Micro Grid System of Cimei Island, Taiwan

Chao-Shun Chen, Prof.
I-Shou University

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2019 Fort Collins Microgrid

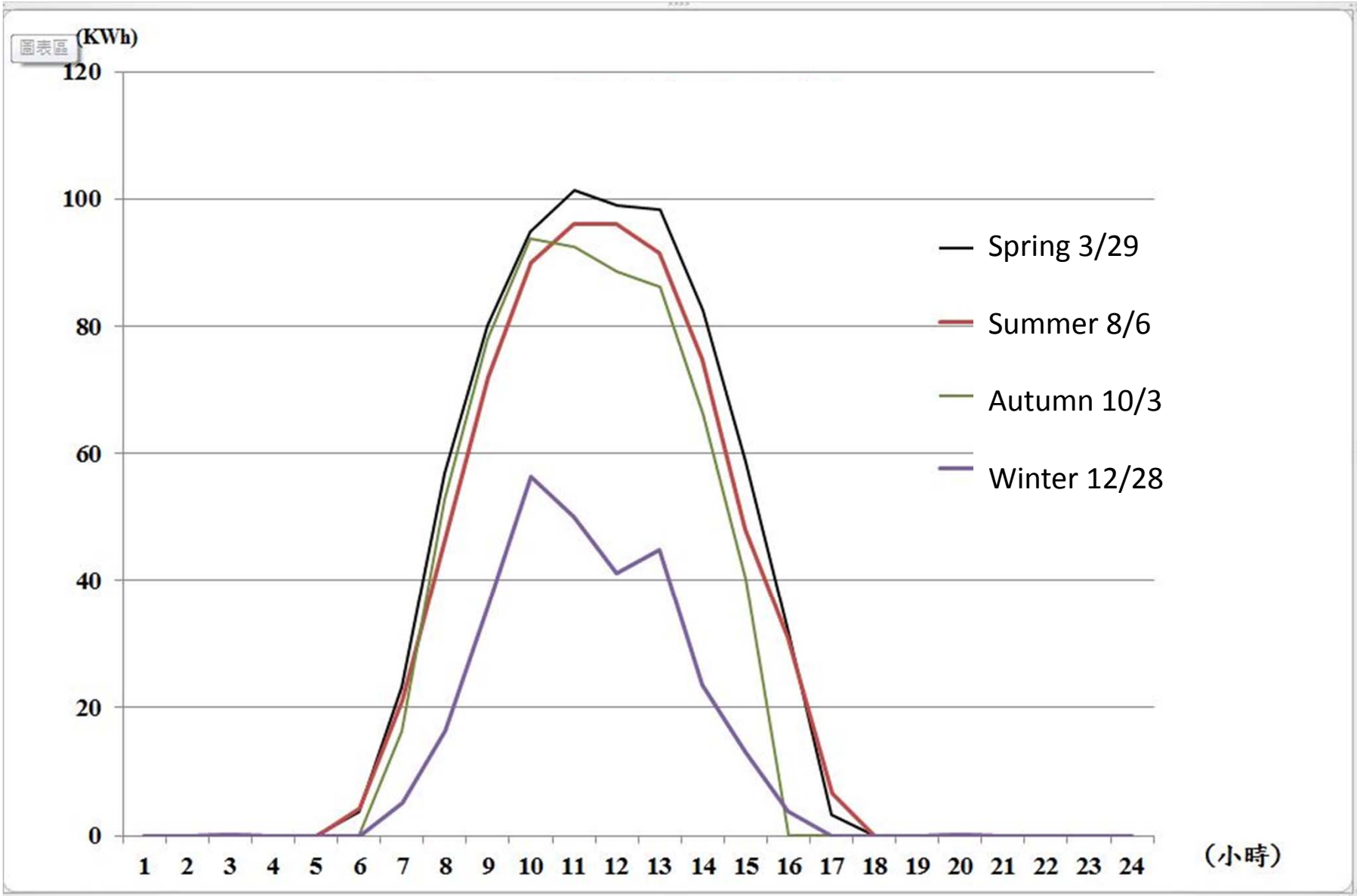
Cimei Island

1. Population: 3,000
2. Land Area: 7kM^2
3. Diesel Generators: 4*1000kW
4. Three Distribution Feeders(3.3kV)
5. System Loading:1700kW/600kW
6. Annual Electricity Consumption: 8M kWh
7. Taipower Annual Service Loss: $4M

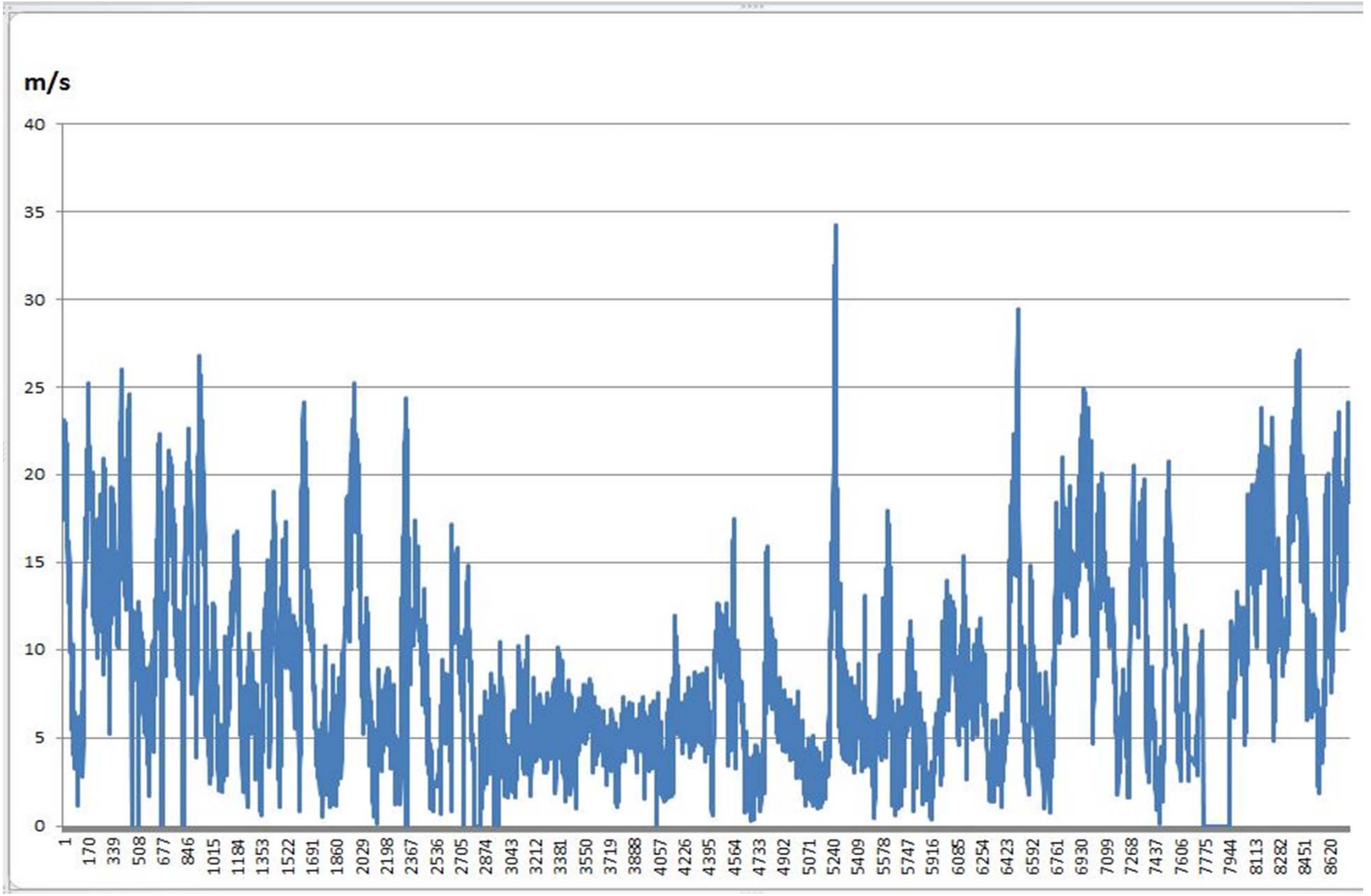
Status of Renewable Energy on Cimei Island

1. PV System: 400kWp
2. Energy Storage System(500kW, 600kWh)
3. Wind Generator: 600kW(to be installed by 2019)

Power Generation of Cimei 155KW PV System (2015)

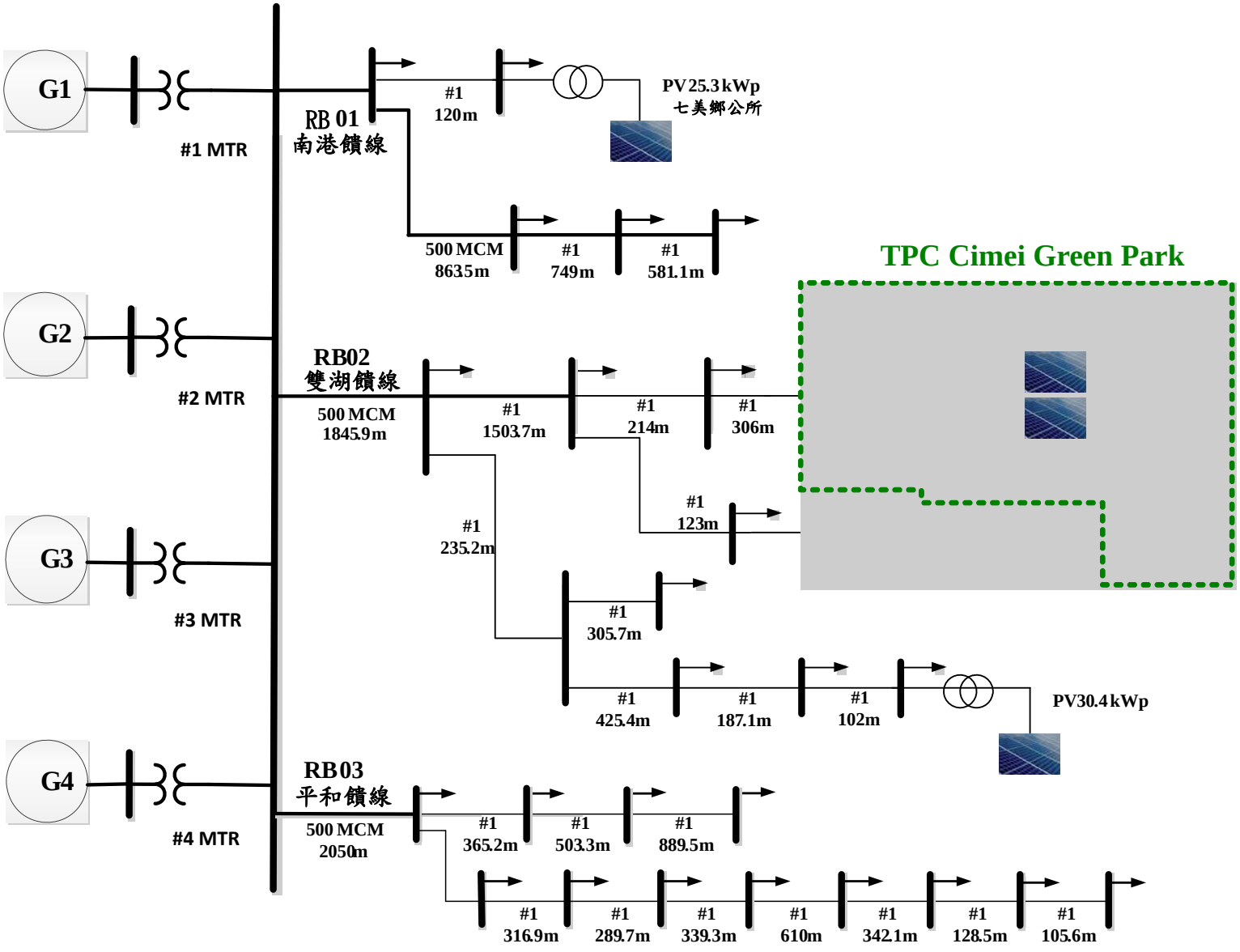


Annual wind speed of Cimei Island (2015)



hour

System Diagram of Cimei Micro Grid



Objectives of Cimei Smart Grid Project

1. Reduce generation cost by high penetration of renewable energy

2. Determine the optimal capacity of PV, WG, Energy Storage System(ESS), and Diesel Generators

3. Execute the Economic Dispatch Control(EDC) of diesel generators according to the forecast of renewable energy

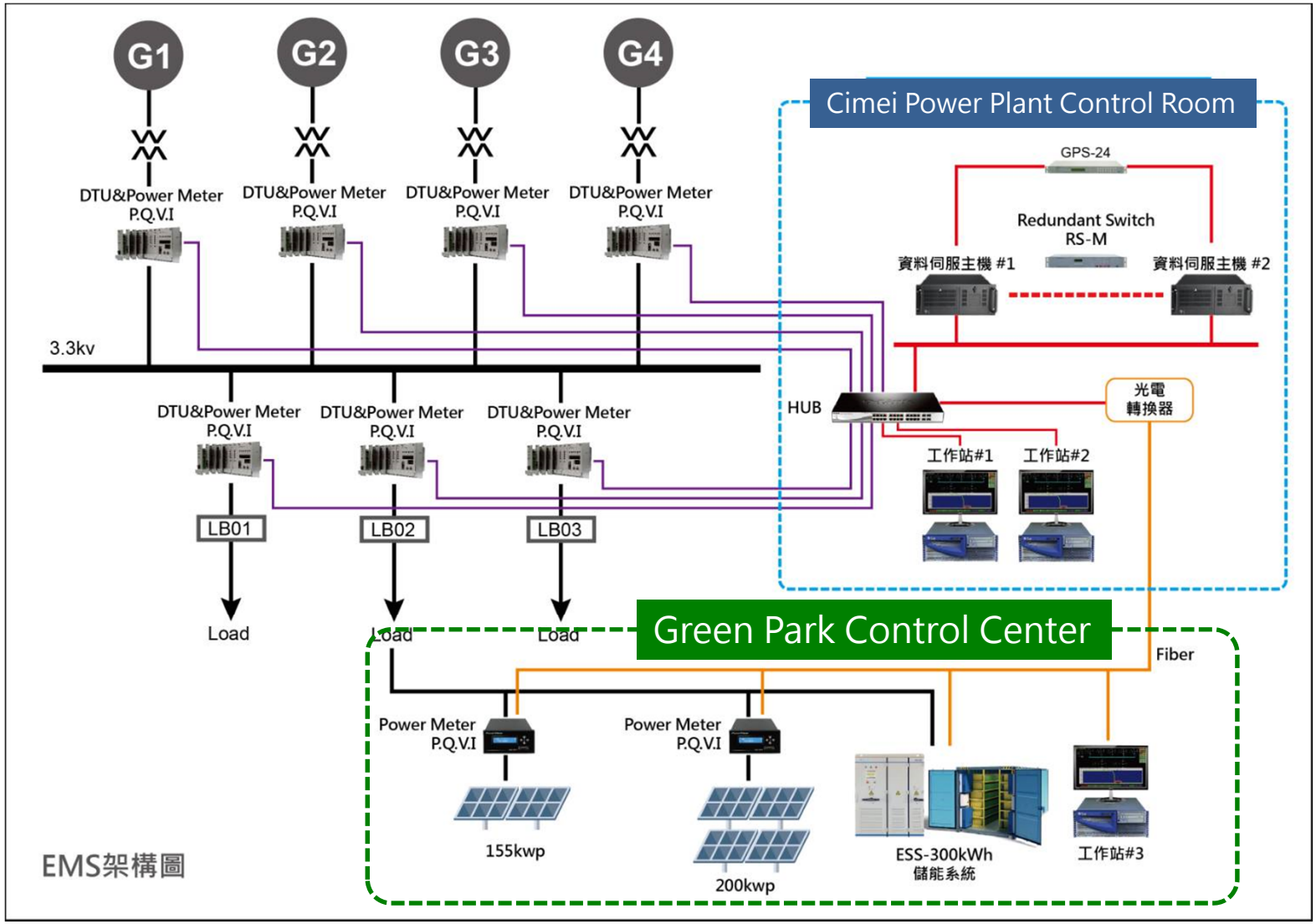
4. Enhance system power quality with coordinating control of diesel generators, PV smart inverters and ESS

5. Support the testing of system operation with zero carbon island

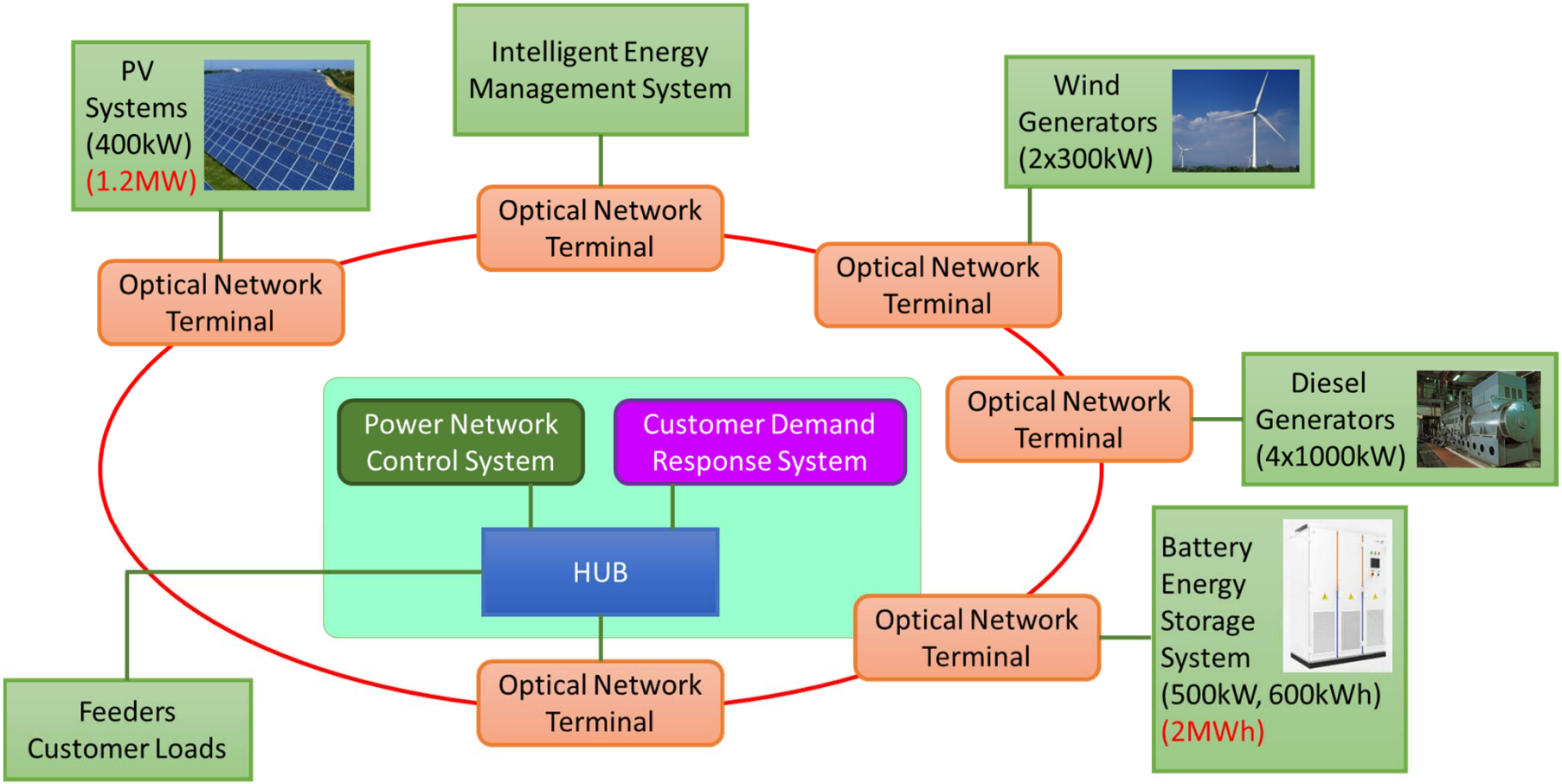
Demonstration of Cimei Smart Micro Grid

1. Intelligent μEMS for system operation and control of PV, WG, ESS and diesel generators to achieve system service power quality.
2. Economic Dispatch Control of diesel generators considering the forecasting of system load and renewable energy.
3. Smart charging and discharging of ESS.
4. Ensure system transient stability for PV shutdown/generator tripping by fast power discharge of ESS.
5. Enhance system voltage quality by coordinating control of PV smart inverters, ESS and diesel generators.

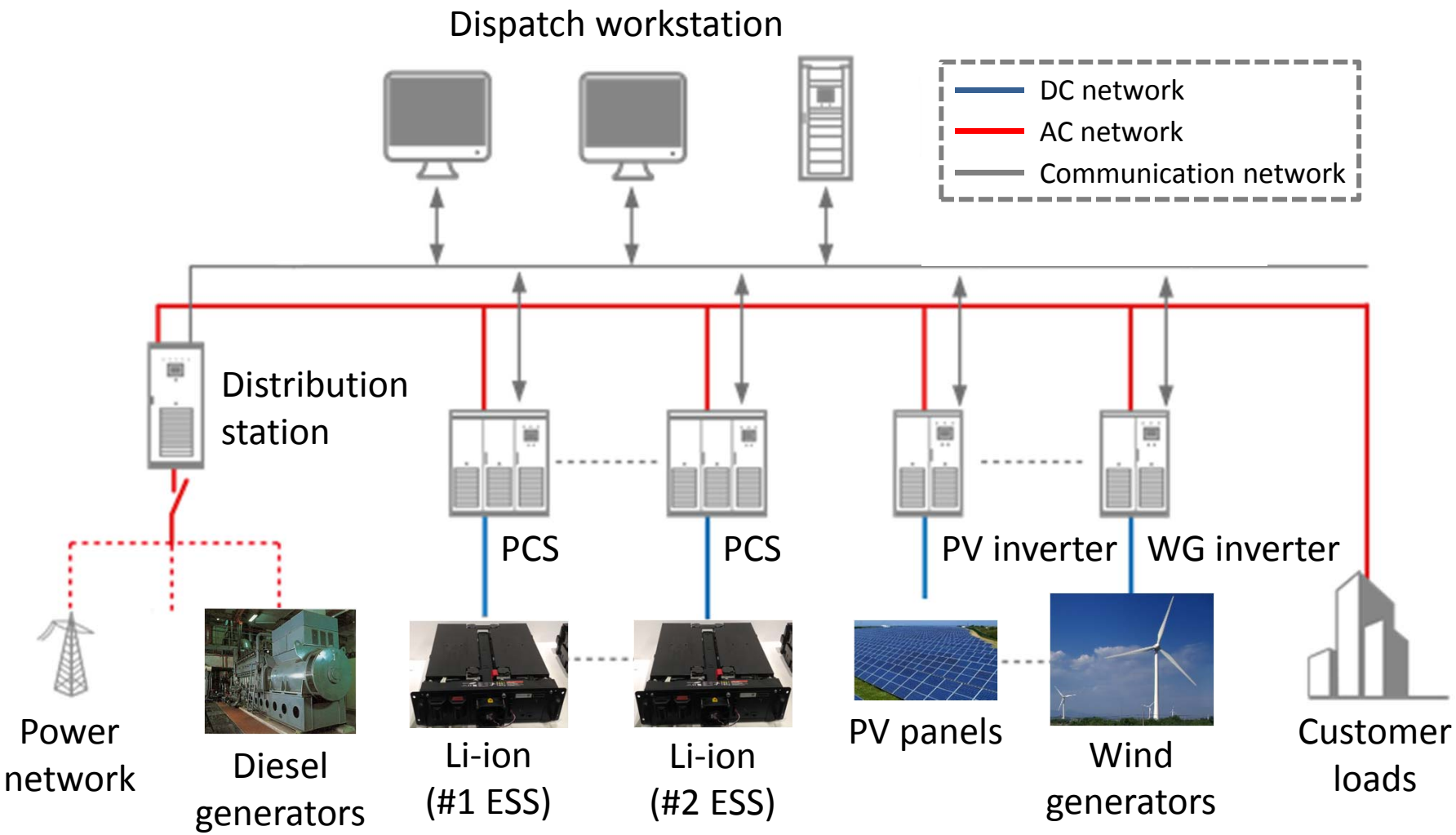
Cimei Energy Management System



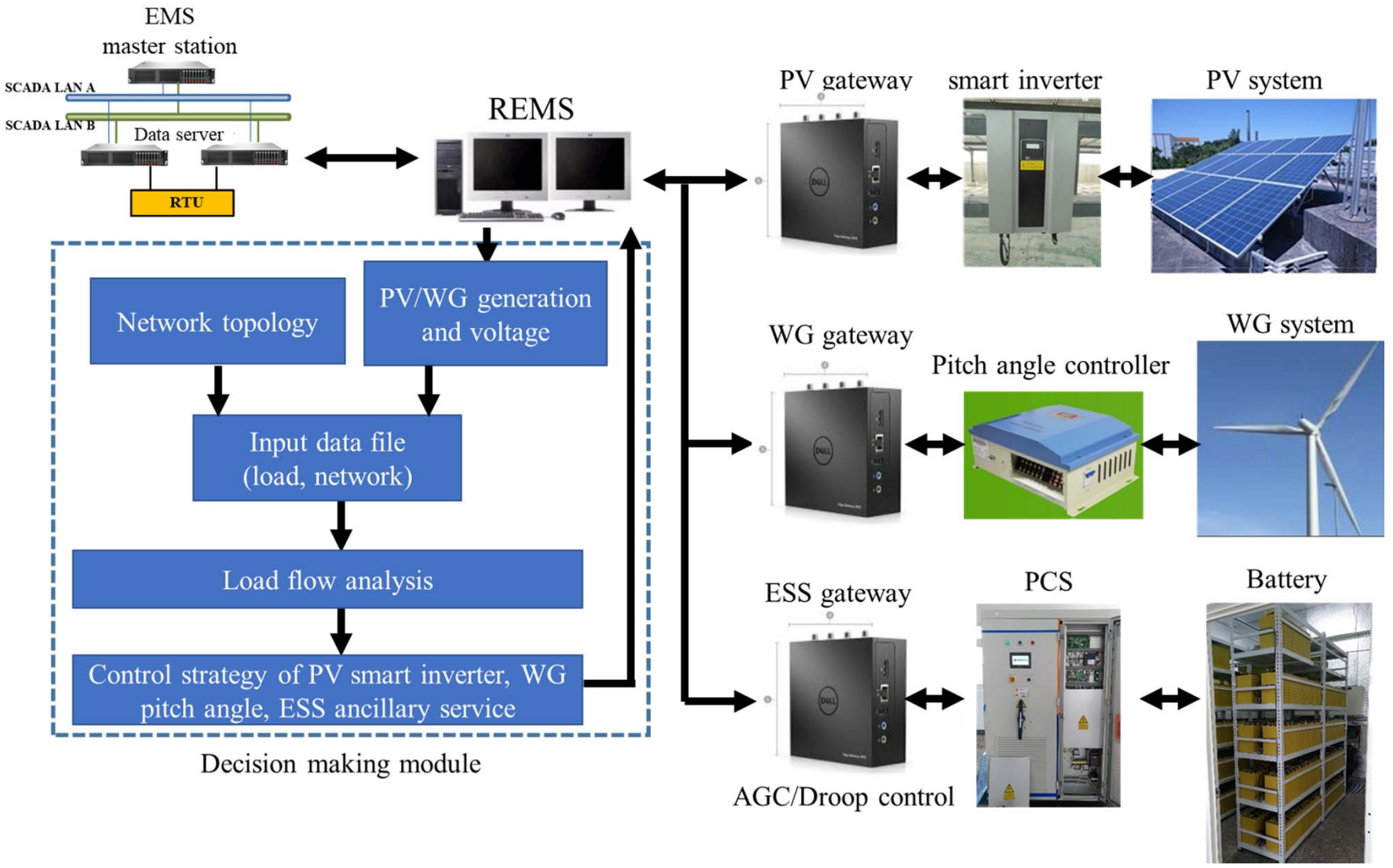
Configuration of Cimei Intelligent µEMS



Schematic Diagram of Intelligent μEMS



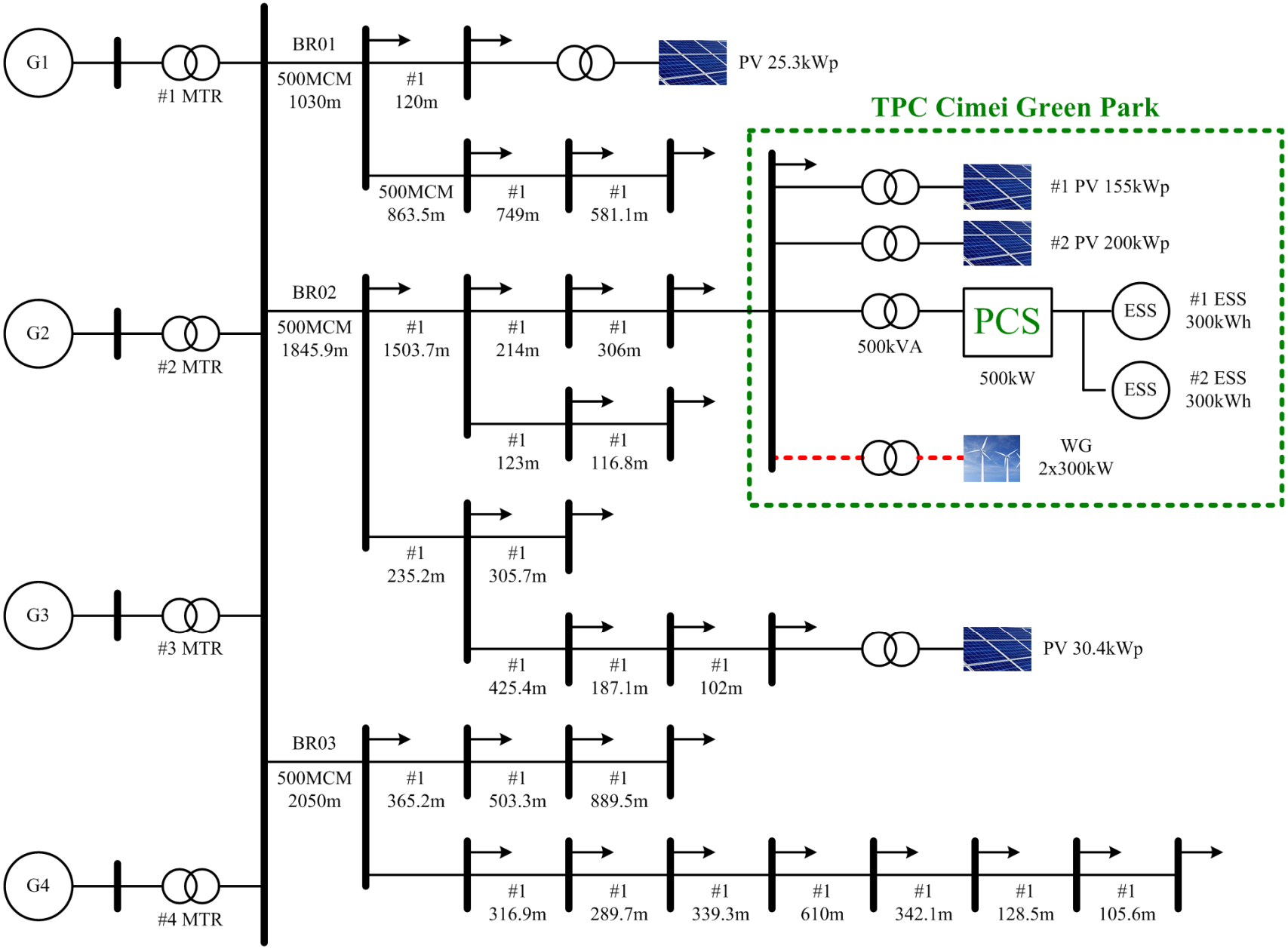
Control Sysem of Renewable Energy and ESS



PV System(355 KWp)

Energy Storage System (Li-On Battery + PCS)

System Network of Cimei Smart Grid



Computer Display of Cimei Intelligent μEMS

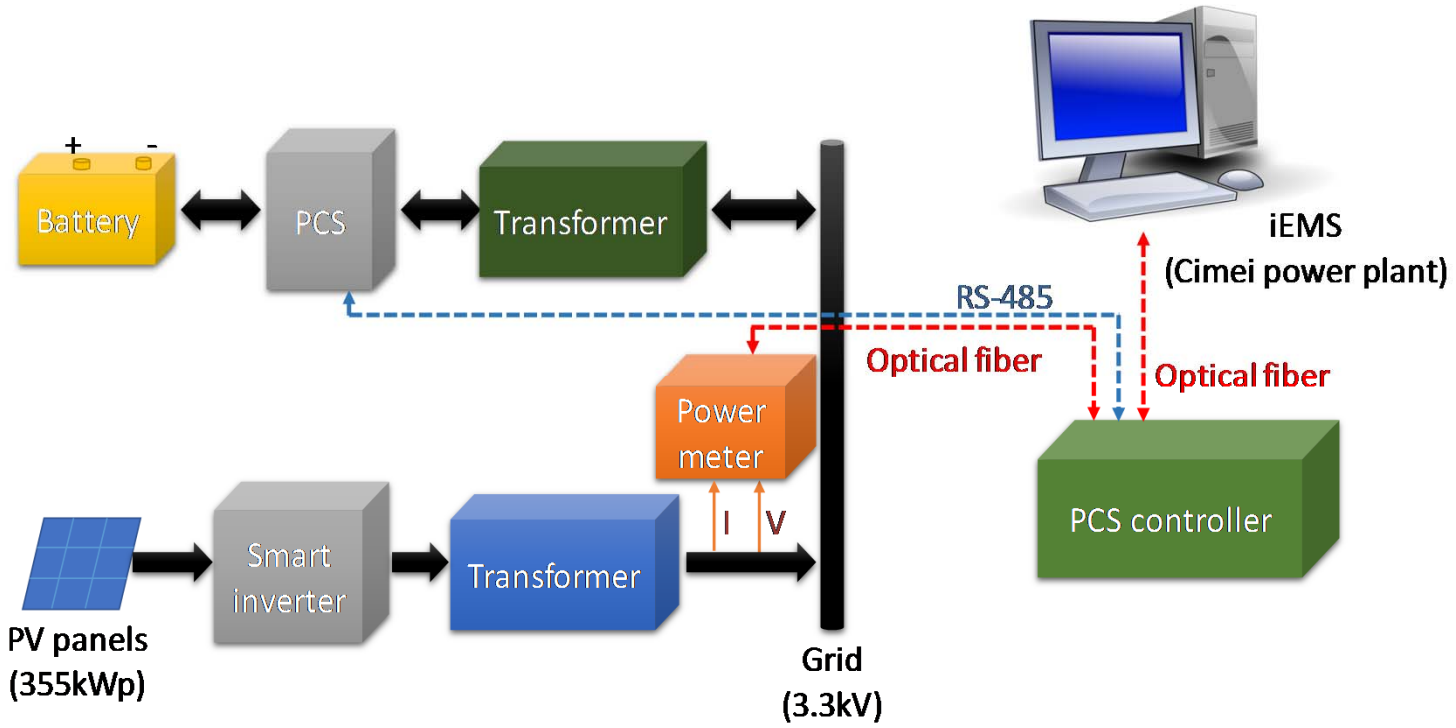
Control Strategies of Energy storage System

ESS(500kW/600kWh，Li-Ion Battery + PCS)，300kWh(fast power discharging 1.3C)，300kWh(slow charging/discharging 0.5C)。

Control Modes

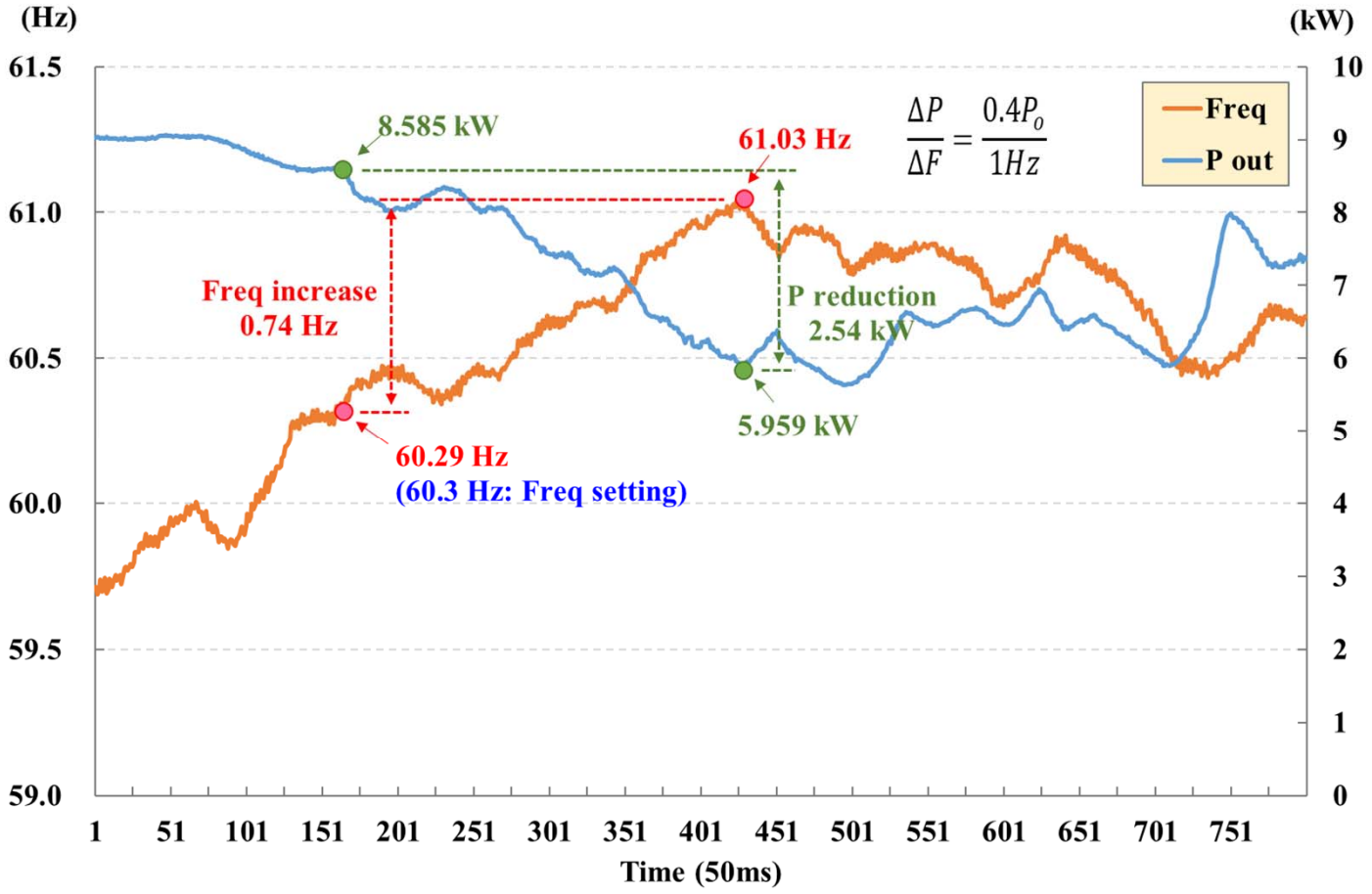
a. Transient stability (Fast power discharging with under freq. trigger)
b. RE smoothing (Slow power charging/discharging with Moving Average Control Algorithm)
c. System Peak load shaving (Slow power charging/discharging considering profiles of system load and RE generation)

ESS control architecture of Cimei smart microgrid

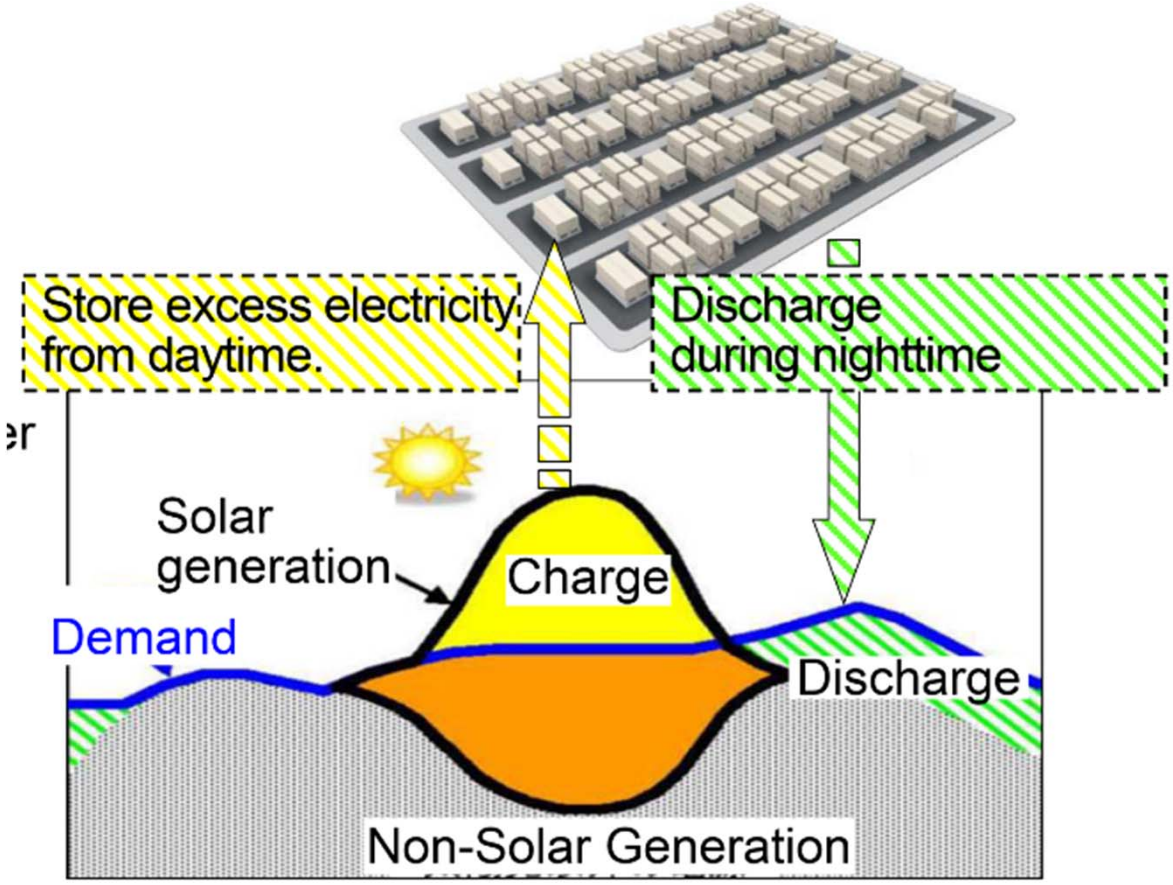


PV smart inverter (V-PF, V-P, Freq.-P)

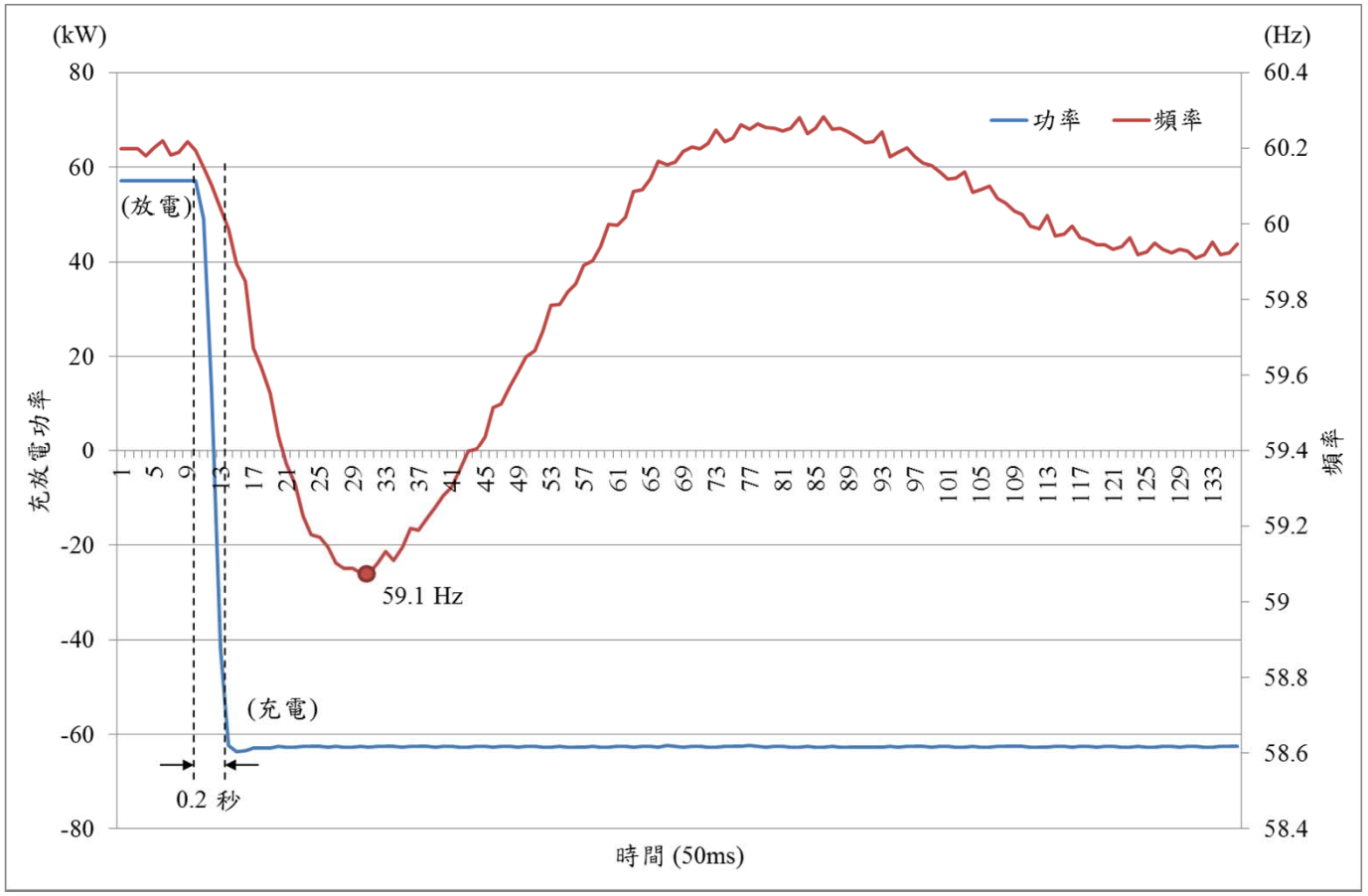
Automatic PV generation control (frequency-P) (2018.04.16)



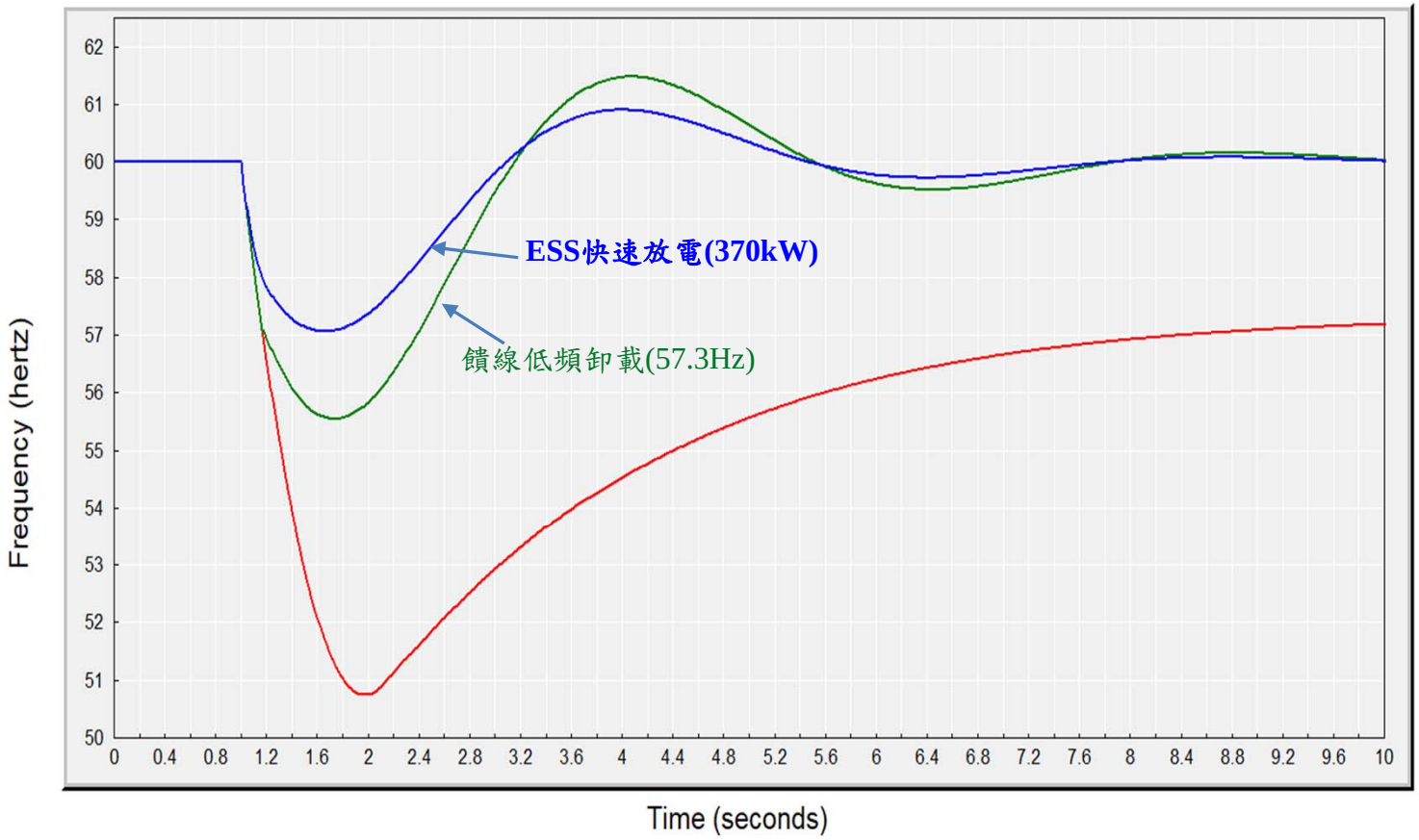
System peak load shaving by ESS



System Frequency Response with ESS fast power discharging (60kW➡-60kW)

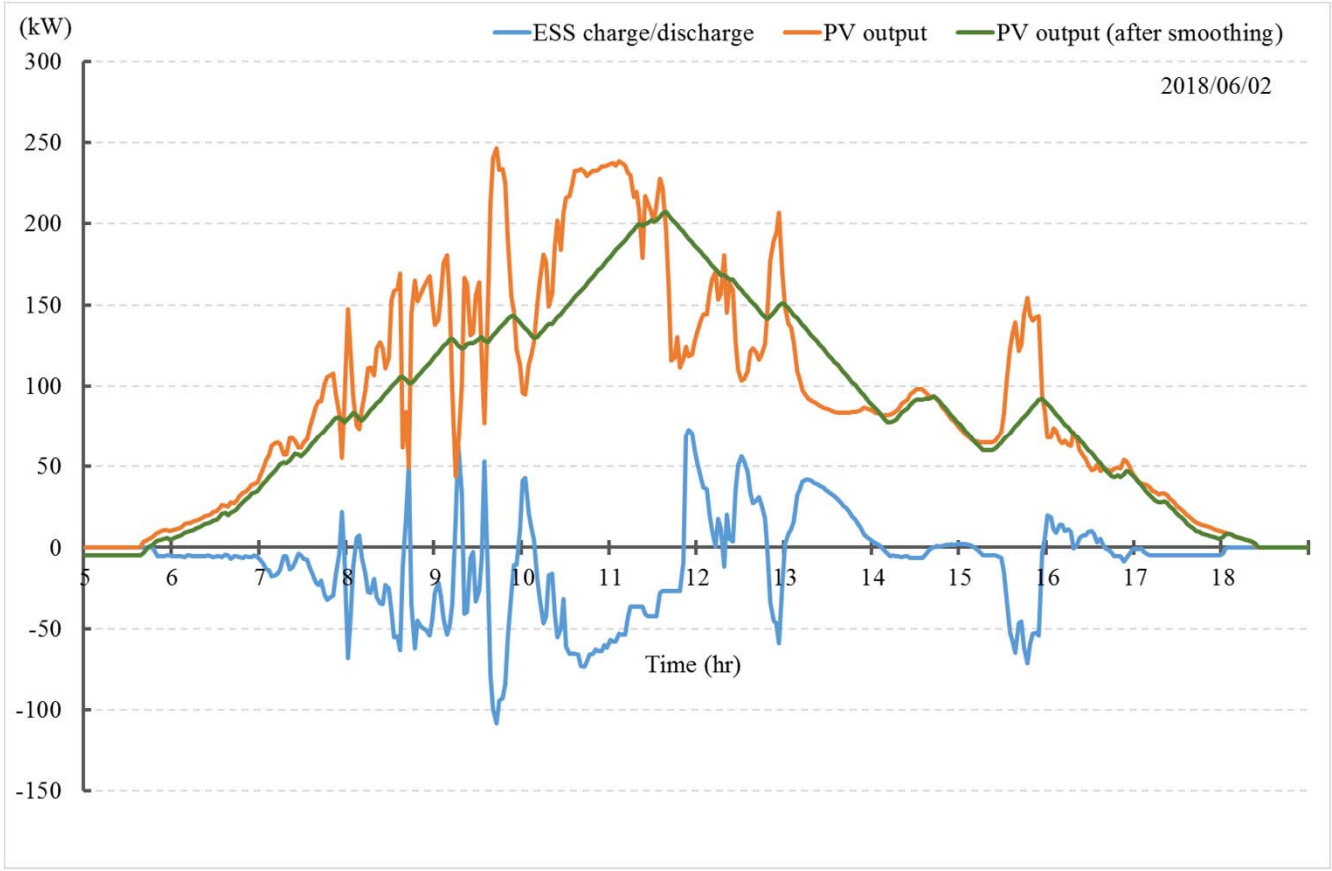


Transient Frequency Response of Cimei System after Generator DG1 tripping(2018.8.1)

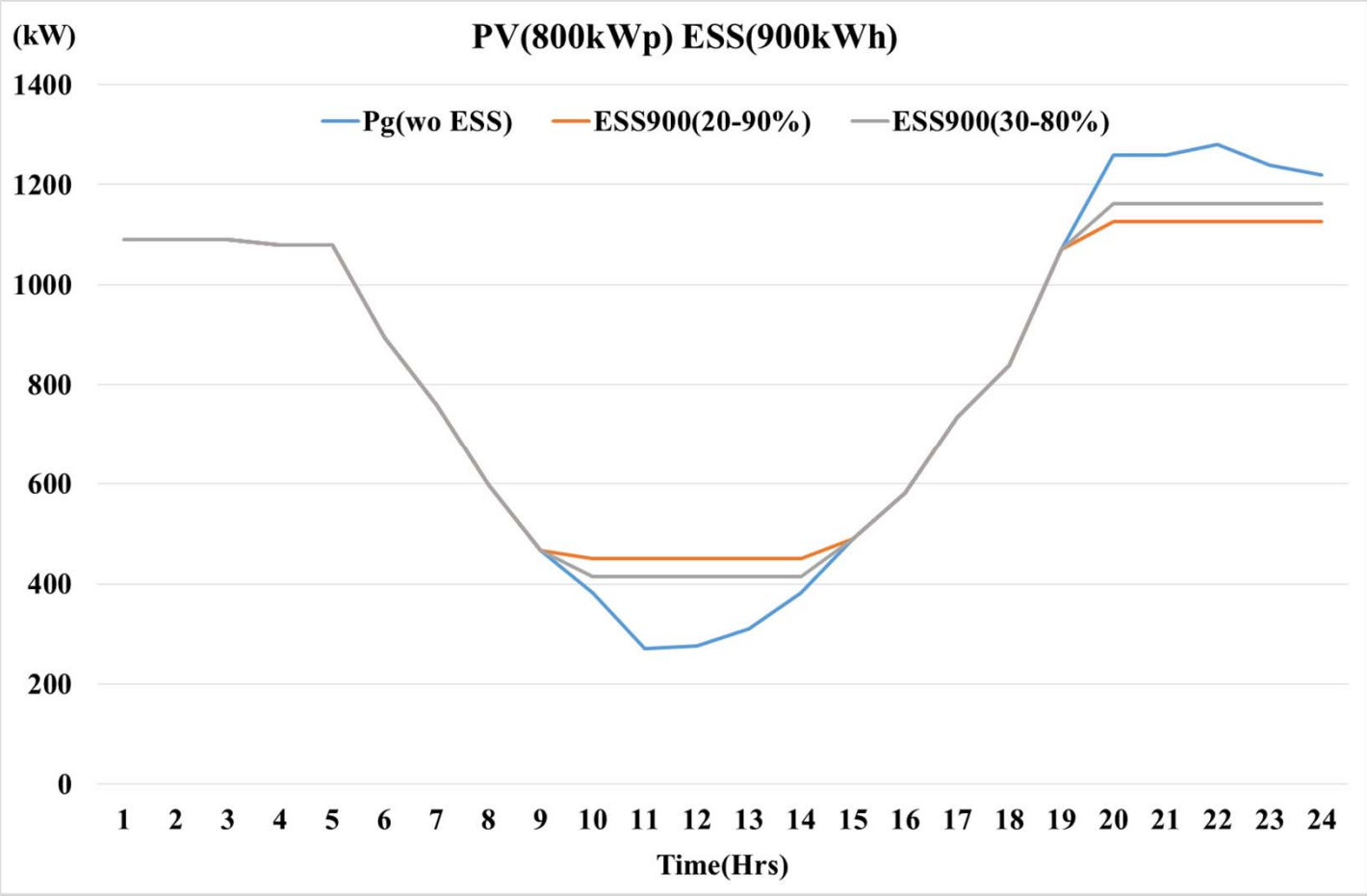


Smoothing of PV power generation by ESS

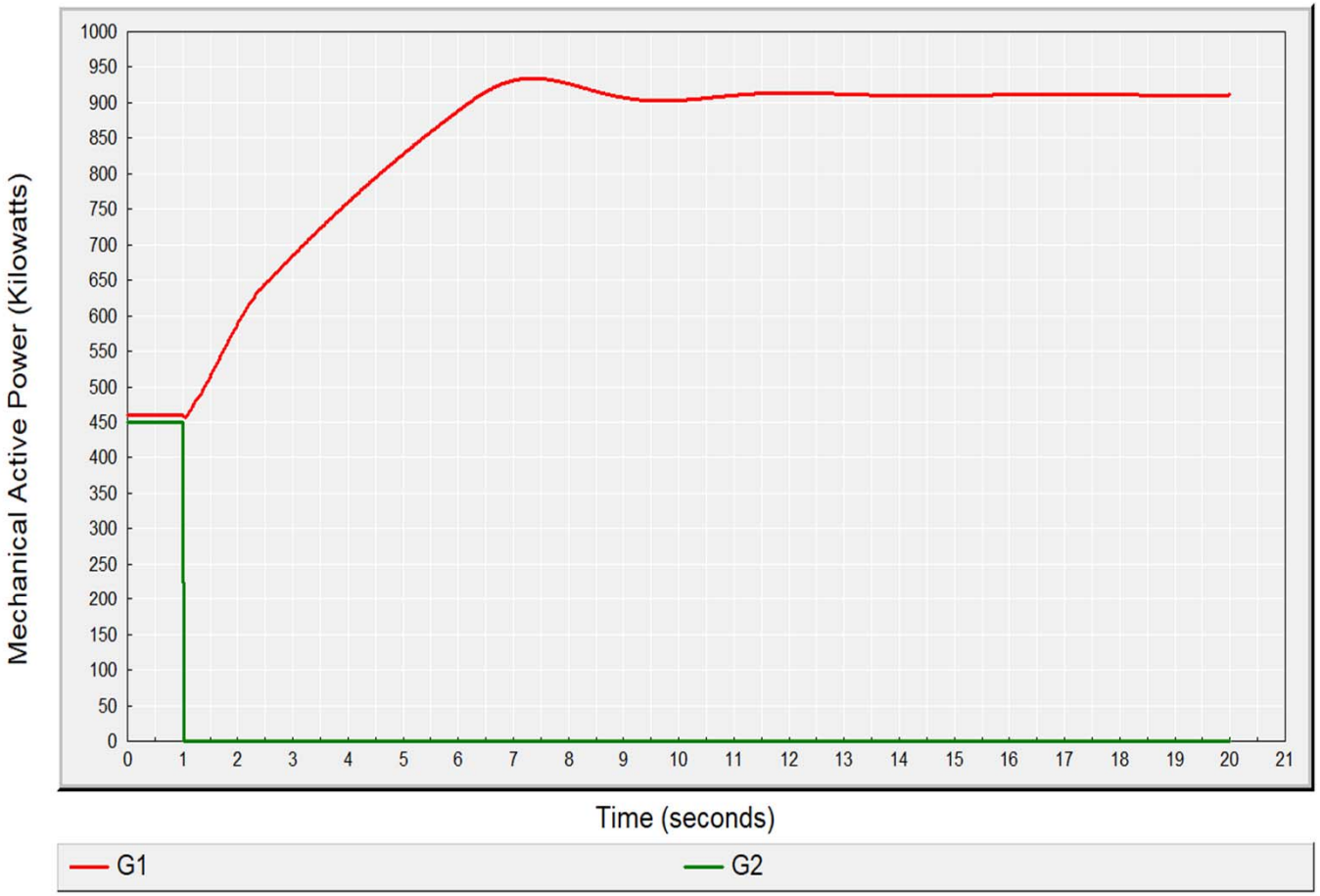
Power profiles of PV system and ESS after RE smoothing



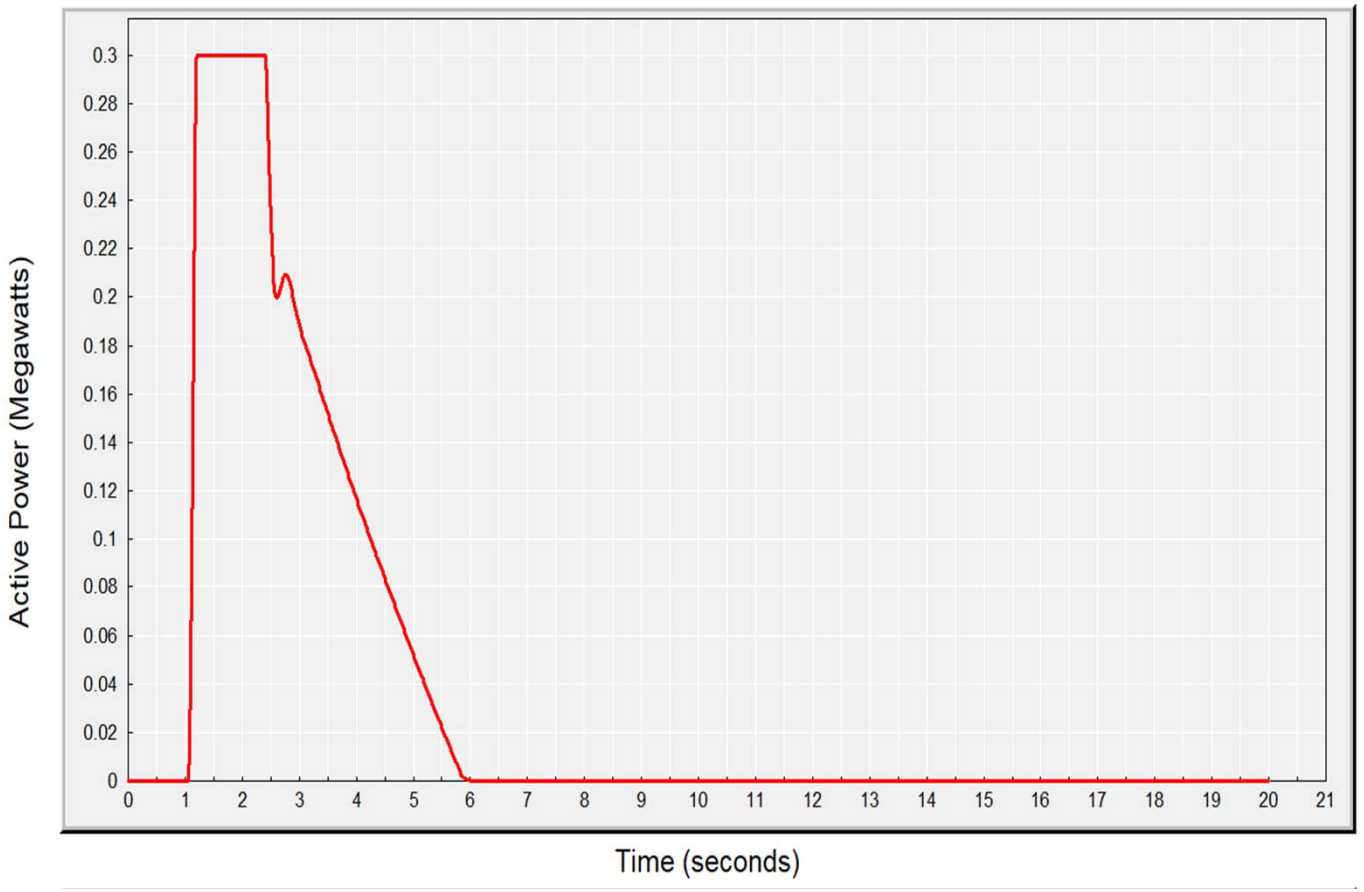
Peak shaving of system net load profile by ESS



Power output of Cimei diesel generators for DG2 tripping



Profiles of ESS fast power discharging with UF triggering



Conclusions

1. Development of operation technology for Cimei Smart Grid to ensure service quality and security for micro grid with high penetration of renewable energy.
2. ESS with control strategies has been applied to perform fast power discharging to enhance system transient stability.
3. Power generation fluctuation has been mitigated effectively by ESS.
4. Slow power charging/discharging of ESS has improved the system loading factors considering daily profiles of system loading and RE generation.
5. Business model needs to be derived to achieve system sustainability for micro grid implementation.


Thanks for your attention