

AI for Flood Prevention

A Climate-Resilient Flood Prevention Model for Community-Based Underground Distribution Rooms

AI问汛，防涝有道
打造具有气候韧性的社区地下配电房防汛模式



国家电网
STATE GRID

国网台州市黄岩区供电公司
STATE GRID TAIZHOI HUANGYAN POWER SUPPLY COMPANY



国家电网
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国网浙江省电力有限公司信息通信分公司
STATE GRID ZHEJIANG INFORMATION & TELECOMMUNICATION COMPANY



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Challenges

Global warming has significantly increased the frequency and intensity of hydrometeorological events. Located along the Zhejiang coast, Huangyan District of Taizhou City serves as the frontline of flood and typhoon prevention efforts. The district has 167 underground distribution rooms, supplying power to more than 200,000 households and key users. While these underground facilities save valuable urban space, they also face the risk of being flooded and failing. Relying on the traditional flood prevention model of “sandbags, pumps, and staff watch or duty” leads to a huge waste of manpower and material resources, and personnel tend to experience “readiness fatigue” from prolonged preparations. However, relocating underground distribution rooms above ground also presents challenges, including difficulties in selecting suitable surface locations, large-scale construction, and the need to revise and approve design plans and planning permits.



Huangyan Urban Flood Prevention Radar System

Solution

In response to these challenges, State Grid Taizhou Huangyan Power Supply Company (“State Grid Huangyan” for short) teamed up with technical experts to develop waterproof distribution equipment and an urban flood prevention radar system, which has created an integrated flood prevention model for underground distribution rooms that combines manual prevention, technological prevention and intelligent prevention, building a robust safety shield for the city’s power infrastructure.

Technological prevention: building the flood gatekeeper

To address the vulnerability of conventional distribution equipment to water damage, the project team successfully developed China's first 10kV waterproof distribution equipment capable of continuous operation while submerged, achieving a "physical hard barrier" against floods. The equipment features a fully sealed design, completely isolating internal components from external air and moisture. It can operate under power for at least 48 hours while fully submerged, effectively addressing the challenges posed by complex operating environments, including dampness, flooding, and corrosion, which constantly threaten the health of electrical equipment. This innovation breaks the traditional limitation of "power shutdown when exposed to water," providing a robust safety barrier for underground distribution rooms.

In July 2024, State Grid Huangyan installed the new waterproof equipment in the underground distribution rooms. Over the past year, the equipment has withstood all flooding caused by typhoons and heavy rains, maintaining zero failures even during multiple intense downpours.

Technological prevention: developing a smart "brain" for flood prevention

If the flood-resistant equipment serves as the "frontline soldier," then the Huangyan Urban Flood Prevention Radar System is the command center. Developed jointly by the State Grid Huangyan and the Energy Big Data Service Center of State Grid Zhejiang Information & Telecommunication Company, this integrated management platform combines big data, artificial intelligence, and IoT technologies, and was officially launched on July 8, 2025.

1. Accurate flood prevention predictions. Powered by AI-driven algorithms, it builds accurate models to predict waterlogging risks. Before a typhoon or heavy rainfall hits, the system can pinpoint which areas and which residential distribution rooms are at high risk, output predictive classification results for underground distribution rooms in the district within 24 hours, as well as detailed early warnings one hour after rainfall. By issuing alerts in advance, the system has improved the accuracy of flood prevention predictions to 92.4%.

2. "One-click" information inquiry. Now, the O&M personnel only need to use the computer client of the "AI-Powered Flood-Prevention Smart Inquiry System" and ask the AI assistant questions like "Show me the list of high-risk distribution rooms" or "Where are the flood-prevention supplies for XX community?" The system can provide the required information in just one second, presented in a rich, illustrated format, including the distribution room's location, risk level, contact information of the responsible personnel, flood-prevention supply status, and real-time monitoring footage. It can intelligently plan optimal repair routes and personnel deployment based on the emergency severity and available resources, which has completely transformed the previous situation of scattered information and cumbersome queries.

3. Smart dispatch and command. When an emergency occurs, the system can leverage GIS maps to visually display the real-time locations of disaster sites, repair personnel, vehicles, and emergency supplies. It can intelligently plan optimal repair routes and personnel deployment based on the emergency severity and available resources, enabling flat, visualized emergency command and significantly improving repair efficiency.



Staff at the Dispatch and Control Sub-Center of State Grid Huangyan continuously monitor the entire district's power grid in real time, mobilizing all resources to defend against typhoons



Multiple Benefits

Economic

Since its deployment, all underground distribution rooms in Huangyan District equipped with the new waterproof devices recorded zero flooding incidents during typhoons and other extreme weather events. Considering that the average repair cost per flooded distribution room is approximately US\$70,536, this alone prevented millions of dollars in direct economic losses. By avoiding outages, the measures also safeguarded the continuity of residential life, commercial activities, and industrial production, generating immeasurable indirect economic benefits. The application of the Huangyan Urban Flood Prevention Radar System has enabled distribution rooms to be monitored with minimal or no on-site personnel. This saves over US\$140,500 in labor costs annually, while also significantly reducing expenses for platform setup and equipment deployment.

Social

The flood prevention model of underground distribution rooms featured by "manual prevention, technological prevention and intelligent prevention" has significantly enhanced urban communities' capacity to withstand flood risks. During extreme weather events, community power supply remained rock-solid, ensuring both the safety of residents and the quality of their daily lives. The Huangyan Urban Flood Prevention Radar System project has received multiple provincial and municipal awards for technological innovation, and been promoted nationwide within the State Grid system.

Environmental

By preventing transformers and other equipment from being submerged, the system can avoid the risk of insulating oil leakage, protecting the soil and groundwater in the community from contamination.



Application Scenarios

Power supply companies and residential communities exposed to the risk of urban waterlogging



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问题与挑战

全球气候变暖导致水文气象事件的强度和频率显著增加，台州市黄岩区是浙江沿海地区防汛防台的“前哨”。黄岩区有167个地下配电房，为超过20万户居民和重要用户供电，这些配电房在节约城市空间的同时，也面临着被淹失效的风险。依赖于“沙袋+抽水泵+人力值守”的传统防汛模式会造成极大的人力和物力资源浪费，而且人员容易出现“久备而怠”的情况。然而将地下配电房搬迁到地上也面临诸如地面位置选择难、工程量大、图纸和规划的修改与审批等难点。



黄岩城市防汛雷达系统

解决方案

针对上述情况，国网台州市黄岩区供电公司联合技术力量，研发防水型配电设备与城市防汛雷达系统，形成一套“人防+技防+智防”的地下配电房防汛模式，为城市筑牢电力安全屏障。

技防, 打造防汛守门员

针对传统配电设备怕水易损的痛点, 项目团队研发了国内首套可在水中持续运行的10kV防水型配电设备, 实现了对洪水的“物理硬隔离”。该设备采取全密封设计, 内部元件与外部空气、水汽完全隔离, 可在完全淹没状态下带电工作至少48小时, 有效解决电力设备运行环境复杂, 受潮、浸水及锈蚀等威胁电力设备健康运行的问题。这一创新打破了配电设备“遇水必停”的固有局限, 为地下配电房提供了一道安全屏障。

2024年7月, 国网台州市黄岩区供电公司在地下配电房投入运行防水型新设备。运行一年来, 新设备扛住所有台风和暴雨带来的洪涝灾害, 在多次强降雨中保持零故障运行。

智防, 开发运筹帷幄的“防汛大脑”

如果说防浸水设备是“前线士兵”, 那么黄岩城市防汛雷达系统就是“指挥中枢”。这套系统是国网台州市黄岩区供电公司联合浙江省能源大数据中心建设的集大数据、人工智能和物联网技术于一体的综合管理平台, 于2025年7月8日启用。

1. 防汛预测准确率高。系统通过AI算法构建了精准的内涝风险预测模型, 在台风或暴雨来临前, 可精准预测出哪些区域、哪些小区配电房存在高风险, 能够输出24小时内辖区地下配电房浸水预测分类结果, 及降雨后1小时的细分预警信息, 并提前发布预警, 将防汛预测准确率提升至92.4%。

2. “一键式”信息查询。如今, 运维人员只需通过电脑客户端“AI防汛智慧问询系统”向AI助手提问, 如“查询高风险配电房列表”“某小区的防汛物资在哪里”, 系统便能在一秒钟内以图文并茂的形式提供所需信息, 包括配电房位置、风险等级、负责人联系方式、防汛物资储备情况、实时监控画面等, 并能根据险情等级和资源状况, 智能规划最优抢修路径和人员调配方案, 彻底改变以往信息分散、查询繁琐的局面。

3. 智慧调度与指挥。当险情发生时, 该系统能够基于GIS地图直观展示受灾点、抢修人员、车辆和物资的实时位置, 并能根据险情等级和资源状况, 智能规划最优抢修路径和人员调配方案, 实现扁平化、可视化的应急指挥, 极大提升抢修效率。



国网台州市黄岩区供电公司调度控制分中心人员
实时跟踪全区电网信息, 全力防御台风

多重价值

1. 经济效益

自投入应用以来, 黄岩区所有安装全新防浸水设备的地下配电房, 在台风等极端天气中实现“零水淹”事故。按照配电房水淹后平均维修成本50万元计算, 仅此一项就避免了数千万元的直接经济损失。通过避免停电, 保障居民生活、商业活动和企业生产的连续性, 其创造的间接经济效益难以估量。黄岩城市防汛雷达系统的应用, 使配电房实现“无人化”或“少人化”值守, 每年可节约人力成本超过百万元, 也节省大量的平台搭建和设备部署的费用。

2. 社会效益

“人防+技防+智防”的地下配电房防汛模式, 全面提升了城市社区抵御洪涝灾害风险的能力。极端天气中, 社区电力供应始终稳如泰山, 居民的生命安全和生活品质得到切实保障。“黄岩城市防汛雷达系统”项目荣获多项省市级电力科技创新奖项, 被国网系统作为典型经验向全国推广。

3. 环境效益

从源头上防止变压器等设备因水淹导致绝缘油泄漏的风险, 保护小区的土壤和地下水体免受污染。



应用场景

受城市内涝威胁的供电公司、社区小区

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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Authors: Yan Jiaxiang, Sun Liang, Yang Jingjing
Editor: Hu Wenjuan
Designer: Guo Zhiyu
Translator: Yang Mingming

作者: 严家祥、孙亮、杨晶晶
编辑: 胡文娟
设计: 郭志宇
翻译: 杨明明