4.1 Strengthening the Smart Grid

4.1.1 The Smart Grid Action Plan

Smart grids are vital to driving energy transition and industrial development. Taipower is dedicated to mitigating the intermittency of renewable energy generation, enhancing grid resilience, improving transmission and distribution integration, and strengthening disaster response and troubleshooting. It also aims to optimize supply-demand management and boost user participation to build an efficient and stable smart grid.

The primary goals of smart grid development are:

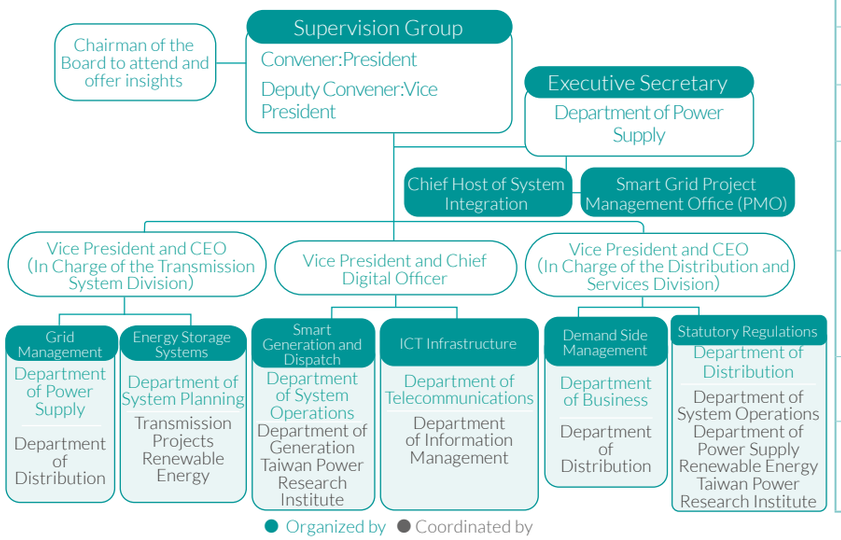
(1) addressing the challenges of integrating renewable energy

(2) strengthening existing grid resilience to improve power quality and cope with extreme weather; and

(3) encouraging user participation in energy conservation to enhance power system efficiency.

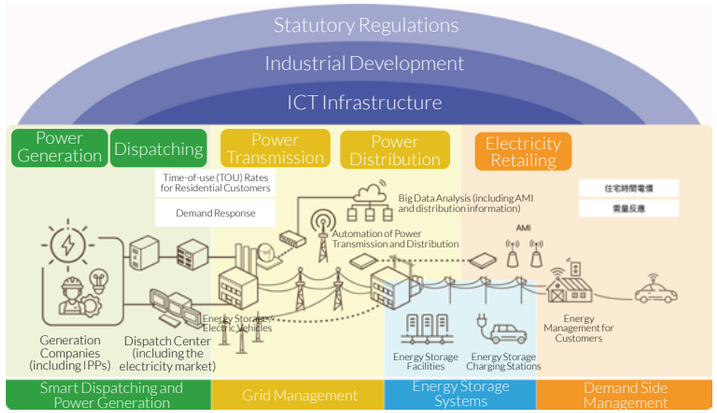
To implement the Smart Grid General Plan, Taipower established a Smart Grid Task Force chaired by the President. The task force holds regular reviews on project progress and future development to accelerate smart grid deployment.

Smart Grid Task Force



Smart Grid Action Plan

Taipower has been implementing smart grid infrastructure based on the Smart Grid Master Plan which was approved and revised by the Executive Yuan on March 27, 2020. The plan is structured around problem-solving and system integration, with 7 strategic areas, 21 specific measures, and 14 key checkpoints. Taipower is responsible for 6 of the 7 areas, 17 of the specific measures, and 13 of the key checkpoints. It continues to implement and regularly review progress to enhance energy management and grid resilience.



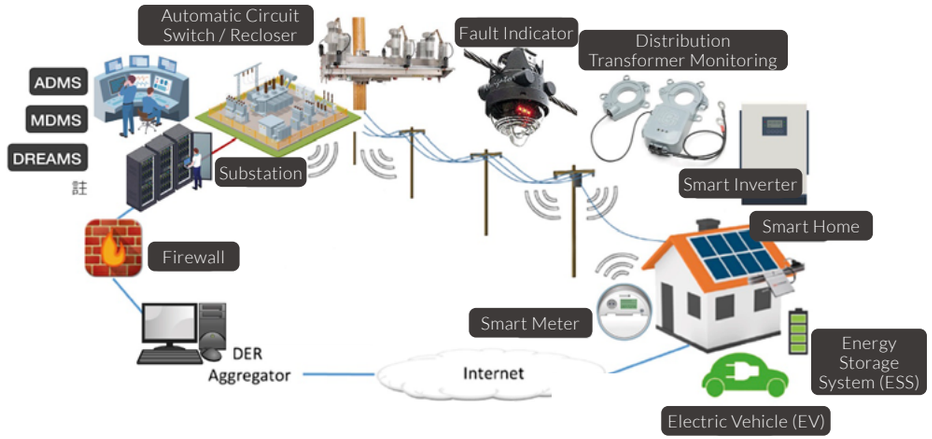
The Smart Grid General Planning Framework

Key Strategic Areas	Specific Practices
Smart Dispatching and Power Generation	● Establish a renewable energy generation monitoring system ● Establish an energy trading platform ● Establish a big data damage monitoring system for the boiler tubes of coal-fired units ● Undertake ancillary service demand research
Grid Management	● Apply and promote transmission system data in planning, operations, and maintenance ● Apply and promote feeder automation system data
Energy Storage Systems	● Construct an Energy Storage System at a Taipower site ● Establish an ancillary service procurement mechanism
Demand Side Management	● Establish a low voltage Automated Meter Infrastructure (AMI) ● Apply AMI data ● Review electricity price structures and run trials on dynamic pricing ● Review and run trials on various demand response schemes
ICT Infrastructure	● Enhance smart grid information security ● Enact a smart grid data application plan ● Establish an upgrade plan for backbone/regional fiber optics systems ● Introduce an electrical IoT communication system
Industrial Development	● Expand product and system services (Industrial Development Bureau) ● Drive enterprises to participate in the electricity market (Industrial Development Bureau)
Statutory Regulations	● Review current electricity-related regulations (BSMI) ● Refine interconnection technology for renewable generation systems ● Develop national standards and establish an equipment testing platform (BSMI)

The Construction of a Smart Grid

As the proportion of renewable energy generation continues to rise, the smart grid serves as a critical foundation for maintaining power supply stability. Through flexible scheduling, it helps stabilize grid operations and ensures overall system reliability. Taipower is promoting smart grid development in three phases. The first, Smart Grid 1.0, focuses on infrastructure building and has been under continued implementation. The second, Smart Grid 2.0, focuses on practical operations. The final phase, Smart Grid 3.0, will aim for full energy market liberalization and the effective integration of energy resources to enable widespread application. Taiwan is currently in the second phase, which emphasizes ensuring stable system operation, improving power quality, and encouraging user participation in energy conservation. Taipower is implementing an Advanced Metering Infrastructure (AMI) system, integrating AI, 5G, IoT, and big data technologies. By using smart meters, communication systems, and data management platforms, the Company consolidates data from generation, equipment operations, and electricity usage to enhance grid efficiency and supply reliability, while also promoting user participation in energy conservation. These efforts support digital transformation and the development of new business models.

Introduction to smart meter applications



Note:1. Advanced Distribution Management System, ADMS
2. Meter Data Management System, MDMS
3. Distributed Renewable Energy Advanced Management System. DREAMS
4. Source::Taiwan Power Company

Introduction to smart meter applications

Strengthening Communication Infrastructure

As part of its digital transformation efforts, Taipower completed communication system deployments in 2024 for key infrastructure, including Hsinta Power Plant's Unit 1, the Changhua Industrial Substation, secondary substations, and service centers. The expansion and upgrade of the Ultra-High-Speed IP Fiber-Optic Communication System, including card module extensions, addressed the bandwidth needs of smart grid, AI, and IoT applications, improving power supply stability. Going forward, Taipower will continue expanding its fiber-optic communication systems to increase bandwidth and communication reliability, thereby strengthening its digital infrastructure

Communication Infrastructure and Upgrades

1.Optical Transport Network (OTN):Planned deployment to meet the high bandwidth demands of Taipower's future cloud data centers.
2.Microwave Communication System Upgrade:Enhances grid dispatching and power supply stability.
3.Strengthening Communication for Power Plants, Substations, and Service Centers (2024 Achievements):

- 106 kilometers of optical cables deployed.
- 61 sets of transmission equipment installed.
- 1,982 communication circuits provided (for relay protection, dispatching lines, and feeder automation).

Enhancing Smart Grid Information Security Management

Taipower has established a secure and high-efficiency fiber-optic network to support smart grid applications such as monitoring, smart substations, distribution automation, and Advanced Metering Infrastructure (AMI). The network also provides IP broadband and power IoT communication services. The Company continues to enhance cybersecurity, data applications, and communication technologies to support smart grid development and energy digital transformation.

1.Strengthening Cybersecurity for Smart Grids:Taipower is implementing Intrusion Detection Systems (IDS) and integrating with its Security Operation Center (SOC). As of now, deployment has been completed at 23 Operational Technology (OT) sites, with full implementation across all dispatch centers expected by 2025.
2.Smart Grid Data Applications:Taipower is developing a Common Information Model (CIM) and establishing a big data analysis and data-sharing platform to improve data utilization efficiency.
3.Fiber-Optic System Upgrade:Backbone and regional fiber-optic communication capabilities are being enhanced to support smart grid development.
4.Power IoT Implementation:A dedicated enterprise network is being developed. Taipower is also evaluating self-built, partnership, and lease models to optimize the power of IoT applications and benefits.

4.1.2 Smart Grid Applications

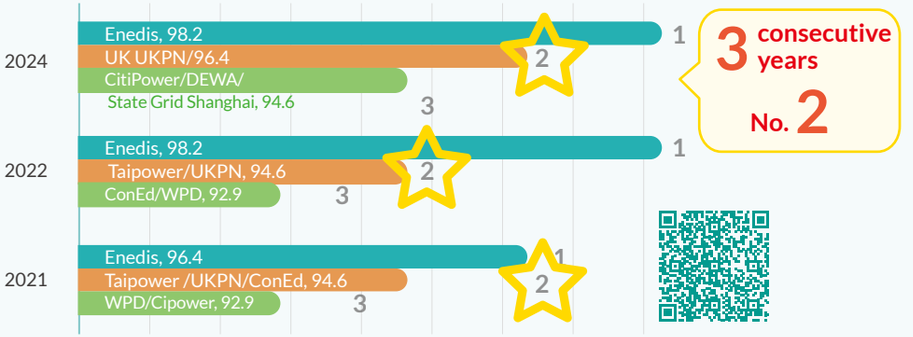
Vehicle-to-Grid (V2G) Technology

Taipower Partnered with Gogoro to Build the World's First Electric Scooter V2G Battery Exchange Station

Energy transition, working to achieve net-zero-carbon emissions, and the increasingly widespread adoption of electric vehicles have all make the effective conversion of electricity demand into power supply a significant challenge. In response, Taipower is exploring diverse power sources that go beyond the conventional paradigm of large-scale power plant construction, while actively developing renewable energy. In 2021, Taipower partnered with Gogoro to establish the world's first electric scooter battery swapping station featuring Vehicle-to-Grid (V2G) functionality. This pioneering initiative enables bidirectional power flow, supports the development of decentralized virtual power plants and new electricity trading models, and enhances grid stability. While V2G technology is becoming more mature, its commercial models and infrastructure such as bidirectional chargers are still under development. Taipower will continue to adjust its strategy based on the growth trends of electric vehicles and charging infrastructure as well as the extent of support provided by international carmakers, to maximize the storage potential of EVs.

Smart Grid Index, SGI

The Singaporean Smart Grid Index (SGI) is an international benchmarking system that evaluates smart grid development across power utilities based on seven core dimensions: customer empowerment and satisfaction, cybersecurity, green energy, distributed energy integration, power reliability, data analytics, and monitoring and control. The evaluation covers companies from the Asia-Pacific region, Europe, and the Americas. After rising to 2nd place in 2021, Taipower retained the 2nd position in both 2022 and 2024. Going forward, Taipower will continue to advance smart grid development and participate in international benchmarking to stay aligned with global smart energy trends.



Smart Grid Index (SGI) by Singapore Power (SP) Group

Smart Streetlights:Illuminating the Path to Smart Cities

Countries including the U.S., U.K., Germany, Canada, South Korea, and Japan are actively building smart cities and promoting smart streetlight systems. In Taiwan, cities such as Taipei, Taoyuan, and Kaohsiung have already implemented smart streetlights capable of wireless data transmission, enabling automatic fault detection and shortening repair time to improve public safety. These smart streetlights use 130-watt energy-saving LED lights (in contrast to traditional 400-watt bulbs) and are equipped with adaptive dimming systems to reduce electricity costs and carbon emissions.

In addition, lamp posts are integrated with 5G base stations and sensors to expand signal coverage and collect environmental, traffic, and weather data, thereby improving public service capabilities. Smart streetlights can also be integrated with traffic signals, community surveillance, and electronic signage to provide real-time information such as weather updates, news, and bus schedules. This helps reduce physical space usage and contributes to creating a more aesthetic and safer urban environment.

Smart Grid Performance in 2024

Under the Smart Grid Master Plan approved by the Executive Yuan, Taipower is responsible for six of the seven strategic areas. In 2024, the Company recorded major achievements in five of these areas. Key performance highlights are as follows:

1. Smart Dispatch and Power Generation: Taipower integrated real-time renewable energy generation data and established an information management platform, a power market trading platform, and a big data monitoring system for coal-fired units. It also introduced the Distribution-level Renewable Energy Advanced Management System (DREAMS). Real-time monitorable renewable capacity reached 8.44 GW in 2024.
2. Grid Management: Taipower planned, operated, and maintained transmission system data, and consolidated information to strengthen asset management for transmission and distribution systems. In 2024, the average failure time of transmission system equipment was 0.0 hours per year.
3. Energy Storage Systems: The installed capacity of energy storage systems reached 1,420.3 MW in 2024.
4. Demand Side Management: Taipower focused its Automated Metering Infrastructure (AMI)deployment on users with high power-saving potential. By the end of 2024, a cumulative total of 3.403 million AMI installationshad been completed.
5. Information and Communications Technology (ICT) Infrastructure: Completed 106 km of optical cable deployment, installed 61 sets of fiber optic communication systems, and provided 1,982 communication circuits.

2024 Asia-Pacific Power Awards
Smart Grid of the Year – Taiwan
Integrate distributed energy resources to provide ancillary services to the power system

Smart Grid Performance and Targets

Review Item		2024 Target	2024 Performance	2025 Target (Approved by Executive Yuan)
1 Real-Time Monitorable Capacity of Renewables (GW)		9	8.44（Wind 3.88、Solar 4.56）	16.5
2 Forecast Accuracy for Renewables (Day-ahead / Hour-ahead Error Rate, %)	Wind Power	13/6.5	10.72/3.3	10/5
	Solar Photovoltaics	12/6	3.59/2.3	10/5
3 Ancillary Service Reserve (MW)	Frequency Regulation Reserve	1,000	1,125	1,300
	Real-Time Reserve	1,100	1,150	1,100
	Supplemental Reserve	1,100	1,197	1,100
4 Number of Power Equipment Incidents (Cases/Year)		16	12	15
5 Equivalent Unavailability Factor (EUF) of Coal-Fired Units (Equivalent Tube Rupture Downtime Hours)		1.35%（118小hours /unit/year）	0.0%	1.2%（105 hours /unit/year）
6 Average Failure Time of Transmission System Equipment (Hours / Year)		1.425	0.0	1.42
7 Percentage of Downstream Automated Feeder Outages Restored within 5 Minutes (%)		58%	66.4%	70%
8 Installed Capacity of Energy Storage Systems (MW)		657	1,420.3	590
9 AMI Smart Meter Infrastructure (Cumulative Households)		3 million	3.403 million	350 million
10 Time to Make AMI User Electricity Data Available Online		5 hours	4 hours	4 hours (2 hours for TOU users)
11 Demand Response Participation (GW)		2.75	3.4	2.8
12 Backbone/Regional Optical Fiber Bandwidth (Gbps)		Regional::10 Gbps Optimization	Procurement for Next-Gen OTN system published (2024.12.19–2025.01.13)	Regional: 10 Gbps (Completed 2023)
13 IDS Cybersecurity Deployment		One regional distribution dispatch center completed	1. 8 sites deployed and integrated into SOC 2. procurement for 11 more underway	All 32 dispatch centers completed
14 Smart Grid Output Value (Industrial Development Bureau)		Accumulated NT$ 368 billion (NT$ 40.3 billion annually)	Accumulated NT$ 392.3 billion (NT$48 billion annually)	Accumulated NT$400 billion (NT$43 billion annually)