

Coal and the Commonwealth

The Greatness of an Australian Resource



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Executive Summary

This study, by a multi-disciplinary panel of experts from The University of Queensland, adopts a plain language approach to present the findings on the past and future uses of coal and the role that this fuel has played and will continue to play, in Australia and globally. Coal currently attracts negative press because of the concern that this particular fossil fuel may have on the changing global climate. This study accepts the dominant role that greenhouse gases are playing in global climate change. Further, it acknowledges that most of these greenhouse gases are produced from the burning of fossil fuels. An often unconsidered reaction to these positions – one sometimes seen in the popular press – is to call for the abandonment of coal and other fossil fuels as an energy source. This report shows that this is a totally unrealistic position for Australia and for the world.

A starting point is to recognise that access to energy, mainly in the form of electricity at affordable prices, is a key factor that lifts people out of poverty. This first occurred in the Industrial Revolution in England in the 18th century but is continuing to occur on an unprecedented scale today in countries with huge populations, such as China and India. Any attempts by countries that have already enriched themselves through the use of cheap fossil fuels to prevent developing countries from raising the living standards of its populations are likely to be met with understandable resistance.

A second point is to recognise that today almost all (80%+) of the world's energy is generated by fossil fuels – dominantly oil (34.4%) and coal (26%) – with the latter being the main fuel used to generate electricity globally. Currently, 41% of the world's electricity is generated using coal and this fraction is continuing to increase. In capital-intensive industries, such as power generation, it is not technologically feasible to achieve rapid change. Therefore, if there was to be a move away from the use of coal because of climate change concerns (and there are no indications that this is likely to happen as the trend is towards increasing the use of coal) such a transition would take decades.

This study argues that coal will be just as important an energy source in the future as it was in the past and it is today. Coal is the world's most abundant fossil fuel. Coal resources are widely dispersed geographically around the world. This overcomes the concerns about energy security that are often expressed about oil and gas where the global resources are concentrated in the politically unstable Middle East and Russia. Undoubtedly renewable energy and nuclear energy will play increasing roles in the global energy mix. Today the former, outside of hydroelectricity (which accounts for 2.2%) is insignificant (0.6%) and the latter, at 9%, is small. Both will grow significantly, but because the world's population is growing, and because the world's poor have the right to a higher standard of living, the demand for energy will increase substantially. Hence the use of all fuels, including coal will continue to increase globally.

For this to be the case, technologies need to be developed that allow the consumption of coal without causing atmospheric pollution, including greenhouse gas emissions. This study describes a range of low emission technologies in various stages of development. Some or all of these will achieve this required goal.

Carbon capture and storage (CCS) takes the carbon dioxide emitted from power plants and reinjects it into suitable rock formations underground. This technology is already used on a modest scale in a few locations around the world. When it is exploited on larger scales it will allow existing power plants to operate in a pollution free manner. This study describes CCS and a range of other technologies, including coal seam gas (CSG), currently the source of a large and rapidly growing industry. The study also describes underground coal gasification, and coal gasification and coal-to-liquids conversion in surface plants.

EXECUTIVE SUMMARY

Australia is blessed with very large reserves of extremely high-quality coal, both thermal coal – used for making steam and generating electricity, and metallurgical (coking) coal – used for steel making. Australia is the world's largest exporter of coal. Over one fifth of Australia's mineral wealth comes from coal. Coal exports generated \$55 billion in export revenues during 2008-09. In addition to Federal Government taxation income derived from coal, Queensland and New South Wales State coal royalties and taxes are expected to exceed \$4 billion during the same period. Coal currently provides 81% of Australia's electrical generation requirements with black coal supplying 57% and brown coal the remaining 24%.

This study reviews the effects that this bountiful resource has on employment and wealth in Australia.

In 2006-07 the Queensland and NSW coal industries directly employed over 32,000 people. Traditionally, “multipliers” of 1:4 have been used to estimate the number of indirect employees generated by the mining industry. A macroeconomic model developed by Monash University – the same one used by Professor Ross Garnaut and his team to model the effects of climate change – was used to estimate that in 2008 household disposable income grew by nearly 7% in Queensland and 6% in NSW as a result of coal mining.

The study also examines the benefits realised by Australia's major trading partners from our coal exports.

Japan is the main destination for these exports, however China and India are expected to become major customers in the near future. Although both of these last two countries have large coal reserves of their own, these reserves are not likely to be sufficient to meet their growing energy requirements. Australian coal is typically cleaner than the indigenous coals as it has a higher energy content and lower contaminants, such as ash and sulphur. The higher quality coal produces lower emissions than inferior coal.

The concept of a 'cleaner coal' is shifting in Australia towards low emission coal technologies. This shift also aligns itself with the new initiatives of the Australian Government via the National Low Emission Coal Council (NLECC), a partnership between the Commonwealth and State Governments, the coal and the power industries and research providers.

Australia is at the forefront of research, development and demonstration of technologies for capturing and storing carbon dioxide emissions from coal power stations. Twelve CCS demonstration programs costing more than \$1 billion are currently underway in NSW, Queensland and Victoria. These projects range in maturity from Australia's first storage project (CO₂CRC Otway Project) and the CSIRO Loy Yang PCC Pilot Project that are already underway, to projects which are under feasibility assessment. China is currently the largest emitter of carbon dioxide in the world. In the short term, CCS demonstration plants are likely to be deployed in China as demand for new power station developments continue.

The rise of the CSG industry in Queensland is also examined in the study. Proven, probable and possible reserves of CSG now exceed 800 Mt – larger than the liquefied natural gas (LNG) reserves off the north and west coasts of Australia. With over \$18 billion of projects in the planning, the CSG industry has the potential to be the next great industry for Australia.

In summary, the Coal and the Commonwealth study makes the case that coal will be a principal energy source for the world for the foreseeable future. Coal is far more abundant and far more geographically dispersed than any other fossil fuel. The way coal is used today is more challenging than many of the other fuels, but technologies to change this are well underway. Australia, because of its vested interest in continuing to reap the economic benefits from its plentiful coal resources and its heavy reliance on coal as an energy resource, is among the world leaders in the development of these low emissions technologies.



Prologue

Australian coal, has played, and will continue to play a vital role in the development and progress of Australia as a nation. Coal is the most abundant fossil fuel on the planet. Coal will outlast oil and natural gas reserves by centuries, with suggestions that coal reserves could possibly last for over 500 years. Coal has two main uses; it is used to power thermal power stations for the generation of electricity or as a metallurgical agent in the production of steel. Australia is blessed with great reserves of black (or hard) coal located close to the eastern seaboard, predominately in New South Wales and Queensland. This, combined with favourable geology, has facilitated the extraction and export of hard coal by bulk carriers to countries such as Japan, India, Korea, Taiwan and China. Over one fifth of Australia's mineral wealth comes from coal. Coal exports generated \$55 billion in export revenues during 2008-09. Black and brown coal currently provide 81% of Australia's electrical generation requirements.

Despite this, in recent times, the coal mining and coal power generation industries have been subject to considerable negative press, principally because of their association with greenhouse gas emissions. At the extreme end of the political spectrum, there are voices calling for an end to coal mining and coal-fuelled power stations. Alternative energy sources are being sought to reduce Australia's dependence on fossil fuels, however renewable energy sources such as wind and solar power produce energy at significantly higher life cycle costs than coal fired power stations. The current government target is for Australia to meet 20% of its electricity needs from renewable sources by 2020. While nuclear power generation remains politically unacceptable within Australia, our base load electricity needs will continue to be met by fossil fuel sources (coal and gas) for the foreseeable future.

In order to provide an alternative viewpoint in the current debate over the future of coal, this study sets out to explore the positive externalities associated with Australian coal. Coal has delivered a multitude of socio-economic benefits to Australians, as well as citizens of other nations, through low-cost energy generation and steel production. This study consists of eight chapters, each drafted by a subject matter expert at The University of Queensland. The study is multi-disciplinary in nature, linking the disciplines of history, economics, social sciences and engineering. The study does not necessarily reflect the views of The University of Queensland: each chapter is the sole responsibility of the contributing author(s).

Coal has two main uses; thermal coal is used to generate electrical power and metallurgical (coking) coal is used to produce steel.

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PROLOGUE



Chapter 1 examines coal in the history of the development of the world; it makes the point that world living standards remained unchanged for thousand of years until the Industrial Revolution. A number of factors coincided to bring about the Industrial Revolution, but chief among these was the substitution of machines for human labour. This was made possible by the Newcomen's invention of the steam pump, and Watt's subsequent refinement of the steam engine, with coal as the fuel that produced the steam. Even before this, Britain became a nation fuelled by coal. Because the richest coal reserves were found around Newcastle upon Tyne in the northeast, a maritime industry developed revolving around the transport of coal to London. A fleet of coal haulers was constructed that became an important part of Britain's naval strength. In times of conflict, ships and sailors were commandeered to help defend the nation. Captain James Cook received his training sailing colliers, and indeed, his ship "Endeavour" began its life as a coal hauler. The chapter concludes that coal continues to power the industrial revolutions being experienced by many developing countries, with China and India having the largest influence on coal consumption.

Chapter 2 follows the historical developments surrounding coal in Australia. It traces the discovery of coal at Coal River, now known as the Hunter River in NSW and the development of the town of Newcastle, named after its British counterpart. It examines the early use of convict labour to mine coal, as well as the early colony's dependence on scarce mining expertise. In 1824 the Australian Agricultural Company (which still exists today) was granted land rights north and west of Newcastle. It went on to monopolise coal production until the late 1840s, around which time important coal reserves were discovered in the Moreton Bay district near Brisbane, at Ipswich and Redbank. Meanwhile the Australian Gas and Light Company (AGL), formed in 1836, began supplying reticulated coal gas (formed by heating coal and capturing its gaseous emissions) for street lighting and wider domestic purposes in the Sydney area. The great coal deposits west of Rockhampton, including Blair Athol in the Bowen Basin, were discovered in the 1860s. However because of the lack of rail infrastructure they were not commercially significant. The introduction of steam powered ships and the development of railways from the late 1840s onwards, broke the "tyranny of distance" in Australia and opened up new trade routes with the world. In the Asia-Pacific region Britain developed key ports such as Singapore, Colombo and Suva as coal storage and refuelling stations for steam ships. Steam ships also transformed internal transport in Australia, with paddle steamers operating along the Murray-Darling river system taking wool downstream to Adelaide and supplies back inland.

The history of coal mining in Australia is also intimately linked with the history of unionism and the growth of the labour movement in Australia. During the early twentieth century, conflicts surrounding working conditions and health and safety were not uncommon in the coal industry. With the revival of the Japanese steel industry following the Second World War, a market for metallurgical (coking) coal was created. In 1959 Thiess Bros discovered reserves of hard coking coal at Moura in Queensland. The family firm needed help to develop the reserves and so turned to Peabody Coal of America and Mitsui of Japan. Thiess Peabody Mitsui became the largest corporate entity in coal until the arrival of the Utah Development Company in 1968. Together they made the Bowen Basin the centre of coking coal production in Australia. In the early twentieth century oil began to displace coal as the primary fuel source for shipping. Railways continued to use coal until the early 1950s, but eventually converted to diesel. Subsequent electrification of the most important railway lines in Australia has seen a renewed dependence on coal as a significant source of energy for transportation.



Chapter 3 details the contribution of coal to the Australian economy: Australia really was built on the miner's back. Queensland and NSW account for 99% of Australia's black coal production. Coal provides a substantial and consistent revenue stream to governments at both Federal and State levels in the form of taxes, natural resource royalties and payment of rail freights. In 2006-07 taxes were in excess of \$8 billion and natural resources royalties amounted to a further \$1.6 billion. The surplus built up by the Australian Government as a result of the minerals – and specifically coal – boom was almost certainly, an important factor in Australia avoiding a technical recession during the global financial crisis of 2008-09.

Coal also directly and indirectly contributes to the economic prosperity of individual households through the payment of wages and salaries, and the provision of low-cost electrical power. In Australia, residential energy use per capita has increased 35% from 1976 to 2006 as houses have increased in size and the number of persons per household has decreased. Australians enjoy a more energy-intensive lifestyle: modern technologies make it possible for us to live in the comfort provided by climate control systems, enjoy entertainment beamed to us on plasma TV screens, and keep a second “beer” fridge for refreshments. Coal also supports the development of physical and social infrastructure, particularly in rural areas. Black coal projects worth \$2 billion were completed in 2007, with further projects requiring a capital investment of \$7 billion scheduled for completion in the short to medium term. Coal provides Australia with energy security and independence: two thirds of the world's conventional oil supplies are in the Middle East, an area that has proved to be politically unstable.

PROLOGUE



Coal on the Yangtze River 2008

Chapter 4 explores the direct and indirect employment and socioeconomic development provided by exploiting our coal reserves. In 2006-07 the Queensland and New South Wales coal industries directly employed over 32,000 people. However this grossly underestimates the jobs created by coal mining. Coal mining activities cannot function without a network of suppliers and service providers. In addition, direct employees spend a portion of their incomes, generating additional employment. Traditionally, “multipliers” of 1:4 have been used to estimate the number indirect employees generated by the mining industry. In this chapter, a macroeconomic model developed by Monash University – the same one used by Professor Ross Garnaut and his team to model the effects of climate change – is used to estimate the flow-on benefits of the coal industry. The model shows that in 2008 household disposable income grew by nearly 7% in Queensland and 6% in New South Wales as a result of coal mining. Employment in the finance, banking and insurance sector grew by around 5,000 people between 2004-07. The mining technology and services industry in Queensland is estimated to be worth around \$1 billion, with over 300 firms – most of these being small to medium enterprises – located in the Brisbane area. Coal also contributes to improve the overall standard and quality of life, through the provision of services such as safe drinking water, lighting and treatment of wastewater made possible by low-cost, reliable electricity. Average life expectancy in Australia is shown to have a high correlation with the availability of electricity.

Chapter 5 looks at global production and consumption of hard coking (metallurgical) coal. Australia is the largest exporter of hard coking coal by volume, with Indonesia a close second and Russia third. The three biggest customers of Australian metallurgical coal are: Japan, India and Korea. The three biggest customers of Australian thermal coal are: Japan, Korea and Taiwan. China and India presently occupy sixth and seventh place respectively, but are expected to grow in importance as export destinations. China, for example, is currently building the equivalent of two new 500MW coal-fuelled power stations each week. China is by far the largest producer and consumer of coal; however reserves of high quality coal are predominately located in the north. Australian thermal coal exports are primarily used to fuel thermal power stations located in the south of China.

In the event that the cost and availability of Australian thermal coal exports were affected by carbon taxes and environmental concerns, China would most likely turn to Indonesia and Russia to supply its thermal coal needs in the southern provinces. However the ability of these countries to sustain supply to China is questionable. At current production rates Indonesian coal reserves are likely to be depleted in 30 years. The largest reserves of Russian coal are land-locked in central Russia complicating transport logistics. In the event of volatility in supply China could revert to exploiting reserves of inferior quality coals located in its central and southern provinces. This coal has inferior heat content, higher ash and sulphur content than the high quality Australian thermal coals. It is therefore in the world's best interests to continue to make low emission Australian coal available at competitive world prices.

Chapter 5 also examines how economic growth of our major trading partners is intimately linked to Australian coal. The growth of GDP per capita for Japan, Korea, India, Taiwan and China is strongly correlated to installed electricity generation capacity. Japan is dependent on coal for 26% of its electrical energy needs, Korea for 38% and China for 82% respectively. Life expectancy in these countries has increased as a function of energy consumption per capita, an example of the vital role that Australian thermal coal exports have played in elevating living standards. In India, the percentage of population having access to sanitation facilities and health expenditure per capita have increased. This coincides with rapid urbanisation, which requires the construction of infrastructure (buildings, bridges, sanitation facilities etc) dependent on the availability of low-cost steel for which Australian metallurgical coal is an essential ingredient.

Chapter 6 considers issues of health, safety, environmental management and community engagement related to coal mining. These issues deal with the workforce and the local and broader community. Native title is included in the community issues, and a case study is provided of Peabody Energy Australia's management of the Wilpinjong Coal Project. Health, safety, environmental management and native title are framed in the context of legislation and how the industry responds to directives and encouragement from the Government. The most significant development is that the coal mining industry is moving towards risk management systems processes. This approach focuses on hazard identification, risk assessment, risk control, competency of key people, monitoring of system effectiveness and review and systems modification. One benefit of the systems approach is that it has the capacity to rapidly change as circumstances evolve. Advanced technology is an integral part of safety and environmental management systems in modern coal mining. An example is provided of the coal industry's support of the development of the Smartcap™, an instrumented baseball cap capable of measuring and monitoring operator fatigue.



PROLOGUE

With over \$18 billion of projects in the planning, the CSG industry has the potential to be the next great industry for Australia.

Chapter 7 reviews current and potential advanced technologies for capturing and storing carbon dioxide emissions from coal-fuelled power stations. Australia has sufficient carbon storage capacity to outlast its reserves of coal. The Australian Government, the Australian Coal Association and the coal industry is providing significant support for the development of carbon capture and storage (CCS) technologies. Twelve CCS demonstration programs worth in excess of \$1 billion are currently underway in Australia. These projects range in maturity from Australia's first storage project (the CO₂CRC Otway Project) and the CSIRO Loy Yang PCC Pilot Project, to projects which are under feasibility assessment.

First generation carbon capture demonstration plants are adopting energy intensive technologies, which reduce power efficiency and increase the cost per kW of power generated. China is currently the largest emitter of carbon dioxide in the world and is undertaking a remarkable expansion of its energy program to the extent where it may host 50% of the world's coal power generation capacity. India has relatively old and inefficient coal power production plants. In the short term, CCS demonstration plants are likely to be developed in China rather than India because of the ability to integrate CCS facilities into its new coal-fuelled power stations.

Chapter 8 looks at coal's new frontiers. It chronicles the rise of the coal seam gas (CSG) industry in Queensland. Proven, probable and possible reserves of CSG now exceed 800 Mt - larger than the LNG reserves off the north and west coasts of Australia. With over \$18 billion of projects in the planning, the CSG industry has the potential to be the next great industry for Australia. The chapter also looks at developments to exploit coal without mining it, by reacting it in-situ with oxygen, steam and or hydrogen in order to recover synthesis gas. This syngas can be used directly for power generation or as the base material from which other transport fuels and chemicals can be made. There are several in-situ coal gasification trials currently underway in Australia. Alternatively, coal can be gasified in plants on the surface after it has been mined. There are no surface coal gasification plants in Australia yet, although one, the ZeroGen project, which will produce power, is well advanced in terms of planning and design.

The eight chapters in this study provide evidence from which to conclude that, in addition to its vital importance as the critical ingredient in the production of steel, fertilisers and cement, coal is not just a fuel of the past, but very much a fuel of today. Of crucial importance - coal is a major fuel for the future.

Coal truly is a Great Resource for Australia.

Professor Peter Knights

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