

I. EXECUTIVE SUMMARY

This report presents an overview of coal in China, examines coal-related policies and issues, and recommends ways the country – both on its own and in co-operation with others – might improve the sustainability of coal use.

Coal meets just over one quarter of the world’s demand for primary energy. In 2007, 2.5 billion tonnes of coal were mined across China, almost one half of global hard coal production. Coal is the nation’s most important fuel, accounting for 63% of total primary energy supply (including all biomass fuels), much greater than the global average.¹ However, coal production and use bring heavy social and environmental burdens. Within China, there is agreement that urgent challenges are posed by the ever-larger volumes of coal that the economy requires to meet national development goals. Internationally, the implications for the regional and global environment, for world coal trade and for China’s comparative economic position have attracted growing attention. China’s challenges are shared in many other countries, since coal use is anticipated to grow worldwide for many years. All of us, directly or indirectly, have a strong stake in a “cleaner coal” future.

To help address the challenges, the IEA makes ten key recommendation, together with suggestions on how these might be implemented in China. Each recommendation is important – all the issues must be tackled and none ignored. The challenges created by coal use in China are no longer just a national issue – they transcend boundaries. Finding solutions in our increasingly globalised world demands much greater international engagement. The most powerful form of co-operation is international trade and this forms a central theme to the recommendations. All governments need to make sure that trade, linked to clean energy, grows quickly.

This report provides policy makers with the information needed to appreciate the scale of the challenges faced and the role of international co-operation and collaboration in solving them. Providing insight for those outside of China is only one objective of the report; another is to share the experiences of developing coal-related policy in IEA member countries with policy makers in China. These experiences have been distilled into a single chapter, which, of course, cannot do justice to the efforts made over many years to improve the way coal is mined and used. Wherever possible, links to more detailed sources of information are suggested. By simultaneously publishing this report in English and Chinese, the concepts and ideas will at least be accessible to the widest possible audience in China and beyond.

1. Official Chinese sources report that coal provided nearly 70% of China’s primary energy in 2007, a higher figure than IEA statistics which include biomass use and treat primary electricity sources differently.

CHINA'S SURGING COAL USE

In the past quarter of a century, China has created wealth for many of its people, lifted many out of poverty, and helped drive and sustain global economic growth. Coal has underpinned China's massive and unprecedented growth in output, fuelling an economic miracle that has helped to improve the standard of living in many countries. Since 1997, annual coal output has increased by 1.1 billion tonnes, more than the United States produced in 2007, and led to approximately 2.2 billion tonnes of additional annual carbon dioxide (CO₂) emissions. The recent *annual growth* of China's coal production has been over 200 Mt, or not much less than Russia's *total annual* production. Projects to sink new mines, build washeries, establish worker communities, add capacity on dedicated rail lines and expand ports all serve the largest expansion of coal-fired power generation capacity in history. The imperative to ramp up output quickly has seen the coal industry undergo many structural changes, and it continues to evolve in response to challenges ranging from inefficient resource exploitation to safety issues at thousands of small mines.

China's reliance on indigenous coal, notably for over 80% of its electricity generation, brings benefits in terms of energy security. The conversion of coal to chemicals, liquid fuels and synthetic natural gas can and does allow an even greater reliance on its indigenous coal resources than seen in most other countries. Recently, the Chinese government has encouraged its coal mining companies to invest in coal mines outside of China to secure coal supplies, while discouraging majority foreign ownership of mines in China for strategic reasons. Most developed nations have found that energy resource ownership does not equate to energy security, since many factors determine the destination of energy supplies. In any event, efficient domestic energy production and import diversity enhance energy security, regardless of ownership. The important point for all governments is to promote greater competition and transparent markets in a way that enhances energy security for all.

From an international coal trade perspective, there is an appetite for better information and data on China. Small imbalances in China's huge internal coal market – which, in 2007, was three times larger than total world seaborne coal trade² – can have a significant impact on global coal flows. While the country has large coal reserves and is likely to remain largely self-sufficient, it is often more economic for coastal customers to import coal. Their demand is likely to become an important component of international trade. In recent years, overall coal demand in China has soared faster than indigenous supply, leading to higher prices and government actions aimed at fulfilling domestic demand, particularly in the power sector to avoid electricity shortages. These actions affect the balance of coal trade. China's rapid growth of exports, much welcomed by coal users around the world, made it a major player from 2000. However, exports peaked in 2003 at 94 million tonnes and have fallen markedly since then, while imports have risen rapidly, adding to the combination of

2. Exports of hard coal from all countries in 2007 totalled 917 million tonnes, of which 834 million tonnes was seaborne.

circumstances that led to unprecedented hikes in traded coal prices during 2007 and the first half of 2008.

Managing the exploitation of China's coal resources

China's coal resources are vast, over 5 500 billion tonnes, and its proven reserves of 189 billion tonnes would last for over 70 years at the current rate of production. Although China is not about to run out of coal, it does face a number of challenges: average mining depth is increasing, adding to costs; resource recovery rates are low; many mines are located in environmentally sensitive areas with limited water resources; the number of mining fatalities is falling, but remains unacceptably high; coal transport routes are relatively long and congested; restructuring to eliminate small mines will lead to rising job losses; and large-scale, timely investment in new mines and transport infrastructure will be needed to meet the forecast growth in demand.

Coal exploitation would be improved by a variety of changes, including fairer and more transparent resource allocation, perhaps through auctioning. Non-discriminatory mine permitting would promote greater competition, and would open the door to international participation – leading to more rapid penetration of the most-efficient mining practices and technologies from around the world. Conditions imposed during permitting could set standards for land restoration and treatment of subsidence damage, and a bond system, as widely used in other countries, could help to ensure such remediation is properly carried out. Operating mines need to be regularly inspected by independent pollution control officers. Beyond that, meeting the highest environmental standards should be seen as a key business objective for all mining companies – the fee-based pilot scheme in Shanxi is a step in this direction.

Recommendation

Environmental charges on coal mining have been introduced, but more should be done to directly link them to levels of pollution (i.e. the widely accepted “polluter-pays principle”). Funding for environmental protection agencies should be guaranteed separately and not be linked to revenues from environmental charges.

Industry restructuring

China has taken some very effective steps towards improving the economic and technical efficiency of coal mining, such as ordering large numbers of small unsafe mines and small inefficient power plants to be shut down. No other country has had to effect such a wide-scale industrial restructuring and it should be no surprise that the local authorities in China lack the resources to ensure that it is carried out as intended by the state government in Beijing. China can learn from experiences in

other countries to establish competitive markets with many players, from small to large, properly regulated to achieve economic and environmental protection goals. The provision of training and social welfare assistance during restructuring will be as necessary in China as it has been in other countries during periods of change. The report draws on experience in Europe, Australia and the United States to highlight those good practices that China should embrace.

Recommendation

Coal-industry restructuring should be founded on a belief in the power of properly regulated markets to deliver economically efficient mines, operated by competing companies of varying sizes, from small to large.

Coal mining safety

Safety should always be the first priority in mining. In addition to the human costs, mining accidents result in productivity losses and economic costs associated with treating injuries and compensating dependents. A viable mining industry avoids these through improved safety. In China, there is a pressing need to strengthen the resources and capabilities of the mines inspectorate to ensure current safety regulations are enforced. Perhaps just as important is the need to enhance training of underground workers, who should be given greater responsibility for ensuring their own safety and that of their fellow workers. These have proven to be essential elements in bringing down accident rates elsewhere.

Recommendation

A properly resourced, national mines inspectorate is central to ensuring mine worker safety. China needs to strengthen its own inspectorate, and complement this by training and empowering coal miners to take greater responsibility for their own safety.

Competitive markets

A stable coal supply is fundamental to achieving other goals. Over the last decade, coal shortages, volatile prices, poor product quality, transport bottlenecks, financial losses and other, near-term issues have all, at times, distracted leaders, government officials and enterprise management from giving their full attention to longer-term, sustainability issues. A properly functioning coal market, with effective supply and demand responses, has clear and immediate benefits that give the space and freedom to address the more difficult problems associated with coal use.

Removing all forms of subsidy (including from the coalbed methane industry) would allow the coal industry to grow on a more commercial footing – consistent with moves towards cost-reflective pricing. This should extend to the power sector, where a timetable could be set for incorporating the full costs of fuel for power generation into wholesale and retail electricity rates. This last point is one of the hardest problems of energy regulation in any country and is often subject to political interference, but can be eased by protecting low-income customers through the simultaneous roll-out of targeted assistance programmes.

Recommendation

Market-based, energy and resource pricing should be used as the primary means of balancing supply and demand in China, so that resources are exploited, transported and used efficiently and effectively, including those that are imported and exported.

STEPS TOWARDS SUSTAINABLE COAL USE

Coal use brings environmental challenges. China emits more sulphur dioxide (SO₂) than any other nation and coal use also adds significantly to dust and NO_x emissions. China is the largest emitter of CO₂, although its cumulative contribution to the atmospheric stock of CO₂ and its per-capita emissions remain well below those of the world's industrialised nations. Further growth in coal use – potentially to 2.8 billion tonnes in 2010 and 3.2 billion tonnes in 2020 under a low-energy intensity scenario, and substantially more under business-as-usual scenarios – makes it more urgent than ever to develop a strategy that marries the clear economic benefits of coal use with China's sustainable development goals.

Any comparative advantages built on resource wastage and environmental degradation are not sustainable, and the Chinese government is making efforts to eliminate unsustainable practices. Successive Five-Year Plans and recent energy and environmental policies provide a framework for sustainable development. The 11th Five-Year Plan (2006-10) sets a target to reduce energy use per unit of GDP by 20% by 2010 compared to 2005, and calls for a 10% reduction in key pollutant emissions. Data for 2006 suggests that good progress is being made in the case of particulate emissions, but that greater effort will be needed to reverse the rising trend of SO₂ emissions and to further reduce energy intensity which remains above its 2002 level. In April 2006, Premier Wen Jiabao announced three new policy directions: to place environmental protection and economic development on an equal footing; to make environmental protection an integral part of economic development, not simply an afterthought; and to integrate environmental protection into all administrative activity. More recently, in October 2007, President Hu Jintao emphasised the pressing need for resource conservation and environmental protection – principles of sustainable development through which China would, “make new contributions to protecting the

global climate”. The government is promoting vigorous development of renewables, natural gas and nuclear power; but, even under the most optimistic scenarios, it would take decades for them to push coal from its dominant position in China. Cleaner coal technologies are therefore critical. In June 2007, China unveiled its *National Action Plan on Climate Change*, which includes goals to develop clean coal technologies, from more efficient coal mining equipment to CO₂ capture and storage (CCS). The country has also strengthened its international engagement on technologies and policies to improve the way coal is exploited.

Promoting cleaner coal technologies

Experience worldwide shows that deployment of clean coal technologies must encompass the entire coal supply chain, and that parallel progress is needed in technical and non-technical areas for coal to remain an acceptable component in a country’s energy mix. A modern coal-fired power plant cannot be considered in isolation from the coal mines, transport infrastructure and coal markets that supply it. The setting that allows clean coal technologies to be deployed effectively at a power plant is complex and includes: the grids and power markets that receive its output; the regulatory apparatus that approves its construction, and oversees its operation and eventual decommissioning; the banks and investors that join the EPC (engineering-procurement-construction) contractor and utility company to build, manage and maintain it; the neighbouring residents who work at it and live with it; and the increasingly global technical community that designs, manufactures and services it.

Making a nation’s coal-based energy system cleaner is not just about improving access to better technology. China already hosts facilities that feature some of the largest-scale and most-advanced equipment in the world from fully automated longwall mining equipment and modern coal washeries, to ultra-supercritical power plants, with 1 000 MW units, and industrial coal gasifiers. An inability to produce critical components is often the main barrier to manufacturing such systems in China, but many of the major equipment suppliers operate in China, so imported components are commercially available. Adaptation of imported technology is often desirable to reduce costs and meet local market needs. Chinese companies have been successful here, for example in adapting flue gas desulphurisation (FGD) systems to their own needs. Technology transfer could deliver more, and China should consider relaxing any remaining barriers to participation of foreign companies in key energy industries, since joint ventures and foreign direct investments are an effective means to technology diffusion on commercial terms. It is the movement of people that allows effective technology transfer, and not simply the transfer of information, such as contained in engineering drawings.

Recommendation

The government should further encourage joint ventures and foreign direct investments in the energy sector to promote technology transfer, both into and out of China.

Developing new cleaner coal technologies

For technologies where R&D is needed, China is in a similar position to other nations. In the area of direct coal liquefaction, China is a pioneer, and is also making significant progress in demonstrating some of the components and processes needed for CO₂ capture and storage. But overall, greater efforts are needed globally in R&D; spending simply does not reflect the challenges faced by the energy industry as a whole. China has shown a willingness to participate in international partnerships and joint ventures in many fields to research, develop and demonstrate new technologies. In the case of cleaner coal, such active participation can speed progress towards those technologies that are most appropriate for commercial markets within China and elsewhere. If a technology is not commercially viable, then it will not be deployed.

Recommendation

International and national partnerships, supported by governments, industry and academia, can stimulate the development of new technologies before their commercialisation.

Deploying well-proven technologies and practices

Sometimes the newest and biggest is not the best for a particular application. There are tremendous opportunities to make improvements using techniques and equipment already widely available in China. For instance, more rational mining would raise the recovery rate of coal resources – a major priority in China – and can be achieved with modern management practices that maximise economic rent under a well-regulated system of resource allocation. Matching fuel quality to users' specifications is another area where coherent policy and effective market regulation are far more important than acquiring new technologies. Simple housekeeping measures during transport, at power plants and at other end users would raise efficiency and reduce unnecessary emissions, especially of dust.

Recommendation

Even as it pursues innovative new technical and policy solutions, China should quickly adopt well-proven technologies, management practices and policies that deliver immediate and sustainable improvements along the entire coal supply chain, from mine to end user.

Importance of effective regulations

In China and elsewhere, the constraint to energy demand growth is not the resource base, but humanity's ability to use fossil fuels without creating unacceptable

environmental impacts. Thus, this report returns repeatedly to the need for stronger implementation of well-designed environmental regulations, without which there is no reason to install and operate cleaner systems. As with mine regulation, the key is well-trained, adequately funded and independent regulatory bodies. In most countries, greater public information and involvement of citizens in approvals and monitoring processes have been essential to making environmental policies work.

Recommendation

Greater accountability and transparency that allow reliable delegation to lower levels of Chinese government are prerequisites to the proper functioning of existing environmental laws and hence the successful deployment of clean coal technologies.

Other countries can contribute to progress through bilateral and multilateral collaboration at all levels. For example, individuals with regulatory experience in other countries should share their first-hand experience with their Chinese counterparts who face similar issues. Official secondments of staff to foreign government departments and regulatory agencies should become an established element of career development in China and elsewhere.

Creating an international price for pollution

China has recently made great strides in deploying FGD equipment; the next challenge is to ensure that these and other pollution control systems are operated in a way that achieves China's emission reduction goals and reduces transboundary air pollution in northeast Asia. With rising coal use, China's SO₂ emissions have followed a rising trend since 1999 to reach 26 million tonnes in 2006, a trend that confounds the rapid increase in FGD capacity to around 50% of total installed thermal capacity. National legislation on atmospheric pollution prevention and control, and detailed regulations that include emission standards for power plants have not reduced emissions, largely because of inadequate enforcement by provincial authorities. Without stronger financial incentives than recent actions have provided, this situation may persist. An alternative would be to make it more profitable to generate electricity and heat, and to produce coke, cement and other products at clean and efficient plants rather than at inefficient plants with poor pollution control. Various means are available to signal the higher value of cleaner production: taxes on emissions, feed-in tariffs, emissions trading and pollution charges. Such market mechanisms have been effective in the US at reducing SO₂ emissions and can be used in combination with appropriate emission standards to give flexibility and the incentive that is missing in China. Fungible emission reduction credits could bring value to pollution control projects, especially if they can be traded between countries.

Recommendation

Market-based mechanisms, such as sulphur and carbon trading, should be central to China's pollution abatement strategy and the key incentive to develop cleaner coal technologies for domestic and international markets.

China's role in a cleaner future

An even greater challenge will be to deploy systems for CO₂ capture and storage – which is a critical technology for coal's long-term future, but which has not yet been demonstrated at a commercial scale at any coal-fired power plant anywhere. Such demonstrations are 5 to 10 years away and China is already participating in R&D initiatives that aim to accelerate progress. Now is the time to look ahead and envision how to encourage deployment. One way would be through international carbon trading systems. Negotiations over the next couple of years will shape a long-term international carbon market, so China needs to move swiftly and with determination so that its domestic actions are compatible with a global effort, and that international flows of funds can be harnessed to build CCS facilities in China. In the near term, the “CO₂ capture-ready” concept needs to be better defined so that the unprecedented number of new, coal-fired power plants built each year in China and other developing countries, and the likely replacement of many ageing coal-fired plants elsewhere, do not lock in CO₂ emissions for decades to come.

More broadly, China has an unprecedented opportunity to become a major player in the global market for cleaner, more efficient coal technologies. It has already developed some unique technologies that other countries should sensibly adopt, and will certainly create more. It should work with other governments to create a global market for clean energy technologies, and allow its manufacturing industry to respond with commercially relevant products, for local markets and for export. The IEA believes that such commercial activities, some in partnership with foreign companies, some in competition with them, will have a far greater impact than piecemeal co-operation on individual, government-supported projects, important though these are during the early stages of product R&D.

Recommendation

China should co-operate with other nations to establish common technical standards for coal-fired plants and their sub-systems, and so allow the wider deployment of more affordable clean coal technologies, both in China and elsewhere.

INTERNATIONAL ENGAGEMENT ON CLEANER COAL

Globally, two market imperfections currently limit the uptake of cleaner coal technologies: it costs less to pollute than to control pollution and barriers, such as

high development costs, slow technological change. Accelerating deployment will require changes at the national and international levels. Commercial deployment of cleaner coal technologies requires investment certainty through stable policies that recognise the costs and risks of long-term capital investment in pollution control, ultra-supercritical, IGCC (integrated gasification combined cycle) and CCS technologies. Hence, the three priorities for international engagement with China are:

- negotiations leading to successful international accords that create national, regional and global markets for clean, low-carbon technologies;
- government-industry partnerships to develop and demonstrate low-carbon, cleaner coal technologies; and
- technology transfer and deployment of cleaner coal technologies through commercial arrangements that respond to the market demand created in China and elsewhere.

China will need to decide for itself how to proceed, but its actions, more than those of any other country, will shape the global approach to the cleaner use of coal that is urgently needed to avoid the worst effects of climate change.