CASE STUDY

Bentley
Advancing Infrastructure

Project Summary

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

Solution:
Mining and Offshore Engineering

Location:
Bohai Sea, China

Project Objectives:
- To design and build a 300-megawatt wind farm within a tight budget and deadline.
- To build around irregular terrain and protect foundations from seasonal ice floes.

Products Used:
MicroStation®, Navigator, OpenBuildings™ Designer, OpenPlant™, OpenWindPower™ (including SACS), ProjectWise®, ProSteel

Fast Facts

- The CNY 5.14 billion project includes 72 wind turbines and a 220-kilovolt booster station.
- The design team felt the project's difficulty was second to none due to an irregular sea floor and seasonal ice floes.
- To protect structures from the ice, the design team created anti-ice cones that could deflect ice chunks.

ROI

- 3D visualization helped the design team detect more than 80 clashes, saving 570 resource days, and CNY 3 million.
- Developing steel structure joints within ProSteel and modeling the environment within SACS saved 500 resource days and CNY 2.5 million.
- SIDRI's 3D designs saved CNY 50 million, and future offshore wind projects can use their design techniques to save over CNY 5 million each.

Shanghai Investigation, Design, & Research Institute Designs a 300-megawatt Offshore Wind Farm

Bentley Applications Help Adopt 3D Construction Modeling to Create Industry-first Anti-ice Cones, Saving Significant Time and Cost

Second-to-None Design Difficulty

China Three Gorges New Energy and Dalian Power Generation, owners of multiple offshore wind developments in China, contracted Shanghai Investigation, Design, & Research Institute (SIDRI) to construct a wind farm in the Bohai Sea. The wind farm is located 22.2 kilometers off the coast of Zhuanghe in Dalian, Liaoning. The China Three Gorges New Energy Dalian Zhuanghe III facility includes 72 wind turbines with a total capacity of 300 megawatts, as well as a 220-kilovolt booster station. At that size, the wind farm could produce enough power for 450,000 households each year. It could also prevent the emission of 6,000 tons of sulfur dioxide and 637,000 tons of carbon dioxide per year caused by coal-fired power generation at the same scale.

A project of this size requires coordinating a large design team with a variety of specialties, including hydraulics, electrical engineering, metal structure, construction, planning, HVAC, water supply and drainage, and architecture. In addition, the terrain presented unique challenges. The Bohai Sea floor in the project area is complex and irregular, with numerous ravines and caves. Additionally, the harsh winter conditions produce frequent ice floes, a problem that other offshore wind development projects in China have not previously encountered. Without protecting the facility, chunks of ice could damage the wind towers. Therefore, SIDRI had to find a way to design around the harsh environment without affecting turbine performance within a tight budget and a short deadline. Fei Jin, BIM manager for SIDRI, said that the overall difficulty of the project's survey and design was "second to none."

Addressing Challenges by Going Digital

SIDRI's first step was to rethink the design process. The design team had modeled previous offshore wind farms with traditional 2D methods. However, 2D design introduced errors, omissions, and clashes, which required manual inspections and revisions on site. Since the design team could not spare any time or expense for this project, it turned to 3D modeling with Bentley applications. The first step was to establish an open, connected data environment through ProjectWise, which ensured all contributors could share data, seamlessly collaborate, and stay up to date with any changes in planning, design, scheduling, cost, and personnel.

With the connected environment in place, SIDRI began the design with OpenWindPower SACS. The multifaceted applications allowed design teams to analyze the complex terrain, determine where the soil could accommodate wind tower loads, predict structural performance, optimize foundation design, and ensure strong turbine performance. Calculations within the applications allowed the design team to reduce the fatigue load by more than 30% and reduce the cost of designing support structures by more than 10%.

With SACS, the design team iterated designs to determine the best way to protect the tower foundations from ice damage. Their work resulted in anti-ice cones, which flare out where the tower meets the water. The design, thought to be the first of its kind in the offshore wind power industry, protects the tower foundation by providing a much thicker surface area that deflects floating ice more effectively than a narrower surface.

Saving Time and Money with Digital Design

Specialist designers created digital iTwin models for individual components within OpenBuildings Designer, Bentley Raceway Design and Cable Management, OpenPlant, and ProSteel. 3D visualization improved the efficiency of the structure designs and the layout of the cables that link the turbines, booster station, and onshore grid. Within ProSteel, the design team created a full steel structure joint model library to assist with model development. Automating steel structure joint placement reduced the design time by 300 resource days and saved CNY 1.5 million. SIDRI also developed an algorithm to run performance studies in OpenWindPower SACS application, which helped designers further improve design efficiency, reduce design time by 200 resource days, and save CNY 1 million.

Once the individual models were completed, SIDRI combined them within MicroStation and Navigator to create a federated model and perform clash detection, comprehensive optimization, and 4D virtual construction stimulation.

With OpenWindPower, the design team iterated designs to determine the best way to protect the tower foundations from ice damage. Their work resulted in anti-ice cones, which flare out where the tower meets the water. The design … protects the tower foundation by providing a much thicker surface area that deflects floating ice more effectively than a narrower surface.

"You can see every level and every deck very clearly, with electrical equipment, the structure, and the water piping," Jin said. During this process, the design team discovered and resolved over 80 clashes between the models. Compared to older 2D design methods, finding and detecting clashes within the 3D environment of MicroStation saved an estimated 400 resource days of design modifications, 100 resource days of proofreading, 70 resource days of on-site error handling, and CNY 3 million in additional expenses. Additionally, construction simulation within Navigator allowed designers to resolve potential construction issues in advance and more intuitively demonstrate design details to construction teams.

Creating an open data environment and visualizing all elements in 3D helped SIDRI streamline collaboration, detect and eliminate clashes, and improve design quality. As a result, the design team finished its work on the wind farm three months ahead of schedule. Though SIDRI was only responsible for the design, its 3D documentation will be used for the full lifecycle of the project, including construction, transfer, and operations. The organization intends to implement a similar digital design process on future wind farms, which should save CNY 5 million on each project. "Based on the digital management platform we've created, it helped us create our own standard design workflow, which is always functioning and can be easily planted to other offshore projects," Jin said.

Calculations within the applications reduced the cost of designing support structures by more than 10%.

Find out about Bentley at: www.bentley.com

Contact Bentley
1-800-BENTLEY (1-800-236-8539)
Outside the US +1 610-458-5000

Global Office Listings
www.bentley.com/contact

Bentley® *Advancing* Infrastructure