executive summary

Potential water sources for coal-fired power plants

Global energy demand is rising, whilst water is becoming a scarcer commodity in many parts of the world. Meeting the growing demand will place increasing stress on limited fresh water resources. The power generation industry is typically the largest industrial user of fresh water in a country. Hence non-fresh water sources will become increasingly important as an alternative or supplementary source.

The full report examines the availability and use of non-fresh water sources for coal-fired power plants in China, India, South Africa and the USA. These are the four top thermal coal consuming countries in the world, and all have water-stressed regions. The alternative sources covered are waste water from municipal water treatment plants, brackish and sea water, mine water, produced water from oil and gas wells (including coalbed methane wells), and water from deep saline aquifers.

Power plants need a reliable supply of water, of a specified quality, that is available over the lifetime of the plant (which can be over 40 years). The economic feasibility of using alternative water sources largely depends on the distance to the power plant, the amount of water available, its price, and treatment costs. Costs will be site-specific. All of the discussed non-fresh water sources are typically of lower quality than fresh water, and therefore, require treatment before use to avoid operational issues. Treatment, such as desalination, can be energy-intensive and expensive. New treatment technologies that can meet the quality requirements of power plants at a much lower energy input (and cost), and new materials that can withstand lower water qualities need to be developed.

Municipal waste water (MWW)

Treated MWW (also called reclaimed water) is a promising alternative water source because of its abundance and often wide geographic distribution. A number of power plants worldwide are already successfully utilising it for cooling purposes. There is potential for more power plants to use this source, especially in China and India where many municipal plants are non-operational or under-utilised for various reasons. The Chinese government has recently raised its waste water treatment targets, and requires new thermal power plants to utilise nearby MWW sources. India has also made it mandatory for power plants to use treated MWW that is available within a 100 km radius. The majority of coal power plants in South Africa are not near the metropolitan areas, making MWW use expensive and impractical. MWW is the most used alternative water supply at US thermal power plants, with around 5% of the 1709 existing cooling systems currently using it, and 25% of the proposed systems planning to do so. The majority of coal power plants are situated near to a publically owned MWW treatment plant (*see* Figure). Nearly 75% of the 407 coal power plants operating in 2007 have sufficient MWW available within a 40 km radius to meet their cooling water needs.

Operational problems associated with the use of MWW (such as corrosion, scaling and biofouling of pipes and cooling systems) can be controlled with adequate water treatment. Human health concerns over the possible emission of bacteria and other trace contaminants in the aerosols from cooling towers can be minimised with proper control and management of cooling operations. Both power plant operators and municipalities can benefit financially and environmentally from the reuse of MWW. However, there is a lack of data on its availability, quantity and quality, and competition for its use is increasing in some areas.

IEA Clean Coal Centre is a collaborative project of member countries of the International Energy Agency (IEA) to provide information about and analysis of coal technology, supply and use. IEA Clean Coal Centre has contracting parties and sponsors from: Australia, Austria, China, the European Commission, Germany, India, Italy, Japan, Poland, Russia, South Africa, Thailand, the UK and the USA.

Each executive summary is based on a detailed study undertaken by IEA Clean Coal Centre, the full report of which is available separately. This particular executive summary is based on the report:

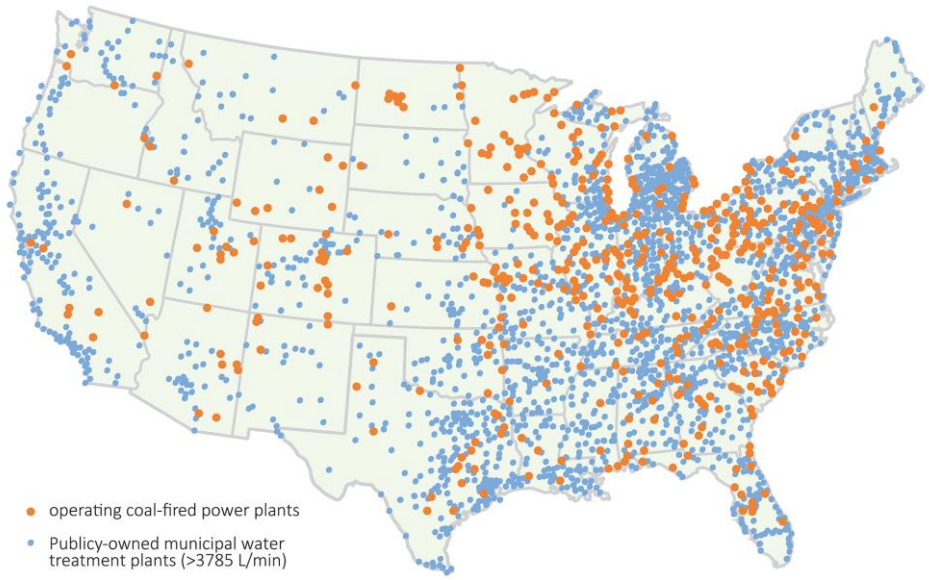
Potential water sources for coal-fired power plants

Anne M Carpenter

CCC/266, ISBN 978-92-9029-589-1, 97 pp, June 2016

This report is free to organisations in member countries, £100 to organisations in non-member countries for six months after publication, and free thereafter.

IEA Clean Coal Centre 14 Northfields London SW18 1DD
www.iea-coal.org | +44 (0)20 8877 6280 | email: mail@iea-coal.org



Location of publically-owned MWW treatment plants and coal-fired power plants in the USA (from http://www.all-llc.com/projects/coal_water_alternatives/page.php?13#potw)

Brackish and sea water

Brackish ground water provides an important water resource for nearby inland and coastal coal power plants, whereas sea water can provide an unlimited supply for coastal power plants. Both can be used directly (with minimal treatment) for cooling purposes instead of fresh water, provided the plant is designed for its use. However, desalination is required to supply their fresh water needs. The national governments in China, India and South Africa have all recognised that desalination is likely to play an important role in augmenting water supply. China, for example, has set a target for online desalination capacity (over 3 million m^3/d by 2020), and requires all new power plants in coastal regions to use sea water desalination to supply their fresh water requirements.

Integrating the power plant and desalination units has both economic and environmental benefits. The majority of the energy needs of a desalination plant using thermal processes can be met by utilising waste or low-grade heat from the power plant, reducing energy costs. Furthermore, the efficiency of the desalination plant is improved, and the volume of cooling water required in the power plant is lowered. If the desalination plant is designed with excess capacity, the power plant can become a co-producer of power and water, instead of a water consumer. The main disadvantage is that the integrated system is harder to operate due to seasonal variability in electricity demand.

Mine water

Mine water from abandoned and active mines could prove to be an important source for nearby power plants in regions where such water is abundant and accessible. Its use could turn a water pollution liability into a water resource. The technical feasibility and economic viability of utilising this source can be seen in the number of power plants currently employing it for cooling purposes. Nevertheless, there are no comprehensive inventories of mine pools and drainage available in China, India, South Africa and the USA, hampering its use. Regulatory and fiscal incentives would also encourage further usage of mine water. China is the only country discussed that has set targets for the reuse of mine water. Furthermore, new power plants in North China have been given priority access to mine drainage and recycled water. Recovering water from acid mine drainage

and the reuse of mine water have been recognised by the South African government in its second National Water Resource Strategy as important ways of increasing water availability.

Produced water

Produced water from oil and gas wells is a limited resource as it is generally only available over the lifetime of the extraction project. Moreover, collecting water from each well within a field, transporting it, and managing the variability in flow and quality over time can make it difficult, and expensive, to use. Nevertheless, the combination of heat, pressure and salinity in the produced water may provide opportunities for energy recovery, and help lower the cost of its treatment. For example, some water may be warm enough to drive thermal desalination processes. Where available, the elevated pressure could drive reverse osmosis processes. Some regulatory issues, such as water ownership in the USA, still need to be addressed. Only a few power plants are currently exploiting this source. These are mainly in Australia where power plants are firing coalbed methane (CBM) and utilising the produced water from the coalfield for cooling purposes.

The amount of produced water is likely to increase in the future as countries develop their unconventional oil and gas resources (where available). The Chinese government is supporting unconventional gas development. Production targets for both shale gas and CBM have been set. India also plans to increase CBM fivefold by 2017–18 to reach 2.1 billion m^3/y. However, the shale gas deposits are in geologically complex areas, and the lack of a fresh water and transport infrastructure are hampering development. In the USA, produced water from oil and gas wells, as well as from CBM activities, could potentially become a significant source of water. It seems unlikely that produced water will be used in South Africa due to the distance of the shale gas deposits from the coal power plants. Publically available data on the quantity and quality of produced water is lacking. National databases would help power plant operators to assess potential nearby water sources.

Water from deep saline aquifers

Another approach to minimise fresh water use at coal power plants is to take advantage of the possible need for CO_2 storage to mitigate global warming. This synergistic approach could, depending on site specific conditions, use deep saline formations as both a CO_2 storage site and as a source of water. Substantial quantities of water may need to be extracted when storing CO_2 in order to reduce the risk of induced seismicity, CO_2 leakage, and subsidence, and to improve storage efficiency and CO_2 plume guidance. The volume extracted may be sufficient to replace, or even exceed, the increased water requirements of carbon capture and, in some cases, may even enable a power plant to become a net producer of both water and electricity. As with produced water, utilising the heat, pressure and salinity in the extracted water, where possible, could help lower water treatment costs.

No power plant is yet utilising this water source, although a few projects are planned. Numerous coal power plants across China and the USA are located above or near saline aquifers. However, this is not the case for India and South Africa. The amount of water that could potentially be extracted with CO_2 storage has not yet been assessed for any of these four countries and there are still a number of issues to be resolved.

To conclude, the utilisation of economically treated non-fresh water by coal power plants will reduce the burden on a nation's fresh water supplies, whilst enabling the plants to continue to deliver the energy that is required. In certain cases, and with a suitable design of the on-site water treatment plant, a coal power plant could become a supplier of both energy and fresh water, instead of a water consumer.