



PEA MICROGRID FOR REMOTE AREA ELECTRIFICATION

CASE STUDY AT BAN KHUN PAE, CHIANG-MAI PROVINCE

Titti Saksornchai, Ph.D. EE.

Chief of Alternative Energy and Energy Efficiency section
PEA North Region I



The Electric Utility of The Future.



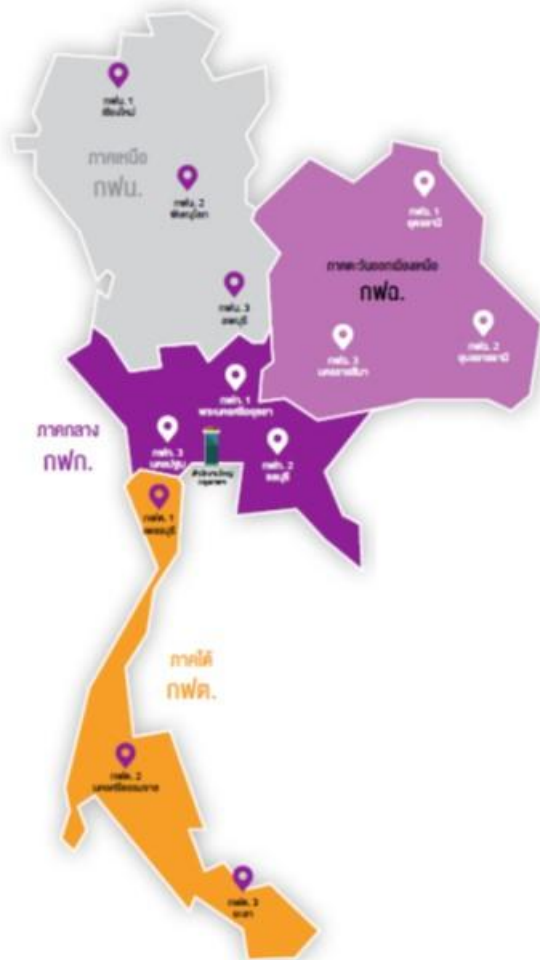
การไฟฟ้าส่วนภูมิภาค



PRECISE

== PEA ==

PROVINCIAL ELECTRICITY AUTHORITY



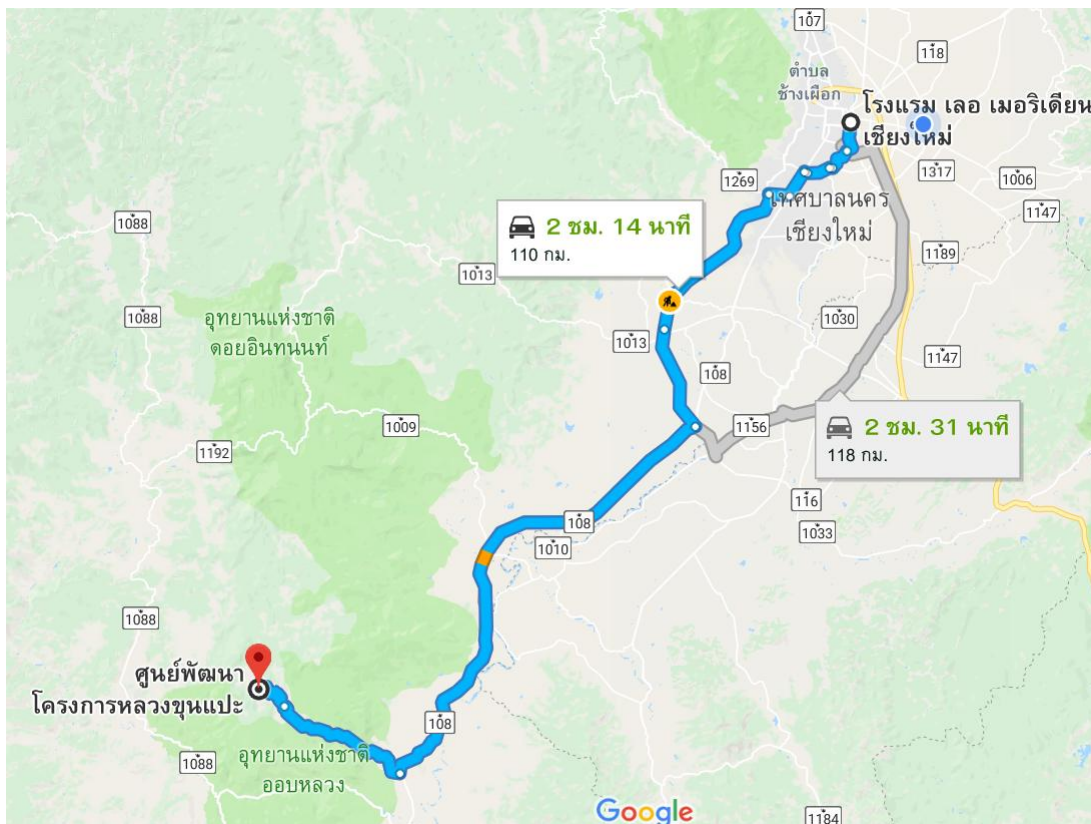
- Distribution Utility (State own Enterprise)
- 74 provinces electrification (99% of Area)
- Established since 1960 (58 years)
- 19.36 Million customers
- 946 branch offices
- Electrical energy 139,548 GWh

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

Add multi-sources

- 56 kW Diesel gen
- 7.3 kW Solar PV

1998

Hybrid system
(off-grid)

2006

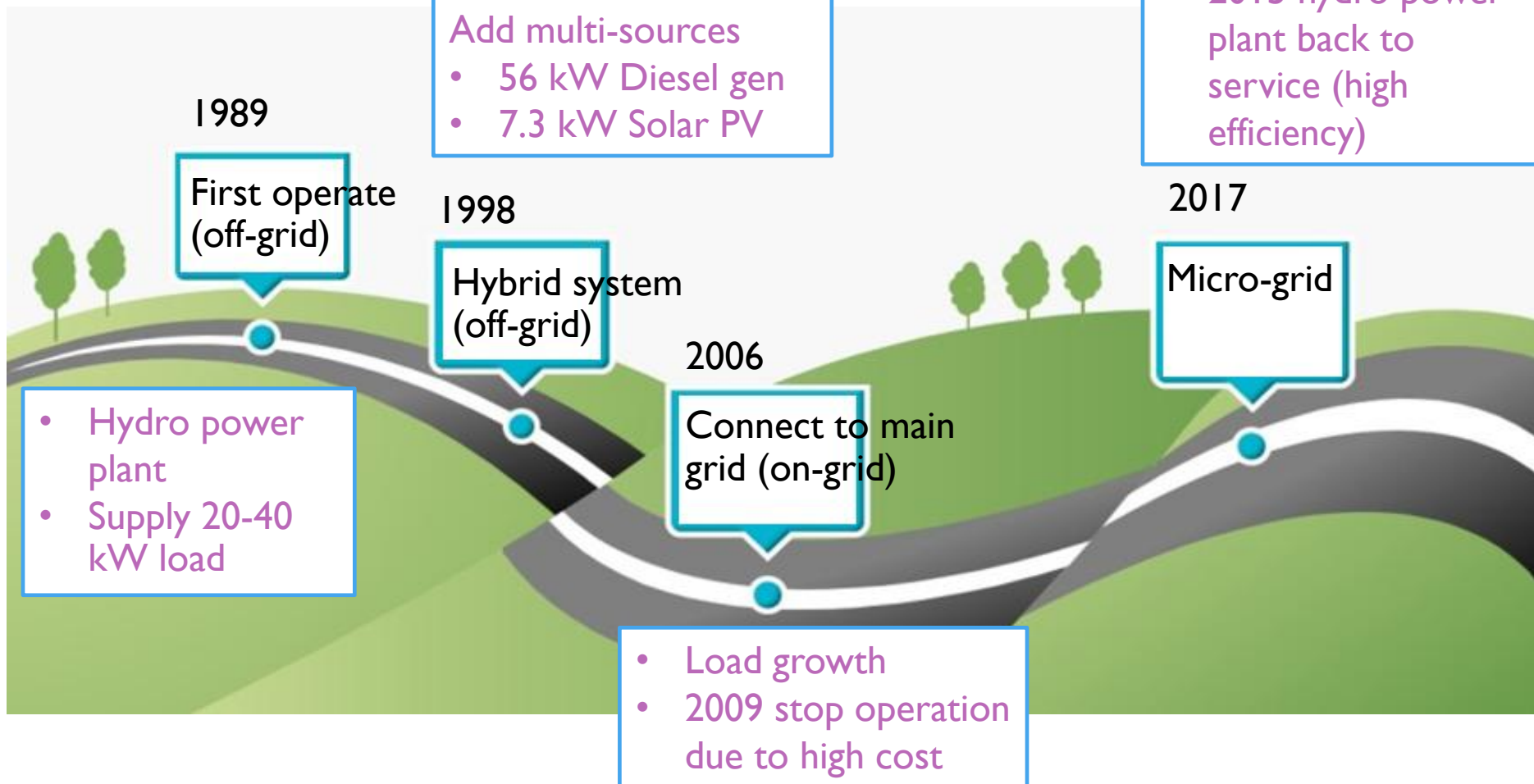
Connect to main
grid (on-grid)

- Load growth
- 2009 stop operation due to high cost

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

2017

Micro-grid

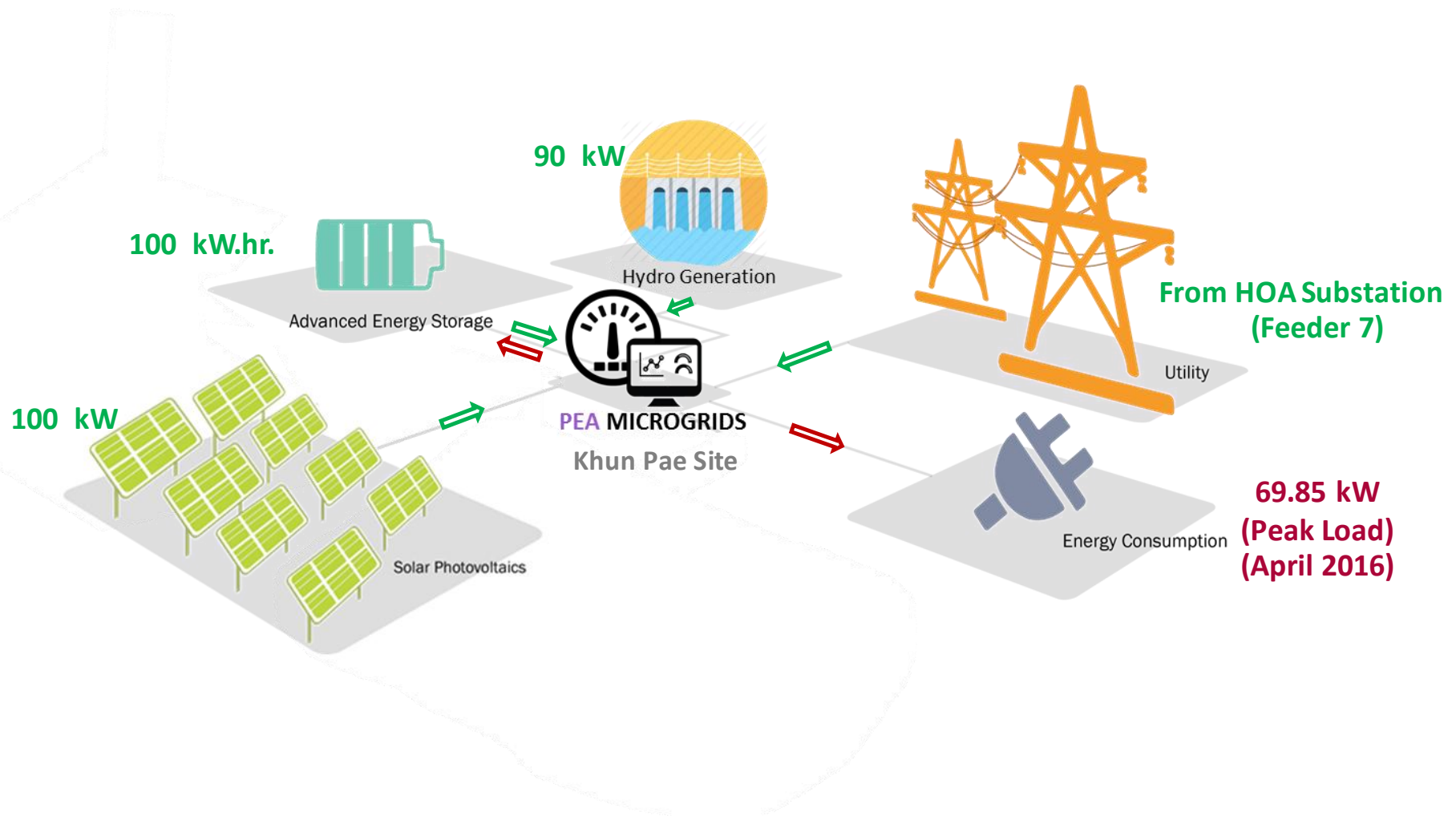


MICRO GRID DEVELOPMENT OBJECTIVE

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



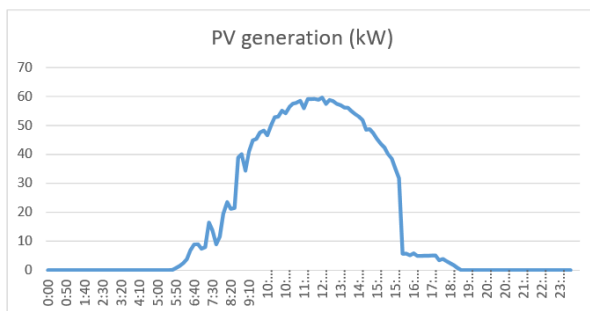
HYDRO POWER PLANT

- 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 kW_p
- Energy production = 120,000 kWh/year



รูปที่ 1.6 ลักษณะกำลังไฟฟ้าที่ผลิตจากระบบโฟโตโวลตาอิก

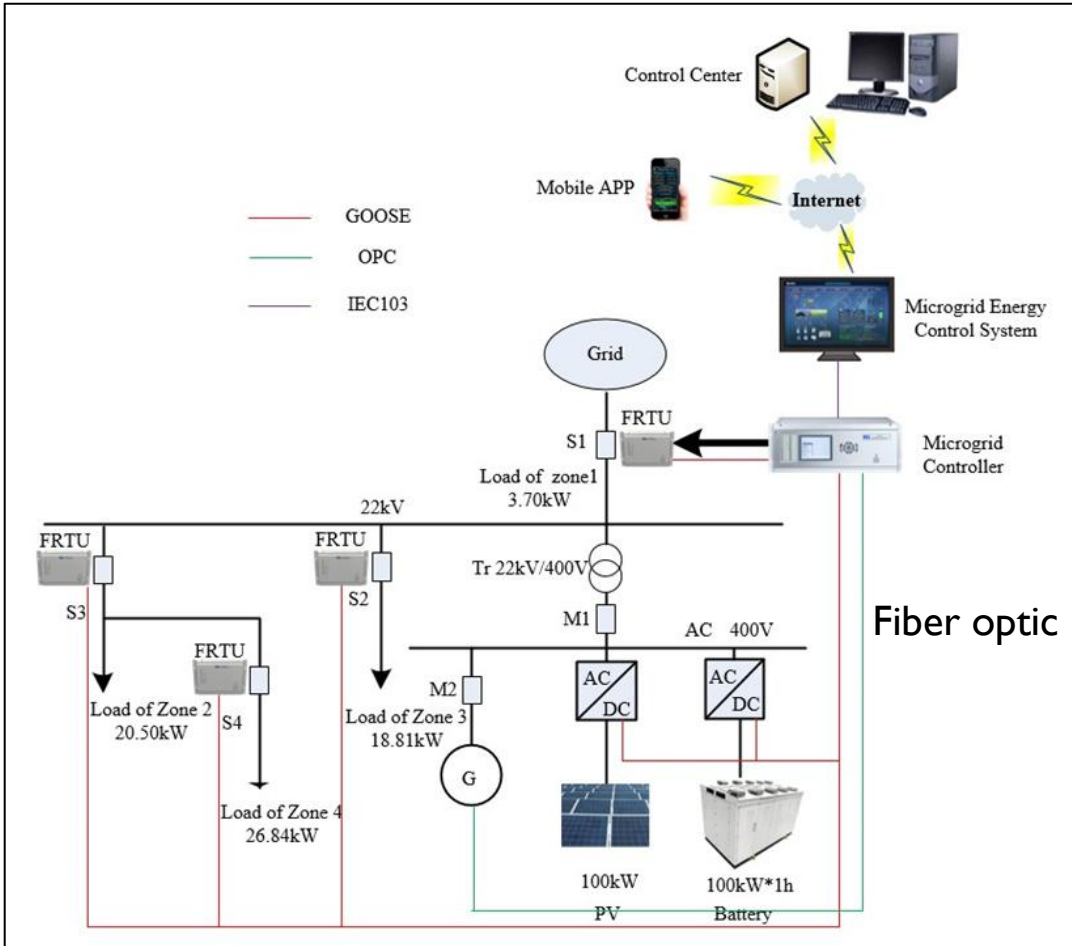


BATTERY STORAGE

- Lithium Ion Battery
- Capacity = 100 kWh
- Max output power = 100 kW
- $PF = \pm 0.90$

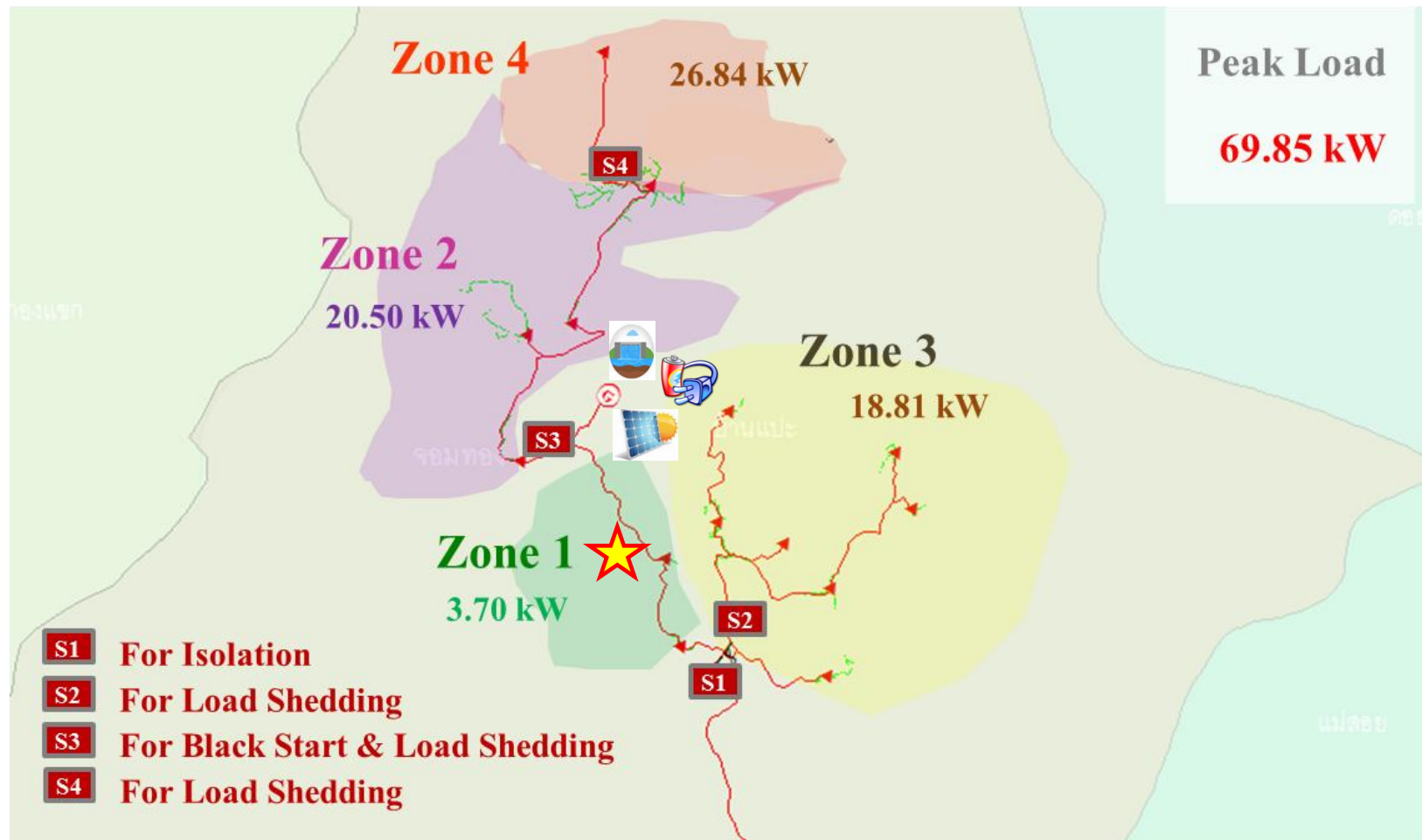


MICROGRID CONTROLLER

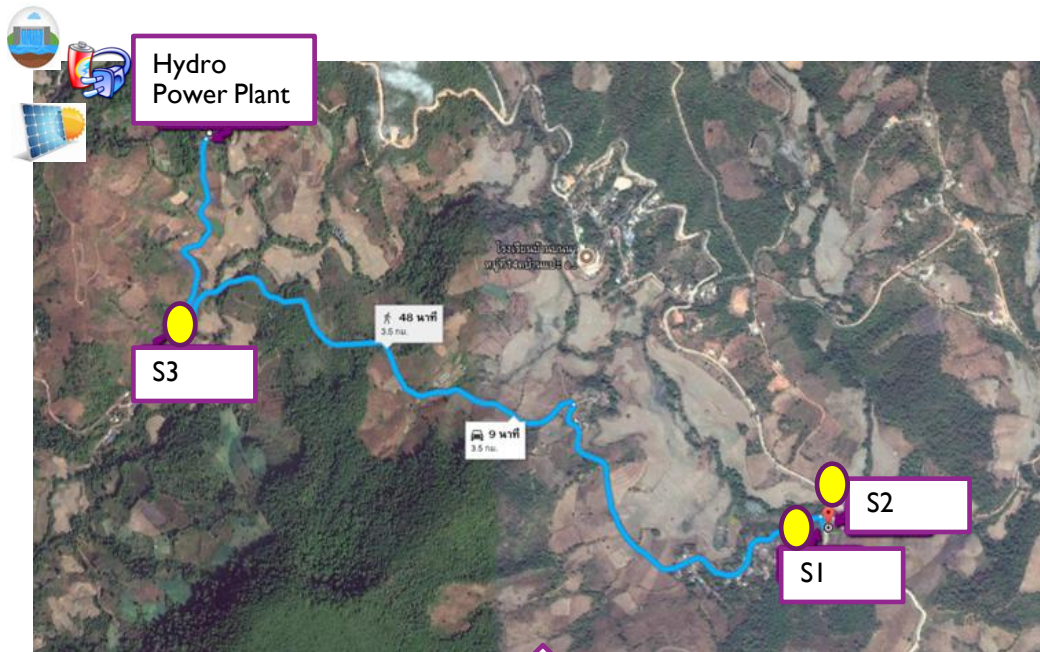


- NR Product
- Model PCS9617MG

SINGLE LINE DIAGRAM AND SWITCHES

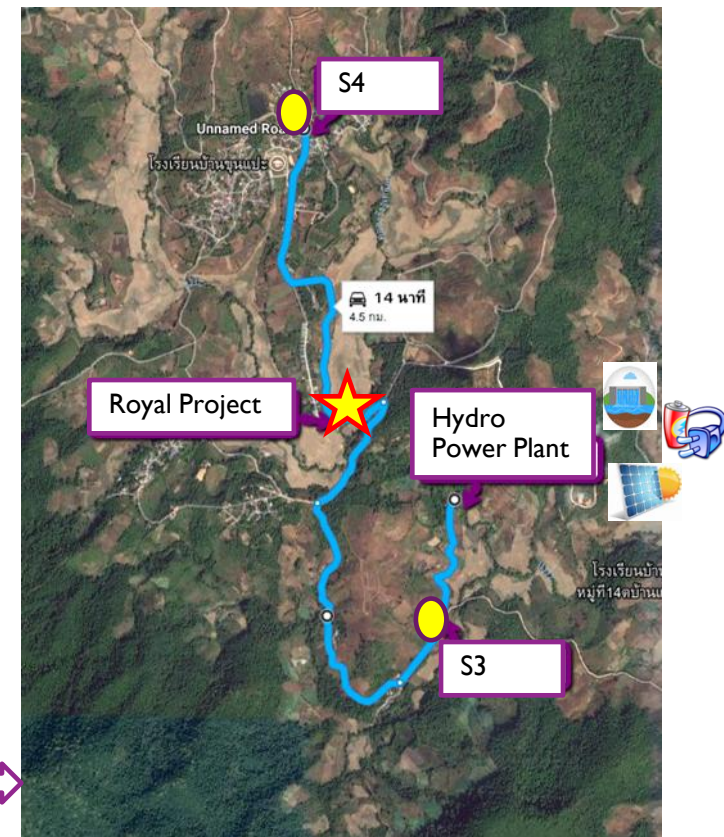


COMMUNICATION



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

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

Island to on-Grid Control

Change system frequency and voltage until synchronism conditions are met, and then syn-close tie line breaker by S1 FRTU.

Micro-Grid Controller

Black Start Control

When main-grid in off power state, Micro-Grid controller control PVS & BESS to support system with stable power

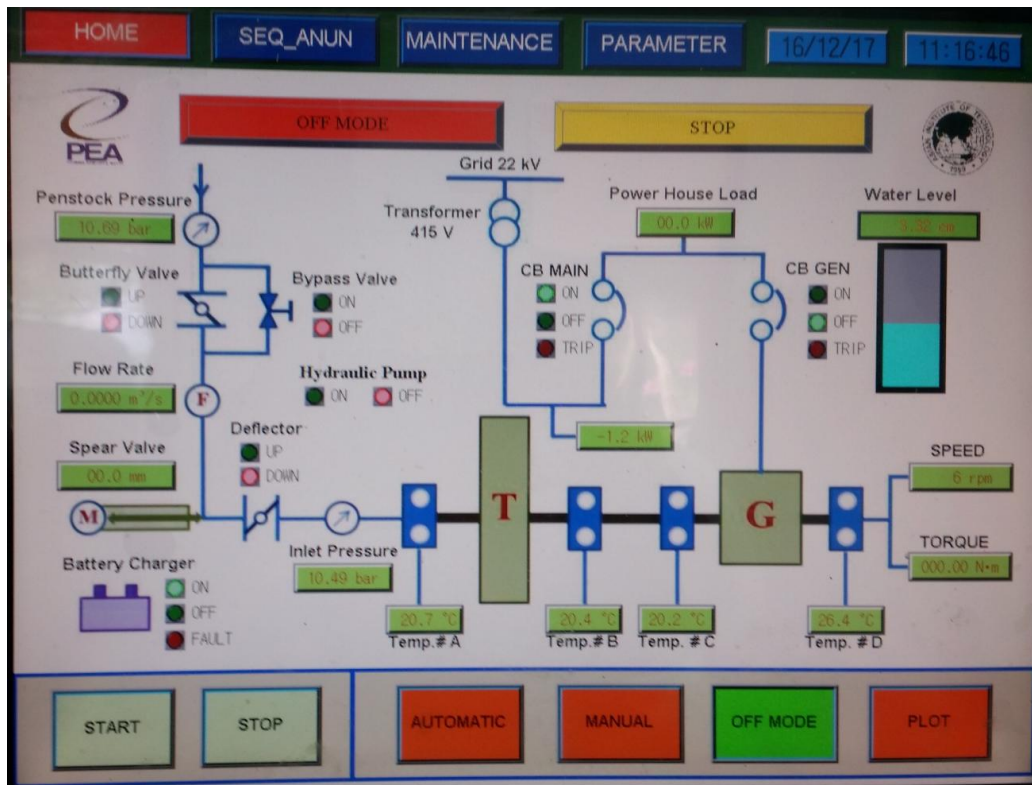
Island Control

In Off-Grid state, maintain the voltage and frequency of Micro-Grid system

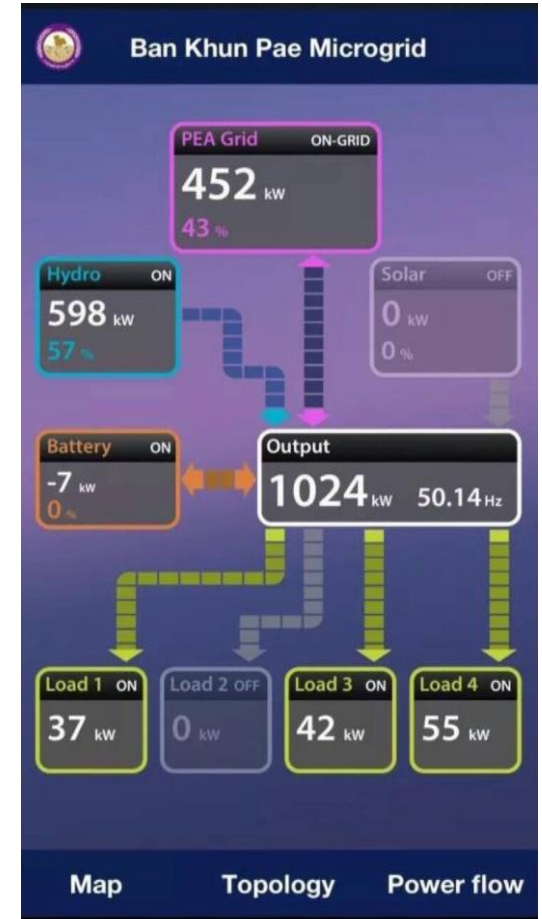
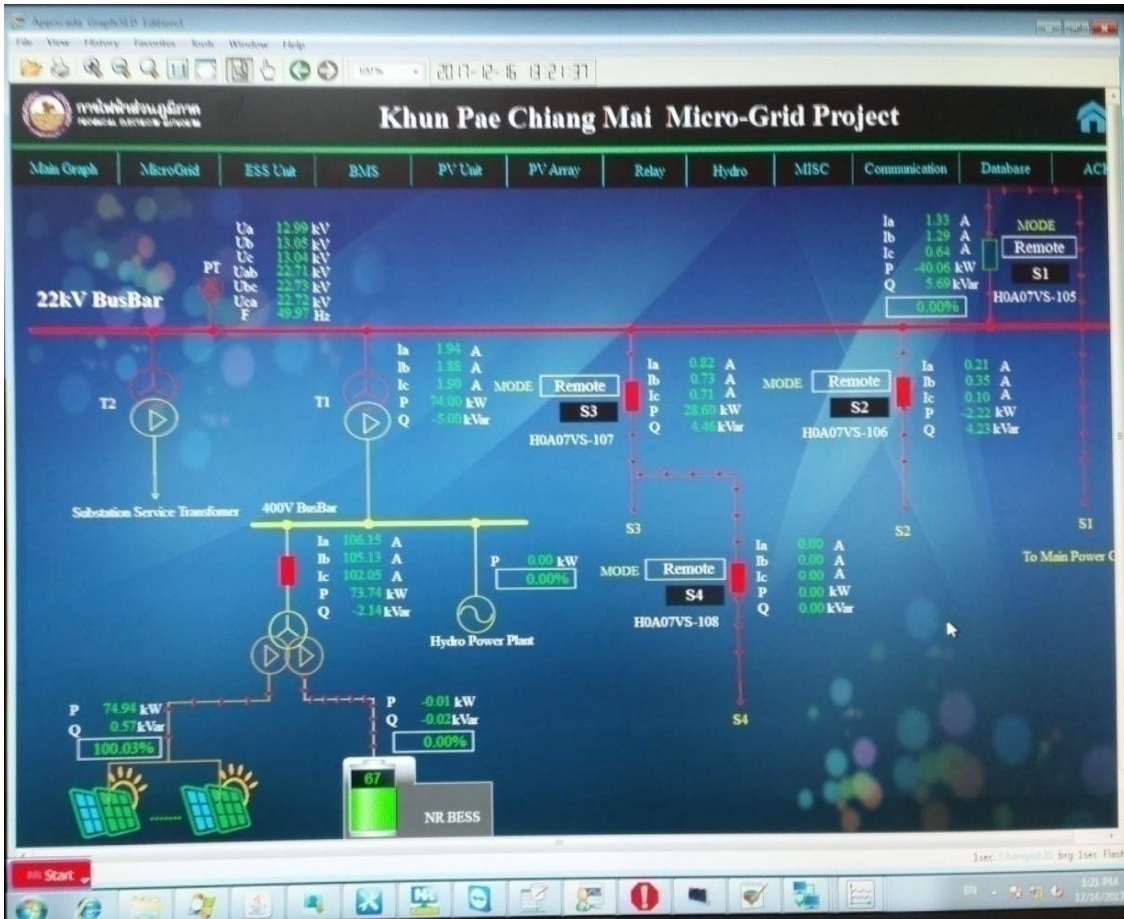
PCC Control

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

EXAMPLE OF HMI (HYDRO POWER PLANT)

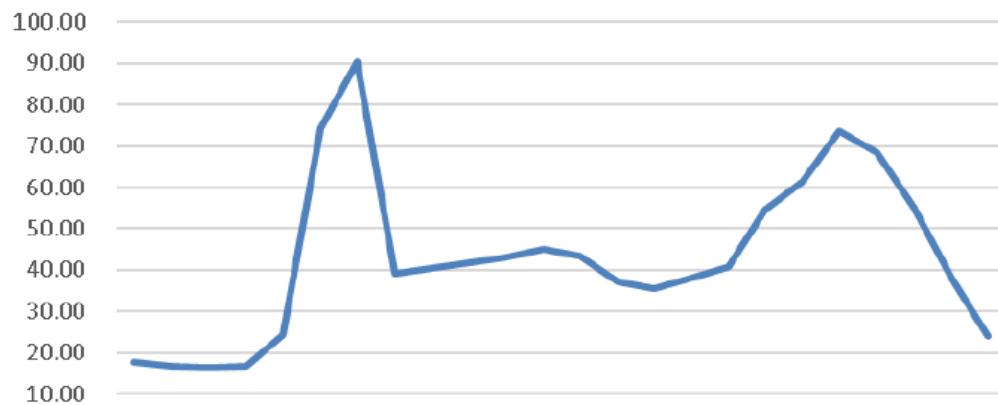


EXAMPLE OF HMI (MICRO GRID CONTROLLER)



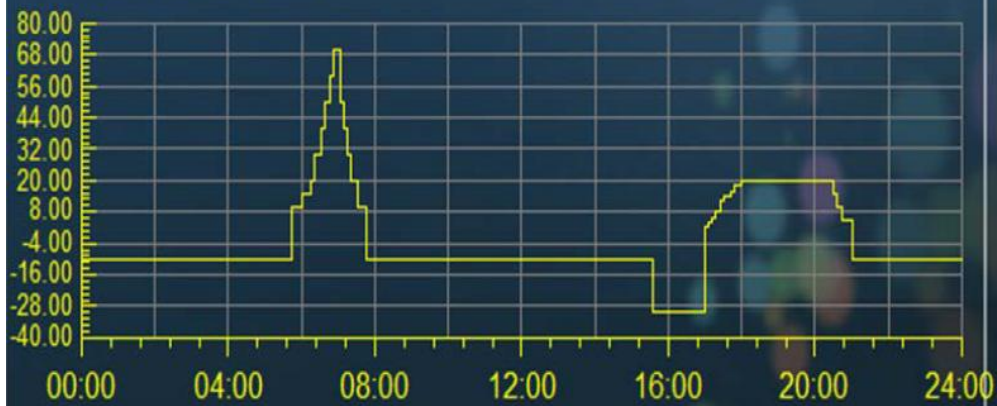
SOME RESULTS

Load Profile (kW)

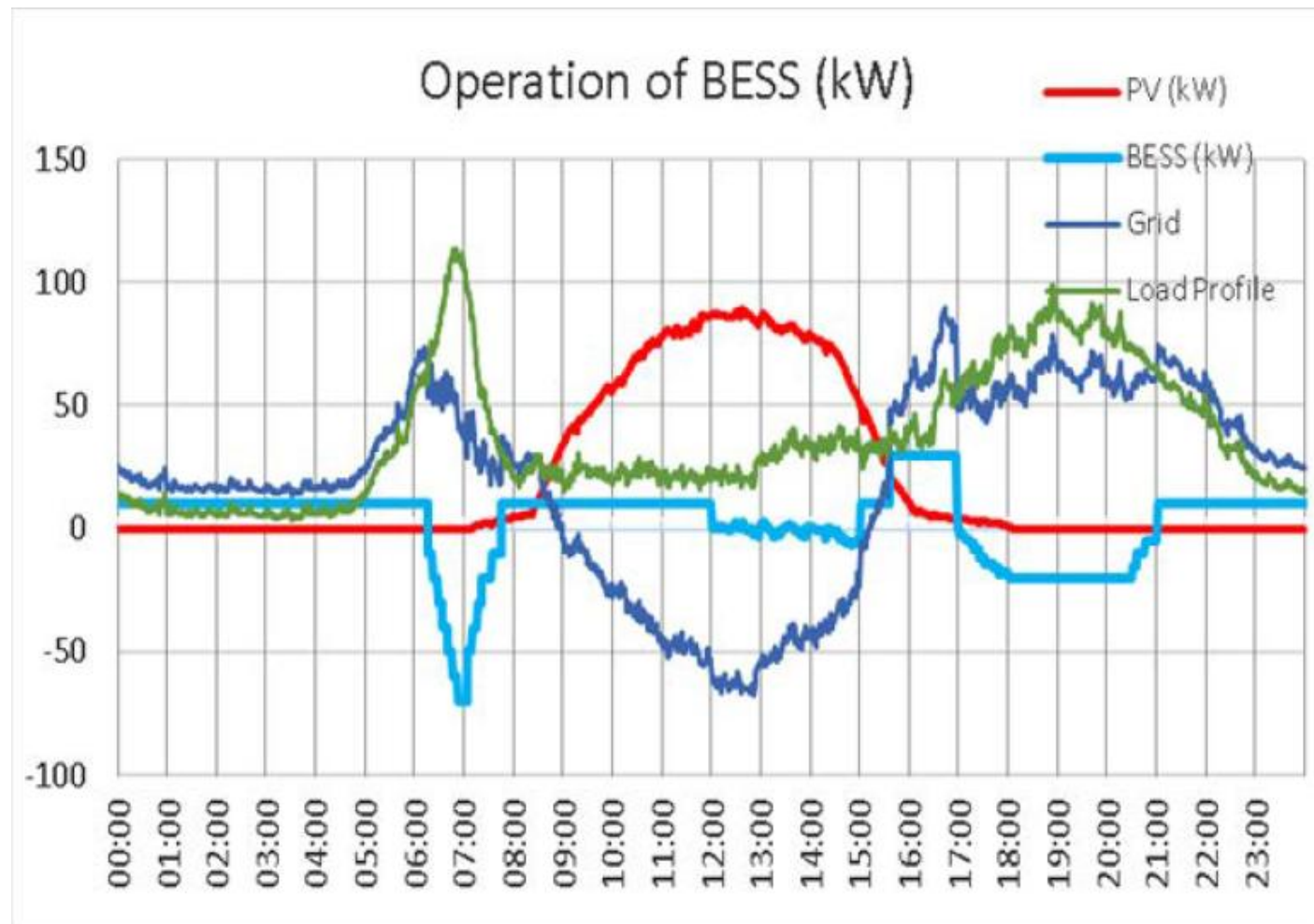


■ Regulation Curve (kW)

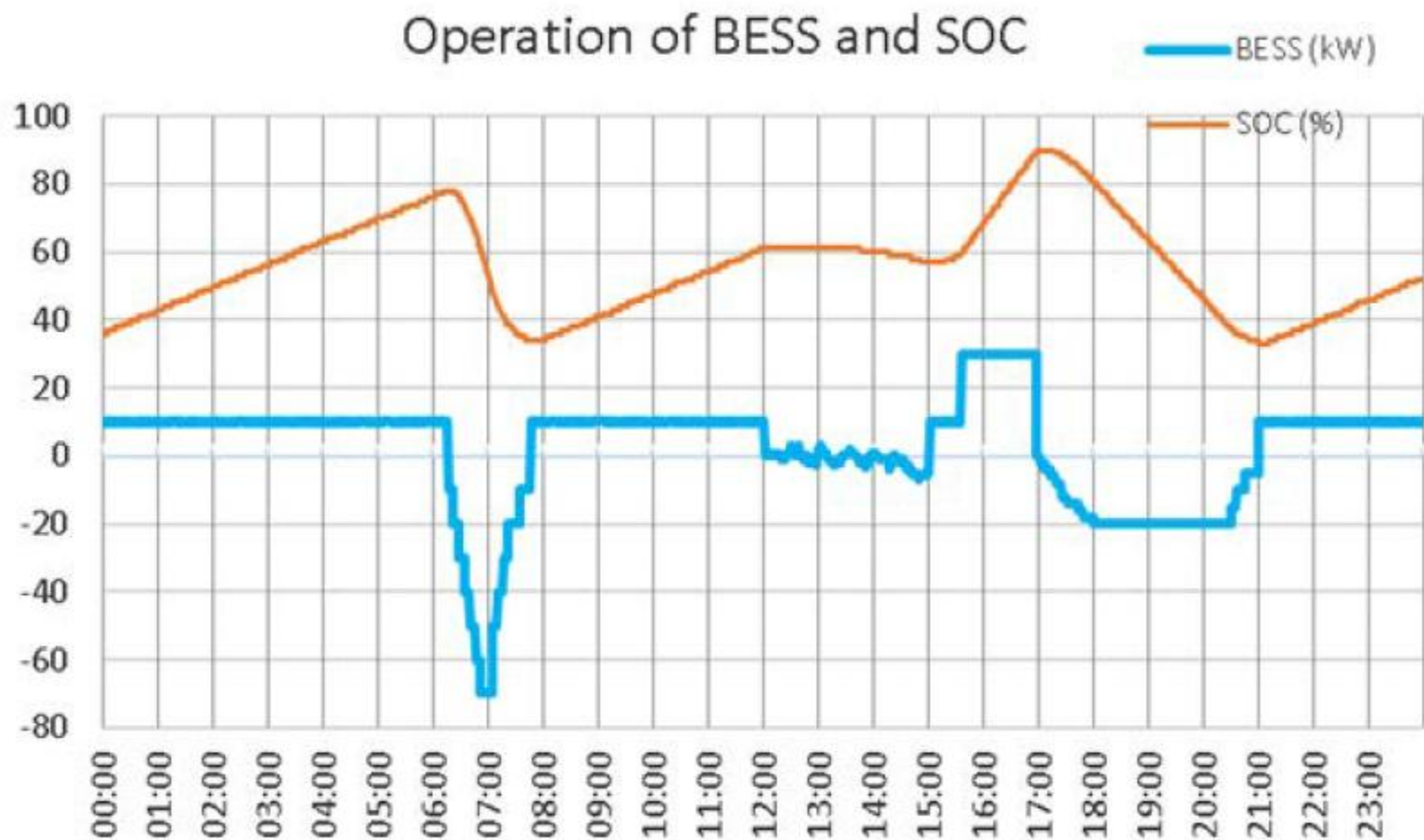
2018-02-12 -10.00



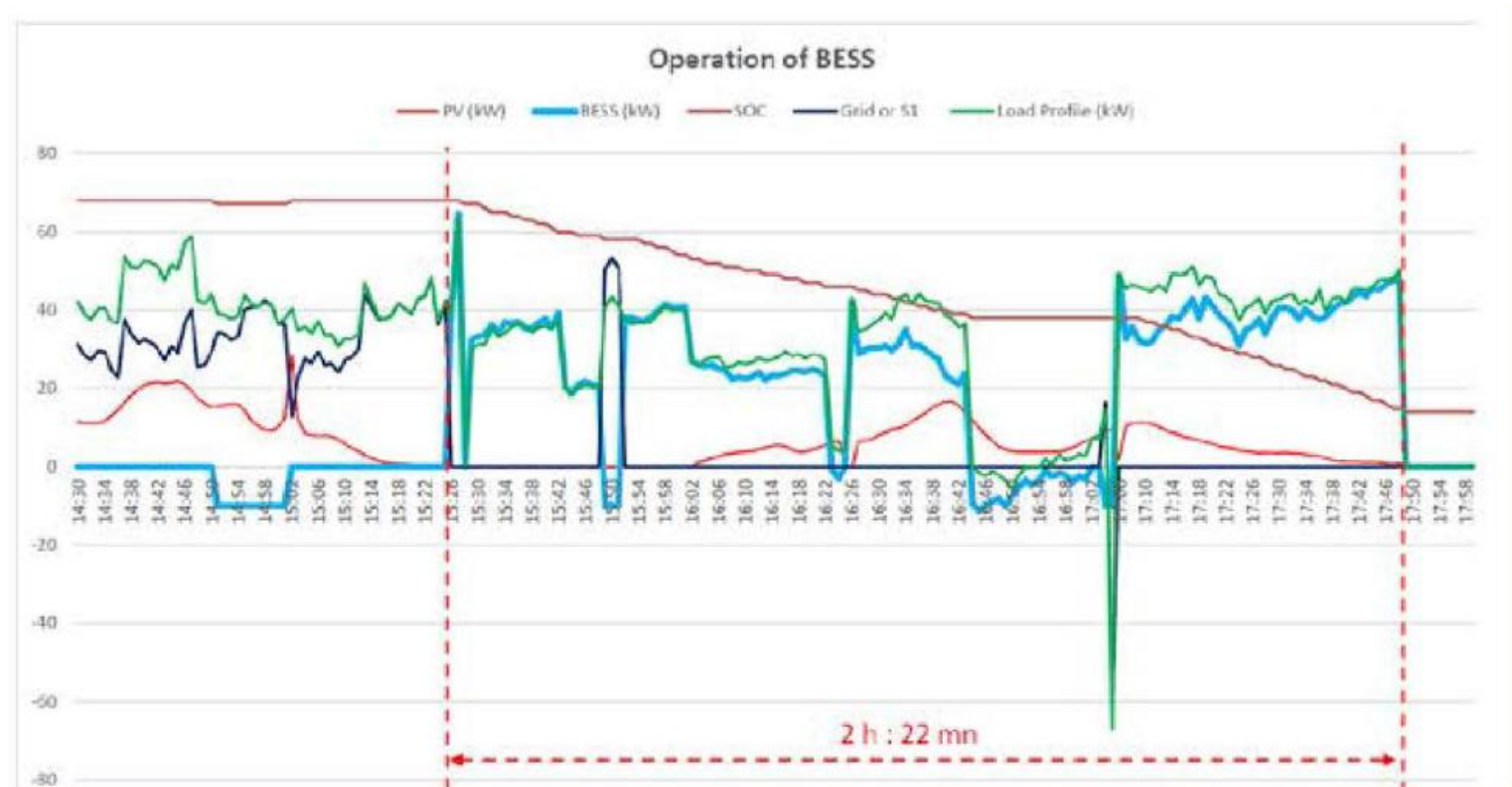
SOME RESULTS



SOME RESULTS



SOME RESULTS



Communication is important !! x2

OPERATION

On grid

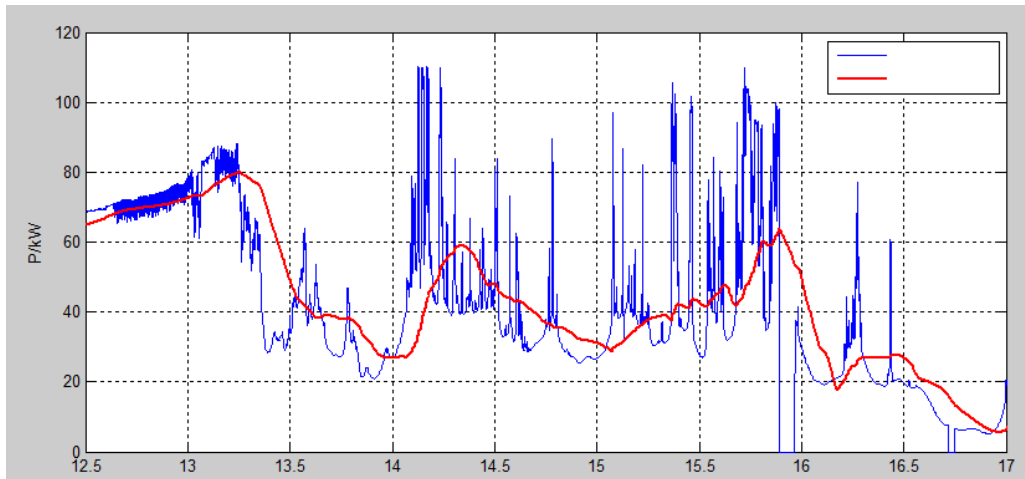
SOC Control (prepared for outage)
+ PV Smoothing
(Export surplus energy to grid)

Off grid

Island control (include load shedding)
Black start control

Transition

PCC Control (Intentional Islanding)
Island to On-grid control



CONCLUSIONS

- A solution for an area that distribution line construction is not possible or not allowed by law
- Local community feed back & 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