

Editor's note: China Daily is publishing a series illustrating the efforts being made to achieve the country's carbon peak and carbon neutrality goals.

CHINA'S LOW-CARBON JOURNEY

Safety at nuclear site paramount

Workers on Shandong reactor project placed under strict supervision to ensure well-being

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Safety for the over 9,000 workers on the construction site of the third and fourth reactors at the Haiyang Nuclear Power Plant in Shandong province is of critical importance.

Each welder is required to wear a recording device upon entering the construction site. Before they start welding, they must position the camera at a suitable distance to ensure that every action can be captured.

At the end of their shift, they upload all data to an intelligent supervision system for review. At the same time, their activities are closely monitored by an artificial intelligence surveillance system and by safety officers around the clock.

The construction site of Phase II of the Haiyang Nuclear Power Plant serves as a prime example of how China has prioritized safety and quality in the construction of nuclear power generation facilities.

Run by Shandong Nuclear Power Co, a subsidiary of the State Power Investment Corporation, the Haiyang plant has two reactors in operation. Construction began on two new reactors in July 2022 that are expected to come online in 2027.

Welding operations across different sections of nuclear power facilities necessitate distinct welding certifications, according to Zhang Zhongwei, deputy head of Shandong Nuclear Power Co's engineering department.

"Record-keeping serves to deter unqualified personnel from engaging in unauthorized welding operations, and it also offers welders a means of self-verification to address quality concerns," he said.

At the click of a mouse, the location and movement of each of the 9,164 workers working on site appear, he added.

There are 981 cameras positioned across the site to monitor different facets of construction, he said, highlighting the role of the intelligent system in preventing the collision of tower cranes.

During the peak period in the initial stages of construction, 12 tower cranes operated simultaneously on the site, which is the size of four soccer fields, he said. The system is capable of alerting crane operators when their jibs are within 20 meters of each other, and automatic brakes are activated once the distance



Engineers monitor the operation of the Shidaowan Nuclear Power Plant in Rongcheng, Shandong province, in October last year. It is the world's first fourth-generation nuclear power station. LIANG XU / XINHUA



A worker demonstrates techniques used in production at Shandong Nuclear Power Equipment Manufacturing Co in Haiyang, Shandong province. LI XINZHOU / CHINA NEWS SERVICE

between them narrows to 15 meters.

Zhang revealed that all safety supervision monitoring data within the system is retained for three months, while data related to quality oversight is stored for six to nine months, based on the requirements

of relevant departments.

The AI cameras can identify any improper behaviors from the workers, he said, such as whether they are wearing a seat belt or not.

A group of five safety officers from different subcontracting companies



An engineer monitors the hoisting of a module of the No 3 generator set at Haiyang Nuclear Power Plant in Haiyang on Aug 4. TANG KE / FOR CHINA DAILY

involved in the construction review real-time footage from the site to detect any instances of improper practices, he said. Their collective effort is dedicated to pinpointing potential risks outside their respective company's operation areas.

"Prompt instructions will be given to address major hazards once they are found. Additionally, a daily safety meeting is conducted to reflect on lessons learned and prevent the recurrence of such incidents," said Zhang.

Haiyang heat exchange cuts carbon emissions, air pollution

By HOU LIQIANG

The process of nuclear fission creates a lot of heat that can be lost and wasted if not for the process of heat exchange.

At the Haiyang Nuclear Power Plant in East China's Shandong province, heat produced by the two working reactors there is being used to heat the homes of the residents in Haiyang and nearby Rushan county — that's over 1 million people.

An added byproduct of using this heat exchange is that less heat is required to be produced by coal, reducing carbon emissions and air pollution at the same time.

Shandong Nuclear Power Co, operator of the facility, said it plans to expand its heat coverage next year to Qingdao over 100 kilometers away.

Launched in 2019, the first phase of the nuclear energy heating project, dubbed "Warm-U-Clear No 1", provided carbon-free heating to buildings covering a total floor area of 700,000 square meters, followed by the second phase in 2021 that covered 5 million sq m.

Its third phase went into operation in 2023 with a capability to serve 12.5 million sq m.

To date, the nuclear energy heating project has supplied 14.32 million gigajoules of heat, equivalent to saving standard coal consumption by approximately 1.29 million metric tons and reducing carbon dioxide emissions by 2.36 million tons, according to Shandong Nuclear Power Co.

It has also cut sulfur dioxide emissions by 15,000 tons, and nitrogen oxides by 14,000 tons, it said.

The transition to carbon-free heating has had a substantial impact on the air quality in Haiyang and Rushan. In Haiyang, the average concentration of PM10 particulate matter has decreased by 43 percent during the heating season compared to levels before the adoption of nuclear heating, while Rushan has seen an 8.7 percent reduction.

Haiyang has experienced a 13.7 percent drop in nitrogen dioxide, with Rushan's falling by 12.8 percent. Previously, both Haiyang and Rushan relied on fossil fuels for heating supply.

Haiyang Nuclear Power Plant has two reactors in operation. Another two reactors are under construction and are expected to go into operation in 2027. Reactors five and six are in the planning phase.

Wang Linhui, an executive with the company's department of chemical and environmental protection, said that a pump station for heating supply is being built for reactor No 3.

"We are striving to achieve a state of readiness for providing heat to Qingdao by the conclusion of next year," he said. In addition to delivering notable environmental benefits, the heating supply project has significantly enhanced energy utilization efficiency by harnessing heat that would otherwise have been released into the environment.

Wang said the Haiyang plant is also utilizing wastewater at a lower temperature in a mangrove planting initiative. Over 10,000 *Kandelia obovata*, a species of mangrove tree, have been planted.

Mangroves exist mainly in coastal areas south of 30 degrees north latitude. Despite Haiyang city being around 37 degrees north latitude, the initiative maximizes the use of thermal discharge to warm up the waters where the mangroves are planted.

Shelters have been built to protect the plants from the harsh winter conditions, ensuring their survival, Wang said.

"Over time, these mangroves are likely to acquire cold-resistant traits, and then they may be able to engage in extensive breeding," he said.

Mangroves provide flood protection and reduce erosion in coastal areas.

According to Shandong Nuclear Power Co, the No 5 and No 6 reactors at Haiyang are expected to be completed and put into operation in 2032. By then, the plant's annual power generation capacity will reach 60.9 billion kilowatt-hours, enough to meet the electricity needs of 70 million people.

It will help save standard coal consumption by almost 18.6 million tons, and reduce carbon dioxide emissions by 48.63 million tons, which is equivalent to planting 134,000 hectares of broad-leaved forests, Shandong Nuclear Power Co said.



Maintenance engineers inspect the "Warm-U-Clear" nuclear heat exchange project equipment in Haiyang. XINHUA



The "Warm-U-Clear" heating project provides carbon-free heating to buildings covering 700,000 square meters. XINHUA

China's use of digital, AI tools praised by intl body

By HOU LIQIANG

Experts from the International Atomic Energy Agency have praised China's innovative application of digital tools and artificial intelligence in strengthening its regulation of nuclear safety.

At the request of the Chinese government, the 24-member Integrated Regulatory Review Service team concluded a 12-day mission in July covering a full-scope review of all facilities, activities and exposure situations in the country.

Using IAEA safety standards and taking advantage of international good practices, IRRS missions are designed to strengthen the effectiveness of national regulatory infrastructure, while recognizing the responsibility of each country to ensure nuclear and radiation safety.

During the visit, the IRRS team observed regulatory oversight at several sites with nuclear facilities, including a nuclear power plant, a research reactor and a hospital. It also conducted interviews and discussions with the National Nuclear Safety Administration, as well as other nuclear-related and health authorities.

The team identified several good practices by China's regulatory body, according to an IAEA media release.

China has, for instance, made unique advances in developing, adopting and exploiting the benefits of AI-based tools to significantly improve the efficiency of its decision-making, safety oversight and knowledge management.

The team commended the body's arrangements for regular, high-level exchanges with all senior industry stakeholders on domestic and global nuclear safety developments, which have ensured a common understanding of nuclear safety priorities and required improvements across China's nuclear industry.

"The fast growth in China's nuclear power program will require the recruitment and training of a significant number of additional nuclear professionals in the regulatory field in the coming years. Its use of technology to support the effectiveness of its national regulator is an exemplar for all of us to learn from," said IRRS team leader Mark Foy, former chief executive and chief nuclear inspector of the United Kingdom's Office for Nuclear Regulation.

The IRRS team put forward some recommendations and suggestions to further improve the overall effectiveness of China's regulatory system.

They, for example, look forward to seeing China clarify its protection strategies in the case of a nuclear or radiological emergency, and provide a documented process for developing inspection plans for nuclear facilities.

The country is expected to enhance its processes to ensure that updates to department rules, guides and standards are completed to appropriately align with the latest IAEA safety standards.

The final mission report will be provided to the Chinese government in three months, according to the IAEA.

China operates 59 nuclear reactors, the world's second-most after the United States. Nuclear generates around 5 percent of the country's total electricity. China is building an additional 32 reactors and planning the construction of another 21.

The previous IRRS mission to China was carried out in 2016, when the country had 32 reactors in operation, it said.

"Over the past decade, China has made impressive headway in establishing a capable and independent regulatory body and promoting a healthy nuclear safety culture. China has a strong, competent and trusted national regulator that works effectively to ensure the safety of the public and environment," Foy said.

Karine Herviou, deputy director-general and head of the IAEA Department of Nuclear Safety and Security, said: "The team of senior regulatory experts recognized the government's unequivocal support to ensure a strong national safety regulator, including the provision of human and financial resources, while also proposing specific actions for further enhancements."