

6.3 Minimizing Environmental Impacts

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6.3.1 Response Measures to Air Pollution



Taipower has formulated air pollution management strategies for thermal power plants. These include load reductions during periods of poor air quality and sufficient power supply. The Company has also conducted a comprehensive inventory of existing control equipment, planned to set up high-efficiency air pollution control equipment, and continuously improved its air pollution improvement measures at thermal power plants over three stages: short, medium, and long-term. These measures ensure a balance is achieved between power supply and environmental protection.

In recent years, the issue of "haze hazard" has been of great concern to the public. As such, Taipower has continued to manage air pollution actively through various plans and management methods. Taipower coordinated its implementation of environmental protection dispatching during periods of poor air quality to voluntarily reduce loads. For sulfur oxides (SO_x), nitrogen oxides (NO_x), and particulate pollutants (PM), the best available control technologies have been applied.

To control the air pollutant emissions generated by the operation of each power plant, Taipower chooses to use low-ash and low-sulfur fuels and is switching to clean energy in its fuel selection. In addition, continuous flue gas emission monitoring instruments have been installed in the smoke fontanel of various thermal power plants to accurately assess the concentration of pollutants in the flue gas, enabling equipment efficiency to be maintained in the best state, and minimizing the emission of pollutants in flue gas. Consequently, Taipower's flue gas pollutants are far lower than regulatory standard values.

The Actual and Regulatory Values of Major Air Pollutants from 2020 to 2022

Year	Concentration (Note)	PM (kg/GWh)		SO _x (kg/GWh)		NO _x (kg/GWh)	
		Actual value	Regulatory value	Actual value	Regulatory value	Actual value	Regulatory value
2020		8	61	102	307	203	407
2021		6	61	98	312	188	393
2022		5	60	84	277	169	359

Note: The EPA published pollutant emission standards (Unit: PPM), multiplied by the exhaust air volume of each emission pipe (Unit: NCMM), then converted from volumetric emissions to mass emissions, and finally divided by the amount of electricity generated (Unit: GWh).

Management of Stationary Emissions ▶▶

Short-term responses

Coal-fired unit loads are reduced during periods of poor air quality and the dispatching of gas-fired units is prioritized

One example of Taipower's environmental commitment can be found in its reduction of coal use. Since 2015, coal-fired thermal power plants have undertaken environmental load reductions, when system supply is secure. Reductions include both voluntary and autonomous actions. In 2022, load reductions occurred 1,301 times, and the cumulative frequency of load reductions reached 5,682 times by the end of December 2022, with a total load reduction of 55,138.96 GWh.

Principles of Load Reduction in Response to Air Pollution Grading

Load Reduction Action	Criteria	Action Plan
Voluntary Load Reduction	Where next day air quality indicator pollutants are predicted by the EPA's air quality forecast to reach targeted levels for "particulate matter (PM _{2.5})" or "ozone hour value (O ₃)," and the air quality indicator reaches the orange level (AQI> 100) or above.	After evaluating power supply sufficiency, the thermal power plants in the upwind area will undertake load shedding in accordance with the measures recommended by the EPA.
Autonomous Load Reduction	Following EPA notifications, where more than one-third of the stations in the air quality area on that day have detected air quality index pollutants at target levels for "particulate matter (PM _{2.5})" or "ozone hour value (O ₃)," and the air quality indicator reaches the orange level (AQI> 100) or above.	After evaluating the sufficiency of power supply, thermal power plants in the upwind area will undertake load shedding in accordance with the orders of the EPA.
Mandatory Load Reduction	Following the issuance of air quality warnings or severe deterioration warnings by local authorities.	When alerts of air quality deterioration are issued, designated power plants will implement a certain percentage of production cuts or load reductions provided the available national generating capacity is at 2.8 GWh and the reserve capacity ratio is more than 10%.

Load Reductions in 2022

All power plants in Taiwan	Frequency of load reductions (times)	Amount of load reductions (10 MWh)		
		Annual overhauls (maintenance)	Non-annual overhauls (maintenance)	Total
Voluntary load reduction	1,223	657,177.1	748,459.5	1,405,636.6
Autonomous load reduction	75	23,230.6	19,973.2	43,203.8
Forced load shedding	3	2,834.0	4,193.0	7,027
Total	1,301	683,241.7	772,625.7	1,455,867.4

Medium-Term Actions

Adopting End-of-Pipe Reductions and Adhering to Emission Standards for Gas-Fired Generating Units

Taipower has conducted a comprehensive inventory of its existing control equipment and plans to install high-efficiency air pollution control equipment, use overhaul periods to improve the functions of control equipment, and enhance the removal efficiency of control equipment as much as possible through operational practices.

Taipower will introduce more advanced and efficient air pollution prevention and control equipment, install equipment in new power plants and renew equipment in existing plants to effectively reduce emissions. It will also set up automatic continuous monitoring equipment for flue gas emissions. Taipower's air pollution control improvement plans for particulate pollutants (PM), nitrogen oxides (NO_x), and sulfur oxides (SO_x) are shown in the table below. Taipower will invest a total of \$69.229 billion between 2017 and 2025 in these initiatives. Together, the measures are expected to reduce particulate matter by 398 tons/year, sulfur oxides by 7,118 tons/year, and nitrogen oxides by 15,460 tons/year. For more information, please refer to the annual report of the Department of Environmental Protection.

Air Pollution Control and Improvement Plan

Air Pollutant	Preventive Measure
PM Particulate Matter	<ul style="list-style-type: none"> Install highly efficient electrostatic precipitators (EP) with a dust removal efficiency of 99.8% Build dust-proof grids around coal yards and configure regular sprinkler systems Use closed facilities for the transportation and unloading of coal, and frequently compact coal piles and clean roads Utilize chemical agents to stabilize the surface of coal piles in long-term storage, and implement the planting of windbreaks.
NO_x Nitrogen Oxides	<ul style="list-style-type: none"> Install low NO_x burners (LNB) and selective catalytic reduction (SCR) equipment
SO_x Sulfur Oxides	<ul style="list-style-type: none"> Install flue-gas desulfurization (FGD) equipment to remove more than 95% of sulfur oxide

Long-Term Action

A Power Source Shift from "Primarily Coal with Gas as support" to "Primarily Gas with Coal as support"

The proportion of renewable energy has been increased in line with the national energy policy. In addition, the thermal generation structure has been adjusted from primarily coal with gas as support to primarily gas with coal as support. As a result, the future power generation fuel structure will be dominated by natural gas. According to the power development plan, all thermal plants, with the exception of the ultra-supercritical coal fired units at Linkou and Talin, will operate gas-fired units. Additional gas-fired units are being added at the Hsieh-ho, Datan, Taichung, and Hsinta plants. This measure will ensure both air quality and a stable power supply. After the new gas-fired units at the Taichung and Hsinta plants are completed and commercialized, some of the existing coal-fired units will be decommissioned or converted to standby.

Taipower is committed to reducing air pollution. In addition to measures such as the renewal and reconstruction of generating units, improvements to generation efficiency, and strengthening the efficiency of air pollution control equipment, the move towards reducing coal and increasing gas is a vital emissions reduction strategy. Under Article 14 of the Air Pollution Control Act, Taipower submits Implementation Plans for Gas Adjustment during Periods of Air Quality Deterioration and the Adoption of Emergency Control Measures. The plans explain the results of Taipower's environmental protection dispatching and evaluate the overall air pollution reduction benefits accordingly. Plans will be submitted annually to the EPA for approval so that when Taipower reduces loads for coal-fired units in response to poor air quality or is required by the competent authority to reduce coal-fired generation, gas-fired power generation can be used instead to ensure a stable power supply is maintained while achieving air pollution reduction.

Air Pollutant Emissions by Power Plants from 2020 to 2022

Unit: kg/GWh

Air Pollutant Type	2020	2021	2022
Nitrogen Oxides (NO _x)	203	188	169
Sulfur Oxides (SO _x)	102	98	84
Particulate Matter (PM)	8	6	5

Management of Mobile Emission Sources ▶▶

According to Environmental Protection Administration (EPA) analysis, diesel trucks account for the largest proportion of emissions from among the various kinds of mobile pollution sources. This has led Taipower to make an inventory of its large diesel vehicles that meet phase one and phase two environmental protection standards. The Company is also cooperating with the EPA to replace older vehicles. It is estimated that 67 kg of PM_{2.5} emissions will be eliminated for each old large diesel vehicle removed from service. Additionally, large diesel vehicles that meet phase three standards are equipped with smoke filters to reduce pollution. It is expected that this will reduce PM_{2.5} emissions by about 10 kg per year for each phase three diesel vehicle.

Management of Fugitive Emission Sources ▶▶

Taipower's fugitive emission sources include construction sites and coal yards. For construction projects, Taipower announced Promotion and Management Guidelines on Environmentally Friendly Measures for Green Construction Sites in 2018. The Company's projects now incorporate these guidelines. An appendix to the guidelines called Environmental Protection Construction Regulations of Taiwan Power Company, requires contractors to formulate Environmental Protection Management Plans and position environmental protection management personnel, who should be full-time and have the qualification of Class B air pollution control or above (one qualified employee is required for project contracts of NT\$50 million, two are required for contracts above NT\$200 million), to reduce air pollution from construction projects.

To reduce emissions from coal yards, Taipower set up dust-proof netting around older, open yard perimeters and uses sprinklers to inhibit the escape of coal dust. With technological progress and increasingly robust environmental quality requirements, Taipower's coal storage yards have gradually been converted from open to indoor storage. The Linkou, Hsinta, and Talin Power Plants have all built indoor coal bunkers, and the Taichung Power Plant is planning to construct indoor coal bunkers. Work on these projects is currently underway and will further restrain the escape of coal dust when completed.

6.3.2 Effluent Recycling

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Water Resources Management ▶▶

Taipower tracks its wastewater discharge in accordance with Environmental Protection Agency rules, follows the progress of legal and regulatory revisions, and develops corresponding solutions for possible risks. For example, 24 new control items were added to the effluent standards for power plants at the end of 2017. New ammonia nitrogen control items were added in 2021, and control limits were tightened for the effluent of the flue gas desulfurization of coal-fired units on mercury, arsenic, and selenium. In 2019, the Water Pollution Control Measures and Test Reporting Management Regulations were also amended, requiring periodic test reporting on wastewater according to the announced items and frequency. If power plants violate the effluent standards, they will be punished according to law.

All of Taipower's power plants follow the ISO 14001 management system and conduct regular compliance inspections. In view of the risks that may arise from ordinance revisions, relevant plans are developed for measures such as increasing the frequency of testing, decreasing pollution emissions at source by process control, and evaluating the need for additional treatment equipment to improve wastewater treatment efficiency over the long term.

Water Consumption for Generation at Taipower's Thermal Power Plants in 2022			
Power Plant	Water Consumption for Generation(m ³)		
	Volume of Tap Water	Volume of Desalinated Water	Total
Hsieh-ho	310,243	4,633	314,876
Linkou	601,612	0	601,612
Datan	408,617	0	408,617
Tunghsiao	590,682	0	590,682
Taichung	4,613,335	0	4,613,335
Hsinta	2,202,606	0	2,202,606
Dalin	377,824	208,419	586,243
Nanbu	104,580	0	104,580
Jinshan	0	48,027	48,027
Tashan	0	33,307	33,307
Total	9,209,499	294,386	9,503,885

Wastewater Reuse ▶▶

Taipower actively pursues a goal of zero wastewater discharge. Rainwater collection (at power plants and dormitories) and wastewater reuse projects have been employed to reduce the use of tap water inside power plants through comprehensive planning. For many years, Taipower's thermal power plants have implemented measures for rainwater reclamation and wastewater reuse. The main uses of the recycled water are green irrigation, furnace bottom sealing, bottom ash water, and dust suppression for coal piles in coal yards. These measures have become normal water use principles for thermal power plants.

Rainwater storage and utilization essentially provides an alternative water source. It is an economical and practical water source development model because it does not consume energy or cause pollution. Taipower records the daily usage of demineralized water in unit operations. If there is any abnormality, Taipower investigates immediately, and implements water conservation. The Company encourages employees to sincerely cherish water resources and develop habits for water conservation.

Reclaimed and Reused Wastewater in Thermal Power Plants			
	Unit: Tons		
	2020	2021	2022
Reuse of Rainwater	108,959.0	115,476	61,292.7
Reuse of Effluent and Wastewater from Processes and Boiler Blowdowns	2,421,670	2,436,777	2,385,843

Note: Flue gas desulfurization (FGD) wastewater is not reused as it contains a high salt content which is likely to cause equipment corrosion and soil salinization. As such it is not included in the calculation of wastewater volumes

6.3.3 Waste Management

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Taipower has taken mitigation and improvement measures to minimize the impact of waste generated at the various stages of power generation, transmission, distribution, and sale. The following outlines the measures exercised for each type of power generation.

Type	Main Waste	Environmental Impact of Waste	Materiality Narrative	Mitigation and Improvement Measures
Thermal Power	Wastes and by-products are generated after fuel use, and include coal ash (fly and bottom ash) and desulfurized gypsum.	Coal ash (fly and bottom ash) is the industrial waste generated after fuel combustion. Improper storage may affect air quality and human health and can also have an impact on nearby ecosystems.	Thermal power (including gas and coal) accounts for approximately 78.5% of Taipower's total generated and purchased power. As such, industrial waste and by-products produced after fuel use must be disposed of properly.	<ol style="list-style-type: none"> 1. Taipower has formulated an air pollution management strategy for thermal power plants. For example, coal-fired thermal power plants are equipped with dust collection equipment to remove particulate pollutants in their smokers, and flue gas desulfurization equipment is installed to remove sulfur oxides from flue gas and to improve air quality. 2. Sulfur oxides combined with a limestone slurry produce desulfurized gypsum ($\text{CaSO}_4 + 2\text{H}_2\text{O}$) through chemical reactions such as absorption, neutralization, oxidation, and crystallization. This can be reused in the cement and fireproof board industries.
Nuclear Power	Main wastes can be divided by high and low-level radioactivity. Low-level radioactive wastes include radioactive waste resins, waste liquids, residues, radiation protection clothing, and parts that are generated during regular operations, equipment maintenance, or improvement projects at the nuclear power plant. High-level radioactive waste refers to the used nuclear fuel withdrawn after the operation of the nuclear power plant.	Radioactive material has a long half-life. If it is released carelessly, it may affect human health and pollute the surrounding environmental, soil and water resources.	If radioactive waste is improperly disposed of, the degree of harm and the scope of its impact could be enormous. Moreover, because radioactive materials have a long half-life, the impact time may last for tens or hundreds of years.	Taipower actively handles, disposes, and manages radioactive waste appropriately to effectively isolate it from the environment. Please refer to the Waste Management Mechanism section for Taipower's plans for high and low-level radioactive waste.
Hydropower Wind Power Solar Power	Decommissioned units and equipment.	There is no waste produced during the power generation process, and the product life cycle of units and equipment is enduring, resulting in low environmental impact.	The power generation processes of hydro, wind, and solar power units rely on natural resources, and unit life cycles are lengthy, so there is no materiality at present.	Regarding renewable energy equipment that may be decommissioned, Taipower will entrust a compliant disposal company to carry out waste cleaning and transportation and will evaluate the reuse of resources to minimize environmental impact.

Waste Management System ▶▶

The accumulation of coal ash also has potential hazards. Taipower takes steps to control ash levels effectively. Fly ash is measured at the angle of repose of the full silo, and the load combination is carried out by considering wind force, seismic force, soil transverse force, silo wall ring stress, temperature stress, and other factors. The Company also considers extreme situations, such as an empty silo with a full silo adjacent to it, by analyzing and confirming that the bearing force, deflection, displacement, subsidence, angular variables, and other items are sufficient to minimize potential hazards. Coal ash accumulation is classified according to the degree of potential hazard as follows:

Diameter, Height, and Level of Fly Ash at Coal-fired Power Plants				
Power Plant	Linkou	Taichung	Talin	Hsinta
Number of Silos	2	10	2	4
Diameter(m)	16.5	15	16	17
Height(m)	36	20	26.6	24
Control Ash Level (m)	28	10	22	20

Nuclear Energy-Related Waste Disposal Methods

Short-term

Storage and disposal processes for low-level radioactive waste

Before 1996, waste was sent to the Lanyu low-level radioactive storage yard for temporary storage. Since 1996, it has been temporarily stored in low-level radioactive storage depots at power plants.

Storage and disposal processes for used nuclear fuel

In keeping with international norms, used nuclear fuel is stored in a dry storage facility after temporary storage in a used nuclear fuel pool.

Medium-term

A temporary storage facility is planned for the medium term and material will be transported to the facility for storage.

Long-term

Transportation from short-term facilities or mid-term temporary storage facilities to a final disposal site.



Utilization of Industrial Waste ▶▶

Reuse of Coal Ash and Desulfurized Gypsum in 2022

Waste	Reuse Practice	Production	Reuse Volum	Reuse Ratio
Coal Ash	Taipower has encouraged its engineering units to use fly ash in civil construction projects and for filling trenches. This raises the volume and utilization rate of fly ash and reduces the environmental burden. Coal ash is also sold for use as a building material.	2.178 million tons	2.051 million tons	94.1%
Desulfurized Gypsum	Desulfurized gypsum is used by local cement and fire-retardant board makers.	0.273 million tons	0.273 million tons	100%

The company is committed to enhancing energy efficiency and reducing the environmental impact of the renewable materials used.

1. The company's coal-fired power plants generate a by-product called coal ash, which can be used as a substitute for cement and as a binding material in concrete. Currently, most of the coal ash produced is sold for external use in construction materials. This use serves as an excellent example of recycling waste resources. In 2022, the production of coal ash reached approximately 2.178 million tons. To promote resource recycling and reuse in response to the government's initiatives. It has also been actively involved in the research, development, and promotion of coal ash reuse technologies, as well as in strengthening coal ash production management. The aim is to achieve diversified reuses for coal ash, increase reuse rates and add value in alignment with the government's goals of reducing waste and promoting a green energy and carbon reduction agenda.
2. In recent years, efforts have been made to increase the reuse rate of coal ash. In addition to its use in industrial building materials and land reclamation, the Company actively promotes the use of controlled low-strength materials (CLSM) containing coal ash in pipeline projects in an effort to expand the utilization of coal ash resources.

In the process of operations, the company generates other waste materials such as cables and metal waste. These are handled through public bidding after recycling, and bidders must meet the qualifications of the "business waste disposal industry" as required by the competent authority. The recycling operations are carried out in accordance with legal procedures to reduce the environmental risks associated with waste disposal.

In the past, when public assets reached the end of their service lives, the company would conduct public auctions in accordance with the "Waste Disposal Act" after completing scrapping procedures. Qualified private waste disposal organizations would then handle the disposal. Unfortunately, this system meant that some items with remaining functionality were not fully utilized. To improve the situation, the Company signed a memorandum of cooperation with the Taipei City Collateralized Loan & Consignment Corporation in 2015. Through this collaboration, some of the still functional and usable scrapped items are auctioned through the "Taipei Used Goods Exchange" operated by the Taipei City Collateralized Loan & Consignment Corporation to promote waste reduction, resource recycling, and reuse in line with green environmental principles.

In 2006, following the Ministry of the Interior's "Joint Investigation and Coordination Meeting on Anti-theft and Contacting", the company began cooperating with police to crack down on the theft of power cables and curb the trade of stolen goods. All waste cables with high copper content, and thereby susceptible to theft, were included in centralized bidding. Police agencies nationwide were notified about the contracted waste disposal companies and the quantity of waste cables as a reference for investigation, and to help prevent dishonest businesses from using the company's authorization to cover up illegal activities.

To reduce operating costs, the company established Equipment and Spare Parts Management Guidelines for Regional Operating Offices in 2014. It also set up tracking and control systems for equipment and spare parts management, set quarterly inventory targets, and implemented quantitative management to reduce the inventory quantity of equipment and spare parts. The activation rate of equipment awaiting repair or inspection was increased while the purchase of new materials was reduced. In addition, regional centralized contract maintenance was implemented, and scrapping procedures were carried out in accordance with regulations. Active measures were taken, such as immediate announcements on the corporate network regarding repair and calibration work and transportation progress. The contracted calibration institutions were also notified and asked to expedite the calibration process, thereby facilitating a reduction in the volume of equipment awaiting repair or inspection.

Sales Volumes and Amounts for Taipower's Industrial Waste from 2020 to 2022

Item	2020	2021	2022
Coal ash output (10,000 tons)	220	234	217.8
Coal ash sales volume (10,000 tons)	198	201.8	205.1
Volume of scrap cable and other metal (1,000 tons)	8.502	10.758	10.097
Value of scrap cable and other metal (\$100 million)	9.679	18.345	16.427