STRANDED ASSETS
PROGRAMME

Smith School of Enterprise and the Environment

UNIVERSITY OF OXFORD

Stranded Down Under?

Environment-related factors changing China's demand for coal and what this means for Australian coal assets

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About the Stranded Asset Programme

'Stranded assets' are assets that have suffered from unanticipated or premature write-downs, devaluations or conversion to liabilities. They can be caused by a range of environment-related risks and these risks are poorly understood and regularly mispriced, which has resulted in a significant over-exposure to environmentally unsustainable assets throughout our financial and economic systems. Current and emerging risks related to the environment represent a major discontinuity, able to profoundly alter asset values across a wide range of sectors. Some of these risk factors include:

- Environmental challenges (e.g. climate change, water constraints)
- Changing resource landscapes (e.g. shale gas, phosphate)
- New government regulations (e.g. carbon pricing, air pollution regulation)
- Falling clean technology costs (e.g. solar PV, onshore wind)
- Evolving social norms (e.g. fossil fuel divestment campaign) and consumer behaviour (e.g. certification schemes)
- Litigation and changing statutory interpretations (e.g. changes in the application of existing laws and legislation)

The Stranded Assets Programme at the University of Oxford's Smith School of Enterprise and the Environment was established in 2012 to understand these risks in different sectors and systemically. We test and analyse the materiality of stranded asset risks over different time horizons and research the potential impacts of stranded assets on investors, businesses, regulators and policymakers. We also work with partners to develop strategies to manage the consequences of stranded assets.

The Programme is currently being supported through donations from the Ashden Trust, Aviva Investors, Bunge Ltd, Craigmore Sustainables, the Generation Foundation, the Growald Family Fund, HSBC Holdings plc, the Rothschild Foundation and WWF-UK. Our non-financing partners currently include Standard & Poor's, Trucost, Ceres, Carbon Tracker Initiative, Asset Owners Disclosure Project, and RISKERGY.

The Programme is led by Ben Caldecott and its work is guided by the Global Stranded Assets Advisory Council chaired by Professor Gordon Clark, Director of the Smith School. The Council is also a high-level forum for work on stranded assets to be co-ordinated internationally. Members currently include:

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Executive Summary

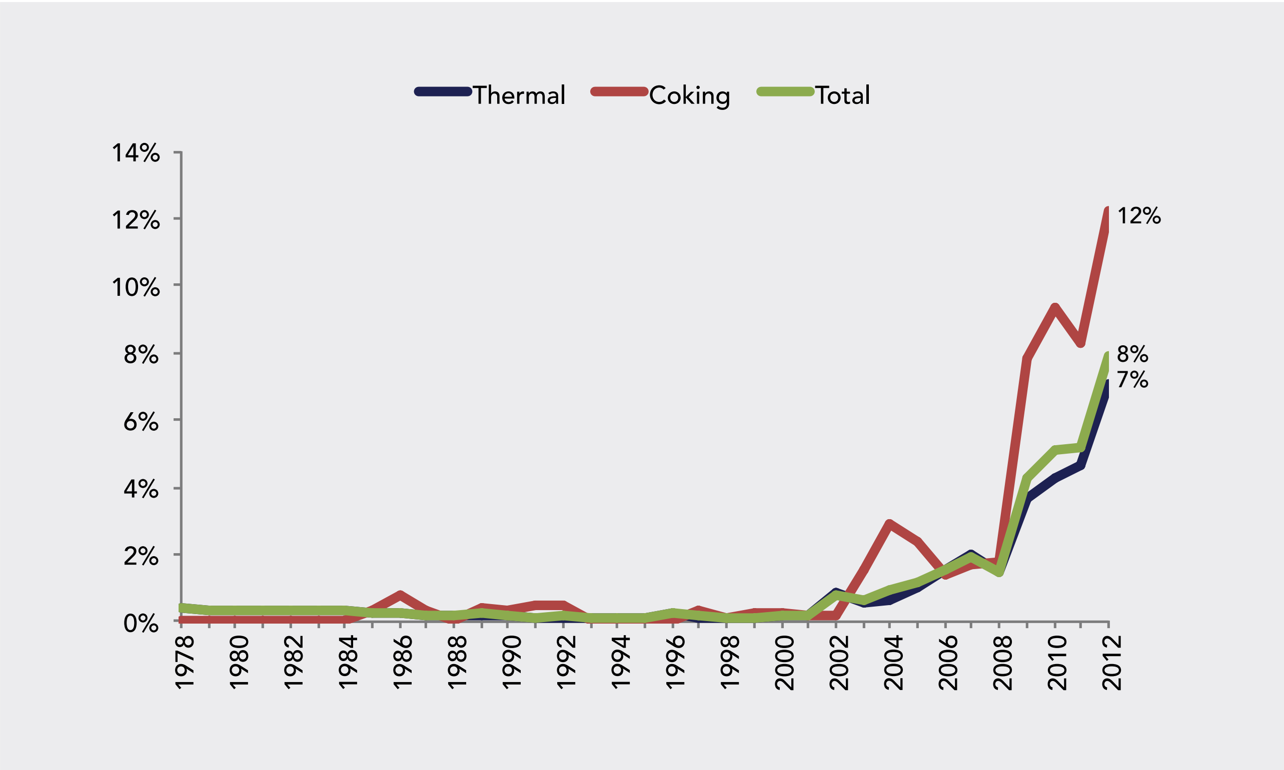
In the last two years, the issue of 'stranded assets' has started to loom larger and larger. Stranded assets are assets that have suffered from unanticipated or premature write-downs, devaluations or conversion to liabilities, and they can be caused by a range of environment-related risks.

This report investigates how China's demand for coal is changing as a result of such factors, including environmental regulation, developments in cleaner technologies, local pollution, improving energy efficiency, changing resource landscapes and political activism. We look at how this evolving demand picture could then translate into impacts on coal and coal-related assets in Australia – a country that is a large and growing coal exporter to China. We also identify areas for further work. This is the first of a series of studies looking at coal and stranded assets internationally.

Investors, businesses and communities, as well as state governments and the federal government in Australia, could be affected by a slowdown in China's demand for coal – changing demand and lower prices could result in stranded coal assets or increase the risk of asset stranding.

China's changing demand for coal

Figure 1: China's coal consumption provided by imports[1]



Footnotes:

[1] IEA, "Beyond 20/20."

China now accounts for half the world's coal consumption.[2] China has abundant coal reserves, but these have not been exploited quickly enough to meet growing demand, with the result that it became a net importer of coking coal in 2004 and a net importer of all coal in 2009,[3] disrupting world markets. Figure 1 shows the proportion of each type of coal consumption met from imports.

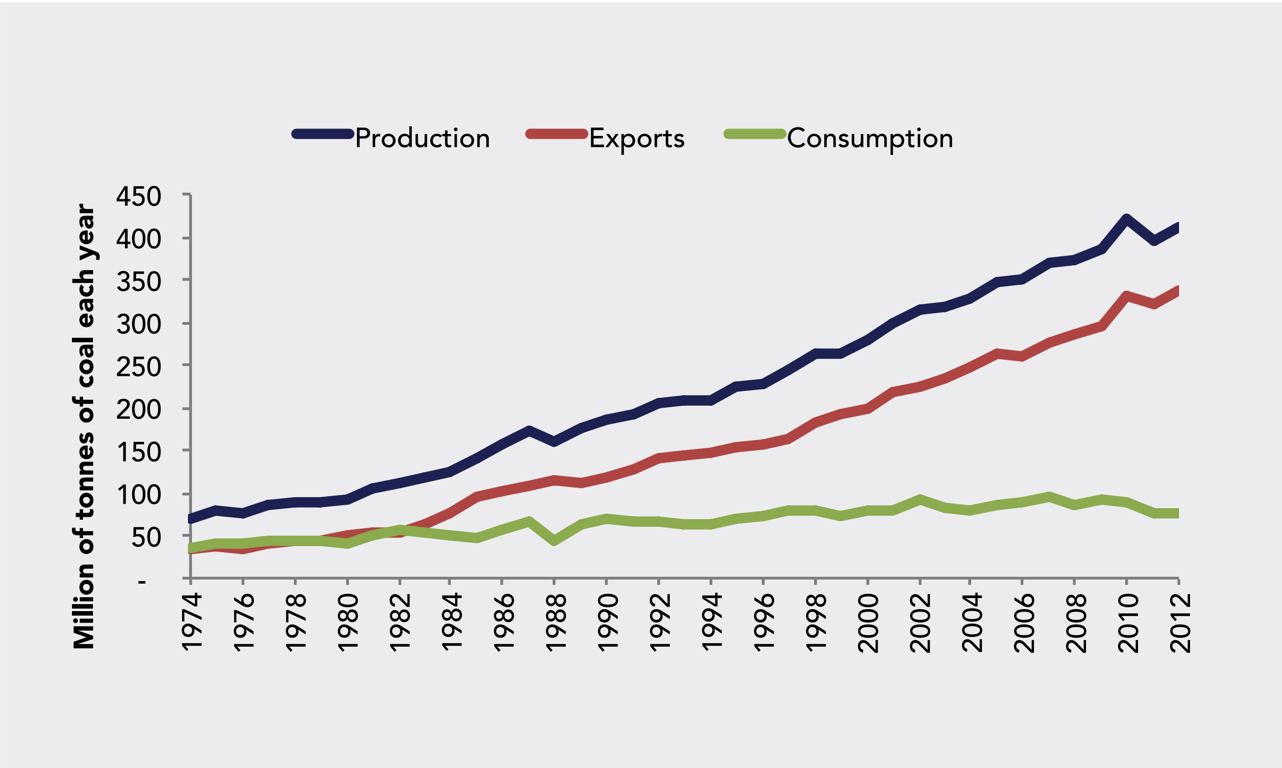
China became a net importer of coking coal in 2004 and a net importer of all coal in 2009, disrupting world markets.

China is becoming the price setter for coal.[4] With a domestic market that is now three times the size of the international coal trade, China is a major force for determining coal prices regionally and internationally.[5] This is likely to be the main mechanism through which changing coal demand in China will affect coal assets internationally – levels of demand will increasingly determine the prices faced by coal exporters in Australia and beyond.

China's recent surge in coal demand has led to proposals for a large number of new coal projects and expansions around the world. There has been renewed interest in areas previously thought to be uneconomic for coal mining – with increasing demand anticipated to provide demand and price support for many years to come.

China is a major force for determining coal prices regionally and internationally.

Figure 2: Australian coal production, exports and consumption[6]



Footnotes:

[2] US EIA, "International Energy Statistics."

[3] Tu and Johnson-Reiser, *Understanding China's Rising Coal Imports.*

[4] IEA, IEF, and OPEC, *Report on the First Symposium on Gas and Coal Market Outlooks.*

[5] Haftendorn, "Economics of the Global Steam Coal Market - Modeling Trade, Competition and Climate Policies."

[6] BREE, *Australian Energy Statistics.*

China's transformation into a significant net importer of coal has made it one of Australia's main export markets in less than five years. Exports to China made up just 3% of Australian thermal coal exports in 2007 and this grew to 18% in 2012.[7] Both the volume of Australian coal exported to China and the size of coal exports relative to total Australian exports is increasing and would be set to continue under business-as-usual conditions (Figure 2). Australian coal asset owners and operators, as well as policymakers, are looking to 'bank' this predicted future growth.

The emergence of environment-related factors

While growth rates and a structural economic shift from investment to consumption are significant determinants of China's future coal requirements, there are other factors shifting China's demand and in ways that are likely to reduce demand below levels currently expected by market participants. Many of these factors are related to the environment and could force owners and operators to re-evaluate the viability of coal projects already developed, as well as those recently proposed – particularly in Australia given its growing dependency on China as an export market.

Demand below expectations, and lower coal prices as a result, would increase the risk that coalmines, reserves and coal-related infrastructure could become mothballed or abandoned. Many planned greenfield projects and mine expansions in Australia were considered feasible based on high coal prices. If prices are low and stay that way, many of these projects will not go ahead. Prices could also drop to the point where it is in the interests of miners to cease production, resulting in stranded mines and dependent infrastructure such as railways.

Shifts already well underway in China are a serious concern over air pollution, a desire to reduce greenhouse gas emissions and to reduce exposure to volatile international commodity markets, particularly in oil and gas. This has resulted in the massive deployment of non-fossil energy driven by new policy frameworks, falling technology costs and the emergence of carbon pricing, which are trends set to continue and grow. Increasing water scarcity could also adversely impact coal demand, while domestic shale gas and changing international gas markets will result in more coal to gas switching. These factors are all likely to reduce China's growth in coal imports below levels currently expected.

Footnotes:

[7] Armitage, *Resources and Energy Statistics.*

Table 1: Summary of environmental-related factors reviewed and their potential impact on China's coal consumption

Reduction/increase in coal use below/above business-as-usual projection	No significant reduction ○	Slight reduction ●	Modest reduction ●	Significant reduction ●
		Slight increase ●	Modest increase ●	Significant increase ●

FACTOR	SHORT TERM 5 YEARS	MEDIUM TERM 10 YEARS	LONG TERM 20 YEARS
Carbon pricing and trading	Modest reduction	Modest reduction	Modest reduction
Coal to liquids and chemicals	Slight reduction	Slight reduction	Modest reduction
Coal quality	No significant reduction	Slight reduction	Slight reduction
Energy intensity and efficiency	Modest reduction	Significant reduction	Significant reduction
Environmental concern	Slight reduction	Slight reduction	Slight reduction
Gas and shale gas	No significant reduction	Slight reduction	Significant reduction
Iron and steel sector	Slight reduction	Modest reduction	Significant reduction
Local pollution	Slight reduction	Slight reduction	Slight reduction
Non-fossil fuel energy and electricity	Modest reduction	Modest reduction	Modest reduction
Water – downside	Slight reduction	Modest reduction	Significant reduction
Water – upside[8]	Slight increase	Modest increase	Significant increase

Footnotes:

[8] Water constraints could result in a decrease or increase in coal consumption, depending largely on government action.

Table 2: Summary of environmental-related factors reviewed and their potential impact on the price of coal

Impact on the price of coal	No significant impact	Slight negative impact	Modest negative impact	Significant negative impact
		Slight positive impact	Modest positive impact	Significant positive impact

FACTOR	SHORT TERM 5 YEARS	MEDIUM TERM 10 YEARS	LONG TERM 20 YEARS
Carbon pricing and trading	Slight negative impact	Modest negative impact	Significant negative impact
Coal to liquids and chemicals	No significant impact	No significant impact	Slight negative impact
Coal quality	No significant impact	Slight negative impact	Slight negative impact
Energy intensity and efficiency	Modest negative impact	Significant negative impact	Significant negative impact
Environmental concern	Slight negative impact	Slight negative impact	Slight negative impact
Gas and shale gas	No significant impact	Slight negative impact	Modest negative impact
Iron and steel sector	Slight negative impact	Modest negative impact	Significant negative impact
Local pollution	Slight negative impact	Slight negative impact	Slight negative impact
Non-fossil fuel energy and electricity	Modest negative impact	Significant negative impact	Significant negative impact
Water – downside	Slight negative impact	Modest negative impact	Significant negative impact
Water – upside	Slight positive impact	Modest positive impact	Significant positive impact

Table 1 summarises our assessment of the likely impact on China's coal demand from each of the environment-related factors surveyed in this report. Each factor has been analysed to see if it could have an impact on coal demand or not and if so, whether this would be slight (5% or less), moderate (5-10%) or significant (10% or more) within 5, 10 and 20 year time horizons. Reductions in coal demand are assumed to result in a proportional fall in coal imports and the indicative impact on coal prices, based on an analysis of supply changes that have affected coal prices in the past, is shown in Table 2. We find the following:

Carbon pricing and trading – This could have a slight impact on coal prices in the short term, a moderate impact in the medium term and a significant impact in the long term. Trial emissions trading schemes have been implemented in 2013 with plans to move to a national scheme by 2016.[9]

Coal to liquids and chemicals – Changes in the chemical sector could have a slight impact on coal prices in the short and medium term and a moderate impact in the long term. The sector consumes 5% of coal directly, and 5% indirectly through electricity use. Increasing energy efficiency could reduce coal use by up to 36% by 2020.

Coal quality – In 2013 draft regulations were released and later suspended that would have favoured Australian coal, which is of higher quality than some of China's other coal suppliers. It is possible that a similar policy will be enacted in the future. This would shift demand towards higher quality coal and potentially also favour domestic production over imports.

Footnotes:

[9] Scotney et al., *Carbon Markets and Climate Policy in China.*

Energy intensity and efficiency – A decrease in energy intensity and an increase in energy efficiency could have a moderate impact on coal prices in the short term and a significant impact in the medium to long term. Energy intensity has decreased by 47% since 1990 and a further reduction of 16% is expected between 2010 and 2015.

Environmental concern – Public pressure to reduce air pollution could indirectly impact coal prices by pressuring the government to reduce coal combustion and close specific coal plants causing localised environmental pollution.

Gas and shale gas – Developments in domestic gas and shale gas are unlikely to impact coal prices in the short term but could have a slight impact in the medium term and a significant impact in the long term. The Chinese government is eager to source more gas domestically in order to increase energy security and address air pollution concerns. However, our forecast of shale gas production in the short term is bearish due to various challenges facing the sector in China.

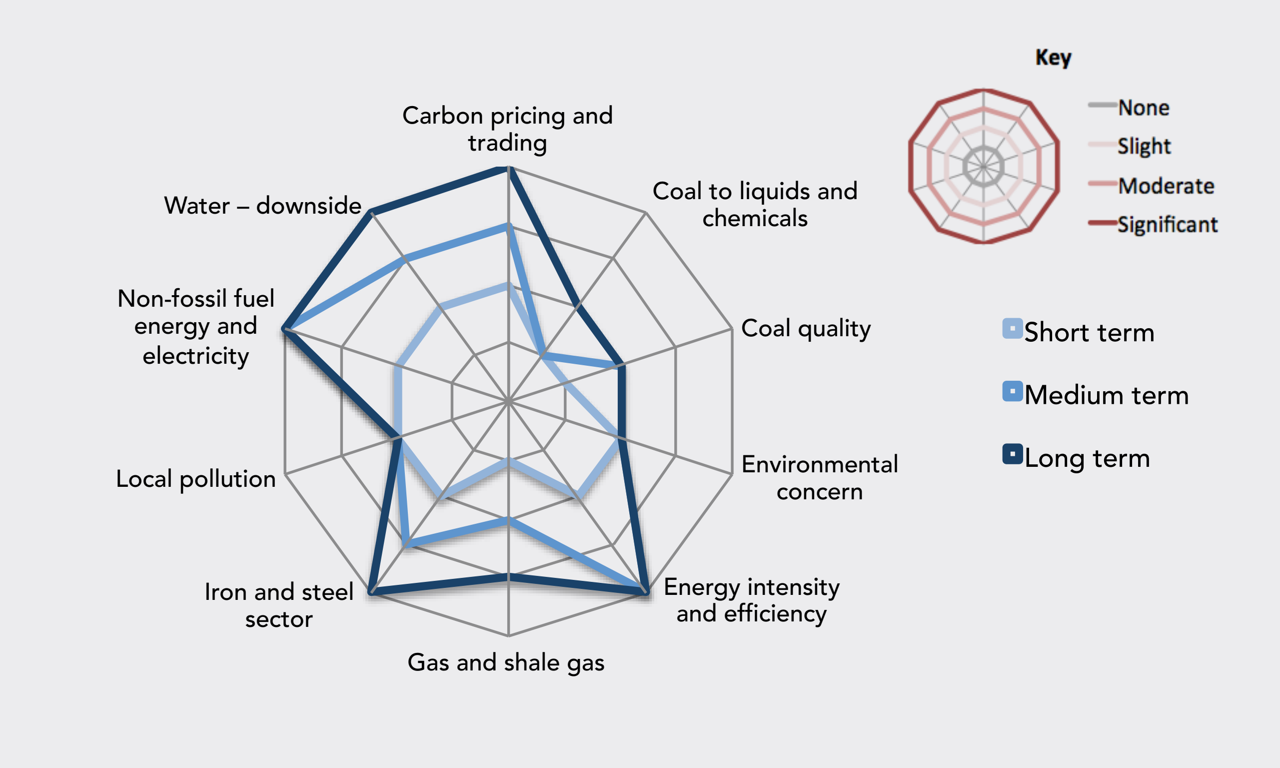
Iron and steel sector – Changes in the iron and steel sector could have a slight impact on coal prices in the short term, a moderate impact in the medium term and a significant impact in the long term. Decreasing investment in infrastructure will reduce steel demand while increasing energy efficiency will result in less coal consumption per unit of steel production.

Local pollution – Local environmental pollution is unlikely to have significant direct impacts on coal prices but will have indirect impacts. Measures to reduce air pollution from coal-fired power stations and boilers is likely to result in decreased coal consumption in certain regions and localities.

Non-fossil fuel energy and electricity – Increasing production of energy and electricity from non-fossil fuel sources could have a moderate impact on coal prices in the short, medium and long term. While coal-fired power is likely to continue to grow in absolute terms, its share of the electricity mix could fall from 70% today to 63% in 2020.

Water scarcity – Water scarcity could have either a positive or negative impact on coal prices, with the impact being slight in the short term, moderate in the medium term and significant in the long term. The direction depends on government action. Shutting down mines and converting power stations to dry cooling systems would result in an increase in imports while increased coal washing and plant efficiency would result in a decrease.

Figure 3: Illustration of coal price impacts over the short, medium and long term



The seven major risks (excluding the potential upside impact of water constraints) from Table 2 are also illustrated in Figure 3.

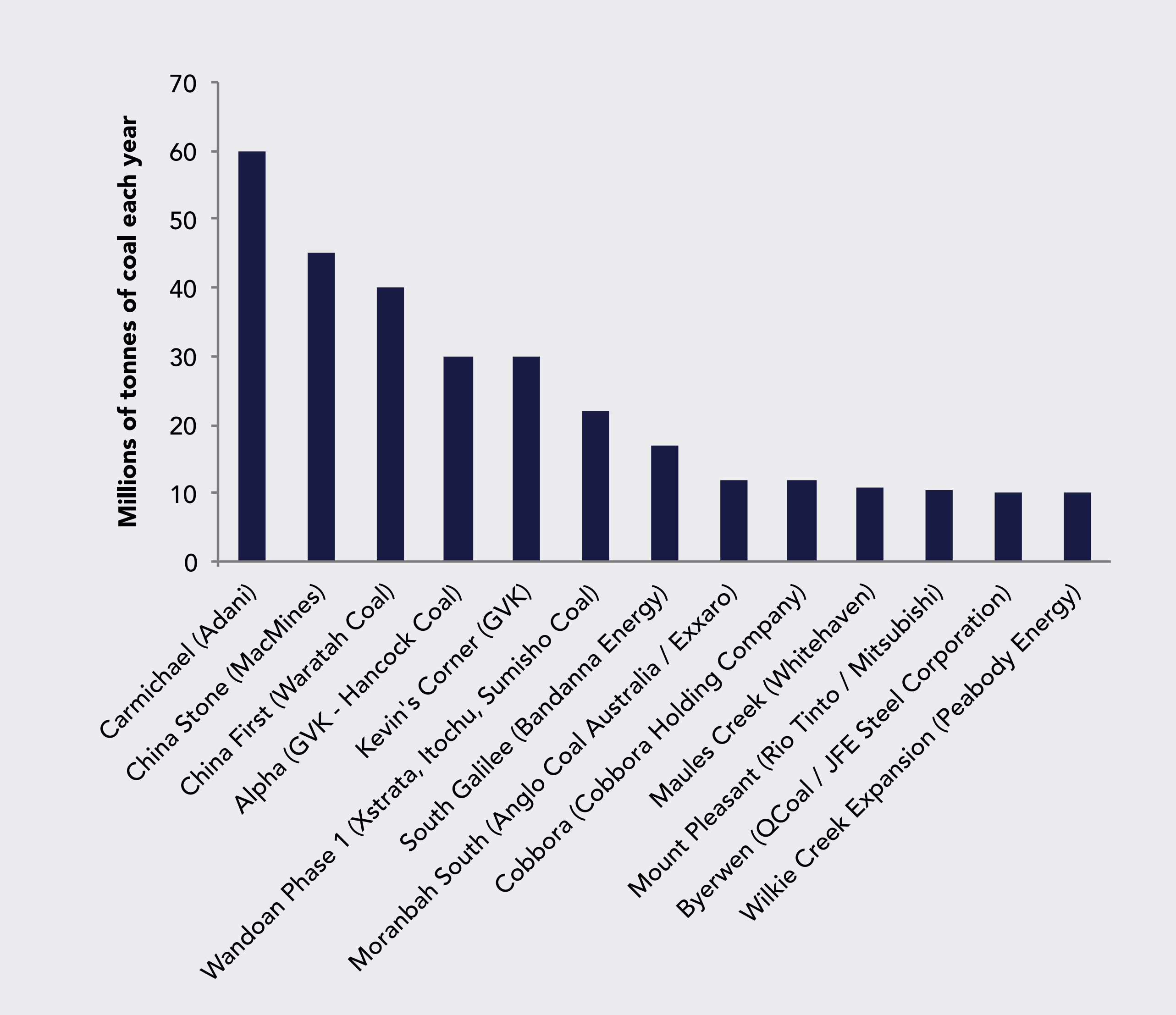
According to the Australian government's Bureau of Resources and Energy Economics, there are 89 coal projects planned for Australia, with a total potential capacity of 550 million tonnes (Mt) per year,[10] almost all of which is planned to meet export demand. By comparison Australia produced about 430 Mt of coal in 2011.[11] More than half the potential increase in capacity could come from just 13 mines, each of which is expected to have an annual output of 10 Mt or more.

Footnotes:

[10] BREE, *Resources and Energy Major Projects*, 2013.

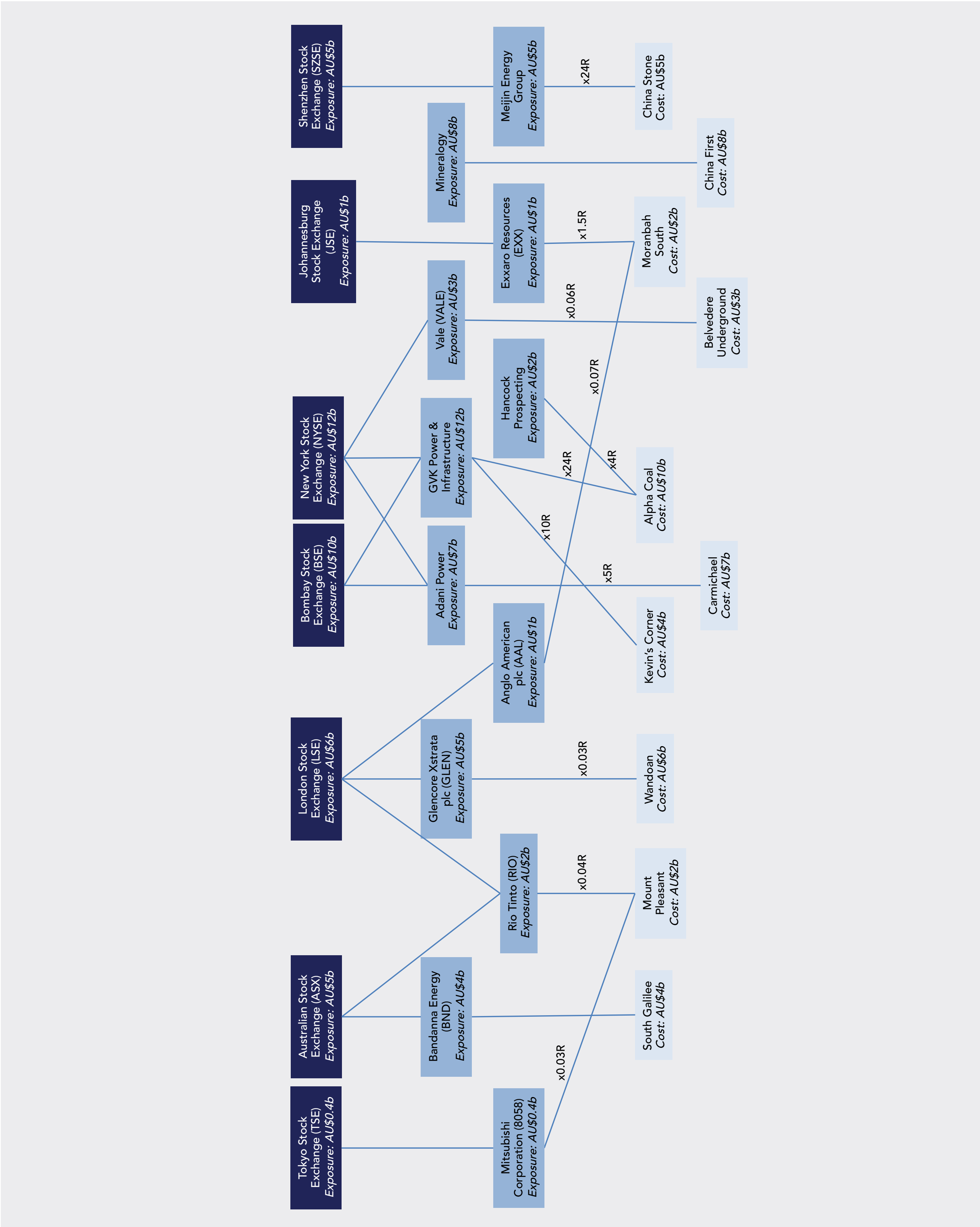
[11] BREE, *Australian Energy Statistics*.

Figure 4: Estimated production of the 13 largest proposed Australian coalmining projects



In order to determine which owners and operators would be at risk if the price of coal decreased we created an ownership map of the ten largest proposed Australian coalmining projects by capital expenditure. There is considerable, but not complete, overlap between these ten mines and the 13 listed in Figure 4, which shows the largest projects by output rather than cost.

Figure 5: Ownership of top ten proposed coalmining projects by cost (and cost as a multiple of company revenue)



The ten projects in Figure 5 with an expected cost of over AU$50 billion make up half of total expected capital expenditure in new coalmines. The projects were analysed to determine their significance to their ultimate parent companies, and identify which stock exchanges those companies are listed on. Two of the companies (Hancock Prospecting and Mineralogy) are privately held. The ten largest projects analysed are ultimately owned by 12 companies, which are together listed on eight stock exchanges. The coal price required for many of these projects to be economic, as determined by a survey of analyst reports and publicly available information, is in our view unlikely to be sustained given China's changing demand for coal and how in particular it could be affected by environment-related factors.

The coal price required for many of these projects to be economic, is unlikely to be sustained given China's changing demand for coal...

To minimise the risk of stranded assets, the companies involved should interrogate the coal price assumptions underpinning the investment case for each of these projects. Investors in the projects' sponsors, especially if investee companies are diversified natural resource companies, should seek clarity on the opportunity costs associated with deploying finite capital into these projects. There could be higher risk-adjusted return opportunities elsewhere in the Australian resources sector or indeed in other markets.

Australian state governments would also be adversely affected financially by projects being abandoned or mothballed – less production will reduce royalty payments. For example, the coal mining industry paid AU$3.1 billion in royalties to the Queensland sate government and AU$1.3 billion to the New South Wales government in 2008-09.[12] In Australia royalties for the extraction of resources are paid to the state governments, although revenues from the carbon price are collected by the national government. The Queensland government in particular, notionally has much to lose from the mega-mines in the Galilee not going ahead. It would be sensible for policymakers to minimise exposure by diversifying their tax base. State and federal governments can also reduce the risk of their own investments becoming stranded assets by limiting the use of public funds and resources that support coal-related infrastructure, such as ports and railways.

It is important to note that there are limitations to the kind of a bilateral trade analysis we have undertaken in this report. While in general reduced coal imports from China would result in reduced demand for Australia's coal, there could be exceptions. Geopolitics could result in China buying more coal from Australia, even if its overall coal consumption declines. For example, Australia suffered a loss of Chinese market share in 1970 after Canada was quicker to switch its recognition from Taipei to Beijing.[13] The consideration of such influences is outside the scope of this report.

...it is clear that China's coal demand patterns are changing as a result of environment-related factors and consequently less coal will be consumed than is currently expected...

Nevertheless, it is clear that China's coal demand patterns are changing as a result of environment-related factors and consequently less coal will be consumed than is currently expected by many owners and operators of coal assets. Given China's growing role as the price setter in global and regional coal markets falling demand will, all things being equal, reduce coal prices. This would result in coal assets under development becoming stranded or operating mines only covering their marginal costs and subsequently failing to provide a sufficient return on investment.

These are risks that owners and operators of coal and coal-related assets in Australia should be aware of and act on. But there are lessons for policymakers too – they should work to understand how assets might become stranded to avoid costly lock-in and to ensure that government revenues, particularly at state level, are resilient to potential discontinuities.

Footnotes:

[12] Australian Coal Association, "Contribution to the Economy."

[13] Kapisthalam, "Australia and Asia's Rise."

Introduction

Aims

This report investigates how China's demand for coal is changing as a result of environment-related factors, such as regulation, developments in cleaner technologies, local environmental pollution, improving energy efficiency, changing resource landscapes and political activism. The report looks at how this changing demand picture could then translate into impacts on coal and coal-related assets in Australia, which is a large and growing coal exporter to China.

Investors, businesses and communities, as well as state and federal governments in Australia, could be affected by a slowdown in Chinese demand for coal. Changing demand and falling prices could result in 'stranded assets', where assets have suffered from unanticipated or premature write-downs, devaluations or conversion to liabilities.

This report aims to provide a greater understanding of the various market dynamics involved, the potential significance of different environment-related factors and an indication of what this could mean for Australian coal assets. It is the first of a series of studies looking at coal and stranded assets internationally.

This report contains five sections. The first section provides some background and methodological guidance. Section two surveys China's coal market and Australia's coal exports to China. Section three looks at environment-related factors in turn and assesses how each could change China's coal demand and imports. Section four looks at how a reduction in China's demand for coal could impact Australian coal assets. The final section provides some guidance so that stakeholders can better manage environment-related risks that have the potential to strand coal assets.

Methodology

This report investigates how China's demand for coal is changing as a result of environment-related factors, such as regulation, developments in cleaner technologies, local environmental pollution, improving energy efficiency, changing resource landscapes and political activism. The report looks at how this changing demand picture could then translate into impacts on coal and coal-related assets in Australia, which is a large and growing coal exporter to China.

Environment-related factors that are changing Chinese demand for coal and coal imports were identified and systematised through a roundtable discussion, interviews, a news analysis and a literature review. Each driver was then analysed with the use of a further literature review, interviews, key industry reports and data provided by agencies such as the Australian Bureau of Statistics, the World Bank and the International Energy Agency. A similar approach was used to identify key coal investments in Australia potentially at risk.

Chinese coal consumption and import data was used to determine the relationship between demand and imports. The factors responsible for the recent downturn in coal prices were analysed, such as increased exports from the US and decreased imports from China. This indicated the order of magnitude of coal import or export fluctuations that can have a significant impact on coal prices.

In order to determine which companies would be at risk if the price of coal decreased an ownership map was created with the ten largest proposed Australian coalmining projects. This involved using Australian government data to identify the biggest mines and data from Standard & Poor's to trace the mines to their ultimate owners and relevant stock exchanges.

Limitations

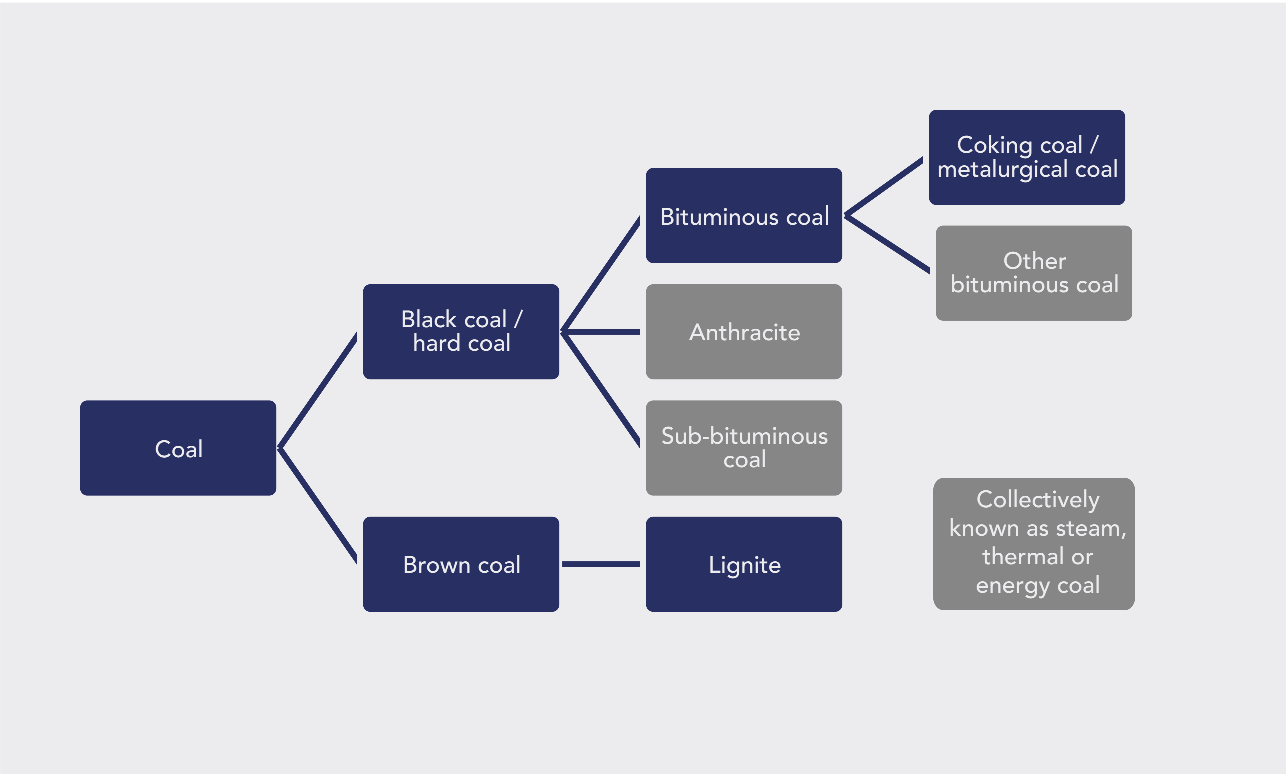
This report is designed to be a high level analysis of the drivers of change in China's coal demand, and how this could impact Australian coal assets. There are limitations to this kind of a bilateral trade analysis. While in general reduced coal imports from China would result in reduced demand for Australia's coal, there could be exceptions.

Geopolitics could play a role, which could result in China buying more coal from Australia, even if its overall coal consumption declines. For example, Australia suffered a loss of Chinese market share in 1970 after Canada was quicker to switch its recognition from Taipei to Beijing.[14] The consideration of such influences is outside the scope of this report.

Coal classification

Coal is usually classified as either brown coal or black coal; the latter is sometimes also called hard coal. Black coal can be broken down into anthracite, bituminous and sub-bituminous. Sub-bituminous is also sometimes referred to as a sub-classification of brown coal. Bituminous coal can be broken down into coking or metallurgical coal, and 'other bituminous coal'. Coking coal is used in steel production due to its high quality. Anthracite, sub-bituminous and 'other bituminous coal' are also collectively known as steam, thermal or energy coal, and are used in power plants.

Figure 6: Classification system for coal[15]



Footnotes:

[14] Kapisthalam, "Australia and Asia's Rise."

[15] IEA, *Coal Information*, 2012; NSW Minerals Council, "What We Mine & Why We Mine."

Coking coal can technically be used to generate electricity but this is rare due to the price premium coking coal demands. These classifications are labels on a continuum of increasing coal quality, therefore different countries and sources will often use different terms and definitions. For example, sub-bituminous coal is considered hard coal in Australia and brown coal in China. For the purpose of this report the classification system shown in Figure 6 is used. This report will focus on black coal because brown coal is not exported by Australia due to its low energy density.[16]

Coal is generally used within its country of origin, but the proportion traded internationally is significant and growing.[17] About 13% of thermal coal produced in the world is traded internationally and 90% of this is seaborn.[18] The seaborn market is divided into the Pacific and Atlantic markets.

The main players in the Pacific market are Australia (24% of world hard coal exports) and Indonesia (30%) as exporters and China (23% of world hard coal imports) and India as importers (13%). The Atlantic market is mostly supplied by Russia (11% of world hard coal exports), Colombia (7%) and South Africa (6%), with demand coming from European markets (19% of world hard coal imports are from OECD Europe).[19] South Africa (6% of world hard coal exports) and Australia form important links between these two regions by being able to supply both markets due to their geographic location.[20]

Footnotes:

[16] Australian Coal Association, "Coal Exports."

[17] Trüby and Paulus, *Market Structure Scenarios in International Steam Coal Trade.*

[18] Ibid.

[19] Paulus and Trüby, "Coal Lumps vs. Electrons: How Do Chinese Bulk Energy Transport Decisions Affect the Global Steam Coal Market?".

[20] Wårell, *Market Integration in the International Coal Industry: A Cointegration Approach*; All percentages in this paragraph are taken from IEA, *Coal Information*, 2013.

Table 3: Energy content of coal exports from some OECD countries (kJ/kg)[21]

COUNTRY	ANTHRACITE	COKING COAL	OTHER BITUMINOUS COAL
Australia	26,700	28,500	25,700
Austria			27,596
Belgium	25,184		25,781
Canada		24,781	24,219
Chile			
Czech Republic	31,714	27,629	24,942
France		30,500	26,000
Germany		29,000	31,130
Greece			23,908
Ireland	31,958		
Italy			26,587
Japan			24,801
Mexico		29,335	
Netherlands		28,671	24,608
New Zealand		29,839	
Norway			28,100
Poland		29,460	27,550
Portugal	27,846		24,959
Slovenia			25,341
Spain	25,300		24,011
Sweden			27,400
United Kingdom		30,604	29,640
United States	28,796	27,567	27,517

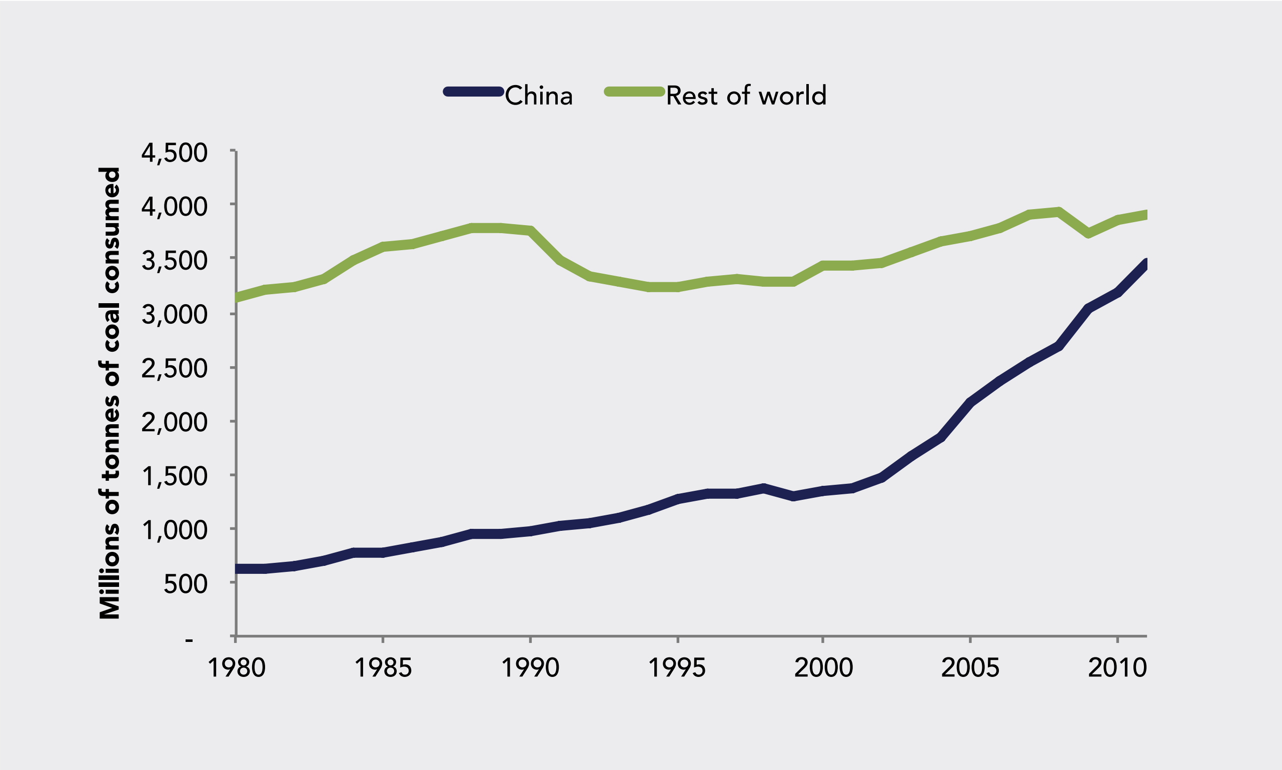
The quality of coal varies considerably, both between countries and between mines in the same country. One of the most common indicators of quality is the energy content of the coal. Table 3 compares the energy content of Australian coal exports to some other OECD countries. By comparison the energy content of coal mined in China averages about 21,000 kJ/kg.

Footnotes:

[21] IEA, "Beyond 20/20."

China's coal market and Australia's coal exports to China

Figure 7: Total coal consumption[22]



One of the key underlying drivers of China's coal consumption is economic growth.[23] Since 1976 China has experienced an average annual GDP growth rate of 10%. By comparison the average annual world GDP growth for the same period was 3%.[24] This economic growth has driven a large increase in energy consumption,[25] which is predominantly supplied by coal. China's economy started to grow rapidly in the early 2000s, which corresponds with the uptick in coal consumption growth shown in Figure 7. China now consumes 47% of the world's coal.[26]

However, this rapid economic growth is expected to slow. The Chinese government has set a target of 7.5% growth for 2013. Over the longer term the OECD expect China's GDP growth to average 6.6% a year until 2030 and then 2.3% a year until 2060.[27]

Footnotes:

[22] US EIA, "International Energy Statistics."

[23] Buckley and Sanzillo, *Stranded - Alpha Coal Project in Australia's Galilee Basin.*

[24] World Bank, "GDP Growth (annual %)."

[25] US EIA, "China."

[26] US EIA, "International Energy Statistics."

[27] OECD, *Looking to 2060: Long-Term Global Growth Prospects.*

Figure 8: Chinese coal imports by country in 2013 until September[28]

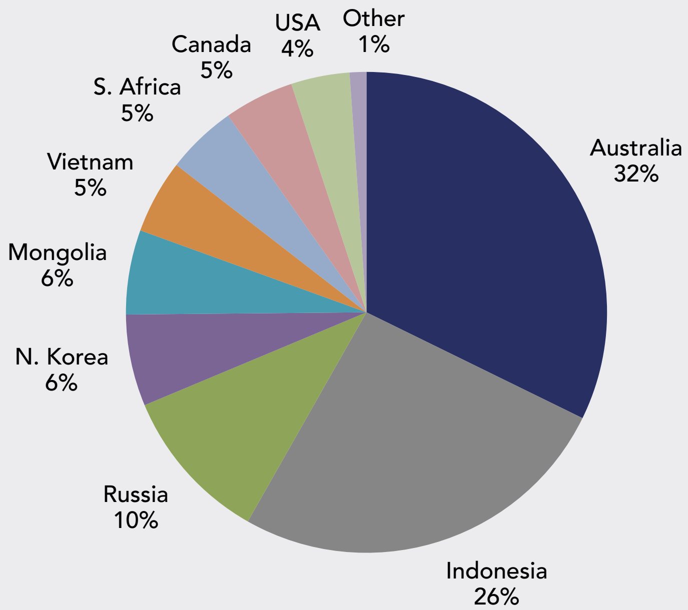
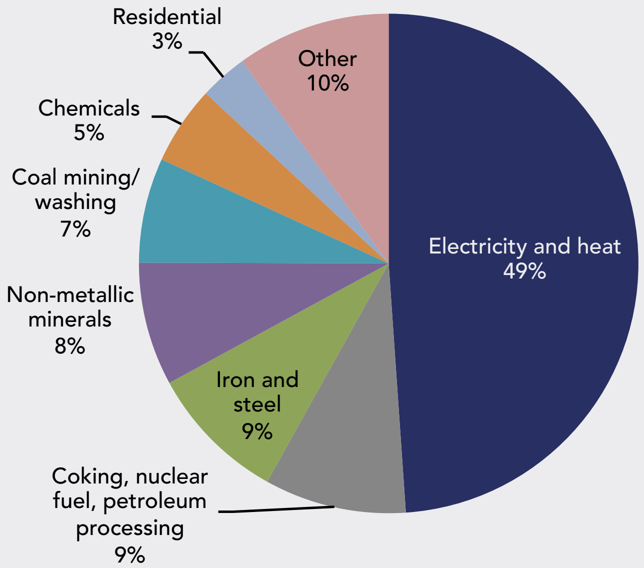


Figure 9: Coal use in China[29]



Footnotes:

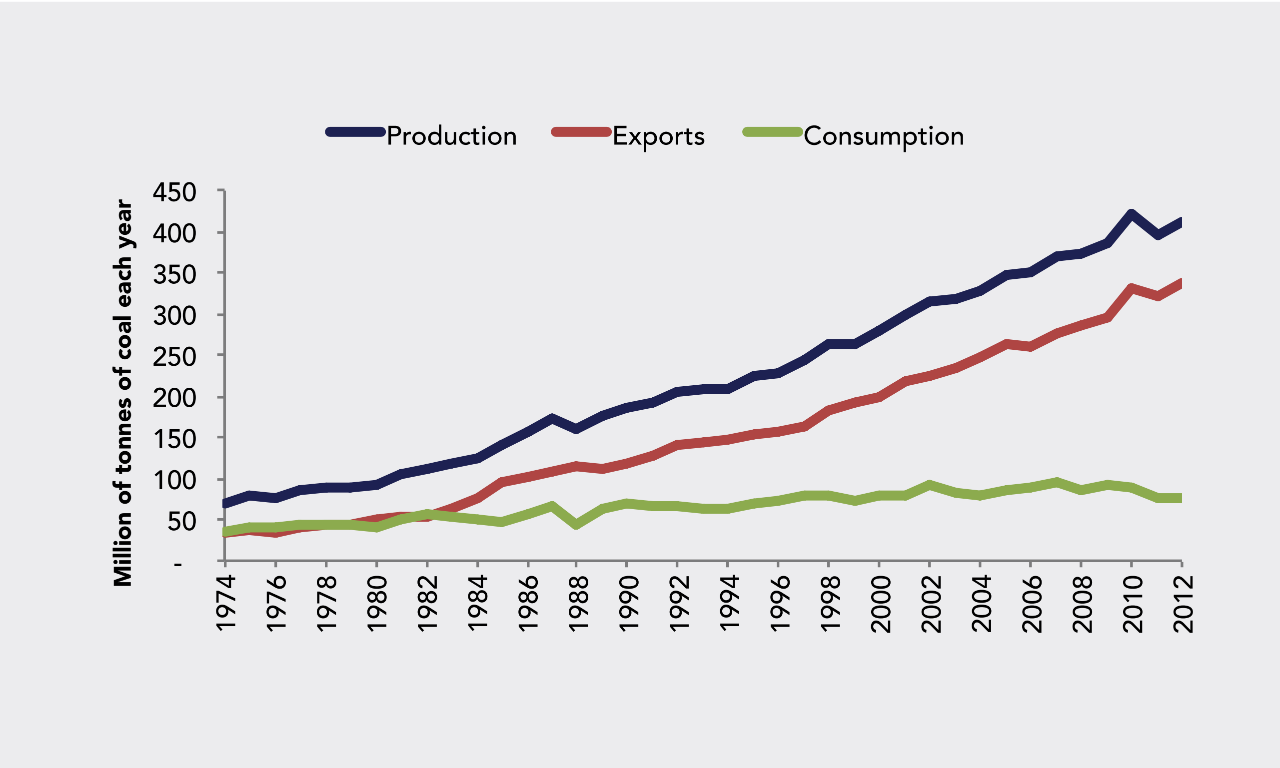
[28] China Coal Resource, "China Coal Import by Source in Sep. 2013."

[29] US EPA, *China's Energy Markets.*

In order to meet its coal demand China both produces and imports considerable quantities of coal. Figure 8 shows the proportion of Chinese imports supplied by each exporting country – Australia is now the largest supplier. About half of China's coal consumption is associated with the production of heat and electricity (Figure 9). The iron and steel industry makes up 10% of total coal use while the chemicals industry consumes about 5%.[30]

Coal exports make up a significant and increasing proportion of Australia's national income. In 2012-13 coal exports were AU$38.9 billion or 16% by value of total exports, [31] equivalent to 3.4% of GDP.[32]

Figure 10: Australian coal production, exports and consumption[33]



The significance of coal as an export, and the importance of exports to the coal industry, have been growing for over 30 years. Since 1974 (the earliest data is available) Australia's coal output has increased by an average of 8.8 million tonnes or 5% a year. This increased production has mostly fuelled exports, which have increased by 6.5% per year. By comparison domestic consumption has only increased by about one million tonnes or 2.8% on average. As shown in Figure 10, this has resulted in a large and increasing dependence on international export markets.

Footnotes:

[30] Ibid.

[31] ABS, *International Trade in Goods and Services.*

[32] ABS, *Australian National Accounts: National Income, Expenditure and Product.*

[33] BREE, *Australian Energy Statistics.*

Figure 11: Australian coal exports by destination[34]

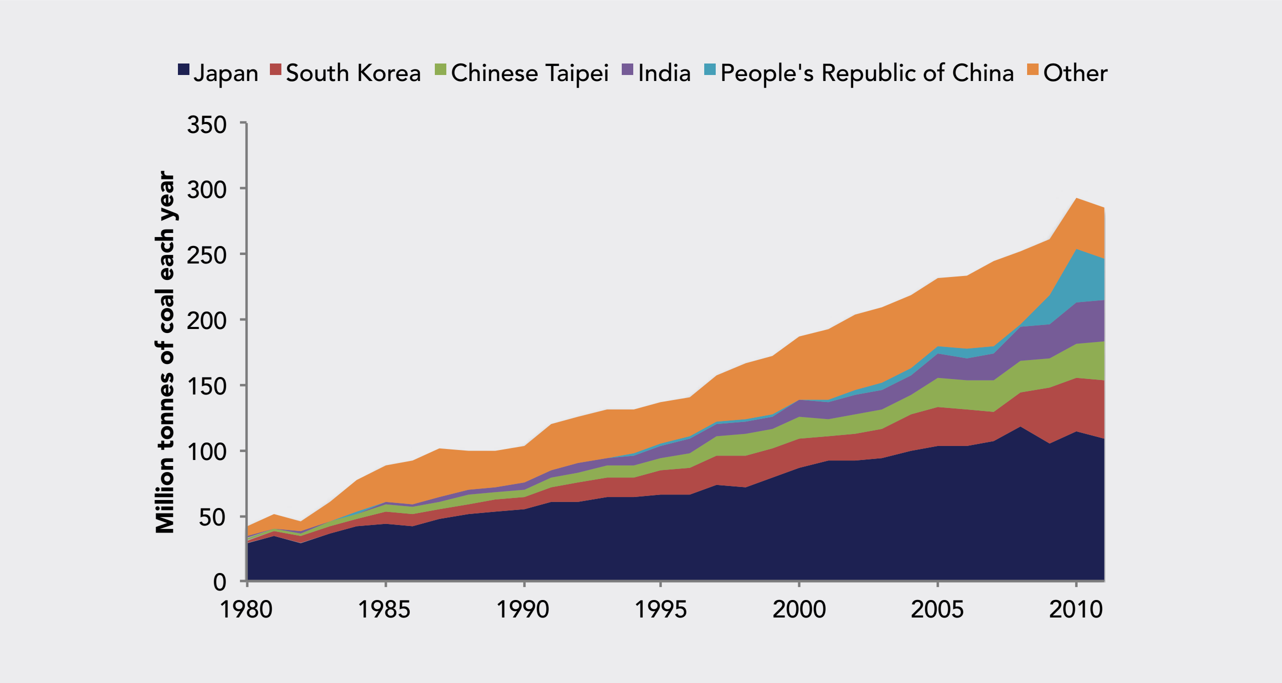
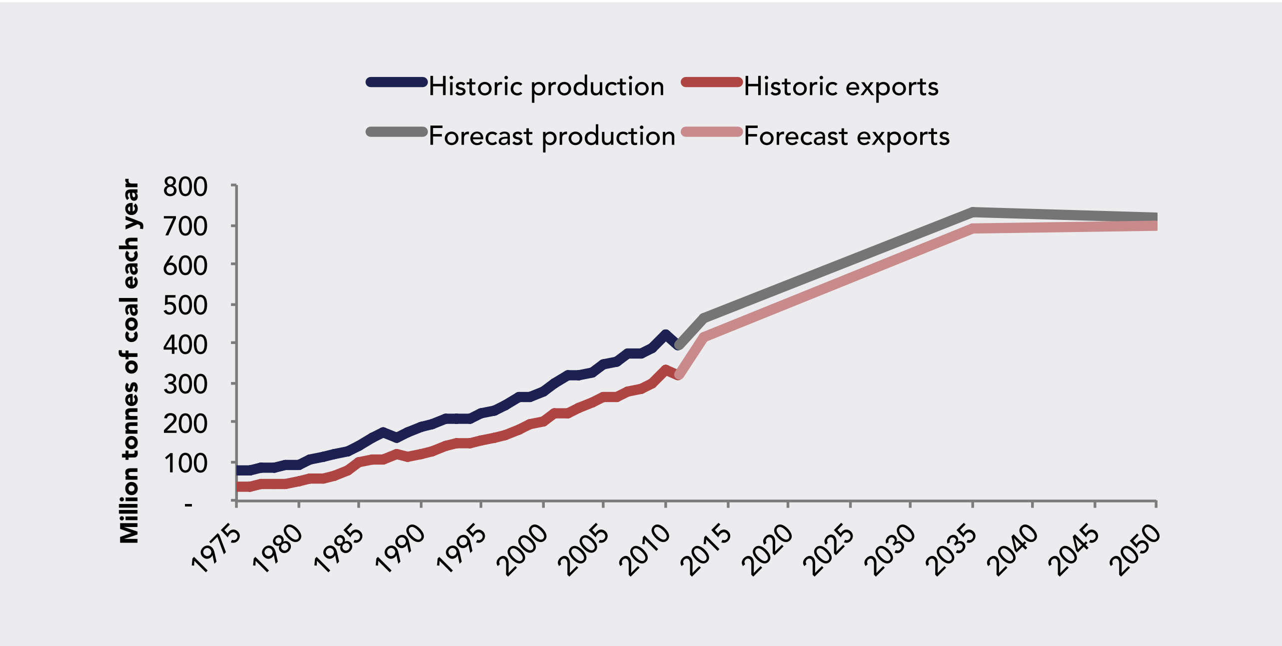


Figure 12: Historic[35] *and ABARE forecast*[36] *of Australian black coal production and exports*



Footnotes:

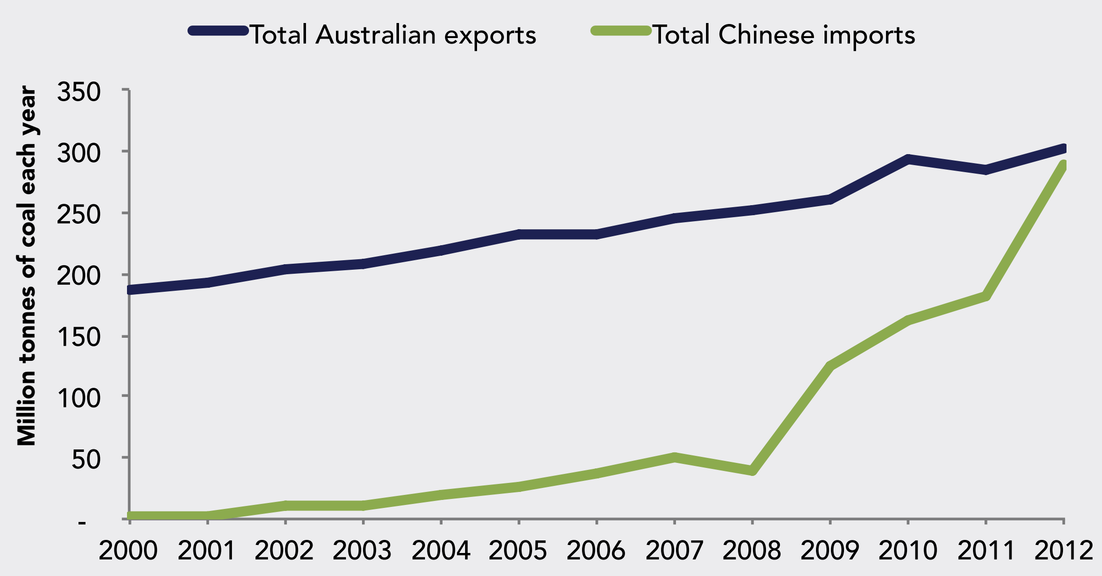
[34] IEA, *Coal Information*, 2012.

[35] BREE, *Australian Energy Statistics*.

[36] Syed, *Australian Energy Projections to 2049–50*.

China is now a major destination for Australian coal exports, though this has not always been the case. China only became a net importer of coking coal in 2004 and a net importer of total coal in 2009.[37] This turned the country from an insignificant customer to one of Australia's main export markets in less than five years (see Figure 11). Exports to China made up 12% of total Australian thermal coal exports in 2011 and this jumped to 18% in 2012.[38] Both the volume of coal exported to China and the proportion it makes up of total exports is increasing and looks set to continue under business-as-usual conditions.[39] The Australian Bureau of Agriculture and Resource Economics (ABARE) expect total Australian black coal exports to continue to grow at a steady rate before levelling off in 2035 (see Figure 12).

Figure 13: Comparison between Australian coal exports and Chinese coal imports[40]



Despite the dip in China's coal imports for 2007-08 due to the global economic downturn, Australian coal exports to China still continued to grow (Figure 13). Year-on-year figures from June 2013 (the latest available at the time of writing) show that while total Chinese coal imports were down 19.6% from 2012, Australian coal exports to China were up 31%.

Footnotes:

[37] Tu and Johnson-Reiser, *Understanding China's Rising Coal Imports.*

[38] Armitage, *Resources and Energy Statistics.*

[39] IEA, "World Energy Balances."

[40] Ibid.

The growth in coal demand seen and anticipated from China is underpinning the expansion of the Australian coal sector. According to federal Bureau of Resource and Energy Economics (BREE), there are 89 major coal projects planned in Australia, with a total potential capacity of 550 million tonnes (Mt) per year,[41] almost all of which is planned to meet export demand. By comparison Australia produced about 430 Mt of coal in 2011.[42] More than half the potential increase in capacity could come from just 13 mines, each of which is expected to have an annual output of 10 Mt or more.

As well as impacting the volume of Australian coal exports, changing demand patterns from China could have an impact on coal prices. China is now the price setter for coal.[43] With a domestic market that is now three times the size of the international coal trade, China's coal market is major determinant of coal prices regionally and internationally.[44] This is likely to be the main mechanism through which changing coal demand in China will affect Australian coal assets.

Footnotes:

[41] BREE, *Resources and Energy Major Projects*, 2013.

[42] BREE, *Australian Energy Statistics.*

[43] IEA, IEF, and OPEC, *Report on the First Symposium on Gas and Coal Market Outlooks.*

[44] Haftendorn, "Economics of the Global Steam Coal Market - Modeling Trade, Competition and Climate Policies."

Environment-related factors changing China's demand for coal

This section analyses the environment-related factors that will, to varying degrees, change China's demand for coal over the next 20 years. Each factor is analysed and an estimate made of its likely impact on China's coal consumption over time, imports and an indication of how these could affect Australian coal assets. The latter are likely to be most affected by reduced demand relative to expectations placing downward pressure on the coal prices regionally and internationally. Correlations and interrelationships between different factors are also identified.

Summary

Table 4: Summary of environmental-related factors reviewed and their potential impact on China's coal consumption

Reduction/increase in coal use below/above business-as-usual projection	No significant reduction ○	Slight reduction ●	Modest reduction ●	Significant reduction ●
		Slight increase ●	Modest increase ●	Significant increase ●

FACTOR	SHORT TERM 5 YEARS	MEDIUM TERM 10 YEARS	LONG TERM 20 YEARS
Carbon pricing and trading	Modest reduction	Modest reduction	Modest reduction
Coal to liquids and chemicals	Slight reduction	Slight reduction	Modest reduction
Coal quality	No significant reduction	Slight reduction	Slight reduction
Energy intensity and efficiency	Modest reduction	Significant reduction	Significant reduction
Environmental concern	Slight reduction	Slight reduction	Slight reduction
Gas and shale gas	No significant reduction	Slight reduction	Significant reduction
Iron and steel sector	Slight reduction	Modest reduction	Significant reduction
Local pollution	Slight reduction	Slight reduction	Slight reduction
Non-fossil fuel energy and electricity	Modest reduction	Modest reduction	Modest reduction
Water – downside	Slight reduction	Modest reduction	Significant reduction
Water – upside[45]	Slight increase	Modest increase	Significant increase

Footnotes:

[45] Water constraints could result in a decrease or increase in coal consumption, depending largely on government action.

Table 5: Summary of environmental-related factors reviewed and their potential impact on the price of coal

Impact on the price of coal	No significant impact ○	Slight negative impact	Modest negative impact	Significant negative impact
		Slight positive impact	Modest positive impact	Significant positive impact

FACTOR	SHORT TERM 5 YEARS	MEDIUM TERM 10 YEARS	LONG TERM 20 YEARS
Carbon pricing and trading	Slight negative impact	Modest negative impact	Significant negative impact
Coal to liquids and chemicals	No significant impact	No significant impact	Slight negative impact
Coal quality	No significant impact	Slight negative impact	Slight negative impact
Energy intensity and efficiency	Modest negative impact	Significant negative impact	Significant negative impact
Environmental concern	Slight negative impact	Slight negative impact	Slight negative impact
Gas and shale gas	No significant impact	Slight negative impact	Modest negative impact
Iron and steel sector	Slight negative impact	Modest negative impact	Significant negative impact
Local pollution	Slight negative impact	Slight negative impact	Slight negative impact
Non-fossil fuel energy and electricity	Modest negative impact	Significant negative impact	Significant negative impact
Water – downside	Slight negative impact	Modest negative impact	Significant negative impact
Water – upside	Slight positive impact	Modest positive impact	Significant positive impact

Table 4 summarises our assessment of the likely impact on China's coal demand from each of the environment-related factors surveyed in this report. Each factor has been analysed to see if it could have an impact on coal demand or not and if so, whether this would be slight (1% or less), moderate (5-10%) or significant (10% or more) within 5, 10 and 20 year time horizons. Reductions in coal demand are assumed to result in a proportional fall in coal imports and the indicative consequent impact on coal prices, based on an analysis of supply changes that have affected coal prices in the past, is shown in Table 5. We find the following:

Carbon pricing and trading – This could have a slight impact on coal prices in the short term, a moderate impact in the medium term and a significant impact in the long term. Trial emissions trading schemes have been implemented in 2013 with plans to move to a national scheme by 2016.[46]

Coal to liquids and chemicals – Changes in the chemical sector could have a slight impact on coal prices in the short and medium term and a moderate impact in the long term. The sector consumes 5% of coal directly, and 5% indirectly through electricity use. Increasing energy efficiency could reduce coal use by up to 36% by 2020.

Coal quality – In 2013 draft regulations were released and later suspended that would have favoured Australian coal, which is of higher quality than some of China's other coal suppliers. It is possible that a similar policy will be enacted in the future. This would shift demand towards higher quality coal and potentially also favour domestic production over imports.

Energy intensity and efficiency – A decrease in energy intensity and an increase in energy efficiency could have a moderate impact on coal prices in the short term and a significant impact in the medium to long term. Energy intensity has decreased by 47% since 1990 and a further reduction of 16% is expected between 2010 and 2015.

Footnotes:

[46] Scotney et al., *Carbon Markets and Climate Policy in China.*

Environmental concern – Public pressure to reduce air pollution could indirectly impact coal prices by pressuring the government to reduce coal combustion and close specific coal plants causing localised environmental pollution.

Gas and shale gas – Developments in domestic gas and shale gas are unlikely to impact coal prices in the short term but could have a slight impact in the medium term and a significant impact in the long term. The Chinese government is eager to source more gas domestically in order to increase energy security and address air pollution concerns. However, our forecast of shale gas production in the short term is bearish due to various challenges facing the sector in China.

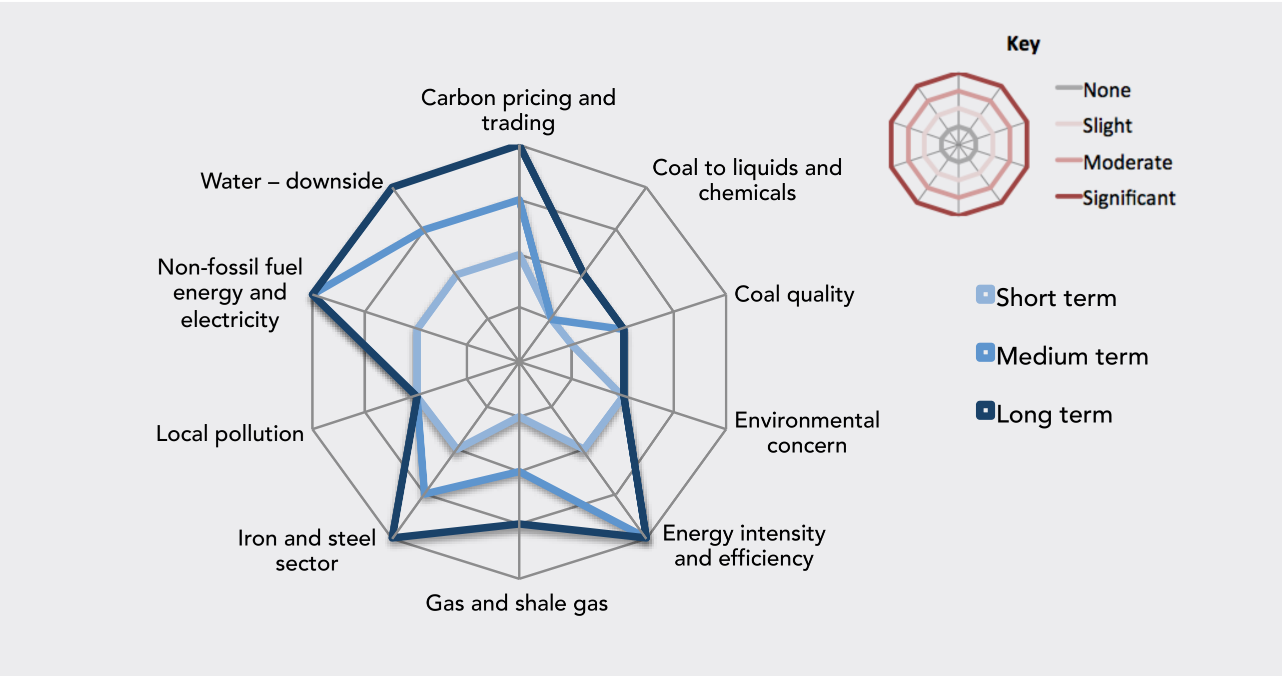
Iron and steel sector – Changes in the iron and steel sector could have a slight impact on coal prices in the short term, a moderate impact in the medium term and a significant impact in the long term. Decreasing investment in infrastructure will reduce steel demand while increasing energy efficiency will result in less coal consumption per unit of steel production.

Local pollution – Local environmental pollution is unlikely to have significant direct impacts on coal prices but will have indirect impacts. Measures to reduce air pollution from coal-fired power stations and boilers is likely to result in decreased coal consumption in certain regions and localities.

Non-fossil fuel energy and electricity – Increasing production of energy and electricity from non-fossil fuel sources could have a moderate impact on coal prices in the short, medium and long term. While coal-fired power is likely to continue to grow in absolute terms, its share of the electricity mix could fall from 70% today to 63% in 2020.

Water scarcity – Water scarcity could have either a positive or negative impact on coal prices, with the impact being slight in the short term, moderate in the medium term and significant in the long term. The direction depends on government action. Shutting down mines and converting power stations to dry cooling systems would result in an increase in imports while increased coal washing and plant efficiency would result in a decrease.

Figure 14: Illustration of coal price impacts over the short, medium and long term



The seven major risks (excluding the potential upside impact of water constraints) from Table 5 are also illustrated in Figure 14.

Carbon pricing and trading

China has set a non-binding target to reduce carbon intensity by 40-45% below 2005 levels by 2020. In line with this target the 12th Five-Year-Plan (FYP) set a 17% reduction target for carbon intensity between 2010 and 2015.[47] The Chinese government is experimenting with market mechanisms to achieve this target[48] – both an emissions trading scheme (ETS) and a carbon tax are being researched and trialled in China.

Bloomberg New Energy Finance (BNEF) expects that a tax on carbon emissions will be implemented with other taxes on emissions such as SO2, NOX and water pollutants. The carbon tax is expected to be set at CNY20/tCO2e (US$3.2/tCO2e) and increase over time. The Chinese government is expected to release more detailed plans by March 2014. It is not yet clear how the ETS and carbon tax will work together but one possibility is that they will each cover different sectors.[49] More details are known about the ETS, which is further progressed.

In 2012 the Chinese government mandated Shenzhen, Beijing, Shanghai, Guangdong, Tianjin, Chongqing and Hubei to implement an emissions trading scheme in 2013.[50] The first ETS was implemented in Shenzhen on 18 June 2013.[51] Businesses in the city of Shenzhen were each assigned an emissions quota and are allowed to trade permits and profit from the scheme if they pollute less than their allocation allows.[52] The Beijing ETS is noteworthy in that it plans to incorporate energy use as well as production, as most of its electricity is imported from outside the city.[53] Shanghai will cover the widest range of sectors, and about half the city's 250 Mt of carbon emissions.[54] Guangdong will be the largest pilot and importantly may be the only region to auction a portion of permits.[55] The Tianjin scheme will cover 60% of the industrial city's emissions.[56] The Chongqing scheme has released few details and is running behind schedule, but still plans to start in the second half of 2013.[57] Hubei will cover 35% of the province's emissions, focusing on its manufacturing and industrial sector.[58]

China has ambitious plans to move quickly from emissions trading pilots to a national scheme. In its 12th FYP for 2011 to 2015 the government announced its intention to implement a nationwide ETS by 2015.[59] Provincial scale schemes are first planned for 2014 before China moves to a national scheme in 2015 or 2016.[60] This is seen as a necessary step to meet China's policy targets.[61]

Footnotes:

[47] BNEF, *Chinese Emissions Trading: Enter the Dragon.*

[48] FORES and SEI, *China's Carbon Emission Trading: An Overview of Current Development.*

[49] BNEF, *China Deep Dive: Pursuing the ETS Dream; BNEF, China Deep Dive: Seven Pilots Prepare for Take-Off.*

[50] Haas, "China Emission Trading Experiment Unlikely to Ease Cities' Smog"; BNEF, *China Emissions Trading: Facts and Figures.*

[51] Song, "Inside China's Emissions Trading Scheme: First Steps and the Road Ahead"; BNEF, *Shenzhen Pilot ETS: Facts and Figures.*

[52] ABC, "China Launches Carbon Trading Scheme in Bid to Reduce Emissions in Shenzhen."

[53] BNEF, *Beijing Pilot ETS: Facts and Figures.*

[54] BNEF, *Shanghai Pilot ETS: Facts and Figures.*

[55] BNEF, *Guangdong Pilot ETS: Facts and Figures.*

[56] BNEF, *Tianjin Pilot ETS: Facts and Figures.*

[57] BNEF, *Chongqing Pilot ETS: Facts and Figures*

[58] BNEF, *Hubei Pilot ETS: Facts and Figures.*

[59] BNEF, *Carbon Markets - China Deep Dive.*

[60] Scotney et al., *Carbon Markets and Climate Policy in China.*

[61] BNEF, *The Future of China's Power Sector.*

In order to implement such a large emissions trading scheme so quickly, China will have to overcome a number of obstacles. One challenge will be opposition from carbon intensive industries such as steel and aluminium, which in some cases are already struggling to remain profitable.[62] Another issue is the fact that electricity prices are controlled by the state and an ETS will not automatically send a price signal to electricity consumers through increased prices.[63] Obtaining sufficient data of sufficient quality to set and retire emissions allowances is also posing a significant challenge.[64]

BNEF estimates that half of the abatement required to meet China's emissions intensity targets will be driven by the ETS.[65] We believe that the ETS could result in a moderate reduction in coal use in the short, medium and long term. The impact on coal prices would be slight in the short term, moderate in the medium term and potentially significant in the long term.

Chemical sector

China's chemical sector influences coal use for two reasons: it consumes coal directly as a feedstock and it uses electricity, which coal is used to produce. The sector is directly responsible for 5% of coal consumption and 10% of electricity consumption.[66] Considering coal is used to produce half of China's electricity,[67] the chemical sector is responsible for approximately 10% of coal consumption. Three main factors affect this consumption: usage of coal as a feedstock, efficiency of production and production volume.

...the chemical sector is responsible for approximately 10% of coal consumption.

There are benefits and disadvantages to using coal as a feedstock that influence its level of use. Oil and gas are typically used as a feedstock in chemical production. Due to the size of China's chemical sector and its comparatively small oil and gas deposits this has caused a reliance on imports,[68] which the government sees as a threat. Its abundant coal reserves can reduce this energy dependence in two ways: coal can be substituted for oil and gas as a feedstock, and coal can be directly converted to liquid or gas to use as fuel. Coal miners and power generators are also a driving force behind increased chemical production from coal, as they see it as an opportunity to expand into the more profitable chemical industry.[69]

The government has actually tried to slow down growth of coal liquefaction since 2006. A major reason for this reluctance is increasing water scarcity and the water intensive nature of liquefaction. Carbon emissions are another reason.[70] Producing chemicals and liquids from coal is an emissions intensive process, more so than the more common oil-based processes.[71] Increasing the use of coal to produce chemicals and oil will conflict with China's climate change commitments. Local governments, which have much to gain from the expansion of coal-to-liquids (CTL), have not shown the same level of restraint as the national government. This sends mixed signals to manufacturers, who might hear one thing from the national government and something different from provincial and local tiers of government.

Footnotes:

[62] Stanway, "China Takes Cautious Step toward Carbon Emissions Trading."

[63] ABC, "China Launches Carbon Trading Scheme in Bid to Reduce Emissions in Shenzhen."

[64] Song, "Inside China's Emissions Trading Scheme: First Steps and the Road Ahead."

[65] BNEF, *China Deep Dive: Seven Pilots Prepare for Take-Off.*

[66] US EPA, *China's Energy Markets.*

[67] Ibid.

[68] Shanxi Fenwei Energy Consulting, "A Look at China's Modern Coal Chemical Industry."

[69] Deloitte, *China's Coal Chemical Industry: In the View of Governance Challenges.*

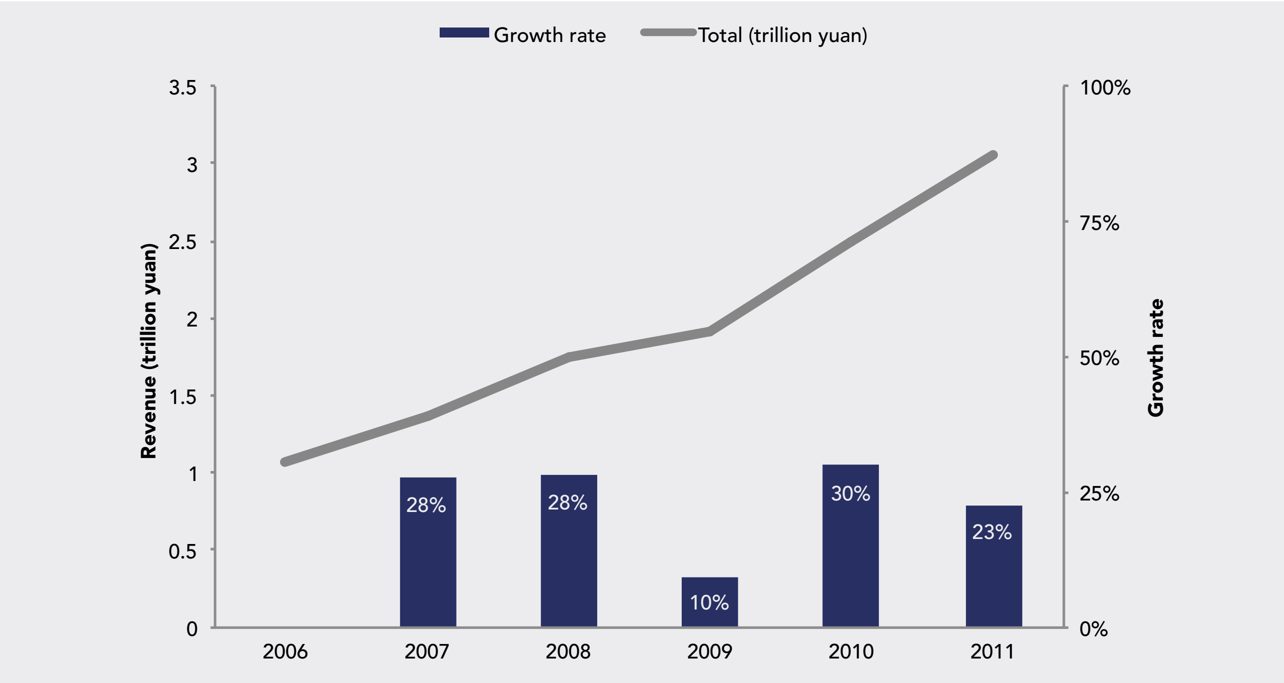
[70] Rong and Victor, "Coal Liquefaction Policy in China."

[71] IEA Clean Coal Centre, *Coal-to-Oil, Gas and Chemicals in China.*

Increasing chemical sector efficiency could be a major driver of decreased coal use. Electricity consumption per unit of output will decrease by 29-47% by 2015 and 49-72% by 2020, depending on government action.[72] As a result coal use would decrease by 14-23% by 2015 and 25-36% by 2020 compared to business-as-usual projections. Increased process efficiency could also reduce the amount of coal feedstock required per unit of output.

Increasing chemical sector efficiency could be a major driver of decreased coal use.

Figure 15: Revenue growth of the Chinese chemical sector



Growth in coal consumption has been linked to growth in chemical production, which is forecast to slow. As shown in Figure 15 the industry grew rapidly in recent years. However KPMG expect the sector to grow by only 9-11% each year until 2015.[73]

These trends will not lead to a reduction in demand for Australian coal in particular, but they will reduce the rate of coal consumption growth. While it is uncertain how much the share of coal as a feedstock will increase, declining energy intensity and slower industry growth will have a significant impact on coal consumption.

Coal quality

Measures related to encouraging the use of better quality coal are likely to impact China's coal export partners over time. In the first half of 2013 the Chinese National Energy Agency (NEA) released draft regulations to restrict imports of coal with a heating value below 4,540kc/kg on a net-as-received basis and with sulphur content and ash content above 1% and 25% respectively. These restrictions were suspended in July[74], but it is worth exploring the impact of such a policy in the event of China potentially enacting one.

Footnotes:

[72] Lin, Zhang, and Wu, "Evaluation of Electricity Saving Potential in China's Chemical Industry Based on Cointegration."

[73] KPMG, *China's Chemical Industry: The Emergence of Local Champions.*

[74] Advanced Global Trading, "China Suspends Policy on Coal Import Curbs: Trade."

Increasing the energy content of coal reduces the amount of fuel that needs to be combusted to produce the same amount of electricity, resulting in less pollution per unit of energy. Sulphur and ash are not combusted but rather emitted in exhaust gases, contributing towards local air pollution. Reducing the incidence of these substances in the coal China burns would contribute towards improving air quality.

Table 6: Quantity and quality of thermal coal from some of China's main coal suppliers[75]

Legend	Doesn't meet criteria	Limit within range	Meets criteria	(average)

COUNTRY	COKING COAL IMPORTS IN 2011 (MILLION TONNES)*	STEAM COAL IMPORTS IN 2011 (MILLION TONNES)*	HEATING VALUE (KCAL/KG)*	SULPHUR CONTENT (%)*	ASH CONTENT (%)*
Australia	11.551 (30%)	22.258 (15%)	(6,008)	0.22-0.64 (0.57)	5.55-21.71 (14.6)
Canada	2.973 (8%)	1.455 (1%)	3,584-6,719	NA	NA
US (Central Appalachia)	3.758 (10%)	0.861 (0.6%)	6,736	0.95	9.9
US (Powder River Basin)			4,354	0.34	5.2
Colombia	0.031 (0.08%)	1.279 (1%)	5,686-8,164 (6,129)	0.33-5.12 (0.68)	0.53-21.34 (7.12)
Indonesia	0.567 (1%)	71.018 (5%)	3,284-7,507 (5,029)	0.14-2.21 (0.72)	2.99-12.63 (6.9)
South Africa	0 (0%)	10.402 (7%)	(6,141)	(0.80)	(13.8)
Russia	2.975 (8%)	6.918 (5%)	6,177	0.34	11.7
Vietnam	0 (0%)	22.063 (15%)	6,033-8,215	0.43-0.79	2.68-25.91
Total	38 (100%)	146 (100%)			

*All figures on an as received basis.

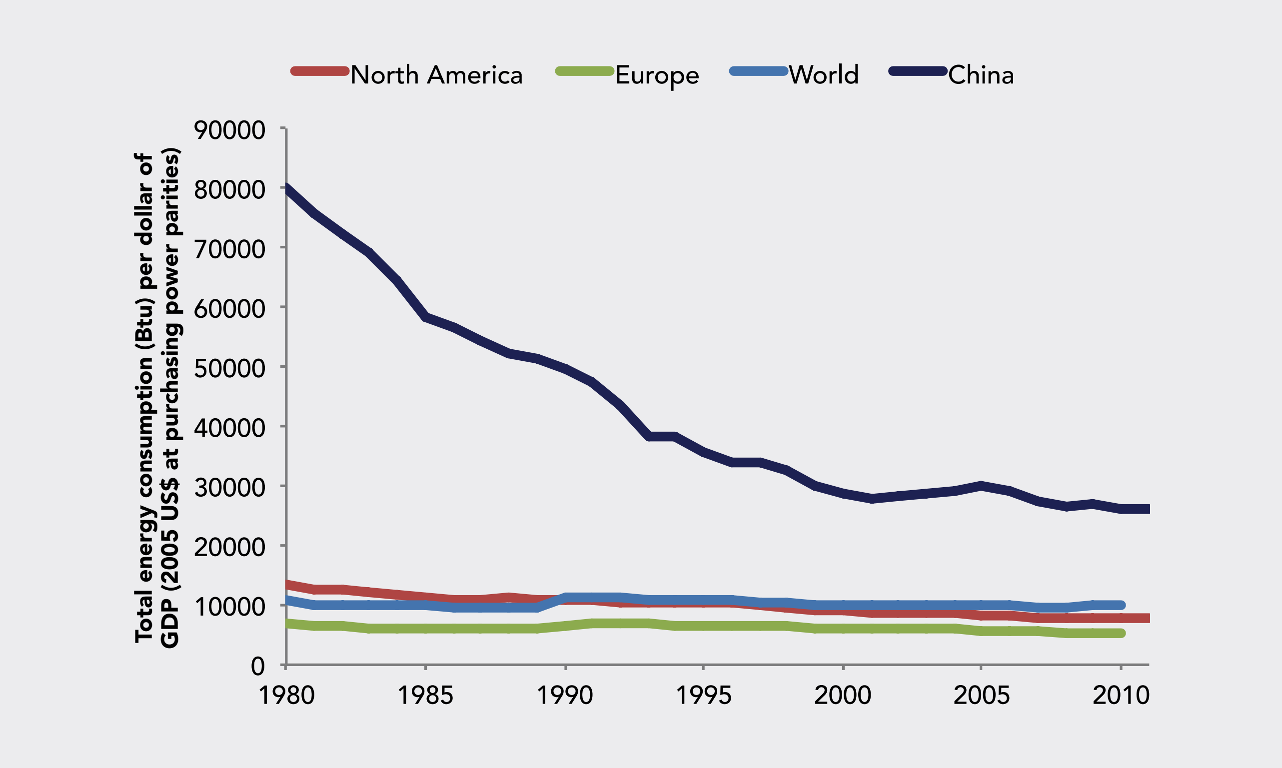
Indonesia would be the main trading partner affected by this policy, with some high sulphur coal from the US also being affected. Australia, as a producer of relatively high quality coal, would be one of the nations expected to benefit from Indonesia's loss. Table 6 compares the potential limits with the quality of coal mined by China's main suppliers.

Footnotes:

[75] IEA, Coal Information, 2012; Tewalt et al., *Chemical Analyses in the World Coal Quality Inventory, Version 1: U.S. Geological Survey Open-File Report 2010-1196;* Deutsche Bank, *Commodities Special Report; IEA, Coal Information 2011 Edition*; World Coal Association, "Coal Statistics."

Energy intensity and efficiency

Figure 16: Energy intensity of the Chinese economy compared to other regions[76]



An underlying driver of China's coal consumption is the energy efficiency of the economy. The amount of energy used per unit of GDP tripled between 1950 and 1978. However, as shown in Figure 16, energy efficiency has improved considerably since 1990, by 47%.

Between 2006 and 2010 the Top-1,000 Enterprises Energy-Saving Programme applied pressure to China's top energy-consuming enterprises to increase their energy efficiency. These organisations account for one third of national energy consumption. The scheme was judged successful but the exact energy savings from the programme are difficult to calculate due to overlap with other initiatives.[77]

Increased energy efficiency has resulted in decreased coal consumption for two reasons. First, lower electricity use results in lower demand for coal. This can disproportionately impact coal in areas where other fuel sources are higher up the merit order. Typically coal is higher up the merit order because it is cheaper to flex or switch off gas or renewables than coal-fired powered stations. In 2007 the Chinese government implemented a trial regulation that placed coal below renewables in the merit order,[78] therefore a decrease in electricity use could result in a disproportionate decrease in coal use.

Footnotes:

[76] US EIA, "International Energy Statistics."

[77] Ke et al., "China's Industrial Energy Consumption Trends and Impacts of the Top-1000 Enterprises Energy-Saving Program and the Ten Key Energy-Saving Projects."

[78] IEA, *Coal Information 2011 Edition.*

Secondly, a significant proportion of energy efficiency improvement has come from increased thermal power generational efficiency.[79] Between 2006 and 2011 the amount of coal required to produce the same amount of electricity decreased by 10%.[80]

There is near total consensus that energy intensity in China per unit of GDP is likely to continue to decrease, although many of the low hanging fruit may have been 'picked'. The key question for the coal sector is by how much and by when.

China's 12th FYP includes targets to reduce energy intensity by 16% by the end of 2015. Targets are often taken more seriously in China than in other countries because there is a direct link between officials meeting these targets and job promotion prospects.[81]

For example, under the 11th FYP a 20% energy intensity target was set and almost met,[82] though it often resulted in unintended consequences, such as cutting off power supply, even to hospitals, in order to meet the goal. The 12th FYP is targeting a 16% reduction in energy intensity.[83] An energy efficiency target of 16% to 17% is likely to be set for the 13th FYP spanning 2016 to 2020, which won't be released until around 2015. Another factor behind the lower target is that the most cost-effective and relatively simple opportunities are becoming fewer.[84]

To meet future energy intensity and efficiency targets coal-fired power stations are likely to be hit hardest – they are the least efficient of the generation technologies.[85] Under the 11th FYP 85 GW of inefficient coal-fired power plants were shut down. Small, inefficient plants are continuing to be closed under the 12th FYP, while remaining plants will be subject to stricter emissions standards.[86]

As well as energy efficiency targets, the Chinese government has set an absolute limit on total energy consumption. In January 2013 it approved a primary energy consumption target of 4 billion TCE (tonnes of coal equivalent, a measure of energy) by 2015. China's energy consumption in 2012 was 3.62 billion TCE, which means that energy use can only expand by 3% a year until 2015 to keep within this target. A cap for the use of coal specifically has also been set at 3.9 billion tonnes, or 2.8 billion TCE, by 2015. It is important to note that tonnes of coal equivalent are not equal to tonnes of coal due to the variable energy content of coal.

The newly introduced energy caps will, if enforced, reduce coal's share of the energy mix from 69% in 2011 to 65% in 2015.[87] But many doubt that China will be able to stay below its energy usage caps. The targets are not binding but merely 'expected targets'. The 11th FYP also contained an energy control target for 2.7 billion TCE of energy consumption, but this was exceeded by 20%.

Footnotes:

[79] Goldman Sachs, *The Window for Thermal Coal Investment Is Closing."*

[80] Chinese government, *China's Energy Policy.*

[81] Jie and Duanduan, "Behind China's Green Goals."

[82] The Institute for Industrial Productivity, "Energy Intensity Target of the 11th Five Year Plan."

[83] Lewis, "Energy and Climate Goals of China's 12th Five-Year Plan | Center for Climate and Energy Solutions."

[84] Jie and Duanduan, "Behind China's Green Goals."

[85] Goldman Sachs, *The Window for Thermal Coal Investment Is Closing.*

[86] IEA, *Tracking Clean Energy Progress 2013.*

[87] Song, "China's New Energy Consumption Control Target."

Environmental concern

Environmental concern in China has grown rapidly and is now the leading cause of social unrest.[88] The number of environmental protests increased on average by 29% a year from 1996 to 2011. Between 2010 and 2011 the number of environmental protests jumped by 120%.[89] One of the driving forces behind this increase in activism is the rise of social media. Platforms like Weibo (China's equivalent of Twitter) have helped unite people around common grievances and to mobilise action.[90]

Figure 17: Protests over large projects in China[91]

Source: The New York Times

Footnotes:

88 News, "China's Cleaner-Air Plan Puts Water Supplies at Risk: WRI."

89 Duggan, "Kunming Pollution Protest Is Tip of Rising Chinese Environmental Activism."

90 Hook, "China's Environmental Activists."

91 The New York Times, "Protests Over Large Projects."

Figure 17 shows the cities where protests have occurred since August 2011 and many of the protests have been targeted towards coal-fired power stations. One example is the protest against the expansion of a coal-fired power plant in Haimen in Guangdong Province, which was eventually suspended.[92] The protestors' main concerns were over local air pollution, which they blame for an increase in cancer rates, as well as water pollution.[93] Another protest was staged against a coal-fired power station in Yinggehai on Hainan Island, involving over 1,000 people.[94] This protest was again over health concerns related to local pollution.[95] These are just two of many such instances.

Climate change is another driver of environmental concern – in one recent Chinese survey 85% of respondents agreed that people were at least partially to blame, and 71% believed they had a responsibility to mitigate their emissions.[96] Young people in particular thought they had a personal responsibility.[97] This concern has just not yet been manifested in organised protests directly targeting anthropogenic climate change and so we anticipate that efforts to reduce local air pollution will be the main way that environmental concern impacts coal consumption.

Gas and shale gas

The unexpected growth of shale gas in the United States has had major impacts on energy markets there and internationally. The US increased shale production from 9 billion cubic metres (bcm) in 2000 to 266 bcm in 2012,[98] equivalent to about 540 billion tonnes of coal.[99] This has had a dramatic effect on the US power sector, displacing coal and nearly overtaking it as the largest energy source.[100] This displaced coal has instead headed to export markets, depressing coal prices.[101]

On the back of the US shale gas boom some are speculating that China could experience a similar shale gas revolution,[102] if not of even greater proportions.[103] These hopes are based on the fact that China has more technically recoverable shale gas resources than any other country in the world, accounting for 15% of the world's total and roughly equal to the combined reserves of Canada and the US.[104]

Footnotes:

92 Yang, "What Is The Future Of King Coal In China?".

93 Wong, "China Major Protest Demands Halt To Planned Coal-Fired Power Plant"; BBC, "More Protests in China Province."

94 The Guardian, "Chinese Protesters Clash with Police over Power Plant."

95 Yun and Ning, "Police Beat Back Coal Plant Protesters in Hainan Province."

96 Yu et al., "Public Perception of Climate Change in China: Results from the Questionnaire Survey."

97 Ibid.

98 Hu and Xu, "Opportunity, Challenges and Policy Choices for China on the Development of Shale Gas"; US EIA, "North America Leads the World in Production of Shale Gas."

99 US EIA, "FAQ."

100 Goldman Sachs, *The Window for Thermal Coal Investment Is Closing.*

101 SMH, "More Coal Cuts Loom as Prices Retreat."

102 Aizhu, "China's Ragtag Shale Army a Long Way from Revolution."

103 Larson, "China's Shale-Gas Potential and Peril."

104 US EIA, *Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States.*

Following the publication of China's 12th FYP in 2011 a subsidiary plan was released for shale gas in March 2012. This plan sets out an ambitious growth target for shale gas production from near zero to 6.5 bcm by 2015 and 60-100 bcm by 2020.[105] In order to reach these targets the government has put in place a range of subsidies and preferential treatment policies for shale gas,[106] which is expected to increase over time.[107] However, some doubt these measures will be enough to meet China's targets due to a number of barriers facing the sector.

Arguably the biggest obstacle to developing shale gas in China is the shortfall in the expertise and technology required to negotiate China's difficult geological conditions – Chinese companies are relatively inexperienced in shale gas exploration and development.[108] In order to address this problem the Chinese government is encouraging companies to work with foreign businesses,[109] particularly American ones.[110]

But even US expertise may not be enough to overcome the challenges. Shale formations exhibit huge variations from country to country,[111] and conditions in China are considerably less favourable than they are in North America.[112] Chinese shale gas basins are tectonically complex, contain numerous fault lines, are sometimes seismically active, are mostly located in mountainous, rocky or desert areas, and are located about twice as deep underground as US reserves.[113] Due to these factors it is not possible to simply use proven US technology in China;[114] more advanced and specialised technologies will need to be developed. These conditions also make construction, installation and transportation of the necessary infrastructure more expensive.[115]

In addition to determining how to extract vast quantities of shale gas, China also has to deliver this gas to where it is needed. The majority of China's shale gas reserves are located far away from existing pipeline networks,[116] which are also of very low density compared to the US, with only 100,000 km of pipeline compared to America's 2 million km.[117] Between 80% and 90% of this pipeline is owned and operated by a single company, which has no legal obligation to grant access to other companies.[118] Installing the amount of infrastructure required to support China's ambitious shale gas development goals will take considerable time and investment.[119]

Footnotes:

[105] Kwok, "China's 12th Five-Year Plan for Shale Gas"; China Greentech Initiative, *The China Greentech Report*; Tollefson, "China Slow to Tap Shale-Gas Bonanza."

[106] Hu and Xu, "Opportunity, Challenges and Policy Choices for China on the Development of Shale Gas."

[107] Deutsche Bank, *China Strategy Update*.

[108] Norton Rose Fulbright, "Shale Gas: A Game Changer for China's Energy Consumption Pattern?"; Hu and Xu, "Opportunity, Challenges and Policy Choices for China on the Development of Shale Gas."

[109] Xingang, Jiaoli, and Bei, "Focus on the Development of Shale Gas in China—Based on SWOT Analysis."

[110] Hu and Xu, "Opportunity, Challenges and Policy Choices for China on the Development of Shale Gas."

[111] Mackenzie, "What's Going on with Shale Gas in China (and Poland)?".

[112] US EIA, *Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States.*

[113] Xingang, Jiaoli, and Bei, "Focus on the Development of Shale Gas in China—Based on SWOT Analysis"; Norton Rose Fulbright, "Shale Gas: A Game Changer for China's Energy Consumption Pattern?"; Hu and Xu, "Opportunity, Challenges and Policy Choices for China on the Development of Shale Gas."

[114] Xingang, Jiaoli, and Bei, "Focus on the Development of Shale Gas in China—Based on SWOT Analysis."

[115] Norton Rose Fulbright, "Shale Gas: A Game Changer for China's Energy Consumption Pattern?"; Hu and Xu, "Opportunity, Challenges and Policy Choices for China on the Development of Shale Gas."

[116] Norton Rose Fulbright, "Shale Gas: A Game Changer for China's Energy Consumption Pattern?".

[117] Xingang, Jiaoli, and Bei, "Focus on the Development of Shale Gas in China—Based on SWOT Analysis."

[118] Larson, "China's Shale-Gas Potential and Peril"; Trabish, "China Backs Off Shale Gas Targets."

[119] Norton Rose Fulbright, "Shale Gas: A Game Changer for China's Energy Consumption Pattern?"; Xingang, Jiaoli, and Bei, "Focus on the Development of Shale Gas in China—Based on SWOT Analysis."

A third challenge to overcome is water scarcity. Fracking requires large volumes of water, with China requiring more water than average, between 10,000 and 24,000 cubic metres (m^3) per well, due to its geological conditions.[120] If the target production of 1.5 bcm of gas is produced in Sichuan province then 171 million m^3 of water will be used, which is equal to 10.5% of the province's domestic water use.[121] Some estimate that the national target of 6.5 bcm of shale gas production would increase the amount of water used by China's industrial sector by over 30%.[122] This is particularly problematic as the majority of shale gas wells are located in arid or semi-arid areas that are already struggling to cope with limited water resources.[123] According to HSBC, water availability in eight out of 31 provinces was classified as extremely scarce on average between 2002 and 2010, with a further three provinces classified as scarce.[124]

Even though China plans to become a world leader in shale gas production in less than a decade,[125] it could be many years before production reaches a significant scale. The Chinese National Energy Administration has set production goals of 6.5 bcm of shale gas each year by 2015 and 62 bcm per year by 2020,[126] but many industry experts believe that China won't reach either target,[127] and could take ten years longer than expected.[128] Long-term prospects for the shale gas industry look better, with analysts expecting China to overcome obstacles to development and commercial scale production to be reached.[129]

Between 2001 and 2011 the US increased its shale gas production by 2,000%.[130] As a result gas prices fell and between 2008 and 2012 the share of US electricity produced from coal fell by 12 percentage points from 49% to 37%, nine percentage points of which was taken up by natural gas.[131] A similar displacement of coal is unlikely to take place in China. The US had been developing shale gas for over seventy years before production really took off.[132] While China's shale gas industry benefits from lessons learnt in the US and strong government backing, there are still many challenges that are unlikely to be overcome. Shale gas may eventually have a moderate impact on coal consumption, but not in the short to medium term.

Assuming the displacement of coal from shale gas is proportionately borne by a reduction in coal imports, a shale gas revolution could significantly impact international coal prices in the long term. But again, our view is that shale gas will have a limited impact in the short term and only a moderate impact in the medium term.

Footnotes:

[120] Yang, Flower, and Thompson, "Shale-Gas Plans Threaten China's Water Resources."

[121] Ibid.

[122] Sudworth, "China's Ambitious Quest for Shale Gas."

[123] Hu and Xu, "Opportunity, Challenges and Policy Choices for China on the Development of Shale Gas"; Yang, Flower, and Thompson, "Shale-Gas Plans Threaten China's Water Resources."

[124] HSBC, *No Water, No Power*.

[125] Sudworth, "China's Ambitious Quest for Shale Gas."

[126] Perkowski, "Shale Gas: China's Untapped Resource."

[127] Ibid.; Trabish, "China Backs Off Shale Gas Targets"; Hook, "China Set to Miss Targets for Shale Gasfield Development"; Aizhu, "China's Ragtag Shale Army a Long Way from Revolution."

[128] Perkowski, "Shale Gas: China's Untapped Resource."

[129] Hook, "China Set to Miss Targets for Shale Gasfield Development"; Larson, "China's Shale-Gas Potential and Peril."

[130] Hu and Xu, "Opportunity, Challenges and Policy Choices for China on the Development of Shale Gas."

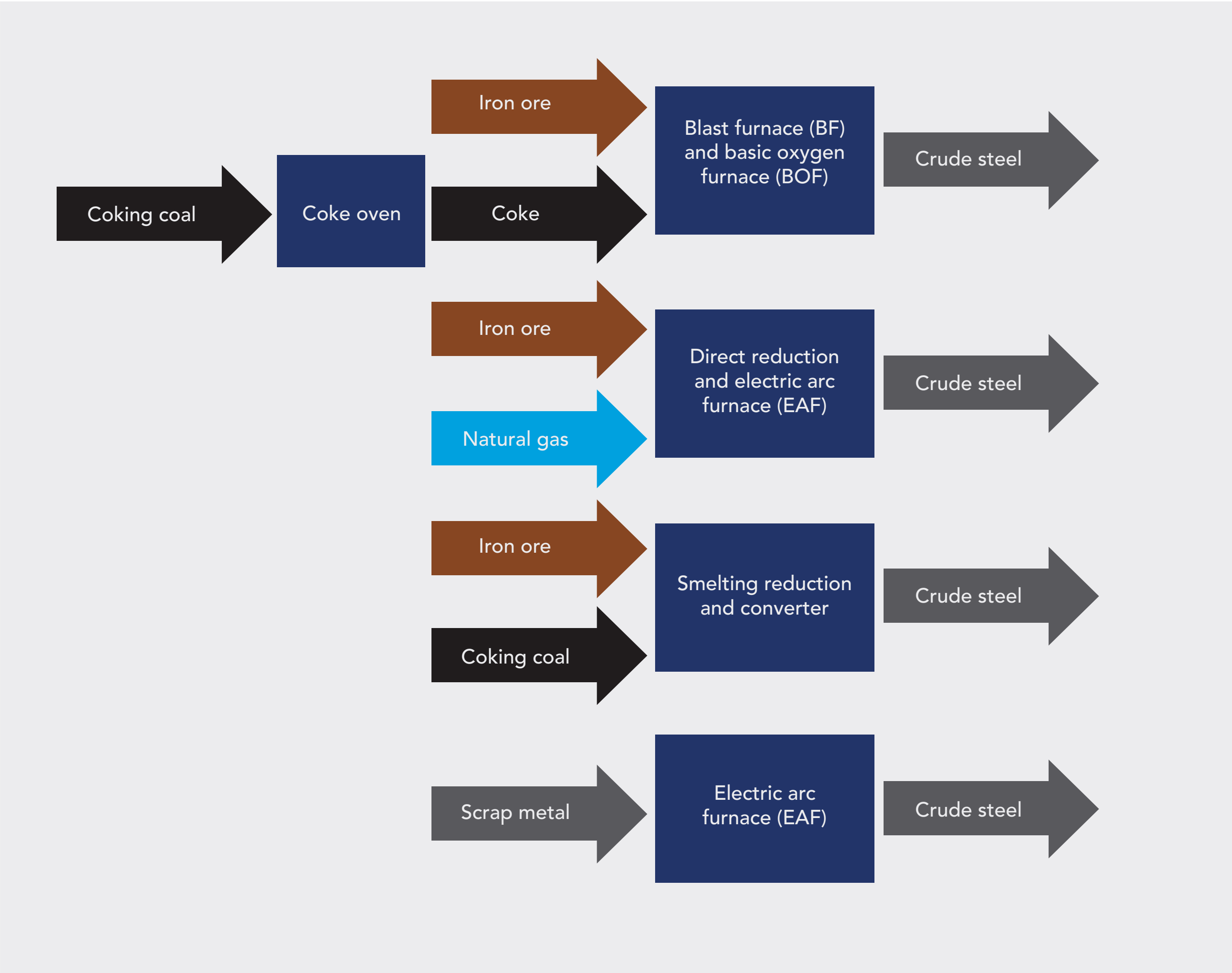
[131] IEA, *Redrawing the Energy-Climate Map*.

[132] Xingang, Jiaoli, and Bei, "Focus on the Development of Shale Gas in China—Based on SWOT Analysis."

Iron and steel sector

Steel is the world's most important metal[133] and steel production is a highly energy intensive activity. There are four different steel production routes, each using a different amount of coal and for different purposes.

Figure 18: A simplified flow diagram of the four steel production processes[134]



As shown in Figure 18, electricity, iron ore and natural gas are the other major inputs. The blast furnace and basic oxygen furnace (BF/BOF) route is the most common, comprising about a third of global production, with the electric arc furnace (EAF) route comprising most of the remaining third.[135] In China 90% of steel is produced by the BF/BOF route and 10% through the EAF route.[136]

Footnotes:

133 IPCC, "Iron and Steel."

134 Hasanbeigi, Price, and Arens, *Emerging Energy-Efficiency and Carbon Dioxide Emissions-Reduction Technologies for the Iron and Steel Industry.*

135 Ibid.

136 World Steel Association, *Steel Statistical Yearbook.*

Figure 19: Energy consumption mix of the Chinese steel industry in 2004[137]

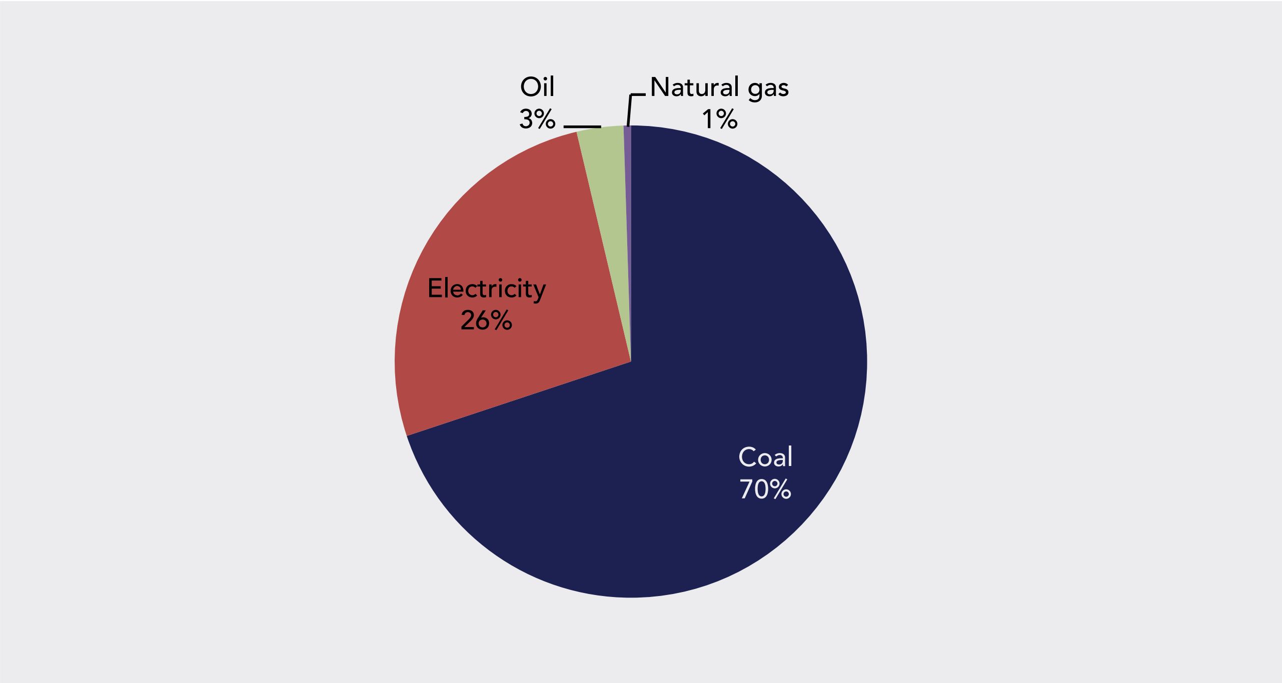
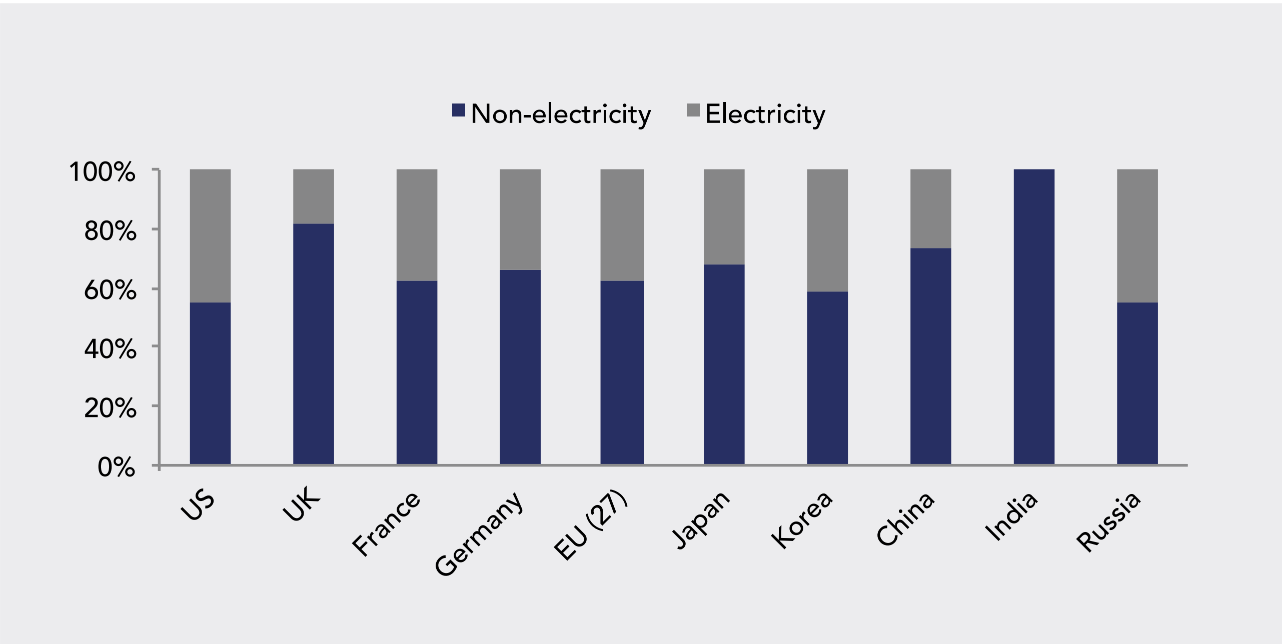


Figure 20: Energy consumption mix of the steel industry in different countries[138]



Footnotes:

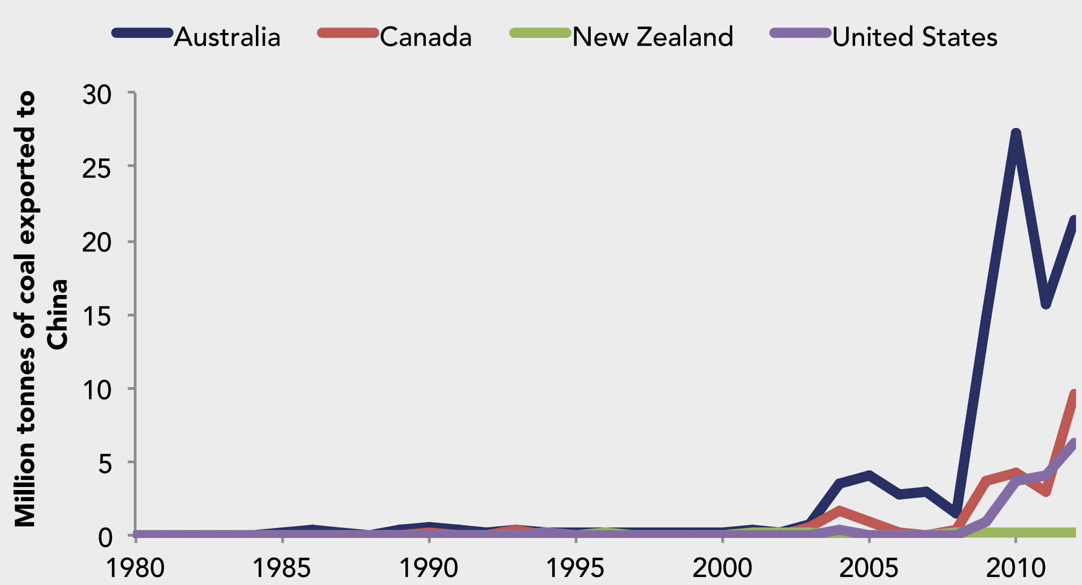
[137] Guo and Fu, "Current Situation of Energy Consumption and Measures Taken for Energy Saving in the Iron and Steel Industry in China."

[138] Oda et al., "International Comparisons of Energy Efficiency in Power, Steel, and Cement Industries."

Increased steel production results in an increase in coal consumption for three reasons: coking coal is used as a material input in steel production for its chemical qualities; it is combusted to produce energy; and it is combusted to produce electricity, which is also used in the process. Coal is the largest source of energy for the steel sector in China, as shown in Figure 19. Other countries typically use a higher mix of electricity, as illustrated by Figure 20.

Coking coal or metallurgical coal is used in the steel production process due to its chemical properties. Coking coal is high in carbon and energy, and low in moisture, ash, sulphur and phosphorus. It also has properties that allow it to melt, expand and resolidify which is important for the steel making process.

Figure 21: Exports of coking coal to China by OECD countries[139]



Due to these specifications coking coal is more expensive than other types of coal and therefore is rarely used for producing electricity.[140] China and Australia are the first and second biggest producers of coking coal respectively. China is also the world's largest consumer of coking coal, using more than four times that of Japan, the next largest market.[141] Australia is the largest supplier of coking coal to China, overtaking Mongolia in February 2013.[142] Figure 21 shows that Australia exports significantly more coking coal to China than other OECD countries.

Australia is the largest supplier of coking coal to China...

Footnotes:

[139] IEA, Coal Information, 2012.

[140] Deutsche Bank, *Commodities Special Report*.

[141] World Coal Association, "Coal & Steel."

[142] Ubpost, "Australia Beats Mongolia in Coking Coal Exports to China."

Rapid growth of the iron and steel sector in China (henceforth referred to the steel sector) has been driven by economic growth.[143] China's steel production doubled between 1990 and 2000, and then increased by a further 174% between 2000 and 2005.[144] China became the largest producer of crude steel in 1996 – and is responsible for 46% of world production and seven times more than Japan, the next largest producer.[145]

China's steel sector has been moving closer to OECD levels of energy efficiency and carbon intensity. This improvement has been attributed to a process of restructuring and optimisation,[146] an increase in market openness leading to greater competition,[147] and the introduction of improved processes and equipment.[148] Despite these improvements, energy intensity in China's steel industry is still one of the highest of the major steel producers, 20% higher than in developed countries.[149]

The rapid growth of the Chinese steel sector has resulted in a fragmented industry[150] with a large number of small steel producers, which is the main reason for lower levels of energy efficiency.[151] These small, decentralised plants are not able to realise economies of scale[152] and lack the funds necessary for investment in research and development and technology upgrades.[153]

In order to address this problem the Chinese government has been encouraging mergers between small producers and acquisitions by larger ones. In the 12th FYP the government set a target to increase the proportion of steel produced by the top ten steel producers from 48% in 2010 to 60% in 2015.[154] The World Bank estimates that these companies will produce 70% of total steel production by 2020.[155]

China will close the energy efficiency gap with Japan, the world's most efficient steel producer...

The 12th FYP also includes other measures to improve the energy efficiency of the Chinese steel sector. The plan focuses on "promoting the use of modern technology, energy efficiency and improved product quality".[156] The government is also encouraging firms to establish energy management centres and to recycle more than half of their waste heat by 2015.[157] One study estimates that the Chinese steel sector could cost-effectively reduce electricity use by 251 TWh (54%) between 2010 and 2030. Cost-effective fuel savings were estimated at 11,999 peta joules (PJ).[158] Another study predicts that China will close the energy efficiency gap with Japan, the world's most efficient steel producer, by 2020, and as early as 2015 if concerted efforts are taken. This would result in an approximately 40% decrease in coal use per unit of output.[159]

Footnotes:

143 Smyth, Narayan, and Shi, "Substitution between Energy and Classical Factor Inputs in the Chinese Steel Sector"; Lin, Wu, and Zhang, "Estimates of the Potential for Energy Conservation in the Chinese Steel Industry."

144 Hasanbeigi et al., *Assessment of Energy Efficiency Improvement and CO_2 Emission Reduction Potentials in the Iron and Steel Industry in China.*

145 World Bank, *Factors Influencing Energy Intensity in Four Chinese Industries; World Steel Association, World Steel in Figures.*

146 Hasanbeigi et al., *Assessment of Energy Efficiency Improvement and CO_2 Emission Reduction Potentials in the Iron and Steel Industry in China.*

147 World Bank, *Factors Influencing Energy Intensity in Four Chinese Industries.*

148 Wei, Liao, and Fan, "An Empirical Analysis of Energy Efficiency in China's Iron and Steel Sector."

149 Smyth, Narayan, and Shi, "Substitution between Energy and Classical Factor Inputs in the Chinese Steel Sector."

150 KPMG, *China's 12th Five-Year Plan: Iron and Steel.*

151 Smyth, Narayan, and Shi, "Substitution between Energy and Classical Factor Inputs in the Chinese Steel Sector."

152 Ibid.

153 Lin, Wu, and Zhang, "Estimates of the Potential for Energy Conservation in the Chinese Steel Industry."

154 Ernst & Young, *Global Steel 2013: A New World, a New Strategy.*

155 World Bank, *Factors Influencing Energy Intensity in Four Chinese Industries.*

156 Ernst & Young, Global Steel 2013: *A New World, a New Strategy*, 5.

157 World Bank, *Factors Influencing Energy Intensity in Four Chinese Industries.*

158 Hasanbeigi et al., *Assessment of Energy Efficiency Improvement and CO_2 Emission Reduction Potentials in the Iron and Steel Industry in China.*

159 Lin, Wu, and Zhang, "Estimates of the Potential for Energy Conservation in the Chinese Steel Industry."

There are three possible trends that could impact the use of coal by the Chinse steel sector: a decrease in total production, an increase in energy efficiency and the substitution of coal for electricity. Considering the high proportion of China's electricity that is currently produced by burning coal, substitution would predominantly shift coal consumption from coking coal to thermal coal. This shift would have a particular impact on Australian coal exporters, which are the largest suppliers of coking coal to China.

Local pollution

In January 2013 Beijing suffered from particularly bad smog that resulted in a spike in public concern about air pollution. One measure of air quality is the concentration of particles with a diameter of 2.5 microns or less. In January Beijing's air held 900 parts per million of these particles, 40 times the level deemed safe by the World Health Organisation. The smog, which was predominantly caused by the region's five million cars and 200 coal-fired power plants, resulted in thousands of business people leaving the city and was the subject of thousands of blog posts.[160] Many other cities throughout China regularly suffer from similarly high levels of air pollution.

Air pollution is acute in the more densely populated and industrialised northern half of the country. Particulate concentrations north of the Huai River are 55% higher than south of the river. This is predominantly due to an arbitrary decision by the Chinese government to provide free coal for household heating to homes north of the river between 1950 and 1980. Due to this difference in air quality life expectancy in the north is estimated to be 5.5 years shorter than it would otherwise be. With half a billion residents in northern China this means that 2.5 billion life years were lost to air pollution in this region during the 1990s.[161] Beyond these health impacts, the cost of environmental degradation to the economy has been estimated at US$200 billion in 2006[162] and 3.5% of GDP in 2010.[163] Due to these factors air quality has increasingly contributed towards social unrest,[164] pushing the issue up the government's agenda.

The government has been attempting to tackle air pollution, most famously before and during the 2008 Beijing Olympic Games. In 2008 it established the Ministry for Environmental Protection and in 2012 added the environment to the four 'platforms' that define what the party stands for. Twenty significant air pollution laws have been implemented and tens of thousands of related decrees issued in the last ten years.[165]

In June 2013 the government announced its most aggressive air pollution policy to date.[166] One of the strategies is to substitute diesel for natural gas in transport. This is estimated to reduce vehicle emissions of particulate matter by 93%, carbon monoxide by 50-70%, nitrogen monoxide by 20-40%, and carbon dioxide by 25%.[167] The government is also expected to increase taxes on sulphur dioxide and nitrogen monoxide, two of the main pollutants associated with burning coal. This will increase the cost of producing electricity from coal and encourage switching to other fuel sources.[168]

Footnotes:

[160] The Economist, "The East Is Grey."

[161] Chen et al., "Evidence on the Impact of Sustained Exposure to Air Pollution on Life Expectancy from China's Huai River Policy."

[162] "China Buys Air Products, Technology For New LNG Plant As Nation Fights Rising Pollution."

[163] IEA, *Redrawing the Energy-Climate Map.*

[164] Chen et al., "Evidence on the Impact of Sustained Exposure to Air Pollution on Life Expectancy from China's Huai River Policy."

[165] The Economist, "The East Is Grey."

[166] Deutsche Bank, *China Strategy Update.*

[167] Perkowski, "Shale Gas: China's Untapped Resource."

[168] Deutsche Bank, *China Strategy Update.*

Figure 22a: SO2 emissions per GDP per person[169]

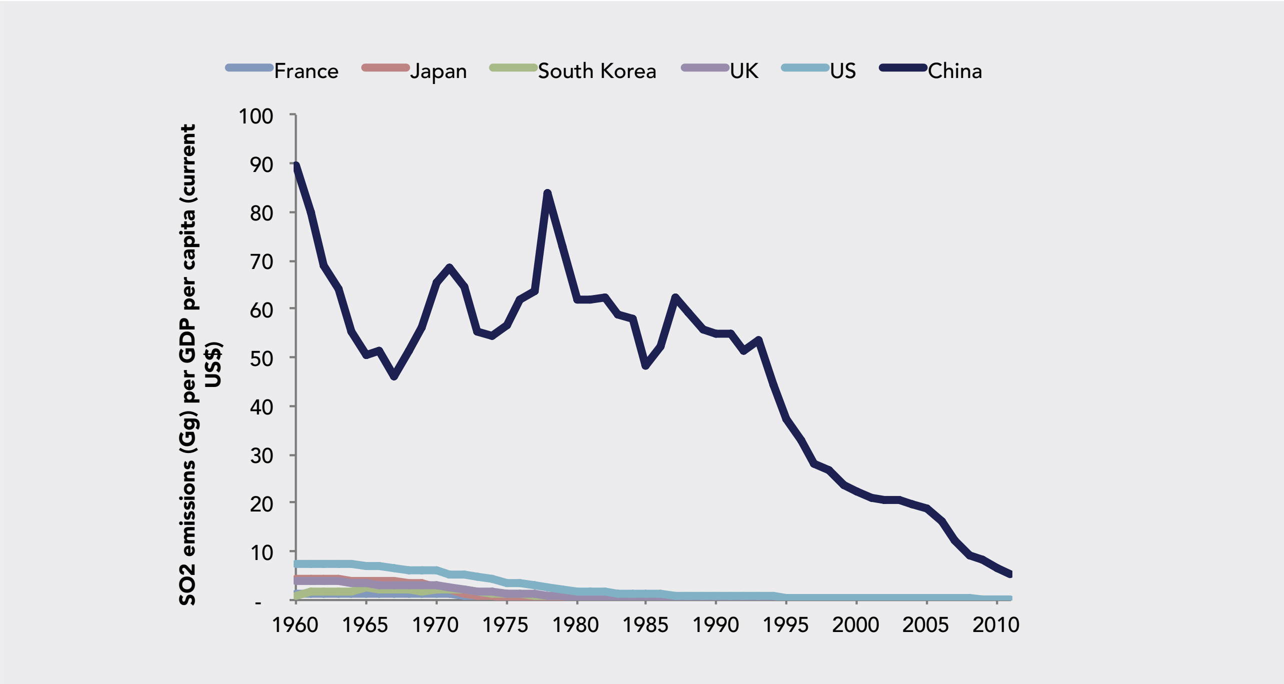
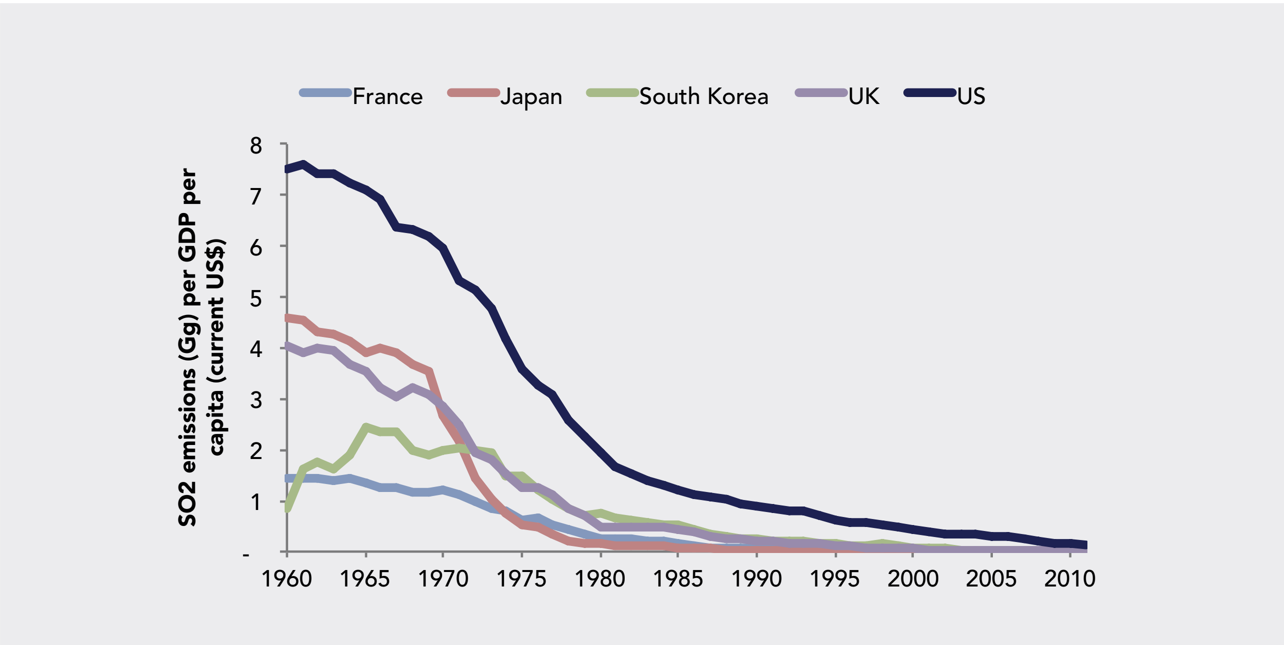


Figure 22b: SO2 emissions per GDP per person[169]



Footnotes:

[169] NASA, "Historical Anthropogenic Sulfur Dioxide Emissions"; World Bank, "GDP per Capita (current US$)"; EEA, "National Emissions Reported to the Convention on Long-Range Transboundary Air Pollution (LRTAP Convention)"; Klimont, Smith, and Cofala, *The Last Decade of Global Anthropogenic Sulfur Dioxide: 2000-2011 Emissions.*

Figure 23a: PM10 emissions per GDP per person[170]

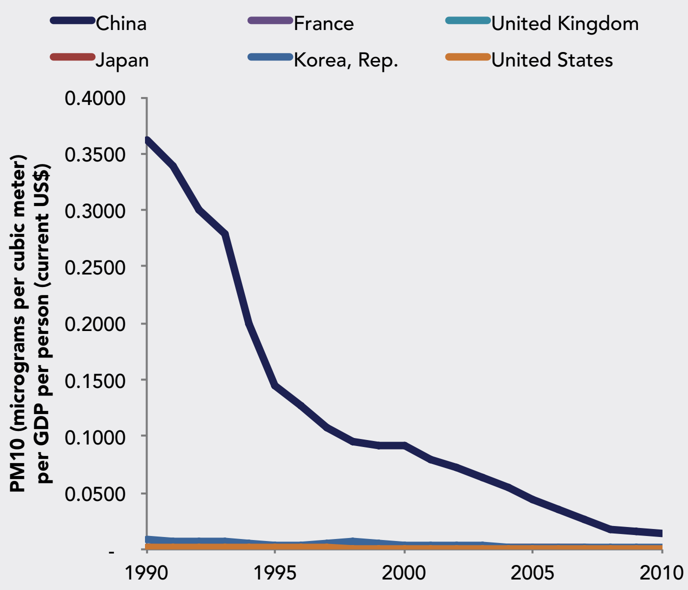
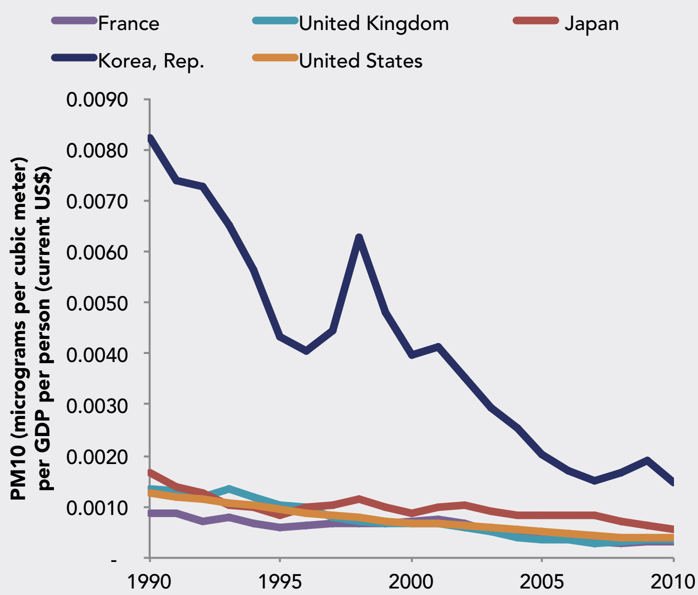


Figure 23b: PM10 emissions per GDP per person[170]



Footnotes:

[170] World Bank, "PM10, Country Level (micrograms per Cubic Meter)," 10; World Bank, "GDP per Capita (current US$)."

One reason for anticipating a fall in China's local air pollution and greenhouse gas emissions is the Environmental Kuznets Curve (EKC) – the idea that as a country's income grows, so will pollution until the point when incomes are high enough for citizens to afford funding environmental protection and pollution reduction. This could be because as people become richer they place a higher value on environmental quality.[171] China's level of air pollution relative to income levels appears to be declining, as illustrated in Figure 22 and Figure 23.

Direct measures to reduce air pollution from coal combustion are likely to include the further installation of desulphurisation and denitration facilities.[172] This will increase the cost of coal relative to alternatives. The government also announced in early 2013 the replacement of four coal-fired heating plants in Beijing for gas equivalents, cutting coal use by 9.2 Mt per year.[173]

Direct measures to reduce air pollution that also reduce coal use appear to be limited though and largely insignificant compared to other factors affecting coal use. The real impact of air pollution is in providing significant additional impetus for the government to pursue initiatives such as emissions trading, energy efficiency and renewable energy.

Non-fossil fuel energy and electricity

China is a major producer of low carbon electricity from wind, solar, hydro and nuclear. In 2012 China invested US$67 billion in renewable energy, more than three times the level of Germany,[174] and produced 714TWh of hydroelectricity in 2010, more than any other country, representing 18% of its total generation.[175] China has roughly doubled its wind capacity every year since 2005 to become the second largest wind energy producer in 2011,[176] and is the world's largest low-cost producer of solar panels.[177] As of mid-2012 China had plans to install a further 33 GW of nuclear power capacity, half of global nuclear power installation proposals.[178]

Despite these successes, low carbon sources make up a small proportion of China's energy mix, with 6.5% coming from hydro, 0.8% from nuclear, 0.7% from wind and 0.02% from solar in 2012.[179] This means there is significant space for further growth. Experience in other markets shows that the deployment of renewables, particularly onshore wind and decentralised solar, can scale up remarkably quickly once policies, a critical mass of project developers and market access are in place. Analysts have consistently underestimated the scale and pace of renewables deployment in different markets and the same has been true in China.

Analysts have consistently underestimated the scale and pace of renewables deployment...

Footnotes:

[171] Dinda, "Environmental Kuznets Curve Hypothesis: A Survey."

[172] Deutsche Bank, *Big Bang Measures to Fight Air Pollution (2nd Edition).*

[173] Reuters, "Beijing to Replace Some Coal-Fired Heating Plants."

[174] The Economist, "The East Is Grey."

[175] US EIA, "China."

[176] Ibid.

[177] The Economist, "The East Is Grey."

[178] US EIA, "China."

[179] Deutsche Bank, *Big Bang Measures to Fight Air Pollution (2nd Edition).*

The government has implemented ambitious plans to increase the proportion of electricity generated from low carbon sources. Based on policies already announced, the IEA expect renewables to make up 28% of China's electricity generation in 2035.[180] China's 5th FYP for the period 2011 to 2015 sets targets to increase nuclear capacity to 40 GW, hydropower to 120 GW, wind power by 70 GW and solar power to 5 GW.[181] In July 2012 an update to the FYP was released and called for wind to reach 200 GW and solar to reach 50 GW by 2020.[182]

If China's renewable energy plans are realised and the increase in renewables comes at the cost of coal-fired electricity, coal consumption would fall from 70% of the electricity mix[183] to 63% by 2020. This would reduce China's total national coal consumption by approximately 5% by 2020.

The resultant decrease in coal imports would be modest in the short term but potentially significant in the medium to long term as more coal is displaced. China's policymakers are also likely to prioritise domestic producers of coal, which would result in exporters being disproportionately affected by a fall in demand.

But there are a number of barriers to China achieving its low carbon energy targets. Its lack of transmission infrastructure poses a threat to the continued development of renewable energy. China and the US have approximately equal wind power capacity but America generates 40% more electricity from its turbines.[184] China's wind farms are often not connected to the grid or are connected in a way that results in power surges forcing them to be disconnected regularly.[185] One study estimates that nearly one third of wind turbines are not connected to the grid.[186] Other barriers include lack of sufficient financial incentives combined with prohibitive licensing procedures for wind and solar PV.[187]

China's rapidly growing power requirements and the fact there is so much coal already in its power system means that absolute coal demand could still grow despite aggressive developments in low carbon power. According to BNEF coal-fired electricity generation will continue to grow by the equivalent of two large power stations every month until at least 2030. Coal's share of the power mix will, however, drop from 67% in 2012 to 44% in 2030.[188]

Water

China is facing severe water shortages and the situation is expected to worsen. China contains 21% of the world's population but only 6% of its freshwater, resulting in a per capita water availability one quarter of the world's average.[189] Over 400 Chinese cities are short of water, nine provinces suffer extreme water scarcity and the country as a whole is experiencing serious water scarcity.[190] This scarcity is partly a result of economic growth, which has come with increased urbanisation and energy use, both of which require water.

Footnotes:

[180] IEA, World Energy Outlook.

[181] National People's Congress, China's Twelfth Five Year Plan (2011- 2015) - the Full English Version.

[182] IEA, World Energy Outlook 2012.

[183] US EIA, "China."

[184] BNEF, Global Trends in Renewable Energy Investment 2012; The Economist, "The East Is Grey"; US EIA, "China."

[185] BNEF, Global Trends in Renewable Energy Investment 2012; The Economist, "The East Is Grey"; US EIA, "China."

[186] Yang, Patiño-Echeverri, and Yang, "Wind Power Generation in China: Understanding the Mismatch between Capacity and Generation."

[187] IEA, Medium-Term Renewable Energy Market Report 2012.

[188] BNEF, The Future of China's Power Sector.

[189] PwC, *Slaking the Thirst of a Huge Nation*.

[190] Ibid.

Water is now a high priority for Chinese officials, who issued water quotas to every province for the first time in 2013.[191] The Chinese government expects water use to increase from 599 billion cubic metres (bcm) in 2010 to 670 bcm by 2030,[192] with a water usage cap set at 700 bcm.[193] Water shortages in China are largely due to the geographic mismatch between water supply and demand for water. The country as a whole has annual water resources of 2,812 bcm, but 2,227 bcm of this is located in the south while the north only has access to 405 bcm each year.[194] This distribution in resources does not match the distribution of population, farming and industry.

The coal sector is a major consumer of water and is expected to continue to increase its water usage. Water is used to manage dust from mines, wash coal of impurities after extraction, and to operate power stations that burn coal.

In 2011 the coal industry accounted for about 17% of China's water withdrawals,[195] and this figure is expected to increase to 27% by 2020.[196] Approximately 70% of China's coalmines are located in water scarce regions and 40% are expected to experience severe water shortages, with some already slowing production due to lack of water.[197] Coal-fired power generation, which makes up the largest portion of this water use,[198] is also predominantly located in water scarce regions. 60% of thermal power capacity is located in the north, which contains only a fifth of the country's water supply. The exposure to water shortages of China's 'Big Five' energy utilities ranges from 65% to 84% of generative capacity.[199]

China is investing billions of dollars to address its water shortage. In 2002 a US$60 billion diversion project was started to pump 45 billion m^3 of water from the south of China to the north each year. The project is not expected to be finished until about 2050.[200] There is considerable progress to be made in reducing demand as well. China water use per unit of industrial output is four to ten times that of developed countries, while its water recycling rates are half those of developed countries.[201]

According to BNEF, China's best strategy for coping with the water crisis is geographical and technological diversification.[202] However, other forms of power generation could also be constrained by water shortages. Gas-fired power stations use less than half the water of coal power plants,[203] but the extraction of shale gas is a very significant user of water. Nuclear power is also water intensive, which is one of the reasons why the government is placing a moratorium on the construction of inland nuclear power stations.[204]

China's likely response to the water crisis could send mixed signals for coal use. The four most important factors are increased coal washing, increased power plant efficiency, conversion to air cooling in power plants, and closure of coalmines.

Footnotes:

[191] Hook, "China: High and Dry."

[192] PwC, *Slaking the Thirst of a Huge Nation.*

[193] BNEF, *China's Power Utilities in Hot Water.*

[194] World Bank, *Addressing China's Water Scarcity.*

[195] HSBC, *China Coal and Power: The Water-Related Challenges of China's Coal and Power Industries.*

[196] Cho, "How China Is Dealing With Its Water Crisis."

[197] HSBC, *China Coal and Power: The Water-Related Challenges of China's Coal and Power Industries.*

[198] Pan et al., "A Supply Chain Based Assessment of Water Issues in the Coal Industry in China."

[199] BNEF, *China's Power Utilities in Hot Water.*

[200] "China's Mega Water Diversion Project Begins Testing"; PwC, *Slaking the Thirst of a Huge Nation.*

[201] Bloomberg, "China's Coal-Fired Economy Dying of Thirst as Mines Lack Water."

[202] BNEF, *China's Power Utilities in Hot Water.*

[203] Pan et al., "A Supply Chain Based Assessment of Water Issues in the Coal Industry in China."

[204] Hook, "China: High and Dry."

Washing coal improves its energy content and thermal properties, so increasing the amount of coal that is washed results in a decrease in water use overall because less coal needs to be burnt per unit of energy produced. If all steam coal was washed and 10% of ash was removed, coal consumption could be reduced by 6-16%, reducing net water consumption.[205] Using washed coal in power stations also reduces air pollution, addressing two pressing issues at once.

Increasing power plant efficiency would reduce both coal and water consumption. As this would address both energy security and water scarcity concerns, this is also an attractive option.

Power stations could be converted from water-cooling systems to closed-cycle and air-cooling systems in order to reduce water use. However, this would also reduce the efficiency of these plants by 3-10%, resulting in a similar increase in coal use.[206] Due to this difficult trade-off it is unclear to what extent power stations will be converted.

Should coalmines be closed due to water shortages this would also result in an increase in coal imports. However, there is scope for coalmines to become more water efficient as most of the water can be reused after proper treatment.[207]

Overall two of these factors point to decreased consumption while the other two point to either increased consumption or increased imports. It is highly likely that the government will encourage increased coal washing to address air pollution and increased power plant efficiency due to its dual benefits. Both these factors point to decreased coal consumption and therefore imports. The remaining two factors – changing cooling systems and closing mines – are less likely due to the expense and more attractive alternatives. Therefore while water scarcity could result in either a decrease or increase in coal imports, a decrease is more likely.

Footnotes:

[205] Pan et al., "A Supply Chain Based Assessment of Water Issues in the Coal Industry in China."

[206] BNEF, *China's Power Utilities in Hot Water.*

[207] Pan et al., "A Supply Chain Based Assessment of Water Issues in the Coal Industry in China."

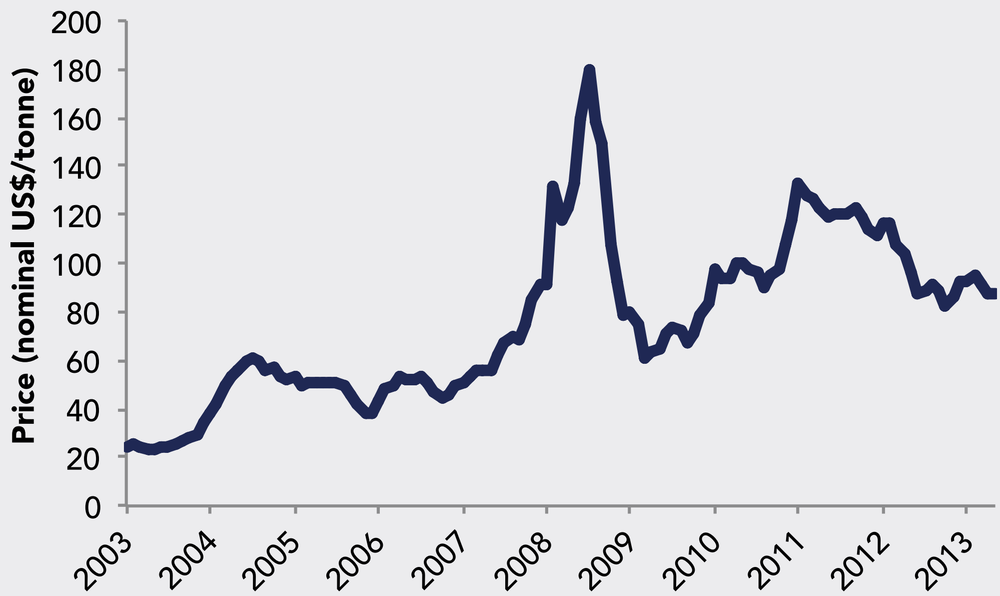
Implications for Australian coal assets

China's coal demand patterns are changing as a result of environment-related factors and consequently less coal will be consumed than is currently expected by many owners and operators of coal assets. These developments may be unexpected for a number of reasons – bias, lack of foresight or a lack of resources.

Given China's growing role as the price setter in global and regional coal markets falling demand will, all things being equal, reduce coal prices. This could result in coal assets under development becoming stranded, or operating mines only covering their marginal costs and subsequently failing to provide a sufficient return on investment. In this section we look at what these developments could mean for Australian coal assets specifically and what current assumptions are for coal prices.

China's coal demand patterns are changing as a result of environment-related factors and consequently less coal will be consumed than is currently expected...

Figure 24: Price of coal over the last ten years[208]

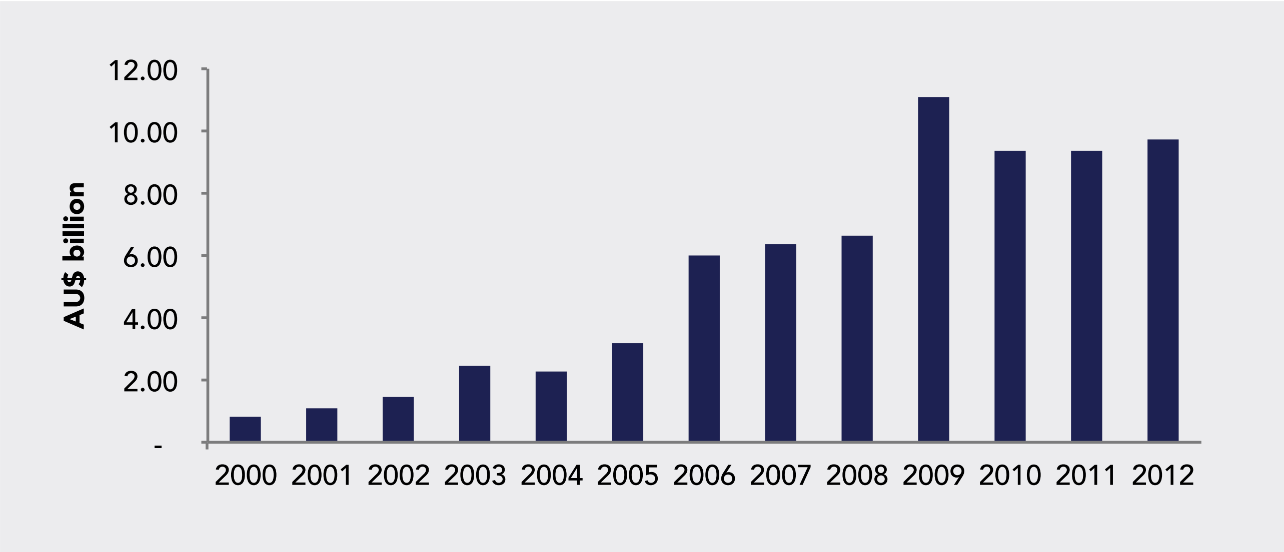


Footnotes:

[28] World Bank, "World Bank Data."

Due to unanticipated changes in the international coal trade, coal prices have fallen below expectations in recent years. As can be seen in Figure 24 there was a 30% drop in the price of coal between the beginning of 2011 and the beginning of 2013. This decline is widely attributed to a combination of oversupply by major exporters, such as Indonesia, Australia and the US, and a reduction in demand from importers such as China.[209] However, Chinese coal imports have increased steadily since 2008, albeit at a slower rate than expected. It would therefore be more accurate to say that China did not push prices down so much as fail to support them.[210] The oversupply was largely due to over-optimistic predictions for the demand for coal and therefore of the coal price. The US shale gas boom also displaced the domestic use of coal and therefore increased US coal exports. Unanticipated changes in demand for coal from China due to the environment-related factors analysed in this report, could place further pressure on coal prices and this is largely ignored by the owners and operators of such assets.

Figure 25: Capital expenditure on coal mining in Australia[211]



The coal industry makes a significant direct and indirect contribution to the Australian economy. According to the Australian Coal Association, coal mining contributes 2% to GDP directly and 4% indirectly, and employs about 180,000 people directly and indirectly.[212] Over each of the last four years an average of AU$10 billion has been invested in coal mining in Australia, as shown in Figure 25.[213] The total cost of Australian coal mining projects either publicly announced, in the feasibility stage, committed or completed is expected to be over AU$100 billion over the next 15 years or more.[214] Not all of these projects will move to production, but this figure indicates the magnitude of current investment and the level of exuberance that has been seen in the Australian coalmining industry.

...this figure indicates the magnitude of current investment and the level of exuberance that has been seen in the Australian coalmining industry

Footnotes:

[209] Sharples, "Coal Crippled by Supply in Worst Quarter in Year: Energy Markets"; Riseborough, "Glencore Said to Study Rio Australia Coal-Assets Combination"; Parkinson, "US, China Deliver Another Double Blow to Australian Coal."

[210] IEA, "World Energy Balances."

[211] ABS, "Industry and Mining Statistics."

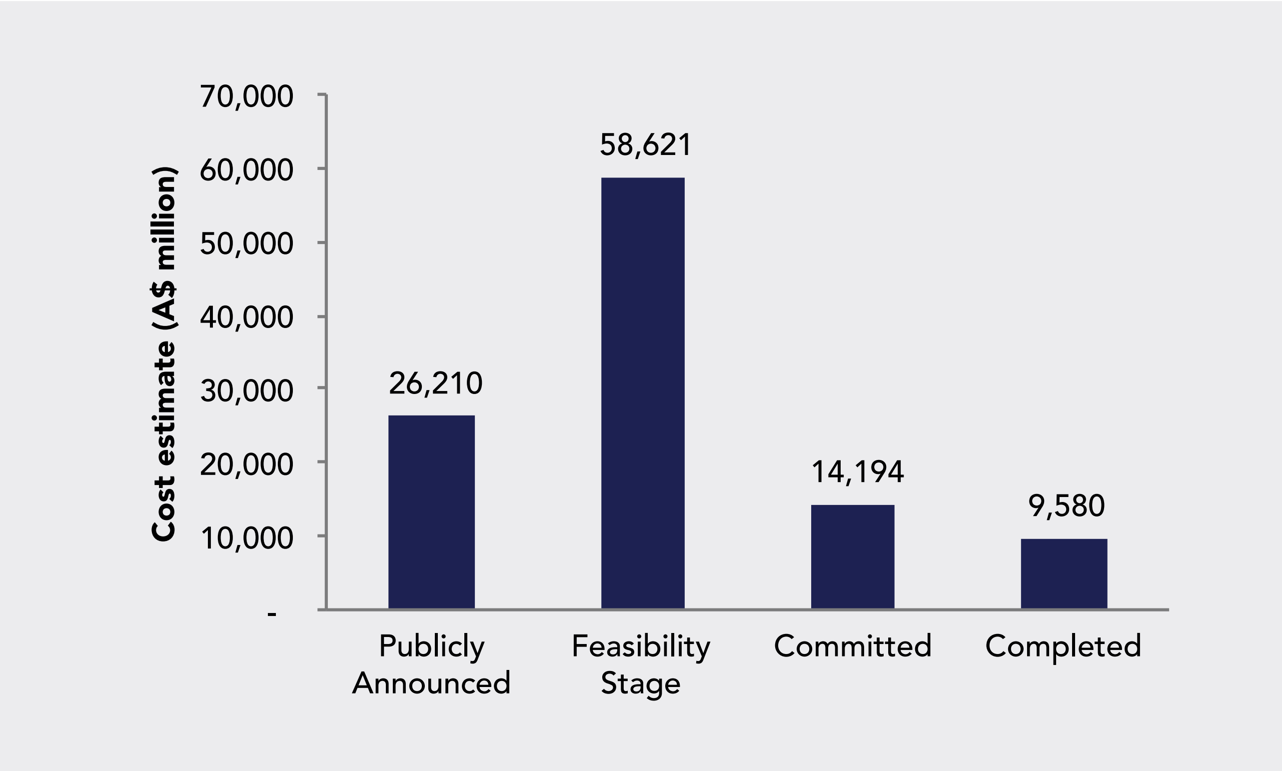
[212] Davidson and de Silva, *The Australian Coal Industry – Adding Value to the Australian Economy.*

[213] ABS, "Industry and Mining Statistics."

[214] BREE, *Resources and Energy Quarterly June 2013.*

Figure 26: *Stages of the investment pipeline of coal projects in Australia (average years until operational)*[215]

Figure 27: Cost estimate of Australian coalmining projects by stage[216]



The investment pipeline for a coal project is separated into six stages, as illustrated in Figure 26. The committed stage involves construction having started or being ready to start, while the completed stage is reached when commercial scale production can be begun. The total value of projects at each stage is shown in Figure 27.[217]

Proposed coal projects in Australia threaten to put more downward pressure on the price of coal, further undermining the investment case for new coal assets. There are advanced plans to build a number of 'mega mines' in the Galilee Basin in Queensland, which would reach peak production around 2020.[218]

Footnotes:

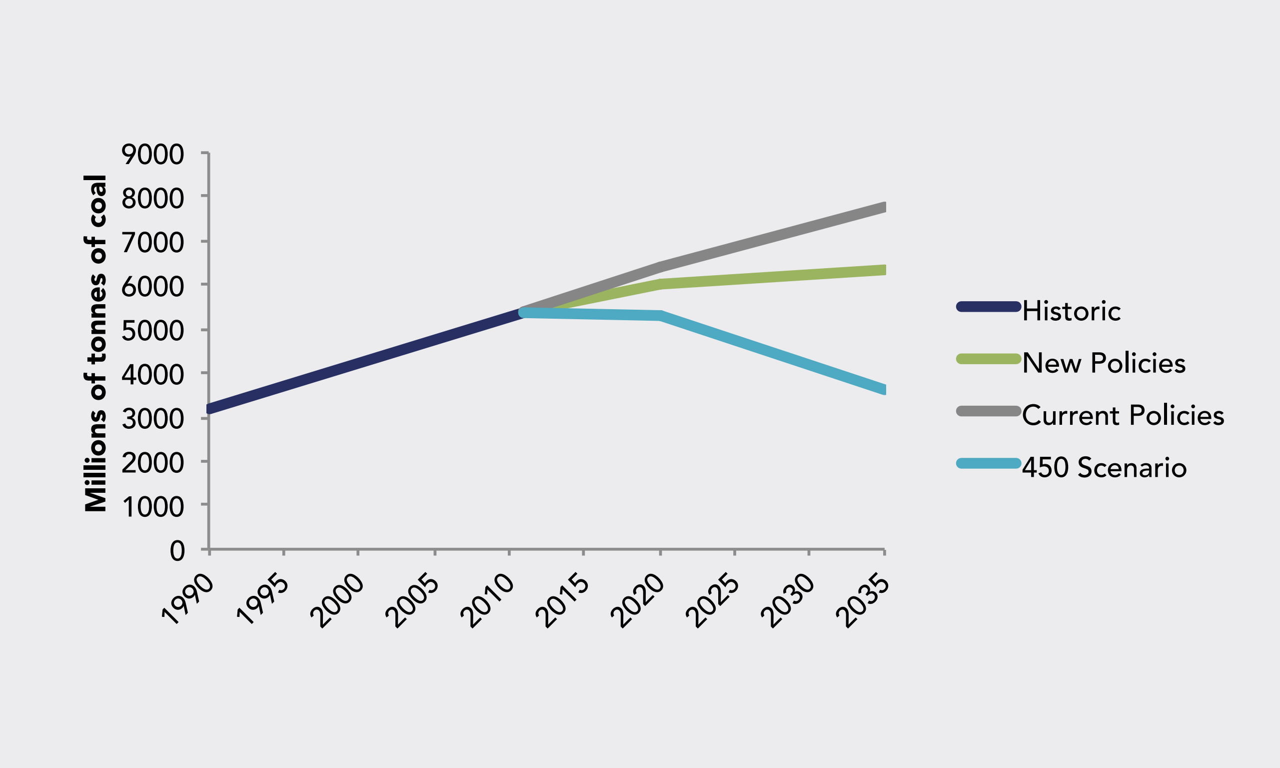
215 BREE, *Resources and Energy Major Projects*, October 2012.

216 BREE, *Resources and Energy Quarterly June 2013.*

217 BREE, *Resources and Energy Major Projects*, October 2012.

218 Greenpeace, *Cooking the Climate Wrecking the Reef: The Global Impact of Coal Exports from Australia's Galilee Basin.*

Figure 28: International Energy Agency world coal demand forecasts[219]



As can be seen in Figure 28 this is also when the IEA expects world coal demand to slow down. The Current Policies scenario refers to a world where no new policies that would impact coal consumption are implemented, which appears unlikely considering the generally increasing attention climate change receives. The New Policies scenario assumes that all currently proposed policies are implemented. This scenario does not assume that any new policies are developed and then implemented, just that policies that have been announced are implemented. While it is unlikely that all currently proposed policies are implemented this scenario is the most realistic because new policies will continue to be developed. The 450 Scenario refers to what is needed to keep the concentration of greenhouse gas emissions in the atmosphere below 450 parts per million and therefore have a 50% chance of restricting global warming to 2°C.

According to BP the world consumed 3,727 Mt of coal in 2012.[220] Depending on the scenario, the IEA forecasts that world coal demand will be between 5,307 and 6,404 Mt in 2020.[221] That is an increase in consumption of between 1,391 and 2,607 Mt between 2012 and 2020. During that period Australia plans on bringing online an additional 550 Mt of coal production.[222] By comparison Australia is estimated to have produced 421 Mt in 2012,[223] or 11% of world consumption. If Australia is to sell all that additional coal it will have to increase its share of the coal market from 11% to 15-18%.

Footnotes:

219 IEA, *World Energy Outlook.*

220 BP, "Coal Consumption."

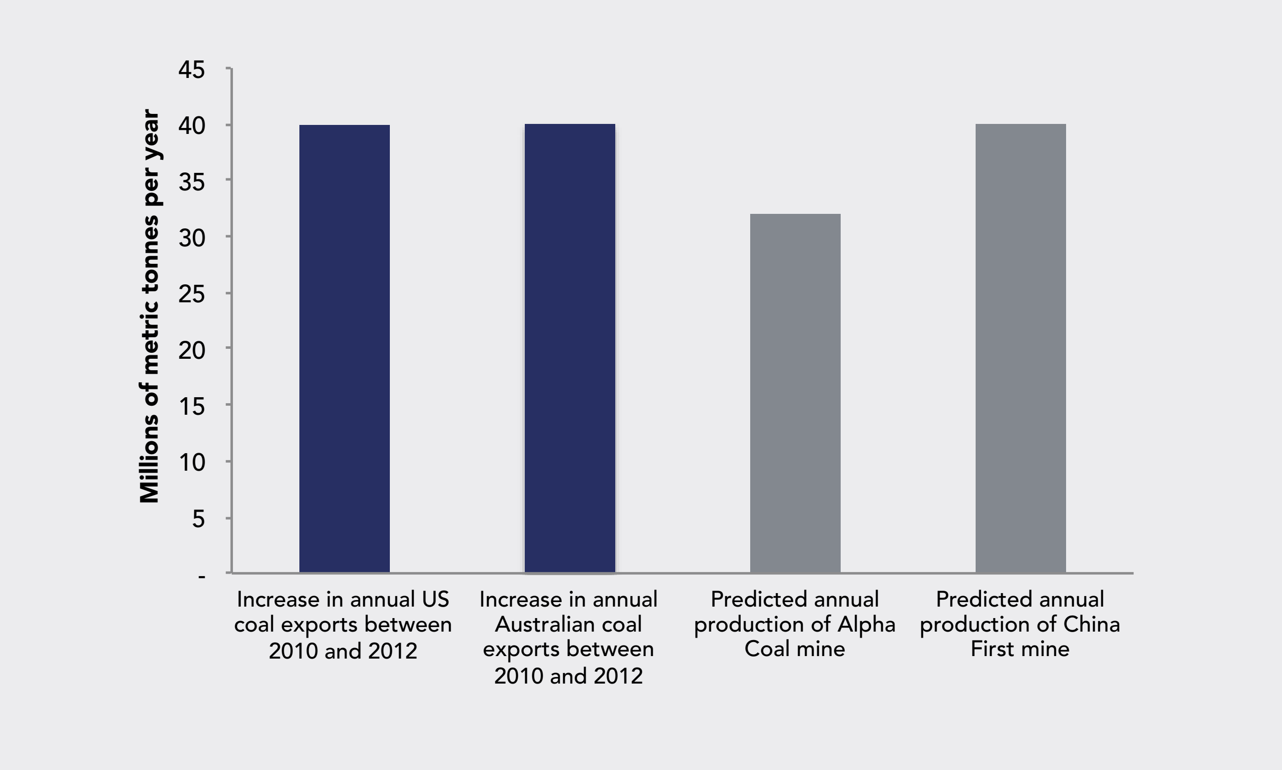
221 IEA, *World Energy Outlook.*

222 BREE, *Resources and Energy Major Projects*, 2013.

223 World Coal Association, "Coal Statistics."

Not all planned projects are expected to make it through the pipeline to production so this is a hypothetical scenario. However, it underlines that current mining proposals are being proposed despite the fact that a *reduction* in the supply of coal is needed in order for prices to increase to profitable levels.

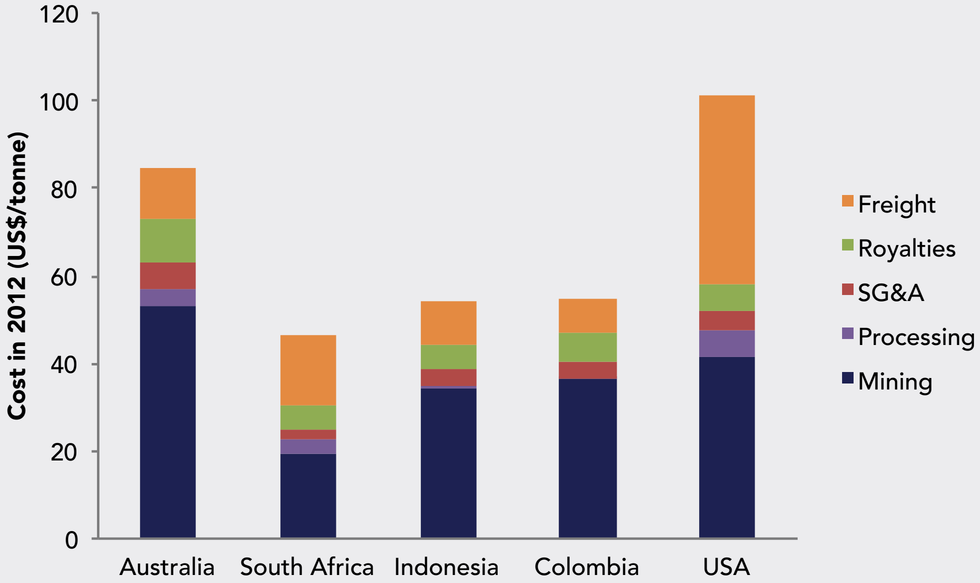
Figure 29: Increases in US and Australian coal exports 2010-12 resulting in depressed prices, compared with annual production from two proposed Australian coalmines



On the left-hand side of Figure 29 is the annual increase in coal exports by the US and Australia that contributed to the decrease in coal prices between 2011 and 2012 is shown. On the right-hand side of the figure is the annual predicted coal production of just two of the proposed nine mines.

It is evident that if these mines come online they will push the price of coal down even further. Considering the relatively low discount rates used on large infrastructure projects, their inability to generate returns after this time represents a significant tail risk.

Figure 30: Cost of mining in a selection of countries[224]



In addition to the low price of coal, Australian mining costs have increased significantly since 2006. Only America currently has higher production costs, predominantly due to significantly higher freight costs, as shown in Figure 30. The increase in the cost of mining in Australia has been due to the increased strength of the Australian dollar relative to the US dollar, increased infrastructure costs to pay for increased investment, the introduction of a carbon tax and increased royalty rates. But by far the most significant of these factors is the increased strength of the Australian dollar.[225] While many factors influence the exchange rate the mining boom has had the biggest impact.[226]

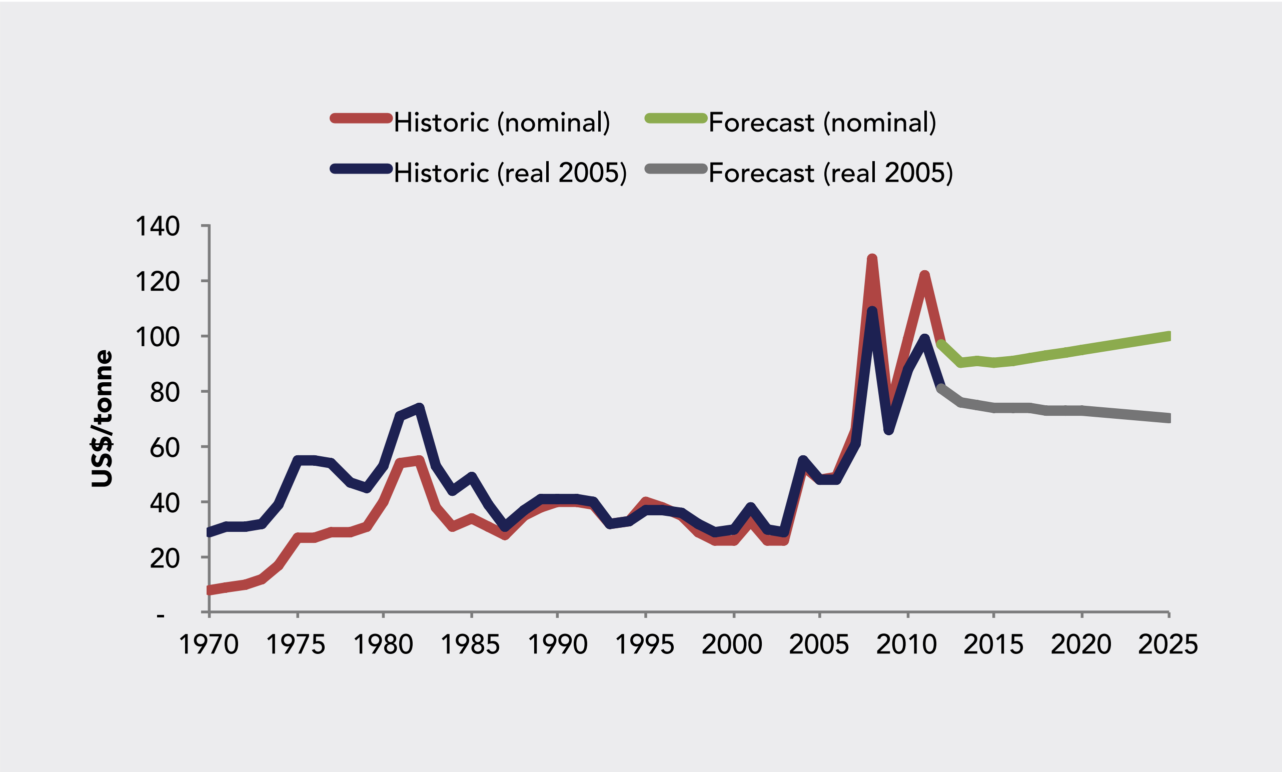
Footnotes:

[224] Goldman Sachs, *Global Investment Research.*

[225] Ibid.

[226] Grudnoff, *Still Beating around the Bush; Denniss, An Analysis of the Economic Impacts of the China First Mine*; Garton, Gaudry, and Wilcox, *Understanding the Appreciation of the Australian Dollar and Its Policy Implications.*

Figure 31: Actual and World Bank forecast price of Australian thermal coal[227]



Due to high costs and a low price of coal many Australian coalminers are experiencing financial pressure. According to Wood Mackenzie at least half Australia's coalmines operate at a loss when the price of coal is below US$96/tonne.[228] At the time of writing the price of Australian coal was about US$85/tonne[229] and according to a forecast by the World Bank (Figure 31) the price of coal is expected to continue to decline in real terms.

HSBC forecast that the price of Australian thermal coal will rise to AU$100/tonne in 2013 and then fall to US$87/tonne in 2015.[230] In an attempt to cut costs the Australian coalmining industry has laid-off more than 11,000 people in the last year, about one fifth of the total workforce.[231] BHP has closed the Norwich Park mine and delayed an expansion of the Peak Downs mine due to falling prices.[232] After taking over Xstrata's operations Glencore announced a series of moves away from coal. The planned mega-project at Wandoan was put on hold, as was the Balaclava Island export terminal, and workers were fired from the Ravensworth, Oaky Creek, Collinsville and Newlands mines.[233]

Footnotes:

[227] World Bank, *Commodity Price Forecast Update.*

[228] Wong, "China's Smog Threatens Health of Global Coal Projects."

[229] Index Mundi, "Australian Thermal Coal Price."

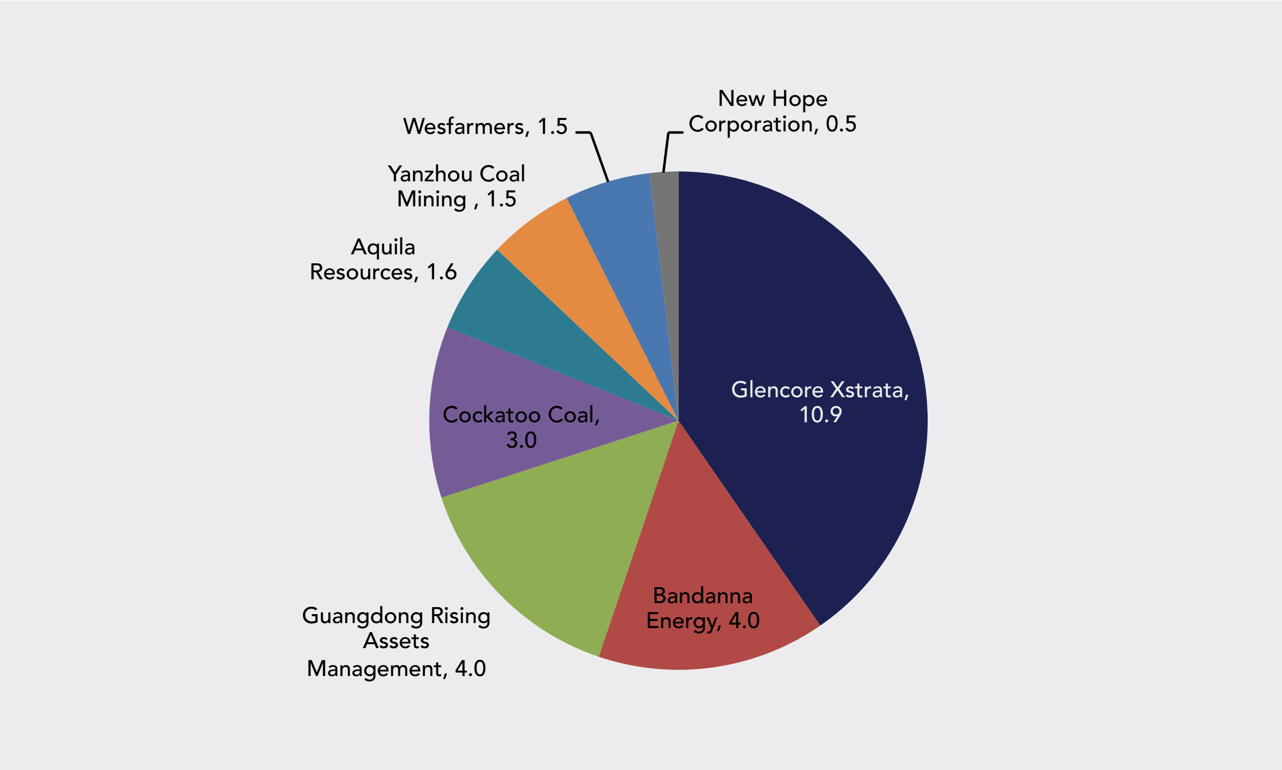
[230] HSBC, *China Coal Energy.*

[231] Valley, "Australia's Coal Miners Feel the Heat as China Investment Cools."

[232] Tasker, "BHP Freezes Coal Plans to Drive down Spending."

[233] Reuters, "UPDATE 1-Glencore Xstrata Scraps Plans for Australia Coal Export Terminal"; Reuters, "RPT-UPDATE 1-Glencore Cuts Production at Two Australian Coal Mines"; Ferreira-Marques, "Glencore Squeezes $2 Billion out of Xstrata Deal."

Figure 32: Stage 1 WICET port allocation by parent company (millions of tonnes each year)[234]



The suspension of the Wandoan mega-project has ramifications for the Wiggins Coal Export Terminal and its financiers. At the end of 2011 there was insufficient port capacity in Australia to export the amount of coal demanded by international markets.[235] To meet this demand a group of mining companies, including Xstrata, came together to form Wiggins Island Coal Export Terminal Pty (WICET) to build a port of the same name. The company borrowed from 19 banks, including Australia & New Zealand Banking Group and Westpac Banking Corp, to finance the A$3.5 billion project.[236] In order to secure the loans the owners agreed to pay for their export allocation even if they failed to utilise it (known as a 'take-or-pay' contract).[237] Figure 32 shows the companies that ultimately own the WICET and how much export capacity each has been allocated in the first stage of the project.

Footnotes:

[234] Wiggins Island Coal Export Terminal, *Submission to the Productivity Commission on Its Draft Report Titled "Australia's Export Credit Arrangements."*

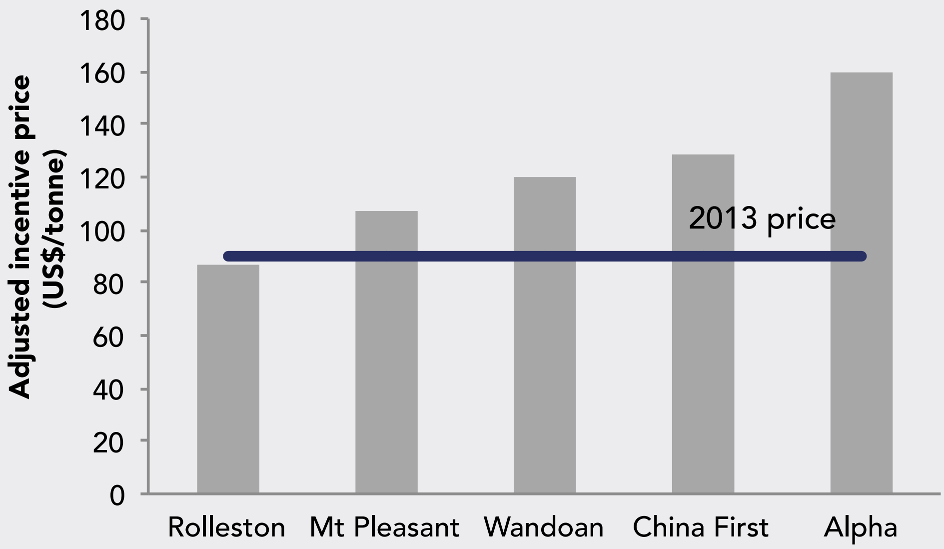
[235] Hoyle and Winning, "Coal Miners Try to Unload Australian Port Assets."

[236] "Australia Coal Port Clears Environmental Hurdle."

[237] Behrmann and Duran, "Coal Slump Leaves Australia Port Half-Used, Lenders at Risk."

Xstrata, which merged with Glencore in early 2013 to become Glencore Xstrata, intended to use at least part of its export capacity for its proposed mega-mine at Wandoan, Queensland.[238] In the second half of 2013 Glencore Xstrata put the mining project on hold due to declining coal prices, among other factors.[239] Now the mining company is attempting to sell 5 million tonnes per year (Mtpa) of its 10.9 Mtpa allocation.[240] Other companies are in a similar position, with Wood Mackenzie estimating that only half the total stage one export capacity of 27 Mtpa will be used. The banks are likely to absorb some of the resulting financial losses, as enforcing take-or-pay contracts may result in putting the smaller miners out of business, which might not be in the banks' longer-term interests.[241]

Figure 33: Incentive prices for key proposed Australian coalmining projects[242]



The declining profitability of coalmining in Australia presents a threat not just to existing coalmines and infrastructure, but also to coalmining projects that have yet to reach full production. Figure 33 shows the 'incentive price' for some of the key projects proposed for Australia. The incentive price is equal to the long-run marginal cost of production, which is the expected total cost of building and running a mine divided by the amount of coal that mine is expected to produce. It represents the coal price above which a rational investor would choose to invest in the project in question.

Footnotes:

[238] Wong, "Xstrata Plans A$15 Bln Coal Expansion in Australia."

[239] Barry Fitzgerald, "Glencore Puts Wandoan on Ice."

[240] Behrmann and Duran, "Coal Slump Leaves Australia Port Half-Used, Lenders at Risk."

[241] Ibid.

[242] Deutsche Bank, *Commodities Special Report.*

Considering the outlook for coal prices none of these investments currently appears financially viable. GVK appears determined to proceed with its Alpha Coal Project, which is the closest to starting production of the projects planned for the Galilee Basin, despite having the highest incentive price. As discussed previously this would significantly increase coal supply, pushing down prices to the detriment of not only its investors but also the investors in other planned and existing coalmines.

Case Study 1: Alpha Coal

If it goes ahead the Alpha Coal Project (ACP), at the site of the largest undeveloped coal deposit in Australia,[243] will rank as one of the largest thermal coalmines in the world.[244] The project involves the development of a black coalmine in the state of Queensland, a 495 km railway line and a coal export terminal, which is expected to cost US$10 billion.[245] GVK, an Indian company leading the project, owns 79% of the endeavour with Hancock Coal owning the remaining 21%.[246]

The mine will be open cut, as opposed to underground, and has a predicted lifespan of 30 years.[247] It is expected to employ 4,000 people during construction, an ongoing 2,000 during operation, and pay US$1.5 billion in taxes and royalties annually at the peak of its production.[248] The newly elected government, led by Tony Abbott, has promised to remove barriers to the development of the project and remove taxes, which could increase the project's profitability.[249]

It is conventional wisdom that due to lack of infrastructure and other factors the Galilee Basin is uneconomic.[250] However, this wisdom was challenged when thermal coal prices hit record heights.[251] According to GVK the project will be able to sell coal at a cost of US$55/tonne,[252] partly due to low rail and port costs that come from the project owning and operating the related infrastructure.

However, a report commissioned by Greenpeace and written by the Institute for Energy Economics and Financial Analysis (IEEFA) predicts that the mine will cost at least US$70/tonne to run. This does not take into account financing costs, which are likely to be large due to heavy debt financing. In addition, the mine would also receive a discounted price due to the low quality of the coal.[253] Others estimate that the coal price would have to be US$160/tonne for the project to be financially viable.[254] GVK has denied IEEFA's claims[255] but have not provided any evidence to substantiate their cost estimate.

Despite the apparent odds against the project, GVK appears determined to push ahead[256] stating that orders for the coal are already oversubscribed.[257] In order for the project to be financially viable coal prices would probably have to increase well above the average 2013 price of US$90/tonne. Given the outlook of demand from China this appears unlikely.

Footnotes:

[243] Stephens and Young, "Mine Protesters Put Focus on Rail Firm."

[244] Phillips, "GVK Hancock Delays Coal Exports from Galilee."

[245] Buckley and Sanzillo, *Stranded - Alpha Coal Project in Australia's Galilee Basin.*

[246] Hannam, "GVK Rejects Claim Alpha Is 'Stranded.'"

[247] Phillips, "GVK Hancock Delays Coal Exports from Galilee."

[248] The Times of India, "GVK's $10 Bn Coal Project Gets Australian Govt's Approval - The Times of India."

[249] Buckley and Sanzillo, *Stranded - Alpha Coal Project in Australia's Galilee Basin.*

[250] Ibid.

[251] Ibid.

[252] Sharples, "Australia Lures $21 Billion Bet on Coal Rebound: Energy Markets"; Sharples, "GVK Says Australian Alpha Coal Mine Order Book Oversubscribed"; Hannam, "GVK Rejects Claim Alpha Is 'Stranded.'"

[253] Buckley and Sanzillo, *Stranded - Alpha Coal Project in Australia's Galilee Basin.*

[254] Deutsche Bank, *Commodities Special Report.*

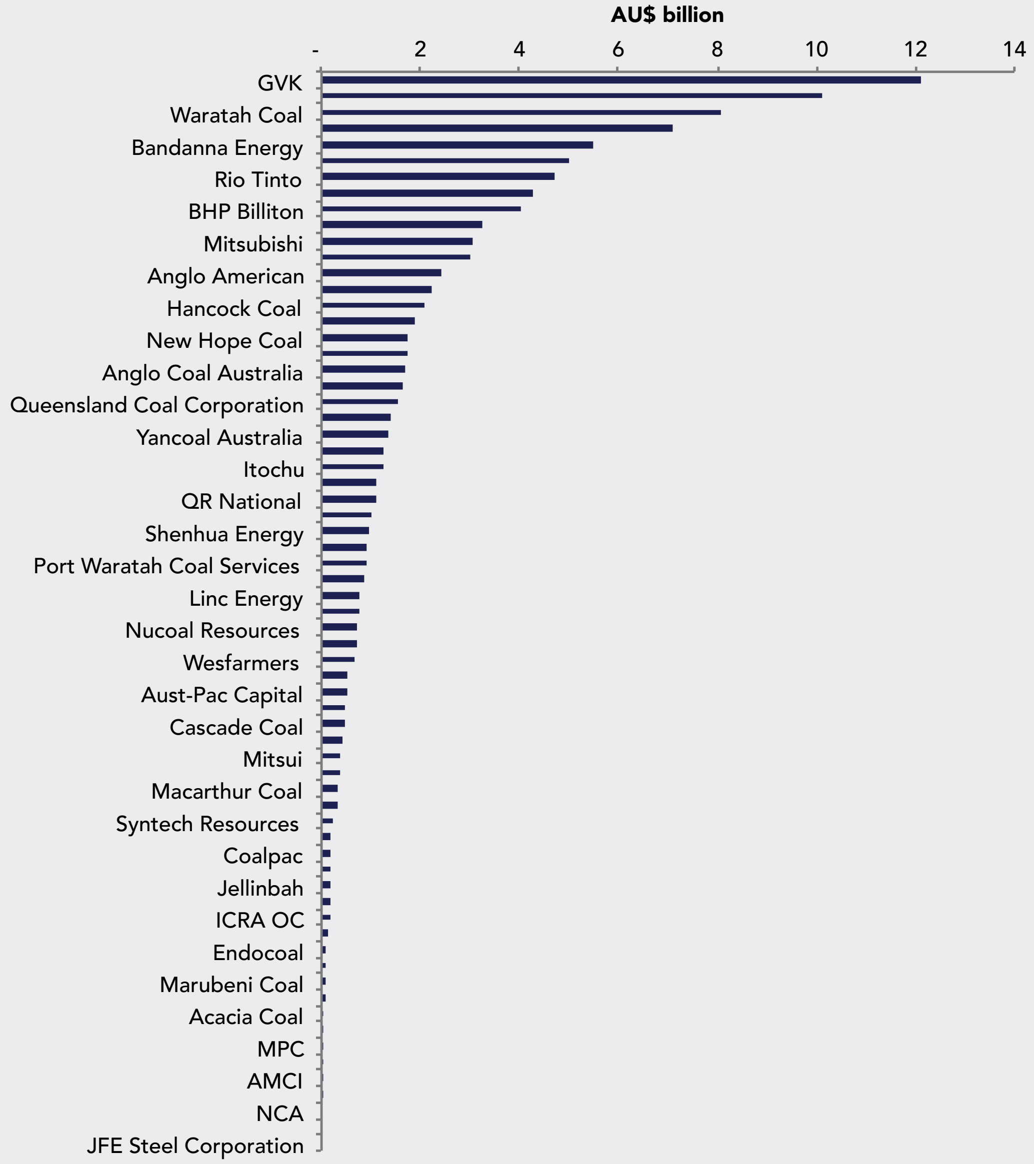
[255] Hannam, "GVK Rejects Claim Alpha Is 'Stranded.'"

[256] Sharples, "Australia Lures $21 Billion Bet on Coal Rebound: Energy Markets."

[257] Sharples, "GVK Says Australian Alpha Coal Mine Order Book Oversubscribed."

We analysed data on Australian coalmining projects to identify the companies most at risk if coal prices fall further below expectations due to China's changing demand patterns. This could occur as a result of the range of the environment-related factors analysed in this report.

Figure 34: Potential pipeline investment in Australian coalmines[258]



Footnotes:

[258] BREE, *Resources and Energy Quarterly June 2013.*

The list of proposed mining projects and their expected costs was obtained from BREE.[259] Official and third-party documentation provided information on the owners of each project and their proportional share. The results of this analysis can be seen in Figure 34, which shows that the majority of investment in Australian coal mining is concentrated in a small number of key players. GVK, an Indian company, has the largest potential investment, mostly due to the Alpha Coal Project. Glencore Xstrata is the next largest potential investor, but due to a much larger number of projects. Waratah Coal's investments are mostly in the China First Coal project, the second most expensive coalmining project proposed in Australia.

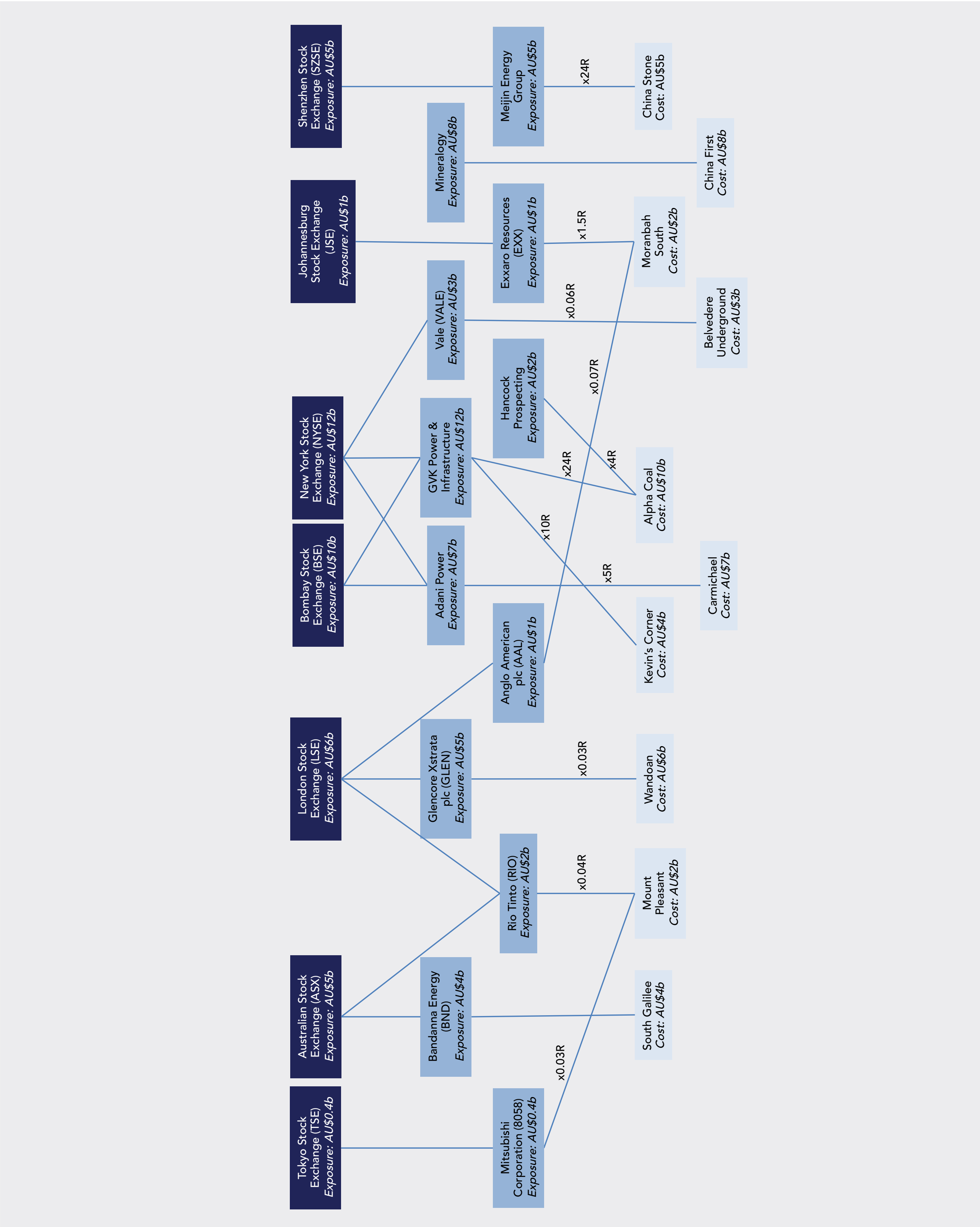
While BREE listed over 100 proposed projects, ten projects with an expected cost of AU$50 billion make up almost half of the total expected investment. These ten projects were analysed further to determine their significance to their ultimate parent companies, and to the stock exchanges those companies are listed on. The analysis was initially performed for all companies but the resulting diagram contained too much 'noise' to be of practical use. Therefore companies that own small stakes in a project (15% or less) have been excluded to simplify the analysis and concentrate on holders of risk.

The results of this analysis can be seen in Figure 35. The ten largest projects by capital expenditure analysed are ultimately owned by 12 companies, which are together listed on eight stock exchanges. In order to indicate their significance, the cost of each project as a multiple of company revenue is listed where possible. These companies should stress test their coal price assumptions given China's changing demand for coal and in particular how these could be affected by environment-related factors.

Footnotes:

[259] Ibid.

Figure 35: Ownership of top ten proposed coalmining projects by cost (and cost as a multiple of company revenue)



Case Study 2: China First

In August 2013 the Queensland government approved the proposed Galilee Coal Project, known as the China First mine after the company developing it (China First Pty Ltd). It will be built with 50% Chinese materials[260] and 50% of production will be sold to China Power International Development.[261] The project is owned by Waratah Coal Pty Ltd, a subsidiary of Australian mining magnate Clive Palmers' Mineralogy Pty Ltd. The mine will involve the construction of a railway and produce 40 Mtpa of thermal coal.[262] If not for the other mines proposed for the Galilee region this would make it the largest coalmine in Australia. However, it has become more known for its potential environmental impact than its size.

Located in the same area as the proposed mine and railway is the Bimblebox Nature Refuge, the China First coalmine will have a considerable environmental impact, which has raised opposition from environmentalists. Half the 8,000-hectare area will be destroyed by open cut mining and the rest affected by subsidence and groundwater pollution from underground mining.[263] Construction and operation of the mine will also produce 2.6 million tonnes of carbon dioxide emissions each year directly and through electricity use.[264] This pales in significance though when compared to the 86 million tonnes of CO2 per year that China and other importers will produce when they burn this fuel.[265] This is more than the country of Kuwait emitted in 2009. These impacts have resulted in opposition from environmental movements such as Friends of the Earth, which is running the Lock the Gate Campaign and held a protest outside parliament on the day the mine was approved.[267]

While the project's proponents have emphasised the benefits to the Australian economy, they have also admitted that these benefits come at a cost. According to a report commissioned by Waratah Coal, manufacturing output is expected to decline by AU$1.25 billion per year between 2013 and 2017 due to the project. Jobs are similarly expected to decline by 2,215 between 2013 and 2017, and by 1,666 between 2018 and 2036, compared to a scenario where the China First mine does not go ahead. The local community and the wider Australian population will also be adversely impacted due to inflation increasing the relative cost of living, except for those directly employed for the project.[268]

According to analyst assessments the 'cash cost' of the mine will be US$93/tonne and the 'incentive price' US$130/ tonne.[269] The cash cost refers to the cost of producing each extra tonne of coal once the mine is built and the incentive price is the price coal would have to be (and remain) in order to provide an adequate return for investors. The price of coal is currently well below US$130 per tonne and this looks likely to continue given historical coal prices (see Figure 24). Decreasing demand from China makes it even less likely that prices will rise to this level.

Footnotes:

260 Denniss, *An Analysis of the Economic Impacts of the China First Mine.*

261 Washington and Allard, "Palmer Project under Pressure after $40b Purchase Contract Cancelled."

262 "Coordinator-General Completes Assessment of Galilee Coal Project - The Queensland Cabinet and Ministerial Directory."

263 Greenpeace, *Cooking the Climate Wrecking the Reef: The Global Impact of Coal Exports from Australia's Galilee Basin.*

264 Ibid.

265 Ibid.

266 Ibid.

267 "Palmer's $6.4b Coal Project Approval Sparks Greens Anger."

268 Denniss, *An Analysis of the Economic Impacts of the China First Mine*; Duxfield, "Mining Subsidies Top $4.5bn: Australia Institute."

269 Deutsche Bank, *Commodities Special Report.*

Australian state governments would also be adversely affected by a decline in the coalmining industry. In Australia royalties for onshore resources are paid to the relevant state government while offshore royalties are collected by the national government. Income tax is paid to the national government, as well as an additional tax levied on mining companies for profits above a certain level[270] and a carbon tax.These last two taxes are likely to be repealed in mid-2014 by the conservative government that was elected in 2013.[271] The Queensland government are also planning to offer royalty discounts for mining projects in the Galilee Basin.[272]

Closing down coalmines will reduce government revenues and the cancellation of proposed projects will reduce future revenues. The coal mining industry paid AU$3.1 billion in royalties to the Queensland State government and AU$1.3 billion to the NSW State government in 2008-09.[273] The Queensland government in particular, notionally has much to gain from the mega-mines in the Galilee going ahead.

In summary, for a number of reasons China's coal consumption is unlikely to grow as fast as expected. As China has a significant influence on coal prices this will result in downward pressure on coal prices. Australia's coal mining industry is already struggling – with at least 15% of coal extracted at a loss – due to low prices. Despite low prices Australia is planning on more than doubling its coal production by 2020. This will also place downward pressure on coal prices, further undermining coal investments. Planned projects at particular risk include Alpha Coal, China First, Wandoan and Mt Pleasant. Cancellation of planned projects and closure of operating mines will also impact government revenues from loss of royalty payments.

Australia's coal mining industry is already struggling...

Footnotes:

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Conclusions and recommendations

This report has investigated how China's demand for coal is changing as a result of environment-related factors, specifically environmental regulation, developments in cleaner technologies, local pollution, improving energy efficiency, changing resource landscapes and political activism. We have looked at how this evolving demand picture could then translate into impacts on coal and coal-related assets in Australia – a country that is a large and growing coal exporter to China.

...levels of demand from China will increasingly determine the prices faced by Australian coal exporters.

It is clear that China's coal demand patterns are changing as a result of environment-related factors and consequently less coal will be consumed than is currently expected by many owners and operators of coal assets. Given China's growing role as the price setter in global and regional coal markets; falling demand will, all things being equal, reduce coal prices. This would result in coal assets under development becoming stranded, or operating mines only covering their marginal costs and subsequently failing to provide a sufficient return on investment.

To minimise the risk of stranded assets, the companies taking forward projects should further interrogate the coal price assumptions underpinning investment cases. Investors in the projects' sponsors, especially if investee companies are diversified natural resource companies, should seek clarity on the opportunity costs associated with deploying finite capital into these coal assets. There could be higher risk-adjusted return opportunities in the Australian resources sector, or indeed elsewhere.

Australian state governments would also be adversely affected financially by projects being abandoned or mothballed – less production will reduce royalty payments. The impact of this can be reduced through diversification. State and national government can also reduce the risk of their own investments becoming stranded assets, by limiting the use of public funds that help finance coal-related infrastructure, such as ports and railways.

The owners and operators of coal and coal-related assets in Australia should be aware of and act on environment-related risks. But there are lessons for policymakers too – they should work to understand how assets might become stranded to avoid costly lock-in and to ensure that government revenues, particularly at a state level, are resilient to potential discontinuities.

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