Project summary

Organization:
Shanghai Investigation, Design & Research Institute Co., Ltd. (SIDRI)

Solution:
Energy production

Location:
Fengjie County, Chongqing, China

Project playbook:
Bentley Descartes, Bentley LumenRT™, iTwin® Capture, MicroStation®, OpenBuildings®, OpenPlant®, PLAXIS®, ProjectWise®, STAAD®, SYNCHRO™

Project overview

A large-scale pumped-storage power station planned in southwest China's challenging karst region required advanced digital modeling for complex geotechnical analysis.

By leveraging iTwin Capture to unify multi-source data into a single digital twin, SIDRI achieved real-time collaboration, accelerated decision-making, and seamless integration, enhancing efficiency and compliance.

Using Bentley solutions, the project established a model for future developments in complex terrains by reducing costs and carbon emissions and minimizing ecological impact.

ROI

Using 3D design reviews, SIDRI was able to detect and resolve 1,850 design conflicts, saving CNY 4.5 million in rework.

By consolidating terrain and design data, the company cut construction by 42 days.

Leveraging iTwin Capture reduced field survey costs, reducing costs by CNY 1.2 million.

Shanghai Investigation, Design & Research Institute sets clean energy benchmark

Bentley solutions help navigate complex terrain challenges, accelerate delivery of pumped-storage power station

Balancing efficiency and ecology in China's karst region

An essential part of China's clean energy strategy, pumped-storage power stations store excess renewable energy and release it during peak demand, ensuring grid stability and reliability. This technology enables greater integration of wind and solar power, helping China move toward its carbon neutrality goals.

In alignment with the nation's 14th Five-Year Plan, the Caiziba Pumped-Storage Power Station—an investment of CNY 8.4 billion—became the first facility of its kind constructed in a region characterized by complex karst geology, including caves, fissures, and underground rivers. Shanghai Investigation, Design & Research Institute (SIDRI), a provider of world-class turnkey solutions for water and clean energy developments, was selected to lead the project. Ensuring safe and efficient construction of the power station while prioritizing ecological protection, SIDRI would undertake comprehensive surveying and design work to address the unique challenges posed by the karst terrain.

Unpredictable geography and data silos

Although the Caiziba Pumped-Storage Power Station would play a vital role in advancing China's clean energy goals, its location presented a unique set of obstacles. The unpredictable underground conditions posed risks to both the design and construction phases. Additionally, coordinating multidiscipline teams and integrating advanced digital technologies required careful planning and adaptation to ensure all aspects of the project aligned with safety and efficiency standards.

The project team needed a collaborative design platform to bring together data across its lifecycle, enable more effective large-scale terrain processing, and realize efficient parametric design. Traditional workflows struggled with fragmented data, inconsistent models, and high design costs. Furthermore, the lack of integration between geological data and architectural models made it difficult to coordinate complex hydraulic machinery and underground cavern designs across disciplines.

Streamlined workflows, precise modeling, and accelerated project delivery

Faced with these formidable geographic and technical hurdles, the project team recognized the need for advanced digital solutions. SIDRI began by integrating exploration data—drilling results, geophysical surveys, and remote sensing—to create a detailed 3D geological model of the site. This model allowed them to identify and mark every cave, fissure, and underground river, and to use GIS analysis to predict areas most at risk for water seepage. With this foundation, they applied BIM and finite element analysis to optimize the support structures for the underground caverns, ensuring safety and stability even in the most fragile rock formations.

The digital transformation didn't stop there. SIDRI adopted Bentley's suite of engineering software, including MicroStation and OpenBuildings Designer for detailed equipment, architectural and structural models, Bentley Descartes and iTwin Capture for high-precision geological models, and ProjectWise for seamless collaboration across teams. At the center of the workflow was the iTwin platform, which unified multisource data into a single digital twin, supported real-time collaboration, and accelerated decision-making. To ensure structural safety and compliance, the team relied on STAAD for structural analysis and design of key power station components. They also used SYNCHRO to build 4D construction simulations, allowing for dynamic scheduling, progress tracking, and improved project management. Throughout the project, Bentley LumenRT helped create immersive project visualizations and animated simulations, enhancing stakeholder communication and presentations.

A new, clean energy standard for complex terrains

The adoption of Bentley's digital tools marked a turning point. As these technologies were integrated into the workflow, collaboration efficiency improved by 40% and design errors were reduced by 65%. The parametric component library was reused over 300 times, and the ProjectWise platform increased data exchange efficiency by 80% while reducing version errors to zero. Automated review and drawing generation improved design accuracy to 98% and increased drawing efficiency by 60%.

As the project progressed, the benefits of digitalization continued to emerge. Hydromechanical modeling time was slashed by 75%, and the team detected and resolved 1,850 design conflicts, saving around CNY 4.5 million in rework. Concrete use was reduced by 3,200 cubic meters, and the construction period was shortened by 42 days. These efficiencies translated into substantial cost savings and a significant reduction in carbon emissions, with 8,960 tons less carbon dioxide released into the atmosphere. Field survey costs dropped by CNY 1.2 million, and the need to excavate 120,000 cubic meters of rock was eliminated. Even steel usage was cut by 860 tons, further lowering the project's environmental footprint.

By embracing advanced digital solutions, SIDRI overcame the formidable challenges of the Caiziba site. These outcomes not only lowered operational expenses but also contributed to environmental and social benefits, positioning the project as a benchmark for sustainable infrastructure development. The Caiziba Pumped-Storage Power Station now stands as a model of innovation and environmental stewardship, blending technical mastery with a deep respect for the natural world.

> **Bentley's iTwin digital twin technology has achieved dynamic coupling of geological modeling and construction, optimized excavation volumes by 120,000 cubic meters, shortened the construction period by 42 days, and reduced carbon emissions from construction by 8,960 tons, providing efficient infrastructure support for the regional clean energy transformation.**
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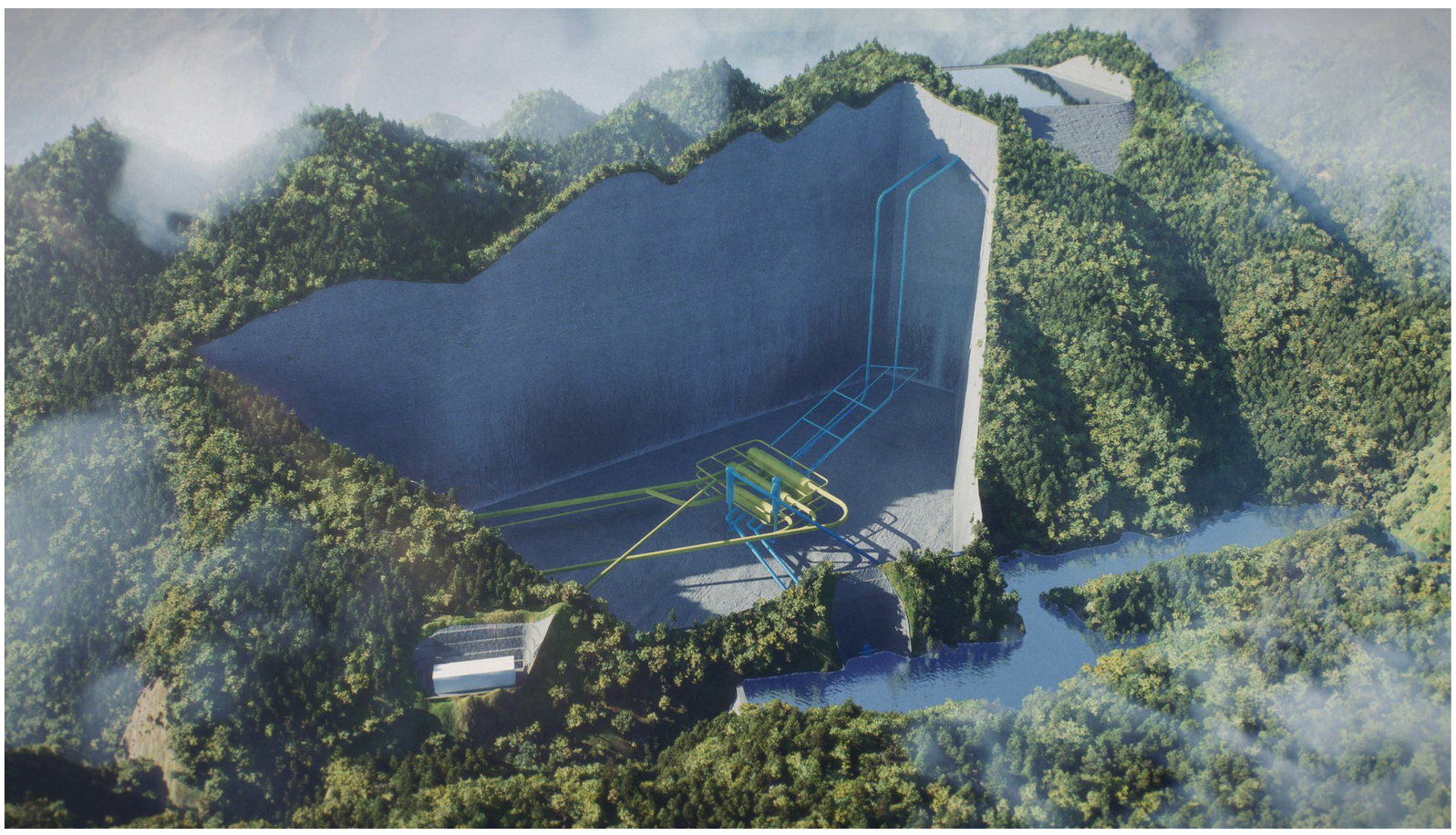
> *— Hu Runxin, Project BIM Manager, Shanghai Investigation, Design & Research Institute Co., Ltd.*



The Caiziba Pumped-Storage Power Plant presented significant engineering challenges related to complex karst geology.

Find out more at Bentley.com
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