Policies and Development of Smart Grid in Taiwan

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第二期能源國家型科技計畫
National Energy Program-Phase II

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Outline

- Current Status of Taipower System
- Master Plan of Smart Grid in Taiwan
- National Energy Program - Phases I-II: Smart Grid General Project
- Penghu Smart Grid Demonstration Project
- Smart PV Inverter Demonstration Project
- Virtual Power Plant Demonstration Project
- AC Microgrid Demonstration Project
- Development of Smart Grid Industry in Taiwan

Current Status of Taipower System

Power System in Taiwan

TPC Power System

Installed Capacity in Year 2013: **41,181** MW

	Installed Capacity	MW		%
Taipower	Nuclear	5,144		12.45
	Thermal	22,132		53.80
	Oil		**3,325**	**8.00**
	Coal		**8,200**	**21.30**
	LNG		**10,607**	**25.60**
	Hydro	4,353.60		**10.5**
	Convential Hydro		**1,792**	**4.20**
	Pumped storage Hydro		**2,602**	**6.30**
	Wind	287		**0.70**
	PV	18		**0.01**
Subtotal of Taipower		32,508.06		**78.50**
IPP	**Thermal**	7,707.10		**18.60**
	Coal		**3,097.1**	**7.50**
	LNG		**4,610.0**	**11.20**
	Hydro	289.10		**0.70**
	Wind	236.10		**0.57**
	PV	350		**0.85**
	CoGeneration	622.00		**1.50**
Subtotal of IPP		8,892.60		**21.5**
Total Installed Capacity		41,181		**100**

Substation	No.	MVA
EHV	**29**	**56000**
Primary	**264**	**68450**
Secondary	**295**	**20728**

	ckt-km
Transmission Lines	**17,054**
Distribution Lines	**351,474**

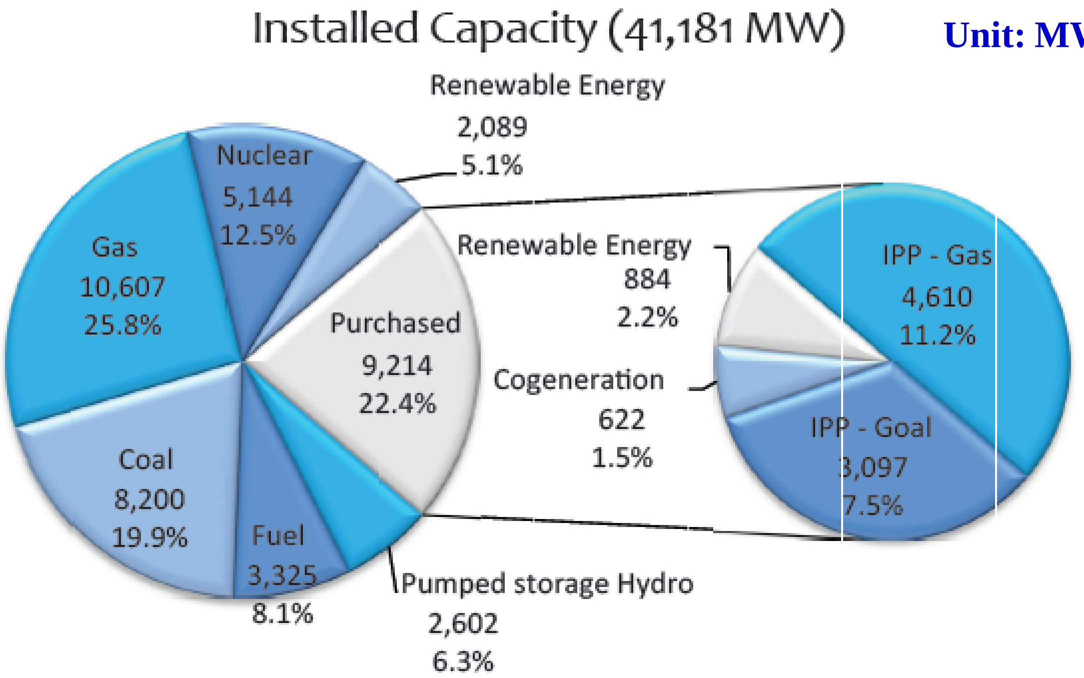
Reference： Taipower www.taipower.com.tw

Power System in Taiwan

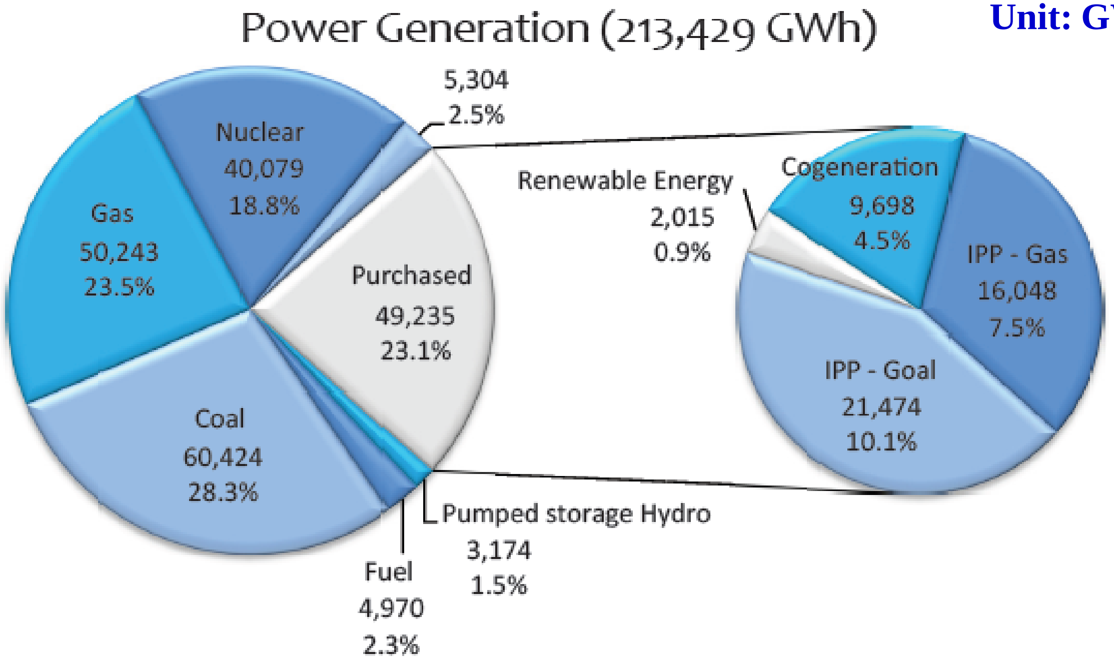
Taiwan Power Profile

Installed Capacity and Generation Data as of **2013**

Unit: MW

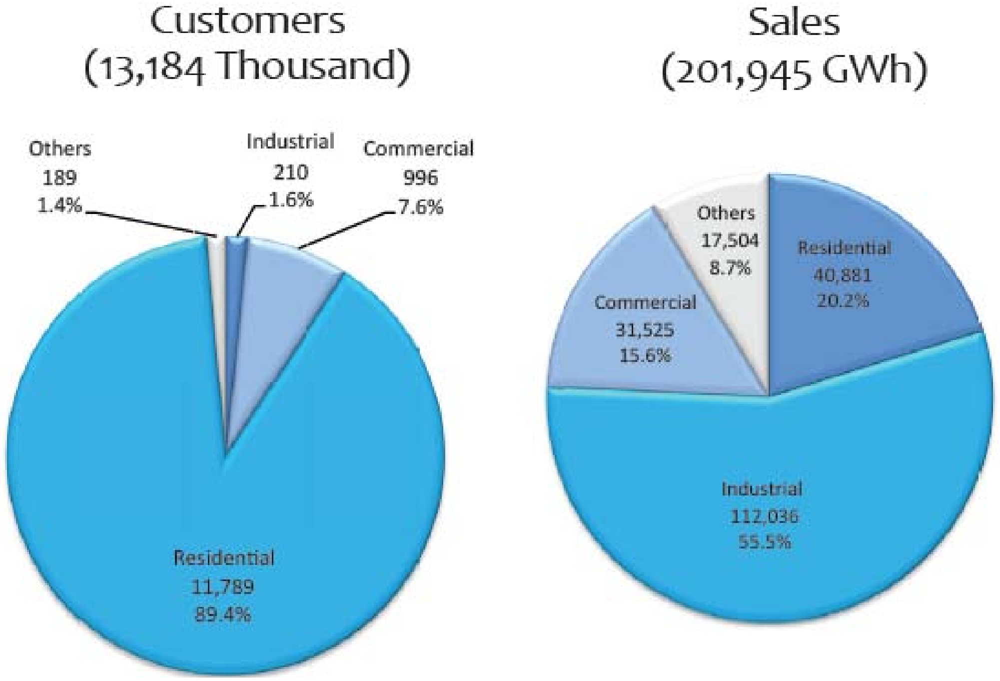


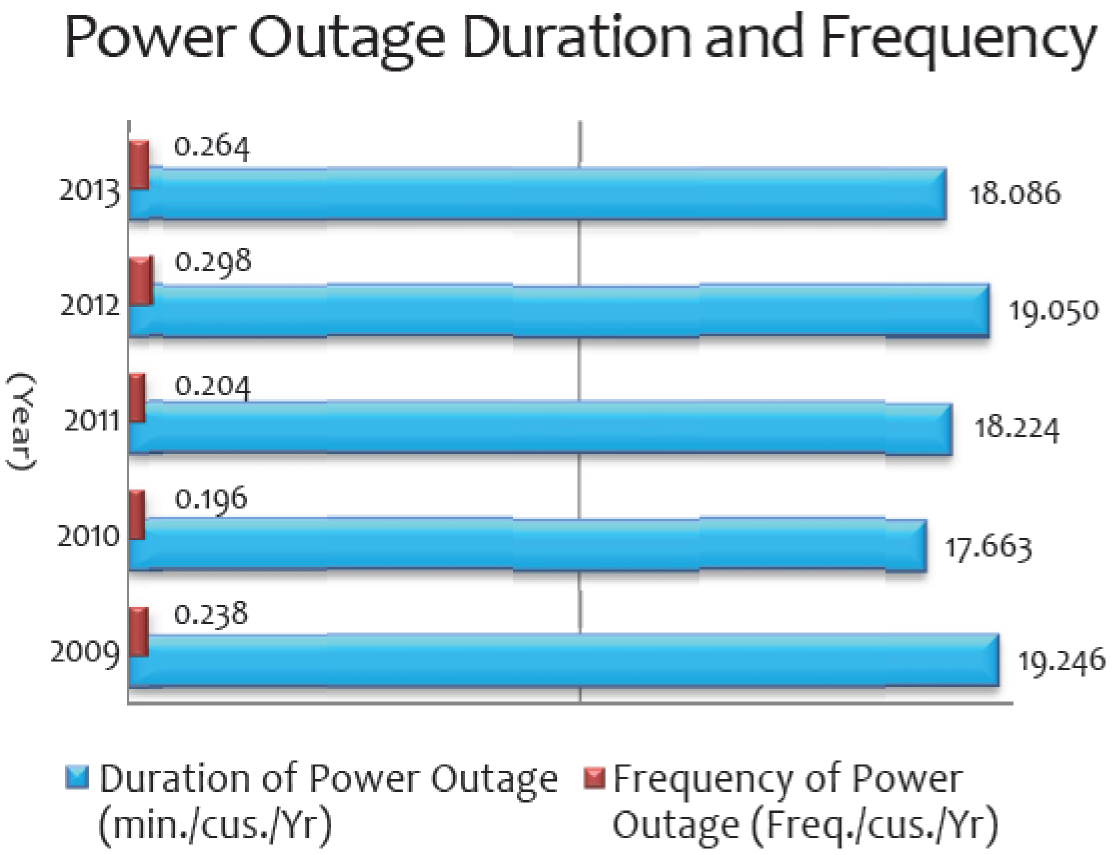
Unit: GWh

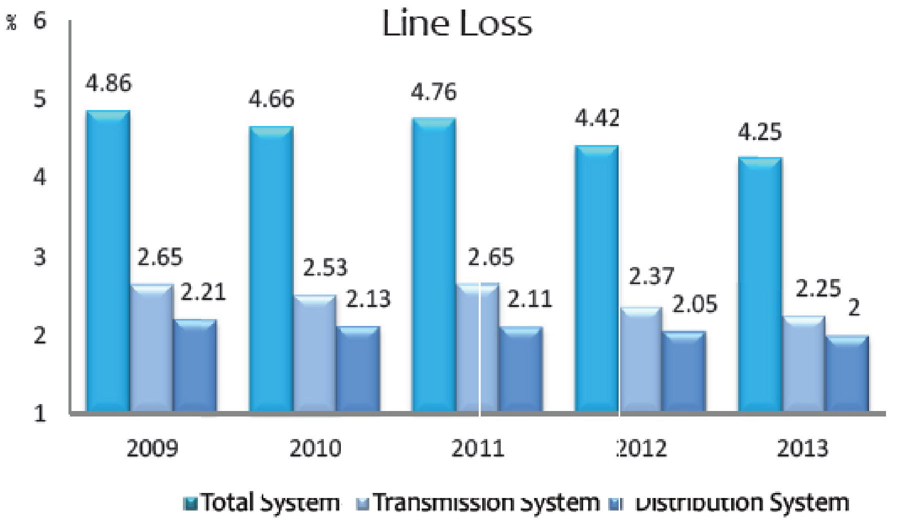


Peak Load in Year **2014**: **34,821MW**

User Profile of Taipower in 2013



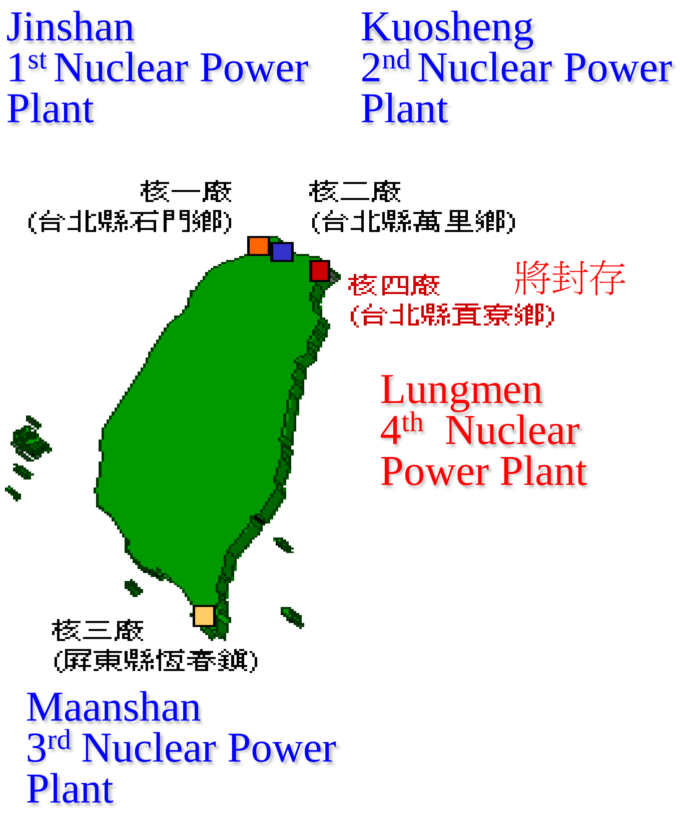




Nuclear Power Plants in Taiwan

■ Nuclear Power Plants in Taiwan

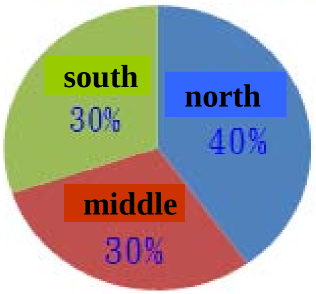
Station	Set	Capacity (MW)	Status
1st Jinshan Nuclear Power Plant	1	636	Retire in 2018
	2	636	Retire in 2019
2nd Kuosheng Nuclear Power Plant	1	985	Retire in 2021
	2	985	Retire in 2023
3rd Maanshan Nuclear Power Plant	1	951	Retire in 2024
	2	951	Retire in 2024
4th Lungmen Nuclear Power Plant	1	1350	Operate after 2017?
	2	1350	Operate after 2018?

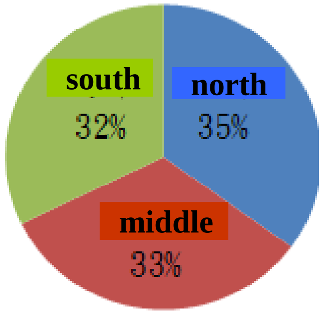


Regional Power Congestion

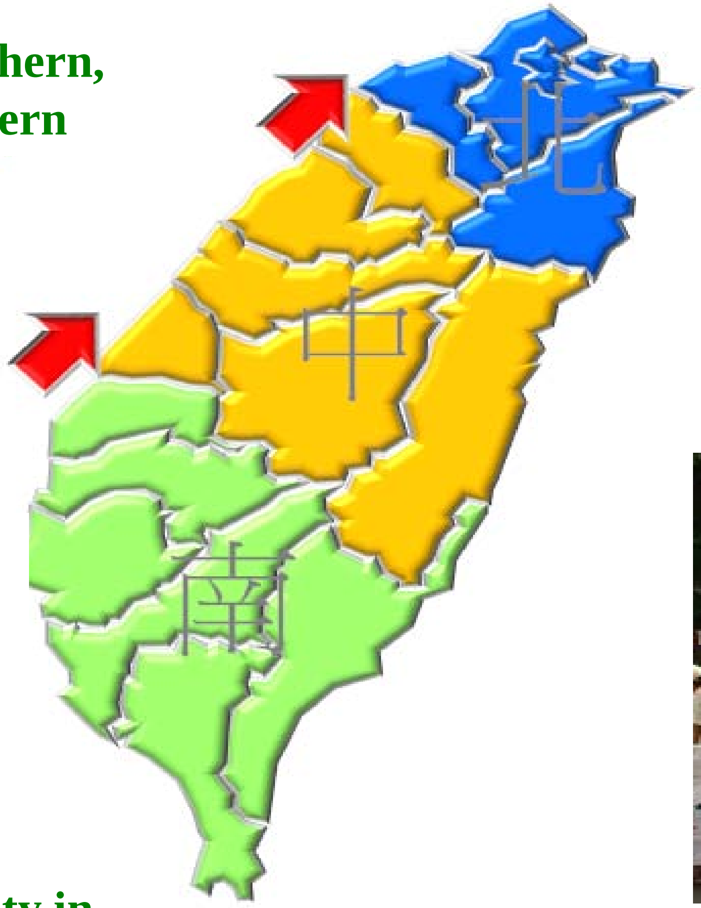
The regional supply capacity and peak load of northern, middle and southern Taiwan in 2013

Peak load in northern, middle and southern





Power supply capacity in northern, middle and southern



Current Status of Taipower and Energy Policy of Taiwan

(1) Current Status of Taipower

a. Due to an extreme lack of indigenous energy resources, Taiwan relies on imported energy resources for 98% of its needs.

b. Fossil fuels play a major role in the energy supply structure, having a tendency of excessive concentration.

c. As an isolated power system, Taiwan Power network has not yet been connected to other power systems.

d. Taipower is owned by the government. Under the government's policy, flat electricity prices have been failing to reasonably reflect the costs.

(2) Energy Policy of Taiwan

a. **Steadily Reducing Nuclear Dependency**

   a) No extension to life spans of existing plants, and the decommissioning plan should be launched as planned.

   b) The security of the 4th Nuclear Power Plant must be ensured prior its commercial operation.

b. **Replacing Nuclear with LNG** for **Base Load**

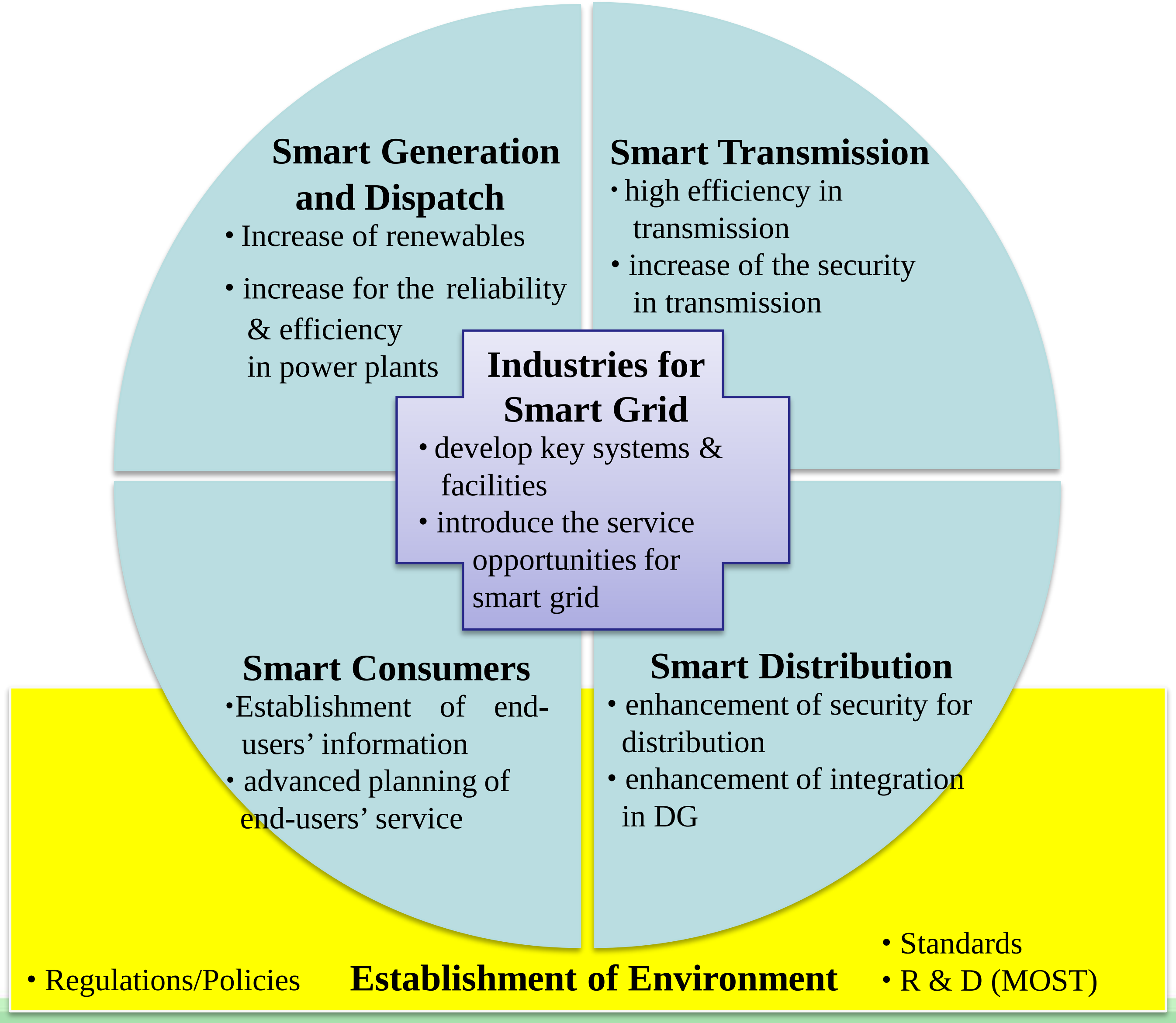
   a) LNG total installation capacity is expected to reach 26,532 MW (accounting for 40% of total capacity of power installations) by 2030.

c. **Promoting Renewable Energy Extensively**

   a) Under the campaign of "one thousand wind mills" and "one million sunshine roofs", the installed capacity of renewable energy is expected to reach 17.25 GW (accounting for 20% of total power installations) by **2030**.

Master Plan of Smart Grid in Taiwan

Master Plan of Smart Grid in Taiwan (2011~2030)



Task Forces：

- **Ministry of Science and Technology (MOST)**
- **Ministry of Economic Affairs (MOEA)**
  - Bureau of Energy
  - Bureau of Standards
  - Industrial Development Bureau
  - Department of Industrial Technology
- **Taiwan Power Company**
- **Institute for Information Industry**
- **Institute of Nuclear Energy Research**
- **Industrial Technology Research Institute**
- **Taiwan Institute of Economic Research**
- **Taiwan Smart Grid Industry Association**

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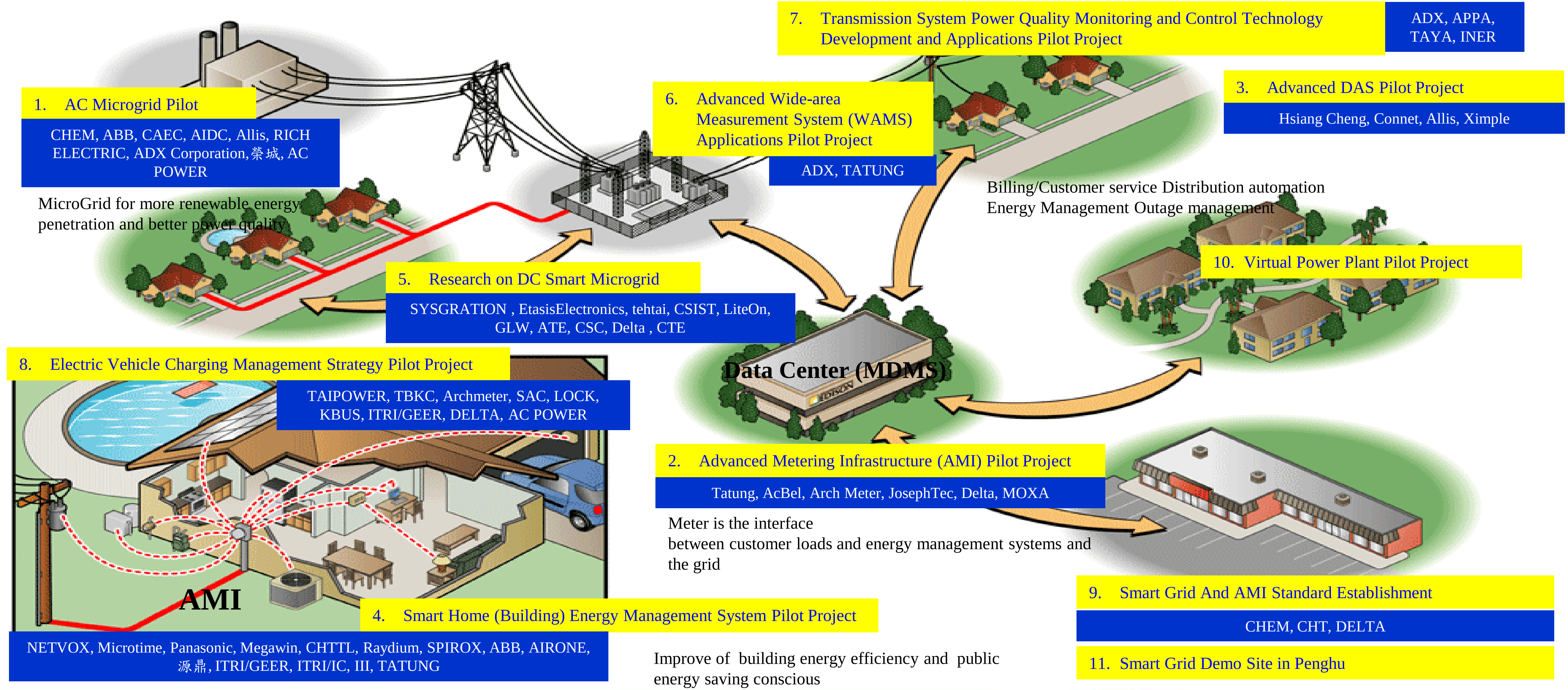
Objectives of Smart Grid Master Plan

Benefit	Objective	2010	2020	2030
Security & Reliability in Power Grid	System average interruption duration index (SAIDI)	21min/ customer · year	16min/ customer · year	15.5min/ customer · year
Energy Efficiency	Efficiency in thermal power plants	42.52%	44.73%	(2023 44.95%)
Renewable (Including Hydro Power)	Percentage of installed capacities	4.7% (2GW)	16% (8.3GW)	26% (17.25GW)
Carbon Reduction	Carbon Oxide reduction	(CO_2 emission: 276 million tons)	35.99 million tons	114.71 million tons

National Energy Program-Phases I-II:
Smart Grid General Project

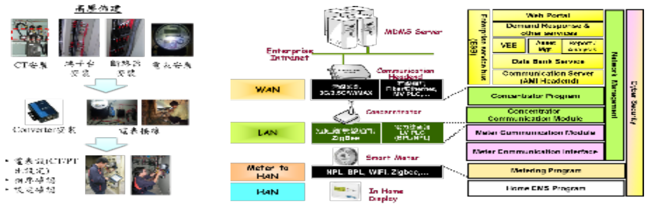
National Energy Program-Phase I: Smart Grid General Project

Pilot Projects and Preliminary Collaborating Firms

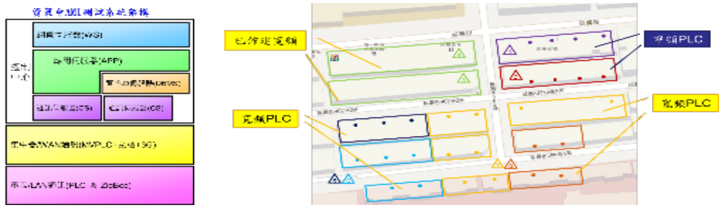


Smart Grid Demo Sites in Taiwan-1

There are currently 18 Smart Grid Demonstration Sites in Taiwan.

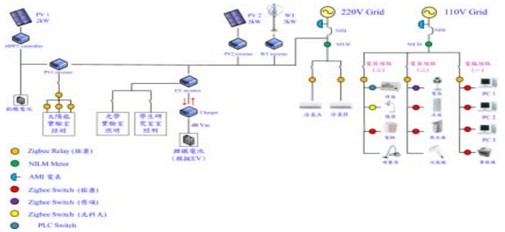


Smart Meter Reading & Demand Response System

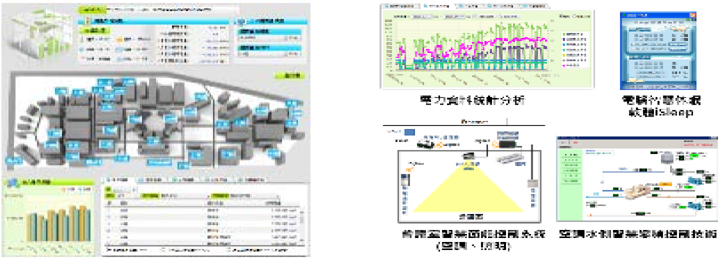


Demonstration of Smart Meter Reading in a Metropolitan Setting

Smart Meter System and Home Energy Management System Demonstration Area



Smart Home (Building) Energy Management System

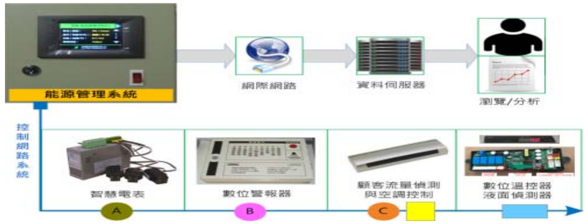


Smart Building Energy Conservation Demonstration Area

Smart Grid Control Center and Smart Home Demo Room

Wastewater Treatment Plant Power Equipment Monitoring and Energy Conservation Management System

Hypermarket Energy Conservation Management System

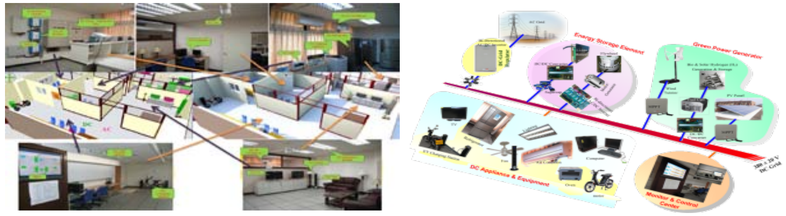


Convenience Store Energy Conservation Management System

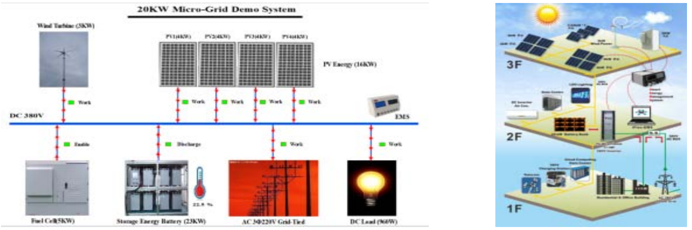
Smart Grid Demo Sites in Taiwan-2

Advanced Distribution Automation Demo System

100 kW Autonomous Micro-grid Demonstration System



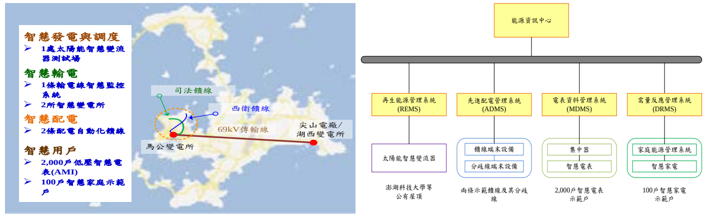
Smart DC Power System Educational Demonstration House



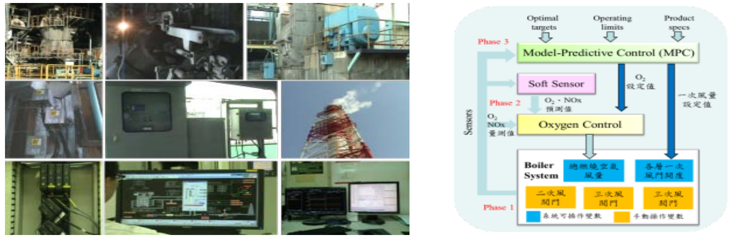
Smart AC/DC Hybrid Micro-Grid Demonstration System

Micro-grid and Electric Vehicle Demonstration Site

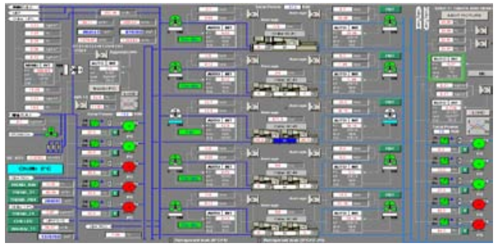
Dongkeng Smart Grid Demonstration Project



Penghu Smart Grid Demonstration Site



Furnace Optimized Operation Demonstration System



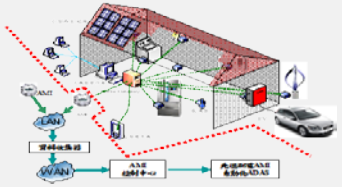
Optimizing Control System for a High-tech Plant Ice Water System

National Energy Program-Phase II: Smart Grid Focus Center Project Framework (2014~ 2018)

sponsored by National Science Council

Equipment and system development

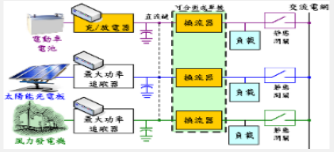
A Smart Energy network and energy saving control Technology



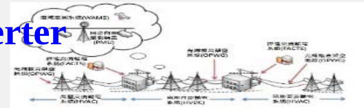
B AMI Value-added service and integration technology

C Distribution Power Control Technology development

D Isolated Microgrid Technology development



E Grid-connected High Power Converter development



F EV charging station manager strategy

G Advanced Wide-area Measurement System (WAMS) and control technology

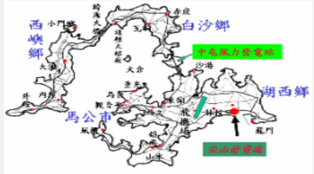
H Transmission System Power Quality improvement and wheeling technology development

I Smart Grid and AMI Standard Development

Technology Commercialization

J Smart Gird Industry Development Project

Demonstration



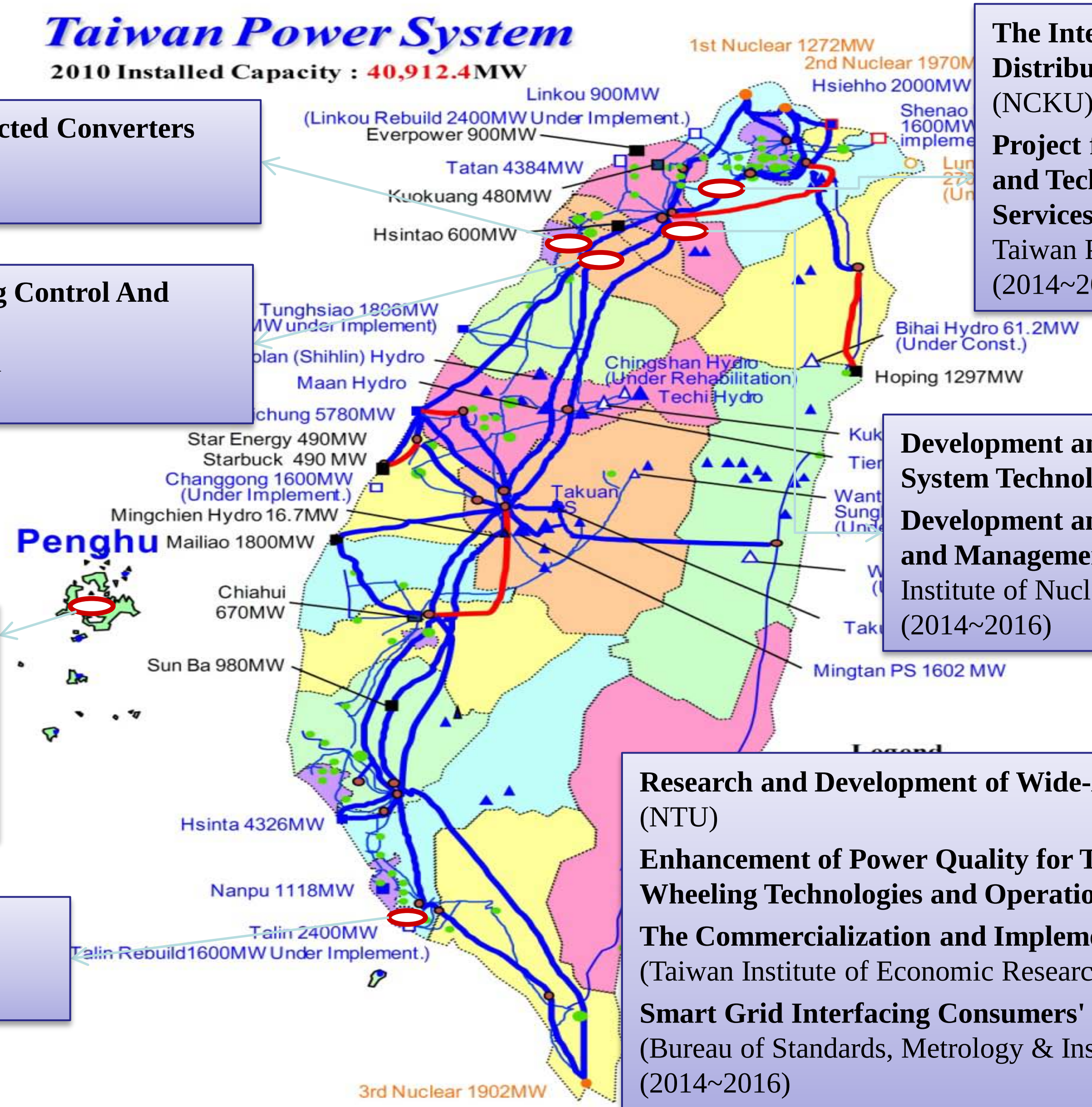
K Penghu Smart Grid Demon Site Construction
(Low Carbon Island)

L Integrated Applications of Demand Response, Distributed Generator, and Energy Storage System
(VPP Demo Site)

Implementation

M Taiwan Power Company Smart Grid Installation

NEP-II Smart Grid Focus Center – Research Projects and Test Fields



Development of High Power Grid-Connected Converters
NTHU, Hsinchu
(2014~2016)

Key Technology Development of Energy Saving Control And System Integration for Smart Grids
Industrial Technology Research Institute, Hsinchu
(2014~2016)

Penghu Smart Grid Demonstration Project (ITRI)

Integrated demonstration project of Penghu smart grid (ISU)
Penghu archipelago
(2014~2016)

EV charging station manager strategy
NSYSU, Kaohsiung
(2014)

The Integrated Application of Demand Response, Distributed Generator, and Energy Storage System (NCKU)

Project for Research on International Energy Policy and Technologies Development on AMI Value-Added Services (Institute for Information Industry)
Taiwan Power Research Institute, Shulin
(2014~2016)

Development and Application of Standalone Microgrid System Technology

Development and Application of Autonomous Power Control and Management Technology for a Distributed Power System
Institute of Nuclear Energy Research, Longtan
(2014~2016)

Research and Development of Wide-Area Monitoring and Control Technologies (NTU)

Enhancement of Power Quality for Transmission Network and Development of Wheeling Technologies and Operations Planning (NCCU)

The Commercialization and Implementation of Smart Grid Technology Project (Taiwan Institute of Economic Research)

Smart Grid Interfacing Consumers' Standards and Their Test Specifications (Bureau of Standards, Metrology & Inspection, M.O.E.A.)
(2014~2016)

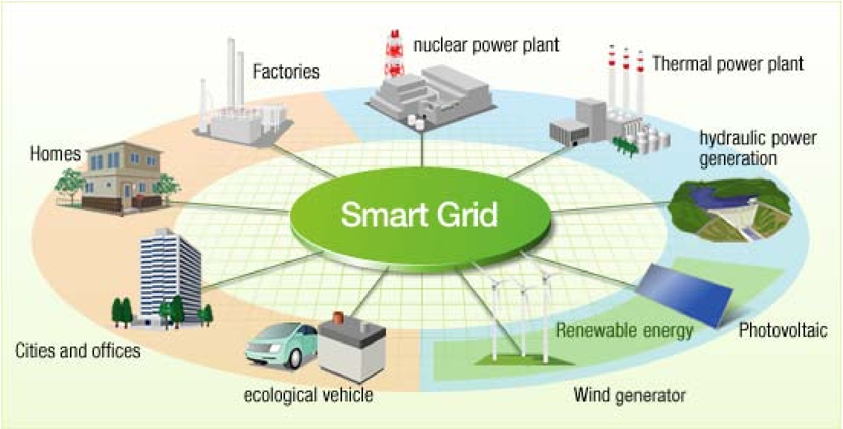
Vision of Smart Grid Promotion in Taipei City

Setting Smart City, Smart Government, Smart Service and Smart Field as core, integrate city government's current promotion policies on power saving, power creating and industry, expand the utilization of green energy, enhance power usage efficiency and the willingness to save power, lower the risk of power shortage, invigorate smart economy, build the future energy planning benchmark for the city.

Smart City

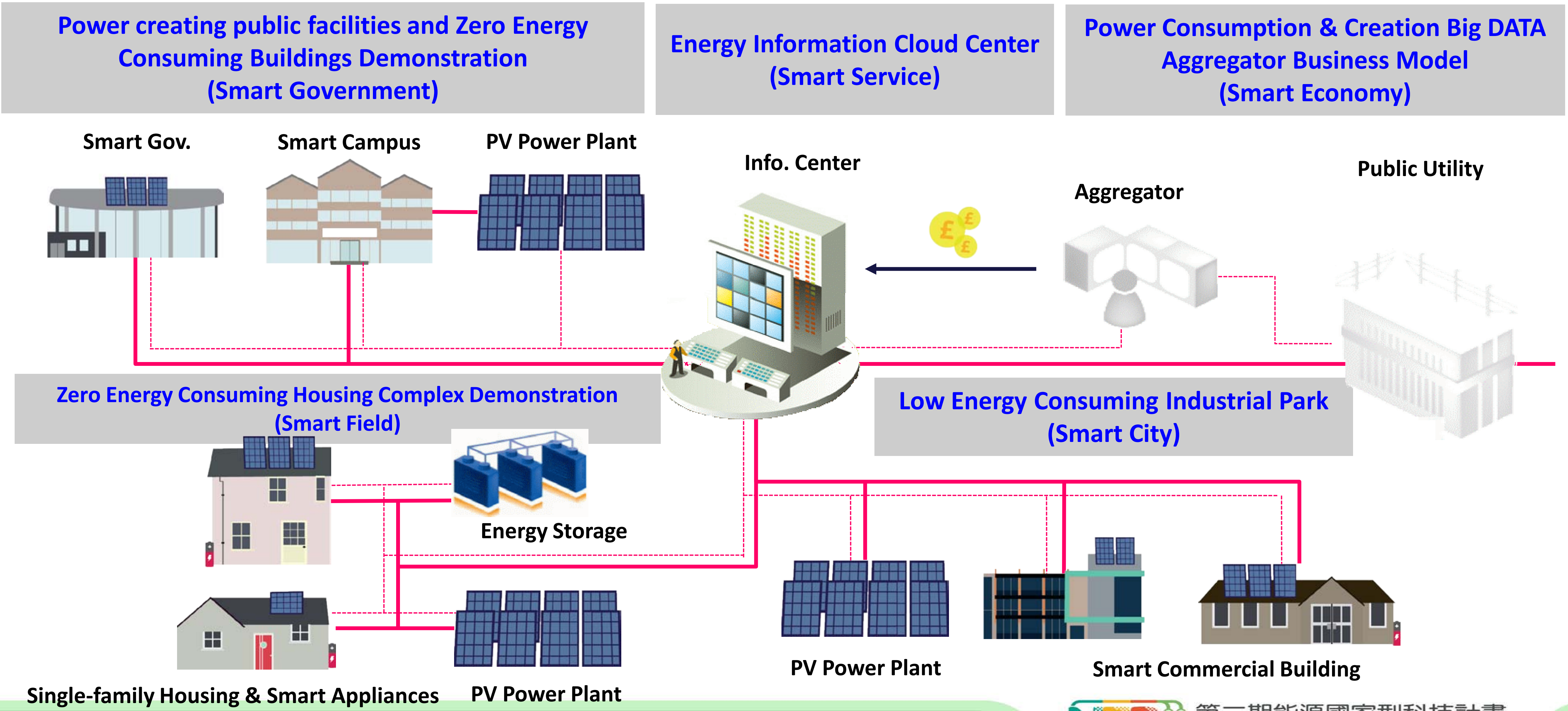
Smart Energy Economy

Smart Grid



Big Data & Cloud

Structure of Smart Grid Promotion in Taipei City



NEP II - Penghu Smart Grid Demonstration Project

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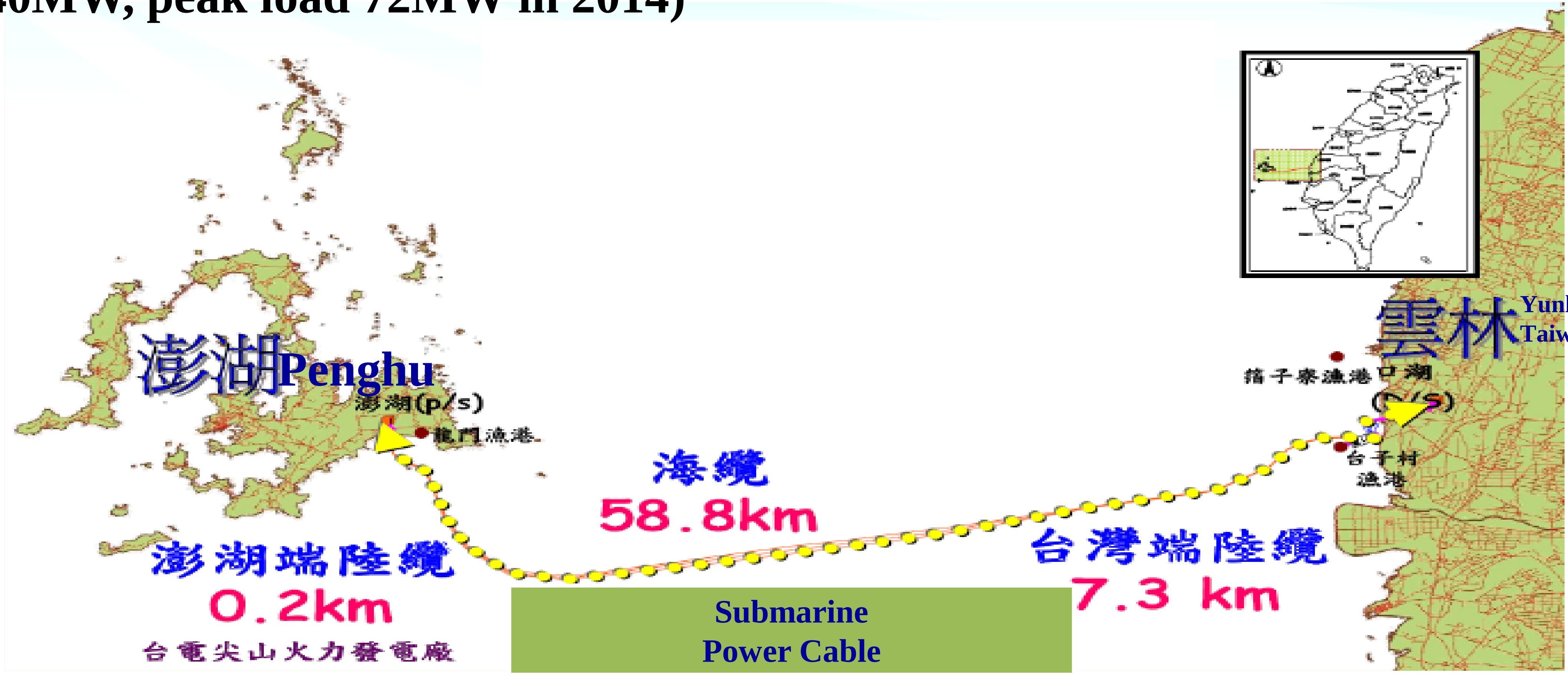
Penghu Smart Grid Demonstration Project

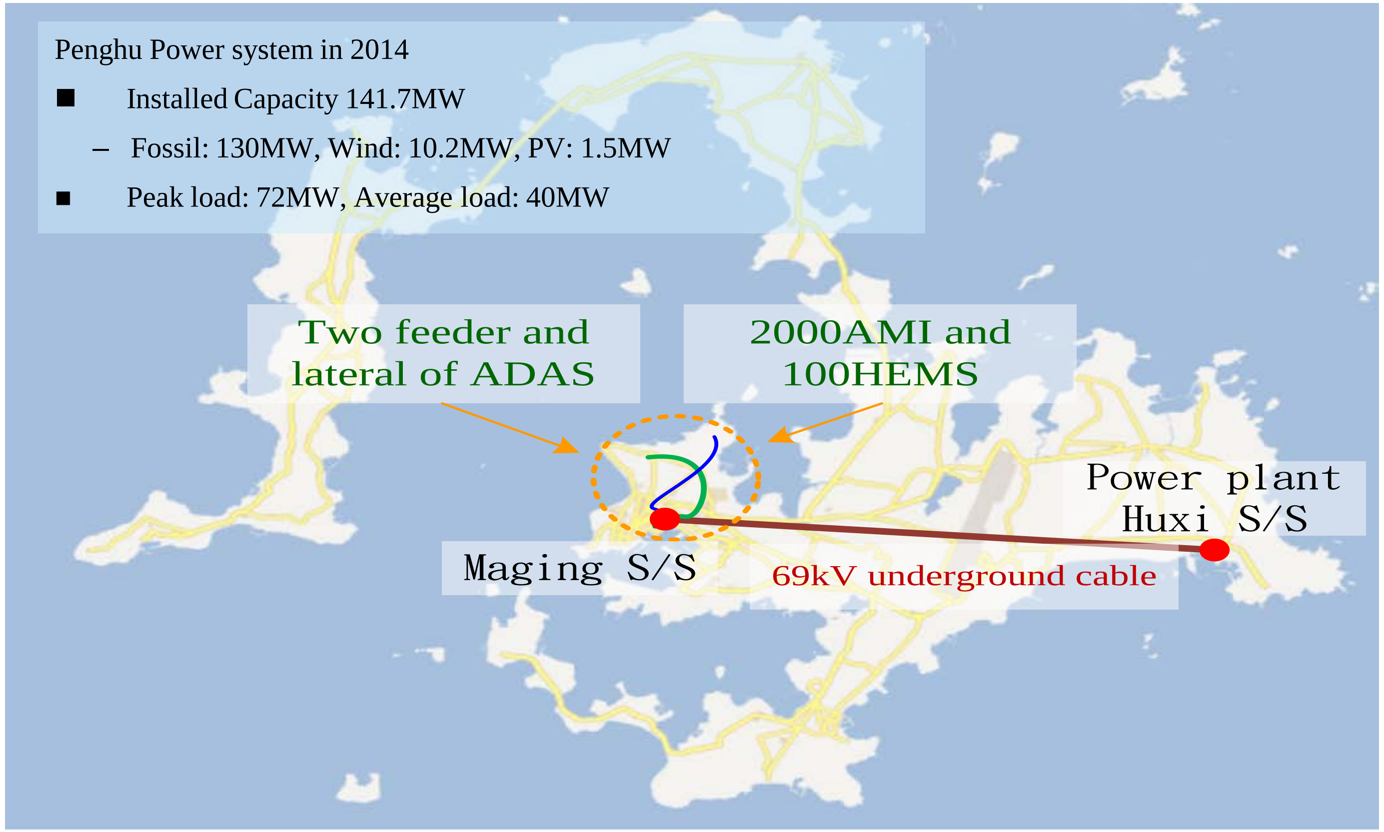
- **Penghu archipelago (48km from Taiwan, inhabitants 100,000, average load 40MW, peak load 72MW in 2014)**



With 161kV/200MW and completed in the end of 2016

Penghu Smart Grid Demonstration Project

- Smart Grid Master Plan was announced in 2012.
- Some technologies need detailed action plans and technology verification.
- Penghu Island is proposed as the demo site of Smart Grids technologies.

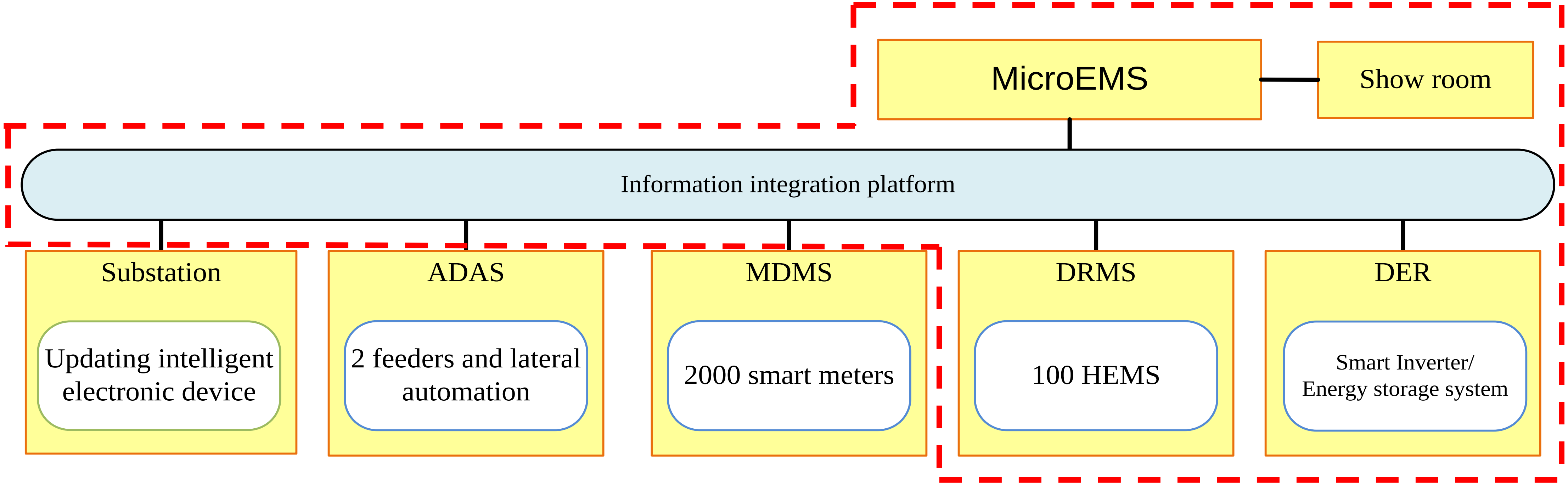


Deployment Items:

1. Smart PV inverter test site
2. Smart Substations (Magong & Huhsi S/S)
3. Advanced DAS with FDIR in two feeders
4. 2,000 smart meters
5. 100 smart users with HEMS
6. Micro-EMS demo system

Penghu Smart Grid Demonstration Project

- An information integration platform accesses data with substation, ADAS, MDMS, DRMS and DER through MicroEMS.



ADAS: advanced distribution automation system
MDMS: metering data management system
DER: distributed energy resource

Penghu Smart Grid Demonstration Project

Show Room of Penghu Smart Grid Demonstration Project

Scenario of smart home, computer room for information integration platform, model of smart grid system, monitoring power generation and transmission of Penghu island

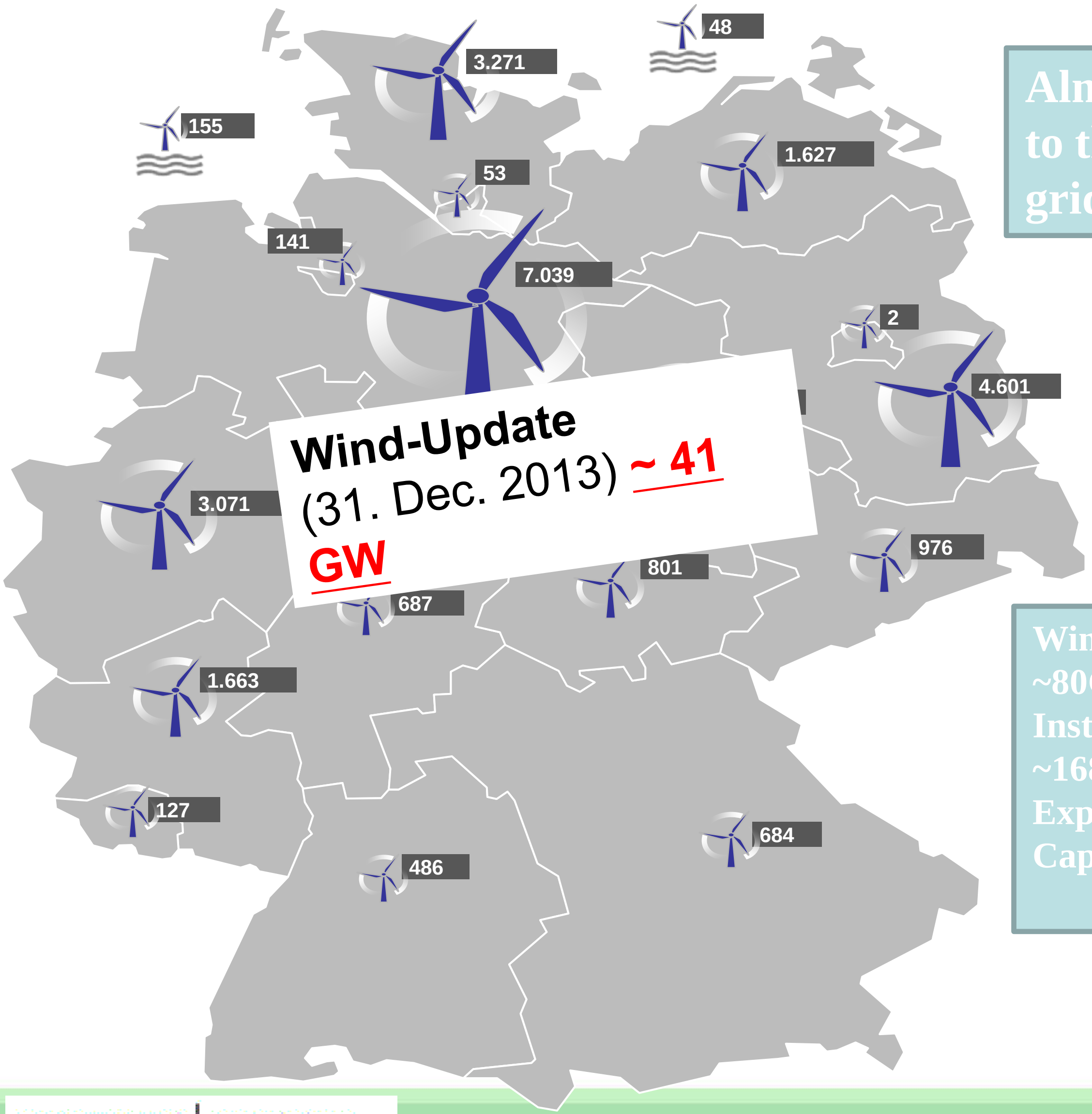
台灣智慧型電網產業協會
Taiwan Smart Grid Industry Association

Penghu Smart Grid Demonstration Project

website http://smartgrids.tw

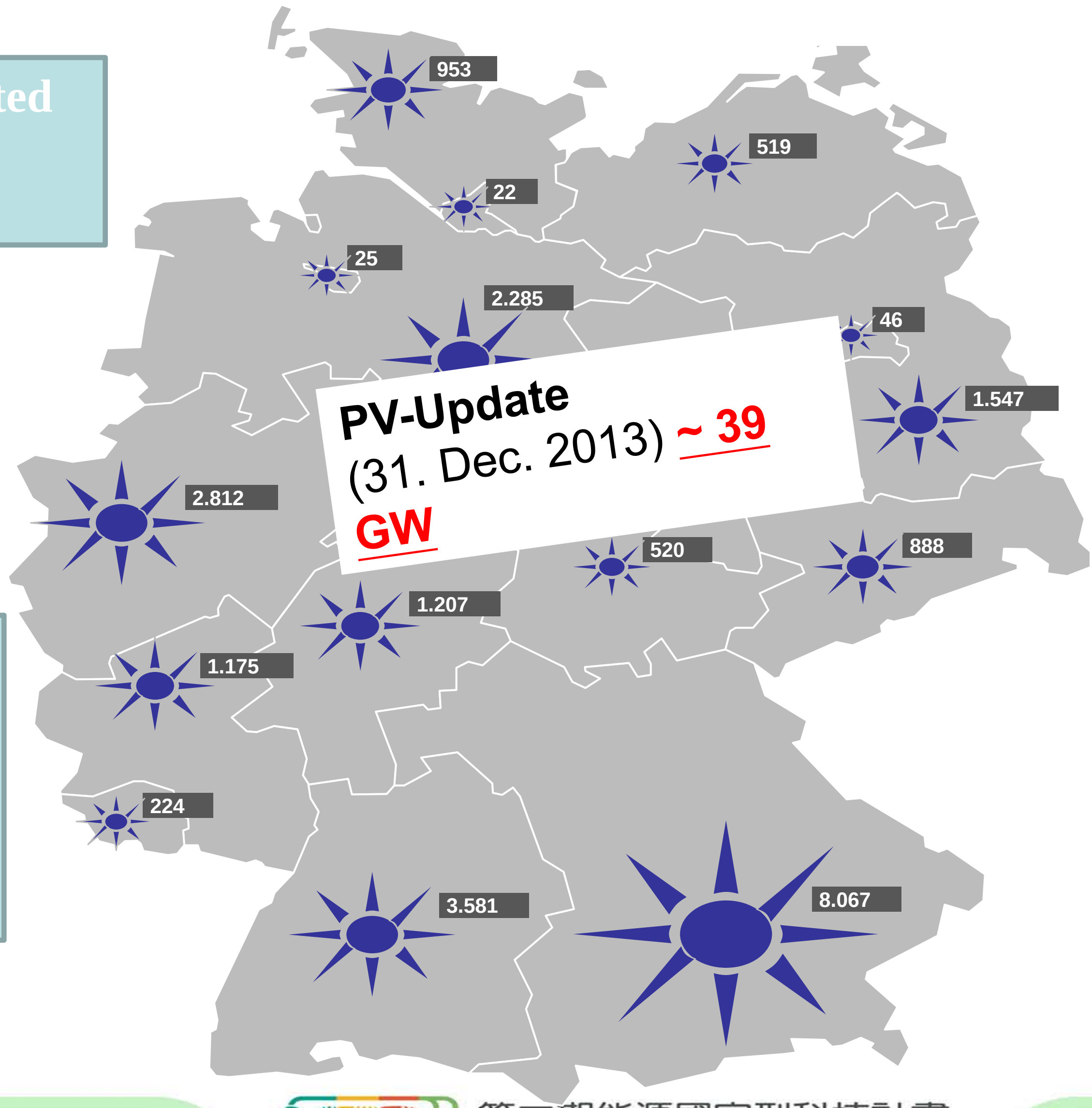
NEP II – Smart PV Inverter Demonstration Project

Wind and PV Capacity (MW) in Germany

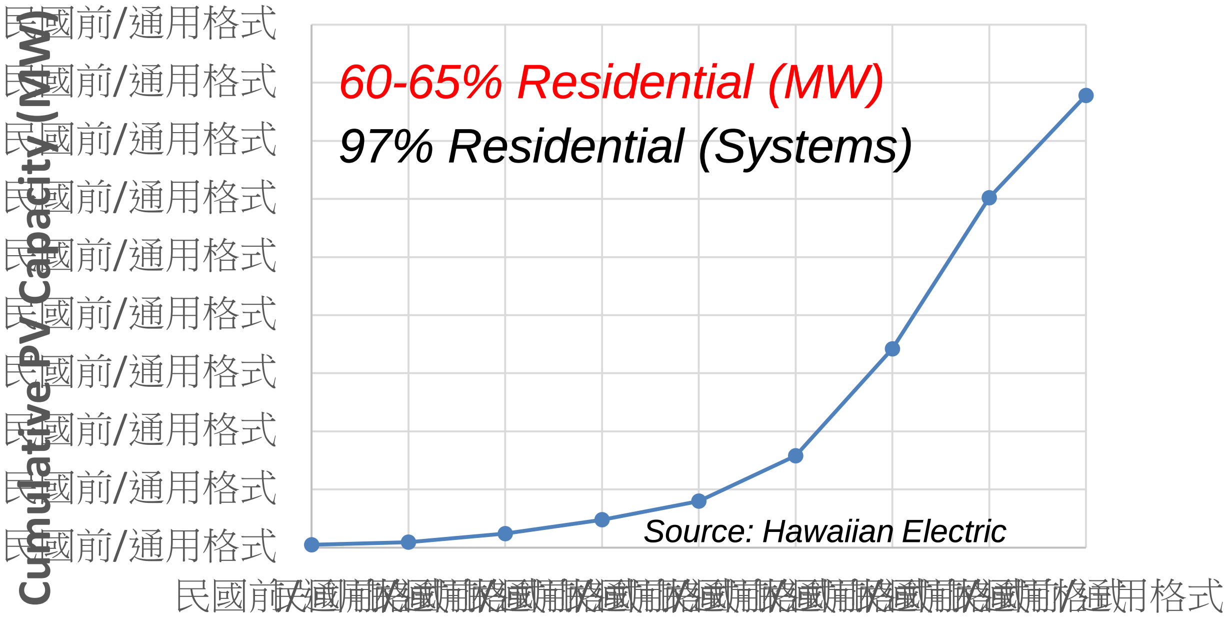


Almost all connected to the distribution grid

Winter Peak Load ~80GW
Installed Capacity ~168GW
Export/Import Capability ~ 18GW

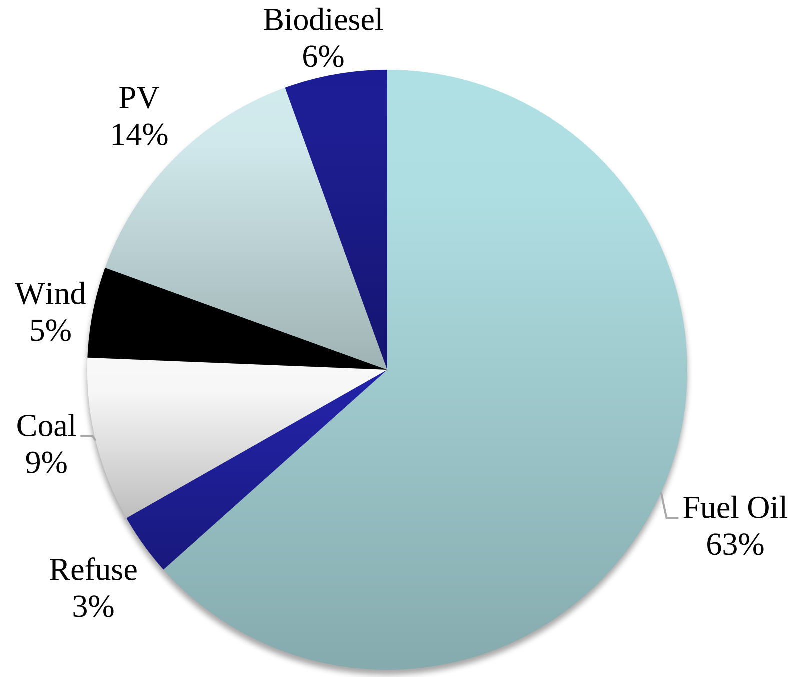


Recent PV Growth in Hawaii



Rapid growth of residential PV over the last 3-4 years

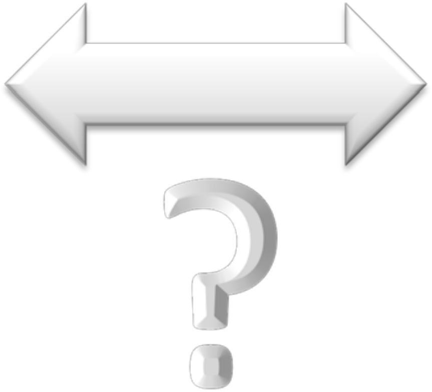
Hawaiian Electric Generation Capacity by Fuel Type

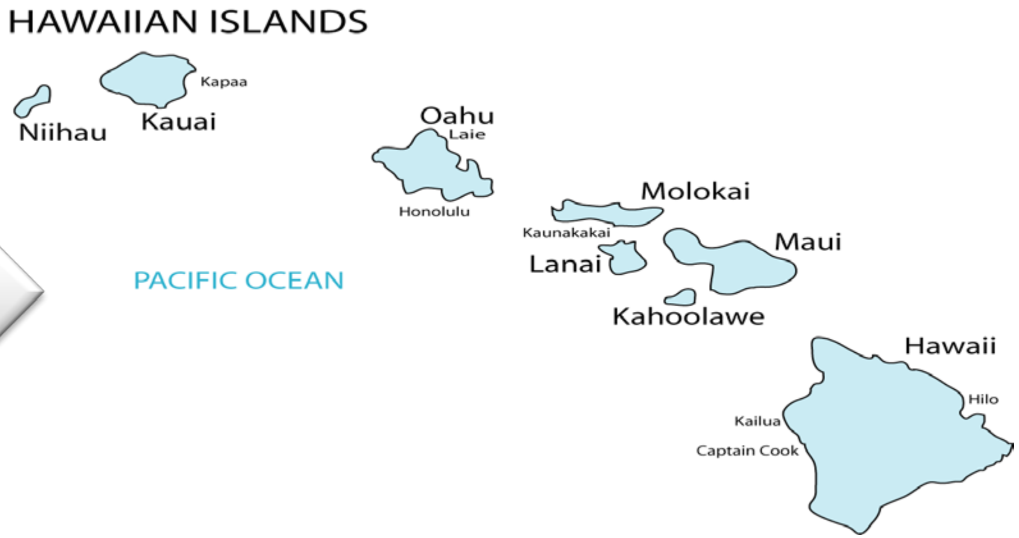


Source: Hawaiian Electric PSIP

During the daytime, PV could be supplying 25-30% of demand

What does PV growth in Germany & Hawaii Have in Common?





- Environmentally-conscious adoption of PV
- Low solar insolation
- Highly interconnected system
- Low-cost thermal generation

- Cost-conscious adoption of PV
- Moderate-high solar insolation
- Small, isolated systems
- Very high-cost thermal generation

2014 Residential ($/kWh): $0.40

2014 Residential ($/kWh): $0.36-$0.38

Inverter – Role in PV Plants?

PV inverter converts DC energy from solar modules in to AC energy and interface the PV system with electricity grid

DC Power

AC Power

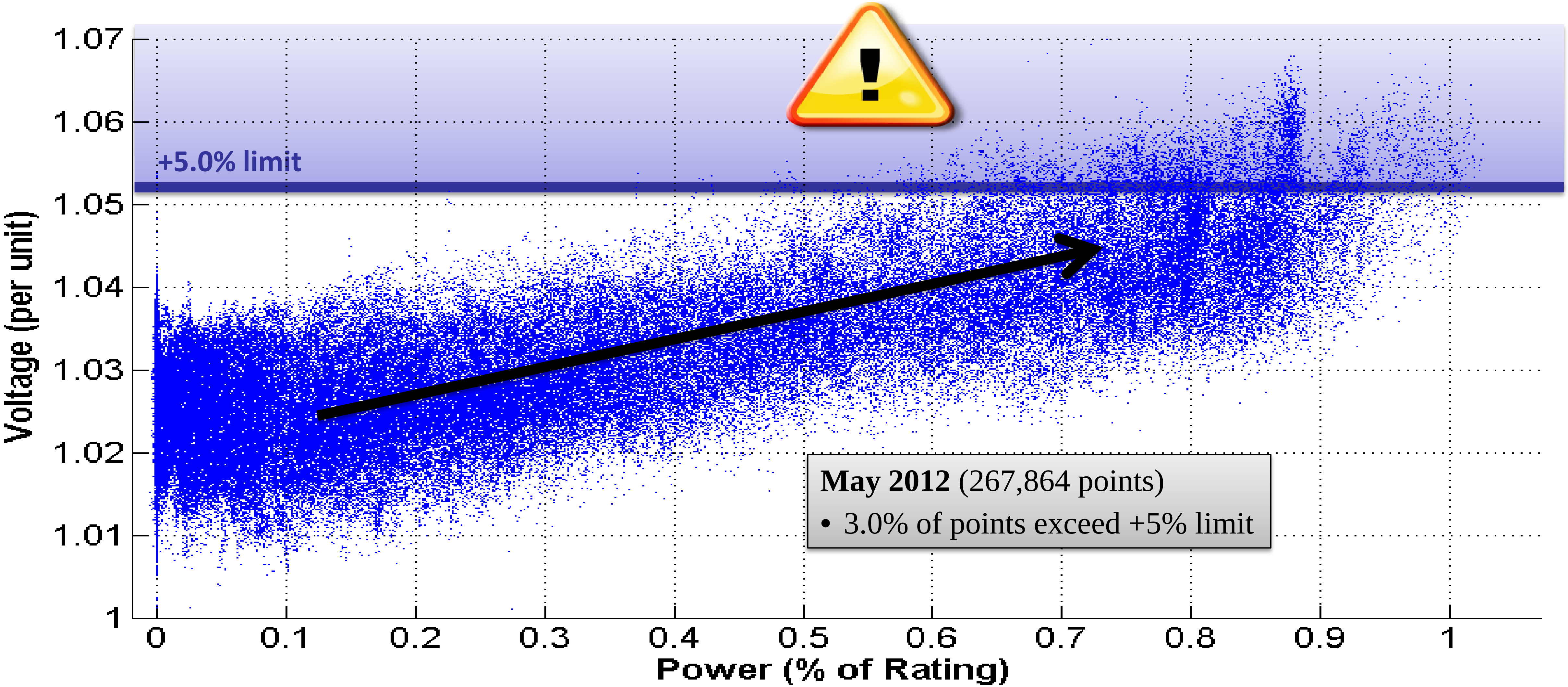
Traditional Inverter

- Harvesting maximum power from PV array
- Matching plant output with grid voltage and frequency
- Providing unintentional islanding protection

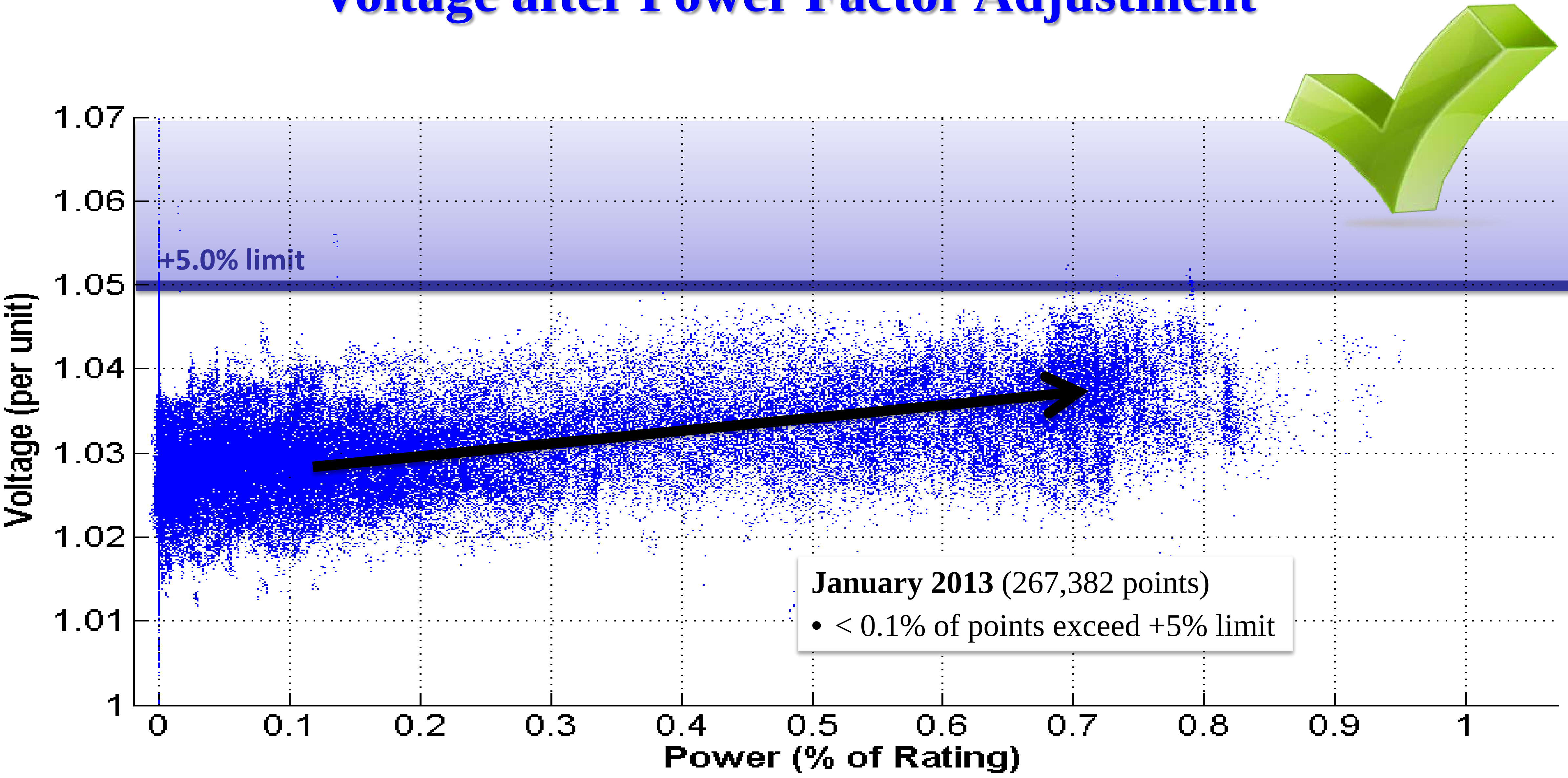
What is Smart Inverter?

- Inverter that can modify it's real and reactive power output to provide grid support
- Can respond autonomously to V/F changes or can respond to communicated signal

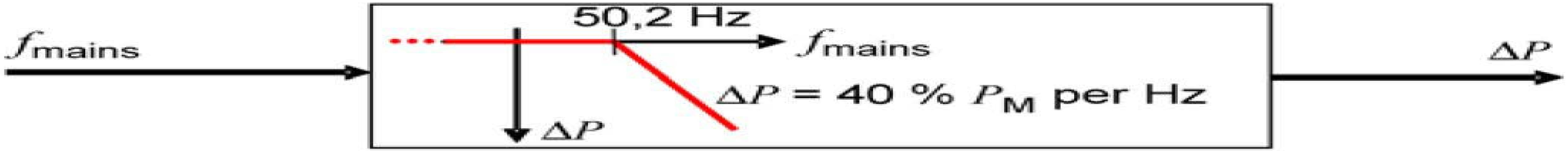
Voltage Violation (w/o smart inverter)



Voltage after Power Factor Adjustment



Active power feed-in control with smart inverter



$$\Delta P = 20\ P_M \frac{50.2Hz - f_{mains}}{50Hz} \qquad \text{for } 50.2 \text{ Hz} \le f_{mains} \le 51.5\text{Hz}$$

Where:

P_M : the power generated at the time of exceeding 50.2 Hz;

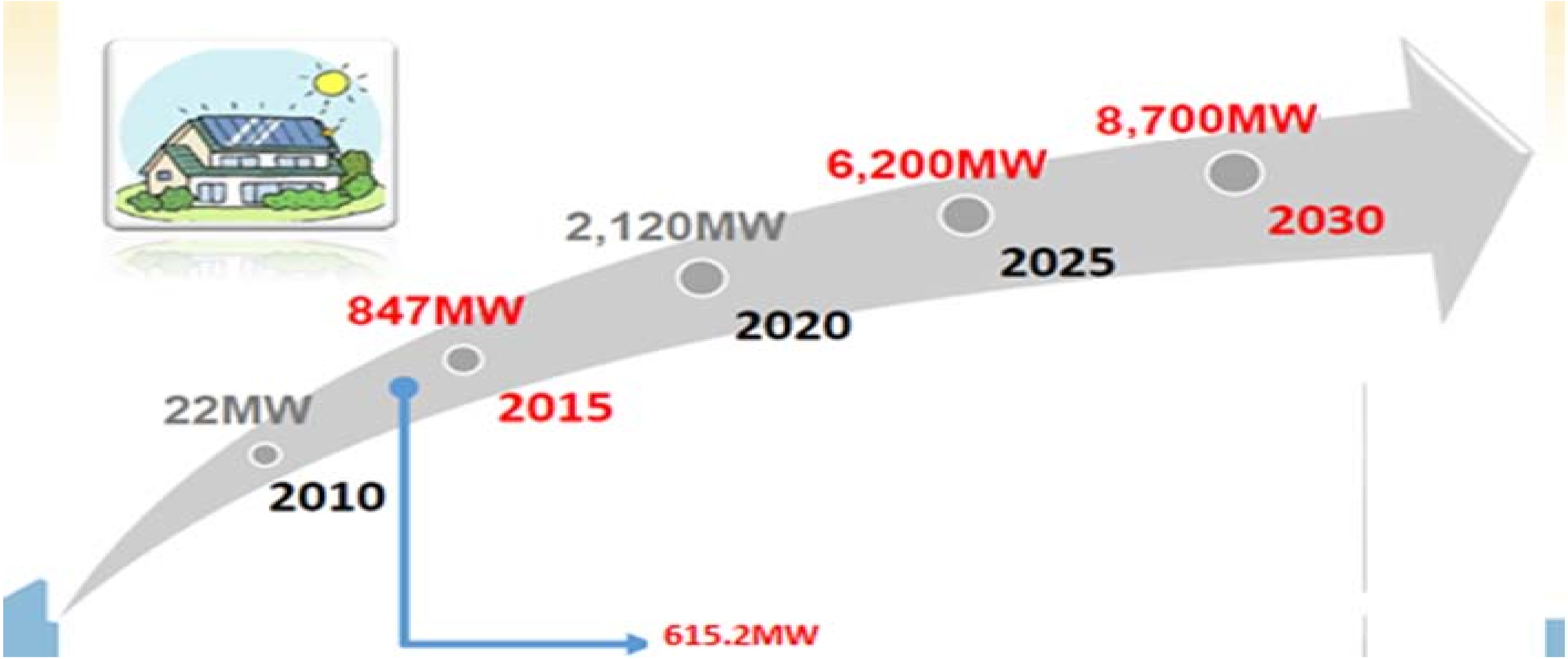
P : the power reduction ;

f_{mains} : the mains frequency.

There are no restrictions for frequencies of 47.5 Hz $\le f_{mains} \le$ 50.2 Hz.

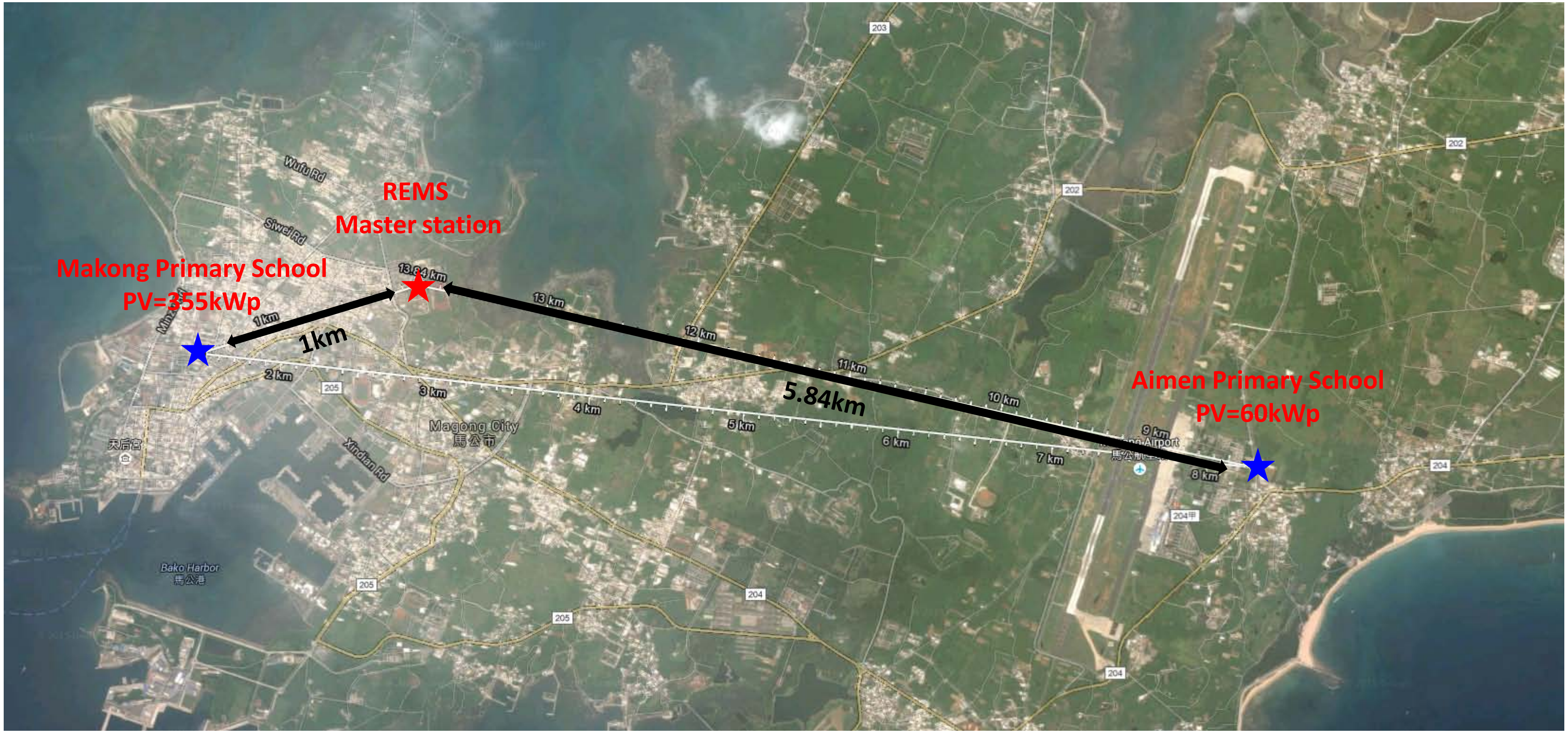
Disconnection from the network is required for $f_{mains} \le$47.5 Hz and $f_{mains} \ge$ 51.5 Hz.

Objective of PV Installation in Taiwan

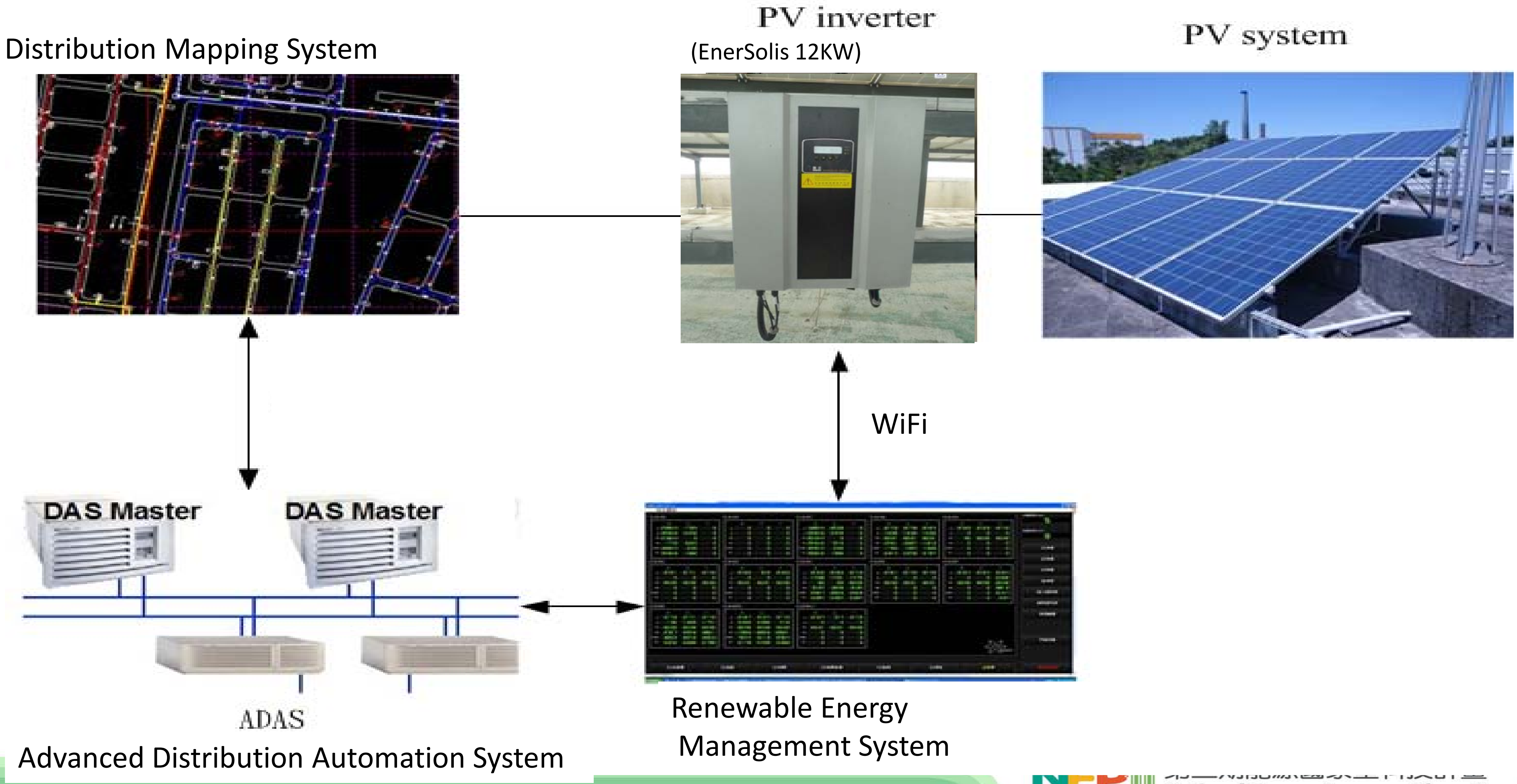


Accumulated PV installation by 2014

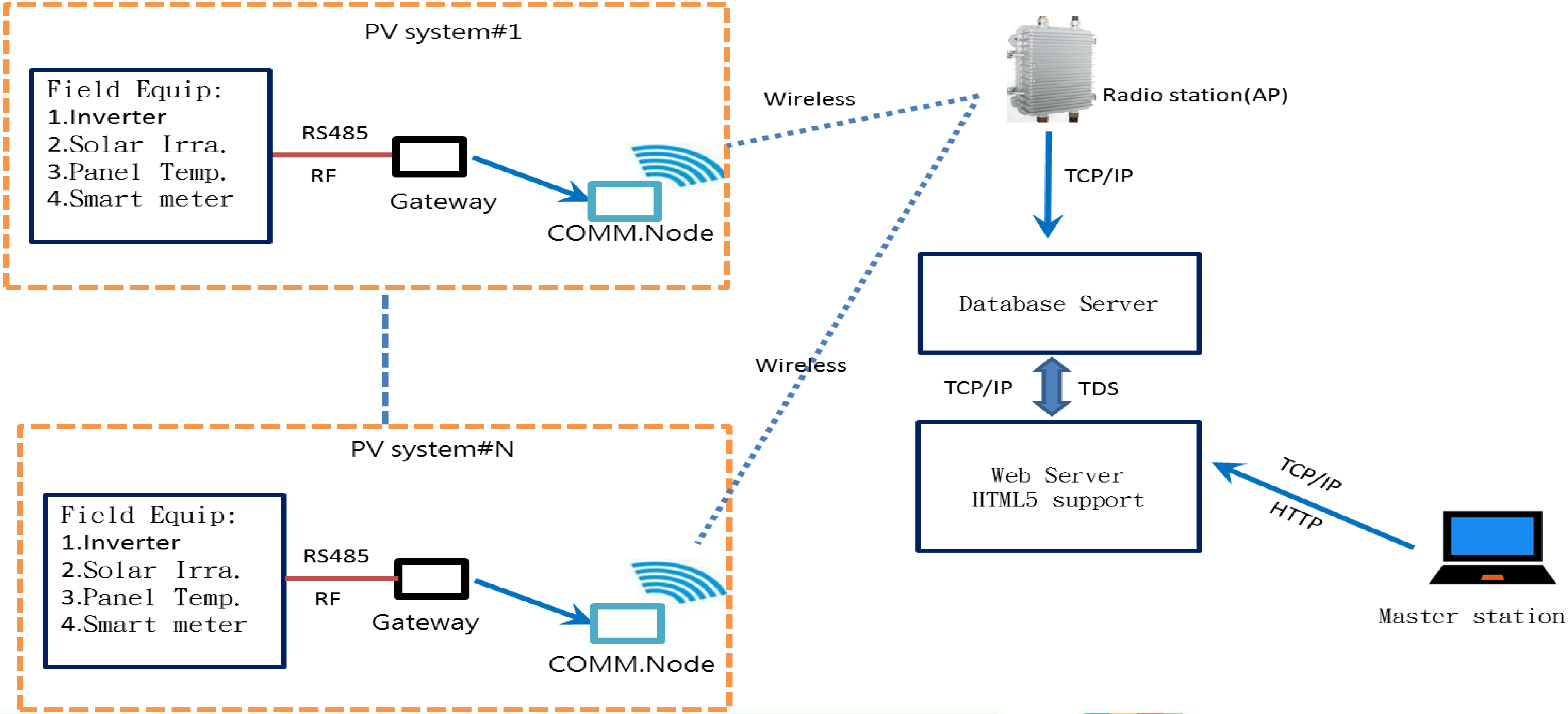
Demonstration of Smart Inverter in Penghu



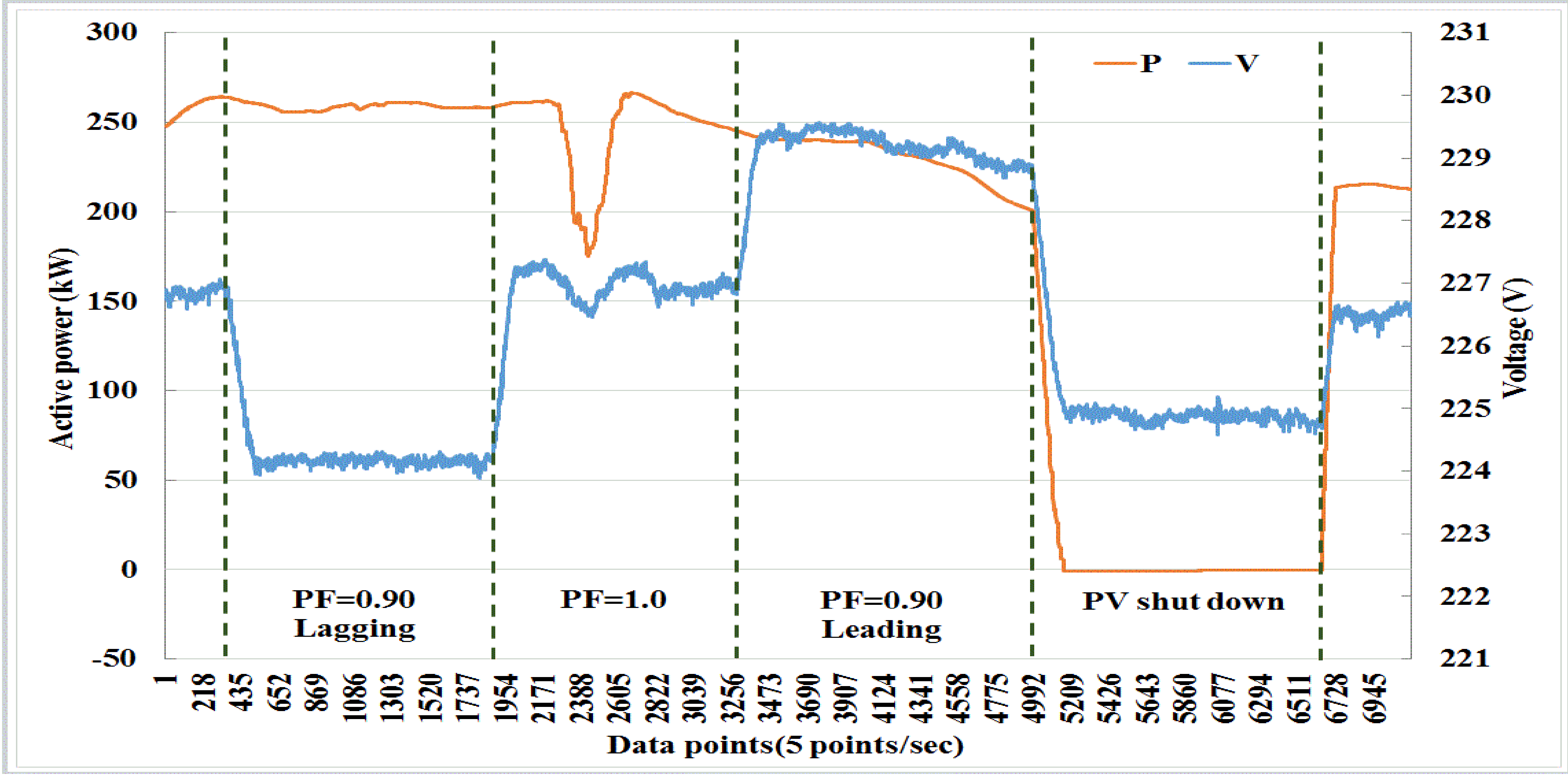
Monitoring and Control of Grid-connected PV System



Communication Architecture of Renewable Energy Management System



Field Test of Smart Inverter
(Makong Primary School, 2015/06/25-10：30AM)



Field Test of Smart Inverter
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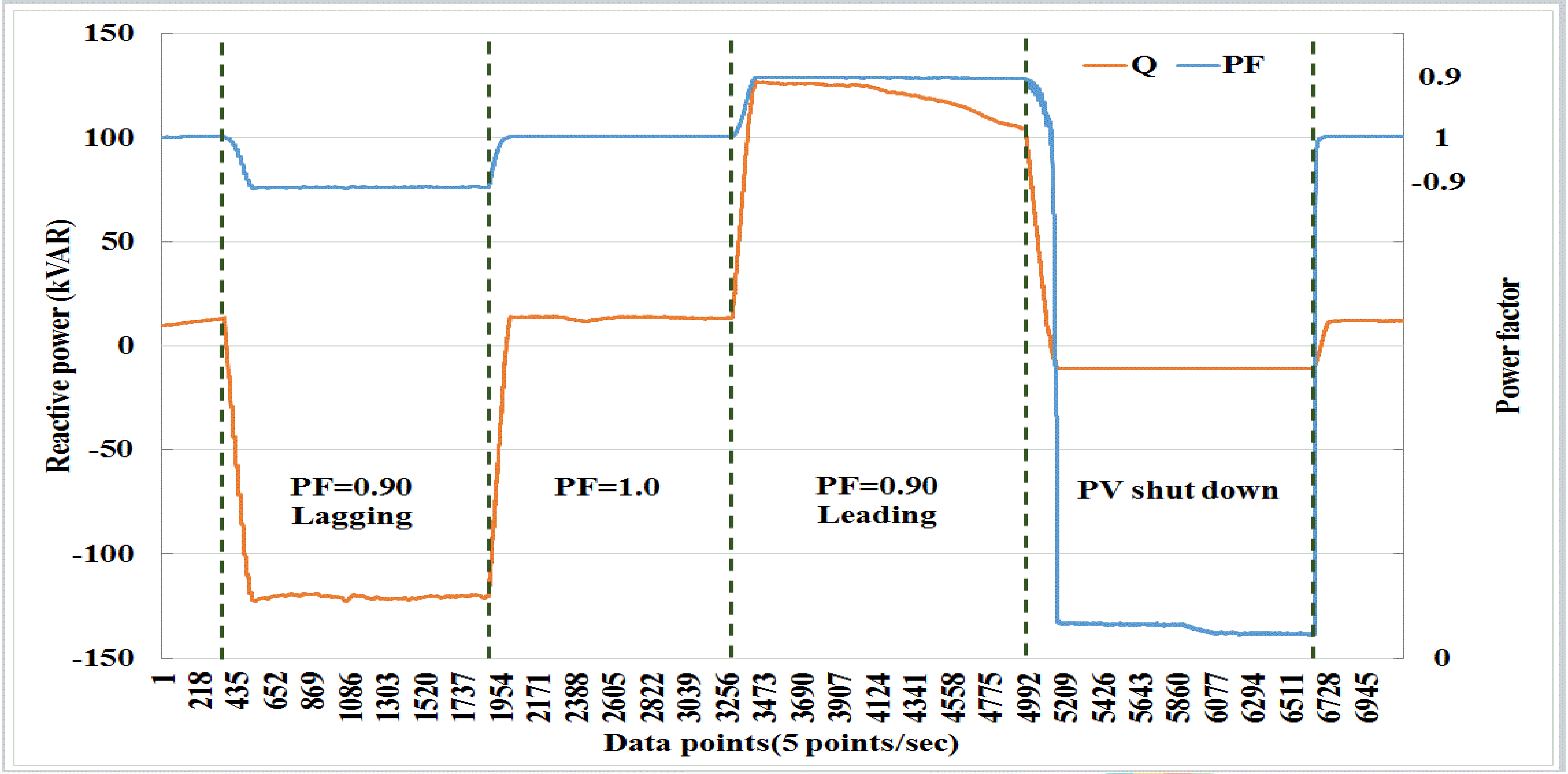
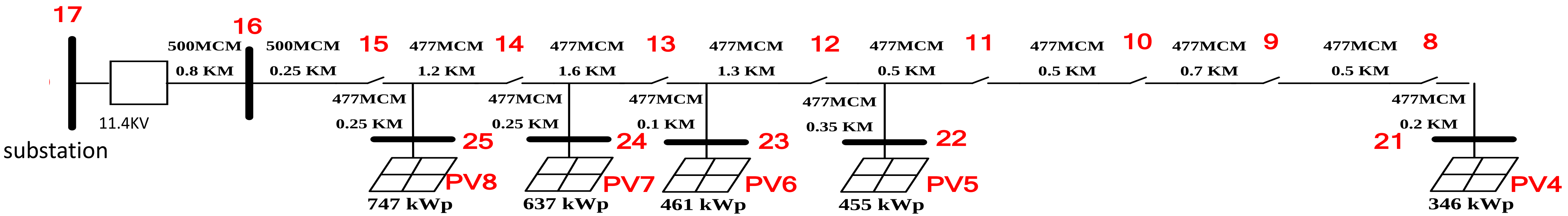


Enhancement of PV penetration by power factor control of smart inverters

- Taipower distribution feeder:
  length=8.5KM
  total existing PV installation=2646KWp
- A new PV installation with smart inverter

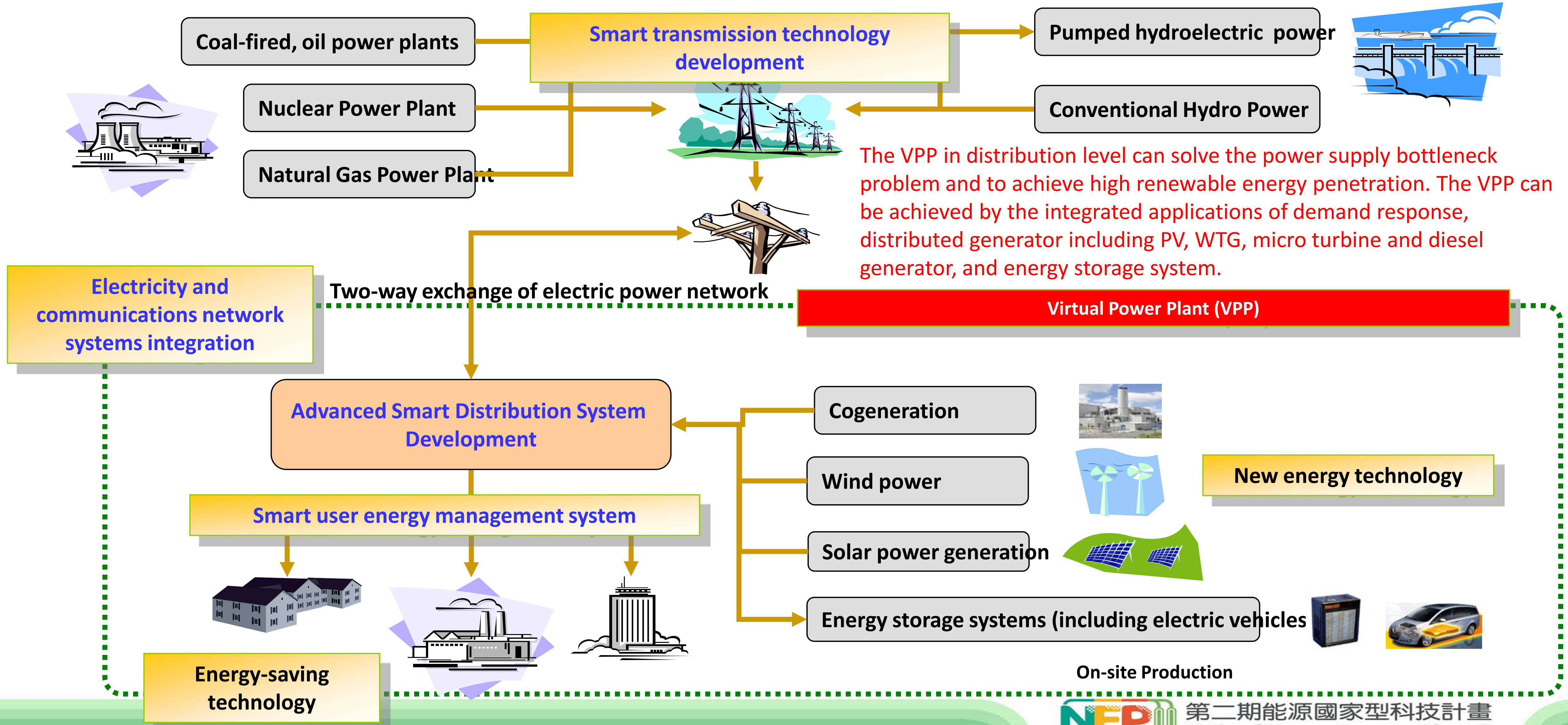


Maximum capacity of PV integration (W/O violating the constraint of voltage variation 2.5%)

- **Conventional PV Inverter (PF=1.0)**
  - PV capacity of 3200 KWp (Maximum PV capacity:3200 KWp)
- **Smart Inverter (operating with PF=0.9)**
  - Maximum PV capacity:5434 KWp
- **Conclusion**
  - The maximum capacity of PV integration is increased by 2234 KWp when the smart inverters are applied for the large PV farm.

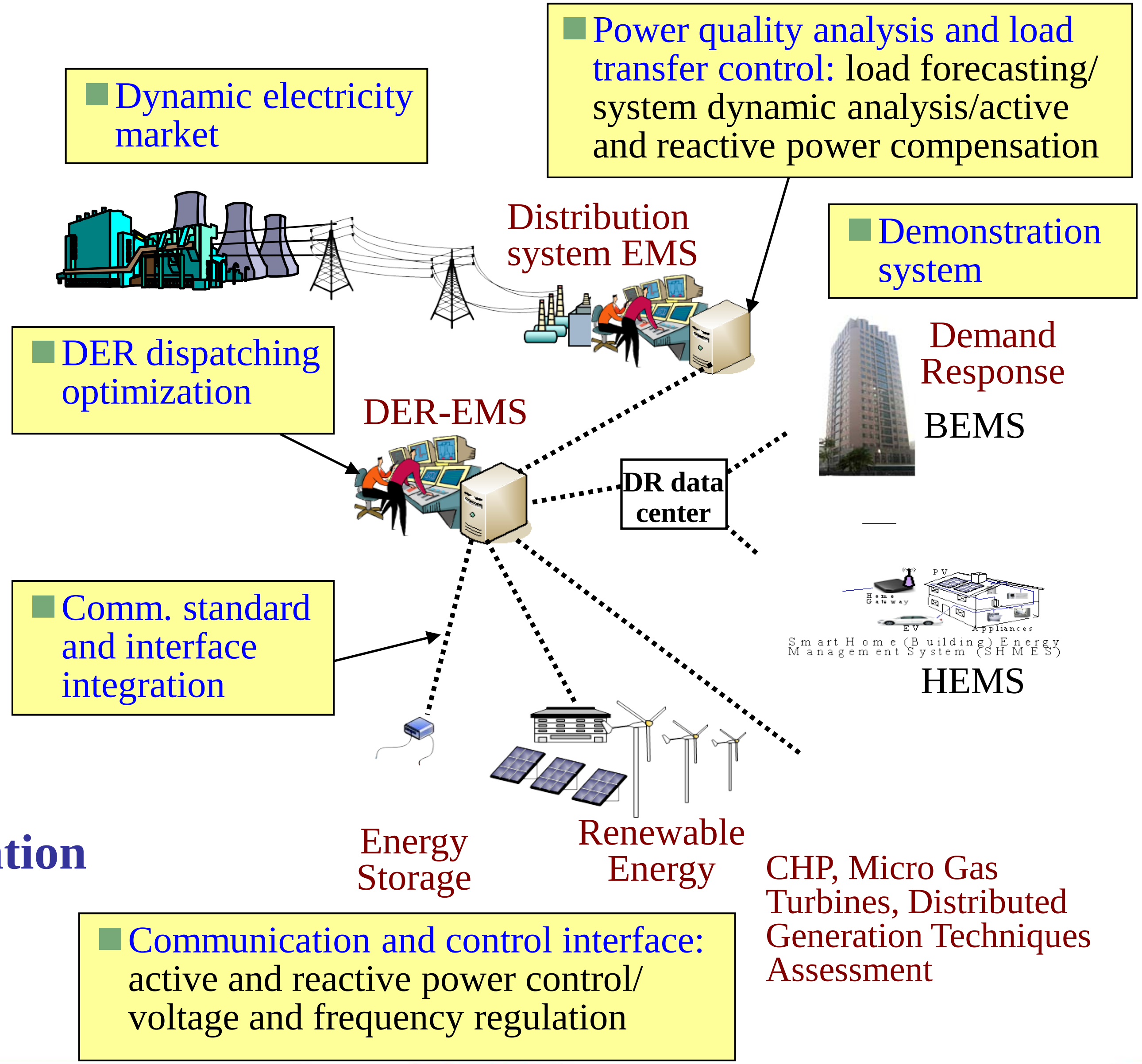
NEP II - Virtual Power Plant Demonstration Project

The Structure of VPP Energy Supply Service Technology



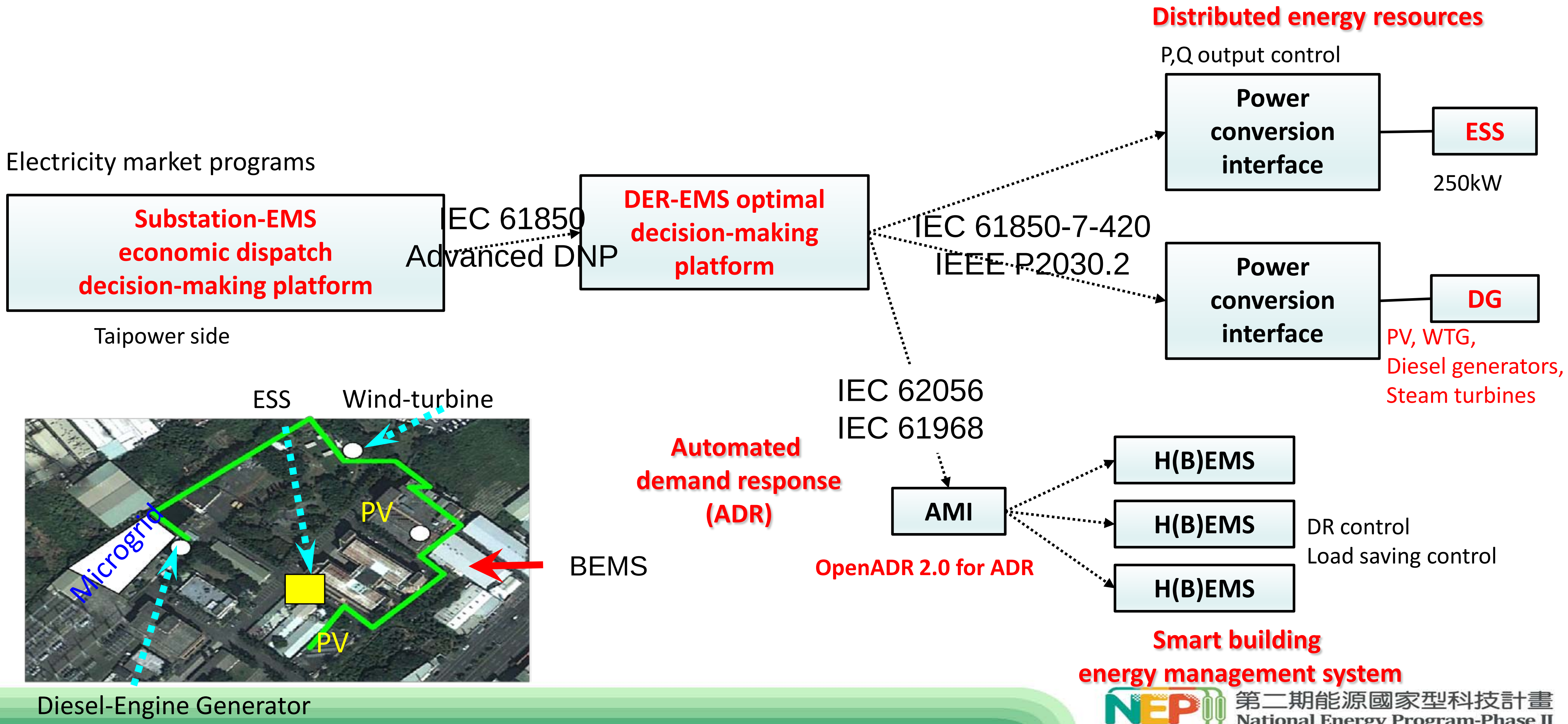
Virtual Power Plant Demonstration Project

- **Dynamic Electricity Market/Ancillary Services Market Mechanisms**
  – Analyze related international VPP and DR experiences, and propose suitable model for Taiwan
- **Comm. Control Interface Standard**
  – Research and development of comm. Interface
  – CAN Bus / DNP3 / IEC 61850
- **Supervisory Control and Data Acquisition (SCADA)**
  – Software and Hardware Developments
  – Human Machine Interface (HMI)
- **DER Energy Management System (DER-EMS)**
  – Forecasting system, optimal EMS algorithms, reactive and real power demand dispatching
- **Comm. and Control Interface of Energy Conversion System**
- **Distribution System Mathematical Model Simulation**
  – Power system and DER models simulation and analysis
- **Testing System Demonstration**
  – Taiwan Power Research Institute
  – BEMS, DER, and DR integration



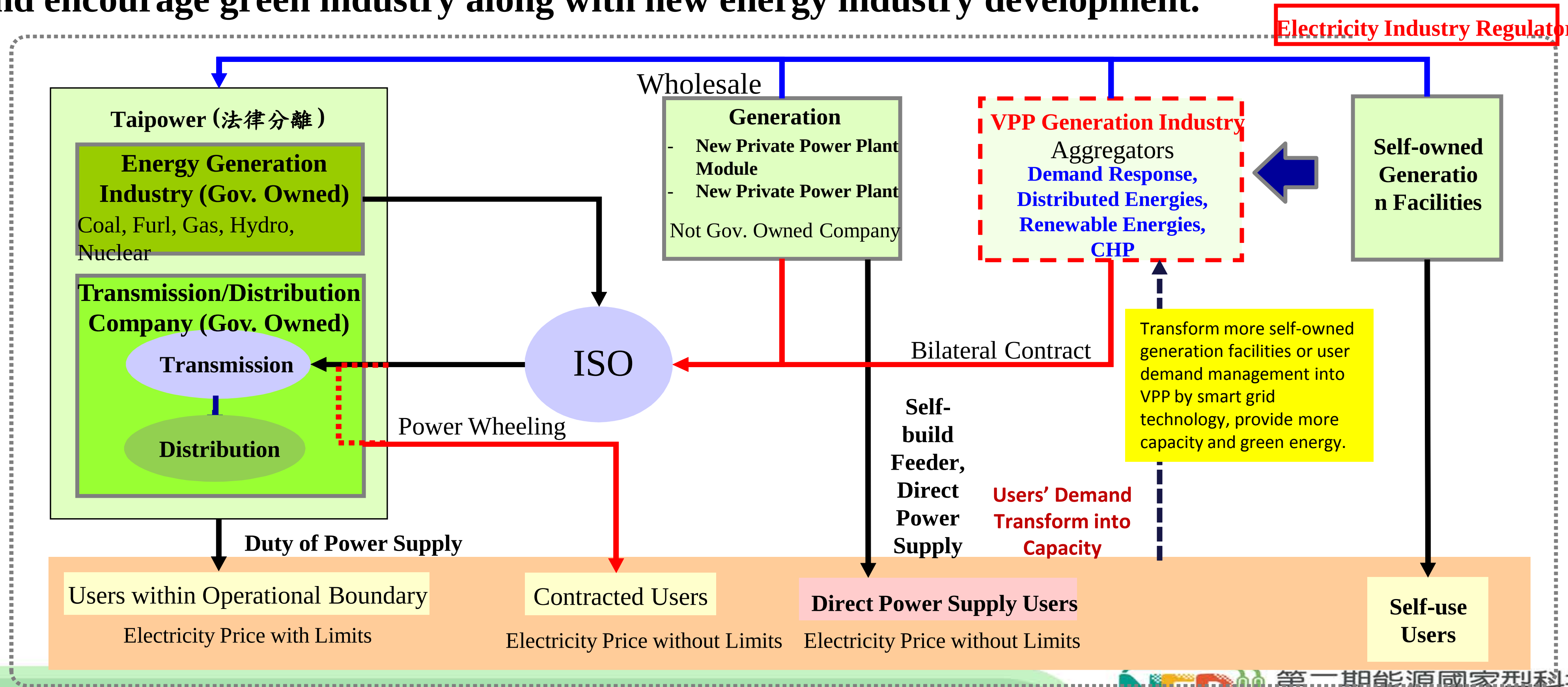
Taipower Research Institute Test Site

To Build DER-EMS System and Technical Verification



Connection between Taiwan VPP Promotion and Energy Market

- **The concept of VPP enables distributed energies, demand response and others with lower capacity to be part of energy market, despite the limitation of ISO financial model and real facility model.**
- **The VPP technology coordinating with energy market liberalization attract enterprises to integrate demand response, distributed energies such as solar energy, wind energy, power saving facilities, fuel cells, CHP, etc., to join energy generation industry, make up for the future capacity gap caused by steady decreasing nuclear power usage, and encourage green industry along with new energy industry development.**



Automatic Demand Response (ADR)

Demand Response (DR) is a set of actions taken to reduce load when electric grid contingencies threaten supply-demand balance or market conditions occur that raise electricity costs. Automated demand response consists of fully automated signaling from a utility, ISO/RTO or other appropriate entity to provide automated connectivity to customer end-use control systems and strategies. Open Automated Demand Response (OpenADR) is a research and standards development effort for energy management led by North American research labs and companies. The typical use is to send information and signals to cause electrical power-using devices to be turned off during periods of high demand. OpenADR provides a foundation for interoperable information exchange to facilitate automated demand response.

Taipower Research Institute Test Site – ADR

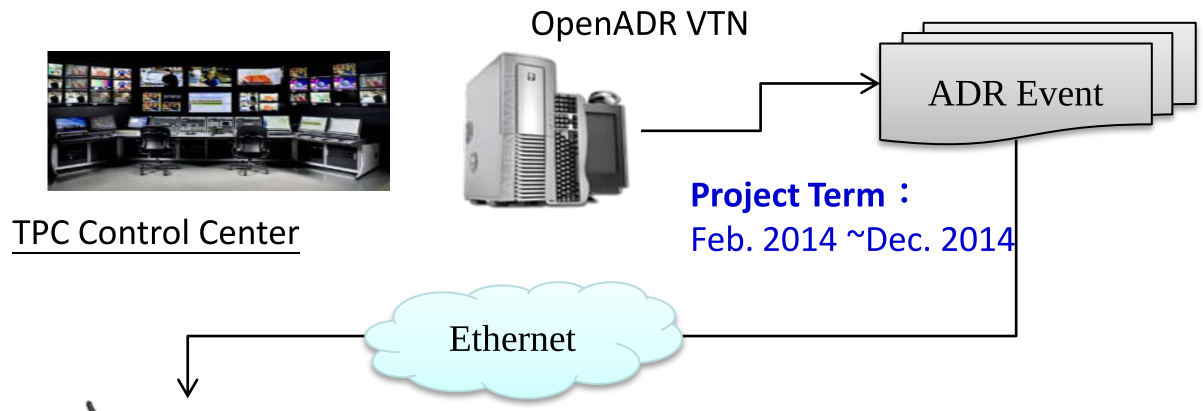
Utility

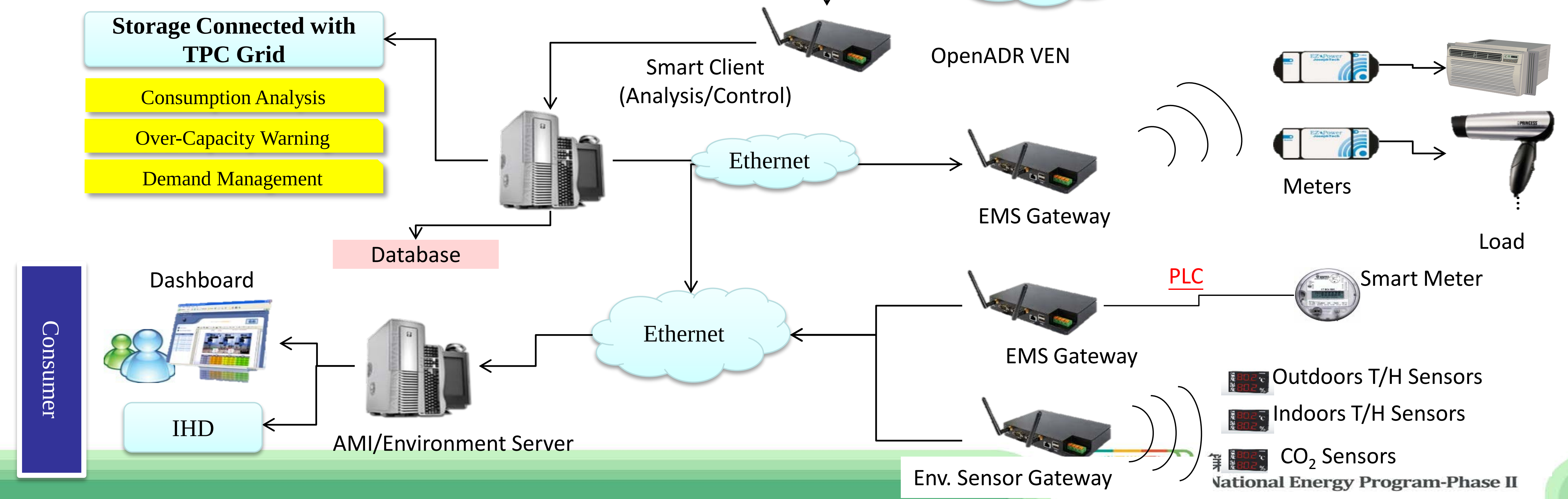
① **Control Center** transmits DR Event with “Reduction Level” to ADR VEN

② **ADR VEN** transmits DR event to responsible client according to DR event and client (simple or smart client)

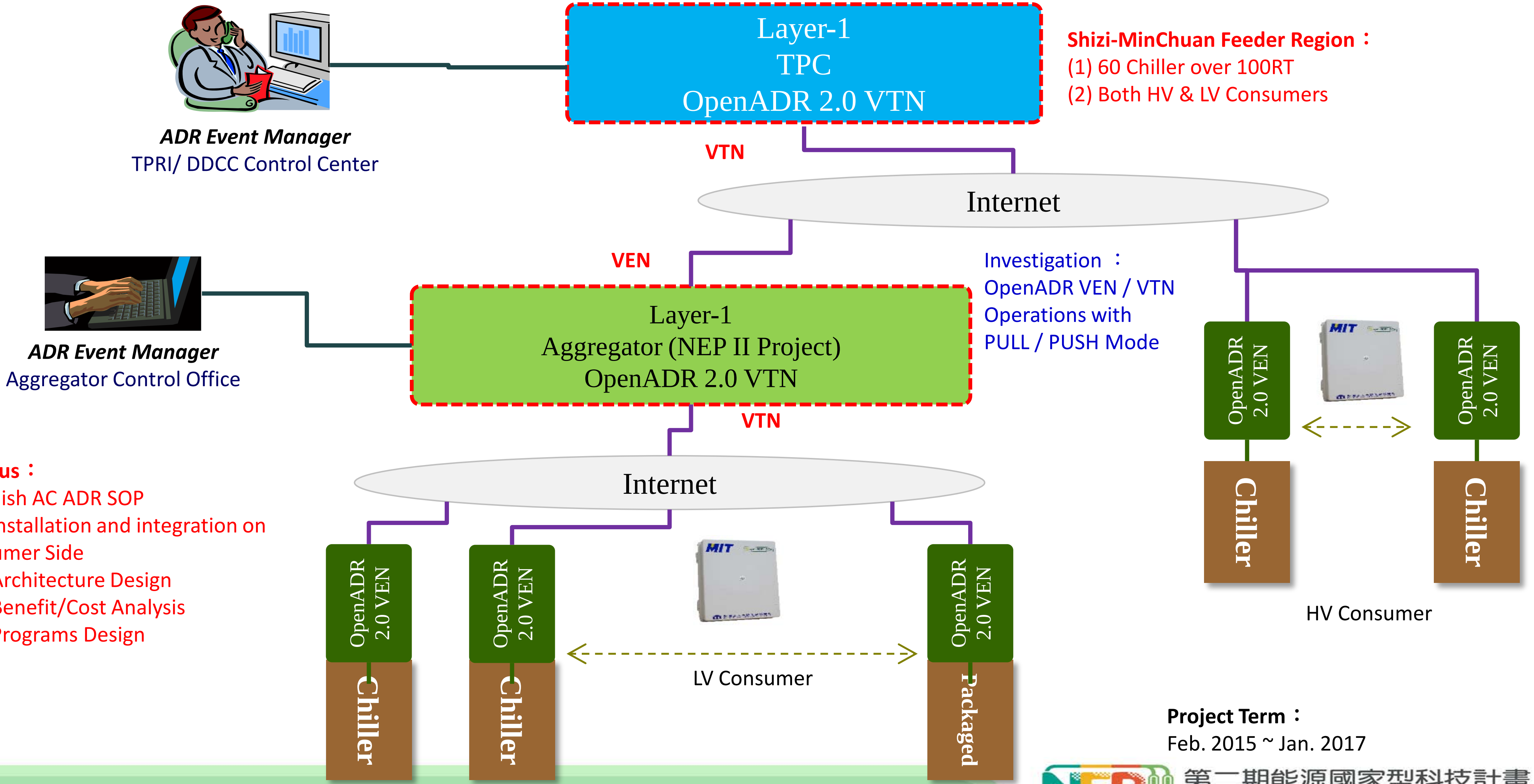
③ **Smart Client** negotiates EMS system to schedules demand reduction accordingly

④ **EMS System** manages and controls load according to demand reduction schedule





Demonstration of ADR Using Large Chiller



Project Focus：

1. Establish AC ADR SOP
2. VEN installation and integration on Consumer Side
3. ADR Architecture Design
4. ADR Benefit/Cost Analysis
5. ADR Programs Design

Project Term：
Feb. 2015 ~ Jan. 2017

NEP II - AC Microgrid Demonstration Project

DOE: Definition of a MicroGrid

A group of interconnected loads and distributed energy resources (DER) with clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid and can connect and disconnect from the grid to enable it to operate in both grid connected or island mode.

Typical Microgrid Requirements

- **Grid Connected Capabilities**

– Optimization for Economic Operation

– Support Integration of Renewables

– Support for DER Market Participation

- **Islanding Capabilities**

– Emergency Islanding Support

– Managing Critical/Non-Critical Loads to Available Generation

– Island Operations with High Penetrations of Renewables

– Optimized Island Operation for Longevity (Fuel, Maximizing REs)

- **Secure Operations**

– Cyber Secure Communications Network

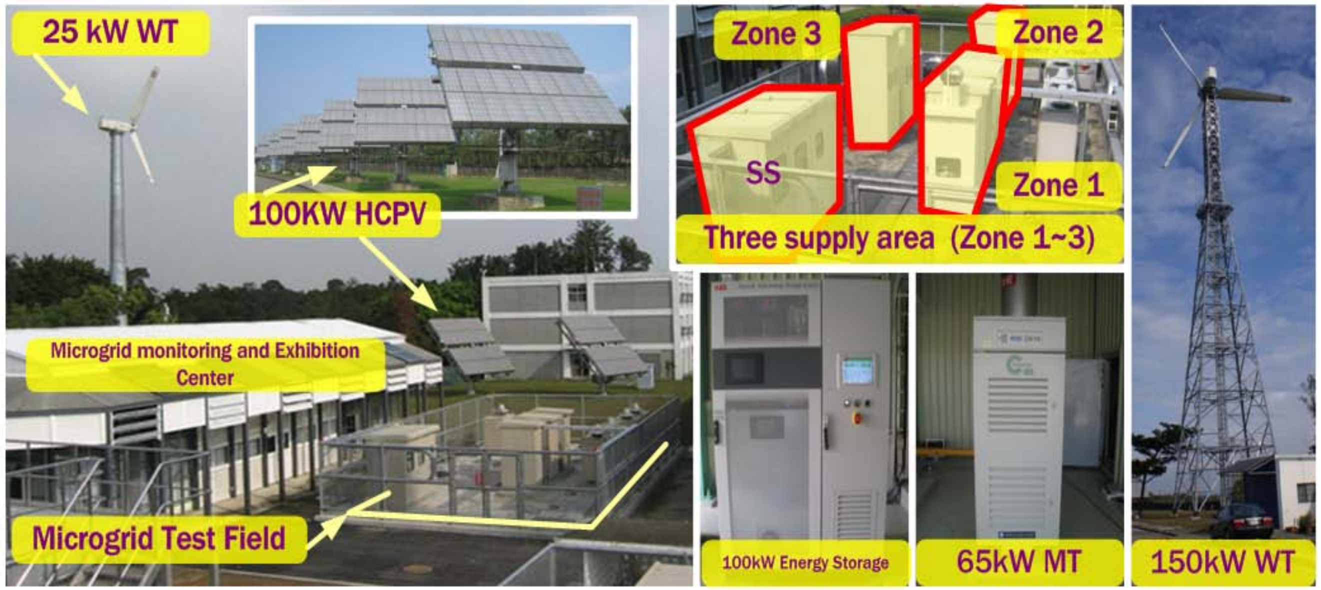
– Distributed and Resilient Architecture

Institute of Nuclear Energy Research Microgrid

- The establishment of an autonomously-controlled microgrid demonstration system, and completion of seamless, stable switching of microgrid between grid-connected and islanding operating modes.

  - INER are developing Microgrid & EV Integration Technology

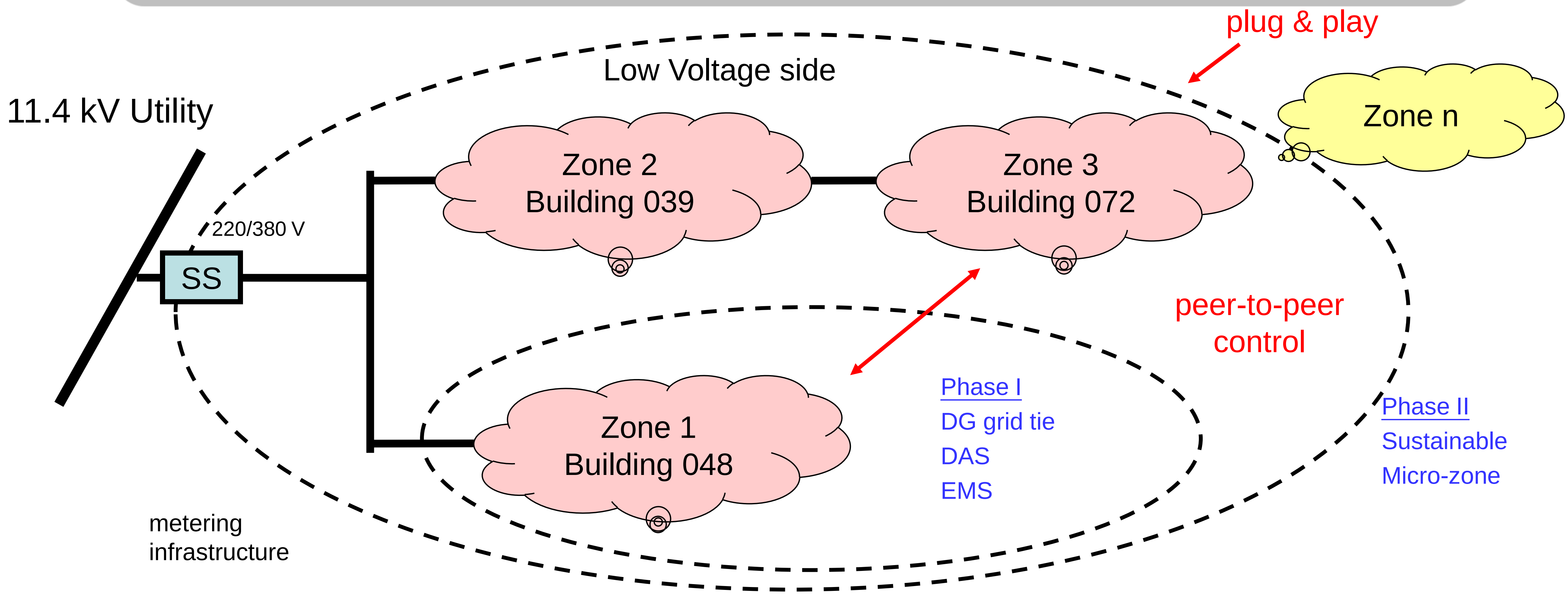
1. Reduce EV charging grid connection impact;
2. Improve the renewable energy usage efficiency
3. Vehicle to Grid (V2G) for Load Shifting



Source: Institute of Nuclear Energy Research for 21st APEC Automotive Dialogue

Target: Developing power control and management technology for low voltage side of microgrid with three zones in which 20% of total energy comes from renewable energy.

Microgrid EMS can be used to perform seamless transition control between grid connected and stand alone operation successfully.

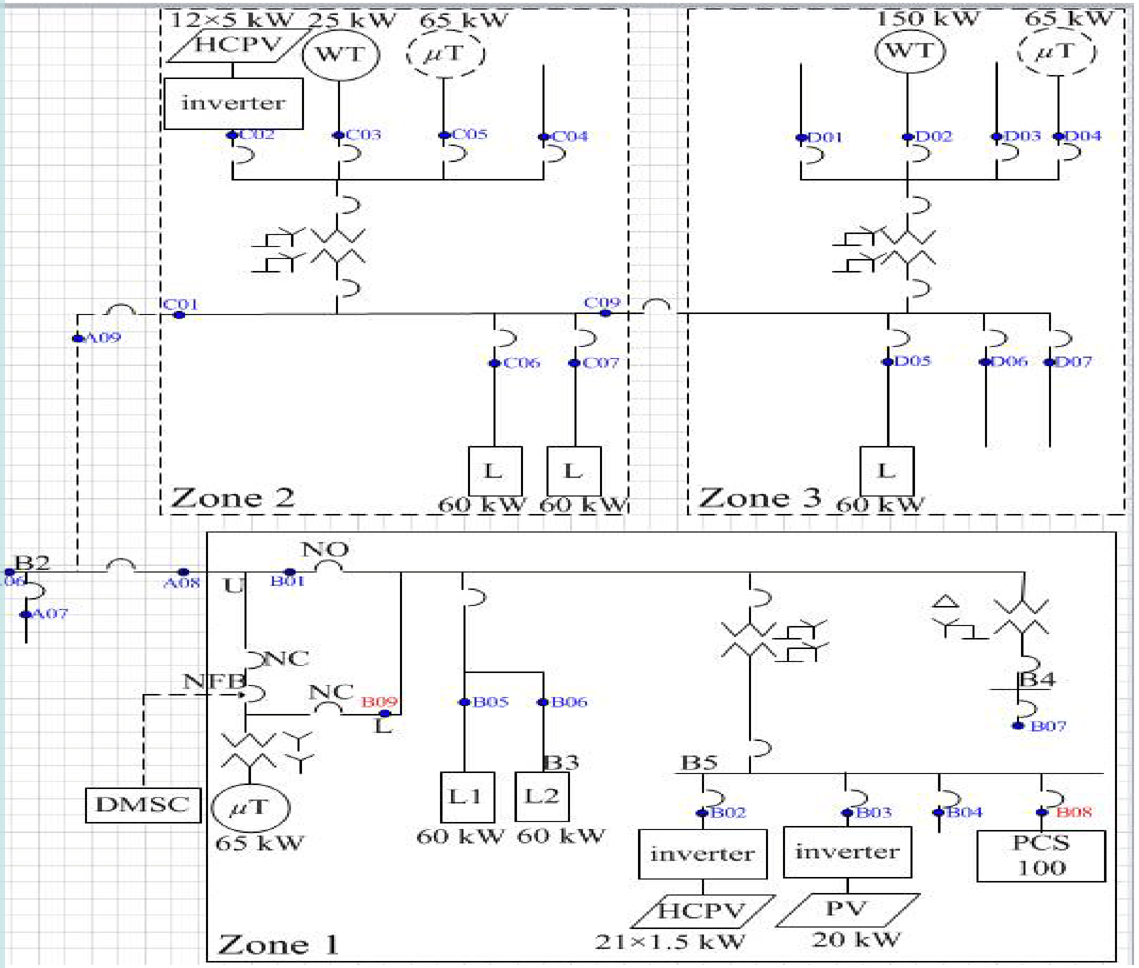


Microgrid Technology Development

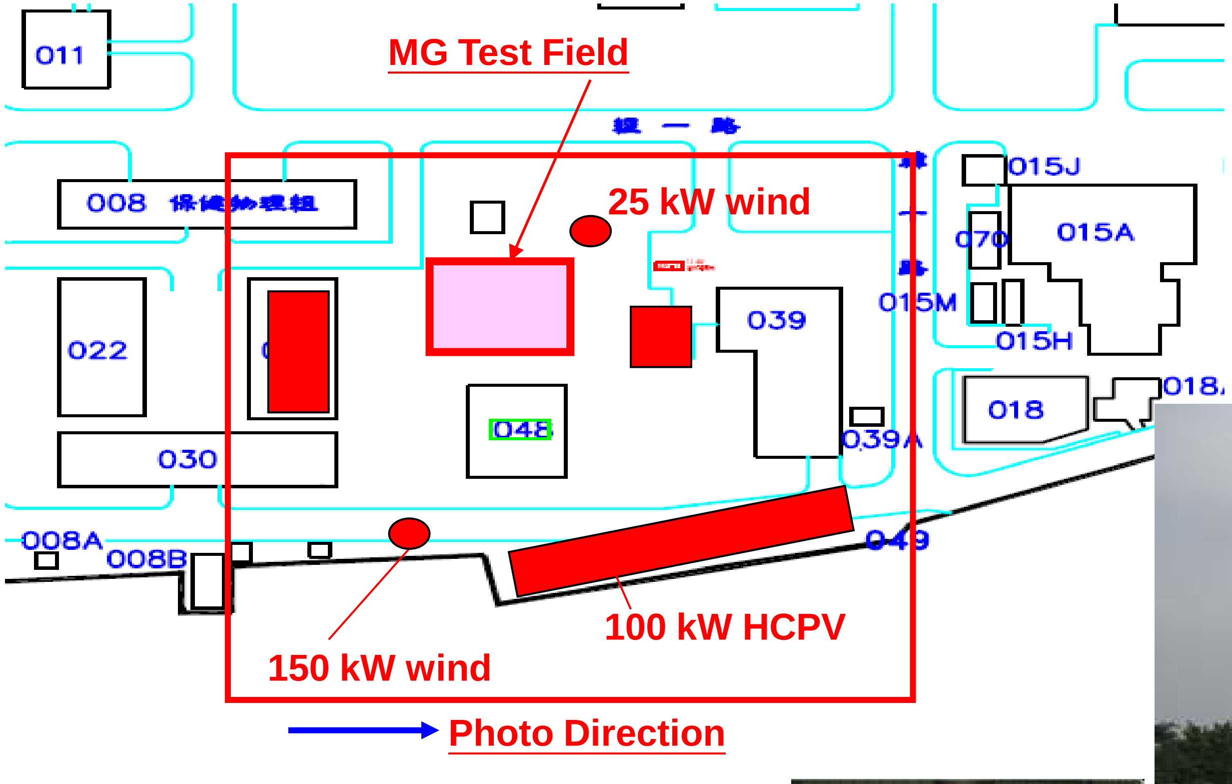
(1) Power System Technology
- Operation Scenarios Design & Testing
- System Stability Analysis
- Protection Coordination for MG
- Microgrid Power Quality Analysis

(2) Power Electronics Technology
- Static Switch and Islanding Detection
- Smooth Switching Inverter
- Active/Reactive Power Control
- Droop Control
- Low Voltage Ride Through

(3) Intelligent control and EMS
- Energy Management System
- Power Flow Analysis
- Generation & Load Prediction
- DAQ and Time Synchronization



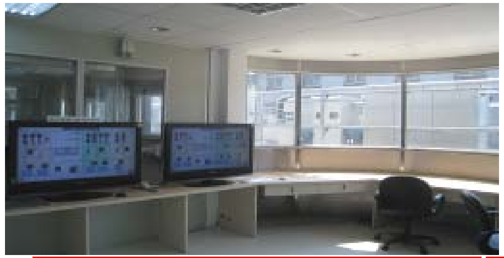
470 kW Microgrid Test Field



100 kW HCPV

150 kW wind

MG Test Field

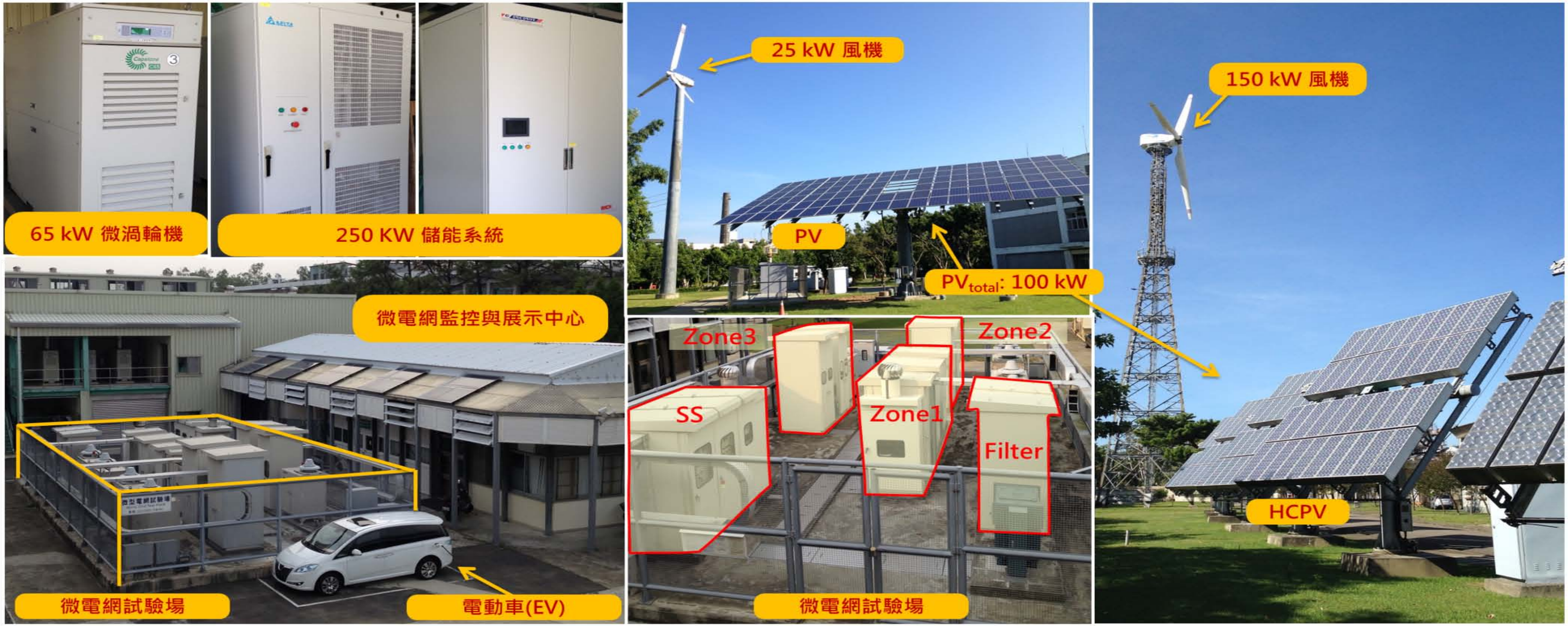


Control Room

250 kW ES

65 kW x3 MT

470 kW Microgrid Test Field

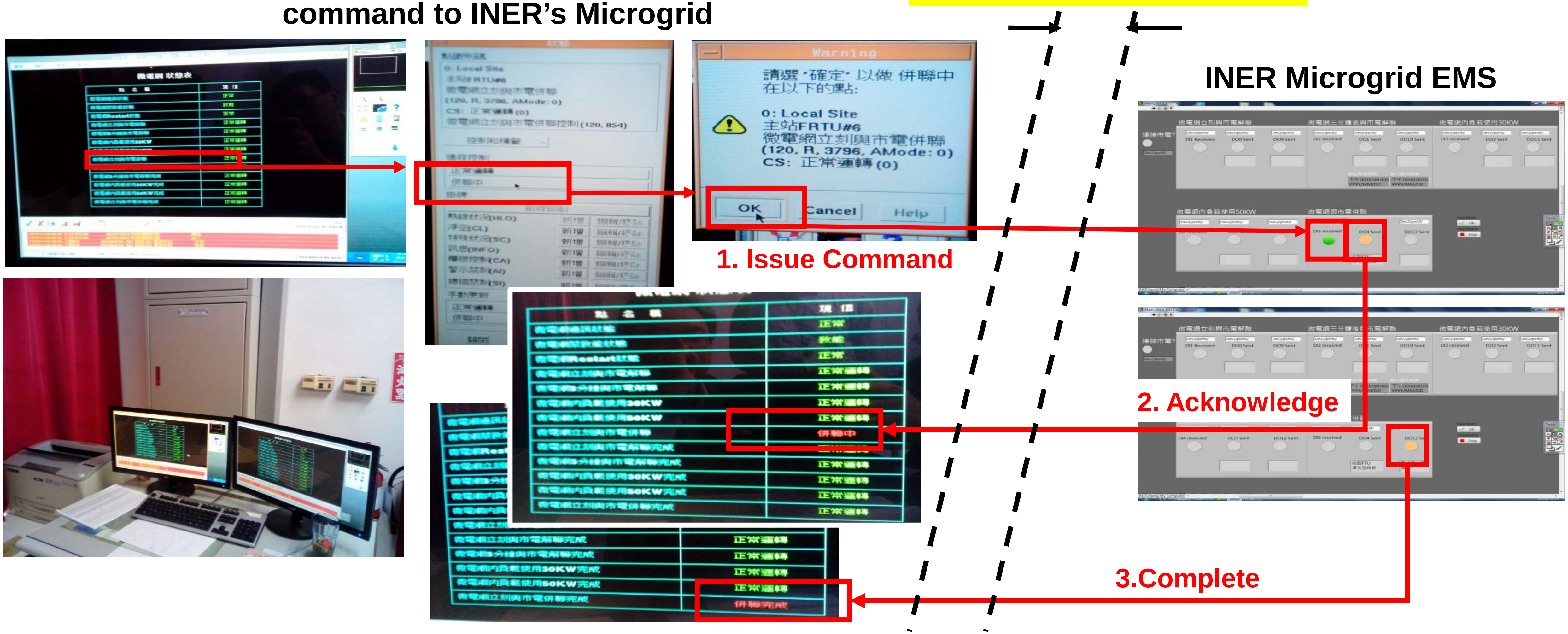



TPC Distribution Feeder
Point of Common Coupling (PCC)
Microgrid Test Field
Overhead Line (700 m)
Underground Line (35m)
魚池

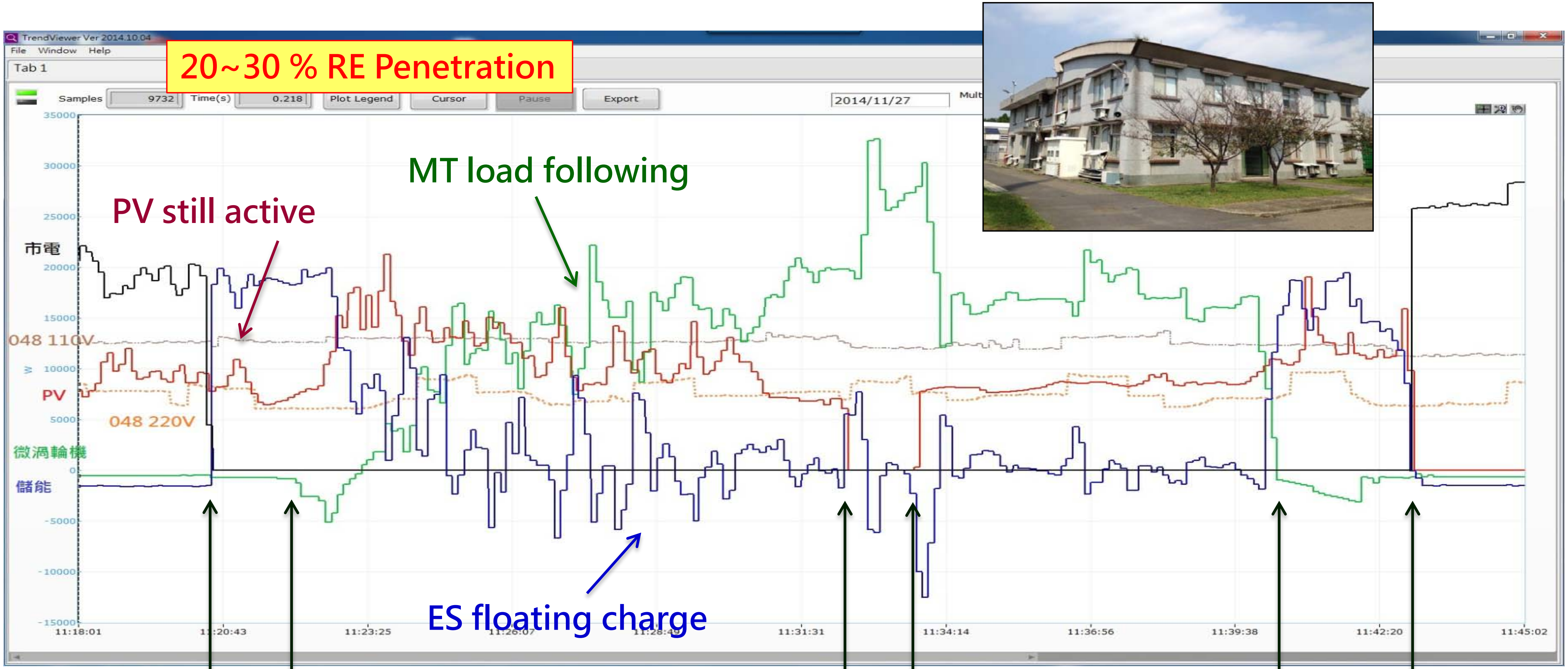
Power Dispatching by TPC

20 km, 4 sec

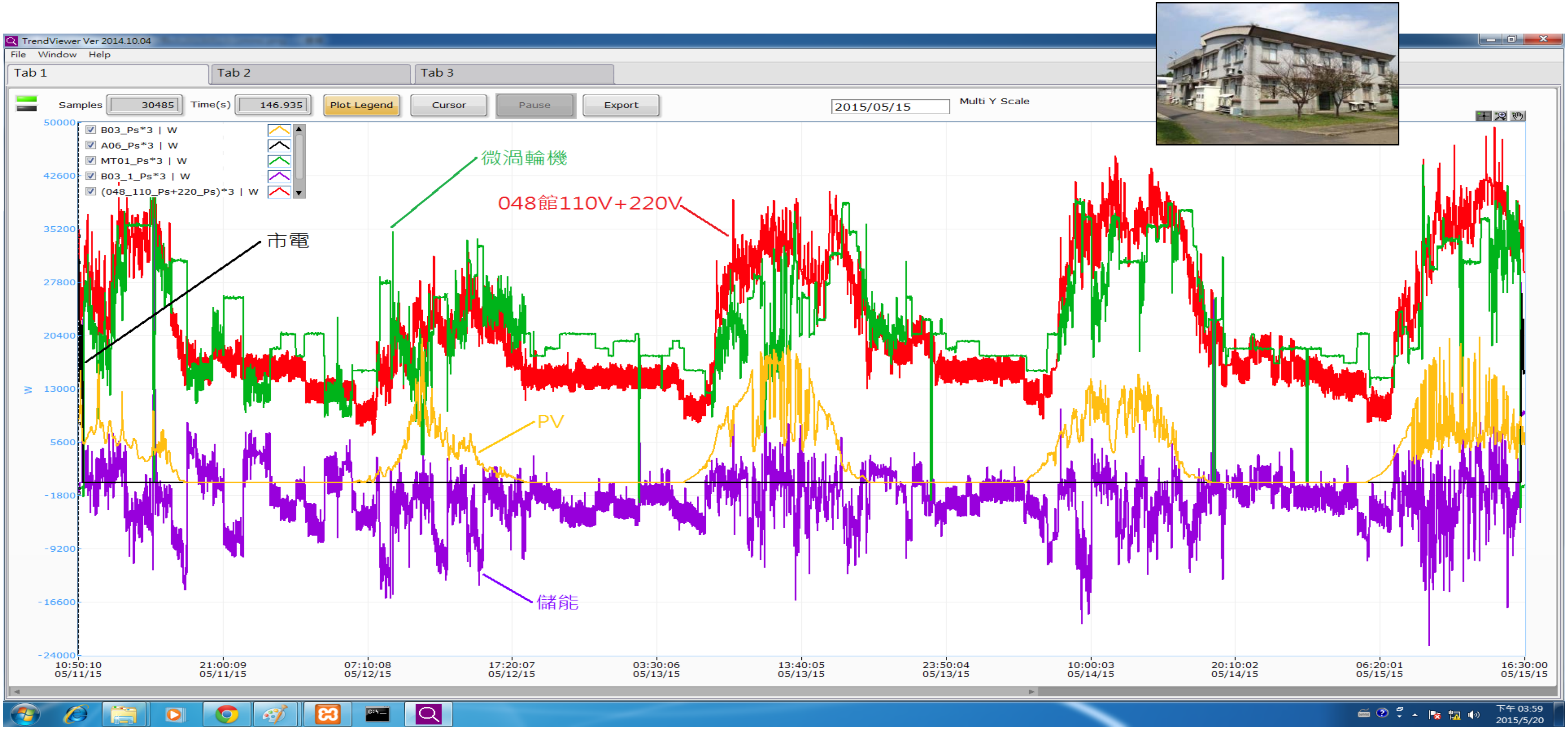
TPC's FDCC issue islanding operation command to INER's Microgrid



Islanding Operation on Building



100 hrs Islanding Operation



Smart Institute Project

INER
6.75 MW
52 buildings

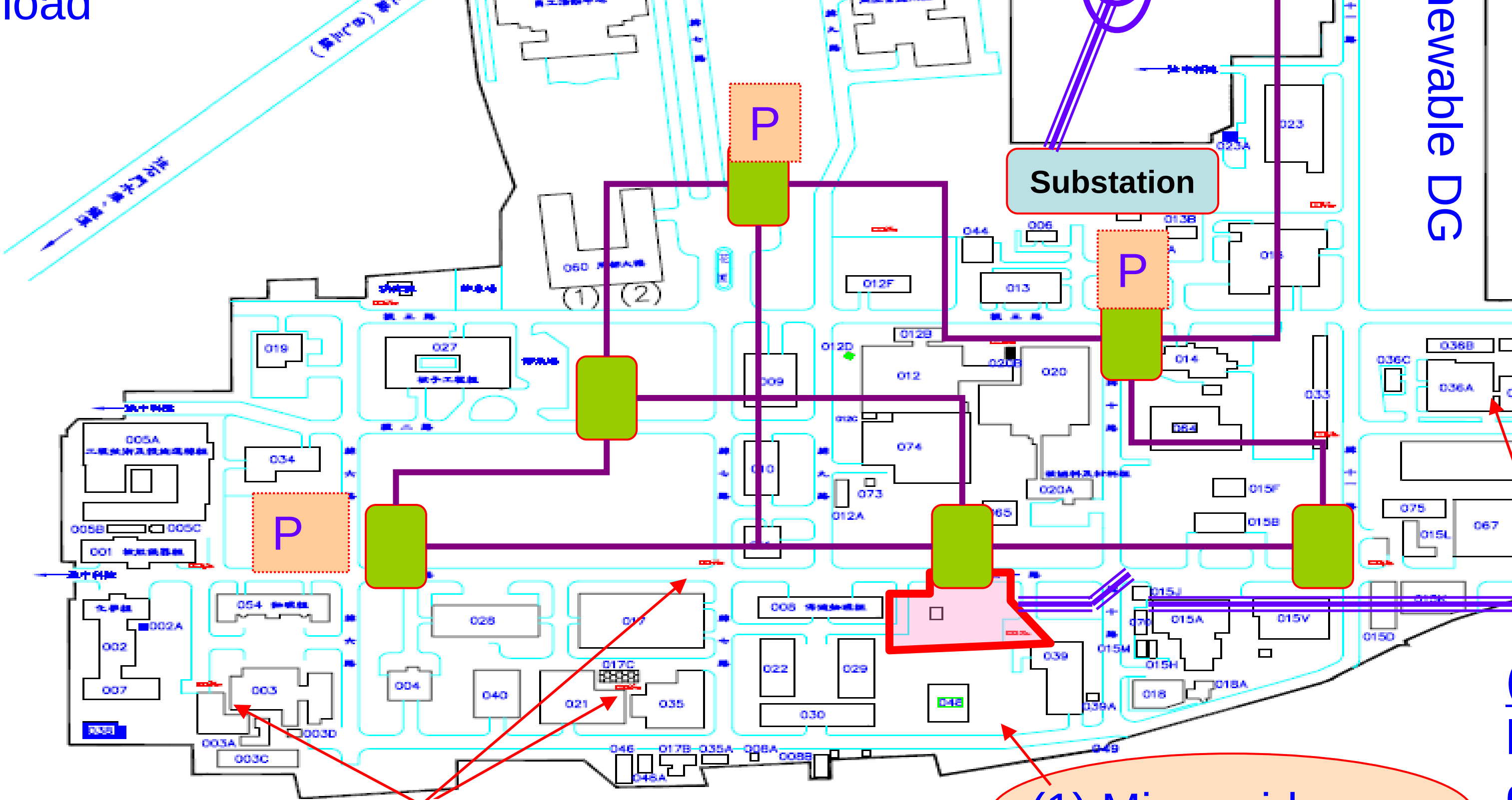
(3) ADAS
loop structure for load transfer

(4) AMI
high, low voltage

(5) EV
smart power dispatching mngt. and ES

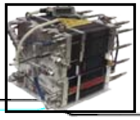
EV充電站

P 停車場




WT


PV


SOFC

DGs locate around buildings

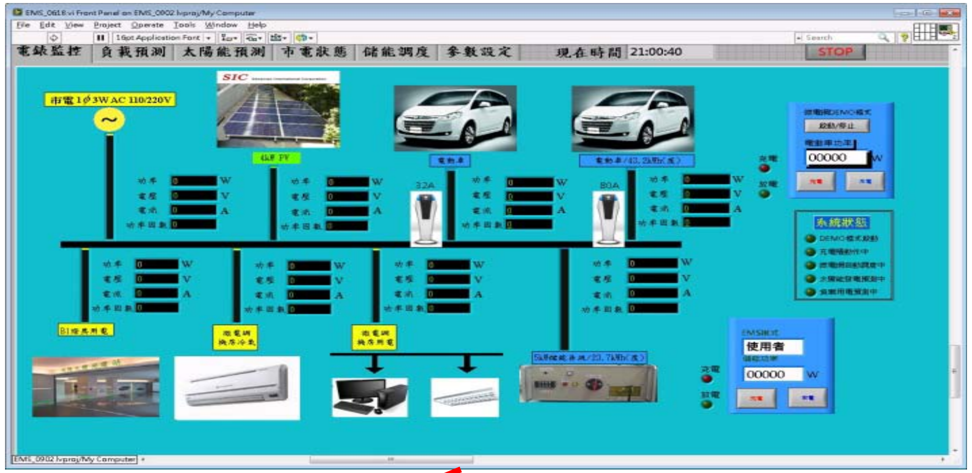
(2) Smart House
located at the end of distributed system

(1) Microgrid

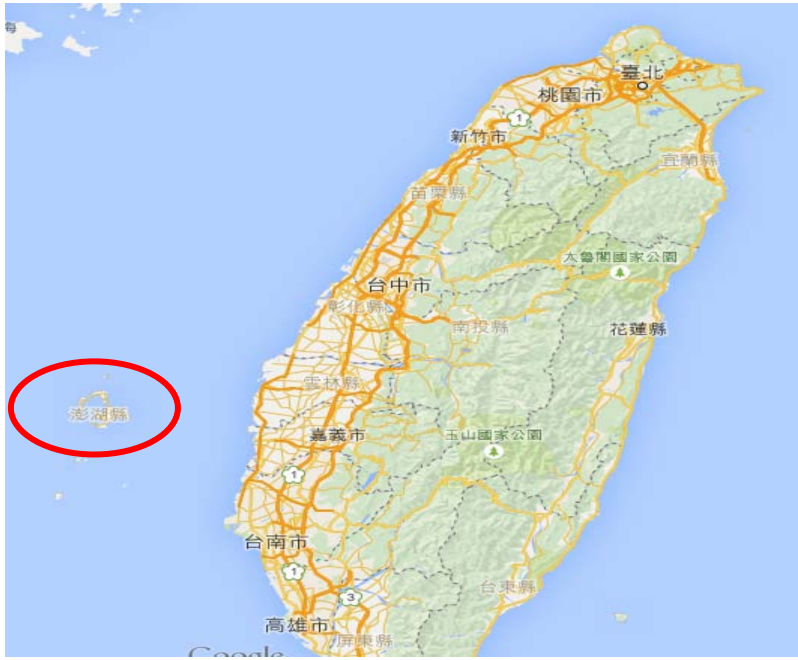
(6) ES + 11.4 kV substation

Water Park of Pingtung Microgrid

Microgrid at Yulon Xindian District



Microgrid on Adjacent Islands

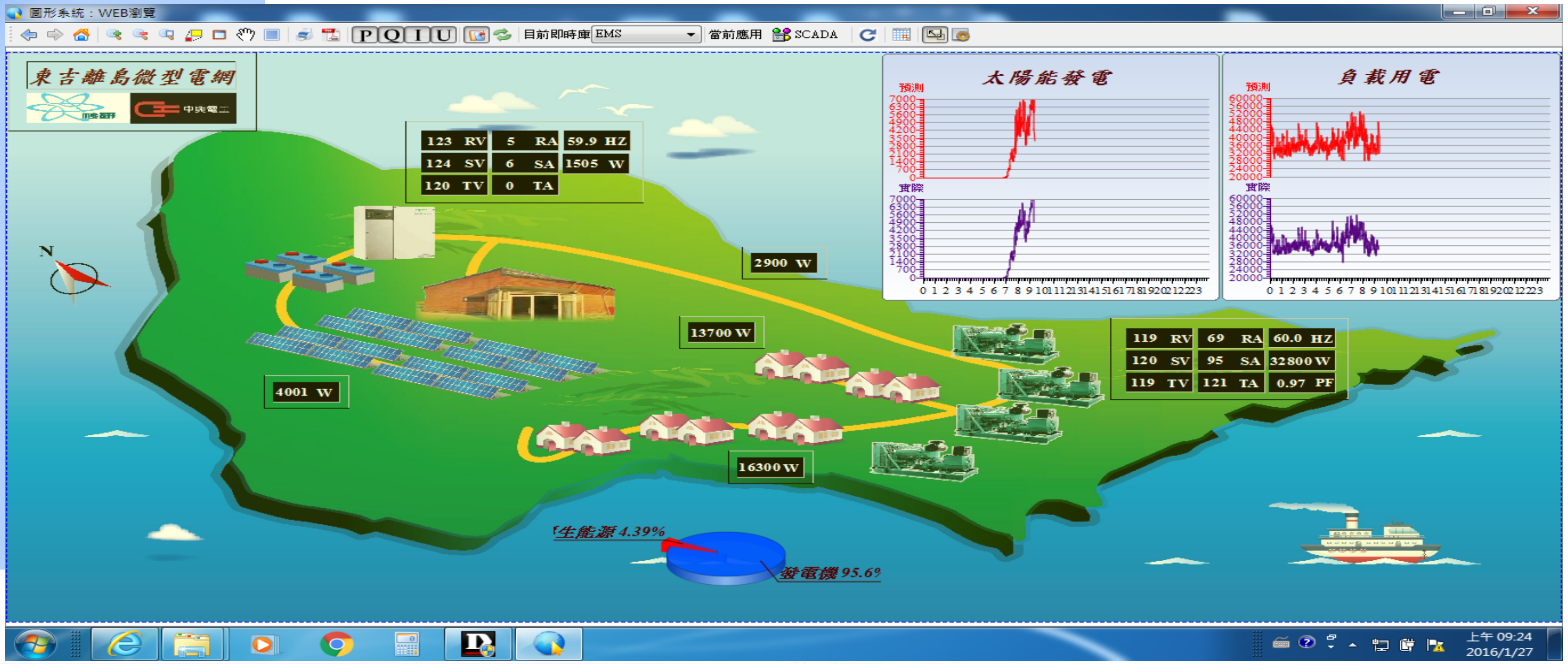


4.8 MW

5.4 MW

All possible types of international collaboration are welcomed !

Microgrid on Dongji Island



Microgrid on Dongji Island

Goals

- Increase the electricity generation of renewable energy.
- Reduce electricity generation from fuels.
- Enhance the power supply quality on offshore islands.
- Pave the way for zero-carbon electricity generation.

Method

- Implementation of Microgrid Power Management Systems on Offshore Island.

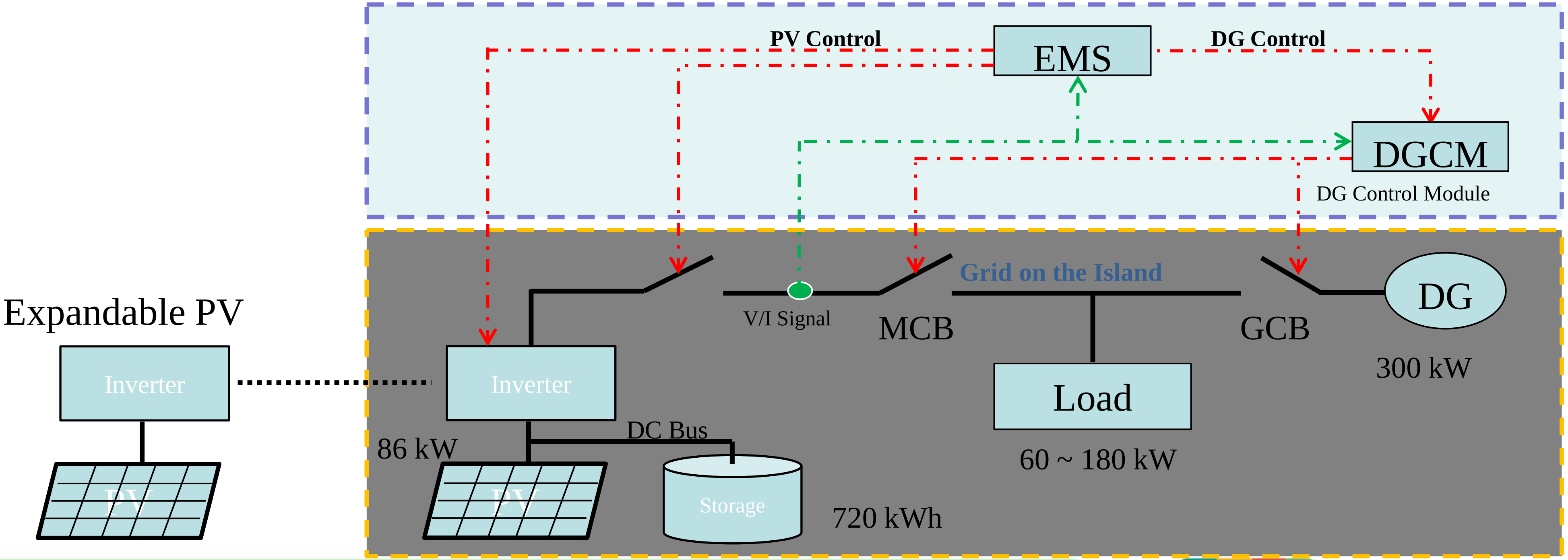
Functions

- Power generation forecasts
- Load forecasts
- Remote monitoring
- Energy distribution
- Demand control
- Unbalanced three-phase power control

Microgrid on Dongji Island

Achieves the coordinated control of PV and DG：

- PV serves as the primary power supply, while DG as the secondary power supply. The target is to generate electricity without fuels.
- Achieves the coordinated control of PV and DG to improve the stability of power supply on offshore islands.
- Increase Penghu's popularity by establishing international case of offshore island which the power generation is mainly supplied by renewable energy.

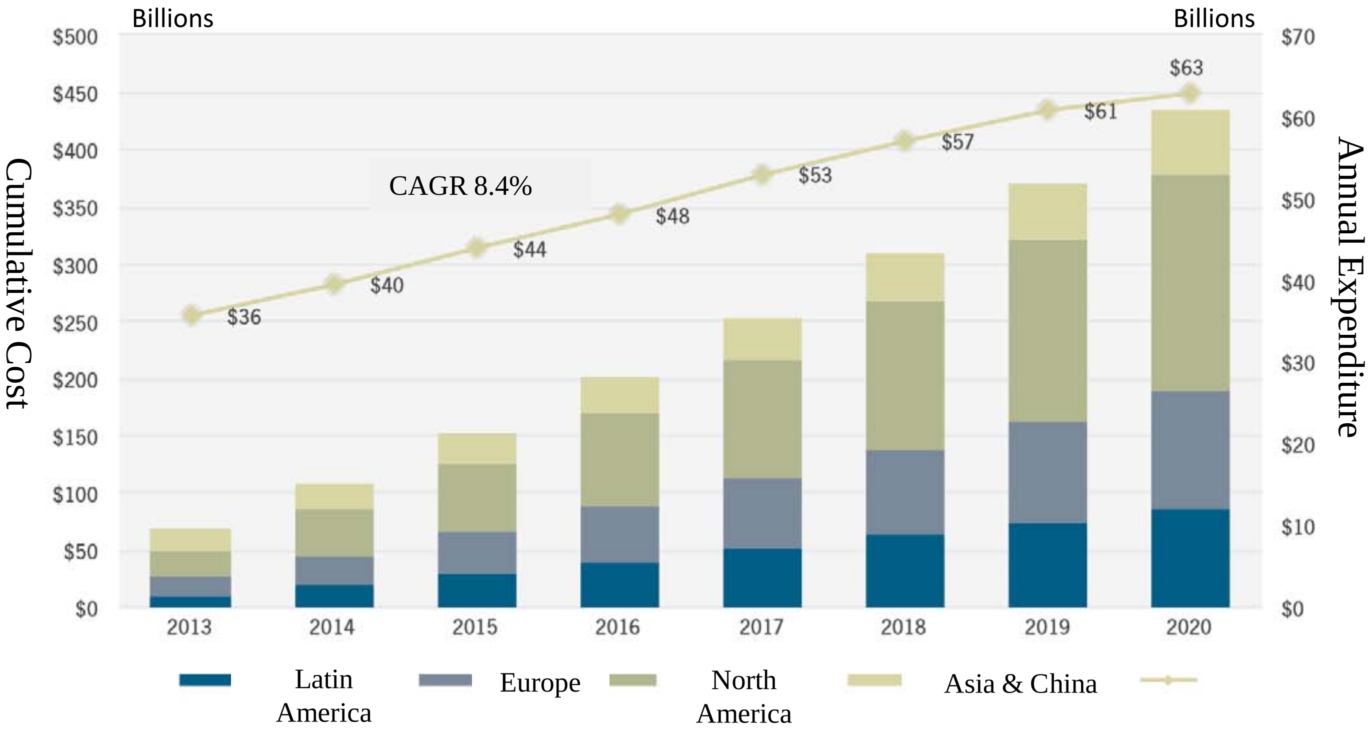


Development of Smart Grid Industry in Taiwan

Global Development of Smart Grid Market

The construction development of smart grid around the world has begun, and the output value of smart grid global market will continue to grow sustainably.

- **Whether grid update projects of developed countries or grid infrastructure installation of developing countries, all will continue over 20 years or more.**
- **According to the analysis done by international research institute GMT, the total output value of smart grid global market will generate over $400 billion with 8% of compound average growth rate (CAGR). It can be expected that the output value of smart grid global market will continue to grow sustainably in the future.**

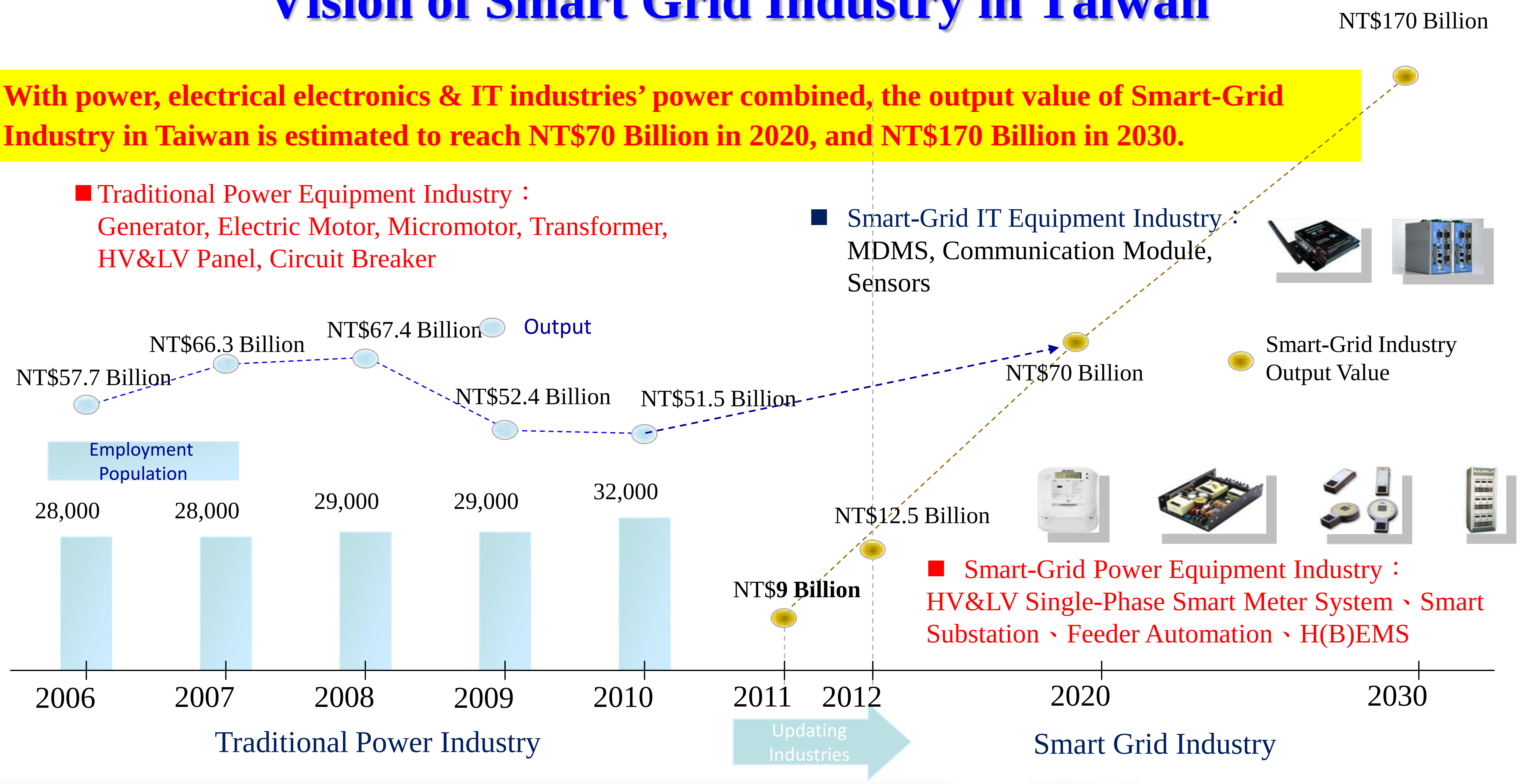


Source：2013 ~ 2020 over output value of smart grid (Source：GTM 2013)

Vision of Smart Grid Industry in Taiwan

With power, electrical electronics & IT industries' power combined, the output value of Smart-Grid Industry in Taiwan is estimated to reach NT$70 Billion in 2020, and NT$170 Billion in 2030.

- Traditional Power Equipment Industry：
  Generator, Electric Motor, Micromotor, Transformer, HV&LV Panel, Circuit Breaker
- Smart-Grid IT Equipment Industry：
  MDMS, Communication Module, Sensors



- Smart-Grid Power Equipment Industry：
  HV&LV Single-Phase Smart Meter System、Smart Substation、Feeder Automation、H(B)EMS

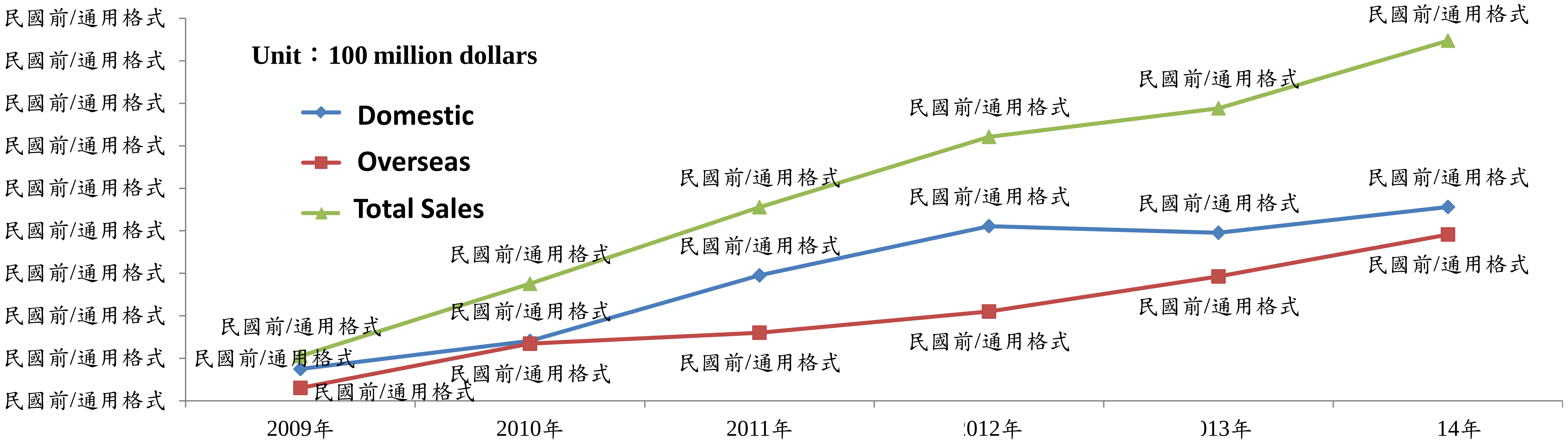
Structure of Taiwan Smart Grid Industry Association

Taiwan Smart Grid Industry Association（TSGIA）was officially established in September 2009 for the purpose of facilitating the development of the smart grid industry in Taiwan

- **General Assembly** (President、Vice-President)
  - **Secretariat TIER**
  - **AMI**
    - TATUNG (Director)
    - DELTA (Co-Director)
  - **Intelligent Transmission & Distribution**
    - AEC (Director)
    - MOXA (Co-Director)
  - **Smart Home**
    - TATUNG (Director)
    - CHT (Co-Director)
  - **Micro Grid**
    - CHEM (Director)
    - INER (Co-Director
    - CSIST (Co-Director)
  - **Standard & Regulation**
    - III (Director)
  - **Market & Industry**
    - TIER (Director)
    - III (Co-Director)
    - ITRI (Co-Director)
  - **Energy ICT**
    - ITRI (Co-Director)
    - CHT (Co-Director)
    - MOXA (Co-Director)
  - **Energy Storage**
    - CSIST (Co-Director)
    - CHEM (Director)

Results of Smart Grid Industry Survey in Taiwan

According to the surveys that were conducted in 2012 and 2014, the result shows that the total sales of Smart Grid related products continue to grow steadily and **have a Compound Annual Growth Rate (CAGR) of 51.71%. 2012, 2013 domestic sales growth lower than expected, mainly due to Taipower's reduce or postpone of investment in transmission and distribution sector, companies more actively developing overseas markets. Overall, nearly six years, domestic and foreign markets showing stable growth trend.**



	Domestic	Overseas	Total Sales	Domestic	Overseas	Growth Rate	CAGR
2009	$14.98	$6.10	71.07%	28.93%	$21.09	-	
2010	$28.18	$26.91	51.15%	48.85%	$55.09	161.25%	
2011	$59.03	$32.08	64.79%	35.21%	$91.12	65.41%	51.71%
2012	$82.20	$42.04	66.16%	33.84%	$124.24	36.36%	
2013	$79.11	$58.54	57.47%	42.53%	$137.65	10.79%	
2014	$91.22	$78.28	53.82%	46.18%	$169.5	23.14%	

Unit：NTD in 100 million dollars

Thank You for Your Listening!