Sabah Electricity
Energising Our Future

Technical Guideline for Indirect Solar PV Power Generation for SOLAR RAKYAT SABAH

CONTENTS

1.0 OVERVIEW

1.1 Introduction

Connection of Solar PV generation system to the customers' internal system under the implementation of Net-Energy-Metering ('NEM') or SOLAR RAKYAT SABAH, requires a review of existing connection scheme and requirements.

The internal generation by the customers in aggregate would impact the Distribution system behaviour, especially when there is excess of generation from the customer. Due consideration of the impacts must be taken to mitigate the problem caused by the internal generation for example voltage rise, safety, power quality etc.

RE developers, service providers, operators and parties otherwise involved in the installation and commissioning of PV generation to the grid can utilise these guidelines for:

a) Reference to issues related to grid connection of PV;
b) Finding out the power quality requirements for PV interconnection with low voltage distribution networks;
c) Understanding the interconnecting requirements whether for small, intermediate or large PV systems; and
d) Understanding the practices to ensure the safety of the personnel and equipment involved in utility-connected PV operations.

1.2 Regulations

Paralleling indirect Solar PV power generation system to the grid shall be subjected to compliance to the prevailing electricity supply rules & regulations to ensure adherence to the standard practices, quality of supply and personal & public safety.

Regulating authority is Energy Commission of Sabah.

The following document shall be referred in determining the compliance to operational conditions terms:

a) Electricity Supply Enactment 2024;
b) Sabah Distribution Code; and
c) Sabah Grid Code.

For customers connected to Distributor Licensee system, connecting indirect Solar PV power generation system internally requires compliance to requirements stated in this document. Power generated from indirect Solar PV power generation system is potentially able to disrupt the existing network quality, security & safety.

Without proper consideration, connecting indirect Solar PV power generation system could result in:

a) Voltage fluctuation;
b) Voltage rise;
c) Voltage unbalance;
d) Overloading of existing grid connecting feeder/cable;
e) Power Quality issues;

f) Islanding; and
g) Coordination with other on-site generations such as backup generator, co-gen and energy storage system.

1.3 Boundary of ownership and responsibilities

Boundary and responsibility limits of Distribution Licensee & SOLAR RAKYAT SABAH consumer must be clearly demarcated, agreed and documented.

Distribution Licensee responsibility is up to the metering point which is as the normal distributor customer boundary.

1.4 Approval & license to build & operate

The consumer shall acquire the appropriate approval from relevant authorities and employ competent personnel to design the installation which include:

a) Permit by local authority;
b) Permit by respective regulatory bodies;
c) Competent installer under regulation;
d) Competent operator; and
e) Repair & maintenance.

2.0 SCOPE

2.1 Scope

The main objective of this guideline is to provide guidance on the technical requirements for customers connected to the Distribution system who plan to install indirect Solar PV generation.

This guideline outlines technical requirements to ensure that connection of the indirect Solar PV power generation system would be standardised in terms of scheme, devices, operation & limits. The ultimate objective is to harmonise indirect Solar PV power generation system with the existing supply network, neighbouring customer and other Distributed Generators ('DG') within the same distribution network. Connection of indirect Solar PV power generation system should not cause breach of power quality, reliability and security of the network and safety of the operators and public.

This guide covers requirements for connection of indirect Solar PV power generation system to the customer internal system. Power generation include:

a) Indirect connection solar photovoltaic; and
b) Battery Energy Storage System (BESS).

2.2 Commercial matters

Commercial matters are not part of this guideline.

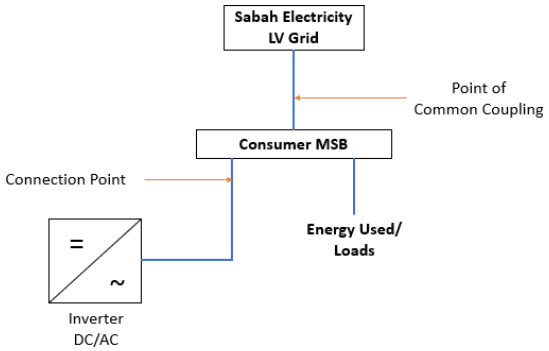
2.3 Application process

Customers that intend to install indirect Solar PV power generation system are required to register with the Energy Commission of Sabah ('ECoS'). Registration to Distributor Licensee is a statutory requirement as the consumer has altered the system registered during bi-directional meter.

The application process and procedures are described in the "Guidelines For Solar Photovoltaic Installation Under The Programme of SOLAR RAKYAT SABAH Sabah by ECoS".

3.0 GLOSSARY

Demand	:	The demand of MW or MVAr of electricity (i.e. both Active Power and Reactive Power respectively) unless otherwise stated.
Direct Connection	:	Connection of Solar PV power generation system directly to the distribution system.
Indirect Connection	:	Connection of Solar PV power generation system to the consumer owned internal network.
Distribution Licensee ('DL')	:	The holder of a license to distribute issued by Energy Commission of Sabah ('ECoS') under Section 8 of the Electricity Supply Enactment 2024.
Distribution System	:	The system of electric lines with voltage levels below 66 kV, within the Area of Supply owned or operated by the Distributor licensee/Embedded Distributor licensee, for distribution of electricity from Grid Supply Points or Generating Units or other entry points to the point of delivery to Customers or other Distributor licensees and includes any electrical plant and meters owned or operated by the Distributor licensee/Embedded Distributor licensee in connection with the distribution of electricity.
	:	A sinusoidal component of a periodic wave or quantity having a frequency that is an integral multiple of the fundamental frequency.
	:	A machine, device, or system that changes direct current ('DC') power to alternating current ('AC') power.
	:	A condition in which a portion of the utility system that contains both load and distributed resources remains energized while isolated from the remainder of the utility system.
	:	A voltage less than 1,000 volts or 1 kV.
Medium Voltage ('MV')	:	A voltage exceeding 1 kV but not exceeding 50 kV.
Connection point	:	The point where indirect Solar PV power generation system is connected to the network.
Point of Common Coupling ('PCC')/ Interconnection	:	The point of connection between utility system and consumer.



Total Harmonic Distortion ('THD')	:	Harmonic distortion is the departure of a waveform from sinusoidal shape that is caused by the addition of one or more harmonics to the fundamental. Total Harmonic Distortion is the square root of the sum of the squares of all harmonics expressed as a percentage of the magnitude of the fundamental.
Type Test	:	Test of one or more devices made to a certain design to demonstrate that the design meets certain specifications.
Power Factor	:	Power factor ('PF') is calculated by dividing the Real Power, P, in the W unit by the Apparent Power, S, in the VA unit. 24-hour, 4-day profile (consisting of Friday to Monday) of customer electricity demand profile which include voltage, kW, kVar for 60-minute sampling. Customers with own generation whose solar PV installed capacity is for self- consumption. In the event of excess of generation, the energy is allowed to be exported to the grid. Highest demand recorded in the load profile submitted during application for SOLAR RAKYAT SABAH. Lowest demand recorded in the load profile submitted during application for SOLAR RAKYAT SABAH.
Battery Energy Storage System ('BESS')	:	An energy storage system that employs battery technology for delayed applications. BESS described in this guide is used at the customer side, for the main purpose of enhanced electricity supply and integration with renewables
Customer With Own Generation ('CWOG')	:	Term used in the Maximum Demand Capacity to categorise customers that have in-house power generation facilities that operate in parallel with the Distributor Licensee distribution system.

Indirect Solar PV power generation	:	Power generation that utilize the solar photovoltaic technology to provide for the consumer's own demand. The indirect Solar PV power generation system is connected within the system and operate in parallel with the Distribution Licensee distribution system. Battery energy storage system could be used as part of the system.

4.0 DESCRIPTION OF INDIRECT SOLAR PV POWER GENERATION

4.1 Description

Consumers may decide to install indirect Solar PV power generation system to reduce their import from the Distribution Licensee. The indirect Solar PV power generation system is installed within its own system. The connection scheme is described in Chapter 5 of this guideline.

4.2 Battery Energy Storage System (BESS)

Use of BESS could enhance the energy utilization. BESS converter operates in bidirectional – charging and discharging.

The grid-connected inverter and BESS shall comply with connection requirements as stated in IEEE 1547.

4.3 Inverter requirements

Inverters to be paralleled to the Distribution Licensee's distribution system shall comply to the following standards and references, in term of design, operation and maintenance:

	Standard/ Guide	Scope
a)	MS 1873	Connection scheme of grid connected inverter.
b)	IEC 61727	Photovoltaic systems – characteristics of utility interface
c)	IEEE 1547	Standard for interconnecting Distributed Resources with Electric Power Systems: ▪ This standard describes the connection requirements of various Distributed Resources to the utility network.
d)	ECoS	Sabah Distribution Code.
e)	Sabah Electricity	Electricity Supply Application Handbook.
f)	Sabah Electricity	Technical Guideline for Indirect Solar PV Power Generation for Net-Energy-Metering @SOLAR RAKYAT SABAH for Sabah.
g)	TNB	Technical Guidelines for Interconnection of Distributed Generator to Distribution System, 2018.
h)	TNB	Technical Guidelines – Application of Inverters to Mitigate Fault Current Contribution of Inverter-based Distributed Generation in Distribution Systems.

Only inverters that comply with the standards above are allowed to be operating in parallel with Distribution Licensee distribution system. Type test certifications could be used as prove of compliance.

4.4 Power limiting capability

The demand from the Distribution system will reduce due to own generation by SOLAR RAKYAT SABAH consumer or export of excess energy to distribution network by SOLAR RAKYAT SABAH consumer.

This could disrupt the distribution system, resulting in voltage rise and reverse power flow.

During such event, the inverter shall reduce its generation upon receiving command from the detection device.

5.0 CONNECTION SCHEME

5.1 Introduction

The connection scheme clauses take into the following considerations:

a) Safety;
b) Connection with least alteration to existing network;
c) Cost; and
d) Compliance to regulatory requirements.

5.2 Connection types

The types of connection for indirect Solar PV power generation system is for LV customers.

5.3 Feedings method

The connection method of Solar PV power generation system can be categorised as Indirect Feed - Connection point at consumer.

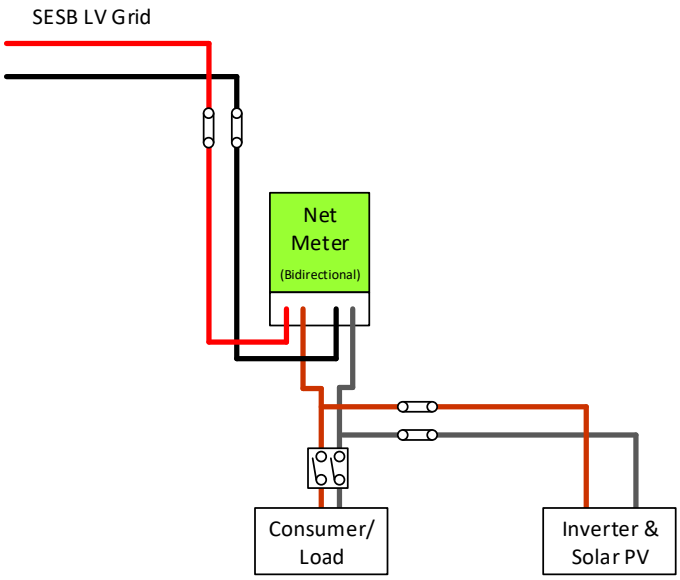


Fig. 5.1: Connection to Sabah Electricity grid

Connection point is within the consumer's network without direct connection to the Distribution Licensee's system. This method is adopted for SOLAR RAKYAT SABAH schemes. Power consumption and export are measured by Net Meter which shall have bi-directional capability to register the import and export units.

5.4 LV customer connections

This is applicable for Distribution Licensee's consumer with connection to LV network. PV connection point shall be done at the consumer's Distribution Board ('DB')/Main Switch Board ('MSB')

Use of a single-phase inverter shall not cause unbalance conditions to Distribution Licensee's system. If such a condition is violated, requirement of a three-phase inverter is automatically enforced.

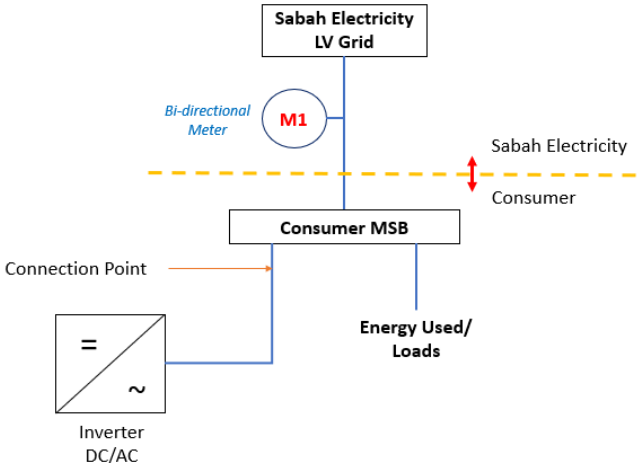


Fig. 5.2: LV connection

6.0 GENERAL REQUIREMENTS

6.1 Introduction

Connection of indirect Solar PV power generation system for SOLAR RAKYAT SABAH consumer shall be done internally which shall result in no requirement for upgrading of the existing utility supply infrastructure such as cable, fuse, switchgear, transformer and protection scheme.

6.2 Connection requirement

As a result of installation of indirect Solar PV power generation system, the quality of power at the point of connection shall not be made worse than the existing quality of supply. Quality of supply is measured as compliance to the standards on voltage, flicker, frequency, harmonics and power factor. To ensure that the addition of indirect Solar PV power generation system does not adversely impact the quality of supply, the following requirements shall be imposed and adhered by the SOLAR RAKYAT SABAH consumer.

Deviation from these standards represents out-of-bounds condition and may require the PV system to sense the deviation and properly disconnect from Distribution Licensee system.

Power quality parameters (harmonics and voltage) must be measured at the utility interface/point of common coupling unless stated otherwise. At PCC, the power quality requirements must comply with Sabah Distribution Code and this Technical Guidebook.

6.3 Selection of connection point

Although the connection of indirect Solar PV power generation system is within the consumer's premise, the following guides shall be satisfied to ensure that the connection does not interfere with the existing power supplied by the Distribution Licensee. The following items are to be considered during design.

a) Customer load during peak and trough;
b) Anti-islanding;
c) Protection system;
d) Interlocking;
e) Energy storage system (if applicable); and
f) Sensitive load.

During periods of low consumption (trough) and high generation from indirect Solar PV power generation system, SOLAR RAKYAT SABAH consumer is to ascertain that the internal network is capable of utilising all the generated energy and its protection system to use of external device or energy storage to mitigate the export of excess energy from consumer's solar PV system to the distribution system.

6.4 Connected voltage

As the connection is done internally, SOLAR RAKYAT SABAH consumer shall appoint a qualified consultant to design the interconnection between indirect Solar PV power generation system and his existing plant.

The interconnection shall comply with the standards as described in this guideline and other regulations issued by the Energy Commission of Sabah.

6.5 Installed capacity

Installed capacity of the system to be connected must be declared correctly during application. Restriction of export is to ensure that the system voltage does not fluctuate so much during high load, low generation and low load, high generation. The installed capacity is declared in term of summation of kWp.

The installed capacity of the indirect Solar PV power generation system shall be capped for domestic consumers as below:

a) Single phase : up to 5kWac; and
b) Three phase : up to 10kWac.

6.6 Export limiting

The export of excess energy from SOLAR RAKYAT SABAH consumer during its low demand and peak power generation could cause disruption to Distribution Licensee's network. Therefore, the amount of export is to be determined by the Distribution Licensee during the application process. For the capacity below 72kW, where there will be no analysis by the DL, the consumer shall ensure that the exported power shall be less than the existing capacity of the DL and consumer's equipment. Appropriate functionality within the inverter or use of external device to be provided to mitigate such a condition.

6.7 Boundary of ownership & operation

Boundary and operational limits of Distribution Licensee & SOLAR RAKYAT SABAH consumer must be clearly demarcated, agreed and documented. The Interconnection Operation Manual (IOM) shall be prepared and endorsed by both parties prior to the operation of the indirect Solar PV power generation system. Distribution Licensee's responsibility is up to the metering point which is as the ordinary Distribution Licensee's consumer boundary.

6.8 Equipment specifications

Major components of the indirect Solar PV power generation system shall comply to the following standard:

a) MS 1837
b) IEC 61727
c) IEEE 1547

6.9 Normal voltage operating range

The PV system injects current into utility and does not regulate voltage.

LV indirect Solar PV power generation system shall be capable of operating within the voltage range in **Table 6.1**.

Table 6.1: Normal operating condition at PCC (LV)

Normal Voltage (V)	Steady State Voltage Limits
230	-6% and +10%
400	-6% and +10%

6.10 Voltage fluctuation

Power generation from indirect Solar PV power generation system constantly varies due to the changing solar irradiation throughout the day. The varying power generation injected into the Distribution Licensee's network is bound to create voltage fluctuations at the interconnection point and other buses within the grid.

The maximum voltage fluctuation range allowed for LV due to varying solar radiation is 6%. Beyond this, there is a danger of utility and consumer equipment getting heated up.

An appropriate voltage control is to be undertaken to mitigate the voltage fluctuation when necessary.

6.11 Harmonic

The harmonic of a wave is a component frequency of a wave that is an integer multiple of the fundamental frequency. In the presence of non-linear loads such as computer power supplies and other appliances, Alternating Current ('AC') can be distorted by introduction of various harmonic frequencies. Harmonics can be measured by percentage of the fundamental frequency or by calculating Total Harmonic Distortion ('THD'). When present at high levels; these harmonics are detrimental to the electrical system and its loads.

The PV system output should have low current-distortion levels to ensure that no adverse effects are caused to other equipment connected to the utility system.

Total harmonic current distortion shall be less than 5 % at rated inverter output at cable connected to PCC. Each individual harmonic shall be limited to the percentages listed in **Table 6.2**.

Even harmonics in these ranges shall be less than 25 % of the lower odd harmonic limits listed.

Table 6.2: Current distortion limits (IEC 61727-2004)

Odd harmonics	Distortion limit (%)
3 – 9	< 4.0
11 – 15	< 2.0
17 – 21	< 1.5
23 – 33	< 0.6

Even harmonics	Distortion limit (%)
2 – 8	< 1.0
10 – 32	< 0.5

Note:

- *The harmonic current injection should be exclusive of any harmonic currents due to harmonic voltage distortion present in the utility grid without the PV system connected.*
- *Type tested inverters meeting the above requirements should be deemed to comply without further testing.*

6.12 Inverter power factor

The power factor is defined as the ratio between the applied active power and the apparent power.

PV systems shall have a leading or lagging power factor greater than 0.9 and 0.85 respectively when the output is greater than 20 % of the rated inverter output power. The smart inverters used shall automatically make necessary adjustments to ensure that the power factor does not cause voltage rise beyond the permissible limit.

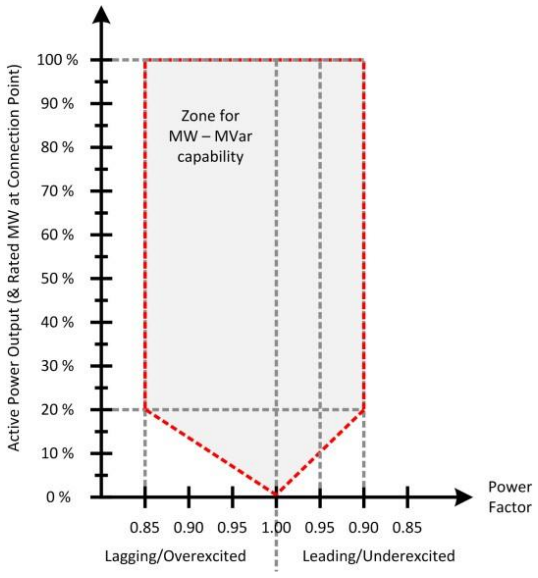


Fig. 6.1: Reactive power requirement at connection point.

6.13 Reactive power compensation

Consumer should be aware that if the installed indirect Solar PV power generation system is set to operate at unity power factor, reactive power for their load will be totally imported from Distribution Licensee and real power will be mixed of own generation and import from Distribution Licensee.

This will result in low power factor reading at Distribution Licensee tariff meter as the ratio of reactive power to active power is higher with own generation.
Therefore, customer is advised to consult their service provider to provide internal compensation to avoid from being penalised.

6.14 DC injection

The PV system shall not inject DC current greater than 1 % of the rated inverter output current into the utility interface under any operating condition.

6.15 Flicker

Flicker is due to rapidly changing loads that cause fluctuate in the customer's voltage. Even a small change in voltage can cause noticeable. Flicker is an irritation issue.

The operation of the PV system should not cause voltage flicker in excess of values stated in **Table 6.3**.

Table 6.3: Reference Sabah Grid Code

Distribution system voltage level which the fluctuating load is connected	Absolute short-term flicker severity (Pst)	Absolute long-term flicker severity (Plt)
LV Systems	1.0	0.8

6.16 Voltage unbalance

Voltage unbalance is defined as the ratio of the negative sequence voltage component to the positive sequence voltage component.

Negative Phase Sequence Voltage (%): 2% for 1-minute duration when multiple single-phase PV units are installed and it should be distributed evenly among the three phases of the power system.

Infrequent short duration peaks with a maximum value of 2% are permitted for Voltage Unbalance.

The unbalance voltage shall not exceed 1% for 5 occasions within any 30-minute time period at the terminals of a user's installation.

6.17 Short circuit level

By regulation, Distribution Licensee is required to ensure that short circuit level of the network is within the equipment ratings. The regulation specifies that network maximum sub-transient 3-phase symmetrical short circuit shall be within 90% of the equipment designed short-time make & break capacity. **Table 6.4** highlights the typical equipment ratings in Distribution Licensee's distribution network.

Table 6.4: Typical Equipment ratings in Sabah Electricity Distribution Network

Nominal Voltage (kV)	Rated Voltage (kV)	Fault Current (kA)
11.0	12.0	20.0
0.4	1.0	31.5

7.0 PENETRATION LIMIT

7.1 Introduction

SOLAR RAKYAT SABAH consumers are allowed to export any excess energy to Sabah Electricity, provided that the exported power is within the capacity of the existing equipment (Sabah Electricity and consumer) and the voltage levels are within the limit.

Generation power limiter is necessary to ensure that during periods of low load and high solar generation, the local voltage level would not rise beyond the limit and the exported power are still within the capacity of the existing equipment (Sabah Electricity and consumer).

7.2 Individual penetration

a) SOLAR RAKYAT SABAH

Applicable for Distribution Licensee registered consumer only. Consumer should decide on the installed capacity with consideration of their own daytime peak demand. Maximum installed capacity as shown in **Table 7.1**.

Table 7.1: Maximum installed capacity allowed for SOLAR RAKYAT SABAH consumer

Category	Maximum Capacity Installed	
Domestic	Single phase	5kWac
	Three phase	10kWac

However, periodically, during low household power consumption period and high solar PV generation, the excess power is to flow into the grid.

b) BESS

Installed capacity of BESS should not cause any export to Distribution Licensee's grid. Appropriate limiting device must be emplaced. BESS may be incorporated as part of the Solar PV during application (coupled with solar PV system).

The installation shall be in accordance with the Act and/or Enactment the subsidiary legislations made under it or any other documents issued by the relevant authorities in relation to BESS. With the capability of manual setpoint adjustments within a range 49.5 Hz and 50.5 Hz. Net-meter will cater the energy export timely from 06:00 am to 18:00 pm only.

8.0 PROTECTION GUIDELINES

8.1 Introduction

Protection system for indirect Solar PV power generation system is to be designed to isolate the faulty from the healthy sections of the system.

DG protection scheme is under SOLAR RAKYAT SABAH consumer responsibility and SOLAR RAKYAT SABAH consumer is to declare the protection scheme and settings to Distribution Licensee. SOLAR RAKYAT SABAH consumer shall design a protection system that fits his target degree of system security. Nonetheless, SOLAR RAKYAT SABAH consumer shall comply to Distribution Licensee's protection requirements to ensure that the fault would not spread beyond the plant.

SOLAR RAKYAT SABAH consumer is to perform protection coordination study to determine the suitable settings to protect the system during fault. Results of such study are to be furnished to Distribution Licensee for reference. Distribution Licensee shall advise SOLAR RAKYAT SABAH consumer on the appropriate settings at the point of common coupling.

For SOLAR RAKYAT SABAH consumer interconnection feeder protection scheme shall inhibit unsafe synchronization.

8.2 Smart inverter

Connection of power generation to distribution network could cause voltage rise during low load, high generation condition. Also, sudden loss of generation from DG could cause instability of the network, especially for system with high DG penetration.

Advanced inverters or known as smart inverters are capable of providing additional features in addition to the power conversion. Smart inverters are PV inverters that stay connected and provide additional functions to help actively support the grid - mainly voltage and frequency. Traditional inverters simply disconnected when the grid voltage or frequency went out of range. Broadly, smart inverters provide some additional benefit to the grid beyond simply converting DC electricity to AC from PV systems. The smart inverter functions is outlined in the **Attachment A**.

8.3 Frequency

Distribution Licensee shall maintain the system frequency and the PV system shall operate in synchronism with Distribution Licensee's frequency. Distribution Licensee shall operate with nominal 50 Hz system with ±1% range band.

8.4 Synchronisation

Synchronisation is an act of matching, within allowable limits, the required DG parameters with the Distribution Licensee's utility supply parameters as in **Table 8.1.**

Table 8.1: Parameters required for synchronisation

Parameters	Required Range
Frequency difference	<0.2 Hz
Voltage magnitude difference	< 10%
Voltage angle difference	< 10 deg
Interlocking logic are satisfied	-

Synchronisation is to be done at the inverter. Re-synchronising is only to proceed once Distribution Licensee's system is normalized and stabilized as in **Table 8.2.**

Table 8.2: Time taken for re-synchronising

Voltage	Time
LV	2 minutes

8.5 Anti-islanding inverter

Non-islanding inverters are unable to supply the load without the presence of the Distribution Licensee's system. For personnel safety reasons, PV plant is not allowed to be energized during outage of Distribution Licensee grid (loss of mains). The SOLAR RAKYAT SABAH consumer shall disconnect from the Distribution Licensee's system for loss of main within 2 second.

Inverters used by SOLAR RAKYAT SABAH consumer shall provide the following anti-islanding detection techniques:

a) Under Voltage;
b) Over Voltage;
c) Under Frequency;
d) Over Frequency; and
e) Additional anti-islanding technique

SOLAR RAKYAT SABAH consumer is to prove the anti-islanding capability of the plant during commissioning tests.

8.6 Inverter Fault Detection

PV system with inverter shall use abnormal voltage or frequency sensing for fault detection.

8.7 Inverter fault current contribution

The fault current contribution by the inverter will be limited usually by inverter control. Based on IEEE 1547, the typical range of short circuit current is between 100% and 200% of the rated inverter current. SOLAR RAKYAT SABAH consumer shall ensure that inverters used comply to the IEEE1547 requirement.

In areas where the network's Short Circuit Level has reached its threshold, as specified in Section 6.17, the inverter used must comply with Short Circuit Testing Certification ('SCTC') requirements. Applicants are advised to refer "Technical Guidelines –

Application of Inverters to Mitigate Fault Current Contribution of Inverter-based Distributed Generation in Distribution Systems" or contact the Distribution Licensee for further clarification on the SCTC process.

8.8 Protection schemes

The basic requirements for the design of the protection schemes shall be as follows:

a) For any internal fault in the indirect Solar PV power generation system, the indirect Solar PV power generation system must not cause problems to the Distributor licensee system and its customers.
b) For any distribution network fault outside the indirect Solar PV power generation system plant, the PV system must be protected from any damaging effect.

SOLAR RAKYAT SABAH consumer shall be required to provide other protection devices to complement existing special features.

8.9 Failure of indirect Solar PV power generation system protection or control equipment

Indirect Solar PV power generation plant must be disconnected from the distribution system during any of the system failure. Failure condition of indirect Solar PV power generation system equipment shall include:

a) Failure of protection equipment;
b) Failure of control equipment; and
c) Loss of control power.

8.10 Voltage disturbance

The inverter should sense abnormal voltage and respond according to the conditions in **Table 8.3**. Consideration shall be given to monitoring voltage in this clause in order to avoid problems due to voltage drop in various transformer, wiring or feeder circuit. When the inverter senses the voltage lies outside its operating limits, the recommended action shall be as in **Table 8.3** below.

Table 8.3: Voltage disturbance

Voltage (at PCC)	Maximum trip time (s)
V<50%	0.10
50%≤V<90%	2.00
110%<V<135%	Continuous operation
90%≤V≤110%	2.00

Inverters are expected to continuously operate during distribution network voltage fluctuation ±10% of its nominal.

During the time of voltage disturbances which could be the result of transmission network switching and distribution switching on nearby feeder, the voltage would be affected. Therefore, inverters must be able to ride thru the voltage disturbance bands

of 50% to 90% and 110% to 135%. This is to help stabilise the Distribution Licensee's system.

Loss-of-mains is indicated by voltage drop less than 50%.

Over voltage and under voltage detection shall be provided for all 3 phases.

8.11 Frequency disturbance

The under frequency and over frequency levels and the corresponding inverter trip time shall be as follows:

a) When the utility frequency is outside the nominal 50 Hz value by ±1 %;
b) Trip time shall be within 0.20s; and
c) Applicable for LV interconnection.

8.12 Utility interface disconnect switch

Indirect Solar PV power generation system interconnection must incorporate utility interface disconnect switch to allow disconnection of indirect Solar PV power generation system output from the interconnecting with Distribution Licensee for safe utility line works. The requirement of such switch could be referred to MS 1837. The switch shall be manual, lockable, load break disconnect switch that:

a) Provide clear indication of switch position;
b) Visible and accessible to maintenance and operational personnel; and
c) Provide visual verification of the switch contact position when the switch is in open position.

9.0 Metering Requirement

9.1 Introduction

Existing single phase and three phase whole current meter needs to be replaced to a bi-directional supply meter. The meter for large power consumer shall be replaced only if bi-directional register is required.

The existing meter board and its wiring (if required) to be re-located or to be replace by the registered wireman appointed by the consumer. The location of the meter shall be assessable to Sabah Electricity personnel, facing the main entrance and comply with the latest Electricity Supply Application Handbook.

The consumer shall bear all costs associated with the connection of indirect Solar PV power generation system including costs of meter replacement, supply upgrading, and system connection/modification (if applicable).

9.2 Energy Meters

Energy meters is required to measure the monthly Distribution Licensee-SOLAR RAKYAT SABAH consumer import & export (M1) for the purpose of net energy calculation. The (M1) meter will be installed by Sabah Electricity.

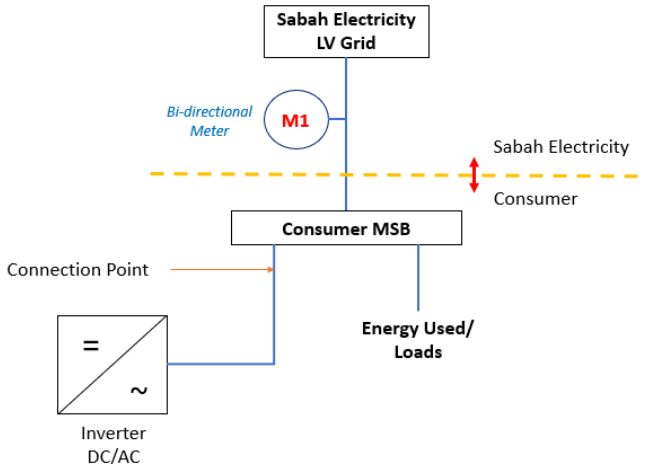


Fig. 9.1: Location of Energy Meters

9.3 Communication Signal

Distribution Licensee uses wireless mode of communication between energy meter and HQ. Location of the meter room shall have adequate reception of the wireless signal to enable data transmission. SOLAR RAKYAT SABAH consumer shall provide a signal booster device whenever the communication signal is weak.

10.0 SAFETY REQUIREMENT

10.1 Introduction

The installation of grid-connected indirect Solar PV power generation systems shall comply with the requirements of MS IEC 60364 or MS IEC 60364-7-712. The provisions of this section are aimed at ensuring that these requirements are met, considering a range of system topologies and earthing arrangements.

10.2 Operation

It is important that for the safety of operating staff and public, both the Distribution Licensee and the SOLAR RAKYAT SABAH consumer operator must coordinate, establish and maintain the necessary isolation and earthing when work and/or tests are to be carried out at the interface/connection point.

The safety coordination applies to when work and/or tests that are to be carried out involving the interface between the distribution network and the indirect Solar PV power generation system plant and it is the responsibility of the Distributor licensee and SOLAR RAKYAT SABAH consumer operator to comply with the requirements of statutory acts, regulations, sub–regulations, individual license conditions, Standardized Distributor licensee's Safety Rules and the Sabah Grid Code.

10.3 Labelling

Labels shall be clearly placed to remind the operator that the device should be access cautiously as there could be an energised part that comes from the indirect Solar PV power generation system.

Test before touch must be practiced.

11.0 APPLICATION PROCESS

11.1 Introduction

SOLAR RAKYAT SABAH applicant is required to submit the clearance application form as **Appendix B** to Sabah Electricity via email solar.rakyatsabah@sesb.com.my. The purposes of the assessment are for the evaluation of the following criteria of the consumer:

a) Malaysian citizen;
b) Domestic tariff;
c) Existing registered consumer;
d) Outstanding other account/bad debt;
e) Blacklist;

12.0 TESTING & COMMISSIONING

12.1 Introduction

There are 2 types of testing required:

a) Inverter compliance tests; and
b) Interconnection compliance tests.

Inverter compliance test

SOLAR RAKYAT SABAH consumer is responsible to ensure that the inverter unit(s) are complying to the requirements of this guideline.

Certified results of tests must be submitted for verification.

Interconnection compliance tests

Prior to commissioning, the interconnection must be tested to ensure that the performance is up to the required standard, installations are according to the approved scheme, settings are done as approved, etc.

Connection of indirect Solar PV power generation system plant should not have detrimental impact to the operation of Distribution Licensee's grid.

Tests to prove the following items shall be carried out in the commissioning process:

a) Anti-islanding on loss of mains;
b) Interlocking scheme (if any);
c) Equipment functional tests; and
d) Power Quality measurement.

12.2 Commissioning tests

Commissioning tests of the installation shall be carried out by the competent person appointed by SOLAR RAKYAT SABAH consumer.

All tests must be carried out by qualified testers.

Test equipment must have valid calibration certificate.

12.3 Commissioning of LV connection

For connections that are situated on a long feeder, special attention to the voltage level during peak and low load is to be made. Such a condition could result in excessive voltage rise during low load period.

13.0 OPERATION AND MAINTENANCE

13.1 Introduction

SOLAR RAKYAT SABAH solar PV installation is owned and maintained by the Consumer.

13.2 Boundary

Any failure of supply from Sabah Electricity grid including the bi-directional meter shall be rectified and normalized by Sabah Electricity.

Any failure of the consumer's electrical installation (after Sabah Electricity meter) and solar PV system shall be rectified and normalized by the Consumer.

In the event of Sabah Electricity supply failure, the Consumer has to ensure that there shall not be any reverse power/back feed from any internal source of generation (example solar PV, battery, generator) to Sabah Electricity grid.

The Consumer is solely responsible for any accident/incident to human beings and equipment that may occur due to reverse power/back feed from any internal source of generation when the Sabah Electricity grid supply is off.

Sabah Electricity reserves the right to disconnect Sabah Electricity supply to Consumer at any time in the event of default as specified in the contract, damage to its grid, meter, etc, or to prevent accident or damage.

14.0 OTHER REQUIREMENTS

14.1 Introduction

In addition to the technical requirements described in the previous sections, the following administrative requirements must be fulfilled.

Local authorities

a) Kebenaran Merancang from the local authorities for overall plant (if applicable);
b) Building plan approval (if applicable);
c) Site suitability.

Regulator

a) Registration with authority for less than 72kW.

Land owner

a) For tenants, written approval by the land owner shall be obtained.

The above list is not exhaustive.

ATTACHMENT A: Smart Inverter Functions

- Continued growth of PV generation puts more challenges on grid infrastructure designed for distribution from centralized energy sources. Advanced or smart inverter functions can help address the grid stability problems posed by high levels of variable distributed generation.

- Smart inverters are PV inverters that stay connected and provide additional functions to help actively support the grid - mainly voltage and frequency. Smart Inverters able to receive commands from grid operators and report information. Traditional inverters simply disconnected when the grid voltage or frequency went out of range.

- Broadly, smart inverters provide some additional benefit to the grid beyond simply converting DC electricity to AC from PV systems. They typically support overall grid reliability by offering the following functions.

No.	Functions	Description	Setting	Reference
1.	Anti-islanding Protection	Automatically disconnect during grid failure within certain duration. The duration is adjustable. Anti-islanding protection is to ensure inverter doesn't back-feed a disabled grid.	LV: • Disconnect 2sec • Reconnect 2min	Distribution Code: 7.8.3.5 - Protection and Control Requirements
2.	Voltage and Frequency Ride-through Capability	Inverter must meet the mandatory and permissive operation requirements as well as the must trip limits when the AC grid voltage and frequency high or low limits are exceeded. Inverters support the grid during brief voltage or frequency excursions. This function will help the grid to self-heal from a disturbance. During periods of (sometimes extreme) deviations in grid voltage and/or frequency, smart inverters are designed to remain connected to the grid and adjust their output to act as a counterbalance to frequency or voltage changes.	LVRT: Refer graph (Distribution Code) LFRT: uninterrupted range 47Hz to 50.5Hz	Distribution Code: 6.5.5.1 - Low Voltage Ride Through (LVRT) & 6.5.5.2 - Frequency disturbance
3.	Reactive Power Control Functions	Inverter is able to supply or absorb reactive power to/from the grid to maintain stable grid voltage when fluctuations are prevalent.	Voltage range: (LV: 230V & 400V) -6% +10%	Distribution Code: 5.4.4.1 - Voltage range,

		Variable Power Factor provides active voltage stabilization: • Grid voltage nominal, purely active power. • Grid voltage high, add 'inductive' reactive power. • Grid voltage low, add 'capacitive' reactive power. Adjusting VARs keeps grid voltage from oscillating; acts like a shock absorber. The reactive power control can be achieved using 3 main controls: a) Dynamic Volt/VAr Mode (voltage control). b) Fixed power factor (pf control). c) Fixed reactive power (eg: using switched reactor or capacitor).	Power Factor range: 0.85 lagging to 0.9 leading.	6.5.5.5 - Reactive power, 7.8.3.8 - Power factor.
4.	Active Power Control Functions Frequency-Watt (Droop Curve) and Volt-Watt	Support grid frequency and voltage by changing inverter wattage output: Help to stable the grid during an under/over frequency and voltage event by controlling the real output of the solar system. • Grid frequency/voltage nominal, inverter at max output. • Grid frequency/voltage high, inverter curtails power. • Grid frequency/voltage low, inverter increases power.	Frequency range: 47Hz to 50.5Hz Voltage range: (LV: 230V & 400V) -6% +10%	Distribution Code: 6.5.5.4 - Droop curve, 5.4.41 - Voltage range & 6.5.5.3 - Power output management.

APPENDIX B: SOLAR RAKYAT SABAH CLEARANCE APPLICATION FORM

Sabah Electricity
Energising Our Future

- SOLAR RAKYAT PROGRAM -
Sabah Electricity Clearance Application Form

RETAI L/NEM/FO RM/Clearance v1.2

PART 1: INFORMATION

- We collect and use your personal data to process your application for clearance under the Solar Rakyat Program, provide related services, send you important updates, and comply with legal and regulatory requirements.
- Please make sure the information you provide is accurate and complete. If your personal data is incomplete or incorrect, we may not be able to process your application .
- You have the right to request to access to your personal data, ask for corrections, and request a copy of your data, subject to applicable laws.
- By submitting your personal data, you agree to its collection and use as described in this notice.

PART 2: CONSUMER INFORMATION – to be filled by the Registered Customer

APPLICANT NAME : _____

NRIC : | | | | | | | - | | | - | | | | |

SESB ACCOUNT NUMBER : | | | | | - | | | | | | | |

PHONE NUMBER : | | | | | - | | | | | | | |

EMAIL ADDRESS : _____

INSTALLATION ADDRESS : _____

_____

LOCATION (GPS) : _____

PART 3: DECLARATION. PLEASE TICK (√)

By signing this form, I confirm that:

☐ I am the owner of the premises, and the information provided above is true and accurate to the best of my knowledge and belief.

☐ I consent to Sabah Electricity using and disclosing my personal data for the purpose of processing the SOLAR RAKYAT SABAH Assessment.

☐ I have provided a copy of my MyKad as required.

Signature : _____

Name : _____

Date : _____

PART 4: SUBMISSION

- Kindly submit the completed form to Sabah Electricity at the following address or via email at: solar.rakyatsabah@sesb.com.my.

Sabah Electricity (Retail Division),
New Business & Development,
Block C, 1st Floor, Bangunan KWSP,
Jalan Karamunsing JT Bypass,
88598 Kota Kinabalu, Sabah.

PART 5: FOR OFFICE USE ONLY – TO BE COMPLETED BY SABAH ELECTRICITY (Preliminary Assessment)

A. Eligibility

Assessment Item	Status/Findings	Remarks
Malaysian Citizen	☐ Yes ☐ No	
Domestic Tariff	☐ Yes ☐ No	
Existing Registered Consumer	☐ Yes ☐ No	

B. Consumer Background Assessment

Assessment Item	Status/Findings	Remarks
Active Utility Account	☐ Yes ☐ No	
Outstanding Bills/Payments	☐ Clear ☐ Outstanding	
Credit History with Utility	☐ Satisfactory ☐ Need Review ☐ Unsatisfactory	
Previous Violations/Non-Compliance	☐ None ☐ Recorded	
Connection/Disconnection History	☐ Normal ☐ Issues Found	
Regulatory Compliance Status	☐ Compliant ☐ Pending	

C. Clearance Recommendation

Based on the assessment above:

☐ **Approved** – Consumer is eligible for SOLAR RAKYAT SABAH Program submission.

☐ **Pending** – Additional documentation/clarification required.

☐ **Rejected** – Consumer does not meet eligibility criteria.

Reason for Pending/Rejection:

_____

_____

_____

PART 6: SABAH ELECTRICITY'S AUTHORISED SIGNATURE

A. Assessed by (Agent MSC)

Signature : _____

Name : _____

Designation : _____

Date : _____

B. Verified by (Manager)

Signature : _____

Name : _____

Designation : _____

Date : _____

C. Endorsement by Senior Executive of New Business & Marketing

Signature : _____

Name : _____

Designation : _____

Date : _____