Development of Smart Grid in Taiwan

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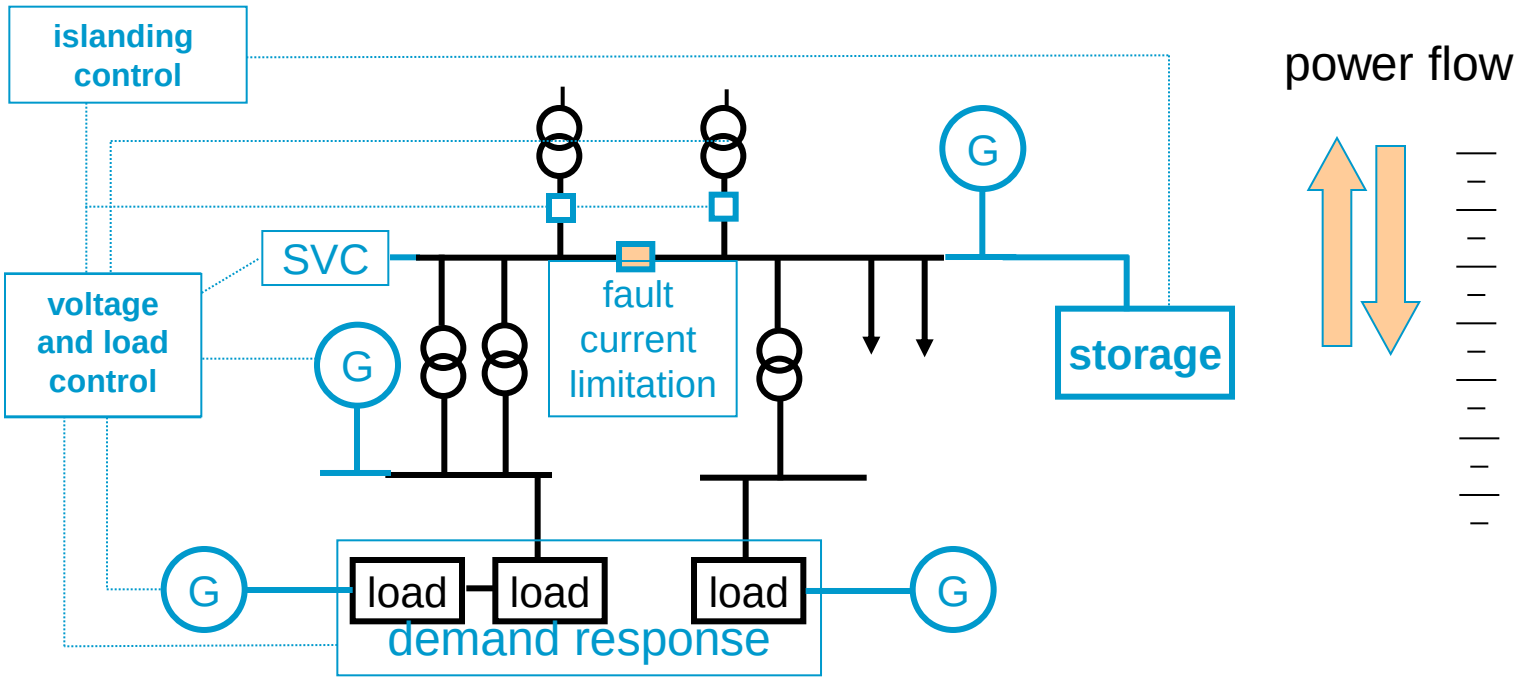
Outline

- Master Plan of Smart Grid in Taiwan
- Smart Grid Roadmap of Taipower
- National Energy Project – Smart Grid and AMI, National Science Council
- Taiwan Smart Grid Industrial Association

The Evolving Electrical Network



bulk storage

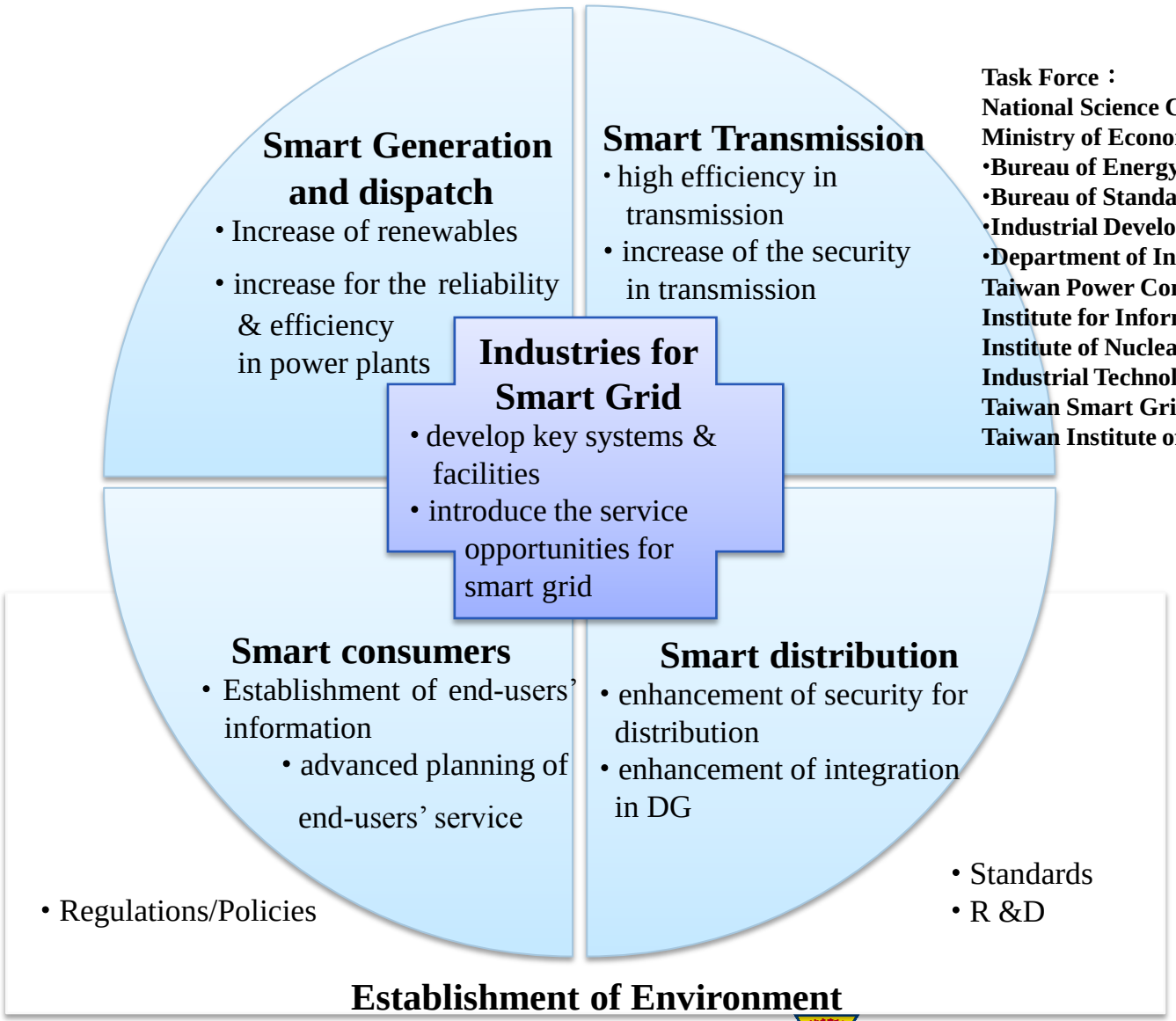
independent operation:
- load scheduling
- islanding control
- reconnection/auto-synchronization
- demand response

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

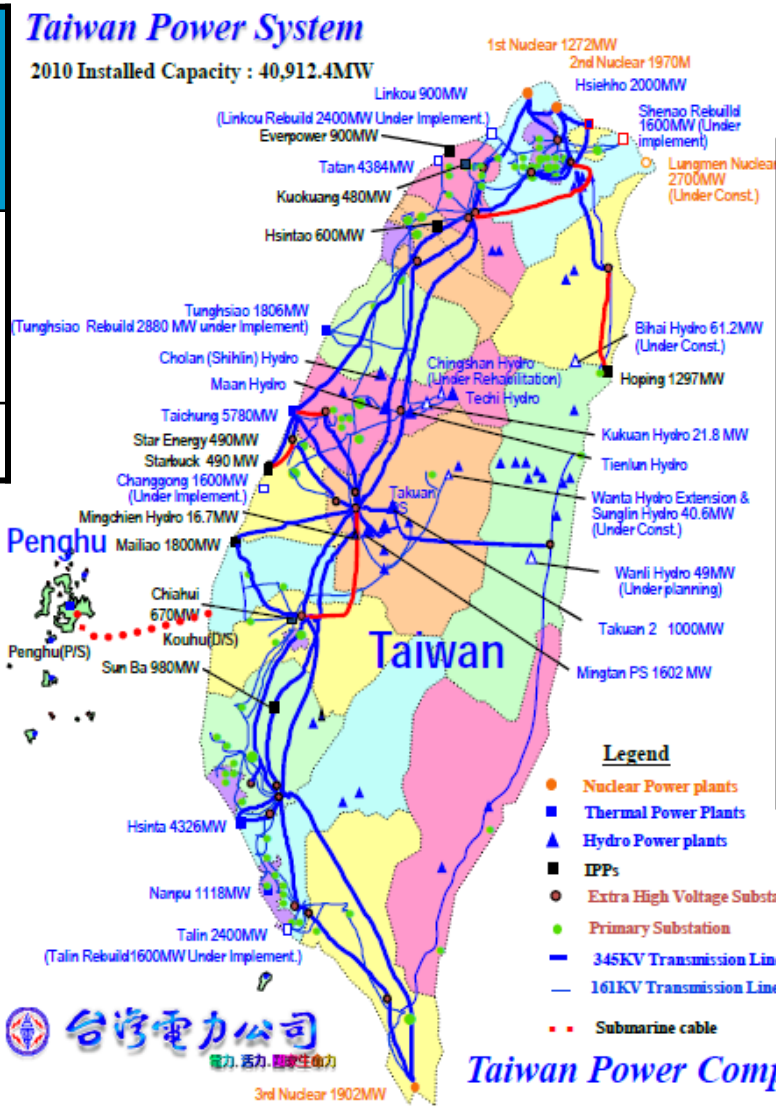
Master Plan of Smart Grid in Taiwan (2011~2030)



Task Force：
National Science Council
Ministry of Economic Affairs
•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 Smart Grid Industry Association
Taiwan Institute of Economic Research

Introduction of Taiwan power system

Item	Nuclear	Thermal	Hydro	Wind Power	Solar Energy	Total
Installed Capacity (MW)	5,144	30,717	4,579	471	1	40,912
%	12.6	75.1	11.2	1.1	0.0	100

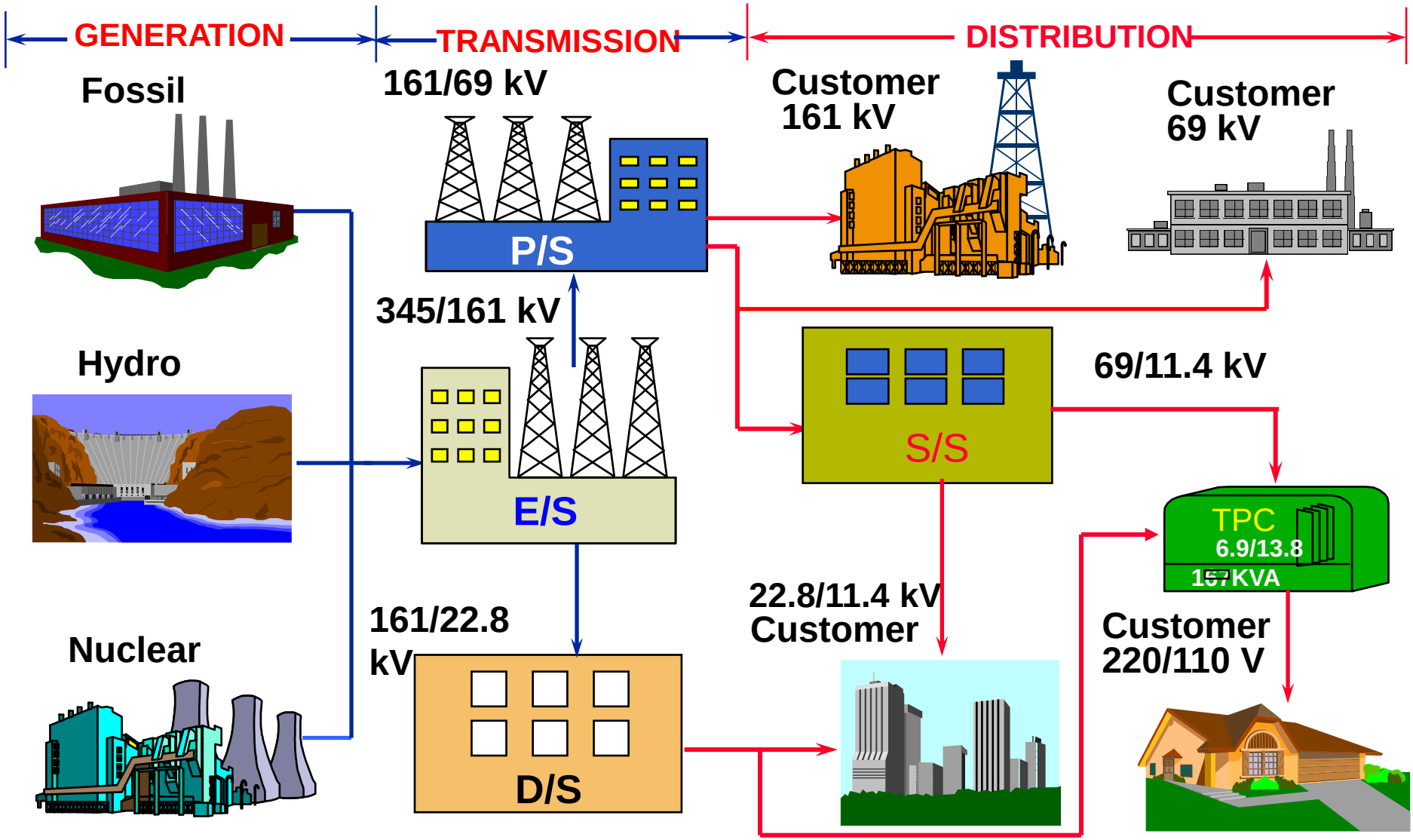


Up to year 2010:

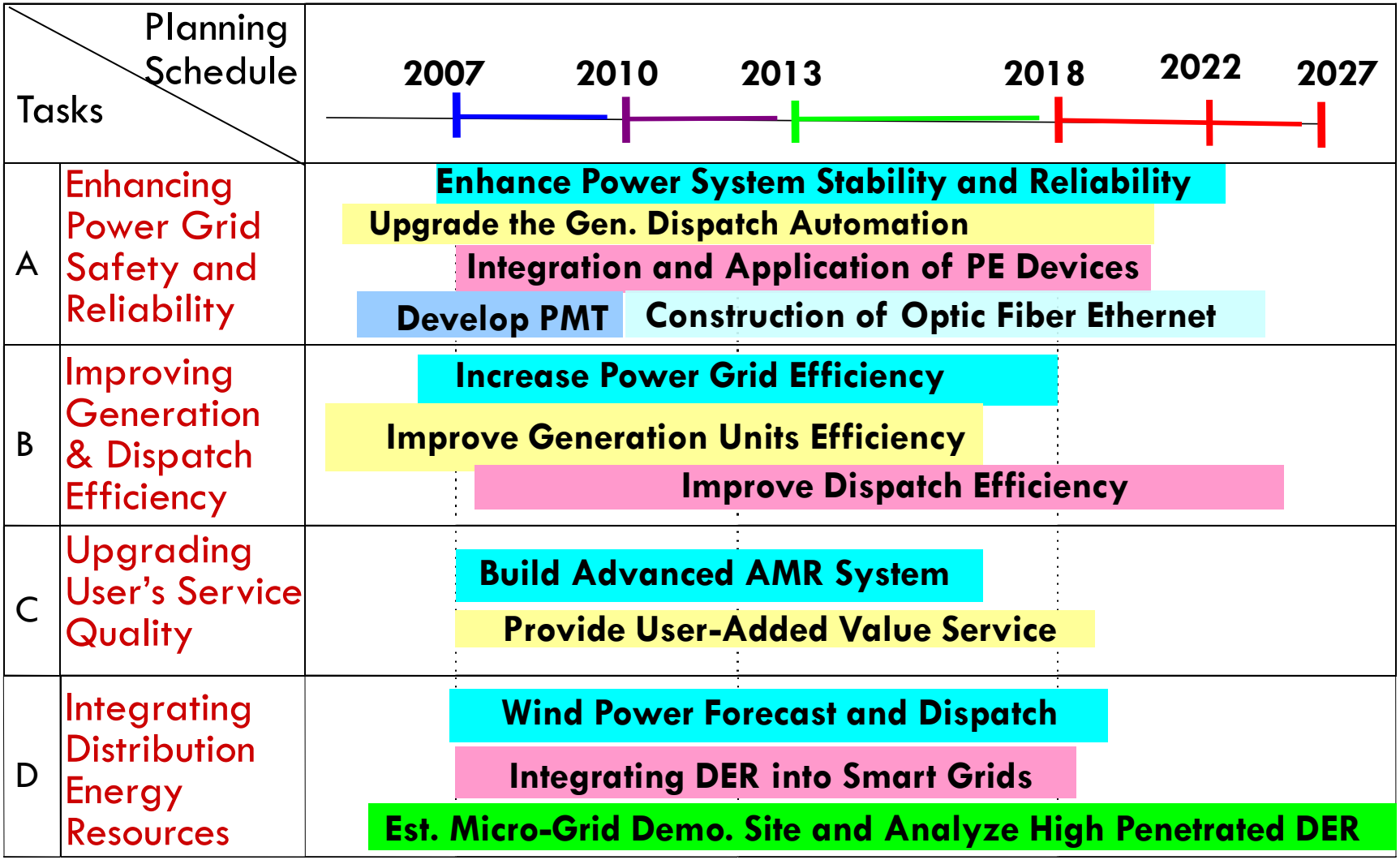
- Peak Load: 33 GW
- Customers: 12.6 million
- Total Generated Electricity (+IPP): 207.4 billion KWh
- Sale Electricity: 193.3 billion KWh

Source：Smart Grid Strategy for Technology Application in Taiwan, Yang Jin-Shyr, TPRI, 20110725

Overview of Taipower's System



Taipower's Roadmap on Smart Grid



PE: Power Electronics PMT: Preventive Maintenance Technology

Supporting platforms: Communication Protocol Guideline and Knowledge Base

Taipower's Vision on Smart Grid

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

Driving Forces

SmartGrid

ICT Based

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

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.**

Distribution Feeder Automation

- 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

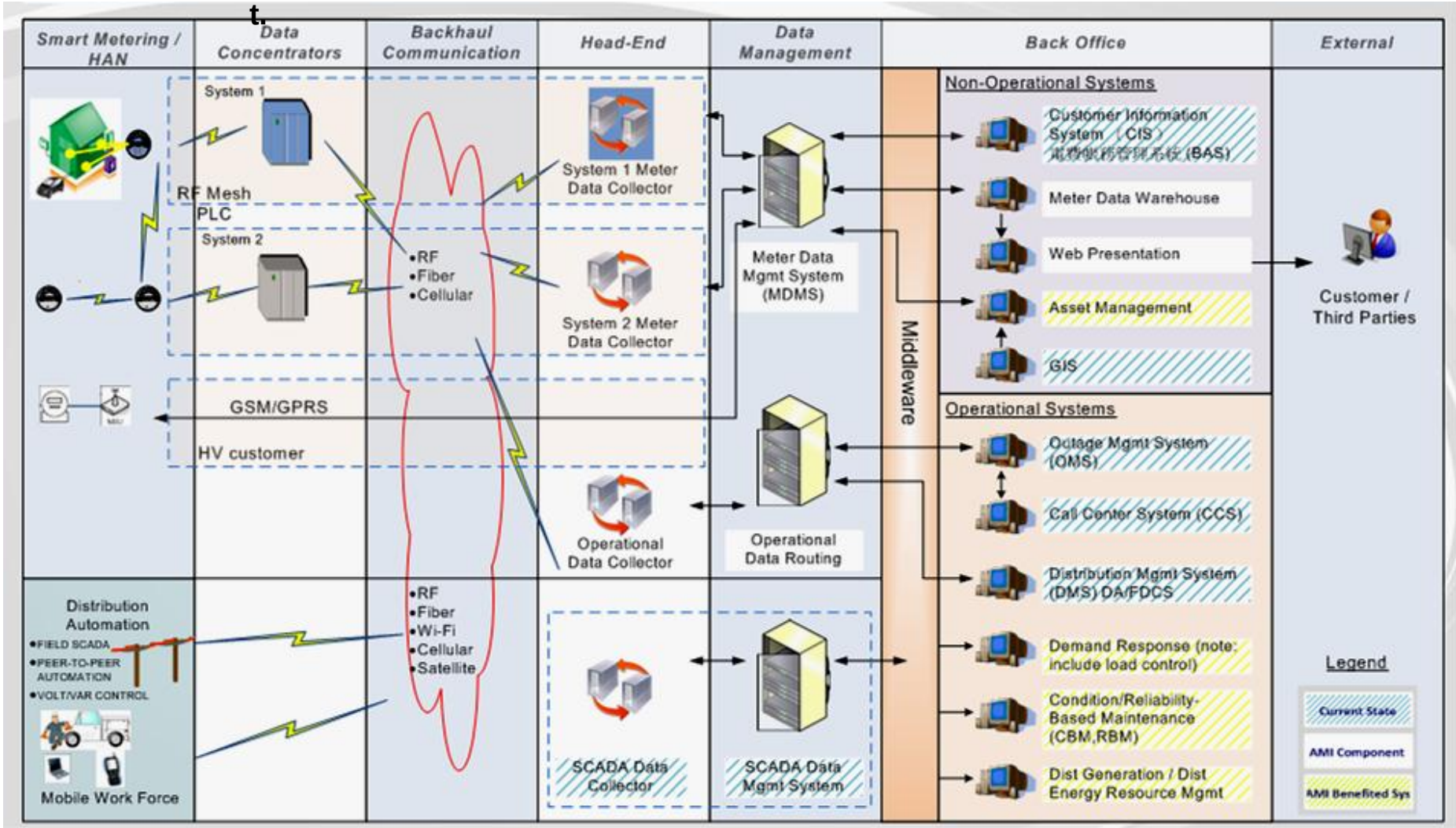
High voltage AMI total 23300 meters covering 59% electrical power consumption of Taipower will be installed before 2012.

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

Meter | Data Concent. | Backhau lComm. | Head-End | Data Managmnt. | Back Office | External



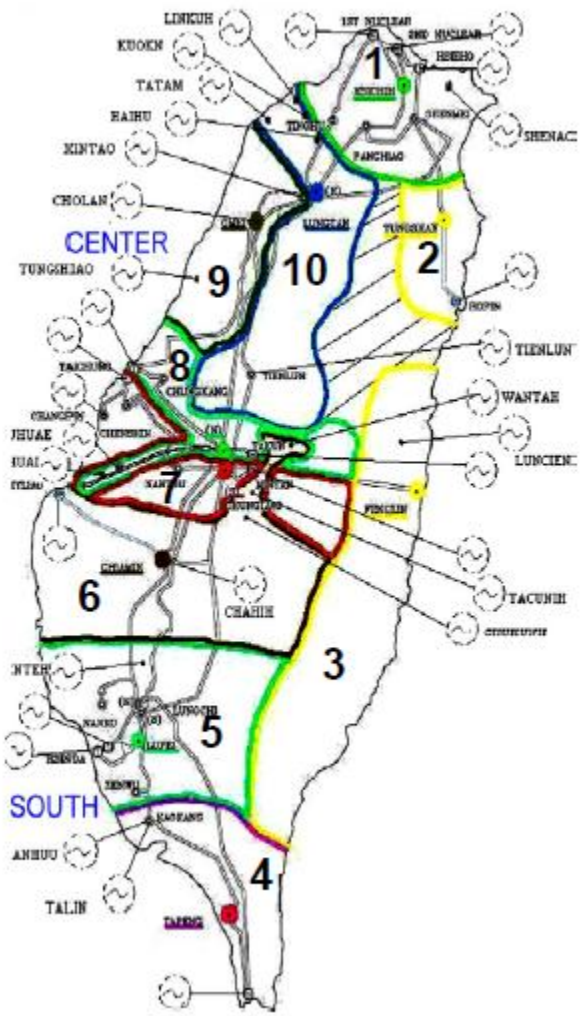
Objectives of Taipower's Smart Grid Action Plan

(preliminary)

Benefit	Objective	2010	2020	Remark
Security & Reliability in power Grid	**System average interruption duration index (SAIDI)**	**22min/ customer · year**	**17.6min/ customer · year**	↑ **20%**
Energy efficiency	**Efficiency in thermal plants**	**42.52%**	**43.58%**	↑ **2.5%**
Renewable	**Percentage of installed capacities**	**4.7%**	**15%**	
Energy conservation & Carbon reduction	**Green gas emission**	**81 million tons**	**80 million tons (reduce to meet the standard in 2005)**	

Extension the Renewable and its Penetration Capability

- **Renewable in Taipower focus on PV and Wind**
- **Divide Taipower's grid to 10 Renewable Deployment Regions (RDR) for Renewable expansion purpose.**
- **Investment evaluation of each project on RDR basis**
  - **Investigate Potential Renewable resources of each RDR**
  - **Examine Effective Load Carrying Capability**
  - **Carry out Cost/Benefit analysis of each investment**
  - **Example: Implement Submarine cable between Taiwan and the Poun-Hu archipelago wind farm**



Source：Smart Grid Strategy for Technology Application in Taiwan, Yang Jin-Shyr, TPRI, 20110725

National Energy Project – Smart Grid and AMI, NSC

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

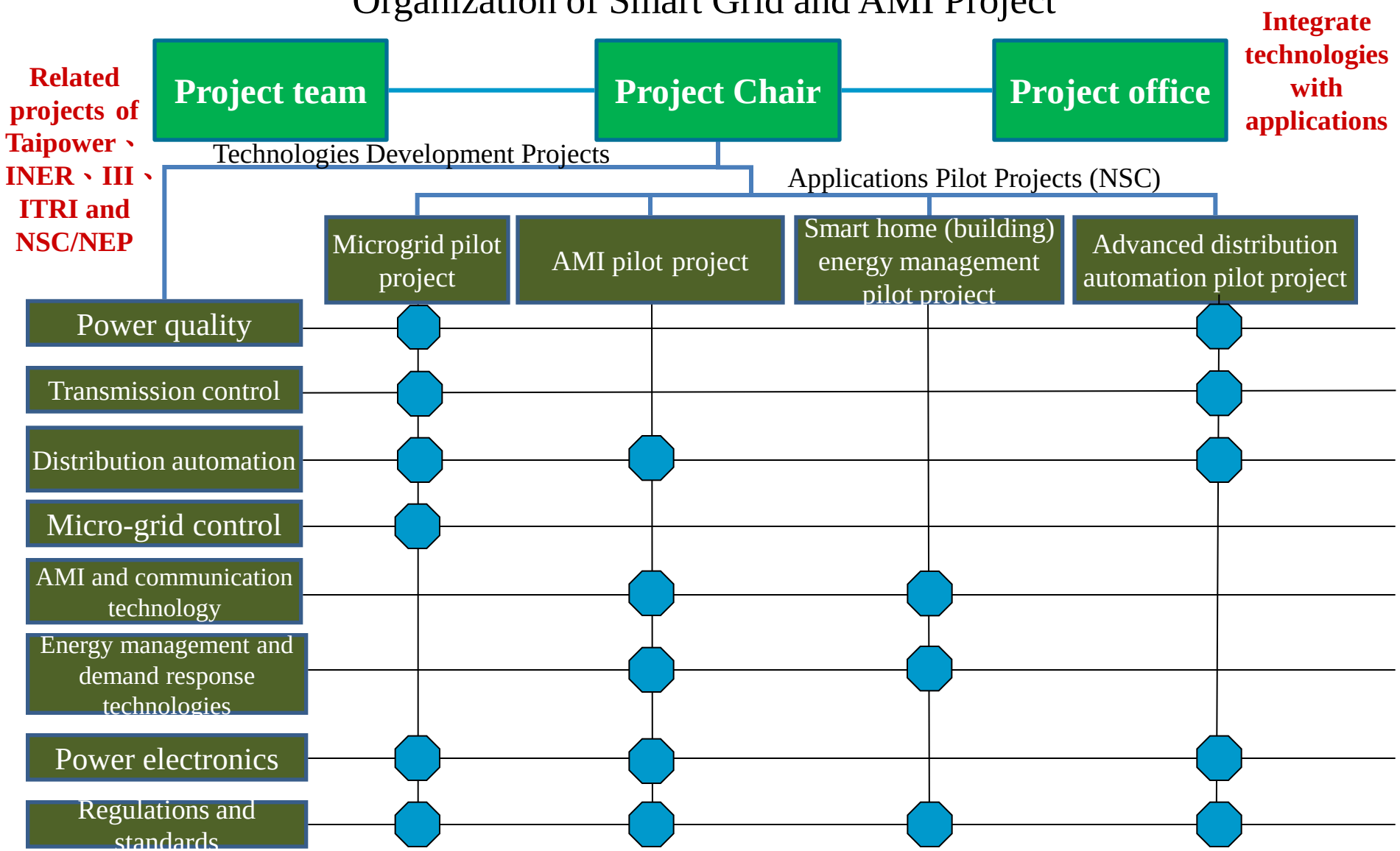
Tying in closely with the smart grid developing schedule of Taiwan Power Company, integrate the research abilities of industry and academia to establish smart grid and support the power facilities industry in Taiwan.

Manner

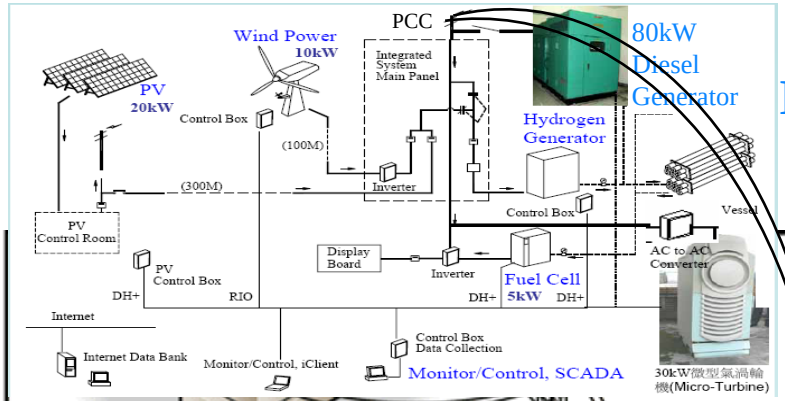
Promote AMI, microgrid, smart home (building) energy management system, advanced distribution automation four pilot projects by NSC to develop key technologies of smart grid and AMI and ensure the merging of the developed technologies into the power system in Taiwan will be reliable and feasible.

National Energy Project – Smart Grid and AMI (cont.)

Organization of Smart Grid and AMI Project



(National Energy Project – Smart Grid and AMI (cont.)

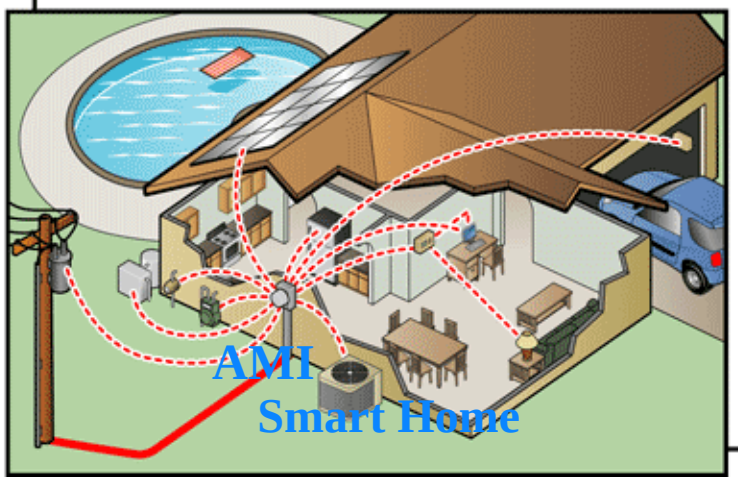


Microgrid System

ADAS

In Data Center:
Billing/Customer service
Distribution automation
Energy management
Outage management

Data Center



AMI
Smart Home

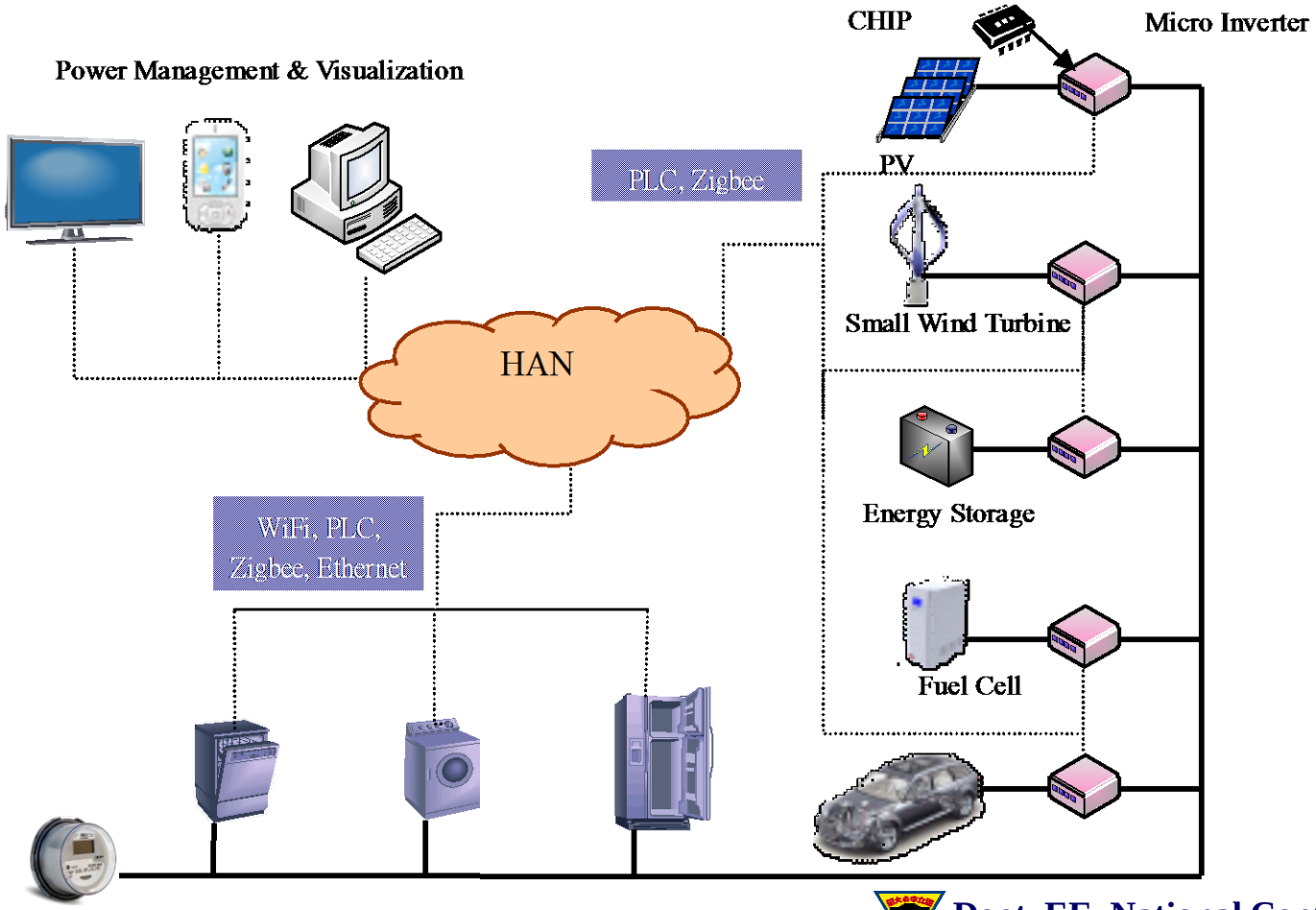
Meter (AMI) is the interface between customer loads and energy management systems and the grid

Southern California Edison

Research Budget of National Energy Project – Smart Grid and AMI, National Science Council	
Year	**Budget (thousand, NTD)**
2010	**126,140.00**
2011	**313,316.41**
2012	**349,028.41**
2013	**349,028.41**
2014	**----------**

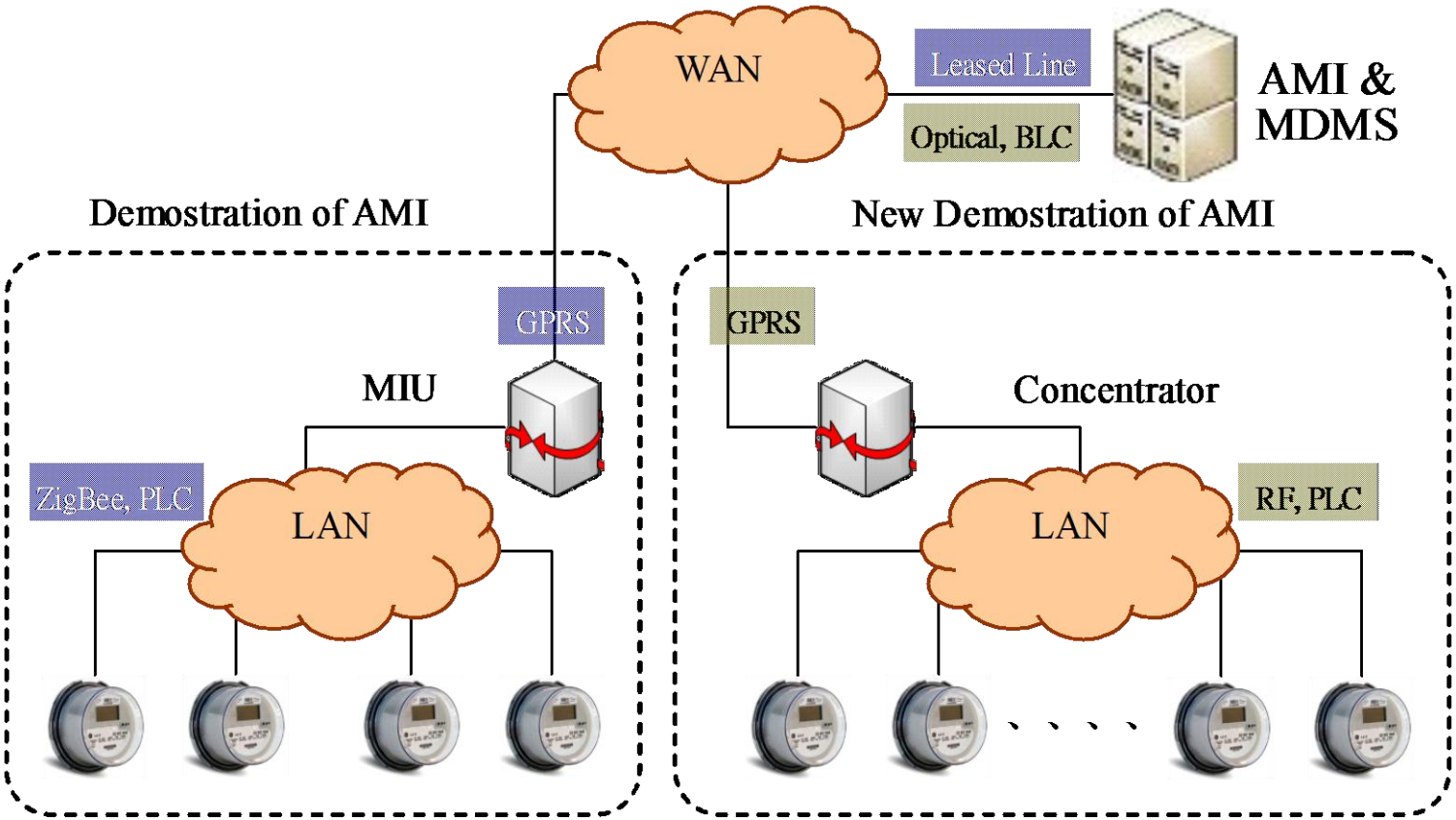
Smart Home and Building Energy Management System

- Equipment associated with smart home energy system includes intelligent home appliances, chargers for electric vehicles, power management chips, energy management system, home gateway, human-machine interface control, load type of control interface, wireless sensors, wired sensors, and communications module.



AMI System Structure

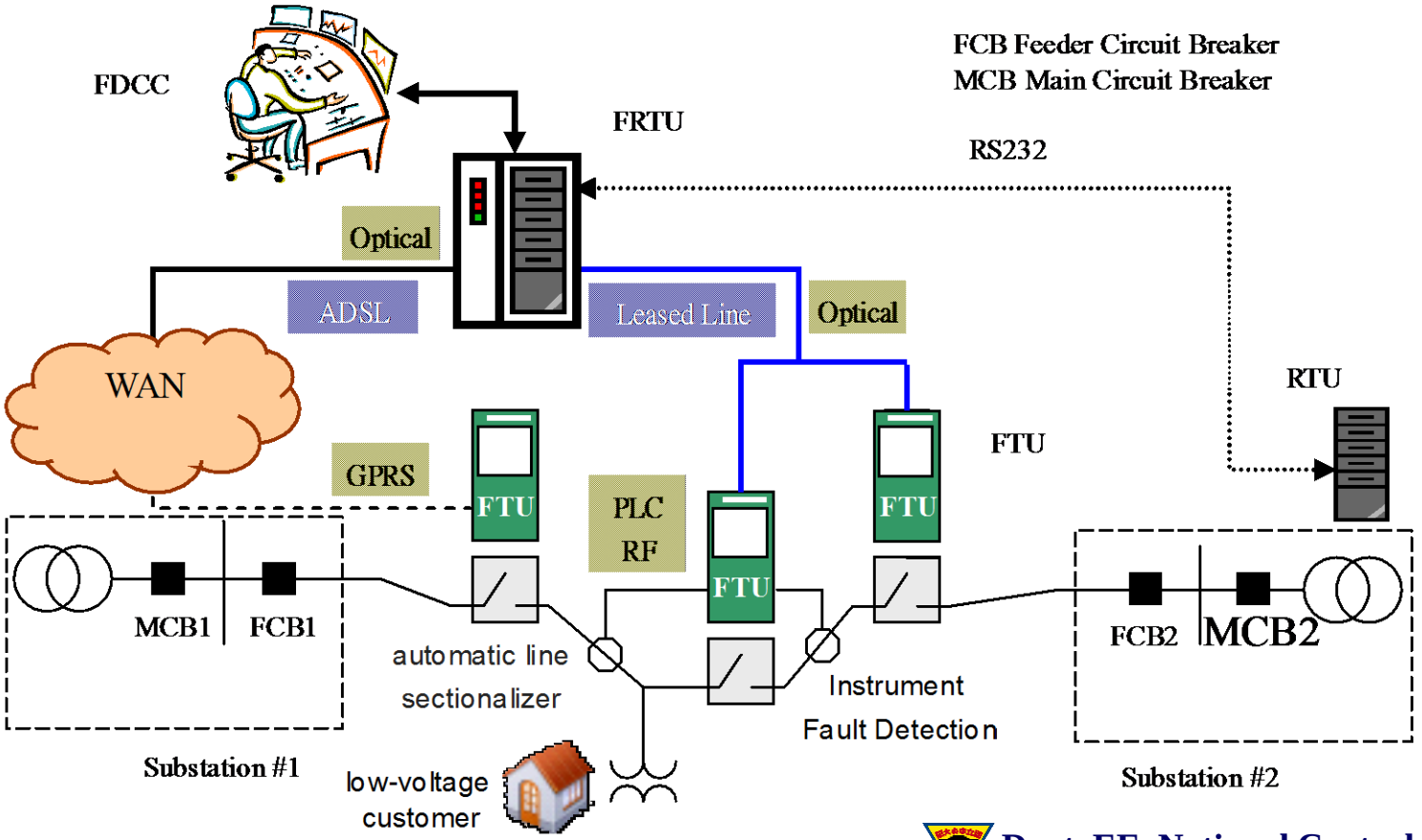
- AMI includes the smart meter, network of communication and meter of control center.
- Smart meter is composed by meter and Concentrator or Meter Interface Unit.



資料來源：能源國家型科技計畫－智慧電網與先進讀表主軸專案計畫總計畫 NSC 100-3113-P-008 -001 -PO

Distribution Automation System

- Distribution Automation System includes Feeder Dispatch and Control Center (FDCC), Feeder Remote Terminal Unit (FRTU), Feeder Terminal Unit (FTU). FRTU is the concentrator in Substation.
- Distribution Automation System has the function of monitoring, control, SCADA and FDIR (Fault, Detection, Isolation and Restoration).



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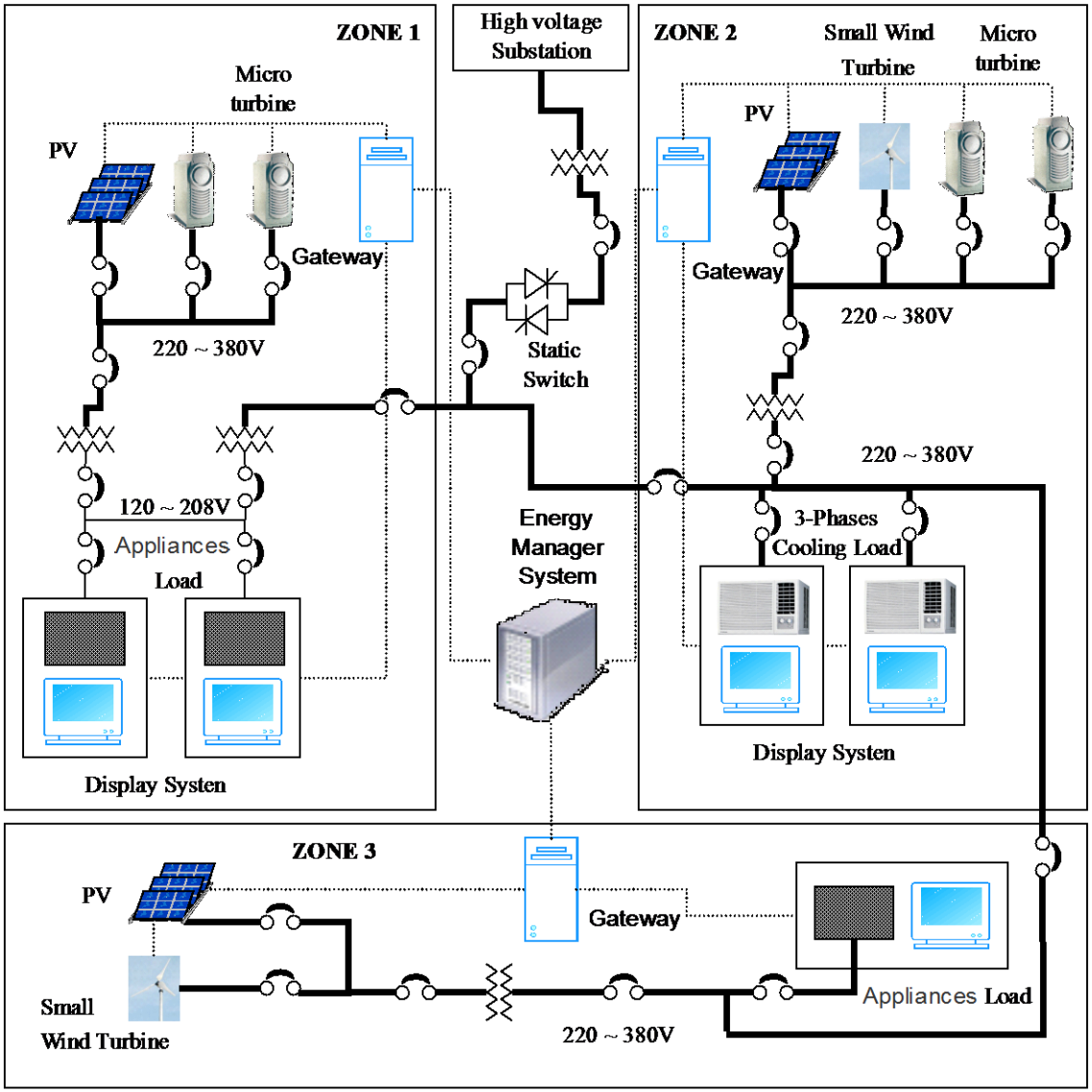
Microgrid System

- The general idea of Microgrid is to integrate a series of power loads with micro sources. The integrated system so called Microgrid is controllable and would provide users with high quality electric power with high penetration rate of DGs.

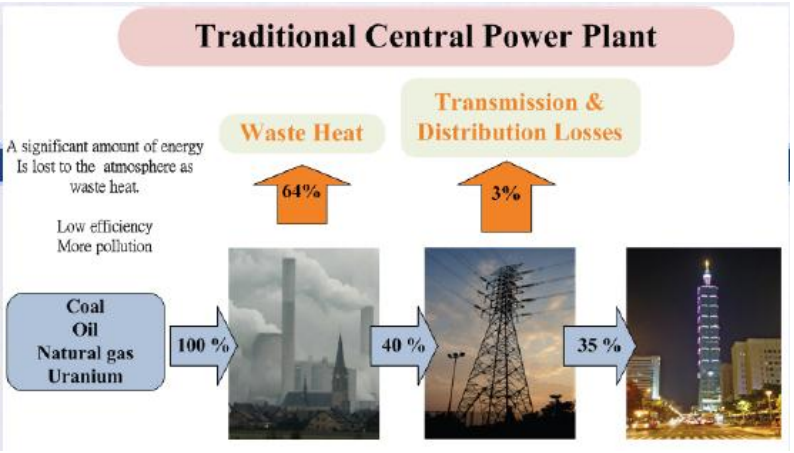
- The concept of Multi-Microgrid is that arbitrary Microgrid could be integrated or separated and become a new grid. This concept could support the development of Cellular Smart Gird.

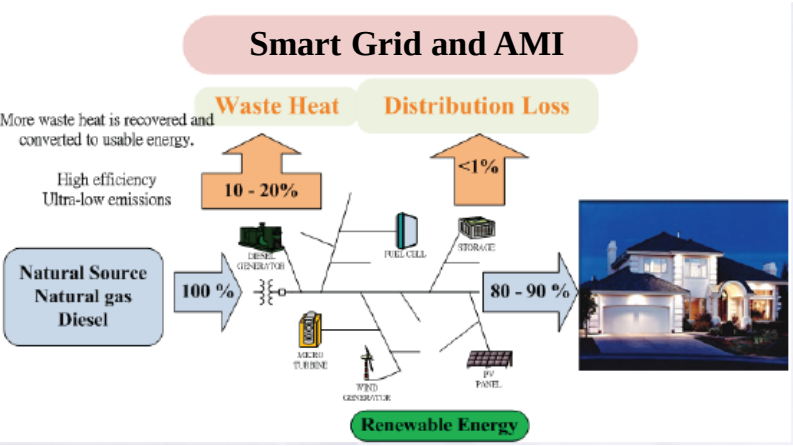


Objectives of Smart Grid and AMI Project

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.

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
- AMI pilot project
- Smart home (building) energy management pilot project
- Advanced distribution automation system (ADAS) pilot project

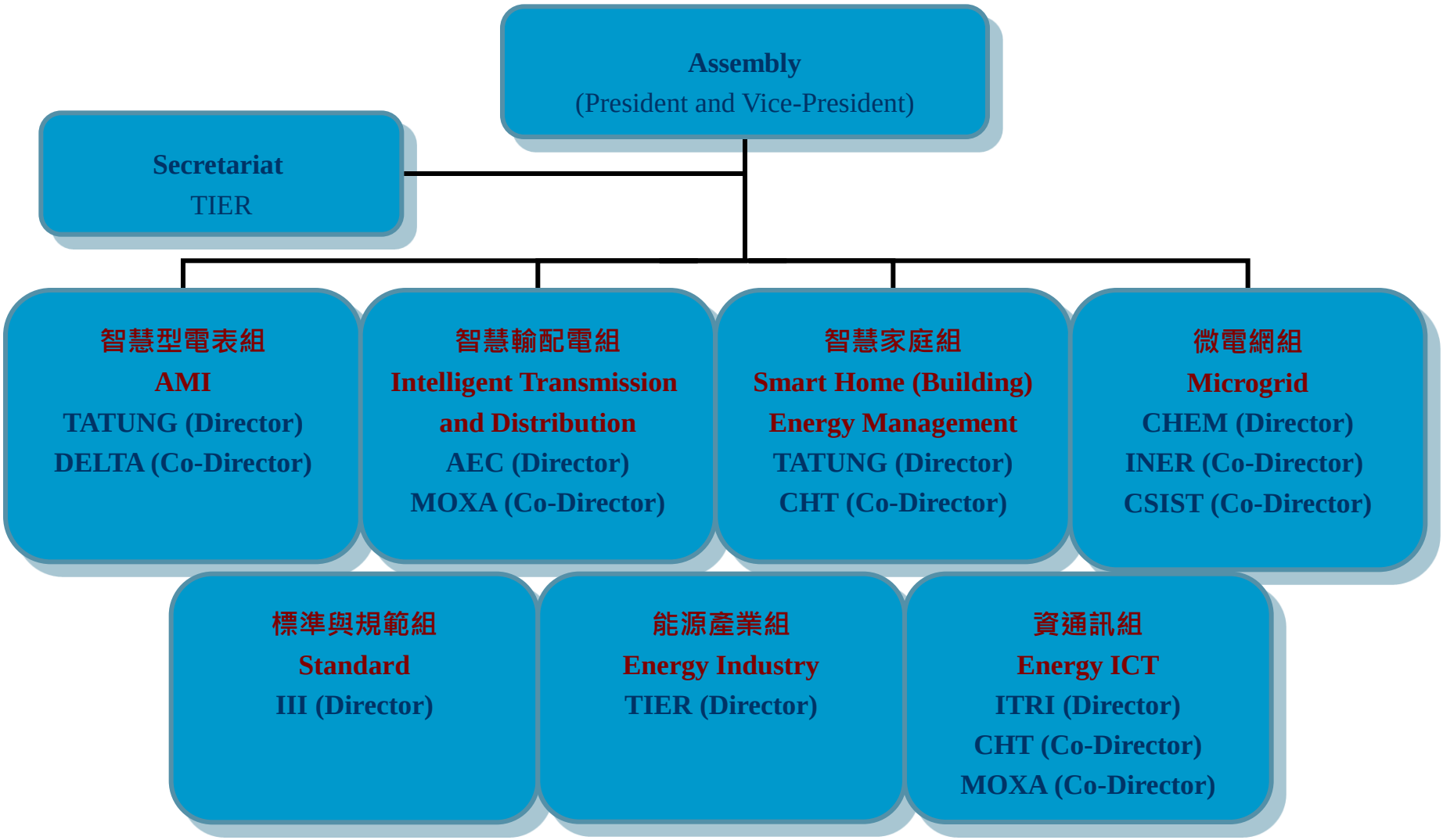
The future

- **High proportion of DG (including renewable energy)**
- **Using microgrid and ADAS technologies, distributed network can be connected to the grid or operated in islanding**
- **Using AMI with demand response (DR), time of usage (TOU) strategies, saving and generating electricity become a concern of public**
- **Significant improvement of overall efficiency due to regional power sources supply local loads**

Taiwan Smart Grid Industry Association (TSGIA)

- **Object**
  - To coordinate the development of power system, power electronics and ICT to develop the smart grid industry in Taiwan.
- **Mission**
  - Build up design and integration capabilities of smart grid.
  - Estabilish a platform for integration and exchanging smart grid technology.
  - Bridge the industry to the government to create an industry-friendly society and policy structure encouraging the development of smart grid industry.
  - Assist Taiwan smart grid industry to reinforce the opportunities of international market shares.

Structure of TSGIA



ALLIS ELECTRIC CO (AEC), Chung-Hsin Electric and Machinery Manufacturing Corp. (CHEM), Institute for Information industry (III), Industrial Technology Research Institute (ITRI), Institute of Nuclear Energy Research (INER) , CHUNG-SHAN INSTITUTE OF SCIENCE &TECHNOLOGY (CSIST), Chunghwa Telecom(CHT)

Taiwan AMI Components Provider

- The high voltage AMI System of Taiwan Power Company is constructed by Tatung (with Institute for Information Industry). MIU is provided by Tatung and CHEM
- The scale of low voltage AMI is about 6 million smart meters.

Component	Provider in Taiwan
Smart Meter	TATUNG, CHEM, SHIHLIN(Arch), DELTA, AcBel, Itron, Danielgroup, Schneider Taiwan
Communications Module	AcBel, DELTA Networks, Billion Electric, TATUNG , Arch, MOXA, SensingTEK, Itron, ITRI
Concentrator or MIU	MOXA, AcBel, DELTA Networks, ZyXEL, Itron, ITRI
AMI Sytem	III, TATUNG, DELTA, Chunghwa Telecom, Ladis+Gyr、Itron, Altos , ITRI
Meter Data Management System(MDMS)	TATUNG , III,Chunghwa Telecom, eMeter, Oracle, Ladis+Gyr, Itron, Altos

Taiwan DAS Equipments Provider

Sort	Equipment	Provider
Power Distribution Equipment)	Transformer Oil Gas Analyzer	CHEM, Fortune, SHIHLIN, TATUNG, PIC(G.E)
	Pad- & Pole-Mounted Transformers	TATUNG, SHIHLIN, Fortune, ALLIS
	Recloser	Fortune, SHIHLIN
	Automatic Line Switches	CHEM, Fortune, ALLIS, SHIHLIN, TECO, TATUNG, Schneider Taiwan
Distribution Feeder Automation System	RTU, FRTU, FTU	CHEM, Connet, HCE , TATUNG
	SCADA System	CHEM, Connet, HCE , TATUNG , Chunghwa Telecom, Siemens、ACS、SNC
	SCADA Server	ADVANTECH, HP
	GPRS/Fiber MODEM	Korenix, MOXA, EDIMAX
	Switch, Router	Connet, Wallnet, TATUNG, MOXA, Cisco, Altran

Taiwan Smart Home and Building Equipment Provider

Equipment	Provider
Intelligent home appliances	EHome：Cheng Xiang Control4 EMS：Justyle, ITRI
Electric vehicles charger	DELTA, ALLIS, LITEON, Fortune, Schneider Taiwan, ITRI
Power management chips	VIA
Energy management system (Interface)	Panasonic Taiwan, Chunghwa Telecom, INTEC, Tung-Chou, ITRI, Schneider Taiwan
Home Gateway	Panasonic Taiwan, Micortime Chunghwa Telecom, ITRI, Schneider Taiwan
Human-machine interface control	Panasonic Taiwan, Chunghwa Telecom, ITRI, Schneider Taiwan
Load type of control interface	Netvox, JosephTech
Wireless sensors	ZigBee：ICP DAS, Netvox
Wired sensors	Hom-thai, Winling
Communications Module	PLC : AcBel, Billion, ITRI ZigBee : ICP DAS, Netvox , ITRI Wi-Fi , Ethernet :MOXA

資料來源：能源國家型科技計畫－智慧電網與先進讀表主軸專案計畫總計畫 NSC 100-3113-P-008 -001 -PO

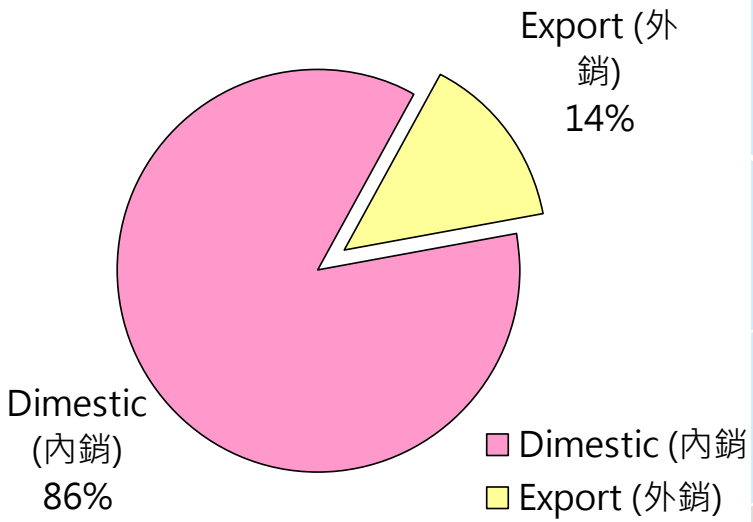
Taiwan Microgrid and DG Equipment Provider

Equipment	Provider
DG – Stationary fuel cell	CHEM, ITRI
DG - PV	Unienergy, HELIUS, ALLIS, Lucky Power, JosephTech, MOTECH, GPI, DELTA, ITRI, TATUNG
DG – Small wind turbine	Hi-VAWT, PGC, Boltun, iWIND, STU, ITRI, TATUNG
DG – Micro turbine	AIDC
DG – Energy saving system	FEMTC, AcBel, ALLIS, Lucky Power, ITRI, CSISTDUP
Electric vehicle quick charger	ALLIS, DELTA, LITEON, Fortune, Schneider Taiwan, ITRI
Bi-directional dc-dc converter	CHEM, DELTA, Ablerex, MOTECH , INER, ITRI, TATUNG
Micro Inverter	ALLIS, DELTA, Fortune, CHEM, Jubilee, Top Tower, GEOPROTEK, Schneider Taiwan, ITRI, TATUNG
Maximum Power Point Tracker	DELTA, INER, ITRI
Local SCADA	ALLIS, ADX, 榮成興業, CHEM, Chunghwa Telecom, ITRI, TATUNG
LVRT (AVR)	MOTECH
Distribution SVC	DELTA, TAIK
Distribution STATCOM	DELTA
AVR	DELTA , CHEM
Power controller / conditioner	INER
Loop Balance Controller (LBC)	NA
Static switch	榮成興業
Protective Relay	ALLIS, TAIK, Schneider Taiwan
Communication Equipment	MOXA

資料來源：紀國鐘，國科會產學合作計畫－微電網技術規範及產業發展研究計畫(1/2) NSC 100-3113-E-009 -003 -CC2

Taiwan's Smart Grid Product Sales Amount

In 2010, Taiwan Smart Grid Product domestic sales amount is NT$ 10.87 Billion (86%) and export sales amount NT$ 1.73 Billion (14%).
Taiwan's Smart Grid Products rely on domestic market.



	Stock Listed	Stock Unlisted	Total
Domestic sales	10.7	0.15	10.8
Export Sales	1.14	0.52	1.67
Total	11.87	0.67	12.55

Unit: billion NT$

資料來源：紀國鐘，國科會產學合作計畫－微電網技術規範及產業發展研究計畫(1/2) NSC 100-3113-E-009 -003 -CC2

資料來源：台灣智慧型電網產業協會整理

Thank You for Your Listening!