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The impact of Galilee Basin development on employment in existing coal regions

Development of the Galilee Basin would displace production in other coal regions. Galilee mines would be more automated and less job-intensive than existing mines. Based on coal industry analysis, central estimates of employment reduction are 9,100 in the Hunter Valley, 2,000 in the Bowen Basin & 1,400 in the Surat Basin compared to a no-Galilee scenario. Galilee mines are likely to employ between 7,840 and 9,800 people, resulting in overall negative impact on coal jobs.

Discussion paper

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Summary

With global coal demand stable or declining, production from new mines will displace production in existing mines. Large scale coal development in the Galilee Basin in Queensland will significantly increase the supply of traded thermal coal and decrease coal prices. Lower prices will reduce investment in other Australian coal regions, and by extension employment in the mines of those regions.

New Galilee Basin mines will be large and highly automated, meaning they will employ fewer people per tonne of coal production. Adani have stated that in their project eventually "everything will be autonomous from mine to port." Automated Galilee Basin mines will come at the expense of relatively job-intensive mines in other regions.

Industry analysts Wood Mackenzie modelled the effects of Galilee Basin production on other coal mining regions – the Hunter Valley, Bowen Basin and Surat Basin. They estimate that Galilee Basin production of 150 million tonnes per year would reduce coal volumes in other areas by 116 million tonnes in 2035 relative to a baseline scenario with no Galilee Basin development.

This paper estimates the effect on jobs of this relative reduction in production from established coal regions. Three methods are used to estimate this impact:

- Applying average labour productivity of existing coal mines to relative reduction in coal volume.
- Applying marginal labour productivity of existing coal mines to relative reduction in coal volume.
- Analysing estimated workforce of mines identified as being delayed or cancelled by Galilee Basin development.

Results from these three estimates are presented in the Summary Table below:

Summary Table: Relative reduction in employment per region in 2035

	Average productivity	Marginal productivity	Workforce in impacted mines
Hunter Valley	9,737	9,102	7,650
Bowen Basin	2,212	2,015	2,456–3,326
Surat Basin	1,692	1,363	2,444
Total	*13,641*	*12,480*	*12,550 – 13,420*

Based on Adani's estimates of labour productivity in its mines, the Galilee Basin would employ between 7,840 and 9,800 people to produce 150 million tonnes per year. Taking the relative employment reductions in other regions of between 12,480 and 13,641, this would see a relative reduction of employment of between 2,680 and 5,801 workers in the coal industry in 2035.

These estimates are based on some important assumptions. Firstly, Wood Mackenzie assumes the world does not act on climate change – they assume Australian thermal coal exports will increase substantially in either scenario. They see demand for traded thermal coal increasing out to 2035. By contrast, the International Energy Agency expects the traded thermal coal market to decline by 60% to 2040 if the world acts in line with the Paris targets. If these targets are achieved and this decline in the coal trade occurs, the impact of Galilee Basin development on other coal regions is likely to be larger still.

Secondly, the degree and effects of automation are unclear. Galilee Basin employment estimates appear to underestimate proponent intentions to automate. Not only would this produce fewer jobs overall, but these more would be located in capital cities, not in regional areas. A University of Queensland study supported by the mining industry found that mine automation can reduce in-pit roles by 50% and overall mine workforce by 30–40%. This has a particular impact on indigenous employment, which is focused in regional areas rather than capital cities.

Government agencies have not conducted analysis on the impacts of Galilee Basin development on other coal regions. Some stakeholders such as NSW Minister for Resources Don Harwin have even dismissed the need for any analysis, saying he is "comfortable and not concerned about ongoing coal exports".

Federal and state government economists and coal analysts should investigate the potential impact of subsidised Galilee Basin development in detail as part of a plan for transitioning our coal regions into a carbon constrained future.

Introduction

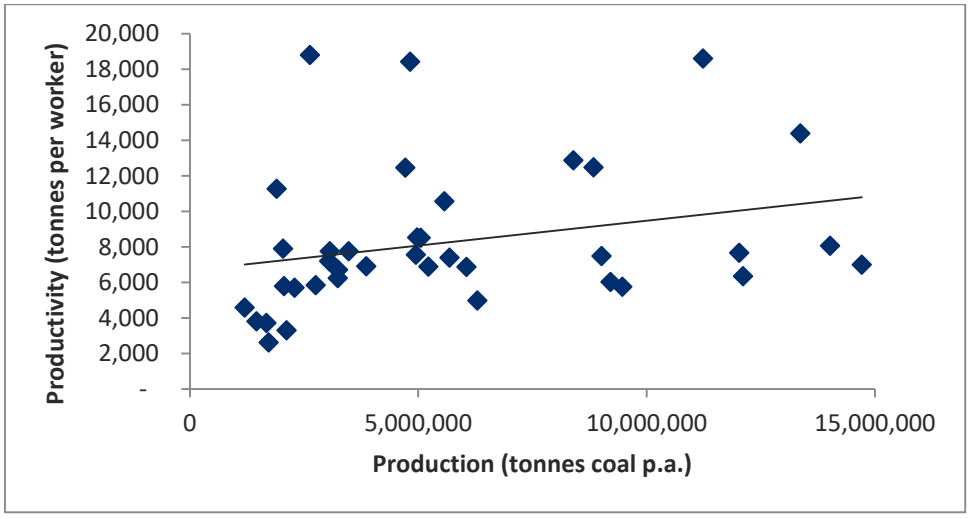
If the world is to avoid dangerous climate change it will use less coal, not more. Indeed, the latest World Energy Outlook from the International Energy Agency states:

> Against a background of falling coal use in Europe, the United States and China, global coal demand fell by 2% in 2016, for the second year in a row.[1]

With demand for coal declining, or at best stable, production from new mines will come at the expense of existing mines. In Australia, the world's largest coal exporter, large new thermal coal mines in the Galilee Basin would displace some amount of coal production in regions such as the Hunter Valley in NSW and Queensland's Surat and Bowen Basins.

The displacement of coal production also displaces employment in these mines. Making matters worse, Galilee Basin mines will be very large and highly automated, employing fewer people per tonne of coal produced. Replacing relatively job-intensive smaller mines with larger, more-automated mines will reduce employment. The trend for larger mines to employ fewer people relative to coal production is evident in existing Queensland and NSW mines, shown in Figures 1 and 2 below.

Figure 1: Worker productivity and production, Queensland

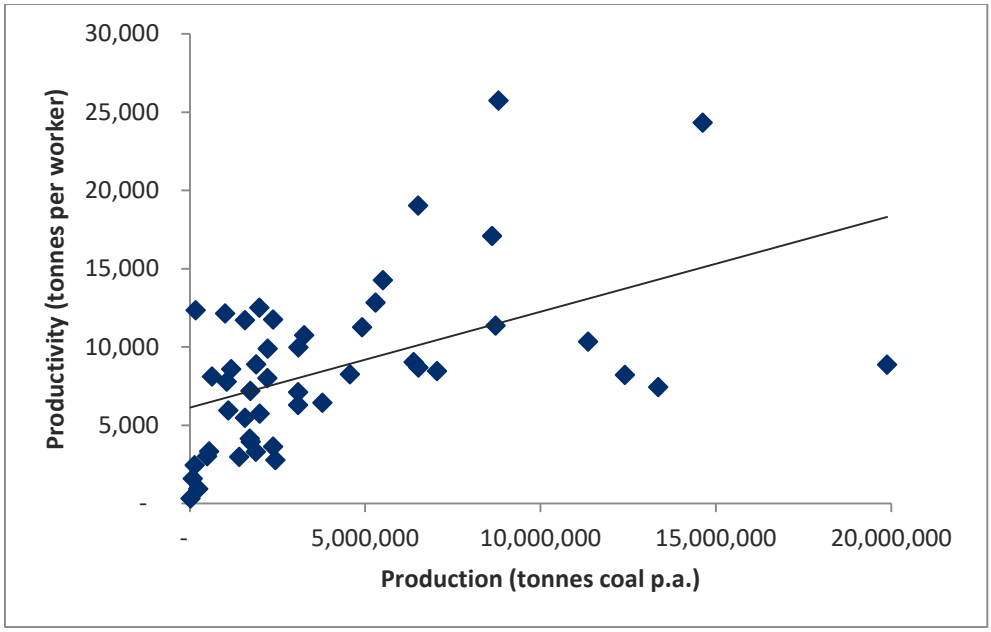


Source: Department of Natural Resources and Mines (2017) *Coal industry review tables 2016-17,* https://data.qld.gov.au/dataset/coal-industry-review-statistical-tables/resource/1b7fb643-c880-42bf-940b-fc3c582d239d; Queensland Government (2017) *Mining industry worker*

[1] IEA. (2017). *World Energy Outlook 2017*, p 203. https://www.iea.org/weo2017/

numbers, https://www.business.qld.gov.au/industries/mining-energy-water/resources/safety-health/mining/accidents-incidents/safety-performance[2]

Figure 2: Worker productivity and production, NSW



Source: Department of Resources and Energy (2014) *NSW Coal Industry Profile 2014 – Volume 1*

The upward sloping lines in Figures 1 and 2 show that, in general, larger mines use fewer workers to produce a given amount of coal. The mines proposed for the Galilee Basin are far larger than all those represented in Figures 1 and 2. The best known is Adani's Carmichael mine, which aims to produce 60 million tonnes per year, three times more than the highest producing mine in Figure 2.[3]

Galilee Basin proponents are aiming to have highly automated mining operations. Adani has stated that it plans to automate the Carmichael coal mine in the Galilee Basin, with CEO of Adani Mining Jeyakumar Janakaraj saying:

[2] Note: This analysis excludes four outliers. Newlands Suttor Creek would have an output of 19 tonnes per worker, but this is a consequence of the mine winding down production in 2016-17. Three other mines – Burton Coal, Commodore and Kogan Creek – all report productivity of over 40,000 tonnes per worker. This is more than double the productivity of the next most productive mines. Commodore and Kogan Creek supply nearby power stations. Burton Coal went into care and maintenance.

[3] The highest production mine in Figure 2 is BHP's Mt Arthur mine in the Hunter Valley, which produced 19.88 million tonnes of saleable production in 2013-14.

> We will be utilizing at least 45, 400-tonne driverless trucks. All the vehicles will be capable of automation. When we ramp up the mine, everything will be autonomous from mine to port. In our eyes, this is the mine of the future.[4]

The planned automation of the Adani mine (and other Galilee mines) will not only reduce the number employed, but also affect where these jobs are distributed. Existing automation and remote-operation technology has led to mining jobs being concentrated in capital cities. For example, the centralised Iron Ore Operational Control Centre in Perth is one of the pillars of Rio Tinto's *Mine of the Future* scheme,[5] which has been developing and deploying remote and automated technology for 10 years. One-fifth of the Rio Tinto truck fleet is autonomous, including some iron ore mines that have only autonomous trucks in operation, and new railway tracks will be compatible with fully autonomous rail.[6]

Despite the political and media focus on Adani and jobs, the extent to which Galilee Basin Development would displace employment in existing Australian mines has not been widely researched. The well-publicised Adani job claims are based on analyses that do not consider this effect. Adani's preferred 10,000 job claim makes no consideration of the wider coal industry, while Adani's evidence in the Queensland Land Court estimating direct and indirect average employment increase of 1,464 jobs assumes no change in the coal price and therefore no change to the viability of other Australian coal projects.[7]

Analysis of how Galilee Basin development would affect other coal producing areas has not been conducted by Australian government agencies. The Department of Industry's Office of the Chief Economist confirmed in answers to questions on notice in 2017 that it does not conduct analysis on potential price impacts of changes to Australian coal

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[4] ANZ Business Chief. (2015). *Adani Mining: Investing in Queensland.* ANZ Business Chief. 13 April 2015. http://anz.businesschief.com/Adani-Mining-Pty-Ltd/profiles/137/Adani-Mining:-Investing-in-Queensland

[5] Rio Tinto. (2018). *Pilbara: Mine of the Future*. http://www.riotinto.com/australia/pilbara/mine-of-the-future-9603.aspx and http://www.riotinto.com/japan/growth-and-innovation-19795.aspx

[6] Rio Tinto. (2016). *Driving productivity in the Pilbara.* http://www.riotinto.com/ourcommitment/spotlight-18130_18328.aspx ; Rio Tinto. (2016) *Annual report 2016,* p 33. http://www.riotinto.com/documents/RT_2016_Annual_report.pdf

[7] See GHD (2013) *Carmichael Coal Mine and Rail Project SEIS Report for Economic Assessment*, http://eisdocs.dsdip.qld.gov.au/Carmichael%20Coal%20Mine%20and%20Rail/SEIS/Appendices/Appendix-E-Economic-Assessment-Report.pdf and Fahrer (2015) Carmichael coal and rail project: economic assessment, expert report to the Queensland Land Court. Note that Fahrer's analysis does estimate an impact on other mining projects from increased demand for mining labour and other inputs, but no consideration is given to competition within the coal market.

production. Instead, it conducts "broad analysis on coal markets, including global prices".[8]

While Adani and governments have not researched the impact of Galilee Basin development on employment in other coal regions, in 2017, commodity analysts Wood Mackenzie were commissioned by the owners of the world's largest export coal port, the Port of Newcastle, to model the impact that the development of the Galilee Basin would have on volume of coal produced in other regions in Australia.[9] This analysis provides a starting point for estimating employment impacts.

[8] Department of Industry, Innovation and Science. (2017). *Answers to Questions on Notice, Economics Legislation Committee, 2016-17 Additional Estimates, Question No.: AI-88.*

[9] Reported in Long, S. (2017). *Galilee Basin mines will slash coal output, jobs elsewhere, Wood Mackenzie says.* ABC News. 6 July 2017. http://www.abc.net.au/news/2017-07-06/galilee-basin-mining-project-will-reduce-coal-output:-research/8682164

Volume analysis

Wood Mackenzie estimated the impact on other coal regions of the Galilee Basin producing up to 150 million tonnes per annum (Mtpa) of thermal coal. An increase of 150 Mtpa is greater than the capacity of the Adani project alone, but is less than the approximately 200 Mtpa total capacity of all Galilee Basin projects.

The 150 Mtpa would represent an increase in the supply of traded coal of around 15%. Wood Mackenzie estimated that the Galilee Basin production would begin to come online from 2023, keeping coal prices lower than would otherwise have been the case – around $3 per tonne lower in 2026, increasing to $25 per tonne lower in 2030.

These lower prices lead to delays or cancellations of other coal projects in Queensland and NSW under Wood Mackenzie's modelling. Eleven mines in NSW and eight in Queensland would be affected, seeing production from Hunter, Bowen and Surat basins lower than would have occurred in the absence of Galilee development.

Importantly, Wood Mackenzie's modelled scenarios effectively assume the world takes little action on climate change. Both scenarios modelled by Wood Mackenzie see world demand for traded thermal coal increase by around 10% to 2035 and Australian thermal coal exports increase substantially. By contrast, the International Energy Agency models the thermal coal trade as declining by 60% in 2040 if the Paris targets are achieved.[10] The effect of Galilee Basin development on other coal regions would likely be greater still if policies to reduce emissions are successful.

The Wood Mackenzie analysis focuses on coal volumes and price, rather than on employment impacts. It does not provide an estimate of how many jobs could be affected in New South Wales and other Queensland coal regions if Galilee Basin production proceeds. This question is addressed here firstly by applying average and marginal labour productivity rates in existing mines to Wood Mackenzie estimates of reduced coal production. Secondly, we consider the potential employment numbers of identified mines and proposed mines that will be affected — either delayed or cancelled — due to the price effects and output from the Galilee Basin.

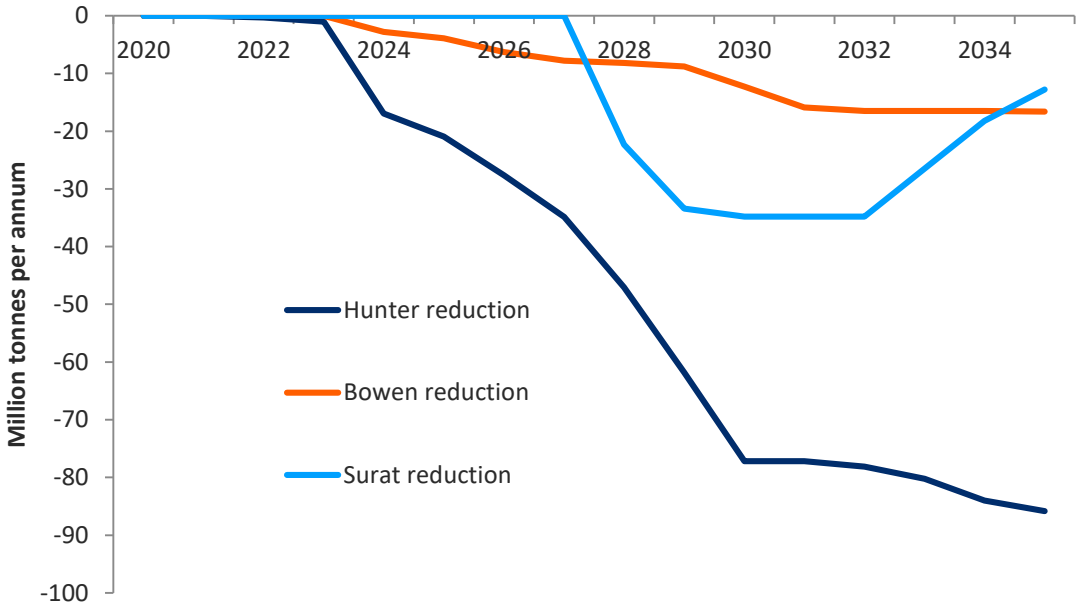
[10] International Energy Agency (2017) *World Energy Outlook 2017*, https://www.iea.org/weo2017/, see Table 5.1 World coal demand, production and trade by scenario, p207

Additionally, the automation of the Galilee coal production chain is likely to affect the location of mining jobs associated with this coal production, with control of automated process likely to be established in capital cities, leading to less regional employment.

Reduced volume

Wood Mackenzie estimated the impact of Galilee Basin development on the volume of thermal coal produced by three other coal producing areas, or potential areas: the Hunter Valley (NSW), the Bowen Basin and the Surat Basin (both in Queensland). Figure below summarises the estimated future declines in coal production in these three regions compared with the scenario of no coal production from the Galilee Basin.

Figure 3: Reduced coal production volumes with Galilee Basin production



Source: Long, S. (2017). Galilee Basin mines will slash coal output, jobs elsewhere, Wood Mackenzie says

Figure shows that the Hunter Valley is most affected by Galilee Basin development, as it has the most existing thermal coal mines. The Bowen Basin is least affected, as many of its mines produce high grade metallurgical coal, a market that would be largely unaffected by the increase in supply of low-grade thermal coal from the Galilee Basin. Wood Mackenzie's analysis accounts for the coal quality of different mines.

Figure also shows that coal production in the Surat Basin is affected later, as most of its mines are currently little more than proposals for new thermal coal mines. Wood Mackenzie expects that in the absence of Galilee Basin production, these Surat Basin mines will come into production in the late 2020s. Large scale production from the Galilee Basin would delay this start into the 2030s, which is why Figure shows the effect on Surat Basin coal production reducing in that period.

Job displacement

EMPLOYMENT INCREASES IN THE GALILEE BASIN

The Adani coal mine is expected to employ 3,920 people (according to the Queensland Department of State Development).[11] This is similar to figures Adani provided in its SEIS, where it said that the mine's operational workforce would be 3,400–3,800 people for most of its lifespan.[12] It is unclear what impact Adani's plans to fully automate the mine would have on these estimates, which appear to include minimal levels of automation.

60 million tonnes from 3,920 employees is equivalent to 15,306 tonnes per person employed per year. This would make the Adani project the second most productive mine per worker in Australia according to the data in Figures 1 and 2.

Wood Mackenzie assesses Galilee Basin coal production up to 150 million tonnes per year, including Adani.[13] Assuming that other Galilee Basin mines have the same labour productivity as the Adani mine is claimed to have, between 7,840 and 9,800 people would be employed per year.

[11] Department of State Development, Manufacturing, Infrastructure and Planning. (2018). *Carmichael Coal Mine and Rail Project Overview*. https://www.statedevelopment.qld.gov.au/assessments-and-approvals/carmichael-coal-mine-and-rail-project.html

[12] GHD. (2013). *Report for Carmichael coal mine and rail project SEIS – Economic Assessment.* http://eisdocs.dsdip.qld.gov.au/Carmichael%20Coal%20Mine%20and%20Rail/SEIS/Appendices/Appendix-E-Economic-Assessment-Report.pdf

Note: The Queensland Land Court heard evidence from Adani based on a 40 million tonne per year version of the project. Peak project employment under that version was estimated at 1,717 people in 2045, with an average over the life of the project around 1,500.

[13] Long, S. (2017). *Galilee Basin mines will slash coal output, jobs elsewhere, Wood Mackenzie says*. ABC News. 6 July 2017. http://www.abc.net.au/news/2017-07-06/galilee-basin-mining-project-will-reduce-coal-output:-research/8682164

IMPACTS ON EMPLOYMENT IN OTHER COAL REGIONS

Average productivity

Employment impacts of Galilee Basin development can be estimated in a variety of ways. The simplest is to take existing average labour productivity figures and assume they hold for the mines in each basin.

In 2016-17, Queensland produced 238m tonnes of coal with 30,925 workers - each employee produced on average 7,684 tonnes of coal.[14] The most recent figures available for NSW are for 2013–14, where 22,262 people produced 261.0 million tonnes of saleable coal, or 8,832 tonnes per person per year on average.[15] In Table 1 below, these average labour productivity figures are applied to Wood Mackenzie's estimates of relative reduction in coal output in each region in 2035:

Table 1: Relative employment reduction with Galilee, average productivity

Region/Time	Relative reduction in production (Mtpa)	Productivity (tonnes per worker)	Relative employment reduction
Hunter Valley	86	8,832	9,737
Bowen Basin	17	7,684	2,212
Surat Basin	13	7,684	1,692
Total	*116*		*13,641*

Sources: Qld DNRM (2017), NSW DRE (2014), Long (2017)

Table 1 shows that coal mine employment would be expected to be 13,641 lower in the Galilee development scenario than under the no-Galilee scenario. Impacts are greatest in the Hunter, 9,737 lower, 2,212 lower in the Bowen Basin and 1,692 lower in the Surat Basin.

[14] Queensland Department of Natural Resources and Mines (2017) *Coal industry review tables 2016-17*, https://data.qld.gov.au/dataset/coal-industry-review-statistical-tables

[15] The Coal Industry Profile 2014 breaks down coal production by region, but uses a narrower definition for the Hunter Valley than the Wood Mackenzie report does. As such, an overall figure for NSW has been used. Division of Resources and Energy. (2014). *NSW Coal Industry Profile 2014 – Volume 1,* p 1, 16–17. https://www.resourcesandenergy.nsw.gov.au/__data/assets/pdf_file/0005/664826/CIP-2014-Vol-1-final.pdf

Marginal productivity

Estimates based on averages have the benefit of simplicity, but from an economic point of view the marginal change in coal output per worker is more useful. Productivity may differ due to any economies or diseconomies of scale in each region.

To estimate the marginal productivity of an additional worker at a coal mine, data from 2011-12 to 2016-17 on Queensland and New South Wales coal mine output and employed workforce are used to estimate a linear model of the relationship between mine output and workforce, accounting for factors such as mine type (underground or open cut) in each coal region. For each coal region, the average workforce and output per year is used for each of the mines where data is available on production and workforce over this period. The equation:

$$Workforce_i = \alpha + \beta Coal\ Output_i + \gamma Underground_i + \varepsilon_{i,j}$$

is estimated each *i* mine in the Bowen Basin, Surat Basin, and Hunter Valley. The output of these regression estimates for each coal region is in Table , with the coal output variable significant in all regions, and the effect of underground mining, unexpectedly, having little average effect on mine workforce.

Table 2: Regression results for each coal region

	Bowen Basin	Surat Basin	Hunter Valley
Coal output (Mt) (β)	121.4***	106.5***	106.0***
Underground (γ)	-50.1	NA	161.9*
Intercept (α)	130.2	-88.3	-18.8
R squared	0.70	0.76	0.74
N	31	8	40
** significant at 10%, ** significant at 5%, *** significant at 1%.*			

Sources: Queensland Government. (2017). *Mining industry worker numbers.* https://www.business.qld.gov.au/industries/mining-energy-water/resources/safety-health/mining/accidents-incidents/safety-performance; Department of Resources and Energy. (2014). *NSW Coal Industry Profile 2014 – Volume 1.* https://www.resourcesandenergy.nsw.gov.au/__data/assets/pdf_file/0005/664826/CIP-2014-Vol-1-final.pdf.[16]

[16] Note: QLD mines apply average output from 2012-13 to 2016-17 to reported workforce in 2014 for Blackwater, Caval Ridge, Clermont Coal, Curragh, Daunia, Ensham OC, Foxleigh, Jellinbah East, Middlemount, Minerva, Yarrabee, German Creek – Grasstree, Kestrel, Oaky Creek No 1, Oaky North, Collinsville Opencut, Coppabella, Goonyella – Riverside, Hail Creek, Isaac Plains, Lake Vermont, Millennium, Moorvale, Newlands, Peak Downs, Poitrel, Saraji, South Walker Creek, Carborough Downs, Moranbah North, North Goonyella, Callide & Boundary

In this model the coefficient estimate of each region's coal output variable is the marginal effect of an additional million tonnes of coal output on jobs for typical mines in that region. The marginal effect relationship can then be applied to Wood Mackenzie's forecast relative output reductions to estimate the employment impact.

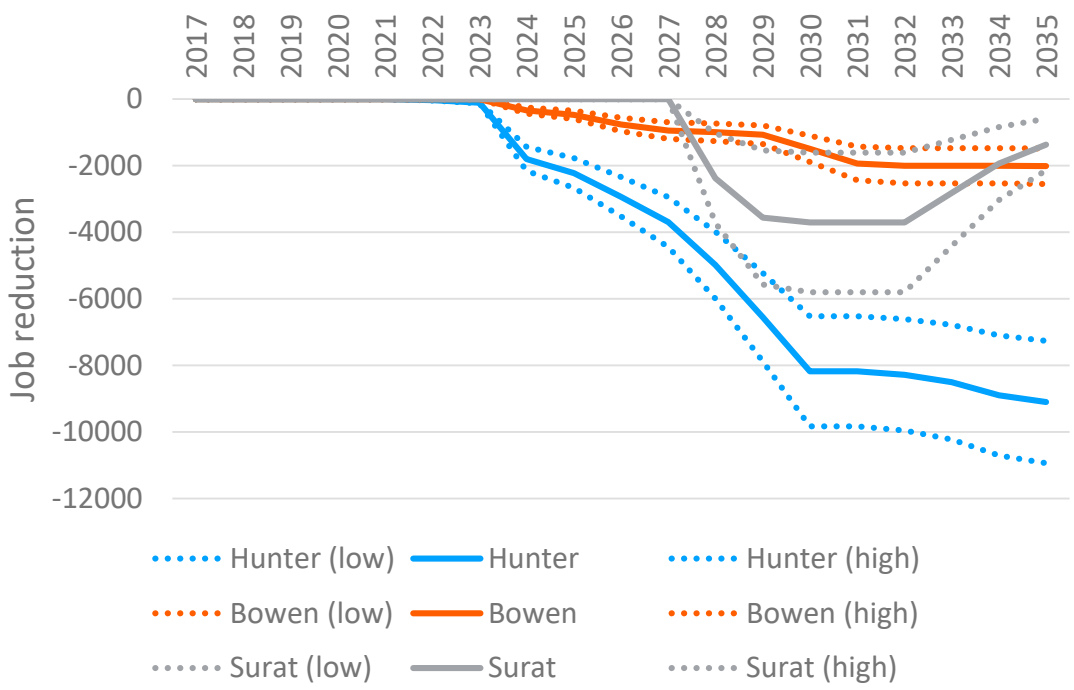
The significant coefficient for coal output in all regions represent the number of jobs related to a 1Mt change in coal output. In the Hunter Valley, for example, there are 106 mining jobs per additional Mt of coal output. Or in other words, an additional worker is associated with an increase in mine output of 9,433 tonnes per year. These relationships between output and workforce in each region that exist in the data for established mines can then be applied to the estimated changes in coal output from Wood Mackenzie to determine an estimate of jobs effect in those regions.

An alternative model specification that did not break coal output into regional associations, but instead applied regional dummy variables, was also tested. The coefficient of 112.3 for coal output, not surprisingly, was around the average of the regional estimates. However, because the Wood Mackenzie estimates of relative volume reduction are regional in nature, the current approach better serves this purpose by matching marginal output and jobs at a coal region level.

Mapping this marginal relationship between coal output and jobs in each region to the relative production reductions estimated by Wood Mackenzie gives the likely job impacts over time in the three regions, shown in Figure 4 below. Note that the dashed lines are the 95% confidence intervals around the coefficient estimates of the coal output variable for each region.

Hill, Cameby Downs, Commodore, Dawson, Kogan Creek, Meandu, and New Acland. NSW mines apply average output from workforce for 2011-12 to 2013-14 for Rolleston, Angus Place UG, Appin UG, Ashton UG, Austar UG, Bulga UG, Chain Valley UG (b), Dendrobium UG, Mandalong UG, Metropolitan UG, Narrabri UG (c), Springvale UG, Tahmoor UG, Ulan UG, Wambo UG, West Cliff UG, West Wallsend UG, Abel UG, Clarence UG, Myuna UG, Bengalla OC, Bloomfield OC, Boggabri OC, Drayton OC, Duralie OC, Hunter Valley Operations OC, Liddell OC, Mangoola OC, Moolarben OC, Mt Arthur Coal OC, Mt Owen OC, Mt Thorley Warkworth OC, Muswellbrook OC, Ravensworth North OC (d), Rix's Creek OC, Rocglen OC, Stratford OC, Tarrawonga OC, Ulan OC (e), Wambo OC, and Wilpinjong OC.

Figure 4: Coal industry job impacts in affected regions (dashed 95% con. intervals)



As shown in Table 1, Wood Mackenzie's scenario of relatively lower coal production in these regions of 116m by 2035 would reduce coal employment by around 12,480 jobs relative to no-Galilee Basin under current coal productivity figures.

Table 1: Approximate employment losses per region (in 2035)

Region/Time	Relative reduction in production (tonnes p.a.)	Assumed productivity (tonnes per employee)	Employment reduction
Hunter Valley	86,000,000	9,432	9,102
Bowen Basin	17,000,000	8,240	2,015
Surat Basin	13,000,000	9,389	1,363
Total	*116,000,000*		*12,480*

Notes: Tonnes per employee is one million divided by the coal output coefficient estimates for each region.

Table 2 shows that under this method, relative employment declines would be slightly lower than under the average productivity method above. The Hunter would experience 9,100 fewer workers, 2,000 fewer in the Bowen Basin and around 1,360 in the Surat Basin, compared to the no-Galilee development scenario.

Estimated workforce in impacted mines

An alternative approach is to consider the estimated workforces that would be engaged in mines that Wood Mackenzie forecasts will be delayed or scrapped under the Galilee development scenario. Many of these projects have published estimates of their workforce, while others have been estimated using state productivity rates to calculate relative job losses from their expected production declines. The results of this analysis are in Table 2 and 4 below:

Table 2: Employment in impacted Queensland coal mines

Mine	Extant	Basin	Predicted coal output p.a. (tonnes)	Jobs (provided)	Jobs (estimated)
Bowen Basin					
Drake	Y, operating	Bowen	6m	>150[17]	
Ensham	Y, operating	Bowen	4.5m	550[18]	
Meteor Downs South	N, advanced	Bowen	1.5m[19]		195
Springsure Creek	N, advanced	Bowen	11m	585[20]	
West Rolleston	Y, operating, planned expansion	Bowen	7.5–12.5m[21]		976–1,846
Bowen sub-total			*30.5–35.5m*	*2,456–3,326*	
Surat Basin					
Collingwood	N	Surat	6m[22]		780
The Range	N, deposit	Surat	6.3m[23]		820
Wandoan	N, deposit	Surat	22m[24]	844	
Surat sub-total			*34.3m*		*2,444*
Queensland Total			*64.8–69.8m*	*4,900–5,552*	

[17] QCoal Group. (2018). *Our Projects: Drake Mine*. http://qcoal.com.au/our-projects/drake-mine/

[18] Idemitsu. (2018). *Operations: Ensham Resources*. https://www.idemitsu.com.au/operations/ensham-resources/

[19] UD Coal. (2018). *Projects: Meteor Downs South*. http://www.udcoal.com.au/default.asp?section_id=34

[20] DEHP. (2018). *Environmental Impact Statement: Springsure Creek Coal Mine Project*. Department of Environment and Heritage Protection. Queensland Government. https://www.ehp.qld.gov.au/management/impact-assessment/eis-processes/springsure-creek-coal-project.html

[21] Ker, P. (2011). *Xstrata gives green light to Rolleston expansion*. Sydney Morning Herald. 18 May 2011. http://www.smh.com.au/business/xstrata-gives-green-light-to-rolleston-expansion-20110517-1erd6.html

[22] State Development. (2018). *North Surat - Collingwood Coal Project*. Department of State Development, Manufacturing, Infrastructure and Planning. Queensland Government. https://www.statedevelopment.qld.gov.au/assessments-and-approvals/north-surat-collingwood-coal-project.html

[23] DEHO. (2018). *Environmental Impact Statement: The Range Project*. Department of Environment and Heritage Protection. Queensland Government. https://www.ehp.qld.gov.au/management/impact-assessment/eis-processes/the-range.html

[24] Xstrata Coal. (2018). *Wandoan Coal Project - Environmental Impact Statement*. https://www.statedevelopment.qld.gov.au/resources/project/wandoan-coal-project/eis-integrated-exec-summary.pdf

Sources: See footnotes for company estimates. Other mines estimated with state-wide productivity average.

Table 3: Employment in impacted Hunter Valley coal mines

Mine	Predicted coal output p.a. (tonnes)	Jobs (Coal Industry Profile)	Jobs (estimated)
Austar and modification	3.6m	473 (current), 275 (modification)	
Dartbrook	4m		453
Ferndale	3m		340
Mt Penny	5m		566
Mt Pleasant	8m	340	
Mt Pleasant (new)	8m		906
Mt Thorley	2.8m	1,300	
Mt Thorley (underground)	4m		
Tarrawonga	2.1m	159 (current), 140 (extension)	
Vickery	3.6m	200	
Wallarah 2	4m	300	
Watermark	5m	500	
West Muswellbrook	15m		1,698
Total	*66.6m*		*7,650*

Sources: Division of Resources and Energy. (2014). *NSW Coal Industry Profile 2014 – Volume 1.*Note: Mines not estimated in DRE (2014) estimated with state-wide productivity average. In some cases, Wood Mackenzie's predicted coal output is lower than the mine's capacity according to DRE (2014).

Tables 3 and 4 show larger relative declines in output (130 Mtpa instead of 116Mtpa) and similar effects on employment (between 12,550 and 13,420) compared to the estimates above. The main reason for the higher output estimate is that data from government and proponent sources is for peak expected output for each mine. Many of these estimates are likely to be optimistic and in any particular year it is unlikely that all mines would have been operating at their peak. However, the data on mine workforce is more likely to be an average, rather than peak, with some proponents publishing a workforce range instead.

Regardless of the method used, the estimates of relative employment reduction are similar. Somewhere between 12,480 and 13,641 fewer people would work in Hunter, Bowen Basin and Surat Basin thermal coal mines with Galilee Basin development in 2035. The Galilee Basin itself would likely employ between 7,840 and 9,800 people. Overall, this would see a relative reduction of employment of between 2,680 and 5,801 workers in the coal industry overall.

Effects of automation

The sections above base estimates of Galilee Basin mine employment on submissions by Adani to state planning processes. It is unclear what degree of automation those estimates envisage, though the opportunity to automate in new coal basins is greater than in other coal mining regions with established mine and rail infrastructure. This is one of the reasons that there are likely to be net jobs losses in coal mining from development of the Galilee Basin even though there will be a net increase in Australian coal production — coal production from a highly labour-efficient automated 'mine to port' system will be offsetting coal production from established coal mining regions with less scope for whole-of-production chain automation. The automation of the Galilee also will affect the location of the jobs it creates, with control of automated functions likely to occur from capital city head offices.

Research from the University of Queensland, partly funded by the mining industry, into autonomous and remote-operated mining outlines a number of likely consequences of these technologies for employment. The research found that, in open pit iron ore mines, a fully autonomous haul truck fleet would reduce in-pit roles by 50%, for an overall decrease in the mine workforce of 30–40%. There are also autonomous drilling rigs and underground equipment that could replace workers.[25]

Existing remote operations centres have been mostly set up in capital cities, increasing employment there but at the expense of regional centres. The University of Queensland researchers only found one example of a regional town having a remote operations centre at the time of writing in 2013, with the remainder being placed in capital cities. Because of increased competition and lower risk, remote operators working in capital cities may also receive lower salaries. The study found that when remote operations centres were built in capital cities, residential employment near the mines would fall.[26]

Fewer on site roles, which subsequently reduce the number of mine-related jobs in regional areas, is "likely to reduce town populations, economic activity in the local and regional area and population-driven social services". In scenarios where remote

[25] McNab,K.,et. al. (2013). *Exploring the social dimensions of autonomous and remote operation mining: Applying Social Licence in Design*. Prepared for CSIRO Minerals Down Under Flagship, Mineral Futures Collaboration Cluster, Sustainable Minerals Institute, The University of Queensland. https://www.csrm.uq.edu.au/publications/exploring-the-social-dimensions-of-autonomous-and-remote-operation-mining-applying-social-license-in-design

[26] *Ibid.*

operations were placed in capital cities, the regional towns saw decreased population, average annual expenditure and services.[27]

The research also found that automation and remote operations would disproportionately affect Aboriginal Australians, both because a disproportionate share of Aboriginal people are employed in mining (21% of Aboriginal employment in the Pilbara, for example) and because most Aboriginal employees live regionally (up to 90% in some cases). This potentially threatens commitments from both industry and government to increase Aboriginal employment in mining.[28]

Due to automation and remote control, many of the jobs created in the development of mining in the Galilee Basin are likely to be in major cities, rather than near to the mines themselves.

[27] *Ibid.*

[28] *Ibid.*

Conclusion

Debate around the impacts of future coal development have often focused on the Adani Carmichael mine and the competing claims around how many jobs that project would result in. Despite Adani's own economist telling the Queensland Land Court that the project would see employment increase by less than 1,500, supporters of the project and the company itself resolutely repeat the fabled 10,000 jobs claim. Prime Minister Turnbull went further still proclaiming "tens of thousands of jobs".[29]

None of these estimates consider some basic points. Firstly, the Adani project is unlikely to proceed in isolation. Other projects in the Galilee Basin would be likely to go into production if infrastructure for Adani's mine is built.

This leads to the second point – the Galilee Basin mines would represent a significant expansion of the traded thermal coal market. This expansion would push down coal prices and see some competing mines not proceed or leave the market. Some of these mines will be in Australia.

Despite these important points, no analysis has been conducted on the impacts of Galilee Basin development on the country's other main coal producing regions. On the contrary, stakeholders such as NSW Minister for Resources Don Harwin have dismissed the need for any analysis, saying he is "comfortable and not concerned about ongoing coal exports".[30]

Harwin's lack of concern is based on his belief that the lower ash content of NSW coal makes Galilee Basin coal irrelevant to his state. This is like one brewer ignoring a new brewery entering the market because their beer is slightly stronger. If the price of XXXX Gold reduces by 15 percent with the assistance of government subsidies, it is unlikely the makers of Carlton Draft would pay no attention due to their slightly different alcohol contents.

Furthermore, this analysis is based on an assumption of expanding coal demand and export sales when the latest data and many projections are for declines. The Paris Agreement makes it clear that the world needs to burn less coal, not more. The level of

[29] Kenny (2017) Adani mine edges closer after Malcolm Turnbull's India visit, https://www.smh.com.au/politics/federal/adani-mine-edges-closer-after-malcolm-turnbulls-india-visit-20170411-gvilmk.html

[30] Legislative Council Hansard (2017) Adani Carmichael Coalmine Proposal Impact, https://www.parliament.nsw.gov.au/Hansard/Pages/HansardResult.aspx#/docid/HANSARD-1820781676-73150

automation that Galilee Basin development would see is also unclear, but appears to be optimistically low in much of the above analysis.

Australia's governments need to address the question of the likely impacts of Galilee Basin Development. The federal Office of the Chief Economist, NSW Resources and Energy and the Queensland Department of Natural Resources, Mines and Energy should investigate this in detail as part of a plan for transitioning our coal regions into a carbon constrained future.