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Review of the Economic Impact Assessment of the Glendell Continued Operations Project

Dr Alistair Davey
Pegasus Economics
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Pegasus Economics • www.pegasus-economics.com.au • PO Box 449 Jamison Centre, Macquarie ACT 2614

Pegasus Economics is a boutique economics and public policy consultancy firm that specialises in strategy and policy advice, economic analysis, trade practices, competition policy, regulatory instruments, accounting, financial management and organisational development.

This report has been commissioned by the Environmental Defenders Office for Scott Franks and Robert Lester.

The views and opinions expressed in this report are those of the author.

For information on this report please contact:

Name: Dr Alistair Davey

Telephone: + 61 2 6100 4090

Mobile: 0422 211 110

Email: adavey@pegasus-economics.com.au

Photograph on the front cover is of the existing Glendell Coal Mine from Google Earth.

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Executive Summary

Pegasus Economics (Pegasus) has been engaged by Mr Scott Franks and Mr Robert Lester, Wonnarua men and representatives of the Plains Clan of the Wonnarua People, at the request of the Environmental Defenders Office, in relation to the Glendell Continued Operations Project (the Project). Pegasus has been requested to provide advice on the economic benefits of the Project. The focus of this report is on the transparency and replicability of the economic assessment and the reliability of the coal price assumptions that underpin the analysis.

As part of the Environmental Impact Statement (EIS) for the Project, an economic impact assessment (EIA) was undertaken by Ernst and Young (EY) (2019) that included a cost benefit analysis (CBA). In its CBA for the Project, EY (2019) estimated that it would generate $659.1 million in total profit in net present value (NPV) terms over the period 2021 to 2044, as well as royalty payments to the NSW Government of $296.1 million in NPV terms over the same period, with all figures in 2019 real Australian dollars (Aus$). In turn, the Project was estimated to provide a net benefit to NSW of $1,149.9 million in net present value (NPV) terms, comprised of $398.0 million and $754.3 million in potential direct and indirect benefits, respectively.

While it is possible to derive several of the main elements that go towards making up the CBA such as the production profile and capital expenditures from Figures contained in the EY EIA, it is not possible to conduct a full replication because other elements of the CBA are shrouded in mystery. While it is possible to derive real capital expenditures, royalty payments and gross mining revenues from the information and assumptions provided by EY, it is not possible derive company tax payments because no details on depreciation have been provided.

The lack of transparency within the economic impact assessment conducted by EY makes it impossible to fully replicate. On this basis, the assessment fails to meet the requirements of the current *Guidelines for the economic assessment of mining and coal seam gas proposals.* One of the most pressing motivations for replications is to address perceived shortcomings in the original research (Reese, 1999, p. 1). The inability to replicate means that fragile results can never be exposed to full scrutiny.

Due to the lack of transparency in the EY economic impact assessment, Pegasus has only focused on the mining revenue from the project, the net present value of that revenue and the estimate of royalty payments to the NSW Government and has taken as given all of the other figures presented in the assessment. However, based on what can be ascertained from the EY EIS, accepting the figures presented by EY does require a giant leap of faith. While not material to the outcome, the EY (2019) EIS contains at least three clear errors, mistakes and/or issues.

The results of the CBA conducted by EY are dependent on the coal price assumptions used.

The critical question for the economic viability of the Project is whether coal prices are likely to remain high or whether they will fall. No one can predict the future, however, it is far more likely than not that coal prices will fall from their current record high levels during March 2022 given structural changes in demand for thermal coal that are likely to occur.

Structural changes in global thermal coal markets are likely to occur due to net zero emissions commitments from China (by 2060), the European Union (by 2050, with the target now legislated), Japan (by 2050), Taiwan (by 2050), and South Korea (by 2050, and also with a legislated target) (Department of Industry, Science, Energy and Resources, 2021b, p. 58).

According to a recent article in *The Wall Street Journal*:

> *In the very long run, coal's prospects still look dim. (Mandavia, 2022)*

Long-term thermal coal price forecasts from both KPMG (2022) and the World Bank (2021) are for thermal coal prices to fall from current high levels. Over the longer term, KPMG (2022) is forecasting thermal coal prices to fall to US$71.70 per tonne (in real 2022 US$) while the World Bank (2022) is forecasting thermal coal prices to fall to US$55 per tonne (in nominal terms) by 2035.

It is extremely unlikely the Project would proceed under the World Bank price forecasts, although it may proceed under the KPMG price forecasts. However, arguably the World Bank price forecasts are superior to the KPMG price forecasts for as the Centre for International Economics (2021, p. 1) has observed, the World Bank coal price forecasts account for the expected decrease in coal demand and alternative energy supply whereas the KPMG coal forecasts do not. In turn, the World Bank price forecasts suggest the Project could become a stranded asset. In the event the Project does not proceed then the claimed net benefits accruing to NSW will fail to materialise.

1. Introduction

1.1 Scope of this report

Pegasus Economics (Pegasus) has been engaged by Mr Scott Franks and Mr Robert Lester, Wonnarua men and representatives of the Plains Clan of the Wonnarua People, at the request of the Environmental Defenders Office, in relation to the Glendell Continued Operations Project (the Project). Pegasus has been requested to provide advice on the economic benefits of the Project.

The focus of this report is on the transparency and replicability of the economic assessment and the reliability of the coal price assumptions that underpin the analysis.

In undertaking this work, Pegasus has reviewed the following documents:

- *Economic impact assessment of the Glendell Continued Operations Project* (Ernst & Young, 2019)
- *Economic impact assessment of the Glendell Continued Operations Project* (Addendum to the 2019 EY Economic Impact Assessment for the Glendell Continued Operations Project) (Ernst & Young, 2021)
- *Review of economic impact assessment supporting the Glendell Continued Operations Project - Peer review* (The Centre for International Economics, 2021)
- *Glendell Continued Operations Project: Environmental Impact Statement - November 2019* (Umwelt (Australia) Pty Limited, 2019)
- *Glendell Continued Operations Project* (Glencore Coal Assets Australia Pty Limited, 2019)
- *Glendell Continued Operations Project* (NSW Department of Planning and Environment, 2022)
- *Glendell Continued Operations Project: Response to Submissions Part A - May 2020* (Unwelt (Australia) Pty Limited, 2020)
- *Response to the peer review of the Economic Impact Assessment of the Glendell Continued Operations Project* (Umwelt (Australia) Pty Limited, 2020a)
- *Singleton Council Submission Glendell Continued Operations Project* (Singleton Council, 2021).

1.2 Our credentials

Pegasus maintains a network of independent professionals who collaborate on consulting projects. We commenced trading in November 2013 as a boutique economics and public policy consultancy firm, specialising in strategic and policy advice, economic analysis, accounting, financial management and organisational performance.

I am the founding Chair of Pegasus. I hold the following academic qualifications:

- Doctor of Policy Administration, Australian National University
- Master of Commerce (specialisation in economics), University of Melbourne
- Postgraduate Diploma in Economics, University of Melbourne
- Bachelor of Arts, University of Melbourne 1988.

Prior to founding Pegasus, I was a Principal Consultant with the Sapere Research Group from November 2010 until November 2013 and was a Senior Consultant with ACIL Tasman from May 2007 until November 2010. Prior to becoming a consultant, I spent 15 years working for the Commonwealth Government in various roles, serving as the competition and microeconomic advisor to the Commonwealth Treasurer from March 1996 until June 1999, as well as serving as a director in the mergers and acquisitions branch of the Australian Competition and Consumer Commission (ACCC) from June 1999 until September 2003, in addition to holding senior positions with the

Commonwealth Department of Finance and Administration and the Australian Bureau of Agricultural and Resource Economics.

I have specialised in consulting on trade practices, competition policy and regulatory instruments and have worked on numerous projects involving energy policy and prices. I have also been published extensively in academic journals.

I have read the Expert Witness Code of Conduct in Schedule 7 of the Uniform *Civil Procedure Rules 2005* and agree to be bound by it.

2. Glendell Mine

2.1 Current Operations

The existing Glendell Mine forms part of the Mount Owen Complex located within the Hunter Coalfields in the Upper Hunter Valley of New South Wales (NSW), approximately 20 kilometres (km) north-west of Singleton and 24 km south-east of Muswellbrook (Umwelt (Australia) Pty Limited, 2019, p. 1). The Mount Owen Complex open cut operations is located in the north-eastern part of the Upper Hunter Valley. The Mount Owen Complex is owned by subsidiaries of Glencore Coal Pty Limited (Glencore). Glencore is a major producer of coal in the global coal market (Umwelt (Australia) Pty Limited, 2019, p. 90). Glencore (Glencore Australia, 2022) is one of Australia's largest coal producers and operates a mixture of open cut and underground coal mines across NSW and Queensland.

The Glendell Mine currently operates under development consent DA 80/952 (Glendell Consent) (Umwelt (Australia) Pty Limited, 2019, p. 1). The Glendell Consent regulates the mining of coal from the Glendell Pit and the rehabilitation of the mining area.

Glendell Mine has an approved production rate of up to 4.5 million tonnes per annum (Mtpa) of run of mine (ROM) coal. Mount Owen Mine (approved 10 Mtpa), Ravensworth East Mine (approved 4 Mtpa) and Glendell Mine ROM coal feed the Mount Owen Coal Handling Preparation Plant (CHPP) and associated infrastructure (Umwelt (Australia) Pty Limited, 2019, p. 1). All ROM coal extracted from the Glendell mine is transported via internal haul roads to the Mount Owen CHPP for processing (NSW Department of Planning and Environment, 2022, p. 90).

The Mount Owen CHPP has a total approved processing capacity of 17 Mtpa of ROM coal (Umwelt (Australia) Pty Limited, 2019, p. 1). Up to 2 Mtpa ROM coal and/or crushed gravel can also be transported via conveyor from the Mount Owen Complex to the Liddell Coal Operations and/or Ravensworth Coal Terminal. Coal is also approved to be transported to the Liddell and/or Bayswater Power Stations by conveyor. Coal is primarily transported via the Mount Owen Rail Loop to the Port of Newcastle for export. The Mount Owen Complex produces both semi soft coking coal (SSCC) and thermal coal.

The Glendell Mine was originally approved by the then NSW Minister for Planning and Environment under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) on 2 May 1983 (DA 80/952 – the Glendell Consent), with an original production rate of 3.6 Mtpa of ROM coal (NSW Department of Planning and Environment, 2022, p. 1). The Glendell Consent has been modified four times and currently allows for open cut mining operations until 30 June 2024. However, current mining operations at the Glendell Mine are due to cease in 2023 (Singleton Council, 2021).

A subsequent modification to the Glendell Consent in 1997 enabled the transport and emplacement of overburden from Glendell Mine into southern voids of the Ravensworth East mine (Umwelt (Australia) Pty Limited, 2019, p. 12). A modification of the Glendell Consent approved in February 2008 allowed the integration of the Glendell Mine with the broader Mount Owen Complex. This modification removed the duplication of coal processing, handling and transport infrastructure and enabled integrated water and tailings management at the operations forming the Mount Owen

Complex. Mining finally commenced at the site in 2009 (NSW Department of Planning and Environment, 2022, p. 1).

2.2 Glendell Pit Extension

On 3 December 2019, Glendell Tenements Pty Limited, a subsidiary of Glencore, lodged a State significant development application for the Glendell Continued Operations Project (the Project), which would extend the life of the existing Glendell Mine by establishing a new mining area (the Glendell Pit Extension) to the north of the current Glendell Pit (NSW Department of Planning and Environment, 2022, p. 1; Umwelt (Australia) Pty Limited, 2019, p. 36).

Development of the Glendell Pit Extension would enable the extraction of an additional 135 million tonnes (Mt) of ROM coal over 21 years, at an increased production rate of up to 10 Mtpa (NSW Department of Planning and Environment, 2022, p. v). The Project ROM coal will be processed at the existing Mount Owen CHPP before being transported via rail (Glencore Coal Assets Australia Pty Limited, 2019, p. 18; NSW Department of Planning and Environment, 2022, p. v). The coal produced will be both SSCC for use in steel manufacture and thermal coal of varying quality for use in coal-fired power stations (Glencore Coal Assets Australia Pty Limited, 2019, p. 18). It is anticipated that the majority of coal from the Project will be exported to Asia. Further information on coal is provided in Appendix D.

While the Project would continue to rely on existing infrastructure including the Mount Owen CHPP, rail loop and existing Glendell mining fleet, it would require the development of a new mine infrastructure area (including associated infrastructure and services), along with construction of new heavy and light vehicle access roads (NSW Department of Planning and Environment, 2022, p. v). In addition, the Project would involve the realignment of a section of Hebden Road, diversion of Yorks Creek, and relocation of the historic Ravensworth Homestead.

3. Cost Benefit Analysis

3.1 The purpose of a Cost Benefit Analysis

In considering the effects of additional regulatory measures in 1996, a group of prominent economists, including the 1972 Nobel Laureate for economics Kenneth Arrow, contended that it was vitally important to undertake cost benefit analysis:

> *Most economists would argue that economic efficiency, measured as the difference between benefits and costs, ought to be one of the fundamental criteria for evaluating proposed environmental, health and safety regulations. Because society has limited resources to spend on regulation, benefit-cost analysis can help illuminate the trade-offs involved in making different kinds of social investments. In this regard, it seems almost irresponsible to not conduct such analyses, because they can inform decisions about how scarce resources can be put to the greatest social good. … In practice, however, the problem is much more difficult, in large part because of inherent problems in measuring marginal benefits and costs. In addition, concerns about fairness and process may be important noneconomic factors that merit consideration. Regulatory policies inevitably involve winners and losers, even when aggregate benefits exceed aggregate costs. (Arrow, et al., 1996, p. 221)*

A cost benefit analysis (CBA) is a process of identifying, comparing and, where possible, measuring the various costs and benefits of a project in current price terms. The costs and benefits should ideally comprise all direct and indirect effects associated with a regulation or policy change. It is clear, however, that while extremely useful as an aid in public decision-making, there are conceptual and methodological limitations in the technique that mean that the results of a CBA alone should not be viewed as a sufficient basis for determining the course of public policy:

> *Benefit- cost analysis can play an important role in legislative and regulatory policy debates on protecting and improving health, safety and the natural environment. Although, formal benefit-cost analysis should not be viewed as either necessary or sufficient for designing sensible public policy, it can provide an exceptionally useful framework for consistently organising disparate information, and in this way, it can greatly improve the process, and hence, the outcome of policy analysis. If properly done, benefit-cost analysis can be of great help to agencies participating in the development of environmental, health, and safety regulations, and it can likewise be useful in evaluating agency decision-making and in shaping statutes. (Arrow, et al., 1996, p. 222)*

As part of the Environmental Impact Statement (EIS) for the Project, an economic impact assessment (EIA) was undertaken by Ernst and Young (EY) (2019) that included a CBA, that is discussed in further detail below.

3.2 Transparency and replicability of the CBA

In its CBA for the Project, EY (2019) estimated that it would generate $659.1 million in total profit in net present value (NPV) terms over the period 2021 to 2044, as well as royalty payments to the NSW Government of $296.1 million in NPV terms over the same period, with all figures in 2019 real Australian dollars (Aus$). In turn, the Project was estimated to provide a net benefit to NSW of $1,149.9 million in net present value (NPV) terms, comprised of $398.0 million and $754.3 million in potential direct and indirect benefits, respectively. The direct benefits of the Project were a function of its profitability, composed of:

- total corporate taxes of $202.1 million in NPV terms for Australia, of which $64.7 million is attributed to NSW
- $333.3 million in other government revenue for NSW in NPV terms, the largest component of this being royalties of $296.1 million, and net payroll taxes of $37.2 million.

The indirect benefits of the Project were related to the linkages that it will have to the NSW economy through both the labour market and suppliers, composed of:

- worker benefits were estimated to be $468.0 million in NPV terms, from the additional ongoing employment attributable to the Project
- supplier benefits were estimated to be $286.3 million in NPV terms based on the NSW-based supplier inputs over the life of the Project of $1,418.8 million in NPV terms.

While it is possible to derive several of the main elements that go towards making up the CBA such as the production profile and capital expenditures from Figures contained in the EY economic impact assessment, it is not possible to conduct a full replication because other elements of the CBA are shrouded in mystery.

While it is possible to derive real capital expenditures, royalty payments and gross mining revenues from the information and assumptions provided by EY, it is not possible derive company tax payments because no details on depreciation have been provided. To be able to derive company tax payments a depreciation schedule or more details on the capital assets for the Project would need to be provided. It should be noted that different capital assets have differing effective lives for depreciation purposes.[1] In its peer review of the economic impact assessment conducted by EY, the Centre for International Economics (2021, p. 14) also raised concerns the amount of company tax paid on the Project could have been over-estimated:

[1] See Australian Taxation Office (2019).

A range from 0 per cent to 30 per cent should be presented, as it is unable to be determined with certainty what income tax will be paid based off an individual entity's earnings. The analysis by EY presents the upper bound estimate of income tax payable, a consideration for zero income tax should be included.

The current NSW *Guidelines for the economic assessment of mining and coal seam gas proposals* released in December 2015 place a great importance on the need for transparency in the conduct of an economic evaluation and a CBA, as outlined below:

The economic assessment is just one part of the broader EIS. However, it is a widely used tool for deciding between alternative development options. It is intended to allow decision-makers to consider trade-offs and decide whether the community as a whole is better or worse off as a result of the proposal. It should be based on rigorous, transparent and accountable evidence that is open to scrutiny. (Department of Planning and Environment, 2015, p. 3)

The economic assessment report prepared by proponents should be transparent and comprehensive and note all important assumptions. The results section of the report should balance readability with presenting sufficient detail to allow the results of the CBA to be easily understood and replicated. (Department of Planning and Environment, 2015, p. 19)

The lack of transparency within the economic impact assessment conducted by EY makes it impossible to fully replicate. On this basis the assessment fails to meet the requirements of the current *Guidelines for the economic assessment of mining and coal seam gas proposals.* One of the most pressing motivations for replications is to address perceived shortcomings in the original research (Reese, 1999, p. 1). Economists have widely acknowledged there is far too little replication work performed within the discipline (Arulampalam, Hartog, MaCurdy, & Theeuwes, 1997, p. 99). The inability to replicate means that fragile results can never be exposed to full scrutiny.

Due to the lack of transparency in the EY economic impact assessment, Pegasus has only focused on the mining revenue from the project, the net present value of that revenue and the estimate of royalty payments to the NSW Government and has taken as given all of the other figures presented in the assessment. However, based on what can be ascertained from the EY EIS, accepting the figures presented by EY does require a giant leap of faith.

3.3 Errors, Mistakes and/or Issues with the EY Economic Impact Assessment

While not material to the outcome, the EY (2019) EIA contains at least three clear errors, mistakes and/or issues.

First, EY (2019, p. 11) claimed that it used the KPMG (2019) publication *Coal Price and FX consensus forecasts June/July 2019*. In fact, EY actually used the median consensus forecasts from the KPMG (2019a) publication *Coal Price and FX consensus forecasts March/April 2019*. This can be established by examining the foreign exchange assumptions used in the EY economic impact assessment. According to EY (2019, p. 15), it used exchange rate forecasts from the KPMG report where "[t]he exchange rate varies between $0.75 and $0.78 US dollars per [Australian dollar] until 2023 and then is fixed long term at $0.75 US dollars per [Australian dollar]." The exchange rate never hits $0.78 US dollars per Australian dollar for either the average or median exchange rate forecasts in the KPMG (2019) publication *Coal Price and FX consensus forecasts June/July 2019* in 2022, but it does in relation to the median exchange rate forecasts for the KPMG (2019a) publication *Coal Price and FX consensus forecasts March/April 2019*.

Second, EY (2019, p. 15) claimed that it "[a]ll nominal coal price forecasts are converted into real 2019 [Australian dollars] using The Treasury *Budget 2019-20* (April 2019) consumer price index forecast." The 2019-20 Commonwealth Budget forecasts for the consumer price index (CPI) were for an increase of 2¼ per cent in 2019-20, followed by an increase of 2½ per cent in 2020-21, with projections of an increase of 2½ per cent for the following years (Commonwealth of Australia, 2019; p. 2-5; p. 2-23). Using the nominal US$ prices for thermal coal and SSCC and median exchange forecasts in 2021 from the KPMG (2019a) publication *Coal Price and FX consensus forecasts March/April 2019*, and then using the CPI Commonwealth Budget forecasts provides real 2019 prices of Aus$102.29 for thermal coal and Aus$127.06 for SSCC in 2021. However, if you instead assume that the CPI is on average 2½ per cent over the entire forecast period, then you arrive at real 2019 prices of Aus$102.16 for thermal coal and Aus$126.91 for SSCC in 2021, consistent with the prices reported by EY rounded to one decimal place.

Third, the calculations EY (2019, p. 15) report in Table 3 for total sales revenue appear to be erroneous, possibly even beyond the scope of rounding to one decimal place. We reproduce the total sales revenue figures from Table 3 of the EY report along with our calculations for total sales revenue both highlighted in yellow in Table 1 below. The multiplication of SSCC and thermal coal production in Mt with their respective prices and then added together can be easily checked.

Table 1: Table 3 from the EY report and Pegasus Calculations of Total Sales Revenue (highlighted in yellow) (real 2019 Aus$ in millions)

	Total	2021	2026	2033	2038
Production (Mt)		-0.3	0.9	1.7	1.4
Semi Soft Coking Coal (Mt)		0.4	2.9	4.8	2.4
Thermal Coal (Mt)					
Real price (2019 Australian dollars)					
Semi Soft Coking Coal		126.9	118.7	118.7	118.7
Thermal Coal		102.2	96.7	96.7	96.7
Total Sales Revenue	8,964.4	2.9	398.8	679.6	411.9
Total Sales Revenue - NPV	3,737.7				
Our Calculations of Total Sales Revenue		2.8	387.3	666.0	398.3

Source: EY (2019, p. 15).

It would appear the Centre for International Economics (2021, p. 8) also noticed arithmetic problems in the EY report as it obliquely refers to discrepancies in the headline financial metrics.

4. Coal Prices

4.1 Coal Price Forecasts in the Economic Impact Assessment

The results of the CBA conducted by EY are dependent on the coal price assumptions used. This point has been acknowledged by EY and by the Centre for International Economics. According to EY (2019, p. 24):

> *In isolation, the estimated net benefit of the Project is most sensitive to the coal price assumptions underpinning the analysis …*

In reflecting on EY's use of the KPMG *Coal Price and FX consensus forecasts* publication for its coal price forecasts, the Centre for International Economics (2021, p. 9) observes:

> *There is a considerable degree of uncertainty in the long-term coal price forecast ... Furthermore, the long-term forecast period for the consensus estimates are based on 2024 onwards, and do not provide estimates for the expected reduction in coal production towards 2050. As the operations of the mine extend to 2044,*

relying on a 2024 onwards estimate would appear to result in a higher than expected range.

In turn, the Centre for International Economics (2021, p. 1) observes that using long run coal price forecasts from the World Bank calls into question the economic viability of the Project:

- *The operations of the mine are expected to continue until 2024, therefore, a long-term outlook on coal prices is required. The KPMG estimates relied upon by EY include a long-term forecast of 2024 onwards, with no revisions for incremental periods. The World Bank forecast provides revisions to the long-term forecast in 2030 and 2035, which accounts for the expected decrease in coal demand and alternative energy supply. The KPMG estimates can be used as an upper bound price, with the World Bank forecast showing a mid-lower bound.*
- *Coal price forecasts at the lower end of the range would place greater pressure on mine profitability and could result in mines halting production (either temporarily or permanently).*

4.2 Recent and the Future Course of Coal Prices

4.2.1 Recent Coal Prices

Global thermal coal use fell sharply in 2020 as a result of the COVID-19 pandemic and subsequent global containment measures, which led to significant falls in electricity use around the world (Department of Industry, Science, Energy and Resources, 2021a, p. 54). In turn, this put downward pressure on thermal coal prices during 2020. Newcastle free on board (FOB) prices for thermal coal with a calorific value (CV) of 6 000 kcal/kg fell to a 14-year low at US$46.5 per tonne in late August 2020 (International Energy Agency, 2021, p. 70).[2]

Prices for thermal coal started recovering in the third quarter of 2020 after supply cutbacks were made to adjust production to reduced pandemic-level demand and China began importing more for prewinter stockage (International Energy Agency, 2021, p. 70). Demand also rose with the beginning of the Northern Hemisphere's heating season, and weather events, such as China's cold snap in December 2020, further boosted coal consumption and also disrupted the transport of coal from Inner Mongolia to demand centres on China's coast.

Thermal coal prices continued to rise in the first five months of 2021, then began to surge in May (International Energy Agency, 2021, p. 70). Thermal coal prices surged during 2021 from less than US$80 per tonne in December 2020 to be over US$220 per tonne in December 2021.

Thermal coal prices increased during 2021 as Asian demand grew amidst an unusually hot northern summer, economic recovery and user restocking after a cold winter across much of the Northern Hemisphere during 2021 (Department of Industry, Science, Energy and Resources, 2021b, p. 58), coupled with supply disruptions in Indonesia and Russia. Indonesian exports of thermal coal were hampered by repeated bouts of heavy rainfall through much of 2021 (Department of Industry, Science, Energy and Resources, 2021b, pp. 61-62).

In 2021, Russian exports were also affected by difficulties with its rail network, partly due to seasonal maintenance, but also due to a bridge collapse on the Trans-Siberian railway (Department of Industry, Science, Energy and Resources, 2021b, p. 62). However, additional rail freight capacity

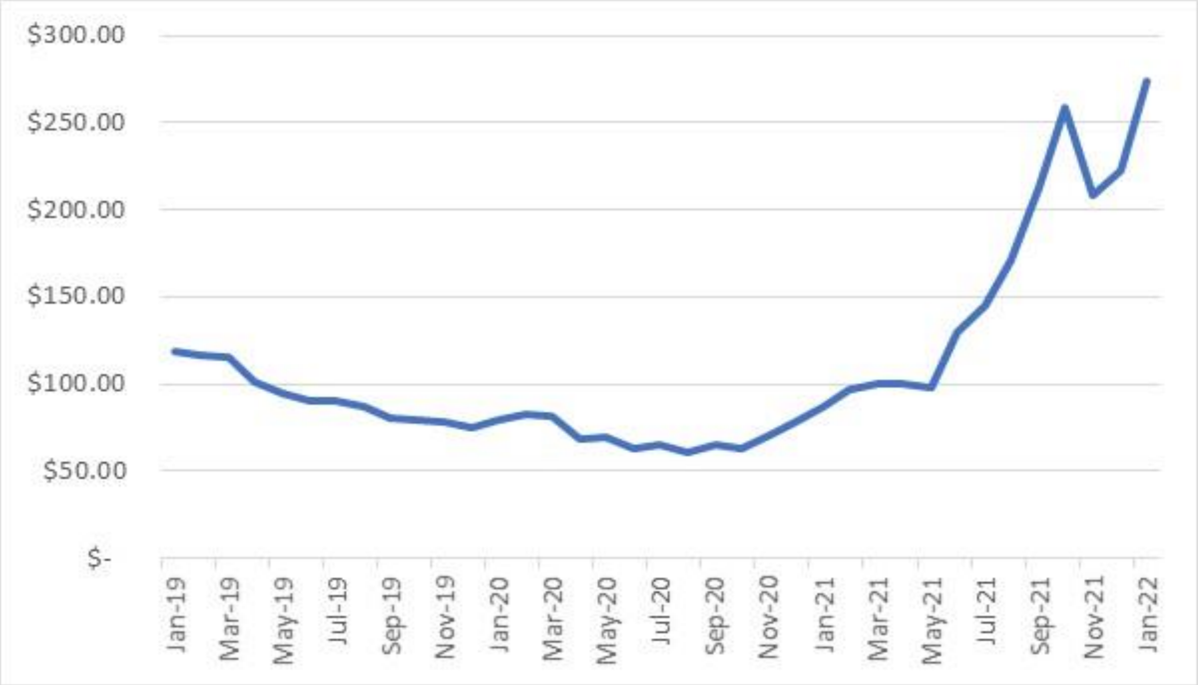
[2] FOB means that the seller pays for transportation of the goods to the port of shipment, plus loading costs. The buyer pays the cost of marine freight transport, insurance, unloading, and transportation from the arrival port to the final destination.

connecting Russia to markets in East Asia is also under development, with R.Z.D. (the Russian state rail operator) foreshadowing growth in eastbound volumes from 53 Mt in 2020 to 69 Mt by 2024.

Thermal coal prices during the first quarter of 2022 have surged even higher given recent upheaval in global energy markets caused by the Russian invasion of Ukraine. Immediately following the Russian invasion, the price of thermal coal almost doubled from its December price to US$440 per tonne in early March 2022 (Mandavia, 2022). Since this peak in early March, have fallen and during the week ending 18 March 2022, coal prices had been trading at around US$ 346 per tonne (Toscano, 2022).

Recent thermal coal prices from January 2019 until January 2022 is outlined in Figure 1 below.

Figure 1: Thermal Coal Prices – January 2019 to January 2022 (based on the Newcastle benchmark of 6,000 kcal/kg in nominal US$)



Source: The World Bank (2022).

While the United States is the only nation to impose a formal ban on Russian coal imports, Russia's ban from the international payments system SWIFT (the Society for Worldwide Interbank Financial Telecommunication) used by financial institutions around the world to make international payments, has significantly impeded Russia's ability to engage in international trade (Evans, 2022). However, an outbreak of peace and a political agreement in the Ukraine could see Russian coal supplies return to international market relatively quickly (Hodge, 2022, p. 4).

4.2.2 Future Course of Coal Prices

The critical question for the economic viability of the Project is whether coal prices are likely to remain high or whether they will fall. No one can predict the future, however, it is far more likely than not that coal prices will fall from their current record high levels during March 2022 given structural changes in demand for thermal coal that are likely to occur.

Structural changes in global thermal coal markets are likely to occur due to net zero emissions commitments from China (by 2060), the European Union (by 2050, with the target now legislated), Japan (by 2050), Taiwan (by 2050), and South Korea (by 2050, and also with a legislated target) (Department of Industry, Science, Energy and Resources, 2021b, p. 58).

A range of South-East Asian countries cancelled a significant number of planned coal plant constructions at the 26th UN Climate Change Conference of the Parties (COP26) in Glasgow last year, leaving China with a dominant share of all coal plants now under development (Department of Industry, Science, Energy and Resources, 2021, p. 61).

China's government has announced plans to reduce coal use over the longer term, which include a net zero target set for 2060 (Department of Industry, Science, Energy and Resources, 2021, p. 61). In April 2021, President Xi Jinping announced at the Leaders Climate Summit that China will "strictly control coal consumption" over the next 14th Five-year Plan (FYP) period (2021-2025) and "will phase down coal consumption" over the 15th FYP period (2026-2030). This is the first time China has issued such strong intent on decoupling economic growth from coal and the first time it has suggested a peak year for coal consumption (Climate Action Tracker, 2021). In any event, China has imposed informal import restrictions on Australian coal imports and has given no sign of this ending (Department of Industry, Science, Energy and Resources, 2021, p. 61).

Japan has recently escalated its policies for a transition out of coal, with Prime Minister Kishida announcing at COP26 that the country would invest US$100 million in transforming coal and gas plants to use nitrogen and hydrogen (Department of Industry, Science, Energy and Resources, 2021, p. 62). Japan has also expanded its climate finance commitments for Asian nations by US$10 billion, announced plans to close 100 coal plants by 2030, and cancelled its proposals to build more coal-fired power plants. The Japanese Government's 6th energy plan forecasts a significant decrease in coal use by 2030. The Japanese Government has also indicated that it is intending to re-open a further 14 nuclear power plants that were closed following the Fukushima nuclear power plant accident back in 2011.

In October 2021, South Korea released a draft plan to reduce coal-fired generation from around 42 per cent of electricity generation (in 2018) to 22 per cent (by 2030) and zero (by 2050) (Department of Industry, Science, Energy and Resources, 2021, p. 62). This builds on the existing Basic Energy Plan, which seeks to shut about half of the nation's 60 coal-fired plants by 2034.

Taiwan has announced that it will cancel all coal plant construction, and reduce the coal share of its power generation from around 45 per cent to 30 per cent by 2025 (Department of Industry, Science, Energy and Resources, 2021, p. 63). The Taiwanese Government has also abandoned previous plans to upgrade its coal fleet — much of which was built 30-40 years ago — and will instead seek to convert its coal plants to natural gas.

Nations in South East and South Asia (excluding India) are expected to begin scaling back on coal power generation capacity during the mid-2020s (Department of Industry, Science, Energy and Resources, 2021, p. 63). The Philippines retains a number of coal plants under construction, but has banned greenfield coal projects, and is considering potential early closure of 10 of its 28 existing coal plants. Thailand's most recent Power Development Plan seeks to phase out coal-fired power generation, reducing the share of coal generation by half (to 10 per cent) by 2030.

Vietnam, which was previously expected to expand its coal power significantly, announced at COP26 that it would dramatically reduce the scale of its coal plant constructions (Department of Industry, Science, Energy and Resources, 2021, p. 63). Vietnam has also recently signed the global "coal to clean power" statement, which effectively commits it to not issuing permits for new unabated coal-fired power generation projects. Other countries to have recently signed the pledge include Canada, Kazakhstan, Poland, Chile, Egypt, Morocco, Korea, and Sri Lanka, along with other countries across Africa and Asia.

One of the few countries expected to significantly increase its use of coal in the foreseeable future is India. Signalling its ongoing intention to use coal, India (and China) advocated for changes to the text of the final COP26 communique, replacing a universal commitment to 'phase out' coal with a commitment to 'phase down' coal (Department of Industry, Science, Energy and Resources, 2021, p.

61). India is continuing to expand its generation capacity from coal, as a number of projects are under construction and several others have been announced (Climate Action Tracker, 2021a). Based on current expansion plans for coal generation, India's coal generation capacity would increase from current levels of over 200 gigawatts (GW) to almost 266 GW by 2029-2030, with 35 GW expected to come online in the next five year. However, Indian Prime Minister Narendra Modi did announce plans at COPS 26 to reach net-zero carbon emissions in 2070 and boost the share of renewables in India's energy mix from about 38 per cent in 2020 to 50 per cent by 2030 (Reuters, 2021).

The Indian Government is also seeking to reduce dependency on imported coal by providing greater access to domestic deposits (Department of Industry, Science, Energy and Resources, 2021, p. 61). The Indian Government ran a series of auctions for coal blocks in 2021. Should work at the sites proceed on schedule, it is likely that new mines would begin to enter the domestic market from the mid-2020s, potentially providing a long-term curb on imports of lower-grade coal.

Recent policy announcements, such as those coming out of COP26, place pressure on long-term prospects for coal demand (Department of Industry, Science, Energy and Resources, 2021, p. 66). Announcements at COP26 also mean that China will now hold a more dominant share of the world's remaining prospective coal plants, although informal import restrictions on Australian coal mean that Australia is not well placed to capitalise.

According to the International Energy Agency (2021, p. 8):

> *The pledges to reach net zero emissions made by many countries, including China and India, should have very strong implications for coal – but these are not yet visible in our near-term forecast, reflecting the major gap between ambitions and action.*

According to a recent article in *The Wall Street Journal*:

> *In the very long run, coal's prospects still look dim. (Mandavia, 2022)*

Long-term thermal-coal price forecasts from both KPMG (2022) and the World Bank (2021) are for thermal coal prices to fall from current high levels. Over the longer term, KPMG (2022) is forecasting thermal coal prices to fall to US$71.70 per tonne (in real 2022 US$) while the World Bank (2022) is forecasting thermal coal prices to fall to US$55 per tonne (in nominal terms) by 2035.

4.3 Updated Coal Price Forecasts and Project Value of Production

The gross mining revenue from the Project in present value terms in real 2019 Australian dollars at a 7 per cent discount rate has been re-estimated using two different price forecasts:

- World Bank (October 2021)
- KPMG (December 2021/January 2022) based on the opinions of coal price experts.

Drawing on the limited information made available by EY (2019) from Figure 6 and Table 3 from their EIS, we have sought to replicate the production schedule for the Project in terms of ROM coal, thermal coal and SSCC. Based on our replication of the production schedule for the Project as well as the coal price and exchange rate assumptions as outlined by EY (2019), we have arrived at similar results to EY that are outlined in Table 2 below. The full results of our replication are provided in Appendix A.

Table 2: Comparison of EY and Pegasus Results for the Glendell Continued Operations Project (real 2019 Aus$ in millions

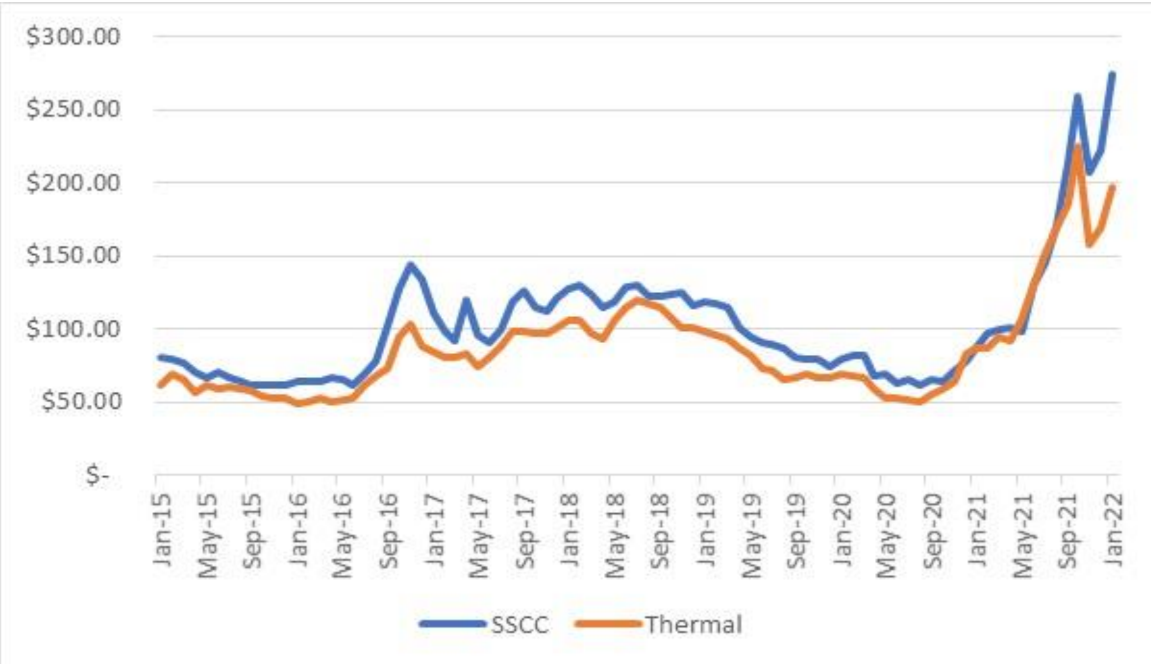
	Ernst & Young	**Pegasus**
Total Sales Revenue	$8,964.4	$8,761.9
Total Sales Revenue NPV	$3,737.7	$3,830.5
Royalties	$296.1	$304.60

Source: EY (2019).

Forecasts of future thermal coal prices have been based on the most recent thermal coal price forecasts published by the World Bank (2021) and published by KPMG (2022). While KPMG (2022) provides coal price forecasts for both thermal coal and SSCC, the World Bank (2021) coal price forecasts only relate to the Newcastle benchmark for thermal coal.

For the World Bank (2021) coal price forecasts to be used for assessment of the Project, we needed to establish whether it was possible to use the World Bank thermal coal price forecasts as the basis to derive price forecasts of SSCC. To that end, we examined the relationship between the monthly average price for the Newcastle thermal coal benchmark and the Platts reported prices for SSCC from Australia FOB. Figure 2 below plots the monthly average price for the Newcastle thermal coal benchmark and reported Platts prices for SSCC since the beginning of 2015 until January 2021.

Figure 2: Monthly Price Averages for Newcastle Thermal Coal Benchmark Price (6,000 kcal/kg NAR) and Semi Soft Coking Coal FOB Australia (USD$ per tonne in nominal terms) – January 2015 to March 2020*



Sources: The World Bank (2021), *Platts Coal Trader* and *Platts SBB Steel Markets Daily*.

As can be seen in Figure 2 above, there is in fact a close relationship between the Newcastle thermal coal benchmark price and the price of SSCC. The correlation coefficient between the two series was 0.96 while the coefficient of determination (r^2) was 0.93.[3] This close relationship was modelled and then used as the basis to convert World Bank forecasts for the Newcastle thermal coal benchmark price into price forecasts of SSCC. A description of the modelling process and results are provided in Appendix C below.

The KPMG coal price forecasts are for both the Newcastle thermal coal benchmark price and SSCC. The average of the KPMG coal price forecasts for thermal coal and SSCC have been used.

The World Bank coal forecasts for the Newcastle thermal coal benchmark price and the derived price forecasts of SSCC as well as the KPMG medium term coal price forecasts for both series are provided in nominal US dollars (US$). Consistent with the approach taken by EY (2019), these forecasts were converted into real 2019 US$ using the US GDP implicit price deflator and forecasts out to 2023 by the U.S. Energy Information Administration. The KPMG long-term coal price forecasts are in 2022 real US$ and were thus converted to 2019 US$ using the US GDP implicit price deflator and 2022 forecast provided by the U.S. Energy Information Administration.

As the World Bank price forecasts only extend to 2035, we have assumed thermal coal prices remain at their 2035 level in constant price terms in the years beyond (rather than remain constant in nominal price terms).

As coal prices are quoted in US$ it is necessary to have a forecast on the exchange rate to convert prices into Australian dollars (Aus$). For both sets of coal price forecasts, in keeping with Commonwealth Treasury practice, the exchange rate is assumed to remain around its recent average level by taking an average of the previous six months from 13 September 2021 until 11 March 2022.[4]

Calculation tables for estimating the gross mining revenue from the Project using the World Bank and the KPMG coal price forecasts are provided in Appendix B.

We have amended the start date for the Project from 2021 and have assumed instead that it will commence in 2023.

Consistent with EY (2019) the current NSW *Guidelines for the economic assessment of mining and coal seam gas proposals* (Department of Planning and Environment, 2015, pp. 9-10), gross NSW royalty payments charged on an ad valorem basis as a percentage of the value of production were estimated in relation to gross mining revenue from the Project using the World Bank and the KPMG coal price forecasts. The coal ad valorem royalty rate is 8.2 per cent for open cut mines (Department of Planning and Environment, Division of Resources and Geoscience). Consistent with the approach taken by EY (2019, p. 15), an allowable beneficiation deduction of 55 per cent for product coal subject to full cycle washing at AUD$3.50 per tonne was subtracted from gross NSW royalty payments in order to calculate net NSW royalty payments.

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[3] Correlation refers to how closely two variables are related to each other. A correlation coefficient puts a value on the relationship and can range from 1 to -1. A “0” means there is no relationship between the variables, “-1” means there is a negative relationship (one goes up while the other one goes down, while “1” refers there is a positive relationship (they both increase or decrease in unison). A correlation coefficient of greater than 0.8 or less than -0.8 is generally referred to as a strong correlation. The coefficient of determination (r^2) is the square of correlation coefficient and gives the proportion of the variance (fluctuation) of one variable that is predictable from the other variable.

[4] See Commonwealth of Australia (2021, p. 37). The average value of the exchange rate from 13 September 2-021 until 11JMarch 2022 for Aus$1 was US$0.7252.

A summary table on the profit (or loss) from the Project using World Bank and KPMG coal price forecasts is provided in Table 3 below. We have accepted the residual cost of capital, operating costs, closure costs, biodiversity costs, and depreciation as reported by EY (2019, p. 16).

Table 3: Project Financials using World Bank and KPMG Coal Price Forecasts – Present Value (real 2019 Aus$ in millions)

	World Bank	KPMG
Revenue		
Revenue from Coal Sales	$2,676.8	$3,601.2
Residual Value of Capital	$25.8	$25.8
Total Revenue	$2,702.6	$3,627.0
Costs		
Operating Costs	$2,545.0	$2,545.0
Royalties	$210.0	$268.1
Closure Costs	-$25.4	-$25.4
Biodiversity Offset	$16.6	$16.6
Total operating costs	$2,746.2	$2,804.3
Depreciation	$272.0	$272.0
Profit	-$315.6	$550.7

Sources: Pegasus, World Bank (2021), EY (2019), and KPMG (2022).

It is extremely unlikely the Project would proceed under the World Bank price forecasts, although it may proceed under the KPMG price forecasts. However, arguably the World Bank price forecasts are superior to the KPMG price forecasts for as the Centre for International Economics (2021, p. 1) has observed, the World Bank coal price forecasts account for the expected decrease in coal demand and alternative energy supply whereas the KPMG coal forecasts do not. In turn, the World Bank price forecasts suggest the Project could become a stranded asset. Should this occur, then the claimed net benefits accruing to NSW will fail to materialise.

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Appendix A: Replication of Gross Mining Revenues from the EY Economic Impact Assessment

Table 4: Pegasus Replication of Project Present Value of Gross Mining Revenues at 7 per cent Discount Rate (real Aus$ 2019 millions)

Year	Calendar Yr	ROM Coal Prodn	Thermal Prodn	SSCC Prodn	Thermal Coal Price	SSCC Price	Gross Reven	NPV	Deduction for washing	Discounted Deductions	Net Disposal Value	NSW Royalties
1	2021	0.3	0.4	-0.3	$ 102.16	$ 126.91	$ 2.79	$ 2.61	$ 0.58	$ 0.54		
2	2022	2.4	1.3	0.3	$ 95.24	$ 111.91	$ 157.39	$ 137.47	$ 4.62	$ 4.04		
3	2023	3.4	2.1	-0.2	$ 91.80	$ 112.94	$ 170.19	$ 138.93	$ 6.55	$ 5.34		
4	2024	5	2.4	0.5	$ 96.67	$ 118.67	$ 291.34	$ 222.26	$ 9.63	$ 7.34		
5	2025	5.4	2.8	0.7	$ 96.67	$ 118.67	$ 353.75	$ 252.22	$ 10.40	$ 7.41		
6	2026	5.5	2.9	0.9	$ 96.67	$ 118.67	$ 387.15	$ 257.97	$ 10.59	$ 7.05		
7	2027	6.2	3.1	0.7	$ 96.67	$ 118.67	$ 382.75	$ 238.35	$ 11.94	$ 7.43		
8	2028	6.5	2.8	1.1	$ 96.67	$ 118.67	$ 401.21	$ 233.51	$ 12.51	$ 7.28		
9	2029	6.2	3.1	0.8	$ 96.67	$ 118.67	$ 394.61	$ 214.64	$ 11.94	$ 6.49		
10	2030	6	3	0.8	$ 96.67	$ 118.67	$ 384.95	$ 195.69	$ 11.55	$ 5.87		
11	2031	6.2	3.1	0.7	$ 96.67	$ 118.67	$ 382.75	$ 181.84	$ 11.94	$ 5.67		
12	2032	7.1	3.3	0.9	$ 96.67	$ 118.67	$ 425.81	$ 189.07	$ 13.67	$ 6.07		
13	2033	10	4.8	1.7	$ 96.67	$ 118.67	$ 665.76	$ 276.26	$ 19.25	$ 7.99		
14	2034	10	5	1.5	$ 96.67	$ 118.67	$ 661.36	$ 256.48	$ 19.25	$ 7.47		
15	2034	7.2	3.4	1.3	$ 96.67	$ 118.67	$ 482.95	$ 175.04	$ 13.86	$ 5.02		
16	2035	6.7	3	1.1	$ 96.67	$ 118.67	$ 420.55	$ 142.45	$ 12.90	$ 4.37		
17	2036	6.4	2.9	1.2	$ 96.67	$ 118.67	$ 422.75	$ 133.83	$ 12.32	$ 3.90		
18	2037	5.9	2.6	1	$ 96.67	$ 118.67	$ 370.01	$ 109.47	$ 11.36	$ 3.36		
19	2038	5.4	2.4	1.4	$ 96.67	$ 118.67	$ 398.15	$ 110.09	$ 10.40	$ 2.87		
20	2039	5.6	2.7	0.8	$ 96.67	$ 118.67	$ 355.95	$ 91.98	$ 10.78	$ 2.79		
21	2040	5.4	2.5	0.7	$ 96.67	$ 118.67	$ 324.74	$ 78.43	$ 10.40	$ 2.51		
22	2041	2.2	1.7	0.5	$ 96.67	$ 118.67	$ 223.67	$ 50.49	$ 4.24	$ 0.96		
23	2042	5.1	2.2	0.8	$ 96.67	$ 118.67	$ 307.61	$ 64.89	$ 9.82	$ 2.07		
24	2043	3.9	1.7	1.2	$ 96.67	$ 118.67	$ 306.74	$ 60.47	$ 7.51	$ 1.48		
25	2044	1.2	0.9	0	$ 96.67	$ 118.67	$ 87.00	$ 16.03	$ 2.31	$ 0.43		
Totals		135.2					$8,761.91	$3,830.49		$ 115.75	$3,714.73	$ 304.61

Appendix B: Updated Coal Price Forecasts

Table 5: Present Value of Project Coal at 7 per cent Discount Rate using World Bank Published Thermal Coal Forecasts (real Aus$ 2019 millions)

Year	Calendar Year	ROM Coal Prodn	Thermal Coal Prodn	SSCC Prodn	Real Thermal $Aus	Real SSCC $Aus	Gross Revenue	NPV	Deduction for washing	Discounted Deductions	Net Disposal Value	NSW Royalties
1	2023	0.3	0.4	-0.3	$ 109.71	$ 130.37	$ 4.77	$ 4.46	$ 0.58	$ 0.54		
2	2024	2.4	1.3	0.3	$ 103.23	$ 123.14	$ 171.14	$ 149.48	$ 4.62	$ 4.04		
3	2025	3.4	2.1	-0.2	$ 97.14	$ 116.34	$ 180.72	$ 147.52	$ 6.55	$ 5.34		
4	2026	5	2.4	0.5	$ 91.40	$ 109.94	$ 274.34	$ 209.29	$ 9.63	$ 7.34		
5	2027	5.4	2.8	0.7	$ 86.01	$ 103.92	$ 313.57	$ 223.57	$ 10.40	$ 7.41		
6	2028	5.5	2.9	0.9	$ 80.93	$ 98.25	$ 323.13	$ 215.31	$ 10.59	$ 7.05		
7	2029	6.2	3.1	0.7	$ 76.15	$ 92.92	$ 301.12	$ 187.52	$ 11.94	$ 7.43		
8	2030	6.5	2.8	1.1	$ 71.66	$ 87.90	$ 297.34	$ 173.05	$ 12.51	$ 7.28		
9	2031	6.2	3.1	0.8	$ 67.43	$ 83.18	$ 275.58	$ 149.90	$ 11.94	$ 6.49		
10	2032	6	3	0.8	$ 63.45	$ 78.74	$ 253.34	$ 128.78	$ 11.55	$ 5.87		
11	2033	6.2	3.1	0.7	$ 59.70	$ 74.56	$ 237.27	$ 112.73	$ 11.94	$ 5.67		
12	2034	7.1	3.3	0.9	$ 56.18	$ 70.63	$ 248.96	$ 110.54	$ 13.67	$ 6.07		
13	2035	10	4.8	1.7	$ 52.86	$ 66.93	$ 367.52	$ 152.51	$ 19.25	$ 7.99		
14	2036	10	5	1.5	$ 52.86	$ 66.93	$ 364.71	$ 141.44	$ 19.25	$ 7.47		
15	2037	7.2	3.4	1.3	$ 52.86	$ 66.93	$ 266.74	$ 96.68	$ 13.86	$ 5.02		
16	2038	6.7	3	1.1	$ 52.86	$ 66.93	$ 232.21	$ 78.66	$ 12.90	$ 4.37		
17	2039	6.4	2.9	1.2	$ 52.86	$ 66.93	$ 233.62	$ 73.96	$ 12.32	$ 3.90		
18	2040	5.9	2.6	1	$ 52.86	$ 66.93	$ 204.37	$ 60.47	$ 11.36	$ 3.36		
19	2041	5.4	2.4	1.4	$ 52.86	$ 66.93	$ 220.57	$ 60.99	$ 10.40	$ 2.87		
20	2042	5.6	2.7	0.8	$ 52.86	$ 66.93	$ 196.27	$ 50.72	$ 10.78	$ 2.79		
21	2043	5.4	2.5	0.7	$ 52.86	$ 66.93	$ 179.01	$ 43.23	$ 10.40	$ 2.51		
22	2044	2.2	1.7	0.5	$ 52.86	$ 66.93	$ 123.33	$ 27.84	$ 4.24	$ 0.96		
23	2045	5.1	2.2	0.8	$ 52.86	$ 66.93	$ 169.84	$ 35.83	$ 9.82	$ 2.07		
24	2046	3.9	1.7	1.2	$ 52.86	$ 66.93	$ 170.18	$ 33.55	$ 7.51	$ 1.48		
25	2047	1.2	0.9	0	$ 52.86	$ 66.93	$ 47.58	$ 8.77	$ 2.31	$ 0.43		
							$5,657.23	$2,676.80		$ 115.75	$ 2,561.04	$ 210.01

Table 6: Present Value of Project Coal at 7 per cent Discount Rate using KPMG Published Thermal Coal and Semi Soft Coking Coal Price Forecasts (real Aus$ 2019 millions)

Year	Calendar Ye	ROM Coal Prodn	Thermal Coal Prodn	SSCC Prodn	Real Thermal $Aus	Real SSCC $Aus	Gross Revenue	NPV	Deduction for washing	Deduction for Crushing	Discounted Deductions	Net Disposal Value	NSW Royalties
1	2023	0.3	0.4	-0.3	$ 122.38	$ 133.72	$ 8.84	$ 8.26	$ 1.93	$ 0.58	$ 2.34		
2	2024	2.4	1.3	0.3	$ 102.18	$ 121.18	$ 169.19	$ 147.77	$ 3.85	$ 4.62	$ 7.40		
3	2025	3.4	2.1	-0.2	$ 94.43	$ 119.51	$ 174.41	$ 142.37	$ 5.78	$ 6.55	$ 10.06		
4	2026	5	2.4	0.5	$ 83.28	$ 106.02	$ 252.88	$ 192.92	$ 7.70	$ 9.63	$ 13.22		
5	2027	5.4	2.8	0.7	$ 89.51	$ 113.35	$ 329.98	$ 235.27	$ 9.63	$ 10.40	$ 14.27		
6	2028	5.5	2.9	0.9	$ 89.51	$ 113.35	$ 361.60	$ 240.95	$ 11.55	$ 10.59	$ 14.75		
7	2029	6.2	3.1	0.7	$ 89.51	$ 113.35	$ 356.83	$ 222.22	$ 13.48	$ 11.94	$ 15.82		
8	2030	6.5	2.8	1.1	$ 89.51	$ 113.35	$ 375.32	$ 218.44	$ 15.40	$ 12.51	$ 16.25		
9	2031	6.2	3.1	0.8	$ 89.51	$ 113.35	$ 368.16	$ 200.26	$ 17.33	$ 11.94	$ 15.92		
10	2032	6	3	0.8	$ 89.51	$ 113.35	$ 359.21	$ 182.61	$ 19.25	$ 11.55	$ 15.66		
11	2033	6.2	3.1	0.7	$ 89.51	$ 113.35	$ 356.83	$ 169.53	$ 21.18	$ 11.94	$ 15.73		
12	2034	7.1	3.3	0.9	$ 89.51	$ 113.35	$ 397.40	$ 176.45	$ 23.10	$ 13.67	$ 16.33		
13	2035	10	4.8	1.7	$ 89.51	$ 113.35	$ 622.35	$ 258.25	$ 25.03	$ 19.25	$ 18.37		
14	2036	10	5	1.5	$ 89.51	$ 113.35	$ 617.58	$ 239.51	$ 26.95	$ 19.25	$ 17.92		
15	2037	7.2	3.4	1.3	$ 89.51	$ 113.35	$ 451.70	$ 163.72	$ 28.88	$ 13.86	$ 15.49		
16	2038	6.7	3	1.1	$ 89.51	$ 113.35	$ 393.22	$ 133.20	$ 30.80	$ 12.90	$ 14.80		
17	2039	6.4	2.9	1.2	$ 89.51	$ 113.35	$ 395.60	$ 125.24	$ 32.73	$ 12.32	$ 14.26		
18	2040	5.9	2.6	1	$ 89.51	$ 113.35	$ 346.08	$ 102.39	$ 34.65	$ 11.36	$ 13.61		
19	2041	5.4	2.4	1.4	$ 89.51	$ 113.35	$ 373.52	$ 103.28	$ 36.58	$ 10.40	$ 12.99		
20	2042	5.6	2.7	0.8	$ 89.51	$ 113.35	$ 332.36	$ 85.89	$ 38.50	$ 10.78	$ 12.73		
21	2043	5.4	2.5	0.7	$ 89.51	$ 113.35	$ 303.12	$ 73.21	$ 40.43	$ 10.40	$ 12.27		
22	2044	2.2	1.7	0.5	$ 89.51	$ 113.35	$ 208.84	$ 47.14	$ 42.35	$ 4.24	$ 10.51		
23	2045	5.1	2.2	0.8	$ 89.51	$ 113.35	$ 287.61	$ 60.67	$ 44.28	$ 9.82	$ 11.41		
24	2046	3.9	1.7	1.2	$ 89.51	$ 113.35	$ 288.19	$ 56.82	$ 46.20	$ 7.51	$ 10.59		
25	2047	1.2	0.9	0	$ 89.51	$ 113.35	$ 80.56	$ 14.84	$ 48.13	$ 2.31	$ 9.29		
							$8,211.38	$3,601.19			$ 331.99	$ 3,269.20	$ 268.07

Appendix C: Modelling the Relationship between the Newcastle Thermal Coal Benchmark Price and Semi Soft Coking Coal (FOB Australia)

In the first model, a regression was run on the average monthly price for semi-soft coking coal FOB Australian in real 2019 US$ (*SSCCA*) on a constant term (β_0), the average monthly Newcastle thermal coal benchmark price FOB in real 2019 US$ (*NTCB*), and an error term (ε) with the subscript (t) representing the time over the period from January 2015 until December 2021:

$$SSCCA_t = \beta_0 + \beta_1 NTCB_t + \varepsilon_t \qquad (1)^5$$

A series is stationary if its mean and variance is time invariant. However, any series that is not stationary is said to be nonstationary or to contain a unit root. If a first difference is taken of a nonstationary time series and found to be stationary then the series is said to be integrated of the first order or I(1), or to contain a unit root.

The price series *SSCCA* and *NTCB* along with their first differences were tested for stationarity using the Phillips-Perron (PP) test. The PP test performs the test of a null hypothesis that a series contains a unit root against the alternative hypothesis that the series is stationary. The PP test was run using two test specifications – with a constant, a constant and a linear time trend. Results from the PP tests are provided in Table 7 below. The results show there is a unit root in both price series at level, but that the first differences of the two-price series are stationary.

Table 7: Phillips-Perron (PP) Test on SSCCA and NTCB and 1st Differences (ΔSSCCA and ΔNTCB)

Variable	PP Test with a Constant	PP Test with a Constant and Linear Time Trend
SSCCA	0.608*	-0.763*
	(0.862)	(0.964)
ΔSSCCA	-7.401#	-7.473#
	(0.000)	(0.000)
NTCB	1.017*	1.462*
	(0.744)	(0.835)
ΔNTCB	-9.109#	-9.161#
	(0.000)	(0.000)

Note: Figures in brackets are the corresponding probabilities. * indicates the null hypothesis of a unit root has been accepted at the 5 per cent level. # indicates the null hypothesis of a unit root has been rejected at the 5 per cent level.

Equation (1) was run initially as an ordinary least square (OLS) regression. The results are reported in Table 8 below.

[5] Nominal coal prices in US$ were converted into real 2019 US$ using the US GDP implicit price deflator (Federal Reserve Bank of St. Louis, 2022).

Table 8: Ordinary Least Squares for Equation (1)

Variable	
Constant (β_0)	5.541
	(0.784)
NTCB	1.116
	(0.000)
R^2	0.913
Adjusted R^2	0.912
F statistic	857,314
	(0.000)
Durbin-Watson statistic	0.594
Breusch-Godfrey LM test (4 lags)	41.331
	(0.000)
White Heteroskedasticity test	17.410
	(0.000)

For equation (1), *NCTB* was statistically significant at the 1 per cent level while the constant was not statistically significant at all. Both the R-squared and adjusted R-squared values indicates that the model fits the data reasonably well. However, diagnostic tests identify both the presence of heteroskedasticity and autocorrelation from the Durbin-Watson statistic and the Breusch-Godfrey LM test.

Estimates of relationships between nonstationary variables could lead to spurious regression by suggesting significant relationships between wholly unrelated variables (Granger & Newbold, 1974). A standard approach to addressing the problem of nonstationary data has been to specify models as relationships between differences. However, the major drawback from this approach is that a model based solely on difference terms can only capture the short-run dynamics in a process, and therefore, fails to identify any long-run relationships between the variables.

Given that all variables are integrated of the same order, it is possible a linear combination of these variables could in fact be stationary. Granger (1981) coined the term cointegration to describe a stationary combination of nonstationary variables. Where a linear combination of nonstationary variables are cointegrated then ordinary least squares analysis can still provide a satisfactory framework for evaluating econometric evidence (Stock & Watson, 1988, pp. 164-165).

In order to test for cointegration between the variables, equation (1) was re-estimated as a dynamic ordinary least squares (DOLS) regression using the heteroskedasticity and autocorrelation-consistent (HAC) standard errors as developed by Newey and West (1987) as both heteroskedasticity and autocorrelation was found. This will ensure the standard errors are robust in the event of both heteroskedasticity and autocorrelation of an unknown form.

DOLS enables a cointegrating relationship to be modelled as a single equation incorporating the structural relationship between the variables as outlined in equation (1) using OLS, as well as dynamic elements using OLS, rather than the two equation error-correction model (ECM) approach where the residuals from the long-run equilibrium regression are entered into the ECM in the place of the levels terms along with short-run dynamics as proposed by Engle and Granger (1987). In DOLS, the static cointegrating regression is augmented by leads and lags of the first differences of the integrated regressors. In this case the leads and lags of first differences were fixed at one each.

The results are presented in Table 9 below.

Table 9: Dynamic Ordinary Least Squares for Equation (1) (HAC t-statistic probabilities in brackets)

Variable	
Constant (β_0)	5.753
	(0.178)
NTCB	1.116
	(0.000)
R^2	0.934
Adjusted R^2	0.931

Note: Figures in brackets are the corresponding probabilities.

For the re-estimated equation (1) using DOLS the constant was not statistically significant while *NTCB* was statistically significant at less than the 1 per cent level and the R-squared and adjusted R-squared indicates the model fits the data reasonably well.

The re-estimated equation (1) was tested for cointegration using various diagnostic tests and found to be cointegrated without exception. The Engle-Granger and Phillips-Ouliaris residual-based tests for cointegration were used and the null hypothesis of no cointegration was rejected at the 5 per cent level of statistical significance in relation to all of the test statistics. Hansen's Instability Test also accepted the null hypothesis of cointegration against the alternative of no cointegration.

Appendix D: Coal

What is Coal?

Coal is a family name for a variety of solid organic fuels and refers to a whole range of combustible sedimentary rock materials spanning a continuous quality scale (International Energy Agency, 2019, p. I.3). Coal is a versatile fuel, and has long been used for heating, industrial processes and in electricity generation (Thomas, 2013, p. 354). Coal is primarily used for the generation of electricity and commercial heat (International Energy Agency, 2019, p. xvi). In 20202, coal was responsible for 35.2 per cent of all electricity generation worldwide (International Energy Agency, 2021a).

The principal uses of traded coals worldwide is for electricity generation and iron and steel manufacture (Thomas, 2013, p. 1). Iron and steel manufacture depend primarily upon coal whereas in the case of electricity generation coal faces competition from other energy sources. The Project is intending to mine metallurgical coal (also referred to as coking coal) as well as steam or thermal coal that is primarily used for electricity generation.

Coal quality refers to those chemical and physical properties of coal that influence its potential use (Thomas, 2013, p. 111). It is essential to have an understanding of the chemical and physical properties of coal, especially those properties that will determine whether the coal can be used commercially. Coals need to possess particular qualities for selected usage, should they meet such requirements, then they can be mined and sold as a pure product or, if the quality could be improved, then they can be blended with other selected coals to achieve the saleable product.

In simple terms coal can be regarded as being made up of moisture, pure coal and mineral matter (Thomas, 2013, p. 112). The moisture consists of surface moisture and chemically bound moisture, the pure coal is the amount of organic matter present and the mineral matter is the amount of inorganic material present, which when the coal is burnt produces ash.

There is no exact method for determining the moisture content of coal, however, the coal industry has developed the following set of empirically determined definitions (Thomas, 2013, pp. 113-14):

1. Surface moisture. This is adventitious moisture, not naturally occurring with the coal and which can be removed by low temperature air drying. This drying step is usually the first in any analysis and the moisture remaining after this step is known as air-dried moisture.
2. **As received** or as delivered moisture. This is the total moisture of the coal sample when received or delivered to the laboratory. Usually a laboratory will air dry a coal sample thereby obtaining the ‘loss on air drying’. An aggressive drying step is then carried out which determines the air-dried moisture. These results are added together to give the total as received/as delivered moisture.
3. Total moisture. This is all the moisture that can be removed by aggressive drying.
4. Air-dried moisture. This is the moisture remaining after air drying and which can be removed by aggressive drying.

The ash of a coal is that inorganic residue that remains after combustion (Thomas, 2013, p. 114). For thermal coal a high ash content will effectively reduce its calorific value. For metallurgical coal, a maximum of 10–20 per cent (air-dried) is recommended, as higher ash contents reduce the efficiency in the blast furnace.

Volatile matter represents that component of the coal, except for moisture, that is liberated at high temperature in the absence of air (Thomas, 2013, p. 114). This material is derived chiefly from the organic fraction of the coal, but minor amounts may also be from the mineral matter present.

The fixed carbon content of coal is that carbon found in the residue remaining after the volatile matter has been liberated (Thomas, 2013, p. 114).

The determination of the effects of combustion on coal will influence the selection of coals for particular industrial uses (Thomas, 2013, p. 116). Tests are carried out to determine a coal's performance in a furnace, that is its calorific value and its ash fusion temperatures. In addition, the caking and coking properties of coals need to be determined if the coal is intended for use in the production of iron and steel.

Metallurgical Coal

Steel is an alloy based primarily on iron (World Coal Association, 2017). As iron occurs only as iron oxides in the earth's crust, the ores must be converted, or 'reduced', using carbon. The primary source of this carbon is metallurgical coal.

Metallurgical coal differs from thermal coal by its carbon content and its caking ability (Bell, 2019). Caking refers to the coal's ability to be converted into coke, a pure form of carbon that can be used in basic oxygen furnaces. Bituminous coal—generally classified as a metallurgical grade—is harder and blacker and contains more carbon and less moisture and ash than low-rank coals.

Metallurgical coal is converted to coke by driving off impurities to leave almost pure carbon (World Coal Association, 2017). The physical properties of metallurgical coal cause the coal to soften, liquefy and then resolidify into hard but porous lumps when heated in the absence of air. Metallurgical coal must also have low sulphur and phosphorous contents.

The coking process consists of heating metallurgical coal to around 1000-1100°C in the absence of oxygen to drive off the volatile compounds (pyrolysis) (World Coal Association, 2017). This process results in a hard porous material – coke. Coke is produced in a coke battery, which is composed of many coke ovens stacked in rows into which coal is loaded. The coking process takes place over long periods of time between 12-36 hours in the coke ovens. Once pushed out of the vessel the hot coke is then quenched with either water or air to cool it before storage or is transferred directly to the blast furnace for use in iron making.

During the iron-making process, a blast furnace is fed with the iron ore, coke and small quantities of fluxes (minerals, such as limestone, which are used to collect impurities) (World Coal Association, 2017). Air which is heated to about 1200°C is blown into the furnace through nozzles in the lower section.

Inside the furnace, the iron ore reacts chemically with coke and limestone (Woodford, 2019). The coke 'steals' the oxygen from the iron oxide (in a chemical process called reduction), leaving behind a relatively pure liquid iron, while the limestone helps to remove the other parts of the rocky ore (including clay, sand, and small stones), which form a waste slurry known as slag. The iron made in a blast furnace is an alloy containing about 90–95 per cent iron, 3–4 per cent carbon, and traces of other elements such as silicon, manganese, and phosphorus, depending on the ore used.

Pure iron is too soft and reactive to be of much practical use, so it is usually turned into an alloy through being mixed with other elements (especially carbon) to make stronger, more resilient form of metal including steel (Woodford, 2019). Broadly speaking, steel is an alloy of iron that contains up to about 2 per cent carbon.

The grade of coal and its caking ability are determined by the coal's rank – a measure of volatile matter and degree of metamorphism – as well as mineral impurities and the ability of the coal to melt, swell and resolidify when heated (Bell, 2019). The three main categories of metallurgical coal are:

1. Hard coking coal (HCC)
2. Semi-soft coking coal (SSCC)
3. Pulverised coal injection (PCI) coal.

HCC is a necessary input in the production of strong coke (Commodity Insights, 2018, p. 7). When heated in a coke oven, HCC will swell to form coke. HCC coal has better coking properties than SSCC, allowing it to garner a higher price (Bell, 2019).

SSCC can be used in the coke blend along with HCC, but results in a low coke quality and more impurities (Commodity Insights, 2018, p. 7). SSCC can also be sold as thermal coal.

PCI coal is used for its heat value and injected directly into blast furnaces (without an intermediate coking phase) as a supplementary fuel (Commodity Insights, 2018, p. 7). PCI coal can also be sold as thermal coal. The primary economic benefits of PCI coal are the replacement of higher-cost coking coals that are used to produce coke, the avoidance of coke plant operating costs and increased productivity at the blast furnace (Duck, 2017). Higher-quality PCI have a lower volatile matter content, low ash content and good grindability, but the coke replacement ratio of a coal in the blast furnace is more dependent on the energy or carbon content of the coal, with low volatile matter coals having the highest coke replacement ratio. The better replacement ratio of low volatile matter PCI coals is reflected in the better market price of these coals compared to the price of high volatile matter PCI coals (Bennett, 2007, p. 1).

Thermal Coal

Thermal coal used in electricity generation is required to have a low mineral matter level with a high calorific value (Thomas, 2013, p. 103). The calorific value (CV) of coal is the amount of heat per unit mass of coal when combusted, and is often referred to as specific energy (Thomas, 2013, p. 116). The CV of coal is expressed two ways:

1. The **gross** calorific or higher heating value. This is the amount of heat liberated during testing in a laboratory, when coal is combusted under standardised conditions at constant volume, so that all of the water in the products remains in the liquid form.
2. The **net** calorific or lower heating value. During actual combustion in furnaces, the gross calorific value is never achieved because some products, especially water, are lost with their associated latent heat of vapourisation. The maximum achievable calorific value under these conditions is the net calorific value at constant pressure.

The CV is often expressed in terms of kilocalories per kilogram (kcal/kg). For Australian coal, it is generally quoted on either a **gross** (CV) **as received** (GAR) basis or a **net** (CV) **as received** (NAR) basis in kcal/kg. There are formulas through which one can convert GAR into NAR if one knows the percentage of hydrogen, moisture and oxygen of the coal.[6] However, if the percentage of hydrogen, moisture and oxygen is unknown, then as an approximate value GAR can be converted into NAR by subtracting 260 kcal/kg (Thomas, 2013, p. 116).

Mineral impurities affect the suitability of coal as a boiler fuel (Thomas, 2013, p. 98). The resulting ash can cause significant problems that include slag flow behaviour, ash deposition, bed agglomeration, corrosion and erosion of system parts, fine particulate that is difficult to collect, and blinding of hot-gas clean-up filters (Benson, Sondreal, & Hurley, 1995, p. 1). In thermal coal, a high ash content will effectively reduce its calorific value (Thomas, 2013, p. 114).

[6] See Thomas (2013, p. 116).