

Pursuing Eco-Friendliness and Embracing Innovation World's First County-Level Demonstration Zone for New-Type Power Systems

逐“绿”而行 向“新”而变
——世界首个县域级新型电力系统示范区落地实践



国家电网
STATE GRID

国网随州供电公司
STATE GRID SUIZHOU POWER SUPPLY COMPANY





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Challenges

As a national demonstration base for new energy power generation, Suizhou possesses abundant solar and wind resources. Yet, for Suizhou power grid, alongside this abundance come pressing challenges in accommodating and absorbing new energy on a large scale. First, grid stability is under severe pressure. The installed capacity of new energy in Suizhou has reached 2.7 times its local maximum load. The imbalance between strong power source and weak load makes the traditional grid structure and control methods inadequate to maintain stable operation. Second, the capacity for accommodating new energy is severely constrained. With relatively weak interconnections to the transmission grid, Suizhou power grid experiences sharp mismatches between the fluctuating energy output and its steady local demand. The shortage of local accommodation space and limited outbound transmission capacity further heighten the risk of wind and solar curtailment. Third, the traditional power protection system lacks adaptability. The fault characteristics of new energy generators reduce the sensitivity and selectivity of relay protection devices based on synchronous sources, increasing the likelihood of cascading failures. Finally, flexible access and precise control capabilities are insufficient. In hybrid AC-DC network scenarios, the existing grid architecture cannot flexibly accommodate new energy and diverse loads, limiting the optimization of resource allocation.



Panoramic view of the Guangshui New-Type Power System Demonstration
Zone powered by 100% new energy

Solution

In 2020, State Grid Hubei Electric Power Co., Ltd. launched the Suizhou Guangshui County-Level High-Proportion New Energy Power Grid Project, creating the world's first hundred-megawatt-level new-type power system demonstration zone powered by 100% new energy. Covering 418 square kilometers and serving over 200,000 residents, the project integrates 244 MW of new energy capacity (including 194 MW of wind power and 50 MW of solar power). Through five core technologies—grid-forming new energy retrofits, high-voltage energy routers, and coordinated source-grid-load-storage control—the project overcomes key challenges of low inertia, weak stability, and limited accommodation under high-proportion new energy access.

- ▶ **Power source side:** For the first time globally, a 100% new energy real-world power system has been built to study key issues such as voltage stability, frequency stabilization, power balance, and fault characteristics under a new-type power system.
- ▶ **Grid side:** For the first time in China, independent grid formation powered solely by new energy has been realized in a real-world grid, marking a pioneering step toward making new energy the main power source of future grids.
- ▶ **Load side:** The project developed the world's largest and highest-voltage energy router, verifying the system's stability under 100% new energy operation without main-grid support, and enabling greater new energy utilization and accommodation.
- ▶ **Energy storage side:** It achieved a breakthrough in 12.5MW energy storage technology for 100% new energy scenarios, enhancing the grid's capacity to accommodate new energy and serving as a stability anchor comparable to thermal generation units.
- ▶ **Control side:** The world's first hundred-megawatt-level coordinated source-grid-load-storage control system was developed, ensuring voltage and frequency stability under highly complex power fluctuation scenarios, especially in the grid formation of 100% new energy.

Multiple Benefits

Environmental

By the end of 2023, the demonstration zone has achieved normalized operation. In 2024, power supply duration powered by 100% new energy reached 77% of total time, and new energy share in total power supply rose to 85%. The project delivered 159 GWh of clean electricity to key industries such as steelmaking, wind turbine, and textiles, reducing overall social electricity costs by about US\$2.8 million and cutting CO₂ emissions by 128,800 tons, equivalent to planting 6.13 million pine trees, a major boost to local energy mix optimization and green transition.

Economic

Through demand-side response mechanisms, the project formed the maximum flexible peak-shaving capacity of 5%. Taking 2024 Suizhou power grid data as an example, a 5% adjustable load could offset the need for 60 MW of new peaking generation. Based on a coal-fired unit construction cost of nearly US\$519 per kW, this amounts to a saving of US\$31 million in peaking-unit investment, deferring conventional transmission and transformation investments, and freeing capital for rural electrification projects.

Social

The project has built the world's largest scientific demonstration project featuring the highest share of flexible load, the highest proportion of new power supply, the longest power supply duration by new energy operation, and the most complex technical architecture. With the ability to realize grid formation by 100% new energy, it provides a comprehensive experimental platform for technologies related to control, protection, and the source-grid-load-storage interaction. Comparable in capability to KEMA Labs in the Netherlands, the demonstration zone can provide consulting, testing, inspection, and product certification services to society and the entire energy industry chain. During China's 15th Five-Year Plan period(2026-2030), it is estimated that thousands of county-level (regional grids and incremental distribution networks) and park-level integrated source-grid-load-storage projects will be developed nationwide. The technical achievements of this project are replicable and scalable, expected to drive collaborative growth across upstream and downstream and form a market valued at tens of billions of US dollars.



CCTV's Chinese International Channel reported on the launch of power transmission of the Guangshui technology demonstration project.

Application Scenarios

Provincial high-density new energy zones; regional power grids, including county-level power grids, industrial parks, and comprehensive energy pilot projects; new energy plants and new energy equipment manufacturing enterprises



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问题与挑战

随州市作为“全国新能源发电示范基地”，拥有得天独厚的太阳能和风能资源。然而，在资源富集的同时，在承接和消纳大规模新能源方面，随州电网也暴露出亟待解决的深层次痛点：一是电网稳定运行面临严峻挑战，随州新能源装机容量已达本地最大负荷的2.7倍，“强电源、弱负荷”的特征导致传统电网的结构和控制方式难以维持稳定运行；二是新能源电力消纳能力严重受限。随州电网与主网联系相对薄弱，能源出力的波动性与本地相对固定的负荷需求严重不匹配，加之本地缺乏足够消纳空间，电力外送通道能力成为瓶颈，弃风弃光风险突出；三是传统电力保护体系适应性不足，新能源机组的故障特性导致依赖传统同步电源特性的继电保护装置灵敏度和选择性下降，易引发连锁故障，扩大事故范围；四是灵活接入与精准控制能力欠缺，在交直流混联的复杂电网场景下，现有电网结构对新能源和多元负荷的接入方式不够灵活，限制了资源的优化配置。



湖北广水100%新能源新型电力系统科技示范工程虎山能量路由器站

解决方案

国网湖北电力于2020年启动湖北随州广水高比例新能源县域电网项目，打造全球首个百兆瓦级100%新能源独立运行的新型电力系统示范区。该项目覆盖供电面积418平方公里，服务超20万人口，集成244兆瓦新能源装机（风电194兆瓦、光伏50兆瓦），通过构网型新能源改造、高压能量路由器、源网荷储协同控制等五大核心技术，攻克新能源高比例接入下的电网低惯量、弱稳定、消纳难等难题。

- ▶ **电源侧：**在世界上首次构建一个100%新能源的真实电力系统，用以研究新型电力系统下的电压稳定、频率稳定、电力电量平衡、故障特性等关键问题。
- ▶ **电网侧：**在全国首次实现在真实电网中由新能源作为主电源进行独立组网，对新能源如何发挥主体作用进行了前沿探索。
- ▶ **负荷侧：**研制世界上容量最大、电压等级最高的能量路由器，检验广水示范区在100%新能源、无大电网支撑场景下的稳定运行能力，促进新能源的利用与消纳。
- ▶ **储能侧：**首次突破100%新能源独立场景下12.5兆瓦储能技术，提升电网对新能源的承载能力，具有替代传统火电机组成为系统稳定压舱石的潜力。
- ▶ **控制侧：**研发世界首套百兆瓦级源网荷储协同控制系统，实现各种极端复杂功率波动场景下，尤其是100%新能源独立组网时的电压、频率稳定。

多重价值

环境效益：

2023年底，示范区实现常态化运行。2024年，示范区100%新能源供电时间占比提升至77%，新能源供电量占比提升至85%，当年为示范区内钢铁冶炼、风机、纺织等重点产业输送清洁绿色电能1.59亿度，降低全社会用电成本约2000万元。同时，项目实现年度二氧化碳减排12.88万吨，相当于种植613万颗青松，有力推动了当地能源结构优化与绿色转型。

经济效益：

项目通过“需求侧响应”机制，形成了最大负荷5%的机动调峰能力。以2024年随州电网运行数据为例，5%可调负荷可减少60MW调峰机组的建设，按照3700元/千瓦燃煤机组造价计算，相当于节省了2.22亿元调峰机组投资，可延缓常规输电变电工程投资，用于反哺乡村电气化改造。

社会效益：

项目建成了世界规模最大、柔性负荷占比最大、可再生能源供电比例最大、供电时间最长、技术难度最大的科技示范工程，具备100%可再生能源独立组网条件，可为控制、保护、源网荷储互动等技术提供丰富的试验场地，将能够比肩荷兰KEMA实验室，具备向全社会、全产业链提供咨询、试验、检测、产品认证的能力。十五五期间，我国预计将会产生数千个县域级（区域电网、增量配网）或园区级源网荷储一体化项目，项目相关成果可在全国复制、推广，带动上下游众多产业协同发展，形成千亿级市场。



中央电视台中文国际频道报道广水科技示范工程启动送电

应用场景

省域局部新能源密集区；包括县域电网、工业园区、综合能源试点工程等在内的区域型电网；新能源场站及新能源设备制造企业。

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
了解更多关于
“金钥匙——面向SDG的中国行动”



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