PEA MICROGRID FOR REMOTE AREA ELECTRIFICATION

CASE STUDY AT BAN KHUN PAE, CHIANG-MAI PROVINCE

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PEA North Region 1

The Electric Utility of The Future.
Distribution Utility (State own Enterprise)

74 provinces electrification (99% of Area)

Established since 1960 (58 years)

19.36 Million customers

946 branch offices

Electrical energy 139,548 GWh
ELECTRICAL INFORMATION

- Peak Load = 19,721 MW (Purchase from EGAT)
- 99.99% Electrification (74,297 villages)
- System voltage 115 kV, 22/33 kV and 380/220 V
- 582 distribution substations
- Overhead distribution line, underground cable, submarine cable (on grid)
- Some off-grid area is developed by DEDE
BAN KHUN PAE, CHIANG MAI

- 35 km from Hod Substation (110 km from Chiang Mai)
- 483 households
- People mostly are agriculturist.
- Land sloping are greater than 12% (75% of the total area)
- Important load
  1. Royal project (Promotion of agricultural occupation in the area)
  2. Public health center
  3. School
HISTORICAL OF ELECTRIFICATION

1989
First operate (off-grid)
- Hydro power plant
- Supply 20-40 kW load

1998
Add multi-sources
- 56 kW Diesel gen
- 7.3 kW Solar PV

1998
Hybrid system (off-grid)

2006
Connect to main grid (on-grid)
- Load growth
- 2009 stop operation due to high cost

2006
Connect to main grid (on-grid)

2015
2015 hydro power plant back to service (high efficiency)

2017
Micro-grid
MICRO GRID DEVELOPMENT OBJECTIVE

1. Research and development in new technology
2. Improve system reliability and quality of supply
3. Power loss reduction
4. Utilize local energy resource and green energy
5. CSR project
MAJOR SYSTEM COMPONENT

90 kW

From HOA Substation (Feeder 7)

69.85 kW (Peak Load) (April 2016)

Energy Consumption

PEA MICROGRIDS
Khun Pae Site

Solar Photovoltaics

Advanced Energy Storage

90 kW

Hydro Generation

100 kW

100 kW.hr.

From HOA Substation

(Feeder 7)
HYDRO POWER PLANT

- New turbine design for high efficiency
- Rated = 90 kW (Avg. = 36 kW, Max = 56 kW)
- Less energy production during summer
- Energy production = 320,000 kWh/year
SOLAR FARM

- Size = 100 kWp
- Energy production = 120,000 kWh/year
BATTERY STORAGE

- Lithium Ion Battery
- Capacity = 100 kWh
- Max output power = 100 kW
- PF = ± 0.90
MICROGRID CONTROLLER

- NR Product
- Model PCS9617MG
Fiber optic route S1 S2 S3 to Hydro power plant

Fiber optic route S3 S4 to Hydro power plant
MICRO GRID CONTROLLER 8 MAIN FUNCTIONS

**Remote Control**
- According to the power plan curve transmitted by scada, the BESS charge and discharge power as controlled.

**Island to on-Grid Control**
- Change system frequency and voltage until synchronism conditions are met, and then synchronize the tie line breaker by S1 FRTU.

**Energy Time Shift**
- According to the power plan curve set by Micro-Grid controller, the BESS charge and discharge power as controlled.

**PV Smooth**
- Smooth the power output of photovoltaic by fast charging and discharging energy storage battery.

**SOC Control**
- In Grid connected state, keep battery SOC as a suitable value for Micro-Grid.

**PCC Control**
- Ensure the tie line active power and reactive power is restricted in the allowable range before tripping the tie line breaker.

**Black Start Control**
- When main-grid is in off power state, Micro-Grid controller control PVS & BESS to support system with stable power.

**Island Control**
- In Off-Grid state, maintain the voltage and frequency of Micro-Grid system.
EXAMPLE OF HMI (HYDRO POWER PLANT)
EXAMPLE OF HMI (MICRO GRID CONTROLLER)
SOME RESULTS

Load Profile (kW)

Regulation Curve (kW)

2018-02-12 ~10.00
SOME RESULTS
SOME RESULTS

Operation of BESS and SOC

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<tr>
<th>Time</th>
<th>BESS (kW)</th>
<th>SOC (%)</th>
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SOME RESULTS

Communication is important !! x2
### OPERATION

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<th><strong>On grid</strong></th>
<th><strong>Off grid</strong></th>
<th><strong>Transition</strong></th>
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<td>SOC Control (prepared for outage)</td>
<td>Island control (include load shedding)</td>
<td>PCC Control (Intentional Islanding)</td>
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<td>+ PV Smoothing</td>
<td>Black start control</td>
<td>Island to On-grid control</td>
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<td>(Export surplus energy to grid)</td>
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CONCLUSIONS

- A solution for an area that distribution line construction is not possible or not allowed by law
- Local community feedback & acceptance
- System growth
- Micro grid can improve system reliability of remote area
- Key feature of microgrid successfully be implemented
- System operation and maintenance
Thank you for your attention

Q & A

Research and Development on hybrid renewable energy power production and management system in remote area