TCFD Adaptation Plans for Climate Change in the Short-/Mid-/Long-term of Chunghwa Telecom

In view of the fact that CHT's communication equipment and facilities are all over Taiwan, and the impact of climate change will become more and more significant, CHT has formulated short-, medium-, and long-term climate change adaptation plans since 2020 to avoid the impact of long-term climate events on communication equipment and facilities. Short-term plans last 1-3 years, medium-term 3-8 years and long-term over 8 years, with adaptation plans covering 100% of the existing and newly-built operating sites and communication equipment.

Adaptation Plans	2023 Operational Results/Progress
(1) **Flood and Disaster Control Action Plans for Telecommunication IDCs, Telecommunication Equipment, and Buildings**	
Short-term adaptation plans (1-3 years)	
Continue monitoring and analyzing climatic disasters (including droughts, tsunamis, floods, wind storms, slope failure, and lightning). At the same time, reduce disaster risk, improve disaster preparedness, disaster recovery drills, disaster response measures, and optimize standard operating procedures for telecommunication IDCs, equipment, buildings, and facilities.	● Units responsible for the management of telecommunication data centers have each established measures for preventing natural disasters, formulated plans for business continuity and emergency response, and carried out planned data evacuation/data backup and recovery drills. ■ Conducted disaster resilience drills for six outlying islands and three transportation networks, including highways and mobile communications. ■ Completed the construction of fixed network transmission backup trailers and conducted disaster drills. ■ Conducted two key infrastructure protection exercises, including a live-fire drill in Taipei CIP and a wargame simulation in Taichung CIP. ■ Passed ISO 27001/27011 with third-party verification. ● All telecommunications equipment is equipped with a 24/7 monitoring mechanism. In the event of a sudden disaster, the network status can be quickly assessed to prepare disaster relief and repair resources based on the scale of the disaster, while constantly monitoring the situation's development. ● Drought prevention drills are carried out each year at CHT's Taipei Aiguo Facility. These drills cover the flood proof doors installed on four exits, one each at the car path, the motorcycle path, the basement stairwell, and the basement emergency exit, as well as that on the exit leading from the outdoors area on the first floor to the basement level.
Reduce electricity reliance	● Based on a statistical analysis, we managed to conserve

Adaptation Plans	2023 Operational Results/Progress
of company equipment and facilities, conduct carbon inventory of operational processes to identify areas where GHG emissions can be reduced, and improve the ability to save energy and reduce emissions. (For example, accelerate the phasing out of older and less energy-efficient data center equipment and improve data platforms to move towards a fully-online service model).	the most electricity in these three areas in 2023: 1. Electricity conserved by fixed network server rooms Replacement of old energy-consuming equipment; PSTN IP transformation; replacement of old air conditioning equipment and SMR equipment; NG SDH-UT decommissioning; reduction of ERI load; replacement of ADSL DSLAM, V1 DSLAM, and 7342 GPON OLT, and integration of broadband AGG-E. In 2023, branches in the region collectively reduced energy consumption by 47.44 million kWh. 2. Electricity conserved by mobile network server rooms (including base stations) Replacement of old and energy-consuming equipment, adoption of C-RAN architecture for base stations, gradual replacement of old and energy-consuming equipment at base stations, implementation of energy-saving measures for base station air conditioning, decommissioning of 2G gateway switches, closure of 3G-F2 cells, nighttime dormancy of 4G, optimization of dismantling and energy-saving in building equipment rooms. A total of 12.99 million kWh of power was saved in 2023. 3. Energy saving in Internet Data Centers (IDCs) Procured high-efficiency, low energy consumption, and high heat tolerance communications equipment, reducing electricity consumed by air conditioning. Replaced electrical equipment, and adopted high-efficiency transformers and UPS, as well as inverter air conditioners (such as magnetic centrifugal cold water mainframes, EC fans, and variable-frequency drives).
Medium-term adaptation plans (3-8 years)	
Based on climate monitoring and analysis results, and accounting for other factors such as potential risks and impact to business operations, CHT has taken measures to make telecommunications data centers, equipment, buildings, and facilities more resilient to climate change. These measures include implementing flood prevention and water drainage infrastructure, as well as establishing backup	● Continuous improvement of the business continuity plan and emergency response plan, as well as conducting backup and communication diversion drills for remote areas and outlying islands. ● To enhance network resilience and minimize the impact of submarine cable failures on national security, public livelihood, and industries, a triple network backup architecture between Taiwan and Matsu will be established, consisting of submarine cables, microwave links, and satellite connections. ● To improve the resilience of data centers in mountainous and remote areas in the eastern part of the country, new microwave stations will be established and existing stations will be upgraded. ● To improve emergency disaster response and rescue efficiency, mobile transmission backup equipment will

Adaptation Plans	2023 Operational Results/Progress
routing.	be established, and the Company will conduct integrated disaster rescue drills for both mobile and fixed networks. ● Complete construction of the Hualien Guanfu, Hualien Yuli, Hualien Fengbin, Taitung Chenggong, and Taitung Guanshan OTNs, providing dual routing for both the mountain and coastal lines, addressing the issue of long electrical circuit paths with only a single route in the Hualian and Taitung regions. ● Complete construction of the Taichung Fushou and Nantou Puli OTN, providing dual-route enhanced circuit availability for vulnerable mountain areas.
In order to reduce electricity reliance, CHT will gradually standardize types of locations where the electrical equipment in telecommunications data centers are installed to avoid rooftops and other areas which heat up easily. At the same time, the Company will adjust the cold and hot aisles in data centers and procure more energy-efficient equipment, with the goal of improving the PUE of CHT's data centers from bronze (PUE of 1.94) to silver level (PUE between 1.43-1.67). Due to reliability limitations, and the rate of customers' IT electricity usage, the PUE target has been set to 1.5 by 2030.	● IDC reliability is of utmost importance, however, PUE value is limited by customers' IT power usage after occupancy. By phasing out two old and small data centers in 2023, the overall power consumption efficiency of IDCs have been improved. ● With reference to IDC operators in regions with similar climate patterns, the PUE of CHT's IDCs have been improved, with the PUE for all IDCs in the region gradually decreasing from 1.67 in 2020. Consequently, the mid-term goal is to reduce it to 1.59 by 2025, while the long-term goal is 1.50 by 2030; the target for 2023 was 1.63, and the actual value was 1.626. ● Adopted more efficient and energy conserving air conditioning equipment, and continued the replacing of older, less efficient equipment, in order to improve the electricity utilization rates in data centers.
Considering the risk that a climate disaster might cause a blackout, leading to business interruption, and in cooperation with the government's policy encouraging citizens to generate their own electricity, CHT will develop energy storage technologies and expand the capacity of its energy storage infrastructure. The	● To mitigate the risk of interrupted communication caused by intermittent power outages, resulted from climate change, and improve call resilience, a backup battery technology has been developed for distribution boxes, where the voice equipment is deployed. Complete the pilot evaluation of 13 light boxes with 48V-30Ah lithium iron battery modules, which can effectively support 288-port voice devices for more than 5 hours of backup power, and can also optimize battery room space in distribution boxes, enhancing backup power lifespan and strengthening call resilience. CHT also proposes the mechanism of thermal runaway of lithium batteries and contingency

Adaptation Plans	2023 Operational Results/Progress
Company will increase the proportion of renewable energy used by its data centers, reducing the reliance on electricity generated by petrol, and allowing for the maintenance of a stable electricity supply in case of intermittent blackouts in the future.	measures in case of fire to provide reference for disaster relief. ● Following the policy of self-built solar power, the Company finalized the bidding for the construction of a 1MW energy storage system in Taipei in 2023. At current, the project is under active construction, it is expected to be completed and put to use in 2024.
Long-term adaptation plans (Over 8 years)	
Integrate national and private resources, combine telecommunications technologies, collaborate with different business, nation and academic organizations, agencies, and institutions to develop disaster analysis and prevention technologies, allowing for faster warnings for climate change disasters and reducing the risk of significant impact. (such as the Earthquake Public Warning Cell Broadcast Service)	● The Company has launched scientific research projects on climate change in collaboration with government and public agencies for disaster analysis; for example: The Taiwan Climate Change Projection Information and Adaptation Knowledge Platform (http://tccip.ncdr.nat.gov.tw). In the future, the Company may integrate and collaborate with industry academia-government organizations, and apply climate change disaster analysis data to develop technologies for preventing these disasters, reducing the impact of climate change risks.
(2) Adaptation action plans for network facilities in response to climate change	
Short-term adaptation plans (1-3 years)	
Underground data center infrastructure: Continue making improvements and inspections (e.g. of the drainage systems), and gradually replace older equipment to prevent accidents from occurring due to aging equipment.	● Conducted regular maintenance inspections based on the specific requirements for different buildings and equipment, and conduct regular (quarterly/annually) inspections of the Mobile Communication Building (Xing Tong Building)'s facilities, e.g. its electrical system/miscellaneous facilities/plumbing system. Based on the inspection results, a rolling management approach was adopted to implement continued improvements and inspections. ● Established the "Operating Guidelines for Underground On-Site Self Inspections" according to the "Chunghwa Telecom Main Criteria for Assessing External Network Equipment Maintenance". Inspection items include 20 operations and equipment categories, including network equipment, disaster prevention, and rescue operations, which focus on maintaining the safety of underground cables,

Adaptation Plans	2023 Operational Results/Progress
	preventing disasters, and ensuring sound rescue operations. ● Conducted regular self-inspections each quarter, and during the annual Mid-Term Inspection and External Network Equipment Maintenance Assessment, carried out inspections and performance assessments. ● In the 2023 External Network Equipment Maintenance Assessment, 17 issues were discovered across 4 inspection items in the Company's overall underground system assessment, and were corrected within 20 days.
Above ground telecommunications infrastructure: Continue building cable splicing boxes, wire distribution cabinets, telecommunication enclosures, and other infrastructure supporting FTTH; gradually phase out switching equipment in existing cross-connection cabinets, preventing damaged equipment from causing internet outages.	● The Company fully commits to building further facilities to improve FTTH network coverage, planning to increase FTTH coverage to above 90% across all regions by 2026. In 2023, total FTTH facilities were increased by 5.00%, achieving 86.39% network coverage. ● Removed V2 equipment used in consolidated cross-connection cabinets. In 2023, CHT implemented plans to reduce 4,696 pieces of such equipment, reducing the usage of cross-connection equipment and reducing the probability of network obstructions. ● Worked together with customers to change from V to H cable networks, reducing the use of cross-connection cabinets.
Underground cable infrastructure: Optimizing gas-filled cable software for laying cables in manholes, handholes, and underground tunnels, in order to discover and address problematic areas in advance.	● Continued to optimize filled gas monitoring software, and gradually update to smart gas filling machines. In 2023, CHT replaced 54 gas filling machines, and removed 19,267 detected cable obstructions, planning to gradually replace 60 machines in the next 2 years, and improving the obstruction advance warning system to prevent cable obstructions.
Overhead cable infrastructure: Optimize the surveying software used for transmission towers and cables, in order to inspect any power cables or transmission tower equipment experiencing issues more effectively and make improvements, preventing cable obstructions.	● The automated workflow process for patrol of line equipment was established in 2023, POC verified on July 15, and is now available for use by field inspection personnel. ● In 2024, CHT plans to optimize the GIS trajectory patrol software through redevelopment, and plans to submit an inspection report titled "Data on Overhead Cable Lines Spanning Across Roads" in order to improve the safety of telecommunications infrastructure.
Medium-term adaptation plans (3-8 years)	
Underground data	● By using copper reduction equipment MSAN and OE1

Adaptation Plans	2023 Operational Results/Progress
infrastructure: Update center network technologies, reduce the use of copper cables, and begin converting cable systems to fiber-optic cables, leveraging these technological updates to reduce the number of exchanges.	MUX for mass cutover, the usage of copper trunk cables from the main office to the distribution box can be significantly reduced, and, coupled with asset revitalization targets, can generate external benefits. ■ Cat 1 cable (relay copper cable): Reduced copper by 501 hundred pairs (coverage: 97.85%), withdrew 43 copper cables (coverage: 93.48%). ■ Cat 2 cable (SVG construction and removal of cables between virtual office and main office): Reduced copper by 296 hundred pairs (coverage rate: 100%), withdrew 11 copper cables (coverage rate: 100%). ■ Cat 3 able (MSAN & VOBB conversion and removal of cables): Reduced copper by 1,149 hundred pairs (coverage rate: 86.72%), withdrew 31 copper cables (coverage rate: 59.62%). ● Replacement of copper cables with fiber-optic cables as PoC: Copper cables have been reduced by a total 1,149 pairs (coverage rate: 84.80%), and 31 cables (coverage rate: 59.62%) in 7 PoC offices. ● Refinement results of replacing copper cables with fiber-optic cables as PoC: ■ Development and testing of the heat dissipation module for distribution boxes: Maintain the temperature of the junction box at below 60°C; utilize PWM fans in order to reduce 162kg of CO_2e annually with each box. ■ Lithium-iron battery inspection and testing results: The lifespan of lithium iron batteries is 5 times that of lead-acid batteries, and the backup capacity is 1.3 times that of lead-acid batteries. Due to their low self-discharge rate, lithium-iron batteries save energy, reduce carbon, and are more environmentally friendly. ■ Continued implementing the POC project for reducing the use of copper cables in server rooms. We plan to be able to complete consolidation operations for the Taoyuan International Airport server room by 2025, with consolidation and conversion progress in 2023 reaching 71.87%.
Ground telecommunications facilities: Accelerate fiber-optic conversion in cable splicing boxes, wire distribution cabinets, and telecommunication boxes, gradually remove copper cables and switching	● Implement fiber-optic coverage construction (Fiber To The Home, FFTH), with the goal of achieving over 90% fiber coverage in the entire area by 2026. In 2023, there was a net increase of 5.00% in construction completed, reaching a fiber coverage rate of 86.39%. ● Reduced V2 equipment in consolidated cross connection cabinets. Plans implemented in 2023 helped conserve 2.223 million kWh of electricity, with empty cross connection cabinets being re-utilized. In

Adaptation Plans	2023 Operational Results/Progress
equipment from distribution boxes.	the past 8 years, CHT has worked with exchange points to reduce and consolidate operations, and have worked together with customers to continue converting older cables to fiber-optic cables.
Underground cable infrastructure: Accelerate converting all cables laid in manholes, handholes, and underground tunnels to fiber-optic cables, reducing the number of copper cables used.	● To increase revenue and reduce cable maintenance costs, CHT's branches have set a total target amount for the sale of scrap cables, motivating the active dismantling and selling of old copper cables, with results in 2023 being as follows: ■ Through the promotion of replacing copper cables with fiber-optic cables, the usage of copper trunk cables from the main office to distribution boxes has been greatly reduced. In addition, the dismantled waste cables are able to be sold or used as maintenance materials (Type A), to reduce maintenance costs and generate revenue. ■ 1,195,368 kg of copper was removed from the entire region in 2023, creating an auction performance of approximately NT$239 million, equivalent to freeing up 118.82 kilometers for fiber optic cable deployment, and reducing pipeline construction costs by about NT$107 million. ■ Replacement of copper cables with fiber-optic cables as PoC for Cat 1, Cat 2, and Cat 3 cables in 2023: (1) Cat 1 cable (relay copper cable): Removed 52,320m of copper. (2) Cat 2 cable (SVG construction and removal of cables between virtual office and main office): Removed 23,943m of copper. (3) Cat 3 cable (SVG construction and removal of cables between virtual office and main office): Removed 38,190m of copper. ● Launched the server room's POC cable conversion and copper cable removal project, which plans to remove 2,611 km of copper trunk cable by 2026. In 2023, 89.9km of copper cable were removed, bringing the total to 292km. ● Implemented project to replace copper cable with fiber-optic cable; across all regions, established and implemented annual schedules for removing 66.9km of underground cables from 2022 to 2026.
Overhead cable infrastructure: Wireless networks shall gradually replace wired networks for transmission towers and overhead cables. This	● Prioritized installing FWA in regions where fiber-optic cables cannot be easily laid, substituting fixed broadband networks with mobile networks, and reducing construction costs. In 2023, 27 routes for MOD HD have been installed. ● Evaluate the use of fixed wireless access (FWA)

Adaptation Plans	2023 Operational Results/Progress
replacement process shall begin being implemented in mountainous and more remote regions.	solutions to address Internet connectivity needs. In 2023, 26 locations across the region that meet the conditions for 5G FWA were selected for proof-of-concept (POC) verification of Internet connectivity, future testings will be carried out with the collaboration between terminal equipment suppliers and the Wireless Institute at Telecom Laboratories.
Long-term adaptation plans (Over 8 years)	
Promote smart maintenance by transforming traditional manual maintenance operations and decentralized management mechanisms into systematic, automated, intelligent, and centralized systems, in order to ensure constant awareness of potential climate disaster risks, strengthen adaptation plans, and enable an immediate response.	● Develop related maintenance management systems, each in charge of the maintenance of related facilities and equipment. Refine management and testing systems according to the continuous evolution and updating of network technology and equipment; set development goals of systematization, automation, intelligence, and centralization to avoid duplication of investment in resources. ● Continue optimizing innovative system features and enhance the centralized and intelligent capabilities of the system. Starting in 2023, CHT has been reviewing the integration of relevant operational management systems, with a goal to integrate systems such as FORCE, GIS, and CEMIS to facilitate on-site operations and ensure safe line maintenance. The integrated system is expected to be operational by August 2024.
(3) Network adaptation action plan in response to climate change for mobile communication base stations	
Short-term adaptation plans (1-3 years)	
Improve safety: Periodically inspect and repair base stations' cell towers/equipment/electrical supply equipment, and gradually replace older electrical equipment to prevent accidents from occurring due to aging equipment.	● Established the "Main Criteria for Assessing Mobile Communications Equipment", inspecting and repairing base stations every six months. These procedures include an external alerts test, battery discharge test, firefighting equipment inspection, inspection of air-conditioning system operation, and fan filter cleaning. CHT completed inspection and repair of all of base stations in 2023, achieving a successful inspection and repair rate of 100%, and completing all improvements.
Improve electricity supply: Convert base stations into C-RAN architecture, install stable electricity supply and sufficient backup electricity sources in data centers.	● By 2023, the number of 5G base stations in the region has exceeded 21,600. In order adapt to the expansion of 5G network coverage, C-RAN equipment rooms has been built to make room for base stations, and the proportion of C-RAN stations in the entire network is now nearly 90%.
Reduce electricity demand: Natural ventilation/exhaust fans shall be introduced at base stations, and RU radio frequency equipment shall	● Power saving measures include the adoption of C-RAN architecture for base stations, gradual replacement of old and energy-consuming equipment at base stations, implementation of energy-saving measures for base station air conditioning,

Adaptation Plans	2023 Operational Results/Progress
be installed outdoors, reducing electricity consumption. CHT shall also halt support for its 3G systems, reducing electricity needed, as well as operational and maintenance costs.	decommissioning of 2G gateway switches, closure of 3G-F2 cells, dismantling of 3G extension modules, nighttime dormancy of 4G, optimization of dismantling and energy-saving in building equipment rooms. In 2023, a total of 11,690,000 kWh of power was saved as a result.
In line with the construction of 5G N2100 base stations, shut down 3G F2 cells, and effectively utilize the 3G U2100 frequency. Extend 5G signal coverage to achieve the twin goals of reducing electricity requirements, as well as maintenance and operational expenses.	● Aligning with the 3G Sun Set plan, the Company optimizes 3/4G network selection parameters to reduce 3G network dependency, continues 5G N2100 base station construction to achieve effective use of 3G U2100 spectrum strategy, and has gradually shut down all 3G F2 cells in 2023 to remove high-capacity extension modules, saving 1.9 million kWh of electricity. In the future, the 3G base station will be phased out in accordance with the 3G Sunset plan to reduce base station energy consumption.
Medium-term adaptation plans (3-8 years)	
Promote smart maintenance by transforming traditional manual maintenance operations and decentralized management mechanisms into systematic, automated, intelligent, and centralized systems, in order to ensure constant awareness of potential climate disaster risks, strengthen adaptation plans, and enable an immediate response.	● Relying on the multi-band properties of 4G, CHT has implemented smart electricity-conserving measures for its 4G base station cells (reducing the number of usable frequencies) during the low-traffic nighttime hours. In 2023, these measures were in place for 14.37 million cell hours, saving 690 thousand kWh of electricity. The Company plans to implement these efforts on a larger scale in the future in order to reduce energy consumption.
Long-term adaptation plans (Over 8 years)	
Improve the ability of base stations to survive disasters, with a primary focus on maintaining electricity supply. A secondary concern is the stability of transmission cables, and strengthening backup systems. Establish systems for protecting transmission cable networks, such as establishing backup routing and equipment redundancy.	● In 2023, CHT successfully installed wind power, photovoltaic power, and energy storage systems in green base stations in remote areas of high mountains, seashores, and outlying islands, generating a total of 113.8kW of power (12kW of wind power and 101.8kW of solar power) for self-consumption at the base stations. ● Equip 5G base station transmission circuits with MSER, providing backup protection mechanisms through dual routing; currently, 4G base station circuits are gradually being equipped with MSER and backed up by dual routing ● 5G Mobile network Adopt the C-RAN architecture for base stations, and the modules and routes important for

Adaptation Plans	2023 Operational Results/Progress
	MBH (Mobile Backhaul) transmission aggregation equipment are to be protected by backup recovery mechanism. Continue to develop maintenance and operational tools to promote smart management and maintenance, improve the network monitoring system, and Access network Cyber resilience. ● In order to ensure reliable transmissions from base stations, CHT has not only considered the appropriate adoption of FSO (Free-Space Optical Communication) to replace the older narrowband microwaves that cannot be used for 4G or higher transmissions, but may also in the future adopt the use of commercial low earth orbit satellites, using the properties of these broadband signals to serve as an important backup transmissions method for its base stations.