



HISTORIC EFFICIENCY IMPROVEMENT OF THE COAL POWER FLEET

Coal has been a key energy source for electricity production for over a century. Many countries, especially developing ones in South-East Asia and Africa still rely on coal for power generation and it will remain an important energy source for at least the medium term. Therefore, it is essential to ensure that the coal fleet operates at the highest achievable efficiency to reduce CO₂ emissions. High efficiency, low emissions (HELE) coal power generation has both environmental and economic benefits and is closely related to six of the UN Sustainable Development Goals. Enhancing performance of the coal fleet can be accomplished by upgrading and modernising existing coal plants, or retrofitting efficient technologies and/or improving operation and maintenance (O&M). Power plant owners tend to invest in efficiency improvements in order to meet regulatory requirements, to be more competitive and/or for economic incentives. Insights into the main drivers and hurdles for improving coal fleet efficiency were obtained by analysing historical data on coal power fleet efficiency improvement in relation to various nations' policies and market mechanisms to see which were effective and which were less so. This information can help decision-makers to gauge effective approaches to minimising the environmental impacts of coal power generation through fleet efficiency improvements.

GLOBAL COAL FLEET EFFICIENCY IMPROVEMENT

The efficiency of the global coal fleet has increased by over 3 percentage points since 1996 and the increase accelerated after 2006. This increase is mainly due to the construction of many new and more efficient coal power plants and the closure of old and inefficient plants. Today, the global average efficiency of electricity production from coal is around 37.5% and the most efficient plants can achieve 49%.

China

China has a top-down economy. Compliance with government policies and regulatory mandates is the main driver. The Chinese power sector was structurally reformed in 2002 and five state-owned power generation corporations were created which still dominate domestic coal power generation. In recent years, China has issued a host of policies and several programmes aiming to increase efficiency and reduce emissions from coal power plants. Mandatory national targets for emissions reduction and coal power generation efficiency are set. Roughly 100 GWe of small inefficient coal plants were forced to close during 2006-15. Technical standards set the minimum size and efficiency for new coal power plants and require the use of best available technologies, which resulted in some 462 supercritical (SC) units (or 244 GWe) and 235 ultrasupercritical (USC) units (>193 GWe) being installed in China by 2018. The existing 300 and 600 MW class coal power plants were required to be upgraded by 2020 to meet new efficiency standards and ultra-low emission levels. Consequently, there has been a continuous improvement in the efficiency of the Chinese coal fleet with a net increase of 7.57 percentage points observed between 2003 and 2018.

India

As millions of Indians still live without access to electricity, the main objectives of India's energy policy are to achieve universal access to energy and energy security. Due to years of inadequate investment and poor management, the efficiency of the Indian coal fleet that consisted mainly of subcritical units was lower than the global average at ~32% during 1996-2014. Since the 1990s, India has implemented a suite of reforms to unbundle, restructure and privatise the state-monopoly power sector. The opening of a power market and the high growth in demand driven by fast economic growth in recent years attracted investment from the public and private sectors. As a result, there has been a boom in coal-based generating capacity. Several large SC coal-fired power plants have been built in the last decade. This, combined with the planned closure of old, inefficient coal power plants, has resulted in a considerable efficiency improvement of the Indian coal fleet of ~5 percentage points over 2015-16. However, the efficiency of existing units remains low and unimproved due to the tariff system and subsidy mechanisms that do not incentivise generators to invest in energy efficiency, as well as other reasons such as the low plant load factor.

Japan

Japan's electricity market has been progressively liberalised since the 1990s. The competition in the liberalised market provided economic incentives that motivated Japanese power generators to invest in power plant efficiency improvement, that led to rapid progress in coal fleet efficiency between 1995 and 2002. Effective regulations ensure modern technologies are employed in coal power plants to achieve high efficiency and minimal environmental impacts. Consequently, Japan's coal fleet has a high proportion of SC and USC generating units and is one of the most efficient in the world.

USA

Deregulation and power market restructuring in the USA started in the 1990s but were carried out to varying extents in individual States. There are now several policies and regulations regulating coal power generation and emission reductions. Some of the environmental regulations are fractured and complicated, causing uncertainties which affect plant owners' *invest-or-retire* decisions. The sustained cheap gas supply, increase in renewable power and an ageing fleet make coal power plants less competitive. Consequently, there has been neither much investment in new coal plant nor upgrading of existing units and as a result, a steady decline in coal's share of generation. The efficiency of the US coal fleet has not improved over the last two decades.

DRIVERS AND BARRIERS

Significant efficiency improvements at existing coal plants generally require large investment. Plant owners need to be motivated to make this commitment. Well-formulated and fully-implemented policies and regulatory mandates seem to be the most effective drivers. A fully-liberalised and competitive market also works as it provides opportunities and economic incentives to power plant owners to improve power generation efficiency. Government policies and preferences play a crucial role in shaping the future power sector. The frameworks put in place by governments affect the pace of improvement and of technology innovation and deployment. Therefore, governments should take the lead in driving and steering their nations' coal fleet onto a more efficient and sustainable course.

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Each executive summary is based on a detailed study which is available separately from www.iea-coal.org. This is a summary of the report: Historic efficiency improvement of the coal power fleet by Dr Qian Zhu, CCC/300, SBN 978-92-9029-623-2, 85 pp, February 2020.