

Clean Heating

China's first commercial nuclear heating solution aims to help the country heat more and emit less **By Li Nan**

The release of Yanlong, a heating solution that harnesses heat generated by a small nuclear reactor, has made headlines. The pool-type low-temperature heating reactor, unveiled by the China National Nuclear Corp. (CNNC), operated safely for over 168 hours in November 2017, heralding a new era for heating in China.

"A 400-megawatt Yanlong, also known as the DHR-400, is expected to be the source of indoor heating for a maximum area of 20 million square meters. According to these calculations, it can supply heating for nearly 500,000 residents, roughly the average population of a Chinese county," Ke Guotu, Chief Designer of the reactor, told *Beijing Review*.

A milestone

The launch of Yanlong is the first step of CNNC's ambitious plan to boost nuclear heating in north China over the next few years. The company expects to gain approval for the construction of a pilot nuclear-fired heating project by the end of 2018, and to put it into commercial operation after 2020.

The use of nuclear energy for heating is nothing new. In the 1960s, nuclear power plants in some European countries, such as Sweden, supplied both heat and electricity. But since nuclear plants were usually located far from densely populated areas, the heat generated by these reactors could not be effectively transmitted to people's households. By contrast Yanlong's reactor is used exclusively for heating and is much smaller than those used in nuclear power plants, and Yanlong is intended to be installed in close proximity to cities. "Yanlong is small and easy to integrate with existing city heating systems," Ke said.

To tackle the problems of air pollution and global warming, China has vowed to increase the proportion of non-fossil fuels in its primary energy consumption to 20 percent by 2030, while ensuring that carbon emissions peak around the same time. Curbing coal consumption and increasing

the use of non-fossil sources of energy are seen as two critical measures necessary for China to build a clean and low-carbon energy system in the coming years.

China is committed to developing nuclear energy, provided safety requirements are met. A number of nuclear power generation projects are scheduled to be launched in coastal areas, according to the 13th Five-Year Plan for Energy Development (2016–20) released by the National Energy Administration in December 2016. In addition, innovative small-scale smart reactor and commercial fast reactor projects will be pursued.

"Yanlong is a milestone in the history of China's household heating, nuclear power and energy development," said Liu Baohua, Deputy Chief of the administration, at the launch ceremony of Yanlong in Beijing on Nov. 28, 2017.

Yanlong is a new substitute for fossil

fuel-fired boilers. According to Ke, a 400-megawatt nuclear heating reactor can generate as much heat per year as the burning of 320,000 tons of coal, or 160 million cubic meters of natural gas, and the reactor releases no carbon dioxide or dust into the atmosphere. Yanlong, if used as an alternative to coal-fired or gas-fired boilers of the same supply capacity, will reduce emissions of carbon dioxide by 640,000 tons or 204,600 tons, respectively, per year.

Multiple advantages

Coal-fired boilers have long been one of the primary causes of north China's atmospheric haze, especially in the Beijing-Tianjin-Hebei region. "More than 20 percent of end-use energy consumption in China is generated by coal, 10 percentage points higher than the global average," reads the 13th Five-Year Plan

for Energy Development.

Nuclear-fueled heating systems do not generate PM2.5, and that is significant for curbing smog in China, Wang Yuanfeng, a civil engineering professor with Beijing Jiaotong University, told *Beijing Review*.

China has slashed its coal consumption in recent years, but there is a long way to go before the country realizes its energy and environmental goals for 2030.

"Yanlong offers a new heating option north China, and since nuclear power is a key part of the energy system, it is expected to help the government deliver on its promises regarding climate change," said Wan Gang, Head of the China Institute of Atomic Energy (CIAE).

Low cost is another of Yanlong's selling points. Producing a gigajoule of heat with a DHR-400 costs just 30–40 yuan (\$4.58–\$6.10), on par with traditional coal-fired boilers and around 40 percent of the cost of producing heat using a gas-fired boiler. "I think Yanlong as cheap as coal and cleaner than gas will be popular in the future residential heating market," He Bingqing, Deputy Director of the Consultation and Research Center of the Ministry of Land and Resources (MLR), said.

The Beijing-Tianjin-Hebei region has launched a clean heating campaign to introduce gas-fired boilers and electric heaters, ditching the old, polluting systems that relied on coal. However, the campaign was thwarted in parts of Hebei Province, as 2017 witnessed a natural gas shortage that drove up gas prices, making both gas and electricity expensive heating options for local residents.

Yanlong makes it possible to turn coal-fired boilers into nuclear energy-fired ones at an affordable price, said He.

According to Ke, building a pool-type low-temperature heating reactor costs 1.5 billion yuan (\$228.8 million). "If a reactor with an investment of 1.5 billion yuan can serve 500,000 people for 60 years, then to me it seems that its long-term benefit is impressive and it's inexpensive," said He of the MLR.

Hurdles ahead

Yet despite the economic and environmental benefits, Yanlong's journey toward widespread marketability does not look set for easy sailing. "Resistance to nuclear power is the biggest hurdle for Yanlong to be commercialized," said Ke. Many Chinese feel apprehensive about the use of nuclear energy, especially



Cyclists ride along an avenue lined with ginkgo trees in Beijing in November 2017.

after the Fukushima nuclear disaster in 2011.

"Yanlong is the outcome of a mature technology," said Ke. The idea of designing a low-temperature heating reactor was first raised in China in 1981, and after decades of study, Chinese scientists have now built more than 10 pool-type reactors for research purposes, maintaining a record of safe operation for over 300 reactor years.

The Yanlong reactor is submerged in a well-sealed underground pool containing more than 1,800 tons of water. This abundant water supply prevents the core from being exposed.

The system through which heat generated by the reactor is transmitted to household heating radiators relies on three isolated pipe circuits; water in the reactor pool does not flow into the heating system, and neither does any radioactive substance.

Statistics from CIAE show that the radiation levels in nuclear-heated buildings are equivalent to the natural background radiation dose, which is considered safe for humans.

In the case of a severe accident, such as an earthquake, the reactor is designed to shut down automatically to avert the possibility of a meltdown. "The technology of a pool-type low-temperature heating reactor is proven to be reliable. A disaster of the kind that occurred in Chernobyl and

Fukushima cannot happen here," said Ke. The management of nuclear waste poses a major challenge. Reprocessing uranium and plutonium is one way to deal with used fuels. China has already mastered certain technologies associated with the treatment and recycling of nuclear waste, while new complexes for the processing of nuclear waste have been set up and the necessary funds earmarked.

But public unease extends to all matters nuclear, as seen in August 2016 when the site selection for a planned Sino-French nuclear fuel reprocessing project was halted following protests in Lianyungang, in east China's Jiangsu Province.

Lu Fengding, former Chinese Ambassador to Sweden, believes that a multi-pronged promotional campaign is necessary for the public to know more about nuclear power, and that the media, including social networks, should communicate more information about nuclear energy, and also that education pertaining to nuclear power should be strengthened on campuses. "Of course, more scientific breakthroughs in this regard are expected. After all, the facts speak for themselves," Lu told *Beijing Review*. ■



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Yanlong, a pool-type low-temperature heating reactor, is unveiled by the China National Nuclear Corp. in Beijing on Nov. 28, 2017.