China's energy challenge

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The Chinese Coal Industry: An Economic History (Thomson, 2003/2013)

"One of the main constraining factors in China's quest to raise living standards, modernize, and become a major world power has been a persistent shortage of energy."

"As the main source of energy in China has always been coal, whether for electric power generation, railway transport, an input into a vast array of industries, or as the principal heating fuel in the residential and commercial sectors, the energy shortage problem until the mid-1990s was essentially a coal industry problem, difficulties or bottlenecks having occurred at all stages – production, transportation or conversion to other energy forms."

"Energy shortages have greatly hindered the industrial, agricultural and social development of China."

"While coal use in the developed world peaked in the first decades of the 1900s, and after the Second World War was being replaced with higher efficiency energy forms – oil, gas, and later hydro and nuclear electric power – China's use of coal reached its zenith only in the late 1990s. There was no foreign exchange with which to import oil and gas, and domestic supplies of these were nowhere near sufficient. In 1949, being a poor, war-exhausted communist country, in fear of foreign domination and exploitation, and under a United Nations embargo, it had no option but to depend on coal as the main source of energy."

"The government of the People's Republic did make efforts to replace coal, this relatively low grade and inconvenient fuel. For a brief period in the 1960s China's oil production ranked among the highest in the world and there was great optimism that major new finds would be discovered. Some consumption equipment was actually converted to use oil during those years, but as no new large and easily exploitable fields were found China was forced to revert to coal and to export what oil there was to earn desperately needed foreign exchange. Though there was abundant hydropower potential, materials and technology were sufficient to build only small- and medium-sized plants."

"When the reform and opening up programme began in the late 1970s, the Chinese leadership reviewed its energy options, and concluded a switch to the modern and efficient fuels would still have to be deferred. While political and security considerations were now less significant factors, costs continued to be a formidable deterrent. Switching from one fuel to one or more other fuels would require huge investments in new equipment and technology. The fear attached to the displacement of a very large work force was probably another factor. It was not until the mid-1990s that there were clear indications that the government was ready to begin a gradual phasing out of the use of coal".

"[B]eginning in the mid-1960s the government hoped the country could reduce its reliance on coal, and tentatively began conversion to oil and electricity. Investment in the coal industry vis-à-vis oil and electricity was lowest in 1976, and coal made the lowest ever contribution, 69.9 percent, to total energy consumption that year. However, as all easily exploitable sources of oil had been surveyed by

then with no major new finds, it was realized there was no alternative but to return to depending on coal as the main fuel."

China: Long-Term Development Issues and Options (World Bank, 1985)

"Coal already dominates energy consumption in China. In 1980, it accounted for about three-quarters of primary commercial energy consumption and one-half of total primary energy consumption (including biomass), the highest share for coal in any major country."

"Cross-country comparisons suggest exceptionally high consumption of both commercial and total primary per unit of GDP in China. This can be explained partly by China's high share of industrial output in GDP and by space heating requirements. But energy consumption per unit of gross output value in Chinese industry is also exceptionally high compared with most other countries. Although the share of energy-intensive subsectors in industry is not significantly different from other countries, Chinese industrial output is weighted towards energy-intensive goods. High energy consumption in industry is also explained by relatively backward technology, the small scale of industrial plant, and the type of fuel used (particularly coal). Low energy prices and insufficient cost consciousness among enterprises and planners also appear to have contributed substantially to the low efficiency of energy use in China."

"In recent years, steps have been taken to reduce both the growth in overall energy consumption and energy use per unit of output. … As a result, during the past five years an impressive reduction in energy use in relation to economic activity has taken place. Energy consumption per unit of gross value of industrial and agricultural output (GVIAO) was reduced by 7 percent per year during 1979-81 and by 3 percent per year during 1982-83. Preliminary data indicate a further reduction of almost 7 percent in 1984. Technical and operational improvements are estimated to have accounted for about 40 percent of these energy savings. The other 60 percent came initially from a decline in the relative importance of heavy industry and the closure of some inefficient small-scale plants, but since 1981 mainly from structural changes within major industrial subsectors."

China: The Energy Sector, Annex 3 (World Bank, 1985)

"A unique feature of energy consumption in China is the high share of coal in both commercial and total energy consumption."

"China's heavy reliance on coal is due primarily to the existence of large, low-cost reserves. There are coal deposits of varying quantities in every major region of the country."

"Comparisons with other countries reveal an exceptionally high energy intensity in the Chinese economy, particularly in the industrial sector."

"Consumption of both commercial and total primary energy per unit GDP in China is well above that of any other major developing countries (sic) reviewed. Compared with Germany, France, Italy and Japan, commercial energy intensities in China are more than four times higher, while total energy intensities are about six times higher."

"One factor contributing to China's high level of energy use relative to GDP is a high share of industrial output in GDP."

"The available data on energy consumption per physical unit of output and on end-use efficiencies in China suggest that, compared with other countries, several factors contribute to China's exceptionally high energy intensities in industrial production. These factors include the scale of industrial plants, the technology employed in industrial production, the raw materials used, industrial organization, and factory operating practices. In the past the efficiency of energy use, particularly fuel use, received little emphasis in China's industrial development policy, and little regard had been given to providing incentives for enterprises to use energy efficiently. In addition, the dominance of coal as an energy source and the use of coal as a feedstock have contributed to inefficiencies, as it is difficult to use coal as efficiently as oil and gas."

"At an aggregate level, one of the most important factors underlying the high level of unit energy consumption in Chinese industry is the preponderance of small-scale enterprises in energy-intensive industries … Unit energy consumption in these small-scale plants tends to be well above levels in large plants, owing primarily to both the inability to realize economies of scale and the use of less advanced technology. Moreover, the quality of commodities produced is usually lower in small plants."

"Currently, boiler fuel for industry and space heating accounts for more than 35% of total final commercial fuel consumption. Nearly 200,000 boilers are currently used in China, of which some 70% have steam production capacities of less than 2 tons per hour. According to Chinese estimates, average thermal efficiencies are roughly 55%, compared with averages of some 70% abroad. The dominance of coal helps explain this difference, but the preponderance of small unit sizes, technology dating to the 1930s and 1940s, lack of mechanization, and inefficient operating practices all contribute to high consumption rates in China."

"Clean and efficient use of coal is critical for China's future … To a very large extent, China's ability to meet economic development goals will depend on the extent to which coal use efficiency can be improved. At the same time, increased coal consumption carries serious implications regarding environmental pollution (especially in urban areas) – and hence standards of living, health, and agriculture – unless improved environmental protection measures are adopted. By the end of the century, China may well be the world's largest coal consumer. Improved efficiency and environmental protection must both be emphasized. These goals often run in parallel and can often be achieved simultaneously. High priority should be accorded to domestic research and development and application of new technology from abroad, to use coal more clearly and efficiently."

"Although future demand levels are particularly uncertain, the potential for improving the efficiency of coal use in the commercial and residential sector is fairly substantial. Improvements could be achieved through use of improved briquettes, boilers and stoves, greater development of district heating, coal gasification and – possibly – more extensive use of electric cooking. In most sectors, but particularly in the residential and commercial sector, improvements in the efficiency of coal use can also yield benefits in environmental protection."

"Air pollution from burning coal, including particulate emissions in the form of fly-ash and smoke, and emissions of sulphur and nitrogen oxides, is already a very serious problem in urban China. By far the largest and most noticeable source of pollution is the burning of coal in industry and most household cooking and heating, which often leads to acute smog conditions during winter in parts of northern China. Household coal stoves and numerous boilers used by small commercial and industrial enterprises are the greatest direct source of smoke and soot. Larger industrial plants and

power stations generally have more efficient combustion systems and contribute less smoke, but generate large quantities of fly ash from the burning of pulverized fuel. Both large and small consumers contribute to the emission of sulphur dioxide, but the larger plants and power stations discharge this through relatively tall stacks, whereas smaller consumers discharge at or near ground level, with a more devastating effect on the local environment."

"Although concentrated air pollution in urban areas represents the most immediate concern, consideration should also be given to possible long-term impacts of nationwide or regionwide coal consumption. Many scientists believe that increased levels of carbon dioxide in the atmosphere resulting from increasing coal consumption could lead to major changes in climate. Linkages may also exist between incidence of acid rain, already reported in some parts of China, and coal consumption."

"The most pressing need for altering current coal utilization practices is in the residential and commercial sector, which accounts for much of the street-level urban air pollution and uses coal particularly inefficiently. While greater use of LPG, kerosene, and natural gas may be possible in some areas in the future, available supplies of these fuels are not expected to be enough to allow a substantial shift from coal to petroleum fuels in households and commercial establishments, especially in northern China. Use of synthetic, medium-BTU gas from coal for cooking, however, may have potential, both as a means to reduce particulate and sulphur dioxide emissions, and as a means to improve the efficiency of coal use. Large-scale projects for production of synthetic gas from coal are already underway in several northern cities. District heating systems, which are relatively underdeveloped in China, compared with many European countries and the Soviet Union, have substantial potential as an improved method of space heating for households, offices, and commercial establishments. Both synthetic and district heating options are highly capital intensive, however, and where retrofits of existing buildings are involved costs are high. Electric cooking in most urban areas has been discouraged, because of shortages of electricity supplies. Conversion of coal to electricity for cooking, however, offers advantages of high efficiencies at end use, the potential for major improvements in environmental protection compared with direct use of coal on a small scale, and relatively inexpensive distribution, especially for existing buildings."

"Over the short and medium terms, it will be difficult to move away from the direct use of coal in existing buildings …Coal briquettes are fairly widely used in China today, but production and use can be expanded. Greater use of (low-sulphur) anthracite, improvement in briquetting technology, and design and dissemination of improved coal stoves could also yield beneficial results."

"In 1980, boilers used in thermal power production, industry and space heating consumed more than one-half of China's total domestic supply of coal. With the anticipated increase in coal-fired power generation, the share of coal consumed in boilers will probably increase in the future. With rapid economic growth, most of China's boiler capacity by the end of the century will also be new. Thus, the technology of new boiler installations plays a critical role, both in China's efforts to improve the efficiency of coal use, and in efforts to check air pollution from coal consumption."