3 Provider of Sustainable Power

Development Vision

A stable supply of electricity is crucial to public livelihood, industry, and economic development. By continuously providing a stable power supply throughout Taiwan, Taipower plays a vital role in the nation's overall economic development. As energy transition continues, the proportion of renewables used will rise. As renewables increase, the unstable nature of their generation will make meeting future electricity demands challenging.

Taipower is eagerly developing diversified energy sources on the supply side. It has prioritized three major areas of development: renewable energy, low-carbon gas, and the renewal of coal-fired power units with ultra-supercritical (USC) generation units. These measures are expected to stabilize the electric system. Other measures include improving the reliability of power generation, transmission, substations and distribution. Meanwhile, Taipower is continuing to make good use of opportunities in power dispatching and constantly upgrading its thermal power generating units to increase the proportion of gas-fired energy. Taipower will continue to implement its energy transition goals and enhance the Company's operational capabilities and market competitiveness.

Performance Highlights

- Strengthen the power transmission and substation systems. The total investment in the 7th Transmission and Substation Revision Project will be about **NT$236.9 billion** (to 2025). By the end of 2021, substation capacity had reached **16,035.98 KVA** (92.95%) and **1,799.54 circuit kilometers** (94.71%) of lines had been completed.
- In 2021, the total length of the underground transmission cable reached **4,639.6 circuit kilometers**.
- In 2021, Taipower's operational renewable capacity was **1,800 MW** for hydropower, **297 MW** for wind power, and **284 MW** for solar power.
- The gross thermal efficiency of all thermal power plants has increased year on year, from **46%** in 2020 to **46.1%** in 2021.
- In 2021, wind power generated **774.4 GWh** and solar power generated **408.8 GWh**.
- The progress of renewal, expansion and new thermal generating unit projects in 2021 was as follows: the Linkou Plant (99.22%), Phase 1 of the Tonghsiao Plant (99.85%), the Datan Plant (63.72%), the Hsinta Plant (38.97%), the Taichung Plant (10.83%).

3.1 Providing Quality Electricity Service

3.1.1 A Stable Power Supply and Generation System 103-2 103-3 203-2

A Stable Power Supply and Installed Capacity

In recent years, Taiwan's power consumption has repeatedly hit historical highs. Since Taipower is responsible for ensuring a stable power supply, this has meant persistently pushing power development projects and planning to launch new generating units every year. In terms of managing the operation of thermal power generating units, apart from refining various operational maintenance strategies, Taipower has established a licensing system and a retraining mechanism for staff with the goal of ensuring stable daily operations. For nuclear power plants, core management measures include analyzing and reviewing the operational weaknesses of each nuclear power plant, strengthening management of operations during overhauls, improving and renewing equipment, as well as reviewing unplanned events in the current year. As shown in the following table, the percentage of energy generated and purchased from renewable sources continues to increase, and the average availability of each plant generator remains stable.

Total Amount and Composition of Power Generation from 2019 - 2021

	2019		2020		2021	
	Billion kWh	Percentage	Billion kWh	Percentage	Billion kWh	Percentage
Net amount of power generated and purchased	**232.5**	**100.0%**	**238.9**	**100.0%**	**248.8**	**100.0%**
Amount of power generated	**180.4**	**77.6%**	**183.9**	**77.0%**	**189.1**	**76.0%**
Pumped storage hydro	3.2	1.4%	3.1	1.3%	3.2	1.3%
Thermal	140.6	60.5%	147.0	61.5%	155.2	62.4%
Nuclear	31.1	13.4%	30.3	12.7%	26.8	10.8%
Renewable energy	5.5	2.4%	3.4	1.4%	3.9	1.6%
Amount of purchased power	**52**	**22.4%**	**55.1**	**23.0%**	**59.7**	**24.0%**
Privately-owned thermal	39.4	16.9%	40.6	17.0%	42.7	17.1%
Renewable energy	8.5	3.7%	10.4	4.3%	11.9	4.8%
Cogeneration	4.1	1.8%	4.1	1.7%	5.1	2.1%

Average Availability Rates for Power Plants from 2019-2021

Unit: %

Unit		Energy type	2019	2020	2021
Thermal	Steam	Coal	82.65	86.82	89.12
		Oil	93.83	87.01	92.74
		LNG	73.70	95.51	82.33
	Combined cycle	LNG	88.00	87.98	88.13
Hydro		Hydro	94.30	96.81	96.09

Average Availability Rates for Nuclear Power Plants from 2019-2021

Unit: %

Year	NPP1		NPP2		NPP3	
	Reactor 1	Reactor 2	Reactor 1	Reactor 2	Reactor 1	Reactor 2
2019	(Note 1)	(Note 2)	100.00	88.03	87.38	97.11
2020	-	-	87.29	88.81	99.36	86.71
2021	-	-	50.43 (Note 3)	98.02	88.09	88.85

Note: Annual availability of nuclear power units = Annual interconnection generation hours/Total annual hours

1. Reactor 1 of Nuclear Power Plant 1 (NPP1) entered the decommissioning stage on December 5, 2018, when its operating license expired.
2. The operating license for Reactor 2 of Nuclear Power Plant 1 (NPP1) expired on July 15, 2019, and remained in shut-down condition during the year.
3. Reactor 1 of Nuclear Power Plant 2 (NPP2) was originally scheduled to remain shut down from February 25, 2021 due to a full fuel pool until the expiration of its operating license on December 27. However, in order to maximize the supply efficiency of the nuclear fuel before decommissioning, the reactor's life was extended until July 2 in a decreasing power operation mode. It was shut down for maintenance until the expiration of the operating license on December 27. The reactor then entered the decommissioning stage.

Increasing the Reliability of the Power Supply

Taipower has a complete power dispatch and reliability management mechanism. Specific action plans are as follows:

Power Dispatch and Reliability Management Mechanism

Regular Review and Analysis	Execution method	• Conduct regular electromechanical system incident review meetings • Conduct regular power dispatch system incident review meetings
	Execution status	• In 2021, electromechanical system incident review meetings were held each month to review and analyze the causes of electromechanical outages for systems above 161kV and make follow-up improvements. • In 2021, power dispatch system incident review meetings were held every two months to ensure the normal operation of energy management system (EMS) related software/hardware and peripheral equipment and the safe and stable operation of power dispatching.
Risk Management Implementation	Execution method	• Given the impact of different power incidents on power dispatching reliability and stability, power shortages affecting system stability and safety were listed as risk control events. Risk levels were determined according to the degree of impact and measurement standards in different scenarios. Also, relevant measures were formulated for tracking and control. • Quarterly follow ups on reviews and execution. • Conducted a general review at the end of the quarter and set future control objectives.
	Execution status	• On December 30, 2021, a review of the execution and effectiveness of the response to power shortages affecting system stability and safety for the fourth quarter of 2021 was conducted. • On February 5, 2022, a meeting was held to review the execution responses to power shortages affecting system stability and safety in 2021. These meetings also conducted continuous adjustments and set control objectives for 2022.
Personnel Training	Execution method	• In preparation for the future electricity market transaction mechanism defined in the Electricity Act, regular on-the-job training was carried out to relay concepts of electricity market operation and quotations for business personnel. • Online dispatchers trained and conducted license certification examinations for new dispatchers. Licensed personnel may renew their licenses after completing a certain number of retraining hours every three years.
	Execution status	• The training center conducted the first Electric System Reactive Power and Voltage Adjustment Seminar. The training targeted on-duty or business-related personnel from the dispatch centers (central, regional, distribution), power plants, IPPs and ultra-high voltage substations with a total of 27 participants. • Dispatchers who passed the examination after completing the training internship can participate in the dispatcher license examination. No dispatcher licenses were issued in 2021 due to the pandemic. Despite this, eight senior dispatchers and seven dispatchers were approved for license renewals.

Taipower actively implements the power supply management mechanisms listed in the table above. This approach helps to ensure a stable power supply throughout Taiwan. Despite this, ensuring reliable power supplies for offshore islands is more challenging because they are not connected to the main island's grid. Therefore, Taipower is proactively assisting the offshore islands in improving their electric systems to ensure offshore users have access to the same electricity services as are available on the main island. For example, the electric system in the Kinmen area has been improved by adopting the group operation model of generators and substations in the area to resolve problems with overly concentrated units and lines at the Tashan Plant. This helps to avoid complete blackouts in the area should an electrical system outage occur.

Simultaneously, Taipower undertook planning to integrate the Penghu regional grid into the main island's through synchronization. A new primary substation project was completed in Penghu and the first 161kV transmission-grade submarine cable (Penghu-Beigang, Sihu Circuit No.2) in the country successfully connected the Taiwan system with the Penghu system at the end of October 2021. A second 161kV transmission-grade submarine cable (Penghu-Beigang, Sihu Circuit No.1) also joined the system in November 2021. The 161kV transmission-grade double circuit supply from Taiwan to Penghu makes power dispatching more flexible. In addition to improving the power supply stability in the Penghu area and reducing the use of local thermal power, it can also send the abundant renewables energy from the Penghu area back to the main island to strengthen broader grid stability.

Power Supply Reliability Results from 2019 to 2021

		2019		2020		2021	
		Target	Performance	Target	Performance	Target	Performance
The average duration of outages (minutes/household · year)	Work blackout	12.481	12.125	12.253	11.696	12.213	11.7324
	Outage blackout	4.619	4.363	4.547	4.235	4.487	48.1593
	Total	17.1	16.488	16.8	15.931	16.7	59.8917
The average number of outages (times/household · year)	Work blackout	0.064	0.059	0.064	0.059	0.064	0.0586
	Outage blackout	0.206	0.150	0.196	0.171	0.196	1.0381
	Total	0.270	0.209	0.260	0.230	0.26	1.0967

Note: Excluding power outage incidents on May 13 and May 17, the average interruption frequency per household in 2021 was 0.233 (times/household, year), and the average interruption duration per household was 16.376 (minutes/household, year).

Line Loss Rate from 2019 to 2021

2019	2020	2021
3.86 %	3.97 %	3.53 %

Responding to the Nationwide Power Outage of March 3, 2022

At 9:07 a.m. on March 3, 2022, the lock-out trip of a communication bus protection relay at Hsinta Power Plant activated the protection mechanism for five extra-high voltage (EHV) substations including Longqi and Lubei. Generating Units in southern Taiwan at Dalin, Nanbu, Hsinta, NPP3, Mailiao, Jiahui and Fengde were all affected and tripped. This reduced the supply capacity by 10.50 GWh in total – the equivalent of one-third of the electricity demand in Taiwan on that day – and affected about 5.49 million households. The power was fully restored at 9:31 pm.

The incident was caused by the failure of an operator to confirm the insulated gas pressure during the isolation switch test during the environmental shutdown and overhaul of Generator 2 at the Xinda Power Plant. The error results in a short-circuit grounding fault in the switchgear, which triggered subsequent events. Due to the imbalance between supply and demand in the southern region caused by the tripping of the Generator, the system automatically disconnected for its own protection. The power system in Taiwan is affected by instantaneous frequency changes, and the imbalance between power supply and demand caused outages in the southern region. Some users in the central and northern regions also experienced power loss due to low-frequency relay actuation.

Taipower has reviewed and responded proactively to the power outage on March 3. In particular, the Company has acted to mitigate problems due to human negligence. Taipower will continue to conduct a comprehensive review and develop improvement measures. In addition to implementing on-site standard operation procedures (SOP), reviewing various preventive mechanisms, and completing the interface for construction, Taipower is refining the operation and maintenance mechanisms of its power facilities and working to strengthen personnel risk analysis and management capabilities. It is also working to comprehensively enhance grid resilience so as to avoid the recurrence of similar incidents.

Facing the Challenge of Natural Disasters

Natural disasters are a significant challenge for Taipower's operations. In terms of internal management, Taipower has a complete disaster prevention and emergency response system, with comprehensive disaster prevention policies and regulations. In addition to all kinds of disaster education and training, random checks are conducted so that all units can effectively and promptly respond to natural disasters and major power supply outages.

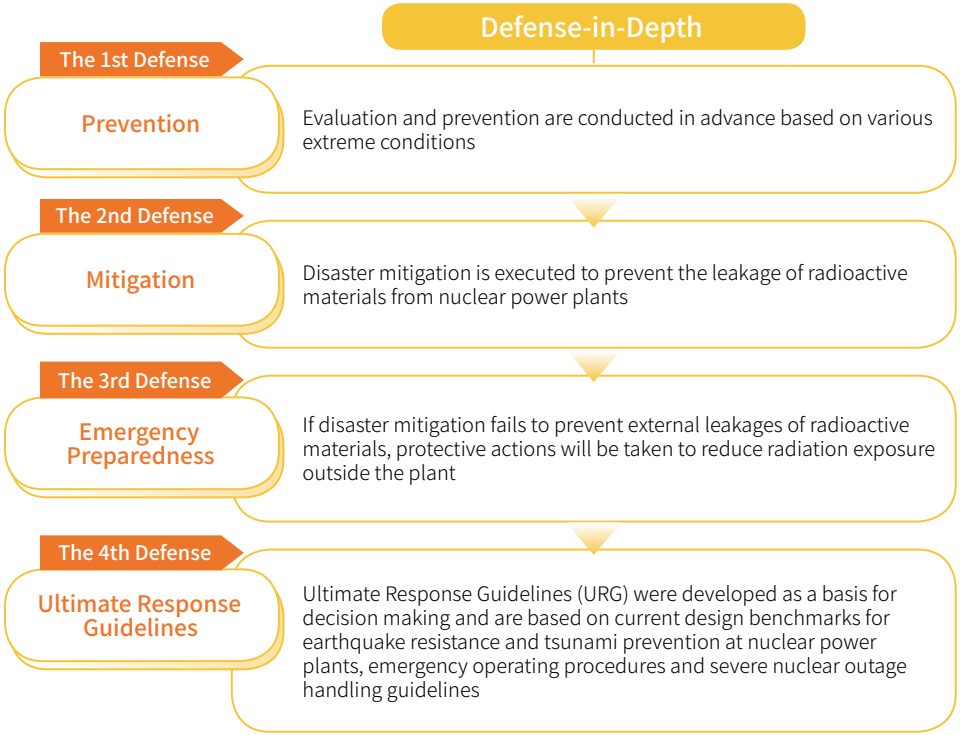
In terms of external response, Taipower's branch offices issue at least one local press release every day before, during, and after each typhoon to reinforce public awareness of disaster prevention and preparation. The Company has also established the Taipower 1911 customer service hotline, a power outage inquiry and notification system on the official website, and an "apply/repair" function on the Taiwan Power application for the public to report blackouts. Branch offices have additionally established real-time communication channels through social media community groups, telephone, fax or e-mail, and other channels based on regional characteristics. This is to ensure comprehensive control and that the power recovery status of users can be confirmed, so that incidents are handled as soon as possible.

Ensuring Nuclear Power Safety

Taipower adheres to the concept of "defense-in-depth" to ensure the safe operation of its nuclear power plants. Taipower aims to:

- Ensure that nuclear power facilities have the highest standard of design, construction, supervision, and quality control in accordance with regulatory mandates. Additionally, geographical considerations are taken into account for each unit's equipment. Potential natural disasters, such as earthquakes, tsunamis, typhoons, tornados and floods, are evaluated in detail to provide "defense-in-depth" thinking that can cope with burst outages.
- Utilize multiple physical barriers that are designed to prevent leakages of fission products from nuclear reactors.
- Employ different and redundant security systems that are well maintained an in operation. These systems must be tested regularly according to regulations to maintain a high degree of readiness to respond to any contingency.

In practice, the Company's approach to "defense-in-depth" incorporates the following four lines of defense.



Taipower has joined the Nuclear Procurement Issues Corporation (NUPIC) of the United States and regularly participates in meetings. This allows the Company to obtain audit information on purchase vendors for each nuclear power plant. It ensures the quality and safety of equipment and components. Taipower also abides by the Enforcement Rules of the Nuclear Materials and Radioactive Waste Management Act. The Company submits reports on radioactive waste treatment, storage, and final disposal to the competent authority, along with reports on the annual operation, radiation protection, and environmental radiation monitoring. Taipower's management and outage response mechanism for nuclear energy are described in the table below.

Taipower's Nuclear Energy Management and Outage Response Mechanism

Routine preparedness	Organize emergency response plan training	• The emergency staff of nuclear power plants and the Nuclear Emergency Preparedness Executive Committee are given regular training according to the expertise of their task forces to maintain outage handling capacity. • Emergency response training includes both general and professional training. The above-mentioned emergency staff undergo general training once every two years and professional training annually.
	Organize in- and out-of-plant emergency response plan drills	• In addition to holding an in-plant drill once a year at each nuclear power plant, Taipower coordinates with the central and local governments, military police, medical and other units in turn to conduct one nuclear safety drill every year at each operating nuclear power plant. Taipower invites experts and scholars, in addition to representatives from competent authorities, to evaluate the response measures of these drills so that the emergency response plans and actions can be gradually improved. • In September 2021, Taipower held "Nuclear Safety Drill No. 27" at Nuclear Power Plant 1 (NPP1). Nuclear Power Plant 2 (NPP2) and Nuclear Power Plant 3 (NPP3) also conducted emergency response planning drills to for nuclear power plants in November and July respectively.
	Construct and implement emergency preparedness performance indicators	• Each nuclear power plant will implement the following three emergency preparedness performance indicators and report on them to the Atomic Energy Council every quarter as part of the control measures taken by the nuclear energy regulatory entity to ensure the preparedness of nuclear power units. 1. Drill/drill performance. 2. Participation in the drills of the emergency response organization. 3. Reliability of the warning and notification system.
Response operations in case of outages	Take emergency measures	• When a nuclear outage occurs, the nuclear power plant will perform unit rescue operations in accordance with the provisions of the emergency response operating procedures of the plant. • In accordance with the Nuclear Emergency Response Act, nuclear accidents shall be properly classified according to the degree of possible impact, and response and notification provisions shall be formulated accordingly. Under the provisions of the Nuclear Accident Categories Notification and Response Measures, accidents are classified into the following three categories based on the degree of possible impact: 1. Emergency Preparedness Alert: Upon the occurrence or possible occurrence of a significant safety deterioration of nuclear reactor facilities which does not yet require the implementation of a Nuclear Emergency Public Protective Action. 2. Site Area Emergency: Upon the occurrence or possible occurrence of a significant failure of the safety function of the nuclear reactor facility which may require the implementation of a Nuclear Emergency Public Protective Action. 3. Full-scale Emergency: Upon the occurrence or risk of a severe core deterioration or meltdown of the nuclear reactor facility and possible loss of containment integrity which requires the implementation of a Nuclear Emergency Public Protective Action. • If the outage cannot be effectively controlled and may affect the people or environment outside the plant, the relevant government units shall activate the National Nuclear Emergency Response Center, the Nuclear Radiation Monitoring and Dose Assessment Center, the Regional Nuclear Emergency Response Center, and the Nuclear Emergency Support Center, as per the Nuclear Emergency Response Act. These entities will jointly perform various disaster relief operations outside the plant where the outage occurred to ensure the safety and well-being of the public.
Post outage recovery operations	Damage assessment and recovery measures	• After the cause of a nuclear outage has been eliminated and the National Nuclear Emergency Response Center has confirmed that all emergency response measures have been completed, the emergency response organization's mandate will be lifted. • After receiving notification from the Nuclear Emergency Recovery Committee, Taipower will carry out recovery operations such as facility damage assessments and recovery according to the task division for each unit. • Taipower is responsible for the recovery of the units within the plant. It has developed and established disaster recovery plans and operating procedures. The emergency control team leader for the plant will command an in-plant restoration organization that carries out recovery operations based on the plant's situation.

3.1.2 A Robust Transmission and Distribution System 203-1

In response to the planned energy transition, Taipower has vigorously promoted renewables. However, due to geographical limitations, solar and wind power generation are mostly concentrated in the central and southern regions. Moreover, with the development of the nation's high-tech industry, the power demand of the Science Parks in the country is increasing, and there is a trend towards concentration in power supply and load centers. Faced with such arduous challenges, Taipower's transmission and distribution system will need to effectively and reliably deliver the power generated by plants in various places to the distribution system and ultra-high voltage (UHV) users. To accomplish this, Taipower has rolled out projects such as Phase 1 of the Offshore Wind Power grid reinforcement, a UHV substation expansion at the Southern Taiwan Science Park, and a Baoshan UHV substation construction project that strengthens grid power integration capabilities and introduces static synchronous compensation equipment that improves regional voltage control. The projects are expected to provide sufficient, high-quality, safe, stable, and reliable power to expedite the development of the nation's high-tech industry and enhance international competitiveness.

Improving the Accessibility of Power

In order to comply with the Electricity Act and exercise social responsibility by maintaining the public's rights and interests through a stable power supply, Taipower has established 24 branch offices and 265 service centers in Taiwan, Penghu, Kinmen, and Matsu. Power supply facilities are installed to increase the availability of power supply in cooperation with local construction and applications. The Company also regularly convenes Timely Power Supply Review Meetings in response to individual applications for electricity and to continuously improve the accessibility, stability, and reliability of power services and ensure the right of equal access to required power services.

Currently, only a few remote areas have no electricity supply. This is typically due to limited access that inhibits the movement of construction equipment and engineering vehicles to the sites and makes the construction of poles difficult. Additionally, setting up electricity in some remote areas may have an impact on the local environment and natural landscape. With the exception of these remote areas, the national power supply penetration rate has reached more than 99.99%. As of December 2021, Taipower has built 619 distribution-level substations and 10,138 feeders.

Strengthening the Infrastructure of the Power Grid

The grid is a connective hub between the power generator and the customer. A sound power grid can effectively reduce the possibility of power outages and maintain the quality of the power supply. Over the years, Taipower has built a dense network around the country to ensure that people are able to use electricity conveniently. Regular maintenance of related facilities is also an important part of a stable power supply. Taipower will continue to promote plans that increase the power grid's resilience, to replace old facilities and lines in order to reduce the line loss rate year by year as well and to maintain a high-quality supply of electricity.

Taipower's current performance indicators for power supply reliability are the System Average Interruption Duration Index (SAIDI) and the System Average Interruption Frequency Index (SAIFI). In May 2021, the 513 and 517 power outage incidents caused the SAIDI to increase to 59.8917 minutes/household, and the SAIFI to increase to 1.0967 times/household. If these two incidents are excluded, the SAIDI was 16.376 minutes/household, and the SAIFI was 0.2331 times/household.

Considering the expected global climate changes of the future, the unstable nature of renewables which is likely to cause an imbalance between supply and demand, and the aging of existing power transmission and distribution facilities, the entire system of power generation, transmission and distribution should continue to reinforce various prevention and system improvement measures. Taipower will constantly strengthen line maintenance and equipment improvement to reduce outages and to ensure power supply quality. Additionally, as intermittent renewables, which may affect the system stability, are added to the grid, Taipower is devoted to grid-connection dispatching and strategy research. As such, the Company has built a generation information consolidation platform and other related systems to help it actively respond to future challenges.

Strengthening Power Transmission and the Substation System

In response to economic growth, Taipower continues to strengthen the overall power grid through power transmission and substation projects, reinforcement of transmission capacity for the main line system, and optimization of power supply capacity for ultra-high voltage, large-scale customers. The Company is also working to complete construction projects as scheduled while maintaining quality.

Increasing the Reliability of Power Distribution

To reduce the cost of generation and increase power supply capacity, the distribution and sales system utilizes a target value for the distribution line loss rate allocated by the Department of System Operations. Branch offices are instructed to find improvements for lines and for anti-distortion of electricity to reduce network losses. Additionally, in consideration of the distribution system's adaptability and wheeling capabilities in the event of outages, Taipower has formulated distribution system planning guides and established management targets to reduce feeders with currents exceeding 300A.

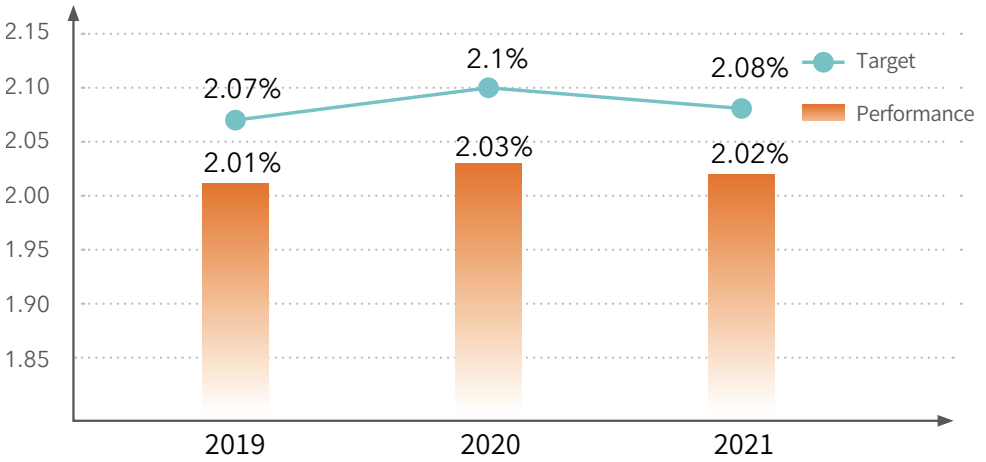
All branch offices and the Department of Distribution regularly conduct high voltage outage review meetings on assessments and improvements in power supply reliability. They review the average outage performance of the distribution system, the causes of major outages, and formulate improved countermeasures to determine the best improvement strategy for each outage. The Company also conducts yearly reviews of possible risk factors that affect the stability and reliability of the power supply. These reviews include risk management controls for the following year. Implementation performance is then tracked and reviewed regularly. In addition,

Taipower regularly organizes on-the-job education and training for maintenance personnel and dispatchers to advance professional skills and strengthen maintenance capabilities.

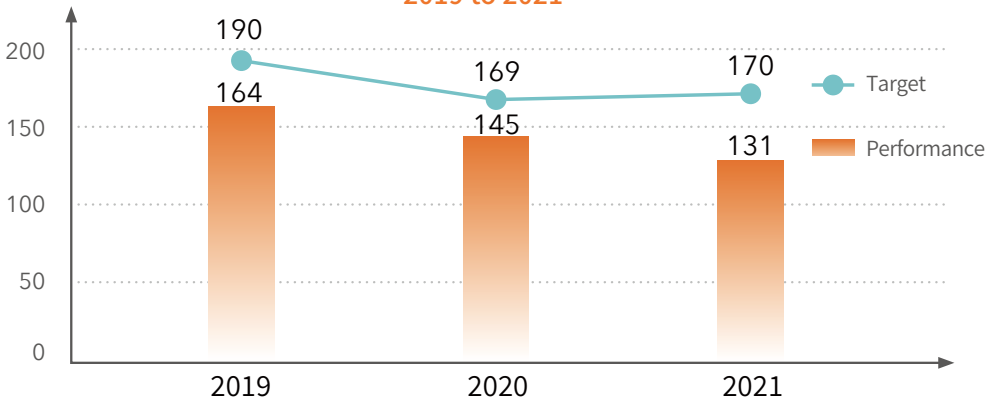
Taipower is working to strengthen its audit operations by evaluating and examining equipment operation periodically, and by supervising each branch's outage prevention and improvement plans to reduce the possibility of human negligence and improper operation.

As Taiwan moves towards energy transition and a new generation of power supply systems, Taipower has accelerated the automation of its distribution feeders. This not only helps to improve the quality of the power supply but also enables fault detection. Through remote control of on-site automatic line switches, outage areas can be isolated promptly to reduce the scale of power failures. At present, a feeder automation system has been implemented for industrial areas, vital metropolitan areas, and remote areas that are difficult to repair, with a penetration rate of about 78.6%. In the future, Taipower will continue to push forward and raise the target value of feeder construction, and is expecting to achieve full feeder automation by 2025.

Distribution Line Loss Rate from 2019 to 2021



Reduction of Feeder Lines with Currents Exceeding 300A from 2019 to 2021



Distribution Feeder Automation Installations from 2019 to 2021

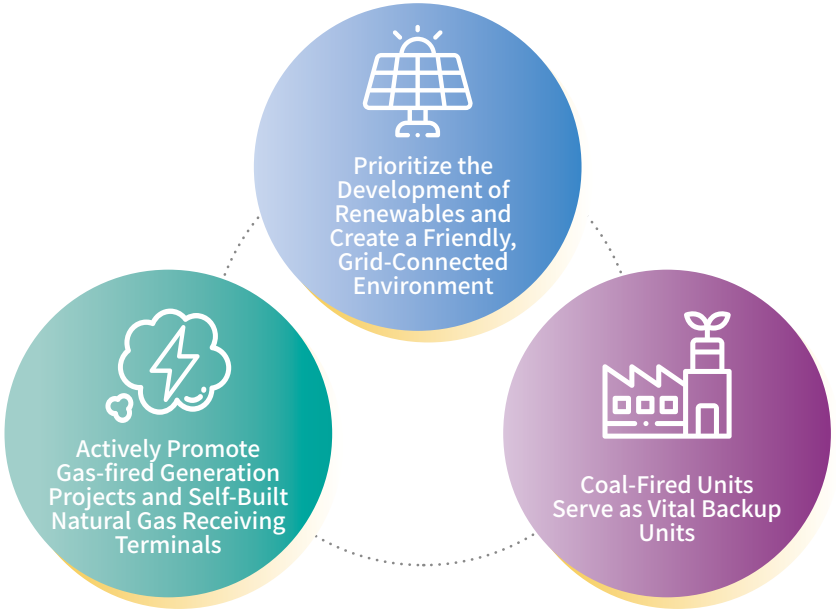
Performance	2019	2020	2021
Feeder Automation	7,590 lines	7,815 lines	7,969 lines
Switch Automation	970 units	1,304 units	1,422 units

3.2 Planning for New Sources of Energy

3.2.1 The Transition to a New Generation of Energy 103-2 103-3 203-2 305-5

The Power Transition Responds to Policy and Public Opinion

Demand for electricity is growing at the same time as a number of large generating units are being decommissioned. In consequence, Taipower has adopted a strategy that is in line with the government's energy transition policy by reducing coal, increasing gas, and developing green and nuclear-free energy. This entails promoting the development of renewables and actively planning low-carbon, gas-fired units while improving environmental protection equipment at existing coal-fired units to reduce air pollution emissions. Through these strategies, Taipower will ensure a stable power supply and meet the 2025 energy ratio target. The development direction of Taipower's energy transition plan is as follows:



Prioritize the Development of Renewables and Create a Friendly, Grid-Connected Environment

Taipower has vigorously worked to provide impetus for the establishment of renewables, such as offshore and onshore wind, solar, geothermal, and small-scale and micro-hydropower. However, to maximize the development of renewables, both active development and joint development with private operators are necessary. For this reason, Taipower has continued to strengthen grid construction, create a friendly, grid-connected environment for private applications, and collaborate with the private sector to fully stimulate the development of renewables.

Actively Promote Gas-fired Generation Projects and Self-Build Natural Gas Receiving Terminals

Gas-fired units produce less carbon and are cleaner than coal-fired units. Therefore, Taipower has committed to renewing and expanding plants with gas-fired generation. Projects include the Tonghsiao renewal, the Datan expansion, the Hsinta renewal, new construction at Taichung, and renewal at Hsieh-ho. To ensure the stability of the natural gas supply for power plants and national energy security, Taipower has considered regional balance and the integration of ports and plants in determining its planning direction. The Company pushed forward the construction of its own natural gas receiving terminals in Taichung Port and Keelung Port (Hsieh-ho), while CPC Corporation is building a third natural gas receiving terminal. Through the joint efforts of the two companies, it is hoped that the construction of natural gas unloading facilities can be expanded, power dispatch flexibility and supply stability can be increased, and the goal of ensuring a friendly environment by reducing air pollution and greenhouse gas (GHG) emissions can be achieved while maintaining energy supply security and the overall power supply economy.

Coal-fired Units Serve as Vital Backups

International energy policy has tended to pursue diversified energy ratios. In Taiwan, 97.4% of domestic energy depends on imports, and the power system is an independent grid. To ensure a stable power supply, energy security, and diversification, it is necessary to maintain some coal-fired generation. At the same time, Taipower is aware of the impact of coal-fired generation on air pollution and greenhouse gas emissions. To ensure a sufficient power supply, Taipower will conduct feasibility assessments on the renewal and obsolescence of environmental protection equipment at the existing coal-fired plants. Taipower will also assess the adoption of environmentally-friendly coal. By controlling air pollution and carbon emissions from the origin to power generation, coal-fired units will remain feasible and vital backup units.

Short, Medium, and Long-Term Plans for Energy Transition

In accordance with the government's energy policy, Taipower moved towards low-carbon power and renewable development while maintaining an actual reserve capacity of 13.5% in the Taipower system in 2021. The overall generation structure consisted of is 42.5% gas-fired, 35.5% coal-fired, 10.8% nuclear energy, 1.6% fuel oil, 6.3% renewable, and 3.4% from other power generation sources (including pumped storage and cogeneration). The proportion of Taipower's gas-fired generation first exceeded that of coal-fired generation in 2019. As gas-fired generation projects are successively commercialized, the 2025 target of 50% gas-fired generation will be achieved.

Short-Term Actions

Since Taiwan is small and densely populated, land for power plants and lines is difficult to obtain. With the not-in-my-backyard (NIMBY) sentiment and greenhouse gas emissions attracting intense attention from the general public, the promotion of plant construction is greatly hindered and takes a long time. Additionally, some of the existing nuclear power plants have been shut down prematurely, causing power supply shortages and making it difficult to plan the addition of conventional thermal power sources to replace them in the short term. To reduce the risk of power shortages, the following response measures were proposed:

- Strengthen various demand-side management measures to depress peak power demand, etc.
- Review the feasibility of using aging units as emergency backups.
- Ensure the stable operation of existing units and that power generation units under construction remain on schedule.

Medium-Term Measures

Taipower continues to push forward with the replacement of its old plants with new thermal power plants. To facilitate the balance of power supply in Taiwan, improve generation efficiency, and coordinate with the government's low-carbon sustainability policy, Taipower has implemented renewal and expansion projects in the northern, central, and southern regions. At present, the renewal and expansion projects include wind, solar, thermal, and hydropower generation plans. The power plant renewal and expansion projects in 2021 were as follows:

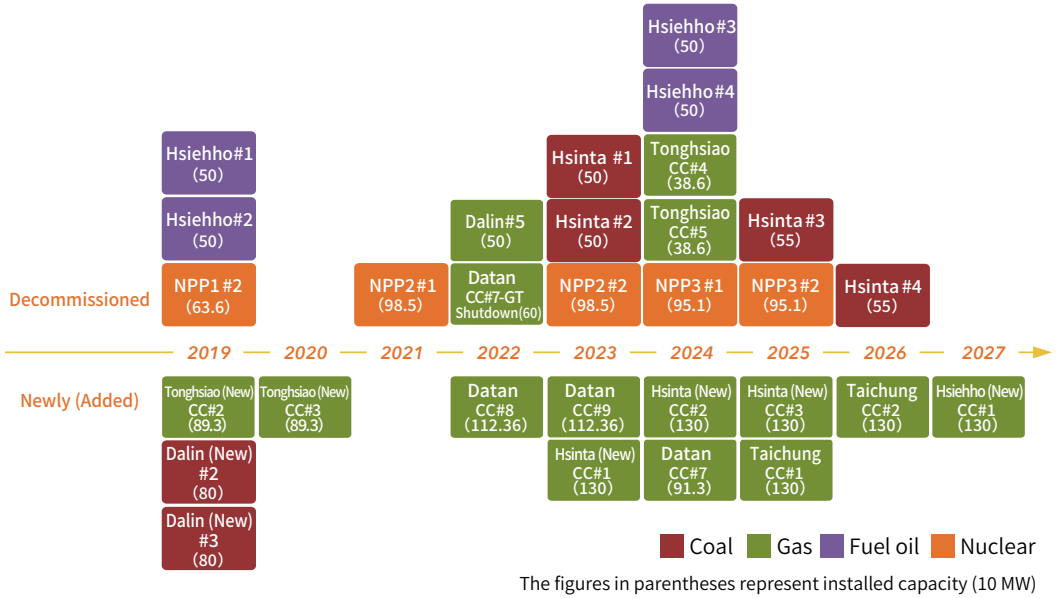
2021 Power Plant Renewal and Expansion Projects

Generation Category	Project Name	Project Capacity	Progress
Hydropower Plant Construction Project	The Liyutan Reservoir of the Jingshan Hydropower Project	Installation of one vertical, Francis-turbine hydraulic generation unit with a capacity of 4,013 kW at the Liyutan Reservoir in Miaoli. The annual capacity of power generation will be 13.886 GWh	As of December 31, 2021, the project was 98.32% completed and was scheduled to begin commercial operation at the end of June 2022
	Hushan Reservoir Small Hydropower Project	It is estimated that the capacity will reach 1.935 MW and the annual generation will be 8.097 GWh	Scheduled for commercial operation at the end of June 2022
	Jiji Weirs South Connecting Channels Small Hydropower Project	It is estimated that the capacity will reach 3.510 MW , and the annual generation will be 16.89 GWh	Scheduled for commercial operation in July 2023
	Phase 1 of the Island-Wide Small Hydropower Project (7 projects)	The installation of one vertical axis Francis turbine generating unit at the crossover pipe of the stone waterway and 12 bulb turbine generating units at six plant sites, including connecting roads on the south bank of the Jiji River Dam for a total of 13 units with a total installed capacity of 16.553 MW and an annual generating capacity of 74.6 GWh	As of December 31, 2021, the project was 60% finished and is expected to be completed in June 2023
Offshore Wind Power Plant Construction Project	Phase 1 of the Offshore Wind Power Project	Installation of a wind field with a total installed capacity of 109.2 MW and an annual generating capacity of 360 GWh	As of December 31, 2021, the project is 92.59% finished and commercialize after the renewal of the Electricity Power Generation license

Long-Term Power Development

Due to the growing power consumption and successive decommissioning of various units, Taipower has planned its long-term power development projects until 2027 in order to meet electricity needs and remain aligned with the government's energy transition policy and various environmental requirements. The plan is shown in the figure below:

Taipower's 2021 Power Planning Table



The figures in parentheses represent installed capacity (10 MW)

3.2.2 Renewables Development 103-2 103-3 203-1

Promoting Renewable Energy

In terms of stimulating renewable development, Taipower has adopted friendly grid connection, demonstration and leadership, and system stability as its three main strategies.

(I) Friendly grid connection: Taipower will strengthen grid infrastructure, provide sufficient feeder capacity, boost the growth of renewable capacity, and assist privately built renewables with connecting to the grid smoothly.

(II) Demonstration and leadership: In addition to continuing to invest in renewable developments such as onshore, offshore wind power, and solar power, Taipower will also participate in advanced high-tech energy demonstration projects. The Company will take the initiative to cooperate with industry, government, and academia in development, and lead the private sector by promoting renewable investment through media publicity, education, and skills.

(III) System stability: Despite the intermittent nature of renewable generation, Taipower is maintaining system stability and security while raising the penetration rate of renewables through technologies such as smart generation and dispatching, demand-side management, and energy storage facilities.

As the scale of green power production increases, so will the demand for grid connections. Taipower is laying the foundation to meet this need as part of its energy transition policy. In 2021, it finalized Phase 1 of the Green Energy Project and is scheduled to develop a renewable generation system with a total installed capacity of 160 MW between 2022 and 2024. The system will include solar photovoltaic, onshore wind power, geothermal power generation, and other energy types. Regarding the current status of renewable development, solar and wind power are the main focuses of work. In 2021, wind power generation reached 774.4 GWh and solar photovoltaic reached 408.8 GWh.

Renewables Generation Status

	Deployments	Installed Capacity (MW)	Generation in 2021 (GWh)	Number of Households Accommodated
Wind Power	24 sites 189 units	406.24	774.4	215,117
Solar Photovoltaics	52 sites	283.845	408.8	113,566

Note: According to Taipower's open data statistics, the average monthly power consumption for a typical residential user is 300 kWh and the estimated annual power consumption is about 3,600 kWh.

In response to government policies, Taipower will continue to work on raising the proportion of renewable generation and researching and developing potential renewables. Through these actions, the Company hopes to achieve lower carbon emissions and more sustainable electricity for users in Taiwan.

Government and Taipower Renewable Development Targets

	Government's Target		Taipower's Target	
Development Timeline	2025		2025	
Item of Promotion	Capacity (MW)	Power Generation (billion kWh)	Capacity (MW)	Power Generation (billion kWh)
Hydropower	2,122	5	1,825	3.52~4.8
Onshore Wind Power	886	2.2	408.2	1.08~1.15
Offshore Wind Power	5,617	12.3	403.7	1.38~1.59
Solar Photovoltaics	20,000	22.8	469.1	0.58~0.66
Geothermal Power Generation	20	0.102	1.4	0.009~0.01
Fuel Cells	0.7	0.0009	-	-
Biomass Energy	778	4.1	-	-
Total	29,423.7	46.5029	3,107.4	7.2

Note: The government targets are based on the "Overall Strategy of Green Energy Implementation" briefing by the Bureau of Energy, Ministry of Economic Affairs on July. 11, 2021.

The Current Status of Renewable Energy

Taipower will continue to play a leading role in the renewable power industry. In addition to hydropower generation, which has a century of history, the Company has also developed a complete plan for wind and solar power in recent years. Taipower is also investing in R&D for emerging fields such as geothermal and biomass energy. The current development status of renewables promoted by Taipower is as follows:

Current Status of Renewable Energy

Hydropower

Hydropower has a long history at Taipower. By the end of 2021, the Company had an installed hydropower capacity of 2.09 GWh (including IPPs). As the government continues to promote renewables, Taipower plans to utilize existing water conservancy facilities such as reservoir weirs, irrigation channels, and hydropower plants to set up small environmentally friendly hydropower generating units that are simple in construction and low in cost. At present, the installation of small generating units at small hydropower plants such as Jingshan's Liyutan Reservoir, the Hushan Reservoir, the Shihmen Reservoir, and the Jiji Weirs are still under construction. Small hydropower generation is expected to reach 88 GWh in 2023 with a capacity of 20.566 MW.

Wind power

Since 2000, Taipower has been dedicated to wind power development. By the end of 2021, the Company had completed the Zhongtun Wind Power Demonstration Project, Phases 1 to 4 of the Wind Power Generation Project, Penghu's Huxi Wind Power Project, and Kinmen's Jinsha Wind Power Project. There are currently 17 wind fields and 168 wind turbines in operation with a total installed capacity of approximately 297 MW. Phase 1 of the Offshore Wind Power Project is deploying 21 offshore wind power generators in the open sea off Fangyuan Township to effectively utilize the abundant wind energy in the Changhua County Sea area. The project has a total installed capacity of about 110 MW and an annual generation capacity of 362 GWh. It began commercial operation on December, 30 2021.

Solar power

Phase 1 of the Solar Power Project was implemented in 2008. By the end of 2020, a total installed system capacity of approximately 283MW had been completed, including the Tainan Salt Field Photovoltaic Project which generates 150MW, the largest photovoltaic field in Taiwan. The planning for Phase 1 of the Green Energy Project was also launched in 2020. It is estimated that 110MW of solar power will be added within three years between 2022 and 2024.

Geothermal power generation

In cooperation with CPC, Taipower is promoting the Yilan Renze Geothermal Generation Project with a capacity of 0.84MW. It is expected to be operating in 2023.

Current Status of Renewable Energy Grid-Connections

Taipower is cooperating with the government to promote the development of renewable energy. While ensuring the safe operation of the grid, Taipower has adjusted its grid connection strategy with reference to international technology and the latest development trends. It has also considered financial operating conditions that meet the demands of renewable grid-connection expansion. The number of applications for various types of solar power plants and the accumulation of capacity are as follows (as of March 10, 2022):

Accumulated Number of Cases and Installed Capacity of Various Types of Solar Power

Case Status		Cases (Number)	Capacity (MW)
Accepted Cases	Under review and without approval (A)	4,220	8,354.37
	Approved but without a signed contract (B)	6,747	29,221.31
	Have signed a contract but haven't connected to the grid (C)	38,957	10,567.83
	Subtotal (=A+B+C)	58,858	48,143.51
Grid-Connected Cases		46,194	7,884.45
Official Power Purchase Cases		42,114	6,366.20

Committed to Renewable Energy Efficiency

To improve the efficiency of renewable energy power generation, Taipower conducts regular preventative maintenance inspections to reduce unit failure rates. The Company also selects components that use materials with low-carbon footprints to reduce its environmental impact. By strengthening the maintenance of ventilation and air-conditioning equipment in renewable energy power plants and by installing energy-saving control equipment, the power consumption of plants has also been reduced. At present, Taipower's onshore plants have set a future target of achieving a basic availability rate of 92.5%. In the future, Taipower will enhance its technical management capabilities and refine its wind energy forecasting system to reduce its failure rate. Meanwhile, through the establishment of a big data analysis system for wind plants, the Company will track the health status of its wind turbines, conduct fault prediction diagnosis, and optimize maintenance schedules. Taipower will also strengthen its management and maintenance of essential component inventories. For solar power, the appropriateness of night power consumption in the photovoltaic field is checked to avoid unnecessary energy consumption and elevate the overall power generation of facilities.

Average Availability Rates of Renewable Energy from 2019 to 2021

	2019	2020	2021
Availability rate of wind power (%)	92.19	93.03	92.61
Capacity factor of solar power (%)	13.85	16.02	16.44

Note: 1. Annual Wind Power Availability Rate = Unit Generating Hours (Including Standby Hours) / Annual Number of Hours
2. Solar Power Capacity Factor = Annual Power Generation of Units / Device Capacity * Year-Round Hours

Countermeasures to Renewable Energy Challenge

Since government policy has placed a strong emphasis on solar photovoltaic power, Taipower must meet the demand for large-capacity, ground-based, solar photovoltaic grid connections as soon as possible. Branch offices located in the grid-connected hot zones actively visit local governments and solar photovoltaic installation operators. The offices guide installation operators to integrate with the grid in a centralized deployment method to avoid wasting Taipower's investment. Meanwhile, Taipower continues to implement its distribution-grade power grid reinforcement project that will enable increased renewable grid-connection and promote short, medium, and long-term model plans:

- Short-term plan (within 1 year): Adjust the load of existing distribution lines, strengthen or add main transformer lines
- Mid-term plan (1 to 3 years): Continue to conduct the expansion of substations and new distribution lines
- Long-term plan (over 3 years): Construct new substations

Taipower is cooperating with the Ministry of Economic Affairs to plan a capacity allocation mechanism for joint booster stations. This will allow the Company to maximize its utilization of limited power transmission resources. To date, Taipower has formulated capacity allocation guidelines and operating procedures. In addition, Taipower has planned specific solar photovoltaic areas to appropriately allocate the capacity of joint booster stations and accelerate renewable grid-connection.

To facilitate information disclosure, Taipower established a renewable application progress query system so that the public can make instant inquiries regarding the status of project applications. There is also a distribution-grade renewable capacity query system that guides developers that are searching for sites to build solar photovoltaics in areas where the grid-connecting capacity is still abundant. As Taipower is actively promoting renewable energy development projects such as wind, solar, geothermal, and small hydro, it is necessary for the Company to provide a friendly, grid-connection environment for private industry that is seeking to apply for green energy power generation equipment. These steps are facilitating Taipower's move towards actualizing the government's goal of 20% renewable energy by 2025.