Weathering the storm: The case for transforming the Hunter Valley

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Executive Summary

In this report we analyse the consequences for the Hunter Valley of the decline in thermal coal demand which will occur as the world takes action to implement the Paris Agreement climate change goals and the UN Sustainable Development goals.

We provide two very different representations of the future:

1. A business as usual approach where few adjustments are taken to prepare for the change in thermal coal demand
2. An active approach where the region diversifies significantly in preparation for change

There are enormous risks and impacts if the region does not prepare for the global changes that are underway. Over 5,000 jobs and $700M in wages and salaries could be lost if predicted global declines in coal occur and the Hunter Valley is not prepared for those changes.

However, if action is taken now to prepare for the changes that are coming and to diversify the Hunter economy, then it is possible to buffer the region and increase employment and wages.

This analysis outlines a scenario which would see 595 more jobs created than are lost from coal mining and local wages and salaries increase by $35M in 2040. This scenario indicates that the Hunter can develop more labour-intensive industries than coal mining, providing jobs and income for the region, even as coal production declines.

Crucial to such a positive and fair transition coming to fruition is immediate action from governments to establish a transition process that involves all stakeholders, to invest substantial resources in key industries and to prioritise workforce re-training and skills development.

Background

The Hunter Valley in New South Wales is the heart of Australia's thermal coal industry and the local economy is deeply rooted in coal mining and exports. Thus, the economic future of the region is intimately bound up with global efforts to prevent dangerous climate change.

The coal mining industry in the Hunter Valley is concentrated in the local government areas of Singleton and Muswellbrook and contributes 58% of the economic output of these two shires. Mining represents 31% of all jobs in Muswellbrook and 41% of jobs in Singleton.

This makes the two shires vulnerable to changes in coal demand and markets, particularly in Asia, where close to 90% of the coal mined in the Hunter Valley is burned. For example, when coal demand and prices fluctuated from highs of $166 in 2008 to lows of $83 in 2014, employment in the coal mining industry fell by 25% in the three years to 2014.

Methodology

This report sets out to investigate two questions:

1. What would be the economic impact on two local government areas in the Hunter if the coal industry contracts in line with predictions for meeting global climate change and development goals?

2. What opportunities are there for the Hunter to diversify and prepare for that challenge by beefing up other employment and economic opportunities that make use of the region's existing skills, knowledge and natural resources?

This report uses the International Energy Agency's World Energy Outlook forecasts for world coal demand and production under a Sustainable Development Scenario (SD). The Sustainable Development scenario assumes that the Paris Agreement climate change goals are met along with ensuring universal access to modern energy services. NSW and Federal Governments have both committed to meeting Paris Agreement goals and Australia is committed to the UN Sustainable Development goals.

Large cuts in coal production and demand must occur if the world is to meet these targets and this report is predicated on the 55% reduction in global coal demand to 2040 presented in the 2017 World Energy Outlook for the Sustainable Development Scenario.

We apply the coal forecast to an input-output model of the Muswellbrook and Singleton region to examine its economic impact. We use the input-output analysis as a visioning exercise to represent the future and to highlight the issues and opportunities for the region. We apply the analysis firstly based on business as usual without any efforts to prepare for change, and then apply it again based on economic diversification to prepare for the change.

Business as usual is not an option

The analysis indicates that there are far-reaching risks to the region under a business as usual scenario with no preparation for global coal decline.

Applying the input-output modelling described above foresees that in 2040 employment in the Hunter coal industry would fall by 5,199 jobs and wages and salaries by $706M if the world acts on climate change. This includes 2,064 jobs and salaries of $280M lost for Muswellbrook and Singleton residents.

Our analysis shows that a lack of economic diversity in Muswellbrook and Singleton means that workers will not be able to move into alternative employment while remaining in the region.

Our review of existing diversification planning and other relevant plans in New South Wales and the Hunter indicates an unwillingness by governments to undertake direct and funded actions to manage the contraction of coal mining.

In most cases existing plans do not provide concrete actions and programs, nor do they come with resources to stimulate diversification and shield the region from the economic consequences of coal market contraction.

In the absence of direct intervention and oversight, diversification is currently not occurring in the Hunter region. Instead of leaving the region to suffer economic contraction unaided, Federal, State and Local governments need to aid the transformation of Muswellbrook and Singleton.

A fair, positive transition is feasible

This analysis indicates that opportunities are available to diversify the economy of the Hunter region using the skills and assets it already possesses. This analysis identifies a positive transition scenario

which sees 595 more jobs created than are lost from coal mining and the direct change in local wages and salaries is positive by some $35m in 2040.

This scenario builds on the region's existing strengths in agriculture and manufacturing industries and on the strong skills base already present of machinery operators and drivers and technicians and trade workers.

We use a range of approaches to identify transition options, including where the Hunter already has comparative advantage, and where the region imports products that could be made locally. The positive transition scenario is based on the modelling of the following:

1. The potential for agriculture (particularly grape growing, horse farming and poultry farming) to provide new employment and income using land currently occupied by coal mining.
2. The replacement of Bayswater and Liddell power stations with renewable energy and storage of the same capacity.
3. Future expectations for tourism, manufacturing, transport and warehousing based on extrapolating growth rates and trends.
4. The continuous development of a renewable energy industry which exports renewable energy products and skills to other regions.
5. Environmental remediation, especially mine rehabilitation, which provides opportunities to transfer mining workforce skills in heavy and civil engineering.

The benefits of large expenditures on renewable energy and remediation will be greater where the income and supply-chain effects are retained within the region, which suggests the need for large-scale subsidisation of growth industries to support the renewable energy and remediation plans.

Recommendations

The opportunities highlighted in this report require support and systematic, targeted and coordinated oversight if they are to balance the decline of coal mining and provide jobs and income for people in Singleton and Muswellbrook.

With the right support, the transition scenario ultimately improves the employment and wages and salaries of local residents even with the sharp decline in coal production predicted. Therefore, we recommend the following measures to support the economic transformation of the region:

1. An independent transition process to ensure that resources are invested in the public interest to aid transition in both the electricity and mining sectors.
2. Support and subsidies for renewable energy and growth industries to ensure income and supply-chain benefits are retained with the Hunter region.
3. Support for the development of an environmentally-responsible container terminal in Newcastle, linked by rail to new enterprises in Singleton and Muswellbrook.
4. Collaboration between the NSW Government and AGL Macquarie and mining companies to ensure the required investment in renewable energy and mine rehabilitation takes place.
5. Review of all exploration and mining titles and the cancelling of titles which are deterring investment in sustainable rural industries whilst establishing buffers on equine and viticulture industries.
6. Coal mining companies to be levied to pay for retraining and skill development for the workforce.

1. Introduction

Sharp declines in coal demand and production will occur if the targets in the Paris Climate Agreement (United Nations 2016) and Sustainable Development Goals (SDGs) (United Nations n.d.) are met. Regions dominated by coal production, such as the Hunter region in NSW and particularly the Local Government Areas (LGAs) of Muswellbrook and Singleton, will suffer most. Given the NSW and Federal government's commitment to the Paris Climate Agreement and Australia's commitment to the SDGs, it is prudent and fair that immediate measures are put in place to prepare Muswellbrook and Singleton for the contraction in coal demand. In this report we conduct an economic analysis of the impact of a sharply declining global coal market on Muswellbrook and Singleton and the transition strategies needed.

The International Energy Agency's (2017) World Energy Outlook forecasts world coal demand and production under a Sustainable Development (SD) Scenario. The Sustainable Development scenario assumes that the SDGs are met and particularly SDGs 3, 7, 11, and 13 which relate to meeting the Paris targets, reducing energy related pollutants and deaths from pollutants, as well as achieving universal access to modern energy services. Large cuts in coal production and demand must occur if the world is to meet the targets and the World Energy Outlook 2017 forecasts a 55% reduction in global coal demand out to 2040.

We use the SD scenario and apply the coal forecast to an input-output model of the Muswellbrook and Singleton region. Input-output modelling is a form of economic impact analysis widely used by governments and by the mining sector itself when proposals for new mines are analysed. Input-output analysis maps the interdependencies of industries (Miller and Blair 2009) and can be used to show the direct effects of output changes on employment, wages and salaries as well as the indirect effects on the rest of the local economy through an analysis of supply chains and consumption patterns. The Australian Bureau of Statistics (ABS) (2018) publishes Input-Output Tables for the Australian economy and these can be modified for individual regions using various techniques (Miller and Blaire 2009, ch. 3). We engaged REMPLAN Economy (2017) to construct regional input-output coefficients for Muswellbrook and Singleton. REMPLAN Economy use Census (ABS 2016), and Place of Work data (ABS 2017) to modify the national input-output tables (ABS 2018).

Input-output analysis does have limitations. For example, as described in Miller and Blair (2009) the main criticism is that input-output analysis assumes fixed technical coefficients. Fixed coefficients mean that each industry is assumed to draw on the same set of inputs each year of the analysis. In addition, there are no economies of scale so a doubling of output in one industry will lead to a doubling of the industry's use of each input. Considering these criticisms and the long timeframe involved in the SD scenario, it should be kept in mind that we use the input-output analysis as a visioning exercise to represent rather than predict or forecast the future. The latter is an impossibility even with the most sophisticated economic modelling. [1] Our aim is to use the modelling

[1] As an alternative to input-output (IO) analysis, computable general equilibrium (CGE) analysis builds from the technical coefficients in IO tables and adds additional assumptions. For example, econometric analysis based on past behaviour is used to predict the reaction of firms, workers and consumers to price shocks and all economic agents are assumed to perfectly optimise, be perfectly informed and act within perfect markets. Often, CGE models assume full-employment and labour is assumed to be responding costlessly to changes in

to highlight the issues and opportunities for the region and emphasise the need for immediate government action. For example, our analysis highlights the dire employment outcomes and impacts on local wages and salaries that will occur under the sharp decline in coal production forecast under the SD scenario.

Instead of leaving the region to suffer this economic contraction unaided, Federal, State and Local governments could aid the transition of Muswellbrook and Singleton LGAs and avoid or alleviate economic disaster. We consider a range of approaches to transition and establish potential growth industries which Government must support. Using the concept of key industries and gap analysis we identify industries where Muswellbrook and Singleton businesses are currently importing goods and services. These goods and services could instead be produced within the LGAs. Shift-share analysis and location quotients allow us to establish industries where Muswellbrook and Singleton have a comparative advantage and strong recent growth. We analyse the occupations and skills prevalent in the mining sector and other industries where those skills may be employed in the future. We also review diversification reports for potential growth industries including the University of Newcastle's BioValley project which promotes an ecologically-sustainable future for the broader Hunter region.

More specifically, we draw upon future expectations in renewable energy construction and environmental remediation and we extrapolate growth rates and trends out to the future for agriculture, tourism, manufacturing, transport and warehousing to model a transition for the region. The transition scenario ultimately improves the employment and wages and salaries of local residents even with the sharp decline in coal production predicted under the SD scenario. However, the visioning exercise highlights the need for immediate government intervention and we outline the measures required.

2. The lack of diversity in Muswellbrook and Singleton

From an economic perspective, the Muswellbrook and Singleton LGAs are dominated by coal mining. Mining represents 31% of all jobs in Muswellbrook and 41% of jobs in Singleton.[2] Tables 1 and 2 below provide summaries of the areas of employment in each LGA.

wages including by leaving or entering regions. While often seen as more sophisticated or dynamic than IO analysis, CGE is not appropriate for the current study because it would impose many additional modelling costs without additional value (West 1995, p. 224). For example, as West (1995) shows, any impact will be more pronounced in IO analysis compared with CGE because prices and then workers, consumers and firms adjust in the CGE model to limit the impact. However, as we model both coal output reductions and output increases in transition industries, the negative and positive impacts under a CGE model would both be of a smaller magnitude than under the IO model. Thus, they would largely cancel each other out. In addition, in small regional economies the price changes that drive the CGE model will not occur because small open economies are price takers. Thus, in small regional economies, IO modelling is appropriate (Rose 1995, p. 291).

[2] Unless otherwise indicated, all data is derived from REMPLAN Economy (2017). REMPLAN Economy uses a variety of Australian Bureau of Statistics (ABS) data to construct regional input-output tables, and estimate Gross Regional Product, employment, and income. REMPLAN Economy 2017 (release 2) incorporates ABS 2016 Census Place of Work Employment (Scaled), ABS 2014/2015 National Input Output Tables, ABS June 2017 Gross State Product, ABS 2016 Census of Population and Housing (Scaled), ABS 2016/ 2017 Tourism Satellite Account, Tourism Research Australia 2015 Tourism Region Profile. All figures are estimates for the year 2017.

Table 1 Jobs in Muswellbrook

Industry Sector	Jobs in Muswellbrook (2017)	
Mining	3,120	31.15%
Electricity, Gas, Water & Waste Services	887	8.85%
Health Care & Social Assistance	694	6.93%
Retail Trade	679	6.78%
Agriculture, Forestry & Fishing	541	5.40%
Construction	515	5.14%
Accommodation & Food Services	505	5.04%
Public Administration & Safety	479	4.78%
Education & Training	441	4.40%
Other Services	366	3.65%
Administrative & Support Services	363	3.62%
Manufacturing	321	3.20%
Wholesale Trade	297	2.96%
Transport, Postal & Warehousing	275	2.75%
Professional, Scientific & Technical Services	244	2.44%
Rental, Hiring & Real Estate Services	95	0.95%
Financial & Insurance Services	70	0.70%
Arts & Recreation Services	67	0.67%
Information Media & Telecommunications	58	0.58%
Total	**10,017**	**100.00%**

Source: REMPLAN Economy 2017.

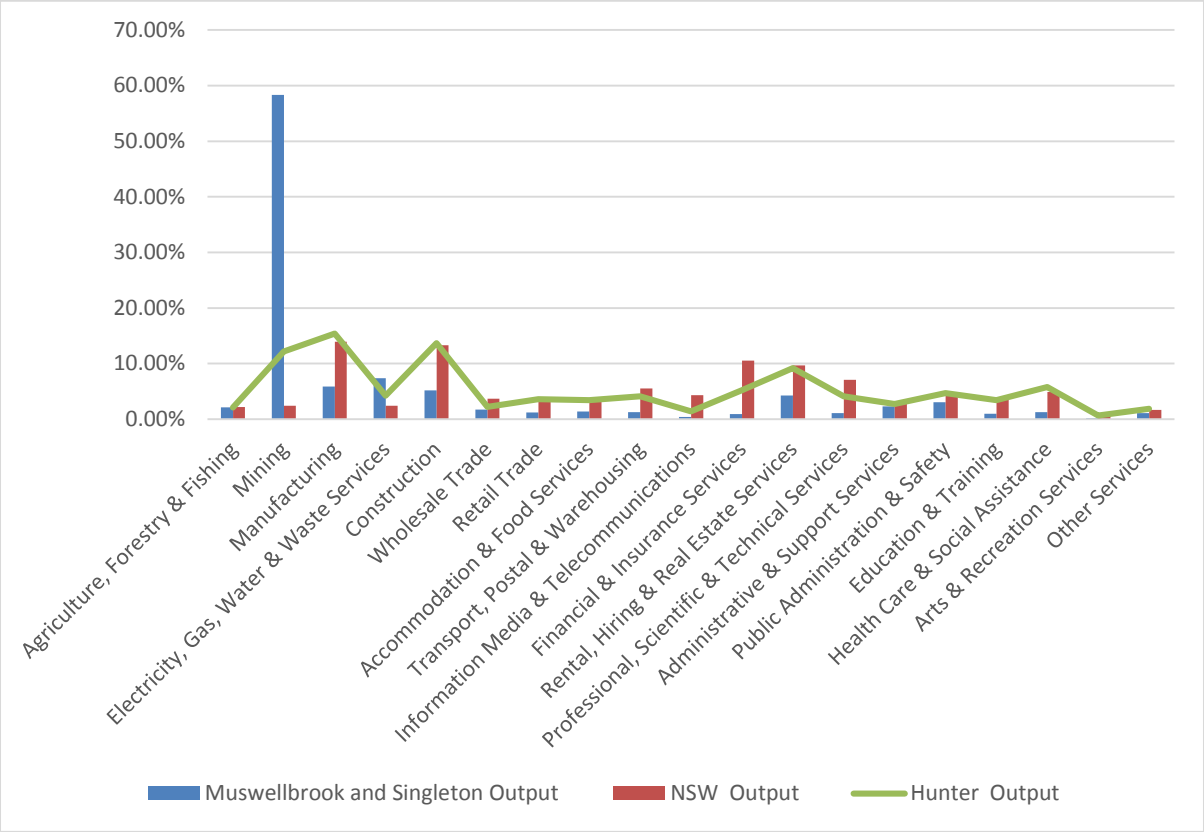
Table 2 Jobs in Singleton

Industry Sector	Jobs in Singleton (2017)	
Mining	6,626	40.59%
Public Administration & Safety	1,061	6.50%
Construction	950	5.82%
Retail Trade	931	5.70%
Accommodation & Food Services	878	5.38%
Health Care & Social Assistance	815	4.99%
Manufacturing	761	4.66%
Administrative & Support Services	739	4.53%
Education & Training	720	4.41%
Other Services	685	4.20%
Agriculture, Forestry & Fishing	455	2.79%
Transport, Postal & Warehousing	390	2.39%
Wholesale Trade	383	2.35%
Professional, Scientific & Technical Services	353	2.16%
Rental, Hiring & Real Estate Services	201	1.23%
Financial & Insurance Services	133	0.81%
Electricity, Gas, Water & Waste Services	121	0.74%
Arts & Recreation Services	73	0.45%
Information Media & Telecommunications	50	0.31%
Total	**16,325**	**100.00%**

Source: REMPLAN Economy 2017.

In addition to coal mining, Muswellbrook is also home to two large coal-fired power plants and an electricity distribution network that together employ 887 people and supply 12% of NSW's electricity. Singleton has a strong workforce in public administration and safety. As with most regions, the health, construction and retail trade sectors employ a large number of people and both LGAs are strong in accommodation and food services with Muswellbrook also strong in agriculture and Singleton in manufacturing. However, it is the relative lack of diversity that characterises the region. Mining output from the Muswellbrook and Singleton areas represents 58% of all output. Figure 1 illustrates the lack of diversity in Muswellbrook and Singleton relative to the Hunter region and NSW as a whole.

Figure 1 The relative lack of diversity in Muswellbrook and Singleton
(Based on 2017 output figures)



Source: REMPLAN Economy 2017.

There is a more even spread of industries in the Hunter and NSW compared to Muswellbrook and Singleton. As described in section 5, the lack of diversity creates a vulnerability and instability in the Muswellbrook and Singleton LGAs and reduces long-run growth. In particular, the potential exists for a major disruption in the region deriving from declining global coal demand as described in the next section.

3. The impact of a fall in coal demand

The International Energy Agency World Energy Outlook (IEA 2017) used several scenarios to model the future of global coal demand and production out to 2040. Under the "New Policies" scenario, the IEA models future demand using existing energy policies as well as policies stemming from

announced intentions regarding energy use. For example, trends in the United States, Europe and China lead to a decline in coal use by 2% in 2016 and the New Policies Scenario forecasts coal demand continuing to fall in Europe (by 61%), China (13%) and the US (11%). These declines are offset by gains elsewhere in India and Southeast Asia (IEA 2017, p. 203). Overall the forecasts for thermal coal is a flattening of growth with a 13% rise in production from 2016 to 2040. This compares with a 61% growth in the 16 years from 2000 to 2016. Thus, under the New Policies Scenario, the core scenario modelled by the IEA for its World Energy Outlook, growth in coal demand and production slows down markedly. However, it should be noted that the New Policies Scenario is not consistent with the Australian and NSW governments' stated commitment to the Paris climate agreement goal of limiting warming to well below 2 degrees above pre-industrial levels. The New Policies Scenario models energy use under announced energy and climate change policies, but those policies have been estimated to be likely to cause global warming of 2.7 degrees (The Climate Institute 2017).

As indicated in Table 3, the World Energy Outlook's Sustainable Development Scenario models coal use consistent with action to address climate change and paints a very different picture of the future, with dramatic contraction of coal markets internationally. The Sustainable Development scenario assumes that the sustainable development goals (SDG) are met and particularly SDGs 3, 7, 11, and 13 which relate to meeting the Paris targets, reducing energy related pollutants and deaths from pollutants, as well as achieving universal access to modern energy services. The scenario works backwards to predict what needs to happen to coal production to achieve these goals. We have used this scenario to understand the implications for Muswellbrook and Singleton of Australia's stated commitment to both the Paris climate agreement and the Sustainable Development Goals. Indeed, the mining industry itself has indicated its alignment with, and implicit support for, the Sustainable Development Goals (Minerals Council of Australia and Cardno 2018). Under the Sustainable Development Scenario, thermal coal declines out to 2040 by 55% as indicated in Table 3.

Table 3 Coal use under the Sustainable Development Scenario

	2000	2016	New Policies		Current Policies		Sustainable Development	
			2025	2040	2025	2040	2025	2040
Demand	**3301**	**5364**	**5488**	**5613**	**5950**	**7208**	**4318**	**2539**
Power generation	2236	3320	3339	3359	3 731	4693	2311	826
Industrial use	856	1714	1854	2040	1902	2240	1733	580
Other sectors	209	330	295	214	318	274	274	132
Power generation share	*68%*	*62%*	*61%*	*60%*	*63%*	*65%*	*54%*	*33%*
Production	**3254**	**5271**	**5488**	**5613**	**5950**	**7208**	**4318**	**2539**
Steam coal	2504	4049	4319	4574	4734	6040	3300	1834
Coking coal	449	967	900	806	923	875	826	595
Lignite and peat	301	255	269	233	293	293	193	110
Steam coal share	*77%*	*77%*	*79%*	*81%*	*80%*	*84%*	*76%*	*72%*

Source: IEA (2017, p. 207).

While meeting the Paris climate goals and Sustainable Development Goals is consistent with Australia's national interest given the economic damage expected to be inflicted by climate change, the consequence of achieving these goals would likely be the rapid contraction of the coal industry in Muswellbrook and Singleton. Under a do-nothing approach, where the Federal, State and Local governments do not act to prepare for a transition away from coal mining, there will be major impacts on local direct and indirect employment, wages and salaries and output. We use an input-output model of the Muswellbrook and Singleton economy to model the impact of a one-off reduction in coal production of 55% under a business as usual approach where few adjustments are taken to prepare for the change. Of course, in reality, there will be abrupt mine closures at distinct points in time. Like all modelling approaches, input-output analysis is static and we are not predicting or forecasting the changes that will occur in the economy. Instead, we aim to represent the impact and transition scenarios using an internally consistent approach. Modelling a one-off reduction in coal demand as we do in Table 4 and elsewhere in the report is equivalent to modelling a linear reduction through 22 years with linear increases in transition industries or a compounded reduction and growth rates in coal and transition industries.

Table 4 Impact of business as usual with a 55% reduction in coal mining
(Based on 2017 output and employment figures)

Impact Summary	Direct Effect	Supply-Chain Effect	Consumption Effect	Total Effect	Type 1 Multiplier	Type 2 Multiplier
Output ($M)	-$4,797	-$930	-$696	-$6,424	1.194	1.339
Employment (Jobs)	-5,199	-2,190	-2,477	-9,866	1.421	1.898
Wages and Salaries ($M)	-$706	-$205	-$153	-$1,064	1.291	1.508

Source: REMPLAN Economy 2017.

A 55% reduction in coal production or output is a direct impact of negative $4,797 million as indicated in Table 4. As almost all coal output is exported, the reduction in output itself is not felt within the community and the income from mining mostly flows elsewhere. For example, for every million dollars of coal mining output, workers receive $147,100 while gross operating surplus or the return to capital is $252,300. As foreign ownership in coal mining is greater than 75% (Campbell 2014, p. 13) much of the gross operating surplus flows overseas. The rest of each million dollar of coal mining output flows to domestic imports from other regions ($435,400) which does not directly benefit the local community and local expenditure on inputs ($160,200) which indirectly benefits the local community as described below (REMPLAN Economy 2017). However, the major impact on the region is felt through the reduction in employment and wages and salaries which fall by 5,199 jobs and $706 million respectively. For Muswellbrook and Singleton residents, these impacts are overstated because more than 60% of workers come from other regions (REMPLAN Economy 2017). Looking at local residents only, the reduction in jobs is expected to be 2,064 (or 39.7% of total employment losses) with wages and salaries falling by $280m.

Impact analysis uses input-output tables to model the interactions in an economy. For example, there are secondary or indirect effects of the reduction in coal production because the mining sector uses inputs from various other suppliers in the region (as discussed, some $160,200 per million

dollars of output). For example, coal mining draws upon the separate industries of mining support services, construction and manufacturing to produce each dollar of output. Thus, if coal output falls, the outputs in these supplying industries also fall. These are the supply-chain effects indicated in Table 4 and the Type 1 multiplier. The Type 1 multiplier indicates that for every dollar of output in coal mining, the region as a whole produces $1.194 in mining output and the output of various supporting industries. For coal mining in Muswellbrook and Singleton the type 1 multiplier is quite low because many inputs are imported into the region from other parts of Australia and internationally. Other industries have higher type 1 multipliers such as agriculture with a type 1 multiplier of 1.262. In addition, the broader the region considered, the higher the type 1 multipliers because domestic imports will reduce and the industry will draw from local suppliers.

There are also induced or consumption effects which derive from the wages and salaries. Wages and salaries are used, in part, for consumption and this generates income and output in, for example, retail trade. The type 2 multiplier includes both the supply-chain effect and consumption effect and is derived by dividing the Total Effect by the Direct Effect. In terms of employment, the Type 2 multiplier is higher than the Type 2 multiplier for output because the consumption effect generates employment in retail trade and other sectors which employ far more workers per million dollars of output than mining. Thus, the impact of a 55% reduction in coal demand and production is the loss of 5,199 direct jobs and a further 4,667 indirect jobs due to the supply-chain and consumption effects. The consumption effect is driven by the size of wages and salaries but it is important to note that the input-output analysis within REMPLAN's software does not distinguish between induced effects for local residents versus those working in the region but living elsewhere. Thus, the consumption effects are overstated as they assume that all wages and salaries are going to Muswellbrook and Singleton residents and being spent in the region.

Clearly, meeting the NSW and Australian government's commitment to the Paris climate agreement and Sustainable Development Goals results in a dramatic change for the economy of Muswellbrook and Singleton over a single generation. In the absence of planning and intervention from Government, this change will be profoundly negative for the Hunter. Instead of leaving the region to suffer this contraction unaided, Federal, State and Local governments could aid the transition of the Muswellbrook and Singleton LGAs and avoid or alleviate economic disaster.

4. Transition plans do not plan for transition

There are already numerous plans related to transition in the Hunter. However, in most cases these plans do not provide concrete actions and programs, nor do they come with resources to stimulate diversification and shield the region from the economic consequences of coal market contraction. Thus, the plans do not develop concrete investment programs for diversification, changes to government land use policy or incentives to attract industries other than mining to the region. In this section we review some existing government plans.

The *Hunter Regional Plan 2036* (Department of Planning and Environment (DPE) 2016) sets out twenty-seven directions for the greater Hunter region moving forward to the year 2036. The Plan sets the agenda for Local Government Authorities with coordination through the Hunter Development Corporation:

> "The plan sets priorities and provides a direction for regional planning decisions. It focusses on new housing and jobs and targets growth in strategic centres and renewal corridors close to transport to deliver social and economic benefits. It sets in place line-of-sight land use planning for the region, regional districts like the Greater Newcastle metropolitan area and each council's area."

Thus, the strategic plans for Singleton and Muswellbrook Shire Councils exist within and are guided by the *Hunter Regional Plan 2036* (DPE 2016, p. 7). There is little in the document that provides certainty for new industries or security for the communities that will be affected by a global reduction in coal demand. For example, Direction 5 relates to transforming the productivity of the Upper Hunter. The "actions" under this direction include "prepare for" diversification and "leverage" off existing advantages, but no concrete policies or programs are cited that could deliver this preparation or leverage. The plan assumes a strong role for coal mining in the region's economy out to 2036 and future development of coal resources (DPE 2016, p.24). For example, Action 5.3 suggests the need to identify land and infrastructure requirements to develop the Hunter's coal resources (as well as alternative energy). Action 5.4 suggests protecting the availability of agricultural land but gives no account of how this will be achieved or what changes will occur in the process of assessing and determining coal mining projects on agricultural land. The main action items are to develop further reports including the *Upper Hunter Economic Diversification Project* report which we discuss below.

Direction 11 is particularly important in the context of Singleton and Muswellbrook as it relates to managing the ongoing use of natural resources. Direction 11 mentions the issue of competing uses for land. However, the Regional Plan delegates responsibility for allocating land use to the NSW Government Strategic Release Framework for Coal and Petroleum. Similarly, Direction 13 refers to land-use conflicts and delegates responsibility to the Release Framework. We note also that the Strategic Release Framework applies only to new releases of land for coal exploration, not to the issue of Mining Leases, and that most new mining activity in Singleton and Muswellbrook takes place on exploration titles that pre-date the creation of the framework. As the granting of new development consents and mining leases and the management and renewal of existing exploration licenses appears to be a major issue in transitioning the Hunter, the Regional Plan is not a transition document and fails to prepare Singleton and Muswellbrook for the coal market contraction envisaged by the World Energy Outlook SD Scenario.

The *Upper Hunter Economic Diversification Project: Action Plan* (Upper Hunter Economic Diversification Task Group, 2016, p. 6) recognises the importance of land use certainty, water security, "encouraging new industry investment" and "developing new market opportunities". However, the responses from the government outlined in the *Action Plan* refer back to the "actions" in the *Hunter Regional Plan 2036* creating a circular logic that fails to deal with the substantial strategic challenges faced by the region. For example, Action 5.7 in the Hunter Regional Plan is to develop the Upper Hunter Economic Diversification Project report (DPE 2016, p. 24) and the government's responses to the recommendations in the Diversification Project report refer back to the actions in the Hunter Regional Plan (Upper Hunter Economic Diversification Task Group 2016, p.

7). Meanwhile, land use has not become any more certain and no change is proposed or made to Government policy around the granting of development consent to coal mining projects that reduce economic diversity and constrain the space for agriculture and other industries.

Contrary to its apparent purpose, Strategic Theme 3 of the *Action Plan* also assumes an ongoing dominant role for coal mining in the region (Upper Hunter Economic Diversification Task Group 2016, p. 14). The industry scenarios that underpin this plan are based on the IEA's New Policies Scenario which is not consistent with meeting the Paris Agreement goal. While the *Action Plan* raises the possibility of new industries such as food processing, industrial hemp, oil seeds and renewables, a continuing focus on coal mining will hamper diversification in the region. Under the *Action Plan*, the vision for the future of LGAs such as Muswellbrook and Singleton is the same as today, defeating the presumed purpose in developing the "action plan" in the first place. This failure leaves the region vulnerable to the dramatic contraction in coal demand envisaged in the IEA's SD Scenario.

Other documents purporting to be diversification or transition plans are similarly lacking in actions and all refer to a strong economic role for coal mining. For example, the Department of Premier and Cabinet's *Hunter Regional Economic Development Strategy 2018-2022* (herein *Hunter REDS*) identifies coal as a major industry for the future due to the degree of specialisation in the sector that currently exists in the region (Department of Premier and Cabinet 2018). The *Hunter REDS* has a strong economic framework as it relies on the theory of comparative advantage to identify strategies. This theory in economics suggests that regions should specialise in industries that rely on the major endowments of resources in the region. For example, if labour was a major endowment, the region should specialise in labour-intensive goods such as textiles. If capital is a major endowment, capital intensive goods should be produced. If a region has a major endowment of coal, it should focus on coal production. The *Hunter REDS* also suggests that industries growing faster than the State average are a good basis for diversification and we return to this economic framework in section 6. However, as the *Hunter REDS* identifies, there is a major conflict between the potential agricultural growth industries and the continued focus on coal mining. As with other Government plans and strategies, this conflict is identified without providing any means by which such conflict will be resolved in favour of industries that will be able to provide employment and growth opportunities as coal demand contracts.

5. Approach to transition

Transition and diversification in the Hunter region is a necessary insurance against declining global coal demand and economic literature suggests that diversification is important for stability and long-run growth. For example, Wagner and Deller (1998) develop a measure of diversity from a region's input-output industrial structure to examine the relationship between diversity, stability and long-run growth. Using US data, they demonstrate that high levels of diversity increase stability and growth. Pede (2013) derives similar conclusions for US counties with diversity positively related to economic growth, and Kluge (2018) uses data for German districts to verify that diversity reduces instability while holding growth constant. Joya (2015) provides evidence that resource-rich countries that lack diversity suffer from increased volatility and lower growth as a consequence. While resource-rich countries in general have higher growth, the volatility creates negative growth impacts.

Diversification is important for a number of reasons. Specialisation can boost short-run growth but at the expense of long-run growth and stability (Wagner and Deller 1998, p. 542). The underlying problem of an undiversified economy derives from the fragility created with changes in demand for a region's specialised products. This is especially the case in Muswellbrook and Singleton where the workforce is heavily reliant on global coal demand. When a region is diversified and the workforce has transferable skills, a sudden reduction in demand for a product is less important. Economic theory predicts that workers will transfer between sectors and stability and growth will be maintained (Wundt and Martin 1993, p. 87, Siegel et al. 1995, p. 271). However, in economies like that of Muswellbrook and Singleton, the lack of diversity means that workers cannot move into alternative employment while remaining in the region. Thus, when coal prices and demand fluctuate from highs of $166 in 2008 to lows of $83 in 2014, employment in the coal mining industry falls by 25% in the three years from 2011/12- 2014/15 ("*Upper Hunter Industry Scenarios Report*" 2016, p. 29) and unemployment in the region increases. This suggests social upheaval as well as underutilisation of labour resources.

While there are many factors that determine the wellbeing of a region, including environmental and social characteristics, from a purely economic perspective labour productivity or output per worker is a key target in the theory of structural adjustment (Krüger 2008). However, while this may suggest a strategy of specialising in industries with high productivity, theory suggests that a lack of diversity can stifle within-industry productivity by reducing competition and innovation in a region (Krüger 2008, p. 352). Thus, measures of success vary. Siegel et al. (1995) focus on output and employment as the measure of performance for a diverse region. This is a more suitable measure when the benefits of labour productivity are not shared equally such as in mining. Due to the high level of foreign ownership (Campbell 2014, p. 13), the majority of the benefits of mining productivity flow overseas in the form of dividends, interest payments and rents. Additional factors to consider include the degree to which industries employ local workers, which encourages consumption effects, and the degree to which industries use inputs that are supplied locally, which encourages supply-side effects.

Of course, in what follows we do not consider and model all potential transition strategies which could become encyclopaedic in scope and is well beyond the requirements for this report. Instead we focus on what is known about the region and we use a framework consistent with the sustainable development goals. We focus on growth industries that reflect the local skills, environment, resources, and strategic advantages in the region to encourage diversification and flexibility for workers. We use direct and indirect employment as our measure of success as well as local wages and salaries. In the following section, we identify potential growth industries before modelling transition.

6. Potential growth industries

There are a number of ways to identify the sectors that could be the target of transition action and policy. Trade theory suggests targeting industries in which a region has comparative advantages. Targeting high productivity and growing industries or industries where demand responds strongly to income (high income elasticity industries) can also be growth strategies (Krüger 2008). Portfolio

theory suggests that a region should target industries that fluctuate in the opposite way to existing industries and thus hedge against adverse movements in the dominant commodity (Kluge 2017). Location theory suggests that industries that support other growth industries should be targeted along with industries that workers can easily move between (Siegel et al. 1995, pp. 270-1). Similarly, key sectors can be identified that enhance inter-sectoral linkages or that reduce imports from other parts of the country or world. However, in terms of diversification, promoting industries with strong linkages to dominant sectors can undermine stability. Thus, supporting industries that provide inputs to the dominant mining sector needs to be balanced with industries unrelated to mining. We consider key sectors in section 6.1 and comparative advantage in section 6.2 where we report on a shift-share analysis and derive location quotients. In section 6.3 we analyse workforce data to consider the occupations that will be most affected by a declining coal sector and where those workers typically find employment. In section 6.4 we analyse the industries recommended in the various diversification reports.

6.1. Key sectors and gap analysis

In gap analysis, import patterns are used to identify key sectors to support. If an economy imports goods and services to support existing, local industries, the production of these goods and services could become future growth industries because there is a ready-made, local demand. Thus, one way to identify future growth industries in Muswellbrook and Singleton is to look at the kind of goods and services purchased by its major industries.

Mining is responsible for 67% of the $5.75 billion worth of imports coming from the rest of the country into Muswellbrook and Singleton. Furthermore, 70% of the jobs created by the region's imports support the mining sector. Of the 10,061 jobs created outside the region through mining imports, 32% are in the Exploration Mining Support Services industry as might be expected. However, as indicated in Table 5, 1,205 jobs or 12% are supported in the Professional, Scientific Technical Services industry and 539 or 8% are supported in the Accommodation sector. Looking at the industries that export to Muswellbrook's and Singleton's electricity, construction, and manufacturing industries in Table 6, the Professional, Scientific Technical Services industry is also high on the list along with Construction Services.

As mentioned, it would be counterproductive to focus only on industries that sell to the mining sector. However, industries that support both mining and other important industries in the region aids diversification. In this respect, the key industries are Professional, Scientific Technical Services, Financial Insurance Services, Construction and Construction Services, Accommodation and Food Services, Transport, and Technical Equipment Appliance Manufacturing.

Table 5 Jobs outside the region supported by mining imports

External Supply Sectors	Jobs (2017)	%
Exploration Mining Support Services	3,193	31.6
Professional, Scientific Technical Services	1,255	12.4
Accommodation Food Services	819	8.1
Repair, Maintenance Other Services	554	5.5
Transport	497	4.9
Technical Equipment Appliance Manufacturing	409	4.0
Financial Insurance Services	364	3.6
Retail Trade	359	3.5
Wholesale Trade	353	3.5
Transport Support Services Storage	343	3.4
Public Administration, Regulatory Services, Order Safety	336	3.3
Construction Services	319	3.2
Metal Metal Product Manufacturing	268	2.7
Construction	135	1.3

Source: REMPLAN Economy 2017.

Table 6 Jobs outside the region supported by the electricity, construction and manufacturing industries

External Supply Sectors	Jobs (2017)	%
Construction Services	284	14.50
Financial Insurance Services	254	12.90
Professional, Scientific Technical Services	251	12.80
Electricity	110	5.60
Transport	96	4.90
Retail Trade	86	4.40
Wholesale Trade	85	4.30
Metal Metal Product Manufacturing	75	3.80
Technical Equipment Appliance Manufacturing	73	3.70
Accommodation Food Services	71	3.60
Gas, Water Waste Services	66	3.30
Mining	64	3.30
Construction	54	2.80
Saw Mill, Wood Paper Product Manufacturing	46	2.30
Public Administration, Regulatory Services, Order Safety	44	2.20
Repair, Maintenance Other Services	43	2.20
Non-Metallic Mineral Product Manufacturing	41	2.10
Livestock, Grains Other Agriculture	39	2.00
Transport Support Services Storage	33	1.70

Source: REMPLAN Economy 2017.

6.2. Shift-share analysis and location quotients

Another method used to identify important, growing industries that can aid transition is shift-share analysis. Shift-share analysis identifies the extent to which the growth or decline in an industry is due to local comparative advantages. Some local employment growth in an industry can be due to overall national or State trends in employment or national industry trends. The shift-share analysis removes these national or State effects and industry effects from the local growth to derive the "local effect." If the local effect is positive, the industry has comparative advantages in the region that are not attributable to industry trends or State employment trends. Location quotients also assist in determining comparative advantages. A location quotient measures the dominance of an industry in a region relative to the dominance of the industry in the country or State. For example, the location quotient for mining reported in Table 7 shows that mining's share of employment in the Hunter is 11.8 times the share of employment in the State. This suggests there is a historical comparative advantage for the Hunter in mining relative to elsewhere in the State.

In Table 7, we report on the shift-share analysis conducted in the Hunter Regional Economic Development Strategy (*Hunter REDS*) (Department of Premier and Cabinet 2018, p. 32) and note that this includes all LGAs in the Hunter region except Newcastle and Lake Macquarie. There are a number of potential growth industries. Coal mining is of course very prominent in this analysis. Its employment growth from 2011-16 exceeded the State and industry trends by 12.6% and it is very dominant in the region. However, there are a number of large and smaller industries that have potential to take over from coal mining as it declines in the years to come. The shift-share analysis and location quotients suggest comparative advantages in the Hunter for the following industries:

- Agriculture – in particular, horse farming, grape growing and poultry farming have positive local effects and strong location quotients. Dairy and beef cattle have declined relative to the state and industry trends but given their location quotients, they could be strong drivers of growth in the future if the impediments to growth are removed.
- Manufacturing – while manufacturing as a whole does not have a comparative advantage in the Hunter, certain subsectors do. In particular, wine and other alcoholic beverages, meat processing, ready-mix concrete, metal coating and finishing, bakery product manufacturing, motor vehicle body and trailer manufacturing all display positive employment growth, high location quotients and positive local effects.
- Accommodation – while employment fell slightly over the period 2011-16, the high location quotient and positive local effect suggests that there is a competitive advantage for accommodation in the region. In Singleton and Muswellbrook, accommodation services could become more prominent if tourism is promoted using the abundant natural resources, wine industry and national parks.
- The *Hunter REDS* identifies transport, postal and warehousing as a future growth industry based on the degree of employment growth from 2011-16 relative to the industry and State trends. If this kind of employment growth can continue, the location quotient will continue to rise indicating a strong competitive advantage in the region. The proximity to major markets and access to ports and Newcastle airport suggests that warehousing could be a major player in the region in the years to come. This will particularly be the case if Newcastle Port diversifies and builds a container terminal (Deloitte Access Economics 2018). While Muswellbrook and Singleton are well outside the port precinct, some innovative thinking and use of the existing train line that runs directly to the Port could result in a large expansion in warehousing and transport in the LGAs.

Table 7 Shift-share analysis and location quotients in the Hunter regional areas

Industry	Employed 2016	LQ (relative to NSW)	Employment Growth (2011-16)	Local employment growth % (2011-16)	State + industry effect %	Local effect %
Mining	10,642	11.8	1,379	14.9	2.3	12.6
Coal Mining	9,936	17.0	1,628	19.6	4.1	15.5
Defence	3,354	5.6	-20	-0.6	-1.5	0.9
Electricity Generation	666	8.5	118	21.5	-8.0	29.5
Agriculture, Forestry and Fishing	3,481	1.6	111	3.3	6.1	-2.8
Horse Farming	752	15.4	61	8.8	-5.6	14.4
Grape Growing	182	4.9	10	5.9	-8.5	14.4
Poultry Farming (Eggs)	159	3.3	82	105.9	60.5	45.4
Dairy Cattle Farming	306	2.7	-26	-7.8	20.7	-28.5
Beef Cattle Farming (Specialised)	1,204	2.6	-2	-0.1	8.7	-8.8
Manufacturing	7,227	1.2	-2,914	-28.7	-23.9	-4.8
Aluminium Smelting	1,050	24.7	-645	-38.1	-38.0	-0.1
Explosive Manufacturing	288	13.1	-27	-8.7	-26.0	17.3
Wine and Other Alcoholic Beverage Manufacturing	745	7.9	94	14.4	-6.5	20.8
Mining and Construction Machinery Manufacturing	324	7.1	-701	-68.4	-66.1	-2.3
Other Professional and Scientific Equipment Manufacturing	280	6.3	-171	-37.8	-36.9	-0.9
Other Electrical Equipment Manufacturing	279	4.1	-64	-18.6	-39.5	20.9
Aircraft Manufacturing and Repair Services	208	3.4	-20	-8.7	-14.8	6.0
Motor Vehicle Body and Trailer Manufacturing	199	3.4	4	1.8	-12.8	14.6
Metal Coating and Finishing	115	2.8	37	46.5	9.0	37.5
Structural Steel Fabricating	155	2.8	-30	-16.4	-30.4	14.0
Ready-Mixed Concrete Manufacturing	182	2.6	68	58.9	21.6	37.3
Concrete Product Manufacturing	102	2.6	-23	-18.1	-45.3	27.1
Meat Processing	561	2.4	209	59.3	11.7	47.6
Bakery Product Manufacturing (Non-factory based)	250	1.6	52	26.4	-2.5	28.9
Accommodation	1,898	1.8	-78	-3.9	-4.8	0.9
Transport, Postal and Warehousing	3,632	0.8	402	12.4	4.2	8.3

Source: Department of Premier and Cabinet (2018, p. 32). Note: Newcastle and Lake Macquarie LGAs are excluded.

Looking more closely at Singleton and Muswellbrook LGAs, we can identify the industries with comparative advantages from location quotients. Table 8 displays the location quotients that are greater than 1.15 relative to NSW for Muswellbrook and Singleton and that are not mining industries. Exploration mining support services is included because this was identified above as a sector lacking in the region and mining continues to be an important sector even under the sustainable development scenario. Agriculture support services is included because with expected growth in Agriculture, the support services will become a key industry.

Table 8 Location quotients for Muswellbrook and Singleton

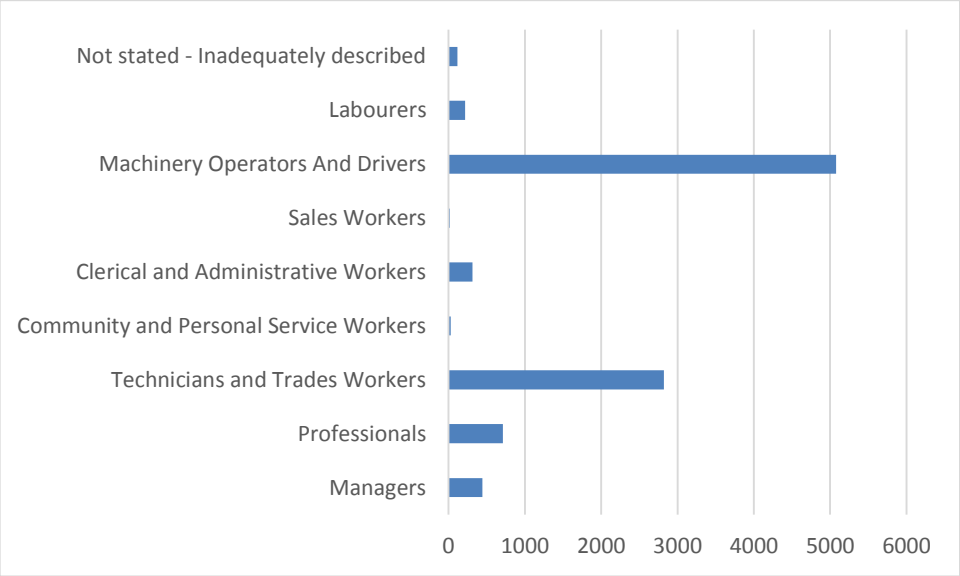
Industry Sector	**Muswellbrook Jobs (2017)**	**Singleton Jobs (2017)**	**LQ Muswellbrook relative to NSW**	**LQ Singleton relative to NSW**
Sheep, Grains, Beef Dairy Cattle	204	276	1.55	1.29
Poultry Other Livestock	266	17	13.05	0.51
Other Agriculture	53	138	1.16	1.85
Agriculture, Forestry Fishing Support Services	18	24	0.87	0.71
Exploration Mining Support Services	87	131	13.09	12.09
Meat and Meat Product Manufacturing	11	255	0.22	3.18
Dairy Product Manufacturing	9	17	1.00	1.16
Wine, Spirits Tobacco	60	101	5.21	5.38
Basic Chemical Manufacturing	35	84	2.54	3.75
Polymer Product Manufacturing	6	68	0.25	1.79
Structural Metal Product Manufacturing	65	7	3.61	0.23
Metal Containers Other Sheet Metal Prod. Manu.	18	15	3.11	1.59
Electricity Generation	627	14	85.93	1.17
Electricity Distribution	209	74	5.19	1.12
Gas Supply	6	0	2.16	0
Water Supply, Sewerage Drainage Services	26	25	1.19	0.70
Heavy Civil Engineering Construction	112	203	1.43	1.59
Rail Transport	65	16	1.84	0.27
Rental Hiring Services (except real estate)	34	110	1.07	2.12
Employment, Travel Agency and Other Administrative Services	204	439	1.09	1.44
Public Order Safety	202	115	1.31	0.45
Defence	15	670	0.23	6.46
Other Repair Maintenance	143	314	2.47	3.33

Source: Based on figures derived from REMPLAN Economy 2017.

6.3. Industries that use the same kind of labour

As discussed above, the degree to which workers can move between industries aids stability and long-run growth in a region. Thus, an aspect of developing a sound transition method is to look at the kind of occupations that will be affected by the reduction in global coal demand and the other industries that employ workers in these occupations. As indicated in Figure 2, the two major occupations in the mining sector are Machinery Operators and Drivers (5,080 workers) and Technicians and Trades Workers (2,821 workers).

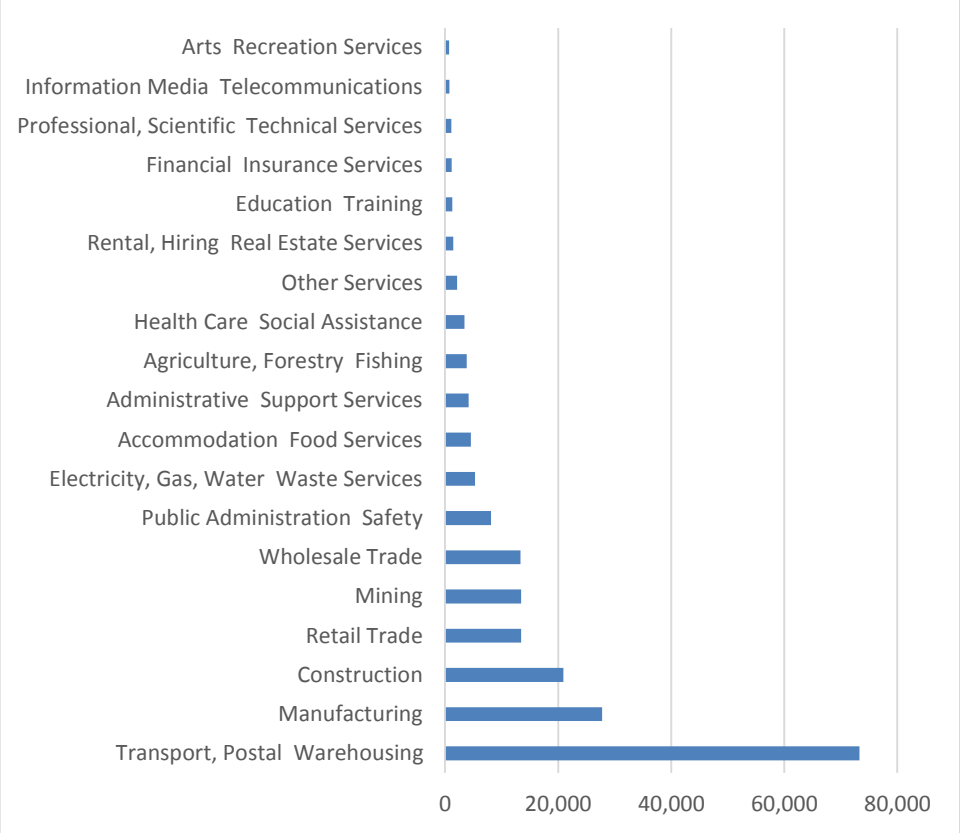
Figure 2 Workers and their Occupations in the mining sector (2017)



Source: REMPLAN Economy 2017.

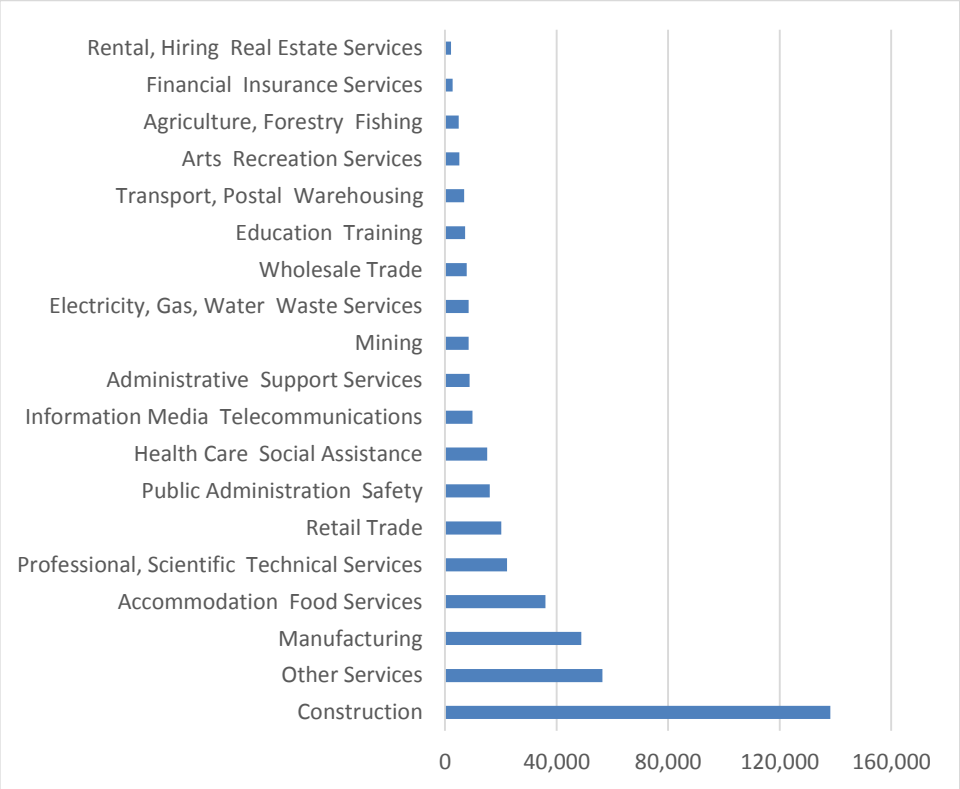
Looking within NSW at where Machinery Operators and Drivers and Technicians and Trades Workers find employment, Figures 3 and 4 provide strong indicators that if properly managed, the main mining occupations can be restructured into other industries. For example, Machinery Operators and Drivers have a strong presence in the Transport, Postal and Warehousing industries along with Manufacturing and Construction. The Technicians and Trade Workers have a strong presence in the Construction, Other Services and Manufacturing industries. Any transition plan should be cognisant of the needs of these workers and plan transition around the industries that require their skills wherever possible.

Figure 3 Machinery Operators and Drivers employment in NSW (2017)



Source: REMPLAN Economy 2017.

Figure 4 Technicians and Trade Workers employment in NSW (2017)



Source: REMPLAN Economy 2017.

6.4 Growth sectors identified in diversification reports

The location and trade theory analysis provides one avenue for identifying growth sectors. Another method is to draw upon diversification reports which can be based on local knowledge and local preferences and are often more fine grained in terms of the potential industries. For example, the Upper Hunter Economic Diversification Project (Buchan Consulting, 2011) identifies the following opportunities for Muswellbrook and Singleton.

Table 9 Growth industries

Region	Muswellbrook	Singleton
Growth areas and opportunities	Power generation and support	Mining support
	Renewable energy and support	Power Generation and support
	Equine industry growth and development	Engineering
	Services to mining industry	Agribusiness – horticulture, wine, beef, new crops
	Engineering	Tourism
	Education and training	Logistics hub
	Tourism	Renewable energy and support
	Professional and technical services	Engineering training centre
	Government services	Government services
	Use of mining sites	Business services

Source: Buchan Consulting (2011, pp. 35, 39)

The *Hunter Regional Plan 2036* (Department of Planning and Environment 2016) also mentions growth industries such as renewable energy, advanced manufacturing, the equine industry, intensive agriculture and tourism. The Smart Specialisation Strategy (Regional Development Australia Hunter, n.d., p. 7) emphasises the industries identified in a regional summit held in 2015 which include advanced manufacturing, creative industries, defence, food and agribusiness, medical technologies and pharmaceuticals, mining equipment, technology and services and oil, gas and energy resources.

The *Hunter REDS* (Department of Premier and Cabinet, 2018, pp. 32-3) uses the shift-share analysis in Table 7 to identify opportunities and in a general sense call for a focus on coal mining, defence, energy generation, agriculture and especially horse farming and grape growing, mechanical, equipment, and material manufacturing, wine production, meat processing, tourism and air services. New and emerging agribusiness opportunities are also identified in the "Upper Hunter Economic Diversification Action Plan: Implementation Priorities" (n.d.) which include cereals and oil seeds as well as hemp with the Hunter region supplying an estimated 87% of the State's industrial hemp (Department of Primary Industries, 2013; Upper Hunter Economic Diversification Task Group 2017, p. 10).

Thus, the various government departments, non-profit organisations and diversification projects derive similar growth sectors. In the following section on modelling transition, we combined the various approaches to identifying growth industries within the framework developed by the University of Newcastle's BioValley project (International Centre for Balanced Land Use, 2017). The BioValley project focusses on an ecologically sustainable future for the Hunter and specifically five areas – renewable energy, environmental remediation and management, agri-food, bio-innovation and green products. In the following section we identify the investments planned and occurring within these areas and model transition in the Hunter.

7. Modelling transition

To provide an overarching framework to the potential growth industries we consider the Hunter BioValley project (International Centre for Balanced Land Use, 2017) which focusses on economic diversification through the lens of the circular economy and green innovation. We use the Biovalley project because it is consistent with the Sustainable Development Goals and Paris Climate Agreement which motivate the modelling in the report. Thus, in section 7.1 we discuss specific growth opportunities within Muswellbrook and Singleton based on the BioValley vision of the future and the growth areas discussed in the previous section. In section 7.2 we use input-output analysis to model transition in the Hunter.

7.1 Growth areas in Muswellbrook and Singleton

The BioValley concept focusses on five main areas – renewable energy, environmental remediation and management, agri-food, bio-innovation and green products (International Centre for Balanced Land Use, 2017). First, the future of the Hunter region will be driven by renewable energy including wind and solar and mass storage through pumped hydro systems, including those that utilise existing mine voids. A pumped hydro project is undergoing investigation by AGL as it plans for the closure of the Liddell coal-fired power station and wind and solar generation will be driven by a $1.4 billion investment by AGL to replace the 2000 megawatts lost from the Liddell power plant when it closes in 2022 (Latimer and Hannam 2018). We model the impact of this investment and a similar level of investment to replace the larger Bayswater plant in 2036 on the region (AGL Energy Limited n.d.). The Bayswater plant is 32% larger and thus the replacement expenditure is also assumed to be 32% larger at $1.848 billion. While this is a strong assumption, the aim of this analysis is to provide a representation of the future economy in Muswellbrook and Singleton so that the importance of concrete transition plans can be recognised. Thus, while the future will undoubtedly incorporate different dollar amounts for investments and other impacts, the issues and opportunities confronting the region will be similar.

Operation and maintenance jobs will also be lost when the power plants close but we assume that operation and maintenance of the new renewable energy facilities will be roughly equivalent to the jobs lost when the power plants closed. This is likely to be a conservative estimate with evidence suggesting that renewable energy facilities employ more permanent workers per megawatt than coal-fired power stations (Teske et al. 2017, p. 21).

The employment that arises from the total renewable energy investment of $3.248b will occur in several industries. For example, Garret-Peltier (2017) provide weights for renewable energy in input-output modelling. The weights are indicated in Table 10 and assume that electricity is provided by a combination of solar and wind renewable energy.

Table 10 Renewable energy investment

Industry Sector	% of renewable energy investment
Heavy and Civil Engineering Construction	28%
Prof, Scientific, Computer & Electronic Equip. Manu.	10.25%
Electrical Equipment Manufacturing	1.5%
Other Fabricated Metal Product Manufacturing	14.75%
Polymer Product Manufacturing	6%
Specialised & Other Machinery & Equipment Manu.	27.25%
Professional, Scientific and Technical Services	12.25%

We assume that the investment stays in the local economy to the extent that the region's construction companies receive 28% of the investment and local manufacturers receive their shares of the investment as indicated in Table 10. The *Hunter REDS* indicated several manufacturing areas where the broader Hunter region has comparative advantages as indicated in Table 7. In accordance with knowledge that manufacturing can thrive in the region and the aims of the Biovalley Project, the first transition strategy is for the government to invest heavily in the supporting industries for renewable energy and establish these industries in Muswellbrook and Singleton. This will draw upon similar kinds of skills to the skills of workers losing jobs in the mining sector. For example, using all of NSW industry as a guide, Technicians and Trades Workers constitute 20.8% of the jobs in the manufacturing industries mentioned in Table 10 with Machinery Operators and Drivers constituting 13.4%. Machinery Operators and Drivers also constitute 18.3% of all the construction jobs with Technicians and Trade Workers at 17.1%.

In the impact modelling, it is assumed that the direct impact of the investment occurs in the local economy with indirect impacts dictated by the input-output coefficients. As these investments occur once and are not cumulative like the reduction in mining output or the increase expected to occur in agriculture and other industries, we divide the total investment in renewable energy by 22 to reflect the fact that renewable energy construction occurs over the period considered (22 years). Of course, actual investment will occur in a less linear fashion but, again, the analysis aims to represent reality and present the issues and opportunities for Muswellbrook and Singleton rather than specifically predict the future. An alternative assumption which we discuss below is that the manufacturing industries supporting renewable energy do grow in a cumulative fashion through time. That is, the local renewable energy manufacturing and support industries are stimulated because of the local investment but continue to grow and export their products and skills to other regions which is to be expected. This is seen as critical in the transition for Muswellbrook and Singleton and requires immediate government investment.

The second area of the BioValley vision is environmental remediation for industrial and mine sites, water treatment and biodiversity. Estimates vary on the extent of this investment but we use estimates based on proposed costings for rehabilitation at the Liddell and Bayswater power-plant sites which AGL estimate at $898 million in current dollars (AGL Energy Limited 2017). We also estimate the additional expenditure that will occur in the economy due to the rehabilitation of closing mine sites. While rehabilitation is supposed to be ongoing, the reduction in mining capacity means that there will be an additional injection of rehabilitation funds. The continuous expenditure on rehabilitation will of course decrease and this is modelled as part of the indirect impacts of the reduction in mining output. However, the one-off rehabilitation expenditure that occurs due to the 55% reduction in mining capacity in the region needs to be modelled.

We estimate this expenditure using the NSW mining rehabilitation security deposits which are intended to cover the future costs of mine rehabilitation should a company default on its obligations (Audit Office of New South Wales 2017). The total NSW deposit of $2.2 billion can be allocated to Muswellbrook and Singleton on the basis of the mining production in the region relative to NSW as a whole. Muswellbrook and Singleton produce 31.7% of total mining output in NSW which equates to $698.41 million of security deposit being dedicated to the region. The reduction of 55% in coal demand is assumed to lead to 55% of the mining sites in the area being rehabilitated at a cost of $384.12 million. While this method is again reliant on strong assumptions, it is likely to be a conservative estimate. For example, using site licenses, Lock the Gate Alliance value the security bonds for the nine largest mines in the Hunter at $824.9 million (Lock the Gate Alliance 2018, p. 6). As with renewable energy construction, the rehabilitation expenditure is one off and to ensure that the impact modelling is internally consistent we divide the amount by 22 years.

The Department of Planning and Environment's (2017, p. 13) Rehabilitation Cost Estimate Guidelines indicate that the following must be considered when estimating rehabilitation costs:

- Machinery/plant/equipment
- Transport of machinery/plant/equipment
- Contractors/personnel to undertake activities which would include labour and material costs
- Monitoring of completed rehabilitation
- Project management
- Contingencies

In terms of the industrial categories used by the Australian Bureau of Statistics, we identify and estimate the relative percentages for remediation expenditure in Table 11. Again, the expected growth in the construction industry is assumed to occur locally with government support and matches the job skills in mining.

Table 11 Remediation investment

Industry Sector	% of rehabilitation investment
Heavy and Civil Engineering Construction	50%
Road Transport	5%
Professional, Scientific and Technical Services	10%
Auxiliary Finance and Insurance Services	10%
Exploration and Mining Support Services	25%

The third area of the BioValley concept relates to a more sustainable food chain. There are no solid estimates of future investments in sustainable food chains and we cannot ignore the potential growth in traditional agricultural sectors along with new sectors. Thus, we build on discussed strengths in wine, agriculture and food industries. For example, as outlined in Table 7, the *Hunter REDS* has shown that there are comparative advantages in meat processing, horse farming, grape growing, poultry farming, and beef. In addition, new industries in seed oils and hemp have been identified (Department of Primary Industries, 2013; Upper Hunter Economic Diversification Task Group 2017, p. 10).

Table 7 provides us with a modelling approach for the future of these industries. We use the employment growth in the Hunter from 2011-2016 to establish a diminishing growth rate moving forward. For example, meat processing added 209 jobs in this five-year period, a growth rate of 59%. Given the comparative advantage, such a raw increase in jobs would be possible for the next five-year period from 2016-2021 with government support which would represent a growth rate of 37%. The following five-year period would be a growth rate of 21 % and so on. These growth rates, beginning with 37% in the case of meat processing, are then applied to the raw employment numbers for Muswellbrook and Singleton and employment growth is predicted out to 2040. The resulting employment growth numbers are indicated in Table 12 with horse farming assumed to be one third of initial employment in the sheep, grains, beef and dairy sector.

Table 12 Growth in selected agriculture and food and beverage industries

External Supply Sectors	Initial Jobs (2017)	Growth in jobs
Meat processing	266	470
Bakery product manufacturing	60	60
Wine and other alcoholic beverage's	161	98
Poultry farming	283	701
Grape growing	191	58
Horse farming	160	62

In addition, coal companies own or occupy 23% of the mapped Biophysical Strategic Agricultural Land in Muswellbrook and 27% in Singleton (Lock the Gate Alliance n.d.) and land designated as

critical industry cluster land for the equine and viticulture industries are affected by coal company leases. In Muswellbrook and Singleton, 4.95% of critical viticulture land is owned by coal mining companies and 3.35% of land critical for the equine industry. We assume that 55% of the Biophysical Strategic Agriculture Land and critical industry cluster land can be reclaimed for agriculture and grow the agriculture sector by 13.9%. The conflict over land use and the removal of uncertainty over land use will likely have much larger positive impacts on agriculture and the associated industries and we discuss policy intervention that reallocates land from mining to local agriculture in section 8. Specifically, we assume growth in the industries indicated in Table 13.

Table 13 Growth in agriculture

Industry Sector	% growth in agriculture
Sheep, Grains, Beef & Dairy Cattle	13.9%
Poultry & Other Livestock	13.9%
Other Agriculture	13.9%

The fourth and fifth areas of the BioValley concept are bio-innovation and green products which draw upon the concept of the circular economy. The circular economy can be defined as follows (Geissdoerfer et al. 2017, p. 759):

> "a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling".

Related to sustainability, the concept embraces the use of waste and biomass to produce manufactured goods including for the built environment. The BioValley vision is the production of bioenergy, biochemicals, and bioplastics in the Hunter region. For example, a $30 million pilot biorefinery for Muswellbrook was recently approved (Newcastle Herald 2018). This type of production draws upon the region's manufacturing base. However, as the Hunter transitions to a greener future, production will decrease in some manufacturing areas and increase in others. For example, explosives manufacturing and aluminium smelting can be expected to continue recent declines along with mining and construction machinery manufacturing. On the other hand, bioplastics, biorefining and biochemical can be expected to increase. The net effect on Muswellbrook and Singleton will be a cleaner environment but it is difficult to predict any increase in employment. Thus, we do not model any growth in the manufacturing sector outside of those identified through the planned investments in renewable energy and remediation.

We do model additional growth in the Tourism area and in Transport, Postal and Warehousing. Based on REMPLAN's modelling of the tourism sector, which is grounded in the 2016-17 Australian Bureau of Statistics Tourism Satellite Account, the total value of tourism-related output in the region is estimated at $212.013 million. There is no single industry category for tourism. Instead, tourist expenditures and the outputs associated with them occur in a number of industries. The satellite

account identifies that the major beneficially of tourism is the industry category Accommodation and Food Services which represents 56.35% of tourism activity. The other industries that benefit from tourism are described in Table 14.

Table 14 Output in individual industries deriving from tourism

Industry Sector	% of Tourism Activity
Accommodation & Food Services	56.35%
Arts & Recreation Services	15.46%
Transport, Postal & Warehousing	10.27%
Retail Trade	9.29%
Education & Training	3.18%
Ownership of Dwellings	2.86%
Wholesale Trade	2.26%
Manufacturing	2.09%
Information Media & Telecommunications	1.44%
Rental, Hiring & Real Estate Services	1.42%
Agriculture, Forestry & Fishing	1.12%
Other Services	0.79%
Administrative & Support Services	0.63%
Health Care & Social Assistance	0.41%

Source: REMPLAN Economy 2017.

In addition, the satellite account identifies how much of the Accommodation and Food Services output in any region is associated with tourism. Thus, in Muswellbrook and Singleton, of the $207m in Accommodation and Food Service output, $116m is associated with tourism. In real terms, according to Destination NSW (2018), the number of visitor nights rose by 26% from June 2010 to June 2018 or 3.25% per annum. We use this per annum growth rate and apply it to the tourism-related output in Muswellbrook and Singleton which results in a real growth rate out to 2040 of 71.5%. That is, we assume that each of the tourism-related outputs from the sectors in Table 14 grow by 71.5%.

Based on Table 7, we model an increase in the Transport Postal and Warehousing sector. This also reflects the potential for a new container terminal at the Port of Newcastle (Deloitte Access Economics 2018). The method is similar to that described for the food and agriculture growth estimates in Table 13. This produces a growth of 353 workers over the 665 workers currently employed in the sector.

7.2 Input-output analysis and transition in the Hunter

We model transition in the Muswellbrook and Singleton region by focussing on the expected investment in renewable energy and remediation, the growth in the agricultural and food sector,

and the additions to those industries affected by tourism as well as the transport and warehousing industry as explained in section 7.1 Table 15 summarises the first transition scenario.

Table 15 Transition scenario 1

Industry Sector	Direct Change Jobs	Direct Change Output ($M)
Coal Mining		-$4,796.994
Sheep, Grains, Beef Dairy Cattle	70	
Poultry Other Livestock	804	
Other Agriculture	88	
Meat Meat Product Manufacturing	470	
Bakery Product Manufacturing	60	
Wine, Spirits Tobacco	124	
Transport, Postal Warehousing	412	
Exploration Mining Support Services		$14.570
Polymer Product Manufacturing		$8.858
Other Fabricated Metal Product Manufacturing		$21.776
Prof, Scientific, Computer Electronic Equip. Manu.		$15.133
Specialised Other Machinery Equipment Manu.		$42.446
Construction		$70.477
Wholesale Trade		$4.241
Retail Trade		$12.423
Accommodation Food Services		$83.215
Information Media Telecommunications		$0.606
Auxiliary Finance Insurance Services		$5.828
Rental Hiring Services (except real estate)		$0.919
Ownership of Dwellings		$9.575
Non-Residential Property Operators Real Estate Serv.		$0.919
Professional, Scientific Technical Services		$23.912
Public Administration, Regulatory Services, Order Safety		$1.567
Education Training		$3.427
Health Care Social Assistance		$0.553
Arts Recreation Services		$2.879
Other Services		$0.956

Transition scenario 1 starts with the 55% or $4,797m reduction in coal production as described in section 3. Under the business as usual case described in Table 4, this direct reduction in production led to a direct fall in employment of 5,199 workers. In Table 15 and the input-output modelling, we consider either direct output or employment reductions but not both. That is, in the first row of Table 15 we could consider either 5,199 direct job losses or $4,797m reduction in direct production. Entering both numbers would be double-counting but it should be noted that the reduction in

output of $4,797 does lead to the same direct reduction in employment as described in Table 4. Similarly, the same supply-chain and consumption effects arise.

However, in transition scenario 1, the negative impacts of the reduction in coal production are alleviated by the positive growth industries described in section 7.1. For example, the changes described in Tables 12 and 13 lead to 804 direct jobs in Poultry and Other Livestock. In Table 12, also, 470 new jobs are assumed to be created in Meat and Meat Product Manufacturing and 60 in Bakery Product Manufacturing. The changes in construction and manufacturing arise from renewable energy and remediation investment described in Tables 10 and 11. For example, the $70.477m direct output growth in Construction arises from Table 10, where 28% of total renewable energy investment accrues to construction, and Table 11, where 50% of total remediation investment accrues to construction. However, as described in section 7.1, total investment in renewable energy ($3.248b) and remediation investment ($1.282b) is divided by 22 (years until 2040) in transition scenario 1 to simulate the impact of one-off investments versus the permanent and continuous reduction in coal production. In Table 15, tourism impacts have been further broken down into their constituent industries. For example, we allocated the information media and telecommunications impact from the addition to tourism to "telecommunication services" and "internet publishing, broadcast, websearch and data services". In addition, Electrical Equipment Manufacturing growth from Table 10 is subsumed within Specialised Other Machinery Equipment Manufacturing due to the fact that there is currently no electrical equipment manufacturing industry in the region and thus no supply chain effects.

The impacts of transition scenario 1 are presented in Table 16. In comparison to the business as usual case, the positive growth in renewable energy and remediation investment and agriculture has alleviated the negative impact of the reduction in coal production to some extent. For example, the direct reduction in employment of 2,028 workers is less than half the reduction under the business as usual scenario (5,199 workers) particularly because the growth industries are more labour-intensive than coal mining. The supply-chain and consumption effects are also more favourable in comparison to Table 4. For example, while industries that support mining suffer, other industries that support manufacturing and agricultural growth industries gain. Thus, the supply-chain effects are negative $537m rather than the negative $930m in Table 4.

Table 16 Impact of transition scenario 1
(Based on 2017 output and employment figures)

Impact Summary	Direct Effect	Supply-Chain Effect	Consumption Effect	Total Effect	Type 1 Multiplier	Type 2 Multiplier
Output ($M)	-$3,648.744	-$537.048	-$517.596	-$4,703.387	1.147	1.289
Employment (Jobs)	-2,028	-1,017	-1,840	-4,885	1.501	2.409
Wages and Salaries ($M)	-$531.035	-$145.684	-$113.571	-$790.290	1.274	1.488

Source: REMPLAN Economy 2017.

However, transition scenario 1 still results in a negative impact on output, jobs and wages highlighting the important role for government in helping the economy transition. Primarily, the impact is still negative because the reduction in coal production is permanent and continuous while the investments in renewable energy and remediation are one off. That is, there would be a direct reduction in coal production each year whereas the $3.248b in new renewable energy investment occurs only once over the time period considered. Other positive changes have been modelled as permanent such as those in agriculture and tourism. However, as described above, we have divided renewable energy and remediation investment by 22 (years to 2040) to simulate the fact that the investment is not permanent. This suggests there is a concrete role for government to support local renewable energy manufacturers and ensure that they establish viable long-term industries supplying national and international markets.

Transition scenario 2 models a local renewable energy industry that continuously supplies products and services needed for national and international markets rather than one that simply supplies the local investment and shuts down. Economic logic suggests that if the government supports the creation of a local renewable-energy supply industry, the industry itself will continue to look outside the local market for growth opportunities. Thus, while we continue to assume that 28% of the $3.248b in renewable energy investment is for one-off Construction in the local market, we assume that the other 72% becomes a permanent addition to the local economy. That is, like the reduction in coal production which will occur each year, transition scenario 2 assumes that the industry is replaced by a renewable-energy supply industry providing $2.34b (72% of $3.248b) of direct output for local, national and international markets. Given this assumption, transition scenario 2 results in a positive impact on the local economy. Table 17 describes transition scenario 2 with changes from Table 15 indicated in bold. The impacts of Transition scenario 2 are indicated in Table 18.

While output still decreases under transition scenario 2, as shown in Table 18, it should be remembered that this is exported output and the income is mostly being delivered to foreign owners and suppliers from outside the region. Thus, the important variables are employment and wages and salaries. Direct job creation is now positive 1,381 workers which reflects the fact that the growth industries are more labour intensive than coal mining. Thus, even though direct output falls, direct employment increases. However, the supply chain and consumption effects for employment are negative because the industries supplying coal mining are themselves labour intensive and because of the reduction in wages in mining. Overall, however, the total effect on employment is positive by 595 jobs.

Table 17 Transition scenario 2

Industry Sector	Direct Change Jobs	Direct Change Output ($M)
Coal Mining		-$4,796.994
Sheep, Grains, Beef Dairy Cattle	70	
Poultry Other Livestock	804	
Other Agriculture	88	
Meat Meat Product Manufacturing	470	
Bakery Product Manufacturing	60	
Wine, Spirits Tobacco	124	
Transport, Postal Warehousing	412	
Exploration Mining Support Services		$14.570
Polymer Product Manufacturing		**$194.880**
Other Fabricated Metal Product Manufacturing		**$479.080**
Prof, Scientific, Computer Electronic Equip. Manu.		**$332.920**
Specialised Other Machinery Equipment Manu.		**$933.800**
Construction		$70.477
Wholesale Trade		$4.241
Retail Trade		$12.423
Accommodation Food Services		$83.215
Information Media Telecommunications		$0.606
Auxiliary Finance Insurance Services		$5.828
Rental Hiring Services (except real estate)		$0.919
Ownership of Dwellings		$9.575
Non-Residential Property Operators Real Estate Serv.		$0.919
Professional, Scientific Technical Services		**$403.700**
Public Administration, Regulatory Services, Order Safety		$1.567
Education Training		$3.427
Health Care Social Assistance		$0.553
Arts Recreation Services		$2.879
Other Services		$0.956

Table 18 also indicates a reduction in wages and salaries of $205m. However, this is misleading because many of the workers in coal mining reside outside the region in contrast to other industries that are growing. To look at the effect of transition scenario 2 on local wages and salaries we divided the analysis into two parts. The first part, as indicated in Table 4, is the impact of the reduction in coal production which reduces direct wages by $706m. In mining only 39.7% of workers reside in Muswellbrook and Singleton (REMPLAN Economy 2017) which means that the $706m reduction in wages and salaries indicated in Table 4 actually corresponds to local wages and salaries falling by $280m. In the second part (not reported in full), we analyse the impact of only the growth industries in Table 17. This leads to an increase in direct wages and salaries of $501m. (Note that negative $706m and positive $501m equates with the negative $205m in direct wages and salaries reported

in Table 18). In these growth industries, 63% of workers in all other industries reside in the region (REMPLAN Economy 2017) which means that local wages and salaries increase by $315m. Bringing both parts of the analysis together, local wages and salaries increase by $35m (+$315m-$280m) under transition scenario 2.

Table 18 Impact of Transition scenario 2
(Based on 2017 output and employment figures)

Impact Summary	Direct Effect	Supply-Chain Effect	Consumption Effect	Total Effect	Type 1 Multiplier	Type 2 Multiplier
Output ($M)	-$1,416.482	-$280.558	-$224.347	-$1,921.387	1.198	1.356
Employment (Jobs)	1,831	-438	-798	595	0.761	0.325
Wages and Salaries ($M)	-$205.036	-$88.282	-$49.226	-$342.544	1.431	1.671

Source: REMPLAN Economy 2017.

While there will be some workers who suffer from the closing of coal mines, there are opportunities if transition strategies are put in place immediately. In particular, as mentioned above, the major occupations employed in mining are machinery operators and drivers and technicians and trade workers. Throughout NSW, the major industries that employ these workers are manufacturing, transport and warehousing, and construction which are some of the larger sectors positively affected by the transition described in Tables 15 and 17.

The impact scenario modelled suggests that there is a strong future for the Muswellbrook and Singleton LGAs even with the predicted reduction in global coal demand. However, the smooth transition in the region requires government intervention. While many of the changes to the renewable energy mix and remediation expenditure will occur within existing government regulations, the government can aid transition in a number of ways as described in the following section

8. Government intervention is needed

Without government intervention, the Muswellbrook and Singleton communities will suffer unfairly from the structural adjustment that occurs under the SD scenario. As the NSW and Federal governments have committed to the Paris Climate Agreement there is an obligation to help the communities adjust and transition to a more sustainable future. There needs to be systematic, targeted and coordinated oversight to ensure that all members of the Muswellbrook and Singleton communities benefit from structural adjustment. We recommend an independent transition process to ensure that resources are invested in the public interest. In addition, under our transition scenarios, the region will be enhanced through five main mechanisms all of which require strong government intervention.

Firstly, the government needs to work closely with AGL-Macquarie and coal companies to ensure the planned investment in renewable energy and expenditure on remediation occurs. The extent to which remediation expenditure is realised and can be increased determines the positive outcome for transition in the region. Similarly, the planned expenditure on renewable energy is the major driver of growth in the region and the government should support and subsidise renewable energy to aid AGL-Macquarie in its endeavours.

Secondly, the impact of these large expenditures on renewable energy and remediation will be greater where the income and supply-chain impacts are retained within the region. This suggests the need for large-scale subsidisation of growth industries to support the renewable energy and remediation plans. For example, a smooth transition will require government subsidies for the construction industry and those manufacturing industries that supply renewable energy and further subsidies may be needed to support their continual growth under transition scenario 2 in Tables 17 and 18.

Thirdly, the agricultural industry in particular is affected by the uncertainty over land use which the government can resolve. The major impediment to growth in the agricultural sector is the uncertainty created by mining exploration and extension licenses. For example, the Hunter Thoroughbred Breeders Association and the Hunter Valley Wine and Tourism Association have lobbied for greater protection (Department of Premier and Cabinet, 2018, p. 49). They have requested prohibiting new open cut, underground and CSG (Coal Seam Gas) mining on and within 10kms of the equine and viticulture critical industry clusters and a prohibitive development clause of the SEPP. In addition, the industry requests legislation to permanently protect the equine and viticulture critical industry clusters with 10km buffers from new mining proposals. Existing Government policy does not provide this protection and proposals to mine lands identified as part of the critical industry clusters is negatively affecting other potential growth industries. The government should review all exploration and mining titles to examine whether they are deterring investment in sustainable rural industries, cancel or not renew those found to be negatively affecting diversification efforts and grant the request from the equine and viticulture industries to establish buffer zones.

Fourthly, although the planned transition works favourably for the occupations that are expected to lose employment as mining declines, there will be a large cohort of workers needing retraining for the new growth sectors in the region. The government could levy mining companies to pay for retraining or subsidise education opportunities which would further boost employment in the education sector in the region. Structural unemployment occurs when economies adjust abruptly such as occurred in Australia with the reduction in tariffs in the 1980s. Planned transition and labour retraining can reduce or eliminate the structural unemployment that would arise with the reduction in global coal production under a do nothing approach.

Finally, the Port of Newcastle needs government support for the creation of a larger container port and aid in the vision of the Hunter region as a major supplier of goods to Sydney (Deloitte Access Economics 2018). The Muswellbrook and Singleton areas could benefit from the warehousing, transport and logistics industry growth that follows. Thus, the government's actions in supporting the vision for the Port of Newcastle would aid transition.

9. Conclusion

We have analysed the Muswellbrook and Singleton region with and without a transition to a more diversified economy. Under a do-nothing approach, the region is lacking in diversity and stability and is highly susceptible to mass unemployment if the global coal sector declines. As a decline in coal demand is consistent with Australian and NSW Government commitments to the Paris climate agreement and Sustainable Development Goals, economic theory suggests that it is efficient and prudent to invest in an alternative future. Fortunately, planned renewable energy and environmental remediation investment the region has great potential in alleviating the impact of a declining coal sector. In addition, the region's natural resources and agricultural potential can aid in the region's diversification. However, Federal, State and Local governments need to act.

Our analysis suggests that a strong Hunter region is possible if the economy transitions but this requires government action. The government needs to establish land security for the agricultural sector and ensure that planned investment in renewable energy and environmental remediation goes ahead. In particular, to ensure that the local economy benefits from the planned investment to the greatest extent, government investment is needed in the industries that supply renewable energy and environmental remediation. In addition, to aid workers, retraining investment is needed so that those workers losing mining jobs can participate in the new growth industries.

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