WORLD COAL ASSOCIATION

CASE STUDY

NEAR-ZERO NON-CO_2 EMISSIONS*

SHENHUA GROUP

Shenhua Group was one of the first in China to research, develop and deploy near-zero emissions technologies for its coal-fuelled power units.

- **Coal will remain China's primary energy source for a long time.**
- **Advanced technologies have reduced unit non-CO_2 emissions below national limits for natural gas turbine units.**
- **Shenhua's cleaner power plan for new units and retrofits are cutting emissions and running costs.**

At Shenhua Guohua's Zhoushan power plant (pictured), Unit No.4 was China's first new power plant to meet near-zero emissions criteria, thanks to a range of technologies

In 2016, China had an overall power generation capacity of 1,650GW, around 57% of which was coal-fuelled power. With the country rich in coal – it accounts for about 94% of China's total fossil energy resources – it will likely remain the primary energy source for some time. However, environmental standards require operators of China's coal-fuelled power plants to reduce emissions of major pollutants such as particulate matter (PM), sulphur dioxide (SO_2) and nitrogen oxides (NO_X) to address concerns about air quality.

In 2011, China's Ministry of Environmental Protection and the State Administration for Quality Supervision and Inspection and Quarantine issued one of the most stringent emissions standards in the world for thermal power plants. For coal-fuelled power units, the limits are 20mg/Nm^3 for PM, 50mg/Nm^3 for SO_2 and 100mg/Nm^3 for NO_X in key areas. Shenhua Group has chosen to go further than the regulation requirements and achieve near-zero emissions, effectively operating at or below the national regulated limits set for gas turbine units (5mg/Nm^3 for PM, 35mg/Nm^3 for SO_2 and 50mg/Nm^3 for NO_X).

"Our research and application of near-zero emissions technologies prove that the roadmap is feasible and the environmental benefits are significant."

Mr Wang Shumin, Vice President of Shenhua Group

Going beyond emissions limits

Shenhua Group researched, developed, and applied an advanced innovation-driven roadmap of high-efficiency, low-emissions technologies so that its plants would operate well below the regulated limits.

A combination of multiple, synergistic removal and capture technologies are used to achieve near-zero PM emissions. These include a low-temperature economiser, which reduces both flue gas velocity and the resistivity of PM; after that, the electrostatic precipitator (ESP) could result in almost complete removal of PM, keeping PM concentration below 20mg/Nm^3. The high-efficiency wet desulpurisation (FGD) system then removes about half of the PM left in the system. At the outlet of FGD, PM is as low as 10-15mg/Nm^3. A wet ESP (WESP) in the final stage, with a PM removal efficiency of 70-90%, can further reduce emissions at the stack to less than 5mg/Nm^3.

To reduce SO_2 emissions, Shenhua Group uses FGD equipment with a capture rate exceeding 98%. This involves, among other things, Shenhua's own patented technology to prevent the pollutants of flue gas from sticking to the walls of the spray tower, as well as an additional layer of spraying,

all of which can also be transplanted to a seawater desulphurisation system. For instance, at the company's Zhousan power plant, its seawater desulphurisation system was proved to have an efficiency of more than 99%, resulting in SO_2 emissions dropping below 2.76mg/Nm^3. Shenhua Group also adopted denitrification technology that combines a low-NO_X burner in the boiler with a full-load denitrification system. This captures more than 85% of NO_X, limiting stack emissions to 10-40mg/Nm^3.

Shenhua's cleaner power plan

Shenhua's cleaner power generation plan was created for the retrofits of existing coal-fuelled power units and the near-zero non-CO_2 emissions project for newly built units.

Unit No.4 of Zhoushan power plant leads the way. Having come on stream in June 2014, it was China's first new power plant that met near-zero emissions criteria, using technologies including low-NO_X burners, high-efficient ESP, WESP and seawater desulphurisation. These have combined to result in emissions that are lower than the national standard by 88% (96 tonnes) for PM, 94% (260 tonnes) for SO_2 and 80% (440 tonnes) for NO_X.

Also in 2014, 12 units in Shenhua Group successfully went through a near-zero emissions retrofit. Shenhua's Sanhe power plant was one such unit, and includes many of the features at Zhoushan, in addition to a limestone-gypsum wet FGD and a natural draft cooling tower. In the wake of the retrofit, its emissions dropped 75% for PM, 82% for SO_2 and 65% for NO_X.

"Since its establishment, Sanhe power plant is shouldering a social responsibility through an enterprise mission to operate with a mind for environment protection and by offering a green energy resource."

Mr Zhang Yi, General Manager, Shenhua Guohua Sanhe Power Plant

Engineering and upgrade work at Shenhua Guohua Sanhe power plant is helping provide cleaner energy from coal

Award-winning low-emissions power plant.

Shenhua's Sanhe power plant provides significant power supply for East Beijing, meeting the electricity demand of 1.5 million people. Sanhe power plant is the first in China that has successfully engineered the integration of a chimney with cooling tower and the recycling of wastewater cross-provincially, as well as FGD without bypass.

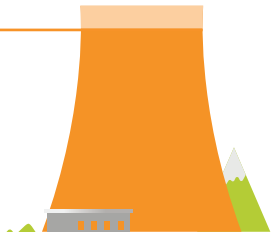
The plant team also spent two years upgrading its units to conserve energy and lower its emissions below the national emissions standard for gas units.

Sanhe power plant has been held in high regard for its efforts on environmental protection and providing cleaner energy from coal. Its research into near-zero emissions retrofit for large coal-fuelled power plants won the China Electric Power Science and Technology Award and China Electricity Innovation Award.

As part of its strategy to become a world-class clean energy supplier, Shenhua Group has demonstrated that clean and efficient coal with near-zero emissions is feasible and can bring significant benefits to both the operator and the country. A pilot platform for the research and development of near-zero non-CO_2 emissions technologies was also established in the plant with sponsorship from the Minister of Science & Technology.

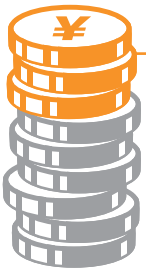
In numbers

90%



The reduction in total emissions of main pollutants from coal-fuelled units required by 2020, compared with the 2013 figure. (State Council 2015 directive)

1/3



Zhoushan's total generating cost is around one-third of a typical natural gas combined-cycle unit elsewhere in the Zhejiang Province.

94

The number of Shenhua-operated/owned near-zero emissions coal units – with total installed capacity of 51.25GW, accounting for 70% of the company's total capacity.

**Emissions in this case study refers to particulate matter (PM), sulphur dioxide (SO2) and nitrogen oxides (NOX).*

Find out more

About Shenhua Group: csec.com

About World Coal Association:

- worldcoal.org
- twitter.com/WorldCoal
- linkedin.com/company/world-coal-association
- youtube.com/worldcoal