4 Leader of Smart Grid Development

The Implication of Leader of Smart Grid Development

Technology is changing our world at an astonishing pace. The wave of artificial intelligence (AI), the rapid changes in information and communications technology (ICT), the breakthroughs and innovations of big data, blockchain, and cloud technology have all overturned the business models of the past and rewritten many industrial applications. To propel low-carbon electric power, Taipower is committed to R&D and innovation. The Company actively invests in smart grid deployment, introduces relevant technologies, improves management efficiency, and increases its operational effectiveness. Taipower also aims to apply itself to meeting the important infrastructure demands of renewable energy.

Major Investments

- Developed Automated Metering Infrastructure (AMI), smart meter big data analysis and value-added applications, refined power consumption visualization and user interaction functions, and guided users to save energy voluntarily. The Company is expected to invest $46.4 billion in smart meters and communication modules between 2019 and 2030.
- Planned to complete a deployment of 6 million smart meters by 2030, along with 3GWs of demand response measures and participation.

Performance Highlights

- Installed a total of **29,621** high-voltage AMIs and **1,096,869** low-voltage AMIs by the end of 2020.
- Installed **65** kilometers of optical cables and deployed **94** optical fiber communication systems in 2020. Provided **773** communication circuits in line with the development of the smart grid.
- Constructed the **Kinmen energy storage system**, consolidated and applied various energy sources, regulated and reduced system fluctuations, and maintained grid stability.

Future Plans

Taipower is in alignment with the government's policies and plans. In the short term (2020), the Company will focus on enhancing operational flexibility, developing a stable power supply network with a high proportion of renewable energy, and strengthening the flexible dispatching capabilities of grid supply, demand, and outage. In the medium term (by 2025), the Company will be focused on reinforcing grid resilience and establishing a safe and highly adaptable grid in response to climate change. In the long term (by 2030), Taipower will have implemented reforms in the electricity industry, increased the use of low-carbon energy, devoted itself to the development of a safe and reliable grid, and propelled open and transparent information and fair market transactions.

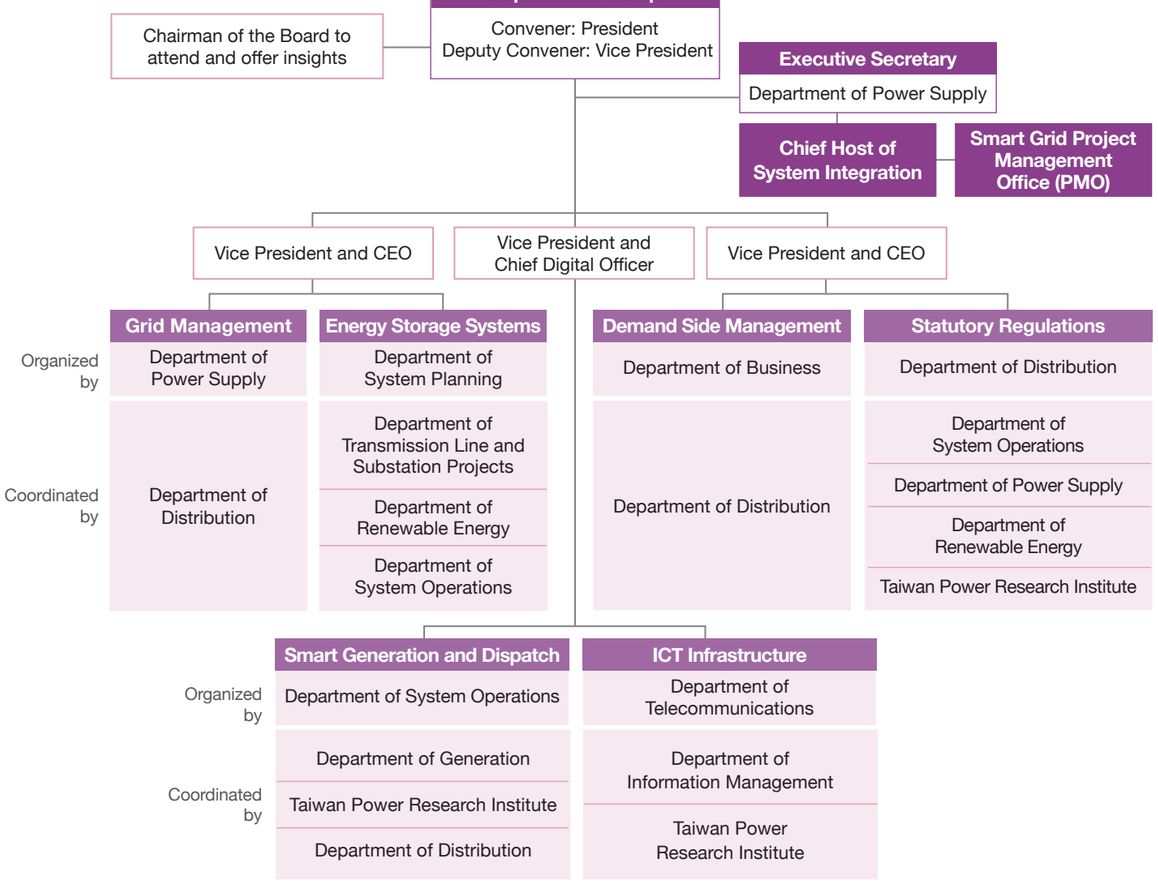
4.1 The Smart Grid General Planning Framework and Action Plan

4.1.1 The Smart Grid General Planning Framework

Smart grids are vital to driving energy transition, leading industrial transformation and new economic development. Taipower is proactively reducing the impact of intermittent renewable energy generation, enhancing grid resilience, and strengthening and consolidating power transmission and distribution systems. The Company is committed to improving disaster prevention and troubleshooting capabilities while increasing the system supply and demand performance, incorporating load management methods, enhancing user participation opportunities, and progressively building a stable and effective smart grid.

In developing the smart grid, the priority objectives are: (1) responding to the challenges of renewable energy grid-connection, (2) strengthening the resilience of existing grids to enhance the power supply quality in the face of extreme climates, and (3) encouraging user participation in energy conservation to improve power system operating efficiency. In response to the broader Smart Grid Master Plan, Taipower formed an internal Smart Grid Task Force with the Company's president as convener. Regular meetings with relevant units are held to review projects, execution status, and future planning directions.

Smart Grid Task Force

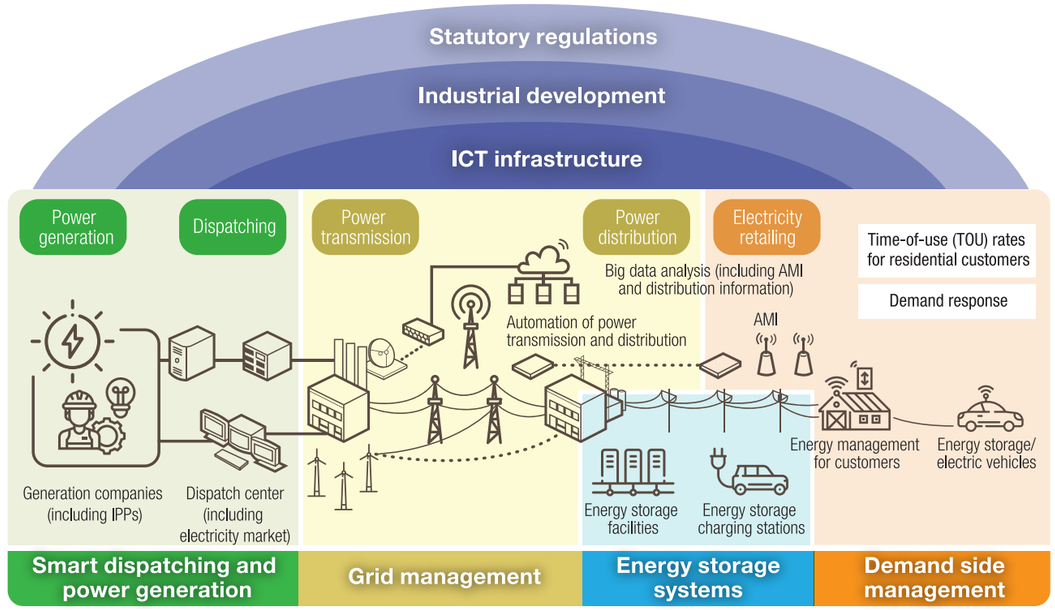


4.1.2 Smart Grid Action Plan

Taipower's smart grid action plan is aligned with the Smart Grid Master Plan as approved by the Executive Yuan on Mar. 27, 2020. The future smart grid strategic plan will be oriented towards problem-solving and focus on the system integration of smart grid functions. The Company has examined existing issues with the power system, revised the plan's structure and organized issues into seven major fields. The seven major fields are: smart dispatching and power generation, grid management, energy storage systems, demand side management, ICT infrastructure, industry, and statutory regulation. Among them, Taipower is responsible for the first five fields, while the Industrial Development Bureau is in charge of developing the industry, and the Bureau of Energy is in charge of statutory regulations.

The Current Development of Seven Major Fields of Smart Grid

Smart Grid General Planning Framework



In 2020, Taipower experienced several major achievements within the five fields under its purview. They are as follows:

Smart dispatching and power generation	Consolidating existing renewable energy generation and establishing an information management platform, creating a power market trading platform and coal-fired unit big data monitoring, and introducing a Distribution-level Renewable Energy Advanced Management System (DREAMS).
Grid management	Transmission system data planning, operation, and maintenance, information Consolidation to strengthen transmission and distribution asset management.
Energy storage system	Self-built 11.5MW of system capacity in 2020 (including a demonstration field) and procured additional ancillary services of 15MW, totaling 26.5MW.
Demand side management	Taipower is targeting potential power-saving users in its deployment of smart meters. The Company plans to complete a cumulative deployment to six million users by 2030. By the end of 2020, a total of 29,621 high-voltage AMIs and 1,096,869 low-voltage AMIs had been installed.
ICT infrastructure	Completed the installation of 65 kilometers of optical cables and 94 optical fiber communication systems, providing 773 communication circuits.

Taipower Smart Grid Planning Objectives

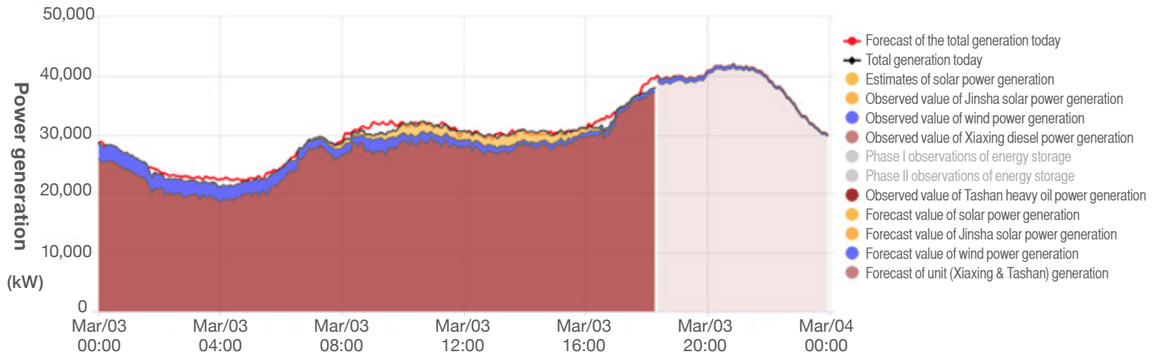
Smart dispatching and power generation	• Real-time monitoring capacity of renewable energy (GW) • Renewable energy forecast accuracy (day-ahead/hour-ahead error rate %) • Electromechanical outage rate (times/year) • Coal-fired plant unavailability index (EUF) (total hours of equivalent pipe downtime) • Ancillary service reserve (MW)
Grid management	• Average failure time of transmission system equipment (hours/year) • The proportion of power recovery outages in the downstream of automated feeder within 5 minutes (%)
Energy storage system	• The capacity of the energy storage system (MW)
Demand side management	• Automated Metering Infrastructure (AMI) (cumulative number of households) • AMI user power consumption data published online for query (hours) • Participation in demand response planning (GW)
ICT infrastructure	• Introduction of intrusion detection system security protection • Bandwidth increase for backbone/regional fiber optics system (bits/sec)
Industry development	Responsibility of the Industrial Development Bureau
Statutory regulations	Responsibility of the Bureau of Energy

4.2 Tracking Smart Grid Achievement - Kinmen Smart Grid Energy Consolidation and Applications

Renewable energy generation is booming in Kinmen. But as renewable energy is integrated into the system, its volatile generation will affect power plant operations and system stability. To mitigate these effects, Taipower has introduced two energy storage systems in Kinmen. A 2MW lithium battery energy storage system swiftly provides short-term power compensation by detecting and responding to system status. This makes the power supply and demand system more stable. Additionally, a 1.8MW sodium-sulfur battery system was designed to have a large storage capacity, and can be used continuously for up to six hours. It is charged during daytime when solar power is abundant and is discharged at night. This system is used in combination with diesel generators.

With the increasing proportion of renewable energy in the Kinmen power system, accurate generation prediction can reduce fuel costs that result from operating thermal units as a reserve. Currently, Taipower has consolidated forecast information for wind and solar power in the Kinmen area to develop a generation information platform that provides a reference for Kinmen's Tashan Power Plant's unit scheduling and maintenance management.

Kinmen Power Plant Generation



Taipower also established an Energy Management System (EMS) at the Tashan Plant in Kinmen. The system integrates information on diesel units, solar photovoltaics, and wind turbines and incorporates information on energy storage system status, grid structure, and user load forecasts to provide dispatchers with operational status for the next 24 hours. An AI algorithm is also used to provide power dispatching countermeasures.

Furthermore, an Advanced Distribution Management System (ADMS) is set up on the power distribution end in the Kinmen area. The system incorporates the management of distribution line structure and equipment status, and provides real-time power generation status control for over than 95% of the island's solar photovoltaics. This information allows Taipower to achieve user load demand assessments, automatic fault recoveries, and renewable dispatch, so as to improve power quality and reliability for users. Through the EMS and ADMS in the Kinmen area, Taipower is able to immediately assess Kinmen's power system situation and respond with the dispatch and coordination of different energy sources to maintain the stable operation of the system while moving towards the goals of becoming a low-carbon society and achieving sustainable development.

Schematic Diagram of Smart Grid