

3.2 Planning for New Sources of Energy

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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 new 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

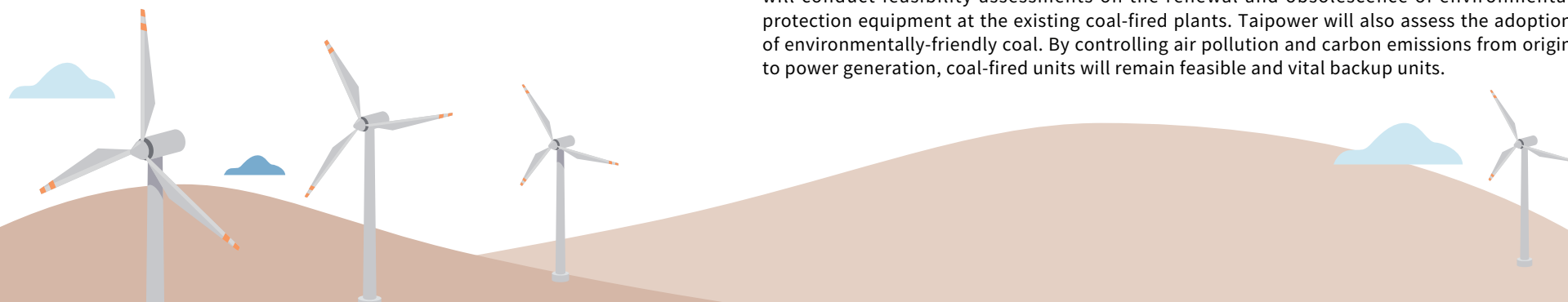
Taipower has vigorously worked to provide the impetus for the establishment of renewables, such as offshore and onshore wind, solar, geothermal, and small-scale and micro-hydropower. However, to maximize the development of renewables, both active development and joint development with private operators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

Actively Promote Gas-fired Generation Projects and 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 the number and scale of gas-fired generation plants. 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 the Taichung and Keelung Ports (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 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 12.2% in the Taipower system in 2022. The overall generation structure was 43.4% gas-fired, 34.8% coal-fired, 9.1% nuclear energy, 1.4% fuel oil, 8.6% renewable, and 2.6% 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 prevalence of the not-in-my-backyard (NIMBY) sentiment and concerns over greenhouse gas emissions attracting intense attention from the general public, the promotion of plant construction has been 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:

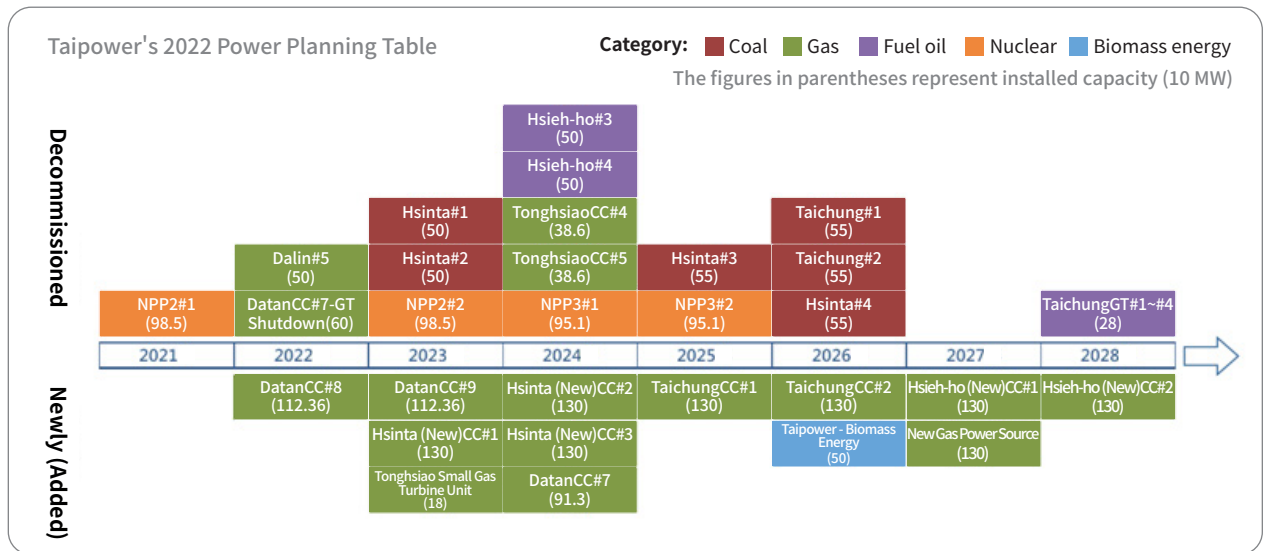
- Strengthen various demand-side management measures to depress peak power demand.
- Review the feasibility of using aging units as emergency backups.
- Ensure the stable operation of existing units and that the construction of new power generation units remains on schedule.

Medium-Term Measures

Taipower continues to push forward with replacing its old plants with new thermal power plants. To facilitate the balance of power supply in Taiwan, improve generation efficiency, and work in conjunction 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.

Long-Term Power Development

Due to growing power consumption and the successive decommissioning of various units, Taipower has planned its long-term power development projects until 2028 with the goal of meeting electricity needs and remaining aligned with the government's energy transition policy and various environmental requirements. The plan is shown in the figure below:



Note: The decommissioning and addition of thermal and nuclear power units by Taipower between 2021 and 2028 is based on the "National Power Resources Supply and Demand Report for the Year 2021" by the Ministry of Economic Affairs.



3.2.2 Renewable Development

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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 renewable generators with connecting to the grid smoothly.
- (II) Demonstration and leadership: In addition to continuing to invest in renewable developments such as solar, onshore and offshore wind power, Taipower will participate in advanced high-tech energy demonstration projects. The Company will take the initiative to cooperate with industry, government, and academia in development, and then lead the private sector by promoting renewable investment through media publicity, education, and skill development.
- (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 2022, wind power generation reached 1072.2 GWh and solar photovoltaic generation reached 402.7 GWh.



Renewables Generation Status

	Deployments	Installed Capacity (MW)	Generation in 2022 (GWh)	Number of Households Accommodated
Wind Power	25 sites 192 units	415.24	1,072.2	298,000
Solar	54 sites	287.45	402.7	112,000

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 energy and researching and developing potential renewable sources. 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

Development Timeline	Government's Target		Taipower's Target	
	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 Photovoltaic	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	46.5009	3,107.4	6.57~8.21

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 research and development 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

<p>Hydropower</p>	<p>To comply with the government's renewable energy policies and continue developing sustainable and stable conventional hydroelectric power, there are currently plans for a number of small-scale hydroelectric projects at various sites. These projects include the Jingshan Small Hydropower Project at the Liyutan Reservoir, the Hushan Small Hydropower Project, the ChiChi Nanan 2 Small Hydropower Project, and the First Phases of other small hydropower projects across Taiwan. The total installed capacity of these projects will reach 26.011 MW. Of the projects, the Jingshan Small Hydropower Project at the Liyu Lake Reservoir began commercial operations in September 2022. The remaining projects are scheduled to gradually begin commercial operations between 2023 and 2024.</p>
<p>Wind power</p>	<p>Since 2000, Taipower has been pursuing wind power development. By the end of 2020, the Company had completed the Jhongtun Wind Power Demonstration Project, Phases 1 to 5 of the Wind Power Generation Project, Penghu's Huxi Wind Power Project, and Kinmen's Jinsha Wind Power Project. There are currently 18 wind fields and 171 wind turbines in operation with a total installed capacity of approximately 306 MW. Phase 1 of the Offshore Wind Power Project is deploying 21 offshore wind power generators in the open sea off Fangyuan Township with a total installed capacity of about 109.2 MW, and an annual power generation capacity of 362 GWh. The project began commercial operations on December 30, 2021. In addition to continuing to develop land-based wind power, Taipower is also expanding wind power in offshore areas. In accordance with the government's plan to promote offshore wind power, Taipower will pursue ongoing planning and development in this area. It is expected that land-based wind power will reach 370MW of generation capacity in 2025. Along with offshore wind power this will help achieve the development capacity target of 403.7 MW.</p>
<p>Solar power</p>	<p>Phase 1 of the Solar Power Project was implemented in 2008. Since that time, a large number of solar photovoltaic systems have been built and, by the end of 2022, approximately 287 MW of solar PV installations have been completed. This includes the Tainan Salt Fields Solar PV Project, which is the largest solar PV project in Taiwan with a capacity of 150 MW. In 2020, the planning for the Green Energy Phase I project was initiated, aiming to add an additional 110 MW of solar PV capacity within the three-year period from 2022 to 2024.</p>
<p>Geothermal power generation</p>	<p>In cooperation with CPC, Taipower is undertaking the Yilan Renze Geothermal Generation Project with a capacity of 0.84MW. It is expected to be operating in 2023.</p>
<p>Biomass power generation</p>	<p>As Taiwan transitions to net-zero emissions, there is an urgent need to increase the number reliable and stable low-carbon energy sources. Internationally, wood pellets, as a carbon-neutral fuel, have been used with coal-fired power units for many years. The relevant technologies are mature and have already been commercialized. In consideration of the successful cases of international coal-fired power plants being transformed into biomass power plants, Taipower has formulated a plan to retrofit its decommissioned coal-fired units into low-carbon biomass units.</p> <p>Taipower plans to retrofit Hsinta's existing coal-fired Unit 1 into a biomass power unit after its decommissioning. The estimated capacity of the retrofit is expected to reach 500MW, with a planned target of generating 3,000 GWh of renewable energy annually.</p>



The 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 technology and the latest international 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 corresponding accumulation of capacity are as follows (as of April 19, 2023):

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

Case Status		Cases (Number)	Capacity (MW)
Accepted Cases	Under review but not yet approved (A)	4,963	10,161.57
	Approved but currently without a signed contract (B)	6,447	41,225.21
	A contract has been signed but not currently connected to the grid (C)	57,436	14,242.72
	Subtotal (=A+B+C)	68,846	65,629.51
Grid-Connected Cases		56,078	10,539.23
Official Power Purchase Cases		51,010	8,352.61

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 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 generated by facilities.

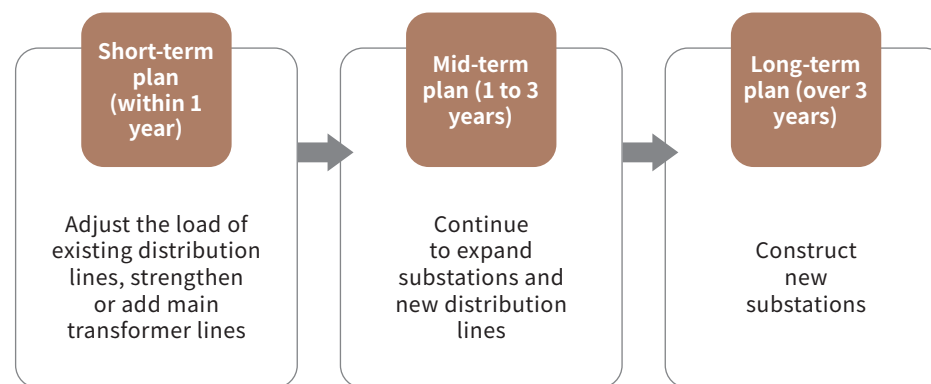
Average Availability Rates of Renewable Energy from 2020 to 2022

	2020	2021	2022
Availability rate of wind power (%)	93.03	92.61	92.05
Capacity factor of solar power (%)	16.02	16.44	16.16

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

Countermeasures to the 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 through a centralized deployment method to avoid wasting Taipower's investment. Meanwhile, Taipower has continued to both implement its distribution-grade power grid reinforcement project that will enable increased renewable grid-connections and to promote short, medium, and long-term model plans:



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 so it can appropriately allocate resources to developing joint booster stations with the capacity to accelerate renewable grid-connections.

To facilitate easy accessibility to information, Taipower established a renewable application progress query system so that the public can make immediate 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 wind, solar, geothermal, and small hydro renewable energy development projects, it is necessary for the Company to provide a friendly, grid-connection environment for private industry that is seeking to pursue green energy power generation. These steps are facilitating Taipower's move towards actualizing the government's goal of 20% renewable energy by 2025.

