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Sinopec Green Energy Geothermal Development Co., Ltd. – Progress Sharing on Geothermal Energy Development and Utilization

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INTRODUCTION

As geothermal heating keeps expanding, the traditional “one-production / one-injection” pattern—only suited to small service areas—can no longer satisfy the demand for large-scale district heating. Meanwhile, legacy coal- and gas-fired boilers burn huge amounts of fossil fuel, keeping operating costs high and pushing the dual-carbon targets out of reach. Clean-energy substitution is therefore imperative: “geothermal-for-coal” and “geothermal-for-gas” have become inevitable strategic choices.
Large-scale geothermal-replacement projects involve clustered well-field development, long-distance geothermal-water transmission, multi-pump parallel operation, reinjection-flow regulation and real-time reservoir-pressure monitoring. In addition, helium and other water-soluble gases inevitably co-produce with the geothermal fluid. By integrating assessments of dissolved-gas content, a “water–heat–mineral” co-development model can be implemented, turning what was once waste into value and ensuring the sustainable utilization of the geothermal resource.
Guided by temperature-level cascaded use, the same geothermal stream can successively drive power generation, space heating and domestic hot-water supply—maximizing energy extraction while minimizing environmental impact.
The successful hosting of the 2023 World Geothermal Congress gave Green Source a global spotlight. Backed by years of targeted R&D and a “technology-first” mindset, the company keeps opening new markets, pioneering fresh geothermal applications and setting the pace for the sector. To squeeze large well clusters into tight sites it created the “well-factory” model; to squeeze more energy out of every drop it is trialling a “power-heat-helium” tri-generation system; to bridge the gap between distant resources and customers it designed a long-distance “collect-transport-reinject” pipeline network; and to cut operating power and personnel costs it built an intelligent control platform that forecasts loads and handles logic control automatically. These innovations not only confirm Green Source’s leadership—they also hand the industry a ready-to-use playbook.
After WGC-2023, Green Source went hunting overseas—scouting high-temperature fields in Saudi Arabia, Indonesia and Hungary on the ground to lock in the right partners for its next chapter abroad.

METHODS

1.Overcoming the challenges of production and reinjection, on the basis of the original "one production and one reinjection" method, Xi'an Thermal Power Company pioneered the deployment of 20 geothermal wells in a group pattern. By applying advanced technologies such as "cluster well groups, combined production and reinjection well, and equal volume backflow", they broke new ground in the domestic development and utilization of geothermal resources through large-scale group production and group reinjection. During the operation period, the reinjection rate reached 100%, verifying the advanced nature and feasibility of the project.

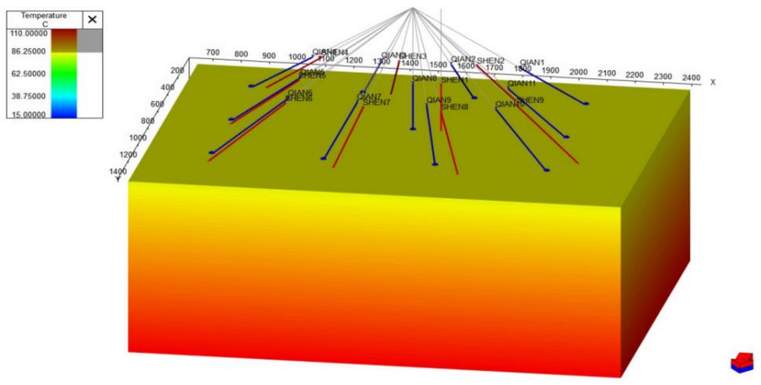


Figure 1 Dynamic Analysis of Three-Dimensional Temperature Field Changes in Xi'an Thermal Power Project

2.The "combined method" for extracting helium was adopted, integrating four-stage technologies of hydrogen removal, membrane separation, pressure swing adsorption, and low-temperature refining to overcome the problem of extracting helium from low concentrations. A collaborative control algorithm for geothermal power generation and helium extraction was developed to achieve precise matching of energy flow and material flow.A comprehensive development model of "energy + resources" was constructed. The helium sales were used to subsidize the costs of geothermal power generation. An "Internet +" service platform for geothermal heating was developed to realize real-time monitoring of user energy consumption data and charging.At the same time, a technical evaluation system for geothermal fluid re-injection technology was established for geothermal wells operating throughout the year, and technical regulations for re-injection and maintenance during the year's operation of geothermal wells were formulated to lead the industry towards high-quality development.

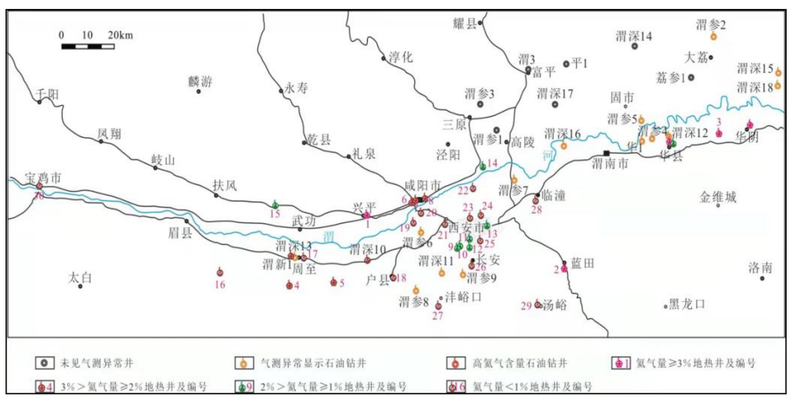


Figure 2 Distribution Map of Geothermal Wells Containing Helium Gas

3. Collection and Conveyance: There are a large number of project well sites and well numbers. Therefore, after extracting the geothermal water, it is transported through the main pipe for centralized delivery. After being utilized, it is also transported back for reinjection, converting the scattered geothermal resources into a consolidated whole.
Centralized Delivery and Long-Distance Transmission: There is a mismatch in the spatial distribution of heat sources and heat demand in the project. Through technical and economic verification, the geothermal water is centrally transported through the geothermal pipeline to the high-speed rail energy station, achieving the goal of stable and efficient long-distance transmission of thermal energy across regions, and realizing "off-site heat extraction" in geothermal energy development, providing a new idea for the development of deep geothermal reservoirs.



Figure 3 Layout of geothermal wells and pipeline routes in the Xiong'an High-Speed Railway Area

RESULTS

1.Located in Weiyang District, Xi'an, Shaanxi Province, the project comprises 20 geothermal wells configured as 9 production, 9 reinjection, and 2 standby, delivering a total heating capacity of 75.75 MW. It provides clean heating for 1.8938 million m² of floor area, with an annual heat supply of 785,400 GJ.
The project is implemented in two phases:
Phase I includes 8 wells (4 production, 4 reinjection), offering a heating load of 33.67 MW, an annual heat output of 349,100 GJ, and serving 841,700 m² of clean heating area.
Phase II adds 12 wells (5 production, 5 reinjection, 2 standby), contributing 42.08 MW of heating load, 436,300 GJ annually, and covering 1.0521 million m².

2.The project is based on the low-temperature sedimentary basin-type geothermal resources in the Guanzhong Basin. It has constructed a comprehensive energy system integrating geothermal power generation, extraction of dissolved helium gas, and regional heating. The core facilities of the project include a geothermal well with a depth of 3,000 meters, whose well water temperature reaches 102°C, the maximum shut-in pressure is 0.3 MPa, the self-flow rate is approximately 35 m³/h, and the starting production flow rate is 90 m³/h. An organic Rankine cycle (ORC) power generation system is also constructed as a supporting facility. Based on the research results of the Xi'an Geological Survey Center of the Chinese Geological Survey and the Shaanxi Geological Survey Institute, the Weihe Basin has superior geological conditions for helium gas occurrence and accumulation. Not only is the prospect of free helium gas resources in the gas field promising, but the content of dissolved helium gas is also exceptionally high, rarely seen abroad. The estimated helium gas reserves are approximately 2.1 billion cubic meters. During the development and utilization of this well, the content of dissolved helium gas can reach up to 1.8%, allowing for industrial extraction.

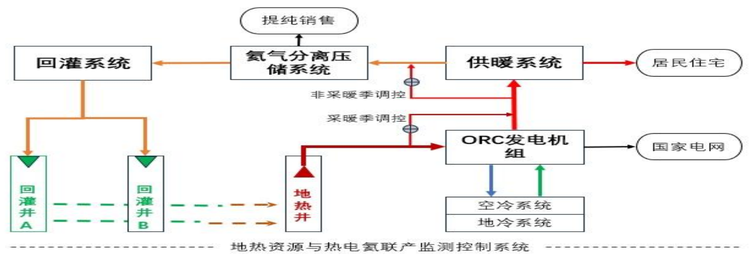


Figure 4 Schematic Diagram of Thermoelectric Helium Production Process

3.The geothermal station of this project is located within the No. 1 Energy Station in the High-Speed Railway Area of Xiongan New Area. It uses deep and medium-depth geothermal energy as the base load, and couples with the gas boilers of Xiongan Group Energy Company for peak load regulation, providing heating services for the thermal users in the High-Speed Railway Area of Xiongan New Area. After the full implementation of the project, the total heating area will be 4.02 million square meters, the heat load will be 148.5 MW, there will be 45 geothermal wells, and 14 well sites will be arranged. The well sites are numerous and scattered, with 2 to 5 geothermal wells drilled at each site, and the spacing between each water extraction section is more than 450 meters, forming a large-scale geothermal development model of 25 extraction and 20 injection. Currently, this project has implemented the first and second phases, with a total of 20 geothermal wells constructed, including 11 production wells and 9 injection wells, with a heat load of 71.86 MW and a heating area of 1.945 million square meters. The pipeline construction has laid a total of 34.7 kilometers of non-metallic pipelines with diameters ranging from DN200 to DN700.

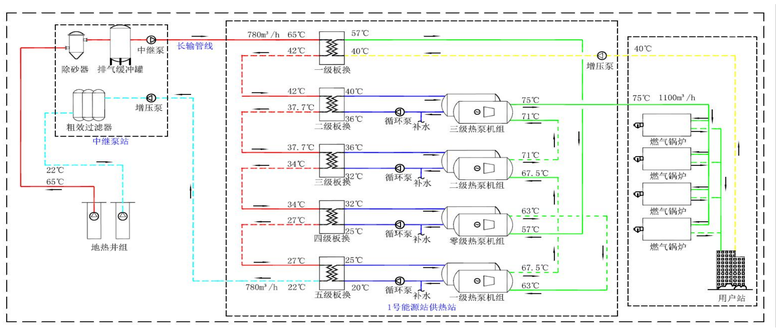


Figure 5 Process Flow Chart of the Xiong'an High-Speed Railway Area Project

DISCUSSION

1.A comprehensive analysis was conducted, including simulations of the temperature field, pressure field, and flow field. Through the dynamic analysis of the three-dimensional temperature field, it was simulated that when all 20 wells were fully operational during the heating season, the slow transmission speed of the cold front in the reinjected water would not affect the operation of the production wells.
2.Technological innovation: Developed a membrane separation + pressure swing adsorption coupling process, increasing the helium purity to 99.99997%. Optimized the design of the ORC unit generator, using a turbine compressor to enhance thermal efficiency. At the same time, an intelligent control platform was established to achieve dynamic optimization of power generation - helium extraction - heating, and to conduct dynamic monitoring and early warning.
3.Parallel operation simulation of multiple pumps: Use simulation software combined with factors such as terrain and topography, as well as obstacles along the way, to dynamically simulate the hydraulic conditions of the pipeline route, analyze the flow distribution of each pipe section and the water pressure at nodes, assist in making decisions on an economically and technically feasible long-distance pipeline network design, and adjust the frequency of each submersible pump by collecting wellhead flow and pressure to improve water balance.

CONCLUSION

Green Source Company has built a geothermal intelligent control system that integrates the physical layer, communication network and intelligent platform. With the B/S architecture and digital twin technology as its core, it has achieved comprehensive perception and intelligent control of geothermal fields and heating systems, significantly enhancing the technological content and industry standards of geothermal development. This system not only realizes business visualization, precise heating and stable operation through modules such as the cockpit, comprehensive monitoring and alarm management, but also provides a systematic solution for solving development problems such as heat breakthrough and continuous heat storage through its intelligent geothermal field module. Its technical concept is in line with the full-factor analysis of Xi'an's "group extraction and group irrigation" well factory model, the system integration thinking of Shaanxi's Gao Ba Jia Yuan's "heat, electricity and helium integration" and the dynamic control strategy of Xiong An's "four stability" new model. Green Source Company has successfully integrated and upgraded scattered project innovations into a replicable and promotable intelligent development model through its forward-looking technological layout and mature platform-based practice. This has effectively promoted the strategic transformation of the geothermal industry from extensive utilization to refined, intelligent and sustainable development, and established its position as a technological innovation and industry leadership in the field of geothermal comprehensive utilization.

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