IEA CLEAN COAL CENTRE executive summary

# An overview of HELE technology deployment in the coal power plant fleets of China, EU, Japan and USA

China, Japan, the EU and USA have strict emission limits for coal-fired power plants. Emission standards, and other drivers and barriers impact on the deployment of high efficiency low emission (HELE) plant.

## China

The Chinese energy sector has recently undergone a huge transformation. The coal-fired fleet has an average operational efficiency of 38.6% (LHV), higher than the average of that across the IEA member countries. China is an exporter of advanced technologies and continues to invest in R&D. For example, the double-reheat 1000 MW ultrasupercritical (USC) Guodian Taizhou II unit 3, in operation since September 2015, was domestically designed, manufactured and built. It has reached an efficiency of 47.82% (net, LHV), the highest globally for a double-reheat coal-fired power plant. Emissions are low: particulate matter (PM) – 2.3 mg/m$^3$, sulphur dioxide ($SO_2$) – 15 mg/m$^3$ and nitrogen oxides (NOx) – 31 mg/m$^3$.

Every Chinese power plant is equipped with PM and $SO_2$ control equipment, and almost all have NOx removal devices. All coal-fired plants will have to be ultra-low emission by 2020.

Strong policies, tight environmental and performance standards and their rapid implementation, combined with available finance for coal-fired projects as well as subsidies for energy generated from ultra-low emission power plants are the main drivers for the implementation of advanced clean coal technologies in China. Overcapacity, competition for limited water resources in some areas, localised pollution control, and the rapid development of renewable energy resources which can reduce the profitability of coal-fired power plants are the main barriers to building new coal-fired plants.

## EU

Coal-fired power generation across the EU varies greatly. Some countries, such as the UK and Germany, have pledged to reduce or phase out coal-fired power plants. Others, particularly Poland, will continue to rely on coal. A few new coal-fired plants are being planned and built.

The average coal-fired power plant efficiency is 38% (LHV, net) and a significant proportion of the fleet is relatively old. However, one of the most advanced coal-fired plants is the 1100 MW USC Maasvlakte Power Plant 3 in the Netherlands. It has an efficiency of 47% (net, LHV), can cofire up to 30% biomass, is carbon capture ready and can supply district heat. Its average emission levels are: $SO_2$ – 5–25 mg/m$^3$, NOx – 60-65 mg/m$^3$ and PM – 1–2mg/m$^3$. Pollution control systems for NOx, $SO_2$ and PM are widely deployed. The EU has ambitious targets to reduce greenhouse gas emissions by 40% by 2030 and by 80–95% by 2050 relative to 1990. This would require all coal-fired power plants wishing to operate after 2030 to have carbon capture and storage (CCS) in place. However, progress on CCS is slow, partly due to a low carbon price under the ETS (Emissions Trading System). This is a barrier to building new coal-fired plants. This could

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change if utilities perceived investing in CCS as a cheaper option than abandoning or converting their assets. Significant ongoing R&D on advanced ultrasupercritical (AUSC) plant, shows a commitment to the future deployment of clean coal technologies, whether domestically or abroad.

### Japan

The Japanese coal fleet is modern, relatively young and has the highest average efficiency (41.6% LHV, net) in the world. Most of the Japanese fleet are HELE plants. For example, Isogo unit 2 has average emissions in single digits for NOx and $SO_2$ and <5 mg/m$^3$ for PM. It is considered to be the world's cleanest coal-fired power plant in terms of emissions intensity.

Japan plans to build more HELE coal-fired power plant and supports the use of HELE technologies around the world, so that energy access and a secure supply can be ensured in developing countries.

### USA

The USA coal fleet is dominated by relatively old units, both subcritical and supercritical, so its average efficiency is around 37.4% (LHV, net). The most efficient coal-fired unit is the 665 MW John Turk Jr plant which achieves an efficiency of 42% net (LHV) and is the only USC unit. There are no new coal-fired power plants being planned or built.

Regulations have been a clear driver for the implementation of advanced clean coal technologies and pollution control systems for NOx, SOx and PM are widely deployed. The USA leads the way in emission standards for toxics, especially mercury, and so has become the leader in mercury specific control technologies. The low price of natural gas and decreasing cost of renewables as well as proposed legislation such as the Clean Power Plan are barriers for building new coal-fired plant.

However, there are various CCS projects under way and R&D on AUSC, hybrid coal and renewable systems as well as oxycombustion and chemical looping combustion. As coal is still predicted to have a significant place in the future energy mix of the USA (21% in 2030 and 18% in 2040) it is possible that once new technologies are demonstrated, old coal-fired units could be replaced with new systems. Additionally, with a market for $CO_2$ in enhanced oil recovery (EOR), relevant R&D, tax incentives and federal support for carbon capture, utilisation and storage, the USA is currently a leader in these areas.

## Concluding remarks

Although the role of coal in the energy mix of the areas studied is changing, coal is predicted to have a significant share in the future. New, more efficient plants are more common in China and Japan, although some new plants will be built in eastern Europe. Coal-fired plants continue to become more efficient and less polluting and there is strong R&D ongoing on new technologies such as AUSC, coal and renewable hybrid systems and CCS.