Strategic Initiatives of Smart Grid in Taiwan

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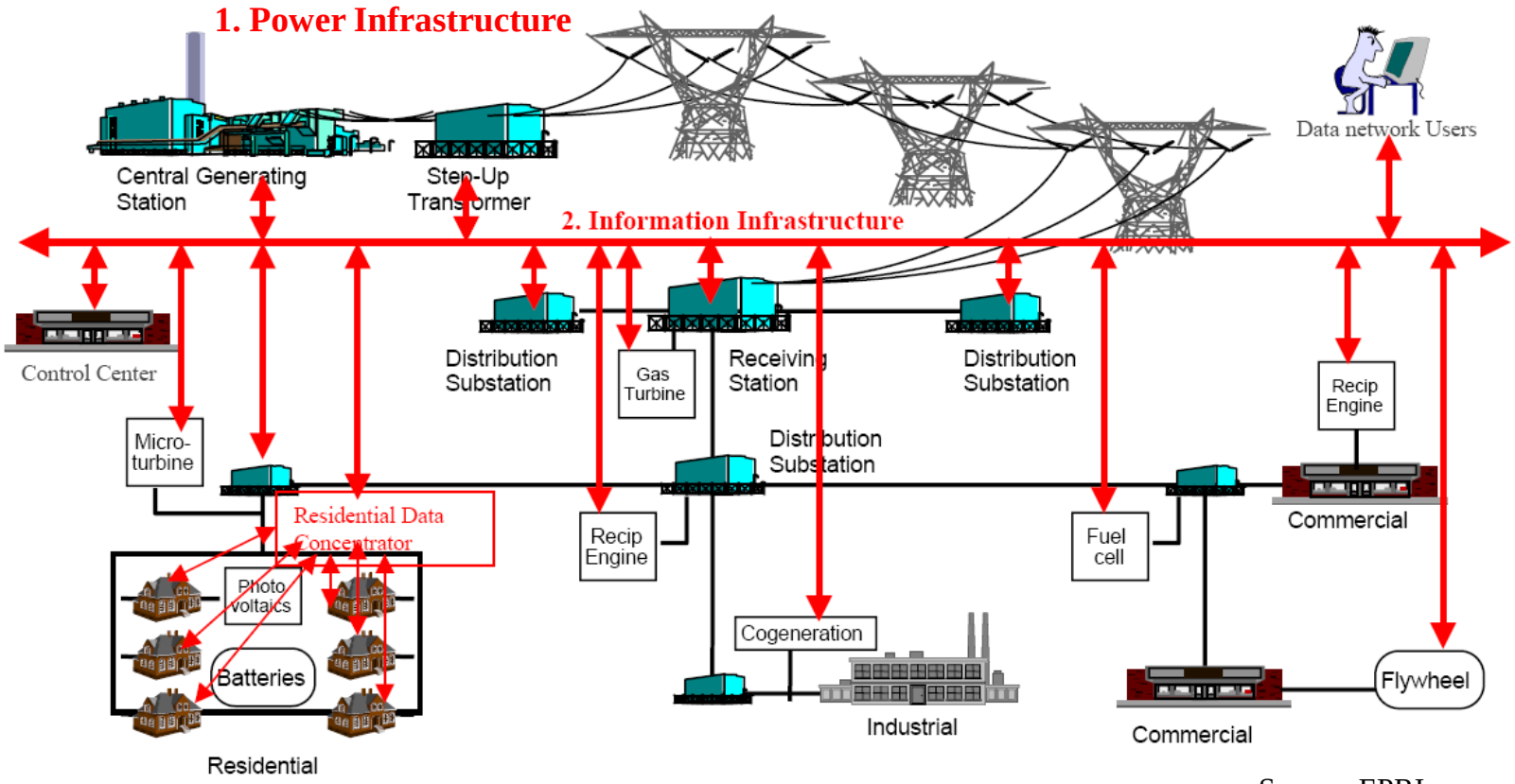
Outline

- **What is smart grid**
- **Taipower's vision on smart grid**
- **Strategic initiatives of smart grid in Taiwan**

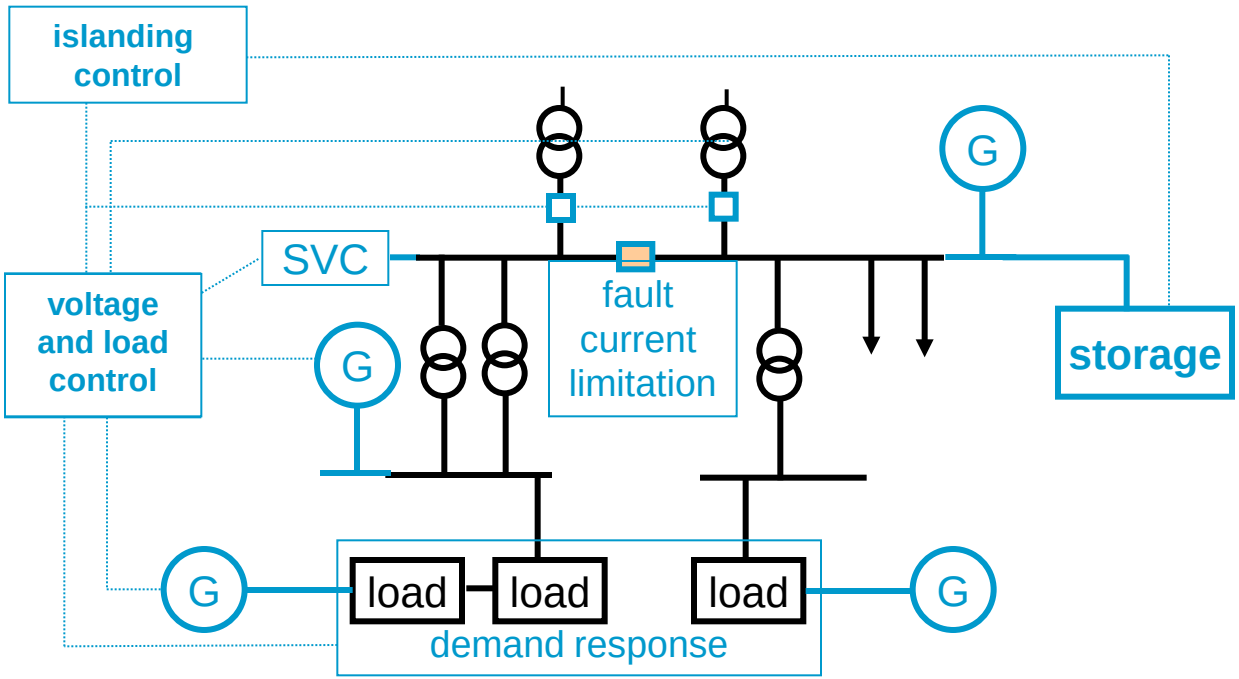
What Is Smart Grid?

Integrate electric power and information/communication technologies to enable better energy management from generation, transmission, distribution to user.



Source: EPRI

The Evolving Electrical Network



bulk storage

independent operation:

- load scheduling
- islanding control
- reconnection/auto-synchronization
- demand response

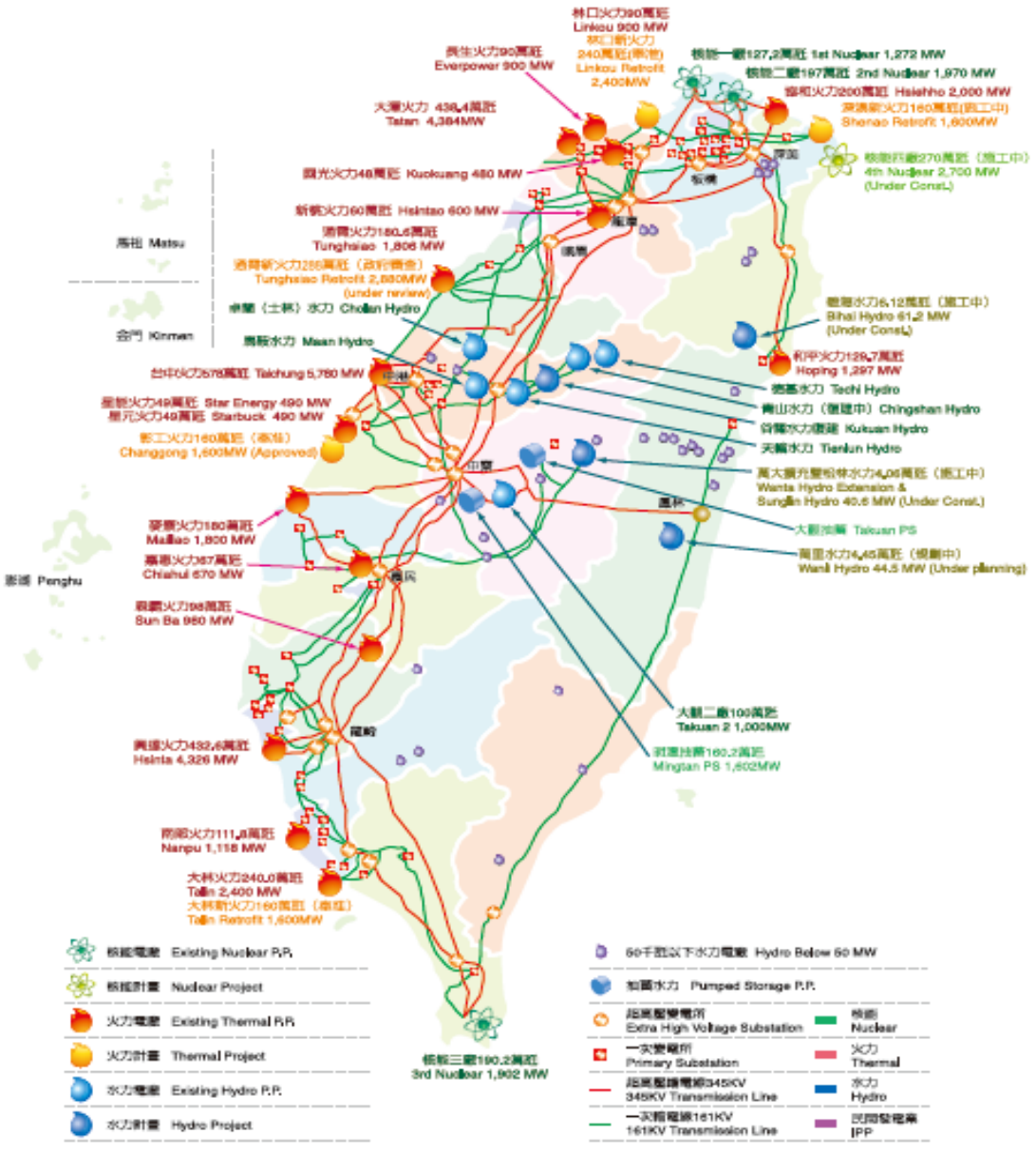
Source: Ofgem, UK

Advantages of Smart Grid

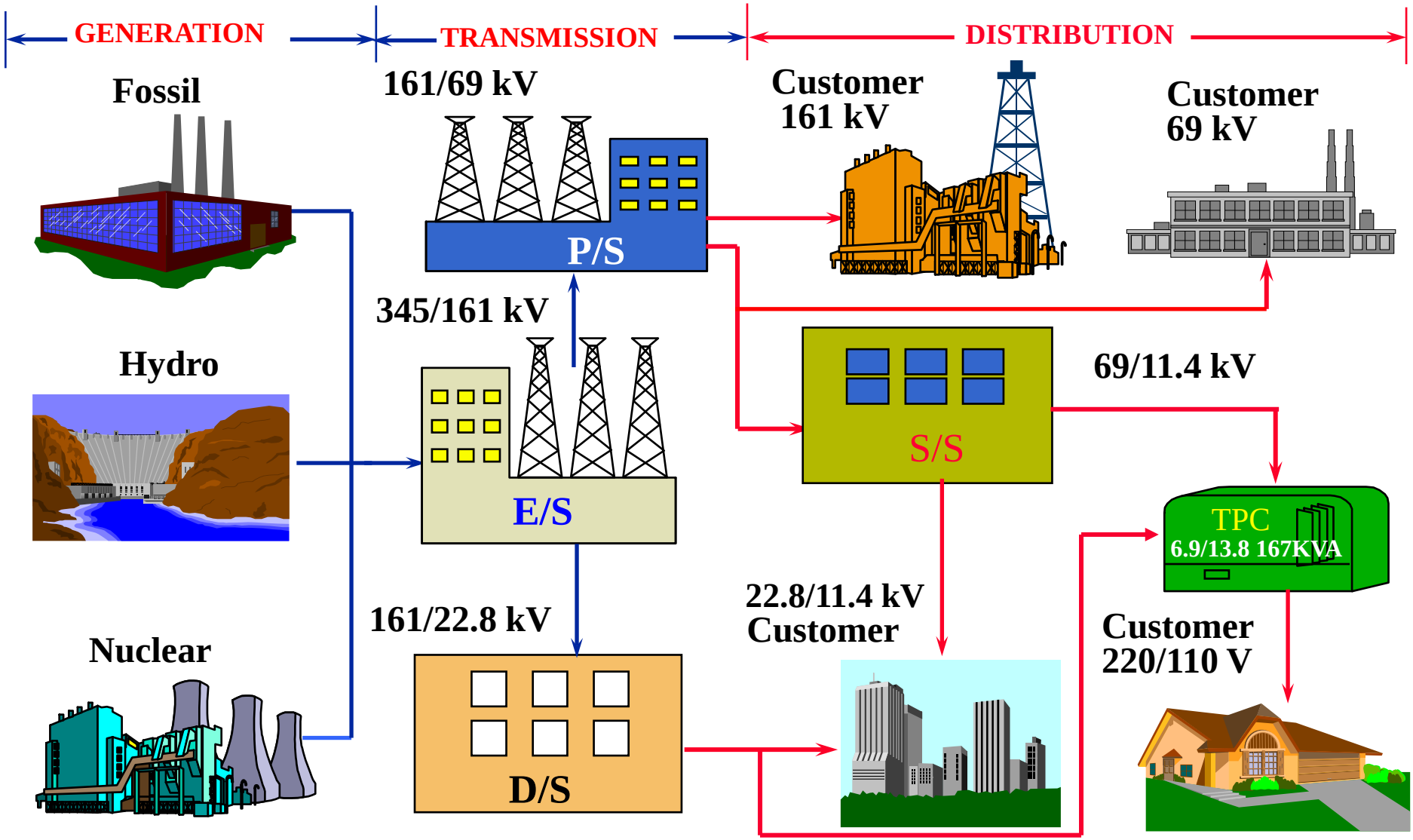
- Improve the overall efficiency for user (by ICT, AMI)
- Improve the proportion of distributed power or renewable energy to total generating capacity (by microgrid and distribution automation)
- Increase the flexibility of supply (by distribution automation)
- Reduce the transmission and distribution losses
- Improve power system stability and power quality (by self-healing)
- Reduce the peak load to reduce the spinning reserves (by AMI, demand response and time of use)
- Improve energy security
- Promote the development of information and communication industry

Overview of Taipower's System

- Installed capacity ≒40.25GW
- Hydro (pump)
  - 2,600 MW
- Thermal
  - 30,194 MW
- Nuclear
  - 5,144 MW
- Renewable
  - 2,306 MW



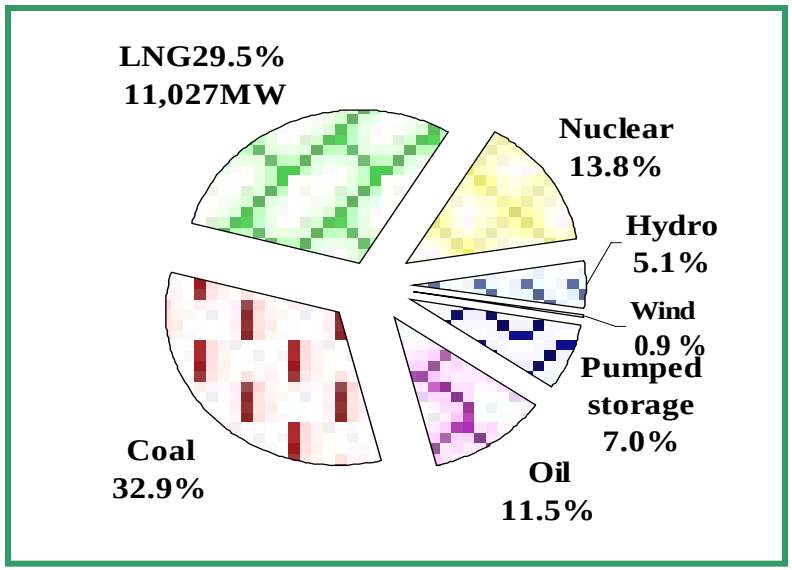
Overview of Taipower's System



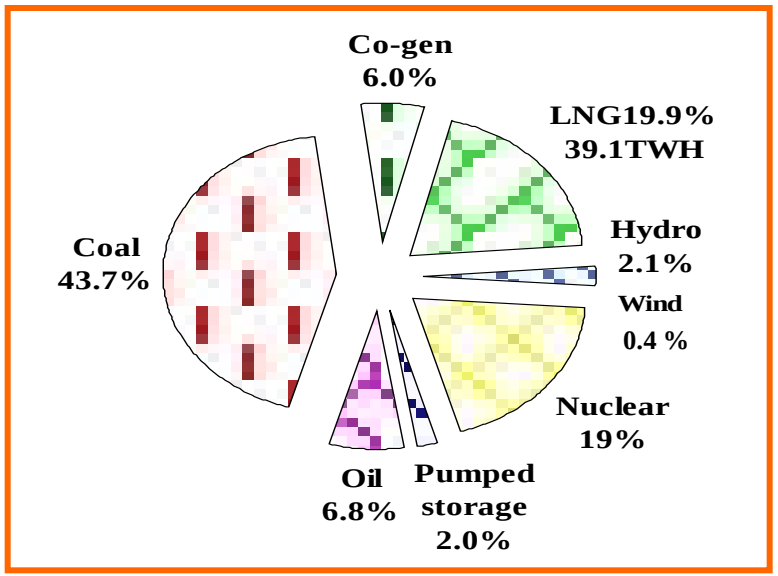
Overview of Taipower's System

Up to year 2009

- System Installed Capacity: 40,247 MW
- Peak Load: 31,011 MW
- Total Generated Electricity (+IPP): 193.6 billion KWh
- Sale Electricity: 179.2 billion KWh
- Customers: 12,414,679
- Line loss: 4.86%



Installed Capacity (40,247 MW)



Generation (193.6TWh)

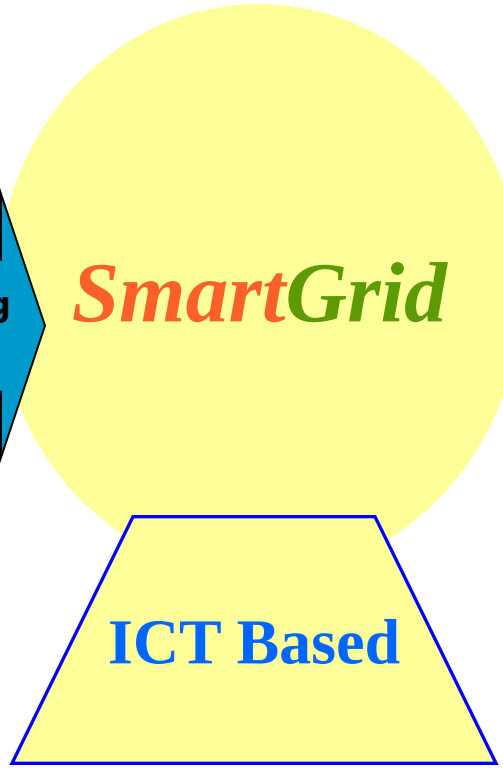
Taipower's Vision on Smart Grid

- **The** "smart grid" **is a high-quality, high-efficiency, customer service-oriented and environment-friendly power grid through integrating the advanced information and communication infrastructures.**
- **Significant smart grid items in Taipower include: advanced metering infrastructure, distributed energy resources integration, wide-area monitoring system, asset management, flexible AC transmission system applications, battery electric vehicle impacts on power grid, and fiber optic Ethernet network implementations.**

Taipower's Vision on Smart Grid (*cont.*)

- **Reliable Power Supply with High Power Quality**
- **Productivity Improvement**
- **Carbon Footprint**
- **Communication, Information and Power Electronics Technology Improvement**

Driving Forces



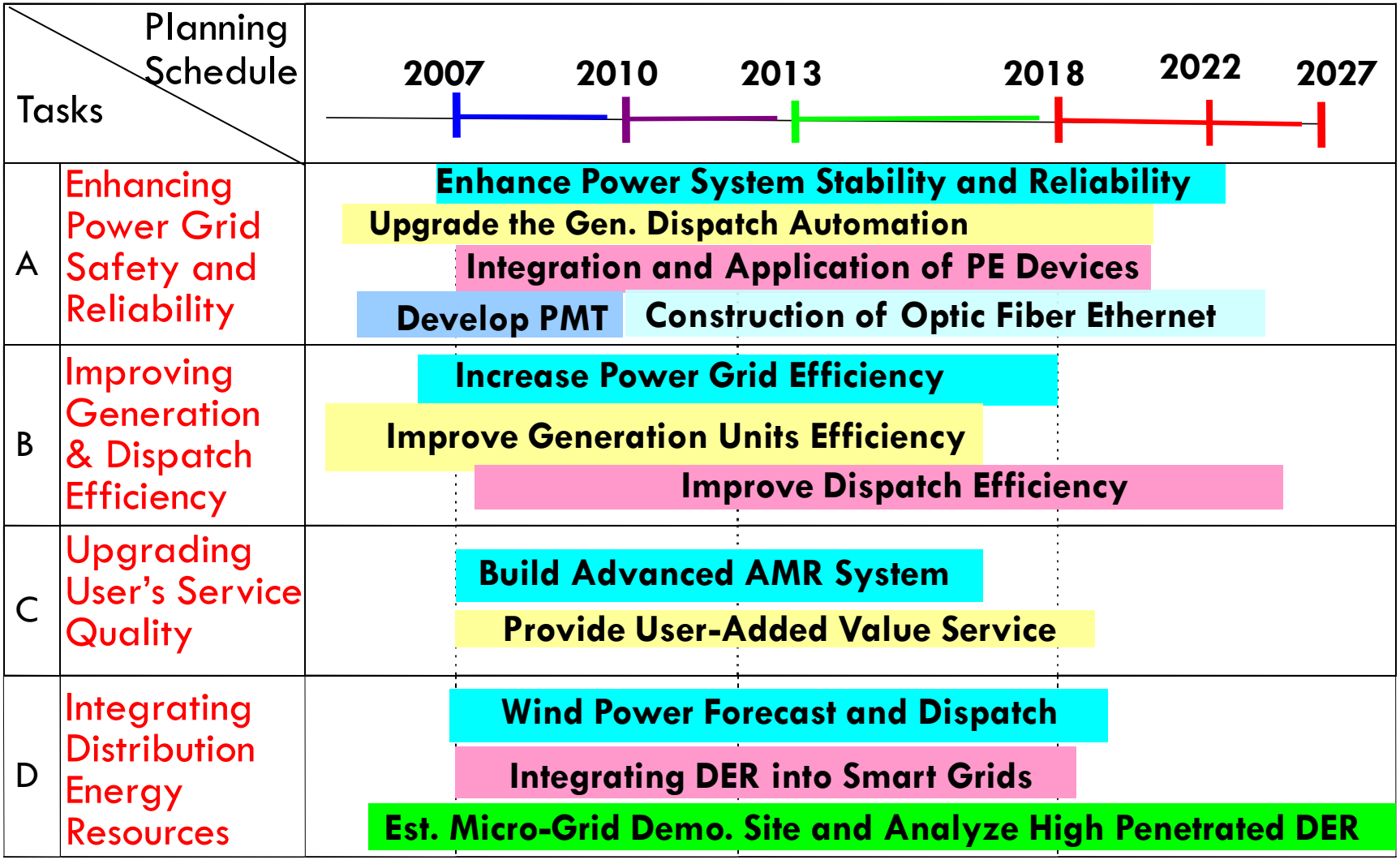
Vision

Create a high-quality, high-efficiency, customer service-oriented, and environment-friendly power grid.

Objective

- **A higher safety and reliability of power network**
- **Higher efficiency of power plants**
- **Service-oriented system**
- **Environment-friendly grid**

Taipower's Vision on Smart Grid - Roadmap



PE: Power Electronics PMT: Preventive Maintenance Technology

Supporting platforms: Communication Protocol Guideline and Knowledge Base

Smart Grid for Transmission System

- Asset Management: **Main Transformer Asset Management constructed in 2008; the risk assessment of power supply stability and safety finished in 2009.**
- Automated Asset Condition Assessment: **RFIDs are applied for equipment, remote reading and analysis software developed in 2009.**
- Automated Fault Location: **Software has been developed in 2009**
- SVR: **Feasibility study: 2006, Construction Plan: 2011-2015**
- SVC: **Feasibility study: 2008, Construction Plan: 2012/2013 (in East Taiwan)**
- STATCOM： **Construction Plan: 2013 (LungTan, 150MVA)**
- Enable Wide Area Monitoring & Control: **PMUs have been installed in 2005, and several advanced features are under development.**
- Integrate Demand Responsive Resources: **The first stage program was operated in 2008, and will be promoted with sufficient incentives.**

Smart Grid for Distribution System

- **Feeder Automation**：6,630 feeders will be automated by 2011
- **Remote Monitoring of Fault Indicator:** first stage demo project was finished in 2009, second test started in 2010
- **Integrated Volt/Var Control:** Field testing
- **Feeder or Area Peak Load Management:** under study
- **Equipment Condition Monitoring Field testing**
- **Substations Automation:** have been installed
- **Micro-Grid Management involving DER and PHEV/BEV:** under study

Target of Feeder Automation

Statistic Month	Feeder Auto. No.	Taipower Total Feeders	Feeder Auto. Rate (%)
2009/07	2,620	8,577	30.55
2009/12	3,480		40.4
2010	4,901 (Scheduled)		56.4
2011	6,632 (Scheduled)		75

Distribution Feeder Automation

- Type
  - Closed Loop
  - Open Loop
  - Both have FDIR function
- Target
  - Finished 53% of feeders with FDIR (Fault Detection, Isolation and Service Restoration)
  - function in year 2012
  - Increase the number from 2,110 to 6,256 feeders
  - Main stream is the open loop type

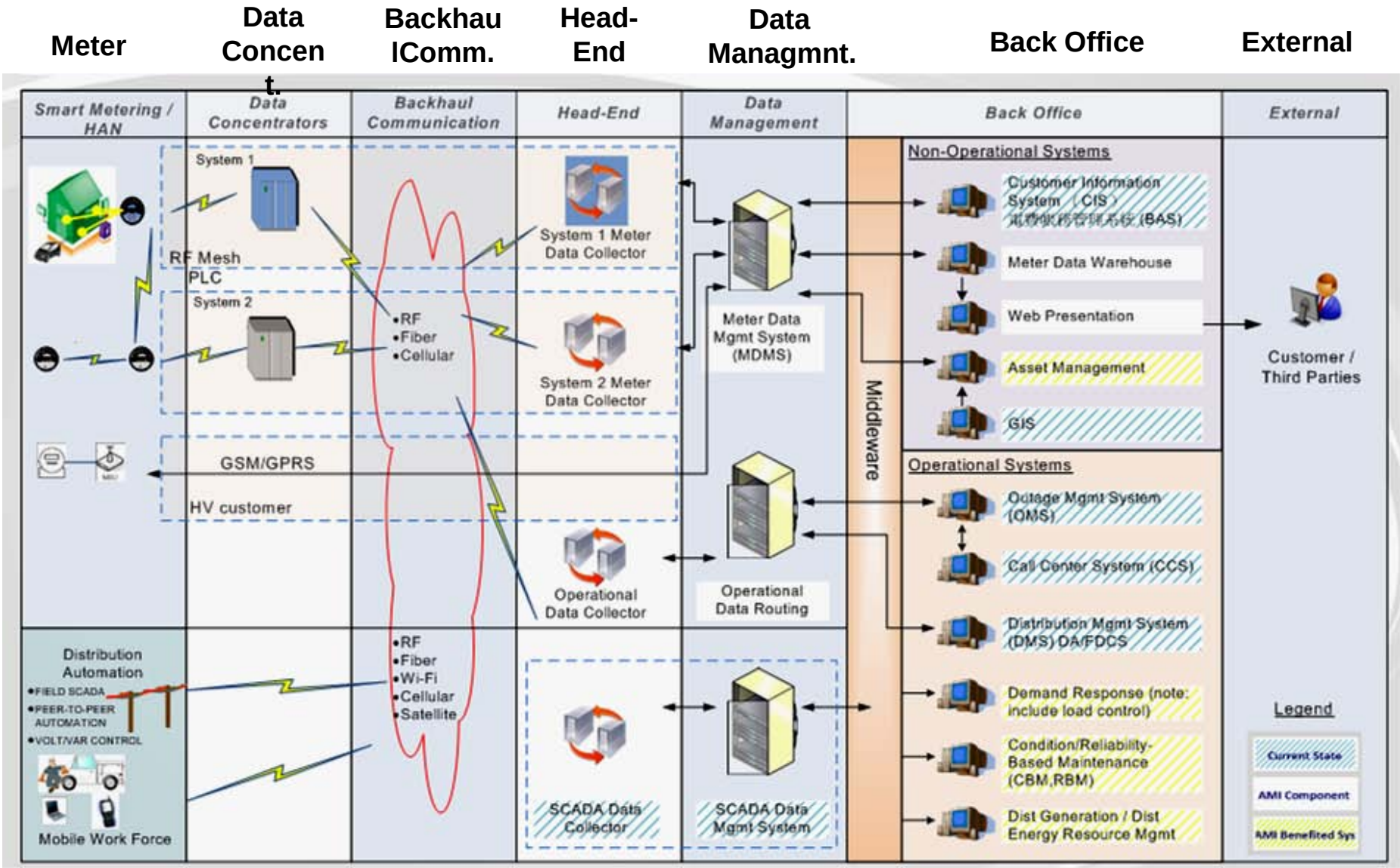
High-Voltage AMI Timeline

High voltage AMI total 23300 meters covering 59% electrical power consumption of Taipower will be installed before 2012.

Low-Voltage AMI Timeline

	1'st Stage (Tech. test)		2'nd Stage (Preliminary Installation)		3'rd Stage (Fundamental Installation)			4'th Stage (Extended Installation)
Year	2009	2010	2011	2012	2013	2014	2015	2016 ->
Meter No.	50	300~500	10,000		1,000,000			5,000,000
Working Items	Communication Technology Testing	*Define Function and Standard *Test Platform Plan	*MDMS Meter Function Test *Meter Function Std. ID. *Construct Test Platform *Construct New TOU Fee	Technology Confirmation	*Meter Installation *New TOU Fee Execution *Load Management and Demand Response Study		Cost/Benefit Assessment	*Construct Distribution Automation System *Apply Load Management and Demand Response

Overall AMI Architecture



Communication Infrastructure and Protocol

- **The communication protocol issue:**
  - **Integration of SCADA systems**
  - **Integrating distributed wind power information platform**
  - **Impact from the new international protocol standards.**
- **Guideline for Taipower's communication protocol:**
  - **Announced on November 2006**
  - **To provide recommendation and instruction to manipulate communication protocol issue on smart grid system.**
- **The communication protocol standard for specific systems will focus on DNP3.0 over TCP/IP or IEC 61850.**
- **The consistency of SCADA protocols in hierarchy system is more important than transmission at high speed.**

Strategic Initiatives of Smart Grid in Taiwan

Vision

Develop the smart grid and AMI industry in Taiwan to establish high quality, high efficiency, user-oriented and environment-friendly power system to reduce CO_2 emission, increase energy efficiency and enhance energy security.

Strategy

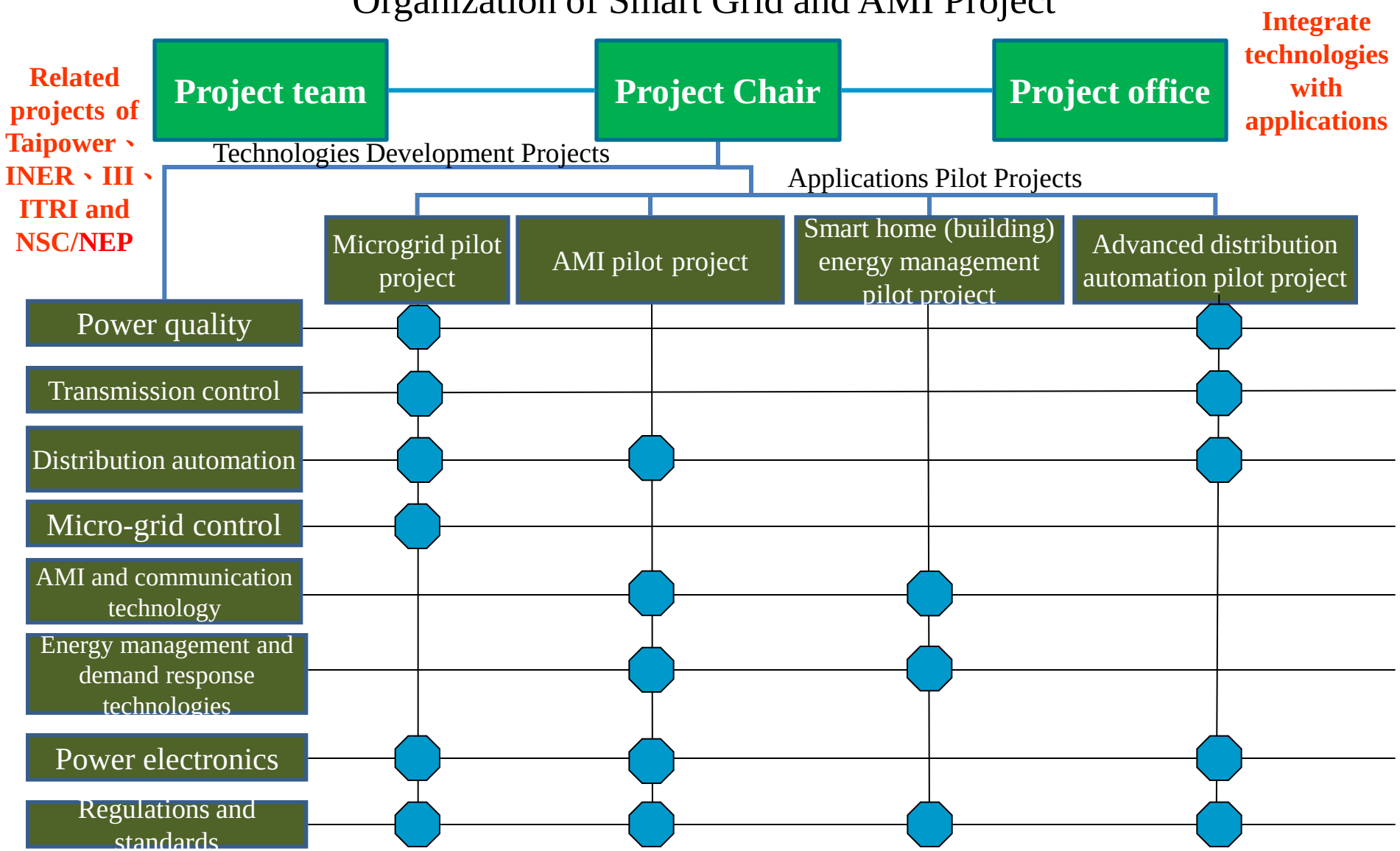
Tying in closely with the smart grid developing schedule of Taiwan Power Company, integrate the research abilities of industry and academia to establish smart grid and support the power facilities industry in Taiwan.

Manner

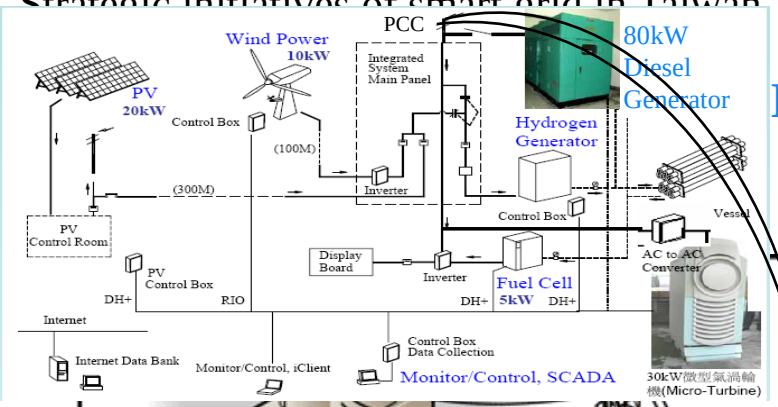
Promote AMI, microgrid, smart home (building) energy management system, advanced distribution automation four pilot projects to develop key technologies of smart grid and AMI and ensure the merging of the developed technologies into the power system in Taiwan will be reliable and feasible.

Strategic Initiatives of Smart Grid in Taiwan (*cont.*)

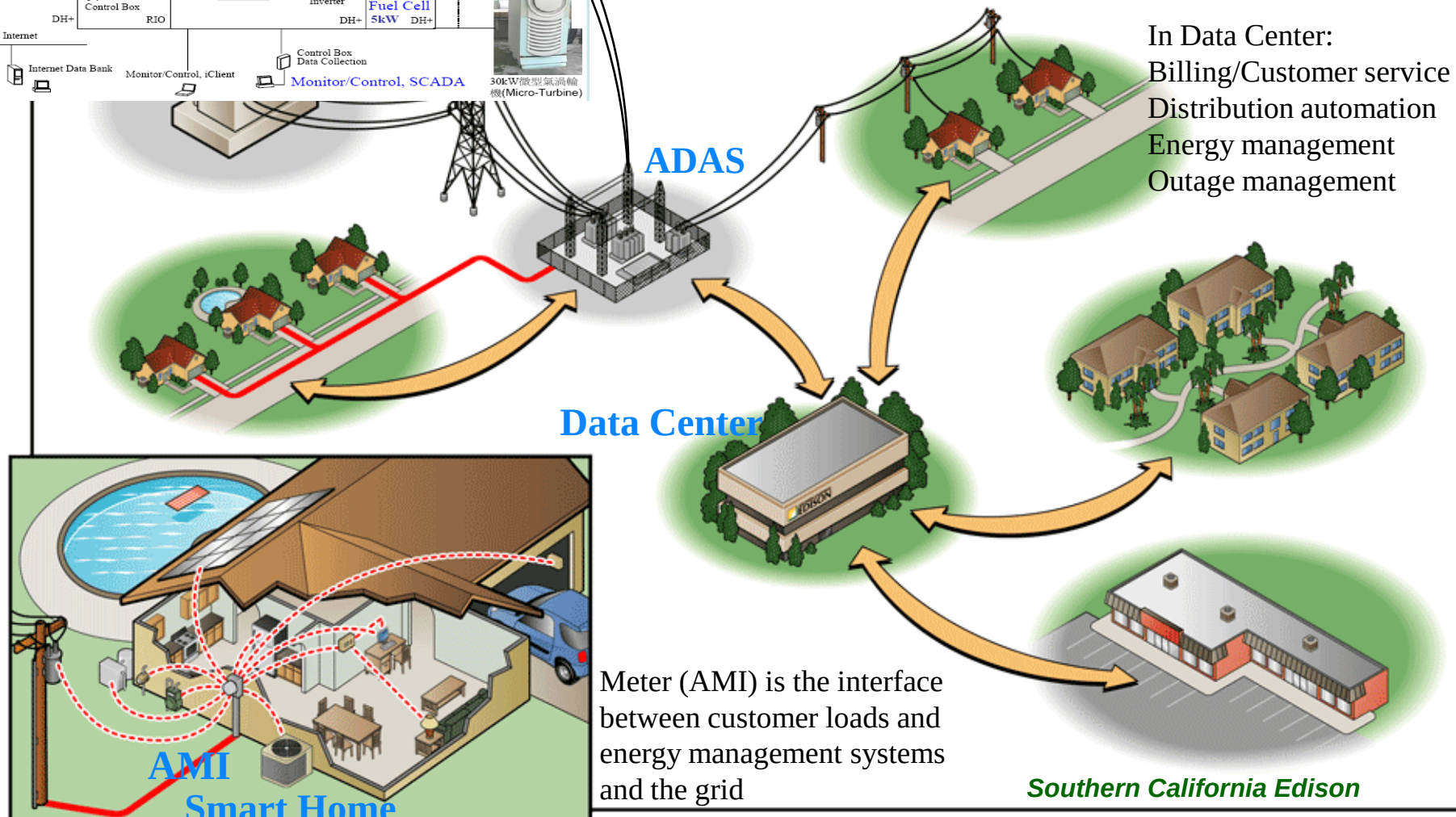
Organization of Smart Grid and AMI Project



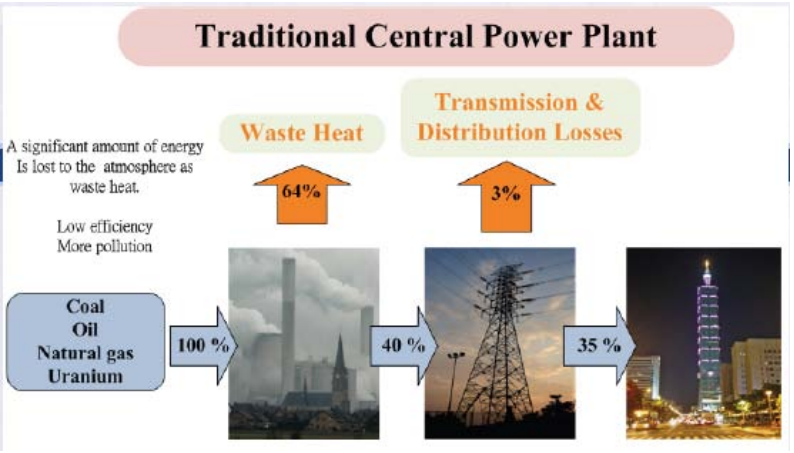
Strategic Initiatives of Smart Grid in Taiwan (*cont.*)

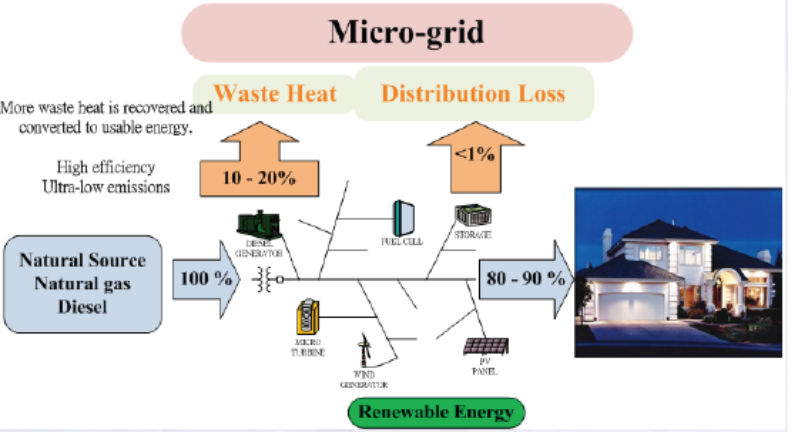


Microgrid System



The Past and The Future of Power System





The past

- Centralized power plant
- Low proportion of DG
- Few islanding operation
- From generation, transmission, distribution to user: overall energy efficiency 30~40%

Smart Grid and AMI Technologies Development

- Power quality
- Transmission control
- Distribution automation
- Micro-grid control
- AMI and communication technology
- Energy management and demand response technology
- Power electronics
- Regulations and standards

Smart Grid and AMI Pilot Projects

- Microgrid pilot projects, pp. 27-32
- AMI pilot project, pp. 33-35
- Smart home (building) energy management pilot project, pp. 36-38
- Advanced distribution automation pilot project, pp. 39-41

The future

- High proportion of DG (including renewable energy)
- Distributed network can be connected to the grid or operated in islanding
- Using microgrid and distribution automation technique
- AMI, demand response (DR), time of usage (TOU): Saving and generating electricity become a concern of public
- New standards and regulations are necessary
- Significant improvement of overall efficiency due to regional power sources supply local loads

Objectives of Smart Grid and AMI Project

1. **Use the developed technologies of distribution automation and microgrid to enhance the total installed capacity of renewable energy and ensure the total renewable energy generated electricity increasing to 10% of the total electricity supply to reduce 20 million tons of carbon dioxide emissions in 2025.**
2. **Promote smart home (building) energy management technology to increase 20% energy usage efficiency in 2015 compared to 2005.**
3. **Implementing the developed key technologies of smart grid and AMI, the install capacity of distributed generations will be 17.8GW and create 120 billions NT and more than 20,000 jobs per year from 2010 to 2025. There are about 60 billions NT market in Smart Grid and more than 10,000 jobs every year.**

Objectives of Smart Grid and AMI Project (*cont.*)

(2010-2013)：

- **Complete the key technologies development of microgrid, AMI, advanced distribution automation, smart home (building) energy management pilot projects.**
- **Complete the relevant regulations and standards of smart grid and AMI.**
- **Hold a joint exhibition to demonstrate the developed key technologies.**

(2014-2025)：

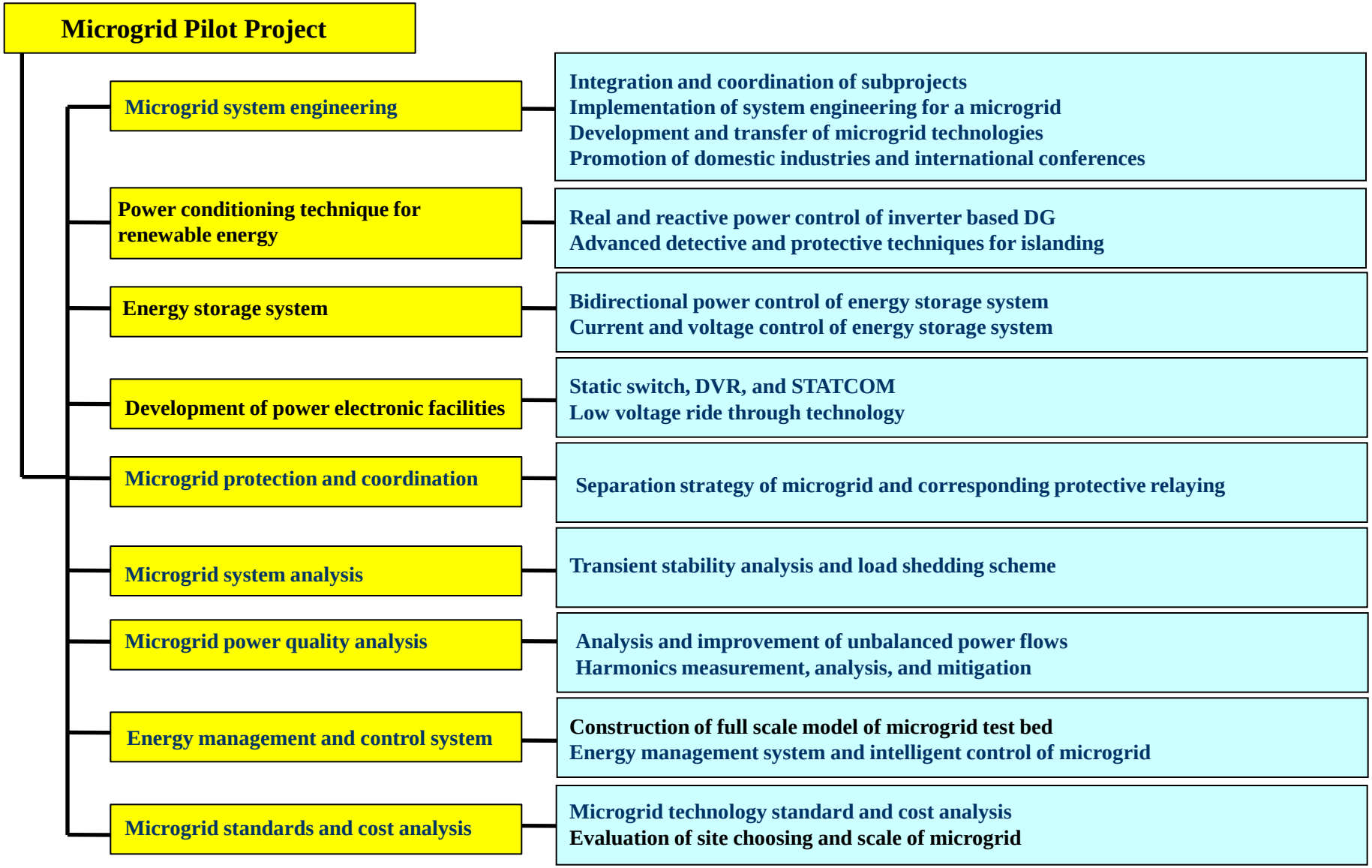
- **Complete key technologies transformation and commercialization.**
- **With the installation of AMI, complete the power management system of Taipower (such as time of usage and demand response).**
- **Tying in with the transmission and distribution projects of Taiwan Power Company, promote the developed technologies of microgrid and advanced distribution automation gradually in Taipower system.**
- **Promote comprehensively of smart home (building) energy management technology.**

Thank You for Your Attention!

Appendix

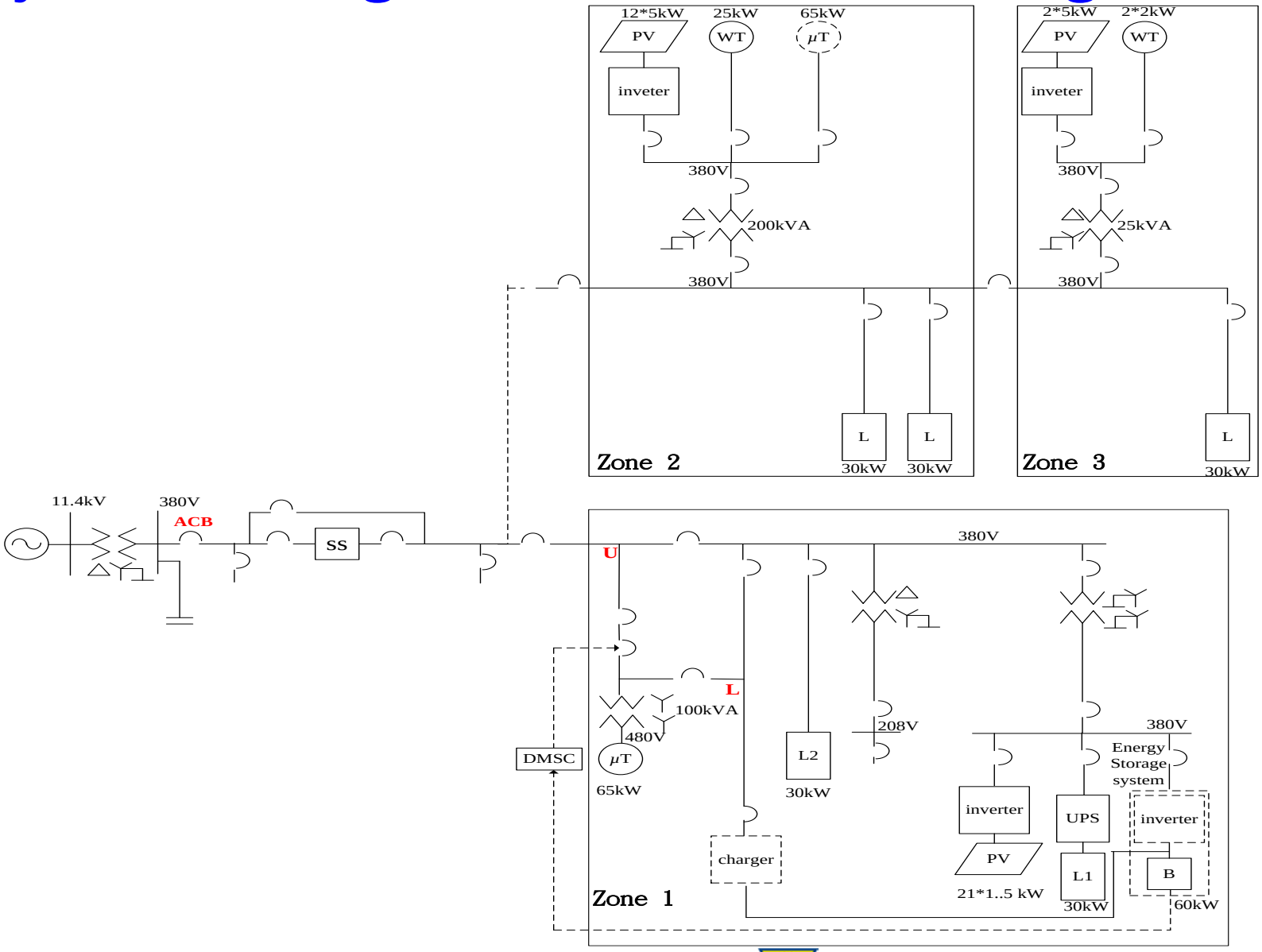
- Microgrid pilot projects, pp. 27-32
- AMI pilot project, pp. 33-35
- Smart home (building) energy management pilot project, pp. 36-38
- Advanced distribution automation pilot project, pp. 39-41

Planning of AC Microgrid Pilot Project

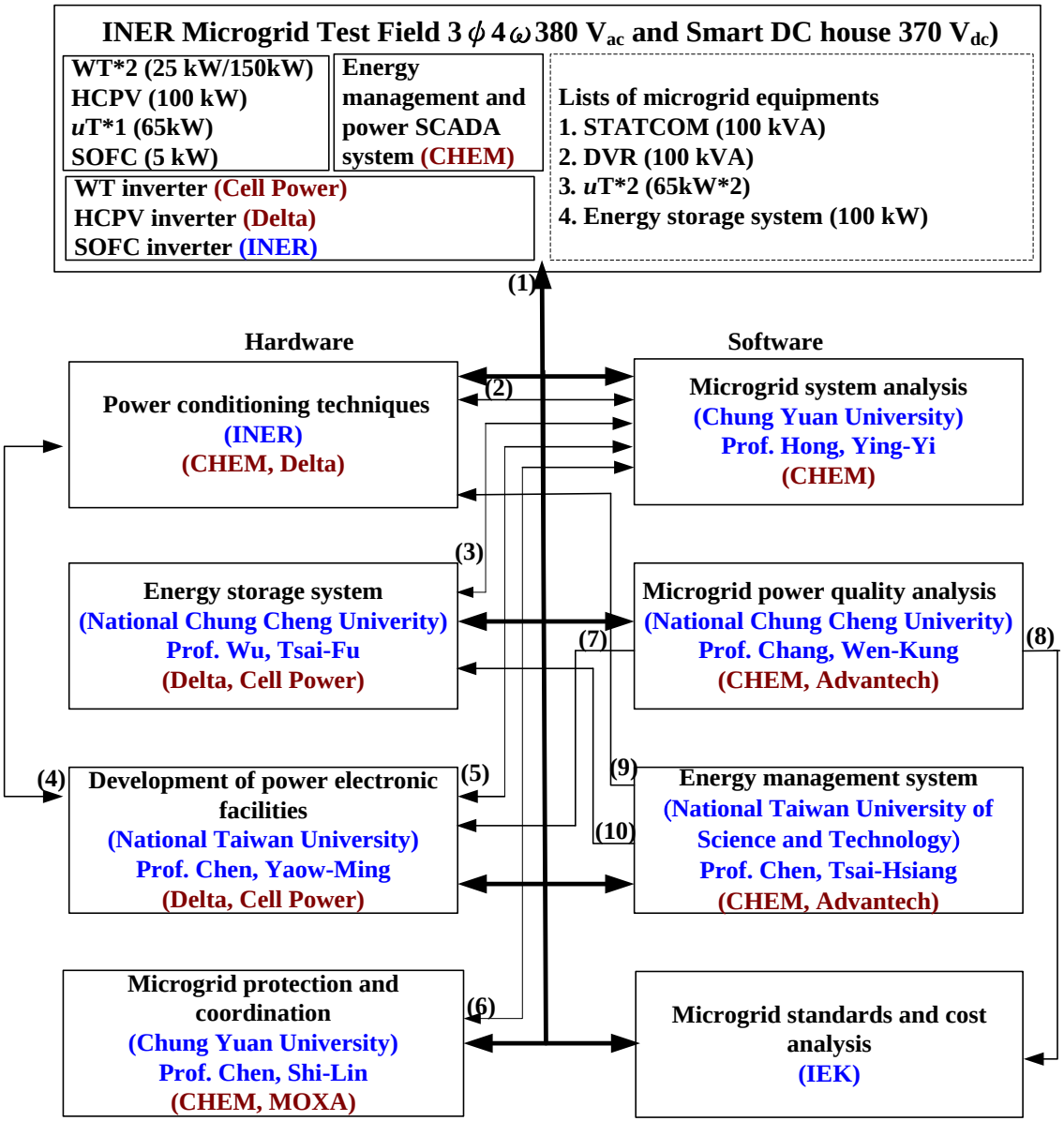


INER AC Mircogrid Test Filed

System Configuration of INER Microgrid



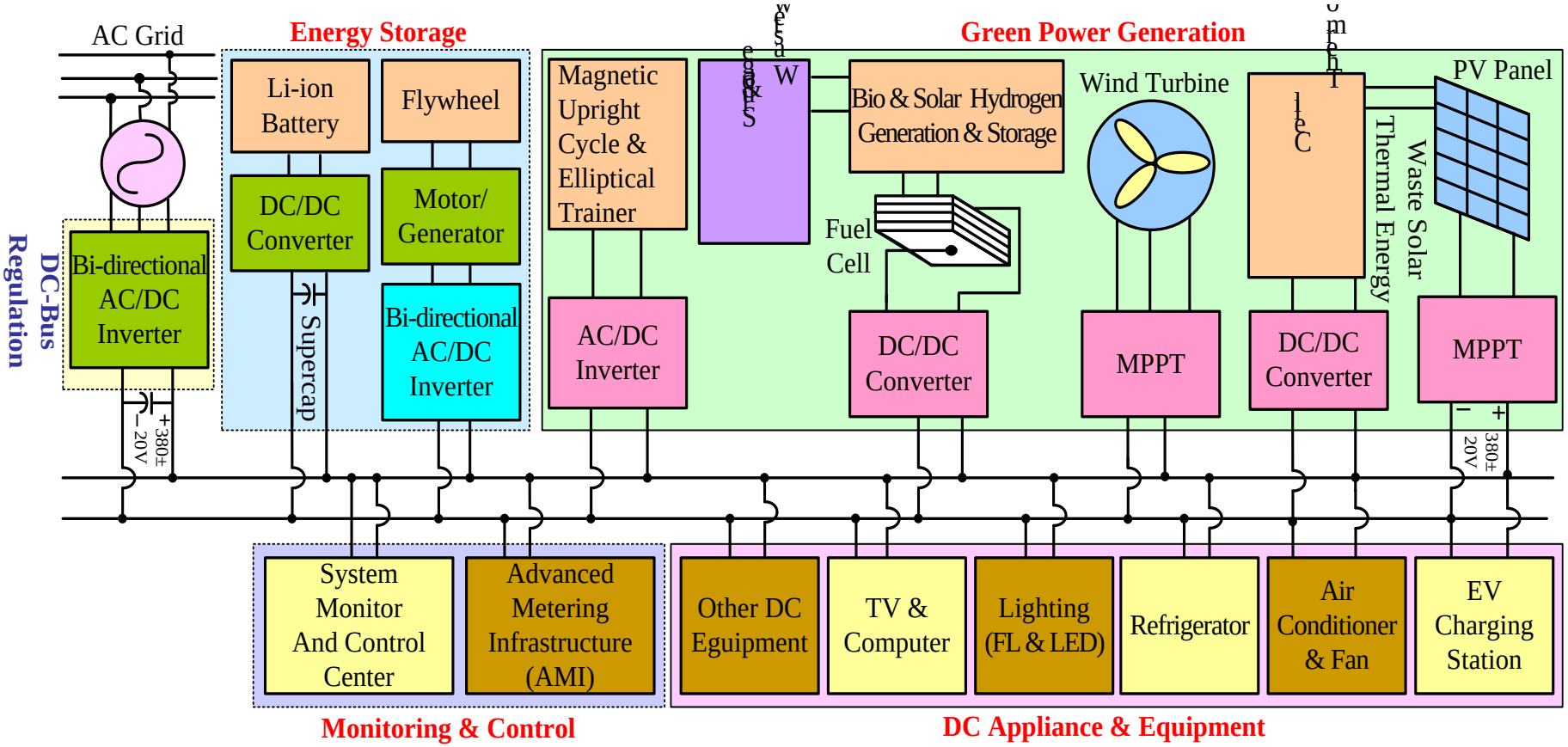
Integration of AC Microgrid Subprojects



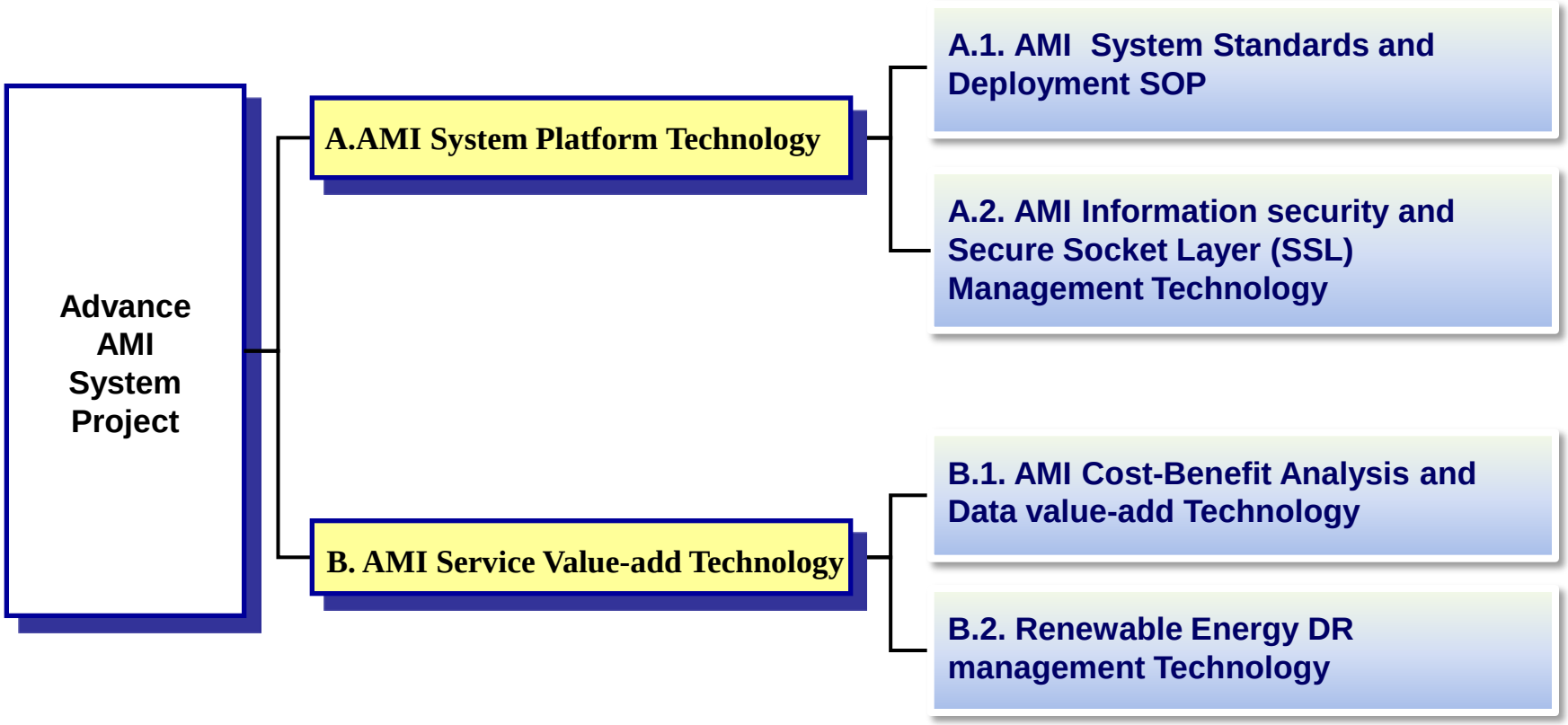
(1) System engineering of INER micorgrid
(2) Operation strategy of power conditioning systems and their protection function
(3) Operation strategy of energy storage system
(4) Voltage regulation equipped with LVRT technique
(5) Settings for the noperation of static switch
(6) Protective relay settings and load shedding scheme
(7) Settings of control parameters for voltage regulation equipments
(8) Power quality standard for microgrid
(9) power output of renewable generation
(10)Power output of energy storage system

Planning of DC Microgrid Pilot Project

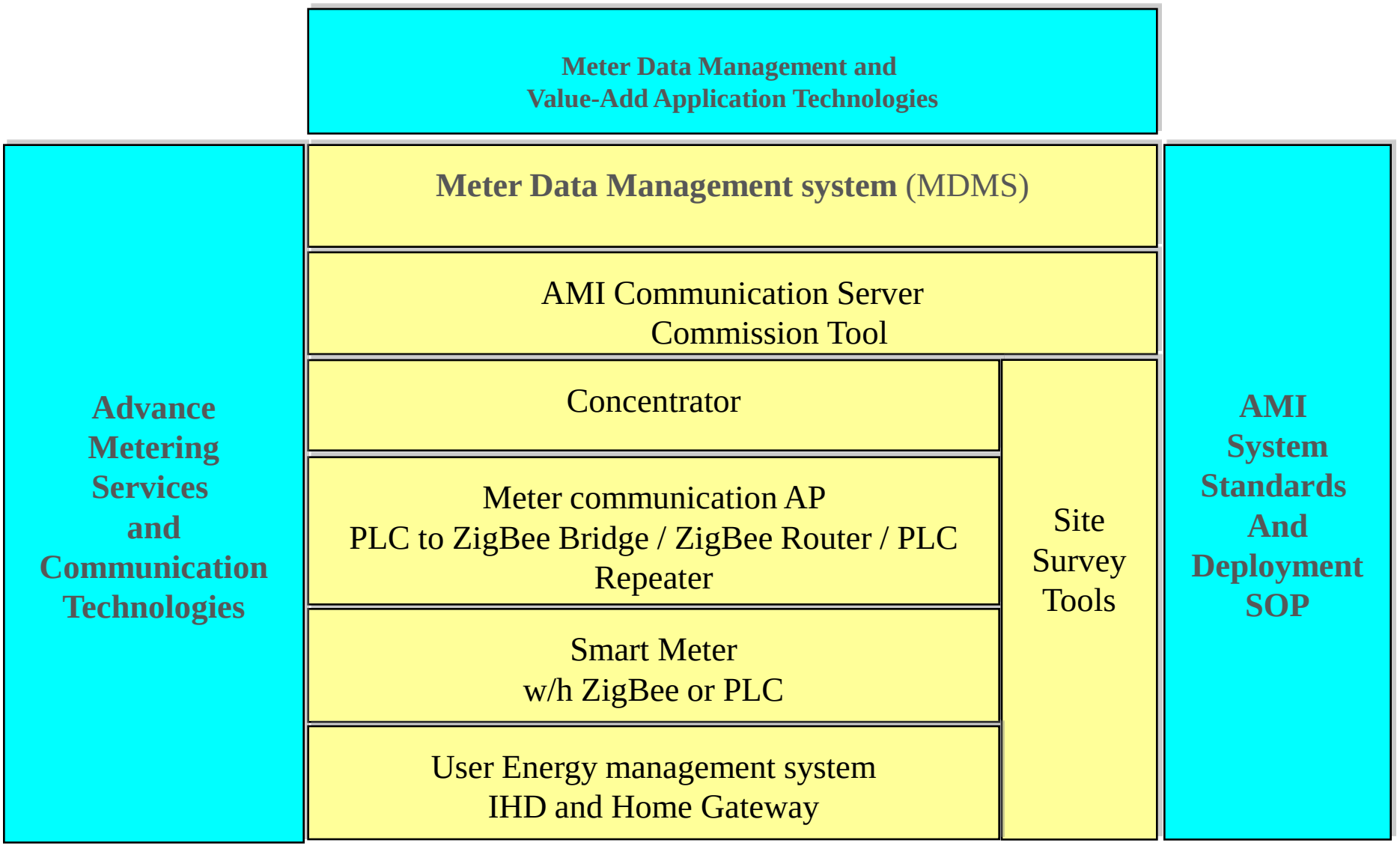
System Configuration of DC Microgrid



Planning of AMI Pilot Project

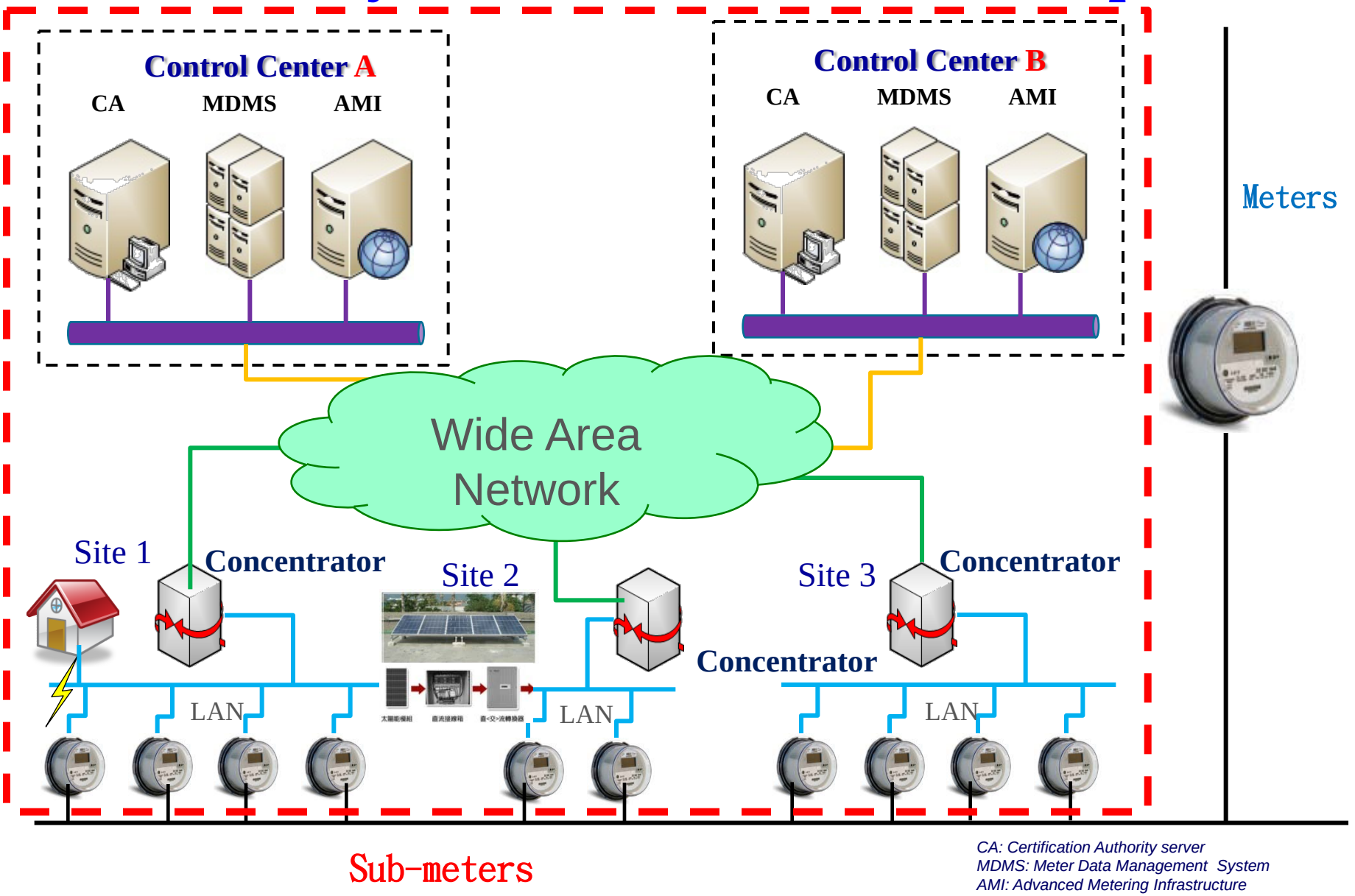


AMI Research and Development Focus



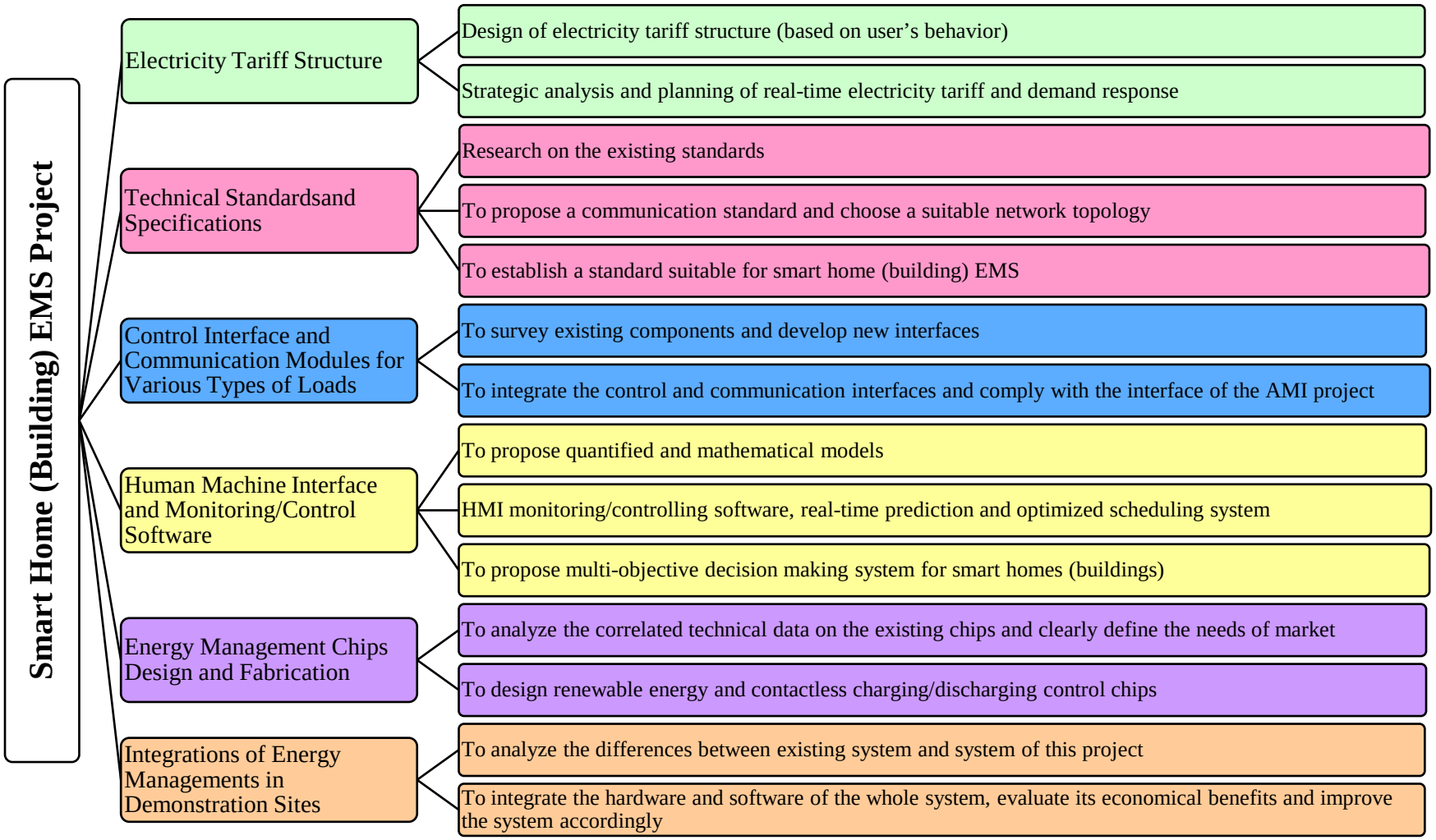
*Blue blocks is main focus research topics

AMI System Architecture and Scope

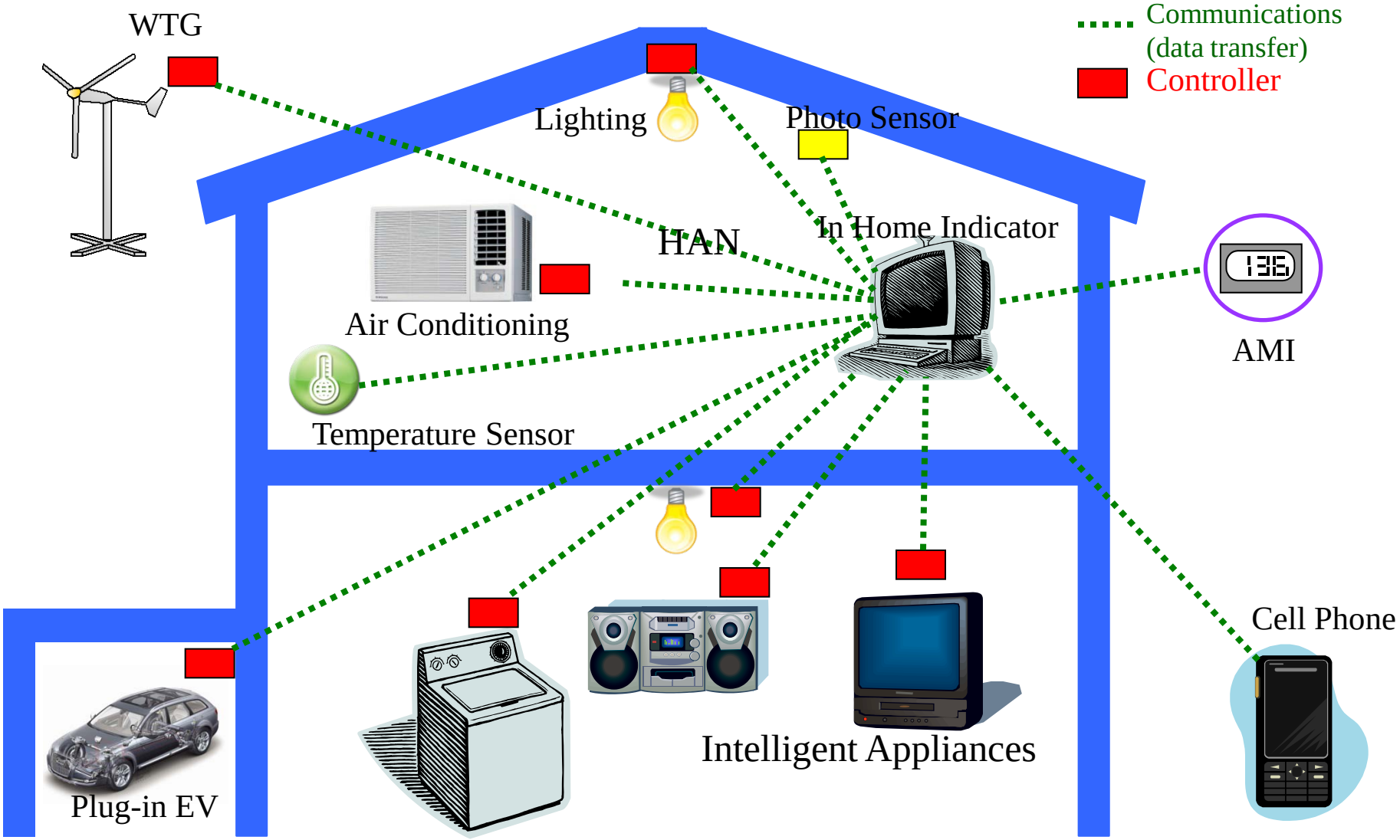


CA: Certification Authority server
MDMS: Meter Data Management System
AMI: Advanced Metering Infrastructure
WAN: Wide Area Network

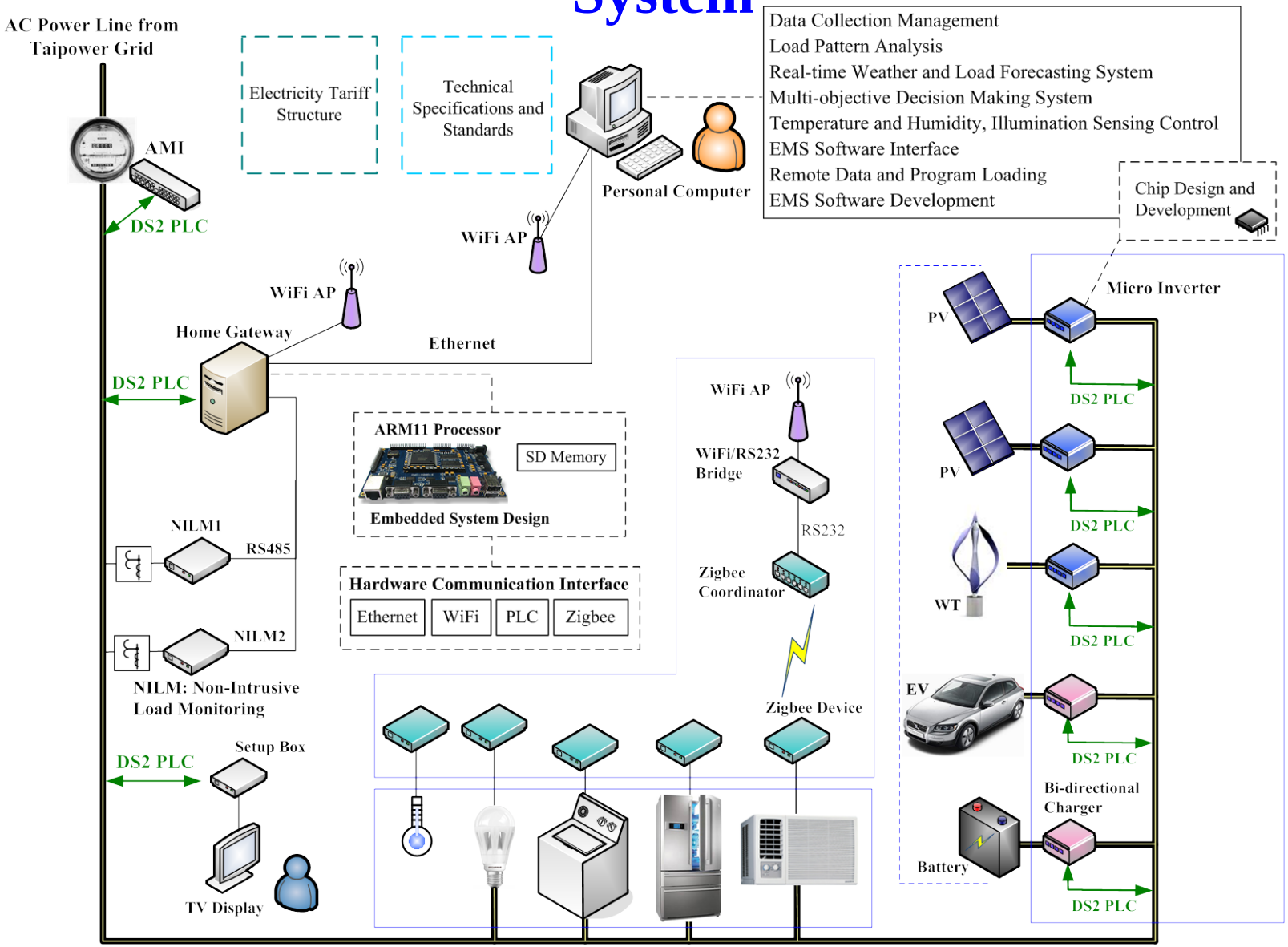
Planning of Smart Home (Building) Energy Management Pilot Project



Smart Home Energy Management System



ICT Frame of Smart Home (Building) Energy Management System



Planning of Advanced Distribution Automation Pilot Project

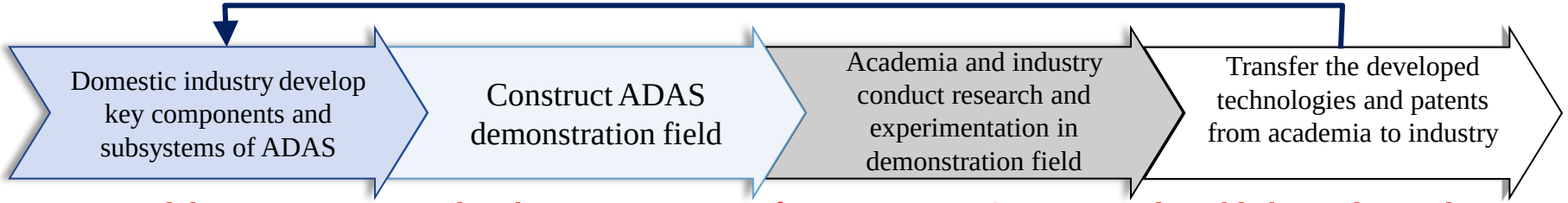
- Construct research and development environment of intelligent distribution network.

Self-content domestic industry
Technologies development and testing, intelligent device communication systems and applications software systems

Academic Research
Recovery from distribution fault, information platform of distribution automation, assessment of hybrid communication performance, integration ADAS with HEMS

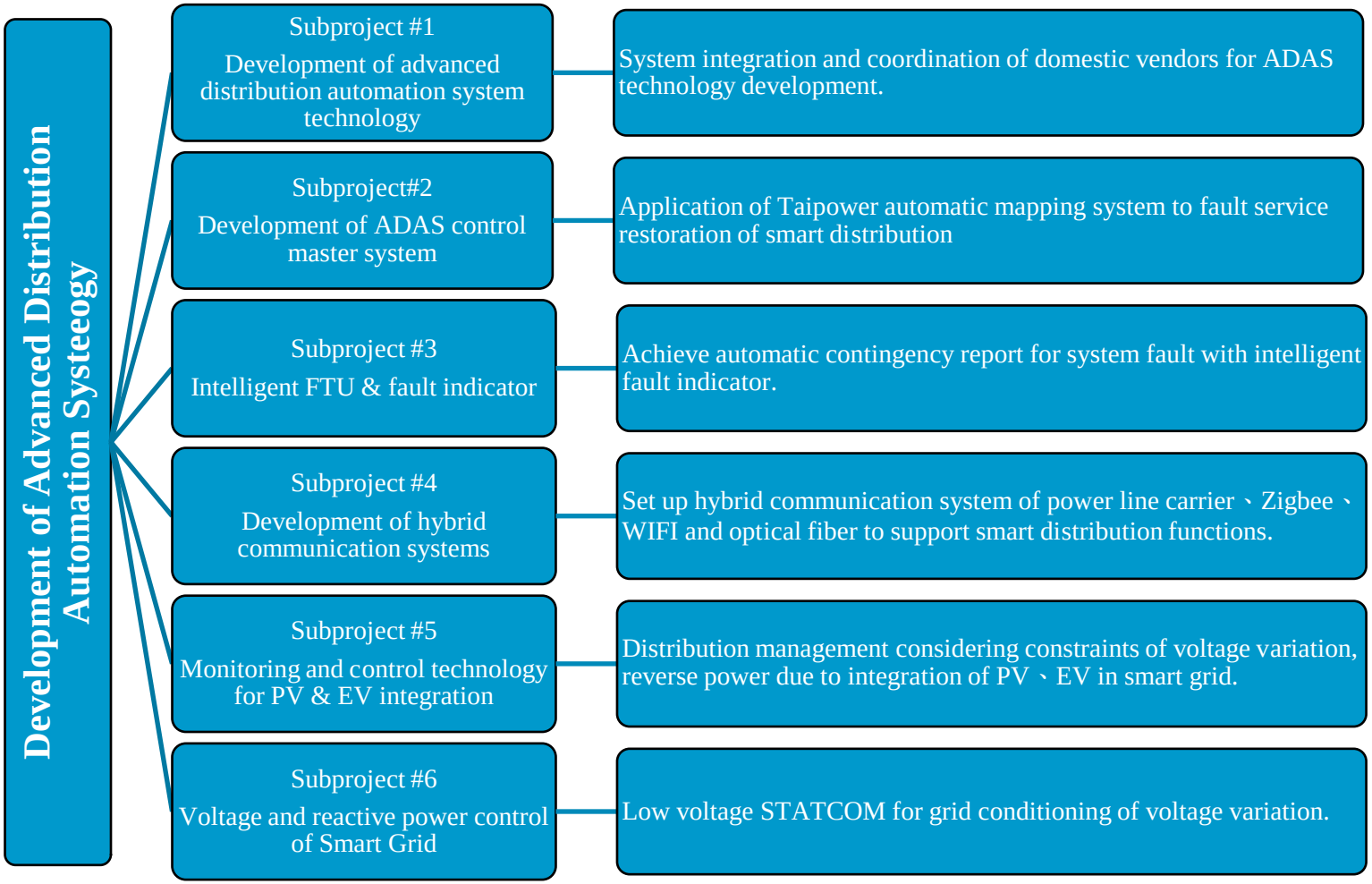
Taipower
Establishment vision of the smart distribution networks, integration distribution automation with home automation.

Establish advanced distribution automation demonstration field.

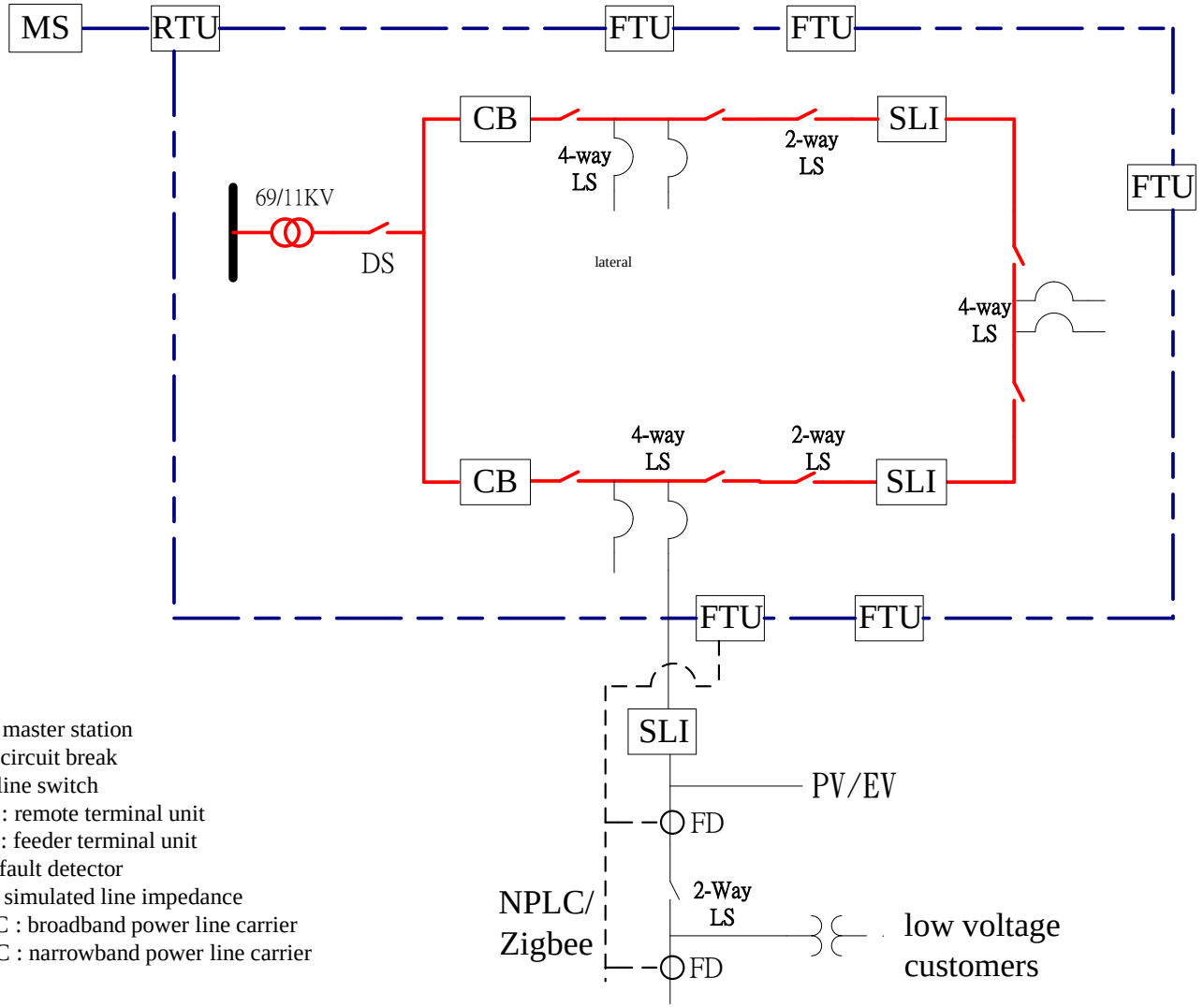


1. Expand the existing 11.4KV distribution test system of Taiwan Power Company and establish an advanced distribution automation system including feeder and test users. Establish a hybrid communication system including optical fiber, BPLC and NPLC of power lines carrier, Zigbee, Wimax (Radio) to support different applications of the intelligent distribution network.
2. The demonstration field helps the academia to verify the research results and support the industry to test the developed equipments and systems.

Planning of Advanced Distribution Automation Pilot Project (cont.)



Configuration of ADAS Demonstration System



MS : master station
CB : circuit break
LS : line switch
RTU : remote terminal unit
FTU : feeder terminal unit
FD : fault detector
SLI : simulated line impedance
BPLC : broadband power line carrier
NPLC : narrowband power line carrier