中广核 CGN

Natural Energy Powering Nature

China General Nuclear Power Group

Report on Biodiversity Conservation

2021

About this Report

Reporting Period

January 1, 2020 to June 30, 2021. Certain parts may extend beyond this period.

Reporting Scope

The Report covers biodiversity management, protection, sustainable measures and research on the effectiveness of related actions carried out within the scope of China General Nuclear Power Group's global operations.

Reference

China General Nuclear Power Group is also referred to as "CGN" or "we" in this report.

Reporting Cycle

The Report is the second biodiversity conservation report by CGN.

Language

China General Nuclear Power Group Report on Biodiversity Conservation 2021 is available in Chinese, English and French. Both print and electronic versions of this report are available. If there is any discrepancy, please refer to the Chinese version.

Further Information

CGN's website provides more detailed information, please go to http://www.cgnpc.com.cn.

Contents

About CGN

Company Profile

China General Nuclear Power Group (CGN) is headquartered in Shenzhen, Guangdong Province, which is a central enterprise controlled by the State-owned Assets Supervision and Administration Commission of the State Council. CGN is committed to the mission of “developing clean energy for the benefit of mankind” and practices the work style of “strict, prudent, careful and practical”. The business has covered nuclear energy, nuclear fuel, new energy, non-power nuclear technology applications, digitalization, technology-based environmental protection, industrial finance, etc. With 3 listed companies in Hong Kong and 2 listed companies in the Mainland, CGN is the largest nuclear power company in China and the third largest in the world. Over 63 million kilowatts of clean power capacity is in operation, of which 28.25 million kilowatts is nuclear power and 35 million kilowatts is new energy.

By June 30, 2021

25 in-service nuclear power units in China; installed capacity of **28.25** GW;

6 nuclear power units in China have been approved for construction; installed capacity of **7.09** GW;

wind power projects in China with installed in-service capacity of **16.125** GW; installed capacity of **0.953** GW;

solar power projects in China with installed in-service capacity of **7.348** GW; overseas new energy projects with an installed capacity of **11.56** GW.

*Note All projects in this map are in-service projects unless otherwise stated.

Clean Energy and Biodiversity

Incorporating biodiversity conservation into its development strategy, CGN adopts the stepwise approach of "avoidance – reduction – mitigation - compensation" to biodiversity management, and has launched a series of practices throughout the full lifecycle of project planning, design, construction, operation and maintenance to conserve biodiversity and achieve harmonious symbiosis with the surrounding natural environment. From 2019 to 2021, following the world-advanced framework of the *Natural Capital Protocol*, the Group has piloted natural capital assessment (NCA) in nuclear power, wind power and other clean energy power generation projects, to measure and value the impacts and/or dependencies of its production and operation activities on natural capital.

CGN's contribution to biodiversity conservation

We are committed to powering nature with natural energy and sustainably developing the energy in nature, to ensure a safe and stable energy supply for the society. In the development of clean energy, we highly value biodiversity conservation and regularly take actions such as environmental impact assessment, environmental monitoring, species protection, ecological compensation, etc., to conserve biodiversity. We have been strengthening our biodiversity management, and work with all parties to preserve planet Earth, our common home.

1987

Starting from its first nuclear power project - Daya Bay Nuclear Power Plant, the Group has carried out professional environmental impact assessment in the planning and site selection stages of all projects.

1994

The Group has established the Environmental Management System (EMS) and carried out environmental monitoring regularly in the operation of all projects.

2013

Daya Bay Nuclear Power Base won the honorary title of Beautiful Power Plant of China and the Special Award for Ecological Conservation; Hongyanhe Nuclear Power Plant won the honorary title of Beautiful Power Plant of China.

Daya Bay Nuclear Power Base commissioned the South China Sea Institute of Oceanography of the Chinese Academy of Sciences to conduct the first survey of marine life in the waters of west Daya Bay.

2014

CGN Swakop Uranium Co., Ltd. in Namibia won a local award for plant protection.

2016

Daya Bay Nuclear Power Base commissioned the Third Institute of Oceanography of the State Oceanic Administration (now named as the Third Institute of Oceanography of the Ministry of Natural Resources) to carry out the second survey of marine life in the waters of west Daya Bay.

Ningde Nuclear Power Plant invited ordinary citizens to take part in offshore biological sampling in the sea area near the power plant.

Chinese white dolphins were found at the sea area near Daya Bay Nuclear Power Base.

Two pink Chinese white dolphins, followed by a small gray one, were found in the sea area around Yangjiang Nuclear Power Base.

More than 100 yellow-beak little egrets were spotted over the sea around Hongyanhe Nuclear Power Plant, the largest population of them ever seen there.

2017

The Group's Operation Training Center was selected into the first batch of National Environmental Protection Training Base.

2018

The project of building artificial wetlands at river corridors with the artificial wetland and biological floating island technologies, initiated by CGN's Hongda Environmental Technology Co., Ltd., was selected among Excellent CSR Cases of Electric Power Companies in 2018 by China Electricity Council.

Daya Bay Nuclear Power Base was awarded the honorary title of Ecological Civilization Awareness and Education Activity Center (Nature School) by Shenzhen.

Yunnan Modou Mountain New Energy Science Popularization Base of CGN, China's largest new-energy science popularization base, was built.

2019

The *2019 Biodiversity Conservation Report of Daya Bay Nuclear Power Base*, the first report on biodiversity conservation in China's nuclear power industry, was released.

The NCA was piloted in Daya Bay Nuclear Power Base and Modou Mountain Wind Farm to measure and value the impacts and dependencies of corporate production and operation activities on natural capital.

The Group registered as a member of the French OREE to work with other member units in biodiversity research and protection.

Yishi Wind Farm in Ninghai became only wind farm in China to win the title of National Model Project for Soil and Water Conservation that year.

The Chinese white dolphins visited the waters near Yangjiang Nuclear Power Base three times, attracting a large number of tourists and even the coverage by CCTV News.

2020

CGN launched its pilot NCA in the Haute-Somme Wind Farm in France and the Brenig Wind Farm in the UK.

The Group established the Coral Conservation Area at Daya Bay Nuclear Power Base, the first of its kind in China.

The Shangchuan Island Wind Farm Project in Taishan, Guangdong Province and CGN's Dapoding Wind Farm in Xiaogan, Hubei Province were named a national and a provincial model project for soil and water conservation respectively.

CGN's biodiversity conservation practices were included into the newsletter of Global Partnership for Businesses and Biodiversity, a network under the United Nations *Convention on Biological Diversity (CBD)*.

CGN participated in the UN Climate Change Conference COP 25.

Nature-based Solutions

Biodiversity conservation involves the responsibility of human beings in the process of sustainable development, and also presents important opportunities for enterprises to achieve sustainable development. CGN insists on " using the energy of nature", integrating corporate development with biodiversity conservation. While promoting the development of the clean energy industry, CGN also addresses the challenges facing mankind in an eco-friendly manner, which effectively enhances human well-being and biodiversity abundance, thus achieving a win-win situation for the economy, society and the environment, and contributing to the achievement of the " double carbon" target in China.

Biodiversity Conservation Management

As China's largest nuclear power company, CGN actively benchmarks against international standards and rules including ISO 26000 and the UN's CBD. It upholds the principles of "symbiosis, mutualism and regeneration" in performing its biodiversity conservation responsibilities through science-based planning, comprehensive protection, active restoration and compensation, contributing to the realization of the *2030 Agenda for Sustainable Development Goals* (SDGs).

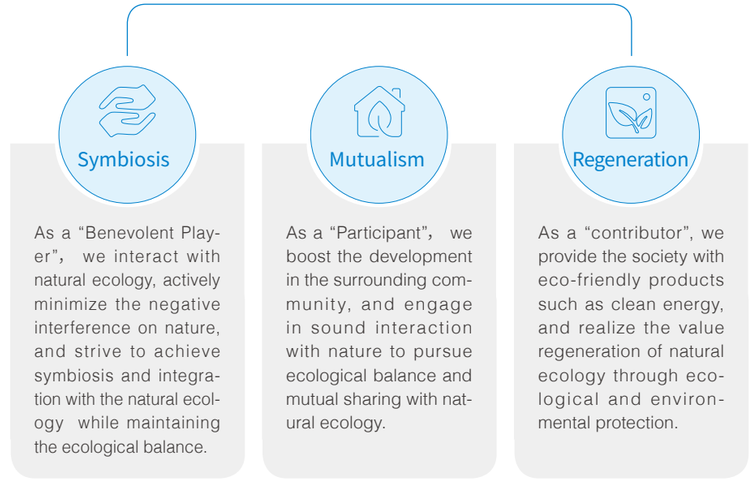
Analysis of material topics

We seize the opportunity to conduct a pilot study on natural capital assessment. Through the internal and external stakeholder research, we identify substantive issues of corporate biodiversity conservation management in terms of the impact and dependence of business activities on natural capital, in order to further improve the biodiversity conservation management system and mechanism and reduce the possible impact of production and operation on the environment and society.

Matrix of substantial topics

The concept of biodiversity conservation

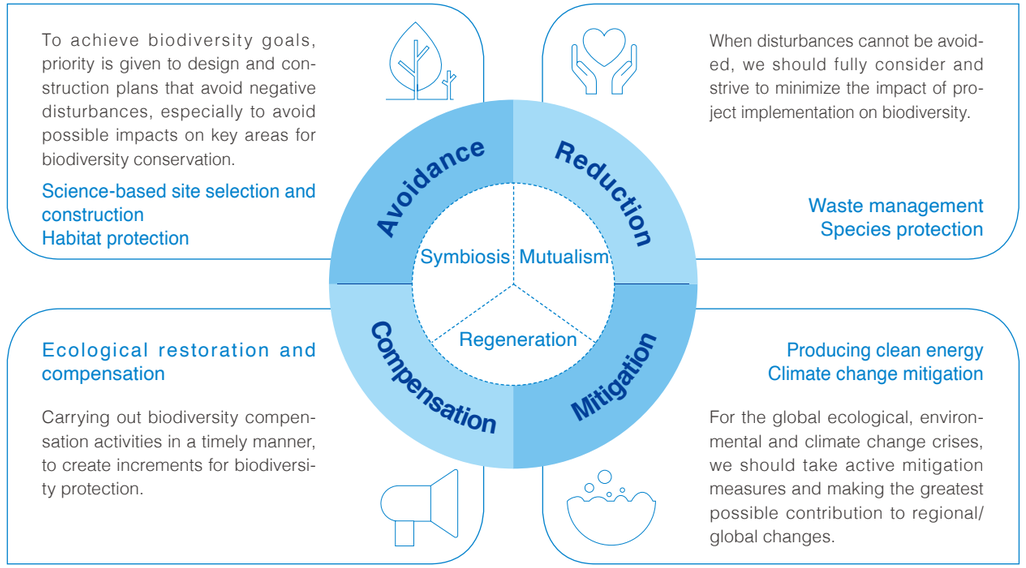
CGN always commits itself to the principles of "symbiosis, mutualism and regeneration" in biodiversity conservation. It respects, makes good use of, and gives back to nature, and seeks nature-based solutions to protect biodiversity and promote the sustainable use of biological resources.



The concept of biodiversity management

Stepwise approach to biodiversity conservation

CGN adopts the stepwise approach of "avoidance – reduction – mitigation - compensation" to protect biodiversity, and provides appropriate solutions for all aspects of production and operation.



The stepwise approach to biodiversity conservation

Science-based Planning to Avoid Impacts

"Avoidance" of impacts is our first choice in selecting biodiversity conservation proposals. By prioritizing the "avoidance" throughout the full lifecycle of production and operation, we strive to minimize negative disturbances to biodiversity. Especially for projects involving key areas of biodiversity protection, we strictly identify and respect the red line, and bypass it in a science-based way, to avoid impacts on the biological habitat and species diversity within the construction area as much as possible.

Site selection stage > Design stage > Construction stage

Feasibility demonstration

- Systematic and scientific feasibility studies are conducted at the project site selection stage to demonstrate the degree of negative disturbance to biodiversity.
- For projects involving environmentally sensitive areas such as nature reserves, scenic spots, world natural heritage sites, drinking water source protection areas, forest parks, etc., we modify the design plan to bypass these areas timely and effectively. We try to minimize negative disturbance to national key protected wild plants and birds, and national and provincial key protected animals.

Environmental assessment

- In the project design stage, environmental assessments are carried out in strict accordance with relevant national regulations, and scientific surveys on the animal and plant resources in the intended construction areas are conducted, to systematically assess the possible impacts of project construction.
- Migratory passages of rare animals and migratory birds are actively avoided. For plans that are assessed to have too much impact, timely adjustment will be made based on the avoidance principle.

Soil and water conservation

- During the project construction period, we strictly follow the water and soil conservation plan under tightened supervision. The measures taken include engineering measures such as retaining wall, intercepting drainage ditch, soil covering and re-cultivation; aerial sowing of grass seeds, planting seedlings and other plant-based measures; temporary covering during construction period, construction of soil drainage ditch and other temporary measures. All of these are of great significance to avoid soil erosion in the project construction area.

Case A sample of Yunnan ecological civilization to avoid the influence of biodiversity

As a green shield for ecological security in the southwest of China and a major ecological province, Yunnan is one of the important windows for showcasing beautiful China. CGN has built several wind farms in Yunnan. In their site selection, demonstration, construction, operation and maintenance, we gave priority to avoiding impacts on biodiversity, and strove to build every project a model in promoting ecological progress.

Take Modou Mountain Wind Farm for example. Built in 2012, it is the first wind farm in Yuxi City, Yunnan Province. In the early site selection stage, we excluded various environmentally sensitive areas such as nature reserves, scenic spots, and water source protection areas from the planned zone, to actively avoid negative disturbance to the ecological environment of these areas. When designing roads entering the wind farm in the mountainous area, we followed as closely as possible along the contour lines and minimized tree felling even though that would drive up the engineering workload and construction costs. In the project construction stage, we made full use of the existing village roads and forest fire escapes to avoid massive damage to or transplantation of the existing plants.

Comprehensive Conservation to Reduce Disturbances

Only by rationally developing and utilizing natural resources, acquiring them from nature in moderation, and minimizing the ecological impact can we effectively protect biodiversity. CGN continues monitoring the ecological environment and biodiversity in its production and operations, improving radioactive waste management, and adopting targeted measures to protect terrestrial and marine species.

Environment and biodiversity monitoring

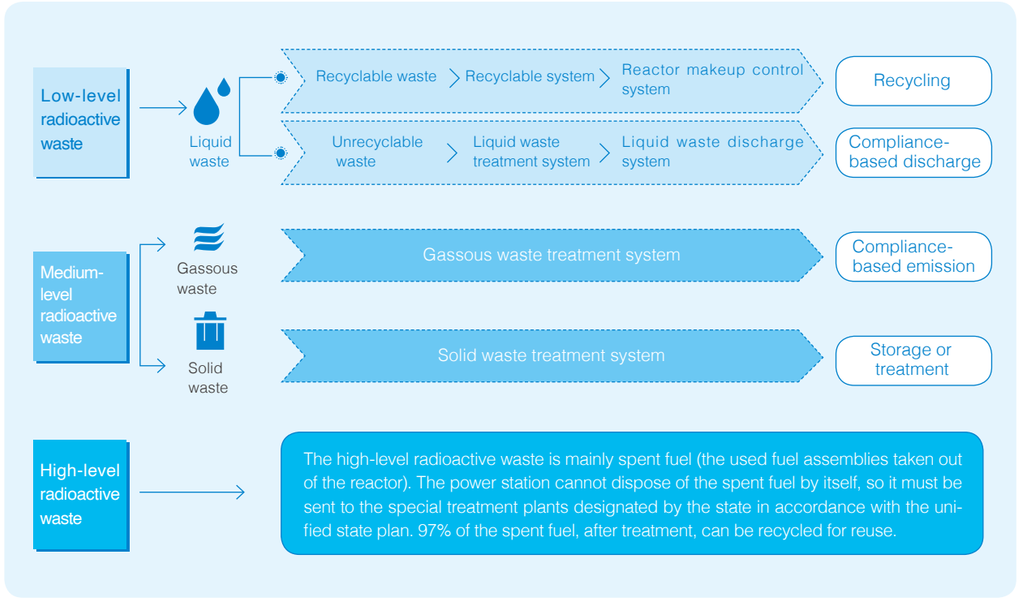
We have established a sound environmental monitoring system to conduct real-time monitoring and sample-based monitoring of air, water, soil, biological samples, etc. within 10 kilometers of all in-service nuclear power bases, and to record environmental patrol inspections. The results are made public through the official websites of the bases to accept the supervision of external stakeholders.

Case Daya Bay Nuclear Power Base monitors seawater quality in surrounding waters

Daya Bay Nuclear Power Base has placed 5 sets of seawater monitoring buoys in the surrounding waters to monitor the seawater quality in real time. Regular manual sampling and testing find the seawater quality to be good. In 2020, 97.1% of the indicators met the national first- and second-class criteria.

Radioactive waste management

The radioactive waste produced by nuclear power plants contains radionuclides, which, if not properly disposed of, may have varying impacts on species survival and habitat environment. In strict accordance with the *Nuclear Safety Law of the People's Republic of China*, the *Law of the People's Republic of China on the Prevention and Control of Radioactive Pollution*, GB 6249-2011 *Regulations for Environmental Radiation Protection of Nuclear Power Plant* and other relevant laws and regulations, CGN applies the most stringent standards to its radioactive waste discharge management to minimize the impact of business operations on biodiversity.



Radioactive waste treatment process

Species conservation

Our clean energy power generation projects are all over the world. During the full lifecycle of project construction and operation, we regard species conservation as an important aspect of biodiversity conservation. We tailor protection plans to the actual conditions of local species and habitat in each project area, to realize the symbiosis, mutualism and regeneration between project operations and nature.

Terrestrial organism conservation

While steadily providing clean energy for production and domestic life, we pay full attention to the protection of surrounding terrestrial animals, plants and their habitats, and adopt special measures to protect endangered species. We strive to minimize the impacts of business operations on species, and build the project area into a vibrant habitat for wildlife.

Case The little egrets return to Daya Bay Nuclear Power Base

The little egret (scientific name:*Egretta garzetta*) is very sensitive to environmental factors such as water and air quality in its habitat, thus known as the "eco-friendly bird." It is included in the national "three-have list" (having benefits, economic or scientific research value) and under state protection. During the peak construction period of the Daya Bay Nuclear Power Plant in the early 1990s, the little egrets were driven away by the flooding of equipment and workers and the environmental impact of the construction. After the nuclear power plant was put into operation in 1994, the Base replanted trees and took other measures to restore and protect the ecological environment, generating obvious ecological benefits, and luring the little egrets back to the beautiful Daya Bay again. The return of the little egrets has become the best testimony of CGN's construction of green nuclear power. As a special visual symbol, the little egret was selected as the logo of CGN, symbolizing its corporate mission of developing clean energy to benefit mankind.

At the turn of spring and summer, flocks of little egrets fly to the Daya Bay Nuclear Power Base, becoming a witness to the development of green nuclear power

Case Optimizing the construction route to protect the rare plant Welwitschia

Welwitschia(scientific name:*Welwitschia mirabilis*) is a rare tropical plant that can survive drought for thousands of years, found only in the deserts of the southwest coast of Africa, and is the national flower of Namibia. The Namibian Husab Uranium Mine of CGN attaches great importance to the ecological protection of the mining area. According to the original construction plan of its permanent water supply pipeline, it needed to transplant 100 Welwitschia plants with an average life span of more than 1,000 years. But CGN Swakop Uranium made several modifications to the route design to minimize the impact on the rare plant. In the end,100 plants were protected.

Protecting the rare plant Welwitschia during project construction

Marine organism conservation

We attach great importance to the protection of marine biodiversity surrounding nuclear power plants and take various measures to protect marine species and their habitats from project site selection, engineering construction to project operation. For example, in the Daya Bay Aquatic Resources Nature Reserve, in order to protect marine ecosystems and biodiversity, we conducted pre-operational and subsequent ecological surveys, by use of satellite remote sensing, measurement and other methods to monitor the water temperature and study the heat resistance of characteristic marine organism. We also optimized the water intake and drainage plan based on the operation of the Base units, and worked with the administrative departments in stock enhancement and releasing.

Case Adhere to green construction, protect the sea elves

The Chinese white dolphins(scientific name:*Sousa chinensis*), under the first-class state protection, like to inhabit in the estuary where the saltwater and freshwater meet in the subtropical waters and rarely enter the seas with a depth of more than 25 meters. The seas near the Pearl River estuary in Guangdong Province is an important habitat for them. During the construction of Yangjiang Nuclear Power Base, CGN formulated whole-process measures to protect the Chinese white dolphins, including the use of anti-proliferation facilities in the early stage of construction to reduce the amount of suspended solids in the seawater; the strict control of waste discharge during construction; and ongoing environmental monitoring and environmental awareness activities after construction. Since the construction of the Yangjiang Nuclear Power Base began, the Chinese white dolphins have been frequently seen playing in the surrounding waters, including visiting there three times in 2018.

The spotted seal (scientific name: *Phoca largha*), is under second-class state protection. It inhabits mainly in the Liaodong Bay area of the Bohai Sea in China and is the only marine pinniped mammal that breeds in China. It is extremely sensitive to the habitat environment: even the sound of ship engines would drive it away. CGN's Hongyanhe Nuclear Power Plant formulated strict management regulations for construction ships from the beginning of the construction stage, prohibiting high-noise navigation and the discharge of sewage and solid waste into the sea. It also set up monitoring points near the sea for regular environmental monitoring, and minimized construction activities in winter to reduce impacts on spotted seals. Moreover, it organized several expert lectures and joined the Dalian Spotted Seal National Nature Reserve in observation and rescue activities, to provide spotted seals with a comfortable and safe living home and protect them in the waters near the Plant.

Chinese white dolphins freely swim in waters near Yangjiang Nuclear Power Base

Spotted seals near the Hongyanhe Nuclear Power Plant

Mitigation of Climate Change

Climate change and biodiversity are serious challenges shared by human society today, and both have an impact on each other. Under the guidance of " 2030 Carbon Peak, 2060 Carbon Neutral", CGN has taken advantage of its advantages as a clean energy company to help transform the global energy mix to a clean and low-carbon one through the safe and efficient development of nuclear, wind and solar energy. Meanwhile, we are dedicated to reducing energy consumption and improving energy efficiency in our operations, thus contributing to addressing global climate change and fulfilling our "dual carbon" commitment through a sustainable solution.

Developing clean energy

Powering nature with natural energy, CGN is committed to zero-carbon clean energy production and supply, and provides large-scale, high-quality, efficient, and sustainable clean energy products and services for human production and life. The Group reduces reliance on fossil energy and greenhouse gas (GHGs) emissions, and is taking concrete actions to cope with global warming, and contributing to biodiversity conservation.

CGN presented the first biodiversity conservation report in China's nuclear power industry to the UN Climate Change Conference COP 25 on December 7, 2019

In 2020

Generated 263.112 TWh on-grid power from clean energy

263.112

Equivalent to reducing GHG emissions by more than 209.999 million tons

209.999

Equivalent to reducing the consumption of 80.3807 million tons of standard coal

80.3807

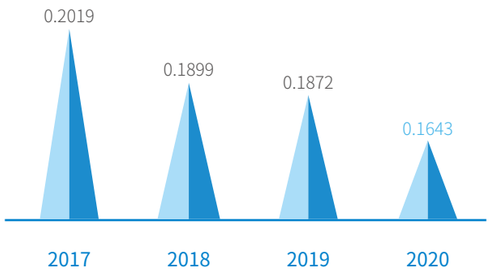
Planting more than 592,000 hectares of forest

592,000

Green and low-carbon operation

CGN continues to optimize the energy management system in the production and operation process, and strives to improve energy efficiency and reduce energy consumption during operations, through replacing energy-intensive equipment, optimizing equipment operation, and carrying out energy-saving transformations.

Synthetic energy consumption per RMB 10,000 output (tons of standard coal consumption)



This indicator refers to the ratio of comprehensive energy consumption of enterprises to their total industrial output value. The formula is comprehensive energy consumption (tons of standard coal consumption) divided by industrial gross output value (RMB 10,000)

Ecological Compensation

In project construction and operation, CGN actively restores and compensates the ecological environment through artificial restoration, technical restoration, vegetation compensation, and animal compensation, etc., to ensure that the local biodiversity is not reduced, or even increased.

Artificial restoration	Mobilizing employees to clean up coastline garbage and restore marine ecological environment.
Technical restoration	Making good use of the power of natural microorganisms to establish a CGN-Weipu Bio-environmental Protection Lab, and making breakthroughs in the R&D of microbial treatment technology of black and stinky polluted water, to effectively restore the river ecological environment.
Vegetation compensation	Paying attention to vegetation protection and taking measures to restore vegetation, including restoration of mangroves, restoration of broken corals, restoration of forest, soil covering, and forest conservation, etc.
Animal compensation	Carrying out stock enhancement and releasing activities, restoring or increasing the number of aquatic animal communities around the project areas, and improving the water ecological environment; rescuing spotted seals and other animals under state protection.

Case Cleaning up the coastline to restore the marine ecological environment

CGN established a team of environmental volunteers to regularly clean up coastal garbage around nuclear power bases, to restore the ecological environment of beaches, and provide monitoring results to assist the decision-making by competent authorities.

In July 2019, the Daya Bay Nuclear Power Base joined hands with the Shenzhen Blue Ocean Conservation Association in a coastline garbage monitoring operation. Under the guidance of experts, quadrats and sample lines were drawn on the coastline and quadrat garbage was cleaned up. Furthermore, the collected garbage was systematically sorted, weighed, identified and counted, and the data recorded.

Case Making good use of the power of microorganisms to restore the water ecological environment

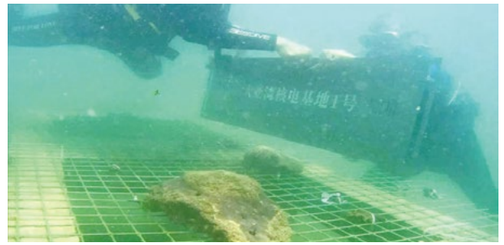
In 2017, the CGN-Weipu Bio-environmental Protection Lab was inaugurated in Beijing. Based on Weipu Resource Platform for Innovative Biological Research, we actively researched pressing ecological restoration issues such as the treatment of black and stinky polluted water. In 2018, the microbial treatment of black and stinky polluted water developed by the laboratory was officially and effectively applied to the demonstration river sections, enabling the green and efficient restoration of the ecological environment, and laying a solid foundation for the restoration of biodiversity in the waters.

Case Establishing the Coral Conservation Area at Daya Bay Nuclear Power Base, the first of its kind in China

On August 7, 2020, CGNPC's eighth "August 7 Public Open Experience Day" was held in the Daya Bay nuclear power base. With the theme of "Planting corals on the seabed and visiting the nuclear power plant through Internet", this Open Day activity created an industry precedent, and through an online live broadcast, the public witnessed the official unveiling of the coral conservation area of Daya Bay nuclear power base, the country's first coral conservation area in a nuclear power base.

Through platforms such as WeChat, Weibo and Tiktok, we publicly called on 40 coral conservation officers to adopt and name the first batch of broken coral branches that finished nursery cultivation. On the day of the event, as the chief coral conservation officer, the popular science expert Wang Yuheng dived down to the seabed to inaugurate the "Coral Conservation Area of Daya Bay Nuclear Power Base", and fixed a nameplate engraved with the information of 40 coral conservation officers next to the conservation nursery. In the future, we will access the video signal at the seabed, and live broadcast the coral growth to the coral conservation officers and friends who care about the natural ecology, and witness the growth of coral together.

Horned porus coral in Daya Bay



Chief coral conservation officer dived into the seabed and set up signs at the Coral Conservation Area of Daya Bay Nuclear Power Base

Case Compensating fishery ecological resources with stock enhancement and releasing

CGN's Zhejiang Daishan Offshore Wind Power Co., Ltd. carried out ecological compensation for the loss of fishery resources through enhancement and releasing, construction of artificial reefs, etc., to reduce the impact on fishery resources. On May 26, 2019, the Daishan No.4 Offshore Wind Power Project (phase I) organized the stock enhancement and releasing for ecological compensation in the Daishan waters of Zhoushan, where 500,000 tongue sole fries with a length of around five centimeters were released into the sea. By the end of 2020, in accordance with the plan for enhancement and releasing, no less than 100 million fries of tongue soles, large yellow croaker, black sea bream and jellyfish had been released in the waters near Daishan, which will increase the trophic level of commercial fish species in natural sea areas and optimize the fishery structure.

> I hope that the fishery compensation of CGN's Daishan No.4 Offshore Wind Power Project (phase I) will set an example for balancing development, utilization and ecological protection, and accumulate more repeatable, feasible, and promotable experience for other projects.
>
> ——Jiang Bo, investigator, Department of Resources and Environmental Protection, Bureau of Fisheries, Ministry of Agriculture and Rural Affairs, P. R. China

> Enhancement and releasing is an effective way to conserve aquatic organisms and improve the ecological environment of waters. It can not only restore resources and ecology, but also boost fishing, increase people's income and benefit future generations. I hope that this activity will strengthen the links between research institutes, enterprises and fishery administrative departments, so as to improve supporting measures, and enhance public awareness of protecting the marine environment and embracing nature.
>
> ——Wang Lumin, Deputy Director of East China Sea Fishery Research Institute of Chinese Academy of Fishery Sciences (CAFS)

CGN's Daishan No.4 Offshore Wind Power Project (phase I) released 500,000 tongue sole fries into the sea for ecological compensation in May, 2019.

In August 2020, an ecological compensation stocking activity was held for the offshore wind power project of CGN in Shengsi. Over 50,000 yellow drum and blackhead seabream were released into the sea of Si Jiao to take root and flourish.

Special Column Together, We Protect Biodiversity

Biodiversity provides the infrastructure to support life on earth and human development. To build a community with a shared future for all life on earth and realize harmonious coexistence between man and nature, we need to engage as many people as possible. Therefore we have mobilized extensively, and extend our biodiversity conservation actions to every stakeholder and every project, to produce a synergy for biodiversity conservation.

• Forming biodiversity partnership with various organizations at home and abroad

We work with governments, universities, and organizations at home and abroad to build a partnership network for biodiversity conservation, and facilitate international cooperation and exchanges on biodiversity.

Government	Research institutes	Domestic companies/ organizations	International organizations
• Ministry of Ecology and Environment, PRC • Ministry of Natural Resources, PRC	• Cambridge University • Tsinghua University • Peking University • South China Sea Institute of Oceanology of the Chinese Academy of Sciences	• GoldenBee ThinkTank • Shenzhen Mangrove Wetlands Conservation Foundation • Shenzhen Dapeng Coral Conservation Volunteer Association (Dive for Love) • Shenzhen Blue Ocean Environmental Conservation Association • Radiation Protection Association of Guangdong Province	• International Union for Conservation of Nature (IUCN) • UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) • OREE • Natural Capital Coalition

Case Co-launching ecological protection activities with non-profit organizations to safeguard the ecology

The Daya Bay Nuclear Power Base has long-term cooperation with non-profit organizations including Shenzhen Mangrove Wetlands Conservation Foundation, Shenzhen Dapeng Coral Conservation Volunteer Association (Dive for Love) to jointly protect the ecological environment. The Base regularly clears beach garbage with the Mangrove Wetlands Conservation Foundation, and jointly surveys the coral reef species in the underwater surrounding the nuclear power plant with Dive for Love. In 2019, the Base and Dive for Love jointly established the Coral Conservation Area which was upgraded to a coral conservation area in 2020, to jointly promote the marine ecological environment restoration and coral conservation near the Base.

Protecting biodiversity in all projects

Our business covers all over China, and extends to Asia, Europe, Oceania, South America, and Africa. We take various measures to protect biodiversity in the entire process of site selection, demonstration, construction, operation, and maintenance of each project to effectively protect the local ecology.

Case

Integrate ethnic characteristics and harmoniously blend with the environment

During the planning and implementation of the project, the Padingliangzi Wind Farm in Menghai County of Yunnan Province absorbed Dai culture of Xishuangbanna and blended harmoniously with the local natural environment. The wind farm was identified as a model unit of ecological conservation by the Yunnan Development and Reform Commission, and was selected by China Electricity Council as one of the “Excellent CSR Cases of Electric Power Companies in 2018”.

Case

Take advantage of innovation to restore the ecology of the watershed

CGN’s Hongda Environmental Technology Co., Ltd. combined the surface flow wetland technology and the river corridor wetland technology to build artificial wetlands along the Laowanfu River, to purify the water and restore the water ecology. The project was selected by China Electricity Council as one of the “Excellent CSR Cases of Electric Power Companies in 2018”.

Case

Emphasis on soil and water conservation to create an ecological civilisation project

Hubei XiaoganJiangjiashan Wind Farm’s “Windmill in the Flower Sea” environmental protection project. It improved and upgraded the environmental protection facilities, and planted vegetation on the wind turbine platform and slopes, achieving remarkable results. The project has won the honorary title of National Model Project for Soil and Water Conservation.

Promoting biodiversity knowledge to every stakeholder

We actively carry out various kinds of education activities on biodiversity protection for all stakeholders, and lead by example to raise stakeholders' awareness of biodiversity.

Achievements of CGN’s biodiversity awareness efforts

Report releasing

Issuing CSR reports for ten consecutive years since 2011

The *2019 Biodiversity Conservation Report of Daya Bay Nuclear Power Base* released in 2019, is the first report on biodiversity conservation in China’s nuclear power industry

Nuclear power on campus

Pilot teaching in Dapeng New District since 2014

Covering 208 schools with 110,000 students

NPC delegates' visit to nuclear power plants

Continuous visits since April 2013

More than 20,000 deputies received

AnnualOpen Day on August 7

Continuous campaigns since 2013

World Environment Day

Carrying out themed environmental protection activities such as "Drawing Lucid Waters and Lush Mountains", and "Inspecting the Water with the Chief of Daya Bay"

Stories of biodiversity protection, in the words of employees

Our employees work and live in a beautiful environment, enjoy nature, protect nature and record nature. The story of CGN’s harmonious embrace of employees and nature is being staged everyday.

> Daya Bay feels like a small forest. Here you can see many cattle egrets and fireflies which are rare to find elsewhere, and hear the sound of nightingales and scarabs. There are so many healthy coral clusters in the surrounding underwater. It’s great!
>
> —A nuclear power engineer of the Daya Bay Nuclear Power Base

> Every summer, we like to snorkel and swim in the Daya Bay. We love this sea and regularly clean its beach. The marine garbage monitoring operation is very meaningful, and we hope that more people will join us to protect this blue home.
>
> —An employee of Daya Bay Nuclear Power Base participating in beach garbage monitoring

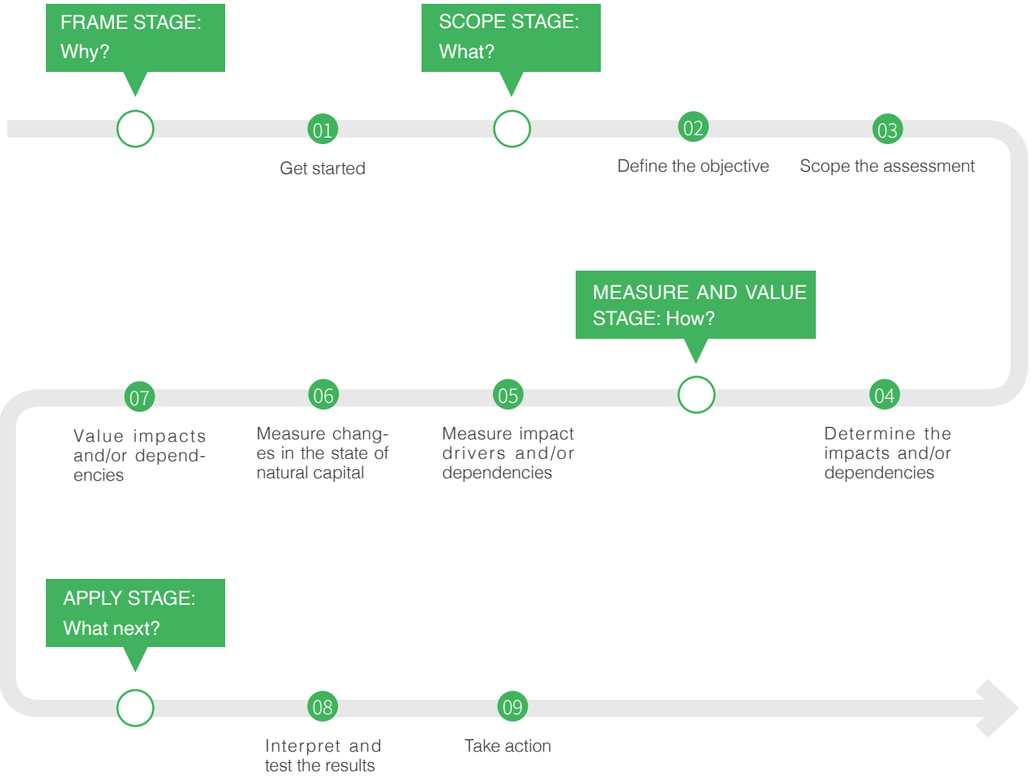
> At first, we were all surprised by the importance CGN attached to environmental protection in Husab. From the early stage of project construction, special surveys were carried out, and the site layout adjusted to protect the environment in biodiversity sensitive areas, and precious animals and plants were under special protection. After construction began, we tried every means to reduce the environmental impact, continued to carry out environmental testing, and released the results to the public. Now, protecting the environment has become a habit shared by all us workers.
>
> —Fanuel Mbambi, an employee of CGN’s Husab Uranium Mine

Natural Capital Assessment (NCA)

Natural capital is the flow of renewable and non-renewable natural resources that combine to produce benefits or “services” for people, and is the basis for all other capital. The increase in social, human and financial capital is obtained to a large extent through the development and use of natural capital. A natural capital assessment can help companies to identify potential risks, improve internal decision-making and build nature-based solutions to better address climate change and other environmental challenges.

In natural capital, biodiversity is an important part as a living component of the stock and as the basis for ecosystem services in flows, which influence the quantity, quality and resilience of the services provided by ecosystems. It can be used as a reference point to measure the quality and resilience of the natural capital stock. Hence, the presence of biodiversity is critical to maintaining the health and stability of natural capital.

Since the 1980s, the international community has tried to incorporate factors reflecting the sustainable development of society, such as the natural environment and natural resources, into the economic accounting system. In 1993, the United Nations issued the System of Integrated Environmental and Economic Accounting (SEEA), the first of its kind. Since then, the world has produced abundant theoretical methods for NCA. Based on previous research results, the Natural Capital Coalition (NCC) issued *the Natural Capital Protocol* in 2016, standardizing the NCA process which consists of four stages, nine steps and related operations, is feasible, science-based, a good source of reference and thus widely used. The NCA cases herein mainly adopt this assessment framework.



The assessment framework of the *Natural Capital Protocol* is divided into four major stages: “frame”, “scope”, “measure and value”, and “apply”, which respectively address “why” and “what”, “how” and “what next”, forming a standardized NCA process. The “frame” stage is mainly to determine the project implementation process based on background information. The “scope” stage includes the determination of the objective, scope, impacts and dependencies, determining the research object for subsequent measurement and valuation. The “measure and value” stage is the core of NCA, including the measurement of impact drivers and dependencies, changes in the state of natural capital, and the valuation of corresponding values. The “apply” stage mainly verifies and interprets the results, and proposes future action plans.

Daya Bay Nuclear Power Base in Guangdong Province: Natural Capital Assessment

A Glance At Daya Bay Nuclear Power Base

Daya Bay Nuclear Power Base is located on the scenic Dapeng Peninsula of Shenzhen City, Guangdong Province, with a straight-line distance of about 45km from the central area of Shenzhen in the west and 50km from the central area of Hong Kong to the southwest. It is home to six Gigawatt-level units operating at Daya Bay Nuclear Power Plant, Ling Ao Nuclear Power Plant Phase I (LANPP Phase I) and Ling Ao Nuclear Power Plant Phase II (LANPP Phase II). As of the end of 2020,, the Base has achieved a cumulative on-grid power generation of 800.506 TWh. Our natural capital assessment is carried out around these 6 units from the construction period to the end of 2019.

The Daya Bay Nuclear Power Base has a land area of 10 km^2 and a winding coastline of 11 km. The western Daya Bay where it is located has a typical subtropical climate and boasts superior natural conditions and diverse species, making it a habitat of considerable marine life. There are 11 natural villages within 5 km of the Base, and the permanent population was estimated to be about 2,560 according to statistics in 2017. Local villagers are mainly engaged in tourism, fishery, and so on.

A bird's view of Daya Bay Nuclear Power Base

Our Relationship With Nature

The production and operation of Daya Bay Nuclear Power Base as well as the upstream and downstream of the nuclear power industry chain have different impacts and/or dependencies on natural capital. Through relevant research and analysis of actual operation of the Base, we have established material topics under the three elements of the Daya Bay Nuclear Power Base's activities on natural capital level, including the impacts on the Base, the impacts on society, and the dependencies of the Base on natural capital. These are material impacts and/or dependencies of Daya Bay Nuclear Power Base.

Components	Potentially material impacts and dependencies
Impacts on the Base	• Environmental compliance costs • Extreme weather • Green and low-carbon operation • Clean energy power
Impacts on society	• Radioactive waste discharge • Discharge of gaseous radioactive waste • Discharge of liquid radioactive waste • Non-radioactive waste discharge • Non-radioactive waste water discharge • Non-radioactive exhaust discharge • Gas regulation • Freshwater resources • Ocean disturbances • Major public security incident • Noise interference • Community well-being • Popular science education
Dependencies on natural capital	• Access to mineral resources • Utilization of land resources • Utilization of freshwater resources • Utilization of seawater resources • Utilization of fossil energy • Climate regulation • Supply of nutrition materials

Potentially material natural capital impacts and dependencies on natural capital

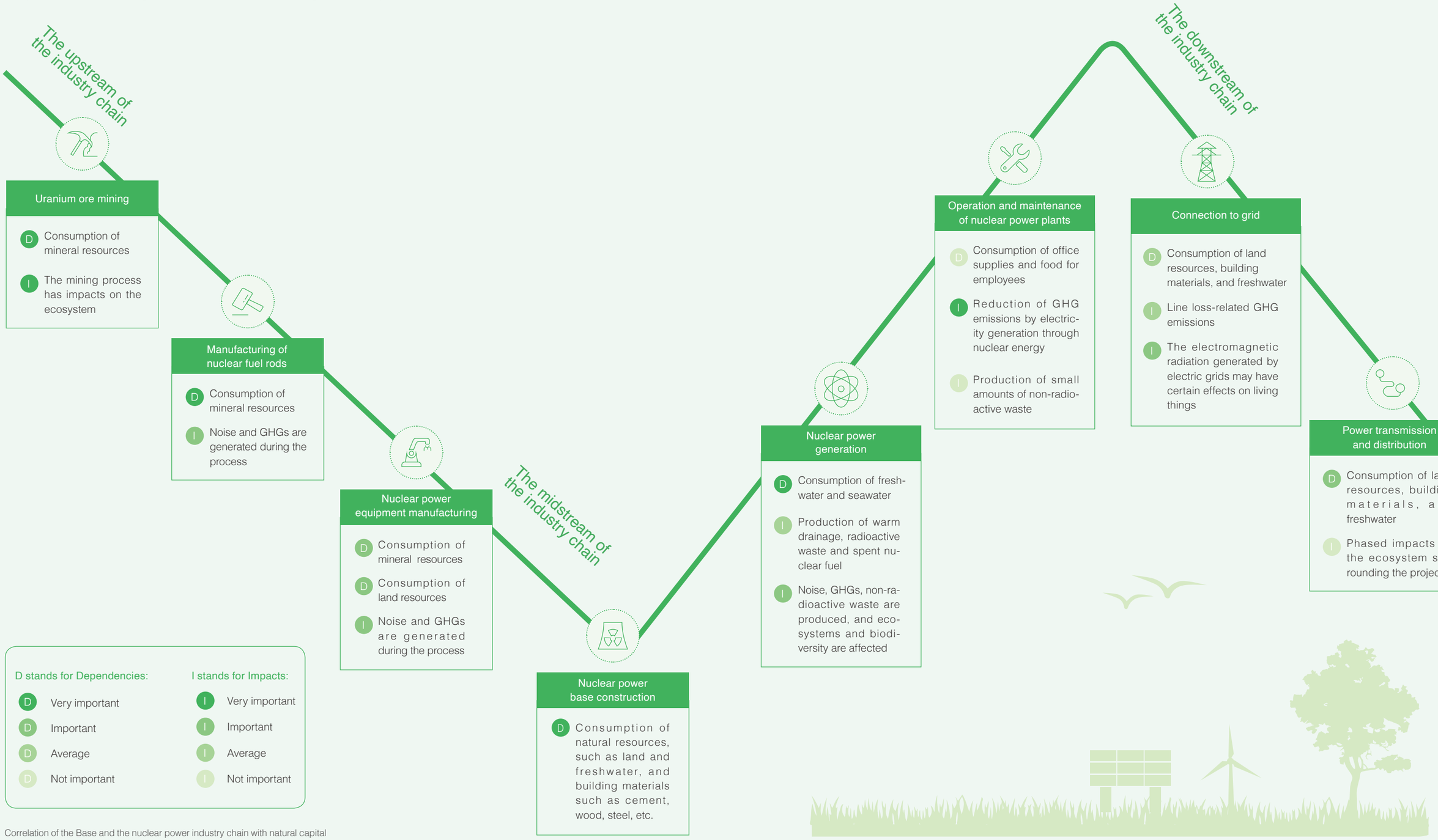
What is natural capital impact?

Natural capital impact refers to the negative or positive impact of corporate activities on natural capital.

What is natural capital dependence?

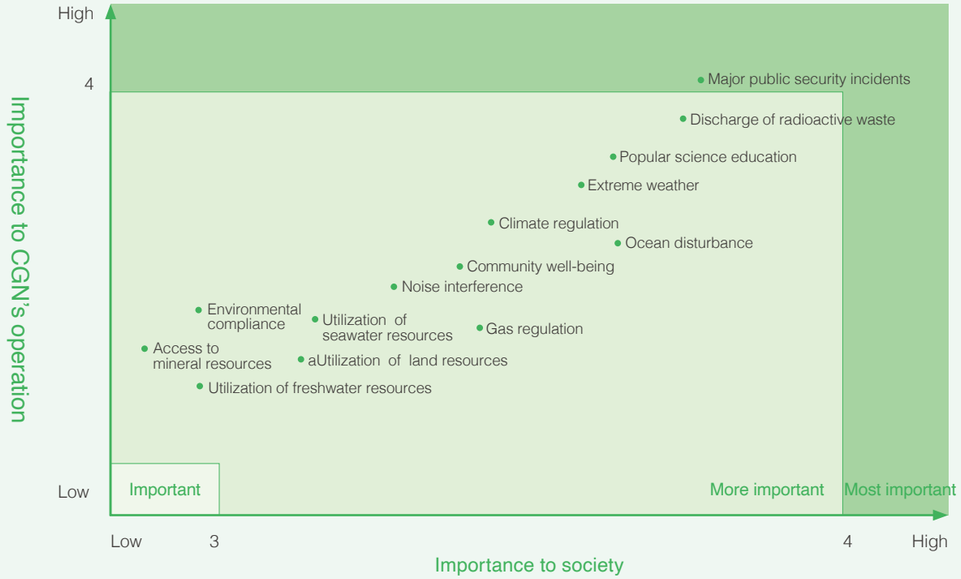
Natural capital dependence refers to the dependence or use of natural capital by enterprises.

The assessment and classification of the impacts and/or dependencies of the Base as well as every stages of the upstream and downstream of the nuclear power industry on natural capital was carried out stages four dimensions of corporate operations, compliance with laws and regulations, reputation and brand image, and society.



Correlation of the Base and the nuclear power industry chain with natural capital

To analyze the materiality of impacts and/or dependencies, we conducted an analysis on stakeholders. 10 types of stakeholders were invited to score 17 potentially material impacts and/or dependencies, and a total of 187 valid questionnaires were collected. Based on this, we developed a matrix of material impacts and/or dependencies for the natural capital accounting of the Base.



Matrix of substantial topics

The green Daya Bay Nuclear Power Base

Measure Our Footprints On Nature

We measure and value the impacts and/or dependencies of the Base on natural capital during its construction and operation periods (1994 to 2019). The result shows a clearer, quantifiable, and comparable environmental footprints of the Base and guides us to further improve our ecological footprint management.

The material impacts and/or dependencies of the Base on natural capital are mainly reflected on:

Impacts on the Base itself

- Environmental compliance
- Disaster prevention and management
- Energy-saving technological transformation, etc.

Impacts on society

- Response to climate change
- Radioactive waste management (including solid, gaseous, and liquid radioactive waste)
- Noise interference
- Community well-being
- Popular science education, etc.

Dependencies on natural capital

- Utilization of resources

  (including utilization of minerals, land, fresh water, sea water, etc.)

We applied qualitative, quantitative and monetary accounting methods to assess the degrees of impacts and/or dependencies of the Base on the above three elements.

Impacts on Daya Bay Nuclear Power Base

Environmental compliance | Monetary valuation | Market and financial prices

- Our action:

  Daya Bay Nuclear Power Base strictly abides by national laws, regulations and standards on environmental protection, applies for environmental protection-related permits in accordance with national regulations, and assesses environmental impacts before the nuclear power project is approved. The Base moves spent nuclear fuel to designated sites for intensive disposal in accordance with national regulations.

- Evaluation result:

  From 2011 to 2019, Daya Bay Nuclear Power Base spent a total of RMB 355.7212 million on environmental protection; from 1994 to 2019, the nuclear power base produced a total of 2,436 tons of spent nuclear fuel, costing a total expenditure of RMB 11.9730621 billion for corresponding treatment.

Extreme weather

Monetary valuation Market and financial prices

- Our action:

  The design work of the nuclear power base took into full consideration of various possible natural disasters, and complied a comprehensive safety analysis report. To enhance its resistance to natural disasters, such as typhoons, rainstorms, and earthquakes, the nuclear power base has built wave walls that are 8 to 17 meters high, and also cooperates with meteorological agencies to give early warnings on extreme weather conditions, and regularly conducts emergency drills to enhance disaster preparedness.

- Evaluation result:

  From 1994 to 2019, Daya Bay Nuclear Power Base invested a total of RMB 3.9042931 billion in the prevention and control of natural disasters, including RMB 1.6116 million in getting access to meteorological information, RMB 676.3639 million in insurances against natural disasters, RMB 2.875548 billion in disaster prevention facilities, such as wave walls, and RMB 350.7696 million in other aspects related to disaster prevention and mitigation.

Green and low-carbon operation

Monetary valuation Market and financial prices

- Our action:

  In accordance with national environmental protection standards, Daya Bay Nuclear Power Base carries out technological transformations for energy conservation and emission reduction, and keeps reducing negative operation impacts on the environment.

- Evaluation result:

  From 1994 to 2019, a total of RMB 3.5046 million was invested in technological transformations for energy conservation and emission reduction.

Clean energy-based power generation

Quantitative evaluation

- Our action:

  The development of nuclear power provides the society with safe, economical and clean electricity, and effectively avoids the GHG emissions generated by thermal power.

- Evaluation result:

  From 1994 to 2019, the total amount of electricity generated by Daya Bay Nuclear Power Base is 755.192 TWh.

Daya Bay underwater world

Cattle Egret in Daya Bay Nuclear Power Base

Impacts on society

Radioactive waste (including solid, gaseous, and liquid radioactive waste)

Quantitative evaluation

- Our action:

  We strictly manage and dispose radioactive waste to ensure that the radioactive dose generated by it has negligible impact on human health.

- Evaluation result:

  From 1994 to 2019, the total amount of radioactive solid waste, liquid radioactive waste, and gaseous radioactive waste generated by Daya Bay Nuclear Power Base are respectively 6,289.65 m^3, 2,310.7TBq, and 463.5TBq, all of which are far below the national limits.

Response to climate change

Monetary valuation Price transfer approach

- Our action:

  The vegetation we planted fixed 596,012.26 tons of carbon, and clean energy-based power generation reduced the amount of CO_2 emissions by 637.3819 billion tons.

- Evaluation result:

  Vegetation helped creating RMB 433.301 million of value by fixing carbon and RMB 463.37666 billion of value by reducing CO_2 emissions.

Sea disturbances

Qualitative evaluation

- Our Action:

  We closely monitored the water quality and biodiversity of the waters around Daya Bay, and commissioned professional organizations to conduct full-scale ocean survey activities in 1983, 2013, and 2016.

- Evaluation result:

  In 2016, total number of phytoplankton species and zooplankton species increased by 105 and 113 respectively compared with 1983. There are abundant biological species in Daya Bay, and there is no abnormality in the evenness index and biodiversity index. The warm drain-off water and low-level radioactive waste discharged from the power base in compliance with regulations have not polluted the surrounding seas or caused obvious negative effects on the indicator species.

Major public security incidents

Qualitative evaluation

- Our action:

  The Daya Bay Nuclear Power Base has conducted a rigorous and reliable feasibility analysis during the entire construction and operation cycle, clarified the baseline risks of each unit, and formed a detailed and thorough nuclear safety management system, as well as a complete safety incident feedback and analysis mechanism. Strictly implement the management of major public safety incidents and the risk control system in the entire process of production management, safety supervision, operation and R&D.

- Evaluation result:

  Ensure that the core-damage-probability (CDP) of each generating unit is lower than 1/10,000 reactor-year. Generating units have quite low probability of damage. Since Daya Bay Nuclear Power Base was put into operation, no operation events of Level 1 or above occurred at Daya Bay Nuclear Power Base.

Noise disturbances

Monetary valuation Market and financial prices

- Our action:

  The Daya Bay Nuclear Power Base has adopted many measures to reduce the impact of noise on the health of employees, including formulating occupational health and safety management measures, strengthening noise monitoring and defense measures, regular physical examinations, and strengthening publicity and training. From 1994-2019, the Daya Bay Nuclear Power Base has invest a total of 167.422 million in labor protection.

- Evaluation result:

  From 2015 to 2019, according to the annual physical examination for employees of Daya Bay Nuclear Power Base, the binaural average hearing threshold abnormality was respectively 16.0%, 15.5%, 15.4%,15.1%, and 13.9%, and the binaural high-frequency average hearing threshold (≥40dBHL) abnor was respectively 6.1%,5.7%,5.1%,5.4%,4.9%, both showing a steady downtrend year by year. Currently, no noise-related occupational diseases have been found among employees at the Daya Bay Nuclear Power Base.

Community well-being

Monetary valuation Replacement cost approach

- Our action:

  Upholding the principle to coexist with surrounding communities “safely, friendly, and warmly,” Daya Bay Nuclear Power Base, over the past 20 years or so, has coexisted harmoniously, friendly, and safely with surrounding communities. Through multi-dimensional actions such as supporting the construction of infrastructure projects, creating a livable environment, education and medical assistance, and promoting industrial development, we effectively improve the well-being of the community.

- Evaluation result:

  By afforestation and environmental protection, we created RMB 8.84 million of benefits to surrounding communities.

Popular science tours

Monetary valuation Travel cost approach

- Our action:

  Daya Bay Nuclear Power Base has received about 2,541 batches of 76,303 people from various types of tourists, including deputies to the National People’s Congress and elementary and middle school students.

- Evaluation result:

  Value of popular science tours reaches RMB 1.526 million.

Dependencies on natural capital

Mineral resources

Monetary valuation Market and financial prices

- The nuclear power base has consumed a total of 2,870 tons of nuclear fuel, and the total cost is RMB 21.343105 billion.

Land resources

Monetary valuation Market and financial prices

- Daya Bay Nuclear Power Base covers an area of 11.05 km^2. Since the Base was founded in 1994 to 2019, it has spent RMB 694.2134 on leasing and transferring land and construction projects.

Freshwater resources

Monetary valuation Market and financial prices

- Daya Bay Nuclear Power Base has built up three reservoirs to provide water. The total amount of freshwater consumed from 1994 to 2019 was 17,182,350 tons. The value of freshwater resources on which the Base depends is about RMB 167.1843 million.

Seawater resources

Qualitative valuation

- Daya Bay Nuclear Power Base has placed five sets of seawater monitoring buoys in the surrounding waters to conduct daily monitoring of seawater quality and continuous online monitoring of the pH value and the levels of dissolved oxygen and chlorophyll. By monitoring the impacts of changes in the marine ecology on work safety of power plants, such as the utilization of seawater, power plants can take corresponding measures.

Climate regulation

Qualitative valuation

- To guarantee safe operation, the Base carries out continuous weather monitoring, and has established a natural disaster early-warning mechanism. In recent years, the number of typhoons around Daya Bay has been basically flat. Although the frequency of severe convective weather events, such as thunderstorms, is relatively high in the local area, with the support of accurate and timely weather forecasts and a comprehensive disaster management and prevention system, these extreme weathers have not had a substantial impact on the safety of the nuclear power plant.

Evaluate Natural Value Creation Capability

The cost/benefit to the enterprise and the cost/benefit to society are the comprehensive value of business activities.

The comprehensive value analysis of the Daya Bay Nuclear Power Base found that activities of Daya Bay Nuclear Power Base generated RMB 38.441317 billion of corporate costs and RMB 200,000 of corporate benefits, RMB 496.3045 million of social costs and RMB 463.424076 of social benefits.

The social benefits far outweigh the sum of social costs and corporate costs. This indicates that Daya Bay Nuclear Power Base has achieved remarkable results in biodiversity management and protection.

Resource utilization

Indicator	Corporate Costs (RMB 10,000)	Corporate Benefits (RMB 10,000)	Social Costs (RMB 10,000)	Social Benefits (RMB 10,000)
Mineral Resources	2,134,310.05	—	—	—
Land Resources	69,421.34	—	—	—
Fresh Water	—	—	16,718.43	—
Total	2,203,731.39	—	16,718.43	—

Business operation requires natural resources. such as mineral resources, land, fresh water and seawater, incurring RMB 22.04 billion of corporate costs and RMB 170 million social costs.

Mineral resources are non-renewable resources and are also the irreplaceable raw materials to produce nuclear power. If CGN fails to obtain mineral resources required for nuclear power production in a sustainable way, such as Uranium 235 and precious metals, it may face continuous increases in raw material cost caused by reserve shortage.

Response to climate change

Indicator	Corporate Costs (RMB 10,000)	Corporate Benefits (RMB 10,000)	Social Costs (RMB 10,000)	Social Benefits (RMB 10,000)
Carbon fixation	—	—	—	43,330.1
Reduced amount of carbon emissions by clean energy-based power generation	—	—	—	46,337,666
Total	—	—	—	46,380,996.1

Compared with thermal power generation, clean-energy nuclear power generation can reduce GHG emissions by 637,381,900 tons. At the same time, the vegetation in Daya Bay Nuclear Power Base contributes a certain amount of CO_2 fixation. On the whole, the social benefits brought about by climate actions is significant, reaching RMB 463.81 billion.

Environmental compliance, disaster prevention, and energy-saving technological transformation

Indicator	Corporate Costs (RMB 10,000)	Corporate Benefits (RMB 10,000)	Social Costs (RMB 10,000)	Social Benefits (RMB 10,000)
Total investment in environmental protection	35,572.12	—	—	—
Government's rewards and subsidies for environmental protection	—	20	—	—
Investment in disaster prevention and management	390,429.32	—	—	—
Total	426,001.44	20	—	—

Daya Bay Nuclear Power Base inputs more attention to investments in disaster prevention and management, environmental compliance and energy-saving technological transformation. The huge corporate cost reaches RMB 4.26 billion.

Radioactive waste management

Indicator	Corporate Costs (RMB 10,000)	Corporate Benefits (RMB 10,000)	Social Costs (RMB 10,000)	Social Benefits (RMB 10,000)
Radioactive waste management	—	—	Low	—
Treatment of spent nuclear fuel	1,197,306.2	—	—	—
Total	1,197,306.2	—	—	—

Daya Bay Nuclear Power Base has invested a total of RMB 11.97 billion in radioactive waste management. The Base has established and implemented a stringent mechanism for radioactive waste disposal. As international advanced technology and standards are adopted to control and dispose of radioactive waste, the radioactive waste discharge is far below the nationally permitted discharge standard. It can be considered that the corporate cost of waste management is much higher than its social cost.

- Community well-being and popular science education

Indicator	Corporate Costs (RMB 10,000)	Corporate Benefits (RMB 10,000)	Social Costs (RMB 10,000)	Social Benefits (RMB 10,000)
Community afforestation	—	—	—	884
Popular science education	—	—	—	152.6
Total	—	—	—	1,036.6

Daya Bay Nuclear Power Base increases natural capital through afforestation, forest protection, popular science tourism and other measures, creating environmental benefits of RMB 10.366 million to society.

- Noise disturbance

Indicator	Corporate Costs (RMB 10,000)	Corporate Benefits (RMB 10,000)	Social Costs (RMB 10,000)	Social Benefits (RMB 10,000)
Noise disturbance	16,742.2	—	Low	—
Total	16,742.2	—	—	—

Daya Bay Nuclear Power Base has invested around RMB 170 million in employee labor insurances to reduce the impact of noise disturbance on employees' health. The results of staff physical examinations in the past five years show that the abnormal rate of the average binaural hearing threshold experiences a steady decrease, and that there is no occurrence of noise-related occupational diseases among employees. Thus, the social cost incurred is negligible.

Cost-benefit analysis of material impacts and dependencies

Material Topics	Corporate Costs	Corporate Benefits	Social Costs	Social Benefits
Resource utilization	●		●	
Response to climate change				●
Radioactive waste management	●			
Noise disturbanWce	●			
Community well-being and popular science education				●
Environmental compliance, Disaster prevention, and energy-saving technological transformation	●	●		
Total	●	●	●	●

Costs	● Very large	● Large	● Minor	Negligible/none
Benefits	● Very large	● Large	● minor	Negligible/none

Outlook 2030

The results show that the practice of Daya Bay Nuclear Power Base to use natural resources in a sustainable manner and serve production and living with clean energy not only aids the fight against climate change and protects the ecological environment, but also effectively improves the well-being of surrounding residents.

In the future, Daya Bay Nuclear Power Base will strive to increase its positive impacts and reduce negative impacts on nature, and take actions to contribute to the realization of the SDGs.

3 GOOD HEALTH AND WELL-BEING	• Substantially supporting education, medical service, and infrastructure construction of surrounding communities, and promoting industrial upgrade and transformation and income increase of residents living nearby • Substantially supporting education, medical service, and infrastructure construction of surrounding communities, and promoting industrial upgrade and transformation and income increase of residents living nearby
7 AFFORDABLE AND CLEAN ENERGY	• Leveraging technological innovation to further reduce the cost of clean-energy nuclear power generation and ensure stable power production and supply for social use
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	• Integrating the concept of biodiversity CGN's sustainable development strategy, and formulating biodiversity strategy targets and management indicators
12 RESPONSIBLE CONSUMPTION AND PRODUCTION	• Promoting energy-saving technological transformation to increase the utilization rate of nuclear fuel and the recycling rate of water resources
13 CLIMATE ACTION	• Adhering to green power generation and reducing CO_2 emissions • Building a green and sustainable supply chain and driving upstream and downstream partners in the industrial chain to pursue green and low-carbon development
14 LIFE BELOW WATER	• Establishing a regular monitoring and protection mechanism for marine biodiversity
15 LIFE ON LAND	• Establishing a regular monitoring and protection mechanism for marine biodiversity
17 PARTNERSHIPS FOR THE GOALS	• Establishing biodiversity conservation partnerships and promoting multi-party participation and collaboration • Strengthening communication with stakeholders, establishing a method for normalized communication, understanding the expectations of stakeholders, and sharing the progress and outcomes of biodiversity conservation

Modou Mountain Wind Farm in Yunnan Province: Natural Capital Assessment

A Glimpse Of Modou Mountain Wind Farm

Modou Mountain Wind Farm is located at the junction of Huaning County and Jiangchuan District, Yuxi City of Yunnan Province, and it is administered by Huaning County. The wind farm sits on Modou Mountain, the highest peak of Huaning County, with an elevation of 2,663 meters, and adjoins Fuxian Lake, China's largest plateau deep-water lake. Occupying an area of about 18.2 km^2, Modou Mountain Wind Farm has a capacity of 48MW. It is equipped with 24 2MW wind turbine generator sets and one 110kV booster station. It connects to Jiangchuan 220kV Transformer Substation.

The wind farm generate 110,350 MWh of on-grid electricity annually. The average annual on-grid power generation per generating unit is 4,598 MWh, and the operation hours at full load each year is 2,299h. The wind farm was completed in 12 months. The static investment totals RMB 441.7011 million.

Geographical location and scope of Modou Mountain Wind Farm (located at the junction of Huaning County and Jiangchuan District of Yuxi City, Yunnan Province)

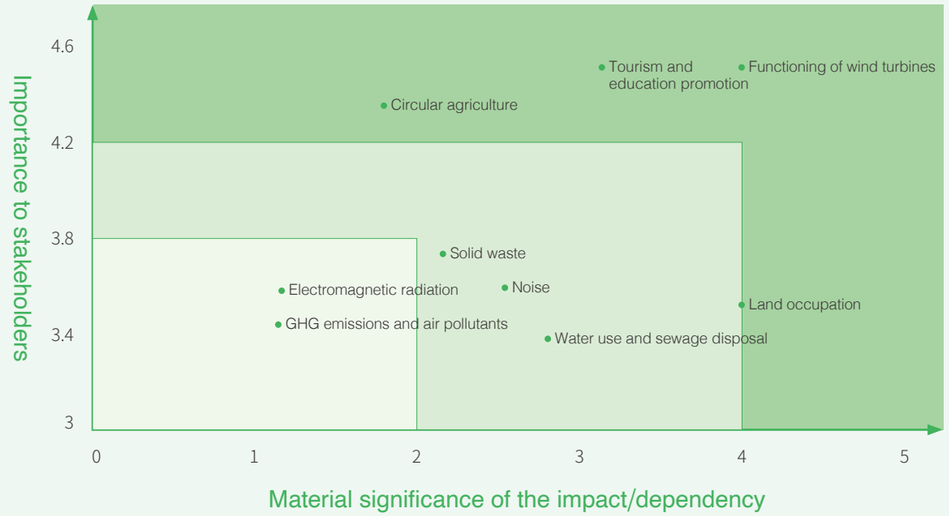
The project started construction on October 16, 2012, and was put into operation in December 2013. It passed water conservation and environmental protection inspections successively, and received the acceptance letters respectively on December 6 and 8, 2014, becoming the first wind farm passing the two inspections.

The project was honored "Education Base for Energy Science Popularization" by China Energy Research Society on November 7, 2018, becoming China's largest new energy science education and popularization base. Yunnan Modou Mountain New Energy Science Education and Popularization Base was branded "Electric Power Science Education & Popularization Base of 2019" on November 13, 2019.

Our Relationship With Nature

The construction and operation of Modou Mountain Wind Farm's dependencies on natural capital are shown mainly by utilization of land and wind resources, and its impacts on natural capital include discharges of pollutants, GHG emissions, electromagnetic radiation, noise, and human activities, among which human activities are further divided into land occupation, solid waste transportation, tourism, grazing in surrounding pastures, etc.

By analyzing the sources and materiality of such dependencies and impacts, we identify material dependencies and impacts from the nine aspects of land occupation, functioning of wind turbines, GHG emissions and air pollutants, water use and sewage disposal, solid waste, noise, electromagnetic radiation, tourism and education promotion, and circular agriculture. The assessment of this case is carried out around these nine units.



Matrix of substantial topics

Panorama of Modou Mountain Wind Farm

Measure Our Footprints On Nature

We apply framework processes and methodology from the *Natural Capital Protocol* to measure and assess the dependencies and impacts of Modou Mountain Wind Farm on natural capital during its construction and operation (2012-2019). Based on the analysis of the nine aspects of materiality and the preliminary result of the monetary valuation, we have combined topics involving little sums of money and with slight dependencies and impacts on natural capital, and finalized the 7 aspects through qualitative, quantitative, and monetary approaches. The report shows the wind farm's impacts and dependencies on nature and analyzes its footprint on nature during operation.

Power generation through wind turbines

Monetary valuation Market and financial prices Price transfer approach

- Our action:

  From its operation in 2014 to the end of 2019, Modou Mountain Wind Farm had relied on wind resources to generate power of 680 million kWh, thereby gaining RMB 409.1487 million in revenue from power generation.

- Evaluation result:

  Clean energy power generation is equivalent to obtaining wind resources of RMB 409,1487 million, reducing SO_2, NO_X, and smoke emissions of RMB 7.4389 million, reducing consumption of coal and water of RMB 68.0419 million.

GHG emissions

Monetary valuation Price transfer approach

- Our action:

  Modou Mountain Wind Farm has established systematic environmental management measures and implemented strictly, rationally arranged transportation routes, and used motor vehicles that meet the national five standard to ensure that discharges of pollutants meet related standards.

- Evaluation result:

  Construction and operation activities caused a loss of RMB 3,800 in GHG emissions. Clean energy-based power generation has reduced CO_2 emissions by 364,611.44 tons and created RMB 293.333 million of benefits through reduced GHG emissions.

Discharges of air pollutants

Monetary valuationx Price transfer approach

- Our action:

  Modou Mountain Wind Farm adopts standardized engineering management, strictly controls the generation of dust, and takes necessary measures to reduce the negative impacts of dust and smoke on nearby residents and the environment.

- Evaluation result:

  Modou Mountain Wind Farm has generated RMB 400 of costs through NO_X emissions.

Water resources

Monetary valuation Price transfer approach

- Our action:

  Water consumption of Modou Mountain Wind Farm is mainly contributed by domestic water, water for cooling wind turbines, water in the fish ponds in farms of circular agriculture, and irrigation water. We constructed sewage treatment facilities to treat domestic sewage, so as to avoid sewage from polluting underground water and affecting the quality of soil and water near the wind farm.

- Evaluation result:

  Modou Mountain Wind Farm has generated RMB 7,000 of social benefits through the synthesis of chemical fertilizers, and RMB 12,100 of social costs through water consumption.

Solid waste

Monetary valuation Market and financial prices Price transfer approach

- Our action:

  Modou Mountain Wind Farm disposes of oily waste, such as waste oil drums and waste oily gloves, and domestic waste produced by tourists, and carry out waste compliant transfer and landfill.

- Evaluation result:

  During the construction and operation, Modou Mountain Wind Farm spent a total of RMB 24,800 on landfill, RMB 79,600 on transporting waste, and RMB 238,800 on collecting waste produced by tourists.

Ecosystem services

Monetary valuation Market and financial prices Price transfer approach

- Our action:

  Modou Mountain Wind Farm takes such measures as replanting trees, restore the vegetation, and growing flowering plants to restore the ecosystem and expand green areas. It helps make up for the loss in the value of the ecosystem caused by use of land resources, improve the landscape of the plant area, and protect species and their habitats.

- Evaluation result:

  Modou Mountain Wind Farm has generated RMB 1.1282 million of corporate costs by paying forest and vegetation restoration fees to the government and RMB 20.9197 million by restoring vegetation. It also caused a loss of RMB 14.9324 million in ecosystem services, including regulating water volume, improving water quality, fixing soil, maintaining land fertility, improving the atmosphere environment.

Tourism and education promotion

Monetary valuation Travel cost approach Price transfer approach

- Our action:

  Modou Mountain Wind Farm has built viewing platforms, gallery roads, and other facilities to make it more convenient for tourists to travel and improve the value of the wind farm's landscape. In 2018, the wind farm built the popular science museum to provide the public with ecological civilization and green development science education activities, thus helping eliminate the NIMBY (Not In My Back Yard) mentality of the public.

- Evaluation result:

  Modou Mountain Wind Farm has created RMB 1.0204 million of social value through tourism and RMB 336,600 of social value through popular science education.

Evaluate Natural Value Creation Capability

The comprehensive value analysis of the Modou Mountain Wind Farm found that it increased the value by RMB 773.9396 million from 2012 to 2019. Total corporate benefits and costs caused by natural capital changes reached RMB 409.1487 million and RMB 22.7713 million respectively; total social benefits and costs caused by natural capital changes reach RMB 402.5357 million and RMB 14.9735 respectively. Both the enterprise and society benefited from natural capital changes, indicating that Modou Mountain Wind Farm has achieved remarkable outcomes in biodiversity management and protection.

Power generation through wind turbines

Indicator	Corporate Costs (RMB 10,000)	Corporate Benefits (RMB 10,000)	Social Costs (RMB 10,000)	Social Benefits (RMB 10,000)
Revenue from power generation	—	40,914.87	—	—
Reduced coal consumption	—	—	—	3,122.97
Total	—	40,914.87	—	3,122.97

Modou Mountain Wind Farm generates electricity by consuming wind resources, which had generated corporate benefits of RMB 409.1487 million. Under the circumstance where the total power consumption of the entire society remains unchanged, the increase in wind power generation reduces thermal power generation, reducing 62,431.8 tons of standard coal consumption and generating social benefits of RMB 31.2297 million.

GHG emissions

Indicator	Corporate Costs (RMB 10,000)	Corporate Benefits (RMB 10,000)	Social Costs (RMB 10,000)	Social Benefits (RMB 10,000)
GHG emission reduction	—	—	—	29,333.30
Total	—	—	—	29,333.30

Compared with traditional fossil energy, wind power is a green and pollution-free new energy technology, which does not produce carbon dioxide and other greenhouse gases. Modou Mountain Wind Farm uses wind power to reduce GHG emissions (364,611.44 tons of carbon dioxide emissions) and generates social benefit of RMB 293.333 million.

Discharges of air pollutants

Indicator	Secondary Indicator		Corporate Costs (RMB 10,000)	Corporate Benefits (RMB 10,000)	Social Costs (RMB 10,000)	Social Benefits (RMB 10,000)
Reduced discharges of air pollutants	Reduced emissions	SO_2	—	—	—	105.00
	Reduced emissions	NO_X	—	—	—	638.04
	Reduced discharges of smoke		—	—	—	0.85
Discharges of air pollutants			—	—	0.41	—
Total			—	—	0.41	743.89

Replacing thermal power generation and other power generation methods, wind power generation reduces discharges of air pollutants such as SO_2, NO_x, and smoke. Modou Mountain Wind Farm reduces 399.62 tons of SO_2 emissions, 399.62 tons of NO_x emissions, and 64.13 tons of smoke discharges, and produces social benefit of RMB 7.4389 million. At the same time, the fugitive dust generated during wind farm construction and exhaust emissions of transportation vehicles generated during construction and operation may worsen air quality. The discharges of air pollutants cause a total social cost of RMB 4,100.

Water resources

Indicator	Secondary Indicator	Corporate Costs (RMB 10,000)	Corporate Benefits (RMB 10,000)	Social Costs (RMB 10,000)	Social Benefits (RMB 10,000)
Water resource conservation		—	—	—	6,804.19
Sewage treatment	Sewage treatment facility construction and repair expenses	40.49	—	—	—
	Benefits of sewage treatment	—	—	—	0.70
Water consumption		—	—	1.21	—
Total		40.49	—	1.21	6,804.89

Wind power generation also reduces the consumption of water resources. Modou Mountain Wind Farm reduces water resource consumption by 6,325,777.3 m^3, resulting in social benefit of RMB 68.0419 million. In order to avoid sewage discharge to nearby farmland and lakes, Modou Mountain Wind Farm has borne the sewage treatment facility construction cost of RMB 404,900, and converted sewage into nitrogen fertilizer and phosphate fertilizer, generating social benefit of RMB 7,000. Besides, Modou Mountain Wind Farm consumes water resources for employees' domestic use, turbine cooling, water supply for fish ponds and irrigation for circular agricultural parks, incurring social cost of RMB 12,100.

Solid waste

Indicator	Corporate Costs (RMB 10,000)	Corporate Benefits (RMB 10,000)	Social Costs (RMB 10,000)	Social Benefits (RMB 10,000)
Solid waste transportation and landfilling	31.84	—	2.48	—
Total	31.84	—	2.48	—

Modou Mountain Wind Farm discharges a certain amount of solid waste during operation, and some tourists may also leave solid waste after mountain climbing, affecting the landscape and ecological environment. Modou Mountain Wind Farm has funded regular cleanups to provide tourists with a pleasant natural landscape, incurring corporate cost of RMB 318,400 and social cost of RMB 24,800.

Solid waste produced by tourists and the sewage treatment station within the wind farm

Ecosystem services

Indicator	Secondary Indicator	Corporate Costs (RMB 10,000)	Corporate Benefits (RMB 10,000)	Social Costs (RMB 10,000)	Social Benefits (RMB 10,000)
Vegetation restoration	Forest and vegetation restoration fees	112.82	—	—	112.82
	Corporate vegetation restoration costs	2,091.97	—	—	—
Ecosystem Service Value Loss	Costs generated by water volume regulation	—	—	857.45	—
	Costs generated by water quality improvement	—	—	43.32	—
	Costs generated by soil consolidation	—	—	161.16	—
	Costs generated by maintaining soil fertility	—	—	298.25	—
	Costs generated by carbon fixation	—	—	3.86	—
	Costs generated by oxygen release	—	—	103.61	—
	Costs generated by atmosphere purification	—	—	25.59	—
	Total	2,204.79	—	1,493.24	112.82

Modou Mountain Wind Farm temporarily or permanently occupies part of forest land and grassland during construction, causing partial loss of ecosystem services, incurring social cost of RMB 14.9325 million. Modou Mountain Wind Farm spends RMB 22.048 million on afforestation and landscaping, and also takes measures to restore vegetation. Modou Mountain Wind Farm pays forest vegetation restoration fees of RMB 1.1282 million to the government, which equals to generating social benefit.

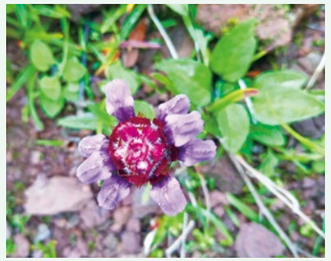


Representative animals of Modou Mountain Wind Farm (from left to right) : Crested bulbul, red-billed leiothioi and red-bellies squirrel

Tourism and education promotion

Indicator	Corporate Costs (RMB 10,000)	Corporate Benefits (RMB 10,000)	Social Costs (RMB 10,000)	Social Benefits (RMB 10,000)
Tourism	—	—	—	102.04
Popular science education	—	—	—	33.66
Total	—	—	—	135.70

Modou Mountain Wind Farm has built viewing platforms, plank roads and other facilities for tourists. With these sightseeing facilities, tourists enjoy greater convenience. Moreover, the camellia forest is better protected and the natural habitat is reserved for some bird species. Modou Mountain Wind Farm conducts transparent operations, welcomes tourist visits and encourages employees to disseminate new energy-related knowledge and showcase relevant equipment, so that more tourists can learn about environmental protection, new energy, carbon emissions, etc. In this way, the wind farm is influencing the public to establish and support the ecological protection vision. In total, the wind farm has created social benefit of RMB 1.357 million through tourism and education promotion.



Representative plants of Modou Mountain Wind Farm (from left to right) : Kudanella, Changshan, Panax notoginseng


Organized teachers and students of Chengmendong Primary School in Huaning County to carry out popular science experiential learning in the wind farm

Organized students from Kunming University of Science and Technology to carry out professional cognitive internships

Viewing platforms, plank roads built for tourists

Cost-benefit analysis of material impacts and dependencies

Material Topics	Indicator	Corporate Costs	Corporate Benefits	Social Costs	Social Benefits
Power generation through wind turbines	Revenue from power generation		●		
	Reduced coal consumption				●
GHG emissions	GHG emission reduction				●
Discharges of air pollutants	Reduced discharges of air pollutants				●
	Discharges of air pollutants			●	
Water resources	Water resource conservation				●
	Sewage treatment	●			●
	Water consumption			●	
Solid waste	Solid waste transportation and landfilling	●		●	
Ecosystem services	Vegetation restoration	●			●
	Ecosystem Service Value Loss			●	
Tourism and education promotion	Tourism				●
	Popular science education				●
Total		●	●	●	●

Costs	● Very large	● Large	● Minor	Negligible/none
Benefits	● Very large	● Large	● Minor	Negligible/none

Modou Mountain Wind Farm has caused changes of natural capital in terms of seven aspects including power generation through wind turbines, GHG emissions, etc. Among them, power generation through wind turbines, GHG emissions and ecosystem services are the top three significant factors to natural capital changes. In general, corporate benefits and social benefits are greater than the corresponding costs. The results above manifest that Modou Mountain Wind Farm has achieved remarkable positive effects, using clean energy to create comprehensive value for the enterprise and society as well. Among them, the benefits of GHGs emission reductions proves to be very large.

Outlook 2030

The corporate and social benefits generated by Modou Mountain Wind Farm are greater than its corresponding costs. Among them, the benefits of GHG emission reduction contributes a lot, which reflects that wind energy is effective in fulfilling the United Nations Framework Convention on Climate Change and achieving the SDGs.

Based on the natural capital evaluation results, Modou Mountain Wind Farm will take diverse measures to increase its positive impact and reduce negative impact on nature, and contribute to the realization of the SDGs as scheduled.

- Carrying out biodiversity conservation. Taking actions to conserve bird species and adopt measures such as landscaping to create a suitable habitat for bird nesting and mammal foraging.
- Strengthening biodiversity monitoring and research. Cooperating with professional third-party organizations to establish and undertake related scientific research projects, carrying out biodiversity monitoring and natural capital assessment, and conducting research on wind power, environment and biodiversity conservation.
- Increasing publicity and education of ecological environment protection. Engaging more in publicity of ecological environmental protection through new media, traditional media, brand activities, academic exchanges and other channels. Related science knowledge can be better disseminated to guide the public to participate in environmental protection. Moreover, efforts can be made to guide more enterprises to care for the ecology, foster the vision of jointly building a community of a shared future for all life on earth, and fulfill corporate social responsibilities.

> “ Among the power stations in Yunnan, the wind farm at Modoushan has performed relatively well in restoring greenery. It has performed very well in public education and public services (building science museums and stacks). After the wind farm hardened the local roads, there were particularly large groups of tourists, which helped the local community particularly well.”
>
> —Han Lianxian, Secretary General of the Yunnan Wildlife Conservation Association and bird expert ”

Brenig Wind Farm in the UK: Natural Capital Assessment

A Glimpse Of Brenig Wind Farm

Brenig Windfarm comprises 16 wind turbines generating enough wind power to provide the annual energy needs of over 30 thousand houses. The turbines have a tip height of 100m from the ground and are situated on around 215 hectares of land which was previously a mix of forestry plantation (77%), and agricultural land (23%) used for grazing cattle and sheep. The site is located 3km south of the village of Nantglyn, to the east of Lyn Brenig reservoir and next to the Mynydd Hiraethog Site of Special Scientific Interest (SSSI), in Denbighshire.

The SSSI represents an important national conservation designation in the UK, in this case protected as an increasingly rare habitat in Wales of uninterrupted upland heather moorland with grasslands and wetlands, of around 6,400 hectares. It is one of the most important breeding sites for wading birds such as curlew and lapwing.

As part of the planning process for the development of Brenig Windfarm, an environmental impact assessment was undertaken in 2007, with consent for the development granted in 2009. Initial site works started in 2014. CGN purchased Brenig Windfarm Ltd in 2015. Since then construction of the wind turbines at the site started in 2018 and their operation commenced in March 2019.

In 2018 the Welsh Government set a 70% renewable electricity target for Wales by 2030. In June 2019, it set a target of net zero carbon emissions no later than 2050. To help achieve this, the Brenig windfarm is within one of fifteen large Priority Areas identified for Solar and Wind Energy development in Wales.

The study had two overall aims. Firstly it was to identify the main natural capital dependencies and impacts, and associated risks and opportunities, and recommend how the latter can best be managed.And secondly, it was to provide information that could be shared, both internally within CGN and externally, to highlight how CGN is managing its biodiversity and natural capital.

Location of Brenig Windfarm

Brenig Windfarm: view east from the wet heath near Turbine 14 (photo taken in 2019)

Our Interaction With Nature

Construction of the windfarm comprised the following main activities

Forest clearance & land management. The land type of conifer trees (predominantly Sitka spruce) was changed in 2015/16 to enable the development to go ahead. Before being planted commercially with conifers, the land was originally heath moorland and peat bog. The developer implemented a Habitat Enhancement Plan to enhance the biodiversity value of the site and to protect the adjacent Mynydd Hiraethog (SSSI) heathland during both the construction and operational phases.

Aerial site image - June 2009 (pre-conifer clearance)

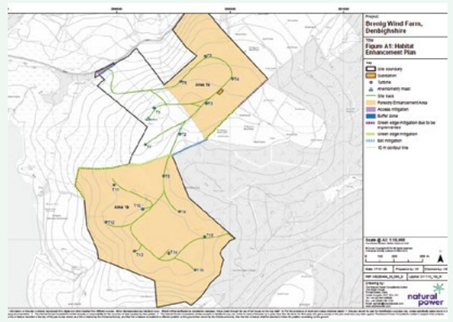
Aerial site image - May 2018 (post-conifer clearance)

Access, tracks & transport. The development required around 4 km of new tracks and 2 km of upgrades to existing tracks. A small area of boggy ground required a layer of geotextile and stones for the new track. An estimated 3,200 movements by Heavy Goods Vehicles and 8,600 movements trips by light personnel and delivery vehicles were made over a 15 month construction period. One public right of way footpath was closed temporarily.

Borrow pits & cabling. During the construction, stones were quarried from four borrow pits from within the wind farm site as raw materials for the construction of the project. The borrow pits were then re-turfed and re-seeded with suitable seed mixes. Cable trenches (1 m deep and 1.5m wide) were dug to take the 33 kV electricity cables from each turbine. These followed the route of the tracks and were then backfilled and the stored turf re-instated.

Compound and buildings. During the construction, a temporary compound (100m x 60m) was constructed on top of a 300mm pad of geotextile material and stone. This was subsequently restored using stockpiled soils, re-turfed and seeded. A substation and control building (22m x 8m and 6m in height) was built along with a parking area (6 x 6 m).

Turbines & foundations. Sixteen turbines were constructed at the site with a hub height of 60m and tip height of 100m (see figure on the right). Each turbine requires its own concrete foundations made of concrete and reinforced steel bars. Individual crane pad hard-standing areas were also constructed using geotextiles and stone for the heavy cranes needed to install each of the turbines. These pads were later covered in topsoil and re-turfed. One permanent wind speed mast was also built.



Layout of Brenig Windfarm showing the 16 turbines

The main operational activities of the wind farm operation are:

Turbine activity. Operation of the turbines is automatic with each turbine operating independently and being managed and monitored remotely.

Site management & maintenance. Site maintenance was first undertaken after 10 days of operation, and then after 3 months. Minor and major service regimes now continue every 6 months and 12 months. These involve brief visits by technicians applying lubricating and hydraulic oils as necessary.

Access, tracks & transport. The tracks to each turbine and the wind mast are required for routine maintenance. Vehicular movements for routine operation are minimised. Both previously existing public rights of way access across the site are unaffected.

Land management. As part of the Habitat Enhancement Plan, it was agreed that the land cleared of conifer trees would be re-instated as heath and peat bog (blanket mire).

Local fund. As part of the development, a community fund (the 'Brenig Fund') was set up to disburse £150,000 per year for 25 years for local environmental, social and economic projects. Projects to date have enhanced local sports activities, forest education, sailing and red squirrel conservation, and provided electric bicycles.

Ecological footprint management

- In order to obtain planning consent for the construction and operation of the windfarm, a full Environmental Impact Assessment was undertaken in 2006-2007. This involved first undertaking a scoping study with initial local consultation followed by a more detailed assessment and wider stakeholder consultation of a broad range of environmental and social impacts associated with the planned development.

- The first ecological surveys were undertaken at the site between April and November 2006, to establish the baseline for vegetation, birds, bats and mammals. This was followed by pre-construction bat surveys in 2012/13 due to the potential impact on bats and the need for additional data to help assess the impacts. A more detailed vegetation survey ('Phase 1 Habitat Survey') was also undertaken in February 2015 to map the broad habitats and investigate the presence of any protected species.

As part of this process numerous mitigation and enhancement measures were proposed to avoid and minimise any negative impacts and to enhance positive impacts. This covered ecological issues as well as visual, hydrology, noise, traffic, safety, cultural heritage, recreation and many other issues. Measures included, amongst other things:

Developing and applying a Pre-Construction Method Statement (PCMS) agreed with the Statutory Consultees to guide the construction and specify how ecological impacts can be reduced, and help manage health and safety issues.

Employing a site representative to monitor the implementation of the PCMS and ensure that proposed ecological protection and safety measures are adhered to.

Establishing a Habitat Enhancement Plan (HEP), in consultation with local stakeholders, to ensure that biodiversity is protected and enhanced.
As part of the HEP, the following were also planned:

- Control of the conifer regeneration.
- Monitoring of vegetation, birds and bats after site construction.
- Review of the HEP to evaluate the success of the outcomes.

Initial post construction monitoring data for vegetation, birds and bats was collected and reported on in 2019. This information forms a key part of the natural capital assessment explained in the next section.

Our Relationship With Nature

The focus of the natural capital assessment was on the construction and operation of Brenig Windfarm, although the assessment also considered at a very high level: the supply chain, the transmission line and customer use of the end product.

The assessment covers both the societal value of impacts (i.e. impacts to all stakeholders) and business values (i.e. the financial impact to Brenig Windfarm Ltd) relating to both the windfarm's impacts and dependencies. The assessment was conducted in two Phases. Phase 1 determined the precise scope of the assessment and applied qualitative valuation of impacts and dependencies. Phase 2 involved more detailed quantitative and monetary valuation of the windfarm's natural capital impacts and dependencies.

The overall qualitative assessment covered a 35 year period from the construction phase starting in 2015 when the conifers were cleared, to the end of the operation phase in 2044, together with a five years following decommissioning of the site. The more detailed qualitative, quantitative and monetary valuation assessment focused only on the period between 2015 and 2020, for which more data exists. The spatial boundary included the potential area of influence of the windfarm, covering the relevant water catchment areas for the site.

The study adopted four approaches to identify potentially material natural capital related impacts and dependencies:

- Reviewing the original environmental impact assessment
- Reviewing literature on environmental impacts associated with on-shore windfarms
- Discussing key issues related to windfarm environmental management
- Considering the materiality criteria set out in the *Natural Capital Protocol*

This process resulted in 12 issues being identified and carried forward to the measurement and valuation stage (see the figure below)

Project activities	Energy	Water		Ecosystem use		Resource use (non-water)	Air related		Recreation	Disturbances	
		Availability	Quality	Habitats	Species		GHG	Air emissions		Noise	Visual
Construction											
Forest clearance & land management						◔					
Access, tracks & transport		◔		◔		◑					
Borrow pits & cabling		◔		◑		◑					
Compound & buildings		◑		◔		◕					
Turbines & foundations		◕		◔		●					
Operation											
Turbine activity	●					◔					
Site management & maintenance		◔		◔		◔					
Access, tracks & transport				◔		◔					
Land management						◔					
Local fund						◔					
Decommissioning											
Turbine removal & recycling		◔		◔		◑					
Land management						◔					
OVERALL NET IMPACT											

Societal value of impacts:

Major positive
Moderate positive
Minor positive
Negligible/no impact
Major negative
Moderate negative
Minor negative
Negligible/no impact

Business value of dependencies:

●	Major
◕	High
◑	Moderate
◔	Minor
	None

Relative value of material impacts and dependencies of Brenig Windfarm

Measure Our Footprints On Nature

Energy

The business incurred substantial financial costs in developing the windfarm so that it could generate electricity, and hence secure significant revenues for itself, from the wind turbines.

Water availability

There was a minor loss in societal value due to the small amount of water required for construction and operation. In the short and long term, with conversion of conifers to blanket bog, more water will be retained within the heathland throughout the year. There will also be less transpiration of water by the conifers. Based on estimates of the value of water supply function of peatlands in the UK determined by the UK Office for National Statistics, and adjustments made based on conifer and heath transpiration rates, a positive value of £65,000 up to now, and around £300,000 up to 2049 was calculated. During the construction period, water was of moderate dependency value to the business, for example for its necessary use in the concrete turbine foundations, but of low financial cost to the business for its use.

Water quality

This was likely to be of minor to negligible negative value during construction, but of minor positive value during operation and decommissioning as a result of the enhanced heath and bog habitat. Ensuring no adverse water quality impacts during the construction phase was a minor cost to the business.

Habitats

There was an initial moderate loss of value through clearance of the conifer forest in the construction phase as the tree habitat was lost. However, this will be significantly offset by the re-instatement of dry and wet heathland and peat bogs (blanket mire). The latter are a globally rare habitat and protected as a priority habitat under the EU habitats Directive.

The 2019 vegetation survey confirms that the habitats have not fully re-established within the short time since the conifer blocks were felled in 2015 and the water level management was undertaken in 2018. The restoration process may take at least 10 years or more. Furthermore, there is a high incidence of natural conifer regeneration which is suppressing the desired target vegetation regeneration. In terms of habitat business dependency, there is a minor to moderate business dependency value from vegetation reducing run-off and through use of stones from the borrow pits during the construction phase.

Previous monetary valuation studies in the UK have shown that the general public and visitors are willing to pay for additional protected peatland (and key species such a hen harriers). Based on the latest emissions data from a UK peatland emissions inventory developed for the UK government and UK government non-traded carbon values, we calculated the value of returning the drained forest peat back to dry heath and wet peatland. The calculations suggest societal benefit values of £150,000 have been generated to date and around £1 million will be generated by 2049.

Resource use

There has likely been a minor negative societal value from resource use from the construction and operation stages, with a moderate loss relating to the turbines and their foundations. The business will though have had a minor to major dependency value on natural capital, especially mineral and metal resources. There is insufficient information available to determine values in monetary terms.

Species

Particular emphasis has been placed in the Habitat Enhancement Plan on assessing the potential impacts on bird (especially raptors and waders) and bat populations as these can be affected by wind turbines. The 2019 bird survey results suggest that construction and operation of Brenig Windfarm does not appear to have had a negative impact on the breeding population of the target raptor species, with an increase of identified breeding by goshawk (a UK Red List bird) within the survey area being shown compared to surveys in 2017 and 2018. As the restored habitats improve in condition and wetness, the additional heathland and peat bog habitat should benefit other UK Red List bird species including merlin, hen harriers, nightjars and black grouse due to the expansion of foraging and nesting habitats.

Again, it is too soon to understand potential changes in bat populations, but the 2019 bat survey data reveals the same number of bat species present (seven) compared to 2006, with slightly more activity seen of Nathusius's Pipistrelle and the Brown Long-eared bat. Other small mammals, reptiles, amphibians, insects and plants are expected to benefit from a more open heathland and banket bog environment too, although these are not being monitored.

In the longer term it is anticipated that major positive species related societal value will be generated as the restored dry heath and blanket mire take. In addition, several other species mitigation measures will come into effect, such as providing a new green edge (hedge) to act as a flight line corridor for bats.

Greenhouse gases (GHGs)

Generation of wind power electricity is resulting in considerable reduced GHG emissions through avoided fossil fuel consumption. A monetary valuation of the societal benefits was undertaken based on actual and predicted wind energy produced at Brenig, estimates of the likely fuel mix replaced (predominantly gas, especially after 2024 when coal should have been phased out), and the UK government non-traded carbon values. The results suggest societal benefits of in the order of £5.6 million to date and £73 million by 2049.

Air emissions (non GHG)

Overall, air emissions are avoided by reduced fossil fuel consumption from the turbine generated electricity, which would more than offset the relatively minor societal costs linked to various other construction and operation activities.

Recreation

Recreational access has been significantly improved by providing walking paths across the entire site. Furthermore, considerable additional local recreational enjoyment and wider community value is being generated through the Brenig Fund. This is providing £4 million in grants to local community projects over the 25 years of windfarm operation.

Noise

The construction activities and operation of the wind turbines cause negligible or possibly minor noise disturbance, and as a result has not been valued in monetary terms as part of this natural capital assessment.

Visual

The windfarm has been specifically located within one of a number of areas designated by the Welsh Government for windfarms, so as to in part result in minor visual impacts. Furthermore, there was already the Clocaenog windfarm adjacent to the site, thereby further reducing the overall visual impact too.

Evaluate Natural Value Creation Capability

The overall qualitative valuation of both business and societal costs and benefits associated with the Brenig Windfarm scheme indicated a highly positive overall impact. This is represented by a major positive business and societal impact, with a major business cost and relatively minor societal cost. Three of the societal benefit impacts where relatively reliable monetary values could be determined, are shown in monetary terms for the period between 2015 to now and as projected from 2015 to 2049.

Although representing only part of the picture, the monetary values show some of the considerable societal benefits generated by the windfarm. They comprise benefits from reduced greenhouse gas emissions through provision of renewable energy, reduced carbon emitted and the additional value of water available in the catchment from the land type change. These give a societal value in the order of around £6 million by 2020 and a total projected value of around £75 million by 2049.

		Business		Society		
		Cost	Benefit	Cost	Benefit	
					£ to date	£ to 2049
Energy						
Water	Availability				65,000	300,000
	Quality					
Ecosystem use	Habitats - Biodiversity					
	Habitats - Carbon				150,000	1,000,000
	Species					
Resource use						
Air related	GHG emission reduction				5,600,000	73,000,000
	Air emissions					
Recreation						
Disturbances	Noise					
	Visual					
TOTAL					5,815,000	74,300,000

Business & societal value of impacts:

Major positive
Moderate positive
Minor positive
Negligible/no impact

Major negative
Moderate negative
Minor negative
Negligible/no impact

Extended Value Chain Assessment

Results for the extended value chain assessment of Brenig Windfarm are shown below. It suggests that there may be a broad range of negative impacts associated with the supply chain (e.g. from extracting raw materials, transporting and manufacturing), and some from the transmission line too. "Customer use" mainly relates to reduced GHG and air emissions from avoided fossil fuel consumption, but this is already counted as a benefit within the assessment of direct operations above.

Project activities	Energy	Water		Ecosystem use		Resource use (non-water)	Air related		Recreation	Disturbances	
		Availability	Quality	Habitats	Species		GHG	Air emissions		Noise	Visual
Supply chain	●	●		◔		◕					
Direct operation	●	◑		◔		◕					
Transmission		◔		◔		◑					
Customer use											
OVERALL NET IMPACT											

Societal value of impacts:

Major positive
Moderate positive
Minor positive
Negligible/no impact

Major negative
Moderate negative
Minor negative
Negligible/no impact

Business value of dependencies:

●	Major
◕	High
◑	Moderate
◔	Minor
	None

Relative value of impacts and dependencies along the Windfarm value chain

Outlook 2030

The natural capital assessment has shown that CGN not only generates significant business value, albeit with a high associated investment cost, but it also generates considerable societal benefits. In particular, the development helps in a significant way towards the UK government's climate commitment – through both the provision of renewable energy and from converting drained peatland forest to a priority biodiversity habitat (blanket mire and dry heath) which is far less carbon emitting.

To ensure the converted habitat carbon and biodiversity benefits are fully realised, it will be important for us to implement the Habitat Enhancement Plan, monitor its progress and potentially adapt its management actions accordingly.

As a result, there is considerable potential for this development to contribute towards SDGs 7, 13 and 15 – as well as support the CBD through ensuring the habitat restoration is successful.

Key risks for Brenig Windfarm

- If the conifer regeneration is not adequately controlled in the coming years, the habitat enhancement efforts may not be so successful, and may become more costly to manage.

Key opportunities for Brenig Windfarm

- Thought should be put into considering how the unwanted conifer saplings could potentially be viewed as a resource. For example, they could potentially be collected as viable trees and given away or sold for use and planting elsewhere.
- There is a potentially significant net biodiversity gain from the habitat enhancements if managed appropriately. This should be carefully measured, evaluated and promoted.
- The Brenig Fund offers significant opportunities to provide local community value, with strategic thinking around investments potentially further enhancing benefits.
- There is potential to engage with a local wildlife group, or local community group, to help with the habitat restoration and wildlife monitoring.
- Information boards could be usefully designed and installed to provide visitors with interesting information about renewable energy and the habitat restoration scheme.
- There is scope to enhance the accuracy of the biodiversity, recreation and landscape monetary valuation through undertaking a 'stated preference' survey of local, Welsh and wider UK population to elicit their 'willingness to pay' for the changes at the site.

Haute-Somme Wind Farm in France: Natural Capital Assessment

A Glimpse Of Haute-Somme Wind Farm

EOLE de la Haute-Somme

Haute-Somme Wind Farm , north of Paris, is located on a vast limestone plateau in the hills of the Vermandois, Hauts-de-France. Built in 2009, the wind farm started a trial operation in 2010. It initially was operated as two independent windfarms which regrouped as one in 2015 and was acquired by CGN Europe Energy in 2018.

Schematic of the location of Haute-Somme Wind Farm

Surrounding environment and ecosystem

- Pre-construction

At the end of the 2000s, an environmental impact study was carried out, noting that the Vermandois is a silty plateau with a very rich agronomic potential, which is almost exclusively oriented towards intensive agriculture and therefore unfavorable to natural environments. The areas left to wild flora and fauna are limited to the shoulders of the farm tracks and roads and the relictual woodland.

Sites of natural and landscape interest are identified within a perimeter of 10 km around the site by French State services, covering the marshes and ponds of the Somme. Nevertheless, these inventory or protection areas are not in the immediate vicinity of the sites where the wind turbines are located.

- Post-construction

The initial impact study revealed that:

Vegetation

The study area is dominated by wasteland, with poor vegetation coverage. Since the original ecological value of the natural habitat within the study area is not high, the construction of the windfarm has not led to significant habitat degradation. Meanwhile, it should be noted that the rare prairies and wooded sites in the study area must be protected or restored as they contribute to the diversification of the environment.

Bird migration

The location of the windfarm is not in the migration route of migrating birds, which ensures that no direct harm will be caused by the operation of the windfarm to the greatest extend.

Bird habitat

Few niches were available in this area, which have been disturbed before the windfarm construction. Therefore, few different species of birds are recorded in this area. Only a few ancient species live here, with a remarkable population of diurnal birds of prey, including the Reed Harrier *(Circus aeruginosus)*, the Montagu's Harrier *(Circus pygargus)* and the Hen Harrier *(Circus cyaneus)*. All three species are of European interest and are listed in Annex 1 of the Birds Directive. Their presence justifies the implementation of a population monitoring of the most remarkable species and will justify defining, if necessary, compensatory measures to be taken to reduce the possible impact on these species.

Bat habitat

There is a dense population of bats in the surrounding area of the windfarm. Wind turbines were located in very open cultivated areas, which are not often frequented by bats. Moreover, the risks of mortality or disturbance by wind turbines are minimized due to the fact that bats fly low and wind turbines are high.

Human disturbances

The human disturbances on the natural capital is caused by is hunting. The diurnal raptors are densely distributed in this area and may be attracted by the feeding points specially set up by hunters.

The comprehensive analysis of the surrounding environment and ecosystem before and after project construction demonstrated that the wind farm project is part of a perimeter already very strongly disturbed by intensive agriculture. Biological communities are already in a very significant state of degradation and disruption. The impacts of the wind farm project would therefore be minimal compared to the pre-existing disturbances.

Measure Our Footprints On Nature

Purpose

The overall goal of this natural capital assessment is to indentify impacts and dependencies on the ecological environment of EOLE de la Haute-Somme windfarm from the start of construction to the present, and to provide suggestions on how CGN European Energy can better manage related risks and opportunities.

Scope

A perimeter of 10 km around the site where the windfarm located.

Methods

The intended audience of the assessment's results includes the general public in China and elsewhere, local stakeholders in EOLE de la Haute-Somme, and employees and shareholders of both EOLE de la Haute-Somme Windfarm and CGN. Due to COVID-19 restrictions, a site visit was not possible as part of this assessment, and stakeholder consultation was limited.

Therefore, based on a thorough review of existing information and species monitoring reports, the environmental impact assessment report before project implementation as well as the data provided by EOLE de la Haute-Somme windfarm, this natural capital assessment adopts the methods of field investigation and literature research.

Dependencies of EOLE de la Haute-Somme windfarm on natural capital

Climate regulation

The windfarm requires continuous wind resources, and climatic stability is a key factor to ensure stable operation and sustainable development.

Land occupation

The windfarm occupies land resources temporarily or permanently during the construction period, as well as during the operation period, causing changes in natural capital.

Utilization of freshwater resources

A small amount of freshwater was used by employees and as cooling water for wind turbines.

Resource utilization

Energy transformation technologies use a variety of materials: steel, copper, aluminum, lead, PVC (from petroleum) and rubber, indicating that the operation of windfarms rely on trees and fossil and non-fossil natural resources.

Impacts of EOLE de la Haute-Somme windfarm on natural capital

- Ex-situ impact

The impact of resource utilization on the environment	The impact of waste on the environment
Resource extraction, equipment production and transportation imply the impacts on the ecosystem.	The metal, plastic, plates, paper and other wastes generated during the production and packaging of wind power equipment will cause pollution to the surrounding environment and damage to the local ecosystem.

- Temporary in-situ impacts

Noise	Air pollution
The scouring and earthworks on the works area, the building of roads, the digging of trenches for cables, the presence of machines and the noise generated during the assembly of wind-turbine will cause negative impacts on local biodiversity.	During the construction phase, air pollutant will be generated. Vehicle transportation will produce exhaust emissions and road dust, leading to a decrease in air quality.

- Permanent in-situ impacts

Impact of noises	The noise of a wind turbine is largely produced by friction between the blades and the air. This may cause some disturbances to the habitat and migration of local wildlife. However, the sound level of wind turbines is quiet and adjustable, so the impact is limited. In addition, wind turbines must be repaired regularly, which may cause additional damage to the surrounding environment.
Electromagnetic radiation	There are booster stations and transmission lines in the windfarm. The electromagnetic field around the booster stations and transmission lines may generate electromagnetic radiation that may affect the health of windfarm staffs, surrounding residents and wild animals.
Atmospheric disturbance	A wind turbine blade tip can rotate at up to 300 km/h which produces a large amount of energy. The movement of the surrounding air create draughts which can be fatal to flying.
Land occupation	During the construction, reinforced concrete foundations of a volume of 500 m^3 are required. The ground coverage of the base is considerable (1 000 m^2) if we include the strip roads, the machine room and even parking space. This contributes to a major cause of the erosion of biodiversity.

Our Actions To Protect Nature

2017 Biodiversity Monitoring Action

The parent company of the EOLE de la Haute-Somme windfarm, CGN European Energy, has commissioned the research firm Tauw France to carry out monitoring of birds and bats to evaluate the real impacts of the wind turbines on wildlife (birds and bats), guaranteeing that this energy sector is integrated into the environment either by optimizing the operation of the wind turbines or by setting up relevant compensation measures.

The monitoring was carried out based on a standardised method developed by Winkelmann (1989) and adapted by André (2005). However, several correction coefficients are taken into account. The monitoring was carried out during the postnuptial migration period of the avifauna and the autumn transit period of the bats.

This monitoring found no death of birds and bats at a close interval of time (2/3 days) in October 2017.

2019 Biodiversity Monitoring Action

CGN revised mortality monitoring protocol between May and October 2019, which was more complete than the 2017 edition, so as to comply with the *Protocol for the Environmental Monitoring of Onshore Windfarms* published in March 2018 and the regulation on environmental monitoring of windfarms in France.

As in 2017, clues (bird feathers and droppings) were found near the wind turbines (250-metre radius), confirming the presence of birds at the foot of the wind turbines, which means that they are not frightened by the installations. Nevertheless, the mortality monitoring carried out in 2019 confirmed a near-zero mortality rate, same as that of 2017.

Over the same period, between May and October 2019, Tauw France carried out a bat activity monitoring, also in conformity with the *Protocol for the Environmental Monitoring of Onshore Windfarms*. Two recorders had been installed on the two wind turbines located near an afforestation area. Thus, we could know all the bats passages at the height of the wind turbine blades.

20 surveys were carried out in two periods:

From May to mid-July for birds and bats during the farrowing period.

From mid-August to the end of October, during the postnuptial migration for the avifauna and the autumn transit of bats.

Over the period:

July is the month where the most activity is recorded

7,391 contacts were recorded

each wind turbine recorded

13 species,

12 of which were identical

In conclusion, the activities of intensive farms have the greatest impact on the natural resources of the area, rather than the construction and operation of the windfarm. The low abundance of terrestrial biodiversity in this area is due to the intensive agricultural hunting in this area.

Outlook 2030

According to the natural capital assessment results, the EOLE de la Haute-Somme windfarm will take corresponding measures to improve biodiversity.

Establish a normalized monitoring mechanism for species such as birds and bats, and continue to track and evaluate the impact of wind turbines on biodiversity.

Take biodiversity compensation measures to protect the vegetation (rare grasslands and woodlands) and animals (birds and bats).

Carry out educational activities to explain results of natural capital assessment to internal and external partners ; encourages stakeholders such as employees, peers, and the public to actively participate in biodiversity conservation projects and build a better community together.

Stakeholders' Comments

CGN Natural Capital Assessment Pilot Project has applied the international standard framework of the ''Natural Capital Protocol'', which reflects that Chinese energy companies are leading the way in assessing and accounting for the impact and dependence of clean energy on nature and society, and innovatively exploring how energy companies can better contribute to nature conservation and social progress. I am delighted to see the great contribution that CGN is providing to the national process of achieving the "double carbon" target and to biodiversity conservation.

——Zhu Chunquan, General Manager of the Global Public Goods Platform, World Economic Forum Beijing Office

As an extra-large enterprise group of our nation, CGN has long been committed to "developing clean energy and benefiting human society". With the vision of "becoming a world-class clean energy enterprise", CGN has incorporated biodiversity conservation into its enterprise development strategy, followed a "step-structure" biodiversity management path of "avoiding, reducing, alleviating and compensating", and carried out a series of biodiversity conservation practices. CGN will try its best to achieve harmonious coexistence with the surrounding natural environment, set up a good biodiversity image for the majority of Chinese enterprises, and explore a path of harmonious advancement of development and protection.

The *CGN Report on Biodiversity Conservation 2021* gives a detailed overview of CGN's biodiversity conservation work. Readers can clarify the path and effectiveness of CGN's biodiversity conservation efforts through the report, and cam also learn about the responsibilities of China's state-owned enterprises for biodiversity conservation.

——Liu Xuehua, Director of Division of Ecology, School of Environment, Tsinghua University

Biodiversity is not only a type of natural capital, but also conducive to the resilience of nature and the regeneration of natural resources. The UN's CBD has recommended "no net loss" of biodiversity. It points out that "land utilization and land use changes are some of the main drivers of biodiversity loss" and encourages "enterprises to identify, measure, and assess the cost-effectiveness of their impacts and dependencies on ecosystem services, evaluate potential risks or opportunities, and report regularly." This has been recognized as the most effective approach for preventing biodiversity loss and CGN has been practicing accordingly while applying the internationally recognized *Natural Capital Protocol* in natural capital accounting. The *CGN Report on Biodiversity Conservation 2021* is one of the first and most detailed corporate biodiversity reports published in China. The Report has four highlights: First, it is compiled in nine steps in four stages, which form the standard reporting procedure; Second, it comprehensively evaluates the "three major elements," which are the dependencies on natural capital, the impacts on self, and the impacts on society; Third, it combines qualitative and quantitative evaluation with monetary valuation; Fourth, it applies "secondary data" and the "value transfer" properly to improve the efficiency of evaluation and reduce the costs of enterprises. The Report also introduces some interesting cases, such as the Base's role in nature-based education and the restoration of habitats. Some of CGN's practices are quite thoughtful, including regular monitoring of birds, bats, turtles, and other species that can indicate the biodiversity situation. Natural capital assessment provides a basis for business decision-making, and it will become a new paradigm for enhancing business transparency and fulfilling the SDGs.

——Zhao Yang, Senior Engineer, The Foreign Economic Cooperation Office (FECO), MEE

CGN's actions and philosophy towards protecting and enhancing biodiversity set an excellent example for all businesses worldwide to follow. The *Report on Biodiversity Conservation 2021* provides plenty of powerful evidence that CGN is taking practical and comprehensive steps to not only better evaluate and manage biodiversity but also natural capital. CGN's biodiversity actions certainly promote both the CBD and SDGs.

——James Spurgeon, President of Sustain Value

This report presents a range of possibilities for responding to the major challenges of biodiversity conservation and the fight against climate change. The four case studies in this report illustrate that the process of the enterprise mastering the interaction between projects and natural capital can help to understand all its biodiversity issues in order to identify the most relevant strategy.

——Patricia Savin, President of ORÉE

I am amazed and impressed to read the report by CGN and admire the company for taking biodiversity conservation so seriously. The report shows the practice of conservation by CGN and its corporate image of respecting nature and green development.

——Ayan, Researcher, Chinese Research Academy of Environmental Sciences

Corporate decisions can interfere with a range of issues including space, natural resources, ecosystems and biodiversity. In this report, CGN has addressed all of these issues, and has attempted to provide an in-depth overview.

There are numerous accessible examples in the report. A corporate perspective on natural capital issues, with biodiversity as the entry point, is an effective way to inform readers about CGN's biodiversity conservation and sustainable use practices. Whether at the level of science popularization or industry driven, it is a very good reference.

——Yao Lin, Associate Researcher, China Institute of Nature Economics

The report is printed on eco-friendly paper.

Clean Green Nature

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