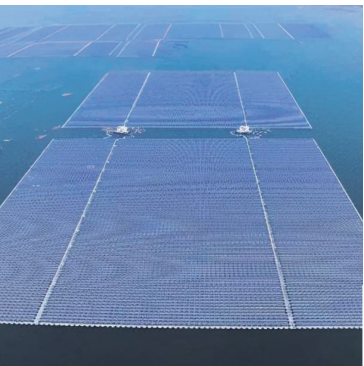




Global Energy Interconnection
Development and Cooperation Organization
全球能源互联网发展合作组织



Energizing Conservation: Practical Cases of Energy Transition for Biodiversity

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and Cooperation Organization

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Foreword

Biodiversity is the material foundation on which human survival depends. Protecting biodiversity is a shared responsibility of governments, businesses, and society around the world. In the past few years, more and more government departments, international organizations, energy companies, research institutions, etc. have gradually realized that energy is playing a critical role in protecting biodiversity and addressing climate change. Accelerating the green and low-carbon transformation of energy, reducing the impact of large-scale development and utilization of fossil energy on natural ecosystems are crucial for promoting the coordinated governance of energy, climate, and biodiversity, and achieving the goals of *The Paris Agreement* and *Kunming-Montreal Global Biodiversity Framework*.

For this reason, the Global Energy Interconnection Development and Cooperation Organization (GEIDCO) solicited innovative engineering practices from its members and partners that address climate change and promote biodiversity conservation through energy transition. From these contributions, GEIDCO has curated the *Energizing Conservation: Practical Cases of Energy Transition for Biodiversity*. This compilation highlights exemplary projects that are innovative, scalable, and have delivered notable results. These initiatives range from large-scale clean energy development, which indirectly supports biodiversity by reducing carbon emissions, to specific interventions in energy planning, construction, and operations. Examples include: avoiding ecologically sensitive areas, replacing overhead power lines with underground cables, installing artificial bird nests on transmission towers, creating fish migration channels at hydropower stations, using solar power for desert control, restoring ecosystems in coal mining regions, and supplying green energy to ecological research bases. These measures help minimize habitat destruction, promote environmental restoration, and provide direct protection for biodiversity, showcasing successful approaches to integrating energy transition with ecological conservation.

This report aims to establish a platform for collaborative governance of energy, climate, and biodiversity. By sharing knowledge, achievements, and experiences, we hope to provide valuable insights for governments, organizations, enterprises, and institutions engaged in these critical efforts. Looking ahead, GEIDCO stands ready to collaborate with all stakeholders to enhance communication, deepen practical cooperation, and promote coordinated actions. Together, we can accelerate progress toward a future where humanity and nature coexist in harmony.



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Chapter I Promoting Carbon Emission Reduction

[Case 1]

Building Brazil's electric power highway to promote green, low-carbon, and sustainable development

PART 01 Case Background

The Belo Monte Phase II Project (hereinafter referred to as the “Belo II Project”) is the transmission project of the second largest hydroelectric power station in Brazil, the Belo Monte Hydroelectric Power Station. It is the main channel for the north-south interconnection of the Brazilian power grid, effectively solving the problem of clean hydroelectric power transmission and consumption in the northern Amazon basin of Brazil, and meeting the annual electricity demand of about 22 million people in the load center of southeastern Brazil. It is known as the “Brazilian electricity highway”.

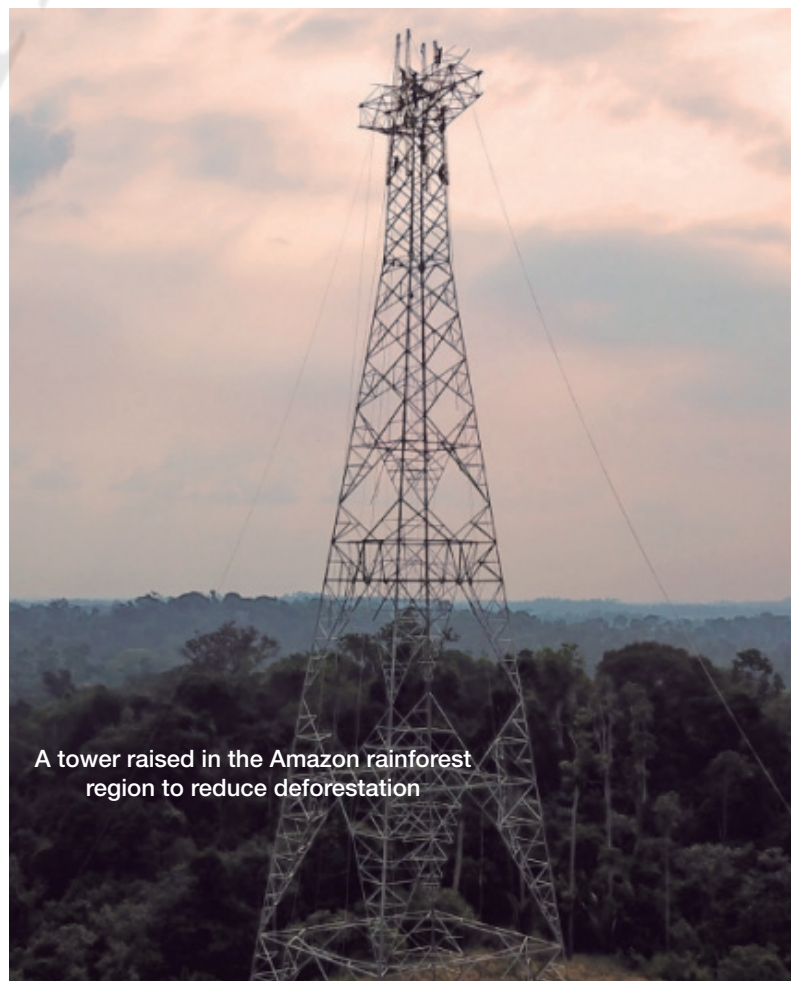
Belo II Project crosses three climate zones in Brazil: the northern Amazon rainforest, the central Cerrado tropical grassland, and the southeastern Atlantic coastal rainforest. It crosses 863 rivers, with a wide variety of flora and fauna in the surrounding area and along the route. The ecological environment is extremely sensitive and complex. During the construction process of Belo II Project, State Grid Corporation of China strictly adhered to Brazilian environmental laws and policies, and implemented environmental protection responsibilities and obligations, in order to serve and promote the Belt and Road Initiative with practical actions, and practice the concept of green development, making significant contributions to promoting biodiversity in Brazil.

PART 02 Actions

During the construction of Belo II Project, while meeting Brazil's strict environmental regulations and policies, State Grid Corporation of China made good practices in promoting carbon reduction, strengthening ecological restoration, and promoting sustainable utilization of biological resources.

In terms of promoting carbon reduction, a long-

distance high-capacity power transmission solution was adopted in Belo II Project, which realized the cross-regional allocation of electric power energy, and avoided redundant construction of traditional fossil energy power sources, establishing a low-carbon pathway for clean energy featuring “production-transmission-distribution”. Belo II Project was put into operation in August 2019 and has delivered a total of 56 billion kilowatt hours of clean hydroelectric power as of September 2022, equivalent to saving 20.15 million tons of standard coal and reducing 55.8 million tons of carbon dioxide emissions. It has provided strong support and services for Brazil's economic and social development and low-carbon energy transition.



A tower raised in the Amazon rainforest region to reduce deforestation



Rescued reptiles, rattlesnakes, and birds

In terms of strengthening ecological restoration, Belo II Project effectively reduced the area of deforestation by adopting measures such as optimizing corridor paths, reducing the width of corridor vegetation clearing, and minimizing the opening of construction roads in native forest areas. After verification, the actual cleared vegetation area of the project was 31% less than the cleared area approved by the Brazilian Environmental Protection Agency, equivalent to the area of 45 Maracanã Stadiums in Rio de Janeiro. Meanwhile, reforestation activities covering a total area of 436 hectares were carried out in the five states where the project transmission lines pass through, effectively promoting forest ecosystem restoration and fulfilling corporate environmental responsibilities.

In promoting the sustainable utilization of biological resources, Belo II Project implemented the *Animal Repulsion, Rescue, and Release* program, which recorded a total of 604 animal species in three different ecological zones in Brazil, including endangered species such as the hyacinth macaw, howler monkey, and seedeater finch. At the construction site, the rescue rate of animals found reached 95.05%. This has effectively promoted the sustainable development of biodiversity in Brazil.

PART 03 Achievements

During the four-year environmental impact assessment and construction period, all environmental protection work of Belo II Project met or exceeded Brazilian environmental regulations, making it the first large-scale project in Brazil to have zero environmental penalties in recent years. The advanced environmental management concepts and measures of this project have been highly recognized by the Brazilian Environmental Agency and industry. Since the high-quality operation of the project, the DC system has been running safely and steadily, achieving reliable power supply.

PART 04 Highlights

The project was awarded important awards such as the “6th China Industry Award”, the “Best Practice Award for Social and Environmental Management in Brazil”, the “Best Practice Award for International Energy Cooperation in the Belt and Road Initiative”, and the “PMI (China) Project Management Award”.

[Case 2]

Building an integrated micro-grid of PV and energy storage to create a solid protection barrier for the golden snub-nosed monkey

PART 01 Case Background

Shennongjia Forestry District is located in the northwest of Hubei Province, China. It is the most well-preserved subtropical forest ecosystem in the 31 degree north latitude zone of the world. It is a World Natural Heritage Site, a World Geopark, a Biosphere Reserve, and an internationally important wetland. In addition, it is one of the 14 key areas for biodiversity conservation and research of international significance. The forest area covers 3,253 square kilometers, with an altitude distribution of 400 meters to 3,100 meters and an average altitude of 1,700 meters. Due to its unique geographical location and climate characteristics, Shennongjia serves as a transitional zone and intersection for biological species, nurturing abundant flora and fauna resources. The forest coverage in the region is 91.12%, with 838 species of deciduous woody plants, 3,183 species of higher vascular plants, and 927 species of fungi, lichens, etc. In addition, there are 318 species of wild animals such as golden snub-nosed monkeys, golden eagles, and sika deer, making it known as a natural gene bank and a refuge for endangered wildlife.

PART 02 Actions

In October 2021, the Chinese government issued the *Opinions on Further Strengthening Biodiversity Conservation*, which included biodiversity conservation in the medium and long-term planning of various regions and relevant fields, and stipulated the need to conduct biodiversity impact assessments on large-scale engineering construction, resource development, and utilization. In June 2023, the local government formulated and promulgated the *Shennongjia Forest Area Natural Ecological Protection and Coordinated Development Plan* based on the actual situation of the Shennongjia area, proposing

to implement strict bottom line and zoning control on Shennongjia with the protection of natural ecological resources such as world natural heritage as the core.

State Grid Hubei Electric Power Company adheres to ecological priority and green development, integrating the protection of biodiversity into the entire process of power grid construction and operation. **During the planning stage**, efforts were made to promote the integration of power planning, rural revitalization planning and forest economic and social development planning, and actively promote clean substitution and electric energy substitution, in order to reduce ecological damage from the source. **During the feasibility study and design stage**, efforts were made to strictly implement the ecological red line protection regulations, and optimize site selection, route selection and construction paths, in order to avoid ecologically sensitive areas as much as possible. In addition, biodiversity assessments were strictly carried out, such as the Dahu Village Rural Energy Revolution and Honghua-Xiangping 110 kV transmission project, which has received biodiversity assessment approval. **During the construction stage**, the environmental impact assessment report and water conservation plan approval documents were required to be obtained before the project starts. During the construction process, efforts were made to implement the requirements of the “three simultaneousness” system for environmental protection and water conservation. After the completion of the project, efforts were made to complete the acceptance of completed equipment in accordance with the law. **During the operation stage**, the normal operation of environment and water conservation facilities was ensured. Environmental factors, waste disposal, etc. complied with the requirements of relevant environmental protection laws, regulations and technical standards.

PART 03 Achievements

Establishment of a zero-carbon micro grid at the **Dalongtan Golden Snub-nosed Monkey Research Base**. Efforts have been made to carry out full electrification transformation of the production and living facilities at the base. A photovoltaic and energy storage integrated micro-grid was built, generating approximately 30,000 kilowatt-hours of photovoltaic power annually. As a result, it can reduce carbon dioxide emissions by 29 tons, and minimize the impact of the research base on the habitat of golden snub-nosed monkeys. After years of efforts by conservation personnel, the population of golden snub-nosed monkeys in Shennongjia has increased from over 500 at the beginning of the establishment of the nature reserve to over 1,300 currently, more than doubling in 30 years.

It has promoted the **green transformation and development of Shennongjia Forestry District**. Efforts have been made to vigorously develop green energy, and achieve about 90% clean energy supply in the entire region. The substitution of electricity in the service industry, transportation, and residential sectors was promoted, with electricity accounting for 67% of final energy consumption. In addition, focus was placed on two major goals of protecting the ecology and increasing income, in order to accelerate the construction of the Shennongjia all-electric green smart scenic area. The “all-electric kitchens” and clean heating pilot projects have been completed for 71 organizations including office spaces, star-rated hotels, and branded homestays.

Establishment of the “dual-chief and dual-channel” working mode. It has promoted cooperation between the forestry department’s “forest chief” and the power department’s “electric transmission line chief”, and established dual-use channels for power line corridors and forest fire barriers, in order to greatly reduce deforestation. Through joint patrols, maintenance, and publicity by grassroots personnel from both sides, hidden dangers in power lines and forest fire prevention can be addressed in a timely



Dalongtan “Zero Carbon” Golden Snub-nosed Monkey Research Base



Firebreak belts and power line corridors combined into a dual-channel system

manner. Joint efforts have been made to promote fire safety, and protect power facilities, with an increasing awareness against poaching and theft, achieving the goal of a shared channel and mutual benefit. Currently, four “dual-channel” covering more than 90 mu have been built, and 170 kilometers of power line channels have been included in the planning of firebreak zones.

PART 04 Highlights

(1) The government has established the basic principle of “developing while protecting and protecting while developing”, and formulated policies related to ecological protection and coordinated development, in order to actively guide energy enterprises to integrate the concept of green development into the entire process of power infrastructure planning, construction, and operation.

(2) Local power companies continue to explore the clean energy sector and green ecological value space around biodiversity protection, low-carbon energy transition, and other aspects, and actively promote the construction of all-green power scenic spots, and integrated micro-grid projects for photovoltaics and energy storage, in order to create a typical demonstration of multi-scenario new energy development and application.

[Case 3]

Peru vigorously promotes the development of electric vehicles to actively promote carbon reduction.

PART 01 Case Background

For a long time, vehicle exhaust emissions have been the main factor causing environmental pollution in Lima, the capital of Peru. However, electric vehicles are not popular in Peru, with only 75 pure electric vehicles sold nationwide in 2022. Luz Del Sur is the largest power distribution company in Peru, serving over 1.3 million users (about 15% of the total electricity users in Peru) with an annual electricity distribution of over 9 billion kilowatt-hours (around 20% of the total electricity consumption in the country). The company is actively promoting the popularization of electric vehicles, in order to reduce carbon emissions and environmental pollution.

PART 02 Actions

In recent years, the Peruvian government has actively committed to the green and low-carbon energy transition, vigorously promoting the development of clean energy, and proposed to achieve a 40% carbon reduction target by 2050. In order to reduce local dependence on fossil fuels, Luz Del Sur developed a vehicle replacement plan in 2022, aiming to replace approximately 400 gasoline vehicles with electric vehicles within three years. Since 2023, Luz Del Sur has started to purchase electric vehicles from China and use the first batch of vehicles for the production, operation, and service of the company's power distribution business. As of June 2024, the number of electric vehicles owned by Luz Del Sur has increased to 62, including various models such as sedans, SUVs, and heavy trucks, forming the largest electric vehicle fleet in Peru. With practical actions, it leads the trend of green development in Peruvian society and promotes the transition of the whole society to a low-carbon economy.

Electric vehicles replace gasoline vehicles at the company





Delivery scene of heavy-duty electric trucks

PART 03 Achievements

According to calculations, the first batch of electric vehicles put into use has effectively reduced over 16,600 gallons of diesel consumption and 112 tons of carbon dioxide emissions. Based on the plan of Luz Del Sur, more Chinese electric vehicles will be purchased in the next two years, aiming to achieve the goal of new energy vehicles accounting for 90% by the end of 2027.



[Case 4]

Biodiversity conservation and sustainable utilization in Qiandao Luneng Resort

PART 01 Case Background

Qiandao Luneng Resort Project is located on Jiashou Islands in Hangzhou, China, with a planned total land area of about 840 hectares. It extends into the lake in a finger-like shape and has a unique spatial texture of alternating lakes and islands, with islands crisscrossing vertically and horizontally. It includes various spatial elements such as forests, mountain bays, island chains, inner lakes, and peninsulas, with excellent landscape and environmental resources. The water quality in the area is excellent, meeting the national Class I surface water standards. The native vegetation is well grown, with abundant economic fruit trees, and the soil is red sandy soil. The base has a rich variety of flora and fauna, especially birds and fish. As the largest cultural and tourism project in Chun'an County, the project undertakes the dual tasks of construction and event guarantee for the Asian Games Chun'an branch of the 2022 Hangzhou Asian Games.

PART 02 Actions

China Green Development Investment Group is responsible for the development, construction, and operation of the Qiandao Luneng Resort Cultural Tourism Project based on the principles of ecology and green development. It focuses on the four dimensions of “ecology, health, sports and culture” to carry out systematic ecological development and product system innovation on the 6,300 mu of land and 6,300 mu of water within the base.

Implementation of demonstration actions for low-carbon parks. With the Asian Games cycling venue as the core, it covers the surrounding outdoor venues for pentathlon events, and researches carbon reduction measures during and after the events. In the construction process of competition venues and supporting projects, green building technologies such as green construction, healthy construction, and indoor environmental control are adopted to promote energy conservation and carbon reduction. The



Aerial view of Qiandao Lake tourist resort

photovoltaic power generation project for the bicycle venue shed has been constructed, with an installed capacity of 55.23 kilowatts, providing an average of about 59,000 kilowatt-hours of green electricity per year. The Yanjia Village Asian Games Low-carbon Ecological Park has been built in Chun'an to support the low-carbon Asian Games.

Implementation of actions for biodiversity restoration and conservation. Efforts have been made to restore the natural environment, optimize the ecological environment, and create habitats for wildlife, in order to provide a peaceful harbor for birds, fish, insects, and other organisms. The project has completed the practice and achievement compilation of biodiversity conservation in the Qiandao Luneng Resort. Currently, 179 species of birds and 114 species of fish have been recorded in the park.

Implementation of measures to prevent soil erosion. During the construction process of the project, efforts were made to simultaneously carry out soil erosion control and adhere to the principles of adapting measures to local conditions and preventing harm according to local conditions. Fully considering the terrain, resources, and characteristics of soil erosion, efforts were made to combine soil erosion control with concentrated demonstration of soil and water conservation techniques, improve soil and water environment improvement, and water quality protection, forming a complete and three-dimensional comprehensive soil erosion control technology system with a forest and grass vegetation coverage rate of over 80%. Ecological tea gardens, wetlands, picking gardens and other soil and water conservation demonstration areas have been built centrally.



Asian Games Cycling Venue

PART 03 Achievements

It has successfully supported the zero-carbon hosting of the Green Asian Games. All sections of Phase I of the Asian Games Resort have obtained a two-star green building certification, and the cycling venue in Chun'an has obtained a one-star green building certification. The photovoltaic power generation project at the cycling venue saves about 23.8 tons of standard coal and reduces carbon dioxide emissions by about 58.8 tons annually. In addition, the Asian Games low-carbon ecological park has been selected for the "Carbon Neutrality for the 19th Asian Games in Hangzhou 2022".

Establishment of a distinctive system for soil and water conservation. The project actively promotes the establishment of the Qiandao Luneng Resort National Soil and Water Conservation Science and Technology Demonstration Park, covering an area of 864.36 hectares, becoming an important window for showcasing soil and water conservation demonstration models, as well as for scientific popularization and education in Zhejiang Province and even nationwide.

PART 04 Highlights

(1) The project, with its comprehensive ecological enhancement plan, rich biodiversity, and magnificent lake and mountain scenery, has successfully been selected as one of the "100+ Global Typical Cases of Biodiversity" by the United Nations.

(2) The project actively carries out nature education practices that integrate knowledge and fun, such as natural science popularization, ecological practice, and ecological experience. It also coordinates the operation of research, camping, ecological tea gardens, and other projects, and has been awarded the honorary title of "Ecological Civilization Education Base" in Chun'an County.



[Case 5]

Port shore power assists in building low-carbon ecology in Zhoushan, Ningbo

PART 01 Case Background

As the endpoint of the Grand Canal of China and the starting point of the Maritime Silk Road, Ningbo has always been a core port for the exchange of Eastern and Western civilizations since ancient times. Currently, the Zhoushan Port, Ningbo has developed into the world's only super port with an annual cargo throughput of over 1.1 billion tons, ranking first in the world for eleven consecutive years. It has established trade channels with over 600 ports in over 190 countries (regions). In recent years, due to the significant increase in the number and density of ships docking, a large amount of fuel has been consumed, resulting in the formation of a large-scale "floating chimney" at sea, which has caused serious damage to the urban environment of Ningbo. Based on incomplete statistics, the carbon emissions generated by auxiliary power generation of docked ships account for 40%-70% of the total carbon emissions in the port, and become a significant factor affecting the air quality in the port and the city.

PART 02 Actions

Since 2014, Beijing Smart Chip Microelectronics Technology Co., Ltd. (hereinafter referred to as "Smart Chip Company") has actively overcome key technologies in port shore based power supply systems, covering various typical ship electrical load calculation and evaluation models, ship group load capacity calculation methods, the impact of large-scale ship shore power access on port scheduling, research on 50-50HZ/60HZ dual-frequency technology, shore power monitoring system, protection devices and scheduling platforms, and established a complete shore power key technology system. In 2015, the first 3MW high-voltage shore power system demonstration project of Ningbo Beilun Third Container Terminal was completed, which can provide 6.6kV/60Hz and 6kV/50Hz power supply for docked ships at the port, meeting the power supply needs of different types of ships, and completely replacing ship auxiliary fuel power supply.



(a) COSCO Taicang connecting to shore power



(b) COSCO Denmark connecting to shore power

**Ningbo Beilun Port Shore Power System
Demonstration Project**

PART 03 Achievements

As of October 2022, Smart Chip Company has jointly built and put into operation 11 sets of intelligent port shore power demonstration projects in Zhoushan Port, Ningbo, with a total capacity of 45.4MVA. The annual electricity substitution amount reaches 2 million kilowatt-hours, which can reduce harmful gas emissions (sulfur dioxide, nitrogen oxides) by 51.6 tons per year, and carbon dioxide emissions by 1,340 tons. It can also replace fuel consumption by approximately 430 tons, effectively reducing air pollution in Zhoushan Port, Ningbo and helping to reduce carbon emissions in the shipping industry in Zhejiang region.



[Case 6]

Shanghai Changxing Island 100,000-ton Coal-fired Gas Turbine CCUS Demonstration Project

PART 01 Case Background

Changxing Island is located at the mouth of the Yangtze River in China, with a well-developed ecosystem and a deep-water coastline of several tens of kilometers on the south bank. The ecological and shoreline resource advantages of Changxing Island are obvious. Changxing Island is positioned as “a world-leading marine equipment island, an ecological water source island in Shanghai, and a unique landscape tourism island”, with a challenging task of green development.

PART 02 Actions

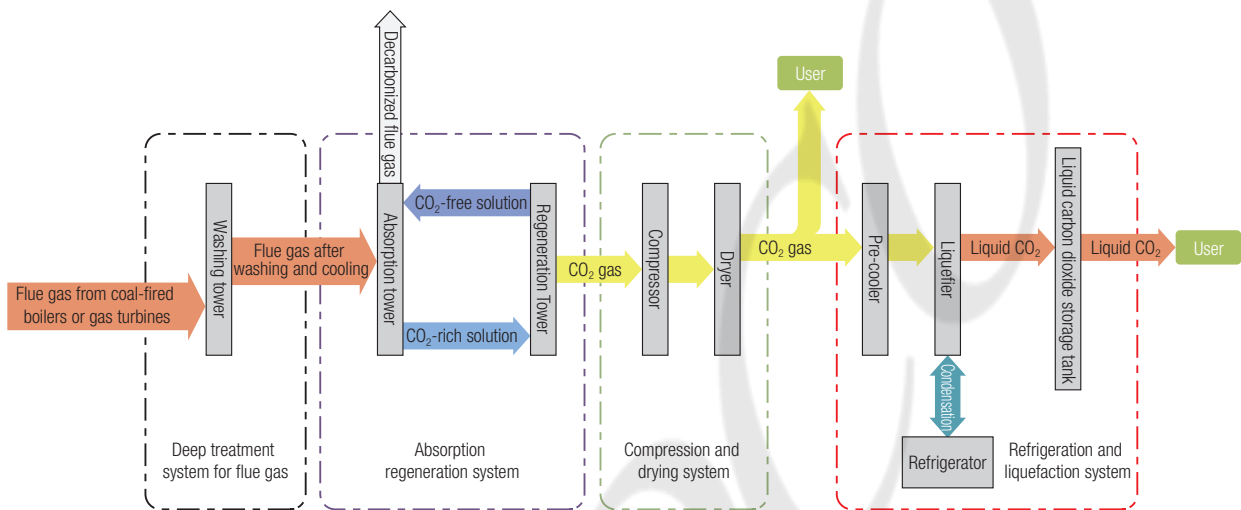
As the only power and heat source in Changxing Island area, Changxing Island Power Plant conducted a research on the application needs of island enterprise users for carbon dioxide, and launched an innovative demonstration project for the 100,000-ton CCUS full industry chain (capture, utilization, and storage) compatible with coal-fired and gas-fired units. The organic amine chemical absorption method is adopted in the project, combined with multiple

advanced energy-saving process and innovative achievements, breaking through the difficulty of low-concentration flue gas carbon capture. The energy consumption of coal-fired flue gas regeneration is further reduced to no more than 2.4 GJ/ton CO₂, and the overall technology has reached the international advanced level.



Changxing Island Power Plant CCUS Demonstration Project





CCUS Process Flow Diagram

PART 03 Achievements

The CCUS demonstration project at Changxing Island Power Plant is China's first 100,000-ton-level gas low-concentration CO₂ capture device, with an annual CO₂ reduction of 100,000 tons, equivalent to planting 5.56 million trees, which strongly supports the development of Changxing Island Ecological Demonstration Park and contributes to the "Green Shanghai".





Chapter II

Reducing Habitat Destruction



[Case 7]

Bird Nest on Power Lines: Promoting Ecological Harmony of the Sanjiangyuan

PART 01 Case Background

Located in the hinterland of the Qinghai-Xizang Plateau, the Sanjiangyuan National Nature Reserve is the largest natural reserve in China and one of the world's most biodiverse high-altitude regions. Known as "China's Water Tower", it is home to large birds such as crows, hawks, falcons, and golden eagles. From 2011 to 2016, a large power grid was gradually extended into the Sanjiangyuan National Nature Reserve in Qinghai, with projects like the Qinghai-Xizang Power Grid Interconnection and Yushu Power Grid Interconnection coming into operation. Power transmission towers, as the tallest structures in the region, became preferred perching and nesting sites for local birds. However, some birds were injured or killed due to high-voltage electric shocks and other factors. Bird activities also posed operational risks to the power grid, including wire corrosion and grid tripping, which threatened the stability and safety of power grid operations in the Xizang area.

PART 02 Actions

Initially, operation and maintenance personnel of the power transmission lines implemented several bird prevention and repelling measures on the transmission towers, such as installing bird spikes, bird repellent mirrors, and inclined bars to prevent birds from perching. However, these measures were ineffective, harming the birds and disrupting the stability of the biological chain in the Sanjiangyuan region, further damaging the fragile ecosystem of the plateau. After studying and analyzing the habits of birds in the Sanjiangyuan region, State Grid Qinghai Electric Power Company set up artificial bird nests and falcon attraction structures on the transmission towers. This innovative approach shifted from traditional bird prevention and repelling to actively attracting birds and building "bird nests on power lines".

This new strategy provided birds with more options for normal activities and perching, preventing them from settling on the overhead conductors of transmission lines and protecting them from high-voltage shocks. Additionally, the company introduced high-tech bird monitoring equipment and conducted monthly statistics and registration of bird activities along power transmission lines at various altitudes and across different geographic and climatic regions in Qinghai Province. They also established a triennial archive, recording details of bird activities, nesting, reproduction, and migration patterns, and assigned a "house number" for each artificial bird nest for monitoring and management.



A worker is installing an artificial bird nest on a transmission tower.

PART 03 Achievements

As of March 2020, a total of 168 artificial bird nests, 20 nest brackets, and 46 perches had been installed along the $\pm 400\text{kV}$ Chaila Line (Qinghai Section) of the Qinghai-Xizang Power Grid Interconnection Project. These facilities successfully attracted birds to build 56 nests and hatch 138 fledglings. Additionally, on the 10kV and 35kV power transmission towers with frequent bird activities in Yushu Tibetan Autonomous Prefecture and Golog Tibetan Autonomous Prefecture, Qinghai Province, a total of 3,280 artificial bird nests and 16 falconry attraction structures had been installed. During operation and maintenance, it was found that 570 of these bird nests had been utilized by birds to build 242 nests and hatch 436 fledglings. This effectively protected the positive development of bird species in the Sanjiangyuan Nature Reserve, while also reducing the number of line trips caused by birds by 98% year-on-year, significantly lowering line maintenance costs and improving the comprehensive value capacity for economic and social development.

PART 04 Highlights

(1) Collaborative Promotion: The “Bird Nest on Power Lines” project is jointly promoted by enterprises in collaboration with local governments, social organizations, and scientific research groups.

(2) Tailored Eco-Friendly Measures: Bird nests are designed according to the bodily forms and habits of the birds. Unique, eco-friendly prevention measures and technical standards are formulated for birds across different altitudes and voltage environments. Artificial bird nests and falcon attraction structures are set accordingly to accommodate these variations.

(3) Broad Promotion and Adaptation: Combining practical experiences and field survey and assessments, the project has been expanded to other plateau and grassland areas in Inner Mongolia, Sichuan, Gansu, Ningxia, Qinghai, Xinjiang, and Xizang.



[Case 8]

Chilquinta Transmisión S.A. protects underground desert plants through relocation during transmission line construction

PART 01 Case Background

The Atacama Desert is located in the central part of west coast of South America and is one of the driest places on Earth. Within the range of 30 degrees south latitude, there are relatively abundant “underground plants”, known as the “desert of flowers”. In 2021, the construction of the “New Maitencillo – Punta Colorada - Nueva Pan de Azúcar line, 2x220 kV, 2x500 MVA” was launched. The line is located between the Atacama and Coquimbo regions in northern Chile and will to some extent affect the ecological environment of the area, leading to significant changes in the monocotyledonous plant population along the transmission line. It is urgent to take mitigation measures to reduce the impact on the local ecology.

PART 02 Actions

During the construction of transmission lines, Chilquinta Transmisión S.A. implemented a rescue plan for 12,000 local plants along the route, using biotechnology to collect, cultivate, and store these plants, and relocate them to suitable growing areas.

Firstly, local plant experts were invited to collect underground plants, which undergo a series of treatments such as cutting, storage, and sealing to control sunlight, temperature, and humidity, prevent excessive dehydration, and preserve the vitality of underground plants. During storage, long-term monitoring of the structure, morphology, and activity of underground plants was carried out.

Secondly, underground plant protection bases were established, and the plants were classified based on their activity, in order to promote their restoration of cellular activity and return to wild growth conditions.

Thirdly, the genetic information of these intervened populations was preserved. Efforts were made to evaluate the genetic diversity within and between intervened populations of the same species to prevent the loss of genetic variation in these populations by using molecular markers.



Long-term monitoring of underground plants



The process of underground plant protection



Monitoring of genetic factors of underground plants in the laboratory



Implementation of protection for underground plants through relocation

PART 03 Achievements

Effective protection has been provided for underground plants with high physiological complexity, and all 12,000 intervened plants have survived, achieving a win-win situation between the power transmission project and underground organisms in desert areas along the line. Meanwhile, active efforts have been made, using biological genetic testing tools, to identify suitable underground biological migration areas, enhancing the adaptive capacity of intervened species to future climate change.

[Case 9]

Digital means help protect birds and promote harmonious coexistence between wildlife and power grid

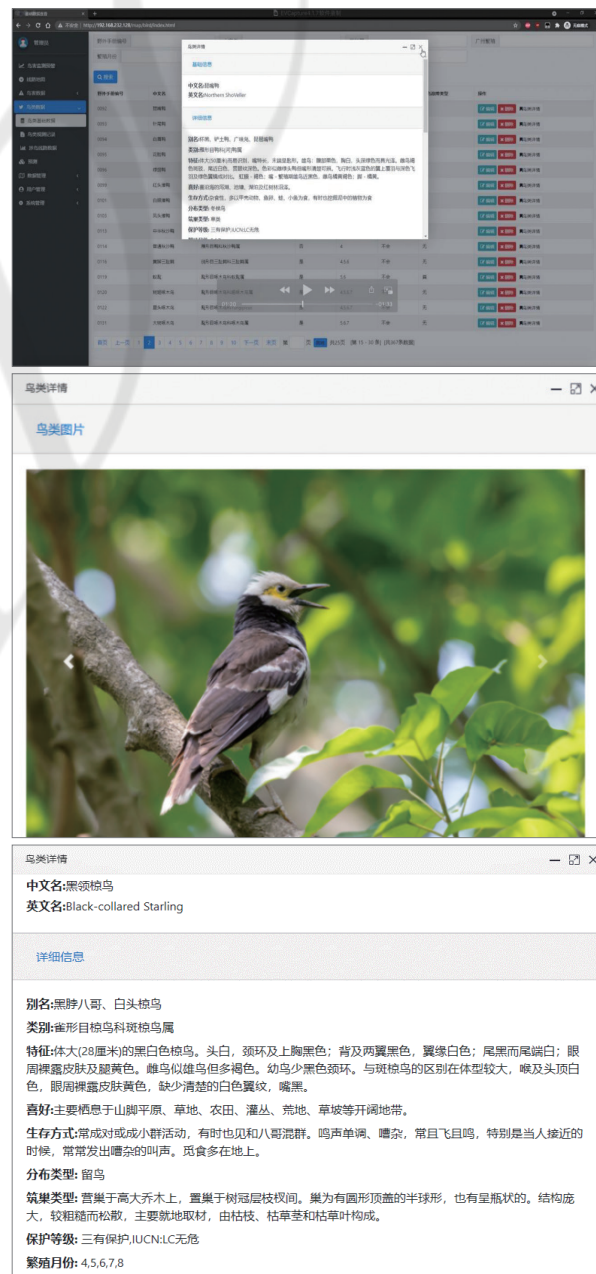
PART 01 Case Background

Guangzhou, China has abundant bird resources, with a total of around 300 species of birds based on comprehensive historical data, accounting for 45.8% of the total number of bird species in Guangdong Province. In addition, among the three bird migration routes that pass through China, two pass through Guangzhou and surrounding areas. In the Guangzhou area, most of the overhead transmission lines are located in the outskirts of the city. Birds, especially herons, magpies, sparrows, prefer to perch on the higher transmission line towers, which often lead to flashover and tripping of transmission lines, posing a significant threat to the safe and stable operation of transmission lines.

PART 02 Actions


China Southern Power Grid Co., Ltd follows the principle of “prevention in advance, handling during the event, and disposal after the event”, starting from three aspects: personal prevention, physical prevention, and technical prevention. It has improved the commonly used isolation and expulsion measures mainly based on “blocking” to guidance based approach, combining “blocking” and “dredging”, and established comprehensive bird protection and control measures.

Establishment of a bird conservation system using data-driven techniques. Efforts have been made to develop a “Bird Species Information Retrieval Database”, and map the distribution of bird hazards along power lines, in order to predict the time and location of bird activities in advance, and carry out bird protection actions in advance.



鸟类详情

鸟类图片



鸟类详情

中文名:黑领椋鸟
英文名:Black-collared Starling

详细信息

别名:黑脖八哥、白头椋鸟

类别:雀形目椋鸟科椋鸟属

特征:体大(28厘米)的黑白色椋鸟。头白, 颈环及上胸黑色; 背及两翼黑色, 翼缘白色; 尾黑而尾端白; 眼周裸露皮肤及腿黄色。雌鸟似雄鸟但多褐色。幼鸟少黑色颈环。与斑椋鸟的区别在体型较大, 喉及头顶白色, 眼周裸露皮肤黄色, 缺少清楚的白色翼纹, 嘴黑。

喜好:主要栖息于山脚平原、草地、农田、灌丛、荒地、草坡等开阔地带。

生存方式:常成对或成小群活动, 有时也和八哥混群。鸣声单调、嘈杂, 常且飞且鸣, 特别是当人接近的时候, 常常发出嘈杂的叫声。觅食多在地上。

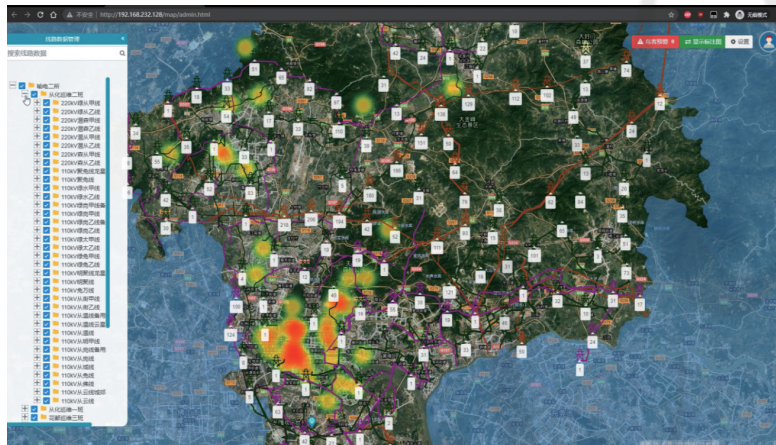
分布类型:留鸟

筑巢类型:营巢于高大乔木上, 巢位于树冠杈杈间, 巢为有圆形顶盖的半球形, 也有呈瓶状的。结构庞大, 较粗糙而松散, 主要就地取材, 由枯枝、枯草茎和枯草叶构成。

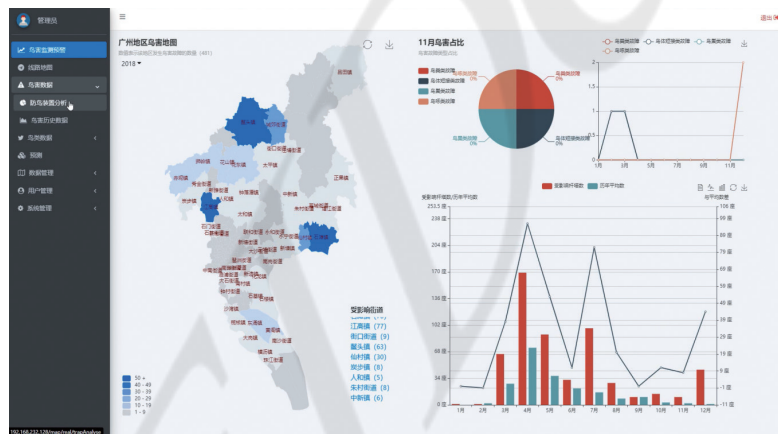
保护等级:三有保护,IUCN:LC无危

繁殖月份:4,5,6,7,8

Self-developed database for retrieving information on bird species



Distribution map of bird hazards along power transmission lines



Bird strike hazard fault monitoring and early warning

New bird's nest picking device, artificial bird's nest, etc were invented. By creating favorable conditions for birds to inhabit and reproduce through artificial and proactive means, birds can be protected and attracted, allowing birds and power systems to coexist harmoniously.

PART 03 Achievements

Currently, China Southern Power Grid Company is using digital means to grasp the distribution of bird activities. In the Guangzhou area, there are more than 1,200 artificial bird nest preservation points on the power transmission lines, with a nest building trace rate of over 80%. More than 200 young birds have been successfully hatched, providing breeding and habitat for protected birds such as the oriental white stork and black-collared starling. The average annual investment in bird prevention is reduced by more than RMB 3 million. The number of bird-related hazard

trips has been decreasing year by year, reducing operation and maintenance costs by about RMB 1 million. Positive social benefits have been generated while promoting the harmonious coexistence between humans and nature.

PART 04 Highlights

(1) A bird hazard defense information system was independently developed for power transmission lines in the Guangzhou area, which can be applied to various production scenarios such as power transmission, distribution operation and maintenance, and agriculture and forestry.

(2) It can avoid waste of manpower and material resources, and reduce enterprise operation and maintenance costs. In addition, it has also established a good corporate image, and provided a new digital transformation approach for enterprises in traditional bird hazard prevention and equipment safety.

[Case 10]

Harnessing geothermal energy resources in Indonesia to support biodiversity conservation

PART 01 Case Background

West Java Province in Indonesia is home to dense tropical rainforests and rich biodiversity. Kamojang, Darajat, and Gunung Salak regions in the province also have abundant geothermal energy resources. In order to promote the synergy between biodiversity conservation and sustainable energy development, the local government is vigorously building geothermal power stations. Compared to traditional thermal power plants, geothermal power plants can minimize damage to vegetation and effectively protect biological habitats.

PART 02 Actions

Birds are highly sensitive to changes in their natural habitats, which is why they are often selected as objects of observation for biodiversity. The University of Padjadjaran in Indonesia (Unpad) has formed a research team to monitor and statistically analyze the bird diversity around the Gunung Salak Geothermal Power Station, with a focus on assessing the impact of the geothermal

power station on local biodiversity. The Gunung Salak Power Station was completed in 1994, and underwent multiple expansions in 2000 and 2010. It currently has an installed capacity of 375 megawatts. Through research, the research team has grasped a comprehensive understanding of the diversity of bird species around the power station, laying a solid foundation for the targeted implementation of biodiversity management and protection in the future.

PART 03 Achievements

1. The geothermal power station supplies an average of over 210 million kilowatt-hours of clean electricity to the local grid each year, equivalent to reducing approximately 113,000 tons of carbon dioxide emissions annually, which is beneficial for mitigating the impact of climate change on biodiversity.

2. All facilities of the power station cover an area of approximately 2,000 hectares and have not had any impact on the nearby Halimun Salak Mountain National Park (a habitat for local wildlife such as gibbon, Javan hawk, and Javan leopard).



Gunung Salak geothermal power station facilities

[Case 11]

Longtan Hydropower Project protects rare wild plants to achieve harmonious coexistence between humans and nature

PART 01 Case Background

The dam site of Longtan Hydropower Station is located in Tian'e County, Hechi City, Guangxi, on the upper reaches of the Hongshui River, a main tributary of the Pearl River, and serves functions such as power generation, flood control, navigation, and salinity intrusion prevention. The power station has an installed capacity of 6.3 million kilowatts, with the reservoir area flooding 10 counties in Guangxi and Guizhou provinces, which has a total submerged area of 37,687.4 hm², where there are rich forest resources.



Ormosia hosiei tree before transplantation in 2008

PART 02 Actions

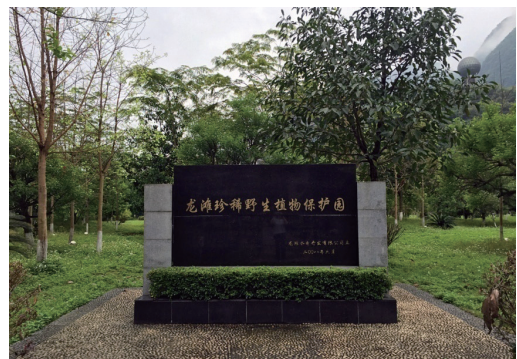
Datang Longtan Hydropower Development Company attaches great importance to ecological engineering protection work. Since April 2006, with strong support from the governments of Guangxi and Guizhou provinces, the company has organized the relocation and protection of rare and endangered wild plants and ancient trees in the reservoir area. A total of 8 rare wild plant protection parks have been built, and a total of 14,103 rare wild plants (clusters) have been relocated and protected, including 4,578 trees, 8,862 orchids, 641 Guizhou cycads, 22 ancient trees, all of which will be permanently protected in these protection parks.



It is now thriving in the rare plant garden after transplantation

PART 03 Achievements

Longtan Rare Wild Plant Protection Park is now shaded with green trees and lush grass, making it a beautiful scenery in Tian'e County, a mountain city. The Longtan Hydropower Station hub area has been awarded the title of "National AAA Tourist Attraction". Datang Longtan Hydropower Development Company has been awarded honors such as "Top 50 Green Energy Enterprises in China" and "Advanced Organization in Green Engineering Construction in Guangxi Zhuang Autonomous Region".



Longtan Rare Wild Plant Protection Park

[Case 12]

Multiple measures to protect biodiversity in the Yangtze River Basin

PART 01 Case Background

The Yangtze River is the largest river in China and the third longest in the world, running from west to east across the central part of the country and eventually flowing into the East China Sea, with a total length of over 6,300 kilometers. Meanwhile, the Yangtze River is also one of the rivers with the richest biodiversity in the world, with over 4,300 species of aquatic organisms, including 424 species of fish, of which 183 are endemic species. Since the 1960s, overfishing, deterioration of water environment, and sand mining in rivers have changed the living and breeding environment of fish, leading to a significant decrease in fish resources. In order to prevent floods and promote social and economic development, a number of cascade reservoirs have been constructed along the main stream of the Yangtze River, which have to some extent altered the natural hydrological and water temperature rhythms of the river and had adverse effects on the growth and reproduction of unique fish species in the middle and upper reaches of the Yangtze River, such as the Chinese sturgeon.

PART 02 Actions

Since the operation of the Three Gorges Project, China Three Gorges Corporation has actively explored expanding the ecological benefits of the Three Gorges Project and established a large-scale rare fish conservation center in the Yangtze River Basin. It has successively overcome many “world’s first” technical challenges such as breeding and releasing Chinese sturgeon, artificially inducing spawning with synthetic hormones, cultivating large-scale seedlings, and breeding the second generation of fish entirely artificially, and successfully bred more than 20 species of rare fish such as round mouthed copper fish and long slim loach. It has also established a unique rare plant garden in the Yangtze River Basin, and relocated over 1,300 species and 29,000 plants of rare plants for protection. In addition, for the first time, the flowering and fruiting of dove trees in the low-altitude areas of central China have been achieved, and technical difficulties such as artificial reproduction of sparse-flowered water fir branches and non-proliferation of spore bodies and non-differentiation of original leaf bodies for *Adiantum reniforme* var.



(a) Chinese sturgeon artificial breeding base



(b) Artificially bred Chinese sturgeon released into the Yangtze River

Three Gorges Group protects rare fish species



(a) Laboratory for tissue culture of rare and unique plants

(b) Artificial breeding of *Adiantum reniforme* var. *sinense*

Three Gorges Corporation protects rare plants

sinense have been successfully overcome, with a spore body proliferation rate of 100% and an original leaf body differentiation rate of over 90%.

PART 03 Achievements

As of 2022, the Rare Fish Conservation Center has more than 100 species of rare fish germplasm resources, including cells, tissues, sperm, nucleic acids, and live organisms. The artificial population of Chinese sturgeons exceeds 6,000, creating a “Noah’s Ark” for the protection of aquatic organisms in the Yangtze River. The total amount of rare fish released exceeds 11 million, including about 5.3 million Chinese sturgeons of various sizes. Ecological regulation was implemented in the Yangtze River Basin to promote the spawning scale of economic fish species such as black carp, grass carp, silver carp, and bighead carp from less than 100 million in 2011 to over 10 billion. Efforts have been made to realize artificial breeding of 210,000 unique and rare resource plants such as

Adiantum reniforme var. *sinense*, *Myricaria laxiflora*, *Taxus chinensis*, and *Asyneuma pulvinatum*, and to actively promoting the return of rare plants to the wild, which has enabled more than 50,000 independently bred rare plant seedlings to “settle down” on both sides of the Yangtze River.

PART 04 Highlights

(1) The project effectively avoids the risk of extinction of endangered wildlife through measures such as protecting wildlife through relocation and reintroducing rare wildlife into the wild, which can safeguard the biodiversity of the Yangtze River Basin.

(2) Based on the characteristics of rare fish species and plants, in-depth and systematic research and practice on the protection of endemic species and specialized fields such as genetics and heredity have been conducted in the project, providing strong technical support for the restoration of biodiversity in the Yangtze River Basin.



[Case 13]

The “Green Power Ark” builds life cradle for endangered species

PART 01 Case Background

Many endangered species around the world only survive in remote forests, remote islands, or natural reserves. Researchers engaged in biodiversity conservation often conduct observations and studies in such sparsely populated areas. The attraction, monitoring, scientific research equipment used in this process, as well as the daily work and life of the conservation area researchers, all require sufficient power supply. However, remote areas often have the weakest electricity infrastructure. During research and conservation efforts, equipment shutdowns due to power outages or damage caused by unstable voltage are common occurrences, which can hinder species protection work.

PART 02 Actions

State Grid Corporation of China collaborates with government agencies, China Environmental

Protection Foundation, and other organizations to carry out the “Green Power Ark” project, which focuses on protecting the main habitats of rare species. By establishing green electricity supply systems in and around these habitats, reliable clean electricity is provided for research and practical work related to biodiversity conservation. Currently, the “Green Power Ark” project is constructing “Net Zero Carbon Bird-watching Houses” in the breeding grounds of the critically endangered species Chinese crested tern on the Jiushan Islands in Xiangshan, Zhejiang. In addition, an ecological micro-grid is being built in the core protection area of the fir wild plant in the Qianjiangyuan-Baishanzu National Park in Zhejiang. These projects provide the necessary electricity for daily scientific research observation, species protection, and lightning protection work in the protected areas, while achieving zero interference with the ecological environment of the habitat.



Marine area utilization assessment, marine environmental evaluation, and biodiversity research are carried out in Xiangshan, Zhejiang



Donation for building zero-carbon micro-grid in the breeding ground of Chinese crested terns in Xiangshan



State Grid Corporation of China checks power supply facilities daily to ensure the normal operation of migratory bird monitoring

PART 03 Achievements



State Grid Corporation of China protects the roll-feather pelican, one of the world's most endangered species

In Xiangshan, Zhejiang, the reserve area has completely eliminated the utilization of diesel power generation, and all the electricity needed for the conservation base comes from clean energy sources. In 2022, a total of 32 Chinese crested tern chicks successfully hatched in the Jiushan Islands National Nature Reserve, Xiangshan, accounting for over 80% of the total hatching in various breeding grounds worldwide. The highest number of simultaneously observed adult birds reached 93, representing about half of the global population. As a result, Xiangshan has become the world's largest breeding base for Chinese crested terns. In Qingyuan, Zhejiang Province, three research bases for the wild breeding of fir trees have been established, along with over 30 mu of field population reconstruction bases. More than 2,000 grafted fir tree seeds and seedlings have been planted in the field. In addition, two standard seedling greenhouses have been built, retaining over 5,000 fir seedlings in the nursery area with a survival rate of 92%.

[Case 14]

“Migratory Bird Lifeline” scientifically promotes the protection of migratory birds

PART 01 Case Background

With the acceleration of urbanization and the continuous shrinking of bird habitats, as well as the sharp decrease in the number of forests and tall trees, more and more birds are choosing to nest and move around on stable and open-view high-voltage power line towers. Especially for large and rare wading birds such as oriental storks and black storks, due to the lack of suitable natural nesting sites, their nests are often built on high-voltage power towers. During the process of bird nesting and activity, issues such as short-circuiting caused by bird bodies, nest materials, and bird droppings contaminating insulators can all cause power line tripping faults. Bird activities not only have become the third major cause of line faults after lightning and external force damage, but also pose a significant threat to the habitat and breeding of migratory birds.



Strengthening bird nests during the departure of oriental storks

PART 02 Actions

“Migratory Bird Lifeline” is a “bird-line” public welfare project initiated by the State Grid Corporation of China Foundation in collaboration with several public welfare organizations in the field of environmental protection, with the oriental white stork, crested ibis and other rare birds along the transmission line as the main protection objects, in Zhalong Wetland in Heilongjiang Province, Qilihai in Tianjin, Tangshan in Hebei Province, Dongying in Shandong Province, Chizhou in Anhui Province, Zhangye in Gansu Province, Aba Prefecture in Sichuan Province, Bayanbulak in Xinjiang, and Linzhou in Xizang. By clarifying the objects, nature, and characteristics of bird-line conflicts, different solutions such as coexistence of power lines and poles, relocation, and joint rescue have been proposed, in order to reduce bird injury incidents during the migration season of migratory birds.



The oriental white stork builds nests and reproduces on the iron tower

PART 03 Achievements

As of 2022, the project has carried out work in 13 provinces with frequent migratory bird activities in Heilongjiang, Hebei, Tianjin, Shandong, Anhui, Jiangsu, Jiangxi, Shaanxi, Sichuan, Gansu, Ningxia, Xinjiang and Xizang, and organized 379 patrols to rescue 12,409 wild birds. The protected species have involved national key protected animals such as oriental white stork, black-necked crane, great bustard, hooded crane, and yellow-bellied horned pheasant. More than 30 species of rare birds, including white spoonbills and other second-level key protected animals, have formed a “Migratory Bird Lifeline” public welfare project covering two main migratory bird migration routes in eastern and western China.

By the end of 2022

State Grid Corporation of China

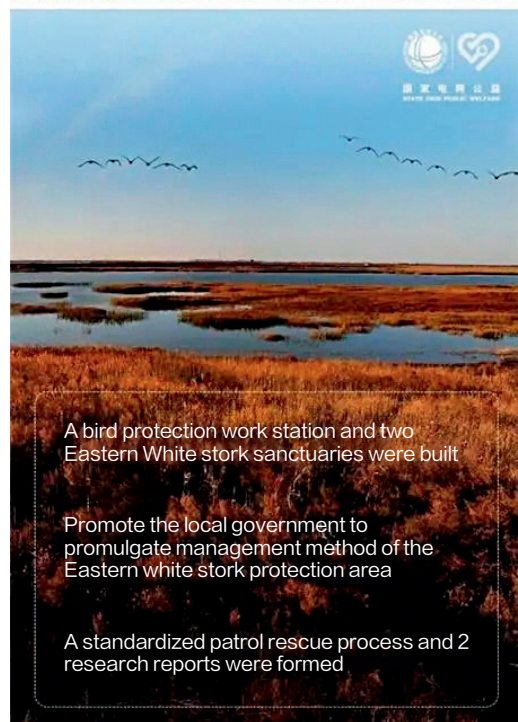


2.0886 million RMB yuan was invested in the public welfare fund

Over **3,000** kilometers migratory bird routes were surveyed

17 project points were built. It covers a number of migratory bird migration routes in **15** provinces in China

More than **800** joint patrol activities were carried out

A bird protection work station and two Eastern White stork sanctuaries were built

Promote the local government to promulgate management method of the Eastern white stork protection area

A standardized patrol rescue process and 2 research reports were formed

[Case 15]

Singapore builds inland floating solar power stations to promote harmony between energy and biology

PART 01 Case Background

Sembcorp Industries is a large multinational corporation headquartered in Singapore, with 14.4 gigawatts of renewable energy capacity in 10 countries. The company has built a station at the Tengeh Reservoir in western Singapore, which is one of the world's largest inland floating solar power stations. The power station covers an area of 45 hectares, with an occupation area of one-third of the reservoir area. The power station started construction in August 2020 and was commissioned in July 2021. It has a designed capacity of 60 megawatts and will provide electricity to 5 water treatment plants in Singapore. During the construction process, the construction party has taken multiple ecological protection measures, in order to reduce the impact on the water quality and biodiversity of the reservoir.



Singapore Tengeh Reservoir Floating Power Station Project by Sembcorp Industries

PART 02 Actions

Careful design. 10 solar panel “floating islands” have been constructed in the project, with sufficient gaps between each solar panel, in order to allow enough oxygen and sunlight to enter the water, while also installing additional aerators to maintain the oxygen levels in the reservoir, reducing the impact on water quality and aquatic plants and animals.

Selection of environmentally friendly materials. Double-glass photovoltaic modules are adopted instead of the single-glass modules commonly used for rooftop installations, in order to enhance durability in humid environments. The photovoltaic modules are supported by high-density polyethylene (HDPE) floats, which are certified as food-grade materials, recyclable, corrosion-resistant, and have UV resistance, in order to prevent degradation from intense sunlight exposure, thus protecting water quality and reducing pollution.

Conduction of real-time monitoring. In order to optimize system performance and reliability, the construction party has deployed a digital monitoring platform to track environmental factors such as wind speed, solar radiation, and ambient temperature in real time. This system can also detect abnormal situations that may indicate potential overheating and fire hazards, allowing for early troubleshooting.



UAV-based electroluminescence imaging technology

PART 03 Achievements

1. The power generated by this station can offset about 7% of the energy demand of the Public Utilities Board (PUB) in Singapore each year, reducing the carbon footprint of water treatment.
2. It can reduce approximately 32,000 tons of carbon emissions annually, equivalent to the carbon emissions of 7,000 cars.
3. Through comprehensive monitoring of the Tengeh Reservoir, the project team is confident that the water quality and aquatic plants and animals in the reservoir have not been significantly affected.

PART 04 Highlights

The floating power station is the world's first project to use UAV for [electroluminescence imaging](#) in a centralized photovoltaic power station. Electroluminescence imaging technology excites the photovoltaic module, in order to emit light by applying current to the solar cells, thereby clearly displaying defects and issues in the solar panel. UAV, which is equipped with high-resolution cameras and electroluminescence imaging sensors, can efficiently conduct wide-range electroluminescence imaging from different angles and heights in the air, and quickly identify subtle defects in photovoltaic cells, such as cracks, hot spots, and other potential issues, greatly improving the efficiency of inspection and maintenance.

[Case 16]

“Invisible Passage” allows ultra-high voltage power lines to “thread the needle” through mountainous forests

PART 01 Case Background

The Zhangbei-Xiong’an 1000kV Ultra High Voltage AC Transmission Project connects Zhangjiakou New Energy Base in Hebei Province, China with Xiong’an New Area, and is the main power supply channel to ensure clean electricity supply in Xiong’an New Area. The project passes through 2 cities and 9 counties (districts) along the route, spanning multiple nature reserves such as Yanshan, Taihang Mountains, and Nihewan. There are 166 families, 704 genera, and 1,836 species of plants and nearly 300 species of animals at risk of disturbance, including 14 plant species and over 30 animal species listed as national key protected species. Strengthening environmental protection and restoration along the project route is one of the key tasks of the project construction.

PART 02 Actions

As the engineering construction management organization, State Grid Hebei Electric Power Company has developed a complete set of solutions with the goal of “zero disturbance of mountainous environment and zero damage to vegetation”.

Firstly, “diagnosing pulses remotely”. By integrating advanced remote sensing, measurement, modeling technologies, and algorithms, a centimeter-level accurate natural environment model along the engineering route is formed, which enables rapid and precise reproduction of terrain, landforms, and vegetation coverage. It can also support design personnel in analyzing, verifying, and making decisions on the optimal route and tower locations at the beginning of the design process.

Secondly, “minimally invasive construction”. In order to achieve “transportation and stringing without road construction” and “minimal earth disturbance

during tower assembly in the mountains”, and ensure minimal environmental impact during the construction process, various measures were taken, such as developing heavy-duty cableways for transporting ultra-high voltage tower materials, eliminating mountain cutting and road construction, using flat arm holding poles and tower crane assembly technology, significantly reducing the disturbance of traditional tower assembly technology to the natural environment caused by large machinery occupying land, and combining with unmanned aerial vehicles for long-distance deployment.

Thirdly, “traceless repair”. Efforts have been made to develop eco-concrete slope protection technology suitable for steep rock slopes, and to develop vegetation rapid recovery technology for small slopes using green vegetation bags. In addition, artificial plant mixed sowing formula was innovated, in



Status of vegetation restoration at the tower site



Restoration is ensured by using vegetation bags

order to improve vegetation survival rate. Meanwhile, AI intelligent recognition technology was used to build a soil and water conservation monitoring platform, upgrading the traditional “monthly monitoring” to “daily management”, and ensuring the implementation of vegetation protection and restoration measures on various operation surfaces.

PART 03 Achievements

In the construction of the Zhangbei - Xiong'an line project, by reducing the construction of new roads, a total of 260 hectares of mountainous area erosion and 150,000 trees felling have been avoided. The technology of flat-arm hoisting and tower crane erection was adopted, in order to avoid damaging 126 hectares of soil, water, and vegetation. Under the “micro-construction” technology system, the project has reduced the land disturbance area by 23%, with a land vegetation recovery rate of 98.7%, effectively achieving the goal of protecting the ecological environment and biodiversity along the route. The Zhangbei - Xiong'an Ultra-High Voltage Transmission Project was awarded the honor of “National Soil and Water Conservation Demonstration Project”.



[Case 17]

China Three Gorges Corporation (Brazil) Company protects biodiversity in Brazil

PART 01 Case Background

Brazil is one of the countries with the richest biodiversity in the world, and with 22% of species on Earth. Its vast Amazon rainforest is known as the “lung of the earth” and plays an irreplaceable role in regulating global climate, maintaining carbon and water cycles, and protecting biodiversity. China Three Gorges Corporation (Brazil) Ltd. (hereinafter referred to as “Three Gorges Brazil”), as the third largest power generation company in Brazil, has a total of 28 power stations in 12 states with an operating installed capacity of approximately 8.3 million kilowatts. The company pays close attention to and actively participates in local biodiversity conservation efforts in engineering practices, striving to become a “guardian” of wildlife.

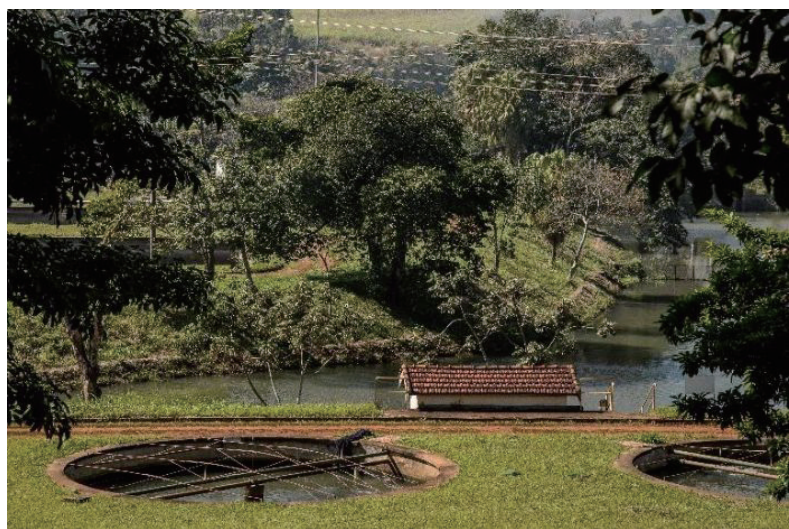
PART 02 Actions

Firstly, incorporating the protection of biodiversity into the company’s management system. The *Biodiversity Monitoring Compliance Environmental Management Plan (PGA)* and the *Basic Environmental Plan (PBA)* have been developed, which provide detailed regulations on solid waste management, wastewater treatment and erosion control, vegetation restoration plans, water quality monitoring, etc., during the development of clean energy projects. In addition, the aim is to minimize disturbances to biodiversity at the project site and to take effective measures for ecological restoration and compensation.

Secondly, operating the Ilha Wildlife Conservation Center. Since 2016, Three Gorges Brazil has successfully obtained the 30-year franchise rights for the Ilha and Jupiá hydropower stations, and

has also taken over the operation of the Ilha Wildlife Conservation Center. The center is located southwest of the Ilha Solteira Hydroelectric Plant, and is the largest and most diverse wildlife park in the northwestern region of the state of Sao Paulo, which can provide a habitat for lost or hunted wildlife around the Ilha Solteira Hydroelectric Plant.

Thirdly, stocking and release work in the Paranapanema River basin. In order to protect local fish species, a fish hatchery has been built near the Salto Grande HPP to breed 3.6 million local fish such as tilapia, blunt-snout bream, Mexican tetra, and Mexican molly, and release them into the reservoir, effectively supplementing the reservoir’s fish resources.



Reservoir Fish Breeding Center of Salto Grande HPP



Three Gorges Company carries out restocking release activities

PART 03 Achievements

1. At present, the Ilha Wildlife Conservation Center houses 410 individuals of 55 different species of wildlife, including 195 birds, 86 mammals, and 129 reptiles. Among them, there are rare or endangered species such as American lions, macaws, toucans, gray brocket deer, and anteaters. The center is also actively involved in providing medical care for the animals and reintroducing them back into the wild.

2. Since 2016, a total of approximately 25 million fish have been released into the Paranapanema River basin, promoting the organic integration of power station construction and operation with local ecological conservation through practical actions.





A person wearing a blue jacket is holding a black bucket, pouring water onto a field of young green plants in a greenhouse. The plants are growing in dark soil. The background is blurred, showing more rows of plants. The text is overlaid on a semi-transparent white and grey background.

Chapter III
Promoting Environmental
Improvement

[Case 18]**Ethiopia's Reppie Waste-to-Energy Plant improves local ecological environment****PART 01 Case Background**

With the rapid urbanization process, Addis Ababa, the Ethiopian capital, is plagued by the problem of “garbage besieging the city”. There is a garbage mountain over 30 meters high in the southern outskirts of the city, where a large amount of garbage is dumped all year round. For a long time, waste disposal has mainly relied on incineration on site, with toxic gases filling the air, serious soil and water pollution, extinction of surrounding animals, and serious threats to the health of surrounding residents. To address this issue, the Ethiopian government has invested \$100 million to build the Reppie waste-to-energy plant. The project was constructed by Ethiopian Electric Power Corporation, started construction in September 2014, and was put into operation in September 2017.



Ethiopia's Reppie Waste-to-Energy Plant

PART 02 Actions

In terms of air pollution control, the process of “SNCR + semi-dry desulfurization + bag filter” was strictly adopted in the project, in order to control the emission of harmful substances such as dioxins. Real-time monitoring of flue gas was conducted to ensure compliance with international standards 24 hours a day.

In terms of water and soil pollution prevention and control, in the project, wastewater was discharged to the leachate treatment station and a process combination of “pre-treatment + anaerobic reactor + deep treatment” was used to ensure that the treated wastewater meets local standards before being discharged into the river.

PART 03 Achievements

1. In the project, 1,800 tons of garbage is processed per day, far exceeding the previous commitment of 1,280 tons. One ton of garbage can generate 400 kilowatt-hours of electricity, with an annual power generation capacity of 185 million kilowatt-hours, which can guarantee lighting for one-third of the households in Addis Ababa.

2. The surrounding ecological environment and residents' living conditions have been significantly improved. Local residents say that the situation of garbage flying around and sewage flowing everywhere has been completely changed.

[Case 19]

Developing green biomass energy to promote the coordinated development of energy and environment in Cote d'Ivoire

PART 01 Case Background

Cote d'Ivoire has abundant palm tree resources for oil extraction. For a long time, a large amount of waste such as palm tree straw and oil residue has been simply burned or discarded, causing serious resource wastage and environmental pollution. To address this issue, China Energy Engineering Group Co., Ltd. (referred to as Energy China) has undertaken the construction of a 46-megawatt biomass power station project in Cote d'Ivoire, helping the country promote the coordinated development of clean energy and climate & environmental governance.

PART 02 Actions

Fuel collection and pre-treatment: In collaboration with local palm plantations, a comprehensive palm waste collection system has been established. The collected waste is processed through crushing, drying, and other pretreatment processes, in order to be converted into fuel suitable for biomass boiler combustion.

Construction of biomass power station: High-temperature and high-pressure biomass boilers and steam turbine generators were used, in order to build efficient and environmentally friendly biomass power

station. Meanwhile, by utilizing waste heat recovery systems, energy utilization efficiency has been further improved and pollutant emissions reduced.

PART 03 Achievements

Significant carbon reduction effect: The biomass power station is expected to be completed and start generating electricity by 2025. After being put into operation, it can generate 348 million kilowatt-hours of clean electricity annually, meeting the electricity demand of 1.7 million people and reducing carbon dioxide emissions by 180,000 tons.

Ecological environment improvement: The effective utilization of palm tree waste can reduce 520,000 tons of waste pollution to the environment annually, promoting the ecological balance in palm planting areas. Meanwhile, the combustion waste from biomass power plants can be used as fertilizer to nourish the growth of palm trees, achieving a circular development of resources.

Economic and social benefits: The stable operation of biomass power station can increase the economic benefits by about 20% for 12,000 local plantation owners. Meanwhile, the project can provide over 1,000 full-time jobs during construction and operation, increasing the income level of residents.



Biomass Power Station Construction Site

[Case 20]

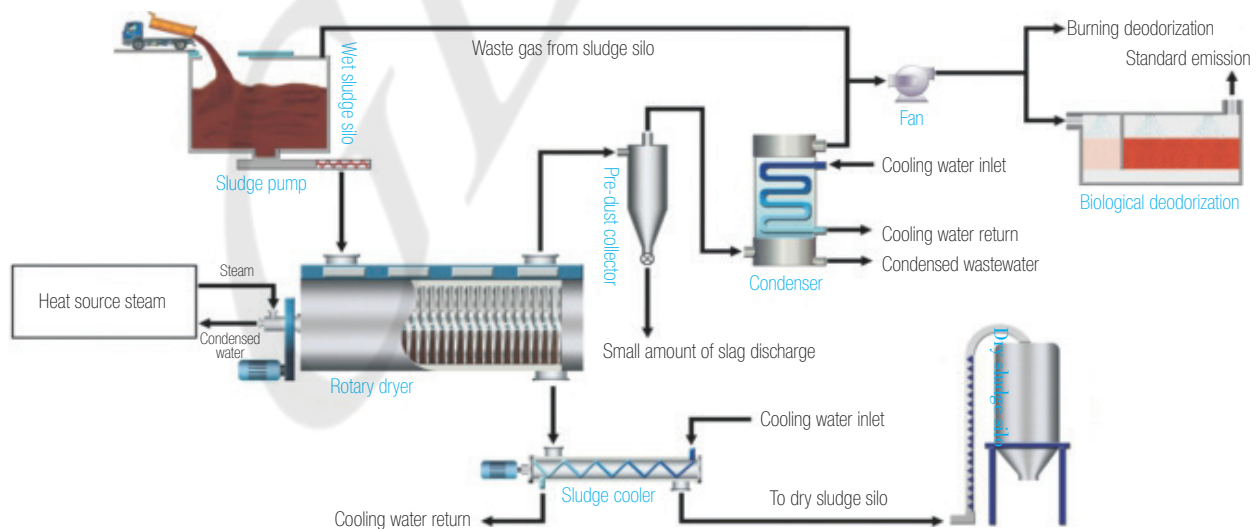
Coal-fired coupled sludge power generation ends “urban pollutants”

PART 01 Case Background

The sludge generated by sewage treatment plants contains about 30%-40% organic biomass, which is combustible and can be considered as biomass. There are currently 20 sewage treatment plants in Chongqing, China, with 22 more planned or under construction. In 2020, the daily production of sludge exceeded 2,000 tons. Previously, the treatment of sludge in Chongqing mainly relied on landfilling, cement kiln co-incineration, and the production of garden nutrient soil, with limited processing capacity and lack of environmental protection. Affected by the ban on landfill disposal methods and the successive closure of cement kilns, Chongqing currently has a daily sludge processing capacity of about 1,200 tons, with a large amount of sludge unable to be processed, posing a serious challenge to the ecological environment.

PART 02 Actions

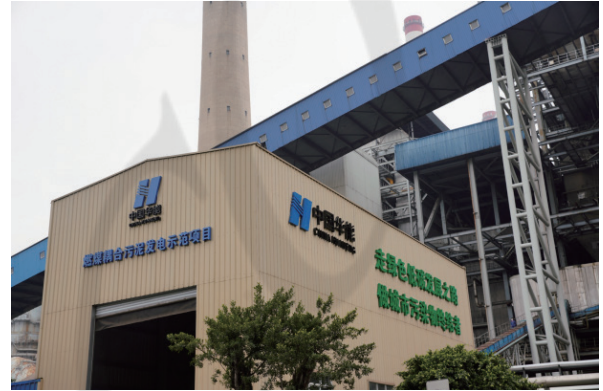
To address the sludge disposal gap in Chongqing, the Luohuang Power Plant of China Huaneng Group has promoted the implementation of a coal-sludge co-firing power generation project. In this project, it utilizes the waste heat of the power plant to convert sludge with 80% moisture content into dried sludge with 30% moisture content through a dryer. Then, the dried sludge is transported to the coal mill in a fully enclosed environment, ground together with coal, and sent to the boiler for incineration and power generation. The dust and pollutants generated are treated by dust removal and desulfurization and denitrification devices. The ash and desulfurized gypsum are comprehensively utilized. The high-concentration waste gas generated by the condensation of the tail gas of the sludge dryer and the waste gas during transportation and storage are also sent to the boiler for high-temperature



Sludge treatment process flow



Sludge drying system



Sludge conveying system

incineration treatment through a negative pressure suction system. The low-concentration waste gas generated by sludge drying is treated with a biological filter for deodorization.

PART 03 Achievements

After the coal-fired coupled sludge power generation project is put into operation, it can dispose of 400,000 tons of wet sludge annually, increasing biomass electricity generation by 98 million kilowatt-hours, which can save 29,600 tons of standard coal, and reduce carbon dioxide emissions by about 82,800 tons.

PART 04 Highlights

(1) The sludge is completely sealed, and the water vapor generated by drying and incineration is also condensed and recycled for reuse. Meanwhile, the odorous pollutants are sent to the boiler through a negative pressure system for high-temperature decomposition. The above measures can effectively prevent the leakage of odorous pollutants throughout the process, achieving harmless, resource-based, and large-scale disposal of sludge.

(2) Relying on the existing coal-fired power generation system, the treatment of biomass energy such as sludge generated by urban sewage treatment plants can not only overcome the disadvantage of high levels of pollutants generated by biomass combustion, but also increase adjustable clean power supply, achieving coordinated prevention and control of air, water, and soil pollution and promoting low-carbon and clean development of coal-fired power generation.



[Case 21]

Anhui has completed the construction of a hydrogen comprehensive utilization demonstration station

PART 01 Case Background

Hydrogen has the characteristics of clean, zero carbon, efficient, and environmentally friendly, and is known as the “ultimate energy” of the 21st century. Through the synergy of electricity and hydrogen, a new model with electricity as the core and hydrogen as the link can be developed, which can achieve important functions such as seasonal storage and consumption of renewable energy, peak shaving and valley filling. It is an important measure to help build a new type of power system with new energy as the mainstay and improve the ecological environment.

PART 02 Actions

State Grid Anhui Electric Power Company has built the first megawatt-level hydrogen energy comprehensive utilization demonstration station in China, and successfully developed the first set of megawatt-level hydrogen production equipment, achieving zero carbon emissions throughout the process by using advanced proton exchange membrane water electrolysis for hydrogen production and hydrogen fuel cell technology for bidirectional conversion of green electricity - green hydrogen - green electricity. The produced hydrogen can be widely used in fields such as hydrogen-powered vehicles, hydrogen-based steelmaking, green hydrogen chemical industry. Hydrogen power generation can also be used for grid peak shaving to promote the consumption of renewable energy.



Aerial images of the demonstration project



Fuel cell

PART 03 Achievements

The demonstration station converts excessive clean electricity into hydrogen energy storage, reducing “waste solar” and “waste wind”, and can replace thermal power as a flexible regulation resource, generating significant benefits for coal saving and emission reduction. Currently, the demonstration station can save about 1,000 tons of standard coal per year, reducing carbon dioxide emissions by about 1,500 tons, and sulfur dioxide emissions by about 1,000 tons.

PART 04 Highlights

State Grid Anhui Electric Power Company, in collaboration with Dalian Institute of Chemical Physics (Chinese Academy of Sciences), Tsinghua University, State Grid Smart Grid Research Institute, and other organizations, promotes collaborative innovation among industry, academia, and research institutions, and conducts in-depth research on core technologies. In addition, it also overcomes more than 20 technical bottlenecks, and elevates the power generation level of Chinese fuel cells from hundred-kilowatt to megawatt level.





Chapter IV

Promoting Ecological Restoration



[Case 22]

“Planting Sun” in the Shagoh Desert to turn the desert green

PART 01 Case Background

Zhangwu County, Fuxin City is located in the northwest of Liaoning Province, China, and the south of the Horqin Sandy Land. It is situated in the transitional zone between temperate monsoon climate and continental climate, with a dry climate and annual precipitation of 300-500 millimeters. Based on monitoring data on desertification and sandification in China, the total area of desertified land in Zhangwu County is about 2 million mu, accounting for about 30% of the total desertified land area in Liaoning Province. The situation of wind and sand control is severe. The water and soil erosion of sandy land is severe, with a decreased organic matter content of the soil and the production capacity. In addition, seeds and seedlings are easily damaged by strong winds, seriously affecting the normal growth of crops.

PART 02 Actions

In 2023, China Huaneng Group invested in the Fuxin Zhangwu photovoltaic composite sand control demonstration project (with an installed capacity of 500,000 kilowatts), in which the “ecology + featured agriculture” model was adopted under and between the photovoltaic panels and arrays, vigorously promoting “power generation on the panels, restoration under the panels, and planting between the panels”, in order to control desertification of the land. To reduce the occupation of arable land, the spacing between the solar arrays in the project is 14 meters, with the lowest point of the components 1.8 meters above the ground, occupying only 20% to 30% of the original land area. In the project, shallow buried drip irrigation planting method was also adopted, and drainage facilities and organic fertilizer application equipment was added in the planting area, in order to improve soil fertility, and increase agricultural output.



(a) Before the photovoltaic construction



(b) After the photovoltaic construction

Fuxin Zhangwu Photovoltaic Compound Desert Control Demonstration Project

PART 03 Achievements

In 2023, Zhangwu County selected 300 mu of sandy land in A'er Township, Zhanggutai Township, Houxinjiu Township, and Fengjia Township, in order to construct the main project of the photovoltaic desert control pilot project, planting six crops including sorghum, soybeans, millet, sunflowers, peanuts, and miscellaneous beans. The test results showed that the yield per mu of land could reach or even exceed the standard yield per mu of other plots, which achieved increased grain production and income for farmers. For example, in the test area, the yield of liquor sorghum per mu reached 616.1 kilograms, with a normal yield of 494.6 kilograms, and the yield of yellow-kernel black beans per mu reached 150.6 kilograms, with a normal yield of 150 kilograms per mu.

PART 04 Highlights

(1) Government departments have explicitly requested to promote the construction of projects for desertification prevention and control and wind and photovoltaic power, and actively guide energy enterprises to promote the integrated development of photovoltaic industry and desertification prevention and control.

(2) In the project, “photovoltaic sand control” is combined with the organic development of agriculture in Zhangwu County, achieving multiple benefits such as ecological security, food security, energy security, and rural revitalization.



[Case 23]

Building a “Saihanba” in the coal sea to empower green development

PART 01 Case Background

The large-scale open-pit mines of Heidaigou and Haerwusu developed by China Energy Investment Corporation (CEIC) are located in Zhungeer Banner, Inner Mongolia, China. They are situated at the junction of the three provinces of Inner Mongolia, Shanxi, and Shaanxi, with an annual designed production capacity of 69 million tons, ranking among the top in the world in terms of scale. The total area of the mining area is about 120 square kilometers, only 5 kilometers away from the main stream of the Yellow River. Due to the drought and barren, the original surface vegetation coverage is around 25%. In recent years, CEIC has actively promoted the restoration of the ecological system in the mining area, basically forming a soil consolidation and sand prevention governance system, continuously enhancing the ability of land and water conservation, and providing important reference for mining enterprises to carry out ecological restoration actions.

PART 02 Actions

Promotion of ecological restoration in mining areas. Through methods such as landscape reshaping, soil reconstruction, vegetation reconstruction, landscape restoration, and biodiversity reorganization and protection, thousands of acres of fertile land have been transformed and formed. By establishing ecological structure models of shrub grass type, tree grass type, tree shrub type, and tree shrub grass type, different species and combinations of biological communities have been formed, and the species diversity and ecological diversity of mining areas have been increased.

Development of industrial models in mining areas. By cultivating the industry consortium of “government + enterprise + farmers” and the consortium of “national mining park + Zhuneng ecological tourism area + Zhungeer Banner Cultural and Tourism Group”, the development of diversified industry models can be integrated such as “ecology



(a) Before repair



(b) After repair

Comparison of before and after ecological restoration in the demonstration area of Zhuneng Group

+ agriculture, animal husbandry, forestry and fruit, cultural tourism, and research and learning”, and diverse transformation paths have been opened up such as “creating green reserves, turning green into revenues, exploring revenues with green, and expanding green to increase revenues”.

PART 03 Achievements

The mining area is getting more beautiful. The company has invested a total of RMB 2.88 billion in reclamation and greening, completing a greening area of 98,500 mu. The vegetation coverage has increased from 25% to over 80%, and the regional biodiversity has significantly improved.

Green economy is getting stronger. Eight ecological functional zones have been established, including forest areas, agricultural areas, field areas, fruit areas, and pasture areas. More than 10,000 mu of forage grass has been planted, and a base for planting feed and side crops of over 3,000 mu has been developed. In addition, a 39,000 mu fruit tree planting base has been established with more than 1,000 mu of flowers. In the past five years, the Gross Ecosystem Product (GEP) has increased by RMB 1.4 billion, and the ecological benefits in the mining area

continue to be realized.

The local people are getting rich. Local enterprises join hands to establish an ecological company, which can promote the thriving development of local eco-tourism industry. Since 2023, the Ecotourism Area of Zhuneng Mine has received over 230,000 visitors, created 60,000 new job positions, and attracted over 800,000 visitors to surrounding scenic spots, which also generates an annual economic benefit of RMB 200 million for the local area.

PART 04 Highlights

(1) The “case of ecological restoration in mining areas” was selected for the World Economic Forum report and was fully promoted in the Chinese government’s issuance of opinions supporting the high-quality development of Inner Mongolia.

(2) The “Ecological Restoration Demonstration Project” won the first prize of the China Green Mine Major Project Award, and the case of the “Ecotourism Area of Zhuneng Mine” has been awarded as the “Green Energy Star” special award and the Management Brand Honor.



[Case 24]

The warm journey home of sea turtles at the Hunutlu Thermal Power Plant in Turkey

PART 01 Case Background

The Hunutlu Power Plant in Adana Province, Yumurtalik City, Turkey, is constructed and operated by China State Power Investment Corporation. In addition, it is the largest direct investment project by a Chinese company in Turkey since the establishment of diplomatic relations between China and Turkey. The beach adjacent to the power plant is one of the important spawning sites for the endangered green sea turtles. From May to September every year, a large number of green sea turtles come here to lay eggs. In order to protect this rare and endangered species, the Hunutlu Power Plant has taken various measures to warm the way home for sea turtles.

PART 02 Actions

Optimization of the cooling water solution. By combining the smokestack and cooling tower of the thermal power plant into one structure, the discharge of cooling water has been significantly reduced. This has helped to keep the sea temperature rise around the discharge point within 1 °C, which can reduce the impact on the marine ecological environment.

Construction of a “turtle bridge”. Efforts were made to optimize the coal conveyor bridge and access road into a long-span truss bridge, directly crossing the beaches belonging to the first and second class sea turtle protection areas, providing better protection for the sea turtle nesting sites.

Optimization of the lighting scheme. Light sources with wavelengths greater than 580nm have been used near spawning areas to reduce light attraction to sea turtles, while avoiding direct light shining on the water surface to prevent hatchlings from getting disoriented.

Installation of tracking equipment. Power plant staff assisted local sea turtle experts in installing

satellite tracking equipment for green sea turtles to monitor their activities within the environmental protection zone and their activity routes throughout the Mediterranean in real time, for subsequent scientific research.



Long-span truss bridge “Turtle Bridge”



Installation of satellite tracking equipment for green sea turtles



Power plant chimney and cooling tower “two towers in one”

PART 03 Achievements

The Hunutlu power plant is vigorously promoting the protection of green sea turtles through various methods such as the “two towers in one”, building a “turtle bridge”, optimizing lighting schemes, and installing tracking equipment, and leaving a life channel for turtle reproduction. After years of observation, the Turkish government and local biologists have clearly stated that the power plant has not damaged the nearby marine ecosystem, and the spawning of local green sea turtles has not been negatively affected.

PART 04 Highlights

(1) The various measures taken by the Hunutlu Power Plant of State Power Investment Corporation to protect green turtles have a strong demonstration effect and can be promoted to other regions, contributing wisdom and experience to global marine ecological governance.

(2) The project was reported by the news channel of the Turkish Radio and Television Corporation (TRT), and received wide recognition and high praise from the local community, promoting exchange and cooperation between China and Turkey in biodiversity conservation.



[Case 25]

Protecting biodiversity to incorporate green infrastructure concepts into engineering construction

PART 01 Case Background

The Yangxu Pumped Storage Power Station (with an installed capacity of 1.2 million kilowatts) constructed by China Southern Power Grid Company is located in Yangjiang City, Guangdong Province, China, adjacent to the extremely diverse Ehuangzhang Provincial Nature Reserve. During the construction and operation of the power station, there are major issues such as the protection and transplantation of rare plants and ancient trees, as well as the restoration and management of the ecological environment.

PART 02 Actions

Protection of rare plants and ancient trees. Under the guidance of the forestry department, the Yangxu Power Station conducted field investigations and discovered national second-level protected plants, such as *Pterocarpus indicus* and *Cinnamomum camphora*, as well as 10 rare and endangered wild plants, including *Anoectochilus roxburghii* and *Arundina graminifolia*. Based on the research results, efforts were made to design targeted protection measures and entrust professional organizations to implement them. Specific measures include: on-site protection was conducted for the

rare and endangered plant, *Euryodendron excelsum*, which may be affected by construction transportation; rare wild plants such as camphor tree, *Euryodendron excelsum*, *hydrangea*, *Castanopsis concinna*, *Cibotium barometz*, *Acidosasa chinensis*, and orchids affected by construction land occupation and reservoir inundation were relocated for protection and transplanted to Hwei Mountain Forest Farm; ancient and famous trees such as banyan, longan, and *Cleistocalyx operculatus* in the reservoir area were transplanted to permanent campsites for protection by professional organizations.

Restoration of the ecological environment of the power station area. During the construction of the power station, measures such as optimizing design, reducing construction land use, adopting new technologies and materials, and implementing construction and governance simultaneously were taken to minimize the impact on the ecological environment. In the initial stage of the completion of the power station, nearly RMB 20 million was invested, in order to carry out a series of ecological restoration projects in different areas such as the downstream reservoir area, permanent campsite, roads connecting the upper and lower reservoirs, slag field, and quarry. Every year, a special tree planting activity called "Promoting Green Development, Creating a Beautiful Power Station" is organized to plant local tree species and continuously improve the greening



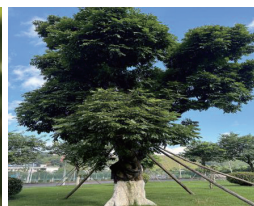
(a) Survey and listing of plants to be transplanted



(b) Appearance of the planting area for transplanted plants at Hwei Mountain Forest Farm



(c) Rare and endangered plant *Euryodendron excelsum*



(d) The ancient banyan tree transplanted to the permanent campsite

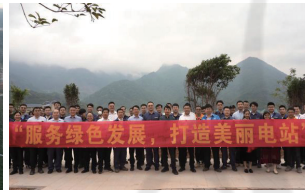
Implementation of the protection of rare plants and ancient trees



(a) Ecological restoration effect behind the reservoir dam



(b) Ecological restoration effect of the lower dam at the Yangxu Power Station reservoir



(c) Special tree planting activities for the power station



(d) Greening effect of permanent campsite at the power station

Promotion of ecological restoration project in the power station area

rate of the permanent campsite and factory area.

Implementation of public welfare projects for the protection of rare and endangered plants. *Euryodendron excelsum* is a unique endangered plant species in China, only sparsely distributed in Baja Village, Yangchun, Guangdong (in the area where the Yangxu Power Station is located), as well as in Siwang Village, Pingnan and Linglu, Bama County, Guangxi. The scientific research and technology team of the Ehuangzhang Nature Reserve found through on-site investigation that the ecological environment in the area behind the lower reservoir dam of Yangxu Power Station is good and suitable for reintroduction of artificially bred *Euryodendron excelsum*. In 2023, Yangxu Power Station collaborated with the nature reserve, in reintroduction experiment of *Euryodendron excelsum* using 20 mu of land behind the dam, and took the responsibility for the daily management of *Euryodendron excelsum*.

PART 03 Achievements

Before construction, 19,482 key protected plants in the area were transplanted to the state-owned Hwei Mountain Forest Farm in Yangchun City, and passed the acceptance inspection by the forestry department of Yangjiang City, as well as the management office of the provincial-level Ehuangzhang Nature Reserve. In 2021, three banyan trees, one *Cleistocalyx operculatus*, and three longan trees in the reservoir area were relocated to the permanent campsite, and the ancient trees have grown well. In 2023, 2,100 seedlings of *Euryodendron excelsum* were planted in the reintroduction experiment behind the dam, and 1,900 of them survived, with a survival rate of 90%. In 2023, the ecological environment restoration and soil erosion control achievements of the Yangxu Power Station were awarded the title of "National Soil and Water Conservation Demonstration Project".

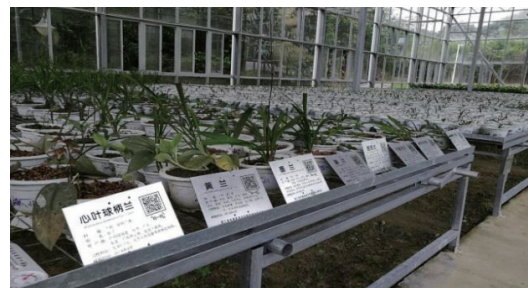
PART 04 Highlights

(1) Under the guidance of the forestry department, targeted protection plans have been designed for key protected plants in different categories, and professional organizations have been commissioned to complete relocation protection to avoid destructive damage to rare and endangered plants and ancient and famous trees caused by construction projects.

(2) By collaborating with the Ehuangzhang Nature Reserve and participating in the conservation and expansion of the rare and endangered plant, *Euryodendron excelsum*, the corporate social responsibility has been demonstrated in the field of biodiversity conservation.



(a) Overview of the transplanted plants in Hwei Mountain State-owned Forest Farm



(b) Transplanted *Cibotium barometz*, a national second-class protected plant

Protection for key protected plants through relocation

[Case 26]

Strengthening ecological protection technology innovation to help build “green upper reaches of the Jinsha River”

PART 01 Case Background

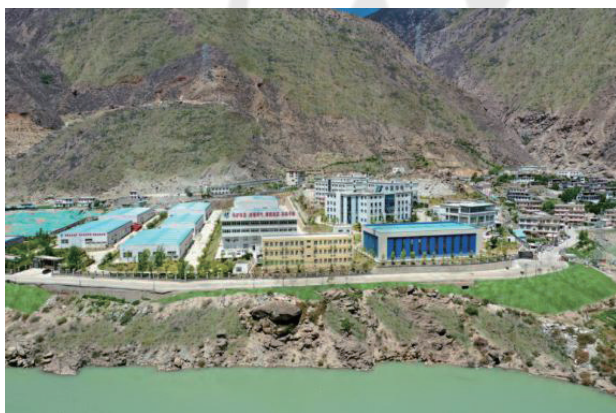
When China Huadian Corporation developed hydropower stations in the upper reaches of the Jinsha River in the Sichuan-Xizang section, various measures were taken, in order to minimize the impact of the hydropower stations on the reserved river sections of the main stream and tributaries, which can preserve the “habitat” for fish to the greatest extent possible. Meanwhile, ecological protection technology research was vigorously carried out to promote the protection of fishery resources in the upper reaches of the Jinsha River with high quality, striving to create “green upper reaches of the Jinsha River” where energy development and ecological protection are coordinated, and humans and nature harmoniously coexist.

PART 02 Actions

Tackling the key technology problems for increasing fish breeding and releasing. Fish in the upper reaches of the Jinsha River have high requirements for water quality and temperature,

and there is no precedent for artificial breeding in this section of the river. Huadian Corporation has overcome difficulties and integrated innovation, in order to solve the technical issues of aquaculture throughout the process of collection, preservation, domestication, breeding, seedling cultivation, marking, and release in high-altitude and high-cold areas. It has successfully achieved artificial propagation and release of *Gymnocypris potanini firmispinatus* and *Schizopygopsis malacanthus* in this region for the first time.

Achievement of synchronization between fish passage and power generation. At the Suwalong Power Station, key technologies such as the fish lift and fish transportation system have been researched. In addition, before production, the first set of fish lift and fish transportation joint system in the Yangtze River Basin has been completed, achieving synchronous fish passage and power generation for the first time in China. On World Environment Day 2023, China News conducted a global live broadcast titled “Watching Fish Take the Elevator on the Jinsha River Together”, which received widespread attention. Based on incomplete statistics, the total online viewership was about 15 million.



Fish reproduction and release station



Figure 2 Two-way Fish Passage System in Hydropower Station

PART 03 Achievements

The fish breeding and release station of the Zangmu Hydropower Station, built by Huadian Corporation with an investment of RMB 48 million, is the first-level fish breeding station along the Yangtze River and the largest fish breeding station in Xizang, which has achieved regular release for five consecutive years. The breeding and release stations supporting power stations such as the Suwalong, Batang, Lawa, Yebatan, and Gangtuo were all completed and put into operation before the closure of the dam, with a total release of approximately 4.075 million fish in the basin. The related achievements were featured in *China Science Communication*.

PART 04 Highlights

In September 2020, the Chinese position paper at the United Nations Biodiversity Summit presented the “53 kilometer downstream section of the Jinsha River tributary as a habitat for protection and mitigation of the adverse impact of the project on the aquatic ecological environment” by the Yebatan Hydropower Station, as a typical case of Chinese enterprises actively fulfilling their social responsibility for environmental protection.



[Case 27]

The UK Centre for Ecology & Hydrology uses data tags to study the impact of offshore wind farms on puffins

PART 01 Case Background

The Aberdeen offshore wind farm is located near the Aberdeen coast in Scotland, UK, consisting of eleven 8.8-megawatt wind turbines. The project was put into operation in July 2018, capable of meeting the electricity needs of 80,000 households annually, which can reduce 13,400 tons of carbon dioxide emissions. From July each year to March of the following year, a large number of puffins winter in the surrounding waters of the project. UK Center for Ecology and Hydrology has conducted research, in which data tagging methods are adopted to analyze the impact of the project on the survival and reproduction of puffins.

PART 02 Actions

In 2019, a research team established four observation areas in the offshore wind farm area, in order to install data tags such as sea water temperature sensors and geolocators on 39 puffins, and collected a large amount of high-precision data. In addition, they also analyzed their migration routes and wintering areas through advanced algorithms. Meanwhile, the team collected samples of puffin feathers and studied their physical condition and foraging habits through stable isotope analysis.

Aberdeen Offshore Wind Farm in the UK





(a) Puffin



(b) Positioning tags

Installation of data tags on the puffins

PART 03 Achievements

Research results indicate that, although there are some differences in foraging habits of puffins in the four observation areas, their physical condition and nutritional level are basically at the same level. Even during the most food scarce months of February and March, there were no significant deaths. It can be concluded that the Aberdeen offshore wind farm has not caused significant impact on the survival of puffins in the nearby waters. In addition, the puffins can obtain sufficient food and are able to maintain normal reproduction and survival.

PART 04 Highlights

(1) In the project, advanced data labeling technology was adopted, in order to monitor puffins with high precision, which can be widely applied in other areas, demonstrating strong potential for replication.

(2) The final report of the project was released in January 2023, becoming an important outcome of the European Offshore Wind Deployment Centre's environmental research and monitoring program.

(3) The project was funded and constructed by the Aberdeen Renewable Energy Group, with a grant of 40 million euros from the European Union, expanding the project's financing channels and reducing financing costs.



[Case 28]

Swedish Vattenfall Energy Company supports ecological protection in the Juctan River basin

PART 01 Case Background

Since the 1960s, Sweden has built multiple hydroelectric power stations in the Juctan River basin in the north, which has disrupted the migration of fish such as salmon and trout, changed the hydrological environment downstream of the hydroelectric power plants, and affected the survival of fish and waterfowl. Swedish Vattenfall Energy Company (referred to as Vattenfall) is the operator of multiple hydroelectric power stations in the river basin. In order to promote ecosystem restoration and biodiversity conservation in the basin, it launched the Juctan River Basin Ecological Restoration Project in 2016.

PART 02 Actions

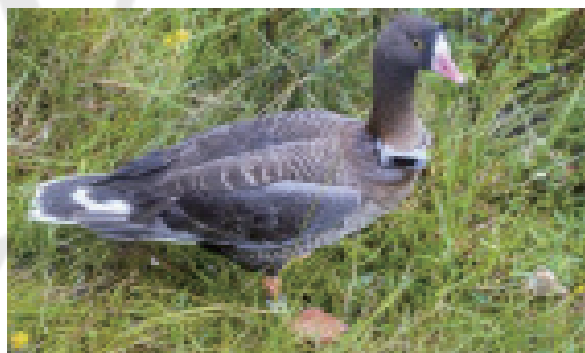
Transformation of hydropower facilities. Vattenfall renovated its hydroelectric power stations, in order to build fish migration channels, ensuring that salmon and trout can return to the upper reaches to spawn. It also changed the water regulation mode of the dam, in order to make the downstream flow more closely resemble the seasonal distribution before the dam was built.

Utilization of AI technology. A database has been established, in which fish photos taken underwater were used for training large AI models. The AI model will automate real-time monitoring and statistics of fish migration.

Active protection of water birds. Efforts were made to install data tags for the local rare bird species, the lesser white-fronted goose. These tags are charged by solar energy and do not require regular battery replacement. Through these tags, the survival status of the geese can be monitored while reducing disturbance to the geese.



(a) Fish passage through migratory fish ways



(b) Data tags installed on lesser white-fronted goose

Protection of the fish and waterfowl in the Juctan River Basin

PART 03 Achievements

The project was completed in the fall of 2020. At present, the ecological environment in the Juctan River basin has significantly improved, and fish such as trout and salmon have returned upstream through migratory fish ways, effectively restoring their spawning areas. The ecological environment downstream of the hydropower station has been effectively restored, and the population of freshwater pearl mussels, which were originally in an endangered state, has begun to grow. As a supplement, fish stocking was also adopted by Vattenfall to further increase the population of fish in the river basin.

PART 04 Highlights

The application of AI large models in the field of biodiversity conservation is highly innovative. At present, Vattenfall's AI model can automatically detect the size of migrating fish and determine the health status of fish schools through thermal imaging technology. Researchers are optimizing the model, aiming to achieve automatic identification of fish gender in the near future. This technology can be promoted to other regions and has broad prospects for development.



[Case 29]

LONGi uses photovoltaic technology to protect biodiversity

PART 01 Case Background

LONGi Green Energy Technology Co., Ltd. is a leading company in the global photovoltaic industry. For a long time, LONGi has been committed to using photovoltaic technology, in order to protect the earth's ecology and actively engage in biodiversity conservation efforts.

PART 02 Actions

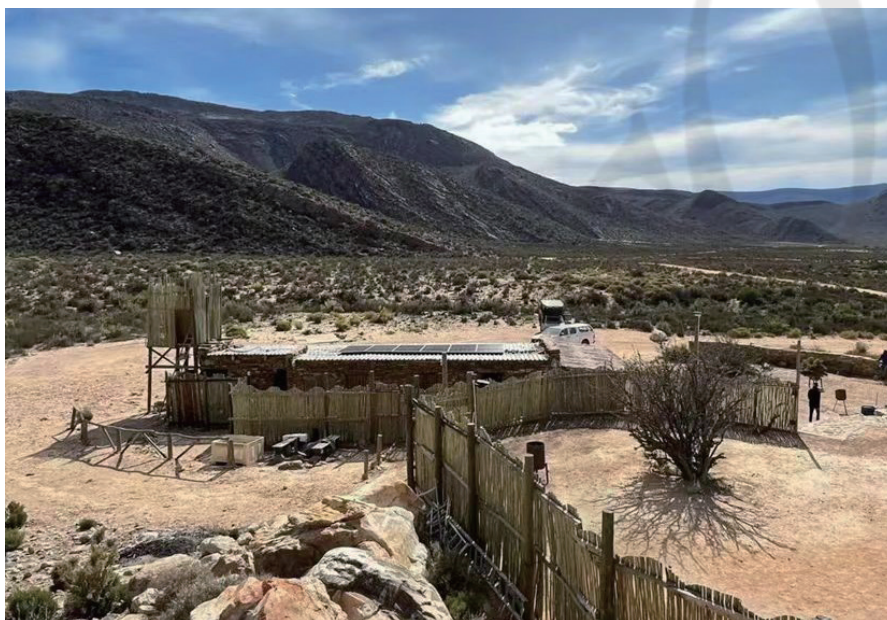
It has implemented the “National Treasure Zero Carbon Living Plan” by providing photovoltaic products and technical support to the Foping National Nature Reserve in Shaanxi Province, China. For

example, it donated a distributed photovoltaic power station to the research building of the Qinling Panda Foping Rescue and Breeding Research Base, to provide green electricity for the park's operation and research work.

Efforts have been made to support biodiversity conservation in Africa by donating a distributed photovoltaic system to the Aquila Wildlife Conservation Center in South Africa. Through the system, clean green electricity can be provided for the protection base, and it will be used to provide clean water sources for wild animals such as African lions, black rhinos, African leopards, African elephants, and water buffaloes.



Photovoltaic system at the research building in Qinling Panda Foping Base



Photovoltaic system in Aquila Animal Protection Base, South Africa

PART 03 Achievements

The distributed photovoltaic power station was completed in 2023 at the Foping Panda Rescue and Breeding Research Base in the Qinling Mountains, making the park's energy use more environmentally friendly. LONGi also plans to promote the second phase of the project, providing more photovoltaic products and technical support for facilities such as fire prevention video systems in the park and dynamic monitoring video systems for wildlife. It can also provide more environmentally friendly, convenient, and reliable green electricity.

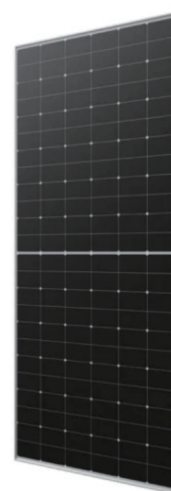
At the Aquila Animal Protection Base in South Africa, diesel generators have been completely replaced, protecting wildlife from environmental pollution such as exhaust gas and noise. The clean water source is also reliably ensured for the wildlife in the park.

PART 04 Highlights

Photovoltaic component of LONGi Hi-MO X6 series are adopted at the photovoltaic power station of Qinling Panda Foping Rescue and Breeding Research Base. The component features an innovative design where dust accumulation on the

component can naturally slide off under the influence of gravity and rainfall, thus avoiding blocking incoming sunlight. This design not only enhances power generation efficiency, but also reduces the frequency and cost of cleaning. In March 2024, Hi-MO X6 Smart Home (anti-dust design) ranked first in the global photovoltaic module power generation test ranking published by the authoritative photovoltaic industry media organization PV Magazine.

LONGi
Hi-MO X6



Photovoltaic component of LONGi Hi-MO X6 Series

[Case 30]

Russian government promotes restoration of biodiversity for Bureyskaya river

PART 01 Case Background

Nizhne-Bureyskaya Hydroelectric Power Plant is located on the Bureyskaya River in the Russian Far East region of Amur Oblast, about 90 kilometers downstream from Bureyskaya Hydroelectric Power Plant, forming the Bureyskaya Energy Complex together. The hydropower station is developed by RusHydro, with an installed capacity of 320 megawatts and an average annual power generation of 16.5 million kilowatt-hours. The design area of the hydropower station reservoir is approximately 15,400 hectares and water injection was completed in 2017. In order to reduce and restore the adverse effects on local biodiversity caused by the construction of the Nizhne-Bureyskaya HPP, in 2014, the Russian Ministry of Natural Resources, the Amur Oblast government, the United Nations Development Programme (UNDP), and the Global Environment Facility (GEF) jointly implemented an ecological restoration project.

PART 02 Actions

During the planning and design phase, efforts were made to conduct field surveys, and collect environmental and biodiversity information. Efforts were also made to monitor local hydrological, meteorological, and flora and fauna conditions, and comprehensively assess potential ecological impacts, in order to design response measures based on this information.

During the construction phase, the Buleya Nature Park was built to provide a natural habitat for local flora and fauna, with various measures being taken to protect mammals, rare birds, and endangered plants. The first is to protect mammals.

Within the protected area, artificial feeding sites were constructed in areas far away from the reservoir to attract mammals to gather here and minimize the impact of reservoir construction on animals. The second is to protect rare bird species. A large number of artificial bird nests were installed in order to provide shelter for rare birds such as mandarin ducks and oriental storks living around the reservoir. The third is to protect rare plants. Rare plants in the reservoir area, such as the red-listed Aleuritopteris Kuna fern, were transplanted by establishing special chambers for spore germination and then the seedlings were moved to suitable locations.



Artificial bird's nest



Artificial feeding ground

PART 03 Achievements

1. The construction of Bureyskaya Nature Park was started in 2015 and currently the park covers an area of 132,000 hectares, providing a vast habitat for local flora and fauna.

2. 25 artificial feeding grounds and 1,000 artificial bird nests have been built, and over 400 rare species have been transplanted.



[Case 31]

B.Grimm Company actively upholds commitment to biodiversity conservation

PART 01 Case Background

B.Grimm Group is a multinational conglomerate founded in 1878, headquartered in Bangkok, Thailand. Its subsidiary Amata Power owns and operates over 20 power plants in Thailand, Laos, and Vietnam. The company places a high priority on biodiversity conservation, and has issued a biodiversity conservation commitment in 2022, requiring all subsidiaries, affiliated companies, and suppliers to uphold the commitment together.

PART 02 Actions

Key initiatives of B.Grimm in fulfilling its commitment to biodiversity conservation include:

(1) **Conduction of on-site assessment.** For planned projects, on-site assessment of their impact on biodiversity should be conducted as a prerequisite for project approval and investment decisions. For ongoing projects, the assessment results should be updated every five years to prevent negative impacts.

(2) **Enhancement of the ideas promotion.** Efforts have been made to establish a biodiversity conservation database, and open it to stakeholders, in order to promote the effectiveness of biodiversity conservation, and enhance understanding among all parties, which can also strengthen cooperation among them.

(3) **Promotion of collective action.** Efforts have been made to conduct annual biodiversity assessments for primary suppliers and other key suppliers to ensure compliance with local ecological and environmental protection policies and regulations. Collaboration was undertaken with external organizations and experts to carry out activities for ecological environment protection and restoration together.





The company launched “Tiger Action”, in order to restore wild tiger population in Thailand

PART 03 Achievements

For a long time, B.Grimm Company has been diligently fulfilling its commitment to biodiversity conservation, and carried out a large amount of work, achieving the following results:

(1) Biodiversity assessment. In 2023, the company conducted biodiversity assessments on 62 sites and 1,023 hectares of land, finding no violations of local environmental laws or actions that harm biodiversity.

(2) Plant trees and forests. Since 2008, the company has been collaborating with local government departments and communities, in order to promote afforestation projects. By the end of 2023, more than 93,000 trees have been planted.

(3) Save the tigers. Since 2021, the company has launched a tiger conservation project, which is aimed at restoring the tiger population in Mae Wong and Klong Lan National Parks to 300 individuals through habitat restoration, banning illegal hunting, and other measures. In 2023, the company produced a promotional video *Tiger Mission* which was broadcast globally, effectively raising international awareness on tiger conservation. The video won the Asian Academy Creative Awards 2023.

[Case 32]

Italian company 3Bee uses AI technology to monitor pollinating insect diversity in photovoltaic power plants

PART 01 Case Background

In response to the global climate and biodiversity crises, the European Union has issued the Corporate Sustainability Reporting Directive (CSRD), which requires large companies to disclose their environmental, social, and governance (ESG) information based on the European Sustainability Reporting Standards (ESRS), in order to support climate and biodiversity governance in Europe. In this context, the Italian company 3Bee provides biodiversity monitoring services to various public and private entities by using advanced technologies such as satellite remote sensing, Internet of Things, artificial intelligence, in order to help implement CSRD requirements and fulfill ESG disclosure responsibilities.

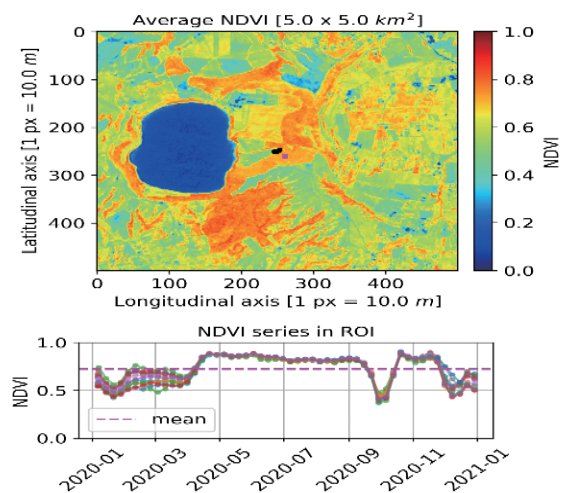
PART 02 Actions

In 2023, the 3Bee Company developed the biodiversity monitoring framework for ELEMENT-E, and conducted monitoring work at the ecosystem and population levels, in order to analyze the collected information in depth, and generate biodiversity assessment indicators and reports.

(1) Monitoring ecosystem diversity. In collaboration with the European Space Agency (ESA), advanced remote sensing technology was used to conduct high-precision imaging of the ground at 10x10 meters using satellites such as Sentinel-2. In addition, artificial intelligence algorithms were utilized, in order to assess ecosystem diversity in various regions and identify key areas for biodiversity conservation.

(2) Monitoring the diversity of pollinating insect populations. IoT acoustic sensors were installed, in order to record and analyze the sound frequencies of pollinating insects such as bees, which can also assess the abundance and survival status of their populations. Powered by photovoltaic cells, these sensors can transmit information through 4G networks, allowing real-time detection and analysis of pollinating insect activity.

(3) Carrying out data analysis. By processing the collected information and analyzing quantitative evaluation indicators such as Mean Species Abundance (MSA), Pollinating Insect Abundance (PA), Nesting Suitability of Insects (NS), Flower Availability (FA), and Nectar Potential (NP), a biodiversity assessment report can be generated based on these metrics.



Element-E satellite remote sensing technology



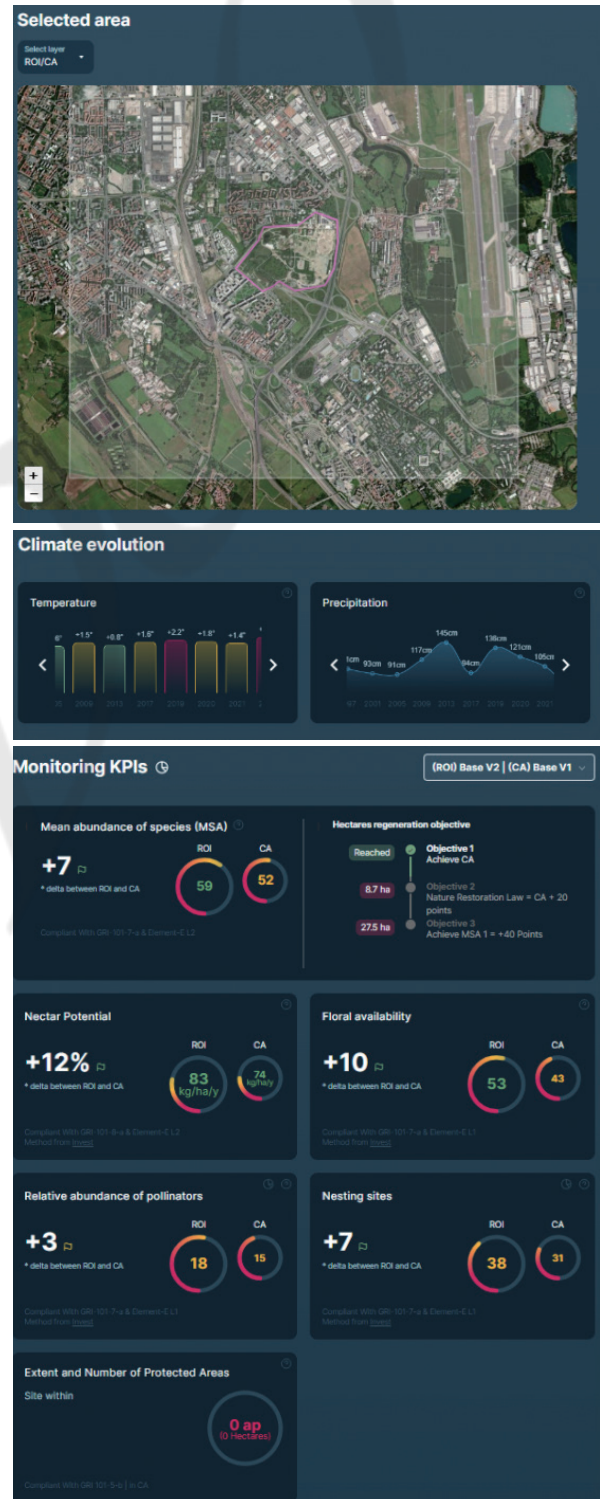
Element-E IoT animal acoustic sensor

PART 03 Achievements

Currently, 3Bee has deployed over 5,000 IoT sensors, which can serve 500 enterprises, 14 universities and research institutions, monitoring biodiversity on about 100,000 hectares of land. By using the ELEMENT-E biodiversity monitoring framework, various public and private entities can more effectively implement ESRS requirements, providing accurate ESG information. This information is beneficial for the government to formulate scientific and rational policies. In addition, it can help businesses to adjust their operational strategies, and also helps to raise public awareness of biodiversity conservation and promote collective action.

PART 04 Highlights

At present, 3Bee has provided pollinating insect diversity monitoring services for 10 photovoltaic power stations in Europe, and has received high recognition from SolarPower Europe (an organization representing the European solar industry with over 300 members). Recently, 3Bee is developing an innovative certification system to certify companies using the ELEMENT-E framework for biodiversity monitoring, which can enhance the social credibility of their ESG reports.



Element-E biodiversity assessment index interface