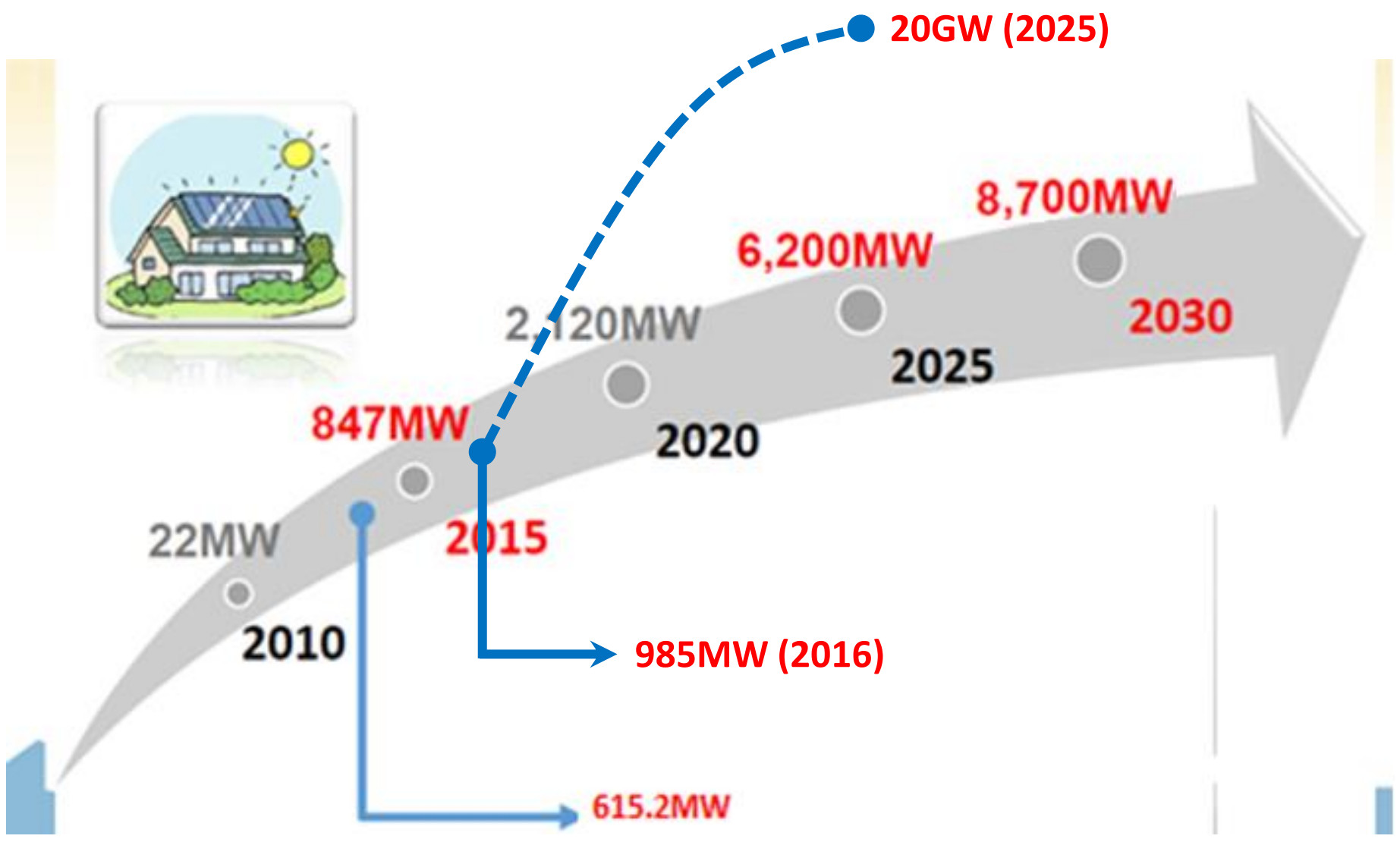


# Penghu Smart Grid Demonstration System

Chao-Shun Chen, Prof.  
I-Shou University  
Taiwan

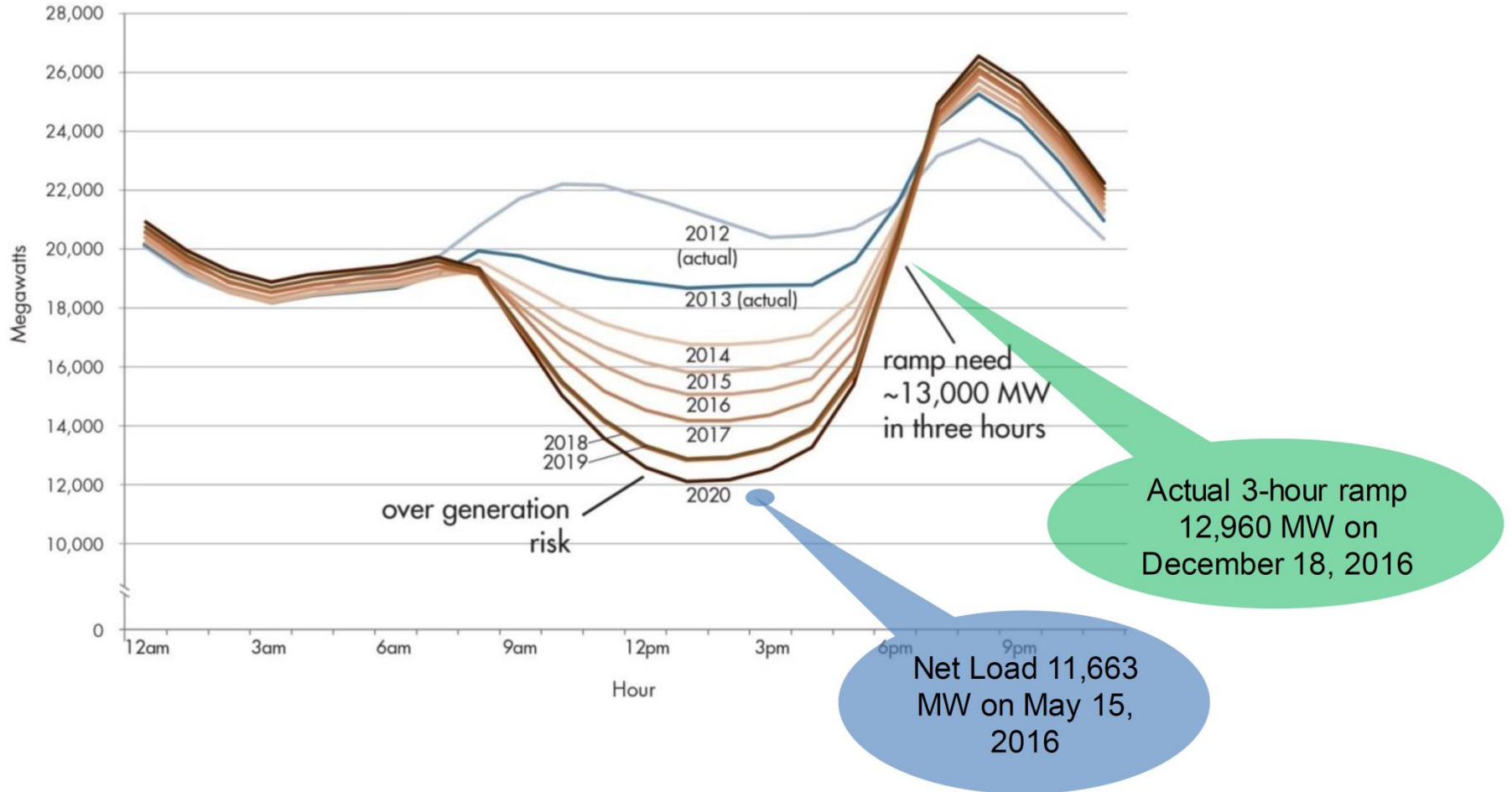
March 9, 2017

# Development of PV Renewable Energy in Taiwan

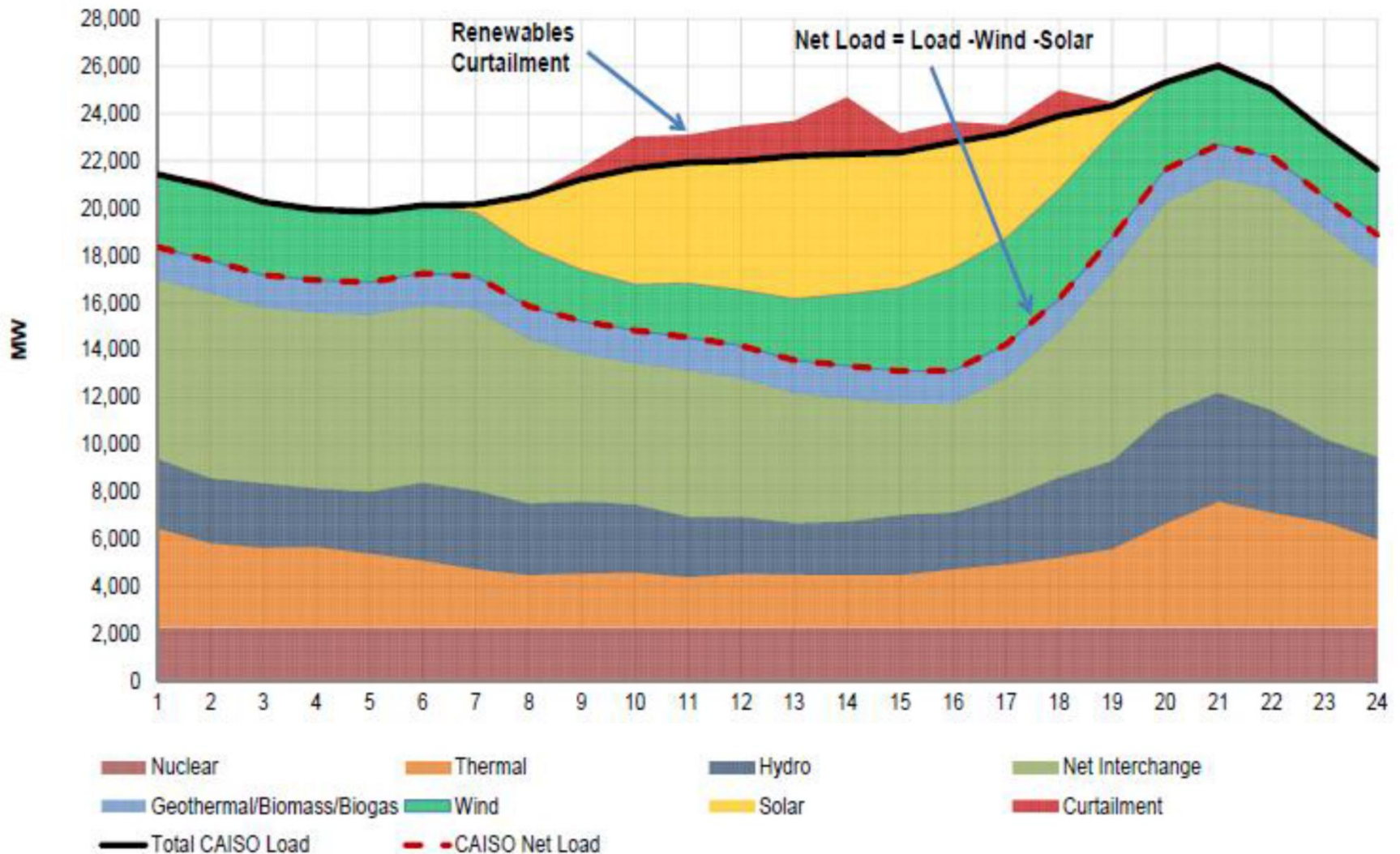


# Duck Load Curve with High PV Penetration (California)

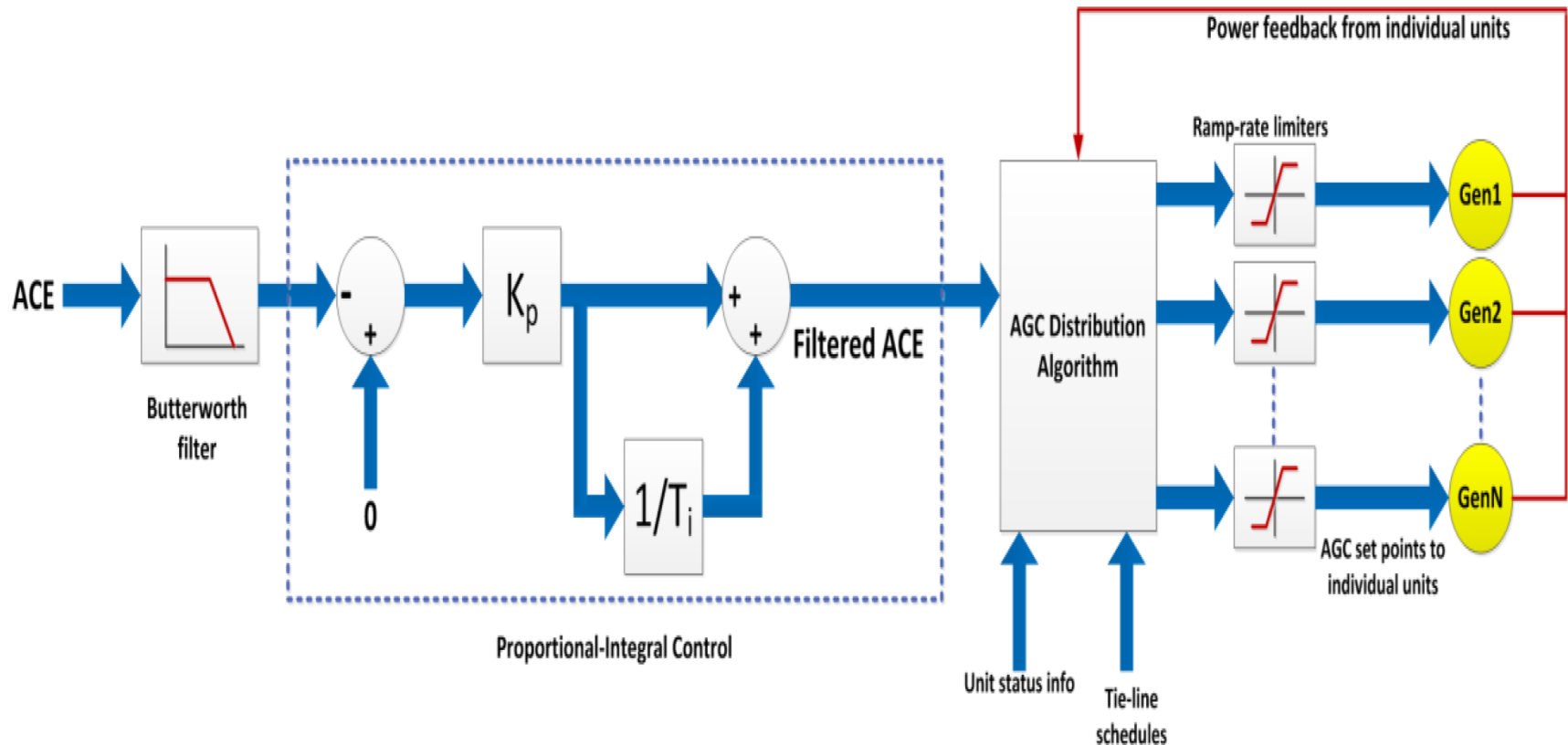
Typical Spring Day



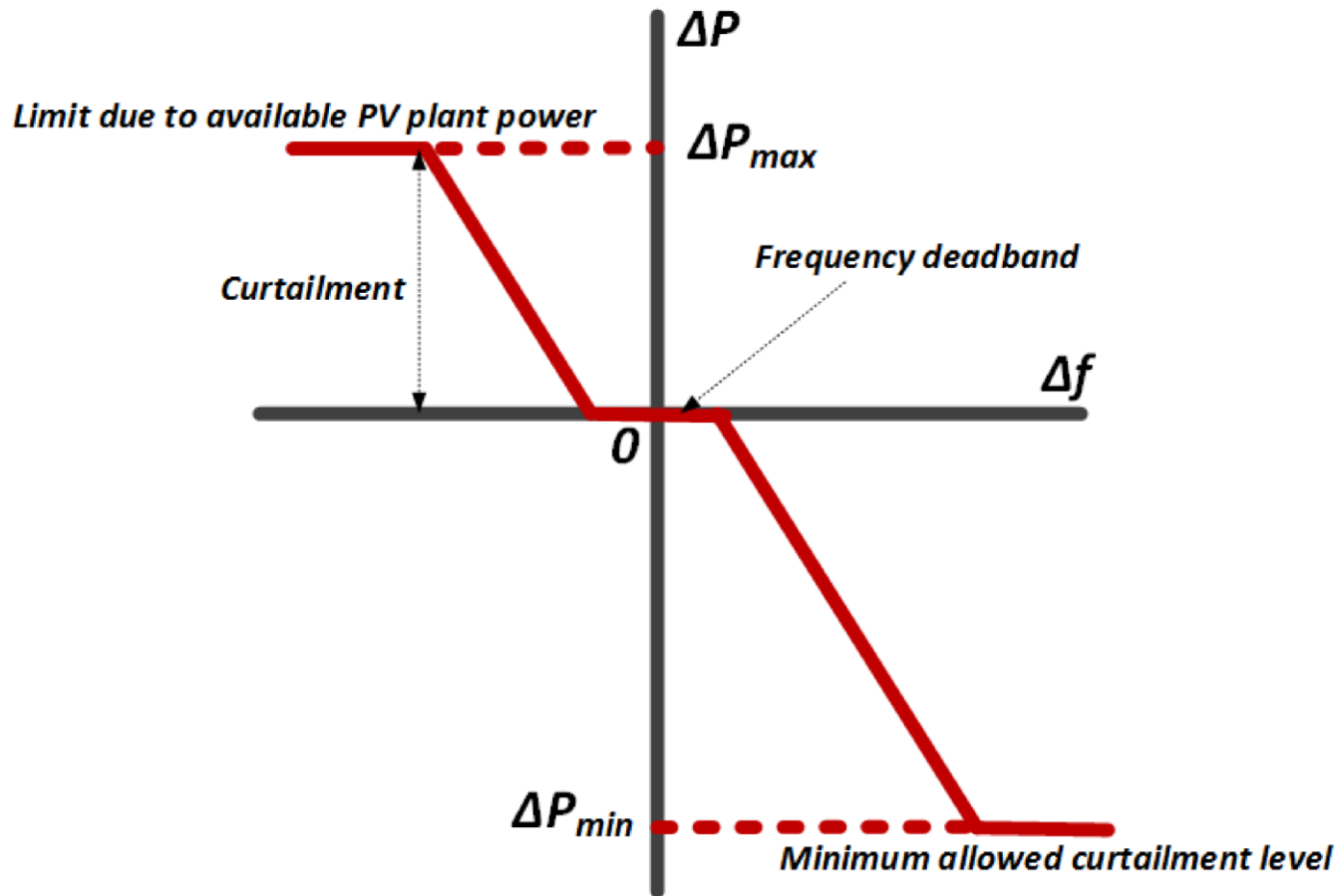
# CAISO generation breakdown for April 24, 2016 (source: CAISO)



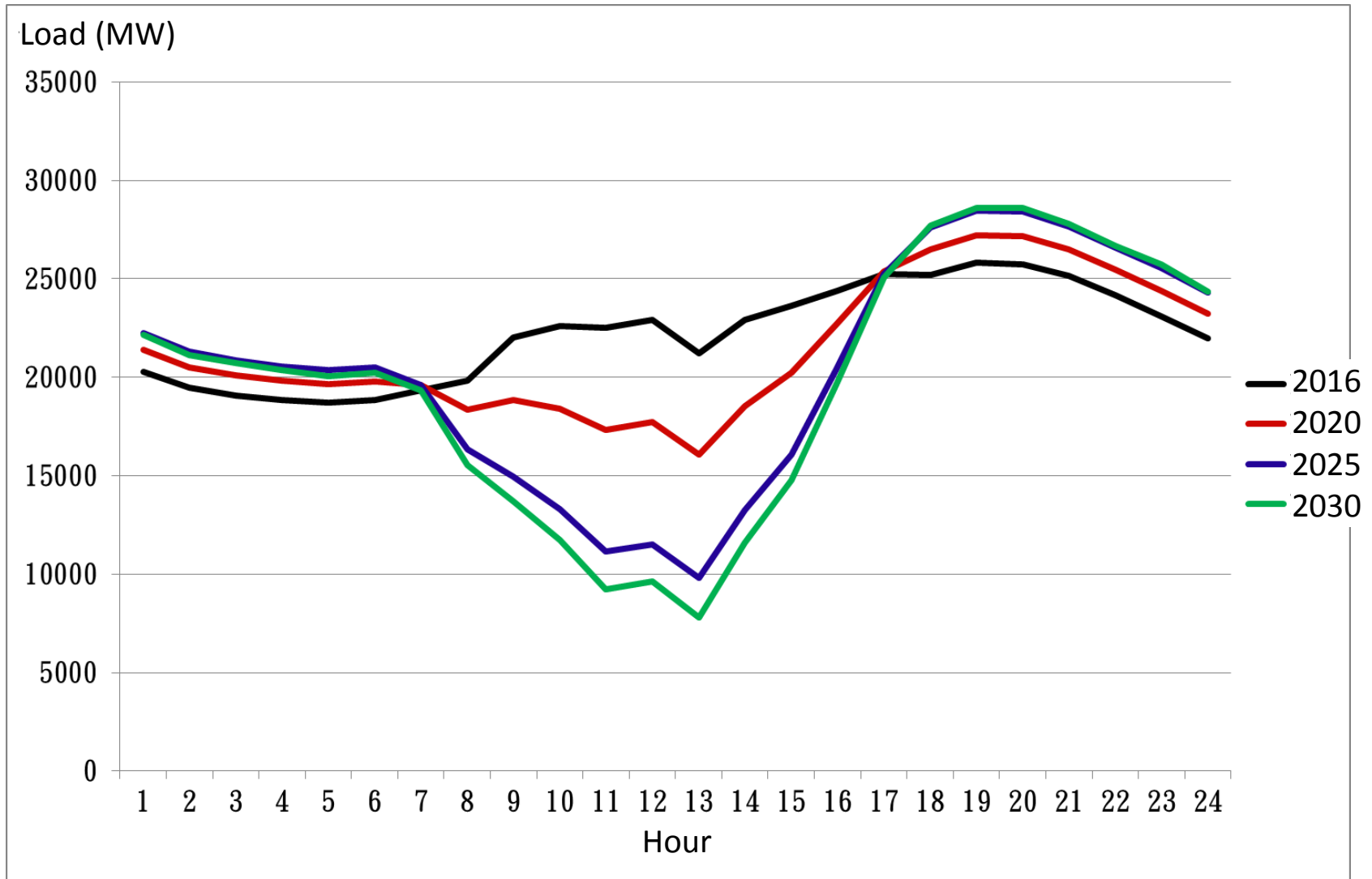
# AGC control of generators and renewable energy



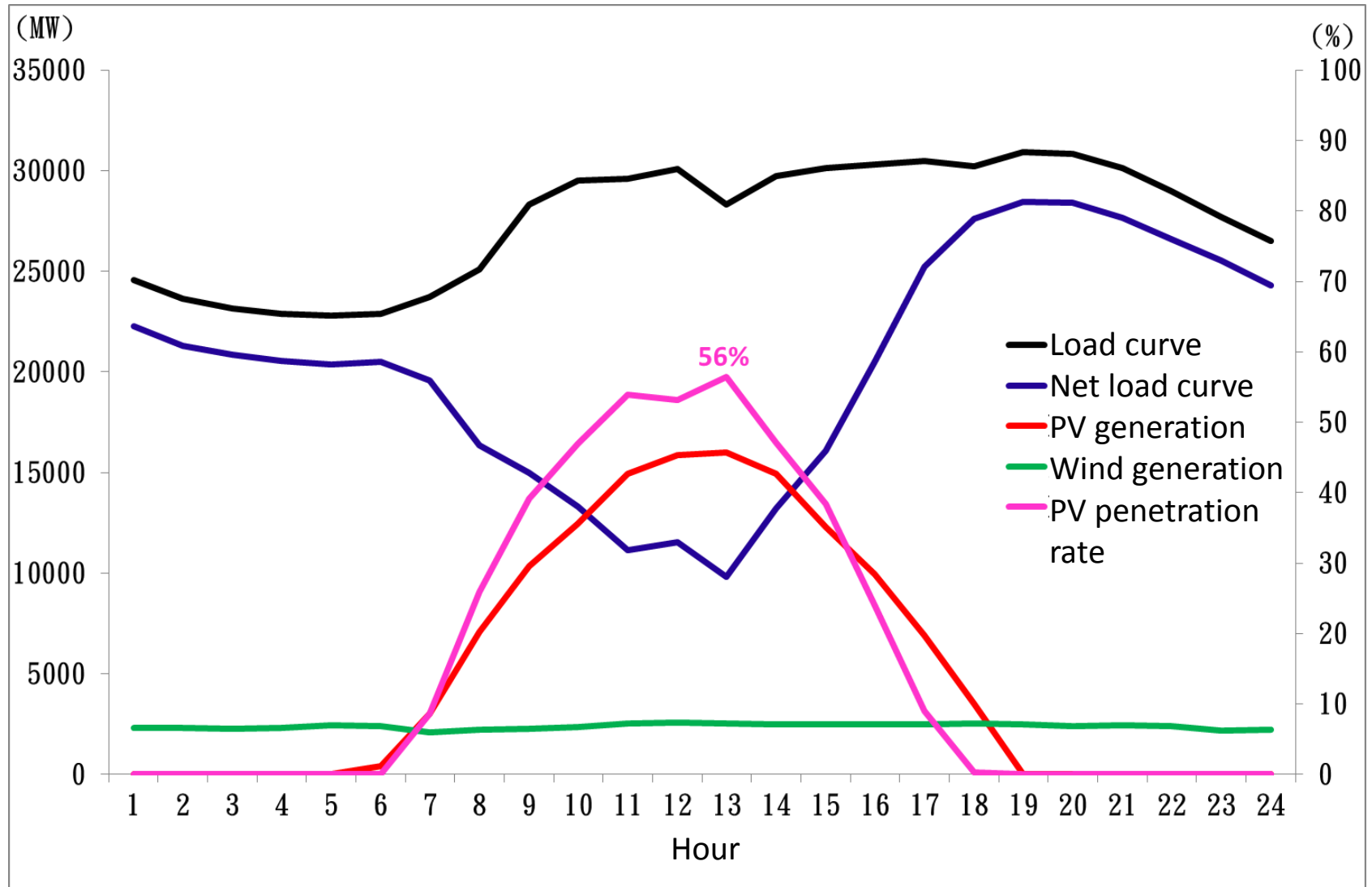
# Frequency droop of renewable energy



# Net Load Curve of Taipower System PV Capacity: 20GW(2025) , 22.5GW(2030)



# PV Penetration and Net Load Curve of Taipower System with PV Capacity of 20GW(2025)

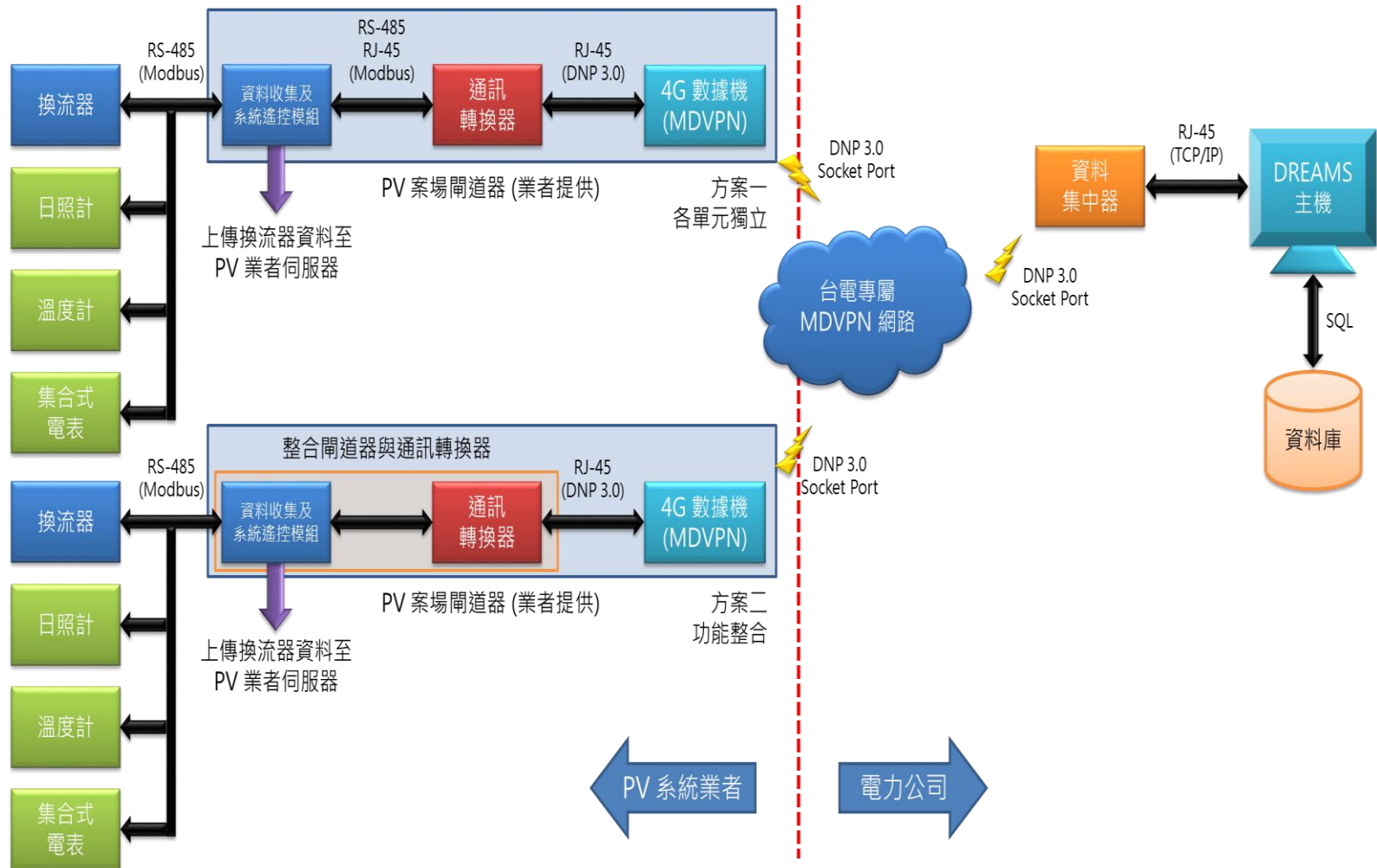




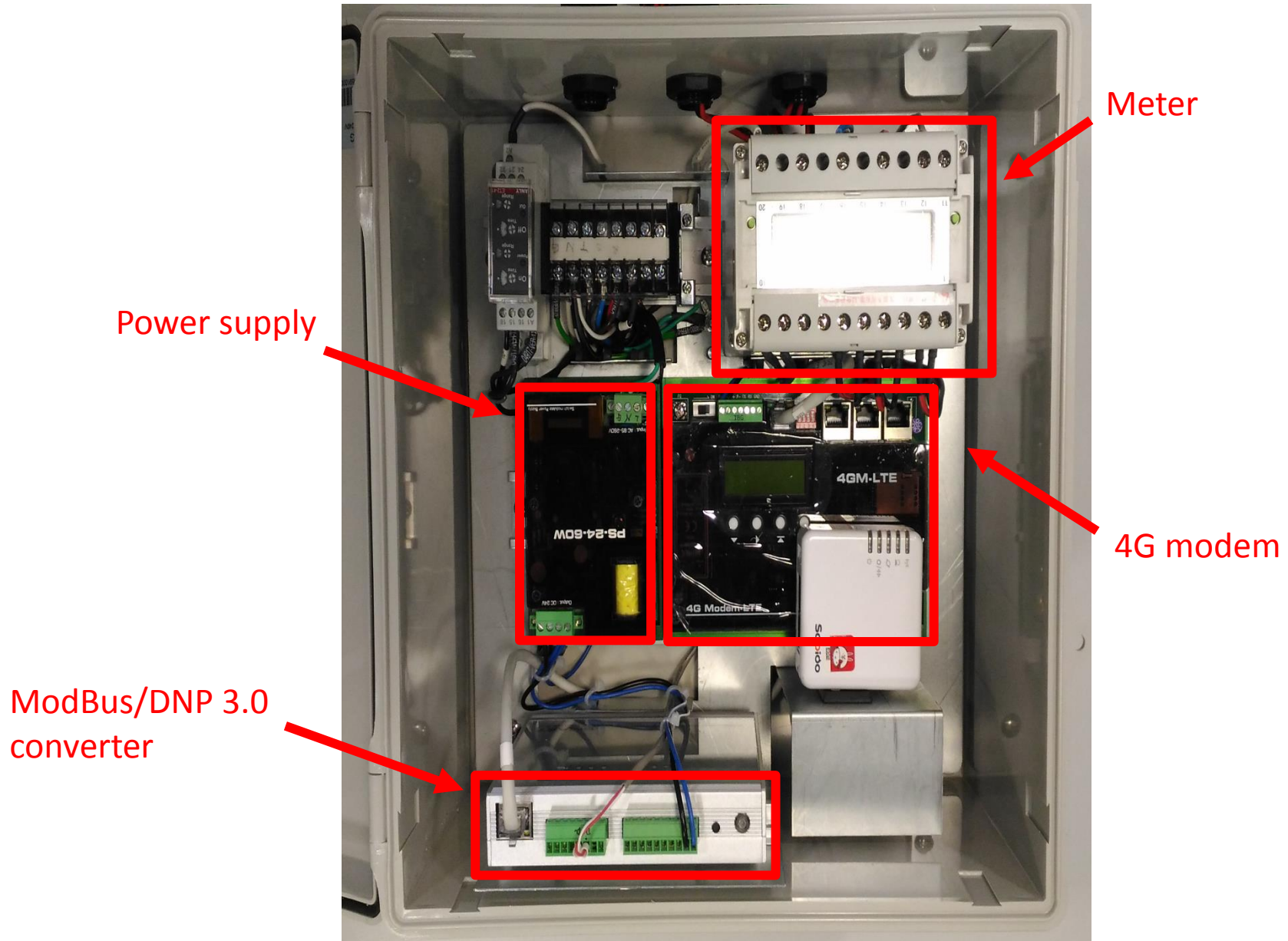
# Challenges of power system with high PV penetration

- Ancillary services (AGC, AVR, Inertia)
- Minimum mode operation of generators
- Ramping up/down capability of generators
- Over voltage
- Ride through capability (Voltage/Frequency) for system contingency

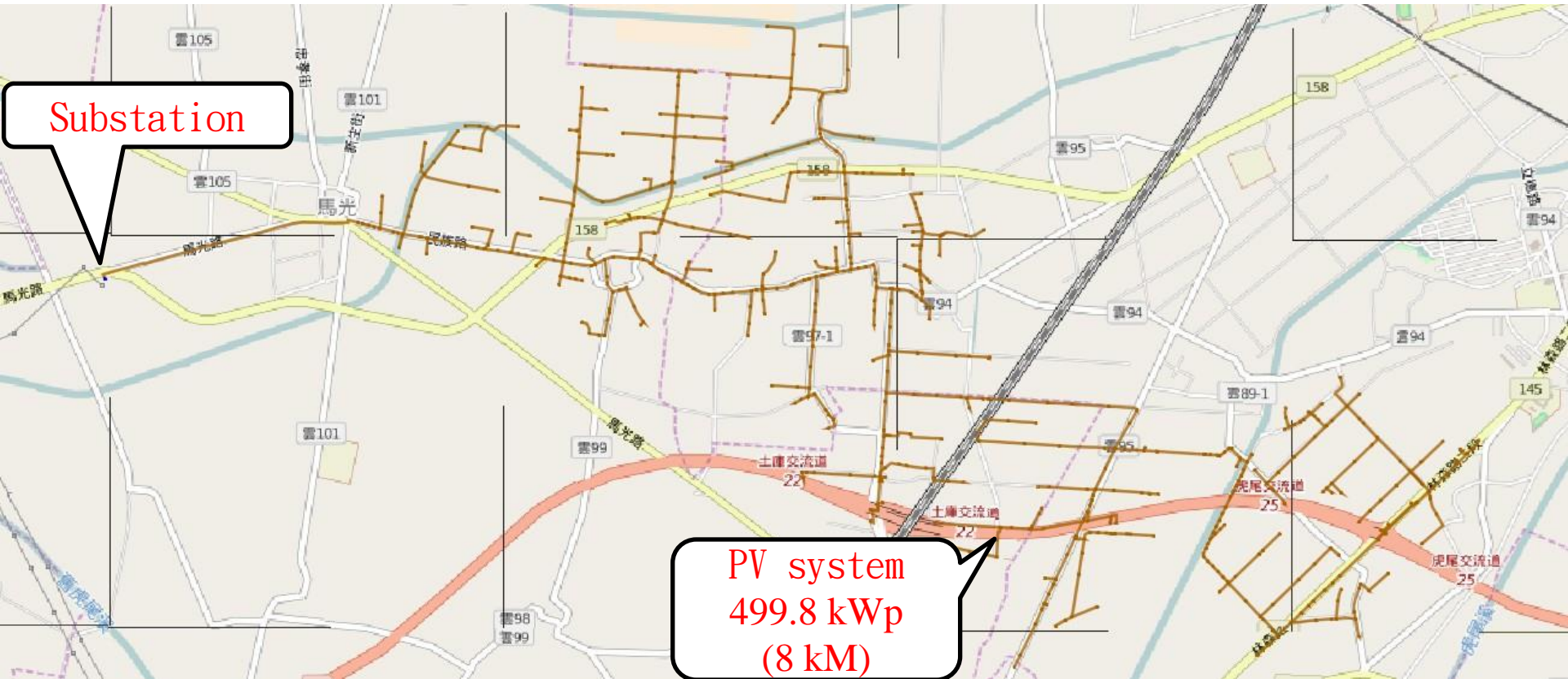
# Communication system of DREAMS



# Gateway of PV system



# Taipower distribution feeder (XD27-Yunlin district)



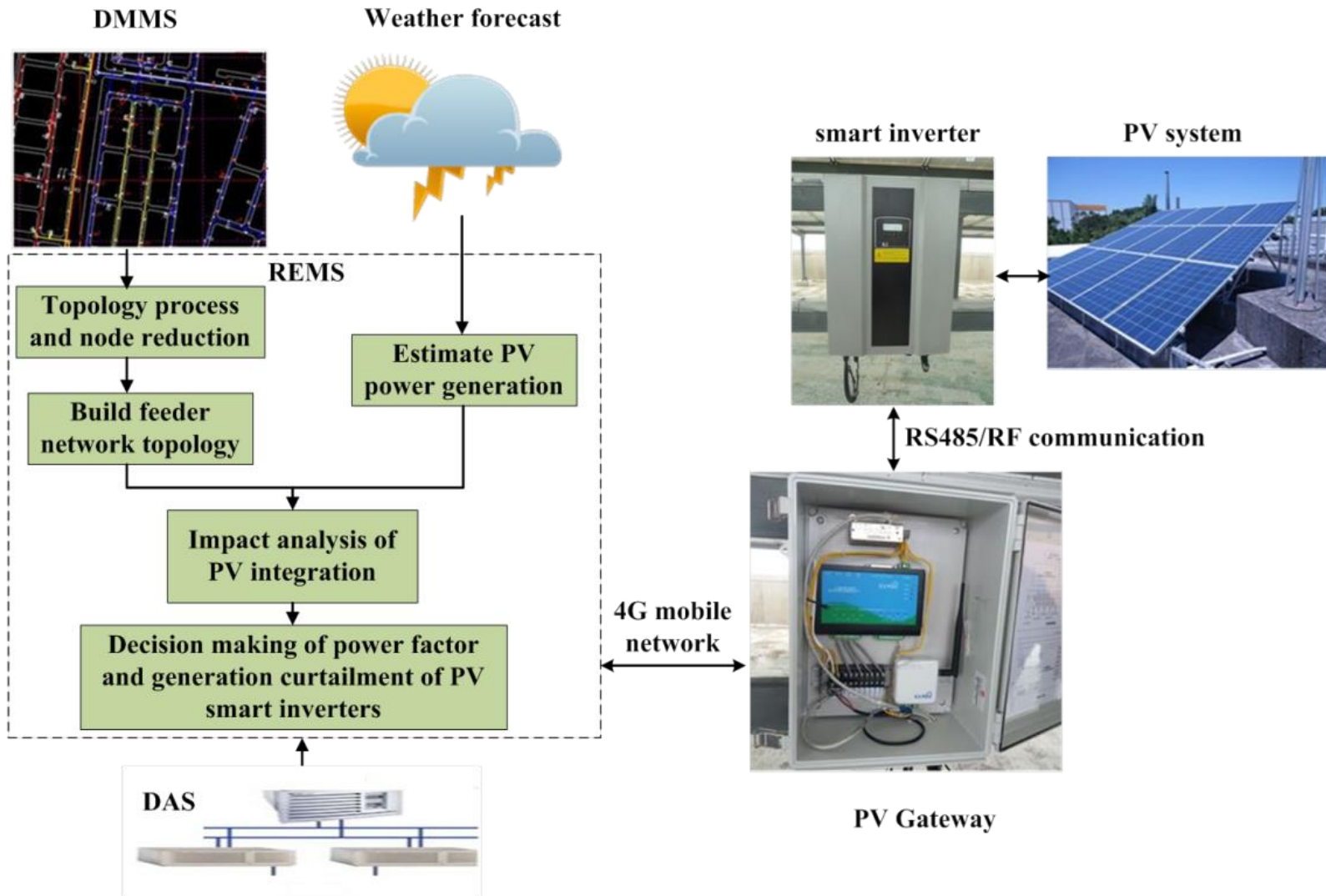
# Enhancement of PV penetration with smart inverter (PF: 1.0 → 0.95)

PF	Maximum PV capacity	Increase of PV capacity
1.0	3154 kWp	1846 kWp
0.95	*5000 kWp	

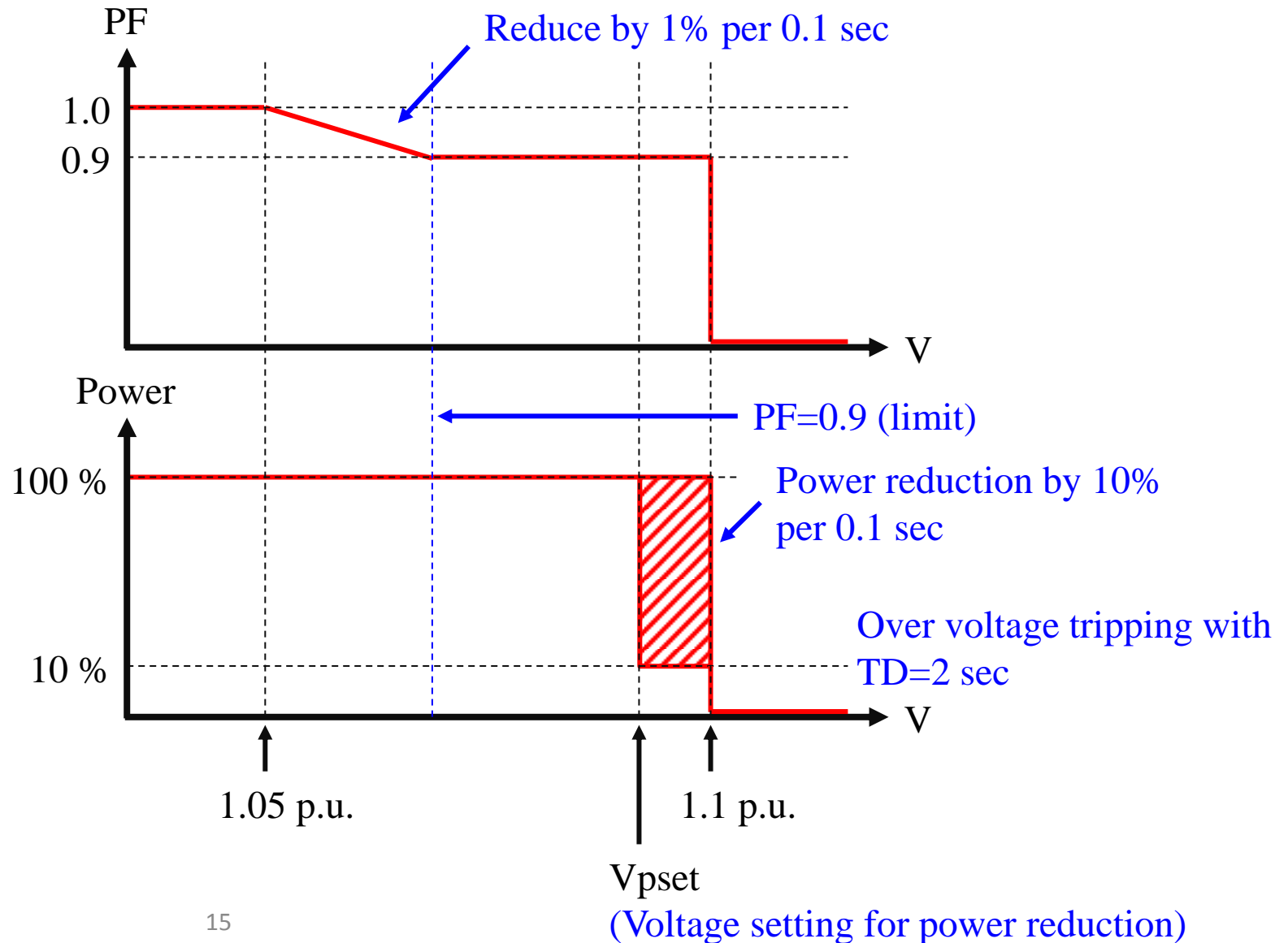
**\*:Maximum limit of PV penetration of Taipower distribution feeder**



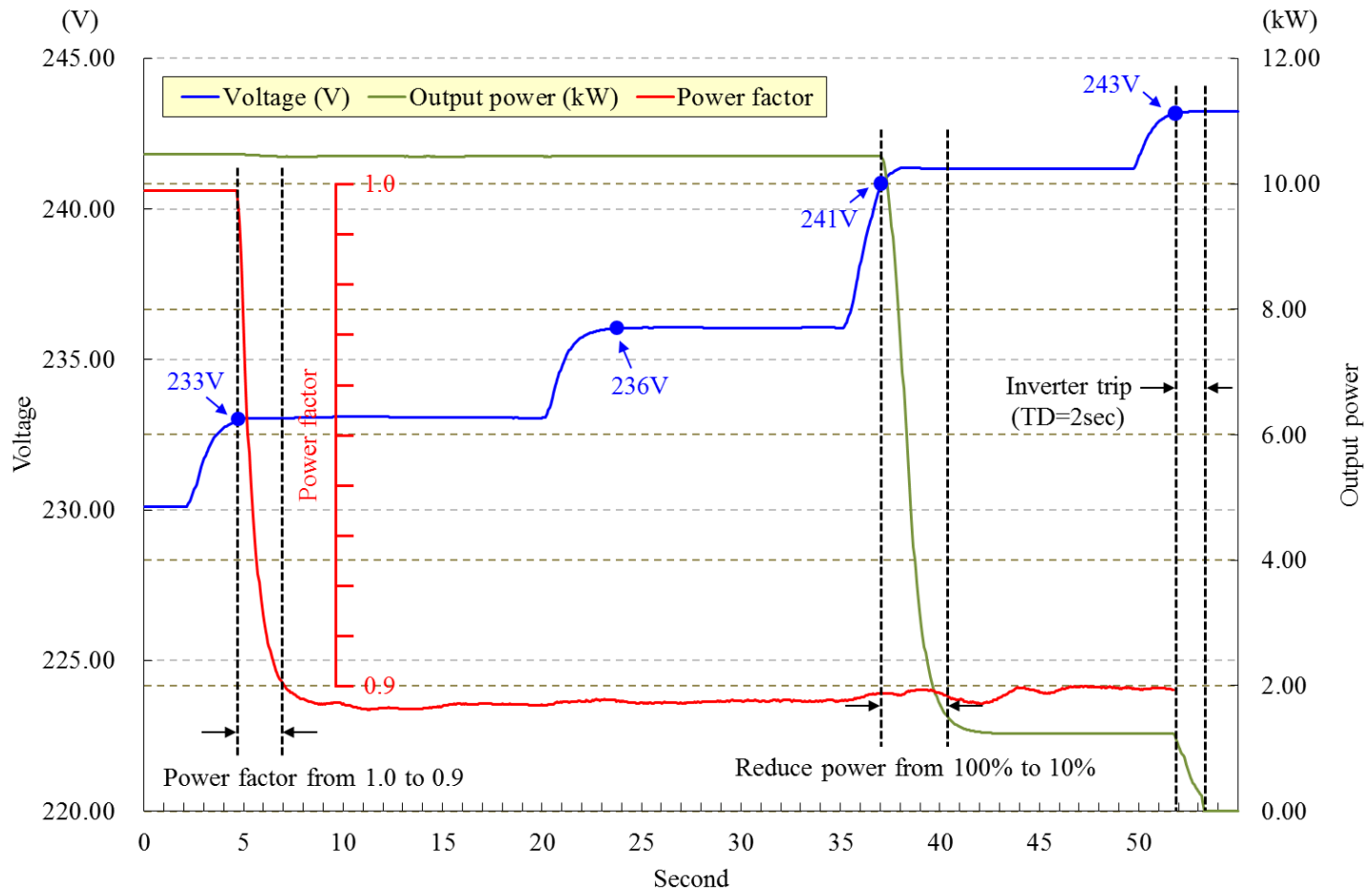
# Distribution Renewable Energy Advanced Management System



# Autonomous control of smart inverter

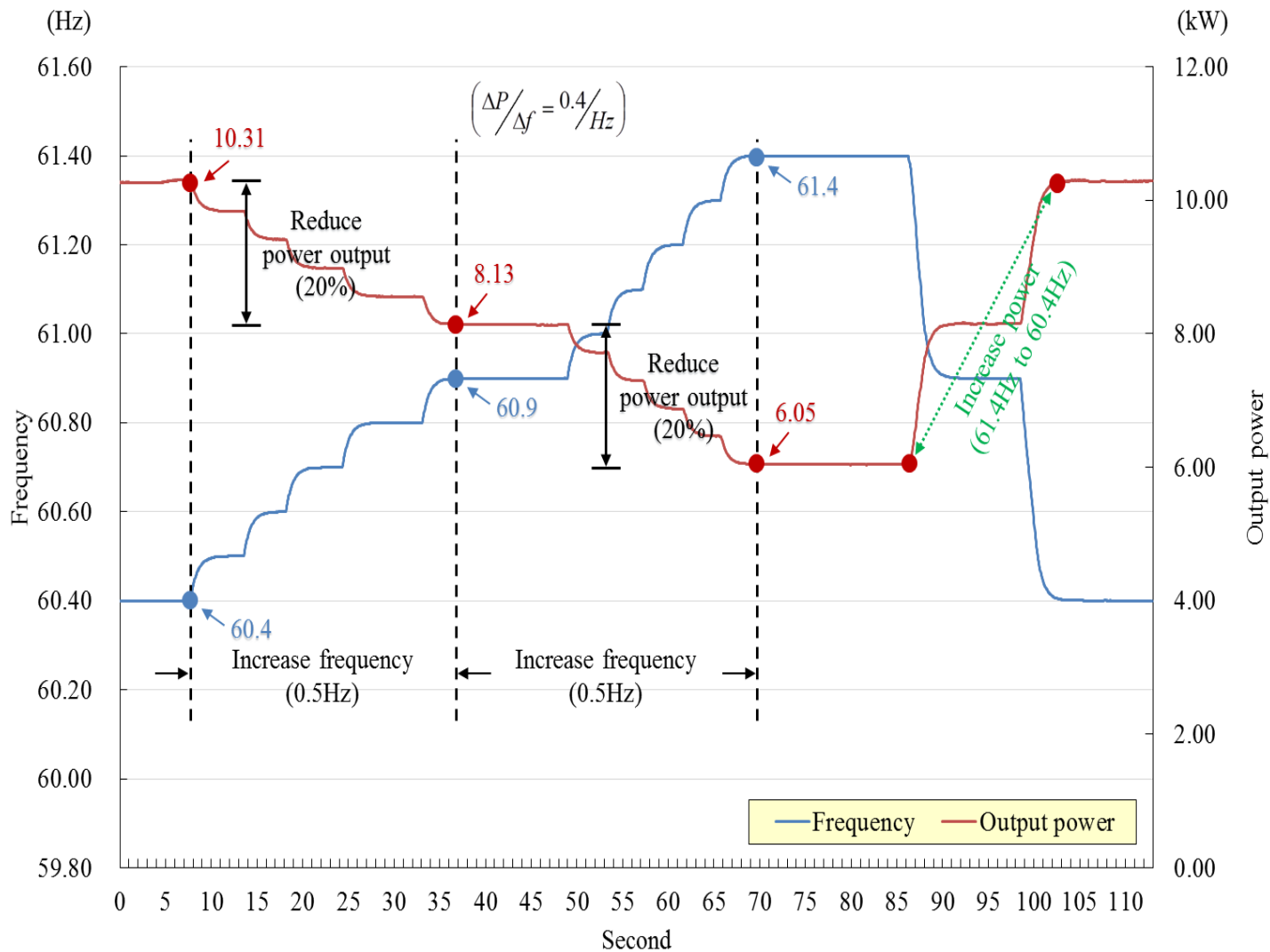


# Response of Autonomous Control of PV Smart Inverters (Power factor reduction/over voltage)

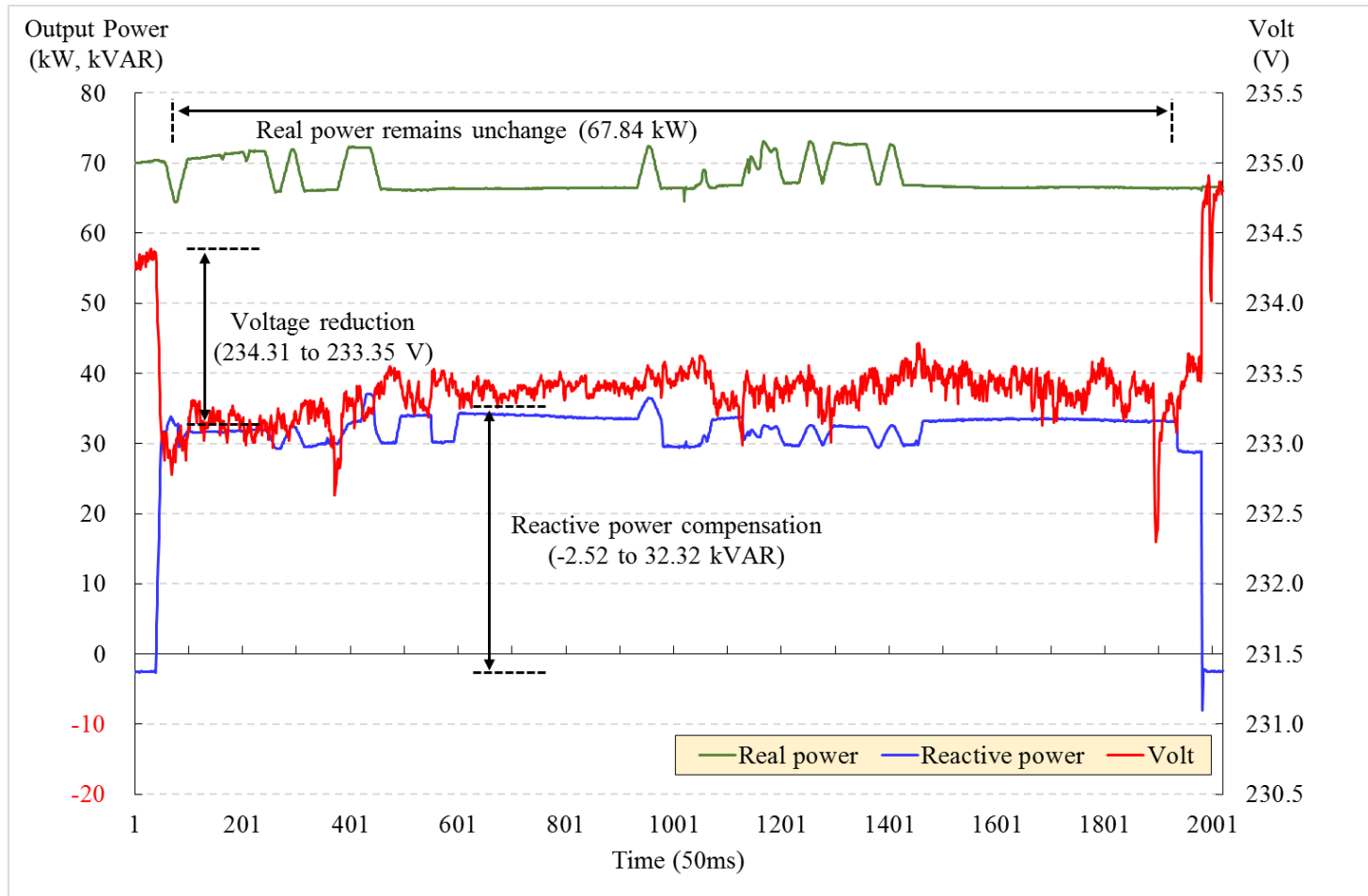




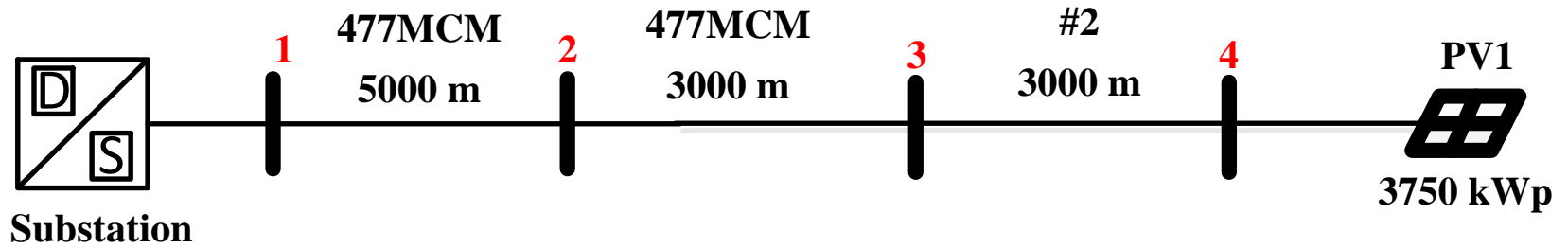
# Response of Autonomous Control of PV Smart Inverters (Power reduction/over frequency)



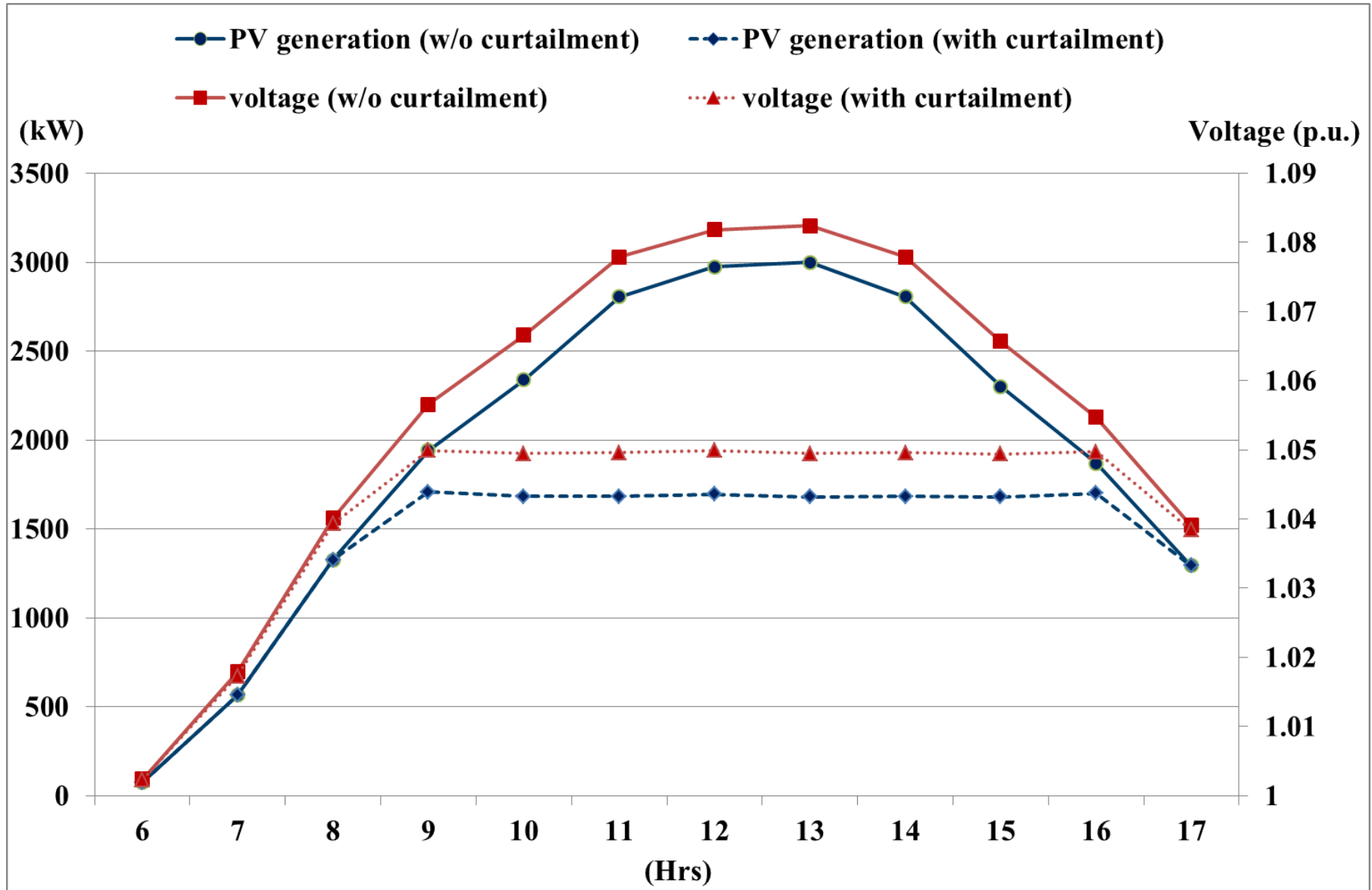
# Field Testing Results of Actual PV System in Taipower



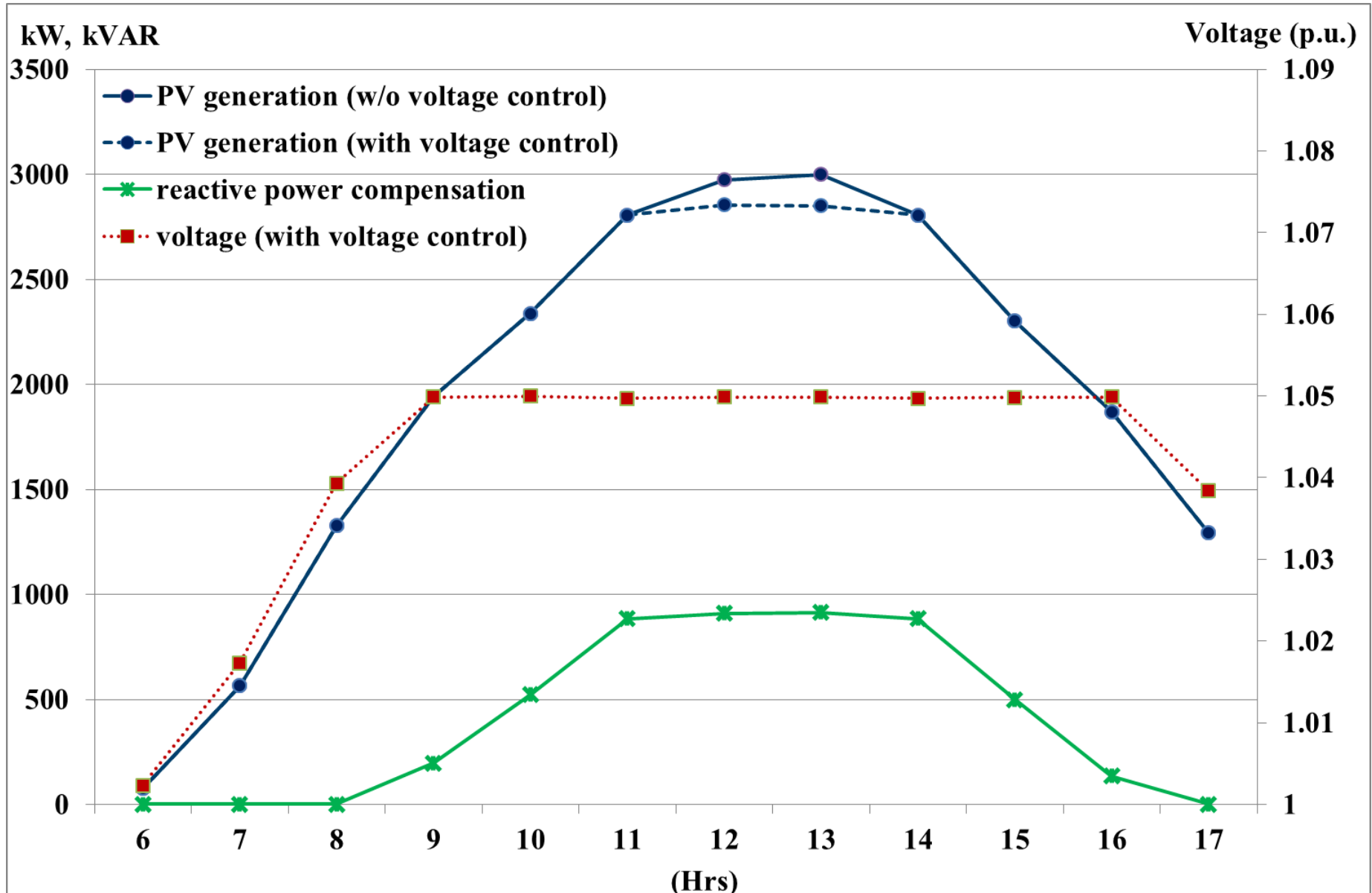
# Test feeder



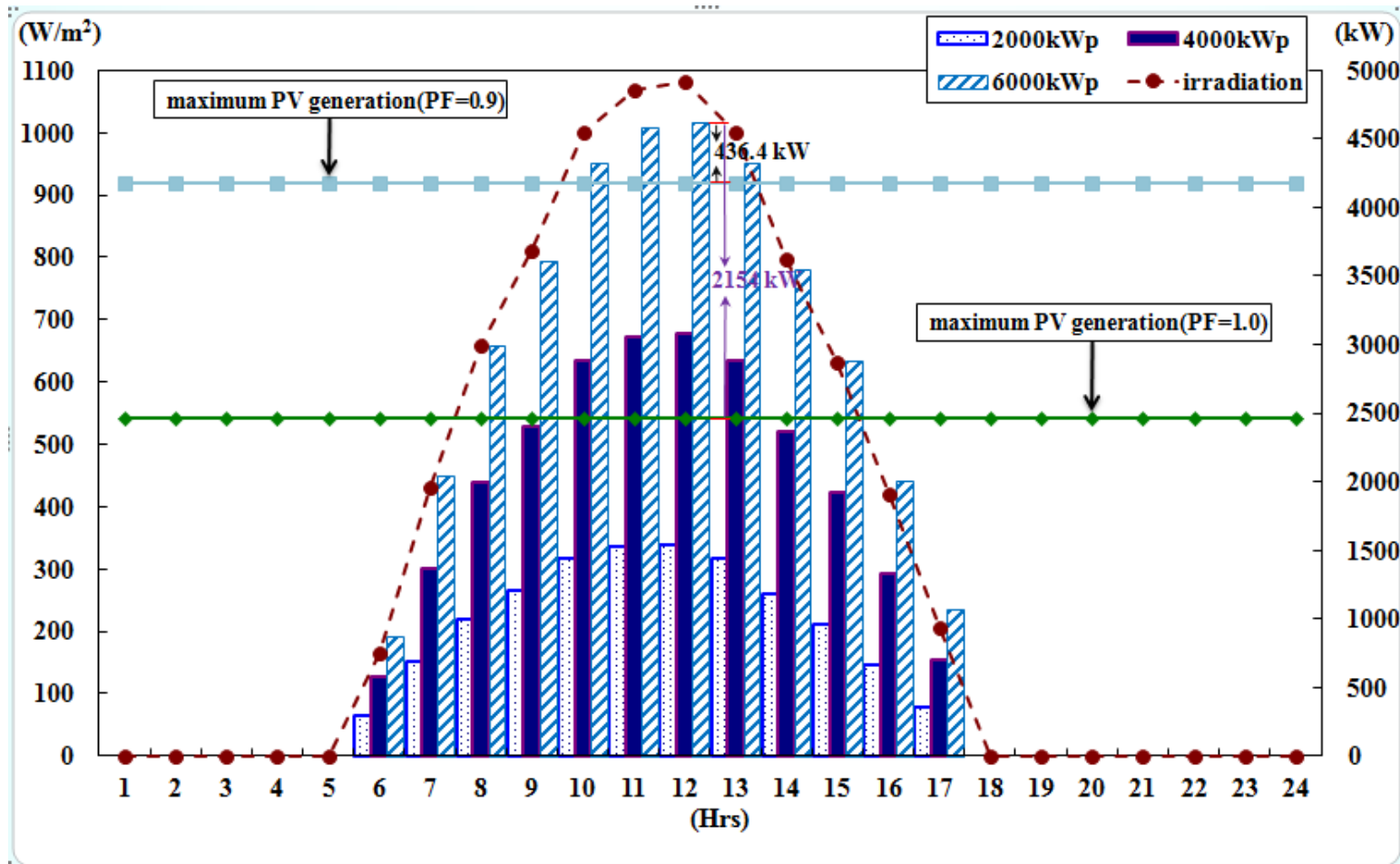
# Power curtailment w/o power factor control (PF=1.0)



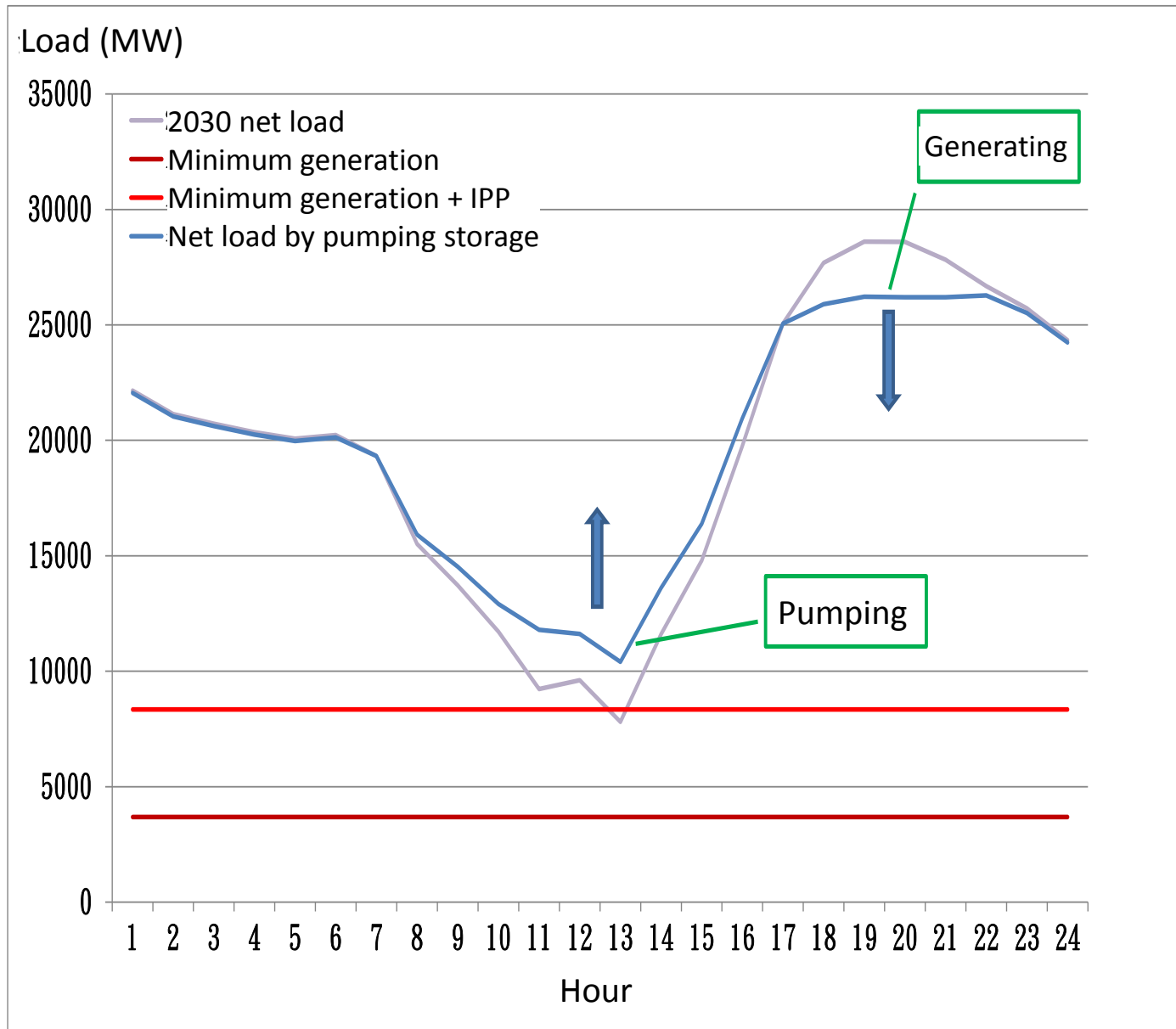
# Power curtailment after power factor control of smart inverter (PF=0.95)



# Enhance PV penetration by power factor control of smart inverter



# Pumping storage for mitigation of PV integration

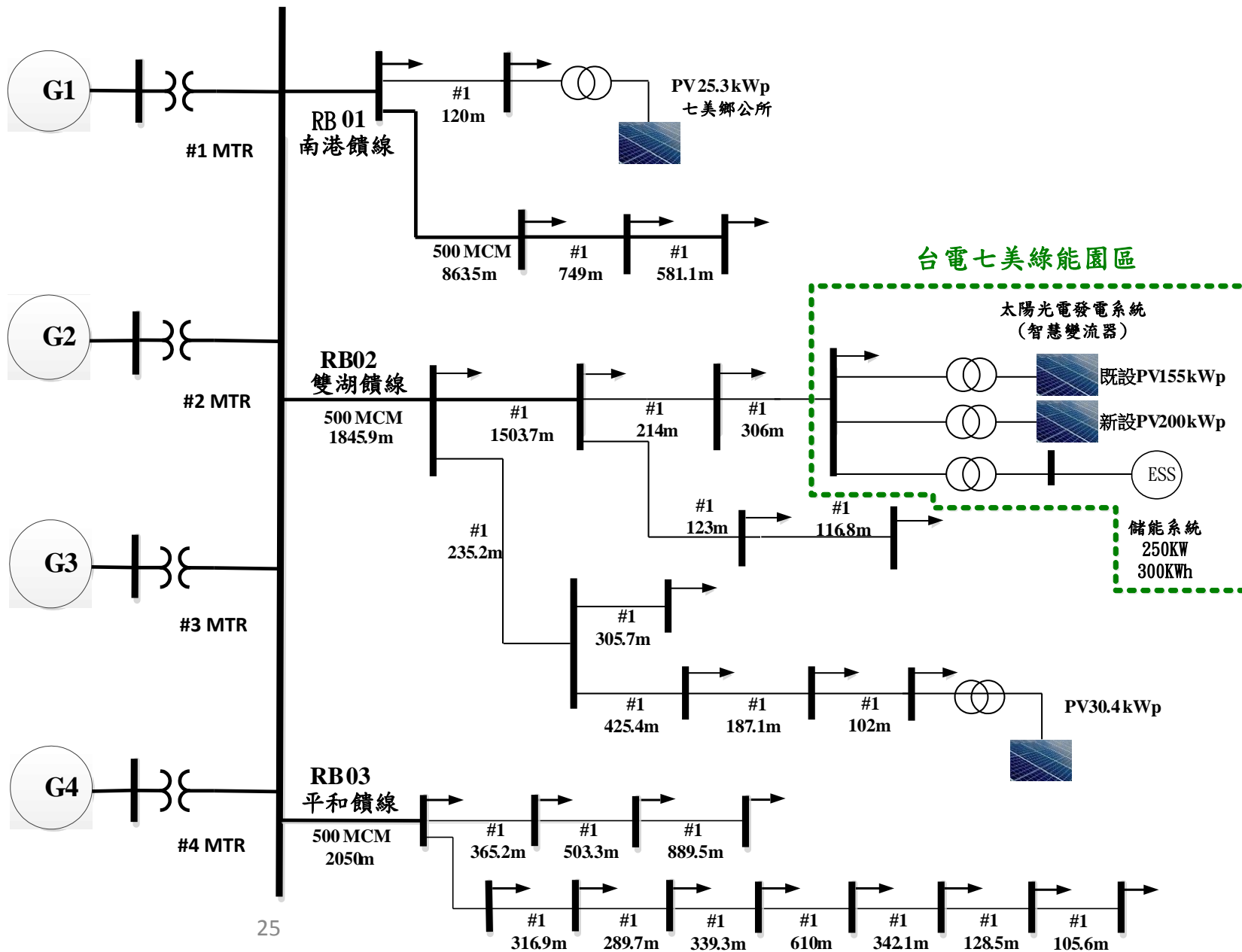


# Cimei Smart Grid

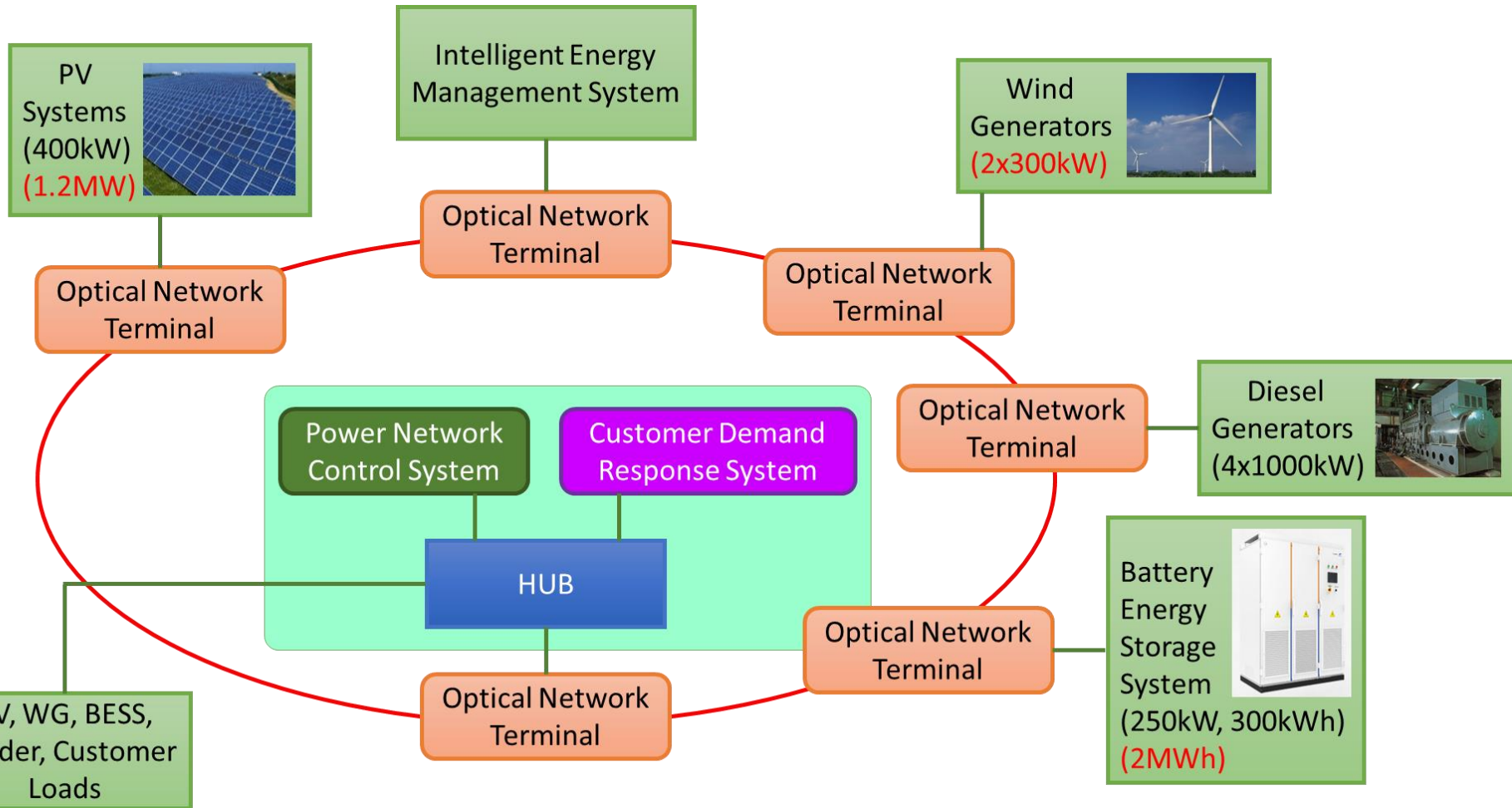
1. Reduce generation cost by high penetration of renewable energy
2. Determine optimal capacity of PV, WG, ES, Diesel Gen for offshore islands
3. Enhance system power quality with smart inverters, ES



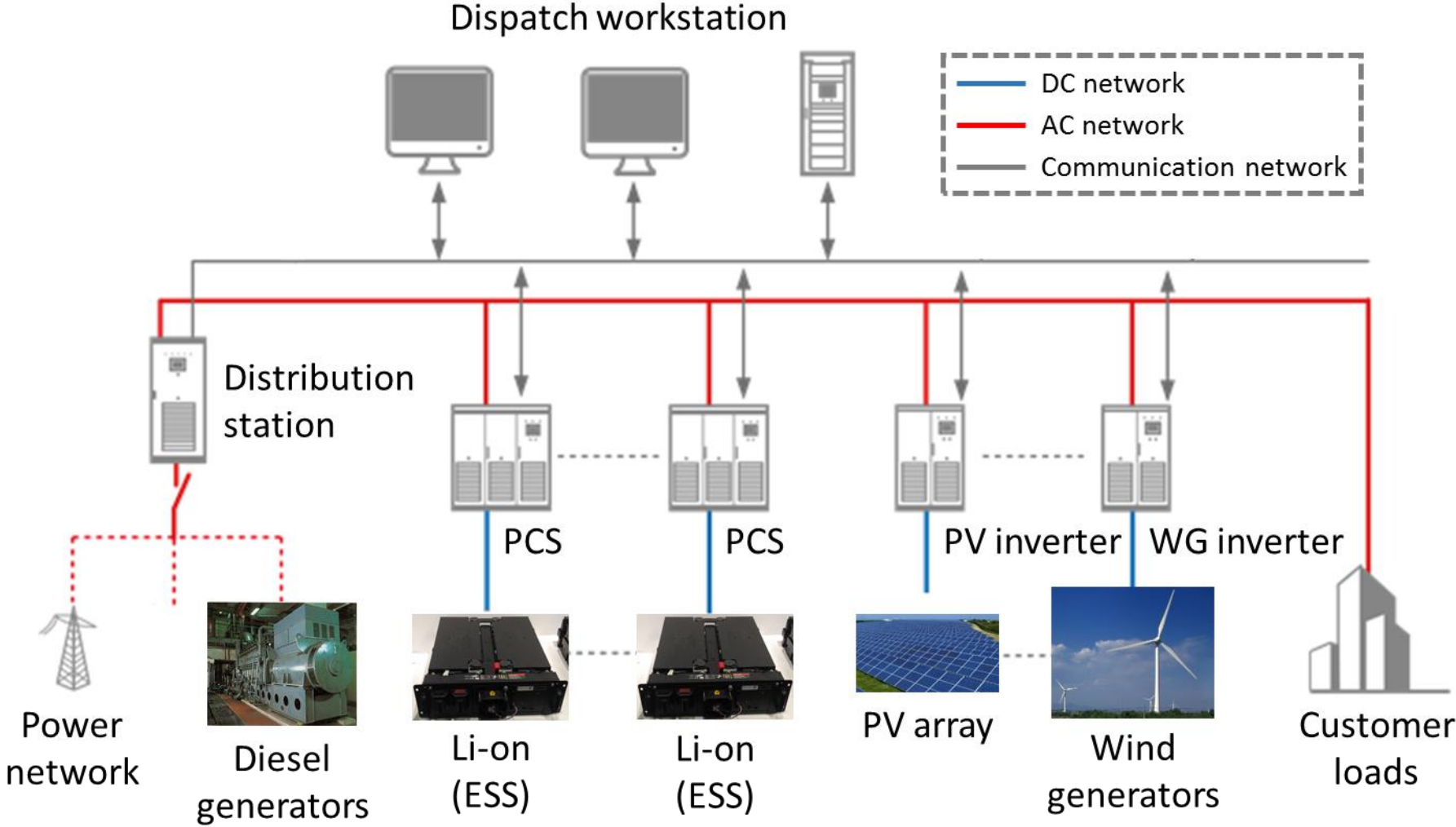
# System Diagram of Cimei Smart Grid



# Cimei Intelligent Energy Management System



# Intelligent energy management system





Thanks for your attention

