智慧電網與讀表主軸專案計畫簡介

林法正
國立中央大學電機系講座教授
桃園縣中壢市, 台灣
E-mail: linfj@ee.ncu.edu.tw

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A Brief Introduction to the Smart Grid and Advanced Metering Infrastructure General Project and Strategic Planning

Faa-Jeng Lin
Chair Professor, Dept. of Electrical Engineering
National Central University
Chung Li 320, Taiwan
E-mail: linfj@ee.ncu.edu.tw

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壹、 計畫背景

智慧電網與讀表主軸專案計畫依據行政院對能源國家型科技計畫之指示，注重再生能源的研究與應用，積極發展替代能源；並積極投入具特色且具商業價值之研究，期使我國能從能源短缺國家變成替代能源技術之輸出國，亦逐步調整與節能減碳政策相結合。

為能有效整合國內研發資源，擬定整體發展策略與進行方式，提出具體有效的行動方案，能源國家型科技計畫分別針對淨煤技術、核能技術、離岸風力、智慧電網等技術領域邀請原能會核研所林立夫博士、清華大學原子科學院潘欽院長、成功大學機械系林大惠主任及中央大學電機系林法正教授協助進行「改善我國能源結構的主軸方案」規劃。林法正教授擔任智慧電網與讀表主軸專案計畫召集人，其工作在負責智慧電網與先進讀表主軸專案計畫之整體策略的規劃作業，並進行後續之計畫推動與管考工作，以期達成智慧電網與先進讀表主軸專案計畫所設定之目標，並負責能源國家型計畫節能減碳分項中「智慧電網與先進讀表」子項相關業務的推動與執行。

1. Project Overview

As an Executive Yuan directive to the National Science and Technology Program-Energy, the Smart Grid and Advanced Metering Infrastructure General Project and Strategic Planning will focus on renewable energy research and its applications and is engaged in active development of alternative energy sources. The project is also involved in research with special characteristics and commercial value, the purpose of which is to transform Taiwan from a country with virtually no energy resources into an alternative energy technology exporter while gradually bringing the efforts in line with the country's energy conservation and carbon reduction policies.

In order to effectively integrate domestic R&D resources, an overall development strategy and approach has been formulated and specific and coherent action plans have been proposed. The National Science and Technology Program-Energy has invited Dr. Li-fu Lin of the Institute of Nuclear Energy Research (INER), Atomic Energy Council (AEC); Professor Chin Pan, Dean of College of Nuclear Science at National Tsing Hua University; Professor Ta-Hui Lin, Chairman, Department of Mechanical Engineering, National Cheng Kung University; and Professor F. J. Lin, Department of Electrical Engineering, National Central University to participate in the planning of Taiwan's "Energy Structure Improvement Principal Program" in clean coal technology, nuclear energy technology, offshore wind power generation and smart grid, respectively. Professor F. J. Lin serves as the chairman of the Smart Grid and Advanced Metering Infrastructure General Project and Strategic Planning and is responsible for the overall strategy development of smart grid and advanced meter reading project and for subsequent promotion of the project as well as its supervision and evaluation, with the purpose of achieving the objectives set by the smart grid and advanced meter reading project. He is also responsible for promoting and implementing the "smart grid and advanced meter reading" sub-program under the energy conservation and carbon reduction sub-project of the National Science and Technology Program-Energy.

貳、 國際發展趨勢

智慧型電網為整合發電、輸電、配電及用戶的先進電網系統，其兼具自動化及資訊化的優勢，具備自我檢視、診斷及修復等功能，提供具高可靠度、高品質、高效率及潔淨之電力，可滿足世界各國能源政策發展方向與因應社會對供電可靠度與供電品質提高的要求；另一方面，可以導入大量再生能源併網發電、結合智慧型電表進行需求面管理，減少 CO2 排放、抑制尖峰負載及節約能源。歐盟(EU Smart Grid)、美國(Intelligrid, GridWise, Modern Grid Initiative)、中國為因應未來的電網需求，均已提出了智慧型電網架構與微型電網(Microgrid)示範計畫，其主要訴求為因應分散型能源大量加入，未來的電力潮流與調度將異於傳統集中式電廠之電力潮流與調度。以下將就各國智慧電網發展發展策略簡述說明。

2. International Development Trends

A smart grid is an advanced electrical grid system that integrates power generation, transmission, distribution and users. It possesses the advantages of being automated and digitally enabled, capable of performing self-inspection, self-diagnosis and self-healing. It provides high-reliability, high-quality, high-efficiency and clean electricity and is able to meet the requirements of the world's energy policy development and the improvement in reliability and quality of power supply demanded by the society. On the other hand, it is possible to bring in a large quantity of renewable energy via connected grids, combining smart meters for demand side management, thus reducing CO2 emissions, suppressing peak load and conserving energy. In response to future electrical grid requirements, the European Union (EU Smart Grid), U.S. (Intelligrid, GridWise, Modern Grid Initiative) and China have proposed smart grid architecture and microgrid demonstration plans. Their main focus is to respond to the trend that decentralized energy sources will become prevalent in the future and power flow and allocation will be different from those of conventional centralized power plants. The following provides a brief description of smart grid development strategies adopted by countries around the world.

一、 歐盟智慧電網推動策略

歐盟為全球再生能源成長之主要地區，由於受到歐盟會員國的環境保護政策及市場發展之鼓勵，各國再生能源及分散式電源比例逐年提升，因此歐盟相當重視分散式電源的開發及先進電網技術之研發。歐盟針對其電力系特性與未來的挑戰，希望所發展的智慧型電網技術除具有彈性，在面對挑戰時能同時滿足用戶端的需求。而新的電力網將具有可取得性(Accessibility)，便於市場參與者併網，特別是有利於再生能源發電與高效率的地區性低碳發電設備。在可靠度方面亦可改善供電可靠度，並提高地區性電源的恢復能力。在經濟性方面，透過創新、效能管理、建構公平競爭環境。未來整合集中式與分散式兩類電源之電網結構示於如圖 1 所示。

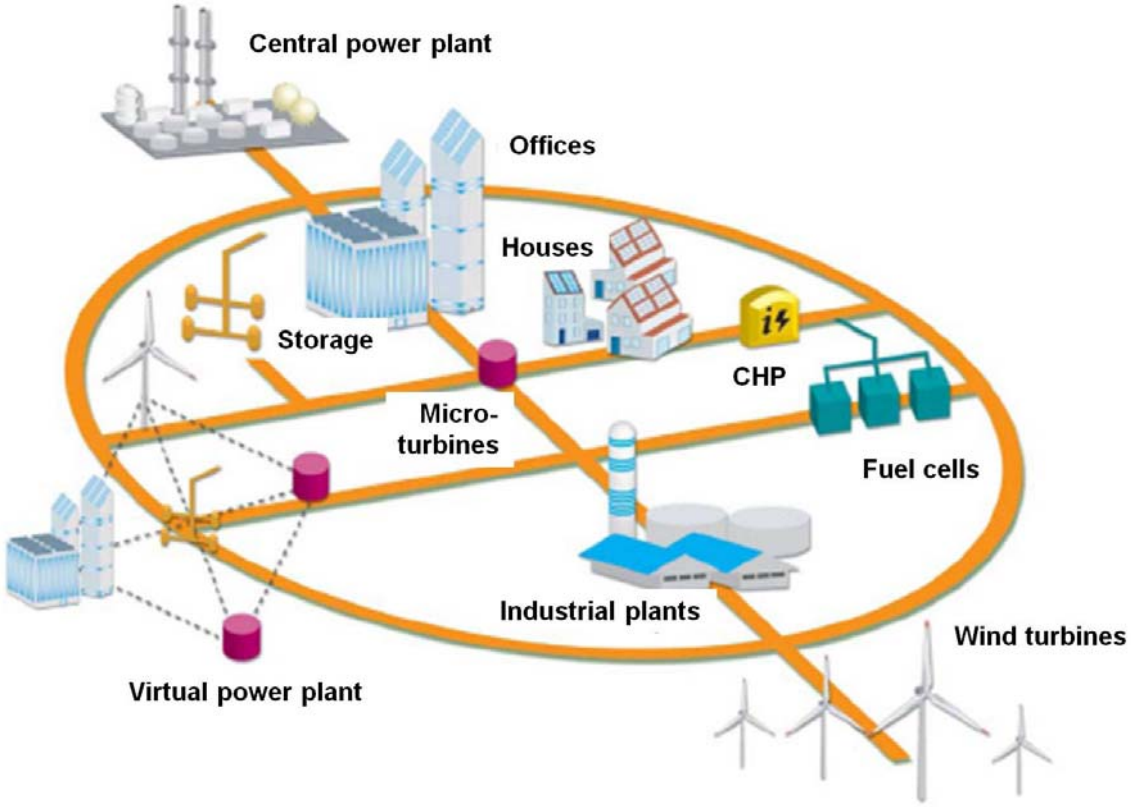


圖 1、整合集中式電源及分散式虛擬電廠之未來電網結構

(1) EU's smart grid promotion strategy

The EU is the principal market for the growth of renewable energy. Due to the environmental policy of EU member states and the encouragement of market development, the proportion of renewable energy and distributed power has increased over the years across the EU. As a result, the EU gives priority to the development of decentralized electrical power and advanced electrical grid technologies. With respect to its electrical system characteristics and future challenges, the EU aims to develop smart grid technologies that are flexible and able to meet the requirements of its users at the same time when faced with these challenges. Accessibility will be a feature of the new grids that facilitates grid connection by participants, and it will be particularly favorable to power generation with renewable energy and high-efficiency regional low-carbon power generation equipment. Reliability in power supply can be improved, and regional power resilience can be enhanced. In terms of economy, a fair competitive environment will be created through innovation and performance management. An electrical grid architecture integrating centralized and distributed power sources is shown in Figure 1.

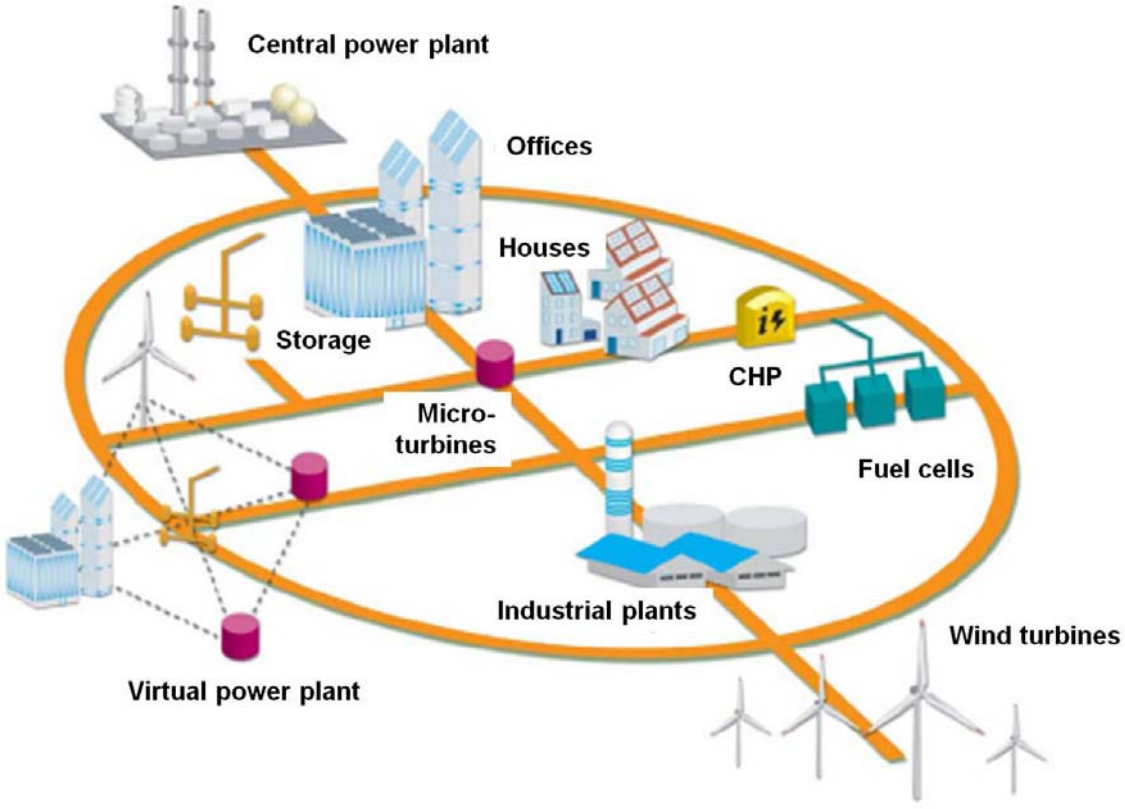


Figure 1. Future grid structure of a virtual power plant integrating centralized and distributed power sources

歐盟希望藉由建構智慧型電網以有效納入高比例的分散式發電與再生能源，並創造一個電源、電網服務的交易環境。在自由化市場方面，建立技術標準和通訊協定以確保系統的相容性與可攜性，運用創新一代的協定、資訊與運算與通訊技術，提高電力交易系統的服務功能與效率，據之強化對客戶的服務。此外，亦須確保新舊系統電網設備的介面設計能夠順利地完成過渡階段。

二、美國智慧型電網發展規劃與策略

美國正積極進行發展現代化電網，如圖 2 所示，目的在整合電力設施與智慧型設備；其所需經費來自於 45 億美元的復甦和再投資法案(Recovery and Reinvestment Act)以及美國國會立法支持。美國智慧型電網發展策略與規劃簡述如下：

（一） **使消費者能夠積極參與：**智慧型電網透過消費者參與和選擇的電力來獲得發展，雙向溝通可以創造供電廠和消費者之間的雙向溝通，消費者在使用電力時可了解自己所使用的電力來自何種發電設施，以及花費多少電力成本。從供電廠的角度來看，顧客參與可使供電廠能獲取消費者的需求資訊，作為另外一種額外發電所需要資源的補償。在客戶的幫助下，供電廠將能透過他們使用方法的修正和購買電力的方式來幫助供需平衡，並且變得更加可靠。

（二） **資產利用最佳化以及系統停擺作出預測和應對方法：**智慧型電網將能夠利用成熟的技術使發電廠、配電所等重要基礎設施最佳化。這種進步將讓更多的電力經由現有的設施流通，同時讓供電廠更精確地了解其它發電廠的需要。操作上改進的範圍涵蓋了電力乘載優化到降低系統損失，這個結果將降低發電廠的成本，並且最大化整個系統的效率。通過不斷執行的自我評估，智慧型電網不僅能對斷電更快做出反應，還可以防止供電中斷。

The EU hopes that by constructing the smart grid a high percentage of distributed power generation and renewable energy will be effectively incorporated and a trading environment for power sources and electrical grid services will be created. With respect to market liberalization, the EU aims to establish technical standards and communication protocols to ensure system compatibility and portability. A new generation of protocols, information, computing and communications technologies are employed to enhance the service functions and efficiency of the power trading system and to strengthen services provided to the customers accordingly. In addition, it is necessary to ensure a smooth transition of the interface design for the grid equipment of both old and new systems.

(2) Smart grid development, planning and strategy in the U.S.

The U.S. is actively developing a modern electrical grid, as shown in Figure 2. The purpose is to integrate power facilities and intelligent equipment; The required US$4.5 billion in funding is derived from the Recovery and Reinvestment Act and legislative support from the U.S. Congress. The smart grid development strategy and planning in the U.S. are summarized as follows:

I. **Enabling consumers' active participation:** Through participation from consumers and their choice of power sources, smart grids will undergo further development, and bidirectional communication will increase the opportunity for power plants and consumers to communicate with each other. Consumers will also be able to know the type of power generation facility from which they receive their power and the costs involved. From the perspective of power plants, customer participation will allow them to obtain consumer information as compensation for another type of resources required for additional power generation. With assistance from customers, power plants will be able to provide a more balanced power supply and demand with their own correctional approaches and the purchase of electricity, thus making the grid more reliable.

II. **Optimized asset utilization and system downtime prediction and response methods:** The smart grid will be able to employ sophisticated technology to optimize important infrastructures such as power plants and power substations. This advancement will allow more electrical power to flow through existing facilities, while enabling power stations to understanding the needs of other power plants more accurately. Operational improvements cover everything from electrical load optimization to system loss reduction, the results of which will reduce the cost of power plants and maximize the system's overall efficiency. With constant self-assessment, the smart grid will not only be able to respond quickly to power disruption but will also be able to prevent service interruption.

（三） **相容於所有可能的生成和儲源裝置**：智慧型電網最成功的地方在於能夠安全、無縫地兼容於各樣的發電裝置—大到大規模的中央發電廠以及小到太陽能面板。電網連結的分佈式發電的機會是很重要的。隨著越來越多智慧型電網的發展被採用，分散式電源將會快速的在整個價值鏈中增加。這個結果將會發展成一個較便宜、更可靠以及對環境更友善的電網。

（四） **動態定價**：現今和新興的技術使得消費者有可能看到自己每天所耗費的電力成本。先進讀表系統(AMI)使得雙向傳遞、間距測量以及定期帳單變得更為容易了，因此提供不同電力需求的顧客(包括所得較低的顧客)一個動態訂價的選擇方案。動態定價反應零售業電力成本每小時的電力變動，提供顧客更為細膩的需求使得他們能夠有效地管理自己的電費。三個主要動態定價的類別包括：(1) 及時定價；(2) 尖峰時段折扣；(3) 關鍵尖峰時段定價。

（五） **激勵供電廠**：過去供電廠的營收率是以生產的電量以及銷售能源數量為基礎的。這種經營模式缺乏任何一方儲存能源的激勵因素，將會使供電廠缺乏動機來從事需求反應、能源效率以及分佈式發電的交流。因此提出去耦合這種方法來為這項議題解套。由於供電廠被認為是降低風險的，所以去耦合降低了供電廠的營收率。實際上施行去耦合後，降低了客戶本來必須支付的稅賦。如果設置過多的供電廠將會造成顧客剩餘，相反地設置不足就必須向顧客收取電費超額使用的金額。去耦合為不同的群體(供電廠、管理者和提倡的消費者)提供了透明的差別訂價制度。

III. **Compatible with all possible power generation and storage devices:** The greatest success of the smart grid is its ability to be securely and seamlessly integrated with all types of power generation devices ─ as large as a full-scale central power plant and as small as a solar panel. Opportunities for distributed power generation from connected grids are very important. As more and more developed smart grids are adopted, distributed power sources will increase rapidly throughout the value chain. They will result in a less expensive, more reliable and more environmentally friendly power grid.

IV. **Dynamic pricing:** Current and emerging technologies enable consumers to access the costs of generating the electricity that they consume every day. The Advanced Metering Infrastructure (AMI) has made two-way data transmission, distance measurement and regular billing much easier, allowing dynamic pricing options to be available to customers with different needs (including those with lower income). Dynamic pricing reflects the hourly changes in the cost of retail electricity and provides customers with more detailed information requirements, enabling them to manage their electricity expenses more effectively. There are three dynamic pricing categories: (1) Just-in-time pricing; (2) Peak hour discount; and (3) Critical peak hour pricing.

V. **Incentives to power plants:** The turnover rates of power plants have in the past been calculated based on the quantity of power generated and the amount distributed. This type of business models lacks incentives for energy storage by any party involved, and does not provide proper motivation to the power plants to engage in the communication of demand response, energy efficiency and distributed power generation with others. Therefore, decoupling has been proposed as a solution to this problem. As power plants are considered to be risk-reduction enterprises, decoupling will lower their turnover rates. In reality, decoupling actually reduces the taxes that customers would otherwise have to pay. Too many power plants will result in customer surplus, but if there are not enough power plants, customers will be charged a premium for excess use of electricity. Decoupling has provided different groups (power plants, managers and consumer advocates) with a transparent system of differential pricing.

（六） **淨用電量**：淨計量方案對於消費者而言就是一項激勵消費者投入分佈式發電的激勵，使得顧客可以用他們自己住宅所生產的電力來抵付自己所需的花費。美國某些州的顧客可以透過自己生產的電力來獲得零售電力的貸款，不再需要向電廠的購買電力。

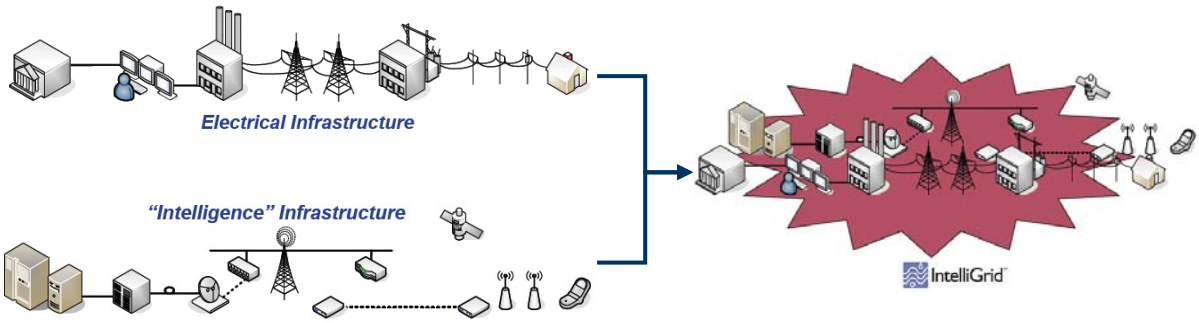


圖 2、Intelligent Grid 係電力設施與智慧型設備的系統整合

三、 中國大陸推進堅強智慧電網建設策略

中國大陸智慧電網推動策略之基本原則採統一規劃、協調發展。各級電網協調發展，6+1 同步規劃、同步建設。總體目標由特高壓電網為骨幹網架，各級電網協調發展，並以資訊化、自動化、互動化為特徵的堅強國家電網全面提高電網的安全性、經濟性、適應性和互動性。如表 1 所示，整體推動的期程策略如下：

VI. **Net electricity consumption:** For consumers, net measurement solutions are an incentive to encourage users to engage in distributed power generation. It allows customers to offset their utility expenses with electrical power generated from their own homes. Customers in certain U.S. states are able to obtain retail electricity loans via electrical power that they produce themselves and no longer need to purchase electricity from power plants.

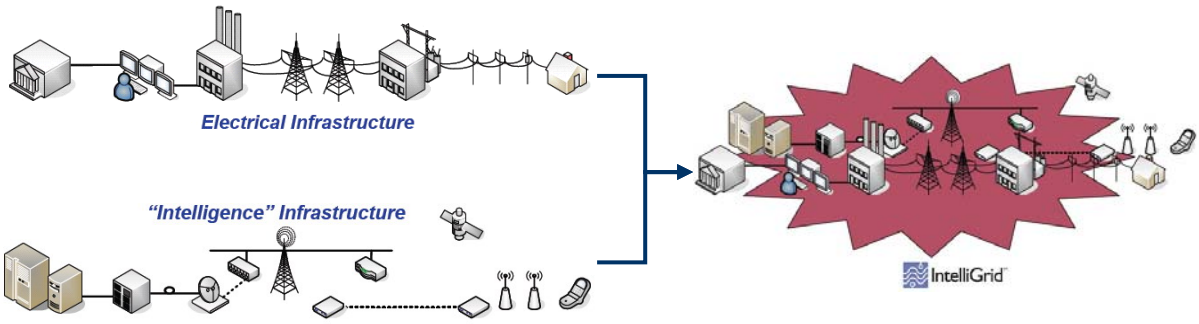


Figure 2. Intelligent Grid is the integration of power facilities and intelligent system equipment

(3) Mainland China's strategy for advancing robust smart grid construction

The basic principles behind the promotion strategy for China's smart grid system are unified planning and coordinated development. Coordinated development of electrical grids at all levels: 6+1 concurrent planning and concurrent construction. Overall objectives include employing ultra-high voltage (UHV) grid as the backbone grid, coordinated development of grids at all levels and the enhancement of the security, economy, adaptability and interactivity of the grid with the robust national grid, which is characterized by its digitally enabled, automated and interactive capabilities. As shown in Table 1, the overall schedule and strategy for promotion are as follows:

（一） **2010 年的主要任務和重點工作如下：**(1) 加強國家電網統一規劃：主網架規劃設計、配電網規劃、通信網規劃、電網智慧化規劃等專項規劃。電力需求預測及負荷特性研究、風電消納能力及發展規模研究、大型能源基地輸電系統規劃設計等重要專題研究。(2) 推進主網架重點工程建設：特高壓工程建設和前期工作。著力解決配電網薄弱問題：配網投資，技術裝備水準，城農網專案建設。(3) 電網智慧化重點工作：上海世博園綜合示範工程、國家風光儲輸示範工程、智慧社區等試點專案。電網智慧化各環節重點攻關，開發應用調度技術支援系統、用電資訊採集系統，深化“多網融合”、電動汽車充放電站等研究和推廣應用。(4) 全面推行統一的建設標準：企業標準，行業標準、國家標準和國際標準。(5) 加強智慧電網創新體系建設：研發基地和創新。(6) 積極營造電網發展的良好環境：系統內外關係。

（二） **2015 年：**堅強國家電網初步形成，資訊化、自動化、互動化水準明顯提升，滿足大規模可再生能源接入和輸送。特高壓及跨區電網輸送能力超 2.4 億千瓦。配網供電能力、品質和可靠性顯著提升，城市配網供電可靠率 99.915%、綜合電壓合格率 99.5%，農網供電可靠率 99.73%、綜合供電電壓合格率達到 98.45%。關鍵技術和裝備重大突破，智慧電能表廣泛應用，電動汽車充放電站佈局基本滿足需要。

I. **Main tasks and priorities for 2010 are as follows:** (1) Enhancing the unified planning of the national grid: Special planning project such as main grid planning and design, distribution grid planning, communications network planning, and smart grid planning. Electricity demand forecasting and load characteristics study, wind power consumption and development scale research, large-scale energy base power transmission system planning and design and other important topical studies. (2) Advancing key construction projects for the main grid: UHV construction projects and preparatory tasks. Efforts to address distribution network weaknesses: Distribution network investment, level of technology and equipment, urban-rural grid construction projects. (3) Main tasks for intelligence-enabling grid: Shanghai World Expo integrated smart grid demonstration project, national wind and solar energy storage and transportation demonstration project, intelligent communities and other pilot projects. Grid intelligence-enabling should focus on handling each individual priority of the process, developing application allocation and scheduling technology support system, electricity consumption data acquisition systems, and enhancing "multi-network integration," electric vehicle charging and discharging stations, as well as their research and applications. (4) Nationwide implementation of uniform building standards: Corporate standards, industry standards, national standards and international standards. (5) Enhancing the construction of smart grid innovation systems: R&D bases and innovation. (6) Actively enabling an environment conducive to grid development: Relationships internal and external to the system.

II. **2015:** Preliminary completion of the robust national grid, with significantly improved digitally enabled, automated, interactive capabilities and able to meet the requirements for the input and transmission of large-scale renewable energy sources. UHV and cross-regional grid power transmission capacity will exceed 240 million watts. Power supply capacity of distribution network, quality and reliability are significantly improved. Metropolitan power distribution networks will achieve a reliability rate of 99.915%. Integrated voltage qualification rate will be 99.5%, and rural grid reliability will be 99.73%. The overall power supply voltage qualification rate will be 98.45%. Major breakthrough in key technologies and equipment; wide adoption of smart meters; availability of electric vehicle charging and discharging stations meet basic demand.

（三） **2020 年：**基本建成堅強智慧電網。“三華”為受端，東北、西北為送端，聯接各大型發電基地的堅強電網結構，特高壓及跨區電網輸送能力超過 4 億千瓦，滿足大型常規發電和千萬千瓦級風電基地接入和負荷中心的用電需求。電網資源配置能力、安全水準、運行效率，以及電網與電源、用戶的互動性顯著提高。

表 1、國家電網公司將分三個階段推進智慧電網的建設階段表

第一階段	第二階段	第三階段
2009 年~2010 年	2011 年~2015 年	2016 年~2020 年
規劃試點階段，重點開展堅強智能電網發展規劃工作，制定技術與標準，開展關鍵技術研發和設備研製，開展各環節的試點工作。	全面建設階段，加快特高壓和城鄉配電網建設，初步形成智能電網運行控制和互動服務體系，關鍵技術和裝備實現重大突破和廣泛應用。	引領提升階段，基本建成堅強智能電網，使電網的資源配置能力、安全水平、運行效率，以及電網與電源、用戶之間的互動性顯著提高。

III. **2020:** Basic construction of robust smart grid completed. “Sanhua” will be the receiving end and Northeast and Northwest will be the transmission ends, connecting all major power generation bases in the robust grid structure. UHV and cross-regional grid power transmission capacity will exceed 400 million watts and will be able to meet the input requirements of large-scale conventional power generation and 10-million watt-class wind farms as well as the power consumption requirements from load centers. Grid resource allocation capability, safety standards and operational efficiency as well as power grid and power sources, and user interaction will be significantly improved.

Table 1. State Grid Corporation of China will implement the construction of the smart grid in three phases

Phase 1	Phase 2	Phase 3
2009 - 2010	2011 - 2015	2016 - 2020
At the planning and pilot phase, priorities will be the planning of the robust smart grid and the development of technical specifications and standards, research and development of key technologies and equipment, and conducting experimental work in each segment of the project.	During the full-scale implementation phase, the pace of constructing UHV and urban-rural power distribution networks will be accelerated, and a preliminary smart grid operational and interactive service system will be formed. Major breakthroughs will be achieved in crucial technologies and equipment and widespread adoption will become a reality.	In the enhancement phase, the robust smart grid is basically complete, and the grid's resource allocation capability, safety standards and operational efficiency as well as power grid and power sources, and user interaction will be significantly improved.

參、 台灣智慧電網發展介紹

行政院於 97 年所頒布「永續能源政策綱領」，以加強能源供應面的「淨源」與能源需求面的「節流」主策略，邁向節能減碳的社會，並設定提高能源效率、發展潔淨能源、確保能源供應穩定等多項目標，如圖 3 所示。在提高能源效率方面，設定未來 8 年每年提高能源效率 2%以上，使能源密集度於 2015 年較 2005 年下降 20%以上；並藉由技術突破及配套措施，2025 年下降 50%以上。在發展潔淨能源方面，將發電系統中低碳能源占比由 40%增加至 2025 年的 55%以上，其中在確保能源供應穩定方面，將建立滿足未來 4 年經濟成長 6%及 2015 年每人年均所得達 3 萬美元經濟發展目標的能源安全供應系統。可預見隨著台灣社會化與工業化的持續發展，將使總能源需求、電力占最終能源需求比例、電力負載曲線中擾動逐年增加，加上溫室氣體排放與電力自由化等因素，我國現有電力系統面臨日漸嚴峻的挑戰。因此，如何藉由電力電子與資通訊技術，提升電力使用效能以及電網再生能源容忍度，進而提供高品質電力，並同時帶動國內電力產業，以建構永續電力供應系統，已成為我國當前能源政策之重要課題。

3. Introduction to the Development of Smart Grid in Taiwan

In 2008, the Executive Yuan officially announced the adoption of the Sustainable Energy Policy Guidelines, the purpose of which is to enhance the principal strategies for "clean energy" on the energy supply side and "reduction" on the demand side, enabling the country to transform itself into a green society. In addition, the guidelines have established a number of targets for improving energy efficiency, developing clean energy and ensuring a stable energy supply. Refer to Figure 3 for details. With respect to improving energy efficiency, the goal is to improve energy efficiency by at least 2% each year over the next 8 years to lower energy intensity in 2015 by 20% compared with 2005; and by at least 50% by the year 2025 via technological breakthroughs and support measures. In terms of the development of clean energy, the guidelines call for increasing the proportion of low-carbon power generation systems from 40% to at least 55% in 2025, and with respect to ensuring a stable supply of energy, the guidelines call for the creation of a secure energy supply system satisfying the goal of 6% annual economic growth over the next 4 years and US$30,000 per capita income by 2015. It is foreseeable that as Taiwan continues to develop socially and to undergo industrialization, overall demand for energy, the percentage of electricity as the ultimate demand for energy, and the disturbance in the electrical load curve will increase over the next few years. Coupled with factors such as greenhouse gas emissions and the liberalization of electricity supply, Taiwan's existing power systems are facing increasingly daunting challenges. Therefore, how electrical, electronic and ICT technologies can be used to enhance electrical power efficiency and the tolerance for renewable energy in electrical grids, thus providing high-quality supply of electricity and promoting the growth of domestic power industry as well as constructing a sustainable electricity supply system, has become a crucial issue that needs to be addressed by Taiwan's current energy policy.

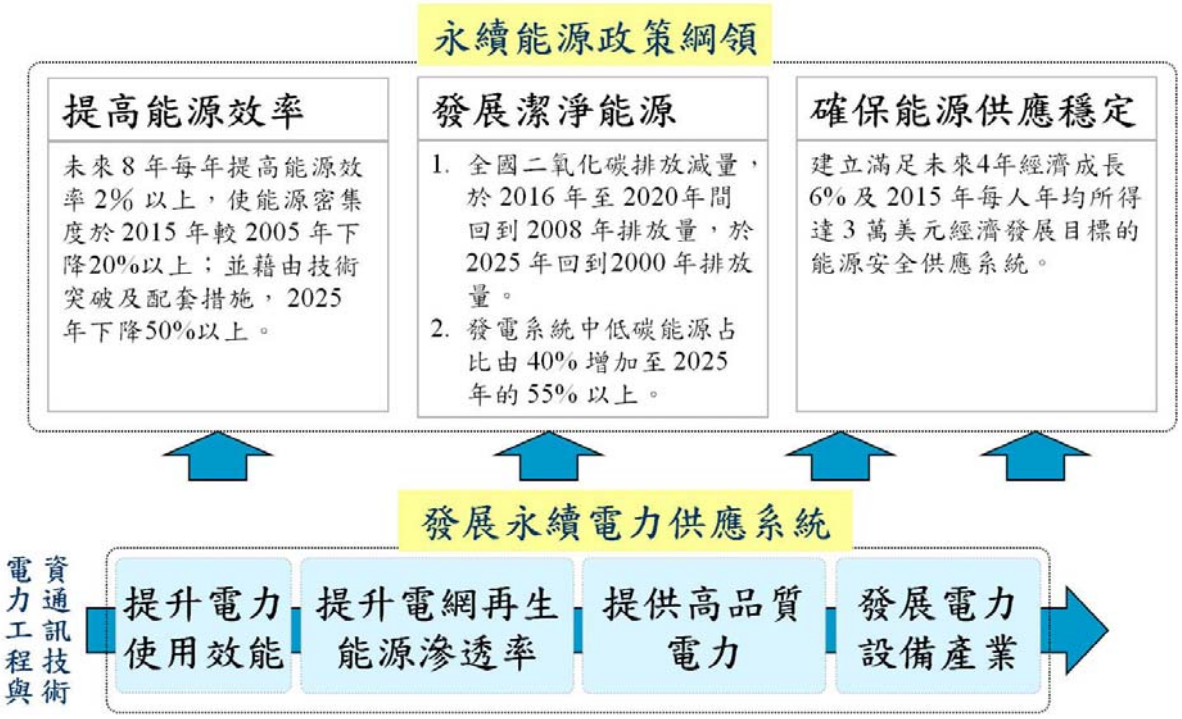


圖 3、發展永續電力供應系統策略

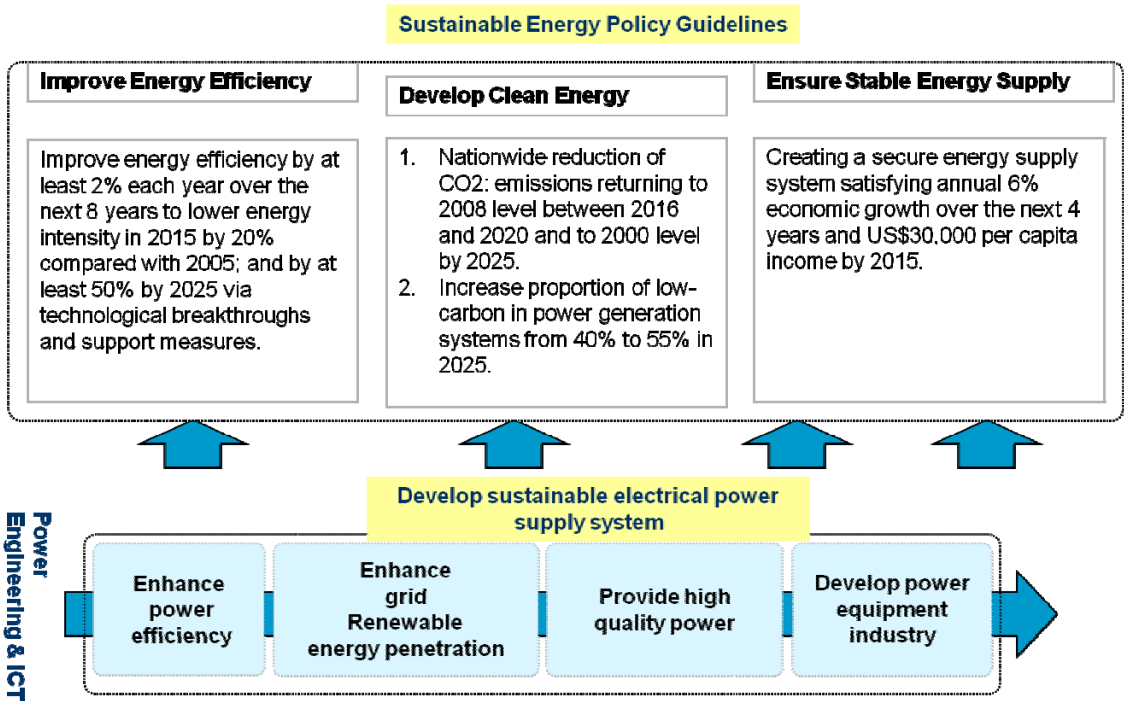


Figure 3. Strategy for the development of sustainable power supply systems

一、 台灣推動智慧電網待克服之挑戰和課題

我國電力系統屬於大型集中式的系統，其電力來源主要為火力(包含：燃油、燃煤和天燃氣)、核能(占總發電量之 96.5%)、和部份的水力與再生能源(占總發電量之 3.5%)。該系統有發電機組大型化及負載集中兩大特色，無論是核能電廠、火力電廠或水力電廠所產生的電力，由於發電廠與用戶端距離遙遠，故必須藉助輸變電系統提高電壓，透過電力線輸，最終變壓供給用戶使用，這造成大量的能量耗損。況且，都會區及工業區的負載集中，電力需求急速成長，但變電所尋址及興建困難，時常遭遇民眾抗爭，集中式電源無法輸送到電力需求端，造成地區性供電瓶頸。此外，最重要的問題在於，遠距離輸電與大電網互連使得系統難以快速追蹤負荷變化，故障問題容易透過電網擴散進一步造成電力系統癱瘓，且龐大的電網和過於集中的發電廠極易遭到攻擊而造成國安問題。因此，電力供應「不患寡而患不均」，且為考慮國家安全及能源問題，適當導入分散式電源及提高電網效率便成為我國的既定政策及發展方向。現有大型發電廠多設於偏遠地區，遠離電力需求中心，為提高輸電能力並減少損失，須先提高電壓以利長距離輸送，再依用電需要逐段降低電壓，供下游使用。

(1) Challenges and issues to be overcome in promoting smart grid in Taiwan

Taiwan's principal electric power systems are large-scale centralized plants, with electricity generated mainly from thermal sources (including: fuel oil, coal and natural gas) and nuclear fission (accounting for 96.5% of total power generation), with a portion from hydropower and renewable energy (3.5%). Two main characteristics of these systems are: large-scale generators and concentrated load. Whether it is electricity generated by nuclear power, thermal power or hydropower plants, the long distance between the plants and users has necessitated the use of power transmission systems to increase the voltage for transmission via power lines and ultimately transformed to be able to supply power to end users. This causes substantial dissipation of energy. Moreover, electrical loads in metropolitan areas and industrial regions are highly concentrated, and the demand for electricity is growing rapidly. However, there are obstacles in locating and constructing substations due to protests by local residents, and centralized power sources are unable to deliver to the demand end, resulting in regional power supply bottlenecks. In addition, the most critical problem lies with the fact that the power transmission over enormous distances and the interconnection of large grids make it difficult for systems to track the rapid changes in load, and power disruption can easily spread through the grids and paralyze the entire power system. Furthermore, the vast grids and over-concentrated power plants are vulnerable to attacks, which is a national security issue. Therefore, the supply of electrical power should follow the principle of being "concerned not with scarcity but uneven distribution." In addition, in consideration of national security and energy issues, the appropriate introduction of distributed power generation sources and enhancing the efficiency of power grids have become the country's policy and direction for development. The majority of existing large-scale power plants are located in remote areas and are far away from electricity demand centers. To order to enhance power transmission capacity and to reduce transmission losses, it is necessary to increase the voltage to facilitate long-distance transmission and to make the electricity available for downstream use by reducing the voltage according to power requirements.

二、 台灣智慧電網整體推動策略

我國智慧電網整體推動架構圖如圖 4 所示：



圖 4、我國智慧電網與能源資通訊技術發展與推廣工作推動架構圖

(2) Overall strategy for the development of smart grid in Taiwan

Taiwan's smart grid promotion and development framework is shown in Figure 4 below:

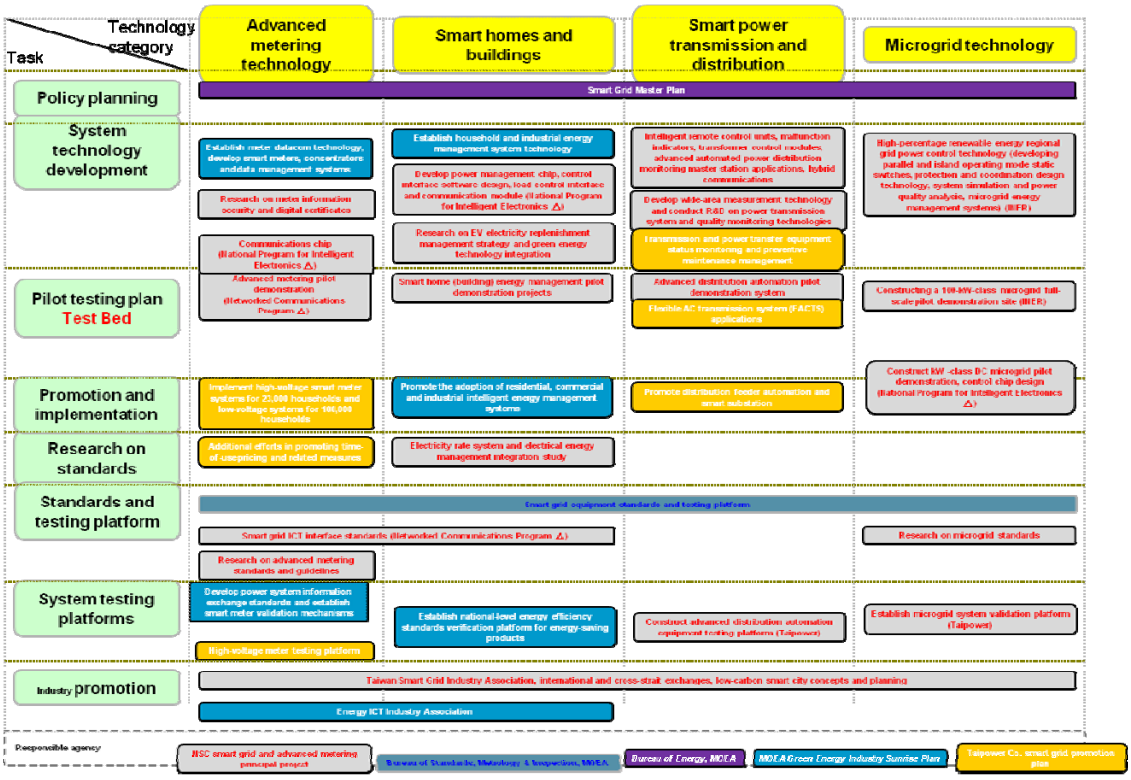


Figure 4. Taiwan's smart grid and energy ICT development and promotion framework

我國電機產業市場對整體製造業之產值貢獻率約 2.1%，約新台幣 2251 億元；然而由於國內電機產業所需關鍵技術或零組件大部份自國外引進，在國際市場上，品質和成本難與國際大廠競爭。而加入 WTO 後，電機產品國產化政策將改變，因此需使國內技術升級或建立自主性技術。我國資訊電子產業的蓬勃發展，使得國內傳統電機技術人才難覓，加上缺乏電力產業相關標準測試平台與研發平台皆為電力產業發展的障礙[1]。如圖 5 所示，目前我國在傳統電力設備產業每年有 500 多億產值且從業人口達 3 萬多人，我國應將既有的資訊電子產業利基擴大至電力產業，發展智慧電網電力設備產業與其它新興電力產業與相關衍生服務型產業。

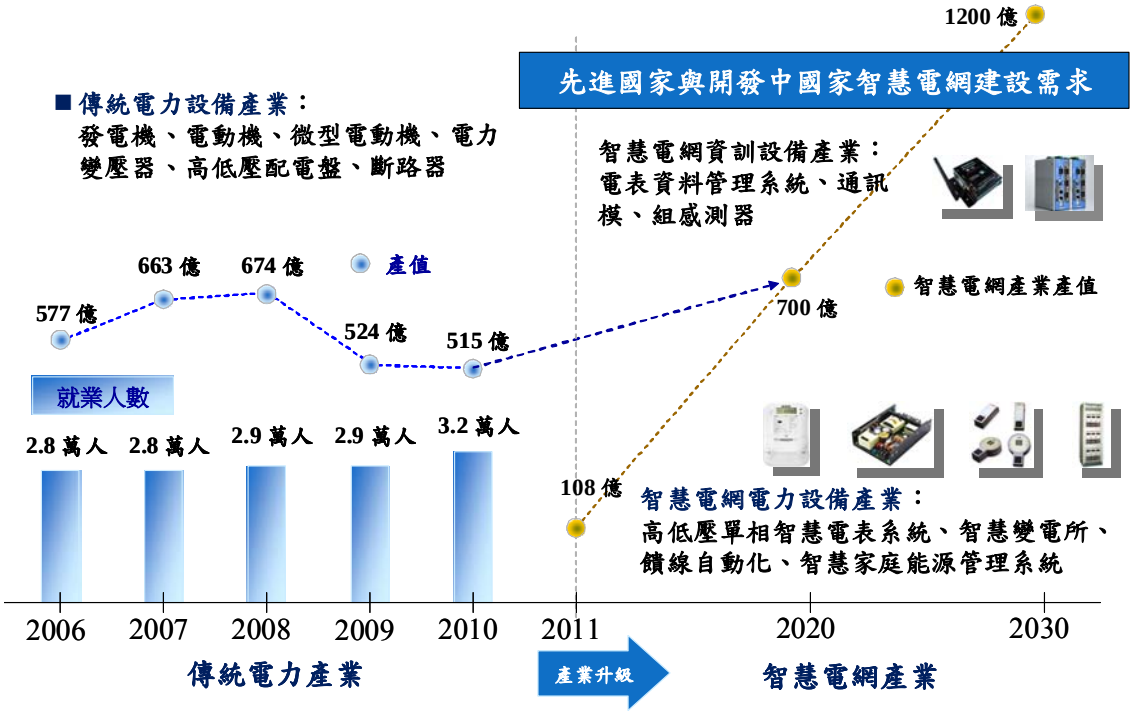


圖 5、台灣智慧電網產業發展潛力圖 (資料來源：本研究)

[1] 2006 電機產業年鑑，經濟部技術處，2006

Taiwan's electrical manufacturing industry accounts for approximately 2.1% of the overall manufacturing sector in terms of industrial output, which translates to about NT$225.1 billion. However, because the domestic electrical industry depends on the import of key technologies and components from abroad, their products are less competitive with those produced by major international corporations in terms of quality or cost. Following Taiwan's accession to the WTO, the country's policy on manufacturing electrical products independently has changed. It is therefore necessary for manufacturers in Taiwan to upgrade their technologies or develop self-reliance in technological expertise. Taiwan's IT and electronics industries have been growing at a rapid pace, which has resulted in a shortage in conventional electrical technology talents. Coupled with the lack of standard test platforms for the power industry and R&D platforms, the power industry has hit a bottleneck[2]. As shown in Figure 5, currently Taiwan's conventional power equipment industry produces over NT$50 billion in annual output and employs a workforce of some 30,000. It is recommended that Taiwan take advantage of the country's existing strengths in IT and electronics industries and expand to include the electrical power industry, as well as to develop the smart grid power equipment industry, other emerging electric power-related industries and also service industries that are derived from them.

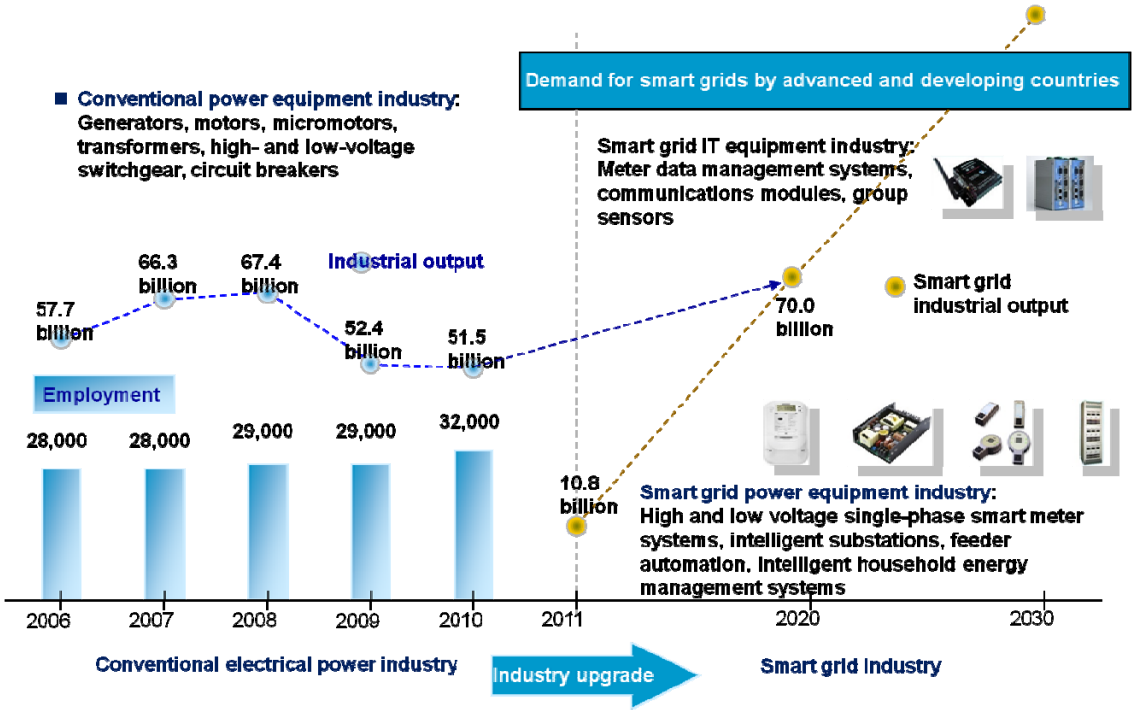


Figure 5. Development potential of Taiwan's smart grid industry (Source: this study)

[2] Electrical Industry Yearbook 2006, DOIT, MOEA, 2006.

台電公司為了因應國際趨勢，並基於優良供電品質需求不斷提升、用戶對電力資訊之渴望與參與、分散式電源逐漸增加需加以整合、針對氣候變遷之節能減碳，以及資訊、通訊與電力電子技術不斷進步及成本下降等因素，而於民國 95 年邀集相關單位研討智慧型電網之建置與里程規劃。另外，「智慧型電網專案小組」設置要點已於 96 年 6 月訂定，該要點將台電公司建構智慧型電網規劃成短、中、長程三階段，並以 4 個目標領域來進行。圖 6 為台灣電力公司規劃智慧型電網重點，在發電系統包括：具 Governer free、AGC (Automatic Generation Control)及 APC (Automatic Performance Control)之高效率機組、引進超臨界汽力機組、火力發電廠機組熱功性能監視系統、整合再生能源發電等。在輸電系統方面包括：以相量量測單元(Phasor Measurement Unit, PMU)組成的廣域監測(Wide-Area Monitoring, WAM)系統、監測結果的可視覺化(Visualization)、特殊保護系統(SPS, Special Protection System) Look-up Table 之分析及更新、電驛系統全面數位化、自動電壓控制系統(SVR)與靜態型同步無效電力補償器(STATCOM)之引進、建構新電能管理系統(TEMS)、彈性交流系統(FACTs)與通信技術整合。在配電系統方面：微電網、變電所自動化、配電監控系統、配電管理系統、饋線自動化、電壓與虛功整合控制、饋線與變電所尖峰負載管理、電力設備狀態監測、線路故障指示器即時監測。在用戶端：AMI，AMR、停限電管理、分散型電源與再生能源及電電車電池之整合管理。而智慧型電網的互通能力(System Interoperability)為整合的關鍵，包括停電管理系統與其他資訊系統整合的系統互通性需求、與大規模分散式資源及需求面資源的系統互通性需求、以及資產管理的系統互通性需求。

In response to international trends and the demand for the improvement in the quality of power supply, users' desire for and participation in the information regarding electrical power, the need for integrating the gradually increasing distributed power sources, energy conservation and carbon reduction measures due to climate change, as well as the continuous advancement and cost reduction in information, communications and power electronics technologies, Taiwan Power Co. assembled a team from relevant agencies and organizations in 2006 to discuss the implementation of the country's smart grid and project milestones. In addition, the guidelines for establishing a "Smart Grid Project Committee" were finalized in June 2007. The guidelines provide a three-stage plan for the implementation of Taipower's smart grid: short-, medium- and long-term plans. The project itself will be carried out with four objective domains as its guiding principles. Figure 6 depicts Taipower's priorities on smart grid planning; those for power generation systems include: High-efficiency generator systems with governor free, AGC (Automatic Generation Control) and APC (Automatic Performance Control); introduction of supercritical steam power systems, thermal power plant generator system and thermal power performance monitoring system, and integrated renewable energy power generation. Power transmission systems include: Wide-Area Monitoring (WAM) systems formed by Phasor Measurement Unit (PMU), Visualization of monitored results, analysis and update of Special Protection System (SPS) look-up table, fully digitally enabled relay systems, introduction of automatic voltage control (SVR) systems and static synchronous compensator (STATCOM), construction of new electrical energy management system (TEMS), Flexible AC transmission systems (FACTs) and integration with communications technology. .With respect to power distribution systems: Microgrid, substation automation, power distribution monitoring system, distribution management system, feeder automation, voltage and VAR integration and control, feeder and substation peak load management, power equipment status monitoring, and real-time monitoring of circuit fault indicators. On user's end: AMI, AMR, power outage and power rationing management, integrated distributed power, renewable energy and electric vehicle battery management. The system interoperability of smart grids is the key to integration, including system interoperability requirements associated with the integration of power outage management with other information systems, system interoperability requirements of integration with large-scale distributed resources and demand-side resources, and system interoperability requirements associated with asset management systems.

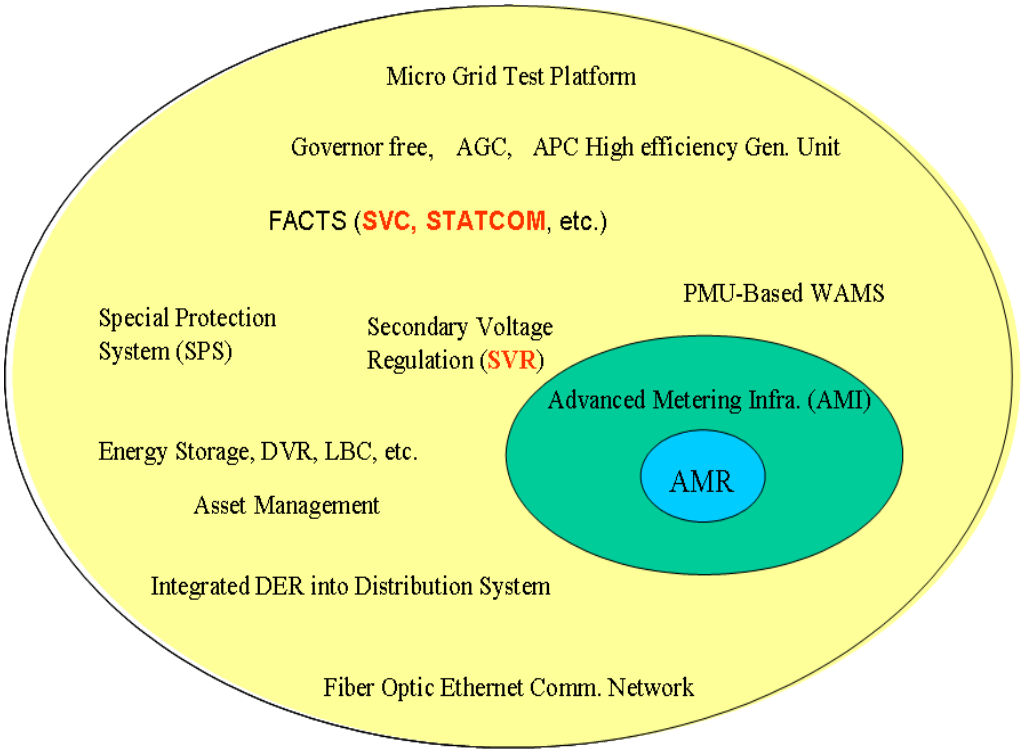


圖 6、台電公司規劃智慧型電網重點(資料來源：台灣電力公司)

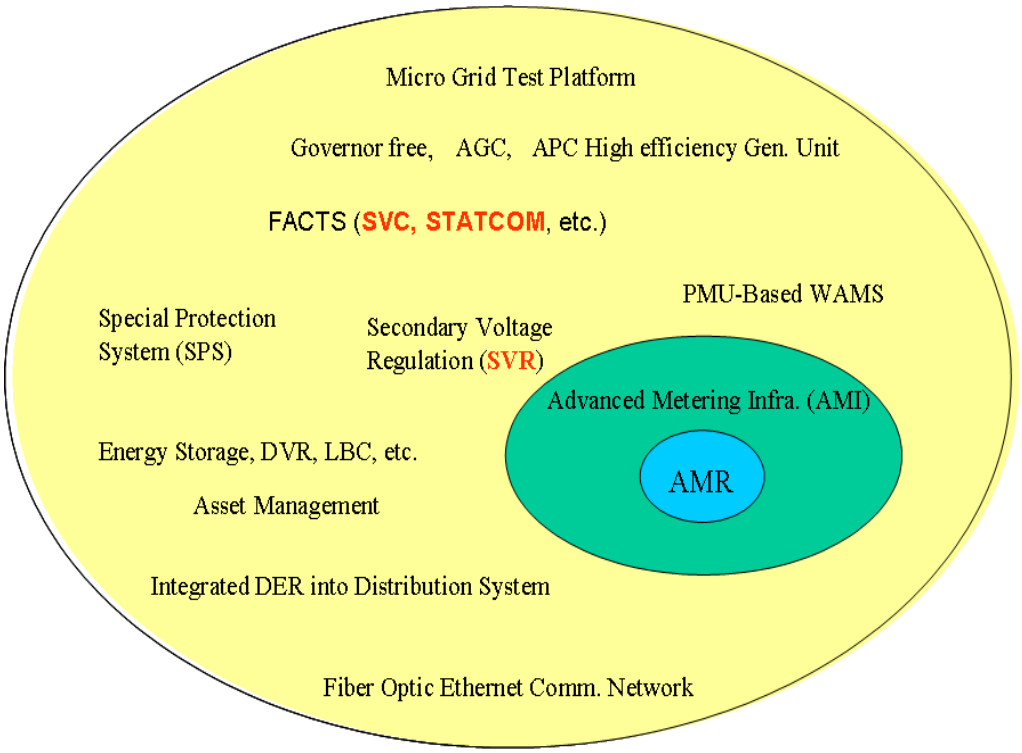


Figure 6. Taipower's priorities on smart grid planning (Source: Taiwan Power Co.)

三、 台灣智慧電網技術推動策略[3]

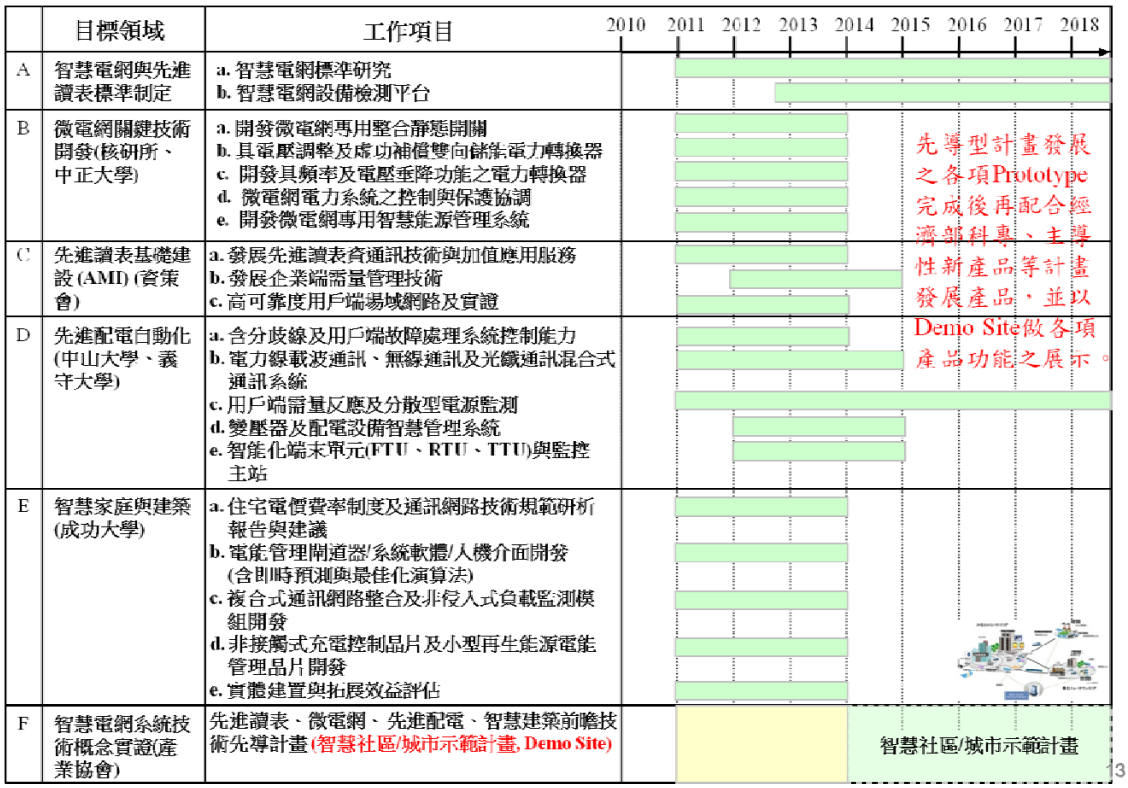
能源國家型科技計畫與 99 年度開始推動智慧電網與先進讀表主軸專案計畫，目的在有效整合國內智慧電網與讀表相關之研發資源，擬定整體發展策略與進行方式，提出具體有效的行動方案，達成「提升能源安全、改善溫氣排放、開創能源產業」願景，並發展台灣電力設備產業，協助建立高品質、高效率、以用戶為導向和環境友善的電力網路系統。在推動方面，如圖 7 所示，初步設定規劃於 2010-2013 年間主要工作為完成微電網、AMI、先進配電自動化、智慧家庭(建築)電能管理四個先導型計畫之關鍵技術開發、智慧電網與讀表相關規範之制定、舉辦先導型計畫成果展示會。2014-2025 年將延續第一期之工作成果完成關鍵技術之技轉與商品化、配合 AMI 之裝設，完成電能管理制度之導入(如時間電價與需量反應)、配合台電輸配電計畫，逐步將微電網與先進配電自動化先導型計畫之成果推廣於台電系統上、全面推廣智慧家庭(建築)電能管理技術。

[3] 林法正，「能源國家型科技計畫智慧電網與先進讀表主軸計畫規劃構想」，行政院國家科學委員會，民國 99 年。

(3) Promotion strategy for smart grid technologies in Taiwan [4]

The National Science and Technology Program-Energy and the Smart Grid and Advanced Metering Infrastructure General Project and Strategic Planning, begun in 2010, aim to integrate Taiwan's R&D resources in smart grid and metering in an effective manner, to formulate overall development strategies and implementation approaches, to propose specific and effective action plans, and to achieve the vision of "Enhancing energy security, reducing greenhouse gas emissions and supporting the development of the energy industry." In addition, the projects also intend to foster the growth of the country's electrical equipment industry and to help establish a high-quality, high-efficiency, user-oriented and environmentally friendly electrical grid system**.** With respect to project advancement, as indicated by Figure 7, the plan preliminarily calls for the development of key technologies for the four pilot projects: microgrids, AMI, advanced distribution automation and smart homes (buildings) power management between 2010 and 2013, in addition to establishing relevant smart grid and metering specifications as well as organizing an exhibition for the results achieved in the pilot projects. Between 2014 and 2025: results achieved in Phase 1 will be used to effect technology transfer and product commercialization; introduction of electrical energy management system in coordination with the completion of AMI (e.g. time-of-use pricing and demand response); gradual adoption of the results from the microgrid and advanced distribution automation pilot projects in Taipower's systems in coordination with the company's power transmission and distribution plans; and the promotion of smart homes (buildings) power management technology on a full-scale basis.

[4] F. J. Lin, "Concept Planning for National Science and Technology Program-Energy - Smart Grid and Advanced Metering Infrastructure General Project and Strategic Planning," National Science Council, the Executive Yuan, 2010.



	目標領域	工作項目
A	智慧電網與先進讀表標準制定	a. 智慧電網標準研究 b. 智慧電網設備檢測平台
B	微電網關鍵技術開發(核研所、中正大學)	a. 開發微電網專用整合靜態開關 b. 具電壓調整及虛功補償雙向儲能電力轉換器 c. 開發具頻率及電壓垂降功能之電力轉換器 d. 微電網電力系統之控制與保護協調 e. 開發微電網專用智慧能源管理系統
C	先進讀表基礎建設 (AMI) (資策會)	a. 發展先進讀表資通訊技術與加值應用服務 b. 發展企業端需量管理技術 c. 高可靠度用戶端場域網路及實證
D	先進配電自動化(中山大學、義守大學)	a. 含分歧線及用戶端故障處理系統控制能力 b. 電力線載波通訊、無線通訊及光纖通訊混合式通訊系統 c. 用戶端需量反應及分散型電源監測 d. 變壓器及配電設備智慧管理系統 e. 智能化端末單元(FTU、RTU、TTU)與監控主站
E	智慧家庭與建築(成功大學)	a. 住宅電價費率制度及通訊網路技術規範研析報告與建議 b. 電能管理開道器/系統軟體/人機介面開發(含即時預測與最佳化演算法) c. 複合式通訊網路整合及非侵入式負載監測模組開發 d. 非接觸式充電控制晶片及小型再生能源電能管理晶片開發 e. 實體建置與拓展效益評估
F	智慧電網系統技術概念實證(產業協會)	先進讀表、微電網、先進配電、智慧建築前瞻技術先導計畫(智慧社區/城市示範計畫, Demo Site)

圖 7、智慧電網與先進讀表主軸專案計畫技術發展規劃總表

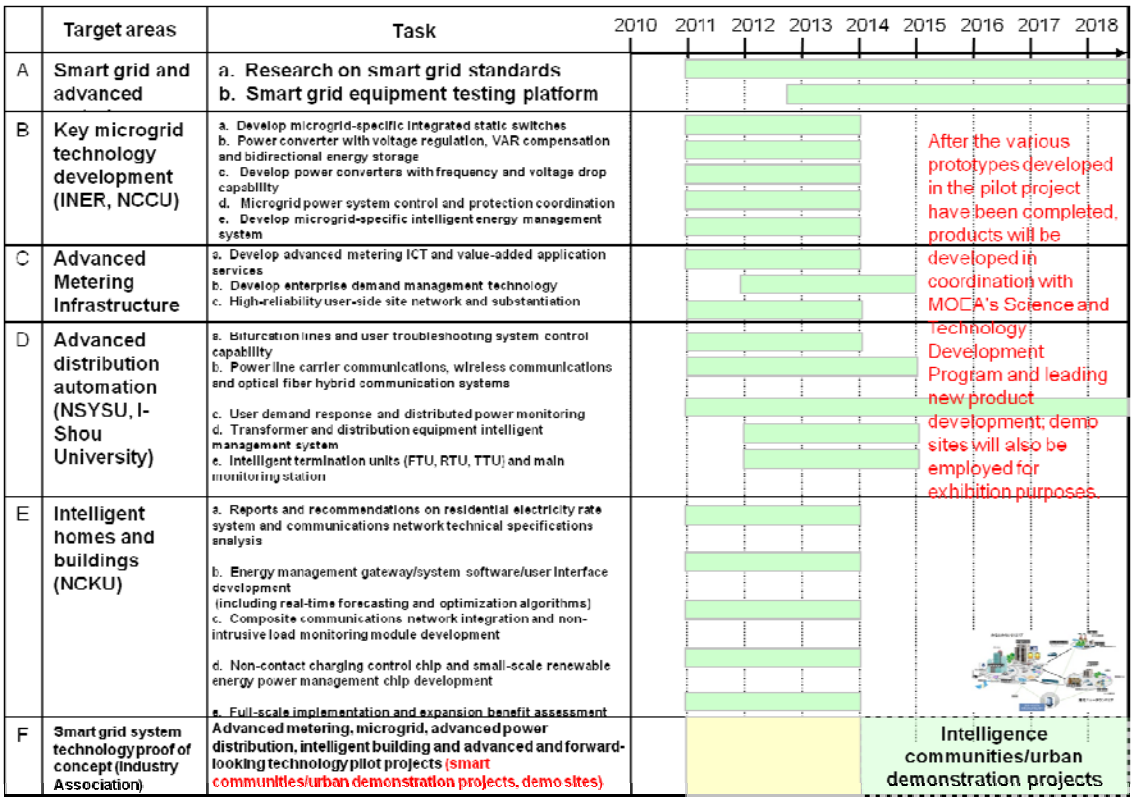


Figure 7. Summary of the technology development planning of Smart Grid and Advanced Metering Infrastructure General Project and Strategic Planning

四、 台灣智慧型電網產業協會

為能使智慧電網與讀表主軸專案計畫可與上述相關產業充份溝通，並於計畫推動時使產業界可充分參與，智慧電網與讀表主軸專案計畫整合台灣智慧型電網產業界之系統廠商、零組件供應廠商、原材料供應商，以及相關學術與研究機構成立之「台灣智慧型電網產業協會」，圖 8、台灣智慧型電網產業協會組織圖，作為與產業界之溝通平台。

不論是近期或長期，就整體就業情形和經濟發展而言，建置智慧型電網可帶來顯著效益。美國智慧電網聯盟(GridWise Alliance)最近將催生一個耗資 640 億美元的計畫，該計畫可以直接創造 28 萬個新職缺，其中大約有 14 萬個永久持續且具高附加價值的職缺還是會持續存在。相較於傳統集中式發電設備，新興的智慧電網展業，是台灣新能源產業的新藍海。目前企業多投入分散式電源與數位電表等各別產品開發，缺少系統整合，不利產品進入國際產業供應鏈，因此建議國內需跨領域整合電力電子、電機與資通訊產業，發展發展微電網系統，並及累積長期運轉經驗，智慧網系統產業才有可能成功發展，進入先進國家市場或其產業供應鏈。[5]

[5] 陳彥豪、陳士麟、紀國鐘、左峻德，<微型電網技術發展現況與策略建議>，《電力電子》，第七期第六號，第 48-67 頁，2009 年 11 月。

(4) Taiwan Smart Grid Industry Association

In order to ensure that the Smart Grid and Advanced Metering Infrastructure General Project and Strategic Planning will be able to communicate effectively with the industries described above, and that the industries will be able to participate fully at the time of the project's implementation, systems vendors, components suppliers and materials suppliers that are involved in the integration of the Smart Grid and Advanced Metering Infrastructure General Project and Strategic Planning and Taiwan's smart grid industry, as well as relevant academic and research institutions, have founded the Taiwan Smart Grid Industry Association. Figure 8, Organizational chart of Taiwan Smart Grid Industry Association, serves as a communication platform between industries.

Judging from the country's overall employment and economic development status, regardless of whether it is viewed from a short- or long-term perspective, the construction of the smart grid will bring significant benefits. The GridWise Alliance of the U.S. is set to begin a US$64 billion project, which will create 280,000 new jobs directly, of which approximately 140,000 are expected to be permanent and are high value-added positions. Compared with conventional centralized power generation equipment, the development of the emerging smart grid industry will become Taiwan's new blue ocean for the country's energy industries. At present, the majority of enterprises have individually invested in the development of products associated with distributed power sources and digital meters, and there is lack of system integration, which is not a favorable situation for the products to join the international supply chain. Therefore, we recommend that Taiwan enterprises should carry out cross-industry integration, bringing together power electronics, electrical and ICT industries in order to develop microgrid systems. In addition, they should accumulate sufficient operational experience so that the smart grid industry will be able to grow successfully and gain access to markets in advanced countries or their supply chains. [6]

[6] Yan-hao Chen, Shi-lin Chen, Guo-zhong Ji, Chun-To Tso, "Current Development Status and Strategy Recommendations for Microgrid Technology," *Power Electronics*, November 2009, pp. 48-67, No. 6, Vol. 7.

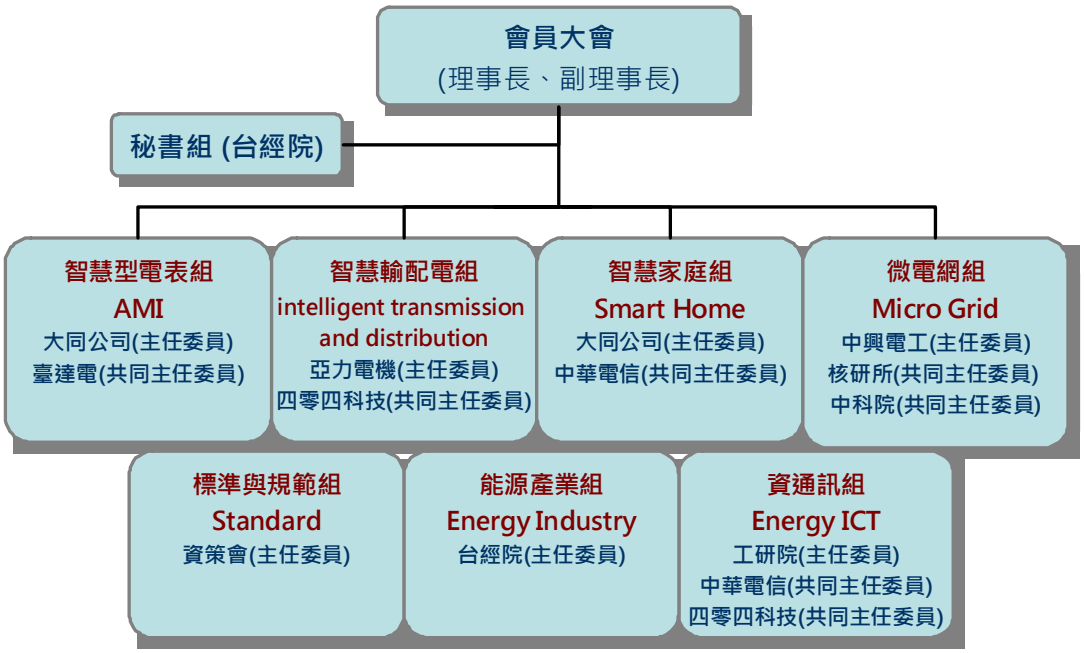


圖 8、台灣智慧型電網產業協會組織圖

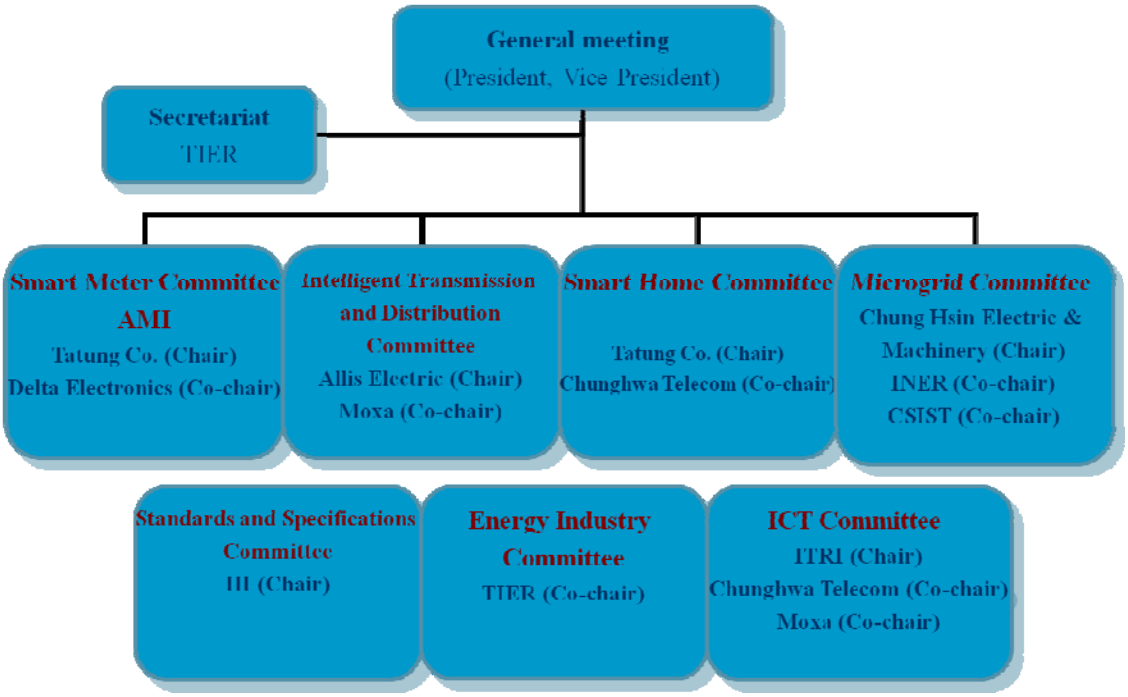


Figure 8. Organizational chart of Taiwan Smart Grid Industry Association

肆、 計畫內容

一、 願景與目標

智慧電網與讀表主軸專案計畫總計畫的目的在有效整合台灣智慧電網與讀表相關之研發資源，針對上述電力系統與產業面臨挑戰，擬定整體發展策略與進行方式，提出具體有效的行動方案，達成「提升能源安全、改善溫氣排放、開創能源產業」願景，並發展台灣電力設備產業，協助建立高品質、高效率、以用戶為導向和環境友善的電力網路系統，初步設定規劃**(1)利用配電自動化與微電網技術提升再生能源裝置容量佔總電力裝置容量之比例大幅提升，使 2025 年國內再生能源發電量佔總電力供應提升至 10%，減少二氧化碳排放 2,000 萬噸；(2)推廣家庭與建築電能管理，提升家庭與建築電能使用效率於 2015 年較 2005 年節能 20%以上；(3)開發智慧電網與讀表之關鍵技術，2010 年至 2025 年共導入 17.8GW 的分散式發電系統，將創造國內每年 1,200 億新台幣市場規模及 2 萬個以上就業機會；智慧型電網市場規模約每年新台幣 600 億元，每年創造 1 萬個以上就業機會，如圖 9 所示。**在推動方面初步設定規劃於 2010-2013 年間主要工作為完成微電網、AMI、先進配電自動化、智慧家庭(建築)電能管理四項先導型計畫之關鍵技術開發、智慧電網與讀表相關規範之制定、舉辦先導型計畫成果展示會。2014-2025 年將延續第一期之工作成果完成關鍵技術之技轉與商品化、配合 AMI 之裝設，完成電能管理制度之導入(如時間電價與需量反應)、配合台電輸配電計畫，逐步將微電網與先進配電自動化先導型計畫之成果推廣於台電系統上、全面推廣智慧家庭(建築)電能管理技術。

4. Project Description

(1) Vision and Objectives

The Master Plan of the Smart Grid and Advanced Metering Infrastructure General Project and Strategic Planning aims to integrate Taiwan's R&D resources in smart grid and metering in an effective manner, to formulate overall development strategies and implementation approaches, to propose specific and effective action plans, and to achieve the vision of "Enhancing energy security, reducing greenhouse gas emissions and supporting the development of the energy industry" in response to the power systems and challenges facing the industry described above. In addition, the projects also intend to foster the growth of the country's electrical equipment industry and to help establish a high-quality, high-efficiency, user-oriented and environmentally friendly electrical grid system. Initially the project calls for **(1) utilizing power distribution automation and microgrid technology to increase the percentage of installed capacity of renewable energy with respect to total electrical power installed capacity, so that by 2025 Taiwan's total domestic renewable energy generating capacity will be increased to 10%, while reducing carbon dioxide emissions by 20,000,000 tons; (2) Promoting the adoption of home and building energy management in order to enhance the power efficiency in the homes and buildings by at least 20% in 2015 compared with 2005 levels; (3) Developing key smart grid and metering technologies, implementing distributed power generation systems capable of producing 17.8GW between 2010 and 2025, thus creating a NT$120 billion per year market and at least 20,000 jobs. The size of the smart grid market will be approximately NT$60 billion a year, with 10,000 new jobs created annually. Refer to Figure 9.** With respect to project advancement, the plan preliminarily calls for the development of key technologies for the four pilot projects: microgrids, AMI, advanced distribution automation and smart homes (buildings) power management between 2010 and 2013, in addition to establishing relevant smart grid and metering specifications as well as organizing an exhibition for the results achieved in the pilot projects. Between 2014 and 2025: results achieved in Phase 1 will be used to effect technology transfer and product commercialization; introduction of electrical energy management system in coordination with the completion of AMI (e.g. time-of-use pricing and demand response); gradual adoption of the results from the microgrid and advanced distribution automation pilot projects in Taipower's systems in coordination with the company's power transmission and distribution plans; and the promotion of smart homes (buildings) power management technology on a full-scale basis.

提升電力使用效率潛能

- **推廣潛能：推廣家庭與建築電能管理**
- **節能效果：提升家庭與建築電能使用效率於2015年較2005年節能20%以上**



提高再生能源比例潛能

- **推廣潛能：突破電網再生能源供電量5% 限制，可提升至佔總電力供應10%**
- **電力結構：使再生能源發電量達 320 億度**
- **減量效果：減量潛能約 2,000 萬公噸二氧化碳(增加 5% 再生能源減量效果)**
- **產業效果：創造國內每年1,200 億市場規模及 2 萬個以上就業機會**



圖 9、智慧電網與先進讀表主軸專案計畫目標

二、 計畫範疇

為配合台灣電力公司智慧電網四個目標領域(電網安全與可靠、電能效率、用戶服務品質及分散型電源整合)之發展，且有效整合與實現由能源國家型計畫智慧電網與讀表子項之年度研究計畫及相關政府科技計畫建構而成之技術面研究成果，智慧電網與先進讀表主軸專案計畫應用面，參考中國、美國與歐洲之現行智慧型電網相關之示範計畫，並參酌台灣相關產學研界業能量與需求分別規劃微電網、先進讀表系統(AMI)、智慧家庭(建築)電能管理、先進配電自動化等四個先導計畫，如圖 10 所示；並有 20 多間公司參與各先導型計畫，以利台灣整體智慧電網與讀表技術與產業之發展。相關技術發展範疇簡述如下：



Figure 9. Objectives of the Smart Grid and Advanced Metering Infrastructure General Project and Strategic Planning

(2) Scope of Project

In coordination with the development of Taiwan Power Co.'s four objective domains (grid security and reliability, power efficiency, customer service quality and integration of distributed power sources), and for the purpose of effectively integrating and realizing the technical research results derived from the annual research plans of the smart grid and metering subprogram under National Science and Technology Program-Energy as well as relevant government technology projects, smart grid projects currently being demonstrated in China, the U.S. and Europe will be consulted for the application aspects of the Smart Grid and Advanced Metering Infrastructure General Project and Strategic Planning. In addition, capabilities and requirements of Taiwan's industrial, academic and research communities will also be taken into consideration for the planning of the four pilot projects: Microgrid, Advanced Metering Infrastructure (AMI), **Power Energy Management System of Smart Home (Building)** and Research of Smart Grid and AMI-Advanced DAS pilot project, as shown in Figure 10; In addition, more than 20 corporations have participated in various pilot projects, which is conducive to the growth of Taiwan's overall smart grid and metering technology industries. The development of relevant technologies is summarized below:

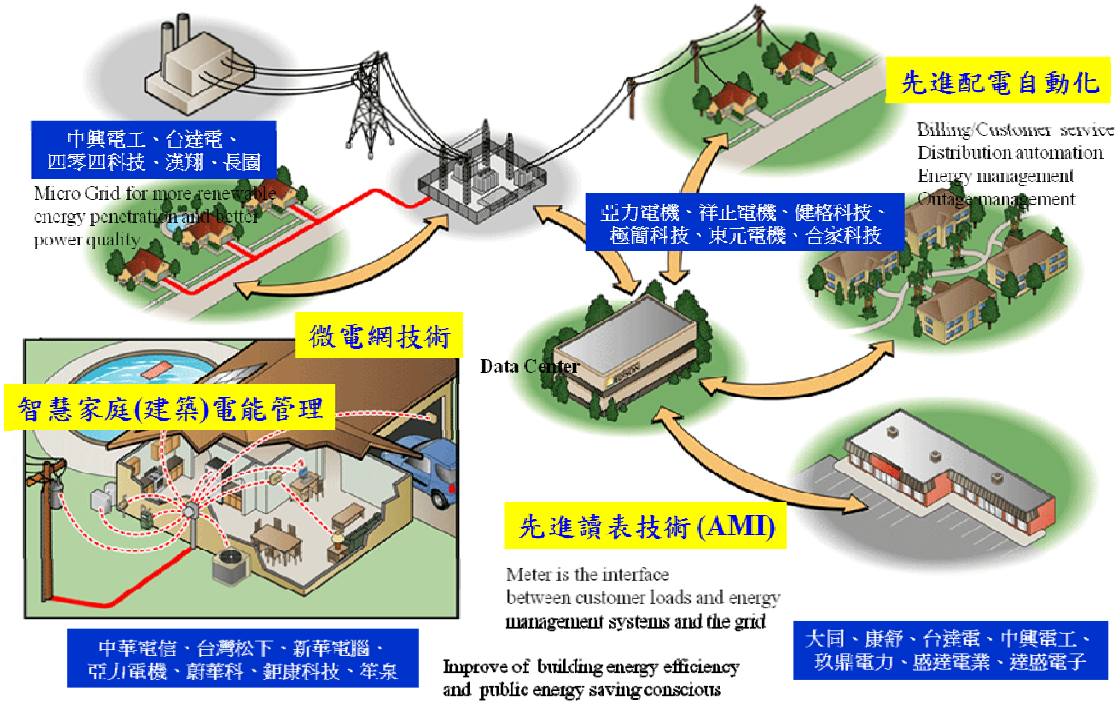


圖 10、智慧電網與先進讀表主軸專案計畫應用面規劃

（一） 微電網先導型計畫

微電網先導型計畫目的在於提升再生能源滲透率，同時增加系統運轉安全，因此必須發展微電網能源管理與電力控制技術，包含具實虛功率控制之再生能源電力轉換系統、儲能及備載控制技術、可運轉於市電併聯與孤島運轉模式平穩切換之靜態開關電力控制設備、微電網保護協調設計、微型電網系統模擬與電力品質分析等，結合能源管理系統(EMS)之開發，完成負載自動卸載/解聯/併聯等控制技術規劃，以加速核研所自主式(Autonomous)控制之微電網示範系統與測試平台建置，有效控制微電網再生能源發電滲透率達 20%目標。

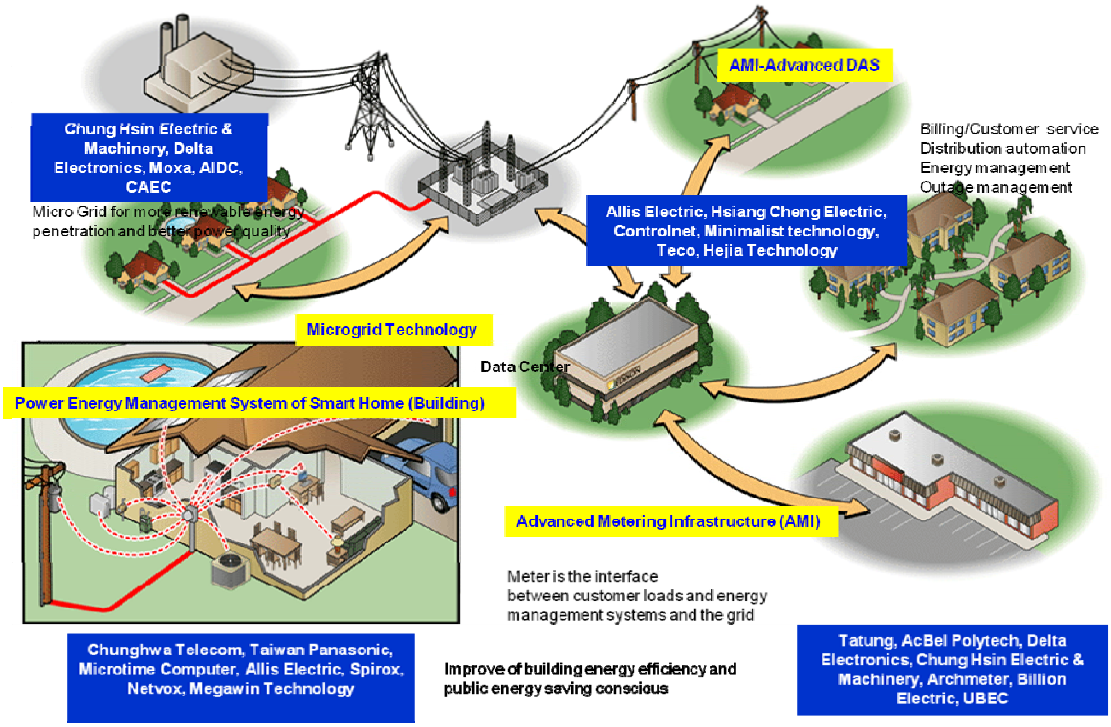


Figure 10. Application planning for the Smart Grid and Advanced Metering Infrastructure General Project and Strategic Planning

I. Microgrid Pilot Project

The Microgrid Pilot Project aims to enhance the penetration rate of renewable energy while enhancing system operational safety. Therefore it is necessary to develop microgrid energy management and power control technologies, including renewable energy power conversion systems equipped with real and virtual power control, energy storage and full load control technology, static switch power control equipment capable of operating in grid-connected and islanding modes in smooth switching, microgrid protection and coordination design, and microgrid system simulation and electrical power quality analysis. When combined with the development of energy management system (EMS), the planning of automatic unloading/desynchronization/ synchronization control technologies will be completed in order to speed up the construction of autonomous-control microgrid demonstration and testing platform, thus effectively achieving the target of 20% penetration of renewable energy.

（二） 微電網先導型計畫（直流智慧微電網研究）

微電網先導型計畫(直流智慧微電網研究)之目標在於：(1)研發直流供電系統之綠色能源發電系統、直流電器負載、儲能設備、以及監控系統之軟、硬體；(2)訂定直流微電網之規格，建立直流供電系統之運轉與管理機制、檢測標準和建置程序；(3)培育種子教師，推廣綠色能源理念，並且落實技術於產業界之產品開發；(4)建置 30 kW 級之綠色能源直流微電網測試系統，作為綠色能源教育、綠色能源政策及產業界相關產品進軍國內外市場之測試場域，進而帶動產業發展，創新產品開發。長期目標為建立百 kW、MW 級之示範系統於中正大學，深入探討高比率(> 50 %)綠色能源供電之可行性。

（三） AMI 先導型計畫

AMI 先導型計畫之計畫目標包含：(1)進行專利布局，每年產出三個以上專利及前瞻技術(2)支援至少一家廠商取得海外智慧電表相關業務(3)引領智慧能源監測與分析之新興能源服務(4)制訂智慧型電表的通訊規範，以利智慧家庭電能管理服務之發展(5)制訂 AMI 電表佈建流程準則及發展佈建工具，以降低大規模 AMI 電表佈建之成本及時程；中長期目標含(1)發展前瞻 AMI 技術，解決 AMI 產業的五大挑戰，讓國內 AMI 產業具備國際競爭力(2)藉由再生能源供電能力估算與用戶之負載走勢模型，來進行即時需量預測，並進行再生能源、儲電設備與市電的需量調配，提升能源用電效率。

II. Microgrid Pilot Project—Research on DC Smart Micro-Grid

The objectives of the Microgrid Pilot Project—Research on DC Smart Micro-Grid are as follows: (1) Developing green power generation system based on DC power supply systems, DC appliance load, energy storage equipment and hardware/software for monitoring systems; (2) Formulating DC microgrid specifications and establishing DC power supply system operational and management mechanisms, testing standards and implementation procedures; (3) Training seed instructors, promoting green energy concept and implementing the use of technology in product development by the industry; (4) Implementing 30 kW-class green energy DC microgrid test system as the test bed for gaining access to domestic and overseas markets for green education, energy policy and relevant products from the green industry, thus helping to advance the growth of the industry and to foster the development of innovative products. Long-term goals include the establishment of 100 kW-class and MW-class demonstration systems at National Chung Cheng University, and conducting an in-depth study on the feasibility of high-percentage (> 50%) green energy power supply.

III. Advanced Metering Infrastructure(AMI) Enhancement Project

The objectives of the Advanced Metering Infrastructure (AMI) Enhancement Project include: (1) Patent positioning; developing at least 3 patents per year and forward-looking technologies; (2) Providing support for at least one vendor in acquiring overseas smart meter-related sales; (3) Providing leadership emerging energy services such as intelligent energy monitoring and analysis; (4) Developing smart meter communications specifications to facilitate the development of intelligent home energy management services; and (5) Developing AMI meter provisioning procedures and guidelines as well as deployment tools to reduce the cost and time for large-scale AMI meter deployment; Long-term objectives include (1) Developing forward-looking AMI technologies to address the five major challenges facing the AMI, thus allowing the domestic industry to develop competitiveness in the global markets; (2) Conducting real-time demand forecast via the estimation of renewable energy power generation capacity and user load trend models, as well as carrying out demand allocation for renewable energy, electricity storage devices and commercial power supply in order to enhance energy efficiency.

（四） 先進配電自動化先導型計畫

先進配電自動化先導型計畫目標為：(1)建置 ADAS 示範系統，提供產學研開發智慧配電網關鍵組件及監控系統測試與驗證；(2)發展智能化組件及主站應用功能，強化國內產業之國際市場競爭力；(3)在台電既有之 DAS 主幹線 FDIR 功能基礎下，擴充至分歧線及用戶端故障復電管理，提升國內智慧配電網技術水準；(4)因應國內分散式電源之推廣，將其納入 ADAS 系統監控，以增加 PV、WG 之併接容量；(5)發展配電系統設備整合管理系統，改善 PV 及 EV 併網對供電系統不良衝擊。

IV. Research of Smart Grid and AMI-Advanced DAS pilot project

The objectives of the Research of Smart Grid and AMI-Advanced DAS pilot project include: (1) Constructing the ADAS demonstration system to provide the industrial, academic and research communities with a platform for the development of key components for smart distribution networks and monitoring system testing and validation; (2) Developing intelligence-enabled components and main station applications to enhance the domestic industry's competitiveness in international markets; (3) Expanding the management of service failure restoration to bifurcation lines and user end based on the FDIR functions of Taipower's existing DAS trunk, thus improving the technical level of Taiwan's smart distribution network; (4) Incorporating distributed power sources into ADAS system monitoring in response to the adoption of distributed power in the domestic market so as to increase the connection capacities of PV and WG; (5) Developing integrated distribution system equipment management systems to reduce the impact of the connection of PV and EV on the power supply system.

（五） 智慧家庭（建築）電能管理先導型計畫

本先導型計畫之目標含：(1)設計適用我國電價費率，提高用戶進行需求端管理之誘因；(2)選用適合的網路拓撲，並將家電負載、感測器模組、小型再生能源發電系統及儲能系統等設備，透過通訊模組與控制介面連結成一智慧家庭電能管理網絡；(3)開發即時預測、負載模式分析及智慧家庭電能最佳化管理等系統，幫助用戶掌握用電資訊及降低用電消耗；(4)評析現存及提出適用我國之技術標準，以供未來政府制定規範之參考依據，並使本系統得與產業連結；(5)配合業界尋找現有零組件、並開發及整合晶片控制電路、通訊介面及負載控制介面等，以縮短研發時程及提昇市場競爭。中長期目標為：(1)透過實體建置經驗及相關技術規範與電價政策研究，評析本系統是否合乎經濟效益，並令本研究得與產業結合以帶來商機(2)提升能源使用效率，同時兼具節能減碳之效果，並可幫助電力業者降低投資成本及電力用戶減少電費支出，期對國家發展、經濟、環保等議題之助益。

V. Leading Project on Power Energy Management System of Smart Home (Building)

The objectives of the pilot project include: (1) Designing electricity rates that are appropriate for Taiwan, and increasing users' incentives for carrying out demand side management; (2) Selecting a suitable network topology to form an intelligent home energy management network by connecting the load from home appliances, sensor modules, small renewable energy power generation systems and energy storage systems via communication modules and control interface; (3) Developing a real-time forecasting, load-pattern analysis and intelligent home energy optimization and management systems to help users gain access to electricity consumption information and to reduce power consumption; (4) Assessing existing technical standards and proposing new technical standards applicable to Taiwan in order to provide the basis of reference for government's future formulation of specifications, thus establishing a connection between this system and the industry; (5) Coordinating with the industry's search for existing components, developing and integrating control circuit chip, communications interface and load control interface in order to shorten development time and enhance competitiveness in the markets. Medium- and long-term objectives include: (1) Providing assessment of the cost-effectiveness of the system through the experience in physical implementation and research on related technical specifications on pricing policy as well as fostering the connection with the industry to create commercial opportunities; (2) Increasing energy efficiency while achieving the results of energy saving and carbon reduction, as well as helping the electrical power industry to reduce investment costs and electricity customers to reduce utility expenses, so as to become a positive force for national and economic development as well as in environmental protection.

三、　計畫架構

智慧電網與讀表主軸專案計畫除主要負責規劃能源國家型計畫中智慧型電網與讀表子項與主軸未來之研究方向外，並且必須將政府相關單位（能源局、工研院、核能研究所等）與台電公司 99 至 104 年五年內智慧型電網與讀表之相關計畫納入其中，為一跨部會共通推動之任務導向協調型計畫，屬矩陣式架構，如圖 11 所示。目前經濟部已完成台灣智慧電網整體規劃（2011-2030），未來經濟部相關單位在台灣智慧電網產業發展上必居領導地位，以使能源型國家計畫之研究成果能充分發揮效益。

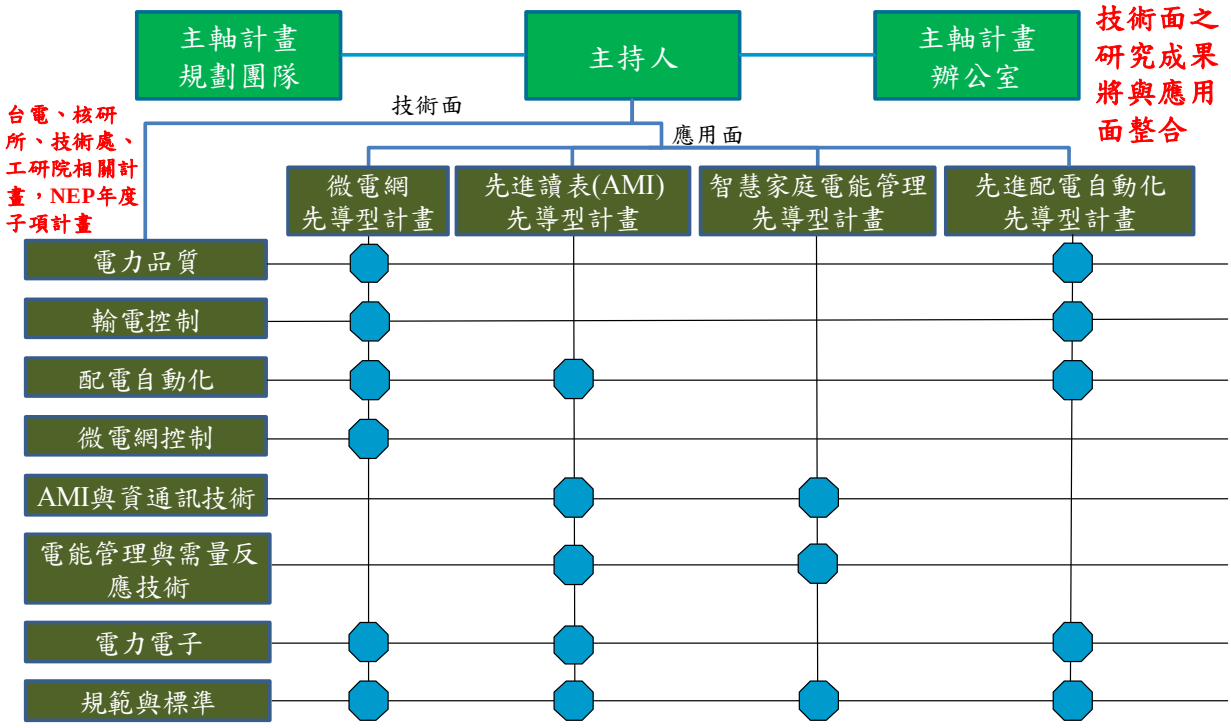


圖 11、智慧型電網與先進讀表主軸專案計畫類矩陣式組織架構示意圖

(3) Project structure

In addition to planning the smart grid and metering subprogram under National Science and Technology Program-Energy and the direction for its research, the Smart Grid and Advanced Metering Infrastructure General Project and Strategic Planning must also incorporate the relevant 5-year (2010-2015) smart grid and metering projects implemented by government agencies (e.g. Bureau of Energy, ITRI and INER) and Taipower, and it is a mission-oriented, joint-ministerial coordinated project with a matrix structure. Refer to Figure 11 for details. Currently the Ministry of Economic Affairs has completed the master plan for Taiwan's smart grid (2011-2030). Going forward, agencies within MOEA are expected to assume a leading position in the development of smart grid within Taiwan, so that the research results of the National Science and Technology Program-Energy and its benefits can be maximized.

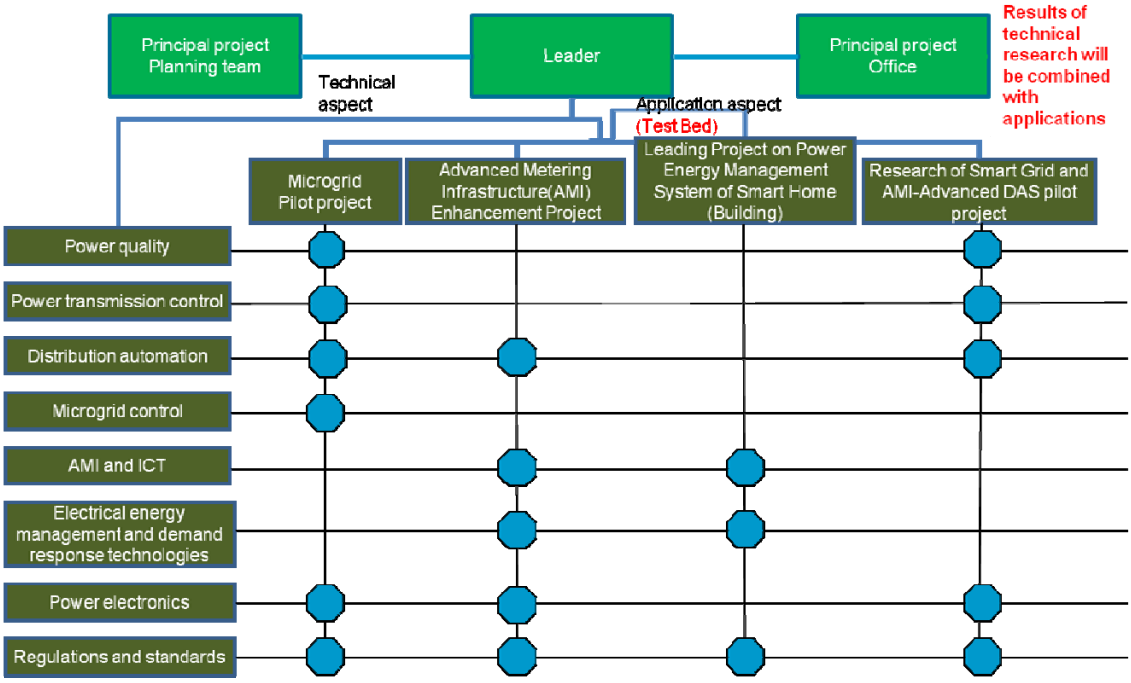


Figure 11. Smart Grid and Advanced Metering Infrastructure General Project and Strategic Planning matrix organizational structure

伍、 計畫主要執行成果

本計畫目前重大執行成果分述如下：

一、研討會之舉辦與參與

（一） 於 100/03/28 參加「2011 台灣智慧電技術與產業座談會」，此次座談會由學界與產業界共同討論智慧電網推動現況與研發重點，對台灣智慧電網技術有重大影響。

（二） 於 100/05/09 召開智慧電網標準討論會，討論我國智慧電網技術面議題，具有重大影響。

（三） 於 100/08/05 假國科會舉行「能源國家型計畫智慧電網與讀表主軸專案計畫智慧書配電網技術座談會」，與台電討論智慧輸電網廣域量測、輸電系統電力品質監控技術、電動車電能補充管理策略等三方面的研究需求，對與台電合作一案以及推動智慧電網主軸計畫有重大貢獻及影響。

（四） 於 100/08/08 至 100/10/26 參加經濟部能源局舉辦之「我國智慧電網總體規劃（Master Plan）」2 次研商會議及 8 次小組會議，與工業研究院及臺灣電力公司討論我國智慧電網總體規劃相關議題，具有重大影響。

（五） 於 100/08/26 參加經濟部能源局舉辦之「智慧電網論壇」，由林法正計畫主持人發表智慧電網與讀表主軸專案計畫推動現況，並與國內外學者及國內產業界先進討論智慧電網安全議題、標準分析、應用規劃等議題，具有重大貢獻及影響。

5. Main Project Implementation Results

Major results from the implementation of the project to date are described individually as follows:

(1) Organization and participation of seminars

I. Participation in the "2011 Taiwan Smart Grid Technology Industry Forum" on March 28, 2011. In this forum, members from the academic and industrial communities discussed the current status of the implementation of smart grid as well as its R&D focus; the forum has a major impact on the development of Taiwan's smart grid technologies.

II. Organized the smart grid standards meeting on May 9, 2011, in which issues related to Taiwan's smart grid technology development were discussed, which produced a significant impact on the industry.

III. Organized the "National Science and Technology Program-Energy: Smart Grid and Advanced Metering Infrastructure General Project and Strategic Planning Intelligent Transmission and Distribution Network Technology Forum," held at the National Science Council, on August 5, 2011; discussed three areas of research requirements with Taipower: smart grid transmission network wide area measurement, power transmission system quality monitoring technology, and electric vehicle power replenishment management strategies, which provided substantial contributions to the joint project with Taipower and has been instrumental in promoting the Smart Grid General Project and Strategic Planning.

IV. Participated, from August 8 to October 26, 2011, in the "Taiwan Smart Grid Master Plan" organized by the Bureau of Energy, 2 discussion sessions and 8 committee meetings, and discussed issues associated with the overall planning of Taiwan's smart grid with ITRI and Taipower, the results of which have had a great impact.

V. Participated in the "Smart Grid Forum" organized by the Bureau of Energy on August 26, 2011. The project leader, Professor F. J. Lin, delivered a report on the implementation status of the Smart Grid and Advanced Metering Infrastructure General Project and Strategic Planning, and he also discussed smart grid security issues, analysis of standards and specifications as well as planning of applications with scholars from home and abroad and with experts from the domestic industry. The discussions have made significant contributions and impact.

二、國際合作

（一） 於 100/02/24 至 100/02/25 赴美國加州理工學院參加「Taiwan - Caltech Energy Workshop」，並於 100/06/10 至 100/06/15 邀請美國加州理工學院 Steven Low 教授來台訪問。此次國際交流除了了解台灣智慧電網之發展現況，並將 ICT 在智慧電網之最新技術介紹給學術與研究單位外，亦將與林法正教授共同進行智慧電網相關技術前瞻性研究之國際合作，以推動台灣與加州理工學院雙邊能源研究之國際合作。

（二） 於 100/04/10 中國電機工程學會李若梅博士與本會左峻德秘書長在北京簽署合作備忘錄，此次合作備忘錄建立兩岸智慧電網交流之平台，並協議定期召開兩岸智慧電網交流研討會(已於2011 年 7 月 25 日召開兩岸智慧電網技術產業論壇)。此外由協會左峻德秘書長於 2011 年 9 月底帶領國內智慧電網訪問團拜訪國家電網公司、國網北京經濟技術研究院、中國電力科學研究院、國家電網裝備公司以及參與大規模儲能技術的發展與應用研討會和參觀國網信通智慧電網展示區。雙方就兩岸可合作議題進行討論，可能合作議題包含兩岸智慧電網共通標準、兩岸共同推動微電網示範計畫之可行性、推動兩岸智慧電網產業項目合作、高壓直流電網的併網工程產業合作、智慧電網先導示範計畫評價模式研究等。

（三） 於 100/07/01，Ontario Delegates' visit to TIER 智慧電網，此次國際交流活動由本協會與加拿大駐台北貿易辦事處安排，就加拿大智慧電網推動現況與產業合作機會進行討論。與會人包含 eCAMION、Canadian Trade Office in Taipei、加拿大安大略省政府、工研院、玖鼎、華城、大同、計量企業、盛達、中華電信、台經院。

(2) International cooperation

I. Participated in California Institute of Technology's "Taiwan - Caltech Energy Workshop" held between February 24 and February 25, 2011, and invited Caltech professor Steven Low to visit Taiwan from June 10 to June 15, 2011. During the visit the guest was introduced to Taiwan's smart grid development. In addition, the latest ICT technologies as applied to smart grid were also presented to academia and a joint international cooperative project with Professor F. J. Lin on smart grid-related technology and forward-looking research has also been initiated to advance the international bilateral cooperation between Taiwan and Caltech.

II. On April 10, 2011 Dr. Li Ruomei of the Chinese Society for Electrical Engineering signed a memorandum of cooperation with TSGIA Secretary General Dr. Chun-To Tso in Beijing. The agreement serves to establish a platform for cross-strait exchange on smart grid technology and both parties agree to organize cross-strait smart grid exchange conferences on a regular basis (on July 25, 2011 a cross-strait smart grid technology industry forum was held).

In addition, a delegation of Taiwan's smart grid industry participants led by TSGIA Secretary General Chun-To Tso in late September 2011 visited the State Grid Corporation of China, the State Power Economic Research Institute, China Electric Power Research Institute and State Grid Equipment Corporation, and the delegation also participated in a seminar for large-scale energy storage technology development and paid a visit to the State Grid's ICT smart grid exhibition. The two sides conducted discussions on potential areas of cooperation, including smart grid standards and specifications common to both Taiwan and mainland China, feasibility of joint implementation of microgrid demonstration projects, promotion of cross-strait cooperation in smart grid industry projects, cooperation in the high-voltage DC on-grid engineering industry and the research on smart grid pilot demonstration project evaluation models.

III. On July 1, 2011, at the international event with Ontario Delegates' visit to the TIER smart grid, which was organized jointly by TSGIA and the Canadian Trade Office in Taipei, discussions were held on the latest development of Canada's smart grid and opportunities for cooperation. Participants included eCAMION, Canadian Trade Office in Taipei, the Government of Ontario, ITRI, Archmeter, Fortune Electric, Tatung, Metrologies Enterprise, Billion Electric, Chunghwa Telecom and TIER.

（四） 於 100/07/25 舉行「2011 兩岸智慧電網技術產業論壇」，與兩岸學界與產業界人士共同討論智慧電網發展現況、策略、應用與研發重點，並討論兩岸技術發展與合作議題，對兩岸智慧電網發展具有重大貢獻與影響。

（五） 於 100/08/10 至 100/08/18 赴歐洲考察智慧電網示範計畫，了解國際技術發展、搜集與更新國外智慧電網與讀表技術發展現況與策略，並可協助國內發展出因應未來電網需求之對策。

（六） 於 100/11/14 參加台灣智慧型電網產業協會舉辦之「第一屆第三次會員大會暨台英智慧電網產業技術交流會議」。

（七） 於 100/11/14 參加 2011 Taiwan-US S&T Workshop for International Collaborate Research。

三、 推動輔導

於 100/10/05 協助經濟部估算智慧電網總體規劃(Master Plan)中我國智慧電網 2011 至 2030 的產值，經濟部擬與 11 月底題出我國慧電網總體規劃，本計畫協助推算我國智慧發電與調度、智慧輸電、智慧配電、智慧用戶 2011~2015、2016~2020、2026~2030，國內國外智慧電網產值；另外由於智慧家電為我國可能發展的重要方向，因此針對此部份也將協助進行產值推估。所有計算結果將納入經濟部能源局所提出之智慧電網總體規劃。

IV. The "2011 Cross-Strait Smart Grid Technology Industry Forum" was held on July 25, 2011, in which discussions with scholars and industry experts from both sides of the Taiwan Strait on the latest development, strategies, applications and focus of research of smart grid technology were held. In addition, views on cross-strait technological development and cooperation were also exchanged, which have had significant contributions to and influence on cross-strait smart grid development.

V. Visited Europe on a learning expedition on the region's smart grid demonstration projects from August 10 to August 18, 2011 to gain a better understanding of overseas technological developments and to collect and update information on the status of development and strategies of smart grids and metering technologies in other countries, as well as to provide support to Taiwan's industry in the development of strategies for addressing future smart grid requirements.

VI. Participated in the "Joint Third Session of TSGIA's First Members' General Meeting and Taiwan-UK Smart Grid Technology Industry Exchange Forum" on November 14, 2011, which was sponsored by the Taiwan Smart Grid Industry Association.

VII. Participated in the 2011 Taiwan-US S&T Workshop for International Collaborate Research held on November 14, 2011.

(3) Promotion and Guidance

Provided support to the Ministry of Economic Affairs on October 5, 2011 on the estimation of Taiwan's industrial output in the smart grid's Master Plan between 2011 and 2030. The MOEA planned to propose the country's smart grid Master Plan by the end of November, and this project has provided estimates on Taiwan's smart grid power generation and allocation, intelligent transmission, intelligent distribution and intelligent users, as well as the domestic and overseas smart grid industrial output from 2011 - 2015, 2016 - 2020 and 2026 - 2030. In addition, as smart appliances are potentially an important avenue for Taiwan's industrial development, assistance in estimating the production output in this area has also been provided. All results of estimation are slated to be included in the smart grid Master Plan proposed by the Bureau of Energy.

四、 推動智慧型電網與讀表主軸專案計畫

整合國內台達電、中興電工、大同、中華電信、四零四科技、漢翔、長園、亞力電機、祥正電機、健格科技、極簡科技、東元電機、合家科技、台灣松下、新華電腦、亞力電機、蔚華科、鉅康科技、笙泉、康舒、玖鼎電力、盛達電業、達盛電子等業者參與先進配電自動化、先進讀表技術、智慧家庭(建築)電能管理、微電網先導示範，建立跨領域系統整合技術，產業目前積極投入中。

五、 智慧電網標準發展與技術交流

號召國內智慧電網產業相關之上市櫃公司、資策會、工研院、台電綜合研究所、核能研究所、中科院、台灣經濟研究院、大電力、電檢中心等研究與驗證機構共 28 單位成立「台灣智慧型電網產業聯盟」，提出認可標準化團體申請，完成智慧電網相關規範之發展現況分析與盤點，並加入由美國國家標準與技術局(NIST)所成立之智慧電網互通性專門小組(SGIP)。

(4) Promotion of the Smart Grid and Advanced Metering Infrastructure General Project and Strategic Planning

Fostered the joint participation from the following corporations in Taiwan in the development of power distribution automation, advanced metering technology, intelligent home (building) power management and microgrid pilot demonstration as well as established cross-industry systems integration technology: Delta Electronics, Chung Hsin Electric & Machinery, Tatung, Chunghwa Telecom, Moxa, AIDC, CAEC, Allis Electric, Hsiang Cheng Electric, Controlnet, Minimalist technology, Teco, Hejia Technology, Taiwan Panasonic, Microtime Computer, Allis Electric, Spirox, Netvox, Megawin Technology, AcBel Polytech, Archmeter, Billion Electric and UBEC. Active investments by the industry are underway.

(5) Development of smart grid standards and technology exchange

Called on 28 corporations, research institutions and certification bodies, including smart grid-related listed or OTC-traded industry participants in Taiwan, III, ITRI, Taiwan Power Research Institute, INER, Chung-Shan Institute of Science and Technology, TIER, Taiwan Electric Research & Testing Center and Electronics Testing Center Taiwan (ETC) to establish the "Taiwan Smart Grid Industry Alliance," which will be responsible for proposing applications from recognized standardization bodies and completing the analysis and inventory checking of the development status of smart grid-related specifications and standards, as well as joining the Smart Grid Interoperability Panel (SGIP) established by the U.S. National Institute of Standards and Technology (NIST).

六、 101 年度新增三件先導型計畫以配合台電在輸配電上之研究需求

（一） 廣域量測系統先進應用先導型計畫

以同步相量量測器(PMU)為基礎之廣域量測系統(WAMS)應用技術為當代智慧輸電網所應具備之重要技術之一。該計畫主要開發 WAMS 之先進應用，包括輸電線阻抗參數線上監測、輸電線動態額定熱容量線上監測、發電機組模型參數線上量測、特殊保護系統、動態事件定位及電力孤島區間偵測等等，均為智慧輸電網必備功能。另一方面，本計畫擬開發一套即時自動監測網，透過無線監測技術，主動掌握各項可能危及超高壓輸電線路與電塔主體設施之威脅。

（二） 輸電系統電力品質監控技術之發展與應用先導型計畫

該計畫就智慧電網在輸電系統電力品質監控技術之發展與應用方面，探討先進功能之智慧電力品質分析儀實現與廣域之電力品質量測技術、辨識並矯正造成電力品質問題之事故的電網監測機制實現，及整合電力品質監測資料與資料庫設計與即時電力品質信號分方法。另一方面，將對電壓調整器/電容器/靜態虛功補償器/再生能源於電網之佈建做最佳規劃以提升電力品質。

(6) Three additional new pilot projects in 2012 in coordination with Taipower's requirements on transmission and distribution research

I. Initiatives of Advanced Applications of Wide-area Measurement System (WAMS)

Wide Area Measurement System (WAMS), an application technology based on phasor measurement unit (PMU) is one of the most important technologies required for an intelligent power transmission network. The main task of the project involves the development of advanced WAMS applications, including the online monitoring of transmission line impedance parameters, dynamic online monitoring of transmission line rated thermal capacity, online measurement of generator system model parameters, special protection systems, dynamic event positioning and islanding detection in power systems, etc., which are functions that are required for intelligent transmission networks. On the other hand, this project intends to develop a real-time, automatic monitoring network that is capable of proactively gaining access to all possible threats that could endanger the ultra-high voltage transmission lines and overhead transmission towers via the use of wireless monitoring technology.

II. Development and Applications of Power Quality Monitoring Techniques for Electric Power Transmission System

With respect to the development and application of power quality monitoring in smart grid power transmission systems, the project explores the realization of wide area power quality measurement techniques with advanced intelligent power quality analyzers, realization of grid monitoring mechanisms that identify and rectify incidents resulting in power quality problems, and the integration of power quality monitoring data, database design and real-time power quality signal subdividing methods. On the other hand, optimal planning of the installation of voltage regulators/capacitors/static VAR compensators/renewable energy on the electrical grid will be carried out to improve power quality.

（三） 電動車電能補充管理策略研究先導型計畫

該計畫主要分析未來電動車充電站對配電系統運轉的衝擊，藉由電力系統模擬建構衝擊評估環境，以期能符合未來實際狀況，精確有效地分析 G2V 及 V2G 的衝擊與效益。另一方面，本計畫擬開發高性能電動車充電站，並以智慧電表輔助對充電站進行電能供給品質監測，透過適當的通訊架構對充電站智慧型變壓器及充電機進行管理，達成充電機之互相協調，進一步考量需量反應及時間電價機制，對充電站進行最佳電能管理。本計畫並包含未來在配電系統上 Virtual Power Plant 之研究與試驗。

III. A Pilot Project on Strategic Power Supply Management for Electric Vehicle Charging

The principal task of this project is the analysis of the impact of electric vehicle charging stations on the operation of power distribution systems in the future. Simulation of electrical systems is employed to construct an impact evaluation environment that satisfies the requirements of likely future scenarios, providing an accurate and effective analysis of the impact and benefits of G2V and V2G. On the other hand, the project intends to develop high-performance electric vehicle charging stations and to employ smart meters to monitor the quality of power supplied by these stations. Intelligent transformers and chargers at the charging stations are administered through an appropriate communications framework in order to achieve mutual coordination between chargers, as well as to carry out optimal power management of the stations by providing further consideration to demand response and time-of-use pricing mechanisms. The project also includes the research and testing of the Virtual Power Plant of the power distribution system in the future.