Kubuqi Photovoltaic Desertification Control Project Brings New Life to the Desert

Solar Farm Uses Clean Energy to Restore a Barren Landscape

Located northwest of Ordos City in Inner Mongolia is the Kubuqi Desert, China's seventh-largest desert. Spanning 18,600 square kilometers, it was once rich with grasslands and forest. However, as centuries passed and the climate shifted, trees were cleared to make way for crops, grass was overgrazed, and sand began to drift. By the 1900s, this stretch of Inner Mongolia was a dry and desolate landscape—and becoming more so all the time.

Throughout the 1900s, the Chinese government made various pushes to restore the area by enforcing policies to prevent misuse of land. It also promoted efforts to plant trees and other vegetation along the Yellow River, which winds along the Kubuqi Desert's northern edge. Progress from these efforts was generally outpaced by the rate of desertification.

In the late 1980s, China also adopted public-private partnerships to address the crisis, kicking off what the United Nations Environment Programme identifies as one of the most successful large-scale modern ecological restoration efforts. One key method used in this undertaking has been the introduction of alternative energy projects in the desert's more barren areas. One such effort is the Kubuqi 2000-megawatt Photovoltaic Desertification Control Project, which is currently under construction. By the end of May 2024, the project is expected to be complete and contributing sustainable energy to North China.

The addition of this solar power station infrastructure will have the double benefit of priming the landscape for vegetative growth. Solar photovoltaic panels and brackets can provide resistance to harsh winds and prevent sand drift, and plant life is able to thrive in the shade between rows of panels. These conditions may open the possibility of farming cash crops suited for the desert climate, such as licorice and cistanche. Project owners also expect a positive impact on the Yellow River by decreasing the sand and silt that is swept into the water due to wind.

"[It's] a win-win situation for photovoltaic power generation and desert control, as well as supporting the adjustment of Inner Mongolia's industrial and energy structure," said Zeyang Lyu, an engineer working in Shanghai Investigation, Design & Research Institute (SIDRI), one of the designers for the Kubuqi 2000-megawatt Photovoltaic Desertification Control Project.

Building a Solar Energy Strategy

SIDRI is a subsidiary of the China Three Gorges Corporation (CTG), a state-owned company known for constructing the world's largest hydroelectric power station, the Three Gorges Project. CTG positions itself as a clean energy group focusing on large-scale hydropower development and operation. Its main businesses cover the construction, international investment and contracting, and development of wind power and solar energy, among other renewable energies, as well as comprehensive development and utilization of water resources. It also helps with providing relevant professional technical services. After more than 20 years of rapid growth, CTG has become the largest hydropower development enterprise worldwide and the biggest clean energy group in China.

Lyu, along with other colleagues at SIDRI, was faced with one of the company's most ambitious solar power undertakings as they began work on the first section of the Kubuqi Photovoltaic Desertification Control Project. The first section of the 2,000-megawatt solar power station will have a 1,400-megawatt direct current capacity (or a 1,200-megawatt alternating current capacity).

While designing this extraordinary project, designers also had to consider how to manage and accommodate tricky desert terrain on a tight deadline. Lyu and his team saw an opportunity to establish a workflow that would serve as a blueprint for SIDRI's future solar enterprises. They created CTG Solar, a project management and design software that provides rapid layout planning, structure modeling, and equipment coding by integrating key features from some Bentley software.

"Based on the Bentley software, SIDRI developed CTG Solar, which achieved a higher level of design automation, shortened project cycles and brought significant benefits to the project," Lyu said.

Forming the foundations of CTG Solar is Bentley's road design software. Lyu's team harnessed this software's terrain processing capabilities to create a digital mesh using the contours and elevation points, and then to plan necessary site leveling. Then, with Bentley's building information modeling software, the team created a 3D model of the panels, brackets, and cables. The 3D model provided a more accurate estimation of building materials needed than manual methods would have yielded. Bentley's 3D structural analysis software is also proved useful in designing brackets that would stand up to environmental loads.

Combined within the CTG Solar workflow, these capabilities allowed Lyu's team to engage in more precise planning on the scale of both kilometers and millimeters. Compared to previous solar power station projects, Lyu said that the team cut down on changes required to initial renderings by 40% and was able to wrap up the design process six weeks ahead of schedule.

Environmental Responsibility
SIDRI's work in the Kubuqi Desert represents a step toward a larger environmental cause as China continues large-scale afforestation and desert reclamation efforts. The country's state council recently released the third iteration of its National Desertification Prevention and Control Plan, laying out ambitious goals to reclaim about 6.8 million hectares of desertified land by 2025, and 12.4 million hectares by 2030. It is around two-thirds of the land affected by desertification that China believes can be redeemed.

Alternative energy projects like the one SIDRI designed in the Kubuqi Desert offer an appealing solution to prevent future degradation of land, air, and other natural resources. Lyu expects the solar power station that his team designed will generate more than 61 billion kilowatt-hours of electricity during over 25 years, saving around 706,600 tons of coal per year. It will also significantly decrease pollution, 1.9 million tons of carbon dioxide emissions and 74 tons of dust per year.

"It's a responsible way to protect environment, as well as human beings," Lyu said.

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Spotlight on Zeyang Lyu
Shanghai Investigation, Design & Research Institute Engineer Uses and Develops Cutting-edge Software to Streamline Clean Energy Design

When studying construction engineering at university, Lyu's interests drew him to water transportation design. He joined SIDRI in 2010, the year of the World Expo 2010 in Shanghai, which brought the opportunity for SIDRI, to present the company's work on the Donghai Bridge offshore windfarm project, which provided wind power to the expo.
That experience shifted Lyu's interests toward clean energy.

"I thought as an [energy] engineer, I could be more constructive to the country and the world," he said. "We need to leave something beautiful and useful for the world during our lives."

After five years of working at SIDRI on both onshore and offshore wind energy contracts, Lyu had the opportunity of international exchange to stay in Portugal for a year to work for the Center for New Energy Technologies (a joint company established by CTG and EDP) in Lisbon. There, he enhanced insight into the research and development of clean energy.

Upon returning to China, Lyu was on a mission to use technology to improve design for clean energy projects.

“I wanted to make the design more efficient. I saw that with the help of IT technologies, such as digital modeling and simulation, there can be a better way to design wind power and solar power stations,” he said.

Lyu had the chance to apply this philosophy during his recent work on the Kubuqi 2000-megawatt Photovoltaic Desertification Control Project, where he and colleagues developed CTG Solar, which integrates and improves various Bentley softwares into a single platform geared toward large-scale solar power station design. CTG Solar will become a backbone for all solar power station projects at SIDRI.

With these technological innovations, Lyu hopes that clean energy projects can become less time-consuming and expensive.

“We need to get a solid foundation of technology, and we need to use it in a clever way, and balance the benefits with the cost,” he said. “It’s important because sometimes we have good ideas, but we have to make them possible and affordable.”

This, after all, is the engineer’s core goal, Lyu believes—to back up idealism with constructive plans. In other words, to be useful and helpful.

Image link

Image caption/courtesy: Compared with previous solar power station projects, SIDRI avoided modifications caused by deviations between drawings and site conditions by 40% and was able to wrap up the design process six weeks ahead of schedule. *Image courtesy of Shanghai Investigation, Design & Research Institute.*

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