



2025 Climate Solutions from Chinese Enterprises

应对气候变化的中国企业解决方案 (2025)

Precision Adaptation & Multi-Energy Integration Cracking the Code on Building Zero-Carbon Mountainous Villages

精准适配，多能共赴：破解山区零碳乡村建设难题



国家电网
STATE GRID

国网文成县供电公司

STATE GRID WENCHENG ELECTRIC POWER SUPPLY COMPANY



Precision Adaptation & Multi-Energy Integration

Cracking the Code on Building Zero-Carbon Mountainous Villages



Challenges

Wuyang Village is a typical mountainous village perched on a 730-meter-high plateau in Nantian town, Wencheng County, Zhejiang Province. Residential clusters are scattered along the mountain slopes, where infrastructure development is severely constrained by the rugged terrain. Despite abundant hydropower resources and an annual average of 1,080 effective sunlight hours, the village was long trapped in a clean energy paradox. Before 2022, Wuyang Village faced three core challenges:

First, fragmented and underutilized green energy. The utilization rate of local hydropower stations stood at only 15%, while PV installations were extremely limited. Around 78% of villagers still relied on firewood stoves and coal for heating, resulting in annual carbon emissions exceeding 2,000 tons — a paradoxical situation of “burning firewood amid abundant green energy.”

Second, fragile grid with supply-demand imbalances. Long supply distances and dispersed loads, combined with frequent thunderstorms, led to an average annual power interruption duration of 1.64 hours per household in 2022. This severely hindered the development of local homestays and rural tourism.

Third, lack of carbon metering and significant misconceptions. The village lacked basic carbon emissions monitoring infrastructure. Misconceptions about low-carbon living were widespread: 63% of villagers believed that “low carbon means a lower quality of life,” and 82% were concerned about the high maintenance costs of new energy equipment.



The forestry-PV complementary project in Wencheng



Solution

State Grid Wencheng Electric Power Supply Company (“State Grid Wencheng” for short) pioneered an integrated approach combining energy revolution, digital empowerment, and cultural immersion. Through the construction of a six-in-one microgrid integrating hydrogen, vanadium, solar power, hydropower, energy storage, and smart charging, it enables the precise low-carbon transition of mountainous villages.

1. Energy revolution: building an intelligent microgrid system. Through the construction of a multi-energy complementary microgrid, the company has installed 44.5 kWp of PV system, 2×630 kW of hydropower system, an 80 kW/240 kWh energy storage system, and a hydrogen production system, forming an integrated source-grid-load-storage architecture. A “1+3” master-slave router system enables precise dispatching and 100% local accommodation of clean electricity. By connecting a 10kV interconnection line with a smart switching station, the microgrid achieves seamless grid-connected and off-grid operation, providing up to 6.08 hours of off-grid power supply. As a result, the average interruption duration per household has been reduced to 0.748 hours.

2. Digital empowerment: creating a “Dual Carbon Brain” platform. This platform integrates multi-source data—including meteorological, hydrological, and grid information—processing around 49,000 data points daily to enable precise metering through a “Dynamic Carbon Emission per kWh” model. By applying AI algorithms to coordinate source, grid, load, and storage, it achieves peak shaving, valley filling, and carbon footprint tracing. In 2024, Wuyang Village’s carbon emissions per kWh dropped by 28.4% year on year, reducing total carbon emissions by around 900 tons.

3. Cultural immersion: fostering a green lifestyle. Low-carbon practices have been incorporated into a bonus points system, allowing villagers to earn bonus points in eight scenarios—such as green commuting and online electricity services—that can be redeemed for goods or electricity bill discounts. The establishment of a VR classroom, a Youth Carbon Neutrality Growth Center, and the “Adopt-a-Tree” carbon sink project has significantly enhanced low-carbon awareness among both residents and tourists, with participation soaring from 37% to 91%.



Multiple Benefits

Environmental

The master-slave energy routing system developed by State Grid Wencheng integrates renewable sources such as hydro, solar, and hydrogen powers to achieve a 100% clean regional energy supply. The system has generated a total of 1.925 GWh of electricity annually, cutting carbon emissions by about 900 tons each year. This efficient energy utilization and green development model protects the ecological environment of Wuyang Village and supports Wencheng County’s “Beautiful Rivers and Lakes” initiative.

Economic

Since the project’s completion, the Wuyang PV system has generated 48.4 MWh of power annually, while energy storage for peak-valley regulation has yielded annual returns of approximately US\$15,400. The full electrification of guesthouses has boosted the village collective’s income from just over US\$14,000 to approximately US\$158,600. Villagers’ average annual income has increased by approximately US\$1,200, homestay occupancy rates have risen by 65%, and total tourism revenue has exceeded US\$102,500.

Social

Grid upgrades have raised power supply reliability to 99.997%, significantly improving villagers’ quality of life. Through promotion, Wuyang Village has cultivated a green, low-carbon lifestyle, offering a replicable zero-carbon transition model for similar rural communities.



Employees of State Grid Wencheng inspect the distribution box of a local guesthouse.



Application Scenarios

Zero-carbon development of mountainous, remote, and tourism-oriented villages; regions with abundant but underutilized distributed renewable energy resources (e.g., hydropower, and solar); communities or parks requiring precise carbon metering and intelligent energy regulation; and sustainable communities seeking to enhance resident engagement



Employees of State Grid Wencheng provide service at the Qiaojiale Guesthouse.

精准适配，多能共赴： 破解山区零碳乡村建设难题

问题与挑战

武阳村是典型的山区乡村，位于浙江省文成县南田镇海拔730米的高山平台上，村民居住点沿山麓散落分布，基础设施建设受地形限制明显。尽管拥有丰富的水能资源和年均1080小时的有效光照，却陷入多重清洁用能困境。2022年以前，该村主要面临三大核心挑战：

一是绿能分散，难以聚合。水电站利用率仅15%，光伏安装率极低，78%的村民仍依赖柴火灶与燃煤取暖，年碳排放超2000吨，形成“守着绿能烧柴火”的窘境。

二是电网脆弱，供需失衡。供电半径长、负荷分散，叠加多雷雨气候，2022年户均年停电时间达1.6418小时，严重影响民宿经营与旅游发展。

三是碳排计量缺失，认知偏差显著。该村缺乏基础碳排放计量设施，村民对低碳生活存在误解，63%的村民认为“低碳即降低生活质量”，82%的村民担心新能源设备维护成本高。



文成林光互补光伏项目

解决方案

国网浙江省电力有限公司文成县供电公司（以下简称国网文成县供电公司）以“能源革命+数字赋能+文化浸润”三维融合路径，构建“氢钒水光充智”六位一体微电网，实现山区零碳乡村的精准转型。

一是能源革命，构建智能微网系统。通过多能互补微网建设44.5kWp光伏、2×630kW水电、80kW/240kWh储能及制氢系统，形成“源-网-荷-储”一体化架构。部署“1+3”主从路由器系统，实现清洁电能的精准调度与100%就地消纳。通过10kV互联线路与智能开关站，实现微网并/离网平滑切换，离网保供能力达6.08小时，户均停电时间降至0.748小时。



二是数字赋能，打造“双碳大脑”平台。集成气象、水文、电网等多源数据，每日处理约4.9万条信息，实现“度电碳排放动态模型”精准计量。通过AI算法协同源-网-荷-储，实现削峰填谷、碳足迹追溯。2024年，武阳村度电碳排放同比下降28.4%，减少碳排放约0.09万吨。

三是文化浸润，推动绿色生活方式。将低碳行为纳入“大明通宝”积分系统，村民可通过绿色出行、线上办电等八大场景获取积分，兑换商品或电费优惠。设立VR学堂、青少年碳中和成长中心，开展“领养一棵树”碳汇林项目，提升村民与游客的低碳意识，参与率从37%跃升至91%。

多重价值

环境价值。

国网文成县供电公司建设主从式能源路由系统，广泛接入水、光、氢等可再生资源，实现地区能源供应100%清洁化，累计发电192.54万kWh，年减少碳排放约0.09万吨。能源高效利用和绿色发展模式，保护了武阳村的生态环境，助力文成县“美丽河湖”建设。

经济价值。

项目建成后，武阳地区光伏年发电4.84万kWh，储能峰谷调节年收益11万元，民宿全电化改造带动村集体收入从10余万元增至113万元。村民年均增收8500元，民宿入住率提升65%，旅游综合收入突破73万元。

社会价值。

电网升级改造让供电可靠性提升至99.997%，村民生活质量显著提高。通过宣传推广，武阳村形成了绿色低碳的生活风尚，为同类型乡村提供了可复制的零碳转型路径。



国网文成县供电公司员工检修民宿配电箱

应用场景

山区、偏远乡村及旅游型村落的零碳建设；具备分散式可再生能源（如水能、光伏）但利用率低的地区；需要精准碳排放计量与智慧调控的社区或园区；需要提升居民参与度的可持续社区。



国网文成县供电公司员工服务侨家乐民宿

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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