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## Modelling the economic impacts of a moratorium on new coal mines

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*Modelling shows that Australia's economy would be barely affected by a moratorium on approval of new coal mines and mine expansions.*

Discussion paper

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**August 2016**

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# Summary

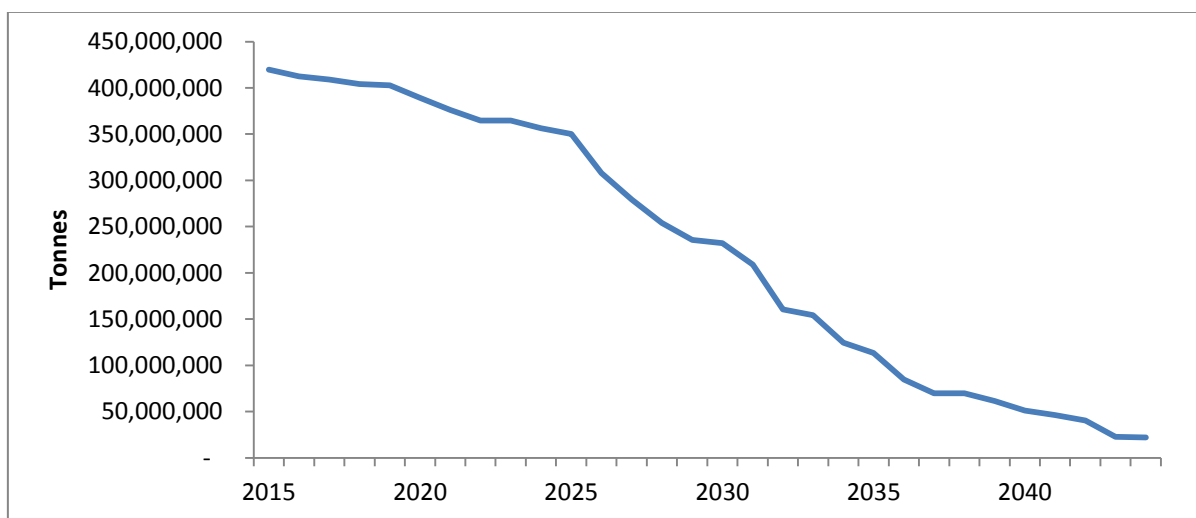
As the world works to reduce greenhouse gas emissions, it will need to burn less coal. As a result, the world will need less coal mines. In the lead up to the Paris climate talks in December 2015, President Anote Tong of Kiribati and other Pacific leaders called for a global moratorium on new coal mines and the expansion of existing coal mines.

Coal industry lobbyists and some political leaders in Australia claim that a coal moratorium “would spell economic and social catastrophe for Queensland and the national economy”. However, economic modelling conducted for this report shows that the economic impacts of a moratorium — on Queensland, New South Wales and Australia more broadly — would be small.

The coal industry employs less than 0.4% of the Australian workforce and its royalties contribute just 2% of revenue to the NSW and Queensland budgets. A moratorium on new building new coal mines and expanding existing ones would allow for a gradual phase out of the industry, which would in turn minimise the social and economic adjustment associated with worldwide commitments to reduce greenhouse gas emissions.

Australian governments have already given approval for coal mines to produce for decades into the future. The chart below shows the currently approved capacity of coal projects in the major coal states of NSW and Queensland:

## Queensland and NSW approved coal production



Sources: TAI analysis, NSW Division of Resource and Energy (2014) *Coal Industry Profile*; Queensland Department of Natural Resources and Mines (2015) *Queensland coal – mines and advanced projects*

This chart shows that if a moratorium was imposed on the construction of new coal mines, Australia’s coal production would decline gradually as existing mines reached the end of economic their lives. Existing coal mines and those already approved could still produce tens of millions of tonnes of coal into the 2040s, assuming other countries are still willing to buy it.

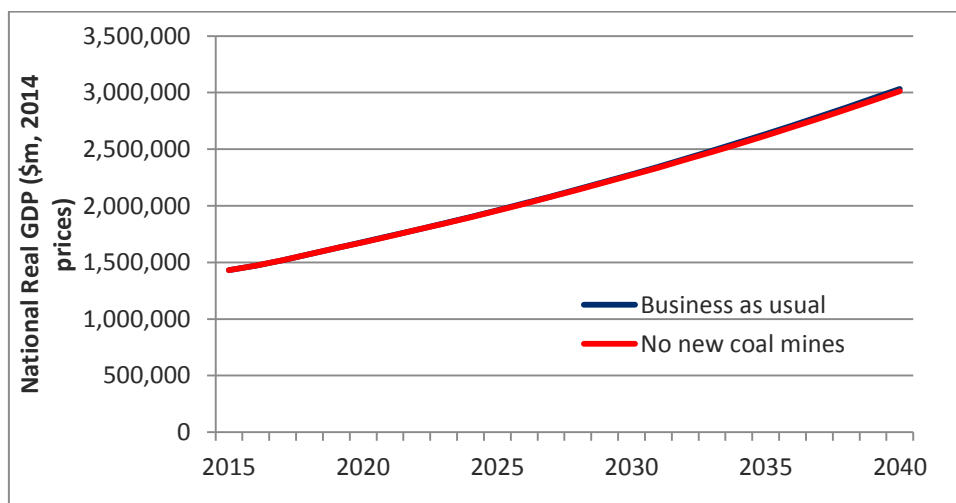
The Australia Institute commissioned Victoria University’s Centre of Policy Studies (CoPS) to model the economic impacts of this phased reduction in coal production relative to the International Energy Agency (IEA)’s central scenario for Australia’s future coal production. The model used is a computable general equilibrium (CGE) model, which considers the resource constraints in the Australian economy. Such models are regularly used by the coal industry, as well as by other industries and government agencies.

Importantly, this model does not consider the economic impacts of the coal industry’s effects on human health or the environment (aside from direct greenhouse gas emissions). This effectively assumes the industry’s impacts on water resources, air quality, etc, are perfectly managed, certainly understating the case for a moratorium on new mines. Other assumptions are described in the report and technical appendix.

## Key results from CoPS Modelling

In the scenarios modelled Australian economic growth is barely affected by a moratorium on new coal mines, with a difference in GDP in 2040 of 0.6% between the two modelled scenarios (“business as usual”, wherein no moratorium is imposed, and a scenario where the moratorium goes ahead as proposed.) In either case, GDP is estimated to reach \$3 trillion in 2040, around twice the size of the economy today.

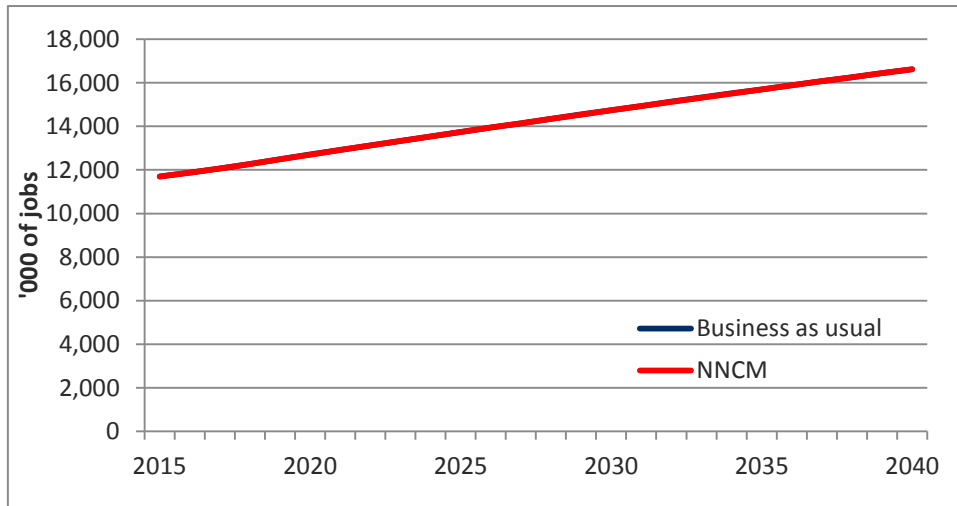
### Impact on GDP from introducing a moratorium on new coal mines



Source: CoPS model

As the coal industry is capital intensive, and a small employer, the impact of a moratorium on building new coal mines on employment in Australia is even smaller than the impact on GDP. While the impact on employment is so small as to be imperceptible in the main chart, the difference in employment peaks at 0.04% in 2030, before the gap closes again as more labour intensive industries expand.

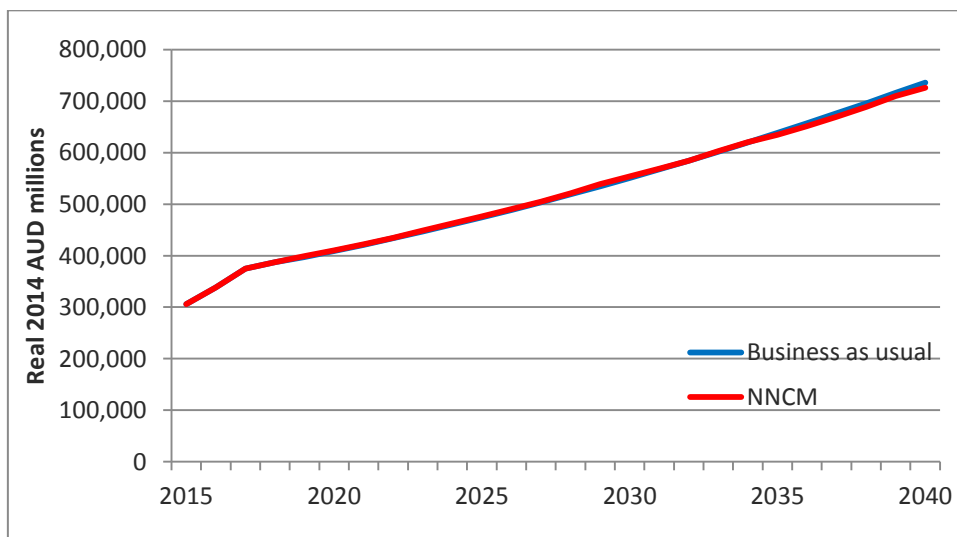
### Impact on employment from introducing a moratorium on new coal mines



Source: CoPS model

Coal exports do account for a large portion of Australian exports, around 12% in 2015. However, overall export values are not projected to differ significantly as a result of introducing a moratorium on new coal mines — there is an estimated reduction of around 1% expected in the final years of the analysis period. This small impact is due to the gradual phase-out and the ability of other industries to increase exports.

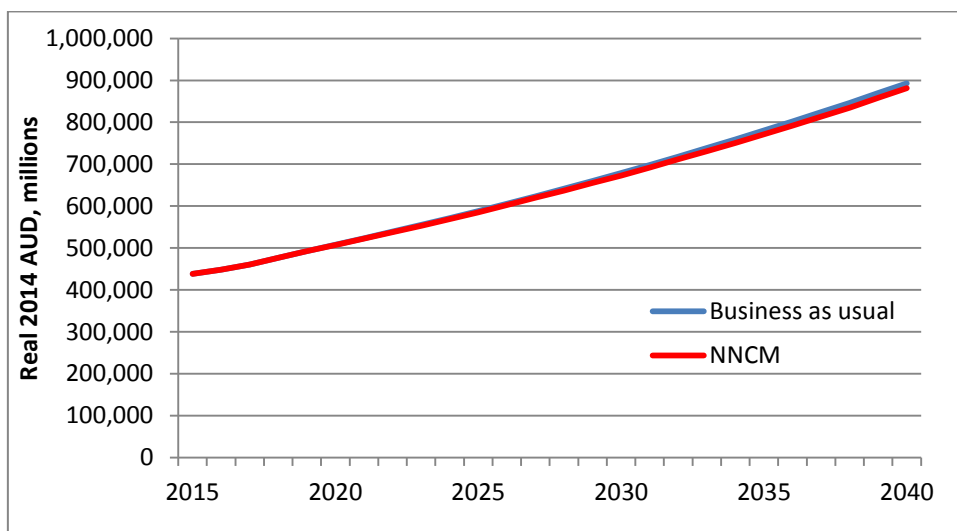
### Impact on exports of introducing a moratorium on new coal mines



Source: CoPS model

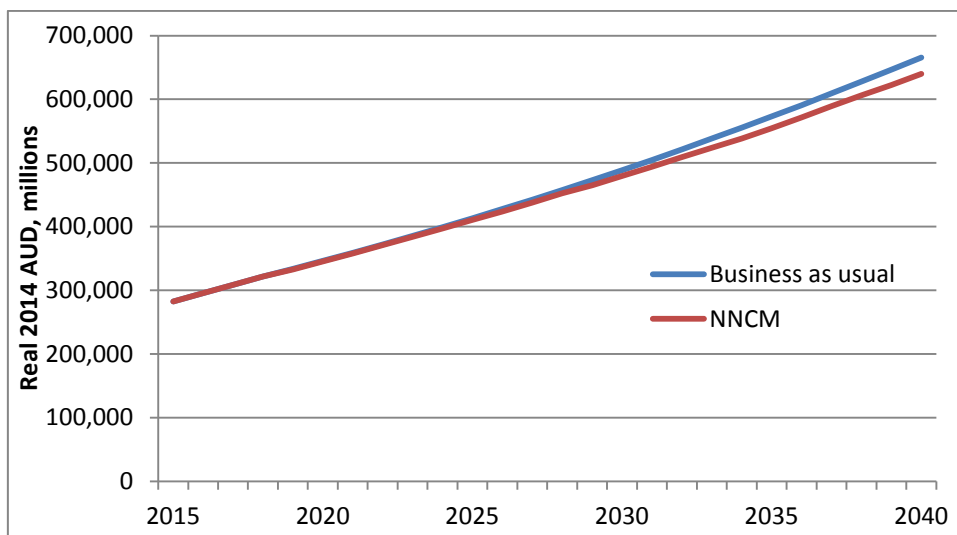
At a state level, a moratorium on new coal mines also has little impact. The main coal producing states, NSW and Queensland, see a difference in economic growth between the two scenarios of 1.3% and 3.8% percent respectively, while other states would see small increases, particularly WA and NT. Significantly, both the Queensland and NSW state economies are expected to more than double in size despite the introduction of a moratorium.

### NSW Gross State Product, business as usual vs no new coal mines



Source: CoPS model

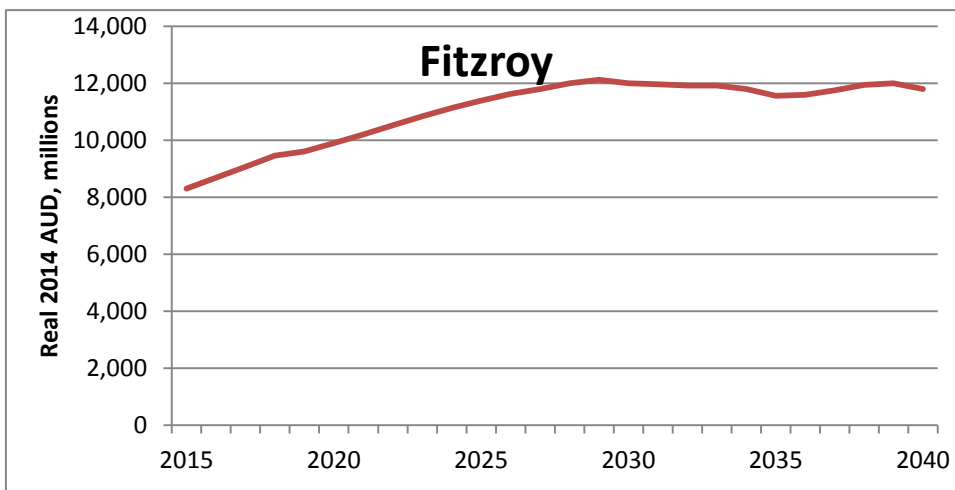
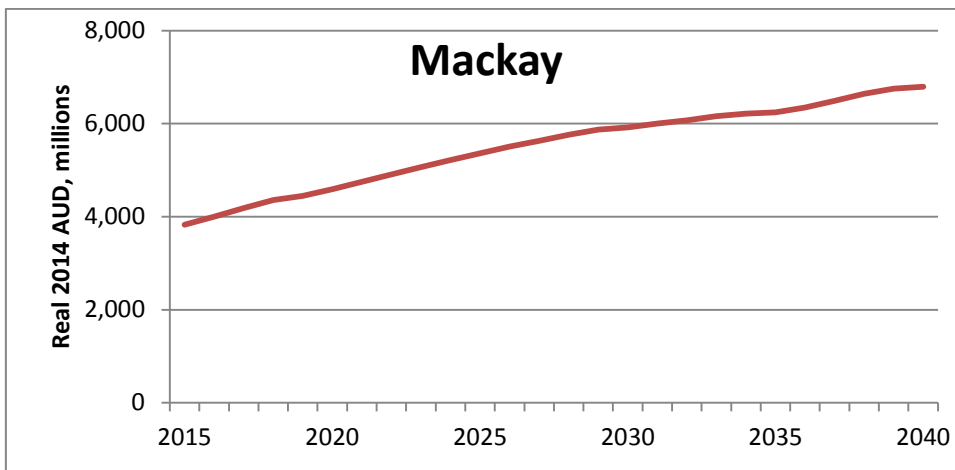
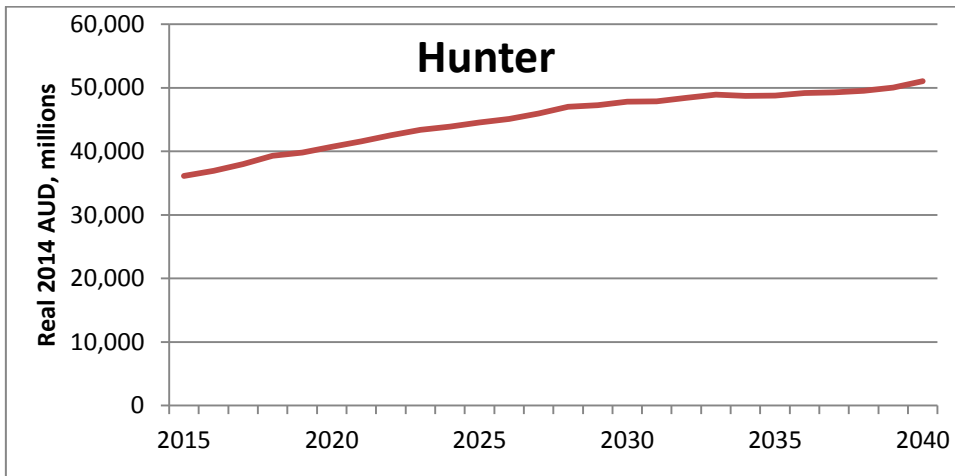
### Queensland Gross State Product, business as usual vs no new coal mines



Source: CoPS model

Coal mining regions experience lower growth than the national or state economies, but still grow substantially through the modelled period. Key regions are shown below.

### Hunter, Mackay and Fitzroy gross regional product with no new coal mines



Source: CoPS model

The Hunter and Mackay economies are expected to grow steadily due to their relative diversity. Economic output in the Fitzroy region (around Rockhampton) is likely to plateau in the 2030s as existing approvals expire and assuming that no new industry takes the place of coal in the region.



This result shows the sensitivity of the Fitzroy region to changes in coal markets and climate policy. Other policies or market fluctuations could cause a similar effect even sooner than the model estimates a moratorium would. Policy intervention is likely to be necessary to transition such areas to a low-carbon future, regardless of whether a policy preventing new coal mines is introduced. Under this scenario, policy makers have over a decade to plan for a low growth period and change in the Fitzroy economy.

The CoPS model does not include any employment in new industries that are yet to emerge. Just as a CGE modelling exercise conducted in the 1980s would ignore potential employment in the mobile phone or internet industries, this modelling exercise inevitably ignores the growth of industries that have yet to emerge. No economic model is able to predict exactly what will happen to an industry, a region, or a household in future decades. Instead, these results help to identify how big an impact a transition away from coal mining would have and to identify the regions that will face the biggest challenges.

All involuntary unemployment is socially and economically harmful, and while the results presented above suggest that the impact of a phase-out of coal mining will be imperceptible at the national level, it will bring change at the regional level. However, it is important to place such impacts in context. The coal industry shed 10,000 jobs in the late 1980s and early 1990s as it introduced new technology such as longwalls and more open cut mines. More recently, the coal industry slashed 20,000 jobs as world demand for coal did not rise as fast as Australian supply growth.<sup>1</sup> And, of course, government decisions to end assistance to the car industry, abolish protections for the textile industry or privatise electricity generation in the Latrobe Valley have all imposed significant costs on households and regions, generally more abruptly than a coal moratorium would affect these regions.

Prominent Australian economics writer Ross Gittins wrote earlier this year:

The mathematical models of the economy that economists produce are supposed to be an aid to thinking. In the public debate, however, they're used as a substitute for thinking.

We hope this report is a step towards addressing this problem. We hope that our modelling assumptions, data and results are presented in a way that assists readers to think about the coal industry in Australia and what might happen to it as the world works to address climate change. Too often, economic modelling is used to present the coal industry as a large and important part of our economy and state budgets. Public debate is then skewed by lobbyists and leaders using modelling results with minimal discussion of how they were derived and the context they should be seen in.

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<sup>1</sup> ABS (2016) 6291.0.55.003 - *Labour Force, Australia, Detailed, Quarterly, May 2016*, <http://www.abs.gov.au/ausstats/abs@.nsf/mf/6291.0.55.003>

Official statistics show that the coal industry employs few Australians, accounts a small portion of government revenues and works mainly in the interests of its overseas owners. Our modelling exercise shows that for the Australian economy and community, the impacts of a phase-out of the coal industry would be minimal. Australia can and should impose a moratorium on new coal mines and mine expansions, as part of climate and wider environmental policy, and should expect minimal economic disruption from doing so.

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# Introduction

## COAL, CLIMATE AND THE AUSTRALIAN ECONOMY

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In 2015, representatives of 195 countries met in Paris and re-affirmed their commitment to reduce greenhouse gas emissions, and to work together to avoid dangerous climate change. Australia was among those countries, with the Australian Minister for the Environment at the time, Greg Hunt, stating:

The Paris Agreement is therefore a profoundly important milestone. It is a turning point in the transition to a lower emissions economy.<sup>2</sup>

There is no plausible scenario in which a world that is reducing greenhouse gas emissions will need more coal mines to help achieve that goal. World coal consumption actually fell in 2014-15 with consumption in China falling by 3.7%.<sup>3</sup>

Regardless of the domestic policies of Australian governments, if the rest of the world is to make good on their commitments to reduce greenhouse gas emission, then world demand for coal must inevitably fall. Given that coal prices are already low, that a significant number of coal mines have suspended operations in Australia and internationally, and that the market price for existing coal mines is as low as \$1,<sup>4</sup> the economic case for the construction of new mines is weak. The consequences of the combination of all these factors for the workers in, and the owners of, existing coal mines are quite significant.

In an environment of low coal prices and the stated commitments of 195 countries to reduce fossil fuel use, the most economically efficient policy tool for a coal exporting country like Australia is likely to be the implementation of a moratorium on the construction of new coal mines, along the lines of that called for by then President of Kiribati, Anote Tong. Such a moratorium on new coal mines would have significant benefits for the owners of existing coal mines, as it would stop the entry of new competitors to their industry. However, this paper focuses on the potential impact on

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<sup>2</sup> Hunt (2015) *National Statement – Signing Of The Paris Climate Change Agreement*, <http://www.greghunt.com.au/Home/LatestNews/tabid/133/ID/3733/National-Statement-Signing-of-the-Paris-Climate-Change-Agreement.aspx>

<sup>3</sup> IEA (2015) *Medium-Term Coal Market Report 2015*, <http://www.iea.org/bookshop/712-Medium-Term-Coal-Market-Report-2015>; The Guardian (2016) *China coal consumption drops again*, <https://www.theguardian.com/environment/2016/feb/29/china-coal-consumption-drops-again>

<sup>4</sup> Willacy (2016) *Rio Tinto's \$1 sale of Blair Athol coal mine 'puts risk back on taxpayer'*, <http://www.abc.net.au/news/2016-07-12/rio-tinto-selling-massive-queensland-coal-mine-for-dollar/7588916>; Validakis (2015) *Isaac Plains coal mine sold for \$1*, <https://www.australianmining.com.au/news/isaac-plains-coal-mine-sold-for-1/>

economic output and employment of implementing a moratorium on the construction of new coal mines in Australia.

Opponents of the introduction of a moratorium on new coal mines, such as Australian Prime Minister Malcolm Turnbull,<sup>5</sup> have sought to conflate the idea of a moratorium on new mines with the instantaneous closure of existing coal mines<sup>6</sup>. In reality though, a moratorium on the construction of new coal mines would deliver greater certainty and higher coal prices for existing coal mines. In turn, this would likely lengthen the economic life of some existing mines, and provide more time for workers and communities to plan the transition away from coal. This transition is inevitable for all mining communities, regardless of whether they have implemented policies to address climate change. Coal mines can last for decades, but by its very nature, mining relies on the extraction of a scarce resource, and thus cannot continue indefinitely.

Significantly, a moratorium provides some political benefits that other climate policies such as carbon pricing do not. For example, a moratorium on new coal mines puts upward pressure on the coal price, with the owners of the coal mine becoming the immediate beneficiaries of any price rise. The increase in price then encourages consumers to move away from coal, and reduces the cost difference between coal-fired energy and renewable energy.

Proponents of new coal mines will most likely oppose a moratorium on new coal mines, especially if they anticipate receiving significant taxpayer support for upfront infrastructure costs<sup>7</sup>. But then, it is difficult to imagine *any* policy initiative designed to reduce greenhouse gas emissions that would not be opposed by the proponents of new coal mines.

## Overview of the Australian coal industry

The coal industry in Australia produced around 437 million tonnes of coal in 2014-15, comprising 45 million tonnes for domestic consumption and 392 for export.<sup>8</sup> Australia is the second largest exporter of coal in the world (behind Indonesia) with a market

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<sup>5</sup> See Astley (1987) *You've been rolled*, <https://www.youtube.com/watch?v=dQw4w9WgXcQ>

<sup>6</sup> Tingle (2015) *Malcolm Turnbull rejects coal ban as chief scientist talks zero emissions*, <http://www.afr.com/business/energy/malcolm-turnbull-rejects-coal-ban-as-chief-scientist-talks-zero-emissions-20151026-gkj8hi#ixzz4EGPloiW>

<sup>7</sup> Australian governments routinely provide infrastructure to assist coal and other mining projects. See Peel, Denniss and Campbell (2014) *Mining the Age of Entitlement*, <http://www.tai.org.au/content/mining-age-entitlement>

<sup>8</sup> Office of Chief Economist (2016) *Resources and Energy Quarterly March 2016*, <http://www.industry.gov.au/Office-of-the-Chief-Economist/Publications/Pages/Resources-and-energy-quarterly.aspx>

share of 27% of the traded coal market.<sup>9</sup> To put the market power of Australian coal exports into perspective, Australia has a larger share of the traded coal market (27%) than Saudi Arabia has of the traded oil market (20%).<sup>10</sup> Australia's supply decisions thus have a bigger impact on the world price of coal than the Saudis' supply decisions have on the world price of oil.

In producing this coal, the coal mining industry directly employs 44,800 people,<sup>11</sup> generates export revenue of \$38 billion<sup>12</sup> and paid royalties worth \$2.9 billion in 2014-15 to state governments.<sup>13</sup> To put those figures into perspective, the coal industry directly employs 0.4% of the Australian workforce, produces 12% of Australia's exports<sup>14</sup>, and accounts for 2% of revenue for the budgets of Australia's two main coal-producing states (NSW and Queensland). While coal accounts for a significant portion of Australia's exports such an outcome is a double edged sword – the high exchange rates that accompanied the recent mining boom were directly responsible for a significant portion of reduced manufacturing, tourism and education exports and, in turn, employment in those industries.<sup>15</sup>

While the majority of coal produced in Australia is exported, a small but significant portion is produced for domestic energy production. The closure of a number of coal mines used for domestic energy production in recent years — such as Leigh Creek, Anglesea, Energybrix and Coalpac — show the small degree of economic and political disruption associated with the gradual closure of geographically dispersed mines over the medium term.

Despite the small contribution of coal mining to employment and government revenue, and the irrelevance of export volumes to state governments who have no

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<sup>9</sup> Office of Chief Economist (2014) *Resource and Energy Statistics*, <http://www.industry.gov.au/Office-of-the-Chief-Economist/Publications/Pages/Resources-and-energy-statistics.aspx>

<sup>10</sup> International Energy Agency (2015) *Key World Energy Statistics 2015*, [http://www.iea.org/publications/freepublications/publication/KeyWorld\\_Statistics\\_2015.pdf](http://www.iea.org/publications/freepublications/publication/KeyWorld_Statistics_2015.pdf)

<sup>11</sup> ABS (2016) 6291.0.55.003 - *Labour Force, Australia, Detailed, Quarterly, May 2016*, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/6291.0.55.003May%202016?OpenDocument>

<sup>12</sup> Office of Chief Economist (2016) *Resources and Energy Quarterly March 2016*, <http://www.industry.gov.au/Office-of-the-Chief-Economist/Publications/Pages/Resources-and-energy-quarterly.aspx>

<sup>13</sup> NSW Treasury (2016) *Budget Paper No. 1: Budget Statement*, [http://www.budget.nsw.gov.au/\\_data/assets/pdf\\_file/0003/128568/Budget\\_Paper\\_1\\_Budget\\_Statement\\_revised.pdf](http://www.budget.nsw.gov.au/_data/assets/pdf_file/0003/128568/Budget_Paper_1_Budget_Statement_revised.pdf); Queensland Treasury (2016) *Budget Paper No.2 Budget Strategy and Outlook*, <https://s3-ap-southeast-2.amazonaws.com/s3-media-budget/pdfs/budget+papers/bp2/Appendix%20C%20-%20Revenue%20and%20expense%20assumptions%20and%20sensitivity%20analysis.pdf>

<sup>14</sup> ABS (2016) 5368.0 *International Trade in Goods and Services, Australia*, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/5368.0May%202016?OpenDocument>

<sup>15</sup> For discussion of this see Tulip (2014) *The Effect of the Mining Boom on the Australian Economy*, <http://www.rba.gov.au/publications/bulletin/2014/dec/pdf/bu-1214-3.pdf>

role in managing the exchange rate, claims about the ‘centrality’ of coal mining to various state governments have been made repeatedly. For example:

We like to romanticise the complexities and sinews of our economy but we really have a very simple business plan – we survive on the charges we raise to allow people to dig up black rocks and red rocks: coal and iron ore.<sup>16</sup>

*Barnaby Joyce, now Deputy Prime Minister of Australia, National Party*

We are in the coal business. If you want decent hospitals, schools and police on the beat we all need to understand that.<sup>17</sup>

*Campbell Newman, former Queensland Premier, Liberal-National Party*

[Proposals to] not approve any further coalmines [are]...just simply preposterous, they would spell economic and social catastrophe for Queensland and the national economy...<sup>18</sup>

*Anna Bligh, former Queensland Premier, Labor Party*

This disconnect between the actual and perceived size of the coal industry has the potential to create a barrier to the implementation of policies aimed at reducing global greenhouse gas emissions — policies such as a moratorium on new coal mines.

One of the most commonly used arguments by those who maintain that the economic significance of coal mining is greater than that suggested by the Australian Bureau of Statistics is that ‘indirect’ jobs associated with the coal industry are far larger than the official employment statistics suggest. While there is no doubt that coal mining does create ‘upstream’ jobs in manufacturing and financial services, and also ‘downstream’ jobs in retail, there is also no doubt that the same is true for all activity in all industries.

The construction of schools, hospitals and bank branches, for instance, also create ‘upstream’ jobs in construction and ‘downstream’ jobs in retail. When the existence of ‘indirect’ jobs in other industries is taken into account the relative size of the mining industry remains largely unchanged — indeed, it is only when the indirect jobs associated with the mining industry are estimated and the indirect jobs from other industries are ignored that the relative size of the mining industry is enhanced. While it is obvious why those interested in inflating the size of the mining industry would undertake such a selective analysis, it is not clear why politicians and policy makers would take their claims seriously.

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<sup>16</sup> Franklin (2011) *Anna Bligh warns of 'radical' Greens*, <http://www.theaustralian.com.au/national-affairs/anna-bligh-warns-of-radical-greens/story-fn59niix-1226063021965>

<sup>17</sup> News.com.au (2012) *“We”re in the coal business’: Campbell Newman slams UNESCO Great Barrier Reef warning*; <http://www.news.com.au/national/unesco-slams-great-barrier-reef-management-youve-got-eight-months-to-fix-it/story-e6frfkwo-1226381188474>

<sup>18</sup> Gillard & Bligh (2011) *Transcript of joint press conference, Gladstone*, [http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Source%3A%22PRIME%20MINISTER%22%20Author\\_Phrase%3A%22bligh,%20anna%22;rec=3](http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Source%3A%22PRIME%20MINISTER%22%20Author_Phrase%3A%22bligh,%20anna%22;rec=3)



This discussion of the economic context of Australian coal largely ignores its substantial impacts on human health and the natural environment. The coal industry produces dust and air quality impacts that are damaging to human health at all stages of production, transport and consumption. Its impacts on water resources have regularly brought it into conflict with agriculture and residents whose drinking water is impacted. Many endangered ecological communities are destroyed by coal mines, with these impacts mitigated only by 'biodiversity offset' schemes widely considered dubious by ecologists.<sup>19</sup>

Such impacts are generally not considered in economic modelling and are not a focus of this paper. Where these impacts are considered, the economic case for coal becomes extremely weak. Well known American economists have estimated that the external costs of coal-fired power generation outweigh its financial value by almost 6:1, largely based on air quality impacts.<sup>20</sup>

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In order to better understand the direct, and indirect, effects of a gradual winding down of coal production in Australia, this paper presents the results of a Computable General Equilibrium (CGE) modelling exercise undertaken by the Centre of Policy Studies at Victoria University.

Like any modelling exercise, the CGE modelling results presented below are constrained by the assumptions upon which the model is based. These assumptions are spelt out in detail below and more fully in the attached report by Victoria University's Professor Philip Adams. While no model perfectly captures the long run dynamics of a rapidly changing economy that is incorporating new technologies and production processes into its economy, the key assumptions and parameters used to generate the results presented below are in line with the assumptions that are typically made by firms seeking to demonstrate the 'significance' of new mines to the economy.

This paper is the first attempt to model the impacts of what is effectively a phase-out of the Australian coal industry using a CGE model and data on Australia's current coal mine approvals.

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<sup>19</sup> See for example Bekessy et al (2010) *The biodiversity bank cannot be a lending bank*, <http://onlinelibrary.wiley.com/doi/10.1111/j.1755-263X.2010.00110.x/abstract>

<sup>20</sup> Muller, Mendelsohn and Nordhaus (2011) *Environmental Accounting for Pollution in the United States Economy*, <https://www.aeaweb.org/articles?id=10.1257/aer.101.5.1649>

# Modelling approach and key assumptions

The model used in this report is a Computable General Equilibrium (CGE) model. CGE models attempt to quantify the interrelationships between different parts of the economy and the likely response of different parts of the economy to different policy shocks. At the heart of a CGE model are the 'Input-Output tables' compiled by the Australian Bureau of Statistics (ABS). These Input-Output (IO) tables provide highly detailed data on the demand for goods and services associated with any change in the output of any industry. For example, all CGE models contain estimates of how much agricultural output is sold to the hospitality and retail sectors and how much manufactured equipment and fertilizers are purchased by agricultural producers. Similarly, these models contain estimates of how much coal is sold to the electricity sector and how much electricity the coal industry buys for its own use.

The Australian Bureau of Statistics publishes its estimates of these relationships in its "input-output tables". These tables provide the foundational assumptions of all CGE models in Australia, as well as many other types of model. The input-output tables use historic data on the relationship between the demand for products and the demand for the factors of production (e.g. labour, capital, raw material, intermediate goods, and so on) required to produce those products.

For example, the input-output tables provide reliable estimates of the linkage between car production in Australia and steel use by the car industry. It is important to note, however, that when technological change in an industry is occurring rapidly, the historic relationship between production and raw material use may have little predictive power (for example, as reliance on renewable energy increases, the historic relationship between the demand for electricity and the consumption of coal will change significantly).

While the ABS IO tables provide data on the historic linkages between industries and factors of production CGE models attempt to estimate the responsiveness of these relationships to changes in variables such as wage rates, tax rates and productivity growth. For example, when wage rates rise, the assumptions in CGE models allow the modeller to estimate the likely impact of such an increase on the supply of labour, the demand for labour, the level of new investment, and the impact on income tax revenue.

A key point to note about CGE models is that they include ‘resource constraints’. This means that the model acknowledges that there is not an infinite amount of land, labour, water and other resources that can be used by any industry or project. While everyone in the real world realises that Australia and the world have finite amounts of these resources, factoring this into economic models complicates them to some degree.

This has two effects. Firstly, it makes models slightly more expensive. Secondly, having resource constraints reduces the size of the model’s estimates of job creation and other beneficial effects. Both of these factors tend to push modellers and their clients towards less accurate models without resource constraints.

A well-publicised example of modelling with and without resource constraints is the economic models commissioned by energy company Adani to assess its Carmichael mine. Its original economic assessment was based on a model with no resource constraints, which estimated the project would create 10,000 jobs. A second assessment prepared for a court case over the mine’s approval used a CGE model with resource constraints. The CGE model estimated the project would result in 1,464 more people being employed, just 15% of the earlier estimate.<sup>21</sup>

Once a CGE model has been created with estimates of interrelationships in the economy, it can estimate the likely response of the economy to some sort of change (known as a “shock” in modelling jargon). In the paper below, the shock to the model is to implement a policy of building no new coal mines in Australia. The model then allows for an examination of direct and indirect effects of an Australian economy with no new mines when compared to an Australian economy with new coal mines continuing to be built.

When modelling a policy ‘shock’, an increase in the relative price of a product (e.g. electricity) or the availability of a resource (e.g. coal) is “imposed” on the model by the modeller. The strength of the pre-existing relationships between other elements of the economy then determine how the rest of the economy is likely to “respond” to such a shock.

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<sup>21</sup> Media coverage in Branco (2015) *Adani Carmichael mine to create 1464 jobs, not 10,000* <http://www.brisbanetimes.com.au/queensland/adani-carmichael-mine-to-create-1464-jobs-not-10000-20150427-1mumbg.html> original assessment in GHD (2013) *Carmichael Coal Mine and Rail Project SEIS Report for Economic Assessment*, <http://eisdocs.dsdp.qld.gov.au/Carmichael%20Coal%20Mine%20and%20Rail/SEIS/Appendices/Appendix-E-Economic-Assessment-Report.pdf>, report for Queensland Land Court in Fahrer (2015) *Carmichael coal and rail project: economic assessment*, <http://envlaw.com.au/wp-content/uploads/carmichael43A.pdf>

For example, the decision to cease building new coal mines will have direct effects on the number of people employed in the construction of new coal mines and, in turn, indirect impacts on the output and employment of industries that supply materials (for example concrete, metal fabrication, earth moving) to coal mine construction.

Just as unconstrained input-output models exaggerate the benefits of building coal mines by assuming that all new jobs are provided to previously unemployed workers and have no impact on raw material prices, input-output models also exaggerate the adverse impact of not building a new mine (or other major project). While it is true that the abandonment of a mine project will result in reduced demand for intermediate inputs, it is not true that all of those resources will lay idle. Indeed, the purpose of a CGE model is to help identify how and where resources that are not utilised by a new coal mine would most likely be utilised elsewhere in the economy.

A key element of CGE models is that as the demand for labour from coal mines declines that same labour becomes available for 'redistribution' to other industries. Indeed, as the mining boom emerged as a big employer, most of the skilled labour it employed was 'redistributed' from existing manufacturing and construction activities.

The rate at which labour can move from one industry to another, or from one region to another, is a major source of controversy when interpreting economic modelling. While assumptions about the rate at which workers displaced from a mine might be reemployed in other industries after sudden closure, for example, are central to the plausibility of modelling claims about the employment impact of the sudden introduction of a carbon price. Such assumptions are, however, less significant when considering the gradual phase-out of coal mining as mines run out of coal at a predictable rate. The long timelines and geographic dispersal involved reduce the prospects of a large surge in employees with near identical skills entering a small regional labour market all at once.

To conclude, all models are only as reliable as their assumptions are reasonable. The key assumptions for the COPS CGE model and the details of the specific coal phase-out are provided in the following sections and the full documentation of the COPS model is described in the appendix and also on the CoPS website.<sup>22</sup>

As the following sections show, the gradual phasing out of the coal industry via the introduction of a moratorium on the construction of new coal mines has a very small impact on the Australian economy. This result, while inevitably dependent on assumptions, is robust for a number of reasons:

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<sup>22</sup> Centre of Policy Studies (nd) VURM, <http://www.copsmodels.com/mmrf.htm>

- a) The coal industry is small and the phase-out is gradual ensuring that large pools of labour are not released into the labour market at once.
- b) The coal industry employs workers with higher than average skills, which reduces the chance that workers who do become unemployed will remain in that state for a lengthy period of time.
- c) As coal mines are assumed to close down when they run out of coal, the closure dates will be well known in advance, giving both workers and communities a lot of time to adjust.
- d) The rapid and unplanned closure of coal mines currently taking place due to low market prices will likely impose greater costs on workers, owners and communities. To the extent that a moratorium helps prevent further oversupply of coal, it would lead to reduced unemployment.

A final key point to note about CGE models is that they take little account of environmental impacts. While the CoPS model includes assessment of the direct greenhouse gas emissions of industries, CGE models in general take no consideration of the impacts on water resources, air quality and therefore on human health. These 'external costs' can have significant economic costs, meaning that CGE models tend to overstate the case for coal mining and any project with environmental and health impacts.

## KEY ASSUMPTIONS

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### Reference case

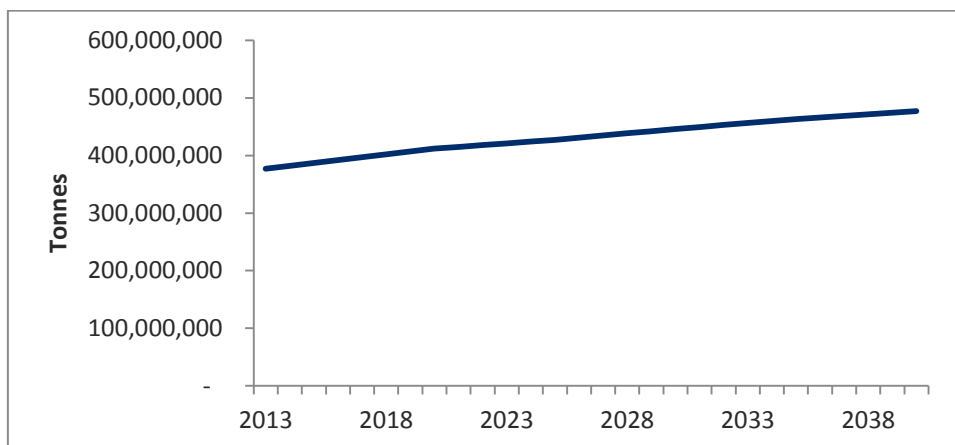
#### *Coal production assumptions*

Under the reference case, we assume that Australia continues to approve new coal mines and expansions for existing mines. Production is assumed to follow the International Energy Agency (IEA)'s estimate for Australian coal production.<sup>23</sup> As shown in Figure 1 below, under the IEA's central scenario Australian coal production increases from 377 million tonnes in 2013 to 477 million tonnes in 2040:

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<sup>23</sup> IEA (2015) *World Energy Outlook*, <http://www.worldenergyoutlook.org/weo2015/>. See page 282, Table 7.4, Coal production by region in the New Policies Scenario.

**Figure 1: Australian coal production in World Energy Outlook 2015**



Source: IEA (2015) World Energy Outlook, Coal production by region in New Policies Scenario.

The IEA provides estimates only for Australian production in only 2013, 2020 and every five years beyond 2020. We have assumed straight line growth between these points. This assumption slightly understates current coal production and production in the early years of the model, as the IEA's forecast levels of production were exceeded in 2015. In the model, reference case volumes have been adjusted above IEA estimates to reflect actual production of over 400 million tonnes in initial years.

### ***General modelling assumptions***

Other important assumptions within the model include the following points. More detailed explanation is found in the Appendix.

- Real GDP grows at an average annual rate of 3.0% over the period 2015 to 2020, slowing to an average rate of 2.6% for 2020 to 2040.
- In line with recent history, the export-oriented states – QLD and WA – are projected to be the fastest growing regions, followed by NSW and VIC. SA and TAS are assumed to be the slowest growing regions. The assumption that QLD and WA will continue to grow fastest — based on growth rates from the mining boom era — may serve to overstate the impacts of a moratorium. If the growth rates of these states revert to national averages or below, our reference case will overstate their business-as-usual growth and, in turn, overestimate the adverse impact of introducing a moratorium on new coal mine construction.
- Real national private consumption grows at an average annual rate similar to that of real GDP.
- The regional pattern of growth for consumption is also similar to that for GDP: that is, consumption growth is fastest in QLD and WA, and slowest in TAS and SA.

- On average, trade volumes grow relative to GDP by about 1.5% annually, but unlike recent history, import growth is projected to be in line with export growth.
- Australia's terms of trade are assumed to return to a historically normal level by 2017 and remain at that level thereafter.

## Policy scenario - no new coal mines approved in Australia

### *Coal production assumptions*

To model a policy of no new coal mine construction in Australia, we need to estimate how coal production would decline under the policy, compared to what would happen under a reference case where no moratorium was imposed. To do so, we compiled a list of all coal mines in NSW and Queensland, based on state government sources.<sup>24</sup> There were a total of 111 coal mines in these states - 58 in NSW and 53 in Queensland that had produced coal in 2014. In total they produced 435 million tonnes of coal in that year.

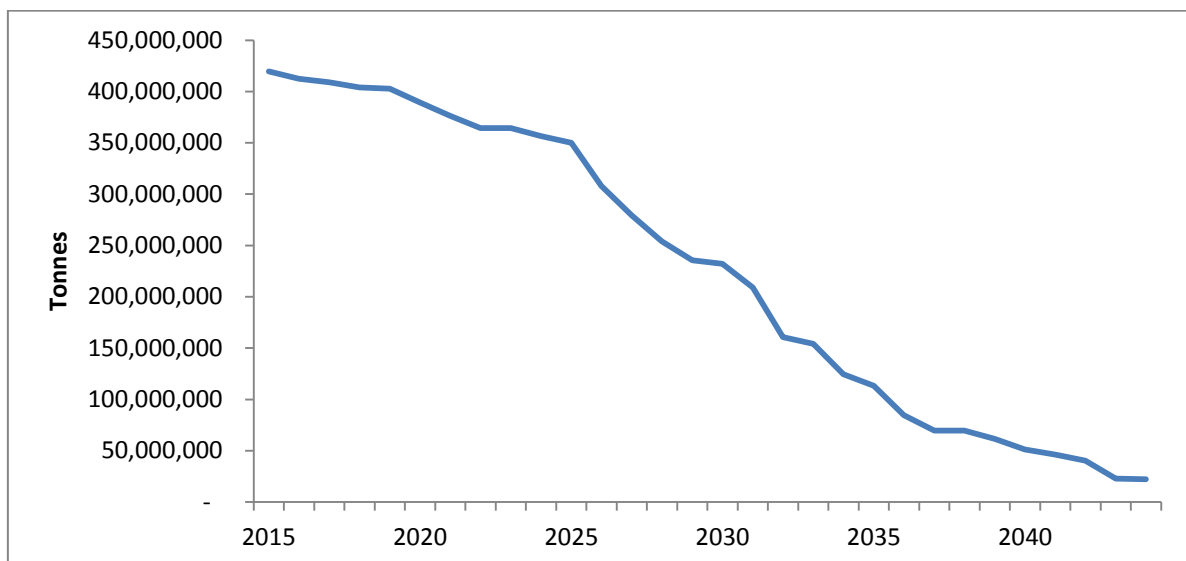
We assessed whether each mine's production in 2014 was typical of its recent and planned levels of production, based on company and regulator sources. For example, the largest coal mine in NSW is the Mount Arthur mine, owned by BHP Billiton. In 2013-2014 its production was 19.9 million tonnes, according to the NSW Division of Resource and Energy. While the mine has over 1 billion tonnes in reserves and approval to mine up to 32 million tonnes of raw coal per year, according to the company's website, 16 million tonnes per year is more likely to be the longer term average saleable production.

Mines usually reduce production before closing completely. Each mine is assumed to ramp down production to 50% and then 25% of approved capacity in the final years of its approval. These assumptions would result in Australia's coal production declining steadily from over 400 million tonnes at present to zero in 2044, as shown in Figure 2 below:

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<sup>24</sup> NSW Division of Resource and Energy (2014) *Coal Industry Profile*; Queensland Department of Natural Resources and Mines (2015) *Queensland coal – mines and advanced projects*

**Figure 2: NSW and Queensland coal production - No new coal mines**



Sources: TAI analysis, NSW Division of Resource and Energy (2014) *Coal Industry Profile*; Queensland Department of Natural Resources and Mines (2015) *Queensland coal – mines and advanced projects*

It is important to note that we assume approved coal mines continue to operate and do not suspend operations at any stage. Coal mines sometimes suspend operations when prices are too low for them to operate profitably, often referred to as ‘care and maintenance’. While this assumption could work to overstate the quantity of coal produced in some periods, as Australian production represents around 27% of global seaborne coal supply,<sup>25</sup> this reduction in supply will place upward pressure on coal prices, which would in turn assist mines with approved capacity to continue producing. We also note that the economic assessments of approved mines, without exception, assume that mines will not suspend operations until resources are exhausted.

It is difficult to directly set the level of coal production in a CGE model. This is because coal production is estimated by the model based on many factors, rather than the model estimating other factors based on policy-induced changes in coal production.

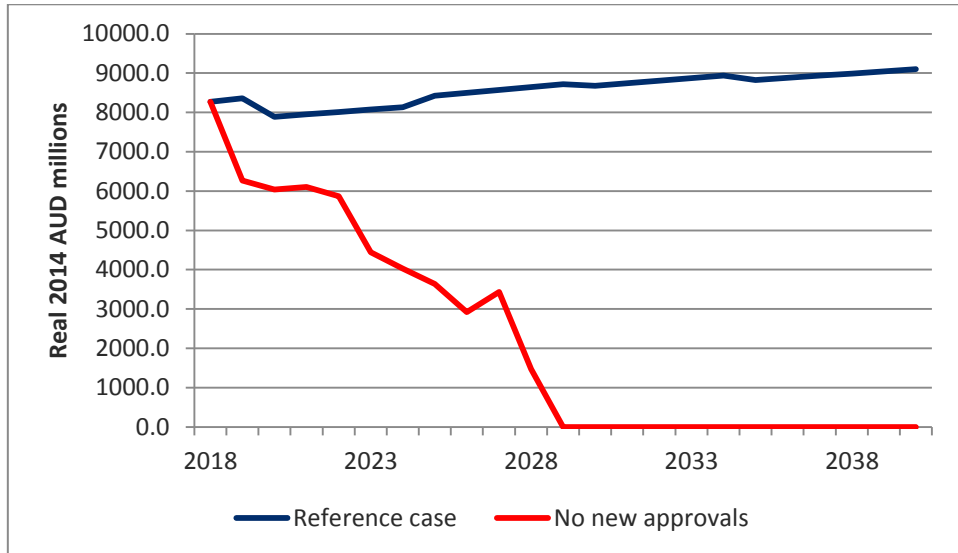
A key factor that determines coal production in CGE models is level of investment in the coal industry. To approximate coal production, in both the modelled reference case and the no new coal mines case, it was necessary to adjust the projected level of investment allocated to the coal industry. These estimates were derived by adjusting levels of real net investment in coal mining in NSW and Queensland. Real net

<sup>25</sup> Based on Office of Chief Economist (2014) *Resource and Energy Statistics*, <http://www.industry.gov.au/Office-of-the-Chief-Economist/Publications/Pages/Resources-and-energy-statistics.aspx>



investment in the reference case grows gradually, while dropping sharply under a moratorium, as shown in Figure 3 below:

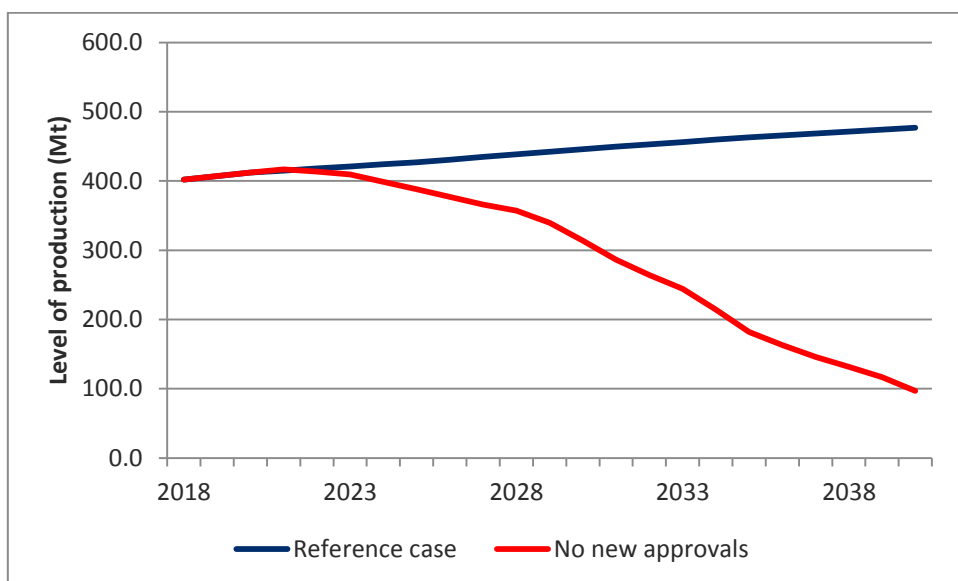
**Figure 3: Real Net Investment in the QLD and NSW coal industries, reference case and No new approvals scenarios (\$m, 2014 prices)**



Source: CoPS model

Adjusting real net investment in the model as shown in Figure 3 gives coal production estimates close to those estimated by the IEA and our analysis of coal approvals in Figure 2. The comparison between the two modeled coal production scenarios is shown in Figure 4 below:

**Figure 4: Production of Coal in QLD and NSW, reference case and no new approvals scenarios (Mt)**



Source: CoPS model

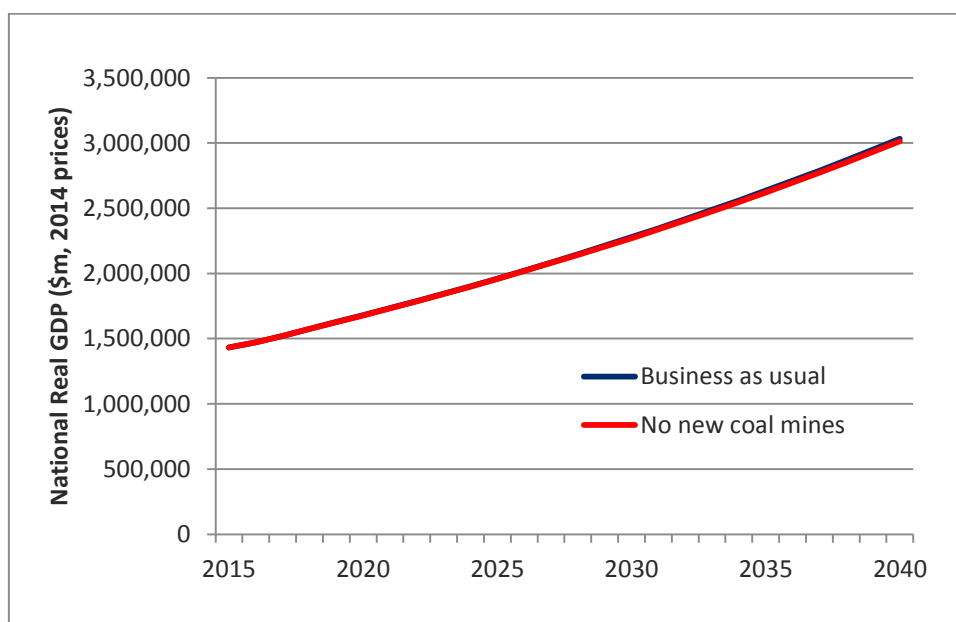
As a result of setting production levels in the model through changing levels of investment, production levels in Figure 4 do not precisely match those in Figures 1 and 2 in the initial years. These differences are small compared to the differences between the two modelled scenarios, however, and this initial difference is not likely to be important in examining the differences in economic output and employment. The differences in these economic indicators between the reference scenario and the no new coal mines scenario under the CoPS model are presented in the next section.

# Results - Australia

## AUSTRALIAN GROSS DOMESTIC PRODUCT

The total GDP for Australia in 2015 is about \$1.6 trillion.<sup>26</sup> The coal mining industry makes up only 1.2% of GDP, or \$18.8 billion.<sup>27</sup> Put another way, 98.8% of Australia's GDP comes from industries other than coal mining. Given that coal mining comprises such a small share of total GDP, it is not surprising that the gradual effect of a moratorium on new coal mines has minimal impact on GDP. The CoPS modelling estimates the impact of a moratorium on new coal mines and the results are shown in Figure 5.

**Figure 5: Impact on GDP from introducing a moratorium on new coal mines**



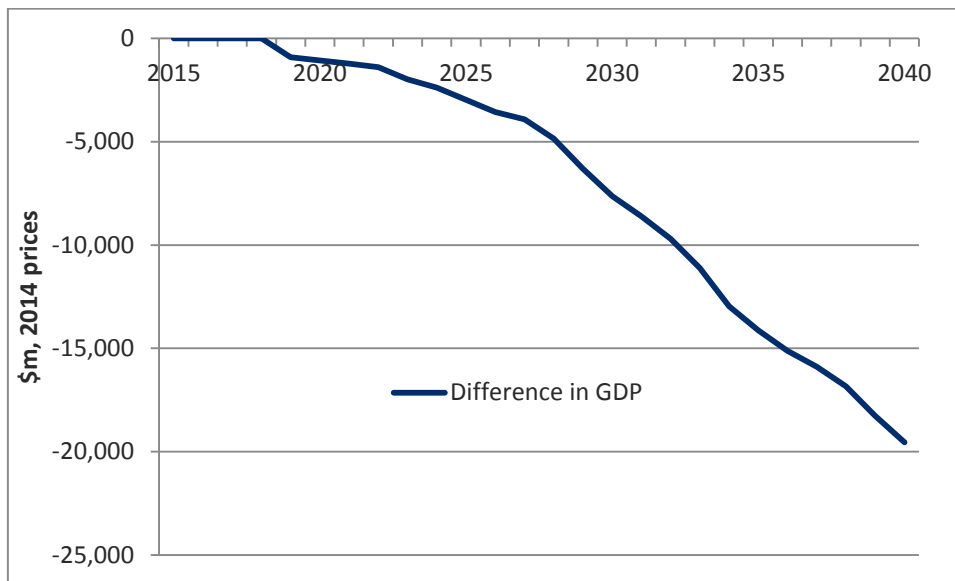
Source: CoPS model

Figure 5 shows that the effect of a moratorium on GDP growth is barely discernible, and highlights the fact that preventing new coal mines will have only a tiny impact on GDP. In order to get a closer look at the actual effect we can focus in on the difference from the no new coal mines case and the business as usual case, shown in Figure 6.

<sup>26</sup> ABS (2015) 5204.0 - Australian System of National Accounts, 2014-15, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/ProductsbyCatalogue/110953FFA28D4E52CA2572110002FF03?OpenDocument>

<sup>27</sup> *ibid*

**Figure 6: Difference in GDP from base case and no new coal mines case**



Source: CoPS model

Figure 6 shows the difference between the base case and the no new coal mines case. While a \$20 billion reduction in the size of GDP by 2040 may seem large, it is important to place it in the context of the fact that total GDP is projected to be some \$3,000 billion by that time. By way of illustration, the difference the loss in GDP due to a moratorium is equivalent to someone who earns a salary of \$100,000 per year today seeing their salary grow to \$210,393 in 2040 instead of \$211,694.

Figure 6 also shows that a moratorium on new coal mines has almost no impact in the early years. This is important as it allows the economy, and individual employees, to plan ahead and adjust slowly, which reduces both the social and economic impact of the policy change.

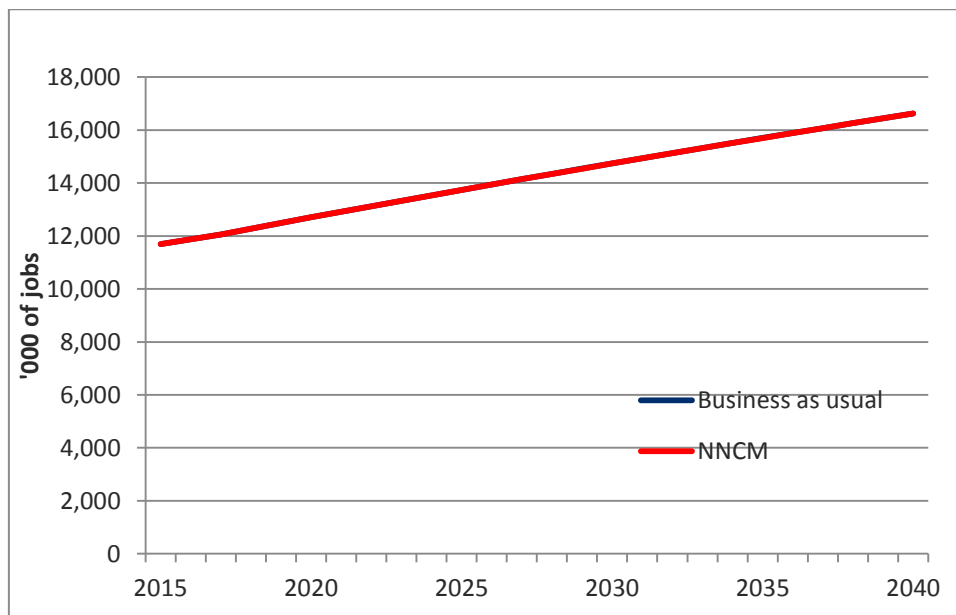
One of the reasons for the small economic impact of a moratorium is the effect of 'crowding in'. This is where the reduction of resources going to coal mining frees up resources to be used in other industries. The mining industry has negative as well as positive impacts on other industries, and a reduction in coal mining therefore also reduces the negative impacts on other industries. Put simply, the macroeconomy adjusts and expands activity in other areas while coal mining contracts.

As discussed above, no consideration is made here of the environmental and social costs of coal production such as impacts on water resources, air quality and local communities. If the full environmental costs of coal were considered the case for a moratorium on new mines would be stronger still.

## AUSTRALIAN EMPLOYMENT

The number of people employed in Australia is estimated to grow at an average rate of 1.4% over the next 25 years under both the base case and the no new coal mines case. As Figure 7 shows the two scenarios are almost indistinguishable.

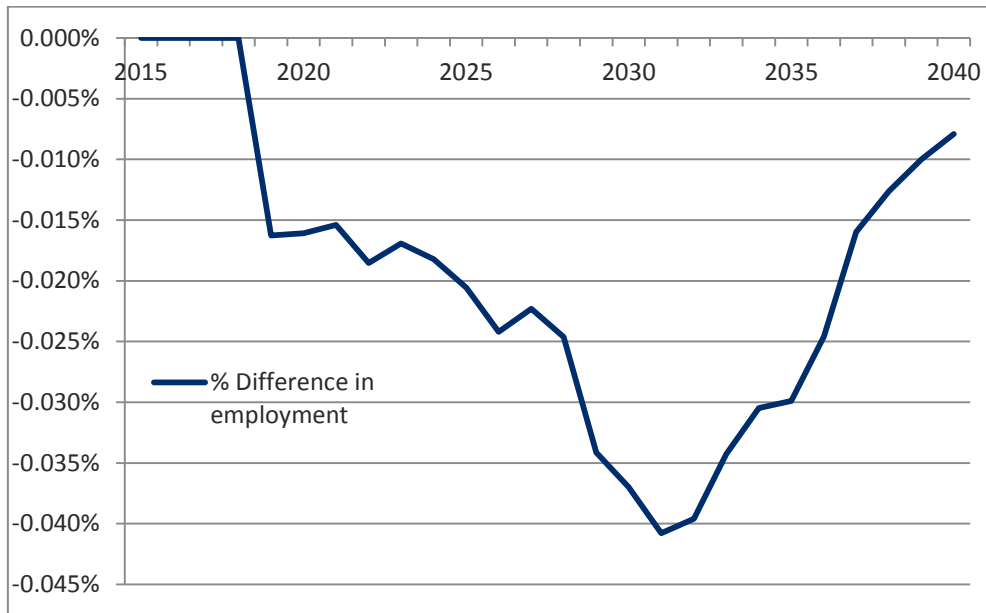
**Figure 7: Impact on employment from introducing a moratorium on new coal mines**



Source: CoPS model

In the graph above, the two lines merge almost into one. The raw data behind the graph shows that the difference in 2040 is just 1,400 jobs out of total employment of almost 17 million. This represents a difference in number of people employed of 0.01%. Figure 8 looks more closely at the small difference between employment growth in the business as usual and no new coal mine cases.

**Figure 8: Difference in GDP from base case and no new coal mines case**



Source: CoPS model

The fall in employment at its greatest is only 0.04%. It falls initially as existing mines run out of coal, but at the same time the economy adjusts and employment growth in other industries increases. By 2040 total employment is almost back at the same point it would have been in the business as usual case.

By way of context, the coal industry has already shed 20,000 jobs in recent years as a result of the lower price of coal.<sup>28</sup> While all involuntary unemployment has adverse impacts on households and regions, there is no guarantee that if Australia continues to build coal mines that involuntary unemployment will not strike large numbers of Australians.

## EXPORTS

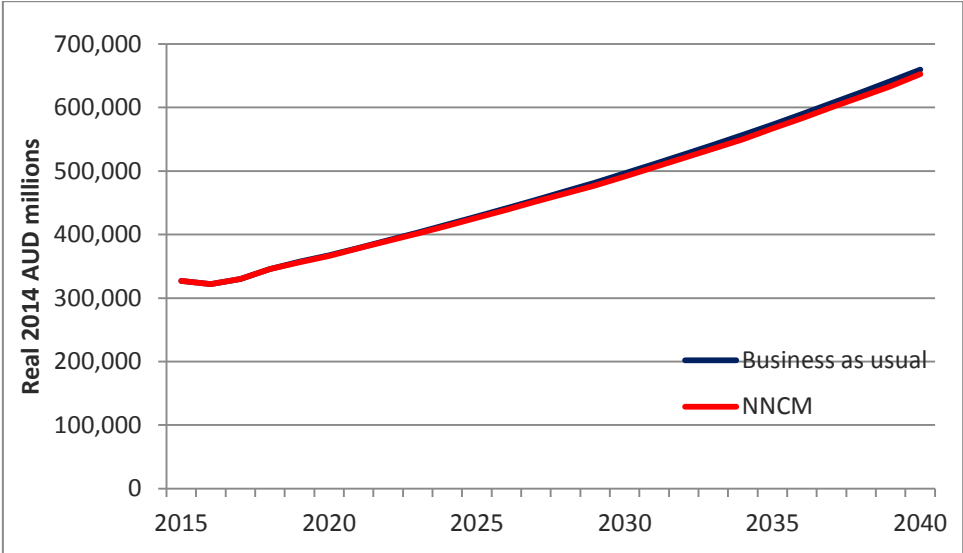
It is often argued that coal is important to the Australian economy because it is a substantial export earner. Coal exports have accounted for about 12% of Australia's total exports over the last five years.<sup>29</sup> However, Australia's mineral exports also have a significant negative impact on non-mineral exports, most notably by driving up the value of the exchange rate. A moratorium on new coal mines will gradually decrease

<sup>28</sup> ABS (2016) 6291.0.55.003 - *Labour Force, Australia, Detailed, Quarterly, May 2016*, [www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/6291.0.55.003May%202016?OpenDocument](http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/6291.0.55.003May%202016?OpenDocument)

<sup>29</sup> ABS (2016) 5368.0 *International Trade in Goods and Services, Australia*, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/5368.0May%202016?OpenDocument>

coal exports, but it will also remove the negative impacts including crowding out of other exports. The final impact on exports will be very small, as shown in Figure 9.

**Figure 9: Impact on exports of introducing a moratorium on new coal mines**



Source: CoPS model

# State and regional results

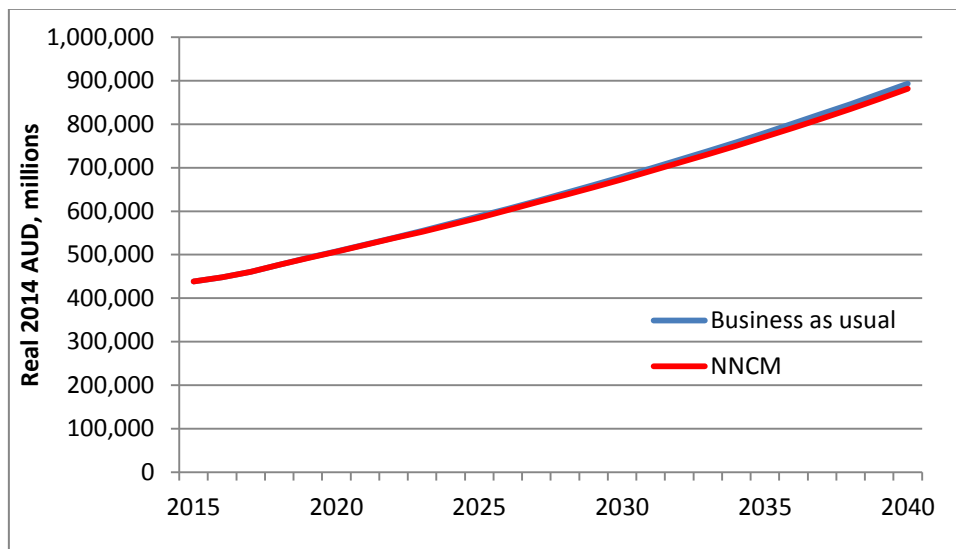
As reported above, the economic impacts of a moratorium on new coal mines and major expansions are minimal in the context of the Australian national economy. The CoPS model also provides estimates of economic impacts at state and regional levels. In this section we present the model results for Australia’s key coal producing states, NSW and Queensland, and their key coal mining regions.

## NEW SOUTH WALES

### GSP

NSW Gross State Product is currently around \$500 billion dollars per year.<sup>30</sup> The entire mining industry, including non-coal mining, accounts for just under \$11 billion of this, or around 2 percent. Given the relatively small size of all mining in the NSW state economy, it is not surprising that the gradual effect of a moratorium on new coal mines would have minimal impact on the state economy, as shown in Figure 10 below:

**Figure 10: NSW Gross State Product, business as usual vs no new coal mines**



Source: CoPS model

<sup>30</sup> ABS (2015) 5220.0 - Australian National Accounts: State Accounts, 2014-15, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/5220.02014-15?OpenDocument> Note that the actual GSP figures as reported by the ABS to date are higher than are forecast and assumed in the CoPS model. More important than the absolute figures, however, is the difference between the two scenarios.

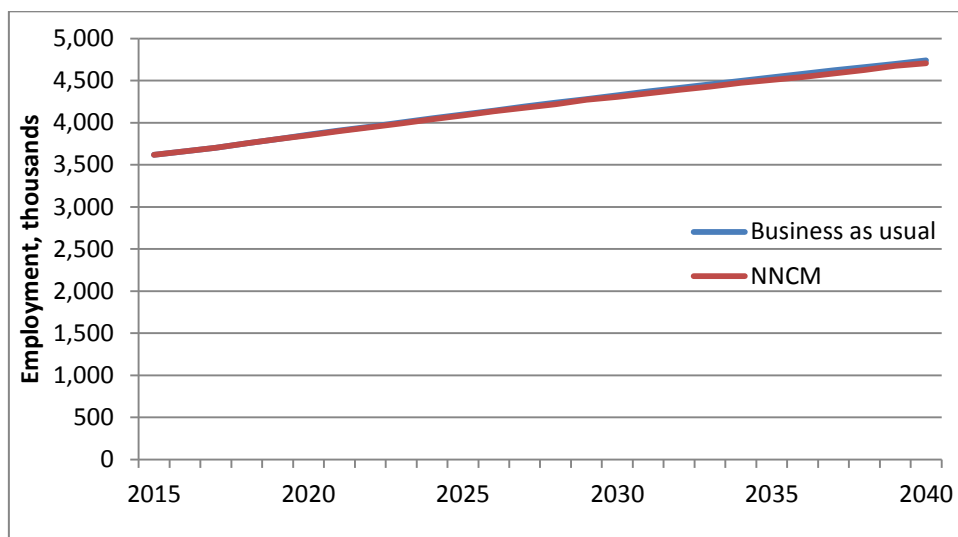


Figure 10 shows that in both cases NSW GSP grows to just under \$900 billion in 2040. The difference between the two cases reaches 1% of GSP in 2033 at \$7.7 billion and 1.3% of GSP or \$11.5 billion in 2040.

### **NSW employment**

Similarly, coal mining accounts for less than 1% of employment in NSW, 32,500 jobs out of a total of 3.8 million. This means that a gradual transition away from coal mining has minimal impact on NSW employment, as shown in Figure 11 below:

**Figure 11: NSW employment, business as usual vs no new coal mines**



Source: CoPS model

In both cases NSW employment reaches 4.7 million in 2040, with a difference of around 30,000, or 0.7%, in the final years of the modelled estimates. It is important to note that this does not mean that more people are unemployed in NSW; rather, the number of employed people in the state has not grown as much. Other states will experience higher growth, as discussed further below.

### **Hunter region**

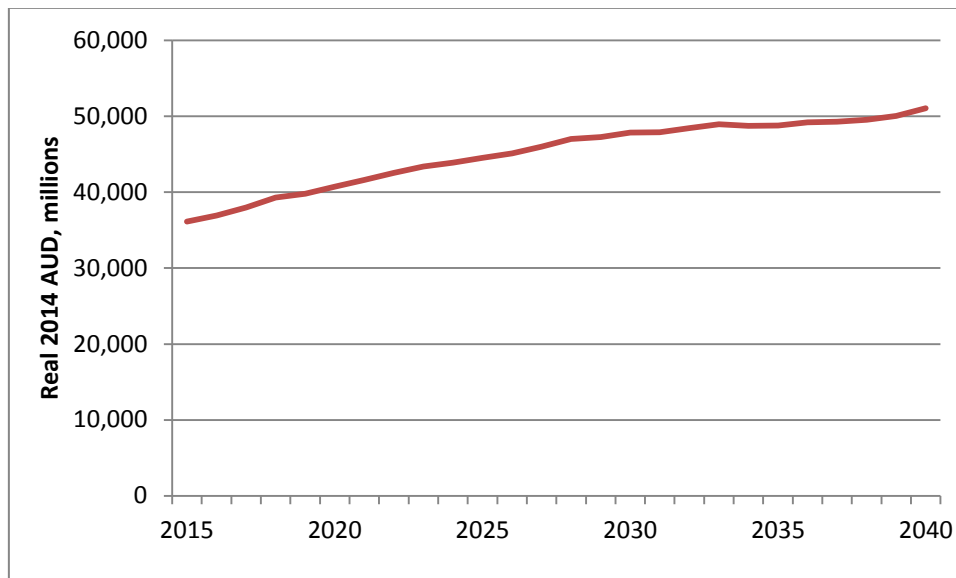
A moratorium on new coal mines would have differing effects on different regions of NSW. Analysis of regional economies is difficult due to limited local level economic data and the mobility of resources and labour between regions, and the NSW Treasury advises caution in interpreting estimates of regional economic output.<sup>31</sup> Most environmental impacts are ignored in CGE modelling, but are felt most keenly at a local level. Ignoring effects on water resources and air quality can heavily overstate the case for the coal industry at a local level.

Keeping these issues in mind, the CoPS model does nevertheless allow for regional estimates to be made.

<sup>31</sup> NSW Treasury (2007) *NSW Government Guidelines for Economic Appraisal*, [http://www.treasury.nsw.gov.au/\\_data/assets/pdf\\_file/0016/7414/tpp07-5.pdf](http://www.treasury.nsw.gov.au/_data/assets/pdf_file/0016/7414/tpp07-5.pdf)

The Hunter Valley is the main coal producing region in NSW and the region likely to be most affected by a phase-out of coal mining. However, even in the Hunter the CoPS model suggests economic growth throughout the modelling period, as shown in Figure 12 below:

**Figure 12: Hunter region gross regional product under no new coal mines**



Source: CoPS model

Figure 12 shows that even with a moratorium on new coal mines, the Hunter economy is estimated to grow from a gross regional output of \$37 billion dollars in 2016 to over \$50 billion dollars in 2040. The continued growth of the Hunter under a policy of no new coal mines is a result of the region's diverse economy. While the region produces most of NSW's coal, it also includes the major city of Newcastle and a range of industries — coal mining accounts for only five percent of employment.<sup>32</sup>

On average, the projected growth in the Hunter region's economy under a moratorium represents a growth rate of 1.2% per year. This is slower than the 2.8 percent growth rate estimated for NSW as a whole, reflecting that the coal industry is a relatively significant part of regional economic production. It is important to note that estimates of gross regional product, like gross national product or gross state product, measure the output of the region, rather than its income. As most coal companies in the Hunter are owned by foreign corporations, or shareholders who live outside of the Hunter, lower economic output as measured through gross regional product has little effect on the economic welfare of Hunter residents. That is, while all of the profit associated with coal production in the Hunter is attributed to Hunter Valley production, in reality most of the profits from Hunter coal mines flow to either foreign owners of Hunter coal mines or Australian shareholders who live outside the Hunter.

<sup>32</sup> Campbell (2014) *Seeing through the dust: Coal in the Hunter Valley economy*, <http://www.tai.org.au/content/seeing-through-dust-coal-hunter-valley-economy>

One aspect of economic welfare is environmental amenity and impact on human health. The required expansion of coal mining operations that the reference case would require is likely to impose such costs on the Hunter community, and these costs are not reflected in the model estimates. A 2014 survey of Hunter residents found that 47% felt that the economic benefits of coal mining do not outweigh the effects of the industry on health, the environment and other industries. 35% felt economic impacts did outweigh these effects, with the remainder unsure.<sup>33</sup>

No estimate of change in Hunter employment is made in the available CoPS model data. As with estimates of economic output, estimating impacts in smaller regional economies is difficult, and the difficulty is compounded by workers' ability to move between regions. It is likely that employment would follow broadly similar trends to economic output, although coal mining is "capital intensive" — meaning it uses a lot of machinery but relatively few workers — and its decline is likely to be somewhat offset by growth in more labour intensive industries in the region. Most industries are more labour intensive than coal mining.

Overall, these results suggest that NSW would experience minimal economic impact from a moratorium on new coal mines. While the Hunter Valley region would experience a lower rate of growth of economic output than the state overall, it would still increase output and likely levels of employment.

## QUEENSLAND

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### *GSP*

Queensland's Gross State Product is currently just over \$300 billion dollars per year.<sup>34</sup> The entire mining industry, including non-coal mining, accounts for just under \$22 billion of this, or around 7%.<sup>35</sup> Given the relatively small size of all mining in the Queensland state economy, and the fact that the state also has significant quantities of bauxite and other minerals being mined, it is not surprising that the gradual effect of a moratorium on new coal mines would have minimal impact on the state economy, as shown in Figure 13 below:

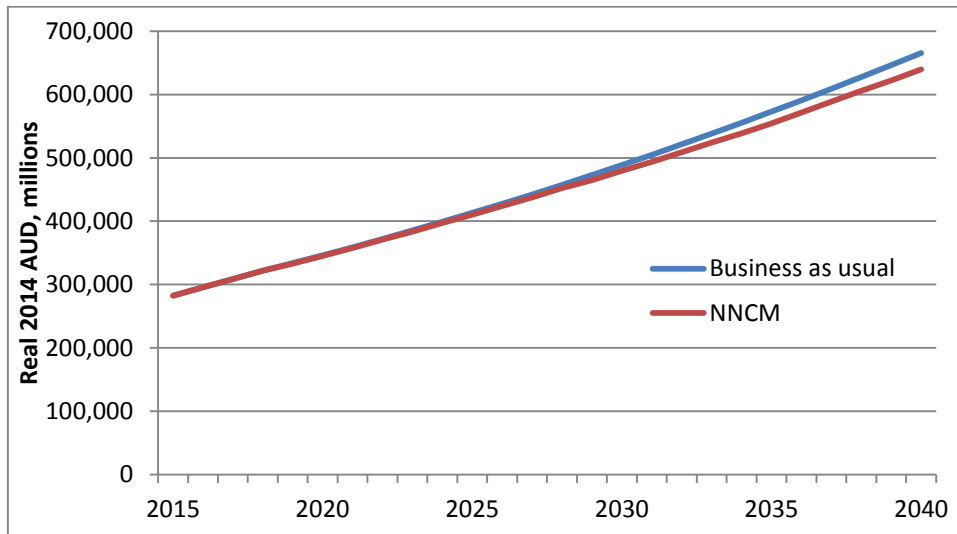
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<sup>33</sup> Campbell (2014) Seeing through the dust: Coal in the Hunter Valley economy, <http://www.tai.org.au/content/seeing-through-dust-coal-hunter-valley-economy>

<sup>34</sup> ABS (2015) 5220.0 - *Australian National Accounts: State Accounts, 2014-15*, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/5220.02014-15?OpenDocument>

<sup>35</sup> Ibid

**Figure 13: Queensland Gross State Product, business as usual vs no new coal mines**



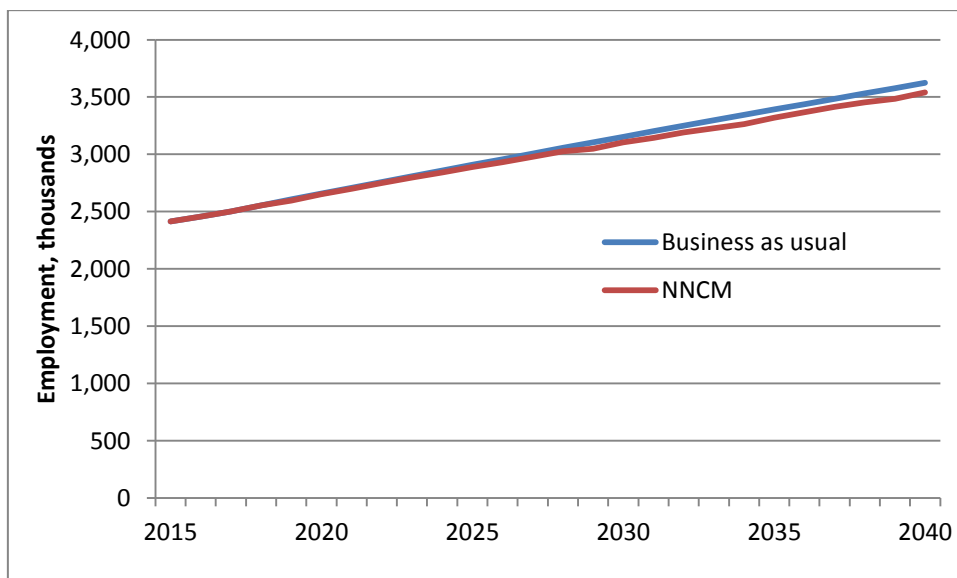
Source: CoPS model

Figure 13 shows that under both the BAU and NNCM scenarios, the Queensland GSP is expected to double in size by 2040, growing to over \$600 billion per year in each case. There is almost no difference in the two scenarios through the 2020s, because many mines in the state already have approval to produce and have reserves adequate to operate through most of that decade. Only into the 2030s does any difference between the two scenarios become apparent and even then the difference never reaches 4% of the business as usual estimate.

### ***Queensland employment***

Employment shows similar trends. In either case, number of jobs in Queensland grows from the current 2.3 million to just over 3.5 million in 2040, as shown in Figure 14 below:

**Figure 14: Queensland employment, business as usual vs no new coal mines**



Source: CoPS model

Figure 14 shows that there is no perceivable difference in employment in Queensland under the no new coal mines scenario until into the 2030s. The reference case is 2% higher in 2040. Importantly this does not mean that more people are unemployed in Queensland, but the number of employed people in the state has not grown as much. Other states experience higher growth, discussed further below.

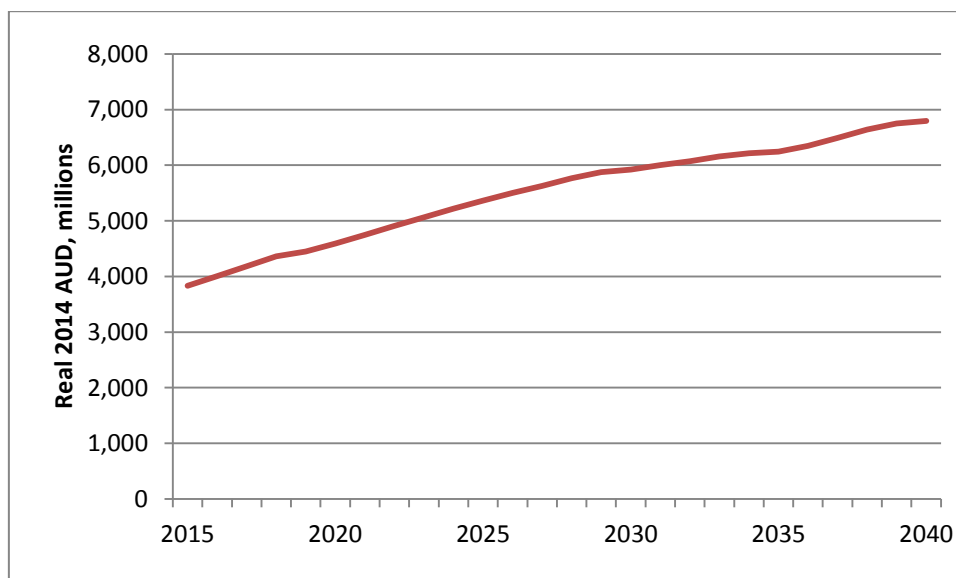
### ***Mackay and Fitzroy regions***

As with NSW, while the state as a whole is barely affected by a moratorium on new coal mines, major coal producing regions are likely to experience slower rates of economic growth than the state overall. Estimating impacts on regional economic growth and impacts on it is difficult. Queensland Treasury provides the following warning about its own estimates of gross regional product:

*[These estimates] are labelled ‘experimental’ owing to the paucity of economic statistics available at the regional level to assist with more rigorous estimation. As such, care should be taken when interpreting changes at the regional industry level.*<sup>36</sup>

Bearing this in mind, and CGE models’ tendency to ignore environmental impacts, the CoPS model does allow for some estimates of economic output to be made at a regional level. Queensland’s main coal producing regions are Mackay and Fitzroy, which take in the Bowen Basin coal mining area. Both regions’ economies are estimated to grow under a no new coal mines scenario. Mackay is expected to continue to grow strongly, while GRP growth in Fitzroy is estimated to be minimal in the 2030s, as shown in Figures 15 and 16 below:

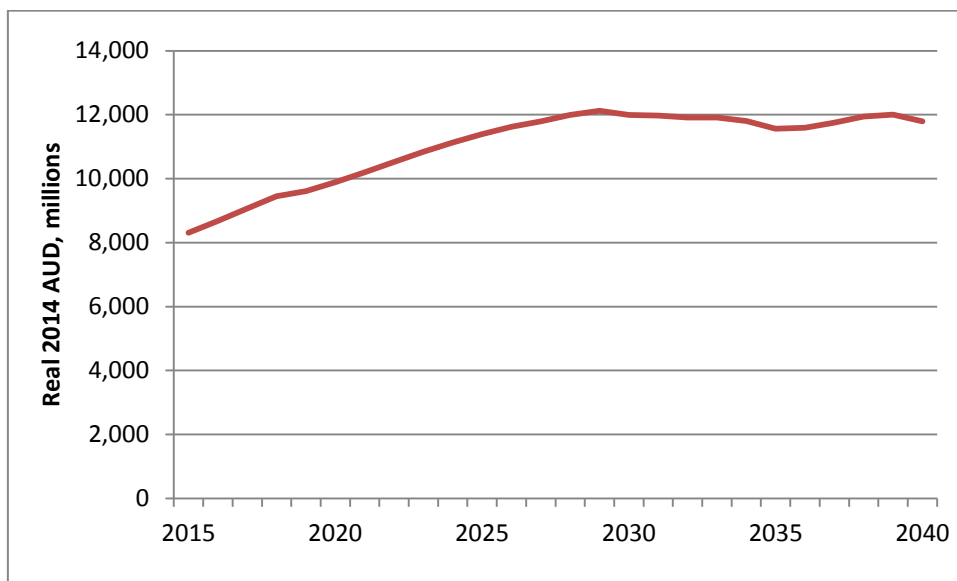
**Figure 15: Mackay region gross regional product with no new coal mines**



Source: CoPS model

<sup>36</sup> Queensland Treasury and Trade (2013) *Experimental Estimates of Gross Regional Product 2000-01, 2006-07 and 2010-11*, <http://www.qgso.qld.gov.au/products/reports/experimental-estimates-grp/experimental-estimates-grp-2010-11.pdf>

**Figure 16: Fitzroy region gross regional product with no new coal mines**



Source: CoPS model

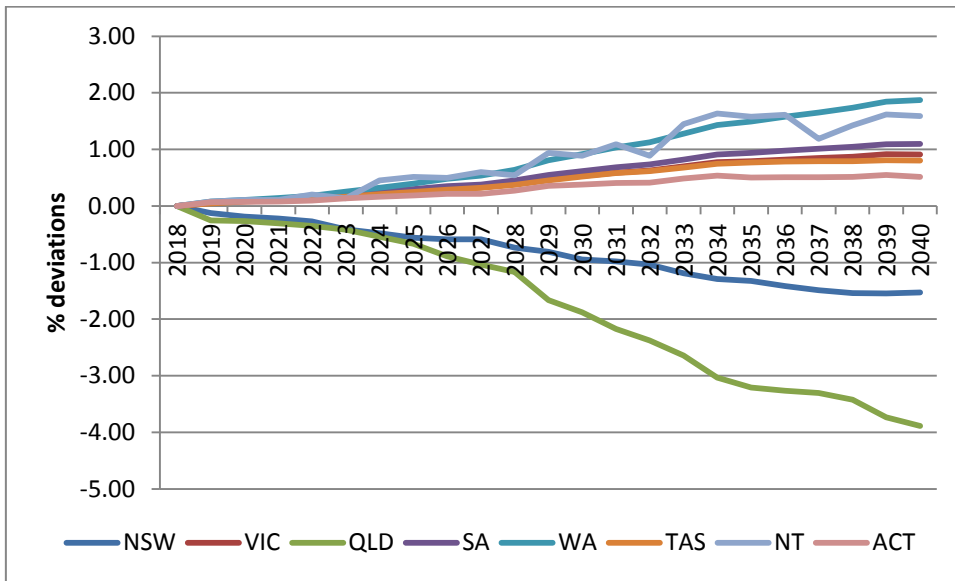
Figure 15 shows Mackay's economic growth relatively steady through the modelled period, reflecting the diversity of the coastal town's economy. Figure 16 shows Fitzroy's regional economic output is more closely tied to coal production, growing through the 2020s before plateauing in the 2030s as existing approvals expire under the no new coal mines policy. Under this scenario, policy makers have over a decade to plan for a low growth period and change in the Fitzroy economy.

This result shows the sensitivity of the Fitzroy region to changes in coal markets and climate policy. Other policies or market fluctuations could cause a similar effect even sooner than the CoPS model estimates a moratorium would. Policy intervention is likely to be necessary to transition these areas to a low-carbon future, regardless of whether a no new coal mines policy is introduced.

## OTHER STATES

The NSW and Queensland state economies show little difference between the reference case and the no new coal mines scenario due to the relatively small size of the coal industry in their overall economies, the slow phase-out and, importantly, the assumption that resources such as labour and capital not used by the coal industry are then used by other industries. While most of these resources would probably be re-allocated within those states, some would also be redeployed in other states. The CoPS model estimates that all other states and territories would benefit from the NNCM policy, as shown in Figure 17 below:

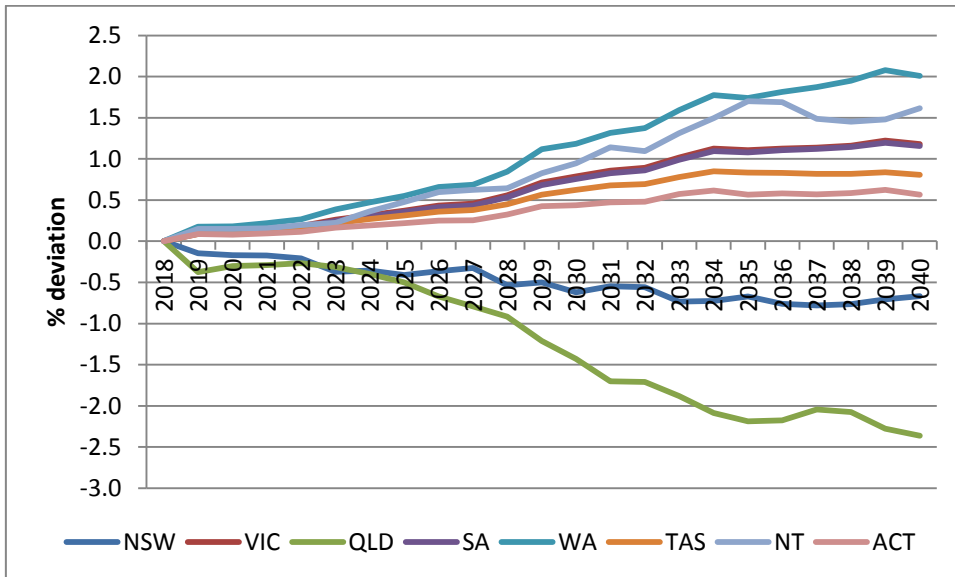
**Figure 17: All states percentage deviation in GSP from reference case under NNCM**



Source: CoPS model

Figure 17 shows that Western Australia and Northern Territory would benefit the most from a moratorium, as their mining sectors would benefit from the NSW and Queensland sectors' reductions. As mining is a relatively large part of WA and NT economies, their increase in growth is estimated to be larger than the other states, which see modest increases in GSP. Employment shows similar trends, shown in Figure 18 below:

**Figure 18: All states deviation in employment from reference case under NNCM**



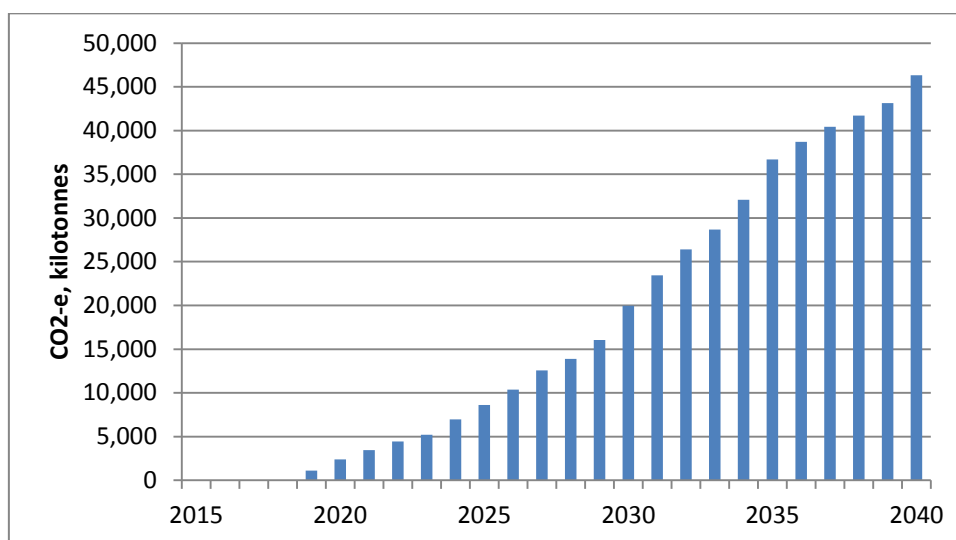
Source: CoPS model

## GREENHOUSE GAS EMISSIONS

The main climate impact of an Australian moratorium on new coal mines would be on the amount of coal burned by countries that buy Australian coal. Australia currently accounts for 27% of the traded coal market.<sup>37</sup> The reduction of this supply would cause a relative increase in the price of coal and therefore a reduction in how much is bought and burned, likely hastening a shift to cleaner energy sources.

This effect is not estimated in the CoPS model and would be the major global benefit of a moratorium on new coal mines. However, the model does estimate the emissions that the coal industry produces while mining coal, and can estimate the reduction in Australian emissions brought about by a policy of no new coal mines. This reduction occurs because the coal mining industry is relatively emissions-intensive and the policy would see resources reallocated to less polluting industries. As shown in Figure 19 below, this policy would save tens of millions of tonnes of greenhouse gas emissions in Australia:

**Figure 19: Australian greenhouse gas emissions saved with no new coal mines**



Source: CoPS model

The CoPS model estimates that by 2030 will be 20 million tonnes of greenhouse gas emissions could be saved with no new coal mines. This represents around 4% of Australia's 536 million tonnes of total emissions for 2015.<sup>38</sup>

<sup>37</sup> International Energy Agency (2015) *Key World Energy Statistics 2015*,

[http://www.iea.org/publications/freepublications/publication/KeyWorld\\_Statistics\\_2015.pdf](http://www.iea.org/publications/freepublications/publication/KeyWorld_Statistics_2015.pdf)

<sup>38</sup> Department of the Environment (2016) *Quarterly Update of Australia's National Greenhouse Gas Inventory: December 2015*, <https://www.environment.gov.au/climate-change/greenhouse-gas-measurement/publications/quarterly-update-australias-national-greenhouse-gas-inventory-dec-2015>



# Conclusion

Prominent Australian economics writer Ross Gittins wrote earlier this year:

The mathematical models of the economy that economists produce are supposed to be an aid to thinking. In the public debate, however, they're used as a substitute for thinking.<sup>39</sup>

We hope this report is a step towards addressing this problem. We hope that our modelling assumptions, data and results are presented in a way that assists readers to think about the coal industry in Australia and what might happen to it as we work to address climate change. Too often, economic modelling has been used to present the coal industry as a large and important part of our economy. Lobbyists and leaders then skew public debate by using modelling results with minimal discussion of how those results were derived and the context in which they should be seen.

Official statistics show that the coal industry employs relatively few Australians, accounts for a small portion of government revenues, and works mainly in the interests of its overseas owners. Our modelling exercise shows that for the Australian economy and community, the impacts of a phase-out of the coal industry would be minimal. The positive environmental and health effects of phasing out coal are not considered in our modelling and if included would further strengthen this conclusion. Australia can and should impose a moratorium on new coal mines and mine expansions, as part of climate and wider environmental policy, and should expect minimal economic disruption from doing so.

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<sup>39</sup> Gittins (2016) *Why economic modelling results are dodgy*, <http://www.rossgittins.com/2016/02/why-economic-modelling-results-are-dodgy.html>

# Appendix: Technical modelling report from Centre of Policy Studies

# Simulations of the Effects of No New Approvals for Coal Mines in NSW and QLD

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*Philip Adams*

## INTRODUCTION

The key distinguishing characteristic of Computable General Equilibrium (CGE) modelling in Australia is its orientation to providing *detailed* inputs to the policy-formation process. This characteristic is ably demonstrated in this paper analysing the impacts on the Australian economy of ceasing new approvals for coal mining in NSW and QLD.

The analysis relies on an application of the Victoria University Regional Model (VURM), which is the rebranded version of the Monash Multi-Regional Forecasting model (MMRF). The change of name reflects CoPS' move from Monash University to Victoria University in early 2014. VURM is a dynamic model of Australia's six states and two territories. It models each region as an economy in its own right, with region-specific prices, region-specific consumers, region-specific industries, and so on. Full documentation of the model's equations can be downloaded from <http://www.copsmodels.com/elecpr/g-254.htm>.

The rest of this paper is organized as follows. A brief general description of VURM is given in Section 2. Aspects of simulation design are given in Section 3. Projected economic impacts of ceasing new approvals for coal mining in NSW and QLD are discussed in Section 4. The discussion of results focuses on explaining outcomes in a sequential way. National outcomes are dealt with first, then results for national industry output.

## **OVERVIEW OF THE VURM MODELLING FRAMEWORK**

Based on the model's current database for 2009-10, in each region 79 industries produce 83 commodities. Capital is industry- and region-specific. In each region, there is a single household and a regional government. There is also a Federal government. Finally, there are foreigners, whose behaviour is summarised by demand curves for international exports and supply curves for international imports.

VURM produces sequences of annual solutions connected by dynamic relationships such as physical capital accumulation. Policy analysis with VURM conducted in a dynamic setting involves the comparison of two alternative sequences of solutions, one generated without the policy change and the other with the policy change in place. The first sequence serves as a control path from which deviations are measured to assess the effects of the policy shock.

The model includes a number of satellite modules providing more detail on the model's government finance accounts, household income accounts, population and demography, and energy and greenhouse gas emissions. Each of the 'satellite' modules is linked into other parts of the model, so that projections from the model core can feed through into relevant parts of a module and changes in a module can feed back into the model core. The model also includes extensions to the core model theory dealing with links between demography and government consumption and the supply and interstate mobility of labour.

The model has a particular focus on greenhouse study. Thus it includes:

- A full set of energy and greenhouse-gas accounts that covers each emitting agent, fuel and region recognized in the model;
- quantity-specific carbon taxes or prices;
- equations for inter-fuel substitution in transport and stationary energy; and
- a representation of Australia's National Electricity Market (NEM).

## **ENERGY AND EMISSIONS ACCOUNTING**

VURM includes an accounting for all domestic emissions, except those arising from land clearing and land-use change. It does not include emissions from the

combustion of Australian exports by the importing economy, but does include any fugitive or combustion emissions arising in Australia from the extraction or production of those exports.

VURM tracks emissions of greenhouse gases according to: emitting agent (79 industries and the household sector); emitting region (8 regions); and emitting activity (5 activities). Most of the emitting activities involve the burning of fuels (coal, natural gas and 2 different types of petroleum products). A residual category, named *Activity*, covers non-combustion emissions such as emissions from mines and agricultural emissions not arising from burning of the fuel. *Activity* emissions are assumed to be proportional to the level of activity in the relevant industries (animal-related agriculture, coal, oil and gas mining, cement manufacture, etc.).

#### **CARBON TAXES AND PRICES**

VURM treats an emissions price/tax as a specific tax on emissions of CO<sub>2</sub>-e. On emissions from fuel combustion, the tax is imposed as a sales tax on the use of fuel. On *Activity* emissions, it is imposed as a tax on the production of the relevant industries.

#### **INTER-FUEL SUBSTITUTION**

VURM allows for various forms of inter-fuel substitution in electricity and non-electricity sectors.

Electricity-generating industries are differentiated according to the type of fuel used. There is also an end-use supplier (*Electricity supply*) in each region and a single dummy industry (*NEM*) covering the six regions that form Australia's National Electricity Market (New South Wales, Victoria, Queensland, South Australia, the Australian Capital Territory and Tasmania). Electricity flows to the local end-use supplier either directly in the case of Western Australia and the Northern Territory or *via* the *NEM* in the remaining regions. Further details of the operation of *NEM* are given below.

Purchasers of electricity from the generation industries (the *NEM* in the case of those regions in the *NEM* or the *Electricity supply* industry in each non-*NEM* region) can substitute between the different generation technologies in response

to changes in generation prices, with the elasticity of substitution between the technologies typically set at around 5.

For other energy-intensive commodities used by industries, VURM allows for a weak form of input substitution. If the price of cement (say) rises by 10 per cent relative to the average price of other inputs to construction, the construction industry will use 1 per cent less cement and a little more labour, capital and other materials. In most cases, as in the cement example, a substitution elasticity of 0.1 is imposed. For important energy goods (petroleum products, electricity supply, and gas), the substitution elasticity in industrial use is set at 0.25.

### **THE NATIONAL ELECTRICITY MARKET**

The NEM is a wholesale market covering nearly all of the supply of electricity to retailers and large end-users in NEM regions. VURM represents the NEM as follows.

Final demand for electricity in each NEM region is determined within the CGE-core of the model in the same manner as demand for all other goods and services. All end users of electricity in NEM regions purchase their supplies from their own-region *Electricity supply* industry. Each of the *Electricity supply* industries in the NEM regions sources its electricity from a dummy industry called *NEM*, which does not have a regional dimension. In effect, the *NEM* is a single industry that sells a single product (electricity) to the *Electricity supply* industry in each NEM region. *NEM* sources its electricity from generation industries in each NEM region. Its demand for electricity is price-sensitive. For example, if the price of hydro generation from Tasmania rises relative to the price of gas generation from New South Wales, then *NEM* demand will shift towards New South Wales gas generation and away from Tasmanian hydro generation.

## **ASSUMPTIONS AND INPUT**

### **INTRODUCTION**

Using VURM we simulate two future trajectories for the Australian economy. One is a business-as-usual scenario in which demography, technological progress and

Australia's trading conditions with the rest of the world move in line with historical or expected future trends. The business-as-usual scenario includes the effects of current government policies, but not possible future policy initiatives. Throughout this paper the business-as-usual scenario is generally referred to as the *Reference* case.

The second scenario deviates from the first due to the cessation of approvals for new coal mines in NSW and QLD from 2017 onwards. In this scenario, the NSW and QLD coal industries can only produce from existing mines and from new mines already approved but not yet in operation. Coal from NSW and QLD is sold domestically, primarily for electricity generation and steel manufacture. It is also exported. Thus in the second scenario, relative to the first, as approved-capacity for mining coal in NSW and QLD is depleted, we see changes in local and foreign use of coal.

The simulations are reported for the period 2018 to 2040. In the remainder of this section, we discuss the key inputs to the projections and the main assumptions regarding the behaviour of the macro-economy in the VURM modelling.

## **REFERENCE CASE**

### **INPUTS**

The Reference case incorporates a large amount of information from specialist forecasting agencies. VURM traces out the implications of the specialists' forecasts at a fine level of industrial and regional detail. Information imposed on the model includes:

- changes in population from the latest version (2015) of the Federal Treasury's Intergenerational Report;
- rates of technological progress consistent with historical trends;
- changes in world trading conditions which are necessary to keep Australia's terms of trade on its observed path from 2010 to 2015, and on the path forecast by the Federal Treasury thereafter;
- regional macroeconomic data to 2014, generated in the main from published state-government information;

- estimates of changes in generation mix, generation capacity, fuel use, emissions and wholesale prices for electricity consistent with the Reference case developed for modelling work undertaken for the South Australian Royal Commission in the nuclear fuel cycle; and
- forecasts for growth in production of coal produced in NSW and QLD from the Australian Institute.

### **PROJECTIONS**

Key features of the Reference case projection for selected macroeconomic variables are as follows.

- Real GDP grows at an average annual rate of 3.0% over the period 2015 to 2020 slowing to an average rate of 2.6% for 2020 to 2040.
- In line with recent history, the export-oriented states – QLD and WA – are projected to be the fastest growing regions, followed by NSW and VIC. SA and TAS are the slowest growing regions.
- Real national private consumption grows at an average annual rate similar to that of real GDP.
- The regional pattern of growth for consumption is also similar to that for GDP: fastest growth occurs in QLD and WA, and slowest growth in TAS and SA.
- On average, trade volumes grow relative to GDP by about 1.5% annually, but unlike recent history import growth is projected to be in line with export growth.
- Australia's terms of trade are assumed to return to a historically normal level by 2017 and remain at that level thereafter.

### **NO NEW APPROVALS SCENARIO**

#### **INPUTS**

The *No New Approvals* (NNA) scenario deviates from the Reference case on the assumption that after 2016 there will be no approvals for the development of new



coal mines in NSW and QLD. This means that relative to Reference case levels, production of coal from NSW and QLD will progressively fall as reserves are depleted at mines currently open or to be opened with pre-2017 approval.

As reserves are depleted, so the cost of producing coal in NSW and QLD rises. This reflects the fact that relatively low-cost reserves, which are the first to be exploited, are the first to deplete. The replacement mines will be higher cost.

Coal producers will attempt to pass on the cost increases to customers, causing the price of NSW and QLD coal to rise. This induces substitution in demand away from NSW and QLD coal towards cheaper alternatives. In electricity supply this means replacing more expensive coal generation with electricity generated from gas and renewables. These purely local effects, however, are small. The largest change in demand comes through exports. On export markets, increases in the price of NSW and QLD coal causes foreign buyers to shift demand away from Australian coal towards coal from other sources. This switch in source causes the volume of coal exports to fall.

We introduce two exogenous changes to mimic the policy of no new approvals for coal mining in QLD and NSW. The model then simulates deviations away from the Reference case in response to these changes. The exogenous shocks are:

1. to gross fixed capital investment in coal mining in NSW and QLD, which allow for changes in investment in existing mines and increases in investment for mines not yet in operation but with pre-2016 approval; and
2. to production of NSW and QLD coal.

The shocks to investment were calculated using data from the Australian Institute for the maximum potential production from QLD and NSW coal mines in operation or with current approval for operation. It was assumed that capital growth in the affected industries in the NNA scenario would follow growth in maximum potential operation. In mathematical terms, it was assumed for year  $t$ , that:

$$\%Capital(t) = \%Production(t),$$

where  $\%Capital(t)$  is percentage growth in capital in year  $t$  and  $\%Production(t)$  is percentage growth in maximum potential production in year  $t$ .

The growth rate of capital in year t can be expressed as follows. First, we note that:

$$\text{Capital}(t) = \text{Capital}(t-1) \times (1-d) + \text{Investment}(t-1),$$

where  $\text{Capital}(t)$  and  $\text{Capital}(t-1)$  are the levels of capital in year t and year t-1, d is the fixed level of depreciation (0.06 for coal in the VURM database) and  $\text{Investment}(t-1)$  is the level of gross investment in year t-1. After some manipulation we obtain:

$$\% \text{Capital}(t) = \frac{\text{Investment}(t-1)}{\text{Capital}(t-1)} - d.$$

Thus, with an initial setting for the investment to capital ratio in year (t-1) and a value for the depreciation rate, knowing the percentage growth rate for capital through time implies a growth path for investment.

In the NNA scenario average annual growth in the affected coal industries is around minus six per cent. This contrasts with average annual growth in the Reference case of about one per cent. The exogenous changes to capital growth were implemented in the model by fixing capital growth in the affected industries *via* model-determined (endogenous) changes in required rate of return on investment.

Production of mined coal in NSW and QLD is forced to move exactly in line with the Australian Institute data on potential production *via* endogenous shifts in the productivity of capital and labour employed. With production exogenous and set to values implied by the Australian Institute data, the model determines the necessary deterioration or improvement in all-factor productivity required to achieve the targeted production level given the imposed growth rates for capital.

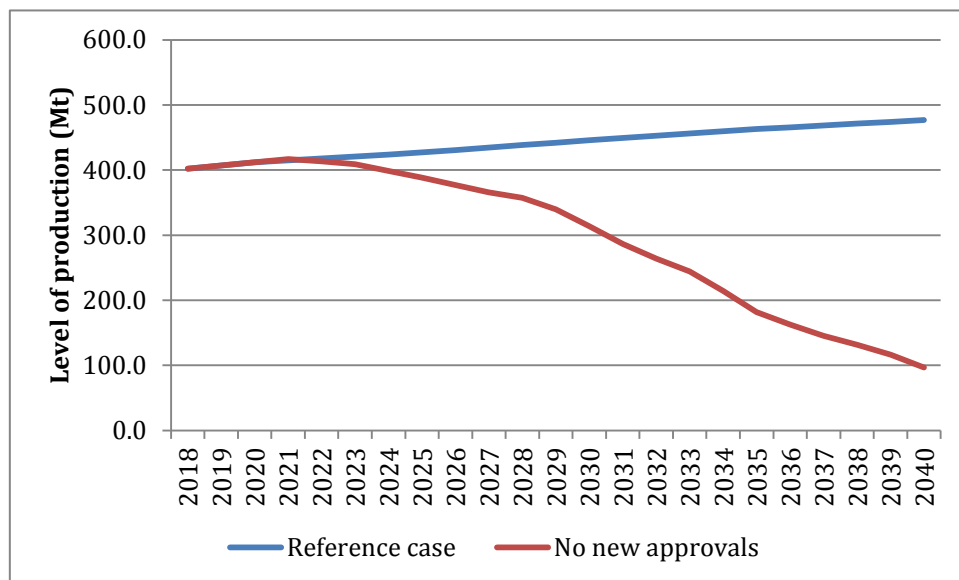
Figure 1 shows the pathways for production of NSW and QLD coal production in the Reference case and NNA scenario. Note that we treat the NSW and QLD coal industries as one, even though in the model they are separate industries.

According to Figure 1, production of coal from the two states in 2018 is around 400 Mt. This rises to around 480 Mt in 2014 in the Reference scenario. In the NNA case, production falls to around 100 Mt in 2040. The fall in production is accommodated by falls in local and foreign demand. Locally, the main adjustments

occur through changes in the structure of electricity generation (as discussed below).

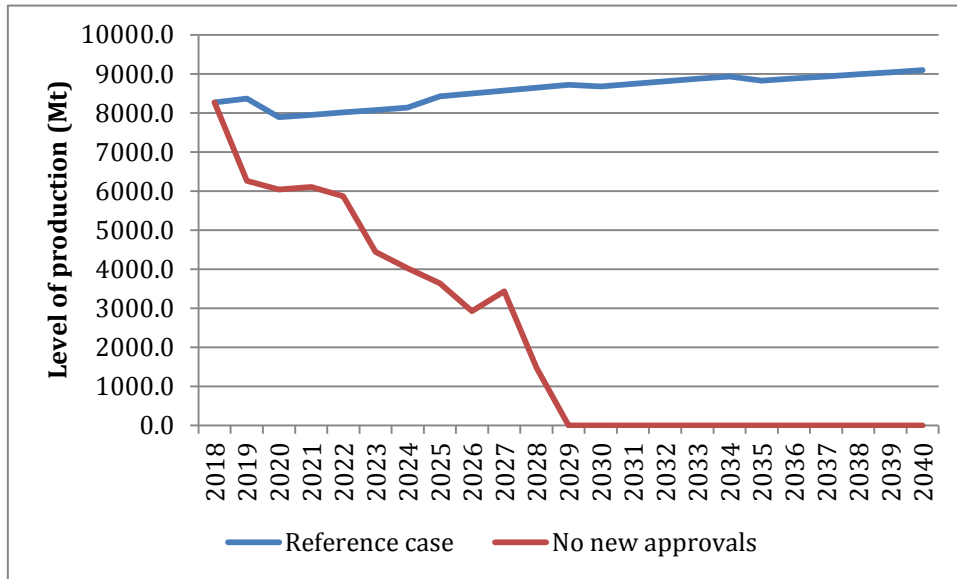
Figure 2 shows the inferred pathways for total real investment for the two coal-mining industries. In the Reference scenario, real net investment in the NSW and QLD coal industries rises from a level of around \$8 billion in 2018 to \$9 billion in 2040.<sup>40</sup> In the NNA case, *net* investment falls from its 2018 level to zero in 2029 and remains zero thereafter.

**Figure 1: Production of Coal in QLD and NSW, Reference case and No new approvals scenarios (Mt)**



<sup>40</sup> Australia-wide investment in 2018 is projected to be around \$370 billion, and in 2040 around \$720 billion. Thus, as a share of Australia-wide investment, net investment in NSW and QLD coal industries in 2018 is around 2 per cent, and in 2040 around 1 per cent.

**Figure 2: Real Net Investment in the QLD and NSW coal industries, Reference case and No new approvals scenarios (\$m, 2014 prices)**



#### **ASSUMPTIONS FOR THE MACROECONOMY**

The following assumptions are made for key aspects of the macro economy to incorporate changes in coal industry investment and production.

#### **Labour markets**

At the national level, lagged adjustment of the CPI-adjusted wage rate to changes in employment is assumed. Reduced coal production is allowed to cause employment to change, but over time real wage adjustments steadily eliminate any employment consequences. This labour-market assumption reflects the idea that in the long run national employment is determined by demographic factors, which are unaffected by conditions in the coal industry.

At the regional level, labour is assumed to be mobile between state economies. Labour is assumed to move between regions so as to maintain inter-state unemployment-rate differentials. Accordingly, regions that are relatively unfavourably affected by reductions in coal production (QLD and NSW) will experience reductions in their labour forces as well as in employment, at the expense of regions that are relatively less unfavourably affected.

### *Private consumption and investment*

Private consumption expenditure is determined *via* a consumption function that links nominal consumption to household disposable income (HDI). The coefficient of proportionality is the Average Propensity to Consume (APC). In these simulations the APC is an exogenous variable that is fixed to its Reference case value. Thus, relative to Reference case values, any change in NSW and QLD coal investment is accommodated not by a change in domestic saving, but by a change in foreign saving directed into the Australian economy. This is consistent with the fact that coal mining is mainly foreign owned.

### *Government consumption and fiscal balances*

In the projection, public consumption is simply indexed to nominal GDP. The fiscal balances of each jurisdiction (federal, state and territory) as a share of nominal GDP are fixed at their projected values in 2019. Budget-balance constraints are accommodated by endogenous movements in lump-sum payments to households.

### *Production technologies and household tastes*

VURM contains many variables to allow for shifts in technology and household preferences. In the NNA scenario, most of these variables are exogenous. The exceptions are technology variables that are made endogenous to allow for changes in the fuel intensity of coal-electricity generation as the price of coal rises.

## **RESULTS**

In interpreting the effects of the cessation of coal mining approvals, we compare the values of VURM variables in the Reference case to their values in the NNA case. We have a number of options for reporting the effects of the NNA policy, all of which will tell a similar story. Option (1) is to compare average annual growth in the Reference scenario with average annual growth in the NNA simulation. Another option is to compare the value of variables in a specific year in the no-approvals simulation with values in the Reference case. Deviations can be expressed as percentage differences from Reference case values in any year, or as absolute (\$m or Mt, etc.) differences from Reference values.

Below we discuss the deviations from Reference-case values in the NNA simulation: national results first, followed by regional results. Generally, the story is told using a series of charts which form a logical sequence of understanding. More detailed results are available on request. Italicised headings summarise the key points

### **NATIONAL RESULTS**

*Deviations in employment are fairly uneven, but are in general negative, with the falls arrested somewhat via real wage adjustment.*

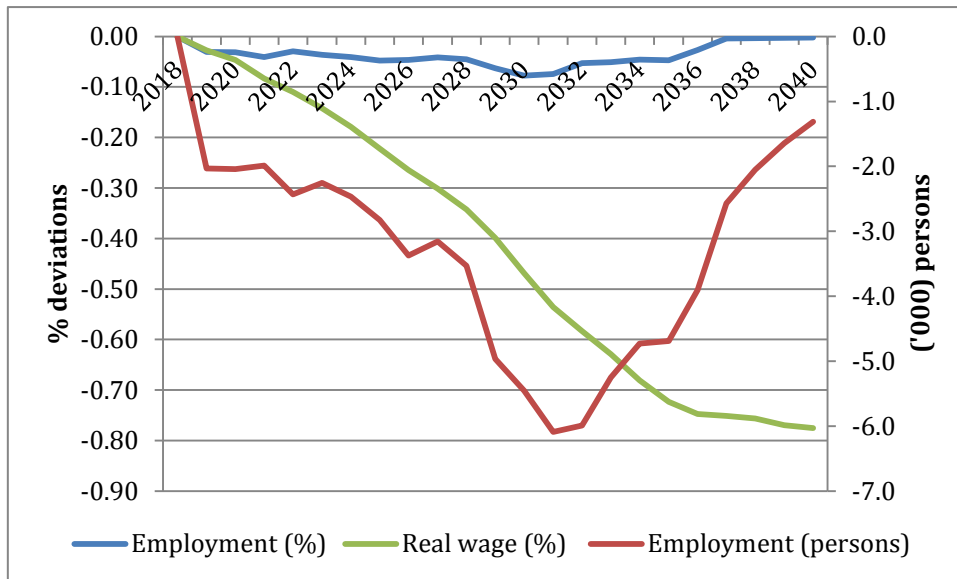
Figure 3 shows percentage and absolute ('000 persons) deviations in national employment and the percentage deviation in the national real wage rate. The labour-market specification in VURM makes the real wage rate sticky in the short run but responsive downwards (upwards) if employment falls (rises).

Coal mining investment is fairly labour intensive. Hence as it falls relative to reference case levels (see Figure 2) so does national employment.

If this were once off, then over time the real wage rate would progressively fall relative to Reference-case levels, reducing the real cost of labour and forcing employment back to its Reference level. But with the no approvals policy progressively reducing coal investment and production through to 2030, so the employment differential continues to widen through to 2030. In 2030, relative to Reference case values national employment has fall by around 6,000 jobs (or -0.06 per cent of its reference case level) , and the real wage rate is down 0.6 per cent.

After 2030, with no further shocks to the economy, the employment deviation is slowly eliminated, as the real wage rate continues to decline. In 2040, the employment deviation is -0.01 per cent, which is equivalent to a loss of around 1,500 jobs. The real wage rate deviation in the final year is -0.76 per cent.

**Figure 3: Employment and the Real Wage Rate  
(Deviations from Reference case values)**



A final point to note is that even though the fall in national employment is relatively small, this does not mean that employment at the individual industry or regional level remains close to Reference-case levels. In some industries and regions, there are significant permanent employment responses to the policy, compounding or defusing existing (Reference-case) pressures for structural change.

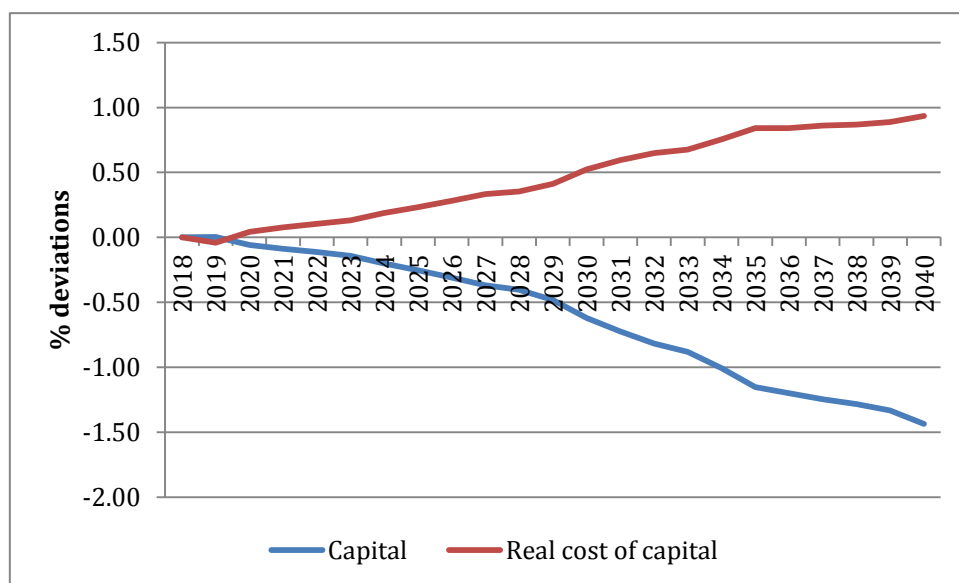
*Increases in the required rate of return on capital in coal mining in NSW and QLD increase the real cost of capital leading to reduced capital*

Figure 4 shows percentage deviations from Reference case values for the national capital stock and the real cost of capital. The latter is defined as the ratio of the nominal rental cost of capital to the national price of output (measured by the factor-cost GDP deflator). In 2040, the capital stock deviation is almost -1.5 per cent. In the same year, the real cost of capital is up around 1.0 per cent relative to its Reference case level.

The reduction in capital is due to changes in relative factor prices. When the real cost of labour falls relative to the real cost of capital (compare the real-wage deviation in Figure 3 to the deviation in real cost of capital shown in Figure 4),

producers substitute labour for capital across the economy. Thus the economy-wide labour/capital ratio rises by nearly 1.5 per cent. The increase in real cost of capital is a result of the increase in required rate of return on coal mining capital in NSW and QLD. To depress investment in those industries (see Figure 2), the model requires an increase in required rate of return. This reduces investment and leads to an increase in real cost of capital.

**Figure 4: Capital in production and the real Cost of Capital  
(Deviations from Reference case values)**



*In the long-run, with little change in employment and technological progress, the reduction in capital leads to a fall in real GDP.*

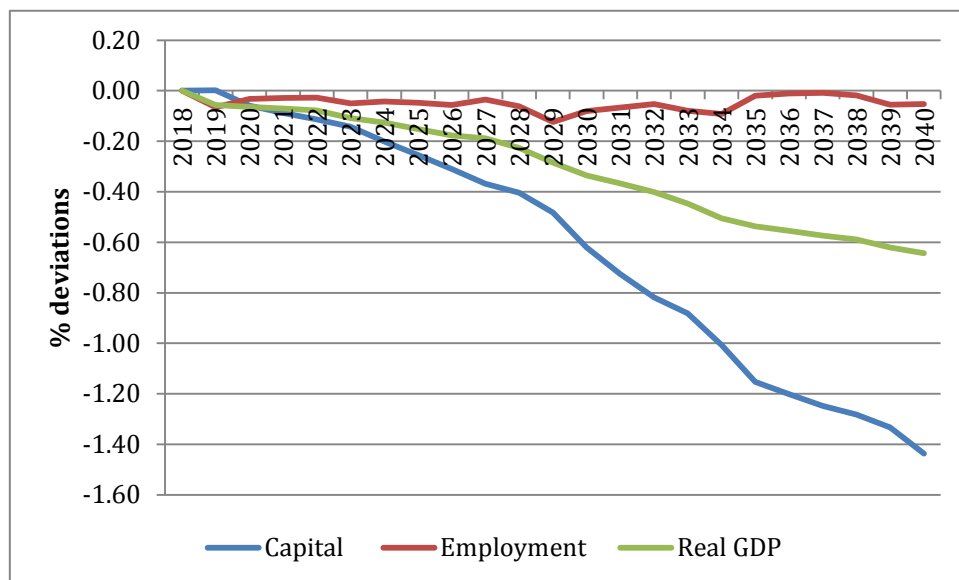
Ignoring changes in indirect taxes, the percentage change in real GDP is a share-weighted average of the percentage changes in quantities of factor inputs (labour, capital and agricultural land). It is assumed that the quantity of agricultural land does not change from Reference case values. Also, with one exception rates of technological progress are held at Reference case levels. The exception is the rate of progress associated with coal mining in NSW and QLD which is allowed to vary to ensure that output follows the trajectory shown in Figure 1. It turns out that technological progress in these industries changes little from its Reference case



level, hence nearly all of the adjustment in real GDP is due to changes in employment and capital.

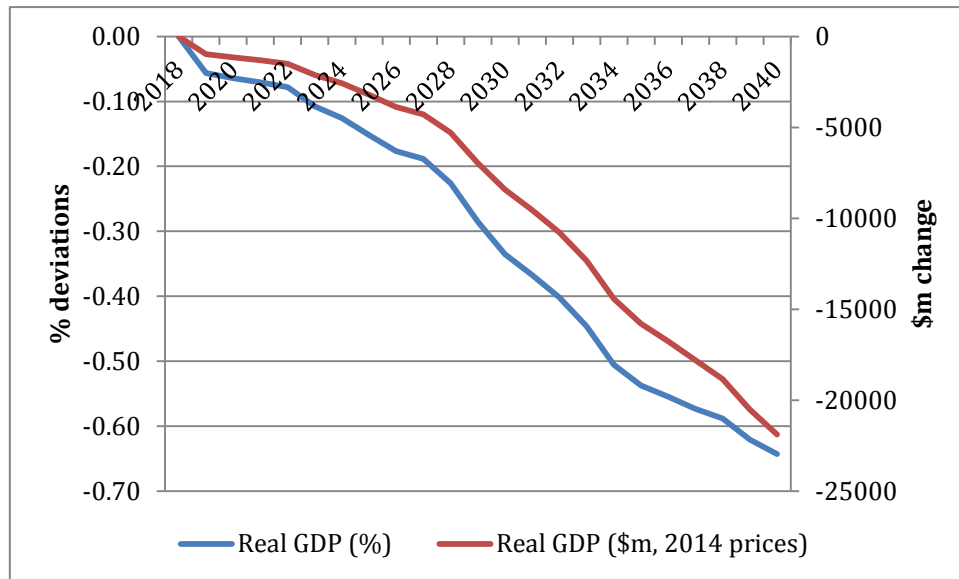
Capital's share in GDP is around 50 per cent. As shown in Figure 5, in the final year with capital down by around 1.4 per cent and employment little changed, we would expect real GDP to be around 0.7 (= 0.5×1.4) per cent lower. The actual projection is -0.64 per cent. To give this some context, in the Reference case average annual growth in real GDP between 2018 and 2040 is 2.89 per cent. In the no new approvals case, average annual growth is 2.85 per cent.

**Figure 5: Real GDP, Capital and Employment  
(Deviations from Reference case values)**



By 2040, relative to Reference case levels the reduction in real GDP of 0.64 per cent is valued at round \$22 billion in 2014 prices (see Figure 6). At coal prices prevailing in 2014, the loss of coal production (Figure 1) is worth about \$31 billion (2014 prices). This is more than the projected reduction in real GDP, suggesting that accompanying the reduction in coal industry production is the *crowding in* of production from other industries. In this simulation the main mechanism of *crowding in* is real devaluation of the exchange rate – to be discussed below.

**Figure 6: Real GDP**  
 (% and \$m deviations from Reference case values)



*In the long-run Real Gross National Expenditure (C + I + G) changes little relative to real GDP (Y), leading to little change in the net volume of trade (X - M).*

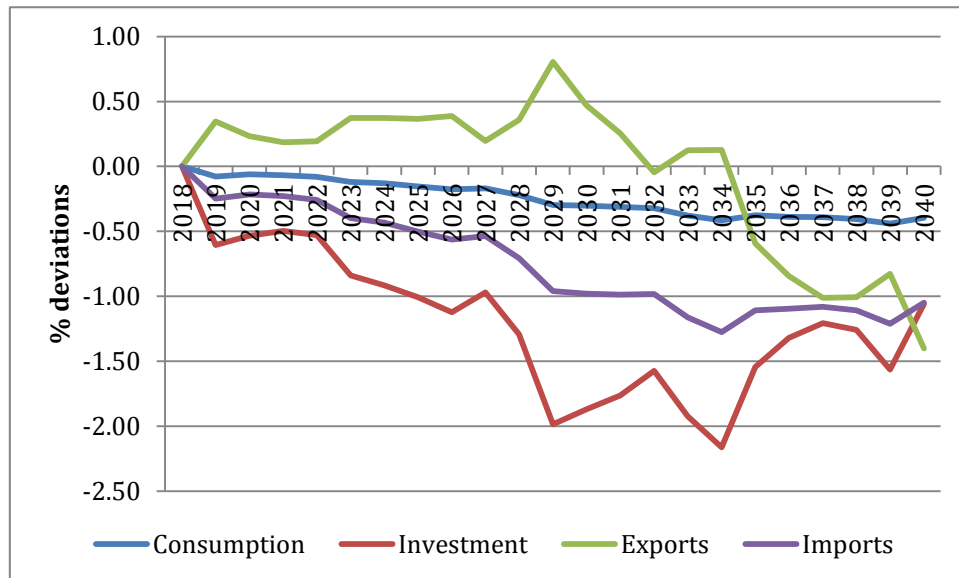
Figure 7 shows percentage deviations from Reference case values for real consumption (C + G), real investment (I), real exports (X) and real imports (M). Deviations in C reflect mainly the deviation in real GDP due to the model's consumption function that links spending to income (see Section 3.3.2). Deviations in I are relatively large due, in the main, to the reductions in coal mining investment imposed in the NNA scenario (see Figure 2).

On balance, real Gross National Expenditure (GNE) (= C + I + G) falls by more than real GDP (Y) through the forecast period to 2035, implying an improvement in the net volume of trade (X-M). In the last few years, the changes in GNE are similar to the changes in Y, implying little change in the net volume of trade.

To achieve the necessary improvements in net trade volumes, mild depreciation of the real exchange rate is necessary. The need for depreciation is made larger by the investment constraint on coal, which directly causes coal exports to fall relative to Reference case levels. Real devaluation improves the competitiveness of export

industries on foreign markets and the competitiveness of import-competing industries on local markets. In 2040, the real exchange rate is 1.1 per cent below its Reference case level.

**Figure 7: Main Expenditure-side Components of real GDP  
(Deviations from Reference case values)**



*Production in some industries increases relative to Reference case values, while production in other industries falls.*

Table 1 gives percentage deviations from Reference case in production levels for industries nationally in 2040.<sup>41</sup> There are a number of industries for which the no new approvals policy raises output. Nearly all these industries are trade –exposed and with little direct connection to the coal mining sector. Because of high trade exposure these industries benefit from real devaluation of the exchange rate.

The top ranked industry produces gas for the domestic market and LNG for export. Relative to Reference case levels, production in this industry is projected to increase by 4.4 per cent, with nearly all of the increase in production coming from increased exports. Similar stories can be told for the mining and metals industries ranked 2-4.

<sup>41</sup> For the sake of brevity we list only the 46 largest industries in terms of value added.

Textiles, clothing and footwear and Basic chemicals benefit from real devaluation, not through additional exports, but through reductions in import penetration on the local market.

**Table 1: National Industry Production**  
 (% changes from Reference case values, 2040, ranked)

Rank	Industry	% Deviation in production
1	Gas mining and LNG production	4.4
2	Mining of non-ferrous metal ores	4.4
3	Non-ferrous metals other than aluminium	3.4
4	Mining of iron ore	3.0
5	Textiles, clothing and footwear	2.6
6	Basic chemicals	2.0
7	Non-metallic mineral building products	2.0
8	Meat products	1.9
9	Agriculture – crops	1.8
10	Aluminium	1.8
11	Agriculture – sheep and cattle	1.8
12	Other food products	1.8
13	Dairy products	1.4
14	Air transport services	1.4
15	Education services	1.3
16	Pulp and paper products	1.2
17	Electricity generation from gas	1.2
18	Accommodation and food services	0.9
19	Oil mining	0.5
20	Wood products	0.5
21	Electricity generation from other renewables	0.5
22	Retail trade	0.3

23	Refined petroleum products	0.1
24	Wholesale trade services	0.1
25	Residential care	0.0
26	Health services	0.0
27	Public administration	-0.1
28	Business services	-0.1
29	Banking services	-0.1
30	Other services	-0.3
31	Dwelling ownership	-0.4
32	Financial services	-0.4
33	Residential construction	-0.4
34	Metal products	-0.5
35	Water transport	-0.6
36	Iron and steel	-0.6
37	Road freight services	-0.8
38	Cement and concrete	-0.9
39	Repair services	-1.1
40	Construction services	-1.3
41	Electricity supply	-1.9
42	Non-residential construction	-1.9
43	Electricity generation from coal	-5.6
44	Rail freight services	-9.3
45	Mining services	-9.8
46	Coal mining	-78.7

At the bottom of the ranking is coal mining, by assumption. Its production is projected to fall, relative to Reference case levels by 78.7 per cent in 2040. Much of this contraction is due to a reduction in exports. At the start of the period, the industry's export propensity was close to 90 per cent. At the end of the period in the NNA scenario the export propensity had fallen to just above 70 per cent.

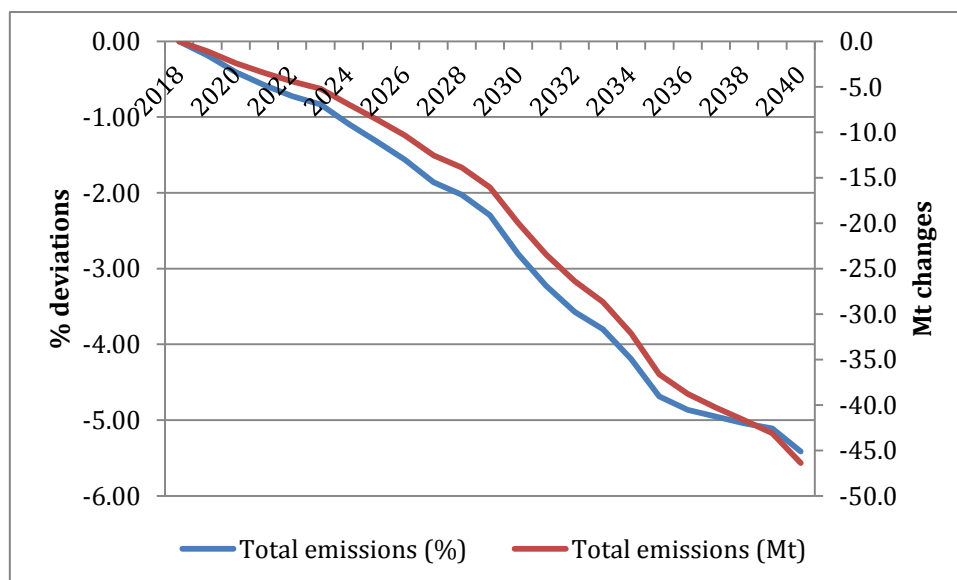
The other most adversely affected industries shown in Table 1 experience reductions in output due to close input/output connections to coal mining. Key examples are mining services (second last ranking, with a reduction in output of 9.8 per cent), rail freight services (third last ranking, with output down 9.3 per cent), and electricity generation from coal (fourth last ranking, with output down 5.6 per cent).

The iron and steel industry experiences only a mild contraction in production relative to Reference case levels (rank 36, output down 0.6 per cent). According to our database direct use of coal and coke contributes less than 7 per cent of the overall cost of iron and steel. This, coupled with the benefits the industry receives from real devaluation, limits the damage that might otherwise be expected

### *Greenhouse gas emissions fall*

Figure 8 shows deviations (in percentages and Mt of CO<sub>2</sub>-e) from Reference case values for total greenhouse gas emissions. In 2040, total emissions are down by around 5.5%, or 45 Mt of CO<sub>2</sub>-e. Nearly all of this reduction comes from a reduction in fugitive emissions from open-cut coal mines that close in the NNA scenario, and from a reduction in coal-fired electricity generation.

**Figure 8: Total Greenhouse Gas Emissions  
(Deviations from Reference case values)**



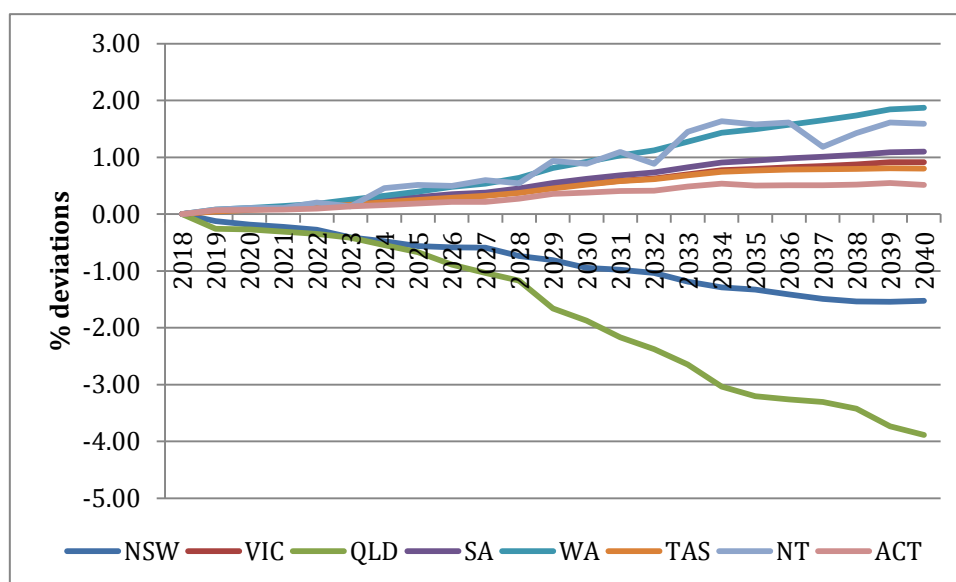
## REGIONAL EFFECTS

*At the state level, there are no surprises – the shares of NSW and QLD in the national economy fall*

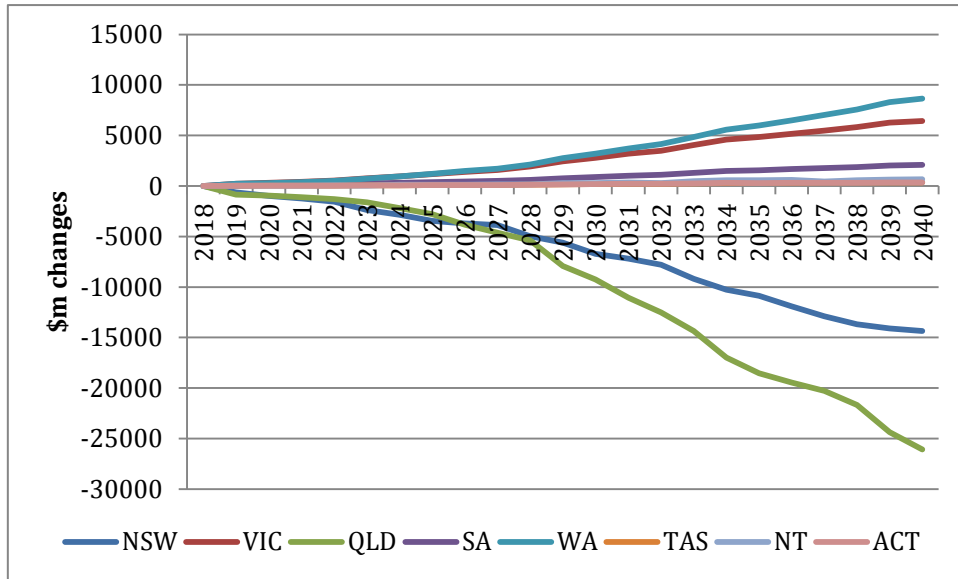
Figure 9a shows deviations from Reference case levels in real Gross State Product (GSP) for the six states and two territories expressed in percentage terms. Figure 9b shows the deviations expressed in dollar (\$m) terms.

In the final year of the simulation the two states directly affected by the NNA policy experience falls in real GSP of around 1.5 per cent (NSW) and 4.0 per cent (QLD). In terms of \$m, these falls are equivalent to \$15 billion and \$26 billion. All other states benefit – experience gains in real GSP relative to Reference case levels. This is due to the real devaluation which benefits all traded goods sectors, including those sectors in NSW and QLD and mild substitution effects towards gas and other coal-substitutes produced in the Rest of Australia.

**Figure 9a: Real GSP (% deviations)  
(Deviations from Reference case values)**

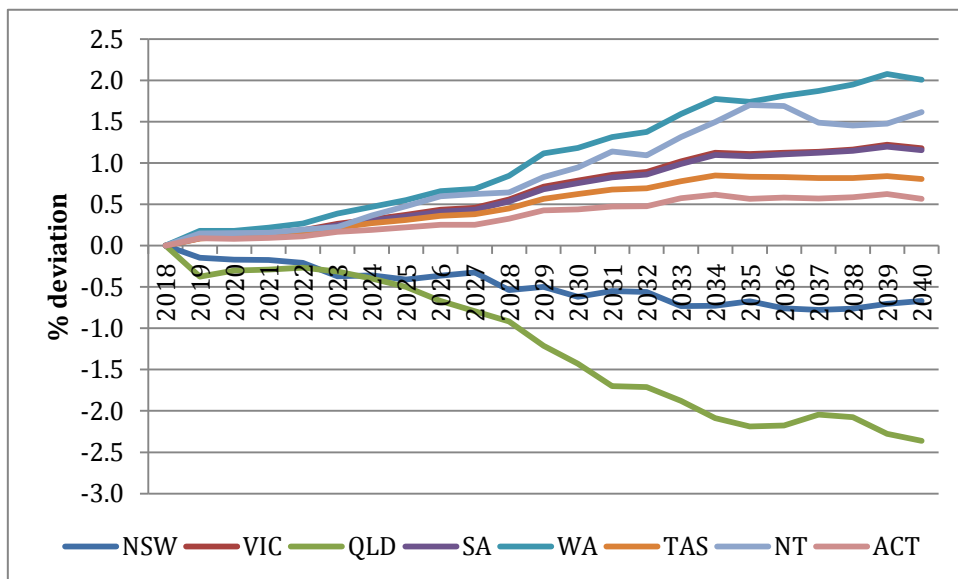


**Figure 9b: Real GSP (\$m deviations)  
(Deviations from Reference case values)**



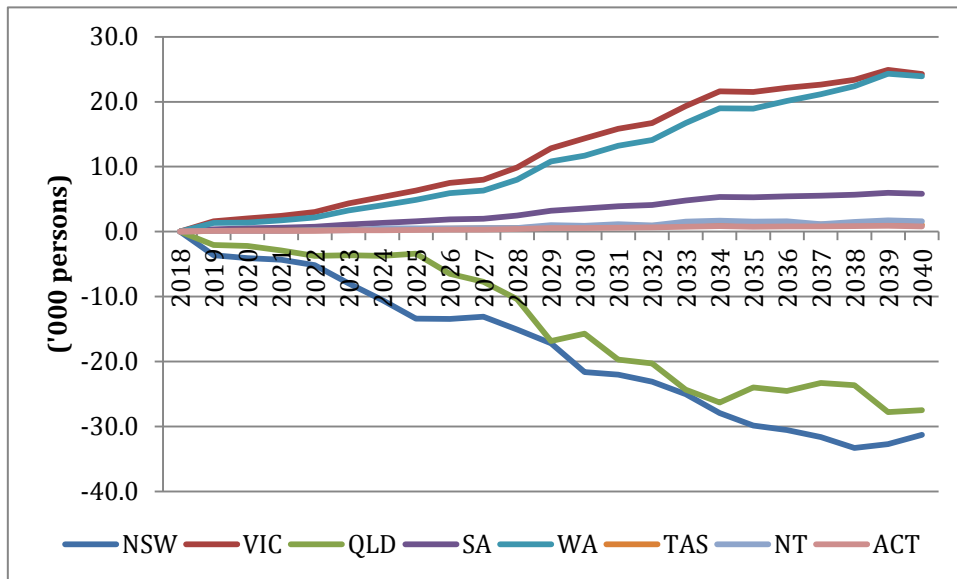
Figures 10a and 10b show corresponding projections for employment.

**Figure 10a: Employment (% deviations)  
(Deviations from Reference case values)**





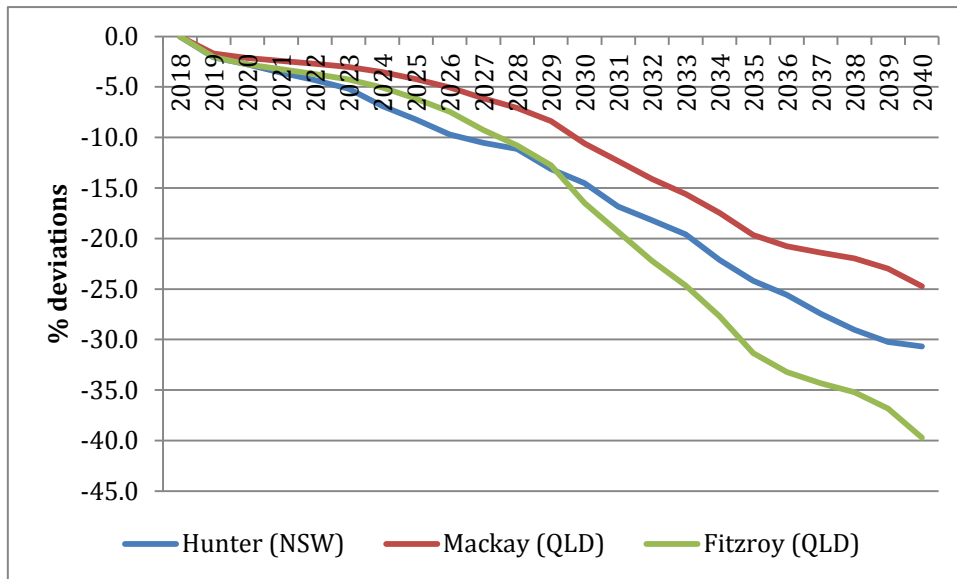
**Figure 10b: Employment ('000 persons)  
(Deviations from Reference case values)**



In addition to results for states and territories, VURM can be used to disaggregate state results down to results for statistical division. at the implication of restrictions on coal investment on sub-state regions. <sup>42</sup> In Figure 10 we show projected deviations from Reference case values for real Gross Regional Product (GRP) in regions directly affected by the shocks: the coal mining statistical divisions of Hunter (NSW), Mackay (QLD) and Fitzroy (QLD). In 2018, the share of coal production in each region's Gross Regional Product (GRP) was: 14.8% (Hunter), 10.6% (Mackay) and 12.85% (Fitzroy).

<sup>42</sup> Statistical divisions are as defined by the ABS in its *Australian Standard Geographical Classification*.

**Figure 11: Real GRP for the Directly Affected Regions  
(Deviations from Reference case values)**



The deviations in Figure 11 are large. If realized, then the regional economies shown will be significantly affected by the reduction in coal volumes. Real GSP in Fitzroy will fall to be around 40 per cent of its Reference case value in 2040, while real GSP in Mackay will be down 25 per cent and real GSP in Hunter will be down 31 per cent.

As bleak as this picture is, there is one important fact to keep in mind. In the Reference case we are projecting growth in these regions at an average annual rate of around 2.5 per cent. In the policy case, growth in all three regions between 2018 and 2040 will be positive, though reduced significantly from the reference case average. For Hunter, real GSP is projected to grow at an average annual rate of 1.2 per cent. For Mackay, the projected growth rate is 1.2 per cent, while for Fitzroy we expect growth at the rate of 0.2 per cent.