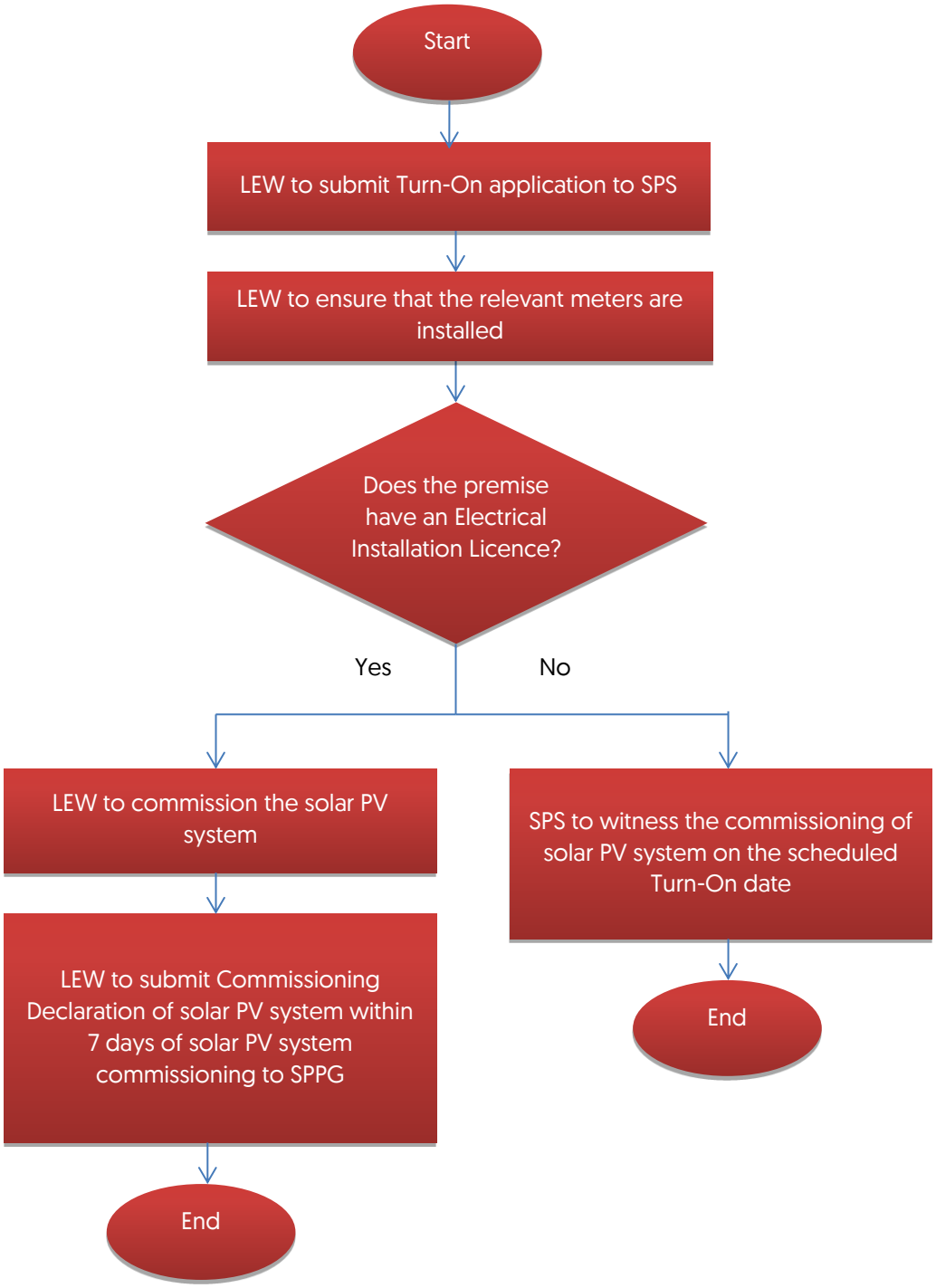


Figure 3: Turn-On Application Process for Solar PV System (less than 1 MWac)



The simplified connection and turn-on application process for solar PV systems 1 MWac and above are illustrated in Figure 4 and 5.

Figure 4: Application Process for Solar PV System Connection (1 MWac and above)

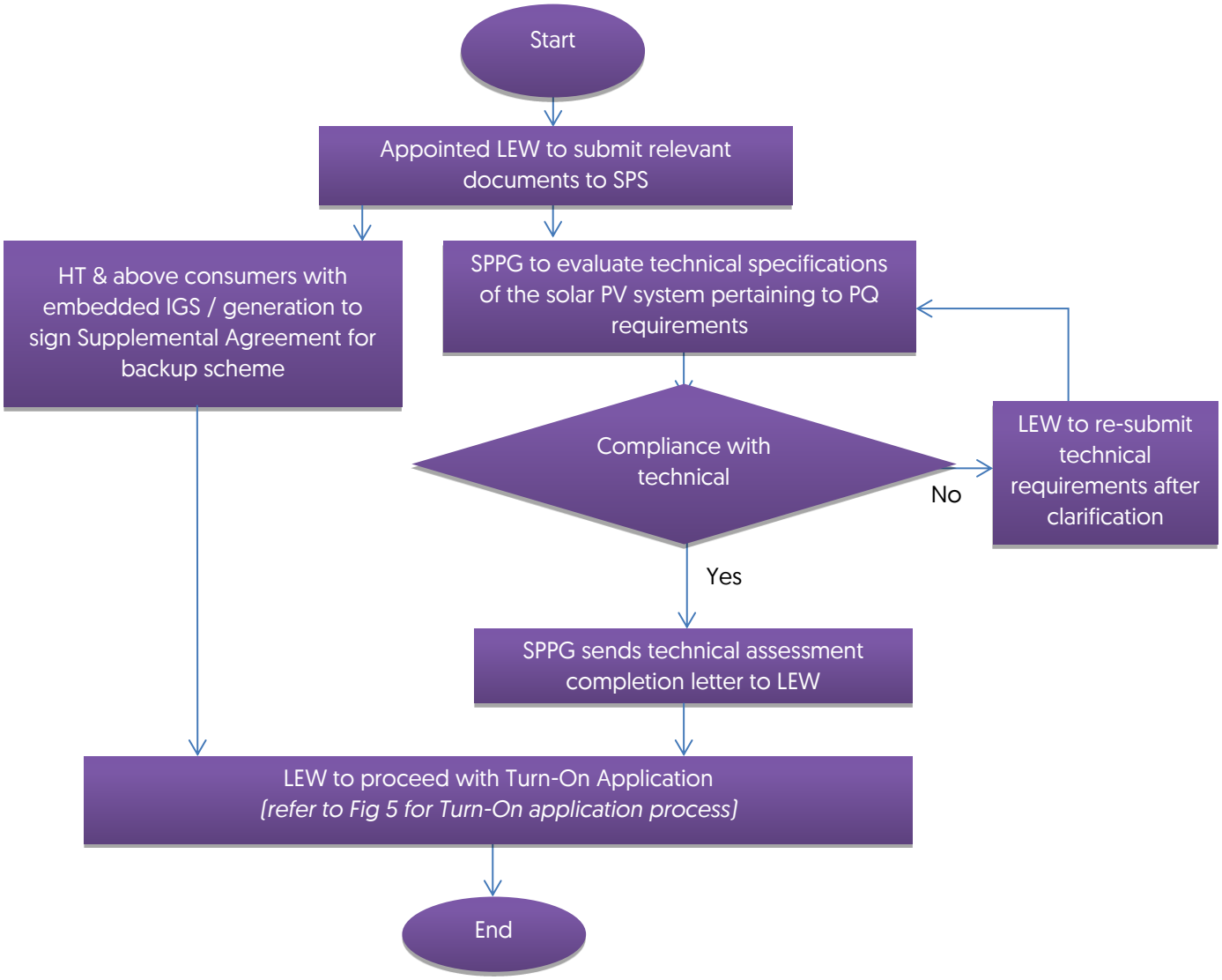
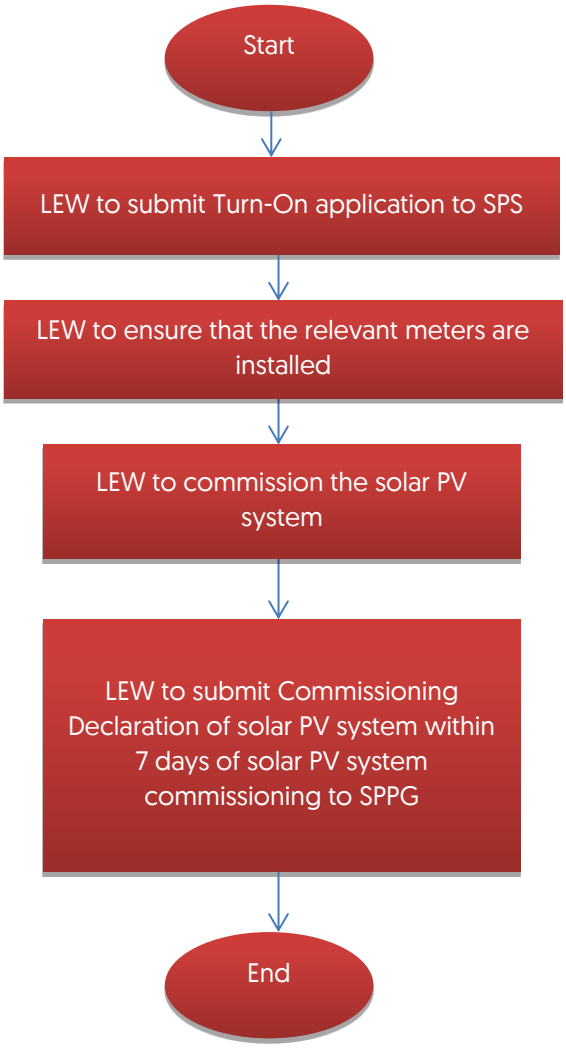


Figure 5: Turn-On Application Process for Solar PV System (1 MWac and above)



5. Market Settlement

The process required and the amount of payment received for selling excess solar electricity back to the grid depends on the size of the solar PV system and contestability status of the consumer. An overview of the available payment schemes can be found on EMA's website.

Consumers with embedded solar PV systems will be given 'net settlement' of the energy component. This means that consumers are either charged for their net consumption or paid for their net generation within each trading period.

5.1 Solar PV system below 1 MWac

Non-contestable consumers (NCCs)

For Low Tension (LT) NCCs with less than 1 MWac embedded solar PV systems, the solar energy produced is first offset by their consumption of that premise. Should there be excess solar energy to be exported back to the grid, they will receive payment (the prevailing low-tension electricity tariff minus grid charge) from SP Services (SPS) by way of credit adjustment to the monthly electricity bill. The quarterly revised low-tension electricity tariffs can be found on SP Group's website (www.spgroup.com.sg).

Contestable consumers (CCs)

For CCs who wish to be paid for the excess electricity sold to the grid, they can register with SPS under the Enhanced Central Intermediary Scheme (ECIS). Under this simplified arrangement, they will be paid the weighted average nodal price through SPS, for the selling of excess solar electricity back to grid. SPS will act as a central intermediary, by passing through the payment and relevant market charges to consumers. Such consumers can either choose (a) to install a meter to accurately measure the solar electricity generated, or (b) to estimate their solar generation. For option (a), consumers will need to install the relevant metering arrangement at each generation point. More details on the meters can be found in Section 8, AMI Meter Charges. For option (b), the solar generation will be estimated based on the Solar Generation Profile (SGP)[2] for the calculations of the relevant payment and market charges. Consumers need not install any meters.

For CCs who do not wish to be paid for the excess electricity sold to the grid, they do not need to register with EMC as Market Participant or with SPS under the ECIS. They will not be eligible for the 'net settlement' scheme and also not be subjected to the applicable market charges.

[2] The SGP is approved by the Energy Market Authority ("EMA") and is based on factors such as Singapore's historical average solar irradiance from 7am to 7pm. This is standardised for all consumers with embedded solar PV systems and will be updated by EMA as new information becomes available.

5.2 Solar PV system 1 MWac and above but below 10 MWac

There are various options for CCs to sell excess electricity back to the grid:

i. **Register with SPS under the Enhanced Central Intermediary Scheme.** Under this simplified arrangement, they will be paid the weighted average nodal price through SPS, for the selling of excess solar electricity back to grid. SPS will act as a central intermediary, by passing through the payment and relevant market charges to consumers. Such consumers can either choose (a) to install a meter to accurately measure the solar electricity generated, or (b) to estimate their solar generation. For option (a), consumers will need to install the relevant metering arrangement at each generation point. More details on the meters can be found in Section 8, AMI Meter Charges. For option (b), the solar generation will be estimated based on the SGP for the calculations of the relevant payment and market charges. Consumers need not install any meters.

ii. **Register with the EMC as Market Participant.** Under this existing arrangement, the CCs are 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 the selling of the excess solar electricity back to the grid. They will be paid nodal price for the selling of excess solar electricity back to the grid, and are subjected to the applicable market charges. Such consumers can either choose (a) to install a meter to accurately measure the solar electricity generated, or (b) to estimate their solar generation. For option (a), consumers will need to install the relevant metering arrangement at each generation point. More details on the meters can be found in Section 8, AMI Meter Charges. For option (b), the solar generation will be estimated based on the SGP for the calculations of the relevant payment and market charges. Consumers need not install any meters.

    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
    - Approved Connection Agreement from SP PowerAsset
    - Signed MSSL-MP Agreement

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

iii. **Register with EMC as Market Participant (IGS non-exporting).** For consumers with embedded solar PV systems below 10 MWac who are not eligible for option (i) or (ii) and will not be selling any electricity back to the grid, they can undergo a streamlined market registration process and pay EMC an estimated fixed charge determined by EMA. This fixed charge will be based on the SGP and the historical average rates of the respective charges.

For options (i) and (ii), CCs would need to register their load and generation accounts under the same entity with SPS.

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

Table 2: Market Payment and Charges for Solar PV Systems less than 10 MWac

Applicable Payments / Charges	CCs with Non-Registered Solar PV System (applicable for less than 1 MWac)	CCs with EMC/ECIS-Registered Solar PV System
Energy Payment / Charges		
Energy Generation	Not Eligible for Payment	• For CCs with EMC-registered solar PV system: Nodal Price • For CCs with CIS-registered solar PV system: Weighted Average Nodal Price (to be paid based on net export)
Energy Consumption	• For CCs who buy electricity from the market: Uniform Singapore Electricity Prices (USEP) + Hourly Energy Uplift Charge (HEUC) • For CCs who buy electricity from retailers: Agreed Retail Price for Energy (to be charged based on meter's import channel)	• For CCs who buy electricity from the market: Uniform Singapore Electricity Prices (USEP) + Hourly Energy Uplift Charge (HEUC) • For CCs who buy electricity from retailers: Agreed Retail Price for Energy (to be charged based on net import)
Reserves Charges		
Spinning Reserves[3]	Not Applicable (subject to change based on the New Pricing Mechanism Framework)	
Regulation Reserves (i.e. AFP)[4]	Half-hourly AFP	Half-hourly AFP

[3] Spinning reserves charge is recovered from all generation facilities scheduled (less the first 5 MWh of each facility, which is allocated the cost of regulation reserve) operating in each half hour dispatch period based on the 'modified runway model'.

[4] Regulation reserves charge is recovered from all loads and the first 5 MWh of each generation facility (including all solar PV systems generation facilities that are registered under CIS) in each half hour dispatch period.

Applicable Payments / Charges	CCs with Non-Registered Solar PV System (applicable for less than 1 MWac)	CCs with EMC/ECIS-Registered Solar PV System
	(to be charged based on meter's import channel)	(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 meter's import channel)	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 meter's import channel)	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 meter's import channel)	Yearly revised MSS Charge (to be charged based on net import only)
Monthly Energy Uplift Charge (MEUC)	Monthly revised MEUC prices (to be charged based on meter's import channel)	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	

5.3 Solar PV systems 10 MWac and above

For consumers with solar PV systems 10 MWac and above, they are 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 the selling of the excess solar electricity back to the grid. They will be paid nodal price for the selling of excess solar electricity back to the grid, and are subjected to the applicable market charges.

In addition to that, consumers would need to register their load and generation accounts under the same entity with SPS. 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
- 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 consumers with solar PV systems 10 MWac and above can be found in the table below.

Table 3: Market Payment and Charges for Solar PV Systems 10 MWac and above

Applicable Payments / Charges	Description
Energy Payment / Charges	
Energy Generation	Nodal Price (to be paid based on net export)
Energy Consumption	• For CCs who buy electricity from the market: Uniform Singapore Electricity Prices (USEP) + Hourly Energy Uplift Charge (HEUC) • For CCs who buy electricity from retailers: Agreed Retail Price for Energy (to be charged based on net import)
Reserves Charges	
Spinning Reserves	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)
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

5.4 Solar Generation Profile

Grid Back-up Scheme

For Summation Scheme consumers who opt for SGP, there may be instances where they will incur uncontracted capacity charge. For example, on a rainy or cloudy day, they will be consuming more electricity from the grid as their solar PV system may be generating little or no electricity. However, as the SGP is a fixed output throughout the year, it would indicate that the solar installation is still generating.

Hence, before deciding on the type of backup scheme and whether to opt for SGP or meters, consumers should assess their consumption profile and operational needs.

They should also consider carefully the costs and benefits, including the risks and uncertainties due to weather variability.

Reactive Power

Currently in the Transmission Code, High-Tension consumers would be required to implement power factor correction measures, if deemed necessary by the Transmission Licensee, to maintain a power factor of no less than 0.85. This is because a load with high reactive power will require more current-carrying capacity from the grid.

For solar consumers who opt for SGP, there may be instances where they are penalised due to differences between active power output based on the SGP and active power output based on actual generation. This affects the calculation of gross load, on which reactive power penalties are determined. Hence, consumers who opt for SGP may risk incurring reactive power penalties when actual generation values differ from SGP values. If so, consumers can opt out of the SGP and install physical meters to accurately measure the active power output.

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.

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. AMI Meter Charges

This section is only applicable to consumers who register their embedded solar PV systems with SPS under the Central Intermediary Scheme, or with EMC as a Market Participant.

The owner of the generation facility (i.e. solar PV system) is the Meter Equipment Service Provider (MESP) for the meter installation associated with it. However, consumers with embedded generation facility (with installed capacity of less than 10 MWac) may choose to engage SPPG to provide, install and maintain the generation meter.

The fees applicable for providing such services by SPPG are shown in the tables below:

Table 4.1: Metering Charges for Generation Meters (inclusive of 7% GST before 1st Jan 2023)

	Main & Check Meters	Main & Check Meters	Main & Check Meters	Main Meters Only
Per Generation Unit / Metering Point	At 66kV and above	At 6.6kV / 22kV	At Low Tension	At Low Tension
Upfront charge (One time)	$5,938.50	$5,938.50	$2,247.00	$1,498.00
Monthly charge (Recurring)	$214.00	$85.60	$42.80	$21.40
Miscellaneous charge				
a) Attending to request for site enquiry during office hours (minimum 3 hours per request).	$42.80 per hour	$42.80 per hour	$42.80 per hour	$42.80 per hour
b) Attending to communication / meter failure during office hour. Charges will be waived if it is due to equipment failure.	$85.60 per trip	$85.60 per trip	$85.60 per trip	$85.60 per trip
c) Attending to adhoc request by customer for meter accuracy test with SAC-SINGLAS test report.	$1,926.00 per meter	$1,926.00 per meter	$706.20 per meter	$706.20 per meter

Table 4.2: Metering Charges for Generation Meters (inclusive of 8% GST with effect from 1st Jan 2023)

	Main & Check Meters	**Main & Check Meters**	**Main & Check Meters**	**Main Meters Only**
Per Generation Unit / Metering Point	At 66kV and above	At 6.6kV / 22kV	At Low Tension	At Low Tension
Upfront charge (One time)	$5,994.00	$5,994.00	$2,268.00	$1,512.00
Monthly charge (Recurring)	$216.00	$86.40	$43.20	$21.60
Miscellaneous charge				
d) Attending to request for site enquiry during office hours (minimum 3 hours per request).	$43.20 per hour	$43.20 per hour	$43.20 per hour	$43.20 per hour
e) Attending to communication / meter failure during office hour. Charges will be waived if it is due to equipment failure.	$86.40 per trip	$86.40 per trip	$86.40 per trip	$86.40 per trip
f) Attending to adhoc request by customer for meter accuracy test with SAC-SINGLAS test report.	$1,944.00 per meter	$1,944.00 per meter	$712.80 per meter	$712.80 per meter

9. 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
- 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 system 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)

10. 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 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