



2025 Climate Solutions from Chinese Enterprises

应对气候变化的中国企业解决方案 (2025)

Yangjiang Sanshandao Offshore Wind Power VSC-HVDC Transmission Project Opens the “Deep-Sea Expressway” for Green Electricity

阳江三山岛风电柔直输电工程打通电力“深海高速路”

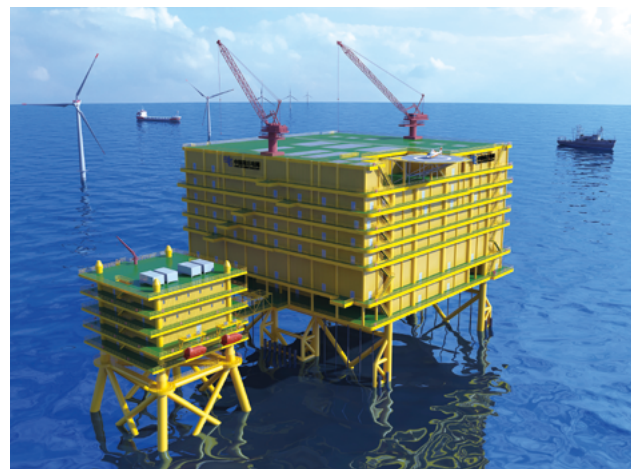




Yangjiang Sanshandao Offshore Wind Power VSC-HVDC Transmission Project Opens the “Deep-Sea Expressway” for Green Electricity

Challenges

China's offshore wind power industry has maintained strong growth momentum, with its total installed capacity ranking first in the world for four consecutive years (2021–2024) and its newly installed capacity leading the world for seven consecutive years (2018–2024). However, as large-scale projects expand into deep-sea and far-shore areas, transmission channels and landing-point resources are becoming increasingly constrained. The traditional model featuring “individually built transmission channels by each wind farm” leads to repetitive submarine cable laying and duplicate control station construction, consuming substantial seabed and land corridor resources. Meanwhile, conventional alternating current (AC) transmission suffers from limited capacity, high losses, and overvoltage issues, making it inadequate for transmitting wind power efficiently from far-shore wind farms on a large scale. As China's Guangdong-Hong Kong-Macao Greater Bay Area (Greater Bay Area) develops, demand for large-scale energy access has surged, while the difficulty of delivering electricity from deep-sea and far-shore wind farms has become a key bottleneck restricting clean energy supply.



Rendering of Offshore Converter Station of the Project

Solution

The Yangjiang Sanshandaof Offshore Wind Power VSC-HVDC Transmission Project is a core project of China's 14th Five-Year Plan period (2021-2025) for main grid development and one of the "Top 100 Projects" designated by the State-owned Assets Supervision and Administration Commission of the State Council (SASAC). It is also the first offshore wind transmission project in China planned and built by a power grid company, and the first integrated offshore-onshore VSC-HVDC project in the nation. Scheduled for commissioning in October 2026, the project is led by China Southern Power Grid Co., Ltd. (CSG) and implemented by its subsidiary Guangdong Power Grid Co., Ltd., achieving multiple technological innovations. By establishing a unified transmission "expressway" planned and constructed by the grid operator, the phase I-IV projects can share a "one-stop transmission hub", like the "one-stop car-pooling", avoiding redundant cable laying and control station construction. This helps optimize both offshore and onshore spatial resources, and ensure the stable delivery of clean energy to the Greater Bay Area, offering valuable experience for future large-scale deep-sea and far-shore wind power transmission.

Overcoming technical bottlenecks for efficient transmission of far-offshore green power

Eight world firsts. The Yangjiang Sanshandaof Offshore Wind Power VSC-HVDC Transmission Project will set eight world records, including the world's largest offshore HVDC transmission project, the first multi-terminal offshore HVDC system, and the first offshore HVDC transmission project operating without centralized DC-dissipation equipment.

Ultra-large-scale power delivery. Existing offshore wind HVDC projects have a maximum transmission capacity of 2,000 MW. By overcoming multiple technical bottlenecks, this project raises the capacity threshold to 6,000 MW, marking a major leap in offshore wind power transmission capability.

Breakthrough in transmission model. Unlike conventional offshore wind projects, the project applies VSC-HVDC technology both offshore and onshore. After the power comes ashore, transmission continues through overhead DC lines directly to load centers in the Greater Bay Area.

Coordinated marine-land planning for an intensive transmission corridor

Integrated marine resources. Working with the departments of oceanic fisheries and natural resources, the project optimizes offshore wind cluster layouts and designates centralized submarine-cable corridors, avoiding conflicts caused by scattered individual development. Through unified cable routing, the number of submarine cables required for the 2 GW Yangjiang offshore wind cluster was reduced from four (AC scheme) to two (VSC-HVDC scheme), saving 59% of the sea area.

Optimized onshore corridors. Given the limited availability of land resources, the onshore transmission route was carefully designed to avoid ecologically sensitive areas. High-span designs were adopted to minimize tree clearing and reduce corridor occupation. Using overhead DC transmission lines to deliver clean electricity directly to load centers, the project can expand its long-term transmission capacity to 60 GW, saving 70% of land corridor area and effectively mitigating over-limit issues of short-circuit current in grid load centers.

Multiple Benefits

Environmental

The project accelerates low-carbon transition, contributing to the carbon peaking and neutrality goals. Once in operation, the project will supply about 6 TWh of clean electricity annually to the Greater Bay Area, equivalent to saving 1.74 million tons of standard coal and reducing 4.63 million tons of CO₂ emissions. This will become a powerful driver of regional economic development through clean energy.

Economic

"One-stop car-pooling" delivers cost reduction and efficiency gains. The model featuring unified planning and shared channel creates clear economic advantages. By adopting the "one-stop car-pooling" approach, the phase I-IV projects can eliminate redundant cable-laying and control station construction, improve spatial efficiency, and save 59% of offshore area and 70% of land corridor space.

Social

It also provides a "new solution", contributing a Chinese approach to the global energy transition. With multiple world-first and domestic-first technological breakthroughs, the project stands as a "Chinese Solution" for the large-scale far-offshore wind power development and transmission, promoting the sustainable growth of the offshore wind industry. By demonstrating China's innovative strength, the project provides Chinese wisdom for the global emission reduction efforts.



Rendering of Submarine Cable to Overhead Line Terminal Station of the Project

Application Scenarios

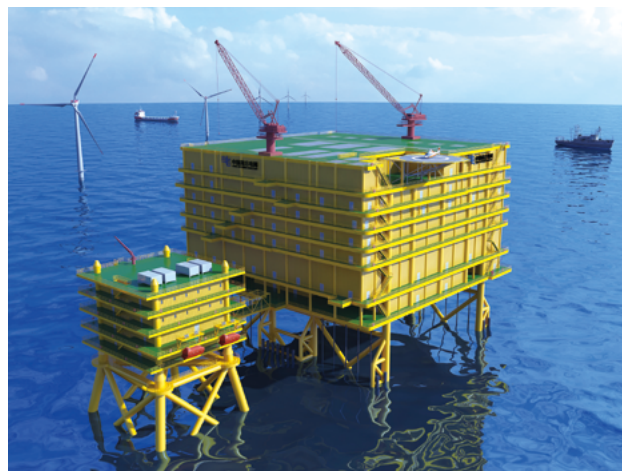
Large-scale, far-offshore wind power cluster development and transmission; sustainable development of the offshore wind industry



阳江三山岛风电柔直输电工程打通电力“深海高速路”

问题与挑战

中国海上风电发展势头强劲，累计装机容量连续4年（2021—2024年）位居全球第一，新增装机容量连续7年（2018—2024年）全球第一。然而，随着深远海域大规模风电快速发展，海上风电送出通道与登陆点资源紧张问题凸显。传统“风电场自建通道送出”模式导致海缆重复敷设、集控站重复建设，占用大量海底路由和陆上走廊资源。同时，传统交流输电存在容量小、损耗大、过电压等弊端，难以满足大规模深远海风电高效送出需求。此外，随着中国粤港澳大湾区建设深入推进，大规模能源接入需求迫切，而深远海域海上风电送出难题成为制约清洁能源供应的瓶颈。



阳江三山岛海上风电柔直输电工程海上换流站效果图

解决方案

阳江三山岛海上风电柔直输电工程作为国家“十四五”电网主网架核心项目及国资委百大示范工程，是全国首个由电网企业统一规划和建设的海上风电配套送出工程，也是全国首个海上风电海陆一体柔性直流输电工程，计划于2026年10月投产。该工程由中国南方电网有限责任公司统筹主导、其所属广东电网公司组织实施，在技术上实现多项创新，统一规划建设成输电“高速路”后，阳江三山岛海上风电一至四项目可实现“一站式拼车”，可避免海缆的重复敷设和集控站的重复建设，促进海陆空间资源的集约高效利用，助力清洁能源送达粤港澳大湾区，为未来深远海域风电项目的规模化送出提供宝贵经验。

攻克技术瓶颈，支撑深远海绿电高效送出

创造8项“世界第一”。阳江三山岛海上风电柔直输电工程将创造世界规模最大的海上风电直流输电工程、首个海上多端直流工程、不依赖集中直流耗能装置的海上风电直流输电工程等8项“世界第一”。

实现超大规模送出。现有的海上风电直流输电工程，最大输送容量为2000MW，阳江三山岛海上风电柔直输电工程突破系列技术瓶颈，将海上风电输电容量提升到6000MW等级。

打破传统送出模式。与常规海上风电项目送出方案不同，阳江三山岛海上风电柔直输电工程不仅在海上部分采用柔性直流输电技术，风电登陆后，陆上电能传输还将继续采用直流输电技术——以直流架空线方式将清洁电能直接送至大湾区负荷中心。

统筹规划海陆资源，构建集约化输电通道

整合海域资源。联合海洋渔业、自然资源等部门，优化海上风电集群布局，划定输电海缆集中敷设区，避免多项目分散开发导致的用海冲突。通过统一规划海缆路由，将阳江海域200万千瓦风电的输电海缆数量从交流方案的4根减少至柔直方案的2根，节约用海面积59%。

优化陆上廊道。针对土地资源紧张问题，工程陆上线路路径避让生态敏感区，并采用高跨设计减少林木砍伐、减少陆上走廊占用，采用直流架空线直送负荷中心模式，远期输送容量可达6000万千瓦，陆上走廊可节省70%，可有效缓解负荷中心地区电网短路电流超标问题。

多重价值

环境效益：

加速低碳转型，贡献“双碳”目标。工程投产后，每年可向粤港澳大湾区提供清洁电能约60亿千瓦时，相当于节约标煤174万吨，减少二氧化碳排放约463万吨，成为支撑湾区经济发展的强劲清洁动力。

经济效益：

“一站式拼车”，实现降本增效。通过“统一规划、共享通道”模式，阳江三山岛海上风电一至四项目可实现“一站式拼车”，不再重复敷设海缆和建设集控站，促进海陆空间资源集约高效利用，节约用海面积59%、陆上走廊70%。

社会效益：

提供“新解法”，贡献全球能源转型“中国方案”。三山岛工程作为全球深远海风电规模化开发送出的“中国方案”，创新采用多项世界或国内首创技术，对大规模、深远海域海上风电集约开发和送出，推动海上风电产业可持续发展具有重要意义，工程正以创新之力，为全球减排行动贡献中国智慧！



阳江三山岛海上风电柔直输电工程海缆转架空终端站效果图

应用场景

大规模、深远海域海上风电集约开发和送出；海上风电产业可持续发展。

About “GoldenKey – SDG Solutions”

To implement the assertion that sustainable development is the “golden key” to solving current global problems proposed by Chinese President Xi Jinping and to respond to the Decade of Action, “GoldenKey – SDG Solutions” (GoldenKey) was launched by China Sustainability Tribune in October 2020. The initiative aims to identify, shape, and promote outstanding corporate SDG solutions in China, tackle humanity's greatest challenges and drive sustainable development in China and beyond. In 2021, the GoldenKey was selected as the UN Good Practices (#33560).

As one of China's most influential platforms for sustainable development, GoldenKey has been held for six consecutive sessions. A total of 2,365 corporate SDG solutions have been collected, with 1,054 selected as outstanding SDG solutions. These solutions span areas such as climate action, well-being for all, rural vitalization, tech4SDG, quality education, action4nature, and zero waste. They stand out for their clear problem definition, outstanding innovation, strong replicability, and significant integrated value, demonstrating the capability and innovation of Chinese enterprises in advancing the SDGs.

With the growing emphasis on green and low-carbon transformation, the number of climate-related corporate solutions featured on the GoldenKey platform has increased each year. Participating enterprises range from central state-owned enterprises and foreign-invested companies to private enterprises of all sizes and sectors, contributing to China's carbon neutrality goal through efforts in energy transition, low-carbon production and operations, digital empowerment, financial support, as well as low-carbon consumption and living. GoldenKey has become one of China's most influential and internationally recognized platforms for corporate sustainability exchange and evaluation.

From 2022 to 2025, GoldenKey and State Grid Corporation of China (SGCC or State Grid) co-hosted the “GoldenKey · SGCC Special” for four consecutive years. The event collects innovative solutions on topics such as low-carbon transformation and green grids, and has identified and promoted numerous exemplary practices within the power sector. In 2025, GoldenKey launched the “GoldenKey · Power Sector Special” in partnership with the China Electricity Council (CEC) to further collect and showcase breakthroughs by power enterprises in climate change, China's 30·60 Decarbonization Goal, and low-carbon transition of clean energy.

GoldenKey continues to optimize and upgrade China's corporate SDG solutions. Through a series of initiatives, including publications, academic forums, field research, international launches, and demonstration projects, GoldenKey showcases and promotes these solutions on domestic and global platforms such as the China International Import Expo, China International Consumer Products Expo, UN Climate Change Conferences, and IUCN World Conservation Congress. This provides replicable models for more regions worldwide and supports the implementation of the SDGs.

Additionally, GoldenKey and the International School of Low-carbon Studies of Shandong University of Finance and Economics jointly established the GoldenKey Low-Carbon Action Center. Focusing on empowering enterprises in their green and low-carbon transformation, the center provides comprehensive knowledge empowerment and capacity building, covering low-carbon strategy development, carbon management capacity building, green project implementation, application of green financial instruments and climate risk control.



GoldenKey Annual Event

关于“金钥匙——面向SDG 的中国行动”

为落实中国国家主席习近平关于“可持续发展是破解当前全球性问题的‘金钥匙’”论断，响应联合国可持续发展目标“行动十年”计划，《可持续发展经济导刊》于2020年发起“金钥匙——面向SDG 的中国行动”（简称“金钥匙”）。

“金钥匙”旨在寻找、塑造、推广来自中国企业贡献SDG的优秀解决方案，应对人类所面临的重大挑战，为推动中国和全球可持续发展贡献力量。2021年，“金钥匙”获评联合国SDG 优秀实践（编号：SDG Action#33560）。

“金钥匙”是中国可持续发展领域具有重要影响力的平台型活动，目前已成功举办六届，共征集了2365项行动，其中1054项行动脱颖而出，在气候行动、人人惠享、乡村振兴、科技赋能、优质教育、礼遇自然、无废世界等领域涌现出一批问题定义精准、创新性突出、可复制性强、综合价值显著的SDG 解决方案，展现出中国企业贡献SDG 的行动力和破解难题的创新力。

随着企业对绿色低碳转型重视程度的增加，金钥匙平台上关注气候议题的企业行动数量逐年增加，涉及企业包括不同规模、不同行业的央企、在华外企以及民营企业等，这些行动分别从能源转型、低碳生产与运营、数字化赋能、金融支持、低碳消费与生活等方面积极参与全球气候治理，贡献中国碳中和目标。“金钥匙”成为中国最具影响力和国际化的企业可持续发展交流与展示活动。

2022-2025年，金钥匙与国家电网连续四年合作举办“金钥匙·国家电网主题赛”，围绕低碳转型、绿色电网等议题征集创新方案，发掘推广了一批行业示范实践；2025年，金钥匙与中国电力企业联合会启动“金钥匙·电力行业主题赛”，旨在更广泛征集推广电力行业在应对气候变化、服务“双碳”目标、促进能源清洁低碳转型等方面的突破性行动。

“金钥匙”持续对中国企业SDG 解决方案进行优化升级，举办成果出版、学术研讨、走访调研、国际发布、推广示范等一系列活动，在中国国际进口博览会、中国国际消费品博览会、联合国气候变化缔约方大会、世界自然保护大会等国内外平台上展现和推广中国企业SDG 解决方案，为全球更多地区提供可复制的经验，助力联合国2030可持续发展目标落实。

此外，“金钥匙”还联合山东财经大学中国国际低碳学院成立“金钥匙低碳行动中心”，以推动企业绿色低碳转型为核心，提供涵盖低碳战略制定、碳管理能力提升、绿色项目实践、绿色金融工具应用及气候风险管控等全方位的知识赋能和能力建设。



金钥匙年度盛典



Read the full version of 2025 Climate Solutions from
Chinese Enterprises
获取《中国企业应对气候变化解决方案》完整案例集



Learn more about GoldenKey SDG Solutions
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“金钥匙——面向SDG的中国行动”



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