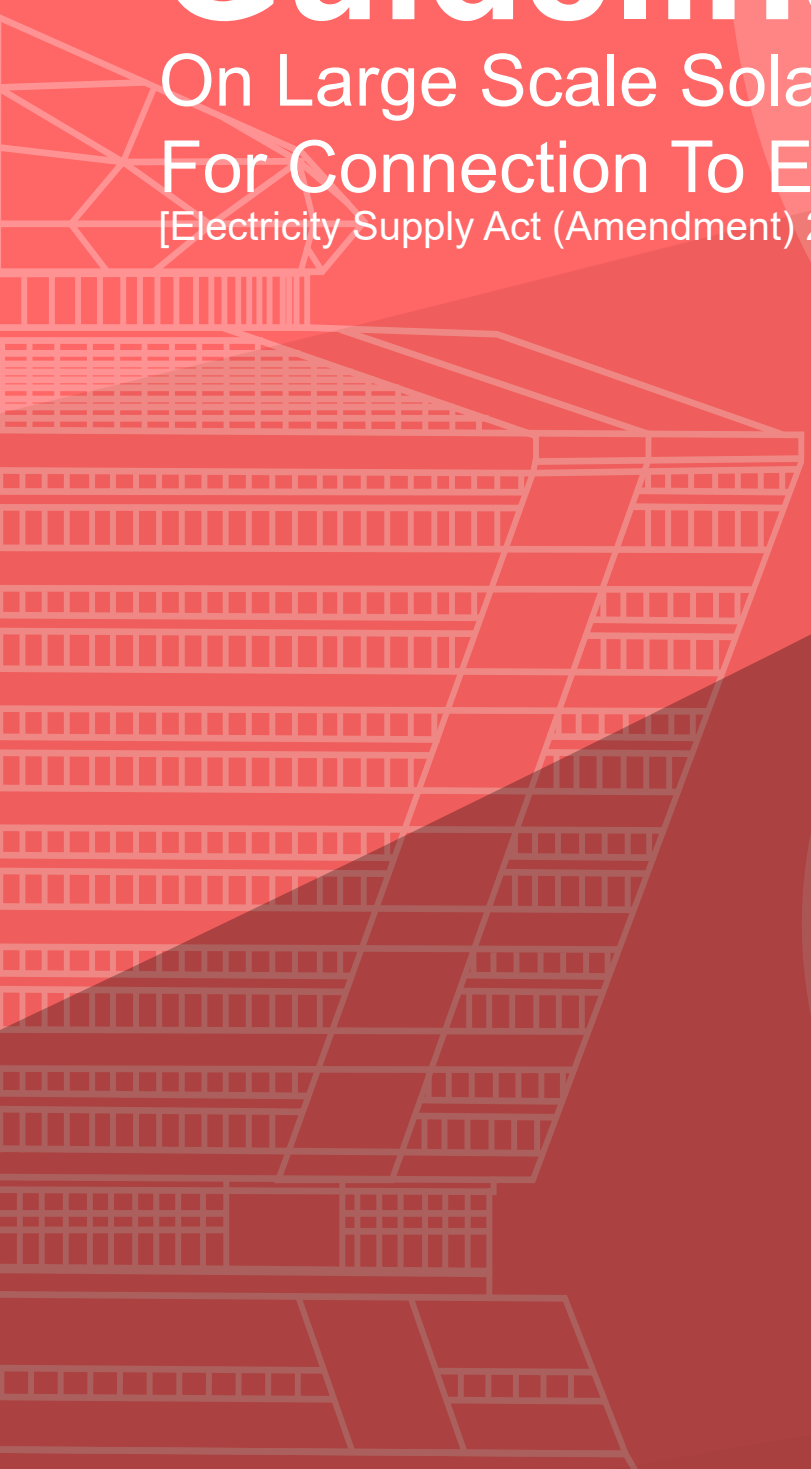
Suruhanjaya Tenaga
Energy Commission

Registration No : GP/ST/No. 1/2016 (Pin. 2019)

Guidelines

On Large Scale Solar Photovoltaic Plant For Connection To Electricity Networks

[Electricity Supply Act (Amendment) 2015 (Act A1501)]



Registration Record

Version	Revised By	Revision Date
GP/ST/No.1/2016	Energy Commission	28 April 2016
GP/ST/No.1/2016(Pin.2019)	Energy Commission	20 December 2018

ELECTRICITY SUPPLY ACT 1990
[*Act 447*]

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

GP/ST/ No. 1/2016 (Pin. 2019)

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

Citation and Commencement

1. These Guidelines may be cited as the Guidelines On Large Scale Solar Power Plants For Connection to the Transmission and Distribution Electricity Networks.

2. These Guidelines shall come into operation on the date of registration of these Guidelines.

Application of these Guidelines

3. These Guidelines shall apply to:
   i) any person who has been given the right by the Commission to develop large scale solar power plant and seeking connection to the transmission and distribution electricity network with a capacity as reflected in the Request for Proposal (RFP) issued by the Commission ;
   ii) the relevant licensee, whose network is to be connected with the Large Scale Solar (LSS) power plant;
   iii) the Single Buyer or relevant distribution licensee who manage the contractual arrangement for the sale and purchase of electricity through the network; and

iv) the Grid System Operator and distribution system operator.

These Guidelines are not applicable to large scale solar power plants which have been given the right through Sustainable Energy Development Authority (SEDA) to develop the plant under feed in tariff scheme.

Interpretation

4. In these Guidelines, the term used shall, unless the context otherwise requires, have the same meaning as in the Act, regulation or codes made under it. In addition, the following words and expressions shall have the meanings hereby assigned to them.

Term	Definition
Commercial Operation Date (COD)	means the date on which all relevant conditions precedent under the Power Purchase Agreement (PPA) have been satisfied or waived;
Commission	means the Energy Commission or Suruhanjaya Tenaga established under the Energy Commission Act 2001 (Act 610) and any successor thereof;
Directly Connected Customers	as defined in the Grid Code;
Distribution Network	as defined in the Grid Code;
Energy Rate	means the approved rate by the Commission or any other rate as may be adjusted in accordance with the terms of the PPA;
Facility	means a solar photovoltaic 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 PPA and includes any modification thereto;
Grid Code	means the Grid Code for Peninsular Malaysia or Grid Code

Term	Definition
	for Sabah and Labuan**,** as amended from time to time in accordance with applicable laws**;**
Grid Owner	means the party that owns the high voltage backbone Transmission Network and is responsible for maintaining adequate Grid System capacity in accordance with the provisions of the Grid Code and license standards and registered as the Grid Owner 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;
Interconnection Point	means the demarcation line for ownership and maintenance as shown in section 3.4 of Appendix B of the Guidelines and more specifically described in the PPA;
Large Scale Solar (LSS)	means any solar photovoltaic plant with capacity as approved by the Commission connected to either the Transmission Network or Distribution Network in Peninsular Malaysia, Sabah or Labuan;
Point of Common Coupling	means the point on the Transmission Network which is electrically closest to the user installation at which either demands (loads) are, or may be, connected;
Power Park Module	as defined in the Grid Code;
Power Purchase Agreement (PPA)	means agreements between TNB or SESB (as the case may be) and generators relating to the financial and technical conditions for the purchase of the energy output and technical conditions relating to its connection to and performance on the Grid System;

Term	Definition
Sabah Electricity Sdn Bhd (SESB)	means a limited liability company incorporated under the Companies Act, 2016 (Company Registration No. 462872-W);
Single Buyer	means as defined under the Guidelines for Single Buyer Market (Peninsular Malaysia);
Shortlisted Bidder	means bidders shortlisted to comply with conditions imposed by the Commission and to finalize the project documents;
SPP Interconnection Facility (SPP IF)	means the new 132kV substation owned by a LSS developer as further described in the PPA to enable LSS developer to deliver solar PV energy from the Facility to the Grid System, as further described in the PPA;
SPP Interconnector	means the transmission line(s) or underground cable(s) (including any associated facilities) that interconnect the SPP Interconnection Facility and TNB Interconnection Facility, as further described in the Technical Specifications;
Successful Bidder	means the Shortlisted Bidder who is issued a letter of award or notice of compliance upon execution of the Project Document;
Tenaga Nasional Berhad (TNB)	means a public listed company incorporated under the Companies Act, 2016 (Company Registration No. 200866-W);
TNB Interconnection Facility (TNB IF) or SESB Interconnection Facility	means the existing TNB's or SESB's substation (including but not limited to any extension works required to be completed by the LSS developer at such TNB's or SESB's substation) or a new switching station to be completed by the LSS developer, as further described in the Technical Specifications;

Term	Definition
Transmission Network	The transmission lines, substations and other associated plant and apparatus operating at 132 kV or above in Peninsular Malaysia, and at primary phase voltages greater than 33kV in Sabah and Labuan as defined in the Grid Code;

Key Principles of LSS Framework

5. The key principles of LSS framework shall be as follows:

i) The participant of the LSS program must be a local company of which the Malaysian equity interest in such local company is at least 51% or a consortium of legal entities which includes a minimum of one local company and which has Malaysian equity interest in the consortium of at least 51%;

ii) The usage of land to be used for the LSS power 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;

iii) The plant capacity range for LSS power plant is as specified in the RFP;

iv) 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;

v) The PPA shall be based on take and pay, energy only under Build, Own and Operate (BOO) concession;

vi) The LSS power 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 PPA with one Energy Rate shall be applied;

vii) The PPA duration is 21 years with fixed energy price throughout;

viii) The offers by the Shortlisted Bidders shall be based on the optimum output, final yield and specific yield of the proposed LSS power plant in accordance with the design and technology used.

ix) The LSS developer shall declare the plant's energy production for 21 years. In the PPA, the LSS developer is entitled to be paid the Energy Rate up to the LSS power plant's Maximum Annual Allowable Quantity (MAAQ). Any energy beyond MAAQ, if accepted by TNB or SESB, shall be paid at the Excess Energy Rate; and

x) The Energy Rate shall include but not limited to the following:

- *Engineering Procurement and Construction (EPC)*
- *Land cost*
- *Project development cost*
- *Financing cost*
- *O&M cost*
- *Interconnection cost*

Potential Connection Points (Nodal Points)

6. Certain locations have been identified as potential connections points (nodal points) to the electricity transmission and Distribution Networks operated by TNB or SESB to facilitate prospective bidders. These nodal points will be issued as part of a request for qualification (RFQ) or RFP documents. LSS developer shall perform power system study (PSS) for connection to the potential nodal points. Any alternative connection point may be proposed but its acceptance is up to the discretion of the Commission after consultation with the Grid System Operator and the distribution system operator. All costs associated with the connection of LSS power 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**.

Responsibility of the LSS developer

7. The LSS developer is fully responsible to:

i) acquire land or submit certified and executed Site/Lease Agreement as reflected in the land title;

ii) obtain right of way (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 Point of Common Coupling as **Figure 1**, **Figure 2** and **Figure 3**; and

iii) design, construct, test, commission and complete the LSS power plant.

Figure 1: Illustration of Asset Demarcation

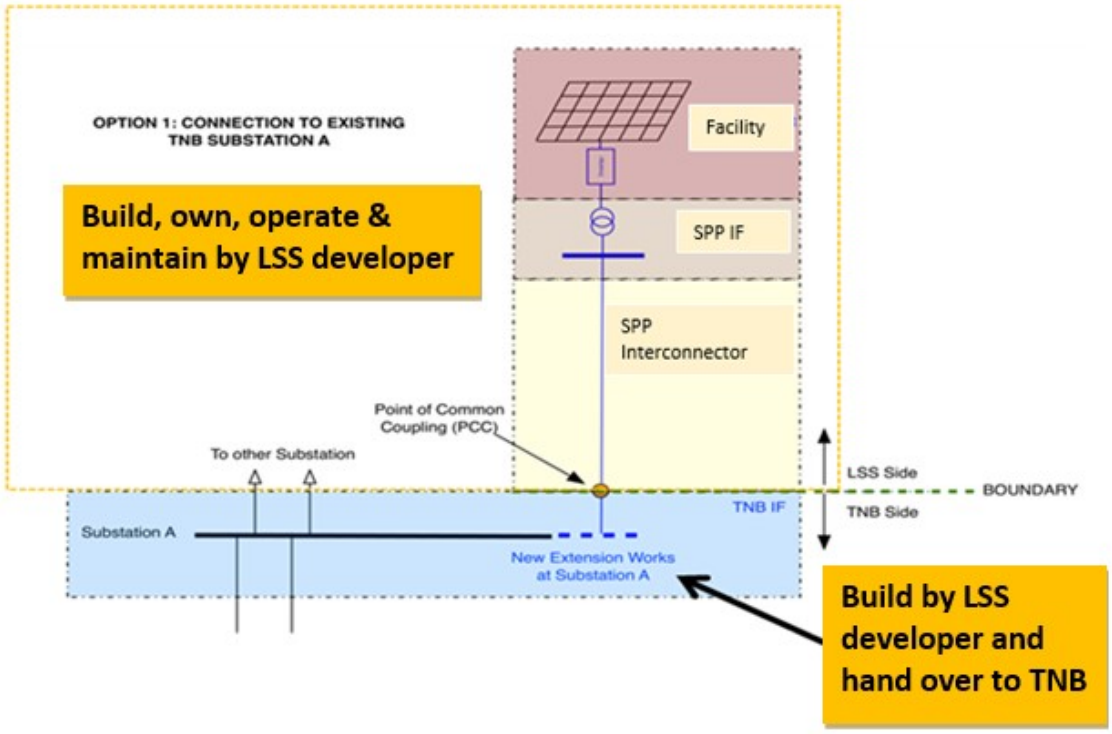


Figure 2: Illustration of Asset Demarcation

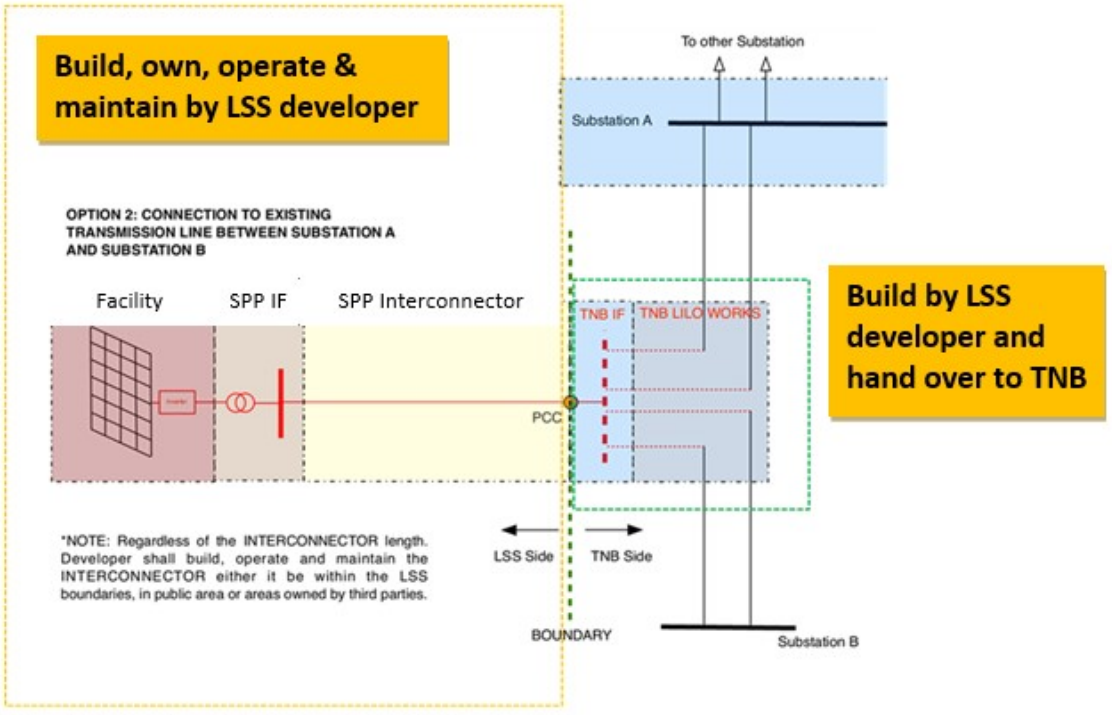
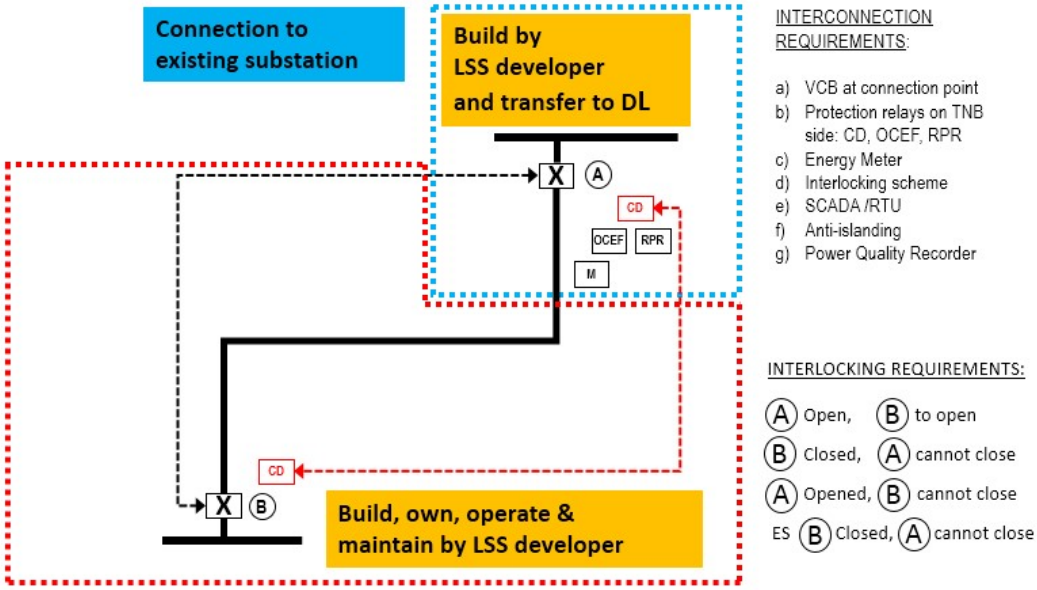


Figure 3: Illustration of Asset Demarcation



8. The following documents will be a useful guide in preparing the RFP submissions:

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

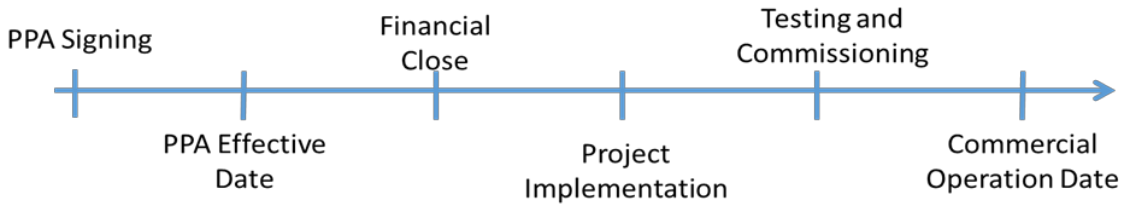
Award of the Project

9. The Commission will issue a letter of acceptance of offer or notice of terms and conditions for development of project to the Shortlisted Bidders, and the Shortlisted Bidders will finalise the PPA with the distribution licensee or Single Buyer based on the PPA that has been approved by the Commission. Upon satisfaction of the conditions imposed by the Commission in the letter of acceptance of offer or notice of terms and conditions, the Commission will issue a letter of award or notice of compliance to the Successful Bidders and the Successful Bidders must fulfill all Conditions Precedents (CPs) under the PPA, particularly on the submission of certified and executed site agreement.

Critical Milestones to Commercial Operation Date (COD)

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

Figure 4: Timelines from Post-PPA to COD



Licensing Requirement

11. All LSS power plants shall be licensed under Section 9 of the Act. For licensing purposes, the Guidelines on Licensing is available on the Commission's website htpps://www.st.gov.my, and an application shall be made through the on-line application at https://oas.st.gov.my link.

Dispute Resolution

12. Any dispute in relation to the implementation of these Guidelines shall be resolved in accordance with the dispute resolution process and procedures as set out by the Act.

Notice by the Commission

13. The Commission may issue written notices from time to time in relation to implementation of these Guidelines.

Amendment and Variation

14. The Commission may at any time amend, modify, vary or revoke these Guidelines.

Dated: 24 January 2019

IR. AZHAR BIN OMAR
Chief Executive Officer
for Energy Commission

APPENDIX A :

LSS Program Process Flow Chart

Principles of LSS Program

Government Policy

- To increase renewable energy in the energy generation mix.
- Planning of LSS power plant planting up as approved by related committee in the Ministry.

Implementation Principles

- Guidelines issued by ST as provided under Section 50C of ESA 1990 (Amendment 2015).
- Competitive bidding by ST.
- Take and pay, energy only PPA for 21 years and the Energy Price is fixed throughout 21 years period.
- Developers to build, own & operate (BOO)
- Foreign ownership shall not be more than 49%.
- To optimize land usage for other economic activities (eg: agriculture)
- Connected to Distribution (for less than 30MW_{ac}) or Transmission (for more than 30MW_{ac}) network.

Program Flow Chart

Pre-Qualification (Request For Qualification) and/or Request For Proposal

- To evaluate company's financial & technical capability
- Request For Qualification and/or Request For Proposal document will be issued by ST.
- ST will invite the shortlisted participants to participate in RFP stage.
- Bidders will receive the RFP documents including draft PPA, Guidelines for LSS Photovoltaic Connection to Electricity Network & Non-Disclosure Agreements form.
- Potential connections (nodal points) to TNB/SESB network will be provided.
- The LSS developer is fully responsible to
  - acquire land or submit certified and executed Site/Lease Agreement over Land Title
  - obtain Right Of Way (ROW) & permits from relevant local authorities, the required Interconnection Facility (IF) and network reinforcement up to the Point of Common Coupling (PCC).
  - design, construct, commission, test and complete LSS plant
- All costs associated with the connection of LSS and power system studies, shall be borne by the LSS developers.

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Submission of Request for Proposal (RFP)

- Bidders submit the following, but not limited to, to ST:
  - All documents as specified in RFP;
  - Financial commitment documents;
  - certified copy of site agreement for facility & route survey for interconnection ROW;
  - Approved PSS study by Grid Owner/Distribution Licensee;
  - Consortium arrangement (if any)
- Declaration of energy production:
  - Annual energy production;
  - Maximum Annual Allowable Quantity (MWh) for 21 years
- To submit financial model.

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Evaluation of RFP Submission

- Levelised cost of energy (LCOE).
- Compliance with technical standard and regulatory requirements.
- Fulfil the technical and financial requirements as per RFP.

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Acceptance of Offer or Notice of Terms and Conditions

- ST issues letter of acceptance of offer or notice of terms and conditions to shortlisted bidders.

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PPA Signing

- Shortlisted bidder will enter into a contract (PPA) with TNB/SESB.
- Shortlisted bidder to complete Project Document as specified in letter of acceptance of offer/notice.

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Award

- ST issues letter of award or notice of compliance to successful bidders.

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PPA Effectiveness

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Financial Close

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Project Implementation

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Commercial Operation Date

APPENDIX B :

Technical Specification for Transmission-Connected LSS

Disclaimer:

The Appendix B of these Guidelines specifies technical specifications for transmission-connected LSS has been prepared for guidance and informational purpose only. It does not contain comprehensive information needed for the submission of the RFP and in designing the facilities needed for the LSS. Whilst all reasonable care has been taken in the preparation of the Guidelines, the Commission, Single Buyer, Grid System Operator and/or Grid Owner does not make any representation, warranty or undertaking, expressed or implied, in or in relation to the completeness and or accuracy of information contained in the Guidelines. To this end, the Commission, Single Buyer, Grid System Operator and/or Grid Owner disclaims all or any responsibility whatsoever to anyone for information contained in the Guidelines or for any representation or statement herein, whether expressed or implied, or for any responses given in response to any queries on or in relation to the Guidelines. All such persons expressly disavow any obligation or duty (whether in contract, tort or otherwise) to any prospective LSS developer and disclaim any and all liability based on or relating to any such information or representations or warranties (expressed or implied) contained in, or errors or omissions from, the Guidelines or based on or relating to the use of the Guidelines or any other written or oral communication transmitted to or information provided to or otherwise acquired by a prospective LSS developer.

A prospective LSS developer shall be solely responsible for its interpretation of the information provided to or otherwise acquired by the prospective LSS developer. The prospective LSS developer certifies that it understands, accepts and agrees to the disclaimers on this page. Nothing contained in any other provision of the Guidelines, nor any statement made orally or in writing by any person or party shall have the effect of negating or superseding any of the disclaimers on this page.

Contents

Abbreviations

This section describes a list of abbreviations that appear in this document.

Abbreviations	Description
AGP	Annual Generation Profile
BOO	Build, Own and Operate
COD	Commercial Operation Date
CDGU	Centrally Despatched Generating Unit
DAQ	Declared Annual Quantity
DDQ	Declared Daily Quantity
EMS	Energy Management System
EPCC	Engineering, Procurement, Construction and Commissioning
EER	the Excess Energy Rate (in RM/kWh) for that billing period
ER	the prevailing Energy Rate (in RM/kWh) applicable for that billing period
FACTS	Flexible Alternating Current Transmission System
FAT	Factory Acceptance Test
GCAP	Generator Reactive Capability
GSO	Grid System Operator
GSU	Generator Step Up
IE	Independent Engineer
IOD	Initial Operation Date
IOM	Interconnection Operation Manual
LSS	Large Scale Solar Photovoltaic Plant
kV	Kilo-Volt
kWh	Kilo-Watt hour
MAAQ	Maximum Annual Allowable Quantity (in kWh)
MW_{ac}	Mega-Watt
NDA	Non-Disclosure Agreement
NEO	Net Electrical Output (in kWh)
PCC	Point- of- Common –Coupling
PPA	Power Purchase Agreement
PSS	Power System Study
PV	Photovoltaic
RFP	Request for Proposal
RFQ	Request for Qualification
SB	Single Buyer
SCADA	Supervisory Control and Data Acquisition
SCOD	Scheduled Commercial Operation Date
ST	Commission
SPP	Solar Power Producer

SPP IF	SPP Interconnection Facility
TNB	Tenaga Nasional Berhad
TNB IF	TNB Interconnection Facility
TSRS	Transmission System Reliability Standard

Glossary of Terms

In the Guidelines, words and expressions which are defined in the Grid Code or the Guidelines for Single Buyer Market (Peninsular Malaysia) shall (unless it is otherwise defined in the Guidelines or the context requires otherwise) have the same meaning when used in the Guidelines. In addition, the following words and expressions shall have the meanings hereby assigned to them.

Term	Definition
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;
Commencement Date	means the date notified by LSS developer to TNB on which the notice to proceed under the Engineering Procurement and Construction contract is issued;
Commercial Operation Date or COD	means the date on which all relevant conditions precedent under the PPA have been satisfied or waived;
Commission	means the Energy Commission or Suruhanjaya Tenaga established under the Energy Commission Act 2001 (Act 610) and any successor thereof;
Contract Year	means the date on which begins on the Commercial Operation Date of the Facility and ends on December 31 of the year in which the Commercial Operation Date of the Facility occurs, each subsequent period during the term of the PPA which begins 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 PPA;
Declared Annual Quantity	means the annual quantity (in MWh) of solar photovoltaic 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 given 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 PPA;

Term	Definition
Despatch Instruction	means an oral or written instruction or electronic signal communicated to LSS developer by the Grid System Operator or the control centre directing the Facility to commence, decrease or cease the generation and delivery of solar photovoltaic energy into the Grid System, in accordance with the provisions of the PPA;
Distribution Network	as defined in the Grid Code;
Effective Date	means the date on which all relevant conditions precedent listed under the PPA have been satisfied or waived;
Energy Rate	means the rate as stated in the PPA or any other rate as may be adjusted with the terms of the PPA;
Established Capacity	means not less than 30MW_{ac} but not more than capacity as approved by the Commission;
Facility	means a solar photovoltaic energy generating facility located at the site with a capacity of not less than 30 MW_{ac} and as approved by the Commission and ancillary equipment and facilities as more specifically described in the PPA and includes any modification thereto;
Grid Code	means the Grid Code for Peninsular or Grid Code for Sabah/Labuan, as amended from time to time in accordance with applicable laws**;**
Grid Owner	means a part of TNB that owns the high voltage backbone Transmission Network and is responsible for maintaining adequate Grid System capacity in accordance with the provisions of the Grid Code and license standards and registered as the Grid Owner 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;
Grid System Operator	as defined in the **Grid Code**;
Initial Operation Date	means the date on which Net Electrical Output is first generated and delivered from the Facility to the Grid System;
Interconnection Point	means the demarcation line for ownership and maintenance as shown in section 3.4 of Appendix B of the Guidelines and more specifically described in the PPA;
Large Scale Solar or LSS	means any solar photovoltaic plant with capacity as approved by the Commission connected to either the Transmission Network or

Term	Definition
	Distribution Network in Peninsular Malaysia, Sabah or Labuan;
Net Electrical Output	means the solar photovoltaic energy generated and delivered to the Grid System at the Interconnection Point from the Facility by LSS developer as measured in kWh by the TNB Metering Equipment or as otherwise determined in accordance with the provisions of the PPA during such period;
Power Park Module	as defined in the **Grid Code**;
Power Purchase Agreement or PPA	means agreements between TNB or SESB (as the case may be) and generators relating to the financial and technical conditions for the purchase of the energy output and technical conditions relating to its connection to and performance on the Grid System;
Project Documents	means, collectively, the Power Purchase Agreement, the engineering procurement and construction contract, the operation and maintenance agreement, the site agreement and such other agreements as TNB and LSS Developer shall from time to time mutually designate as a "Project Document";
Prudent Utility Practice	as defined in the **Grid Code**;
Rolling 24 Hours Forecast	means the forecasted capacity (in MWac) 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 GSO to LSS developer in writing, and updated at every half-hour on a rolling basis commencing from the Initial Operation Date until the expiry of the PPA;
Sabah Electricity Sdn Bhd (SESB)	means a limited liability company incorporated under the Companies Act, 2016 (Company Registration No. 462872-W);
Single Buyer	means as defined under the Guidelines for Single Buyer Market (Peninsular Malaysia);
Solar Power Producer or SPP	means the owners of the LSS or solar photovoltaic plant with capacity as approved by the Commission, connected to either the Transmission Network or Distribution Network in Peninsular Malaysia, Sabah or Labuan;
SPP Interconnection Facility (SPP IF)	means the new 132kV substation owned by LSS developer to enable LSS developer to deliver solar photovoltaic energy from the Facility to the Grid System, as described in Section 3.4 hereunder and as further described in the PPA;

Term	Definition
SPP Interconnector	means the overhead transmission line(s) or underground cable(s) (including any associated facilities) that interconnect the SPP Interconnection Facility and the Grid System, as described in Section 3.4 hereunder and as further described in the PPA;
SPP Works	means the design, engineering, procurement, supply, manufacturing, construction, installation, erection, testing, commissioning, labour, services, facilities, equipment, supplies and materials to be furnished, supplied or performed by LSS developer at the TNB Interconnection Facility and if applicable including transmission lines and loop-in loop-out (LILO) works as further described in Appendix D of the PPA;
Tenaga Nasional Berhad	means a public listed company incorporated under the Companies Act, 2016 (Company Registration No. 200866-W);
TNB Interconnection Facility (TNB IF)	means the existing TNB's substation (including but not limited to any extension works required to be completed by the LSS developer at such TNB's substation) or new TNB's switching station, as described in Section 3.4 hereunder and as further described in the PPA;
TNB Metering Equipment	means the main and back-up metering equipment and devices (including telemetering equipment and software) as further described in the PPA, 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	The transmission lines, substations and other associated plant and apparatus operating at 132kV or above in Peninsular Malaysia, or at primary phase voltages greater than 33kV in Sabah and Labuan as defined in the Grid Code; and
Transmission System Reliability Standards (TSRS)	as defined in the Grid Code.

1. Introduction

The Guidelines have been prepared by the Commission to provide guidance to prospective LSS developers seeking connection to the Transmission Network in Peninsular Malaysia. The Guidelines comprise of nine (9) sections covering the following topics:

(i) Introduction;
(ii) Scope and Limitation;
(iii) Connection to The Grid System;
(iv) Power System Study (PSS);
(v) PPA Aspects;
(vi) Appendix B of PPA Requirements;
(vii) Requirement for Tests of the Facility;
(viii) Operation of Transmission-Connected LSS; and
(ix) Forecasting Requirements.

The Guidelines have been prepared based on Prudent Utility Practice and experiences with the existing generators.

2. Scope and Limitation

2.1. Description of Transmission-connected LSS

LSS that is allowed to be connected to the Transmission Network shall have capacity of not less than 30MW$_{ac}$ and as approved by the Commission at one Interconnection Point.

Therefore, if LSS developer owns more than one (1) LSS at different sites but connected to the TNB Interconnection Facility at one Interconnection Point, with cumulative capacity of not less than 30MW$_{ac}$ and as approved by the Commission, such LSS shall be connected to the Transmission Network as illustrated in Figure 1 below:

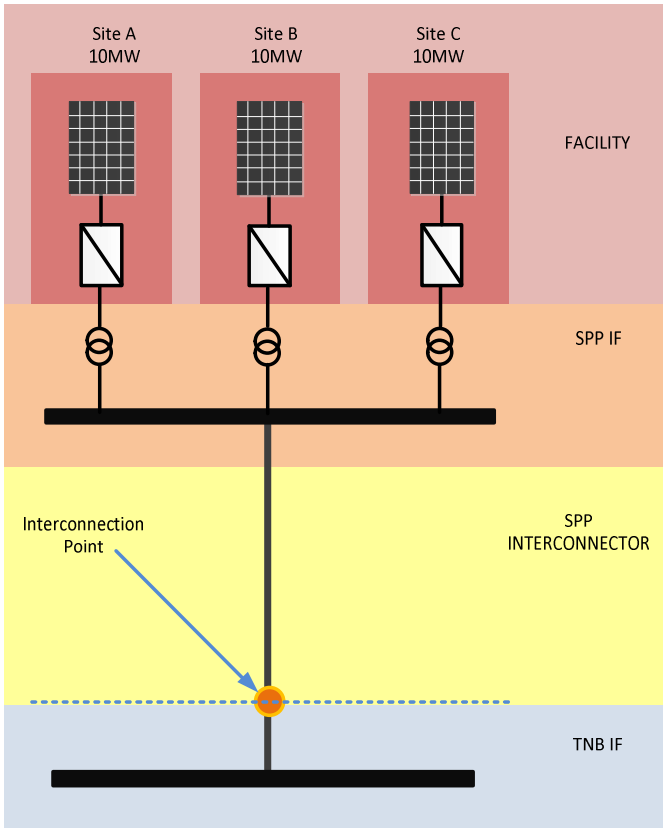


Figure 1: Example of Transmission-Connected LSS

2.2. Scope of the Guidelines

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

- LSS connected to the Transmission Network and Distribution Network in Sabah and Labuan; and
- LSS connected to the Distribution Network in Peninsular Malaysia.

The Guidelines are 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 transmission-connected LSS.

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 nodes as identified by the Grid Owner in order to meet the requirements of its PPA. 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 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. The Grid Owner shall bear no responsibility for any error, inaccuracy or omission of any kind and no warranty or representation is given in respect thereof. Each LSS developer accepts 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 Appendix B of the Guidelines.

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 the transmission-connected LSS. However, the capacity of the Grid System to accept power output from a transmission-connected LSS 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. In addition, the proximity of the transmission infrastructure to the transmission-connected LSS 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.

It is envisaged that the power generated by the transmission-connected LSS would be consumed locally, thus the connection shall be at the 132kV voltage level only. Aside from a lower associated equipment cost, the connection at 132kV voltage will ensure that the reliability and security of the bulk power highway are not affected.

3.3. Connection Schemes

There are two (2) possible connection schemes for transmission-connected LSS:

(i) Option 1: Connection Scheme to Existing Substation; or
(ii) 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 Interconnection Facility 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 Interconnection Facility 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.

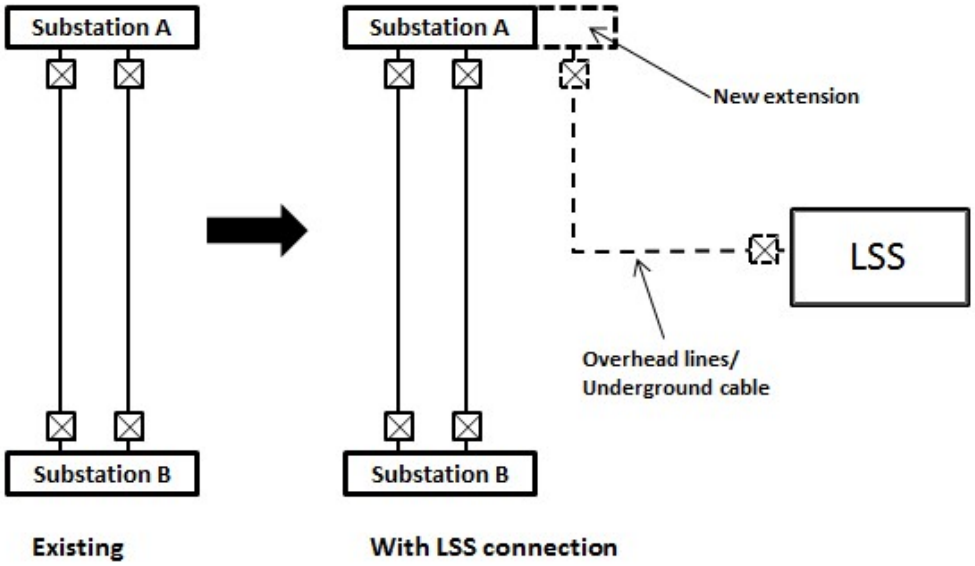


Figure 2: Option 1- Connection to Existing Substation

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 a fully switched connection. The existing overhead transmission lines or underground cable circuits shall be looped-in-looped-out and connected via overhead transmission lines or underground cable into the newly established switching station. The newly established switching station or new TNB Interconnection Facility 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 Interconnection Facility 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.

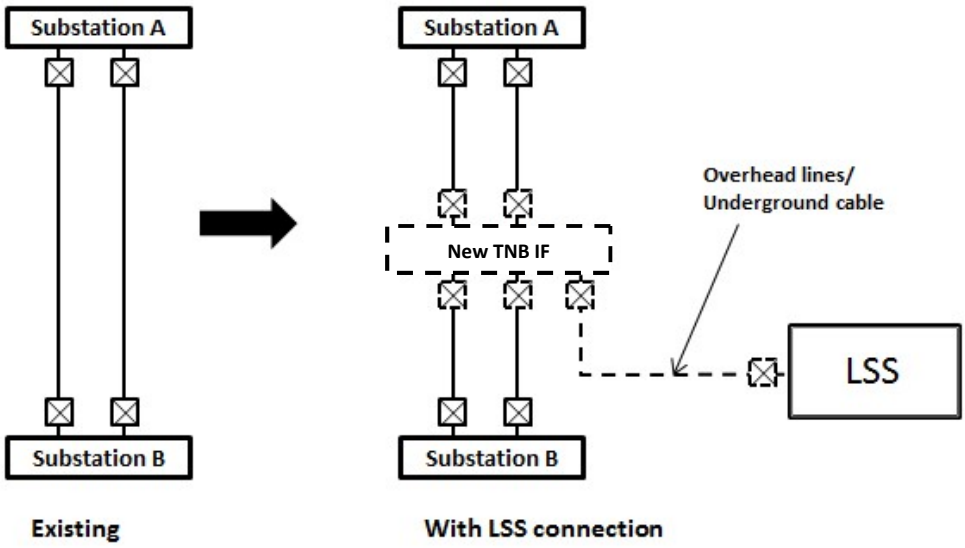


Figure 3: **Option 2- Connection to Nearest Existing Transmission Lines**

3.4. Scope of Works & Asset Demarcation

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 Interconnection Facility, SPP Interconnector and SPP Works; and

(b) the design, procurement, construction, commissioning, testing and completion of the followings:
   (i) Facility
   (ii) SPP Interconnection Facility;
   (iii) SPP Interconnector; and
   (iv) SPP Works which comprise the following:
      a. For option 1:
         i. Extension of main and reserve busbars work at existing TNB Interconnection Facility;
         ii. Establishment of full bay/bays for the SPP Interconnector; and
         iii. Including works in item (c) below.

b. For option 2:
   i. Establishment of a new TNB Interconnection Facility 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 Interconnection Facility to the two (2) single/double circuit (as determined by TNB) transmission lines;
   ii. Substation control building, including civil works, (M&E) works and associated facilities;
   iii. Two (2) single/double circuit (as determined by TNB) transmission lines connecting the new TNB Interconnection Facility to the nearest transmission lines (including loop-in-loop-out ("LILO") works for connection of the new TNB Interconnection Facility to the nearest existing transmission lines; and
   iv. Including works in item (c) below.

c. For both option 1 and option 2:
   i. Secondary equipment such as DC supply, control and relay panel, protection, auxiliary power and control cabling (APC), telecontrol, telecommunication, ICT and associated works;
   ii. Substation earthing system and associated works which includes soil resistivity tests;
   iii. Underground mapping for any underground cable routes;
   iv. TNB Metering Equipment; and
   v. Modifications or replacement of existing telecontrol and/or telecommunication equipment if required and protection relays retrofitting works in the existing TNB Interconnection Facility and in existing TNB's substations at both remote ends of the new TNB Interconnection Facility if required.

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

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

Upon successful commissioning and testing of the SPP Works, 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 PPA. Further, 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 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.

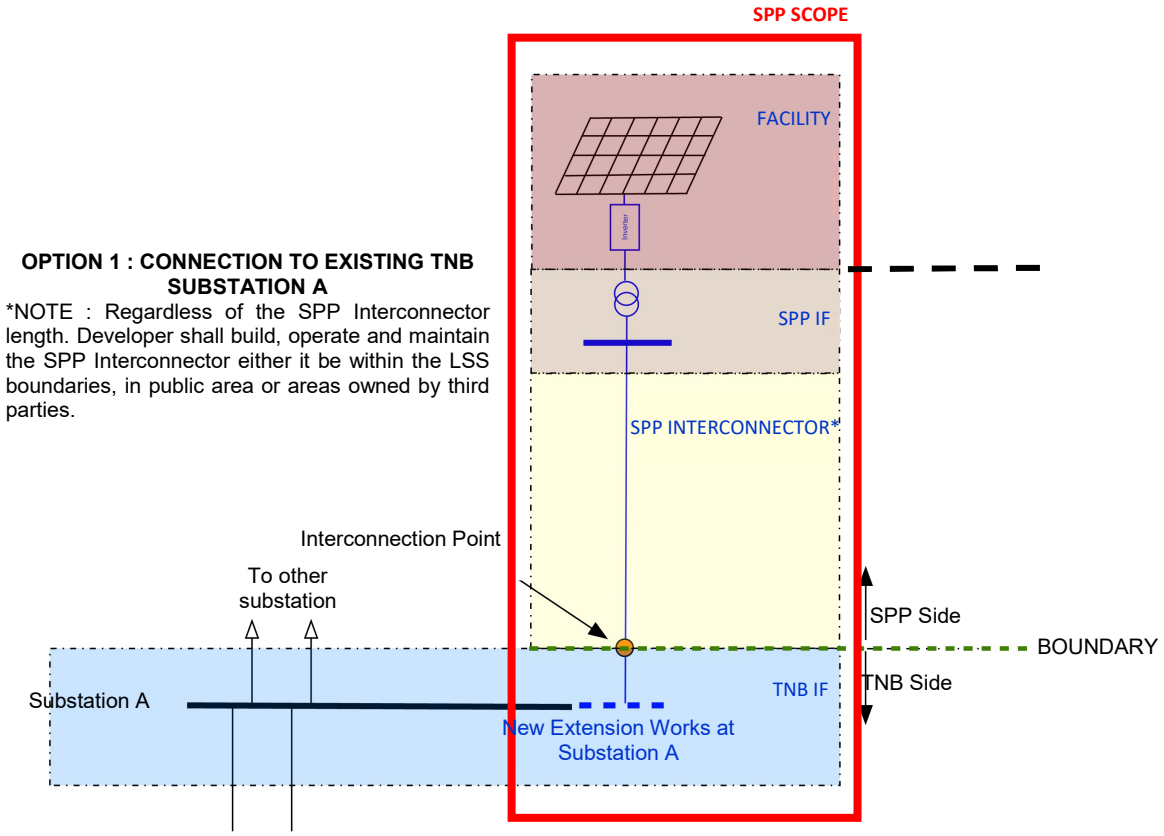


Figure 4: Scope of works & asset demarcation for Option 1

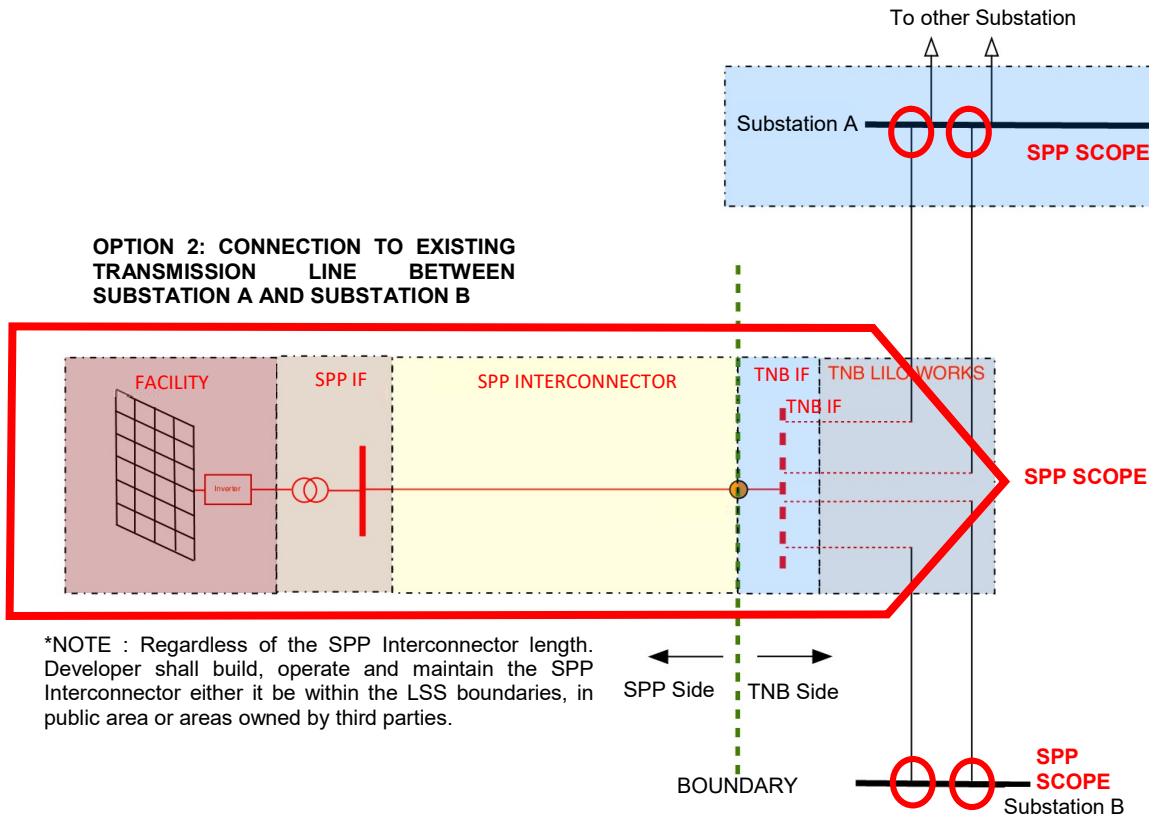


Figure 5: Scope of works & asset demarcation for Option 2

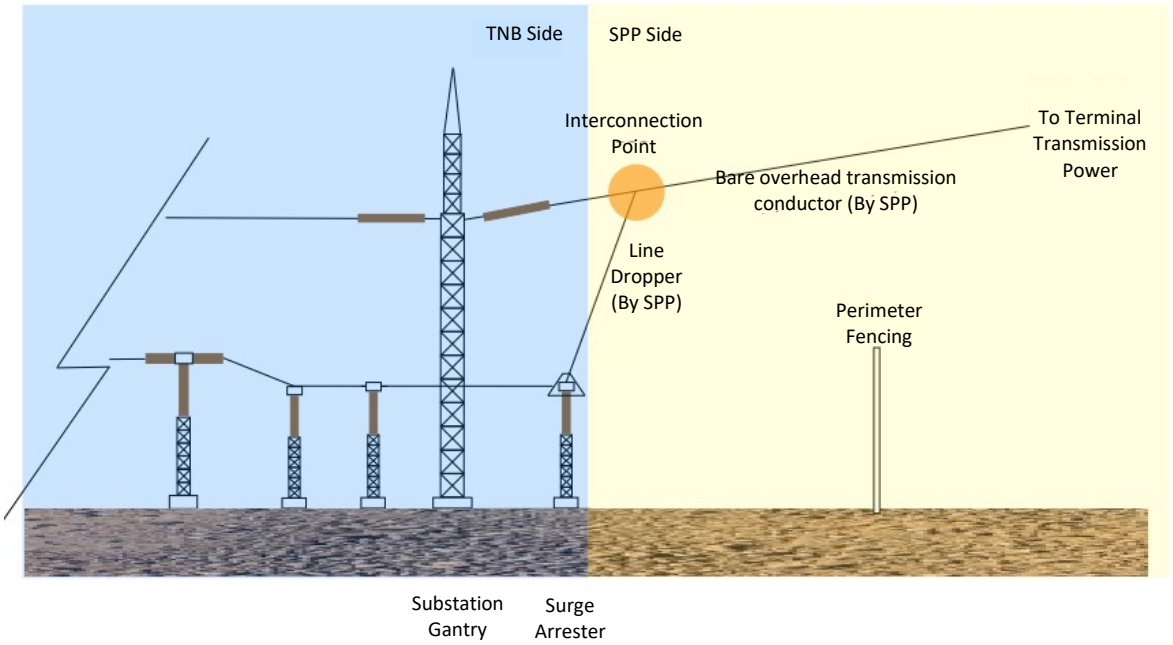


Figure 6: Interconnection Point for transmission line connection

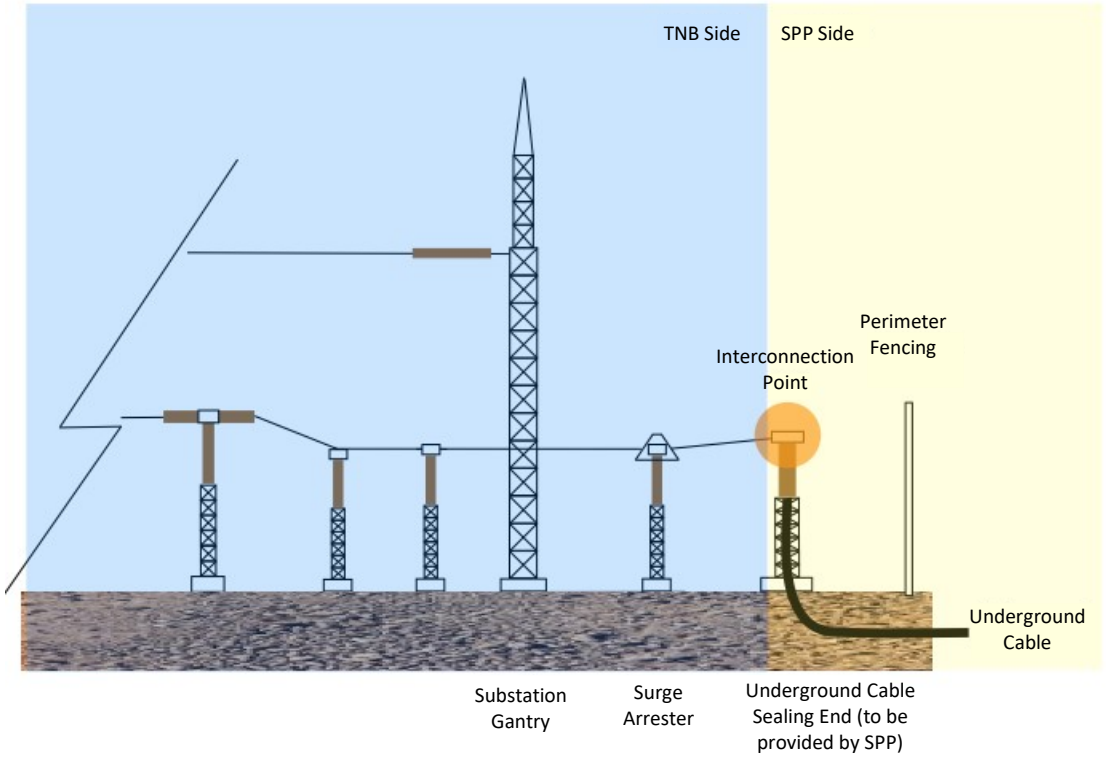


Figure 7: Interconnection Point for underground cable connection

TNB and LSS developer shall jointly prepare an Interconnection Operation Manual (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 132kV switching operations, boundaries, maintenance, authorized personnel and LSS developer's competent engineer (certified by ST). 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 Zonal Nodes for Grid Connection

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

LSS developer may connect their solar farm to the identified nodes or propose other nodes that is deemed suitable to their solar farm site. The Grid Owner may consider and provide approval (or rejection) on the connection node.

The Grid Owner shall bear no responsibility for any error, inaccuracy or omission of any kind in respect of the nodes identified and proposed by the Grid Owner. Each LSS developer accepts 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. Power System Study (PSS)

4.1. Objectives of PSS

(i) To identify connection scheme options (and configurations) for the transmission-connected LSS to be connected to the Grid System, taking into account the existing transmission infrastructure within the vicinity of the LSS plant.

(ii) 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.

(iii) To assess the ability of the transmission-connected LSS to comply with the technical requirements as stated in the Grid Code, specifically with the solar photovoltaic 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. The Grid Owner is currently using PSSE® version 32.

PSS shall be conducted in two (2) stages:

(i) **Stage 1**: Stage 1 PSS using "generic" modeling of the Facility (including but not limited to the solar PV components), the SPP Interconnection Facility and the SPP Interconnector.

Description: Stage 1 PSS mainly verifies the impact on 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.

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

Description: Stage 2 PSS provides indicative evidence of the Transmission-connected LSS 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), the SPP Interconnection Facility 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:

(i) Table 1: Scope of Stage 1 PSS

No.	PSS scope of studies	Description / Requirements	Criteria to benchmark
1	**Modelling**	• To model lumped solar photovoltaic 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: – PSS®E load flow data ("sav file"); and/or – PSS®E load raw data file ("raw file") and sequence data file ("seq file").	
2	**Power-flow & Contingency Analysis**	• 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 determine the need for reinforcements to allow the connection of the Facility to the Grid System.	Grid Code and TSRS
3	**Short Circuit Analysis**	• 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. • To determine the required short circuit ratings for the selection of equipment. • To identify mitigations to ensure short circuit fault level remains within limits.	Grid Code and TSRS
4	**Reactive Power Requirements**	• To assess the profile of transmission voltage at the Interconnection Point and its vicinity. • To determine the necessity to install reactive	Grid Code and TSRS

No.	PSS scope of studies	Description / Requirements	Criteria to benchmark
		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 power factor range between 0.85 lagging to 0.95 leading as specified in the Grid Code.	

(ii) Table 2: Scope of Stage 2 PSS

No.	PSS scope of studies	Description / Requirements	Criteria to benchmark
1	**Modelling**	• To model the solar photovoltaic inverters and the Facility in PSS®E in detail. • From the detailed models, create the lumped inverter and aggregate Facility models in PSS®E. • To compare the results between detailed and lumped models. • To prepare dynamic models for lumped inverter, controller and proposed reactive power compensation/FACTS devices (if installed). • To submit the detailed and aggregated power flow models in the simulation software format as agreed by TNB, which includes the following: – 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: – PSS®E dynamic data file (“dyr file”); and – Model software source codes (flecs and/or fortran codes) for ‘user defined’ model.	
2	**Power-flow & Contingency Analysis**	• 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,	Grid Code and TSRS

No.	PSS scope of studies	Description / Requirements	Criteria to benchmark
		underground cable, transformer etc.) and voltage level of the substations under both normal conditions and N-1 contingencies. • 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**	• 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 contribution at the Interconnection Point. • To finalize the short circuit ratings for the selection of equipment. • To identify mitigation steps to ensure short circuit fault level remains within limits.	Grid Code and TSRS
4	**Reactive Power Requirements**	• 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 power factor range between 0.85 lagging to 0.95 leading as specified in the Grid Code.	Grid Code and TSRS
5	**Transient Stability Analysis**	• 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	Grid Code and TSRS

No.	PSS scope of studies	Description / Requirements	Criteria to benchmark
		when a relatively large disturbance happens at the Interconnection Point. • To identify critical fault clearing time at the Interconnection Point to ensure the Grid System remains stable.	
6	**Fault Ride-Through Capability**	• 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 photovoltaic 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 photovoltaic inverters is able to meet the fault ride through requirements as specified in the Grid Code.	Grid Code and TSRS
7	**Power Quality Requirements**	• 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: 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 IEC 61727-2004 Table 1); • The study shall utilize data from field measurement test as further described in paragraph B3.11 of Appendix B of the PPA. Such test shall be conducted at the existing TNB substation(s) depending on configuration	Refer standards listed under Description/ Requirements

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

4.3. Guideline 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' 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 PPA. Upon request by LSS developer, Grid System data will be provided by the Grid Owner subject to signing of Non-Disclosure Agreement (NDA) 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 developer should take note that fifteen (15) business days are required for the finalization of the terms and conditions of the NDA. The stamping cost for the NDA shall be fully borne by the LSS developer.

4.5. Stage 1 Power System Study Report and Stage 2 Power System Study Report

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

(i) Executive Summary;
(ii) Introduction;
(iii) Proposed Connection Scheme;
(iv) Methodology of the study/analysis;
(v) Power Flow Models
(vi) Dynamic Simulation models (for Stage 2 Power System Study only);
(vii) Scenario Study;
(viii) 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;
(ix) Recommendations, if applicable, shall include but not limited to any modification to the Facility's design, filters and/or compensation equipment; and
(x) 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 three (3) years from the date of submission subjected to the following conditions:

(i) Same connection point / connection scheme / capacity;
(ii) Load levels at the vicinity of the studied site does not show major changes;
(iii) Generation plant-up within the vicinity of the studied site that may affect the system stability; and
(iv) The adequacy of transmission facilities.

4.7. Submission of Transmission-connected LSS Simulation Models Upon Completion of the Power System Study

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 Power System Study	• To submit the aggregate model in the simulation software format as agreed by TNB, which includes the following: – PSS®E load flow data ("sav file"); and/or – PSS®E load raw data file ("raw file") and sequence data file ("seq file"). • The simulation models in PSS®E shall represent the following system, but not limited to: – Aggregate generator model (lumped inverter); – Single lumped unit transformer; – Equivalent 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	NA

PSS	Steady State Models	Dynamic Models
	compensation/FACTS devices (if installed).	
Stage 2 Power System Study	• To submit the detailed and aggregated models in the simulation software format as agreed by TNB, which includes the following: – 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. • The detailed simulation models in PSS®E shall represent the following system, but not limited to: – The detailed model of solar photovoltaic 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 Interconnection Facilities; and – Reactive power compensation/FACTS devices (if installed). • The aggregate simulation models in PSS®E shall represent the following system, but not limited to: – Aggregate generator model (lumped inverter); – Single lumped unit transformer; – Equivalent reticulation impedance; – Step-up transformer; – High voltage cables / overhead lines connecting the high voltage side of the GSU to the	• To submit the dynamic models for aggregate inverter, controller and proposed reactive power compensation/FACTS devices (if installed), in the simulation software format as agreed by TNB, which includes the following: – PSS®E dynamic data file ("dyr file"); and – Model software source codes (flecs and/or fortran codes) for 'user defined' model. • The dynamic simulation models in PSS®E shall represent the following system, but not limited to: – The solar photovoltaic inverter; – Power Plant Controller; – Maximum power point tracker (MPPT) control (if installed); and – SVC/SVG/STATCOM/any FACTS devices (if installed).

PSS	Steady State Models	Dynamic Models
	Interconnection Facilities; and – Reactive power compensation/FACTS devices (if installed).	

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 Interconnection Facility and SPP Interconnector to the following address:

Grid Strategy Department,
Grid Division,
Tenaga Nasional Berhad,
Level 24, Bangunan Dua Sentral,
No. 8, Jalan Tun Sambanthan,
50470 Kuala Lumpur

Attention : General Manager (Grid Planning Unit)
Facsimile : 603 – 2180 4800

5. PPA Aspects

This section highlights some of the salient points of the PPA.

5.1. Relevant Salient Terms of a Transmission-connected LSS PPA

(i) Established Capacity
The Established Capacity must be not less than 30MW_{ac} and as approved by the Commission.

(ii) Facility Type
Solar photovoltaic facility.

(iii) Terms of the PPA
The period of the PPA shall be 21 years.

(iv) Type of Concession
The type of Concession is Build, Own and Operate (BOO) by the LSS developer itself.

(v) Maximum Annual Allowable Quantity
In the PPA, the LSS developer is entitled to be paid energy payment at the Energy Rate up to the LSS power plant's Maximum Annual Allowable Quantity (MAAQ). Any energy beyond MAAQ, if accepted by TNB, shall be paid at the Excess Energy Rate as determined in the PPA.

(vi) Type of PPA
An energy payment only PPA.

(vii) Exceptions to TNB's Obligation to Accept Net Electrical Output:

a. An emergency condition occurs within the Grid System and/or any constraint or interruption in the Grid System, subject to certain limits as further described in the PPA;
b. The Facility delivers to TNB Net Electrical Output which does not conform to the technical requirements as described in the PPA and the Grid Code;
c. TNB interrupts the acceptance of solar photovoltaic energy from the Facility to conduct necessary maintenance, subject to certain limits as further described in the PPA;
d. the energy source for the generation of Net Electrical Output delivered by the Facility to TNB is not from solar photovoltaic technology; or
e. the Facility has delivered to TNB Net Electrical Output in a Contract Year which exceed the MAAQ of such Contract Year.

5.2. Delay Compensation

(i) Failure to achieve Scheduled Commercial Operation Date (SCOD)

LSS developer shall compensate TNB an amount equal to Ringgit Malaysia calculated by multiplying the Established Capacity with RM5,000.00 per day for each day following the SCOD of the Facility until the earlier of;

a. the COD;
b. the date the PPA is terminated by TNB in accordance with the provision of the PPA ; or
c. one hundred and eighty (180) days after the SCOD.

(ii) Abandonment of the project

If LSS developer abandons the project after the Effective Date, LSS developer shall forthwith compensate TNB an amount equal to Ringgit Malaysia calculated by multiplying the Established Capacity with RM5,000.00 and 180 days.

6. Appendix B of PPA Requirements

In general, the LSS developer shall adhere to the requirements as stipulated in the Grid Code and the TSRS. The Appendix B of the PPA details 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 PPA 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.	• 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.	• 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.	• 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.	• 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.	• TSRS Clause 4.6
6	**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.	• Grid Code CC6.3.4.11
7	**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	

NO	REQUIREMENTS	GRID CODE/OTHER STANDARDS CORRESPONDING CLAUSE
	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 GSO prior to such delivery of energy from the Facility to the Grid System upon successful reclosing of the SPP Interconnector.	
8	**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 GSO.	• Grid Code CC6.4.2.3 • Grid Code CC6.4.4.5
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.	• 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 PPA during Despatch Instruction, normal load variation, start-up and shut down.	• 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 PPA and Grid Code to prevent or limit damage to its generation and auxiliary equipment.	• Grid Code CC6.3.4

NO	REQUIREMENTS	GRID CODE/OTHER STANDARDS CORRESPONDING CLAUSE
12	**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: (a) Voltage Harmonics (Engineering Recommendation ER G5/4-1); (b) Phase voltage unbalance (Engineering Recommendation P29); (c) Voltage fluctuation and flicker (Engineering Recommendation P28); and (d) Current harmonics (as per IEC 61727-2004 Table 1). The LSS developer shall install PQ recorder(s) at the Facility/SPP Interconnection Facility 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 Interconnection Facility. LSS developer shall submit such PQ reports upon request by TNB.	• PQ standards in TSRS • Engineering Recommendation (ER) G5/4-1, ER P29 & 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). • IEC 61727-2004 Table 1
13	**Fault Ride Through** – The Facility shall be capable of fault ride through capability as stipulated in Grid Code.	• Grid Code CC6.4.15.2
14	**Philosophy of Plant Design & Redundancy** – Submission of conceptual design report of the Facility by LSS developer.	
15	**SCADA & EMS Requirements** – The Facility shall be designed with SCADA & EMS capability, which shall meet the GSO's requirements. LSS developer shall submit SCADA & EMS database to NLDC at least 30 working days prior to the Back Energisation (BE).	• NLDC SCADA/EMS Interfacing Guidelines
16	**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)	

NO	REQUIREMENTS	GRID CODE/OTHER STANDARDS CORRESPONDING CLAUSE
	and power (P) signal from the GSO and respond accordingly.	
17	**Scope of Tests** – LSS developer shall carry out site tests to verify compliance with the technical requirements stated in the Appendix B of the PPA prior to COD.	
18	LSS developer shall submit procedures for the site tests specified in the **Scope of Tests** for the GSO's approval according to the timeline specified in the PPA.	
19	LSS developer shall submit preliminary test results and final reports for the site tests in accordance with the timelines specified in the PPA.	
20	**Facility Parameters & 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 GSO in the system security assessment studies.	• Grid Code PCA.5
21	**Submission of Simulation Models & Simulation Model Report** – LSS developer shall submit simulation models and simulation model reports prior to the Initial Operation Date. The simulation models and simulation model reports shall serve as the reference for the relevant site tests specified under **Scope of Tests** in the PPA.	• Refer to section 4.7 of the Guidelines.
22	**Submission of Machine Model Validation Report -** LSS developer shall submit a machine model validation report for TNB's and GSO's review. TNB's and GSO's comments, if any, shall be incorporated by LSS	• Refer to section 4.7 of the Guidelines

NO	REQUIREMENTS	GRID CODE/OTHER STANDARDS CORRESPONDING CLAUSE
	developer in a revised machine model validation report which shall be submitted together with the fully validated machine model prior to the COD.	
23	**Factory Acceptance Tests (FAT) Reports & Type Test Reports** – LSS developer shall submit the FAT and type test reports on major plant equipment to demonstrate compliance of the Facility with the relevant Grid Code and PPA 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 PPA. 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 GSO to demonstrate compliance by Power Park Modules with the requirements of the Grid Code, PPA or other contractual agreements with TNB.

The Grid Code has defined Power Park Module as **"A collection of one or more Non-Synchronous Generating Units (registered as a Power Park Module under the Planning Code) that are powered by an Intermittent Power Source, joined together by a System with a single electrical point of connection directly to the Transmission System. The connection to the Transmission System may include a DC Converter"**. Associated with this, a Power Park Unit is defined as an individual Generating Unit within a Power Park Module.

(i) 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 GSO of such tests, including commissioning tests and compliance tests in accordance with the PPA or other contractual agreements.

(ii) 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 GSO and TNB in advance of their plans for such modification and seek the GSO's advice on the required tests. Upon the GSO'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.

(iii) 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 GSO may also notify LSS developer to conduct compliance tests to prove the security of the system. Upon such notification by the GSO, the LSS developer shall then schedule the tests accordingly.

(iv) 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 PPA unless with the prior written consent from the GSO 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 PPA, 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 GSO and propose suitable alternative test recommendations for TNB and GSO 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 the instant when such variations are required.	• Grid Code CC6.4.2.3
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.	• Grid Code CC6.4.2.1

NO	TEST	TEST REQUIREMENT	CODES/ STANDARDS
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.	• 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 (HVCB) after the fault being detected by the Facility's protection relays are within the limits.	• 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 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.	• Grid Code CC6.4.2.3
6	**Ramp Rate**	To demonstrate that Power Park Module is capable of meeting the ramp rate requirement stated in the PPA.	

NO	TEST	TEST REQUIREMENT	CODES/ STANDARDS
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.	The maximum allowable limits at the Interconnection Point shall comply with the following standards: (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)
8	**Automatic Interchange Control (AIC), Automatic High Voltage Control (AHVC), and Fast Deloading**	To demonstrate the AIC, AHVC, and Fast Deloading capabilities of the Facility to respond and follow signals from the GSO.	• 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 Power Plant Controller (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 PV power plant is a plant-level controller, or generally known as Power Plant Controller (PPC). It is designed to regulate active and reactive power output from the PV plant, such that it behaves as a single large generator. While the 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:

(i) Dynamic voltage and/or power factor regulation of the solar plant at the Point of Common Coupling (PCC)

(ii) Frequency control to lower plant output in case of over-frequency situation

(iii) Active power control following variation in irradiance

(iv) 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

(v) Start-up and shut-down control.

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 remote terminal unit (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 Point of Common Coupling (PCC).

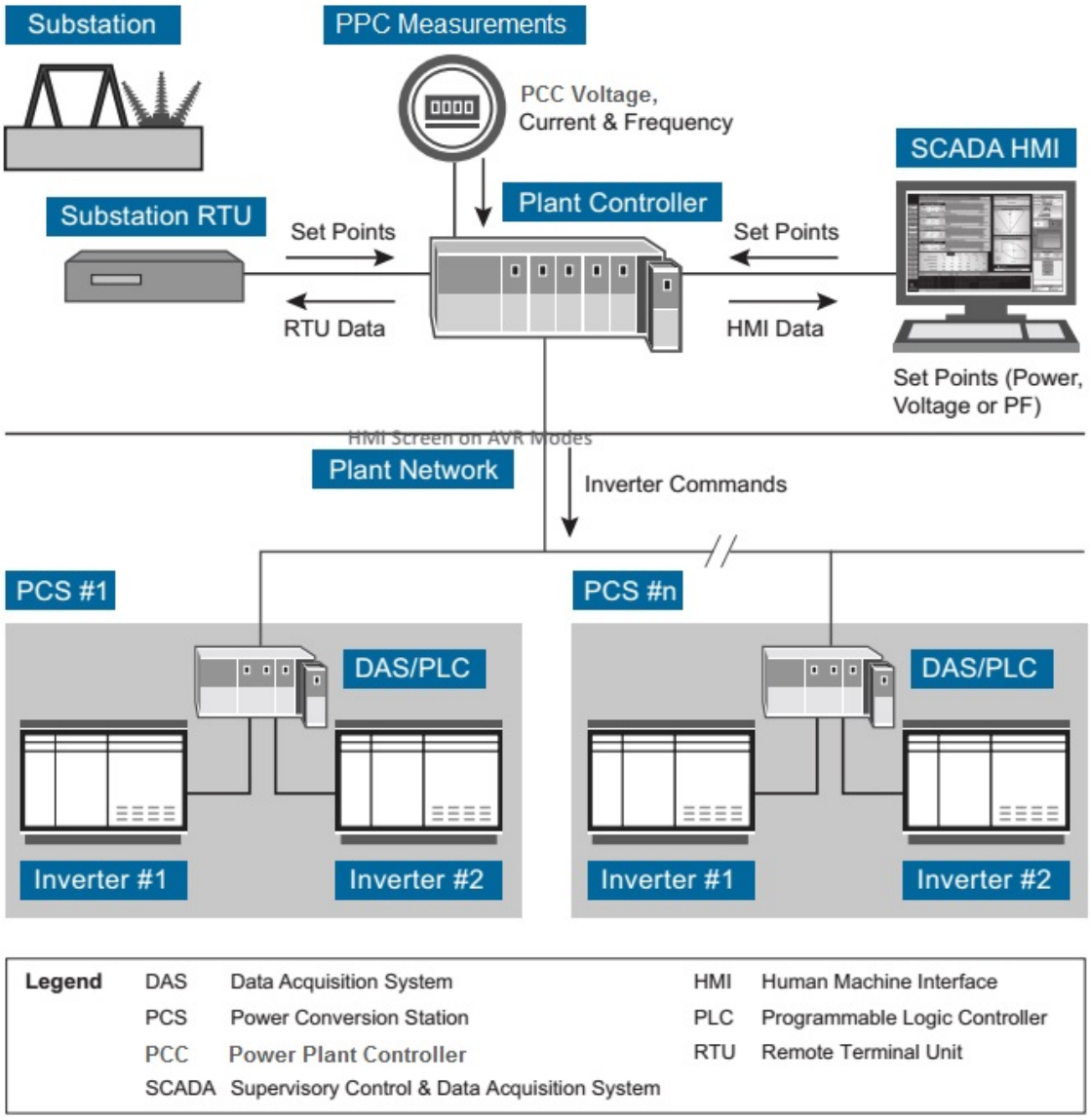


Figure 8: Plant Control System and Interfaces to Other Components

Advanced features such as voltage regulation, active power controls, ramp-rate controls, fault ride through, and frequency control within LSS power plants will provide intrinsic benefits of reliable plant operation in the Grid System. These “grid-friendly” capabilities, essential for increased penetration of LSS power plants into the electric grid, are operational and available

today for utility-scale PV plants ranging from several MW to several hundred MW. These advanced plant features enable solar PV plants to behave more like conventional generators and actively contribute to grid reliability and stability, providing significant values to utilities and GSO.

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 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

9.1. Despatch of the Transmission-connected LSS

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

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

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

9.2. Ramp Rate

The transmission-connected LSS 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) Despatch Instruction;
(ii) Facility startup; and
(iii) Facility shutdown.

9.3. Emergency Conditions

The transmission-connected LSS shall be despatchable to reduce power output under certain emergency conditions as instructed by GSO.

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

9.4. Telemetry

The transmission-connected LSS 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 PPA. 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. Meteorological Measuring Facilities (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 GSO Control Centre 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 GSO Control Centre with online access to the MMF signals data at all times as further described in Appendix E of the PPA. 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 GSO in the planning, scheduling and grid operation in order to minimize risks of deviation in generation despatch.

10.1. Long-term forecast

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

10.2. Medium and short-term forecast

Throughout the term of the PPA, 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 GSO :

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

10.3. Website and real-time online forecast

Beginning from the Initial Operation Date, 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 Grid System Operator and with web services facilities to enable automatic extraction of such data into the Grid System Operator's IT system via internet) or by any other manner or form as may be prescribed from time to time by the GSO. LSS developer shall establish such LSS developer's website and web services facilities prior to the Initial Operation Date and notify TNB and the GSO of the same.

Attachments

Attachment A: Data Requirement for Submission of RFP

a. Data Requirement

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

(i) Single Line Drawings, which shall be endorsed by Professional Engineer;

(ii) Plant layout drawings;

(iii) Installed capacity, which is the total rating of PV plant in MW_{DC};

(iv) Output capacity, which will be the Established Capacity in MW_{AC};

(v) Maximum Annual Allowable Quantity;

(vi) Expected COD;

(vii) Inverter datasheet;

(viii) PV panel datasheet;

(ix) Site and location layout;

(x) Proximity to nodal point; and

(xi) Declarations of compliance to standards.

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

b. Submission of Data

The technical information as specified in (a) above shall be submitted to ST's office at the following address:

Energy Commission
No. 12, Jalan Tun Hussein
Precinct 2
62100 Putrajaya.
Toll-Free Number : 1800- 2222-78
Telephone : +603- 8870 8500
Facsimile : +603- 8888 8637

APPENDIX C :

Technical Specification for Distribution-Connected LSS

Disclaimer:

The Appendix C of these Guidelines specifies technical specifications for distribution-connected LSS has been prepared for guidance and informational purpose only. It does not contain comprehensive information needed for the submission of the Request for Proposal and in designing the facilities needed for the LSS. Whilst all reasonable care has been taken in the preparation of the Guidelines, Commission does not make any representation, warranty or undertaking, expressed or implied, in or in relation to the completeness and or accuracy of information contained in the Guidelines. To this end, Commission disclaims all or any responsibility whatsoever to anyone for information contained in the Guidelines or for any representation or statement herein, whether expressed or implied, or for any responses given in response to any queries on or in relation to the Guidelines. All such persons expressly disavow any obligation or duty (whether in contract, tort or otherwise) to any prospective LSS developer and disclaim any and all liability based on or relating to any such information or representations or warranties (expressed or implied) contained in, or errors or omissions from, the Guidelines or based on or relating to the use of the Guidelines or any other written or oral communication transmitted to or information provided to or otherwise acquired by a prospective LSS developer.

A prospective LSS developer shall be solely responsible for its interpretation of the information provided to or otherwise acquired by the prospective LSS developer. The prospective LSS developer certifies that it understands, accepts and agrees to the disclaimers on this page. Nothing contained in any other provision of the Guidelines, nor any statement made orally or in writing by any person or party shall have the effect of negating or superseding any of the disclaimers on this page.

Table of Contents

Abbreviations

This section describes a list of abbreviations that appear in this document.

Abbreviations	Description
AC	Alternating Current
AVQC	Automatic Voltage and Reactive Power Control
BOO	Build, Own and Operate
CLOA	Conditional Letter of Award
COD	Commercial Operation Date
CT	Current Transformer
DAQ	Declared Annual Quantity (in MWh) of Solar PV energy for each Contract Year which shall not exceed the MAAQ
DL	Distribution Licensee
EMS	Energy Management System
EER	the Excess Energy Rate (in RM/kWh) for that Billing Period
ER	the prevailing Energy Rate (in RM/kWh) applicable for that Billing Period
FAT	Factory Acceptance Test
GCPV	Grid Connected Photovoltaic
GIS	Gas Insulated Switchgear
GSO	Grid System Operator
IF	Interconnection Facility
IOD	Initial Operation Date
kV	kilo-Volt
LSS	Large Scale Solar
MAAQ	Maximum Annual Allowable Quantity (in kWh)
MDC	Malaysian Distribution Code
MW	Mega-Watt
NEO	Net Energy Output (in kWh)
PCC	Point- of- Common -Coupling
PPA	Power Purchase Agreement
PSS	Power System Study
PV	Photovoltaic
RCC	Regional Control Centre
RFP	Request for Proposal
RFQ	Request for Qualification
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
SCOD	Scheduled Commercial Operation Date
SESB	Sabah Electricity Sdn Bhd
ST	Commission
THDI	Total Harmonic Distortion Current
TNB	Tenaga Nasional Berhad
VCB	Vacuum Circuit Breaker
VT	Voltage Transformer

Glossary of Terms

This section describes a list of terms that appear in this document.

Term	Definition
Anti Islanding	During loss of mains, the inverter should cease to operate in islanded mode. Inverter should be equipped with anti-islanding protection;
Commercial Operation Date or COD	Means the date at which all relevant conditions precedent under the PPA have been satisfied or waived;
Connection Point	Means the point of common coupling where LSS is connected to the distribution system;
Contingency	Under contingency condition, when one or more circuit elements are on outage, scheduled or non-scheduled;
Contract Year	Means, the date on which begins on the Commercial Operation Date of the Increment and ends on December 31 of the year in which the Commercial Operation Date of the Increment occurs, each subsequent period during the Term which begins 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 PPA Term;
Contracted Capacity	Means the capacity of solar photovoltaic energy to be generated and delivered to the Grid system at the interconnection point from the facility (as the case may be) for each contract year;
Distribution Licensee	The holder of a license to distribute issued by Commission under Section 9 of the Electricity Supply Act 1990;

Term	Definition
Distribution Network	The system consisting (wholly or mainly) of electric lines which are owned or operated by a Distribution Licensee (Distributor) and used for the distribution of electricity from Grid Supply Points or Generating Units or Power Park Modules or other entry points to the point of delivery to Customers or other Distributors. "Distribution electricity network" means a system or part of a system at nominal voltage of less than 132 kilovolts of electric lines or cables, substations and associated equipment and buildings for transporting electricity to any person, regardless of whether a generating plant is connected to such system;
Distribution System	The system of electric lines with voltage levels below 66 kV, within the Area of Supply owned or operated by the Distributor/Embedded Distributor, for distribution of electricity from Grid Supply Points or Generating Units or other entry points to the point of delivery to Customers or other Distributors and includes any electrical plant and meters owned or operated by the Distributor/ Embedded Distributor in connection with the distribution of electricity;
Demand or Load	Means demand of MW/kW and MVar/kVar of electricity (i.e. both active power and reactive power), unless otherwise stated;
Facility	means a solar photovoltaic energy generating facility located at the site with a capacity of 0.1MW_{ac} to 30MW_{ac} and ancillary equipment and facilities as more specifically described in the Power Purchase Agreement and includes any modification thereto;
Financial Closing Date	means the date on which the Financing Documents relating to the financing or refinancing for the total construction costs of the LSS have been entered into by IPP and the financing parties, and all of the conditions precedent for the initial drawdown under such financing documents have been satisfied by IPP or waived by the financing parties thereunder;
Interconnection Facility or IF	The components that interconnect the LSS and the distribution network. This includes the substation at the LSS, overhead lines or underground cables where the connection to the distribution network is made;

Term	Definition
Initial Operation Date or IOD	The date on which the LSS installation first delivers Net Electrical Output to the DL network for testing purposes;
Inverter	A machine, device, or system that changes DC power to AC power;
Islanding	A condition in which a portion of the utility system that contains both load and distributed resources remains energized while isolated from the remainder of the utility system;
Large Scale Solar or LSS	Any solar PV Plant, with minimum with capacity as approved by the Commission connected to either transmission or distribution network in Peninsular Malaysia, Sabah or Labuan;
MAAQ	means the maximum annual allowable quantity (in kWh) determined as a product of the Established Capacity, the capacity factor and the number of hours in a year, as further described in the Power Purchase Agreement;
Malaysian Distribution Code or MDC	Means the Distribution Code For Peninsular Malaysia, Sabah & F.T Labuan (Amendments) 2017, as amended from time to time in accordance with applicable laws. The Malaysian Distribution Code is a document containing a set of technical rules and Procedures that facilitate coordinated planning, coordinated design, coordinated development, and coordinated operation of the Distribution System;
Medium Voltage	A voltage equal to or exceeding 1 kV but not exceeding 50 kV; A voltage normally exceeding 1kV but equal to or not exceeding 50,000 volts or 50 kV;
Net Energy Output or NEO	Means for any period, the amount of solar energy generated and delivered to the DL at the metering point or as otherwise determined in accordance with provisions of PPA during such period;
Power Purchase Agreement or PPA	Agreements between the Distribution Licensee (DL) and LSS Developer relating to the financial and technical conditions relating to the purchase of LSS output and technical conditions

Term	Definition
	relating to its connection to and performance on the Grid System;
Prudent Utility Practice	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;
Suruhanjaya Tenaga or ST	Commission or Energy Commission established under the Energy Commission Act 2001 (Act 610);
Type Test	Test of one or more devices made to a certain design to demonstrate that the design meets certain specifications;
Power Factor	Power factor (PF) is calculated by dividing the Real Power, P, in the W unit by the Apparent Power, S, in the VA unit.

1. Introduction

This guideline has been prepared jointly by Commission, Tenaga Nasional Berhad and Sabah Electricity Sdn Bhd to provide guidance to prospective LSS developers seeking connection to the TNB/SESB's Distribution Network. Contents of these guidelines differ from the Feed In Tariff (FiT) guideline due to larger capacity available for LSS.

The content of this guideline is prepared based on prudent utility practice, experiences during implementation of FiT program and international practices.

MW described in this guideline refers to the AC side of the LSS plant.

Developers, operators and other parties involved in the planning, installation, commissioning and operation of LSS power generation plant could utilise this guideline for:

a) Process of connection application
b) Technical requirements
c) Commercial aspects

2. Scope and Limitation

Large Scale Solar (LSS) PV Plants described in this document refer to those connected to the distribution network at 33kV or 11kV. Technical administration of the connection is described in the current Malaysian Distribution Code.

The connected capacity range allowed for connection at a single point is between 0.1MW_{ac} to less than 30MW_{ac}. The available connections are listed in the nodal point list in this guideline.

The guidelines does not cover the followings:

- LSS connected to Peninsular Malaysia's transmission network

The Guidelines are 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 LSS.

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 nodes as identified by the DL in order to meet the requirements of the Power Purchase Agreement. 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 and to otherwise perform its obligations under the Power Purchase Agreements 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.

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 ST/DL shall bear no responsibility for any error, inaccuracy or omission of any kind and no warranty or representation is given in respect thereof.

3. Overview of LSS Process

The general process for LSS application is as illustrated in Figure 1. All application shall be submitted to ST and will undergo a Pre-Qualification stage and/or Request For Proposal (RFP) stage. During the RFP stage, the LSS developer shall submit a power system study (PSS) application to the DL. The maximum capacity of connection at a single point is 30MW$_{ac}$.

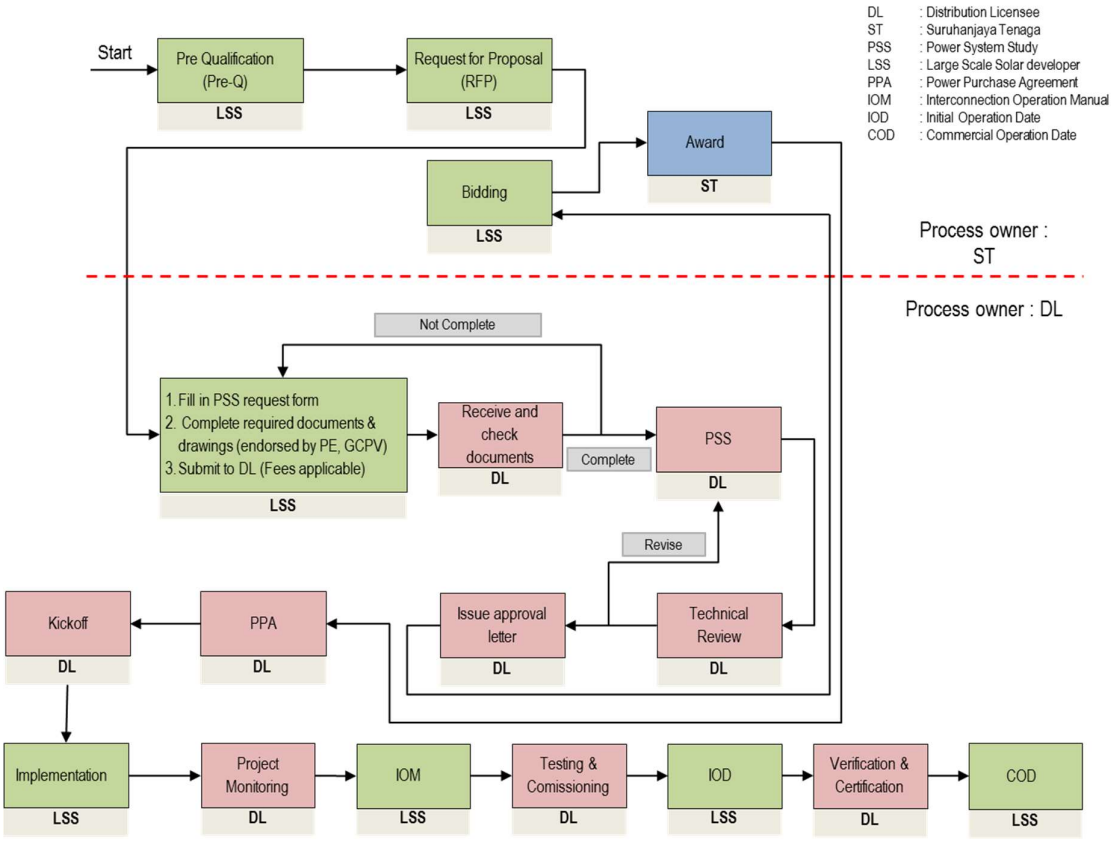


Figure 1: The general process for LSS application

4. Connection to the Grid Distribution System

4.1 Background

The connection of the LSS plant shall be made only at the existing DL owned substation. The evaluation of connection requirements is subject to the terms and requirements in the latest version of Malaysian 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 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 DL 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, the 50% feeder loading is to be adopted.

Output from LSS connected to distribution network shall be consumed locally. Therefore, the penetration limit of LSS to a substation is limited to the daytime loading level of the substation. The loading level shall be determined by the DL 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
Transformers (33/11kV, 132/11kV, 132/33kV)	85% of daytime trough

4.4 Nodal Points

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

For the purpose of facilitating the potential LSS developer, nodal points have been identified for connection to distribution network. The nodal points were selected based on the following considerations:

a) Fault level
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 possible nodal points is as shown in the Request For Proposal (RFP).. The list shall be used as a guide as actual feasibility depends on the findings of the PSS. The DL has the rights to review and update the list.

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 to the grid shall be borne by the LSS developer.

Typical scope of works for the interconnection feeder is described in Table 4. 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
▪ Replace existing Ring Main Unit (RMU) to VCB ▪ Remote Control Box (RCB) ▪ Direct Current(DC) system ▪ SCADA/RTU ▪ Building works as necessary ▪ Meter room	▪ Extension to existing switchgears (VCB/GIS) ▪ Control Relay Panel (CRP) ▪ SCADA/RTU ▪ Arc protection (where applicable) ▪ Building works as necessary ▪ Meter room

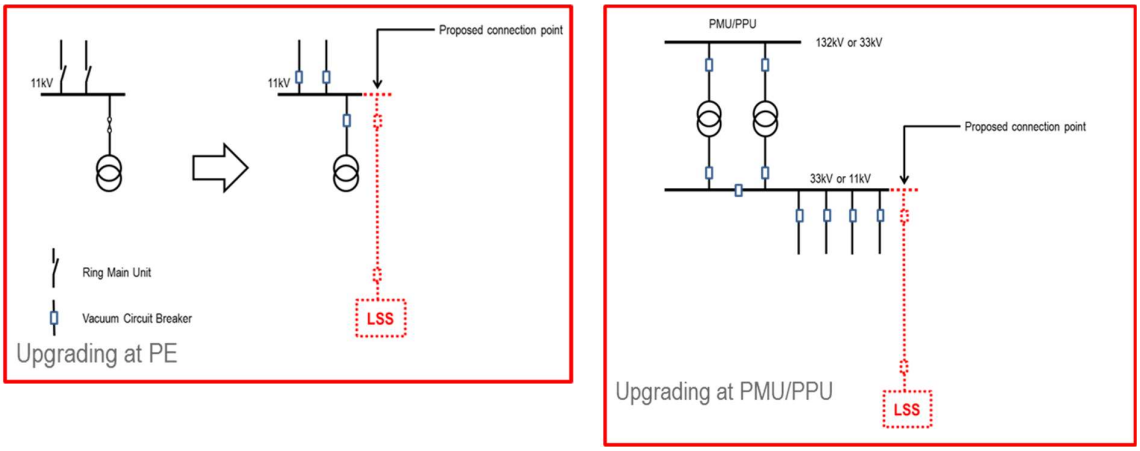


Figure 2: Upgrading of the Switchgears at PCC

4.6 Scope of Interconnection Facilities & Asset Demarcation

This section describes the feature of the interconnection feeder which connects the LSS plant to the DL 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 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.

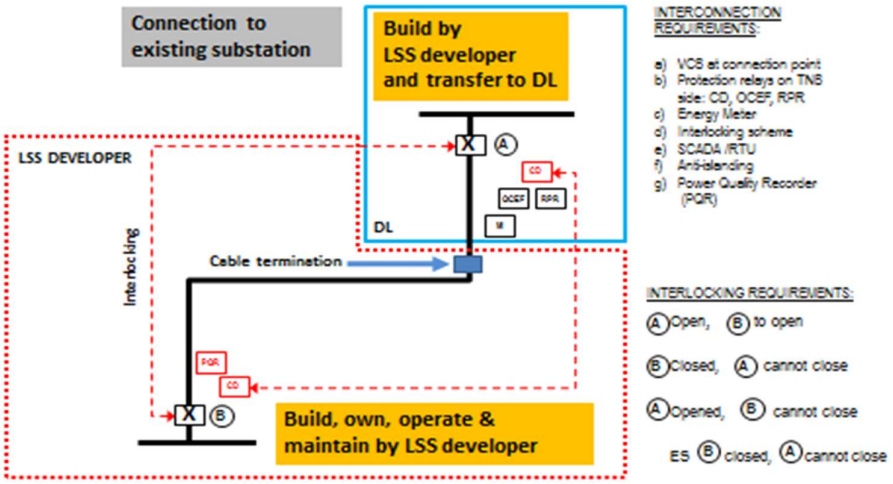


Figure 3: DL-LSS Interconnection Feeder Scheme

The followings are the scope of work by LSS developer:

(i) Supply of interconnection facilities for LSS and DL side (refer to Figure 3)
(ii) The interconnection works shall be designed, built, owned, operated and maintained by the LSS developer
(iii) All works for interconnection is under the responsibility of LSS developer
(iv) Interconnecting power cable capacity and fibre optics based on PSS
(v) The equipment is to match existing specifications
(vi) Protection scheme
(vii) Energy meters and dedicated metering room
(viii) Interlocking scheme
(ix) SCADA requirements
(x) Anti islanding shall be provided at the LSS plant
(xi) Install and maintain PQ Recorder at LSS plant
(xii) Other requirements as stated in the PSS
(xiii) Submission of drawings and manuals

5. Power System Study (PSS)

5.1 Objectives of PSS

(i) To identify connection scheme options (and configurations) for the LSS plant to be connected to the distribution network.
(ii) To investigate the impact of the LSS power generation to the distribution network
(iii) To assess LSS compliance with the technical requirements in the current Malaysian Distribution Codes (MDC)

5.2 Scope of PSS

DL 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:

(i) Adequacy – penetration limit
(ii) Power flow analysis
(iii) Short circuit analysis
(iv) Redundancy study
(v) Operational constraints & limitations
(vi) Interconnection method & scope of work

In evaluating the LSS 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 proposal.

(i) Single Line Drawings, which shall be endorsed by Professional Engineer;
(ii) Plant layout drawings;
(iii) Installed capacity, which is the total rating of PV plant in MW_{DC};
(iv) Output capacity, which will be the Established Capacity in MW_{AC};
(v) Maximum Annual Allowable Quantity;
(vi) Expected COD;
(vii) Inverter datasheet;
(viii) PV panel datasheet;
(ix) Site and location layout;
(x) Proximity to nodal point; and
(xi) 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.

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

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 (subject to GST)	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 DL.

Upon completion of the study, a review meeting shall be held between DL and LSS developer to conclude the findings and recommendations of the PSS. DL 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 DL offices:

TNB

Customer Service Department,
16th Floor, Wisma TNB,
19, Jalan Timur,
46200 Petaling Jaya, Selangor
Telephone : 03-7967 9000
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 MDC. A copy of the MDC can be obtained from the official portal of ST (www.st.gov.my).

Any violation to the codes and standards pertaining to the LSS 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 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 (THD) shall be <5 % at inverter rated output. The point of measurement is at the Point of Common Coupling.

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 DL 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	Total Harmonic Distortion 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 Power factor

The allowed power factor of LSS plant range is 0.85 lagging to 0.9 leading as shown in Figure 4. The reactive power output is to be achieved at generation level as shown level as shown in part 6.2.4.

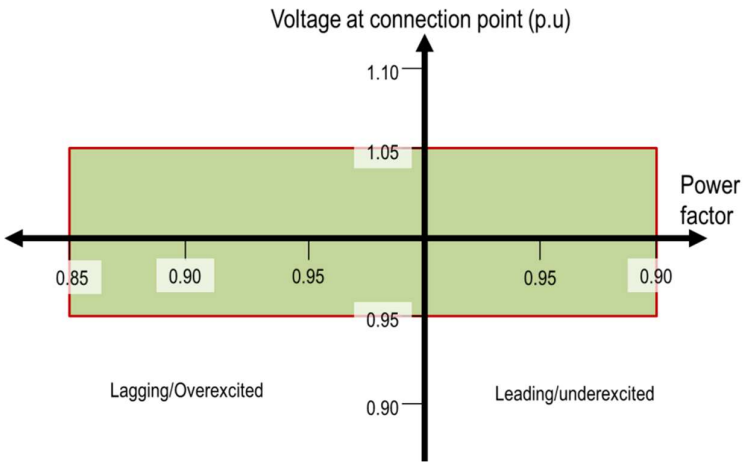


Figure 4: Voltage versus power factor curve

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 : Basic Impulse Insulation Levels (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 MDC, DL is limited to plan for not exceeding 90% of the equipment rated design.

Table 11 : Short Circuit Withstand Rating for Power Equipment

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

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:

(i) Interlocking logics are satisfied
(ii) Frequency difference <0.2 Hz
(iii) Voltage magnitude difference < 10%
(iv) 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 direct-current (DC) electricity to alternating current (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 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:

(i) To not disconnect
(ii) 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 5.

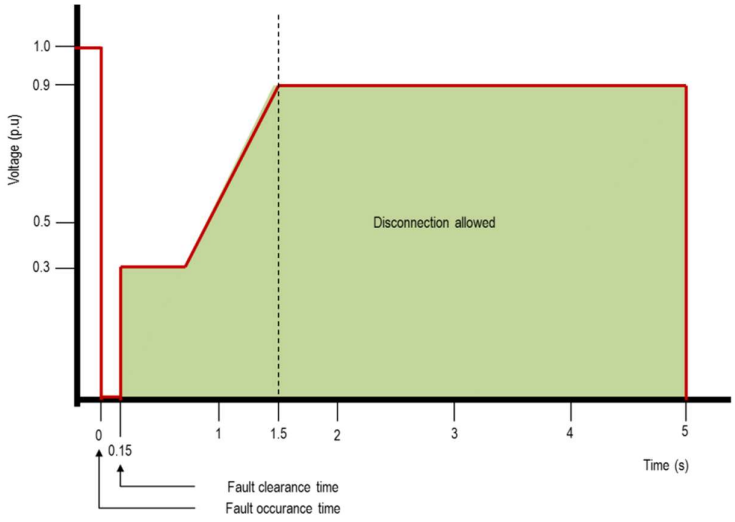


Figure 5: Low Voltage Ride Through Curve

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 6.

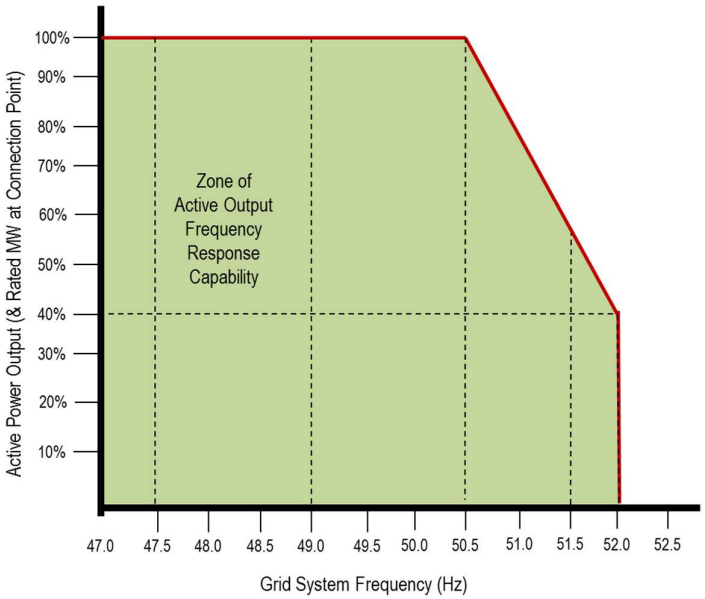


Figure 6: Frequency Disturbance Curve

6.2.3 Power output management

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

(i) The LSS plant shall be able to reduce its power output or disconnect from the distribution system during system contingencies.
(ii) LSS plant shall reduce its generation output to avoid voltage rise above the limit.
(iii) The LSS developer shall monitor and ensure that the power generation of the plant does not exceed the contracted capacity.
(iv) The inverter shall have the capability to perform active/reactive power control and/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 7. Full range of reactive power 0.85 lagging to 0.9 leading shall be achieved at 20% output.

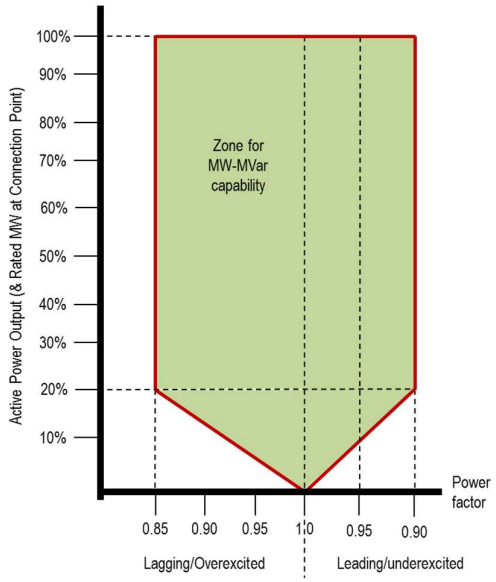


Figure 7: Active power output versus power factor curve

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:

(i) Despatch Instruction (if required);
(ii) Normal load variation;
(iii) Facility startup; and
(iv) 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 DL.

6.3.1 Connection point feeder protection at DL

The protection interfacing requirements are as follows:

(i) Unit Protection (Current Differential)

(ii) OCEF / Non Directional OCEF

(iii) Interlocking scheme

(iv) Reverse Power Relay

Where applicable, the following protection schemes may be required:

(i) Arc protection

(ii) Busbar protection

(iii) Automatic transfer scheme

6.3.2 Feeder requirements at LSS plant

The LSS feeder shall be equipped with the following equipment:

(i) Current Differential Relay shall match with 6.3.1
(ii) 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 & transformer faults	150ms
Overhead line & cable faults	600ms

6.3.4 Interlocking of the interconnection feeder

The interlocking facilities shall operate in the following manner, referring to Figure 8 below.

- A open – B to open
- B close position – A cannot close
- A open position – B cannot close
- Earth Switch (ES) B ON – A cannot close

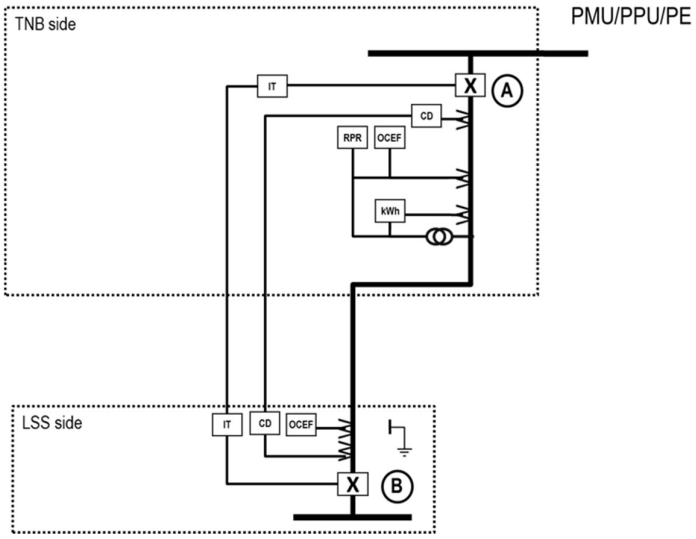


Figure 8: Interlocking of the interconnection feeder with DL

6.3.5 Protection equipment

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

6.3.6 Protection coordination study

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

(i) 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:
   a. Failure of protection equipment
   b. Failure of control equipment
   c. Loss of control power
   d. Interconnection power and fibre optics cables

(ii) 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:

(i) Safety
(ii) Power quality
(iii) Inverter technical limit

6.3.7.1 Anti islanding detection

Inverters shall have the following anti-islanding capabilities:

(i) Under Voltage
(ii) Over Voltage
(iii) Under Frequency
(iv) Over Frequency
(v) 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 DL connection has been stabilised.

6.3.9 Earthing scheme

The LSS plant earthing scheme shall not cause maloperation to the DL protection scheme

The zero sequence components between the DL network and LSS plant shall be isolated. The LSS plant step up transformer(s) shall have delta (Δ) configuration on DL side as illustrated in Figure 9 to ensure the plant does not contribute zero sequence current to DL network during fault.

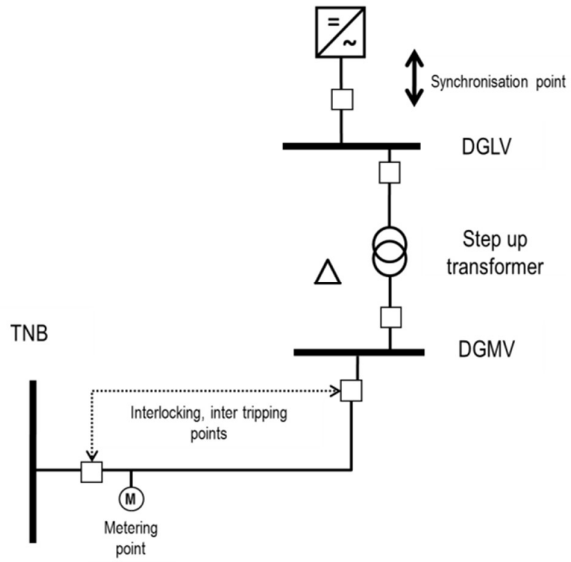


Figure 9: Step up Transformer Earthing Scheme

6.4 Meteorological Monitoring Facilities (MMF) and Pyranometer

The LSS developer shall provide the following:

(i) Install Meteorological Measuring Facilities (MMF) and pyranometer at the site.
(ii) 1 set (MMF & pyranometer / solar cell sample) per 1MW
(iii) Meteorological station has an independent and backup power source.
(iv) LSS must maintain historical data of readings for throughout the term.
(v) Minimum data resolution: Every 15 minutes.
(vi) Submit meteorological report to ST/DL as and when required

6.5 Operational Requirements

6.5.1 Preparation of Interconnection Operation Manual (IOM)

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

(i) Interconnection Facilities
(ii) Communication
(iii) Switching Procedures
(iv) Fault Reporting
(v) Outage Program
(vi) System Emergency / Collapse
(vii) Sequence Of Operation
(viii) Boundaries and Ownership

6.5.2 Contingencies

During contingency, the LSS plant may be isolated until the system is normalised. Contingencies include scheduled and unscheduled outages:

(i) Network upgrading
(ii) Maintenance
(iii) Shutdown
(iv) Breakdown

6.5.3 Declared Annual Quantity (DAQ)

The LSS developer shall declare annual output to the DL. Format of the declaration forms could be referred to the relevant forms in Schedule 5 of MDC.

6.6 SCADA

The provision of SCADA is mandatory for all LSS plant interconnection. 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 DL.

The following parameters are to be made available for monitoring to the Regional Control Centre (RCC).

(i) Frequency (Hz)
(ii) Voltage (V)
(iii) Current (A)
(iv) Real Power Energy flow (kW or MW)
(v) Reactive Power Energy flow (kVAR or MVar)
(vi) Circuit Breaker status
(vii) Relay indications

All interfacing wirings shall be prepared by the LSS developer with DL supervision.

6.7 Ownership and Boundaries

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

6.7.1 Boundaries

Determinations of boundaries are as shown in Table 13.

Table 13 : Boundaries and Ownership Between DL and LSS developer

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

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 interconnection facilities beyond his or its ownership boundary to the DL and take all actions necessary to transfer to the DL of all rights, title and interests to the interconnection facilities so that the DL shall become the owner of such interconnection facilities.

The DL shall be responsible for the operation and maintenance of the interconnection facilities.

6.7.3 Defects in interconnection facilities

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

(i) Was not designed, constructed, installed and tested in accordance with prudent utility practices; or
(ii) 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 interconnection facilities 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:

(i) From the DL'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;
(ii) From the effects of ordinary wear and tear or erosion or corrosion which such facilities were not designed for; or
(iii) After an initial period of twelve 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 twelve 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 DL's specifications. DL shall determine the point at which every supply line shall terminate in any premise in view of ease of accessibility to DL's personnel.

The LSS developer shall provide meter panel according to DL's specifications for the installation of meter and their accessories. DL 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 DL to measure the energy import and export. The energy meters are shall be procured from DL. 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 DL electricity supply application guideline. All drawings shall be endorsed by a Professional Engineer.

7.3 Metering Point

Energy meter is to be installed at the connection point in a dedicated meter room at DL substation. The LSS developer shall provide a Switch Socket Outlet (13 Amps) at the meter room.

7.4 Communication Signal

DL uses wireless mode of communication between energy meter and DL data centre. Location of the meter room must have adequate reception of the wireless 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	$\frac{Vs / \sqrt{3}\ V}{110 / \sqrt{3}V}$ * where Vs is the voltage at metering point
Class	0.5
Burden	100 VA, sharing can be allowed provided separate fusing is provided
Voltage factor	1.9 for 8 hours
Unit	3 nos. for each feeder
Standards	IEC 60044-2 (1997)

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	Is / 5A * where Is is the primary ratio of the metering CT
Class	Class 0.2
Burden	15 VA
Unit	3 Nos. for each feeder
Standards	IEC 60044-1 (1996)

7.7 Meter Application and Approval

The LSS developer shall liaise with the respective DL 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 CTs and VTs shall have a valid test certificate from an accredited laboratory. The LSS developer shall send the CT to the DL for calibration and all costs shall be borne by the LSS developer.

7.8 Meter Reading

The LSS developer shall read the revenue meter with DL (joint inspection) 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 DL for payment.

The LSS developer may at any time submit a written request to the DL to inspect or test the energy meters. If the meters are found to be defective or inaccurate, both DL 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.

7.9 Metering Panel/Cubicle

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

The LSS developer shall maintain the meter panel/cubicle and its accessories except for the energy meter and test terminal block.

8. Testing and Commissioning for IOD

8.1 General

The LSS developer shall notify DL 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:

(i) A certificate from an Independent Engineer approved by ST stating that the interconnection facilities have been designed and constructed in accordance with prudent utility practices.
(ii) Copies of approved as-built drawing of the interconnection facilities
(iii) Copies of IOM approved by DL
(iv) Test results of the Interconnection Facilities
(v) A copy of metering scheme approval
(vi) Transfer documents for DL substation and land if applicable
(vii) Permanent generation license from ST
(viii) Approval letters from authorities on right of ways for poles and/or cable routes
(ix) Written confirmation from DL on the completion of site work without any outstanding issues

The submission of a complete IOD document as per IOD checklist in Attachment B 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 Interconnection Operation Manual (IOM)

The purpose of the IOM is to outline the duties and responsibilities of both parties at the interconnection between DL 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 DL.

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

8.3 Testing for Interconnection Facilities

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

(i) Electrical protection scheme
(ii) Protection coordination study
(iii) Cable and/or overhead test result
(iv) SCADA
(v) 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:

(i) Inverter compliance tests
(ii) Interconnection compliance tests

The scope of testing during IOD shall cover:

(i) The LSS plant shall cease to energise during loss of mains. Anti-islanding test must comply with the following time:
   - Disconnection time: ≤2s and
   - Reconnection time: >5min
(ii) Functional tests of all equipment
(iii) 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 DL.

8.5 Power Quality Measurements

8.5.1 Pre/Post Initial Operation Date (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.

Measurement shall capture the following parameters and not limited to:

(i) Total harmonic distortion (THD) voltage
(ii) Unbalanced voltage
(iii) Flicker voltage
(iv) RMS Voltage
(v) Power Generation (kW)
(vi) Reactive Power (kVAr)
(vii) Power factor
(viii) Energy kWh (daily)

8.5.2 Permanent Power Quality Measurements

The LSS developer shall install a permanent power quality recorder at the LSS circuit breaker and to submit the PQ report as and when requested by DL.

Measurement shall capture the following parameters and not limited to:

(i) Total harmonic distortion (THD) Voltage
(ii) Total harmonic distortion (THD) Current and each individual current harmonic

(iii) Unbalanced voltage
(iv) Flicker voltage
(v) RMS Voltage
(vi) Power Generation (kW)
(vii) Reactive Power (kVAr)
(viii) Power factor
(ix) Energy kWh (daily)
(x) Voltage dip and swell events

9. Commercial Operation Date (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 ST and witnessed by DL. The verification test parameters include the following:

(i) Grid Frequency Variation
(ii) Reactive Power Control (voltage control and power factor control modes)
(iii) Grid system voltage variation
(iv) Grid system fault level
(v) Protection System
(vi) Voltage support (AVQC) & Active Power Control
(vii) Equivalent control device to speed governor (Droop curve)
(viii) Frequency MW Response
(ix) Power Quality
(x) Fault ride through (LVRT)
(xi) Power ramping (up and down)
(xii) 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 : Interconnection Facility Verification Methods

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

9.2 Confirmation for COD

The LSS developer shall submit to ST and DL the report for COD confirmation. The report shall consist of:
(i) Verification report
(ii) PQ report

Upon receipt of the reports, ST shall issue a letter of confirmation on COD to the LSS developer and DL to initiate payment.

10. Safety and Performance Sustainability Requirements

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

(i) The LSS developer shall provide the single line diagrams of the interconnection facilities at the respective side of the connection point;
(ii) The LSS developer shall have their own safety rules and/or safety instructions which comply with the Electricity Supply Act and prudent utility practices.
(iii) The LSS developer shall designate a competent personnel registered with ST to operate the interconnection facilities within their boundary.

The LSS developer shall at its own cost conduct the testing of LSS plant (including the Interconnection Facility) and thereafter, submit the report of such testing, which report shall be certified by the Independent Engineer, to ST and DL on the 10^{th} and 15^{th} year of the contractual Term.

11. Commercial

11.1 Power Purchase Agreement (PPA)

The PPA is an agreement between DL and LSS developer. The agreement is based on Energy PPA only. It will be commenced for 21 years from the COD (Term).

11.2 LSS Plant Capacity

The established capacity allowed for connection to distribution network shall be in the range of $1MW_{ac}$ to less than $30MW_{ac}$ only. Type of concession is Build, Own and Operated (BOO) by the LSS developer.

Capacity factor must be declared and validated by the Independent Engineer approved by ST. At any point, the LSS developer shall not install solar panels more than the maximum Contracted Capacity. The contracted capacity will be dependent on the approved CLOA.

11.3 Maximum Annual Allowable Quantity (MAAQ)

The MAAQ (in kWh) is to be proposed by the LSS developer based on the Capacity of the Plant, the capacity factor and the number of hours in a year. Such MAAQ and any related documents shall be certified by the Independent Engineer approved by ST.

Energy produced annually by the LSS plant is capped at the agreed MAAQ in terms of payment of the Energy Rate. If MAAQ is exceeded, lower rate is applicable (Excess Energy Rate) as stipulated in the PPA.

11.4 Energy Beyond Contracted Capacity

Contracted Capacity (MW) shall depend on the bid submitted and subject to the approval of the ST. Any energy produced on a half hourly basis beyond the Contracted Capacity shall be free of charge.

11.5 PPA Timeline

Figure 10 illustrates the generic timeline for LSS PPA from the effective date of letter of acceptance of offer.

Figure 10: Timeline for LSS Plant

The Financial Closing Date shall occur on or before 6 months prior to the IOD.

11.6 PPA Submission

The shortlisted LSS developer is required to submit the PPA to DL within 90 days upon receiving letter of acceptance from ST.

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

(i) PPA.
(ii) Conditional Letter of Award.
(iii) LSS plant installation.
(iv) Interconnection and Communication facilities.
(v) Power system study (PSS) report.
(vi) Declaration of MAAQ.
(vii) Permanent generation licence by ST is condition precedence (CP) to IOD and will be part of IOD checklist.
(viii) 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.
(ix) Corporate Authorisations.

11.7 Billing and Payment

11.7.1 Test Energy

Test energy refers to the energy generated and delivered from the date of IOD until COD. During this period, LSS Developer needs to perform all relevant tests and shall be verified by the Independent Engineer approved by ST.

11.7.2 Energy Rate

LSS developer shall submit proposed energy rate during the bidding process. The final energy rate will be awarded by ST in the letter of acceptance of offer.

The energy rate will be effective during the PPA contract period. Any changes to the energy rate are not permitted except upon ST approval.

11.7.3 Change of ownership

The successful LSS developer shall not change the ownership of the LSS plant without the approval from ST.

However, if the approval granted by ST, the existing LSS developer shall terminate the existing PPA with the DL. The new owner shall submit new PPA to the DL and the effective period shall be the remaining years of the PPA.

11.7.4 Billing

The LSS Developer shall read the energy meter on a monthly basis and prepare an invoice stating the amount of solar net energy output (NEO) and the amount payable by DL to the LSS developer. The LSS developer shall submit to DL the following documents:

(i) Invoice (refer to Attachment D).
(ii) A photo of the meter with the kWh reading.

11.7.5 Payment

11.7.5.1 Test Energy

No energy payment shall be applicable for any test energy generated during the testing and commissioning of the Interconnection Facility.

11.7.5.2 Annual energy generation less than or equal to MAAQ

DL will pay the LSS developer on the prevailing energy rate. The calculation will be as below:

Payment (RM) = NEO x ER

11.7.5.3 Annual energy generation exceeding MAAQ

DL will pay the LSS developer on the special energy rate that will be approved by ST.

Payment (RM) = NEO x EER

The rate for ER and EER shall refer to PPA.

Note:
DAQ =Declared Annual Quantity (MWh)
ER = the prevailing Energy Rate (in RM/kWh) applicable for that Billing Period
EER = the Excess Energy Rate (in RM/kWh) for that Billing Period
MAAQ = Maximum Annual Allowable Quantity (in kWh)
NEO = Net Energy Output (in kWh)

Figure 11: Calculation of Energy Payment

11.7.5.4 Penalty

Penalty may be imposed when there is a consequence of non-delivery of energy to DL based on capacity and energy commitment by LSS Developer. The details will be stipulated in the PPA.

11.8 Delay Compensation

11.8.1 Failure to achieve Scheduled Commercial Operation Date (SCOD)

LSS developer shall pay to DL compensation for each day beginning from the expiry of the SCOD until the earlier of;

(i) the COD of the LSS plant; or
(ii) the date of PPA termination by DL in accordance with the provision of PPA; or
(iii) 180 days after the SCOD

The calculated amount of compensation shall be specified in the PPA.

11.8.2 Abandonment of the project

If the LSS developer abandons the project after the Effective Date, the LSS developer shall compensate DL an amount as stipulated in the PPA.

ATTACHMENTS

ATTACHMENT A : Smart Inverter Functions

- Continued growth of PV generation puts more challenges on grid infrastructure designed for distribution from centralized energy sources. Advanced or smart inverter functions can help address the grid stability problems posed by high levels of variable distributed generation
- Smart inverters are PV inverters that stay connected and provide additional functions to help actively support the grid - mainly voltage and frequency. Smart Inverters able to receive commands from grid operators and report information. Traditional inverters simply disconnected when the grid voltage or frequency went out of range.
- Broadly, smart inverters provide some additional benefit to the grid beyond simply converting direct-current (DC) electricity to alternating current (AC) from PV systems. They typically support overall grid reliability by offering the following functions:

No.	Functions	Description	Setting	Reference
1	Anti-islanding Protection	Automatically disconnect during grid failure within certain duration. The duration is adjustable. Anti-islanding protection is to ensure inverter doesn't back-feed a disabled grid	LV : • Disconnect 2sec • Reconnect 2min MV: • Disconnect 2sec • Reconnect 5min	• Distribution Code: 7.8.3.5 - Protection and Control Requirements
2	Voltage and Frequency Ride-through Capability	Inverter must meet the mandatory and permissive operation requirements as well as the must trip limits when the AC grid voltage and frequency high or low limits are exceeded. Inverters support the grid during brief voltage or frequency excursions. This function will help the grid to self-heal from a disturbance. During periods of (sometimes extreme) deviations in grid voltage and/or frequency, smart inverters are designed to remain connected to the grid and adjust their output to act as a counterbalance to frequency or voltage changes	LVRT/HVRT: Refer the graph (6.2.1) LFRT/HFRT: uninterrupted range 47Hz to 50.5Hz	• Distribution Code: 6.5.5.1 - Low Voltage Ride Through & 6.5.5.2 - Frequency disturbance
3	Ramp Rate Control	The rate of power increase when first ramping (start ramp) and subsequent increases in offsetting or selling (normal ramp) 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.	Does not exceed 15% of rated capacity per minute. Applicable for LSS capacity of 5MW and above	• Grid Code: CC6.4.12

4.	Reactive Power Control Functions	Inverter is able to supply or absorb reactive power to/from the grid to maintain stable grid voltage when fluctuations are prevalent. Variable Power Factor provides active voltage stabilization: • Grid voltage nominal, purely active power • Grid voltage high, add 'inductive' reactive power • Grid voltage low, add 'capacitive' reactive power Adjusting VARs keeps grid voltage from oscillating; acts like a shock absorber The reactive power control can be achieved using 3 main controls: (a) Dynamic Volt/VAr Mode (voltage control) (b) Fixed power factor (pf control) (c) Fixed reactive power (eg: using switched reactor)	Voltage range: (MV-11kV&33kV) ± 5% (LV- 230V & 400V) -6% +10% Power Factor range: 0.85 lagging to 0.9 leading	• Distribution Code: 5.4.4.1 - Voltage range, 6.5.5.5 - Reactive power, 7.8.3.8 - Power factor
5.	Active Power Control Functions Frequency-Watt (Droop Curve) and Volt-Watt	Support grid frequency and voltage by changing inverter wattage output: Help to stable the grid during an under/over frequency and voltage event by controlling the real output of the solar system. • Grid frequency/voltage nominal, inverter at max output • Grid frequency/voltage high, inverter curtails power • Grid frequency/voltage low, inverter increases power	Frequency range: 47Hz to 50.5Hz Voltage range: (MV-11kV&33kV) ± 5% (LV- 230V & 400V) -6% +10%	• Distribution Code: 6.5.5.4 - Droop curve, 5.4.41 - Voltage range & 6.5.5.3 - Power output management
6.	Data log/Memory card for event logs	Capture profile of networks parameters – Voltage, Current, Frequency, Power (active & reactive), power factors and events log. The data log can be used for troubleshooting and monitoring purposes.	N/A	Distribution Code: 6.8.1.3 - Distribution System Control Structure
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 facilites:	
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 Perjangkaan 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 oustanding issues	

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

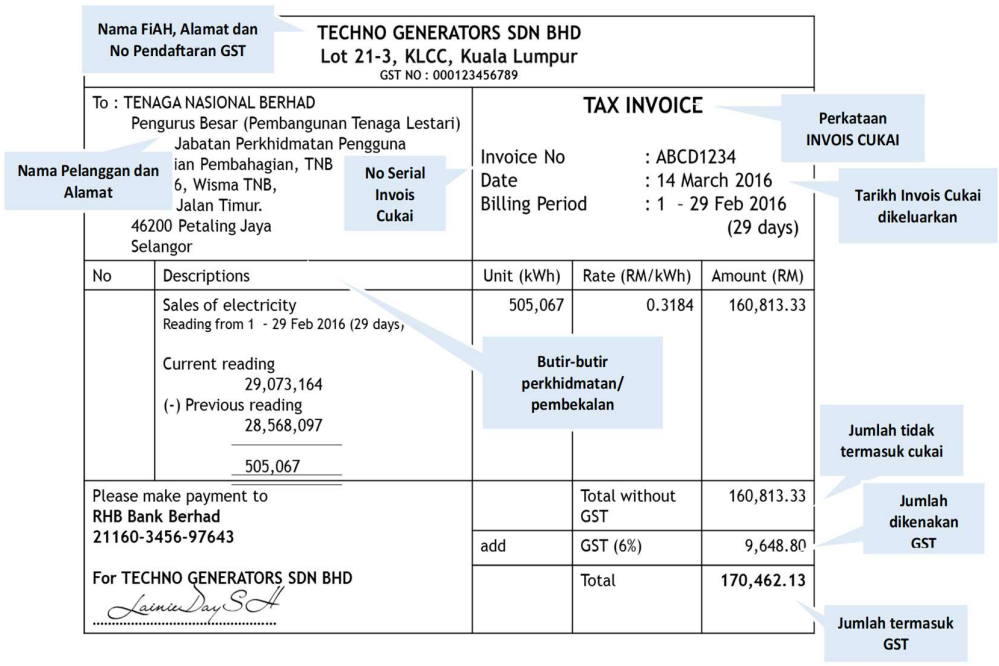
Prepared by: Independent Engineer (appointed by ST)	Checked by: (TNB - RE&GT)	Verified by: (TNB - RE&GT)
.....	.....	.....
Name:	Name:	Name:
Date:	Date:	Date:

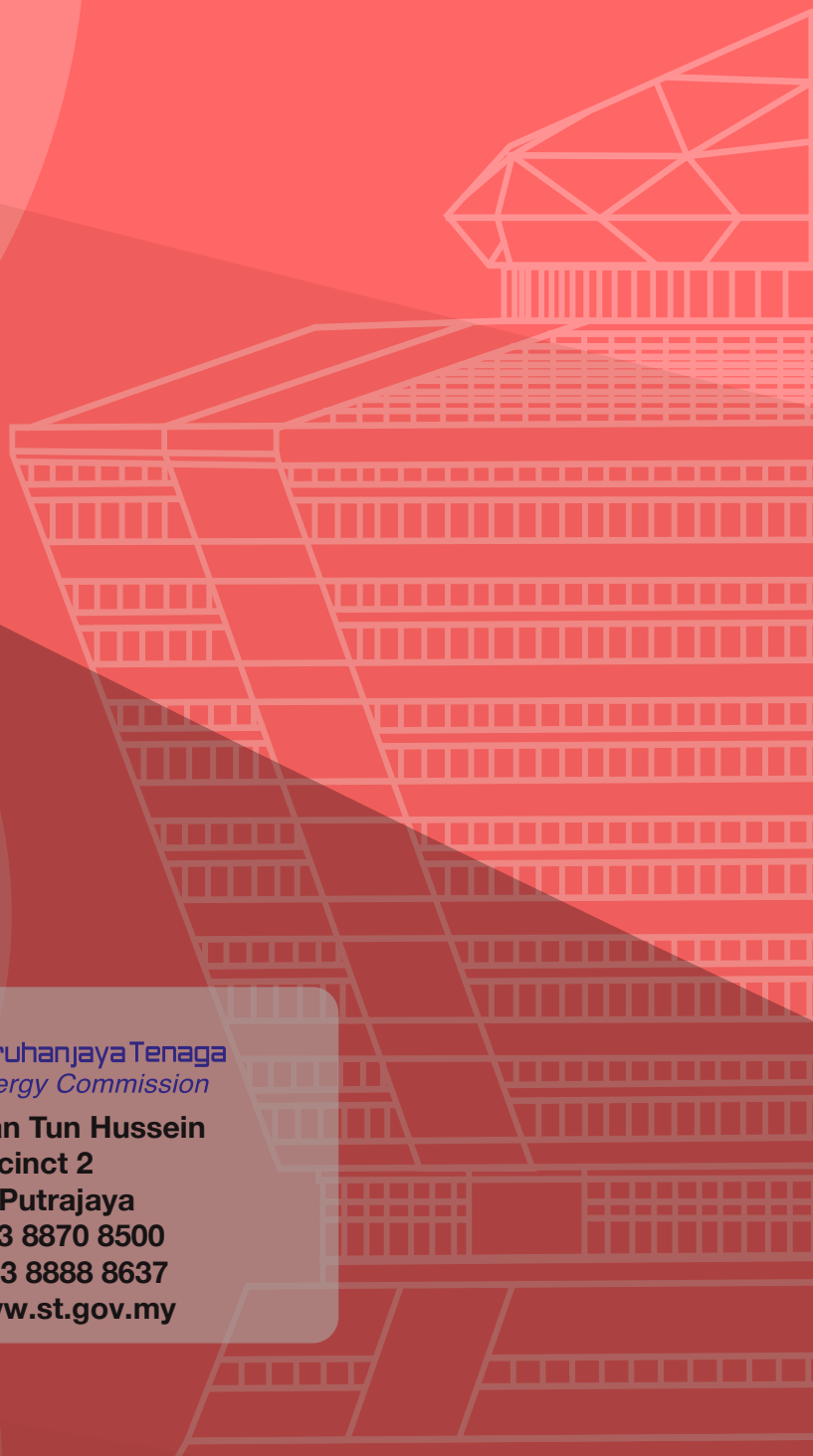
ATTACHMENT C: COD Testing Requirements

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

	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) Power factor control mode	6.2.4 & 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 Power System Study	Site verification based on nameplate rating	Compliance to Power System Study
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) & 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
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





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