Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 2 Technical Specification and Requirements of Microgrid Controller

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
1	Principal Requirement				
		1.1 MGC shall be able to operate in all use cases as described in Section 3.			
		1.2 MGC shall be able to operate to support different objective functions such as reliability, power quality, peak reduction, reduce power losses in distribution line, or Volt/VAR control, etc.			
		1.3 MGC shall be able to give weights or priority to avoid conflict between different objective functions. High priority objective function always has presidencies over lower priority objective function.			
		1.4 MGC shall be able to communicate with the existing ADDC system, the substation, the hydro power plant (monitoring), the diesel generator controller, the battery storage management system, the PV inverter (monitoring), AVRs (monitoring), and SWs, field device controllers.			
		1.5 MGC shall be able to perform fault location, isolation and service restoration (within the boundary of the microgrid).			
		1.6 Substation battery shall be used to provide backup emergency power when the primary power source is not available.			
		1.7 MGC shall be able to operate with and without 115 kV transmission line from Hot Substation to Mae Sariang Substation.			
		1.8 MGC shall be able to forecast on loads and generations. And weathers forecast shall be provided by bidder or agency. [Archetecture and accuracy will not defined]			
		1.9 MGC shall be able to time synchronize with CSCS and all components in the system.			
		1.10 MGC shall control circuit breaker and receive signal of protection system in substation via CSCS.			
		1.11 MGC shall be compliant to to some propose part of IEC62898-1, IEC62898-2. [PEA provide draft version]			
		1.12 Detailed factory acceptance test of MGC shall be proposed after signing contract to verify the functional of MGC before installation at site			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 2 Technical Specification and Requirements of Microgrid Controller

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
2	Hardware Requirements				
		2.1 MGC shall have redundant server in order to be a highly reliable controller, i.e the MGC shall be able to operate with contingency of controller at least n-1. MGC which is centralized architecture shall have redundant server. MGC, which is distributed architecture, shall be able to operate when one of distributed controllers is failed. No loss station data during system fails. The fail shall occur in period less than 10 second.			
		2.2 MGC controller set shall be industrial grade.			
		2.3 MGC shall have at least 3 human machine interface (HMI) monitors. Three monitors for operator at control room shall have screen size at least 27". One monitor for monitor at electric office (EO) room shall have screen size at least 23". One monitor for displaying at conference room shall have screen size at least 50".			
		2.4 Graphic display on monitor shall support at least both English and Thai language.			
3	Software Requirements				
		3.1 The configuration of power system shall be able to be reconfigured by PEA after commissioning. PEA shall be able to add and/or remove any electrical equipment by PEA personnel. Vendor shall describe in detail the configuration tools use to configure modify microgrid controller.			
		3.2 MGC shall be able to store history operation data for at least 1 year continuously according to First in First out (FIFO) process.			
		3.3 Operating Systems (OS) of HMI and Engineering Workstation shall be latest version of Windows or Linux according to OS of MGC.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 2 Technical Specification and Requirements of Microgrid Controller

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		3.4 The Engineering Workstation at MGC control room shall include these functions: • Real time data historian & analysis • Communication network management • System access control and cyber security management • MGC monitoring, diagnostics and maintenance • Disturbance and fault information handling, analysis and evaluation • Engineering HMI • Web server and interface (for equipment setting) • Sequence of events and alarm analysis • Data archiving, trending and historical analysis • Automatic fault report generation and notification • Substation Protection, Automation and Control system • Substation status display • Substation documentation management • Dashboard status display of overall MGC system • Realtime graphic of system analog			
		3.5 The operation screen displays for the monitoring and control of MGC shall include: • Detailed equipment status and network configuration information • Import GIS info graphic from database of PEA • Visual indication of device setting, selection, operation and interlocking • Service and measurement values, including analog measurements and their limit setting • Alarm annunciation • Visual record of system alarms, including fault information and events • A means of displaying the status of devices that are not monitored automatically but are under the substation operator's control such as application of tags or labels • Screen saver mode after 1 hour of keyboard input inactivity • Display detailed equipment and network configuration information according to each use cases			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 2 Technical Specification and Requirements of Microgrid Controller

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		3.6 MGC shall be able to display data at ADDC. It also be able to display in web service or mobile application without using public cloud. MGC shall have open source web server for display web page. [PEA modify existing ADDC config]			
		3.7 User interface, log report, message or related user interfaces shall be displayed in English.			
		3.8 Upgrade and patched management shall be able to be done remotely. Vendor shall describe mechanism of how and when upgrade and patched are available to PEA. PEA shall be notified immediately once the upgrade and patched are available.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 3 Technical Specification and Requirements of Battery Energy Storage System (BESS)

Item	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
1	General				
		BESS shall consist of a power conversion system (PCS) suitable for outdoor installation on a user-furnished concrete pad or the user-furnished box pad. [Outdoor or Indoor with container]			
		BESS shall be an energy storage unit of at least 3MW/ at least 1.5 MWh at 20%-95% SOC, at least 0.5 hour at 3 MW, lithium-ion battery with life expectancy rating of 10 years under normal operating conditions, suitable for outdoor installation, and a battery management system (BMS). [3MW/1.5MWh output to load not installation capacity]			
		The BESS shall be connected to the medium voltage 22kV AC three phase distribution line at a frequency of 50Hz. A step-up transformer shall be provided to allow connection between the BESS and the 22kV distribution line. Rating of a step-up transformer is at least 4 MVA. The winding type of transformer can be defined by bidder. The vector group of transformer shall be YNd group.			
		The PCS shall be designed to operate under the following condition: Phase 3 Rated voltage 22kV Voltage range Max 23.1 kV, Min 20.9 kV Voltage fluctuation/Flicker According to PEA regulations Rated frequency 50 Hz Frequency range 50 ± 0.5 Hz Harmonics According to PEA regulations Voltage unbalance < 2%			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 3 Technical Specification and Requirements of Battery Energy Storage System (BESS)

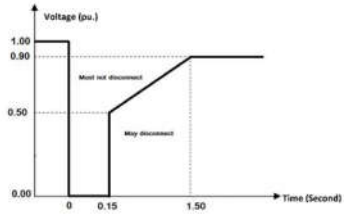
Item	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		In normal operation, BESS shall operate in current-source mode, providing such functionality as voltage regulation, power factor correction, peak shaving and **load following** (for PV output smoothing). It shall have the ability to perform **four-quadran**t control.			
		If the utility power source is interrupted, the BESS shall have low-voltage ride through (LVRT) capability according to PEA Grid connection code 2016 as shown below to support the transition from grid connected to islanded condition. The energy storage unit and converter shall then power the islanded 3.0 MW load for at least 0.5 hours, or until utility service is resumed for the energy storage unit is depleted.  			
		The BESS shall be capable of communicating over a standard protocol, like DNP 3.0 over IP or IEC61850 protocol, furnished and installed by the system manufacturer, which shall permit - communication to the microgrid controller (MGC- This will allow PEA to monitor and control such parameters as battery voltage, current, temperature, state of charge and state of health at the cell/module/tray and rack levels; as well as allow to control charging, discharging and other functions of BESS, as necessary.			
		Battery management system (BMS) shall connect and transfer data to MGC/ADDC.			
		The PCS shall communicate with the energy storage unit controller via a standard protocol defined by vendor, e.g. Modbus RTU or Modbus TCP, etc. In case of Modbus communication, all Modbus detail shall be provided.			
		The BESS shall have a maintenance port (serial, WiFi, Bluetooth, etc.) to allow monitoring and control of BESS at local level via a PC.			
		The BESS shall have security access for maintenance battery container.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 3 Technical Specification and Requirements of Battery Energy Storage System (BESS)

Item	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
2	Standards and Codes				
	Equipment furnished shall meet the guidelines defined in the applicable sections of the standards and codes listed below.	ANSI/IEEE Standard C2-2007: National Electrical Safety Code			
		ANSI C57.12.28-2005: Pad-mounted Equipment Enclosure Integrity			
		ANSI Z535.4-2002: Product Safety Signs and Labels			
		ANSI C62.41.2-2002: IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000V and Less) AC Power Circuits			
		IEC 61000: Electromagnetic compatibility (EMC) o EN61000-6-2 EMC immunity o EN61000-6-4 EMC emission o Reference - FCC Sections 15.109&15.209: FCC Code of Federal Regulations Radiation Emission Limit			
		IEEE Standard 519-2014: IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems			
		IEEE Standard 1547.1-2005: IEEE Standard Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems			
		IEEE Standard 1547.3-2007: Guide for Monitoring, Information Exchange, and Control of Distributed Resources with Electric Power Systems			
		IEEE C37.90.2-2004: IEEE Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers			
		IEEE Standard C37.90.1-2002: IEEE Standard for Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems (ANSI)			
		International Building Code: Applicable to seismic rating, requirements, location and design of mounting pad (designed by others).			
		NISTIR 7628: Guidelines for Smart Grid Cyber Security			
		IEC 62619 or UL 1973 - Safety Requirements for Secondary Lithium Cells and Batteries or Standard for Stationary Batteries			
		IEC 62109 or UL 1741: Safety of power converters for use in photovoltaic power systems or			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 3 Technical Specification and Requirements of Battery Energy Storage System (BESS)

Item	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
3	Environmental Requirements				
		The system shall be designed for use in the following environment Operating temperature 0 C - 45 C without derating Humidity 0 – 95% non-condensing Maximum altitude 1,000 m without derating Seismic Rating Uniform Building Code Zone 4 Audible Noise Audible Noise shall be complied with Thailand environmental standard less than 80 dBA. Supplier must provide sufficient information specific to their particular product to facilitate utility personnel training and communications with emergency response and environmental agencies. Material Safety Data Sheets (MSDS) shall be provided as applicable.			
4	Power Conversion System (PCS)				
	4.1 General	The PCS may consist of one or more parallel units.			
		The PCS shall be bi-directional converter that can be operated in inverting mode for battery discharging and rectifying mode for battery charging.			
		The PCS shall be cooled, with final rejection of waste heat to the ambient air. The air-handling systems shall include filtering that is adequate to keep dust from the interior of the PCS system. Replacement of filter shall not require special tools or involve more than two hours of labor at the site			
		The PCS shall consist of an converter area, user-accessible AC termination area, user-accessible DC termination area, and user-accessible control area.			
		Converter area: The converter area shall contain an AC circuit breaker, converter and DC circuit breaker. • AC circuit breaker – The AC circuit breaker shall isolate the power unit from the utility source if needed. • Converter – Upon opening of the AC circuit breaker in response to interruption of the utility source, the three-phase converter shall power the islanded load until utility service is resumed or energy in the battery pack is depleted. • DC circuit breaker – The DC circuit breaker shall provide isolation of the battery pack,			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 3 Technical Specification and Requirements of Battery Energy Storage System (BESS)

Item	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		AC termination area The user-accessible AC termination area shall include bus terminal pads for connection of utility source and the customer load cables.			
		DC termination area The user-accessible DC termination area shall include terminations for cables from the battery pack.			
		Controls area The user-accessible controls area shall contain the master controls and associated circuitry to support operation. Within the control area shall be the following: • Control panel – The control panel shall include a three-position rotary switch for selecting the control mode of the power unit (MGC or ADDC-enabled, MGC or ADDC-disabled, and Remove From Service). • Master control board – The master control board shall provide the main processing and control functions of the converter. • Power supply – The power supply shall provide the necessary DC control power for the system controls.			
	4.2 System Operation	4.2.1 Start/stop characteristics The PCS starts or stops by pushing buttons “RUN” or “STOP”, respectively, or receiving control commands from a local HMI, or MGC (or ADDC in case MGC fails).			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 3 Technical Specification and Requirements of Battery Energy Storage System (BESS)

Item	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		4.2.2 Operation during normal condition The following functions shall be required with the PCS for the grid-connected and islanded (off grid) operation. 1. The AC power transformed efficiently from the DC power of the battery arrays shall be bi-directionally transferred to or from the distribution line without causing harmonics higher than the PEA regulation. 2. The following operation modes shall be provided: a. Virtual synchronous generator b. Active and reactive power control c. Voltage and frequency control d. Voltage and frequency droop for parallel operation (BESS may be paralleled with Solar Farm, Diesel Gen Set, Run of River Hydro) 3. Black start capability 4. The PCS shall contain a remote synchronization feature, as well as the standard synchronization used when starting the PCS online. The remote synchronization feature allows the PCS to synchronize its voltage and frequency to any other remote AC bus or generator. 5. PCS shall be stable against the usual change in voltage and frequency of the grid.			
		Mode selection and control parameter setting shall be done by local HMI, or control command from MGC (or ADDC in case MGC fails).			
		The PCS shall have the following capability: • The PCS shall have the ability to perform four-quadrant control. • The PCS shall be able to perform load following (for PV smoothing) Voltage shall be maintained at +/- 5% nominal under normal operating conditions and +/- 10% under emergency conditions. • The PCS shall have zero-voltage ride through capability to support the transition from grid connected to islanded condition. Please state your compliance to the latest draft of IEEE 1547 • The PCS shall have the synchro-check function to allow parallel operation with the grid, diesel and PV generators.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 3 Technical Specification and Requirements of Battery Energy Storage System (BESS)

<table>
<tr><th rowspan="2">Item</th><th rowspan="2">Details</th><th rowspan="2">Requirements</th><th>Statement of Compliance</th><th rowspan="2">Proposed Data</th><th rowspan="2">Referred to Page</th></tr>
<tr><th>C/N</th></tr>
<tr><td></td><td></td><td>4.2.3 Operation during abnormal condition
The PCS shall operate as follows during abnormal operation:
• The PCS stops automatically when serious abnormal conditions are detected.
• When not-serious errors are detected, the PCS continues operation with error signals which shall be reported to MGC and ADDC.</td><td></td><td></td><td></td></tr>
<tr><td></td><td>4.3 Detailed Technical Specifications</td><td>PCS shall have following technical specfications
Table 1. PCS technical specifications<table>
<tr><th>Details</th><th>Technical requirement</th></tr>
<tr><td>AC ratings</td><td></td></tr>
<tr><td>Total rated output power to load @ nominal voltage</td><td>– 3MW (charge) to 3 MW (discharge)</td></tr>
<tr><td>Apparent power @ nominal voltage</td><td>≥3 MVAR</td></tr>
<tr><td>Rate output power of each unit</td><td>> 500 kW</td></tr>
<tr><td>Real and reactive power control accuracy</td><td>±1%</td></tr>
<tr><td>Voltage range</td><td>as defined by bidder</td></tr>
<tr><td>Type of output</td><td>AC three-phase system</td></tr>
<tr><td>Frequency</td><td>50 Hz ±1%</td></tr>
<tr><td>VAR production</td><td>Full VAR production at rated voltage</td></tr>
<tr><td>Harmonics</td><td>according to PEA standards</td></tr>
<tr><td>DC input ratings</td><td></td></tr>
<tr><td>Voltage range</td><td>as defined by bidder</td></tr>
<tr><td>Ripple voltage</td><td>Less than 4V RMS</td></tr>
<tr><td>Ripple current</td><td>Less than 10% of full current peak to peak</td></tr>
<tr><td>Environmental ratings</td><td></td></tr>
<tr><td>Operating temperature</td><td>0°C - 45°C* without derating</td></tr>
<tr><td>Humidity</td><td>0 – 95% non-condensing</td></tr>
<tr><td>Maximum altitude</td><td>1,000* m without derating</td></tr>
<tr><td>Seismic Rating</td><td>Zone 4</td></tr>
<tr><td>Functions/Features</td><td></td></tr>
<tr><td>Power flow operation</td><td>Yes, support four-quadrant control</td></tr>
<tr><td>Real power control</td><td>Yes, positive and negative</td></tr>
<tr><td>Reactive power control</td><td>Yes, capacitive and inductive</td></tr>
<tr><td>Combination of real and reactive power control</td><td>Yes, with real power taking priority</td></tr>
<tr><td>Load following (renewable smoothing)</td><td>Yes, allowing renewable smoothing</td></tr>
<tr><td>Low-voltage ride through</td><td>Yes, supporting transition from grid connected to islanded operation</td></tr>
<tr><td>Synchro-check function</td><td>Yes, supporting parallel operation with the grid, PV and diesel generator</td></tr>
<tr><td>Operation modes</td><td></td></tr>
<tr><td>Black start</td><td>Yes, external command</td></tr>
<tr><td>Commanded power</td><td>Yes, external command</td></tr>
<tr><td>Commanded VAR</td><td>Yes, external command</td></tr>
<tr><td>Frequency regulation</td><td>Yes, external command</td></tr>
<tr><td>Frequency response</td><td>Yes, automatic</td></tr>
<tr><td>Islanding</td><td>Yes, automatic (when utility source is lost) or external command (from MGC or ADDC)</td></tr>
<tr><td>Renewable smoothing</td><td>Yes, automatic</td></tr>
<tr><td>Scheduled power</td><td>Yes, preconfigured time/date of work power profiles</td></tr>
<tr><td>Voltage regulation</td><td>Yes, external command</td></tr>
<tr><td>Response time of PCS to the command received</td><td>< 100 ms</td></tr>
<tr><td>Communications</td><td></td></tr>
<tr><td>Communications with MGC</td><td>Yes, via DNP 3.0 over IP or IEC61850</td></tr>
<tr><td>Communications with ADDC</td><td>Yes, via DNP 3.0 over IP</td></tr>
<tr><td>Battery technologies</td><td></td></tr>
<tr><td>Battery technologies supported</td><td>Li-ion</td></tr>
</table></td><td></td><td></td><td></td></tr>
</table>

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 3 Technical Specification and Requirements of Battery Energy Storage System (BESS)

Item	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		Physical systems | Protection class | Containerized solution for indoor installation or IP54 for outdoor installation Cooling system | Yes **Time source** | Time source | CSCS via MGC **Monitoring and control** | Interface, status and control panel | Yes Battery voltage (AC/DC) | Yes Battery current (AC/DC) | Yes Active power (AC/DC) | Yes Reactive power | Yes Energy (AC/DC) | Yes Capacity (Ah) | Yes Power factor | Yes Fault | Yes Battery information | Yes Audible alarm | Yes Battery temperature (average/extreme) | Yes State of Charge (SOC) | Yes Warning messages | Yes **Efficiency** | Efficiency of power conversion | ≥ 95% **Protection system** | Under/over voltage (DC and AC) | Yes Under/over frequency | Yes Over current protection | Yes Ground fault protection | Yes Over heat protection | Yes Smoke detection (Trip/Alarm) | Yes Surge protection (DC and AC) | Yes Automatic AC & DC open circuit when fault detection | Yes Insulating monitoring | Yes **Function Features** | Overload capability of 3 MW | 120% 30 seconds Switching frequency | >= 1 kHz Insulation resistance | Over 3 M-Ohm at DC 1000 V (exclude the circuit less than DC 60V) Withstand voltage | AC 2000V 1 minute (exclude the circuit less than DC 60V) Withstand impulse voltage | ± 5000V 1.2 x 50μS each 3 times **Noise level** | Noise level | Audible Noise less than 80 dBA.			
	4.4 Standards	The PCS shall be of high quality product, preferable produced by a manufacturer certified with ISO 9001 or equivalent. The PCS shall comply with IEC62109/UL 1741: Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 3 Technical Specification and Requirements of Battery Energy Storage System (BESS)

Item	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	4.5 PCS Electrical Protection	The PCS shall be protected against thermal overload, over-current and over-voltage. Insulating monitoring ground fault detection shall be provided. The following protective function shall be provided: • DC over-voltage • DC under-voltage • DC over-current • AC over-voltage • AC under-voltage • AC over-current • Anti-Islanding • Battery protection • Internal fault (over temperature, logic failure, etc.) The electrical shield cable shall be adopted for the signal and control cable. The surge absorber shall be connected on both sides. EMC requirement shall meet IEC 61000 or equivalent standard. Neutral point high resister grounding type (DC side) for ground fault alarm shall be provided.			
5	**Energy Storage**				
	5.1 Battery Type	Battery shall be off Lithium-Ion type suitable for utility scale BESS. Different chemistry of Lithium-Ion batteries, such as Lithium Manganese (LMO), Lithium Phosphate (LFP), Lithium Nickel Manganese Cobalt Oxide (NMC), Lithium Nickel Cobalt Aluminum Oxide (NCA), can be proposed.			
	5.2 Detailed Technical Specifications	Battery shall have technical specification as follows: Table 2. Energy storage unit technical specifications Details / Technical requirement Rated output power @ nominal voltage: − 3MW (charge) to 3 MW (discharge) (Continuous discharge measured at PCS output) Energy: At least 1.5 MWh at 20%-95% SOC, at least 0.5 hour at 3 MW to load Type: Li-ion Allowable charging capacity: See Note #1 below table Discharging capacity: See Note #1 below table Round-trip AC energy efficiency (including auxiliaries) at 22 kV system: > 80% Cycle life: > 4,000 at 20-80% SOC			
	5.3 Standard	Battery preferable produced by a manufacturer certified with ISO 9001 or equivalent			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 3 Technical Specification and Requirements of Battery Energy Storage System (BESS)

Item	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	5.4 Battery Module/Tray	• Battery module shall consist of many battery cells connected in series/parallel. • Module/tray battery management system (BMS) shall be provided. • Automatic module balancing shall be provided. • Module/tray cooling system shall be provided.			
	5.5 Battery Rack	• Battery modules shall be connected in series/parallel in the battery rack so that the nominal voltage of the DC is more than 480V, suitable for PCS DC voltage. • Rack BMS with battery fuse, DC current measurement devices and contractors shall be provided. • Electrical connection shall be at rack front side. • Many racks shall be connected in parallel to total capacity required for this project. • 300 kWh spare space for rack extension shall be provided.			
	5.6 Battery Protection	The following protections shall be provided: • Over-charge protection • Over-discharge protection • Over-temperature protection • Over-current protection • Ground-fault detection • Internal battery fault detection • Cell balancing			
		Protective devices should include for DC-side protection: • Battery fuse for each battery cell and module (preferred) • DC contactor for each battery rack • Grounding over current (76G)			
	5.7 Cycle Life	• If the product is sensitive to depth of discharge, the manufacturer must state the limitations and the product should be sized such that the depth of discharge corresponds to the required cycle life. • For purposes of estimating and demonstrating cycle life, cycles are defined in the same manner as system efficiency. • For lifetime assessment the supplier should provide a graph that displays the relationship between depth of discharge and the corresponding number of cycles available within the system's life.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 3 Technical Specification and Requirements of Battery Energy Storage System (BESS)

Item	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
6	**Battery Management System (BMS)**				
	6.1 General	BMS is used to monitor, protect, maintain safety and optimal operation of each battery cell, module and rack. BMS consist of: Module/tray BEMS, rack BMS and system BMS.			
	6.2 Minimum Functions of Module/Tray BMS	• Metering and monitoring o Battery cell voltage (all cells) o Battery module voltage o Battery cell temperature (at least one or several measured locations in battery module/tray) o Battery module current • Cell balancing o Module/tray BMS should balance voltage of cells • Safety protection o Module/tray BMS should protect the battery cells and module/tray from: ☐ Over and under voltage ☐ Over current ☐ Short circuit current ☐ Over and under temperature • Data communication: all metering items and contactor status shall be provided for rack BMS control and monitoring system.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 3 Technical Specification and Requirements of Battery Energy Storage System (BESS)

Item	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	6.3 Minimum Functions of Rack BMS	• Metering and monitoring o Battery rack voltage o Battery rack current o Battery rack temperature (one or several locations in battery rack)* o Battery SOC of battery modules • Module/tray balancing o Balancing battery modules/trays scheme • Safety protection o Rack BMS should protect the battery rack from: ☐ Over and under voltage ☐ Over current ☐ Short circuit current ☐ Over and under temperature • Data communication: all metering items and contactor status shall be provided for system BMS control and monitoring system.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 3 Technical Specification and Requirements of Battery Energy Storage System (BESS)

Item	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	6.4 Minimum Functions of System BMS	• Metering and monitoring o Battery system voltage o Battery system current o Battery rack voltage o Battery rack current o Battery rack temperature (one or several locations in battery rack)* o Battery SOC of each rack and battery system o Battery SOH (state of health) of each rack • Safety protection o System BMS should protect the battery system from: ☐ Over and under voltage ☐ Over current ☐ Short circuit current ☐ Over and under temperature • Data communication: all metering items and contactor status shall be provided for PCS control and monitoring system by a standard protocol, e.g., Modbus RTU or Modbus TCP protocol. Data sampling rate should be configured based on process requirement but not more than 2 seconds. • Preferred functions of system BMS: Controlling individual battery rack • BMS data communication: All metering items and contactor status shall be provided for PCS control and monitoring system by a standard protocol, e.g., Modbus RTU or Modbus TCP protocol.			
7	**Functional Requirements**				
	7.1 Voltage Regulation	Voltage deviation should be controlled within +/- 1% for a specified sec sampling rate.			
	7.2 Reactive Power Regulation	The system shall maintain a defined VAR flow level within +/- 5%.			
	7.3 Frequency Regulation	Frequency deviation should be controlled within plus/minus ½ cycle per second.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 3 Technical Specification and Requirements of Battery Energy Storage System (BESS)

Item	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	7.4 Round-trip Efficiency	The roundtrip AC-AC energy efficiency, measured at the point of common coupling 22 kV system, shall be provided and include parasitic and auxiliary losses under worst case conditions. The calculation is as follows: $$\eta = \frac{kWh_{out}}{kWh_{in}} \times 100\% = \frac{(rated\ discharge\ power) \times (discharge\ time)}{(rated\ charge\ power) \times (charge\ time) + losses} \times 100\%$$ Wherein, the discharge time is from a fully charged to fully discharged system, and charge time is from a fully discharged to fully charged system. If the auxiliary power is provided by a separate connection from the energy storage system, these measured values should be reflected in the losses term in the equation.			
	7.5 Self-Discharge	Supplier shall provide self-discharge characteristics.			
	7.6 Basic Insulation Level	The BESS AC system equipment shall have a Basic Insulation Level in accordance with IEC62109/UL 1741 and ANSI C62.41.2-2002 standards.			
8	**Alarms and Resets**				
	8.1 Alarms	The BESS shall provide the following alarms. • Informational Notification—indicates the status of the unit. • Warning Alarm—indicates a problem with the converter requiring attention (not affecting proper operation). • Converter Inhibit—indicates a problem with the converter affecting proper operation. The converter will stop operation. • Trip Offline Alarm—indicates a severe problem with the converter. The system will not operate. • Isolate Alarm—indicates a problem affecting proper operation of the system. The system will operate with limited functionality.			
	8.2 Resets	Energy storage unit alarms shall be reset by any of the following means. • Manual Reset—via the reset button located on the control panel, or via a personal computer connected to the control panel Ethernet port. • Auto Reset—automatically performed until reaching a predetermined reset count. • Self Reset—automatically performed whenever require.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 3 Technical Specification and Requirements of Battery Energy Storage System (BESS)

Item	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	9.1 Modular Replacement	The BESS PCS, control, energy storage system and current sensors shall be modularized and connected in a manner that enables field replacement of each module. It is expected that most maintenance will be accomplished while maintaining service.			

	9.2 Enclosure	The PCS shall be contained within a weatherproof, moisture-sealed, tamper-resistant, metal enclosure with a minimum IP54 or equivalent rating suitable for outdoor installation on a concrete pad or cover of a fiberglass box pad, in accordance with the following requirements.
		• The enclosure shall not utilize replaceable filters, dehumidifiers, or similar features requiring periodic maintenance. Air intakes are designed so that any entrance of water or dust is directed away from internal components and does not affect operation of the unit.
		• The enclosures shall be equipped with complete and failsafe fire detection/extinguishing system.
		• The enclosure shall comply with security requirements of IEEE C57.12.28 Section 4. The enclosure shall limit access to the controls and physical network connections.
		• The enclosure shall comply with coating system requirements of IEEE C57.12.28 Section 5.
		• Enclosure grounding shall be provided.
		• The enclosure shall have access control.
		• If applicable, wiring and weather-tight enclosure egress to an external antenna shall be provided.
		• A nameplate shall be provided specifying the following:
		  ○ Manufacturer name
		  ○ Connection diagram
		  ○ Unit ratings: Power, energy, voltage, BIL
		  ○ Specimen data: serial number, date of manufacture
		• Signage shall indicate Source and Load-Side AC Buses, Neutral Bus, DC Bus, Isolation Contactor, and Module names. Custom signage will be in accordance with specific utility requirements.
		• All necessary safety signs and warnings as described in ANSI Z535-2002 shall be included on the unit.
		• All necessary signs and warnings for identification of hazardous materials as described in NFPA 704 shall be included on the unit.			

10	**Safety**				
	10.1 General	• The BESS must be compliant with IEEE 1547, IEC 62619, and UL 1973 as appropriate. Systems must be able to protect themselves from internal failures and utility grid disturbances. • For all BESS equipment, the Supplier shall provide information on specific safety issues related to the equipment, including appropriate responses on how to handle the energy storage system in case of an emergency, such as fires or module ruptures.			
	10.2 Fire Mitigation	Provisions shall be included to extinguish internal container fires without the need to open container doors.			
11	**Warranty**				

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 3 Technical Specification and Requirements of Battery Energy Storage System (BESS)

Item	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		Manufacturer warranty shall be provided for the period of at least thirty-six (36) months from the date of commissioning. Please submit price reduction for 12 month warranty, The warranty shall cover all defects of the PCS and the energy storage unit from manufacturing and non-compliance with the contract; and manufacturer shall repair or replace the defect product at their own cost. The certified warranty issued by battery vendors/manufacturers shall be transferred to PEA before the issuance of Final Acceptance Certificate.			
12	**Information Security**				
		Supplier Shall Design The Bess To Be Hardened against willful attack or human negligence as per NISTIR 7628. Supplier shall contract information/cyber security scans and penetration tests by a 3rd party security company.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 4 Technical Specification and Requirements of Communication System

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
1	**Introduction**				
	Scope	Technical Specifications define the requirements for communication links between MGC, DERs and hi-speed SW within the scope of MGDP. The document defines the following aspects ☐ Functionalities and interface requirements between devices. ☐ Physical media of the communication links ☐ Backup communication links within the microgrid network ☐ Functionalities and interfaces with PEA backbone network			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 4 Technical Specification and Requirements of Communication System

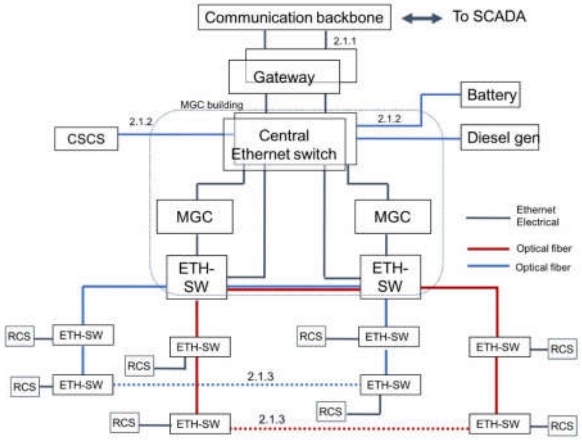
	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
2	**Principal Requirement**				
	2.1 Overview of the communication system	Communication system consists of 3 sections as shown in Fig. 1. Note that this figure is used for classification purpose, the actual implementation may be different from this figure. The contractor shall provide fully working communication system to carry all microgrid functions in all sections.  Fig. 1 Basic concept of Microgrid communication (May not be actual implementation)			
		2.1.1 Communication with the authority's backbone network. This section allows communication between MGC and ADDC North 1's SCADA network via gateway equipment to the backbone network.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 4 Technical Specification and Requirements of Communication System

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		2.1.2 Communication with CSCS, Battery and Diesel Generators. This section allows communication between MGC to CSCS, Battery and Diesel Generators via an Ethernet Switch. The links shall be optical fiber which support the required lengths (Appendix B).			
		2.1.3 Communication in Power distribution system within Microgrid. This section allows communication between MGC and all 13 SWs within the microgrid. The communication system consists of two Ethernet root switches and other switches in ring topology. Due to geographic locations and the number of total switch, the contractor should implement two rings.			
	2.2 Necessary hardware requirements	2.2.1 Communication with the authority's backbone network Between the MGC via the gateway and PEA backbone network, two physical links shall be installed from the gateway to different SDH routers, located at different sites. If links from Gateway to communication backbone equipment are only indoor, the links may be electrical cables, otherwise optical fiber links shall be used which support full-duplex over single mode fiber or better. In the case of optical fiber links additional equipment must be provided by the contractor to enable seamless connection to the backbone routers, such as electrical-optical media converters. Spare communication ports must be available and installed at both ends of each link in case of malfunction.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 4 Technical Specification and Requirements of Communication System

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		2.2.2 Communication with CSCS, Battery and Diesel Generator Physical optical fiber links shall be installed from Ethernet switch to the communication interface of MSR substation control system, battery control unit and diesel generator control unit. If necessary, media converter will be required at both ends. The communication link shall support the lengths specified in Appendix B and the optical cable to be installed shall be either single-mode or multi-mode. Two sets of physical duplex links shall be available, one link to be in operation and one link to be spare.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 4 Technical Specification and Requirements of Communication System

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		2.2.3 Communication in Power distribution system within Microgrid All 13 SWs shall be connected to the MGC via 13 industrial Ethernet switches and two root Ethernet switches each connected to each MGC. Ethernet switches as shown in Fig. 2, shall be ring connected. Geographic locations of the switches are shown in Fig. 3. Ethernet switches are connected to one another by optical fiber using duplex connector via SFP pluggable modules (with specification in Appendix C). Thus the field industrial Ethernet switches ETH-SW1 to ETH-SW13 each contain 3 optical ports as minimum (2 for two-direction of the ring and 1 spare). Wavelength in use shall be in 1550 nm window. Note that the Ethernet switches are physically located at the same site as SW, where they can share the same cabinet; and each SW is connected to one of electrical Ethernet ports of each Ethernet switch. The distances between each adjacent pair of Ethernet Switches are summarized in Appendix B.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 4 Technical Specification and Requirements of Communication System

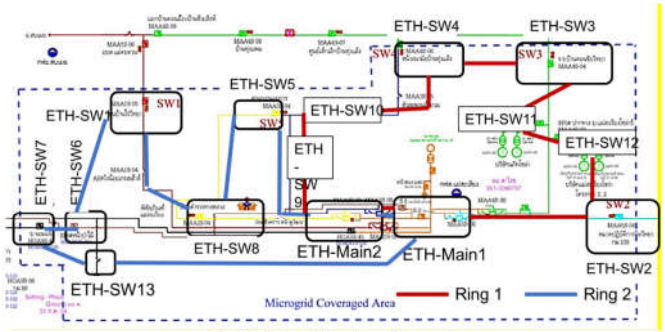
	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		 Fig. 2 Network topology diagram[1]			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 4 Technical Specification and Requirements of Communication System

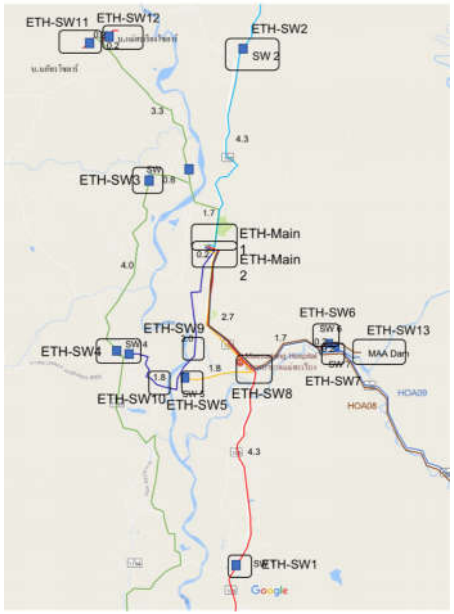
	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		 Fig. 3 Diagram of Ethernet Switches locations with distances in km			
		2.2.3.1 Ethernet switch location and topology It is required that each Ethernet switch has two physical connection paths in ring topology. The contractor shall design the topology such that the optical fiber length between two adjacent Ethernet switches is below 10 km that satisfies the service level agreement. If necessary, two physical rings should be considered to limit the ring dimension, as shown in Fig. 2.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 4 Technical Specification and Requirements of Communication System

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		2.2.3.2 Optical Fiber Installation Optical cables shall be installed along the PEA distribution power lines. Optical cables shall be single mode and follow specifications in Appendix A. The number of usable cores shall be 24 cores. Where necessary, attenuation should be inserted in if any fiber section is too short in order that the received optical power is within range. In actual installation, it may be necessary that a ring topology is formed by loop-back along the same route, the loop-back fiber may use a fiber core in a different tube within the same cable. Fiber cable installation, where applicable, shall adhere to the requirements with the authority's approved specification numbers in Appendix A, such specifications are obtainable from the authority's database.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 4 Technical Specification and Requirements of Communication System

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		2.2.3.3 Ethernet switches Ethernet switches are industrial grade and have layer 3 routing capability. Ethernet switch specifications are given in Appendix C. They can be classified in 2 types, indoor and outdoor Ethernet switches. Indoor switches are 3 Ethernet switches located in the building as shown in Fig. 1, their mounting type is rackmount. The number and type of communication ports shall equal to the required connections in contractor's designed network, plus at least additional 50% of total use ports to be used as spare ports. Spare ports for Electrical and optical interfaces are counted separately. The Ethernet switch that is next to the gateway shall contain redundancy in active-standby mode. Outdoor or offsite switches are 13 Ethernet switches in the field. They may have DIN rail mounting which can be installed in the same cabinet as each SW. The number and type of communication ports shall equal to the required connections in contractor's designed network, plus at least additional 50% of total use ports to be used as spare ports. Spare ports for Electrical and optical interfaces are counted separately.			
3	**Functional requirements and communication use cases**				
	3.1 Communication with PEA backbone network	The system shall provide seamless communication integration with PEA existing backbone communication and future backbone networks. The communication protocol used in this section of communication system is DNP3.0 over IP.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 4 Technical Specification and Requirements of Communication System

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	3.2 Communication with CSCS	3.2.1 Normal operation Gateway bypasses command data from SCADA network to CSCS which uses DNP3.0 over IP protocol. CSCS returns data to SCADA network via Gateway also using DNP3.0 over IP. The Gateway stores events in the buffer. The gateway responds to MGC commands and send the stored data to MGC, all using IEC61850 protocol, the buffer is then cleared. Protocol conversion is performed by the gateway.			
		3.2.2 Backbone communication failure Gateway should periodically check the link to ADDC N1, once timeout occurs, the gateway should instead convert commands from MGC in IEC61850 format to DNP3.0 over IP and route to CSCS. The event data from CSCS are once again stored in the buffer. If the gateway re-establishes connection with ADDC N1, the operation should revert to case 3.2.1.			
		3.2.3 Both MGC failure Gateway continues to operate as in case 3.2.1, but the events are stacked up at the gateway.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 4 Technical Specification and Requirements of Communication System

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	3.3 Communication in Power distribution system within Microgrid including Battery and Diesel Generator	3.3.1 Normal operation MGC and SWs, Battery and Diesel Generator communication uses IEC61850 protocol. Ethernet switches are using spanning tree / rapid spanning tree protocol and ring protocol so that alternative route to SW can be restored within acceptable time as approved by the authority. Alternative route should be found within the fiber network as the priority. If a fiber connection to any SW is not reachable in typical route, MGC shall be able to connect to the affected RTU via the other route. Gateway checks for at least one active MGC and obtain SW data, the data are stored in gateway's buffer. ADDC N1 should access SW data from the buffer.			
		3.3.2 Backbone communication failure MGC and Gateway work as in 3.3.1 case, but SW data are not accessed by ADDC N1.			
		3.3.3 Both MGC failure If gateway cannot establish connection to either MGC, the status shall be sent to ADDC N1. ADDC N1 then takes control of the RTU by DNP3.0 over IP protocol and the gateway convert the protocol to IEC61850 and relay commands to RTUs. Once gateway can establish connection to MGC after periodic attempts, normal operation resumes.			
4	**Electrical power supplies to the communication equipment**				

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 4 Technical Specification and Requirements of Communication System

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		Communication equipment at the microgrid controller building shall be able to use the AC electricity through uninterruptible power supply (UPS) and shall have necessary AC-to-DC converter supply module with redundancy. (See Book9)			
		Communication equipment in outdoor cabinets and at remote sites shall be able to use the power supplied to the SW equipment and shall have necessary backup.			
		All electrical supplies shall have surge protection. Communication racks and cabinets shall have appropriate grounding system.			
		All required electricity cabling must be provided and installed meeting safety standards and with tidiness.			
5	**Fiber cabling and other signal cabling**				
		Optical fiber outdoor cables follow all specified items in Appendix A. Cables are laid along the authority's distribution power lines and the installation should adhere to the cable installation manual in Appendix A.10			
		The contractor provides all necessary cabling, wiring, terminal blocks, connectors, and other hardware that may be necessary to ensure a fully functioning communication system.			
		Optical cables and signal cables must be installed aesthetically and following industrial safety standards.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 4 Technical Specification and Requirements of Communication System

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	6.1 Continuation guarantee	In the case that a communication port malfunctions, the fiber or communication media should be able to be swapped to a spare port without restarting. Transceiver, transmitter, receiver modules shall be hot-pluggable for replacing purpose. The fiber breakage and re-splicing do not interrupt the unaffected communication links and nodes.			
	6.2 Network availability guarantee	The contractor shall guarantee the availability of network service at least 99.9% up time. In the case of topology change such as a single fiber section breakage, the network shall be restored with convergence time according to the spanning tree protocol standard IEEE802.1D-2004 or faster. In the case of double section breakage, the physical link and network availability shall be restored within 24 hours.			
	6.3 Network performance guarantee	The average monthly network latency shall be in the order of 40ms or lower. If the latency is found to be greater than specified, the contractor shall find the cause and rectify the problem within 24 hours after being notified of the problem. The performance parameters of the Ethernet ring network including frame delay, frame jitter and frame loss shall be according to latest IEEE802.1q standard as minimum. In addition, the parameters shall satisfy the requirement of microgrid operation.			
	6.4 Order of transmission of data packets	All links in the communication system shall have standard implementation to ensure that all received data packets at any communication device are interpreted in chronological order as the transmitted data. Consequently, it is necessary that when several commands are issued to a device, the device must respond to the commands in order that they were issued.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 4 Technical Specification and Requirements of Communication System

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
7	Gateway				
		The gateway is the equipment that enables communication between microgrid and the authority's backbone network. The equipment has protocol conversion capability and security functions including secure communication and firewall. The specification of the gateway is given in Appendix D. Support protocols shall include IEC61850, and DNP3.0 over IP as minimum with other protocols to support the operation of microgrid under all use cases. There shall be redundant links to both backbone network and MGC (via Ethernet Switch) as in Fig. 1. The gateway contains buffer which store at least 512 events or more. The storage shall be flash memory and the buffer is first in first out. The gateway should have redundancy, where two units are deployed in active-standby mode.			
8	Deliverables				

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 4 Technical Specification and Requirements of Communication System

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	8.1 List of Deliverables	The list of deliverables shall itemize each hardware and software component. The hardware list shall include associated hardware accessories such as cables and connectors. It shall also include equipment configuration information of sufficient detail that the Authority can procure an identical equipment item from the manufacturer. As a minimum, the document shall include the equipment name, product name, product model, and serial number (or other ID in case some of the equipment does not have a serial number). The software list shall include the name of the software item and its supplier along with the software version number. For each software item, it shall also identify the distribution media and whether or not a software license is required. The Contractor shall provide all such software licenses including a description of any significant restrictions that apply.			
	8.2 Configuration Diagrams	The configuration diagrams shall depict, in detail, the specific equipment comprising each communication sections and the logical and physical interconnection of this equipment operating as an integrated system. The configuration diagrams shall also show how the Contractor-supplied communications equipment interconnects with the equipment supplied by others. This includes, for example, the field device interfaces and the terminal equipment of the Authority's backbone communications system and specific standard compliances.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 4 Technical Specification and Requirements of Communication System

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	8.3 Site Installation Drawings and Procedures	Microgrid communication system as well as individual communication component drawings shall be provided. These drawings, including the required as-built drawings, shall show all major components of the system along with individual equipment details and shall include all necessary materials and installation data. As a minimum, the Contractor shall provide: 1) Configuration/assembly drawings for each device showing the placement of all subassemblies. 2) Drawings of the materials for each type of equipment, identifying all subassemblies and components used to assemble the equipment. 3) Equipment internal wiring and/or cabling drawings. 4) Equipment external connection drawings. These drawings shall include the communication ports as used to interconnect the Contractor-provided equipment such as to the backbone network and to Mae Sa Riang substation.			
	8.4 Instruction Manuals	Instruction manuals shall include all information and instructions needed by Authority technicians to maintain the equipment and to troubleshoot and repair the equipment to the level of replacing printed circuit boards and other easily replaceable modules and assemblies.			
A	**Appendix A: Optical Fiber Specification and installation requirements**				
		Optical fiber specifications shall be referred to the authority's approved specifications according to the given codes. The contractor has the responsibility to ensure the conformance.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 4 Technical Specification and Requirements of Communication System

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		A.1 Figure 8 Optical Cable specification The specification for 24 core optical cable of Figure 8 type shall follow PEA specification. : CDD-OFC-FIG8-G652D			
		A.2 Optical Fiber Cable (Fig-8) Aluminum Clamp The aluminium clamp for Figure 8 cable shall follow PEA specification : DAS-FAC-001			
		A.3 Optical Fiber Cable Dome closure The requirement of outdoor fiber cable splice closure shall follow PEA specification : CDD-OFC-ACC-DC01			
		A.4 Optical Fiber Cable (Fig-8) Preform Preform for fiber optic line construction shall follow PEA specification : CDD-OFC-ACC-FIG8-PF01			
		A.5 Optical Fiber Cable Machine Bolts Bolts and nuts for fiber cable installation shall follow PEA specification : CDD-OFC-ACC-MB01			
		A.6 Straight Thimble Eye Bolts and Nuts Straight thimble eye bolts and nuts for fiber optic line installation shall follow PEA specifications : CDD-OFC-ACC-TB01 : CDD-OFC-ACC-TN01			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 4 Technical Specification and Requirements of Communication System

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		A.7 Cross arm in fiber pole installation Steel cross arm type-c for use to support optical cable installation on poles shall follow PEA specification : CDD-OFC-ACC-CA01			
		A.8 Hook bolt The steel hook used with the suspension clamp in optical fiber installation shall follow PEA specification : CDD-OFC-ACC-HB01			
		A.9 Figure 8 Cable J-clamp The requirement of clamps for the suspension of Fig-8 type cable shall follow PEA Specification : CDD-OFC-ACC-JC01			
		A.10 Optical Fiber Cable Installation Standards Figure -8 The installation of Fig-8 type optical fiber cable should abide the standards as specified by PEA in the installation manual number : CDD-MAN-FIG8-003			
B	**Appendix B: Distances of optical fiber**				

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 4 Technical Specification and Requirements of Communication System

<table>
<tr><th></th><th>Details</th><th>Requirements</th><th>Statement of Compliance
C/N</th><th>Proposed Data</th><th>Referred to Page</th></tr>
<tr><td></td><td></td><td>
B.1 Distances of optical fiber installation between each switch location in kilometers.
<table>
<tr><th colspan="3">Ring 1</th></tr>
<tr><th>From</th><th>To</th><th>Distance (km)</th></tr>
<tr><td>Eth-Main 1</td><td>ETH-SW2</td><td>4.5</td></tr>
<tr><td>Eth-SW2</td><td>Eth-SW12</td><td>9.5</td></tr>
<tr><td>Eth-SW12</td><td>Eth-SW11</td><td>0.4</td></tr>
<tr><td>Eth-SW11</td><td>ETH-SW3</td><td>4.3</td></tr>
<tr><td>Eth-SW3</td><td>ETH-SW4</td><td>4</td></tr>
<tr><td>ETH-SW4</td><td>ETH-SW10</td><td>1.8</td></tr>
<tr><td>Eth-SW10</td><td>ETH-SW9</td><td>1</td></tr>
<tr><td>ETH-SW9</td><td>ETH-Main2</td><td>2</td></tr>
<tr><td>Eth-Main 2</td><td>Eth-Main 1</td><td>0.1</td></tr>
</table>
<table>
<tr><th>Ring 2</th><th></th><th></th></tr>
<tr><th>From</th><th>To</th><th>Distance (km)</th></tr>
<tr><td>Eth-Main 1</td><td>Eth-SW13</td><td>5.5</td></tr>
<tr><td>ETH-SW13</td><td>Eth-SW7</td><td>0.9</td></tr>
<tr><td>ETH-SW7</td><td>ETH-SW6</td><td>0.5</td></tr>
<tr><td>ETH-SW6</td><td>ETH-SW1</td><td>6.2</td></tr>
<tr><td>ETH-SW1</td><td>ETH-SW8</td><td>4.3</td></tr>
<tr><td>ETH-SW8</td><td>ETH-SW5</td><td>1.8</td></tr>
<tr><td>ETH-SW5</td><td>ETH-Main2</td><td>5</td></tr>
<tr><td>Eth-Main 2</td><td>ETH-main 1</td><td>0.1</td></tr>
</table>
B.2 Distances of links from gateway Ethernet switch to CSCS, Battery and Diesel Generator
<table>
<tr><th>From</th><th>To</th><th>Distance (km)</th></tr>
<tr><td>Gateway Ethernet SW</td><td>CSCS</td><td>1</td></tr>
<tr><td>Gateway Ethernet SW</td><td>Battery</td><td>0.5</td></tr>
<tr><td>Gateway Ethernet SW</td><td>Diesel Generator</td><td>1</td></tr>
</table>
</td><td></td><td></td></tr>
<tr><td>C</td><td colspan="5">Appendix C: Indoor / Outdoor Ethernet Switch Specifications</td></tr>
</table>

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 4 Technical Specification and Requirements of Communication System

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	C.1 General features	- Gigabit Ethernet Switch Layer 2 or Layer 3 (for some switches specified in the main text) switching functionality, IEEE802.3 compliant - IEEE 1558v2 (PTP) Precision Time Protocol for time synchronization of networks - VLAN capability with Q-in-Q tagging - DHCP Option 82 for IP address assignment - SNMP protocols for device management and monitoring - IGMP snooping and GMRP for filtering multicast traffic - IEEE 802.1Q VLAN and GVRP protocol - Redundant ring protocol - Spanning tree protocol RSTP/STP, and MSTP QoS (IEEE 802.1p/1Q and TOS/DiffServ) or better - Port Trunking for optimum bandwidth utilization - TACACS+, SNMPv3, IEEE 802.1X, HTTPS, and SSH - SNMPv1/v2c/v3 for different levels of network management - Bandwidth management prevents unpredictable network status - Lock port function for blocking unauthorized access based on MAC address - Port mirroring for online debugging - LED status & error indicators			
	C.2 Optical Interface	Pluggable SFP Transceiver Fiber type: Single mode fiber Wavelength: 1550 nm Connector: LC duplex Flow control: Pause frames (IEEE802.3x), configurable Data rate: Gigabit Ethernet (1000 Mbit/s) 1488.000 packets per second			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 4 Technical Specification and Requirements of Communication System

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		The number of optical ports shall include operating ports as required in the designed system and at least one spare port per Ethernet switch. Pluggable transceivers are provided in all ports which support single mode fiber link up to 10 km.			
	C.3 Electrical Interface	Fast Ethernet 10/100/1000 base TX Connector: RJ-45, shielded Cable type: Cat 5e, Impedance 100Ω, support length up to 100 m Flow control: Pause frames (IEEE802.3x), configurable Pinout: Auto MDI/MDI-X, auto polarity The number of Electrical Ethernet ports shall include operating ports in the designed system and at least additional equal number of ports as spare. For example, if two devices are connected to two Ethernet ports on the switch, this switch must have at least four RJ-45 ports where two will be available as spare. The electrical ports shall have surge protection which have the following specifications or better. ESD/EMP Protection Absorbing Transient Current with Response to Surge Voltage from 100V/s to 1kV/µs DC Spark-Over Voltage 90V @ 100V/s Maximum Impulse Spark-over Voltage 700V @ 1kV/µs Discharge Current 2kA (Maximum) 100A (Normal) Maximum Insulation Resistance 1G ohm @ 50V Maximum Capacitance 50 pF			
	C.4 Switching performance	Layer 3 Switching: Static routing, RIP V_1/V_2, OSPF, DVMRP, PIM-DM Layer 3 Switching Redundancy: VRRP Store-and-forward, Full wire-speed, non-blocking on all ports Max number of VLANs: 256 VLAN ID Range: VID 1 to 4094 IGMP Groups: 4096 MAC Table Size: 16K Packet Buffer Size: 12 Mbit DRAM Size: 128 MB Flash Size: 16 MB Jumbo Frame Size: 9.6 KB			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 4 Technical Specification and Requirements of Communication System

	Details	Requirements	Statement of Compliance	Proposed Data	Referred to Page
			C/N		
	C.5 Mounting type	Offsite Ethernet switches mounting type is DIN Rail. Mounting type for Ethernet switches in MGC Building is rack mount under 2U size.			
	C.6 Operating condition	Temperature: -10˚C to 60˚C or better Humidity: 5-90% non condensing			
	C.7 Management	Web based HTTP, Telnet, SNMP			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 4 Technical Specification and Requirements of Communication System

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	C.8 Standard Compliance	Safety: UL 60950-1, EN 60950-1 EMC: EN 55032/24 EMI: CISPR 32, FCC Part 15B Class A EMS: IEC 61000-4-2 ESD: Contact: 4 kV; Air: 8 kV IEC 61000-4-3 RS: 80 MHz to 1 GHz: 10 V/m IEC 61000-4-4 EFT: Power: 2 kV; Signal: 1 kV IEC 61000-4-5 Surge: Power: 2 kV; Signal: 1 kV IEC 61000-4-6 CS: Signal: 10 V IEC 61000-4-8 Rail Traffic: EN 50121-4 Shock: IEC 60068-2-27 Freefall: IEC 60068-2-32 Vibration: IEC 60068-2-6			
D	Appendix D: Gateway specification				
	D.1 General specification	Network protocol: TCP/IP, UDP/IP, SMTP, POP, HTTP, FTP, SNMP, ICMP, DHCP, BOOTP, DNS, ARP, PPPoE Security: NERC/CIP compliant, SSL, SSHv2 Features: -Multi master/SCADA communication capability - protocol conversion capability–IEC61850, DNP3.0 - Automatic startup and initialization following power Restoration - Time synchronization using IEC60870/DNP3/SNTP/NTP/IEEE1588 - management using SNMP/Webserver			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 4 Technical Specification and Requirements of Communication System

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	D.2 Communication Interface	**D.2 Communication Interface** Ethernet port (copper) 10/100/1000 BaseTX Ethernet Optical port (SFP) Gigabit Ethernet RS232 Serial ports (DB9) 9-pin, DTE, 16550-compatible Redundancy: All port types must have required number and redundancy according to the required specifications of the communication system in this book.			
	D.3 Controller protocol	Master/Client Protocol DNP3.0 Serial and TCP, IEC 60870-5, IEC61850 Slave/Server Protocol DNP3.0 Serial and TCP, IEC 60870-5, IEC61850 Number of supported connections upstream As required Number of supported connections downstream As required			
	D.4 Mounting	Rack mounting under 3U			
	D.5 Power supply	Primary supply 100–240 V, 50/60 Hz Hot-plug, redundant supply 100–240 V, 50/60 Hz			
	D.6 Buffer storage	Flash storage for minimum of 512 events			
	D.7 Redundancy	Dual unit (Active-standby) with automatic swapping between two modules.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 5 Technical Specification and Requirements of Modification of Diesel Generator

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
1	**Interface of diesel generator controller**				
		The microgrid controller shall connect to input port of master controller, DSE8660, which are RS232, RS485 or Ethernet.			
		The microgrid controller shall be able to display and monitor all 5 diesel generators on the display of microgrid controller screen.			
		The contractor shall provide and make connection of power cable, control cable and communication cable between Mae Sariang substation, microgrid control center building, and diesel generator building.			
2	**Preheating system for diesel generator**				
		The contractor has to provide preheating system to all diesel generators at Mae Sariang area.			
		The preheating system will be needed it for easy engine starts and also immediate full power within one minute.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 6 Technical Specification and Requirements of Remote Control Switch

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
1	Scope of works				
		1.1 The contractor must supply the complete set of outdoor SW type for 22kV 50Hz distribution system.			
		1.2 The operation time to open the switches at rated normal current shall not be more than 2 second and to close the switches at rated normal current shall not be more than 5 second.			
		1.3 The SW shall have the functions to indicate the open/closed position of each interrupter, phase voltages and currents, reason for a phase trip, wave shave event and to monitor power quality.			
		1.4 The communication module shall include an integrated Global Positioning System clock for event time-stamping.			
		1.5 The communication standard between SWs and micro grid controller (MGC) must be based on IEC61850 standard. The communication channels is a fiber optic cable. The fiber optic cable is utilized in a normal condition. If the MGC is failed, the PEA's SCADA system must be able to control all of SWs.			
		1.6 The SWs shall be installed at point, which is provided by the PEA. The contactor must deliver 13 units of SW plus a spare part. The spare part of SW must not less than 20 % of delivered SWs.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 6 Technical Specification and Requirements of Remote Control Switch

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
2	**Technical specification and requirements of remote control switch**				
	2.1 Common requirements	2.1.1 Standards The SW and its accessories should be designed in accordance with the following standards: 1) International Electrotechnical Commission (IEC) 2) Institute of Electrical and Electronic Engineers (IEEE) 3) American National Standards Institute (ANSI) 4) National Equipment Manufacturers Association (NEMA).			
		In addition to the RCS, it shall be manufactured and tested in accordance standard with the following issues: 1) Interrupting 2) Dielectric 3) Temperature Rise 4) Short Time 5) Fault Closing 6) Mechanical Endurance			
		2.1.2 Service condition The SW shall be suitable for operation under the following conditions: 1) Ambient air temperature: up to 50OC 2) Relative humidity: up to 94% 3) Altitude: up to 1,000 m above mean sea level 4) Climatic condition : tropical climate			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 6 Technical Specification and Requirements of Remote Control Switch

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		the RCS and its accessories shall be manufactured and tested in accordance standard with the following issues: 1) Interrupting 2) Dielectric 3) Temperature Rise 4) Short Time 5) Fault Closing 6) Mechanical Endurance			
	2.2 Functional requirements	The following issues are the major requirements for each SW			
		2.2.1 Fault detection The SW shall include a function to determine if phase-to-phase or phase-to ground faults on the both side of the SW. The fault detection function shall work properly for all possible configurations of the circuit on which the RCS are installed. The feeder fault detection function shall be designed to prevent mis-operation due to magnetizing-inrush currents and other transient, no-fault conditions. Note that the fault detection is a part of FLISR operation.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 6 Technical Specification and Requirements of Remote Control Switch

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		2.2.2 Sequence of event The SW shall include the sequence-of-events (SOE) reporting capability. It shall be possible to assign any status input point to SOE reporting in addition to normal status reporting. The SW shall detect changes in the state of SOE points, record the date and time of change with a resolution of plus or minus one millisecond (±1 ms) relative to the SW internal clock, inform the MGC that SOE data has been recorded, and report SOE data to the MGC upon request.			
		2.2.3 Waveshape monitoring The SW shall include the waveshape monitoring function at the installation location. The waveshape of all switches has to be sent to MGC with the equal accurate event time-stamping. In additional, the software to examine of waveforms and events at the location of switch has to be provided, which the communication could be the secure Wi-Fi communication to a nearby laptop computer or hard connect direct to the SW.			
		2.2.4 Protection and control The RCS shall include a complete set of protection and control functions, including: • Simultaneous independent directional phase, ground, negative-sequence, and sensitive-earth time-overcurrent, instantaneous-overcurrent, and definite-time elements • Directional blocking of overcurrent elements • Over/under voltage elements • Over/under frequency elements The protection and control elements shall enable sequence coordination, phase unbalance detection, and synchronization check functions, and include a cold-load pickup modifier.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 6 Technical Specification and Requirements of Remote Control Switch

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		2.2.5 Communication protocol The communication standard between SW and MGC must be based on IEC61850 standard, which the communication channels is a fiber optic cable. If the MGC is failed, the PEA's SCADA system must be able to control all SW.			
	2.3 The remote control switch	The operation time of RCS shall be as follows: • The time to open the switches at rated normal current shall not be more than 2 second. • The time to close the switches shall not be more than 5 second. The opening and closing times shall be measured as follows: • Timing shall start when the switches open or close action is initiated at the local control panel of the switches, and • Timing shall end when the switches position indicator changes state. The number of operation shall be as follows: • Mechanical operation should not less than 2000 times. • Electrical operation at rated current should not less than 400 times.			
		The RCS shall be operated both manually without power supply by using a NEMA-head hook stick, and electrically by using operating mechanism and control unit. It shall be interlocked to permit operation only when the switches are open.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 6 Technical Specification and Requirements of Remote Control Switch

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		The RCS housing shall be molded from cycloaliphatic epoxy resin. All metallic housing components shall be stainless steel or corrosion resistant non-painted materials, and all components shall be mounted on a unitized stainless-steel base.			
		the RCS unit and its accessories shall be designed and constructed for mounting on the same pole, which has to be firstly approved by PEA.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 6 Technical Specification and Requirements of Remote Control Switch

<table>
<tr><th></th><th>Details</th><th>Requirements</th><th>Statement of Compliance
C/N</th><th>Proposed Data</th><th>Referred to Page</th></tr>
<tr><td></td><td></td><td>2.3.1 Rating
The ratings and characteristics of RCS are specified in Table 2.1.

Table 2.1 Ratings and characteristics of the RCS
<table><tr><th>Ratings and characteristics</th><th>unit</th><th>Requirement</th></tr><tr><td>Rated nominal system voltage</td><td>kV</td><td>22</td></tr><tr><td>Rated frequency</td><td>Hz</td><td>50</td></tr><tr><td>Rated normal current</td><td>A</td><td>not less than 600</td></tr><tr><td>Rated symmetrical interrupting current</td><td>A</td><td>not less than 600</td></tr><tr><td>Maximum voltage for power module</td><td>kV</td><td>24</td></tr><tr><td>Minimum voltage for power module</td><td>kV</td><td>20</td></tr></table></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>2.3.2 Local operation
The RCS shall be furnished with local swing type control panel for initiating control actions and viewing the status indicators of the switches. As minimum, the local control panel shall include the following:
1. A color code indicator shall be provided, i.e. “Open” (green) and “Close” (red), with LED super bright pilot lamps or better. The indicator shall be readily visible from the ground.
2. An operation counter to indicate the number of switching cycles of the switches. The operation counter shall count the increment for electrical operations (remote control or local control) and mechanical operations (hook-stick).
3. Others according to manufacturer’s design.</td><td></td><td></td><td></td></tr>
</table>

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 6 Technical Specification and Requirements of Remote Control Switch

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		2.3.3 Operation control interface In general, the RCS shall be support the mechanical operations (hook-stick). Furthermore, the RCS shall be support the remote control and/or local control cabinet. If the bidder proposes the remote control interface, the communication to RCS shall be the secure Wi-Fi communication to a nearby laptop computer. The unit shall not transmit a Wi-Fi signal until an encrypted wake-up message is sent by the securely recognized laptop. All wireless communications shall be adequately encrypted with user definable encryption keys and password protected for security purposes. The control software shall permit the selection of local (mechanical operations) or remote operation. When local operation has been selected, the control program shall command local electrical opening and closing of the interrupters. The laptop computer, software and its necessary accessories have to be provided. Remarks, the secure Wi-Fi communication and the communication distance to RCS have to be approved by PEA.			
		If the bidder proposes the local control cabinet, it has to be mounted on the same pole of RCS. Each set of the RCS shall be equipped with a control cabinet that will houses all equipment according to manufacturer's design. Remarks, the wiring design inside control cabinet, the wiring design to its switch, and material of control cabinet have to be approved by PEA.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 6 Technical Specification and Requirements of Remote Control Switch

	Details	Requirements	Statement of Compliance	Proposed Data	Referred to Page
			C/N		
	2.4 The feeder device control unit	2.4.1 Inputs The FDCU shall: 1. They shall be used for connecting dc power cables to the FDCU and for terminating all IO signals between the RCS and FDCU. 2. Acquire analog inputs directly without transducers from each of three power system voltage and current terminals in the existing or Contactor-provided RCS control cabinets. 3. Apply suitable filtering to eliminate the risk of signal aliasing. 4. Use voltage and current inputs for calculations that support MGC acquisition of the following data as a minimum: a. Line-to-line voltages. b. Phase current magnitudes and phase angles. c. Real and reactive powers (three-phase kW and kvar totals with sign). d. Power factor. 5. Accept AC voltage input signals with a normal input level of 110 V.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 6 Technical Specification and Requirements of Remote Control Switch

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		6. Employ analog to digital converters with minimum of 16-bit resolution for a bipolar input signal. 7. Accurately resolve AC voltage input signal levels from 0 to 150 V. 8. Accurately resolve AC current input signals with normal ranges of 0 to 5 A or 0 to 1 A. 9. Include the capability to report all analog values that have changed by more than their programmable dead bands from their last values successfully reported to the MGC. 10. Record maximum RMS fault current signals, over a period of at least one (1) second, up to 20 times normal (100 A) within a maximum error of 2.5% of Full Scale Deflection (FSD). 11. Not impose a total analog input burden of more than 0.5 VA for all current and voltage inputs. 12. Demonstrate an overall analog input error of no more than ±0.2% of 1.2 times normal FSD over the temperature range 0 to 70 °C 13. Demonstrate an analog input linearity better than ±0.05%. 14. Reject common mode AC (50 Hz) voltages up to 150 V			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 6 Technical Specification and Requirements of Remote Control Switch

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		2.4.2 Status Inputs As a minimum, the FDCU shall accept isolated wet and dry single contact two-state status inputs and two-state status inputs with memory, i.e., Momentary Change Detection (MCD) inputs. Input change of state shall be time-stamped to a precision of 1 millisecond. Within this context: 1. All necessary wetting voltage, current limiting, input isolation, and bounce fdtering shall be provided. 2. Contact de-bounce time periods shall be individually configurable. 3. The input circuits shall be optically isolated from the external signal. 4. Unless the FDCU can provide its own self-supplied wetting voltages, input contact wetting voltages shall be 24 Vdc as obtained from the dc power supply in the existing or Contactor-provided RCS control cabinets. 5. Each wetting voltage circuit shall be protected with its own circuit breaker.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 6 Technical Specification and Requirements of Remote Control Switch

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		2.4.3 Control outputs The FDCU shall support the following control output features: 1. A Select-CheckBack-Before-Operate (SCBO) procedure for all control operations. In this respect, the following concepts shall apply: a. On receipt of a control point select command, the FDCU shall check that no other point is selected, select the requested point, acknowledge the select command, and start a Command Receipt Timer. b. Control point selection shall be canceled if the subsequent operate command is not received within the Control Receipt Timer's programmable time-out period, which shall be adjustable from five (5) to thirty (30) seconds. c. On receipt of the operate command, if the control point has remained selected and no other point has become selected, the FDCU shall then initiate the requested control action. d. The SCBO procedure shall be canceled automatically on completion of the control action or if not completed within an adjustable time-out period of up to 60 seconds. e. Any further attempt at control shall require a new SCBO procedure.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 6 Technical Specification and Requirements of Remote Control Switch

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		2. RCS opening and closing by sending commands to a complimentary pair of contact outputs such that: a. One command activates the contact used to open the switch. b. The other command activates the contact used to close the switch. c. Only one contact output in a complimentary pair can be activated at a time. 3. Momentary control where each output provides a contact closure pulse having an individually programmable duration from 1 to 60 seconds in increments of 1 second. The following requirements shall also apply: 1. The voltage rating of the control output contacts shall be 24 Vdc. 2. All control power shall be obtained from the existing or Contractor supplied 24 Vdc power supply. 3. FDCU control outputs shall be able to drive loads of at least six (6) amps. 4. Output relays shall be designed for 106 (one million) mechanical operations. 5. The FDCU shall monitor all operations and local status information and give warnings or advisory messages when any wrong operational sequence is requested. 6. Abnormal conditions shall inhibit control operations.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 6 Technical Specification and Requirements of Remote Control Switch

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		2.4.4 Fail safe design The FDCUs shall be designed to prevent false control actions being executed and erroneous data being transmitted. In this respect, they shall incorporate the following fail-safe design criteria in their control output logic: 1. No false output shall result from a single point of failure in any FDCU. 2. No false output shall result during FDCU power up or power down. 3. No false output shall result from inadvertently inserting a circuit card into a wrong slot within the FDCU.			
		2.4.5 I/O module Each I/O module shall be capable of interfacing with analog inputs, digital inputs, control output points, and combinations of point types. I/O modules shall be replaceable without reprogramming, redefinition of configuration parameters, or rewiring. A control disable switch shall be provided within each I/O module. When the switch is in the control position, the MGC or test set shall have control of the digital control outputs. When the switch is in the disable position, the digital control outputs shall be disabled. The minimum requirement of I/O signals are given in Appendix. Note that, some extra I/O is only required, if the bidder proposes the local control cabinet.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 6 Technical Specification and Requirements of Remote Control Switch

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		2.4.6 Time and date module The communication module of FDCU shall have an internal clock for data collection coordination and time tagging. The internal clock shall be synchronized using a Greenwich Mean Time (GMT) reference signal generated by the MGC in long format and properly accounting for relevant communication path delays. The resolution of the internal clock shall be 1 millisecond or better, and its real-time synchronization accuracy shall be within 10 milliseconds of the of the MGC time reference signal. Time drift of the internal clock shall drift by no more than 100 milliseconds per hour in the event that no time synchronization is received from the MGC. No internal batteries shall be used to power the internal clock when the communication module of FDCU is disconnected from its 24 V DC power source. Therefore, whenever the communication module of RCS unit is powered up, the internal clock must be re-synchronized using the MGC time and date reference signal. The need to re-synchronize, however, shall not prevent the communication module of RCS from immediately registering inputs even before the time and date reference signal has been received from the MGC. Thus, any such registered inputs shall also be reported to the MGC.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 6 Technical Specification and Requirements of Remote Control Switch

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		2.4.7 Local control panel The local control panel shall include: 1. An RCS A/C power supply on/off switch. 2. Switches for opening and closing the RCS. When the A/C power source is off, operation of the RCS shall be possible by using the battery backup feature of the Contractor supplied dc power supply. 3. A Local/Remote switch. While this switch is in the “Local” position, control shall be permitted only from the local control panel (i.e., remote control shall be prohibited). Otherwise, while the switch is in its “Remote” position, control shall be permitted only from the MGC (i.e., local control shall be prohibited). 4. Separate green and red super bright LED pilot lamps not less than 6 mm in diameter for showing the open/close status of the RCS respectively. 5. An operations counter to indicate the number of RCS switching cycles. The counter shall increment for electrical operations (whether remote or local) and for mechanical hook-stick operations.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 6 Technical Specification and Requirements of Remote Control Switch

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		6. Red super bright LED lamps not less than 3 mm in diameter to show the following status indications as a minimum: a. Switch Mechanical Lock. b. Switch Mechanical Free. c. Low Battery Voltage. d. High Battery Voltage. e. Battery Failed Alarm. f. Battery Charger Overvoltage. g. Local or Remote Control. 7. Battery voltage test points			
		2.4.8 Interlocking The FDCU shall include configurable interlock logic to prevent misoperation of the RCS. In addition to preventing RCS operation locally and/or remotely in accordance with the positions of the Local/Remote and Mechanical Lock/Free switches.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 6 Technical Specification and Requirements of Remote Control Switch

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	2.5 Power supply	1) The power supply shall be derived from an integral power module fed from one phase on one side of the interrupting system; or the power supply shall be derived from two integral power modules, each fed from a different phase on both sides of the fault interrupting system. 2) The integral power module(s) shall provide all control power for the interrupting system in standalone (non-communicating) applications. 3) AC line voltage must be available to the integral power module, which the integral power module shall supply 24 V DC. 4) The backup power supply shall be available and maintenance free. The backup power supply shall have sufficient capacity to sustain operation of the equipment including FDCU for not less than 12 hours after the AC power supply is failed, and shall be able to operate RCS with not less than 2 open – close cycles.			
	2.6 Electric surge protection	1) All necessary measures shall be taken to ensure proper functions and component safety of the local control panel, the power supply, and all other RCS components with respect to switching voltage transients and all regular atmospheric, electrical, and magnetic disturbances, whether induced or directly coupled.			
		2) In particular, the equipment shall be constructed and tested to meet the latest applicable standards of IEC 60255-5, or ANSI/IEEE C37.90.1 and ANSI/IEEE C37.1 and be capable of withstanding the tests described in these standards without damage, false control output, or loss of internally stored data and parameters.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 6 Technical Specification and Requirements of Remote Control Switch

Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	4) The electric surge protection for power supply shall be Surge Protective Device (SPD) and shall be installed as follows: - Connected between Line and Neutral (L-N) - Connected between Neutral and Ground (N-G)			
	5) The SPD shall have rating as the follows: - Standard : IEC 61643-11 - Arrester class : class II - Nominal voltage, U_n : 240 V AC - Maximum continuous operating voltage, U_C (L-N) : 350 V AC - Maximum continuous operating voltage, Uc (N-G) : 264 V AC - Nominal discharge surge current, In (8/20 µs) : 20 kA per phase - Max discharge surge current, Imax (8/20 µs) : 40 kA per phase - Response time (L-N) : ≤25 ns - Response time (N-G) : ≤100 ns - Voltage protection level, Up (L-N) : ≤1.5 kV - Voltage protection level, Up (N-G) : ≤1.5 kV - Temperature range : -40°C to 70°C			
2.7 Minimum nameplate information	1) Manufacturer's name/country 2) Type 3) Manufacturer's serial number 4) Year of manufacture 5) Rated voltage 6) Rated frequency 7) Rated normal current 8) Rated symmetrical interrupting current 9) Rated short-time withstand current, 1 sec 10) Rated short-circuit making current 11) Rated power frequency withstand voltage, 1 min 12) Rated impulse withstand voltage 13) Rated auxiliary voltage 14) Net weight			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 6 Technical Specification and Requirements of Remote Control Switch

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	2.8 Test and test report	The bidder shall submit the test report to PEA. The required test reports are the type test report and the routine test report. Further information according to test and test report is given in Book1–the project overview.			
	2.9 Marking	PEA's code number and contract number shall be painted in orange on all components. The code and contract number shall be easily visible from ground level. The code number and dimensions of each letter to be marked will be given by PEA after the final of bid consideration			
	2.10 Packing	Each set of the RCS with installation instruction and its accessories with part list shall be seaworthy packed in an export crates or wooden cases; but each set of accessories with part list may be separately seaworthy packed in other wooden cases to avoid damage during transportation. Part belonging to different sets of the RCS shall not be packed in the same package. If the package is made of rubber wood (Yang-para of Hevea brasiliensis), the wooden parts shall be treated with wood preservative. A plastic foam will not be accepted.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 7 Technical Specification and Requirements of Protection System

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	Principal Requirement				
		1) The contractor shall provide power system study for both 22kV and 115kV power source such as short circuit study, power flow study, protection scheme design, dynamic study, designed and engineer report for setting protective relay as microgrid operation in 4 operation modes in MGDP area for PEA approval.			
		2) The contractor shall modify the protection system to cover all switchgears, also provide relay setting group operation and synchronizing condition for 115kV and 22kV protective relay system according to at least 4 scenario operations (grid-connected mode, islanding mode with only battery energy storage, islanding mode with only diesel engines, and islanding mode with both battery energy storage and diesel engines).			
		3) The contractor shall provide the display of active group of working relay in order to check the grouping of relay both at MGC and CSCS at Mae Sariang substation.			
		4) The contractor shall supply all necessary devices or materials and perform all necessary fabrication, testing, wiring, and interconnection work during the process of assembling and connecting to microgrid controller.			
		5) Protection system operation event and communication status between protection relay and MGC shall be monitored in microgrid controller system.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 7 Technical Specification and Requirements of Protection System

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		6) The contractor shall supply tools for communication between MGC and CSCS in order to be able to change automatically group of working relay, send alarm signals or send others command through CSCS.			
		7) The contractor shall provide site acceptance testing (SAT) for every modes of operation of protection system for microgrid system. SAT shall include the test sets in order to demonstrate the readiness of the protection system.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 8 Technical Specification and Requirements of Cyber Security

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
1	**Principal Requirement**				
		The Contractor's responsibilities shall include, but shall not be limited to:			
		1) The contractor shall provide designed and engineered of cybersecurity of microgrid operations to meet three fundamental requirements: availability, integrity, and confidentiality for MGDP for PEA approval.			
		2) The contractor shall supply all necessary materials and perform all necessary fabrication, testing, wiring, and interconnection work during the process of assembling and connecting to microgrid controller.			
		3) The contractor shall provide site acceptance testing (SAT) of every mode of operation of cyber security for microgrid system. SAT shall include the test sets in order to demonstrate the readiness of the cyber security system.			
		4) The contractor shall provide training PEA staff so that they will be self-sufficient in designing, testing, and maintaining the cyber security system.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 8 Technical Specification and Requirements of Cyber Security

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	Appendix: Cyber Security Implementation Guideline				
	1 Policies and Procedures	1.1 Microgrid Cyber Security Policies and Procedures The Contractor shall, with PEA management support and guidance, and in accordance with NISTIR 7628 Guidelines for Smart Grid Cyber Security v1.0 – Aug 2010 or a later version, develop cyber security policies and procedures for the Microgrid information system.			
	2 Access Control	2.1 Account Management			
		2.1.1 The Microgrid information system shall automatically terminate temporary and emergency accounts after an organization-defined time period for each type of account.			
		2.1.2 The Microgrid information system shall automatically disable inactive accounts after an organization-defined time period. The awarded Contractor will discuss the use of single sign on at the start of the project in order to agree on the work process with PEA.			
		2.1.3 The Microgrid information system shall automatically audit account creation, modification, disabling, and termination actions and notifies the required individuals. The awarded Contractor will discuss the use of single sign on at the start of the project in order to agree on the work process with PEA.			
		2.2 Access Enforcement			
		2.2.1 The Microgrid information system enforces assigned authorizations for controlling access to the Microgrid information system in accordance with organization-defined policy and risk assessment.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 8 Technical Specification and Requirements of Cyber Security

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		2.3.1 The Microgrid information system shall enforce different levels of user privilege in interacting with the system.			
		2.3.2 The Microgrid information system shall provide real-time logging and recording of the use of privileged accounts.			
		2.4 Unsuccessful Login Attempts			
		2.4.1 The Microgrid information system shall enforce a login delay after a limited number of consecutive invalid login attempts.			
		2.4.2 The Microgrid information system shall provide real-time logging and recording of unsuccessful login attempts.			
		2.4.3 The Microgrid information system shall provide real-time alerting to a management authority for the Microgrid information system when the number of defined consecutive invalid access attempts is exceeded.			
		2.5 Microgrid Information System Use Notification			
		2.5.1 The Microgrid information system shall display an approved system use notification message or banner before granting access to the Microgrid information system that provides privacy and security notices consistent with applicable laws, directives, policies, regulations, standards, and guidance.			
		2.6 Previous Logon Notification			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 8 Technical Specification and Requirements of Cyber Security

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		2.6.1 The Microgrid information system shall, notify the user, upon successful logon, of the date and time of the last logon and the number of unsuccessful logon attempts since the last successful logon.			
		2.7 Concurrent Session Control			
		2.7.1 The Microgrid information system shall limit the number of concurrent sessions for any user on the Microgrid information system			
		2.8 Session Lock			
		2.8.1 The Microgrid information system shall, where feasible, after a defined period of inactivity or when the logged on user is away from the system, lock user access to the system.			
		2.8.2 The Microgrid information system shall retain the session lock until an authorized user reestablishes access using appropriate identification and authentication procedures.			
		2.9 Remote Session Termination			
		2.9.1 The Microgrid information system shall terminate a remote session at the end of the session or after a period of inactivity.			
		2.10 Remote Access			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 8 Technical Specification and Requirements of Cyber Security

	Details	Requirements	Statement of Compliance	Proposed Data	Referred to Page
			C/N		
		2.10.1 The Microgrid information system shall authorize, monitor, and manage all methods of remote access to the Microgrid information system.			
		2.10.2 The Microgrid information system shall authenticate remote access, and to protect the confidentiality and integrity of remote access sessions.			
		2.10.3 The Microgrid information system shall route all remote accesses through a limited number of managed access control points.			
		2.10.4 The Microgrid information system shall protect wireless access to the Microgrid information system using authentication and encryption. Note: Authentication applies to user, device, or both as necessary.			
		2.10.5 The Microgrid information system shall monitor for unauthorized remote connections to the Microgrid information system.			
		2.10.6 The Contractor shall enable remote access to Microgrid information system component locations (e.g., control center, field locations) only when necessary, approved, authenticated, and for the duration necessary.			
		2.10.7 The Microgrid information system shall employ automated mechanisms to facilitate the monitoring and control of remote access methods.			
		2.10.8 The Contractor shall disable, when not intended for use, wireless networking capabilities internally embedded within Microgrid information system components			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 8 Technical Specification and Requirements of Cyber Security

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		2.11 Wireless Access Restrictions			
		2.11.1 Where wireless networks are used, the Microgrid information system shall use separate wireless networks for control system, business and guest access.			
		2.11.2 Where wireless networks are used for other than control system communications, the Microgrid information system shall use WPA2-Enterprise or stronger.			
		2.12 Access Control for Portable and Mobile Devices			
		2.12.1 The Contractor shall disable on all Microgrid information system devices physical ports that can accept removable media when not intended for use.			
		2.13 Control System Access Restrictions			
		2.13.1 The Microgrid information system shall employ mechanisms in the MGIS design and implementation to restrict access from PEA's enterprise network. Connections should be proxied through an intervening DMZ.			
		2.13.2 The Microgrid information system shall implement mechanisms to restrict access to the Microgrid information system from PEA's enterprise network to read-only.			
		2.14 Publicly Accessible Content			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 8 Technical Specification and Requirements of Cyber Security

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		2.14.1 The Contractor shall remove all nonpublic information from the publicly accessible information systems in the Microgrid information system.			
		2.15 Passwords			
		2.15.1 The Microgrid information system shall, where feasible, employ username and password combinations to gain access to Microgrid information system assets.			
		2.15.2 Passwords shall be a minimum of 8 characters long and contain a combination of uppercase, lowercase, numeric, and special characters, or using an alternative means be of greater strength.			
		2.15.3 The Microgrid information system shall not allow direct user logins using privileged (e.g. with administrator or root) accounts.			
		2.15.4 Passwords shall expire automatically after an organization defined period of time.			
	3 Awareness and Training	3.1 Security Awareness Training			
		3.1.1 The Contractor shall, with PEA management support and guidance, develop a cyber security awareness and training program for the Microgrid information system.			
	4 Audit and Accountability	4.1 Auditable Events			
		4.1.1 The Contractor shall, with PEA management support and guidance, develop a lists of			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 8 Technical Specification and Requirements of Cyber Security

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		4.1.2 The list of auditable events shall be based on risk assessment			
		4.1.3 The list of auditable events shall include execution of privileged functions			
		4.2 Content of Audit Records			
		4.2.1 The Microgrid information system shall generate audit records that at a minimum provide for each event, the date and time of the event, device or component where the event occurred, the type of event, user/subject identity, and the outcome of the event.			
		4.3 Time Stamps			
		4.3.1 The Microgrid information system shall use internal system clocks to generate time stamps for audit records and that the system synchronizes internal Microgrid information system clocks on an organization-defined frequency using an organization-defined time source.			
	5 Security Assessment and Authorization	5.1 Microgrid Information System Connections			
		5.1.1 The Contractor shall identify, document and protect from tampering or damage, all external Microgrid information system and communication connections.			
	6 Configuration Management	6.1 Component Inventory			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 8 Technical Specification and Requirements of Cyber Security

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		6.1.1 The Contractor shall provide an accurate inventory of all Microgrid information system components (devices and software) and their base-line configuration settings, either individually or by component class.			
		6.2 Factory Default Settings Management			
		6.2.1 The Contractor shall replace default usernames and passwords whenever possible.			
	7 Identification and Authorization	7.1 Authenticator Management			
		7.1.1 Define initial authentication credential content, such as defining password length and composition, tokens; and establish administrative procedures for initial authentication credential distribution; lost, compromised, or damaged authentication credentials; and revoking authentication.			
		7.1.2 Authentication credentials on publicly accessible devices (e.g smart meters) shall use shall be unique to each device. On other assets, the use of non-unique credentials shall be minimized where feasible.			
		7.2 User Identification and Authorization			
		7.2.1 The Microgrid information system shall use multifactor authentication for (1) Remote access to non-privileged accounts, (2) local access to privileged accounts, and (3) remote access to privileged accounts.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 8 Technical Specification and Requirements of Cyber Security

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		7.3 Device Identification and Authentication			
		7.3.1 The Microgrid information system shall uniquely identify and authenticate devices against an organization-defined list of approved devices before establishing a connection.			
		7.3.2 The Microgrid information system shall authenticate devices before establishing remote network connections using bidirectional authentication between devices.			
		7.4 Authenticator Feedback			
		7.4.1 Authentication mechanisms in the Microgrid information system shall obscure feedback of authentication information during the authentication process.			
	8 Information and Document Management	8.1 Information Exchange			
		8.1.1 When a specific device is required to communicate with another device outside the Microgrid information system, communications shall be limited to only the devices that need to communicate.			
	9 Incident Response	9.1 Incident Handling			
		9.1.1 The Microgrid information system shall employ automated mechanisms to assist in the tracking of security incidents and in the collection and analysis of incident information.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 8 Technical Specification and Requirements of Cyber Security

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		9.2.1 The Microgrid information system shall create backups. If the design to support this requirement needs hardware or software to be deployed, this is the Contractor's responsibility.			
	10 System Development and Maintenance	10.1 Maintenance Personnel			
		10.1.1 Remote maintenance sessions into the Microgrid information system shall be protected through the use of a strong authentication credentials.			
	11 Physical and Environmental Security	11.1 Physical Access Control Authorizations			
		11.1.1 The Contractor shall implement physical access control mechanisms requiring multifactor authentication to gain access to the facility where the Microgrid information system resides. The system shall be installed at the existing facility.			
		11.2 Physical Access Control			
		11.2.1 The Contractor shall employ hardware to deter unauthorized physical access control to Microgrid information system devices. The system shall be installed at the existing facility.			
		11.2.2 The Contractor shall employ measures to ensure that every physical access control point to the facility where the Microgrid information system resides is guarded or alarmed and monitored on an organization-defined frequency.			
		11.3 Monitoring Physical Access Control			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 8 Technical Specification and Requirements of Cyber Security

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		11.3.1 The Contractor shall install real-time physical intrusion alarms and surveillance equipment to protect access to facilities where the Microgrid information systems reside. The system shall be installed at the existing facility.			
		11.4 Emergency Power			
		11.4.1 The Contractor shall implement an alternate power supply to facilitate an orderly shutdown of noncritical Microgrid information system components in the event of a primary power source loss.			
		11.4.2 For self-contained Microgrid information system components not reliant on external power generation, the Contractor shall implement alternate power supply for long-term operation. The awarded Contractor will agree on the details with PEA later before the start of the project as PEA will provide the power sources.			
		11.5 Location of Microgrid Information System Assets			
		11.5.1 Microgrid information system assets shall be located to minimize potential damage from physical and environmental hazards.			
	12 Risk Management and Assessment	12.1 Risk Assessment			
		12.1.1 The Contractor shall provide the results of a cyber security risk assessment from the unauthorized access, use, disclosure, disruption, modification, or destruction of information and Microgrid information systems of the proposed system design.			
		12.1.2 The Contractor shall use the risk assessment to determine the types of security			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 8 Technical Specification and Requirements of Cyber Security

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	13 Services Acquisition	13.1 Software License Usage Restrictions			
		13.1.1 The Contractor shall use software and associated documentation in accordance with contract agreements and applicable copyright laws.			
		13.2 Security Engineering Principles			
		13.2.1 The Contractor shall require the Microgrid information system and its components to be created or modified using secure engineering practices.			
	14 Communication Protection	14.1 Communications Partitioning			
		14.1.1 The Microgrid information system shall partition the communications for telemetry/data acquisition services and management functionality.			
		14.2 Security Function Isolation			
		14.2.1 The Microgrid information system shall isolate security functions from non-security functions.			
		14.3 Denial-of-Service Protection			
		14.3.1 The Microgrid information system shall mitigate or limit the effects of denial-of-service attacks based on an organization-defined list of denial-of-service attacks.			
		14.3.2 The Microgrid information system shall restrict the ability of users to launch denial-of-service attacks against other Microgrid information systems or networks.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 8 Technical Specification and Requirements of Cyber Security

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		14.4 Boundary Protection			
		14.4.1 The Microgrid information system shall have a defined and documented boundary of the Microgrid information system. The awarded Contractor will agree on the details with PEA later before the start of the project as PEA will provide the existing information.			
		14.4.2 The Microgrid information system shall monitor and control communications at the external boundary of the system and at key internal boundaries within the system.			
		14.4.3 The Microgrid information system connects to external networks or information systems only through managed interfaces consisting of boundary protection devices.			
		14.4.4 The managed interface implements security measures appropriate for the protection of integrity and confidentiality of the transmitted information			
		14.4.5 The Contractor shall configure the Microgrid information system to prevent public or other external access into the organization's internal Microgrid information system networks except as appropriately mediated.			
		14.4.6 The Microgrid information system shall be configured to deny network traffic by default and allow network traffic by exception (i.e., deny all, permit by exception).			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 8 Technical Specification and Requirements of Cyber Security

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		14.4.7 The Microgrid information system shall check incoming communications to ensure that the communications are coming from an authorized source and routed to an authorized destination.			
		14.5 Communication Integrity			
		14.5.1 The Microgrid information system shall protect the integrity of electronically communicated information including during aggregation, packaging, and transformation in preparation for transmission.			
		14.5.2 The Microgrid information system shall employ cryptographic mechanisms to ensure integrity.			
		14.6 Communication Confidentiality			
		14.6.1 The Microgrid information system protects the confidentiality of communicated information.			
		14.6.2 The Microgrid information system shall employ cryptographic mechanisms to prevent unauthorized disclosure of information during transmission.			
		14.7 Use of Validated Cryptography			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 8 Technical Specification and Requirements of Cyber Security

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		14.7.1 All of the cryptography and other security functions (e.g., hashes, random number generators, etc.) that are required for use in the Microgrid information system shall be limited to those algorithms that have received substantial public review and have been proven to work effectively.			
		14.8 Public Key Infrastructure Certificates			
		14.8.1 For Microgrid information systems that implement a public key infrastructure, the organization issues public key certificates under an appropriate certificate policy or obtains public key certificates under an appropriate certificate policy from a PEA approved service provider.			
		14.9 Mobile Code			
		14.9.1 The Microgrid information system shall have the capability to document, monitor, and manage the use of mobile code within the Microgrid information system.			
		14.9.2 The Microgrid information system shall implement detection and inspection mechanisms to identify unauthorized mobile code and takes corrective actions, when necessary.			
		14.10 System Connections			
		14.10.1 All external Microgrid information system and communication connections are identified and protected from tampering or damage.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 8 Technical Specification and Requirements of Cyber Security

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		14.10.2 External access point connections to the Microgrid information system shall be secured. Access points include any externally connected communication end point (for example, dial-up modems).			
		14.11 Security Roles			
		14.11.1 The Microgrid information system design and implementation shall specify the security roles and responsibilities for the users of the Microgrid information system.			
		14.12 Message Authenticity			
		14.12.1 The Microgrid information system shall provide mechanisms to protect the authenticity of device-to-device communications, including message authentication			
		14.13 Secure Name/Address Resolution Service			
		14.13.1 Systems that provide name/address resolution shall be configured to supply additional data origin and integrity artefacts along with the authoritative data returned in response to resolution queries.			
		14.13.2 Systems that provide name/address resolution when operating as part of a distributed, hierarchical namespace, shall provide the means to indicate the security status of child subspaces and, if the child supports secure resolution services, enabled verification of a chain of trust among parent and child domains.			
		14.14 Fail in Known State			
		14.14.1 The Microgrid information system shall fail to a known state for defined failures			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 8 Technical Specification and Requirements of Cyber Security

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		14.15 Microgrid Information System Partitioning			
		14.15.1 The Microgrid information system shall be partitioned into components residing in separate physical or logical domains (or environments).			
	15 Information Integrity	15.1 Malicious Code and Spam Protection			
		15.1.1 The Microgrid information system shall implement malicious code protection mechanisms.			
		15.1.2 The Microgrid information system shall update malicious code protection mechanisms (including signature definitions) whenever new releases are available in accordance with organizational configuration management policy and procedures.			
		15.1.3 The Microgrid information system shall prevent users from circumventing malicious code protection capabilities.			
		15.1.4 Malicious code protection mechanisms in the Microgrid information system shall be centrally managed.			
		15.1.5 The use of mechanisms to centrally manage malicious code protection must not degrade the operational performance of the Microgrid information system			
		15.1.6 The Microgrid information system shall employ spam protection mechanisms at system entry points and at workstations, servers, or mobile computing devices on the network to detect and take action on unsolicited messages transported by electronic mail, electronic mail attachments, Web accesses, or other common means.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 8 Technical Specification and Requirements of Cyber Security

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		15.2.1 The Contractor shall employ mechanisms to allow events on the Microgrid information system to be monitored to detect attacks, unauthorized activities or conditions, and non-malicious errors.			
		15.2.2 In response to detected activity, the Microgrid information system shall notify a defined list of incident response personnel			
		15.2.3 The Contractor shall configure the Microgrid information system to protect information obtained from intrusion monitoring tools from unauthorized access, modification, and deletion.			
		15.2.4 Individual intrusion detection tools shall be interconnected and configured into a Microgrid system-wide intrusion detection system using common protocols.			
		15.2.5 The Microgrid information system shall provide a real-time alert when indications of compromise or potential compromise occur.			
		15.2.6 The Microgrid information system prevents users from circumventing host-based intrusion detection and prevention capabilities.			
		15.3 Security Alerts and Advisories			
		15.3.1 The Microgrid information system shall receive Microgrid information system security alerts, advisories, and directives from external organizations.			
		15.3.2 The Microgrid information system shall generate and disseminate internal security alerts, advisories, and directives as deemed necessary.			
		15.3.3 The Microgrid information system shall employ automated mechanisms to disseminate security alert and advisory information throughout the organization.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 8 Technical Specification and Requirements of Cyber Security

	Details	Requirements	Statement of Compliance	Proposed Data	Referred to Page
			C/N		
		15.4.1 The Microgrid information system provide the capability to allow the organization, upon Microgrid information system startup and restart, to verify the correct operation of security			
		15.5 Information Input Validation			
		15.5.1 The Microgrid information system shall employ mechanisms to check the accuracy, completeness, validity, and authenticity of information input to the system.			
		15.6 Error Handling			
		15.6.1 The Microgrid information system shall identify error conditions, and generate error messages that provide information necessary for corrective actions without revealing potentially harmful information that could be exploited by adversaries.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)
Tender Reference No. : PEA-MGDP-001/2018

Book 9 Technical Specification and Requirements of Microgrid Control Center

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
1	**Principal Requirement**				
		Contractor shall build 2 storey building according to the outline in appendix as guideline. The building has been designed based on contemporary building which represents the local architecture combined with model of building and new material. Structure of building is reinforced concrete building. Roof is constructed steel structure. Electrical system is combined with electrical from grid with photovoltaic (PV) system.			
		The building shall be certified with green building standard (Thai's Rating of Energy and Environment Sustainability : TREES).			
		Contractor shall build 2 storey building with area at least 753.1 square meter. The building shall have at least key area as following: - Microgrid control room with raised floor and precision air conditioner - Conference room with stage - Electric office (EO) room - Bedroom for operators - Toilet			
		Contractor shall submit the details design of building and surround areas and bill of materials for PEA approval before starting construction.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
1	General				
		Smart devices shall have Open API and allow monitoring and/or control from PEA HiVE- an open-architecture platform for building energy management developed by PEA. PEA HiVE will be provided, and integration of smart devices to PEA HiVE will be performed by PEA.			
	1.1 Components of the smart buil	Smart devices in the smart building shall consist of: • A solar photovoltaics (PV) system at least 10kW • A smart inverter at least 10kVA • Power/energy meter(s) • Air conditioning unit(s) • Lighting load controller(s)/occupancy sensor(s) • Plug load controller(s) • Integrated security system • Smoke detector(s) • Wall mount Battery storage System at least 10kW/10kWh • Smart curtain • Projector with screen control • KVM switch(es)			
	1.2 General requirements	The smart building shall be certified based on the Thai's Energy and Environmental Sustainability (TREES) Rating System, which is a green building rating system developed by Thai Green Building Institute (URL: http://www.tgbi.or.th/).			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		Smart devices shall allow communications with PEA HiVE. Hence, the following requirements are necessary: • All smart devices shall have open Application Programming Interface (API). • All smart devices shall be able to connect to the building Ethernet/WiFi network. In case a converter/gateway is needed to allow smart devices to connect to the building Ethernet/WiFi network, such a converter/gateway shall be provided. • API documentation that describes a means to obtain device readings and send control commands to smart devices shall be provided.			
	1.3 Environmental requirements	The system shall be designed for use in the following operating conditions: Operating temperature 0C – 45C Humidity 0% - 100% Maximum altitude 1,000 m			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
2	**Solar Photovoltaics (PV) System**				
		The PV system shall comprise a solar PV array and balance of system components, i.e., a smart inverter, wirings, a PV circuit breaker and disconnects. Solar PV array and other balance of system components are discussed in this Section. Inverter specifications are discussed in Section 3.0.			
	2.1 Standards and codes	• IEC 61730: Photovoltaic (PV) module safety qualification • IEC 61215:Terrestrial photovoltaic (PV) modules – Design qualification and type approval			
	2.2 Array location and orientation	• The solar PV array shall be installed on the roof of the smart building. • The section of the roof to install solar PV shall have little to no current or anticipated shading. • Care shall be taken to ensure that the solar PV array location is not affected by plumbing or mechanical roof penetrations. • Azimuth of the proposed PV array shall not be deviated more than +/-45 degree off of due south, as the energy output of a solar energy system is optimized by siting the array where the roof is oriented due south at 180 degree azimuth.			
	2.3 PV array specifications	PV modules shall conform to the following specifications. Table 1. PV array specification requirements **Details** / **Technical requirement** **PV module** PV module type: Mono/Polycrystalline **PV array** Output: At least 10kWp			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	2.4 Balance of system components	• Smart inverter: o See Section 3.0.			
		• DC conduit: o A metal conduit shall be installed from the designated array location to the designated inverter location with the end of the conduit clearly labeled, indicating its intended use. o The conduit shall be located in an area that provides sufficient accessibility and clearance for a solar installer to continue the conduit run above the roof deck to the solar array area at a future point in time. o The conduit shall have three or fewer 90-degree turns from the roof to the designated inverter location, as required by the National Electric Code. o The conduit shall terminate near the edge of the designated inverter location to facilitate the final connections to the balance of system components, or for aesthetic reasons, terminate into a flush mount junction or pull box near the designated inverter location. o Both conduit ends shall be sealed. o The conduit run shall be identified on the electrical and architectural diagrams.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		• AC conduit: o A metal conduit from the designated inverter location to the main service panel where the system is intended to be tied into the building's electrical service shall be installed. o The conduit should be capped and clearly labeled, indicating its intended use, on the stubbed end near the inverter location. o Both conduit ends shall be sealed. o The conduit run shall be identified on the electrical and architectural diagrams.			
		• Circuit breaker: o A circuit breaker shall be installed in the electrical service panel for use by the solar PV system. o The circuit breaker shall be labeled for use by the PV system.			
		• Disconnects: o Properly rated DC and AC disconnects shall be provided.			
		• Mounting system: o Mounting system shall be provided to allow PV to be mounted on the rooftop of the smart building. o Voltage drop shall be low enough to allow the inverter to operate as intended. Voltage drop shall be less than 3% overall from the modules through to the interconnection.			
	2.5 Installation	The PV unit shall be installed in accordance with the manufacturer's installation instructions.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	2.6 Field testing and certification	The PV unit shall be tested in accordance with the following: • Conduct a complete inspection and test of the PV system. This includes testing and verifying all connections. • Provide staff to test the device and all operational features of the PV/inverter system (the inverter is discussed in Section 3.0) for witness by PEA's representatives as applicable. • Correct deficiencies until satisfactory results are obtained. • Submit written copies of test results.			
	2.7 Documentation	The following documents shall be provided for the PV system: • PV specifications o Model and spec sheet of solar PV modules o Electrical characteristics of PV modules (maximum power, open circuit voltage, short circuit current, voltage at maximum power point, current at maximum power point) o Number of PV modules connected in series and paralle			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		• Architectural drawings that summarize the installed system equipment: o Location of the solar PV array o Square footage of the solar PV array area relative to the building roof space o Detailed orientation (azimuth) of the array location relative to the roof plane o Inclination (tilt) for the solar PV array o Location of the inverter and balance of system components o Conduit size, type and location o Electrical circuit panel location and dedicated circuit breaker slots o Length of conduit from the designated array location to the designated inverter location o Length of conduit from the designated inverter location to the electrical service panel o Location and number of necessary pull boxes in line with each conduit run			
		• Electrical drawings of PV system components that provide in sufficient detail to call out the electrical components, the wire types and sizes, number of conductors, conduit type and size, as well as the dedicated location for the mounting of the balance components.			
		• The code-compliant documentation of the structural capacity of the roof and of the current dead loads on the roof, demonstrating that the roof has the capacity to support a minimum of 6 pounds per square foot additional dead load for a future PV system.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		• The certified warranties issued by PV vendor/manufacturer(s) shall be transferred to PEA before the issuance of Final Acceptance Certificate.			
3	Smart Inverter				
	3.1 Relevant standards and codes	• ANSI C12.1: Electric Meters • ANSI/IEEE C62.41: IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits • CSA C22.2 No. 107.1-01: General User Power Supplies • CSA TIL M-07: Interim Certification Requirements for Photovoltaic (PV) DC Arc- Fault Protection • IEC 62109-1: Safety of power converters for use in photovoltaic power systems - Part 1: General requirements • IEEE 1547: Standard for Interconnecting Distributed Resources with Electric Power Systems • IEEE 1547.1: Standard for Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems • UL 1699B: Outline of Investigation for Photovoltaic (PV) DC Arc-Fault Circuit Protection (or Equivalent) • PEA Grid Code 2016 or later			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

<table>
<tr><th rowspan="2"></th><th rowspan="2">Details</th><th rowspan="2">Requirements</th><th>Statement of Compliance</th><th rowspan="2">Proposed Data</th><th rowspan="2">Referred to Page</th></tr>
<tr><th>C/N</th></tr>
<tr><td></td><td>3.2 Inverter location</td><td>• The inverter shall be installed in a dedicated area– which shall be free of direct sunlight, excessive heat, or any harsh or extreme weather conditions. The inverter mounting area shall not share a common wall with a working space, such as an office or a meeting room, where slight noise and vibration may be considered a nuisance.
• A finished aesthetic to the wall area shall be maintained.</td><td></td><td></td><td></td></tr>
<tr><td></td><td>3.3 Inverter specifications</td><td>The inverter shall conform to the following specifications.
Table 2. PV inverter specification requirements
<table><tr><th>Details</th><th>Technical requirement</th></tr><tr><td>Input</td><td></td></tr><tr><td>PV power</td><td>At least 10kWp</td></tr><tr><td>Maximum DC voltage</td><td>1000V DC</td></tr><tr><td>Output</td><td></td></tr><tr><td>Maximum output power</td><td>Compatible with PV output, i.e., 10kW</td></tr><tr><td>Grid connection</td><td>380V AC</td></tr><tr><td>Grid voltage tolerance</td><td>±10%</td></tr><tr><td>Phase</td><td>3</td></tr><tr><td>Frequency</td><td>50Hz</td></tr><tr><td>Total harmonic distortion</td><td>< 5%</td></tr><tr><td>Power factor</td><td>0.85-1</td></tr><tr><td>Efficiency</td><td></td></tr><tr><td>Efficiency</td><td>> 95%</td></tr><tr><td>Functions/Features</td><td></td></tr><tr><td>Maximum power point tracker</td><td>Yes</td></tr><tr><td>Grid voltage/frequency monitoring</td><td>Yes</td></tr><tr><td>Islanding condition monitoring</td><td>Yes</td></tr><tr><td>Fault ride through</td><td>Yes (can be enabled or disabled)</td></tr><tr><td>Revenue grade meter</td><td>Yes – the inverter shall measure the amount of energy fed into the grid in accordance with ANSI C12.1, accuracy class 2%.</td></tr><tr><td>Inverter topology</td><td>Transformer-less</td></tr><tr><td>Cooling</td><td>Yes</td></tr><tr><td>Night time consumption</td><td>< 1W</td></tr><tr><td>Control features</td><td></td></tr><tr><td>On/off</td><td>Yes</td></tr><tr><td>Active power control</td><td>Yes</td></tr><tr><td>Reactive power control</td><td>Yes</td></tr><tr><td>Constant power factor control</td><td>Yes</td></tr><tr><td>Limited control from specific IP addresses</td><td>Yes</td></tr><tr><td>Protective devices</td><td></td></tr><tr><td>DC insulation measurement</td><td>Yes</td></tr><tr><td>DC disconnector</td><td>Yes</td></tr><tr><td>Reverse polarity protection</td><td>Yes</td></tr><tr><td>Overload behavior</td><td>Yes</td></tr></table></td><td></td><td></td><td></td></tr>
</table>

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		Indicators | | Display values, settings, menus | Yes | Operating status of PV | Yes | Interruption of grid power | Yes | Status diagnosis | Yes | **Communications** | | Communication technology | Wire/Wireless | Communication protocol/data exchange format | Open API, such as SunSpec, HTTP/JSON and Modbus | Enable remote data collection and control of PV output, including power, reactive power and power factor from PEA HiVE | Yes | Data logger and webserver | Yes | USB | Preferred, data logging | External relay control | Optional | SMS or email in case of errors | Yes | Android and iOS APP | Yes | **General** | | Installation | Indoor | Degree of protection | At least IP54 or equivalent			
	3.4 Communications with third party systems	The inverter shall provide an Ethernet interface (Wi-Fi and serial communications are optional) to allow PEA HiVE to obtain readings from and send control commands to the inverter. Open communication protocols (e.g., SunSpec, JSON/XML and Modbus), shall be used for communicating with the inverter. The ON/OFF status, active/reactive power and power factor of the inverter shall be controlled via its OpenAPI interface (such as Modbus). API documentation shall be provided.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		At the minimum, the following inverter data shall be available. • AC output power (W) • AC reactive power (VAr) • AC voltage (V) • AC output current (A) • AC frequency (Hz) • Power factor • DC power (W) • DC voltage (V) • DC current (A) • AC energy yield (kWh/MWh) • AC maximum output power (W) • AC max voltage (V) • DC maximum voltage (V)			
		Data logging intervals shall be adjustable (e.g., 5, 10, 15, 20 and 30 minutes).			
		At the minimum, the following control features shall be available. • On/off • Active power control (W) • Reactive power control (VAr) • Constant power factor control			
		For a security purpose, the inverter shall provide the “limit control” option where inverter control commands are only permitted form specific IP address(es).			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
3.5 Installation	The inverter shall be installed in accordance with the manufacturer's installation instructions.			
3.6 Field testing and certification	The inverter shall be tested in accordance with the following: • Conduct a complete inspection and test of the PV/inverter system. This includes testing and verifying all connections. • Provide staff to test the device and all operational features of the PV/inverter system for witness by PEA's representatives as applicable. • Correct deficiencies until satisfactory results are obtained. • Submit written copies of test results.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	3.7 Documentation	The following documents shall be provided for the smart inverter: • Full API documentation—This documentation provides a means for third parties to obtain data from the inverter and send control commands in a defined format. • Instruction to connect the device to a Wi-Fi network (if Wi-Fi is used). • Product Data—This documentation includes catalog sheets and technical data sheets indicating physical data and electrical performance, electrical characteristics, and connection requirements. • Operation and Maintenance—This documentation includes a manual for preparing, operating, and maintaining the inverter. This includes equipment wiring connection outlines and written instruction for troubleshooting. • System Electrical Connection Drawings—This documentation includes drawings for properly connecting electrical wiring at the time of installation. • Installation Instructions—This documentation includes step-by-step installation instructions for properly installing the unit. • Device setup instructions on Android/iOS APP			
4	**Power/Energy Meter**				
	4.1 Relevant standards and codes	• ANSI C12.xx: Electric Meters • EN 61000 – Electromagnetic Compatibility (or Equivalent) • UL/IEC STD 61010-1/CSA STD C22.2 No. 61010.1: Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

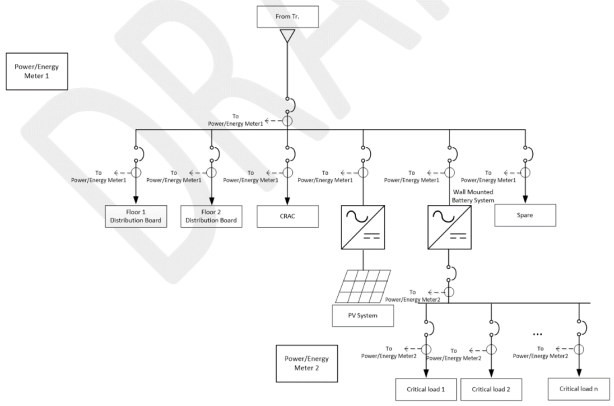
	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	4.2 Meter location	Power/energy meter(s) shall be installed next to the main distribution breaker box. The meter(s) shall be used to measure power/energy consumption of the entire smart building, floor#1, floor#2, the CRAC circuit and PV output as shown in Figure 1. Additionally, power/energy meter(s) shall be installed to measure power consumption of (a) lighting circuits; (b) plug load circuits and (c) air conditioning circuits; of floor#1 and floor#2 as show in Figure 2. Power/energy consumption of critical load circuits shall also be monitored. Note: one power meter may be capable of measuring power/energy consumption of 12 circuits or more.			
		 Figure 1. Main Distribution Board with Power/Energy Meter			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

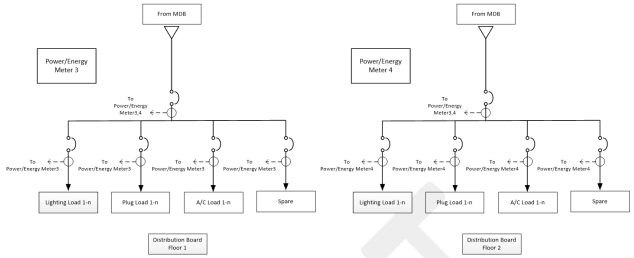
	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		 Figure 2. Distribution Board with Power/Energy Meter for Floor 1 and Floor 2			
	4.3 Power/energy meter specifications	Power/energy meters, including current transformer, shall conform to the following specifications. Table 3. Power/energy meter specification requirements **Details** / **Technical requirement** Power/energy meter / Logging values / V, A, W, Wh, Hz, VA, VAr, THD, deg Voltage / 0-460Vrms Current / Refer to PEA Phase / 3 Electrical frequency / 50Hz Accuracy / ANSI C12.1 –1% with certificate (or equivalent) Data resolution / Adjustable at 1-second, 1-minute, 15-minute, 30-minute and 1-hour intervals Internal storage capacity / Capable of storing 1 minute data for at least 1 year Communication technology / Ethernet or Serial Communication protocol/data exchange format / Open API, such as HTTP/XML Enable remote data collection from PEA HiVE / Yes Current transformer / Type / Split-core Amperage rating / Refer to PEA Accuracy / 1% Enclosure / Degree of protection / At least NEMA 3X (or equivalent)			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	4.4 Communications with third party systems	The power/energy meter shall provide an Ethernet interface to allow third party systems to obtain readings from the power/energy meter(s). Open communication protocols, e.g., JSON/XML, shall be used for communicating with the power/energy meter(s). Full API documentation shall be provided. At the minimum, the following data shall be available. • Voltage (V) • Current (A) • Real power (W) • Reactive power (VAr) • Apparent power (VA) • Energy (Wh) • Frequency (Hz) • Harmonic distortion (THD) • Power factor			
		Data logging intervals shall be adjustable at 1-second, 1-minute, 15-minute, 30-minute and 1-hour intervals.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	4.5 Installation	The power/energy meter shall be installed in accordance with the manufacturer's installation instructions.			
	4.6 Field testing and certification	The power/energy meter shall be tested in accordance with the following: • Conduct a complete inspection and test of the power/energy meter. This includes testing and verifying all connections. • Provide staff to test all operational features of the power/energy meter for witness by PEA's representatives as applicable. • Correct deficiencies until satisfactory results are obtained. • Submit written copies of test results.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	4.7 Documentation	The following documents shall be provided: • Full API documentation—This documentation provides a means for third parties to obtain data from the power/energy meter in a defined format. • Product Data—This documentation includes catalog sheets and technical data sheets indicating physical data and electrical performance, electrical characteristics, and connection requirements. • Operation and Maintenance—This documentation includes a manual for preparing, operating, and maintaining the power/energy meter. This includes equipment wiring connection outlines and written instruction for troubleshooting. • System Electrical Connection Drawings—This documentation includes drawings for properly connecting electrical wiring at the time of installation. • Installation Instructions—This documentation includes step-by-step installation instructions for properly installing the unit. • Ethernet network set up instruction—This documentation includes step-by-step instructions to connect the device to an Ethernet network.			
5	**Air Conditioning (AC) Unit**				
	5.1 Relevant standards and codes	• Thai Industrial Standards Institute (TISI) • Thai Energy Efficiency Standards and Labeling (Label N.5)			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	5.2 AC locations	5.2.1 Air conditioning units (AC) shall be properly sized to provide sufficient cooling needs to the smart building. Please refer to drawing in Building for AC locations. 5.2.2 The AC serving the main control room (Computer Room Air Conditioning: CRAC) should be able to provide enough cooling needs and operate 24 hrs. a day. The set-point and relative humidity of the AC serving the main control room should be set at 22 degree C and 45%, respectively. The sizing of the main control room AC shall be approved by PEA.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

<table>
<tr><th></th><th>Details</th><th>Requirements</th><th>Statement of Compliance
C/N</th><th>Proposed Data</th><th>Referred to Page</th></tr>
<tr><td></td><td>5.3 Air conditioning specifications</td><td>Air conditioning units shall obtain the Thai Energy Efficiency Rating of Number 5, and conform to the following specifications.

Table 4. AC specification requirements
<table><tr><th>Details</th><th>Technical requirement</th></tr><tr><td>Type</td><td></td></tr><tr><td>Split system</td><td>Yes</td></tr><tr><td>Power supply</td><td></td></tr><tr><td>Voltage input</td><td>208-230V or 380 V</td></tr><tr><td>Phase</td><td>1or 3</td></tr><tr><td>Electrical frequency</td><td>50Hz</td></tr><tr><td>Basic functions</td><td></td></tr><tr><td>Inverter power control</td><td>Yes</td></tr><tr><td>COOL mode</td><td>Yes</td></tr><tr><td>AUTO mode</td><td>Yes</td></tr><tr><td>FAN-only mode</td><td>Yes</td></tr><tr><td>Multiple fan speeds</td><td>Yes</td></tr><tr><td>ECONO operation</td><td>Yes</td></tr><tr><td>Indoor unit ON/OFF button</td><td>Yes</td></tr><tr><td>Self diagnosis</td><td>Yes</td></tr><tr><td>System ratings – cooling</td><td></td></tr><tr><td>Cooling capacity range (BTU/h)</td><td>* specified by the bidder to provide sufficient cooling need</td></tr><tr><td>SEER</td><td>> 13</td></tr><tr><td>EER</td><td>> 8</td></tr><tr><td>Energy Star rated</td><td>Yes</td></tr><tr><td>Sensor/timer</td><td></td></tr><tr><td>Built-in occupancy sensor</td><td>Yes</td></tr><tr><td>24 hour ON/OFF timer</td><td>Yes</td></tr><tr><td>Protection</td><td></td></tr><tr><td>Low voltage start-up</td><td>Yes</td></tr><tr><td>Over current protection</td><td>Yes</td></tr><tr><td>Anti-freeze protection</td><td>Yes</td></tr><tr><td>High and low pressure protection</td><td>Yes</td></tr><tr><td>Communication and control</td><td></td></tr><tr><td>Remote control</td><td>Yes</td></tr><tr><td>Communication technology</td><td>Ethernet or Wi-Fi connection–required</td></tr><tr><td>Communication protocol/data exchange format</td><td>Open API, such as HTTP/JSON</td></tr><tr><td>Enable remote data collection and control of its ON/OFF status, mode and set-point from PEA HiVE</td><td>Yes</td></tr><tr><td>Android or iOS APP</td><td>Yes</td></tr></table></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>Note:
• EER: Energy Efficiency Rating. It measures the ratio of output power to the input power.
• SEER: Seasonal Energy Efficiency Ratio. It provides an annual measure of the efficiency of the air conditioner. Higher numbers use less energy.
• COP: Coefficient of Performance. It is the ratio between the cooling or heating provided and the electrical power consumption.</td><td></td><td></td><td></td></tr>
</table>

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	5.4 Communications with PEA HiVE	The air conditioning unit(s), except the CRAC, shall provide an Ethernet or Wi-Fi interface to allow PEA HiVE to obtain readings from and send control commands to the air conditioning unit(s). Open communication protocols, e.g., HTML/JSON, shall be used for communicating with the unit(s). API documentation shall be provided.			
		At the minimum, the following data shall be available. • Indoor temperature (C) • AC mode (COOL/HEAT/AUTO/OFF) • FAN mode (ON/AUTO/OFF) • Cool set point (C)			
		At the minimum, the following control features shall be available. • AC mode (COOL/HEAT/AUTO/OFF) • FAN mode (ON/AUTO/OFF) • Cool set point (C)			
		For security purpose, the AC serving the main control room (CRAC) shall not be controlled by PEA HiVE. Additional temperature/humidity sensor(s) that has open API shall be provided to monitor in-door temperature of the main control room.			
	5.5 Installation	The AC units shall be installed in accordance with the manufacturer's installation instructions.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	5.6 Field testing and certification	The AC units shall be tested in accordance with the following: • Conduct a complete inspection and test of all AC units. This includes testing and verifying all connections. • Provide staff to test all operational features of all AC units for witness by PEA's representatives as applicable. • Correct deficiencies until satisfactory results are obtained. • Submit written copies of test results.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	5.7 Documentation	The following documents shall be provided: • Full API documentation—This documentation provides a means for third parties to obtain data from the AC unit(s) in a defined format. • Product Data—This documentation includes catalog sheets and technical data sheets indicating physical data and electrical performance, electrical characteristics, and connection requirements. • Operation and Maintenance—This documentation includes a manual for preparing, operating, and maintaining the AC unit(s). This includes equipment wiring connection outlines and written instruction for troubleshooting. • System Electrical Connection Drawings—This documentation includes drawings for properly connecting electrical wiring at the time of installation. • Installation Instructions—This documentation includes step-by-step installation instructions for properly installing the unit. • Wi-Fi set up instruction—This documentation includes step-by-step instructions to connect the device to a Wi-Fi network. • Device setup instructions on Android/iOS APP			
6	**Lighting Load Controller and Occupancy Sensor**				

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	6.1 Relevant standards and codes	• Illuminating Engineering Society (IES) lighting handbook • ASHRAE 90.1 – Energy standard for commercial buildings o Automatic lighting shutoff (9.4.1.1) – "All indoor lighting must include a separate automatic shut-off control, such as an occupancy sensor or timer switch." o Space control (9.4.1.2b) – "An occupancy sensor that automatically turns lighting off within 30 minutes must be installed in classrooms, conference rooms, break rooms, storage rooms, printing rooms, private offices, restrooms and dressing rooms." o Additional control (9.4.1.6) – "Lighting in enclosed stairwells shall have one or more control devices to automatically reduce lighting power by at least 50% within 30 minutes of all occupants leaving." • IECC 2012 – International Energy Conservation Code o Occupancy sensors (405.2.2.2) – "Requires use of occupancy or vacancy sensors in classrooms, conference/meeting room, break rooms, private offices, restrooms, storage rooms, janitorial closets and all spaces 300 sq. ft. or less."			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

<table>
<tr><th></th><th>Details</th><th>Requirements</th><th>Statement of Compliance
C/N</th><th>Proposed Data</th><th>Referred to Page</th></tr>
<tr><td></td><td>6.2 Lighting requirements</td><td>All lighting fixtures shall be of LED type and provide lighting levels to meet standard illumination requirements in offices.

Table 5. Lighting type requirements
<table><tr><th>Lighting type requirement</th><th>Technical requirement</th></tr><tr><td>Lighting type</td><td>Dimmable LED</td></tr><tr><td>Voltage input</td><td>220V</td></tr><tr><td>Phase</td><td>1</td></tr><tr><td>Electrical frequency</td><td>50Hz</td></tr></table>
Table 6. Recommended illuminance by space type
<table><tr><th>Recommended illuminance by space type
(per IES lighting handbook)</th><th>Illuminance (LUX)
(fc = footcandle)</th></tr><tr><td>Open offices</td><td>30-50fc or 323-538lux</td></tr><tr><td>Private offices</td><td>50fc or 538lux</td></tr><tr><td>Conference rooms</td><td>30fc or 323lux</td></tr><tr><td>Corridors</td><td>5fc or 53.8lux</td></tr><tr><td>Restrooms</td><td>10fc or 10.8lux</td></tr><tr><td>Lobby</td><td>10fc or 10.8lux</td></tr><tr><td>Kitchen</td><td>50fc or 53.8lux</td></tr><tr><td>General warehousing/storage</td><td>10fc or 10.8lux</td></tr><tr><td>Inactive storage</td><td>5fc or 53.8lux</td></tr></table></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>There are different lighting requirements in different sections of the building, as described below. Please refer to PEA for the lighting zones.</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>6.2.1 Conference room
Lighting in conference room shall be divided into several zones. Each zone shall be controlled by a separate wireless smart switch. Occupancy/vacancy sensors are required to automatically turn all lights off after a configurable period of inactivity.

Table 7. Lighting requirements – conference room
<table><tr><th>Details</th><th>Technical requirement</th></tr><tr><td>Number of zones</td><td>Setting by PEA</td></tr><tr><td>Light switch for ON/OFF control</td><td>Yes – wireless smart light switch</td></tr><tr><td>Occupancy/vacancy sensor</td><td>Yes</td></tr><tr><td>Light ON</td><td>Manually – occupant flips the switch</td></tr><tr><td>Light OFF</td><td>After a configurable period (e.g., 30 minutes) of inactivity</td></tr></table></td><td></td><td></td><td></td></tr>
</table>

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

<table>
<tr><th></th><th>Details</th><th>Requirements</th><th>Statement of Compliance
C/N</th><th>Proposed Data</th><th>Referred to Page</th></tr>
<tr><td></td><td></td><td>6.2.2 EO
Lighting in EO shall be divided into several zones. Each zone shall be controlled by a separate wireless smart switch. Occupancy/vacancy sensors are required to automatically turn all lights off after a configurable period of inactivity.

Table 8. Lighting requirements – EO
<table><tr><th>Details</th><th>Technical requirement</th></tr><tr><td>Number of zones</td><td>Setting by PEA</td></tr><tr><td>Light switch for ON/OFF control</td><td>Yes – wireless smart light switch</td></tr><tr><td>Occupancy/vacancy sensor</td><td>Yes</td></tr><tr><td>Light ON</td><td>Manually – occupant flips the switch</td></tr><tr><td>Light OFF</td><td>After a configurable period of inactivity (e.g., 30 minutes)</td></tr></table></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>6.2.3 Employee bedroom
Lighting in the employee bedroom shall be controlled by a smart switch. Occupancy/vacancy sensors are required to automatically turn all lights off after a configurable period of inactivity.

Table 9. Lighting requirements – employee bedroom
<table><tr><th>Details</th><th>Technical requirement</th></tr><tr><td>Light switch for ON/OFF control</td><td>Yes – wireless smart light switch</td></tr><tr><td>Occupancy/vacancy sensor</td><td>Yes</td></tr><tr><td>Light ON</td><td>Manually – occupant flips the switch</td></tr><tr><td>Light OFF</td><td>After a configurable period of inactivity (e.g., 30 minutes)</td></tr></table></td><td></td><td></td><td></td></tr>
</table>

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

<table>
<tr><th></th><th>Details</th><th>Requirements</th><th>Statement of Compliance
C/N</th><th>Proposed Data</th><th>Referred to Page</th></tr>
<tr><td></td><td></td><td>6.2.4 Main control room
Lighting in main control room shall be divided into several zones. Each zone shall be controlled by a separate wireless smart switch. Occupancy/vacancy sensors are required to automatically turn all lights off after a configurable period of inactivity.

Table 10. Lighting requirements – main control room
<table><tr><th>Details</th><th>Technical requirement</th></tr><tr><td>Light switch for ON/OFF control</td><td>Yes – Wireless smart light switch</td></tr><tr><td>Occupancy/vacancy sensor</td><td>Yes</td></tr><tr><td>Light ON</td><td>Manually – occupant flips the switch</td></tr><tr><td>Light OFF</td><td>After a configurable period of inactivity (e.g., 10 minutes)</td></tr></table></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>6.2.5 Office
Lighting in office shall be divided into several zones. Each zone shall be controlled by a separate wireless smart switch. Occupancy/vacancy sensors are required to automatically turn all lights off after a configurable period of inactivity.

Table 11. Lighting requirements – the office
<table><tr><th>Details</th><th>Technical requirement</th></tr><tr><td>Number of zones</td><td>Setting by PEA</td></tr><tr><td>Light switch for ON/OFF control</td><td>Yes – wireless smart light switch</td></tr><tr><td>Occupancy/vacancy sensor</td><td>Yes</td></tr><tr><td>Light ON</td><td>Manually – occupant flips the switch</td></tr><tr><td>Light OFF</td><td>After a configurable period of inactivity (e.g., 30 minutes)</td></tr></table></td><td></td><td></td><td></td></tr>
</table>

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		6.2.6 Storage room Lighting in the storage room shall be occupancy-based. The occupancy sensor shall automatically turn lights on when someone enters the room, and off after a configurable period of inactivity. Table 12. Lighting requirements – the storage room **Details** / **Technical requirement** Number of zones: 1 Light switch for ON/OFF control: No Occupancy sensor: Yes Light ON: Automatically with an occupant entering the storage room Light OFF: After a configurable period of inactivity (e.g., 10 minutes)			
		6.2.7 Restrooms Lighting in each restroom shall be occupancy-based. The occupancy sensor shall automatically turn lights on when someone enters the room, and off after a configurable period of inactivity. Table 13. Lighting requirements – restrooms **Details** / **Technical requirement** Number of zones: One for women restroom and one for men restroom Light switch for ON/OFF control: No Occupancy sensor: Yes Light ON: Automatically with occupant entering the restroom Light OFF: After a configurable period of inactivity (e.g., 10 minutes)			
		6.2.8 Stairs Stairs lighting shall have control devices to automatically reduce lighting power by at least 50% within 30 minutes of all occupants leaving. Table 14. Lighting requirements – stairs **Details** / **Technical requirement** Number of zones: 1 Light switch for ON/OFF/dimming control: Yes Occupancy sensor: Yes – one on the first floor; one on the second floor Light ON: • Illuminance-based control 0- 50% intensity • Increase intensity to 100% when occupancy is detected • Change to illuminance-based control 0-50% intensity			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	6.3 Lighting load controller specifications	Lighting load controllers shall be Wi-Fi enabled smart light switches that conform to the following specifications. Table 15. Lighting load controller requirements **Lighting load controller details** / **Technical requirement** Type: In-wall Dimmer: Yes Voltage input: 220V Phase: 1 Electrical frequency: 50Hz Communication technology: Wireless Communication protocol/data exchange format: Open API, such as HTTP/JSON Enable remote ON/OFF control from third party systems: Yes Android and iOS APP: Yes Certification and listing: IEC/EC or equivalent certified			
	6.4 Communications with PEA HiVE	The lighting fixtures in the conference room, EO, the employee bedroom, main control room, office room shall be controlled by wireless smart switches (in-wall type) that allow PEA HiVE to obtain their ON/OFF status and send ON/OFF control commands to the switches. Open communication protocols, e.g., HTML/JSON, shall be used for communicating with the unit(s). API documentation shall be provided. At the minimum, the following data shall be available. • Status (ON/OFF) • Brightness level (%) At the minimum, the following control features shall be available. • Status (ON/OFF) • Brightness level (%)			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

<table>
<tr><th></th><th>Details</th><th>Requirements</th><th>Statement of Compliance
C/N</th><th>Proposed Data</th><th>Referred to Page</th></tr>
<tr><td></td><td>6.5 Occupancy/vacancy sensor specifications</td><td>In some applications discussed in Section 6.2, occupancy sensors are required, while in the other applications vacancy sensors are required. An occupancy sensor automatically turns lights on when one enters a room and off when one leaves. A vacancy sensor also turns off the light when one leaves a room, but the lights need to be manually turned on when one enters a room. Vacancy sensing maximizes the energy savings from the sensor because it is not always necessary to turn lights on when someone walks into a room.</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>Table 16. Occupancy/vacancy sensor requirements
<table><tr><th>Occupancy/vacancy sensor details</th><th>Technical requirement</th></tr><tr><td>Technology</td><td>PIR, ultrasonic or both – for very fine motion detection</td></tr><tr><td>Adjustable timeout</td><td>Yes – 1, 5, 15 or 30 minutes</td></tr><tr><td>Occupancy/vacancy</td><td>Yes – Auto-on/auto-off and manual-on/auto-off</td></tr><tr><td>Type</td><td>Wall-mounted or ceiling mounted* specified by the bidder</td></tr><tr><td>Power supply/battery</td><td>Wired or wireless; if wireless, at least 10-year battery life is required.</td></tr><tr><td>High-low sensitivity adjustment</td><td>Yes</td></tr></table></td><td></td><td></td><td></td></tr>
<tr><td></td><td>6.6 Installation</td><td>The lighting load controllers and sensors shall be installed in accordance with the manufacturer’s installation instructions.</td><td></td><td></td><td></td></tr>
<tr><td></td><td>6.7 Field testing and certification</td><td>The lighting/sensor system shall be tested in accordance with the following:
• Conduct a complete inspection and test of the entire lighting/sensor system. This includes testing and verifying all connections.
• Provide staff to test all devices and all operational features of the entire system for witness by PEA’s representatives as applicable.
• Correct deficiencies until satisfactory results are obtained.
• Submit written copies of test results.</td><td></td><td></td><td></td></tr>
</table>

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	6.8 Documentation	The following documents shall be provided: • API documentation—This documentation provides a means for third parties to obtain data from the light switches in a defined format. • Product Data—This documentation includes catalog sheets and technical data sheets indicating physical data and electrical performance, electrical characteristics, and connection requirements. • System Electrical Connection Drawings—This documentation includes drawings for properly connecting electrical wiring at the time of installation. • Installation Instructions—This documentation includes step-by-step installation instructions for properly installing the unit. • Set up instruction—This documentation includes step-by-step instructions to connect the device to a communication network. • Device setup instructions on Android/iOS APP.			
7	**PLUG LOAD CONTROLLER (SMART PLUG)**				
	7.1 Relevant standards and codes	• CE Certification (CE = Conformity of Europe) or UL certification.			
	7.2 Plug load controller location	At least five plug load controllers shall be installed. Please refer to PEA for their locations. These smart plugs shall be of in-wall type.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

<table>
<tr><th rowspan="2">Details</th><th rowspan="2">Requirements</th><th>Statement of Compliance</th><th rowspan="2">Proposed Data</th><th rowspan="2">Referred to Page</th></tr>
<tr><th>C/N</th></tr>
<tr><td>7.3 Plug load controller specifications</td><td>Plug load controllers shall conform to the following specifications.

Table 17. Plug load controller requirements
<table><tr><th>Details</th><th>Technical requirement</th></tr><tr><td>Type</td><td>In-wall</td></tr><tr><td>Voltage rating</td><td>220V</td></tr><tr><td>Current rating</td><td>15A</td></tr><tr><td>Electrical frequency</td><td>50Hz</td></tr><tr><td>Phase</td><td>1</td></tr><tr><td>Communication technology</td><td>Wireless</td></tr><tr><td>Communication protocol/data exchange format</td><td>Open API, such as HTTP/JSON</td></tr><tr><td>Enable remote ON/OFF control from third party systems</td><td>Yes</td></tr><tr><td>Android and iOS APP</td><td>Yes</td></tr><tr><td>Certification and listing</td><td>IEC/EC or equivalent certified</td></tr></table></td><td></td><td></td><td></td></tr>
<tr><td>7.4 Communications with PEA HiVE</td><td>The plug load controllers shall allow PEA HiVE to obtain their ON/OFF status and send ON/OFF control commands. Open communication protocols, e.g., HTTP/JSON, shall be used for communicating with the unit(s). API documentation shall be provided.
At the minimum, the following data shall be available.
• Status (ON/OFF)
• Energy or power consumption (kW or kWh)
At the minimum, the following control features shall be available.
• Status (ON/OFF)</td><td></td><td></td><td></td></tr>
<tr><td>7.5 Installation</td><td>The smart plugs shall be installed in accordance with the manufacturer’s installation instructions.</td><td></td><td></td><td></td></tr>
</table>

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	7.6 Field testing and certification	The smart plugs shall be tested in accordance with the following: • Conduct a complete inspection and test of the smart plugs. This includes testing and verifying all connections. • Provide staff to test all devices and all operational features of smart plugs for witness by PEA's representatives as applicable. • Correct deficiencies until satisfactory results are obtained. • Submit written copies of test results.			
	7.7 Documentation	The following documents shall be provided: • API documentation—This documentation provides a means for third parties to obtain data from the smart plugs in a defined format. • Product Data—This documentation includes catalog sheets and technical data sheets indicating physical data and electrical performance, electrical characteristics, and connection requirements. • System Electrical Connection Drawings—This documentation includes drawings for properly connecting electrical wiring at the time of installation. • Installation Instructions—This documentation includes step-by-step installation instructions for properly installing the unit. • Set up instruction—This documentation includes step-by-step instructions to connect the device to a communication network. • Device setup instructions on Android/iOS APP			
8	**Integrated Security System**				

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		The integrated security system shall include a network-enabled access control and security camera system.			
	8.1 Access Control System	An access control system shall be installed for managing the entrance and exit of people through secure areas. The access control system shall be network-enabled and installed at the smart building to allow employees to swipe ID cards to access the building, and scan the cards/fingerprints to access particular rooms in the building according to their access rights. This will provide management, traceability and forensics to building access. The entire system shall support at least three (3) card readers and two (2) card/biometric readers. The system shall support at least 20 cards. The card/biometric readers shall be capable of performing authentication based on both card scan and fingerprint scan. The system shall allow PEA to install additional card and card/biometric readers or fix the readers. Access control management software shall be provided.			
		8.1.1 Relevant standards and codes • UL294 – Access Control System (or Equivalent) • ISO/IEC 27001 – Information Security Management (or Equivalent)			
		8.1.2 Access control system location Please refer to PEA for the location(s) of the access control devices, including three(3) card readers and two (2)card/biometric readers.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

<table>
<tr><th></th><th>Details</th><th>Requirements</th><th>Statement of Compliance
C/N</th><th>Proposed Data</th><th>Referred to Page</th></tr>
<tr><td></td><td></td><td>8.1.3 Access control specifications
The access control system shall conform to the following specifications.

Table 18. Access control requirements
<table><tr><th>Access control system details</th><th>Technical requirement</th></tr><tr><td>Features:</td><td></td></tr><tr><td>Support multiple operator workstations via LAN/WAN</td><td>Yes</td></tr><tr><td>Multi-level password protection</td><td>Yes</td></tr><tr><td>Provide graphical user interface</td><td>Yes</td></tr><tr><td>Support industry standard database management systems, which allows edit, add, delete, search, sort and print options for records in the database</td><td>Yes</td></tr><tr><td>Automatic backup of database files</td><td>Yes</td></tr><tr><td>Provide encryption</td><td>Yes</td></tr><tr><td>Ability to activate or deactivate cards</td><td>Yes</td></tr><tr><td>Monitor and log intrusion system events and send alerts</td><td>Yes</td></tr><tr><td>Alert:</td><td></td></tr><tr><td>Provide a display of the most current transactions in real time</td><td>Yes</td></tr><tr><td>Send an alert (e.g., email) based on events</td><td>Yes</td></tr><tr><td>Allow to send an email message selectable per card event type</td><td>Yes</td></tr><tr><td>Allow an operator to acknowledge and clear alarms</td><td>Yes</td></tr><tr><td>Access level:</td><td></td></tr><tr><td>Provide option to restrict access to sensitive information by user ID</td><td>Yes</td></tr><tr><td>Provide an option to define specific access time</td><td>Yes</td></tr><tr><td>Provide an option to define specific readers for access</td><td>Yes</td></tr><tr><td>Customizable card access level with beginning and end dates</td><td>Yes</td></tr><tr><td>Report:</td><td></td></tr><tr><td>Provide card holder report with filter options to define doors, card holder name</td><td>Yes</td></tr><tr><td>Generate history report for an alarm point state (e.g., normal, alarm)</td><td>Yes</td></tr><tr><td>Generate history report of system alarm (e.g., power failure, panel tamper)</td><td>Yes</td></tr><tr><td>Generate history report for system operator activities</td><td>Yes</td></tr><tr><td>Generate history report based on the frequency of usage of a card</td><td>Yes</td></tr><tr><td>Card:</td><td></td></tr><tr><td>Contain information inside card shall include at the minimum:
First name, last name, card number, activation date, de-activation date, status, note fields and a photo image</td><td>Yes</td></tr><tr><td>Provide special card options for visitor/temporary use</td><td>Yes</td></tr><tr><td>Card/biometric reader:</td><td></td></tr><tr><td>Card reader</td><td>Yes</td></tr><tr><td>Fingerprint</td><td>Yes</td></tr></table></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>8.1.4 Communications with PEA HiVE
The access control system shall allow PEA HiVE to access its database to obtain data on entry and exit information of individuals with time stamp. Only read-only access shall be granted to PEA HiVE. No write privilege shall be allowed. SDK/API documentation shall be provided.</td><td></td><td></td><td></td></tr>
<tr><td>8.2 Security Camera System</td><td></td><td>The security camera system shall include a digital video recorder (DVR) and a total at least 10</td><td></td><td></td><td></td></tr>
</table>

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		8.2.1 Relevant standards and codes • Open network video interface forum (ONVIF) or equivalent.			
		8.2.2 Security camera system location Please refer to PEA for the location(s) of the DVR and security cameras.			
		8.2.3 Security camera system specifications The IP camera system shall be an IP-based wire solution (Ethernet cable) and conform to the following specifications.			

Table 19. Security camera system specification requirements

Security camera system details	Technical requirement
DVR specifications	
Real-time recording on all channels	Yes
Built-in Power-over-Ethernet ports or external power supply	Yes
Automatic detection of all compatible IP cameras in the network	Yes
Video compression	Yes
Pentaplex operation (view, record, playback, back up & remote control)	Yes
Motion detection	Yes
Motion detection alert (by email or upload image snapshot)	Optional
Sound detection	Optional
Sound detection alert (by email or upload image snapshot)	Optional
Schedule recording	Yes
Password protection	Yes
Support multi-camera operation	Yes
Firewall	Supports IP filtering
Local storage	Yes
FTP or cloud storage	Optional
Communications	
Communication technology	Ethernet, RJ-45 connection, or WiFi
Enable communications with PEA HiVE	Yes
Security camera specifications	
Camera power	Power-over-Ethernet connectivity through the DVR or an external power supply
Video resolution	At least 2 Megapixels
Support night vision	Yes – with IR illuminator
IR range	At least 8 meters
Pan	Yes
Tilt	Yes
Zoom	Yes
Hue, brightness, contrast, saturation, sharpness	Adjustable
Operating condition	
Installation	Both Indoor and Outdoor

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
		8.2.4 Communications with PEA HiVE The security camera system shall use Real-time Steaming Protocol (RTSP), and allow PEA HiVE to obtain real-time video stream, and send control commands (e.g., pan, tilt, zoom) to the camera(s). API documentation shall be provided.			
	8.3 Installation	The integrated security system including access control and security camera system shall be installed in accordance with the manufacturer's installation instructions.			
	8.4 Field testing and certification	The access control and security camera system shall be tested in accordance with the following: • Conduct a complete inspection and test of all installed access control system. This includes testing and verifying all connections. • Provide staff to test all devices and all operational features of the entire access control system for witness by PEA's representatives as applicable. • Correct deficiencies until satisfactory results are obtained. • Submit written copies of test results.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	8.5 Documentation	The following documents shall be provided: • SDK/API documentation—This documentation provides a means for third parties to obtain readings from the access control/security camera system in a defined format. • Manufacturer's Product Data—This documentation indicates systems and components proposed for use. • Shop drawings—This documentation indicates system components and wiring diagrams. • Record drawings—This documentation indicates location of equipment and wiring. • Operation and maintenance data—This documentation includes manufacturer's operation and maintenance data customized to the access control system installed, as well as system and operator manuals. Maintenance service agreement—This documentation includes a copy of manufacturer's maintenance service agreement, including cost and services for a two-year period for PEA review.			
9	**Smoke Detector**				
	9.1 Relevant standards and codes	• UL 2034 – Single and multi station carbon monoxide alarms (or Equivalent) • UL 217 – Single and smoke alarm (or Equivalent) • NFPA-72 – National Fire Alarm and Signaling Code (or Equivalent)			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

<table>
<tr><th></th><th>Details</th><th>Requirements</th><th>Statement of Compliance
C/N</th><th>Proposed Data</th><th>Referred to Page</th></tr>
<tr><td></td><td>9.2 Smoke detector location</td><td>Bidder(s) shall determine the location(s) of the smoke detector(s) to be approved by PEA.

Table 20. Smoke detector specification requirements
<table><tr><th>Smoke detector details</th><th>Technical requirement</th></tr><tr><td>Electrical</td><td></td></tr><tr><td>Wired connector</td><td>Yes</td></tr><tr><td>Backup batteries</td><td>Yes</td></tr><tr><td>Feature/function</td><td></td></tr><tr><td>Voice alarms</td><td>Yes</td></tr><tr><td>Detect smoke</td><td>Yes</td></tr><tr><td>Detect carbon monoxide</td><td>Yes</td></tr><tr><td>Alert for low battery</td><td>Yes</td></tr><tr><td>Alert for sensor failure</td><td>Yes</td></tr><tr><td>Sensors</td><td></td></tr><tr><td>Carbon monoxide sensor</td><td>Yes</td></tr><tr><td>Smoke sensor</td><td>Yes</td></tr><tr><td>Heat sensor</td><td>Optional</td></tr><tr><td>Humidity sensor</td><td>Optional</td></tr><tr><td>Occupancy sensor</td><td>Optional</td></tr><tr><td>Ambient light sensor</td><td>Optional</td></tr><tr><td>Speaker</td><td></td></tr><tr><td>Speaker</td><td>Yes</td></tr><tr><td>Communications</td><td></td></tr><tr><td>Communication technology</td><td>Wire or wireless</td></tr><tr><td>Communication protocol/data exchange format</td><td>Open API, such as HTTP/JSON</td></tr><tr><td>Enable communications with PEA HiVE</td><td>Yes</td></tr><tr><td>Operating condition</td><td></td></tr><tr><td>Installation</td><td>Indoor</td></tr></table></td><td></td><td></td><td></td></tr>
<tr><td></td><td>9.3 Communications with PEA HiVE</td><td>The smoke detector(s) shall allow PEA HiVE to obtain status readings. Open communication protocols, e.g., HTTP/JSON, shall be used for communicating with the unit(s). API documentation shall be provided.

At the minimum, the following data/parameters shall be able to retrieve by PEA HiVE.
• Get online/offline status
• Get carbon monoxide alarm state
• Get smoke alarm state
• Get battery status</td><td></td><td></td><td></td></tr>
</table>

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	9.4 Installation	The smoke detectors shall be installed in accordance with the manufacturer's installation instructions.			
	9.5 Field testing and certification	The smoke detectors shall be tested in accordance with the following: • Conduct a complete inspection and test of the smoke detectors. This includes testing and verifying all connections. • Provide staff to test all operational features of the smoke detectors for witness by PEA's representatives as applicable. • Correct deficiencies until satisfactory results are obtained. • Submit written copies of test results.			
	9.6 Documentation	The following documents shall be provided: • API documentation—This documentation provides a means for third parties to obtain data from the smoke detector in a defined format. • Product Data—This documentation includes catalog sheets and technical data sheets indicating physical data, electrical characteristics, and connection requirements. • Installation Instructions—This documentation includes step-by-step installation instructions for properly installing the unit. • Communication set up instruction—This documentation includes step-by-step instructions to connect the device to a communication network.			
10	**Wall Mounted Battery Storage System**				

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

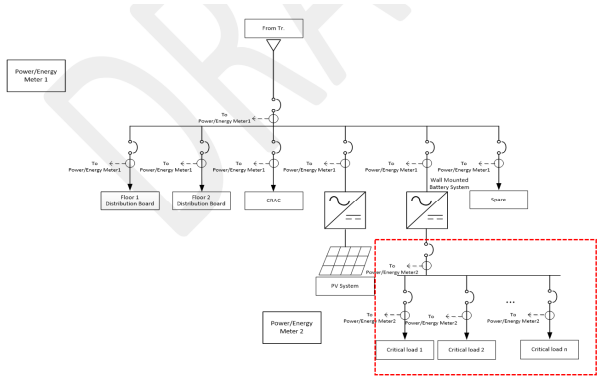
	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	10.1 Relevant standards and codes	• IEC 62109-1 – Safety of power converters for use in photovoltaic power systems - Part 1: General requirements • IEC 62619 – Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications			
	10.2 Wall mounted battery storage location	Wall mount battery storage units shall be installed at the smart building. Please refer to PEA for the location(s) of the batteries.			
	10.3 Critical loads served by the wall mounted battery storage system	A dedicated critical load circuit shall be served by the wall mounted battery storage as shown in Figure 3. For the list of critical loads, please refer to PEA.  Figure 3. Critical Load Supply by Wall Mounted Battery Storage			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

<table>
<tr><th rowspan="2"></th><th rowspan="2">Details</th><th rowspan="2">Requirements</th><th>Statement of Compliance</th><th rowspan="2">Proposed Data</th><th rowspan="2">Referred to Page</th></tr>
<tr><th>C/N</th></tr>
<tr><td></td><td>10.4 Wall mounted battery storage specifications</td><td>Wall mounted battery storage units shall conform to the following specifications.
Table 21. Wall mounted battery storage system requirements<table><tr><th>Details</th><th>Technical requirement</th></tr><tr><td>Feature/Performance</td><td></td></tr><tr><td>Type</td><td>Wall mounted</td></tr><tr><td>Battery type</td><td>Li-Ion</td></tr><tr><td>Efficiency</td><td>At least 90% round trip</td></tr><tr><td>Total power output</td><td>At least 10kW con.</td></tr><tr><td>Total storage size</td><td>At least 10kWh</td></tr><tr><td>Inverter</td><td>Provide</td></tr><tr><td>Depth of discharge</td><td>100%</td></tr><tr><td>Operating condition</td><td></td></tr><tr><td>Operating output voltage</td><td>220V</td></tr><tr><td>Operating frequency</td><td>50Hz</td></tr><tr><td>Installation</td><td>Indoor or outdoor rated</td></tr><tr><td>Interface</td><td></td></tr><tr><td>Communication technology</td><td>Wire or Wireless</td></tr><tr><td>Communication protocol/data exchange format</td><td>Open API, e.g., Modbus or HTTP/JSON</td></tr><tr><td>Enable remote ON/OFF control from PEA HiVE</td><td>Yes</td></tr></table></td><td></td><td></td><td></td></tr>
<tr><td></td><td>10.5 Communications with PEA HiVE</td><td>The wall mounted battery system shall allow PEA HiVE to obtain their charge/discharge and state-of-charge status. Open communication protocols, e.g., Modbus, HTTP/JSON, shall be used for communicating with the unit(s). API documentation shall be provided.
At the minimum, battery charge/discharge schedule shall be controlled via manufacturer’s APP, or the battery system shall allow PEA HiVE to set charge/discharge schedule.</td><td></td><td></td><td></td></tr>
<tr><td></td><td>10.6 Installation</td><td>Wall mounted battery systems shall be installed in accordance with the manufacturer’s installation instructions.</td><td></td><td></td><td></td></tr>
</table>

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	10.7 Field testing and certification	The system shall be tested in accordance with the following: • Conduct a complete inspection and test of the wall mounted battery systems. This includes testing and verifying all connections. • Provide staff to test the battery systems and all operational features for witness by PEA's representatives as applicable. • Correct deficiencies until satisfactory results are obtained. • Submit written copies of test results.			
	10.8 Documentation	The following documents shall be provided: • Full API documentation—This documentation provides a means for third parties to obtain data from the battery units in a defined format. • Product Data—This documentation includes catalog sheets and technical data sheets indicating physical data and electrical performance, electrical characteristics, and connection requirements. • System Electrical Connection Drawings—This documentation includes drawings for properly connecting electrical wiring at the time of installation. • Installation Instructions—This documentation includes step-by-step installation instructions for properly installing the unit. • Communication set up instruction—This documentation includes step-by-step instructions to connect the device to a wire/wireless network.			
11	**Smart Curtain**				
	11.1 Relevant standards and	N/A			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

<table>
<tr><th rowspan="2">Details</th><th rowspan="2">Requirements</th><th>Statement of Compliance</th><th rowspan="2">Proposed Data</th><th rowspan="2">Referred to Page</th></tr>
<tr><th>C/N</th></tr>
<tr><td>11.2 Smart curtain location</td><td>At least five (5) smart curtain sets shall be installed in main control room, office, conference room, EO, employee bedroom. Please refer to PEA for the location(s) and dimensions of the smart curtains.</td><td></td><td></td><td></td></tr>
<tr><td>11.3 Smart curtain specifications</td><td>Smart curtains shall conform to the following specifications.

Table 22. Smart curtain requirements
<table><tr><th>Details</th><th>Technical requirement</th></tr><tr><td>Feature</td><td></td></tr><tr><td>Type</td><td>Motorized shades or blinds</td></tr><tr><td>Power</td><td>Wired (220V 50Hz) or solar + battery (if powered by solar + battery, battery life shall be up to six months with no sun with automatic notification for low battery)</td></tr><tr><td>Control option</td><td>Smart phone, on-device, ambient light sensor</td></tr><tr><td>Ambient light sensor</td><td>Allow for automatic operation of motorized curtains according to the amount of sunlight (optional)</td></tr><tr><td>iOS and Android app</td><td>Yes</td></tr><tr><td>Smart home integration</td><td>Capable</td></tr><tr><td>Openness factor</td><td>Specified by the contractor</td></tr><tr><td>UV blockage</td><td>At least 90%</td></tr><tr><td>Interface</td><td></td></tr><tr><td>Communication technology</td><td>Wire or Wireless</td></tr><tr><td>Communication protocol/data exchange format</td><td>Open API</td></tr><tr><td>Enable remote open/close control and schedule setting from a third party system</td><td>Yes</td></tr></table></td><td></td><td></td><td></td></tr>
<tr><td>11.4 Communications with PEA HiVE</td><td>The smart curtains shall allow PEA HiVE to perform remote open and close control and set schedules/scenes. API documentation shall be provided.</td><td></td><td></td><td></td></tr>
<tr><td>11.5 Installation</td><td>Smart curtains shall be installed in accordance with the manufacturer’s installation instructions.</td><td></td><td></td><td></td></tr>
</table>

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	11.6 Field testing and certification	The system shall be tested in accordance with the following: • Conduct a complete inspection and test of the curtains. • Provide staff to test the curtains and all operational features for witness by PEA's representatives as applicable. • Correct deficiencies until satisfactory results are obtained. • Submit written copies of test results.			
	11.7 Documentation	The following documents shall be provided: • Full API documentation—This documentation provides a means for third parties to obtain data from the curtains in a defined format. • Product Data—This documentation includes catalog sheets and technical data sheets indicating physical data and electrical performance, electrical characteristics, and connection requirements. • System Electrical Connection Drawings—This documentation includes drawings for properly connecting electrical wiring at the time of installation (if applicable). • Installation Instructions—This documentation includes step-by-step installation instructions for properly installing the unit. • Communication set up instruction—This documentation includes step-by-step instructions to connect the device to a wire/wireless network.			
12	**Projector with Screen Control**				
	12.1 Relevant standards and codes	• CE Certification (CE = Conformity of Europe), which is a combination of safety and electromagnetic compatibility requirements			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
12.2 Projector and screen location	One projector and one motorized projector screen shall be installed at the smart building. Please refer to PEA for the location(s) and dimensions of the smart curtains.			
12.3 Projector and screen specifications	Projector and screen shall conform to the following specifications. Table 23. Projector and screen requirements **Details** / **Technical requirement** Projector Power: Wired (220V 50Hz) Lumen: At least 1500 Contrast ratio: At least 1000:1 Lamp: LED Lamp life: At least 20,000 hours Resolution: Max resolution 1920x1080 Work noise: < 50dB Aspect ratio: 16:9 Connectivity technology: VGA, HDMI- Compatible projection size: Adjustable Screen Aspect ratio: 16:9 Diagonal screen size: At least 200 inch Screen material: High contrast, washable with soap and water Viewing angle: At least 160 degree Installation: Wall or ceiling Motor system: Energy efficient, quiet motor Projector compatibility: All projectors (e.g., LCD, HD, 3D, DLP, CRT) Control: Remote, iOS/Android App, and wall-mounted control panel for use without remote or App Communication technology: Wire or Wireless			
12.4 Communications with PEA HiVE	The projector screen shall allow PEA HiVE to perform remote open and close control. API documentation shall be provided.			
12.5 Installation	The projector and screen shall be installed in accordance with the manufacturer's installation instructions.			

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	12.6 Field testing and certification	The system shall be tested in accordance with the following: • Conduct a complete inspection and test of the projector & screen. This includes testing and verifying all connections. • Provide staff to test all devices and all operational features for witness by PEA's representatives as applicable. • Correct deficiencies until satisfactory results are obtained. • Submit written copies of test results.			
	12.7 Documentation	The following documents shall be provided: • Full API documentation—This documentation provides a means for third parties to obtain status of the projector screen, and send ON/OFF control command in a defined format. • Product Data—This documentation includes catalog sheets and technical data sheets indicating physical data and electrical performance, electrical characteristics, and connection requirements. • System Electrical Connection Drawings—This documentation includes drawings for properly connecting electrical wiring at the time of installation (if applicable). • Installation Instructions—This documentation includes step-by-step installation instructions for properly installing the unit. • Communication set up instruction—This documentation includes step-by-step instructions to connect the device to a wire/wireless network.			
13	KVM Switch				

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

<table>
<tr><th rowspan="2">Details</th><th rowspan="2">Requirements</th><th>Statement of Compliance</th><th rowspan="2">Proposed Data</th><th rowspan="2">Referred to Page</th></tr>
<tr><th>C/N</th></tr>
<tr><td>13.1 Relevant standards and codes</td><td>• HDMI 1.4 and HDCP (High-bandwidth Digital Content Protection) compliant</td><td></td><td></td><td></td></tr>
<tr><td>13.2 KVM switch specifications</td><td>The KVM switch shall conform to the following specifications.
Table 24. KVM switch requirements<table><tr><th>Details</th><th>Technical requirement</th></tr><tr><td>Power supply</td><td>220V 50Hz</td></tr><tr><td>Form factor</td><td>1U rack mount-PLEASE SPECIFY</td></tr><tr><td>HDMI input</td><td>Yes, at least 2</td></tr><tr><td>HDMI output</td><td>Yes, at least 1</td></tr><tr><td>Maximum resolution</td><td>Up to 4K (3840x2160)</td></tr><tr><td>USB</td><td>Yes, at least 2</td></tr><tr><td>Audio</td><td>Yes, embedded in HDMI signal</td></tr><tr><td>Ethernet (TCP/IP) via RJ-45</td><td>Yes</td></tr></table></td><td></td><td></td><td></td></tr>
<tr><td>13.3 Installation</td><td>The system shall be installed in accordance with the manufacturer’s installation instructions.</td><td></td><td></td><td></td></tr>
<tr><td>13.4 Field testing and certification</td><td>The system shall be tested in accordance with the following:
• Conduct a complete inspection and test of the monitor & KVM switch. This includes testing and verifying all connections.
• Provide staff to test all devices and all operational features for witness by PEA’s representatives as applicable.
• Correct deficiencies until satisfactory results are obtained.
• Submit written copies of test results.</td><td></td><td></td><td></td></tr>
</table>

Table of Compliance

Request for Proposal (RFP) : Microgrid Development Project at Mae Sariang District, Mae Hongson Province (MGDP)

Tender Reference No. : PEA-MGDP-001/2018

Book 10 Technical Specification and Requirements of Smart Devices for a Building Energy Management System (BEMS)

	Details	Requirements	Statement of Compliance C/N	Proposed Data	Referred to Page
	13.5 Documentation	The following documents shall be provided: • Product Data—This documentation includes catalog sheets and technical data sheets indicating physical data and connection requirements. • System Electrical Connection Drawings—This documentation includes drawings for properly connecting electrical wiring at the time of installation (if applicable). • Installation Instructions—This documentation includes step-by-step installation instructions for properly installing the unit. • Communication set up instruction—This documentation includes step-by-step instructions to connect the device to a wire/wireless network.			