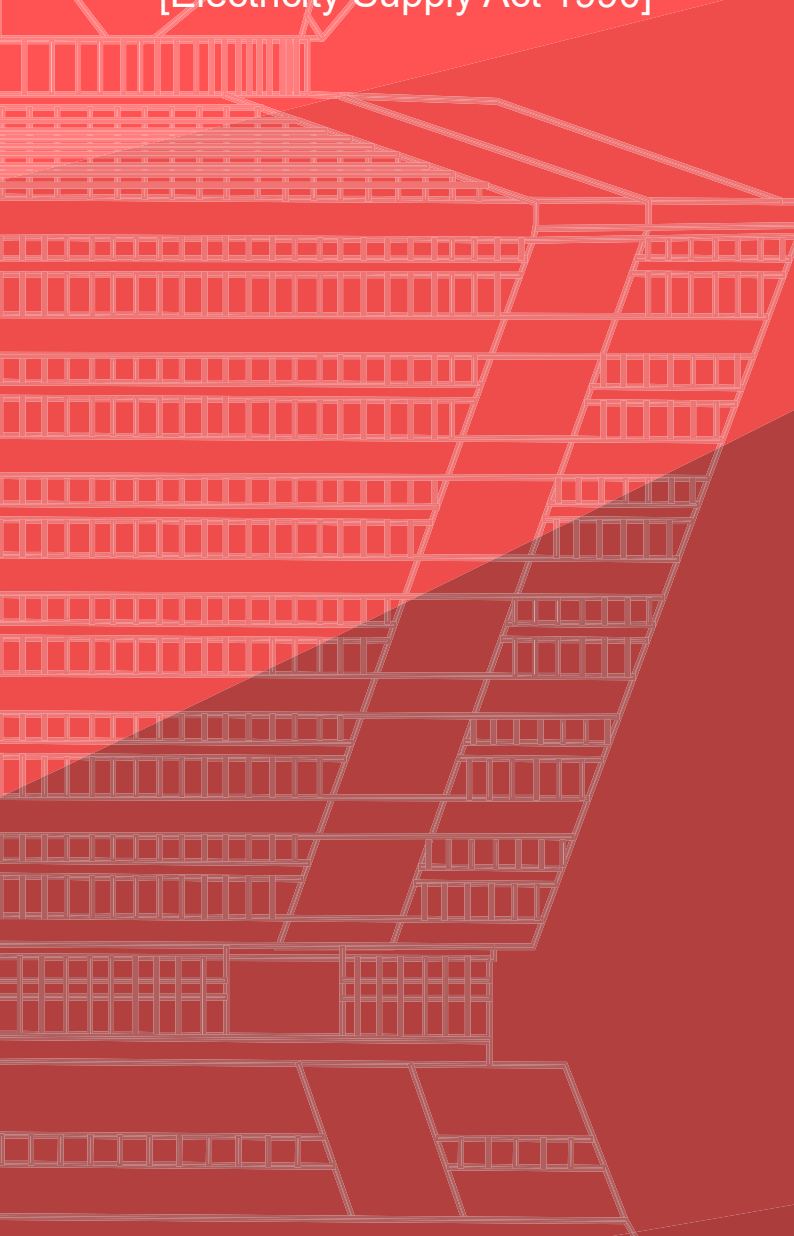


Guidelines

On Large Scale Solar Photovoltaic Plant For Connection To Electricity Networks

[Electricity Supply Act 1990]



**GUIDELINES ON LARGE SCALE
SOLAR PHOTOVOLTAIC PLANT
FOR CONNECTION TO
ELECTRICITY NETWORKS**

Registration Record

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ELECTRICITY SUPPLY ACT 1990 [ACT 447]
GUIDELINES ON LARGE SCALE SOLAR PHOTOVOLTAIC PLANTS
FOR CONNECTION TO ELECTRICITY NETWORKS (Pin.2024)

GP/ST/No.1/2016(Pin.2024)

IN exercise of the power conferred by section 50C of the Electricity Supply Act 1990 [Act 447], the Commission issues the following guidelines:

Citation and commencement

1. These guidelines may be cited as the Guidelines on Large Scale Solar Photovoltaic Plants for Connection to Electricity Networks.
2. These Guidelines shall come into operation on 2 April 2024.

Purposes

3. These Guidelines is to describe the procedures for development of large scale solar power plants and to provide guidance to prospective large scale solar power plants developers seeking connection to the electricity network.

Dated 2 April 2024

DATO' IR. TS. ABDUL RAZIB BIN DAWOOD

Chief Executive Office

Energy Commission

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1.0 Objectives

1.1 These Guidelines are developed by the Commission with the following objectives:

- (a) to describe the procedures for the development of large scale solar power plants; and
- (b) to provide guidance to any prospective large scale solar power plant developers seeking connection to the electricity network.

2.0 Scope

2.1 These Guidelines shall apply to—

- (a) any person who wishes to participate in the development of any large scale solar power plant in Peninsular Malaysia and Federal Territory of Labuan;
- (b) any person who has been approved to develop large scale solar power plants and seeking connection to the transmission and distribution electricity network with a capacity as reflected in the Request of Proposal (RFP) issued by the Commission;
- (c) the licensee whose network is to be connected with the LSS Plant;
- (d) the Single Buyer;
- (e) the relevant Distribution Licensee who manage the contractual arrangement for the sale and purchase of electricity through the network; or
- (f) the System Operator.

2.2 These Guidelines are not intended in any way to circumvent the application, obligations or requirements under any other written law or standards.

2.3 These Guidelines are not applicable to large scale solar power plants which have been given the right by the Sustainable Energy Development Authority (SEDA) to develop under FIT.

3.0 Interpretation

3.1 In these Guidelines, the following terms shall bear the following meanings:

TERM	DEFINITION
AC	means alternating current;
Act	means the Electricity Supply Act 1990 [Act 447];
Annual Generation Profile	means the forecasted annual generation profile (in MW _{ac}) of the Facility's output for every hourly interval to be generated and delivered to the Grid System at the Interconnection Point from the Facility for each Contract Year;
Anti Islanding	means during loss of mains, the Inverter should cease to operate in islanded mode.
BOO	means build, own and operate;
Commencement Date	means the date notified by LSS Developer to TNB on which the notice to proceed under the EPCC is issued;
COD	means commercial operation date, which is the date where on which all relevant conditions precedent under the SPPA have been satisfied or waived;
Commission	means the Energy Commission established under the Energy Commission Act 2001 [Act 610];
Company	means a body corporate incorporated in Malaysia under the Companies Act 2016 [Act 777];

TERM	DEFINITION
Connection Point	means the PCC where the LSS Plant is connected to the Distribution System;
Contingency	means under contingency condition, when one or more circuit elements are on outage, scheduled or non-scheduled;
Contract Year	means the duration when the SCOD of the Facility begins and ends on December 31 of the year in which the SCOD of the Facility occurs, and for each subsequent period during the term of the SPPA which begins on January 1 and ends on December 31 of the same year and the period of twelve (12) months or less which begins on January 1 and ends on the last day of the term of the SPPA;
Contracted Capacity	means the capacity of solar PV energy (in MW) to be generated and delivered to the Grid System at the Interconnection Point from the Facility for each Contract Year;
Control Centre	the RCC for the Distribution Networks and NLDC for the Transmission Networks;
DC	means direct current;
DAQ	means declared annual quantity, that is the annual quantity (in MWh) of solar PV energy to be generated and delivered to the Grid System at the Interconnection Point from the Facility for each Contract Year which shall not exceed the MAAQ of the Facility;
Declared Daily Capacity	means on any day of a Contract Year, the forecasted daily capacity (in MW _{ac}) of the Facility's output for every fifteen (15) minutes interval to be generated and delivered to the Grid System at the Interconnection Point from the Facility pursuant to the requirements of the SPPA;

TERM	DEFINITION
Dispatch Instruction	means an oral, written instruction or electronic signal communicated to LSS Developer by the System Operator or the Control Centre directing the Facility to commence, decrease or cease the generation and delivery of solar PV energy into the Grid System, in accordance with the provisions of the SPPA;
Directly Connected Customers	has the same meaning assigned to it under the Grid Code;
Distribution Code	means the Distribution Code for Peninsular Malaysia and Federal Territory of Labuan;
Distribution Licensee	means a licensee that distributes electricity through an electricity distribution network;
Distribution Network	means a Distribution System;
Distribution System	has the same meaning assigned to it under the Grid Code;
EER	means an excess energy rate, which will be paid to SPP in the event SPP sells and delivers and TNB purchases and accepts any Net Electrical Output in a contract year in excess of the Maximum Annual Allowable Quantity of such contract year, in RM xx /kWh.;
Effective Date	means the date on which all relevant conditions precedent listed under the SPPA have been satisfied or waived;
Electricity Utility Company	means the main electricity supply company in Peninsular Malaysia, or Federal Territory of Labuan, as applicable and as further described in the RFP;
EMS	means an energy management system;

TERM	DEFINITION
Energy Rate	means any rate approved by the Commission and may be adjusted in accordance with the terms of the SPPA;
EPCC	means engineering, procurement, construction and commissioning;
Established Capacity	means capacity of LSS Plant as approved by the Commission;
Facility	means a solar PV energy generating facility located at the site with a capacity as approved by the Commission and ancillary equipment and facilities as more specifically described in the SPPA and includes any modification thereto;
FACTS	means Flexible AC Transmission System;
FAT	means Factory Acceptance Test;
FiT	means Feed-in-Tariff, which is a scheme where the special tariff payable to feed-in approval holders in consideration for renewable energy generated and sold to a distribution licensee as specified in the third column of the Schedule in the Renewable Energy Act 2011 [Act 725];
FCD	<p>means financial close date, which is the date on which:</p> <p>(a) all the financing documents relating to the financing or refinancing for the total construction costs of the Project have been entered into by the SPP and the financing parties; and</p> <p>(b) all of the conditions precedent for the initial drawdown by the SPP under such financing documents have been satisfied by the SPP or waived by the financing parties thereunder.</p>

TERM	DEFINITION
GCAP	means a generator reactive capability;
Generating Unit	has the same meaning assigned to it under the Distribution Code;
GIS	means a gas insulated switchgear;
Grid Code	means the Grid Code for Peninsular Malaysia and Federal Territory of Labuan;
Grid Owner	has the same meaning assigned to it under the Guidelines for Single Buyer Market (Peninsular Malaysia);
Grid System	means the Transmission Network with directly connected Generating Unit including Power Park Module and Directly Connected Customers;
GSU	means a generator step up;
IF	means an interconnection facility which refers to the components that interconnect the LSS Plant and the Distribution Network. This includes the substation at the LSS Plant, overhead lines or underground cables where the connection to the Distribution Network is made;
IOD	means an initial operation date, and refers to the date on which Net Electrical Output is first generated and delivered from the Facility to the Grid System or Distribution Network;
IOM	means the interconnection operation manual;
Independent Engineer	means an established reputable consulting engineering firm or professional engineers, registered with the Board of Engineers Malaysia and who shall not be the owner's engineer, retained by SPP and approved by the Commission, the financing parties and TNB as the independent engineer in

TERM	DEFINITION
	connection with the design, engineering, procurement, construction, installation, testing and commissioning of the Facility, the site, the SPP Interconnection Facility, the SPP Interconnector, the SPP Works and associated facilities;
Interconnection Point	means the physical point where the LSS Plant is connected to the Distribution System or Grid System;
kV	means kilo-Volt;
kWh	means kilo-Watt hour;
LILO	means loop-in-loop-out;
LSS Developer	means a person developing the LSS Plant;
LSS Plant	means a large scale solar plant, which is any solar PV plant with capacity as approved by the Commission connected to either the Transmission Network or Distribution Network in Peninsular Malaysia or Federal Territory of Labuan;
MAAQ	means a maximum annual allowable quantity (in MWh) which is 106% of the total annual quantity of the LSS Plant for the first twelve (12) months of the term of the SPPA;
MMF	means meteorological monitoring facilities;
MW (or MW_{ac})	means Mega-Watt;
Net Electrical Output	means the solar PV energy generated and delivered to the Grid System at the Interconnection Point from the Facility by the LSS Developer as measured in kWh by the TNB Metering Equipment or as otherwise determined in accordance with the provisions of the SPPA during such period;

TERM	DEFINITION
Net Energy Output	means for any period, the amount of solar energy generated and delivered to the IF at the metering point or as otherwise determined in accordance with provisions of SPPA during such period;
NLDC	means a National Load Dispatch Centre, from which the System Operator directs the control of the Peninsular Malaysia power system;
Notification to Shortlisted Bidder	means a notification issued by the Commission to a Shortlisted Bidder for the purpose of notifying the Shortlisted Bidder and the SPP to finalize the Project Documents with the relevant parties and to achieve the FCD as specified in the Notification. The Notification to Shortlisted Bidder shall contain the terms and conditions to be fulfilled by the Shortlisted Bidder in order to maintain his status as a Shortlisted Bidder and to avoid the Notification to be withdrawn;
PCC	means a Point of Common Coupling, that is the point on the Transmission Network which is electrically closest to the user installation at which either demands (loads) are, or may be, connected;
PF	means a Power Factor which is calculated by dividing the Real Power, P, in the W unit by the Apparent Power, S, in the VA unit;
Potential Injection Point	means the potential point for injection at the Interconnection Point;
Power Park Module	has the same meaning assigned to it under the Grid Code;
Power Park Unit	means an individual Generating Unit within a Power Park Module;

TERM	DEFINITION
PPC	means a power plant controller;
PQR	means a power quality recorder;
Professional Engineer	means a person registered as a Professional Engineer under the Registration of Engineers Act 1967 [Act 138];
Project Documents	means the SPPA and any other documents which are necessary to be entered into by the SPP with the related parties for the interconnection;
Prudent Utility Practices	means the exercise of that degree of skill, diligence, prudence and foresight which would reasonably and ordinarily be expected from a skilled and experienced operator engaged in the same type of undertaking under the same or similar circumstances;
PSS	means a power system study;
PV	means photovoltaic;
RCC	means a Regional Control Centre, from which the Electricity Utility Company monitors the Distribution System;
RFP	means a request for proposal, which is the document issued by the Commission on behalf of the Government in respect of the development of the LSS Plants;
RFP Participant	means any person who participates in the RFP exercise;
RFQ	means a request for qualification, which is the document issued by the Commission on behalf of the Government in respect of the development of the LSS Plants;

TERM	DEFINITION
Rolling 24 Hours Forecast	means the forecasted capacity (in MW _{ac}) of the Facility's output to be generated and delivered to the Grid System at the Interconnection Point from the Facility for every fifteen (15) minutes interval for the following twenty-four (24) hours or such other period as may be notified by the System Operator to LSS Developer in writing, and updated at every half-hour on a rolling basis commencing from the IOD until the expiry of the SPPA;
ROW	means a right of way;
RTU	means a remote terminal unit;
SESB	means Sabah Electricity Sdn. Bhd. a limited liability company incorporated under the Companies Act 2016 (Company Registration No. 462872-W);
SESB IF	means the existing SESB substation (including but not limited to any extension works required to be completed by the LSS Developer at such SESB substation) or a new switching station to be completed by the LSS Developer, as further described in the Technical Specifications;
SCADA	means a supervisory control and data acquisition;
SCOD	means a scheduled commercial operation date, which is the date scheduled by the LSS Developer for the LSS Plant to come into operation;
Single Buyer	has the same meaning assigned to it under section 22B of Act 447;
Shortlisted Bidder	means a bidder who is issued with a Notification to Shortlisted Bidder which has not been withdrawn;

TERM	DEFINITION
SPPA	means a solar power purchase agreement, which is the agreement to be entered into between the SPP and the Electricity Utility Company pertaining to the sale of electricity produced by the LSS Plant to the Electricity Utility Company;
SPP	means a Solar Power Producer, which is the owner of a LSS Plant with capacity as approved by the Commission, connected to either the Transmission Network or the Distribution Network in Peninsular Malaysia or Federal Territory of Labuan;
SPP IF	means a SPP Interconnection Facility, which is the new substation owned by a LSS Developer as further described in the SPPA to enable the LSS Developer to deliver energy generated from solar PV panels from the Facility to the Grid System or Distribution Network, as further described in the SPPA;
SPP Interconnector	means the transmission line(s) or underground cable(s) (including any associated facilities) that interconnect the SPP IF and TNB IF, as further described in the Technical Specifications;
SPP Works	means the design, engineering, procurement, supply, manufacturing, construction, installation, erection, testing, commissioning, labor, services, facilities, equipment, supplies and materials to be furnished, supplied or performed by LSS Developer at the TNB IF or at IF owned by Electricity Utility Company;
System Operator	has the same meaning assigned to it under section 22A of the Act;

TERM	DEFINITION
Technical Specification	means the technical specifications specified in Appendix B or Appendix C;
THD	means a Total Harmonic Distortion which has the same meaning assigned to it under the Distribution Code;
TNB	means Tenaga Nasional Berhad with the Company Registration No. 200866-W);
TNB IF	means the existing TNB substation including but not limited to any extension works required to be completed by the LSS Developer at such TNB substation or a new switching station to be completed by the LSS Developer, as further described in the Technical Specifications;
TNB Metering Equipment	means the main and back-up metering equipment and devices (including telemetering equipment and software) as further described in the SPPA, owned by TNB for the measurement of Net Electrical Output and electrical energy delivered to the Grid System at the applicable Interconnection Point from the Facility;
Transmission Network	has the same meaning assigned to it under the Grid Code;
TSRS	has the same meaning assigned to it under the Grid Code;
Type Test	means the test of one or more devices made to a certain design to demonstrate that the design meets certain specifications;
VCB	means vacuum circuit breaker; and
VT	means voltage transformer.

3.2 Subject to paragraph 3.0 and unless expressly indicated to the contrary or unless the context otherwise requires, terms adopted and used in these Guidelines shall bear the same meaning as they are defined in the Act and subsidiary legislations made under it.

3.3 If there are any conflict between the provisions of these Guidelines and of those contained in the Act and subsidiary legislations made under it, the provisions in such Act and the subsidiary legislations shall prevail.

4.0 Key Principles of LSS Plant Development Framework

4.1 The key principles of LSS Plant development framework shall be as follows:

- (a) The participant in the LSS plant development program including the LSS Developer and SPP shall be —
 - (i) a Company; or
 - (ii) a consortium of legal entities which includes a minimum of a Company;

of which the Malaysian equity interest in each such Company or consortium is at least 51% or a higher percentage as may be determined by the Commission;

- (b) Upon participating in the LSS Plant development program, there shall be no change to the shareholding structure of the participant without written approval of the Commission;
- (c) The participant in the LSS plant development program shall not offer, assign, transfer or otherwise convert any share, preference share, redeemable preference share or redeemable convertible preference whatsoever that may result in a change of its equity shareholdings or its status as a company without a written approval of the Commission;
- (d) The usage of land to be used for the LSS Plant may also be optimized for other economic activities (e.g.: agricultural) and not restricted only to solar energy generation, and may carry certain merit points;

- (e) The plant capacity range for LSS Plant is as specified in the RFP;
- (f) The connection to the electricity network, whether to the Transmission Network or Distribution Network, shall be based on technical criteria and evaluation through a comprehensive system study;
- (g) The SPPA shall be based on take and pay, energy only under a BOO concession;
- (h) The LSS Plant may be a combination of several solar farms from different sites from one single Shortlisted Bidder and arising out of the same submission of RFP and connected to one Interconnection Point, whereby a single SPPA with one Energy Rate shall be applied;
- (i) The SPPA is for a term of 21 years with fixed energy rate throughout;
- (j) Bids submitted pursuant to the RFP shall be based on the optimum output, final yield and specific yield of the proposed LSS Plant in accordance with the design and technology used;
- (k) The LSS Developer shall declare the plant's energy production for 21 years. In the SPPA, the LSS Developer is entitled to be paid the Energy Rate up to the LSS Plant's MAAQ. Any energy beyond MAAQ, if accepted by TNB or SESB, shall be paid at the EER; and
- (l) The Energy Rate shall include but is not limited to the following:
 - (i) EPCC costs;
 - (ii) Land costs;
 - (iii) Project development costs;
 - (iv) Financing costs;
 - (v) Operation and maintenance costs; or
 - (vi) Interconnection costs.

5.0 Potential Injection Points

- 5.1 Certain locations have been identified as Potential Injection Points to the Grid System and Distribution Networks operated by TNB or SESB to facilitate prospective bidders. These Potential Injection Points will be issued as part of a RFQ or RFP documents. LSS Developer shall perform PSS for connection to the Potential Injection Points.
- 5.2 Any alternative Connection Point may be proposed but its acceptance is up to the discretion of the Commission after consultation with the System Operator and the Distribution System operator.
- 5.3 All costs associated with the connection of LSS Plants and PSS, shall be borne by the LSS Developer. The demarcation of ownership of the plant and system is as depicted in **Figure 1**, **Figure 2** and **Figure 3** in paragraph 6.0.

6.0 Responsibility of the LSS Developer

The LSS Developer is fully responsible to —

- (a) acquire land or submit certified and executed site or lease agreement as reflected in the land title;
- (b) obtain ROW and permits from relevant local authorities required for the construction of the Facility, SPP IF, SPP Interconnector, TNB IF and network reinforcement up to the PCC as **Figure 1**, **Figure 2** and **Figure 3**; and
- (c) design, construct, test, commission and complete the LSS Plant.

Figure 1: Illustration of Asset Demarcation

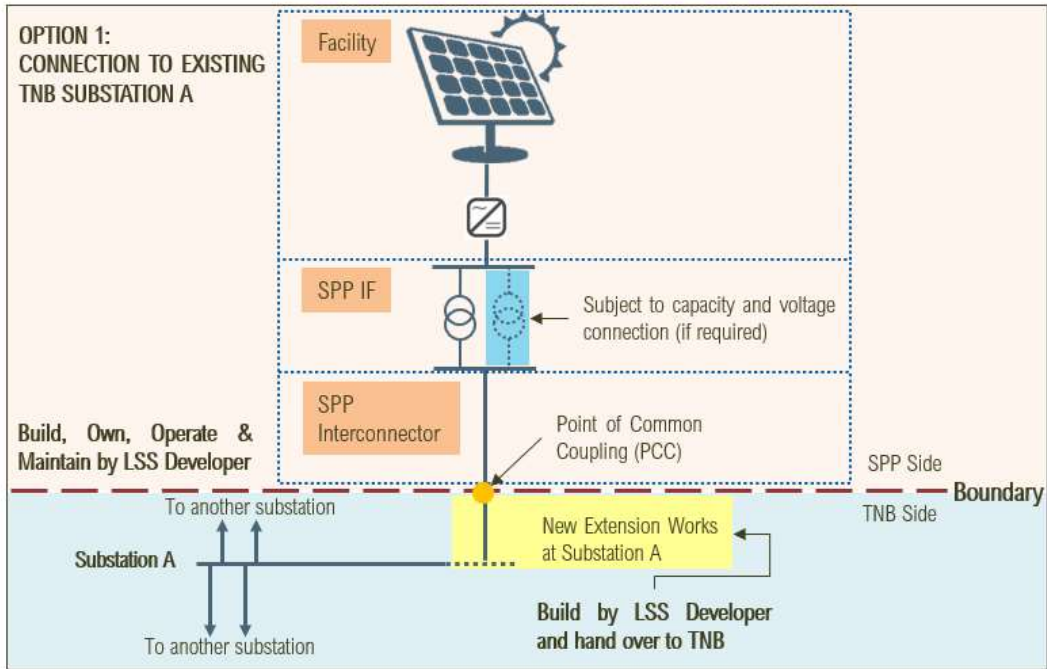
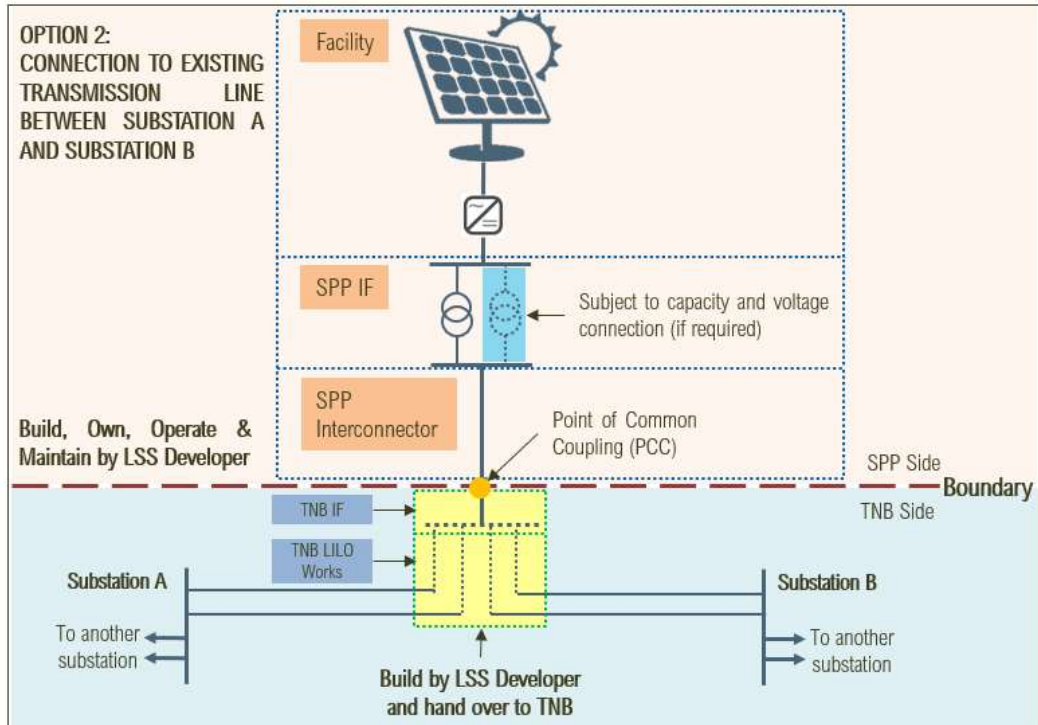
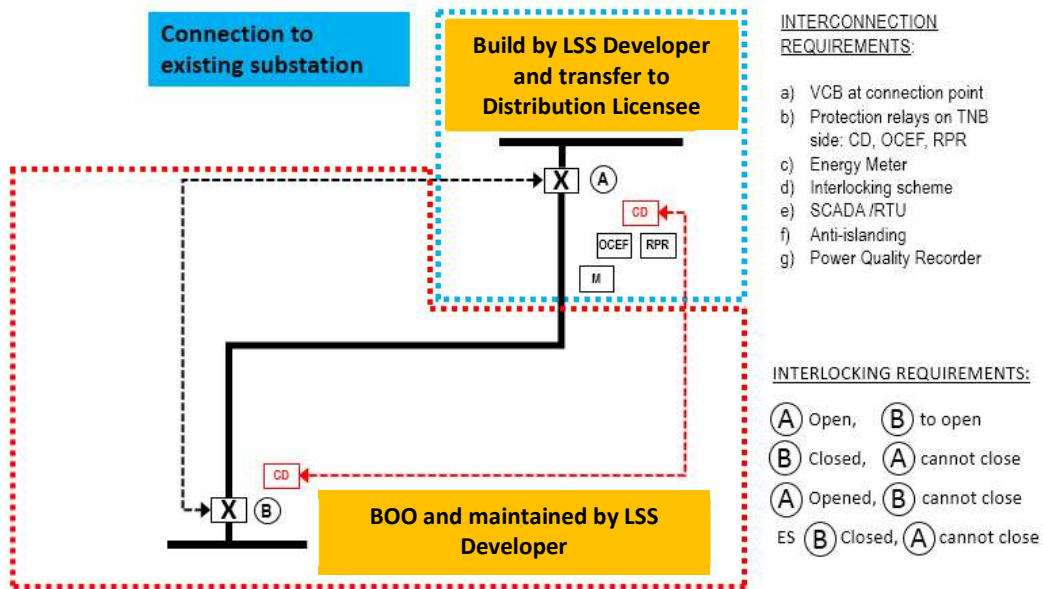


Figure 2: Illustration of Asset Demarcation



*NOTE: Regardless of the SPP Interconnector length, the LSS Developer shall build, operate and maintain the SPP Interconnector either it be within the LSS Plant boundaries, in public area or areas owned by third parties.

Figure 3: Illustration of Asset Demarcation



7.0 Appendices of the Guidelines

The following documents will be a guide in preparing the RFP submission:

- APPENDIX A:** Process Flow Chart for Development of LSS Plant;
- APPENDIX B:** Technical Specifications for Transmission Connected LSS Plant; and
- APPENDIX C:** Technical Specifications for Distribution Connected LSS Plant.

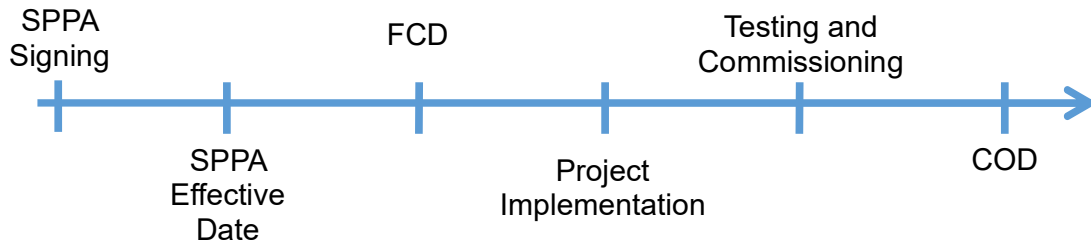
8.0 Notification to Shortlisted Bidder for the LSS Plant

The Commission will issue a Notification to Shortlisted Bidder to the Shortlisted Bidders, which, among others, notifies the Shortlisted Bidder to finalize and execute the SPPA and other Project Documents with the relevant parties, to achieve the FCD and SCOD, within the stipulated time as per the Notification to Shortlisted Bidder and SPPA. Shortlisted Bidder must fulfill all the terms and conditions in the Notification to Shortlisted Bidder in order to avoid its selection as a Shortlisted Bidder to be withdrawn.

9.0 Critical Milestones to COD

As shown in **Figure 4** below, the critical milestones for successful completion of a LSS Plant shall take place prior to COD.

Figure 4: Timelines from Post-SPPA to COD



10.0 Licensing Requirement

All LSS Plants shall be licensed under section 9 of the Act. For licensing purposes, the Guidelines on Licensing Under Section 9 of The Act is available on the Commission's official website at <https://www.st.gov.my>, and an application shall be made on-line at <https://oas.st.gov.my>.

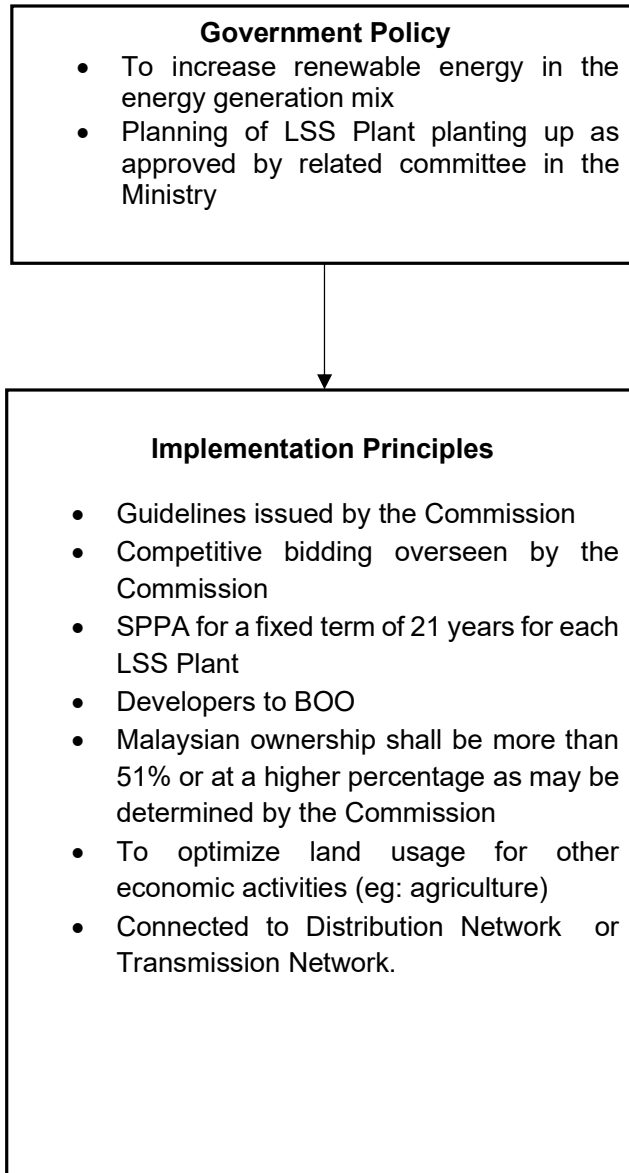
11.0 Direction by the Commission

The Commission may issue any direction from time to time in relation to the implementation of these Guidelines.

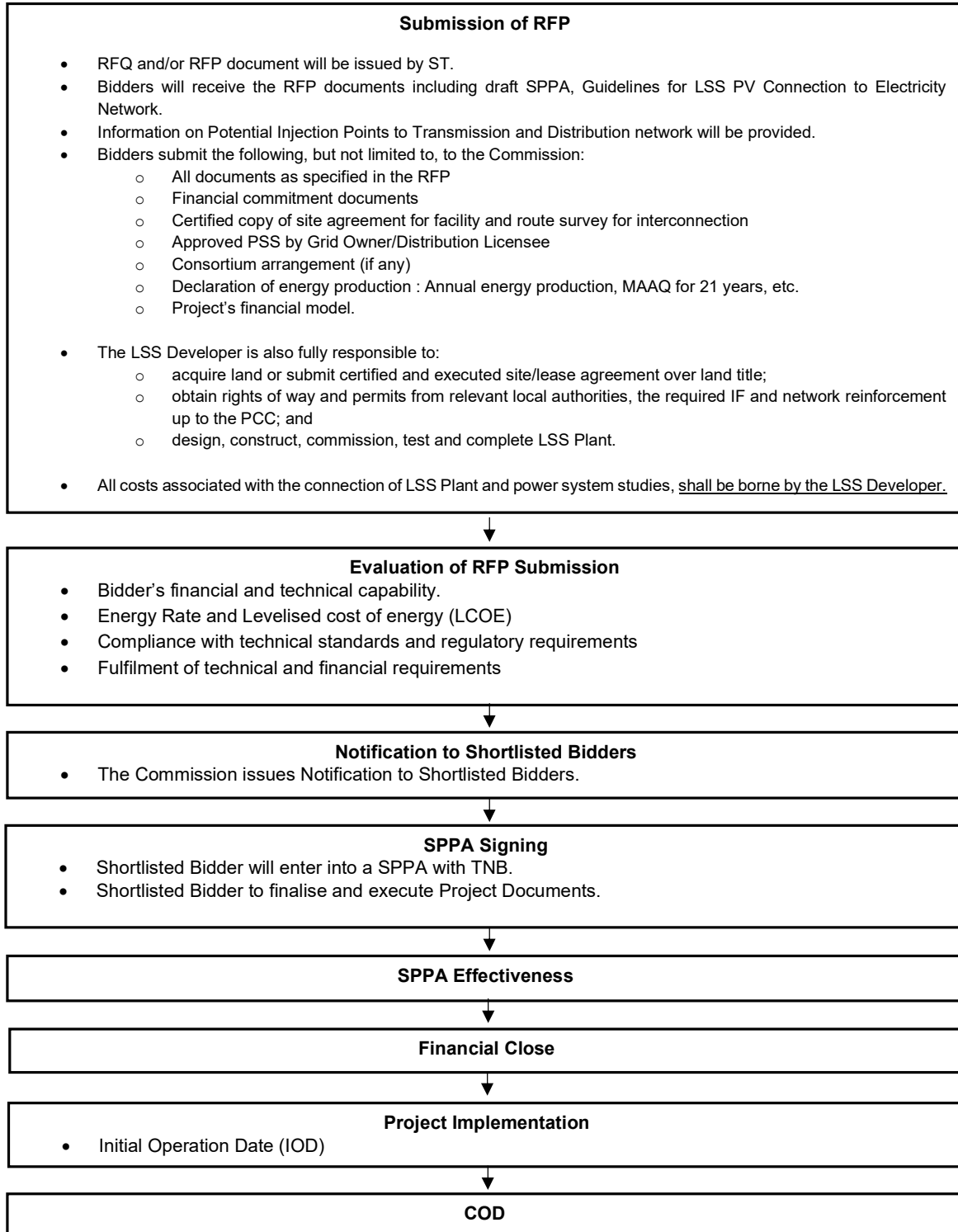
Appendix A

Process Flow Chart for Development of LSS Plant

Principles of Development of LSS Plants



Program Flow Chart



Appendix B

1. Introduction

This Appendix B shall be the guidance to prospective participant in the LSS plant development seeking connection to the Transmission Network in Peninsular Malaysia. Appendix B comprises of nine (9) sections covering the following topics:

- (a) Introduction;
- (b) Scope and Limitation;
- (c) Connection to The Grid System;
- (d) PSS;
- (e) SPPA Aspects;
- (f) Appendix B of SPPA Requirements;
- (g) Requirement for Tests of the Facility;
- (h) Operation of Transmission-Connected LSS Plant; and
- (i) Forecasting Requirements.

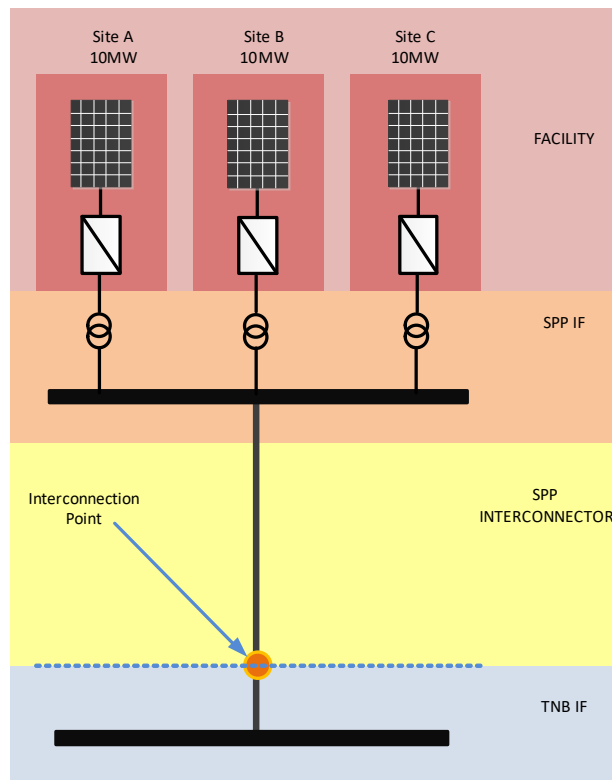
2. Scope and Limitation

2.1. Description of Transmission-connected LSS Plant

LSS Plants that are allowed to be connected to the Transmission Network shall have capacity of not less than 30MW_{ac} or as approved by the Commission, at one Interconnection Point.

Therefore, if the LSS Developer owns more than one (1) solar farms at different sites but connected to the TNB IF at one Interconnection Point, with cumulative capacity of not less than 30MW_{ac} or as approved by the Commission, such LSS Plant shall be connected to the Transmission Network as illustrated in Figure 1 below:

Figure 1: Example of Transmission Connected LSS Plant



2.2. Scope of Appendix B

The scope of Appendix B of these Guidelines is limited to LSS Plants connected to the Transmission Network in Peninsular Malaysia and does not cover the following:

- (a) LSS Plants connected to the Transmission Network and Distribution Network in Federal Territory of Labuan; and
- (b) LSS Plants connected to the Distribution Network in Peninsular Malaysia.

Appendix B of these Guidelines is not intended to cover all required authorizations, permits or licenses which the LSS Developer is required to obtain from the relevant bodies or authorities for the purpose of the development of transmission connected LSS Plants.

The demarcation line for ownership and maintenance as shown in section 3.4 of Appendix B of these Guidelines and more specifically described in the SPPA.

The LSS Developer shall, at its own costs, be fully responsible for the inspection, examination, checking and verifying the accuracy, correctness and completeness of any and all data as to the site and its surroundings and the nature of the climatic, geological, soil and general conditions of the site as well as the Potential Injection Points as identified by the Grid Owner in order to meet the requirements of its SPPA. The LSS Developer shall also, at its own costs, be responsible to obtain, maintain and renew all authorizations, permits and licenses necessary for it to develop the transmission-connected LSS Plants and to otherwise perform its obligations under its PPA or any other Project Documents and comply with all conditions and requirements as may be imposed or prescribed by any relevant bodies and/or authorities which has jurisdiction over the development of transmission-connected LSS Plants. Neither the Commission nor the Grid Owner shall bear any responsibility for any error, inaccuracy or omission of any kind and no warranty or representation is given in respect thereof. Each LSS Developer shall accept full responsibility for conducting an independent analysis of the accuracy, correctness and completeness of any and all data and for gathering and presenting all necessary information.

2.3. Data Requirement

The data requirement for submission of technical information is described in Attachment A of this Appendix B.

3. Connection to the Grid System

3.1. Background

In general, connection can be made at any point of the Grid System to enable the export of power generated by transmission connected LSS Plants. However, the capacity of the Grid System to accept power output from a transmission connected LSS Plant will depend on the existing network infrastructure and current use of the system. The rating of overhead lines, cables and transformers will be an important factor in assessing the connection capacity available. Switchgear fault levels and protection settings may also be affected by the connection of a transmission connected LSS Plant. In addition, the proximity of the transmission infrastructure to the transmission connected LSS Plant is vital to ensure the cost associated with the grid connection would not be prohibitive for the developer to implement.

3.2. Connection Voltage Level

Currently the Grid System in Peninsular Malaysia consists of three voltage levels namely the 132kV, 275kV and 500kV. The 275kV and 500kV networks are mainly used for bulk transfer of electrical power from large generating power plants to substations located near demand centers.

The power generated by the LSS Plant at the connection point connected to the Grid System at a voltage of 132kV and above is subjected to the results of the PSS and final advice/decision from the Grid Owner and System Operator. From the results of this PSS, the injection capacity (MW) of power generation at the LSS Plant connected to the Grid System will be determined to ensure the reliability and security of the existing 132kV, 275kV and 500kV Grid System.

3.3. Connection Schemes

There are two (2) possible connection schemes for transmission connected LSS Plants as follows:

- (a) Option 1: Connection Scheme to Existing Substation; or
- (b) Option 2: Connection Scheme to Nearest Existing Transmission Lines.

The connection method to the Grid System can be either through overhead transmission line or underground cable. The capacity of the connection shall be appropriately designed to cater for power export to the Grid System. The connection scheme shall allow for switching of the TNB IF thus ensuring the reliability and security of the Grid System.

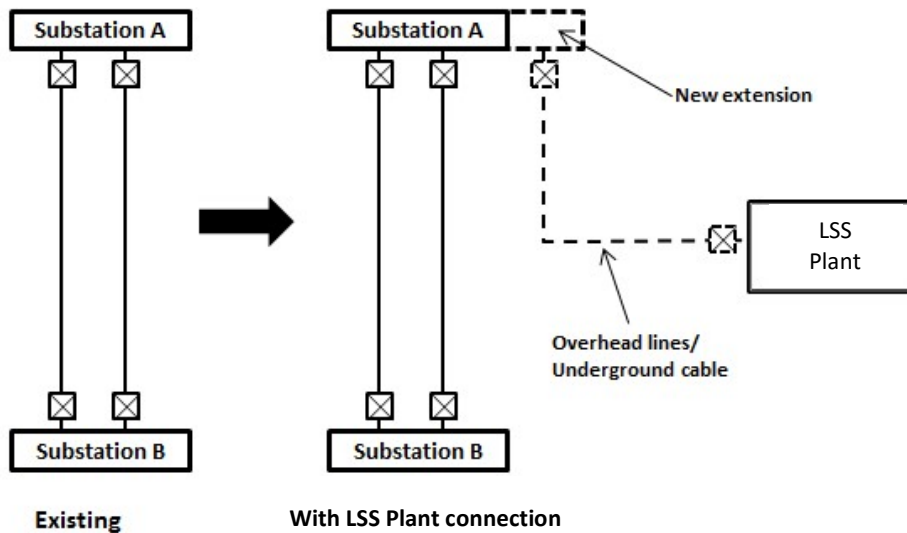
Subject to the results of the PSS, the Grid Owner will decide the most appropriate point of connection and the voltage level. Please refer to the next section for the details on PSS.

3.3.1 Option 1: Connection Scheme to Existing Substation

The connection to the identified existing substation or TNB IF is permissible subject to the availability of space for the extension of busbars for new full bays, inclusive of the space for new control relay panel in the substation building. It shall be built, designed and constructed by the LSS Developer in accordance with TNB’s specifications, which will be provided by the Grid Owner. The SPP Works shall be handed over to the Grid Owner for the operation and maintenance of the equipment upon successful commissioning.

This type of connection is illustrated in Figure 2 below.

Figure 2: Option 1- Connection to Existing Substation

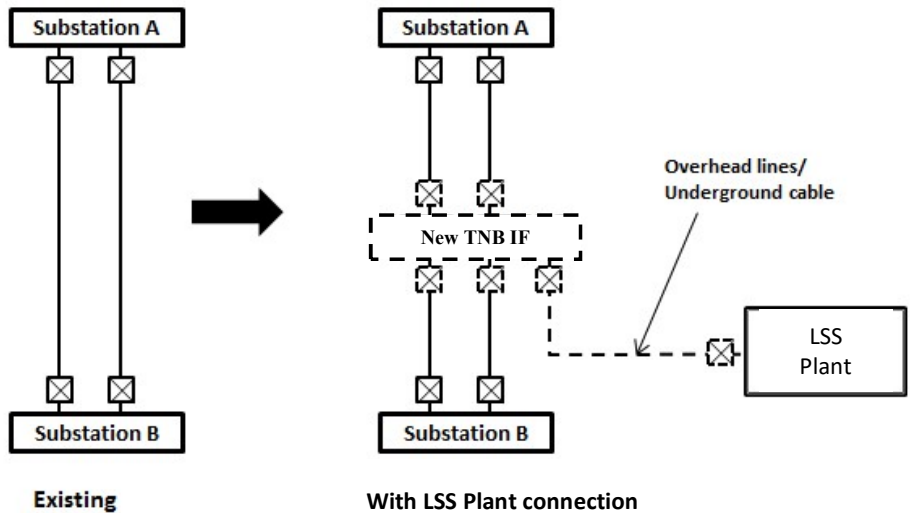


3.3.2 Option 2: Connection Scheme to Nearest Existing Transmission Lines

In the event that the possible connection to the Grid System is to the nearest existing overhead transmission lines or underground cable, a new switching station is required to be constructed by the LSS Developer to facilitate the connection to the Grid System. The existing overhead transmission lines or underground cable circuits shall be a configuration of Double Circuit LILLO and connected via overhead transmission lines or underground cable into the newly established switching station. The newly established switching station or new TNB IF shall be built, designed and constructed by LSS Developer in accordance with TNB’s specifications. The specifications shall be obtained from the Grid Owner. The new TNB IF shall be handed over to the Grid Owner for the operation and maintenance of the equipment upon successful commissioning.

This type of connection is illustrated in Figure 3.

Figure 3: Option 2- Connection to Nearest Existing Transmission Lines



3.4. Scope of Works and Asset Demarcation

The demarcation line for ownership and maintenance is as shown in Figure 4. In accordance with Clause CC4.3 of the Grid Code, the LSS Developer shall propose the connection scheme to the Grid Owner for approval. The connection to the Grid System can be either through overhead transmission line or underground cable.

The LSS Developer shall, at its own cost and expense, be fully responsible for the following:

(a) the land acquisition and obtaining necessary permits from relevant local authorities, relating to the parcels of land required for the Facility, SPP IF, SPP Interconnector and SPP Works; and

(b) the design, procurement, construction, commissioning, testing and completion of the following:

- (i) the Facility;
- (ii) the SPP IF;
- (iii) the SPP Interconnector; and
- (iv) the SPP Works which comprise the following:

(aa) For option 1:

- (aaa) Extension of main and reserve busbars work at existing TNB IF;
- (aab) Establishment of full bay/bays for the SPP Interconnector; and
- (aac) Including works in item (c) below.

(ab) For option 2:

- (aaa) Establishment of a new TNB IF which includes but not limited to main and reserve busbars, full bay/bays for connection of the SPP Interconnector and full bay/bays for out-going feeders connecting the new TNB IF to the two (2) double circuit (as determined by TNB) transmission lines;
- (aab) Substation control building, including civil works, mechanical and electrical (M&E) works and associated facilities;
- (aac) Two (2) double circuit (as determined by TNB) transmission lines connecting the new TNB IF to the nearest transmission lines (including double circuit LILO works for connection of the new TNB IF to the nearest existing transmission lines with respect to the voltage

level, coordination of design, implementation and work coordination that may impact the duration of the outage period); and

(aad) Including works in item (ac) below.

(ac) For both option 1 and option 2:

(aaa) Secondary equipment such as DC supply, control and relay panel, protection, auxiliary power and control cabling (APC), telecontrol, telecommunication, ICT and associated works;

(aab) Substation earthing system and associated works which includes soil resistivity tests;

(aac) Underground and utility mapping for any underground cable routes;

(aad) TNB Metering Equipment; and

(aae) Modifications or replacement of existing telecontrol and/or telecommunication equipment if required and protection relays retrofitting works in the existing TNB IF and in existing TNB's substations at both remote ends of the new TNB IF if required.

(aaf) IEC 61850 Digital Substation system related to the protection, telecontrol and telecommunication within existing TNB IF and/or existing TNB's substations at both remote ends of the new TNB IF, if required.

Details of the scope of works shall be read together with Appendix D of the SPPA.

The LSS Developer shall, at its cost and expense, be responsible for any damage to the existing installations during extension works within the substation caused by the LSS Developer or its agents.

LSS Developer is fully responsible to own, operate and maintain:

- (i) the Facility;
- (ii) the SPP IF; and
- (iii) the SPP Interconnector up to the Interconnection Point.

Upon successful commissioning and testing of the SPP Works, the LSS Developer shall transfer to TNB and take all actions necessary to effect the transfer of all rights, title and interest to the completed SPP Works, free from encumbrances and as further described in the SPPA. Further, the LSS Developer shall acquire and transfer to TNB all ownership rights and title relating to the parcel of land on which the SPP Works are located on or before the successful commissioning of the SPP Works. All costs associated with the connection of transmission connected LSS Plants to the Grid System, shall be borne by the LSS Developer.

The Interconnection Point will be at the cable sealing end at the substation (in the case of underground cable connection) and at the line dropper (in the case of overhead line connection). Illustration of asset demarcation is as shown in Figure 4 to Figure 7 below.

Figure 4: Scope of works and asset demarcation for Option 1

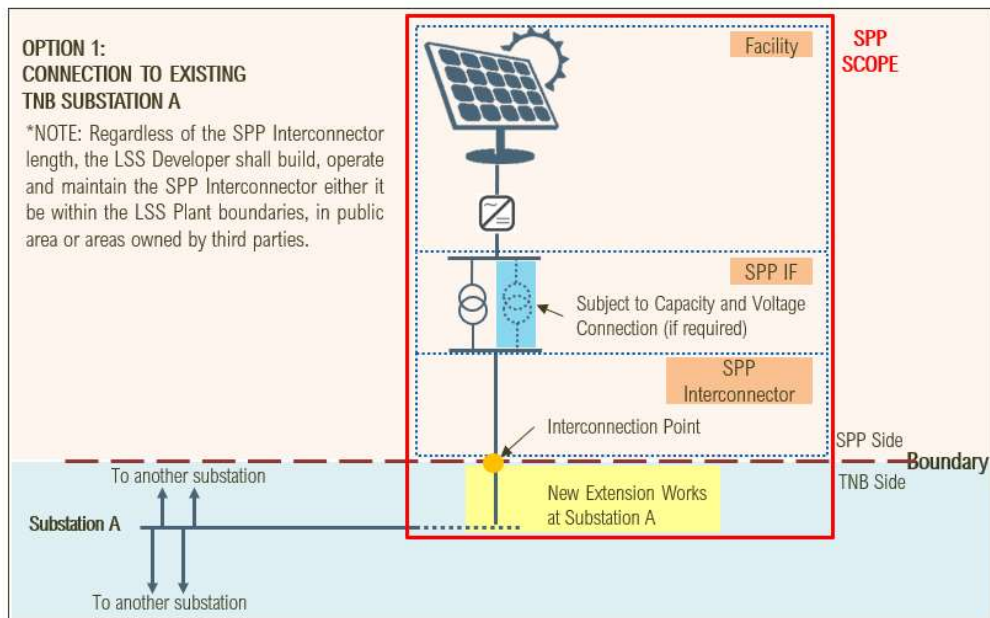


Figure 5: Scope of works and asset demarcation for Option 2

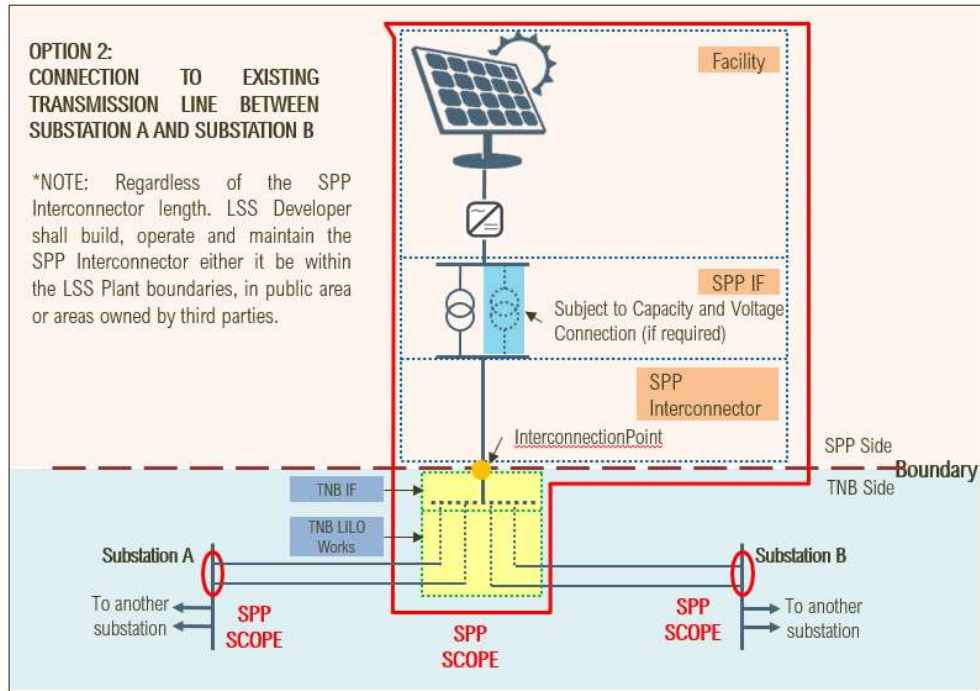


Figure 6: Interconnection Point for transmission line connection

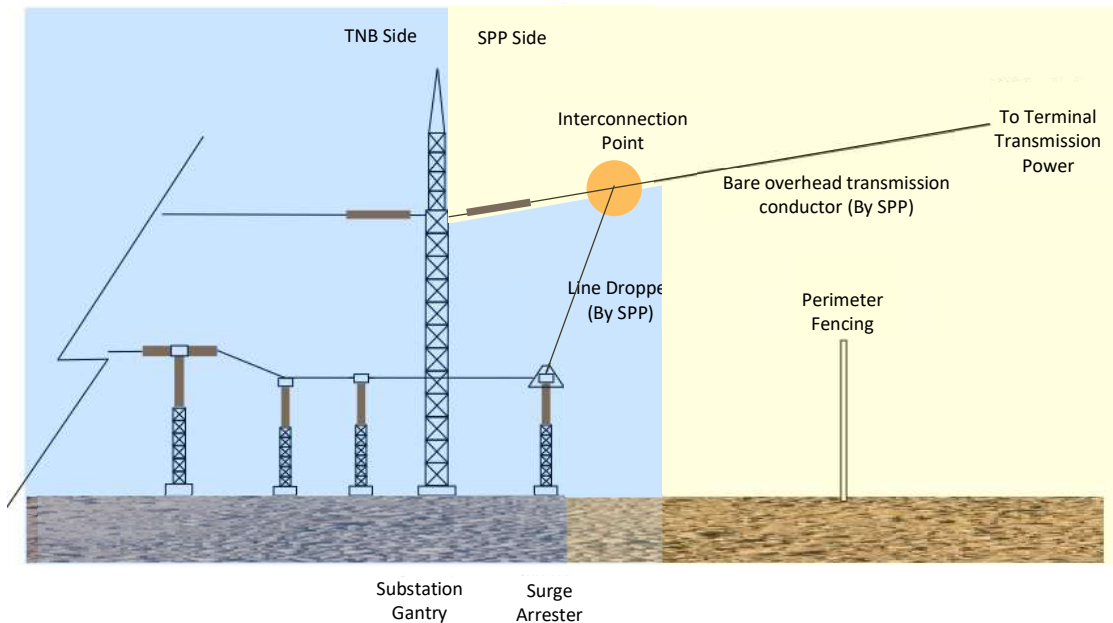
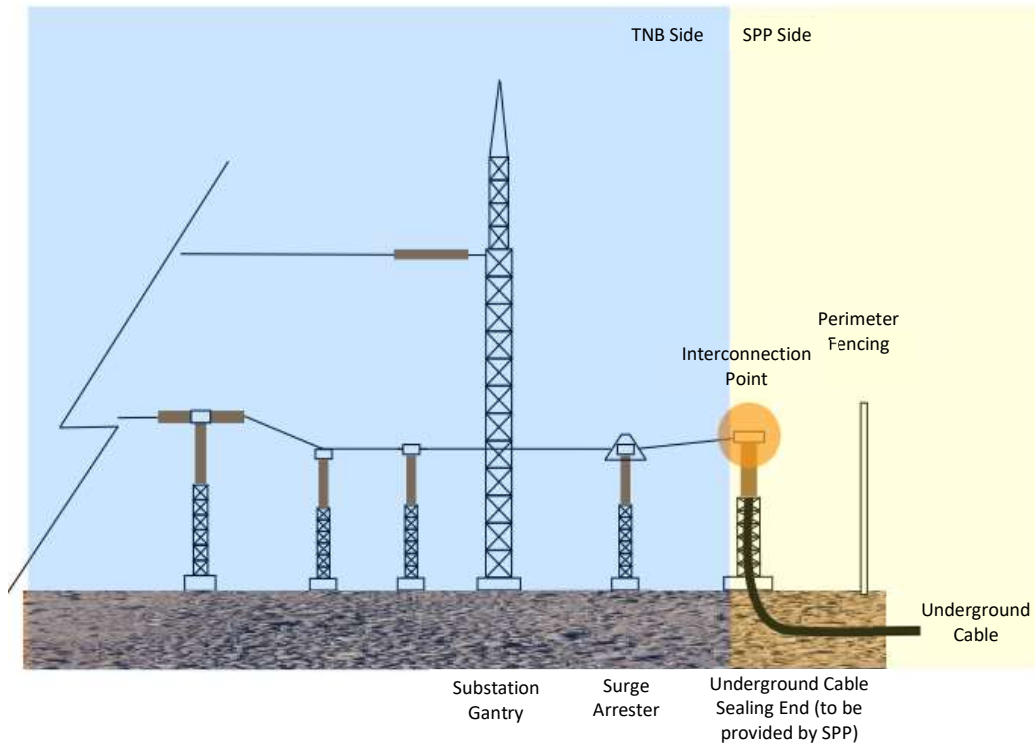


Figure 7: Interconnection Point for underground cable connection



TNB and LSS Developer shall jointly prepare an IOM which must be completed and signed off by both parties prior to the energizing of supply, the contents of which shall include but not limited to communications with respect to switching operations, boundaries, maintenance, authorized personnel and LSS Developer's competent engineer (certified by the Commission). The IOM shall be reviewed by the parties involved from time to time and the parties may jointly revise the IOM by mutual written agreement. Upon such revision, the revised IOM shall apply.

3.5. Potential Injection Points for Grid Connection

For the purpose of facilitating participant in the LSS plant development , certain locations have been identified by the Grid Owner as Potential Injection Points for grid connection. The identified Potential Injection Points will be specified in the RFP document and may require acquisition of additional land by participant in the LSS plant development to facilitate busbar extension. In general, spare bays at any existing substations are provisioned for future development.

The LSS Developer may connect their solar farm to the identified Potential Injection Points or propose other Potential Injection Points that is deemed suitable to their solar

farm site. The Grid Owner may consider and provide approval (or rejection) on the Potential Injection Point.

The Grid Owner shall bear no responsibility for any error, inaccuracy or omission of any kind in respect of the Potential Injection Points identified and proposed by the Grid Owner. Each LSS Developer shall accept full responsibility for conducting an independent analysis of the accuracy, correctness and completeness of any and all data and for gathering and presenting all necessary information.

4. PSS

4.1. Objectives of PSS

- (a) To identify connection scheme options (and configurations) for the transmission-connected LSS Plants to be connected to the Grid System, taking into account the existing transmission infrastructure within the vicinity of the LSS Plant;
- (b) To investigate the impact of the new interconnection to the Grid System as well as the impact of the Grid System to the operations of the LSS Plant; and
- (c) To assess the ability of the transmission-connected LSS Plants to comply with the technical requirements as stated in the Grid Code, specifically with the solar PV technology to be installed.

4.2. Scope of PSS

LSS Developer, at its own cost and expense, shall conduct the PSS using simulation software available in the market such as Power System Simulator for Engineering (PSSE®) developed by Siemens PTI, USA. compatible with the version used by the Grid Owner.

PSS shall be conducted in two (2) stages:

- (a) **Stage 1:** Stage 1 PSS using “generic” modeling of the Facility (including but not limited to the solar PV components), the SPP IF and the SPP Interconnector.

Description: Stage 1 PSS mainly verifies the impact to the existing Grid System as well as proposes any mitigation measures, which can be analyzed based on relevant information of the Facility already known at the point of time.

Submission: Final report of Stage 1 PSS (revised for compliance with the Grid Owner’s recommendations) shall be submitted along with the RFP submission.

- (b) **Stage 2:** Stage 2 PSS using the actual modeling of the Facility (including but not limited to the solar PV components), the SPP IF and the SPP Interconnector taking into consideration the topology and converter type.

Description: Stage 2 PSS provides indicative evidence of the transmission connected LSS Plant’s ability to comply with the Grid Code requirements based on the behavior of the Facility. Thus, the Facility (including but not limited to the solar PV components, internal reticulations etc), the SPP IF and the SPP Interconnector need to be modeled in greater details based on the design and technology used.

Submission: Final report of Stage 2 PSS (revised for compliance to the Grid Owner’s recommendations) shall be submitted no later than sixty (60) days prior to the Commencement Date for approval by the Grid Owner.

Both stages of the PSS shall include, but not limited to, the following scopes:

(a) Table 1: Scope of Stage 1 PSS

No.	PSS scope of studies	Description / Requirements	Criteria to benchmark
1	Modelling	<ul style="list-style-type: none"> • To model lumped solar PV Inverter and the aggregate Facility models in PSS®E. • To submit the aggregate model in the simulation software format as agreed by TNB, which includes the following: <ul style="list-style-type: none"> – PSS®E load flow data (“sav file”); and/or – PSS®E load raw data file (“raw file”) and sequence data file (“seq fi”) – Reactive power capability curve of the Facility, written in the format compatible to PSS®E activity GCAP 	

No.	PSS scope of studies	Description / Requirements	Criteria to benchmark
2	Power-flow and Contingency Analysis	<ul style="list-style-type: none"> • To evaluate the Grid System's adequacy to accommodate the energy to be delivered by the Facility without violating the thermal loading of transmission elements (eg. overhead line, underground cable, transformer etc.) and voltage level of the substations under both normal conditions and N-1 contingencies. • Power flow shall consider various operating scenarios to reflect the Facility's intermittent behaviour. • To assess the impact of N-1-1 and/or N-2 contingencies to the Transmission System at the grid interconnection point and its vicinity. • To determine the need for reinforcements to allow the connection of the Facility to the Grid System. 	Grid Code and TSRS
3	Short Circuit Analysis	<ul style="list-style-type: none"> • To provide short circuit impedances for the selection of equipment. • To calculate the maximum short circuit fault current contribution from the Facility at the Interconnection Point in the event of single-phase fault to ground fault, phase to phase fault and bolted three-phase fault events. 	Grid Code and TSRS

No.	PSS scope of studies	Description / Requirements	Criteria to benchmark
		<ul style="list-style-type: none"> • IEC 60909 calculation method is to be used. • Short circuit analysis shall consider various generation dispatch scenarios in the Transmission System to determine the maximum short circuit fault current contribution at the Interconnection Point. • To determine the required short circuit ratings for the selection of equipment. • To identify mitigations to ensure short circuit fault level remains within limits. 	
4	Reactive Power Requirements	<ul style="list-style-type: none"> • To assess the profile of transmission voltage at the Interconnection Point and its vicinity. • To determine the necessity to install reactive power compensation equipment to meet the reactive power requirements at the Interconnection Point over the entire operating range of the Facility at any point of the PF range between 0.85 lagging to 0.95 leading as specified in the Grid Code. 	Grid Code and TSRS

(b) Table 2: Scope of Stage 2 PSS

No.	PSS scope of studies	Description / Requirements	Criteria to benchmark
1	Modelling	<ul style="list-style-type: none"> • To model the solar PV Inverters and the Facility in PSS®E in detail. • From the detailed models, to create the lumped Inverter and aggregate Facility models in PSS®E. • To compare the results between detailed and lumped models. • To prepare the dynamic simulation models in PSS@E that shall represent the following system, but not limited to: <ul style="list-style-type: none"> i. Lumped solar photovoltaic inverter; ii. Power Plant Controller; iii. Maximum power point tracker (MPPT) control (if installed); and iv. SVC/SVG/STATCOM/any FACTS devices (if installed) v. BESS (if installed) vi. Working files including PSSE output • To submit the detailed and aggregated power flow models in the simulation software format as agreed by TNB, which includes the following: 	

No.	PSS scope of studies	Description / Requirements	Criteria to benchmark
		<ul style="list-style-type: none"> - PSS®E load flow raw data file (“raw file”) and sequence data file (“seq file”); and - Reactive power capability curve of the Facility, written in the format compatible with PSS®E activity GCAP. • To submit the dynamic models for lumped Inverter, controller and proposed reactive power compensation/FACTS devices (if installed), in the simulation software format as agreed by TNB, which includes the following: <ul style="list-style-type: none"> - PSS®E dynamic data file (“dyr file”); and - Dynamic Link Library file (.dll) that compatible to PSS®E version used by Grid Owner for ‘user defined’ model; and - Model software source codes (flec and/or fortran codes) for ‘user defined’ model (to be included in Stage 2 PSS submission). 	
2	Power-flow and Contingency Analysis	<ul style="list-style-type: none"> • To evaluate the Grid System’s adequacy to accommodate the energy delivered by the Facility without violating the thermal loading of transmission elements (eg. overhead line, underground cable, transformer etc.) and voltage level of the 	Grid Code and TSRS

No.	PSS scope of studies	Description / Requirements	Criteria to benchmark
		<p>substations under both normal conditions and N-1 contingencies.</p> <ul style="list-style-type: none"> • To assess the impact of N-1-1 and/or N-2 contingencies to the Grid System at the grid interconnection point and its vicinity. • Power flow shall consider various operating scenarios to reflect the Facility's intermittent behavior. • To determine the need for reinforcements to allow the connection of the Facility to the Grid System. 	
3	Short Circuit Analysis	<ul style="list-style-type: none"> • To provide short circuit impedances for the selection of equipment. • To calculate the maximum short circuit fault current contribution from the Facility at the Interconnection Point in the event of single-phase fault to ground fault, phase to phase fault and bolted three-phase fault events. • IEC 60909 calculation method is to be used. • Short circuit analysis shall consider various generation dispatch scenarios in the Grid System to determine the maximum short circuit fault current 	Grid Code and TSRS

No.	PSS scope of studies	Description / Requirements	Criteria to benchmark
		<p>contribution at the Interconnection Point.</p> <ul style="list-style-type: none"> • To finalize the short circuit ratings for the selection of equipment. • To identify mitigation steps to ensure short circuit fault level remains within limits. 	
4	Reactive Power Requirements	<ul style="list-style-type: none"> • To assess the profile of transmission voltage at the Interconnection Point and its vicinity. • To determine the necessity to install reactive power compensation equipment to meet the reactive power requirements at the Interconnection Point over the entire operating range of the Facility at any point of the PF range between 0.85 lagging to 0.95 leading as specified in the Grid Code. 	Grid Code and TSRS
5	Transient Stability Analysis	<ul style="list-style-type: none"> • To identify the Grid System's capability to remain stable and maintain synchronism following a relatively large disturbance arising from loss of a single and two or more transmission elements or generation facilities. • To determine the oscillation damping factor when a relatively large disturbance happens at the Interconnection Point. 	Grid Code and TSRS

No.	PSS scope of studies	Description / Requirements	Criteria to benchmark
		<ul style="list-style-type: none"> To identify critical fault clearing time at the Interconnection Point to ensure the Grid System remains stable. 	
6	Fault Ride-Through Capability	<ul style="list-style-type: none"> To identify the fault ride-through capability of the Facility in accordance with the Power Park Module Fault Ride Through Requirements in the Grid Code (monitored at the Interconnection Point) for faults that may occur in the Grid System including but not limited to (i) three phase fault for 150ms at the Interconnection Point; and (ii) single phase fault for 300ms at the Interconnection Point; and at the fault scenarios as requested by TNB. To identify solar PV Inverters' performance upon fault clearance. To verify the AC voltage and active power recovery of the Facility under dynamic conditions and such scenarios as mutually agreed by TNB and SPP. To determine the necessity to install any FACTS device to meet the requirements. To ensure the selection of solar PV Inverters is able to meet the fault ride through requirements as specified in the Grid Code. 	Grid Code and TSRS

No.	PSS scope of studies	Description / Requirements	Criteria to benchmark
7	Power Quality Requirements	<ul style="list-style-type: none"> • To assess power quality (PQ) at the Interconnection Point during parallel operation of the Facility in the Grid System and to determine mitigation steps and/or modification to ensure the PQ at the Interconnection Point remains within the allowable limits as specified in the following standards: <ul style="list-style-type: none"> (a) Voltage harmonics (Engineering Recommendation ER G5/4-1); (b) Phase voltage unbalance (Engineering Recommendation P29); (c) Voltage fluctuation and flicker (Engineering Recommendation P28); (d) Current harmonics (according to IEEE 1547); • The study shall utilize data from field measurement test as further described in paragraph B3.11 of Appendix B of the SPPA. Such test shall be conducted at the existing TNB substation(s) depending on configuration of the Facility's connectivity to the Grid System (either Option 1 or Option 2 as described in section 3.3 in Appendix B of this Guidelines). • To determine the necessity (if any) of modification to the design of the Facility and/or to install filters/compensation 	Refer standards listed under Description/ Requirements

No.	PSS scope of studies	Description / Requirements	Criteria to benchmark
		equipment to meet the PQ requirements.	

4.3. Standards and Criteria to be used for PSS

The PSS shall be conducted in accordance with the MS 2572:2014 “Guidelines for power system steady state, transient stability and reliability studies”, Engineering Recommendation ER G5/4-1 (for harmonics), Engineering Recommendation P29 (for phase voltage unbalance) and Engineering Recommendation P28 (for voltage Fluctuations and flicker). The results of the Stage 1 PSS and Stage 2 PSS shall be benchmarked against the relevant clauses in the Grid Code, TSRS and the standards as specified in Table 1 and Table 2 above. Any violation of the codes and standards due to the transmission-connected LSS Plants’ connection to the Grid System shall be highlighted in the report and mitigation option shall be proposed by the LSS Developer accordingly.

A copy of the Grid Code and TSRS can be obtained from the official portal of the Commission. LSS Developer shall obtain the other specified standards for the PSS at its own expense.

4.4. Grid System Data for the PSS

PSS shall be conducted by the LSS Developer for the purpose of RFP submission and as further specified in the SPPA. Upon request by LSS Developer, Grid System data will be provided by the Grid Owner subject to signing of a non-disclosure agreement between the party that will perform the study and the Grid Owner. The Grid System data will be provided for the requested year of study in a format compatible with PSSE®, simulation software by Siemens PTI.

LSS Developers should take note that fifteen (15) business days are required for the finalization of the terms and conditions of the non-disclosure agreement. The stamping cost for the non-disclosure agreement shall be fully borne by the LSS Developer.

4.5. Stage 1 PSS Report and Stage 2 PSS Report

Upon completion of the Stage 1 PSS and Stage 2 PSS, a report shall be prepared and submitted to the Grid Owner for review and approval, but not limited to, the grid connection scheme and point of connection. The reports shall, (at the minimum), encompass the following details:

- (a) Executive Summary;
- (b) Introduction;
- (c) Proposed Connection Scheme;
- (d) Methodology of the study/analysis;
- (e) Power Flow Models
- (f) Dynamic Simulation models (for Stage 2 PSS only);
- (g) Scenario Study;
- (h) Results and findings in form of table listing, plots, etc. are to be benchmarked against the criteria as stated in the Grid Code and TSRS;
- (i) Recommendations, if applicable, shall include but not limited to any modification to the Facility's design, filters and/or compensation equipment; and
- (j) Conclusion.

Prior to making a decision on the connection scheme and reinforcement, TNB may request LSS Developer to clarify on its findings of the Stage 1 PSS and Stage 2 PSS. TNB shall provide its decision on the connection scheme and reinforcement. Submission of the final reports and simulation models in PSS@E for Stage 1 PSS and Stage 2 PSS are compulsory for LSS Developer to receive final and unconditional approval from TNB.

Submission of the final Stage 1 PSS and Stage 2 PSS reports and RFP to the Commission is subject to the following conditions:

- (a) the LSS Developer has received final and unconditional approval from the Grid Owner; and
- (b) the submission of the final Stage 1 PSS and Stage 2 PSS reports and RFP must be accompanied by a letter evidencing that final and unconditional approval from the Grid Owner as referred to in Section 4.5 (a) above has been obtained.

4.6. Validity Period of the Stage 1 PSS Report

LSS Developer may seek clarification with the Grid Owner in the event the LSS Developer intends to utilize the same final Stage 1 PSS report for future bidding exercises, if any.

For such case, the Stage 1 PSS report, as approved by the Grid Owner shall be valid for two (2) years from the date of submission subjected to the following conditions:

- (a) Same Connection Point / connection scheme / capacity;
- (b) Load levels at the vicinity of the studied site does not show major changes;
- (c) Generation plant-up within the vicinity of the studied site that may affect the system stability; and
- (d) The adequacy of transmission facilities.

4.7. Submission of Transmission-connected LSS Plant Simulation Models Upon Completion of the PSS

Generally, models are used to represent the full power system for simulation studies relating to planning and operation of the Grid System. Simulation studies are sometimes required where it is impractical to demonstrate capability through testing as the consequence to the overall Grid System is intolerable. Currently, all transmission components and generators connected to the Grid System are modeled based on what are installed at site.

LSS Developer shall submit models of the LSS Plant to be connected to the Grid System. At the minimum, the models shall represent the following behaviour and/or control system for Stage 1 PSS and Stage 2 PSS:

PSS	Steady State Models	Dynamic Models
Stage 1 PSS	<ul style="list-style-type: none"> • To submit the aggregate model in the simulation software format as agreed by TNB, which includes the following: 	NA

PSS	Steady State Models	Dynamic Models
	<ul style="list-style-type: none"> – PSS®E load flow data (“sav file”); and/or – PSS®E load raw data file (“raw file”) and sequence data file (“seq file”). – Reactive power capability curve of the Facility, written in the format compatible to PSS®E activity GCAP. <ul style="list-style-type: none"> • The simulation models in PSS®E shall represent the following system, but not limited to: <ul style="list-style-type: none"> – Aggregate generator model (lumped Inverter); – Single lumped unit transformer; – Detailed reticulation impedance; – Step-up transformer; – High voltage cables/overhead lines connecting the high voltage side of the GSU to the Interconnection Facilities; and – Reactive power compensation/FACTS devices (if installed). – BESS (if installed). 	
Stage 2 PSS	<ul style="list-style-type: none"> • To submit the detailed and aggregated models in the 	<ul style="list-style-type: none"> • To submit the dynamic models for aggregate

PSS	Steady State Models	Dynamic Models
	<p>simulation software format as agreed by TNB, which includes the following:</p> <ul style="list-style-type: none"> – PSS®E load flow data (“sav file”); and/or – PSS®E load flow raw data file (“raw file”) and sequence data file (“seq file”); and – Reactive power capability curve of the Facility, written in the format compatible to PSS®E activity GCAP. <ul style="list-style-type: none"> • The detailed simulation models in PSS®E shall represent the following system, but not limited to: <ul style="list-style-type: none"> – The detailed model of solar PV Inverters and the Facility; – All unit transformers; – Detailed reticulation impedance; – All Step-up transformer; – High voltage cables/overhead lines connecting the high voltage side of the GSU to the IF; and – Reactive power compensation/FACTS devices (if installed). – BESS (if installed). 	<p>Inverter, controller and proposed reactive power compensation/FACTS devices (if installed), in the simulation software format as agreed by TNB, which includes the following:</p> <ul style="list-style-type: none"> – PSS®E dynamic data file (“dvr file”); and – Dynamic Link Library file (.dll) that compatible to PSS®E version used by Grid Owner for ‘user defined’ model; and – Model software source codes (flects and/or fortran codes) for ‘user defined’ model (to be included in Stage 2 PSS submission). <ul style="list-style-type: none"> • The dynamic simulation models in PSS®E shall represent the following system, but not limited to: <ul style="list-style-type: none"> – The solar PV Inverter; – Power Plant Controller; – Maximum power point tracker (MPPT) control (if installed); and – SVC/SVG/STATCOM/any FACTS devices (if installed). – BESS (if installed).

PSS	Steady State Models	Dynamic Models
	<ul style="list-style-type: none"> • The aggregate simulation models in PSS®E shall represent the following system, but not limited to: <ul style="list-style-type: none"> – Aggregate generator model (lumped Inverter); – Single lumped unit transformer; – Detailed reticulation impedance; – Step-up transformer; – High voltage cables / overhead lines connecting the high voltage side of the GSU to the IF ; and – Reactive power compensation/FACTS devices (if installed). – BESS (if installed). 	<ul style="list-style-type: none"> – Working files including PSSE output.

4.8. Data Submission

In accordance with the Grid Code, the LSS Developer shall submit connection application form (Form A) to the Grid Owner. The duly completed connection application form shall be submitted together with the relevant information of the Facility, SPP IF and SPP Interconnector to the following address:

Head Grid Strategy,
 Grid Division,
 Tenaga Nasional Berhad,
 Level 6, Tower C, TNB Platinum,
 No. 3, Jalan Bukit Pantai,
 59100 Kuala Lumpur.
 Attention : Head (Grid Planning)

5. SPPA Aspects

Shortlisted Bidder will finalize SPPA with Utility Electricity Company upon receiving the Notification Shortlisted Bidder by the Commission. The followings are some of the parameters covered under SPPA:

- (a) Established Capacity of the LSS Plant, which will be dependent on the Notification to Shortlisted Bidder;
- (b) MAAQ of the LSS Plant;
- (c) Explanation on energy beyond contracted capacity, Established Capacity;
- (d) Energy Rate of the LSS Plant;
- (e) EER of the LSS Plant;
- (f) Treatment on test energy from the LSS Plant;
- (g) Provision on change of ownership of the LSS Plant;
- (h) Provision on penalty when there is non-delivery of energy based on energy committed by the LSS Developer; and
- (i) Provision on delay compensation and abandonment of projects.

6. Facility Technical and Operating Requirements

(1) The LSS Developer shall adhere to the requirements as stipulated in the Grid Code and the TSRS.

(2) The SPPA will detail out the salient requirements extracted from the relevant clauses in the Grid Code or other standards, which are summarized as follows:

Table 1: Appendix B of SPPA requirement

NO.	REQUIREMENTS	GRID CODE/OTHER STANDARDS CORRESPONDING CLAUSE
1.	Grid Frequency Variation – The Facility to remain operational in the range of frequency stipulated in the Grid Code.	<ul style="list-style-type: none"> • Grid Code CC6.4.2.3
2.	Reactive Power Capability – The Facility shall be capable of providing the reactive power at the Interconnection Point according to the Grid Code.	<ul style="list-style-type: none"> • Grid Code CC6.4.2.1 • Grid Code CC6.4.2.5
3.	Grid Voltage Variation – The Facility shall be capable of operating continuously for the voltage variations as stipulated in the Grid Code and TSRS.	<ul style="list-style-type: none"> • Grid Code CC6.2.4 • TSRS Clause 4.2
4.	Grid System Fault Level – The Facility shall be capable of withstanding the Grid System’s fault as stipulated in the TSRS.	<ul style="list-style-type: none"> • TSRS Clause 4.7
5.	Fault Detection and Clearing Limits - The Facility shall be capable of operating continuously for faults in the Grid System cleared within the times stipulated in the TSRS.	<ul style="list-style-type: none"> • TSRS Clause 4.6

NO.	REQUIREMENTS	GRID CODE/OTHER STANDARDS CORRESPONDING CLAUSE
6.	<p>High Speed and Delayed Auto-Reclosing - The Facility shall remain operational on the Grid System without tripping and adverse behavior during and after the operation of the auto re-closing equipment in the Grid System.</p>	<ul style="list-style-type: none"> • Grid Code CC6.3.4.11
7.	<p>Restart and Delivery of Energy to Grid System – LSS Developer may provide auto-reclose facility for the SPP’s Interconnector. For such case, in the event of disconnection from the Grid System due to tripping of the SPP Interconnector, the Power Park Module’s interconnector shall be capable of restarting and delivering energy to the grid system upon successful auto-reclose or manual reclose of the SPP Interconnector. LSS Developer shall notify the System Operator prior to such delivery of energy from the Facility to the Grid System upon successful reclosing of the SPP Interconnector.</p>	
8.	<p>Fast Acting Control Device – The Facility shall be equipped with fast acting control device to enable the Facility to contribute in restoring the Grid System frequency to normal (close to nominal frequency) following a change in the generation-load balance. The droop must be adjustable and capable of being set with an overall droop of any value between 3% and 5% in accordance with the Grid Code. LSS Developer shall set the final droop setting according to instruction by the System Operator.</p>	<ul style="list-style-type: none"> • Grid Code CC6.4.2.3 • Grid Code CC6.4.4.5

NO.	REQUIREMENTS	GRID CODE/OTHER STANDARDS CORRESPONDING CLAUSE
9.	High Frequency MW Response – The Facility shall have active power output frequency response capability in accordance with the limits stipulated in the Grid Code.	<ul style="list-style-type: none"> • Grid Code CC6.4.2.3
10.	Ramp Rate – The Facility shall be capable of operating according to the ramp rate setting as stipulated in the SPPA during the period in a Despatch Instruction, normal load variation, start-up and shut down.	<ul style="list-style-type: none"> • Grid Code CC6.4.12
11.	Protection System of Facility – The LSS Developer shall ensure sufficient protection systems in accordance with the requirements of the SPPA and Grid Code to prevent or limit damage to its generation and auxiliary equipment.	<ul style="list-style-type: none"> • Grid Code CC6.3.4

NO.	REQUIREMENTS	GRID CODE/OTHER STANDARDS CORRESPONDING CLAUSE
12.	<p>Quality of Service – The LSS Developer shall ensure that the power quality (PQ) at the Interconnection Point shall not exceed the limits associated with PQ as follows:</p> <p>(a) Voltage Harmonics (Engineering Recommendation ER G5/4-1);</p> <p>(b) Phase voltage unbalance (Engineering Recommendation P29);</p> <p>(c) Voltage fluctuation and flicker (Engineering Recommendation P28); and</p> <p>(d) Current harmonics (as per IEEE 1547).</p> <p>The LSS Developer shall install PQ recorder(s) at the Facility/SPP IF for continuous PQ monitoring (i.e. harmonics, phase voltage unbalance, voltage fluctuation and flicker, and current harmonics), accurate determination and reporting of any PQ issues at the Facility/SPP IF. LSS Developer shall submit such PQ reports upon request by TNB.</p>	<ul style="list-style-type: none"> • PQ standards in TSRS • Engineering Recommendation (ER) G5/4-1, ER P29 and ER P28. • Testing in accordance to IEC 61000-3 series (and its amendments). • Field measurement for voltage flicker shall use an equipment which meets the requirements of IEC 61000-4 series (and its amendments). • IEEE 1547 .
13	<p>Fault Ride Through – The Facility shall be capable of fault ride through capability as stipulated in Grid Code.</p>	<ul style="list-style-type: none"> • Grid Code CC6.4.15.2
14	<p>Philosophy of Plant Design and Redundancy – Submission of conceptual design report of the Facility by LSS Developer.</p>	

NO.	REQUIREMENTS	GRID CODE/OTHER STANDARDS CORRESPONDING CLAUSE
15	<p>SCADA and EMS Requirements – The Facility shall be designed with SCADA and EMS capability, which shall meet the System Operator’s requirements. LSS Developer shall submit SCADA and EMS database to NLDC at least 30 working days prior to the Back Energisation (BE).</p>	<ul style="list-style-type: none"> NLDC SCADA/EMS Interfacing Guidelines
16	<p>Power Plant Controller (PPC) Control Modes – The PPC shall be capable of controlling the Facility to operate in active power (P) and voltage (V) control modes. The PPC shall be able to receive external reference voltage (V) and power (P) signal from the System Operator and respond accordingly.</p>	
17	<p>Scope of Tests – LSS Developer shall carry out site tests to verify compliance with the technical requirements stated in the Appendix B of the SPPA prior to COD.</p>	
18	<p>LSS Developer shall submit procedures for the site tests specified in the Scope of Tests for the System Operator’s approval according to the timeline specified in the SPPA.</p>	
19	<p>LSS Developer shall submit preliminary test results and final reports for the site tests in accordance with the timelines specified in the SPPA.</p>	

NO.	REQUIREMENTS	GRID CODE/OTHER STANDARDS CORRESPONDING CLAUSE
20	<p>Facility Parameters and Characteristics (Voltage Step Change) – LSS Developer shall submit complete information on the Facility’s model parameters and machine response characteristic data which clearly define and trustworthily represent the characteristics of operation of each component of the Facility, over the whole range of its capability. In addition, LSS Developer shall conduct tests to verify the characteristics and values of submitted parameters to be used by TNB and the System Operator in the system security assessment studies.</p>	<ul style="list-style-type: none"> • Grid Code PC7.2
21	<p>Submission of Simulation Models and Simulation Model Report – LSS Developer shall submit simulation models and simulation model reports but not limited to dynamic models in the simulation software format compatible and used by Grid Owner including Dynamic Link Library file (.dll) and model software source codes (flecs and/or fortran codes) for ‘user defined’ model prior to the IOD. The simulation models and simulation model reports shall serve as the reference for the relevant site tests specified under Scope of Tests in the SPPA.</p>	<ul style="list-style-type: none"> • Refer to section 4.7 of the Guidelines.
22	<p>Submission of Machine Model Validation Report - LSS Developer shall submit a machine model validation report for TNB’s and System Operator’s review. TNB’s and System Operator’s comments, if any, shall be</p>	<ul style="list-style-type: none"> • Refer to section 4.7 of the Guidelines

NO.	REQUIREMENTS	GRID CODE/OTHER STANDARDS CORRESPONDING CLAUSE
	incorporated by LSS Developer in a revised machine model validation report which shall be submitted together with the fully validated machine model prior to the SCOD.	
23	Factory Acceptance Tests (FAT) Reports and Type Test Reports – LSS Developer shall submit the FAT (corresponding to the actual installed) and Type Test reports on major plant equipment to demonstrate compliance of the Facility with the relevant Grid Code and SPPA technical requirements.	

7. Requirement for Tests of the Facility

7.1. Introduction

The requirement for tests of the Facility is detailed in Appendix B of the SPPA. This section contains a brief summary of the required tests which shall be conducted in accordance with the “Testing Guidelines for Power Park Modules in TNB Grid System”.

The “Testing Guidelines for Power Park Modules in TNB Grid System” has been developed and progressively updated based on the experience of TNB, the Single Buyer and the System Operator to demonstrate compliance by Power Park Modules with the requirements of the Grid Code, SPPA or other contractual agreements with TNB.

- (a) The tests shall be successfully completed by new Power Park Unit installations prior to commercial operation of the units in the Grid System. Any tests, which may have a significant impact on the Grid System, can only be undertaken at certain times of the day and year. Other tests may also be subject to timing constraints. LSS Developer is required to submit advanced notification to TNB and the System Operator of such tests, including commissioning tests and compliance tests in accordance with the SPPA or other contractual agreements.
- (b) The scope of tests includes commissioning tests to be undertaken by LSS Developer during a planned outage, forced outage and/or upon modifications to the control systems or plant that may affect their performance in the Grid System or their connection to the Grid System. LSS Developer are required to notify the System Operator and TNB in advance of their plans for such modification and seek the System Operator’s advice on the required tests. Upon the System Operator’s instruction, LSS Developer shall schedule the required tests upon completion of the plant modifications, prior to or during the re-commissioning of the Power Park Units in the Grid System.
- (c) The tests also include certain compliance tests as specified in the Grid Code to be undertaken by LSS Developer from time to time during commercial operation and shall be scheduled accordingly. The System Operator may also notify LSS Developer to conduct compliance tests to prove the security of the

system. Upon such notification by the System Operator, the LSS Developer shall then schedule the tests accordingly.

- (d) The final settings as accepted by TNB (including protection settings, etc.) shall be implemented and tested. LSS Developer shall not adjust or modify the settings during the term of the SPPA unless with the prior written consent from the System Operator and/or TNB.

The “Testing Guidelines for Power Park Module in TNB Grid System” document contains the minimum requirements to be followed by the LSS Developer in implementing the tests. These test requirements are neither to be used as an all-inclusive step-by-step testing manual nor as replacement for manufacturer supplied Power Park Unit test procedures. At appropriate time or as specified in the SPPA, LSS Developer shall submit detail procedures for each test listed in this Guidelines.

The requirements shall not restrict the LSS Developer from proposing alternative test procedures. However, where the minimum test requirements in this testing guidelines document are unable to be implemented, the LSS Developer shall provide the necessary justifications to TNB and the System Operator and propose suitable alternative test recommendations for TNB and System Operator approval.

7.2. List of Tests

Table 2: Summary of Tests under “Testing Guidelines for Power Park Module in TNB Grid System”

NO	TEST	TEST REQUIREMENT	CODES/ STANDARDS
1	Grid Frequency Variation	To verify that Power Park Module, the associated Power Park Units and auxiliary system are able to operate continuously over the frequency changes within the range 52.0Hz to 47.0Hz, subject to appropriate availability of solar irradiance at	<ul style="list-style-type: none"> • Grid Code CC6.4.2.3

NO	TEST	TEST REQUIREMENT	CODES/ STANDARDS
		the instant when such variations are required.	
2	Reactive Power	To demonstrate Power Park Module is able to provide the full extent of its Reactive Power capability, without being unduly compromised by conservative limiter settings.	<ul style="list-style-type: none"> • Grid Code CC6.4.2.1
3	Grid Voltage Variation	To demonstrate that Power Park Module is capable of operating continuously for Grid System voltage variations within the prescribed range specified in Grid Code.	<ul style="list-style-type: none"> • Grid Code CC6.2.4
4	Fault Detection and Clearing Time Limits	To measure the minimum signal levels that imitate fault protection and demonstrate that the operating times of the high voltage side circuit breaker after the fault being detected by the Facility's protection relays are within the limits.	<ul style="list-style-type: none"> • Grid Code CC6.3.4 • Grid Code CC6.3.5 • TSRS
5	High Frequency MW Response	To verify that Power Park Module, the associated Power Park Units and auxiliary system are able to operate continuously over the frequency changes within the range 52.0Hz to 47.0Hz, subject to appropriate availability of solar irradiance at	<ul style="list-style-type: none"> • Grid Code CC6.4.2.3

NO	TEST	TEST REQUIREMENT	CODES/ STANDARDS
		the instant when such variations are required. To demonstrate that the Power Park Module is able to adjust its power output according to agreed droop setting based on the Grid Code requirement.	
6	Ramp Rate	To demonstrate that Power Park Module is capable of meeting the ramp rate requirement stated in the SPPA.	
7	Quality of Service	To demonstrate the interconnection of the Power Park Module with the Grid System, at any time, shall not cause any reduction in the quality of service at the Interconnection Point.	<p>The maximum allowable limits at the Interconnection Point shall comply with the following standards:</p> <ul style="list-style-type: none"> (a) Voltage harmonics (Engineering Recommendation ER G5/4-1) (b) Phase voltage unbalance (Engineering Recommendation P29) (c) Voltage fluctuation and flicker (Engineering Recommendation P28) (d) Current harmonics (IEC 61727 – 2004 Table 1)

NO	TEST	TEST REQUIREMENT	CODES/ STANDARDS
8	Automatic Power Curtailment (APIC), Automatic High Voltage Control (AHVC), and Fast Deloading	To demonstrate the AIC, AIPC, and Fast Deloading capabilities of the Facility to respond and follow signals from the System Operator.	<ul style="list-style-type: none"> NLDC SCADA/EMS Interfacing Guidelines
9	Facility Parameters (Voltage Step Change)	To verify the Power Park Module parameters associated with the submitted simulation models and also to verify the design characteristics. LSS Developer shall provide the test procedure for TNB's acceptance.	

8. Requirements for PPC

8.1. Background

A typical PV solar generation plant is composed of multiple individual “generators” connected to the electrical network via power electronics (Inverters), rather than synchronous machines. The PV plant’s response to Grid System disturbances is not similar to the inherent electromechanical dynamics of synchronous machines. Through sophisticated control functions, however, the PV plant is able to contribute actively to grid stability and reliability and operate effectively in the grid.

8.2. Plant Level Control Functions

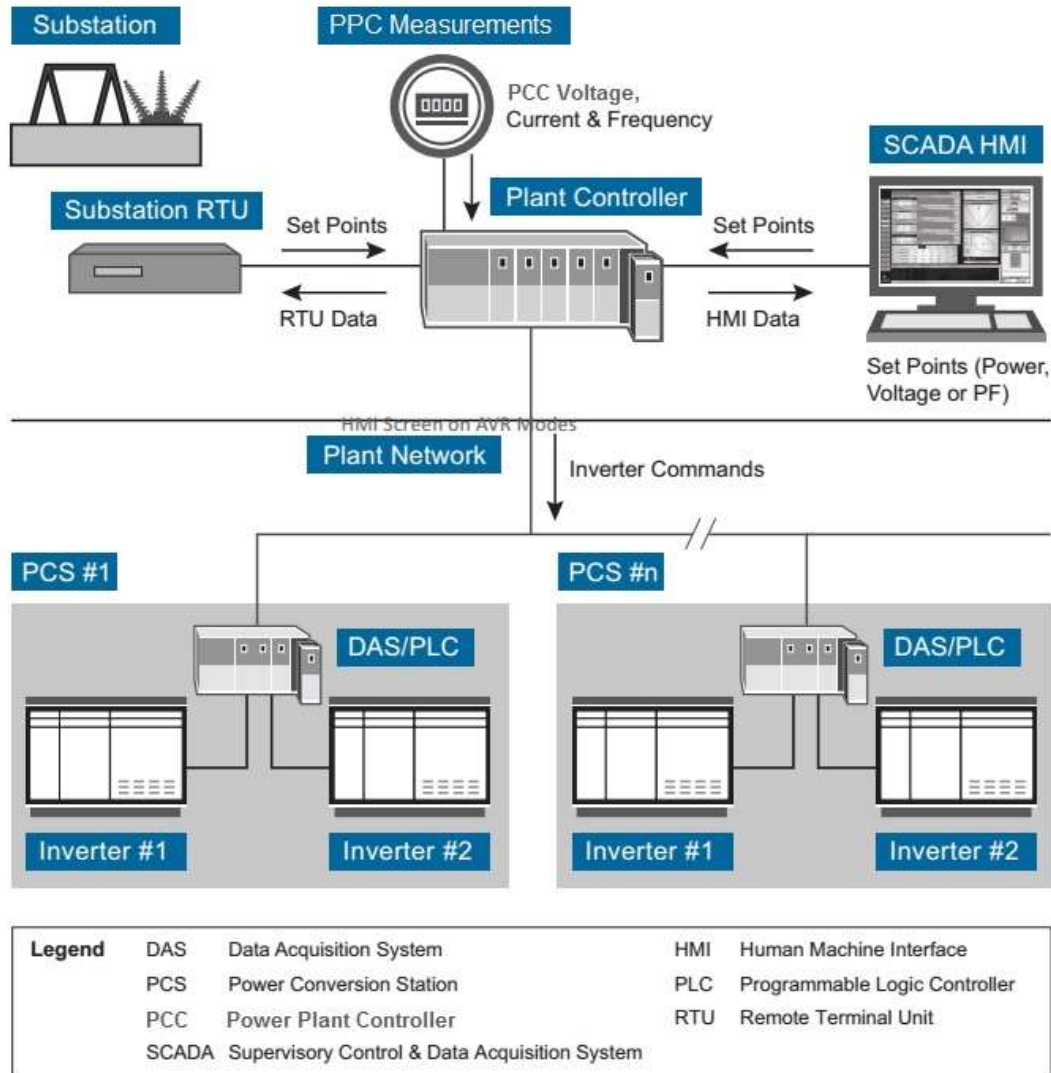
A key component of a grid-friendly LSS Plant is a plant-level controller, or generally known as PPC. It is designed to regulate active and reactive power output from the LSS Plant, such that it behaves as a single large generator. While the LSS Plant is composed of individual Inverters, with each Inverter performing its own energy production based on local solar array conditions, the function of the plant controller is to coordinate the power output to provide typical large power-plant features such as active power control and voltage regulation (through reactive power regulation). The PPC provides the following plant-level control functions:

- (a) Dynamic voltage or PF regulation of the LSS Plant at the PCC;
- (b) Frequency control to lower plant output in case of over-frequency situation;
- (c) Active power control following variation in irradiance;
- (d) Ramp-rate controls to ensure that the plant output does not ramp up or down faster than a specified ramp-rate limit, to the extent possible;
- (e) Start-up and shut-down control; or
- (f) Voltage regulation during non-solar hours (or reactive power (Q) at night).

The PPC implements plant-level logic and closed-loop control schemes with real-time commands to the Inverters to achieve fast and reliable regulation. It relies on the ability of the Inverters to provide a rapid response to commands from the plant controller. The commands to the plant controller can be provided through the supervisory control and data acquisition system (SCADA) human-machine interface (HMI) or even through other interface equipment, such as a substation RTU.

Figure 8 illustrates a block-diagram overview of the control system and its interfaces to other devices in the plant. The PPC monitors system-level measurements and determines the desired operating conditions of various plant devices to meet the specified targets. It manages capacitor banks and/or reactor banks, if present. It manages all the Inverters in the plant, ensuring that they are producing the active and reactive power necessary to meet the desired settings at the PCC.

Figure 8: Plant Control System and Interfaces to Other Components



Advanced features such as voltage regulation, active power controls, ramp-rate controls, fault ride through, reactive power generation during non-solar hours or at night and frequency control within LSS Plants will provide intrinsic benefits of reliable

plant operation in the Grid System. These “grid-friendly” capabilities, essential for increased penetration of LSS Plants into the electric grid, are operational and available today for utility-scale LSS Plants ranging from several MW to several hundred MW. These advanced plant features enable LSS Plants to behave more like conventional generators and actively contribute to grid reliability and stability, providing significant values to utilities and System Operator.

LSS Developer shall ensure the LSS Plant is equipped with a PPC. The PPC shall be able to receive external reference voltage signal (controlled via AHVC) to maintain the HV voltage at desired level by controlling and coordinating Inverters reactive power, transformer tap changers and reactive power compensation devices. The PPC shall also be able to perform active power management and reactive power management.

9. Operation of Transmission-connected LSS Plants

9.1. Dispatch of the Transmission-connected LSS Plants

All transmission-connected LSS Plants will supply energy to the Grid System subject to the provisions of the SPPA whereby TNB is not obliged to accept the Net Electrical Output in certain circumstances.

The transmission-connected LSS Plant's operation shall be based on take and pay principle. The transmission-connected LSS Plants will be treated as a must run unit (not subject to merit order dispatch).

The transmission-connected LSS Plants shall be self-dispatch up to its maximum energy output for any period with provisions for TNB not to accept delivery as further described in the SPPA.

9.2. Ramp Rate

The transmission-connected LSS Plants shall be able to automatically and manually control the ramp rate and limit the active power. This is to ensure stability of the system and prevent any power surge caused by sudden injection by the Facility.

Ramp rate(s) setting of the Facility shall not exceed 15% of rated capacity per minute. The Facility shall be able to regulate the ramp rate of the active power output in the following scenarios:

- (i) During the period in a Dispatch Instruction;
- (ii) Facility startup; and
- (iii) Facility shutdown.

9.3. Emergency Condition

The transmission-connected LSS Plants shall be dispatchable to reduce power output under certain emergency conditions as instructed by the System Operator.

The System Operator shall be able to disconnect the transmission-connected LSS Plants under certain emergency conditions.

9.4. Telemetry

The transmission-connected LSS Plants must have telemetry facility to NLDC SCADA via IEC60870-5-104 protocol. List of telemetry signals for monitoring shall include plant data and site weather data which are further described in Appendix D and Appendix E of the SPPA. The telemetry facility shall be available at all times and have suitable independent back-up power source in cases of grid shut-down or maintenance outages.

9.5. MMF

The LSS Developer shall install at least one (1) set of pyranometer for every 10MW_{ac} of plant size at appropriate locations within the site. In addition, at least one (1) set of full weather station shall be installed for every 10MW_{ac} of plant size. The real-time data from the pyranometers and weather stations shall be transmitted to the NLDC at all times via telemetry and web service available via the internet.

LSS Developer shall provide a secure communication link and web service to the NLDC with online access to the MMF signals data at all times as further described in Appendix E of the SPPA. Both pyranometers and weather stations must have an independent and backup power source.

10. Forecasting Requirements

Solar PV generation is significantly influenced by weather condition. In this respect, it is mandatory for the LSS Developer to submit its solar PV generation forecast to assist the Single Buyer and the System Operator in the planning, scheduling and grid operation in order to minimize risks of deviation in generation dispatch.

10.1. Long-term forecast

LSS Developer shall submit the Annual Generation Profile and maintenance programmes (subject to the System Operator outage approval) as further described in the SPPA in such manner or form as may be prescribed from time to time by the Single Buyer and the System Operator.

10.2. Medium and short-term forecast

Throughout the term of the SPPA, the LSS Developer shall submit the Declared Daily Capacity in such manner or form as may be prescribed from time to time by the Single Buyer and the System Operator :

- (a) rolling 4-month ahead by 25th of each month;
- (b) 9-day ahead (Saturday to Sunday) every Wednesday before 12:30 p.m.; and
- (c) day-ahead by 10 a.m. for the following day.

10.3. Website and real-time online forecast

Beginning from the IOD, LSS Developer shall publish the details of the Rolling 24 Hours Forecast on the real-time basis via LSS Developer's website (accessible to the System Operator and with web services facilities to enable automatic extraction of such data into the System Operator's IT system via internet) or by any other manner or form as may be prescribed from time to time by the System Operator. LSS Developer shall establish such LSS Developer's website and web services facilities prior to the IOD and notify TNB and the System Operator of the same.

Attachment A: Data Requirement for Submission of RFP

1. Data Requirement

The participant in the LSS plant development are required to furnish to the Commission, among others, the following technical information together with the submission of RFP proposal:

- (a) Single Line Drawings, which shall be endorsed by Professional Engineer;
- (b) Plant layout drawings;
- (c) Installed capacity, which is the total rating of PV plant in MW_{dc};
- (d) Output capacity, which will be the Established Capacity in MW_{ac};
- (e) MAAQ;
- (f) SCOD;
- (g) Inverter datasheet;
- (h) PV panel datasheet;
- (i) Site and location layout;
- (j) Proximity to Potential Injection Point; and
- (k) Declarations of compliance to standards.

For further details, kindly refer to the RFP issued by the Commission.

2. Submission of Data

The technical information as specified in (a) above shall be submitted to the Commission's office as a part of RFP submission at the following address:

Energy Commission
No. 12, Jalan Tun Hussein,
Precinct 2,
62100 Putrajaya.
Telephone : +603- 8870 8500

Appendix C

1. Introduction

Appendix C shall be the guidance to participant in the LSS plant development seeking connection to the TNB or SESB Distribution Network. Contents of these Guidelines may differ from guidelines issued by other regulators or authorities and prospective participant in the LSS plant development should obtain independent advice on the applicability of the same to themselves or their facilities.

Appendix C to these Guidelines have been prepared based on Prudent Utility Practices, experiences during implementation of LSS program and international practices.

MW described in these Guidelines refers to the AC side of the LSS Plant.

Developers, operators and other parties involved in the planning, installation, commissioning and operation of LSS Plants power generation plant could utilize these Guidelines for:

- (a) Process of connection application;
- (b) Technical requirements; and
- (c) Commercial aspects.

2. Scope and Limitation

LSS Plants described in this Appendix C refer to those connected to the Distribution Network at 33kV or 11kV. Technical administration of the connection is described in the current Distribution Code. The connected capacity range allowed for connection at a single point is between 0.1MW_{ac} to less than 30MW_{ac}. This Appendix C does not apply to LSS Plants connected to Peninsular Malaysia's Transmission Network.

Appendix C of these Guidelines is not intended to cover all required authorizations, permits and/or licenses which the LSS Developer is required to obtain from the relevant bodies and/or authorities for the purpose of the development of distribution-connected LSS Plants.

The LSS Developer shall, at its own costs, be fully responsible for the inspection, examination, checking and verifying the accuracy, correctness and completeness of any and all data as to the site and its surroundings and the nature of the climatic, geological, soil and general conditions of the site as well as the Potential Injection Points as identified by the Distribution Licensee in order to meet the requirements of the SPPA.

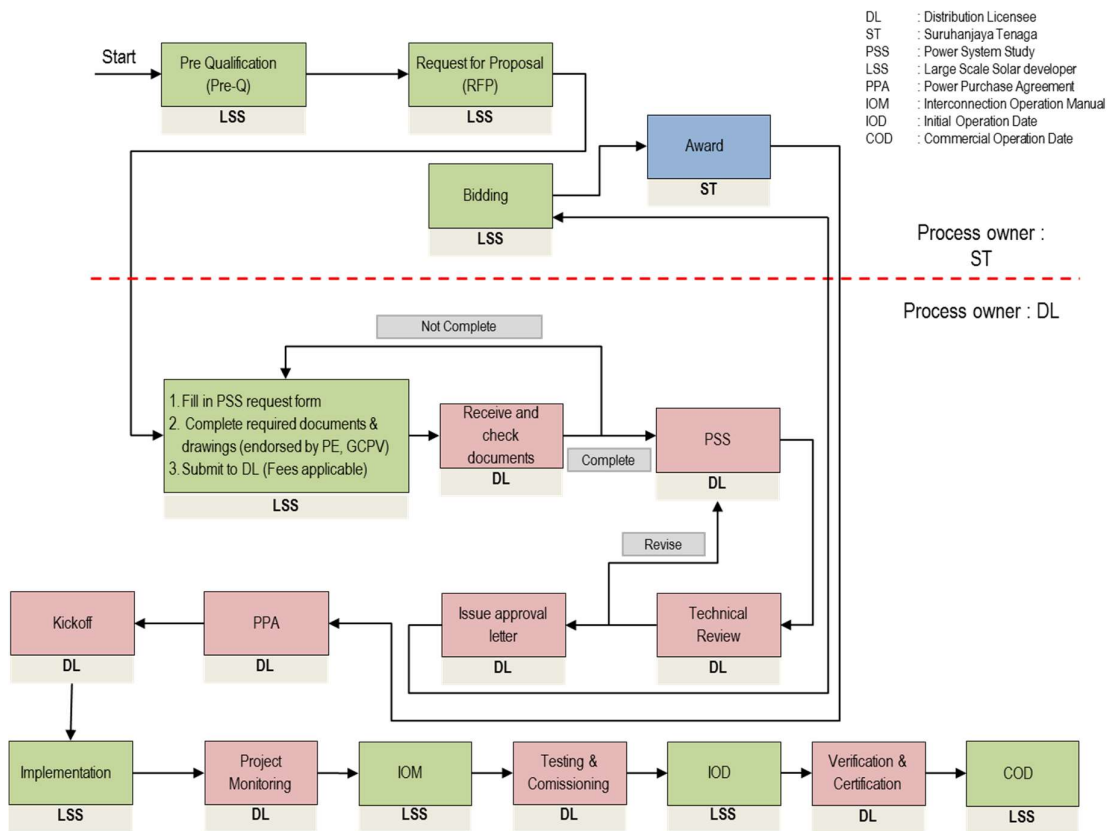
The LSS Developer shall also, at its own costs, be responsible to obtain, maintain and renew all authorizations, permits and licenses necessary for it to develop the LSS Plants and to otherwise perform its obligations under the SPPA or any other Project Documents and comply with all conditions and requirements as may be imposed or prescribed by any relevant bodies and/or authorities which has jurisdiction over the development of LSS Plants.

Each LSS Developer shall accept full responsibility for conducting an independent analysis of the accuracy, correctness and completeness of any and all data and for gathering and presenting all necessary information. The Commission and the Distribution Licensee shall bear no responsibility for any error, inaccuracy or omission of any kind and no warranty or representation is given in respect thereof.

3. Distribution Connected LSS Plant Development Process

The general process for LSS Plant distribution-connected development is illustrated in Figure 1. All applications shall be submitted to the Commission and will undergo a Pre-Qualification stage and/or RFP stage. During the RFP stage, the LSS Developer shall submit a PSS application to the Distribution Licensee. The maximum capacity of connection at a single point is 30MW_{ac}.

Figure 1: The general process for LSS Plant distribution-connected



4. Connection to the Grid Distribution System

4.1 Background

The connection of the LSS Plant shall be made only at the existing Distribution Licensee owned substation. The evaluation of connection requirements is subject to the terms and requirements in the latest version of the Distribution Code.

The limiting factors at the substation such as fault level, transformer daytime loading are important for the assessment of the connected generation capacity. Impacts such as substation loading and voltage rise due to power generation could determine the limit of capacity allowed for the LSS Plant's power generation.

4.2 Connection Voltage Level

The LSS Plant can be connected to the 33kV, 11kV and 415V distribution voltage level. Table 1 and Table 2 describe the range of connected capacity to the type of Distribution Licensee substation. The preferred connection of the LSS Plant is to an indoor substation with adequate space availability to avoid complication due to land matters.

TNB

Table 1: Connected Capacity Range (TNB)

Substation	415V	11kV PE	11kV PMU/PPU	33kV
Min	100kW	≥425kW	>2MW	>10MW
Max	425kW	2MW	10MW	30MW

SESB

Table 2: Connected Capacity Range (SESB)

Substation	11kV PE	11kV PMU/PPU	33kV
Min	≥1MW	>2MW	>5MW
Max	2MW	5MW	15MW

4.3 Penetration Limit

Distribution Network is operated in lateral feeders with off-point located strategically. To cater for the n-1 Contingency requirement, feeders are loaded at only 50% of its

thermal capacity. Therefore, to determine the capacity of connected LSS Plants, the 50% feeder loading is to be adopted.

Output from LSS Plants connected to Distribution Network shall be consumed locally. Therefore, the penetration limit of LSS Plants to a substation is limited to the daytime loading level of the substation. The loading level shall be determined by the Distribution Licensee based on its record of recent substation demand trend. Estimation of future demand growth shall not be considered.

The penetration limits are as follows:

Table 3: Penetration Limit for 11kV Feeder and Transformers

Network element	Limit
11kV feeder	2MW*
33kV feeder	50% of cable capacity*
Transformers (33/11kV, 132/11kV, 132/33kV)	85% of daytime trough

*Subject to source transformer day through load limit

4.4 Potential Injection Points

The connection to the Distribution Network is to be done only at the existing substations owned by the Distribution Licensee. The capacity of connection for each substation type is described in section 4.2.

For the purpose of facilitating the potential LSS Developer, Potential Injection Points have been identified for connection to Distribution Network. The Potential Injection Points were selected based on the following considerations:

- (a) Fault level less than 90% of equipment short circuit rating, and;
- (b) Adequate daytime trough load.

Other possible constraints include the availability of space for the new switchgear including the associated control panel and the metering room.

The list of Potential Injection Points can be accessed at the following link: <https://dghostingcapacity.tnb.com.my/DGHostingApp/> . The list shall be used as a guide as actual feasibility depends on the findings of the PSS. The Distribution Licensee has the rights to review and update the list.

For the connection that is not in the Potential Injection Points list due to fault level more than 90% of equipment short circuit rating, the LSS Plant shall minimize its fault current contribution as per the Distribution Code Clause 5.4.9.6. Among the technologies that can be used to minimize fault current are fault current limiter, current limiting reactor, or any other similar equipment / technologies that have capability to minimize or limit the fault current. The LSS Plant connection will be implemented provided that the above conditions are carried out by the developer.

4.5 Connection Schemes

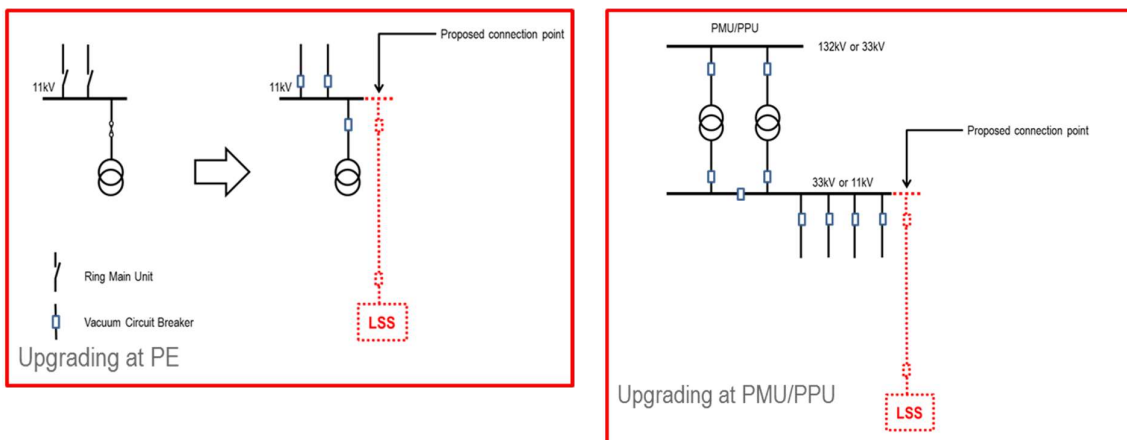
The interconnection feeder shall be using circuit breaker which shall be provided by the LSS Developer. All costs including any modification/extension to the existing substation in order to accommodate connection of LSS Plants to the grid shall be borne by the LSS Developer.

Typical scope of works for the interconnection feeder is described in Table 4 and Figure 2. However, the actual works shall be determined based on the actual site requirements.

Table 4: Typical Scope of Works for Upgrading

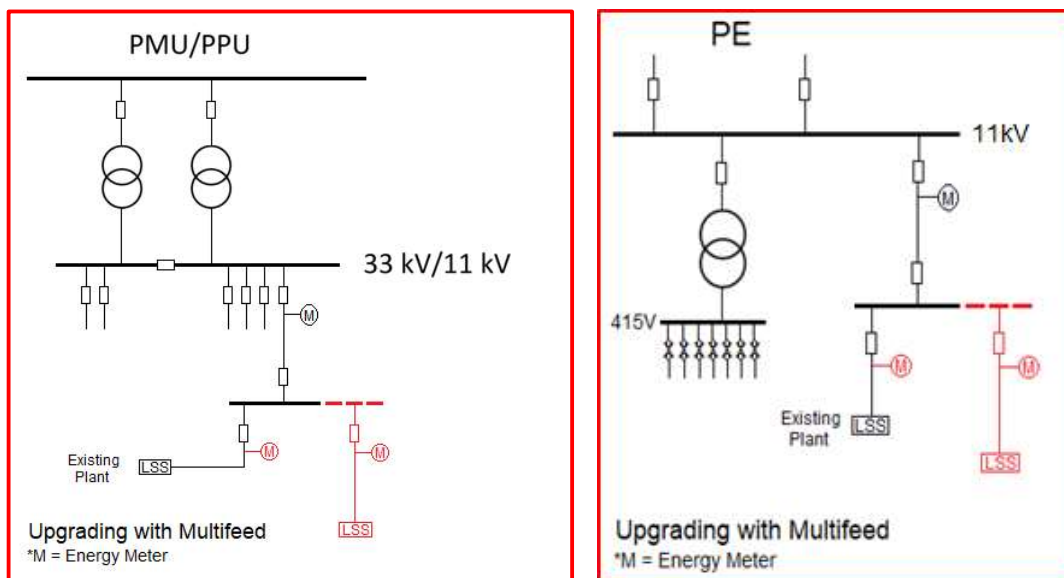
Upgrading at PE	Upgrading at PPU/PMU
<ul style="list-style-type: none"> ▪ Replace existing Ring Main Unit (RMU) to VCB ▪ Remote Control Box (RCB) ▪ DC system ▪ SCADA/RTU ▪ Building works as necessary ▪ Meter room 	<ul style="list-style-type: none"> ▪ Extension to existing switchgears (VCB/GIS) ▪ Control Relay Panel (CRP) ▪ SCADA/RTU ▪ Arc protection (where applicable) ▪ Building works as necessary ▪ Meter room

Figure 2: Upgrading of the Switchgears at PCC



Connection to an existing LSS Plant which is already in operation using multi-feed connection is only allowed if the owner of the existing and the proposed new LSS Plant are the same owner. A written consent from the existing LSS Plant to share the Interconnection Facility is required. The multi-feed connection scheme is shown in Figure 3.

Figure 3: Upgrading of the Switchgears at PCC for multi-feed Scheme



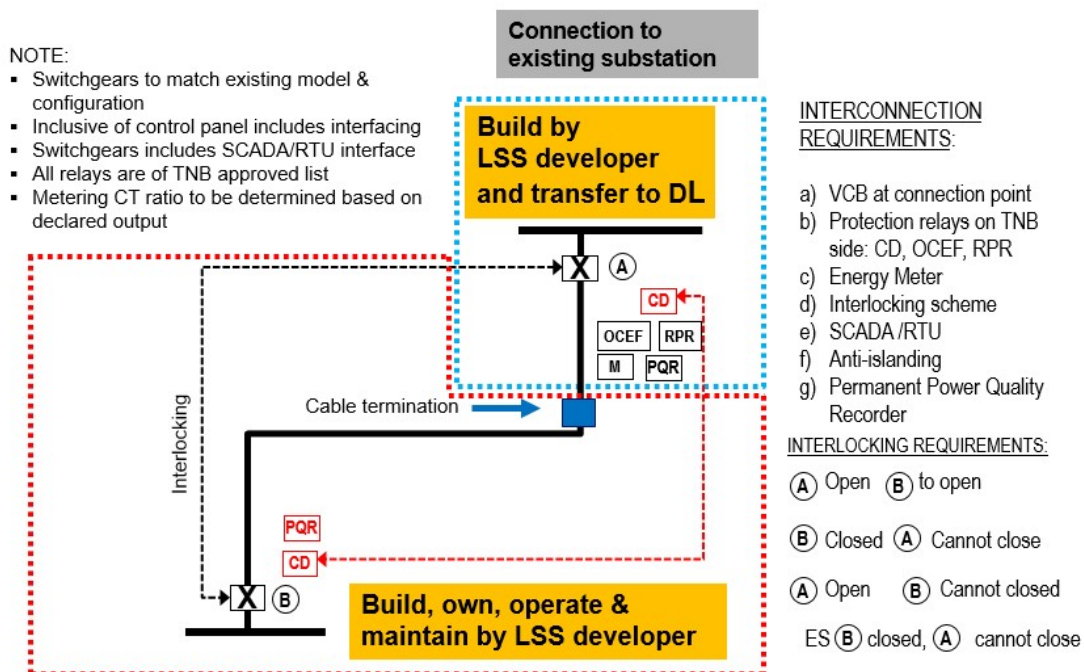
4.6 Scope of Interconnection Facilities and Asset Demarcation

This section describes the feature of the interconnection feeder which connects the LSS Plant to the Distribution Licensee substation. The connecting cable consists of underground or aerial cable to carry only the generated power and fibre optics cable for differential protection relay and interlocking communications.

All costs including any modification/extension to the existing substation in order to accommodate connection of LSS Plants to the grid shall be borne by the LSS Developer.

The LSS Developer is responsible in acquiring the right of way for the underground or aerial cable route and any related land acquisitions.

Figure 4: Distribution Licensee-LSS Plant Interconnection Feeder Scheme



The following are the scope of work by LSS Developer:

- Supply of interconnection facilities for LSS Plants and Distribution Licensee side (refer to Figure 4);
- The interconnection works shall be designed, built, owned, operated and maintained by the LSS Developer;

- (c) All works for interconnection is under the responsibility of LSS Developer;
- (d) Interconnecting power cable capacity and fibre optics based on PSS;
- (e) The equipment is to match existing specifications;
- (f) Protection scheme;
- (g) Energy meters and dedicated metering room;
- (h) Interlocking scheme;
- (i) SCADA requirements;
- (j) Anti Islanding shall be provided at the LSS Plant;
- (k) Install and maintain PQ Recorder at LSS Plant;
- (l) Other requirements as stated in the PSS; and
- (m) Submission of drawings and manuals.

5. PSS

5.1 Objectives of PSS

- (a) To identify connection scheme options (and configurations) for the LSS Plant to be connected to the Distribution Network;
- (b) To investigate the impact of the LSS Plant's power generation to the Distribution Network; and
- (c) To assess the LSS Plant's compliance with the technical requirements in the current Distribution Code.

5.2 Scope of PSS

Distribution Licensee will perform the PSS using any one of the simulation softwares, such as PSS ADEPT, PSS Sincal, PSSE by Siemens, DigSilent by Powerfactory, or other similar softwares.

Scope of PSS includes:

- (a) Adequacy – penetration limit;
- (b) Power flow analysis;
- (c) Short circuit analysis;
- (d) Redundancy study;
- (e) Operational constraints and limitations; and
- (f) Interconnection method and scope of work.

In evaluating the LSS Plant's connection, the operational flexibility of the network is not to be compromised.

5.3 PSS Information Requirements

LSS Developers are required to furnish, among others the following technical information together with the submission of RFP.

- (a) Single Line Drawings, which shall be endorsed by the Professional Engineer with Practicing Certificate;

- (b) Plant layout drawings;
- (c) Installed capacity, which is the total rating of PV plant in MW_{dc};
- (d) Output capacity, which will be the Established Capacity in MW_{ac};
- (e) MAAQ;
- (f) SCOD;
- (g) Inverter datasheet;
- (h) PV panel datasheet;
- (i) Site and location layout;
- (j) Proximity to Potential Injection Point; and
- (k) Declarations of compliance to standards.

All applications will be processed in the order in which they are received. Incomplete applications will not be accepted and will be returned to the person submitting the application.

Distribution Licensee will issue invoice for application processing fee. The payment of invoice can be made at any Distribution Licensee payment outlet and a copy of payment receipt must be sent to the Distribution Licensee.

Application processes and the relevant forms and fees are subject to change without prior notice.

5.4 PSS Fees

The applicable fees for PSS are shown in Table 5 based on the proposed connected capacity.

Table 5 : PSS Fees According to Capacity Range

Capacity	Fee	Delivery days
≤ 180kW (low voltage)	RM1,000	30 days
>180kW, ≤425kW (low voltage)	RM5,000	30 days
>425kW, ≤1MW	RM20,000	30 days
>1MW, ≤10MW	RM40,000	40 days
≤30MW	RM60,000	40 days

The 'day one' for PSS delivery days shall begin upon receipt of the proof of payment to Distribution Licensee.

Upon completion of the study, a review meeting shall be held between Distribution Licensee and LSS Developer to conclude the findings and recommendations of the PSS. Distribution Licensee shall issue an official report of the agreed findings and recommendations.

5.5 Submission of PSS Application

All applications for connection of LSS Plant to the Distribution Network shall be submitted to the respective Distribution Licensee offices:

TNB PSS application for connection of LSS Plant to the Distribution Network can be submitted via the following link:

<https://myaccount.mytnb.com.my/Service/RE/TechnicalStudyApplicationChecklist>

Telephone: 03-22965566

Email: re@tnb.com.my

5.6 PSS Validity

The PSS report is valid only for 1 cycle of bidding process. No extension of PSS report is allowed.

5.7 Guideline and Criteria to be used for PSS

The PSS results are to comply with relevant requirements in the Distribution Code. A copy of the Distribution Code can be obtained from the official portal of the Commission (www.st.gov.my).

Any violation to the codes and standards pertaining to the LSS Plant connection are to be highlighted and mitigation action(s) shall be recommended accordingly in the report.

6. Technical Requirements

6.1 General

The technical requirements are outlined in this guideline to ensure that the connection of LSS Plants to the Distribution System is harmonised with the existing system characteristics.

6.1.1 Voltage range

Distribution Network voltage fluctuates in response to the feeder length and the load level. Table 6 describes the limits to be complied for the planning of the interconnection.

Table 6 : Steady State Voltage Limits

Nominal Voltage	Steady state voltage limits
230V, 400V	+10%, -6%
11kV	±5%
33kV	±5%

6.1.2 Voltage fluctuation

The maximum voltage fluctuation range allowed due to varying solar radiation is 6%. This requirement differs from that for voltage flicker.

6.1.3 Frequency

LSS Developer shall maintain plant frequency to operate in synchronism with Distribution System. Nominal system frequency is 50 Hz with normal range of ±1% which is between 49.5Hz and 50.5Hz. The LSS Plant is also to withstand short time operation within the range 47Hz and 52 Hz according to requirement 6.2.2.

6.1.4 Current Harmonics

Total Harmonic Distortion Current Distortion shall be <5 % at Inverter rated output. The point of measurement is at the PCC.

Each individual harmonic shall be limited to the percentages listed in table below (Current distortion limits reference to IEC 61727-2003 Table 1). Even harmonics in these ranges shall be less than 25 % of the lower odd harmonic limits listed.

Table 7 : Distortion limit for Odd Harmonics

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

Table 8 : Distortion Limit for Even Harmonics

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

6.1.5 Voltage Fluctuation and Harmonics

Table 9 highlights the acceptable permissible values for voltage fluctuation and harmonics. The point of measurement is at the Connection Point normally at the Distribution Licensee substation.

Table 9 : Acceptable Permissible Values at PCC for Voltage Fluctuation and Harmonics

Type Of Disturbance	Indices	Acceptable permissible values at Connection Point	Reference Document
Voltage Flicker	Absolute Short Term Flicker Severity (P_{st})	1.0 (at 132kV and below)	UK's Engineering Recommendation P28
	Absolute Long Term Flicker Severity (P_{lt})	0.8 (at 132kV and below)	
Harmonic Distortion	THD Voltage (THDV) %	4 % at 11kV	Engineering Recommendation ER G5/4
		3% at 33kV	
Voltage Unbalance	Negative Phase Sequence Voltage %	2% for 1 minute	UK's Engineering Recommendation P29

6.1.6 DC injection

LSS Plant shall not inject DC current more than 1 % of the rated Inverter output current under any operation condition.

6.1.7 PF

The allowed PF of LSS Plant range is 0.85 lagging to 0.9 leading as shown in Figure 5. The reactive power output is to be achieved at generation level as shown level as shown in part 6.2.4.

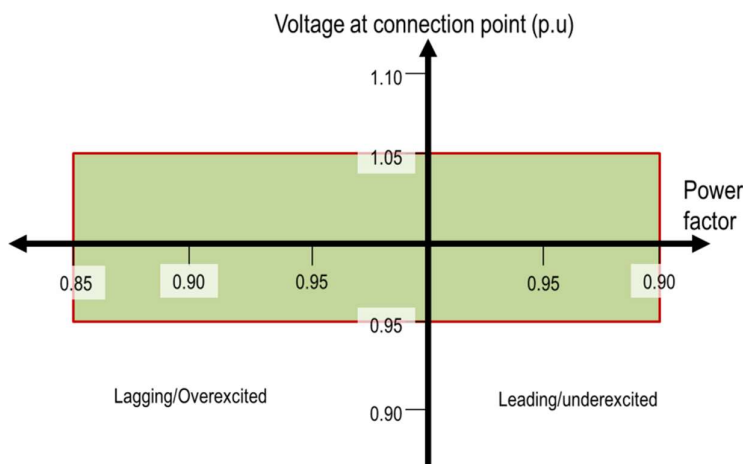


Figure 5: Voltage versus PF curve

6.1.8 Transient Overvoltages

Typical Basic Impulse Insulation Levels (“BIL”) of the Distribution System is as given in Table 10. The LSS Plant and its apparatus shall be compatible with the insulation levels of the Distribution System.

Table 10 : BIL

System Voltage (kV)	BIL (kV)
11	75
33	170

6.1.9 System fault level

Table 11 below shows the rated equipment to be used to withstand the maximum sub-transient three phase symmetrical short circuit fault levels. Under the Distribution Code clause 5.4.9.1, the Distribution System shall be planned such that the maximum sub-

transient three phase symmetrical short circuit fault levels are not greater than 90% of the design short circuit break and make capacity of switchgear connected to the Distribution System and within 90% of the short time current rating of equipment connected to the Distribution System.

If the proposed LSS Plant is to be connected to the Distribution System that already reach 90% or will be exceeded 90% of equipment rating, for operational and safety reasons, the contribution of the fault current from the proposed LSS Plant shall be limited or minimized so that the impact on the existing fault level is neutral. Among the technologies that can limit the fault current are the fault current limiter, current limiting reactor or any other similar equipment/technologies that have the ability to limit the fault current. This is in line with the requirement specified in the Distribution Code under clause 5.4.9.6.

Table 11 : Short Circuit Withstand Rating for Power Equipment

Nominal Voltage [kV]	Rated Voltage [kV]	Fault Current [kA]
33	36	25
11	12	20

6.1.10 Synchronisation

Synchronisation devices shall be provided and maintained by the LSS Developer. During operation, synchronisation is at the LSS Plant side by matching with the Distribution System parameters as mentioned below:

- (a) Interlocking logics are satisfied
- (b) Frequency difference <0.2 Hz
- (c) Voltage magnitude difference < 10%
- (d) Voltage angle difference < 10 degrees

Inverter shall be capable of synchronising with the grid automatically within the specified reconnection time.

6.1.11 Inverter

The LSS Plant shall use any type of Inverters that have advanced or smart Inverter functions. The Inverter shall comply with the RFP and technical requirement for

connection to Distribution Network as outlined in the current Distribution Code. 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.

6.1.12 Standard compliance

The LSS Plant and its interconnection shall comply with the following standards of MS1837, IEC 61727, IEEE 1547.

6.2 Network Support

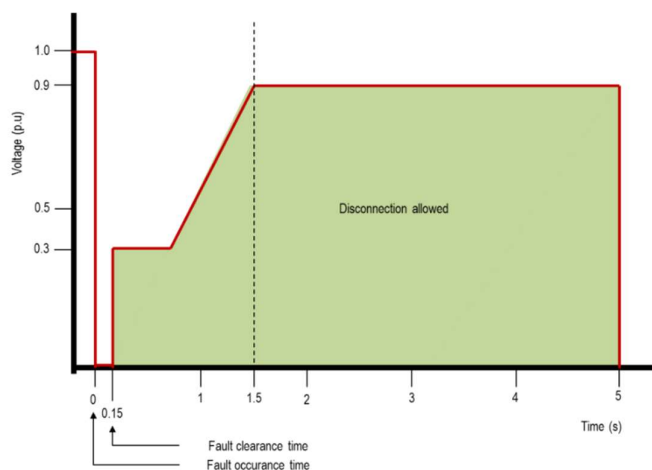
The LSS Plant shall provide support to the network to ensure that the system is stable by:

- (a) To not disconnect; and
- (b) To support network voltage by feeding reactive power.

6.2.1 Low Voltage Ride Thru

During disturbance at transmission system, Distribution System will experience temporary low voltage/sag. The LSS Plant is expected to continuously operate during Distribution System voltage fluctuation as shown in Figure 6.

Figure 6: Low Voltage Ride Through Curve

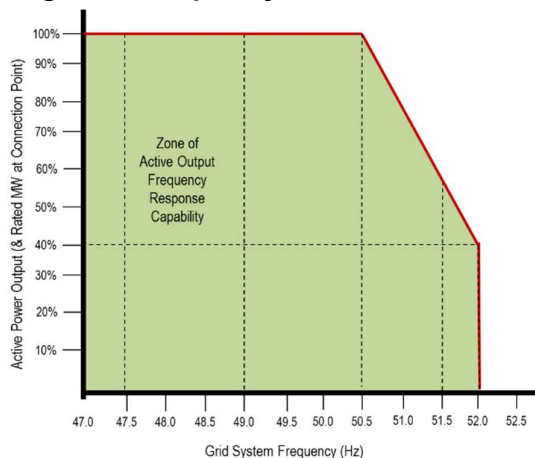


6.2.2 Frequency disturbance

The LSS Plant is expected to be uninterrupted within the frequency range of 47Hz to 50.5Hz.

During frequency disturbance, when the frequency increases more than 50.5Hz, the LSS Plant shall reduce its power output as shown in Figure 7.

Figure 7: Frequency Disturbance Curve



6.2.3 Power output management

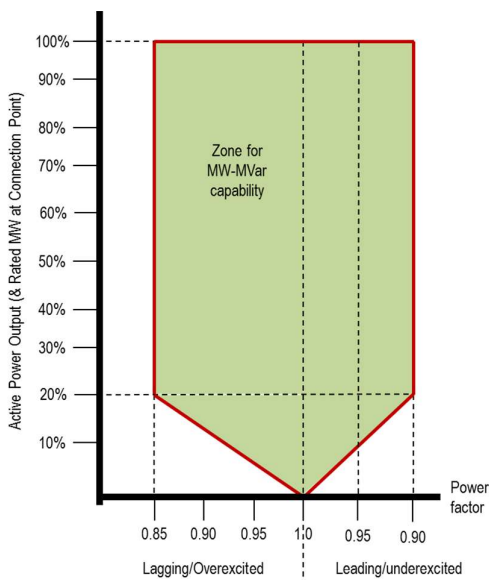
The LSS Plant shall have the capability to manage its power generation as follows:

- (a) The LSS Plant shall be able to reduce its power output or disconnect from the Distribution System during system contingencies;
- (b) LSS Plant shall reduce its generation output to avoid voltage rise above the limit;
- (c) The LSS Developer shall monitor and ensure that the power generation of the plant does not exceed the Contracted Capacity; and
- (d) The Inverter shall have the capability to perform active/reactive power control or voltage control for voltage regulation.

6.2.4 Reactive power

The LSS Plant shall be able to deliver the reactive power requirement at the Connection Point as shown in Figure 8. Full range of reactive power 0.85 lagging to 0.9 leading shall be achieved at 20% output.

Figure 8: Active power output versus PF curve



6.2.5 Droop curve

The LSS Plant shall be fitted with a droop controller or equivalent control device to provide frequency response under normal operational conditions as in 6.1.3.

6.2.6 Power Ramping

The LSS Plant shall be able to automatically and manually control the ramp rate and limit the real power. This is to ensure stability of the system and prevent any power surge caused by sudden injection by the Facility.

The LSS Plant shall be capable to control the increase and decrease of power delivery within ramp rate of 15% per minute of rated capacity.

The Facility shall be able to regulate the ramp rate of the active power output for the following scenarios:

- (a) During the period in a Despatch Instruction (if required);
- (b) Normal load variation;
- (c) Facility startup; and
- (d) Facility shutdown.

6.3 Protection Requirements

The LSS Plant protection scheme is under the LSS Developer's responsibility and the LSS Developer shall declare the protection scheme and settings to the Distribution Licensee.

6.3.1 Connection Point feeder protection at Distribution Licensee

The protection interfacing requirements are as follows:

- (a) Unit Protection (Current Differential);
- (b) OCEF / Non Directional OCEF;
- (c) Interlocking scheme; and
- (d) Reverse Power Relay.

Where applicable, the following protection schemes may be required:

- (a) Arc protection;
- (b) Busbar protection; or
- (c) Automatic transfer scheme.

6.3.2 Feeder requirements at LSS Plant

The LSS Plant feeder shall be equipped with the following equipment:

- (a) Current Differential Relay shall match with 6.3.1; and
- (b) PQ recorder.

The PQ recorder shall measure THDI, voltage fluctuation and flicker. Data storage capacity for the PQ recorder is to last at least for 1 month. The sampling rate shall be at least 128 samples per cycle.

6.3.3 Fault clearing time

The fault clearing time for 11kV and 33kV network is as depicted in Table 12.

Table 12 : Fault Clearing Time

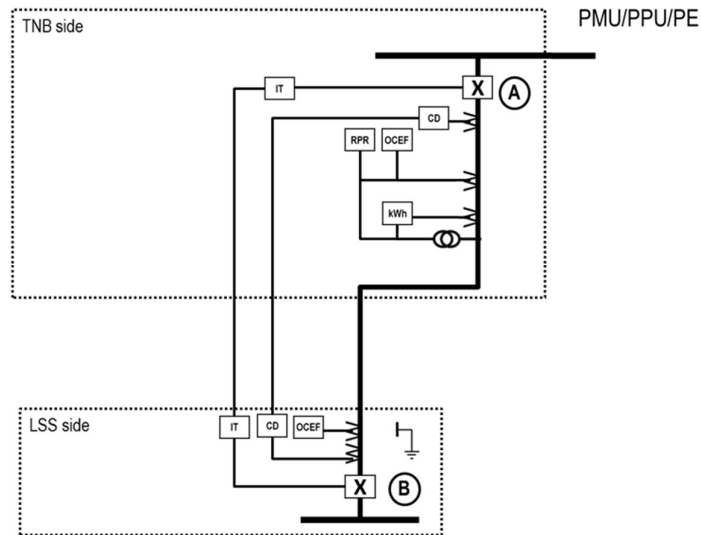
Type of fault	11kV, 33kV
Substation and transformer faults	150ms
Overhead line and cable faults	600ms

6.3.4 Interlocking of the interconnection feeder

The interlocking facilities shall operate in the following manner, referring to Figure 9 below.

- (a) A open – B to open
- (b) B close position – A cannot close
- (c) A open position – B cannot close
- (d) Earth Switch (ES) B ON – A cannot close

Figure 9: Interlocking of the interconnection feeder with Distribution Licensee



6.3.5 Protection equipment

The protection relay and PQR equipment to be used is subject to the approval by Distribution Licensee.

6.3.6 Protection coordination study

LSS Developer shall carry out the internal protection coordination to mitigate internal and external fault.

- (a) For any internal fault, the LSS Plant shall not cause problems to the utility system and its customers. The failure of the LSS Plant equipment includes:
 - (i) Failure of protection equipment;
 - (ii) Failure of control equipment;
 - (iii) Loss of control power; or
 - (iv) Interconnection power and fibre optics cables.

- (b) For any Distribution Network fault outside the LSS Plant, the LSS Plant shall be protected from any damaging effect.

LSS plant shall be disconnected from the grid during any of the above conditions.

6.3.7 Anti Islanding

During loss of mains, the Inverter shall cease to operate in islanded mode. The Anti Islanding protection is required to mitigate the following events:

- (a) Safety;
- (b) Power quality; and
- (c) Inverter technical limit.

6.3.7.1 Anti Islanding detection

Inverters shall have the following Anti Islanding capabilities:

- (a) Under Voltage;
- (b) Over Voltage;
- (c) Under Frequency;
- (d) Over Frequency; and
- (e) 1 additional active/passive Anti Islanding detection.

6.3.7.2 Isolation time

Upon detection of the loss of mains, LSS Plant shall be isolated within the time as shown in 6.2.1.

6.3.8 Reconnection time

The reconnection time of the LSS Plant to the Distribution Network shall be more than 5 minutes after Distribution Licensee connection has been stabilized (for 33kV or 11kV) or 2 minutes after Distribution Licensee connection has been stabilized (for 415V).

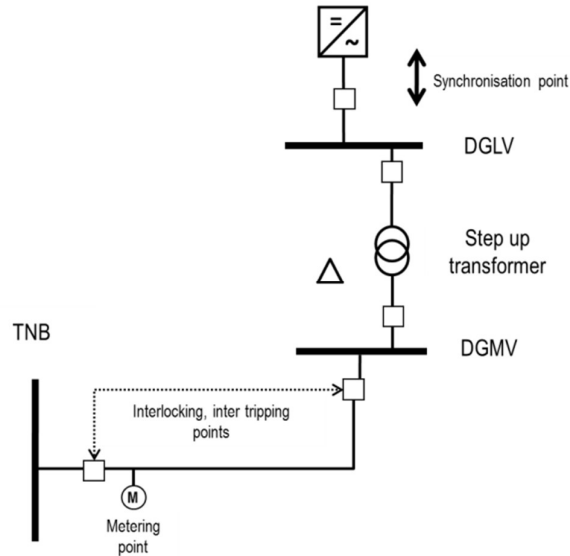
6.3.9 Earthing scheme

The LSS Plant earthing scheme shall not cause maloperation to the Distribution Licensee protection scheme.

The zero sequence components between the Distribution Licensee network and LSS Plant shall be isolated. The LSS Plant step up transformer(s) shall have delta (Δ) configuration on Distribution Licensee side as illustrated in Figure 10 to ensure the

plant does not contribute zero sequence current to Distribution Licensee network during fault.

Figure 10: Step up Transformer Earthing Scheme



6.4 MMF and Pyranometer

The LSS Developer shall provide the following:

- (a) Install MMF and pyranometer at the site;
- (b) 1 set (MMF and pyranometer / solar cell sample) per 1MW;
- (c) Meteorological station has an independent and backup power source;
- (d) LSS Plants must maintain historical data of readings for throughout the term;
- (e) Minimum data resolution: Every 15 minutes; and
- (f) Submit meteorological report to the Commission or Distribution Licensee as and when required.

6.5 Operational Requirements

6.5.1 Preparation of IOM

The documents to be prepared for each interconnection shall address the followings:

- (a) Interconnection Facilities;
- (b) Communication;

- (c) Switching Procedures;
- (d) Fault Reporting;
- (e) Outage Program;
- (f) System Emergency / Collapse;
- (g) Sequence Of Operation; and
- (h) Boundaries and Ownership.

6.5.2 Contingencies

During Contingency, the LSS Plant may be isolated until the system is normalized. Contingencies include scheduled and unscheduled outages:

- (a) Network upgrading;
- (b) Maintenance;
- (c) Shutdown; or
- (d) Breakdown.

6.5.3 DAQ

The LSS Developer shall submit a DAQ to the Distribution Licensee. Format of the DAQ could be referred to the relevant forms in Schedule 5 of the Distribution Code.

6.6 SCADA

The provision of SCADA is mandatory for all LSS Plant interconnection for capacity 1MW and above. All cost for the SCADA facility shall be borne by the LSS Developer including RTU cubicle and associated cards and SCADA ready switchgears. SCADA equipment to be used is subject to the approval by Distribution Licensee.

The following parameters are to be made available for monitoring to the Distribution System operator:

- (a) Frequency (Hz);
- (b) Voltage (V);
- (c) Current (A);
- (d) Real Power Energy flow (kW or MW);
- (e) Reactive Power Energy flow (kVAR or MVar);
- (f) Circuit Breaker status; and

(g) Relay indications.

All interfacing wirings shall be prepared by the LSS Developer with Distribution Licensee supervision.

6.7 Ownership and Boundaries

All equipment which are to be transferred to Distribution Licensee, shall comply with Distribution Licensee specifications. The ownership boundary of the LSS Developer is up to and including the cable termination at the Connection Point at Distribution Licensee Distribution System.

6.7.1 Boundaries

Determinations of boundaries are as shown in Table 13.

Table 13 : Boundaries and Ownership Between Distribution Licensee (DL) and LSS Developer

Item	Ownership	Control	Operation	Maintenance
DL substation				
Primary	DL	DL	DL	DL
Secondary				
▪ OCEF + RPR	DL	DL	DL	DL
▪ PQR	DL	DL	DL	DL
▪ CD + communication	LSS Developer	LSS Developer	LSS Developer	LSS Developer
▪ Interlocking	LSS Developer	LSS Developer	LSS Developer	LSS Developer
LSS Plant substation				
Primary	LSS Developer	LSS Developer	LSS Developer	LSS Developer
Secondary				
▪ OCEF + RPR + CD	LSS Developer	LSS Developer	LSS Developer	LSS Developer

OCEF – Overcurrent Earth Fault, CD – Current Differential, RPR – Reverse Power Relay, PQR – Power Quality Recorder

The LSS Developer shall own and be responsible for the costs of operation and maintenance of all installations located within their boundary.

6.7.2 Transfer of interconnection facilities

Upon the completion of the interconnection facilities, the LSS Developer shall transfer the IF beyond his or its ownership boundary to the Distribution Licensee and take all actions necessary to transfer to the Distribution Licensee of all rights, title and interests to the IF so that the Distribution Licensee shall become the owner of such IF. The warranty period for all asset transferred to Distribution Licensee is 3 years.

The Distribution Licensee shall be responsible for the operation and maintenance of the IF.

6.7.3 Defects in IF

If the Distribution Licensee discovers that the interconnection facilities or any part of the IF that has been transferred to it :

- (a) Was not designed, constructed, installed and tested in accordance with Prudent Utility Practices; or
- (b) Contains any defect in its design, materials or workmanship.

The LSS Developer shall, at his or its own cost, make all necessary repairs or replacements so that the IF conform to the requirements of Prudent Utility Practices and shall be free from any such defect.

The obligation of the LSS Developer shall not apply in respect of any non-conformance or defect arising as follows:

- (a) from the Distribution Licensee's failure to operate and maintain the interconnection facilities in accordance with the operation and maintenance manuals referred to in paragraph 6.5 and Prudent Utility Practices;
- (b) from the effects of ordinary wear and tear or erosion or corrosion which such facilities were not designed for; or
- (c) after an initial period of thirty-six months from the COD, and in respect of any part of such facilities that was repaired or replaced during such IOD, after a period of thirty-six months from the date of completion of such repair or replacement.

7. Metering

7.1 General

All energy meters used for measuring the import and export of electricity shall comply with Distribution Licensee’s specifications. Distribution Licensee shall determine the metering point at which every supply line shall terminate in any premise in view of ease of accessibility to Distribution Licensee’s personnel.

The LSS Developer shall provide meter panel according to Distribution Licensee’s specifications for the installation of meter and their accessories. Distribution Licensee may change any meter and its accessories or their positions in any premise as deemed necessary at any time for purposes of maintenance and meter reading.

7.2 Energy Meter

The main and check meters are to be installed by Distribution Licensee to measure the energy import and export. The energy meters are shall be procured from Distribution Licensee. The cost will be inclusive of supply and installation for both meters.

The energy meters shall be mounted on the metering cubicle. The dimension and specifications of the meter cubicle are to comply with the latest Distribution Licensee electricity supply application guideline. All drawings shall be endorsed by a Professional Engineer.

7.3 Metering Room

Energy meter is to be installed at the Connection Point in a dedicated meter room or at a location point agreed by the approver at Distribution Licensee substation. The LSS Developer shall provide a Switch Socket Outlet (13 Amps) at the meter room.

7.4 Communication Signal

Distribution Licensee uses wireless mode of communication between energy meter and Distribution Licensee data center. Location of the meter room must have adequate reception of the communication medium signal to enable data transmission. LSS Developer shall provide signal booster equipment whenever the communication signal is weak.

7.5 Metering Voltage Transformer (For 11 kV and 33 kV)

The details for the Inductive type VTs is shown in Table 14.

Table 14: Metering Voltage Transformer

Ratio	$\frac{V_s / \sqrt{3} V}{110 / \sqrt{3} V}$ * where V_s is the voltage at metering point
Class	0.5
Burden	50 VA minimum, sharing can be allowed provided separate fusing is provided. If the burden of the shared load is more than 10 VA, then 100 VA VT shall be used.
Voltage factor	1.9 for 8 hours
Unit	3 nos. for each feeder
Standards	IEC 61869-2

7.6 Metering Current Transformer (For 11 kV and 33 kV)

The details for the metering current transformer are shown in Table 15.

Table 15: Metering Current Transformer

Ratio	$I_s / 5A$ * where I_s is the primary ratio of the metering CT
Class	Class 0.2s
Burden	15 VA minimum for indoor 11 kV and 33 kV 30 VA minimum for outdoor 33 kV outdoor
Unit	3 Nos. for each feeder
Standards	IEC 61869-3

7.7 Metering Wiring and Accessories

The CT and VT secondary leads shall be multi-core (copper) armored cable and in accordance with the latest TNB electricity supply application guideline.

As separate and enclosed cable conduit/ trunking shall be installed to route the armored cable to the metering kiosk. The metering kiosk shall be located in the metering room as described in 7.3. The internal wiring inside the metering kiosk termination shall be provided by the LSS developer. The final layout diagram for the metering kiosk shall be provided by the LSS developer for the approval by the TNB.

All of the cables, cable routing, marshalling cubicle, metering kiosk and related metering accessories such as fuses and terminal block shall be provided by the LSS developer.

7.8 Meter Application and Approval

The LSS Developer shall liaise with the respective Distribution Licensee on the requirements for meter application and approval.

Test certificate and wiring diagram of the current transformers and voltage transformers shall be supplied by LSS Developer. The current transformers and voltage transformers shall have a valid test certificate from an accredited laboratory. The LSS Developer shall send the current transformer to the Distribution Licensee for calibration at either TNB testing laboratory or an independent test laboratory accredited with ISO/IEC 17025 and all costs shall be borne by the LSS Developer.

7.9 Meter Reading, Inspection and Testing

The LSS Developer shall read the revenue meter with Distribution Licensee (joint inspection) or through remote meter reading facility installed by LSS Developer on a monthly basis and not later than 7 days after reading the revenue meter, the LSS Developer shall prepare and submit an invoice to Distribution Licensee for verification and payment.

The LSS Developer may at any time submit a written request to the Distribution Licensee to inspect or test the energy meters. If the meters are found to be defective or inaccurate, both Distribution Licensee and the LSS Developer shall recalculate and

agree on the amount payable during the period of inaccuracy. However, if the meter is accurate, the cost for energy meter testing shall be borne by the LSS Developer.

The energy meters shall be tested by TNB on a schedule determined by TNB in accordance with Prudent Utility Practices. The cost and expense for any additional inspections and tests shall be borne by LSS developer.

7.10 Metering Panel/Cubicle

The meter panel/cubicle shall be designed by LSS Developer and endorsed by Distribution Licensee. LSS Developer shall prepare the wiring for the meter and conduct the relevant test as per the Distribution Licensee requirements.

8. Testing and Commissioning for IOD

8.1 General

The LSS Developer shall notify Distribution Licensee in writing once the LSS Plant installation and the interconnection facilities is ready to be commissioned. The LSS Developer shall submit all the documents for IOD as stated below:

- (a) A certificate from an Independent Engineer approved by the Commission stating that the interconnection facilities have been designed and constructed in accordance with Prudent Utility Practices;
- (b) Copies of approved as-built drawing of the interconnection facilities;
- (c) Copies of IOM approved by Distribution Licensee;
- (d) Test results of the IF;
- (e) A copy of metering scheme approval;
- (f) Transfer documents for Distribution Licensee substation and land if applicable;
- (g) Permanent generation license from the Commission;
- (h) Approval letters from authorities on right of ways for poles and/or cable routes; and
- (i) Written confirmation from Distribution Licensee on the completion of site work without any outstanding issues.

The submission of a complete IOD document as per IOD checklist in Attachment C shall be made not less than 60 days of the proposed IOD. The commissioning notification shall be issued upon receipt of the complete IOD documents.

8.2 IOM

The purpose of the IOM is to outline the duties and responsibilities of both parties at the interconnection between Distribution Licensee and the LSS Plant. The IOM is also to set out the necessary procedures to be followed to ensure safety to the operating personnel and to avoid any damage to the equipment at the Interconnection Point. The LSS Developer shall prepare the IOM for the interconnection and jointly agreed by the Distribution Licensee.

The IOM has to be completed before the commissioning process could be considered.

8.3 Testing for IF

Testing shall be carried out during the shutdown stage which involves the connection of the LSS Plant to Distribution Licensee network. Such test includes and not limited to the following:

- (a) Electrical protection scheme;
- (b) Protection coordination study;
- (c) Cable and/or overhead test result;
- (d) SCADA; and
- (e) VCB and DC system.

All tests shall be carried out by a qualified tester and with a valid calibration certificate.

8.4 Commissioning Tests for IOD

There are 2 levels of testing required:

- (a) Inverter compliance tests; and
- (b) Interconnection compliance tests

The scope of testing during IOD shall cover:

- (a) The LSS Plant shall cease to energise during loss of mains. Anti Islanding test must comply with the following time:
 - (i) Disconnection time: $\leq 2s$;
 - (ii) Reconnection time: $> 5min$;
 - (iii) Reconnection time: $> 2 min$ (for 415V).
- (b) Functional tests of all equipment; and
- (c) Any resetting of factory-set parameters at site requires testing to be redone.

All test results shall be certified by service engineer to be submitted to Distribution Licensee.

8.5 Power Quality Measurements

8.5.1 Pre/Post IOD

Power quality measurements are to be done at the point of connection to ascertain the existing power quality before commissioning and after the connection of LSS Plant. The recording period shall be 7 days before commissioning to capture the base voltage regulation profile without LSS Plant and 7 days after commissioning with the LSS Plant connected. The recording interval shall be not less than 10 minutes as per IEC61000-2-4.

Measurement shall capture the following parameters and not limited to:

- (a) THD voltage;
- (b) Unbalanced voltage;
- (c) Flicker voltage;
- (d) RMS Voltage;
- (e) Power Generation (kW);
- (f) Reactive Power (kVAr);
- (g) PF;
- (h) Energy kWh (daily).

8.5.2 Permanent Power Quality Measurements

The LSS Developer shall install a permanent power quality recorder at Distribution Licensee's substation.

Measurement shall capture the following parameters and not limited to:

- (a) THD Voltage;
- (b) THD Current and each individual current harmonic;
- (c) Unbalanced voltage;
- (d) Flicker voltage;
- (e) RMS Voltage;
- (f) Power Generation (kW);
- (g) Reactive Power (kVAr);
- (h) PF;
- (i) Energy kWh (daily); and
- (j) Voltage dip and swell events.

9. COD

9.1 Verification for COD

The verification for COD shall be conducted after IOD and the minimum duration shall be not less than 7 days. The verification tests shall be performed by an Independent Engineer approved by the Commission and witnessed by Distribution Licensee. The verification test parameters include the following:

- (a) Grid Frequency Variation;
- (b) reactive power control (voltage control and PF control modes);
- (c) Grid System voltage variation;
- (d) Grid System fault level;
- (e) Protection System;
- (f) Voltage support (AVQC) and Active Power Control;
- (g) Equivalent control device (Droop curve);
- (h) Frequency MW Response;
- (i) Power Quality;
- (j) Fault ride through (LVRT);
- (k) Power ramping (up and down); and
- (l) Inverter functional tests and verifications.

The COD verification requirements are as suggested in Attachment C and the verification methods are depicted in Table 16.

Table 16 : IF Verification Methods

Test method	
Factory test	Valid test certificate/results from the factory
Site test	Electrical and functional tests of the IF
Site verification	Confirmation against approved drawings or specification

9.2 Confirmation for COD

The LSS Developer shall submit to the Commission and Distribution Licensee the report for COD confirmation. The report shall consist of:

- (a) Verification report; and
- (b) PQ report

Upon receipt of the reports, the Commission shall issue a letter of confirmation on COD to the LSS Developer and Distribution Licensee to initiate payment.

10. Safety and Performance Sustainability Requirements

The safety requirements to be adopted by the LSS Developer and Distribution Licensee for work or testing at the interconnection facilities shall include the following:

- (a) The LSS Developer shall provide the single line diagrams of the interconnection facilities at the respective side of the Connection Point;
- (b) The LSS Developer shall have their own safety rules and/or safety instructions which comply with Act 447 and Prudent Utility Practices; and
- (c) The LSS Developer shall designate a competent personnel registered with the Commission to operate the interconnection facilities within their boundary.

The LSS Developer shall at its own cost conduct the testing of LSS Plant (including the IF) and thereafter, submit the report of such testing, which report shall be certified by the Independent Engineer, to the Commission and Distribution Licensee on the 10th and 15th year of the contractual term.

11. Commercial

11.1 SPPA

The SPPA is an agreement entered between the Electricity Utility Company and the LSS Developer. Payment under the SPPA is based on energy produced by the LSS Developer. The SPPA is for a fixed term of 21 years for each LSS Plant. For clarity, one SPPA shall be required to be entered into for each LSS Plant. As an illustration, for three different LSS Plants connected to three (3) different Interconnection Points, there shall be three (3) SPPAs to be executed with the Electricity Utility Company. The followings are some of the parameters covered under SPPA:

- (a) Established Capacity of the LSS Plant, which will be dependent on the Notification to Shortlisted Bidder;
- (b) MAAQ of the LSS Plant;
- (c) Explanation on energy beyond contracted capacity, Established Capacity;
- (d) Energy Rate of the LSS Plant;
- (e) EER of the LSS Plant;
- (f) Treatment on test energy from the LSS Plant;
- (g) Provision on change of ownership of the LSS Plant;
- (h) Provision on penalty when there is non-delivery of energy based on energy committed by the LSS Developer; and
- (i) Provision on delay compensation and abandonment of projects.

11.2 SPPA Timeline

Figure 11 illustrates the generic timeline for the SPPA from the signing of the PPA. This timeline is indicative only.

Figure 11: Indicative timeline for the SPPA



11.3 SPPA Submission

A Shortlisted Bidder is required to submit the SPPA to Distribution Licensee within 90 days upon receiving the Notification to Shortlisted Bidder from the Commission.

Below are the lists of documents required for submission (not limited to)—

- (a) SPPA;
- (b) Notification to Shortlisted Bidder and Notification to Shortlisted Bidder;
- (c) LSS Plant installation;
- (d) Interconnection and Communication facilities;
- (e) PSS report;
- (f) Declaration of MAAQ;
- (g) Permanent generation license by the Commission is condition precedence to IOD and will be part of IOD checklist;
- (h) Submission of certified and executed site/lease agreement over land title as the estimated time for issuance of a land title is expected to be longer – may involve issue of conversion of type of land use etc; and
- (i) Corporate Authorizations.

ATTACHMENTS

ATTACHMENT A : Smart Inverter Functions

1. 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.

2. 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.

3. 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	<p>Automatically disconnect during grid failure within certain duration. The duration is adjustable.</p> <p>Anti Islanding protection is to ensure Inverter doesn't back-feed a disabled grid</p>	<p>Low voltage :</p> <ul style="list-style-type: none"> • Disconnect 2sec • Reconnect 2min <p>Medium voltage:</p> <ul style="list-style-type: none"> • Disconnect 2sec • Reconnect 5min 	<ul style="list-style-type: none"> • Distribution Code: 7.8.3.5 - Protection and Control Requirements
2	Voltage and Frequency Ride-through Capability	<p>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.</p>	<p>LVRT/HVRT: Refer the graph (6.2.1)</p> <p>LFRT/HFRT:</p>	<ul style="list-style-type: none"> • Distribution Code: 6.5.5.1 - Low Voltage Ride Through and 6.5.5.2 -

No.	Functions	Description	Setting	Reference
		<p>Inverters support the grid during brief voltage or frequency excursions. This function will help the grid to self-heal from a disturbance.</p> <p>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</p>	<p>uninterrupted range 47Hz to 50.5Hz</p>	<p>Frequency disturbance</p>
3	Ramp Rate Control	<p>The rate of power increase when first ramping (start ramp) and subsequent increases in offsetting or selling (normal ramp)</p> <p>To help smooth transitions from one output level to the next. Supports grid by ramping up slowly giving the grid time to adjust to the PV energy coming back online.</p>	<p>Does not exceed 15% of rated capacity per minute.</p> <p>Applicable for LSS Plant capacity of 5MW and above</p>	<ul style="list-style-type: none"> Grid Code: CC6.4.12
4.	Reactive Power Control Functions	<p>Inverter is able to supply or absorb reactive power to/from the grid to maintain stable grid voltage when fluctuations are prevalent.</p> <p>Variable PF provides active voltage stabilization:</p> <ul style="list-style-type: none"> Grid voltage nominal, purely active power Grid voltage high, add 'inductive' reactive power 	<p>Voltage range:</p> <p>(MV-11kV and 33kV) ± 5%</p> <p>(LV- 230V and 400V) -6% +10%</p> <p>PF range:</p>	<ul style="list-style-type: none"> Distribution Code: 5.4.4.1 - Voltage range, 6.5.5.5 - Reactive power, 7.8.3.8 - PF

No.	Functions	Description	Setting	Reference
		<ul style="list-style-type: none"> • Grid voltage low, add 'capacitive' reactive power <p>Adjusting VARs keeps grid voltage from oscillating; acts like a shock absorber</p> <p>The reactive power control can be achieved using 3 main controls:</p> <ul style="list-style-type: none"> (a) Dynamic Volt/VAr Mode (voltage control) (b) Fixed PF (pf control) (c) Fixed reactive power (eg: using switched reactor) <p>Inverters are able to provide reactive power (Q) at night function.</p>	<p>0.85 lagging to 0.9 leading</p>	
5.	<p>Active Power Control Functions</p> <p>Frequency-Watt (Droop Curve) and Volt-Watt</p>	<p>Support grid frequency and voltage by changing Inverter wattage output:</p> <p>Help to stable the grid during an under/over frequency and voltage event by controlling the real output of the solar system.</p> <ul style="list-style-type: none"> • Grid frequency/voltage nominal, Inverter at max output • Grid frequency/voltage high, Inverter curtails power • Grid frequency/voltage low, Inverter increases power 	<p>Frequency range: 47Hz to 50.5Hz</p> <p>Voltage range: (MV-11kV and 33kV) $\pm 5\%$</p> <p>(LV- 230V and 400V) -6% +10%</p>	<ul style="list-style-type: none"> • Distribution Code: 6.5.5.4 - Droop curve, 5.4.41 - Voltage range & 6.5.5.3 - Power output management
6.	<p>Data log/Memory card for event logs</p>	<p>Capture profile of networks parameters – Voltage, Current, Frequency, Power (active and reactive), PFs and events log.</p>	<p>N/A</p>	<p>Distribution Code: 6.8.1.3 - Distribution System Control Structure</p>

No.	Functions	Description	Setting	Reference
		The data log can be used for troubleshooting and monitoring purposes.		
7.	Remote monitoring and configurability	Able to control remotely using SCADA system (for capacity 1MW and above)	N/A	Distribution Code: 6.8.1.3 - Distribution System Control Structure

ATTACHMENT B: IOD Checklist

CHECKLIST FOR INITIAL OPERATION DATE (IOD) FOR RENEWABLE ENERGY PROJECT

SOLAR POWER PRODUCER (SSP):

LOCATION OF DEVELOPMENT:

NET EXPORT CAPACITY: kW CLOA NO.

M&E CONSULTANT: M&E CONTACT NO.

M&E EMAIL ADD:

1. Notification letter for IOD (not less than 60 days) to TNB attached with complete documents
2. A certificate from an Independent Engineer (approved by ST) stating that interconnection facilities have been designed and constructed in accordance with Prudent Utility Practices
3. Attach a copy of as-built drawing of RE installation and interconnection facilities
4. Attach a final copies of Interconnection Operation Manual (IOM) agreed by TNB
5. Attach the acceptance test result, Factory Acceptance Test and laboratory test result for anti-islanding of installation to TNB
6. Attach the details and test results of interconnection facilities:
 - a) Electrical protection scheme
 - b) Protection coordination study for DG Plant
 - c) Cable test result (if applicable)
 - d) Overhead test result (if applicable)
 - e) SCADA
 - f) VCB dan DC system test results
 - g) Calibration certificate for testing equipments used
 - h) G & H forms (requested by Electricity Supply Act 1990)
7. Metering installation:
 - a) A copy of Borang Maklumat Awal Perjangkain Besar approval letter
 - b) A copy of payment receipt for purchasing the meter(s)
8. Handover document for substation & land (if any):
 - a) Borang A and Borang TNB 229
 - b) Pre-comp plan (substation lot etc)
 - c) Bank Guarantee RM 20k
9. Copies of all authorities approval letters;
 - a) CLOA from ST
 - b) Permanent Generation License By Suruhanjaya Tenaga (ST)
 - c) Approved Certificate as an Independent Engineer from ST
 - d) Right of Ways for poles and/or cable routes By Local Authorities
10. Attach schedule of RE generation (kWh) on hourly basis from IOD to COD (not less than 7 days)
11. Written confirmation by TNB station and Protection Head on the satisfactory of site works and none outstanding issues

Herewith, we verify that the above documents have been submitted and received by TNB

Prepared by: Independent Engineer (appointed by ST)	Checked by: (TNB - RE>)	Verified by: (TNB - RE>)
.....
Name: Date:	Name: Date:	Name: Date:

ATTACHMENT C: COD Testing Requirements

In general, the LSS Plant shall adhere to the requirements as stipulated in the Distribution Code. The salient requirements extracted from the relevant clauses in the Distribution Code or other standards are summarized as follows:

No.	Test	Requirement in MV connection guideline	Procedure	Expected passing result
1.	Grid frequency variation	6.1.3	Factory test	Pass
2.	Reactive power control a) Voltage control mode b) PF control mode	6.2.4 and 6.2.3	Factory test and Site test	Pass
3.	Grid System voltage variation	6.1.1	Factory test	Pass
4.	Grid System fault level	6.1.10 and PSS	Site verification based on nameplate rating	Compliance to PSS
5.	Protection System	6.3.1 6.3.2 6.3.3 6.3.4 6.3.6	Site verification	Compliance to coordination study
6.	Voltage Support (AVQC) and Active Power Control	6.2.3	Factory test and Site test	Pass
7.	Equivalent control device to speed governor (Droop curve)	6.2.5 6.1.3	Factory test	Pass
8.	Frequency MW Response	6.2.2	Factory test	Pass
9.	Power Quality	6.1.5	Site test	Pass

No.	Test	Requirement in MV connection guideline	Procedure	Expected passing result
10.	Fault ride through (LVRT)	6.2.1	Factory test	Pass
11.	Power Ramping (up and down)	6.2.6	Site test	Pass
12.	Inverter functional tests and verifications	6.3.7.1 6.3.7.2 6.3.8 6.1.4 6.1.5	Site test	Pass

ATTACHMENT D: Example of Invoice Layout

Nama FIAH, Alamat dan No Pendaftaran GST TECHNO GENERATORS SDN BHD Lot 21-3, KLCC, Kuala Lumpur GST NO : 000123456789		TAX INVOICE		
To : TENAGA NASIONAL BERHAD Pengurus Besar (Pembangunan Tenaga Lestari) Jabatan Perkhidmatan Pengguna ian Pembahagian, TNB 6, Wisma TNB, Jalan Timur. 46200 Petaling Jaya Selangor		Invoice No : ABCD1234 Date : 14 March 2016 Billing Period : 1 - 29 Feb 2016 (29 days)	Perkataan INVOIS CUKAI Tarikh Invois Cukai dikeluarkan	
Nama Pelanggan dan Alamat	No Serial Invois Cukai	Butir-butir perkhidmatan/ pembekalan	Jumlah tidak termasuk cukai	
No	Descriptions	Unit (kWh)	Rate (RM/kWh)	Amount (RM)
	Sales of electricity Reading from 1 - 29 Feb 2016 (29 days)	505,067	0.3184	160,813.33
	Current reading 29,073,164 (-) Previous reading 28,568,097 <hr/> 505,067			
Please make payment to RHB Bank Berhad 21160-3456-97643 For TECHNO GENERATORS SDN BHD <i>Leenie Day SA</i>			Total without GST	160,813.33
		add	GST (6%)	9,648.80
			Total	170,462.13
				Jumlah dikenakan GST
				Jumlah termasuk GST



**No. 12, Jalan Tun Hussein
Precinct 2**

62100 Putrajaya

Tel : +603 8870 8500

Fax : +603 8888 8637

Web : www.st.gov.my