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Economically, socially and environmentally sustainable coal mining sector in China

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China Coal Information Institute

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Preface

Sustainable development is a comprehensive concept which involves extensive contents. The core of the concept focuses on coordinated development of human being, economy and the society. It emphasizes eternality of development. The development should on one hand satisfy the needs of contemporary people and on the other hand not jeopardize the benefits of the future generations. The ancient Chinese philosophers advocated that “man is an integral part of nature”. They maintained that man should exist harmoniously with the nature, which included the simple thought of sustainable development.

The sustainable development of coal mining industry is, under the guidance of scientific development concept, aiming at the goal of overall coordinated development of the employees, coal sector and economy and the society, using advanced technology and scientific administration as a means to improve gradually safety capacity of coal mines and occupational safety and health conditions, to optimize consistently the industrial and product structure, to improve continuously the quality of growth of coal economy, and to take the path of achieving more secured safety, high utilization rate of resources, less environmental pollution and good economic benefits, and the path of sustainable development of coal mining industry.

Since the opening up and reform, the demand for coal has increased drastically with fast growth of economy and the society. Coal output rose from 618 Mt in 1978 to 2523 Mt in 2007. As a result of 30 years hard work of employees in coal industry, the coal sector has made profound changes in China. Under such background, it is of important significance and far-reaching influence to make a to-the-depth survey of current status of the coal sector, summarize the achievements obtained since the opening up and reform, analyze the problems that affect the sound development of the industry and explore the path for sustainable development of coal sector.

In 2005, the State Council promulgated “Some Opinions on Promoting the Sound Development of the Coal Industry (Guo-Fa No. 18)”. Since then, the coal mining industry entered a completely new stage: the steps of restructuring of coal mining sector were accelerated; large scale conglomerates were rapidly fostered and the production concentration was gradually improved; investment of coal enterprises increased to a great extent; new system for technical innovation that integrated the efforts of enterprises, universities and institutes was set up steadily, the production force was gradually improved and the work safety conditions were evidently improved; “Black coal and Green Mining” was enhanced, circular economic development of coal made some progress; results were obtained in energy conservation and reduced emission; building of harmonious mine areas and promotion of coordinated development of regional economy became a common knowledge and conscientious action of coal sector.

In order to meet the requirements of the World Bank, the State Administration of Energy of NDRC organized the relevant departments and research institutes to set up a research project entitled “Economically, Socially and Environmentally Sustainable Coal Mining Sector in China”, and made investigations from 2006 to 2008. The World Bank also invited international coal experts to join the research project to embody the leading awareness and international angle of view in the project.

The project has made an overall summary of the current status of the coal mining sector and detailed analysis of the existing problems in China in aspects of administration system, policies, laws and regulations, work safety, environmental protection, etc., barriers and challenges. It has proposed policy measures and recommendations for addressing the above-mention problems and for optimization of coal mining, acceleration of trade reform, balance of resource environment and for promotion of sustainable development of coal sector.

The project lasted for two years and more. Thanks to the concerted efforts of the project team and experts at home and abroad, it is successfully completed. It is a beneficial attempt to discuss the path for sustainable development of coal mining sector in China through international cooperation. The results are fruitful, which provide effective criteria for the Government to make policy decision.

I would like to express my heart-felt thanks here to all the participants of the research project. I wish a sound, ordered and sustainable development of coal mining sector in China.

Mr. Wu Yin

Chief Engineer
State Administration of Energy
December 10 2008

Foreword

Sustainable coal mining will optimize the use of natural resources to meet today's coal supply needs at an acceptable cost to both society and the environment, but without jeopardizing the needs of future generations.

A sustainable coal mining sector is one in which coal is extracted to acceptable economic, social and environmental standards by all coal mines. In a sustainable coal mining industry, mines meet the full costs arising from their activities and compliance is assured by effective regulation. Thus, a competitive environment is created within which enterprises will strive for increased economic efficiency, greater returns on investment, reduced wastage of resources, reduced environmental impact, and safer coal mining operations.

A sustainable coal sector depends on both its production and utilization. Demand side initiatives are therefore also critical. These include improved energy efficiency, the application of clean coal technologies, and the mitigation of air pollutants and GHGs. Although the latter are worthy and significant topics, this report focuses on the reforms required by China's coal mining industry to evolve a sustainable coal supply industry. This is a gargantuan task in itself. The issues associated with coal utilization are addressed by several on-going and planned World Bank studies.

A previous study (ESMAP 2004) introduced many of the problems that China's coal mining industry needed to address on the path towards sustainability. Since then, the Government of China has taken many initiatives and achieved a great deal of progress with coal industry reform. This study builds on the previous work and concentrates on recent developments and emphasizes the key issues that remain to be addressed. There are no simple solutions and bold action will be required by the Government of China if its coal mining industry is to achieve long-term sustainability. Fundamental necessities are a functioning market economy, effective regulatory processes and enforcement of coal law.

This report is not intended to provide a detailed strategy for achieving coal sector sustainability. But it does provide recommendations, rationales, and actions that the Government may wish to consider, as well as suggestions for detailed studies to implement them.

Mr. David Dollar

Country Director
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The World Bank
December 10 2008

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The report also drew heavily from the following contributions: a case study of environmental controls on coal mining operations in the Hunter Valley, NSW, Australia, prepared by David Laurence, University of New South Wales, Australia; case studies of environmental impact and subsidence in Shanxi Province, China, prepared by David Wilshaw, Technical Director, Wardell Armstrong LLP, UK; and a case study of sustainable coal mining, policies and practices, in Shanxi, prepared by Wang Hong Yi, Shanxi Academy of Social Science, China.

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Abbreviations and Acronyms

ASX	Australian Stock Exchange
AUD	Australian dollar (1AUD = US$0.83, April 2007)
BAU	Business as usual
bbl	Barrel, 1 bbl = 42 gal = 159 l = 0.137 t
Bt	Billion metric tones(Gigatonnes), 1 Bt = 1 Gt
CBM	Coalbed Methane
CCII	China Coal Information Institute
CCN	China Coal News
CCT	Clean Coal Technology
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CMM	Coal mine methane
CO_2	Carbon dioxide
CSRC	China Securities Regulatory Commission
CTA	Coal Trading Association (USA)
CTL	Coal To Liquid
d	Day
DME	Di methyl ether
DMR	Department of Mineral Resources (of the State of New South Wales in Australia)
DPI	Department of Primary Industries (Australia)
dwt	Dead weight tonnage
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPA	U.S. Environmental Protection Agency
EPB	Environmental Protection Bureau
ESMAP	The Energy Sector Management Assistance Program of the World Bank
ETC	Economic and Trade Commission (local level)
EWG	Energy Watch Group
FDI	Foreign direct investment
FIFR	Fatal injury frequency rate
FOB	Free on board
GDP	Gross domestic product
GoC	Government of China
ha	Hectare (1 ha = 10,000m^2)
IGCC	Integrated gasification and combined cycle
ILO	International Labor Organization
IPCC	Intergovernmental Panel on Climate Change
IPO	Initial Public Offerings

KWh	Kilowatt hour
KSOCM	Key state-owned coal mines
LSOCM	Local state-owned coal mines
LTI	Lost time injuries
m	Meter
MBI	Market-based instrument
MCA	Minerals Council of Australia
MOF	Ministry of Finance
MOH	Ministry of Health
MOLAR	Ministry of Land and Resources
MSHA	Mine Safety and Health Administration (U.S.A)
Mt	Megatonnes (million metric tonnes)
Mtpa	Million tonnes per annum
mu	Area (1 mu = 667m^2)
NDRC	National Development and Reform Commission
NOx	Oxides of nitrogen
NSW	New South Wales (a State in Australia)
OS&H	Occupational safety and health
OTC	Over-the-counter (commodity trading)
PF	Pulverized fuel (coal)
ROM	Run-of-mine coal (raw coal)
SASAC	States Assets Administrative Commission
SACMS	State Administration of Coal Mine Safety
SAWS	State Administration of Work Safety
SCM	Small coal mine
SEPA	State Environmental Protection Administration (now Ministry of Environmental Protection, MOEP)
SETC	State Economic and Trade Commission
SOCM	State-owned coal mine
SOE	State owned enterprise
SOx	Oxides of sulfer
tce	Tonnes coal equivalent
tpa	Metric tonnes per annum
TVCM	Township and village coal mine
UCG	Underground coal gasification
UNDP	United Nations Development Program
U.K.	United Kingdom
U.S.A.	United States of America
VAT	Value-Added Tax
Yuan	Unit of Chinese currency, US$1 = 7.7 Yuan, April 2007

Executive Summary

1 An overview

China is the largest coal producer and coal user in the world. Unlike other large producers, most of China's coal comes from underground mines. It extracts six times more coal per day from underground coal mines than the USA, the second largest coal mining country. As a result of China's continuing economic development it is now responsible for over 70 percent of the growth in world coal consumption. Its coal mine production capacity has grown by over 1.5 Bt since the year 2000, achieving an output of 2.52 Bt in 2007.

Coal demand in China could rise to more than 4.0 Bt by 2020. This is much higher than the 3.0 Bt predicted by China's government planners which assumes certain rates of development of the renewable sector as well as increased energy efficiency, both of which may not be realized in practice. In addition, China's economic growth rate could be much higher than planned. Thus, the rate of growth in demand for coal could be significantly underestimated.

China's coal supply must therefore expand annually by around 140 Mt, which is 40 Mtpa more than was achieved from production expansion in key state-owned coal mines (KSOCM) from 2001 to 2005. Due to internal coal transportation constraints some of the increase in demand will be met by rising imports, especially in the southern coastal regions of China. However, international trade will only be able to supply a relatively small proportion of China's overall coal needs. Approximately 2 percent was imported in 2007.

Higher than expected economic growth, and use of more coal than planned during the period of the 10th Five Year Plan, led China to miss 8 out of 14 targets set for improving environmental standards. The Government recognized that the national economic growth and energy pattern is unsustainable and has focused the 11th Five Year Plan on the adoption of stringent sustainable development policies.

Coal resources are not an immediate limiting factor, although the ultimate magnitude of China's coal resources are not accurately known and more detailed exploration, mapping and analysis are needed. Tentative projections indicate that economically extractable reserves could be approaching exhaustion in 70-80 years or less depending on the scale of imports. Due to its long-term dependence on coal, China needs to implement policies to ensure that its coal resources are systematically explored and accurately documented and exploited in the most economically efficient way. This has led to the urgency of a sustainable development strategy for the industry.

The State Council (2005) has identified the problems that need to be solved to develop a sustainable coal industry. Unregulated expansion of coal production had resulted in the inefficient exploitation of resources, over capacity mining, insufficient concentration of scale, and shortcuts in accelerated new mine construction with minimal regard for worker health and safety and environmental protection. A historical legacy of social and environmental problems has been created which requires treatment and funding.

The State Council has ruled that provincial and local governments should no longer interfere with the business activities of coal mining enterprises and instead, concentrate on introducing policies aimed at developing a fair and competitive market environment. A cornerstone of the State Council's plan is the restructuring and consolidation of the industry into large, economically efficient enterprises. Small mines of less than a minimum capacity which are illegal, backward, inefficient and polluting, and which cannot be merged into larger mines, are to be eliminated. The Government's view is that efficiency of scale will facilitate rapid progress towards a sustainable, modern coal industry with improved safety, mining efficiency, resource recovery, and environmental protection and restoration with mines bearing the full costs of coal extraction. The energy security interests of the State will continue to be protected by macro-controls exerted by NDRC.

2 Progress with coal industry reform

The Government has achieved a great deal of progress with coal industry reform. A major campaign was undertaken as part of the 10th Five Year Plan (2001-2005) to rationalize the structure of the coal mining industry and accelerate modernization. Coal production was designated as the priority. In the 11th Five Year Plan increasing efficiency of resource exploitation replaced maximization of coal production as the priority, marking the Government's realignment of objectives towards sustainable development.

Institutional reform has seen State Administration of Work Safety (SAWS) raised to Ministry status while State Administration of Coal Mine Safety (SACMS) has been established as a separate entity with specific responsibility for coal mine safety. However, there remains a gap at State level in the coal industry management structure. Production responsibility is shared mainly between NDRC and SACMS but no single entity takes overall responsibility for coal mining industry management at the central level. At the provincial and lower levels of coal industry administration there remains excessive bureaucracy and overlap. Policy enacted at central and provincial level is not always implemented by county governments due to conflicts with local economic drivers.

Price controls on coal have been largely removed and the industry is more profitable than ever before in its history. In 2007, the average profit margin of the large coal mine enterprises increased by 29% in comparison with that in 2006. Particularly, the average rate of return on net assets for domestically listed coal companies reached a healthy 28%.
However, these profits include external costs of mining that have not yet been internalized. The average salary of the coal industry workers is below those of other comparative industries and is not high enough to attract skilled staff.

Coal prices are now able to freely adjust to fluctuations in supply and demand but power prices are still constrained by government controls and are unable to respond similarly. This means that coal market efficiencies will not be transmitted across the energy sectors. The Government retains the right to intervene in coal prices if it deems it necessary, but has shown considerable restraint.

The efficiency and scale of mining operations have been raised through industry restructuring and modernization. Despite these efforts, overall productivity is still relatively low at about 400t per man year, about one twentieth that of Australia. Nevertheless, the best Chinese coal mines deliver world leading performances in coal production rates.

The KSOCM have been transformed into limited liability companies, increasing numbers of which have diversified ownership though share offerings on domestic and foreign stock exchanges, although the State retains a controlling interest. Local mines have been incorporated into company structures both state-owned and private. Foreign direct investment (FDI) in coal mining remains low, with the Government showing little interest in relaxing ownership controls to attract overseas capital.

Consolidation and transition from inefficient small-scale mining to modern mechanized large-scale mining has proved to be effective in creating safer and more efficient mines, maintaining county revenues, reducing wastage of coal resources, introducing responsible environmental management, and promoting local economic and social development. Despite these reforms, many small, unsafe, polluting and inefficient mines remain which local municipal and county governments are reluctant to close despite repeated State edicts.

In main mining areas, large mining enterprises are absorbing small mines through merger and acquisition to concentrate scale and consolidate coal resources. Thirteen coal areas have been identified for expansion and exploration is being assisted with government funding. Outside the main mining areas small mines are required to consolidate to increase scale and integrate their resources, or close if they are below a minimum capacity. Thus, coal resources are being consolidated under fewer, larger companies to facilitate more efficient exploitation.

A new approach to the granting of mining rights has been demonstrated in Shanxi Province which should lead to a more efficient exploitation of resources. Until 2003, coal mining rights in China were largely granted by administrative allocation and coal mines had no incentive to optimize resource recovery. In 2005, Shanxi Province introduced an experimental pre-paid royalty system based on reserves. Thus, a precedent has been firmly established for assigning a proper value to coal reserves which will encourage more efficient mining and provide a revenue stream to the mineral owner – the Government.

The Government is investing in railway, road and port expansions to raise the freight transport capacity of domestic and internationally traded coal, but there are still coal supply concerns. Rail construction and train operating companies are being established to engender competition, increase efficiency and broaden access to capital which should lead to reduced coal transport bottlenecks. Government has also introduced policies to reduce pressure on coal transport by rail from remote mining areas by encouraging greater coal use at the source in mine mouth power-plants and coal-chemical industry development. While these policies are successful in guiding industrial development, they are, of themselves, insufficient to offset the lack of rail transport capacity.

Massive investment in safety improvements in large state-owned mines, increased mechanization and improved safety measures in locally owned mines combined with the closure of many unsafe, unlicensed small mines have all contributed to a reduction in fatal accidents. The average fatality rate per Mt mined in KSOCM reduced from 1.1 in 2003 to 0.6 in 2006, an almost 50 percent improvement in safety. Fatalities in all coal mines decreased by 20 percent in 2007, the second consecutive year such reductions have been achieved. However, average fatality rates are still significantly higher than those in the industrialized countries and further improvement is required.

Employment and social conditions for miners have also been improved over the last few years. Social welfare provisions have been progressively reformed with the introduction of pension funds and unemployment, health and injury insurance in all KSOCM. All mining enterprises are now required to make these provisions. Most of the inherited social liabilities from the central planning era have now been passed from KSOCM to local authorities and newly constructed mines are not beset by these problems.

The Government's sustainable development strategy for the coal mining sector consists of a series of environmental measures which include compensation and restoration schemes, water resource protection and improved governance of coal mining waste and subsidence issues. The measures are being implemented through improved planning, EIA procedures, supervision, collection and governance of restoration funds, and the incorporation of environmental reparation expenditure into mine operating costs. The strategy does not explicitly mention greenhouse gas emission reductions. These are seen as beneficial when achieved through methane utilization projects, but are not viewed as a priority under China's Kyoto Protocol obligations.

Environmental awareness has been raised but is only just starting to have a positive impact on environmental protection activities. EIAs are required by the Government prior to mine construction and must be reviewed and approved before project construction commences. Until recently, an EIA has only been required for each single mine construction project but in future a broader environmental assessment will be needed prior to the development of a large multi-shaft mine complex to ensure a holistic approach.

The Government is testing coal industry sustainable development policies in Shanxi Province and a sustainable development fund has been established to which all coal mines contribute. The proceeds are apportioned between social and environmental projects. Various environmental-related charges have been levied on coal mines in the past, but until recently there has been too little accountability of the use of the funds.

3 Policy options to improve the market orientation and hence sustainability of the industry

A sustainable coal mining industry will deliver a quality product to the customer at an acceptable cost to society and the environment. The market system, if allowed to act without excessive government intervention, yet properly regulated, will deliver China's finite coal resources to users at minimum economic, social and environmental cost.

Whilst espousing the need for development in accordance with market principles, the Government continues to focus on strengthening its planning controls underlining a reluctance to accede fully to a market mechanism. Rigid government controls weaken the effectiveness of many of the reforms and cause inefficiencies in coal supply.

The route to a sustainable coal industry, therefore, involves removing barriers which are impeding market determination of resource allocation, coal exploration, mining method, and beneficiation. The efficient functioning of the domestic coal market is, in particular, inhibited by coal transport limitations with investment in development of the rail sector insufficient to keep pace with coal transport demand. International trade restrictions, albeit now diminished, shelter exposure of China's coal mines from external competition reducing pressure on them to increase efficiency and also preventing coal users from accessing the most competitive supplies.

Optimization of resource exploitation

Optimum exploitation of resources and efficient mining is being prevented by micro-regulation of mining activities through the imposition of detailed, prescriptive standards such as specified resource recovery factors. These leave little scope for innovation and competition resulting in higher mining costs and lower economic efficiency than achieved by international mining companies.

Coal mines would have sufficient incentive to optimize extraction of coal resources in a free market, where a royalty is paid in advance based on reserves (as demonstrated in Shanxi), without need to specify recovery rates

and minimum seam thicknesses to extract. Resource recovery factors are not specified in other major coal mining countries. To enforce them in China could cause mine owners to subject mine workers to unacceptable safety risks and encourage mining of dirty, polluting coals.
The Bank therefore recommends that resource recovery factors be abolished and that a pre-paid royalty scheme for coal based on the value of the resource is introduced across all coalfields in China. Advanced payment of a royalty excludes under-capitalized coal mining enterprises and provides an incentive to mines to increase efficiency to recover as much of the coal as it is cost-effective to do so. The market will optimize recovery rates from a social perspective provided it is facing undistorted market prices and bearing the full costs of production (financial, health and safety and environmental).

The pre-paid royalty element is relatively low compared with revenue based royalties incurred in other mining countries [1]. *The merit of charging an additional, modest royalty linked to the value of the product should therefore be examined. This would ensure that the coal owner (government) is compensated for the true value of the resource.*

China has extensive and incompletely explored coal resources in its remote western regions. In addition to satisfying local demands for thermal coal, current expansion of coalfield development is mainly associated with coal-to-liquid (CTL) projects. It is important that these coal resources are exploited optimally, consistent with the long term strategic energy needs of China.

The Government should therefore undertake detailed economic, social and environmental studies of coal transport and coal derived energy transmission options. Meanwhile, there should be no policy incentives for CTL, in the western regions and elsewhere, to ensure that coal use is determined by undistorted market demands to obtain the optimum economic benefit for China.

To extend the life of China's coal resources, the economic and financial viability of alternative methods for extracting energy from seams that are too deep or difficult to mine conventionally should be investigated as a source of energy for power generation. *In particular, additional policy and financial incentives should be provided to support the demonstration and commercialization of underground coal gasification technology as this technology could, in the future, prove to be competitive with alternative fuel sources.*

Coal industry restructuring

Restructuring of the coal sector is well advanced and the necessary policies are in place to guide the establishment of large-scale production enterprises. The remaining structural problem to be solved is the closure of small mines. A sustainable coal mining sector cannot accommodate the unregulated coal mining activity which has been prevalent at the small mine scale. The Government has struggled to sustain its closure plans as local governments, mainly at county level, are finding it difficult to implement policy which conflicts with local economic drivers and social needs. The problem is exacerbated by some local government officials who, despite government regulations to the contrary, continue to retain financial interests in local mines.

Legal small coal mines should be guaranteed payment of the compensation they are entitled to if closed by administrative order for policy, consolidation or transformation reasons. The Government should provide social protection for laid-off workers including itinerants. Funds, such as micro-credit schemes could be made available for encouraging new businesses in areas affected by extensive small mine

[1] Royalties paid on underground mined coal are typically 5-8% of revenue in Australia and USA respectively

closures to provide alternative income earning opportunities and so reduce temptations to return to illegal mining.

The closure policy on small mines based on minimum capacity is too inflexible in failing to recognize the energy and economic needs of remote communities. *Minimum capacity criteria for coal mines should be abolished in remote mining areas where there are no large mines. Small mine construction and mining approvals should be based on the mine adhering to specific safety and environmental performance criteria, the qualification of the mine manager and a demonstration of local social and economic need.*

In the USA, the Mine Safety and Health Administration (MSHA) has demonstrated that safety of small mine operations can be improved significantly if it is supported by a suitably robust enforcement and advisory regime. Since the creation of its Small Mines Office in 2003, small mining operations (employing five or less miners) experienced a 66 percent decrease in fatality incidences, bringing them into line with the large mines, within five years.

Provincial authorities should therefore be empowered to issue "small scale mining licenses" which clearly spell out the minimum employment and safety requirements that small scale coal mines must achieve, with operations being regulated and policed by provincial (rather than local) authorities who have the power to terminate licenses and shut operations if safety and employment practices do not comply with the license conditions.

Enhancing competition and production efficiency

A competitive and sustainable coal mining sector should have access to the most modern, advanced and energy efficient technology. Participants in a competitive coal market will continuously strive to develop and adopt new technologies that save both energy and other productive inputs so as to minimize costs and thus increase efficiency. Foreign manufacturers are often reluctant to introduce their most recent technologies into China's coal mining sector due to intellectual property rights (IPR) protection concerns. In addition, outdated underground equipment and electrical safety approval procedures in China (Mei Anquan) delay entry of advanced foreign equipment manufactured and tested to internationally approved levels of safety. *It is therefore recommended that IPR protection for foreign imported mining equipment and technology is conspicuously enforced and punitive fines imposed on malefactors and that China's mining electrical safety standards are made comparable with European systems.*

The current approval procedures for coal mine engineering design and construction ensure wide replication of proven, but not universally applicable, designs to prescribed standards. However, this rigid approach stifles innovation. State Council has asked that the long overdue revision of mine design standards be expedited. China is also increasing expenditure on mining-related research and development (R&D) but any new developments arising from work at mining institutes and research centers will have little impact on improving the efficiency and sustainability of an industry bound by inflexible standards. *It is recommended that restrictive, prescriptive policy standards are replaced by performance standards as these will allow new developments to be accommodated, mining costs reduced and production efficiency increased.*

The use of more and increasingly sophisticated mechanized mining equipment and technology is being hampered by a growing skills shortage. Large mining groups, keen to attract and retain graduates and skilled technicians, are offering attractive employment packages. Therefore, the most profitable mines will attract the best qualified staff, a just market reward for efficiency. *More high quality education and training resources should be established to provide the increasing numbers of specialists required by the coal industry, otherwise the full potential for improving production efficiency through mechanization and advanced technology will not be realized.*

Government policies issued by SAWS and NDRC which encourage concentration of coal production on fewer longwalls and limit the number of men in an underground shift are providing impetus to mechanization, thereby reducing the number of miners underground at risk. The aim is to increase mining efficiency and deter hazardous manually intensive mining operations. *However, in a competitive market mines should be free to make such decisions on commercial grounds. Increasing labor costs and enforcement of safety regulations will automatically result in mines turning to increased mechanization to improve efficiency without need for specific policies. The current policies have merit as an interim, temporary measure but they should be removed once the restructuring of the coal industry is complete.*

Financing industry expansion

The coal mining industry will require an estimated investment of more than US$100 billion over the next 12 years with additional funds to raise the capacity of coal transport infrastructure. Growth in the coal mining sector is currently funded almost wholly from domestic sources through enterprise funds, share offerings, banks and government subsidy. In the two years to December 2006 US$26 billion was invested in additional coal production. To accelerate reforms towards a sustainable coal industry, access will be required to the capital markets.

Current government policy, which prevents majority foreign ownership and management of coal mines, is an impediment to FDI and to the establishment of improved safety and environmental performance and increased competition (and therefore efficiency). *The Government should therefore consider removing investment barriers to FDI by opening controlling ownership of coal mining enterprises to the private sector and international participation. This would accelerate modernization and speed efficiency gains in the drive to maximize returns to investors.*

Establishing real costs and stabilizing coal prices

In a sustainable coal mining sector all mines should meet the full costs of production and, in particular, mitigation of social and environmental impact. These costs should be visible in accounting statements. Currently, only subsidence cost is shown. KSOCM already make substantial contributions towards mitigating their impact on health, safety, the environment, and the community through various mining fees, compensation payments and social, health and accident insurance schemes. In a sustainable industry, these same fees and requirements must be applied to all coal mines to create “a level playing field”.

Between the mine and coal user, additional fees are sometimes incurred; some of which have no legal basis or regulatory function. In accordance with State Council’s direction, such charges should be removed. The effect of these charges is to increase the price of coal for no added economic benefit, thus reducing the competitiveness of coal.

Greater exposure of China’s coal mines to competition in a market where the full costs of mining are met will lead to a realistic pricing structure. A market system will provide the balances through price variations and these will be influenced by domestic and international factors. Stability of coal prices depends on coal supply and demand. Any government attempts at stabilizing the price of coal will lead to supply-demand imbalance. Producers and buyers can reduce exposure to volatility by futures trading. *Government should therefore refrain from intervening in coal pricing and a coal futures trading market should be established in China.*

Where there is a strong and natural linkage between a coal mine and a power plant, good international practice is for long term (5-20 years) supply contracts to be signed between the mine and the plant. These contracts should fix annual volumes and set an initial base year price that provides a reasonable return on capital to the mine and include provisions for annual price adjustments based on cost-related inflation factors. For this recommendation to be effective power plants would need to be allowed to adjust power prices to reflect the initial increase in coal prices that would result from such coal supply and pricing contracts. Raising power prices would not only adequately reward the coal suppliers and encourage more coal investment, but it would also encourage consumers to use energy more efficiently which would help reduce the rapid growth of energy demand in the future which in turn would help reduce the likelihood of future coal shortages. *Coal mines and users should therefore be encouraged to enter into long-term contracts and a freer pricing policy be established for the power sector.*

Improving mine safety

Progress still needs to be made before China's coal industry can match international coal mining safety standards. Average fatal accident rates in China's coal mines were still two orders of magnitude higher than those in Australia and the USA in 2006, but the situation is improving. Further improvements in mine safety are constrained by a lack of worker involvement in accident prevention. While miners in China have the right to refuse to work where dangers are evident, they have insufficient empowerment, protection and training to exercise this right effectively.

The introduction of worker safety inspectors in mines in some of the industrialized countries, supported in some cases by regional union safety inspectors, has resulted in significant accident reductions, especially where workers elect their own representatives. The Government of China has already commenced a similar approach with the decision in May 2005 to appoint 100,000 worker safety supervisors or inspectors, but the move lacks clarity and transparent policy support. *The Government should introduce a policy that requires worker safety inspectors to be appointed at all coal mines in China. These worker safety inspectors should be selected by their colleagues, be suitably trained and authorized to carry out inspections on behalf of fellow workers and represent them to management without fear of persecution.*

Government mine safety inspectors in China have too little power and independence compared with their foreign counterparts in the industrialized mining countries to be effective. *Enforcement of safety standards at coal mines in China should be strengthened with regular underground inspections of working areas made by experienced and technically qualified provincial level SACMS inspectors. These inspectors should have the power to suspend, if judged necessary, coal production without reference to higher authority until identified problems are rectified and to impose punitive fines for specified safety contraventions.* A major recruiting and training effort would be needed to provide the necessary number and quality of inspectors, together with funds to meet the costs.

Gas explosions are a major concern in China's coal mines. These can only occur where there is an explosive mixture and an ignition source simultaneously present. The Government has invested considerable effort and funds to introduce gas drainage and to improve ventilation standards in coal mines to reduce gas accumulation risks. However more needs be done to remove potential ignition sources. *Training and knowledge transfer is needed to refine gas control management systems, to reduce the risk of explosion and to improve the effectiveness of gas capture systems, many of which are performing inadequately. Thus, more of the gas released by mining can be captured, and increased gas quantities can be made available for utilization. Consequently, mine methane emissions to the atmosphere will be reduced.*

Coal mining fatalities per Mt in different provinces have ranged from 0.04 to almost 40 in recent years. Some KSOCM, including gassy mines, have matched the zero fatality achievements of the safest mines of the international coal mining companies demonstrating that best practice world standards are achievable in China. *The Government should therefore gradually move towards a zero fatality tolerance target for all mining enterprises.*

Safety agencies in the industrialized countries with responsibility for coal mines generally publish annual statistics showing safety performances, including non-fatal accidents, to provide a fuller insight into the wide range of accidents, their severity and causes. *Paying more serious attention to non-fatal accidents will help to establish a safety culture that will result in fewer fatalities and fewer multiple fatality accidents. SACMS should follow this example.*

Mine management, mine staff and students in teaching and training institutions would increase their understanding of accident causes and thereby contribute to innovation in safer working practices if they were given free access to detailed accident reports and data. *Investigations of all major coal mine accidents should therefore be completed and a factual report openly published as soon as possible, or within one year of the incident, to ensure that lessons are learned. This will allow the public and mine workers to recognize bad practice and thus bring social pressure to bear on irresponsible companies and officials.*

The present provincial government led administration of mine production safety (separate from work safety) is cumbersome. Safety in coal mine production in China is treated as an additional feature requiring detailed administrative supervision by provincial and lower level departments. *The Government should transfer total responsibility for safe production to mine designers and managers in line with overseas practice and treat safety as an inherent part of mine design. The role of mines inspectors should be to check compliance with operational safety criteria*.

Coal mine safety training programs have been implemented to ensure all management and personnel are certified on paper. Despite this, safety practices are still inadequate in many mines. Traditional, non interactive, teaching methods also tend to be used which do not stimulate creative thinking. *The content of the courses, training, and examination and assessment methods should be regularly audited and developed to ensure continuing improvement in the safety of mining operations.*

Healthier working conditions

Health issues receive less attention than safety in coal mines, although substantially more workers are affected by chronic lung disease than are killed in accidents. Some 300,000 coal miners at KSOCM are suffering from various stages of lung disease and there are 12,000 new cases in KSOCM and about 60,000 new cases reported annually in State owned coal mines (SOCM) and township and village coal mines (TVCM). The resulting direct and indirect costs could amount to over US$6.5 billion per year, equivalent to an average of US$0.5/t in KSOCM and US$2.5/t in other mines.

Dust conditions in China’s coal mines and the high incidence of chronic dust-related diseases are unacceptable in a modern society. Coal mines must meet the costs of treating and compensating afflicted miners in a sustainable coal mining industry. These costs will be felt indirectly through loss of skilled workers, absenteeism, additional training costs for new workers, and directly through insurance premiums. The alternative of investing in prevention will be the lower cost option.

Failure to tackle the serious and growing problem of dust-related disease will lead to a serious legacy of ill health, premature deaths and, at some time in the future, claims for significant individual compensation payments. Laws and regulations exist which define legal liability and specify requirements for prevention, protection, supervision, inspection and treatment but these are not fully implemented or enforced. Although some attempt at compliance is made in KSOCM most TVCM are largely ignorant of the effects of dust on workers health and of protection methods. The following measures should be taken to improve the situation:

- *Prepare national guidance on modern dust prevention, protection and control measures and implement a national program of training for coal mine officials and management.*
- *Enforce dust measurement and protection regulations at all coal mines with severe penalties for non-compliance exacted by provincial work safety bureau.*
- *Implement health screening for all mineworkers, not just those in KSOCM, by SACMS and the Ministry of Health (MOH). The service should be charged to coal mines.*
- *Publish annual mineworker health data to enable society, government and coal mine management to monitor the effectiveness of dust protection, control measures and enforcement of the regulations.*

Social conditions

A sustainable coal mining sector will exercise its full social responsibilities. At coal mines of all type, all workers should be offered fair and equitable contracts that include health and accident insurance and retirement pensions. *A certification scheme should be devised which will allow temporary and itinerant workers to aggregate insurance and pension rights payable from a third party institution such as a reputable insurance company.*

Applying and enforcing fair employment regulations across all mines will not only ensure improved social conditions for workers in local and small mines but will also bring labor costs into closer parity with KSOCM and provide impetus for increased mechanization, fewer workers at risk, safer working and greater mining efficiency. *At the same time policy action will be needed to create jobs for redundant mine workers with low skills.*

Coal quality policy options to reduce coal use impact on society

Coal mines produce coal of a quality to satisfy the requirements of users. The air quality benefits of using clean, washed coal instead of dry-screened run-of-mine coal are well recognized, but users will only buy more expensive coal if required to comply with strictly enforced environmental emission regulations and controls. *Supply-side coal quality policies have been attempted, but these have been largely unsuccessful, are difficult to enforce and should be abandoned and replaced by demand-side controls.*

Controlling the environmental impact of coal mining

Subsidence caused by underground mining has damaged surface water courses and underground aquifers, led to flooding of arable land, destabilized slopes, disrupted surface transport infrastructure and caused small village communities to be moved. The impact is the most severe where thick seams are extracted at shallow depth.

A study in Shanxi Province on environmental mitigation costs suggested an average deficit between environmental damage and environmental reparation and compensation charges of US$5.4/t of coal mined (Shanxi Institute of Energy Economy, 2007). However, the results seem to be based on worst case assumptions and the actual figure could be as low as US$1.2/t. Nevertheless, it is clear that all coal mining enterprises are not yet bearing the full environmental costs of mining. *More research should be sponsored by government to develop a rationale for estimating true environmental costs.*

Environmental fees charged to coal mines tend to be standardized across provinces and regions rather than adjusted to site specific impact. Application of standard fees which are less than remedial costs provides no incentive for mines to lessen any impact. In any event, fee charging is generally ineffective as mines tend to consider the payment of a fee as justification for abdicating any further responsibility for action. Charging mining companies for the full costs imposed on the environment would give them an incentive to take due care of the environment. *It is therefore recommended that fixed provincial and regional environmental fees are replaced by requirements to meet environmental performance standards, and thus actual costs, relevant to local, site specific conditions. Mines should only incur fees and costs relevant to their impact.* This would encourage mine operators to identify and establish safer and less environmentally damaging mining practices to reduce production costs.

Operational mining decisions should be based on environmental sensitivity plans prepared for each proposed longwall panel. From these the impact of coal extraction on land stability, land quality, water courses, aquifers, built development and infrastructure can be assessed and the costs of mitigation and reparation estimated. This process, practiced for many years in the UK, allows mine management to select the lowest cost mining options that conform to prevailing environmental standards.

Recently introduced provisions in Shanxi Province for financing environmental restoration from sustainable development fees paid to government are a positive development, but concerns remain on how projects will be designed and managed effectively by local governments.

To prevent future compounding of mining restoration problems China should align with good international practice by requiring that initial mine closure plans be prepared as part of the mining license application (feasibility study) and that all operating mines be required to provide the licensing authority with mine closure plans and periodic updates. The mine closure plans should address environmental reclamation and social mitigation, and also include post-closure monitoring and, where needed, further reclamation.

A safeguard environmental policy for all mining projects requires that an EIA must be prepared and accepted before construction approval can be granted. The charges for EIA consulting were set by government in 2002 but since that time the work load and requirements of an EIA have increased. *Higher fees should be allowed for environmental impact studies, which are undertaken by third party specialists, to facilitate more detailed site investigations and the standards of EIAs should be commensurately improved.*

Failure to submit or comply with an EIA can lead to fines from US$6,500 – US$26,000. This is a fairly significant fine for a small mine operator but not for a large mining enterprise and therefore *the fine should be determined in proportion to the scale of the project.*

While suitable environmental protection laws and regulations exist, they are often not strictly observed. *The Ministry of Environmental Protection (MOEP, formerly SEPA) and its lower level departments should take a more active role in inspecting major coal mine exploration and construction activities* and also surface impact during operation where concerns have been raised in the EIA or complaints have been made by affected individuals or organizations. *Local government should receive a proportion of any environmental fines to encourage support of EPB activities and to finance local awareness campaigns on the benefits of environmental protection.*

The economic impact of climate change attributable to mining has not been factored into China's coal mining costs as this is not yet general practice in any coal mining country. However, planning authorities in Australia are applying similar calculations when reviewing new mine proposals and the Government of China should monitor such developments.

Government policy and financial assistance has enabled the coal mining sector to widely implement methane drainage technology and raise the gas capture potential of gassy coal mines. Coal mine methane utilization is now being widely implemented, helped by Clean Development Mechanism (CDM) financing. Thus, growth in the release of greenhouse gas emissions attributable to the coal mining industry is being reduced, although more could be achieved (ESMAP 2006). MOEP has issued a standard that requires mines to destroy surplus drained methane that cannot be used provided its concentration is 30 percent or higher[2]. The latter marks an important change in government thinking from an energy led initiative to a climate change priority. However, the emissions standard is weakened because there are no incentives to encourage mines with poor drainage systems to raise the quantity and quality of gas drained and thus increase the potential of methane utilization and emission reductions. *It is therefore recommended that MOEP and SACMS collaborate in developing a policy to encourage improvements in gas drainage practices which will lead to safer mining conditions, more methane utilization and reduced emissions of drained mine gas.*

Of the methane gas released from underground coal mines, about 70 percent is emitted at low concentration in the ventilation air and this is the next emission abatement challenge which China must address to offset the climate change implications of a still rapidly expanding coal mining sector. *The Government should develop and introduce a* ventilation air methane (*VAM) emissions reduction policy for its coal mines.*

Strengthening the institutional, legal and regulatory framework

A sustainable industry must be responsive in its adherence to law and regulations, especially those relating to safety and the environment, and therefore it is important to establish a clear legal and regulatory framework. China's safety and environmental laws and regulations are reasonably well-developed, but enforcement is still weak. Without strong enforcement, detailed regulations are of limited value.

A well functioning coal sector requires laws and regulations that clearly specify (i) which institution has the authority to issue exploration and mining licenses; and (ii) which institutions are responsible for the oversight of the industry in terms of complying with conditions of exploration and mining licenses, health, safety, and social and environmental rules and regulations.

The institutional structure of China's coal mining sector has been undergoing reform for a number of years to reduce overlap between departmental functions

[2] A national safety regulation for utilization of coal mine methane

and conflicting regulations, but problems still remain. *A cohesive and efficient coal sector administrative organization should be established.* The legal regime which defines the instructional structure should clearly set out the roles and responsibilities of national and sub-national government agencies to ensure that there are no overlaps of authority and responsibility. Inspection and enforcement is best provided by officials from provincial and regional offices, under national oversight, who are disengaged from local interests and influences.

Government reforms announced in March 2008 included raising SEPA to ministerial status and the establishment of a State Energy Administration to undertake strategic planning and policy making. What, if any, extra powers the Ministry of Environment will possess that allow it to raise its effectiveness are unclear. It is also to be seen how the re-organization has contributed to improving coal industry management coordination at Central Government level, but at least a body has been identified whose responsibilities should include strategic coal sector planning.

Despite recent institutional reforms, the roles of key Central Government ministries and administrations in coal industry management still need to be clarified to prevent further inappropriate intervention with short-term policies that contradict long-term needs, and to ensure clear focus on their primary objectives:

- The role of NDRC should be to provide coal mining sector oversight on behalf of the Government. This duty should pass to an Energy Ministry, should one be formed. NDRC should not intervene in coal pricing as this distorts the market and hinders supply-demand balance.

- The Ministry of Land and Resources (MOLAR) should focus on establishing strategic policy and monitoring and also auditing provincial land and resources departments to ensure effective implementation. *It should desist from attempting to exercise control over construction of coal mining capacity by halting coal exploration.* Exploration should be allowed to proceed as far in advance of demand as practical and economic. The timing of exploration should be a matter for the holder of the mining rights to determine on commercial grounds. Government intervention is unnecessary if markets are functioning efficiently.

- SACMS is required to undertake coal industry production management functions in addition to its safety role. These include residual functions from the former Ministry of Coal Industry, together with new tasks recently handed from the NDRC. Government mine safety agencies in other countries are wholly independent of coal mining interests. *It is recommended that SACMS relinquishes its production-related tasks and concentrates its resources wholly on mine safety administration and enforcement. The displaced duties should be passed to a centralized coal industry management department which should be accommodated in an Energy Ministry if such an institution is formed.*

- The Ministry of Environment and its lower levels are responsible for the administration of environmental protection. *The role of the Ministry of Environment is, and should be limited to, ascertaining that coal mines manage and limit environmental impact in* *accordance with China's laws. Particularly, MOE should strengthen its monitoring and enforcement capacity to ensure that coal mines fully comply with the approved environmental impact management plan during construction and operation phases.*

The coal sector administration is in urgent need of rationalization at provincial and lower levels where there are too many agencies, sometimes as many as three, with overlapping coal industry management and safety responsibilities. Coal mining functions in provincial and local government Economic and Trade Commission (ETC) departments should be transferred to the existing Coal Industry Bureau or equivalent department. *Mine safety enforcement and coal industry administrative functions should be clearly separated at all levels.* These reforms would lead to greater administrative efficiency and reduce the temptation by frustrated coal mining enterprises to act without formal approval.

Prescriptive regulations should be reviewed and where practical, abolished, and replaced with performance standards. Thus, provincial and lower level government coal department supervision and enforcement duties will be reduced, allowing the regulatory authorities more time and resources to concentrate on fewer and more critical key regulatory issues.

4 Conclusions

Efficient, competitive free markets for coal with appropriate regulations to address health, safety and environmental problems will supply the coal necessary to meet China's future energy commitments. Government attempts at controlling supply and demand in the past have been ineffective and long-term planning should be aimed at allowing markets to function efficiently. This will provide energy security safeguards as a buffer against unexpected international events and will encourage the development of alternative energy sources and imports as indigenous coal reserves become depleted. The Government's primary strategy should therefore be to foster the development of efficient coal markets.

The large, consolidated mining group companies now have the corporate, financial and management resources to guide investment and optimize revenue. It is, therefore, an opportune time to relax government planning controls and take full advantage of market forces, placing more reliance on market-based instruments for regulation of coal industry activities.

The present legal and regulatory framework is detailed, but rationalization is needed. In particular, overly prescriptive policy regulations and standards are creating inefficiencies within the coal industry by suppressing innovation and advancement. These government controls are preventing market mechanisms from acting as cost reduction, and hence efficiency, drivers.

All of the above recommendations made in this report could feasibly be completed within three years or less, as the major reform steps have already been taken by the Government.

Summary of recommendations

Policy aim	Current status	Recommendation
Optimizing coal resource recovery	• Application of resource recovery rate and minimum seam thickness criteria • Resource life dependent on economic depth limit of conventional mining	• Abolish prescriptive resource recovery criteria • Apply pre-paid royalty system based on coal reserves throughout China to encourage optimum extraction • Consider additional revenue-based royalty to reflect the coal value • Research feasibility of deep underground gasification
Industry restructuring	• Increasing scale of mining enterprises • Closing small scale, inefficient, hazardous and polluting small mines	• Remove SCM capacity minimum for remote areas with specific energy and social needs • Guaranteed financial and social provisions when legal SCMs closed
Enhancing competition and production efficiency	• Trade controls • IPR leakage • Inflexible design standards Protracted mining equipment approval process	• Remove import and export tariffs • Protect IPR. • Replace inflexible design standards with performance standards • Harmonize mining equipment approval process with EU
Financing expansion	• In general, new mines are domestically financed and controlled	• Allow foreign majority ownership of coal mines to attract FDI and technology transfer
Ensuring a reliable supply of coal to the power sector with stable and predictable prices	• Coal supply continues to be contracted between producers and power companies at annual meetings monitored by government although longer term contracts (e.g., 3 year) are starting to emerge	• Introduce long term (5-20 year) supply contracts that fix annual volumes with annual price adjustments based on cost-related inflation factors (long-term agreements dependent on relaxation of electricity price controls)
Establishing real costs and stabilizing coal prices	• Mines not paying full HSEC costs • Supply-demand imbalances created by short-term policy intervention	• All mines to meet full HSEC commitments • Refrain from government intervention to allow market mechanisms to act • Futures trading facility to reduce price volatility effects • Undertake economic studies of coal by wire versus coal by rail to determine best development options for coal in western China
Improving mine safety	• Mainly top-down approach • Weak enforcement of regulations • Poor gas drainage performance • Safety targets too low	• Introduce worker safety representatives elected by peers at all mines • Government safety inspectors authorized to halt unsafe

Policy aim	Current status	Recommendation
	• Cumbersome administration at provincial and lower levels	operations without referral • Gas control training and technology transfer • Publicize accident data • Zero fatality targets • Simplify safety administration by better defining responsibilities of designers and managers
Healthier working and social conditions	• Serious dust disease problem • Poor conditions in local mines • No social security net for itinerant workers	• Enhanced guidance, practice and enforcement of dust control measures • Health screening for all • Disseminate occupational health data • Equitable contracts for all miners
Environmental protection	• Fixed rate environmental fees • Standard EIA consulting charge not matching increased workload • Fines for non EIA compliance low • Trial CMM emissions reduction standard issued by MOEP	• Set environmental performance compliance criteria • Mines pay fees and compensation linked to full costs of site specific impact • Raise EIA consulting fee • Increase non compliance fines in proportion to project scale • Add VAM abatement to MOEP's emission reductions standard • Feasibility study to include conceptual mine closure plan • All operating mines to submit mine closure plans and update at prescribed intervals
Strengthening institutional, legal and regulatory framework	• Contradictory short-term policy interventions by MOLAR and MOEP • SACMS also carrying production related duties • No central coal industry authority • Overlapping and inefficient administration at provincial and lower levels • Rigid prescriptive regulations	• Clarify specific roles of key ministries and administrations and transfer coal industry management duties to a new central government coal industry department • Streamline administration at provincial and lower levels. Cleanly separate safety and production functions • Introduce performance standards • Reduce illegal mining by allowing provincial authorities to issue "small scale mining licenses" which clearly define the minimum employment and safety requirements that must be met to be allowed to operate or else face closure

Chapter 1 Introduction

China's coal industry development strategy

China's current strategy for the development of its coal industry is based on policies developed and implemented in accordance with the State Council's detailed opinions (Some Opinions of the State Council on Promoting the Sound Development of the Coal Industry, No. 18 [2005] of the State Council, 7 June 2005). The highest level of government authority has thus defined principles to be followed and guidelines to be adopted in developing a sustainable, coal industry which meets the needs of the national economy. The above document summarizes the rapid progress which has already been achieved within the coal industry and highlights the key issues that must be addressed as the growing economy continues to drive coal demand, thus increasing pressure on resources, the environment, and safety. The State Council's proposals are fundamental and far-reaching. Once accomplished, China's coal industry will be capable of achieving sustainability.

According to the State Council, the aims of increasing efficiency of resource exploitation, improving safety, improving economic performance and reducing environmental damage should be achieved through the advance of technology. Safety must be the foremost consideration. The key objectives are to consolidate coal mines into large-scale conglomerates with 100 Mt production capacities which are safer and which are more responsive to environmental stewardship, as well as to refine the underpinning policies and regulations. These gains should be joined by strengthened management of resources and their comprehensive exploitation, including development of downstream coal processing and chemical industries. Specific aims and objectives are listed in Table 1.1.

A principle is thereby introduced where the State provides guidance without over intervention in the development of coal enterprises. Thus, the importance of commercial independence as a prerequisite for an efficient business is acknowledged. Nevertheless, traditional planning controls are still to be exercised on coal mining enterprises and the State will help mining enterprises to address historically inherited liabilities. The ultimate aim is to develop a fair and competitive market environment. The legal basis for the macro-control of coal industry regulation and policy is encapsulated in the *Law of the People's Republic of China on the Coal Industry* and the *Mineral Resources Law of the People's Republic of China*, both are under revision.

The Government has made substantial progress in addressing most of the State Council's aims. However, there are a few omissions and key areas where significantly more needs to be done to achieve the desired objective of a sustainable coal mining industry.

Table 1.1 State Council's objectives - development of the coal industry (June 2005)

Category	Objectives
Efficient resource exploration and exploitation	Coal exploration efforts are to be enhanced and sufficient reserves established to safeguard national energy demand. The quality of coal explorations methods, standards and techniques are to be improved. Detailed coal resource data and management of exploration and mining right allocation will be centralized.

Category	Objectives
	Taxation through production and sales revenue should be replaced by a fee (pre-paid royalty system) based on the value of coal reserves once the mechanism has been tested and proven. Revenue earned from the transfer of mining rights to coal enterprises is to be re-invested in coal exploration through rotating funds.
Improving mining efficiency	Use of advanced mining technologies for exploiting thin and difficult seams should be promoted. The revision and updating of coal mine design codes should be accelerated.
Coal industry restructuring	Coal mining industry restructuring should be accelerated and coal supply infrastructure strengthened. Accelerate the construction of 13 large-scale coal bases founded on KSOCM with high-quality resources and good development potential. The State will inject capital from its infrastructure budget to assist the development of large coal-bases and the State financial sector should improve and expand their financial services to the coal enterprises. Diversity of ownership though public share offerings is encouraged. Priority should be given to industrial down-stream coal use projects (e.g. thermal power plants) sited at coal mines to reduce pressure on coal transport. Large-scale coal conglomerates which are not territorially constrained should be fostered. These large enterprises should compete internationally and also develop overseas projects. Large scale coal enterprises should be encouraged to annex and reform small and medium-sized coal mines, and encourage small and medium-sized coal mines with reliable coal reserves to consolidate through asset restructuring. Streamline corporate management and strengthen quality and commitment of front line management in coal mining enterprises. Continued closure of backward, inefficient, polluting and hazardous small coal mines which are wasteful of coal resources. Improve co-investment mechanisms for coal mine safety improvements by enterprises, and local and central government. Technology transfer, collaborative ventures and R&D should be aimed at producing more key, modern mining equipment in China. Collaboration among coal enterprises, scientific research institutes and universities should be strengthened to promote technical innovation. Stimulate mining related education, improve vocational training, mine staff training and raise skills and qualification standards within the industry. Foster a service industry of agencies and consultancies to provide industrial statistics, technical services, safety appraisals, market information and professional advice to government and enterprises.

Category	Objectives
	This should include technical services support for small and medium scale mines.
Institutional strengthening	Improve the legal system, rules and regulations, policies, and macro-control of the coal industry Local government at various levels in coal-producing areas should set up effective coal industry management departments and strengthen their administrative practices. Local DRC coal departments at various levels are responsible for coal mining development supervision and the land and resources departments for managing access to coal resources. A specific requirement of the latter is not to exceed its authority in granting rights to attract FDI, presumably a pointed reprimand for past actions. New, transformed and expanded mining projects must be approved by the department of safety production supervision at the appropriate level of authority. Approvals and mining licenses should not be granted to mining projects that are not designed to achieve the standard extraction performance. Mining operations should be examined annually and those which are underperforming should be required to rectify the situation within a fixed time or be penalized and ultimately have their mining license revoked. Tighten licensing of coal mining enterprises, eradicate unofficial sales and transport charges, and ensure tax and financial probity. Reinforce the safety production system comprising State supervision, local government inspection and acceptance of responsibility by the coal mining enterprise. Promote sustainable development of coal enterprises. Coal mining enterprises should make financial provisions for eventual decline and closure, improve accounting procedures, increase resource exploitation efficiency and improve environmental stewardship.
Coal market reforms	Use economic measures together with administrative rules and regulations to balance the interests of coal mines and the power sector. Encourage suppliers and retailers to interact freely, without government intervention, and to negotiate long-term contracts. Accelerate the building of a modern, central, internet-based coal trading system.
Health, safety, environment and community	Improve the working, employment and living conditions of coal miners, including enhanced mechanization, shorter working shifts, improved personal protection equipment, accident insurance, income increases linked to the financial improvement of the enterprise and upgrading of sub-standard housing. Improve gas prevention and control technology.

Category	Objectives
Coal utilization	Environmental impact assessment, protection and restoration measures should be strengthened and observed rigorously by mining enterprises. Promote industrialization of clean coal technology, including improved coal beneficiation, coal liquefaction and gasification. Accelerate demonstration of underground coal gasification for recovering energy from unworkable coal seams. Promote integrated clean utilization of previously discarded coal mine resources, including coal waste, coal mine methane, mine water and waste rock. Integrated resource utilization should become a condition for project approval and favorable financial and tax policies should be devised to aid implementation.

Some Opinions of the State Council on Promoting the Sound Development of the Coal Industry, No. 18 [2005] of the State Council, 7 June 2005

China's coal mining industry achievements

China's coal mining sector has been undergoing reform for the past two decades during which time it has modernized its large mines, expanded coal production, significantly improved mine safety and raised the social benefits to miners. The output of raw coal has risen by 1.1 Bt in the past decade from 1.4 Bt in 1996 to 2.5 Bt in 2007. In the last 5 years, China's coal production capacity has also been increased by 1.1 Bt including newly built mines, mines under construction, and expanded and transformed mines (CCN 1 June 2007).

Coal mines have become safer places to work with an absolute reduction in fatalities by over 40 percent since 1996 and the fatalities per Mt coal mined reduced to a third of the 1996 figure by 2007. The fatality rate in coal mines throughout Shanxi province dipped below 1.0 for the first time in 2004 falling to 0.90 in 2005, while some large mining groups have achieved zero fatalities in recent years. The expenditure of 83 billion yuan (US$11 billion) over the last five years, mainly on safety technology and improvements in KSOCM, has resulted in a reduction in the average fatality rate per Mt mined from 1.1 in 2003 to 0.6 in 2006, an almost 50 percent improvement. However, significant progress needs to be made to match international safety standards.

Since 1996, social welfare provisions have been progressively reformed in the KSOCM with the introduction of pension funds, and unemployment, health and injury insurance. These provisions are now required to be made by all mining enterprises.

In 1999, bankruptcy provisions were introduced which facilitated the closure of exhausted, inefficient and high cost mines. This, together with the closure of many small, polluting, wasteful and dangerous small mines, and the consolidation and transformation of legal small and medium mines into larger industrial scale mines, has improved the structure of the coal mining sector.

Price controls on coal have been largely removed and the industry is more profitable than ever before in its history. In 2007, the average profit margin of the large coal mine enterprises increased by 29% in comparison with that in 2006. Particularly, the average rate of return on net assets for domestically listed coal companies reached a healthy 28%.

China's coal industry challenges

China's sustainable development depends on its ability to modernize and expand its coal mining sector in a manner that is safe, as well as socially and environmentally sustainable. In 2005, China was responsible for nearly 77 percent of the growth in world coal consumption as a result of its continued strong economic growth and high dependence on coal as a source of energy. Coal will still provide around 60 percent of China's energy in 2020 by which time coal demand could reach more than 4 Bt (Figure 1). If China is to maintain stable growth it must therefore double its 2005 coal supply by 2020 and the Government seems committed to producing as much of this as possible from domestic sources. Failure to address the impact will result in an unprecedented scale of environmental damage and greenhouse gas emissions that will contribute significantly to global climate change.

Coal mines cannot increase coal supply when they are already producing at full or over-capacity and transport systems are fully utilized. A continuous program of mine and transport construction must therefore be implemented, and without detriment to the environment, to ensure sustainability of the sector. Government policy of encouraging downstream coal use at mine sites is aimed at alleviating strains on coal transport.

The Government of China does not seem to have fully recognized the likely scale of the coal supply problem. Despite the surge in energy demand in the last 5 years, planners are still projecting total energy demand of 3.0 billion tce or less by 2020, compared to 2.4 billion tce in 2006. According to government forecasts, 58 percent of total electricity generation in 2020 will be based on coal, reduced from 74 percent in 2006. Furthermore, the NDRC is proposing to cap coal production at 2.6 Btpa from 2010. These forecasts are based on an optimistic projection of over 205 GW per annum of renewable capacity by 2020 (CCN 5 Feb 2007).

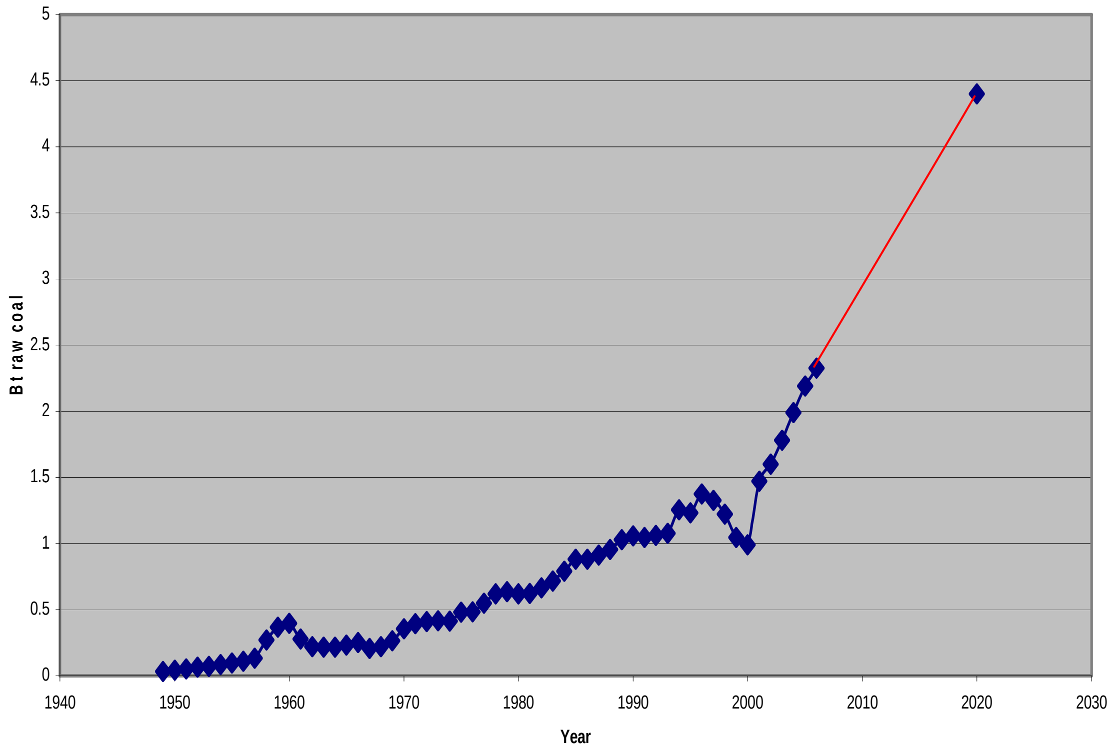

Figure 1.1 Total coal output in China and future projections(unit: 10 Bt raw coal)

In addition, the coal industry will need to meet growing coal demand from households, and steel and other manufacturing sectors, which together are projected to account for 45 percent of total coal demand. If, as is likely, energy demand grows much faster than projected there will be a large shortfall between coal

demand and indigenous coal supply. This concern is compounded by the likelihood that the renewable sector will not develop as fast as projected.
Renewable energy at present provides 7 percent of China's total energy supply and the official target is 16 percent by 2020. Planned increases in energy efficiency may not be realized as the targets appear too ambitious. In 2006 and 2007, China reduced its energy consumption per unit of GDP by 1.33 percent and 3.27 percent respectively, well below the 4 percent target, and is very difficult to improve on this, while the heavy, energy intensive industries maintain high growth rate.

An increase in the price of coal-fired electricity would drive improved energy efficiency and cause electricity generated from alternative fuels and renewable sources to appear more competitive. However, it is uncertain how far government is prepared to go in freeing electricity pricing.

Environmental protection is suffering as China missed its target of reducing emissions of pollutants by 2 percent and failed to achieve 8 out of 14 targets it had set itself for improving environmental standards over the 10th Five Year Plan due to higher than expected growth in the economy and the subsequent use of more coal than planned.

Sustainable growth will continue to be a major challenge for China over the coming decades. China's economic growth over the past 25 years has been impressive and continued economic growth is an imperative for the Government if it is to attain its objectives of urbanization, rising living standards, reduction of wealth differentials and continued social stability. A cost of growth to date has been an unprecedented pressure on the environment, serious air and water pollution and rising greenhouse gas emissions. Strong economic growth has also contributed to water and land scarcity.

Coal resources have been wasted in the past by failure to control the activities of large numbers of inefficient small mines and coal exploration has not kept up with exploitation. Coal mining resources, efficiency, environmental and safety issues are being addressed now by the Government and reinforcement of these efforts will ensure that China's development will not be compromised.

Government has been reluctant to allow market controls to balance supply and demand and instead has intervened. Large imbalances between supply and demand have thus arisen, necessitating major intervention to prevent economic downturns and the Government has demonstrated an ability to induce rapid increases in coal supply in response to coal shortages. However, the consequential suspension of environmental, social and safety considerations was both unacceptable and damaging to the country. This is particularly well exemplified by the rapid expansion of small coal mines that was encouraged by government legislation enacted in 1983 in response to a coal supply shortage. The output of the town and village owned coal mines peaked at 638 Mt in 1996, representing 46 percent of the national coal output in that year. The supply problem was solved, but at a high cost to the environment from uncontrolled excavation, water pollution and surface fires from spontaneous combustion. In 2008 the Government is still actively combating the problems created by this policy.

Sustainable development is a strong focus of government policy and a sustainable coal mining sector is crucial to securing energy supply. The aim of a sustainable coal mining sector is to ensure a smooth supply of coal to China's key industrial and power consumers. This can only be achieved in a market in which all coal is produced to economically, socially and environmentally sustainable standards ensuring that equal conditions apply to KSOCM, foreign invested joint ventures, domestically invested private mines and overseas mining companies exporting coal to China. Fair competition will lead to increased efficiency, greater returns on investment, reduced wastage of resources and a safer coal mining sector. Sustainable use of coal depends on both the production and the use of coal. Demand side initiatives are therefore also important, including improved energy efficiency and the application of clean coal technologies.

Chapter 2 Optimizing extraction

Proven coal reserves account for 94 percent of China's total proven fossil energy resources, with oil and natural gas accounting for only 5.4 percent and 0.6 percent respectively. Therefore, China will continue to be heavily reliant on the exploitation of coal resources to fuel its economic growth. A coal mining industry which adopts policies that recognize the finite nature of the resources and encourages economically efficient exploitation will be sustainable.

2.1 Quantifying coal resources and recoverable reserves

A coal resource assessment, conducted between 1992 and 1997, identified a total resource of 5,560 Bt of coal of which roughly half occurs at depths of less than 1000 m and the remainder from 1000 m to 2000 m. About 1,018 Bt of the resource was proven by exploration, including 192 Bt contained in existing mines and those under construction. The concept of reserves being coal that is economically viable to mine held little meaning during the central planning period in China. The new standards issued in June 1999 for the classification of mineral reserves sought to address this shortcoming.

In 2003 MOLAR revised China's coal resources and reserves classification system, bringing it more into line with international convention. The following categories were introduced:

- *Basic reserves*: The underground coal reserves, which can be utilized under current techno-economical conditions, i.e.
- *Reserves* : Deducting all kinds of losses from basic reserves, the coal reserves that can be economically worked out
- *Resources* : The less economic underground coal reserves, or the their economic significance were uncertain, were defined as coal resource
- *Proven resources* are the sum of *basic reserves* and *resources* which have been found by reconnaissance.

The revised assessment identified proven resources of 1,021 Bt consistent with the total established by exploration in the earlier survey, but this time with a detailed classification broken down regionally (Table 2.1).

China's western areas are isolated from the main economic hubs where most coal is consumed due to a lack of transport infrastructure. The Government therefore classifies these coal regions as "self supporting."

Table 2.1 Status of Coal Resources and Reserves in China (Bt)

Development Region	Planning area	No. of mining areas	Reserves (mineable)	Basic reserves (1)	Resources (2)	Proven resources(1) + (2)
Eastern Region	Beijing, Tianjin Hebei	274	4.2	9.8	8.1	17.9
	Liaoning, Jilin, Heilongjiang	641	6.8	15.9	15.5	31.4
	Jiangsu, Anhui, Shandong, Henan	781	17.4	37.0	41. 6	78.6
	Zhejiang, Fujian,Jiangxi, Hubei, Hunan, Guangdong. Guangxi, Hainan	1,618	2.4	4.7	.4.5	9.2
	Sub-total	3,314	30. 9	67.4	69.7	137.1
Central Region	Shanxi, Inner Mongolia, Shaanxi, Ningxia	1,208	126.7	213.4	472.6	686.0
	Guizhou, Yunnan, Chongqing, Sichuan	1,051	24.4	36.8	49.5	86.3
	Sub-total	2,259	151.1	250.1	522.1	772.2
Western Self-supporting Region	Tibet, Gansu, Qinghai, Xingjiang	538	7.3	16.7	95.1	111.8
Grand totals		6,111	189	334	687	1,021

Source: All China Reserves and Resources Bulletin, MOLAR, 2003

Reserves and resources are dynamic quantities. Mineable reserves are being depleted at increasing rates each year as coal is extracted, with 2.5 Bt being removed in 2007. At the same time, new resources are being found and the status of existing resources upgraded by detailed geological exploration. Tracking these changes is difficult as detailed coal reserve data is not publicly available and it is unclear whether annual reviews take full account of coal extracted in the interim period. Documentation gleaned from various government departments and institutions often does not clearly differentiate between resources and reserves, further confusing analysis.

Nevertheless, it is clear that exploration and mapping of coal occurrences is incomplete and continuing exploration is yielding substantial new coal resources (Table 2.2).

Table 2.2 Coal resource estimates

Year	Proven resources (Bt)	Bi-annual increase (Bt)	Source
2003	1,021	-	MOLAR (via CCII)
2005	1,035	14	MOLAR (via CCII)
2007	1,091	56	McCloskey 2008

Additions to resources and reserves over the last few years include:

- 620 Mt of proven coal reserves in the "Three Rivers" area of Yunnan province.
- In 2004, 10.4 Bt of coal resources were identified by Shanxi Coalfield Geological Exploration Team and 890 Mt added to coal reserves.
- Xian Geological Reconnaissance Research Institute of Shaanxi Provincial Geological & Mineral Reconnaissance Bureau found some 3.5 Bt of resources of low ash, steam coal in Jingbian County, southwest of Yulin city during investigation of a Jurassic coal basin in the Yuheng mining area of North Shaanxi. The thickness of coal seams varies from 2 m to 2.2 m at depths ranging from 400 m to 800 m.
- The No.2 exploration team of the Geological and Mineral Reconnaissance and Development Bureau of Henan Province has identified 55 km^2 of coal resources in eastern Jiaozuo coalfield with 390 Mt of coal at depths of less than 1500 m and a further 240 Mt at depths greater than 1500 m. There are 2 main coal seams. No. 1 seam is 6m thick and No.2 coal seam is almost 3 m thick. The depth of some of these seams would exclude them from being considered as mineable reserves under present economic conditions due to the high cost of extraction.

The accuracy of coal reserve and resource estimates are ultimately limited by the quality of raw data which is variable. Core recovery standards and core analyses are not consistently rigorous across China's coalfields. Lack of rigor in sampling, assay and reporting adds doubt to results of past exploration. The rationale of basing coal seam quality on a clean coal sub-section rather than the full workable seam is questionable.

There is uncertainty attached to reserves associated with existing mines due to the possibility that reserves have been overstated to comply with outdated mine design rules to ensure Feasibility Study approval, and hence mine construction approval. As much coal as possible is included in assessments for coal mine feasibility studies to ensure that the prescribed mine life criterion in China's mine design code can be met. For example, to obtain approval for a coal mine project, a mine with a production capacity of 0.45-0.90 Mtpa should have a life of at least 50 years and achieve a specified coal recovery (for example, 85 percent for thin coal seams). A feasibility study will show the required result, but whether it will be actually followed in practice is uncertain. The mine design codes have been under revision for a number of years and despite a request from State Council have still not been completed and released.

The Government specifies a minimum thickness of coal seams to be included in reserve estimates. In areas where coal seams are scarce, thinner coals should be included. In contrast to the reserve and resource classification, the thickness standards have no economic basis and are purely prescriptive.

For all of the above reasons, resource and reserve estimates need to be treated with caution.

On "paper" China has vast coal resources, yet there is a question as to how much of these reserves can be economically recovered. To estimate the quantity of coal that might be extracted (technically recoverable reserves), this data must be discounted to take account of recovery losses due to geological faults, washouts, poor quality coals, seam thinning, pillars to protect surface features, and mine structural pillars. For geological reasons, not all of the resources identified in preliminary exploration will necessarily be convertible to reserves.

A broad estimation, based on experience of geological complexity, mining and other factors that inhibit coal recovery, is that 40 percent of the basic reserves might be technically mineable (reserves) and 60 percent of the resources may be convertible into basic reserves. Proportionally scaling the basic reserves and resource totals in Table 2.1 to match the 2007 proven resource in Table 2.2 yields an estimate of 369 Bt basic reserves and 722 Bt resources. Applying the above factors gives total reserves of 321 Bt for the year 2007.

Based on the 2007 proven resources, China would appear to have sufficient coal in place to provide the 40 Bt likely to be mined from 2007 to 2020. Making a highly speculative assumption that coal demand will level out at around 4 Bt from 2020 onwards implies 65 years of reserves remain beyond 2020. This estimate assumes negligible imports and no further significant coal finds, but does assume that coal energy in the western regions will become economically accessible. Ramping net imports would add nine more years of life.

From the present (2008), therefore, China has an estimated 75-80 years of technically mineable coal (reserves) remaining.

The composite, overall rate of coal production depends on geological and mining factors which increase in complexity, thereby raising production costs as the most accessible, geologically undisturbed, high quality coals become exhausted. As coalfields are intensively worked, basic reserves are reduced and at some stage a peak production is reached after which mining becomes more costly and difficult and alternative energy sources become more competitive. Increasingly scarce coal forces prices upwards, causing demand for coal to fall due to more efficient use of coal and consumers switching to other fuels such as gas. Production of coal, therefore, will start to decline long before basic reserves are totally exhausted.

The trend of coal production rate over the life of the reserves can be empirically represented by a bell-shaped curve. Hubbert (1956) first described this process in an analysis of oil production in the USA in which he postulated that a peak production would be attained that cannot be exceeded. Tao and Li (2007) have used a computer model to apply Hubbert's theory to a simulation of China's raw coal production. According to this simulation, a peak coal production of 3.34 – 4.45 Bt will reached between 2025 and 2032. The model predicts coal supply falling to 2.34 Bt by 2050. The underlying rigor of this analysis has been questioned. Further analysis of the life cycle of China's coal resources is therefore needed.

Conventional coal mining becomes more difficult, costly, and hazardous as the mining depth increases. Depending on geothermal gradient, geological and gas factors, the practical limiting mining depth using conventional technology lies typically between 1000 m and 2000 m. The former limit seems to be applied in China.

China could potentially expand its coal reserves substantially by developing underground coal gasification (UCG). UCG is a technically feasible technology (Appendix 1) that is not constrained by coal seam depth. China has implemented several pilot projects, but the technology has yet to be demonstrated on a sustainable commercial scale.

2.2 Resource exploitation policy

The above analysis indicates that China can probably support intensive coal mining beyond the mid-part of the 21st century. How effectively this resource is exploited will depend on government policy. Current government policy identifies maximum coal resource recovery as a priority, but a more economically efficient result would be obtained by optimizing exploitation.

Coal exploration and mining licensing policy and issues have been discussed in a previous study (ESMAP 2004) which should be consulted for additional detail.

Coal exploration

Coal exploration of potential new coalfields is jointly financed by central and local government and coal enterprises.

Each coal exploration project is examined, approved, registered and licensed by the department in charge of geology and mineral resources under the State Council. The exploration licensee must commit to minimum amounts of exploration expenditure: 2,000 yuan/km^2 for the first year of exploration, 5,000 yuan/km^2 for the second year and 10,000 yuan/km^2 for each year thereafter. Surplus expenditure in one year can be offset in the following year. Proof of expenditure seems more important than reporting and filing of results, so data may be poorly collated and difficult to trace if required by third parties at some later date.

Exploration rights can be acquired by bidding and auction (as illustrated in Appendix 2) where the project is state funded, where exploration rights have been forfeited or surrendered, or where there are potentially large energy resources, for projects deemed of national importance and for projects in environmentally sensitive development areas. MOLAR handles applications where resources straddle multiple administrative areas, for offshore resources, for foreign invested projects and where exploration investment exceeds 5 million yuan.

For an exploration project involving an area of more than 30 km^2, MOLAR is responsible for issuing exploration permits. For lesser areas, local land and resources departments are authorized to issue exploration permits. Where non-coking coal reserves are greater than 100 Mt or coking coal reserves are greater than 50 Mt, the mining permit is issued by MOLAR. Provincial land and resources departments are authorized to issue mining permits for smaller projects.

In early 2007, MOLAR placed a moratorium on coal exploration due to concerns at construction of excess capacity in the coal mining sector. This was a short term decision and symptomatic of the ineffective stop-start controls that the Government uses to attempt to balance supply and demand. The expected long-term trend for coal is one of strongly increasing demand. If this demand is to be met from local sources, there is a need for a steady increase in coal mining capacity and continuous exploration.

Allocating resources for mining

Allocation of mining rights has moved away from an administrative process where no value was assigned to the coal resources, to a more competitive process in which the successful bidder or applicant pays a royalty fee to reflect the value of the resource.

Bidding is not conducted if the applicant is the exploration license holder, or for a mine expanding in compliance with local plans or where coal exploitation is being developed under the auspices of a single enterprise. There are few barriers to the transfer of existing mining rights during enterprise reform, merger, sale or formation of a joint venture provided there has been one year of full production and all requisite fees have been paid. However, the scale of exploration and mining rights requested must be compliant with general and local plans and be consistent with resource protection policies and environmental protection regulations.

In early 2007, China began introducing a new coal exploitation system whereby coal producers must pay fees to government to utilize the country's coal resources. The system, referred to as the “paid utilization system”, has been introduced into eight coal producing provinces and regions, including Shanxi, Shaanxi and Henan and the Inner Mongolia Autonomous Region. The aim is to stimulate an increase in resource recovery from the current rate of between 15 and 20 percent to a rate of between 40 and 50 percent.

The basis of royalty assessment, payment method and amount, as applied in Shanxi Province, is shown in Tables 2.3 and 2.4. The royalty value of around 2.5-3.5 yuan/t reserves is broadly equivalent to about 1.2 percent of the current coal price.

Table 2.3 Paid use (royalty) for mining right in Shanxi Province

Method by which obtained mining right	Basis for valuation assessment	Method of payment	Comment
Administrative allocation	2004 reserves	Direct or state-owned share equivalent (if not private)	
Resource integration from small mine closure and consolidation		By agreement	If not willing to be integrated, the paid use will be implemented by public transfer
Mines closed before 2004	Price of reserves doubled		

Table 2.4 Payment criteria for mining right in Shanxi province

Category	Price (yuan/t)	Payment schedule
Bituminous coal	2.48-3.03	na
Anthracite	2.98-3.53 (3.3 for seams 2&3; 2.7 for seams 9 & 15	na
<10Mt reserves or expanded reserves	na	Lump sum
10-20 Mt reserves or expanded reserves	na	Installments completed within 6 months. First payment ≥60%
>20 Mt reserves or expanded reserves	na	Installments completed within 12 months. First payment ≥50%

The royalty paid in return for mining rights is allocated to provincial, city and county governments in the following proportions: 3:2:5 where the mining right had been previously allocated administratively. In the event of open tendering for resources the split is 2:3:5. The royalties paid to county and city governments are to be used for environmental protection, public welfare, and compensation for owners of legal coalmines that have been closed under a minimum capacity policy.

Advanced payment of a royalty excludes under-capitalized and non credit worthy coal mining enterprises, and provides an incentive to mines to increase efficiency to recover as much of the coal as it is cost-effective to do so. On the basis of economics it is logical that coal will be recovered, provided that the price received exceeds the expected cost of extraction plus the royalty. If there were no royalty, mining costs would be lower and so more coal would be mined. If royalties are paid in advance of mining, the royalty payments are capitalized. Therefore, it will always be worthwhile to mine, provided the coal price is greater than the extraction cost.

Advanced royalties also deter mines from holding large tracts of un-worked reserves for which they cannot obtain finance to develop or for reasons of speculation. Independently accredited companies with qualified surveyors are needed to provide the necessary assessments and a dispute system established. Royalty charges should also accurately reflect the value of the coal taking into account mining difficulty.

Comparisons with royalty regimes in other countries

In other major coal producing countries, royalties are based on mining revenue. For instance, in the USA the royalty on underground coal from Federal lands in the USA is charged at 8 percent of gross mining revenue (Kepler et al 2004).

The coal royalty regime in NSW, Australia was revised in July 2004 when a new ad valorem coal royalty was introduced (State of NSW 2005). Under this regime, a royalty is charged as a percentage of the value of production (total revenue less allowable deductions). The coal ad valorem royalty rates are 5 percent for deep underground mines (coal greater than 400 m), 6 percent for other underground mines and 7 percent for open cut mines.

Royalty is also payable on the coal content of coal rejects if they are used for producing energy. This would not be advisable for China as the Government is attempting to encourage use of coal waste to increase the energy recovery from coal mining.

In NSW, leaseholders are required to lodge monthly returns and payment on or before the 21st day of the month following extraction of coal, and annual returns on or before 31 July each year. The collection of mining royalties is based on 'self assessment'. It is the responsibility of the mining leaseholder to calculate and promptly lodge the royalty return. The government carries out a number of check audits annually to review the royalty returns lodged by lease holders. Such a system would be impractical to implement among China's small mines.

While the royalty charges are lower (equivalent to about 1.2 percent at a flat rate value) than those imposed in the USA and Australia, they are reasonable for an industry undergoing major reform. The fact that they are paid in advance in China provides an incentive to maximize recovery – a driver not required in developed countries where extraction is a function of the mining economics. However, the Government of China should consider the possible merit of also charging an additional revenue-related royalty to take account of the changing value of the coal.

Controls on approval for coal exploitation

The Government exerts controls on coal exploitation. No extraction is allowed without permission and a technical evaluation is required if:

- The coal is inferior, with high ash and high sulfur content;
- The coal has low calorific value;
- There is no market;
- The coal could not be exploited unless blended with other ranks of coal;
- Complicated mining conditions prevail;
- There is a high risk of natural hazards; or

- Extraction of the coal may damage the reserves.

On the basis of the technical evaluation the provincial or local governments can grant approval, but may impose specific conditions under which the coal can be extracted. A coal industry which is allowed to make commercial decisions on economic grounds has no need of such bureaucratic controls.

Coal recovery rate

A vast wastage of coal resources has occurred due to lack of systematic mine planning and use of archaic and inefficient mining methods. Some small mines encroached on the lease areas of KSOCM reducing reserves available for mechanized mining. For example of the 50 small mines in Hegang municipality in Heilongjiang, 48 operated within the boundaries of large state mines (Wright 1998). Small mines often recovered no more than 10 percent of available resources (Zhongguo meitan bao, 16 April 1995) compared with KSOCM which generally recover around 45-50 percent. One estimate was that, in extracting 370 Mt of coal, the small mines sterilized 1.5 Bt (Wright 1998). It is therefore not surprising that the Government has sought means of improving resource recovery**.**

Not only is minimum seam thickness to be worked now specified, but the amount of coal that must be recovered is also prescribed. The coal recovery rate is defined as the ratio of the quantity of coal mined to the quantity of mineable reserves. Regulations stipulate that the recovery rate from mines with an annual designed capacity of more than 90,000t of coal shall not be lower than 85 percent for thin coal seams (0.7m -1.4 m in thickness band), 80 percent for medium-thick seams (thickness), not less than 75 percent for thick seams (thickness band), and not less than 70 percent for hydraulic coal mining. This performance should be achieved irrespective of geological conditions and mining economics.

Typically across China, the coal recovery rate of the KSOCM is around 45 percent and that of the local and private mines vary between 15 percent and 20 percent, with the country average being 30 percent. In Shanxi, arguably the most important coal mining province, the average coal recovery rate is 39 percent. Reasons for low recovery are use of out-dated mining methods, poor management and low levels of mechanization. While 98 percent of mining in the KSOCM is mechanized, the level of mechanization is only 20 percent in the LSOCM and less than 10 percent in the TVCM. Consequently, thick seams are incompletely mined, recovery from medium-thick seams is low and thin coal seams, which account for 12 percent to 18 percent of the total “reserves” in the province, are abandoned.

To improve their understanding of the issues and practical problems preventing coal resource recovery standards being achieved, MOLAR and NDRC organized a nationwide survey and inspection in mid 2005. This involved an internal audit by coal mining enterprises, general inspections by government departments and selected spot checks by expert groups. Nineteen coal-producing provinces (prefectures, and municipalities) and two large coal enterprises were inspected. The detailed results have not been published but the general findings have. A steady rise in recovery rates over recent years was reported but improvements have not been uniform. The best performance was recorded in the east and the poorest in the west where resources are more plentiful. The main problems revealed by the inspection were:

- The computation of coal recovery rates in some coal enterprises is not standardized and reported results are therefore unreliable;
- Many medium-sized and small mines do not have professional geologists or other technical specialists who are able to provide reliable data;

- The mining technology and techniques used have constrained the coal recovery rate at some mines. Intensification of mechanized mining in large and medium sized coal enterprises, especially mechanized full seam height extraction, has resulted in coal loss where seams are thick but locally variable;
- Loss of coal in pillars in faulted zones, in room and pillar operations and the abandonment of some thin seams;
- The fully mechanized sub-level caving method has improved productivity but the recovery rate of coal is still low;
- Small coal mines that have not yet introduced total extraction mining methods; and
- The implementation of environmental protection policies has raised environmental awareness. However, increased awareness has raised concerns with subsidence and this has cause mine managers to reduce recovery rates.

Wang Xianzheng (China Energy Strategy High Level Forum, 9th Exposition of Sciences, (July 2006) stipulated the following four reforms considered necessary to improve coal recovery rates in China:

1. Apply a mineral resources tax based on an assessment of reserves.
2. Determine suitable recovery rates for different regions and categories of coal seams, and establish a strict system of supervision with penalties imposed where serious contraventions are identified.
3. Raise the threshold of market access to motivate more coal enterprises to value resources and make rational development and utilization of resources.
4. Strengthen guidance on coal development planning, scale of mine construction and control of coal production, with special attention to scarce resources such as coking coal.

Of the above, items 1 and 3 have been addressed by the pre-paid royalty. Detailed specification of regional recovery rates in item 2 would be too prescriptive and impractical to implement and item 4 suggests customary planning controls rather than allowing the market to decide.

Regulating and reserving use of resources

It is questionable whether exploitation of all economic reserves should be allowed provided the requisite approvals are obtained. Coal is a finite resource essential for meeting China's long-term energy needs and unless its uses are regulated, strategic reserves will not be available when they are needed. China has substantially less than 100 years of coal resources accessible by current, conventional mining technology. There may, therefore, be some justification for prioritizing coal use for thermal power generation in modern, efficient low emissions plant to meet China's long-term energy needs.

However, there is a dichotomy between reserving thermal coal for power generation due to the continuing rising demand and the limited, finite resource available and using more coal for synthesis of petroleum derivatives to reduce reliance on imported petroleum.

Free markets recognize the value of some products and no policy provisions are necessary. For instance, there is no need to specifically reserve coking coal for metallurgical purposes, as the high market price for this grade of coal automatically assures its final use.

Free markets throughout the whole supply chain would theoretically yield the most economically efficient result for all coal products. However, few, if any, countries are unable to totally relinquish control on prime energy sources for reasons of preserving national security and to ensure sufficient energy independence to protect society and industry against any short-term fluctuations in international trade. It is therefore reasonable to expect the Government of China to protect its energy security by preserving a strategic resource of coal as a buffer against interruptions to imports. The USA conserves its indigenous gas resources for a similar reason**.** The NDRC has stated that extensive coal resources in Xinjiang represent China's strategic energy reserves. However, no policy mechanism is evident for identifying and protecting the resources and specifying the conditions in which they can be exploited.

2.3 Coal resource policy reform needs

Current coal exploitation policies follow the traditional administrative approach of setting standards without providing the detail, and strengthening control rather than establishing a performance oriented regulatory framework. The negative aspects of the Government's current "resource protection" policies are:

- Enforcing recovery rates could reduce the profitability of mining if companies are forced to mine uneconomic coal which could also exacerbate safety and environmental problems.

- Enforcement of prescribed minimum thickness of seam to be worked will result in continuation of manual and semi-mechanized extraction methods in thin seams contrary to government policy to fully mechanize the mining industry to reduce numbers of miners at risk and to maximize coal extraction rates.

- Stringent enforcement of resource protection regulations will mean that overall productivity and safety will not reach standards comparable with those in advanced coal mining countries.

The minimum thickness of coal seams that must be included in reserves, and in feasibility studies and also which must be worked under the terms of mining leases, are stipulated by regulation in China. This is in contrast to most other coal producing countries, including Australia and the U.S.A, where the mine operator determines what coal can be worked safely and economically within the prevailing market conditions taking into account geological, mining, environmental, resource, and other constraints. Resource recovery is not considered a major issue in these countries. Maximizing resource recovery is unnecessary. What is important is to optimize resource recovery which involves making mining decisions that maximize the net present value of the resource.

The policy to encourage maximum resource recovery may tempt mine owners to minimize support pillar sizes and to mine into pillars of protection beneath sensitive surface features such as water courses and villages. This policy must therefore be supported by stronger safety regulation enforcement in mines and more rigorous monitoring of mining induced surface impact. There is also a danger that this policy will encourage mining of poor quality coal to maximize revenue to offset royalty charges.

2.4 Recommended policies to improve efficiency of resource exploitation

If its coal markets work efficiently, China can ensure that its coal resources are optimally utilized. Thus, China is likely to achieve maximum benefit from the utilization of its finite coal resources.

Not all exploration projects result in the discovery of mineable coal reserves. Further, the process of proving reserves, determining feasibility, mine planning and approvals can take up to five years. Due to the significant risk and long lead times, there should be no impediment to allowing exploration to proceed as far in advance of demand as is judged to be commercially viable. This will facilitate timely delivery of coal to meet market demand and ensure there is a bank of reserves ready for developing when required. The MOLAR moratorium on exploration should be withdrawn because market prices provide a better guide to the industry as to when to increase exploration activity and when to reduce it. The timing of exploration should be a matter for the holder of the mining rights to determine on commercial grounds and government intervention is unnecessary.

Prescriptive resource recovery standards, which specify minimum seam thickness and recovery rates, have been introduced by government with the aim of improving resource recovery. These factors prevent economic efficiencies being realized through market mechanisms. Resource recovery factors are not specified in other major coal mining countries and to enforce them in China could cause mine owners to subject mine workers to unacceptable safety risks or encourage mining of dirty, polluting coals. Resource recovery factors should be abolished as the market will optimize recovery rates from a social perspective provided it is facing undistorted market prices and bearing the full costs of production (financial, health and safety and environmental).

Coal mines will optimize extraction of coal resources in a free market, where a royalty is paid in advance based on reserves, without the need to specify recovery rates and minimum seam thicknesses to extract. The pre-paid royalty scheme for coal, based on the value of the resource, should therefore be introduced across all coalfields in China. Advanced payment of a royalty excludes under-capitalized coal mining enterprises, and provides an incentive to mines to increase efficiency to recover as much of the coal as it is cost-effective to do so. The pre-paid royalty element is relatively low compared with revenue based royalties incurred in other mining countries. The merit of charging an additional, modest royalty linked to the value of the product should be examined. This would ensure that the coal owner (government) was compensated for the true value of the resource.

The Government has identified the coal resources in the west of China as “strategic reserves” to ensure energy security in the event of unexpected downturns in international energy supply markets. There should be no policy incentives for coal-to-liquid (CTL) installations due to the high economic cost and inefficient use of valuable coal resources in these remote areas.

Current assessments of coal resources are based on exploitation by conventional mining methods. The economic and financial viability of alternative methods for extracting energy from seams that are too deep or difficult to mine conventionally should be investigated to extend the life of China’s coal resources. The European deep UCG technology as a source of energy for power generation could be competitive with alternative fuel sources once commercially proven. A first stage could be to review current UCG technologies, the experiences from the existing projects in China, and issues and barriers encountered, and to determine a strategy for future research, development and commercialization. In parallel with the technical appraisal, a geological assessment should be undertaken to identify additional potential coal resources that UCG technology could access. These proposals would complement existing State Government policy to demonstrate the application of UCG to low quality and difficult to mine coal seams.

Chapter 3 Coal supply infrastructure

China's coal resources are widely, but unevenly, distributed over a total coal bearing area of 600,000 km^2. Coal resources are more concentrated in the north and west than in the south and east, and the regional distribution of coal resources tends to be inversely related to the distribution of economic activity. The mismatch is illustrated in Table 3.1. 80 percent of China's GDP is produced in eastern areas, where only 38 percent of the coal resources lie. Therefore, the capacity of long distance transport infrastructure is critical to the coal supply chain. Delivery of coal to satisfy market demand not only depends on coal resource and mine production capacity, but also on the supply chain infrastructure linking the producer and the user.

Table 3.1 Regional coal production and consumption in 2004 (Mt)

Area	Coal consumption	Coal production	Net input (+) net output(-)
Beijing	25.2	7.5	17.7
Tianjin	30.1	0	30.1
Hebei	146.4	75.8	70.6
Shanxi	192.3	565.1	-372.8
Inner Mongolia	97.6	236.7	-139.1
Liaoning	102.4	63.8	38.6
Jilin	49.0	26.6	22.4
Heilongjiang	63.0	97.4	-34.4
Shanghai	44.1	0	44.1
Jiangsu	113.8	25.9	87.9
Zhejiang	71.78	0.4	71.3
Anhui	67.1	78.4	-11.3
Fujian	32.6	15.3	17.3
Jiangxi	33.8	20.5	13.3
Shandong	156.6	130.4	26.3
Henan	128.0	149.6	-21.5
Hubei	69.0	10.5	58.5
Hunan	51.8	49.1	2.7
Guangdong	75.4	3.0	72.3
Guangxi	28.9	6.2	22.7
Hainan	4.1	0	4.1
Chongqing	24.9	33.1	-8.2
Sichuan	70.2	80.9	-10.7
Guizhou	68.5	106.2	-37.6
Yunnan	48.8	64.8	-16.0
Shaanxi	42.5	158.1	-115.6
Gansu	29.8	35.9	-6.08
Qinghai	5.8	5.6	0.2
Ningxia	23.7	26.5	-2.9
Xinjiang	31.1	39.4	-8.3

Source: CCII

Rising domestic coal prices, continuously rising demand and domestic transport infrastructure limitations are increasing the demand for imports which are, in turn, dependent on the capacity of transport, both for domestic and international movement of coal.

According to the NDRC, *2008 Outlook for Coal Demand and Supply*, at least 250 Mt of coal production capacity will enter operation in 2008 but the annual growth in coking coal output capacity will fall from 22 Mt in 2007 to 18 Mt in 2008, mainly due to the closure of many inefficient, polluting small-scale coal mining operations in Shanxi. An additional 63 GW of power generation capacity will be introduced, a quarter of which will be thermally coal based in the south-east of China, remote from the main centers of coal production. Internal rail transport capacity limits will constrain domestic supplies but demand can be balanced by imports. The Government is expecting coal price rises, but will intervene if it considers them to be excessive. Unfortunately, such a restriction will inhibit investment in coal transport by rail and ship, as well as complicate the negotiation and adherence to long-term supply contracts by domestic and overseas suppliers.

3.1 Current status

China's current ability to supply coal to its industrial, commercial and household consumers depends largely on domestic coal production, imports and the capacity of its national transport networks of rail, road and waterway.

The flexibility of domestic coal production and supply is dependent on the quantities of coal held in stockpiles, the availability of surplus production capacity at mines, the speed at which new production capacity can be added, and imports and bulk coal transport infrastructure.

Stockpiles can buffer relatively small spikes in demand but sustainable supply increase is largely dependent on new mine capacity. Large stockpiles that occasionally arise at mines and ports are indicative of transport infrastructure problems.

International coal trade

International coal trade is small in comparison to domestic trade and is subject to ad hoc policy adjustment by government. For instance, China expanded its coal export capacity in response to concerns about a possible domestic over-supply in 2003 that was soon absorbed by internal growth in energy demand. Since then exports have fallen annually, but not as a result of free trade. The Government has been strengthening its control over coal imports and exports by adjusting export quotas, export tax and tax relief with the aim of discouraging exports and promoting imports. Exports have reached no higher than 93 Mt and imports did not exceed 10 Mt until 2002. Imports attained their highest volume in 2007 (Table 3.2) and are likely to continue rising annually. The proportion of coal imported compared with domestic production amounted to 2 percent in 2007.

Table 3.2 China's international coal trade (1992-2007)

Year	Export (Mt)	Import (Mt)	Net export Mt
1992	19.7	1.2	18.4
1993	19.8	1.4	18.4
1994	24.2	1.2	23.0

1995	28.6	1.6	27.0
1996	36.5	3.2	33.3
1997	30.7	2.0	28.7
1998	32.3	1.6	30.7
1999	37.4	1.7	35.8
2000	55.1	2.2	52.9
2001	90.1	2.7	87.5
2002	83.9	11.3	72.6
2003	93.0	10.8	82.3
2004	86.7	18.6	68.1
2005	71.7	26.1	45.7
2006	63.3	38.3	25.0
2007	53.2	51.0	2.2

Source: CCII

Until recently, China's energy coal supply was largely derived from its own mines, but a 34 percent rise in imports reduced net exports to 2.2 Mt in 2007 (Xinhua, 19 January 2008). China is likely to become a net importer of coal for the first time in 2008. Exports have been suppressed by a 10 percent export tax on thermal coal after having introduced a 5 percent export tax for coking coal. Not all coal mines are free to export coal. Currently, only four domestic large-scale enterprises have a coal export license[3].

Most of the imported coal will enter China through the southern provinces of Guangdong and Fujian. Shortfalls in coal supply to coastal regions can continue to be met by imports, subject to any unforeseen port and transport capacity constraints. However, saturation of rail transport will hinder inland transfer of coal imports as equally as it hinders domestic supplies.

An agreement to export an average 1 billion KWh of electricity per year for 10 years from China to Vietnam starting in May 2007 is also tantamount to exporting coal resources, but is not similarly constrained.

Port capacity

Port capacity for coal handling is an important element of China's internal transport infrastructure as well as providing a gateway for international traded coal. In 2007, the coal volume loaded at major ports in China was 463 Mt (Table 3.3). Of this total, coal transported for coastal domestic trade was 411 Mt and exported coal was 52 Mt.

The Government is planning for increased sea-borne coal transport by raising port capacity. By the end of 2007, China had over 14 ports of 100Mt, 1403 deep-water berths of 10,000t and above with an annual handling capacity about 3,400 Mt. Domestic coal is transported from northern areas to southern areas through the loading ports of Qinhuangdao, Tangshan, Tianjin, Huanghua, Qingdao, Rizhao and Lianyungang. By 2007 there were 7 northern coal transportation ports with a total loading capacity of 495 Mt. In eastern China and the coastal areas of southern China, there are 122 unloading berths for coal of which 75 are deep-water berths, with a total unloading capacity of 270 Mt.

[3] China National Coal Group Corporation, Shenhua Group Corporation, Shanxi Coal Import & Export Group Company and China Minmetals Corporation.

Table 3.3 Coal quantities loaded at major ports in China (Mt)

Ports	2001	2002	2003	2004	2005	2006
Qinhuangdao	100.07	97.92	109.59	130.81	144.74	**186.00**
Jingtang	9.64	11.47	12.92	14.21	13.60	**14.37**
Tianjin	52.59	56.37	55.74	62.91	68.94	**48.00**
Huanghua	0.18	6.53	31.56	45.31	66.89	**80.30**
Qingdao	15.58	16.87	12.18	9.05	7.96	**8.23**
Rizhao	22.86	22.74	22.60	19.75	19.52	**17.44**
Lianyungang	15.69	15.26	13.69	11.58	11.48	**9.51**
Others	5.45	16.88	18.79	44.03	37.87	**42.49**
Total	**222.1**	**244.0**	**277.1**	**337.7**	**371.0**	**406.34**

Qinhuangdao is the most important coal port handling over 45.78 percent of the coal trade in 2006, followed by Huanghua with 19.76 percent. The expansion of the Qinhuangdao port is continuing at a rate of 65 Mt each year. Government plans are for the number of dedicated coal berths in northern coastal areas to increase to 56 by 2010 to provide a total capacity of 520 Mt. Finance for port expansion is coming through SOEs but there are no obstacles to FDI entering this arena.

As port capacity is expanded, it must be matched by rail capacity. Coal transportation should therefore be viewed as an integrated system. In 2006, the total capacity of railways to the seven northern ports was 47 Mt greater than that of the cargo volume of those ports. However, as imports continue to increase a stage may be reached when onshore transport becomes the limiting factor.

COSCO (China Ocean Shipping Co), China's biggest shipping company, expects US$49 billion in spending on ports over the next five years. This includes the ports of Nantong in Jiangsu Province, Tianjin, Qinhuangdao and the new Caofeidian Port in Hebei Province. The latter is initially expected to have an annual capacity of 50 Mt of coal, eventually reaching 200 Mt.

Few, if any, ports currently accommodate large, cape-size dry bulk carriers (approximately 165,500 dwt) that represent the most cost-effective ocean transport. This confirms that at present the main driver for port expansion is coastal trade. China will need to develop port capacity for larger ships to minimize transport costs if demand for coal imports rises as expected.

The maximum coal handling capacity of major coastal ports could be approaching 900 Mt by 2010. The actual quantities handled and the proportion of imports to coastal trade will depend on domestic coal production, internal transport constraints, transport costs, port building programs, availability of bulk carriers and international coal prices.

Rail transport capacity

China relies heavily on railways as the lowest cost means of mass transportation; the energy consumption ratio of transportation by air, road and railways is 11:8:1. According to China's railway statistics, only sufficient freight wagons can be supplied on average to meet 40 percent of demand.

China's Minister of Railways, Liu Zhijun, illustrated the scale of the rail transport infrastructure problem when he stated that China has been using 6 percent of the world's operational railways to move 23 percent of the total people and freight transported by the world's railway systems each year. In an effort to rectify this deficiency, China plans to invest around US$160 billion from 2007 to 2012 (Wang Hui, China plans five-year leap forward of railway development, Peoples Daily online, 30 September 2006).

Many mines are located in areas that require coal to be transported over significant distances to major industrial centers. Transport links are particularly vital to maintaining coal supplies to power plants. In 2007, coal transported by rail exceeded 1.22 Bt. Almost half of the material transported by rail in China was coal in that year and over 60 percent of domestically mined coal was transported by rail, over an average distance of 500 km.

Distribution constraints have led to major consumers of coal located in southern provinces of China purchasing imports, as well as mines in the north increasing exports. This situation has arisen from insufficient transport capacity in periods of peak electricity production. Tightness of supply caused by transport constraints not surprisingly results in coal price rises. In 2005, coal prices stabilized as distribution constraints eased following substantial price rises in 2004 resulting from infrastructure bottlenecks (Melanie and Austin 2006).

The total amount of coal transported in each year between 1980 and 2007 is shown in Table 3.4. By 2020 rail transport requirements for coal could reach 2.9 Btpa. Assuming that 50 percent of total rail freight is coal, a total rail freight capacity of 5.8 Bt will be required in 2020. This represents an increase of 3.1 Bt or 216 percent of the 2005 freight capacity over a 15 year period. Such an expansion requires detailed advance planning and will involve substantial financing. Some of the growth in capacity will be achieved through efficiency increases arising from use of larger trains and freight wagons and faster train speeds, but mainly it will involve the construction of new track**.** According to NDRC projections (NDRC 2007), coal transportation capacity by rail will increase by only 60 Mt in 2008, not an auspicious start to addressing future rail capacity needs.

Table 3.4 The amount of coal transported by railway in China 1980 to 2007

Year	Total goods (Mt)	Coal (Mt)	Coal share of total (%)	Annual growth rate of coal transport	Average distanc e (km)
1980	1086	415	38.2	5.0	426
1986	1322	531	40.2	4.2	522
1990	1462	629	43.0	4.3	548
1995	1592	674	42.3	1.4	561
1996	1616	721	44.6	7.0	562
1997	1617	703	43.5	-2.4	554
1998	1532	641	41.8	-8.9	553
1999	1569	649	41.4	1.3	550
2000	1655	685	41.4	5.6	552
2001	1786	766	42.9	11.8	558
2002	1880	818	43.5	6.8	560
2003	1998	881	44.1	7.7	na
2004	2178	992	45.5	12.6	na
2005	2247	1071	48.0	8	na
2006	2444	1120	45.8	4.6	na
2007	2612	1221	46.7	9	na

Source: “China Electricity and Coal Industry”, 2004, China Coal Industry Publishing House. Economic Information Daily, 24 Feb 2006.

The Government has introduced policies to reduce pressure on rail transport by encouraging greater coal use at source, such as mine-mouth power-plants and coal-chemical industry development, but as no specific targets are evident it is difficult to quantify their effectiveness. In a market situation such policies would not be necessary in any event. The concentration of new power plant and industry in the populous coastal regions will probably limit the impact of the policy to the western development regions. The large distances between major mining areas in the west and high-demand consumers in the east and the resulting high transportation costs, especially for low heat value coals, may make a policy of building mine-mouth power plants and transmitting coal-by-wire a feasible alternative option. Ultimately, any decision should be made on economic grounds.

Recognizing that rail transport capacity is insufficient, government policy has been to adjust transport priorities in response to specific supply problems as they arise, but not without creating unplanned side-effects. For example, during September and October 2003, shortages of food in the northern provinces resulted in the Government giving other products priority for rail freight for at the expense of coal. A consequence of the change in rail allocations was a reduction in coal stocks at power plants and at ports. At least ten of the largest power plants in Shanghai, Guangdong, Zhejiang, Jiangsu and Fujian provinces experienced coal shortages (Platts 2003). Following the shortages, the Government readjusted allocations in favor of coal rail freight (Tian 2004).

The State Council's research organization has identified necessary reforms, especially within the natural monopolies and public utilities, for moving towards a market economy. SOEs should be reformed into corporate structures, the level of state ownership lowered and enterprise management separated from government administration. Within the natural monopolies, [such as railways], the recommendation was that competition should be introduced together with, where possible, new entities (Liu Shijin et al 2001).

Reform of the railway sector is progressing. A number of rail construction enterprises have been established and train companies are the next step. On 7 December 2007 China Railways Group Ltd (China Railway) listed on the Hong Kong stock exchange. Further listings are imminent as the Ministry of Railways experiences difficulties in financing its plans. In the first 8 months of 2007, fixed asset investment in the railway sector was US$15.2 billion, representing only 44 percent of planned investment.

The Government has introduced various measures to raise the scale of operations and to increase efficiency. Measures that have been implemented for increasing the coal freight capacity of the rail network are:

- Building new track in parallel to existing track;
- Building dedicated coal railways; the first being the Daqin Railway, linking the Datong coalfield in Shanxi Province to Qinhuangdao port in Hebei Province;
- Modernizing track to allow for faster and heavier trains;
- Constructing large, modern coal loading and unloading facilities to reduce turnaround times (in collaboration with customers);
- Introducing 80t coal wagons;
- Raising freight train speeds to 120 km/hr on all tracks by 2010;
- Introducing high-load trains; the Daqin Railway started running 20,000t coal trains in March 2006.

Capacity allocation to coal suppliers is dependent on various factors, including commercial, market and government control:

- Contractual arrangements between the Ministry of Railways and coal users;
- Competing demands of other commodities and passenger trains;
- Government intervention to reduce social impact resulting from any prevailing shortages.

While annual coal order meetings between coal mining enterprises and power producers are no longer orchestrated in detail by the NDRC, firm coal orders must be in place before rail freight contracts can be agreed.

The Ministry of Railways is developing strategic partnerships with key coal customers to increase the scale and efficiency of transport services. Customers transporting over 1.0 Mtpa are provided with a comprehensive, customized service to ensure prompt allocation of capacity and reduced bureaucracy. Government regulations prohibit mining enterprises contracting for less than 0.2 Mt from receiving a priority transport allocation.
Shortage of rail transport capacity for coal, exacerbated by disruptions due to heavy snow in the unusually severe winter weather experienced by southern China in early 2008, once again led to power plants exhausting limited stocks of coal. Initial blame placed on the railways for inadequate capacity and planning may not be warranted. Although the situation caused by exceptional weather conditions could not have easily been predicted, larger winter coal stocks at power plants would have reduced the impact on power supplies.

The Railway Ministry considers that China needs to spend US$240 billion expanding its rail system but the period of implementation is not stated. According to the WTO timetable, China's rail infrastructure should be opened to foreign investment by 2008. However, government intervention in pricing remains a major obstacle to foreign investment. Uncertainty over whether or not the Government will fully allow market forces to come into effect for rail transport for strategic commodities such as coal remains a serious barrier for many potential investors.

The Ministry of Railways priorities for 2007 were the construction of rail lines for passenger transport, and coal transport and inter-regional connections. It allocated 332 billion yuan (US$42 billion) for the construction of new lines and to purchase rolling stock for the year. Railway track is a natural monopoly, but the provision of rail freight services above the track is a competitive activity as demonstrated in many countries that have introduced competition. For example, the UK Government has liberalized train operations allowing qualified, independent companies to compete to provide services.

Full rail freight privatization may be too ambitious for China at present but a start has been made. The long-term needs of the coal sector can be satisfied provided the Government increases transparency of rail pricing, invests in increased infrastructure and capacity to match projected coal transport needs, and allows freer access to the network.

Road transport

In recent years, coal transport by road has been growing rapidly due to saturation of the rail network and the opening up of new mining areas not yet served by rail. The road transport capacity of existing highways has been constrained, for sound reasons, by enforcing loading weights to reduce damage to roads and improve the safety of road haulage operations. New roads are planned to provide access to new mining areas in the mountainous regions. For example, a coal highway from Tuoketuo, Huhehaote to Hebei is scheduled to be constructed to allow the development of over 10 Mt per year of coal capacity in the west part of Inner Mongolian that is currently inaccessible.

Shanxi is the largest inter-provincial coal-exporting province in China with total coal export sales volume in 2007 of 536 Mt. Of this sales volume, 128.55 Mt was transported by road, 11.22 percent more than in the previous year. Rail transport is more efficient but trucks are needed to transport coal from small mines and other mines that do not have rail links to the rail loading points.

Inland barge transport

To alleviate internal transportation constraints, the Government plans to utilize its extensive water network in the Yangtze River Delta, Pearl River Delta and Bohai Bay area. Handling capacity in three major harbor groups is planned to be doubled, reaching 3.5 Bt each before 2010. This will reduce delays in deliveries of coal, iron ore and oil.

Domestic coal export contracts

Existing long-term export contracts are difficult to manage in the presence of government measures to control exports through quotas and taxes. Reduced export quotas and the removal of tax incentives may have been important factors leading Chinese suppliers to suddenly increase the prices demanded for contracted tonnage sales to both Japanese and Korean long-term customers (McCloskey, 2007). In the early part of the 2007 contract year, Chinese suppliers were demanding prices from Japan for Datong brands of US$74.50 per tonne FOB, a US$21.53 rise on the previous year. In the case of the Koreans, the Chinese suppliers asked for an increase of US$10-plus per tonne. The Japanese totally rejected this price increase. Such incidents destabilize the market and are not conducive to the acceptance of long-term contracts by overseas buyers or sellers.

External coal resources

Primarily as a result of China's growing demand for coal, large increases in imports of both steam and metallurgical coal are projected for Asia. According to the IEA, China is expected to import 2 Mt more than it exports in 2030, but current signs indicate that this has been vastly under-estimated. According to the China Securities Journal (November 2007), China will import between 150 Mt and 230 Mt of coal per year by 2010, significantly higher than a previous estimate of 70 Mtpa. The new prediction is based on a China Coal Industry Association report that China's annual coal output will grow at the moderate rate of 3.5 percent between now and 2010, increasing the country's annual coal output by 400 Mtpa to 2.8 Btpa by 2010.

International coal suppliers, given suitable signals (and the absence of barriers to imports) can help to smooth China's future coal supply imbalances. International coal producers in the major coal exporting countries are gearing for an expected rising thermal demand from China, but the amount of coal that can ultimately be supplied will be determined by sustainable development and resource limitations in the countries of origin. If there are supply constraints, prices will rise resulting in a reduction in the rate of increase in coal demand. Provided China's coal markets are open to trade, demand for coal will generally be met, although prices may be somewhat higher than their current levels. There will be no coal supply imbalances – coal prices will adjust to ensure that coal supply (from both domestic and import sources) will be sufficient to meet coal demand in China.

Ocean trade

The United States with 26 percent and the former Soviet Union with 23 percent account for nearly half of global coal reserves, followed by China (12 percent), Australia (8 percent), South Africa (5 percent) and Poland (2 percent). The six largest exporters of coal in 2004 were Australia, Indonesia, China, South Africa, Colombia, and the United States. Australia has large reserves of high quality coal that is suitable for both electricity generation and industrial applications. IEA (Coal Outlook, 2006) projections show

Australia as the world's foremost coal exporter through 2030, followed by Indonesia. Australia and Indonesia both benefit from their highly productive mines and proximity to Asian markets. Colombia, a relative newcomer to maritime coal trade, is expected to be the third largest exporter of coal in 2030 and Vietnam is projected to increase its share of world coal trade to 5 percent in 2030.

In anticipation of future coal trade volumes, exporting countries are investing in their port, coal mining, and coal transportation infrastructure. In Australia, there are plans to expand the total export capacity of its coal terminals at Abbot Point, Dalrymple Bay, Hay Point, R G Tanna, Barney Point, and Fisherman Islands by about 55 Mt by 2010. In addition, a feasibility study in Australia is underway for a terminal at Wiggins Island in Queensland with a throughput capacity of 22 Mt. There are also plans to expand rail transportation capacity in Queensland to 281 Mt.

Anticipating rising coal imports by China, South Africa's Richards Bay Coal Terminal recently announced plans to spend US$150 million to increase its capacity by at least 28 percent, making it the world's biggest coal export port, rising from 72 Mt to 92 Mt by July 2008.

Rapid growth in low rank (high moisture, low ash and low sulfur content) Indonesian coal output has been projected for 2007, some of which is likely to be destined for China. In Indonesia there are plans to raise thermal coal production by about 10 percent in 2007 to 196 Mt, although much of this coal will be of low heat value and therefore relatively costly on a per energy unit transported basis. For this reason, increasing quantities of the output will be destined for local power generation plants. In anticipation of higher coal prices, investors are looking at building coal upgrading plants. This will involve investment in new technology to increase the calorific value of low rank coals without losing the ability to be handled by removing inherent moisture. The Indonesian Government plans to cap its coal exports at 150 Mtpa to ensure energy security, although there are suggestions from within the industry that this quantity might already have been exceeded.

Overland imports

There are coal resources in countries bordering China which could not only provide a buffer against production shortfalls, but also contribute to China's long-term coal needs.

There are large resources of coking and thermal coal in Mongolia and the Shenhua Group has been mandated by the Government to negotiate access to exploit the reserves on behalf of China. The Shenhua Group has demonstrated its ability to bring coal production on stream from zero to 107 Mt in 12 years from 8 mines and has the technical capacity to develop the Mongolian coalfields. It also has the credibility to finance and construct a high capacity rail transport link across the Gobi desert.

A sole customer position ensures a low cost supply to China due to the weak negotiating position of land-locked Mongolia. A market price would need to be agreed to fully compensate Mongolia for the exploitation of the resource and for the necessary environmental and safety protection. This is a supply option that could be financially viable for China and should be considered as part of its coal mining strategy, but with an approach that is sensitive to the development aspirations of Mongolia, and the application of international standards of safety, social and environmental protection.

Vietnam exports anthracite to China but export taxes (tariffs are taxes on imports) have been imposed by Vietnam to limit these exports and to allow development of what it sees as being more lucrative markets. The response of Vietnam is a manifestation that China is too accustomed to low-cost coal and must start to recognize that sustainability of coal mining is a global imperative and that the cost and pricing of both indigenous and external coal supplies should reflect true economic, social, safety and environmental costs.

Western China developments

Coal resources are important to the development of the isolated and relatively backward western regions of China. The Government has already introduced policies to encourage investment in industrial development in these areas. Local industrial growth will drive coal demand. Government also plans to develop a west to east electricity transmission scheme. This "coal-by-wire" infrastructure project will increase coal demand in the west to satiate power demand in the east. However, such a project is only realistic if it is economically viable. If it is not viable, the optimum economic value of the western coal reserves will not be realized.

The remote coalfields of Xinjiang can be considered as external coal resources for practical purposes. The extensive coal resources in Xinjiang have been classified by the Central Government as a national strategic reserve. At some time in the future this strategic reserve will need to be brought into production. The lack of detailed coal exploration and development, limited infrastructure, skills shortage and the long distance and limited transport capacity for carrying bulk freight to the south and east of China are barriers to the exploitation of this coal for which solutions would need to be identified.

Various logistical options for energy transfer include new rail links, low-loss power transmission from mine-mouth power plants together with more innovative suggestions of long-distance pipelines for coal suspensions or gasification products. Box 3.1 illustrates a methodology for selecting optimum coal transport solutions. However, current indications are that high volumes of coal in Xinjiang could be consumed for chemical use, thus reducing China's long-term coal-fired power generation potential.

Box 3.1

Choosing the most suitable coal energy transport options

There are similarities between the USA and China in the importance of rail transport for coal distribution in the interior of the country and also the long-term dominance of coal for power generation due to extensive domestic resources. In the USA a ton of coal is transported an average distance of 1287 km.

A hybrid life-cycle analysis is critical for evaluating the cost, efficiency and environmental tradeoffs of an energy supply system, according to Bergerson (2005) whose studies show that if a small amount of additional coal is to be transported, current rail infrastructure should be used where possible. If entirely new infrastructure is required, mine-mouth power generation options are cheaper but these have a greater environmental impact due to the increased generation required to compensate for transmission line losses. Gasifying the coal to produce coal gas shows promise in terms of lowering environmental emissions.

As a specific case study, Bergerson and Lave (2005) examined the life-cycle costs, environmental discharges and social impact of transporting coal via rail, coal gas via pipeline, and electricity via reasonably efficient high-voltage, direct current transmission lines from the Powder River Basin in Wyoming to Texas. They concluded that where no infrastructure exists, greater distances and larger amounts of energy favor coal transport by rail and gasified coal by pipeline over electricity transmission.

Their research shows that for the transport of over 9 GW of power over a distance of approximately 1,600 km the lowest cost option, and the lowest environmental impact, is to use a gasifier and methanation process to convert the coal to synthetic natural gas and transmit it via pipelines.

The above analysis is site specific, but the principles are valid and similar studies should be undertaken in China to determine the best long-distance transport options for coal and coal-derived energy. This approach has particular relevance to China's development strategy for the coal resources in Xinjiang which are in danger of being under-utilized through failure to address long-term thermal coal supply needs for China.

Long-term analysis, focusing on the implications of a high coal use future, show that when advanced technologies such as an integrated gasifier combined cycle (IGCC), where carbon capture and sequestration are used, emissions during generation decrease to a level where environmental discharges from extraction, processing and transportation become the dominant concern. Gasification-based technology, such as IGCC, is arguably the only environmentally friendly technology that provides the flexibility to co-produce hydrogen, synthetic natural gas (SNG), and premium hydrocarbon liquids, including transportation fuels and electric power, in desired combinations from coal. The US Department of Energy is conducting research into this field to assist development of a strategy to make optimum use of the USA's extensive coal resources which have a projected life of 250 years (Turk, 2006). However, according to skeptics (or some analysts) a carbon tax of US$46 per ton may be necessary to force switching to IGCC for power generation from conventional pulverized fuel (PF) power plants.

A possible long-term solution in a carbon constrained world for Xinjiang could involve IGCC power generation with carbon sequestration and hydrogen as a transportable co-product injected into existing natural gas pipelines; up to 3 percent hydrogen can be added to with negligible impact on transportation and end-use efficiency and costs.

Alternative coal-energy transport modes

Bulk solid coal can be transported by rail, road, sea or waterway, but there are alternative options for transmitting coal energy from producer to customer which may reduce delivery costs, increase distribution flexibility or provide a higher value product to offset transport costs from remote sources. These alternatives include electricity transmission from conventional PF mine-mouth power plants, combined gas and power generation in centralized local or mine-mouth power plants or gasification and pipeline transport of the gaseous product.

In planning the timeline for implementing critical elements in a coal mining sector strategy, allowance must be made for detailed examination of coal energy transport options and logistics, and consideration of environmental, safety, social and economic factors specific to the project. A combination of clean, efficient IGCC power generation and hydrogen or *syngas* transport is worthy of further study by the Government (and the private sector) in developing its long-term strategy for coal energy supply and distribution. The simpler alternative of gasification and gas pipeline transport should also be examined. It must be stressed that a priority use of coal for hydrogen generation is not being suggested as this has similar limitations in terms of useful energy recovered to CTL.

Coal pipeline

Coal slurry technology involves transporting pulverized coal suspended in water and pumped through pipelines. The mined coal is crushed, formed into slurry, suspended in water, and pumped through the pipe to the power plant. Roughly one m^3 of water is used per tonne of coal transported. At the end of its journey, the slurry is placed in storage tanks, the water removed and the coal used for combustion.

In the USA there are extensive slurry pipeline systems. Total USA coal-slurry output totaled 91 Mt in 1995, including transport by tramway and conveyor. The key developmental factor in coal-slurry technology was its cost competitiveness when compared to other methods of transporting coal. By the late 1990s, pipelines up to 2,400 km were in operation. A plentiful supply of water is required, and in some instances a benefit of the process can be the transfer of water in addition to coal. This transport method is therefore not suitable for mining areas with scarce water resources.
In 1994 an international consortium signed an agreement with the Government to build an 800 km, US$889 million, underground coal slurry pipeline in northern China linking Shanxi with the coast of Shandong Province, but no information on its subsequent development has been found. As China has serious water supply problems, and past attempts to popularize this technology appear to have been largely unsuccessful, further development is not likely to be pursued.

Coal-to-liquid (CTL)

High value, more easily transported products than coal can be generated by converting coal into liquid fuels and chemicals. Direct liquefaction exploits about 55 percent of the energy in the coal and the Fischer-Tropsch process about 45 percent. The attraction of these processes is that domestic energy resources can be used to offset costly petroleum imports. However, coal is itself a limited resource and the cost of extensive conversion cannot be justified as an expedient to overcome short-term transport constraints overriding national policy (Box 3.2).

Box 3.2
Transportation constraints on development of remote coal resources should not be used to justify coal uses inconsistent with a long-term national strategy for coal.

New technologies should only be adopted where they are competitive with existing processes (taking into account social and environmental costs and benefits).

Accelerated development of coal mining seems to have started in Xinjiang contrary to the aims of rational and sustainable development and its status as a national strategic reserve to ensure energy security for China. The region's coal production stood at 43 Mt in 2006. Before the end of the decade, two or three mining bases each with an annual output of 50 Mt, along with a number of 10 Mt mines are expected to be built. Xinjiang has a limited local demand for coal but its main market lies some 3,000 km to the east and transport capacity and cost issues have not been adequately addressed. The development in Xinjiang remains behind the rest of China and the province has limited natural resources. Therefore the local government has strong incentives to develop its natural assets.

Construction began at the end of April 2007 on what will be the largest coal mine in Xinjiang. Located at Ili in the western part of the region, it will involve a total investment of about 2.6 billion yuan (US$336 million). Construction of the mine will take 42 months, the planned capacity is 10 Mt and the estimated coal resource is about 301 Bt. The colliery is being built and financed by Xinwen Mining Group Corporation, China's eighth largest coal mining group, based in east Shandong Province. The expected annual revenue is 1.45 billion yuan (US$188 million). The Xinwen Mining Group also revealed plans to invest in facilities that will be able to process 30 Mt of coal a year for the production of methanol and olefin in Ili.

Higher world oil prices in recent years have prompted the development of the coal-chemical industry in China to find alternatives for petroleum substitutes. China's methanol production capacity reached 5.36 Mt by the end of 2005 and it is expected to attain an annual methanol production capacity of 13 Mt by the end of 2008. The NDRC is trying to avoid the construction of excessive over capacity in case the price of oil drops sharply. It is also discouraging inefficient, small-scale projects.

Anhui Huainan Chemical Group plans to raise its ammonia production by 50 percent to 300,000 t/yr by 2008 after introducing a coal gasification unit. Dow is examining a project with Shenhua Group to convert coals to olefins at Yulin city in Shaanxi Province and Sasol has completed a pre-feasibility study for two 80,000 bbl/day CTL projects.

Rising demand for poly-olefins (eg polypropylene and polyethylene) in Asia and a supply deficit, escalating prices of oil and flatter rises in coal prices are all acting to drive the CTL market in China. The capital costs of coal to olefins plants are high at greater than US$5,000/t capacity compared with conventional petrochemical routes at US$900-US$1400/t (King 2007). Commercial viability depends both on low coal prices and achieving production efficiencies to contain operating costs, which requires investment in large-scale plants.

The commercial viability of coal-to-liquid (CTL) projects is predicated on continuing high oil prices. The cartel of oil producers could conceivably increase supply to depress prices if CTL was threatening oil markets. This would undermine investments in CTL plants in China. In such a situation, remote western areas of China that had become reliant on CTL would suffer in the absence of alternative coal markets. However, at present such a scenario seems highly unlikely.

The Government issued a circular on regulating the coal-chemical industry in July 2006, urging local governments to tighten control on new projects. The Government will not approve coal liquefaction (coal-to-liquids) projects with an annual production capacity of less than 3 Mt; coal to methanol or dimethyl ether (DME) projects of less than 1Mt; and coal-to-alkene projects of less than 0.6 Mt according to a circular released by the NDRC.

3.2 Policy reform needs to enhance performance of the coal supply chain

In the past, the needs of the economy for increased coal production over-rode considerations of social, safety and environmental costs. Such an approach is no longer acceptable to the Chinese Government and its people, neither is it sustainable. Action from government is needed to remove barriers to the development of competitive markets, including major barriers which inhibit external coal supply.

Government policy is to adjust export quotas in response to short-term coal supply surplus or shortages, but a market system would be more efficient in achieving a balance.

China will need to import increasing tonnages of coal as the cost of domestic coal rises and the market will achieve the desired balance provided the Government does not intervene. Key elements that will soon be in place to facilitate increased international sea-borne imports include deep water loading ports in exporting countries, increasing vessel sizes and numbers of vessels which will over time result in reductions in real freight rates, the construction of deep water receiving ports in China and adequate internal transport capacity to customer's sites.

Railway infrastructure is not sufficiently well developed to satisfy coal transport demand. Ongoing reforms to introduce competition and mobilize finance for expansion will bring market mechanisms into play which will lead to increased economic efficiencies which should also be reflected in sector performance improvements. Although coal price controls have now been largely removed in China, sellers are invariably faced with high transport costs. The determination of rail freight rates is not transparent, there is no mechanism for coal suppliers to negotiate long-term transportation contracts and the Government sets minimum coal carriage capacities for the privilege of establishing transport service provisions that should be available to all.

3.3 Recommended policies

Market systems naturally find the supply-demand balance, and policies should be introduced to improve the market orientation of the supply chain.

Lack of recognition of the sanctity of export contracts is damaging to the credibility of China as a coal trading nation and it should not expect any favors as an importer. The Government should abolish its current export control policies because these affect the competitiveness of China on world coal markets. All China's coal producers should be free to export to their best available markets and China's coal consumers should be allowed to import from the least cost source.

The capacity for producing, stockpiling, importing and distributing coal in China must be sufficient to obviate the need to rely on the short-term production of small mines. A sustainable mining sector must therefore be able to build coal production without resorting once again to a "let the coal flow" policy which allows occasional uncontrolled expansion of small, polluting, hazardous mines. A free market system will produce the most efficient supply chain economics. Government policy should be aimed at regulating the process to protect employment conditions, worker and public safety, and the environment.

Remote western areas, including Xinjiang, have extensive coal resources for which bulk coal transport to the east by railway is not necessarily the most efficient solution. Coal resources in these areas should be explored in detail but production geared to meet local demands in the first instance while the Government researches energy transport options as part of a long-term strategy for regional development. Consideration should be given to clean, high efficiency power generation for west-to-east transmission and to hydrogen transport where there are existing, or proposed, gas pipelines.

The costs and security of supply of coal and other bulk commodities on which the economic growth of China relies, depends heavily on the efficacy of the transport sector and accordingly a steady growth in capacity must be maintained. Otherwise, China's internal coal flows will be constrained. Rail will remain the primary transport system for coal in the eastern and central regions of China. The bulk loading and storage capacities of inland waterway ports should be enhanced where feasible to alleviate rail capacity limitations and provide competition to the railways. Private investment is needed to finance necessary expansions in rail freight capacity, but the Government will have to surrender a degree of control of the sector if the large sums needed are to be attracted.

China will soon have a port capacity theoretically capable of landing around 500 Mt of imports each year. However, sustainable development constraints, transport capacity limitations and ultimately limited coal resources in Australia, Indonesia and South Africa and the competing demands of Japan and Korea, means supply could be tight. Therefore, China's coal users need to negotiate long-term contracts directly with coal suppliers. No government intervention is necessary for this to take place.

The Government of China should allow free import of coal to provide much-needed competition to mainland mines forcing them to improve efficiency. Coal imports and coal stocks will replace small mines as a supply buffer. The Government should issue reliable coal supply and demand statistics and long-term projections to signal future needs to facilitate a measured response from international producers and to prevent unexpected surges in demand which escalate prices.

China should take a more sensitive approach to its coal development ambitions with its neighbors, in particular Mongolia, and not exploit its sole market position to the detriment of the sustainable development of the Mongolian coal mining sector as this will weaken long-term supply potential and defer development of an important coal resource for China.

CTL conversion may offer a potential means of adding value to coal mined in remote areas while oil prices remain high, but proliferation of such plants should be carefully controlled by the Government on the basis of strategic fuel supply needs and national long-term energy security. There should be no policy incentives for constructing and operating coal-chemical conversion or CTL plants as this could lead to excessive investment in these projects involving a misallocation of resources. The market, rather than government subsidies, should determine the allocation of China's coal resources across competing users.

Chapter 4 Restructuring and reform

The Government undertook a major campaign as part of the 10th Five Year Plan (2001-2005) to rationalize the structure of the coal mining industry and accelerate modernization. This process is well advanced and the benefits are apparent in increased economic efficiency, safer operations and improved social conditions for miners. The KSOCM have been transformed into limited liability companies, some of which have diversified ownership though share offerings on domestic and foreign stock exchanges. Nevertheless, the State, through provincial and regional governments, maintains a strong controlling interest through majority holdings. The heavy burden of social costs for hospitals, schools, public security and utilities (5.7 billion yuan in 1997) has been largely removed from KSOCM, transferred to local authority ownership and merged with existing community services. Consolidation and transition from inefficient small-scale to modern mechanized large-scale mining shows signs of being effective in creating safer and more efficient mines, maintaining county revenues, reducing wastage of coal resources, introducing responsible environmental management and promoting local economic and social development (ESMAP 2004).

4.1 Current status

Coal mines in China are classed as large, medium and small based on their annual productive capacity, respectively greater than 0.9 Mtpa, 0.3-0.9 Mtpa, and less than 0.3 Mtpa (Coal Industry Mine Design Specifications GB50215-2005, 1 January 2006).

The traditional classification of mines for statistical reporting purposes as KSOCM (former Central Government managed coal mines under the Ministry of Coal Industry and subsequently passed to provincial government), LSOCM (province, city and county-owned) and TVCM (village and local community owned) no longer accurately reflects the nature of ownership, but it is still helpful as a general indicator of the effectiveness of structural reform. The current coal production from the different mine types as conventionally classified is summarized in Table 4.1.

Table 4.1 China coal production from mines of different types

Year	Total (Bt)	KSOCM (Mt)	SOCM (Mt)	TVCM (Mt)
2001	1.47	618	223	633
2002	1.60	715	267	623
2003	1.78	814	280	686
2004	1.99	939	297	762
2005	2.19	1014	286	890
2006	2.332	1119.57	319.85	892.36
2007	2.523	1229.31	337.52	956.58
2010 (planned)	2.45	1837		613 (small mines)

Source: 2001-2005 China Coal Transportation and Marketing Association (adjusted for unreported TVCM production using sales data; recent data from SACMS; numbers in parentheses estimated from part-year data.
Data in 2006 and 2007 from China Coal Outlook 2008, China Coal Information Insititute

Ownership of coal mines in China falls basically into the following categories: wholly state-owned and invested coal enterprise, state-owned coal enterprise through majority share holding and private coal enterprise. Foreign companies are permitted to form wholly foreign owned coal mining enterprises. However, they can only hold minority shares in joint ventures undertaking the exploration and mining of some special and scares coal resources.

The scale of operations in China is much less than in other major coal mining countries. The output of the top four coal enterprises only accounted for about 18.71 percent of the total production of China in 2007, while the output of the top eight coal enterprises only accounted for about 25.79 percent (Table 4.2) of the total compared with Australia 46 percent, USA 51 percent, South Africa 87 percent and India 89 percent. The reasons for this difference are the large amounts of coal produced by small coal mines in China that are operating to environmental and safety standards that would not be permitted in the above countries; the fewer opportunities for low cost, large-scale opencast mining in China and remnants of central planning which prevent coal mines from acting according to commercial interests.

Table 4.2 Coal production by the largest coal mining enterprises in 2007

Enterprises	**ROM coal output (Mt)**	**ROM output/ national total (%)**	**Comparison between 2007 & 2006 (+/-)**
Shenhua Group Corporation Limited	235.77	9.34	0.82
China National Coal Group Corporation	105.02	4.16	0.35
Shanxi Coking Coal Group Co.	65.82	2.61	- 0.33
Datong Coalmine Group Co.	65.50	2.60	0.01
Total of four enterprises	**472.11**	**18.71**	**0.85**
Heilongjiang Longmei Mining Group Co. Ltd	54.04	2.14	-0.12
Shaanxi Coal Mining Co. Ltd.	50.26	1.99	0.37
Pingdingshan Coal Group Co. Ltd	37.43	1.48	0.18
Shanxi LU' AN Group Co. Ltd	37.18	1.47	0.15
Total of eight enterprises	**651.02**	**25.79**	**0.97**

Source: China Coal Outlook 2008, March 2008

The Government strategy for raising the production scale of coal mines involves:

- The closure of (illegal) small mines;
- Restrictions on the size of permitted new coal mines (typically no smaller than 300 ktpa);
- Encouraging the consolidation and transformation of small mines into larger, more efficient industrial-scale enterprise companies; and
- The aggregation of the major state-owned coal mining companies into a few very large enterprises which will produce a high proportion of the country's coal from areas of prime reserves using modern mining methods.

Whether the latter will produce the desired returns to scale is uncertain as the large state-owned groupings may be too cumbersome, introducing diseconomies of scale (e.g. coordination cost) that might outweigh production scale economies.

The Government is restructuring and reforming its coal mining sector by:

- Corporate restructuring and diversification of ownership, allowing public participation through share holding, with the State maintaining majority control of the KSOCM;
- Strengthening of management provisions and resurrection of provincial coal industry management bureaus;
- Specifying the minimum coal mining capacity.

Reform of the property rights system

Most of the former large and medium-sized coal enterprises have been transformed into joint-stock companies by converting debts into shares, introducing strategic investors, or through merger and acquisition, although the State retains a controlling interest in all the KSOCM.

At the end of 2003 there were 2,955 state-owned coal enterprises of which 788 were KSOCM and 2,167 were LSOCM. By the end of 2004 these mines had been reformed with 931 mines under majority state-ownership. The remaining 2,024 mines were gradually reformed into privately owned, joint stock and co-operative ventures. (not a big problem, just keep it) This restructuring was achieved over a short time period demonstrating the strong commitment of government to reform. While the reforms have facilitated private ownership at local level, there are still large elements of government ownership and management.

By the end of 2004, 17 coal enterprises in China had listed on the Shanghai and Shenzhen stock exchanges or on foreign stock exchanges. Listed coal mining companies included Zhengzhou Coal & Power, Yanzhou Coal, Jinniu Energy, Anyuan Share, Guoyang New Energy, Shanxi Coking, and Shanghai Energy. In June 2005 the China Shenhua Energy Limited Liability Company, with the Shenhua Group as majority equity holder, listed in Hong Kong, the second largest IPO in the Hong Kong exchange after the China Life Insurance Company.

Creating scale

In accordance with government policy, large coal enterprises have been aggregated into larger, “super-groups” such as Shenhua, Datong, Shanxi Coking Coal and China Coal Energy. The assets, prospects, profitability and liabilities vary greatly from group to group. The Government’s aim is to seek returns to scale and create inter-provincial rather than intra-provincial competition, as well as international participation through overseas development. Small mines within the key coalfield development areas have also been aggregated under the groups.

The challenges facing some coal mining groups are immense. For instance, in August 2005, the seven key state-owned coal mines in Sichuan province and the Sichuan Provincial Coal Industry Supply and Marketing Company were combined to form the Sichuan Provincial Coal Industry Group Limited Liability Company (Sichuan Mei Group). The proven coal reserves were 13.5 Bt and the available reserves were 12.1 Bt in Sichuan Province in 2005. At present, there are 2,200 mines in the province of which 91 percent are small coal mines and the proportion of coal output from the key coal mines is low. The formation of the Sichuan Mei Group is likely to improve the performance of the coal industry in the province which has been characterized by small-scale, widely distributed mines, poor working conditions, lack of progress in developing key mines, and insecure coal supplies. The formation of the group is also beneficial in focusing talented people and technology on improving mine safety conditions, mechanization and modernization, as well as the rational development and utilization of coal resources.

Large coal enterprises have been formed through merger and acquisition. An example of this process is provided by Shenhua Group's acquisition of a majority equity holding in the Ningxia Coal Group (Box 4.1).

Box 4.1

Example of M&A in China's coal mining sector to increase scale

On 18 January 2006, the Shenhua Ningxia Coal Group Liability Limited Company was set up as a subsidiary company of the Shenhua Group. The increased scale and access to financing and aggressive management quickened the completion of projects under construction and the planned projects under control of the former Nining Mei Group. These projects were the Yangchangwan, Zaoquan, Meihuajing, Qingshuiying, Hongliu and Maiduoshan mine projects. As a result, the annual production scale of the Shenhua Ningxia (Ningmei) Coal Group will reach 80 Mt in 2008 and over 100 Mt in 2010. The integration of coal and power and coal chemical projects will be accelerated.

The Shenhua Ningmei Group Co. legal structure includes a chairman, a general manager and two independent directors on the board. The registered capital of the group company was 10.1 billion yuan, the total available assets amounted to 21.3 billion yuan and the net assets were 12.2 billion yuan.

The organizational structure encompasses 67 major production units, including 14 coal mines and 3 coal preparation plants. The Group employs 47,000 staff and workers of which 7,404 are technical staff.

The scope of the business mainly involves coal mining, coal washing and processing, coal export, mine construction, machinery manufacture, power generation, metallurgy, chemicals, construction, and building materials.

State-owned coal mine investment

The investment pattern in the State-owned coal mining sector has changed significantly over the years. In the period from the 1st Five Year Plan to the 5th Five Year Plan, State investment accounted for between 85 percent and 97 percent of the total investment in the coal mining industry. During the 9th Five Year Plan, State investment had fallen to 13 percent of the total. Now, finance is mainly raised from internal funds and bank loans with state investment accounting for a minor proportion. Enterprises have built internal cash reserves from asset sales and operating profits.

For example, of the total investment in the Zaoquan coal mine project of the Shenhua Ningmei Group, State investment amounted to only 7 percent, internal funds accounted for 28 percent of the total while 65 percent was in the form of a bank loan.

The Government is planning to increase its level of investment in the KSOCM to accelerate construction of new mines to strengthen coal bases. While administrative intervention by the Government in KSOCM has been gradually reduced, the links are still strong. In 2004 and 2005, the Government issued 3.9 billion yuan of government bonds to support exploration and coal mine construction in the areas designated as large coal bases. Construction was planned to expand coal production capacity and to replace that of closed small coal mines.

Financing structures typical of large, State-owned coal enterprises is shown in Box 4.2.

Box 4.2

The Shanxi Coking Coal Group, founded in October 2001, provides an example of the ownership and financing structure of the large coal mining enterprises.

A state-owned holding coal enterprise with seven subsidiary companies, the Shanxi Coking Coal Group was the first large group in the coal industry to introduce a closely related 'parent and son' system connected by investment. By the end of 2005, the total assets of the Group were 42 billion yuan.

The major financing modes of the Group include:

1. Bank loan. In April 2006, the Shanxi Group signed an overall cooperative agreement totaling 20 billion yuan with the Shanxi Provincial branch of the Bank of China.
2. Stock exchange listing. The listing of Xishan Coal & Power Ltd (a subsidiary of the Group) stocks raised 1.869 billion yuan, the highest on record at any one time for a Shanxi enterprise.
3. Financing through equity participation. The Group has established strategic partnerships though medium and long-term mutual equity participation with 30 large companies at home and abroad. These companies include Ruhr Kohle in Germany, the Nippon Steel Corporation, (of Japan), Pohang in Korea, and Baoshan Steel, Anshan Steel, Capital Steel, Wuhan Steel and Huaneng in China.

Construction plan for large coal bases

The State Council issued Guo Fa [2005] Document No.18 "Some Opinions of the State Council on Promoting Healthy Development of the Coal Sector" (June 2005) proposed the development of coal resources and the building of large coal bases (areas of concentrated and integrated mine infrastructure development) in coalfields with favorable resource (and market) conditions. These coalfields are mainly located in Shandong, north Shaanxi, and mid-Shanxi. The State Council also requested that state-owned and commercial banks improve their financial services to the industry and provide innovative financial products to support coal development construction projects which comply with national policy.

The Government plans to develop 13 key, large-scale coal bases before 2020 to meet China's projected coal demand (Table 4.3). This is an important strategic action that demonstrates that government thinking extends beyond five-year planning periods. The economic effectiveness of this plan will depend on the role the Government adopts. It should limit its activities to an enabling and permitting role, setting and enforcing standards, leaving the market to determine operational performance.

Table 4.3 The thirteen Large Coal Bases identified for development by the Government

Coal base	Proven coal resources (Bt)	Details
1. Shaanxi and Inner Mongolia	136	The Shandong base is a trans-provincial coal complex including several mining areas in Inner Mongolia and Shaanxi. The coal is high quality steam coal suitable for chemical and metallurgical applications. The Shenhua Group is mainly responsible for the development of this coal base.

Coal base	Proven coal resources (Bt)	Details
2. North Shaanxi	60	The northern Shaanxi coal base lies mainly in the Yulin and Yan'an areas in the north of Shaanxi Province
3. Shaanxi and Gansu	22	This coal base is located on the boundary of Shaanxi and Gansu Provinces. The coal is of good quality and can be either transported to eastern China and the central south regions, or to Sichuan Province and the Chongqing municipality. It is an important base for steam coal and for the coal chemical industry that the Government views as pivotal in balancing the supply and demand for coal between these regions.
4. Jinbei	75	The Jinbei coal base is located in the northern part of Shanxi province. The area mainly produces steam coal and has good prospects for expansion into a super-large coal-producing complex.
5. Jinzhong	52	The Jinzhong coal base is situated in the central west part of Shanxi Province. The notable Hedong coalfield located east of the Yellow River and west of the Liuliangshan mountains is an area identified for large scale exploitation.
6. Jindong	77	The Jindong coal base is located in the south eastern part of Shanxi Province. The area has the potential to be developed into an extensive coal base of superior anthracite and steam coal.
7. Luxi	23	Located in the western part of Shandong Province this coal base includes the Juye mining area with available reserves of almost 6Bt, a prime area for development.
8. Lianghuai	30	The Lianghuai coal base is a trans-provincial base, straddling the northern part of Anhui Province and eastern part of Henan Province.
9. Jizhong	16	Located in Hebei Province, the heavily worked area has good rail transport facilities. About 90% of the available coal reserves are in the Jizhong coal basin with the remainder in Weixian.
10. Yuxi	20	The Yuxi coal base is located in central Henan and west of the Jing-Guang (Beijing-Guangzhou) railway. The area has rich coal reserves, a wide range of coal ranks and is well served by rail transport.
11. Southwest	46	The Southwest coal base is an inter-provincial base, extending across western Guizhou and eastern Yunnan. This is a key western coal mining area. Although developed in some parts, there are still virgin coalfields in northwest Guizhou, south of Panxian, and east of Yunnan remaining to be explored and developed. It has some promise as a large coal-producing complex. It is considered a potentially important electricity and coal base for the southern route of the "West-East Electricity Transmission" project.

Coal base	Proven coal resources (Bt)	Details
12. Northeast	63	The Northeast coal base includes all the major mining areas in the provinces of Liaoning, Jilin and Heilongjiang, and also some mining areas in eastern Inner Mongolia.
13. Ningdong	27	The Ningdong coal base is situated in the eastern part of the Ningxia Hui Autonomous Region. The coal is mainly of non-coking coal, part coking coal and coking coal in rank.

Source: China Coal Outlook 2004, CCII

The 13 large coal bases encompass 98 mining areas with total coal reserves in excess of 850 Bt. The total coal output from these mining areas was 1.8 Bt in 2005, representing 82 percent of the national output, and is expected to reach 2.1 Bt in 2010 which will represent 72 percent of the expected demand. The Government will provide funds for preliminary exploration of coal resources and for the necessary detailed geological exploration to delineate the extent of the coal bases. According to the NDRC plan, large coal enterprises will lead the development of the specified coal areas. They will be encouraged to attract foreign investment through joint venture and to participate in the consolidation and transformation of small and medium coal mines. No coal resource in the bases will be allocated to small coal mines. Any (legal) small coalmines that overlap the proposed development of a large coal mine will be closed and the owners compensated. All illegal small coal mines and those not compliant with resource protection will be permanently closed – presumably without compensation.

Consolidation of resources, merger and acquisition of small mines

Consolidation of mining operations under the dominant KSOCM in major coalfield areas is bringing many small, private mines under the management of KSOCM. In fact, the KSOCM may be part owners through substantial share holdings in them. This activity is pivotal to the Government's strategy to reduce resource wastage and improve safety. By the end of 2004 there were more than 25,000 coal mines of various categories. The productive capacity of many mines was less than 30,000 tpa. The problems associated with low levels of concentration of production were not being fundamentally addressed at that time.

In the 11th Five Year Plan for Coal the Government switched the priority from placing coal production before resource protection, to increasing efficiency of resource exploitation.

In April 2006, 11 departments, including the SAWS, the NDRC and the MOF, jointly issued An Jian Zong Meikuang [2006] No. 48 Document, namely, "*Some opinions on promotion of work safety and standardization of coal resources aggregation*" which proposed the following actions:

1. Closing mines that were illegal, unsafe and wasting resources;
2. Phasing out obsolete production capacity;
3. Upgrading mine safety conditions and introducing safer mining methods;
4. Reducing the number of small mines and increasing the size of a single mine to meet the agreed minimum level of 90 ktpa in the southwest and mid-southern China, and 150 kt in other regions;

5. To develop mines rationally and protect coal resources.

All activities must be in conformity with the approved general plan of the mine areas, while the scheme for an allocation of mining rights and the recovery rate must satisfy the related stipulations of the Government. A target is to eliminate mines with a production capacity of less than 30,000 tpa.

The detailed procedures were to be carried out sequentially by local government in accordance with a plan approved by provincial government which involves:

1. Identifying mines which do not meet legal, safety and capacity criteria;
2. Revoking all licenses and disconnecting the electricity supply;
3. Ensuring legal SCM participate in the resource consolidation;
4. Promoting the principle of absorbing SCM through merger and acquisition into the management structure of the dominant, large coal mining enterprise.

Aggregation of coal resources can only be carried out by one legal person entity, suitably qualified, with the necessary finance, with advanced technology and knowledge. After aggregation, the mine must have only one integrated production system and adopt advanced mining technology and equipment. The production capacity of the mine after consolidation should meet the relevant stipulations of the Government and the resources (reserves) shall be compatible with the production scale and mine service life. The consolidation process must be treated as a construction project and all the relevant formalities of mining rights transfer, review and approval procedures should be followed. Examples are shown in Box 4.3.

Box 4.3

Examples of consolidation and transformation of small mines by large coal enterprises

The reform of the Shaping mine area in Hequ County in Shanxi Province jointly by the Shenhua Group and the Shanxi Province Coal Transport and Marketing Company provides one example of consolidation. In 2005 these two organizations founded the Jinshen Energy Co and jointly invested 850 million yuan for consolidating nine small coal mines and replacing them with a 2.4 Mt per annum capacity mine to enter production in the third quarter of 2006 as a first stage. The area of the Shaping coalfield after consolidation covers 20.8km^2 with industrial coal reserves of around 600 Mt and an anticipated, albeit seemingly ambitious, recovery rate of 70 percent to 80 percent.

There is an associated coal washing plant with an annual handling capacity of 5 Mt and a dedicated 11 km railway line for the mine area.

A further example is the consolidation of 90 small mines in the Pingsuo mining area by the China Coal Energy Group under the auspices of the Antaibao and Anjialing mines in 2006, which resulted in formation of three large-sized surface mines and 14 deep mines. The reformed Pinsuo coal base has an annual capacity of 100 Mt. The Anjialing coal mine project, the first of its type in China, will combine surface and underground mining methods. The actual productive capacity of the mine will reach 30 Mt. The recovery rate of coal from the surface mine will be over 95% and that of the underground mines is expected to be 75 percent to 85 percent. An anticipated 200 Mt of resources will be saved by this process.

When resource consolidation reform completed, the exploitation of each mining area will then be under the control of a single entity. There are 5,345 mining areas with verified reserves nationwide, but the number of mining operators currently totals 13,227 and some areas are exploited by several enterprises, often leading to pernicious competition, over-capacity mining, all too frequent accidents, inefficient use of resources and damage to the environment such as subsidence for which no compensation is paid. Areas failing to complete the process of integration in time will be inspected and closed off to prospecting and mining franchises.

The process of aggregating the coal resources of small mines and consolidating and merging them with large mining operations will allow the large enterprises to determine production and resource recovery rates and to impose their higher safety and environmental protection standards. This is a very positive reform step.

Table 4.4 Results of consolidation of small mines under KSOCM in Henan province

Provincial statistic	2003	Present
No. mines under the 7 KSOCM	58	82
Proven coal resources (Bt)	7.9	11.6
ROM output (Mt)	69.8	86.6
Final production capacity (Mt)	-	100
No. of SCM	1569	592
Min. capacity of remaining SCM	-	150,000
Overall fatalities/Mt mined	2.6	0.87 (2007)

Progress with policy implementation

The process of aggregation of resources and closure of small mines is being actively led by the governments of the major coal producing provinces with some measure of success as shown in the following examples:

Henan: The improvement in resource base, safety and output achieved in Henan, shown in Table 4.4, exemplifies the benefits of the resource aggregation and consolidation process. As a result of this process, resource recovery is expected to improve by 10 percent, increasing the potentially recoverable coal by over 200 Mt. The fatality rate per Mt of raw coal in the Pingdingshan municipality, previously afflicted by many accidents, fell to 0.26 in 2005, placing it among the best performers in China.

Shanxi: Consolidation and transformation of coal mines to form modern, large-scale, efficient groupings is well advanced in Shanxi. Three large super-group coal enterprises, were initiated as planned by Shanxi Province. These groups are a steam coal group with the Datong Mine as the entity, Shanxi Coking Coal Group with Xishan Coal and Power as the entity and an anthracite group with the Jincheng and Yangquan mines as the core. The Datong Coal Group combined small coal mining enterprises that produced thermal coal north of Taiyuan city, increasing the production capacity from 30 Mt in 2003 to 58 Mt in 2005. The production capacity of the Shanxi Coking Coal Group rose from less than 30 Mt to 50 Mt through aggregation.

In February 2006, the Shanxi Government enacted the legislation "*Procedures for aggregation and use of coal resources with compensation in Shanxi Province*". It stipulated that the merger of minefields of more than two mines, or the merger of the remaining reserves of the eliminated mines should be based on the mines remaining for transformation (to larger-scale, modern mines). Coal mines in major coal-producing counties with an annual production less than 300,000 tons are not permitted to acquire and merge the closed mines. For the aggregation of resources in an administrative region at county government level, the newly-added area should not exceed 10 percent of the total occupied area before aggregation, and the newly added capacity should not exceed 10 percent of the capacity before aggregation. Coal mines after aggregation must meet the requirements of work safety. The above restricts the power of local government to allowing only small changes, ensuring that major re-structuring decisions are made at provincial level.

Inner Mongolia: Under the plan for the aggregation of coal resources in the Autonomous Region of Inner Mongolia, the number of mines will be reduced from currently near 1,000 to less than 200 within the next ten years. The Government of the Autonomous Region of Inner Mongolia issued the regulation "*Enforcement regulations (for trial) of the People's Government of the Autonomous Region of Inner Mongolia for promotion further of aggregation and use of coal resources with compensation*". It specified that by 2010 the total number of coal mines will be 500 or less of which no more than 200 will have an annual production of less than 450 kt. Small mines with an annual output less than 300 kt will be closed.

Small mine closure planning

The Government plans to close 4,861 small mines from 2007 to mid-2008 leaving a total of around 10,000. The aim is to close illegal mines and those which do not comply with the minimum production capacity set arbitrarily by government. The spectrum of what constitutes illegality is wide, varying from an administrative licensing error to serious safety defects.

Based on the No.68 circulation 2001 issued by the General Office of the State Council, all the coal enterprises must have the following licenses: mining, coal production, work safety, coal business qualification and business. A mine is deemed illegal if any one of these licenses is not extant. According to a survey conducted for this study, some TVCM receive as many as 1000 documents each year and failure to respond to any one of these could be interpreted as non-legal compliance of the mining operation. A combination of inefficient government administration and the number of certificates with short-term applicability required by enterprises exacerbates the risk of non-compliance to small mines.

Each coal mining province has identified its closure targets. In North Shaanxi, mines with less than 60 kt capacity will be closed, less than 10 kt capacity in South Shaanxi and less than 30kt capacity elsewhere. By the end of 2008, small mines with capacities less then 90 ktpa will be closed in Shandong.

By the first quarter of 2006 there were 23,000 coal mines nationwide of which small coal mines accounted for 86 percent in number, but about 38 percent of production capacity (Table 4.5).

Table 4.5 Coal industry structure Q1 2006

Type of coal mine	Number	Production capacity (Mt/a)	Production capacity % of total	Average production capacity of a single shaft (Mt/a)
KSOCM	879	1198	44	1.36
LSOCM	2,379	499	18	0.21
TVCM	19,818	1057	38	0.05
Total	23,076	2,754	100	0.12(average of whole)

There is still substantial coal production from small mines despite the many reported closures (Table 4.5). Much of this output is presumably from merged and consolidated small mines that should have upgraded their working methods and equipment, and also from new modern private mines. If the reported closure statistics are correct then substantial new mine construction must be taking place. Cases of over-production sanctioned by local government officials have been cited which also cast doubt on the statistics. For example, mines with a design capacity of 50,000 tpa have been certified to produce 150,000 tpa by corrupt officials (Xinhua, China Daily, 30 November 2006). Shanxi Provincial Government and SAWS introduced a regulation in 2006 to limit the number of miners to 100 per shift in an attempt to control the problem of over-production.

Progress in closing small, inefficient mines is being hindered by local authorities that are delaying closures to reduce the economic and social impact. Some officials continue to retain financial interests, despite government policy requiring divestment. Closure plans are therefore being continually revised.

The success of planned closures (Table 4.6) will ultimately be judged by government on the basis of coal output attributable to small and local mines. The whole process is clouded however, by incomplete reporting of coal production. While this can be estimated by back calculation from total sales, an illegal coal market will obscure this data.

Table 4.6 Planned small mine closures

Year	Planned. closures during year	No. remaining at year end	Estimated TVCM coal output in the year (Mt)
2001	12,257	na	633
2002	3,151	25,343	623
2003	No significant progress	na	686
2004		na	762
2005	5,001	19,826	890
2006	2,652	17,176	na
2007	2,209	14,967	na
2008-2010	4,967	10,000	700

Sources: SACMS, China Coal Transportation and Marketing Association

The NDRC issued its national coal industry policy in November 2007, the core of which is focused on reducing the contribution of small-scale coal mining to national coal production (Jing Yang, 29 Nov 2007, Interfax-China). The new policy, which represents the first mid to long-term plan for China's coal industry raises entry requirements for coal mine and CBM exploration and exploitation, and reaffirms the suspension of approvals for small-scale coal projects. The policy states that no coal production project with an annual production capacity of less than 300 kt (0.3 Mt) will be approved for development before 2010.

Table 4.7 Region specific minimum annual production capacity

Province/region	**Minimum annual production capacity (Mt)**
Shanxi and Shaanxi and Inner Mongolia	1.2
Shandong	0.45
Sichuan, Guizhou, Yunnan and Chongqing Municipality	0.15
Fujian, Jiangxu, Hubei, Hunan and Guangxi Zhuang	0.09

Region-specific minimum annual production benchmarks that take into account regional coal reserves (Table 4.7) are set out in the policy. The implication of the 0.3 Mt threshold is that no small mine coal mine projects outside Shanxi, Shaanxi and Inner Mongolia will be approved before the end of the decade.

The policy supports government efforts to phase out small-scale mines. However, as the measures disregard local social and economic factors, it is quite likely that illegal mines will reappear when local supplies are unable to meet demand. There will be no safety inspections and no social protection for the workers at these illegal mines.

Illegal small-scale mining

The tally of illegal activities recorded from 2001 to September 2006 is shown in Table 4.8. Shanxi Province, the country's largest coal producer, closed 3,550 illegal coal mines in 2006 and since the start of resource reform has reduced the number of its small coal mines by 30 percent.

Table 4.8 Illegal coal mining activities 2001- September 2006

Non compliant activity	Number of cases
Penalties for operating unlicensed mines	168,506
Lease boundary transgressions	12,500
Illegal transfer of mining right	3,033
Exploration licenses revoked	92
Mining licenses revoked	6021

Source: CCN, 27 October 2006.

Scant data exists regarding the continuing extent of illegal coal mining. Eradication will be difficult in remote mountain regions where the economic survival of communities depends on local small coal mines of a size below the minimum capacity set by government. Data on many of these mines may not even enter the statistics. However, exclusion of such mines from the coal industry administrative system is not desirable as mine management’s awareness of good mining, safety and environmental practices will remain low.

Local governments have offered compensation after closing legal coal mines, but no compensation for illegal ones. According to a case study of small mine closures in Qinshui County in Jincheng city, three legal coal mines were closed in 2003, with each receiving 300,000 yuan compensation. After 2006, no compensation from government was offered to any of the closed small coal mines in Shanxi, as the compensation should be determined and financed by merger.

Coalfield development policies

A resource consolidation policy has enabled large mines to subsume reserves of small mines and maximize the opportunities for the application of modern, efficient and safe high-production mining techniques. However, reserves in some coalfield areas are virtually exhausted, while others have scattered resources with difficult geology and mining conditions. The latter conditions are only suitable for small-scale mining and the policy is to modernize and aggregate SCMs into larger units and to maintain production at current levels. This policy is necessary as cessation of production would result in increased transport capacity requirements on an already saturated rail network to import the coal from other provinces. Reserves of low rank, low heat value coals are to be mined and used for power generation at the mine site to relieve coal transport pressure. This would also occur due to their relatively low economic value which makes long-distance transport uneconomical. The general policies applied to different coalfield areas are illustrated in Table 4.9.

Table 4.9 Coalfield development strategies

General Coal Region	Province	Situation	Policy
Eastern	Liaoning, Jilin and Hebei, (Beijing)	Reserves declining.	Close all SCM in Beijing by 2010 due to exhaustion of reserves. Stabilize production elsewhere.
	Heilongjiang	Coking coal reserves.	Limited increase in production.
	Shandong	Reserves declining.	Stabilize production.
	Henan	Substantial reserves.	Maintain production scale and upgrade SCMs.
	Anhui	Scope for large and medium scale mines.	Increase production.
	E Inner Mongolia	Lignite reserves with scope for large and medium scale mines.	Construct integrated mines and mine-mouth power plants.
	Zhejiang	Reserves approaching exhaustion.	Close mines as they become exhausted.
	Jiangxi, Fujian	Scattered resources, thin seams and difficult mining conditions.	SCMs to be upgraded to maintain production and reduce pressure on inter-provincial rail transport.
	Hunan, Hubei and Guangxi	Resources dispersed with thin seams and poor mining conditions.	SCMs to be upgraded to maintain production and reduce pressure on inter-provincial rail transport.
Central	Shanxi, Inner Mongolia, Shaanxi and Ningxia	Geological conditions are favorable to the construction of modern, high production coal mines. Includes eight large mining areas: Shendong, Shaanbei, Huanglong, Jinbei, Jinzhong, Jindong, Mengdong (Inner Mongolia part) and Ningdong.	Prime areas for resource consolidation, for the absorption of small mines by the large mining enterprises and for exploration and expansion of production capacity. New mines of less than 0.3Mt prohibited (0.9Mtpa minimum if thick seams).
Western	Guizhou, Yunnan	Enhanced exploration of substantial resources needed to identify workable reserves.	Construction of large and medium-sized coal mines in combination with consolidation and transformation of small mines to satisfy local need.
	Sichuan, Chongqing	Coal resources with development potential in the Guxu and Junlian mining areas.	Transformation of small mines to stabilize production scale and reduce pressure on coal transport into these areas.

General Coal Region	Province	Situation	Policy
	Xingjiang, Gansu and Qinghai	Sufficient coal resources to support large and medium-sized mines but they are remote from the main coal consumers. Development potential in the Huating coalfield in Gansu.	Coal production is mainly aimed at meeting local demand. Efforts to be concentrated on exploration and increasing identified resources and proven reserves.

The Government's policy towards coal development is highly prescriptive. For example, it specifies the minimum capacity for new mines. The problem is that coal deposits differ substantially and it may be more economical to mine some deposits at a lesser scale of operations. The approach that the Government is adopting is not consistent with a market-oriented approach to the development of the coal industry. Consolidation of coal production under fewer larger enterprises, in some instances, may be counter to the objective of encouraging competition. Where the policy of consolidation should produce benefits of scale, the full opportunity to improve economic efficiency will not be realized, unless the mines are allowed to make subsequent operational decisions on commercial grounds.

In a free market system merger and acquisition allows companies to improve their economic efficiency while at the same time decisions are determined by market conditions. Due to the complexities of local conditions and the convoluted local government and private interests in the coal mining industry, such opportunities are not easily exercised even where there may be likely benefits. Determined administrative action by central and provincial government has therefore been essential to overcome these local problems and force the restructuring pace.

Financing coal industry restructuring and expansion

Interpolating between actual coal production in 2006 and the World Bank projection for 2020 indicates the need for an average increase in capacity of 148 Mt each year. At US$50/t (based on recent mine costs) this will require an average annual capital investment of US$7.4 billion and would be equivalent to the commissioning of, for example, 15 new very large mines each with a capacity of 10 Mtpa every year. The projected investment requirement compares proportionally with the US$4.5 billion per year invested in mining fixed assets between 2001 and 2005 and the approximately 100 Mt expansion of KSOCM capacity per year during that period. In practice, more mines will be constructed as not all mining areas will support large mines, and some may fail due to unforeseen problems.

In addition to these new mines, replacement capacity for exhausted mines must be financed. Further, an allowance needs to be made for under-capacity performance as mining difficulties increase, raising the annual investment perhaps by a further 20 percent.

The total investment, therefore, from 2007 to 2020 in coal mine construction could amount to US$115.4 billion with additional funds required to raise the capacity of the coal transport infrastructure commensurately. In a wholly competitive environment the actual build program would depend on coal production costs and delivered prices compared with imported coal.

At present there are substantial domestic financing resources available to the coal mining sector from share markets and state banks. The

Government has expressed a desire to attract FDI, mainly motivated by a policy aim of introducing advanced foreign technology. Likely conditions for FDI would be foreign majority ownership and the introduction of modern safety management systems. As there is little prospect of the acceptance either of foreign management of coal mines or majority ownership, such investment is not likely to be forthcoming. At present a joint venture (with less than 50 percent ownership) is the only vehicle for involvement in coal mining, other than by share holding on the stock market. International mining companies are discouraged from investment in China's coal mining by the absence of fair competition due to uneven enforcement of safety and environmental legislation, the paucity of identified available commercial reserves, and uncertainty in tenure of title, and data inaccessibility.

The limited degree of any foreign control permitted by the Government would probably ensure no significant competition was developed with the large domestic mines. This would be acceptable, provided domestic mining companies were free to compete with each other and there was competition between domestic coal, imported coal and other fuel sources.

Strategic planning of coal exploitation

China's coal industry has demonstrated an ability to expand coal exploitation at a prodigious rate. In 2005, the China Shenhua Energy Co. produced more than 121 Mt of coal, an increase of 20 Mt over the previous year. On its existing achievements, the company's goal of 800 Mt by 2020 would require 60 Mtpa expansion each year for 10 years. In comparison, the average annual expansion rate achieved by all KSOCM from 2000 to 2004 was 100 Mtpa.

In 2005, Shenhua Group's marketable coal reserves were 5.74 Bt, so at planned future rates of production, the reserves of its existing mining areas will be exhausted by 2019. The company has therefore sought to expand its reserves base through acquisition, consolidation and transformation of clusters of small mines in new mining areas.

It will be a major challenge for the Shenhua Group to accomplish such a rapid expansion without significant damage to the environment, not only from the mining activities but also from the continuous massive infrastructure expansion for coal transport. Shenhua has received a best enterprise award for its current environmental protection performance but whether this good practice can be maintained at four times the current rate of expansion is uncertain. The Shenhua Group has ably demonstrated what can be achieved where geological and mining conditions are favorable. The coalfields in the northern and eastern parts of China are generally less geologically complex than those to the south and are therefore easier to mine and higher capacity outputs can be sustained. The Shenhua model is therefore not replicable across China.

The coal mining industry has been struggling to keep pace with increasing demand. Out of five mines of various scale examined for this study (2003 data), four were producing at between 113 - 133 percent of capacity and the other at 96 percent. The Government has expressed concern about the safety hazards of over-capacity production, but the practice still continues to some extent and many mines are working at maximum capacity due to the strong coal price. Comparison of KSOCM capacity and KSOCM output in 2006 (Tables 4.2 and 4.5) suggest the mines were working at 105 percent of capacity on average (or at full capacity making allowance for statistical error).

Increases in coal production are not matching increases in coal-fired power generation capacity. Chinese raw coal output rose from 2.19 Bt in 2005 to 2.33 Bt in 2006, an increase of 6 percent. However, in the same year China's total coal-fired power generating capacity rose by nearly 24 percent, or about 484 GW.

The existence of proven reserves does not necessarily mean that all coal can be extracted at the desired rates. As mines work deeper reserves, the coal seam gas content will tend to increase and output from the gassiest mines will be constrained and production costs increased. While methane drainage systems have been installed in virtually all medium and large gassy mines, the efficiency of drainage capture systems in many mines is poor. Moreover, in some mines coal production is allowed to continue when methane concentrations exceed the permitted limit

More rigorous enforcement of safety regulations, combined with increasingly difficult mining conditions due to gas, could mean that by 2020 actual production is only 90 percent of mine capacity for the coal industry as a whole (estimated by assuming half the mines are gassy or in difficult mining conditions and that coal production in 20 percent of these mines is constrained by gas or other geological factors).

Choice of exploitation method

Government policy encourages the use of longwall mining methods to ensure maximum recovery of coal resources. All but the most backward small mines now probably practice some form of longwall mining, although a substantial proportion are only semi-mechanized. Semi-mechanized methods involve drilling and blasting the coalface, manual setting of supports and manually getting the broken coal onto a conveyor. The method is therefore labor intensive and has low productivity.

The Government is taking positive steps to fully mechanize coal mining operations to concentrate coal production on fewer coalfaces, to reduce the number of miners at risk and to improve mine safety. Fully mechanized longwalls are capital intensive and less flexible than the “conventional” drill and blast longwalls. In Shanxi Province, 20 percent of state-owned mines use drill and blast longwall methods. Many fully mechanized faces in China use last-generation mining technology and locally manufactured Chinese equipment, which is much lower in price than imported western equipment, but sometimes less reliable.

Recently introduced safety regulations that limit the number of underground workers per shift to 100 is aimed at forcing mines to automate, as the alternative is a reduced output if manually intensive mining methods are used.

Mechanization becomes more of an issue in respect of thin seam mining due to the possibility of conflict between resource recovery requirements and economic efficiency. Enforced mechanization of thin seam working could reduce the economically mineable reserves, increase mining costs and reduce the amount of recoverable coal compared with the current situation in which more versatile, but more labor intensive and hazardous, semi-mechanized methods are used in geologically challenging mining areas.

Seams of thermal coal as thin as 0.8m in horizontal and gently dipping deposits are considered workable in China and western observers consulted during this study have expressed concern at the hazards of low working heights. Underground mines in western countries typically work seams of no less than 1.5-2.0 m thickness as modern, highly productive longwall face systems can typically operate to a minimum of 1.5 m.

In response to market demand from coal mines, Chinese manufacturers have made significant technology advances in mechanized thin seam mining. For example, JNEG Xingtai Mining Industry Group manufactures longwall coalface equipment suitable for 1.0 to 1.9m height extraction at 700t/h. The Zaozhuang Mining Group Corporation, Shandong, has developed thin seam roof support systems that have enabled up to a fourfold increase in the production rate from 0.5 - 0.8 m seams and enhanced safety with the best monthly production reaching 104,000t. Innovations in the Chongqing municipality have facilitated mechanization of seams down to 0.4 m in thickness, below the standard minimum of 0.8 m. However, no details on the costs, output or working conditions are available.

The ability to mine thin seams efficiently is important to the Tiemei Group in Liaoning Province. This mining enterprise has proven reserves of 2.3 Bt, just over one third of the province's total, of which thin seams constitute 26 percent of the coal. Production from these thin seams was low at around 100 ktpa due to the difficulties in mining using conventional drill and blast methods, until a mechanized solution was found. An automated plough system combining core German technology (38 million yuan) with domestic coalface equipment costing a total of 600 million yuan (one-third the cost of an imported full coalface system) was installed in Xiaoqing mine of Teimei Group and put into trial production on January 5, 2006. It produced 215,900t of coal in 63 working days, an average rate of 3,427t/day. The best daily production achieved was 4,750t. The annual rate of production under the new system of 1.5 Mt is anticipated to increase to 2 Mtpa if the underground coal transport system is upgraded. An investment payback time of less than one year is possible.

There are two fully mechanized thin seam longwalls, 1.3 - 1.6 m, in Shanxi, mined using German plough technology. However, this equipment is costly and unlikely to be used widely. Its application is also limited by the physical characteristics of the coal seams. A package comprising a German-manufactured plough, control system and conveyor with Chinese supports for a 150 m face, together with a road-header was reported as costing 100 million yuan. Output from one longwall face achieved 600 ktpa but production could be limited by coal panel development rates rather than the longwall technology.

On balance, overall safety is likely to improve as a consequence of the efforts to fully mechanize thin seam extraction. The performance of modern plough equipment imported from Germany shows that improved extraction efficiency and operating cost reductions, which are high on the agenda of coal mining enterprises, are achievable in certain geological conditions. The above developments illustrate that given an appropriate incentive, mining companies will seek to find a technical solution to optimize extraction performance. The current driving incentive is not the resource recovery standards, but the price of coal.

Improving mining efficiency and reducing costs

Mining costs will increase as mines start to operate to similar safety and environmental standards as those in developed countries. Power consumption at individual mines will also increase with more degree of mechanization and with an increase in coal production capacity which will come predominantly from modern, fully mechanized longwalls. To remain competitive, efforts must be made to match increased costs with higher mining efficiencies. Energy efficient mines should be a goal and policies should be put in place to encourage investment in energy saving technology and practices which will not lead to any compromise either in safety or any reduction in the sophistication of mechanization of coal extraction.

Mine design rules are still out-dated, relying on a formulaic approach which inevitably leads to inefficiencies in mining operations. New design rules have been forming for a number of years and in 2005 State Council requested that the revision be accelerated.

Reluctance by some foreign companies to import their most up-to-date and efficient mining technologies into China is denying China's coal mines access to technologies that could help to improve both the safety and efficiency of coal mining operations. Unlicensed copying of mining equipment is blatantly practiced and current government efforts to enforce IPR are having little impact in the coal mining sector. This process also hinders development of competition which is needed to drive domestic manufacturers to invest in R&D and improve product quality and performance.

4.2 Sector structural reform needs

Coal industry restructuring to raise the scale of coal mining enterprises is well advanced but the problem of small coal mine closures remain

As long as national concern about inadequate coal supply persists and prices remain strong, small mine closures are difficult to enforce (and there are strong incentives for operators to evade the closures). In many coalfield areas, local governments are highly dependent on small mines for tax revenue and are therefore reluctant to close them. Closure also causes serious unemployment among manual workers, results in loss of residual coal in heavily worked areas, removes a low cost source of energy from isolated towns and villages, leaves environmental problems untreated and creates public safety hazards after abandonment. Until policies are devised and implemented to solve the economic and social issues arising from small mine closure, unsafe illegal mining operations will continue.

Due to a lack of alternative opportunities for workers and owners of small mines that have been closed, these mines are often re-opened illegally. Owners of small mines in general see little point in investing in modern mining technology, long-term mine planning and safety equipment to comply with current regulations as all can be lost in the event of enforced mine closure. As a consequence, closure of hazardous, polluting small mines is proving problematic. Government policy requires that legal mines which are below the minimum capacity criteria are compensated on closure, but these payments are not always made.

Some of the small coal mines may be continuing operations under the guise of aggregated units that nominally meet government conditions for the minimum scale of permitted capacity. Shanxi, one of the major coal mining provinces, had planned to complete the closure of all mines with a capacity of less than 90 ktpa in 2005 but did not meet the goal. Furthermore, nearly 60 percent of the 5,001 SCM closures across China ordered by the Government in 2005 were still operating in January 2006 (Zhao Tiechui, SACMS, 4 September 2006). Despite government policy, the owners of small coal mines are not receiving compensation for the loss of resources and income when their mines are closed. Neither, apparently, do willing participants automatically receive shares in the consolidated company. Due to the complex licensing regime for coal mines, it is very difficult for small coal mines to keep all the necessary documents up to date and it is possible that compensation could be withheld on grounds that a mine is technically illegal.

4.3 Recommended policy reforms

The Government should continue its current policy of resource consolidation and transformation of mines into modern, mechanized, efficient high-production units under the control of the large coal mining enterprises in the major coal base development areas.

Small mine consolidation at local level is increasing the scale of domestic private sector participation in the coal mining sector. Some large operations could develop from these nuclei to compete directly with the administratively unwieldy KSOCMs. These emerging large-scale private companies have less social liabilities, and they are also likely to be more commercially orientated and less susceptible to political interference. The emergence of large-scale private sector coal mines should be encouraged by allowing them to compete for coal resources with KSOCM. These mines should receive similar levels of government support to KSOCM, but also be regulated with similar rigor.

Property and coal mining rights should be clarified for legally (according to local rules) operated small mines with guarantees of payment of compensation if closed by administrative order. The Government should provide social protection for the laid-off workers, including itinerant workers.

The economic and social benefits that properly regulated small mines can provide to isolated communities should be recognized and a code of standards developed to allow such mining to continue at a scale determined by the local market rather than by government prescription. The prescriptive minimum mine production capacity should therefore be revoked. Instead, specific small mine operational, safety, social and environmental standards which are reasonable and achievable should be formulated and implemented. Such an approach would legitimize small mines and allow closure decisions to be made on commercial grounds. The licensing system should be streamlined to reduce administrative burden and the ownership rights clarified so investment can be secured.

Barriers deterring the introduction of some modern mining technologies into China should be removed. IPR protection for foreign imported mining equipment and technology should therefore be conspicuously enforced and punitive fines imposed on malefactors to encourage foreign manufacturers to expose their most up-to-date technologies, where suitable, to China’s coal mining sector.

Underground equipment and electrical safety approval procedures in China (Mei Anquan) should be made compatible with the European systems to remove the delay to market entry of advanced foreign equipment already manufactured and tested to internationally approved levels of safety.

Chapter 5 Safety, health and community impact

5.1 Safety of mineworkers

Coal mines in China have become safer places to work with an absolute reduction in fatalities by over 40 percent since 1996 and the fatalities per Mt coal mined reduced to a third of the 1996 figure by 2007. This has been achieved mainly by raising safety standards in local private and community owned mines and by increased mechanization which has reduced the numbers of miners at risk per unit of coal extracted.

Some of the large coal mining companies are developing an exemplary approach, achieving very low fatalities rates (measured as the number of fatalities per million tonnes of coal mined), comparable with some developed coal mining countries. For example, the fatality rate in the coal mines of Yitai Mining Group, Inner Mongolia, averaged 0.036 per Mt in 2005 and 2006 compared with 0.018-0.040 in the USA over the last ten years (Feickert 2007). For the first half of 2006, the fatality rate of the Shenhua Group's Shandong Coal Company was 0.028, compared with 0.6 for the key state-owned mines and the national average of 2.2, after producing about 50Mt of thermal coal.

The fact that Xishan Coal and Electricity Company, Shanxi Coking Coal Group, could produce 30 Mt coal in 2004 from their mines, some of which are gassy, without a fatality after spending around US$158 million on safety improvements in the preceding five years, shows that the concept of zero fatalities, the only internationally acceptable target, is achievable.

In contrast, some large mining groups have appalling safety records. For example Fuxin has recently experienced two large scale accidents. 214 miners were killed in an explosion in February 2005 and 27 in June 2006.

Work in many of China's coal mines remains dangerous despite robust regulations and massive government investment. Fatal accidents occur almost daily in Chinese mines as safety regulations are ignored by mine managers and workers and because coal production rates often exceed the capacity of ventilation and methane control systems. The large difference between coal prices and costs in the small mines attracts unscrupulous operators which, combined with the complicity of corrupt, local officials, means that profit is pursued with little regard for human health and safety. Serious cases are prosecuted. For example, two mine owners in Guangdong province were jailed for 11 and 10 years each for a colliery flood that killed 121 people in August 2005.

In November 2006, in response to the increasing fatality rate in Shanxi Province, the Provincial Government and SAWS imposed a new rule, limiting to 100 the maximum number of people allowed underground during any shift in SOCM and TVCM. This was based on safety limits to prevent uncontrolled production, with managers exceeding agreed mine capacity.

Yu Youjun, Governor of China's coal-rich Shanxi Province, apologized on 30 January 2007 for the major coal mine accidents of the previous year (and also for the province's failure to fulfill its energy-saving target – which would have reduced pressure on coal production). The Governor stated that an average of 0.8 miners died for every 1Mt of coal mined in Shanxi in 2006, a record better than the national average. Shanxi had also planned to reduce energy cost for per unit of GDP by 5.6 percent in 2006, but only achieved a 2 percent decrease. It is not common for such a high-ranking official to apologize openly in China and shows a strong commitment and the acceptance of responsibility by government. In fact, Shanxi Province has made exceptional progress in improving the safety of medium and small mine operations.

Accident statistics

The closing of small, hazardous, polluting coal mines has resulted in an overall improvement in safety with the average fatality rate for all types of coal mine in 2006 at an all time low of 2.04 (Figure 5.1) but serious accidents, especially explosions, remain a too frequent occurrence in the KSOCM among which there is a large variation in safety performance.

Most of the available data refers to fatal accidents. The most serious of these involved explosions, flooding and falls of ground. While coal mines receive reports of investigations, these take a long time for the relevant government departments, through SAWS and SACMS, to complete. However, this is little different from developed countries where five years can elapse in some instances before a detailed serious accident investigation report is released. In China, there is a scarcity of case study data on serious non fatal accidents, their scale and causes, but this is understandable given the priority to reduce fatal accidents.

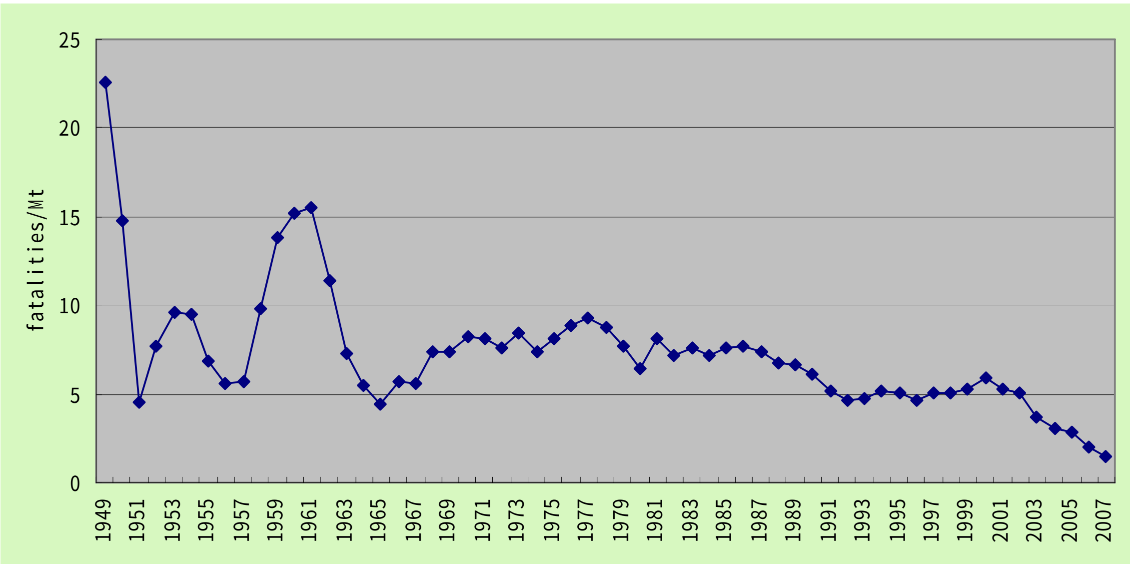

Figure 5.1 The trend of average fatality rate in China's coal mines

Figure 5.1 shows the long-term average fatality trend for China's coal industry. Data from the 1950s may be suspect, but the overall trend is one of significant decline. The steeper decline after 2000 shows the effectiveness of government policy and actions in recent years. This is a very positive result.

A closer look at the fatality rates in the different types of mine is needed to determine the potential for the continuation of the downward trend towards those in developed mining countries.

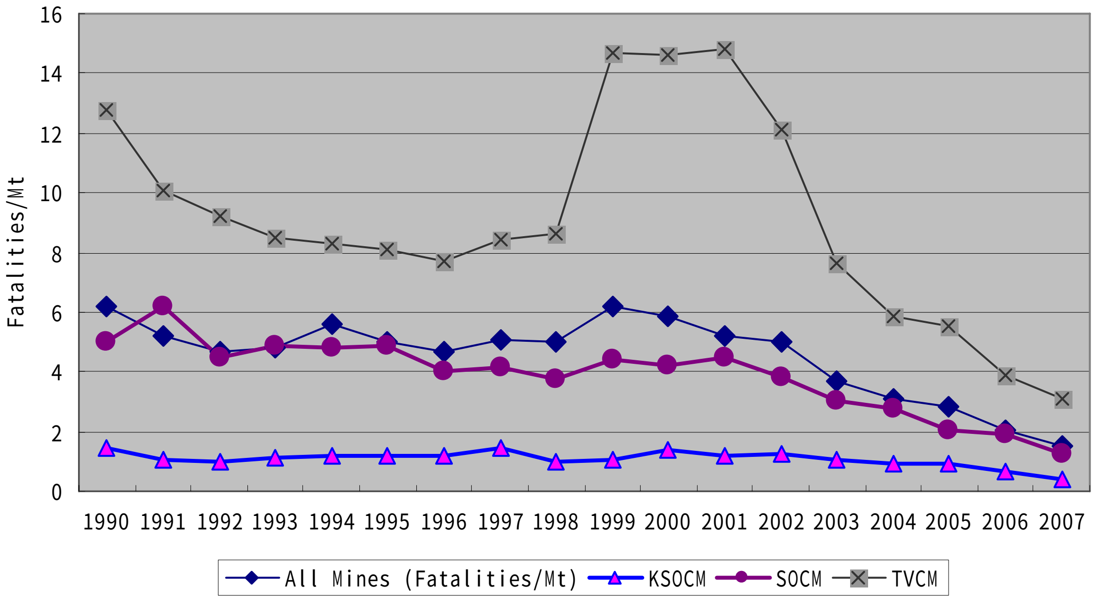

Figure 5.2 Fatality rate trends in coal mines of different type in China

Figure 5.2 shows that since 2000, fatality rates have declined rapidly in SOCM and TVCM, and the composite rates are approaching that of the KSOCM which set the standard for China.

The expenditure of 83 billion yuan (US$11 billion) over the last five years, mainly on safety technology and improvements in KSOCM, has resulted in a reduction in the average fatality rate per Mt mined from 1.1 in 2003 to 0.6 in 2006, an almost 50 percent improvement. However, the average fatality rate is still an order of magnitude higher than international coal mine safety standards. The average figure belies the fact that some large coal mining enterprises have world class safety records, but the average fatality rate is driven upwards by occasional, but very serious, major accidents that cause many deaths (Table 5.1).

Table 5.1 Single accident occurrences causing over 100 deaths from 2000 to 2007

Date	Location	Types	Fatalities
2000.9.27	Muchonggou coal mine, Guizhou Province, Shuicheng Mining Bureau	Gas and coal dust explosion	162
2002.6.22	Chengzihe coal mine, Heilongjiang Province, Jixi Mining Group	Gas explosion	124
2004.10.20	Daping coal mine, Henan Province, Mechanical Group Limited, Zhengzhou	Gas explosion	148
2004.11.28	Chenjiashan coal mine, Shaanxi Province, Tongchuan Mining Group	Gas explosion	166
2005.2.14	Sunjiawan Haizhou coal shaft, Liaoning Province, Fuxin Mining Group	Gas explosion	214
2005.8.7	Daxing coal mine, Guangdong Province, Xingning City	Flooding	123
2005.11.27	Dongfeng coal mine, Heilongjiang Province, Qitaihe Mining Group	Coal dust explosion	171
2005.12.7	Liuguantun coal mine, Hebei Province,	Gas explosion	108

	Tangshan City Kaiping District		
2007.12.05	Xinyao coal mine, Shanxi Province, Ruizhiyuan Minging Ltd.	Gas explosion	105

Source: United States Mines Rescue Association (USMRA); The State Administration of Work Safety

The coal mines which became operational in the 1950s, especially those that did so with assistance from the former Soviet Union in North East China such as Fuxin and Jixi, seem particularly prone to serious explosions. A possible contributory factor is equipment obsolescence. Worn out or poorly maintained electrical equipment increases gas ignition risk.

Statistics must be interpreted with caution. While official statistics show a significant decline in fatality rates in small mines, not all accidents in small coal mines are reported due to concerns about closure by the owners. Local communities are often also concerned about losing a source of employment and therefore tend to support the mine owners irrespective of the poor and unsafe working conditions faced by the miners. There is also uncertainty on coal production quantities attributable to small mines as some illegally mined coal may not pass through official sales channels. However, on balance it seems reasonable to accept the trend data.

Local governments show determination in responding to accidents in small mines, but sometimes action is drastic and not necessarily sustainable in the long-term. For example, following a flood at Daxing coal mine in Guangdong which killed 123 miners on 7 August 2005, the provincial government ordered lower level governments to start destroying some 100 unlicensed mines in Meizhou, Shaoguan and Qingyuan counties. Valuable underground equipment was lost and no compensation paid. Several thousand people petitioned the city government in Shaoguan in Guangdong and thirteen people were arrested for creating disturbances. However, some mine owners representing 20 mines in Meizhou took a peaceful approach, hiring lawyers to sue the local governments.

This event shows the determination of government to tackle mine safety issues. However, the closure activity was initiated as a knee-jerk reaction to a major accident when it should have been managed through mine inspections as a preventative measure. In addition, social programs to generate alternative employment are an essential component that is currently missing from the small mine closure process.

It is likely that small mining operations in some remote areas can be justified economically. It is therefore unreasonable to impose a blanket ban on small mines based on an arbitrary minimum capacity. The effect of a prescriptive ban is to push many small mines, which will continue to operate for local economic and social reasons, outside the safety inspection regime. Mine owners will not risk investment in safe, modern equipment as they are unlikely to be compensated if the mine is destroyed. Neither will the miners receive any social protection while working. Local government officials, anxious to protect the local economy and their own interests, in some instances, have conspired to falsify closures (Xinhua News, China Daily 30 November 2006).

The fatality rate in Jiangsu, Shandong, Inner Mongolia, Shanxi, Hebei, Henan and Anhui provinces and regions was less than one in 2007 (Table 5.2). Among individual mining enterprises, Shenhua Group produced 150 Mt of coal at a fatality rate of 0.021 comparable to USA standards and a substantial improvement on the average for KSOCM of 0.96. The Daliuta mine of the Shenhua Group’s subsidiary Shendong Company has 600 employees and produced 20 Mt of commercial coal without any fatal accidents. Other large mines achieved a similar record. The best safety performances are generally from modern, fully mechanized, profitable mining operations which can attract high caliber workers and management through good pay. A necessary prerequisite is relatively simple geology and good mining conditions which allow for economically efficient and safe mining.

Table 5.2 Some regions and provinces with an average fatality/Mt rate below one (2007)

Regions/Provinces	Fatalities/Mt
Anhui	0.587
Hebei	0.808
Henan	0.871
Inner Mongolia	0.196
Jiangsu	0.366
Shandong	0.154
Shanxi	0.72

Source: The State Administration of Work Safety

Table 5.3 shows that safety is poor in general across coal industry enterprises in China, not just in the coal mines. The data indicates that coal mines accounted for 37 percent of the total fatalities from 2003 to 2005. Clearly, industrial safety is a wider issue in China, not just confined to coal mining and therefore the causes of the poor safety record are not only coal specific.

Table 5.3 Accident trends in mining enterprises from 2002 to 2005

Year	Total Industry and Mine Enterprise		Coal mining Industry		Coal accidents as a proportion of total Industry and Mine Enterprise accidents	
	The number of accidents	Fatalities	The number of accidents	Fatalities	Proportion of accidents %	Proportion of fatalities %
2002	13960	14924	4344	6995	31.1	46.9
2003	15626	17326	4143	6434	26.51	37.13
2004	14702	16497	3641	6027	24.77	36.53
2005	13142	15868	3306	5938	25.16	37.42

Source: China Coal Information Institute

The reason for government action on small mine inspections and closures is that over recent years the number of accidents and fatalities in TVCM represent over 70 percent of the totals across all types of coal mine. Another concern is that fatalities from very serious accidents, in which 10 or more miners are killed, have not been declining (Table 5.4). In 2005, there were 45 very serious coal mine accidents, up by 45.2 percent on the previous year, and the total death toll was 1,271, an increase of 75.80 percent. However, the recent situation has been improving: In 2007, there were 25 very serious coal mine accidents, down by 26.47 percent on the previous year, and the total death toll was 494, an decrease of 23.29 percent.

Table 5.4 Very serious accidents (10 or more fatalities)in coal mining industry from 2000 to 2007

Year	Number of accidents	Number of fatalities
2000	75	1405
2001	57	1388
2002	59	1269
2003	42	1131
2004	31	723
2005	45	1271
2006	34	644
2007	25	494

Source: The State Administration of Work Safety

The incidence of gas explosions is a major concern. From 2000 to 2005, 7 out of the 8 accidents, each of which caused over 100 deaths, (Table 5.1) involved gas or gas and coal dust explosions. The precise accident causes are uncertain as the detailed investigative reports are not published. Administrative and management problems tend to be reported, but not the technical details. For instance, SAWS revealed that the Hebei mine in which 108 miners were killed was operating under a mining license that had been fraudulently altered. The implication is that inadequate supervision by local government is considered a contributory factor. Fuxin Mining Group, in which the worst explosion in recent years occurred, operates aging mines constructed with the assistance of the former Soviet Union. Obsolete, unsafe equipment and entrenched practices hinder safety improvement.

The accident reports could provide a very important source of data for an analysis of the underlying causes of fatal accidents.

There are major regional differences in coal mine safety performance (Table 5.5) but in interpreting the relevance of the statistics account needs to be taken of the number of events, average number of fatalities per event (as a measure of severity) and fatalities per Mt mined. In 2005, the most fatalities occurred in Guizhou (837), Sichuan (532), Hunan (510), Shanxi (492) and Chongqing (455), but when expressed in terms of coal extracted the highest fatality rates/Mt occurred in Guangdong and Zhejiang. Coal mines in the latter two provinces are approaching exhaustion. Mines in declining coal mining areas invariably suffer from loss of skilled staff, low motivation to adhere to safety standards and can involve hazardous mining of residual coal pillars.

After adjusting the data to remove the effects of single, exceptionally major incidents (more than a 100 fatalities), the provinces with the highest average severity of coal mine accidents (more than 3 fatalities per accident event) are Hebei, Henan and Shanxi. This high severity rate statistic arises due to the occurrence of multiple accidents in these provinces with 10 or more fatalities (Table 5.5). These three provinces are all in northern China, situated close to industrial markets where production pressures are high.

The highest fatality rates tend to occur in the southern, central and western parts of China where the geological conditions are difficult, hindering mechanization, limiting mining scale and complicating gas drainage. The explosion risk is lower in the mines of Shandong and Inner Mongolia due to the lower gas content of the coal. Shandong has few small mines and a high proportion of the coal production in Inner Mongolia comes from modern, high productivity coal mines. Shandong province is the major coal producing province in the coastal area with relatively difficult mining conditions. Having the best safety mine safety performance statistics, Shandong's coal mining sector warrants further study to determine the reasons for its success.

Table 5.5 Statistics of fatal coal mine accidents in different regions 2005

Region	Accident events	Fatalities	Average fatalities/event	Fatalities/Mt mined	No. accidents with 10 or more fatalities
Guangdong[1]	31	174	5.6 (1.7)	57.2 (16.8)	2
Zhejiang	11	16	1.5	38.1	0
Chongqing	349	455	1.4	13.7	3
Hubei	109	129	1.2	12.3	0
Hunan	340	510	1.5	10.4	2
Jilin	136	212	1.6	8.0	2
Guizhou	521	837	1.6	7.9	10
Jiangxi	70	138	2.0	6.7	2
Sichuan	423	532	1.3	6.6	2
Xinjiang	98	225	2.3	6.3	3
Fujian	77	95	1.2	6.2	1
Liaoning[2]	81	321	4.0 (1.3)	5.0 (1.7)	1
Hebei[3]	66	315	4.8 (3.2)	4.2 (2.8)	5
Yunnan	165	265	1.6	4.1	1
Heilongjiang[4]	152	398	2.6 (1.5)	4.1 (2.3)	3
Guangxi	20	23	1.2	3.7	0
Xinjiang	11	13	1.2	3.6	3
Qinghai	12	12	1.0	2.1	0
Beijing	11	13	1.2	1.7	0
Henan	69	210	3.0	1.4	5
Shaanxi	135	216	1.6	1.4	3
Gansu	35	48	1.4	1.3	0
Ningxia	42	29	0.7	1.1	0
Anhui	58	77	1.3	1.0	0
Shanxi	165	492	3.0	0.9	10
Inner Mongolia	56	131	2.3	0.6	3
Shandong	44	42	1.0	0.3	0
Jiangsu	18	7	0.3	0.3	0

Includes exceptional events with fatalities numbering: (1) 123; (2) 214; (3) 108; (4) 171
Values in parentheses show fatality indices after removing major accidents with more than 100 fatalities

The statistics provide numerical and spatial information on fatal accidents in coal mines which are helpful to the Government for monitoring the impact of policy on coal mine safety improvements.

Co-ordination of government mine safety initiatives

On 17 March 2005, a national co-ordination group on mine safety, with an emphasis on gas control, was set up under the leadership of the NDRC, involving many government bodies. Experts were dispatched to the mines considered to be the most hazardous and plans made for the expenditure of a further US$360 million at KSOCM on safety, gas control and the acceleration of gas utilization projects, the latter as a means of encouraging more effective gas drainage.

A coal mine expert safety group has also been established consisting of 99 experts from various sectors, including government departments, universities, science institutes and coal enterprises. They formed four groups focused on mining, geology, electrical and mechanical, ventilation, and engineering safety. These four groups were involved in major accident site investigations, assessments, validation, safety technical consultancy and trouble shooting technical problems at coal mines (China Coal News, 13 Oct 2006).

International mine safety initiatives

Feickert (2007) argues that with continuing determination from the Government of China and a level of assistance from the developed mining countries greater than is currently being deployed, China can move rapidly towards achieving international standards of health and safety.

The Chinese Government has embarked on improving mine safety with an increasing amount of international help from the USA (US$2.5 million Department of Labor, training for managers), Australia (Federal Government and mining company technology transfer), Japan (training for underground foremen), New Zealand (training for managers, underground foremen and coal face safety representatives) and, potentially in the near future, the EU.

From 2007 to 2010, China and UNDP will jointly invest over US$14 million mainly for building up coal mine safety capability in Anhui, Guizhou, Henan, Liaoning and Shanxi provinces. The project is jointly managed by the China National Safety Production Supervision Management Bureau, UNDP and the China International Economic Technology Exchange Centre.

In January 2007, China became a signatory to the International Labor Organization's (ILO) convention on occupational health and safety and the Government has committed to increasing cooperation with international organizations to help improve its occupational health and safety standards. The Government, through SAWS, has pledged to develop better health and safety policies, increase supervision, introduce risk evaluation and enhance education and training.

The Asian Development Bank (ADB), in collaboration with SAWS, has initiated a technical assistance (TA) project to develop a strategy for improving safety conditions in small mines focusing on the Zhengzhou mining area and identifying potential safety projects for ADB financing.

The above initiatives show that the Government is focusing seriously on safety issues and is committed to raising standards. The involvement of international agencies provides access to expertise and experience from outside China. Aid projects, however, are small and a current trend is to maximize the domestic input leaving insufficient scope for international expertise to inject new ideas.

Safety training and certification

Professional standards have recently been raised for the directors of KSOCM. SAWS issued a standard early in 2007 requiring that senior management must be institute graduates and also have three years experience in coal mine safety, production and technology and two years management experience. Based on stipulations of "*Methods for supervision and checking of coal mine* *safety training (proposed methods)*" (An Jian Zong Meikuang Zi [2005] No. 135 Document), a mine director must be certified as qualified both in safety and for the post. SACMS is responsible for organizing and implementing training, assessment and issuing safety qualification certificates though local safety bureaus. However, in Shanxi for instance, the director's qualification, which fulfils the same aim, is issued by a separate coal administration department. There would appear to be no independent monitoring of training standards and courses are not internationally certified. Nevertheless, this is a positive step towards improving the competence of mine management. It is the attitudes and examples of senior management that ultimately determine the safety culture at a particular mine.

SAWS has identified the lack of experience and knowledge and low skills of the industry as one of the major causes of high accident rates. Graduates are not attracted to work in the industry, once they have been through university, as the image of coal mining is poor. SAWS and other agencies are involved in extensive training but it remains insufficient and, so far, foreign expertise in training is being applied only to a limited degree. SAWS could attempt to co-ordinate the international input in a more systematic manner.

Government statistics show that nearly half of China's 5.5 million miners are migrant workers from northern Sichuan, southern Shaanxi and the mountainous regions of Jiangxi, Fujian and Henan provinces. Less than 10 percent of university graduates from mining-related universities choose to work in mines. Consequently, there are many poorly educated miners in the coal industry. A major challenge is to ensure that these miners receive adequate training.

Natural risk factors affecting coal mine safety

Unlike the other major coal mining countries which have substantial opencast reserves, China extracts 95 percent of its coal from underground. Underground mining is more hazardous and manpower intensive than surface mining. Much of the shallow coal has been worked out in China and the average mining depth is now 400 m. As production rates increase, workings are progressing deeper and gas emission, outburst, flooding and roof instability risks are increasing. Coal dust explosion hazards are present in 60 percent of the coal mines. Spontaneous combustion risks are high in over 70 percent of large and medium-sized coal mines and more than 40 percent of mines are highly gassy or susceptible to coal and gas outbursts. Coal is mined wherever it occurs in China and in some southern parts of the country, mines were constructed in the past by governments to provide employment and stimulate economic development irrespective of geologically difficulty and mining cost. A combination of direct government subsidy and not paying full costs of impact allows coal to be extracted under more difficult conditions than would be possible in a true market situation in which the total production cost would make some of the coal uncompetitive.

Coal mining in China is therefore inherently more risky than in the other major coal mining countries. Any improvements in safety have to overcome overall worsening mining conditions. In developed countries, the cost of achieving an acceptable level of safety risk is factored into mining projects and mining is discontinued once hazard mitigation costs become excessive. China's KSOCM, in contrast, tend to absorb the costs many of which are not transparent in their current accounting systems, and continue mining despite all odds, irrespective of the economics, using government and cross subsidies to finance operations.

The approach of the KSOCM to safety is reactive rather than preventative. Instead of including the costs of risk management as part of their capital and operating costs, they only consider the cost of accidents and fatalities after they occur. While they may pay part of this cost (compensation to workers, penalties and lost production) themselves, part of the cost is paid by the Government. The incentive to invest in safety improvements and to take safety issues into account in mining decisions is reduced because the Government essentially subsidizes risk. It might be argued that privatization of all coal mines would have the effect of placing full responsibility for safety on individual firms, raising the financial incentives to improve safety standards. However, this would only work in a well-regulated coal industry and such conditions are far from present in China. The way forward in China must come through stronger Government enforcement of safety regulations and larger penalties to force mines into improving risk management.

Deficiencies in safety management

Weak safety management by mining enterprises with a deficit of 69.8 billion yuan expenditure on safety projects were identified in an inspection of 56 key coal enterprises by safety experts in 2005. The problem of under spending on safety is compounded by a shortage of skilled management and technical staff (Table 5.6). Underground electrical equipment requires expert maintenance to prevent gas ignition risks. Mechanization of coal extraction and transport, and introduction of effective underground environmental monitoring technology, is reliant on skilled staff to install, maintain and operate. Many gassy mines have installed gas drainage systems but they are often ineffective and can introduce new hazards. 96 percent of the large coal mining enterprises are short of mechanical and electrical professionals and 88 percent of them are short of mining professionals.

Technical skill levels among the main force of underground workers are very low as a large proportion of them, about half in KSOCM and practically all in TVCM, are rural migrant workers. The training is poor and appreciation of safety and self-protection is low. One problem is that workers judge that the rewards they are offered, relative to what they can earn elsewhere, justify the risks that they take.

Table 5.6 Education level of mine employees (mines greater than 0.3Mtpa)

Education grade	Proportion of total (%)
Senior technician	3
College graduate	5
Middle school	63
Primary or none (1)	29

(1) Deduced by difference
Source: Study Team

Safety administration, regulation and enforcement

The Government has responded quickly to major mining accidents in an effort to control the problem. A devastating coal mine explosion on 14 February 2005 in the Sunjiawan workings of Haizhou shaft killed 214 miners in Northeast China's Liaoning Province. A few weeks later, the State Council dismissed the Vice-Governor who was responsible for industrial safety in Liaoning. It also elevated SAWS to ministerial level and formally established the State Administration of Coal Mine Safety (SACMS) as a separate organization in its own right at deputy ministerial level within SAWS.

SACMS was allocated a permanent staff of 48, a relatively large number of staff compared with the 160 total of SAWS responsible for all other industries (China Coal News 29 March 2005). This number of staff would be sufficient for managing the provincial and regional safety bureau if the tasks of monitoring coal production and gathering information that were inherited from the former Ministry of Coal Industry were relinquished. However, there is no other central organization to transfer these tasks to. Furthermore, even more coal industry management tasks have recently been passed to SACMS from NDRC.

The effectiveness of the safety administration has been compromised by failures and collusion of some local officials but the Government has taken determined steps to eliminate these deficiencies. Investigations were conducted into nine explosions that occurred in the industry in 2005 that resulted in a total of 270 deaths. Official prosecutors found 46 local work-safety officials guilty of dereliction of duty for not enforcing laws that could have prevented many or all of these accidents. In the first nine months of 2006, seven director-level officials at various coal mine safety administrations in Shanxi were prosecuted for corruption (Xinhua, September 14, 2006). This demonstrates the seriousness of Government in tackling underlying safety critical issues.

However, deterrents have not been strong enough as illustrated in the following example. A methane explosion occurred on 5 December 2007 at Xinyao coal mine, a TVCM in Hongtong County, Linfen City, while 128 miners were working in the mine. 105 miners were killed. There should have been no more than 100 miners on a shift according to a regulation implemented by Shanxi coal mine authorities. The mine's registered annual capacity was 210,000 tons, but the owners illegally expanded it to 500,000 tons in 2005 (Shanghai Daily, 18 December 2007). Apparently, county officials inspected the mine in late November, 10 days before the gas explosion but did not report any workplace hazard. Following the Xinyao accident the mayor of Linfen city was removed from his post of deputy Party chief and also expelled from the city's standing committee of the Communist Party of China (CPC) for breaching his duty of supervising the mine's work safety. The mine owner and others thought to be responsible for the incident were arrested. Punishment can be an effective deterrent, but only if enforcement is sufficiently effective to ensure a high probability of malefactors being caught and prosecuted.

Due to the perceived high degree of collusion between local officials and coal mine owners, the Government requires that the national body, SACMS investigate serious coal mine accidents. This is again a positive step because it increases the degree of independence with which investigations are conducted and it brings China's mine safety inspection procedures more closely into line with those in developed countries.

In the six years since SAWS was given the mandate to decrease the number of China's coal mine accidents, it has imposed increasingly stringent safety regulations, but has yet to establish a consistent and effective enforcement network across the country. Tu Jianjun (2006) suggested that the following measures are necessary if safety improvements are to be accelerated: (1) establish transparent, legal and institutional frameworks to protect the interests of all stakeholders; (2) set an aggressive quantity based safety target; (3) hold local officials accountable; (4) allow for additional media and grassroots monitoring; and (5) eliminate incentives that seriously distort safety statistics.

Effective systems for responding to mine accidents have been developed in China. The authorities can act quickly to launch rescue teams, investigate the accident, identify those responsible who should be punished and compensate families of the dead miners. Compensation for families of miners killed in accidents has been raised to over US$24,000, almost triple the previous cap. However, greater attention is needed to prevent mine accidents. The safety administration needs more resources at a local level, and greater powers to inspect mines, stop production and levy punitive fines against any mine or official that contravenes safety laws.

A plethora of instructions by provincial and local government have been issued to mines. Coal production at mines that do not comply will be stopped while improvements are carried out. Failure to undertake suitable remedial measures can lead to permanent closure. The instructions are sound but there is insufficient practical guidance for systematic implementation. There is a pressing need for education and training to ensure project and mine designers, and officials and management understand the current best practice and the fundamental principles of mine safety. Investment in safety equipment alone will be wasteful, and the results in terms of reduced accidents may be disappointing.

Both knowledge and respect for the law and regulations by mine owners and mine developers is weak as is indicated by the many reported instances of illegal mine construction and illegal mining. For example, in early 2005, the SAWS identified 17 illegal KSOCM construction projects and requested immediate cessation pending proper approval of construction and safety procedures. The operation of small mines without permits is rife, making safety administration problematic. Operational violation of regulations is also a major problem which led to 57 percent of accidents and 43 percent of fatalities in 2005 according to SACMS.

National safety regulations are not always fully complied with at local government levels suggesting that benefits may arise from a liberal interpretation of the rules. An example of local government overriding safety regulations is when the use of low concentration CMM engines for power generation is condoned. These engines are designed to utilize gas with less than 30 percent methane concentration and, at many sites, the drained gas is in the explosive range of 5-15 percent methane in air, which is neither permitted nor safe. The NDRC is reviewing this problem and weighing energy gains against safety issues but so far has not reached a decision.

To increase its effectiveness, SACMS needs to be able to confidently delegate responsibility for inspection and enforcement to provincial level. Enforcement of safety regulations must be strengthened. Suitable and qualified staff must be recruited and trained. All inspectors should be appointed by, and be held accountable to, provincial safety bureau. The inspectors should have the power to halt any potential dangerous mining activity and their employment conditions should be sufficiently attractive to deter corruption. Examples of how mines inspectors are recruited, trained and empowered in Australia, the USA and the UK are shown in Box 5.1. Lessons for China are the powers available to mines inspectors, long training periods and generous employment packages.

Box 5.1

Recruitment, rewards and roles of mines inspectors in some developed mining countries

Australia, New South Wales

Mine safety enforcement in NSW is undertaken by inspectors and safety officers of the NSW Department of Primary Industries (DPI), Mineral Resources Branch. These officers are given powers under legislation to enter any mine, at any time, for the purposes of inspecting the mine. They can prosecute mine owners and managers in the event of a breach. Prosecution is considered in all instances where a significant breach of legislation is discovered which cause, or are likely to cause, death, or serious injury or ill health; or- continue to occur after other representations or interventions by the Department; or- which interfere with the proper investigation of causes and circumstances surrounding an event. Inspectors tend to be proactive in educational awareness and advisory roles. The DPI frequently publishes Safety Alerts, often describing a serious incident that has occurred on a mine site either in NSW, or elsewhere in Australia. It also hosts safety seminars to address specific areas of concern.

USA

The Mine Safety and Health Administration (MSHA) is the federal agency under the Department of Labor in the USA charged with inspection of mining operations nationwide for adherence to regulations designed to protect the safety and health of working miners. It recruits staff through open advertising. Selected candidates participate in a formal two-year training program. They should be able to perform arduous duties and can expect a starting annual salary of about $43,000. In addition to a 40-hour working week with generous annual, sick and holiday leave, selected candidates are offered health, life and long-term care insurance; pensions, including a tax-deferred savings plan; travel reimbursement; and flexible spending accounts for medical and dental expenses.

UK

The role of the Mines Inspectors within the UK Government's Health and Safety Executive is to inspect mines (of all types of mineral including coal) and to advise managers and others not only on compliance with the law, but on what they consider to be good practice. They also investigate accidents and incidents in mines. Mines Inspectors have a wide range of legal powers that they can use to enforce compliance including, if necessary, though the judicial system. They have powers to immediately stop work where they perceive an imminent risk to health or safety, and powers to require improvements in other circumstances.

Mines Inspectors in the UK are only recruited after they have spent several years in a senior management position at a large mine. Inspectors are completely independent of the mines they inspect and their salary levels are similar to managers of large mines. Inspectors have a range of responses to breaches of the law ranging from verbal warnings to written warnings, cautions, enforcement notices or citations, withdrawal of permissions and, ultimately, prosecution. A mining inspector will visit a large coal mine about 20 times a year covering the whole range of activities at the mine. Electrical and mechanical engineering inspectors both make about 10 inspections each year at each large coalmine. Smaller mines and low hazard mines are inspected far less frequently. All inspection reports are entered onto a national database that inspectors can access and search at any time to ensure consistency and also to monitor trends.

Compensation for fatal accidents

Inadequate compensation for the death of a miner reduces the incentives for mine owners to improve safety standards. A significant step was taken by the Shanxi Provincial Government on 30 November 2005, when it increased the minimum amount of compensation to 200,000 yuan (US$25,000) per coal mine fatality, a move that in turn was adopted by other major coal producing provinces.

Compensation is not the only cost faced by a mine after a serious accident. In addition, there are other costs imposed on mine operators including legal costs, damage to reputation of the company and the individuals responsible, penalties imposed on responsible persons, loss of income while mining operations cease and damage to equipment and structures as a result of the accident. The costs of accidents are substantial. It is important to recognize this fact, as failure to do so will lead to wrong solutions being proposed.

The Shanxi Government decided that the new regulation was insufficient, but rather than increase the amount of compensation required, officials instead imposed an additional fine of one million yuan (US$130,000) per coal mine fatality payable to the local government itself (People's Daily, November 1, 2005). The incremental penalty was counterintuitive because it not only turned the widespread coal mine accidents into a lucrative source of revenue for the authorities who collected the fines, but also offered significant incentives for mine owners to reach private deals with miners' families to cover up fatalities so as to avoid fines, further distorting death tolls.

Fines are more effective if aimed at preventing accidents through a range of penalties for safety breaches. However, there should still be punishments for individuals responsible for accidents to reinforce the incentives for management to operate mines safely. The important benefits of prevention are fewer deaths, fewer compensation claims and less production time lost. The USA's coal mining industry has an excellent safety record and a major contributory factor is a robust inspection regime and strong punitive action for safety violations (Box 5.2).

Box 5.2

Severe financial penalties for violations of safety regulations are a better way to prevent accidents than large fines after the event

To encourage mines to strengthen accident prevention, the U.S. Department of Labor's Mine Safety and Health Administration (MSHA) has recently handed out maximum civil penalties against a mine operator amounting to a total of US$440,000 for failing to adequately support the roof and failing to follow the approved roof control plan. The hazards (hidden dangers) were identified during a routine inspection of the mine and cited as "flagrant violations" under the Mine Improvement and New Emergency Response (MINER) Act.

"Mine operators that show reckless disregard for the well-being of their workers must be held accountable for their actions," said Richard E. Stickler, assistant secretary of labor for mine safety and health. "It was highly likely that a miner would have been seriously injured if these conditions were allowed to persist, and the purpose of this enforcement action is to prevent accidents and injuries from occurring in the first place."

A flagrant violation is defined as "a reckless or repeated failure to make reasonable efforts to eliminate a known violation of a mandatory safety and health standard that substantially and proximately caused, or reasonably could have been expected to cause, death or serious bodily injury." Under the MINER Act, a civil penalty of up to $220,000 may be assessed for each flagrant violation.

Costs of coal mining accidents

In China the financial impact of an accident is largely viewed in terms of direct compensation and payments of fines. Substantial coal production can be lost, especially from small mines which may be halted for several months while improvements are made and inspected – although it is patently clear that many still continue mining during this stage. Coal mining enterprises, of all sizes, should analyze the true costs of accidents as this would underline the benefits of prevention (Box 5.3).

Box 5.3

Full costs of mining accidents

Mining companies in Australia do not publish direct costs of mining accidents but they can be deduced from industry information. Fortunately, fatalities are rare. The last multiple fatality occurring in 1996 when four miners died at Gretley colliery as a result of an inrush of water. Xstrata coal purchased the assets of Newcastle Wallsend Coal Company Pty Ltd which owned the Gretley coal mine. After a vigorous prosecution Xstrata was fined $1.46 million and four officials fined collectively A$102,000. Prosecutions in NSW have since increased and currently around 15 separate cases are in progress. As a result of the Gretley accident, a mine safety review was carried out which lasted six months and resulted in changes to legislation.

For a fatality at a mine, total costs could include (Galvin personal communication):

- Direct loss of revenue
    - Ranging from loss of one day minimum (union-directive for all mines) to one week's production (in the case of one company)
    - For a 5 Mtpa operation this is in the order of A$500,000
- Investigation costs, including legal advice, legal monitoring of interviews etc. 4 weeks x 2 persons x 12hrs/day x $400/hr = $192,000
- Coroners legal costs – $150,000
- Prosecution legal costs – $300 000 to $1.5 million, depending on how vigorously the matter is defended and appealed.
- Occupational Health and Safety fine –from $300,000 to $1,500 000
- Common law claim – $750,000 times number of dead or incapacitated – covered by insurance
- Compassionate payment to family – $50,000/family
- Ramp back to full production and morale after fatality – three months reduced coal output

Accidents may also result in:

- Damage to equipment and to structures
- Increased insurance premiums
- Damage to company reputation which could impact on future business dealings
- Additional compliance, especially as safety officials may take a closer look at the operations of the company and engage in closer monitoring after the event

It is estimated therefore that the total cost to an Australian coal mining company of a fatality is in the range A$3 to $10 million.

For a non fatal injury or accident a mining company may incur medical costs, equipment damage, loss of production and damage to reputation.

Application of technology

Increased mechanization is seen as an important measure for improving work safety, and reducing the number of miners underground and at risk, and various means are being employed by the Government to promote this. Mines that concentrate all their coal production on one face can be certified as high efficiency which raises the status of senior management, helps their career development and is thus effective. Further impetus to mechanize mines and hence reduce more hazardous manual mining operations comes from instructions from SAWS and NDRC limiting the number of longwalls in an underground mining area to no more than two and allowing no more than 100 men per shift to work in a particular underground mining area.

There is insufficient understanding of basic principles. For instance mine management should be more aware of the effect of barometric pressure on underground gas emissions. A methane explosion occurred at 11:15 p.m. Wednesday 5 December 2007 at Xinyao coal mine, a small coal mine in Hongtong County, Linfen City, killing 105 miners. The explosion occurred after a prolonged barometric pressure drop over more than 24 hours at a rate of 0.89mb/h reducing to 0.67mb/h (Figure 5.3). While such rates of barometric pressure fall are not high, the steady fall would have resulted in a period of elevated methane emissions from goaf areas that could have contributed to the accumulation of gas. Clearly, there was also a failure to control ignition sources. The possible role of barometric pressure change in affecting methane emission risks in coal mines should be examined more closely in China. The phenomenon is recognized in developed mining countries. For instance, the meteorological office in the UK issues pressure fall warnings to coal mines to allow precautionary action to be taken to control the emission hazard. It must be stressed that the latter is not the only causal factor and other causes of gas emission and accumulation also need to be controlled

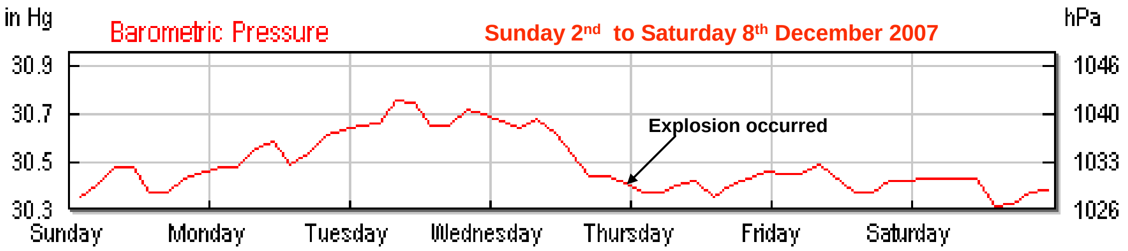

Figure 5.3 A major explosion occurring after a prolonged barometric pressure fall

The fundamental safety principles of gas control are dilution of gas to safe concentrations by ventilation, minimization of volumes of explosive gas and ensuring that potential ignition sources and gas accumulations are not juxtaposed. The latter principles are not applied rigorously in China's coal mines. This is particularly exemplified by the fact that gassy mines are allowed to capture and drain gas with a composition in the explosive range, and furthermore are effectively encouraged to continue this practice after installing low concentration CMM generators capable of utilizing the gas. Thus, explosive gas mixtures are allowed to accumulate underground, in pipe-work and pass through moving machinery. Safety protection measures reduce the explosion risk but any failure could be catastrophic. A safety regulation that only methane of 30 percent concentration or higher can be utilized is not enforced.

The equipment and technology is relatively backward in many mines with 83 percent of KSOCM mechanized, but mines of other types remain mostly reliant on less sophisticated manual mining methods. Some of the earliest large mines, for example Jixi, Fuxin, Fushun, Kailuan, and Jiaozuo were built during the 1950s with the assistance of the former Soviet Union and are still persevering with obsolete equipment, some of it unsafe by modern standards.

Scientific research on safety issues in China is insufficiently advanced and needs greater investment. Moreover, language barriers have limited exchanges of ideas with the international mine safety community. Specialist design institutes involved with safety and gas drainage are relatively few and tied too closely to safety equipment manufacture which stifles development. Some SOEs have received government grants to develop and implement new technology, but instead used the aid to subsidize sales. This is counterproductive as it hinders competition, discourages companies from investing in their own R&D and acts as a barrier against imported products.

The operators of large, gassy mines are responding to the requirements set by the Government to improve gas control, and more gas drainage systems are being installed. Of the 286 former key State-owned coal enterprises with gassy mines, 260 have started gas extraction and in the first 8 months of 2006 1.66 Bm^3 of gas was extracted and 352 Mm^3 used, 80 percent by domestic consumers and 20 percent for power generation. The utilization efficiency is low at 21 percent, but the data may be incomplete.

Standardized gas drainage designs tend to be imposed which are not always appropriate to the geology and mining conditions, although it is conceded that for a gassy mine to have at least installed a gas drainage system is a positive development. Individual coal mine operators have little scope to make technical changes and improvements. Any such changes generally have to be approved by referring to higher levels within the mining enterprise and, in some instances, to the provincial government. The fact that provincial vice-governors with safety responsibilities are now held accountable for serious mine accidents could further inhibit innovation due to the extension of the decision making hierarchy and risk aversion on the part of these officials. Initiative may be stifled, but the risk of a bad decision is reduced. The net result will be slower progress.

Gas monitoring systems are being widely installed but reliability is sometimes questionable due to poor quality of equipment, and lack of calibration and maintenance facilities. Suitable, reliable, advanced monitoring systems are readily available on the international market but protracted electrical safety approvals procedures are delaying their introduction. The lack of compatibility between Chinese and current international mining equipment standards also precludes Chinese manufacturers from access to world markets for the export of equipment – desirable as a driver for improvement in product performance and quality which will ultimately benefit the Chinese miner.

Investment in safety improvements

A safety equipment survey of KSOCM conducted in 13 provinces by MOF, NDRC and SAWS in 2003 identified a 50 billion yuan (US$6.4 billion) deficiency in spending. The precise details of the inspection methodology have not been published. As this requirement represents a cumulative problem over a number of years, the annual cost per tonne that should be spent on safety equipment is not easily determined. The real problem would appear to be lack of replacement capital. While mining enterprise accounts carry depreciation provisions there is no attempt to offset this with a replacement capital fund.

China’s coal mines expected to pay a total safety fee of 24 billion yuan in 2006 and by October 2006 20 billion yuan had been paid and 18 billion yuan invested on mine safety projects. In 2006, NDRC also directed companies to undertake 536 coal mine safety improvement projects at a total investment of 13.5 billion yuan. This comprised 2.5 billion yuan national debt, 0.7 billion yuan from local government and 10.3 billion yuan from the mining companies.

Improving safety in TVCM

Any policy must address local government dependencies on mining for revenue, their capacities to implement national closure policies, the need for extra or alternative employment for poor farmers and the energy requirements of local economies.

Socio-economic policy should view small coal mines as much a part of the rural economy as of the energy economy. It would also start from the premise that poor farmers require support in sustaining the agricultural component of the local economies.

Any safety policy must include basic miner training for the rural farmers working in the industry, before they enter their first mine. This would have to be funded by the local authority through an existing revenue stream. Teams of skilled trainers and a training package specifically adapted to small mine conditions would be required.

Safety inspection is critical in small mines, but the concept of worker safety representatives may not be readily accepted by owners or local authorities. A first stage is to raise the frequency and standard of official safety inspections and to ensure that workers are free to exercise the right to withdraw from hazardous workplaces. Training for workers in risk awareness and appraisal would be an essential component of this strategy. This would add a worker based approach to safety organization in small mines.

Owners would be encouraged to adhere to safety regulations through the imposition of higher penalties and an increased chance of being caught and prosecuted.

Secure tenure over the mining property would also provide the incentive to invest in modernizing the operation and upgrading safety equipment. The lack of legal protection for private investment is a primary factor behind the failure to impose safe working standards on TVCM. While private ownership of TVCM has increased, no legal framework was established to protect rights and investment. Governments can close small mines on grounds of scale as well as for failure to comply with regulations and procedures. Without any long term legal guarantees of ownership rights, private mine owners are generally unwilling to invest in the necessary safety requirements, resulting in unsafe working conditions for the miners. This is evidenced by the much higher fatality rates in the TVCM (Tu Jianjun, Jamestown Foundation. China Brief, Volume 7, Issue 1, 25 Oct 2006). This factor may also explain the unreliable coal mine fatality statistics as some owners of small mines falsify death counts in order to avoid mine closures or fines that may compromise their security of tenure.

Small mines can be operated safely if supported by a suitable regime as has been demonstrated in the USA by MSHA. Since the creation of its Small Mines Office in 2003, small mining operations (employing five or less miners) experienced a 66 percent decrease in fatality incidences, bringing them into line with the large mines, within five years. The Small Mines Office combines robust enforcement and assistance to small mine operators in developing safety and health programs tailored to their specific operations (Walter L, 2008). SACMS should examine this process.

Further changes are needed

While great efforts are being made by the Central Government to improve mine safety there is a need to change attitudes among management and workforce before significant reductions in accidents will be achieved (Appendix 3).

In the 11th Five Year Plan, the Government intends to reduce the rate of coal mine fatalities by a modest 5.5 percent per year, reaching 2.1 (some reports state 2.2) per Mt of coal mined in 2010. This target has already been reached and is therefore not sufficiently challenging, especially in the light of the positive achievements in Shanxi of a reduction to 0.8 fatalities per Mt in 2006.

The Government has adopted some of the safety management measures applied in developed coal mining countries, such as training and management qualification requirements, and there are other changes that it could make to further increase the effectiveness of the safety administration (Box 5.4 and 5.5). These include appointing a safety administration whose only activity is improving work safety, establishing a regime aimed at prevention by implementing risk assessment procedures, replacing prescriptive regulations with performance-based regulations and more detailed accident reporting and analysis.

Box 5.4

The effective management of health and safety in deep coal mines in the UK

The underground coal mining industry in Great Britain is among the safest in the world and fatal accidents are a rarity. This situation was established even before the recent decline of the industry. All industrial safety matters are the responsibility of the Health and Safety Commission (HSC) and its operational arm, the Health and Safety Executive (HSE) which advises on, promotes and enforces health and safety legislation on behalf of the Government. The HSC is a representative body including members from employers, trades unions, consumers and local government. It has a number of advisory committees, including one for deep mined coal, whose main purpose is to advise the HSC on the adequacy and practicability of its proposals. Unlike SAWS and SACMS this organization is wholly focused on safety with no industrial operational management responsibilities.

In recent years development of safety legislation has moved from being disaster-driven, as in China, to an approach that requires employers and managers to identify hazards, assess risks and to take steps to avoid or control them. That is, to prevent accidents and incidents rather than react to them. China's coal industry is starting to move in the direction of risk management, but implementation will be limited until mines carry all the costs of accidents, and safety regulations are enforced.

Health and safety management legislation

Current British health and safety legislation places duties on employers to ensure that they have in place safe systems of work. Modern legislation does not prescribe what should be *done* but what should be *achieved* (a performance based approach). For example, the Management and Administration of Safety and Health at Mines (MASHAM) regulations require mine owners to ensure that their mines are worked in accordance with the provisions of health and safety law. Not only do owners have to comply with their legal duties, but also they have to have design and implement procedures to ensure that people who work in their mines comply with the legal duties placed on them. Mine owners therefore have a legal incentive to ensure the safety and health of people that work in their mines. The mine owner has to appoint a sole manager who is suitably qualified and competent in safety matters before a mine can be worked.

Coal mine managers have to be certified and must have had several years of practical experience in coal production, and several years as a supervisor. They also need to hold a recognized mining academic qualification and to have passed an examination in health and safety law. This is now also a mandatory requirement in China.

Senior members of the management team are responsible for ensuring that supervisors are properly implementing risk control measures and the supervisors responsible for mining operations are also responsible for the health and safety of their charges. The legal responsibilities of workers focus on complying with specific parts of the law and with any health and safety rules or instructions, and reporting danger. They also have legal duties to co-operate with employers on health and safety, and an overriding duty is not to put themselves or others at risk through their acts or omissions.

In summary, the law requires that:

- mine owners should have a clear health and safety policy
- there should be a mine management structure that contains a sufficient number of competent and suitably qualified people who are capable of implementing that

policy and ensuring that health and safety law is complied with
- there should be clear procedures and methods of safe working
- the policy, management structure and procedures should be monitored to check that they are working effectively
- workers have legal responsibilities to comply with health and safety policies
- safety management systems should be audited and reviewed, periodically or when a significant change occurs.

Coal mining companies have realized that the investment in reducing accident and health related losses can bring a higher return than the investment of a similar amount in increasing production and sales.

Box 5.5

Safety performance of the Australian Mining and Minerals Industry

Mine safety is a concern in all coal mining countries. Safety becomes increasingly acute when there is pressure on mines to maintain high output levels. This has been a particular problem in China. In December 2006, Australian union leaders drew attention to an apparent decline in safety standards after the sector's third death in Queensland in less than six months. There were only two deaths in the state in the previous financial year.

Union leaders stated that miners were forced to work long hours in sometimes unsafe conditions by management to exploit the worldwide resources boom. At the same time government statistics showed an increase in potentially fatal near-misses, a rise in the severity of accidents in underground coal mines and a large increase in the number of disabling injuries. The Queensland Mines and Quarries Safety Performance and Health Report for 2005-2006 showed 839 near-misses reported in the period, an increase of 124 from the previous year and the highest number since records began. The number of disabling injuries rose from 384 to 515. Medical treatments rose from 492 to 758.

The significant difference between the situation as described in Australia with that in China is the seriousness with which single fatality accidents are treated and the importance given to monitoring non-fatal accidents in the former.

Accident reporting

The Minerals Council of Australia (MCA) reports safety trends across the whole of the minerals and mining industry in terms of the fatal injury frequency rate (FIFR = fatalities per million hours worked) and lost time injuries (LTIs). This rate has varied widely from year to year around an average of 0.07. In 2004/5 the underground coal sector recorded zero fatalities. Within the coal sector, underground coal experienced the most LTIs (381) followed by open-cut coal (194) and brown coal (5).

Mine safety legislation

Australian OH&S legislation is founded on the recommendations of the Robens Inquiry into workplace safety in the UK in the early 1970s and on ILO Convention 155. A core principle is that individuals should be held accountable, within the bounds of what is reasonably practicable, for OH&S in areas of work that they control. There is considerable variation between Australian states in the manner in which OH&S legislation is framed and administered. The obligation by an employer to provide a safe workplace is a reasonable principle, but the legal severity with which it is applied in NSW places a heavy burden on management and China should not proceed to this extreme.

Australia's mine safety achievement

In the last 2 decades there has been over a 90 percent reduction in lost time injuries and fatalities in the Australian minerals industry to levels that now rival many other industries. The Australian coal sector represents international best practice, with a fatality rate of 0.5

in 2004, one third that of the United States and one quarter that of South Africa. These results have been achieved primarily by adopting a risk management approach for establishing a safe workplace environment and China should examine this principle closely.

Wang Xianzheng, director of the State Administration of Work Safety acknowledges that China lags far behind the developed countries in mine safety (China Labor Bulletin, *Safety Standards in Chinese Mines – What are the International Standards?* 2004). Li Yizhong, Minister of the State Administration of Work Safety (SAWS), said that lax laws, rules and regulations and ineffective enforcement had contributed to the serious work safety situation that has plagued the country for many years (Fu Jing, Improvement Promised on Work Safety, China Daily, June 19 2006, p.2). Maximum punishments of a seven year prison sentence and company fines of up to 200,000 yuan (US$ 27,000) were inadequate. By comparison, in the U.S.A executives could face life-time imprisonment and in Australia executives could be barred from the mining business. Higher fines also applied elsewhere.

Historically, other developing economies have experienced an “accident-prone period.” For instance, the UK and the USA each experienced such a period for 70 years (1880-1950) and 60 years (1900-1960) respectively, when their GDP per capita reached US$1,000 to US$3,000; and Japan experienced that period for 26 years (1948-1974) when its GDP per capita reached US$1,000 to US$6,000. However, China has the advantage that it can learn from the extensive and accessible previous experience of the developed mining countries and should be able to move quickly beyond this stage (Li Yizhong 2006).

China’s main response to the serious industrial safety and health situation has been largely administrative and “top down”. Efforts have been directed towards stricter supervision and enforcement and tackling corruption by attempting to sever local government investment links with privately owned coal mines. SAWS recognizes that safety training of coal industry employees, especially at management levels, is essential and several programs have been established with international partners to achieve this, in addition to training carried out in the nation’s own institutes and universities (Feickert 2007).

The Government of China emphasizes the importance of technology in improving mine safety. Technical improvements certainly help but are insufficient by themselves. Without proper training and use they can be ineffective or even introduce new hazards in the absence of proper controls, as mechanized mining did at first in Europe. Incidences of lung disease climbed as machine cutting speeds and dust levels rose prior to the development of dust suppression technology.

Pringle and Frost (2003) identified the barriers that Chinese workers faced in general in all industries to securing their safety. These included the decline in government authority, the responsibility for health and safety resting with numerous and diverse local authorities, the lack of investment in safety systems, the inadequacy of the inspectorate and the failure of the All China Federation of Trade Unions to organize workers around safety, the complexity of administrative changes resulting from government restructuring and the influx of an impoverished and untrained migrant workforce into many sectors, including coal mining. Pringle and Frost took the view that imposing a “top-down” structure of rules and regulations was unlikely to succeed and a “bottom-up” approach was necessary.

The role of trade unions in improving industrial health and safety

Various studies have shown that trade unions provide a positive force in improving safe working. A study of coal mining in the USA in the early part of the twentieth century showed that unionism lowered accidents by around 40 percent and was most effective at mine level, possibly through miners refusing to work in unsafe workplaces (Boal 2003).

In a study of British manufacturing it was shown that those companies which had trade union health and safety committees experienced half the injury rate of those which managed safety without unions or under joint arrangements (Reilly et al 1995). Another study, analyzing the same figures, reached the conclusion that arrangements where management deals with health and safety without consultation with the workforce resulted in higher injury rates.

Debate on the union role in coal mines has surfaced again in the USA after the Sago, West Virginia and Darby No 1, Kentucky mine disasters. Neither of these two mines was union-organized. Of the 33 miners killed in US mines in the first five months of 2006 only three worked in union mines (Feickert 2007). It is arguably not the presence of trade unions that leads to safer working, but the confidence imbued in the workers to take a more active role in determining working conditions.

In China, the role of unions in health and safety has recently been the subject of discussion and decision at the National People's Congress, where the Prime Minister called on trade unions at all levels to bring their role into full play "especially in work safety supervision" to better safeguard workers' interests (People's Daily Online, *Premier Stresses Role of Trade Unions in Work Safety Supervision*, 14 March 2006)

Trade Union Occupational Health and Safety Inspectors, under Article 5.8 of the Regulations, are entitled to recommend that management take urgent measures and evacuate workers in the event of immediate danger. If management does not take the necessary action, they can organize workers to take the necessary measures to avoid risk and to submit reports immediately.

Moreover, in 2006, the State Administration of Coal Mine Safety and the All-China Federation of Trade Unions announced that they would join forces in a campaign to improve migrant workers' health and safety. The aim is to ensure suitable training is provided and that the legal right of workers to refuse hazardous work without fear of dismissal or intimidation is enforced. Official statistics show that 75 percent of those killed in 2005 in coal mines and on construction sites were migrant workers.

Worker safety inspectors

The current "top-down" approach to improving health and safety in coal mines is not proving effective due to institutional and cultural complexities. The people most affected, and those most able to act effectively to prevent accidents, are the miners themselves. A safer industry can be achieved by developing a European-style risk assessment and social partnership approach similar to that of the British, Australian and New Zealand coal industries, the core of which involves the safety triangle of mine manager, government inspector and worker inspector. This approach requires strong leadership from government, industry and employers. The Government of China has taken the first step towards increasing the role of workers in accident prevention with the decision in May 2005 to appoint 100,000 worker safety supervisors or inspectors. These worker safety inspectors must be suitably trained and empowered to carry out inspections on behalf of fellow workers and represent them to management. The most effective systems in other countries are those where the workforce themselves appoint their own worker safety inspector (Feickert 2007). Further details are provided in Appendix 4.

The role and rights of safety representatives, both worker and union, are enshrined in European law and also in health and safety regulations in other countries (Feickert August 2006). For instance, in Australia the union safety official covering several mines in an area has the power to suspend operations in the event of operator non-compliance with the law which is endangering workers. In New Zealand, worker safety representatives can issue a hazard notice and advise workers to refuse dangerous work when faced with imminent danger. Safety representatives are protected.

Many of the new Chinese worker inspectors have been appointed to local mines and their wages are paid by the state, to maintain their independence from the owners. In the KSOCM, the safety structure already includes worker and union involvement, although this could be substantially improved if the safety triangle system based on worker inspectors, managers and government inspectors (Feickert 2007) were to be adopted.

In summary, the Government has introduced many initiatives in China over the last few years in its drive to improve mine safety. The effectiveness of these, the scope for further enhancement and any undesirable side-effects are reviewed in Table 5.7. Most of the improvement has been in the small mines where the largest change was needed. In comparison, despite considerable expenditure and effort, improvement in KSOCM has not been so significant over the last five years. The principle reason for this is the absence of a mechanism which involves workers in hazard identification and safety inspection. However, much groundwork has been done to provide a basis for achieving further improvement.

Table 5.7 Factors contributing to China's improvements in coal mine safety and opportunities for further improvement

Factor	Comment
Safety training for miners	A massive effort has been made to recruit and train the trainers by government and educational institutions. All miners are required to attend induction and refresher training and lose pay if they do not complete the courses. This is a positive step but the quality of training should be monitored and courses refined to incorporate modern learning aids. The traditional Chinese method of teaching by rote is not effective and more interactive methods should be introduced.
Increased safety awareness through training and certification of mine managers and officials	Effective training programs will be well designed, well presented and interactive. A combination of continuous assessment during the course and examination will ensure fair appraisals and prevent collusion to short-cut the procedures. The certification process involves overlapping functions of two different government departments which needs to be resolved and simplified
More stringent safety inspections	Inspections seem to be concentrating less on checking paper work and more on examining operations which is a positive move. However, safety bureau inspectors do not have sufficient power to halt mining activity without consultation with their seniors, although they can impose punitive fines
Regular safety events and competitions organized at mines by SAWS	Mainly aimed at KSOCM. Safety competitions, first aid, rescue and quiz shows raise safety awareness among miners and mine officials. Team spirit is engendered and knowledge is learned through fun. Success is difficult to measure but most mining countries and large international mining companies engage in this type of activity

Factor	Comment
Proportion of pay linked to safety performance of officials in KSOCM	This provides a strong incentive to officials to place safety first. However, the system is reduced in effectiveness if miners can earn production bonuses. Production incentives can help to improve efficiency, but require a strong safety regime.
Senior line management and government officials with mining responsibility are held accountable for serious fatal accidents and can be punished with dismissal	Accountability from the top down ensures a positive approach to accident prevention. However, in top heavy KSOCM management hierarchies this could slow innovation as SOE culture is to minimize career risk by avoiding decisions which change the status quo. Accountability extends to the vice Governor with mining responsibility who must also be convinced of the wisdom of making any innovative change.
Raising minimum scale of production to facilitate introduction of mechanized longwall mining in all coal mines	Prescribing the minimum size of mine reduces the total number of mines which makes regular safety inspection more feasible. The mine should also have sufficient scale to practice longwall mining, subject to geological provisions. The downside is that a capacity criterion is arbitrary and does not recognize that economic factors differ in each place
Installation of safety monitoring systems with financial assistance from government	Throughout the country 12,287 mines have installed gas monitoring and control systems. These consist of 556 KSOCM (76% of the total), 1157 SOCM (83%) and 10574 TVCM (75%). However, much of the gas monitoring equipment is inaccurate and unreliable. Imported equipment is considered too expensive by mines. To have installed a system is a first positive step, but equipment standards need setting and enforcing to achieve effective safety protection.
Installation of gas drainage systems in gassy mines with financial assistance from government	93.5% of the gassy KSOCM (272 out of 291) are practicing gas drainage, extracting 1159 Mm3 and using 348 Mm3 of methane each year (CCN 11 June 2007). Many of the gas drainage systems are operating at low efficiency and extracting gas in the explosive range which is dangerous and bad practice. The positive initiative of installing gas drainage now needs to be followed up by a drive to raise standards which will result in a significant improvement in safety
Minimum of 200,000 yuan compensation payable by mine owner to families of fatal accident victims	A deterrent for mine owners, but not sufficiently strong to be effective in preventing dangerous mining operations. Where local small mine owners flee after an accident, local government is left to pay the compensation, a subsidy to illegal mining. Mine owners should be required to lodge a bond with government to cover such eventualities
Regulations limiting numbers of miners per shift to encourage mechanization and deter over-production from TVCM (Introduced by Provincial Government and SAWS in Shanxi in November 2006)	Some local and consolidated small mines using semi mechanized longwall mining methods have been unable to produce to their approved capacity. However, new, consolidated and transformed local mines are starting to install mechanized longwalls. This is creating unemployment problems in some local communities and hence resistance to compliance

Factor	Comment
Awards to mine management for increased efficiency by achieving planned coal production from fewer longwalls	Prestige and peer recognition of achievement is important to directors of KSOCM. The impact on safety at KSOCM is by reducing numbers of miners at risk, but it also engenders competition between mines and therefore promotes increased efficiency.
Placing responsibility on large mines in key coalfield areas for the acquisition, transformation and consolidation of small mines	A relatively new process so the effectiveness cannot be judged but it should help reinforce the higher safety standards of the KSOCM in the smaller mines. However, a side effect will be that it provides KSOCM with a lever to reduce competition with local mines. Thus, economic efficiency might suffer but not safety, so it is not an optimum solution for sustainable development.
Overseas study tours to visit coal mines and mine safety institutions and agencies	Raises awareness and creates opportunities to develop long term information exchange ties. However, language difficulties will limit the benefits
Bilateral safety training programs implemented in China (e.g., US Dept of Labor, New Zealand Trade Unions)	These provide training for trainers to ensure a multiplier effect in the dissemination of new ideas and examples of successful experience from overseas. Workplace risk assessment and the concept of worker safety representatives have been introduced. Both of these approaches have proved effective elsewhere but no major uptake among the KSOCM is yet apparent. It will be some time before the culture of management in verticals can be overcome.
Aid agency and development bank mine safety-related projects (ADB, UNDP)	Until recently, safety related projects did not fit easily into aid program categories. Current activity is mainly aimed at improving safety in small mines and dealing with poverty issues arising from closures.
Closure of illegal and hazardous small coal mines	Due to low levels of investment, poor technical abilities of owners and operators and the incentive to maximize production due to strong prices, these mines contributed significantly to high fatality rates so closures result in real improvements in safety
Severe penalties for corruption	The Government is committed to combating corrupt practices and awards severe penalties. Local government officials have been instructed to withdraw from any mining interests to remove the incentive to collude in allowing illegal mining operations to continue. Obstructing safety procedures is also looked on severely. For example, the former chief of the technology and equipment department of the Shanxi Provincial Coal Mine Safety Supervision Administration, was sentenced to 13 years in prison for taking bribes totaling more than one million yuan (about US$126,000) between 2001 and 2004 in exchange for assistance in passing safety examinations and assessments (Xinhua, 12 Nov 2006).
Appointment of worker safety inspectors and introduction of risk assessment procedures	China has made a first attempt at involving workers in accident prevention. Empowering workers to be involved in determining the safety of their methods of working is the “missing link” which differentiates safety management in China’s coal mines with those in the industrialized countries. Future effort must be concentrated in this area.

5.2 Health of mineworkers

China's workers in all industries reported a total of 12,212 cases of occupational illness in 2005, according to a report jointly published by the Ministry of Health, the State Administration of Work Safety and the All China Federation of Trade Unions in April 2006. No comparable figures for the preceding year were given. Pneumoconiosis (including silicosis) was the most common occupational illness reported and accounted for 9,173 cases or 75 percent of all cases. The coal industry was the source of most of the new cases, a total of 4,477 cases or 49 percent (China Labor Bulletin 30 June 2006, Ministry of Health 24 April 2006).

The overall cost of occupational illnesses and work-related injuries in China has been estimated at 100 billion yuan (US$12.5 billion) in direct losses every year (China Labor Bulletin, July 21 2006).

Health issues receive less attention than safety in coal mines, although substantially more workers are affected by chronic disease than are killed in accidents. Occupational diseases caused by high levels of mining dust and other toxic substances, unhealthy working conditions are seriously threatening the health and lives of workers in China's mining industry. The situation is exacerbated by inadequate protective equipment and lack of proper training in safety awareness and procedures. The health impact in poorly ventilated, backward, labor intensive small mines is likely to be much greater than in the large mines which are managed to higher standards.

The most serious occupational health problem in the coal mining industry arises from exposure of the underground workforce to excessive concentrations of respirable dust. Dust exposure can cause pneumoconiosis, a disease that accounts for 73 percent of health ailments reported in the industry. Some 300,000 coal miners at KSOCM are suffering from various stages of lung disease and there were 12,000 new cases in KSOCM in 2005 (some reports state 5,000 new cases of pneumoconiosis are reported annually). Around 60,000 new cases occur annually in SOCM and TCVM. In reality, the incidence could be much higher as data on itinerant worker health is scant.

According to a recent report by SAWS chronic lung diseases kill between 6,000 and 8,000 workers annually (presumably mostly coal workers given the higher exposure). By 2005 more than 600,000 cases had been reported and of these more than 140,000 have died, a death rate of over 20 percent. Only 50 percent of miners take health checks. The many rural migrant workers working in the industry, especially in the small mines, are ignorant of health care and fail to seek and get treatment if affected. They are unlikely to be able to claim compensation as few have employment contracts. A worrying feature is that an official release by SAWS in April 2007 on such a major topic of concern quotes only 2005 data. There is an urgent need for more detailed and up-to-date statistics to raise the profile of this major health issue.

Due to confusing and incomplete statistics, the cost of treating and compensating miners who have developed pneumoconiosis is not known precisely. The Chinese Centre for Disease Control and Prevention estimates the direct cost to be around 8 billion yuan per year, with indirect economic losses of between 40 to 50 billion yuan. Assuming that the coal mining industry is responsible for about half of the pneumoconiosis cases, the annual direct costs of treating and compensating workers who have developed pneumoconiosis from working in Chinese coal mines is likely to be around 4 billion yuan, with indirect economic losses of between 20 and 25 billion yuan. Another estimate, based on 0.3 million cases in KSOCM and a treatment cost of 30,000 yuan per patient, suggests a direct cost of 9 billion yuan attributable to KSOCM alone (Prof Zhou, CUMT)

These are very significant costs, which could be as high as 9.5 yuan/t of coal mined, for a disease which has largely been eradicated in the coal industries of the developed countries. In addition, the health problem could be much more severe than this as it is quite possible that there is an additional underlying problem relating to other lung diseases such as chronic bronchitis and emphysema not yet quantified.

Although the information available regarding lung diseases in the Chinese coal mines is imperfect because the statistics for pneumoconiosis, silicosis and other lung diseases appear to be aggregated and incomplete, there is little doubt that a significant and growing problem remains to be solved. If not, it will lead to a serious legacy of ill health, premature deaths and possible claims for significant individual compensation payments. The effect of introducing any changes to improve dust protection and prevention in China's coal mines will not be seen for some time and the costs of dealing with the disease will continue to rise in the meantime.

Occupational disease prevention

Occupational disease prevention does not receive the same level of attention as accident prevention in coal mines, although it affects a larger number of workers. Respirable dust prevention in coal mines is weak with many mines exceeding dust control standards on coalfaces with lax enforcement. Some mines do not undertake any dust prevention supervision measures and many KSOCM mined areas do not have an occupational disease prevention institute. Very few coal mines below the regional and city administrative level have any professional guidance on occupational disease prevention.

Laws and regulations exist which define legal liability and specify requirements for prevention, protection, supervision, inspection and treatment but they are neither implemented nor enforced, other than superficially. Some attempt is made in KSOCM, but most TVCM are probably totally ignorant of both the effects of dust on workers health and protection measures that can be taken.

The cost of prevention is likely to be much lower than the treatment of the impact of dust. Preventative measures would involve investment in dust suppression technology such as extraction drums on longwall face machines, use of effective conical sprays behind every cutting pick on coalface and heading machines (pick-back flushing should be adopted as opposed to the current pick-face flushing to additionally provide frictional ignition protection), use of dust suppression sprays on conveyors, and provision of personal dust protection equipment for miners. These measures would need support from reliable dust monitoring, enforcement of dust exposure standards, training for workers in self-protection, dust minimization, and use of dust control technology. Regular health screening would ensure that the first signs of disease are recognized and immediately treated.

The cost of such measures and precautions could amount to less than 5 yuan/t. This is around one half of the direct and indirect cost of lung disease caused by coal mining of 9.5 yuan per tonne. However, the adoption of these measures would still result in a cost increase to the coal mining industry as, at present, the Government is absorbing most of the medical and disease compensation costs.

A National Coal Health and Safety Fund has been established. The proceeds of the fund will be used to develop medical services to treat dust induced pulmonary disease. Several institutes and Hospitals have been designated to treat dust induced pulmonary disease. But further efforts are required to tackling of a massive problem.

There is insufficient investment in occupational disease prevention in China and therefore protection measures are not being implemented. A major reason why investment is insufficient is that mining companies are not bearing the full costs of occupational diseases. Developed mining countries take dust prevention in coal mines very seriously, not only to protect the workers or because of stringent enforcement by independent inspectors, but also to reduce their liabilities to potentially massive legal claims from affected workers. The latter is an effective incentive for companies to take due care in protecting their workers. A problem in China, which would also lead to inadequate investment in occupational disease prevention in China, may be that it is more difficult for workers to obtain compensation through the courts.

5.3 Labor and social security

A sustainable coal mining sector must be able to recruit, train and retain staff with a wide range of skills and expertise. In addition, government should ensure that they are adequately protected by insurance to ensure that no additional burden is created for society or government that should be borne by mining operations. The communities which develop around mines and become reliant on their economies must also be protected by government when the mined resources become exhausted and then communities helped to adjust to the reduced economic opportunities.

Remuneration of employees of key state-owned coal mines

An overall improvement in the coal mining business in recent years has been accompanied by large increases in average wages. By the end of 2005 there were 2662417 fully employed staff and workers in KSOCM nationwide. In 2005, the average wage of the fully employed staff and workers was 1,816 yuan per month, an increase of 476 yuan per month over the previous year, a substantial increase of 35.5 percent (Table 5.8). Moreover, average wages almost trebled over the period 2000 to 2005; a very large increase in real wages. In addition, miners in KSOCM now have pension, injury and health insurance schemes to which the employer contributes. Employment conditions have therefore improved considerably.

Table 5.8 Average monthly salary in Key State-owned Coal Mines

Year	Employee's average salary (yuan/month)
2005	1816
2004	1340
2003	1122
2002	953
2001	812
2000	683

Source: China Coal Industry Yearbook, Coal Information

Comparative coal mining enterprise salaries

But the salaries are still too low to attract the increasing number of skilled staff and management that are required in moder mining operations to compete with other modernizing industries. The higher the average skills required by an industry, the higher will be the wages rates. Only salaries in the machinery manufacturing sector were lower than coal miners, reflecting a higher preponderance of low skilled workers, and then only by 8 percent. Recent statistics show that average mine worker salaries have still not reached 2004 levels in the power sector (Table 5.9). However, comparisons of averages offer little insight and it is likely that the low average is due to the large number of low paid itinerant workers in the coal mines.

Table 5.9 Monthly salaries in China's coal and power sectors

Applicable dates	Sector	Monthly pay (yuan)
2004	Power	3,300 (US$429)
2004	Coal	1,340 (US$174)
August 2005	KSOCM	1,595 (US$207)
Jan-Sept 2006	KSOCM	1,959 (US$254)

Source: China Coal Industry Yearbook, Coal Information

According to data from the World Coal Industry Development Report, in the early 1980s, the salary of U.S. coal mine workers was 26 percent higher than the workers in the manufacturing sector and by the mid 1990s salaries of coal mine workers were among the highest in industry. The US coal industry is very different to the coal Chinese industry. It is a very capital intensive industry and productivity per worker (measured as GDP per worker) in the coal industry is very high. Similarly, the income of coal miners in Australia are far in excess of workers in other industries. The average weekly earnings for Australian full time workers in 2005 were US$910 and that of a mineworker was US$1,582 (Australian Bureau of Statistics). Therefore, a worker in the coal mining sector earned, on average, 74 percent higher wages than workers in other sectors. With the current skills shortage in the mining sector, this discrepancy is likely to be even higher.

A shortage of both mining graduates and experienced coal mining engineers has elevated salaries in Australia and a similar phenomenon is occurring within the leading coal mining enterprises in China, but probably not of sufficient scale to significantly increase average salaries across the sector. China's coal mines will need to raise miner's salaries substantially to attract and keep a skilled workforce capable of improving safety, technical and efficiency standards and to facilitate industry wide mechanization.

Insurance protection for workers

China's Safety Production Law prescribes that production and business operation entities must cover the employment injury insurances according to law, and pay insurance premiums for their employees. Employment contracts should include stipulations regarding labor safety guarantees, the avoidance of vocational injuries and the provision of employment injury insurance. Labor contracts are at a transition stage and some mines have yet to sign contracts with their employees establishing their rights to health and injury insurance and initiating the keeping of health records.

There is no insurance or social protection for itinerant workers. This, combined with the poor underground conditions in which many work, is leading to a serious and growing social problem of how to treat the large numbers likely to be affected by pneumoconiosis and other dust-related disease. Of those relatively few migrant workers that have signed employment contracts with KSOCM, most leave and return to their homes before the serious effects of the disease are manifested.

Accident insurance: Shanxi provincial coal industry bureau initiated a unified accident insurance scheme in August 2004 in which all the 11 large coal mining enterprises in the province participate. Accident insurance premiums in 2007 were 120 yuan per person each year for KSOCM and 300 yuan per person in other mines to reflect the higher risk. The rates are set by government.

The accident insurance premiums in Australian coal mines are proportionally much higher relative to salaries (7 percent) compared with those in China's KSOCM (0.4 percent) and compensation is mainly for minor accidents rather than fatalities. Insurance costs are likely to rise in China as the rights of miners become strengthened. An example of the insurance and health protection afforded to mineworkers in Australia is shown in Box 5.6. An important difference in Australia is that premiums are related to the claims history of the mining company, thus providing a financial incentive to reduce frequency and severity of accidents.

Box 5.6.

Insurance protection for mineworkers in Australia

The NSW coal industry provides financial support to Coal Services Pty Limited for workers' compensation insurance, occupational health services and mines rescue services. There were around 1,900 new workers' compensation claims in the NSW coal industry in 2004/5, a reduction of 10 percent on the previous year. A total of A$69 million was paid to injured workers in that year. The majority of claims (50 percent) related to back, head/neck and shoulder/arm injuries. Of these 61 percent were caused from strains and sprains and 29 percent of the claims were attributed to "slips and falls".

It is mandatory for a coal mining company to use this insurance scheme and each pays a premium, based largely on the company's claim history. The rate is a percentage of the salaries of the workforce. In 2005 - 2006, this figure was 7.3 percent of a company's payroll. The cost to a mining company of insuring one of its workers is quoted at A$6,637 per employee.

Coal Services Pty Ltd also provides pre-employment medical checks, routine health assessments, drug and alcohol screenings and lung function testing.

Endowment insurance pensions: Mining companies are now using insurance companies to meet miner's pension obligations. In the past, enterprises had made inadequate internal arrangements for funding pensions causing difficulties to company and retirees. Insurance risk assessment is not fully matured and premiums may not reflect life expectancy among miners due to the harsh working environment and high probability of occupational disease.

Minimum income guarantee: To ensure social and political stability during reform of the KSOCM, re-deployment and minimum income schemes were introduced. In 2001, 55 KSOCM raised funds of 752 million yuan for nearly 0.3 million laid-off workers who were registered in "re-employment centers." At the same time, employees and employee's relatives with special difficulties were guaranteed a minimum income. By June 2002, the registered number of employees using the "lowest guarantee" policy was 0.41 million, and total funds of 88.98 million yuan were in place.

This level of social security did not extend to small mines and no similar level of protection is available to workers and families affected by the current large number of small mine closures.

Unemployment insurance: Large coal mining enterprises pay an unemployment insurance premium based on 2 percent of the total salary and an individual employee pays 1 percent of the total. Unemployed workers who terminate their work contracts and sign an agreement with the "re-employment centre" receive 1/3 of living expenses and social insurance, but seemingly little chance of a new job. However, the enterprises also have to provide living subsidies or assistance money to those laid-off workers who have not signed the agreement.

Policy on coal mine closure and bankruptcy

In 2000, detailed provisions were made for bankrupting of poorly performing and exhausted KSOCM previously kept open for social reasons. This attempt to remove the tail-end of loss-making coal mines was an important reform step which has established principles and policy that can be applied to future exhausted mines. However, the implementation process was to some extent flawed.

In 1999, 593 mines operated by 94 KSOCM were investigated by the Government and 257 shafts were found to be either exhausted, mining polluting high ash and high sulfur coal or unlikely to be profitable. The total production capacity of those coal mines was 100 Mt and their actual output in 1998 was 63.2 Mt. They had 0.797 million employees and 0.47 million retirees, total assets of 3.45 billion yuan and total liabilities of 31.9 billion yuan. By 2002 most of these unprofitable large mines had been closed.

The expenses for closure and bankruptcy of exhausted coal mines mainly consist of liquidation expenses; site maintenance fee costs and employee's living expenses during the liquidation period; the settlement fee for employees; pension and medical expenses for retirees; injury and occupational health expenses and compensation; expenses for social services such as schools, medical care, and housing stock; and salary and pension.

Restructuring of the coal mining sector and closure and bankruptcy of exhausted and loss making mines had an impact on the older, industrialized parts of China, especially the northeast, where local economies relied heavily on coal mining. Central Government led strategies have been developed to encourage diversification of industry, private investment, rejuvenation of agriculture and livestock businesses, reform of urban administrative divisions, and construction of new housing stock. Enterprise zones and high-technology R&D provide a basis for creating new wealth and employment. The important message is to ensure that future coal mining development is carried out under a broader economic basis to forestall the social and economic problems and costs that can accompany coal mine closure in coal-rich areas.

There is no social security safety net for miners affected by SCM closures. Recent closures of some 1,200 small mines in Shanxi province led to around 60,000 worker redundancies, which mainly affected small villages. After closure of the coal mines, about 10 percent of the workers were reemployed and the remainder returned to their villages. In one particular city, 10,000 miners out of a total of 90,000 lost their jobs when the city government closed 209 small coal mines from 2001 to 2005. Most of the redundant miners had no social security or limited employment skills, as educational levels were generally no higher than senior middle school. Most returned to their villages with no income and little hope for the future. Only a few of the redundant workers had graduated from technical schools or college and a small minority were professional or technical personnel.

Social impact of coal mine development

The social impact of new, extended and transformed coal mines and the growth of dependent communities have not been studied in detail in China, neither are all the issues recognized by the Government. New mine sites are designed and constructed according to a detailed plan, but as the mine undergoes development changes are made which are less well planned. Living and social arrangements are invariably incorporated within the mine's footprint which is convenient for work and ensures that a similar standard of management is applied to both the operational mine and the site as a whole. However, large areas of land become occupied by permanent buildings, many of which will become a liability when resources are exhausted and the mine closes.

Outside of the formal coal mine's residential and social facilities, buildings of variable quality, including private dwellings, services, commercial enterprises and small-scale factories, are built or adapted and the overall economic standing of the area improves. But, hygiene conditions are often poor, public services inadequate and solid waste disposal often involves indiscriminate discharge into water courses which are also polluted by raw sewage. Examples of this are evident around Sihe mine in Shanxi.

A major concern may arise where there is a level of economic dependency of the surrounding community on the mine. Mine closure after exhaustion of the reserves may leave nothing but a ravaged landscape due to inadequate planning and development controls and there is often no alternative source of primary wealth creation to sustain the community. The impact of the mine is such that agricultural land is lost due to building development and rural job skills are lost. More data is needed to quantify such impact.

Shorter mine lives would lead to an increased rate of mine closures. This can be catered for financially with bonds to cover restoration costs- and perhaps also by incorporating retraining and redevelopment schemes. Permanent mine buildings can be re-developed as workshops or factories, but locations are often not suitable. There is experience of this type of redevelopment in Eastern Europe, but a preferred approach is to reduce the scale and permanence of surface infrastructure to a more temporary arrangement – similar to Australian practice.

5.4 Reform needs

Mine safety

There is no simple solution for improving safety performance. It is not just funds that are required but also technical expertise, integration of international effort, a massive training and re-education program, effective and suitably empowered safety inspectors and strong, responsible leadership from mine management. A mass of safety regulations have been enacted to protect mine workers, but they are not being applied effectively or enforced with sufficient rigor as revealed by the rate of fatal accident statistics.

The prescriptive safety legislation is a limiting factor and lessons could be learned by examining the successful performance-based approaches introduced in developed mining countries. Improvements in technology, equipment, regulations and standards have resulted in a reduction of accidents. Further reductions require input from the individuals at risk. There is an absence of safety culture and a failure to convince individuals of their collective safety responsibilities in the work place. Coal mine safety training programs have been implemented to ensure all management and personnel are certified on paper but the content of the courses, training and assessment methods are not delivering the required result. Stronger enforcement is an essential ingredient to improved safety but the regulations being enforced need to be practical, relevant and effective.

A few of the large mining enterprises have demonstrated that a zero fatality target is realistic, but government continues to set and accept higher targets which would not be condoned in any developed mining country.

Nevertheless, positive steps are being made towards safer coal mines. Central Government pressure on coal mines to adhere to safety principles has been increased and, most importantly, mine inspections are becoming less focused on checking paper work and more on underground technical examinations.

There has been widespread adoption of methane drainage for gassy mines, mandatory in many provinces, but standards and performance are low in many. The next step is to raise gas capture standards and increase gas quantities both extracted and utilized.

A greater understanding of the underlying causes of fatal accidents would be obtained by gathering information on a wider range of hazardous occurrence and on non-fatal serious and non serious accidents. A wider range of mine safety statistics and indices are formulated in Australia than China which provides a fuller insight into the scope of accidents, their severity and implications for productivity and mining costs. The impact of many non-fatal accidents on the business, and on society, can equal those of a fatality. An increased awareness by mine management, workers and the public will bring important social pressure to bear on seeking improvements. More serious attention to non-fatal accidents will help to establish a safety culture that will result in fewer fatalities and multiple fatality accidents.

Occupational health

Too little attention is given to protecting coal mine workers from dust exposure and resultant debilitating respiratory diseases. Due to incomplete health screening of miners, the full scale of the problem is unknown. The limited available information shows that it is likely to be massive with more than 12,000 new cases reported annually and many more unreported cases among migrant workers from the TVCM.

Social protection for mine workers

All coal mines are required by law to provide health, as well as accident and retirement cover for their permanent workers. However, many mine owners are avoiding this obligation by employing workers on temporary, short-term contracts particularly at the small mines.

Social impact of mine development

China’s large mine surface installations occupy too large a footprint and the resources used in their construction are too costly. Development of commercial services and support industries around new coal mine sites need to be better planned and regulated to raise the living standards of the surrounding community, expand the local economy beyond reliance on mining and protect the environment. It is a weakness in China that constructional development is invariably well advanced before local institutional infrastructure is established. However, often this occurs too late to establish and exercise robust development controls.

5.5 Recommendations

Improving mine worker safety

The Government has achieved considerable success in improving safety standards at coal mines. The approach has been predominantly top-down. Further safety improvements are impeded by the lack of worker involvement in accident prevention through inspection, risk-assessment and design of safe working practices. While miners have the right to refuse to work where dangers are evident, they have insufficient empowerment, protection and training to be effective. Workers in some small mines in China have been subject to intimidating tactics for refusing to go underground when hazardous conditions have been encountered, but the extent of this problem is not known.

The Government of China has taken the first step towards involving workers in accident prevention with the decision in May 2005 to appoint 100,000 worker safety supervisors or inspectors. These worker safety inspectors must be suitably trained and authorized to carry out inspections on behalf of fellow workers and represent them to management. The most effective systems in other countries are those where the workforce themselves appoint their own worker safety inspector (Feickert 2007). In Australia and New Zealand, independent trade unions provide an effective means of balancing management authority and miners rights resulting in a safety record significantly better than in the USA where not all mines are unionized. All of China's coal mining enterprises should be required to train and empower selected miners as worker inspectors to use their knowledge of the workplace to ensure its safety. This approach has been successful in many other countries and would represent an extremely positive advance if introduced in mines of all type in China.

Enforcement of safety standards at coal mines in China should be strengthened with regular underground inspections of working areas made by experienced and qualified SACMS inspectors. These inspectors should have the power to suspend, if judged necessary, coal production without reference to higher authority until identified problems are rectified and to impose punitive fines for specified safety contraventions.

Gas explosions are a major concern and the Government has invested considerable effort and funds in introducing gas drainage and increasing ventilation standards in coal mines. However, more should be done to remove potential ignition sources. Training and knowledge transfer is needed to improve the effectiveness of gas capture systems, many of which are performing inadequately.

The Government should set a zero fatality tolerance target for all mining enterprises and publish annual statistics showing safety performances, including non-fatal accidents as this would provide a fuller insight into the wide range of accidents, their severity and causes. More serious attention to non-fatal accidents will help to establish a safety culture that will result in fewer fatalities and multiple fatality accidents.

Investigations of all major coal mine accidents should be completed and a report openly published as soon as possible, or within one year of the incident. This would ensure that lessons are learned. This will allow the public and mine workers become better equipped to recognize bad practice and thus bring social pressure to bear on irresponsible companies and officials. Reports will also educate mine management, miner's families, mining equipment suppliers, mining contractors, government officials, training institutes and the public in the key safety issues and help to raise safety culture awareness across the sector. Mine management, mine staff and students in teaching and training institutions would increase their understanding of accident causes and contribute to innovation in safer working practices if provided free access to detailed accident reports and data.

China's coal mining enterprises could internally drive for higher safety standards and raise their corporate credibility in the market place as "safety committed" by introducing international, certified safety management systems. There is no pressure or perceived benefit to adopt these systems in a demand driven market unless the consumer or regulator demands them as a condition, or if the company wishes to establish itself as a global mining enterprise. However, reputation is perceived as being very important to state-owned enterprise management, so once introduced safety management systems could proliferate rapidly.

Improving health protection of mineworkers

Dust measurement and protection standards should be enforced through regulations at all coal mines, and mining operations that are not in compliance with dust standards should be required to implement dust control measures and demonstrate compliance within three months or face suspension of the mining face until specified improvements are made. Any attempt to continue production after suspension should be treated with severity.

SACMS and MOH should organize and implement health screening for all mineworkers paid for by the coal mines. Annual mineworker health statistics should be published to make the coal mining sector aware of the scale of the problem and to enable society, government and coal mine management to monitor the effectiveness of dust protection, control measures and enforcement of the regulations. As coal mines will be expected to meet the costs of treating and compensating afflicted miners in a sustainable coal mining sector, the alternative of investing in prevention would be the lower cost option.

In particular, the following dust precautions should be adopted:

- The introduction of maximum permitted dust levels that are based on a proper assessment of health risks.
- Training of separate dust control and dust monitoring staff. These positions should report directly to top management and have the authority to make changes or prohibit certain activities.
- The dust control staff should not be under the direct control of managers responsible for coal production so as to remove potential conflicts of interest. (Alternatively, these staff could report to the production manager who has a legal duty to ensure that dust standards are met).
- Training of production managers, officials, engineers and dust control staff in the science of dust creation and suppression.
- Workers and staff need to know about the circumstances in which masks should be worn, how they should be worn, how they should be cleaned and serviced and the benefits of using them.
- Procurement staff must be capable of specifying the most appropriate dust control equipment for particular machines, given the conditions in which it is to be working.
- The importance of ventilation for dust dilution must be understood by all employees and managers.
- Mine safety inspectors should be fully trained in dust control techniques and should have the authority to suspend mining operations and/or direct that improvements are made urgently where necessary.

National guidance on modern dust prevention, protection and control measures should be prepared and a national program of training implemented for coal mine officials and management.

Improved employment conditions for miners

Regulations require workers in all sizes of coal mine to be offered fair and equitable contracts that include health and accident insurance and retirement pensions. Permanent workers in KSOCM are already covered by these pensions. The issue is whether itinerant or casual workers should also be given the same full range of benefits. If this were enforced, there would be a significant increase in the cost of labor that would have an impact on the viability of many coal mines. This could cause many mines to close and other more viable mines to seek to reduce their workforces through mechanization. The result may be a significant increase in unemployment in regions where there are few alternatives sources of employment. If wages are set artificially high in the industry this will not be in the interests of the development of a sustainable coal industry.

A scheme should be devised which will permit both permanent and temporary workers to maintain pension contributions across employers. There is no need for this in the case of insurance as each company would be required to cover all workers while they are working in the industry. Pension contributions could be paid into an industry wide or general pension fund or workers could be allowed to cash out benefits.

Sustainability of mining communities

Proposals for new mining projects could take account of how the land and facilities could be used after eventual closure and included in a rehabilitation plan.

Funds could be made available for encouraging new businesses – such as micro-credit schemes – and this should be done while the mine is operational and not purely as a response to closure. Social development should be separate from the mine, but properly controlled by the local government while keeping in mind the needs of living conditions.

Chapter 6 Environmental impact

6.1 Current status

Surface and underground mining activities damage the environment, and the economic value of land resources, by causing subsidence, soil erosion, slope instability, reductions in water availability, desertification and pollution of land and water resources with solid and liquid mine wastes. Land which is occupied by mine waste-tips results in leaching which causes surface and groundwater pollution. Almost 90 percent of China's coal resources occur in continental drought and semi-drought areas.

Gaseous waste by-products of mining include greenhouse gas emissions in the form of methane and also oxides of sulfur and carbon from waste-tips, especially where spontaneous combustion is occurring. Solid wastes from coal mining consist mainly of siliceous rock, carboniferous shale and poor quality coal that are rejected in the washing process. The underground mining methods employed in China generally involve more rock drivages than those used in western countries where labor costs are higher. Therefore more rock is mined and disposed of as waste than in most western coal mines.

Mine water

In northern China, high volume water flows from underground karst features into deep mine workings can cause a rapid decline in groundwater resources leading to the drying out of springs and rivers. In Shanxi, Shaanxi, Inner Mongolia, and Ningxia regions groundwater level has been lowered substantially in areas of extensive mining.

Coal waste

The output of coal waste from underground coal mines in China is huge, accounting for 8 percent to 10 percent of the raw coal production and waste-tips occupy large areas of land. This accumulation prevents any constructive use of the ground and allows leaching of hazardous trace elements which cause severe soil pollution. Waste-tip fires create hazards and cause air pollution. At one site visited in Shanxi, the mine waste material was reported to contain 15 percent coal and the tip, not surprisingly, was on fire. The incidence of polluting fires and the waste of coal could be reduced by more, and improved, coal washing. This would result in the additional benefits of increased resource recovery efficiency, more clean coal and a new revenue stream. Such activity would make commercial sense once the marginal cost of mining (including environmental costs) exceeds the washing cost.

Outcrop fires

Large areas of shallow coal outcropping on hillsides have been destroyed by spontaneous combustion. These are thought to have originated as natural occurrences exacerbated by uncontrolled shallow mining which has allowed oxygen to infiltrate deeper into the seams. Major occurrences have been recorded and mapped in Ningxia, Inner Mongolia and Xinjiang. As a result large amounts of coal are being lost and major greenhouse and other noxious gas emissions are being generated. Since 1993 joint Chinese and international studies have charted the extent of these occurrences using satellite and aerial surveys, and local fire-fighting teams have been established in some areas. Estimates of combusted coal vary widely from 20 Mtpa to 200 Mtpa (Krajik K, 2005). Treatments to date have only met with limited success. These fires are a major source of greenhouse gas emissions which require concerted efforts to treat. However, the provisions of the current Kyoto mechanisms are not easily applied, and in the absence of any alternative, insufficient international and domestic assistance is being mobilized.

Nevertheless, the Xinjiang Government is making a determined effort and has pledged to extinguish all of its coal seam fires by 2015, ahead of its 2020 deadline, thus saving about 24 Mt of coal. In November 2007, a 50-year-old coal seam fire was finally extinguished which had consumed more than 12 Mt of coal (Xinhua, 21 Nov 2007).

Coal mine methane emissions

China's coal mining sector is a major global emitter of greenhouse gases. Methane, a major greenhouse gas, is released as a consequence of coal mining and China's CMM emissions represent 43 percent of global methane released by coal mining. Total amounts of CMM released will increase by more than 65 percent above the present level to represent over one half of global coal mining emissions by 2020 due to increases in coal production (ESMAP 2007). Through its ratification of the Kyoto Protocol, China is committed to achieving reductions in emissions of greenhouse gases, even if it is not obliged to set caps. Government policy is to encourage coal mines to utilize drained gas and as a result schemes involving CMM power generation and direct gas use have been constructed (ESMAP 2007). The increase in the volumes of CMM vented to atmosphere could be reduced further by improving capture, utilization and destruction of the gas at coal mines. The clean development mechanism (CDM) is being used to finance projects that reduce CMM emissions, although more could be done.

At present there are no penalties in China for methane emissions from coal mines, but MOEP has introduced a policy standard which prohibits venting of drained gas (where methane concentration $\geq$30 percent) which must be flared if it cannot be used (SEPA 2007, MOEP 2008). This policy represents an important contribution to reducing China's greenhouse gas emissions in line with a World Bank recommendation (ESMAP, 2007). A weakness of the policy is that no incentive is provided to encourage mines with poor gas drainage that are extracting methane at low and hazardous concentrations to improve performance. By raising gas drainage standards mines can increase gas capture, improve gas quality, ensure safer mining conditions and facilitate greater utilization and destruction of CMM.

Table 6.1 Estimates of mining induced environmental impact

Environmental impact	Quantity
Subsidence damaged land from which inhabitants have been permanently displaced	5,850 km^2
Average surface subsidence from underground coal mining	0.2 hectare per 10,000t of coal mined
Destruction and occupation of land by open cast	80 km^2 per year

mines	
Ground water extracted from coal mines	2.2Bm^3 per year
Water cleaned and recycled	23% (other sources >40%)
Mine waste	150 to 250 Mtpa
Area occupied by waste tips	74km^2
Total mine waste on surface	3.0-3.6Bt
No. of coal waste tips at KSOCM	1,500 - 2600
No. of KSOCM coal waste tips with fires (spontaneous combustion)	389 (80 serious)
Total methane released from coal mines (2004)	18 billion m^3
CMM drained and vented to atmosphere (2004)	15Mt CO_2 equivalent
Ventilation air methane emitted to the atmosphere (2004) from ESMAP 2007	244Mt CO_2 equivalent
Economic losses due to mining subsidence damage in Shanxi over past 20 years (domestic estimate)	15.3 billion yuan (approx US$2.0 billion)
Economic losses caused by mine water discharge in Shanxi (domestic estimate)	30 billion yuan (approx US$3.9 billion)

Source: China Coal Information Institute

Subsidence impact of underground coal mining

After coal is extracted from a longwall the roof is allowed to cave. The removal of support causes surface subsidence, the severity of which depends on various factors, including depth of working, thickness of the coal extracted, width of longwall panel, pillar sizes and strata properties. Subsidence caused by underground mining has damaged surface water courses, led to flooding of arable land, destabilized slopes, damaged surface transport infrastructure and has necessitated the relocation of small village communities. The subsidence impact is most severe where thick seams are extracted at shallow depth.

Occasionally, catastrophic surface subsidence incidents occur as a result of underground mining. On 24 October 2007 five houses in a residential part of Yangquan city, Shanxi province, collapsed into a mine tunnel excavation. 12 people were reported killed, with one missing and two injured (Xinhua News Agency). The report does not state whether the fatalities and injured persons were miners or occupants of the damaged houses. Cracked and damaged structures are fairly common sites in older coalfield areas, but no statistics on the overall extent and magnitude of this impact is available.

Of China's provinces, Shanxi has probably been the worst affected by coal mining. Since 1948 an estimated 9,000 Mt of coal has been extracted in the province and is continuing at around 700 Mt per year. Direct economic losses inflicted by sinking of land equals 42 billion yuan. By 2005, over 5000 km^2 of land had been under-mined, with around 2,940 km^2 seriously affected by subsidence. The area of subsidence created by longwall extraction is expanding by 94 km^2 annually. Over the years some 1,900 villages and 950,000 people have been affected by mining subsidence, causing lowering of groundwater level, degrading of farmland, failure of slopes and damage to buildings and roads. Resettlement costs are significant. Relocation costs are substantial but not excessive and presumably make economic sense to the mines. For example, Shanxi Coking Coal Group paid 31 million yuan (US$4 million) to resettle 13 villages and 1,248 households, an average of 24,800 yuan (US$3,200) per household. However, these costs do not address loss in land quality.

In March 2005, Shanxi Provincial Land and Resources Department investigated the mining subsidence problem and devised a response to address the social and environmental impact attributable to the KSOCM at a cost of 8.9 billion yuan. The costs were to be met by the Central Government, local governments, mining enterprises and individuals with 40 percent coming from government sources. About 180,000 households with 600,000 inhabitants were to be resettled.

Shanxi Coking Coal Group is responsible for a cumulative area affected by subsidence of 131 km^2. In dealing with its liability, the Group has already spent 88 million yuan (US$11.4m), but a further 46 million yuan (US$6.0m) is required to complete the rehabilitation and compensation program. These costs equate to about one million yuan per km^2 or one yuan per m^2. This is a very low amount, compared with other mines, and is due to much of the overlying land being mountainous and sparsely populated.
Where subsidence affects farmland, houses and roads, the mining company is required to compensate the affected parties, or undertake reparations that are mutually agreed. For example, if mining interrupts a farmer's water supply, the farmer is either compensated or a new water supply system is installed. The Shandong Land and Resources Bureau specifies a subsidence fee of 1.0-2.0 yuan/t depending on the extent of subsidence.

Mining enterprises are responsible for dealing with subsidence issues. On a day to day basis, mining enterprises address subsidence issues by leaving coal pillars intact to protect sensitive surface features, restore subsided land, or pay compensation for damage and resettlement of villages before mining beneath them. As the true costs are not known, mines cannot optimize solutions.

The costs of remediation vary depending on the magnitude and type of impact. Restoration projects range from infilling subsidence areas with fly ash, constructing water conservation projects and waste rock utilization, to grandiose amenity schemes with golf courses, luxury housing and commercial development. Projects tend to be piecemeal and more akin to demonstrations than routine practice. Land restoration costs can include surveying, planning, design, site preparation, materials, transport and handling and project management, and can vary significantly. The costs incurred in some mine restoration projects in Shandong province varied from 6 to 45 yuan per m^2, but the extent of the areas treated were small, ranging from 1.5 to 21 km^2.

In general, most severe subsidence problems affecting land quality will occur where there has been multiple seam extraction. However, there will be some areas where the water table is close to the surface and even modest subsidence will lead to flooding and severe loss of productive farming land. The cost not only depends on the severity of damage and the original land quality, but also on the quality of the restoration. The spectrum of subsidence compensation costs will therefore be very wide and a general compensation fee value will be totally inadequate in some instances. In many parts of Shanxi, for example, reparation mainly involves solving water supply problems for the small mountain villages affected by longwall mining. The subsidence fee of typically 0.1-0.9 yuan/t paid by the mines is often too low to cover this as well as any localized subsidence damage.

Subsidence fees should relate to anticipated restoration costs and will be site specific. Site specific variations are evident in costs being paid currently by mines. For example, in a coalfield area studied in Shanxi, subsidence fee costs per tonne ranged from 0.81 yuan to 10.88 yuan. The higher costs of subsidence are generally incurred where the depth of working is shallow and seam extraction thickness is greatest. In one instance subsidence of 10 m was reported with fissures developing up to 600 mm in width.

The subsidence related issues identified were:

- Extensive fissuring of land
- Relocation of villages
- Landslips
- Fault reactivation causing severe structural damage
- Interruption to services (water and electricity)
- Interruption of river flows
- Desiccation of farm land
- Destruction of aquifers and loss of water resource
- Loss of crops
- Failure to adequately repair highways causing public hazards

Although evidence of severe mining damage could be found, it was highly localized. Most of the areas affected are sparsely populated, the land is arid, soils mainly poor and the numbers of dwellings affected are relatively low. The overall impact on major infrastructure, highways, railway lines and motorways appears to be minimal. Where land quality is not a major issue, the main subsidence cost is mainly associated with relocating villages. The density of these, for example in the Datong coalfield of Shanxi Province, ranges from 1 to 6 per 50 km^2 (roughly 1 village for every 17 to 100 longwall panels).

Village relocation is less common in developed countries compared to China due to local government planning constraints, high costs and negative community reaction. In countries such as Australia with low population densities such action may be rarely, if ever, needed. In densely populated countries, such as the UK, pillars of support are left or subsidence control measures are employed as the lowest cost option.

While government subsidence policies and regulations have been adopted by Chinese mine operators there seems to be no standard guidance on how to avoid and manage subsidence problems to minimize mining costs. Methods for reducing subsidence by increasing pillar sizes have implications for coal resource recovery and are a potential issue for which there is currently no regulatory solution. A market system in which resource recovery rates are not mandated, would allow mines to choose the least cost option which is likely to be the most economically efficient option.

When mine owners are required to meet the full costs of dealing with mining-induced damage to the land surface, they will pursue means of minimizing impact to reduce costs.

Environmental costs

Proper protection of the environment during mining and restoration after mining is a key element of sustainable development. The full range of environmental costs incurred as a result of coal mining has been estimated in a study in Shanxi Province (Institute of Energy Economy, 2007). The results for KSOCM are summarized in Table 6.2. In comparison, the actual environmental costs paid by KSOCM in Shanxi are shown in Table 6.3. The difference indicates a deficit of 41 yuan/t (US$5.3).

However, observations made during a field study suggest this cost data may be too high. In practice, mines arrange and pay for restoration of village water supplies. Aquifer damage is a consequence of mining and the Government's permitting agencies decide whether it is an acceptable price for the energy. The water resource loss component in Table 6.3 can therefore be justifiably removed. The high ecological reparation and air pollution costs in Table 6.3 are difficult to justify as averages, as this impact tends to be highly localized in Shanxi where a substantial proportion of the province is mountainous with relatively low quality land. Reducing these figures to 30 percent of the stated values, a reasonable assumption, would give a combined cost of 8.2 yuan/t. The amended average environmental deficit thus becomes 9 yuan/t (US$1.2/t), a relatively low figure given the uncertainties of estimation. Actual costs will vary between mines and even across different longwall panels in the same mine.

The methodologies for assigning environmental costs are not yet fully developed in China and these results should be considered as preliminary. Nevertheless, the use of the estimation method based on remedial and restoration costs, is sound. The approach is also consistent with China's environmental laws which require the polluter to meet the costs of treatment.

Table 6.2 Estimated costs of coal mining induced environmental damage in Shanxi, 2005

Impact	Detail	Total cost (Billion yuan)	Average cost (yuan/t)
Water resource loss	Damage to aquifers, drinking water supplies, surface water drainage and collection, and mitigation by provision of alternative supplies and storage	7.2	13.0
Subsidence and relocation costs	Subsidence damage to land, buildings and infrastructure, and village and housing relocation costs	2.6	4.7
Waste coal tips	Waste coal disposal, land occupation, soil and water pollution and spontaneous combustion impact and treatment	2.9	5.3
Air pollution	Damage to human health and crops from airborne particulates and cleaning costs	4.1	7.4
Water pollution	Loss of water supplies due to pollution, industrial waste water discharge control, drainage pollution	1.8	3.3
Ecological damage	Added cost for controlling soil erosion, damage to vegetation and wetland ecological systems	11.0	19.9
Total environmental cost incurred		29.6	53.6

Source: Institute of Energy Economy, Shanxi Academy of Social Science, 26 October 2007

Table 6.3 Actual environmental costs paid by KSOCM in Shanxi, 2005

Fee item	Amount (yuan/t)	Note
Subsidence fee	0.1-0.9	
Coal waste disposal	2	10 yuan/t of waste equates to 2 yuan/t of coal assuming 20% ash content
Sustainable development fund (environmental component)	7-10	The 50% of payment intended for environmental protection is included here
Land rehabilitation (1993 regulation)	0.4-0.6	Rehabilitation of farmland
Soil protection (1993 regulation)	0.5-0.8	
Forest and vegetation restoration (2002 regulation)	(2-10yuan/m^2) 0.2	Sum depends on degree of forestation and its protection status. Amount/t estimated
Forestation construction fund	0.2	

(1993 regulation)		
Total environmental cost paid by KSOCM	12.6	Average

Source: Institute of Energy Economy, Shanxi Academy of Social Science, 26 October 2007

The total external costs of coal mining not yet paid by KSOCM could therefore amount to around US$1.2 yuan/t on average. However, there are likely to be some sensitive areas where costs are much higher and the fees will not match the remedial costs. Application of standard fees which are less than remedial costs provides no incentive for mines to lessen the impact. However, where fees are too high, the mine is disadvantaged competitively. Fees tend to be based on provincial and regional regulatory standards and these should be replaced by performance standards relevant to local, site specific conditions to encourage mines to minimize impact costs. Making mine owners pay the full cost for environmental liabilities will encourage them to act more responsibly in the future.

Actions to improve environmental protection

Environmental protection is considered during the design, construction and operation of coal mines, as with other projects, to minimize pollution. The projected environmental impact and management strategies are required to be included in the EIA for the project, but not mine closure issues.

Comprehensive development policies can be designed to encourage more efficient use of resources, use of waste materials such as rock and coal waste and recycling of water. Improved coal processing can result in the recovery of more coal which is less polluting. It can also prevent spontaneous combustion in waste dumps and reduce the damage caused by leaching of pollutants from waste dumps. There is a need for treatment of mine water emissions and tips in abandoned mining areas, but no clear management or financing mechanism exists to address these problems.

Until now, an environmental assessment has only been required for the mine construction project itself. In the future, a broader environmental assessment is likely to be required by authorities. This includes requiring the mine complex to manage the whole of the mining activity's environmental impact. SEPA has asked its subsidiary organizations in each province for their advice to make an "Environmental Assessment Guide" for mine developments.

The Shanxi Government is establishing a comprehensive coal mining compensation and environmental rehabilitation system to demonstrate how sustainable development can be achieved and the Shanxi Government has allocated 2.3 billion yuan for restoration of vegetation and forestry in mining areas. However, there is the need to further improve the institutional and regulatory procedures to ensure that the funds is used for the designated purpose in an efficient and effective way..

Land use, subsidence and other fees

When a new mine is constructed, various fees relating to land use must be paid. These include:

- a compensation fee to the former user of the land and the local government;
- a land use fee to the local government. Land use fees are 7-8 Y/m^2 per year in coal producing counties and up to 30 Y/m^2 in coal producing prefectures; and
- a land construction fee for developing new land to offset the land damaged by mining.

A discharge fee for coal waste of 5 Y/t has also been stipulated.

Land restoration rules and regulations

In 1998, the Government issued the Land Restoration Rules (Rehabilitation Rules) which defined the responsibilities and liabilities of the authorities, mines and individuals on restoration of damaged land, as well specifying the sources of funds. Coal mine land restoration is managed by the various administrative departments responsible for land, water, power and environmental protection. Determination of the extent of damage to the land depends on whether the affected land loses its original function, whether it is recoverable and how many changes in function have occurred.

Compensation for damage is based on the changes of the land functions, rather than on the reduction in the asset value of the land, and also on the impact on the local community. There is no national valuation standard and hence no uniformity in method. There is an optimal finite amount that should be spent on land restoration and unless this is recognized, the situation could result in millions of yuan being spent on restoring low value land that would be more socially valuable spent elsewhere.

Local governments do not have the capacity and skills to effectively monitor assessments and compensation. Penalties for failing to take remedial action or pay compensation are not sufficiently strict and can be overturned by the influence of the mine developers. Due to the multiplicity of government departments involved, including land and resources, environmental protection, safety supervision, forestry and agriculture, the administration system is costly and not very effective.

Restoration

Based on the ‘polluter pays’ principle, China’s Land Restoration Rules, Mineral Resources Law, and Land Administration Law stipulate that mining enterprises should be responsible for the restoration of land damaged or polluted by their mining activities. Mining enterprises can either undertake restoration directly or pay a fee to a restoration fund controlled by local government.

The funds for restoration of land and resources damaged by mining are provided by the Central Government and by local governments. These funds are financed by a range of fees levied on mining enterprises by both levels of government in addition to restoration fees. There are no set rules on how much of this finance should be devoted to restoration. Some local governments stipulate that 20 percent to 40 percent of the funds collected should be used. It is probable that in some instances, none of the capital is used as prescribed and hence a more transparent procedure is needed.

During the 11th Five Year Plan, Shanxi Province plans to spend 7 billion yuan dealing with the impact of coal mining, Anhui will spend 1.2 billion yuan and Liaoning Fuxin will spend 0.8 billion yuan. These funds are mainly intended for the resettlement of employees from closed and bankrupted mines and from areas about to be under-mined and affected by subsidence. Private investment in rehabilitated land is encouraged in return for usage rights. Donations from society and international aid funds are also encouraged.

Different coal mining enterprises follow different procedures for dealing with environmental reparation. Clearer and stricter regulations plus accountability to government is needed, including provisions for long-term after-care.

According to the statistics gathered by Land and Resources departments only about 10 percent of mining land has been restored, of which an estimated 80 percent is associated with coal mining and that the standard of restoration is relatively low. The main reason is the historical legacy when the former state-owned mines did not undertake any environmental recovery or land restoration. To promote the sale and development of rehabilitated land, some cities have introduced incentives, including reductions in or exemptions from, land taxes and charges. In Shandong Province, the Government of Jining City has established land restoration funds at city, county, and district level to be devoted to the rehabilitation of land affected by coal mining. A special rotating fund has been established for allocation on a project by project basis. The rehabilitated subsidence land will be sold on the market or open tenders invited from towns and villages. The amounts collected from the sale of rehabilitated land will be used to finance further rehabilitation projects.

In the past, local governments required that coal mining enterprises acquire land for coal mining first, and then conduct land restoration after mining. Mining enterprises therefore had to pay the farmland requisition fee up front and then later bear the expenses of land restoration. Once the coal has been mined the enterprises have no incentive to rehabilitate the land and in many cases, failed to set aside funds for restoration.

Coal mining companies in developed countries are generally required to lodge a post closure restoration bond with the coal managing authority *before* mining starts. This ensures that local government is not saddled with ongoing liabilities after cessation of mining or closure of coal mines. This is alternative policy to a restoration fee has proved successful.

At a national level, in recent years, MOLAR has cooperated with related organizations from UN, Japan, and USA in carrying out demonstration and research projects on environmental recovery and land restoration in mining areas.

Effectiveness of the EIA process

The EIA process is well-defined and failure to submit or comply with an EIA can lead to fines from 50,000 yuan (US$6,500) to 200,000 yuan (US$26,000). For a large coal mine project these sums are not significant. The enforcement of the EIA process instead comes from the requirement of the NDRC for an approved EIA before granting approval for construction.

The relatively low fixed fee for undertaking an EIA limits the value and depth of environmental impact studies. The standard of charges for EIA consulting was set in 2002, but since then the work load and requirements of an EIA have increased. The environmental awareness of many construction contractors is also weak and the environmental impact assessment is too often regarded by developers as a rubber stamp process which does not need to be taken too seriously. SEPA is seeking to correct this misguided view.

An important first step to encourage public participation in the EIA process was announced on 22 February 2006 and made effective from 18 March 2006. SEPA issued a regulation clarifying the rights and obligations of the public, developers, and environmental groups in the EIA process. Five specific vehicles for public participation were outlined: opinion surveys, consultations, seminars, debates, and hearings. Project developers and their advisors are required to represent a broad range of regions, occupations, and expertise when selecting individuals or groups to review their reports. The assessments should also be clear, concise, and widely available to the public. However, observers have expressed concern that the proposed public comment period on EIA reports of only 10 days is too short and that exemptions for projects deemed to be “state secrets” could be abused by developers to avoid publicizing their environmental responsibilities. It will be some time before public awareness on opportunities for participation in environmental activities will be raised sufficiently to engage more than the relatively few (mainly academics and experts) who are currently active. There is a role for NGOs in promoting public participation (Liu Lingling, China Watch, Beijing, 24 Feb 2006).

In comparison, in NSW, Australia (Appendix 5) there is wide stakeholder involvement at all stages of mine project development. Mining companies provide detailed information to government and the public at all stages, not just a detailed EIA. However, in supporting the views of the local populace, government in Australia arguably gives insufficient weight to national and economic benefits and the potential of mining operations to limit long-term environmental impact. China cannot afford to adopt such rigid procedures and needs to seek a more balanced approach.

Environment and sustainable development

The Government of China has established a sustainable development strategy for the coal mining sector which requires the introduction of, among others, policies to address environmental related issues. These include comprehensive mining damage compensation and restoration schemes, strengthened ecological and water resource protection and improved governance of coal mining waste and subsidence issues. The measures will be implemented through improved planning, EIA procedures, supervision, collection and governance of restoration funds and incorporation of environmental reparation expenditure into mine operating costs. The details of how this will be achieved are evolving from a pilot study in Shanxi Province. The strategy does not explicitly mention greenhouse gas emission reductions. Although such reductions are seen as beneficial, it is as a by-product of energy projects and not as a priority under China's Kyoto Protocol obligations.

The Government appears to have two main standards for judging whether a project is compliant with China's sustainability development principles. These are an environmental standard based on adherence to clean production and a technical standard based on efficient use of coal resources. However, the Government places a broad interpretation on what it expects in terms of a sustainable coal mining sector.

In April 2007, the policy of coal sustainable development was initiated in Shanxi. Under this policy all coal mining enterprises are required to pay a fee calculated as the product of a coal category fee, a production capacity adjustment factor and raw coal production. The categories and factors are shown in Table 6.5.

Table 6.4 Fees and factors for calculating coal sustainable development fund contributions in Shanxi province

Coal type	Fee range for category (yuan/t)	Capacity ranges (Mtpa)	Scale factor	Mine types	Scale factor
Anthracite	10-20	$\geq$0.90	1	KSOCM	1
Coking	15-20	0.45-0.90	1.5	LSOCM	1.5
Steam	5-15	<0.45	2	TVCM/SCM	2

The fees paid by KSOCM are divided between provincial, municipal and county governments where the coal mine is located in the proportion of 8:1:1. Fees paid by other coal mines are allocated similarly, but in the proportion of 6:2:2, and the fee is collected by the local taxation bureau. The fund will be used for environmental protection (50 percent), transformation of coal resource cities (30 percent) and addressing social problems resulting from mining (20 percent).

Corporate social responsibility

Coal mining companies have an obligation to their shareholders (and government as a major shareholder in the case of KSOCM) to maximize the value produced by the assets they control. International coal mining companies operate stringent HSEC policies, work to internationally recognized sustainability criteria and demonstrate corporate responsibility by their actions. Corporate social responsibility also extends to buyers and users of products. Some of the major international manufacturing companies are expressing concern, driven by increasingly sensitive and aware shareholders, about the life-cycle impact of their processes and products. Poor labor practices have been targeted and attention is now being given by some international companies to assessing climate change and human safety issues associated with energy supply on which manufacturing and assembly depends.

Building an international reputation

Some large Chinese coal mining enterprises are amalgamating to form global scale companies, although only a few are taking a global perspective. To become truly global operators they will need to adopt international good practice. Foreign governments and societies are concerned that a competitive edge will be gained in emerging economies by the adoption of lower environmental and safety standards.

China's first venture into the world market with the Barapukuria coal mine and power plant projects in Bangladesh was beset with problems. The geological, hydrological and mining conditions were difficult and costs for the mine escalated from US$132 million to US$239 million. The project started in 1992, should have been completed by 2001 but fell six years behind schedule. The initial production target was reduced from 1.0 Mtpa to 0.5 Mtpa and three fatalities occurred during mine construction. Water extracted for the neighboring power plant depressed the water table affecting water supplies to 15 villages around the coal mine area. International standards of environmental impact analysis and assessment do not appear to have been applied by the developer or enforced by the authorities. As China is a recent starter in international coal mining, with little experience and a low chance of getting the most favorable projects. Nevertheless, it should exercise judgment and only undertake projects that it can complete responsibly in accordance with good-practice international standards otherwise opportunities for overseas development will be limited.

6.2 Reform needs

Failure to effectively enforce environmental regulations to prevent excessive environment impact arises where there is inadequate understanding of the implications of mining by local governments, rapid industrial growth, use of quick but inefficient technology fixes, short-term vision and weak governance. The environmental cost is excessive when mining companies are not charged the full cost of their depletion of environmental resources. Environmentally-related fees tend to be standardized across provinces and regions rather than designed to match any site specific impact. Charging mining companies for the full costs imposed on the environment would give them an incentive to take due care of the environment. The solution lies in putting in place standards for environmental impact and rehabilitation of mined areas. Mining companies should have to meet those performance standards, but should be free to choose the manner in which they achieve them. This will encourage them to adopt the most efficient (least cost) approach.

In areas currently being mined, subsidence and restoration charges on coal production are sometimes too low to cover the costs of correcting the problem. Until recently the problem has been compounded by local governments diverting collected land compensation fees to other uses in trying to balance their budgets and to maintain development growth. The advent of the sustainable development fund in Shanxi offers a solution to meet the environmental and social impact of the coal industry, but concerns remain on how restoration projects will be designed and managed effectively by local governments and the Central Government should monitor this process.

Mitigation of mining related greenhouse gas emissions is a major challenge for China that requires attention at the highest level of government, otherwise the sustainability of the energy sector will be undermined. Strong and urgent measures needed to reduce these emissions have been recommended by the World Bank (ESMAP 2007) and there are signs that these are being heeded.

6.3 Policy recommendations

Improving effectiveness of environmental protection regulation

Suitable environmental protection laws and regulations are in place but are often not strictly observed. SEPA and its lower level departments should take a more active role in inspecting major coal mine exploration and construction activities as well as investigating surface impact during operation where concerns have been raised in the EIA or when complaints have been made by affected individuals or organizations.

Higher fees should be allowed for environmental impact studies which are undertaken by third party specialists to facilitate more detailed site investigations and the standards of EIAs should be commensurately improved.

Failure to submit or comply with an EIA can lead to fines from US$6,500 – US$26,000. This is a fairly significant fine for a small mine operator but not for a large mining enterprise and therefore the fine should be determined in proportion to the scale of the project. Local government should receive a proportion of any environmental fines to encourage support of EPB activities and to finance local awareness campaigns on the benefits of environmental protection.

KSOCM pay a raft of environmentally related fees to government which, if spent on addressing the impact of mining would, in many instances, cover a substantial proportion of the costs. A study in Shanxi Province on environmental mitigation costs suggests a possible average deficit in the range US$5.3/t – US$1.2/t of coal mined. However, there will be some sensitive areas where costs are much higher and the fees will not match the remedial costs. Application of standard fees which are less than remedial costs provide no incentive for mines to lessen any impact and, in the cases where fees are too high, mines are competitively disadvantaged. It is recommended that fee policies based on provincial and regional regulatory standards be replaced by performance standards relevant to local, site specific conditions to encourage mines to adjust their mining practices to minimize production costs.

The Government should reinforce environmental fee policies by ensuring that mines only incur fees relevant to their impact. This provides a driver to reduce costs by seeking to identify and establish safer and less environmentally damaging mining practices.

Climate change costs have not been factored into China's coal mining costs as this is not yet general practice in any coal mining country. However, planning authorities in Australia are applying similar calculations when reviewing new mine proposals and the Government of China should monitor such developments.

Mine planning to minimize impact cost

Coal mines should enhance environmental impact planning at mines and be required to prepare environmental sensitivity plans for each proposed longwall panel, assess the impact of coal extraction on land stability, land quality, water courses, aquifers, built development and infrastructure and estimate the costs of mitigation and reparation.

This provides an effective decision tool for senior mine management who must choose whether working a particular longwall panel is financially viable, while at the same time meeting environmental standards. A suggested approach based on a successful system used by the former British Coal is summarized in Appendix 6. The onus is with the mining company to remedy any unacceptable damage caused by mining and to plan the lowest cost strategy to the business. Self-regulation works satisfactorily when failure to address any impact is penalized. However, it is necessary that penalties exceed the remedial costs. Enforcement is through legal action taken by those affected or by a government environmental enforcement agency.

Full redress for mining induced damage

Individuals and organizations whose land, roads, property, livelihoods, water supply and any other activities or resources have been affected by coal mining have a right to proper compensation for any loss or damage caused. This is recognized by governments in China already and there are provisions in law relating to compensation, but the onus should be placed on mines to meet the full costs. The effectiveness of compensation payment policies should be closely monitored by government and measures taken to identify and resolve causes of deficiencies.

Reducing greenhouse gas emissions from coal mining

Low methane emission coal mining involving a combination of CMM utilization where practicable, destruction of surplus CMM by flaring and destruction of ventilation air methane (VAM) by oxidation is technically feasible. MOEP has issued a trial standard on reducing coal mine emissions which focuses on CMM utilization and prohibits venting of drained methane where methane concentration is 30 percent or higher[4]. However, many mines are draining methane at low concentrations, within or close to the explosive limits, of which some is used in special engines but most is vented. MOEP should therefore liaise with SACMS to introduce a requirement for these mines to raise gas drainage standards to improve safety, and also to increase the potential for increasing capture, utilization and destruction of CMM.

The MOEP emissions standard should be further revised to include VAM abatement. This is because more than 70 percent of the methane released by mining is emitted in the ventilation air. Such policies can be adopted without compromising the economics and international competitiveness of China's coal industry because of Clean Development Mechanism (CDM) financing. However, China's CDM approval procedures urgently need to be

[4] The current national regulation for the minimum methane concentration that can be safely utilised at coal mines

streamlined to facilitate rapid and significant reductions in emissions.

Engendering corporate responsibility
The Government and responsible coal and energy users should encourage increased corporate responsibility for the environment among China's coal mining enterprises. Conversely, international companies that wish to demonstrate corporate responsibility as coal and energy users in China could play a role by contributing funds and expertise to improvements in the sustainability of the coal mining industry in China. Some international companies are already assessing ways of achieving effective participation to discharge their social responsibility and successful applications should be identified and popularized.

Chapter 7 Real costs and stabilized prices

China has relaxed price controls on coal and has, theoretically, fully liberalized the market. Allowing supply and demand to freely interact is the best way forward for China's coal sector, but for the market to operate efficiently the Government should ensure prices reflect the true costs of coal production.

The State and private coal mines will under-spend on health, safety and environmental protection because they do not have to recognize these as being costs. If the mines are forced to take these into account as costs, they will have stronger incentives to reduce these costs and accordingly environmental and safety performance will improve. The difficult part is determining the true costs and then allocating these costs over the life of a mine. These costs will differ from locality to locality and will change over time as incomes change and relative social valuations change.

7.1 True cost of producing coal

The costs of coal production borne by a coal mining enterprise are far from complete. Some costs are paid for by central, provincial and local governments through grants and subsidies. Of particular importance are environmental and safety costs that are not fully met by mining enterprises. These costs need to borne by coal mining enterprises if the industry is to be sustainable.

Coal mining costs are determined from entries into a specific account template which all enterprises are required to use. The standard cost categories do not allow the full true costs of coal mining to be accommodated. Unaccounted for costs are either absorbed through internal enterprise accounting, various central and local government subsidies or are not met. Operating costs are notoriously difficult to decipher.

Coal production costs are recorded in the accounting systems of coal enterprises under the following headings:

1. Materials
2. Salary and employment costs
3. Electricity
4. Depreciation
5. Shaft and roadway development
6. Maintenance
7. Repair
8. Subsidence compensation
9. Others

A safety fee is also used to account for safety-related spending and compliance with safety regulations. However, this is largely an accounting split, difficult to equate with true safety initiatives and does not generally correlate with the safety performance.

The above categories do not allow easy comparison of all the costs now borne by coal mines, many of which are attributed to “Other” which can account for as much as 38 percent of the operating cost.

The Shanxi Government has been progressive in assigning true production costs for coal and has trialed measures prior to wider introduction in China. Recently introduced charges are:

- A sustainable coal development fund implemented in March 2007. Under this fund, companies are required to pay 14 yuan (US$1.80), 18 yuan (US$2.43) and 20 yuan (US$2.70) respectively for each tonne of steam coal, anthracite coal and coking coal they produce. This fund will be used for environmental and social projects.

- An environmental restoration fund payable by local coal companies at 10 yuan/t (US$1.35) of coal produced. This fund is for environmental measures around coal mines aimed at protecting water sources, preventing silt and mudflows and controlling pollution that would have been caused by mining activities. The fund will also be used to restore previously damaged areas.

- A social fund to which Shanxi coal companies contribute 5 yuan/t (US$0.68) of coal produced to compensate the laid-off employees of bankrupted local coal companies, in addition to various other training and social security expenses.

The latter two fees will be levied from the beginning of next year onwards, as some coal companies have told the Government that they are under already under too much financial pressure this year and could not meet the fees. The commercial viability of some mines will be drawn into question as soon as they are required to absorb the true cost of mining.

Funds raised by the two new fees will be kept in separate accounts, and will be used as specified under the direct supervision of government. This is a major reform. A previous fee, the now abolished "energy construction fund," was levied by the local Shanxi Provincial Coal Transportation and Sales Corporation, a large SOE, rather than directly by the Government.

The problem with fixed unit charges is that there is no incentive to improve performance to reduce them. If costs incurred, for example environmental costs, are directly related to the impact of mining then coal companies will have stronger incentives to reduce them and environmental performance will improve.

Mining cost factors not directly accounted for at coal mines

During the planned economy period, the Government undertook all of the geological surveys and there were no charges for the exploration or exploitation of coal resources. Systems are now being developed which are intended to pass all these costs to coal mining enterprises, including administration charges. Various government imposed fees have been introduced in the past. A water resource fee imposed in a 1982 regulation required enterprises that constructed their own water supply to pay 0.12 yuan/m^3, for industrial use, to the water resources department. From 1993 to 1996, various regulations introduced a coal resource tax, a sales based mineral resources compensation fee, exploration and mining rights fees, a land rehabilitation fee and a soil erosion prevention fee. Local coal mines in Shanxi were also required to pay 20-30 yuan/t into an energy fund which was used mainly by local government for infrastructure developments. This has now been replaced by a sustainable development fund charge which applies to all mines. Coal mines in Shanxi have historically faced a plethora of charges, many of them with no legal basis which increase enterprise costs. As many of these were not true external costs they were economically damaging to the mining enterprises. The Shanxi provincial price bureau has cancelled some 16 charge categories placed on coal mines and in 2005 the State Council decreed that non legal fees should be banned. There is no place for these in a market system.

While principal external cost items have been identified, fees are often insufficient to meet the costs. For example, surface subsidence damage costs on average in Shanxi are some nine times higher than the fees charged. This problem arises because fees are calculated by a standardized formula rather than based on site specific situations.

The cumulative social impact of relocating villages in mining areas to reduce the amounts of coal sterilized in pillars of support is not fully appreciated and compensation payments seem to involve significant input from government. These would also normally be included in the category of subsidence costs.

There is incomplete provision for the engineering, environmental and social costs of closing a coal mine and also for dealing with post closure environmental liabilities. Coal mining enterprises do not have funds for addressing these matters and must resort to the Government for assistance.

The Government often publishes shortfalls in mine safety expenditure, but it is unclear whether these represent real avoided costs. The Government and its coal industry management departments specify safety projects and equipment upgrades that coal mines are required to implement. The Government determines the expected costs and any under spending is interpreted as a failure to invest adequately in safety improvements. If, in fact, the investment is necessary to enable a mine to attain the required standard of safety, then the under spent amount can be regarded as a cost that the mine should have incurred. Some of the safety improvements involve one-off capital outlays subsidized by the State, a reasonable and not unusual course of action by governments wishing to address national, social issues.

The fact that massive expenditure on mine safety improvements has yielded a sufficient reduction in accidents in KSOCM to meet government targets would indicate that any recent under spending is not significant and can be ignored. So while theoretical under spends of 5-10 yuan/t have been identified, there is no basis at present for including these as unaccounted for costs. In a market system, mines incur all the safety costs involved in meeting the legal safety standards.

Occupational health costs are substantial, although now that all mines are required to operate social insurance schemes these costs should be largely internalized. However, it will be some time before private and LSOCM are able to offset these costs by insurance due to lack of knowledge of dust control measures and high risk of disease occurrences.

The remaining costs not fully accounted for by mining enterprises, and which should be included in a future sustainable mining business, are environmental. The major environmental costs of mining activities for mineral resources in mining areas relate to pollution and damage to the land, water, atmosphere and vegetation. The estimated shortfall paid by coal mining enterprises in Shanxi is US$5.3, although there are indications that this estimate may be too high (see Chapter 6). There is no unified China standard for accounting for environmental cost items.

Social cost of methane released by mining

Greenhouse gas emissions have long-term climate change implications from which a social cost can be deduced. While these costs are not yet included in conventional coal mining operating cost analyses, they are relevant from a long-tem economic viewpoint to China.

Coal mining releases methane, which together with all the other anthropogenic greenhouse gas emissions is “almost certainly” (IPCC 2007) contributing to global warming. Only the methane released by mining is considered in this analysis because the CO_2 produced by combustion is an end-use cost.

According to Stern (2006), the generalized social cost of emissions under a business as usual scenario is US$85/t CO_2 equivalent emitted, and if efforts are made to stabilize CO_2 (other gases are not considered in the analysis) in the atmosphere at 450-550 ppm then the social cost of carbon will be reduced to US$25-US$30/t CO_2 equivalent. The predictions, although dependent on some very broad assumptions, do provide some basis for estimating the potential contribution of future mining activity to the social impact of greenhouse gas emissions.

The analysis presented in Table 7.1 uses the estimated average methane emitted per tonne of coal mined in China. This average was determined from a model developed in a World Bank CBM/CMM study in which small coal mine capacity is progressively replaced by longwall coal mines with higher relative emissions due to the larger volumes of strata disturbed per unit output (World Bank, Beijing 2006).

The costs derived in Table 7.1 are very tentative. The BAU case is probably not too far from the levelized cost of mitigating methane emissions from coal mines, although the cost element for the removal of methane from ventilation air is uncertain at present.

Table 7.1 Estimated social cost of carbon attributable to coal mining based on Stern (2006)

Year	Relative emission m^3/t	Emission factor tCO_2e per tonne of coal mined	Cost/t coal at BAU of US$85/t CO_2e	Cost/t for stabilized situation at US$30/t CO_2e
2007	9.3	0.1401	11.9	4.2
2010	9.5	0.1431	12.2	4.3
2020	10.0	0.1506	12.8	4.5

An indication of a possible future trend in developed countries which eventually will probably also apply to China in the post-Kyoto world, is illustrated in Box 7.1.

Box 7.1

13 Feb. 2007 (Bloomberg) -- *Centennial Coal Ltd.'s proposed A$9 billion ($6.9 billion) Anvil Hill coal mine project is at risk because a state government is forcing the company to factor in a cost of A$109 ($85) for each metric ton of carbon dioxide created when the coal is burned, the Australian Financial Review said. The added cost would be A$1.4 billion a year if calculated at $85 a ton, the rate proposed in an Oct. 30 report from U.K. Treasury economist Nicholas Stern, which the New South Wales Department of Planning has requested be applied, the Review said, citing the company. The department is assessing the mine for development approval. Centennial has rejected the carbon price, saying it was impossible to accurately measure the costs of burning the coal after it was sold overseas.*

Production cost trends during coal sector modernization

From 1997 to 2003 average production costs in KSOCM fell from 151 yuan/t to 116 yuan/t. This mainly reflects the transfer of social liabilities to local government, the shedding of some surplus manpower and the closure of some old, high cost, exhausted mines. In contrast, the last few years have seen large increases in production cost for various reasons, including increased expenditure on safety, increases in salary and increasing material costs. From 2002 to 2005 average monthly salaries have increased by 67 percent.

Salary and employment costs will continue to rise over the next decade and bring pay more into line with other industrial sectors because mines are competing for labor with other sectors of the economy. The commercial response will be to shed manpower and increase efficiency, but the use of more and increasingly sophisticated mechanized mining equipment and technologies is being hampered as the skilled labor required to operate the equipment is in short supply.

Emphasis on resource protection in the 11th Five Year Plan will further drive small mine closure, requiring large mines to achieve high resource recovery thus constraining the scope for productivity improvements, keeping production costs relatively high and squeezing profit margins.

7.2 Coal price

Market pressures, coal quality and price

Increasing demand for coal, removal of artificial pricing, internalizing of external mining costs and reduction of coal supplies from unsustainable low cost mines, have resulted in rising coal prices. Prices are set to remain high as demand is projected to continue rising to fuel increasing numbers of power plants with the coal supply chain constrained by transport capacity limitations.

In the first eight months of 2006, the average commercial gate price from KSOCM was 300 yuan/t (US$38/t). Thermal coal price increases ranged from 3-20 yuan/t in September 2006 across many provinces due to rising demand with the approach of the heating season.

Late stocking by power plants and other consumers delaying expenditure put upward pressure on supply. This shows that the coal market is working.

In the winter of 2008, China suffered its worst ever power shortages, approaching 70 GW, as around 10 percent of generating capacity was closed due to lack of coal supplies (Reuters UK, 23 January 2008). Rising coal prices, small mine closures, limited transportation capacity and adverse weather were blamed. However, the underlying cause is not a high coal price but insufficient exposure of the electricity supply business to market forces. Unlike coal prices, power prices are still strongly controlled by government. While some latitude in power price linked to coal price increases is allowed, electricity prices are not allowed to adjust to the freer market conditions in which the coal mining industry operates. There is no incentive for power plants to stock or source additional coal to meet unusually high demand as they receive no commercial benefit. The limitations of the coal supply chain to thermal power plants will not be wholly resolved until power prices are determined by a market system.

Coal prices in China are determined by supply and demand with regulatory forces applied on the consumption side to encourage use of clean coal technologies and emissions control. Large power producers are contracting for supply of premium grade coals, whereas household and small business users buy cheaper, lower quality coals. The converse is preferable, as large power plants can utilize proven technologies to control sulfur, NOx and dust emissions whereas small volume coal users tend to use simple stoves creating low level pollution which is problematic to mitigate. Supply side regulation is being used, but is difficult to enforce. Regulations limiting permitted sulfur and ash contents of urban coal supplies have been introduced in many of China's cities. While this is an admirable policy, which signals to suppliers the need for good quality coal for it to be effective, there must be a premium to the supplier and penalties for suppliers and users of non-compliant coal.

Coal washing can improve quality and reduce pollution when coal is burned, but the added cost of processing makes for an unattractive price for consumers, especially cash-strapped enterprises and poorer members of the community – those most affected by pollution.

The Government has been promoting coal washing, but the quantity of coal subjected to coal washing depends on the market demand. There are still not adequate incentives for the power companies and industrial end users to use clean, but higher price washed coal. According to data from the Statistics Bureau, the proportion of coal from KSOCM that was washed was about 26 percent in 2005. The total quantity of washed coal products in 2004 amounted to 193 Mt of coking coal and 341 Mt of steam coal. Coal preparation plants at KSOCM washed 446.5 Mt of raw coal of which 53 percent was for energy and the remainder for metallurgical purposes. Washed steam coal output was 84 percent of the feed and 61 percent for coking coal.

The only viable mechanism available for driving users to purchase cleaner coal is through emissions penalties, but it is only practicable to enforce such measures at major commercial and industrial sites. There are also restrictions on the quality of coal mined, to try and keep high sulfur coal off the market, but where local supply is tight, these coals are still being mined. Awareness and social responsibility needs to be raised among the public to change their coal buying habits. While this may be effective for the emerging middle classes, it is likely to have little impact on lower income groups. For the latter, the most effective response is the provision of alternative, cleaner fuels competitively priced against coal.

Coal prices vary from region to region as shown in Table 7.2. This is due to differences in road tolls, railway transportation costs, resource use tax, safety expenses and resource use charges. The dominant cost factor, however, is rail transport.

Table 7.2 Average sales price of commercial coal from KSOCM (Jan-April 2006)

Regions	2006 (4 months) yuan/t	Difference from 2005 (4months) yuan/t	Difference from 2005 (4months) %
North China	291.92	18.57	6.79
Northeast	268.96	-13.40	-4.75
East China	356.09	-35.01	-8.95
Central-south	317.46	13.63	4.49
Southwest	335.97	6.22	1.89
Northwest	208.31	13.47	6.91

Source: Study Team

According to government analyses, during the 10th Five Year Plan, coal supply and demand in China was largely balanced. Taking surface stocks into account with coal transport capacity was the critical factor in matching the supply and demand distribution. While on average a balance was achieved, there were large price fluctuations which caused disquiet to the Government.

Coal price controls

In 2002, coal prices were freed from government price controls with the exception of contracted power station coal for which the Central Government set a reference price for coal supply contracts between coal suppliers and power generators. However, this process led to increasing differentials between contracted power coal prices and spot market prices. The power companies benefited from the subsidy and the large mining enterprises suffered from low margins on coal sales to power producers, and even made losses, as costs increased.

Stalemate approached as coal producers became increasingly reluctant to enter into contracts and power producers were reluctant to pay the market price. At the end of 2004 the Government saw the need for action and introduced a mechanism linking coal and electricity prices. The aim was to allow coal prices to follow market fluctuations, but still at a lower level, and adjust electricity prices accordingly within defined limits.

In 2006 the Government relaxed price controls further on coal and all but abolished price fixing, the caveat being that the Government would exercise oversight over contract prices negotiated between buyers and sellers.

The ROM coal production costs and coal prices at KSOCM during the planned economy and transition to a market system are shown in Table 7.3. Comparing the last two columns shows that since 1997 a steady margin between price and production cost has been established of 40-60Y/t (5.2-7.8US$/t).

Prior to that time, under strict government price controls, differences between average price and costs ranged wildly from -15Y/t to +16Y/t. Businesses cannot operate with economic efficiency under such conditions.

Table 7.3 ROM coal production costs and coal prices at KSOCM

Price regime		Year	Average unit production cost (yuan/t)	Average Sales Price (yuan/t)	Average price minus production cost (yuan/t)
Central Government set coal price	Single planned price system	1953	9.72	11.00	1.28
		1960	9.26		
		1965	15.78	17.68	1.90
		1970	13.49		
		1975	15.86	16.48	0.62
		1980	20.05	21.33	1.28
De-regulation commences	Double-track price system (1)	1985	29.33	26.05	-3.28
		1990	58.60	43.85	-14.75
		1991	64.87	58.45 (2)	-6.42
		1992	74.70	90.67 (2)	15.97
The Government is increasingly relaxing coal price controls		1993	95.50	105.42 (2)	9.92
		1994	101.35	108.94 (2)	7.59
		1995	107.03	115.00 (2)	7.97
		1996	112.31	125.00 (2)	12.69
		1997	108.57	166.60	58.03
		1998	110.82	160.20	49.38
		1999	103.80	143.98	40.18
		2000	101.54	140.19	38.65
		2001	110.71	150.99	40.28

Coal price controls largely abolished	2002	121.37	167.81	46.44
	2003	123.87	173.81	49.94
	2004	169.0	206.43	37.43
	2005(3)	208.0	270.20	62.20

(1) Government managed power coal contract price and market price;
(2) Estimated
(3) Average sales price from KSOCM of which the power coal price component was 212.75 yuan/t.

Source: The Operation of 2005 Coal Economy, China National Coal Association; "China Electricity and Coal Industry", China Coal Industry Publishing House, 2004. China Coal, March 2006.

While the coal market has been freed, the electricity market has not. Power generators cannot pass on the true costs of coal to consumers, thus reducing the economic efficiency of the energy market. In 2005 the State Council approved the implementation of a pricing mechanism to link electricity charges to coal costs. An increase in the coal price is passed on to electricity consumers when the average price of coal changes by more than 5 per cent over a six month period. If the change in the average coal price is less than 5 per cent in a six month period, the percentage price rise is carried over to the next six month period. Electricity generators can pass on 70 percent of the increase in coal prices to end users, but are obliged to absorb 30 percent through productivity gains (Melanie and Austin 2006).

The NDRC released a notice (Wang T, Interfax-China 26 November 2007) offering guidelines for the signing of annual key coal contracts for 2008. The NDRC anticipated that coal contracts involving 785 Mt of coal for the railway industry would be signed but stated that rail transport plans cannot be made before the contracts are signed. In contrast to previous years no mention was made of linking electricity prices with coal prices. By end of January 2008, power prices had still not been raised since June 2006, whereas coal prices for power coal rose by 10 percent in 2007 (Reuters, UK 17 Feb 2008).

Coal pricing policy and regulation

Market thinking is taking time to displace an ingrained command economy approach. and the government continues to view coal price as important to inflation control and macro economic stability, thus should be subjected to oversight, and control if necessary by government. Strict market economic theories cannot be realistically applied in China and must be tempered in the light of China's unique circumstances and practices.

The Price Law of the People's Republic of China, which took effect on 1 May 1998, still provides the powers for the NDRC to intervene in pricing. Despite coal price control relaxation, adjustment mechanisms still remain in the form of coal price adjustment fees. For example, on 1 August 2004, Guizhou Province started to raise coal price adjustment fees at the point of sale for raw coal (including washed and mixed coal) at 30 yuan/t and washed coal (including anthracitic lump coal) at 50 yuan/t. Shanxi Province also adjusts coal price according to resource recovery as shown in Table 7.4 as an incentive to maximize resource recovery.

Table 7.4 Shanxi province coal price regulation

Resource recovery (%)	Price adjustment (yuan/t)
>65	0

60-65	1-10
40-60	10-20
20-40	20-30

The NDRC and the General Administration of Quality Supervision, Inspection and Quarantine issued a notice in 2007 on further strengthening coal quality management. The notice emphasizes that coal prices should be related to coal quality. The issue seems to be that high quality coals are being squandered through failure to reflect the quality in the marketplace. In some parts of China suppliers are not providing coal to the standards specified by users, yet pricing them as if it was.

The pricing system is distorted where production from illegal mines is being traded. Discounting to place illegally mined coal and limited access to the market means that quality is not necessarily reflected in the price. The NDRC notice requires that coal transportation companies refuse transportation services to coal mines without coal production licenses and to illegal coal trading companies without coal business licenses.
Coal prices will only accurately respond to supply and demand in a reputable trading environment and the quality control systems in China need overhauling if effective pricing is to be achieved. In a free market, prices would automatically relate to coal quality.

The average domestic price of Chinese raw coal was 508.17 yuan/t (US$68.86) in October 2007, over 12 percent higher than in the previous year (Ministry of Commerce, 22 November 2007). Continued growth of energy intensive industries and rising crude oil prices has increased demand for coal and prices have risen.

Influences on coal price and its stability

In China's coal market system, three major factors influence coal price. Firstly, the relationship between coal supply and demand, which takes into account coal in storage and production at coal mines. Secondly, is the issue of cost and profit. Cost and price jointly determine the ROA (return on assets) and a healthy ROA releases economic resources (capital, loan, talents and new technologies) and will support investment in new capacity. Conversely, poor returns signal a drain on the economy and stimulate government into adjusting policy. In the past, government response was invariably to adjust prices but it has progressively relaxed its grip on coal price controls and is allowing market forces to act. The third influence is the price relationship between domestic coal, international coal markets and alternative energy sources. These relationships are complex and government attempts to control the balance are almost certainly going to fail.

Coal prices are jointly determined by the interaction of supply and demand. The demand for coal depends on the price of coal relative to other energy sources. The supply of coal depends on a comparison between coal prices, production and delivery costs. High rates of return will provide an incentive to invest in the industry in new production capacity. Low rates of return will undermine incentives to invest in this industry.

The coal price is stable when supply and demand are closely matched, and fair competition prevails. The progressive reduction of supply from small coal mines that do not carry the full costs of safety, social and environmental protection is creating conditions that are increasingly becoming equal in China. During the transition to a freer coal market, market corrections have been inhibited by governmental actions causing imbalances with cyclic regularity.

Coal pricing does not strictly reflect market conditions as government coordinates production, transportation, sales and demand through its policy guidance and supervision mechanism, as well as determining rail transport pricing. The NDRC raised the national unified railway goods tariffs from 8.61 fen/t.km to 9.05 fen/t.km in April 2006 which directly affected price to the customer. In a competitive transport system blanket increases would not be made.

The annual Coal Order-Placing Meetings, an aftermath of the planned economy, until recently weakened the effectiveness of the market function for efficient resource allocation. However, this is no longer a factor.

Internationally, network transaction and trading centers ensure coal markets function effectively and China is set to establish a national trading centre in Taiyuan, Shanxi Province at a cost of one billion yuan, including an exhibition centre. Whether foreigners will be able to participate is uncertain.

Stabilizing price through futures trading

Developed countries, in which coal futures are traded, arguably achieve more stable pricing than China. The futures markets with uniform commodity pricing, grading and delivery enable buyers to protect themselves from price fluctuations by locking in a specific price for a commodity over a future period of time.

Futures markets allow both buyers and sellers to reduce their exposure to risk by hedging against price changes. China has implemented a futures trading platform under the auspices of the China Securities Regulatory Commission (CSRC), an institution of the State Council of the People's Republic of China (PRC) with functions similar to those of the US Securities and Exchange Commission.

7.3 Reform needs

The true cost of coal is currently obscured by government subsidies, inadequate environmental and social protection and insufficient attention to safe working practices. At the first quarter of 2007 these costs were in the range US$1.2/t – US$5.3/t (based on studies in Shanxi), excluding the notional social cost of climate change attributable to coal mining activities in China. Full production costs must be borne by all coal mining enterprises.

In a balanced economic environment coal price is determined by the marginal cost of production, marginal investment cost of capacity increases, investment costs for new capacity, transport costs, commissions by handling agents, profit and taxes. Competitive bidding by consumers, consequent inflationary pressures on essential mining materials and investment into expanding capacity first pushes up prices and then costs when supply shortages arise. Government price controls at any part of the chain hinder market participants from pursuing the most efficient pathway.

Greater exposure of China's coal mines to competition than is currently the case, in a market environment where the full costs of actual impact is met, would lead to a realistic pricing structure. Stability of coal prices depend on coal supply and demand. A market system will provide the balances through price variations and these will be influenced by domestic and international factors. A coal futures trading market would help buyers and sellers reduce their exposure to price fluctuations.

Market thinking is taking time to displace the ingrained command economy approach. Government continues to view coal price as important to inflation and macro economic stability, thus should be subjected to oversight, and control if necessary by government. Strict market economic theories cannot be realistically applied in China and must be tempered accordingly. Nevertheless, economic efficiency, which is a cornerstone of sustainable development, will not be achieved without allowing market conditions to prevail. It is therefore recommended that government reduce intervention in coal and supply chain pricing.

Between the mine and coal user, additional fees are sometimes incurred. Some of these have no legal basis or regulatory function. In accordance with the State Council's direction, such charges should be removed. The effect of these is to increase coal price for no added economic benefit and thereby reducing the competitiveness of the coal.

A coal futures trading market in China could reduce the exposure of mining enterprises and customers to price volatility. However, concerns about government intervention in mining operations and rail transport allocation and consequent price risks that are not easily quantified might deter brokers. As a result more transparent coal supply market conditions need to be established. A free flow of statistical information would help to reduce uncertainty and assist supplies with forward planning.

Longer term contracts between coal producers and power generation companies would lead to improved price stability. There is evidence of a move by electricity companies towards negotiating longer term contracts outside the annual government sanctioned coal conference. For example, in June 2005, Huaneng Power International Corporation signed an agreement with Pingdingshan Coal Group to supply 0.5 Mt of coal in 2005 and 2 Mt for both 2006 and 2007 (Interfax 2005 from Melanie and Austin 2006).

Coal washing can substantially reduce the ash content of coal, leading to much lower particulate and SOx emissions from the burning of coal and improved efficiency, which in turn leads to lower CO_2 emissions. However, coal washing involves additional costs and customers will only buy the coal if clean coal is a process requirement or if emission penalties exceed the difference between the prices of washed and raw, screened coal and there is a high chance of prosecution. An increase in saleable proportion of raw coal output would be matched by reduced gas emissions and environmental damage caused by mining in proportion to the additional coal recovered by washing. Clearly, major environmental benefits would accrue from increasing the use and efficiency of coal washing processes.

7.4 Recommendations

In a sustainable coal mining sector all mines should meet the full costs of production and mitigation of any social and environmental impact and these costs should be visible in accounting statements. KSOCM already make substantial contributions towards mitigating their impact on health, safety, environment and the community through various mining fees, compensation payments and social, health and accident insurance schemes. These same fees and requirements must be applied to all coal mines in a sustainable industry.

Climate change costs have not been factored into China's coal mining costs as this is not yet general practice in any coal mining country. However, planning authorities in Australia are applying similar calculations when reviewing new mine proposals and the Government of

China should monitor such developments.

Pricing of rail freight operations should be more transparent and predictable and should allow for the free negotiation of long-term transportation contracts with suppliers.

Between the mine and coal user, additional fees are sometimes incurred, some of which have no legal basis or regulatory function. In accordance with State Council's direction, such charges should be removed. The effect of these is to increase coal price for no added economic benefit, thereby reducing the competitiveness of the coal.

Greater exposure of China's coal mines to competition, in a market where the full costs of mining are met, will lead to a realistic pricing structure. Stability of coal prices depends on coal supply and demand. A market system will provide the balances through price variations and these will be influenced by domestic and international factors. Any government attempts at stabilizing coal price will lead to a supply-demand imbalance. Government should therefore resist all temptations to intervene in coal pricing.

A coal futures trading market should be established in China to allow coal producers and buyers reduce their exposure to price volatility.

The Government should publish reliable monthly statistics on energy supply and demand, including coal. This should be published in an international format which will signal current trends. This will assist mining companies, both in China and overseas, to develop long-term business strategies, invest in new mining capacity and mobilize coal supplies and shipping capacity which will prevent sudden price surges on the international coal market and ensure more stable coal supplies to China's industrial consumers.

Where there is a strong and natural linkage between a coal mine and a power plant, good international practice is for long term (5-20 year) supply contracts to be signed between the mine and the power plant. These contracts should fix annual volumes and set an initial base year price that provides a reasonable return on capital to the mine and include provisions for annual price adjustments based on cost-related inflation factors. As is common practice worldwide, these contracts should also include incentives related to the customer's coal quality requirements and to coal quality testing procedures. For this recommendation to be effective, power plants would need to be allowed to adjust power prices to reflect the initial increase in coal prices that would result from such coal supply and pricing contracts. Raising power prices would not only adequately reward the coal suppliers and encourage more coal investment, but it would also encourage consumers to use energy more efficiently. This would help reduce the rapid growth of energy demand in the future which in turn would help reduce the likelihood of future coal shortages. Coal mines and users should therefore be encouraged to enter into long-term contracts and a freer pricing policy established for the power sector.

Coal mines produce coal of a quality to satisfy the requirements of users. The air quality benefits of using clean, washed coal over dry-screened run-of-mine are well recognized but users will only buy more expensive coal if made to comply with strictly enforced environmental emission regulations and controls. Supply side coal quality policies have been attempted. However these are largely unsuccessful, difficult to enforce and should be abandoned and replaced by demand side controls. Coal quality for industrial and commercial utilization should be controlled indirectly through environmental legislation by imposing and enforcing stricter environmental emission penalties. Environmental protection agencies will need to be strengthened to achieve this. Consumers can avoid emission penalties either by end-of-pipe solutions or by purchasing higher quality coal. If coal users are paying sufficiently high emissions charges, they will pay a premium for clean coal and this will encourage increased washing of coal.

Chapter 8 Institutional and legal framework and policy

8.1 Current status

The institutional structure of China's coal mining sector has been undergoing reform for a number of years to reduce the overlap between regulations and department functions as well as remove inefficiencies. However, problems still remain. The State Council has transferred some regulatory powers for safety management from NDRC to SAWS and SACMS, but NDRC still considers itself as a source of safety initiative. While this is well intended it is largely ineffective. SACMS established two new departments in 2007, a science and technology equipment department with responsibility for coal mining equipment and technical safety standards, and a department providing guidance on fundamental industry safety management and training.

Increasing transparency and accountability to the Central Government has been achieved through SASAC (the State-owned Assets Supervision and Administrative Commission) which acts on behalf of the State Council by supervising the use of state owned assets and protecting the interest of the owners. Other than representing the interests of the owner, SASAC is not supposed to interfere with the business activities of the state enterprises. SASAC sends supervisory panels to inspect the business activities of state enterprises which are obliged to co-operate fully.

A State Energy Administration has been established to supervise, among other duties, the implementation of the forthcoming Energy Law.. The aim of this new law is to provide an overarching framework for energy policy, and it is being drafted in parallel with amendments to existing energy-related laws on coal, electricity, energy conservation and renewable energy. There are no laws as yet governing petroleum, natural gas and nuclear energy.

The current status of China coal industry legal framework

There are many instruments by which the coal industry is regulated such as laws (legislation), policies, technical standards and rules, disciplines and criteria. Fundamental, is the Law of the People's Republic of China on the Coal Industry, formulated by the former Ministry of Coal Industry and passed at the 21st Session of the Eighth National People's Congress on August 29 1996. The legal framework encompasses laws, regulations, rules and other legal instruments to regulate coal exploration development and utilization, resource protection, production and operations, environmental protection and supervision, health and safety, and administration of coal mining activities.

Centrally formulated legislation includes laws, administrative laws, and rules of departments while local legislation includes local decrees and rules of local governments. Some local governments establish additional regulating documents which are outside the scope of the legislation, but usually enforceable. There are many technical and economic regulations comprising administrative regulations (promulgated by the State Council) and rules (promulgated by the Departments and Committees and Bureaus directly under the State Council) which are also enforceable. The Central Government has promulgated over one hundred laws, regulations, rules and other regulating documents related to the coal industry.

The principle laws are summarized in Table 8.1 and these, together with associated regulations and rules, comprise the current legal structure of

China's coal industry which has evolved during the institutional and economic transition of China from a centrally planned system towards a market economy.

Table 8.1 Broad scope of China's coal-related laws

Laws
• Energy (pending)
• Coal Industry
• Mineral Resources
• Mine Safety
• Production Safety
• Prevention and Treatment of Occupational Diseases
• Environmental Protection
• Prevention and Control of Environmental Pollution by Solid Waste
• Labor

The coal industry administrative laws and rules of departments can be divided into six categories: coal resource administration, administration of coal production and exploitation, administration of coal business and the market, coal safety administration and supervision, coal mine employee rights protection and environmental protection of coal mining areas.

Shortcomings and gaps in the legal framework are currently being addressed and the Mineral Resources Law, Law of the Coal Industry and the Law on Safety in Mines are being amended. The State Council through the NDRC (the national administrative department of the coal industry), SAWS, MOLAR and MOEP are steadily formulating and promulgating new regulations and rules to regulate the coal industry, removing apparent problems as they arise.

Generally, local coal legislation is based on the stipulations and requirements of Central Government legislation. The People's Congress of provinces, autonomous regions and municipalities (directly under the Central Government) formulate local decrees and local government rules. The municipal government, with the approval of the State Council also can formulate corresponding rules. Local decrees and local rules should not violate the central and upper legislation and the local decrees and rules only take legal effect within their own administrative regions.

8.2 Reform needs

China has enacted a series of laws, regulations (ordinances) and rules to regulate the coal industry. However, until the coal mining industry becomes more responsive to adhering to law and regulations, especially safety and environmental regulations, eliminating deficiencies in the legal framework will have no impact on actual performance. Nevertheless, the legal basis should be reviewed and revised to ensure it is consistent with, and supportive of, sustainable coal mining activities.

Shortcomings of China's coal industry legal framework

China's legal framework which underpins the coal industry is incomplete and contains serious structural defects. Many laws, regulations and rules have not been enacted and in particular many are neither monitored nor enforced. Due to the frequent legislative changes, amendments and abolishment, the composition of the framework is constantly changing. The overall legal authority of the legislation is relatively low, exacerbated by the large number of rules emanating at local level. Many rules are provisional and consist of emergency measures introduced for crisis management, rather than long term or being logically derived. Consequently, the relationships between the components of the legal framework are not orderly, systematic or sufficiently well coordinated. Overlap and gaps exist in the legislation, while some have not been enacted and other legislation is impractical or outdated.

According to domestic legal experts, specific problems exist within the legal framework due to the pace of coal sector development which has outstripped the legislation. However, most, if not all the deficiencies advocated as requiring legal stipulations relate to prescriptive regulations, for example on resource recovery, which would not be needed in a more developed market system. A complete legal system is desirable to ensure that responsibilities and liabilities of coal mining enterprises and government are unambiguously defined. However, during a period of rapid reform and economic transition, there is a danger of introducing barriers to change by trying to underpin dynamic change with rigid rules.

The requirements for establishing coal mines and permitting coal production under the existing “Law on Coal Industry” are insufficiently onerous, allowing access too easily to the coal mining business. Coal management departments and other relevant departments have too much power through approval and permitting procedures which allows some individuals and units with insufficient funds, backward technology, poor safety production conditions and a weak environmental protection capacity to enter the coal mining sector.

The principle of royalty payment for exploitation of coal resources is not prescribed in the Law on Coal Industry. However, due to its importance this is an area that should be covered by legislation.

Domestic experts have identified missing legal details and lack of explicit regulations on coal exploration, transfer of mining rights, mining methods and resource protection to match currently applied policy criteria. Such regulations are unnecessary in a market system and further legal definition would be unhelpful. In a market system there is no need for a phalanx of prescriptive policy standards and regulations.

The stipulations on coal mine safety, mining area protection, and environmental protection issues during the exploitation and utilization of coal are incomplete. Coal mine accidents in China occur too frequently. While the causes are many and various, there is a perceived connection with the incomplete stipulation of coal laws, such as Law on Coal Industry and The Mine Safety Law. The main problems regarding the stipulations on mining area protection cited by domestic experts are that they are not detailed enough, largely impractical and incomplete in defining legal responsibilities.

Detailed stipulations regarding the conditions and procedures for mine closure and abandonment are absent from the current Law on Coal Industry. Some state-owned large and medium-scale coal mines have exploited this loophole and taken advantage of insolvency proceedings to strip off bad assets even from coal mines that were not actually exhausted. Moreover, some mines, which should not have been closed or abandoned were sold or transferred at a low price to individuals causing huge losses of state-owned assets. This poor governance means that management can pursue private rather than corporate interests.

Coal sector administration

Coal sector management by the various relevant government ministries and departments is not sufficiently effective. Vast tracts of agricultural land have already been lost due to mining in China, aquifers disrupted, water courses polluted and millions of miners exposed to unacceptable health and safety conditions. Reforms are urgently needed which ensure that mines meet the full social, safety and environmental cost of their activities to ensure sustainability of the mining sector. While the Central Government has introduced progressive policies to address some of the issues, these are not being implemented uniformly at local level due to conflicting interests and corruption.

Continuing reforms demonstrate the Government's commitment to modernizing the industry and its determination to improve the safety and environmental record, but the "top down" management approach remains ineffective and regulations are ignored at local level where the imperative is financial gain at any cost. Attempts to decouple local government from lucrative associations with small coal mining activities, and to deter provincial governments from intervening in the operational strategy of large mining enterprises which come under their jurisdiction, have had limited success. Provincial governments have a right to regulate the activities of mining companies to ensure that the environment, workers and communities are adequately protected from the adverse effects of coal mining, but not to intervene in commercial activities.

The management system of the coal industry is weak and poorly organized. Governmental administration of coal mine enterprises is effected mainly through licensing and certification documents which are issued and inspected by a multiplicity of different authorized government departments (Table 8.2).

Table 8.2 Government administration of coal mining enterprises

Licenses and certificates	Departments involved in issuing and inspection
(1) Mining License (2) Coal Production License (3) Safe Production License (4) Safety Qualification Certificate of Director of Coal Enterprise (5) Safety Qualification Certificate of Deputy Director of Coal Enterprise (6) Safety Qualification Certificate of safe production managers of coal enterprises (7) Qualification Certificate of Director of Coal Enterprise (8) Professional Qualification certificate for coal mine special working positions (9) License of Coal Business and (10) Business License.	(1) National land and resources administration departments (2) Work safety supervision and coal mine safety supervision administration departments (3) Business administration departments (4) Coal industry administration departments at all levels and the coal industry administration departments at provincial and municipal level (5) SASAC departments (6) Administrative departments of environmental protection. Departments of finance, labor and social security are also involved in the process.

There is little interdepartmental co-ordination and each department tends to follow its own aims. The management responsibilities and rights of different department are not clearly or legally defined and there are many overlaps and gaps. Interdepartmental disputes over inconsequential matters and power struggles are common place to the detriment of the sector which the departments are meant to be servicing. For example, the coal business license issued by administrative departments of the coal industry at a local level specifies safety requirements, but according to the stipulation of the legislation, the safe production supervision and administration department must issue the safe production license again. Thus, administrative resource is wasted and the administrative burden to coal mining enterprises increased.

Administrative complexity, overlap and inefficiency are exemplified by the situation in Shanxi Province (Appendix 7), which is gradually being resolved.

There is a clear need for restructuring of the coal sector administration to improve efficiency and functionality by defining the roles and responsibilities of departments and removing overlaps, particularly at the provincial and lower levels. Provincial departments are accountable to the Central Government and should be the highest level of operational involvement, with the central administrative role being largely strategic review and development of regulatory mechanisms and subsequent monitoring of their implementation and effectiveness. The provincial departments should be responsible for enforcement of the regulations.

In March 2003, the SETC was abolished at the central level, but the provincial and lower level departments still remain. They continue to undertake functions that overlap with coal administration departments further decreasing administrative efficiency and imposing additional burdens on coal enterprise administration staff. At local level the ETC had a leading role but with the demise of SETC that position became irrelevant.

SAWS and SACMS are located in the building of the former Ministry of Coal Industry, which was abolished in 1998, inheriting many of its staff and still undertakes coal enterprise production and performance monitoring that lies outside its main function of safety administration, regulation and enforcement. At the same time the NDRC is leading safety initiatives with SAWS and other government departments as subordinates for which SAWS should take responsibility. The strength and role of the NDRC is in strategic planning and broad goal setting to implement government policy.

Recent institutional reforms

At the end of 2006, five coal mining sector management functions were transferred from the NDRC to SACMS:

1. Framing of orders and standards in coal industry
2. Certification of coal mine leaders
3. Approving the construction projects of coal mines planned by NDRC
4. Verifying technical safety renovation and methane management projects at KSOCM
5. Instructing the provincial management of the coal industry and the basic safety management of coal mine enterprises

Overlapping functions and excessive bureaucracy means that most coal departments after rationalization should have adequate staff resources. However, central and provincial safety departments under SACMS are likely to need more senior and specialist mines inspectors to strengthen coal mine inspection and enforcement.

In March 2008 the Government announced a “major” restructuring of its administration that involved forming five new “super ministries” **(**Xinhua, 11 March 2008). Amongst other changes SEPA gained ministerial status to become MOEP. To strengthen the government management of the energy sector, a high-level inter-ministerial coordinator, the National Energy Commission, is to be established, with a State Adminstration of Energy as its executive arm under the NDRC. The new Administration will integrate the NDRC's functions relating to energy management and the functions of the National Energy Leading Group and the Commission of Science, Technology and Industry for National Defense on nuclear power management.

While promising a reduction in bureaucracy, there otherwise seems to be little overall change. After re-organization, the State Council will have

27 ministries and commissions apart from the General Office after the re-organization, compared with the present 28.

Energy strategy development, sector planning and management will be the responsibility of the new State Energy administration. What, if any, extra powers the environment ministry will have to raise its effectiveness are unclear. The re-organization has not seemingly contributed to improving coal industry management co-ordination at the Central Government level. However, a body has been identified whose responsibilities should include strategic coal sector planning.

Table 8.3 Clarification and reform of roles of the main Government departments with coal industry responsibilities

NDRC and provincial coal departments **STRATEGIC PLANNING**	**MOLAR and provincial land and resources departments** **LAND USE AND RESOURCE RIGHTS ALLOCATION**	**SACMS and provincial safety bureau** **HEALTH AND SAFETY**	**MOEP and provincial environmental protection bureau** **ENVIRONMENTAL IMPACT**
Provide strategic oversight and monitoring at national government level Consolidate coal mining industry management duties in a single cohesive department at national level At provincial level transfer ETC mining functions to coal industry bureau Reduce intervention in commercial mining activities and progressively dismantle market barriers	Establish a department with sole responsibility for coal within MOLAR Management of land use and property Administration and issue of exploration and mining rights through bidding and valuation methods Holding and managing post closure restoration bonds Valuing and managing subsidence claims Inspection and archiving of mine plans including abandoned mines Managing inherited safety and environmental	Independent of other government departments Relinquish coal sector performance monitoring to a central coal department at national level Strengthen the powers of inspectors but centrally led. Shift accident response from reactive to risk based prevention International H&S liaison Provide guidance to mines on safer working Safety training and certification Investigate fatal accidents and expedite open	Raise standard of EIAs Assess mine project compliance with environmental regulations Strengthen EPBs to inspect mine sites, encourage implementation of EMPs and enforce environmental regulations Provide guidance and training to coal mines on environmental management Strictly enforce pollution emission controls and raise penalties to encourage users to buy cleaner coal or introduce new clean coal technologies Raise climate

	liabilities from abandoned coal mines and protect the public from associated hazards Central repository for geological and coal resource information. Liaise with natural gas exploration licensing authority on CBM-coal mining interaction issues	publication of reports Gather and publish mine non-fatal accident statistics Liaise with MOH on occupational disease control Mandate and facilitate acceptance of worker safety representatives at all mines	change awareness and promote methane emission mitigation measures at coal mines

8.3 Reform needs

The coal mining sector administration can be substantially strengthened by rationalizing the allocation of duties and responsibilities spread across NDRC, MOLAR, SACMS, provincial ETC and MOEP. It can also be improved by better integrating the related functions in clearly defined departments to form a cohesive coal sector administrative organization as suggested in Table 8.3.

The effectiveness of municipal and lower level government is inhibited by overlapping departmental functions and, in some cases, inadequate manpower resources.

8.4 Recommendations

The institutional structure of China's coal mining sector has been undergoing reform for a number of years to reduce problems caused by overlap between departmental functions and conflicting regulations, but difficulties still remain. A cohesive and efficient coal sector administrative organization should be established at central level to co-ordinate rationalization and activities of provincial and lower level coal industry administration bureau and departments. The proposed department should be accommodated in an Energy Ministry if such an institution was formed.

The roles of key Central Government ministries and administrations should also be clarified to prevent inappropriate intervention in coal industry activities and to ensure their clear focus on primary objectives.

MOLAR has various responsibilities relating to land use for coal mining with departments at local level and these should be consolidated at an operational level under provincial land and resources departments. These provincial departments should be equipped with the necessary expertise to administer exploration and mining rights, ensure effective exploitation of coal resources, assess and collect royalties, manage subsidence claims, hold and apply restoration bonds, provide a public repository for abandoned mine plans, store geological exploration information, and protect the public from mining related hazards.

NDRC and MOLAR should separate coal mine production management and coal resource administration functions and delegate all operational responsibilities to provincial level. Provincial and lower level ETC coal-related functions should be abolished and their non-overlapping functions merged into coal management departments at the same level.

The role of NDRC and State Energy Administration should be to provide oversight on behalf of the Government and to undertake long-term strategic planning under a cohesive energy policy with access to the technical and statistical resources of provincial coal departments. Coal mining sector management should be delegated to provincial government coal departments which have the resources to implement and enforce policy.

Effective government mine safety agencies in other countries are wholly independent of coal mining interests and China should follow this example. SACMS should pass its residual coal production management functions from the former Ministry of Coal Industry to a central coal coordinating department including gathering, analyzing and disseminating coal mine production and performance data provided by provincial level departments. This central coal department should establish regular and close liaison with both SACMS and MOEP to ensure common aims of improving safety and protection of the environment respectively are being effectively tackled. It should also ensure that safety and environmental issues are treated as paramount and not compromised in any revised or new coal administration regulations.

SAWS and SACMS have already been raised in administrative authority by the State Council, but their powers of enforcement are still inadequate. SACMS should be more strongly and transparently enforcing mine safety laws and regulations through provincial and lower level safety departments. Safety inspectors should have the authority to stop mining operations irrespective of mine type without referral to higher authority in the event of serious non compliance. Safety inspectors should be paid high salaries to deter corruption and facilitate recruitment of experienced and able staff. More staff are needed to ensure all mines can be regularly inspected. The functions of SACMS should be clearly separated from coal mining management departments.

MOEP's powers to enforce environmental protection laws and regulations in coal mining areas should be strengthened and its resources increased accordingly. This will involve capacity building in local environmental protection agencies and the recruitment and training of specialist coal mine sector inspection and enforcement staff.

MOEP and its lower level departments should take a more active role in inspecting major coal mine exploration and construction activities, and also of any surface impact during operation where concerns have been raised in the EIA or complaints have been made by affected individuals or organizations. Local government should receive a proportion of any environmental fines to encourage them to support environmental protection activities and to finance local awareness campaigns on the benefits of environmental protection.

China's safety and environmental laws and regulations are reasonably well-developed, but enforcement is still weak. A sustainable industry must become more responsive in its adherence to law and regulations, especially safety and environmental and therefore it is important to establish a clear legal and regulatory framework. An effective, strongly enforced regulatory framework is necessary to ensure that the full costs of mining are borne by the China's coal mines in respect of environmental protection, work safety and social responsibility.

Prescriptive regulations should be reviewed and where practical, abolished and replaced with performance standards. Provincial and lower level government coal department supervision and enforcement duties will be reduced allowing the regulatory authorities more time and resources to concentrate on fewer and more critical key regulatory issues. Thus, the administration system would become more effective.

Chapter 9 Conclusions

China's coal sector faces many challenges but the Government has shown determination in developing a modern coal mining industry that will ultimately satisfy growing energy demands.

The ability of China's coal mining sector to meet the nation's massive and increasing energy needs is determined by the availability of identified mineable reserves, exploration to prove new reserves, the production capacity of existing mines, construction of replacement mines and expansion of capacity, and a transport infrastructure to complete the supply chain to the customer. Sustainable development requires a socially responsible and environmentally sensitive approach to both resource exploitation and supply logistics.

In summary, a sustainable coal industry will be market driven and this requires that government:

- Relinquishes controls on exploration and mine development quota
- Should not introduce any special policy incentives for CTL
- Promotes R&D into UCG methods for exploiting deep coals that are uneconomic to mine conventionally
- Replaces inflexible, prescriptive, regulatory standards with performance standards
- Facilitates investment in enhanced transport capacity to match coal freight demands
- Allows equal competition between private and State-owned mines
- Exposes China's coal mines to foreign competition by abolishing import and export duties
- Ensures full costs of production are met by all mining companies
- Establishes rational small mine approval criteria for remote areas to replace arbitrary minimum capacity criterion
- Allows foreign majority ownership of coal mines to attract FDI and technology transfer
- Introduces a "bottom-up" approach to improving mine safety
- Streamlines coal industry administration, assigns clear, non overlapping roles to ministries, and establishes a coal industry management authority at Central Government level.

Strategic planning

Long-term strategic planning of coal mining sector development is essential if China is to meet its sustainability aspirations. During the 11th Five Year Plan (2006-2010), China intends to produce 2.6 Bt of coal by 2010 of which 2.1 Bt is expected to come from large and medium scale mines and about 0.5 Bt from small mines (calculated assuming 10,000 small mines with an average production of 500 Ktpa). Half of this coal will come from the very large coal enterprises (super-groups) of which 6 to 8 will be producing over 100 Mt coal per year each and 8 to 10 will each be producing over 50 Mt per year. The Government plans to cap coal production capacity at 2.6 Btpa, but industry observers are predicting a demand of 3 Bt or considerably more by 2010. By this time small-scale mining will have limited capacity for expansion thereby removing the ability of the coal mining sector to rapidly switch in production to meet shortfalls. Restrictions to market competition from overseas suppliers must therefore be lifted to encourage increased efficiency in domestic coal mines and the free flow of imports.

Rather than set production caps and then adopt a "stop go" strategy, the Government of China should be establishing market conditions in which the coal price moves in response to supply and demand variations.

Regulations and enforcement should be aimed at ensuring that safety and environmental performance standards are attained.

The full environmental and social costs must be carried by the mining operations, otherwise the Government will be faced with growing future liabilities for pollution and loss of water resources, degraded land and worker disease which will have a serious impact on an economy that will become strained by increasing scarcity of energy resources.

China cannot rely wholly on its own coal resources to supply the expected rise in demand because of geographical, transportation and development constraints and should plan to accommodate increased imports. This will sharpen competition, extend the limited life of China's coal reserves and integrate China into the global coal market. The strategy should recognize the finite life of the currently proven coal reserves and create conditions which will encourage more investment in the exploration of coal resources and development of advanced technologies for recovering energy from coal seams that are either inaccessible to conventional mining or of too poor quality. Without a long-term strategic action plan for coal supply, China's coal reserves could be exhausted well before the end of the century. Fundamental to the strategy are sustainable mining practices; otherwise the environmental fabric of China will be irreparably damaged with serious impact on the inhabitants of mining areas, and ultimately the national economy.

To ensure sustainability of coal supply, reserves must be extracted using modern, safe and efficient mechanized mining methods without having an adverse impact on the social and environmental fabric of the country, especially water resources. Best use must be made of finite coal resources and technologies for extracting energy from coal below feasible mining depths should be developed to extend China's coal resources. To ensure smooth coal supplies, new mines must be constructed, imports gradually ramped up and transportation systems expanded commensurately with internal coal distribution needs. Government policy to concentrate mining on fewer longwall faces will make coal output more sensitive to both geology and accidents. More detailed exploration and improved safety measures are therefore fundamental to the control of domestic coal supply risks. Without these improvements overall operating costs will increase which will have an impact on price stability.

High grade management and skilled technical staff must be recruited, trained and retained by the mines to ensure that the performances of mining assets are maximized for improved efficiency. This is recognized by the mining companies, but the market for high caliber graduates, management and technical staff is competitive and mining is not viewed as the most attractive career.

Coal market and competition

The fundamental market principle that should be recognized by the Government is that mining companies should be allowed to pursue their own self interest, but be forced by regulations to take into account the adverse impact of their activities on society and the environment.

The performance of a market based coal mining sector in which the Government expended its efforts on strengthening regulatory controls of the impact of mining, rather than invoking ineffective central planning techniques, would be more predicable and compatible with achieving its aims using tried and tested policy tools that have been amply demonstrated in developed coal mining countries.

The Government of China includes coal mining as one of its strategically important sectors to which state capital should be channeled. The Government insists on maintaining State control despite outwardly encouraging diversified ownership through share holding reform, strategic investors, restructuring or listing. The ownership structure of the large former key State-owned coal mining enterprises inhibits entrepreneurial activity and the trend is towards domination by a few large corporate entities under provincial and Central Government control with public and private sector participation limited to nominal shareholding. Inter ministerial and inter departmental policy conflicts and disparate aims are distracting senior decision makers from the core business of management and developing long-term sustainable strategy.

The large, consolidated mining group companies now have the corporate, financial and management resources to guide investment in the business to optimize revenue and it is an opportune time to relax too rigid, largely ineffective government planning controls and take fuller advantage of market forces. This will place more reliance on market-based instruments for regulation of sector activities.

As the Government of China has not yet declared its willingness to relinquish its majority ownership of a large part of the nation's coal mining capacity, and continues to intervene with planning controls, inherent inefficiencies are inevitable within the coal industry and will remain unless further reforms are undertaken as recommended in this report.

Safety, health and environment

Environmental, safety, health and social performance of coal mining enterprises is of concern to the Central Government. Substantial policy has been introduced in an attempt to improve protection of the environment from mining induced damage, raise health and safety conditions in mines and to provide employee health, accident and pension protection. However, due to ineffective enforcement through supervision and monitoring and failure to address underlying causes, progress has been slow and inconsistent and further government action is required. The objectives of the coal mining sector are focused on meeting energy demands first, with too little consideration of the human and environmental cost, especially among the small private, locally and community owned mines and this situation must be changed in order to develop a sustainable coal mining sector.

Criteria that define a modern, safe and sustainable coal mining sector should be encapsulated in a legal and regulatory framework and include competitive access to reserves, efficient and economic extraction (including resource protection), enforced safe working practices, acceptance of environmental protection responsibilities, training, recruitment and retention of skills and expertise.

In moving towards a sustainable coal mining sector the key social and environmental coal mining sector issues that need to be addressed by the Government are miners' health, safety, welfare and employment; mine closures; land subsidence; mine waste; water pollution and environmental problems created by past mining. There is a historical legacy of environmental degradation associated with past mining. Restoration of abandoned mine sites, waste tips, polluted water courses and subsided land will involve massive government expenditure, but future problems can be prevented by ensuring mines carry the true costs of controlling its negative impact.

Environmental priorities in China's coal mining sector that require government action are:

1. Greenhouse gas emission reductions
2. Groundwater protection and water conservation to ensure civil and industrial water supplies can be sustained

3. Land protection, reclamation and re-use to prevent degradation and further mining-induced loss of agricultural land which is also being severely eroded by urbanization.

Appendix 1 Underground coal gasification (UCG)

UCG exploits the energy content of coal while avoiding the environmental problems at the surface associated with coal mining, disposal of mining waste and coal combustion. Moreover, there are no methane emissions when this technology is used. The UCG process involves injecting water/steam and air or oxygen into a coal seam. The injected gases react with coal to form a combustible gas which is brought to the surface and cleaned prior to utilization. The use of a combined cycle plant will provide high efficiency power generation and the CO_2 could be concentrated for sequestration.

Large-scale, shallow seam-based schemes have operated in the Soviet Union for more than 40 years. Early research into UCG concentrated on coals at relatively shallow depth. These projects mainly involved the use of existing and purpose made mine entries and underground infrastructure, shallow boreholes or a combination of the two approaches. Recent work in the USA, Europe and Australia has concentrated on the exploitation of UCG in coal seams accessed using advanced guided drilling techniques (Creedy et al 2001). While all the technologies needed for UCG are technically feasible, no long-term commercial operations have been established outside the former Soviet Union. China has undertaken many UCG projects, but relies on mining methods for creating underground gasifiers which will not be feasible for large-scale exploitation of deep coal seams.

Many UCG trials have been carried out by government-financed research institutes in China where the technology has been applied to recover energy from residual coal pillars in mined areas, thus increasing resource recovery. There are two distinct UCG approaches in China: the under-surface gasification method and the long tunnel, large section, two-stage method. Under-surface gasification is an extension of mining in which gasifiers replace working faces and are controlled independently from underground to ensure optimum performance. Underground access is maintained at all stages of the operation. The long tunnel method involves controlling a mined gasifier from the surface through a series of surface boreholes. This method can produce an intermittent 12 to 14 MJ/m^3 of gas from its two stage process compared with 4 to 6 MJ/m^3 in an air-blown under-surface gasifier. Product stability is difficult to maintain without the use of costly oxygen and performances are unpredictably variable in Chinese gasifiers.

Optimized reaction conditions in deep, drilled systems could produce gas with a heat value of $16MJ/m^3$. Benefits of deep UCG gasifiers, compared with shallow installations, additional to higher gas quality, are elevated pressures, higher mass flows and hence greater efficiency of energy transmission to the surface. This technology, if commercially viable, would provide a cleaner and lower greenhouse gas emission route for power generation and, by allowing exploitation of seams below feasible mining depths, has the potential to substantially extend China's recoverable coal energy resources.

The use of advanced gas cleaning techniques at a UCG plant could enable high sulfur coal seams to be exploited for power generation without causing air pollution. The technology being developed in Australia, the UK and some other countries involves the application of drilled, safe, deep UCG technologies linked to combined-cycle power generation plants. UCG combined with power generation provides a zero methane emissions alternative to conventional coal mining and a significant reduction in greenhouse gas emissions, possibly by as much as 50 percent, over current mining and coal-fired power plant operations (Creedy et al 2001).

Appendix 2 Example of selling mining right by auction

An announcement for transfer of exploration and mining rights by bidding

In accordance with the relevant laws and regulations, approved by the Department of Land & Resources of Heilongjiang Province, it is intended to transfer the exploration rights of Jixi Hezuo (cooperative) coal mine (part of the mine) of Heilongjiang Longxing International Resources Development Group Co. Ltd. and Qifeng No. 2 District of Qitaihe municipality and the mining right of Jixi Pingyang mine. The extent of the mining area transferred and the contents of relevant issues about auction will include:

1. Introduction of mining right, the initial price and cash deposit for auction
2. Introduction of exploration right, the initial price and cash deposit for auction
3. The scope of bidders

(1) All companies, enterprises and natural persons (except being stipulated by other laws) within and outside People’s Republic of China may take part in auction (The bid can be bought individually or collectively).

(2) All the participants, enterprises (organizations) should go through formalities for bidding, by holding a copy of business license, assets evidentiary materials; legal agent certificate, original and copy of ID of legal agent or a letter of authority of the legal agent, or power of attorney of the legal person, an original and copy of the principal (if the bidder is a natural person, holding an original of ID).

4. Time and place for listing application
5. Time and place for listing
6. Miscellaneous items

(1) For type of payment, the relevant stipulations about the auction and issues not mentioned please see the relevant transfer document obtained in making the application.

(2) The cash deposit will be returned to those not getting the bid within five working days after completion of listing (not including the interest).

Heilongjiang Province Land Resources Purchase and Reserve Trading Centre, June 26 2006.

Appendix 3 Safety management and culture

Introduction

This Appendix examines the role of safety management, and the importance of a culture of safety, in improving workplace safety in the coal mining industry.

A responsible employer will recognize the moral, legal and financial necessity of ensuring the safety of employees. The benefits to a company of improved safety standards can be substantial and include:

- Fewer working days lost due to accidents
- Increased profit
- More secure and motivated workforce
- Better image to public and customers

In most countries, health and safety laws have been enacted and regulations implemented to protect the safety of the workforce. Inspection and enforcement by a trained inspectorate monitor compliance. However, a legal requirement for safe working practices and the threat of prosecution does not necessarily guarantee the law is obeyed.

Failures to manage safety adequately arise in both developing and developed countries although, in general, the consequences are less severe in the latter. One reason for this is that there are fewer men underground due to greater mechanization, while another may be that non-compliance with safety rules occurs less frequently.

The challenges are also greater in developing countries where accident rates may be exacerbated by:

- Obsolete equipment
- Lack of management skills
- Absence of a safety culture
- Poor rewards
- Shortage of investment in modern safety equipment

It is all too easy to place the blame for accidents solely on management. They have an important role to play, but effective safety management also requires the active participation of the workers. There is strong evidence that involvement of the workforce, both in safety committees and as workers safety representatives, can reduce workplace injuries significantly, sometimes by more than fifty per cent according to some research. The failures leading to any workplace accident arise as a result of human frailty involving both management and workforce. To provide the necessary level of protection the following elements are required:

- An effective safety management system
- A safety culture which permeates both management and workforce.

Effective safety management systems facilitate the safe integration of humans and work-related processes. Human error is unavoidable so safety management is designed to minimize the consequences of human failure and take account of the notion that the more severe the consequences of failure, the greater the importance of safety management.

A safety management system, as required by the UK Health and Safety Executive and used as a framework by UK mining companies, contains the following elements:

- Policy – a definition of what needs to be achieved and the strategy for achieving it.
- Organization – a management structure which identifies who is responsible and who does what.
- Planning – identification of risks, probability of occurrence and their potential impact (risk assessment), and design of control measures to reduce risks to an acceptable level. Identification of suitable,

safe technologies to do the job and provision of technical support from experienced specialists. Definition of operating rules and procedures (safe methods of working).

- Monitoring to ensure the effectiveness of the safety management system.
- Audit and review to assess whether procedures are working and, if not, then how to amend them.

Safety culture

A safety culture will only develop once individuals recognize and accept some responsibility for the safety of themselves and colleagues.

The attitudes of individuals to safety can be influenced by a variety factors. These could include a macho culture, social problems, poor living conditions, lack of hope for future improvement, low value of life, lack of self esteem, lack of recognition by seniors, ignorance, poor education, and inadequate training. Attitudes will also depend on parental influence, education, training, leader and peer pressures.

Job related pressures may also play a part, especially in developing countries due to:

- Increased mechanization
- Unfamiliar equipment
- Increased production
- Reduced staffing level
- Cost saving pressures
- Difficult mining conditions

Various approaches can be employed to raise awareness of safety issues and help to change cultural attitudes. These include introducing incentives and rewards for accident free achievements and for safety suggestions, worker involvement in safety competitions and dissemination of safety promotional material. Training is of paramount importance. This could include risk assessment techniques, improving the understanding of the workplace environment, use of safety equipment and first-aid techniques. Once individuals recognize how they can help each other to work more safely, the necessary cultural change has started to take place.

Safety culture in the workplace will also be reflected by the safety culture in society. Greater awareness of personal safety in everyday life, such as the wearing of seat belts in road vehicles, is a sign of a maturing safety culture. Factors conducive to an improving workplace safety culture are:

- Changing social attitudes
- Improving living and working conditions
- Increased responsibility for everyday living

The modern approach to safety education is to use interactive teaching methods and positive reinforcement of principles, that is, to concentrate on rewarding improvement rather than highlighting failure. In a country such as China which is developing rapidly, external assistance is needed to accelerate training in safety practices and culture. The most effective help would be to train the trainers and the US and Australian governments have funded suitable training schemes, while UNDP and ADB have also initiated mine safety projects.

Conclusions

The basic principles of safety management - the systematic control of risk - can be applied to all workplaces. However, safety management will only be effective where a safety culture exists throughout all levels of the industry, including the senior management.

A safer workplace can be achieved by a combination of:

- Suitable technology to perform the job required
- Compliance with all relevant laws, regulations and official guidance

- Regular inspection (by the statutory body, management, safety professionals and workers representatives)
- Firm enforcement of rules by management and laws by the regulatory authority
- Training for safe working
- Responsibility (a safety culture)

Appendix 4 Role of mineworker safety inspectors (after Feickert 2007)

United Kingdom: The role of 'workmen's inspector' was recognized as early as 1872. By 1911 the UK had a well-structured system of statutory safety inspection, a statutory role for pit safety supervisors (deputies) and a statutory role for worker inspectors who were elected by the workforce, through the union representing the majority of the workers. Candidates must have five years' experience as miners. As required by law, after their regular safety inspections, a copy of their statutory inspection report is sent to the Government Mines Inspector covering their mine. The role of workmen's inspector, which was strengthened further in Section 123 of the Mines and Quarries Act, 1954, became a model for general worker safety representatives. This was embodied for the other workplaces in the 1977 Safety Representatives and Safety Committees Regulation and the 1995 Health and Safety Consultation with Employees Regulations. This legislation is, in turn, supported by the EU Framework Directive on Safety and Health 1989 and its linked Extractive Industries Directive 1992. In addition, when the UK coal industry was nationalized in 1946, the legislation required the National Coal Board (NCB) to consult the miners' unions on operational questions and on health and safety. A safety consultation system was built up from the mine level to the national level based on safety committees. The National Union of Mineworkers employed qualified mining engineers, with extensive safety and production experience. The NCB and Inspectorates were professionalized. With such a safety organization the accident rate fell rapidly from 1946 to the point where the UK could claim to have the safest coal industry in the world. Training for workmen's inspectors was organized by the union's safety engineers, in co-operation with the NCB Safety Department and the Mines Inspectorate.

Australia: In Australia, the legislation is similar to the UK but is applied at state rather than federal level. The following is taken from the revised proposals for New South Wales (NSW), although most of the provisions only slightly modify existing law. Check inspectors are located at both site level and district level. The site check inspectors are elected by the workforce. Candidates must have three years experience at the site, or at a similar site. Electrical site check inspectors are also elected. The employer must assist the check inspector to carry out his inspection responsibilities and allow sufficient time to do so during normal working hours. The district check inspector is paid and full-time. The site check inspector has access to the Mines Inspector and reports to him through the district check inspector as well as to the manager. If the site check inspector reports a dangerous occurrence the operator must immediately inform the Chief Inspector. The district check inspector has the power to suspend operations in event of operator non-compliance with the law leading to danger to the workers. The site check inspectors must undertake a course of training in occupational safety and health that is accredited by the Minister. The NSW Department of Primary Industries covers the cost of the training.

New Zealand: Until 1992 there were workmen's inspectors, similar to those in British mines. The Health and Safety in Employment Act 1992, as amended in 2002 and 2003 replaced them with worker safety representatives at the same time that the latter were introduced throughout NZ workplaces, in many for the first time. The Act lays out the rights of worker safety representatives. These must be elected by the workers themselves, with any unions organizing them involved in the election. The overall approach to health and safety is based on worker participation, with the objective of securing an agreement between workers and the management, via a trade union. Mining is covered by these arrangements. Worker safety representatives must be trained on a course which is certified by the Minister. They have the right to undertake two days paid training. The Council of Trade Unions' Course is the certified course commonly used and since the Act was introduced, 13,000 safety representatives have been trained. Trained representatives can make recommendations regarding safety to their employers, who have a legal duty to either adopt the recommendation or explain why they will not do so. Worker representatives can also issue hazard notices and can advise workers to refuse dangerous work when faced with imminent danger.

Appendix 5 Comparative environmental protection case study from Australia

A case study has been undertaken into the environmental impact and controls of coal mining in the Hunter Valley of New South Wales (NSW), Australia as an example of what China should strive to achieve, and as illustrative of costs and administrative mechanisms. The Hunter Valley region is one of the largest coal producers in Australia. Surface mining is dominant with around 80 percent of production occurring by open cut methods. This type of mining is large-scale and results in extensive environmental impact, particularly loss of visual amenity, dust, noise, surface and ground water. Although underground mining is less visually intrusive, it adds another dimension to the environmental issues, in particular the impact of subsidence on roads and other public infrastructure as well as private property.

The Hunter Valley mining industry co-exists with other land users, including agriculture, horse-breeding and tourism. Wine production in particular has grown in the area in recent years and conflicts between both industries are occasionally resolved in the courts. Opposition to mining from other sources is also growing. A recent court judgment for example found against the mining company concerned on the grounds that the global impact of climate change from a new open cut operation was not considered sufficiently in the Environmental Impact Assessment.

The case studies illustrate that mining can co-exist with competing and theoretically incompatible land uses by:

- working within a robust regulatory environment
- adopting voluntary, self-regulatory initiatives such as Codes
- being proactive in environmental management and community engagement; and
- using sound mine planning based on good science and engineering

There is no doubt that the environmental and safety controls that the Australian mining companies operating in the Hunter Valley have implemented, are among world’s best. However, such efforts and excellence come at a significant cost. It is estimated that the annual cost of environmental management measures at a typical Hunter Valley surface mine is around AUD$4 to $7 million. Due to the large tonnages mined, this translates to around 30 cents per raw tonne mined. For underground mines, it may be around A$2 to 3 million, with similar costs per tonne. However to continue to operate in a region in which mining competes as a land use with wine growers, horse breeders, hobby farmers and tourists in general, this is the price that must be paid.

Companies spend a significant proportion of their budgets on health and safety prevention also. But when one considers that a single fatality can cost the company between A$3 and A$10 million (about US$2.5m to US$8.3m), prevention strategies are a good business strategy.

Despite the initiatives, mining companies face increasing challenges to gain community and political support for their activities. Furthermore, recent court cases involving both environmental and safety issues have damaged the industry’s credibility and created additional costs and distractions, at a time when there is enormous global demand for its products.

Appendix 6 A recommended mine planning approach to control subsidence impact

The subsidence impact planning procedures developed by the former British Coal provide a model that could adopted by China's coal mines (Wilshaw D, Coal Mining Environmental Impact Study, Shanxi Province, China. Wardell Armstrong LLP on behalf of the World Bank, 31 May 2007)

Subsidence impact should be considered as an integral part of the mine planning procedure. With this in mind a 'Subsidence Sensitivity Plan' should be prepared for each mine identifying areas of concern. For example, built up areas should be delineated along with major rivers, cultivated land, fault outcrops, service routes and major aquifers. Thus, the potential impact of subsidence on each of these features can be assessed.

A report should be prepared for each proposed mine panel well in advance of the mining event (e.g. 2-3 years in advance). Specific consideration should be given to:

- assessing the potential resultant ground movements
- identifying any significant environmental / social consequences
- appraising the likelihood of high subsidence costs

Where workings are required to be carried out beneath sensitive areas such as buildings and bodies of water, then consideration should be given to minimizing the subsidence impact by:

- limiting panel widths to 50 m to 100 m
- limiting the height of coal extraction to 1.5 rfm
- adoption of a partial extraction system of mining to produce a more uniform subsidence profile
- carrying out preventative measures to surface structures / landforms

Village re-location may be necessary where the coal seam is at very shallow depth (less than 100 m), the extraction height is more than 2 m and/or where the village is a small community and relocation is feasible.

Having implemented mining activities a standard code of practice should be applied to deal with the remediation of damage. Emphasis should be based on repair rather than just compensation. Repairs and treatment should be undertaken as soon as possible.

Where services are disrupted, for example whereby villages lose water and / or electric supplies, these should be repaired as soon as possible.

Fissures should be repaired by capping or plugging and where necessary re-grading of the land profile to reinstate the land to its former use. Un-repaired fissures represent a hazard to the public and render land permanently incapable of being farmed.

Where there is a perceived risk of a landslip being induced which could have a serious impact on properties or infrastructure, consideration should be given to carrying out works in advance of the mining (preventative works) to mitigate such effects.

Where watercourses are affected by fissuring then remedial measures should be carried out to contain flows within the river channel and prevent flows into the underlying aquifer. Where such fissures are left unattended there can be serious affects on the downstream environment which can result in pollution of the aquifer.

Destruction of aquifers, in a dry climate, appears environmentally unacceptable. However, in view of the mining parameters such problems may not be able to be avoided. The problem is not simply associated with the provision of alternative water supplies as this does nothing to reinstate the aquifer. Alternative mining practices appear to be the primary solution to this problem.

Where crop yields are affected then farmers should be properly compensated. If land is rendered permanently incapable of farming then the farmer's loss should be quantified accordingly. It is not sufficient to offer farmers limited compensation and thereafter leave them to determine their own destiny.

Significant damage to highways, affecting traffic flows, and residential properties should be considered as 'emergency works' to enable their continued function. Such works would not necessarily be a permanent repair, but suffice to enable continued and safe use of the facility.

In one instance it was reported that pillars of protection had been provided for a village but small mine operations and illegal mining had taken place causing damage to the properties in the village. Such operations need to be regulated, otherwise coal reserves are being sterilized for no benefit.

In the UK, under the former nationalized coal industry, internal procedures required mine proposals to be referred to senior management when subsidence costs were expected to exceed 3 percent of proceeds. This criterion allows mine managers to make decisions and manage subsidence issues when costs are within normal bounds.

Appendix 7 Coal industry administration in Shanxi Province

Authorities at provincial, municipal and county levels have coal industry administrative responsibilities. However, coal administration agencies at municipal and country levels have different operating roles from those at provincial level.

The three main coal sector administration departments at Shanxi provincial level are the Coal Mine Safety Supervision Bureau, Coal Industry Bureau and the Work Safety Supervision Bureau.

Additional coal sector functions are undertaken by the Provincial Department of Land and Resources, the Development and Reform Commission, the Economic and Trade Committee and the State-owned Assets Supervision and Administration Commission.

The Shanxi Coal Mine Safety Supervision Bureau was founded in a government reform of 2000 by re-designation of the Coal Industry Bureau and vertically integrated under the State Bureau of Coal Mine Safety Supervision. According to the regulations *Provisions on Coal Mine Safety Supervision System* issued by the State Council, its duties include dealing with illegal mining practices, licensing and certification, reviewing of designs of safety facilities and completed projects, training and the investigation of accidents. It has a staff of 75.

The Provincial Safety Work Supervision Bureau is affiliated to the provincial government and its duties include inspecting local coal mines, enforcing regulations, closing mines that do not comply with safety regulations, investigating accidents and supervising the training of miners. There are 35 staff members working in various divisions, namely office services, policy, planning and technology, safety work co-ordination, coal mine safety supervision, dangerous chemicals safety supervision, rescue office and a personnel training centre.

Coal Industry Bureau of Shanxi**:** In September 2000, the provincial department of coal industry was reorganized as the Shanxi Coal Industry Bureau. Its main responsibilities are to develop coal industry strategies and plans, advise on comprehensive utilization and restructuring, formulate development policies and regulations, supervise the law, regulations and technical standards, supply chain market orientation, promote reforms, close illegal mines, regulate licensing, gather, analyze, disseminate coal industry information and manage government subsidies and development funds. According to the *Notice of Duties and Manning* by the provincial government, the Provincial Bureau of Safety Supervision comprises the following divisions: office, planning and development, industry administration, operations, accounting and personnel. Its many tasks are undertaken by 32 staff members.

Shanxi Provincial Land and Resources Department**:** Shanxi Provincial Land and Resources Department is responsible for land and mineral resources administration. Its main responsibilities are: geological resources plans and management, resource protection, reviewing plans at municipal, county and township levels and approval of exploration and mining right licenses. Shanxi Provincial Land and Resources Department has 15 agencies, including those involved in coal industry management, mineral resources exploitation and management division, mineral resources reserve division, geological environment division and geological exploration division. At present the department has 2,749 staff members and 12,741 employees with over 900 management staff.

Shanxi Provincial Development and Reform Commission**:** Shanxi Provincial Development and Reform Commission is in charge of formulating economic and social policies of the province, economic reform, macro management of the coal industry and approval of coal mine construction projects. The energy division is responsible for proposing energy strategies and policies, and for setting energy development plans. It is also in charge of transportation and sales of coal.

Shanxi Provincial Economic Committee**:** Shanxi Provincial Economic Committee is part of the Provincial Government. The committee is responsible for supervising the economic operation of the coal industry, coal production, transportation, sales and issuing of licenses. It has 15 divisions, of which the most relevant to the coal industry is the energy division. This division has responsibilities which including devising energy base construction plans, coal production, transportation and sales coordination and adjustment, setting coal special fund management policies, organizing coal fairs and setting annual target for coal sales, and reviewing operation qualification and issuing licenses.

State-owned Assets Supervision and Administration Commission of Shanxi Provincial Government**:** The State-owned Assets Supervision and Administration Commission of Shanxi Provincial Government is affiliated to the Provincial Government. Its duties include supervising key state-owned coal enterprises' state-owned assets, and reform and management.

In Shanxi, there are problems in the coal administration agencies arising due to overlapping of both agencies and duties which in turn causes weakening of the administration. In July 2007, according to the policies of the state council, the Government issued the *Notice on the Adjustment of Coal Industry Administration.* This procedure put the Provincial Bureau of the Coal Industry in charge of safety supervision of coal mines and also issuing certificates to heads of coal mines and special operators.

As a consequence, the bureau added the following divisions to its structure: general affairs, safety supervision, implementation, rescue, environmental protection and training. The number of divisions increased from 6 to 13 and staff members from 32 to 68.

Coal administration agencies at municipal and county level

Coal mine safety work supervision agencies**:** All of the 11 cities in the province established coal mine safety supervision subdivisions which are responsible for the local coal mine safety supervision. These have a total of 220 staff members.

Safety supervision and administration agencies and coal industry agencies: In 2001, all the 11 cities organized safety supervision bureaus based on the former coal industry bureau. Except for Taiyuan and Yuncheng, all the other nine cities retained the title of coal industry bureau.

The safety supervision bureaus in each city are affiliated to the municipal government. Their main duties include: supervision of the enterprises' implementation of the law, regulations, policies, standards and development strategies; technology improvements; production and operational practices; co-ordination of closure of illegal coal mines; approving newly opened mines; and reporting to higher authorities. The compositions of safety supervision bureau and coal industry bureau differ from city to city. Generally, they have such divisions as coal industry management and safety supervision with numbers of staff ranging from 30 to 90.

After 2005, the organization of safety supervision and coal industry agencies in some cities changed. All the 11 cities, except Yuncheng, established a coal industry bureau. Six coal industry bureaus were formed separate from the safety supervision agencies while four coal industry bureaus shared the same staff with safety supervision agencies. Ten Coal Industry Bureaus at city level are under the local government. Xinzhou, Linfen, Shuozhou, Lvliang, Taiyuan and Datong Coal Industry Bureaus belong to the ETC, but with independent operation. Jinzhong, Yangquan, Jincheng and Changzhi Coal Industry Bureaus answer to the ETC, but without independent operation. Coal industry bureau at city level normally have 10-20 staff members with 5-6 inner agencies.

Coal administration departments at county level are mainly coal industry bureaus and safety supervision bureaus. They are normally operated together, thus sharing the responsibilities of safety, planning, technical instruction and co-ordination. Most of the counties also established safety supervision offices at coal producing townships. Coal management departments at county level differ in composition and manning. For example, Qinshui coal industry bureau and safety supervision bureau has four departments, one office, one team and three centers with 69 staff members. Eight coal producing townships have established safety supervision offices, with 43 staff members and 61 supervisors stationed in the coal mines and 24 gas supervisors.

In 2007, the Provincial Government issued a notice requiring all the 11 cities to establish coal industry bureau and adjust their duties accordingly. However, to date reorganization has been slow.

Problems with coal administration agencies at different levels

The existing administrative system comprising Shanxi coal mine safety supervision bureau, Shanxi coal industry bureau, Shanxi safety supervision bureau and Shanxi land and resources department has many problems arising from overlapping and conflicting duties, especially involving the three former bureaus.

There are agencies with overlapping duties in the Shanxi coal mine safety supervision bureau, safety supervision bureau and coal industry bureau all which have supervision responsibilities.

In July 2007, the 11th circular issued by Shanxi adjusted the coalmine safety supervision system. Accordingly, the coal mine supervision duty of the safety supervision bureau should be transferred to the coal industry bureau making it solely responsible for production, construction and safety of all mines. Both Shanxi coal mine safety supervision bureau and the provincial coal industry bureau have a safety supervision office and a training center.

Shanxi Coal Mine Safety Supervision Bureau and Shanxi Coal Industry Bureau have overlapping duties in coal mine safety management and coal industry administration regarding the issue and examine and approval of several licenses.

According to the Coal Law, coal production license regulation, the issuing of coal production licenses, licensing the coal mine head of coal, training and issuing special work permits is the responsibility of the coal administration.

According to the Work Safety Law, coal mine safety supervision regulation and the 79th circular, Shanxi coal safety supervision bureau is responsible for the issue of certificates of coal mine safety work, coal mine head safety, and special staff. The C*oal Mine Head Certificate* and C*oal Mine Head Safety Certificate* are identical in effect and therefore represent unnecessary duplication.

In view of the above problem, in July 2007, Shanxi Provincial Government transferred the responsibility of both supervision and the appraisal of coal mine head from the work safety supervision bureau to the provincial coal industry bureau. This represents a positive move towards reducing the complexity of Shanxi's coal mining administration.

The overlapping duties have affected the efficiency of enterprises. Too many certificates are needed for enterprises and they are only applicable for a limited period which means that enterprises have to start applying for the next certificate almost immediately on being issued a new one. The enterprises cannot operate legally unless all certificates are extant. Some coalmines at township level receive as many as 1000 documents each year which the small enterprises have difficulty in understanding and complying with. Such an avalanche of administration is unreasonable, representing a high burden of administrative cost to mines and also results in excessive and wasteful administrative costs to local governments.

Coal mine safety supervision department's duties are extended to industry administration which effectively make it both the enforcer and supervisor. This is especially the case of the five coal industry administration departments and safety work supervision departments which share the same staff. When accidents occur, the same personnel are the investigator and the investigated, a scenario which inevitably weakens the strength of enforcement.

There are too few staff for coal mine safety enforcement because work safety supervision departments are responsible for not only coal mine safety supervision, but also for the safety supervision of all industrial sectors. There are only 220 staff members in charge of coal mine safety supervision work and over 3000 coal mines. Thus, safety problems are not detected as rapidly as they should be and mining enterprises are not subjected to sufficient inspections to deter bad practice.

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