Development of Smart Grid in Taiwan

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Outline

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

Master Plan of Smart Grid in Taiwan

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

Smart Generation and dispatch
- Increase of renewables
- increase for the reliability & efficiency in power plants

Smart Transmission
- high efficiency in transmission
- increase of the security in transmission

Industries for Smart Grid
- develop key systems & facilities
- introduce the service opportunities for smart grid

Smart consumers
- Establishment of end-users' information
- advanced planning of end-users' service

Smart distribution
- enhancement of security for distribution
- enhancement of integration in DG

- Regulations/Policies
- Standards
- R &D

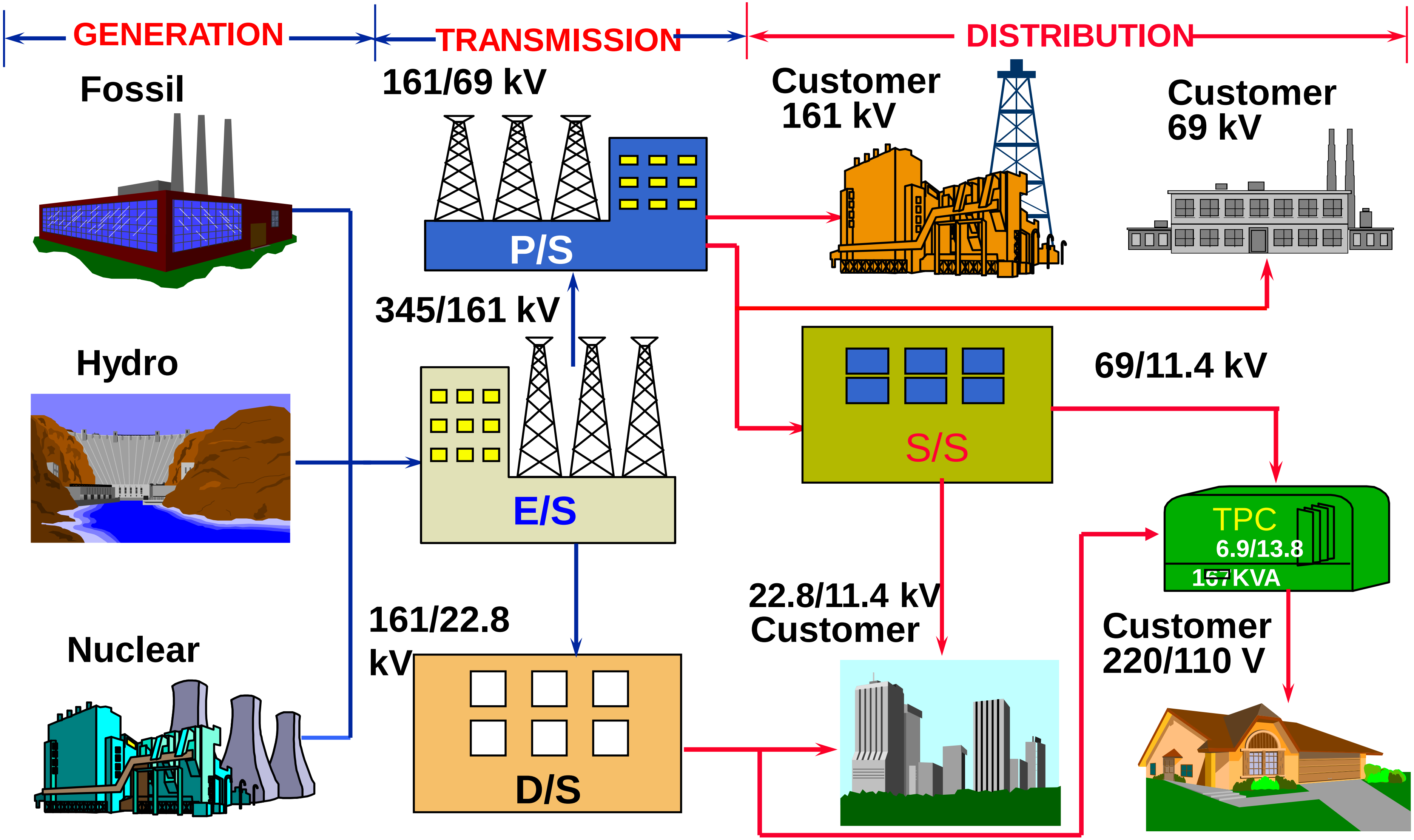
Establishment of Environment

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

Smart Grid Implementation Plan of Taipower

Overview of Taipower's System



Overview of Taipower's System

(1) Current Status of Energy Use

a. Due to an extreme lack of indigenous energy resources, Taiwan relies on imported energy resources for 99% of its needs.

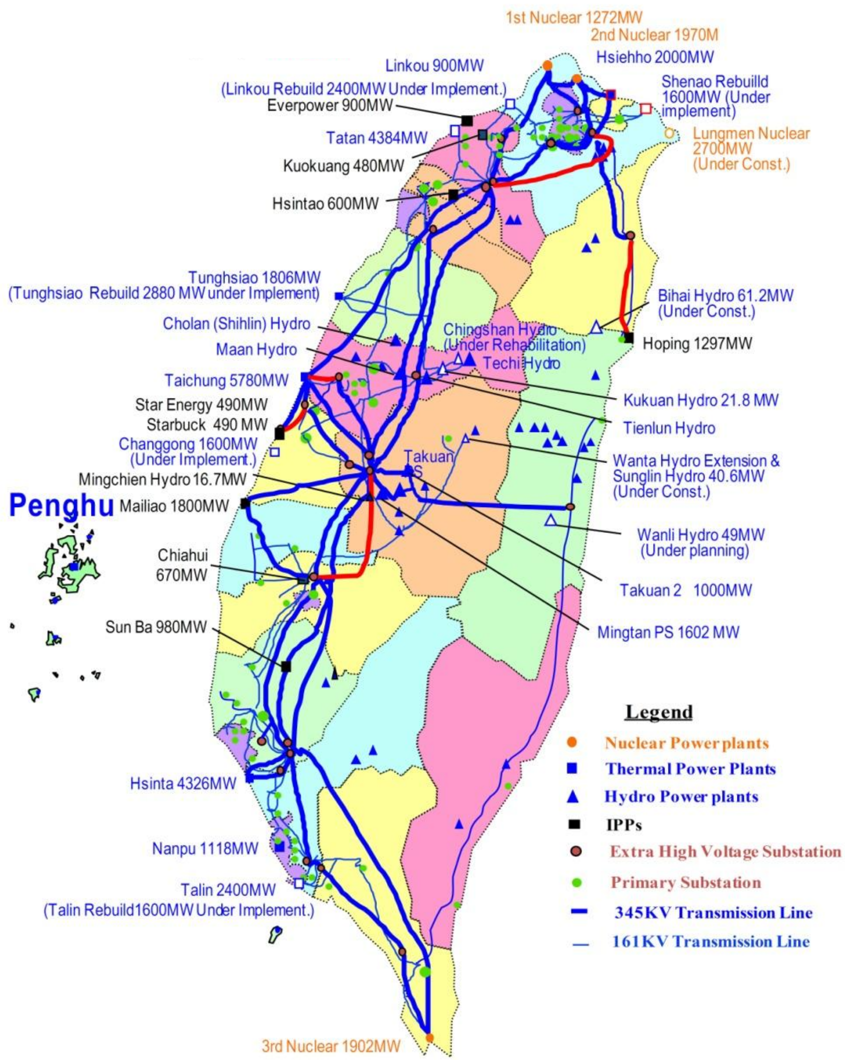
b. Fossil fuels play a major role in the energy supply structure, having a tendency of excessive concentration.

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

d. Under the government's policy, energy prices have been failing to reasonably reflect the costs.

Overview of Taipower's System

(2) Taiwan Power System



Installed Capacity in Year 2011: 41,400 MW

	Installed Capacity	MW		%
Taipower	Nuclear	5,144.00		12.6
	Thermal	22,717.60		54.90
	Oil		3,324.6	8.00
	Coal		8,800.0	21.30
	LNG		10,593.0	25.60
	Hydro	4,353.60		10.5
	Convential Hydro		1,751.6	4.20
	Pumped storage Hydro		2,602.0	6.30
	Wind	286.76		0.70
	PV	6.10		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	11.10
	Hydro	289.10		0.70
	Wind	236.10		0.50
	PV	38.30		0.01
	CoGeneration	622.00		1.50
Subtotal of IPP		8,892.60		21.5
Total Installed Capacity		41,400.7		100

Substation	No.	MVA
EHV	28	56000
Primary	261	68450
Secondary	295	20728

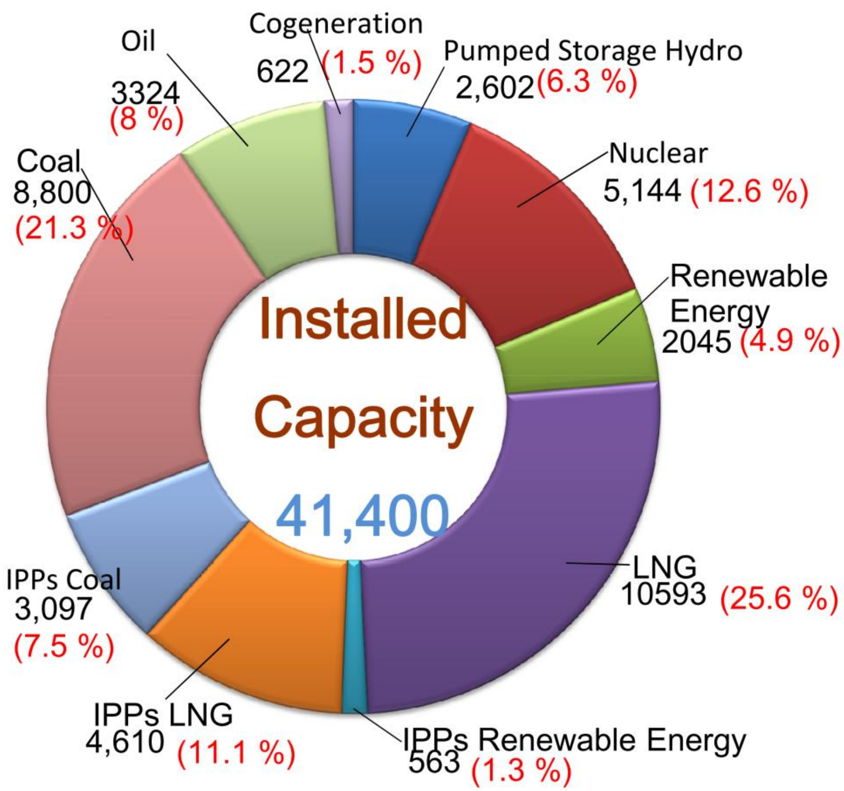
	ckt-km
Transmission Lines	16,898
Distribution Lines	339,057

Overview of Taipower's System

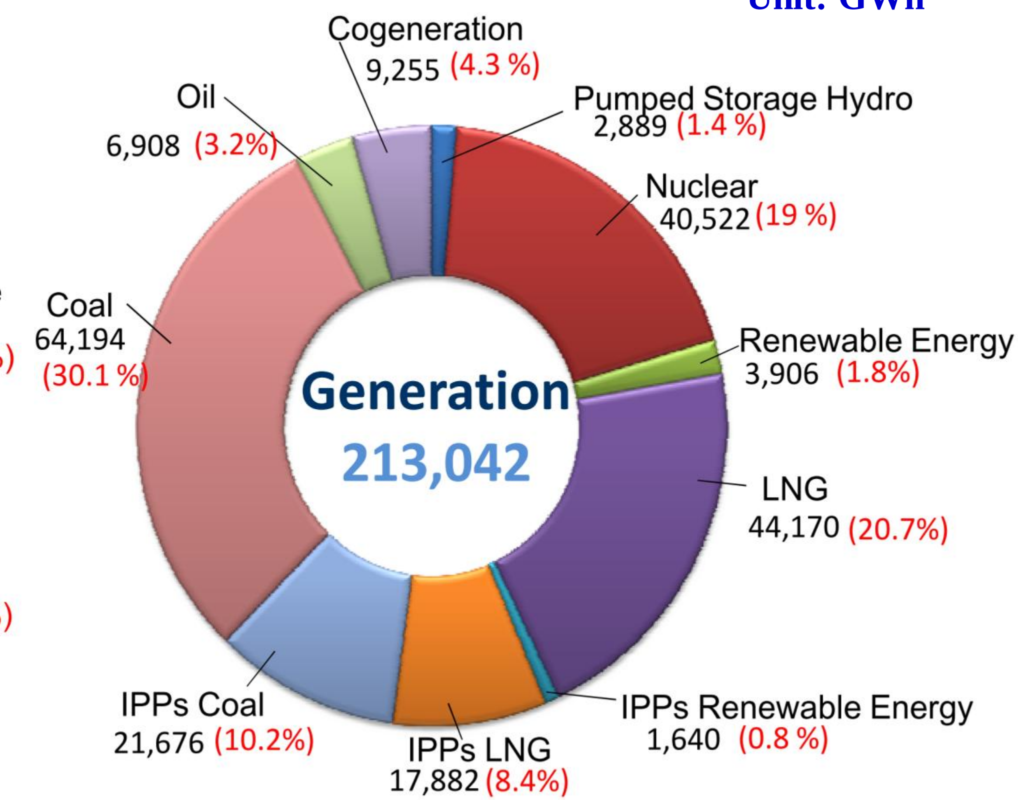
(3) Taiwan Power Profile (1/2)

Peak Load in Year 2011 : 33,787MW

Unit: MW



Unit: GWh



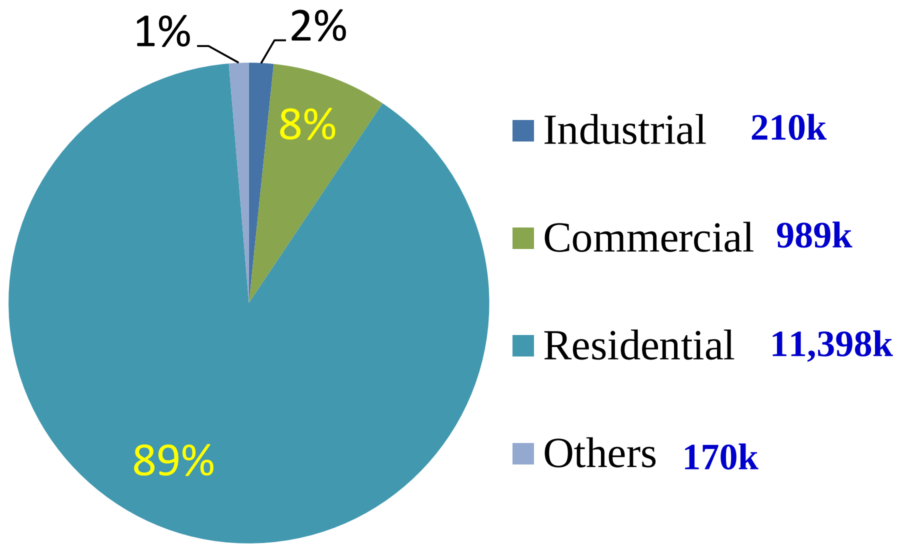
Independent Power Producers 8,893 (21.5%)

Purchased Power 41,198 (23.7%)

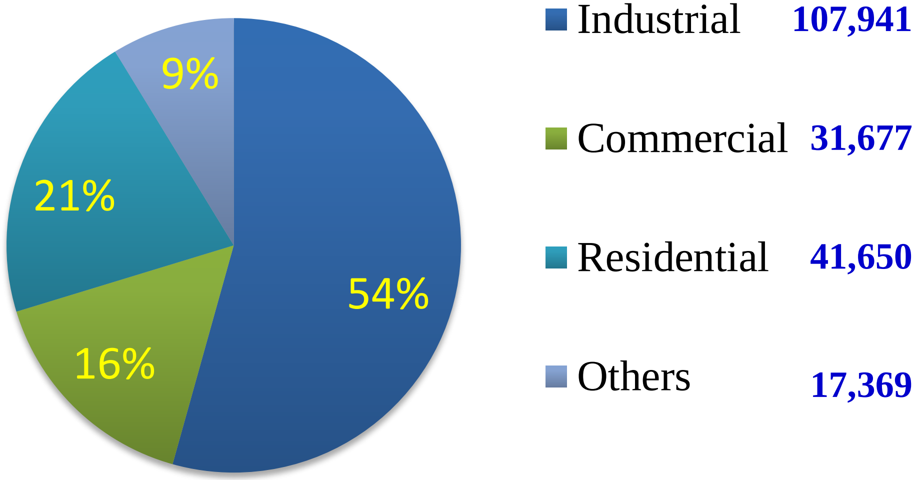
Overview of Taipower's System

(3) Taiwan Power Profile (2/2)

No. of Customers (12,768 k)



Sales (198,637 GWh)



Overview of Taipower's System

(4) Energy Policy

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 12,502 MW (accounting for 16% of total power installations) by 2030.

Smart Grid Implementation Plan In Taipower

(1) Strategies

a. Smart Generation & Dispatching

- a) Upgrade traditional thermal power generation efficiency
- b) Integrate large scale renewable energies

b. Smart Transmission

- a) Increase transmission grid efficiency and reliability using new technologies
- b) Enhance capability of asset management

c. Smart Distribution

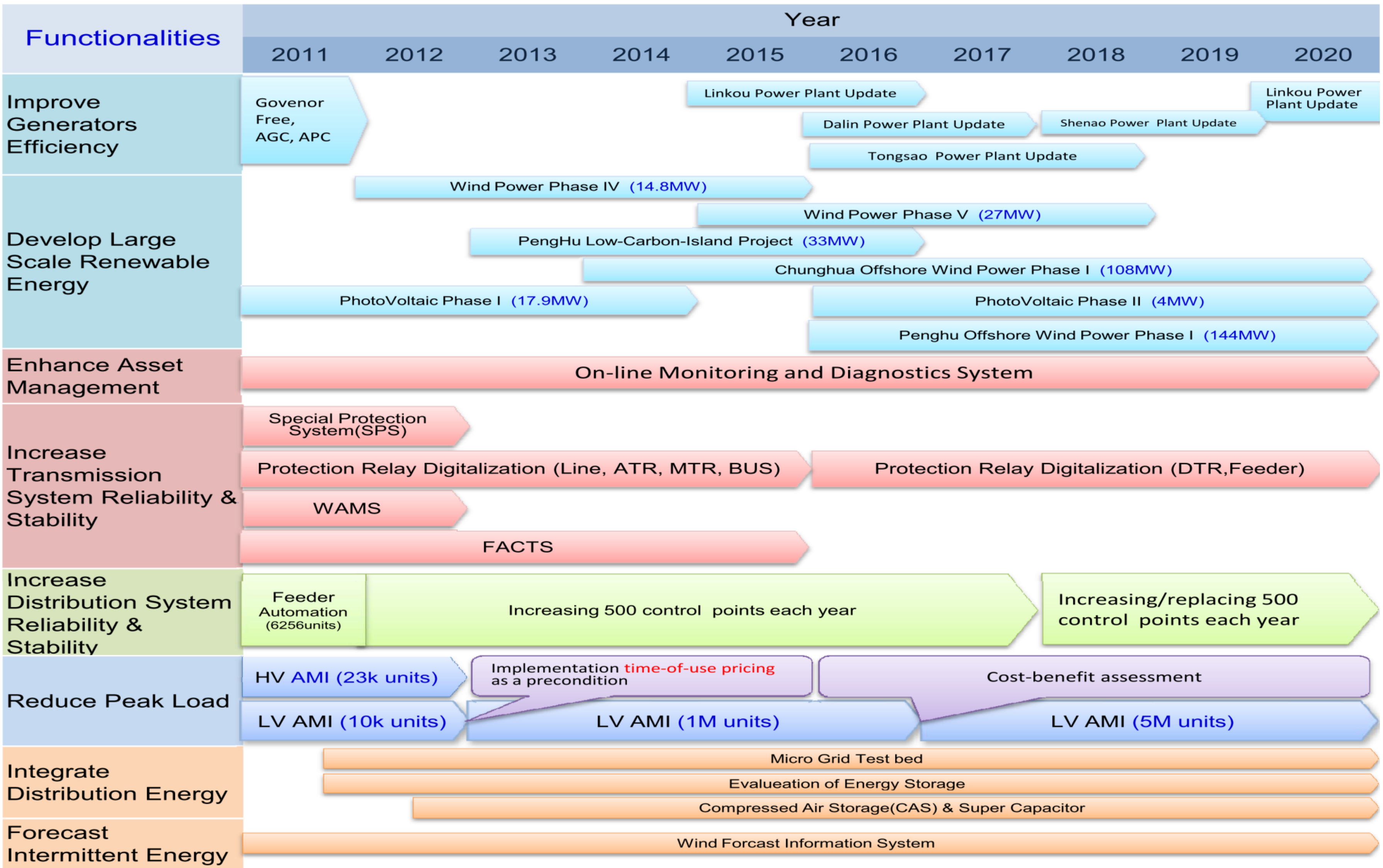
- a) Improve the reliability of distribution network
- b) Increase the penetration of distributed renewable energy

d. Smart Customer

- a) Improve energy usage efficiency through customer participation
- b) Reduce peak load by way of demand response

Smart Grid Implementation Plan In Taipower

(2) Schedules



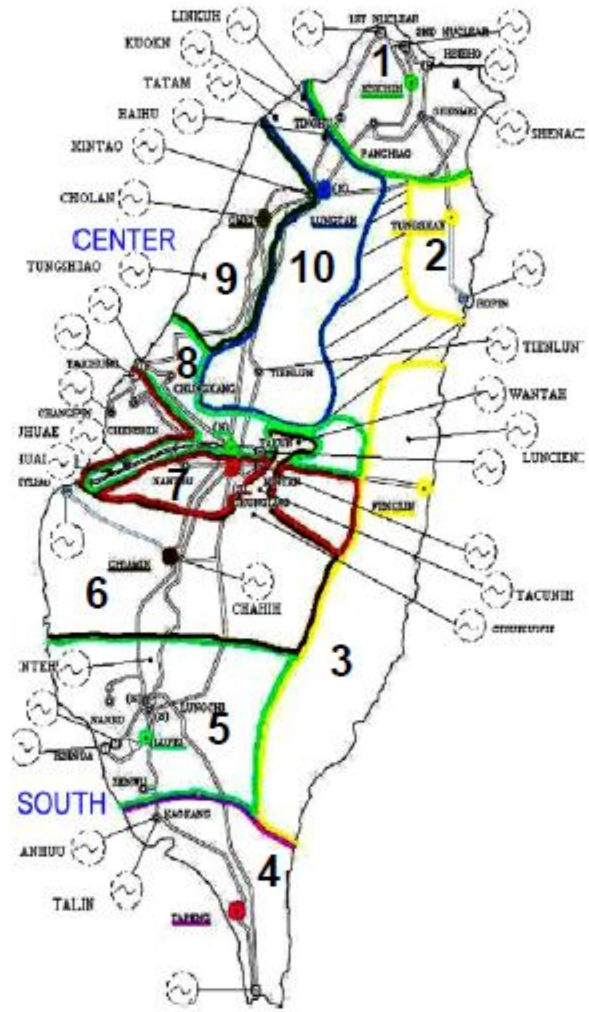
Objectives of Taipower's Smart Grid Action Plan

(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%**	**2025 20%**
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**



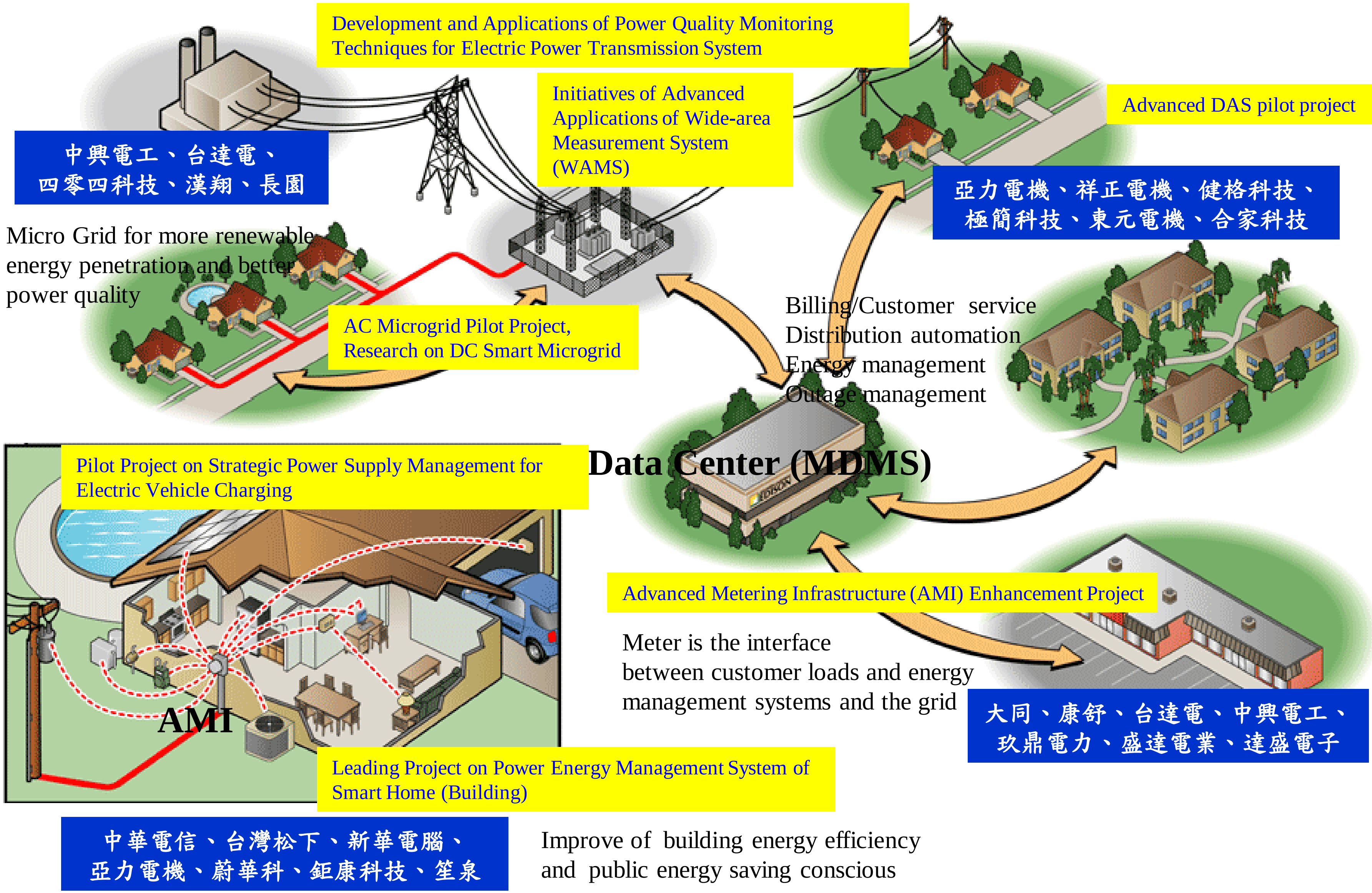
Source：Smart Grid Strategy for Technology Application in Taiwan, Yang Jin-Shyr, TPRI, 20110725

National Energy Project – Smart Grid and AMI, National Science Council

National Energy Project – Smart Grid and AMI

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



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 20% of the total electricity supply to reduce 40 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.

AC Microgrid Pilot Project — Major Achievement

Establish Microgrid Test Field (Fig. 1)

- Hundred KW scale of Microgrid system with Zone 1~3, distributed renewable energy generation systems, micro turbine generator, energy storage system, and controllable loads. The MGCC and protection system can be used to perform seamless transition control between grid connected and stand alone operation successfully. It is the only one outdoor microgrid test bed in Taiwan for research.

Fig. 1

Develop Multi Functional 5 kVA Bi-directional Inverter (Fig. 2)

Item	Spec.	Remark
AC Voltage	1φ220 V/60 Hz	
DC Voltage	380 ± 20 Vdc	
Power Factor	＞0.99	Charge Mode
	+0.9 ~ 1 ~ -0.9	Discharge Mode
Efficiency	＞96%	Max.
Rate Power	5 kVA	
Vac(UPS Mode)	220 Vac ± 5 %	VDE
THDv	< 5 %	linear Load

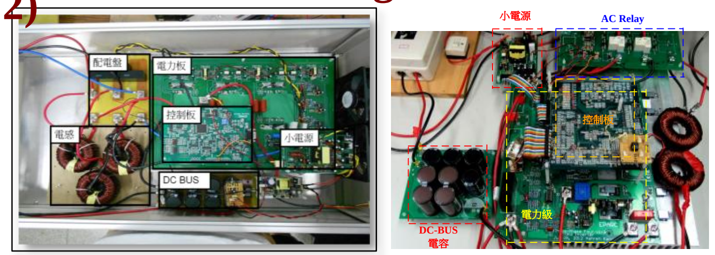


Fig. 2

Develop Grid-tied Inverter with Network Communication Control of Real and Reactive Power (Fig. 3)

Item	Spec.	Remark
AC Voltage	3φ220V/60 Hz	Over Current /under voltage protection
DC Voltage	170 V~250 V	Over/Under Voltage protection
Rate Power	1 kVA	
Efficiency	Inverter (92%)/Boost (90%)/MPPT (>97%)	
Network Communication	EIA-485	From Labview to Moxa Nport

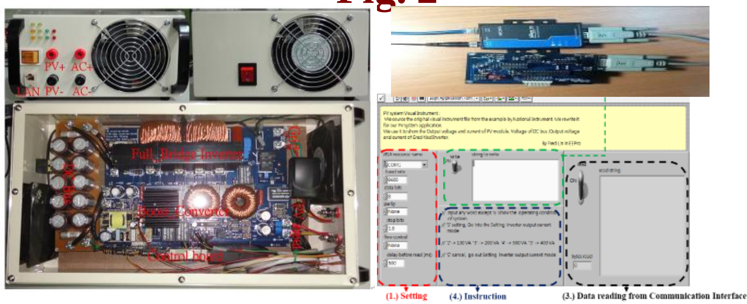


Fig. 3

Develop Energy Management System Platform (Fig. 4)

The advanced algorithm is developed in the SCADA platform to solve real time power flow for three phase distributed network with high R/X ratio and multiple DGs. The platform can also perform the state estimation, weather forecast, load prediction, demand responses to achieve optimal power flow control.

Fig. 4

Advanced Metering Infrastructure(AMI) Enhancement Project－Major Achievement

AMI communication architecture and platform

- Completing the development of field area network mixed by ZigBee/PLC, and Wide Area Network composed of MVPLC、fiber、3G

AMI Value-added Services on meter data management platform

- Developing the Rule-based Validation, Estimation and Editing (VEE) tool with high flexibility to utility requirement
- Providing the short-term load forecasting for reference of energy distribution and load management
- Enhancing security of AMI, providing light-weight certification architecture for AMI devices and staff ID authentication

AMI Demo Site Establishment

- In min-shang residential community, an AMI system with 650 meters is deployed and operating well, consistently
- In NCU test bed
  - High/Low-voltage Hybrid AMI systems are deployed to monitor whole campus load profile
  - Deploying demand response system which followed the open standard - OpenADR and integrated to campus EMS for a real practice

Support for Smart-Meter Industry Development

- AMI technology transferred to Companies, Moxa, AcBel, Tatung, Joseph-Tech, Delta and Arch Meter applied in Tai-power AMI system
- Coordinating local vendors to achieve a common interface for products inter-operability

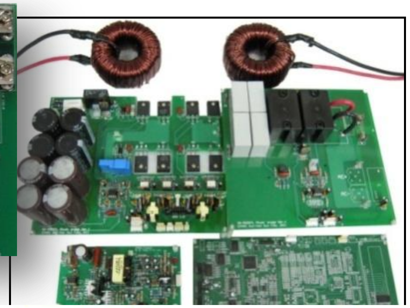
NCU Campus Zone

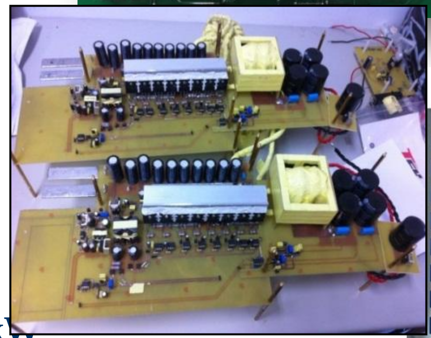
Residential demo site

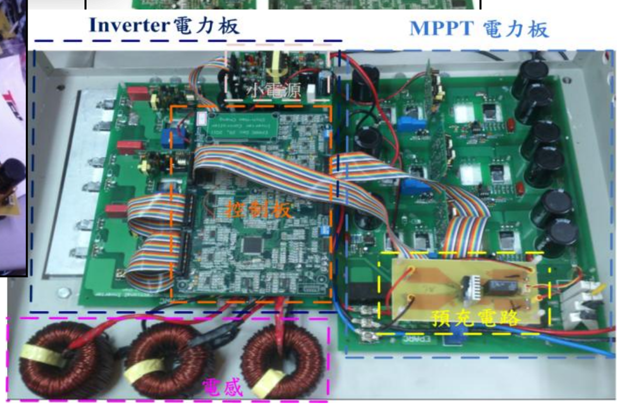
Microgrid Pilot Project (DC Smart Microgrid)- Significant Outcomes

Specifications and Features of the Technique Breakthrough

- **3-Phase Bi-directional Converter**
  - Accommodate wide inductance variation (over 9 times)
  - Comply with VDE-AR-N4105
  - Regulate dc-bus voltage (360 ~ 400V) by following a linear load-line relationship
  - Realize multi-functions in one set of converter, including grid connection, rectification and UPS
  - Highest efficiency of 98%, PF of 0 ~ 1 and power rating of 10 kW
- **Maximum Power Point Tracker**
  - Cover a wide input voltage range of 0 ~ 850V
  - Achieve step-down, step-up and smooth transition features
  - 3-modules can be independent or in parallel operation and with the feature of uniform current distribution
  - Highest efficiency of 98.5%
- **Full Cell Converter**
  - Input voltage: 42 V, output voltage: 380 V
  - Highest efficiency: 96%, power rating: 5 kW
  - Parallel operation
- **DC Loads – input voltage 380 ± 20V**
  - Air Conditioner – Power rating: 1.5 kW
  - Electric Scooter – Power rating: 1.5 kW
  - LED Lighting – Power rating: 100 W
  - Projector – Power rating: 200 W
- **Bi – directional Charger/Discharger**
  - Voltage conversion: 96⇔380 V
  - Highest efficiency: 96%, Power rating: 6 kW
  - Charger/discharger in one set
- **Active Islanding Detection**
  - Fast detection in one line cycle







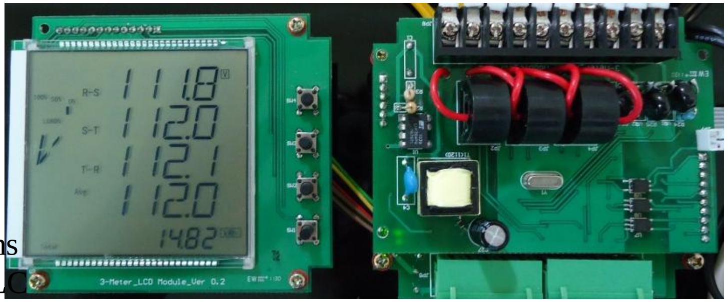
Advanced Distribution Automation Systems

Transformer Management System(TMS)

- Development of Transformer Terminal Unit(TTU) to measure oil temperature current and power delivered
- Integration of hybrid communication with TMS
- Automatic mapping display of transformers with abnormal operation condition
- Execution of demand response to achieve energy conservation

Supervisory Control of PV systems

- Enhance PV penetration by control of PV inverters
- Assessment of distribution system impact due to PV integration
- Real power and reactive power control of PV inverters by intelligent FTU to reduce the system impact by PV systems.



Hybrid Communication System

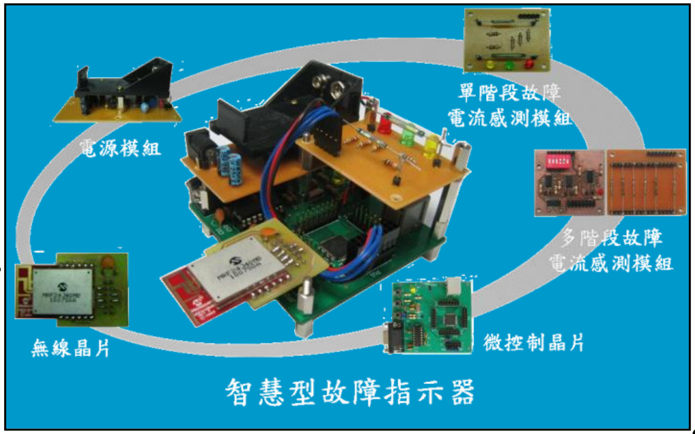
- Feasibility analysis of hybrid communication system to support various ADAS applications
- Communication schemes performance analysis of hybrid communication systems with PLC and wireless
- Integration test of hybrid communication systems consisting of BLPC,NPLC and optical fiber on actual Taipower distribution system

Application functions of ADAS systems

- Fault Detection, Isolation and Service Restoration (FDIR)
- Update of distribution network topology and real time database (RTDB)
- Fault restoration of laterals
- Development of ADAS application functions

Development of Intelligent FTU and Fault Detector(FD)

- Identify fault location with FD using hybrid communication system
- Develop intelligent FTU to support lateral fault restoration and achieve supervisory control of PV systems and smart appliances
- Integrate FTU and FD with master control station to achieve real time mapping display of system operation status.

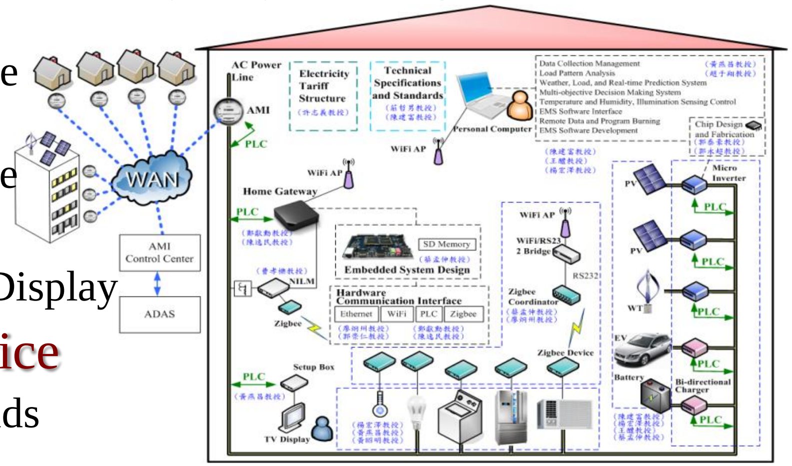


Smart Home (Building) Energy Management System Pilot Project－Significant Achievements

■ Control Strategies and AMI for SH(B)EMS

- Modularized EMS function control, including renewable energies and the storage system
- Capabilities of preference setting and Demand Response
- Deployment of building AMI
- Accommodating mobile device and IPTV as In-Home Display

1st year: System Planning and Interface Definition

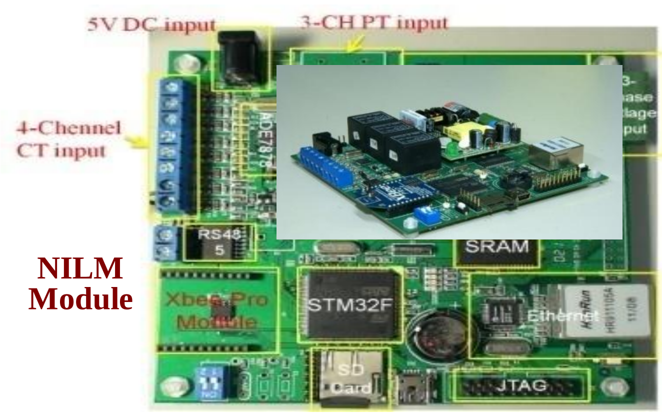


2nd year: Smart Building EMS demonstration

3rd year: System Demonstration and Cost/Benefit Analysis

■ Non-intrusive Line Monitoring (NILM) Device

- Measuring power consumption of appliances in 2 seconds
- Accuracy up to 90% above
- Providing status analysis of appliance and user behavior of using electricity
- Applications of Clouds technologies and data base
- Minimized size (10x6cm), cost effective solution (US$30-50)
- Technical transferring to vendors



NILM Module

■ Vendors involvement and cooperation in R&D

- R&D cooperation with Netvox, Nation Instruments, Panasonic, Chunghwa Telecom, Megawin Technology, Raydium, ABB, Spirox, III and ITRI
- Devices developed including Zigbee, PLC, Home Gateway、EMS HMI, Inverters, and Energy control chip designs

Initiatives of Advanced Applications of WAMS

Online Parameter Estimation and Dynamic Thermal Rating of Power Transmission Line / Power Tower Safety Monitoring

- **Parameter Estimation**: PMU data is simulated and transmitted to phasor data concentrators (PDC) to estimate parameters of power transmission lines.
- **Dynamic thermal rating** scheme with weather forecast information.
- **Wide-area Measurement System**: Measurements of power transmission lines and power tower are collected by a embedded gateway via IEEE 802.15.4. Selected power towers are equipped with long-range Wi-Fi access point to form a high-speed, free of charge and stable platform for WAMS.
- **Fault detection, classification and location** on transmission lines.
- A **secured and fault-tolerant database** with GUI for **geo-data visualization**.

On-line Measurement-based Model Parameter Estimation for Synchronous Generators / Optimal PMU Placement

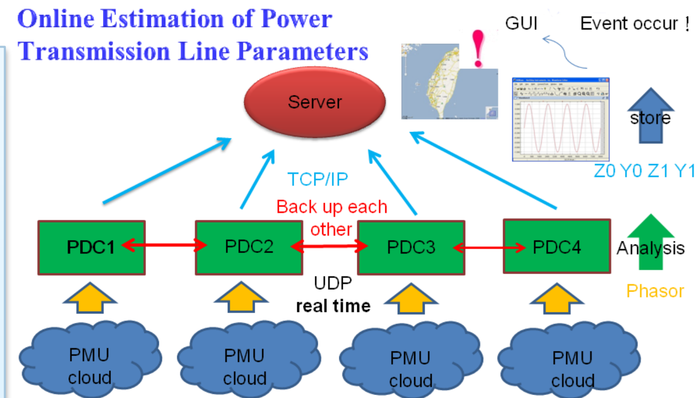
- **Off-line Measurement**: 6 fossil-fuel generators and 1 nuclear reactor
- **Optimal PMU Placement**: Satisfying the requirements of the power system observability based on the grid structure and EHV/UHV transmission substation of TaiPower Company.

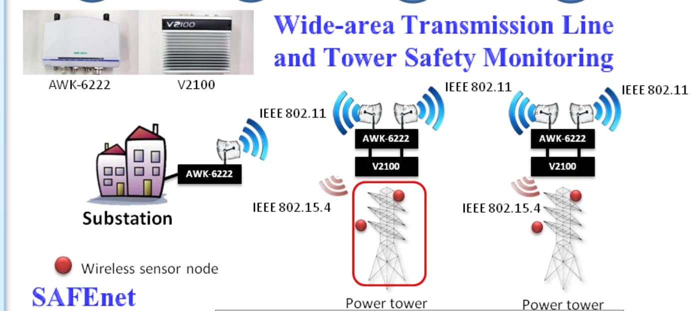
Development of Micro PMU Prototype

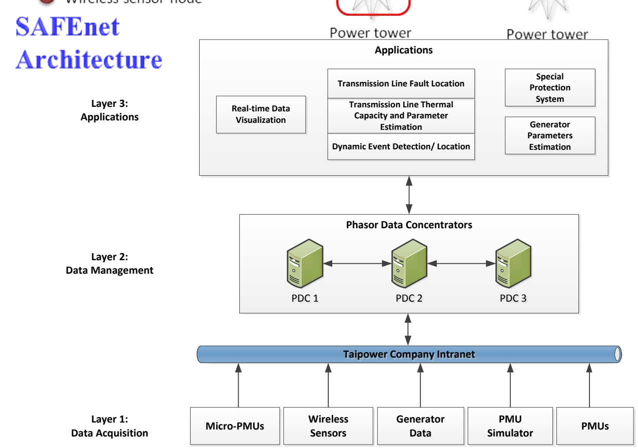
- **FPGA-based Micro-PMU**: Algorithm implementation and integration of embedded-systems.
- **Synchronized Phasor Measurement**: Developing three-phase voltage phasor measurement device with ADX Corp.
- **SAFEnet Communication Architecture**: Providing comprehensive system-wide grid protection.

Development of Response-based Special Protection System

- Completed the **Treatment Scheme and Analysis for Vulnerability and Accidents** of TaiPower Grid.



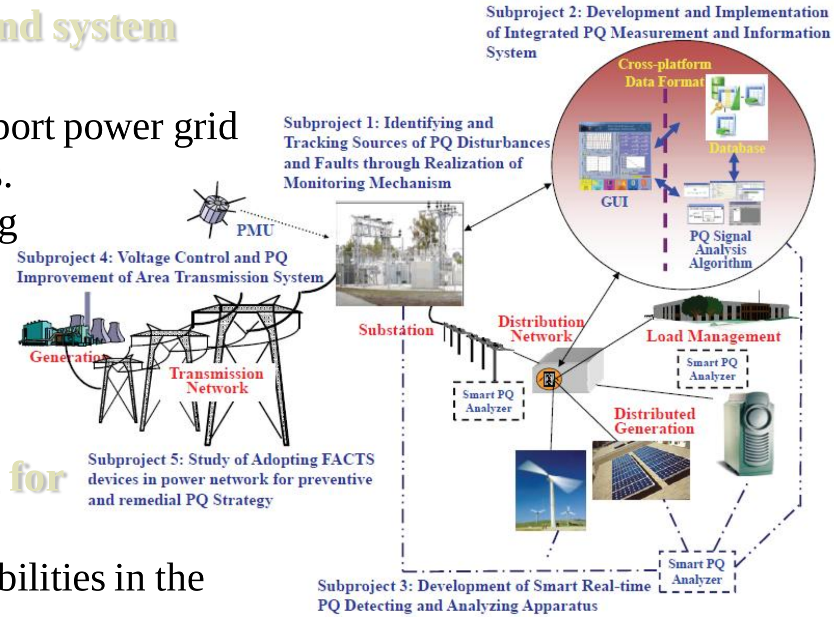




Development and Applications of Power Quality Monitoring Techniques for Transmission System - Highlights

Power quality (PQ) monitoring techniques, standards, and system development transmission system

- Design of real-time tracking and identification algorithm to support power grid monitoring mechanism and implementation for PQ disturbances.
- Planning of fixed network-type of installations of PQ monitoring mechanisms to provide the necessary parameters of the power system information and mitigation of PQ events.
- Development of advanced PQ signal analysis method and investigation of preventive solutions to PQ disturbances.

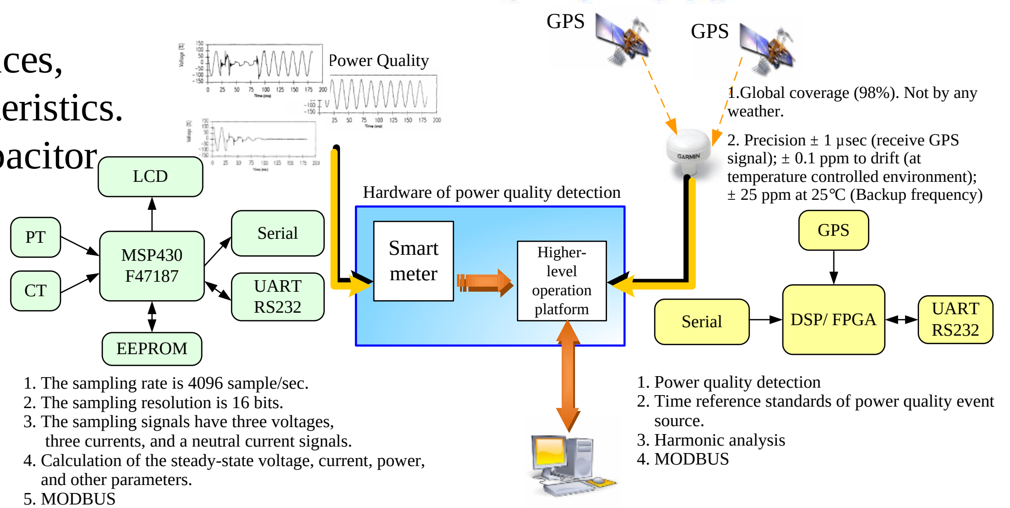


PQ analysis and mitigation strategies of implementation for transmission system

- Planning of deployment of smart devices with PQ analysis capabilities in the grid to assess the quality information.
- Investigation of current system voltage control practices, compensation principles, and DER operation characteristics.
- Study of STATCOM application in Taipower and capacitor planning for enhancement of voltage quality.

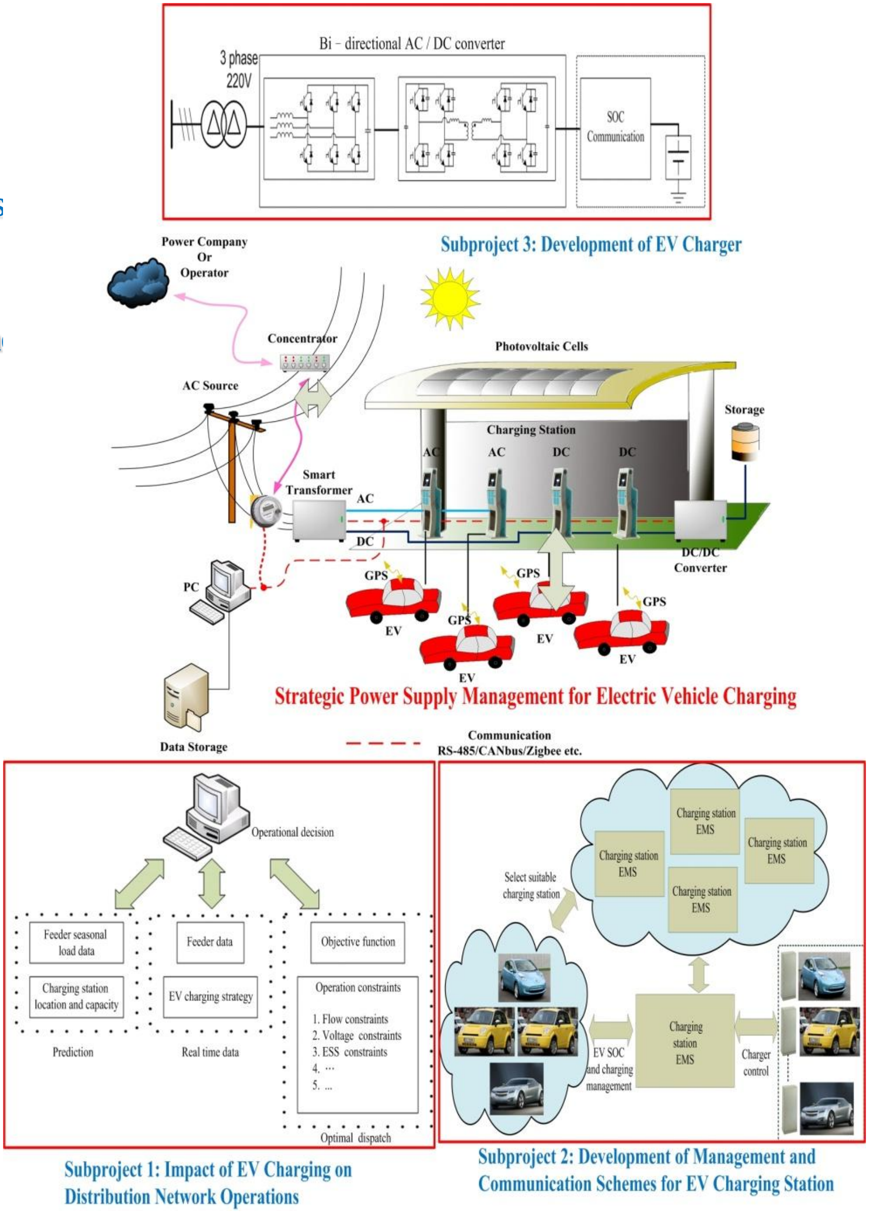
Manufacturers joining in early stage of R&D

- Taipower, ADX, and APPA.
- Joined work includes PQ improvement strategies, planning of monitoring mechanisms, and design of real-time PQ analyzer.



Strategic Power Supply Management for Electric Vehicle Charging

- Impact of EV Charging on Distribution Network Operation
  - Develop EV charging station power supply scheme
  - Analyze power and voltage quality measurements of substations feeders and charging stations of EV demonstrative projects
  - Determine evaluation indices for voltage drop, line loss and flow congestion for different number of EV charging stations an locations.
  - Perform OpenDSS-based load flow analysis
  - Establish operation models for EV charging stations
- Development of management and communication schemes for EV charging station
  - Develop of an EMS embedded Smart Transformer for EV charging stations
  - Design EMS schemes for EV charging stations
  - Design EV chargers control schemes
  - Develop digital controller for on-board EV chargers
- Development of EV charger
  - Design a 3 kW smart chargers
  - Develop a bi-directional AC/DC converter
  - Develop protocol for EV charger and battery communications
- Industry-University Collaboration Activities



National Energy Project II– Demo Site of Smart Grid and AMI, National Science Council

Development and Goals of the 2nd phase of Smart Grid and AMI Master Project

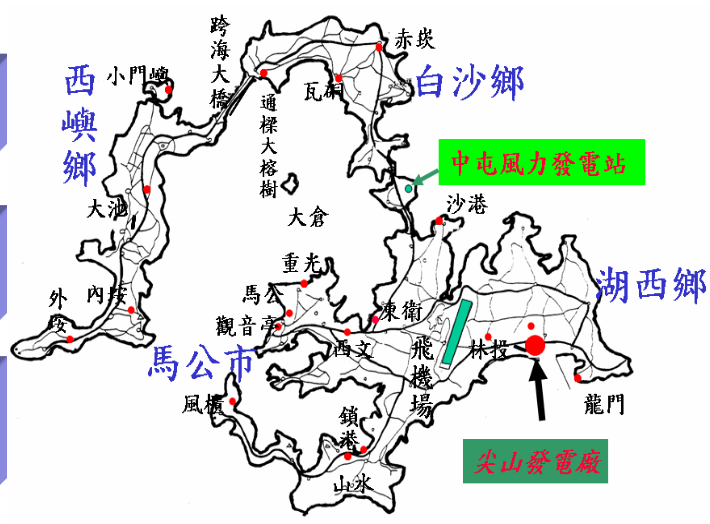
Between 2013 and 2017, we are planning to continue working after results from the 1st phase of the project and to complete the key technology transfer of smart gird and AMI, such as

- **Commercializing, cooperating with the promotion of smart meters and electric vehicles**
- **Completing power energy and electric vehicle energy supply management system lead-in (ex. time electrovalence, demand response, etc.)**
- **Cooperating with the power transmission and distribution plan led by Taiwan Power Company (TPC)**
- **Promoting the project achievements of micro-grid (AC and DC), advanced distribution automation , wide area measurement system, quality monitoring of power transmission system on TPC's system**
- **Promoting smart home (building) power management technology for household users**
- **Building the first demo site of smart grid and AMI in Penghu, Taiwan.**

Overall Demonstration to Promote the Idea of Smart Grid and AMI

Using results from the 1st phase of this project, cooperating with the Executive Yuan to implement Low Carbon Island Project in Penghu archipelago (50Km from Taiwan, inhabitants 89000, average load 45MW, peak load 83MW), as well as with the Bureau of Energy, Ministry of Economic Affairs and TPC to promote AMI, micro grid, advanced power distribution, smart home and building energy management, and electric vehicle energy supply management.

- Smart Meters
- Substation Intelligentize
- Power management system



- Solar thermal energy → Alternative gas
- Photovoltaic system
- Large-scale wind turbine
- Small-scale wind turbine
- Motor vehicle subsidies Charging stations

Visions and Objectives of Low Carbon Island Project in Penghu

To complete a field demonstration of low-carbon green living, to apply low-carbon living service and carbon reduction technology, to conjoin with tourism service, and to expand the application of green energy products, in order to prompt Taiwan accelerating the move towards one of the low carbon countries. Citizens participate in energy conservation activities to create electricity negative growth in low-carbon homes.

- As the country's first, it can be compared with the world and it will definitely reach a certain size.
- Promoting Penghu to be the benchmark for world-class low-carbon island.
- In 2015, the target of having a decrease of 50% of carbon emissions compared to 2005 will be reached.
- In 2015, renewable energy will supply more than 50% of the total energy demand.
- Electricity consumption growth rate will be dropped by 7%, and per capita carbon emission will be reduced to 2.1 tons per year.
- Establishing investment pattern of Taiwan's first large-scale wind turbine in prefectural stake (the benefit of the island will be 1.6 times more).

Schedule of the Second Phase of Smart Grid Master Program

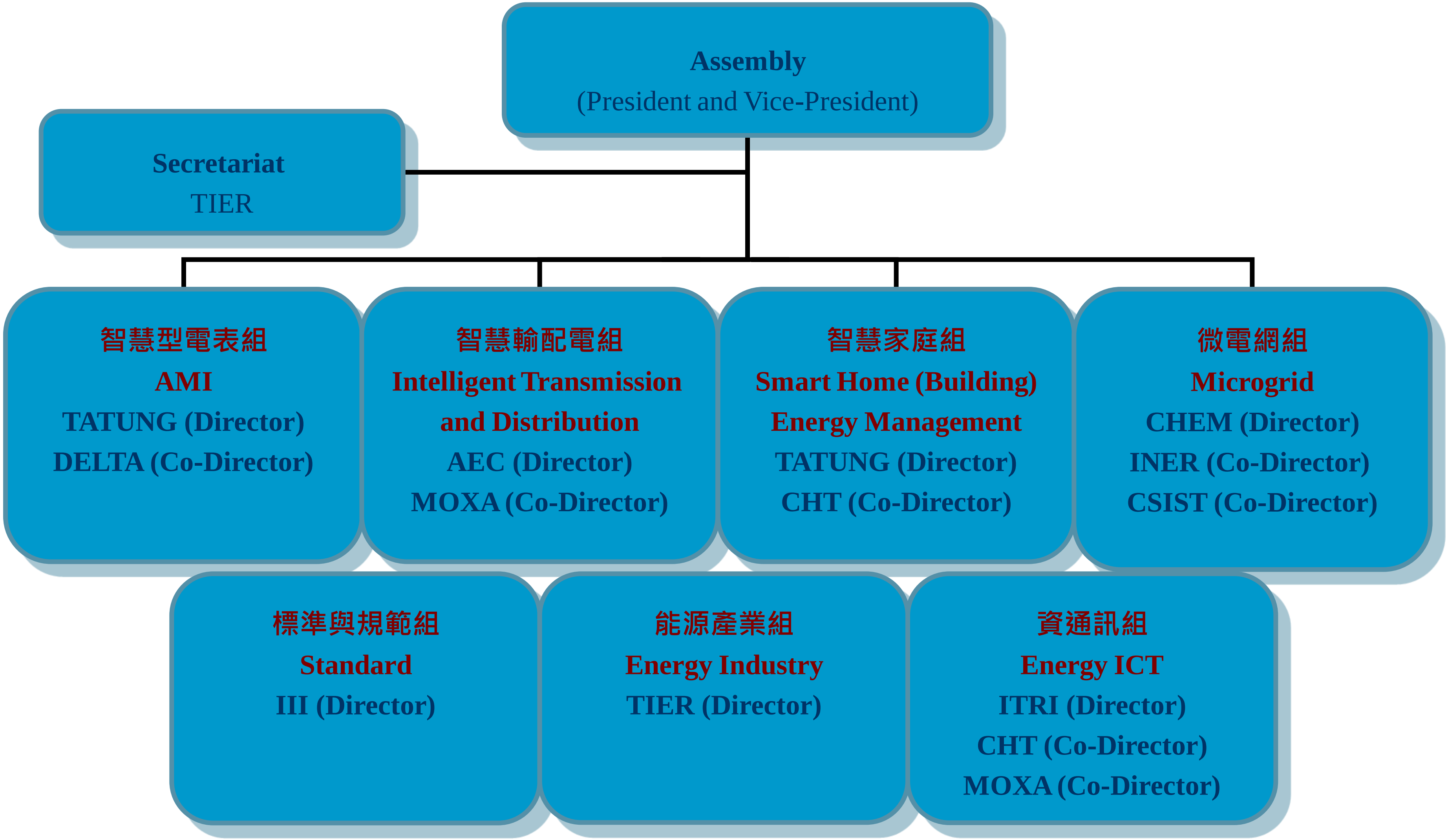
	Goals	2013	2014	2015	2016	2017	2018	2019	2020	2021
A	Planning of Smart Grid and Smart Grid Industry in Taiwan (program office cooperated with Bureau of Energy andTaipower)	■	■	■	■	■	■			
B	Smart Community Demo Project Planning and Promotion (Penghu	■	■	■	■	■	■			
C	Key Technology Development of Microgrid		■	■	■	■	■			
D	Advanced Metering Infrastructure		■	■	■	■	■			
E	Advanced distribution automation		■	■	■	■	■			
F	Smart home and building energy management		■	■	■	■	■			
G	Electric vehicle energy supply management		■	■	■	■	■			
H	Smart grid and AMI standard establishment	■	■	■	■	■	■			
I	Renewable energy integration and energy storage application (VPP)	■	■	■	■	■	■			
J	Taiwan Power Company smart grid related development		■	■	■	■	■			

Taiwan Smart Grid Industrial Association

Taiwan Smart Grid Industry Association (TSGIA)

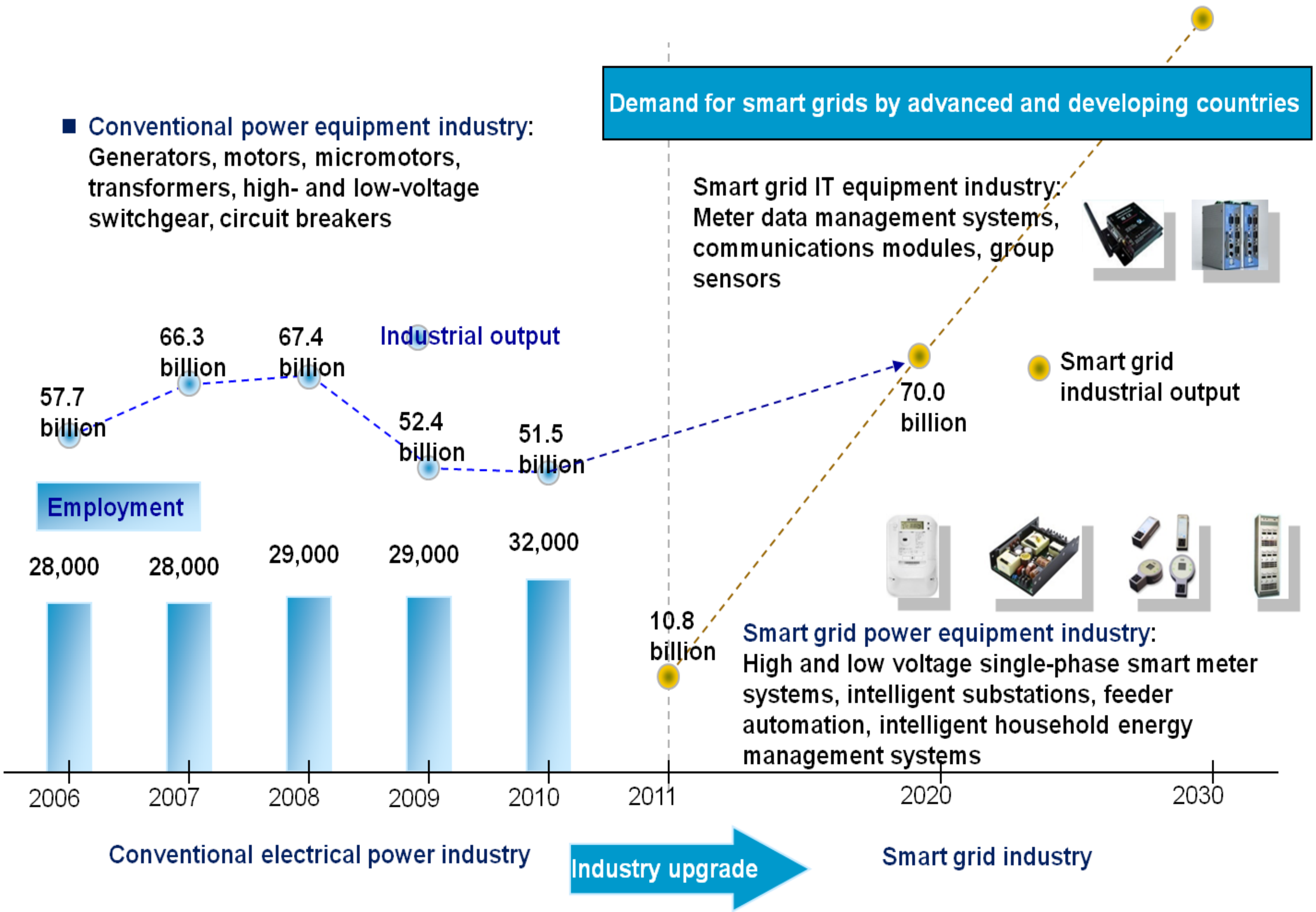
- **Object**
  - **To coordinate the development of power system, power electronics and ICT to develop the smart grid industry in Taiwan.**
- **Mission**
  - **Build up design and integration capabilities of smart grid.**
  - **Estabilish a platform for integration and exchanging smart grid technology.**
  - **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)

Development of Smart Grid in Taiwan



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**

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 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

History and Trend of Smart Appliances

Traditional Appliances

First Generation Smart Appliances

Display current power costs and have automatic driving function, such as energy-saving frequency conversion appliances.

Automatically regulate the water volume
Zero-consumption Reduce 76% of power consumption from digital standby.

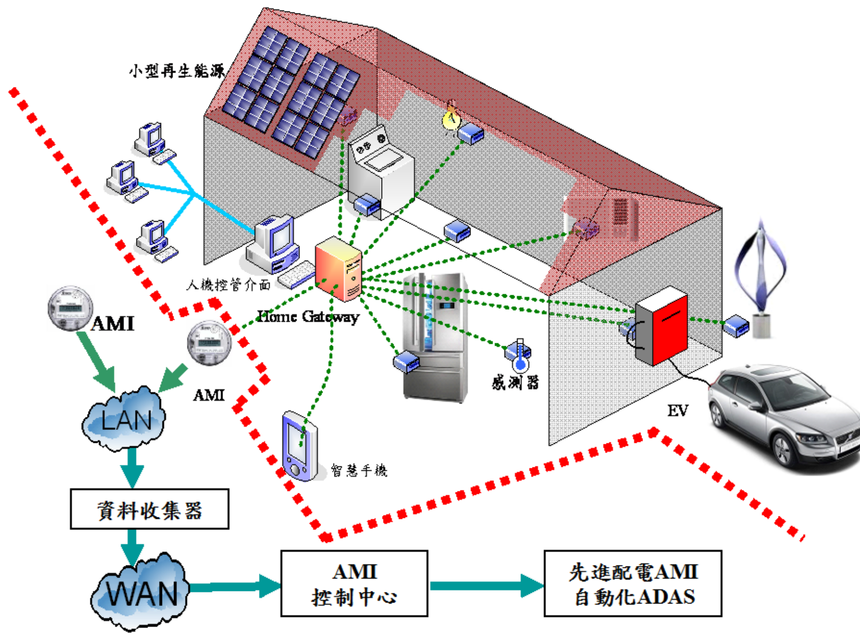
Sharp Multi-spots Induction
Reduce 64% power consumption by adjusting the temperature of the refrigerator automatically.

Display temperature and power consumption
Decrease electric power to 45W(as same electric fan)
Reduce 26% of power consumption

Automatically judge the amount of refuse
Automatically regulate power supply and suction

Second Generation Smart Appliances (Future)

An household appliances integration system to truly reflect power cost by integrating ICT technologies with Smart appliances and expanding users' involvement.



The time for smart appliances to enter general household
(1) Standardize the information connection system of smart appliances
(2) Establish TOU pricing system.

1949 — 2000 — 2014 ~2016

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

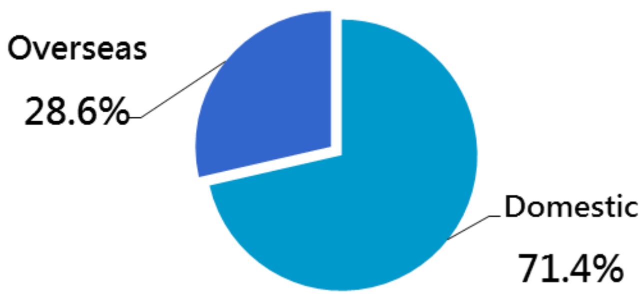
Equipment	Provider
DG – Stationary fuel cell	CHEM, ITRI
DG - PV	Unienergy, HELIUS, ALLIS, Lucky Power, JosephTech, MOTECH, GPI, DELTA, ITRI, TATUNG
DG – Small wind turbine	Hi-VAWT, PGC, Boltun, iWIND, STU, ITRI, TATUNG
DG – Micro turbine	AIDC
DG – Energy saving system	FEMTC, AcBel, ALLIS, Lucky Power, 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

Results of Smart Grid Industry Survey in Taiwan-1

- **In 2009, the total sales of smart grid products are 2.13 billion dollars, among which, 1.52 billion dollars, 71.4% of the total sales, are from domestic sales and 0.61 billion dollars, 28.6% of the total sales, are from products sold abroad. In 2010, the total sales of smart grid products are 5.549 billion dollars, among which, 2.87 billion dollars, 51.6% of the total sales, are from domestic sales and 2.68 billion dollars, 48.4% of the total sales, are from products sold abroad. This shows that the demand of our domestic smart grid products is increasing significantly with** the average growth rate of 20% from 2011 to 2015.
- **The main export equipment include power transmission switching mechanism, concentrators, transformer remote monitoring module, raw material of smart grid products, exchange board, embedded computers, home display unit, converter, electric meter detection equipment and active power filter.**

Proportion of sales of smart grid related products in 2009



Proportion of sales of smart grid related products in 2010

	Domestic	Overseas	Total
Total Sales of Smart Grid Products in 2009	1.50 billion dollars	0.61 billion dollars	2.13 billion dollars
Total Sales of Smart Grid Products in 2010	2.866 billion dollars	2.684 billion dollars	5.55 billion dollars
Growth Rate	88.55%	340%	160.56%

Notes：(1) Due to some companies readjusted their category of their smart grid products in 2011, the result of the second survey might different from the first one.

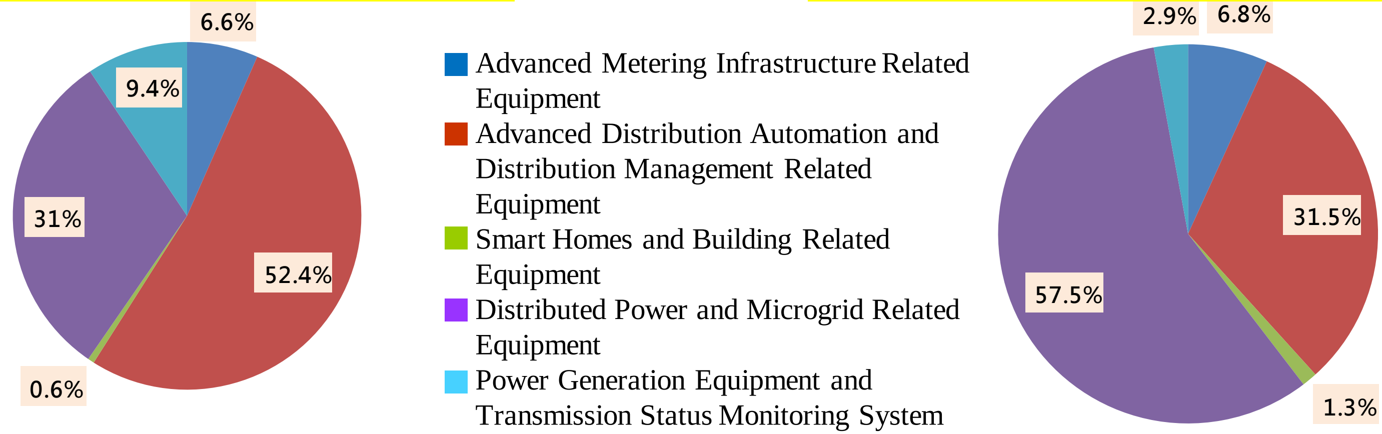
(2) This data is based on the questionnaire survey from 21 companies of the smart grid industry, but lacking of the questionnaire from Hsiang Cheng Electric, Teco, Shih Lin Electric and Controlnet .

Results of Smart Grid Industry Survey in Taiwan-2

This survey is also aim at the value of sales of " Advanced Metering Infrastructure Related Equipment "," Advanced Distribution Automation and Distribution Management Related Equipment", "Smart Homes and Building Related Equipment", " Distributed Power and Microgrid Related Equipment", "Power Generation Equipment and Transmission Status Monitoring System" five categories. The result shows: the value of other categories increase significantly except "Power Generation Equipment and Transmission Status Monitoring System". In 2010, the annual sales of "Smart Homes and Building Related Equipment" increase the most which is 5 times the original sales. Ranked in second place is " Distributed Power and Microgrid Related Equipment", which the annual sales increase about four times the original sales.

Sales of Smart Grid Related Production in 2009

Sales of Smart Grid Related Production in 2010

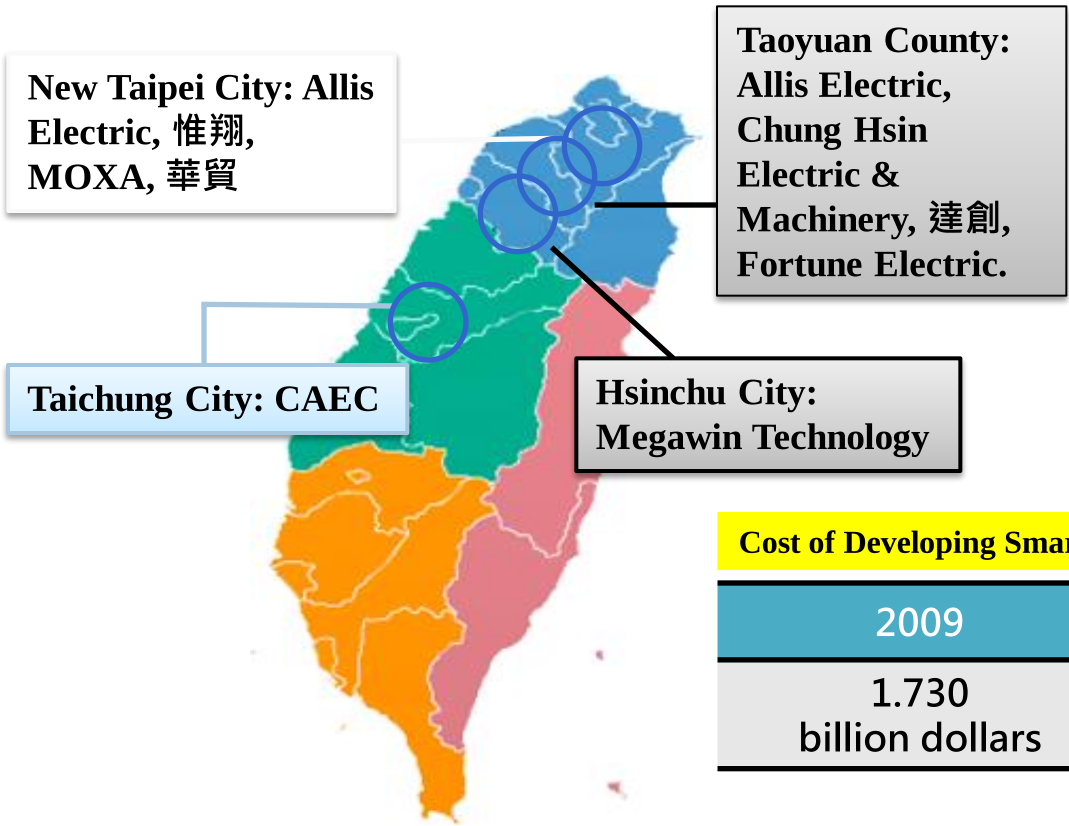


Production Category / Year	1. Advanced Metering Infrastructure Related Equipment	2. Advanced Distribution Automation and Distribution Management Related Equipment	3.Smart Homes and Building Related Equipment	4. Distributed Power and Microgrid Related Equipment	5. Power Generation Equipment and Transmission Status Monitoring System	Total
Sales of Smart Grid Related Production in 2009	17.72 million dollars	140 million dollars	1.50 million dollars	82.84 million dollars	25 million dollars	267 million dollars
Sales of Smart Grid Related Production in 2010	51.61 million dollars	240 million dollars	10 million dollars	438 million dollars	22 million dollars	761 million dollars
Growth Rate	191.25%	71.42%	566.6%	428.7%	-12%	185%

Unit：NTD

Results of Smart Grid Industry Survey in Taiwan-3

Classify by region, in 2009-2010, the major markets of Taiwanese smart grid related products are as follow : China, Japan, South Korea, India, Australia, Germany, United Kingdom, USA, Canada, Mexico, Brazil, South Africa. Factories are expecting to develop Japan, China, Southeast Asia, India, Europe, Middle Asia, USA, South America.



Location of Producing Taiwanese Smart Grid Related Products

Most of domestic factories which produce smart grid related products are located in New Taipei City, Taoyuan County, Hsinchu City and Taichung City. Otherwise, most of foreign locations are in Qingdao, Shanghai, Jiangsu, Shenzhen, Guangzhou, Dongguan, Berlin (Germany).

Cost of Developing Smart Grid Related Products in Taiwan from 2009 to 2010

2009	2010	Growth Rate
1.730 billion dollars	2.057 billion dollars	18.9%

unit : NTD

Smart Grid Industry Technology Roadmap

	Phase	Outcome	Steps	Comments	Keys for Vendors
1	Innovation and Validation	Establish proof of concept and reliability Measures	• Innovation developed • Engineering tests • Pilots	• Dominated by large utilities, large grid vendors, labs • Testing in cooperation with utilities or large energy users, often with funding from state (e.g. California's PIER program) or federal programs (e.g. DOE)	• Compelling technology • Testing and demonstration • Strong reputation with leading Utilities
2	Standards Development	Establish industry standard	• Early deployments • Joint standards Development	• Key grid standards bodies include IEEE and ASME • Technical associations that include vendors, users, and researchers try to influence standards • Regulators may also establish working groups to sort out the emerging standard • Validity data	• Links to standards bodies and Regulators
3	Standards Deployment	Generate standard technical specification	• Incorporation into functional requirements • Standards education • Regulations, mandates & Incentives	• Integrators and manufacturers begin incorporating the standard • Regulators are lobbied to increase adoption by removing barriers, developing mandates or adding incentives •Note: Many standards never make it to full deployment	• Marquee reference customers • Central role in consortia or platform efforts
4	Product Acceptance	Integrate into established buying practices	• Incorporation into new products • Broad set of utilities begin considering • Core requirements stabilized, yet differentiation remains	• Utilities begin broader integration of the standard into specifications for new purchases • Opinion-leading utilities monitored carefully as models of why and how to implement these technologies	• Brand presence • Financial strength • Product and market alliances

Reference：The Emerging Smart Grid, GLOBAL ENVIRONMENT FUND, 2005

Standard structure of smart grid technology in Taiwan

Industry Association of Taiwan's smart grid planning standard structure of smart grid technology, with the intention of facilitating the involvement of the industry.

Intelligent Generation
1. Coordination of conventional power network source
2. New energy generation and network
3. Large scale energy storage systems facilitate network

Intelligent Transmission
1. Flexibility DC transmission
2. Flexible AC Transmission
3. Line Status and Operational Environment Monitoring

Smart Electrical substation
1. Smart Electrical substation

(Taipower、Fortune Electric Co.、ALLIS ELECTRIC CO.)

Intelligent Distribution
1. Distribution Automation
2. Distributed power grid
3. Distributed energy storage systems and network(Tatung Company、Chung Hsin Electric & Machinery Mfg. Corp.、ALLIS ELECTRIC CO.)

Information and communications
1. **Transmission network**
1. **Distribution and User-side communication network**
2. **Services Network**
3. **Communications support network**
4. **Smart grid information infrastructure platform**
5. **Smart grid information application platform**
6. **Information and Communication Security**

(Chunghwa Telecom、Institute for Information Industry)

Smart Power Consumption
- **Two-way interactive services**
- **Electricity information collection**
- **Smart electricity services**
- **Electric vehicles charge – discharge**
- **Intelligent measurement**

(Tatung Company、Chung Hsin Electric & Machinery Mfg. Corp.、VIA Technologies, Inc.、ALLIS ELECTRIC CO)

Intelligent transmission
1. **Smart grid scheduling support system**
2. **Grid operation control**

comprehensive planning
1. **Terminology and methodology of the smart grid**
2. **Smart grid planning and design**

Thank You for Your Listening!