Performance Highlights

- In terms of the proportion of overall power generation, gas-fired power generation surpassed coal-fired power generation for the first time in 2019, illustrating the effectiveness of Taipower's energy transition.
- In 2020, the System Average Interruption Frequency Index was **0.23** times/household, and the System Average Interruption Duration Index was **15.931 minutes/household.**
- In 2020, Taipower's renewable capacities in operation were **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 by year, from **45.64%** in 2019 to **46%** in 2020.
- In 2021, **the first phase** of the Green Energy Project is completed and a renewable electricity generation system with a total capacity of **160 MW** is scheduled for development between 2022 and 2024.
- The progress of renewal, expansion and new thermal generating unit projects in 2020 is as follows: Linkou Plant (98.57%), Dalin Plant (100%), Tongxiao Plant Phase 1 (99.74%), Datan Plant (38.19%), Taichung Plant (5.99%), Xingda Plant (18.56%), Xiehe Plant (3.64%), and Tongxiao Plant Phase 2 (0.62%).

3 Provider of Sustainable Power

The Implication of Provider of Sustainable Power

A stable power supply is closely related to people's livelihood issues. Taipower supplies electricity steadily day and night in support of Taiwanese people, enterprises, and economic development. As Taipower undergoes transition, it has prioritized three major focal points: the development of renewable energy, the promotion of low-carbon gas, and the renewal of coal-fired power units with ultra-supercritical (USC) generation units. These measures will stabilize the hardware capital of the electric system. Along with the renewal of generating units, the development of low-carbon power, and improved reliability of power generation, transmission, substations and distribution, Taipower will continuously implement the energy transition goals through multi-track parallelism.

Major Investments

- Invest $418 billion in renewables between 2015 and 2030.
- Strengthen the construction of the power transmission and substation system. The total investment in the 7th Transmission and Substation Revision Project will be about NT$236.9 billion (until 2021). By the end of 2020, substation capacity of 15,725.20 KVA (84.75%) and 1,770.44 circuit kilometers (90.04%) of lines had been completed.
- The total length of the underground transmission cable will reach 4,406.74 circuit kilometers.
- In the case of power failures, employ drone aerial photography to transmit back video of outage points along the power supply line, conduct data processing, and establish an AI abnormal image recognition model to assist in anomaly detection for the relevant transmission equipment.

Future Plans

As the trend of energy transition continues, the proportion of renewables used will gradually, but inevitably, rise. However, the unstable nature of this generation will make meeting future electricity demands challenging. Taipower is eagerly developing diversified energy sources on the supply side to cope with policy requirements. Meanwhile, it continues to make good use of opportunities in power dispatch, constantly renews thermal power generating units, increases the proportion of gas-fired energy, and enhances the Company's operational capabilities and market competitiveness.

3.1 Providing Quality Electricity Service

3.1.1 A Stable Power Supply and Generation System

A Stable Power Supply and Installed Capacity

In recent years, Taiwan's electricity consumption has repeatedly hit record highs. To ensure the stability of the power supply, Taipower continuously strengthens its management, promotes power development plans, and brings new generating units online. In terms of managing the operation of thermal power generating units and apart from refining various operational maintenance strategies, Taipower has also established a licensing system and a retraining mechanism for staff to ensure the stability of daily operations. Additionally, the main management measures for nuclear power units 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.

Installed Capacity and Structure Over the Years

Total Amount and Composition of Power Generation from 2018 to 2020

	2018		2019		2020	
	Billion kWh	Percentage	Billion kWh	Percentage	Billion kWh	Percentage
Net amount of power generation and purchase	**233.3**	**100.0%**	**232.5**	**100.0%**	**238.9**	**100.0%**
Amount of power generated	**182.7**	**78.3%**	**180.4**	**77.6%**	**183.9**	**77.0%**
Pumped storage hydro	3.4	1.4%	3.2	1.4%	3.1	1.3%
Thermal	148.3	63.6%	140.6	60.5%	147.0	61.5%
Nuclear	26.7	11.4%	31.1	13.4%	30.3	12.7%
Renewable energy	4.3	1.9%	5.5	2.4%	3.4	1.4%
Amount of purchased power	**50.6**	**21.7%**	**52.0**	**22.4%**	**55.1**	**23.0%**
Privately-owned thermal	38.9	16.7%	39.4	16.9%	40.6	17.0%
Renewable energy	7.1	3.0%	8.5	3.7%	10.4	4.3%
Cogeneration	4.6	2.0%	4.1	1.8%	4.1	1.7%

Average Availability Rates for Power Plants from 2018 to 2020 Unit: %

Unit		Energy type	2018	2019	2020
Thermal	Steam	Coal	86.55	82.65	86.82
		Oil	89.01	93.83	87.01
		Natural gas	90.21	73.70	95.51
	Combined cycle	Natural gas	87.62	88.00	87.98
Hydro		Hydro	95.58	94.30	96.81

Average Availability Rates for Nuclear Power Plants from 2018 to 2020 Unit: %

	NPP1		NPP2		NPP3	
	Reactor 1	Reactor 2	Reactor 1	Reactor 2	Reactor 1	Reactor 2
2018	- (Note 2)	41.76 (Note 3)	85.46	56.62 (Note 4)	87.70	92.07
2019	-	-	100.00	88.03	87.38	97.11
2020	-	-	87.29	88.81	99.36	86.71

Note. 1. Annual availability of nuclear power units = Annual interconnection generation hours/Total annual hours

2. Reactor 1 of Nuclear Power Plant 1 (NPP1) entered the decommissioning stage on December 5, 2018, when its operating license expired.
3. The operating license of reactor 2 of Nuclear Power Plant 1 (NPP1) expired on July 15, 2019, and remained at shut-down condition during the period.
4. Reactor 2 of Nuclear Power Plant 2 (NPP2) tripped on May 16, 2016 due to a failure of the lightning arrester on the generator. The power plant completed all maintenance and testing work on June 27, 2016. On June 13, 2016, the Education and Culture Committee of Legislative Yuan made an interim proposal, demanding the Atomic Energy Council provide a report to the Legislative Yuan before restarting reactor 2 of NPP2. The units were approved by the Atomic Energy Council to apply for grid connection after a major overhaul on March 27, 2018 and full load operation was reached on June 17. The units are currently in stable operation.

▼ Longjing Solar Photovoltaic Field

Increasing the Reliability of the Power Supply

Taipower has a complete power dispatch and reliability management mechanism. The specific action plan is 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

- An electromechanical system incident review meeting is held every month to review and analyze the causes of electromechanical outages for systems above 161kV and make follow-up improvements.
- A power dispatch system incident review meeting is held every two months to ensure normal operation of the 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 are listed as a risk control event. The risk level is determined according to the degree of impact and measurement standards in different scenarios. Also, relevant measures are formulated for tracking and control.
- Quarterly follow ups on reviews and execution.
- Conduct a general review at the end of the quarter and set future control objectives.

Execution status

- On January 11, 2021, a review of the execution and effectiveness of the power shortages affecting system stability and safety for the fourth quarter of 2020 was conducted.
- On February 5, 2021, a meeting was held to review the execution of power shortages affecting system stability and safety in 2020. These meetings also conduct continuous adjustments and set the control objectives for 2021.

Personnel Training

Execution method

- In response to the future electricity market transaction mechanism of the Electricity Act, regular on-the-job training is carried out to establish the concept 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 of the dispatch centers (central, regional, distribution), power plants, IPPs, ultra-high voltage substations, etc., with a total of 29 participants.
- Dispatchers who had passed the examination after completing the training internship can participate in the dispatcher license examination. In 2020, one dispatcher license was issued. In addition, seven senior dispatchers and five dispatchers were approved for license renewals.

Taipower actively implements the power supply management mechanisms from the three dimensions above to ensure a stable power supply throughout Taiwan. Nonetheless, 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 and provides offshore users with 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 in the Tashan Plant. This helps to avoid a complete blackout in the area in the event of an electric system outage.

At the same time, Taipower is currently planning to integrate the Penghu area grid into the main island's interconnected operations. At present, a new substation construction project in Penghu has been completed. The double circuit line of the Taiwan-Penghu submarine cable is being added to the system. The Penghu system will be integrated into the main island's system, and some of the Jianshan Plant's units will be decommissioned and converted into a standby plant. Moreover, as the proportion of renewable grid-connections in the Penghu area will be greatly increased in the future, the surplus renewables may also be sent back to the main island.

Responding to the Taiwan-Wide Blackout of May 13 and the Power Rationing on May 17 in 2021

At 2:37 pm on May 13, a bus bar outage in Kaohsiung's ultra-high voltage substation led to a sharp drop in voltage. This resulted in the tripping of four units at the Xingda Plant and the loss of 2.2 Gwh of power supply. To maintain grid stability, the electric system automatically started immediate, low-frequency load shedding. The emergency divisional power outage was carried out from 3 pm onwards, affecting approximately four million households in total, and the normal power supply was restored at 8 pm.

Then, on the afternoon of May 17, the Xingda Plant's Reactor 1 failed and tripped. This was caused by excessively high temperature and increased demand that resulted from pandemic related working and studying from home. The power consumption hit a record high (the peak loads usually occur around July, but in 2021, historically high consumption rates were reached on seven days in May with the record electricity consumption peak being broken on May 28). At the time, a unit with a total capacity of 4.57 GWh was unavailable for use due to an overhaul, resulting in a tight power supply. The system automatically protected its equipment at 8 pm, resulting in power failures for some users. Subsequently, the emergency divisional power outage mechanism was carried out at 8:50 pm. The power supply was restored at 9:40 pm.

Taipower actively reviewed and responded to the two power failure incidents. In response to the power failure on May 13, which was due to human error, the Company will implement an on-site SOP, review individual fool proofing mechanisms, and optimize the accountability mechanism for its construction interface. The incident that occurred on May 17 was due to the record-high power consumption in May, in addition to the water drought in 2021, and the record-low precipitation in the same month. Both were not foreseen by Taipower during the annual maintenance planning conducted in the previous year. Therefore, in response to abnormal weather and pandemic-related electricity behavior changes, Taipower will review and strengthen the impact of related social factors on the future growth of electricity consumption. In addition, Taipower will reassess its annual maintenance schedule, strengthen its ability to respond to power dispatch, promote demand-side management strategies, and accelerate diversified power construction to enhance the reliability and resilience of the power system.

▼ Techi Dam dried up reservoir from water shortage

Facing the Challenges 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, all kinds of disaster flash report education and training, as well as 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 will issue at least one local press release every day before, during, and after each typhoon to reinforce public awareness of disaster prevention and preparation. It also sets up the Taipower 1911 customer service hotline, a power outage inquiry and notification system on the official website, and the "apply/repair" function on the Taiwan Power application for the public to report blackouts. In addition, the branch offices have established real-time communication channels such as social media community groups, telephone, fax or e-mail, and other channels based on regional characteristics. This is to ensure a comprehensive control and that the power recovery status of users can be confirmed, so that incidents are handled as soon as possible. Please scan the QR code and refer to the website for Taipower's specific management policy and implementation schedule for natural disasters.

Specific Management Policies and Implementation Schedules for Natural Disasters

Ensuring Nuclear Power Safety

The Company always 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 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.

Regarding "defense-in-depth," the Company uses the following four lines of defense in practice.

Defense-in-Depth

The 1st Defense **Prevention**	Evaluation and prevention are conducted in advance based on various extreme conditions.
The 2nd Defense **Mitigation**	Disaster mitigation is executed to prevent the leakage of radioactive materials from nuclear power plants.
The 3rd Defense **Emergency Preparedness**	If disaster mitigation fails to prevent external leakages of radioactive materials, protective actions will be taken to reduce the radiation exposure outside the plant.
The 4th Defense **Ultimate Response Guideline**	Ultimate Response Guidelines (URG) were developed as a basis for decision making and are based on current design benchmarks for earthquake resistance and tsunami prevention in nuclear power plants, emergency operating procedures and the severe nuclear outage handling guidelines.

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. Taipower submits reports on radioactive waste treatment, storage, and final disposal to the competent authority, as well as on the annual operation, radiation protection, environmental radiation monitoring, etc. 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

Usual preparedness	**Organize emergency response plan training**	• The emergency staff of nuclear power plants and the Nuclear Emergency Preparedness Executive Committee shall be 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	• Each nuclear power plant will conduct an in-plant drill once a year. Taipower will invite experts and scholars, in addition to representatives from competent authority, to evaluate the response measures of the drill so that the emergency response plans and actions can be gradually improved. • In 2020, Taipower conducted 2020 Nuclear Safety Drill No. 26 (NPP2). Other nuclear power plant emergency response plan drills were conducted at NPP3 and NPP1 in July and November 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. – Drill/drill performance. – Participation in the drills of the emergency response organization. – Reliability of the warning and notification system.
Response operation 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. • 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 people.
Post outage recovery operations	**Damage assessment and recovery measures**	• After the cause of the 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 tasks 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 a disaster recovery plan and its 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

Taipower's power transmission and distribution system has always faced stringent challenges. In response to the planned energy transition, Taipower has vigorously promoted renewables in recent years. 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 of concentration in power supply and load centers. Faced with such arduous challenges, Taipower's transmission and distribution system will 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 the offshore wind power phase I grid reinforcement, the UHV substation expansion at the Southern Taiwan Science Park, and the Baoshan UHV substation construction project that strengthen grid power integration capabilities and to introduce 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 268 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 to 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 ecological 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 2020, Taipower has built 618 distribution-level substations and 10,097 feeders.

Furthermore, to help accelerate the acquisition of electricity for factories set up by returning Taiwanese businesses, Taipower has proposed an accelerated power supply review mechanism. The mechanism shortens the review period to one month for newly added UHV power consumption cases connected to the three major investment plans in Taiwan (The Action Plan to Welcome Taiwanese Businessmen to Return to Taiwan to Invest, the Action Plan for SMEs to Accelerate Investment, and the Action Plan for Accelerating Investment by Taiwanese Enterprises to Root in Taiwan).

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 and replace old facilities and lines. The Company will also promote grid projects in a timely manner to maintain a high-quality supply of electricity.

Taipower's current performance indicators of power supply reliability are the System Average Interruption Duration Index (SAIDI) and the System Average Interruption Frequency Index (SAIFI). In 2020, the SAIDI was 15.931 minutes/household, and the SAIFI was 0.230 times/household. Over the past decade, Taipower has continued to show stable performance in terms of outage duration and number of outages. This has greatly contributed to the quality of power supply, customer service, and corporate image. Nevertheless, considering the extreme 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 blackout 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 system and strategy research. It has also built the generation information consolidation platform and other related systems to actively respond to future challenges.

Power Supply Reliability Results from 2018 to 2020

		2018		2019		2020	
		Target	Performance	Target	Performance	Target	Performance
System Average Interruption Duration Index (minutes/household • year)	Work blackout	12.518	12.052	12.481	12.125	12.253	11.696
	Outage blackout	4.7120	4.1351	4.619	4.363	4.547	4.235
	Total	**17.23**	**16.187**	**17.1**	**16.488**	**16.8**	**15.931**
System Average Interruption Frequency Index (times/household • year)	Work blackout	0.063	0.057	0.064	0.059	0.064	0.059
	Outage blackout	0.207	0.170	0.206	0.150	0.196	0.171
	Total	**0.270**	**0.227**	**0.270**	**0.209**	**0.260**	**0.230**

Line Loss Rate from 2018 to 2020

2018	2019	2020
3.94%	3.86%	3.97%

Strengthening Power Transmission and the Substation System

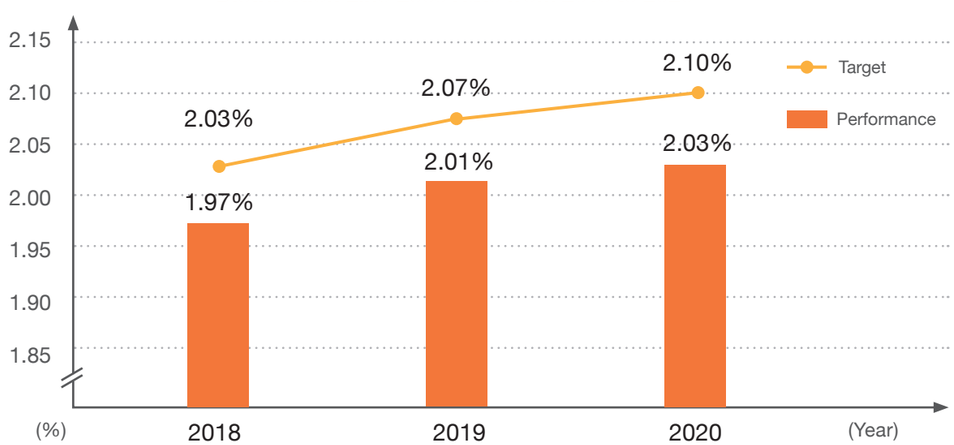
In response to economic growth, Taipower continues to strengthen the overall power grid through power transmission and substation projects, reinforcement of transmission capacity for the main line system, and optimization of the power supply capacity for ultra-high voltage, large-scale customers. The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

Important Project Plans

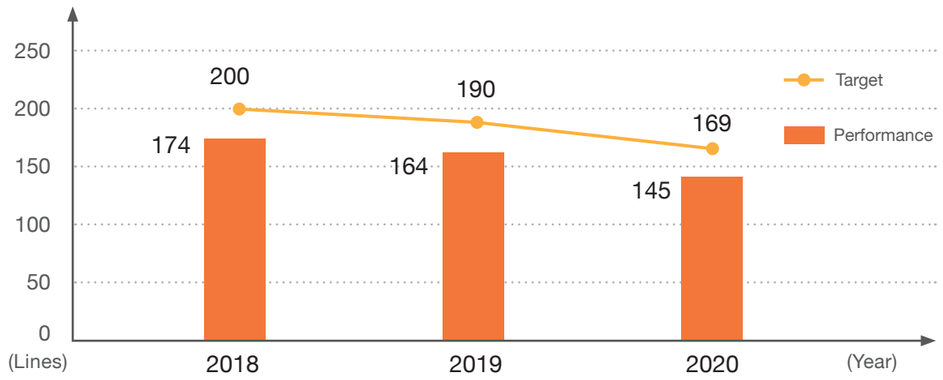
Increasing the Reliability of Power Distribution

To reduce the cost of generation and increase the power supply capacity, the distribution and sales system is based on the target value of the distribution line loss rate allocated by the Department of System Operations. Branch offices are instructed to work out improvements in 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 a management target of reducing the feeders with currents exceeding 300A as a basis for the performance of distribution lines.

Distribution Line Loss Rate from 2018 to 2020



Reduction of Feeder Lines with Currents Exceeding 300A from 2018 to 2020



Distribution Feeder Automation Installations from 2018 to 2020

Performance	2018	2019	2020
Feeder Automation (No.)	7,354 lines	7,590 lines	7,815 lines
Switch Automation (No.)	963 new units	970 new units	1,304 new units

Taipower's Measures for Improving Distribution Reliability

Management approach	Implementation method
Regular review and analysis	- All branch offices regularly conduct high voltage outage review meetings for assessment. - The Department of Distribution holds a monthly improvement meeting on power supply reliability to regularly review the average outage performance of the distribution system, the causes of major outages, and to formulate improved countermeasures and provide the best improvement strategy for each outage.
Risk management implementation	- Yearly review of possible risk factors that affect the stability and reliability of the power supply. The review also includes risk management control for the following year. The implementation performance is then tracked and reviewed a regularly.
Personnel training	- Regularly organize on-the-job education and training for maintenance personnel and dispatchers to advance professional skills and strengthen maintenance capabilities.
Audit operations strengthening	- During spot checks of electrical work or power supply quality, irregular assessments and inspections of equipment operation are reinforced and the outage prevention improvement plans of all branch offices can be supervised.

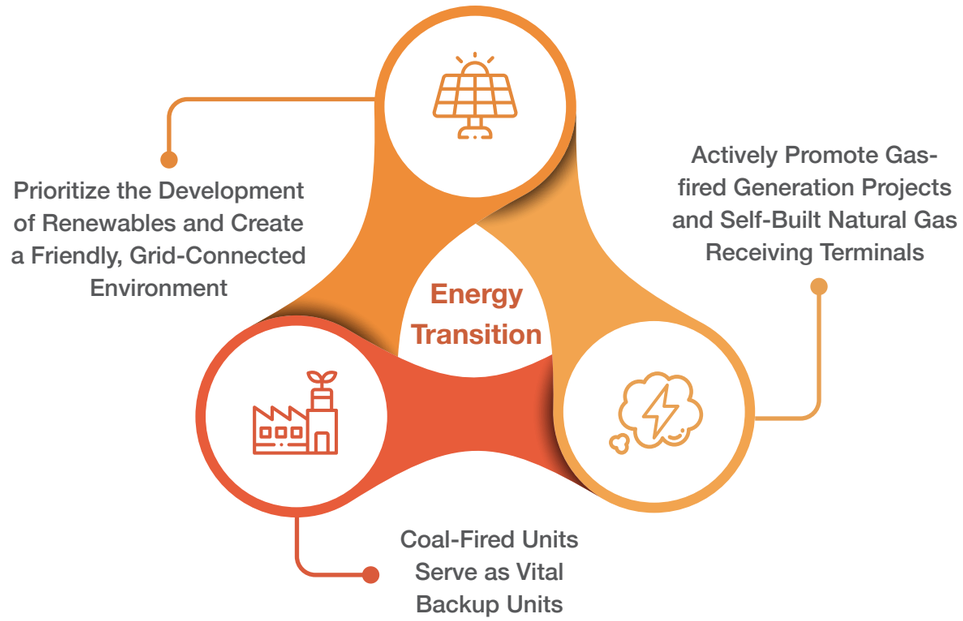
In response to the energy transition and the move towards a new generation of power supply systems, Taipower has accelerated the automation of its distribution feeders. This not only helps to improve the quality of the power supply but also enables fault detection. Through remote control of on-site automatic line switches, outage areas can be isolated promptly to reduce the scale of power failures. Feeder automation has been applied to industrial areas, vital metropolitan areas, and remote areas that are not accessible for repair. In the future, Taipower will continue to promote distributed feeder automation and raise the target value of feeder construction.

3.2 Planning for New Sources of Energy

3.2.1 The Transition to a New Generation of Energy

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 successively decommissioned. In consequence, Taipower has adopted a strategy of reducing coal, increasing gas, and developing green and nuclear-free energy as its future power development strategy. At the same time, in line with the government's energy transition policy, the Company is promoting the development of renewables and actively planning low-carbon, gas-fired units and improving the environmental protection equipment of 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 vigorously gives impetus to the establishment of renewables, such as offshore and onshore wind power, solar power, 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 collaborates 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 are cleaner and emit less carbon than coal-fired units. Therefore, Taipower is enthusiastically renewing and expanding plants with gas-fired projects. These projects include the Tongxiao renewal, the Datan expansion, the Xingda renewal, the Taichung new construction, the Xiehe renewal, and more. To ensure the stability of the natural gas supply for power plants and national energy security, Taipower has taken regional balance and the integration of ports and plants as in determining its planning direction. The Company pushed forward the construction of its own natural gas receiving terminals in Taichung Port and Keelung Port (Xiehe), 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 taking into account 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, 97.8% 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 is currently moving towards low-carbon power and renewable development while maintaining an actual reserve capacity of 16.4% in the Taipower system. The overall generation structure consists of is 40.8% gas-fired, 36.4% coal-fired, 12.7% nuclear energy, 1.3% fuel oil, 5.8% renewable, and 3% from other power generation sources (including pumped storage and cogeneration). In addition to meeting the government's 2020 target of a 15% reserve capacity rate to ensure a stable power supply, the proportion of Taipower's gas-fired generation 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

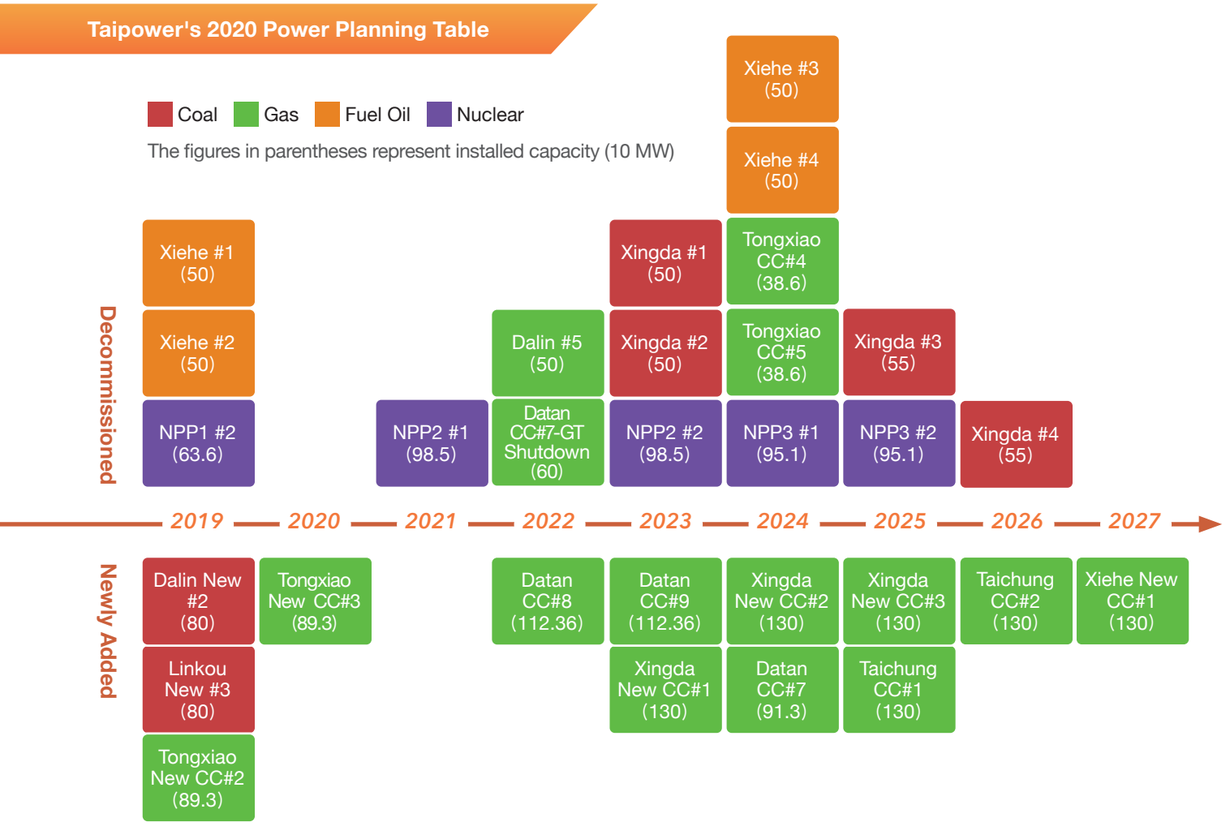
Taipower continues to push forward with the replacement of old plants with new thermal power plants. To facilitate the balance of power supply in Taiwan, improve generation efficiency, and coordinate with the government's low-carbon sustainable policy, Taipower has implemented renewal and expansion projects in the northern, central, and southern regions. At present, the renewal and expansion projects include wind power, solar power, thermal power, and hydropower generation plans. Please scan the QR Code for more details.

Medium-Term Measures

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 so that it can meet electricity needs and remain aligned with the government's energy transition policy and various environmental situations. The plan is shown in the figure below:

Taipower's 2020 Power Planning Table



Note: Based on the 2019/2020 National Power Supply and Demand Report by the Ministry of Economic Affairs.

3.2.2 Renewables Development

Promoting Renewable Energy

In response to the potential demand for grid connections due to the mass production of green power in the future, Taipower is laying the foundation for its energy transition policy. In 2021, it finalized the Green Energy Phase 1 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 focus of work. In 2020, wind power generation reached 775 GWh and solar photovoltaic reached 254 GWh.

Renewables Generation Status

	Deployments	Installed Capacity (MW)	Generation in 2020 (GWh)	Number of Households Accommodated
Wind Power	23 sites 168 units	297.040	775	215,278
Solar Photovoltaics	53 sites	283.845	254	70,556

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 constantly work on raising the proportion of renewable generation and continue to research and develop potential renewables. Taipower is hoping to achieve lower carbon emission and more sustainable electricity for users in Taiwan.

Government and Taipower Renewables 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	2,150	6.6	1,828	4.48
Onshore Wind Power	1,200	2.8	370	0.91
Offshore Wind Power	5,667	20.5	403	1.33
Solar Photovoltaics	20,000	25.6	500	0.66
Geothermal Power Generation	200	1.3	2	0.01
Fuel Cells	60	0.5	-	-
Biomass Energy	813	4.3	-	-
Total	**30,090**	**61.5**	**2,928**	**7.2**

Note: The government targets are based on the Taiwan Green Energy Development Trend briefing by the Bureau of Energy at the 2020 Energy Vision Summit Forum on November 11, 2020.

The Current Status of Renewable Energy

Taipower will continue to be play a leading role in the 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 invests 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 2020, 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, small hydropower plants such as those at Jingshan Hydropower and in Phase 1 of the Island-wide Small Hydropower Project are still under construction. Small hydropower installed capacity is expected to reach 20,566 kw in 2023.

Wind power

Since 2000, Taipower has been dedicated to wind power development. By the end of 2020, the Company had completed the Zhongtun Wind Power Demonstration Project, phases 1 to 4 of the Wind Power Generation Project, the Penghu Huxi Wind Power Project, and the Kinmen 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. The Offshore Wind Power Phase 1 Project deploys 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. By the end of 2020, two wind turbines had been installed and work had proceeded to the interconnection test phase, with a completion target of August 31, 2021. It is expected that the security dispatch of all units will be completed by October 31, 2021.

Solar power

Phase 1 of the Solar Power Project was implemented in 2008. Since that time, a large number of solar photovoltaic systems have been built. By the end of 2020, a total of 53 solar photovoltaic fields had been completed, including the Tainan Salt Field Photovoltaic Project which generates 150MW. This is the largest photovoltaic field in Taiwan with a total system installed capacity of approximately 283MW. 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

The pilot project for the Green Island geothermal generating unit and Phase 1 of geothermal power generation at Renze and Tuchang in Yilan.

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 (dated on February 18, 2021)

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)	4,580	13,274.97
	Approved but haven't signed a contract (B)	5,885	17,697.37
	Have signed a contract but haven't connected to the grid (C)	38,957	7,819.23
	Subtotal (=A+B+C)	49,422	38,791.57
Grid-connected cases		38,475	5,842.55
Official power purchase cases		35,058	4,769.11

Committed to Renewable Energy Efficiency

To improve the efficiency of renewable energy power generation, Taipower conducts regular preventative maintenance inspections to reduce the unit failure rate. 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 93% and a capacity factor of 30%. In the future, Taipower will enhance its technical management capabilities and refine the 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 2018 to 2020

	2018	2019	2020
Availability rate of wind power (%)	93.83	92.19	93.03
Capacity factor of solar power (%)	15.05	13.85	16.02

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 the grid in a centralized deployment method to avoid waste of Taipower's investment. Meanwhile, Taipower continues to implement its distribution-grade power grid reinforcement project that enables increased renewable grid-connection and promotes the 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 guise 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.