

concept economics

REPORT

**THE EMPLOYMENT EFFECTS
IN THE AUSTRALIAN
MINERALS INDUSTRY FROM
THE PROPOSED CARBON
POLLUTION REDUCTION
SCHEME IN AUSTRALIA**

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Minerals Council of
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Table of contents

EXECUTIVE SUMMARY	I
1. INTRODUCTION	1
1.1. MODELLING OF THE SCHEME	2
1.2. AIMS IN THE PRESENT STUDY	4
1.3. ANNOUNCED CHANGES TO PROPOSED ETS MAY 4 TH 2009	4
2. THE AUSTRALIAN MINERALS INDUSTRY	5
2.1. EMPLOYMENT IN THE AUSTRALIAN MINERALS INDUSTRY	6
3. POTENTIAL EFFECTS ON EMPLOYMENT FROM AN ETS	7
4. ESTIMATING EMPLOYMENT EFFECTS	9
4.1. POLICY SCENARIO	9
4.2. EMISSIONS REDUCTION TRAJECTORY, OUTPUT EFFECTS	9
4.3. TREATMENT OF THE CURRENT ECONOMIC CLIMATE	11
5. EMPLOYMENT EFFECTS AT NATIONAL AND STATE LEVELS	12
5.1. NATIONAL EFFECT ON EMPLOYMENT IN THE MINERALS INDUSTRY	13
5.2. STATE LEVEL EFFECT ON EMPLOYMENT	14
5.3. ESTIMATING REGIONAL EMPLOYMENT EFFECTS	23
5.4. STATE BASED INPUT OUTPUT EMPLOYMENT EFFECTS	23
5.5. EMPLOYMENT MULTIPLIERS	24
6. PROJECTED REGIONAL EMPLOYMENT EFFECTS	26
6.1. QUEENSLAND	28
6.2. NEW SOUTH WALES	32
6.3. WESTERN AUSTRALIA	37

List of tables

Table 1:	State distribution of production (by quantity) in the Australian minerals industry (per cent)	6
Table 2:	State distribution of employment in the Australian minerals industry, by sub-sector (per cent)	7
Table 3:	Key sectoral results for Australia at 2020 and 2030, percentage change from reference case ^a	10
Table 4:	Minerals sector breakdown	12
Table 5:	National employment results for the minerals industry	14
Table 6:	State employment loss results for the minerals industry at 2020	15
Table 7:	State employment loss results for the minerals industry at 2030	16

Table 8:	Qld employment results minerals industry	17
Table 9:	New South Wales employment results minerals industry	18
Table 10:	Western Australian employment results minerals industry	19
Table 11:	NT employment results minerals industry	20
Table 12:	South Australia employment results minerals industry	21
Table 13:	Victoria employment results minerals industry	22
Table 14:	Tasmania employment results minerals industry	22
Table 15:	Projected regional employment losses by state, 2020	26
Table 16:	Projected regional employment losses by state, 2030	27
Table 17:	Allocation of employment to minerals industry – Qld statistical division	28
Table 18:	Queensland statistical division employment losses, 2030	28
Table 19:	Employment effects – Fitzroy SD	29
Table 20:	Employment effects – Northern SD	30
Table 21:	Employment effects – Mackay SD	30
Table 22:	Employment effects – North West SD	31
Table 23:	Allocation of employment to minerals industry – NSW statistical division	32
Table 24:	New South Wales statistical division employment losses, 2030	32
Table 25:	Employment effects – Hunter SD	33
Table 26:	Employment effects – Illawarra SD	34
Table 27:	Employment effects – Far West SD	34
Table 28:	Employment effects – North West SD	35
Table 29:	Employment effects – Central West SD	36
Table 30:	Allocation of employment to minerals industry – WA Statistical Division	37
Table 31:	Western Australian statistical division employment losses, 2030	37
Table 32:	Employment effects – South West SD, including Peel region	38
Table 33:	Employment effects – Pilbara SD	39
Table 34:	Employment effects – South Eastern SD	39
Table 35:	Employment effects – Kimberley SD	40
Table 36:	Employment effects – Central SD	40

EXECUTIVE SUMMARY

An estimated 142,000 people are employed in mining activities in the mineral sector, with almost 20,000 employed in the smelting and refining of minerals commodities. Indirect employment is estimated to be around 200,000.

The introduction of an emissions trading scheme (ETS) will have significant production effects on the minerals industry and on individual regional communities. These effects will be felt through direct reductions in employment in the minerals industry, and further flow-on reductions in demand for goods and services in communities heavily reliant on minerals industry activity.

Concept Economics has estimated the employment effects in the Australian minerals industry projected to arise from the proposed introduction of an ETS. The number of jobs lost in the minerals industry is calculated as the difference between employment in the industry under the reference case and employment assuming a 5 per cent reduction in emissions by 2020, consistent with the Australian Government's announced CPRS-5 policy.

At the national and state level, these estimates do not represent the economy-wide employment effects of the scheme of the sort provided by general equilibrium modelling. Instead they are an estimate of the number of workers in the minerals industry that would be displaced from their jobs and need to find alternative employment in other sectors of the economy following the adjustment in the minerals industry arising from the ETS.

In 2020, it is projected that approximately 23,510 fewer people will be employed in the Australian minerals industry due to the imposition of the proposed ETS, a fall in employment of 11 per cent compared to what otherwise would have occurred. In 2030, this number is projected to reach in excess of 66,400 jobs, a reduction in employment in the minerals sector of 24 per cent compared with the reference case. The state level distributions of minerals industry job losses in 2020 and 2030 (compared with what otherwise would have occurred) are presented in the Tables A and B.

Table A. Projected national and state level employment losses by state, 2020

	Total minerals industry	Minerals mining sector	Minerals smelting and refining sector
<i>Numbers of jobs lost compared with what otherwise would have occurred</i>			
National	23510	14940	8570
Qld	11440	6770	4670
NSW	4260	4110	150
WA ¹	3410	2410	1000
NT	150	N.R.	N.R.
SA	1990	310	1680
Vic	1210	1120	90
Tas	1050	N.R.	N.R.
<i>Per cent of Australian minerals industry job losses</i>			
Qld	49	45	54
NSW	18	28	2
WA ¹	15	16	12
NT	1	N.R.	N.R.
SA	8	2	20
Vic	5	7	1
Tas	4	N.R.	N.R.

N.R. = not reported for confidentiality reasons.

Table B. Projected national and state level employment losses by state, 2030

	Total minerals industry	Minerals mining sector	Minerals smelting and refining sector
<i>Numbers of jobs lost compared with what otherwise would have occurred</i>			
National	66480	32810	33670
Qld	34090	14810	19280
NSW	14600	10180	4420
WA ¹	5750	4460	1290
NT	540	N.R.	N.R.
SA	3150	450	2700
Vic	5830	2310	3520
Tas	2520	N.R.	N.R.
<i>Per cent of Australian minerals industry job losses</i>			
Qld	51	45	57
NSW	22	31	13
WA ¹	9	14	4
NT	1	N.R.	N.R.
SA	5	1	8
Vic	9	7	10
Tas	3	N.R.	N.R.

N.R. = not reported for confidentiality reasons.

¹ Does not include oil and gas sub-sector

At the state level, Queensland is projected to bear the largest job losses of any state or territory in Australia. This is due to the high prevalence of emissions intensive technologies. The Queensland minerals industry is projected to employ 34,000 less people in 2030, accounting for 50 per cent of all jobs lost in the Australian minerals industry. The Queensland smelting and refining sub-sector is projected to employ just over 19,000 less people in 2030 than otherwise would have been the case. The mining sector (predominantly coal mining) is projected to lose almost 15,000 jobs.

New South Wales experiences the second highest level of job losses in Australia, losing almost 15,000 jobs in 2030, 10,000 mining jobs (predominantly coal mining) and 4000 smelting jobs compared to what otherwise would have occurred.

Western Australia accounts for 8 per cent of industry job losses nationally in 2030 (5800 jobs), though the proportion of jobs lost in that state relative to the reference case is somewhat less than the national figure – a reflection of the relatively lower share of highly emissions intensive minerals production in Western Australia. It should be noted that the employment effects reported in this study for Western Australia do not include impacts on the oil and gas sub-sector.

Of the 66,480 minerals industry jobs lost as a consequence of the introduction of the proposed ETS by 2030 relative to the reference case, 49 per cent are in the mining sector and 51 per cent are in smelting and refining. In the former, 47 per cent of overall employment displacement is in coal mining, followed by other non-ferrous ore mining (copper, gold, lead zinc, silver etc.) at 16 per cent, then mining services (14 per cent) and other mining (gravel, sand, industrial minerals etc.) at 10 per cent.

Concept Economics has also estimated the minerals industry job losses across a number of key statistical divisions in Queensland, New South Wales and Western Australia. Total regional job losses and displacement of workers in these regions was also calculated. Flow on employment effects in non-minerals industries will be felt most heavily in regional areas where there is a relatively high level of reliance on the minerals industry for total regional employment combined with a projected high level of lost minerals industry jobs. The total job losses in regional Australia that are discussed here represent the number of displaced workers that are likely to have to move from regional areas to find employment due to the impact of the proposed ETS. At the national and state level, these figures were not reported as, in the economy as a whole, displaced workers may find employment in other industries, and hence there is likely to be a smaller number of total jobs lost in non-minerals industries. It is at the regional level that displaced workers from all industries will often need to relocate to find new employment and hence displacement is more closely aligned with job losses.

The capital cities of Brisbane, Sydney and Perth were not included in the regional analysis due to the minimal level of minerals operations undertaken in these regions as well as the ability of capital cities to provide alternate employment options. However, due to the prevalence of fly in fly out employment, as well as differences in place of employment and place of residence reported in the ABS census, sizeable State level job displacements were attributed to these capital cities. Therefore, the reported sum of minerals sector job losses in regional Australia will not add up to total State level minerals industry jobs displaced.

Regional employment effects in 2020 and 2030 are presented in Tables C and D. The distribution of job losses across statistical divisions is not equal, with those regions with larger emissions intensive sectors accounting for the greatest proportion of state level jobs lost. For

example, Fitzroy, Northern and Mackay regions of Queensland account for almost 60 per cent of Queensland minerals industry job losses.

The differences in regional employment effects in 2020 and 2030 represent a number of factors, including the initial level of compensation provided to the sub-sectors of the minerals industry in the early years of the proposed ETS.

Due to the large proportion of Australian minerals industry job losses occurring in Queensland, the total job losses in Queensland regional economies represent up to 8 per cent of 2030 regional employment.

In New South Wales, the Hunter region and the Illawarra account for almost 60 per cent of total minerals industry job losses. However, due to the more diversified employment base of these regions (compared to the Queensland regions) the employment losses in the minerals industry represent a smaller share of regional employment than for the major mining regions in Queensland.

The South West region of Western Australia is projected to lose almost 1700 minerals jobs in 2030 and in the Pilbara 1330 fewer people are projected to be employed in the sector. Total employment losses in these regions are projected to be approximately 4000 and 2000 people respectively.

Table C. Projected regional employment losses, 2020

State and Statistical Division	Total minerals jobs lost	Total regional jobs lost	Per cent of regional employment lost
Queensland	11440		
Fitzroy	1950	4180	2.6
Northern	1870	3600	2.3
Mackay	2600	4500	3.4
North West	390	770	2.9
New South Wales	4260		
Hunter	2150	4300	1.2
Illawarra	720	1440	0.6
Central West	420	840	0.8
North Western	210	420	0.6
Far West	75	150	1.2
Western Australia²	3410		
South West	560	1200	0.7
Pilbara	520	700	1.9
South Eastern	400	750	1.6
Kimberley	40	80	0.3
Central	130	260	0.6

Table D. Projected regional employment losses, 2030

State and Statistical Division	Total minerals jobs lost	Total regional jobs lost	Per cent of regional employment lost
Queensland	34090		
Fitzroy	7800	16000	8.1
Northern	7200	14400	7.5
Mackay	5060	12000	7.2
North West	1420	2800	8.3
New South Wales	14600		
Hunter	6150	11970	2.7
Illawarra	2100	4200	1.4
Central West	1070	2140	1.6
North Western	540	1080	1.2
Far West	230	430	3.0
Western Australia²	5750		
South West	1690	4000	2.0
Pilbara	1330	2000	4.6
South Eastern	750	1590	2.9
Kimberley	65	130	0.4
Central	240	470	0.8

² Does not include oil and gas sub-sector

1. INTRODUCTION

The Australian Government believes that acting on climate change is essential. It has developed a strategy based on three pillars: reducing Australia's emissions; adapting to unavoidable climate change; and helping to shape a global solution.

The Australian Government intends to introduce an emissions trading scheme (ETS) on 1 July 2011.³ The Government's White Paper released in December 2008 sets out key policy positions on scheme design and a medium-term target range for reducing Australia's emissions by 2020. Exposure draft legislation (*Carbon Pollution Reduction Scheme Bill 2009*) was released on 10 March 2009. Further changes to the proposed scheme were announced by the Prime Minister on 4 May 2009 and the draft legislation was introduced into the House of Representatives on 14 May 2009.

The ETS is a 'cap and trade' system that limits (or caps) the aggregate output of greenhouse gas emissions at a level consistent with an environmental objective. A number of tradable permits, equal to the cap, will give permit holders the right to emit in accordance with the permit limit.

The long-term target for emissions reductions is 60 per cent below 2000 levels by 2050 with a medium-term (2020) target of between 5 per cent and 25 per cent below 2000 levels by 2020. The interim range represents a minimum commitment – unconditional on global action – to reduce emissions to 5 per cent below 2000 levels by 2020, and a commitment to reduce emissions by up to 15 per cent below 2000 levels by 2020 in the context of global agreement under which all major economies commit to substantially restrain emissions and advanced economies take on reductions comparable to Australia.

The ETS will cover all six greenhouse gases that are covered under the Kyoto Protocol and will cover around 75 per cent of Australia's emissions. Emissions from stationary energy, transport, fugitive, industrial processes, waste and forestry sectors will be included from 2010, with a decision on the inclusion of agriculture into the scheme in 2015 to be made in 2013.

The emission price generated by the ETS will be determined by the market except where a price cap is binding. If there are no restrictions on international emissions trade, Australia's emission price will be determined by the global price. In the scenarios the Treasury has modelled, Australia's emission price is equal to the global price, with an allowance for changes in the exchange rate.

Assistance will be provided to emissions-intensive trade-exposed (EITE) industries to reduce the risk that industries will relocate offshore due to competition from countries without emissions constraints and to provide general transitional assistance following the introduction of an ETS.

Assistance will be targeted to the most emissions-intensive trade-exposed activities. In its White Paper, the government proposed that permits will initially be provided at a 90 per cent rate for the most emissions-intensive activities (activities above 2000 t CO₂-e/\$ million revenue or 6000 t CO₂-e/\$ million value-added) and at a 60 per cent rate for activities that are

³ Delayed from 2010, as announced on 4 May 2009.

moderately-emissions intensive (activities between 1000 and 1999 t CO₂-e/\$ million revenue or 3000 and 5999 t CO₂-e/\$ million value-added). Changes to these arrangements were announced on 4 May 2009 and continue to be subject to change. Those changes included a small increase in the assistance to EITE affected industries, a one year delay in the start date to July 2011, a \$10 fixed price of carbon for the first year, and a new conditional 25 per cent emissions reduction target by 2020 (against 2000 levels) if other nations agree to large emissions cuts.

The rates of assistance per unit of production will be reduced by 1.3 per cent per annum such that EITE activities share in the national improvement in carbon productivity over time. The EITE assistance program will be reviewed at each five yearly review (or at another date at the request of the responsible minister).

The assessment process to determine which activities will be eligible for EITE assistance involves several steps (DCC 2009).

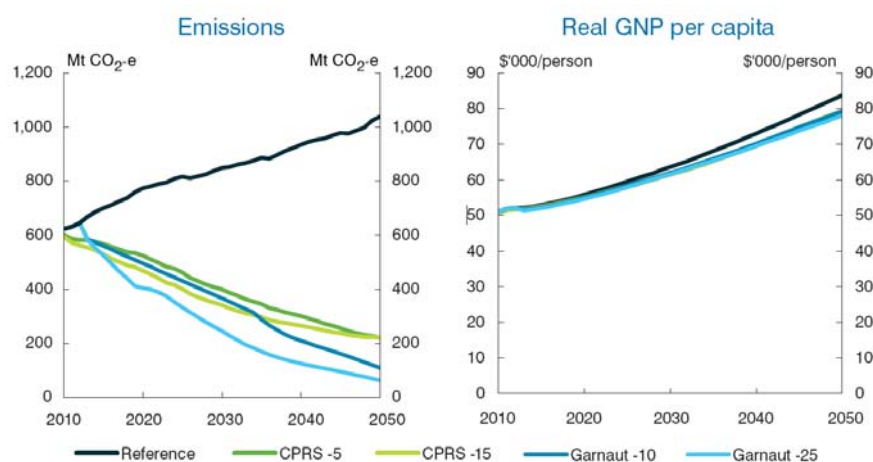
- *Preliminary assessment.* Activities that demonstrate the potential to meet EITE eligibility criteria are identified (set out in the White Paper (DCC 2008)).
- *Formal assessment.*
 - Activities that will proceed to formal assessment are defined.
 - Collection, auditing and submission of required emissions, production, trade and financial data will be made by entities to the government.
 - The government will assess the eligibility of each activity taking into account data submitted by entities. The data will be used (in conjunction with other data) to: determine industry average emissions intensity per unit of production for each activity; assess the trade exposure of the entity; and determine allocative baselines for eligible activities – specifying how many permits per unit of production an entity will receive.
- *Scheme regulation.* Eligible activities will be listed in draft regulations, including the rate of assistance and allocative baseline for each activity.

On 1 April 2009, the first set of activity definitions approved for data collection were released (Wong 2009). Activities include: silicon, carbon black, glass containers, fused alumina, synthetic rutile, methanol, and zinc smelting.

1.1. MODELLING OF THE SCHEME

Modelling of the effects of an ETS on the Australian economy has been conducted by the Commonwealth Treasury ('Treasury'). The Treasury modelling of four ETS policy scenarios projects that from 2010 to 2050 Australia's real gross national product (GNP) per person grows at an average annual rate of 1.1 per cent, compared to 1.2 per cent if there were no ETS (the reference scenario). By 2020, real GNP per person is around 9 per cent above current levels, compared to around 11 per cent in the reference scenario. By 2050, real GNP per person is 55-57 per cent above current levels, compared to 66 per cent in the reference scenario (see Figure 1).

Figure 1: Australia's GNP in the four emissions scenarios and the reference case



Note: Units are in Australian 2005 prices.

Data source: (Commonwealth Treasury 2008)

The ETS will have far-reaching implications for economic activity and jobs in Australia. The effects will differ markedly across sectors and regions of Australia.

There are a number of issues with the Treasury modeling that suggest that the projections do not provide a full and accurate picture of the impact of an ETS on the Australian economy.

Issues with the Treasury modeling include:

- The reporting of impacts only at a highly aggregated level, both across sectors and regions;
- The disregard of short- to medium-term adjustment costs by only reporting long-term results;
- Insufficient consideration of the discontinuities that typically characterise business decisions (especially with respect to lumpy, long-term assets such as mines, power stations and metal processing facilities);
- Insufficient consideration of the spillovers at the community level of the loss of high-value economic activity;
- The use of relatively optimistic assumptions that underpin the modeling results (these indicate a substantial risk that the modelling process may have resulted in unrealistically low carbon prices and results which underestimate the costs associated with emissions reduction targets);
- Reference case assumptions for metal prices and energy commodities that cannot in all cases be verified against real world data and industry trends; and
- The absence of assumptions concerning the scale and timing of binding emissions reductions by other leading economies (these assumptions significantly influencing the global carbon price).

1.2. AIMS IN THE PRESENT STUDY

Unfortunately, the Treasury modeling of the impacts of the proposed ETS on the Australian economy does not provide an adequate basis for understanding the effects on different industries and sectors or on local communities in regional Australia. This report aims to address the lack of sub-sector and local community impacts and to provide a realistic picture of the impacts of the proposed ETS on economic activity and jobs at a local level in regional Australia – focusing on the employment impacts in the minerals sector.

1.3. ANNOUNCED CHANGES TO PROPOSED ETS MAY 4TH 2009

The changes to the proposed CPRS announced on May 4th do not materially affect the findings of this report.

The one year delay in the start of the scheme does not reduce the estimated job losses as the scheme's unconditional interim emissions reduction target will still have to be reached by 2020. Industry expectations about the long run impacts of the proposed scheme will remain the same and the necessary adjustment will potentially be compressed into a shorter period.

The changes in EITE assistance (from 60 to 66 per cent for selected firms and from 90 to 94.5 per cent allocated permits for certain others) will not have a material impact on the results. There are two reasons for this. First, less than 10 per cent of minerals exports, by value, will receive any assistance under the proposed EITE arrangements. Second, the modelling assumes that EITE 'compensation' will be paid at the full level of 90 per cent and 60 per cent respectively. In practice, under the so-called 'activity based' approach proposed in the CPRS legislation, firms will receive an allocation of permits only for emission generated in their most emissions intensive activity. This means that for the vast majority of firms the *effective* rate of assistance is likely to be lower than the 66/94.5 EITE levels. In other words, the study's findings are conservative, and predicated on firms receiving more generous assistance than is likely to actually be provided.

2. THE AUSTRALIAN MINERALS INDUSTRY

The Australian minerals industry includes the exploration, mining and processing of resources such as coal, iron ore, uranium, nickel, bauxite, gold, lead, copper, zinc, minerals sands and diamonds. Australia is among the top producers of most of the world's key mineral commodities.

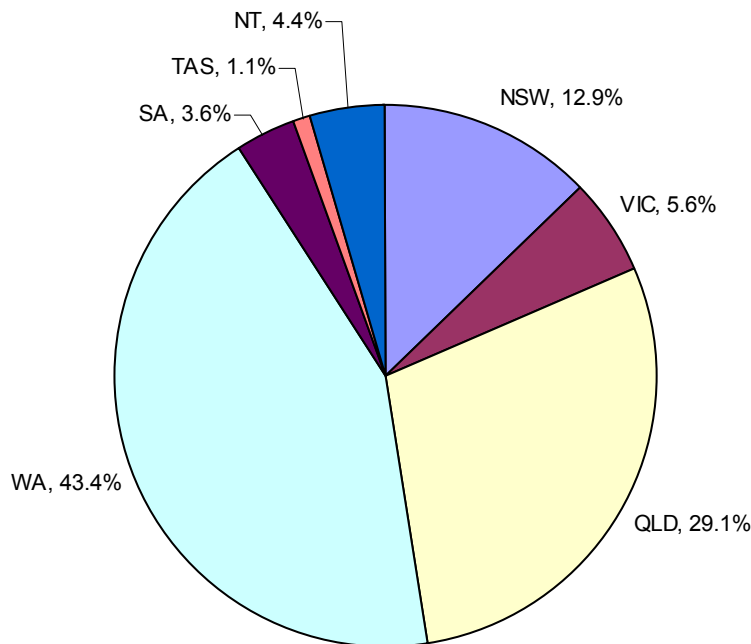
In 2006-07, the minerals industry reported a value of production in the mining sector of \$79.1 billion (ABS cat 84510, excluding coal, shale oil and carbon dioxide) with an additional \$9.8 billion of value added in the manufacturing sector, associated with aluminium and alumina production as well as other non-ferrous metal smelting.

Comprising around 7 per cent of GDP, the mineral resources industry is a major source of national income, investment, export earnings and employment opportunities in Australia.

Mineral resources (including energy commodities) accounted for 49 per cent of Australia's exports in 2007-08, up from 36 per cent in 2003-04.

Percentage shares of Australian mineral production by state are shown in Figure 2.

Figure 2: Gross value of Australian mineral production, by state (2005-06)



Source: Australian Bureau of Agricultural and Resource Economics.

The distribution of minerals sector production is presented in Table 1. Both the distribution of production across States, as well as across industries within States, is important for the ultimate distribution of employment effects across States and industries.

Table 1: State distribution of production (by quantity) in the Australian minerals industry (per cent)

	WA	NSW	QLD	NT	VIC	SA	TAS
Mining Sector							
	%						
Coal	2	34	47		17	<1	
Natural gas	32		11	12	36	8	
Coal seam methane			100				
Bauxite	66		27	7			
Copper	14	24	39	0		20	4
Gold	66	13	9	5	3	3	2
Iron ores	97			<1		2	1
Lead	10	15	70				5
Nickel	100						
Zinc	8	10	55	20			6
Other metallic minerals	31		11	31		26	
Total industrial minerals	34	14	20	7	7	13	4
Total construction materials	4	19	33	1	31	9	4
Smelting and Refining Sector							
	%						
Aluminium		35	28		28		9
Alumina	62		29	9			
Nickel	15		85				
Copper			20			80	
Lead			37			63	
Zinc			41			8	51

Source: ABS cat no. 84150

2.1. EMPLOYMENT IN THE AUSTRALIAN MINERALS INDUSTRY

An estimated 142,000 people are employed in mining activities in the mineral sector, with almost 20,000 employed in the smelting and refining of minerals commodities (MCA 2008, ABS cat. no. 84510). Indirect employment is estimated to be around 200,000 (ABARE 2008a, MCA 2008).

With production predominantly located in regional and rural areas of Australia, the minerals sector accounts for a large proportion of employment in many regional and remote townships. The industry is especially important to the economies of Western Australia, Queensland and the Northern Territory.

Based on the 2006 ABS census, a State level breakdown of employment in the minerals industry (by reported State of usual residence) is presented in Table 2. The distributions of employment by industry and the emissions intensity of each industry are not uniform across States. For example, 91 per cent of employees working in the iron ore mining sector reside in Western Australia. For this reason, the employment effects associated with an ETS will also not be uniformly distributed across the States and regions.

In addition, within States, minerals production is predominantly located in regional and rural areas where the minerals sector accounts for a large proportion of employment in many regional townships. Where there is a larger proportion of regional employment reliant on the minerals industry, these townships will be more heavily exposed to employment effects emanating from the proposed ETS.

Table 2: State distribution of employment in the Australian minerals industry, by sub-sector (per cent)

	WA	NSW	QLD	NT	SA	VIC	TAS
<i>Minerals sub-sector</i>							
Coal mining	3	42	53		<1	3	
Iron Ore Mining	91	2	1		2	1	3
Bauxite Mining	53	1	26	9	8	2	
Copper Ore Mining	9	12	54		22	1	2
Gold Ore Mining	62	12	11	2	2	9	2
Mineral Sand Mining	53	9	20		3	13	1
Nickel Ore Mining	83	1	15	1		1	
Silver-Lead-Zinc Ore Mining	8	25	49	5	2	2	8
Other Metal Ore Mining	22	5	12	32	20	3	4
Gravel and Sand Quarrying	9	34	31	1	6	16	3
Other Construction Material Mining	13	25	25	1	10	25	2
Other Non-Metallic Mineral Mining and Quarrying	66	8	10	1	7	7	1
Mineral Exploration	54	12	20	1	5	6	1
Other Mining Support Services	48	11	26	2	6	6	2
Alumina Production	43	1	37	18		1	0
Aluminium Smelting	2	30	39		2	17	9
Copper, Silver, Lead and Zinc Smelting and Refining	2	15	18		30	9	27
Other Basic Non-Ferrous Metal Manufacturing	53	7	26		1	12	1

Source: ABS 2006 Census data

3. POTENTIAL EFFECTS ON EMPLOYMENT FROM AN ETS

A decrease in mining activity due to the imposition of the proposed ETS will directly displace employment in the Australian mineral industry. This direct displacement effect is often referred to as the 'first-round' effect and considers only those employed directly in the minerals industry - through, for example, mining and extraction, smelting and refining, and services to the minerals industry.

However, the first-round employment effects do not provide the full picture of employment effects from the proposed ETS in Australia. While the mining and minerals sector is likely to experience a disproportionately large employment effect from the proposed ETS, there are many other industries in Australia that rely on the minerals industry for both the supply of goods and services, as well as for provision of demand for products and services.

Large scale employment effects in the Australian minerals industry will have negative flow-on implications for many other industries in Australia. The total employment effects of the proposed ETS would include:

- First-round effect on minerals industry employment;
- Second-round employment effects in associated industries - for example, transport and construction;
- Additional second-round effects in industries that rely on custom from minerals sector employees - for example, retail trade, health care, teachers and other service industries.

These indirect or second-round employment effects will be felt most heavily at a regional level where there is a relatively high level of reliance on the minerals industry for total regional employment. In addition, in the economy as a whole, displaced workers may find employment in other industries. At a regional level, displaced workers will often need to relocate to find new employment and hence displacement is more closely aligned with job losses.

The effect on the demand for local goods and services, and hence the demand for flow on labour will be greater if:

- The number of people employed in the minerals sector accounts for a large share of regional employment;
- Those employed in the minerals industry live in the regional area in which they work; and
- Mining industry workers displaced from the mining industry migrate to other regions (in search of work).

Regions are most likely to lose skilled and more specialised labour. This will make the process of economic recovery after the jobs are lost more difficult if it is indeed possible. More remote regions have a limited resource base and the cost of diversification will be high given their level of comparative advantage in attracting labour compared to major cities.

These adjustment costs imposed are unlikely to be small in the Australian minerals industry.

4. ESTIMATING EMPLOYMENT EFFECTS

Utilising modelling output from Access Economics, Concept Economics has estimated the employment effects on the Australian minerals industry from the imposition of the proposed ETS.

4.1. POLICY SCENARIO

The policy assumptions underlying the implementation of the proposed ETS are those reported by the Treasury in their CPRS-5 scenarios. The modelling of the scenarios was undertaken by Access Economics. The quantitative analysis is based on Access Economics' general equilibrium model called AE-RGEM (Access Economics Regional General Equilibrium Model). General equilibrium models like AE-RGEM are a widely accepted tool for estimating the direct and indirect impacts of policy changes, such as the imposition of an emissions trading scheme. The main benefit of a model such as AE-RGEM is that greenhouse gas emissions arise from a range of activities across the economy and, as such, policies designed to constrain emissions growth will have widespread economic consequences.

4.1.1. Assistance scenarios for EITE industries

The assistance levels, including the levels of administration permit allocations that have been adopted, are as set out in DCC(2008).

4.2. EMISSIONS REDUCTION TRAJECTORY, OUTPUT EFFECTS

The policy scenario used in the analysis was the CPRS-5 emissions reduction target utilised by the Australian Treasury.

The stabilisation of greenhouse gas emissions at 550 ppm in 2100 is projected to be achieved through setting a range of reduction targets across developed and developing countries in a staged manner, and the use of global market based mechanisms.

There is a multi-stage approach to emission abatement, with Annex B economies beginning abatement at 2010, China and higher income developing countries from 2015, India and middle income developing countries from 2020 and low income developing economies from 2025. Based on these targets, a global carbon price was determined that resulted in the desired level of abatement. The global level of abatement is consistent with the figures provided in the Treasury report, and trade in permits is allowed.

The projected changes in production from the reference case for the key sectors of the Australian economy as a whole are presented in Table 3.

Table 3: Key sectoral results for Australia at 2020 and 2030, percentage change from reference case^a

Variable	2020	2030
Crops	0.33	-0.58
Livestock	-0.64	-2.62
Other Ag	-0.36	-1.39
Brown coal	-41.14	-39.55
Thermal Coal	-27.02	-30.51
Coking coal	-11.97	-13.32
Natural Gas	-13.70	-15.68
Bauxite	0.00	-16.46
Other Minerals	-3.20	-3.10
Process Food	-0.46	-2.40
Lumber and Wood	-0.79	-3.30
Petroleum and Coal products	-12.74	-18.80
Chemical Rubber and plastics	0.82	1.32
Non-Metallic Mineral products	3.67	-9.37
Alumina	-2.85	-30.54
Aluminium	-3.78	-60.96
Other Nonferrous Metals	-26.71	-34.05
Pulp Paper Printing	-0.85	-2.37
Motor Vehicle Parts	0.23	-2.82
Electronic Equipment	-1.40	-6.13
Other Manufacturing	0.74	-0.71
Water	-1.29	-1.94
Electricity Generation	-13.92	-16.01
Construction	-2.24	-2.02
Trade	-0.98	-0.95
Air Transport	-0.80	-1.38
Water Transport	0.52	1.32
Land Transport	-1.51	-2.50
Commercial Services	-0.81	-1.00
Other Business Services	-1.09	-1.32
Government Services	-0.31	0.05
Other Services	-0.37	-0.25

^a The modelled production impacts take account of the lumpy nature of long lived assets in the mining and smelting industries.

Appendix A outlines the methodology used to rebalance input output tables and estimate labour effects in the Australian minerals industry.

4.3. TREATMENT OF THE CURRENT ECONOMIC CLIMATE

Recent events in the global economy have resulted in a reduction in demand for minerals and energy production, with reported closures of mines as well as smelting and refining operations both in Australia and around the world. While these global economic conditions are having a serious negative effect on the Australian minerals industry in the short to medium term, these effects are not considered to be likely to have a long term impact on the size of the minerals industry in Australia.

5. EMPLOYMENT EFFECTS AT NATIONAL AND STATE LEVELS

Concept Economics has estimated the displacement of full time equivalent (FTE) employment in the Australian minerals industry due to the ETS. The number of full time jobs lost is calculated as the difference between employment in the industry under the reference case minus employment under the policy case. These estimates do not represent the economy-wide employment effects of the scheme of the sort provided by general equilibrium modelling. Instead they are an estimate of the number of workers in the mining industry that would need to find alternative employment in other sectors of the economy.

The results in this part of the report are estimates of the first-round, direct employment effects on the Australian minerals industry from the imposition of the proposed ETS. These figures will, by definition, under-estimate the total employment effect at the state level, due to the flow-on impacts of reduced employment and output in the minerals industry on employment in associated industries.

Definitions of the minerals industry aggregated sectors are presented in Table 4.

Table 4: Minerals sector breakdown

<i>Mining Sector</i>	
Coal	Including black and brown
Gas	Including coal seam methane
Other non-ferrous metal ore mining	Copper ore mining Gold ore mining Lead ore mining Nickel ore mining Silver ore mining Zinc ore mining
Other mining	Gravel and sand mining Heavy minerals sand mining Industrial minerals
<i>Smelting and Refining Sector</i>	
Other non-ferrous metals refining	Copper smelting Lead smelting Zinc smelting Silver smelting Nickel smelting

In the results tables, national figures have been rounded to the nearest 100, state figures have been rounded to the nearest 10.

5.1. NATIONAL EFFECT ON EMPLOYMENT IN THE MINERALS INDUSTRY

The national results by industry sector are reported in Table 5. In 2020, it is estimated that there will be approximately 23,510 less people employed in the Australian minerals industry due to the imposition of the proposed ETS than otherwise would have been the case. This represents a fall in employment of 11 per cent relative to the reference case. In 2030, this number reaches just over 68,000 jobs, a reduction in employment in the minerals sector of 25 per cent compared with the reference case.

The reduction in employment is not consistent across the minerals industry or across Australian states. More emissions intensive sub-sectors, and states utilising more emissions intensive technologies, are projected to experience a greater reduction in production, and therefore lose a greater number of jobs by 2030 compared to what otherwise would have been the case. Where compensation is provided to sub-sectors for the initial period of the proposed ETS, the employment effects are limited. However, these effects grow once the compensation effects are removed and free permits are no longer issued. By 2030, these industries experience significant falls in employment relative to the reference case.

In the mining sector:

- there are approximately 32,810 less people employed (16 per cent of reference case employment) as a consequence of the proposed ETS in 2030 compared to what otherwise would have been the case;
- coal mining (see Table 5) accounts for the largest share (47 per cent) of lost jobs by 2030 relative to the reference case, followed by other non-ferrous ore mining (16 per cent) and mining services (14 per cent).

In the smelting and refining sector there are projected to be 33,670 less people employed (51 per cent of reference case employment) by 2030 compared to what otherwise would have been the case.

Table 5: National employment results for the minerals industry

	Change from reference case	
	Employment effect 2020	Employment effect 2030
Minerals Industry (Jobs)	-23510	-66480
Minerals Industry sector (%)	-11	-24
<i>Mining Sector</i>		
Jobs	-14940	-32810
Percentage	-9	-16
Coal	-9040	-15610
Gas	-870	-1730
Bauxite	-40	-600
Other non-ferrous metal ore mining	-1720	-5290
Iron ores	-560	-1740
Other mining	-1130	-3240
Mining services	-1580	-4600
<i>Smelting and Refining Sector</i>		
Jobs	-8570	-33670
Percentage	-15	-51

5.2. STATE LEVEL EFFECT ON EMPLOYMENT

At the state level, the loss of jobs in the minerals sector relative to the reference case is determined by a number of factors:

- the relative size of the mining and refining sector in the State;
- the relative breakdown of minerals sector production into highly emissions-intensive and less emissions-intensive sub-sectors; and
- the reliance of other industries on the minerals sector for both demand and supply of industry production – that is, whether the minerals industry provides input, or consumes production from, related sectors.

The state level employment effects of the proposed ETS are presented in the following tables. The effects are reported at the aggregate sector level for the minerals industry.

Significant displacement of employment is projected for the minerals industry between 2020 and 2030 in Queensland where highly emissions intensive production methods are utilised. Employment in New South Wales is also projected to be heavily affected, predominantly in the mining sector, due to the importance of the coal industry in that state. Such large employment effects will arise as a result of closure of some mining and refining and smelting operations, and the scaling back of operations in others. These estimates have not taken into account the exact timing or location of plants that may be closed.

A summary of the state level effects on jobs losses due to the proposed ETS in 2020 and 2030 are presented in Table 6 and Table 7. The results indicate that Queensland accounts for 49 per cent of total mineral industry job losses in 2020 relative to the reference case, and 45 per cent of the smelting and refining job losses. In 2020, New South Wales accounts for 28 per cent of job losses in the Australian minerals mining sector relative to the reference case, and 18 per cent of total job losses in the Australian minerals sector in 2020 due to the proposed ETS. Western Australia accounts for 15 per cent of Australian minerals industry job losses in 2020, and 16 per cent of Australian mining job losses.

Table 6: State employment loss results for the minerals industry at 2020

	Total minerals industry	Minerals mining sector	Minerals smelting and refining sector
<i>Numbers of jobs lost compared with what otherwise would have occurred</i>			
National	23510	14940	8570
Qld	11440	6770	4670
NSW	4260	4110	150
WA ⁴	3410	2410	1000
NT	150	N.R.	N.R.
SA	1990	310	1680
Vic	1210	1120	90
Tas	1050	N.R.	N.R.
<i>Per cent of Australian minerals industry job losses</i>			
Qld	49	45	54
NSW	18	28	2
WA ⁴	15	16	12
NT	1	N.R.	N.R.
SA	8	2	20
Vic	5	7	1
Tas	4	N.R.	N.R.

N.R. = not reported for confidentiality reasons.

⁴ Does not include oil and gas sub-sector

Table 7: State employment loss results for the minerals industry at 2030

	Total minerals industry	Minerals mining sector	Minerals smelting and refining sector
<i>Numbers of jobs lost compared with what otherwise would have occurred</i>			
National	66480	32810	33670
Qld	34090	14810	19280
NSW	14600	10180	4420
WA ⁵	5750	4460	1290
NT	540	N.R.	N.R.
SA	3150	450	2700
Vic	5830	2310	3520
Tas	2520	N.R.	N.R.
<i>Per cent of Australian minerals industry job losses</i>			
Qld	51	45	57
NSW	22	31	13
WA ⁵	9	14	4
NT	1	N.R.	N.R.
SA	5	1	8
Vic	9	7	10
Tas	4	N.R.	N.R.

N.R. = not reported for confidentiality reasons.

⁵ Does not include oil and gas sub-sector

5.2.1. Queensland

State level employment effects for Queensland are presented in Table 8. Due to the high use of emissions intensive technology in the state relative to the rest of Australia, the Queensland minerals industry is projected to experience the greatest number of jobs lost of any state or territory in Australia due to the proposed ETS. In 2020 it is projected that there will be 11,400 less people employed relative to the reference case, and 34,000 less in 2030 compared to what otherwise would have occurred.

In 2030, Queensland accounts for 50 per cent of total displaced jobs in the Australian minerals industry. Significant employment effects are observed in the coal mining and smelting and refining industry.

Table 8: Qld employment results minerals industry

	Change from reference case	
	<i>Employment effect 2020</i>	<i>Employment effect 2030</i>
QLD - Minerals Industry (Jobs)	-11440	-34090
QLD - Minerals Industry sector (%)	-15	-34
<i>Mining Sector</i>		
Jobs	-6770	-14810
Percentage	-13	-22
Coal	-4940	-8220
Gas	-370	-910
Bauxite	0	-450
Other non-ferrous metal ore mining	-620	-2340
Other mining	-310	-980
Mining services	-530	-1910
<i>Smelting and Refining Sector</i>		
Jobs	-4670	-19280
Percentage	-20	-62
Aluminium	-170	-6010
Alumina	-130	-2400
Other non-ferrous metals refining	-4370	-10870

In the mining sector:

- there are projected to be 14800 less people employed (22 per cent of reference case employment) are lost as a consequence of the proposed ETS in 2030;
- coal mining accounts for the largest share of job losses (56 per cent), followed by other non-ferrous ore mining (16 per cent) and mining services (13 per cent).

In the smelting and refining sector:

- there are projected to be 19,300 less people employed (62 per cent of reference case employment) in 2030 compared to what otherwise would have been the case;

- other non-ferrous metals refining accounts for 56 per cent of employment displacement relative to the reference case, with aluminium smelting accounting for 31 per cent.

5.2.2. New South Wales

State level employment effects for New South Wales are presented in Table 9. Overall, 4260 jobs are displaced in the minerals industry in New South Wales compared with the reference case in 2020, rising to 14600 displacements in 2030. In the minerals industry as a whole coal mining accounts for more than two-thirds of the jobs lost in NSW compared with the reference case. Aluminium smelting accounts for 30 per cent of jobs lost in the NSW minerals sector in 2030.

Table 9: New South Wales employment results minerals industry

	Change from reference case	
	Employment effect 2020	Employment effect 2030
NSW - Minerals Industry (Jobs)	-4260	-14600
NSW - Minerals Industry sector (%)	-12	-34
<i>Mining Sector</i>		
Jobs	-4110	-10180
Percentage	-14	-28
Coal	-3300	-6440
Other non-ferrous metal ore mining	-280	-1220
Other mining	-250	-1190
Mining services	-280	-1330
<i>Smelting and Refining Sector</i>		
Jobs	-150	-4420
Percentage	-3	-80
Aluminium	-150	-4420

In the mining sector:

- it is projected that 10,200 less people (28 per cent of reference case employment) will be employed as a consequence of the proposed ETS in 2030 compared to what otherwise would have been the case;
- coal mining accounts for 63 per cent of these lost jobs, with the remainder distributed fairly evenly across mining services (13 per cent), other non-ferrous metal ore mining (12 per cent) and other mining (12 per cent).

In the smelting and refining sector it is projected that there will be 4420 less people employed (80 per cent of reference case employment) in 2030 than otherwise would have been the case.

5.2.3. Western Australia

State level employment effects for Western Australia are presented in Table 10. In 2020, there are projected to be 3400 fewer people employed in the Western Australian minerals industry relative to what otherwise would have been the case as a consequence of the proposed ETS. This number is projected to increase to 5800 jobs lost in 2030.

A lower share of emissions-intensive minerals production in Western Australia means the proportion of jobs lost relative to the reference case in 2030 is below the national figure. Even so, Western Australia still accounts for approximately 8 per cent of Australian mineral jobs displaced by the proposed ETS in 2030, and 14 per cent of smelting and refining jobs lost.

These employment effects do not include job losses in the oil and gas sub-sector due to the proposed ETS.

Table 10: Western Australian employment results minerals industry⁶

	Change from reference case	
	<i>Employment effect 2020</i>	<i>Employment effect 2030</i>
WA - Minerals Industry (Jobs)	-3410	-5750
WA - Minerals Industry sector (%)	-5	-8
<i>Mining Sector</i>		
Jobs	-2410	-4460
Percentage	-4	-6
Coal	-330	-320
Gas	-210	-350
Bauxite	-40	-150
Other non-ferrous metal ore mining	-510	-960
Iron ores	-550	-1710
Other mining	-210	-130
Mining services	-560	-840
<i>Smelting and Refining Sector</i>		
Jobs	-1000	-1290
Percentage	-14	-18
Alumina	-110	-280
Other non-ferrous metals refining	-890	-1010

In the mining sector:

- 4460 less people (6 per cent of reference case jobs) are employed due to the proposed ETS in 2030 compared to what otherwise would have been the case;
- iron ore mining accounts for the largest share (38 per cent) of employment displacement by 2030 relative to the reference case, followed by other non-ferrous ore mining (21 per cent) and mining services (19 per cent).

⁶ Does not include oil and gas sub-sector

In the smelting and refining sector 1290 fewer people (18 per cent of reference case employment) are employed in 2030, predominantly from other non-ferrous metals smelting.

5.2.4. Northern Territory

Employment effects for the Northern Territory are presented in Table 11. The Northern Territory minerals industry is projected to experience the loss of 150 jobs relative to the reference case in 2020, and 540 jobs in 2030.

Table 11: NT employment results minerals industry

	Change from reference case	
	<i>Employment effect 2020</i>	<i>Employment effect 2030</i>
NT - Minerals Industry (Jobs)	-150	-540
NT - Minerals Industry sector (%)	-3	-22
<i>Mining, Refining and Smelting</i>		
Gas	-80	-130
Other mining, refining and smelting	-70	-410

Note: Further disaggregation is not possible due to confidentiality issues.

5.2.5. South Australia

State level employment effects for South Australia are presented in Table 12. The proposed ETS is expected to displace almost 2000 jobs in the South Australian minerals industry relative to the reference case in 2020, and 3150 jobs in 2030.

Compared with other states, additional jobs displacement in South Australia from 2020 to 2030 is relatively small (just under 7 percentage points). This is because the South Australian smelting and refining sector, based solely on other non-ferrous metals smelting does not receive as much assistance in the initial period of the proposed ETS as seen in other states.

In the mining sector:

- 3150 less people (23 per cent of reference case employment) are projected to be employed as a consequence of the proposed ETS in 2030;
- gas accounts for the largest share of employment displacement (40 per cent), other non-ferrous metal ore mining (33 per cent) and mining services (18 per cent).

In the smelting and refining sector 2700 less people (47 per cent of reference case employment) are projected to be employed in 2030.

Table 12: South Australia employment results minerals industry

	Change from reference case	
	<i>Employment effect 2020</i>	<i>Employment effect 2030</i>
SA - Minerals Industry (Jobs)	-1990	-3150
SA - Minerals Industry sector (%)	-16	-23
<i>Mining Sector</i>		
Jobs	-310	-450
Percentage	-4	-5
Gas	-140	-180
Other non-ferrous metal ore mining	-80	-150
Iron ores	-10	-30
Other mining	-30	-10
Mining services	-50	-80
<i>Smelting and Refining Sector</i>		
Jobs	-1680	-2700
Percentage	-36	-47
Other non-ferrous metals refining	-1680	-2700

5.2.6. Victoria

State level employment effects for Victoria are presented in Table 13. The Victorian minerals industry is projected to experience 1210 jobs losses relative to the reference case in 2020, and 5830 jobs losses in 2030.

The large swing in projected outcomes in Victoria is due to the size of the smelting and refining sector in the Victorian minerals industry and the effect of proposed ETS assistance for some smelting and refining operations. In 2020, the short-term impacts of administrative permit allocation in the smelting and refining sector reduces the job losses (relative to the reference case). However, once the allocation of free permits falls away the Victorian smelting and refining industry is projected to lose 3500 jobs, almost 80 per cent of the reference case employment.

In the mining sector:

- 2310 less people are projected to be employed (18 per cent of reference case employment) as a consequence of the proposed ETS in 2030;
- other mining accounts for the largest share of employment displacement (29 per cent), followed by coal mining (27 per cent), mining services (19 per cent) and other non-ferrous metal ore mining (17 per cent).

In the smelting and refining sector 3520 jobs in aluminium smelting (77 per cent of reference case) are lost in 2030 relative to what otherwise would have been the case.

Table 13: Victoria employment results minerals industry⁷

	Change from reference case	
	<i>Employment effect 2020</i>	<i>Employment effect 2030</i>
Vic - Minerals Industry (Jobs)	-1210	-5830
Vic - Minerals Industry sector (%)	-9	-40
<i>Mining Sector</i>		
Jobs	-1120	-2310
Percentage	-12	-22
Coal	-470	-630
Gas	-70	-160
Other non-ferrous metal ore mining	-150	-390
Other mining	-270	-690
Mining services	-160	-440
<i>Smelting and Refining Sector</i>		
Jobs	-90	-3520
Percentage	-2	-77
Aluminium	-90	-3520

5.2.7. Tasmania

State level employment effects for Tasmania are presented in Table 14. The Tasmanian minerals industry is projected to experience the loss of 1050 jobs associated with the proposed ETS in 2020 relative to the reference case, and the loss of 2500 jobs in 2030.

Job losses in the Tasmanian smelting and refining sector is insulated in 2020 due to compensation for aluminium smelting and refining sub-sector's transitional assistance. By 2030, jobs displacement in the aluminium smelting and refining sector contributes to the higher level of job losses in the Tasmanian mineral industry.

Table 14: Tasmania employment results minerals industry

	Change from reference case	
	<i>Employment effect 2020</i>	<i>Employment effect 2030</i>
Tas - Minerals Industry (Jobs)	-1050	-2520
Tas - Minerals Industry sector (%)	-16	-32

Note: Further disaggregation is not possible due to confidentiality issues.

⁷ Victorian coal mining employment figures were provided by C. Fraser (MCA) (pers comm.). As with other States, the remainder of employment data were sourced from TERM/ABS.

5.3. ESTIMATING REGIONAL EMPLOYMENT EFFECTS

Concept Economics has estimated regional job losses in the minerals industry in some key non-metropolitan regions in Queensland, New South Wales and Western Australia.

Two methodologies were applied to establish a potential range of estimated flow on job losses by region in non-minerals industries. These ranges were based on:

1. Job losses estimated through application of state level changes in industry employment at the regional level; and
2. The application of employment multipliers derived from published studies, for the minerals industry.

As has been discussed earlier, flow on employment effects will be felt most heavily in regional areas where there is a relatively high level of reliance on the minerals industry for total regional employment. The total job losses in regional Australia that are discussed here represent the number of workers that are likely to be displaced from regional areas due to the impact of the proposed ETS. At the national and state level, these figures were not reported as, in the economy as a whole (as modelled), displaced workers find employment in other industries, and hence there is likely to be a smaller number of total jobs lost. It is at the regional level that displaced workers from all industries will often need to relocate to find new employment and hence displacement is more closely aligned with job losses and a potential increase in the numbers of long term unemployed.

5.4. STATE BASED INPUT OUTPUT EMPLOYMENT EFFECTS

The percentage changes in state level employment due to the proposed ETS are reported above. The job losses were estimated through the application of output shocks to Australian industries, and then a rebalancing of state level input output tables to account for changing production and output relationships between industries. These percentage state level employment shocks, by industry, were then applied to ABS statistical division employment data available in the TERM database from Monash University.

The state level effects were used at the regional level as it was not possible to distinguish between resident and non-resident labour in the regional economic accounts that make up the input output tables, an important issues in the minerals industry.

These state level input output table based employment shocks provide a reliable estimate of the distribution of state level minerals industry job losses within statistical divisions. The flow on job losses estimated in non-minerals industries such as construction, agriculture, tourism and retail trade for example also provide an indication of the total jobs that could be lost at a regional level due to the proposed ETS.

Care must be taken when considering the second round employment effects estimated as different regions will have greater and lesser dependence on the minerals industry than the respective state as a whole. The estimates will be overstated in more diversified regional economies and understated in less diversified regions.

These issues have been addressed through the application of assumed employment multipliers, as outlined below, to provide a range of potential job losses that could eventuate in regional Australia due to the imposition of the proposed ETS.

5.5. EMPLOYMENT MULTIPLIERS

Employment multipliers at both an economy wide and regional level attempt to measure how many non-sector jobs are supported by employment in a given industry. That is, for every job in the minerals industry, how many non-minerals industry jobs are established?

Employment multipliers take into account of three factors when estimating associated job levels:

- a. supplier effects – that is, the level of employment derived from supplying inputs required by the given industry;
- b. spending effects – that is, the level of employment derived from employees in a given industry spending their wages; and
- c. government employment effects – that is, the level of government administration employment that is derived from the existence of the given industry through the payment of taxes.

The employment multiplier estimated for a given industry will necessarily be different across a nation, a state and a region. This difference is mainly driven by the different levels of supplier effects at each level of disaggregation. For example, where a nation may be completely self-sufficient in producing all required inputs for an industry, the supplier employment effects will be quite large. However, where a regional level assessment is made, it is more likely that inputs will be imported into the region, and as such, the supplier employment effects will be less as job losses will not be observed in these input industries in the given region.

In the context of this study, the relative level of self-sufficiency of the minerals industry (that is, what proportion of mineral industry inputs are produced regionally and what proportion of minerals industry wages are spent regionally) will necessarily alter the level of the employment multiplier.

Without the level of information required to accurately estimate employment multipliers for each statistical division considered, Concept Economics has applied a conservative estimate of 1.0. That is, for every minerals industry job lost in regional Australia, there is a non-minerals industry, flow on, job lost as well. This estimate is based on work previously completed for the mining industry in the United States. Bivens (2003) estimates that the appropriate multiplier for the mining industries re-spending and government effects is 0.86. To allow for some level of supplier effects, Concept Economics has applied a multiplier of 1.0. This figure is used as an average estimate applied to all regions consistently and as such will tend to over estimate regional job losses where there is a lower level of self sufficiency and will tend to under estimate regional job losses where there is a higher level of self sufficiency⁸.

⁸ As a guide, Bivens (2003) estimates that at the national level, US supplier effects are 1.17. That is, the employment multiplier for the US mining industry could be as high as 2 jobs lost for every 1 mining job lost.

Used together, the input output based employment effects and the employment multiplier effects should provide a reasonable estimate of the potential bounds on job losses in regional Australia due to the imposition of the proposed ETS.

6. PROJECTED REGIONAL EMPLOYMENT EFFECTS

With the majority of employment in the Australian minerals industry located outside of major capital cities, and with some regions being dependent on the minerals industry for a significant proportion of economic activity, any substantial changes in minerals industry activity and employment will have substantial implications for the viability of many regional townships.

The results tables for each region provide the level of minerals industry jobs estimated to be lost due to the proposed ETS compared to what otherwise would have occurred, estimated using the input out and the employment multiplier methodologies.

Due to the lack of dynamics in either methodology, the estimates can be either greater than, less than or equal to each other, and so one cannot consistently be used as an upper bound or lower bound estimate. Assessment of the underlying reasoning for movements in the effects will be considered in each region as part of discussion of the results.

Presented in Table 15 and Table 16 are Concept Economics' best estimates for the total regional employment effects due to the proposed ETS in 2020 and 2030, taking into account results from both methodologies and information regarding the characteristics of each of the statistical divisions.

Table 15: Projected regional employment losses by state, 2020

State and Statistical Division	Total minerals jobs lost	Total regional jobs lost	Per cent of regional employment lost
Queensland	11440		
Fitzroy	1950	4180	2.6
Northern	1870	3600	2.3
Mackay	2600	4500	3.4
North West	390	770	2.9
New South Wales	4260		
Hunter	2150	4300	1.2
Illawarra	720	1440	0.6
Central West	420	840	0.8
North Western	210	420	0.6
Far West	75	150	1.2
Western Australia⁹	3410		
South West	560	1200	0.7
Pilbara	520	700	1.9
South Eastern	400	750	1.6
Kimberley	40	80	0.3
Central	130	260	0.6

⁹ Does not include oil and gas sub-sector

Table 16: Projected regional employment losses by state, 2030

State and Statistical Division	Total minerals jobs lost	Total regional jobs lost	Per cent of regional employment lost
Queensland	34090		
Fitzroy	7800	16000	8.1
Northern	7200	14400	7.5
Mackay	5060	12000	7.2
North West	1420	2800	8.3
New South Wales	14600		
Hunter	6150	11970	2.7
Illawarra	2100	4200	1.4
Central West	1070	2140	1.6
North Western	540	1080	1.2
Far West	230	430	3.0
Western Australia¹⁰	5750		
South West	1690	4000	2.0
Pilbara	1330	2000	4.6
South Eastern	750	1590	2.9
Kimberley	65	130	0.4
Central	240	470	0.8

The capital cities of Brisbane, Sydney and Perth were not included in the regional analysis due to the minimal level of minerals operations undertaken in these regions as well as the ability of capital cities to provide alternate employment options. However, due to the prevalence of fly in fly out employment, as well as differences in place of employment and place of residence reported in the ABS census, sizeable State level job displacements were attributed to these capital cities. Therefore, the reported sum of minerals sector job losses in regional Australia will not add up to total State level minerals industry jobs displaced.

Maps of the statistical divisions are provided in Appendix B.

¹⁰ Does not include oil and gas sub-sector

6.1. QUEENSLAND

Queensland accounts for approximately 50 per cent of all jobs lost in the Australian minerals industry due to the proposed ETS, in 2030 compared to what otherwise would have occurred. Table 17 outlines the statistical divisions that are the most heavily reliant on employment in the minerals industry. The North West region of Queensland is the most intensive in terms of employment in the minerals industry, with 21 per cent of employees in the region reported as working in the minerals industry. In the Mackay region, approximately 12 per cent of regional employment is in the minerals industry.

Table 17: Allocation of employment to minerals industry – Qld statistical division

Statistical division	% of regional employment in minerals industry
North West	21
Mackay	12
Fitzroy	10
Northern	6

The breakdown by statistical division of job losses in the minerals industry by 2030 due to the introduction of the proposed ETS is presented in Table 18.

The Fitzroy region is projected to account for the largest proportion of job losses in Queensland, with 7800 jobs lost. These job losses are mainly derived from the emissions intensive industries of alumina refining and coal mining. The Northern region accounts for 21 per cent of Queensland jobs losses in the minerals industry, followed by Mackay accounting for 15 per cent. Together, these five regions account for almost 70 per cent of Queensland minerals industry job losses.

Table 18: Queensland statistical division employment losses, 2030

	Total minerals industry
<i>Numbers of jobs lost</i>	
Queensland	34090
Fitzroy	7800
Northern	7200
Mackay	5060
North West	1420
<i>Per cent of Queensland minerals industry job losses</i>	
Fitzroy	23
Northern	21
Mackay	15
North West	4

Estimated regional level employment effects are presented in Table 19 to Table 22.

Table 19: Employment effects – Fitzroy SD

	Change from reference case			
	<i>Employment effect 2020</i>		<i>Employment effect 2030</i>	
	I/O based estimate	Applied multiplier estimate	I/O based estimate	Applied multiplier estimate
Minerals industry job losses	1950		7800	
Per cent of reference case minerals industry jobs	13		41	
Total job losses	4180	3900	16740	15630
Per cent of reference case employment lost	2.6	2.5	8.4	7.9
Implied regional job loss multiplier	1.1	1.0	1.1	1.0

The Fitzroy region, accounting for the largest proportion of Queensland minerals industry job losses, is projected to lose 1950 jobs or 13 per cent of the minerals workforce in 2020. In 2030, this figure is projected to increase to 7800, representing 41 per cent of the regional minerals sector workforce in 2030.

The projected total regional job losses for the Fitzroy region range from approximately 4000 lost jobs in 2020 up to 16,000 in 2030 – approximately 8 per cent of total regional employment in 2030.

The employment multipliers of 1.1 in both 2020 and 2030 estimated through the input output methodology imply a reasonable level of regional self sufficiency for supplier effects and wage effects in Fitzroy due to minerals industry job losses. This is likely to be driven by the locality of major smelting operations in and near to major regional centres such as Gladstone, where employees will be both working and living. However, due to the locality of these major regional centres, it is unlikely that there would be any stronger flow on employment effects than those estimated here due to the ability of these regional city economies to provide alternate employment opportunities.

Table 20: Employment effects – Northern SD

	Change from reference case			
	<i>Employment effect 2020</i>		<i>Employment effect 2030</i>	
	I/O based estimate	Applied multiplier estimate	I/O based estimate	Applied multiplier estimate
Minerals industry job losses	1870		7200	
Per cent of reference case minerals industry jobs	14		41	
Total job losses	3590	3750	14350	14400
Per cent of reference case employment lost	2.3	2.4	7.5	7.5
Implied regional job loss multiplier	0.9	1.0	1.0	1.0

The Northern region is projected to lose 1870 minerals industry jobs in 2020 and 7200 jobs in 2030. That is, approximately 14 per cent of minerals industry employment in 2020 and 40 per cent in 2030. These jobs are predominantly associated with the emissions intensive smelting and refining sub-sector.

Up to 7.5 per cent of regional employment is projected to be lost in the Northern statistical division of Queensland due to the proposed ETS. This is made up of approximately 3600 jobs in 2020 and up to 14,000 jobs in 2030. These figures are consistent with a minerals industry employment multiplier of approximately 1.0.

Table 21: Employment effects – Mackay SD

	Change from reference case			
	<i>Employment effect 2020</i>		<i>Employment effect 2030</i>	
	I/O based estimate	Applied multiplier estimate	I/O based estimate	Applied multiplier estimate
Minerals industry job losses	2600		5060	
Per cent of reference case minerals industry jobs	18		28	
Total job losses	4200	5190	12130	10130
Per cent of reference case employment lost	3.2	3.9	7.3	6.1
Implied regional job loss multiplier	0.6	1.0	1.4	1.0

Due to the proposed ETS, the Mackay region is projected to lose approximately 2600 minerals industry jobs in 2020 and 5000 jobs in 2030 – approximately 18 and 28 per cent of regional minerals industry employment respectively. These job losses are predominantly associated with coal mining. Estimates of total regional job losses are relatively close between the two methodologies, indicating job losses in excess of 10,000 by 2030.

The input output based methodology indicates an increase in the level of self reliance of the minerals industry in the region by 2030, hence a greater number of jobs in associated

industries being lost by 2030 than under the fixed multiplier methodology (i.e. the implied employment multiplier increases from 0.6 in 2020 to 1.4 in 2030). In a dynamic sense, that is unable to be fully captured by this methodology, this result may be generated through minerals industry job losses strongly changing the employment profile of the region between 2020 and 2030. Despite the location of regional centres of Mackay and Bowen, it is unlikely that significant absorption of displaced employees will take place within the region, hence it is likely that job losses will be closer to the input output estimates of 12,000 in 2030.

Table 22: Employment effects – North West SD

	Change from reference case			
	Employment effect 2020		Employment effect 2030	
	I/O based estimate	Applied multiplier estimate	I/O based estimate	Applied multiplier estimate
Minerals industry job losses	390		1420	
Per cent of reference case minerals industry jobs	7		19	
Total job losses	690	770	2760	2830
Per cent of reference case employment lost	2.6	2.9	8.2	8.4
Implied regional job loss multiplier	0.8	1.0	0.9	1.0

The North West region of Queensland, predominantly associated with operations in Mount Isa, is projected to experience 390 job losses in the minerals industry in 2020 and 1400 in 2030. This accounts for approximately 19 per cent of minerals industry employment in 2030.

Total job losses in the region, estimated by both the input output methodology and the applied multiplier methodology, are almost 3 per cent of total regional employment in 2020 and just over 8 per cent of regional employment in 2030. That is, in total, the North West region of Queensland is projected to lose 770 jobs in 2020 and 2800 jobs in 2030.

6.2. NEW SOUTH WALES

New South Wales is projected to account for 22 per cent of the Australian minerals industry jobs losses in 2030. As shown in Table 23, the major minerals regions of New South Wales have highly diversified employment profiles. For example, the top three statistical divisions in terms of minerals industry employment have a relatively small proportion of total employment in the minerals industry. The Far West region has only 9 per cent of regional employment directly in the minerals industry, the Hunter, 5 per cent and the Central West 4 per cent.

Table 23: Allocation of employment to minerals industry – NSW statistical division

Statistical division	% of regional employment in minerals industry
Far West	9
North Western	3
Central West	4
Hunter	5
Illawarra	2

In Table 24 the distribution of projected New South Wales based minerals industry job losses are presented. Of the 14,600 jobs projected to be lost in 2030 due to the proposed ETS, 42 per cent, or 6150 jobs, are expected to be lost in the Hunter region. This is followed by 15 per cent, or 2130 jobs in the Illawarra region. Both of these areas are predominantly associated with coal mining and smelting and refining operations.

Table 24: New South Wales statistical division employment losses, 2030

	Total minerals industry
<i>Numbers of jobs lost</i>	
New South Wales	14600
Hunter	6150
Illawarra	2100
Central West	1070
North Western	540
Far West	230
<i>Per cent of New South Wales minerals industry job losses</i>	
Hunter	42
Illawarra	15
Central West	7
North Western	4
Far West	2

Estimated regional level employment effects are presented in Table 25 to Table 29. Care should be taken when considering the input output based estimates of total regional job losses in New South Wales. The figures calculated with this methodology are occasionally too high to be reasonable. These errors are likely to be being driven by a number of factors including:

- differences in employment profiles within regions more so than other states, including major regional centres disassociated with remote minerals operations; and,
- static evaluation of regional labour mobility options, that is, insufficient account taken for absorption of job losses within the region, hence displacement should not be accounted for as regional job losses.

For this reason, most of the regional employment results are likely to be based around the applied employment multiplier of 1.0.

Table 25: Employment effects – Hunter SD

	Change from reference case			
	<i>Employment effect 2020</i>		<i>Employment effect 2030</i>	
	I/O based estimate	Applied multiplier estimate	I/O based estimate	Applied multiplier estimate
Minerals industry job losses	2150		6150	
Per cent of reference case minerals industry jobs	14		32	
Total job losses	7000	4300	29670	11970
Per cent of reference case employment lost	1.9	1.2	6.7	2.7
Implied regional job loss multiplier	2.2	1.0	4.0	1.0

The Hunter region, accounting for the largest proportion of New South Wales minerals industry job losses in 2030, is projected to lose 2150 mineral jobs in 2020 and 6150 by 2030. This represents 14 and 32 per cent of regional minerals industry employment in 2020 and 2030 respectively.

Estimated total regional job losses range from 4300 to 7000 in 2020 (or between 1.2 and 1.9 per cent of regional employment) and 11,970 to 29,670 in 2030 (or between 2.7 and 6.7 per cent of regional employment).

The input output methodology implied employment multipliers indicate up to 4 additional job losses for every 1 minerals job lost in the region. This estimate is likely to be unfeasibly high, especially due to the proximity to major regional centres. Therefore, actual total job losses are likely to be at the lower end of these scales. That is, while still accounting for a significant proportion of regional employment, job losses are likely to be approximately 4300 and 11970 jobs lost in 2020 and 2030 respectively.

Table 26: Employment effects – Illawarra SD

	Change from reference case			
	<i>Employment effect 2020</i>		<i>Employment effect 2030</i>	
	I/O based estimate	Applied multiplier estimate	I/O based estimate	Applied multiplier estimate
Minerals industry job losses	720		2100	
Per cent of reference case minerals industry jobs	15		33	
Total job losses	3870	1440	17700	4150
Per cent of reference case employment lost	1.6	0.6	6.1	1.4
Implied regional job loss multiplier	4.4	1.0	7.5	1.0

The Illawarra region is projected to lose 720 minerals jobs in 2020 and 2100 jobs in 2030 due to the proposed ETS. This is 15 and 33 per cent of reference case regional minerals industry employment. These job losses are associated predominantly with coal mining operations.

As previously discussed, the input output based employment multipliers are less reliable and as such, total projected job losses for the Illawarra region in total are estimated to be approximately 2260 in 2020 and 4150 in 2030. These figures represent 0.6 and 1.4 per cent of total regional employment in 2020 and 2030 respectively.

Table 27: Employment effects – Far West SD

	Change from reference case			
	<i>Employment effect 2020</i>		<i>Employment effect 2030</i>	
	I/O based estimate	Applied multiplier estimate	I/O based estimate	Applied multiplier estimate
Minerals industry job losses	75		230	
Per cent of reference case minerals industry jobs	6		14	
Total job losses	230	150	900	430
Per cent of reference case employment lost	1.9	1.2	6.2	3.0
Implied regional job loss multiplier	2.1	1.0	3.2	1.0

The Far West region of New South Wales, incorporating operations around Broken Hill, is projected to lose approximately 75 minerals jobs (7 per cent) in 2020 and 230 jobs (14 per cent) in 2030.

Total job losses projected for the region are estimated at 150 in 2020 and 430 in 2030, or 1.2 and 3 per cent of regional employment respectively.

Table 28: Employment effects – North West SD

	Change from reference case			
	<i>Employment effect 2020</i>		<i>Employment effect 2030</i>	
	I/O based estimate	Applied multiplier estimate	I/O based estimate	Applied multiplier estimate
Minerals industry job losses	210		540	
Per cent of reference case minerals industry jobs lost	9		17	
Total job losses	1050	420	5240	1080
Per cent of reference case employment lost	1.5	0.6	6.2	1.2
Implied regional job loss multiplier	4	1.0	9.2	1.0

The North West region of New South Wales is projected to lose approximately 210 minerals jobs in 2020 and 540 minerals jobs in 2030 – that is, 9 and 17 per cent of minerals industry employment in the region respectively.

Employment multipliers estimated through the input output methodology imply up to 4 and 9 additional jobs lost in the region for every 1 minerals job lost. Due to the large scale of the North West statistical division and the relatively localised minerals operations, these are likely to be over estimates.

Therefore, the projected total regional job losses for the North West region are approximately 420 and 1080 jobs in 2020 and 2030 respectively. That is, 0.7 and 1.2 per cent of regional employment.

Table 29: Employment effects – Central West SD

	Change from reference case			
	<i>Employment effect 2020</i>		<i>Employment effect 2030</i>	
	I/O based estimate	Applied multiplier estimate	I/O based estimate	Applied multiplier estimate
Minerals industry job losses	420		1070	
Per cent of reference case minerals industry jobs	11		20	
Total job losses	1780	840	8525	2140
Per cent of reference case employment lost	1.6	0.8	6.5	1.6
Implied regional job loss multiplier	3.2	1.0	7.3	1.0

The Central West region of New South Wales, including Orange and Cowra, is projected to lose 420 and 1020 minerals jobs in 2020 and 2030 respectively. That is, 11 and 20 per cent of regional minerals employment.

Total regional job losses are projected to be around 840 in 2020 and 2140 in 2030, or 0.8 and 1.6 of total regional jobs lost due to the proposed ETS.

6.3. WESTERN AUSTRALIA

The distribution of commodities production and minerals sector employment across the State is not uniform, with the Pilbara reporting up to 30 per cent of regional employment in mineral ore mining. In the South Eastern region, approximately 20 per cent of total employment is associated with the production of minerals with much lower dependence on the minerals sector elsewhere. It should be noted that these estimated employment effects do not consider the impacts on the oil and gas sub-sector in Western Australia.

Table 30: Allocation of employment to minerals industry – WA Statistical Division

Statistical Division	% of regional employment in minerals industry
Pilbara	30
South Eastern	20
Central	7
South West (including Peel)	8
Kimberley	5
Midlands	4

Such large regional proportions of employment associated with the minerals industry means that regional employment and the viability of towns outside of metropolitan regions are highly exposed to changes in production and demand for labour in the minerals industry in key regions. The distribution of the projected minerals industry job losses across regional Western Australia in 2030 is presented in Table 31.

Table 31: Western Australian statistical division employment losses, 2030

	Total minerals industry
<i>Numbers of jobs lost</i>	
Western Australia	5750
South West	1690
Pilbara	1330
South Eastern	750
Kimberley	65
Central	240
<i>Per cent of Western Australian minerals industry job losses</i>	
South West	29
Pilbara	23
South Eastern	13
Kimberley	1
Central	4

The south west region of Western Australia is projected to lose the greatest number of jobs, accounting for 29 per cent of total minerals industry job losses in Western Australia. The Pilbara region accounts for the second largest number of job losses, accounting for 23 per cent of Western Australian mineral industry job losses.

Estimated regional level employment effects are presented in Table 33 to Table 36. Employment effects reported here do not include job losses in the LNG sector due to the proposed ETS.

Table 32: Employment effects – South West SD, including Peel region

	Change from reference case			
	<i>Employment effect 2020</i>		<i>Employment effect 2030</i>	
	I/O based estimate	Applied multiplier estimate	I/O based estimate	Applied multiplier estimate
Minerals industry job losses	560		1690	
Per cent of reference case minerals industry jobs	5		15	
Total job losses	1760	1130	5110	3380
Per cent of reference case employment lost	1.1	0.7	2.6	1.7
Minerals job loss multiplier	2.1	1.0	2.0	1.0

The South West statistical division of Western Australia includes the Peel region. It is estimated that in 2020 there will be approximately 560 minerals industry jobs lost in the south west region, and in 2030, 1690 jobs lost as a consequence of the introduction of the proposed ETS.

Total regional job losses due to the introduction of the proposed ETS are estimated to be within 1130 and 1760 in 2020, and 3380 and 5110 in 2030. These figures are bound closely around 1 per cent and 2 per cent of regional employment in 2020 and 2030 respectively and imply flow on job losses from non-minerals industries of over 500 in 2020 and over 1700 in 2030.

Care must be taken when considering the impacts of job losses in a region so closely located to a metropolitan area as there is the potential for non-minerals industry jobs to be relocated without employees having to change residence. Therefore, it is likely that for the south west region, flow on employment effects are likely to be closer to the applied multiplier level.

Table 33: Employment effects – Pilbara SD

	Change from reference case			
	Employment effect 2020		Employment effect 2030	
	I/O based estimate	Applied multiplier estimate	I/O based estimate	Applied multiplier estimate
Minerals industry job losses	520		1330	
Per cent of reference case minerals industry jobs	5		11	
Total job losses	690	1040	1840	2660
Per cent of reference case employment lost	1.9	2.9	4.3	6.2
Minerals job loss multiplier	0.3	1.0	0.4	1.0

In 2020, it is estimated that 520 minerals industry jobs will be lost in the Pilbara due to the introduction of the proposed ETS. In 2030, this figure increases to 1330 job losses.

The estimated bounds of total job losses felt in the Pilbara due to the introduction of the proposed ETS are between 680 and 1040 in 2020 (2-3 per cent of regional employment) and 1840 and 2660 in 2030 (4-6 per cent of regional employment). This implies flow on job losses in non-minerals industries of up to 500 jobs in 2020 and 1330 in 2030.

The low estimate of the regional employment multiplier implied by the input output based job loss estimates indicates that the Pilbara region is relatively reliant on external goods and services to maintain the mineral industry in the region – this is consistent with the significant use of fly in fly out workers within the region.

Table 34: Employment effects – South Eastern SD

	Change from reference case			
	Employment effect 2020		Employment effect 2030	
	Concept estimate	Applied multiplier estimate	I/O based estimate	Applied multiplier estimate
Minerals industry job losses	400		750	
Per cent of reference case minerals industry jobs	5		8	
Total job losses	690	800	1590	1500
Per cent of reference case employment lost	1.5	1.7	2.9	2.7
Minerals job loss multiplier	0.7	1.0	1.1	1.0

The two estimates for total regional job losses in the South Eastern region of Western Australia are very close. With 400 and 750 minerals industry job losses estimated for 2020 and 2030, total job losses are estimated to be in the order of between 690 and 800 and 1500 and 1590 respectively. This represents approximately 1.6 per cent of regional employment in 2020 and 2.8 per cent of regional employment in 2030.

Table 35: Employment effects – Kimberley SD

	Change from reference case			
	<i>Employment effect 2020</i>		<i>Employment effect 2030</i>	
	I/O based estimate	Applied multiplier estimate	I/O based estimate	Applied multiplier estimate
Minerals industry job losses	40		65	
Per cent of reference case minerals industry jobs	4		6	
Total job losses	190	80	500	130
Per cent of reference case employment lost	0.8	0.3	1.7	0.4
Minerals job loss multiplier	3.7	1.0	6.7	1.0

With only a small absolute number of minerals industry job losses estimated for the Kimberley region (due to the level of less emissions intensive mining operations in the region) there is a relatively small level of associated job losses estimated by both methods. In total 65 minerals jobs are projected to be lost in 2030 and up to approximately 130 total jobs in the region by 2030.

The percentage of regional employment in the Kimberley is estimated to fall by between 0.3 and 0.8 per cent in 2020, and between 0.4 and 1.7 per cent in 2030.

The relatively large employment multipliers estimated through the input output methodology are likely to be picking up anomalies due to the isolation of the Kimberley region compared to the state of Western Australia as a whole. For example, industries that are likely to be affected at the state level may not be as strongly affected within the Kimberley region where fly in fly out workers and services are utilised. For this reason, total employment effects are likely to be closer to the fixed employment multiplier estimates of 80 job losses in 2020 and 130 job losses in 2030.

Table 36: Employment effects – Central SD

	Change from reference case			
	<i>Employment effect 2020</i>		<i>Employment effect 2030</i>	
	I/O based estimate	Applied multiplier estimate	I/O based estimate	Applied multiplier estimate
Minerals industry job losses	130		240	
Per cent of reference case minerals industry jobs	5		7	
Total job losses	490	260	1280	470
Per cent of reference case employment lost	1.0	0.6	2.3	0.8
Minerals job loss multiplier	2.8	1.0	4.4	1.0

The Central statistical division of Western Australia is projected to lose 130 and 240 minerals industry jobs in 2020 and 2030 respectively as a result of the introduction of the proposed

ETS. This represents approximately 45 per cent of regional minerals employment in 2020 and 7.3 per cent in 2030.

As with the Kimberley region, the higher employment multiplier estimated via the input output table methodology is likely to be driven by significant differences in the Central region economy profile than the state of Western Australia. This results in a more than proportional employment impact being estimated in non-minerals industries. For this reason, the expected total regional job losses are more likely to be closer to the 260 and 470 estimated by the fixed multiplier methodology in 2020 and 2030 respectively.

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APPENDIX A METHODOLOGY

To calculate state and regional employment effects, input-output tables were obtained from Monash University using the TERM database. The reference year for the database is 2005-06. The TERM model is a regional CGE model specified at the Statistical Division level that can be aggregated to reflect different industry compositions. The TERM model database aggregation used for this analysis is shown in Table A1.

Table A1 TERM Industry aggregation

Industry	Industry	Industry	Industry
Crops	Mining Services	Electricity Biogas	Rail Passenger
Livestock	Alumina	Electricity Wind	Air Freight
Other Agriculture	Aluminium	Electricity Distribution	Air Passenger
Coal Black	Non Ferrous Metals	Gas Supply	Other Transport
Coal Brown	Iron and Steel	Water and Drainage	ITT Telecom
Oil	Other Manufacture	Construction	Finance Insurance
Gas	Electricity Coal Black	Wholesale Trade	Rental Real Estate
Iron Ores	Electricity Coal Brown	Retail Trade	Professional Service
Non-Ferrous Ores	Electricity Gas	Accomm. and Food	Public Admin
Bauxite	Electricity Oil	Road Freight	Education
Other Mining	Electricity Hydro	Road Passenger	Health
Crops	Electricity Biomass	Rail Freight	Recreation Culture

These industries were mapped to the Access Economics model industry breakdowns through direct aggregation if the Access Economics breakdown was finer than or the same as the Monash database. Where the TERM database provided greater detail, it was assumed that the TERM industry aggregates remained in constant proportions.

The calculation of employment effects using the State level 2005-06 input tables directly would have generated considerable inconsistencies. This is due to the fact that there are substantial changes projected in the output mix of Australian economy in 2020 and 2030 by Access Economics both for the reference case and for the policy scenarios.

To address this problem the input-output tables were rebalanced. The criteria for rebalancing the input-output tables were:

- Total output from each industry was equal to the projected level of output for the reference case or policy scenario in a given region;
- The sum of domestic utilization, imports and income less taxes by industry was equal to the sum domestic output, consumption and exports by industry.

To rebalance the input-output matrix a set of scaling parameters were estimated. The parameters for a 4 by 4 matrix would be:

$$\delta \begin{pmatrix} \lambda_1 + \gamma_1 & \lambda_1 + \gamma_2 & \lambda_1 + \gamma_3 & \lambda_1 + \gamma_4 \\ \lambda_2 + \gamma_1 & \lambda_2 + \gamma_2 & \lambda_2 + \gamma_3 & \lambda_2 + \gamma_4 \\ \lambda_3 + \gamma_1 & \lambda_3 + \gamma_2 & \lambda_3 + \gamma_3 & \lambda_3 + \gamma_4 \\ \lambda_4 + \gamma_1 & \lambda_4 + \gamma_2 & \lambda_4 + \gamma_3 & \lambda_4 + \gamma_4 \end{pmatrix}$$

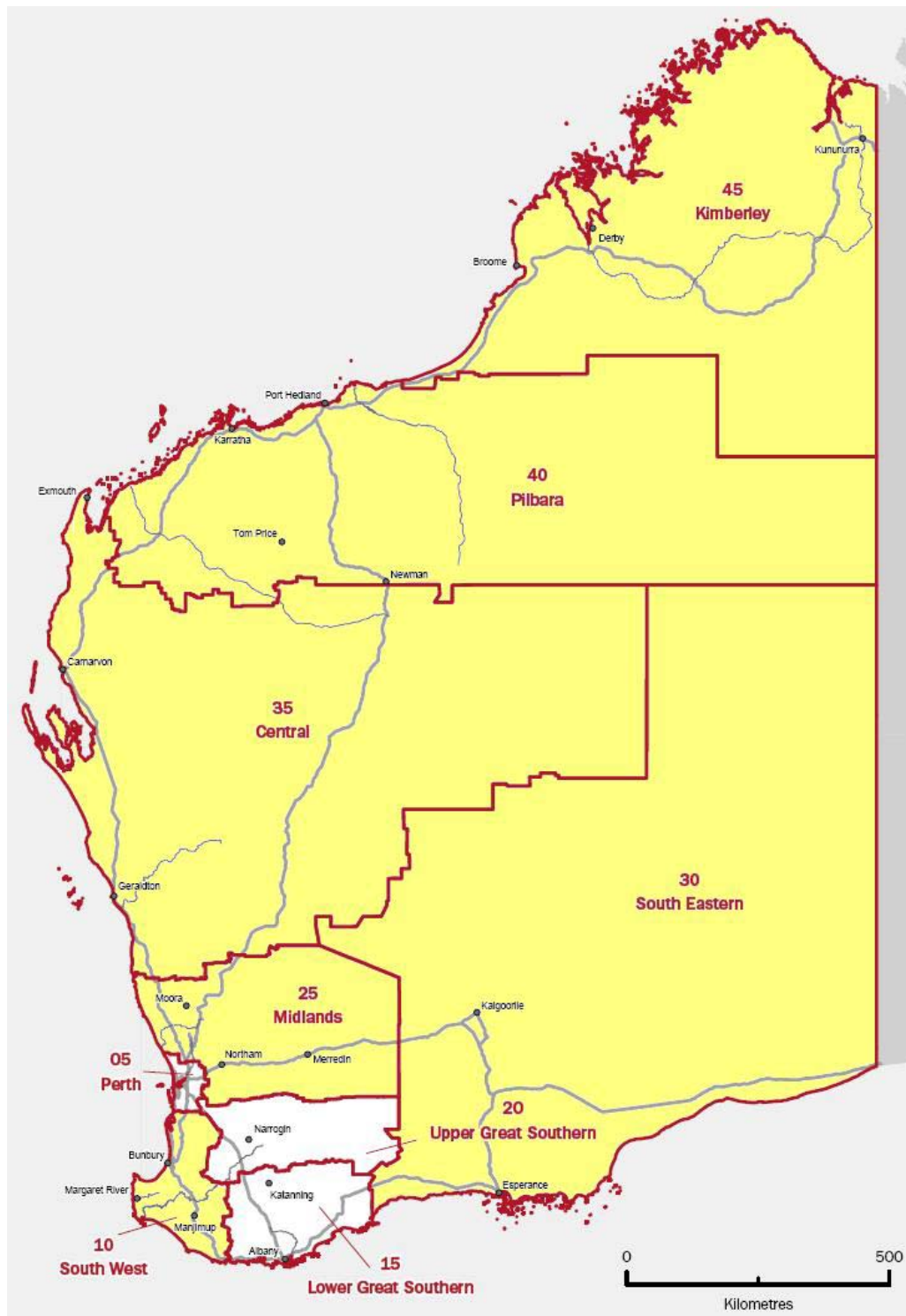
where λ is a row scale factor, γ is column scale factor and δ is a common scale factor. The scaling factors were estimated using least squares minimisation, subject to a non-negativity constraint.

National level output effects by industry were apportioned at a State level in fixed proportions based on State level shares of the value of industry output derived from the input-output tables. The scaled matrices were then used to determine State level employment by sector. No significant changes in labour productivity were assumed.

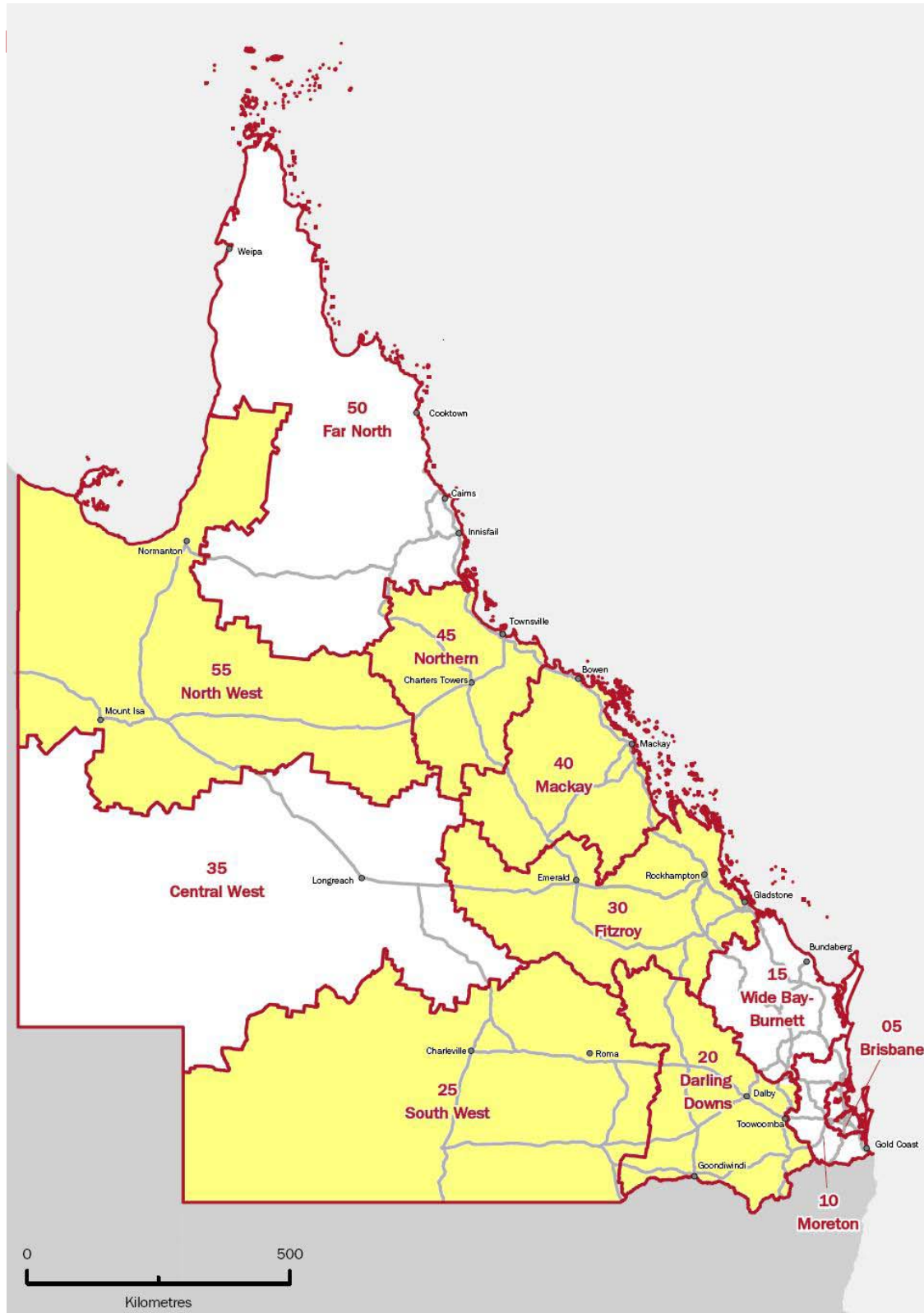
APPENDIX B MAPS OF STATISTICAL DIVISIONS

Sourced from Australian Bureau of Statistics, Australian Standard Geographical Classification (ASGC) 2005.

B.1. WA STATISTICAL DIVISIONS



B.2. QLD STATISTICAL DIVISIONS



NSW STATISTICAL DIVISIONS

