Book 9

Technical Specification and Requirements of Building for BESS and MGC

Technical Specification and Requirements of Building for BESS and MGC

Contractor shall build a 2 storey building to be a microgrid control center building. The microgrid control center building will be used as BESS and MGC control room. Since the microgrid system is a new technology for controlling electric power distribution system, PEA will use this building as one of test bed to demonstrate the microgrid concept.

Structure of building is reinforced concrete building at least Total area in Table 1. Roof is constructed steel structure using for installation photovoltaic (PV) system. Electrical system is combined with electrical from grid and PV. The construction of the building shall comply with relevant Thailand regulation, law, and standard. The microgrid control center shall install smart devices with mobile application both support on android and ios. Precision air condition, projector, audio system and KVM switch are not necessary to support on android or ios application.

The building shall have at least key area as following:

- Microgrid control room with raised floor and precision air conditioner.
- Battery system room with raised floor and air-cooling system together with Hydrogen and Methane ventilation system and gas detection system.
- PCS room with air ventilation system.
- Step up transformer and service transformer (outdoor type).
- Meeting and control room at least 25 people with Audio/Video system and Furniture.
- Local operator room.
- Restroom/Toilet with sanitary ware.
- Smart devices.
- Integrated security system.
- Automatic fire fighting system.
- Wall, doors, and windows for battery system room and PCS room shall be explosive/flammable proof type.
- Main entrance and loading gateway at least for Battery, PCS, Step up transformer, and Service transformer shall install motorized stainless gateway and glass gateway with access control.
- Electrical system and Ground grid system.
- Communication system such as Telephone system and Network system.
- Plumbing System and Building Waste Water System.

Item	Detail	Area (sq.m) (tentative)	Storey no# (tentative)	Note
1	Transformer room for step up and service transformer	30	1	
2	PCS Room	40	1	
3	Battery system room	75	1	Raised floor
4	MGC server room	30	2	Raised floor
5	Control room	15	2	
6	Meeting room	75	2	
7	Restroom	20	2	
8	Service area for M&E room, CDU, water tank and MDB	86	В	
Total		371		

Table 1. Usage areas of microgrid control center.



Book 9: Technical Specification and Requirement of Microgrid Building



The microgrid control center building shall be equipped with electrical system, telephone system, network system for normal operation and smart devices, and appliance at least is as follow:

- 1. Precision air condition for microgrid control room.
- 2. Air-conditions.
- 3. 10 kWp (at least) PV system.
- 4. 10 kW Inverter. The inverter/converter for PV and the BESS could be separate or hybrid inverter system that share the same DC bus.
- 5. 10 kWh Battery. 10 kW continuous/10 kWh (at least) lithium BESS for critical load.
- 6. Lighting.
 - Indoor Lighting (load controller and occupancy sensor for indoor lighting)
 - Outdoor Lighting (load controller with photo switch control for outdoor lighting)
- 7. Power Energy Meter.
- 8. Audio system in the meeting room.
- 9. LED monitor. 2 sets of LED monitors (at least 80 inches) for meeting room. 6 sets of LED monitors (at least 32 inches) for control room.
- 10. Integrated Security.
 - 10.1 Access control
 - 10.2 Camera which can monitor all area indoor and outdoor (MGC control building, diesel generators and STATCOM/SVG)
- 11. Automatic fire fighting system.

General requirements

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.

Environment requirements

Defined in Book 3.

1. Precision air condition for microgrid (MGC) server room

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.

The AC serving the main control room (Computer Room Air Conditioning: CRAC) should be able to provide enough cooling needs and operate 24/7. The set-point and relative humidity of the AC serving the main control room should be set at 22 °C and 45%, respectively. The sizing of the main control room AC shall be approved by PEA.

2. AIR CONDITIONING (AC) UNIT

2.1 Relevant standards and codes

- Thai Industrial Standards Institute (TISI)
- Thai Energy Efficiency Standards and Labeling (Label N.5)

2.2 AC locations

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.

2.3 Air conditioning specifications

Air conditioning units shall obtain the Thai Energy Efficiency Rating of Number 5, and conform to the following specifications.

Details	Technical requirement
Туре	
Split system	Yes
Power supply	
Voltage input	208-230V or 380 V
Phase	1or 3
Electrical frequency	50Hz
Basic functions	
Inverter power control	Yes
COOL mode	Yes
AUTO mode	Yes
FAN-only mode	Yes
Multiple fan speeds	Yes
ECONO operation	Yes
Indoor unit ON/OFF button	Yes
Self diagnosis	Yes
System ratings – cooling	
Cooling capacity range (BTU/h)	* specified by the bidder to provide sufficient cooling need
SEER	>13
EER	> 8
Energy Star rated	Yes
Sensor/timer	
Built-in occupancy sensor	Yes
24 hour ON/OFF timer	Yes
Protection	
Low voltage start-up	Yes
Over current protection	Yes
Anti-freeze protection	Yes
High and low pressure protection	Yes
Communication and control	
Remote control	Yes
Communication technology	Ethernet or Wi-Fi connection-required
Android and iOS APP	Yes

Table 2. AC specification requirements

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.

2.4 Installation

The AC units shall be installed in accordance with the manufacturer's installation instructions.

2.5 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.

2.6 Documentation

The following documents shall be provided:

- 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.
- Communication 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

3. SOLAR PHOTOVOLTAICS (PV) system

A solar photovoltaics (PV) system coverts sunlight into electricity. 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 4.0.

3.1 Standards and codes

- IEC 61730: Photovoltaic (PV) module safety qualification
- IEC 61215:Terrestrial photovoltaic (PV) modules Design qualification and type approval

3.2 Array location and orientation

- The solar PV array shall be installed on the roof of the microgrid 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° off of due south, as the energy output of a solar energy system is optimized by setting the array where the roof is oriented due south at 180° azimuth.

3.3 PV array specifications

PV modules shall conform to the following specifications.

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Details	Technical requirement
PV module	
PV module type	Mono/Polycrystalline
PV array	
Output	At least 10kWp
Grid-tied or Hybrid	Yes
Maximum DC voltage	* specified by the bidder
Number of PV modules connected in series	* specified by the bidder
Number of PV modules connected in parallel	* specified by the bidder

3.4 Balance of system components

Balance of system components are a smart inverter, wirings, a PV circuit breaker, disconnects and mounting system. These are described below:

- Smart inverter:
 - \circ See Section 4.0.
- DC conduit:
 - 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.
 - 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.
 - 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.
 - 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.
 - Both conduit ends shall be sealed.
 - The conduit run shall be identified on the electrical and architectural diagrams.
- AC conduit:
 - 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.
 - The conduit should be capped and clearly labeled, indicating its intended use, on the stubbed end near the inverter location.
 - Both conduit ends shall be sealed.
 - The conduit run shall be identified on the electrical and architectural diagrams.
- Circuit breaker:
 - A circuit breaker shall be installed in the electrical service panel for use by the solar PV system.
 - The circuit breaker shall be labeled for use by the PV system.
- Disconnects:
 - Properly rated DC and AC disconnects shall be provided.
- Mounting system:
 - Mounting system shall be provided to allow PV to be mounted on the rooftop of the smart building.
 - 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.

3.5 Installation

The PV unit shall be installed in accordance with the manufacturer's installation instructions.

3.6 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 4.0) for witness by PEA's representatives as applicable.
- Correct deficiencies until satisfactory results are obtained.
- Submit written copies of test results.

3.7 Documentation

The following documents shall be provided for the PV system:

- PV specifications
 - Model and spec sheet of solar PV modules
 - Electrical characteristics of PV modules (maximum power, open circuit voltage, short circuit current, voltage at maximum power point, current at maximum power point)
 Number of PV modules connected in series and parallel
 - Architectural drawings that summarize the installed system equipment:
 - Location of the solar PV array
 - 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
 - Inclination (tilt) for the solar PV array
 - Location of the inverter and balance of system components
 - Conduit size, type and location
 - Electrical circuit panel location and dedicated circuit breaker slots
 - Length of conduit from the designated array location to the designated inverter location
 - Length of conduit from the designated inverter location to the electrical service panel
 - 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.

4. Inverter

The contractor shall install the inverter which it can be the smart inverter(s) for only PV or the hybrid inverter(s) for both PV and Battery system at least 10 kW continuous both for PV and Battery system.

4.1 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

4.2 Inverter location

- 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.

4.3 Inverter specifications

The technical specification requirements of the smart inverter are summarized in Table 4. In addition to the inverter, sensors for measuring irradiance, wind speed, ambient temperature and module temperature shall be supplied.

Details	Technical requirement
Input	6
PV power	At least 10kWp
Maximum DC voltage	1000V DC
Output	(9)
Maximum output power	Compatible with PV output, i.e., 10kW
Grid connection	380V AC
Grid voltage tolerance	±10%
Phase	3
Frequency	50Hz
Total harmonic distortion	< 5%
Power factor	0.85-1
Efficiency	
Efficiency	>95%
Functions/Features	
Maximum power point tracker	Yes
Grid voltage/frequency monitoring	Yes
Islanding condition monitoring	Yes
Fault ride through	Yes (can be enabled or disabled)
Revenue grade meter	Yes – the inverter shall measure the amount of energy
	fed into the grid in accordance with ANSI C12.1,
	accuracy class 2%.
Inverter topology	Transformer-less
Cooling	Yes
Night time consumption	<1W
Control features	
On/off	Yes
Active power control	Yes
Reactive power control	Yes
Constant power factor control	Yes
Limited control from specific IP addresses	Yes
Protective devices	
DC insulation measurement	Yes
DC disconnector	Yes
Reverse polarity protection	Yes
Overload behavior	Yes
Indicators	
Display values, settings, menus	Yes
Operating status of PV	Yes

Table 4. PV inverter specification requirements

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Interruption of grid power	Yes
Status diagnosis	Yes
Communications	
Communication technology	Wire/Wireless
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

4.4 Installation

The inverter shall be installed in accordance with the manufacturer's installation instructions.

4.5 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.

4.6 Documentation

The following documents shall be provided for the smart inverter:

- 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

5. 10kWh lithium BESS for critical load

The contractor shall install the 10 kW continuous/10kWh (at least) lithium BESS for critical load with the bypass switch or circuit breaker of the 10 kW/10kWh lithium BESS for critical load and gird.

5.1 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

5.2 Battery storage location

Battery storage units shall be installed at the smart building. Please refer to PEA for the location(s) of the batteries.

5.3 Critical loads served by the battery energy storage system

A dedicated critical load circuit shall be served by the battery storage as shown in Figure 3. For the list of critical loads, please refer to PEA. Hybrid inverter system for PV and Battery could be proposed.



Figure 1. Concept design of Critical Load Supply by Battery Storage

5.4 The battery storage specifications

Battery storage units shall conform to the following specifications.

Table 5. Battery storage system requirements

Details	Technical requirement
Feature/Performance	
Туре	Wall mounted/rack
Battery type	Li-Ion
Efficiency	At least 90% round trip
Total power output	At least 10kW con.
Total storage size	At least 10kWh
Inverter	Provide
Depth of discharge	100%
Operating condition	
Operating output voltage	220V or 380V
Operating frequency	50Hz
Installation	Indoor or outdoor rated
Interface	
Communication technology	Wire or Wireless

5.5 Installation

The battery systems shall be installed in accordance with the manufacturer's installation instructions.

5.6 Field testing and certification

The system shall be tested in accordance with the following:

- Conduct a complete inspection and test of the 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.

5.7 Documentation

The following documents shall be provided:

- 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 communication network.

6. Lighting (load controller and occupancy sensor for indoor lighting)

The contractor shall install the LED lighting system indoor and outdoor with control system.

6.1 Relevant standards and codes

- Illuminating Engineering Society (IES) lighting handbook
- ASHRAE 90.1 Energy standard for commercial buildings
 - 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."
 - 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."
 - 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
 - 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."

6.2 Lighting requirements

All lighting fixtures shall be of LED type and provide lighting levels to meet standard illumination requirements in offices.

Table 6. Lighting type requirements

Lighting type requirement	Technical requirement
Lighting type	Dimmable LED
Voltage input	220V
Phase	1
Electrical frequency	50Hz

Table 7. Recommended illuminance by space type

Recommended illuminance by space type	Illuminance (LUX)
(per IES lighting handbook)	(fc = footcandle)
Open offices	30-50fc or 323-538lux
Meeting	30fc or 323lux
Corridors	5fc or 53.8lux
Restrooms	10fc or 108lux
Lobby	10fc or 108lux
General warehousing/storage	10fc or 108lux
Electrical Equipment Manufacturing	30fc or 323lux
IT Administrative tasks	30fc or 323lux
Inactive storage	5fc or 53.8lux
Outdoor	5fc or 53.8lux

There are different lighting requirements in different sections of the building, as described below. Please refer to PEA for the lighting zones.

6.2.1 Control and Meeting room

Lighting in Control and Meeting 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 ON with occupancy detection and OFF after a configurable period of inactivity.

Table 8. Lighting requirements – Control and Meeting room

Details	Technical requirement
Number of zones	Setting by PEA
Light switch for ON/OFF/dimming control	Yes – wireless smart light switch
Occupancy/vacancy sensor	Yes
Light ON	Automatic
Light OFF	After a configurable period (e.g., 30 minutes) of
	inactivity

6.2.2 Server Room

Lighting in server room 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 – Server Room

Details	Technical requirement
Light switch for ON/OFF/dimming control	Yes – wireless smart light switch
Occupancy/vacancy sensor	Yes
Light ON	Manually – occupant flips the switch
Light OFF	After a configurable period of inactivity (e.g., 30
	minutes)

6.2.3 Electrical Equipment Room (Transformer Room, PCS Room, Precision A/C Electrical Room, Battery Room)

Lighting in the Electrical Equipment 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.

Tuble 10. Eighting requirements - Electrical Equipment 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)	

Table 10. Lighting requirements - Electrical Equipment Room

6.2.4 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.

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Table		Lighting	requirements	- restrooms
ruore	11.	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)

6.2.5 Stairs

Stairs lighting shall have control devices to automatically change lighting intensity based on ambient light level (0-50% intensity). The light intensity shall be increased to 100% when occupancy is detected, and change back to illuminance-based control at 0-50% after an adjustable period of inactivity.

Table	12.	Lighting	requirements	– stairs
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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
$\sim \rightarrow$	detected
	Change to illuminance-based control 0-50%
	intensity after an adjustable period of inactivity
Light OFF	None

6.2.6 Outdoor

Outdoor lighting shall have control devices to automatically turn on and turn off according to sunshine.

6.3 Lighting load controller specifications for indoor lighting

Lighting load controllers shall conform to the following specifications.

Table 13. Lighting load controller requirements	Table 1	3. I	ighting	load	controller	rec	uirements
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Lighting load controller details	Technical requirement
Туре	In-wall
Dimmer	Yes
Voltage input	220V
Phase	1
Electrical frequency	50Hz
Communication technology	Wireless
Android and iOS APP	Yes
Certification and listing	IEC/EC or equivalent certified

6.4 Occupancy/vacancy sensor specifications

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.

Table 14. Occupancy/vacancy sensor requirements

Occupancy/vacancy sensor details	Technical requirement	
Technology	PIR, ultrasonic or both – for very fine motion detection	
Adjustable timeout	Yes – 1, 5, 15 or 30 minutes	
Occupancy/vacancy	Yes – Auto-on/auto-off and manual-on/auto-off	
Туре	Wall-mounted or ceiling mounted* specified by the bidder	
Power supply/battery	Wired or wireless; if wireless, at least 5-year battery life is	
	required.	
High-low sensitivity adjustment	Yes	

6.5 Installation

The lighting load controllers and sensors shall be installed in accordance with the manufacturer's installation instructions.

6.6 Field testing and certification

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.

6.7 Documentation

The following documents shall be provided:

- 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. Power Energy Meter

7.1 Relevant standards and codes

- ANSI C12.xx: Electric Meters(or Equivalent)
- 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

7.2 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 each floor 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 2. Concept of Main Distribution Board with Power/Energy Meter



Figure 3. Concept of Distribution Board with Power/Energy Meter for each Floor

7.3 Power/energy meter specifications

Power/energy meters, including current transformer, shall conform to the following specifications.

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 or Wifi
Current transformer	
Туре	Split-core
Amperage rating	Refer to PEA
Accuracy	1%
Enclosure	
Degree of protection	At least NEMA 3X (or equivalent)

Table 15. Power/energy meter specification requirements

7.4 Installation

The power/energy meter shall be installed in accordance with the manufacturer's installation instructions.

7.5 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.

7.6 Documentation

The following documents shall be provided:

- 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.

8. Audio system in the meeting room

The contractor shall provide the meeting room sound system with all main seat microphone.

9.LED monitor

LED monitor. 2 sets of LED monitors (at least 80 inches) for meeting room. 6 sets of LED monitors (at least 32 inches) for control room.

10. Integrated Security

The integrated security system shall include a network-enabled access control and security camera system.

10.1 Access control

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 microgrid control 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 all gateway of card/biometric readers except fire exit. The system shall support at least 20 cards. The card/biometric readers shall be capable of performing authentication based on both card scan and biometric 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.

11.1.1 Relevant standards and codes

- UL294 Access Control System (or Equivalent)
- ISO/IEC 27001 Information Security Management (or Equivalent)

11.1.2 Access control system location

Please refer to PEA for the location(s) of the access control devices, at least three (3) card/biometric readers.

11.1.3 Access control specifications

The access control system shall conform to the following specifications.

Table 18.	Access	control	requi	rements

Access control system details	Technical requirement
Features:	
Support multiple operator workstations via LAN/WAN	Yes
Multi-level password protection	Yes
Provide graphical user interface	Yes
Support industry standard database management systems, which allows edit,	Yes
add, delete, search, sort and print options for records in the database	
Automatic backup of database files	Yes
Provide encryption	Yes
Ability to activate or deactivate cards	Yes
Monitor and log intrusion system events and send alerts	Yes
Alert:	
Provide a display of the most current transactions in real time	Yes
Send an alert (e.g., email) based on events	Yes

Allow to send an email message selectable per card event type	Yes
Allow an operator to acknowledge and clear alarms	Yes
Access level:	
Provide option to restrict access to sensitive information by user ID	Yes
Provide an option to define specific access time	Yes
Provide an option to define specific readers for access	Yes
Customizable card access level with beginning and end dates	Yes
Report:	
Provide card holder report with filter options to define doors, card holder	Yes
name	
Generate history report for an alarm point state (e.g., normal, alarm)	Yes
Generate history report of system alarm (e.g., power failure, panel tamper)	Yes
Generate history report for system operator activities	Yes
Generate history report based on the frequency of usage of a card	Yes
Card:	
Contain information inside card shall include at the minimum:	Yes
First name, last name, card number, activation date, de-activation date,	
status, note fields and a photo image	9
Provide special card options for visitor/temporary use	Yes
Card/biometric reader:	
Card reader	Yes
Biometric	Yes

10.2 Camera which can monitor all area indoor and outdoor

The security camera system shall include a digital video recorder (DVR) and coverage all area indoor and outdoor except in the rest room and bedroom. For outdoor monitoring, the contractor shall provide the security camera system for MGC control building, STATCOM/SVG and diesel generator.

11.2.1 Relevant standards and codes

• Open network video interface forum (ONVIF) or equivalent.

11.2.2 Security camera system location

Please refer to PEA for the location(s) of the DVR and security cameras.

11.2.3 Security camera system specifications

The IP camera system shall be an IP-based wire or wireless solution 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	Yes
control)	
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

แผนงานพัฒนาระบบไมโครกริด ที่ อ.เบตง จ.ยะลา (ผมบ.)

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
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	Option
Tilt	Option
Zoom	Yes
Hue, brightness, contrast, saturation, sharpness	Adjustable
Operating condition	
Installation	Both Indoor and Outdoor

11.3 Installation

The integrated security system including access control and security camera system shall be installed in accordance with the manufacturer's installation instructions.

11.4 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.

11.5 Documentation

The following documents shall be provided:

- 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.

11. Automatic fire fighting system

The contractor shall install the automatic fire fighting system. The detection system shall be able to locate a source of fire in each compartment and room. In critical room (e.g. battery system room, PCS room, and MGC server room), the gaseous fire suppression agent shall be NOVEC 1230 in order to protect the controllers, servers and all critical equipment. Total flooding system shall be protected according to NFPA 2001. There shall be linear heat detector for battery rack which can monitor temperature at the resolution of 0.1 degree Celsius and of which sensor spacing can be selected.

The contractor can choose the suitable type of fire extinguisher for each compartment and room (excluded critical room). In addition, the contractor shall design appropriately for the building and coverage area with fire fighting system, considering the effect of the system when activated.

The contractor shall test fire fighting system before install the important equipment (e.g. Battery, PCS, MGC server, and etc.) in accordance with the applicable standards.

The contractor shall submit the details design of building and surrounding areas and bill of materials for PEA approval before starting construction. The automatic fire extinguishers according to safety standards shall be installed in rooms and hallway.

12. The Ventilation system

.. The contractor shall install the ventilation system with monitoring system. Especially, the battery system room shall have at least hydrogen gas detector. The contractor shall submit the details design of the system and bill of materials for PEA approval before starting construction.

Appendix

3	ั้นวแบงพนทกอสรางเครงการ Micro Grid
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# **Draft of Microgrid Building**