Garnaut Climate Change Review

The potential impacts of climate change on the mining (minerals and energy) sector in Australia

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1 Summary

- In 2006–07 the mining sector accounted for about 5 per cent of Australia's gross domestic product and 1 per cent of total employment.
- The majority of mineral and energy resources produced in Australia are exported. In 2006–07 the mineral and energy resources sector accounted for about 50 per cent of the value of Australia's total exports.
- Climate change is expected to impede mining activities in Australia as a result of changes in water availability, and changes in the frequency and severity of extreme climate events such as tropical storms and cyclones, and flooding.
- Future demand for goods or services that use mineral and energy resources as a key input (such as electricity) is also expected to be affected due to climate change and mitigation responses.
- Adaptive responses in the mining sector will be important for maintaining industry profitability. Such responses include improving water use efficiency, diversifying production and the export base as relevant and establishing effective water markets.
- The net impacts of climate change on the mining sector in Australia remain uncertain and depend on: the level of changes in key climate variables in Australia and internationally, domestic and international mitigation responses, changes in industry competitiveness, and the cost effectiveness of adaptive responses.

2 Introduction

In this paper the potential impacts of climate change on the Australian mining sector are discussed. Changes in water availability and increased incidence or severity of extreme events such as flooding and tropical storms are expected to impede production of key mineral and energy resources in some regions in Australia in the long term. This could have implications for the profitability of mining activities in the affected regions.

Climate change is also expected to influence demand for mineral and energy products through changes in demand for end products or services such as electricity which rely on mineral and energy resources as inputs into production. Given that the majority of Australian mineral and energy products are exported, changes in international production of, or demand for, mineral and energy products in response to climate change or response policies will also influence the Australian mining sector. For example, mitigation responses such as carbon penalties may reduce demand for mineral and energy products that have a high carbon footprint such as coal. Conversely, demand for lower emission intensive resources such as natural gas may increase in the medium term in response to carbon penalties.

A range of adaptation measures are available to the mining sector to ameliorate some of the projected impacts of climate change. These measures could include increasing water use efficiency, participation in water trading schemes and diversifying production and export bases as relevant.

3 The mining sector in Australia

The mining sector includes activities that involve the extraction of naturally occurring minerals and energy resources including solids, liquids or gases such as coal, ores, crude petroleum and natural gas. Extraction can occur through open cut or underground mining, dredging, quarrying, the operation of wells or evaporation pans, or by recovery from waste material. The mining sector also encapsulates other activities that are carried out at or near mine sites as an integral part of mining operations. These activities are aimed at preparing the crude materials for marketing, including milling, dressing and beneficiation of ore, screening, washing and flotation, natural gas absorption, purifying and other related treatment works (ABS and Statistics New Zealand 2006).

3.1 Economic contribution—output and employment

The contribution of the Australian mining sector (including both mineral and energy resources) to total economic output—gross domestic product (GDP)—and aggregate employment over the past 7 years is presented in Table 1. In 2006–07 the mining sector (including services to mining) accounted for around 5.1 per cent of GDP. However, the inclusion of mineral processing increases the contribution to 8.9 per cent (ABARE 2007b)

Given the capital intensive nature of the mining industry, its contribution to total employment is low, accounting for only about 1 per cent of total employment in 2006–07. Employment in the mining sector has increased over the past few years as the sector has expanded to meet rising demand for energy and mineral commodities. The contribution to total employment increases to around 4 per cent when including further processing (which is reported as part of manufacturing) (ABARE 2007b).

Table 1 Economic contribution of the mining sector in Australia

	Australian gross domestic product ($b), chain volume measure			Australian employment ('000)		
Year	Mining sector (including services to mining)	Total Australian GDP	Contribution of the mining sector to total GDP	Mining sector	Total Australian employment	Contribution of the mining sector to total employment
2000–01	45.7	784.0	5.8%	79	9016	0.9%
2001–02	45.7	813.5	5.6%	81	9133	0.9%
2002–03	45.6	839.2	5.4%	86	9321	0.9%
2003–04	44.0	873.2	5.0%	92	9431	1.0%
2004–05	46.2	896.6	5.2%	93	9536	1.0%
2005–06	45.2	922.7	4.9%	115	9857	1.2%
2006–07	48.8	952.7	5.1%	120	10123	1.2%

Source: ABARE 2007a.
Note: 2004–05 dollars

3.2 Economic contribution—exports

Reflecting Australia's comparative advantage in the production of several mineral and energy resources, the majority of mineral and energy resources produced in Australia are exported. In 2006–07 the mineral and energy resources sector (which includes finished metal products in addition to the mining sector shown in Table 1), accounted for around 50 per cent of the value of total exports (Table 2). The strong growth in mineral and energy resources exports over the past few years has been fuelled primarily by the continued industrialisation and urbanisation of rapidly growing developing countries such as China and India.

Table 2 Contribution of the mineral and energy resource sectors to total Australian exports (balance of payments basis)

Year	Contribution (%)
2000–01	37.1
2001–02	36.7
2002–03	37.6
2003–04	36.4
2004–05	40.9
2005–06	46.4
2006–07	49.3

Source: ABARE 2007a.

3.3 Location and type of mining operations

Just under half of all value added by mining (excluding services to mining) in Australia comes from Western Australia, while Queensland contributes just over a quarter (Table 3). Mine locations reflect mineral deposits and fossil fuel fields that were assessed to be cost effective to develop taking into account factors such as distance from ports and other key infrastructure.

Table 3 Contribution of states to total value added by the Australian mining industry in 2005–06, per cent

Western Australia	48.2
Queensland	27.5
New South Wales and the Australian Capital Territory	10.9
Victoria	5.8
South Australia	4.0
Northern Territory	3.1
Tasmania	0.7

Source: ABS 2007.
Note: Figures do not add to 100 because of rounding.

Coal, petroleum and iron ore account for about 70 per cent of the total value of Australian minerals and energy resources production (Table 4). This reflects rising production capacity and strong prices for these commodities. Base and precious metals and other mineral commodities account for the remaining 30 per cent of production value.

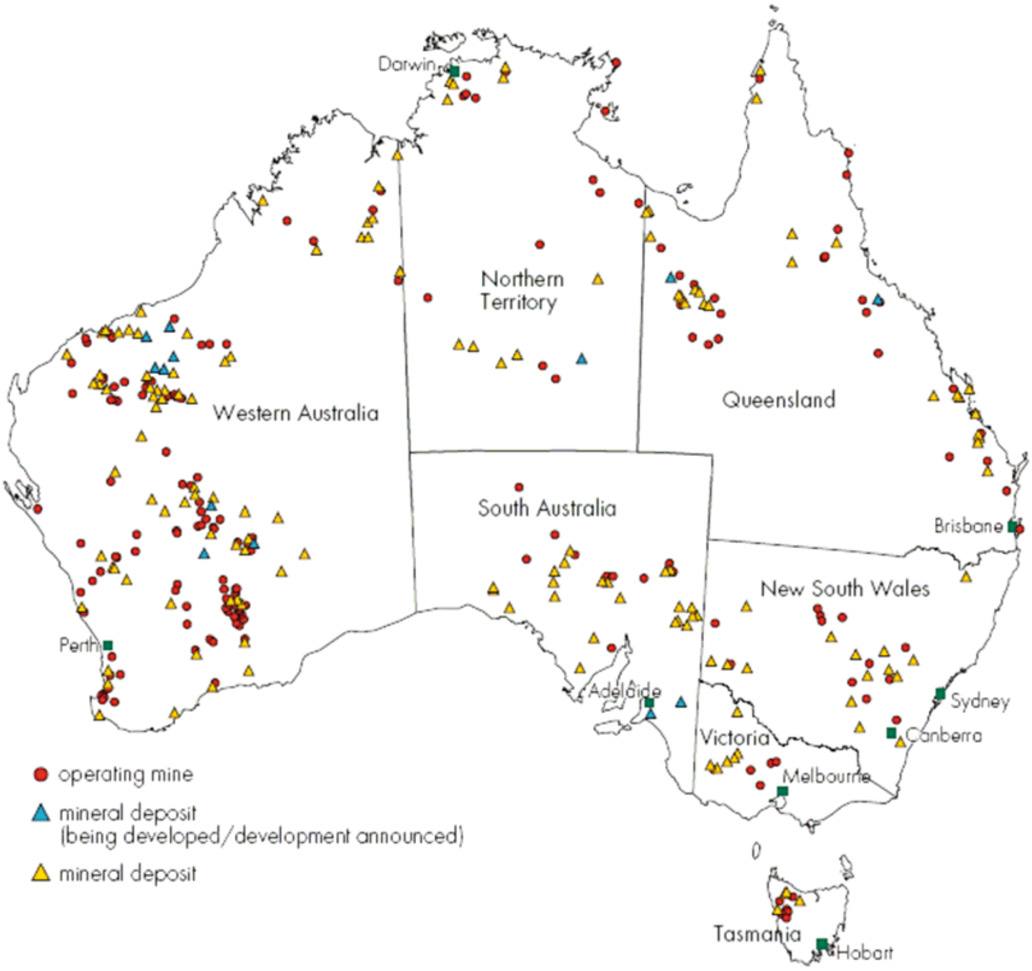
Table 4 Value of major Australian minerals and energy resources production, by commodity, 2005–06

	Value ($m)	Proportion of total
Coal	27379	30%
Petroleum	23325	26%
Iron ore	13155	14%
Other	27910	30%
Total	91769	

Source: ABARE 2007a.

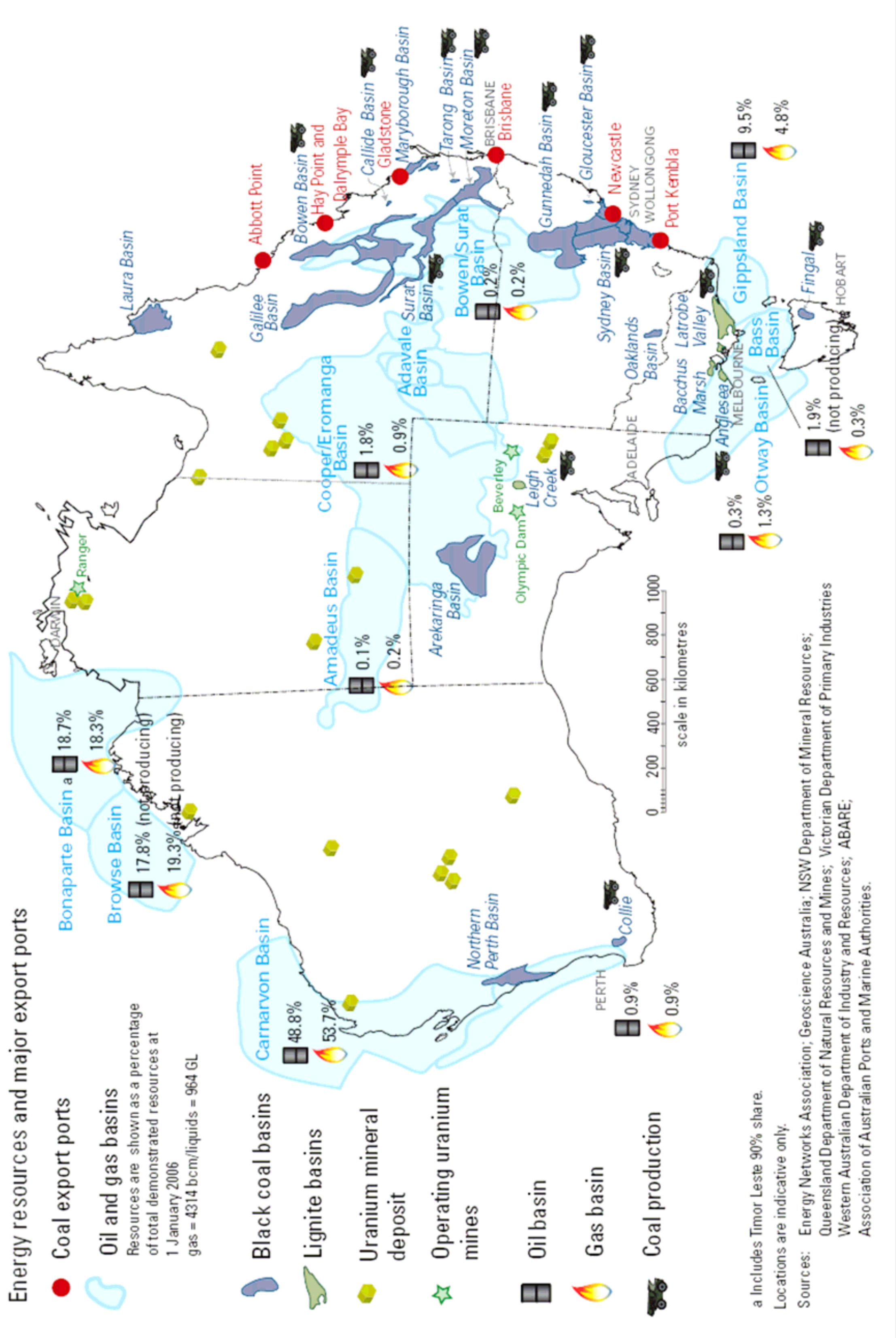
In Figure 1 two maps detailing the locations of Australia's main energy and mineral resources are presented.

Figure 1 Location of main mineral and energy resources in Australia



Source: Penney et al. 2007.

Australia's energy resources



Source: ABARE 2008.

4 Direct impacts of climate change on the supply of mineral and energy products

The supply of mineral and energy products could be impacted as a result of changes in the occurrences and severity of extreme climate events and changes in the availability, distribution and quality of water.

4.1 Extreme events

Climate change has the potential to significantly hinder or prevent some mining activities in Australia through increases in both the frequency and the severity of extreme weather events such as cyclones, floods and extreme rainfall.

A report that assessed the vulnerability of the worldwide mining sector to various effects of climate change concluded that the Australian mining sector was the most vulnerable in the world to the risk of severe weather events (Prior et al. 2007). Vulnerability to extreme weather events is also influenced by the inherent uncertainties involved in predicting climactic events.

4.2 Projections of changes in frequency and severity of extreme climatic events and their impacts

Severe storms

Severe storms have the potential to severely affect mining operations and may result in temporary shutdowns in mining activities. In particular, open pit mines face a significant risk of flooding during heavy rains. Severe storms such as cyclones may also damage equipment and infrastructure, or damage operations at shipping ports, which could potentially hamper export flows (box A).

Scientific projections indicate that the severity of tropical cyclones in Australia is expected to increase as a result of climate change. However, the number of cyclones is projected to fall (CSIRO and BoM 2007).

Rising sea levels

Offshore and near shore mining operations are potentially at risk of intensified storm surges and tidal waves associated with rising sea levels.

Projections indicate that global sea levels could rise by between 18–59 centimetres by 2100 as a result of climate change. Global climate models indicate that long term sea level rises on the east coast of Australia may be higher than the global average (CSIRO and BoM 2007).

Broader impacts of disruption to mining operations

Interruptions to mining operations in response to severe weather or other events will potentially have short term flow on impacts across the economy, and in some cases to other countries if Australia accounts for a large share of exports on the world market for a particular commodity. For example, Australia accounts for around two thirds of world metallurgical coal exports. In the first two months of 2008, severe floods forced the temporary closure of a number of coal mines in Queensland, resulting in a significant decline in production and export volumes. If the magnitude and duration of these disruptions are significant, there will be consequent direct economic costs for end use activities with flow-on implications for other economic activities.

Box A Extreme weather events—recent impacts on mines

Although current and recent extreme weather events are not necessarily correlated with long term climate change, insights into the potential impacts of climate change on the mining sector may be gained by examining recent impacts of such events.

January/February 2008—Floods in Queensland caused a number of mines to suspend operation, and damages are expected to reach tens of millions of dollars. Rio Tinto declared *force majeure* (which is a legal term allowing certain contractual obligations to be released as a result of some unforeseeable or uncontrollable event) at its open cut Hail Creek coal mine, near Mackay in Queensland, because of severe flooding of the mine site. Xstrata also declared *force majeure* on coal shipments from its Newlands and Collinsvale mines, also near Mackay, after heavy rains damaged roads and other infrastructure at the mines (Feary 2008). BHP Billiton has estimated lost production at its Queensland coal operations as a result of the floods to be between about 7 and 9 million tonnes for the financial year ending 30 June 2008 (BHP Billiton 2008).

January 2008—The Ensham open cut coal mine in Emerald, Queensland was flooded in early January. The mine's operator, Ensham Resources, was forced to evacuate employees by helicopter who became stranded at the mine. Several of the mine's open pits were completely flooded and one of the mine's four draglines, valued at around $100 million, was submerged in the floods (Ensham Resources 2008).

March 2007—Fortescue Metals Group's Pilbara Iron Ore project was affected by three tropical cyclones, causing $106 million in damage. The project's first shipments of iron ore were delayed by six weeks as a result of the cyclones. Two employees were killed and several others were injured when one of the cyclones passed directly over the mine (Jacoby 2007).

February and March 2007—Energy Resources of Australia's Ranger uranium mine in the Northern Territory was affected by monsoonal rain. The rain forced the temporary closure of the mine, which is normal practice in heavy rain, and flooding of the open pit resulted in lost production. Consequently, Energy Resources of Australia declared *force majeure* on its sales contracts (Energy Resources of Australia 2007).

4.3 Gradual changes in climate

Variations in water availability and quality

Water is required for a number of purposes at mining operations, including drilling, ore processing and dust management. Reductions in water availability increase the cost of mining activities or may force temporary or permanent closure of operations.

Best estimate projections from the CSIRO and BoM (2007) indicate potentially little change in average precipitation for Northern Australia and decreases of around 10 per cent in southern areas by 2070, relative to 1990. South Western areas in Australia are projected to experience decreased rainfall of up to 40 per cent by 2070 in winter and spring. However, changes in precipitation as a result of long term climate change in Australia are uncertain and are expected to vary significantly across regions and seasons in Australia. The number of drought months are also expected to increase in eastern Australia and south Western Australia by up to 40 per cent and 80 per cent respectively in 2070.

Table 5 Projected changes in precipitation in Australia, compared with 1990

	2030	2050	2070
	%	%	%
Annual			
Northern areas (and central and eastern for 2050 and 2070)	-10 to +5	-20 to +10	-30 to +20
Southern areas	-10 to 0	-20 to 0	-30 to +5
Winter and spring			
South east	-10 to 0	-20 to 0	-35 to 0
South west	-15 to 0	-30 to 0	-40 to 0
Eastern areas	-15 to +5	-20 to +10	-40 to +15
Summer and autumn	-15 to +10	-20 to +15	-40 to +30

Source: CSIRO and BoM (2007).

4.4 Potential impacts of changes in water availability and quality

The potential changes in water availability as a result of climate change present significant challenges for the mining industry. A lack of water could force a cutback in production across a number of mines throughout Australia. Furthermore, owing to the high value added per megalitre of water, uncertainty over future water supplies could present a constraint on efficient mining related investment opportunities (ACIL Tasman 2007; Hogan and Byrne 2000).

In box B, a case study that highlights the significant impacts that uncertain water availability can have on mines is presented.

Box B Direct effects on mines of uncertain water availability

Cadia Valley (Newcrest Mining)

Cadia Valley is an open pit gold mine near the inland New South Wales town of Orange. Cadia uses water for a number of purposes, including minerals processing, dust suppression, water for the Ridgeway underground mine and environmental flows. The mine is located on the Belubula river, which has been severely affected by drought. An ongoing difficulty for the mine is maintaining reliable access to water.

In early 2007, uncertainty over future water availability meant that the mine faced closure within a year if it could not source additional water supplies. Newcrest mining has subsequently invested large amounts of money into securing future water supplies. The company has developed methods of extracting water from numerous sources around Orange (including effluent water, water recovered from concentrates, runoff water, ground water, and water recovered from tailings) and has constructed significant infrastructure to transport water from these sources. Notwithstanding these investments, water supply issues present an ongoing barrier to Cadia's operations and to the further development of the mine (ACIL Tasman 2007).

4.5 Other impacts of climate change

Changes in assessed future profitability and levels of investment

The increased risk of damage to infrastructure, or potential shut downs in response to long term climate changes may reduce the assessed profitability of current or future mining operations. If changes in assessed profitability are significant, this may have implications for the further expansion of mining operations, investment and exploration.

Environmental rehabilitation and corporate reputation

Most mines operate on a triple bottom line basis, considering the economic, environmental and social impacts of every decision. Some mines have noted the risk of corporate reputation being damaged as a result of climate change if gradual changes in climate adversely affect the environment near a mining site (Prior et al. 2007). Climate change may also limit the ability of companies to rehabilitate mine sites. For example, decreased water availability may limit the ability to establish vegetation on disturbed land.

5 Impacts of climate change on demand for mineral and energy products

The demand for mining is derived from the demand for any good or service that uses mineral or energy resources as an input such as electricity generation or cement production. In this section the potential impacts of climate change on demand for these products is assessed. The potential impacts of mitigation policies are discussed in a later section.

5.1 International context

The majority of mineral and energy resources produced in Australia are exported. As a result, changes in international demand for mineral and energy resources will have significant impacts on the Australian mining sector. In Table 6 the major export destinations of Australian mineral and energy resources are presented.

Table 6 Value of Australian mineral and energy exports by destination, 2006–07

	Value ($m)	Proportion of total
Asia		
China	13195	13.2%
India	8838	8.8%
Japan	24967	25.0%
Korea, rep. of	9561	9.6%
Other Asia	16529	16.5%
Total Asia	73090	73.0%
Europe	10524	10.5%
Other	16441	16.5%

Source: ABARE 2007a.

Climate change has the potential to change demand for mineral and energy products, relative to what they would otherwise be, through a number of avenues. Firstly, climate change may alter the demand for key mineral and energy resources or end goods or services as importing economies attempt to adapt to the impacts of climate change. The IPCC (2007) has projected that in Australia climate change will lead to a decrease in demand for heating and an increase in demand for cooling. Environmental and economic damages associated with unmitigated climate change may also lead to a contraction in global economic activity in the long term (Stern 2006), which may have implications for the demand for Australian minerals and energy resources.

As Asia accounts for about 73 per cent of Australian exports of mineral and energy resources (Table 6), the impacts of climate change in Asia and associated changes in demand for mineral and energy resources will have a significant affect on the Australian mining sector.

5.2 Changes in international competitiveness

The potential impacts of climate change on the ability of different nations to produce mineral and energy resources will differ between regions and commodities. For example, Canadian and Russian mining operations face challenges as a result of thawing arctic permafrost, and climate change is expected to increase the risk of malnutrition and disease in Africa, affecting mining operations there. The mining sector in Australia has been identified as being particularly vulnerable to the impacts of climate change (Prior et al. 2007). As a result climate change may have negative impacts on the international competitiveness of Australian mining products. However, a range of adaptation measures are available to the sector that can reduce the potential impacts of climate change.

6 Adapting to potential climate change impacts

Adaptation responses at a firm or industry level aim to reduce the potential impacts of climate change and take advantage of any opportunities that may arise. There are a range of adaptation measures available to the mining sector such as increasing water use efficiency, diversifying production and moving assets in some situations. Most adaptation strategies can have significant impacts in a relatively short time such as enhancing water use efficiency. Governments can also play an important role in developing institutional frameworks, such as efficient markets that are important for optimal adaptation responses.

6.1 Adaptive capacity

The ability of the mining industry to implement appropriate adaptation strategies will depend on its adaptive capacity, which is determined by a number of different factors including financial and physical resources, technology and institutional frameworks (both government and industry). Australia's mining industry is generally well endowed with both financial and physical resources, and has demonstrated its ability to use technological innovation to adapt to and manage the risks and costs of disruptions to supply over a short to medium term timeframe (box C).

6.2 Adaptation strategies

Increasing water use efficiency and water availability

There are a number of options including desalination or water recycling that mining companies can use to increase the efficiency of water use and the level of water available. These options are discussed below.

The establishment of an efficient water market which ensures that scarce water supplies are allocated to their highest value use will become increasingly important as climate change is projected to result in a significant reduction in water availability in key regions of Australia. Impediments to water trading have been identified by some mines as leading to inefficient allocation of already scarce water supplies (ACIL Tasman 2007). An efficient water market may also reduce uncertainty about future access to water which is important for investment and exploration decisions. Governments have a key role to play in facilitating the development of efficient markets for water.

Desalination plants

Desalination plants, which involve treating saline water to a standard suitable for general consumption, can increase water availability in some mining operations. For example, the Illawarra Coal Water Filtration Plant, commissioned in 2006, turns two million litres of saline mine water into fresh water daily. This has increased Illawarra Coal's recycled water use from around 83 per cent to 95 per cent. As a result, the use of potable water from Sydney dams has been significantly reduced (New South Wales Department of Primary Industries 2006). Although desalination plants can be an emissions intensive option, there are ways of reducing these emissions in certain situations. For instance, the desalination plant in Perth is powered predominately by wind power (Water Corporation 2006).

Water recycling plants

Most mines already treat waste water for use at their operations. The process of water treatment can range from sediment stilling ponds to sophisticated filtering, dosing and reverse osmosis plants. Variable water availability in the future is likely to encourage companies to utilise or develop more ways to treat water on site and increase the rate of water recycling.

In box C a case study of a New South Wales mining company that has effectively adapted to the challenges of reduced water availability is presented.

Box C Increasing water availability—adaptation at Northparkes Mine

Rio Tinto's Northparkes Mine is a copper and gold mine located near the New South Wales town of Parkes. The mine has long been confronted with the issue of water evaporation from tailings water before it is returned to processing centres for re-use. In response Rio Tinto has developed a system of floating modules which can be placed on ponds to reduce evaporation. The modules have proven to reduce evaporation during the summer months by up to 90 per cent. Reduced evaporation has allowed the mine to drastically increase the amount of water available for re-use, and hence to reduce the amount of fresh water demanded.

Source: New South Wales Minerals Council 2007.

Diversifying production and export base

Some mining companies could potentially diversify their operations across a range of mineral or non mineral resources in order to try and reduce their exposure to climate change impacts. Another diversification option, noted by the NSW Minerals Council (2007), might be to diversify the export base by exporting mining technology, know-how and equipment in addition to raw materials. A shift toward service based mining exports is already starting to take place. In 2000–01 mining services accounted for about $3.6 billion of Australia's gross domestic product, and by 2006–07 this had grown to almost $4.6 billion (ABARE 2007a).

Altering or moving assets

Another option to adapt to the impacts of climate change is to temporarily move portable assets away from the path of extreme climate events such as cyclones. For example, ships or oil rigs involved in the production of oil and gas in the north west of Australia can be temporarily shutdown and moved to safe harbour if threatened by cyclones. However, onshore fixed or very large assets, such as grinding mills, will invariably be very costly to alter or relocate, and economic benefit-cost analyses would be required on a case by case basis to assess the financial viability of such measures.

7 Mitigation policies and potential mitigation options

In this section the potential impacts of mitigation policies and possible mitigation responses are discussed.

Market based policies to mitigate greenhouse gases such as emissions trading schemes, result in an explicit price on greenhouse gas emissions. Products with high production and/or consumption emissions intensities will potentially face relatively larger increases in costs and thus relatively greater reductions in demand, all other things being equal.

ABARE modelling (Ahammad et al. 2006) suggests that Australia's coal based energy production will decline, relative to what would otherwise be, in response to a carbon penalty. These declines are driven primarily by a reduction in demand for end use goods or services such as electricity. Substitution to other lower emission intensive fuels such as natural gas and renewable energy may occur in response to carbon penalties, relative to what would otherwise be.

There is also a risk that the international competitiveness of Australia's mineral and energy production may decline if the relative price of carbon in Australia is higher than in key export competitors. Many of Australia's main competitors in minerals and energy production such as the Middle East, parts of developing Asia, South America and southern Africa are unlikely to impose carbon penalties in the near future (Minerals Council of Australia 2007).

7.1 Options for reducing emissions intensity in mining

Growth in greenhouse gas emissions in mining may be reduced through the uptake of lower energy or emissions intensive technologies or processes. For example, advanced sensors to characterise ore and new excavation techniques that optimise particle size and crushability, can reduce energy use and lower emissions intensity (Office of Industrial Technologies 2001). Fugitive emissions in coal mining can also be reduced by capturing and burning the methane, supplying energy to offset the mining activities' own energy use (Australian Greenhouse Office 2007).

The development and uptake of lower emission or energy intensive technologies in key end use sectors such as electricity may also reduce the emissions intensity of consumptive emissions from mineral and energy resources. Carbon capture and storage technologies and increased energy efficiency in the electricity sector could play a significant role here.

8 Concluding comments

In this paper some of the key challenges that the Australian mining industry faces as a result of climate change are discussed. These challenges range from direct impacts on the operation of mines caused by extreme weather events or by a gradually changing climate, to indirect impacts on the demand for Australian mineral and energy resources.

Effective adaptation and mitigation measures will be essential to minimise the impacts of climate change on the mining sector. The Australian mining sector is well placed to adapt to the potential challenges likely to be presented by climate change. Further research and development will assist the sector to develop ways of adapting to, and mitigating these impacts. Ongoing collaboration between industry and government will assist.

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