Book 1
Project Overview

Table of Contents

NOMENCLATURE

ADDC	Area Distribution Dispatching Center
AEPS	Alternative Energy Portfolio Standards
BAA	Banglang substation
BESS	Battery Energy Storage System
BMS	Battery Management System
CSCS	Computer-Based Substation Control System
DDIP	Distribution Dispatching Center Improvement Project
DG	Distributed Generator
DEDE	Department of Alternative Energy Development and Efficiency, Ministry of Energy
DER	Distributed Energy Resources which include distributed generation and energy storage
DMS	Distribution Management System
DNP over IP	Distributed Network Protocol over Internet Protocol
EMS	Energy Management System
FLISR	Fault Location, Isolation, and Service Restoration
FRTU	Feeder Remote Terminal Unit
GenSet	Diesel Generator Set
GHG	Green House Gas
MARS	Multiple Address Radio System
MGC	Microgrid Controller
MGBT	Microgrid Development Project at Betong District, Yala Province
OP	General Operations associate with the MGC
PCS	Power Conversion System
PEA	Provincial Electricity Authority
PCC	Point of common coupling reference point on the electric power system where the user's electrical facility is connected
PON	Passive Optical Network
RCS	Remote Control Switch
RE	Renewable Energy
SCADA	Supervisory Control and Data Acquisition
SDH	Synchronous Digital Hierarchy
SNMP	Simple Network Management Protocol
SOC	State of Charge of Battery
SOH	State of Health of Battery
STATCOM	Static Var Compensator

SVG	
SW	Switch which is the complete set of the RCS and FDCU
TOT	Telephone Organization of Thailand
VSPP	Very Small Power Producer
WDM	Wavelength Division Multiplexing
YRA	Yupparachun Substation

STANDARDS AND CODES

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
FCC Sections 15.109&15.209	FCC Code of Federal Regulations Radiation Emission Limits; General Requirements
IEC 61000	Electromagnetic compatibility (EMC)
IEC 61850-7-420	Communication networks and systems for power utility automation - Part 7- 420: Basic communication structure - Distributed energy resources logical nodes
IEC 61850-90-7	Communication networks and systems for power utility automation - Part 90- 7: Object models for power converters in distributed energy resources (DER) systems
IEC 61968	Common Information Model (CIM) / Distribution Management
IEC 61970	Common Information Model (CIM) / Energy Management
IEC 62786	Demand Side Energy Resources Interconnection with the utility grid
IEC 62109/UL 1973	Standard for Stationary Batteries
IEC 62619	Safety Requirements for Secondary Lithium Cells and Batteries
IEC62109/UL 1741	Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources
IEC/TS 62898-2 Ed.1:	Technical requirements for operation and control of microgrids
IEEE Standard 519-1002	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)
IEEE Standard 2030.8 - 2018	IEEE Standard for the Testing of Microgrid Controllers

IEEE Standard 2030.3 - 2016	IEEE Standard Test Procedures for Electric Energy Storage Equipment and Systems for Electric Power System Applications
NERC CIP	North American Electric Reliability Corporation, Critical Infrastructure Protection
NISTIR 7628	Guidelines for Smart Grid Cyber Security

Overview of Microgrid Development Project at Betong District, Yala Province Provincial Electricity Authority (PEA)

1. Introduction

PEA has an electric power network development plan according to economic and social development plan No. 12. The objective of this development plan is to develop electric power network that should be secured, sufficient supply and supplied throughout the country according to service quality standard. In addition, the electric power network is developed to support distributed generators and renewable energy resources, and efficient energy management technology in future. PEA has identified a development of a microgrid at Betong District, Yala Province project as one of the developments to transform electric power networks to be PEA smart grid within 15 years. The plan will improve reliability and quality of electric power network of PEA.

The existing Betong District distribution system has faced many problems such as:

- The number of outage is more than 20 times per year caused by terrorist, damaged equipment, maintenance, or weather related,
- The operation in this area still depends on the local operator due to lead time to recovery the outage system due to the terrorist, the reliability of controlled equipment in power system. Therefore, when the outage occurs, it will take about 20 minutes to more than 22 hours in case of terrorist issue to connect and disconnect equipment and repair the power pole 33 kV and 115 kV.

2. Target and Operational Area

This project will develop a microgrid system at Betong District (MGBT), Yala Province as a target area as shown in Fig.1. It has a 33 kV distribution line from Banglang substation about 86 kilometers and also 115 kV transmission line cross country and along the road about 55 kilometers. The transmission and distribution line also have to pass through the forest. 115 kV transmission line about 23 kilometers installed at cross country, easy to be destroyed by the terrorist. Therefore, it has interruption problems and also other power quality problems. It difficult to find a cause of the interruption and take a long time to recover the power system from interruption.

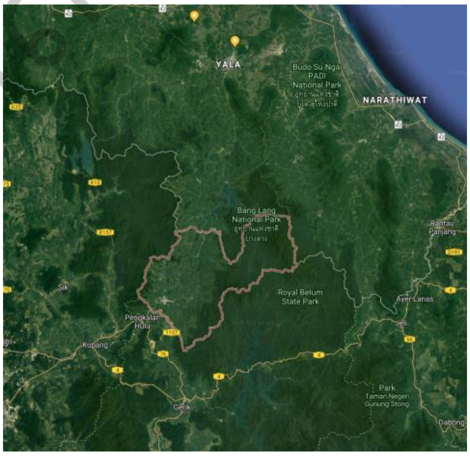

Figure 1 MGBT Coverage area.

Therefore, the microgrid will be implemented in this target area. In the normal grid connected operation, the microgrid will operate to manage efficiency of energy usage in system. In addition, the microgrid also will manage the interruption in the grid or subsystem the coverage area. However, when the high or medium voltage system is interrupted, the coverage area will be supplied by energy sources from battery, diesel generator, and future VSPP to form as islanding area in order to increase the reliability of the system.

This project will develop the coverage area to be secured and sufficient power supply and supplied throughout area according to service quality standards. In addition, this project also develops electric power network to be ready to support distributed generators and future VSPP, and be able to manage efficiency of energy usage.

3. Objectives of Project MGBT

3.1 to improve the reliability and quality of power in the Betong coverage area,
3.2 to replace other types of peaking generation to meet growth in peak demand,
3.3 to reduce power losses in distribution line and overcome constraints in the development of new transmission line,
3.4 to reduce the Green House Gas (GHG) and carbon dioxide (CO2),

4. Microgrid System at Betong District (MGBT), Yala Province

Microgrid system for Betong District, Yala Province has been shown in Fig.2. The one existing VSPPs 7.5 MW owned by private comapany (other 5 MW is in the plan) and diesel generators owned by PEA (7 sets of 1 MW which be able to supply at 5.6 MW as a usual operation) shall be integrated in the MGBT both grid connected and islanding mode of operation. Diesel generators have been installed at Yupparachun Substation and the location for building of microgrid controller (MGC) control center and Battery Energy Storage System (BESS) have been shown in Fig.3. The MGC and BESS building shall be designed and installed by contractor at existing PEA area with limited area as shown in Fig.3 (a). The MGC and BESS building shall be designed to match with the new dispatching control center as shown in Fig.3(b).

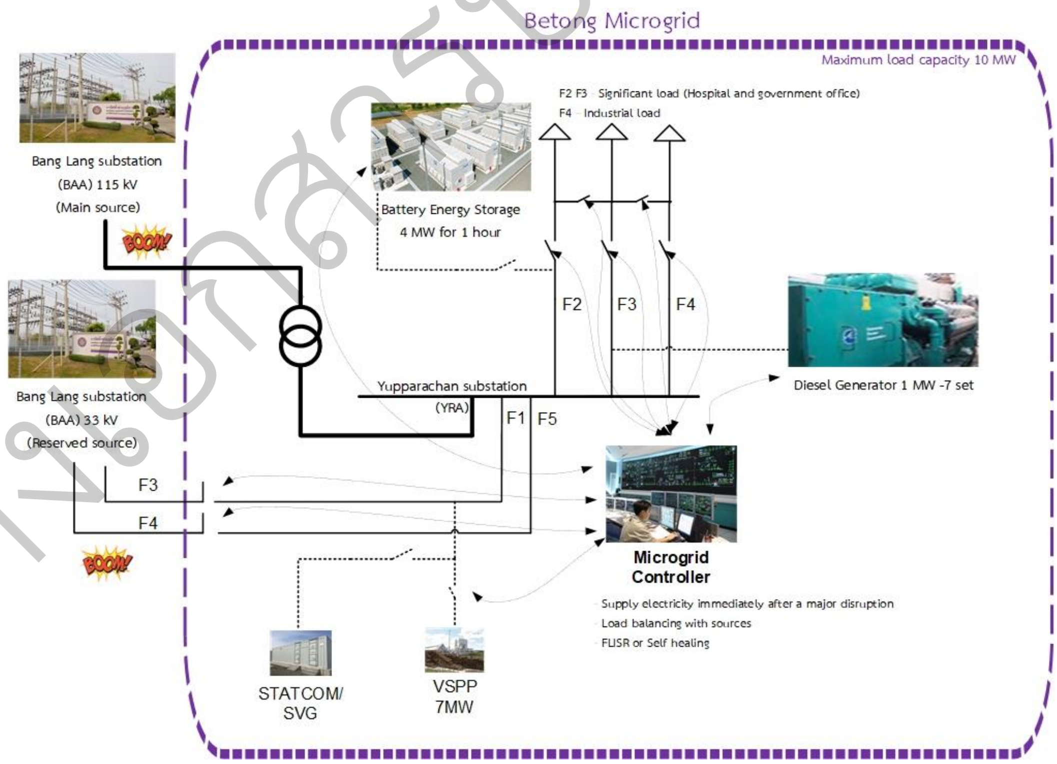

Figure 2: Diagram of the MGBT.

(a) Geographical view for the MGBT.

(b) New dispatching control center.

Figure 3: Location and area for the MGBT.

Microgrid system at Betong District consists of the following equipment:

1) Microgrid Controller (MGC): The main function is data processing and issuing commands to control system as per specified performance requirements. The specification of microgrid controller is described in Book 2: Technical and Specification of Microgrid Controller.
2) Battery Energy Storage System (BESS): Lithium Ion battery is chosen for this project. This battery is used to supply power to distribution system within short time during failure in transmission/distribution system. As the battery technology has been developed very fast. However, as review battery technology recently, the technology of lithium ion battery is still appropriated to this project. The specification of energy storage is described in Book 3: Technical and Specification of Battery Energy Storage System (BESS).
3) Communication System: Communication system is crucial for microgrid as continuously communication between microgrid controller and devices in microgrid system is required. Therefore, the reliability of communication system is a key of success of microgrid system. The specification of communication system is described in Book 4: Technical and Specification of Communication System.
4) Diesel Engine: This diesel engine will supply power to distribution system when failure in transmission/distribution line occurs. However, it cannot delivery power instantaneously, because starting diesel engine takes time at more than 1 (one) minutes to be ready for delivery power. The specification of modification of diesel engine is described in Book 5: Technical and Specification of DG Integration.
5) Static Var Compensator (STATCOM) or Static Var Generator (SVG): To utilize the private VSPP, the contractor shall provide the STATCOM/SVG at the private VSPP area. The requirement of STATCOM/SVG is also described in Book 5: Technical and Specification of DG Integration.
6) Switching Devices: They will be used to disconnect the short circuit part of distribution line and to adjust electric power network to supply continuity and affect least customers. Theses switching devices will be used in Fault Location Isolation and Service Restoration (FLISR) function. The specification of switching devices are described in Book 6: Technical and Specification of Switch (SW).
7) Measurement System: It measures electrical quantities to show the operation performance of the system such as current, voltage, power, position of tap changer, etc. This information is used to make decision by microgrid controller.

8) Protection System: Protection system is able to operate both in 2 modes, normal mode and islanding mode. In normal mode, the power system is connected with PEA substation. In islanding mode, the transmission and distribution line are out of service. As each mode may have a different fault level, therefore, the protection system should be able to adapt according to mode of operation. The specification of protection system is described in Book 7: Technical and Specification of Protection System.
9) Interface Devices and Connection: These will improve physical configuration of Yupparachun substation (YRA) to meet the standards. The configuration will have all connections at one point and will also support automatic operation of the microgrid system as shown in Fig. 2.
10) Protection system would be designed for overall power system in microgrid area. The requirement of protection system is described in Book 7: Protection.
11) Cyber security system would be designed for overall system in microgrid area. The requirement of cyber security system is described in Book 8: Cyber security system.
12) Building for Microgrid Controller (MGC), Battery Energy Storage System (BESS), and other accessary system. The requirement of building is described in Book 9: Building for Microgrid Controller (MGC) and Battery Energy Storage System (BESS).

5. Microgrid System Performance

5.1 General Requirements

5.1.1 Overall life expectancy of the system and the life expectancy of critical system parts and components of the microgrid shall be provided.

5.1.2 The microgrid system shall be designed for an expected average life time of at least 10 years. An accelerated aging/stress test shall be provided to demonstrate the test environment and the corresponding life time.

5.1.3 The expectancy support for spare parts shall be provided with a guarantee period of no less than 10 years from the date of the latest delivery of equipment containing these parts or assemblies.

5.1.4 Notification shall be provided at least six months in advance if any part or assembly becomes unavailable for purchase. However, the vendor shall cover the guarantee according to 5.1.3.

5.2 Microgrid System Availability

5.2.1 The system availability evaluation methodology, assumptions, and calculation results, including expected number of microgrid system failures per year, of the proposed design shall be documented and provided for PEA's review. Proven track records through a number of customer references for like systems (including contact information for persons who can provide authentic testimony) will carry greater weight than purely theoretical calculations. A greater number or references will dispel the concern of cherry-picking customer references. A system approach that does not require routine maintenance is preferable by PEA.

5.2.2 The availability of the system is defined as the probability that the system will be available when required, or as the proportion of total time that the system is available for use. Annual availability of the system, defined as the ratio of the system uptime and total operating time, shall be 99.95% or better on average (IEC 60870-4, Table 2 – Class A3). This requires that system downtime be less than 262 minutes per year.

5.3 Reliability

5.3.1 The reliability of the system is defined as the probability that a piece of equipment or component will perform its intended function satisfactorily for a prescribed time and under stipulated environmental conditions. The system reliability evaluation methodology, assumptions and calculation results shall be provided to PEA for verification and validation.

5.3.2 The expected failure modes for the system and the components shall be declared. Preferably, the failure mode and effect analysis (FMEA) shall be based on IEC 60812.

5.3.3 The system and component failure rates shall be provided to PEA for verification and validation.

5.3.4 The worst-case event estimation and consequences shall be provided to PEA for verification and validation.

5.3.5 The system shall be free from design flaw and design error. Design error shall be detected and tested out before installation and commissioning.

5.3.6 The system shall be free from deviation from a desired or intended state.

6. Project Responsibilities

Both the Authority and Contractor shall take responsibility for different tasks as described in the following sub-clauses.

6.1 Contractor Responsibilities

The Contractor shall supply, install, and commission the specified quantity of equipments for microgrid system are in a contract so that they are in good clean working order, fit for their intended purpose, and fully integrated with the corresponding existing Authority's SCADA system. In this respect, the Contractor's responsibilities shall include, but shall not be limited to:

1) Ensuring the microgrid controller is designed and engineered to meet the Authority's requirements fully and completely in coordination with the existing Authority's SCADA.
2) Supplying all necessary materials and performing all necessary fabrication, testing, wiring, and interconnection work during the process of assembling or otherwise producing the microgrid system.
3) After contract awarded, completing all relevant type testing as well as factory acceptance testing (FAT) shall submit to PEA for reviewing and approval. Completing all relevant type testing as well as factory acceptance testing (FAT) prior to delivering each component of microgrid system to its assigned site. FAT shall include use of all necessary Contractor-supplied test equipment. Contractor shall submit Full Function Test & Factory Routine Test report to PEA.
4) Provide transportation and accommodation for members of the Authority's acceptance committee to the factory where they will inspect each component of microgrid system and witness the test procedures.
5) Work plans and drawings for installing the microgrid system and all other relevant equipment such as Lay-Out of Equipment, control circuits and etc. at their installation sites.
6) Provision of all necessary test equipment.
7) Transportation of all components of microgrid system and all accessories to their assigned sites.
8) Site acceptance testing (SAT) of every components of the microgrid system. SAT shall include Contractor use of the test sets in order to demonstrate the readiness of the microgrid system be end-to- end tested with the existing Authority's SCADA.
9) End-to-End testing (ETE) of every components of the microgrid system. In this respect, Contractor personnel shall be readily available to identify and resolve related microgrid system problems. This shall include any necessary modifications or adjustments to the installed microgrid system.
10) Participation in project meetings, such as design and progress review meetings, and submission of all necessary transmittals related, for example, to items such as meeting agendas, meeting minutes, progress reports, etc.
11) Ensuring and periodically demonstrating that the work is progressing according to the approved schedule. In this respect, the controller, the battery energy storage, the switching devices, communication system and others components shall be installed and tested for readiness well before they are required to perform any of the overall end to-end system tests.

12) Provision of preliminary and as-built drawings, functional design documents, operation and maintenance manuals, test plans, test procedures, and test reports.
13) Training Authority staffs so that they will be self-sufficient in monitoring, testing, and maintaining the microgrid system's equipment. This includes provision of all necessary training equipment and materials.
14) Maintaining the microgrid system's equipment until acceptance and start of the corresponding warranty period.
15) Providing and implementing all warranty services that relate to the microgrid system's equipment.

6.2 Authority Responsibilities

Authority responsibilities will include supervision and support of all Contractor activities as follows:

1) Provision of Site installation including with x-y coordination GPS, drawings such as schematic diagrams of remote controlled switch and pea's standard general arrangement drawing for remote control switch installation.
2) Review and approval of Contractor-supplied drawings, manuals, design documents, training materials, test procedures, and other required documentation.
3) Providing appropriate 33 kV power sources at sites.
4) Providing water supply at sites.
5) Participation in Contractor-provided training courses. This will include Authority auditing of these courses to ensure the training objectives are met.
6) Witnessing of factory and site acceptance tests.
7) Review and approval of Contractor-supplied work plans for installing the microgrid system.
8) Inspection and approval of goods and materials both before and at time of delivery.
9) Coordination and supervision of the Contractor's on-site work.
10) Switching and blocking of primary power system equipment as required by the approved work plan.
11) Inspection and approval of completed the microgrid system installations.
12) Preparing all databases for the existing Authority's SCADA and personal to identify and resolved the SCADA problem during End-to-End testing.

7. Technical Proposal Format and Content

The Proposer shall structure the Technical Proposal as follows:

7.1 Describe past experiences of proposer on microgrid system, this section should describe at least on concept, architecture, performance characteristics.

7.2 Proposed Methodology, Approach and Implementation Plan - this section should demonstrate the Proposer's response to the Terms of Reference by identifying the specific components proposed, how the requirements of the microgrid system shall be addressed, as specified, point by point; providing a detailed description of the essential performance characteristics proposed; identifying the works/portions of the work that will be subcontracted; and demonstrating how the proposed methodology meets or exceeds the specifications. The proposal shall cover at least 2 main critical parts: microgrid controller and BESS. The methodology and approach in proposal shall be a part of contract of the work.

7.3 Expertise of Firm/Organization - this section should provide details regarding management structure of the organization, organizational capability/resources, and experience of organization/firm, the list of projects/contracts (both completed and ongoing, both domestic and international) which are related or similar in nature to the requirements of this TOR, and proof of financial stability and adequacy of resources to complete the project.

7.4 Management Structure and Key Personnel - This section should include the comprehensive curriculum vitae (CVs) of key personnel that will be assigned to support the implementation of the proposed methodology during entire project period, clearly defining the roles and responsibilities compared with the proposed methodology. CVs should establish competence and demonstrate qualifications in areas relevant to the TOR.

7.5 Other Information as may be relevant to the Proposal.