

# Balancing Act

A TRIPLE BOTTOM LINE ANALYSIS  
OF THE AUSTRALIAN ECONOMY

VOLUME 3



The University of Sydney



CSIRO

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## VOLUME 3

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# Sector 2112: Tobacco Products (To)

*Cigarettes, cigars, cheroots and tobacco*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicators of greenhouse emissions, water use, and land disturbance are respectively 40%, 25%, and 65% below average. The social indicators of employment generation and income are 40% and 30% below average respectively, while government revenue is 20 times the average. The financial indicators show that the operating surplus is 15% below average, export propensity is 40% above average, and import penetration is 70% above average. A tension exists between the use of tobacco as a revenue source for government and its downstream and long term impacts on population health.

## Sector Description

About 280 tobacco farmers around Myrtleford in Victoria, Mareeba in Northern Queensland, and in Southern Queensland, grow 7 million kg of tobacco annually on 3 000 ha of irrigated land, and collectively use 30 GL (10<sup>9</sup> litres) of irrigation water. Australia also imports tobacco and tobacco products from the US, Taiwan, Zimbabwe, Malawi and Brazil, and exports mainly to New Zealand and the Pacific Islands. Once tobacco is graded and dried, it is matured in 200 kg cases for 16 months before processing. Batches of 9 000 kg containing up to 14 grades of tobacco are processed through capital intensive machinery which manufacture 10 000 cigarettes per minute, and require 630 metres of cigarette paper, and 270 metres of filter. Australians consume about 23 billion cigarettes per year or 1.2 kg of tobacco per capita (over 15 years of age) spending over \$9 billion of household expenditure on tobacco products. Currently, the excise, GST and customs duties generate over \$5 billion per year in government revenue. The retail cost of a cigarette is made up of excise (60%), GST (10%), manufacture (15%) and retailing (15%). Estimates suggest that tobacco smoking causes 12% of the total disease burden in males, and 8% in females, with a financial cost of about \$7 billion yearly. Nearly 19 000 deaths yearly (15% of total deaths) are attributed to smoking through the causes of cardio-vascular disease (38%), cancers (35%) and chronic pulmonary obstructions (23%). In constant dollar terms, the sector's turnover has halved in the last 30 years and is currently \$1 billion and involves three manufacturers and 48 000 retailers.

## Place of Industry in the Economy

The tobacco sector ranks 116<sup>th</sup> out of 135 sectors in value adding in the economy and contributes 0.07% of GDP in this analysis. It is similar in value adding to the cosmetics and toiletries, and soaps and detergents sectors. It is a small employer with 3 000 employment years embodied in final demand, and another 5 000 years in the sector's suppliers giving a total of 8 000 employment years. It has small resource requirements with about one tenth of one percent of national water use, land disturbance, energy use, and greenhouse emissions. Imports are 60% greater than exports.

## Strategic Overview

The spider diagram portrays a TBL account with three outliers: the two social indicators of employment generation and income, and the financial indicator of import penetration. The downstream health impacts of tobacco are not included in this upstream-orientated analysis. There are two important issues. Firstly, tax revenue from tobacco use is over \$5 billion, significantly less than the yearly societal and health costs estimated conservatively to be over \$7 billion. Secondly, domestic tobacco growing could be phased out and replaced by imports. However, industry restructuring programs have not yet solved the regional issues of substitution by alternative crops.

## TBL Account #1

The financial indicator of operating surplus is 15% below average, while the social indicator of employment generation is 40% below average, and the environmental indicator of greenhouse emissions is 40% below average. The direct effect for greenhouse emissions is relatively small at 9% of total suggesting improvement efforts could be directed at upstream sources such as electricity generation (9%) and the paper production chain (22%). Other sources include tobacco growing (5%), wool production (4%) (a component of filters) and garbage disposal (4%).

## TBL Accounts #2 and #3

The second TBL account shows that export propensity is 40% above average but much of this is imported materials that are re-exported, and the income indicator is 30% below average. The water use indicator is 25% below average and one half of this (15 litres per \$) is due to in-field tobacco growing. Thus a packet of cigarettes with a factory price of approximately \$2 (before excise, GST and retail mark-up), has approximately 60 litres of water embodied in its full production chain of which 30 litres is on-farm. Depending on the irrigation area and soil type, tobacco growing requires 4-6 ML (10<sup>6</sup> litres) per hectare. The third TBL account shows that import penetration is 70% above average, government revenue is 20 times the average, and land disturbance is 65% below average.

## Structural Path Analysis and Linkages

The indicators of employment generation, income, and import penetration are below average. The social indicators may be difficult to improve because of the excise burden borne by the product, the capital intensive and labour-limited nature of production, and requirement for imports of tobacco for blending as well as generating products for global markets. The employment indicator reveals that the direct sector effect is 34% with contributions from hotels and cafes (7%), tobacco growing (7%), road transport (3%), technical services (2%), business support (2%), wholesale trade (2%), gambling and entertainment (2%), paper containers (2%) and pulp and paper (1%). The income indicator is similar in composition with a direct sector effect of 41%. The import indicator shows a direct sector effect of 82%, paper and paper containers (3%) and tobacco growing (1%). Imported product is currently required for blending and is more competitive in terms of brand attractiveness, quality and cost, thus limiting the growth of domestic employment generation and income. Suggestions by health activists that tobacco growing be phased out presents a political challenge and an economic one for the three production regions. However it would have limited effects as tobacco growing contributes 7% of the employment effect, and 3% of the income effect.

The sector's stimulus to its upstream suppliers is 10% below average with impacts on accommodation cafes and restaurants, road transport, wholesale trade, tobacco growing, pulp and paper products, and accounting and marketing. The linkages to downstream industries are almost negligible as all of the effect is dissipated by final consumption and exports.

## Future Trends in Sector

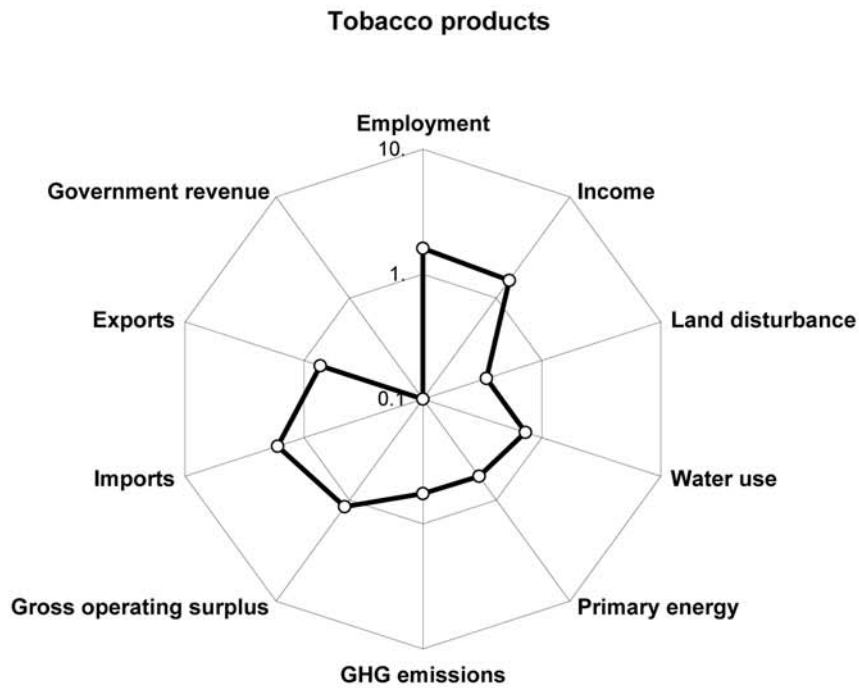
There are many health, social, workplace, and public space initiatives that aim to limit active and passive smoking. If long term trends are simply projected into the future, male smoking rates will be near to zero in 2022 and for women in 2034. Considerable variation in smoking exists due to socio-economic factors and a recent trend for higher numbers of younger women smokers versus younger men. This could play out in health consequences for women for many decades into the future.

## Innovation and Technical Opportunities

The medical literature on smoking is currently concerned with the promotion of 'safer smoking' and highlights that lower tar intake can be accompanied by a higher intake of other harmful substances.

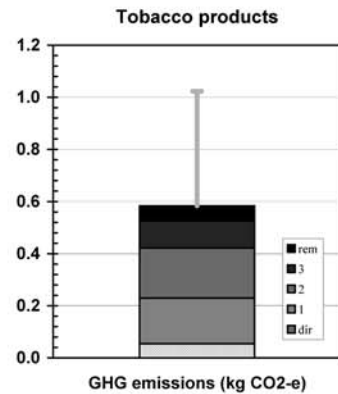
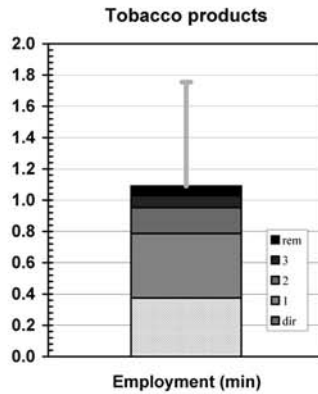
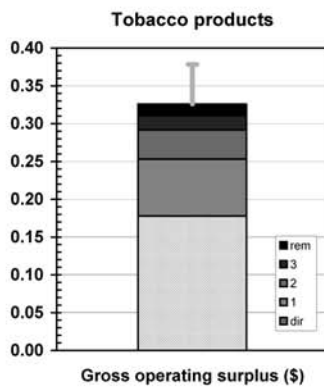
Tobacco products

Spider diagram

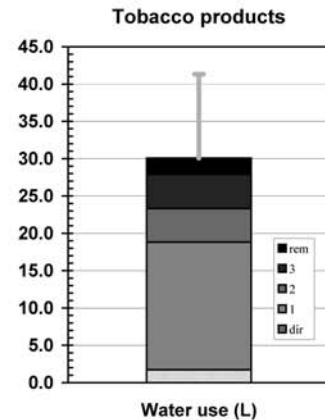
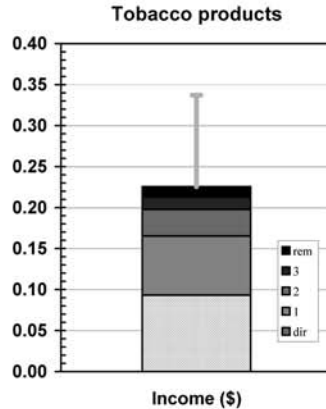
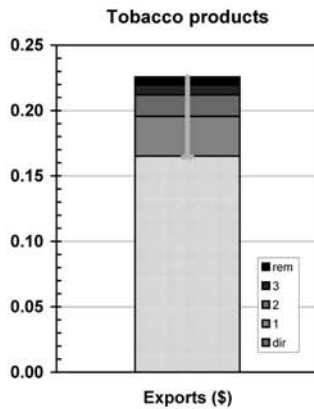


Bar graphs

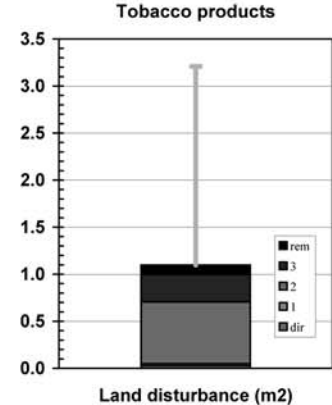
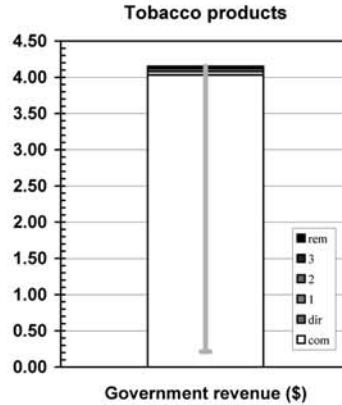
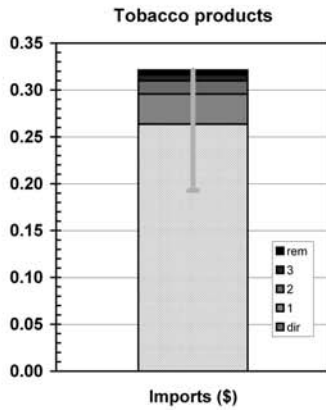
Account #1



Account #2



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 1,107.1	(0.42% of total)	(\$m 664.8 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 4.7	(0.00% of total)	(\$m 4.7 domestically produced)
Net changes in stocks	\$m 170.4	(9.64% of total)	(\$m 102.0 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 1,282.2</b>	<b>(0.28% of GNE)</b>	<b>(\$m 771.6 domestically produced)</b>
Exports	\$m 154.3	(0.19% of total)	(\$m 154.3 domestically produced)
<b>Final demand</b>	<b>\$m 1,436.5</b>	<b>(0.26% of GNT)</b>	<b>(\$m 925.8 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 87.1	(0.05% of total)
Gross operating surplus	\$m 166.1	(0.09% of total)
Taxes less subsidies	\$m 46.7	(0.05% of total)
<b>Sectoral GDP*</b>	<b>\$m 299.8</b>	<b>(0.07% of GDP)</b>
Imports	\$m 246.3	(0.25% of total)
<b>Primary inputs</b>	<b>\$m 546.1</b>	<b>(0.10% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 166.1	(0.09%)	\$m 164.5	(0.16%)
Exports (\$m)	\$m 154.3	(0.19%)	\$m 152.8	(0.25%)
Imports (\$m)	\$m 246.3	(0.25%)	\$m 244.0	(0.30%)
Employment (e-y)	2,800 e-y	(0.04%)	2,774 e-y	(0.11%)
Income (\$m)*	\$m 87.1	(0.05%)	\$m 86.3	(0.12%)
Government revenue (\$m)†	\$m 3,777.7	(3.50%)	\$m 3,777.3	(3.56%)
GHG emissions (kt CO <sub>2</sub> -e)	50 kt	(0.01%)	50 kt	(0.10%)
Water use (ML)	1,608 ML	(0.01%)	1,593 ML	(0.13%)
Land disturbance (kha)	2 kha	(0.00%)	2 kha	(0.06%)
Primary energy (TJ)	851 TJ	(0.02%)	843 TJ	(0.11%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.18	0.33	0.38
Exports (\$)	0.17	0.23	0.16
Imports (\$)	0.26	0.32	0.19
Employment (min)	0.37	1.09	1.75
Income (\$)	0.09	0.23	0.34
Government revenue (\$)	4.08	4.15	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.05	0.58	1.02
Water use (L)	1.72	30.08	41.32
Land disturbance (m <sup>2</sup> )	0.02	1.10	3.21
Primary energy (MJ)	0.91	4.45	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
To	0.178	(0; 55.%)	To	0.374	(0; 34.%)	To	0.0539	(0; 9.2%)
Vf To	0.0144	(1; 4.4%)	Ho To	0.0793	(1; 7.3%)	El To	0.0499	(1; 8.5%)
Ho To	0.00632	(1; 1.9%)	Vf To	0.0712	(1; 6.5%)	Sw Pp To	0.0377	(2; 6.5%)
Rd To	0.00623	(1; 1.9%)	Rd To	0.0366	(1; 3.4%)	Pp To	0.0368	(1; 6.3%)
Pp To	0.00598	(1; 1.8%)	Ts To	0.0265	(1; 2.4%)	Vf To	0.0278	(1; 4.8%)
Ts To	0.00588	(1; 1.8%)	Bs To	0.026	(1; 2.4%)	Wo Tx To	0.0235	(2; 4.%)
St To	0.00448	(1; 1.4%)	Wt To	0.0249	(1; 2.3%)	Gd To	0.0212	(1; 3.6%)
Rs To	0.00433	(1; 1.3%)	Rs To	0.0202	(1; 1.9%)	Fr Vf To	0.0166	(2; 2.8%)
Wt To	0.00346	(1; 1.1%)	Pa To	0.0167	(1; 1.5%)	Fr Sw Pp To	0.0163	(3; 2.8%)
Bs To	0.00263	(1; 0.81%)	Pp To	0.0135	(1; 1.2%)	Bc Mp Ho To	0.0157	(3; 2.7%)
Ms To	0.00251	(1; 0.77%)	Ms To	0.0113	(1; 1.%)	El Pp To	0.0155	(2; 2.7%)
Pa To	0.00247	(1; 0.76%)	Os To	0.0111	(1; 1.%)	El Ho To	0.0104	(2; 1.8%)
El To	0.00202	(1; 0.62%)	Gd To	0.00838	(1; 0.77%)	Rd To	0.00989	(1; 1.7%)
Wo Tx To	0.00166	(2; 0.51%)	St To	0.00731	(1; 0.67%)	Bc Mp To	0.00519	(2; 0.89%)
Cm To	0.00148	(1; 0.45%)	Pl To	0.00692	(1; 0.63%)	Pa To	0.00496	(1; 0.85%)
Lg To	0.00133	(1; 0.41%)	Wo Tx To	0.0068	(2; 0.62%)	Sw Pp Pa To	0.00417	(3; 0.71%)
Pl To	0.0013	(1; 0.4%)	Tx To	0.00601	(1; 0.55%)	Pp Pa To	0.00407	(2; 0.7%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
To	0.165	(0; 73.%)	To	0.0932	(0; 41.%)	Vf To	14.9	(1; 49.%)
Ho To	0.00441	(1; 2.%)	Ho To	0.0116	(1; 5.1%)	To	1.72	(0; 5.7%)
Vf To	0.00434	(1; 1.9%)	Rd To	0.0063	(1; 2.8%)	Sc Cg Vf To	1.54	(3; 5.1%)
Tx To	0.00361	(1; 1.6%)	Ts To	0.0062	(1; 2.7%)	Pp To	0.92	(1; 3.1%)
Wt To	0.00283	(1; 1.3%)	Vf To	0.00586	(1; 2.6%)	Wo Tx To	0.76	(2; 2.5%)
Rd To	0.00217	(1; 0.96%)	Wt To	0.00535	(1; 2.4%)	Ws Ho To	0.578	(2; 1.9%)
Wo Tx To	0.00208	(2; 0.92%)	Pa To	0.00385	(1; 1.7%)	Wa To	0.529	(1; 1.8%)
Lg To	0.00156	(1; 0.69%)	Pp To	0.00335	(1; 1.5%)	Bc Mp Ho To	0.415	(3; 1.4%)
Pp To	0.00111	(1; 0.49%)	Bs To	0.00319	(1; 1.4%)	Sc Cg Tx To	0.36	(3; 1.2%)
St To	0.00111	(1; 0.49%)	Os To	0.00311	(1; 1.4%)	Dc Dp Ho To	0.344	(3; 1.1%)
Pa To	0.00101	(1; 0.45%)	Rs To	0.0027	(1; 1.2%)	El To	0.276	(1; 0.92%)
Ts To	0.000932	(1; 0.41%)	Ms To	0.00262	(1; 1.2%)	Ri Fc Ho To	0.267	(3; 0.89%)
At To	0.000864	(1; 0.38%)	Gd To	0.00235	(1; 1.%)	Vf Ho To	0.219	(2; 0.73%)
Rs To	0.000761	(1; 0.34%)	St To	0.00187	(1; 0.83%)	Ri Fc To	0.195	(2; 0.65%)
Cg Vf To	0.000718	(2; 0.32%)	Tx To	0.00151	(1; 0.67%)	Vf Rs To	0.181	(2; 0.6%)
Rf To	0.000626	(1; 0.28%)	Pl To	0.0014	(1; 0.62%)	Sc Cg Wo Tx	0.142	(4; 0.47%)
Mp Ho To	0.000612	(2; 0.27%)	Bk To	0.000939	(1; 0.42%)	Bc Mp To	0.137	(2; 0.45%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /\$)		
To	0.264	(0; 82.%)	To	0.0499	(0; 41.%)	Wo Tx To	0.564	(2; 51.%)
Pp To	0.00565	(1; 1.8%)	Ho To	0.00609	(1; 5.%)	Bc Mp Ho To	0.114	(3; 10.%)
Pa To	0.00482	(1; 1.5%)	Rd To	0.00447	(1; 3.7%)	Bc Mp To	0.0377	(2; 3.4%)
Vf To	0.00354	(1; 1.1%)	Vf To	0.0036	(1; 3.%)	Sw Pp To	0.0296	(2; 2.7%)
Ho To	0.00294	(1; 0.92%)	Ts To	0.00305	(1; 2.5%)	To	0.0229	(0; 2.1%)
Ts To	0.00169	(1; 0.52%)	Wt To	0.0025	(1; 2.1%)	Vf To	0.014	(1; 1.3%)
Rd To	0.00158	(1; 0.49%)	Rs To	0.00235	(1; 1.9%)	Wo Mp Ho To	0.0129	(3; 1.2%)
Pl To	0.00133	(1; 0.41%)	Pa To	0.00202	(1; 1.7%)	Ba Bm Ho To	0.00934	(3; 0.85%)
Rs To	0.00119	(1; 0.37%)	Pp To	0.00201	(1; 1.7%)	Fr Vf To	0.00534	(2; 0.49%)
Wt To	0.000804	(1; 0.25%)	Os To	0.00144	(1; 1.2%)	Fr Sw Pp To	0.00523	(3; 0.48%)
Pp Pa To	0.000625	(2; 0.19%)	Ms To	0.00124	(1; 1.%)	Wh Vf To	0.00428	(2; 0.39%)
Ms To	0.000571	(1; 0.18%)	Gd To	0.00109	(1; 0.9%)	Wo Mp To	0.00426	(2; 0.39%)
Tx To	0.000554	(1; 0.17%)	Tx To	0.00107	(1; 0.88%)	Sw Pp Pa To	0.00328	(3; 0.3%)
Bs To	0.000523	(1; 0.16%)	St To	0.000997	(1; 0.82%)	Wo Tx Ho To	0.00324	(3; 0.29%)
Pr To	0.000437	(1; 0.14%)	Bs To	0.000944	(1; 0.78%)	Rs To	0.00247	(1; 0.23%)
St To	0.000406	(1; 0.13%)	In To	0.000721	(1; 0.59%)	Wh Fc Ho To	0.00231	(3; 0.21%)
Fo Vf To	0.000387	(2; 0.12%)	Pl To	0.00061	(1; 0.5%)	Wo Tx Pa To	0.00204	(3; 0.19%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	0.887 ±0.012	(±1.4%)
Downstream	0.010 ±0.001	(±7.5%)

# Sector 2201: Fibres Yarns and Fabrics (Tx)

*Processed wool, textile fibres, yarns, towels and woven fabrics*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse gas is over twice the average, water use is nearly three times the average, and land disturbance is 16 times the average. These high values are due to the upstream impacts of wool and cotton production that are included in the spun and woven products. The social indicator of employment generation is 10% above average, income is 10% below average, and government revenue is equal to average. The financial indicators show an operating surplus that is 5% below average, export propensity that is four times the average and import penetration that is 40% below average.

## Sector Description

This sector includes wool scouring (35%), making yarns and fabrics from wool (8%), cotton (13%), and synthetics (18%), and fabric finishing (26%). The spinning and weaving sector has within it some manufacturing success stories. The former Rocklea Spinning Mills used Australian grown cotton to produce 14 000 tonnes per annum of cotton fabrics and in particular the Colana® fabric of 30% fine wool and 70% cotton. Bradmill Denim exports 12 000 tonnes of Australian made denim fabric to leading denim apparel manufacturers in the US, Europe and Asia. In constant dollar terms over the last 30 years, spinning and weaving activity has halved, while wool scouring and fabric finishing has doubled. Turnover in 2002 was about \$4 billion and involved over 200 enterprises.

## Place of Industry in the Economy

The 'fibres, yarns and fabrics' sector ranks 79<sup>th</sup> out of 135 sectors in terms of value adding in the economy, and contributes 0.19% of value adding in this analysis. It is similar in value adding to the alumina production, and garbage disposal sectors. It is a moderate sized employer with 5 000 employment years directly embodied in final demand, and another 16 000 years in the sector's upstream suppliers giving a total of 21 000 employment years. In addition, it supplies another 8 000 employment years to the final demand of downstream industries such as textile products, clothing manufacture and furniture making. It has moderate resource requirements with less than one percent of national water use, energy use, and greenhouse emissions, but over four percent of national land disturbance. This is due to the inclusion of sheep grazing land in the sector's production chain. In financial terms, exports are more than six times the level of imports although local operations are now being severely challenged by large scale, low cost developments in Asia.

## Strategic Overview

The spider diagram shows three outliers for the environmental indicators of land disturbance, water use and greenhouse emissions. Collectively these are due to the inclusion or embodiment of wool and cotton growing in the supply of primary materials to the spinning and weaving activities in this sector. The social indicators of employment generation and income are near average, while the financial indicators are all above or near average. This TBL account poses important policy challenges. Internalising the full environmental costs of production in spinning and weaving and the consumer items that are made from them, may produce a number of perverse outcomes. Shutting down Australian production merely shifts the environmental issues to another value adding chain elsewhere in the world. It also lengthens the supply chain for local manufacturers, reduces the domestic employment and value adding and may also increase import penetration. Large integrated complexes in Asia seem set to dominate local production operations in all bulk commodity lines.

## TBL Account #1

The financial indicator of operating surplus is 5% below average with a direct effect of 12% and contributions from wool production (34%), wholesale trade (4%), cotton ginning (2%), cotton growing (1%), electricity production (1%) and road transport (1%). The social indicator of employment generation is 10% above average with equal contributions from the direct sector effect (24%) and wool growing (27%). The environmental indicator of greenhouse emissions is two and a half times the average and is described in more detail below.

## TBL Accounts #2 and #3

The second TBL account shows that the export propensity is nearly four times the average due mainly to the volume of scoured and combed wool, rather than spun and woven fibre, while income is 10% below average, and water use is over three times the average. The third TBL account shows that import propensity is 40% below average, government revenue is equal to average, and land disturbance is sixteen times the average and is discussed in more detail below.

## Structural Path Analysis and Linkages

The three environmental indicators of greenhouse emissions, water use and land disturbance are all above average. The greenhouse emissions chain has a direct sector effect of less than 1%. Two thirds of its total from the first order chain of 'wool production–textile spinning' and most of this is due to methane from sheep. Additional contributions include electricity production (4%) and cotton growing (1%). The water indicator includes a direct effect of 3%, with wool growing and wool scouring (42%), cotton growing (29%), hay growing for sheep (2%) and water delivery (1%). The land disturbance effect is dominated by sheep grazing land with 81% of the total. Moderating all of these indicators in unison presents a formidable task, but one to which the manager of an environmentally focused procurement chain might be attracted. Reducing the greenhouse and land disturbance indicators for wool may focus on high quality and productive pastures, requiring less land and emitting less methane. Balancing the irrigation requirements of cotton with fibre production and quality may give an environmentally certified product rewarded in the market place.

The sector's stimulus to its upstream suppliers is 60% above average and impacts on wholesale trade, shearing and cotton ginning, road transport, property development, and accounting and marketing. The linkages to downstream industries are 5% below average and suggest that any expansion of the sector must be led by increased activity in textile products, clothing manufacture and furniture making, or in export markets.

## Future Trends in Sector

Given the globalised forces currently impacting on the 'clothing, footwear and textile' industries, particularly the highly dynamic restructuring of supply chains, the most optimistic anticipation is that the sector maintains its current domestic production base in the face of large scale and efficient new production centres in Asia. The sector has advantages in its proximity to large supplies of high quality wool and cotton giving it the opportunity to choose suppliers. The environmental impact of the entire production chain can be reduced and this could generate market rewards in affluent and environmentally aware markets.

## Innovation and Technical Opportunities

Research innovation in Australian textiles is viewed as leading edge, but much of it has been applied overseas. Insights from current industry reviews may need to be fused with the theory of industry and regional clusters. This could help stimulate communities to form the basis of industry innovation and advantage, rather than relying on theories of economics and competition alone.

Sector

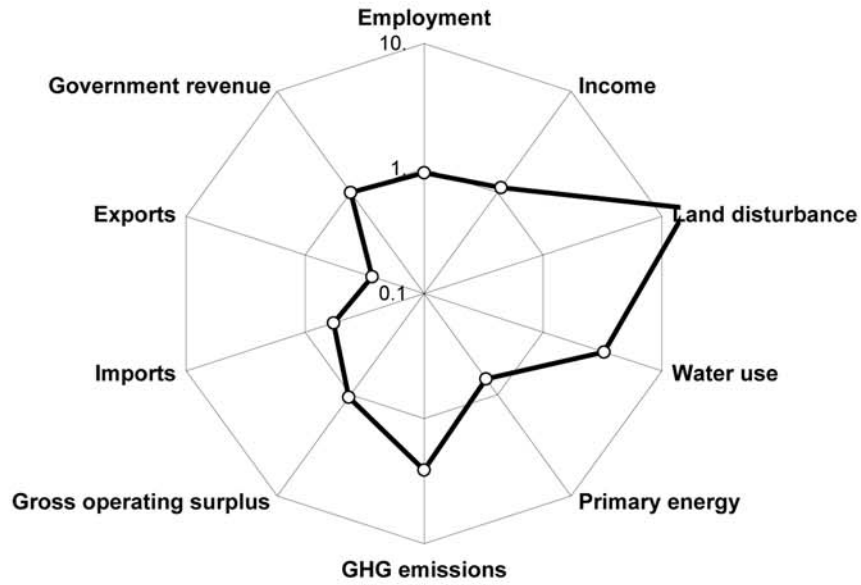
Fibres, yarns, fabrics

(Tx)

Processed wool, textile fibres, yarns, towels and woven fabrics

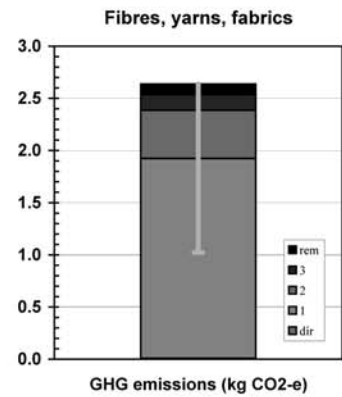
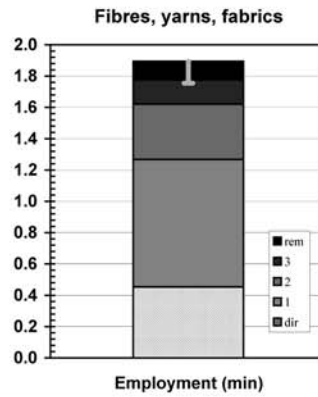
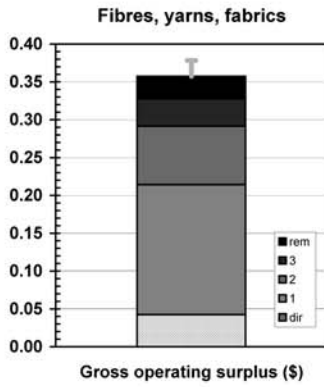
**Spider diagram**

**Fibres, yarns, fabrics**

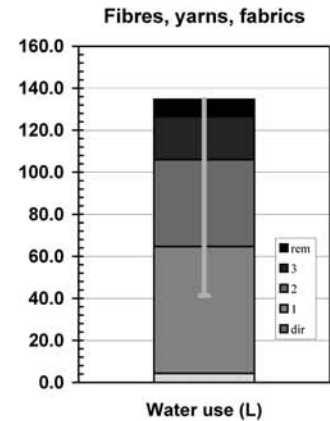
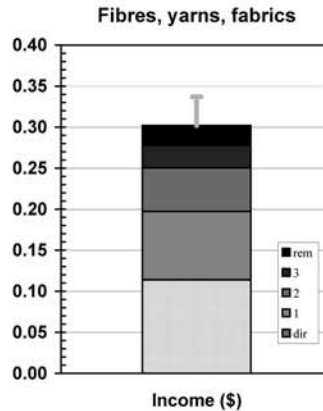
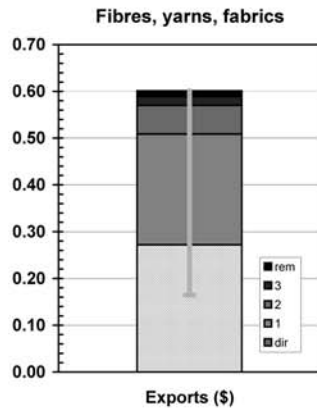


**Bar graphs**

**Account #1**

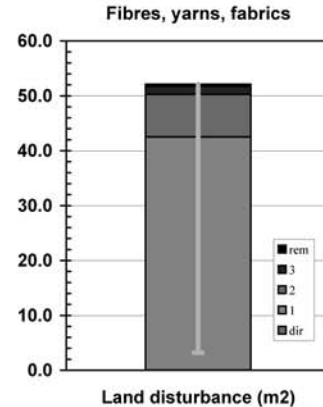
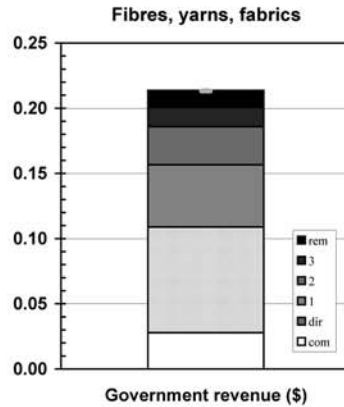
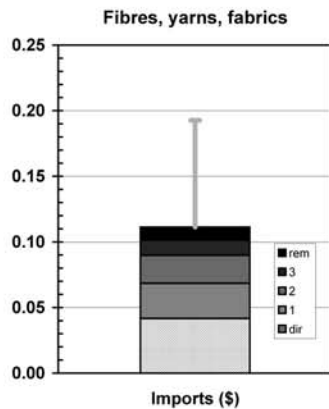


**Account #2**





Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 593.0	(0.22% of total)	(\$m 399.8 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	
Gross fixed capital expenditure	\$m 16.1	(0.02% of total)	(\$m 16.1 domestically produced)
Net changes in stocks	-\$m 14.0	-(0.79% of total)	(\$m 2.0 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 595.1</b>	<b>(0.13% of GNE)</b>	<b>(\$m 417.8 domestically produced)</b>
Exports	\$m 965.1	(1.16% of total)	(\$m 965.1 domestically produced)
<b>Final demand</b>	<b>\$m 1,560.2</b>	<b>(0.29% of GNT)</b>	<b>(\$m 1,383.0 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 404.1	(0.24% of total)
Gross operating surplus	\$m 150.1	(0.08% of total)
Taxes less subsidies	\$m 287.5	(0.34% of total)
<b>Sectoral GDP*</b>	<b>\$m 841.6</b>	<b>(0.19% of GDP)</b>
Imports	\$m 148.1	(0.15% of total)
<b>Primary inputs</b>	<b>\$m 989.7</b>	<b>(0.18% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 150.1	(0.08%)	\$m 58.5 (0.03%)	\$m 494.4 (0.26%)
Exports (\$m)	\$m 965.1	(1.16%)	\$m 376.0 (0.45%)	\$m 831.8 (1.00%)
Imports (\$m)	\$m 148.1	(0.15%)	\$m 57.7 (0.06%)	\$m 154.0 (0.16%)
Employment (e-y)	12,888 e-y	(0.18%)	5,020 e-y (0.07%)	21,004 e-y (0.29%)
Income (\$m)*	\$m 404.1	(0.24%)	\$m 157.4 (0.09%)	\$m 417.5 (0.24%)
Government revenue (\$m)†	\$m 325.9	(0.30%)	\$m 150.5 (0.14%)	\$m 295.5 (0.27%)
GHG emissions (kt CO <sub>2</sub> -e)	24 kt	(0.00%)	10 kt (0.00%)	3,649 kt (0.70%)
Water use (ML)	15,283 ML	(0.07%)	5,953 ML (0.03%)	186,280 ML (0.89%)
Land disturbance (kha)	6 kha	(0.00%)	2 kha (0.00%)	7,210 kha (4.43%)
Primary energy (TJ)	341 TJ	(0.01%)	133 TJ (0.00%)	7,379 TJ (0.19%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.04	0.36	0.38
Exports (\$)	0.27	0.60	0.16
Imports (\$)	0.04	0.11	0.19
Employment (min)	0.45	1.90	1.75
Income (\$)	0.11	0.30	0.34
Government revenue (\$)	0.11	0.21	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.01	2.64	1.02
Water use (L)	4.30	134.70	41.32
Land disturbance (m <sup>2</sup> )	0.02	52.14	3.21
Primary energy (MJ)	0.10	5.34	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Wo Tx	0.125	(1; 35.%)	Wo Tx	0.512	(1; 27.%)	Wo Tx	1.77	(1; 67.%)
Tx	0.0423	(0; 12.%)	Tx	0.453	(0; 24.%)	El Tx	0.108	(1; 4.1%)
Wt Tx	0.0157	(1; 4.4%)	Wt Tx	0.113	(1; 5.9%)	Sc Cg Tx	0.0259	(2; 0.98%)
Cg Tx	0.00717	(1; 2.%)	Cg Tx	0.0472	(1; 2.5%)	Wt Tx	0.0156	(1; 0.59%)
Sc Cg Tx	0.00526	(2; 1.5%)	Sc Cg Tx	0.0261	(2; 1.4%)	Fr Wo Tx	0.0116	(2; 0.44%)
El Tx	0.00437	(1; 1.2%)	Rd Tx	0.0203	(1; 1.1%)	Sc Cg Wo Tx	0.0102	(3; 0.39%)
Rd Tx	0.00345	(1; 0.97%)	Cg Wo Tx	0.0187	(2; 0.99%)	Ch Tx	0.00753	(1; 0.29%)
St Wt Tx	0.00299	(2; 0.84%)	Wt Wo Tx	0.0123	(2; 0.65%)	Tx	0.00688	(0; 0.26%)
Cg Wo Tx	0.00284	(2; 0.79%)	Vf Wo Tx	0.0104	(2; 0.55%)	El Wo Tx	0.00643	(2; 0.24%)
Ms Wt Tx	0.00227	(2; 0.63%)	Sc Cg Wo Tx	0.0103	(3; 0.54%)	Fr Sc Cg Tx	0.00608	(3; 0.23%)
Vf Wo Tx	0.00209	(2; 0.58%)	Ms Wt Tx	0.0102	(2; 0.54%)	Ch Wo Tx	0.00564	(2; 0.21%)
Sc Cg Wo T:	0.00208	(3; 0.58%)	Rf Tx	0.0082	(1; 0.43%)	Rd Tx	0.00548	(1; 0.21%)
Wa Tx	0.00201	(1; 0.56%)	Rd Wo Tx	0.00602	(2; 0.32%)	Fo Wo Tx	0.00522	(2; 0.2%)
Pd Wt Tx	0.0018	(2; 0.5%)	Ms Wo Tx	0.00508	(2; 0.27%)	El Wt Tx	0.0047	(2; 0.18%)
Rv Wo Tx	0.00178	(2; 0.5%)	St Wt Tx	0.00487	(2; 0.26%)	Vf Wo Tx	0.00404	(2; 0.15%)
Wt Wo Tx	0.0017	(2; 0.48%)	El Tx	0.00485	(1; 0.26%)	El Rf Tx	0.00299	(2; 0.11%)
Bk Wo Tx	0.00114	(2; 0.32%)	Rv Wo Tx	0.00476	(2; 0.25%)	Rf Tx	0.00298	(1; 0.11%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Tx	0.272	(0; 45.%)	Tx	0.114	(0; 38.%)	Wo Tx	57.3	(1; 43.%)
Wo Tx	0.157	(1; 26.%)	Wt Tx	0.0242	(1; 8.%)	Sc Cg Tx	27.1	(2; 20.%)
Wt Tx	0.0128	(1; 2.1%)	Wo Tx	0.0176	(1; 5.8%)	Sc Cg Wo Tx	10.7	(3; 8.%)
Cg Tx	0.0126	(1; 2.1%)	Cg Tx	0.00811	(1; 2.7%)	Tx	4.3	(0; 3.2%)
Cg Wo Tx	0.00499	(2; 0.83%)	Rd Tx	0.00349	(1; 1.2%)	Vf Wo Tx	2.16	(2; 1.6%)
Rf Tx	0.00168	(1; 0.28%)	Cg Wo Tx	0.00321	(2; 1.1%)	Wa Tx	1.48	(1; 1.1%)
Wt Wo Tx	0.00139	(2; 0.23%)	Wt Wo Tx	0.00263	(2; 0.87%)	El Tx	0.597	(1; 0.44%)
Rd Tx	0.0012	(1; 0.2%)	Ms Wt Tx	0.00237	(2; 0.78%)	Sc Cg Sc Cg	0.564	(4; 0.42%)
Bl El Tx	0.00106	(2; 0.18%)	Rf Tx	0.0023	(1; 0.76%)	Wh Wo Tx	0.293	(2; 0.22%)
Ch Tx	0.000876	(1; 0.15%)	Sc Cg Tx	0.00214	(2; 0.71%)	Sc Cg Vf Wo	0.224	(4; 0.17%)
St Wt Tx	0.00074	(2; 0.12%)	Pd Wt Tx	0.00162	(2; 0.54%)	Sc Cg Sc Cg \	0.223	(5; 0.17%)
Wh Wo Tx	0.000738	(2; 0.12%)	El Tx	0.00131	(1; 0.44%)	Wa Wo Tx	0.209	(2; 0.16%)
Ch Wo Tx	0.000657	(2; 0.11%)	St Wt Tx	0.00124	(2; 0.41%)	Su Fd Wo Tx	0.105	(3; 0.078%)
Vf Wo Tx	0.00063	(2; 0.1%)	Ms Wo Tx	0.00118	(2; 0.39%)	Ri Fc Wo Tx	0.0983	(3; 0.073%)
At Wt Tx	0.000606	(2; 0.1%)	Bk Wo Tx	0.00111	(2; 0.37%)	Wt Tx	0.0631	(1; 0.047%)
Oi Fo Wo Tx	0.000507	(3; 0.084%)	Rd Wo Tx	0.00103	(2; 0.34%)	Wa Ms Wt Tx	0.0583	(3; 0.043%)
Rd Wo Tx	0.000356	(2; 0.059%)	Ms Tx	0.00088	(1; 0.29%)	Wa Cg Tx	0.0545	(2; 0.04%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Tx	0.0417	(0; 37.%)	Tx	0.081	(0; 44.%)	Wo Tx	42.5	(1; 82.%)
Wo Tx	0.0089	(1; 8.%)	Wt Tx	0.0113	(1; 6.1%)	Wh Wo Tx	0.0427	(2; 0.082%)
Wt Tx	0.00364	(1; 3.3%)	Wo Tx	0.0102	(1; 5.5%)	Sc Cg Tx	0.0356	(2; 0.068%)
Cg Tx	0.00201	(1; 1.8%)	Cg Tx	0.00426	(1; 2.3%)	Tx	0.017	(0; 0.033%)
Fo Wo Tx	0.00171	(2; 1.5%)	Rd Tx	0.00248	(1; 1.3%)	Sc Cg Wo Tx	0.0141	(3; 0.027%)
Sc Cg Tx	0.00129	(2; 1.2%)	Cg Wo Tx	0.00168	(2; 0.91%)	Wo Tx Kn Tx	0.00544	(3; 0.01%)
Ch Tx	0.000877	(1; 0.79%)	Sc Cg Tx	0.00132	(2; 0.71%)	Ba Wo Tx	0.00461	(2; 0.0088%)
Rd Tx	0.000875	(1; 0.79%)	Wt Wo Tx	0.00123	(2; 0.66%)	Bc Mp Ho Wo	0.00414	(4; 0.0079%)
Cg Wo Tx	0.000795	(2; 0.71%)	Ms Wt Tx	0.00112	(2; 0.6%)	Wo Tx Wt Tx	0.00401	(3; 0.0077%)
Ac Wo Tx	0.000787	(2; 0.71%)	Pd Wt Tx	0.00106	(2; 0.57%)	Fr Wo Tx	0.00372	(2; 0.0071%)
Ch Wo Tx	0.000657	(2; 0.59%)	Rf Tx	0.00106	(1; 0.57%)	Bc Mp Ch Tx	0.00299	(3; 0.0057%)
Ms Wt Tx	0.000516	(2; 0.46%)	El Tx	0.000819	(1; 0.44%)	Bc Mp Ho Wt	0.00232	(4; 0.0044%)
Vf Wo Tx	0.000514	(2; 0.46%)	Rd Wo Tx	0.000734	(2; 0.4%)	Bc Mp Ch Wo	0.00224	(4; 0.0043%)
Sc Cg Wo T:	0.000512	(3; 0.46%)	St Wt Tx	0.000664	(2; 0.36%)	Bc Mp Wo Tx	0.00215	(3; 0.0041%)
Pr Wt Tx	0.000494	(2; 0.44%)	Bk Wo Tx	0.000616	(2; 0.33%)	Vf Wo Tx	0.00204	(2; 0.0039%)
Wt Wo Tx	0.000396	(2; 0.36%)	Ms Wo Tx	0.000561	(2; 0.3%)	Fr Sc Cg Tx	0.00196	(3; 0.0038%)
Ac Cg Tx	0.000357	(2; 0.32%)	Vf Wo Tx	0.000523	(2; 0.28%)	Bc Mp Fd Wo	0.00188	(4; 0.0036%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.597 ±0.040	(±2.5%)
Downstream	0.952 ±0.032	(±3.3%)

# Sector 2202: Textile Products (Tp)

*Carpets, felt, curtains, tarpaulins, belts, sails, tents, sleeping bags, rope, cordage, bags, sacks, lace, embroidery, napkins, wadding, tampons, parachutes and other textile products*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is 5% below average, while water use is 25% below average, and land disturbance is nearly three times the average. The social indicators reveal that employment generation is 20% above average, income is equal to average, and government revenue is equal to average. The financial indicators show that the operating surplus is 40% below average, export propensity is 60% above average and import penetration is 50% above average. The 'cradle to grave' life cycle of floor coverings is receiving more attention as sustainability issues focus on building fit-outs and building design. There is now a well developed 'cradle to cradle' life cycle which re-assigns floor coverings from higher to lower use areas and includes designed-in recycle options for end of life products.

## Sector Description

The sector's production is dominated by textile floor coverings such as carpet, rugs, and underfelt (40%), diverse textile products such as soft furnishing, blinds, and canvas goods (45%), and rope and textile bags and sacks (15%). Carpet industry statistics suggest that yearly sales cover 49 million square metres, or enough to cover 7 000 rugby union playing pitches. Locally made carpet accounts for 80% of sales, and requires about 20 000 tonnes of carpet wool, with most imported from New Zealand. A European life cycle analysis of one square metre of floor coverings (in place with underfelt and adhesive etc.) compared woollen carpet (2.6 kg/m<sup>2</sup>) and polyamide pile (2.2 kg/m<sup>2</sup>) found that the full energy cost was 157 MJ/m<sup>2</sup> for wool, and 329 MJ/m<sup>2</sup> for polyamide. However woollen carpet was judged to have the highest global warming impact because it includes methane emitted from sheep during wool production. The disposal of used carpet is an issue for many countries, and increasingly it contributes to a waste stream used for co-firing in electricity generation and in cement kilns. In constant dollar terms, the sector's production has doubled over the last 30 years, and in 2002 was about \$2.4 billion dollars and included over 300 enterprises.

## Place of Industry in the Economy

The textile products sector ranks 101<sup>st</sup> out of 135 sectors in terms of value adding in the economy, and contributes 0.11% of GDP in this analysis. It is similar in value adding to the ship building, and pipeline sectors. It is a moderate employer with 10 000 employment years directly embodied in final demand, and another 6 000 years in the sector's upstream suppliers, giving a total of 16 000 years. In addition, it supplies 7 000 years to the final demand of downstream industries such as domestic building, and accommodation cafes and restaurants. It has moderate resource requirements with two tenths of one percent of national water use, energy use, and greenhouse emissions, but one half of one percent of land disturbance. In financial terms, imports are twice the levels of exports.

## Strategic Overview

The spider diagram reveals a reasonable TBL account, with outliers in the financial indicators of import penetration and operating surplus, and the environmental indicator of land disturbance. Improving the financial indicators in the face of strong competition from low wage manufacturers will remain a challenge, but the floor covering component of the sector is still essentially local and this may continue. Wool carpet manufacturers could improve the land disturbance indicator by sourcing wool from productive regions and thereby become stewards of the full production chain.

## TBL Account #1

The financial indicator of operating surplus is 40% below average, the social indicator of employment generation is 20% above average, and the environmental indicator of greenhouse emissions is 5% below average. The direct sector effect for emissions is 18% with contributions from 'wool production-fibres and yarns-textile products' (31%), electricity production (9%), 'electricity-fibres and yarns-textile products' (2%), basic chemicals (2%) and garbage disposal (1%) suggesting wool production and electricity generation may provide options for emissions reductions.

## TBL Accounts #2 and #3

The second TBL account shows that export propensity is 60% above average, income is equal to average and water use is 25% below average. The third TBL account shows that import penetration is 50% above average, government revenue is equal to average, and land disturbance is three times the average.

## Structural Path Analysis and Linkages

The three indicators of operating surplus, import penetration and land disturbance are above average. The direct sector effect in operating surplus is 29% with contributions from the 'wool-spinning-textile products' chain of 9%, wholesale trade (3%), technical services (3%), accounting and marketing (3%), spinning (3%), electricity production (2%), knitted products (1%) and road transport (1%). The recent reviews of the 'textile, clothing and footwear' industries emphasised the need for innovation in the supply chain, and the paths for operating surplus are a good example of this challenge. The import penetration indicator is simpler with a direct effect of 78%, fibres and yarns (3%), and knitted products 1%. Carpet manufacturing in Australia and New Zealand is moderately integrated, with both final carpet product, and intermediate raw wools and spun fibres, flowing between the manufacturers and distributors. This partly accounts for the high import and export indicators. The land disturbance indicator is dominated by a 77% contribution from the 'wool production-fibres and yarns-textile products' chain, i.e. the wool in the final product.

The sector's stimulus to its upstream suppliers is 10% above average and impacts on fibre and yarn production, wholesale trade, sheep production, accounting and marketing, and technical design services. The linkages to downstream industries are 30% below average because much of the production is dissipated by final consumption. Nevertheless, expansion of the sector must be led by expansion of obvious sectors such as residential building, and accommodation cafes and restaurants.

## Future Trends in Sector

Under the base case scenario for the *Future Dilemmas* study with 25 million people by 2050, the requirement for textiles in buildings increases fourfold due to a doubling of combined floor area in domestic, commercial, and institutional buildings as well as assumptions on rising affluence and per capita consumption. The production in this sector, apart from floor coverings and soft furnishings, may follow population growth and increase by about 25%.

## Innovation and Technical Opportunities

Two innovations in floor covering are notable. The multinational chemical firm Cargill Dow has developed a versatile and compostable 'polylactide' polymer that can be used in carpet manufacture. It is made from biomass derived lactic acid rather than petroleum feedstocks, and is part of the company's strategy to develop a full array of renewable chemicals. Another US firm Shaw Industries, has developed a fully integrated carpet tile production and leasing system, that gives maximum mileage for each carpet tile through rotation and placement systems, based on redesigned composition of carpets that allows easy separation and recycling of top tuft and backing materials.

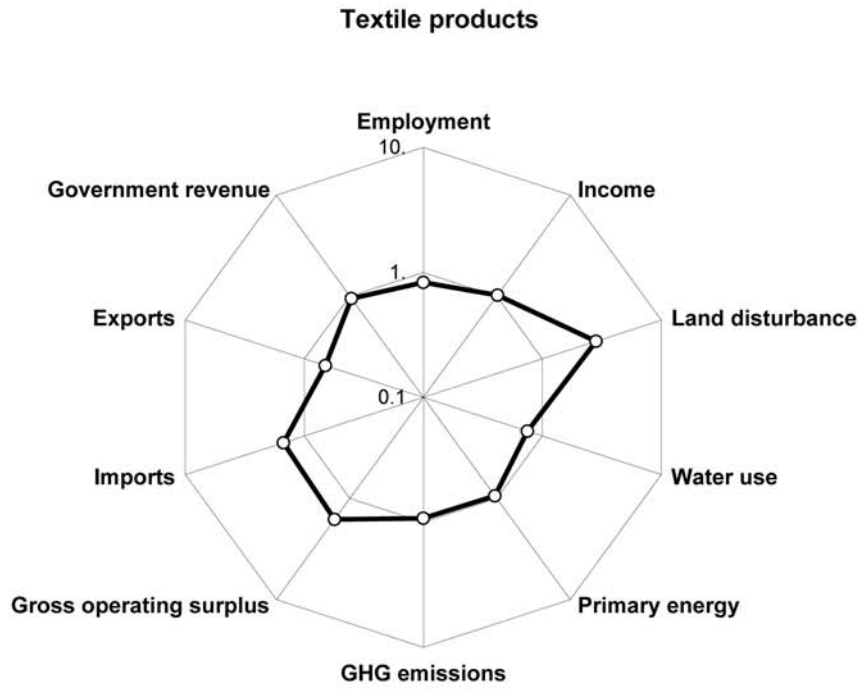
**Sector**

**Textile products**

**(Tp)**

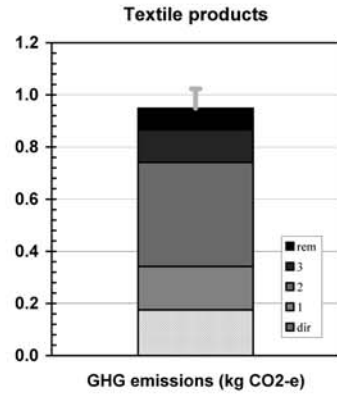
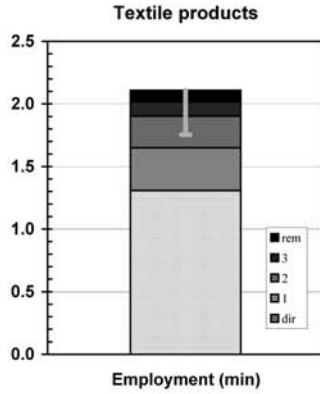
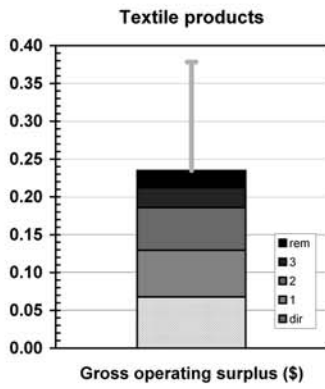
Carpets, felt, curtains, tarpaulins, belts, sails, tents, sleeping bags, rope, cordage, bags, sacks, lace, embroidery, napkins, wadding, tampons, parachutes and other textile products

**Spider diagram**

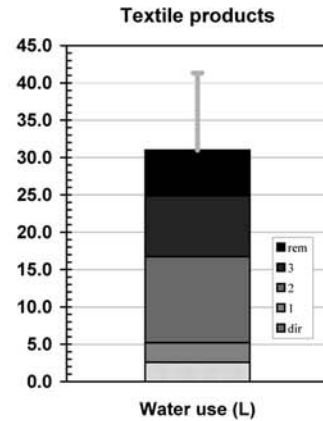
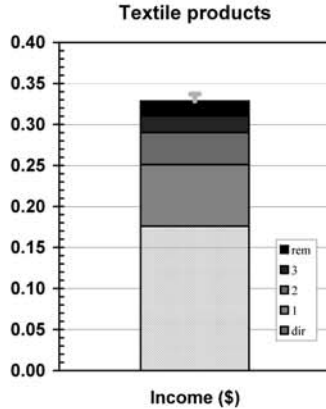
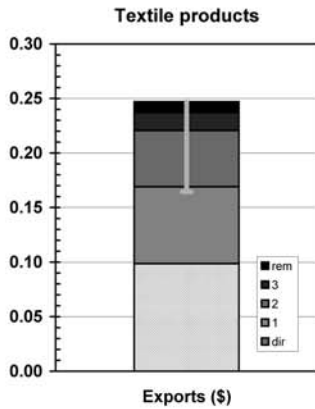


**Bar graphs**

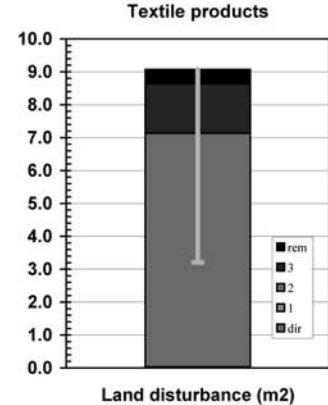
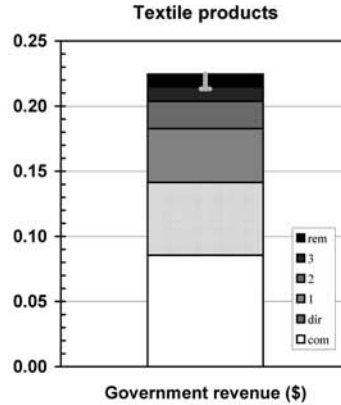
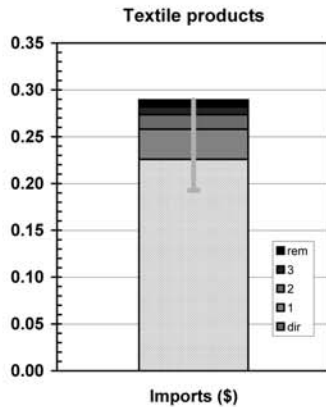
**Account #1**



**Account #2**



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 902.9	(0.34% of total)	(\$m 705.7 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 121.8	(0.12% of total)	(\$m 94.7 domestically produced)
Net changes in stocks	\$m 31.2	(1.76% of total)	(\$m 10.2 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 1,055.9</b>	<b>(0.23% of GNE)</b>	<b>(\$m 810.6 domestically produced)</b>
Exports	\$m 162.6	(0.20% of total)	(\$m 162.6 domestically produced)
<b>Final demand</b>	<b>\$m 1,218.5</b>	<b>(0.22% of GNT)</b>	<b>(\$m 973.2 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 289.9	(0.17% of total)
Gross operating surplus	\$m 111.5	(0.06% of total)
Taxes less subsidies	\$m 92.1	(0.11% of total)
<b>Sectoral GDP*</b>	<b>\$m 493.5</b>	<b>(0.11% of GDP)</b>
Imports	\$m 372.4	(0.38% of total)
<b>Primary inputs</b>	<b>\$m 865.9</b>	<b>(0.16% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 111.5	(0.06%)	\$m 65.8 (0.03%)	\$m 228.5 (0.12%)
Exports (\$m)	\$m 162.6	(0.20%)	\$m 95.9 (0.12%)	\$m 240.5 (0.29%)
Imports (\$m)	\$m 372.4	(0.38%)	\$m 219.7 (0.23%)	\$m 281.6 (0.29%)
Employment (e-y)	17,288 e-y	(0.24%)	10,201 e-y (0.14%)	16,442 e-y (0.23%)
Income (\$m)*	\$m 289.9	(0.17%)	\$m 171.1 (0.10%)	\$m 319.6 (0.19%)
Government revenue (\$m)†	\$m 175.3	(0.16%)	\$m 137.6 (0.13%)	\$m 218.4 (0.20%)
GHG emissions (kt CO <sub>2</sub> -e)	288 kt	(0.06%)	170 kt (0.03%)	923 kt (0.18%)
Water use (ML)	4,255 ML	(0.02%)	2,511 ML (0.01%)	30,164 ML (0.14%)
Land disturbance (kha)	3 kha	(0.00%)	2 kha (0.00%)	883 kha (0.54%)
Primary energy (TJ)	5,080 TJ	(0.13%)	2,997 TJ (0.08%)	7,008 TJ (0.18%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.07	0.23	0.38
Exports (\$)	0.10	0.25	0.16
Imports (\$)	0.23	0.29	0.19
Employment (min)	1.31	2.11	1.75
Income (\$)	0.18	0.33	0.34
Government revenue (\$)	0.14	0.22	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.17	0.95	1.02
Water use (L)	2.58	30.99	41.32
Land disturbance (m <sup>2</sup> )	0.02	9.07	3.21
Primary energy (MJ)	3.08	7.20	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Tp	0.0676	(0; 29.%)	Tp	1.31	(0; 62.%)	Wo Tx Tp	0.292	(2; 31.%)
Wo Tx Tp	0.0206	(2; 8.8%)	Wo Tx Tp	0.0846	(2; 4.%)	Tp	0.175	(0; 18.%)
Wt Tp	0.00759	(1; 3.2%)	Tx Tp	0.0748	(1; 3.5%)	El Tp	0.0876	(1; 9.2%)
Ts Tp	0.00755	(1; 3.2%)	Wt Tp	0.0546	(1; 2.6%)	El Tx Tp	0.0178	(2; 1.9%)
Ms Tp	0.00711	(1; 3.%)	Ts Tp	0.034	(1; 1.6%)	Ch Tp	0.0167	(1; 1.8%)
Tx Tp	0.00698	(1; 3.%)	Ms Tp	0.0319	(1; 1.5%)	Ga Tp	0.0103	(1; 1.1%)
El Tp	0.00354	(1; 1.5%)	Wt Tx Tp	0.0186	(2; 0.88%)	Bc Mp Tp	0.00917	(2; 0.97%)
Kn Tp	0.00308	(1; 1.3%)	Rd Tp	0.0175	(1; 0.83%)	Ng Tp	0.00798	(1; 0.84%)
Rd Tp	0.00298	(1; 1.3%)	Kn Tp	0.0171	(1; 0.81%)	Wt Tp	0.00757	(1; 0.8%)
Wt Tx Tp	0.00259	(2; 1.1%)	Pl Tp	0.0115	(1; 0.54%)	Bl Tp	0.0069	(1; 0.73%)
Pl Tp	0.00215	(1; 0.92%)	Ho Tp	0.00818	(1; 0.39%)	Is Tp	0.00602	(1; 0.63%)
Bl Tp	0.00177	(1; 0.75%)	Cg Tx Tp	0.0078	(2; 0.37%)	Ch Pl Tp	0.00479	(2; 0.51%)
Ng Tp	0.00176	(1; 0.75%)	Fm Tp	0.00538	(1; 0.26%)	Rd Tp	0.00473	(1; 0.5%)
Cm Tp	0.00151	(1; 0.64%)	Ms Wt Tp	0.00493	(2; 0.23%)	At Tp	0.0044	(1; 0.46%)
Ga Tp	0.0015	(1; 0.64%)	Sc Cg Tx Tp	0.00431	(3; 0.2%)	Sc Cg Tx Tp	0.00428	(3; 0.45%)
St Wt Tp	0.00145	(2; 0.62%)	Cm Tp	0.00418	(1; 0.2%)	Wo Tx Kn Tp	0.00312	(3; 0.33%)
Ch Tp	0.00139	(1; 0.59%)	Ch Tp	0.00407	(1; 0.19%)	El Ms Tp	0.00298	(2; 0.31%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Tp	0.0986	(0; 40.%)	Tp	0.176	(0; 54.%)	Wo Tx Tp	9.46	(2; 31.%)
Tx Tp	0.0449	(1; 18.%)	Tx Tp	0.0188	(1; 5.7%)	Sc Cg Tx Tp	4.48	(3; 14.%)
Wo Tx Tp	0.0259	(2; 10.%)	Wt Tp	0.0117	(1; 3.6%)	Tp	2.58	(0; 8.3%)
Wt Tp	0.00621	(1; 2.5%)	Ts Tp	0.00796	(1; 2.4%)	Sc Cg Wo Tx	1.77	(4; 5.7%)
Bl Tp	0.00268	(1; 1.1%)	Ms Tp	0.00742	(1; 2.3%)	Tx Tp	0.711	(1; 2.3%)
Wt Tx Tp	0.00211	(2; 0.86%)	Kn Tp	0.00413	(1; 1.3%)	Wa Tp	0.485	(1; 1.6%)
Cg Tx Tp	0.00209	(2; 0.84%)	Wt Tx Tp	0.004	(2; 1.2%)	El Tp	0.484	(1; 1.6%)
Ch Tp	0.00194	(1; 0.79%)	Rd Tp	0.00301	(1; 0.92%)	Vf Tp	0.391	(1; 1.3%)
At Tp	0.0014	(1; 0.57%)	Wo Tx Tp	0.0029	(2; 0.88%)	Vf Wo Tx Tp	0.356	(3; 1.2%)
Kn Tp	0.00138	(1; 0.56%)	Pl Tp	0.00232	(1; 0.71%)	Wa Tx Tp	0.244	(2; 0.79%)
Oc Tp	0.00122	(1; 0.5%)	Cg Tx Tp	0.00134	(2; 0.41%)	Bc Mp Tp	0.242	(2; 0.78%)
Ts Tp	0.0012	(1; 0.48%)	Ho Tp	0.00119	(1; 0.36%)	Wa Ms Tp	0.183	(2; 0.59%)
Ms Tp	0.0011	(1; 0.45%)	Ms Wt Tp	0.00115	(2; 0.35%)	Kn Tp	0.153	(1; 0.49%)
Rd Tp	0.00104	(1; 0.42%)	El Tp	0.00107	(1; 0.32%)	Wa Ts Tp	0.102	(2; 0.33%)
Bl El Tp	0.000857	(2; 0.35%)	Oc Tp	0.000974	(1; 0.3%)	El Tx Tp	0.0986	(2; 0.32%)
Nf Tp	0.00085	(1; 0.34%)	Cm Tp	0.000949	(1; 0.29%)	Dc Dp Tp	0.0796	(2; 0.26%)
Cg Wo Tx Tp	0.000825	(3; 0.33%)	Ch Tp	0.000863	(1; 0.26%)	Sc Cg Tp	0.0663	(2; 0.21%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$		
Tp	0.226	(0; 78.%)	Tp	0.0558	(0; 40.%)	Wo Tx Tp	7.02	(2; 77.%)
Tx Tp	0.00689	(1; 2.4%)	Tx Tp	0.0134	(1; 9.6%)	Wo Tx Kn Tp	0.0749	(3; 0.83%)
Kn Tp	0.00406	(1; 1.4%)	Wt Tp	0.00548	(1; 3.9%)	Bc Mp Tp	0.0667	(2; 0.73%)
Pl Tp	0.00221	(1; 0.76%)	Ts Tp	0.00392	(1; 2.8%)	Tp	0.0174	(0; 0.19%)
Ts Tp	0.00217	(1; 0.75%)	Ms Tp	0.00352	(1; 2.5%)	Bc Mp Ho Tp	0.0118	(3; 0.13%)
Ch Tp	0.00194	(1; 0.67%)	Rd Tp	0.00214	(1; 1.5%)	Bc Mp Lp Tp	0.00851	(3; 0.094%)
Oc Tp	0.00189	(1; 0.65%)	Kn Tp	0.00201	(1; 1.4%)	Wo Mp Tp	0.00753	(2; 0.083%)
Wt Tp	0.00176	(1; 0.61%)	Wt Tx Tp	0.00187	(2; 1.3%)	Wh Wo Tx Tp	0.00705	(3; 0.078%)
Ms Tp	0.00162	(1; 0.56%)	Wo Tx Tp	0.00168	(2; 1.2%)	Bc Mp Ch Tp	0.00664	(3; 0.073%)
Wo Tx Tp	0.00147	(2; 0.51%)	Pl Tp	0.00101	(1; 0.73%)	Sc Cg Tx Tp	0.00588	(3; 0.065%)
Rd Tp	0.000755	(1; 0.26%)	Cg Tx Tp	0.000704	(2; 0.51%)	Wo Lp Tp	0.00442	(2; 0.049%)
Wt Tx Tp	0.000601	(2; 0.21%)	El Tp	0.000664	(1; 0.48%)	Bc Ch Tp	0.00334	(2; 0.037%)
Ch Pl Tp	0.000558	(2; 0.19%)	Ho Tp	0.000628	(1; 0.45%)	Tx Tp	0.00281	(1; 0.031%)
At Tp	0.000418	(1; 0.14%)	At Tp	0.000627	(1; 0.45%)	Sc Cg Wo Tx	0.00232	(4; 0.026%)
Pr Tp	0.00041	(1; 0.14%)	Oc Tp	0.000578	(1; 0.42%)	Wo Tx Pl Tp	0.00221	(3; 0.024%)
Fm Tp	0.000364	(1; 0.13%)	Ms Wt Tp	0.000545	(2; 0.39%)	Wo Tx Wt Tp	0.00195	(3; 0.021%)
Cg Tx Tp	0.000332	(2; 0.11%)	Pd Wt Tp	0.000515	(2; 0.37%)	Bc Mp Ch Pl T	0.0019	(4; 0.021%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.118 ±0.022	(±2.0%)
Downstream	0.653 ±0.010	(±1.5%)

# Sector 2203: Knitting Mill Products (Kn)

*Hosiery, jumpers and knitting mill products*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicators of greenhouse emissions and water use are 40% and 30% below average respectively while land disturbance is 50% above average. The latter is due to the inclusion of sheep grazing land through wool and spun yarn, into final knitted products. The social indicator of employment generation is 15% below average, income is 5% below average and government revenue is 60% above average. The financial indicator of operating surplus is 30% below average, export propensity is equal to average and import penetration is 25% above average. The sector has adapted to the changing circumstances of the 'textile clothing and footwear' industries, due in part to innovation in the upstream spinning sector, but also by being responsive to domestic niche markets requiring quick turnaround.

## Sector Description

This sector uses the spun products from the 'fibres, yarns and fabrics' sector to produce knitted products such as woollen, cotton and synthetic jumpers and pullovers, socks, stockings and pantihose, and other knitted products such as 'Sportwool Pro' sporting attire, and 'Thermo Fleece' woollen underwear. Much of the production of basic attire such as woollen jumpers has been imported for sometime, formerly from Fiji and New Zealand, but now mostly from China. Nevertheless a mix of more expensive 'designer' clothes, and moderately priced 'Australian Country' clothes maintain a niche position in the market. Many local knitting mills are focused on corporate, sporting, and 'just in time' requirements of consumers who require personal service that is culturally attuned. Much of the capital investment is focused on flexible knitting machinery for small runs of high quality product. In constant dollar terms, production has been relatively stable for the past 30 years, and turnover in 2002 was around \$1 billion involved more than 100 enterprises.

## Place of Industry in the Economy

The knitted products sector ranks 114<sup>th</sup> out of 135 sectors in terms of value adding in the Australian economy, and contributes 0.07% of GDP in this analysis. It is similar in value adding to the mineral and glass wool, and soaps and detergents sectors. It is a small employer with 2 000 employment years directly embodied in final demand, and another 3 000 years in the sector's upstream suppliers, giving a total of 5 000 employment years. In addition, it supplies 3 000 employment years to downstream industries such as textile products, clothing manufacture, and retail trade. It has small resource requirements, with less than one tenth of one percent of national water use, energy use and greenhouse emissions, but just over one tenth of one percent of land disturbance because of the wool production embodied in the sector's products. Imports are three times the level of exports.

## Strategic Overview

The spider diagram portrays a reasonable TBL account for the knitting mill products sector that shows the import and profitability issues common to the whole 'clothing textiles and footwear' industries, but also the advantages of better than average environmental indicators (except for land disturbance), and average social indicators. The steady development of a range of new processes and mixes for traditional fibres such as wool and cotton show potential in niche markets such as sporting and outdoor wear, as well as for industrial applications, and higher quality fashions. The synthetic fleece outer garments produced from recycled plastic containers and used in activewear will soon be joined on the market by a real fleece product made by an Australian manufacturer.



## TBL Account #1

The financial indicator of operating surplus is 30% below average while the social indicator of employment generation is 15% below average. The environmental indicator of greenhouse emissions are 40% below average with a direct sector effect of 5% and contributions from the 'wool production-fibres and yarns-knitting mill products' of 19% and electricity production of 13%.

## TBL Accounts #2 and #3

The second TBL account shows export propensity equal to average, income 5% below average and water use 30% below average. The third TBL account reveals that import penetration is 25% above average, government revenue is 60% above average, and land disturbance is 50% above average.

## Structural Path Analysis and Linkages

The poorer than average outcome for the operating surplus and import penetration indicators are symptomatic of the general challenges facing the 'clothing, textile and footwear' industries and the subject of a wide ranging review process over recent years. Examining the structural pathways show that for the surplus indicator, the direct sector effect is 41% with small contributions from wool-fibres yarns and fabrics-knitting (3%), wholesale trade (3%) and electricity generation (1%). Improving the surplus indicator therefore seems to rest primarily within the sector, because supply chain issues though important, are relatively diffuse and thus difficult to manage and improve. The import penetration indicator is similar with a direct effect of 61%, and small contributions from basic chemicals (1%), fibres yarns and fabrics (1%), and wholesale trade (1%). The land disturbance indicator is dominated by a 57% contribution from the second order chain of wool production-fibres and yarns-knitting products, and a diffuse chain of minor contributions.

The sector's stimulus to its upstream suppliers is 20% greater than average and impacts primarily on the sector of 'fibres yarns and fabrics' and wholesale trade. The downstream linkages are slightly weaker than average, and suggest that expansion in this sector needs to be led by expansion in downstream sectors such as textile products, clothing manufacture, and retail trade.

## Future Trends in Sector

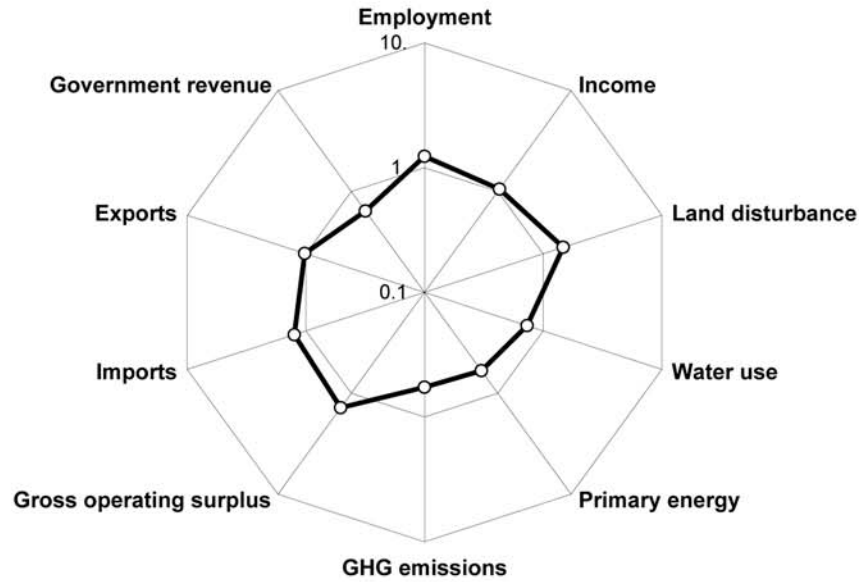
Under the base case scenario in the *Future Dilemmas* study, the population size increases by 25% to 25 million people by 2050. In a pro rata sense, this could increase the market for knitted products by 25% provided that economic growth and its distributional effects stay similar to current settings. At least five major uncertainties are obvious. The first is survival of the wool industry with a sufficient optimism, size and profitability to maintain spinning mills which supply yarn. The second is fashion which could either increase or decrease demand. The third is the technological advance of designer fabrics perhaps associated with innovations in nanotechnology i.e. knitted products could simply assemble themselves in vats from added molecules. The fourth is the possibility of resource taxes or full cost pricing (land, water, greenhouse): while their impact is uncertain, they may disadvantage natural fibres relative to artificial fibres. The fifth is the possibility that climate change could alter consumer demand for knitted garments.

## Innovation and Technical Opportunities

Recent reviews of the 'textile, clothing and footwear' industries highlighted a number of factors required for success. Some of these included: a strong and passionate attitude; clarity about core business and core markets; leadership skills; good industrial relations; preparedness to do business on the ground anywhere in the world; commitment to reputation and quality; clear understanding of the supply chain context; clever management of offshore business; and a desire to do things differently. One strategy that emerged from the industry plan was that of products that are designed and made in Australia, so that successes in culture, wine and tourism could catalyse clothes sales.

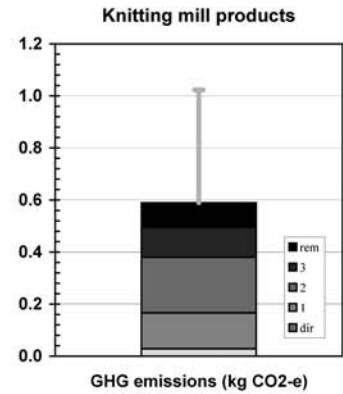
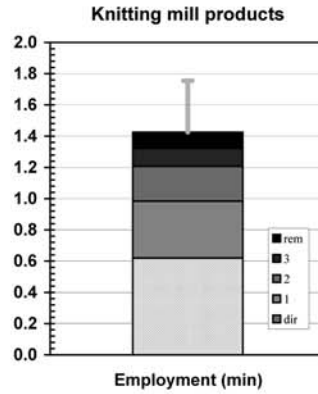
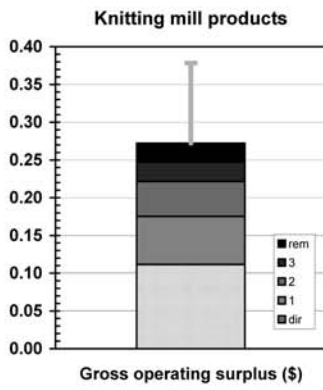
Spider diagram

Knitting mill products

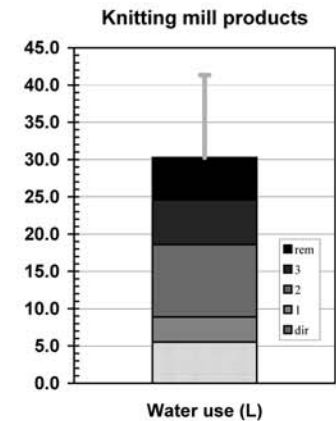
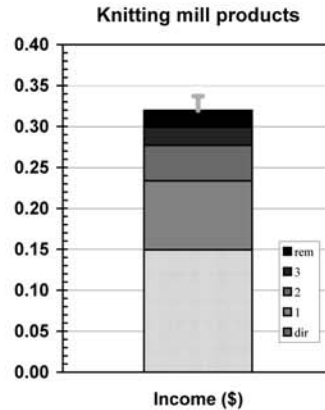
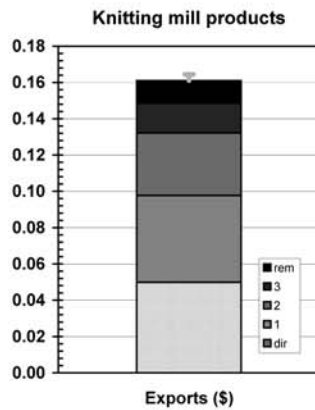


Bar graphs

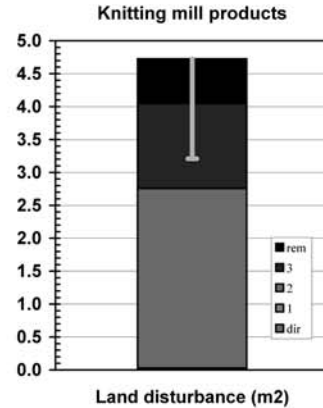
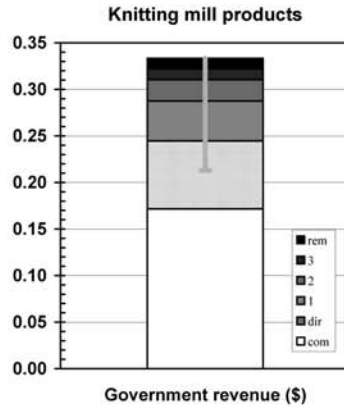
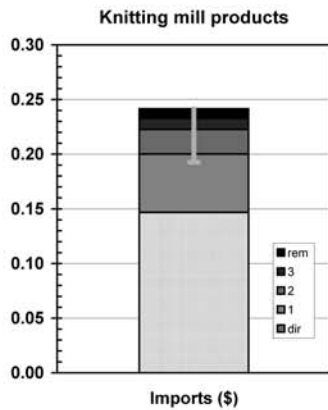
Account #1



Account #2



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 621.9	(0.24% of total)	(\$m 351.6 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 0.3	(0.00% of total)	(\$m 0.3 domestically produced)
Net changes in stocks	\$m 26.9	(1.52% of total)	(\$m 17.2 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 649.1</b>	<b>(0.14% of GNE)</b>	<b>(\$m 369.1 domestically produced)</b>
Exports	\$m 49.5	(0.06% of total)	(\$m 49.5 domestically produced)
<b>Final demand</b>	<b>\$m 698.6</b>	<b>(0.13% of GNT)</b>	<b>(\$m 418.6 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 148.0	(0.09% of total)
Gross operating surplus	\$m 110.6	(0.06% of total)
Taxes less subsidies	\$m 72.2	(0.08% of total)
<b>Sectoral GDP*</b>	<b>\$m 330.8</b>	<b>(0.07% of GDP)</b>
Imports	\$m 145.6	(0.15% of total)
<b>Primary inputs</b>	<b>\$m 476.4</b>	<b>(0.09% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT		
		(% of national)	direct (% of national)	total (% of national)	
Gross operating surplus (\$m)	\$m 110.6	(0.06%)	\$m 46.7	(0.02%)	\$m 113.9 (0.06%)
Exports (\$m)	\$m 49.5	(0.06%)	\$m 20.9	(0.03%)	\$m 67.4 (0.08%)
Imports (\$m)	\$m 145.6	(0.15%)	\$m 61.4	(0.06%)	\$m 101.1 (0.10%)
Employment (e-y)	4,925 e-y	(0.07%)	2,078 e-y	(0.03%)	4,783 e-y (0.07%)
Income (\$m)*	\$m 148.0	(0.09%)	\$m 62.5	(0.04%)	\$m 133.8 (0.08%)
Government revenue (\$m)†	\$m 144.1	(0.13%)	\$m 102.3	(0.09%)	\$m 139.5 (0.13%)
GHG emissions (kt CO <sub>2</sub> -e)	28 kt	(0.01%)	12 kt	(0.00%)	247 kt (0.05%)
Water use (ML)	5,470 ML	(0.03%)	2,308 ML	(0.01%)	12,668 ML (0.06%)
Land disturbance (kha)	2 kha	(0.00%)	1 kha	(0.00%)	198 kha (0.12%)
Primary energy (TJ)	495 TJ	(0.01%)	209 TJ	(0.01%)	1,913 TJ (0.05%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.11	0.27	0.38
Exports (\$)	0.05	0.16	0.16
Imports (\$)	0.15	0.24	0.19
Employment (min)	0.62	1.43	1.75
Income (\$)	0.15	0.32	0.34
Government revenue (\$)	0.24	0.33	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.03	0.59	1.02
Water use (L)	5.51	30.27	41.32
Land disturbance (m <sup>2</sup> )	0.02	4.73	3.21
Primary energy (MJ)	0.50	4.57	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Kn	0.111	(0; 41.%)	Kn	0.62	(0; 43.%)	Wo Tx Kn	0.113	(2; 19.%)
Wo Tx Kn	0.00796	(2; 2.9%)	Wt Kn	0.0565	(1; 4.%)	El Kn	0.0766	(1; 13.%)
Wt Kn	0.00785	(1; 2.9%)	Wo Tx Kn	0.0327	(2; 2.3%)	Kn	0.0279	(0; 4.7%)
El Kn	0.00309	(1; 1.1%)	Tx Kn	0.0289	(1; 2.%)	Ch Kn	0.0271	(1; 4.6%)
Ot Kn	0.00299	(1; 1.1%)	Ot Kn	0.0239	(1; 1.7%)	El Ot Kn	0.00872	(2; 1.5%)
Tx Kn	0.0027	(1; 0.99%)	Ms Kn	0.0118	(1; 0.83%)	Wt Kn	0.00783	(1; 1.3%)
Ms Kn	0.00263	(1; 0.96%)	Ts Kn	0.00963	(1; 0.68%)	El Tx Kn	0.00689	(2; 1.2%)
Ch Kn	0.00226	(1; 0.83%)	Cg Kn	0.00762	(1; 0.53%)	At Kn	0.00589	(1; 1.%)
Ts Kn	0.00214	(1; 0.79%)	Wt Tx Kn	0.00719	(2; 0.5%)	Sc Cg Kn	0.00417	(2; 0.71%)
St Wt Kn	0.0015	(2; 0.55%)	Ch Kn	0.0066	(1; 0.46%)	El Ch Kn	0.00408	(2; 0.69%)
Wa Kn	0.00129	(1; 0.47%)	Bs Kn	0.00564	(1; 0.4%)	Gd Kn	0.00321	(1; 0.55%)
Cg Kn	0.00116	(1; 0.42%)	Rd Kn	0.00536	(1; 0.38%)	El Wt Kn	0.00236	(2; 0.4%)
Ms Wt Kn	0.00114	(2; 0.42%)	Ms Wt Kn	0.0051	(2; 0.36%)	Bl El Kn	0.00193	(2; 0.33%)
Wt Tx Kn	0.000998	(2; 0.37%)	Tp Kn	0.00486	(1; 0.34%)	Sc Cg Tx Kn	0.00165	(3; 0.28%)
Rd Kn	0.000911	(1; 0.33%)	Ho Kn	0.00482	(1; 0.34%)	Bc Mp Ch Kn	0.00148	(3; 0.25%)
Pd Wt Kn	0.000901	(2; 0.33%)	Sc Cg Kn	0.0042	(2; 0.29%)	Rd Kn	0.00145	(1; 0.25%)
Cm Kn	0.000889	(1; 0.33%)	El Kn	0.00344	(1; 0.24%)	Ga Kn	0.00133	(1; 0.23%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Kn	0.0499	(0; 31.%)	Kn	0.149	(0; 47.%)	Kn	5.51	(0; 18.%)
Tx Kn	0.0173	(1; 11.%)	Wt Kn	0.0121	(1; 3.8%)	Sc Cg Kn	4.37	(2; 14.%)
Wo Tx Kn	0.01	(2; 6.2%)	Tx Kn	0.00726	(1; 2.3%)	Wo Tx Kn	3.65	(2; 12.%)
Wt Kn	0.00642	(1; 4.%)	Ot Kn	0.00672	(1; 2.1%)	Sc Cg Tx Kn	1.73	(3; 5.7%)
Ch Kn	0.00315	(1; 2.%)	Ms Kn	0.00274	(1; 0.86%)	Wa Kn	0.947	(1; 3.1%)
Cg Kn	0.00204	(1; 1.3%)	Ts Kn	0.00225	(1; 0.71%)	Sc Cg Wo Tx	0.683	(4; 2.3%)
At Kn	0.00188	(1; 1.2%)	Wt Tx Kn	0.00154	(2; 0.48%)	El Kn	0.423	(1; 1.4%)
Wt Tx Kn	0.000816	(2; 0.51%)	Ch Kn	0.0014	(1; 0.44%)	Tx Kn	0.275	(1; 0.91%)
Cg Tx Kn	0.000806	(2; 0.5%)	Cg Kn	0.00131	(1; 0.41%)	Vf Wo Tx Kn	0.138	(3; 0.45%)
Bl El Kn	0.000749	(2; 0.46%)	Ms Wt Kn	0.00119	(2; 0.37%)	Wa Tx Kn	0.0942	(2; 0.31%)
Ms Kn	0.000407	(1; 0.25%)	Wo Tx Kn	0.00112	(2; 0.35%)	Sc Cg Sc Cg †	0.0909	(4; 0.3%)
St Wt Kn	0.000371	(2; 0.23%)	At Kn	0.00104	(1; 0.33%)	Ch Kn	0.0827	(1; 0.27%)
Tp Kn	0.000366	(1; 0.23%)	El Kn	0.000931	(1; 0.29%)	Wa Ms Kn	0.0675	(2; 0.22%)
Lg Kn	0.000348	(1; 0.22%)	Rd Kn	0.000921	(1; 0.29%)	El Ot Kn	0.0482	(2; 0.16%)
Ts Kn	0.000339	(1; 0.21%)	Pd Wt Kn	0.000812	(2; 0.25%)	Bc Mp Ch Kn	0.0391	(3; 0.13%)
Cg Wo Tx Kn	0.000319	(3; 0.2%)	Ho Kn	0.000703	(1; 0.22%)	El Tx Kn	0.0381	(2; 0.13%)
Rd Kn	0.000317	(1; 0.2%)	Bs Kn	0.000692	(1; 0.22%)	Ws Ho Kn	0.0351	(2; 0.12%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Kn	0.147	(0; 61.%)	Kn	0.0728	(0; 45.%)	Wo Tx Kn	2.71	(2; 57.%)
Ch Kn	0.00316	(1; 1.3%)	Wt Kn	0.00567	(1; 3.5%)	Wo Tx Tp Kn	0.026	(3; 0.55%)
Tx Kn	0.00266	(1; 1.1%)	Tx Kn	0.00516	(1; 3.2%)	Kn	0.0171	(0; 0.36%)
Wt Kn	0.00182	(1; 0.75%)	Ot Kn	0.00309	(1; 1.9%)	Wo Tx Cl Kn	0.013	(3; 0.27%)
Tp Kn	0.000838	(1; 0.35%)	Ms Kn	0.0013	(1; 0.81%)	Bc Mp Ch Kn	0.0108	(3; 0.23%)
Ot Kn	0.000772	(1; 0.32%)	Ts Kn	0.00111	(1; 0.69%)	Bc Mp Ho Kn	0.00696	(3; 0.15%)
Ts Kn	0.000613	(1; 0.25%)	At Kn	0.000839	(1; 0.52%)	Sc Cg Kn	0.00574	(2; 0.12%)
Ms Kn	0.000597	(1; 0.25%)	Wt Tx Kn	0.000721	(2; 0.45%)	Bc Ch Kn	0.00542	(2; 0.11%)
Wo Tx Kn	0.000567	(2; 0.23%)	Ch Kn	0.000698	(1; 0.43%)	Bc Mp Lp Kn	0.00329	(3; 0.07%)
At Kn	0.000559	(1; 0.23%)	Cg Kn	0.000687	(1; 0.43%)	Wh Wo Tx Kn	0.00272	(3; 0.058%)
Cl Kn	0.00041	(1; 0.17%)	Rd Kn	0.000654	(1; 0.4%)	Sc Cg Tx Kn	0.00227	(3; 0.048%)
Pl Kn	0.000347	(1; 0.14%)	Wo Tx Kn	0.000648	(2; 0.4%)	Wo Tx Wt Kn	0.00201	(3; 0.043%)
Cg Kn	0.000324	(1; 0.13%)	El Kn	0.00058	(1; 0.36%)	Wo Lp Kn	0.00171	(2; 0.036%)
Pa Kn	0.00031	(1; 0.13%)	Ms Wt Kn	0.000563	(2; 0.35%)	El Kn	0.00124	(1; 0.026%)
Ms Wt Kn	0.000259	(2; 0.11%)	Pd Wt Kn	0.000532	(2; 0.33%)	Wo Mp Ch Kn	0.00122	(3; 0.026%)
Pr Wt Kn	0.000248	(2; 0.1%)	Ho Kn	0.00037	(1; 0.23%)	Bc Mp Ho Wt	0.00116	(4; 0.025%)
Wt Tx Kn	0.000232	(2; 0.096%)	St Wt Kn	0.000333	(2; 0.21%)	Tx Kn	0.00109	(1; 0.023%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.213 ±0.034	(±2.8%)
Downstream	0.925 ±0.037	(±4.0%)

# Sector 2204: Clothing (CI)

*Clothing and safety headgear and eyewear*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is 20% below average, water use is equal to average, and land disturbance is nearly over three times the average. The social indicators reveal that employment generation is 25% above average, income is 10% below average, and government revenue is equal to average. The financial indicators show that the operating surplus is 40% below average, while export propensity and import penetration are 80% and 70% above average respectively. For iconic branded apparel and some high technology lines domestic production may possibly endure, but for ordinary apparel low cost imports will continue to dominate the Australian marketplace.

## Sector Description

Physical data on clothing consumption in Australia is difficult to obtain, but the household consumption survey suggests that an average consumption for all 'clothing and footwear' is \$640 per capita per year, and that more affluent households spend twice as much per capita as less affluent households. As a guide to maximum consumption levels, available data for Japan shows they purchase 65 units of clothing per capita per year and that market is considered close to saturation at this level of consumption. Composition of that consumption includes suits (11%), coats (3%), jumpers (10%), shirts (8%), tee shirts (10%), underwear (12%), socks and pantyhose (16%) and gloves and mittens (17%). For Europe, total textile consumption is 14 kg per capita per year, of which 6 kg is for clothing. European lifecycle assessments report that cotton consumes 40% less energy per kg, but uses 5 000 litres of irrigation water per kg, compared to polyester's 17 litres of process water. However energy use in garment care by consumers accounts for three quarters of the lifecycle energy of either product. Australian turnover is composed of 30% men's and 40% women's clothing, and in 2002 was about \$6 billion per annum.

## Place of Industry in the Economy

The clothing sector ranks 63<sup>rd</sup> out of 135 sectors in terms of value adding in the economy, and contributes 0.25% of GDP in this analysis. It is similar in value adding to the liquefied natural gas, and dairy cattle and whole milk sectors. It is a relatively large employer with 42 000 employment years directly embodied in final demand, and 24 000 years in the sector's upstream suppliers, giving a total of 66 000 employment years. This may have declined recently with restructuring, but may be balanced with contracted outworking. In addition, the sector supplies 4 000 employment years to downstream industries such as the community care, and police and fire brigade sectors. The sector has moderate resource requirements because of wool and cotton growing embodied in the garments chain. Land disturbance is 2.5% of national total, while water use (0.8%), energy use (0.3%), and greenhouse emissions (0.3%), represent significant totals. In financial terms imports are twice exports, but this has recently widened considerably mostly due to the increase of Chinese imports.

## Strategic Overview

The spider diagram depicts the symptoms that have led to widespread industry review and considerable restructuring. Because labour represents 60% of manufacturing costs, the employment generation and income indicators give good outcomes but are linked to poor financial outcomes for operating surplus and import penetration. Land disturbance is greater due to upstream impacts from sheep grazing for woollen garments, and cattle grazing for the leather used in leather garments.

## TBL Account #1

The financial indicator of operating surplus is 40% below average, employment generation is 25% above average, and the greenhouse emissions indicator is 20% below average.

## TBL Accounts #2 and #3

The second TBL account shows that export propensity is 80% above average. This is due to a diffuse chain of activities upstream from clothing manufacture such as wool and cotton growing, wholesale trade, and airline travel. The income indicator is 10% below average while water use is equal to average due to a direct sector effect of 24%, a wool production chain of 26%, and a cotton growing chain of 12%. The third TBL account shows import penetration 70% above average, government revenue equal to average and land disturbance over three times the average.

## Structural Path Analysis and Linkages

The indicators of operating surplus, import penetration and land disturbance are all outliers. The operating surplus has a direct effect of 29% with the high price of domestic labour and marginal scale of production relative to global competitors, the widely reported causes. This is reflected in the import penetration indicator where the direct effect is 81%. Three quarters of the land disturbance indicator is due to sheep grazing in the production chain so supply chain initiatives that extend back to farming systems could improve this indicator.

The sector's stimulus to its upstream suppliers is equal to the economy wide average and impacts on processed wool, wholesale trade, knitted products, sheep and wool, property development, and accounting and marketing. The linkages to downstream industries are weak as most production leaks to final consumption, but the community care and police and fire brigade sectors are notable, presumably due to specialised clothing and uniforms that are manufactured domestically.

## Future Trends in Sector

The base case scenario for the *Future Dilemmas* study sees an increase in domestic population to 25 million people by 2050, and thus a 25% increase in clothing requirement. The study also anticipates a five fold increase in international inbound traveller nights by 2050 and it is feasible that they could prove a buoyant market for "Made in Australia" garments. Growth in per capita consumption of garments should also be considered possible as has occurred in the Japanese market. Japan gives insights on market saturation levels where consumers become satiated. The assumption that garment sales will continue to grow in line with economic growth should also be explored. However the distributional effects of growth are more important since households in the highest income quintile spend twice as much on clothes as the lowest income quintile. Much of this consumption spend could be image and quality, rather than quantity of textiles. Furthermore by 2050, population ageing will have created three consumption cohorts of roughly equal size, the 1-25 year olds (34%), the 26-50 year olds (31%) and the greater than 51 year olds (34%). Currently, the requirements of the older cohort are poorly represented in the marketplace but many analysts expect that they will retain the dominant purchasing power. Finally, global climate change may alter the winter purchasing decisions across southern Australia and clothing styles may change.

## Innovation and Technical Opportunities

In the face of scale of manufacture and price competition offered by Asian countries, and the dominance of European haute culture in leading fashion design, the only way forward seems to be re-designing and re-branding Australian lifestyle. Innovation in production systems and regional branding of wool and cotton growing may decrease a garment's environmental footprint, providing these brands with valid claims to genuine eco-label status for affluent consumers worldwide.

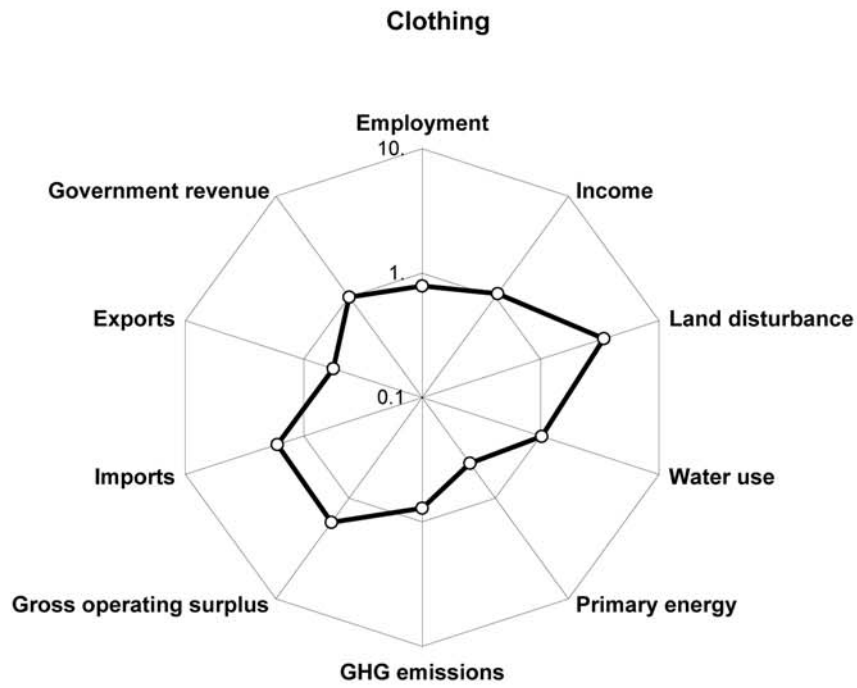
**Sector**

**Clothing**

**(CI)**

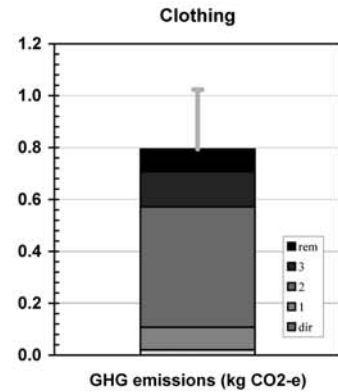
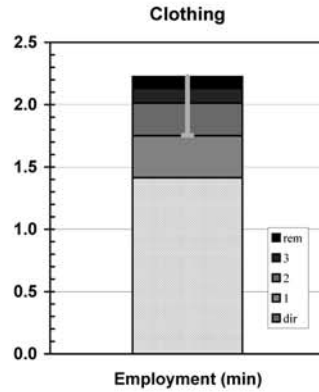
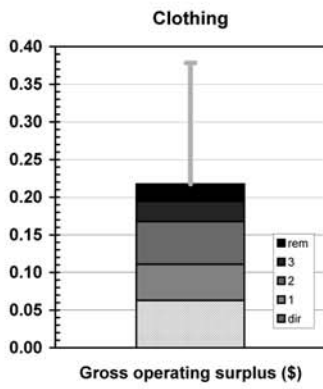
Clothing and safety headgear and eyewear

**Spider diagram**

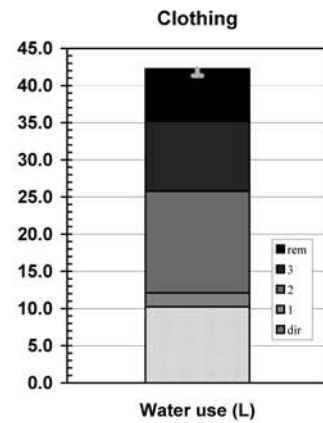
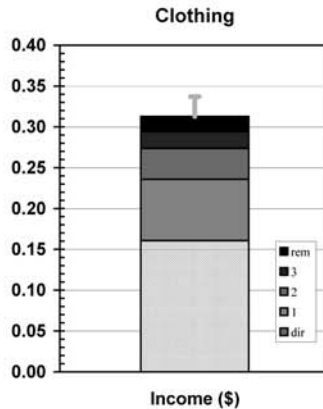
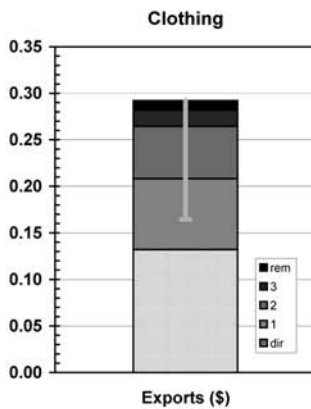


**Bar graphs**

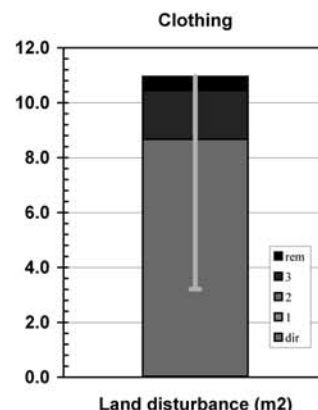
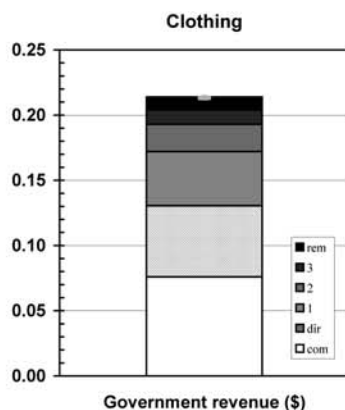
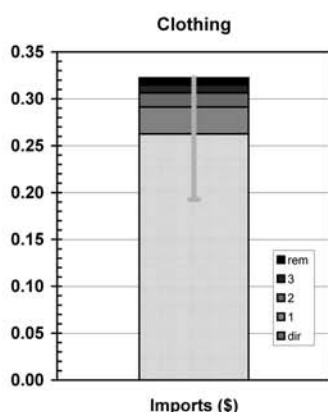
**Account #1**



**Account #2**



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 4,676.1	(1.77% of total)	(\$m 3,117.2 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	
Gross fixed capital expenditure	\$m 7.8	(0.01% of total)	(\$m 7.8 domestically produced)
Net changes in stocks	\$m 77.9	(4.41% of total)	(\$m 49.9 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 4,761.8</b>	<b>(1.04% of GNE)</b>	<b>(\$m 3,174.8 domestically produced)</b>
Exports	\$m 541.1	(0.65% of total)	(\$m 541.1 domestically produced)
<b>Final demand</b>	<b>\$m 5,302.9</b>	<b>(0.98% of GNT)</b>	<b>(\$m 3,716.0 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 658.6	(0.39% of total)
Gross operating surplus	\$m 258.0	(0.13% of total)
Taxes less subsidies	\$m 224.0	(0.26% of total)
<b>Sectoral GDP*</b>	<b>\$m 1,140.5</b>	<b>(0.25% of GDP)</b>
Imports	\$m 1,076.3	(1.10% of total)
<b>Primary inputs</b>	<b>\$m 2,216.8</b>	<b>(0.41% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT		
		(% of national)	direct	total (% of national)	
Gross operating surplus (\$m)	\$m 258.0	(0.13%)	\$m 233.7	(0.12%)	\$m 808.6 (0.42%)
Exports (\$m)	\$m 541.1	(0.65%)	\$m 490.3	(0.59%)	\$m 1,086.3 (1.30%)
Imports (\$m)	\$m 1,076.3	(1.10%)	\$m 975.3	(1.00%)	\$m 1,197.3 (1.23%)
Employment (e-y)	46,463 e-y	(0.65%)	42,102 e-y	(0.59%)	66,259 e-y (0.93%)
Income (\$m)*	\$m 658.6	(0.39%)	\$m 596.8	(0.35%)	\$m 1,161.7 (0.68%)
Government revenue (\$m)†	\$m 505.9	(0.47%)	\$m 484.9	(0.45%)	\$m 795.1 (0.74%)
GHG emissions (kt CO <sub>2</sub> -e)	83 kt	(0.02%)	75 kt	(0.01%)	2,950 kt (0.57%)
Water use (ML)	41,982 ML	(0.20%)	38,043 ML	(0.18%)	156,983 ML (0.75%)
Land disturbance (kha)	7 kha	(0.00%)	6 kha	(0.00%)	4,071 kha (2.50%)
Primary energy (TJ)	1,561 TJ	(0.04%)	1,415 TJ	(0.04%)	12,812 TJ (0.33%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.06	0.22	0.38
Exports (\$)	0.13	0.29	0.16
Imports (\$)	0.26	0.32	0.19
Employment (min)	1.41	2.23	1.75
Income (\$)	0.16	0.31	0.34
Government revenue (\$)	0.13	0.21	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.02	0.79	1.02
Water use (L)	10.24	42.25	41.32
Land disturbance (m <sup>2</sup> )	0.02	10.96	3.21
Primary energy (MJ)	0.38	3.45	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks



**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
CI	0.0629	(0; 29.%)	CI	1.41	(0; 64.%)	Wo Tx CI	0.345	(2; 43.%)
Wo Tx CI	0.0243	(2; 11.%)	Wo Tx CI	0.0999	(2; 4.5%)	Bc Mp CI	0.0403	(2; 5.1%)
Tx CI	0.00824	(1; 3.8%)	Tx CI	0.0883	(1; 4.%)	El CI	0.0351	(1; 4.4%)
Wt CI	0.00741	(1; 3.4%)	Wt CI	0.0534	(1; 2.4%)	El Tx CI	0.0211	(2; 2.7%)
Kn CI	0.00451	(1; 2.1%)	Kn CI	0.0251	(1; 1.1%)	CI	0.0203	(0; 2.6%)
St CI	0.0039	(1; 1.8%)	Wt Tx CI	0.022	(2; 0.99%)	At CI	0.013	(1; 1.6%)
Wt Tx CI	0.00305	(2; 1.4%)	Ed CI	0.0182	(1; 0.82%)	Gd CI	0.00982	(1; 1.2%)
Ms CI	0.0026	(1; 1.2%)	Bs CI	0.0149	(1; 0.67%)	Wt CI	0.00739	(1; 0.93%)
Rd CI	0.00226	(1; 1.%)	Os CI	0.0133	(1; 0.6%)	Ch CI	0.00613	(1; 0.77%)
Ne CI	0.00204	(1; 0.94%)	Rd CI	0.0133	(1; 0.6%)	Sc Cg Tx CI	0.00505	(3; 0.64%)
Ts CI	0.00156	(1; 0.72%)	Ms CI	0.0117	(1; 0.52%)	Wo Tx Kn CI	0.00457	(3; 0.58%)
Bs CI	0.00151	(1; 0.7%)	Ho CI	0.00924	(1; 0.42%)	Bc Mp Lp CI	0.00437	(3; 0.55%)
Cm CI	0.00145	(1; 0.67%)	Cg Tx CI	0.00921	(2; 0.41%)	Rd CI	0.00359	(1; 0.45%)
El CI	0.00142	(1; 0.65%)	Ts CI	0.00705	(1; 0.32%)	El Kn CI	0.0031	(2; 0.39%)
St Wt CI	0.00141	(2; 0.65%)	Ne CI	0.00692	(1; 0.31%)	Wt Tx CI	0.00305	(2; 0.38%)
Cg Tx CI	0.0014	(2; 0.64%)	At CI	0.00653	(1; 0.29%)	Ch Pl CI	0.00258	(2; 0.33%)
At CI	0.00119	(1; 0.55%)	St CI	0.00636	(1; 0.29%)	Fr Wo Tx CI	0.00226	(3; 0.28%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
CI	0.132	(0; 45.%)	CI	0.161	(0; 51.%)	Wo Tx CI	11.2	(2; 26.%)
Tx CI	0.053	(1; 18.%)	Tx CI	0.0222	(1; 7.1%)	CI	10.2	(0; 24.%)
Wo Tx CI	0.0306	(2; 10.%)	Wt CI	0.0115	(1; 3.7%)	Sc Cg Tx CI	5.28	(3; 13.%)
Wt CI	0.00606	(1; 2.1%)	Kn CI	0.00604	(1; 1.9%)	Sc Cg Wo Tx	2.09	(4; 4.9%)
At CI	0.00414	(1; 1.4%)	Wt Tx CI	0.00472	(2; 1.5%)	Bc Mp CI	1.06	(2; 2.5%)
Wt Tx CI	0.0025	(2; 0.85%)	Ed CI	0.0045	(1; 1.4%)	Tx CI	0.839	(1; 2.%)
Cg Tx CI	0.00246	(2; 0.84%)	Os CI	0.00373	(1; 1.2%)	Vf Wo Tx CI	0.421	(3; 1.%)
Kn CI	0.00202	(1; 0.69%)	Wo Tx CI	0.00342	(2; 1.1%)	Wa Tx CI	0.288	(2; 0.68%)
Mp CI	0.00157	(1; 0.54%)	Ms CI	0.00272	(1; 0.87%)	Wa CI	0.236	(1; 0.56%)
Lp CI	0.00134	(1; 0.46%)	At CI	0.0023	(1; 0.74%)	Kn CI	0.223	(1; 0.53%)
Cg Wo Tx CI	0.000974	(3; 0.33%)	Rd CI	0.00228	(1; 0.73%)	El CI	0.194	(1; 0.46%)
St CI	0.000965	(1; 0.33%)	Bs CI	0.00183	(1; 0.59%)	Sc Cg Kn CI	0.177	(3; 0.42%)
Rd CI	0.000786	(1; 0.27%)	Ts CI	0.00165	(1; 0.53%)	Wo Tx Kn CI	0.148	(3; 0.35%)
Ch CI	0.000713	(1; 0.24%)	St CI	0.00162	(1; 0.52%)	El Tx CI	0.116	(2; 0.28%)
Tx Kn CI	0.000702	(2; 0.24%)	Ne CI	0.00159	(1; 0.51%)	Sc Cg Tx Kn CI	0.0699	(4; 0.17%)
Ho CI	0.000514	(1; 0.18%)	Cg Tx CI	0.00158	(2; 0.51%)	Ws Ho CI	0.0673	(2; 0.16%)
Ed CI	0.000443	(1; 0.15%)	Ho CI	0.00135	(1; 0.43%)	Wa Ms CI	0.067	(2; 0.16%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /\$)		
CI	0.262	(0; 81.%)	CI	0.0546	(0; 40.%)	Wo Tx CI	8.29	(2; 76.%)
Tx CI	0.00813	(1; 2.5%)	Tx CI	0.0158	(1; 11.%)	Bc Mp CI	0.293	(2; 2.7%)
Kn CI	0.00594	(1; 1.8%)	Wt CI	0.00535	(1; 3.9%)	Wo Tx Kn CI	0.11	(3; 1.%)
Wo Tx CI	0.00173	(2; 0.54%)	Kn CI	0.00295	(1; 2.1%)	Wo Mp CI	0.0331	(2; 0.3%)
Wt CI	0.00172	(1; 0.53%)	Wt Tx CI	0.0022	(2; 1.6%)	Bc Mp Lp CI	0.0318	(3; 0.29%)
At CI	0.00123	(1; 0.38%)	Wo Tx CI	0.00198	(2; 1.4%)	CI	0.017	(0; 0.16%)
Pl CI	0.00119	(1; 0.37%)	At CI	0.00185	(1; 1.3%)	Wo Lp CI	0.0165	(2; 0.15%)
Ne CI	0.000984	(1; 0.31%)	Os CI	0.00173	(1; 1.3%)	Wo Tx Tp CI	0.0151	(3; 0.14%)
Pa CI	0.000845	(1; 0.26%)	Ed CI	0.00165	(1; 1.2%)	Bc Mp Ho CI	0.0133	(3; 0.12%)
Ch CI	0.000714	(1; 0.22%)	Rd CI	0.00162	(1; 1.2%)	Wh Wo Tx CI	0.00833	(3; 0.076%)
Wt Tx CI	0.000709	(2; 0.22%)	Ms CI	0.00129	(1; 0.93%)	Sc Cg Tx CI	0.00694	(3; 0.063%)
Ms CI	0.000592	(1; 0.18%)	St CI	0.000866	(1; 0.63%)	Wo CI	0.005	(1; 0.046%)
Rd CI	0.000573	(1; 0.18%)	Cg Tx CI	0.000831	(2; 0.6%)	Wo Mp Lp CI	0.00359	(3; 0.033%)
Tp CI	0.000485	(1; 0.15%)	Ts CI	0.000813	(1; 0.59%)	Tx CI	0.00332	(1; 0.03%)
Ap At CI	0.000466	(2; 0.14%)	Ne CI	0.000796	(1; 0.58%)	Sc Cg Wo Tx	0.00274	(4; 0.025%)
Ts CI	0.000449	(1; 0.14%)	Ho CI	0.000709	(1; 0.51%)	Bc Mp Pe Mp	0.0025	(4; 0.023%)
Cg Tx CI	0.000392	(2; 0.12%)	Bk CI	0.000594	(1; 0.43%)	Bc Mp Ch CI	0.00244	(3; 0.022%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.108 ±0.025	(±2.2%)
Downstream	0.140 ±0.003	(±1.8%)

# Sector 2205: Footwear (Fw)

*Footwear, soles and other parts, repairing*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is 10% below average, water use is 25% below average, while land disturbance is twice the average. The social indicators show that employment generation, income and government revenue are respectively 40%, 10%, and 100% above average. The financial indicators show that operating surplus is 45% below average, while export propensity and import penetration are 80% and 40% above average respectively. High levels of imports from low wage countries will probably continue, but domestic manufacturing could survive for higher value lifestyle and fashion brands.

## Sector Description

Australia currently consumes 66 million pairs of non-sporting shoes annually. Data on sporting shoes are difficult to locate but financial data suggest that one half of the sector turnover is sports shoes. On the assumption that currently marketed sporting shoes are twice as expensive as normal shoes, then consumption may be conservatively estimated as 33 million pairs per year, giving total sales of all shoes of nearly 100 million pairs, or five pairs per capita. Overseas data suggest that yearly European consumption is 4.4 per capita of which two are leather, one synthetic, and one a pair of slippers, and that their life span is 1 000 hours. The domestically manufactured share of non-sports shoe consumption has declined from 42% in 1991 (production 19.3m, imports 27.5m) to 12% in 2001 (production 8.1m, imports 57.8m). Some life cycle analyses show that solid wastes from the shoe making process are four times the weight of the final shoe. Labour standards used in some imports may be an issue. In constant dollar terms, the turnover in the sector has reduced by one third over the last 30 years, and was about \$600 million in 2002, involving over 200 enterprises.

## Place of Industry in the Economy

The footwear sector ranks 124<sup>th</sup> out of 135 sectors in terms of value adding in the economy, and contributes 0.05% of GDP in this analysis. It is similar in value adding to the diesel refining, and oils and fats sectors. It is a moderate sized employer with 6 500 employment years directly embodied in final demand, and another 3 500 years in the sector's suppliers giving a total of 10 000 employment years. In addition, it contributes 1 000 employment years to downstream industries. It has small resource requirements with less than one tenth of one percent of national water use, energy use and greenhouse emissions, and two tenths of one percent of land disturbance because of cattle and sheep grazing land embodied in the production chain of leather used in shoes. In financial terms, imports are three times greater than exports but this ratio has since widened.

## Strategic Overview

The spider diagram reveals many of the issues for the 'textiles clothing and footwear' sector that have led to extensive reviews of its tariff structure, and calls for the maintenance of government assistance. The social indicators reveal high employment generation and income, but these are checked by lower performance levels in operating surplus and import penetration. The higher than average export propensity is due to a first order production chain effect of exports of semi processed leather. The outlier of land disturbance is due to cattle production land that produces leather as a co-product. The recent reviews suggest that the sector can maintain its domestic manufacturing in some fashion, lifestyle and workplace footwear lines. However high import penetration is likely to remain due to the scale and labour cost advantages of Asian manufacturing, particularly in China.

## TBL Account #1

The financial indicator of operating surplus is 45% below average, with a direct sector effect of one third and a long chain of small contributions. The social indicator of employment generation is 40% above average with a direct effect of two thirds. The high embodiment of labour in the sector has challenged the economic resilience of domestic manufacturing, and led to increasing imports. The environmental indicator of greenhouse emissions is 10% below average, with a direct effect of 5% and most emissions derived from animal production industries which produce leather.

## TBL Accounts #2 and #3

The second TBL account shows that export propensity is 80% above average, income is 10% above average and water use is 25% below average. The third TBL account reveals that import penetration is 40% above average, and government revenue and land disturbance are both twice the average.

## Structural Path Analysis and Linkages

The indicators of export propensity, import penetration, and land disturbance are higher than average. The size of the export indicator is surprising given the competition from imports. The structural path shows that the direct sector effect is one quarter of the total while the first order effect of leather products is one third of the total. Import penetration is as expected, with a direct sector effect of 74% reflecting the low cost advantages of Asian manufacturers for all shoe lines. The high level for the land disturbance indicator is due to the inclusion of animal production land in the final shoe product. The direct sector effect is a negligible proportion of the total, with major contributions from 'beef cattle-meat products-leather production-footwear' (33%), 'wool-textiles-footwear' (20%), 'sheep-leather-footwear' (17%) and 'sheep-meat products-leather-footwear' (4%).

The sector's stimulus to its upstream suppliers is about average, and impacts on meat products, wool textiles, leather production, wholesale trade, and accounting and marketing. The linkages to downstream industries are weak as the sector's production is dissipated by final consumption.

## Future Trends in Sector

The base case scenario for the *Future Dilemmas* study anticipates current population expansion of 25% to 25 million people by the year 2050. In a simple proportional analysis, this could see the current yearly market expand to approximately 125 million pairs by the year 2050. However the per capita consumption has increased by 25% in the last decade. If this trend continues, it is possible that yearly consumption may plateau at eight pairs per capita, taking the yearly requirement to 200 million per year, or double today's levels. There are two major uncertainties. Consumer appreciation of the embodiment of environmental resources in shoes may cause a shift away from the built-in obsolescence apparent in many product lines today to longer wearing designs. Full resource costing within the final product may increase price and reduce consumer demand. Activist campaigns against leather shoes should be considered carefully, as synthetic shoes have their own resource footprints. Also the question of what to do with leather without leather shoes, presents its own consumption and disposal challenges.

## Innovation and Technical Opportunities

An eco-label program for shoe manufacture is underway in Europe, while major sports shoe manufacturers are reformulating used shoes as synthetic running tracks and surfaces for basketball courts. The science literature focuses on shoe redesign to help rather than hinder skeletal health and well being, and also safe mobility for older people, driven by the issue of future population ageing. The challenge for the domestic sector is to exploit iconic niches typified by R.M. Williams boots.

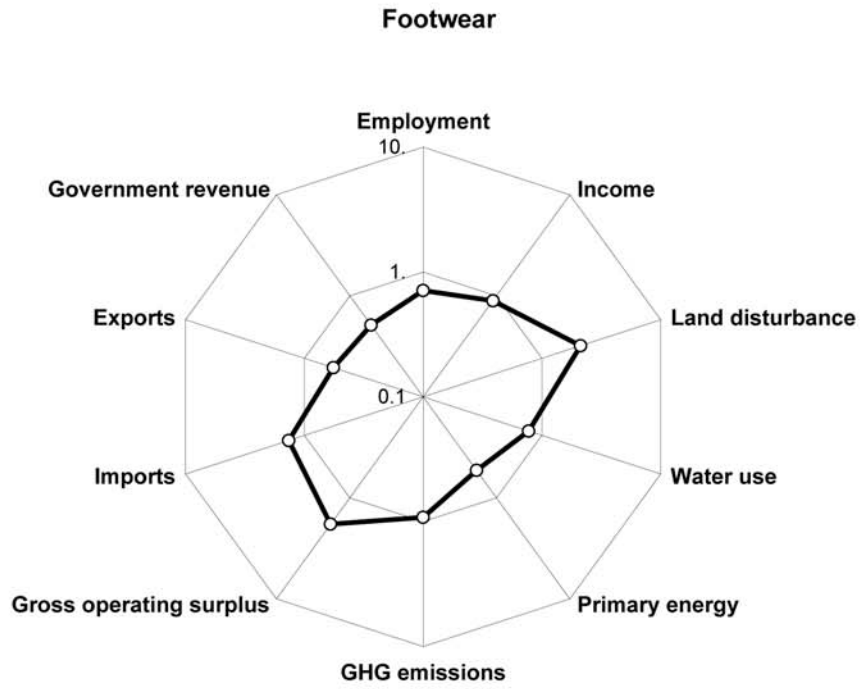
**Sector**

Footwear, soles and other parts, repairing

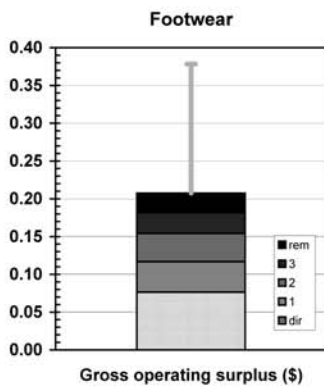
**Footwear**

(Fw)

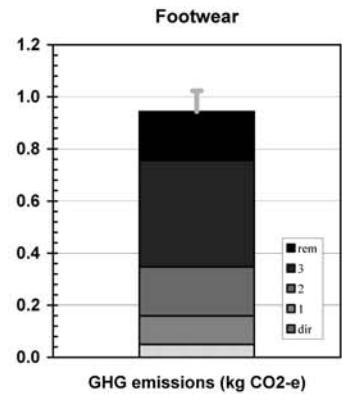
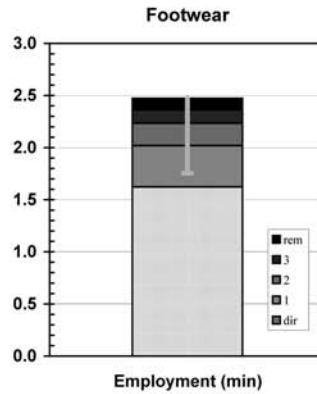
**Spider diagram**



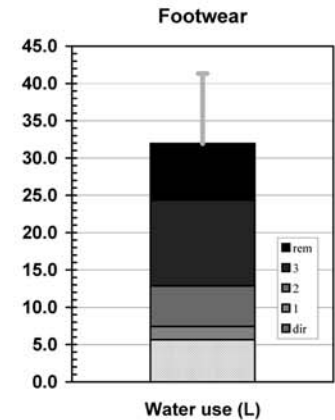
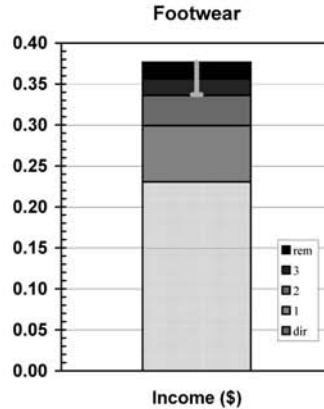
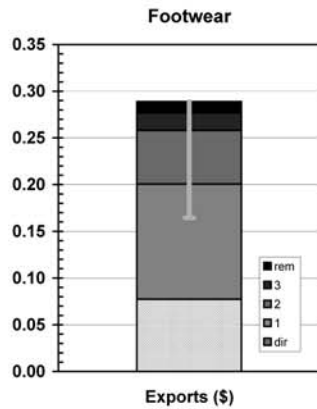
**Bar graphs**



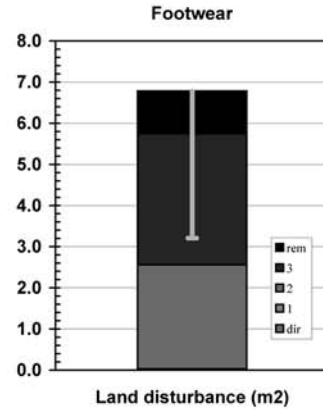
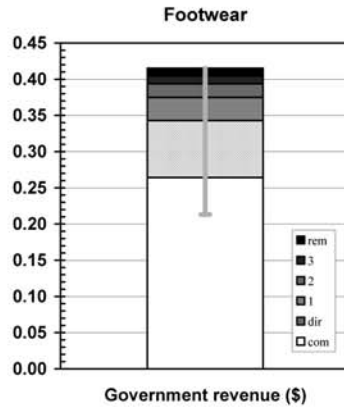
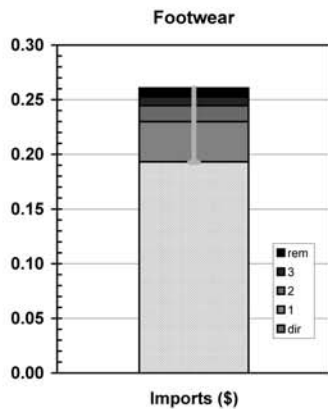
**Account #1**



**Account #2**



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 968.9	(0.37% of total)	(\$m 455.4 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 1.8	(0.00% of total)	(\$m 1.8 domestically produced)
Net changes in stocks	\$m 16.4	(0.93% of total)	(\$m 8.6 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 987.1</b>	<b>(0.21% of GNE)</b>	<b>(\$m 465.8 domestically produced)</b>
Exports	\$m 45.7	(0.05% of total)	(\$m 45.7 domestically produced)
<b>Final demand</b>	<b>\$m 1,032.8</b>	<b>(0.19% of GNT)</b>	<b>(\$m 511.5 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 136.3	(0.08% of total)
Gross operating surplus	\$m 45.1	(0.02% of total)
Taxes less subsidies	\$m 46.6	(0.05% of total)
<b>Sectoral GDP*</b>	<b>\$m 228.1</b>	<b>(0.05% of GDP)</b>
Imports	\$m 114.2	(0.12% of total)
<b>Primary inputs</b>	<b>\$m 342.3</b>	<b>(0.06% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 45.1	(0.02%)	\$m 39.0 (0.02%)	\$m 106.2 (0.06%)
Exports (\$m)	\$m 45.7	(0.05%)	\$m 39.5 (0.05%)	\$m 147.8 (0.18%)
Imports (\$m)	\$m 114.2	(0.12%)	\$m 98.8 (0.10%)	\$m 133.4 (0.14%)
Employment (e-y)	7,688 e-y	(0.11%)	6,647 e-y (0.09%)	10,134 e-y (0.14%)
Income (\$m)*	\$m 136.3	(0.08%)	\$m 117.9 (0.07%)	\$m 192.6 (0.11%)
Government revenue (\$m)†	\$m 181.7	(0.17%)	\$m 175.4 (0.16%)	\$m 212.4 (0.20%)
GHG emissions (kt CO <sub>2</sub> -e)	29 kt	(0.01%)	25 kt (0.00%)	483 kt (0.09%)
Water use (ML)	3,337 ML	(0.02%)	2,886 ML (0.01%)	16,337 ML (0.08%)
Land disturbance (kha)	1 kha	(0.00%)	1 kha (0.00%)	347 kha (0.21%)
Primary energy (TJ)	508 TJ	(0.01%)	440 TJ (0.01%)	2,091 TJ (0.05%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.08	0.21	0.38
Exports (\$)	0.08	0.29	0.16
Imports (\$)	0.19	0.26	0.19
Employment (min)	1.62	2.47	1.75
Income (\$)	0.23	0.38	0.34
Government revenue (\$)	0.34	0.42	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.05	0.94	1.02
Water use (L)	5.64	31.94	41.32
Land disturbance (m <sup>2</sup> )	0.02	6.78	3.21
Primary energy (MJ)	0.86	4.09	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Fw	0.0763	(0; 37.%)	Fw	1.62	(0; 66.%)	Bc Mp Lp Fw	0.313	(3; 33.%)
Wt Fw	0.00691	(1; 3.3%)	Lp Fw	0.138	(1; 5.6%)	El Fw	0.0609	(1; 6.4%)
Bc Mp Lp Fw	0.00522	(3; 2.5%)	Wt Fw	0.0497	(1; 2.%)	Wo Tx Fw	0.0555	(2; 5.9%)
Wo Tx Fw	0.00391	(2; 1.9%)	Bc Mp Lp Fw	0.023	(3; 0.93%)	Wo Lp Fw	0.0491	(2; 5.2%)
Wo Lp Fw	0.00346	(2; 1.7%)	Mp Lp Fw	0.019	(2; 0.77%)	Fw	0.0488	(0; 5.2%)
Ms Fw	0.00264	(1; 1.3%)	Bs Fw	0.0167	(1; 0.68%)	Gd Fw	0.0159	(1; 1.7%)
Lp Fw	0.00259	(1; 1.2%)	Wt Lp Fw	0.0163	(2; 0.66%)	Wo Mp Lp Fw	0.0107	(3; 1.1%)
St Fw	0.00254	(1; 1.2%)	Wo Tx Fw	0.0161	(2; 0.65%)	El Lp Fw	0.00895	(2; 0.95%)
El Fw	0.00246	(1; 1.2%)	Wo Lp Fw	0.0142	(2; 0.58%)	Ch Lp Fw	0.00784	(2; 0.83%)
Wt Lp Fw	0.00226	(2; 1.1%)	Tx Fw	0.0142	(1; 0.57%)	Wt Fw	0.00689	(1; 0.73%)
Rd Fw	0.00212	(1; 1.%)	Rd Fw	0.0124	(1; 0.5%)	Fr Bc Mp Lp F	0.00577	(4; 0.61%)
Pl Fw	0.00209	(1; 1.%)	Ms Fw	0.0118	(1; 0.48%)	Ch Pl Fw	0.00464	(2; 0.49%)
Oc Fw	0.0019	(1; 0.92%)	Pl Fw	0.0111	(1; 0.45%)	Pg Mp Lp Fw	0.00384	(3; 0.41%)
Bs Fw	0.0017	(1; 0.82%)	Gd Fw	0.00629	(1; 0.25%)	Lg Fw	0.00369	(1; 0.39%)
Lg Fw	0.00155	(1; 0.75%)	Oc Fw	0.00562	(1; 0.23%)	At Fw	0.00365	(1; 0.39%)
Tx Fw	0.00133	(1; 0.64%)	Ts Fw	0.00539	(1; 0.22%)	El Tx Fw	0.00339	(2; 0.36%)
St Wt Fw	0.00132	(2; 0.63%)	Cl Fw	0.00502	(1; 0.2%)	Rd Fw	0.00336	(1; 0.36%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Lp Fw	0.0954	(1; 33.%)	Fw	0.23	(0; 61.%)	Bc Mp Lp Fw	8.24	(3; 26.%)
Fw	0.0773	(0; 27.%)	Lp Fw	0.0186	(1; 4.9%)	Fw	5.64	(0; 18.%)
Mp Lp Fw	0.0122	(2; 4.2%)	Wt Fw	0.0107	(1; 2.8%)	Wo Tx Fw	1.8	(2; 5.6%)
Tx Fw	0.00852	(1; 2.9%)	Tx Fw	0.00357	(1; 0.95%)	Wo Lp Fw	1.59	(2; 5.%)
Wt Fw	0.00565	(1; 2.%)	Wt Lp Fw	0.0035	(2; 0.93%)	Sc Cg Tx Fw	0.85	(3; 2.7%)
Wo Tx Fw	0.00492	(2; 1.7%)	Mp Lp Fw	0.00327	(2; 0.87%)	Lp Fw	0.639	(1; 2.%)
Wo Lp Fw	0.00435	(2; 1.5%)	Ms Fw	0.00275	(1; 0.73%)	Wo Mp Lp Fw	0.346	(3; 1.1%)
Wt Lp Fw	0.00185	(2; 0.64%)	Pl Fw	0.00225	(1; 0.6%)	El Fw	0.336	(1; 1.1%)
Lg Fw	0.00182	(1; 0.63%)	Rd Fw	0.00214	(1; 0.57%)	Sc Cg Wo Tx	0.336	(4; 1.1%)
Oc Fw	0.00169	(1; 0.59%)	Bs Fw	0.00205	(1; 0.55%)	Sc Lp Fw	0.32	(2; 1.%)
At Fw	0.00116	(1; 0.4%)	Gd Fw	0.00176	(1; 0.47%)	Sc Cg Wo Lp	0.298	(4; 0.93%)
Wo Mp Lp Fw	0.000947	(3; 0.33%)	Oc Fw	0.00135	(1; 0.36%)	Sc Cg Mp Lp l	0.26	(4; 0.82%)
Ch Lp Fw	0.000912	(2; 0.32%)	Ts Fw	0.00126	(1; 0.34%)	Sc Cg Bc Mp l	0.258	(5; 0.81%)
Rd Fw	0.000736	(1; 0.25%)	Os Fw	0.00114	(1; 0.3%)	Vf Lp Fw	0.219	(2; 0.68%)
St Fw	0.000629	(1; 0.22%)	St Fw	0.00106	(1; 0.28%)	Wa Fw	0.209	(1; 0.65%)
Pl Fw	0.000604	(1; 0.21%)	Ms Wt Fw	0.00104	(2; 0.28%)	Vf Bc Mp Lp F	0.191	(4; 0.6%)
Bl El Fw	0.000595	(2; 0.21%)	Pa Fw	0.000982	(1; 0.26%)	Dc Dp Fw	0.169	(2; 0.53%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /(\$))		
Fw	0.193	(0; 74.%)	Fw	0.0788	(0; 52.%)	Bc Mp Lp Fw	2.27	(3; 33.%)
Lp Fw	0.0122	(1; 4.7%)	Lp Fw	0.00811	(1; 5.4%)	Wo Tx Fw	1.33	(2; 20.%)
Oc Fw	0.00262	(1; 1.%)	Wt Fw	0.00499	(1; 3.3%)	Wo Lp Fw	1.18	(2; 17.%)
Pl Fw	0.00214	(1; 0.82%)	Tx Fw	0.00254	(1; 1.7%)	Wo Mp Lp Fw	0.257	(3; 3.8%)
Wt Fw	0.0016	(1; 0.62%)	Wt Lp Fw	0.00164	(2; 1.1%)	Wo Tx Cl Fw	0.0294	(3; 0.43%)
Tx Fw	0.00131	(1; 0.5%)	Mp Lp Fw	0.00155	(2; 1.%)	Bc Mp Pe Mp	0.0194	(5; 0.29%)
Pa Fw	0.00123	(1; 0.47%)	Rd Fw	0.00152	(1; 1.%)	Fw	0.017	(0; 0.25%)
Cl Fw	0.000932	(1; 0.36%)	Ms Fw	0.00131	(1; 0.86%)	Wo Tx Lp Fw	0.0158	(3; 0.23%)
Ch Lp Fw	0.000913	(2; 0.35%)	Pl Fw	0.00098	(1; 0.65%)	Wo Tx Tp Fw	0.0122	(3; 0.18%)
Ru Fw	0.000739	(1; 0.28%)	Gd Fw	0.000818	(1; 0.54%)	Bc Mp Fw	0.0114	(2; 0.17%)
Ms Fw	0.0006	(1; 0.23%)	Oc Fw	0.0008	(1; 0.53%)	Bc Mp Ch Lp l	0.00312	(4; 0.046%)
Ch Pl Fw	0.000541	(2; 0.21%)	Ts Fw	0.000622	(1; 0.41%)	Wh Bc Mp Lp	0.00304	(4; 0.045%)
Rd Fw	0.000536	(1; 0.21%)	Bs Fw	0.000609	(1; 0.4%)	Lp Fw	0.00261	(1; 0.038%)
Wt Lp Fw	0.000526	(2; 0.2%)	St Fw	0.000564	(1; 0.37%)	Bc Mp Ho Lp l	0.00229	(4; 0.034%)
Bc Mp Lp Fw	0.00049	(3; 0.19%)	Os Fw	0.000529	(1; 0.35%)	Wo Mp Pe Mp	0.00219	(5; 0.032%)
Tp Fw	0.000393	(1; 0.15%)	At Fw	0.00052	(1; 0.34%)	Wo Tx Pl Fw	0.00214	(3; 0.032%)
At Fw	0.000347	(1; 0.13%)	Pa Fw	0.000517	(1; 0.34%)	Fr Bc Mp Lp F	0.00186	(4; 0.027%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.059 ±0.021	(±2.0%)
Downstream	0.217 ±0.005	(±2.1%)

# Sector 2206: Leather Products (Lp)

*Leather, hides, skins, handbags, suitcases, wallets, saddlery, harness and other leather products*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicators for greenhouse emissions, water use and land disturbance are respectively four, three, and ten times, the economy wide average. This is due to the relatively high resource intensity of animal production and the moderate prices paid for animal products. The social indicators of employment generation, income and government revenue are 40%, 5% and 10% above average respectively. The financial indicator of operating surplus is 25% below average, export propensity is over six times the average, and import penetration is 10% below average. Changing the physical resource embodiment in leather products will be difficult, particularly since it is essentially a by-product of grazing. High value leather goods could aim to source leather from productive regional areas, with accredited production systems that are low in water use, animal methane and emissions from land clearing.

## Sector Description

On the assumption that cow hides weigh 23 kg and sheep hides weigh 10 kg, the slaughtering of 9 million cattle and 17 million sheep per year give a wet hide production base of about 370 000 tonnes per year. Most of this is exported as lightly processed in 'wet blue' or 'brine cured' states. Between 3 and 4 million kangaroos are culled each year and 25 000 tonnes processed for leather which, due to its tensile strength and flexibility, is ideal for sporting shoes. On average, one tonne of tanned leather requires four tonnes of wet skins, 40 tonnes of water, 1.3 tonnes of inorganic chemicals, and 20 GJ (10<sup>9</sup>J) of energy. In constant dollar terms, the sector's output has doubled in the last 30 years, and the sector turnover in 2002 was \$1 billion, involving about 200 enterprises.

## Place of Industry in the Economy

The leather products sector ranks 128<sup>th</sup> out of 135 sectors in terms of value adding in the economy, and contributes 0.04% of GDP in this analysis. It is similar in value adding to the softwood plantations, and prefabricated buildings sectors. It is a moderate employer with 4 000 employment years directly embodied in final demand, and another 8 000 years in the sector's upstream suppliers, giving a total of 12 000 employment years. In addition, it supplies 2 000 employment years to downstream industries such as footwear. However, downstream employment effects are constrained since most leather is exported for full tanning and finishing. The sector has moderate resource requirements with one percent of national land disturbance, and four tenths, three tenths, and one tenth of one percent respectively of greenhouse emissions, water use, and energy use. In financial terms, exports are nearly eight times the value of imports, although this excludes footwear.

## Strategic Overview

The overview provided by the spider diagram is dominated by three significant outliers for the environmental indicators. The social and financial outcomes are reasonable. The animal production systems using the grazing area that provide the leather hides contribute to the land and water indicators. Land clearing in Northern Australia is the largest component of the greenhouse indicator. Apart from the physical reality of how animal production systems function in Australia, a major part of the indicator problem is the limited amount of value adding in the sector. Greater Australian processing could improve a number of indicators as the value added components dilute the environmental loading. However, Australia lacks the historic 'leather product and design' advantage of Italy and the scale and competitive wages structure of countries such as China.

## TBL Account #1

The financial indicator of operating surplus is 25% below average with a direct effect of 6% and an extended production chain dominated by beef production (15%) and sheep production (10%) with a number of minor contributors. The social indicator of employment generation is 40% above average with a direct effect of 37%, and contributions from beef cattle (11%), sheep production (5%), wholesale trade (4%), and road transport (2%). The environmental indicator of greenhouse emissions is nearly four times the average and is discussed in more detail below.

## TBL Accounts #2 and #3

The second TBL account shows an export propensity that is nearly six times the average, income that is 5% above average and water use that is nearly three times the average. The third TBL account shows an import penetration that is 10% below average, government revenue 10% above average, and land disturbance that is nearly ten times the average. The higher than average environmental indicators reflect both the environmental loading of the production chain as well as the low prices paid for semi-processed leather which is mainly exported for finishing overseas.

## Structural Path Analysis and Linkages

The indicators for greenhouse, water and land disturbance are all substantially above average. For emissions, the direct sector effect is less than 1% while the 'beef cattle-meat products-leather' chain is 55%, wool production is 9%, 'sheep-meat products-leather' is 2%, electricity production is 2% and basic chemicals is 1%. Land clearing in Northern Australia is allocated entirely to beef production, and thus flows through the chain. The water use chain is an extended one with a direct effect of 4%, and contributions from 'beef cattle-meat production-leather' (46%), 'wool production-leather' (9%), 'sheep-meat products-leather' (2%), 'cotton-cotton ginning-sheep-leather' (2%) (cottonseed supplement for sheep), 'cotton-leather' (2%), 'cotton-cotton ginning-meat products-leather' (2%) and 'hay-beef cattle-meat products-leather' (2%). The land disturbance chain is due to sheep (31%) and cattle (46%) grazing, and could be improved by focused procurement policies.

The sector's stimulus to its upstream suppliers is 90% above average, one of the strongest in this analysis. It impacts on sheep and beef production, meat products, basic chemicals, wholesale trade, road transport, property development, and accounting and marketing. There is a linkage to the footwear sector, but generally linkages to downstream industries are weak, as most of the production leaks from the economy in the form of semi processed exports.

## Future Trends in Sector

The base case scenario of the *Future Dilemmas* study shows an increase in the production of raw skins as a feedstock for leather processing of 80% by the year 2050. This is a knock-on effect of an assumption that both sheep and beef meat production doubles over the next 50 years in response to increases in per capita consumption by Asian countries as rising incomes increase the affordability of meat. Australia's quarantine standards, and the market's perception of clean green production systems, are the supporting rationales for this assumption. Climate change and variability are key uncertainties, particularly on forage production in key animal production zones. Future leather demand seems assured with leather covering being preferred for higher value vehicle and lounge upholstery. Of the 12 billion pairs of shoes made globally each year, 50% have leather uppers.

## Innovation and Technical Opportunities

Initiatives for greener leather production have led to enzyme based processing systems which produce equivalent quality leather, but reduce the use of chemicals from 440 to 40 kg per tonne of raw skin, and decrease the biological oxygen demand of effluent water by 80%.



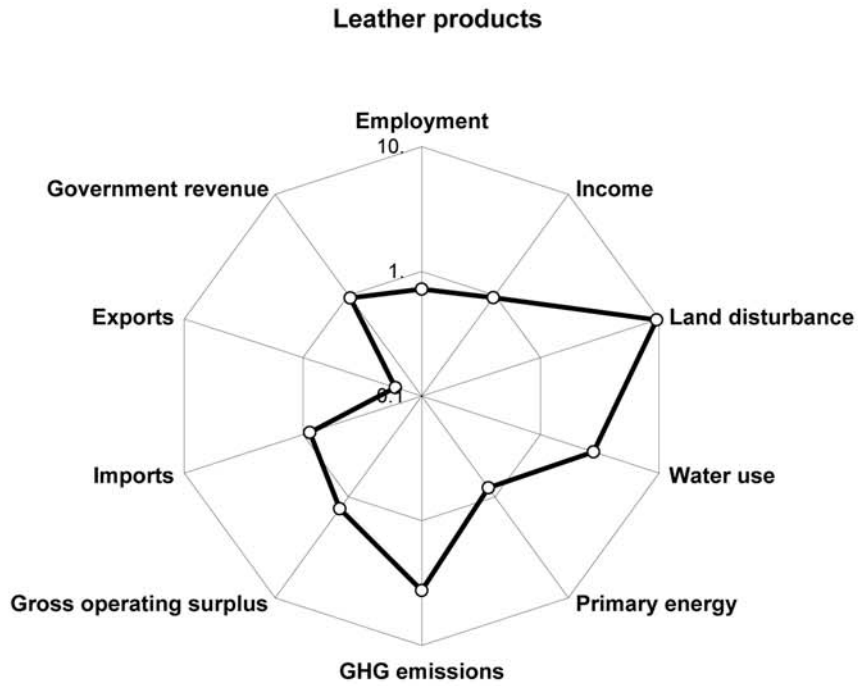
**Sector**

**Leather products**

(Lp)

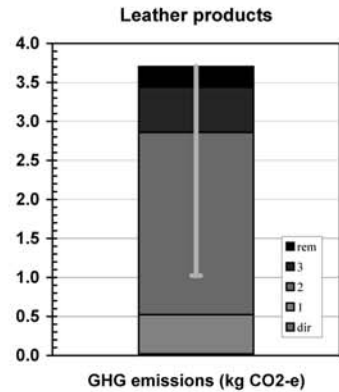
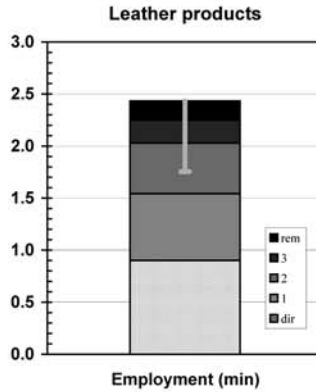
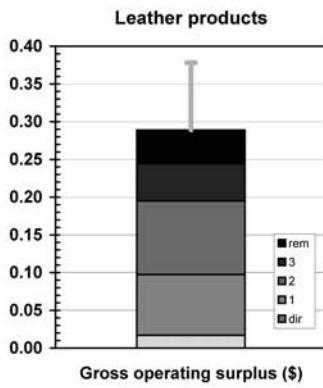
Leather, hides, skins, handbags, suitcases, wallets, saddlery, harness and other leather products

Spider diagram

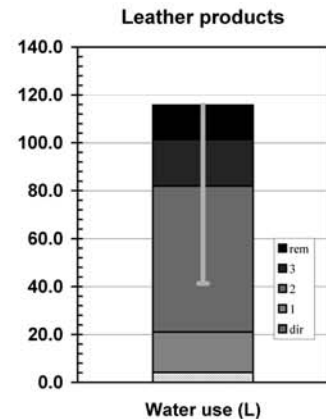
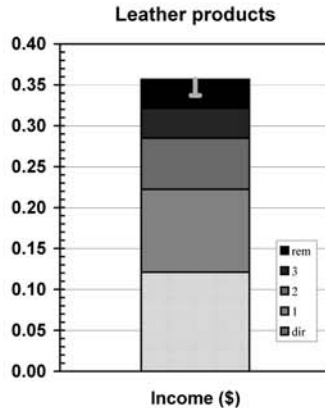
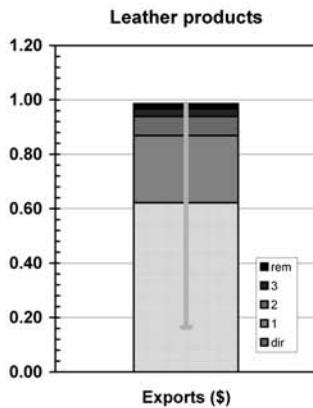


Bar graphs

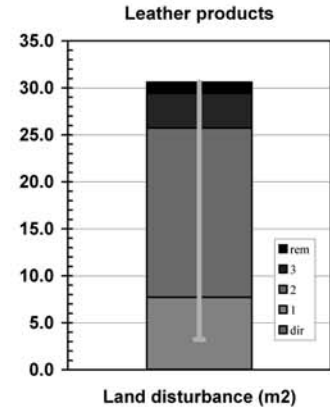
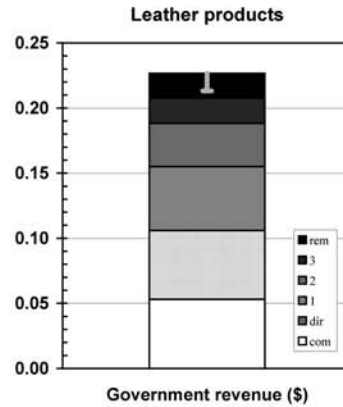
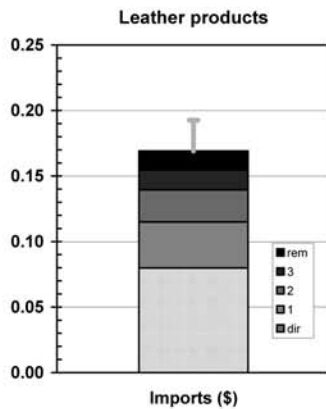
**Account #1**



**Account #2**



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 397.0	(0.15% of total)	(\$m 22.8 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 3.9	(0.00% of total)	(\$m 3.9 domestically produced)
Net changes in stocks	\$m 17.4	(0.98% of total)	(\$m 10.2 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 418.3</b>	<b>(0.09% of GNE)</b>	<b>(\$m 36.9 domestically produced)</b>
Exports	\$m 564.7	(0.68% of total)	(\$m 564.7 domestically produced)
<b>Final demand</b>	<b>\$m 982.9</b>	<b>(0.18% of GNT)</b>	<b>(\$m 601.5 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 109.8	(0.06% of total)
Gross operating surplus	\$m 15.3	(0.01% of total)
Taxes less subsidies	\$m 48.0	(0.06% of total)
<b>Sectoral GDP*</b>	<b>\$m 173.2</b>	<b>(0.04% of GDP)</b>
Imports	\$m 72.5	(0.07% of total)
<b>Primary inputs</b>	<b>\$m 245.7</b>	<b>(0.05% of GNT)</b>

\* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT		
		(% of national)	direct (% of national)	total (% of national)	
Gross operating surplus (\$m)	\$m 15.3	(0.01%)	\$m 10.2	(0.01%)	\$m 173.8 (0.09%)
Exports (\$m)	\$m 564.7	(0.68%)	\$m 374.1	(0.45%)	\$m 592.9 (0.71%)
Imports (\$m)	\$m 72.5	(0.07%)	\$m 48.0	(0.05%)	\$m 101.7 (0.10%)
Employment (e-y)	6,550 e-y	(0.09%)	4,339 e-y	(0.06%)	11,730 e-y (0.16%)
Income (\$m)*	\$m 109.8	(0.06%)	\$m 72.8	(0.04%)	\$m 214.6 (0.13%)
Government revenue (\$m)†	\$m 79.9	(0.07%)	\$m 63.7	(0.06%)	\$m 136.3 (0.13%)
GHG emissions (kt CO <sub>2</sub> -e)	16 kt	(0.00%)	11 kt	(0.00%)	2,228 kt (0.43%)
Water use (ML)	3,782 ML	(0.02%)	2,505 ML	(0.01%)	69,621 ML (0.33%)
Land disturbance (kha)	2 kha	(0.00%)	1 kha	(0.00%)	1,841 kha (1.13%)
Primary energy (TJ)	297 TJ	(0.01%)	196 TJ	(0.01%)	3,737 TJ (0.10%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*	
	direct	total
Gross operating surplus (\$)	0.02	0.29
Exports (\$)	0.62	0.99
Imports (\$)	0.08	0.17
Employment (min)	0.90	2.43
Income (\$)	0.12	0.36
Government revenue (\$)	0.11	0.23
GHG emissions (kg CO <sub>2</sub> -e)	0.02	3.70
Water use (L)	4.16	115.74
Land disturbance (m <sup>2</sup> )	0.02	30.61
Primary energy (MJ)	0.33	6.21

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Nation-wide average
total
0.38
0.16
0.19
1.75
0.34
0.21
1.02
41.32
3.21
7.65

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Bc Mp Lp	0.034	(2; 12.%)	Lp	0.9	(0; 37.%)	Bc Mp Lp	2.04	(2; 55.%)
Wo Lp	0.0226	(1; 7.8%)	Bc Mp Lp	0.15	(2; 6.2%)	Wo Lp	0.32	(1; 8.6%)
Lp	0.0169	(0; 5.8%)	Mp Lp	0.124	(1; 5.1%)	Wo Mp Lp	0.0696	(2; 1.9%)
Wt Lp	0.0148	(1; 5.1%)	Wt Lp	0.106	(1; 4.4%)	El Lp	0.0583	(1; 1.6%)
Mp Lp	0.0084	(1; 2.9%)	Wo Lp	0.0927	(1; 3.8%)	Ch Lp	0.0511	(1; 1.4%)
Wo Mp Lp	0.00491	(2; 1.7%)	Rd Lp	0.0218	(1; 0.9%)	Fr Bc Mp Lp	0.0376	(3; 1.0%)
Ch Lp	0.00426	(1; 1.5%)	Wo Mp Lp	0.0202	(2; 0.83%)	Pg Mp Lp	0.025	(2; 0.68%)
Rd Lp	0.00371	(1; 1.3%)	Rd Mp Lp	0.0198	(2; 0.81%)	Gd Lp	0.0211	(1; 0.57%)
Pe Mp Lp	0.00337	(2; 1.2%)	Pe Mp Lp	0.0157	(2; 0.65%)	Lp	0.018	(0; 0.48%)
Rd Mp Lp	0.00336	(2; 1.2%)	Bs Lp	0.0141	(1; 0.58%)	Bc Mp Pe Mp	0.0174	(4; 0.47%)
Ts Lp	0.00304	(1; 1.1%)	Ts Lp	0.0137	(1; 0.56%)	El Mp Lp	0.0164	(2; 0.44%)
Ms Lp	0.00285	(1; 0.99%)	Ms Lp	0.0128	(1; 0.53%)	Wt Lp	0.0147	(1; 0.4%)
St Wt Lp	0.00281	(2; 0.97%)	Ch Lp	0.0124	(1; 0.51%)	Mp Lp	0.0132	(1; 0.36%)
El Lp	0.00236	(1; 0.82%)	Pg Mp Lp	0.011	(2; 0.45%)	Pe Mp Lp	0.00847	(2; 0.23%)
Ms Wt Lp	0.00214	(2; 0.74%)	Ho Lp	0.0104	(1; 0.43%)	El Ch Lp	0.00769	(2; 0.21%)
Pd Wt Lp	0.00169	(2; 0.59%)	Os Lp	0.01	(1; 0.41%)	El Bc Mp Lp	0.00621	(3; 0.17%)
Pg Mp Lp	0.00164	(2; 0.57%)	Ms Wt Lp	0.00959	(2; 0.39%)	Rd Lp	0.00589	(1; 0.16%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Lp	0.622	(0; 63.%)	Lp	0.121	(0; 34.%)	Bc Mp Lp	53.7	(2; 46.%)
Mp Lp	0.0792	(1; 8.%)	Wt Lp	0.0228	(1; 6.4%)	Wo Lp	10.4	(1; 9.%)
Wo Lp	0.0284	(1; 2.9%)	Mp Lp	0.0213	(1; 6.%)	Lp	4.16	(0; 3.6%)
Wt Lp	0.0121	(1; 1.2%)	Bc Mp Lp	0.00513	(2; 1.4%)	Wo Mp Lp	2.25	(2; 1.9%)
Wo Mp Lp	0.00617	(2; 0.63%)	Rd Lp	0.00375	(1; 1.1%)	Sc Lp	2.09	(1; 1.8%)
Ch Lp	0.00594	(1; 0.6%)	Rd Mp Lp	0.0034	(2; 0.95%)	Sc Cg Wo Lp	1.94	(3; 1.7%)
Bc Mp Lp	0.00297	(2; 0.3%)	Ts Lp	0.0032	(1; 0.9%)	Sc Cg Mp Lp	1.7	(3; 1.5%)
At Lp	0.00154	(1; 0.16%)	Wo Lp	0.00318	(1; 0.89%)	Sc Cg Bc Mp Lp	1.68	(4; 1.5%)
Rd Lp	0.00129	(1; 0.13%)	Ms Lp	0.00297	(1; 0.83%)	Vf Lp	1.42	(1; 1.2%)
Rd Mp Lp	0.00117	(2; 0.12%)	Os Lp	0.0028	(1; 0.79%)	Vf Bc Mp Lp	1.24	(3; 1.1%)
Fd Pe Mp Lp	0.000938	(3; 0.095%)	Ch Lp	0.00264	(1; 0.74%)	Wa Lp	0.833	(1; 0.72%)
Cg Wo Lp	0.000904	(2; 0.092%)	Gd Lp	0.00234	(1; 0.66%)	Mp Lp	0.676	(1; 0.58%)
Cg Mp Lp	0.000791	(2; 0.08%)	Ms Wt Lp	0.00223	(2; 0.63%)	Dc Dp Pg Mp	0.619	(4; 0.54%)
Cg Bc Mp Lp	0.000784	(3; 0.08%)	Pe Mp Lp	0.00177	(2; 0.5%)	Sc Cg Wo Mp	0.422	(4; 0.36%)
Wt Mp Lp	0.000702	(2; 0.071%)	Bs Lp	0.00173	(1; 0.49%)	Vf Wo Lp	0.391	(2; 0.34%)
St Wt Lp	0.000697	(2; 0.071%)	Pd Wt Lp	0.00153	(2; 0.43%)	Ri Fc Pg Mp L	0.344	(4; 0.3%)
Mp Pe Mp Lp	0.000676	(3; 0.069%)	Ho Lp	0.00151	(1; 0.42%)	El Lp	0.322	(1; 0.28%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Lp	0.0798	(0; 47.%)	Lp	0.0529	(0; 30.%)	Bc Mp Lp	14.8	(2; 48.%)
Ch Lp	0.00595	(1; 3.5%)	Wt Lp	0.0107	(1; 6.1%)	Wo Lp	7.69	(1; 25.%)
Wt Lp	0.00343	(1; 2.%)	Mp Lp	0.0101	(1; 5.8%)	Wo Mp Lp	1.67	(2; 5.5%)
Bc Mp Lp	0.00319	(2; 1.9%)	Bc Mp Lp	0.00301	(2; 1.7%)	Bc Mp Pe Mp	0.126	(4; 0.41%)
Wo Lp	0.00161	(1; 0.95%)	Rd Lp	0.00266	(1; 1.5%)	Wo Tx Lp	0.103	(2; 0.34%)
Rd Lp	0.000941	(1; 0.56%)	Rd Mp Lp	0.00241	(2; 1.4%)	Bc Mp Ch Lp	0.0203	(3; 0.066%)
Ts Lp	0.000871	(1; 0.52%)	Wo Lp	0.00184	(1; 1.1%)	Wh Bc Mp Lp	0.0198	(3; 0.065%)
Mp Lp	0.000863	(1; 0.51%)	Ts Lp	0.00158	(1; 0.91%)	Lp	0.017	(0; 0.056%)
Rd Mp Lp	0.000852	(2; 0.5%)	Ms Lp	0.00141	(1; 0.81%)	Bc Mp Ho Lp	0.0149	(3; 0.049%)
Cl Lp	0.000693	(1; 0.41%)	Ch Lp	0.00132	(1; 0.76%)	Wo Mp Pe Mp	0.0143	(4; 0.047%)
Ne Lp	0.000659	(1; 0.39%)	Os Lp	0.0013	(1; 0.75%)	Fr Bc Mp Lp	0.0121	(3; 0.04%)
Ms Lp	0.000648	(1; 0.38%)	Gd Lp	0.00108	(1; 0.62%)	Bc Ch Lp	0.0102	(2; 0.033%)
Pg Mp Lp	0.000628	(2; 0.37%)	Ms Wt Lp	0.00106	(2; 0.61%)	Pg Mp Lp	0.00935	(2; 0.031%)
Pe Mp Lp	0.000507	(2; 0.3%)	Pd Wt Lp	0.001	(2; 0.58%)	Bc Mp Bc Mp	0.00872	(4; 0.028%)
Ms Wt Lp	0.000486	(2; 0.29%)	Pe Mp Lp	0.00086	(2; 0.5%)	Wh Pe Mp Lp	0.0086	(3; 0.028%)
Pr Wt Lp	0.000466	(2; 0.28%)	Pd Lp	0.000799	(1; 0.46%)	Wh Wo Lp	0.00773	(2; 0.025%)
At Lp	0.000458	(1; 0.27%)	Ho Lp	0.000795	(1; 0.46%)	Bc Mp Fd Pe L	0.00742	(5; 0.024%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.878 ±0.036	(±1.9%)
Downstream	0.479 ±0.022	(±4.6%)

# Sector 2301: Sawmill Products (Ti)

*Sawn and dressed timber, treated wood, ground bark, woodchips and other sawmill products*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is more than three times the national average, while water use and land disturbance are respectively 85% and 50% below average. The social indicators of employment generation and income are 10% above and equal to average respectively, while government revenue is 25% below average. The financial indicators show that operating surplus is 10% above average, export propensity is 80% above average, and import penetration is 20% below average. The sector's products could contribute substantially to greenhouse-friendly housing designs. However, the greenhouse signature may require life cycle stewardship of wood, from forest coupe to final product.

## Sector Description

On average, it takes 2.5 tonnes of sawlog to produce one tonne of rough sawn timber with remains of one tonne of woodchips, 0.3 tonnes of shavings and dust, and 0.2 tonnes of bark. Australia consumes about 4.6 million cubic metres of sawnwood annually of which 4 million m<sup>3</sup> are produced domestically. In addition 700 000 m<sup>3</sup> are imported and 100 000 m<sup>3</sup> are exported. Most of the imports come from New Zealand (radiata pine and douglas fir) and Canada (douglas fir and western red cedar). Export of woodchips is currently 11 million tonnes per year composed of 80% hardwood and 20% softwood. In financial terms, the sector's activity is composed of rough sawn timber (42%), hardwood and softwood woodchips (18%) and resawn and dressed timber (40%). The financial turnover in 2002 was around \$3 billion and involved over 750 enterprises.

## Place of Industry in the Economy

The sawmill products sector ranks 68<sup>th</sup> out of 135 sectors in terms of value adding in the economy and contributes 0.23% of GDP in this analysis. It is similar in value adding to steel and metal containers, and gas production and distribution. It is a moderate employer with 4 000 employment years embodied in final demand, and another 5 000 years in the sector's upstream suppliers, giving a total of 9 000 employment years, much of it regional. In addition, the sector supplies 17 000 employment years to downstream industries such as wood products, domestic building, furniture making, and non-domestic construction. The sector has small resource requirements with less than one tenth of one percent of national water use, land disturbance and energy use, but four tenths of one percent of greenhouse emissions, three quarters of which comes from land use change rather than fossil fuel combustion. In financial terms, exports are more than twice imports.

## Strategic Overview

The spider diagram reveals a relatively good outcome for the sawmill products sector with outliers for greenhouse emissions and government revenue indicators, but average or better than average outcomes for the remaining eight indicators. Forest issues have occupied a substantial part of the national resource and environmental debate for the past two decades, and are likely to continue. Because of lower prices paid at the first stage of processing and value adding, the portrayal of the greenhouse outlier is possibly exaggerated. In a theoretical sense, it is possible that restrictions on landuse change could guide the woodchip component into more value adding in the wood products sector, but long term woodchip export contracts may have to be changed. Minimising the wastage of wood in harvesting and processing may help reduce the emissions indicator, particularly if it fuelled biomass based electricity, and the production of bio-alcohols for use as transport fuels.

## TBL Account #1

The financial indicator of operating surplus is 10% above average with a direct sector effect of 45% and contributions from road transport (5%), softwood plantations (4%), forwarding and storage (4%), wholesale trade (2%), electricity production (2%) and hardwood forests (1%). The social indicator of employment generation is 10% above average, with a direct effect of 51% and a composition similar to the surplus indicator. The environmental indicator of greenhouse emissions is 3.3 times the average and is discussed in more detail below.

## TBL Accounts #2 and #3

The second TBL account shows that export propensity is 80% above average, income is equal to average and water use is 85% below average. The third TBL account reveals that import penetration is 20% below average, government revenue is 25% below average, and land disturbance is 50% below average, but the biodiversity consequences of forestry operations lies outside this analysis.

## Structural Path Analysis and Linkages

The greenhouse indicator is above average and an examination of the structural path shows that the direct sector effect is 10%. The softwood supply chain is responsible for 54%, the hardwood chain for 10%, electricity production for 4%, and road transport for 1%. The greenhouse accounting of forest products, particularly in relation to international forest trade, is currently being evaluated in the science literature. Depending on the analytical or system boundary chosen, the chain of greenhouse emissions derived from forest harvesting can be shown as in this analysis, or ignored. Improving the indicator by increasing the harvested portion for processing may have long term negative effects due to organic matter and nutrient removal, and possible loss of ecosystem function.

The sector's stimulus to its upstream suppliers is 10% greater than average and impacts on road transport, wholesale trade, softwood plantations, and forwarding and storage. The linkages to downstream industries are 30% stronger than average and imply that any expansion of the sawmill products sector will have to be led by expansion in obvious sectors such as domestic buildings, other wood products, furniture making, non-domestic construction, and ownership of dwellings.

## Future Trends in Sector

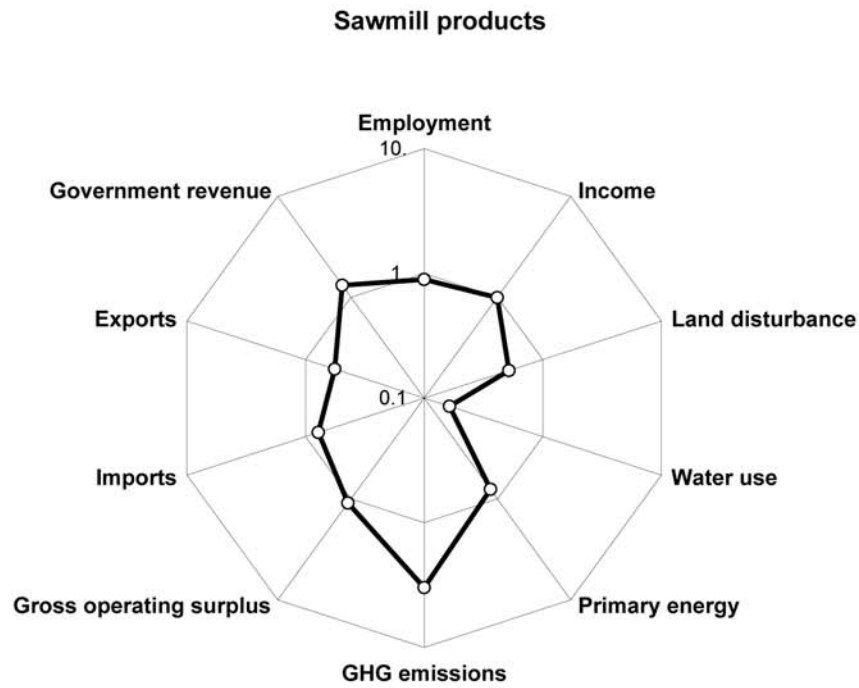
While the base case scenario of the *Future Dilemmas* study did not model this sector in detail, three drivers suggest a reasonably optimistic future out to 2050. Firstly, the combined floor area of domestic, commercial, and institutional space doubles by 2050. Secondly, the forestry planting regimes are set to exceed the national *Forestry 2020 Vision*, and to provide a positive wood products balance. Thirdly, the wood composition of new buildings is assumed to reflect today's designs, and the total requirement for wood, but not necessarily the same wood products. This will grow steadily with population and building replacement. Most woodchip exports go to Japan where Australia supplies about 30% of the market. It is expected that expanding the plantation estate (both hardwoods and softwoods) will reduce native forest woodchipping to lower levels by the year 2010. However woodchip markets are not assured in the long term, as substantial wood volumes are expected to come on line from South Africa, Chile and Brazil during this decade.

## Innovation and Technical Opportunities

Four challenges seem apparent. Firstly, rigorous environmental certification schemes will require full chain analysis per physical unit of sawn wood and woodchip. Secondly, full ecosystem costing requires acceptance by final consumers. Thirdly, methods to reduce land based emissions following harvesting require further development. Finally, woody wastes not able to be value added in the wood products sector could be routed through biomass based electricity and liquid fuel systems.

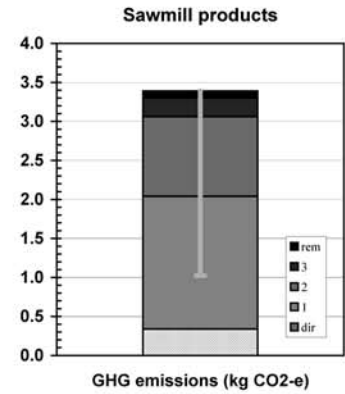
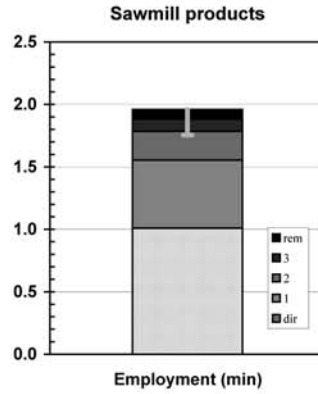
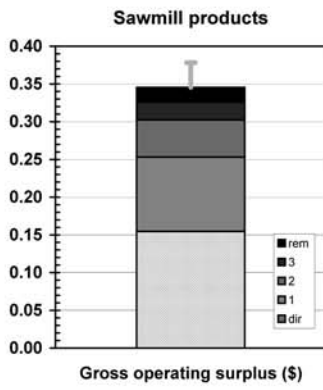
Sawn and dressed timber, treated wood, ground bark, woodchips and other sawmill products

Spider diagram

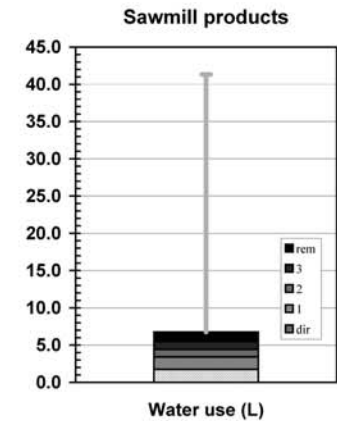
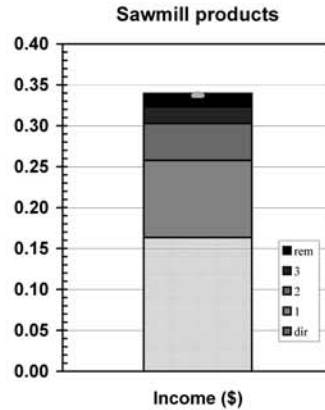
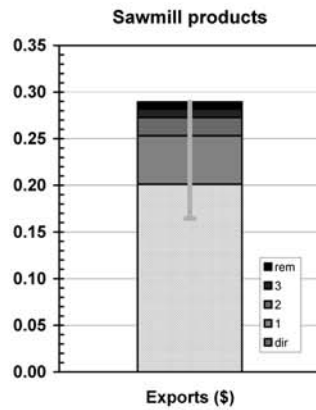


Bar graphs

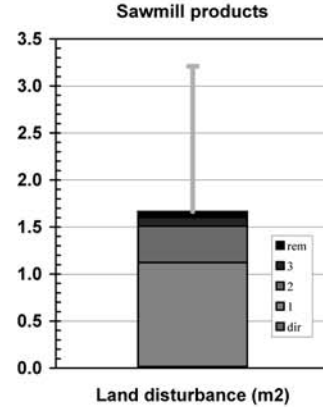
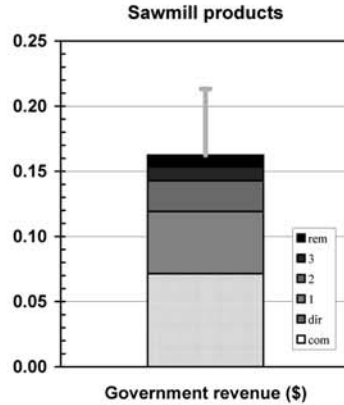
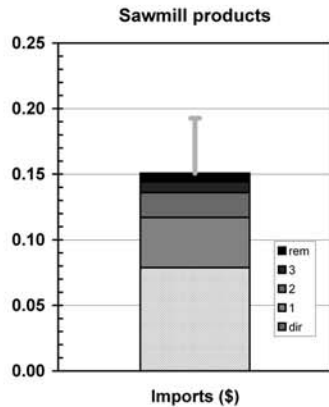
Account #1



Account #2



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 1.8	(0.00% of total)	(\$m 1.6 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 12.7	(0.01% of total)	(\$m 12.7 domestically produced)
Net changes in stocks	\$m 13.2	(0.75% of total)	(\$m 10.9 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 27.7</b>	<b>(0.01% of GNE)</b>	<b>(\$m 25.2 domestically produced)</b>
Exports	\$m 525.6	(0.63% of total)	(\$m 525.6 domestically produced)
<b>Final demand</b>	<b>\$m 553.4</b>	<b>(0.10% of GNT)</b>	<b>(\$m 550.8 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 426.9	(0.25% of total)
Gross operating surplus	\$m 404.1	(0.21% of total)
Taxes less subsidies	\$m 186.8	(0.22% of total)
<b>Sectoral GDP*</b>	<b>\$m 1,017.8</b>	<b>(0.23% of GDP)</b>
Imports	\$m 205.7	(0.21% of total)
<b>Primary inputs</b>	<b>\$m 1,223.5</b>	<b>(0.22% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 404.1	(0.21%)	\$m 85.2 (0.04%)	\$m 190.3 (0.10%)
Exports (\$m)	\$m 525.6	(0.63%)	\$m 110.8 (0.13%)	\$m 159.4 (0.19%)
Imports (\$m)	\$m 205.7	(0.21%)	\$m 43.3 (0.04%)	\$m 83.0 (0.09%)
Employment (e-y)	21,125 e-y	(0.30%)	4,452 e-y (0.06%)	8,654 e-y (0.12%)
Income (\$m)*	\$m 426.9	(0.25%)	\$m 90.0 (0.05%)	\$m 187.1 (0.11%)
Government revenue (\$m)†	\$m 186.8	(0.17%)	\$m 39.4 (0.04%)	\$m 89.5 (0.08%)
GHG emissions (kt CO <sub>2</sub> -e)	885 kt	(0.17%)	186 kt (0.04%)	1,867 kt (0.36%)
Water use (ML)	4,545 ML	(0.02%)	958 ML (0.00%)	3,722 ML (0.02%)
Land disturbance (kha)	4 kha	(0.00%)	1 kha (0.00%)	92 kha (0.06%)
Primary energy (TJ)	3,238 TJ	(0.08%)	682 TJ (0.02%)	3,383 TJ (0.09%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.15	0.35	0.38
Exports (\$)	0.20	0.29	0.16
Imports (\$)	0.08	0.15	0.19
Employment (min)	1.01	1.96	1.75
Income (\$)	0.16	0.34	0.34
Government revenue (\$)	0.07	0.16	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.34	3.39	1.02
Water use (L)	1.74	6.76	41.32
Land disturbance (m <sup>2</sup> )	0.02	1.67	3.21
Primary energy (MJ)	1.24	6.14	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Ti	0.155	(0; 45.%)	Ti	1.01	(0; 51.%)	Sw Ti	1.27	(1; 38.%)
Rd Ti	0.0156	(1; 4.5%)	Sw Ti	0.101	(1; 5.2%)	Fr Sw Ti	0.55	(2; 16.%)
Sw Ti	0.014	(1; 4.1%)	Rd Ti	0.0914	(1; 4.7%)	Ti	0.339	(0; 10.%)
St Ti	0.0124	(1; 3.6%)	Wt Ti	0.0606	(1; 3.1%)	Hw Ti	0.172	(1; 5.1%)
Wt Ti	0.00841	(1; 2.4%)	Hw Ti	0.0308	(1; 1.6%)	Fr Hw Ti	0.168	(2; 4.9%)
El Ti	0.00537	(1; 1.6%)	St Ti	0.0203	(1; 1.%)	El Ti	0.133	(1; 3.9%)
Hw Ti	0.00427	(1; 1.2%)	Rh Ti	0.016	(1; 0.82%)	Rd Ti	0.0247	(1; 0.73%)
Rh Ti	0.00262	(1; 0.76%)	Ms Ti	0.00902	(1; 0.46%)	Fr Ti	0.0158	(1; 0.46%)
Ms Ti	0.00201	(1; 0.58%)	Bs Ti	0.00858	(1; 0.44%)	Wt Ti	0.00839	(1; 0.25%)
Rv Sw Ti	0.00172	(2; 0.5%)	Fr Sw Ti	0.00802	(2; 0.41%)	Gd Ti	0.0074	(1; 0.22%)
St Wt Ti	0.0016	(2; 0.46%)	Wt Sw Ti	0.00728	(2; 0.37%)	El St Ti	0.00518	(2; 0.15%)
Rv Rd Ti	0.00146	(2; 0.42%)	El Ti	0.00597	(1; 0.3%)	Bl El Ti	0.00335	(2; 0.099%)
Rv Ti	0.00145	(1; 0.42%)	Ms Wt Ti	0.00547	(2; 0.28%)	El Rd Ti	0.00315	(2; 0.093%)
Ms Wt Ti	0.00122	(2; 0.35%)	Rf Ti	0.00493	(1; 0.25%)	Fo Ti	0.00278	(1; 0.082%)
Fr Sw Ti	0.00111	(2; 0.32%)	Wp Ti	0.00491	(1; 0.25%)	El Wt Ti	0.00252	(2; 0.074%)
Cm Rd Ti	0.00106	(2; 0.31%)	Gv Ti	0.00485	(1; 0.25%)	Fo Sw Ti	0.00252	(2; 0.074%)
Wt Sw Ti	0.00101	(2; 0.29%)	Rv Sw Ti	0.0046	(2; 0.23%)	Fo Rd Ti	0.00225	(2; 0.066%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Ti	0.201	(0; 69.%)	Ti	0.163	(0; 48.%)	Ti	1.74	(0; 26.%)
Wt Ti	0.00688	(1; 2.4%)	Rd Ti	0.0157	(1; 4.6%)	El Ti	0.734	(1; 11.%)
Rd Ti	0.00541	(1; 1.9%)	Sw Ti	0.0134	(1; 4.%)	Sc Cg Sw Ti	0.208	(3; 3.1%)
Sw Ti	0.00336	(1; 1.2%)	Wt Ti	0.013	(1; 3.8%)	Sw Ti	0.176	(1; 2.6%)
St Ti	0.00308	(1; 1.1%)	St Ti	0.00518	(1; 1.5%)	Wa Ti	0.158	(1; 2.3%)
Bl El Ti	0.0013	(2; 0.45%)	Hw Ti	0.0041	(1; 1.2%)	Rd Ti	0.0649	(1; 0.96%)
Rf Ti	0.00101	(1; 0.35%)	Ms Ti	0.0021	(1; 0.62%)	Sc Cg Hw Ti	0.0634	(3; 0.94%)
Wt Sw Ti	0.000826	(2; 0.29%)	Rh Ti	0.00175	(1; 0.52%)	St Ti	0.0538	(1; 0.8%)
Lg Ti	0.000822	(1; 0.28%)	El Ti	0.00162	(1; 0.48%)	Hw Ti	0.0537	(1; 0.79%)
Eq Sw Ti	0.000528	(2; 0.18%)	Wt Sw Ti	0.00156	(2; 0.46%)	Wa Ms Ti	0.0517	(2; 0.77%)
Wt Rd Ti	0.000517	(2; 0.18%)	Rf Ti	0.00139	(1; 0.41%)	Vf Sw Ti	0.0426	(2; 0.63%)
Hw Ti	0.000484	(1; 0.17%)	Os Ti	0.00128	(1; 0.38%)	Wa El Ti	0.0425	(2; 0.63%)
St Wt Ti	0.000397	(2; 0.14%)	Ms Wt Ti	0.00127	(2; 0.37%)	Wp Ti	0.0404	(1; 0.6%)
Eq Ti	0.000353	(1; 0.12%)	Gv Ti	0.00122	(1; 0.36%)	Wt Ti	0.0339	(1; 0.5%)
At Wt Ti	0.000325	(2; 0.11%)	Gv Rd Ti	0.0011	(2; 0.32%)	Wa Ms Wt Ti	0.0313	(3; 0.46%)
Ms Ti	0.000311	(1; 0.11%)	Fr Sw Ti	0.00107	(2; 0.31%)	El St Ti	0.0287	(2; 0.42%)
Oi Fo Ti	0.00027	(2; 0.093%)	Bs Ti	0.00105	(1; 0.31%)	Ws Ho Ti	0.0279	(2; 0.41%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Ti	0.0787	(0; 52.%)	Ti	0.0715	(0; 44.%)	Sw Ti	1.0	(1; 60.%)
Sw Ti	0.00902	(1; 6.%)	Rd Ti	0.0111	(1; 6.9%)	Fr Sw Ti	0.177	(2; 11.%)
Rd Ti	0.00394	(1; 2.6%)	Wt Ti	0.00607	(1; 3.7%)	Hw Ti	0.0885	(1; 5.3%)
Hw Ti	0.00275	(1; 1.8%)	Sw Ti	0.00592	(1; 3.6%)	Fr Hw Ti	0.0539	(2; 3.2%)
Wt Ti	0.00195	(1; 1.3%)	St Ti	0.00277	(1; 1.7%)	Ti	0.0157	(0; 0.94%)
Rh Ti	0.00135	(1; 0.9%)	Hw Ti	0.00181	(1; 1.1%)	Bc Mp Ho Ti	0.00551	(3; 0.33%)
St Ti	0.00113	(1; 0.75%)	El Ti	0.00101	(1; 0.62%)	Fr Ti	0.00506	(1; 0.3%)
Fo Ti	0.000912	(1; 0.6%)	Ms Ti	0.000996	(1; 0.61%)	Wo Tx Wt Ti	0.00216	(3; 0.13%)
Fo Sw Ti	0.000824	(2; 0.55%)	Rh Ti	0.000805	(1; 0.5%)	El Ti	0.00214	(1; 0.13%)
Fo Rd Ti	0.000736	(2; 0.49%)	Wt Sw Ti	0.00073	(2; 0.45%)	Rd Ti	0.00192	(1; 0.12%)
Fr Sw Ti	0.000715	(2; 0.47%)	Rf Ti	0.000637	(1; 0.39%)	Bc Mp Ho Rd	0.00131	(4; 0.079%)
Mv Rd Ti	0.000574	(2; 0.38%)	Ms Wt Ti	0.000604	(2; 0.37%)	Bc Mp Ho Wt	0.00124	(4; 0.075%)
Wp Ti	0.000484	(1; 0.32%)	Os Ti	0.000595	(1; 0.37%)	Wo Tx Tp Ti	0.000869	(3; 0.052%)
Ms Ti	0.000457	(1; 0.3%)	Pd Wt Ti	0.000571	(2; 0.35%)	Bc Mp Ch Ti	0.000836	(3; 0.05%)
Ap Ti	0.000423	(1; 0.28%)	In Ti	0.000513	(1; 0.32%)	Bc Mp Wt Ti	0.000822	(3; 0.049%)
El Ti	0.000373	(1; 0.25%)	Ts Ti	0.000487	(1; 0.3%)	Sw Wp Ti	0.000708	(2; 0.042%)
Oc Ti	0.000357	(1; 0.24%)	Fr Sw Ti	0.000469	(2; 0.29%)	Rf Ti	0.000695	(1; 0.042%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.143 ±0.022	(±2.0%)
Downstream	1.296 ±0.047	(±3.6%)



# Sector 2302: Other Wood Products (Wp)

*Plywood, veneers, fibreboard, panels, particle board, roof trusses, parquetry, wall and window frames, doors, pallets, cases, boxes, crates, casks, barrels, handles, moulds and other wood products*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is 25% above average, while water use and land disturbance are respectively 70% and 85% below average. The social indicators of employment generation and income are both 5% above average, while government revenue is over two times the average. For the financial indicators, the operating surplus is 25% below average, the export propensity is 25% below average, and import penetration is 10% below average. While the sector's TBL account could be improved, the production of plywoods and particle boards, and structural strength composite woods present an ideal opportunity for value adding, provided that export markets can be developed and maintained.

## Sector Description

The domestic manufacture of plywoods, particle boards and fibreboards is about 2 million cubic metres per year, with exports of 480 000 m<sup>3</sup> and imports of 370 000 m<sup>3</sup> giving an apparent consumption of about 1.9 million m<sup>3</sup>. This is an attractive proposition in value adding with a financial value of about \$1 000 per tonne (depending on density assumptions) compared to exported woodchips of \$150 per tonne (on a dry weight basis). Such comparisons assume that an export market can be found for the value added product or that the sector's products can substitute for other materials currently used domestically. The embodied energy of particle boards range from 7-22 MJ (10<sup>6</sup>J) per kilogram depending on the degree of processing. Chemicals such as formaldehyde used in the particleboard process, which diffuse slowly after construction, have led to a focus on the indoor air quality of buildings where the sector's products are ultimately consumed. The financial composition of output is plywood (7%), fibre and particle board (24%), joinery products (47%), and assorted products such as pallets and picture frames (21%). In constant dollar terms, the value of joinery products has doubled, and manufactured wood has quadrupled over the last 30 years. Financial turnover in 2002 was about \$5.2 billion, and involved over 2 200 enterprises.

## Place of Industry in the Economy

The wood products sector ranks 58<sup>th</sup> out of 135 sectors and contributes 0.30% of GDP in this analysis. It is similar in value adding to the dairy products and electronic equipment sectors. It is a small employer with 1 000 employment years directly embodied in final demand, and another 1 000 years in the sector's suppliers, giving a total of 2 000 employment years. However, it contributes 26 000 employment years to the final demand of downstream industries such as domestic building, wholesale trade, non-domestic construction, and furniture making. It has small resource requirements with less than one tenth of one percent of national water use, land disturbance, energy use, and greenhouse emissions. In financial terms, the import/export ratio is 3.8:1 in this analysis.

## Strategic Overview

The spider diagram presents a reasonably positive TBL report for the wood products sector with small outliers for greenhouse emissions and export propensity, and average or better than average outcomes for the remaining eight indicators. The combination of labour intensive and more valuable processes such as roof trusses, doors and window frames, and the capital intensive manufacture of plywood and particle boards, are responsible for the outcome. Improvements in the export or import indicators may further improve the social indicators, but may increase greenhouse emissions.

## TBL Account #1

The financial indicator of operating surplus is 25% below average and composed of a direct sector effect of 33%, with contributions from sawn timber (6%), wholesale trade (4%), forwarding and storage (3%), road transport (2%), electricity production (2%) and nuts and bolts (1%). The social indicator of employment generation is 5% above average, with a direct effect of 47% and a composition similar to operating surplus. The environmental indicator of greenhouse emissions is 25% above average and discussed in more detail below.

## TBL Accounts #2 and #3

The second TBL account reveals that the export propensity is 25% below average, income is 5% above average, and water use is 70% below average. The third TBL account reveals that import penetration is 10% below average, government revenue is more than two times the average, and land disturbance is 85% below average. A lower than average operating surplus is possibly tied to higher than average social indicators of employment generation, income, and government revenue, but also to domestic and international price competition both with other wood products such as sawn timber, and also for building material substitutes produced by other non-wood sectors.

## Structural Path Analysis and Linkages

The greenhouse emissions indicator is above average. The structural path shows that the direct sector effect is 6%, so that energy savings in the factory, while advantageous, are not going to give large reductions. The softwood plantation chain is the biggest component with 'softwoods-wood products' (13%), 'softwoods-sawn timber-wood products' (11%) and 'harvesting-softwoods-wood products' (6%), giving a total of 30%. The hardwoods chain represents 9% of total. Other contributors include electricity production (11%), wholesale trade (1%), road transport (1%) and basic chemicals (1%). Reducing emissions will require new harvesting and waste product processes.

The sector's stimulus to its upstream suppliers is 25% greater than average and impacts on sawn timber, wholesale trade, road transport, accounting and marketing and property development. The linkages to downstream industries are nearly 40% greater than average, and suggest that expansion in this sector must be led by expansion in obvious sectors such as domestic building, wholesale trade, ownership of dwellings, furniture making, and non-domestic construction.

## Future Trends in Sector

While the *Future Dilemmas* study did not model this sector in detail, three drivers suggest a reasonably optimistic future out to 2050. Firstly, the combined floor area of domestic, commercial, and institutional space doubles by 2050. Secondly, the forestry planting regimes are set to exceed the national *Forestry 2020 Vision* and to provide a positive wood products balance. Thirdly, the wood composition of new buildings is assumed to have similar total requirement for wood as today's designs (but not necessarily the same wood products), and will thus grow slowly in line with population and building replacement. It is possible that building designs may change and be driven by the embodied greenhouse content in materials. For a Victorian residential building, comparing the total embodied energy in a light timber design (1 427 GJ) with a cavity brick construction (2 063 GJ) showed a 45% difference. The energy payback period (embodied energy in construction divided by annual operating energy) was several decades shorter for timber, compared to brick construction.

## Innovation and Technical Opportunities

The combination of wood, wood fibre and synthetic materials, particularly for structural building elements, will advance rapidly. The wood materials in future buildings could be re-designed from first principles to allow an almost full recyclability on a 'cradle-to-cradle' life cycle basis.

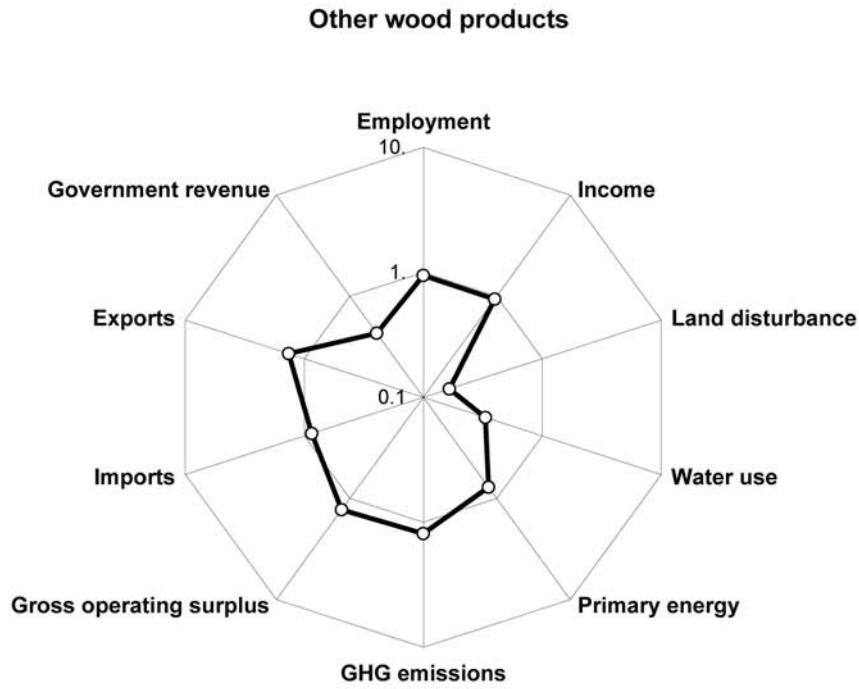
**Sector**

**Other wood products**

**(Wp)**

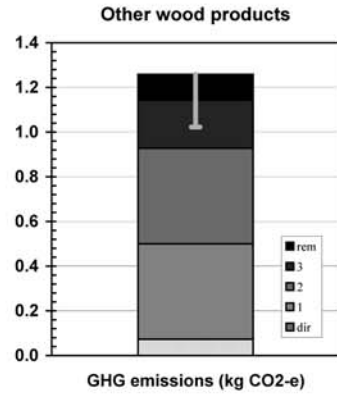
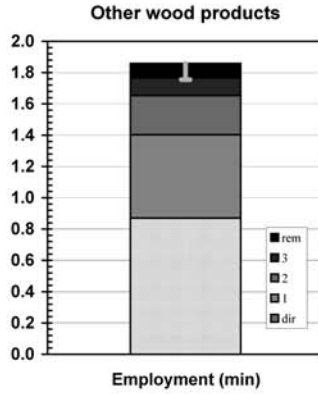
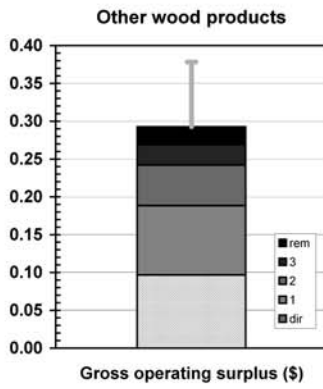
Plywood, veneers, fibreboard, panels, particle board, roof trusses, parquetry, wall and window frames, doors, pallets, cases, boxes, crates, casks, barrels, handles, moulds and other wood products

**Spider diagram**

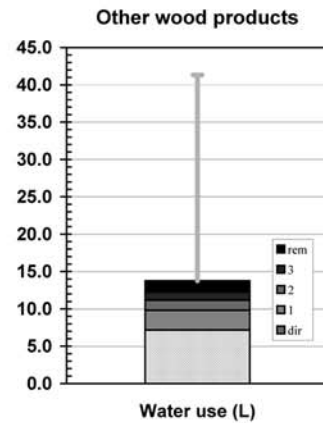
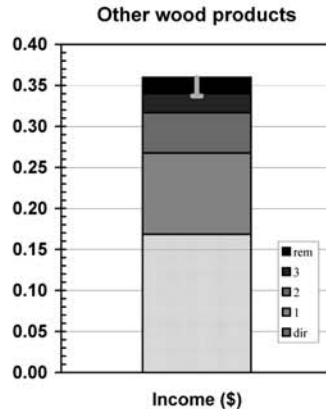
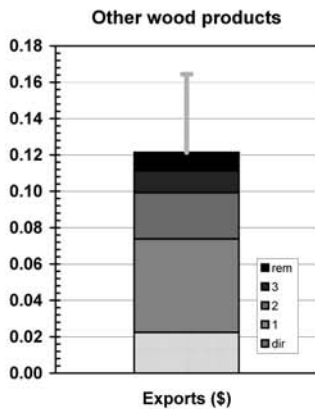


**Bar graphs**

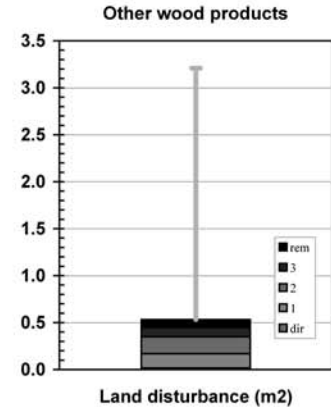
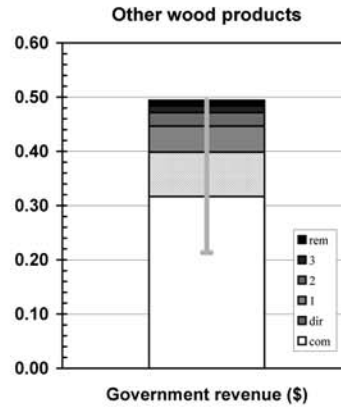
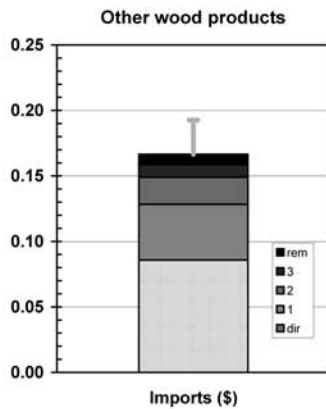
**Account #1**



**Account #2**



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 55.3	(0.02% of total)	(\$m 29.6 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 44.0	(0.04% of total)	(\$m 43.8 domestically produced)
Net changes in stocks	\$m 0.3	(0.02% of total)	
<b>Sectoral GNE</b>	<b>\$m 99.5</b>	<b>(0.02% of GNE)</b>	<b>(\$m 69.6 domestically produced)</b>
Exports	\$m 85.9	(0.10% of total)	(\$m 85.9 domestically produced)
<b>Final demand</b>	<b>\$m 185.4</b>	<b>(0.03% of GNT)</b>	<b>(\$m 155.5 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 645.5	(0.38% of total)
Gross operating surplus	\$m 370.8	(0.19% of total)
Taxes less subsidies	\$m 314.1	(0.37% of total)
<b>Sectoral GDP*</b>	<b>\$m 1,330.4</b>	<b>(0.30% of GDP)</b>
Imports	\$m 328.5	(0.34% of total)
<b>Primary inputs</b>	<b>\$m 1,658.9</b>	<b>(0.30% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct (% of national)	total (% of national)
Gross operating surplus (\$m)	\$m 370.8	(0.19%)	\$m 15.4 (0.01%)	\$m 46.6 (0.02%)
Exports (\$m)	\$m 85.9	(0.10%)	\$m 3.6 (0.00%)	\$m 19.3 (0.02%)
Imports (\$m)	\$m 328.5	(0.34%)	\$m 13.6 (0.01%)	\$m 26.5 (0.03%)
Employment (e-y)	26,725 e-y	(0.37%)	1,110 e-y (0.02%)	2,372 e-y (0.03%)
Income (\$m)*	\$m 645.5	(0.38%)	\$m 26.8 (0.02%)	\$m 57.3 (0.03%)
Government revenue (\$m)†	\$m 364.5	(0.34%)	\$m 63.5 (0.06%)	\$m 78.7 (0.07%)
GHG emissions (kt CO <sub>2</sub> -e)	279 kt	(0.05%)	12 kt (0.00%)	200 kt (0.04%)
Water use (ML)	27,467 ML	(0.13%)	1,141 ML (0.01%)	2,192 ML (0.01%)
Land disturbance (kha)	6 kha	(0.00%)	0 kha (0.00%)	8 kha (0.01%)
Primary energy (TJ)	2,252 TJ	(0.06%)	94 TJ (0.00%)	943 TJ (0.02%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.10	0.29	0.38
Exports (\$)	0.02	0.12	0.16
Imports (\$)	0.09	0.17	0.19
Employment (min)	0.87	1.86	1.75
Income (\$)	0.17	0.36	0.34
Government revenue (\$)	0.40	0.49	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.07	1.26	1.02
Water use (L)	7.16	13.76	41.32
Land disturbance (m <sup>2</sup> )	0.01	0.53	3.21
Primary energy (MJ)	0.59	5.92	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

### Structural Paths (intensities - commodities)

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Wp	0.0967	(0; 33.%)	Wp	0.87	(0; 47.%)	Sw Wp	0.159	(1; 13.%)
Ti Wp	0.0172	(1; 5.9%)	Ti Wp	0.112	(1; 6.%)	Sw Ti Wp	0.142	(2; 11.%)
Wt Wp	0.0121	(1; 4.1%)	Wt Wp	0.0868	(1; 4.7%)	El Wp	0.131	(1; 10.%)
St Wp	0.00751	(1; 2.6%)	Fm Wp	0.0403	(1; 2.2%)	Wp	0.0727	(0; 5.8%)
Rd Wp	0.0063	(1; 2.2%)	Rd Wp	0.037	(1; 2.%)	Fr Sw Wp	0.0687	(2; 5.5%)
El Wp	0.00529	(1; 1.8%)	Sm Wp	0.0155	(1; 0.83%)	Fr Sw Ti Wp	0.0613	(3; 4.9%)
Fm Wp	0.00363	(1; 1.2%)	Rh Wp	0.014	(1; 0.75%)	Ti Wp	0.0377	(1; 3.%)
Ms Wp	0.00277	(1; 0.95%)	Sw Wp	0.0126	(1; 0.68%)	Hw Wp	0.0346	(1; 2.7%)
Pt Wp	0.00238	(1; 0.81%)	Ms Wp	0.0124	(1; 0.67%)	Fr Hw Wp	0.0338	(2; 2.7%)
St Wt Wp	0.0023	(2; 0.79%)	St Wp	0.0123	(1; 0.66%)	Hw Ti Wp	0.0191	(2; 1.5%)
Rh Wp	0.00229	(1; 0.78%)	Sw Ti Wp	0.0113	(2; 0.61%)	Fr Hw Ti Wp	0.0187	(3; 1.5%)
Cp Wp	0.00178	(1; 0.61%)	Bs Wp	0.0102	(1; 0.55%)	El Ti Wp	0.0148	(2; 1.2%)
Sm Wp	0.00177	(1; 0.6%)	Rd Ti Wp	0.0102	(2; 0.55%)	Wt Wp	0.012	(1; 0.96%)
Sw Wp	0.00175	(1; 0.6%)	Ms Wt Wp	0.00783	(2; 0.42%)	Rd Wp	0.01	(1; 0.79%)
Ms Wt Wp	0.00175	(2; 0.6%)	Wt Ti Wp	0.00675	(2; 0.36%)	Ch Wp	0.00702	(1; 0.56%)
Oc Wp	0.00175	(1; 0.6%)	Hw Wp	0.00622	(1; 0.33%)	Is Fm Wp	0.00586	(2; 0.47%)
Rd Ti Wp	0.00173	(2; 0.59%)	El Wp	0.00588	(1; 0.32%)	Is Sm Wp	0.00503	(2; 0.4%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Wp	0.0224	(0; 18.%)	Wp	0.168	(0; 47.%)	Wp	7.16	(0; 52.%)
Ti Wp	0.0224	(1; 18.%)	Wt Wp	0.0186	(1; 5.2%)	El Wp	0.723	(1; 5.3%)
Wt Wp	0.00985	(1; 8.1%)	Ti Wp	0.0182	(1; 5.1%)	Wa Wp	0.462	(1; 3.4%)
Rd Wp	0.00219	(1; 1.8%)	Rd Wp	0.00636	(1; 1.8%)	Ti Wp	0.194	(1; 1.4%)
Fm Wp	0.00208	(1; 1.7%)	Fm Wp	0.00632	(1; 1.8%)	Sm Wp	0.0982	(1; 0.71%)
St Wp	0.00186	(1; 1.5%)	St Wp	0.00313	(1; 0.87%)	El Ti Wp	0.0818	(2; 0.59%)
Nf Wp	0.00156	(1; 1.3%)	Ms Wp	0.00289	(1; 0.8%)	Wa Ms Wp	0.0712	(2; 0.52%)
Oc Wp	0.00155	(1; 1.3%)	Sm Wp	0.00267	(1; 0.74%)	Fm Wp	0.0557	(1; 0.41%)
Bl El Wp	0.00128	(2; 1.1%)	Ms Wt Wp	0.00182	(2; 0.51%)	Wt Wp	0.0485	(1; 0.35%)
Ch Wp	0.000817	(1; 0.67%)	Rd Ti Wp	0.00175	(2; 0.49%)	Wa Ms Wt Wp	0.0449	(3; 0.33%)
Wt Ti Wp	0.000766	(2; 0.63%)	Sw Wp	0.00168	(1; 0.47%)	Wa El Wp	0.0418	(2; 0.3%)
Lg Wp	0.000671	(1; 0.55%)	El Wp	0.00159	(1; 0.44%)	Wa Pd Wt Wp	0.0378	(3; 0.27%)
Rd Ti Wp	0.000603	(2; 0.5%)	Rh Wp	0.00153	(1; 0.43%)	St Wp	0.0324	(1; 0.24%)
St Wt Wp	0.00057	(2; 0.47%)	Sw Ti Wp	0.0015	(2; 0.42%)	Pp Wp	0.0322	(1; 0.23%)
Sm Wp	0.000546	(1; 0.45%)	Wt Ti Wp	0.00145	(2; 0.4%)	Wa Bs Wp	0.0313	(2; 0.23%)
Nf Fm Wp	0.000532	(2; 0.44%)	Bs Wp	0.00126	(1; 0.35%)	Wa Oc Wp	0.0277	(2; 0.2%)
At Wp	0.000528	(1; 0.43%)	Pd Wt Wp	0.00125	(2; 0.35%)	Rd Wp	0.0263	(1; 0.19%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Wp	0.0857	(0; 51.%)	Wp	0.0819	(0; 46.%)	Sw Wp	0.125	(1; 24.%)
Ti Wp	0.00877	(1; 5.3%)	Wt Wp	0.00871	(1; 4.9%)	Sw Ti Wp	0.112	(2; 21.%)
Wt Wp	0.0028	(1; 1.7%)	Ti Wp	0.00796	(1; 4.5%)	Fr Sw Wp	0.0221	(2; 4.2%)
Fm Wp	0.00273	(1; 1.6%)	Rd Wp	0.00452	(1; 2.5%)	Fr Sw Ti Wp	0.0197	(3; 3.7%)
Pt Wp	0.0026	(1; 1.6%)	Fm Wp	0.0022	(1; 1.2%)	Hw Wp	0.0179	(1; 3.4%)
Oc Wp	0.0024	(1; 1.4%)	St Wp	0.00167	(1; 0.94%)	Wp	0.0147	(0; 2.8%)
Rd Wp	0.0016	(1; 0.96%)	Ms Wp	0.00137	(1; 0.77%)	Fr Hw Wp	0.0109	(2; 2.%)
Sm Wp	0.00127	(1; 0.76%)	Rd Ti Wp	0.00124	(2; 0.7%)	Hw Ti Wp	0.00986	(2; 1.9%)
Rh Wp	0.00118	(1; 0.71%)	Sm Wp	0.00102	(1; 0.58%)	Fr Hw Ti Wp	0.00601	(3; 1.1%)
Sw Wp	0.00113	(1; 0.68%)	El Wp	0.000992	(1; 0.56%)	Bc Mp Ho Wp	0.00515	(3; 0.97%)
Sw Ti Wp	0.00101	(2; 0.6%)	Ms Wt Wp	0.000865	(2; 0.49%)	Wo Tx Wt Wp	0.00309	(3; 0.58%)
Ch Wp	0.000818	(1; 0.49%)	Pd Wt Wp	0.000818	(2; 0.46%)	Bc Mp Ch Wp	0.00279	(3; 0.53%)
Pl Wp	0.00081	(1; 0.49%)	Sw Wp	0.00074	(1; 0.42%)	Wo Tx Tp Wp	0.00246	(3; 0.46%)
St Wp	0.00068	(1; 0.41%)	Oc Wp	0.000734	(1; 0.41%)	El Wp	0.00211	(1; 0.4%)
Ms Wp	0.00063	(1; 0.38%)	Rh Wp	0.000704	(1; 0.4%)	Bc Mp Ho Wt	0.00178	(4; 0.34%)
Hw Wp	0.000555	(1; 0.33%)	Wt Ti Wp	0.000677	(2; 0.38%)	Ti Wp	0.00175	(1; 0.33%)
Rd Ti Wp	0.000439	(2; 0.26%)	Sw Ti Wp	0.00066	(2; 0.37%)	Bc Mp Rt Wp	0.0017	(3; 0.32%)

### Linkages (average = 1)

	Value	C.o.V.
Upstream	1.263 ±0.022	(±1.7%)
Downstream	1.367 ±0.046	(±3.4%)

# Sector 2303: Pulp, Paper and Paperboard (Pp)

*Pulp, newsprint, paper and paperboard*

## Short Summary

This is the primary production sector for the paper industry and most of the final demand or consumption activity occurs in downstream sectors. The greenhouse emissions indicator is over three times the economy wide average. One quarter of emissions are derived from within the sector (i.e. the factory) with the remainder from the production chain including softwood plantations, harvesting, transport, electricity supplied to the factory, and a small part due to hardwood plantations. Water use is 15% below average while land disturbance is 60% below average. For the social indicators, employment and income are 40% and 30% below average respectively, while government revenue is nearly seven times the average. The financial indicators show that operating surplus is 10% below average, while export propensity is 45% below average and import penetration is 15% above average. The sector shows strong downstream linkages to the printing, wholesale and retail trade, government administration and newspapers and books sectors. Increased consumer demand shows moderate upstream linkages to its suppliers. A number of issues such as biodiversity, old growth logging, and bleaching agents used, lie outside the scope of this analysis.

## Sector Description

Australia consumes 3.6 million tonnes of paper products per year or about 180 kg per capita. There are six major paper companies in Australia with 18 paper mills, 14 of which use recycled paper as inputs. We produce about 60% of our requirements and 40% (by weight) is imported. The financial value of imports is \$2.8 billion and exports are \$0.7 billion currently giving a trade deficit of \$2.1 billion. More than 1.6 million tonnes of paper is recycled each year with over 70% of newsprint recycled. The recycled content of domestic packaging is 100%, newsprint varies from 22-55%, tissues have 12% and printing papers are around 10%. Under an appropriate pricing regime, Australia could be self sufficient in paper products if processing was expanded and woodchips diverted from exports.

## Place of Industry in the Economy

The pulp and paper sector ranks 84<sup>th</sup> out of 135 in terms of value adding in the economy and contributes 0.16% of GDP in this analysis. The industry is a small generator of employment with 1 000 employment years in both direct and indirect sector activity, and 7 000 employment years contributed to the final demand in downstream sectors. The sector's requirement for energy and water, and generation of greenhouse emissions and land disturbance, is less than one tenth of one percent of national totals. In financial terms, imports are five times exports.

## Strategic Overview

The integrated overview provided by the spider diagram gives a mixed result with below average outcomes in financial, social and environmental areas. Many of these issues may only be resolved through structural adjustments at higher levels, rather than managerial and technical fixes within the sector. In the financial area, the industry has lobbied government for special procurement guidelines (similar to that for locally produced motor vehicles) to give the industry some advantage over low wage countries with weaker workplace and environment standards. Full resource pricing may encourage further improvement of the environmental indicators. The basic or factory gate prices for paper products would need to double to reduce the primary energy use and greenhouse emissions indicators to a level within easy reach of technological solutions.

## TBL Account #1

The financial indicator of surplus is 10% below average with a direct effect of one half and contributions from first order suppliers such as electricity production (5%), softwoods (3%), road transport (3%), storage (2%) and natural gas (1%). The social indicator of employment generation is 40% below average with one third a direct effect. This reflects in part, the capital intensive nature of paper plants, and the intense global competition in the sector. The greenhouse indicator is over three times the economy wide average, and one quarter is a direct within-plant effect with the remainder due to the supply chain.

## TBL Accounts #2 and #3

In the second TBL account, export propensity, income and water use are respectively 45%, 30% and 15% below average. In the third TBL account, import penetration is 15% below average. The land disturbance indicator is 60% below average, reflecting intensive plantation management and high amounts of paper recycling. The government revenue indicator is nearly seven times the average and may at first seem an anomalous result. Further examination reveals that this is due to the application of a 'wholesale sales tax' (now replaced by the GST) to a range of intermediate inputs such as paper and transport. When a ratio is made against the dollar value of final consumption (which is low because most final consumption occurs in other sectors) then the resultant government revenue value is higher than expected.

## Structural Path Analysis and Linkages

Examination of the structural path for greenhouse gases reveals that emissions from paper factories and softwood plantations are roughly equal, at one quarter each. Harvesting activities in softwood plantations and electricity production (external to the factory) are the next most important at 12% and 11% respectively. Hardwood plantations (4%) and lime production (2%) are followed by 1% contributions from basic chemicals, natural gas and road transport.

Increases in consumer demand give average upstream linkages to sectors such as softwood plantations, recycled paper, electricity, wholesale trade and road freight. The sector shows strong downstream linkages so that paper containers, printing, wholesale and retail trade, government administration, and newspapers and books, must also expand to dissipate the effect of any additional investment into the sector.

## Future Trends in Sector

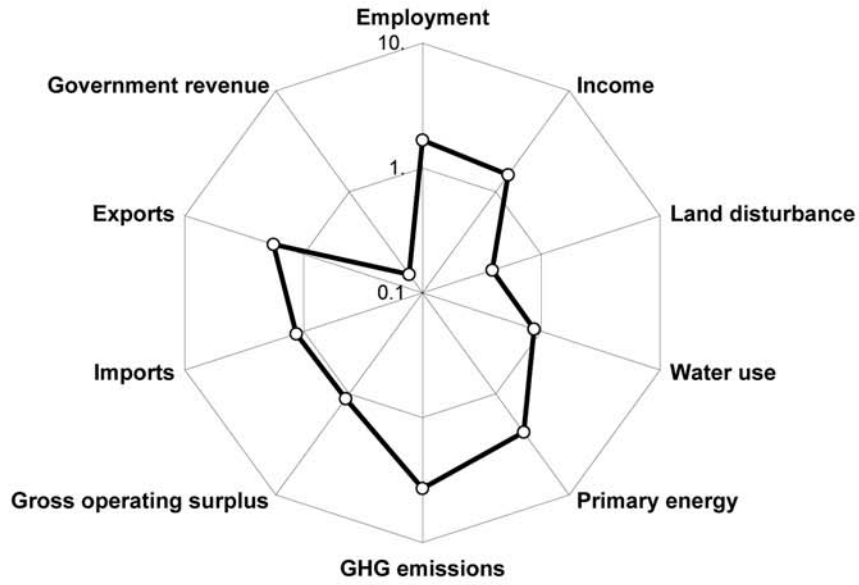
The base case scenario in the *Future Dilemmas* study anticipates an increase of 70% in the total requirement for paper products by 2050. This is due to an increase in population to 25 million as well as growth of 40% in per capita usage, a little under 1% per annum. This would grow the total requirement to over six million tonnes per annum in 2050. Small improvements in recycling with a steady expansion of the forest estate would make this feasible and could also allow a progress towards paper products self sufficiency at a national level and a positive trade balance.

## Innovation and Technical Opportunities

The domestic pulp and paper sector in Australia covers a wide range of mill, process and feedstock specific contexts that are missed in this analysis. For example, the state of the art mill at Tumut will report lower water and greenhouse indicators than the average values reported here. It is worth noting that for many of the TBL indicators, the within plant components represent one third of the total effect. Therefore improvements should focus on the supply chain as well as the manufacturing plant itself. Since paper is a global industry, there is a competitive requirement for high environmental standards, and the industry will not readily accept environmental laggards.

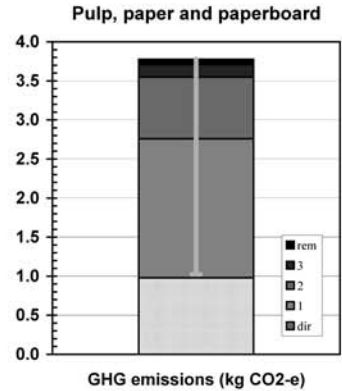
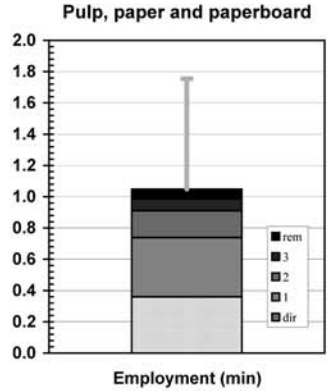
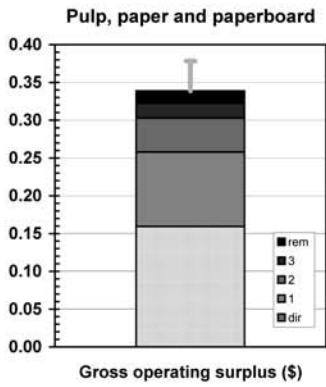
Spider diagram

Pulp, paper and paperboard

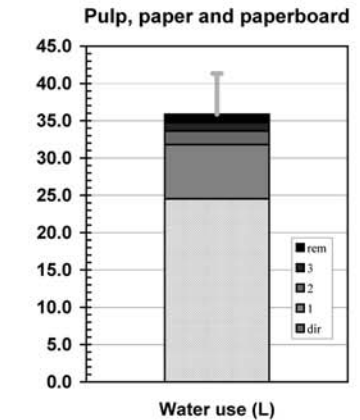
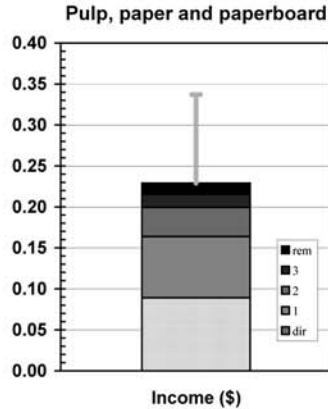
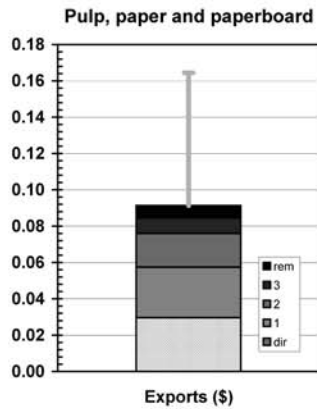


Bar graphs

Account #1

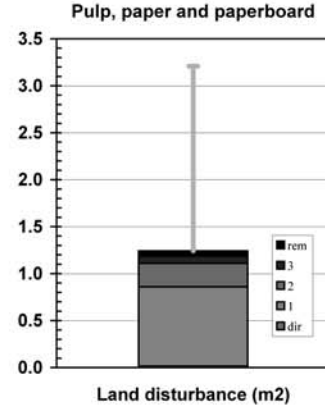
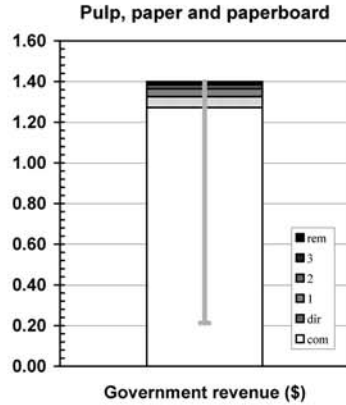
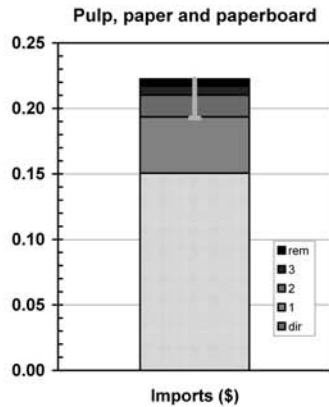


Account #2





Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 74.1	(0.03% of total)	(\$m 43.7 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 17.0	(0.02% of total)	(\$m 17.0 domestically produced)
Net changes in stocks	-\$m 161.0	-(9.11% of total)	
<b>Sectoral GNE</b>	<b>-\$m 70.0</b>	<b>(0.02% of GNE)</b>	
Exports	\$m 70.5	(0.08% of total)	(\$m 70.5 domestically produced)
<b>Final demand</b>	<b>\$m 0.5</b>	<b>(0.00% of GNT)</b>	<b>(\$m 14.0 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 211.9	(0.12% of total)
Gross operating surplus	\$m 378.6	(0.20% of total)
Taxes less subsidies	\$m 127.1	(0.15% of total)
<b>Sectoral GDP*</b>	<b>\$m 717.5</b>	<b>(0.16% of GDP)</b>
Imports	\$m 357.6	(0.37% of total)
<b>Primary inputs</b>	<b>\$m 1,075.1</b>	<b>(0.20% of GNT)</b>

\* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 378.6	(0.20%)	\$m 20.9 (0.01%)	\$m 44.4 (0.02%)
Exports (\$m)	\$m 70.5	(0.08%)	\$m 3.9 (0.00%)	\$m 12.0 (0.01%)
Imports (\$m)	\$m 357.6	(0.37%)	\$m 19.7 (0.02%)	\$m 29.2 (0.03%)
Employment (e-y)	6,849 e-y	(0.10%)	378 e-y (0.01%)	1,102 e-y (0.02%)
Income (\$m)*	\$m 211.9	(0.12%)	\$m 11.7 (0.01%)	\$m 30.0 (0.02%)
Government revenue (\$m)†	\$m 293.8	(0.27%)	\$m 173.8 (0.16%)	\$m 183.4 (0.17%)
GHG emissions (kt CO <sub>2</sub> -e)	2,329 kt	(0.45%)	128 kt (0.02%)	495 kt (0.10%)
Water use (ML)	58,249 ML	(0.28%)	3,213 ML (0.02%)	4,701 ML (0.02%)
Land disturbance (kha)	3 kha	(0.00%)	0 kha (0.00%)	16 kha (0.01%)
Primary energy (TJ)	20,555 TJ	(0.53%)	1,134 TJ (0.03%)	2,402 TJ (0.06%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.16	0.34	0.38
Exports (\$)	0.03	0.09	0.16
Imports (\$)	0.15	0.22	0.19
Employment (min)	0.36	1.05	1.75
Income (\$)	0.09	0.23	0.34
Government revenue (\$)	1.33	1.40	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.98	3.78	1.02
Water use (L)	24.51	35.86	41.32
Land disturbance (m <sup>2</sup> )	0.01	1.24	3.21
Primary energy (MJ)	8.65	18.32	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)		Employment (min/\$)		GHG emissions (kg CO <sub>2</sub> -e/\$)	
Pp	0.159 (0; 47.%)	Pp	0.36 (0; 34.%)	Sw Pp	1.0 (1; 27.%)
El Pp	0.0167 (1; 4.9%)	Sw Pp	0.0797 (1; 7.6%)	Pp	0.98 (0; 26.%)
Sw Pp	0.011 (1; 3.3%)	Rd Pp	0.0489 (1; 4.7%)	Fr Sw Pp	0.433 (2; 11.%)
Rd Pp	0.00833 (1; 2.5%)	Wt Pp	0.0312 (1; 3.%)	El Pp	0.413 (1; 11.%)
St Pp	0.00629 (1; 1.9%)	El Pp	0.0185 (1; 1.8%)	Hw Pp	0.079 (1; 2.1%)
Ng Pp	0.00475 (1; 1.4%)	Hw Pp	0.0142 (1; 1.4%)	Fr Hw Pp	0.0772 (2; 2.%)
Wt Pp	0.00433 (1; 1.3%)	Fm Pp	0.0124 (1; 1.2%)	Lm Pp	0.0652 (1; 1.7%)
Ga Pp	0.00421 (1; 1.2%)	Os Pp	0.0118 (1; 1.1%)	Ch Pp	0.0291 (1; 0.77%)
Wa Pp	0.00297 (1; 0.88%)	St Pp	0.0103 (1; 0.98%)	Ga Pp	0.0289 (1; 0.76%)
Bl El Pp	0.00266 (2; 0.78%)	Bs Pp	0.00954 (1; 0.91%)	Ng Pp	0.0216 (1; 0.57%)
Ch Pp	0.00243 (1; 0.72%)	Sm Pp	0.00823 (1; 0.78%)	Rd Pp	0.0132 (1; 0.35%)
Br Pp	0.00235 (1; 0.69%)	Pa Pp	0.00781 (1; 0.74%)	Gd Pp	0.0128 (1; 0.34%)
Lg Pp	0.0021 (1; 0.62%)	Ch Pp	0.00709 (1; 0.68%)	Bl El Pp	0.0104 (2; 0.28%)
Hw Pp	0.00197 (1; 0.58%)	Gv Pp	0.00675 (1; 0.64%)	Sw Ti Pp	0.00575 (2; 0.15%)
Ms Pp	0.00146 (1; 0.43%)	Ms Pp	0.00657 (1; 0.63%)	Lg Pp	0.005 (1; 0.13%)
Rv Sw Pp	0.00135 (2; 0.4%)	Fr Sw Pp	0.00631 (2; 0.6%)	El Ch Pp	0.00439 (2; 0.12%)
Pa Pp	0.00115 (1; 0.34%)	Pi Pp	0.0063 (1; 0.6%)	Wt Pp	0.00432 (1; 0.11%)

Exports (\$/\$)		Income (\$/\$)		Water use (L/\$)	
Pp	0.0296 (0; 32.%)	Pp	0.0891 (0; 39.%)	Pp	24.5 (0; 68.%)
Bl El Pp	0.00403 (2; 4.4%)	Sw Pp	0.0106 (1; 4.6%)	El Pp	2.28 (1; 6.4%)
Wt Pp	0.00354 (1; 3.9%)	Rd Pp	0.00841 (1; 3.7%)	Wa Pp	2.18 (1; 6.1%)
Ch Pp	0.00339 (1; 3.7%)	Wt Pp	0.00669 (1; 2.9%)	Br Pp	0.189 (1; 0.53%)
Rd Pp	0.0029 (1; 3.2%)	El Pp	0.00502 (1; 2.2%)	Sc Cg Sw Pp	0.164 (3; 0.46%)
Sw Pp	0.00265 (1; 2.9%)	Os Pp	0.0033 (1; 1.4%)	Sw Pp	0.139 (1; 0.39%)
Lg Pp	0.00246 (1; 2.7%)	St Pp	0.00262 (1; 1.1%)	Wa El Pp	0.132 (2; 0.37%)
St Pp	0.00156 (1; 1.7%)	Fm Pp	0.00194 (1; 0.85%)	Ch Pp	0.0889 (1; 0.25%)
Rf Pp	0.00107 (1; 1.2%)	Hw Pp	0.00189 (1; 0.82%)	Bl El Pp	0.0539 (2; 0.15%)
Pc Pp	0.00092 (1; 1.%)	Pa Pp	0.00179 (1; 0.78%)	Sm Pp	0.0522 (1; 0.15%)
Ti Pp	0.000907 (1; 0.99%)	Pi Pp	0.00177 (1; 0.77%)	Pp Pa Pp	0.0475 (2; 0.13%)
Bl Pp	0.00085 (1; 0.93%)	Gv Pp	0.0017 (1; 0.74%)	Pa Pp	0.045 (1; 0.13%)
Wt Sw Pp	0.000651 (2; 0.71%)	Ga Pp	0.00163 (1; 0.71%)	Ng Pp	0.0424 (1; 0.12%)
Fm Pp	0.000637 (1; 0.7%)	Ms Pp	0.00153 (1; 0.67%)	Bc Mp Ch Pp	0.042 (3; 0.12%)
Oi Pc Pp	0.00058 (2; 0.64%)	Ch Pp	0.0015 (1; 0.66%)	Wa Ms Pp	0.0377 (2; 0.11%)
Pa Pp	0.00047 (1; 0.51%)	Rf Pp	0.00146 (1; 0.64%)	Ws Ho Pp	0.0367 (2; 0.1%)
Eq Sw Pp	0.000416 (2; 0.46%)	Gd Pp	0.00142 (1; 0.62%)	Rd Pp	0.0347 (1; 0.097%)

Imports (\$/\$)		Government revenue (\$/\$)		Land disturbance (m <sup>2</sup> /(\$))	
Pp	0.15 (0; 68.%)	Pp	0.0535 (0; 42.%)	Sw Pp	0.79 (1; 64.%)
Sw Pp	0.00711 (1; 3.2%)	Rd Pp	0.00597 (1; 4.7%)	Fr Sw Pp	0.139 (2; 11.%)
Ch Pp	0.00339 (1; 1.5%)	Sw Pp	0.00466 (1; 3.7%)	Hw Pp	0.0408 (1; 3.3%)
Pa Pp	0.00225 (1; 1.%)	El Pp	0.00313 (1; 2.5%)	Fr Hw Pp	0.0248 (2; 2.%)
Rd Pp	0.00211 (1; 0.95%)	Wt Pp	0.00313 (1; 2.5%)	Pp	0.0139 (0; 1.1%)
Pc Pp	0.00196 (1; 0.88%)	Os Pp	0.00153 (1; 1.2%)	Bc Mp Ch Pp	0.0116 (3; 0.93%)
Fo Pp	0.00134 (1; 0.6%)	St Pp	0.0014 (1; 1.1%)	Bc Mp Ho Pp	0.00725 (3; 0.58%)
Hw Pp	0.00127 (1; 0.57%)	Pa Pp	0.000944 (1; 0.74%)	El Pp	0.00666 (1; 0.54%)
El Pp	0.00116 (1; 0.52%)	Hw Pp	0.000831 (1; 0.65%)	Bc Ch Pp	0.00582 (2; 0.47%)
Wt Pp	0.00101 (1; 0.45%)	Ga Pp	0.00083 (1; 0.65%)	Sw Ti Pp	0.00452 (2; 0.36%)
Fm Pp	0.000837 (1; 0.38%)	Pi Pp	0.000813 (1; 0.64%)	Wo Tx Tp Pp	0.00211 (3; 0.17%)
Sm Pp	0.000674 (1; 0.3%)	Ch Pp	0.00075 (1; 0.59%)	Sw Pp Pa Pp	0.00153 (3; 0.12%)
Fo Sw Pp	0.000649 (2; 0.29%)	Ms Pp	0.000726 (1; 0.57%)	Wo Mp Ch Pp	0.00131 (3; 0.11%)
St Pp	0.00057 (1; 0.26%)	Fm Pp	0.000676 (1; 0.53%)	Gd Pp	0.0012 (1; 0.097%)
Fr Sw Pp	0.000563 (2; 0.25%)	Rf Pp	0.000672 (1; 0.53%)	Wo Tx Wt Pp	0.00111 (3; 0.089%)
Oc Pp	0.000505 (1; 0.23%)	Gd Pp	0.000659 (1; 0.52%)	Wa Pp	0.00108 (1; 0.087%)
Wa Pp	0.000452 (1; 0.2%)	Wa Pp	0.000642 (1; 0.5%)	Rd Pp	0.00103 (1; 0.083%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	0.986 ±0.014	(±1.5%)
Downstream	2.339 ±0.047	(±2.0%)

# Sector 2304: Paper Containers and Products (Pa)

*Paper and paperboard containers, corrugated sheeting, toilet paper, tissues, serviettes, towels, dishes, cups, box files, decoration, wallpaper and other paper products*

## Short Summary

Against the metric of one dollar of final demand the environmental indicator of greenhouse emissions is 20% greater than average, while water use and land disturbance are respectively 70% and 85% below average. The social indicator of employment generation is 25% below average, income is 15% below average and government revenue is 10% above average. For the financial indicators, operating surplus and export propensity are 30% and 40% below average respectively, while import penetration is 40% above average. The challenge for the sector is to transfer successes such as recycled paperboard to the market advantage of higher value products in the sector.

## Sector Description

In financial terms, the products from this sector include solid and corrugated paperboard boxes (57%), paper bags (8%), tissues (18%), paper plates and box files (3%) and assorted products such as wallpaper, adhesive paper and decorations (14%). In physical terms, about 250 000 tonnes per year of tissue-like products are consumed, and 50 000 tonnes of these are imported. Nearly 1.5 million tonnes of packaging board are consumed, with about 300 000 tonnes both imported and exported. About 12% of tissue production is recycled paper, and industry sources note that thinnings from plantation pines make up 80% of the feedstock, and hardwood plantations the remainder. Over 60% of the fibre used in paper production in Australia is recycled, and paperboard has a 100% recycled content. One tonne of paperboard requires 1.9 tonnes of pulpwood and 70 tonnes of water if made from virgin materials, or 1.1 tonnes of recycled paper and 60 tonnes of water if it is recycled. The turnover was about \$3.8 billion in 2002 and involved more than 100 enterprises.

## Place of Industry in the Economy

The paper containers and products sector ranks 72<sup>nd</sup> out of 135 sectors in terms of value adding in the economy, and contributes 0.21% to GDP in this analysis. It is similar in value adding to the beer and malt, and the vegetable and fruit preserving sectors. It is a moderate sized employer with 4 000 employment years directly embodied in final demand, and another 4 000 years in the sector's upstream suppliers giving a total of 8 000 employment years. In addition, it contributes 11 000 employment years to the final demand of downstream industries such as wholesale and retail trade, accommodation cafes and restaurants, wine and spirit manufacture, and government administration. It has small resource requirements with less than one tenth of one percent of national water use and land disturbance, but two tenths of one percent of energy use and greenhouse emissions. In financial terms, imports are four times the level of exports.

## Strategic Overview

The spider diagram portrays a sector with below average outcomes in eight out of ten TBL indicators. An analysis of today's data may show significant improvement in the energy and greenhouse indicators with the commissioning of a number of technically advanced paperboard manufacturing plants, and improved recycling rates. The trade deficit in pulp, paper and paperboard products is about \$2 billion although much of this is for newsprint and finer papers, and not for paper containers. The financial and social indicators of the sector may present ongoing challenges.

## TBL Account #1

The financial indicator of operating surplus is 30% below average with an extended production chain including the direct effect (35%), pulp and paper (9%), forwarding and storage (6%), wholesale trade (3%), electricity production (3%) and accounting and marketing (2%). The employment indicator is 25% below average, with half of the effect being direct, and the remainder having a similar composition to the surplus indicator. The greenhouse emissions indicator is 20% above average, and is discussed in more detail below.

## TBL Accounts #2 and #3

The second TBL account shows an export propensity 40% below average, income that is 15% below average, and water use that is 70% below average. The third TBL account reveals an import penetration indicator that is 40% above average, government revenue that is 10% above average and land disturbance that is 85% below average. Higher levels of import penetration will usually advantage the environmental indicators, and disadvantage the social indicators.

## Structural Path Analysis and Linkages

Analysis of the greenhouse chain shows that the direct sector effect is 15% with softwood supply chain contributing 19% and the hardwood supply chain contribution 5%. The pulp and paper sector contributes 12%, electricity production 16%, basic chemicals 2%, natural gas production 2% and lime production 1%. The import chain is dominated by the direct sector effect of 69% and presumably this is for the more complicated products in the sector, as the paperboard products segment has a neutral trade outcome, with exports equal to imports in physical terms.

The sector's stimulus to its upstream suppliers is average with most impact on the sectors of pulp and paper production, wholesale trade, forwarding and storage, and accounting and marketing. The linkages to downstream industries are stronger than average, and suggest that sectors such as wholesale and retail trade, wine manufacturing, accommodation cafes and restaurants, and government administration must expand ahead of any expansion in paper containers and products.

## Future Trends in Sector

While the *Future Dilemmas* study did not model the paper products sector in detail, it anticipated that the total requirement for paper will increase 75% by 2050. Projections by ABARE suggest that paper consumption will grow at over 2% per annum for several decades giving a doubling time of around 30 years. Uncertainty surrounding continuing growth for this sector's products comes from four areas. The increasing adoption of product-stewardship regulatory models, which return responsibility for packaging to the manufacturer, may stimulate increased reuse and recycling of containers. Constraints in cheap oil feedstocks may limit the use of plastic packaging, and increase the market for wood fibre products. The long-awaited advent of the paperless office may reduce the availability of used paper feedstocks, and thereby the cost and consumer acceptability of paperboard containers. Complex compositions of paperboards may limit options for recycling.

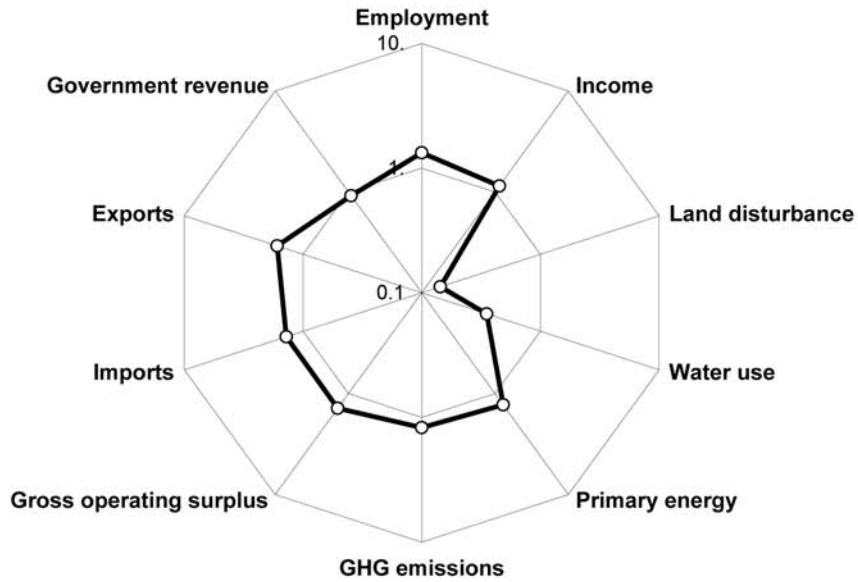
## Innovation and Technical Opportunities

The current advantages of paperboard packaging are expected to increase, especially in relation to its high recycled content and the positive environmental attitudes that this engenders. There may be competition for the recycled paper stream to be used as combustible material in home heating (paper logs) and as an insulating material to replace materials such as fibreglass that have a higher embodied energy content. It is possible that substitute feedstocks materials such as kenaf, straw, bagasse and bamboo will become more important. Finally, innovation such as nanotechnology in building products may give programmable building boards that replace products such as wallpaper.

Paper and paperboard containers, corrugated sheeting, toilet paper, tissues, serviettes, towels, dishes, cups, box files, decoration, wallpaper and other paper products

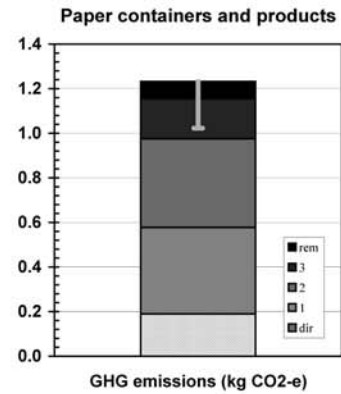
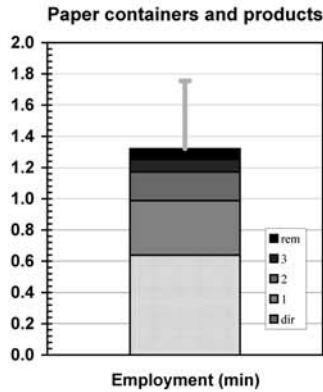
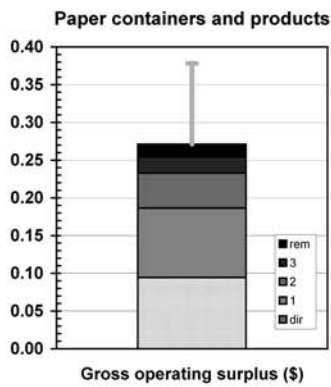
Spider diagram

Paper containers and products

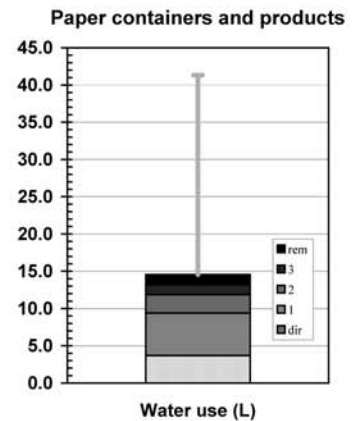
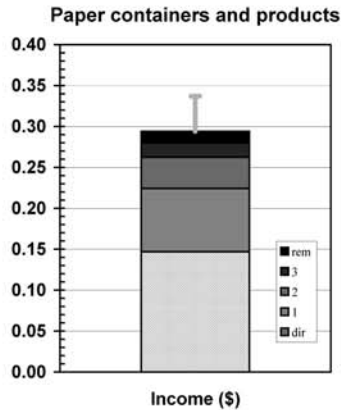
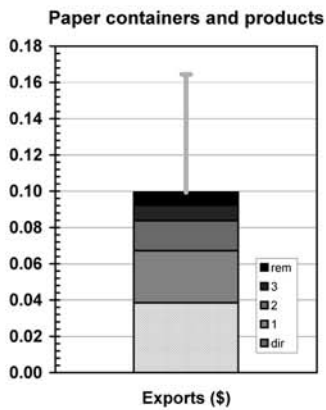


Bar graphs

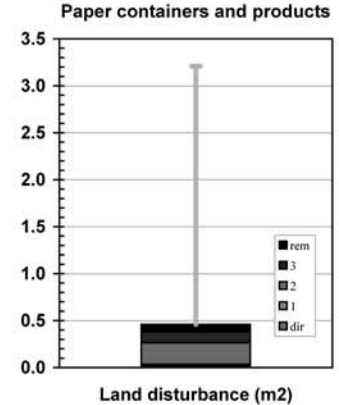
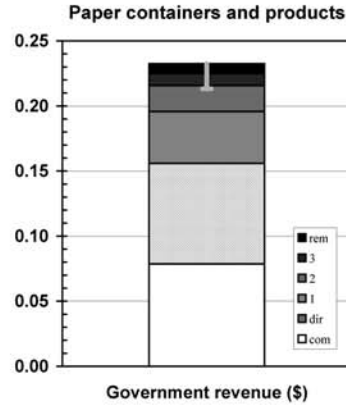
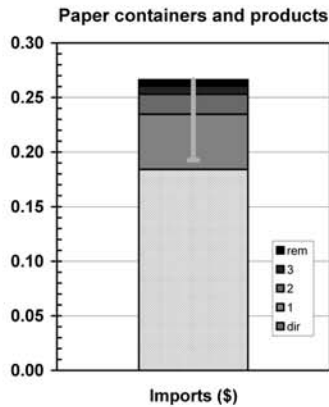
Account #1



Account #2



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 662.1	(0.25% of total)	(\$m 596.7 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 17.8	(0.02% of total)	(\$m 17.8 domestically produced)
Net changes in stocks	\$m 38.1	(2.15% of total)	(\$m 33.0 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 718.0</b>	<b>(0.16% of GNE)</b>	<b>(\$m 647.5 domestically produced)</b>
Exports	\$m 113.7	(0.14% of total)	(\$m 113.7 domestically produced)
<b>Final demand</b>	<b>\$m 831.7</b>	<b>(0.15% of GNT)</b>	<b>(\$m 761.2 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 434.2	(0.25% of total)
Gross operating surplus	\$m 278.9	(0.15% of total)
Taxes less subsidies	\$m 228.4	(0.27% of total)
<b>Sectoral GDP*</b>	<b>\$m 941.5</b>	<b>(0.21% of GDP)</b>
Imports	\$m 544.4	(0.56% of total)
<b>Primary inputs</b>	<b>\$m 1,485.9</b>	<b>(0.27% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 278.9	(0.15%)	\$m 71.8 (0.04%)	\$m 206.5 (0.11%)
Exports (\$m)	\$m 113.7	(0.14%)	\$m 29.3 (0.04%)	\$m 75.7 (0.09%)
Imports (\$m)	\$m 544.4	(0.56%)	\$m 140.1 (0.14%)	\$m 202.7 (0.21%)
Employment (e-y)	15,139 e-y	(0.21%)	3,896 e-y (0.05%)	8,058 e-y (0.11%)
Income (\$m)*	\$m 434.2	(0.25%)	\$m 111.7 (0.07%)	\$m 223.9 (0.13%)
Government revenue (\$m)†	\$m 288.3	(0.27%)	\$m 118.6 (0.11%)	\$m 177.0 (0.16%)
GHG emissions (kt CO <sub>2</sub> -e)	560 kt	(0.11%)	144 kt (0.03%)	938 kt (0.18%)
Water use (ML)	10,898 ML	(0.05%)	2,805 ML (0.01%)	11,080 ML (0.05%)
Land disturbance (kha)	4 kha	(0.00%)	1 kha (0.00%)	35 kha (0.02%)
Primary energy (TJ)	8,535 TJ	(0.22%)	2,196 TJ (0.06%)	7,509 TJ (0.19%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.09	0.27	0.38
Exports (\$)	0.04	0.10	0.16
Imports (\$)	0.18	0.27	0.19
Employment (min)	0.64	1.32	1.75
Income (\$)	0.15	0.29	0.34
Government revenue (\$)	0.16	0.23	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.19	1.23	1.02
Water use (L)	3.68	14.56	41.32
Land disturbance (m <sup>2</sup> )	0.02	0.46	3.21
Primary energy (MJ)	2.89	9.87	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Pa	0.0943	(0; 35.%)	Pa	0.639	(0; 48.%)	Pa	0.189	(0; 15.%)
Pp Pa	0.0252	(1; 9.3%)	Pp Pa	0.057	(1; 4.3%)	Sw Pp Pa	0.159	(2; 13.%)
St Pa	0.0161	(1; 5.9%)	Wt Pa	0.0534	(1; 4.%)	Pp Pa	0.155	(1; 13.%)
Wt Pa	0.00742	(1; 2.7%)	Ms Pa	0.028	(1; 2.1%)	El Pa	0.127	(1; 10.%)
Ms Pa	0.00624	(1; 2.3%)	St Pa	0.0263	(1; 2.%)	Fr Sw Pp Pa	0.0686	(3; 5.6%)
El Pa	0.00512	(1; 1.9%)	Gv Pa	0.0139	(1; 1.1%)	El Pp Pa	0.0653	(2; 5.3%)
El Pp Pa	0.00264	(2; 0.97%)	Pl Pa	0.0136	(1; 1.%)	Ch Pa	0.0281	(1; 2.3%)
Pl Pa	0.00255	(1; 0.94%)	Rd Pa	0.0128	(1; 0.97%)	Hw Pa	0.0201	(1; 1.6%)
Ch Pa	0.00235	(1; 0.87%)	Sw Pp Pa	0.0126	(2; 0.95%)	Fr Hw Pa	0.0196	(2; 1.6%)
Rd Pa	0.00218	(1; 0.8%)	Bs Pa	0.0122	(1; 0.92%)	Hw Pp Pa	0.0125	(2; 1.%)
Ts Pa	0.00198	(1; 0.73%)	Fm Pa	0.0118	(1; 0.89%)	Fr Hw Pp Pa	0.0122	(3; 0.99%)
Ng Pa	0.00198	(1; 0.73%)	Os Pa	0.011	(1; 0.83%)	Ga Pa	0.0106	(1; 0.86%)
Oc Pa	0.00187	(1; 0.69%)	Ts Pa	0.00894	(1; 0.68%)	Lm Pp Pa	0.0103	(2; 0.84%)
Sw Pp Pa	0.00175	(2; 0.64%)	Ho Pa	0.00793	(1; 0.6%)	Ng Pa	0.00899	(1; 0.73%)
Ga Pa	0.00155	(1; 0.57%)	Rd Pp Pa	0.00775	(2; 0.59%)	Gd Pa	0.00786	(1; 0.64%)
St Wt Pa	0.00141	(2; 0.52%)	Ch Pa	0.00685	(1; 0.52%)	Wt Pa	0.0074	(1; 0.6%)
Rv Pa	0.0014	(1; 0.52%)	El Pa	0.00569	(1; 0.43%)	El St Pa	0.00672	(2; 0.55%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Pa	0.0384	(0; 39.%)	Pa	0.147	(0; 50.%)	Pp Pa	3.88	(1; 27.%)
Wt Pa	0.00607	(1; 6.1%)	Pp Pa	0.0141	(1; 4.8%)	Pa	3.68	(0; 25.%)
Pp Pa	0.0047	(1; 4.7%)	Wt Pa	0.0115	(1; 3.9%)	El Pa	0.7	(1; 4.8%)
St Pa	0.004	(1; 4.%)	St Pa	0.00672	(1; 2.3%)	Wa Pa	0.585	(1; 4.%)
Ch Pa	0.00327	(1; 3.3%)	Ms Pa	0.00651	(1; 2.2%)	El Pp Pa	0.361	(2; 2.5%)
Oc Pa	0.00166	(1; 1.7%)	Gv Pa	0.00349	(1; 1.2%)	Wa Pp Pa	0.346	(2; 2.4%)
Bl El Pa	0.00124	(2; 1.2%)	Os Pa	0.00307	(1; 1.%)	Wa Ms Pa	0.16	(2; 1.1%)
Ms Pa	0.000966	(1; 0.97%)	Pl Pa	0.00274	(1; 0.93%)	Wo Tx Pa	0.105	(2; 0.72%)
Rd Pa	0.000758	(1; 0.76%)	Rd Pa	0.0022	(1; 0.75%)	Ch Pa	0.0859	(1; 0.59%)
Pl Pa	0.000737	(1; 0.74%)	Ts Pa	0.00209	(1; 0.71%)	St Pa	0.0697	(1; 0.48%)
At Pa	0.000678	(1; 0.68%)	Fm Pa	0.00185	(1; 0.63%)	Ws Ho Pa	0.0578	(2; 0.4%)
Ch Pl Pa	0.000659	(2; 0.66%)	Sw Pp Pa	0.00168	(2; 0.57%)	Sc Cg Tx Pa	0.0497	(3; 0.34%)
Bl El Pp Pa	0.000639	(3; 0.64%)	El Pa	0.00154	(1; 0.52%)	Bc Mp Ho Pa	0.0415	(3; 0.29%)
Fm Pa	0.000609	(1; 0.61%)	Bs Pa	0.0015	(1; 0.51%)	Bc Mp Ch Pa	0.0405	(3; 0.28%)
Wt Pp Pa	0.00056	(2; 0.56%)	Ch Pa	0.00145	(1; 0.49%)	Wa El Pa	0.0405	(2; 0.28%)
Ch Pp Pa	0.000536	(2; 0.54%)	Rd Pp Pa	0.00133	(2; 0.45%)	Wa Bs Pa	0.0373	(2; 0.26%)
Tx Pa	0.000498	(1; 0.5%)	Oc Pa	0.00132	(1; 0.45%)	El St Pa	0.0372	(2; 0.26%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Pa	0.184	(0; 69.%)	Pa	0.0772	(0; 50.%)	Sw Pp Pa	0.125	(2; 27.%)
Pp Pa	0.0238	(1; 8.9%)	Pp Pa	0.00847	(1; 5.5%)	Wo Tx Pa	0.0779	(2; 17.%)
Ch Pa	0.00328	(1; 1.2%)	Wt Pa	0.00536	(1; 3.5%)	Fr Sw Pp Pa	0.0221	(3; 4.8%)
Pl Pa	0.00261	(1; 0.98%)	St Pa	0.00359	(1; 2.3%)	Pa	0.015	(0; 3.3%)
Oc Pa	0.00257	(1; 0.97%)	Ms Pa	0.00309	(1; 2.%)	Bc Mp Ho Pa	0.0114	(3; 2.5%)
Wt Pa	0.00172	(1; 0.65%)	Rd Pa	0.00156	(1; 1.%)	Bc Mp Ch Pa	0.0112	(3; 2.4%)
St Pa	0.00146	(1; 0.55%)	Os Pa	0.00142	(1; 0.93%)	Hw Pa	0.0104	(1; 2.3%)
Ms Pa	0.00142	(1; 0.53%)	Gv Pa	0.00121	(1; 0.79%)	Hw Pp Pa	0.00645	(2; 1.4%)
Sw Pp Pa	0.00113	(2; 0.42%)	Pl Pa	0.0012	(1; 0.78%)	Fr Hw Pa	0.00631	(2; 1.4%)
Fm Pa	0.0008	(1; 0.3%)	Ts Pa	0.00103	(1; 0.67%)	Bc Ch Pa	0.00562	(2; 1.2%)
Ch Pl Pa	0.00066	(2; 0.25%)	El Pa	0.000961	(1; 0.62%)	Wo Tx Kn Pa	0.00503	(3; 1.1%)
Ts Pa	0.000569	(1; 0.21%)	Rd Pp Pa	0.000946	(2; 0.61%)	Fr Hw Pp Pa	0.00393	(3; 0.85%)
Rd Pa	0.000552	(1; 0.21%)	Oc Pa	0.000785	(1; 0.51%)	Wo Tx Pl Pa	0.00262	(3; 0.57%)
Ch Pp Pa	0.000537	(2; 0.2%)	Sw Pp Pa	0.000739	(2; 0.48%)	Bc Mp Ch Pl F	0.00225	(4; 0.49%)
Rh Pa	0.000367	(1; 0.14%)	Ch Pa	0.000725	(1; 0.47%)	Pp Pa	0.0022	(1; 0.48%)
Gv Pa	0.000361	(1; 0.14%)	ln Pa	0.000668	(1; 0.43%)	Bc Mp Rt Pa	0.00207	(3; 0.45%)
Pa Pp Pa	0.000356	(2; 0.13%)	Fm Pa	0.000646	(1; 0.42%)	El Pa	0.00205	(1; 0.44%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.043 ±0.019	(±1.8%)
Downstream	1.295 ±0.016	(±1.3%)

# Sector 2401: Printing (Pr)

*Stationery, envelopes, labels, cards, diaries, banknotes, cheque books, tickets, printing and services to printing*

## Short Summary

Against the metric of one dollar of final consumption, the environmental indicators of greenhouse emissions, water use and land disturbance are respectively 30%, 80% and 90% below average. The social indicators show that employment generation is 10% below average, income is 5% below average and government revenue is 60% above average. The financial indicators reveal that the operating surplus is 35% below average, export propensity is 60% below average, and import penetration is 40% above average. The challenges posed by globalised competition and electronic publications are immense. Industry revitalisation requires a radical evolution of skills and products, far beyond price competition and efficient management of printing presses, into knowledge services.

## Sector Description

Financial activity is composed of stationery and greeting cards (13%), writing pads and books (13%), newspapers printed on contract (7%), trade and advertising material (47%), security printing such as banknotes and cheque books (2%) and printing services such as type composition and plate making (16%). In constant dollar terms, the sector has increased eight fold in the last 30 years. Over the last 50 years, the industry has experienced considerable technological change progressing from hot metal typeset in the 1950s, through to computer typeset in the 1980s, and to the current digital era of 'computer to plate'. Printing requirements today are less dictated by price and more by the range of design and knowledge management capability that the printer brings to the client. The industry remains challenged by high levels of imports and the requirement for expensive machinery to remain competitive. In constant dollar terms turnover has risen eight fold over the last 30 years. The financial turnover in 2002 was around \$7.5 billion and involved more than 2 500 enterprises.

## Place of Industry in the Economy

The printing sector ranks 33<sup>rd</sup> out of 135 sectors in terms of value adding in the economy and contributes 0.66% of GDP in this analysis. It is similar in value adding to the crude oil, and hairdressing and personal services sectors. It is a moderate sized employer with 6 000 employment years directly embodied in final demand and another 3 000 years in the sector's upstream suppliers giving a total of 9000 employment years. The sector supplies 51 000 employment years to downstream industries such as wholesale and retail trade, and government administration. The sector has small resource needs with less than one tenth of one percent of national water use, land disturbance, energy use, and emissions. In financial terms, the import export ratio is 18:1.

## Strategic Overview

The spider diagram portrays the current situation in the printing sector with three below average outliers for the financial indicators, but good performance in the social and environmental areas. Traditionally, the main tactics to counter competition were to invest in better machinery to improve quality and productivity, and engage in strong price competition. Given the trend towards globalisation in the printing industry, particularly the strong competition posed by China, the industry is finding profitability and survival becoming more closely intertwined with the evolving requirements of its customers. A sector workforce with a more sophisticated and broader skills that directly meet the client's requirements could improve both financial and social indicators. However it might also increase the greenhouse emissions as more of the embodied production chain for paper becomes a domestic activity, rather than being located offshore.



## TBL Account #1

The financial indicator of operating surplus is 35% below average and composed of a direct sector effect of 50%, with contributions from pulp and paper (7%), wholesale trade (3%), inks (2%) and accounting and marketing (1%). The social indicator of employment generation is 10% below average with a direct sector effect of 67%, reflecting that while printing is now highly mechanised, the requirement for skilled personnel in the production chain is critical. This may become more so as the sector evolves beyond physical printing to a different place in the information economy. The greenhouse emissions indicator is 30% below the economy wide average with a direct sector effect of 4%. Nearly 50% of emissions are embodied in the pulp and paper production chain and the indicator is advantaged by the high level of imports in the sector. If overseas printing is included in the greenhouse account then the greenhouse indicator becomes 30% above average. This method of full chain accounting is not currently implemented in national greenhouse inventories, but in future such audit activities may target the country of consumption rather than the country of production.

## TBL Accounts #2 and #3

The second TBL account shows that export propensity is 60% below average, income is 5% below average and water use is 80% below average. The third TBL account shows that import penetration is 40% above average, government revenue is 60% above average and land disturbance is 90% below average. The use, recycling, and disposal of inks, solvents and papers are outside the scope of this analysis. However the industry acknowledges these as key environmental issues.

## Structural Path Analysis and Linkages

The competition posed by the penetration of imported printing services is perhaps the most important TBL indicator for this sector. An examination of the structural pathway reveals that 74% of the indicator is a direct sector effect, i.e. printing undertaken overseas. Other import effects include pulp and paper (6%), printing inks (3%), wholesale trade (1%), basic chemicals (1%) and paper containers (1%).

The sector's stimulus to its upstream suppliers is 20% below average and impacts primarily on pulp and paper manufacture and wholesale trade. The linkages to downstream industries are 50% greater than average, and suggest that any short term expansion in the printing sector must be led by expansion primarily in the wholesale and retail trade, and government administration sectors.

## Future Trends in Sector

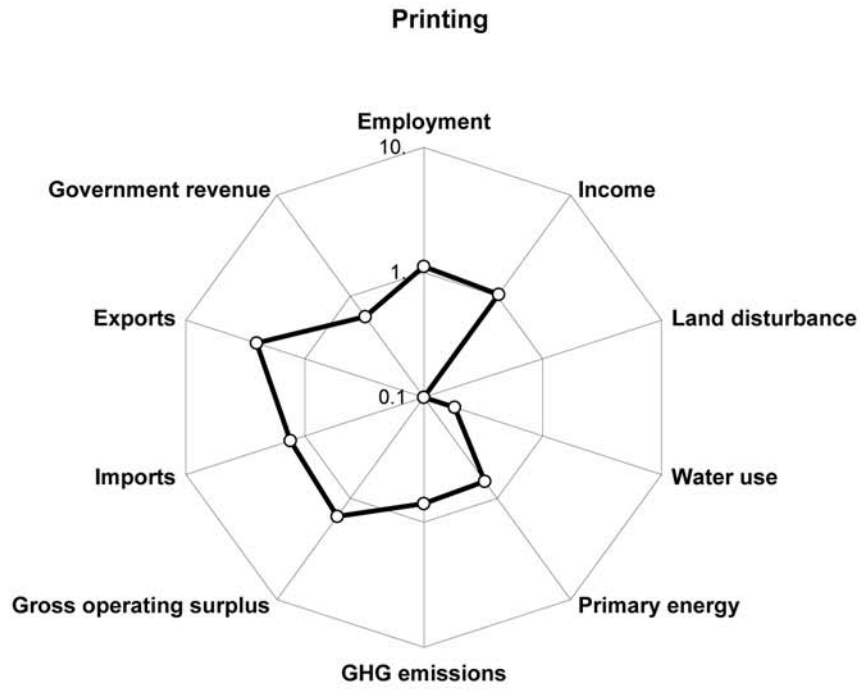
While the *Future Dilemmas* study did not model the publishing sector in detail, it anticipated that the total requirement for paper will increase by 75% by 2050. Projections by ABARE suggest that paper consumption will grow at over 2% per annum for several decades giving a doubling time of around 30 years. Just over a half of total paper consumption is made up by newsprint, printing, and writing papers. Electronic publication seems certain to make significant inroads into printed media over the next two to three decades, but physical printed products may be far from obsolete.

## Innovation and Technical Opportunities

The technical literature notes the future tensions for the sector in four areas. Publications could move to completely digital forms particularly given the longevity of storage due to the rapid evolution of digital storage media. The sector's response to electronic publishing includes highly pigmented inks that approach the human eye's appreciation of colour density and tone, and new water based inks with a less chemical process which aim to entice the consumer as well as protect the health of printers. Books on demand and high quality distributed printing have already changed the structure of printing. However the printery as a cultural institution may be making a comeback.

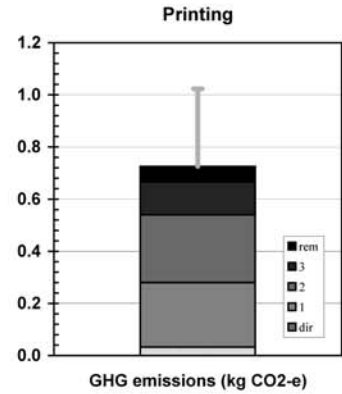
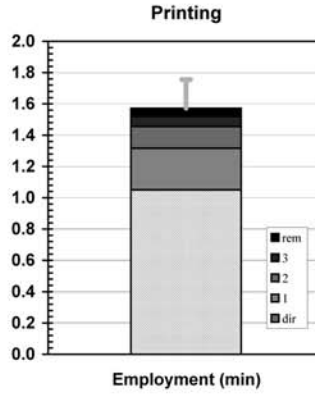
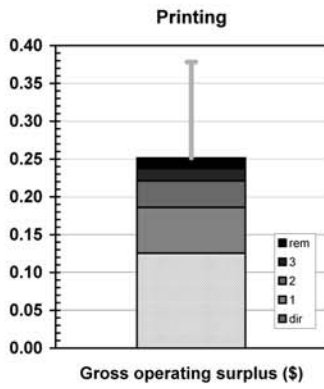
Stationery, envelopes, labels, cards, diaries, banknotes, cheque books, tickets, printing and services to printing

Spider diagram

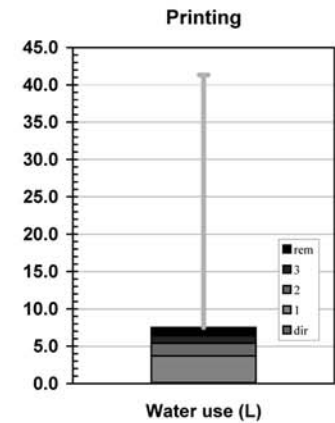
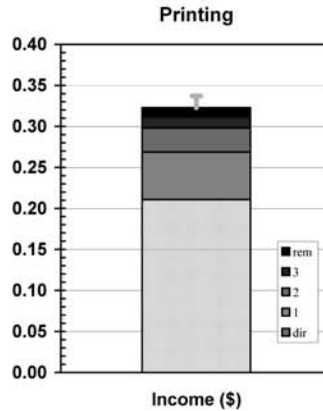
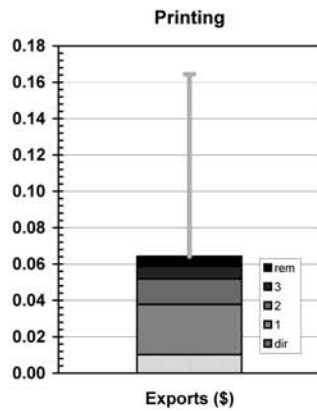


Bar graphs

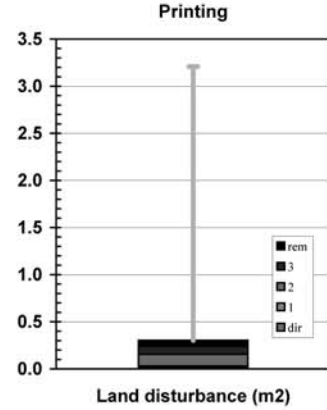
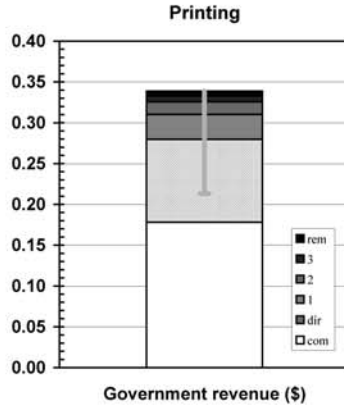
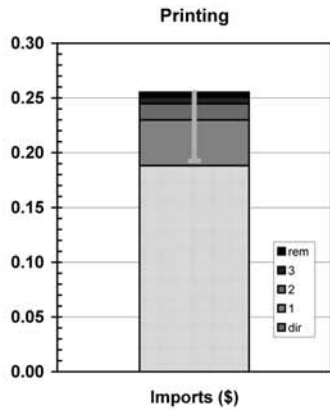
Account #1



Account #2



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 594.7	(0.22% of total)	(\$m 542.7 domestically produced)
Government final consumption	\$m 76.3	(0.09% of total)	(\$m 76.3 domestically produced)
Gross fixed capital expenditure	\$m 22.9	(0.02% of total)	(\$m 22.9 domestically produced)
Net changes in stocks	\$m 32.6	(1.85% of total)	(\$m 24.5 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 726.5</b>	<b>(0.16% of GNE)</b>	<b>(\$m 666.4 domestically produced)</b>
Exports	\$m 68.5	(0.08% of total)	(\$m 68.5 domestically produced)
<b>Final demand</b>	<b>\$m 794.9</b>	<b>(0.15% of GNT)</b>	<b>(\$m 734.8 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 1,422.6	(0.83% of total)
Gross operating surplus	\$m 847.9	(0.44% of total)
Taxes less subsidies	\$m 687.2	(0.80% of total)
<b>Sectoral GDP*</b>	<b>\$m 2,957.7</b>	<b>(0.66% of GDP)</b>
Imports	\$m 1,270.5	(1.30% of total)
<b>Primary inputs</b>	<b>\$m 4,228.2</b>	<b>(0.77% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 847.9	(0.44%)	\$m 92.3 (0.05%)	\$m 184.7 (0.10%)
Exports (\$m)	\$m 68.5	(0.08%)	\$m 7.4 (0.01%)	\$m 47.2 (0.06%)
Imports (\$m)	\$m 1,270.5	(1.30%)	\$m 138.2 (0.14%)	\$m 187.5 (0.19%)
Employment (e-y)	56,863 e-y	(0.80%)	6,187 e-y (0.09%)	9,258 e-y (0.13%)
Income (\$m)*	\$m 1,422.6	(0.83%)	\$m 154.8 (0.09%)	\$m 237.1 (0.14%)
Government revenue (\$m)†	\$m 818.0	(0.76%)	\$m 205.6 (0.19%)	\$m 248.9 (0.23%)
GHG emissions (kt CO <sub>2</sub> -e)	218 kt	(0.04%)	24 kt (0.00%)	533 kt (0.10%)
Water use (ML)	698 ML	(0.00%)	76 ML (0.00%)	5,508 ML (0.03%)
Land disturbance (kha)	10 kha	(0.01%)	1 kha (0.00%)	22 kha (0.01%)
Primary energy (TJ)	3,229 TJ	(0.08%)	351 TJ (0.01%)	3,805 TJ (0.10%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.13	0.25	0.38
Exports (\$)	0.01	0.06	0.16
Imports (\$)	0.19	0.26	0.19
Employment (min)	1.05	1.57	1.75
Income (\$)	0.21	0.32	0.34
Government revenue (\$)	0.28	0.34	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.03	0.73	1.02
Water use (L)	0.10	7.50	41.32
Land disturbance (m <sup>2</sup> )	0.02	0.30	3.21
Primary energy (MJ)	0.48	5.18	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Pr	0.126	(0; 50.%)	Pr	1.05	(0; 67.%)	Sw Pp Pr	0.108	(2; 15.%)
Pp Pr	0.0171	(1; 6.8%)	Wt Pr	0.0565	(1; 3.6%)	Pp Pr	0.105	(1; 15.%)
Wt Pr	0.00784	(1; 3.1%)	Pp Pr	0.0387	(1; 2.5%)	El Pr	0.066	(1; 9.1%)
Oc Pr	0.00497	(1; 2.%)	Oc Pr	0.0147	(1; 0.93%)	Fr Sw Pp Pr	0.0466	(3; 6.4%)
Ms Pr	0.00287	(1; 1.1%)	Bs Pr	0.0138	(1; 0.88%)	El Pp Pr	0.0443	(2; 6.1%)
El Pr	0.00267	(1; 1.1%)	Ms Pr	0.0129	(1; 0.82%)	Pr	0.0323	(0; 4.4%)
Rv Pr	0.00237	(1; 0.94%)	Rd Pr	0.00998	(1; 0.63%)	Fr Pr	0.0185	(1; 2.6%)
Ts Pr	0.00208	(1; 0.83%)	Ts Pr	0.00938	(1; 0.6%)	Ch Pr	0.0147	(1; 2.%)
Cm Pr	0.00194	(1; 0.77%)	Sw Pp Pr	0.00856	(2; 0.54%)	Gd Pr	0.0122	(1; 1.7%)
El Pp Pr	0.00179	(2; 0.71%)	Pl Pr	0.00706	(1; 0.45%)	Hw Pp Pr	0.00849	(2; 1.2%)
Rd Pr	0.0017	(1; 0.68%)	Ho Pr	0.00684	(1; 0.43%)	Fr Hw Pp Pr	0.0083	(3; 1.1%)
St Wt Pr	0.0015	(2; 0.6%)	Rv Pr	0.00635	(1; 0.4%)	At Pr	0.00817	(1; 1.1%)
Bs Pr	0.0014	(1; 0.56%)	Oe Pr	0.00574	(1; 0.37%)	Wt Pr	0.00782	(1; 1.1%)
St Pr	0.0014	(1; 0.56%)	Cm Pr	0.00536	(1; 0.34%)	Lm Pp Pr	0.007	(2; 0.96%)
Pl Pr	0.00133	(1; 0.53%)	Rd Pp Pr	0.00526	(2; 0.33%)	Ch Oc Pr	0.00573	(2; 0.79%)
Ch Pr	0.00123	(1; 0.49%)	Pa Pr	0.00522	(1; 0.33%)	El Oc Pr	0.00357	(2; 0.49%)
Sw Pp Pr	0.00119	(2; 0.47%)	Ms Wt Pr	0.0051	(2; 0.32%)	Ch Pp Pr	0.00313	(2; 0.43%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Pr	0.0101	(0; 16.%)	Pr	0.211	(0; 65.%)	Pp Pr	2.63	(1; 35.%)
Wt Pr	0.00641	(1; 10.%)	Wt Pr	0.0121	(1; 3.8%)	El Pr	0.365	(1; 4.9%)
Oc Pr	0.00442	(1; 6.9%)	Pp Pr	0.00958	(1; 3.%)	Wa Pr	0.29	(1; 3.9%)
Pp Pr	0.00319	(1; 5.%)	Oc Pr	0.00352	(1; 1.1%)	El Pp Pr	0.245	(2; 3.3%)
At Pr	0.0026	(1; 4.%)	Ms Pr	0.00299	(1; 0.93%)	Wa Pp Pr	0.235	(2; 3.1%)
Oe Pr	0.00208	(1; 3.2%)	Ts Pr	0.0022	(1; 0.68%)	Pr	0.103	(0; 1.4%)
Nf Pr	0.002	(1; 3.1%)	Rd Pr	0.00172	(1; 0.53%)	Wa Oc Pr	0.0789	(2; 1.1%)
Ch Pr	0.00171	(1; 2.7%)	Bs Pr	0.0017	(1; 0.53%)	Wa Ms Pr	0.0738	(2; 0.98%)
Ch Oc Pr	0.000667	(2; 1.%)	At Pr	0.00145	(1; 0.45%)	Ws Ho Pr	0.0498	(2; 0.66%)
Bl El Pr	0.000645	(2; 1.%)	Pl Pr	0.00143	(1; 0.44%)	Ch Pr	0.0448	(1; 0.6%)
Rd Pr	0.000591	(1; 0.92%)	Gd Pr	0.00135	(1; 0.42%)	Oc Pr	0.0431	(1; 0.58%)
Ms Pr	0.000444	(1; 0.69%)	Oe Pr	0.00131	(1; 0.41%)	Wa Bs Pr	0.0423	(2; 0.56%)
Bl El Pp Pr	0.000433	(3; 0.67%)	Os Pr	0.00128	(1; 0.4%)	Wo Tx Pr	0.036	(2; 0.48%)
Pl Pr	0.000384	(1; 0.6%)	Cm Pr	0.00122	(1; 0.38%)	Bc Mp Ho Pr	0.0358	(3; 0.48%)
Ho Pr	0.00038	(1; 0.59%)	Pa Pr	0.0012	(1; 0.37%)	Pp Pa Pr	0.0317	(2; 0.42%)
Wt Pp Pr	0.00038	(2; 0.59%)	Ms Wt Pr	0.00119	(2; 0.37%)	Wt Pr	0.0316	(1; 0.42%)
St Wt Pr	0.000371	(2; 0.58%)	Sw Pp Pr	0.00114	(2; 0.35%)	Pa Pr	0.0301	(1; 0.4%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Pr	0.188	(0; 74.%)	Pr	0.102	(0; 63.%)	Sw Pp Pr	0.0849	(2; 28.%)
Pp Pr	0.0162	(1; 6.3%)	Pp Pr	0.00575	(1; 3.6%)	Wo Tx Pr	0.0267	(2; 8.8%)
Oc Pr	0.00684	(1; 2.7%)	Wt Pr	0.00566	(1; 3.5%)	Pr	0.0151	(0; 5.%)
Wt Pr	0.00182	(1; 0.71%)	Oc Pr	0.00209	(1; 1.3%)	Fr Sw Pp Pr	0.015	(3; 4.9%)
Ch Pr	0.00171	(1; 0.67%)	Ms Pr	0.00142	(1; 0.88%)	Bc Mp Ho Pr	0.00986	(3; 3.2%)
Pa Pr	0.0015	(1; 0.59%)	Rd Pr	0.00122	(1; 0.76%)	Fr Pr	0.00595	(1; 2.%)
Pl Pr	0.00136	(1; 0.53%)	At Pr	0.00116	(1; 0.72%)	Bc Mp Ch Pr	0.00583	(3; 1.9%)
Oe Pr	0.00127	(1; 0.5%)	Ts Pr	0.00108	(1; 0.67%)	Wo Tx Tp Pr	0.00485	(3; 1.6%)
At Pr	0.000775	(1; 0.3%)	Oe Pr	0.00065	(1; 0.4%)	Hw Pp Pr	0.00438	(2; 1.4%)
Sw Pp Pr	0.000764	(2; 0.3%)	Rd Pp Pr	0.000642	(2; 0.4%)	Bc Mp Oc Pr	0.00371	(3; 1.2%)
Ch Oc Pr	0.000668	(2; 0.26%)	Pa Pr	0.000631	(1; 0.39%)	Wo Tx Cl Pr	0.00368	(3; 1.2%)
Ms Pr	0.000653	(1; 0.26%)	Rv Pr	0.00063	(1; 0.39%)	Wo Tx Oc Pr	0.00348	(3; 1.1%)
Ts Pr	0.000597	(1; 0.23%)	Gd Pr	0.000627	(1; 0.39%)	Bc Ch Pr	0.00293	(2; 0.97%)
Rd Pr	0.00043	(1; 0.17%)	Pl Pr	0.000622	(1; 0.39%)	Fr Hw Pp Pr	0.00267	(3; 0.88%)
Ch Pp Pr	0.000364	(2; 0.14%)	Os Pr	0.000593	(1; 0.37%)	Bc Mp Ch Oc	0.00228	(4; 0.75%)
Ru Pr	0.000351	(1; 0.14%)	Cm Pr	0.000582	(1; 0.36%)	Wo Tx Wt Pr	0.00201	(3; 0.66%)
En Pr	0.000346	(1; 0.14%)	Ms Wt Pr	0.000563	(2; 0.35%)	Pp Pr	0.0015	(1; 0.49%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	0.797 ±0.014	(±1.8%)
Downstream	1.564 ±0.033	(±2.1%)

# Sector 2402: Publishing (Ne)

*Newspapers, magazines, books, periodicals, maps, recorded media and other publishing*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicators of greenhouse emissions, water use and land disturbance are respectively 45%, 85%, and 95%, below average. The social indicators of employment generation and income are 20% and 10% below average, respectively, while government revenue is 30% above average. The financial indicators show that the operating surplus is 5% below average, import penetration is 10% below average, while export propensity is 50% below average. By 2020 telecommunications bandwidth and new devices may revolutionise publishing as digitally adept consumers move away from paper products.

## Sector Description

In financial terms, the publishing sector is composed of newspapers and newspaper advertising (59%), periodicals (14%), books (15%) and recorded CDs and DVDs (10%). Daily metropolitan newspapers sell nearly 900 million copies per year plus 180 million Sunday editions, while regional dailies sell 160 million, and regional non-dailies sell 31 million. There are 10 metropolitan dailies, 2 national dailies, 36 regional dailies, 96 other regional newspapers and 243 suburban newspapers. Over 500 000 people each month visit the internet site of a leading metropolitan daily newspaper. Magazine publishing is strong and diverse with the top 100 titles selling over 113 million copies annually or over 5 per capita. There are around 240 book publishers operating domestically who sell 130 million books, 77 million of which are domestic in origin, while 45 million are imported. There are around 9 000 new Australian book titles per year, over half of which are educational titles. Over 65 million music CDs and related media are sold annually in spite of internet downloading. The financial turnover in 2002 was around \$10 billion and involved around 1 500 enterprises.

## Place of Industry in the Economy

The publishing sector ranks 30<sup>th</sup> out of 135 sectors in terms of value adding in the economy, and contributes 0.76% of GDP in this analysis. It is similar in value adding to the basic iron and steel and vegetable and fruit growing sectors. It is a moderate employer with 13 000 employment years directly embodied in final demand, and another 11 000 years in the sector's suppliers giving a total of 24 000 employment years. In addition, it contributes 30 000 employment years to downstream industries such as wholesale and retail trade, property development and real estate, and legal accounting and marketing. The sector has small resource requirements with less than one tenth of one percent of water use and land disturbance, and less than three tenths of one percent of energy use and greenhouse emissions. In financial terms, imports are three times the level of exports.

## Strategic Overview

The spider diagram shows a reasonably balanced TBL account with one below average outlier of export propensity. The social indicators are around average, which in spite of the increasing complexity and capital intensity of the sector, reflect the requirement for creative labour in developing the content for both printed and digital media. The environmental indicators are all below average reflecting the more service nature of the sector, and outsourcing of printed books in particular to countries with scale and wage advantages such as China, Taiwan and Hong Kong. The financial indicators are near average except for export propensity. Increasing vertical integration could see some social indicators disadvantaged in the future. However, consumers' desire for personal and timely service along with local content may limit these globalised drivers.

## TBL Account #1

The financial indicator of operating surplus is 5% below average and composed mainly of the direct effect (62%) with a diffuse chain of small contributions such as forwarding and storage (3%), pulp and paper (3%), accounting and marketing (2%) and technical services (2%). The social indicator of employment generation is 20% below average, with one half being a direct sector effect. The environmental indicator of greenhouse emissions is 45% below average and is discussed below.

## TBL Accounts #2 and #3

The second TBL account shows that export propensity, income and water use are 50%, 10% and 85% below average respectively. The third TBL account shows that import penetration and land disturbance are 10% and 95% below average respectively while government revenue is 30% above average.

## Structural Path Analysis and Linkages

While the greenhouse indicator is below average, the structural path reveals a diverse number of relatively independent components making it difficult to manage in an integrated sense. The direct sector effect, mostly from car travel, comprises 15% of the total. The 'softwoods-pulp and paper-newspapers' chain accounts for 12%, pulp and paper production for 11%, electricity generation for 7%, 'forest harvesting-softwoods-pulp and paper-newspapers' for 5%, electricity used in pulp and paper production for 5%, garbage disposal for 4% and airline travel for 3%. In an overall sense, a strategy to reduce greenhouse emissions may have to include both forest plantations and the pulp and paper factory. In reality though, this chain makes up 36% of the total meaning its influence is limited. A life cycle analysis of the Australian paper cycle found that the largest single contributor to overall emissions is methane from decaying paper in land fills. Thus, the publishing sector could possibly improve its greenhouse performance by becoming more involved in the post-consumption disposal of its products.

The linkages to the sector's upstream suppliers are 20% below the economy wide average and impact on pulp and paper production, wholesale trade, and accounting and marketing. The linkages to downstream industries are 25% stronger than average. They imply that expansion of the sector must be led by expansion in sectors such as wholesale and retail trade, property development, marketing, education, and government administration.

## Future Trends in Sector

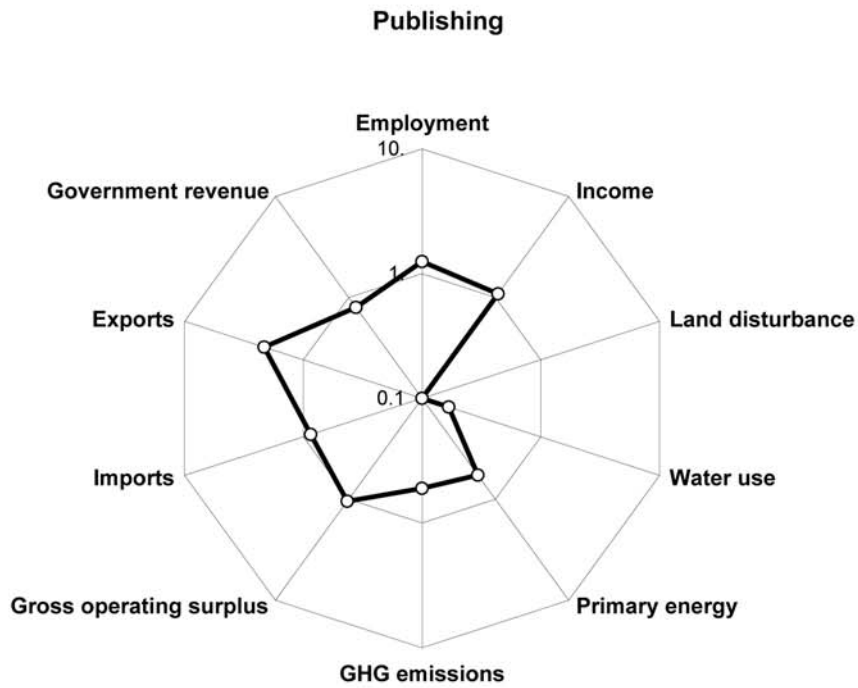
While the *Future Dilemmas* study did not model the publishing sector in detail, it anticipated that the total requirement for paper will increase by 75% by 2050. Projections by ABARE suggest that paper consumption will grow at over 2% per annum for several decades giving a doubling time of around 30 years. Just over one half of total paper consumption is made up by newsprint, printing, and writing papers. Electronic publication seems certain to make significant inroads into printed media over the next two to three decades, but physical printed products may be far from obsolete.

## Innovation and Technical Opportunities

The delivery of both academic publishing and pornography have been revolutionised by the world wide web. A large proportion of professionals now access their journals through electronic library services, and seldom see a physical journal. Pornography, formerly the preserve of the glossy centrefold, is said to be the primary driver for growth in data transmission on the web. Some studies suggest that newspapers should concentrate on targeting a local audience, facilitating community publishing, and investing in research. Other studies suggest that on-line and printed newspapers are complementary, and serve different information needs in networked and linked individuals.

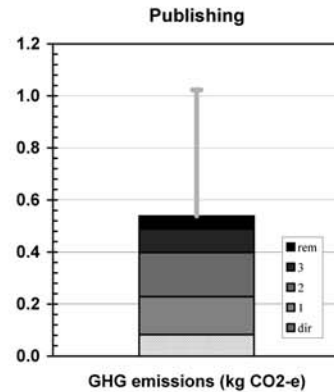
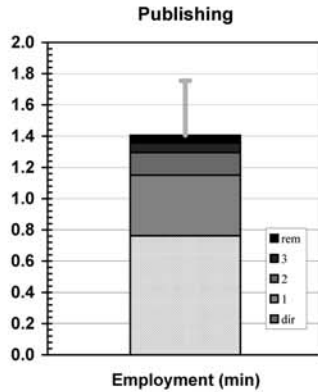
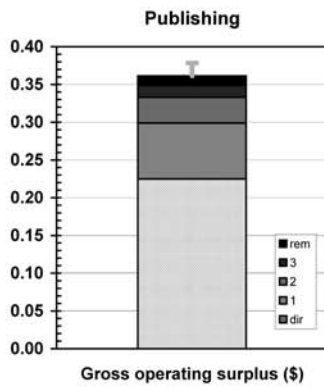
Newspapers, magazines, books, periodicals, maps, recorded media and other publishing

Spider diagram

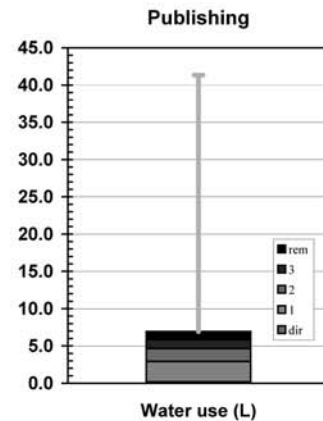
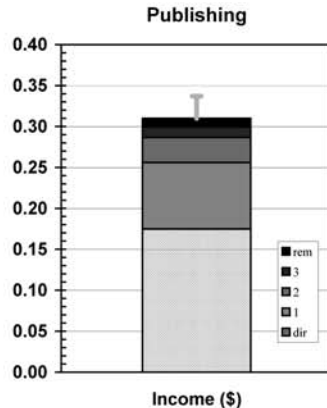
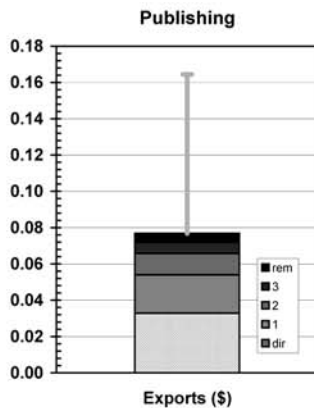


Bar graphs

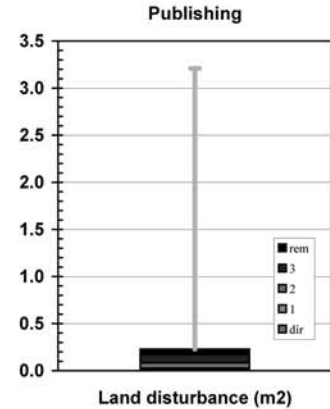
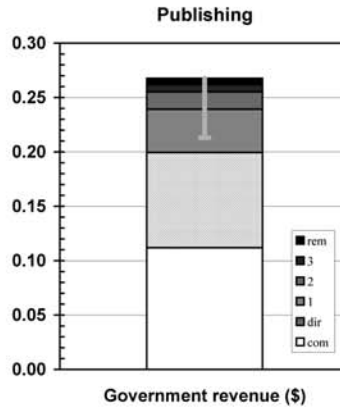
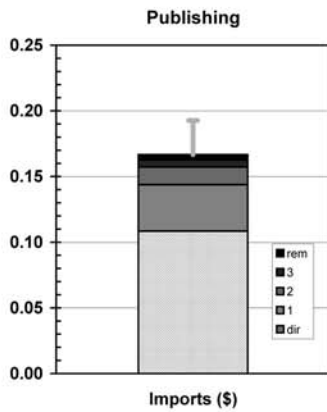
Account #1



Account #2



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 2,525.1	(0.96% of total)	(\$m 1,685.6 domestically produced)
Government final consumption	-\$m 0.1	(0.00% of total)	
Gross fixed capital expenditure	\$m 444.7	(0.42% of total)	(\$m 190.3 domestically produced)
Net changes in stocks	\$m 59.9	(3.39% of total)	(\$m 36.5 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 3,029.6</b>	<b>(0.66% of GNE)</b>	<b>(\$m 1,912.3 domestically produced)</b>
Exports	\$m 230.6	(0.28% of total)	(\$m 230.6 domestically produced)
<b>Final demand</b>	<b>\$m 3,260.2</b>	<b>(0.60% of GNT)</b>	<b>(\$m 2,142.8 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 1,227.1	(0.72% of total)
Gross operating surplus	\$m 1,579.3	(0.82% of total)
Taxes less subsidies	\$m 615.1	(0.72% of total)
<b>Sectoral GDP*</b>	<b>\$m 3,421.5</b>	<b>(0.76% of GDP)</b>
Imports	\$m 760.9	(0.78% of total)
<b>Primary inputs</b>	<b>\$m 4,182.4</b>	<b>(0.77% of GNT)</b>

\* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 1,579.3	(0.82%)	\$m 481.9 (0.25%)	\$m 774.6 (0.40%)
Exports (\$m)	\$m 230.6	(0.28%)	\$m 70.4 (0.08%)	\$m 164.7 (0.20%)
Imports (\$m)	\$m 760.9	(0.78%)	\$m 232.2 (0.24%)	\$m 357.2 (0.37%)
Employment (e-y)	42,875 e-y	(0.60%)	13,084 e-y (0.18%)	24,140 e-y (0.34%)
Income (\$m)*	\$m 1,227.1	(0.72%)	\$m 374.5 (0.22%)	\$m 664.3 (0.39%)
Government revenue (\$m)†	\$m 854.8	(0.79%)	\$m 427.4 (0.40%)	\$m 573.4 (0.53%)
GHG emissions (kt CO <sub>2</sub> -e)	576 kt	(0.11%)	176 kt (0.03%)	1,153 kt (0.22%)
Water use (ML)	1,198 ML	(0.01%)	366 ML (0.00%)	14,864 ML (0.07%)
Land disturbance (kha)	12 kha	(0.01%)	4 kha (0.00%)	49 kha (0.03%)
Primary energy (TJ)	8,343 TJ	(0.22%)	2,546 TJ (0.07%)	9,450 TJ (0.24%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.22	0.36	0.38
Exports (\$)	0.03	0.08	0.16
Imports (\$)	0.11	0.17	0.19
Employment (min)	0.76	1.41	1.75
Income (\$)	0.17	0.31	0.34
Government revenue (\$)	0.20	0.27	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.08	0.54	1.02
Water use (L)	0.17	6.94	41.32
Land disturbance (m <sup>2</sup> )	0.02	0.23	3.21
Primary energy (MJ)	1.19	4.41	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks



**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Ne	0.225	(0; 62.%)	Ne	0.762	(0; 54.%)	Ne	0.0821	(0; 15.%)
St Ne	0.00979	(1; 2.7%)	Gv Ne	0.0402	(1; 2.9%)	Sw Pp Ne	0.0603	(2; 11.%)
Pp Ne	0.00957	(1; 2.6%)	Ms Ne	0.0292	(1; 2.1%)	Pp Ne	0.0589	(1; 11.%)
Ms Ne	0.0065	(1; 1.8%)	Cu Ne	0.0277	(1; 2.%)	El Ne	0.0358	(1; 6.6%)
Ts Ne	0.00473	(1; 1.3%)	Pr Ne	0.0257	(1; 1.8%)	Fr Sw Pp Ne	0.026	(3; 4.8%)
Cm Ne	0.00442	(1; 1.2%)	Bs Ne	0.0238	(1; 1.7%)	El Pp Ne	0.0248	(2; 4.6%)
Rv Ne	0.00341	(1; 0.94%)	Pp Ne	0.0216	(1; 1.5%)	Gd Ne	0.0201	(1; 3.7%)
Pr Ne	0.00307	(1; 0.85%)	Ho Ne	0.0214	(1; 1.5%)	At Ne	0.0137	(1; 2.5%)
Rh Ne	0.00306	(1; 0.85%)	Ts Ne	0.0213	(1; 1.5%)	Hw Pp Ne	0.00475	(2; 0.88%)
Wt Ne	0.00287	(1; 0.79%)	Wt Ne	0.0206	(1; 1.5%)	Fr Hw Pp Ne	0.00464	(3; 0.86%)
Cu Ne	0.00266	(1; 0.74%)	Rh Ne	0.0187	(1; 1.3%)	Bc Mp Ho Ne	0.00424	(3; 0.79%)
Bs Ne	0.00241	(1; 0.67%)	St Ne	0.016	(1; 1.1%)	El St Ne	0.00408	(2; 0.76%)
Gv Ne	0.00171	(1; 0.47%)	Cm Ne	0.0122	(1; 0.87%)	Lm Pp Ne	0.00391	(2; 0.73%)
Ho Ne	0.0017	(1; 0.47%)	Rv Ne	0.00913	(1; 0.65%)	Wt Ne	0.00286	(1; 0.53%)
Bk Ne	0.00169	(1; 0.47%)	Os Ne	0.00891	(1; 0.63%)	El Ho Ne	0.00279	(2; 0.52%)
El Ne	0.00145	(1; 0.4%)	Rd Ne	0.00848	(1; 0.6%)	El Ms Ne	0.00272	(2; 0.51%)
Rd Ne	0.00144	(1; 0.4%)	Gd Ne	0.00794	(1; 0.56%)	El Gv Ne	0.0027	(2; 0.5%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Ne	0.0328	(0; 43.%)	Ne	0.175	(0; 56.%)	Pp Ne	1.47	(1; 21.%)
At Ne	0.00436	(1; 5.7%)	Gv Ne	0.0101	(1; 3.3%)	Cu Ne	0.383	(1; 5.5%)
St Ne	0.00243	(1; 3.2%)	Ms Ne	0.00678	(1; 2.2%)	Wa Ne	0.261	(1; 3.8%)
Wt Ne	0.00234	(1; 3.%)	Pp Ne	0.00535	(1; 1.7%)	El Ne	0.198	(1; 2.9%)
Pp Ne	0.00178	(1; 2.3%)	Pr Ne	0.00515	(1; 1.7%)	Ne	0.171	(0; 2.5%)
Ho Ne	0.00119	(1; 1.5%)	Cu Ne	0.00509	(1; 1.6%)	Wa Ms Ne	0.167	(2; 2.4%)
Oc Ne	0.00117	(1; 1.5%)	Ts Ne	0.00499	(1; 1.6%)	Ws Ho Ne	0.156	(2; 2.2%)
Ms Ne	0.00101	(1; 1.3%)	Wt Ne	0.00443	(1; 1.4%)	El Pp Ne	0.137	(2; 2.%)
Ts Ne	0.00075	(1; 0.98%)	St Ne	0.00408	(1; 1.3%)	Wa Pp Ne	0.131	(2; 1.9%)
Cm Ne	0.00059	(1; 0.77%)	Ho Ne	0.00311	(1; 1.%)	Ws Ne	0.118	(1; 1.7%)
Cu Ne	0.00054	(1; 0.7%)	Bs Ne	0.00292	(1; 0.94%)	Bc Mp Ho Ne	0.112	(3; 1.6%)
Oe Ne	0.000535	(1; 0.7%)	Cm Ne	0.00278	(1; 0.9%)	Dc Dp Ho Ne	0.0926	(3; 1.3%)
Rd Ne	0.000502	(1; 0.65%)	Os Ne	0.0025	(1; 0.8%)	Wa Bs Ne	0.0727	(2; 1.%)
Bs Ne	0.000446	(1; 0.58%)	At Ne	0.00243	(1; 0.78%)	Ri Fc Ho Ne	0.0719	(3; 1.%)
Bl El Ne	0.00035	(2; 0.46%)	Gd Ne	0.00222	(1; 0.72%)	Pp Pr Ne	0.0643	(2; 0.93%)
Ai At Ne	0.000296	(2; 0.38%)	Rh Ne	0.00205	(1; 0.66%)	Wa Ts Ne	0.0638	(2; 0.92%)
In Ne	0.000293	(1; 0.38%)	Bk Ne	0.00166	(1; 0.54%)	Vf Ho Ne	0.059	(2; 0.85%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$		
Ne	0.108	(0; 65.%)	Ne	0.0876	(0; 56.%)	Sw Pp Ne	0.0474	(2; 21.%)
Pp Ne	0.00904	(1; 5.4%)	Gv Ne	0.00352	(1; 2.3%)	Bc Mp Ho Ne	0.0308	(3; 13.%)
Pr Ne	0.00459	(1; 2.8%)	Ms Ne	0.00322	(1; 2.1%)	Ne	0.0169	(0; 7.4%)
Oc Ne	0.00181	(1; 1.1%)	Pp Ne	0.00321	(1; 2.1%)	Fr Sw Pp Ne	0.00836	(3; 3.7%)
Rh Ne	0.00158	(1; 0.95%)	Pr Ne	0.00249	(1; 1.6%)	Wo Tx Tp Ne	0.00659	(3; 2.9%)
Ms Ne	0.00148	(1; 0.89%)	Ts Ne	0.00246	(1; 1.6%)	Wo Tx Cl Ne	0.00356	(3; 1.6%)
Ts Ne	0.00136	(1; 0.81%)	St Ne	0.00218	(1; 1.4%)	Wo Mp Ho Ne	0.00348	(3; 1.5%)
Cu Ne	0.00132	(1; 0.79%)	Wt Ne	0.00207	(1; 1.3%)	Ba Bm Ho Ne	0.00252	(3; 1.1%)
At Ne	0.0013	(1; 0.78%)	At Ne	0.00195	(1; 1.3%)	Hw Pp Ne	0.00245	(2; 1.1%)
Gv Ne	0.00105	(1; 0.63%)	Cu Ne	0.00188	(1; 1.2%)	Sw Pp Pr Ne	0.00207	(3; 0.91%)
Pl Ne	0.00102	(1; 0.61%)	Ho Ne	0.00164	(1; 1.1%)	Gd Ne	0.00188	(1; 0.83%)
Ap Ne	0.000894	(1; 0.54%)	In Ne	0.00162	(1; 1.%)	Bc Mp Ho Ms	0.00158	(4; 0.69%)
St Ne	0.000886	(1; 0.53%)	Cm Ne	0.00133	(1; 0.85%)	Fr Hw Pp Ne	0.00149	(3; 0.65%)
Ho Ne	0.000792	(1; 0.47%)	Os Ne	0.00116	(1; 0.74%)	At Ne	0.00149	(1; 0.65%)
Cm Ne	0.000757	(1; 0.45%)	Rd Ne	0.00104	(1; 0.66%)	Wo Tx Ne	0.00126	(2; 0.55%)
Wt Ne	0.000666	(1; 0.4%)	Gd Ne	0.00103	(1; 0.66%)	Bc Mp Rt Ne	0.00113	(3; 0.49%)
Et Ne	0.000597	(1; 0.36%)	Rh Ne	0.000939	(1; 0.6%)	Wo Tx Pl Ne	0.00102	(3; 0.45%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	0.815 ±0.011	(±1.4%)
Downstream	1.273 ±0.022	(±1.7%)

# Sector 25100010: Automotive Petrol (Ap)

*Automotive petrol, gasoline refining or blending, motor spirit, aviation spirit*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is 40% greater than average, while water use and land disturbance are 85% and 95% below average respectively. The social indicators of employment generation and income are 75% and 65% below average respectively, while government revenue is ten times the average. The financial indicators reveal that operating surplus is 10% below average, export propensity is 10% above average and import penetration is over two times the average. Medium term challenges include building new refineries with sufficient scale and complexity to meet clean fuel requirements. Longer term challenges are implementing gas-to-liquids technology as domestic oil stocks decline, and identifying the place of methanol in the fuel cycle if it becomes the fuel of choice for a new generation of cars powered by proton exchange membrane (PEM) fuel cells.

## Sector Description

Current automotive petrol accounts suggest that Australia refines 17 984 ML of petrol, imports 1 673 ML mainly from Singapore, exports 1 058 ML mainly to New Zealand and Pacific Island nations, and consumes domestically 18 872 ML. The current domestic refinery capacity is around 800 000 barrels of oil per day spread across seven plants. By comparison, Singapore has a refinery capacity of 1.3 million barrels per day with three refineries of 300, 450 and 580 million barrels per day size. Around 90% of refinery costs relate to the price of crude oil. The pump price per litre in Australia is made up of refinery costs (37%), federal excise (41%), GST (10%) and retail margins (12%). Of the 43 GJ per tonne of energy in crude oil, 5 GJ per tonne is consumed in the refining process. Refining also uses 60 litres of process water per tonne of oil, much of which can now be recycled. The financial turnover in 2002 was around \$7 billion and involved four major companies.

## Place of Industry in the Economy

The automotive petrol sector ranks 103<sup>rd</sup> out of 135 sectors in terms of value adding in the economy and contributes 0.10% of GDP in this analysis. It is similar in value adding to the pipeline transport and 'taxi and hired car with driver' sectors. It is a moderate sized employer with 1 500 employment years directly embodied in final demand, and another 6 000 years in the sector's upstream suppliers giving a total of 7 500 employment years. In addition, it contributes 1 500 employment years embodied in the output of downstream industries such as wholesale and retail trade. The sector has moderate resource requirements with less than one tenth of one percent of national water use and land disturbance, eight tenths and six tenths of one percent respectively of primary energy use and national greenhouse emissions. In financial terms, imports are 21 times the level of exports.

## Strategic Overview

The spider diagram reveals two sets of significant outliers in employment generation and income, and energy use and greenhouse emissions. The government revenue indicator shows major positive returns in producing 40% of the pump price of petrol for use in broader societal goals. This demonstrates the trade offs between employment and environmental issues such as greenhouse emissions and cheap and accessible mobility. The most pressing issues are downstream from petrol refining where petrol consumption generates air emissions, noise, congestion and road accidents.

## TBL Account #1

The financial indicator of operating surplus is 10% below average, the social indicator of employment generation is 75% below average and greenhouse emissions are 40% above average.

## TBL Accounts #2 and #3

The second TBL account shows that export propensity is 10% above average, income is 65% below average, and water use is 85% below average. The third TBL account shows that import penetration is over twice the average, government revenue is ten times the average, and land disturbance is 95% below average.

## Structural Path Analysis and Linkages

The indicators of employment generation, income, and greenhouse emissions warrant further examination. Employment and income reflect both the capital intensity and the scale of the sector which requires large integrated complexes with high degrees of automation. Industry sources note that low profits driven by society's requirement for cheap petrol constrain the development of advanced refinery infrastructure. For both social indicators, the direct effect is around 20% of a 'below average' total, with contributions from oil production (20%), rail freight (4%) and wholesale trade (4%). The greenhouse emissions indicator shows a direct sector effect of 51% along with oil production (26%) and electricity production (8%). Improving the refining process offers potential for greenhouse reductions although improved oil extraction could also be significant.

The sector's stimulus to its upstream suppliers is 15% below average with impacts principally on oil production and on wholesale trade. The linkages to downstream industries are average and suggest that wholesale and retail trade and road transport must expand before refining capacity can.

## Future Trends in Sector

The base case scenario of the *Future Dilemmas* study (25 million people by 2050) anticipates that the requirement for transportation fuel will increase by 60%. Shorter term analyses to 2020 by ABARE, project that transport energy consumption will rise 37%. Three critical uncertainties surround these anticipations of continuing growth in road transport energy. The first is the legislative frameworks surrounding transport modes and fuel use. If road pricing or new urban transit modes were implemented, petrol use may stabilise or even decline. The second is access to global stocks of low to moderate priced oil when Australia's domestic stocks become constrained and self sufficiency declines to below 50%. The third is the rapidity with which market options such as fuel thrifty cars, fuels from biomass and other transport modes penetrate the domestic economy. The above scenario has reasonable penetration of new engine technologies but is not a radical transition to fuel celled vehicles which improve fuel consumption by 65%.

## Innovation and Technical Opportunities

Setting aside the downstream implications of petrol use by consumers, four important challenges face the refining industry. The first is to further reduce the emissions of carbon dioxide in the refining process by reducing the reliance on hydrogen the main source of which is other fossil fuels. Secondly, further development of catalysts is seen as critical, with increasing emphasis on zeolites (crystalline silicates and aluminosilicates) that have three dimensional structures and networks, giving large surface areas suitable for reactions of bulky molecules. Thirdly, societal demand for higher quality and cleaner fuels, particularly in the middle distillates, requires sulphur removal and the hydro-cracking of the heavier fractions to improve yields of lighter products. Finally, the industry faces a transitional decade after the year 2020 when compressed and liquefied gas, gas-to-liquids production, and methanol synthesis may begin to replace traditional petrol as the main fuel.

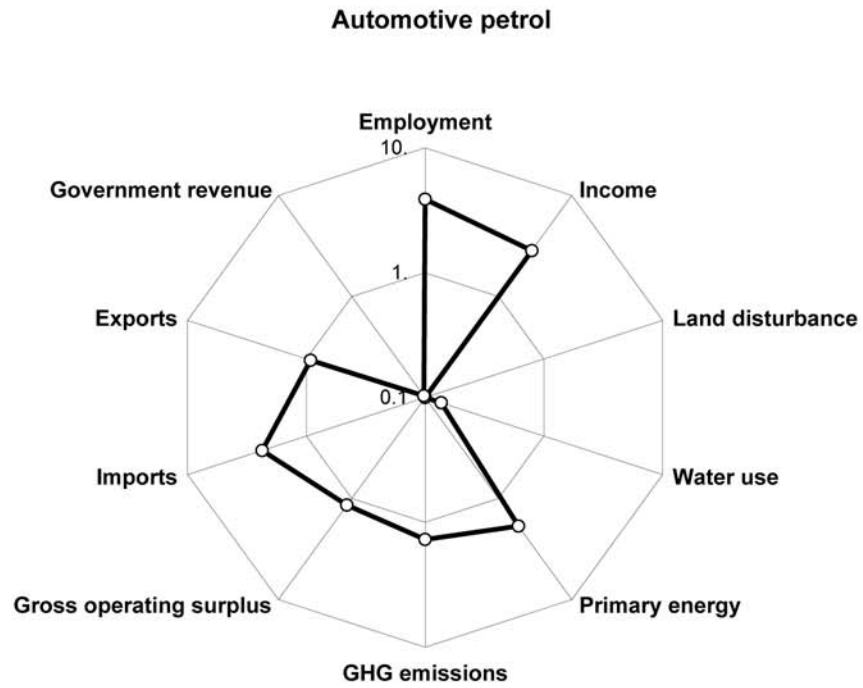
Sector

Automotive petrol

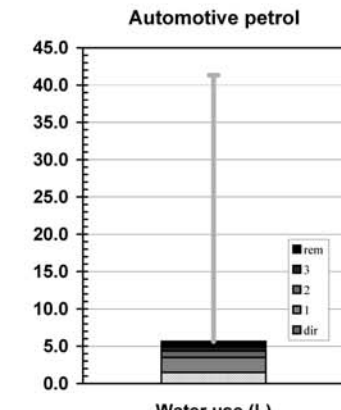
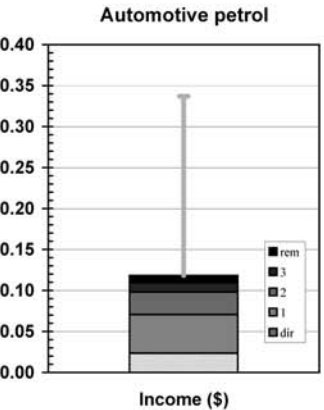
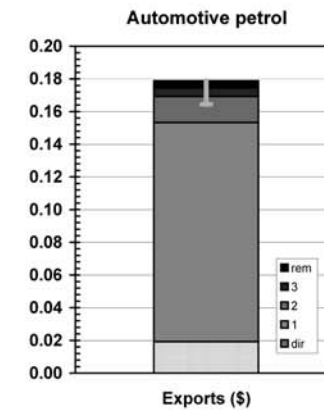
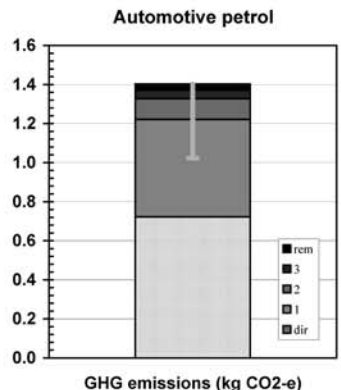
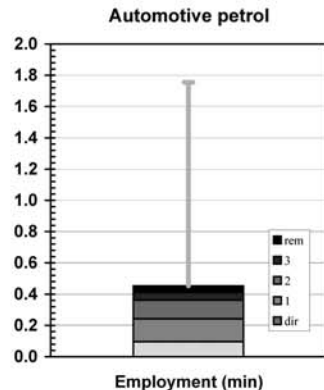
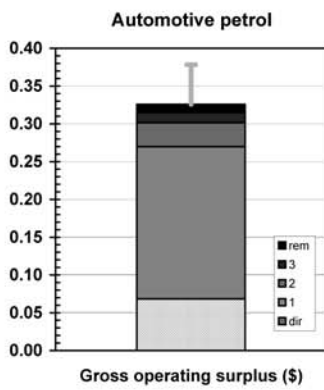
(Ap)

Automotive petrol, gasolene refining or blending, motor spirit, aviation spirit

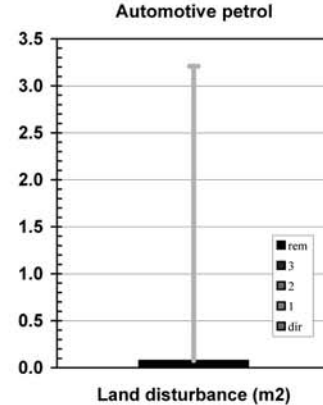
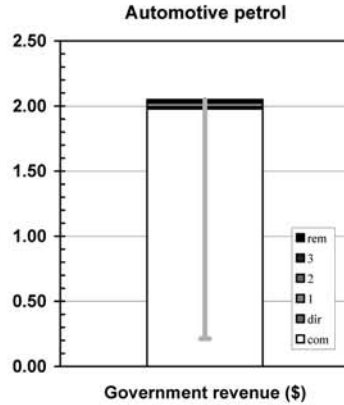
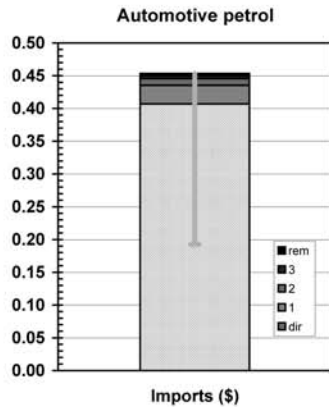
Spider diagram



Bar graphs



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 2,232.2	(0.84% of total)	(\$m 1,973.6 domestically produced)
Government final consumption	\$m 0.0		
Gross fixed capital expenditure	\$m 0.0		
Net changes in stocks	\$m 44.1	(2.49% of total)	(\$m 39.0 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 2,276.2</b>	<b>(0.50% of GNE)</b>	<b>(\$m 2,012.6 domestically produced)</b>
Exports	\$m 78.6	(0.09% of total)	(\$m 78.6 domestically produced)
<b>Final demand</b>	<b>\$m 2,354.9</b>	<b>(0.43% of GNT)</b>	<b>(\$m 2,091.3 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 95.8	(0.06% of total)
Gross operating surplus	\$m 279.0	(0.15% of total)
Taxes less subsidies	\$m 61.8	(0.07% of total)
<b>Sectoral GDP*</b>	<b>\$m 436.6</b>	<b>(0.10% of GDP)</b>
Imports	\$m 1,663.3	(1.70% of total)
<b>Primary inputs</b>	<b>\$m 2,100.0</b>	<b>(0.38% of GNT)</b>

\* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT		
	(% of national)		direct (% of national)	total (% of national)	
Gross operating surplus (\$m)	\$m 279.0	(0.15%)	\$m 142.7	(0.07%)	\$m 681.5 (0.36%)
Exports (\$m)	\$m 78.6	(0.09%)	\$m 40.2	(0.05%)	\$m 374.1 (0.45%)
Imports (\$m)	\$m 1,663.3	(1.70%)	\$m 850.7	(0.87%)	\$m 948.4 (0.97%)
Employment (e-y)	3,157 e-y	(0.04%)	1,615 e-y	(0.02%)	7,595 e-y (0.11%)
Income (\$m)*	\$m 95.8	(0.06%)	\$m 49.0	(0.03%)	\$m 247.4 (0.14%)
Government revenue (\$m)†	\$m 4,197.7	(3.88%)	\$m 4,167.5	(3.85%)	\$m 4,285.6 (3.96%)
GHG emissions (kt CO <sub>2</sub> -e)	2,953 kt	(0.57%)	1,510 kt	(0.29%)	2,935 kt (0.57%)
Water use (ML)	6,069 ML	(0.03%)	3,104 ML	(0.01%)	11,792 ML (0.06%)
Land disturbance (kha)	1 kha	(0.00%)	0 kha	(0.00%)	16 kha (0.01%)
Primary energy (TJ)	41,937 TJ	(1.08%)	21,448 TJ	(0.55%)	29,933 TJ (0.77%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.07	0.33	0.38
Exports (\$)	0.02	0.18	0.16
Imports (\$)	0.41	0.45	0.19
Employment (min)	0.10	0.45	1.75
Income (\$)	0.02	0.12	0.34
Government revenue (\$)	1.99	2.05	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.72	1.40	1.02
Water use (L)	1.48	5.64	41.32
Land disturbance (m <sup>2</sup> )	0.00	0.08	3.21
Primary energy (MJ)	10.26	14.31	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Oi Ap	0.177	(1; 54.%)	Ap	0.0964	(0; 21.%)	Ap	0.722	(0; 51.%)
Ap	0.0682	(0; 21.%)	Oi Ap	0.0682	(1; 15.%)	Oi Ap	0.374	(1; 27.%)
Lg Ap	0.00486	(1; 1.5%)	Rf Oi Ap	0.021	(2; 4.6%)	El Ap	0.0636	(1; 4.5%)
Rf Oi Ap	0.00262	(2; 0.81%)	Wt Ap	0.0185	(1; 4.1%)	El Oi Ap	0.0426	(2; 3.%)
El Ap	0.00257	(1; 0.79%)	Cs Oi Ap	0.00792	(2; 1.7%)	Ch Ap	0.014	(1; 1.%)
Wt Ap	0.00257	(1; 0.79%)	Rd Ap	0.00753	(1; 1.7%)	Lg Ap	0.0115	(1; 0.82%)
St Ap	0.0024	(1; 0.74%)	Wt Oi Ap	0.00741	(2; 1.6%)	El Rf Oi Ap	0.00765	(3; 0.54%)
Mn Oi Ap	0.00205	(2; 0.63%)	Bk Ap	0.00689	(1; 1.5%)	Rf Oi Ap	0.00761	(2; 0.54%)
Bk Ap	0.00174	(1; 0.53%)	Bk Oi Ap	0.00623	(2; 1.4%)	Ng Ap	0.00406	(1; 0.29%)
El Oi Ap	0.00172	(2; 0.53%)	Gv Ap	0.00511	(1; 1.1%)	Ga Ap	0.004	(1; 0.28%)
Bk Oi Ap	0.00157	(2; 0.48%)	Mn Oi Ap	0.0043	(2; 0.95%)	Fo Oi Ap	0.00337	(2; 0.24%)
Rd Ap	0.00128	(1; 0.39%)	St Ap	0.00392	(1; 0.86%)	Wt Ap	0.00256	(1; 0.18%)
Ch Ap	0.00117	(1; 0.36%)	Ho Ap	0.00349	(1; 0.77%)	El Ch Ap	0.00211	(2; 0.15%)
Wt Oi Ap	0.00103	(2; 0.32%)	Ch Ap	0.00341	(1; 0.75%)	Rd Ap	0.00204	(1; 0.15%)
Ng Ap	0.000894	(1; 0.27%)	Rd Oi Ap	0.00302	(2; 0.67%)	Bl El Ap	0.0016	(2; 0.11%)
St Oi Ap	0.000832	(2; 0.26%)	El Ap	0.00286	(1; 0.63%)	Is Oi Ap	0.00145	(2; 0.1%)
Wa Ap	0.000756	(1; 0.23%)	Ma Oi Ap	0.00262	(2; 0.58%)	At Ap	0.00132	(1; 0.094%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Oi Ap	0.121	(1; 67.%)	Oi Ap	0.0296	(1; 25.%)	Ap	1.48	(0; 26.%)
Ap	0.0192	(0; 11.%)	Ap	0.0234	(0; 20.%)	Oi Ap	0.892	(1; 16.%)
Lg Ap	0.00568	(1; 3.2%)	Rf Oi Ap	0.00589	(2; 5.%)	Wa Ap	0.556	(1; 9.9%)
Rf Oi Ap	0.0043	(2; 2.4%)	Wt Ap	0.00397	(1; 3.4%)	El Ap	0.352	(1; 6.2%)
Wt Ap	0.0021	(1; 1.2%)	Bk Ap	0.0017	(1; 1.4%)	El Oi Ap	0.235	(2; 4.2%)
Ch Ap	0.00163	(1; 0.91%)	Wt Oi Ap	0.00159	(2; 1.3%)	Mn Oi Ap	0.136	(2; 2.4%)
Wt Oi Ap	0.000841	(2; 0.47%)	Bk Oi Ap	0.00154	(2; 1.3%)	Wa Oi Ap	0.045	(2; 0.8%)
Bl El Ap	0.000622	(2; 0.35%)	Mn Oi Ap	0.00144	(2; 1.2%)	Ch Ap	0.0428	(1; 0.76%)
St Ap	0.000595	(1; 0.33%)	Rd Ap	0.0013	(1; 1.1%)	El Rf Oi Ap	0.0423	(3; 0.75%)
Rd Ap	0.000446	(1; 0.25%)	Gv Ap	0.00128	(1; 1.1%)	Ws Ho Ap	0.0254	(2; 0.45%)
At Ap	0.00042	(1; 0.23%)	St Ap	0.001	(1; 0.85%)	Rf Oi Ap	0.0229	(2; 0.41%)
Bl El Oi Ap	0.000416	(3; 0.23%)	Cs Oi Ap	0.000946	(2; 0.8%)	Wa El Ap	0.0203	(2; 0.36%)
Ma Oi Ap	0.000385	(2; 0.22%)	Lg Ap	0.000814	(1; 0.69%)	Bc Mp Ch Ap	0.0202	(3; 0.36%)
Eq Oi Ap	0.000331	(2; 0.19%)	El Ap	0.000774	(1; 0.65%)	Wa Cs Oi Ap	0.02	(3; 0.35%)
Oi Fo Oi Ap	0.000327	(3; 0.18%)	Ch Ap	0.000724	(1; 0.61%)	Bc Mp Ho Ap	0.0183	(3; 0.32%)
Sp Ap	0.000318	(1; 0.18%)	Pd Oi Ap	0.000583	(2; 0.49%)	Wa Pd Oi Ap	0.0177	(3; 0.31%)
Sg Ap	0.00031	(1; 0.17%)	Rd Oi Ap	0.000519	(2; 0.44%)	Lg Ap	0.0175	(1; 0.31%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Ap	0.407	(0; 90.%)	Oi Ap	0.0214	(1; 30.%)	Bc Mp Ch Ap	0.00557	(3; 7.4%)
Oi Ap	0.013	(1; 2.9%)	Ap	0.0151	(0; 21.%)	Bc Mp Ho Ap	0.00504	(3; 6.7%)
Ch Ap	0.00163	(1; 0.36%)	Rf Oi Ap	0.00271	(2; 3.8%)	Wo Tx Ap	0.00312	(2; 4.2%)
Fo Oi Ap	0.0011	(2; 0.24%)	Wt Ap	0.00186	(1; 2.6%)	Oi Ap	0.00308	(1; 4.1%)
Mn Oi Ap	0.000937	(2; 0.21%)	Mn Oi Ap	0.000982	(2; 1.4%)	Rf Oi Ap	0.00295	(2; 3.9%)
Rf Oi Ap	0.000677	(2; 0.15%)	Bk Ap	0.000939	(1; 1.3%)	Bc Ch Ap	0.0028	(2; 3.7%)
Wt Ap	0.000597	(1; 0.13%)	Rd Ap	0.000919	(1; 1.3%)	Ap	0.00128	(0; 1.7%)
Ma Oi Ap	0.000454	(2; 0.1%)	Bk Oi Ap	0.000849	(2; 1.2%)	Bc Mp Ho Oi /	0.00108	(4; 1.4%)
Pc Oi Ap	0.000383	(2; 0.084%)	Wt Oi Ap	0.000743	(2; 1.%)	El Ap	0.00103	(1; 1.4%)
Lg Ap	0.000358	(1; 0.079%)	Lg Ap	0.00059	(1; 0.82%)	Bc Mp Ap	0.000906	(2; 1.2%)
Oc Oi Ap	0.000357	(2; 0.079%)	St Ap	0.000534	(1; 0.75%)	Wo Cs Oi Ap	0.00081	(3; 1.1%)
Rd Ap	0.000325	(1; 0.072%)	El Ap	0.000482	(1; 0.67%)	El Oi Ap	0.000688	(2; 0.92%)
Cs Oi Ap	0.000242	(2; 0.053%)	In Ap	0.000482	(1; 0.67%)	Wo Tx Wt Ap	0.000659	(3; 0.88%)
Wt Oi Ap	0.000239	(2; 0.053%)	Gv Ap	0.000447	(1; 0.62%)	Wo Mp Ch Ap	0.000629	(3; 0.84%)
Eq Oi Ap	0.000219	(2; 0.048%)	In Oi Ap	0.000385	(2; 0.54%)	Wo Mp Ho Ap	0.000569	(3; 0.76%)
St Ap	0.000217	(1; 0.048%)	Pd Oi Ap	0.000382	(2; 0.53%)	Wo Tx Oi Ap	0.000555	(3; 0.74%)
Rh Oi Ap	0.000208	(2; 0.046%)	Rd Oi Ap	0.000368	(2; 0.51%)	Bc Mp Cs Oi /	0.000509	(4; 0.68%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	0.863 ±0.033	(±3.8%)
Downstream	0.992 ±0.024	(±2.4%)

# Sector 25100020: Kerosene and Aviation Jet Fuel (Ke)

*Kerosene and kerosene-type jet fuel*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is 40% above average, while water use and land disturbance are 85% and 95% below average respectively. The social indicators of employment and income are respectively 75% and 65% below average, while government revenue is over four times the average. The financial indicators reveal an operating surplus 15% below average, and export propensity and import penetration which are both twice the average. Kerosene is a strategic input into a modern economy, fuelling time efficient air transport. As domestic oil supplies become constrained, imports will rise further and gas-to-liquids technology and oil seed crops may eventually be developed as substitutes.

## Sector Description

Power kerosene or aviation turbine fuel (avtur) has current production levels of around 5 212 million litres (ML) per year, with exports of 549 ML and imports of 225 ML giving a net usage of around 5 000 ML. In a simple oil refinery, around 55% of the initial crude oil feedstock becomes light and middle products such as petrol, diesel and kerosene, while 45% is left as heavier residual fuel oil. Increasing the technological complexity of the refinery allows a greater yield of lighter and middle distillation products but requires higher capital investment. Australian crude oils tend to be lighter than average and thus have higher yields of lighter products such as kerosene. However the domestic refining capacity of 800 000 barrels per day is now spread across seven refineries, each of which currently lacks the scale to be competitive at the leading edge of technological design. Crude oil has an energy content of around 43 GJ (10<sup>9</sup>J) per tonne and 6 GJ per tonne is consumed in refining. In 2002, the sector had turnover of \$1.8 billion and involved six enterprises.

## Place of Industry in the Economy

The kerosene refining sector ranks 131<sup>st</sup> out of 135 sectors in terms of value adding in the economy and contributes 0.02% of GDP in this analysis. It is similar in value adding to the pig farming and rice growing sectors. It is a small employer with around 300 employment years directly embodied in final demand, and another 1 200 years in the sector's upstream suppliers, giving a total of 1 500 employment years. Another 400 employment years are embodied in the output of downstream industries such as air travel and defence. The sector has low resource requirements with negligible water use and land disturbance, and less than two tenths of one percent of national energy use and greenhouse emissions. In financial terms, imports are twice the level of exports.

## Strategic Overview

The spider diagram highlights two sets of outliers in the social and environmental areas. Both employment generation and income are lower than average but government revenue is substantially greater than average due to excise levied on jet fuel. Both energy use and greenhouse emissions are above average. Thus the TBL account reveals tradeoffs that are made to contain the costs of airline travel. These tradeoffs give lower social returns for employment and income due to the capital intensity of refining, but also give higher levels of government revenue and greenhouse emissions. The kerosene sector is thus small but vital. Increasing oil price, if maintained, will challenge the financial viability of major airlines that do not have hedging mechanisms to manage these risks.

## TBL Account #1

The financial indicator of operating surplus is 15% below average, the direct effect being 20% of the total with contributions from oil production (54%), natural gas (2%), railway freight (1%), and electricity production (1%). The social indicator of employment generation is 75% below average with a direct effect of 20% and a similar composition to the surplus indicator. The environmental indicator of greenhouse emissions is 40% above average, and is discussed in more detail below.

## TBL Accounts #2 and #3

The second TBL account shows that export propensity is over twice the average while income and water use are 65% and 85% below average respectively. The third TBL account shows that import penetration is also twice the average, government revenue is over four times the average and land disturbance is 95% below average.

## Structural Path Analysis and Linkages

An examination of the structural path for greenhouse emissions reveals that one half of the indicator is a direct sector effect and the result of the distillation process. Other contributions include oil production (27%), electricity production (8%) and basic chemicals (1%). The science literature suggests that substantial redesign of oil refining processes, both for clean fuel production and reduced greenhouse emissions, is possible but is difficult in an economic sense with current low prices for liquid fuels. Within current refineries, incremental changes in some key processes can give beneficial greenhouse savings. Improved oil recovery systems at the oil well may help reduce the greenhouse intensity of oil production, which accounts for one quarter of the total.

The sector's stimulus to its upstream suppliers is 10% below average and focused almost entirely on crude oil production. The linkages to downstream industries are 20% greater than average and suggest that a wide range of industries such as air travel, electricity supply (gas turbines), wholesale trade, accounting and marketing, and government administration, must expand in order to dissipate any expansion in kerosene refining capacity.

## Future Trends in Sector

The base case scenario in the *Future Dilemmas* study (25 million people by 2050), anticipates that fuel uplifted in Australia for international travel will increase four fold by 2050, while energy for domestic air travel will more than double. Energy studies by ABARE suggest that energy for air travel (both domestic and international) will more than double by 2020. Both of these studies assume moderate economic growth and thus a continuing requirement for aviation turbine fuel since air travel expands with economic growth. There are many uncertainties surrounding international tourism and the degree to which issues of traveller safety, disease pandemics, and economic meltdowns affect continuous growth in long haul air travel. In a domestic sense, the eventual constraints in the supply of cheap oil will affect the affordability and therefore the volume of air travel, given that fuel price normally contributes 10-30% of an airline's overall operating costs.

## Innovation and Technical Opportunities

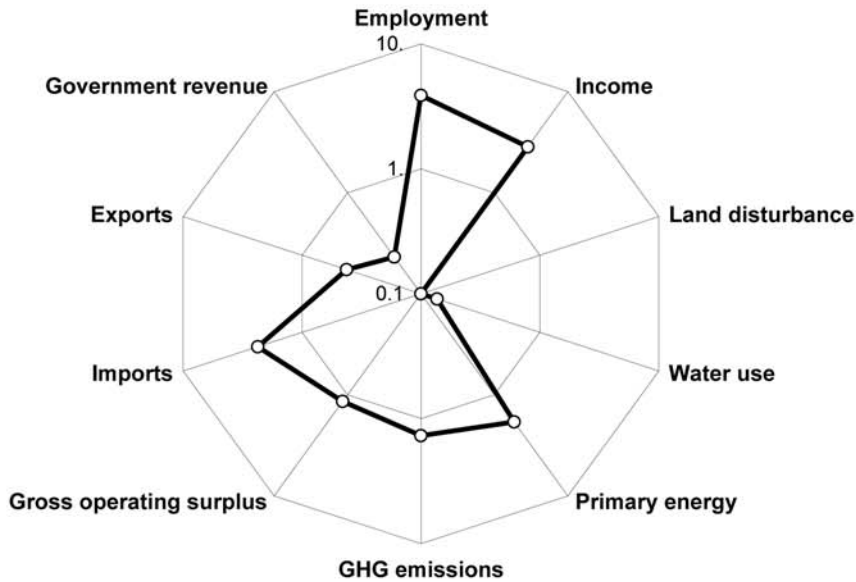
Kerosene-equivalent fuels for aircraft engines can be made in a number of ways. The gas-to-liquids technology can transform natural gas into synthetic crude oil, and then to its normal distillation components. Oil from grains such as soybeans can power jet engines provided that certain fats are removed to ensure that the fuel does not freeze at temperatures above -40°C. Depending on the life cycle of the grain production system, the net carbon emissions could be considerably less than for petroleum derived jet fuel. The design of future fuel production and jet engine systems will need to be harmonised with global environmental considerations, engine performance and life cycle cost.



Kerosene and kerosene-type jet fuel

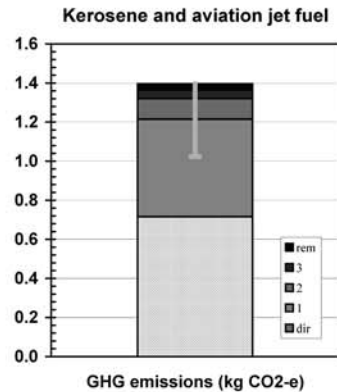
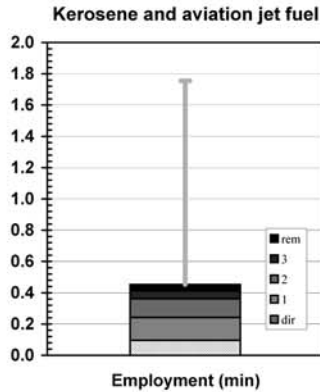
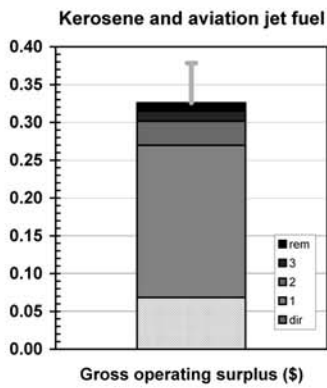
Spider diagram

Kerosene and aviation jet fuel

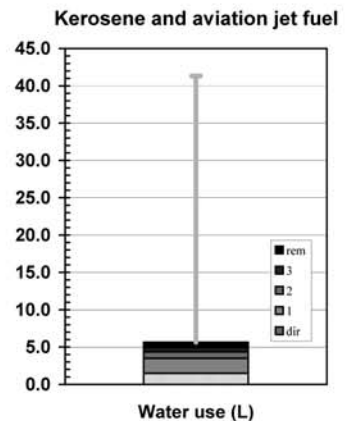
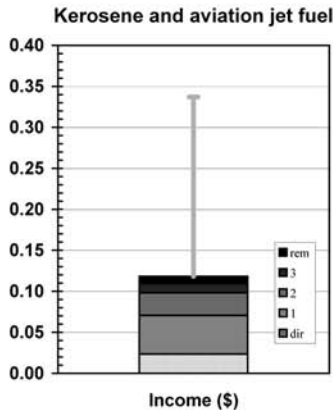
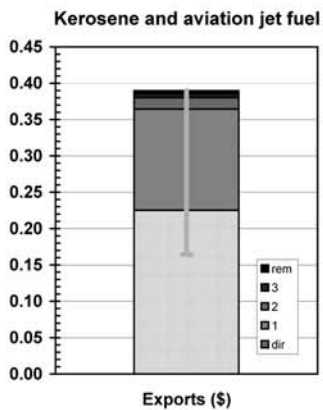


Bar graphs

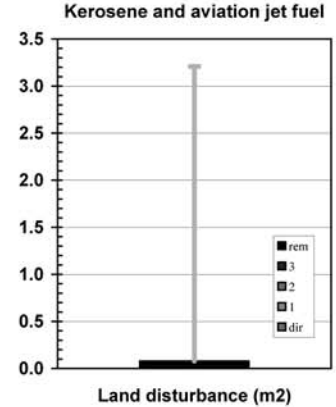
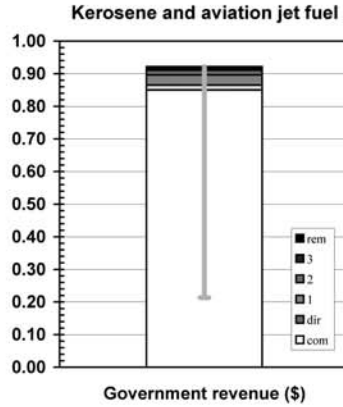
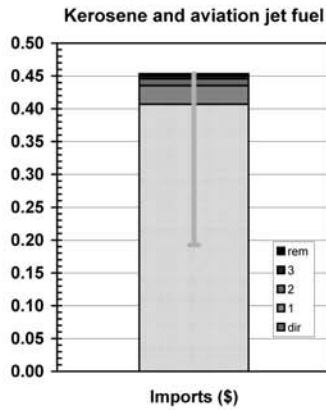
Account #1



Account #2



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 203.9	(0.08% of total)	(\$m 184.1 domestically produced)
Government final consumption	\$m 0.0		
Gross fixed capital expenditure	\$m 0.0		
Net changes in stocks	\$m 3.5	(0.20% of total)	(\$m 3.1 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 207.4</b>	<b>(0.05% of GNE)</b>	<b>(\$m 187.3 domestically produced)</b>
Exports	\$m 217.9	(0.26% of total)	(\$m 217.9 domestically produced)
<b>Final demand</b>	<b>\$m 425.2</b>	<b>(0.08% of GNT)</b>	<b>(\$m 405.1 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 22.7	(0.01% of total)
Gross operating surplus	\$m 66.0	(0.03% of total)
Taxes less subsidies	\$m 14.6	(0.02% of total)
<b>Sectoral GDP*</b>	<b>\$m 103.3</b>	<b>(0.02% of GDP)</b>
Imports	\$m 393.5	(0.40% of total)
<b>Primary inputs</b>	<b>\$m 496.8</b>	<b>(0.09% of GNT)</b>

\* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 66.0	(0.03%)	\$m 27.6 (0.01%)	\$m 132.0 (0.07%)
Exports (\$m)	\$m 217.9	(0.26%)	\$m 91.2 (0.11%)	\$m 158.0 (0.19%)
Imports (\$m)	\$m 393.5	(0.40%)	\$m 164.8 (0.17%)	\$m 183.7 (0.19%)
Employment (e-y)	747 e-y	(0.01%)	313 e-y (0.00%)	1,471 e-y (0.02%)
Income (\$m)*	\$m 22.7	(0.01%)	\$m 9.5 (0.01%)	\$m 47.9 (0.03%)
Government revenue (\$m)†	\$m 359.0	(0.33%)	\$m 350.5 (0.32%)	\$m 373.4 (0.35%)
GHG emissions (kt CO <sub>2</sub> -e)	692 kt	(0.13%)	290 kt (0.06%)	566 kt (0.11%)
Water use (ML)	1,436 ML	(0.01%)	601 ML (0.00%)	2,284 ML (0.01%)
Land disturbance (kha)	0 kha	(0.00%)	0 kha (0.00%)	3 kha (0.00%)
Primary energy (TJ)	9,835 TJ	(0.25%)	4,119 TJ (0.11%)	5,762 TJ (0.15%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.07	0.33	0.38
Exports (\$)	0.23	0.39	0.16
Imports (\$)	0.41	0.45	0.19
Employment (min)	0.10	0.45	1.75
Income (\$)	0.02	0.12	0.34
Government revenue (\$)	0.87	0.92	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.72	1.40	1.02
Water use (L)	1.48	5.64	41.32
Land disturbance (m <sup>2</sup> )	0.00	0.08	3.21
Primary energy (MJ)	10.17	14.22	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Oi Ke	0.177	(1; 54.%)	Ke	0.0964	(0; 21.%)	Ke	0.716	(0; 51.%)
Ke	0.0682	(0; 21.%)	Oi Ke	0.0682	(1; 15.%)	Oi Ke	0.374	(1; 27.%)
Lg Ke	0.00486	(1; 1.5%)	Rf Oi Ke	0.021	(2; 4.6%)	El Ke	0.0636	(1; 4.6%)
Rf Oi Ke	0.00262	(2; 0.81%)	Wt Ke	0.0185	(1; 4.1%)	El Oi Ke	0.0426	(2; 3.%)
El Ke	0.00257	(1; 0.79%)	Cs Oi Ke	0.00792	(2; 1.7%)	Ch Ke	0.014	(1; 1.%)
Wt Ke	0.00257	(1; 0.79%)	Rd Ke	0.00753	(1; 1.7%)	Lg Ke	0.0115	(1; 0.83%)
St Ke	0.0024	(1; 0.74%)	Wt Oi Ke	0.00741	(2; 1.6%)	El Rf Oi Ke	0.00765	(3; 0.55%)
Mn Oi Ke	0.00205	(2; 0.63%)	Bk Ke	0.00689	(1; 1.5%)	Rf Oi Ke	0.00761	(2; 0.54%)
Bk Ke	0.00174	(1; 0.53%)	Bk Oi Ke	0.00623	(2; 1.4%)	Ng Ke	0.00406	(1; 0.29%)
El Oi Ke	0.00172	(2; 0.53%)	Gv Ke	0.00511	(1; 1.1%)	Ga Ke	0.004	(1; 0.29%)
Bk Oi Ke	0.00157	(2; 0.48%)	Mn Oi Ke	0.0043	(2; 0.95%)	Fo Oi Ke	0.00337	(2; 0.24%)
Rd Ke	0.00128	(1; 0.39%)	St Ke	0.00392	(1; 0.86%)	Wt Ke	0.00256	(1; 0.18%)
Ch Ke	0.00117	(1; 0.36%)	Ho Ke	0.00349	(1; 0.77%)	El Ch Ke	0.00211	(2; 0.15%)
Wt Oi Ke	0.00103	(2; 0.32%)	Ch Ke	0.00341	(1; 0.75%)	Rd Ke	0.00204	(1; 0.15%)
Ng Ke	0.000894	(1; 0.27%)	Rd Oi Ke	0.00302	(2; 0.67%)	Bl El Ke	0.0016	(2; 0.11%)
St Oi Ke	0.000832	(2; 0.26%)	El Ke	0.00286	(1; 0.63%)	Is Oi Ke	0.00145	(2; 0.1%)
Wa Ke	0.000756	(1; 0.23%)	Ma Oi Ke	0.00262	(2; 0.58%)	At Ke	0.00132	(1; 0.094%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Ke	0.225	(0; 58.%)	Oi Ke	0.0296	(1; 25.%)	Ke	1.48	(0; 26.%)
Oi Ke	0.121	(1; 31.%)	Ke	0.0234	(0; 20.%)	Oi Ke	0.892	(1; 16.%)
Lg Ke	0.00568	(1; 1.5%)	Rf Oi Ke	0.00589	(2; 5.%)	Wa Ke	0.556	(1; 9.9%)
Rf Oi Ke	0.0043	(2; 1.1%)	Wt Ke	0.00397	(1; 3.4%)	El Ke	0.352	(1; 6.2%)
Wt Ke	0.0021	(1; 0.54%)	Bk Ke	0.0017	(1; 1.4%)	El Oi Ke	0.235	(2; 4.2%)
Ch Ke	0.00163	(1; 0.42%)	Wt Oi Ke	0.00159	(2; 1.3%)	Mn Oi Ke	0.136	(2; 2.4%)
Wt Oi Ke	0.000841	(2; 0.22%)	Bk Oi Ke	0.00154	(2; 1.3%)	Wa Oi Ke	0.045	(2; 0.8%)
Bl El Ke	0.000622	(2; 0.16%)	Mn Oi Ke	0.00144	(2; 1.2%)	Ch Ke	0.0428	(1; 0.76%)
St Ke	0.000595	(1; 0.15%)	Rd Ke	0.0013	(1; 1.1%)	El Rf Oi Ke	0.0423	(3; 0.75%)
Rd Ke	0.000446	(1; 0.11%)	Gv Ke	0.00128	(1; 1.1%)	Ws Ho Ke	0.0254	(2; 0.45%)
At Ke	0.00042	(1; 0.11%)	St Ke	0.001	(1; 0.85%)	Rf Oi Ke	0.0229	(2; 0.41%)
Bl El Oi Ke	0.000416	(3; 0.11%)	Cs Oi Ke	0.000946	(2; 0.8%)	Wa El Ke	0.0203	(2; 0.36%)
Ma Oi Ke	0.000385	(2; 0.099%)	Lg Ke	0.000814	(1; 0.69%)	Bc Mp Ch Ke	0.0202	(3; 0.36%)
Eq Oi Ke	0.000331	(2; 0.085%)	El Ke	0.000774	(1; 0.65%)	Wa Cs Oi Ke	0.02	(3; 0.35%)
Oi Fo Oi Ke	0.000327	(3; 0.084%)	Ch Ke	0.000724	(1; 0.61%)	Bc Mp Ho Ke	0.0183	(3; 0.32%)
Sp Ke	0.000318	(1; 0.082%)	Pd Oi Ke	0.000583	(2; 0.49%)	Wa Pd Oi Ke	0.0177	(3; 0.31%)
Sg Ke	0.00031	(1; 0.08%)	Rd Oi Ke	0.000519	(2; 0.44%)	Lg Ke	0.0175	(1; 0.31%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$		
Ke	0.407	(0; 90.%)	Oi Ke	0.0214	(1; 30.%)	Bc Mp Ch Ke	0.00557	(3; 7.1%)
Oi Ke	0.013	(1; 2.9%)	Ke	0.0151	(0; 21.%)	Bc Mp Ho Ke	0.00504	(3; 6.4%)
Ch Ke	0.00163	(1; 0.36%)	Rf Oi Ke	0.00271	(2; 3.8%)	Ke	0.0049	(0; 6.2%)
Fo Oi Ke	0.0011	(2; 0.24%)	Wt Ke	0.00186	(1; 2.6%)	Wo Tx Ke	0.00312	(2; 4.%)
Mn Oi Ke	0.000937	(2; 0.21%)	Mn Oi Ke	0.000982	(2; 1.4%)	Oi Ke	0.00308	(1; 3.9%)
Rf Oi Ke	0.000677	(2; 0.15%)	Bk Ke	0.000939	(1; 1.3%)	Rf Oi Ke	0.00295	(2; 3.7%)
Wt Ke	0.000597	(1; 0.13%)	Rd Ke	0.000919	(1; 1.3%)	Bc Ch Ke	0.0028	(2; 3.6%)
Ma Oi Ke	0.000454	(2; 0.1%)	Bk Oi Ke	0.000849	(2; 1.2%)	Bc Mp Ho Oi Ke	0.00108	(4; 1.4%)
Pc Oi Ke	0.000383	(2; 0.084%)	Wt Oi Ke	0.000743	(2; 1.%)	El Ke	0.00103	(1; 1.3%)
Lg Ke	0.000358	(1; 0.079%)	Lg Ke	0.00059	(1; 0.82%)	Bc Mp Ke	0.000906	(2; 1.2%)
Oc Oi Ke	0.000357	(2; 0.079%)	St Ke	0.000534	(1; 0.75%)	Wo Cs Oi Ke	0.00081	(3; 1.%)
Rd Ke	0.000325	(1; 0.072%)	El Ke	0.000482	(1; 0.67%)	El Oi Ke	0.000688	(2; 0.87%)
Cs Oi Ke	0.000242	(2; 0.053%)	In Ke	0.000482	(1; 0.67%)	Wo Tx Wt Ke	0.000659	(3; 0.84%)
Wt Oi Ke	0.000239	(2; 0.053%)	Gv Ke	0.000447	(1; 0.62%)	Wo Mp Ch Ke	0.000629	(3; 0.8%)
Eq Oi Ke	0.000219	(2; 0.048%)	In Oi Ke	0.000385	(2; 0.54%)	Wo Mp Ho Ke	0.000569	(3; 0.72%)
St Ke	0.000217	(1; 0.048%)	Pd Oi Ke	0.000382	(2; 0.53%)	Wo Tx Oi Ke	0.000555	(3; 0.7%)
Rh Oi Ke	0.000208	(2; 0.046%)	Rd Oi Ke	0.000368	(2; 0.51%)	Bc Mp Cs Oi Ke	0.000509	(4; 0.65%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	0.863 ±0.033	(±3.8%)
Downstream	1.224 ±0.034	(±2.8%)

# Sector 25100030: Gas Oil, Fuel Oil (Fo)

*Gas oil and fuel oil (diesel) excluding motor spirit and kerosene*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is 90% above average while water use and land disturbance are 85% and 95% below average respectively. The social indicators of employment generation and income are respectively 75% and 65% below average. However the government revenue indicator is over eight times the average due to the excise tax levied on diesel fuel. The financial indicator of operating surplus is 15% below average, export propensity is 30% above average and import penetration is over twice the average. In absolute financial terms imports outweigh exports by a factor of eight to one. The sector is important to downstream sectors in agriculture, mining and road transport where diesel is the dominant fuel type. Supply of diesel may become an issue within the next 20 years if traditional oil becomes constrained for resource depletion or political reasons. While both biodiesel and compressed natural gas are feasible fuel substitutes, total replacement by biodiesel is probably infeasible. Past 2020, methanol fuels cells may begin to power trucks, buses and tractors.

## Sector Description

This sector includes the production of distillate fuel for on road and off road diesel engines as well as oil for heating and industrial applications. Diesel and heating oil are middle distillates and the amount that a refinery can produce per barrel of oil is process-limited. In 2001, Australian motorists purchased 13 274 million litres of diesel. Australia has eight refineries that can produce diesel and the overall refinery output is 42% petrol, 29% diesel and 12% jet fuel. Australian refineries produce 13 306 million litres of diesel. About 35% of crude oil input is from domestic oil wells. Australia imported 1 143 million litres of diesel (80% from Singapore) and exported 1 008 million litres (40% to Fiji). Some industries have a particular reliance on diesel such as mining (50%), agriculture (84%) and construction (96%). Diesel accounts for 28% of total fuel for vehicles.

## Place of Industry in the Economy

The gas and fuel oil sector ranks 123<sup>rd</sup> out of 135 sectors in terms of value adding in the economy and contributes 0.05% of GDP in this analysis. It is a small employment generator with a total requirement of 500 employment years. In addition, it contributes 1 600 employment years to downstream sectors such as primary production and road freight. The sector is responsible for less than one tenth of one percent of national greenhouse emissions, energy use, water use and land disturbance. In financial terms, imports outweigh exports by a factor of eight to one due mainly to the direct imports of diesel fuel from large refineries in Singapore.

## Strategic Overview

The integrated overview of the gas oil and fuel oil sector provided by the spider diagram portrays a sector of extremes with stark contrasts particularly for the social and environmental indicators. The employment and income indicators are substantially below average due to the capital intensive nature of petroleum refining and strong competition. These are offset against the government revenue indicator that is eight times the average. The environmental indicators show a similar contrast with low water use and land disturbance and higher than average energy use and greenhouse emissions. Upstream issues for the sector include maintaining supply in the longer term and improving the refining process to increase yield of useable product. Downstream issues include air pollution and possible public health risks from micro-sized combustion products.

## TBL Account #1

The financial indicator of surplus is 15% below the economy wide average. About one fifth of the surplus is a direct effect, with half due to crude oil and minor amounts due to natural gas and rail freight. The social indicator of employment generation is 75% below average with one quarter a direct effect and the rest due to the sector's suppliers. Greenhouse emissions are 90% above the economy wide average, with three fifths due to the direct sector effect. Improving the account may prove a challenge. Diesel is the dominant fuel for the mining and agriculture industries (both important earners of export income) and construction industries (important for regional development and jobs). As diesel is a central input into many industries, attempting to improve the sector's TBL account might increase its price and produce substantial negative knock-on effects.

## TBL Accounts #2 and #3

For the second TBL account, export propensity is 30% above average with about one fifth a direct sector effect. Income is 65% below average and water use is 85% below average. For the third TBL account, import penetration is more than twice the average while the government revenue is over eight times the average reflecting the state and federal taxes levied on diesel fuel. The land disturbance indicator is 95% below average. Both these accounts portray extreme situations where an adequate export indicator is overshadowed by a larger import indicator reflecting a 1:8 ratio in dollar terms. Similarly for social indicators, a relatively poor income indicator is overshadowed by a large government revenue indicator. Attempting to improve import penetration, for example by producing biodiesel locally, may improve the income and employment indicators, but increase the water use and land disturbance indicators.

## Structural Path Analysis and Linkages

An examination of the structural path for greenhouse emissions reveals that 64% of the effect is direct and therefore may be open to improvement through innovation in refining processes. The basic refinery feedstock from the crude oil sector accounts for 19% of emissions, with further contributions from electricity (6%) and basic chemicals (1%).

The sector shows extremely strong downstream linkages to the road freight, wholesale trade, base metal mining, sand and gravel, vegetable and fruit growing and gold and lead mining sectors. Increases in consumer demand give a weak upstream stimulus to the crude oil sector.

## Future Trends in Sector

The base case scenario in the CSIRO *Future Dilemmas* study anticipates all sectors which use diesel will steadily expand over the next fifty years. The freight task doubles and the production of coal, iron ore and other minerals almost treble. The agricultural sector intensifies with reductions in broad-acre activity balanced by intensification in the animal and horticultural industries. Thus it is possible that the physical activity currently fuelled by diesel may at least double by the year 2050. However considerable uncertainty exists regarding the availability of traditional cheap oil, and whether future carbon constraints might force fuel substitution and economic restructuring.

## Innovation and Technical Opportunities

Considerable effort is being devoted worldwide to biodiesel production with a yield potential of about 1 tonne of biodiesel per ha of oilseed cultivated, and 2 tonnes/ha proven under intensive systems in Europe. Local self sufficiency would require 13 million ha of arable land to produce all of current diesel consumption, and is probably not feasible. With engine modification, compressed natural gas is a feasible medium term replacement for diesel. Past 2020, methanol (from natural gas or biomass) powered fuel cells could replace traditional diesel engines in trucks, tractors and buses.

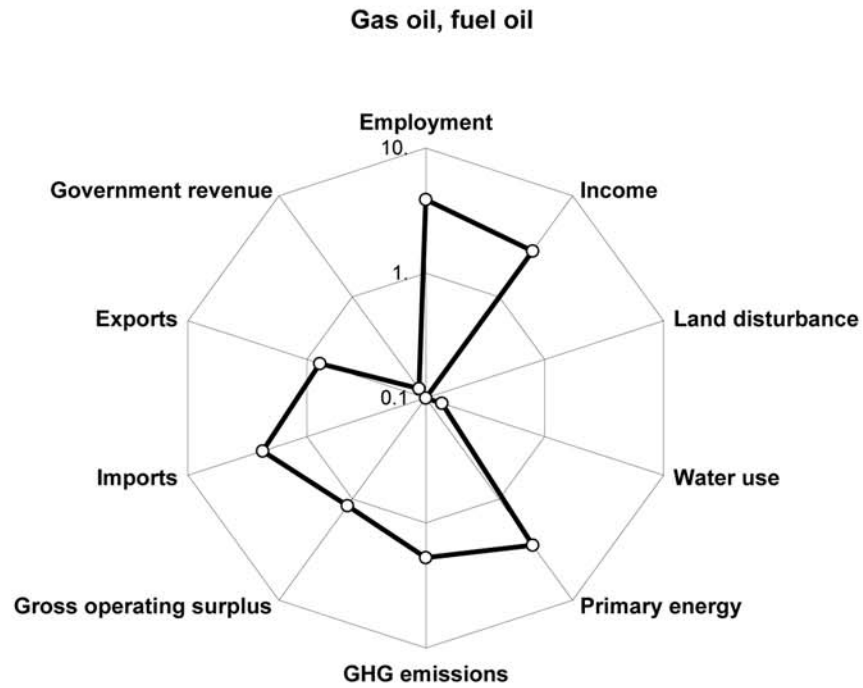
Sector

Gas oil, fuel oil

(Fo)

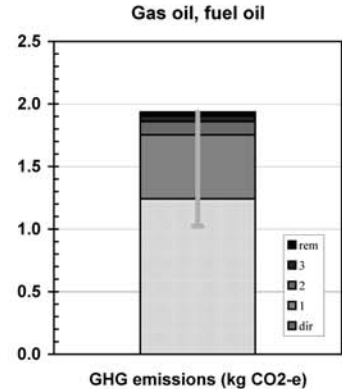
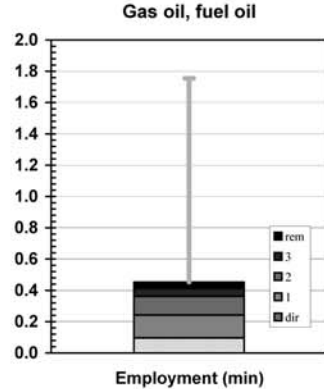
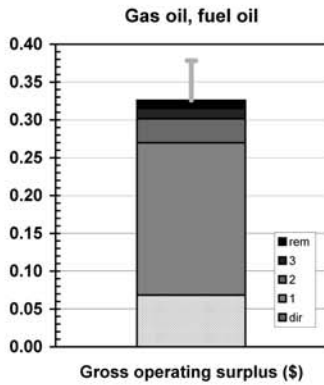
Gas oil, fuel oil

Spider diagram

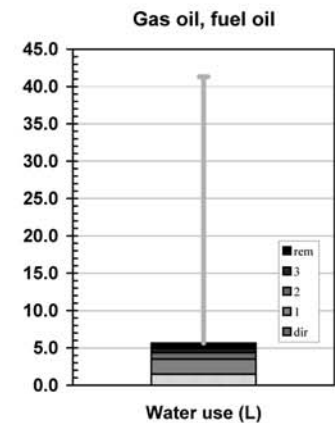
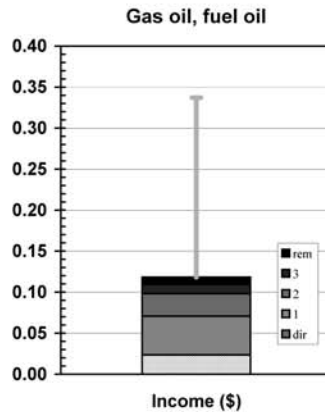
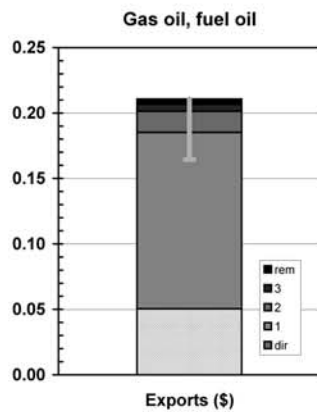


Bar graphs

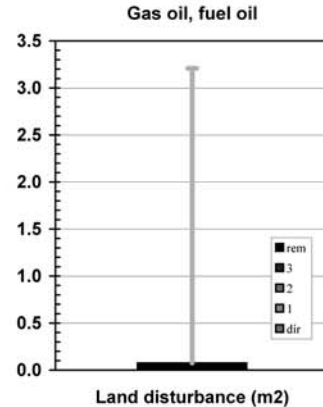
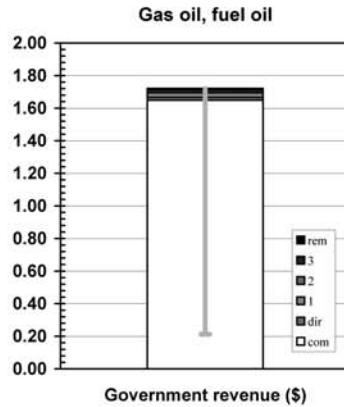
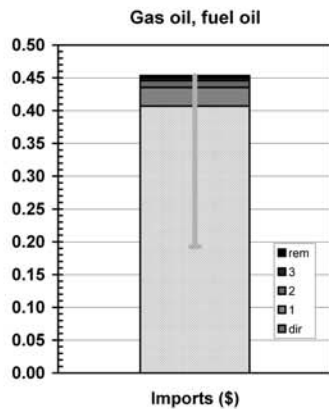
Account #1



Account #2



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 2.4	(0.00% of total)	(\$m 2.1 domestically produced)
Government final consumption	\$m 0.0		
Gross fixed capital expenditure	\$m 0.0		
Net changes in stocks	\$m 25.5	(1.44% of total)	(\$m 21.8 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 28.0</b>	<b>(0.01% of GNE)</b>	<b>(\$m 23.9 domestically produced)</b>
Exports	\$m 114.2	(0.14% of total)	(\$m 114.2 domestically produced)
<b>Final demand</b>	<b>\$m 142.2</b>	<b>(0.03% of GNT)</b>	<b>(\$m 138.1 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 53.1	(0.03% of total)
Gross operating surplus	\$m 154.5	(0.08% of total)
Taxes less subsidies	\$m 34.3	(0.04% of total)
<b>Sectoral GDP*</b>	<b>\$m 241.9</b>	<b>(0.05% of GDP)</b>
Imports	\$m 921.4	(0.94% of total)
<b>Primary inputs</b>	<b>\$m 1,163.2</b>	<b>(0.21% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 154.5	(0.08%)	\$m 9.4 (0.00%)	\$m 45.0 (0.02%)
Exports (\$m)	\$m 114.2	(0.14%)	\$m 7.0 (0.01%)	\$m 29.1 (0.03%)
Imports (\$m)	\$m 921.4	(0.94%)	\$m 56.2 (0.06%)	\$m 62.6 (0.06%)
Employment (e-y)	1,749 e-y	(0.02%)	107 e-y (0.00%)	502 e-y (0.01%)
Income (\$m)*	\$m 53.1	(0.03%)	\$m 3.2 (0.00%)	\$m 16.3 (0.01%)
Government revenue (\$m)†	\$m 262.0	(0.24%)	\$m 229.8 (0.21%)	\$m 237.6 (0.22%)
GHG emissions (kt CO <sub>2</sub> -e)	2,812 kt	(0.54%)	171 kt (0.03%)	267 kt (0.05%)
Water use (ML)	3,362 ML	(0.02%)	205 ML (0.00%)	779 ML (0.00%)
Land disturbance (kha)	1 kha	(0.00%)	0 kha (0.00%)	1 kha (0.00%)
Primary energy (TJ)	39,937 TJ	(1.03%)	2,435 TJ (0.06%)	3,020 TJ (0.08%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.07	0.33	0.38
Exports (\$)	0.05	0.21	0.16
Imports (\$)	0.41	0.45	0.19
Employment (min)	0.10	0.45	1.75
Income (\$)	0.02	0.12	0.34
Government revenue (\$)	1.66	1.72	0.21
GHG emissions (kg CO <sub>2</sub> -e)	1.24	1.94	1.02
Water use (L)	1.48	5.64	41.32
Land disturbance (m <sup>2</sup> )	0.00	0.08	3.21
Primary energy (MJ)	17.63	21.87	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Oi Fo	0.177	(1; 54.%)	Fo	0.0964	(0; 21.%)	Fo	1.24	(0; 64.%)
Fo	0.0682	(0; 21.%)	Oi Fo	0.0682	(1; 15.%)	Oi Fo	0.374	(1; 19.%)
Lg Fo	0.00486	(1; 1.5%)	Rf Oi Fo	0.021	(2; 4.6%)	El Fo	0.0636	(1; 3.3%)
Rf Oi Fo	0.00262	(2; 0.81%)	Wt Fo	0.0185	(1; 4.1%)	El Oi Fo	0.0426	(2; 2.2%)
El Fo	0.00257	(1; 0.79%)	Cs Oi Fo	0.00792	(2; 1.7%)	Ch Fo	0.014	(1; 0.72%)
Wt Fo	0.00257	(1; 0.79%)	Rd Fo	0.00753	(1; 1.7%)	Lg Fo	0.0115	(1; 0.6%)
St Fo	0.0024	(1; 0.74%)	Wt Oi Fo	0.00741	(2; 1.6%)	El Rf Oi Fo	0.00765	(3; 0.4%)
Mn Oi Fo	0.00205	(2; 0.63%)	Bk Fo	0.00689	(1; 1.5%)	Rf Oi Fo	0.00761	(2; 0.39%)
Bk Fo	0.00174	(1; 0.53%)	Bk Oi Fo	0.00623	(2; 1.4%)	Ng Fo	0.00406	(1; 0.21%)
El Oi Fo	0.00172	(2; 0.53%)	Gv Fo	0.00511	(1; 1.1%)	Ga Fo	0.004	(1; 0.21%)
Bk Oi Fo	0.00157	(2; 0.48%)	Mn Oi Fo	0.0043	(2; 0.95%)	Fo Oi Fo	0.00337	(2; 0.17%)
Rd Fo	0.00128	(1; 0.39%)	St Fo	0.00392	(1; 0.86%)	Wt Fo	0.00256	(1; 0.13%)
Ch Fo	0.00117	(1; 0.36%)	Ho Fo	0.00349	(1; 0.77%)	El Ch Fo	0.00211	(2; 0.11%)
Wt Oi Fo	0.00103	(2; 0.32%)	Ch Fo	0.00341	(1; 0.75%)	Rd Fo	0.00204	(1; 0.11%)
Ng Fo	0.000894	(1; 0.27%)	Rd Oi Fo	0.00302	(2; 0.67%)	Bl El Fo	0.0016	(2; 0.083%)
St Oi Fo	0.000832	(2; 0.26%)	El Fo	0.00286	(1; 0.63%)	Is Oi Fo	0.00145	(2; 0.075%)
Wa Fo	0.000756	(1; 0.23%)	Ma Oi Fo	0.00262	(2; 0.58%)	At Fo	0.00132	(1; 0.068%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Oi Fo	0.121	(1; 57.%)	Oi Fo	0.0296	(1; 25.%)	Fo	1.48	(0; 26.%)
Fo	0.0504	(0; 24.%)	Fo	0.0234	(0; 20.%)	Oi Fo	0.892	(1; 16.%)
Lg Fo	0.00568	(1; 2.7%)	Rf Oi Fo	0.00589	(2; 5.%)	Wa Fo	0.556	(1; 9.9%)
Rf Oi Fo	0.0043	(2; 2.%)	Wt Fo	0.00397	(1; 3.4%)	El Fo	0.352	(1; 6.2%)
Wt Fo	0.0021	(1; 1.%)	Bk Fo	0.0017	(1; 1.4%)	El Oi Fo	0.235	(2; 4.2%)
Ch Fo	0.00163	(1; 0.77%)	Wt Oi Fo	0.00159	(2; 1.3%)	Mn Oi Fo	0.136	(2; 2.4%)
Wt Oi Fo	0.000841	(2; 0.4%)	Bk Oi Fo	0.00154	(2; 1.3%)	Wa Oi Fo	0.045	(2; 0.8%)
Bl El Fo	0.000622	(2; 0.3%)	Mn Oi Fo	0.00144	(2; 1.2%)	Ch Fo	0.0428	(1; 0.76%)
St Fo	0.000595	(1; 0.28%)	Rd Fo	0.0013	(1; 1.1%)	El Rf Oi Fo	0.0423	(3; 0.75%)
Rd Fo	0.000446	(1; 0.21%)	Gv Fo	0.00128	(1; 1.1%)	Ws Ho Fo	0.0254	(2; 0.45%)
At Fo	0.00042	(1; 0.2%)	St Fo	0.001	(1; 0.85%)	Rf Oi Fo	0.0229	(2; 0.41%)
Bl El Oi Fo	0.000416	(3; 0.2%)	Cs Oi Fo	0.000946	(2; 0.8%)	Wa El Fo	0.0203	(2; 0.36%)
Ma Oi Fo	0.000385	(2; 0.18%)	Lg Fo	0.000814	(1; 0.69%)	Bc Mp Ch Fo	0.0202	(3; 0.36%)
Eq Oi Fo	0.000331	(2; 0.16%)	El Fo	0.000774	(1; 0.65%)	Wa Cs Oi Fo	0.02	(3; 0.35%)
Oi Fo Oi Fo	0.000327	(3; 0.16%)	Ch Fo	0.000724	(1; 0.61%)	Bc Mp Ho Fo	0.0183	(3; 0.32%)
Sp Fo	0.000318	(1; 0.15%)	Pd Oi Fo	0.000583	(2; 0.49%)	Wa Pd Oi Fo	0.0177	(3; 0.31%)
Sg Fo	0.00031	(1; 0.15%)	Rd Oi Fo	0.000519	(2; 0.44%)	Lg Fo	0.0175	(1; 0.31%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Fo	0.407	(0; 90.%)	Oi Fo	0.0214	(1; 30.%)	Bc Mp Ch Fo	0.00557	(3; 7.3%)
Oi Fo	0.013	(1; 2.9%)	Fo	0.0151	(0; 21.%)	Bc Mp Ho Fo	0.00504	(3; 6.6%)
Ch Fo	0.00163	(1; 0.36%)	Rf Oi Fo	0.00271	(2; 3.8%)	Wo Tx Fo	0.00312	(2; 4.1%)
Fo Oi Fo	0.0011	(2; 0.24%)	Wt Fo	0.00186	(1; 2.6%)	Oi Fo	0.00308	(1; 4.1%)
Mn Oi Fo	0.000937	(2; 0.21%)	Mn Oi Fo	0.000982	(2; 1.4%)	Rf Oi Fo	0.00295	(2; 3.9%)
Rf Oi Fo	0.000677	(2; 0.15%)	Bk Fo	0.000939	(1; 1.3%)	Bc Ch Fo	0.0028	(2; 3.7%)
Wt Fo	0.000597	(1; 0.13%)	Rd Fo	0.000919	(1; 1.3%)	Fo	0.00224	(0; 2.9%)
Ma Oi Fo	0.000454	(2; 0.1%)	Bk Oi Fo	0.000849	(2; 1.2%)	Bc Mp Ho Oi F	0.00108	(4; 1.4%)
Pc Oi Fo	0.000383	(2; 0.084%)	Wt Oi Fo	0.000743	(2; 1.%)	El Fo	0.00103	(1; 1.4%)
Lg Fo	0.000358	(1; 0.079%)	Lg Fo	0.00059	(1; 0.82%)	Bc Mp Fo	0.000906	(2; 1.2%)
Oc Oi Fo	0.000357	(2; 0.079%)	St Fo	0.000534	(1; 0.75%)	Wo Cs Oi Fo	0.00081	(3; 1.1%)
Rd Fo	0.000325	(1; 0.072%)	El Fo	0.000482	(1; 0.67%)	El Oi Fo	0.000688	(2; 0.9%)
Cs Oi Fo	0.000242	(2; 0.053%)	In Fo	0.000482	(1; 0.67%)	Wo Tx Wt Fo	0.000659	(3; 0.87%)
Wt Oi Fo	0.000239	(2; 0.053%)	Gv Fo	0.000447	(1; 0.62%)	Wo Mp Ch Fo	0.000629	(3; 0.83%)
Eq Oi Fo	0.000219	(2; 0.048%)	In Oi Fo	0.000385	(2; 0.54%)	Wo Mp Ho Fo	0.000569	(3; 0.75%)
St Fo	0.000217	(1; 0.048%)	Pd Oi Fo	0.000382	(2; 0.53%)	Wo Tx Oi Fo	0.000555	(3; 0.73%)
Rh Oi Fo	0.000208	(2; 0.046%)	Rd Oi Fo	0.000368	(2; 0.51%)	Bc Mp Cs Oi F	0.000509	(4; 0.67%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	0.863 ±0.033	(±3.8%)
Downstream	1.958 ±0.021	(±1.1%)



# Sector Rem. 2501: Other Petroleum and Coal Products (Pc)

*Petroleum bitumen, petroleum coke, refinery LPG, mineral waxes, lubricating oils and solvents*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is 45% above average while water use and land disturbance are 85% and 95% below average respectively. The social indicators of employment generation, income and government revenue are respectively 75%, 65% and 65% below average. The financial indicator of operating surplus is 15% below average while both export propensity and import penetration are more than twice the average. The sector is made up of by-products of crude oil refining and characterised by high capital intensity and low labour use. In absolute financial terms, imports are twice exports. If global supplies of cheap oil become constrained in the next 25 years, some substitution for this sector's products may be required. Bitumen supply from heavy oils is reasonably assured. However lubricants and industrial feedstocks may be substituted by biodegradable vegetable oils.

## Sector Description

This sector represents the range of crude oil refining by-products that remain after the key economic fuels of petrol, diesel and kerosene have been produced. Australian crude oil resources are generally less dense than benchmark crude oils, yielding lower fractions useful for lubricating oils and bitumen. Heavier crude oils have to be imported. In 2001, 755 000 tonnes of bitumen and 653 000 tonnes of lubricating oils were imported. Crude oil and refined products are both imported and exported. In overall value, petroleum trade exports in 2001 were \$6.4 billion and imports were \$7.5 billion leaving a trade deficit of \$1.1 billion and 3.3 million tonnes. An important industrial product from this sector is petroleum coke used for anodes in aluminium smelting.

## Place of Industry in the Economy

The sector is a small contributor to value adding in the economy ranking 126<sup>th</sup> out of 135 sectors and contributing 0.04% of GDP in this analysis. It is similar in value adding to the softwoods and oils and fats sector. It is a small generator of employment with a direct and indirect requirement of 2 500 employment years. In addition, the sector supplies 1 000 employment years to downstream sectors such as construction, basic chemicals and iron and steel products. The sector has a requirement for three tenths of one percent of national energy use and generates two tenths of one percent of national greenhouse emissions. In dollar terms, imports are twice the level of exports.

## Strategic Overview

The strategic overview provided in the spider diagram reveals outliers for environmental, social and financial indicators. An integrated solution for these issues may be difficult to achieve because the sector is essentially a by-products activity with its function governed by major upstream processes such as petrol refining and crude oil. Some of the upstream issues such as greenhouse emissions, energy use, import penetration, employment generation and income could be solved to some degree by producing lubricating oils and feedstocks from plant crops. This transition (to what is increasingly being called the carbohydrate economy) would have to be well integrated with process innovations in petroleum refining to ensure that the sector as a whole was not left with unusable material posing downstream disposal problems. Possible downstream issues for petroleum by-products such as industrial solvents, focus on possible health implications from their use.

## TBL Account #1

The financial indicator of operating surplus is 15% below the economy wide average. One fifth is a direct effect while half is due to the primary sector of crude oil with minor contributions from the sectors of liquefied natural gas, rail freight, electricity and wholesale trade. The social indicator of employment generation is 75% below the average with one quarter a direct effect. Greenhouse emissions are 45% greater than the average, half of which is a direct effect. It is difficult for a by-products sector to provide a balanced TBL account since it is heavily dependent on upstream sectors and feedstock inputs. Strongly related sectors such as petroleum and kerosene also provide below average social accounts. However most basic commodities such as petroleum are capital intensive and are open to world competition. As the building blocks of industrial activity, they provide a form of physical 'subsidy' to activities that are downstream in the value adding process.

## TBL Accounts #2 and #3

In the second TBL account, export propensity is more than twice the average, half being a direct effect. Income is 65% below average and water use is 85% below average. In the third TBL account, import penetration is more than twice the average and mostly a direct effect, government revenue is 65% below average and land disturbance is minimal. Thus the social indicators may require improvement, there is a tension between the financial indicators with imports larger than exports, and the two environmental indicators for water and land are excellent.

## Structural Path Analysis and Linkages

Examining the structural path for greenhouse emissions reveals that one half are direct emissions from within the sector, one quarter come from the primary supplier crude oil, and about one tenth come from the direct and indirect use of electricity. Direct sector change may improve these.

Given that this is essentially a by-products sector, the downstream linkages provided by investment into the sector are average. The principal links are basic chemicals (a feedstock effect), and steel products, residential and non-residential building (a road construction effect). Increases in consumer demand for the sector give a weak upstream stimulus to suppliers, particularly the crude oil sector.

## Future Trends in Sector

The CSIRO *Future Dilemmas* study indicates that two key products in this sector will increase under the base case scenario with a population of 25 million by the year 2050. Requirements for bitumen may increase from 755 000 tonnes per annum to 1 100 000 tonnes per annum driven by the requirements for suburban roads and highways as well as road refurbishment and maintenance. Similarly, lubricating oils could rise from 650 000 tonnes per year to 1.2 million tonnes per year. The scenario also includes a large increase in aluminium production which requires 0.4 tonne of petroleum coke anode for each tonne of aluminium produced. The future for petroleum coke is uncertain as synthetic anodes can be made from powdered coal and coal tar.

## Innovation and Technical Opportunities

Given possible constraints to oil availability over the next fifty years (and therefore its by-products) opportunities for by-product substitution require examination. Vegetable oils are seen as biodegradable replacements for petroleum lubricants and feedstocks. However their low temperature properties and chemistry of their cracking and reformulation require considerable research and development. There are large supplies of bitumen and heavy oils in countries such as Canada, so bitumen for road making may continue to be available. However social constraints may emerge as some European countries are concerned about the effect of bitumen exposure on road construction workers. Concrete roads may replace bitumen roads in dryland salinity areas.

**Sector**

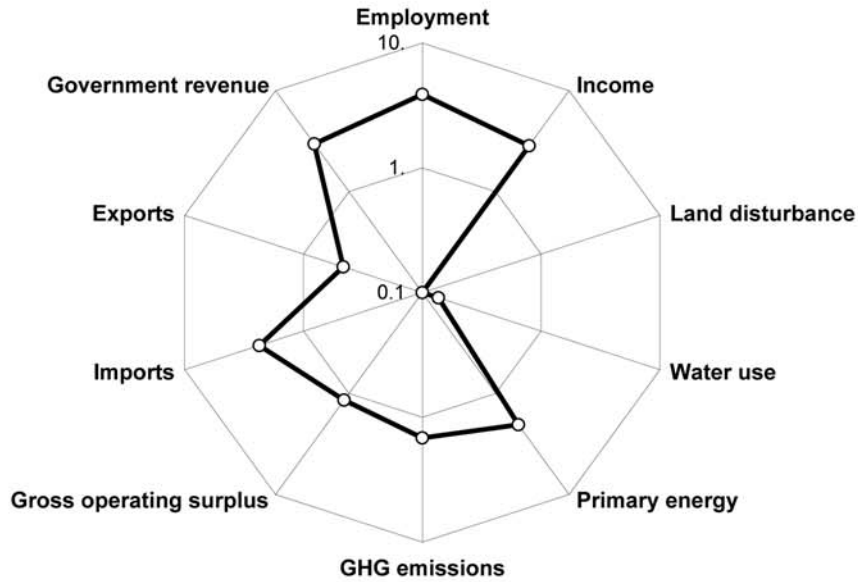
**Other petroleum and coal products**

**(Pc)**

Petroleum bitumen, petroleum coke, refinery LPG, mineral waxes, lubricating oils, solvents, char, pitch and pitch coke, asphalt, metallurgical coke and other petroleum and coal products

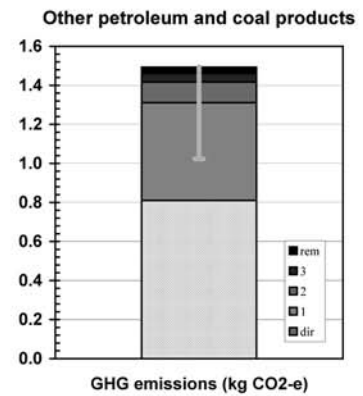
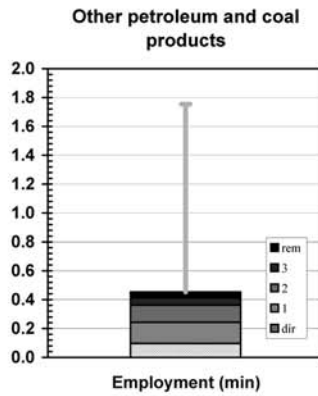
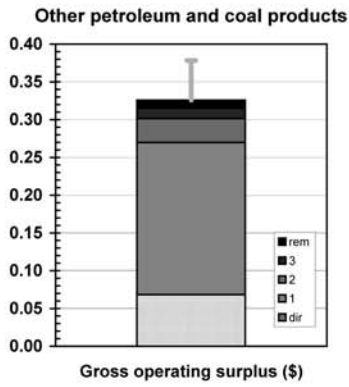
**Spider diagram**

**Other petroleum and coal products**

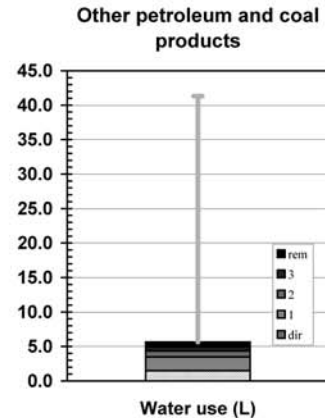
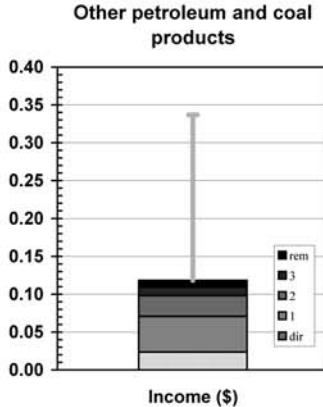
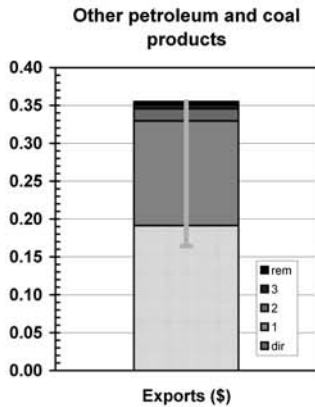


**Bar graphs**

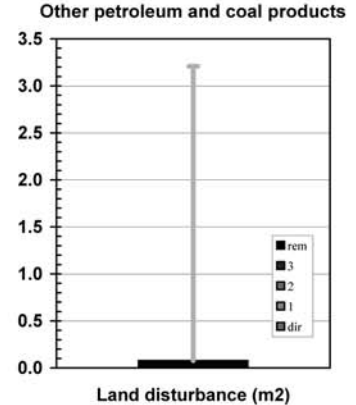
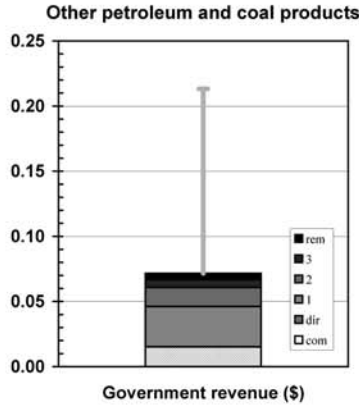
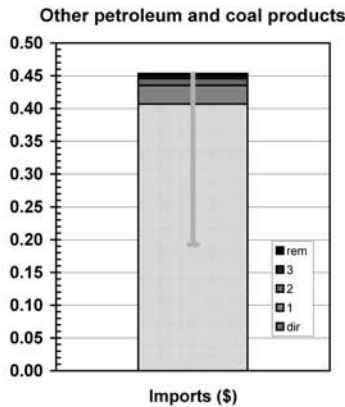
**Account #1**



**Account #2**



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 74.2	(0.03% of total)	(\$m 38.1 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 0.7	(0.00% of total)	(\$m 0.7 domestically produced)
Net changes in stocks	\$m 392.0	(22.18% of total)	(\$m 306.3 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 466.8</b>	<b>(0.10% of GNE)</b>	<b>(\$m 345.0 domestically produced)</b>
Exports	\$m 318.2	(0.38% of total)	(\$m 318.2 domestically produced)
<b>Final demand</b>	<b>\$m 785.0</b>	<b>(0.14% of GNT)</b>	<b>(\$m 663.2 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 39.0	(0.02% of total)
Gross operating surplus	\$m 113.5	(0.06% of total)
Taxes less subsidies	\$m 25.2	(0.03% of total)
<b>Sectoral GDP*</b>	<b>\$m 177.7</b>	<b>(0.04% of GDP)</b>
Imports	\$m 676.9	(0.69% of total)
<b>Primary inputs</b>	<b>\$m 854.5</b>	<b>(0.16% of GNT)</b>

\* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 113.5	(0.06%)	\$m 45.2 (0.02%)	\$m 216.1 (0.11%)
Exports (\$m)	\$m 318.2	(0.38%)	\$m 126.8 (0.15%)	\$m 235.5 (0.28%)
Imports (\$m)	\$m 676.9	(0.69%)	\$m 269.8 (0.28%)	\$m 300.8 (0.31%)
Employment (e-y)	1,285 e-y	(0.02%)	512 e-y (0.01%)	2,409 e-y (0.03%)
Income (\$m)*	\$m 39.0	(0.02%)	\$m 15.5 (0.01%)	\$m 78.5 (0.05%)
Government revenue (\$m)†	\$m 25.2	(0.02%)	\$m 10.0 (0.01%)	\$m 47.5 (0.04%)
GHG emissions (kt CO <sub>2</sub> -e)	1,348 kt	(0.26%)	537 kt (0.10%)	990 kt (0.19%)
Water use (ML)	2,470 ML	(0.01%)	984 ML (0.00%)	3,739 ML (0.02%)
Land disturbance (kha)	0 kha	(0.00%)	0 kha (0.00%)	5 kha (0.00%)
Primary energy (TJ)	19,145 TJ	(0.49%)	7,630 TJ (0.20%)	10,342 TJ (0.27%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.07	0.33	0.38
Exports (\$)	0.19	0.36	0.16
Imports (\$)	0.41	0.45	0.19
Employment (min)	0.10	0.45	1.75
Income (\$)	0.02	0.12	0.34
Government revenue (\$)	0.02	0.07	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.81	1.49	1.02
Water use (L)	1.48	5.64	41.32
Land disturbance (m <sup>2</sup> )	0.00	0.08	3.21
Primary energy (MJ)	11.51	15.59	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

### Structural Paths (intensities - commodities)

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Oi Pc	0.177	(1; 54.%)	Pc	0.0964	(0; 21.%)	Pc	0.81	(0; 54.%)
Pc	0.0682	(0; 21.%)	Oi Pc	0.0682	(1; 15.%)	Oi Pc	0.374	(1; 25.%)
Lg Pc	0.00486	(1; 1.5%)	Rf Oi Pc	0.021	(2; 4.6%)	El Pc	0.0636	(1; 4.3%)
Rf Oi Pc	0.00262	(2; 0.81%)	Wt Pc	0.0185	(1; 4.1%)	El Oi Pc	0.0426	(2; 2.9%)
El Pc	0.00257	(1; 0.79%)	Cs Oi Pc	0.00792	(2; 1.7%)	Ch Pc	0.014	(1; 0.94%)
Wt Pc	0.00257	(1; 0.79%)	Rd Pc	0.00753	(1; 1.7%)	Lg Pc	0.0115	(1; 0.77%)
St Pc	0.0024	(1; 0.74%)	Wt Oi Pc	0.00741	(2; 1.6%)	El Rf Oi Pc	0.00765	(3; 0.51%)
Mn Oi Pc	0.00205	(2; 0.63%)	Bk Pc	0.00689	(1; 1.5%)	Rf Oi Pc	0.00761	(2; 0.51%)
Bk Pc	0.00174	(1; 0.53%)	Bk Oi Pc	0.00623	(2; 1.4%)	Ng Pc	0.00406	(1; 0.27%)
El Oi Pc	0.00172	(2; 0.53%)	Gv Pc	0.00511	(1; 1.1%)	Ga Pc	0.004	(1; 0.27%)
Bk Oi Pc	0.00157	(2; 0.48%)	Mn Oi Pc	0.0043	(2; 0.95%)	Fo Oi Pc	0.00337	(2; 0.23%)
Rd Pc	0.00128	(1; 0.39%)	St Pc	0.00392	(1; 0.86%)	Wt Pc	0.00256	(1; 0.17%)
Ch Pc	0.00117	(1; 0.36%)	Ho Pc	0.00349	(1; 0.77%)	El Ch Pc	0.00211	(2; 0.14%)
Wt Oi Pc	0.00103	(2; 0.32%)	Ch Pc	0.00341	(1; 0.75%)	Rd Pc	0.00204	(1; 0.14%)
Ng Pc	0.000894	(1; 0.27%)	Rd Oi Pc	0.00302	(2; 0.67%)	Bl El Pc	0.0016	(2; 0.11%)
St Oi Pc	0.000832	(2; 0.26%)	El Pc	0.00286	(1; 0.63%)	Is Oi Pc	0.00145	(2; 0.097%)
Wa Pc	0.000756	(1; 0.23%)	Ma Oi Pc	0.00262	(2; 0.58%)	At Pc	0.00132	(1; 0.088%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Pc	0.191	(0; 54.%)	Oi Pc	0.0296	(1; 25.%)	Pc	1.48	(0; 26.%)
Oi Pc	0.121	(1; 34.%)	Pc	0.0234	(0; 20.%)	Oi Pc	0.892	(1; 16.%)
Lg Pc	0.00568	(1; 1.6%)	Rf Oi Pc	0.00589	(2; 5.%)	Wa Pc	0.556	(1; 9.9%)
Rf Oi Pc	0.0043	(2; 1.2%)	Wt Pc	0.00397	(1; 3.4%)	El Pc	0.352	(1; 6.2%)
Wt Pc	0.0021	(1; 0.59%)	Bk Pc	0.0017	(1; 1.4%)	El Oi Pc	0.235	(2; 4.2%)
Ch Pc	0.00163	(1; 0.46%)	Wt Oi Pc	0.00159	(2; 1.3%)	Mn Oi Pc	0.136	(2; 2.4%)
Wt Oi Pc	0.000841	(2; 0.24%)	Bk Oi Pc	0.00154	(2; 1.3%)	Wa Oi Pc	0.045	(2; 0.8%)
Bl El Pc	0.000622	(2; 0.18%)	Mn Oi Pc	0.00144	(2; 1.2%)	Ch Pc	0.0428	(1; 0.76%)
St Pc	0.000595	(1; 0.17%)	Rd Pc	0.0013	(1; 1.1%)	El Rf Oi Pc	0.0423	(3; 0.75%)
Rd Pc	0.000446	(1; 0.13%)	Gv Pc	0.00128	(1; 1.1%)	Ws Ho Pc	0.0254	(2; 0.45%)
At Pc	0.00042	(1; 0.12%)	St Pc	0.001	(1; 0.85%)	Rf Oi Pc	0.0229	(2; 0.41%)
Bl El Oi Pc	0.000416	(3; 0.12%)	Cs Oi Pc	0.000946	(2; 0.8%)	Wa El Pc	0.0203	(2; 0.36%)
Ma Oi Pc	0.000385	(2; 0.11%)	Lg Pc	0.000814	(1; 0.69%)	Bc Mp Ch Pc	0.0202	(3; 0.36%)
Eq Oi Pc	0.000331	(2; 0.093%)	El Pc	0.000774	(1; 0.65%)	Wa Cs Oi Pc	0.02	(3; 0.35%)
Oi Fo Oi Pc	0.000327	(3; 0.092%)	Ch Pc	0.000724	(1; 0.61%)	Bc Mp Ho Pc	0.0183	(3; 0.32%)
Sp Pc	0.000318	(1; 0.09%)	Pd Oi Pc	0.000583	(2; 0.49%)	Wa Pd Oi Pc	0.0177	(3; 0.31%)
Sg Pc	0.00031	(1; 0.087%)	Rd Oi Pc	0.000519	(2; 0.44%)	Lg Pc	0.0175	(1; 0.31%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$		
Pc	0.407	(0; 90.%)	Oi Pc	0.0214	(1; 30.%)	Bc Mp Ch Pc	0.00557	(3; 7.3%)
Oi Pc	0.013	(1; 2.9%)	Pc	0.0151	(0; 21.%)	Bc Mp Ho Pc	0.00504	(3; 6.6%)
Ch Pc	0.00163	(1; 0.36%)	Rf Oi Pc	0.00271	(2; 3.8%)	Wo Tx Pc	0.00312	(2; 4.1%)
Fo Oi Pc	0.0011	(2; 0.24%)	Wt Pc	0.00186	(1; 2.6%)	Oi Pc	0.00308	(1; 4.%)
Mn Oi Pc	0.000937	(2; 0.21%)	Mn Oi Pc	0.000982	(2; 1.4%)	Rf Oi Pc	0.00295	(2; 3.8%)
Rf Oi Pc	0.000677	(2; 0.15%)	Bk Pc	0.000939	(1; 1.3%)	Pc	0.00293	(0; 3.8%)
Wt Pc	0.000597	(1; 0.13%)	Rd Pc	0.000919	(1; 1.3%)	Bc Ch Pc	0.0028	(2; 3.6%)
Ma Oi Pc	0.000454	(2; 0.1%)	Bk Oi Pc	0.000849	(2; 1.2%)	Bc Mp Ho Oi F	0.00108	(4; 1.4%)
Pc Oi Pc	0.000383	(2; 0.084%)	Wt Oi Pc	0.000743	(2; 1.%)	El Pc	0.00103	(1; 1.3%)
Lg Pc	0.000358	(1; 0.079%)	Lg Pc	0.00059	(1; 0.82%)	Bc Mp Pc	0.000906	(2; 1.2%)
Oc Oi Pc	0.000357	(2; 0.079%)	St Pc	0.000534	(1; 0.75%)	Wo Cs Oi Pc	0.00081	(3; 1.1%)
Rd Pc	0.000325	(1; 0.072%)	El Pc	0.000482	(1; 0.67%)	El Oi Pc	0.000688	(2; 0.9%)
Cs Oi Pc	0.000242	(2; 0.053%)	In Pc	0.000482	(1; 0.67%)	Wo Tx Wt Pc	0.000659	(3; 0.86%)
Wt Oi Pc	0.000239	(2; 0.053%)	Gv Pc	0.000447	(1; 0.62%)	Wo Mp Ch Pc	0.000629	(3; 0.82%)
Eq Oi Pc	0.000219	(2; 0.048%)	In Oi Pc	0.000385	(2; 0.54%)	Wo Mp Ho Pc	0.000569	(3; 0.74%)
St Pc	0.000217	(1; 0.048%)	Pd Oi Pc	0.000382	(2; 0.53%)	Wo Tx Oi Pc	0.000555	(3; 0.72%)
Rh Oi Pc	0.000208	(2; 0.046%)	Rd Oi Pc	0.000368	(2; 0.51%)	Bc Mp Cs Oi F	0.000509	(4; 0.66%)

### Linkages (average = 1)

	Value	C.o.V.
Upstream	0.863 ±0.033	(±3.8%)
Downstream	1.025 ±0.013	(±1.2%)

# Sector 25310040: Mixed Fertilisers (Fe)

*Mixed fertilisers (excluding nitrogen fertilisers and superphosphate)*

## Short Summary

In the mixed fertilisers sector, greenhouse emissions are nearly three times the economy wide average. Water use and land disturbance are respectively 45% and 50% below economy wide averages. The social indicators show below average performance with employment generation and income both 30% below average and government revenue 40% below average. For the financial accounts, operating surplus is 10% below average, export propensity is 20% below average and import penetration is 60% above average. Increased consumer demand for fertilisers provides an average stimulus to the upstream supplying sectors particularly basic chemicals, wholesale trade and marketing. There is a strong downstream linkage to sectors such as beef cattle, grains, vegetable and fruit growing, fruit and vegetable products, and accommodation, cafes and restaurants. Like the pesticide sector, the fertiliser sector is crucial to food production, but shows some indicators that are difficult to improve due to physical constraints and the realities of globalised trade.

## Sector Description

This sector serves as a proxy for the function of fertiliser manufacturing in general, as information on the major components of the sector (nitrogen and phosphorus fertilisers) is restricted in the national accounts due to confidentiality agreements. Around 5.6 million tonnes of fertiliser is used in Australia each year comprising around 2 million tonnes in elemental nutrients of nitrogen (50%), phosphorus (17%), sulphur (17%) and potassium (9%). About 60% by volume of Australia's fertilisers have been imported from the Middle East, Africa and the Americas although significant re-manufacturing is undertaken here, eg adding locally produced sulphuric acid to imported phosphate rock to make superphosphate. A new hub in Queensland, built around sulphuric acid from Mt Isa, phosphate from Phosphate Hill and port facilities in Townsville, is now producing one million tonnes per year of di-ammonium phosphate (DAP) and mono-ammonium phosphate (MAP). Of this 30% is exported and 70% is used locally capturing 20% of the domestic market.

## Place of Industry in the Economy

The mixed fertilisers sector is a very small contributor to value adding in the economy ranking 134<sup>th</sup> out of 135 and contributing 0.01% of GDP in this analysis. This will change as recent industry restructuring and the Queensland production facility are added to the national accounts. It is a relatively small generator of employment and has only minor requirements for resources.

## Strategic Overview

The integrated overview provided by the spider diagram illustrates the challenges faced by the sector with social, environmental and financial indicators significantly outside the economy wide averages. Part of this could be a data problem caused by the confidentiality agreements that restrict information on the limited number of industry players. However there could also be higher level effects, where the maintenance of low food prices for the domestic population and exports is critically dependent on key physical inputs such as fertilisers and pesticides. Measures such as a fertiliser excise tax may provide an incentive to optimise fertiliser applications. The government revenue generated could possibly be used to finance cross compliance measures to help solve problems caused by excess fertiliser use such as soil acidification and water pollution. Other downstream issues from overuse of chemical fertilisers relate to micronutrient deficiencies in food, due to chemical bonding of nutrients in forms that are less available for human metabolism.

## TBL Account #1

The financial indicator of surplus is 10% below average with two fifths a direct effect, and significant contributions from basic chemicals (7%), electricity production (3%), storage (3%) and wholesale trade (2%). The employment generation indicator is 35% below average, reflecting the capital intensive nature of fertiliser production and also the intense competition from imports. The greenhouse indicator is nearly three times the economy wide average with over half a direct effect, and another quarter due to first order effects such as basic chemicals and electricity production (9% each). The physical realities of the fertiliser production process and the financial realities of globalised trade may constrain improvements to these indicators.

## TBL Accounts #2 and #3

The second TBL account shows that the export propensity and income indicators are 20% and 30% below average respectively, while the water indicator is 45% below average. The third TBL account shows import penetration is 60% above average, government revenue is 40% below average, while land disturbance is 50% below average. An interesting facet of the land account is that 70% of the effect is related to the beef and meat industry. This is due to meat and bone meal residues from meat production and processing that are dried and used as non-chemical or biological fertilisers.

## Structural Path Analysis and Linkages

Import penetration is above average. The structural chain analysis suggests that improvement could be best achieved by increasing local production, since two thirds of the effect is direct. When the effect of the new Queensland production complexes are translated into the national accounts, part of this challenge may have partly been met and the exports indicator may also have improved.

Increases in consumer demand show average upstream linkages to suppliers such as basic chemicals, wholesale trade and business services and marketing. There are strong downstream linkages. Expansion of the sector must be accompanied by expansion of agricultural sectors (sheep, wheat, beef, sugar, vegetable and fruit growing), meat products, fruit and vegetable products, and accommodation, cafes and restaurants, in order to dissipate the effect of the investment.

## Future Trends in Sector

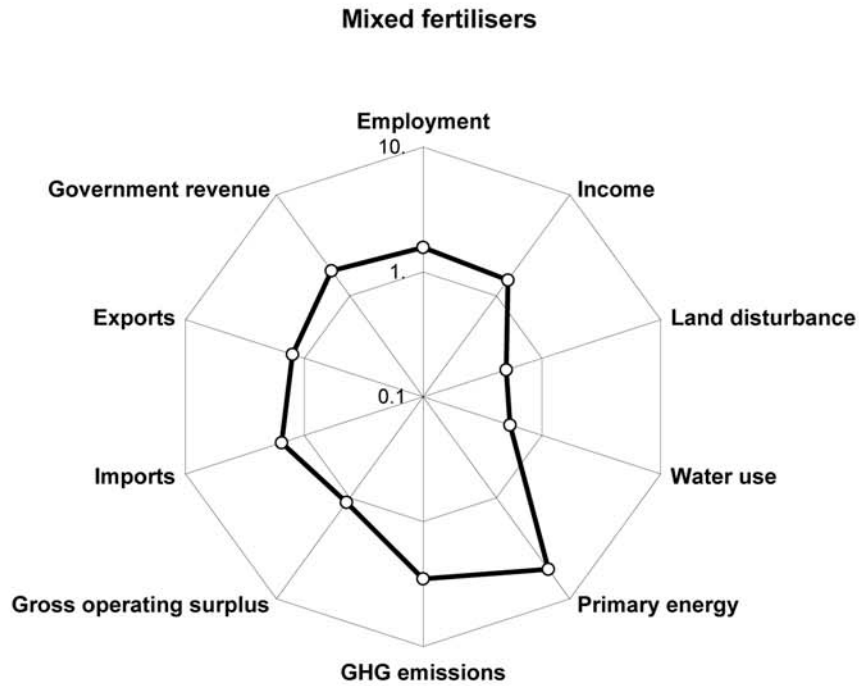
Maintaining the current approach to agriculture, the *Future Dilemmas* study anticipated a doubling of fertiliser requirements by 2050 to around 11 million tonnes per annum. This scenario enabled agricultural production to be maintained in the face of steady loss of land due to dryland salinity and acidification, by intensifying production on the more resilient or less affected areas of the landscape. This result is highly uncertain on three counts. Firstly, genetic engineering and nanotechnology could produce plants, micro-organisms and micro-devices (scavenging for nutrients) that reduce the requirements for external inputs. Secondly, precision agriculture will routinely apply exact fertiliser requirements where they are required spatially. Thirdly environmental pressures may change the face of Australian landscapes to a perennial tree cover for biofuel, biodiversity and carbon farming.

## Innovation and Technical Opportunities

Strategic policy should examine two issues. Increasing fertiliser self sufficiency could be important for food trade in view of the centrality of natural gas (and constraints to gas stocks) to fertiliser production. Closing the nitrogen cycle in a biogeochemistry context will become a global issue of importance. Immediate policy development could focus on decoupling fertiliser use from land and water degradation (e.g. differential levies based on the potential impact of active ingredients; a move to more biological systems of farming), and ensuring that food and fibre consumers pay the complete costs of production rather than the yearly marginal costs of the farm system. Technology should focus on smart fertilisers with a long in-soil life that are dynamically available when required by crops.

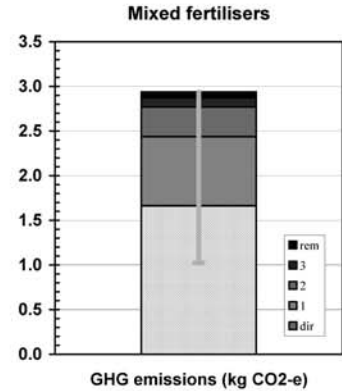
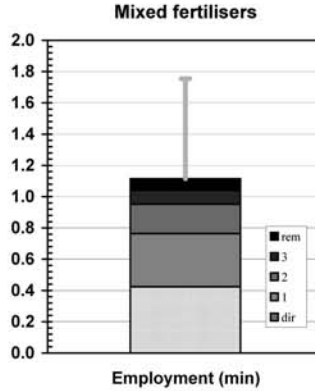
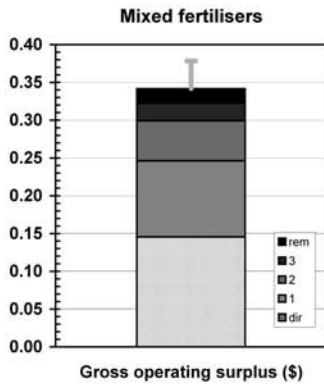
Mixed fertilisers

Spider diagram

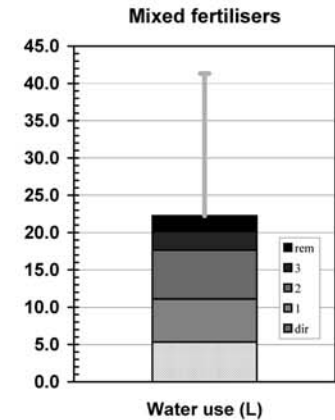
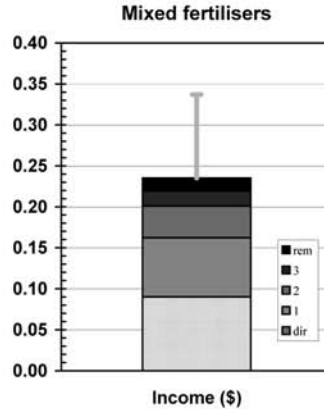
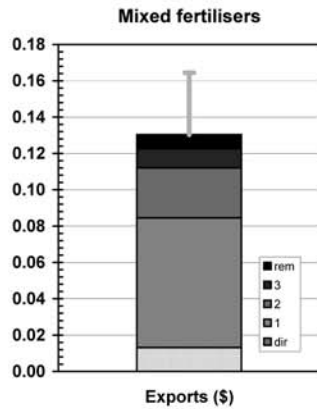


Bar graphs

**Account #1**

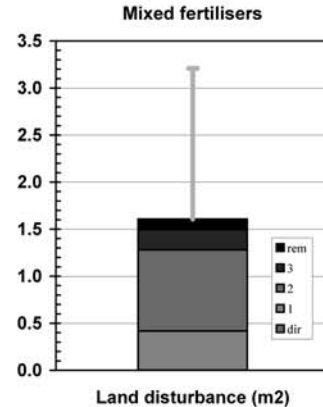
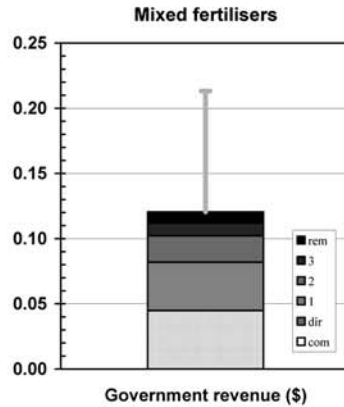
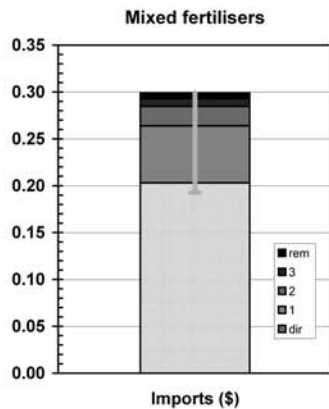


**Account #2**





Account #3



National Accounts extracts

Receipts: GNT(E) - commodities

Private final consumption	\$m 21.7	(0.01% of total)	(\$m 9.5 domestically produced)
Government final consumption	\$m 0.0		
Gross fixed capital expenditure	\$m 0.0		
Net changes in stocks	\$m 62.1	(3.51% of total)	(\$m 27.2 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 83.8</b>	<b>(0.02% of GNE)</b>	<b>(\$m 36.6 domestically produced)</b>
Exports	\$m 2.8	(0.00% of total)	(\$m 2.8 domestically produced)
<b>Final demand</b>	<b>\$m 86.5</b>	<b>(0.02% of GNT)</b>	<b>(\$m 39.4 domestically produced)</b>

Costs: GNT(I) - industries

Wages and salaries	\$m 19.0	(0.01% of total)
Gross operating surplus	\$m 30.7	(0.02% of total)
Taxes less subsidies	\$m 9.5	(0.01% of total)
<b>Sectoral GDP*</b>	<b>\$m 59.2</b>	<b>(0.01% of GDP)</b>
Imports	\$m 42.9	(0.04% of total)
<b>Primary inputs</b>	<b>\$m 102.0</b>	<b>(0.02% of GNT)</b>

\* Sectoral gross value added + net taxes on products

TBL factors

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 30.7	(0.02%)	\$m 5.7 (0.00%)	\$m 13.5 (0.01%)
Exports (\$m)	\$m 2.8	(0.00%)	\$m 0.5 (0.00%)	\$m 5.1 (0.01%)
Imports (\$m)	\$m 42.9	(0.04%)	\$m 8.0 (0.01%)	\$m 11.8 (0.01%)
Employment (e-y)	718 e-y	(0.01%)	134 e-y (0.00%)	352 e-y (0.00%)
Income (\$m)*	\$m 19.0	(0.01%)	\$m 3.5 (0.00%)	\$m 9.3 (0.01%)
Government revenue (\$m)†	\$m 9.5	(0.01%)	\$m 1.8 (0.00%)	\$m 4.7 (0.00%)
GHG emissions (kt CO <sub>2</sub> -e)	351 kt	(0.07%)	66 kt (0.01%)	116 kt (0.02%)
Water use (ML)	1,123 ML	(0.01%)	210 ML (0.00%)	877 ML (0.00%)
Land disturbance (kha)	0 kha	(0.00%)	0 kha (0.00%)	6 kha (0.00%)
Primary energy (TJ)	5,789 TJ	(0.15%)	1,080 TJ (0.03%)	1,538 TJ (0.04%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

TBL multipliers - commodities

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.15	0.34	0.38
Exports (\$)	0.01	0.13	0.16
Imports (\$)	0.20	0.30	0.19
Employment (min)	0.42	1.11	1.75
Income (\$)	0.09	0.24	0.34
Government revenue (\$)	0.04	0.12	0.21
GHG emissions (kg CO <sub>2</sub> -e)	1.66	2.94	1.02
Water use (L)	5.32	22.26	41.32
Land disturbance (m <sup>2</sup> )	0.00	1.61	3.21
Primary energy (MJ)	27.42	39.01	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

### Structural Paths (intensities - commodities)

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Fe	0.145	(0; 43.%)	Fe	0.424	(0; 38.%)	Fe	1.66	(0; 57.%)
Ch Fe	0.0226	(1; 6.6%)	Ch Fe	0.0658	(1; 5.9%)	Ch Fe	0.27	(1; 9.2%)
El Fe	0.0106	(1; 3.1%)	Wt Fe	0.0563	(1; 5.%)	El Fe	0.262	(1; 8.9%)
St Fe	0.00962	(1; 2.8%)	Rd Fe	0.0237	(1; 2.1%)	Bc Mp Fe	0.0953	(2; 3.2%)
Wt Fe	0.00781	(1; 2.3%)	Ms Fe	0.0221	(1; 2.%)	Fr Fe	0.075	(1; 2.6%)
Ms Fe	0.00492	(1; 1.4%)	St Fe	0.0157	(1; 1.4%)	Bc Fe	0.0479	(1; 1.6%)
Lg Fe	0.00452	(1; 1.3%)	El Fe	0.0118	(1; 1.1%)	El Ch Fe	0.0407	(2; 1.4%)
Rd Fe	0.00403	(1; 1.2%)	Bs Fe	0.011	(1; 0.99%)	Ga Fe	0.019	(1; 0.65%)
Oi Pc Fe	0.00393	(2; 1.2%)	Pl Fe	0.0106	(1; 0.95%)	Pc Fe	0.018	(1; 0.61%)
Sg Fe	0.00368	(1; 1.1%)	Ho Fe	0.00984	(1; 0.88%)	Bc Mp Ch Fe	0.0148	(3; 0.5%)
Ng Fe	0.00316	(1; 0.92%)	Ts Fe	0.00919	(1; 0.82%)	Ng Fe	0.0143	(1; 0.49%)
Ga Fe	0.00278	(1; 0.81%)	Wt Ch Fe	0.00873	(2; 0.78%)	Fr Ch Fe	0.0116	(2; 0.4%)
Ts Fe	0.00204	(1; 0.6%)	Bc Mp Fe	0.007	(2; 0.63%)	Lg Fe	0.0107	(1; 0.37%)
Pl Fe	0.002	(1; 0.58%)	Gv Fe	0.00645	(1; 0.58%)	Oi Pc Fe	0.00833	(2; 0.28%)
Wa Fe	0.00176	(1; 0.52%)	Mp Fe	0.00578	(1; 0.52%)	Gd Fe	0.00827	(1; 0.28%)
Bl El Fe	0.00169	(2; 0.5%)	Ms Wt Fe	0.00508	(2; 0.46%)	Wt Fe	0.0078	(1; 0.27%)
El Ch Fe	0.00165	(2; 0.48%)	Sg Fe	0.00465	(1; 0.42%)	Bc Ch Fe	0.00743	(2; 0.25%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Ch Fe	0.0314	(1; 24.%)	Fe	0.09	(0; 38.%)	Fe	5.32	(0; 24.%)
Fe	0.0131	(0; 10.%)	Ch Fe	0.014	(1; 5.9%)	Bc Mp Fe	2.51	(2; 11.%)
Wt Fe	0.00639	(1; 4.9%)	Wt Fe	0.0121	(1; 5.1%)	El Fe	1.45	(1; 6.5%)
Lg Fe	0.00528	(1; 4.1%)	Ms Fe	0.00513	(1; 2.2%)	Wa Fe	1.29	(1; 5.8%)
Pc Fe	0.00426	(1; 3.3%)	Rd Fe	0.00408	(1; 1.7%)	Bc Fe	1.26	(1; 5.7%)
Mp Fe	0.0037	(1; 2.8%)	St Fe	0.00401	(1; 1.7%)	Ch Fe	0.825	(1; 3.7%)
Oi Pc Fe	0.00269	(2; 2.1%)	El Fe	0.00319	(1; 1.4%)	Sc Cg Fe	0.769	(2; 3.5%)
Bl El Fe	0.00257	(2; 2.%)	Ts Fe	0.00215	(1; 0.91%)	Su Fd Fe	0.68	(2; 3.1%)
St Fe	0.00238	(1; 1.8%)	Pl Fe	0.00215	(1; 0.91%)	Bc Mp Ch Fe	0.39	(3; 1.7%)
Sg Fe	0.00183	(1; 1.4%)	Wt Ch Fe	0.00187	(2; 0.8%)	El Ch Fe	0.225	(2; 1.%)
Gl Fe	0.00166	(1; 1.3%)	Gv Fe	0.00162	(1; 0.69%)	Wa Ch Fe	0.201	(2; 0.9%)
Fd Fe	0.00155	(1; 1.2%)	Ho Fe	0.00144	(1; 0.61%)	Bc Ch Fe	0.196	(2; 0.88%)
Rd Fe	0.0014	(1; 1.1%)	Bs Fe	0.00135	(1; 0.57%)	Ri Fc Fe	0.191	(2; 0.86%)
Wt Ch Fe	0.000991	(2; 0.76%)	Os Fe	0.00121	(1; 0.52%)	Ws Fe	0.157	(1; 0.7%)
Bl Fe	0.00097	(1; 0.74%)	Ms Wt Fe	0.00118	(2; 0.5%)	Bx Fe	0.13	(1; 0.58%)
At Fe	0.00095	(1; 0.73%)	Pi Fe	0.00116	(1; 0.49%)	Wa Ms Fe	0.126	(2; 0.57%)
Lg Ch Fe	0.000819	(2; 0.63%)	Ga Fe	0.00108	(1; 0.46%)	Sc Cg Ch Fe	0.119	(3; 0.54%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Fe	0.203	(0; 68.%)	Fe	0.0449	(0; 37.%)	Bc Mp Fe	0.693	(2; 43.%)
Ch Fe	0.0315	(1; 11.%)	Ch Fe	0.00696	(1; 5.8%)	Bc Fe	0.348	(1; 22.%)
Pc Fe	0.00905	(1; 3.%)	Wt Fe	0.00564	(1; 4.7%)	Bc Mp Ch Fe	0.107	(3; 6.7%)
Ac Fe	0.00207	(1; 0.69%)	Rd Fe	0.00289	(1; 2.4%)	Wo Mp Fe	0.0782	(2; 4.9%)
Pl Fe	0.00204	(1; 0.68%)	Ms Fe	0.00244	(1; 2.%)	Bc Ch Fe	0.054	(2; 3.4%)
Wt Fe	0.00182	(1; 0.61%)	St Fe	0.00214	(1; 1.8%)	Wo Fe	0.0343	(1; 2.1%)
Pc Ch Fe	0.0014	(2; 0.47%)	El Fe	0.00199	(1; 1.7%)	Fr Fe	0.0241	(1; 1.5%)
Sg Fe	0.00115	(1; 0.39%)	Ts Fe	0.00106	(1; 0.88%)	Bc Mp Ho Fe	0.0142	(3; 0.88%)
Ms Fe	0.00112	(1; 0.37%)	Pl Fe	0.000937	(1; 0.78%)	Bc Mp Fd Fe	0.0122	(3; 0.76%)
Rd Fe	0.00102	(1; 0.34%)	Wt Ch Fe	0.000875	(2; 0.73%)	Wo Mp Ch Fe	0.0121	(3; 0.75%)
St Fe	0.000871	(1; 0.29%)	Ho Fe	0.000756	(1; 0.63%)	Bc Mp Pe Mp	0.00591	(4; 0.37%)
El Fe	0.000736	(1; 0.25%)	Bk Fe	0.000572	(1; 0.47%)	Wh Fd Fe	0.00533	(2; 0.33%)
Ts Fe	0.000585	(1; 0.2%)	Gv Fe	0.000564	(1; 0.47%)	Wo Ch Fe	0.00533	(2; 0.33%)
Ch Pl Fe	0.000517	(2; 0.17%)	Os Fe	0.000563	(1; 0.47%)	Bc Mp Of Fe	0.00453	(3; 0.28%)
Oc Fe	0.000514	(1; 0.17%)	Ms Wt Fe	0.000561	(2; 0.47%)	El Fe	0.00424	(1; 0.26%)
Fo Fe	0.000426	(1; 0.14%)	Lg Fe	0.000549	(1; 0.46%)	Fr Ch Fe	0.00374	(2; 0.23%)
Ne Fe	0.000416	(1; 0.14%)	Ga Fe	0.000547	(1; 0.45%)	Bc Mp Pe Fe	0.00348	(3; 0.22%)

### Linkages (average = 1)

	Value	C.o.V.
Upstream	1.106 ±0.020	(±1.8%)
Downstream	1.591 ±0.033	(±2.1%)

# Sector Rem. 2502: Basic Chemicals (Ch)

*Phosphate, nitrate and other fertilisers, acetylene and other gases, PVC, polystyrene, polyethylene, carbon black, alcohols, hydrocarbons, ethers, acids, colouring agents, pigments and other basic chemicals*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is over three times the economy wide average, while water use and land disturbance are both 50% below average. The social indicators show that employment generation and government revenue are both 40% below average, while income is 40% below average. The financial indicators show that the surplus is 10% below average, exports are two times the average while import penetration is 60% above average. This sector is central to many products and services consumed in everyday lifestyle and its TBL account may require improvement in some areas. The sector is hampered by its diversity and lack of scale, but concepts of industrial ecology may catalyse change.

## Sector Description

The basic chemical sector produces a diverse range of both intermediate and final demand products. By financial value in broad groupings, the products include industrial gases (6%), synthetic resins such as polypropylene, polystyrene and polyvinyl chloride (32%), organic chemicals such as alcohols, dyes and lactic acid (10%), inorganic chemicals such as sulphuric acid, chlorine and sodium hydroxide (32%), and fertilisers such as superphosphate and urea (21%). The sector's industrial organisation is a complex array of interdependent feedstocks that can be combined in many ways, giving diverse products. The PET resin used in carbonated drink bottles provides some process examples. Producing one tonne of PET resin requires 870 kg of ethylene and xylene feedstock, 300 kg of oxygen, and 50 kg of methanol, together with 13 GJ (10<sup>9</sup>J) of various forms of energy. In constant dollar terms over the last 30 years, the turnover of basic chemicals has doubled, chemical fertilisers have tripled and industrial gases have increased by 50%. The financial turnover in 2002 was \$8.5 billion per year, and involved 300 enterprises.

## Place of Industry in the Economy

The basic chemicals sector ranks 55<sup>th</sup> out of 135 sectors in terms of value adding in the economy and contributes 0.35% of GDP in this analysis. It is similar in value adding to the electrical equipment, and the copper, silver, lead, zinc and nickel sectors. It is a moderate employer with 4 000 employment years directly embodied in final demand, and another 8 000 years in the sector's upstream suppliers giving a total of 12 000 employment years. In addition, it contributes 14 000 employment years to the activities of downstream industries such as paints, cosmetics, and wholesale trade. It has moderate resource requirements with less than two tenths of national water use and land disturbance but 1.3% of energy use and 0.76% of greenhouse emissions. In financial terms, imports are equal to exports.

## Strategic Overview

In the spider diagram, the basic chemicals sector shows significant outliers in the three components of its triple bottom line account. Employment generation and income are below average due to the capital intensive nature of the industry, and also because of the level of imports. The energy intensive nature of the industry gives outliers for energy use and greenhouse, but reasonable outcomes for water use and land disturbance. Above average export propensity and import penetration balance out in financial terms, while the operating surplus is average.

## TBL Account #1

The financial indicator of operating surplus is 10% below average with the direct sector effect accounting for 43% of the total, and additional contributions from electricity generation (3%), forwarding and storage (3%), wholesale trade (2%), petroleum feedstock (1%), road transport (1%), oil (1%) and natural gas (2%). The social indicator of employment generation is 40% below average with a direct effect of 38% and a composition similar to the surplus indicator. The greenhouse gas indicator is more than three times the average and is discussed in more detail below.

## TBL Accounts #2 and #3

The second TBL account shows that export propensity is twice the average, income is 30% below the average and water use is 50% below the average. The third TBL account reveals that import penetration is 60% above average, government revenue is 40% below average and land disturbance is 50% below average. This sector provides a good example of linkages between TBL indicators and the effects of international trade. The relatively small scale of the domestic chemical industry drives higher imports which in turn dilutes the social indicators such as employment generation, but advantages greenhouse indicators as materially intensive processes happen overseas.

## Structural Path Analysis and Linkages

The greenhouse gas indicator may require improvement especially since it is currently diluted by a high level of imports. The greenhouse path shows that the direct sector effect is 58% of the total, with additional contributions from electricity generation 9%, meat products (5%), and services to forestry (3%). Marginal changes could be achieved by using lower carbon electricity from gas turbines or establishing in-house combined heat and power plants. However the dominance of the direct sector effect will focus greenhouse savings on the redesign of many chemical processes.

The sector's stimulus to its upstream suppliers is slightly above average and impacts on wholesale trade, road transport and accounting and marketing. The linkages to downstream industries is 75% above the average and suggests that sectors such as cosmetics and toiletries, paints, and wholesale trade must expand in order to dissipate any growth this sector. The importance of downstream linkages may decrease if large scale export oriented chemical plants are established.

## Future Trends in Sector

The base case scenario in the *Future Dilemmas* study anticipates that the requirement for both organic and inorganic chemicals will increase by 30% by 2050. This is highly uncertain and will be changed by export opportunities, recycling trends for final products and government regulation. A number of projects now undergoing evaluation may have major impacts on the sector. Dampier Nitrogen is planning a 1.2 million tonne per year urea fertiliser plant on the Burrup Peninsula in Western Australia which will use 35 PJ of natural gas per year. This will meet most of the current domestic urea requirements for agriculture of 1.5 million tonnes per year while adding 85% to the value of natural gas compared to exports of LNG. Currently on hold, are plans for a large methanol production plant in Darwin or the Burrup Peninsula producing 1.3 million tonnes per year.

## Innovation and Technical Opportunities

Three dominant trends will shape the sector. Firstly, the 400 million tonnes of global chemical production and its 100 000 substances are likely to be more regulated. Secondly, possible constraints in petroleum feedstocks and greenhouse policies will stimulate process innovation, but also see the demise of some product lines that cannot be improved technically or economically. Thirdly, the sector will go through a paradigm shift as molecular assembly and 'green' chemistry replaces catalysis, temperature, and pressure as the driving forces of industrial chemical reactions.

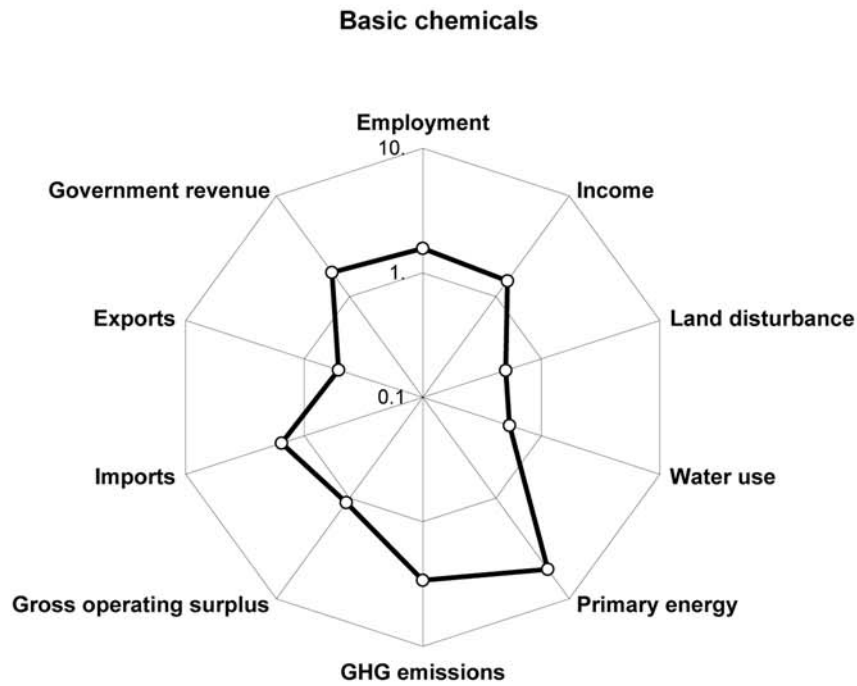
**Sector**

**Basic chemicals**

**(Ch)**

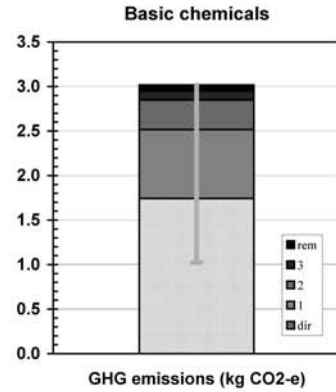
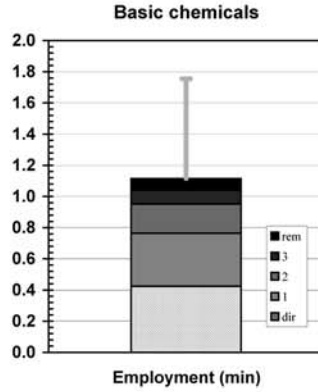
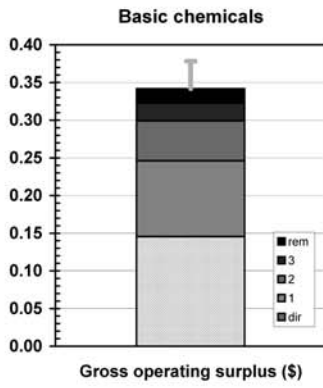
Phosphate, nitrate and other fertilisers, acetylene and other gases, PVC, polystyrene, polyethylene, carbon black, alcohols, hydrocarbons, ethers, acids, colouring agents, pigments and other basic chemicals

Spider diagram

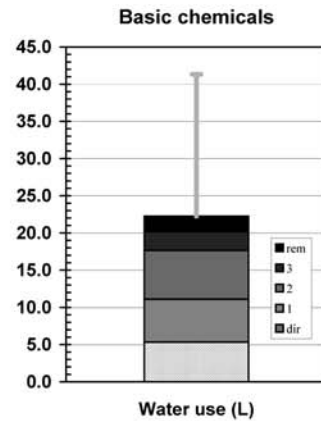
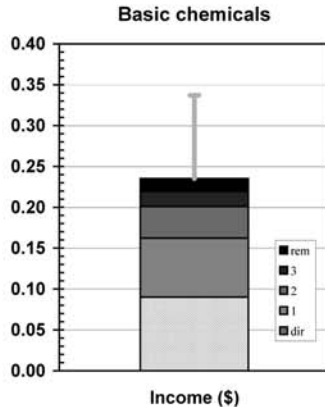
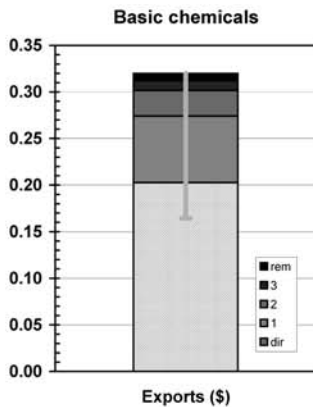


Bar graphs

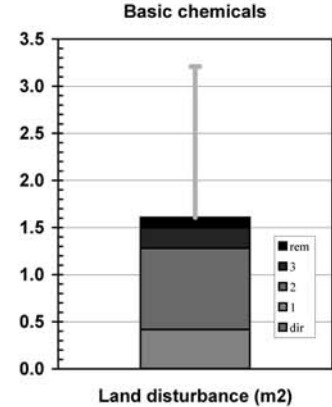
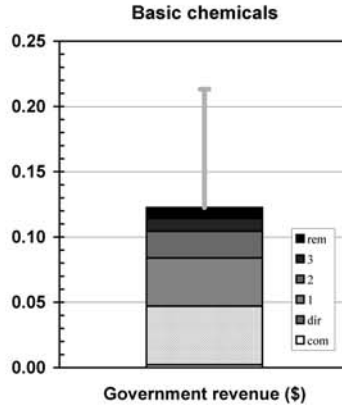
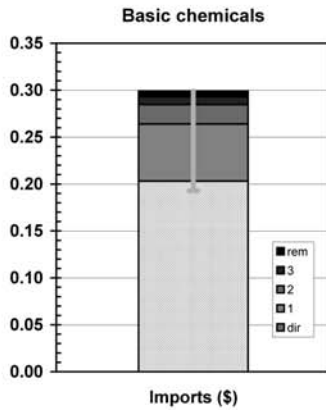
**Account #1**



**Account #2**



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 57.0	(0.02% of total)	(\$m 34.9 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 38.4	(0.04% of total)	(\$m 38.4 domestically produced)
Net changes in stocks	\$m 190.2	(10.76% of total)	(\$m 106.7 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 285.7</b>	<b>(0.06% of GNE)</b>	<b>(\$m 180.0 domestically produced)</b>
Exports	\$m 1,125.3	(1.35% of total)	(\$m 1,125.3 domestically produced)
<b>Final demand</b>	<b>\$m 1,411.0</b>	<b>(0.26% of GNT)</b>	<b>(\$m 1,305.3 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 499.8	(0.29% of total)
Gross operating surplus	\$m 807.6	(0.42% of total)
Taxes less subsidies	\$m 249.2	(0.29% of total)
<b>Sectoral GDP*</b>	<b>\$m 1,556.6</b>	<b>(0.35% of GDP)</b>
Imports	\$m 1,126.7	(1.15% of total)
<b>Primary inputs</b>	<b>\$m 2,683.3</b>	<b>(0.49% of GNT)</b>

\* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 807.6	(0.42%)	\$m 189.9 (0.10%)	\$m 446.0 (0.23%)
Exports (\$m)	\$m 1,125.3	(1.35%)	\$m 264.6 (0.32%)	\$m 417.6 (0.50%)
Imports (\$m)	\$m 1,126.7	(1.15%)	\$m 264.9 (0.27%)	\$m 390.6 (0.40%)
Employment (e-y)	18,870 e-y	(0.26%)	4,436 e-y (0.06%)	11,661 e-y (0.16%)
Income (\$m)*	\$m 499.8	(0.29%)	\$m 117.5 (0.07%)	\$m 306.9 (0.18%)
Government revenue (\$m)†	\$m 251.9	(0.23%)	\$m 61.3 (0.06%)	\$m 160.0 (0.15%)
GHG emissions (kt CO <sub>2</sub> -e)	9,676 kt (1.87%)		2,275 kt (0.44%)	3,940 kt (0.76%)
Water use (ML)	29,528 ML (0.14%)		6,942 ML (0.03%)	29,055 ML (0.14%)
Land disturbance (kha)	0 kha (0.00%)		0 kha (0.00%)	210 kha (0.13%)
Primary energy (TJ)	152,219 TJ (3.92%)		35,787 TJ (0.92%)	50,925 TJ (1.31%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.15	0.34	0.38
Exports (\$)	0.20	0.32	0.16
Imports (\$)	0.20	0.30	0.19
Employment (min)	0.42	1.11	1.75
Income (\$)	0.09	0.24	0.34
Government revenue (\$)	0.05	0.12	0.21
GHG emissions (kg CO <sub>2</sub> -e)	1.74	3.02	1.02
Water use (L)	5.32	22.26	41.32
Land disturbance (m <sup>2</sup> )	0.00	1.61	3.21
Primary energy (MJ)	27.42	39.01	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Ch	0.145	(0; 43.%)	Ch	0.424	(0; 38.%)	Ch	1.74	(0; 58.%)
El Ch	0.0106	(1; 3.1%)	Wt Ch	0.0563	(1; 5.%)	El Ch	0.262	(1; 8.7%)
St Ch	0.00962	(1; 2.8%)	Rd Ch	0.0237	(1; 2.1%)	Bc Mp Ch	0.0953	(2; 3.2%)
Wt Ch	0.00781	(1; 2.3%)	Ms Ch	0.0221	(1; 2.%)	Fr Ch	0.075	(1; 2.5%)
Ms Ch	0.00492	(1; 1.4%)	St Ch	0.0157	(1; 1.4%)	Bc Ch	0.0479	(1; 1.6%)
Lg Ch	0.00452	(1; 1.3%)	El Ch	0.0118	(1; 1.1%)	Ga Ch	0.019	(1; 0.63%)
Rd Ch	0.00403	(1; 1.2%)	Bs Ch	0.011	(1; 0.99%)	Pc Ch	0.018	(1; 0.6%)
Oi Pc Ch	0.00393	(2; 1.2%)	Pl Ch	0.0106	(1; 0.95%)	Ng Ch	0.0143	(1; 0.48%)
Sg Ch	0.00368	(1; 1.1%)	Ho Ch	0.00984	(1; 0.88%)	Lg Ch	0.0107	(1; 0.36%)
Ng Ch	0.00316	(1; 0.92%)	Ts Ch	0.00919	(1; 0.82%)	Oi Pc Ch	0.00833	(2; 0.28%)
Ga Ch	0.00278	(1; 0.81%)	Bc Mp Ch	0.007	(2; 0.63%)	Gd Ch	0.00827	(1; 0.27%)
Ts Ch	0.00204	(1; 0.6%)	Gv Ch	0.00645	(1; 0.58%)	Wt Ch	0.0078	(1; 0.26%)
Pl Ch	0.002	(1; 0.58%)	Mp Ch	0.00578	(1; 0.52%)	Bl El Ch	0.00661	(2; 0.22%)
Wa Ch	0.00176	(1; 0.52%)	Ms Wt Ch	0.00508	(2; 0.46%)	Rd Ch	0.0064	(1; 0.21%)
Bl El Ch	0.00169	(2; 0.5%)	Sg Ch	0.00465	(1; 0.42%)	Fd Ch	0.00563	(1; 0.19%)
Bc Mp Ch	0.00159	(2; 0.47%)	Os Ch	0.00434	(1; 0.39%)	Ch Pl Ch	0.00444	(2; 0.15%)
Pc Ch	0.00152	(1; 0.44%)	Bk Ch	0.00419	(1; 0.38%)	El St Ch	0.00401	(2; 0.13%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Ch	0.203	(0; 63.%)	Ch	0.09	(0; 38.%)	Ch	5.32	(0; 24.%)
Wt Ch	0.00639	(1; 2.%)	Wt Ch	0.0121	(1; 5.1%)	Bc Mp Ch	2.51	(2; 11.%)
Lg Ch	0.00528	(1; 1.7%)	Ms Ch	0.00513	(1; 2.2%)	El Ch	1.45	(1; 6.5%)
Pc Ch	0.00426	(1; 1.3%)	Rd Ch	0.00408	(1; 1.7%)	Wa Ch	1.29	(1; 5.8%)
Mp Ch	0.0037	(1; 1.2%)	St Ch	0.00401	(1; 1.7%)	Bc Ch	1.26	(1; 5.7%)
Oi Pc Ch	0.00269	(2; 0.84%)	El Ch	0.00319	(1; 1.4%)	Sc Cg Ch	0.769	(2; 3.5%)
Bl El Ch	0.00257	(2; 0.8%)	Ts Ch	0.00215	(1; 0.91%)	Su Fd Ch	0.68	(2; 3.1%)
St Ch	0.00238	(1; 0.75%)	Pl Ch	0.00215	(1; 0.91%)	Ri Fc Ch	0.191	(2; 0.86%)
Sg Ch	0.00183	(1; 0.57%)	Gv Ch	0.00162	(1; 0.69%)	Ws Ch	0.157	(1; 0.7%)
Gl Ch	0.00166	(1; 0.52%)	Ho Ch	0.00144	(1; 0.61%)	Bx Ch	0.13	(1; 0.58%)
Fd Ch	0.00155	(1; 0.48%)	Bs Ch	0.00135	(1; 0.57%)	Wa Ms Ch	0.126	(2; 0.57%)
Rd Ch	0.0014	(1; 0.44%)	Os Ch	0.00121	(1; 0.52%)	Wo Mp Ch	0.105	(2; 0.47%)
Bl Ch	0.00097	(1; 0.3%)	Ms Wt Ch	0.00118	(2; 0.5%)	Br Ch	0.102	(1; 0.46%)
At Ch	0.00095	(1; 0.3%)	Pi Ch	0.00116	(1; 0.49%)	Sg Ch	0.0934	(1; 0.42%)
Ac Ch	0.00077	(1; 0.24%)	Ga Ch	0.00108	(1; 0.46%)	Wa El Ch	0.0839	(2; 0.38%)
Nf Ch	0.000765	(1; 0.24%)	Bk Ch	0.00104	(1; 0.44%)	Sc Cg Mp Ch	0.0793	(3; 0.36%)
Ms Ch	0.000761	(1; 0.24%)	Ac Ch	0.001	(1; 0.43%)	Sc Cg Bc Mp	0.0786	(4; 0.35%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Ch	0.203	(0; 68.%)	Ch	0.0449	(0; 37.%)	Bc Mp Ch	0.693	(2; 43.%)
Pc Ch	0.00905	(1; 3.%)	Wt Ch	0.00564	(1; 4.7%)	Bc Ch	0.348	(1; 22.%)
Ac Ch	0.00207	(1; 0.69%)	Rd Ch	0.00289	(1; 2.4%)	Wo Mp Ch	0.0782	(2; 4.9%)
Pl Ch	0.00204	(1; 0.68%)	Ms Ch	0.00244	(1; 2.%)	Wo Ch	0.0343	(1; 2.1%)
Wt Ch	0.00182	(1; 0.61%)	St Ch	0.00214	(1; 1.8%)	Fr Ch	0.0241	(1; 1.5%)
Sg Ch	0.00115	(1; 0.39%)	El Ch	0.00199	(1; 1.7%)	Bc Mp Ho Ch	0.0142	(3; 0.88%)
Ms Ch	0.00112	(1; 0.37%)	Ts Ch	0.00106	(1; 0.88%)	Bc Mp Fd Ch	0.0122	(3; 0.76%)
Rd Ch	0.00102	(1; 0.34%)	Pl Ch	0.000937	(1; 0.78%)	Bc Mp Pe Mp	0.00591	(4; 0.37%)
St Ch	0.000871	(1; 0.29%)	Ho Ch	0.000756	(1; 0.63%)	Wh Fd Ch	0.00533	(2; 0.33%)
El Ch	0.000736	(1; 0.25%)	Bk Ch	0.000572	(1; 0.47%)	Bc Mp Of Ch	0.00453	(3; 0.28%)
Ts Ch	0.000585	(1; 0.2%)	Gv Ch	0.000564	(1; 0.47%)	El Ch	0.00424	(1; 0.26%)
Ch Pl Ch	0.000517	(2; 0.17%)	Os Ch	0.000563	(1; 0.47%)	Bc Mp Pe Ch	0.00348	(3; 0.22%)
Oc Ch	0.000514	(1; 0.17%)	Ms Wt Ch	0.000561	(2; 0.47%)	Wh Ac Ch	0.00315	(2; 0.2%)
Fo Ch	0.000426	(1; 0.14%)	Lg Ch	0.000549	(1; 0.46%)	Wo Tx Ac Ch	0.00221	(3; 0.14%)
Ne Ch	0.000416	(1; 0.14%)	Ga Ch	0.000547	(1; 0.45%)	Wo Tx Pl Ch	0.00205	(3; 0.13%)
Pa Ch	0.000411	(1; 0.14%)	Pi Ch	0.000535	(1; 0.44%)	Wo Tx Wt Ch	0.002	(3; 0.12%)
Ho Ch	0.000365	(1; 0.12%)	Pd Wt Ch	0.00053	(2; 0.44%)	Bc Mp Ch Pl C	0.00176	(4; 0.11%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.106 ±0.020	(±1.8%)
Downstream	1.745 ±0.027	(±1.6%)

# Sector 2503: Paints (Pt)

*Paints, primers, filler, putty*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicators of greenhouse emissions, water use and land disturbance are 40%, 75% and 90% below average respectively. The social indicators of employment generation, income and government revenue are respectively 50%, 40% and 50% below average respectively. The financial indicator of operating surplus is 10% below average, while export propensity is 25% below average and import penetration is 70% above average. Surface coatings are pervasive in everyday life. Thus the lifecycles of their manufacturing use and disposal phases are coming under more scrutiny. Environmental accreditation and 'eco-labelling' are a matter of course in Europe and may soon become mainstream in Australia.

## Sector Description

The yearly production of paint in Australia is around 220 million litres of which 55% is for architectural and decorative covering, and 45% is for industrial uses such as coatings for cars, metals and machinery. There are over 4 000 product names and most paint is produced in batch rather than continuous processes because of the relatively constrained market. Exports are around 9 million litres per year mostly to New Zealand and the Pacific Islands, while imports are around 8 million litres. Most housing paints today are water based and made with polyvinyl acetate or acrylic materials. Paint manufacture underwent a revolution in the 1960s as titanium dioxide pigments replaced the 'white lead' or lead carbonate paints that had dominated the market. Paints based on lead constituted a significant health risk especially when a house painting regime of the early 1900s could apply 200-600 kg of lead to interior and exterior walls. Life cycle analysis of vehicle paints show that finishing one vehicle (4-6 kg of paint) requires 1 000 MJ (10<sup>6</sup>J) of energy and 1 000 litres of water, and generates 5 kg of solid wastes, and 40 kg of carbon dioxide emissions. In constant dollar terms, the sector's activity has doubled in the last 30 years implying a growth rate of 2.4% per annum. Financial turnover was \$2 billion in 2002 and involved over 100 enterprises.

## Place of Industry in the Economy

The paint manufacturing sector ranks 93<sup>rd</sup> out of 135 sectors in terms of value adding in the Australian economy, and contributes 0.13% of GDP in this analysis. The sectors of sugar cane and glass and glass products have similar amounts of value adding. The sector is a small employer with 300 employment years directly embodied in final demand, and another 400 years in the sector's upstream suppliers giving a total of 700 employment years. However 5 000 employment years are embodied in the final demand of downstream industries. Comparatively little paint is sold across the counter to final demand, and most is embodied in final products such as domestic buildings, motor cars, and industrial products. The sector has extremely small resource requirements with less than one tenth of one percent of national water use, land disturbance, energy use, and greenhouse emissions. In financial terms, imports are six times the levels of exports.

## Strategic Overview

The spider diagram reveals a number of outliers in the social and financial areas. The social indicators for employment generation, income, and government revenue are below average, caused in part by relatively high imports of key paint components. The environmental indicators are below average since many materially intensive processes are undertaken overseas where scale in manufacturing gives price advantages, and is backed by sophisticated research and development.



## TBL Account #1

The financial indicator of operating surplus is 10% below average with two thirds being a direct sector effect and contributions from basic chemicals (5%), wholesale trade (2%), accounting and marketing (1%) and forwarding and storage (1%). The social indicator of employment generation is 50% below average, one half of this is a direct effect and the upstream suppliers have a similar composition to the surplus indicator. The environmental indicator of greenhouse emissions is 40% below average, with a direct effect of 4% and major contributions from basic chemicals (33%), electricity production (11%), services to forestry (5%), beef cattle (fats used in putty manufacture) (2%), non-metallic minerals (2%), and steel products (1%). Including the embodied emissions in the imported components of paint increases the greenhouse indicator to 30% above average.

## TBL Accounts #2 and #3

The second TBL account reveals that export propensity is 25% below average, income is 40% below average, and water use is 75% below average. The third TBL account reveals that import penetration is 70% above average, government revenue is 50% below average and land disturbance is 90% below average. Improving the import penetration indicator by larger domestic manufacture of paint components may improve the employment and income indicators, but also increase the greenhouse and water use indicators unless leading edge manufacturing processes were used.

## Structural Path Analysis and Linkages

The import penetration indicator may require some attention and the structural path analysis reveals that 77% of the indicator is a direct sector effect due to the import of essential components. Other contributors include basic chemicals (8%) and petroleum coke (1%). Most of this is a structural issue relating to the relatively small scale and diversity of the domestic chemicals industry. Paints of all types are becoming more complex, with key ingredients developed by major chemical manufacturers with world scale research and manufacturing plant capacity.

The sector's stimulus to its upstream suppliers is 20% below average but still impacts on basic chemicals, wholesale trade, and accounting and marketing. The linkages to downstream industries such as motor vehicles, residential building, non-residential construction, wholesale trade and property development are strong, and suggest that these sectors must expand in advance of expansion of paint manufacturing in order to dissipate the effect.

## Future Trends in Sector

Under the base case scenario of the *Future Dilemmas* study with 25 million people by 2050, the floor area of built infrastructure for domestic, commercial, and institutional purposes doubles. This will probably mean less than a doubling of requirements for paint products because the human population approaches stability in numbers and growth in new buildings reduces, thus reducing the current 'newly built' market requirement for paint products. However consumers may require more frequent colour changes leading to increases in paint requirement. Innovation in materials science and nanotechnology may result in paints that regularly refurbish themselves in situ or even change colour, leading to more complex production processes but less regular re-paintings.

## Innovation and Technical Opportunities

While innovation in paint manufacturing has been considerable, the science literature suggests that the industry is on the edge of another paradigm shift due to the possibilities of nanotechnology and combinatorial chemistry. Many steel coatings may be applied in the steel mill by advanced processes such as plasma deposition. Paint manufacturers and steel makers may work together more closely and end users such as car manufacturers may receive their raw materials pre-painted.

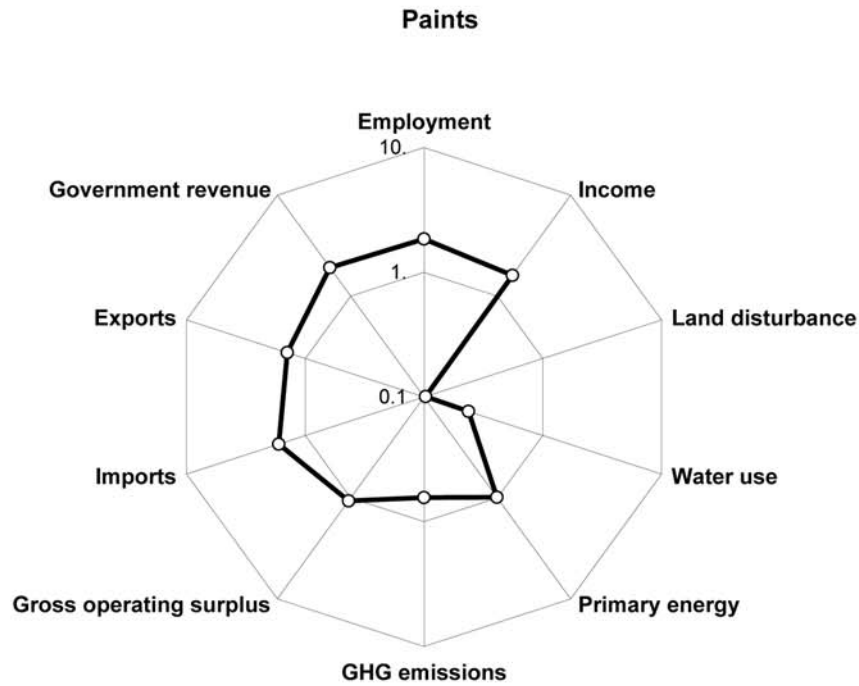
Sector

Paints

(Pt)

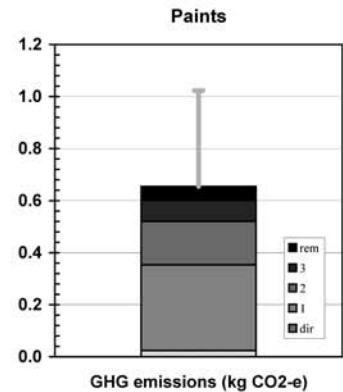
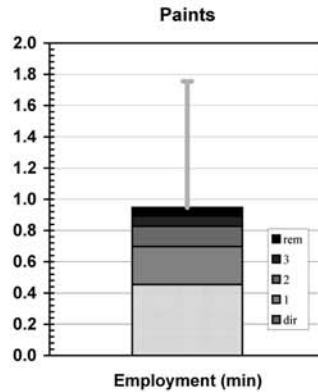
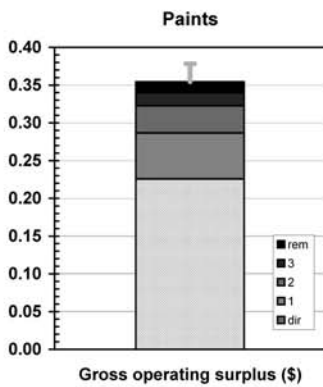
Paints, primers, filler, putty

Spider diagram

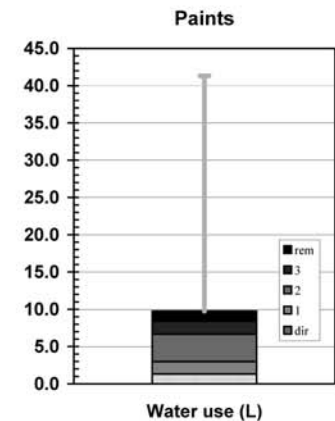
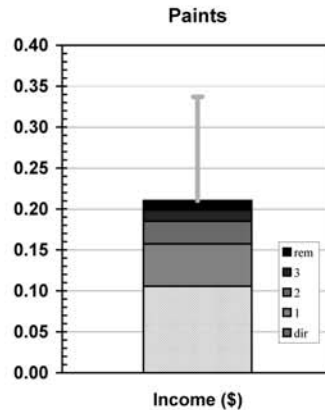
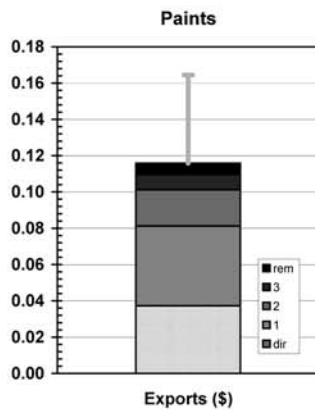


Bar graphs

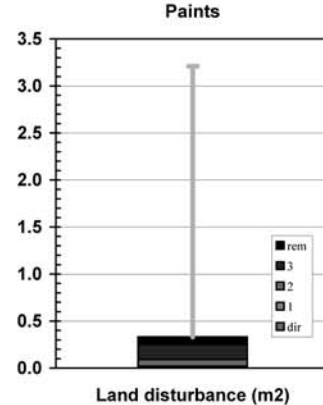
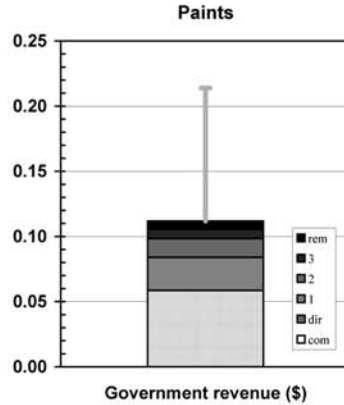
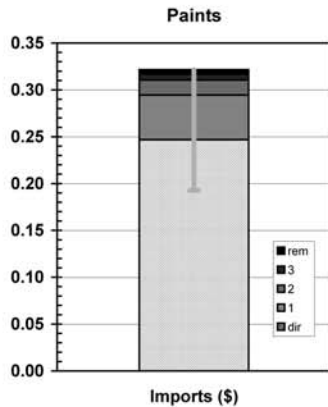
Account #1



Account #2



Account #3



National Accounts extracts

Receipts: GNT(E) - commodities

Private final consumption	\$m 15.4	(0.01% of total)	(\$m 14.2 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 9.8	(0.01% of total)	(\$m 9.8 domestically produced)
Net changes in stocks	\$m 11.0	(0.62% of total)	(\$m 9.1 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 36.2</b>	<b>(0.01% of GNE)</b>	<b>(\$m 33.0 domestically produced)</b>
Exports	\$m 55.3	(0.07% of total)	(\$m 55.3 domestically produced)
Final demand	\$m 91.4	(0.02% of GNT)	(\$m 88.3 domestically produced)

Costs: GNT(I) - industries

Wages and salaries	\$m 156.7	(0.09% of total)
Gross operating surplus	\$m 335.1	(0.17% of total)
Taxes less subsidies	\$m 86.9	(0.10% of total)
<b>Sectoral GDP*</b>	<b>\$m 578.7</b>	<b>(0.13% of GDP)</b>
Imports	\$m 366.2	(0.38% of total)
<b>Primary inputs</b>	<b>\$m 944.9</b>	<b>(0.17% of GNT)</b>

\* Sectoral gross value added + net taxes on products

TBL factors

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 335.1	(0.17%)	\$m 19.9 (0.01%)	\$m 31.3 (0.02%)
Exports (\$m)	\$m 55.3	(0.07%)	\$m 3.3 (0.00%)	\$m 10.2 (0.01%)
Imports (\$m)	\$m 366.2	(0.38%)	\$m 21.8 (0.02%)	\$m 28.4 (0.03%)
Employment (e-y)	5,396 e-y	(0.08%)	321 e-y (0.00%)	670 e-y (0.01%)
Income (\$m)*	\$m 156.7	(0.09%)	\$m 9.3 (0.01%)	\$m 18.6 (0.01%)
Government revenue (\$m)†	\$m 86.8	(0.08%)	\$m 5.1 (0.00%)	\$m 9.8 (0.01%)
GHG emissions (kt CO <sub>2</sub> -e)	35 kt	(0.01%)	2 kt (0.00%)	58 kt (0.01%)
Water use (ML)	1,930 ML	(0.01%)	115 ML (0.00%)	863 ML (0.00%)
Land disturbance (kha)	1 kha	(0.00%)	0 kha (0.00%)	3 kha (0.00%)
Primary energy (TJ)	549 TJ	(0.01%)	33 TJ (0.00%)	666 TJ (0.02%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

TBL multipliers - commodities

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.23	0.35	0.38
Exports (\$)	0.04	0.12	0.16
Imports (\$)	0.25	0.32	0.19
Employment (min)	0.45	0.95	1.75
Income (\$)	0.11	0.21	0.34
Government revenue (\$)	0.06	0.11	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.02	0.65	1.02
Water use (L)	1.30	9.77	41.32
Land disturbance (m <sup>2</sup> )	0.01	0.33	3.21
Primary energy (MJ)	0.37	7.54	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Pt	0.226	(0; 64.%)	Pt	0.454	(0; 48.%)	Ch Pt	0.22	(1; 34.%)
Ch Pt	0.0183	(1; 5.2%)	Ch Pt	0.0534	(1; 5.6%)	El Pt	0.036	(1; 5.5%)
Wt Pt	0.00624	(1; 1.8%)	Wt Pt	0.045	(1; 4.7%)	El Ch Pt	0.0331	(2; 5.1%)
Ms Pt	0.00475	(1; 1.3%)	Ms Pt	0.0213	(1; 2.3%)	Fr Pt	0.0248	(1; 3.8%)
St Pt	0.00271	(1; 0.76%)	Sh Pt	0.0147	(1; 1.6%)	Pt	0.0237	(0; 3.6%)
Sh Pt	0.00246	(1; 0.7%)	Mi Pt	0.00968	(1; 1.%)	Bc Mp Ch Pt	0.012	(3; 1.8%)
Cm Pt	0.00236	(1; 0.67%)	Wt Ch Pt	0.00709	(2; 0.75%)	Mi Pt	0.0106	(1; 1.6%)
Mi Pt	0.00233	(1; 0.66%)	Ts Pt	0.00707	(1; 0.75%)	Fr Ch Pt	0.00946	(2; 1.4%)
Ts Pt	0.00157	(1; 0.44%)	Cm Pt	0.00652	(1; 0.69%)	Is Sh Pt	0.00716	(2; 1.1%)
El Pt	0.00145	(1; 0.41%)	Ho Pt	0.00621	(1; 0.66%)	Wt Pt	0.00623	(1; 0.95%)
El Ch Pt	0.00134	(2; 0.38%)	Ed Pt	0.005	(1; 0.53%)	Pc Pt	0.00612	(2; 0.93%)
Oi Pc Pt	0.00133	(2; 0.38%)	Pl Pt	0.00467	(1; 0.49%)	Bc Ch Pt	0.00604	(2; 0.92%)
St Ch Pt	0.00121	(2; 0.34%)	Gv Pt	0.00447	(1; 0.47%)	Gd Pt	0.00552	(1; 0.84%)
St Wt Pt	0.00119	(2; 0.34%)	Bs Pt	0.00445	(1; 0.47%)	At Pt	0.00324	(1; 0.5%)
Wt Ch Pt	0.000985	(2; 0.28%)	St Pt	0.00442	(1; 0.47%)	Oi Pc Pt	0.00283	(2; 0.43%)
Ms Wt Pt	0.000905	(2; 0.26%)	Ms Wt Pt	0.00406	(2; 0.43%)	Bc Mp Of Pt	0.00273	(3; 0.42%)
Pl Pt	0.000877	(1; 0.25%)	Rd Pt	0.00358	(1; 0.38%)	El Mi Pt	0.00242	(2; 0.37%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Pt	0.0372	(0; 32.%)	Pt	0.106	(0; 50.%)	Sc Cg Pt	2.04	(2; 21.%)
Ch Pt	0.0255	(1; 22.%)	Ch Pt	0.0113	(1; 5.4%)	Pt	1.3	(0; 13.%)
Wt Pt	0.00511	(1; 4.4%)	Wt Pt	0.00965	(1; 4.6%)	Ch Pt	0.67	(1; 6.9%)
Nf Pt	0.00173	(1; 1.5%)	Ms Pt	0.00496	(1; 2.4%)	Bc Mp Ch Pt	0.316	(3; 3.2%)
Pc Pt	0.00144	(1; 1.2%)	Sh Pt	0.00291	(1; 1.4%)	Wa Pt	0.255	(1; 2.6%)
Mi Pt	0.0011	(1; 0.95%)	Ts Pt	0.00166	(1; 0.79%)	El Pt	0.199	(1; 2.%)
At Pt	0.00103	(1; 0.89%)	Mi Pt	0.00165	(1; 0.78%)	El Ch Pt	0.183	(2; 1.9%)
Cg Pt	0.00095	(1; 0.82%)	Wt Ch Pt	0.00152	(2; 0.72%)	Mi Pt	0.178	(1; 1.8%)
Oi Pc Pt	0.000911	(2; 0.79%)	Cm Pt	0.00148	(1; 0.7%)	Wa Ch Pt	0.163	(2; 1.7%)
Wt Ch Pt	0.000805	(2; 0.7%)	Ed Pt	0.00124	(1; 0.59%)	Bc Ch Pt	0.159	(2; 1.6%)
Ms Pt	0.000736	(1; 0.64%)	St Pt	0.00113	(1; 0.54%)	Wa Ms Pt	0.122	(2; 1.3%)
St Pt	0.000671	(1; 0.58%)	Gv Pt	0.00112	(1; 0.53%)	Sc Cg Ch Pt	0.0969	(3; 0.99%)
Lg Ch Pt	0.000665	(2; 0.57%)	Pl Pt	0.000945	(1; 0.45%)	Su Fd Ch Pt	0.0857	(3; 0.88%)
Is Sh Pt	0.000634	(2; 0.55%)	Ms Wt Pt	0.000944	(2; 0.45%)	Bc Mp Of Pt	0.0718	(3; 0.74%)
Nf Sh Pt	0.0006	(2; 0.52%)	Ho Pt	0.000906	(1; 0.43%)	Dc Dp Pt	0.0679	(2; 0.7%)
Sh Pt	0.000592	(1; 0.51%)	Pd Wt Pt	0.000646	(2; 0.31%)	Pp Pt	0.0485	(1; 0.5%)
Pc Ch Pt	0.000536	(2; 0.46%)	Ms Ch Pt	0.000646	(2; 0.31%)	Of Pt	0.0471	(1; 0.48%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Pt	0.247	(0; 77.%)	Pt	0.0585	(0; 52.%)	Bc Mp Ch Pt	0.0873	(3; 26.%)
Ch Pt	0.0256	(1; 8.%)	Ch Pt	0.00566	(1; 5.1%)	Bc Ch Pt	0.0439	(2; 13.%)
Pc Pt	0.00307	(1; 0.96%)	Wt Pt	0.00451	(1; 4.%)	Bc Mp Of Pt	0.0198	(3; 6.%)
Sh Pt	0.0017	(1; 0.53%)	Ms Pt	0.00235	(1; 2.1%)	Wo Mp Ch Pt	0.00986	(3; 3.%)
Wt Pt	0.00145	(1; 0.45%)	Sh Pt	0.00128	(1; 1.1%)	Bc Mp Ho Pt	0.00896	(3; 2.7%)
Pc Ch Pt	0.00114	(2; 0.35%)	Ts Pt	0.000815	(1; 0.73%)	Fr Pt	0.00798	(1; 2.4%)
Ms Pt	0.00108	(1; 0.34%)	Wt Ch Pt	0.000711	(2; 0.64%)	Pt	0.00683	(0; 2.1%)
Pl Pt	0.000898	(1; 0.28%)	Cm Pt	0.000708	(1; 0.63%)	Wh Of Pt	0.00637	(2; 1.9%)
Of Pt	0.000879	(1; 0.27%)	Mi Pt	0.000613	(1; 0.55%)	Bc Mp Pt	0.00453	(2; 1.4%)
Pa Pt	0.000607	(1; 0.19%)	St Pt	0.000602	(1; 0.54%)	Wo Ch Pt	0.00433	(2; 1.3%)
Mi Pt	0.000516	(1; 0.16%)	Ho Pt	0.000477	(1; 0.43%)	Fr Ch Pt	0.00304	(2; 0.92%)
Ts Pt	0.00045	(1; 0.14%)	At Pt	0.000462	(1; 0.41%)	Sc Cg Pt	0.00268	(2; 0.81%)
Cm Pt	0.000404	(1; 0.13%)	Ed Pt	0.000454	(1; 0.41%)	Wo Mp Of Pt	0.00224	(3; 0.68%)
Ne Pt	0.00034	(1; 0.11%)	Ms Wt Pt	0.000448	(2; 0.4%)	Bc Mp Ho Ch	0.00179	(4; 0.54%)
At Pt	0.000307	(1; 0.096%)	Rd Pt	0.000437	(1; 0.39%)	Wo Tx Wt Pt	0.0016	(3; 0.48%)
Et Pt	0.000307	(1; 0.096%)	Pd Wt Pt	0.000424	(2; 0.38%)	Sw Pp Pt	0.00156	(2; 0.47%)
Is Sh Pt	0.000299	(2; 0.093%)	Pl Pt	0.000412	(1; 0.37%)	Bc Mp Fd Ch	0.00154	(4; 0.47%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	0.795 ±0.016	(±2.0%)
Downstream	1.688 ±0.026	(±1.5%)

# Sector 25430010: Pharmaceuticals (Ph)

*Pharmaceutical goods for human use*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicators of greenhouse emissions, water use, and land disturbance are respectively 55%, 70% and 70% below average. The social indicator of employment generation is 25% below average, income is 15% below average, and government revenue is 45% below average. The financial indicators reveal that the operating surplus is 20% below average, while export propensity and import penetration are both 50% above average. A major new issue for the sector may be the downstream persistence in terrestrial and marine ecosystems after use, and potential effects of some products as endocrine disruptors.

## Sector Description

The pharmaceuticals for human use sector manufactures, packages, promotes and distributes a wide range of medicines and minor products such as artificial sweeteners, sunscreens, disposable baby nappies, and sanitary napkins. Manufacturing is a complex process and life cycle analyses of the 'cradle to grave' type have highlighted solvents as key drivers of material and energy use, and subsequent emissions and wastes. Persistence of many pharmaceuticals in ecosystems is a key management issue due to the possibility of endocrine disruption. The sector's current turnover was around \$6 billion in 2002, which has doubled in the last decade. Exports have trebled in the last decade and are around \$2.3 billion, most of which are non-generic or patented drugs with a higher value added. Over \$150 million of government R&D funding in the next decade aims to stimulate industry investment, and to double Australia's share of the global pharmaceuticals industry by 2012. Typical of the new drugs under development and testing is Xenome's Xen2174, a peptide isolated from cone shells on the Great Barrier Reef, which targets the transmission of pain signals to the brain, and is anticipated to have wide application in treating the victims of trauma.

## Place of Industry in the Economy

The pharmaceuticals for human use sector ranks 86<sup>th</sup> out of 135 sectors in terms of value adding in the economy and contributes 0.16% of GDP in this analysis. It is similar in value adding to the water transport, and bricks and ceramics sectors. It is a moderate sized employer with 9 000 employment years directly embodied in final demand, and another 19 000 years in its upstream suppliers, giving a total of 28 000 employment years. It has small resource requirements with less than three tenths of one percent of national water use, land disturbance, energy use, and greenhouse emissions. In financial terms, imports are 40% greater than exports in these data, but the gap has widened recently despite expanding Australian exports.

## Strategic Overview

The overview provided by the spider diagram reveals positive outcomes for five of the indicators, and possible issues with the remaining five. The social indicators of employment generation, income and government revenue are below average. This reflects the structure of a globalised industry where new or advanced medicines are imported and thereby dilute domestic social multipliers. The environmental indicators are below average and are also advantaged by imports as complex manufacturing processes occur overseas. The government revenue indicator includes the effect of the Pharmaceutical Benefits Scheme where a \$4.5 billion subsidy is supplied to reduce the cost to individual consumers in the community of new and/or expensive medicines. Upstream issues include animal testing protocols while downstream issues include unidentified side effects on users.

## TBL Account #1

The financial indicator of operating surplus is 20% below average with a direct effect of 37% and the rest from a wide range of suppliers. The social indicator of employment generation is 25% below average, while the environmental indicator of greenhouse emissions is 55% below average.

## TBL Accounts #2 and #3

The second TBL account shows that export propensity is 50% above average, income is 15% below average and water use is 70% below average. The third TBL account shows that import penetration is 50% above average, government revenue is 45% below average and land disturbance is 70% below average. Lower than average social multipliers are linked to high import penetration.

## Structural Path Analysis and Linkages

Leading international pharmaceutical firms are at the forefront of triple bottom line accounting and most report in detail on greenhouse emissions and water use. In the Australian context, direct greenhouse emissions are relatively minor at 2% of total. The emissions path is diffuse with major contributions from electricity (15%), garbage disposal (10%), wholesale trade (4%), basic chemical (4%), textiles (2%), medicinal crops (2%), 'electricity production for plastics, wholesale trade, and business services' (3%), and airline travel (1%). The water chain is also diffuse with a direct effect of 11%, and contributions from wholesale trade (18%), water supply (5%), and electricity (3%).

The sector's stimulus to its upstream suppliers is 20% above average and impacts on wholesale trade, legal and marketing services, research and technical services, property development and plastic products. The downstream linkages are small and are dissipated by private consumption.

## Future Trends in Sector

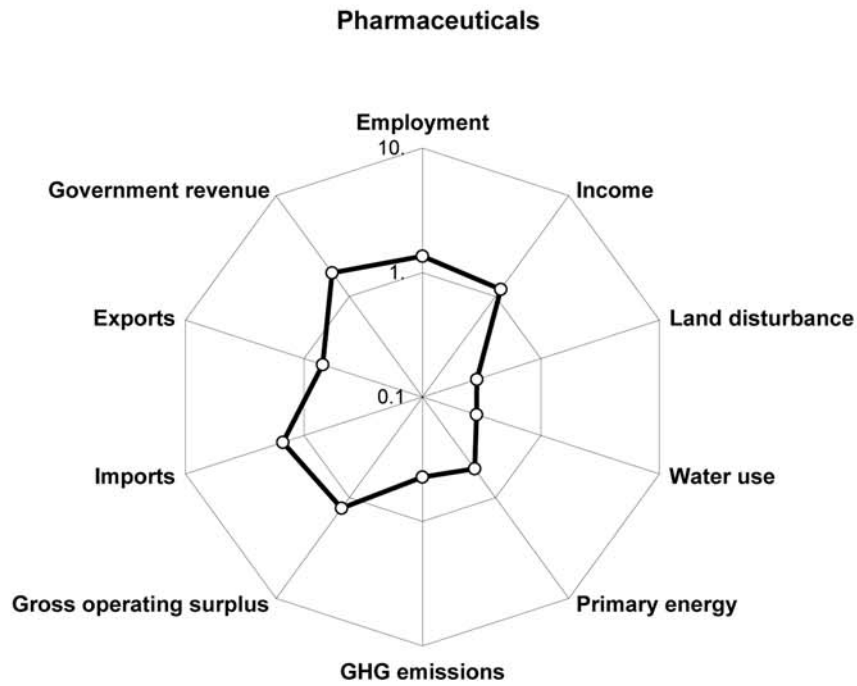
The base case scenario for the *Future Dilemmas* study gives a population of 25 million by 2050, 28% of whom will be over the age of 65. Therefore in the future there may be a substantial increase in the requirement for aged care and age related illnesses. The relatively simple modelling for pharmaceuticals in this case suggests an increase of 28% compared to today. The Department of Treasury's Intergenerational Report released in 2002 suggests that the cost of the Pharmaceutical Benefits Scheme subsidy will grow by a factor of 5.6 over a 40 year period from 0.6% of GDP in 2002, to 3.35% in 2042. Uncertainty surrounds these projections as age related illness might follow the progression of age cohorts, drug usefulness may decline, and outbreaks of new and potent diseases may continue. In a more positive light, the majority of younger and older age cohorts may recapture healthy lifestyles, pharmaceuticals may ensure health rather than cure sickness, and global disease pandemics may occur with less frequency, spread and intensity.

## Innovation and Technical Opportunities

Four future directions in the development of human pharmaceuticals stand out. The first and potentially most complex is that lifestyle and consumption habits may change in ways that decrease the requirements for pharmaceuticals. Drug development may increasingly be integrated with medical insurance, healthcare, and lifestyle to focus on preventative rather than curative health repair. Secondly, there are calls for much greater use of biomedical informatics or data mining to create evolutionary change in drug development rather than incremental or stepwise development. The chain from patients to drug designers may shorten to allow designers to interact with direct clinical information from practicing doctors treating patients in real time. Thirdly, there will be an ongoing tension between the search for new drugs from plant and marine origins, versus their design and fabrication by molecular assembly. Finally, the downstream effects of potential drug persistence in the environment will have to be designed out and rapid decay designed in.

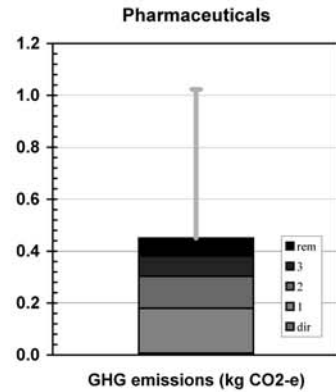
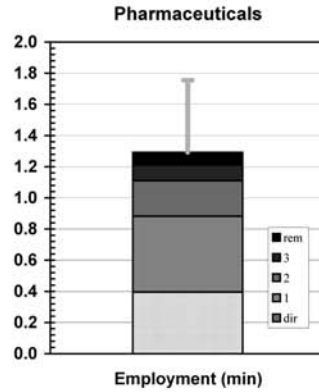
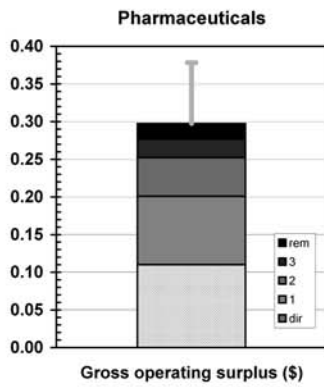
Pharmaceutical goods for human use

Spider diagram

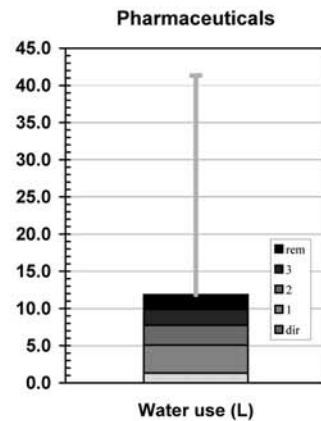
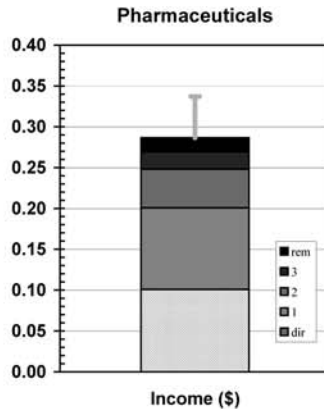
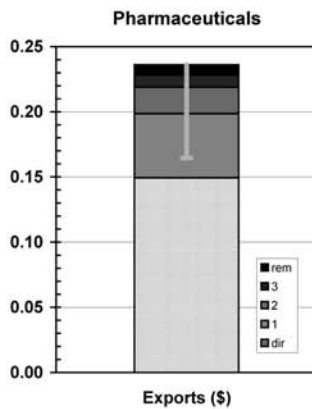


Bar graphs

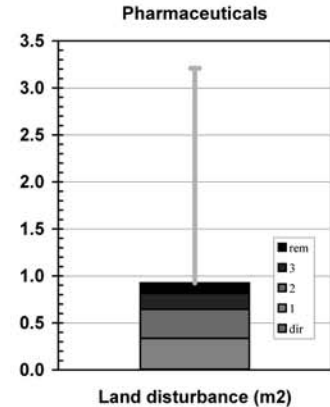
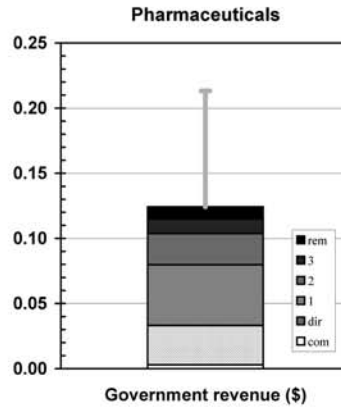
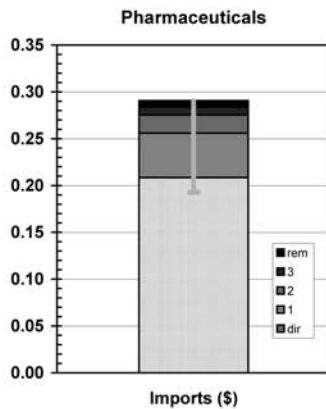
Account #1



Account #2



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 630.9	(0.24% of total)	(\$m 115.2 domestically produced)
Government final consumption	\$m 2,130.0	(2.41% of total)	(\$m 2,130.0 domestically produced)
Gross fixed capital expenditure	\$m 0.0		
Net changes in stocks	\$m 92.8	(5.25% of total)	(\$m 17.0 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 2,853.7</b>	<b>(0.62% of GNE)</b>	<b>(\$m 2,262.1 domestically produced)</b>
Exports	\$m 434.6	(0.52% of total)	(\$m 434.6 domestically produced)
<b>Final demand</b>	<b>\$m 3,288.4</b>	<b>(0.61% of GNT)</b>	<b>(\$m 2,696.8 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 293.3	(0.17% of total)
Gross operating surplus	\$m 320.2	(0.17% of total)
Taxes less subsidies	\$m 87.7	(0.10% of total)
<b>Sectoral GDP*</b>	<b>\$m 701.2</b>	<b>(0.16% of GDP)</b>
Imports	\$m 606.4	(0.62% of total)
<b>Primary inputs</b>	<b>\$m 1,307.6</b>	<b>(0.24% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 320.2	(0.17%)	\$m 296.7	(0.15%)
Exports (\$m)	\$m 434.6	(0.52%)	\$m 402.8	(0.48%)
Imports (\$m)	\$m 606.4	(0.62%)	\$m 561.9	(0.58%)
Employment (e-y)	9,234 e-y	(0.13%)	8,557 e-y	(0.12%)
Income (\$m)*	\$m 293.3	(0.17%)	\$m 271.8	(0.16%)
Government revenue (\$m)†	\$m 95.7	(0.09%)	\$m 89.3	(0.08%)
GHG emissions (kt CO <sub>2</sub> -e)	19 kt	(0.00%)	18 kt	(0.00%)
Water use (ML)	3,783 ML	(0.02%)	3,506 ML	(0.02%)
Land disturbance (kha)	2 kha	(0.00%)	2 kha	(0.00%)
Primary energy (TJ)	372 TJ	(0.01%)	344 TJ	(0.01%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.11	0.30	0.38
Exports (\$)	0.15	0.24	0.16
Imports (\$)	0.21	0.29	0.19
Employment (min)	0.40	1.29	1.75
Income (\$)	0.10	0.29	0.34
Government revenue (\$)	0.03	0.12	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.01	0.45	1.02
Water use (L)	1.30	11.86	41.32
Land disturbance (m <sup>2</sup> )	0.01	0.93	3.21
Primary energy (MJ)	0.13	3.95	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks



**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Ph	0.11	(0; 37.%)	Ph	0.396	(0; 31.%)	EI Ph	0.0682	(1; 15.%)
Wt Ph	0.0164	(1; 5.5%)	Wt Ph	0.118	(1; 9.1%)	Gd Ph	0.0426	(1; 9.5%)
Ms Ph	0.0126	(1; 4.3%)	Ms Ph	0.0567	(1; 4.4%)	Wt Ph	0.0163	(1; 3.6%)
St Ph	0.00839	(1; 2.8%)	Bs Ph	0.0427	(1; 3.3%)	Ch PI Ph	0.0103	(2; 2.3%)
Ts Ph	0.00785	(1; 2.6%)	Ts Ph	0.0354	(1; 2.7%)	Wo Tx Ph	0.00926	(2; 2.1%)
PI Ph	0.00463	(1; 1.6%)	PI Ph	0.0247	(1; 1.9%)	Wh Ph	0.00899	(1; 2.%)
Bs Ph	0.00433	(1; 1.5%)	Wh Ph	0.0211	(1; 1.6%)	Ph	0.00659	(0; 1.5%)
Wh Ph	0.00426	(1; 1.4%)	Ho Ph	0.0173	(1; 1.3%)	Ch Ph	0.00571	(1; 1.3%)
St Wt Ph	0.00312	(2; 1.%)	Gd Ph	0.0169	(1; 1.3%)	EI PI Ph	0.00538	(2; 1.2%)
EI Ph	0.00276	(1; 0.93%)	Pa Ph	0.0145	(1; 1.1%)	EI Ms Ph	0.00529	(2; 1.2%)
Ms Wt Ph	0.00237	(2; 0.8%)	St Ph	0.0137	(1; 1.1%)	EI Wt Ph	0.00491	(2; 1.1%)
Rd Ph	0.00226	(1; 0.76%)	Rd Ph	0.0133	(1; 1.%)	At Ph	0.00442	(1; 0.98%)
Pa Ph	0.00214	(1; 0.72%)	Os Ph	0.013	(1; 1.%)	Pa Ph	0.0043	(1; 0.95%)
Pd Wt Ph	0.00188	(2; 0.63%)	Ms Wt Ph	0.0106	(2; 0.82%)	Hw Ph	0.00365	(1; 0.81%)
Ne Ph	0.00155	(1; 0.52%)	Ps Ph	0.00674	(1; 0.52%)	Sw Pp Pa Ph	0.00361	(3; 0.8%)
Ho Ph	0.00138	(1; 0.46%)	Bs Ms Ph	0.00545	(2; 0.42%)	Rd Ph	0.00358	(1; 0.79%)
Cm Ph	0.0013	(1; 0.44%)	Ne Ph	0.00524	(1; 0.41%)	Fr Hw Ph	0.00357	(2; 0.79%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Ph	0.149	(0; 63.%)	Ph	0.101	(0; 35.%)	Wh Ph	2.18	(1; 18.%)
Wt Ph	0.0134	(1; 5.7%)	Wt Ph	0.0253	(1; 8.8%)	Ph	1.3	(0; 11.%)
Wh Ph	0.00548	(1; 2.3%)	Ms Ph	0.0132	(1; 4.6%)	Wa Ph	0.609	(1; 5.1%)
St Ph	0.00208	(1; 0.88%)	Ts Ph	0.00828	(1; 2.9%)	EI Ph	0.377	(1; 3.2%)
Ms Ph	0.00196	(1; 0.83%)	Bs Ph	0.00524	(1; 1.8%)	Wa Ms Ph	0.325	(2; 2.7%)
Tx Ph	0.00142	(1; 0.6%)	PI Ph	0.00499	(1; 1.7%)	Wo Tx Ph	0.3	(2; 2.5%)
At Ph	0.00141	(1; 0.6%)	Gd Ph	0.00472	(1; 1.6%)	Sc Cg Tx Ph	0.142	(3; 1.2%)
PI Ph	0.00134	(1; 0.57%)	Os Ph	0.00365	(1; 1.3%)	Wa Bs Ph	0.131	(2; 1.1%)
Ts Ph	0.00125	(1; 0.53%)	St Ph	0.00349	(1; 1.2%)	Sc Cg Wh Ph	0.128	(3; 1.1%)
Ch PI Ph	0.0012	(2; 0.51%)	Pa Ph	0.00333	(1; 1.2%)	Ws Ho Ph	0.126	(2; 1.1%)
Ho Ph	0.000962	(1; 0.41%)	Ho Ph	0.00252	(1; 0.88%)	Wa Ts Ph	0.106	(2; 0.89%)
Pa Ph	0.000873	(1; 0.37%)	Ms Wt Ph	0.00247	(2; 0.86%)	Bc Mp Ho Ph	0.0904	(3; 0.76%)
Wo Tx Ph	0.000821	(2; 0.35%)	Rd Ph	0.00228	(1; 0.8%)	Pp Pa Ph	0.0881	(2; 0.74%)
Bs Ph	0.000802	(1; 0.34%)	Pd Wt Ph	0.00169	(2; 0.59%)	Pa Ph	0.0836	(1; 0.71%)
Rd Ph	0.000784	(1; 0.33%)	St Wt Ph	0.0013	(2; 0.45%)	Dc Dp Ho Ph	0.075	(3; 0.63%)
St Wt Ph	0.000774	(2; 0.33%)	Ne Ph	0.0012	(1; 0.42%)	Bc Mp Of Ph	0.0724	(3; 0.61%)
Eq Ph	0.000726	(1; 0.31%)	Ed Ph	0.000953	(1; 0.33%)	Wt Ph	0.0659	(1; 0.56%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Ph	0.208	(0; 72.%)	Ph	0.0301	(0; 25.%)	Wh Ph	0.317	(1; 34.%)
PI Ph	0.00475	(1; 1.6%)	Wt Ph	0.0118	(1; 9.8%)	Wo Tx Ph	0.222	(2; 24.%)
Pa Ph	0.00418	(1; 1.4%)	Ms Ph	0.00627	(1; 5.2%)	Bc Mp Ho Ph	0.0249	(3; 2.7%)
Wt Ph	0.0038	(1; 1.3%)	Ts Ph	0.00408	(1; 3.4%)	Bc Mp Of Ph	0.02	(3; 2.2%)
Ms Ph	0.00288	(1; 0.99%)	Gd Ph	0.00219	(1; 1.8%)	Wh Of Ph	0.00641	(2; 0.69%)
Ts Ph	0.00225	(1; 0.77%)	PI Ph	0.00218	(1; 1.8%)	Ph	0.00621	(0; 0.67%)
Ch PI Ph	0.0012	(2; 0.41%)	St Ph	0.00187	(1; 1.5%)	Bc Mp De Ph	0.00482	(3; 0.52%)
Of Ph	0.000885	(1; 0.3%)	Pa Ph	0.00175	(1; 1.4%)	Wo Tx PI Ph	0.00476	(3; 0.51%)
Bs Ph	0.00086	(1; 0.3%)	Os Ph	0.00169	(1; 1.4%)	Wo Tx Wt Ph	0.0042	(3; 0.45%)
De Ph	0.000817	(1; 0.28%)	Rd Ph	0.00162	(1; 1.3%)	Bc Mp Ch PI F	0.0041	(4; 0.44%)
St Ph	0.00076	(1; 0.26%)	Bs Ph	0.00155	(1; 1.3%)	Gd Ph	0.004	(1; 0.43%)
Ne Ph	0.000746	(1; 0.26%)	Ho Ph	0.00133	(1; 1.1%)	Bc Mp Ho Ms	0.00307	(4; 0.33%)
Ch Ph	0.000665	(1; 0.23%)	Ms Wt Ph	0.00118	(2; 0.97%)	Bc Mp Ph	0.00306	(2; 0.33%)
Ho Ph	0.000641	(1; 0.22%)	Pd Wt Ph	0.00111	(2; 0.92%)	Sw Pp Pa Ph	0.00284	(3; 0.31%)
Rd Ph	0.000571	(1; 0.2%)	St Wt Ph	0.000694	(2; 0.57%)	Wo Mp Ho Ph	0.00282	(3; 0.3%)
Pp Pa Ph	0.000541	(2; 0.19%)	At Ph	0.000629	(1; 0.52%)	Bc Mp Ho Wt	0.00242	(4; 0.26%)
Ms Wt Ph	0.00054	(2; 0.19%)	Ne Ph	0.000603	(1; 0.5%)	Bc Mp Ch Ph	0.00227	(3; 0.25%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.189 ±0.021	(±1.8%)
Downstream	0.131 ±0.008	(±6.4%)

# Sector 2504: Agricultural Chemicals (Ac)

*Insecticides, pesticides and veterinary chemicals*

## Short Summary

The sector shows good environmental indicators per dollar of final consumption with greenhouse emissions 55% below average, and water use and land disturbance 70% below average. Most of the environmental indicators are due to the production chain, rather than the sector itself. The social indicators are weaker than average, with employment generation and income both 30% below average, while government revenue is 15% below average. The financial indicator of operating surplus is 20% below average, while export propensity is equal to average and import penetration is 50% above average. Increased consumer demand gives above average stimulus to the sector's suppliers. Downstream linkages to the sectors that use agricultural chemicals are also above average. The government revenue and import components of the TBL account may require improvement. Government revenue per dollar is low in light of government spending on pesticide safety, management of its residues and environmental contamination. However this is a complex area given appropriate pesticide usage is central to maintaining food safety, food quality and reasonable financial returns for agricultural production systems. Key issues including toxicity, residues, environmental loadings, and occupational health and safety are outside the scope of this analysis. Biological control agents are covered by the scientific and technical services sector.

## Sector Description

The agricultural chemicals sector supplies in excess of 1 700 products with sales of \$2 billion to farmers and farm companies. Over 11 500 tonnes of solid product are produced locally and 4 000 tonnes imported. Over 118 million litres of liquid product are produced annually with 6 million litres imported. Under the industry body Avcare, the sector is well advanced in TBL and environmental accounting and has developed a range of indicators for energy use, water use and waste production. Avcare has also implemented advanced container and product stewardship programs.

## Place of Industry in the Economy

In terms of value adding the agricultural chemicals sector is in the smallest quartile of the economy ranking 111<sup>th</sup> out of 135 and contributing 0.08% of GDP in this analysis. It is a relatively small employment generator with a direct requirement of 1 000 employment years and another 4 000 years in the sector's suppliers, giving a total of 5 000 employment years. In addition, the sector contributes 3 000 employment years to the final demand for downstream agricultural sectors. It has relatively small requirements for energy, greenhouse emissions, water and land requiring less than one tenth of one percent of national totals. Imports are three times exports in financial terms.

## Strategic Overview

The integrated overview provided in the spider diagram reveals better than average environmental outcomes, with lower than average social and financial outcomes. The higher than average import penetration has a number of knock-on effects. The environmental indicators may benefit from high imports since most of the chemical processing takes place overseas with domestic activities including the bulking up of concentrates, packaging and marketing. A lower proportion of domestic manufacture also leads to lower social indicators of employment generation and income. However the global chemicals sector is highly capital intensive, and often located in countries such as the US and Germany, and associated with long term investment in research and development capacity.

## TBL Account #1

The financial indicator of operating surplus is 20% below average with one third a direct effect, and the remaining two thirds due to the sector's suppliers. The social indicator of employment generation is 25% below average with one third a direct effect. The environmental indicator of greenhouse emissions is 55% below average with the direct effect of fuel combustion in the sector accounting for only 2% of the total. Performance in the sector is cyclical, and improving the surplus and employment indicators could be difficult given the climatic and market variability in Australian agriculture, and intense global competition in the sector's products.

## TBL Accounts #2 and #3

In the second TBL account, the financial indicator of export propensity is equal to average with one half a direct effect and contributions from wholesale trade, grains, business management services, and scientific research. The social indicator of income is 15% below average with the direct effect one third of the total. Water use is 70% below average with one tenth a direct effect. The third TBL account shows an import penetration indicator 50% above average due imports of key chemicals mostly in concentrate form, that are not manufactured in Australia. Government revenue is 15% below average and land disturbance is 70% below average.

## Structural Path Analysis and Linkages

Import penetration and government revenue are below average. The structural path for imports shows that the direct effect is 72% so increasing local production is a logical route to improvement if issues of manufacturing scale can be solved. The structural path for government revenue reveals a diverse range of first order effects. The revenue indicator could be increased by an excise on active chemical ingredients, but this may face political and social opposition.

Increased consumer demand for agricultural chemicals shows a stronger than average upstream linkage to the sectors of wholesale trade, scientific research, marketing and management, and property development. Increased investment into the sector requires expansion of beef, vegetable and fruit growing, meat products and community services to dissipate the expansionary effect.

## Future Trends in Sector

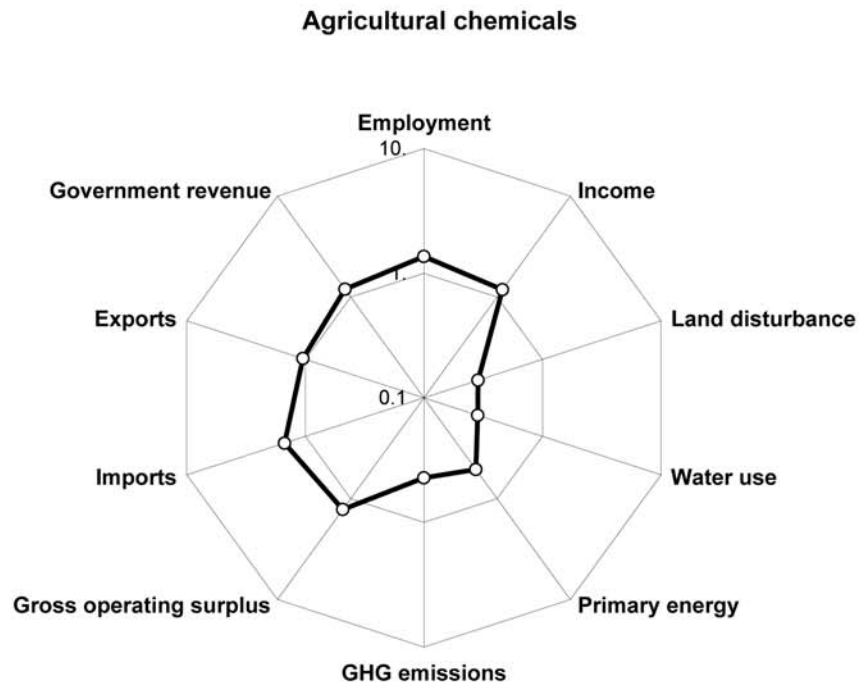
While the *Future Dilemmas* study does not model this sector specifically, the general materials class of organic chemicals is anticipated to increase by 30% over the next 50 years. Future growth is difficult to anticipate because of the uncertainty surrounding key agricultural drivers such as biotechnology and low-till agriculture. The former promises to reduce chemical inputs to agriculture while the latter, with extensive use of herbicides to reduce machinery and energy inputs, could drive an expansion in requirements. Trends towards organic or biological agriculture could also reduce the requirement for pesticides but increase the requirement for energy and labour in agriculture.

## Innovation and Technical Opportunities

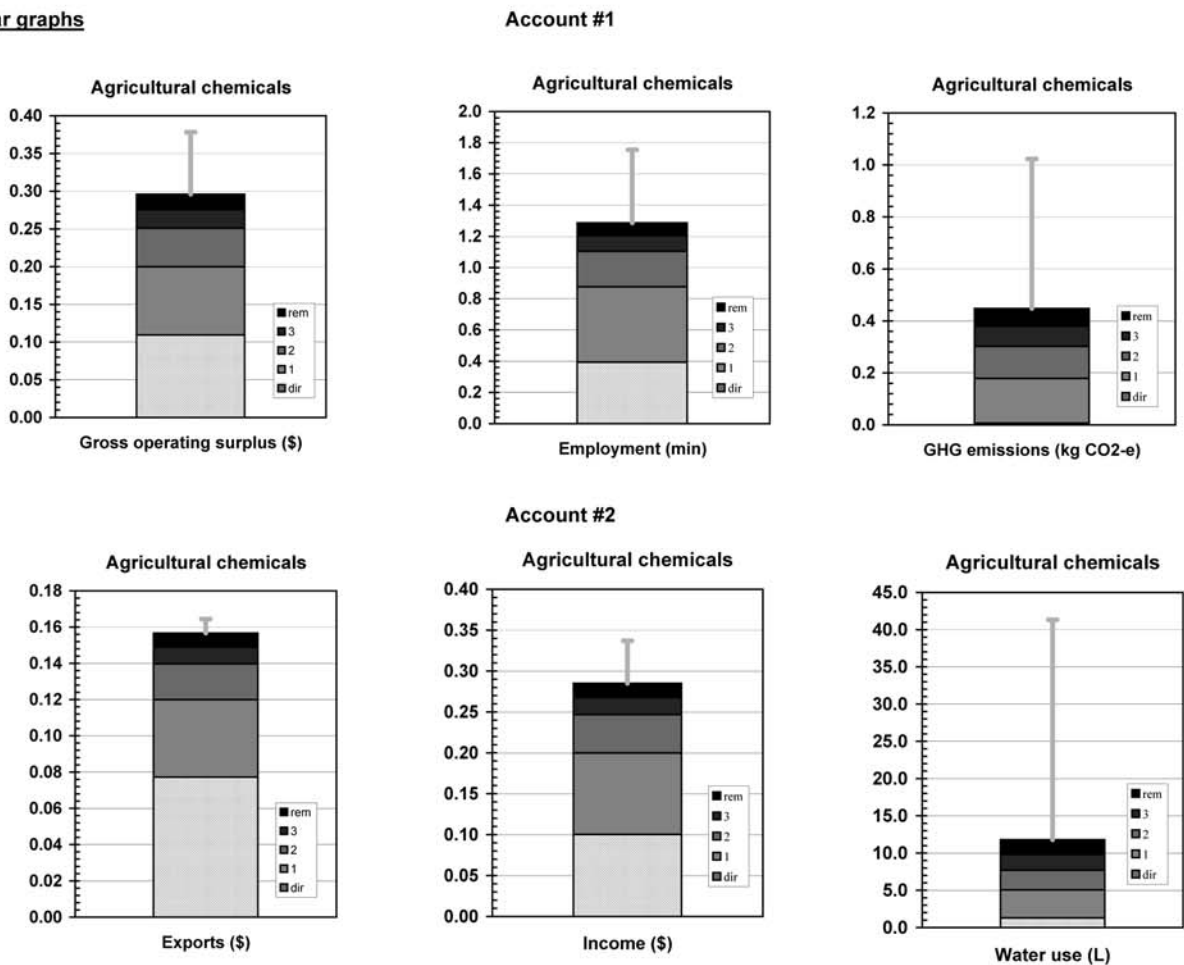
Public concern with pesticides in food production and as contaminants of land and water is leading to regulation and taxation regimes to constrain their use. While both plant and animal organic farming is growing strongly, rapid developments in conventional precision agriculture will allow direct application almost to the 'problem square metre', and thereby reduce chemical use. While farming will remain strongly chemical dependent, future plant and pest engineering will reduce the opportunity for pest outbreaks, while bio-pesticide development (viruses, bacteria and fungi) will expand the farmer's armoury. Increasingly, more complex and knowledge intensive forms of integrated pest management will be mandated. These developments could increase the functional importance of this sector, or the work could be transferred to the services to agriculture sector.

Insecticides, pesticides, veterinary products and other agricultural chemicals

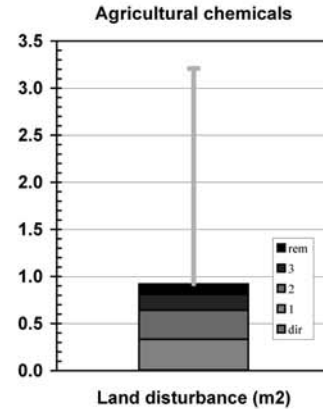
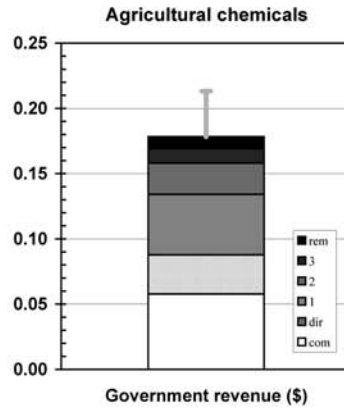
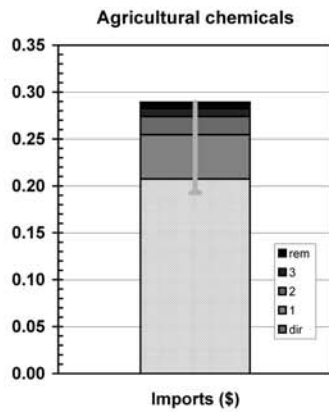
Spider diagram



Bar graphs



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 340.4	(0.13% of total)	(\$m 323.9 domestically produced)
Government final consumption	-\$m 2.7	(0.00% of total)	
Gross fixed capital expenditure	\$m 27.4	(0.03% of total)	(\$m 27.4 domestically produced)
Net changes in stocks	-\$m 3.8	-(0.22% of total)	
<b>Sectoral GNE</b>	<b>\$m 361.2</b>	<b>(0.08% of GNE)</b>	<b>(\$m 341.1 domestically produced)</b>
Exports	\$m 116.2	(0.14% of total)	(\$m 116.2 domestically produced)
<b>Final demand</b>	<b>\$m 477.4</b>	<b>(0.09% of GNT)</b>	<b>(\$m 457.3 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 151.1	(0.09% of total)
Gross operating surplus	\$m 164.9	(0.09% of total)
Taxes less subsidies	\$m 45.2	(0.05% of total)
<b>Sectoral GDP*</b>	<b>\$m 361.2</b>	<b>(0.08% of GDP)</b>
Imports	\$m 312.3	(0.32% of total)
<b>Primary inputs</b>	<b>\$m 673.5</b>	<b>(0.12% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 164.9	(0.09%)	\$m 50.9 (0.03%)	\$m 137.6 (0.07%)
Exports (\$m)	\$m 116.2	(0.14%)	\$m 35.9 (0.04%)	\$m 72.8 (0.09%)
Imports (\$m)	\$m 312.3	(0.32%)	\$m 96.4 (0.10%)	\$m 134.4 (0.14%)
Employment (e-y)	4,756 e-y	(0.07%)	1,467 e-y (0.02%)	4,789 e-y (0.07%)
Income (\$m)*	\$m 151.1	(0.09%)	\$m 46.6 (0.03%)	\$m 132.4 (0.08%)
Government revenue (\$m)†	\$m 72.0	(0.07%)	\$m 40.8 (0.04%)	\$m 82.9 (0.08%)
GHG emissions (kt CO <sub>2</sub> -e)	10 kt	(0.00%)	3 kt (0.00%)	208 kt (0.04%)
Water use (ML)	1,949 ML	(0.01%)	601 ML (0.00%)	5,480 ML (0.03%)
Land disturbance (kha)	1 kha	(0.00%)	0 kha (0.00%)	43 kha (0.03%)
Primary energy (TJ)	191 TJ	(0.00%)	59 TJ (0.00%)	1,824 TJ (0.05%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.11	0.30	0.38
Exports (\$)	0.08	0.16	0.16
Imports (\$)	0.21	0.29	0.19
Employment (min)	0.39	1.29	1.75
Income (\$)	0.10	0.29	0.34
Government revenue (\$)	0.09	0.18	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.01	0.45	1.02
Water use (L)	1.29	11.79	41.32
Land disturbance (m <sup>2</sup> )	0.01	0.92	3.21
Primary energy (MJ)	0.13	3.92	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Ac	0.109	(0; 37.%)	Ac	0.394	(0; 31.%)	EI Ac	0.0679	(1; 15.%)
Wt Ac	0.0163	(1; 5.5%)	Wt Ac	0.117	(1; 9.1%)	Gd Ac	0.0424	(1; 9.5%)
Ms Ac	0.0126	(1; 4.3%)	Ms Ac	0.0565	(1; 4.4%)	Wt Ac	0.0163	(1; 3.6%)
St Ac	0.00835	(1; 2.8%)	Bs Ac	0.0425	(1; 3.3%)	Ch PI Ac	0.0103	(2; 2.3%)
Ts Ac	0.00781	(1; 2.6%)	Ts Ac	0.0352	(1; 2.7%)	Wo Tx Ac	0.00922	(2; 2.1%)
PI Ac	0.00461	(1; 1.6%)	PI Ac	0.0246	(1; 1.9%)	Wh Ac	0.00895	(1; 2.2%)
Bs Ac	0.00431	(1; 1.5%)	Wh Ac	0.021	(1; 1.6%)	Ac	0.00656	(0; 1.5%)
Wh Ac	0.00424	(1; 1.4%)	Ho Ac	0.0172	(1; 1.3%)	Ch Ac	0.00568	(1; 1.3%)
St Wt Ac	0.00311	(2; 1.%)	Gd Ac	0.0168	(1; 1.3%)	EI PI Ac	0.00535	(2; 1.2%)
EI Ac	0.00274	(1; 0.93%)	Pa Ac	0.0144	(1; 1.1%)	EI Ms Ac	0.00527	(2; 1.2%)
Ms Wt Ac	0.00236	(2; 0.8%)	St Ac	0.0136	(1; 1.1%)	EI Wt Ac	0.00489	(2; 1.1%)
Rd Ac	0.00224	(1; 0.76%)	Rd Ac	0.0132	(1; 1.%)	At Ac	0.0044	(1; 0.98%)
Pa Ac	0.00213	(1; 0.72%)	Os Ac	0.013	(1; 1.%)	Pa Ac	0.00428	(1; 0.96%)
Pd Wt Ac	0.00187	(2; 0.63%)	Ms Wt Ac	0.0106	(2; 0.82%)	Hw Ac	0.00364	(1; 0.81%)
Ne Ac	0.00154	(1; 0.52%)	Ps Ac	0.0067	(1; 0.52%)	Sw Pp Pa Ac	0.00359	(3; 0.8%)
Ho Ac	0.00137	(1; 0.46%)	Bs Ms Ac	0.00543	(2; 0.42%)	Rd Ac	0.00356	(1; 0.8%)
Cm Ac	0.0013	(1; 0.44%)	Ne Ac	0.00522	(1; 0.41%)	Fr Hw Ac	0.00355	(2; 0.79%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Ac	0.0772	(0; 49.%)	Ac	0.1	(0; 35.%)	Wh Ac	2.16	(1; 18.%)
Wt Ac	0.0133	(1; 8.5%)	Wt Ac	0.0252	(1; 8.8%)	Ac	1.29	(0; 11.%)
Wh Ac	0.00545	(1; 3.5%)	Ms Ac	0.0131	(1; 4.6%)	Wa Ac	0.606	(1; 5.1%)
St Ac	0.00207	(1; 1.3%)	Ts Ac	0.00824	(1; 2.9%)	EI Ac	0.375	(1; 3.2%)
Ms Ac	0.00195	(1; 1.2%)	Bs Ac	0.00522	(1; 1.8%)	Wa Ms Ac	0.324	(2; 2.7%)
Tx Ac	0.00142	(1; 0.9%)	PI Ac	0.00497	(1; 1.7%)	Wo Tx Ac	0.298	(2; 2.5%)
At Ac	0.0014	(1; 0.89%)	Gd Ac	0.0047	(1; 1.6%)	Sc Cg Tx Ac	0.141	(3; 1.2%)
PI Ac	0.00134	(1; 0.85%)	Os Ac	0.00363	(1; 1.3%)	Wa Bs Ac	0.13	(2; 1.1%)
Ts Ac	0.00124	(1; 0.79%)	St Ac	0.00348	(1; 1.2%)	Sc Cg Wh Ac	0.128	(3; 1.1%)
Ch PI Ac	0.00119	(2; 0.76%)	Pa Ac	0.00332	(1; 1.2%)	Ws Ho Ac	0.125	(2; 1.1%)
Ho Ac	0.000957	(1; 0.61%)	Ho Ac	0.00251	(1; 0.88%)	Wa Ts Ac	0.105	(2; 0.89%)
Pa Ac	0.000868	(1; 0.55%)	Ms Wt Ac	0.00246	(2; 0.86%)	Bc Mp Ho Ac	0.09	(3; 0.76%)
Wo Tx Ac	0.000817	(2; 0.52%)	Rd Ac	0.00227	(1; 0.8%)	Pp Pa Ac	0.0877	(2; 0.74%)
Bs Ac	0.000798	(1; 0.51%)	Pd Wt Ac	0.00169	(2; 0.59%)	Pa Ac	0.0832	(1; 0.71%)
Rd Ac	0.000781	(1; 0.5%)	St Wt Ac	0.00129	(2; 0.45%)	Dc Dp Ho Ac	0.0746	(3; 0.63%)
St Wt Ac	0.00077	(2; 0.49%)	Ne Ac	0.0012	(1; 0.42%)	Bc Mp Of Ac	0.072	(3; 0.61%)
Eq Ac	0.000723	(1; 0.46%)	Ed Ac	0.000948	(1; 0.33%)	Wt Ac	0.0656	(1; 0.56%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Ac	0.207	(0; 72.%)	Ac	0.03	(0; 25.%)	Wh Ac	0.315	(1; 34.%)
PI Ac	0.00472	(1; 1.6%)	Wt Ac	0.0118	(1; 9.8%)	Wo Tx Ac	0.221	(2; 24.%)
Pa Ac	0.00416	(1; 1.4%)	Ms Ac	0.00624	(1; 5.2%)	Bc Mp Ho Ac	0.0248	(3; 2.7%)
Wt Ac	0.00378	(1; 1.3%)	Ts Ac	0.00406	(1; 3.4%)	Bc Mp Of Ac	0.0199	(3; 2.2%)
Ms Ac	0.00286	(1; 0.99%)	Gd Ac	0.00218	(1; 1.8%)	Wh Of Ac	0.00638	(2; 0.69%)
Ts Ac	0.00224	(1; 0.77%)	PI Ac	0.00217	(1; 1.8%)	Ac	0.00618	(0; 0.67%)
Ch PI Ac	0.0012	(2; 0.41%)	St Ac	0.00186	(1; 1.5%)	Bc Mp De Ac	0.0048	(3; 0.52%)
Of Ac	0.000881	(1; 0.3%)	Pa Ac	0.00174	(1; 1.4%)	Wo Tx PI Ac	0.00474	(3; 0.51%)
Bs Ac	0.000856	(1; 0.3%)	Os Ac	0.00169	(1; 1.4%)	Wo Tx Wt Ac	0.00418	(3; 0.45%)
De Ac	0.000813	(1; 0.28%)	Rd Ac	0.00161	(1; 1.3%)	Bc Mp Ch PI Ac	0.00408	(4; 0.44%)
St Ac	0.000756	(1; 0.26%)	Bs Ac	0.00155	(1; 1.3%)	Gd Ac	0.00398	(1; 0.43%)
Ne Ac	0.000742	(1; 0.26%)	Ho Ac	0.00132	(1; 1.1%)	Bc Mp Ho Ms	0.00305	(4; 0.33%)
Ch Ac	0.000662	(1; 0.23%)	Ms Wt Ac	0.00117	(2; 0.97%)	Bc Mp Ac	0.00305	(2; 0.33%)
Ho Ac	0.000638	(1; 0.22%)	Pd Wt Ac	0.00111	(2; 0.92%)	Sw Pp Pa Ac	0.00283	(3; 0.31%)
Rd Ac	0.000569	(1; 0.2%)	St Wt Ac	0.000691	(2; 0.57%)	Wo Mp Ho Ac	0.0028	(3; 0.3%)
Pp Pa Ac	0.000538	(2; 0.19%)	At Ac	0.000626	(1; 0.52%)	Bc Mp Ho Wt	0.00241	(4; 0.26%)
Ms Wt Ac	0.000537	(2; 0.19%)	Ne Ac	0.0006	(1; 0.5%)	Bc Mp Ch Ac	0.00226	(3; 0.25%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.182 ±0.021	(±1.8%)
Downstream	1.237 ±0.021	(±1.7%)

# Sector 2505: Soap and Other Detergents (De)

*Soap and other detergents, candles, toothpaste, bleach, disinfectants, abrasive cleaners*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicators of greenhouse emissions, water use, and land disturbance, are 15%, 50%, and 35%, below average respectively. The social indicators of employment generation, income, and government revenue are respectively 30%, 30%, and 15% below average. The financial indicator of operating surplus is 20% below average, while export propensity and import penetration are respectively equal to and 70% above average. The high level of imports advantages the environmental indicators, and disadvantages the social indicators, since many essential ingredients for detergent are manufactured overseas.

## Sector Description

Production and consumption information on detergents is difficult to obtain but industry data suggest that 130 000 tonnes of laundry detergents are domestically produced each year. Other sources suggest that per capita use is around 19 kg per year with laundry (12 kg), dishwashing (3 kg), and other household cleaning (4 kg). If this is so, then total consumption is around 380 000 tonnes per year, not adjusted for water content. In European life cycle analyses, one tonne of a generic building base for detergents required 22 GJ ( $10^9$ J) of total energy, 19 tonnes of water, and produced 280 kg of solid wastes. Of equal importance were downstream effects after use, particularly the requirement for wastewater treatment to remove key substances that may impact water bodies. The sector's financial turnover is composed of a wide variety of materials such as toothpaste (14%), soaps (12%), detergents (11%), bleach (5%), disinfectant (6%), scouring agents (3%), candles (2%), and many unspecified materials. Consumption in constant dollar terms has been relatively constant over the past 15 years perhaps reflecting a competitive market place and better detergents. Turnover of the sector in 2002 was around \$1.8 billion and involved 100 enterprises.

## Place of Industry in the Economy

The soap and detergents sector ranks 115<sup>th</sup> out of 135 sectors in terms of value adding in the economy, and contributes 0.07% of GDP in this analysis. It is similar in value adding to the knitting mill products, and cosmetics and toiletries sectors. It is a relatively small employer with 3 000 employment years embodied in final demand, and another 5 000 years in the sector's upstream suppliers, giving a total of 8 000 employment years. In addition, the sector contributes 1 000 employment years to downstream industries such as accommodation cafes and restaurants. The sector has small resource requirements with less than two tenths of one percent of national water use, land disturbance, energy use, and greenhouse emissions. Imports are four times exports.

## Strategic Overview

The spider diagram shows a relatively well balanced outcome with import penetration as an outlier. This high level of imports is due to the relatively small scale of the domestic chemicals industry and its difficulty in competing with world scale manufacturers of key ingredients for modern detergents. This tends to slightly disadvantage the social indicators of employment and income but advantage the environmental indicators, as the resource intensive manufacturing processes described in the life cycle analysis above, take place outside Australia. Downstream issues include the effects of detergents on water bodies and human allergies due to overuse of cleaning agents in homes.

## TBL Account #1

The financial indicator of operating surplus is 20% below average with 42% of the total being a direct sector effect and additional contributions from plastics (5%), basic chemicals (4%), accounting and marketing (3%), wholesale trade (2%), technical services (1%), road transport (1%), meat products (1%) and electricity production (1%). The social indicator of employment generation is 30% below average with a similar composition to the surplus indicator. The greenhouse indicator is 15% below average and is discussed in more detail below.

## TBL Accounts #2 and #3

The second TBL account reveals that the export propensity is equal to average, income is 30% below average, and water use is 50% below average. The third TBL account shows that import penetration is 70% above average, government revenue is 15% below average, and land disturbance is 35% below average. The below average outcomes for all social indicators are related to the relatively high levels of imports where domestic industry undertakes synthesis and packaging, but essential ingredients are fabricated in large scale chemical complexes overseas.

## Structural Path Analysis and Linkages

While the greenhouse indicator is below average, greenhouse emissions are an important issue in a full life cycle context as many of the key ingredients are manufactured overseas and are excluded from the domestic boundary of this analysis. Within the domestic boundary, direct sector emissions account for only 4% of total. Key contributions to emissions come from 'beef cattle to meat products' chain (21% of total) due mainly to oil and tallow used in soap manufacture. Other contributions include basic chemicals (15%), electricity production (8%), 'basic chemicals used in plastics' (4%), 'electricity used in basic chemicals and plastics' (4%), and garbage disposal (2%). If the imported components were included, emissions would rise to 50% above average, highlighting the supply chain issues for many sectors that seek global environmental accreditation.

The sector's stimulus to its upstream suppliers is about 10% above the economy wide average and impacts particularly on basic chemicals, plastic products, wholesale trade and marketing. The linkages to downstream industries are weak as, apart from accommodation cafes and restaurants, most of the effect leaks to private consumption.

## Future Trends in Sector

In the base case scenario of the *Future Dilemmas* study (25 million people by 2050), it is reasonable to assume that detergent requirements will increase in a pro rata sense by around 25%. However consumption preferences may change. Studies show that naturally sourced vinegar is equally effective in reducing microbial contamination, but chemical cleaners are superior for stains.

## Innovation and Technical Opportunities

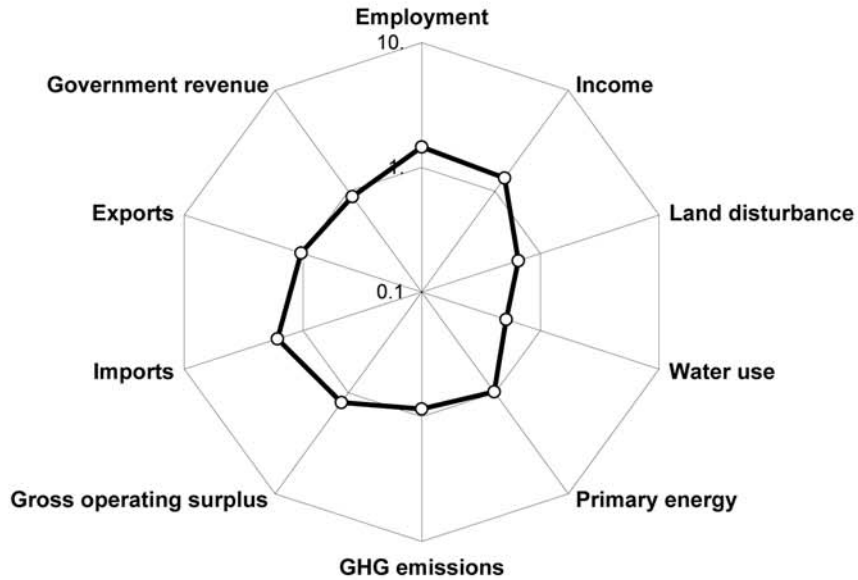
A recent study by the German detergent industry found that process innovation gave only marginal improvements to downstream impacts of detergent use. Ultrasound machines could improve laundry cleaning efficiency by a factor of six but the study judged that even more radical change was required to improve the clothes cleaning life cycle as the majority of life cycle energy and materials were used in the home laundry, rather than during detergent manufacture. Innovation should focus on the home rather than the factory. Any radical transformation of clothes cleaning would require fully integrated development by fabric and fashion designers, washing machine manufacturers and detergent makers. In the toothpaste industry, the new products that protect teeth using milk protein casein delivered in chewing gum with a positive effect on phosphate content of teeth enamel, could be augmented by smart materials that actively clean, whiten and freshen breath continuously.



Soap and other detergents, candles, toothpaste, bleach, disinfectants, abrasive cleaners

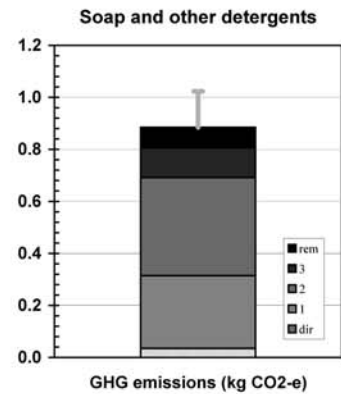
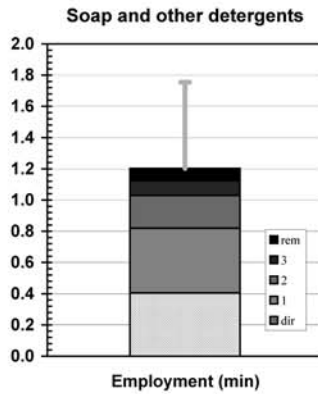
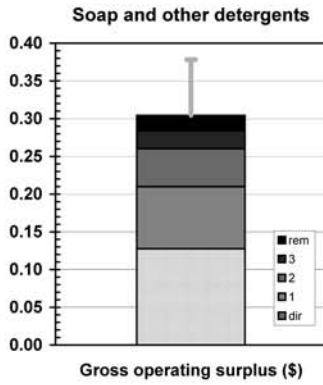
Spider diagram

Soap and other detergents

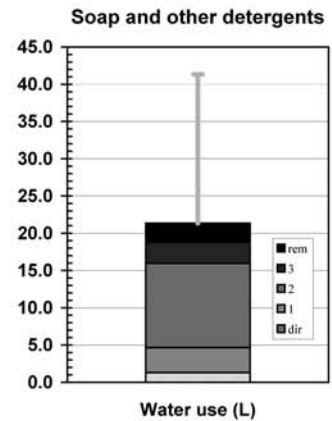
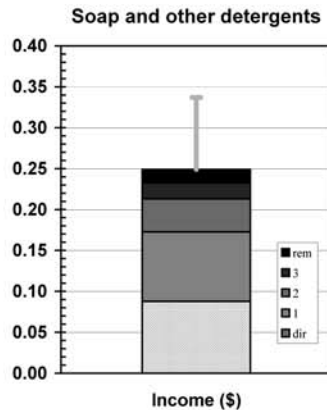
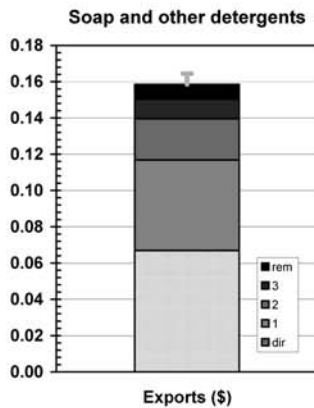


Bar graphs

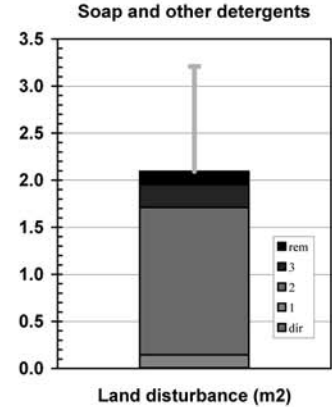
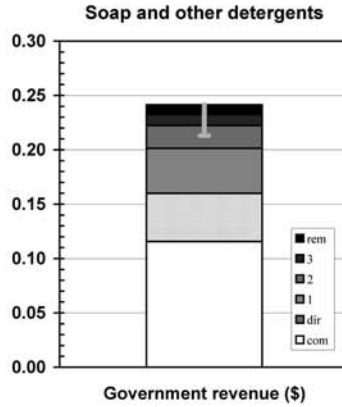
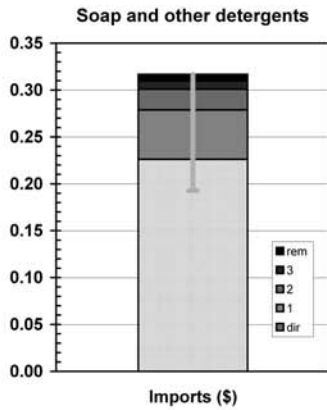
Account #1



Account #2



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 924.9	(0.35% of total)	(\$m 797.5 domestically produced)
Government final consumption	\$m 0.4	(0.00% of total)	(\$m 0.4 domestically produced)
Gross fixed capital expenditure	\$m 2.9	(0.00% of total)	(\$m 2.9 domestically produced)
Net changes in stocks	-\$m 0.8	-(0.04% of total)	
<b>Sectoral GNE</b>	<b>\$m 927.5</b>	<b>(0.20% of GNE)</b>	<b>(\$m 800.1 domestically produced)</b>
Exports	\$m 78.9	(0.09% of total)	(\$m 78.9 domestically produced)
<b>Final demand</b>	<b>\$m 1,006.4</b>	<b>(0.19% of GNT)</b>	<b>(\$m 879.0 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 103.5	(0.06% of total)
Gross operating surplus	\$m 150.4	(0.08% of total)
Taxes less subsidies	\$m 52.3	(0.06% of total)
<b>Sectoral GDP*</b>	<b>\$m 306.1</b>	<b>(0.07% of GDP)</b>
Imports	\$m 266.5	(0.27% of total)
<b>Primary inputs</b>	<b>\$m 572.7</b>	<b>(0.10% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 150.4	(0.08%)	\$m 112.2	(0.14%)
Exports (\$m)	\$m 78.9	(0.09%)	\$m 58.9	(0.17%)
Imports (\$m)	\$m 266.5	(0.27%)	\$m 198.9	(0.29%)
Employment (e-y)	3,825 e-y	(0.05%)	2,854 e-y	(0.12%)
Income (\$m)*	\$m 103.5	(0.06%)	\$m 77.2	(0.13%)
Government revenue (\$m)†	\$m 153.9	(0.14%)	\$m 140.7	(0.20%)
GHG emissions (kt CO <sub>2</sub> -e)	40 kt	(0.01%)	30 kt	(0.15%)
Water use (ML)	1,532 ML	(0.01%)	1,143 ML	(0.09%)
Land disturbance (kha)	1 kha	(0.00%)	1 kha	(0.11%)
Primary energy (TJ)	578 TJ	(0.01%)	432 TJ	(0.17%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.13	0.30	0.38
Exports (\$)	0.07	0.16	0.16
Imports (\$)	0.23	0.32	0.19
Employment (min)	0.40	1.20	1.75
Income (\$)	0.09	0.25	0.34
Government revenue (\$)	0.16	0.24	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.03	0.89	1.02
Water use (L)	1.30	21.34	41.32
Land disturbance (m <sup>2</sup> )	0.01	2.09	3.21
Primary energy (MJ)	0.49	7.47	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

### Structural Paths (intensities - commodities)

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
De	0.128	(0; 42.%)	De	0.405	(0; 34.%)	Bc Mp De	0.183	(2; 21.%)
Pl De	0.0141	(1; 4.6%)	Pl De	0.0751	(1; 6.2%)	Ch De	0.135	(1; 15.%)
Ch De	0.0112	(1; 3.7%)	Wt De	0.0524	(1; 4.4%)	El De	0.0739	(1; 8.3%)
Ms De	0.0104	(1; 3.4%)	Ms De	0.0466	(1; 3.9%)	De	0.0343	(0; 3.9%)
Wt De	0.00728	(1; 2.4%)	Ch De	0.0328	(1; 2.7%)	Ch Pl De	0.0314	(2; 3.5%)
Ts De	0.00403	(1; 1.3%)	Bs De	0.0241	(1; 2.%)	El Ch De	0.0203	(2; 2.3%)
Rd De	0.00324	(1; 1.1%)	Rd De	0.019	(1; 1.6%)	Gd De	0.0188	(1; 2.1%)
Bc Mp De	0.00306	(2; 1.%)	Ts De	0.0182	(1; 1.5%)	El Pl De	0.0164	(2; 1.8%)
El De	0.00299	(1; 0.98%)	Pa De	0.018	(1; 1.5%)	Bc Mp Ch De	0.00736	(3; 0.83%)
Pa De	0.00266	(1; 0.87%)	Bc Mp De	0.0135	(2; 1.1%)	Wt De	0.00726	(1; 0.82%)
Ch Pl De	0.00262	(2; 0.86%)	Ho De	0.0114	(1; 0.95%)	Bc Mp Of De	0.0069	(3; 0.78%)
St De	0.00247	(1; 0.81%)	Mp De	0.0111	(1; 0.93%)	At De	0.00628	(1; 0.71%)
Bs De	0.00244	(1; 0.8%)	Os De	0.0108	(1; 0.9%)	Wo Mp De	0.00627	(2; 0.71%)
Of De	0.00189	(1; 0.62%)	Wh De	0.00865	(1; 0.72%)	Fr Ch De	0.0058	(2; 0.65%)
Cm De	0.00178	(1; 0.59%)	Ch Pl De	0.00764	(2; 0.64%)	Pa De	0.00533	(1; 0.6%)
Wh De	0.00175	(1; 0.58%)	Gd De	0.00745	(1; 0.62%)	Rd De	0.00514	(1; 0.58%)
Rv De	0.00142	(1; 0.47%)	Cg De	0.00674	(1; 0.56%)	El Ch Pl De	0.00473	(3; 0.53%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
De	0.0669	(0; 42.%)	De	0.0878	(0; 35.%)	Bc Mp De	4.84	(2; 23.%)
Ch De	0.0157	(1; 9.9%)	Pl De	0.0152	(1; 6.1%)	Sc Cg De	3.87	(2; 18.%)
Mp De	0.00713	(1; 4.5%)	Wt De	0.0112	(1; 4.5%)	De	1.3	(0; 6.1%)
Wt De	0.00595	(1; 3.8%)	Ms De	0.0108	(1; 4.4%)	Wh De	0.894	(1; 4.2%)
Pl De	0.00408	(1; 2.6%)	Ch De	0.00695	(1; 2.8%)	Wa De	0.793	(1; 3.7%)
Ch Pl De	0.00365	(2; 2.3%)	Ts De	0.00425	(1; 1.7%)	Ch De	0.411	(1; 1.9%)
Wh De	0.00225	(1; 1.4%)	Pa De	0.00413	(1; 1.7%)	El De	0.409	(1; 1.9%)
At De	0.002	(1; 1.3%)	Rd De	0.00327	(1; 1.3%)	Wa Ms De	0.268	(2; 1.3%)
Cg De	0.0018	(1; 1.1%)	Os De	0.00304	(1; 1.2%)	Vf De	0.207	(1; 0.97%)
Ms De	0.00161	(1; 1.%)	Bs De	0.00296	(1; 1.2%)	Wo Mp De	0.203	(2; 0.95%)
Of De	0.00113	(1; 0.71%)	Gd De	0.00209	(1; 0.84%)	Bc Mp Ch De	0.194	(3; 0.91%)
Rd De	0.00113	(1; 0.71%)	Mp De	0.00192	(1; 0.77%)	Vf Pl De	0.186	(2; 0.87%)
Pa De	0.00108	(1; 0.68%)	Ho De	0.00167	(1; 0.67%)	Bc Mp Of De	0.182	(3; 0.85%)
Bl El De	0.000722	(2; 0.46%)	Ch Pl De	0.00162	(2; 0.65%)	Sc Cg Mp De	0.153	(3; 0.72%)
Ts De	0.00064	(1; 0.4%)	Gv De	0.00127	(1; 0.51%)	Sc Cg Bc Mp	0.151	(4; 0.71%)
Ho De	0.000636	(1; 0.4%)	Cg De	0.00116	(1; 0.46%)	Of De	0.119	(1; 0.56%)
St De	0.000613	(1; 0.39%)	Cm De	0.00112	(1; 0.45%)	El Ch De	0.112	(2; 0.53%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$		
De	0.226	(0; 71.%)	De	0.0443	(0; 35.%)	Bc Mp De	1.33	(2; 64.%)
Ch De	0.0157	(1; 4.9%)	Pl De	0.00662	(1; 5.3%)	Wo Mp De	0.151	(2; 7.2%)
Pl De	0.0144	(1; 4.6%)	Wt De	0.00526	(1; 4.2%)	Wh De	0.13	(1; 6.2%)
Pa De	0.00518	(1; 1.6%)	Ms De	0.00515	(1; 4.1%)	Bc Mp Ch De	0.0535	(3; 2.6%)
Ch Pl De	0.00365	(2; 1.2%)	Ch De	0.00347	(1; 2.8%)	Bc Mp Of De	0.0501	(3; 2.4%)
Ms De	0.00237	(1; 0.75%)	Rd De	0.00232	(1; 1.8%)	Bc Ch De	0.0269	(2; 1.3%)
Of De	0.00222	(1; 0.7%)	Pa De	0.00217	(1; 1.7%)	Bc Mp Ho De	0.0165	(3; 0.79%)
Wt De	0.00169	(1; 0.53%)	Ts De	0.00209	(1; 1.7%)	Wh Of De	0.0161	(2; 0.77%)
Ts De	0.00116	(1; 0.37%)	Os De	0.00141	(1; 1.1%)	Wo Tx Pl De	0.0145	(3; 0.69%)
Rd De	0.00082	(1; 0.26%)	Gd De	0.000967	(1; 0.77%)	Bc Mp Ch Pl I	0.0125	(4; 0.6%)
Pc Ch De	0.000699	(2; 0.22%)	Mp De	0.00091	(1; 0.72%)	Bc Mp Pe Mp	0.0114	(4; 0.54%)
Pp Pa De	0.000671	(2; 0.21%)	At De	0.000895	(1; 0.71%)	Wo Tx Tp De	0.00736	(3; 0.35%)
At De	0.000596	(1; 0.19%)	Ho De	0.000879	(1; 0.7%)	De	0.00681	(0; 0.32%)
Bs De	0.000485	(1; 0.15%)	Bs De	0.000876	(1; 0.7%)	Bc Ch Pl De	0.00627	(3; 0.3%)
Ho De	0.000424	(1; 0.13%)	Ch Pl De	0.000808	(2; 0.64%)	Wo Mp Ch De	0.00604	(3; 0.29%)
Pr De	0.000389	(1; 0.12%)	Of De	0.000769	(1; 0.61%)	Wo Mp Of De	0.00566	(3; 0.27%)
Cm De	0.000305	(1; 0.096%)	Cg De	0.000608	(1; 0.48%)	Sc Cg De	0.00508	(2; 0.24%)

### Linkages (average = 1)

	Value	C.o.V.
Upstream	1.122 ±0.019	(±1.7%)
Downstream	0.472 ±0.007	(±1.5%)

# Sector 2506: Cosmetics and Toiletry Preparations (Ct)

*Shampoo, conditioner, sprays, hair colouring, makeup, cream, lotions, polishes, perfume, deodorants and other cosmetics and toiletry preparations*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicators of greenhouse emissions, water use, and land disturbance are 35%, 50% and 85% below average respectively. The social indicators of employment generation and income are 20% and 15% below average respectively, while government revenue is over two times the average. For the financial indicators, operating surplus is 10% below average, while export propensity is equal to average and import penetration 20% above average respectively. The environmental indicators are reduced by the above average imports. When the sector's upstream production processes and post consumer downstream effects are included, the environmental indicators in this sector may warrant more scrutiny.

## Sector Description

In financial terms, the output of the sector is composed of shampoo and hairdressing preparations (35%), facial makeup (24%), hand creams (4%), and perfumes and deodorants (36%). On the assumption that each person uses on average, one half of a kilogram per month of toiletries and cosmetics, current national consumption could be around 120 000 tonnes per year. Producing one tonne of cosmetics and toiletries in a generic sense requires 5 tonnes of water, 2.2 GJ ( $10^9$ J) of energy and produces 200 kg of CO<sub>2</sub> emissions. Because of the wide range and constantly changing nature of personal products from this sector, flexibility of production and packaging lines is increasingly important. The sector's turnover was relatively constant for the period 1970 to 1990 but has risen by more than 50% in the last decade. The financial turnover of the sector in 2002 was around \$1 billion and involved about 100 enterprises.

## Place of Industry in the Economy

The cosmetics and toiletry sector ranks 117<sup>th</sup> out of 135 sectors in terms of value adding in the economy and contributes 0.07% of GDP in this analysis. It is similar in value adding to the cement manufacture and tobacco products sectors. It is a small employer with 3 000 employment years directly embodied in final demand, and another 3 000 years in the sectors upstream suppliers giving a total of 6 000 employment years. In addition, it contributes 1 000 employment years to downstream industries such as hairdressing and personal services. It has small resource requirements with less than one tenth of one percent of national water use, land disturbance, energy use, and greenhouse emissions. In financial terms, the import to export ratio is 2:1.

## Strategic Overview

The spider diagram shows a reasonably well balanced TBL account for cosmetics and toiletries. Production processes will become more complex and open to more scrutiny as the boundaries between personal care and health products become more diffuse. In an upstream sense, the personal care products should limit environmental loadings in their production systems, as well as animal testing. In a downstream sense after use, the products should not have persistent effects on ecosystem chains and water bodies, or effects on human health. Within increasing complexity in the formulation of anti-aging skin creams for example, systematic verification of the composition and its production process becomes more important, but more difficult in extended production chains.

## TBL Account #1

The financial indicator of operating surplus is 10% below average with one half being a direct sector effect and additional contributions from plastics (4%), basic chemicals (3%), marketing (3%), wholesale trade (3%), electricity production (1%) and water supply (1%). The social indicator of employment generation is 20% below average, with a composition similar to the surplus indicator. The environmental indicator of greenhouse emissions is 35% below average and is discussed below.

## TBL Accounts #2 and #3

In the second TBL account, the export propensity is equal to average, the income indicator is 15% below average, and the water use indicator is 50% below average. In the third TBL account, the import penetration indicator is 20% above average, the government revenue indicator is more than two times the average, and the land disturbance indicator is 85% below average. The relatively high level of imports potentially reduces the environmental indicators on a full life cycle basis as some of the physically intensive transactions are undertaken overseas. The import issue is also reflected in the lower than average indicators for employment generation and income.

## Structural Path Analysis and Linkages

Although the greenhouse indicator is below average, market-leading cosmetic manufacturers promote their environmental credentials, and therefore their production chain may require more scrutiny. For emissions, the direct effect is only 2% of the total while most is due to basic chemicals (18%), electricity production (20%), garbage disposal (3%) and beef cattle (gelatin) (2%).

The sector's stimulus to its upstream suppliers is around average and impacts on basic chemicals, plastic products, wholesale trade, and accounting and marketing. The linkages to downstream industries are very weak as most production leaks to private consumption, except for hairdressing.

## Future Trends in Sector

Under the base case scenario of the *Future Dilemmas* study, a population of 25 million in 2050 could see the product requirement from the sector increase by 25% on the assumption that per capita use stays at the currently assumed level of 6 kg per year. Given the fast changing nature of fashion and the cosmetic culture, this is uncertain. Much promotion currently has a focus of families, the young and the beautiful. However, the demographic shift due to population ageing will see a large proportion of consumption power in the so called 'young-old' who have relatively good health and activity levels, affluent lifestyles and might require different and more complex products than the range currently available. In general, the requirements of this mature market are relatively under-researched in many sectors and some initial studies, particularly in food, have uncovered large shifts that potentially render many contemporary marketing and consumption paradigms invalid.

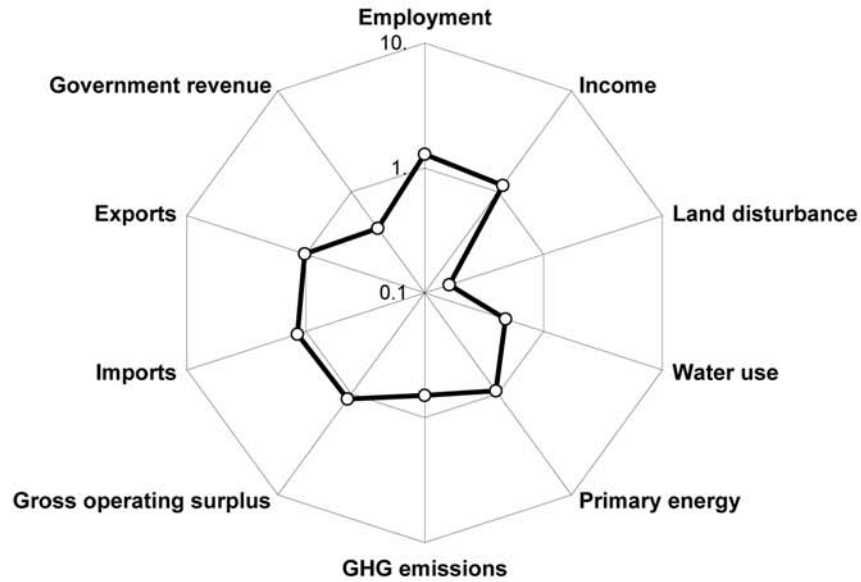
## Innovation and Technical Opportunities

The current literature suggests substantial innovation in four areas. In testing products for skin irritation and allergy, genetic marking techniques used with reconstituted human skin and other human layers will allow the phasing out of animal testing. The use of human molecules such as cholesterol as a framework for surface modification is being developed to deliver protection and recovery treatments for damaged and ageing skin. More advanced products will be capable of delivering biochemical reactions and gene therapy to intermolecular spaces suggesting that skin colour fashions such as whitening or tanning may indeed become more than 'skin deep'. Finally, while much product development will be focused on synthesising new molecules and using genetic markers in testing, cosmetics will also look back to a history of cosmetic use that extends for several thousand years. Ancient natural treatments and substances may still have currency today.

Shampoo, conditioner, sparys, hair colouring, makeup, cream, lotions, polishes, perfume, deodorants and other cosmetics and toiletry preparations

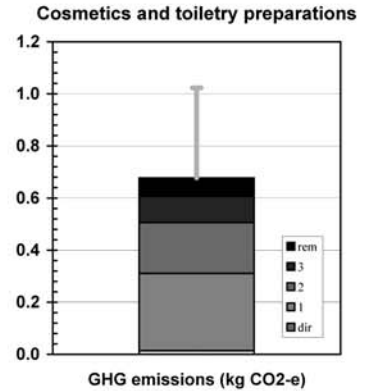
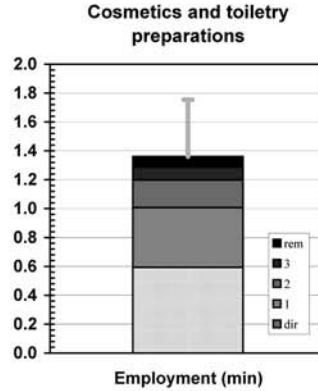
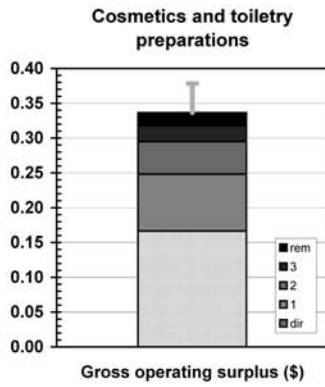
Spider diagram

Cosmetics and toiletry preparations

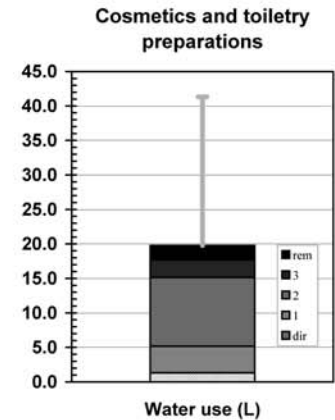
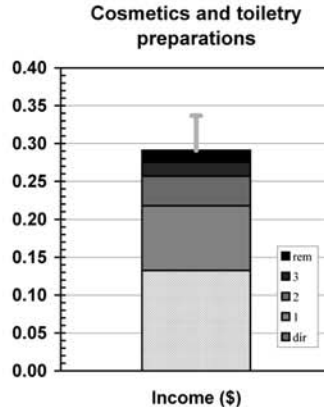
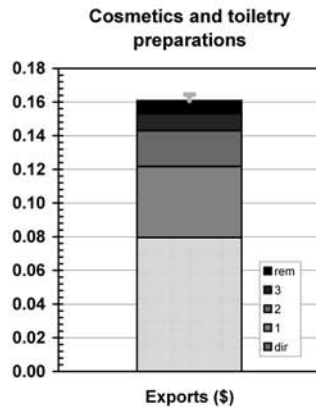


Bar graphs

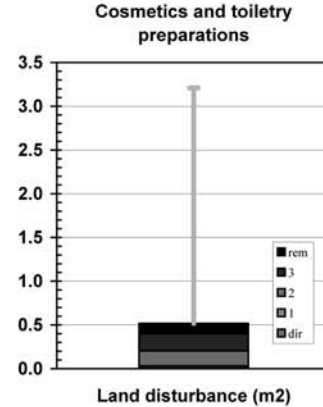
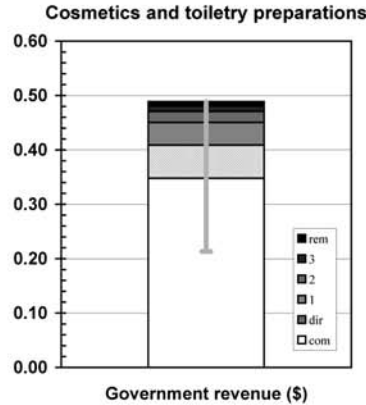
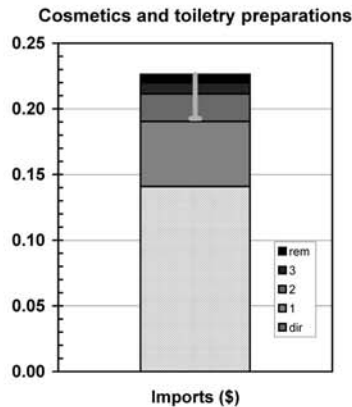
Account #1



Account #2



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 803.9	(0.30% of total)	(\$m 520.3 domestically produced)
Government final consumption	\$m 1.4	(0.00% of total)	(\$m 1.4 domestically produced)
Gross fixed capital expenditure	\$m 0.8	(0.00% of total)	(\$m 0.8 domestically produced)
Net changes in stocks	-\$m 2.3	-(0.13% of total)	
<b>Sectoral GNE</b>	<b>\$m 803.8</b>	<b>(0.17% of GNE)</b>	<b>(\$m 520.8 domestically produced)</b>
Exports	\$m 64.6	(0.08% of total)	(\$m 64.6 domestically produced)
<b>Final demand</b>	<b>\$m 868.5</b>	<b>(0.16% of GNT)</b>	<b>(\$m 585.4 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 107.5	(0.06% of total)
Gross operating surplus	\$m 135.1	(0.07% of total)
Taxes less subsidies	\$m 49.6	(0.06% of total)
<b>Sectoral GDP*</b>	<b>\$m 292.2</b>	<b>(0.07% of GDP)</b>
Imports	\$m 114.5	(0.12% of total)
<b>Primary inputs</b>	<b>\$m 406.7</b>	<b>(0.07% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct (% of national)	total (% of national)
Gross operating surplus (\$m)	\$m 135.1	(0.07%)	\$m 97.6	(0.10%)
Exports (\$m)	\$m 64.6	(0.08%)	\$m 46.7	(0.11%)
Imports (\$m)	\$m 114.5	(0.12%)	\$m 82.7	(0.14%)
Employment (e-y)	3,863 e-y	(0.05%)	2,791 e-y	(0.09%)
Income (\$m)*	\$m 107.5	(0.06%)	\$m 77.7	(0.10%)
Government revenue (\$m)†	\$m 253.7	(0.23%)	\$m 240.0	(0.27%)
GHG emissions (kt CO <sub>2</sub> -e)	11 kt	(0.00%)	8 kt	(0.08%)
Water use (ML)	1,054 ML	(0.01%)	762 ML	(0.06%)
Land disturbance (kha)	1 kha	(0.00%)	0 kha	(0.02%)
Primary energy (TJ)	180 TJ	(0.00%)	130 TJ	(0.11%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.17	0.34	0.38
Exports (\$)	0.08	0.16	0.16
Imports (\$)	0.14	0.23	0.19
Employment (min)	0.59	1.36	1.75
Income (\$)	0.13	0.29	0.34
Government revenue (\$)	0.41	0.49	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.01	0.68	1.02
Water use (L)	1.30	19.79	41.32
Land disturbance (m <sup>2</sup> )	0.01	0.52	3.21
Primary energy (MJ)	0.22	7.12	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

### Structural Paths (intensities - commodities)

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Ct	0.166	(0; 49.%)	Ct	0.593	(0; 44.%)	Ch Ct	0.124	(1; 18.%)
PI Ct	0.0131	(1; 3.9%)	PI Ct	0.0696	(1; 5.1%)	EI Ct	0.105	(1; 15.%)
Ch Ct	0.0103	(1; 3.1%)	Wt Ct	0.0619	(1; 4.5%)	Ch PI Ct	0.0291	(2; 4.3%)
Ms Ct	0.0101	(1; 3.%)	Ms Ct	0.0455	(1; 3.3%)	Gd Ct	0.0213	(1; 3.1%)
Wt Ct	0.00859	(1; 2.6%)	Ch Ct	0.0301	(1; 2.2%)	EI Ch Ct	0.0187	(2; 2.8%)
EI Ct	0.00424	(1; 1.3%)	Ho Ct	0.024	(1; 1.8%)	EI PI Ct	0.0152	(2; 2.2%)
Wa Ct	0.003	(1; 0.89%)	Bs Ct	0.0227	(1; 1.7%)	Ct	0.0136	(0; 2.%)
Ts Ct	0.00295	(1; 0.88%)	Rd Ct	0.0153	(1; 1.1%)	Bc Mp Ct	0.0135	(2; 2.%)
Rd Ct	0.0026	(1; 0.77%)	Ts Ct	0.0133	(1; 0.98%)	Wt Ct	0.00857	(1; 1.3%)
Ch PI Ct	0.00243	(2; 0.72%)	Os Ct	0.012	(1; 0.88%)	Bc Mp Ch Ct	0.00677	(3; 1.%)
Bs Ct	0.0023	(1; 0.68%)	Cg Ct	0.012	(1; 0.88%)	Sc Cg Ct	0.00656	(2; 0.97%)
Et Ct	0.00218	(1; 0.65%)	Et Ct	0.0103	(1; 0.76%)	Fr Ct	0.00635	(1; 0.94%)
Ho Ct	0.00191	(1; 0.57%)	Pa Ct	0.00967	(1; 0.71%)	At Ct	0.00597	(1; 0.88%)
Cg Ct	0.00182	(1; 0.54%)	Gd Ct	0.00842	(1; 0.62%)	Fr Ch Ct	0.00533	(2; 0.79%)
St Ct	0.00181	(1; 0.54%)	Ch PI Ct	0.00708	(2; 0.52%)	Bc Mp Ho Ct	0.00477	(3; 0.7%)
Ne Ct	0.00177	(1; 0.53%)	Sc Cg Ct	0.00661	(2; 0.49%)	Bc Mp Of Ct	0.00473	(3; 0.7%)
St Wt Ct	0.00164	(2; 0.49%)	Ed Ct	0.0063	(1; 0.46%)	EI Ch PI Ct	0.00438	(3; 0.65%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Ct	0.0795	(0; 49.%)	Ct	0.132	(0; 45.%)	Sc Cg Ct	6.87	(2; 35.%)
Ch Ct	0.0144	(1; 9.%)	PI Ct	0.0141	(1; 4.8%)	Wa Ct	2.21	(1; 11.%)
Wt Ct	0.00703	(1; 4.4%)	Wt Ct	0.0133	(1; 4.6%)	Ct	1.3	(0; 6.6%)
PI Ct	0.00378	(1; 2.4%)	Ms Ct	0.0106	(1; 3.6%)	EI Ct	0.58	(1; 2.9%)
Ch PI Ct	0.00338	(2; 2.1%)	Ch Ct	0.0064	(1; 2.2%)	Dc Dp Ct	0.414	(2; 2.1%)
Cg Ct	0.0032	(1; 2.%)	Ho Ct	0.00351	(1; 1.2%)	Ch Ct	0.378	(1; 1.9%)
At Ct	0.0019	(1; 1.2%)	Os Ct	0.00336	(1; 1.2%)	Bc Mp Ct	0.355	(2; 1.8%)
Ms Ct	0.00157	(1; 0.98%)	Ts Ct	0.00311	(1; 1.1%)	Wa Ms Ct	0.261	(2; 1.3%)
Ho Ct	0.00134	(1; 0.83%)	Bs Ct	0.00279	(1; 0.96%)	Bc Mp Ch Ct	0.178	(3; 0.9%)
BI EI Ct	0.00103	(2; 0.64%)	Rd Ct	0.00263	(1; 0.9%)	Ws Ho Ct	0.175	(2; 0.88%)
Rd Ct	0.000905	(1; 0.56%)	Gd Ct	0.00236	(1; 0.81%)	Vf PI Ct	0.173	(2; 0.87%)
Of Ct	0.000777	(1; 0.48%)	Pa Ct	0.00222	(1; 0.76%)	Sc Cg Sc Cg Ct	0.143	(4; 0.72%)
Pa Ct	0.000582	(1; 0.36%)	Cg Ct	0.00206	(1; 0.71%)	Bc Mp Ho Ct	0.126	(3; 0.63%)
Oc Ct	0.000526	(1; 0.33%)	Et Ct	0.00182	(1; 0.63%)	Bc Mp Of Ct	0.125	(3; 0.63%)
Mp Ct	0.000523	(1; 0.33%)	Ed Ct	0.00156	(1; 0.54%)	Vf Ct	0.115	(1; 0.58%)
Om Ct	0.000502	(1; 0.31%)	Ch PI Ct	0.0015	(2; 0.52%)	Dc Dp Ho Ct	0.104	(3; 0.53%)
Wt PI Ct	0.000496	(2; 0.31%)	Ne Ct	0.00138	(1; 0.47%)	EI Ch Ct	0.103	(2; 0.52%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Ct	0.141	(0; 62.%)	Ct	0.061	(0; 43.%)	Bc Mp Ct	0.0978	(2; 19.%)
Ch Ct	0.0144	(1; 6.4%)	Wt Ct	0.00621	(1; 4.4%)	Bc Mp Ch Ct	0.0492	(3; 9.5%)
PI Ct	0.0134	(1; 5.9%)	PI Ct	0.00614	(1; 4.4%)	Bc Mp Ho Ct	0.0347	(3; 6.7%)
Ch PI Ct	0.00339	(2; 1.5%)	Ms Ct	0.00503	(1; 3.6%)	Bc Mp Of Ct	0.0344	(3; 6.6%)
Pa Ct	0.00279	(1; 1.2%)	Ch Ct	0.00319	(1; 2.3%)	Bc Ch Ct	0.0248	(2; 4.8%)
Ms Ct	0.00231	(1; 1.%)	Rd Ct	0.00186	(1; 1.3%)	Wo Tx PI Ct	0.0134	(3; 2.6%)
Wt Ct	0.002	(1; 0.88%)	Ho Ct	0.00185	(1; 1.3%)	Wh Ct	0.0132	(1; 2.6%)
Et Ct	0.00154	(1; 0.68%)	Os Ct	0.00156	(1; 1.1%)	Bc Mp Ch PI Ct	0.0116	(4; 2.2%)
Of Ct	0.00152	(1; 0.67%)	Ts Ct	0.00153	(1; 1.1%)	Wo Mp Ct	0.011	(2; 2.1%)
Ho Ct	0.000891	(1; 0.39%)	Pa Ct	0.00117	(1; 0.83%)	Wh Of Ct	0.011	(2; 2.1%)
Ne Ct	0.000853	(1; 0.38%)	Gd Ct	0.00109	(1; 0.78%)	Sc Cg Ct	0.00902	(2; 1.7%)
Ts Ct	0.000846	(1; 0.37%)	Cg Ct	0.00108	(1; 0.77%)	Ct	0.0065	(0; 1.3%)
Oc Ct	0.000814	(1; 0.36%)	At Ct	0.00085	(1; 0.6%)	Bc Ch PI Ct	0.00581	(3; 1.1%)
Rd Ct	0.000659	(1; 0.29%)	Bs Ct	0.000827	(1; 0.59%)	Wo Mp Ch Ct	0.00556	(3; 1.1%)
Pc Ch Ct	0.000644	(2; 0.28%)	EI Ct	0.000796	(1; 0.56%)	Wo Mp Ho Ct	0.00391	(3; 0.76%)
Sh Ct	0.000629	(1; 0.28%)	Et Ct	0.000761	(1; 0.54%)	Wo Mp Of Ct	0.00388	(3; 0.75%)
At Ct	0.000566	(1; 0.25%)	Ch PI Ct	0.000749	(2; 0.53%)	Wo Tx Tp Ct	0.003	(3; 0.58%)

### Linkages (average = 1)

	Value	C.o.V.
Upstream	1.073 ±0.018	(±1.7%)
Downstream	0.394 ±0.016	(±4.1%)



# Sector 2507: Other Chemical Products (Oc)

*Adhesives, inks, degreasing preparations, waxes and polishes, fuses, explosives and other chemical products*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicators of greenhouse emissions, water use and land disturbance are 25%, 65%, and 80% below average respectively. The social indicators of employment generation and income are 40% and 30% below average respectively, while government revenue is 70% above average. The financial indicators reveal that the operating surplus is 15% below average, while export propensity and import penetration are 40% and 60% above average respectively. Both intermediate inputs to production and consumer products are imported at relatively high levels. Reducing the import penetration may improve the employment, income and operating surplus indicators, but will also increase the energy use and subsequent greenhouse emissions. Import-replacing chemical processes will require large integrated plants with locational and competitive advantage in a globalised marketplace.

## Sector Description

In financial terms, the products of this sector include fuses and explosives (33%), printing inks (14%), adhesives (15%), surface cleaners (10%) and other chemical products (28%). The volume of sales has tripled over the last 30 years in constant dollar terms. The sector had a financial turnover of about \$1.6 billion per annum in 2002 and involved over 150 enterprises.

## Place of Industry in the Economy

The other chemical products sector ranks 99<sup>th</sup> out of 135 sectors in terms of value adding in the economy, and contributes 0.11% of GDP in this analysis. It is similar in value adding to the wine and spirits, and ship building sectors. It is a relatively small employer with around 1 000 employment years directly embodied in final demand, and another 2 000 years in the sector's suppliers giving a total of 3 000 employment years. In addition, the sector contributes 4 000 employment years to the production of downstream industries such as printing and stationery, domestic building, wholesale trade and retail trade. It has relatively low resource requirements with less than one tenth of one percent of national water use, land disturbance, energy use and greenhouse emissions. In financial terms, imports are 50% greater than exports.

## Strategic Overview

The other chemical products sector presents a reasonably good TBL outcome which is influenced by a high levels of imports of intermediate production inputs, as well as final consumption products. The energy and greenhouse outcomes are improved by high levels of imports since physical processing takes place overseas. The social indicators could be improved by more domestic manufacturing, but at the expense of the energy and greenhouse indicators. Upstream issues relate to the safety and sophistication of the manufacturing process, where even small imperfections in the design and management of integrated chemical processing, can give contaminated products and/or emissions and wastes with disposal problems. Downstream issues relate to the safe use of the products, effect on human health, disposal of containers and residues and possible contamination issues. Many chemical processes are intensive in scale, skills and capital. Decisions to manufacture domestically must therefore be harmonised within a framework of global markets and trade politics.

## TBL Account #1

The financial indicator of operating surplus is 15% below average and the direct sector effect is nearly 50%, with additional contributions from basic chemicals(5%), forwarding and storage (4%), wholesale trade (3%), road transport (1%), electricity production (1%), plastic products (1%) and water transport (1%). The social indicator of employment is 40% below average with a similar composition to the surplus indicator. The level of imports is one cause of the low employment multiplier and investment barriers posed by the capital intensive nature of modern chemical plants are also a factor. The environmental indicator of greenhouse emissions is 25% below average and is advantaged by the level of imports, since energy intensive processes are performed outside Australia usually in countries with several centuries of expertise in chemical fabrication.

## TBL Accounts #2 and #3

The second TBL account shows an export propensity that is 40% above average, income that is 30% below average and water use that is 65% below average. The third TBL account shows that the import penetration is 60% above average, government revenue is 70% above average, and land disturbance is 80% below average.

## Structural Path Analysis and Linkages

The low employment and income multipliers are important issues and the structural pathway reveals that the direct sector effect in both cases is 40% with contributions from wholesale trade (5%), basic chemicals (4%), road transport (2%), forwarding and storage (2%), plastic products (2%) and accounting and marketing (2%). Industry sources note the lack of new export orientated developments (only two in the last decade) in contrast to continuing support for some other mature industries in the metal refining sectors.

The sector's stimulus to its upstream suppliers is equal to the economy wide average due partly to the high import penetration. It impacts on basic chemicals, wholesale trade, road transport, forwarding and storage, and accounting and marketing services. The linkages to downstream industries is 60% greater than average and suggests that expansion in the sectors needs to be led by sectors such as printing and newspapers (inks), domestic and non domestic construction (adhesives), defence (explosives), wholesale trade, retail trade and government administration.

## Future Trends in Sector

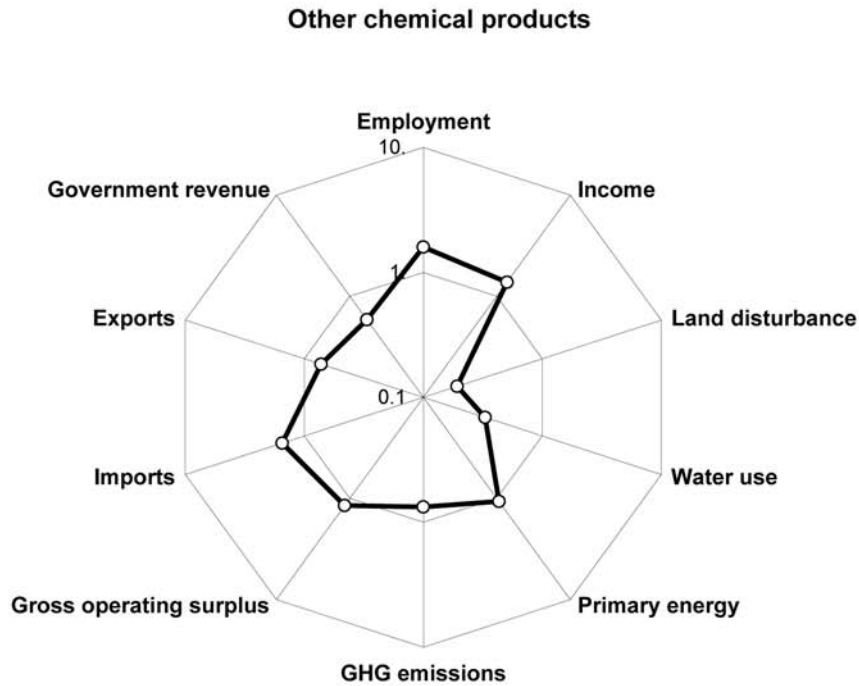
In the base case scenario of the *Future Dilemmas* study, the consumption of some commodities from this sector increase by 50% over the next 50 years. This is probably conservative given the threefold increase in consumption over the past 30 years. However there are major uncertainties. The steady increase in the use of inks depends on paper printing defending its position against e-books and e-newspapers. Phillips of Holland has recently released flexible and scrollable e-paper that could make market inroads around the year 2010. New adhesives may give energy savings of 50-80% compared to traditional bonding processes using a mix of adhesives and rivets to replace traditional metal welds. Major step changes in mineral production in Australia and the Asia Pacific Rim could see moderate growth in explosives production, use, and exports.

## Innovation and Technical Opportunities

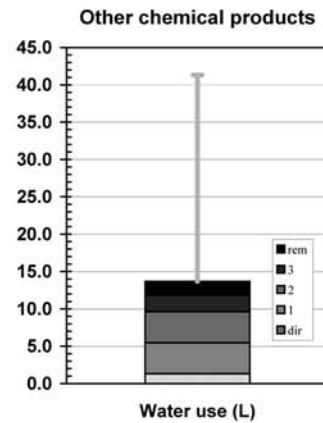
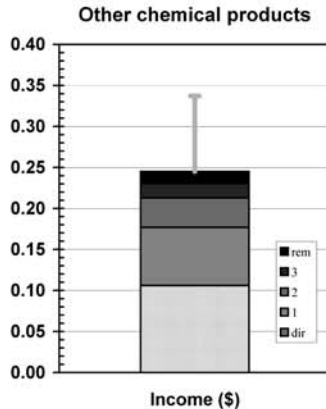
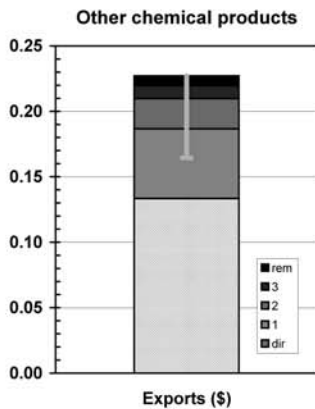
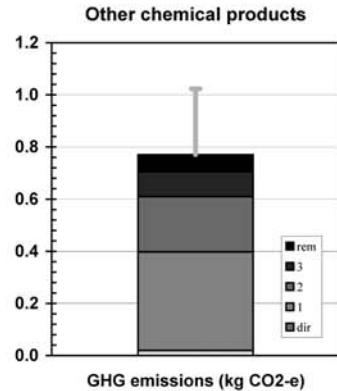
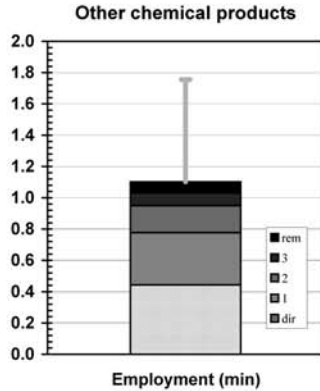
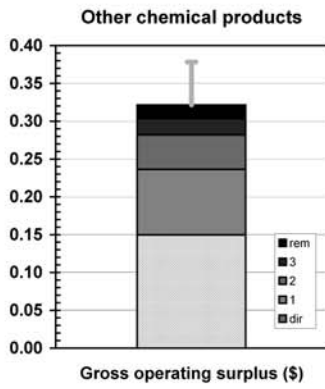
Increasing focus on the 'cradle-to-grave' or 'cradle-to-cradle' life cycle will highlight the sector's energy use in manufacturing, and subsequent downstream effects such as global climate change, and regional acidification and eutrophication processes. The concept of 'green chemistry' in explosives is being applied to 'high energy density materials' which have high stability and safety characteristics, high energy release upon explosion, but little release of toxic metals and inorganic compounds.

Adhesives, inks, degreasing preparations, waxes and polishes, fuses, explosives and other chemical products

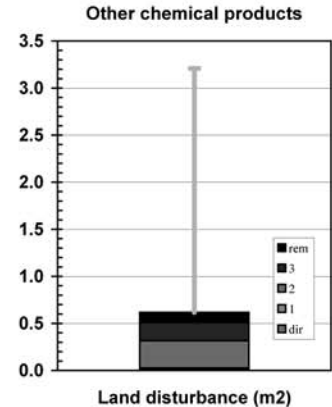
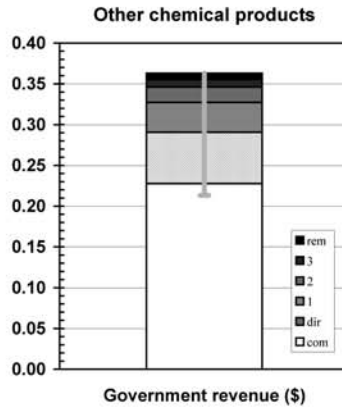
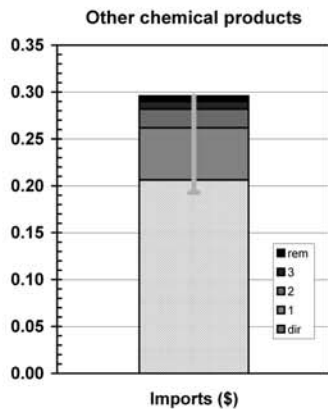
Spider diagram



Bar graphs



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 191.4	(0.07% of total)	(\$m 153.7 domestically produced)
Government final consumption	\$m 0.9	(0.00% of total)	(\$m 0.9 domestically produced)
Gross fixed capital expenditure	\$m 8.4	(0.01% of total)	(\$m 8.4 domestically produced)
Net changes in stocks	\$m 20.5	(1.16% of total)	(\$m 8.0 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 221.2</b>	<b>(0.05% of GNE)</b>	<b>(\$m 171.0 domestically produced)</b>
Exports	\$m 209.6	(0.25% of total)	(\$m 209.6 domestically produced)
<b>Final demand</b>	<b>\$m 430.8</b>	<b>(0.08% of GNT)</b>	<b>(\$m 380.6 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 166.8	(0.10% of total)
Gross operating surplus	\$m 235.5	(0.12% of total)
Taxes less subsidies	\$m 99.0	(0.12% of total)
<b>Sectoral GDP*</b>	<b>\$m 501.3</b>	<b>(0.11% of GDP)</b>
Imports	\$m 324.2	(0.33% of total)
<b>Primary inputs</b>	<b>\$m 825.5</b>	<b>(0.15% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 235.5	(0.12%)	\$m 57.0 (0.03%)	\$m 122.4 (0.06%)
Exports (\$m)	\$m 209.6	(0.25%)	\$m 50.7 (0.06%)	\$m 86.5 (0.10%)
Imports (\$m)	\$m 324.2	(0.33%)	\$m 78.5 (0.08%)	\$m 112.6 (0.12%)
Employment (e-y)	5,576 e-y	(0.08%)	1,350 e-y (0.02%)	3,359 e-y (0.05%)
Income (\$m)*	\$m 166.8	(0.10%)	\$m 40.4 (0.02%)	\$m 93.2 (0.05%)
Government revenue (\$m)†	\$m 185.6	(0.17%)	\$m 110.6 (0.10%)	\$m 138.2 (0.13%)
GHG emissions (kt CO <sub>2</sub> -e)	31 kt	(0.01%)	7 kt (0.00%)	293 kt (0.06%)
Water use (ML)	2,044 ML	(0.01%)	495 ML (0.00%)	5,205 ML (0.02%)
Land disturbance (kha)	1 kha	(0.00%)	0 kha (0.00%)	24 kha (0.01%)
Primary energy (TJ)	556 TJ	(0.01%)	135 TJ (0.00%)	3,118 TJ (0.08%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.15	0.32	0.38
Exports (\$)	0.13	0.23	0.16
Imports (\$)	0.21	0.30	0.19
Employment (min)	0.44	1.10	1.75
Income (\$)	0.11	0.24	0.34
Government revenue (\$)	0.29	0.36	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.02	0.77	1.02
Water use (L)	1.30	13.68	41.32
Land disturbance (m <sup>2</sup> )	0.01	0.62	3.21
Primary energy (MJ)	0.35	8.19	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Oc	0.15	(0; 47.%)	Oc	0.443	(0; 40.%)	Ch Oc	0.173	(1; 22.%)
Ch Oc	0.0144	(1; 4.5%)	Wt Oc	0.0578	(1; 5.2%)	El Oc	0.108	(1; 14.%)
St Oc	0.012	(1; 3.7%)	Ch Oc	0.0421	(1; 3.8%)	El Ch Oc	0.026	(2; 3.4%)
Wt Oc	0.00802	(1; 2.5%)	Rd Oc	0.0273	(1; 2.5%)	Fr Oc	0.0231	(1; 3.%)
Rd Oc	0.00465	(1; 1.4%)	Pl Oc	0.0216	(1; 2.%)	Oc	0.0195	(0; 2.5%)
El Oc	0.00435	(1; 1.4%)	St Oc	0.0196	(1; 1.8%)	Bc Mp Oc	0.0154	(2; 2.%)
Pl Oc	0.00406	(1; 1.3%)	Ho Oc	0.0151	(1; 1.4%)	Bc Mp Ch Oc	0.00945	(3; 1.2%)
Wa Oc	0.00324	(1; 1.%)	Ms Oc	0.0122	(1; 1.1%)	Ch Pl Oc	0.00903	(2; 1.2%)
Ms Oc	0.00271	(1; 0.84%)	Bs Oc	0.0103	(1; 0.94%)	Wt Oc	0.008	(1; 1.%)
Cm Oc	0.00195	(1; 0.61%)	Ts Oc	0.00623	(1; 0.57%)	Fr Ch Oc	0.00745	(2; 0.97%)
Ne Oc	0.00183	(1; 0.57%)	Ne Oc	0.00619	(1; 0.56%)	Rd Oc	0.00738	(1; 0.96%)
St Wt Oc	0.00153	(2; 0.48%)	Wt Ch Oc	0.00558	(2; 0.51%)	Ce Oc	0.00624	(1; 0.81%)
Sg Oc	0.00139	(1; 0.43%)	Fm Oc	0.00549	(1; 0.5%)	Ga Oc	0.00578	(1; 0.75%)
Ts Oc	0.00138	(1; 0.43%)	Cm Oc	0.00538	(1; 0.49%)	Is Oc	0.00553	(1; 0.72%)
Pt Oc	0.00134	(1; 0.42%)	Ms Wt Oc	0.00521	(2; 0.47%)	Gd Oc	0.00538	(1; 0.7%)
Rv Oc	0.00132	(1; 0.41%)	Os Oc	0.00505	(1; 0.46%)	Pc Oc	0.00515	(1; 0.67%)
Ho Oc	0.00121	(1; 0.38%)	Eq Oc	0.005	(1; 0.45%)	El St Oc	0.005	(2; 0.65%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Oc	0.133	(0; 59.%)	Oc	0.106	(0; 43.%)	Wa Oc	2.38	(1; 17.%)
Ch Oc	0.0201	(1; 8.9%)	Wt Oc	0.0124	(1; 5.1%)	Oc	1.3	(0; 9.5%)
Wt Oc	0.00656	(1; 2.9%)	Ch Oc	0.00893	(1; 3.6%)	Sc Cg Oc	0.607	(2; 4.4%)
St Oc	0.00298	(1; 1.3%)	St Oc	0.005	(1; 2.%)	El Oc	0.595	(1; 4.4%)
Rd Oc	0.00162	(1; 0.71%)	Rd Oc	0.0047	(1; 1.9%)	Su Fd Oc	0.564	(2; 4.1%)
Fd Oc	0.00128	(1; 0.56%)	Pl Oc	0.00437	(1; 1.8%)	Ch Oc	0.528	(1; 3.9%)
Pc Oc	0.00122	(1; 0.53%)	Ms Oc	0.00283	(1; 1.2%)	Bc Mp Oc	0.406	(2; 3.%)
Pl Oc	0.00117	(1; 0.52%)	Ho Oc	0.00221	(1; 0.9%)	Dc Dp Oc	0.27	(2; 2.%)
Bl El Oc	0.00105	(2; 0.46%)	Ts Oc	0.00146	(1; 0.6%)	Bc Mp Ch Oc	0.249	(3; 1.8%)
Ch Pl Oc	0.00105	(2; 0.46%)	Ne Oc	0.00142	(1; 0.58%)	Ri Fc Oc	0.236	(2; 1.7%)
Eq Oc	0.000892	(1; 0.39%)	Os Oc	0.00141	(1; 0.58%)	El Ch Oc	0.144	(2; 1.1%)
Ho Oc	0.000842	(1; 0.37%)	El Oc	0.00131	(1; 0.53%)	Wo Tx Oc	0.141	(2; 1.%)
At Oc	0.00079	(1; 0.35%)	Bs Oc	0.00126	(1; 0.52%)	Wa Ch Oc	0.128	(2; 0.94%)
Oi Pc Oc	0.000767	(2; 0.34%)	Cm Oc	0.00122	(1; 0.5%)	Bc Ch Oc	0.125	(2; 0.92%)
Sg Oc	0.000691	(1; 0.3%)	Ms Wt Oc	0.00121	(2; 0.5%)	Ws Ho Oc	0.11	(2; 0.81%)
Tx Oc	0.00067	(1; 0.3%)	Wt Ch Oc	0.0012	(2; 0.49%)	Bc Mp Ho Oc	0.0792	(3; 0.58%)
Wt Ch Oc	0.000634	(2; 0.28%)	Bk Oc	0.00117	(1; 0.48%)	Sc Cg Ch Oc	0.0763	(3; 0.56%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$		
Oc	0.206	(0; 70.%)	Oc	0.063	(0; 46.%)	Bc Mp Oc	0.112	(2; 18.%)
Ch Oc	0.0201	(1; 6.8%)	Wt Oc	0.00579	(1; 4.3%)	Wo Tx Oc	0.105	(2; 17.%)
Pl Oc	0.00415	(1; 1.4%)	Ch Oc	0.00445	(1; 3.3%)	Bc Mp Ch Oc	0.0687	(3; 11.%)
Pc Oc	0.00258	(1; 0.87%)	Rd Oc	0.00333	(1; 2.5%)	Bc Ch Oc	0.0346	(2; 5.6%)
Wt Oc	0.00186	(1; 0.63%)	St Oc	0.00267	(1; 2.%)	Bc Mp Ho Oc	0.0218	(3; 3.5%)
Pt Oc	0.00146	(1; 0.49%)	Pl Oc	0.00191	(1; 1.4%)	Wo Mp Oc	0.0126	(2; 2.%)
Rd Oc	0.00118	(1; 0.4%)	Ms Oc	0.00134	(1; 0.99%)	Bc Mp Fd Oc	0.0101	(3; 1.6%)
St Oc	0.00109	(1; 0.37%)	Ho Oc	0.00116	(1; 0.86%)	Wo Mp Ch Oc	0.00776	(3; 1.3%)
Pa Oc	0.00106	(1; 0.36%)	El Oc	0.000816	(1; 0.6%)	Fr Oc	0.00741	(1; 1.2%)
Ch Pl Oc	0.00105	(2; 0.36%)	Ts Oc	0.000718	(1; 0.53%)	Oc	0.00637	(0; 1.%)
Pc Ch Oc	0.000898	(2; 0.3%)	Ne Oc	0.000712	(1; 0.52%)	Wo Tx Tp Oc	0.0045	(3; 0.73%)
Ne Oc	0.000881	(1; 0.3%)	Wa Oc	0.000699	(1; 0.52%)	Wh Fd Oc	0.00442	(2; 0.72%)
Ms Oc	0.000616	(1; 0.21%)	Os Oc	0.000656	(1; 0.48%)	Wo Tx Pl Oc	0.00417	(3; 0.67%)
Eq Oc	0.00059	(1; 0.2%)	Bk Oc	0.000649	(1; 0.48%)	Wh Oc	0.00385	(1; 0.62%)
Ho Oc	0.000562	(1; 0.19%)	Cm Oc	0.000583	(1; 0.43%)	Bc Mp Ch Pl C	0.00359	(4; 0.58%)
Wa Oc	0.000492	(1; 0.17%)	Ms Wt Oc	0.000576	(2; 0.42%)	Wo Ch Oc	0.00341	(2; 0.55%)
Fo Oc	0.000477	(1; 0.16%)	Wt Ch Oc	0.00056	(2; 0.41%)	Wo Mp Ho Oc	0.00247	(3; 0.4%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.022 ±0.017	(±1.7%)
Downstream	1.602 ±0.021	(±1.3%)

# Sector 2508: Rubber Products (Ru)

*Tyres, tubes, gloves, belting, pipes, hoses, sheets, strips, profile shapes, rubber vessels, mattresses, sponges, foam rubber and other rubber products*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions, water use and land disturbance are respectively 45%, 80% and 80% below average. The social indicator of employment generation is 25% below average, income is 10% below average and government revenue is nearly three times the average. The financial indicator of operating surplus is 35% below average, export propensity is 20% below average and import penetration is 50% above average. Diversion of used tyres from landfill will facilitate moves to life cycle stewardship of rubber products, with increased recycling and co-firing in industrial furnaces.

## Sector Description

The rubber products sector makes vehicle tyres, rubber hoses, floor tiles, rubber mattresses and machine belts. Australia consumes about 200 000 tonnes of rubber per year and around one half of this is tyres. There are about 45 million tyres on the road, 18 million are disposed of each year, and 18 million new tyres are purchased. Annually, about 6 million tyres are manufactured domestically by two manufacturers, with the remaining 12 million imported by nearly 70 importers. A used tyre weighing 8.5 kg has the energy equivalent of 6 litres of petrol or diesel embodied in it. On a per kilogram basis it has the energy equivalent of black coal (27 MJ/kg), but with 15% less CO<sub>2</sub> emissions when combusted. Germany is stopping the land filling of tyres completely in 2005. It will then dispose of 900 000 tonnes of tyres annually by retreading (21%), recycling (18%), cement kilns and other combustion (60%). The turnover of the rubber products sector was about \$1.5 billion in 2002, split equally between vehicle tyres and other rubber products.

## Place of Industry in the Economy

The rubber products sector ranks 95<sup>th</sup> out of 135 sectors in terms of value adding in the economy, and contributes 0.12% of GDP in this analysis. It is similar in value adding to the glass and glass products sector and the concrete and mortar sector. It is a relatively small employer with 2 000 employment years directly embodied in final demand, and another 2 000 employment years in the sector's suppliers giving a total of 4 000 employment years. In addition, the sector supplies nearly 6 000 employment years to downstream industries such as motor vehicle manufacturing, wholesale trade, road transport, government administration, and defence. The sector has relatively small resource requirements with less than one tenth of one percent of national water use, land disturbance, energy use, and greenhouse emissions. The import to export ratio is more than 3:1.

## Strategic Overview

The integrated overview shown in the spider diagram presents reasonable outcomes for the social and environmental areas, but there may be some challenges for the financial indicators. The environmental indicators are below average and for the energy and emissions indicators, the sector is advantaged by high imports as the physical transactions of manufacture occur elsewhere. The downstream issues for tyres in particular, focus on the contamination caused by tyre wear on roads, when heavy metals such as zinc enter the storm water flow after rainfall. This is particularly so after long dry periods when pulses of contaminants can occur. If domestic tyre plants could remain internationally competitive, any improvements in the financial and employment indicators may also be accompanied by increases in energy use and greenhouse emissions in the production chain.

## TBL Account #1

The financial indicator of operating surplus is 35% below average with half of this being a direct sector effect with contributions from basic chemicals (4%), wholesale trade (3%), technical services (2%), electricity production (2%), legal and accounting (2%) and road transport (1%). The social indicator of employment generation is 25% below average with a composition similar to the surplus indicator. The environmental indicator of greenhouse emissions is 45% below average and this, together with the lower than average employment multiplier, is due mainly to the high level of imports. Water use and land disturbance are also underestimates as all virgin rubber is imported.

## TBL Accounts #2 and #3

The second TBL account shows that the export propensity is 20% below average, income is 10% below average, and water use is 80% below average. The third TBL account shows that import penetration is 50% above average, government revenue is 2.7 times the average and land disturbance is 80% below average. The government revenue figure is due to a tariff on imported tyres set at 15% in this data but decreasing to 10% after 2005. Domestic industry sources note that preferential tariffs for tyre plants in developing countries aid their main competitors. Some countries maintain non-tariff barriers which limit the export competitiveness of Australian made tyres. Domestic sources also promote strategic geopolitical reasons for maintaining tyre manufacturing in Australia, and as essential inputs for domestic car manufacturing. This TBL account reflects the current realities of low profits, high imports and an industry facing strong international competition.

## Structural Path Analysis and Linkages

When the structural paths of the financial indicators are examined, the direct sector effect dominates in all cases being 46%, 49%, and 76% for operating surplus, export propensity and import penetration respectively. The high level of imports stimulated by larger scales of production and cheaper costs in other countries, perhaps the process of globalisation in a more generic sense, seems to be the main issue behind the lower than average financial indicators. Industry sources note that specific areas of domestic tyre manufacturing can remain viable, provided that prices of raw materials are contained and labour practices of the manufacturing workforce improved.

The sector's stimulus to its upstream suppliers is 20% below the economy wide average due mainly to imports. Stronger linkages are basic chemicals, wholesale trade, and the legal, accounting and marketing sector. The linkages to downstream industries are 30% above average and suggest that expansion of this sector must be led by expansion in motor vehicle manufacturing, wholesale trade, road transport, government administration and defence activities.

## Future Trends in Sector

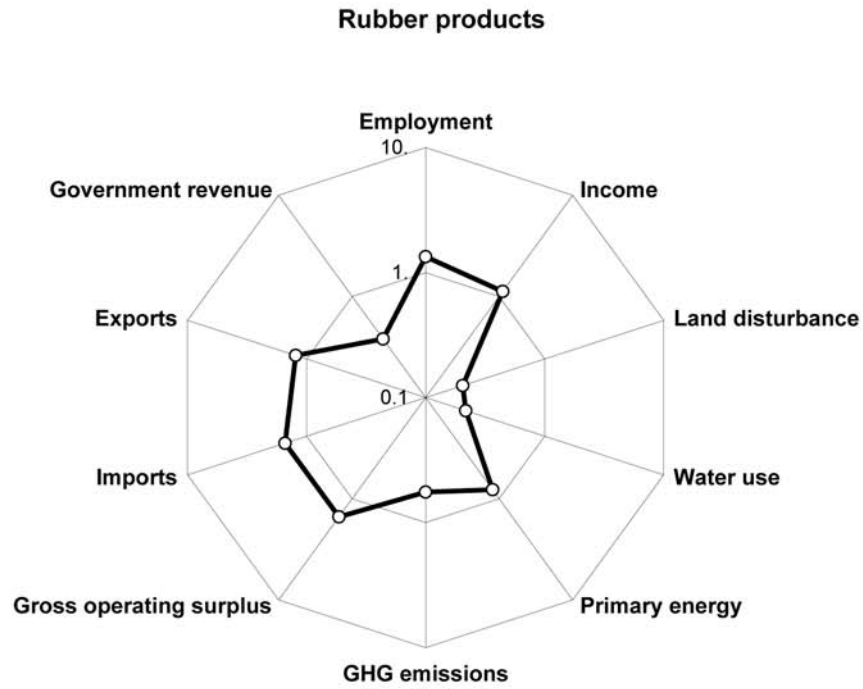
Under the base case scenario of the *Future Dilemmas* study, the number of cars and kilometres driven may both expand by 40% by the year 2051. This could imply that the annual requirements will expand to 25 million tyre equivalents over the next 50 years. There are four issues that could reduce this requirement. Innovation could produce wear resistant tyres, congestion taxes in major cities could reduce car numbers, recycling technologies could reduce the requirement for virgin materials, and urban transport systems may substitute for private vehicles.

## Innovation and Technical Opportunities

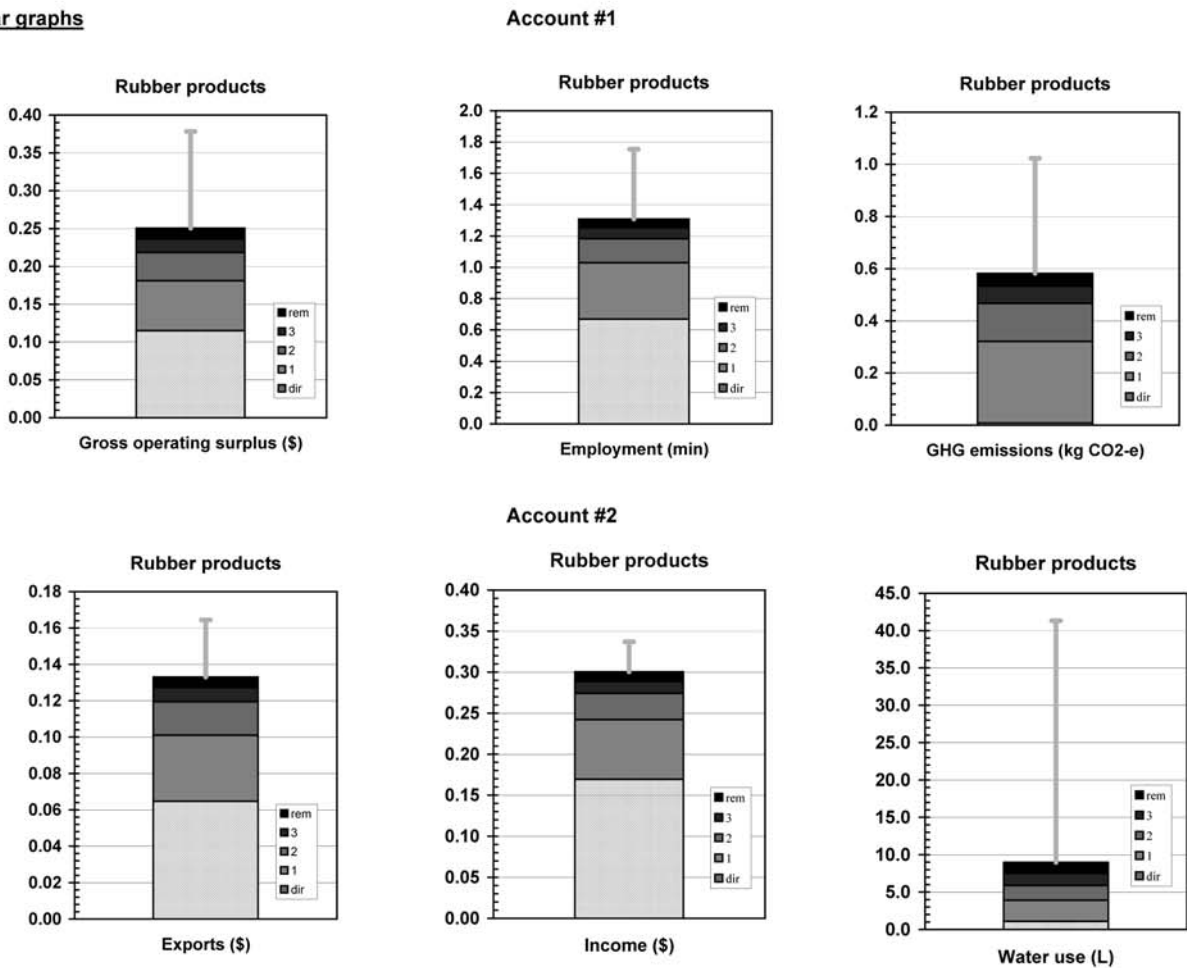
Intelligent tyres now in production have embedded wireless sensors linked to the vehicle's management systems that over-ride the driver's actions in dangerous situations. Now that full life cycle analyses are available, selling the service of mobility (through tyres) will allow a manufacturer to manage a vehicle's tyres on a 'cradle to cradle' basis, with least environmental impact.

Tyres, tubes, gloves, belting, pipes, hoses, sheets, strips, profile shapes, rubber vessels, mattresses, sponges, foam rubber and other rubber products

Spider diagram

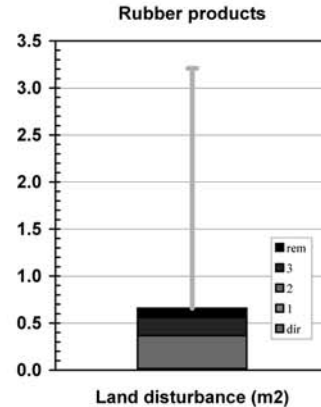
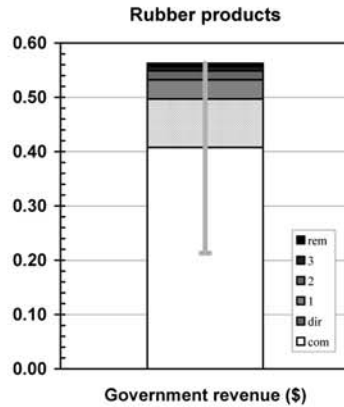
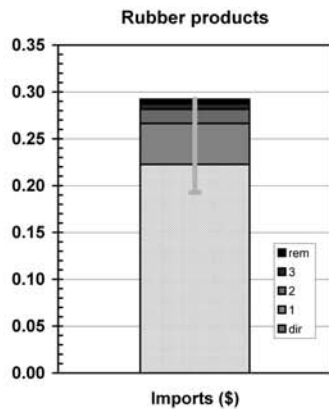


Bar graphs





Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 424.6	(0.16% of total)	(\$m 252.1 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 18.8	(0.02% of total)	(\$m 15.4 domestically produced)
Net changes in stocks	\$m 28.6	(1.62% of total)	(\$m 14.0 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 472.0</b>	<b>(0.10% of GNE)</b>	<b>(\$m 281.5 domestically produced)</b>
Exports	\$m 92.6	(0.11% of total)	(\$m 92.6 domestically produced)
Final demand	\$m 564.7	(0.10% of GNT)	(\$m 374.2 domestically produced)

**Costs: GNT(I) - industries**

Wages and salaries	\$m 242.3	(0.14% of total)
Gross operating surplus	\$m 164.6	(0.09% of total)
Taxes less subsidies	\$m 127.6	(0.15% of total)
<b>Sectoral GDP*</b>	<b>\$m 534.5</b>	<b>(0.12% of GDP)</b>
Imports	\$m 318.8	(0.33% of total)
<b>Primary inputs</b>	<b>\$m 853.2</b>	<b>(0.16% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 164.6	(0.09%)	\$m 43.0 (0.02%)	\$m 93.8 (0.05%)
Exports (\$m)	\$m 92.6	(0.11%)	\$m 24.2 (0.03%)	\$m 49.8 (0.06%)
Imports (\$m)	\$m 318.8	(0.33%)	\$m 83.3 (0.09%)	\$m 109.3 (0.11%)
Employment (e-y)	7,675 e-y	(0.11%)	2,006 e-y (0.03%)	3,924 e-y (0.06%)
Income (\$m)*	\$m 242.3	(0.14%)	\$m 63.3 (0.04%)	\$m 112.4 (0.07%)
Government revenue (\$m)†	\$m 280.1	(0.26%)	\$m 185.9 (0.17%)	\$m 210.5 (0.19%)
GHG emissions (kt CO <sub>2</sub> -e)	11 kt	(0.00%)	3 kt (0.00%)	218 kt (0.04%)
Water use (ML)	1,542 ML	(0.01%)	403 ML (0.00%)	3,362 ML (0.02%)
Land disturbance (kha)	1 kha	(0.00%)	0 kha (0.00%)	25 kha (0.02%)
Primary energy (TJ)	168 TJ	(0.00%)	44 TJ (0.00%)	2,334 TJ (0.06%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.11	0.25	0.38
Exports (\$)	0.06	0.13	0.16
Imports (\$)	0.22	0.29	0.19
Employment (min)	0.67	1.31	1.75
Income (\$)	0.17	0.30	0.34
Government revenue (\$)	0.50	0.56	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.01	0.58	1.02
Water use (L)	1.08	8.99	41.32
Land disturbance (m <sup>2</sup> )	0.01	0.66	3.21
Primary energy (MJ)	0.12	6.24	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Ru	0.115	(0; 46.%)	Ru	0.669	(0; 51.%)	El Ru	0.139	(1; 24.%)
Ch Ru	0.00955	(1; 3.8%)	Bs Ru	0.0536	(1; 4.1%)	Ch Ru	0.114	(1; 20.%)
Wt Ru	0.00744	(1; 3.%)	Wt Ru	0.0535	(1; 4.1%)	Gd Ru	0.0253	(1; 4.3%)
Ts Ru	0.00566	(1; 2.3%)	Ch Ru	0.0278	(1; 2.1%)	El Ch Ru	0.0172	(2; 3.%)
El Ru	0.00564	(1; 2.2%)	Ts Ru	0.0255	(1; 1.9%)	Wo Tx Ru	0.013	(2; 2.2%)
Bs Ru	0.00543	(1; 2.2%)	Ms Ru	0.0212	(1; 1.6%)	Ru	0.008	(0; 1.4%)
Ms Ru	0.00473	(1; 1.9%)	Rd Ru	0.0202	(1; 1.5%)	Wt Ru	0.00742	(1; 1.3%)
Rd Ru	0.00344	(1; 1.4%)	Os Ru	0.0175	(1; 1.3%)	Bc Mp Ch Ru	0.00625	(3; 1.1%)
Rh Ru	0.002	(1; 0.8%)	Rh Ru	0.0122	(1; 0.93%)	Rd Ru	0.00546	(1; 0.94%)
St Ru	0.0017	(1; 0.68%)	Gd Ru	0.01	(1; 0.76%)	Fr Ch Ru	0.00492	(2; 0.85%)
Ne Ru	0.00151	(1; 0.6%)	Ps Ru	0.00981	(1; 0.75%)	Bl El Ru	0.00351	(2; 0.6%)
Pl Ru	0.00149	(1; 0.59%)	Pl Ru	0.00792	(1; 0.61%)	Ch Pl Ru	0.00331	(2; 0.57%)
St Wt Ru	0.00142	(2; 0.57%)	El Ru	0.00627	(1; 0.48%)	El Bs Ru	0.00331	(2; 0.57%)
Cm Ru	0.00127	(1; 0.51%)	Tp Ru	0.00602	(1; 0.46%)	Bc Ch Ru	0.00314	(2; 0.54%)
Wa Ru	0.00108	(1; 0.43%)	Ne Ru	0.00512	(1; 0.39%)	Pc Ru	0.00277	(1; 0.48%)
Ms Wt Ru	0.00108	(2; 0.43%)	Ms Wt Ru	0.00483	(2; 0.37%)	Is Ru	0.00247	(1; 0.42%)
Wo Tx Ru	0.00092	(2; 0.37%)	Ee Ru	0.00407	(1; 0.31%)	El Wt Ru	0.00223	(2; 0.38%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Ru	0.0647	(0; 49.%)	Ru	0.169	(0; 56.%)	Ru	1.08	(0; 12.%)
Ch Ru	0.0133	(1; 10.%)	Wt Ru	0.0115	(1; 3.8%)	Wa Ru	0.796	(1; 8.9%)
Wt Ru	0.00608	(1; 4.6%)	Bs Ru	0.00657	(1; 2.2%)	El Ru	0.771	(1; 8.6%)
Tx Ru	0.002	(1; 1.5%)	Ts Ru	0.00597	(1; 2.%)	Vf Ru	0.598	(1; 6.7%)
Bl El Ru	0.00136	(2; 1.%)	Ch Ru	0.00591	(1; 2.%)	Wo Tx Ru	0.422	(2; 4.7%)
Rd Ru	0.0012	(1; 0.9%)	Ms Ru	0.00494	(1; 1.6%)	Ch Ru	0.349	(1; 3.9%)
Wo Tx Ru	0.00116	(2; 0.87%)	Os Ru	0.00489	(1; 1.6%)	Sc Cg Tx Ru	0.2	(3; 2.2%)
Bs Ru	0.00101	(1; 0.76%)	Rd Ru	0.00348	(1; 1.2%)	Bc Mp Ch Ru	0.165	(3; 1.8%)
Ts Ru	0.000899	(1; 0.68%)	Gd Ru	0.0028	(1; 0.93%)	Wa Bs Ru	0.164	(2; 1.8%)
Nf Ru	0.000854	(1; 0.64%)	El Ru	0.0017	(1; 0.56%)	Wa Ms Ru	0.122	(2; 1.4%)
Ms Ru	0.000733	(1; 0.55%)	Pl Ru	0.0016	(1; 0.53%)	El Ch Ru	0.0952	(2; 1.1%)
At Ru	0.000672	(1; 0.5%)	Rh Ru	0.00134	(1; 0.44%)	Wa Ch Ru	0.0848	(2; 0.94%)
Ee Ru	0.000655	(1; 0.49%)	Ne Ru	0.00117	(1; 0.39%)	Bc Ch Ru	0.0829	(2; 0.92%)
Pc Ru	0.000655	(1; 0.49%)	Ms Wt Ru	0.00112	(2; 0.37%)	Sc Cg Wo Tx	0.079	(4; 0.88%)
Tp Ru	0.000454	(1; 0.34%)	Ed Ru	0.0009	(1; 0.3%)	Wa Ts Ru	0.0764	(2; 0.85%)
Pl Ru	0.000431	(1; 0.32%)	Tx Ru	0.000839	(1; 0.28%)	Sc Cg Vf Ru	0.0621	(3; 0.69%)
St Ru	0.00042	(1; 0.32%)	Tp Ru	0.000809	(1; 0.27%)	Sc Cg Ch Ru	0.0505	(3; 0.56%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Ru	0.223	(0; 76.%)	Ru	0.0891	(0; 57.%)	Wo Tx Ru	0.313	(2; 48.%)
Ch Ru	0.0133	(1; 4.6%)	Wt Ru	0.00537	(1; 3.5%)	Bc Mp Ch Ru	0.0455	(3; 6.9%)
Wt Ru	0.00173	(1; 0.59%)	Ch Ru	0.00295	(1; 1.9%)	Wo Tx Tp Ru	0.0323	(3; 4.9%)
Ts Ru	0.00163	(1; 0.56%)	Ts Ru	0.00294	(1; 1.9%)	Bc Ch Ru	0.0229	(2; 3.5%)
Pl Ru	0.00152	(1; 0.52%)	Rd Ru	0.00247	(1; 1.6%)	Ru	0.00645	(0; 0.98%)
Pc Ru	0.00139	(1; 0.48%)	Ms Ru	0.00235	(1; 1.5%)	Bc Mp Lp Ru	0.00556	(3; 0.84%)
Bs Ru	0.00108	(1; 0.37%)	Os Ru	0.00227	(1; 1.5%)	Wo Mp Ch Ru	0.00513	(3; 0.78%)
Ms Ru	0.00108	(1; 0.37%)	Bs Ru	0.00195	(1; 1.3%)	Bc Mp Ho Ru	0.00382	(3; 0.58%)
Tp Ru	0.00104	(1; 0.36%)	Gd Ru	0.0013	(1; 0.84%)	Wo Lp Ru	0.00288	(2; 0.44%)
Rh Ru	0.00103	(1; 0.35%)	El Ru	0.00106	(1; 0.68%)	Gd Ru	0.00238	(1; 0.36%)
Rd Ru	0.000871	(1; 0.3%)	Pl Ru	0.000699	(1; 0.45%)	Wo Ch Ru	0.00225	(2; 0.34%)
Ne Ru	0.000727	(1; 0.25%)	Rh Ru	0.000613	(1; 0.4%)	El Ru	0.00225	(1; 0.34%)
Ee Ru	0.00064	(1; 0.22%)	Tx Ru	0.000597	(1; 0.38%)	Wo Tx Wt Ru	0.00191	(3; 0.29%)
Pc Ch Ru	0.000594	(2; 0.2%)	Ne Ru	0.000588	(1; 0.38%)	Fr Ch Ru	0.00158	(2; 0.24%)
Fo Ru	0.000571	(1; 0.2%)	Ms Wt Ru	0.000534	(2; 0.34%)	Wo Tx Pl Ru	0.00153	(3; 0.23%)
Os Ru	0.000392	(1; 0.13%)	Pd Wt Ru	0.000505	(2; 0.33%)	Wo Os Ru	0.00138	(2; 0.21%)
El Ru	0.000391	(1; 0.13%)	Cm Ru	0.000381	(1; 0.25%)	Bc Mp Ch Pl F	0.00132	(4; 0.2%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	0.854 ±0.014	(±1.6%)
Downstream	1.348 ±0.020	(±1.5%)

# Sector 2509: Plastic Products (PI)

*Plastic bottles, pipes, plates, bags, floor coverings, tanks and fittings*

## Short Summary

The plastic products sector provides reasonable environmental indicators with greenhouse emissions equal to average and water use and land disturbance are 70% and 80% below average respectively. Most of the effect is indirect, so improvement efforts should focus on the supply chain. The social indicators show employment generation is 20% below average, while income is 10% below average and government revenue is 30% above average. The financial indicators show that operating surplus is 20% below average, export propensity is 5% below average while import penetration is 30% above average (due mainly to imports of resin feedstocks). Increase in consumer demand for plastics gives an average stimulus to its upstream suppliers, particularly basic chemicals and wholesale trade. The sector shows strong downstream linkages to wholesale trade, dairy products and communication services. Supply chain improvements to reduce the greenhouse indicator should focus on the origin of the chemical feedstocks, and the carbon intensity of the electricity used. The import penetration indicator could be improved by sourcing key chemical feedstocks locally, at competitive prices and with a low greenhouse content. Pollution and waste issues are important but are outside the scope of this analysis. Inevitably the final consumer must share the responsibility for plastics. Education, regulation and resource levies all have a part in post-consumer plastics waste.

## Sector Description

The sector produces a wide range of plastic products based on eight key resin materials made from refinery by-products and from ethane piped directly from the Cooper Basin in South Australia. The total yearly consumption of plastics in Australia is in excess of 1.5 million tonnes or 76 kg per capita. About 50% of yearly consumption ends up in landfill, 10% is recovered for recycling and 40% accumulates in the national plastics stock as component of houses, cars and offices etc. Total local resin production is 800 000 tonnes, 700 000 tonnes is imported, 70 000 tonnes is exported and 120 000 tonnes is recycled. Worldwide, yearly plastics production is about 80 million tonnes.

## Place of Industry in the Economy

The plastic products sector gives a moderate contribution to value adding in the economy and ranks 43<sup>rd</sup> out of 135 sectors with a contribution of 0.47% to GDP in this analysis. The sector is a small employment generator with a direct requirement of 7 000 employment years and another 7 000 years in the sector's suppliers, giving a total of 14 000 employment years. In addition, the sector contributes 28 000 employment years to the final demand of downstream sectors such as road transport, motor vehicle manufacture and government administration. The sector's requirement for water and land are less than one tenth of one percent of national total, while energy use and greenhouse emissions are about one third of one percent of national totals. In financial terms, imports outweigh exports by a factor of three.

## Strategic Overview

The integrated overview provided by the spider diagram shows a reasonably balanced TBL outcome with one outlier for energy use and some below average outcomes in social and financial areas. Plastics have replaced many traditional materials such as glass, wood, metal and natural fabrics in a wide range of domestic and commercial applications. Downstream concerns directed at plastics in post-consumer waste may eventually lead to product levies and increased recycling, or to directing used plastics to energy production particularly for use as a fuel oil substitute.

## TBL Account #1

The financial indicator of operating surplus is 20% below average with one half a direct effect and the remainder due to the supply chain. Employment generation is also 20% below average with half being a direct effect. The greenhouse emissions indicator is equal to average with only 2% due to direct fuel combustion within the plastics factory. A range of first order suppliers such as basic chemicals (32%), electricity production (17%), waste services returning recycled material (2%) and wholesale trade (1%) contribute over one half of the greenhouse indicator. The greenhouse indicator could be improved by replacing coal fired electricity with local gas turbine electricity or combined heat and power (CHP) plants partly fuelled by industrial and consumer waste.

## TBL Accounts #2 and #3

In the second TBL account, export propensity is 5% below average with one quarter a direct effect, and contributions from basic chemicals (26%), wholesale trade (4%) and textiles (1%). The income indicator is 10% below average, while water use is 70% below average. In the third TBL account, import penetration and government revenue are both 30% above average, while land disturbance is 80% below average.

## Structural Path Analysis and Linkages

The structural path analysis of the import penetration indicator shows that the import of plastic products (60%) and basic chemicals (15%) makes up most of the indicator. The feasibility of improvement would depend on the availability of basic feedstocks which in turn will depend on maintaining access to domestic oil and gas resources.

Increases in consumer demand for plastic products show average upstream linkages to sectors such as basic chemicals and wholesale trade. The sector shows moderately strong downstream linkages to sectors such as dairy products, animal feeds, wholesale trade and communication services which will have to lead any expansion of the plastics sector.

## Future Trends in Sector

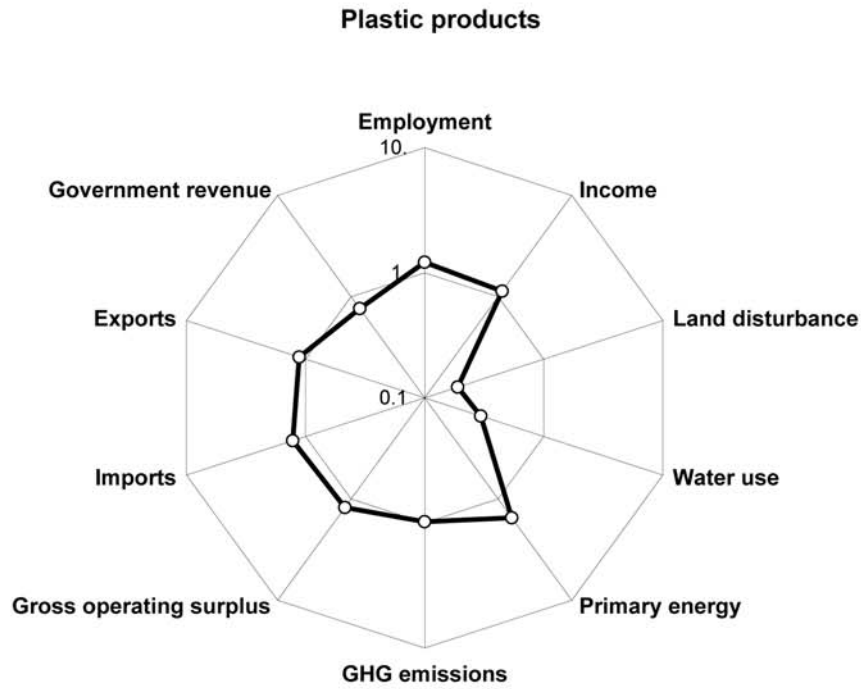
The *Future Dilemmas* study anticipates a doubling of plastics requirements over the next 50 years as the population increases by one quarter to 25 million people. This would see the per capita consumption increase from today's level of 76 kg to 120 kg in 2050, an increase of about 1 kg per capita per year. Given the importance of petrochemicals for plastics, the possibility of constrained domestic oil supplies past 2020 should be noted, but they could be substituted by plant feedstocks.

## Innovation and Technical Opportunities

While this TBL account for plastics reports generally positive outcomes, there are many pollution and waste issues outside the scope of this analysis. The embodied energy in the 50% of consumer product that goes to landfill yearly (750 000 tonnes) is wasted and could be recycled. This would require changes in personal behaviour and institutional policy. A recycled PET bottle requires the energy equivalent of one litre of petrol per kg in the recycled plastic chips that makes the next bottle. By comparison, production of the virgin material requires the energy equivalent of two litres of petrol per kg. Full lifecycle analyses for replacement options should be undertaken in selecting alternatives. For example, reusable glass bottles or cotton shopping bags may reduce the energy and greenhouse indicators, but increase the water and land disturbance indicators. Durable reuse should be the key policy objective. Changing plastic waste to other materials required by consumers is also an attractive option. Pilot plants in Japan are now testing a continuous process for converting plastics to oil. Converting plastic waste to extruded building materials such as beams and walls may also save forest and mineral resources.

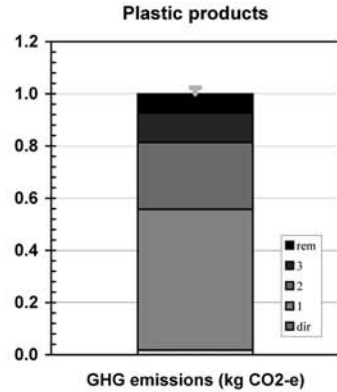
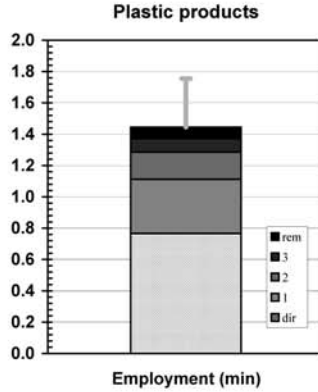
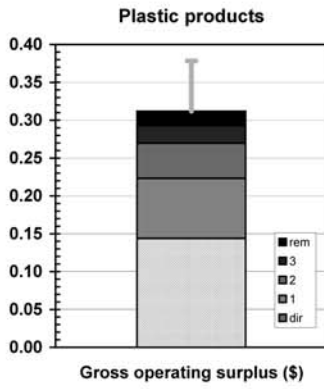
Plastic bottles, tubes, pipes, hoses, belts, plates, strip, tape, sacks, bags, tanks, fittings, household articles, coated textiles, and other plastic products

Spider diagram

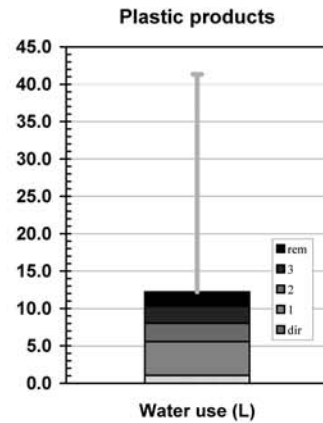
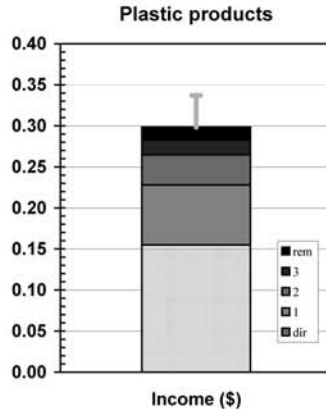
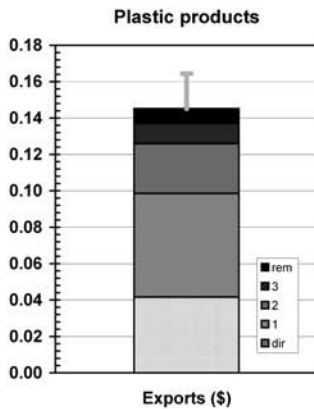


Bar graphs

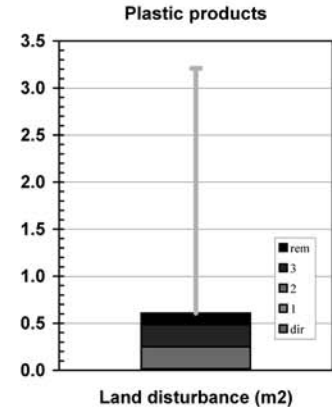
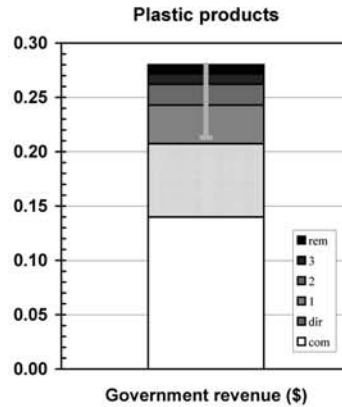
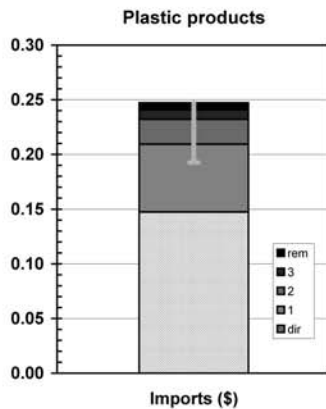
Account #1



Account #2



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 1,158.5	(0.44% of total)	(\$m 890.1 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 60.9	(0.06% of total)	(\$m 54.1 domestically produced)
Net changes in stocks	\$m 45.3	(2.56% of total)	(\$m 34.9 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 1,264.7</b>	<b>(0.28% of GNE)</b>	<b>(\$m 979.1 domestically produced)</b>
Exports	\$m 237.9	(0.29% of total)	(\$m 237.9 domestically produced)
<b>Final demand</b>	<b>\$m 1,502.6</b>	<b>(0.28% of GNT)</b>	<b>(\$m 1,217.0 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 884.9	(0.52% of total)
Gross operating surplus	\$m 821.8	(0.43% of total)
Taxes less subsidies	\$m 385.9	(0.45% of total)
<b>Sectoral GDP*</b>	<b>\$m 2,092.7</b>	<b>(0.47% of GDP)</b>
Imports	\$m 841.6	(0.86% of total)
<b>Primary inputs</b>	<b>\$m 2,934.2</b>	<b>(0.54% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 821.8	(0.43%)	\$m 175.0	(0.09%)
Exports (\$m)	\$m 237.9	(0.29%)	\$m 50.7	(0.06%)
Imports (\$m)	\$m 841.6	(0.86%)	\$m 179.2	(0.18%)
Employment (e-y)	35,063 e-y	(0.49%)	7,467 e-y	(0.10%)
Income (\$m)*	\$m 884.9	(0.52%)	\$m 188.5	(0.11%)
Government revenue (\$m)†	\$m 556.0	(0.51%)	\$m 252.3	(0.23%)
GHG emissions (kt CO <sub>2</sub> -e)	99 kt	(0.02%)	21 kt	(0.00%)
Water use (ML)	5,941 ML	(0.03%)	1,265 ML	(0.01%)
Land disturbance (kha)	4 kha	(0.00%)	1 kha	(0.00%)
Primary energy (TJ)	1,581 TJ	(0.04%)	337 TJ	(0.01%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.14	0.31	0.38
Exports (\$)	0.04	0.15	0.16
Imports (\$)	0.15	0.25	0.19
Employment (min)	0.77	1.45	1.75
Income (\$)	0.15	0.30	0.34
Government revenue (\$)	0.21	0.28	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.02	1.00	1.02
Water use (L)	1.04	12.21	41.32
Land disturbance (m <sup>2</sup> )	0.01	0.61	3.21
Primary energy (MJ)	0.28	11.71	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
PI	0.144	(0; 46.%)	PI	0.766	(0; 53.%)	Ch PI	0.32	(1; 32.%)
Ch PI	0.0267	(1; 8.6%)	Ch PI	0.0779	(1; 5.4%)	EI PI	0.167	(1; 17.%)
EI PI	0.00675	(1; 2.2%)	Wt PI	0.0481	(1; 3.3%)	EI Ch PI	0.0482	(2; 4.8%)
Wt PI	0.00667	(1; 2.1%)	Ot PI	0.0183	(1; 1.3%)	Bc Mp Ch PI	0.0175	(3; 1.7%)
Ms PI	0.00323	(1; 1.%)	Ms PI	0.0145	(1; 1.%)	PI	0.0174	(0; 1.7%)
Ot PI	0.00229	(1; 0.73%)	Bs PI	0.0112	(1; 0.77%)	Gd PI	0.0161	(1; 1.6%)
Ts PI	0.00204	(1; 0.66%)	Rd PI	0.0105	(1; 0.72%)	Fr Ch PI	0.0138	(2; 1.4%)
EI Ch PI	0.00195	(2; 0.62%)	Wt Ch PI	0.0103	(2; 0.71%)	Bc Ch PI	0.00879	(2; 0.88%)
Vf PI	0.00184	(1; 0.59%)	Ts PI	0.00921	(1; 0.64%)	EI Ot PI	0.00666	(2; 0.67%)
Rd PI	0.00178	(1; 0.57%)	Vf PI	0.00911	(1; 0.63%)	Wt PI	0.00666	(1; 0.67%)
St Ch PI	0.00177	(2; 0.57%)	Rh PI	0.00821	(1; 0.57%)	Wo Tx PI	0.00615	(2; 0.62%)
St PI	0.00154	(1; 0.49%)	Os PI	0.0082	(1; 0.57%)	BI EI PI	0.00421	(2; 0.42%)
Wt Ch PI	0.00143	(2; 0.46%)	EI PI	0.0075	(1; 0.52%)	Vf PI	0.00355	(1; 0.36%)
Cm PI	0.00138	(1; 0.44%)	Gd PI	0.00636	(1; 0.44%)	Ga Ch PI	0.0035	(2; 0.35%)
Rh PI	0.00134	(1; 0.43%)	Pa PI	0.00538	(1; 0.37%)	Nf PI	0.00338	(1; 0.34%)
Ne PI	0.0013	(1; 0.42%)	Ho PI	0.00462	(1; 0.32%)	Pc Ch PI	0.00331	(2; 0.33%)
St Wt PI	0.00127	(2; 0.41%)	Ne PI	0.00439	(1; 0.3%)	Rd PI	0.00283	(1; 0.28%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
PI	0.0416	(0; 29.%)	PI	0.155	(0; 52.%)	Vf PI	1.9	(1; 16.%)
Ch PI	0.0372	(1; 26.%)	Ch PI	0.0165	(1; 5.5%)	PI	1.04	(0; 8.5%)
Wt PI	0.00546	(1; 3.8%)	Wt PI	0.0103	(1; 3.5%)	Ch PI	0.976	(1; 8.%)
Nf PI	0.00247	(1; 1.7%)	Ot PI	0.00513	(1; 1.7%)	EI PI	0.923	(1; 7.6%)
BI EI PI	0.00163	(2; 1.1%)	Ms PI	0.00337	(1; 1.1%)	Bc Mp Ch PI	0.461	(3; 3.8%)
Wt Ch PI	0.00117	(2; 0.81%)	Os PI	0.0023	(1; 0.77%)	Wa PI	0.322	(1; 2.6%)
Lg Ch PI	0.000969	(2; 0.67%)	Wt Ch PI	0.00222	(2; 0.74%)	EI Ch PI	0.266	(2; 2.2%)
Tx PI	0.000945	(1; 0.65%)	Ts PI	0.00216	(1; 0.72%)	Wa Ch PI	0.237	(2; 1.9%)
Pc Ch PI	0.000782	(2; 0.54%)	EI PI	0.00203	(1; 0.68%)	Bc Ch PI	0.232	(2; 1.9%)
Oc PI	0.000723	(1; 0.5%)	Rd PI	0.0018	(1; 0.6%)	Wo Tx PI	0.199	(2; 1.6%)
Mp Ch PI	0.00068	(2; 0.47%)	Gd PI	0.00178	(1; 0.6%)	Sc Cg Vf PI	0.197	(3; 1.6%)
Rd PI	0.00062	(1; 0.43%)	Bs PI	0.00137	(1; 0.46%)	Sc Cg Ch PI	0.141	(3; 1.2%)
Vf PI	0.000554	(1; 0.38%)	Pa PI	0.00124	(1; 0.41%)	Su Fd Ch PI	0.125	(3; 1.%)
At PI	0.000552	(1; 0.38%)	Ms Wt PI	0.00101	(2; 0.34%)	Sc Cg Tx PI	0.0942	(3; 0.77%)
Wo Tx PI	0.000545	(2; 0.38%)	Ne PI	0.00101	(1; 0.34%)	Wa Ms PI	0.0831	(2; 0.68%)
Ms PI	0.0005	(1; 0.34%)	Ms Ch PI	0.000942	(2; 0.32%)	Wa EI PI	0.0534	(2; 0.44%)
Oi Pc Ch PI	0.000493	(3; 0.34%)	Rh PI	0.000898	(1; 0.3%)	Sc Cg Wo Tx	0.0372	(4; 0.3%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
PI	0.147	(0; 60.%)	PI	0.0675	(0; 48.%)	Wo Tx PI	0.148	(2; 24.%)
Ch PI	0.0373	(1; 15.%)	Ch PI	0.00824	(1; 5.9%)	Bc Mp Ch PI	0.127	(3; 21.%)
Pc Ch PI	0.00166	(2; 0.67%)	Wt PI	0.00482	(1; 3.4%)	Bc Ch PI	0.0639	(2; 11.%)
Wt PI	0.00155	(1; 0.63%)	Ot PI	0.00236	(1; 1.7%)	Wo Mp Ch PI	0.0144	(3; 2.4%)
Pa PI	0.00155	(1; 0.63%)	Ms PI	0.0016	(1; 1.1%)	Wo Tx Tp PI	0.00938	(3; 1.5%)
Oc PI	0.00112	(1; 0.45%)	Rd PI	0.00128	(1; 0.91%)	Bc Mp Ho PI	0.00666	(3; 1.1%)
Ms PI	0.000735	(1; 0.3%)	EI PI	0.00127	(1; 0.9%)	PI	0.00663	(0; 1.1%)
Rh PI	0.000693	(1; 0.28%)	Os PI	0.00107	(1; 0.76%)	Wo Ch PI	0.0063	(2; 1.%)
Pt PI	0.000684	(1; 0.28%)	Ts PI	0.00106	(1; 0.76%)	Fr Ch PI	0.00443	(2; 0.73%)
Ne PI	0.000625	(1; 0.25%)	Wt Ch PI	0.00104	(2; 0.74%)	EI PI	0.0027	(1; 0.44%)
Ot PI	0.00059	(1; 0.24%)	Gd PI	0.000826	(1; 0.59%)	Bc Mp Ho Ch	0.00261	(4; 0.43%)
Ts PI	0.000586	(1; 0.24%)	Pa PI	0.00065	(1; 0.46%)	Bc Mp Fd Ch	0.00225	(4; 0.37%)
EI PI	0.000468	(1; 0.19%)	Rd Ch PI	0.000531	(2; 0.38%)	Vf PI	0.00179	(1; 0.29%)
Vf PI	0.000452	(1; 0.18%)	Ne PI	0.000505	(1; 0.36%)	Wo Tx Wt PI	0.00171	(3; 0.28%)
Rd PI	0.000452	(1; 0.18%)	Ms Wt PI	0.000479	(2; 0.34%)	Gd PI	0.00151	(1; 0.25%)
Ac Ch PI	0.00038	(2; 0.15%)	Vf PI	0.00046	(1; 0.33%)	Bc Mp Pe Mp	0.00109	(5; 0.18%)
PI Ch PI	0.000375	(2; 0.15%)	Pd Wt PI	0.000453	(2; 0.32%)	Sw Pp PI	0.00106	(2; 0.17%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.062 ±0.023	(±2.2%)
Downstream	1.385 ±0.016	(±1.1%)

# Sector 2601: Glass Products (Gp)

*Float glass, safety glass, windscreens, containers, vacuum vessels and other glass products*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is 30% above average, while water use and land disturbance are 80% and 95% below average respectively. The social indicators of employment generation and income are both 15% below average, while government revenue is 75% above average. The financial indicators reveal that the operating surplus is 10% above average and that export propensity and import penetration are 20% and 40% below average respectively. Drink container reuse and increasing national recycling rates above the current 40% could help reduce energy use and greenhouse emissions.

## Sector Description

The glass production sector produces glass bottles and containers, kitchenware, glass for windows and car window screens, mirrors and scientific glassware. Australian glass production is greater than 1 million tonnes per annum, consumption is around 850 000 tonnes, and recovery from consumers is 360 000 tonnes giving a recycle rate of around 40%. It would be possible to increase the recycle rate to 60% if domestic collection operations were altered, and sorting and separation activities improved. Switzerland has a glass recycling rate of more than 90%, the highest in the world. Compared to virgin material, glass recycling can save around one third of the energy requirement and subsequent greenhouse emissions, and one half of the raw materials. To make one tonne of virgin glass requires two tonnes of sand, limestone and salt, as well as 10-14 GJ (10<sup>9</sup>J) of gas and electricity. Since 1960, improvements in glass making processes have reduced the energy requirements per tonne produced by more than 50%. The financial turnover of the sector was about \$1.5 billion in 2002 and involved over 100 enterprises.

## Place of Industry in the Economy

The glass products sector ranks 94<sup>th</sup> out of 135 sectors in terms of value adding in the economy and contributes 0.12% of GDP in this analysis. It is similar in value adding potential to the paint manufacturing and rubber products sectors. It is a small employer with around 700 employment years directly embodied in final demand, and another 600 years in the sector's suppliers giving a total of 1 300 employment years. In addition, the sector supplies another 7 000 employment years to downstream industries such as non residential construction, accommodation cafes and restaurants, preserved fruits and jams, and wine and spirits production. The sector has negligible requirements for water use and land disturbance, and less than one tenth of one percent of national energy use and greenhouse emissions. In financial terms, imports and exports are roughly equivalent.

## Strategic Overview

The integrated overview in the spider diagram gives a reasonably balanced TBL outcome for the glass making sector with outliers in the energy use and greenhouse indicators. Some downstream issues for the glass sector relate to perceived litter issues of used containers disposed in public places and along roadways, the volumetric contribution to landfill and human safety issues from broken glass. Direct reuse of glass containers could reduce energy and greenhouse but contamination and public health are key concerns. Full recycling can halve material requirement, and to a lesser degree energy as melting of glass 'cullet' remains an energy intensive process. The physical efficiency of collecting, sorting and directing waste streams for recycling in urban areas is complex and needs to be integrated within a holistic framework of society's industrial ecology.



## TBL Account #1

The financial indicator of operating surplus is 10% above average and one half of this is a direct sector effect, with additional contributions from natural gas (5%), electricity (3%), sand and gravel (3%), road transport (1%) and wholesale trade (1%). The social indicator of employment generation is 15% below average, with one half of this a direct effect and with a composition similar to the surplus indicator. The environmental indicator of greenhouse emissions is 30% above average and the greenhouse chain is described and analysed below.

## TBL Accounts #2 and #3

The second TBL account shows that export propensity is 20% below average, income is 15% below average and water use is 80% below average. The third TBL account shows import penetration 30% below average, government revenue is 75% above average, and land disturbance is 95% below average. Overall, the glass production sector presents a reasonable TBL account. The downstream issues in the use and disposal of glass materials and containers is not canvassed in this analysis. South Australia, which has point of sale deposits on drink containers, reports twice the recycling rate (80-90%) for drink containers compared to other states (50%). The effectiveness of container deposit legislation remains a matter of active policy debate.

## Structural Path Analysis and Linkages

An examination of the structural path for the greenhouse indicator reveals that the direct sector effect is one third of the total, with additional contributions from electricity generation (21%), gas distribution (6%), gas production (4%), non-metallic minerals (1%), basic chemicals (1%), alumina production (1%) and road transport (<1%). Depending on the scale of a glass making plant, it may be possible to reduce embodied emissions by installing gas turbines with waste heat recovery to partially replace coal fired electricity and provide process heat. In addition, there are many process improvements in heat and mechanical activities which can recycle heat and save primary energy.

The sector's stimulus to its upstream suppliers is around average with impacts on sand and gravel mining, electricity supply, wholesale trade, and road transport. The sector's linkages to downstream industries is 60% above average with the strongest links being to wholesale trade, accommodation cafes and restaurants, non-residential construction, fruit and jam preservation, and wine and spirit manufacturing. The downstream links imply that these sectors must expand ahead of any expansion in the glass manufacturing sector.

## Future Trends in Sector

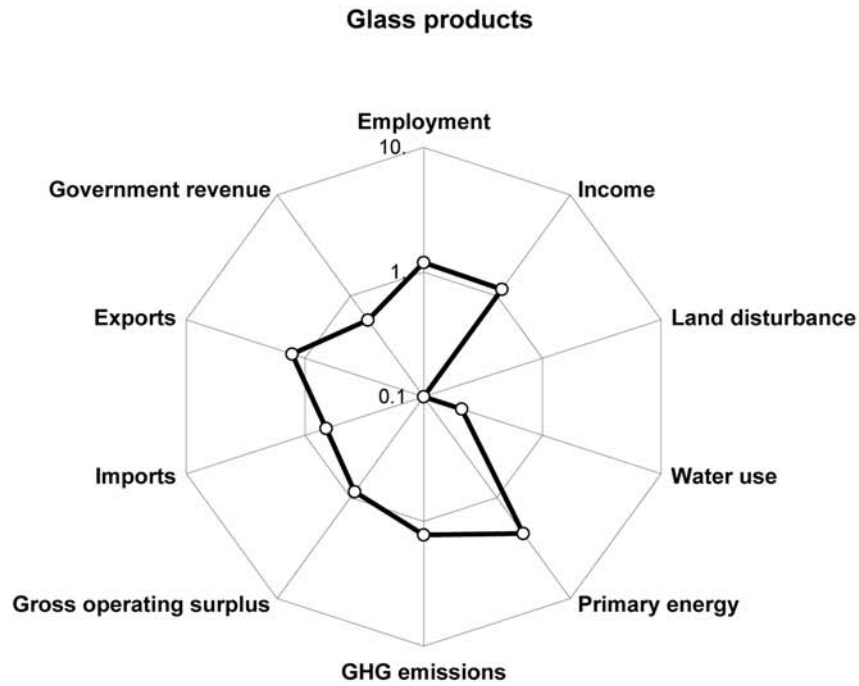
The base case scenario in the *Future Dilemmas* study anticipates that glass production may be relatively constant over the next 50 years. This estimate could be uncertain for three reasons. Firstly, major inroads into the market share of glass containers have been made by plastics although glass packaging may use less energy per unit than plastics, depending on the level of recycled content. Secondly, environmental concerns may drive glass manufacturing in a number of ways. A consumer preference for refillable and larger glass bottles, along with increased recycling rates, may decrease total glass requirements. However new building standards which stimulate double glazing, solar hot water systems and photovoltaic arrays may increase society's overall glass requirements. Thirdly, carbon constraints could alter the use of energy intensive materials.

## Innovation and Technical Opportunities

Alongside a possible decline in glass for more basic packaging, future glass production systems may become more complex as materials such as glass windows and glass building facades are also used to produce solar electricity, manage light transmission and provide advanced thermal control.

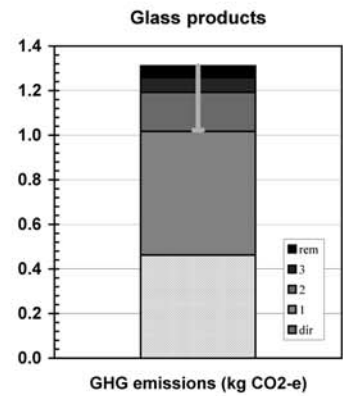
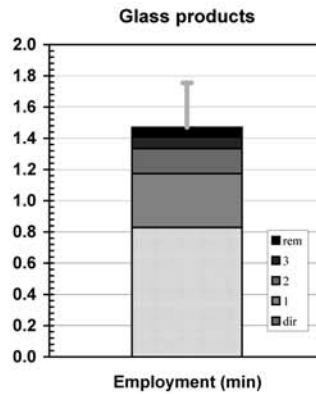
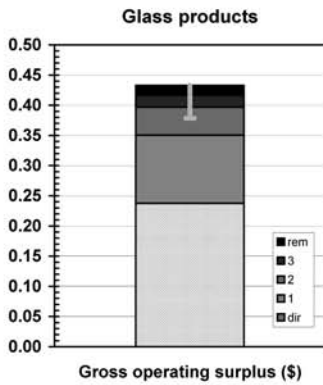
Float glass, safety glass, windscreens, containers, vacuum vessels and other glass products

Spider diagram

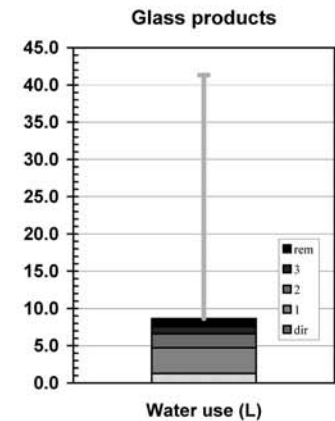
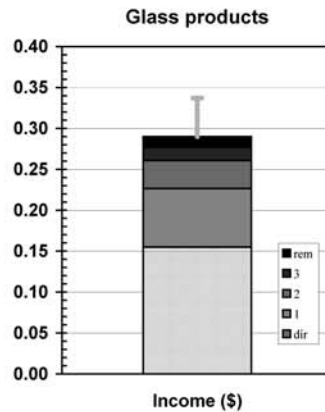
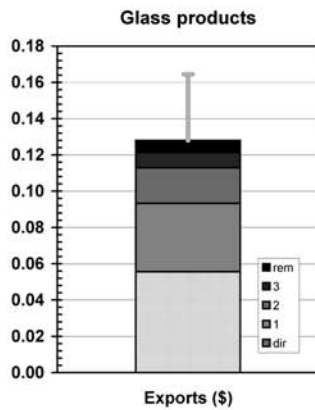


Bar graphs

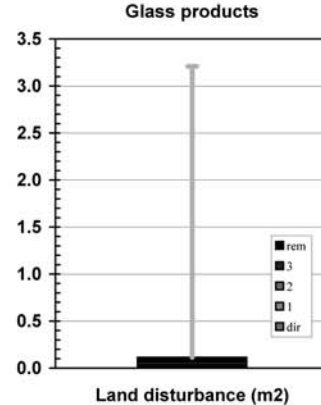
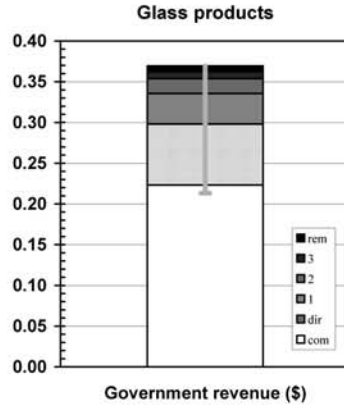
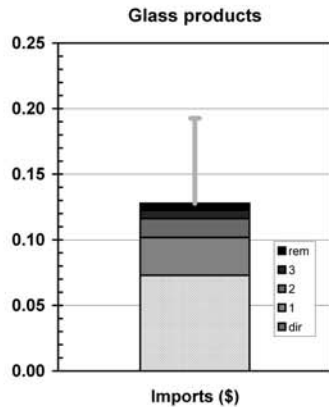
Account #1



Account #2



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 121.1	(0.05% of total)	(\$m 38.4 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 2.8	(0.00% of total)	(\$m 2.8 domestically produced)
Net changes in stocks	\$m 2.0	(0.11% of total)	(\$m 0.7 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 125.8</b>	<b>(0.03% of GNE)</b>	<b>(\$m 41.9 domestically produced)</b>
Exports	\$m 65.6	(0.08% of total)	(\$m 65.6 domestically produced)
<b>Final demand</b>	<b>\$m 191.4</b>	<b>(0.04% of GNT)</b>	<b>(\$m 107.4 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 182.8	(0.11% of total)
Gross operating surplus	\$m 280.2	(0.15% of total)
Taxes less subsidies	\$m 88.3	(0.10% of total)
<b>Sectoral GDP*</b>	<b>\$m 551.3</b>	<b>(0.12% of GDP)</b>
Imports	\$m 86.0	(0.09% of total)
<b>Primary inputs</b>	<b>\$m 637.3</b>	<b>(0.12% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 280.2	(0.15%)	\$m 25.5 (0.01%)	\$m 46.5 (0.02%)
Exports (\$m)	\$m 65.6	(0.08%)	\$m 6.0 (0.01%)	\$m 13.7 (0.02%)
Imports (\$m)	\$m 86.0	(0.09%)	\$m 7.8 (0.01%)	\$m 13.7 (0.01%)
Employment (e-y)	7,838 e-y	(0.11%)	713 e-y (0.01%)	1,265 e-y (0.02%)
Income (\$m)*	\$m 182.8	(0.11%)	\$m 16.6 (0.01%)	\$m 31.2 (0.02%)
Government revenue (\$m)†	\$m 112.3	(0.10%)	\$m 32.0 (0.03%)	\$m 39.7 (0.04%)
GHG emissions (kt CO <sub>2</sub> -e)	545 kt	(0.11%)	50 kt (0.01%)	141 kt (0.03%)
Water use (ML)	1,495 ML	(0.01%)	136 ML (0.00%)	928 ML (0.00%)
Land disturbance (kha)	1 kha	(0.00%)	0 kha (0.00%)	1 kha (0.00%)
Primary energy (TJ)	10,358 TJ	(0.27%)	943 TJ (0.02%)	1,867 TJ (0.05%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.24	0.43	0.38
Exports (\$)	0.06	0.13	0.16
Imports (\$)	0.07	0.13	0.19
Employment (min)	0.83	1.47	1.75
Income (\$)	0.15	0.29	0.34
Government revenue (\$)	0.30	0.37	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.46	1.31	1.02
Water use (L)	1.27	8.64	41.32
Land disturbance (m <sup>2</sup> )	0.01	0.11	3.21
Primary energy (MJ)	8.78	17.38	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Gp	0.237	(0; 55.%)	Gp	0.829	(0; 56.%)	Gp	0.462	(0; 35.%)
Ng Gp	0.0121	(1; 2.8%)	Rd Gp	0.0332	(1; 2.3%)	El Gp	0.281	(1; 21.%)
El Gp	0.0113	(1; 2.6%)	Wt Gp	0.033	(1; 2.2%)	Ga Gp	0.0719	(1; 5.5%)
Sg Gp	0.0112	(1; 2.6%)	Pi Gp	0.0161	(1; 1.1%)	Ng Gp	0.0551	(1; 4.2%)
Ga Gp	0.0105	(1; 2.4%)	Mi Gp	0.0156	(1; 1.1%)	Mi Gp	0.017	(1; 1.3%)
Rd Gp	0.00565	(1; 1.3%)	Ga Gp	0.0154	(1; 1.1%)	Ch Gp	0.0137	(1; 1.%)
Wt Gp	0.00459	(1; 1.1%)	Sg Gp	0.0142	(1; 0.96%)	Ao Gp	0.0127	(1; 0.97%)
Mi Gp	0.00375	(1; 0.87%)	El Gp	0.0126	(1; 0.86%)	Rd Gp	0.00896	(1; 0.68%)
Ts Gp	0.00265	(1; 0.61%)	Ts Gp	0.012	(1; 0.81%)	Sg Gp	0.00884	(1; 0.67%)
St Gp	0.00232	(1; 0.54%)	Bk Gp	0.00893	(1; 0.61%)	Bl El Gp	0.00707	(2; 0.54%)
Bk Gp	0.00225	(1; 0.52%)	Bs Gp	0.00806	(1; 0.55%)	Is Gp	0.0067	(1; 0.51%)
Pi Gp	0.00202	(1; 0.47%)	Ms Gp	0.00778	(1; 0.53%)	El Pi Gp	0.00588	(2; 0.45%)
Bl El Gp	0.00181	(2; 0.42%)	Ho Gp	0.00733	(1; 0.5%)	Nf Gp	0.00484	(1; 0.37%)
Ms Gp	0.00173	(1; 0.4%)	Wp Gp	0.00629	(1; 0.43%)	Wt Gp	0.00458	(1; 0.35%)
Lg Gp	0.00152	(1; 0.35%)	Ng Gp	0.00468	(1; 0.32%)	El Mi Gp	0.0039	(2; 0.3%)
Ch Gp	0.00114	(1; 0.26%)	Fm Gp	0.00429	(1; 0.29%)	Lg Gp	0.00361	(1; 0.28%)
Nf Gp	0.00105	(1; 0.24%)	Rt Gp	0.00385	(1; 0.26%)	Pc Gp	0.00296	(1; 0.23%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Gp	0.0555	(0; 43.%)	Gp	0.155	(0; 53.%)	El Gp	1.55	(1; 18.%)
Sg Gp	0.00558	(1; 4.4%)	Wt Gp	0.00709	(1; 2.4%)	Gp	1.27	(0; 15.%)
Wt Gp	0.00375	(1; 2.9%)	Rd Gp	0.0057	(1; 2.%)	Wa Gp	0.717	(1; 8.3%)
Nf Gp	0.00354	(1; 2.8%)	Pi Gp	0.00453	(1; 1.6%)	Bx Ao Gp	0.364	(2; 4.2%)
Ao Gp	0.00307	(1; 2.4%)	Ga Gp	0.00407	(1; 1.4%)	Mi Gp	0.286	(1; 3.3%)
Bl El Gp	0.00274	(2; 2.1%)	El Gp	0.00341	(1; 1.2%)	Sg Gp	0.285	(1; 3.3%)
Gl Gp	0.00235	(1; 1.8%)	Ts Gp	0.0028	(1; 0.97%)	Ng Gp	0.108	(1; 1.3%)
Rd Gp	0.00196	(1; 1.5%)	Mi Gp	0.00264	(1; 0.91%)	Wa El Gp	0.0897	(2; 1.%)
Lg Gp	0.00177	(1; 1.4%)	Sg Gp	0.00239	(1; 0.82%)	Ws Ho Gp	0.0534	(2; 0.62%)
Mi Gp	0.00176	(1; 1.4%)	Bk Gp	0.00221	(1; 0.76%)	Wp Gp	0.0518	(1; 0.6%)
Ch Gp	0.00159	(1; 1.2%)	Ng Gp	0.00203	(1; 0.7%)	Wa Ms Gp	0.0446	(2; 0.52%)
Pc Gp	0.000698	(1; 0.55%)	Ms Gp	0.00181	(1; 0.62%)	Ch Gp	0.0417	(1; 0.48%)
Gl Nf Gp	0.000644	(2; 0.5%)	Wp Gp	0.00122	(1; 0.42%)	Bc Mp Ho Gp	0.0383	(3; 0.44%)
Is Gp	0.000593	(1; 0.46%)	Ho Gp	0.00107	(1; 0.37%)	Bl El Gp	0.0367	(2; 0.42%)
St Gp	0.000575	(1; 0.45%)	Bs Gp	0.000989	(1; 0.34%)	Wa Ts Gp	0.0358	(2; 0.41%)
Oi Pc Gp	0.00044	(2; 0.34%)	St Gp	0.000966	(1; 0.33%)	El Pi Gp	0.0325	(2; 0.38%)
Ts Gp	0.000421	(1; 0.33%)	Ch Gp	0.000706	(1; 0.24%)	Dc Dp Ho Gp	0.0318	(3; 0.37%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Gp	0.0729	(0; 57.%)	Gp	0.0748	(0; 51.%)	Bc Mp Ho Gp	0.0106	(3; 9.2%)
Sg Gp	0.00352	(1; 2.7%)	Rd Gp	0.00405	(1; 2.8%)	Gp	0.00718	(0; 6.2%)
Ch Gp	0.00159	(1; 1.2%)	Wt Gp	0.00331	(1; 2.3%)	Bc Mp Ch Gp	0.00543	(3; 4.7%)
Pc Gp	0.00148	(1; 1.2%)	El Gp	0.00213	(1; 1.5%)	El Gp	0.00453	(1; 3.9%)
Rd Gp	0.00143	(1; 1.1%)	Pi Gp	0.00208	(1; 1.4%)	Wo Tx Gp	0.00279	(2; 2.4%)
Wt Gp	0.00107	(1; 0.83%)	Ga Gp	0.00207	(1; 1.4%)	Bc Ch Gp	0.00273	(2; 2.4%)
Ng Gp	0.000895	(1; 0.7%)	Sg Gp	0.00157	(1; 1.1%)	Bc Mp Rt Gp	0.00206	(3; 1.8%)
Mi Gp	0.000829	(1; 0.65%)	Ng Gp	0.00147	(1; 1.%)	Wo Mp Ho Gp	0.00119	(3; 1.%)
El Gp	0.000787	(1; 0.62%)	Ts Gp	0.00138	(1; 0.94%)	Wo Tx Wt Gp	0.00118	(3; 1.%)
Ts Gp	0.000762	(1; 0.6%)	Bk Gp	0.00122	(1; 0.83%)	Ga Gp	0.00102	(1; 0.89%)
Ga Gp	0.000657	(1; 0.51%)	Mi Gp	0.000984	(1; 0.67%)	Wo Tx Tp Gp	0.000926	(3; 0.81%)
Wp Gp	0.000619	(1; 0.48%)	Ms Gp	0.000859	(1; 0.59%)	Sw Wp Gp	0.000906	(2; 0.79%)
Pi Gp	0.000521	(1; 0.41%)	Wp Gp	0.000592	(1; 0.4%)	Ba Bm Ho Gp	0.000864	(3; 0.75%)
Pl Gp	0.000483	(1; 0.38%)	Ho Gp	0.000563	(1; 0.38%)	Sw Ti Wp Gp	0.000808	(3; 0.7%)
Fo Sg Gp	0.000473	(2; 0.37%)	St Gp	0.000516	(1; 0.35%)	Rd Gp	0.000696	(1; 0.61%)
Pt Gp	0.000447	(1; 0.35%)	In Gp	0.000419	(1; 0.29%)	Bc Mp Ho Wt	0.000679	(4; 0.59%)
Nf Gp	0.000426	(1; 0.33%)	Rd Sg Gp	0.000383	(2; 0.26%)	Wo Mp Ch Gp	0.000613	(3; 0.53%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	0.963 ±0.015	(±1.6%)
Downstream	1.648 ±0.031	(±1.9%)

# Sector 2602: Ceramic Products (Cr)

*Bricks, refractory products, tiles, basins, tableware and other ceramic products*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicators of greenhouse emissions are 70% above average, while water use and land disturbance are 80% and 95% below average respectively. The social indicators portray positive outcomes with employment generation 20% above average, income equal to average, and government revenue 30% above average. The financial indicators reveal that operating surplus is equal to average, while both the export propensity and import penetration are 40% below average. The greenhouse intensity of the ceramics sector is significant. However, they are generally long lived products with low maintenance costs, and the emissions content can be amortised on a whole of life basis. Ceramics production can incorporate waste materials from sewage sludge and can use waste oil and biomass to fire kilns. Old bricks can be reused on site in new buildings or to add a vintage feel to new building façades.

## Sector Description

This sector makes products from clay materials that are dried and then fired in kilns. They include the traditional building bricks, roofing tiles, clay pipes, refractory products which line furnaces, floor and wall tiles for internal use, and ceramic products such as kitchen pottery, china goods, washbasins and toilet cisterns. Industry sources suggest that current yearly production of clay bricks and pavers is around 1.2 billion units per year or approximately 4.3 million tonnes with an average brick size of 3.5 kg. Materials databases suggest that each 3.5 kg clay brick has nearly 9 MJ (10<sup>6</sup>J) embodied in its manufacture, or the energy equivalent of one quarter of a litre of petrol or diesel. Kilns are fired mostly by natural gas, but waste oil, coal, bagasse, or saw dust may also be used. The financial turnover was \$1.6 billion in 2002 and was composed of traditional bricks (57%), refractory and industrial products (14%), kitchen and houseware (19%), and tiles and pipes (10%).

## Place of Industry in the Economy

The ceramic products sector ranks 87<sup>th</sup> out of 135 sectors in terms of value adding in the economy and contributes 0.15% of GDP in this analysis. It is similar in value adding to the pharmaceuticals and scientific and medical equipment sectors. It is a relatively small employer with 2 500 employment years directly embodied in final demand and another 1 000 years in the sector's upstream suppliers giving a total of 3 500 employment years. In addition, it contributes 13 500 employment years to downstream industries such as domestic building and non-domestic construction. It has relatively small resource requirements with less than one tenth of one percent of domestic water use, land disturbance and greenhouse emissions and slightly more than that of primary energy use. Imports are 50% greater than exports, although exports are now growing.

## Strategic Overview

The integrated overview in the spider diagram reveals generally positive outcomes for the ceramic products sector with two significant outliers for the energy use and greenhouse emissions indicators. The energy intensity of ceramics and brick production should be set against long life and generally low maintenance requirements. The export propensity indicator is also lower than average. Traditionally ceramics have transport cost disadvantages because of their bulk, essentially local manufacture and regional use. Back-loading of freight, that would otherwise run empty, may reduce this cost disadvantage. The main downstream issue is the embodied energy and greenhouse content which may disadvantage some building designs in a greenhouse life cycle context.

## TBL Account #1

The financial indicator of operating surplus is equal to average and half of this is a direct sector effect with additional contributions from non metallic minerals (4%), natural gas (7%), sand, gravel and clay mining (3%), road transport (3%), electricity (3%), business management services (1%) and wholesale trade (1%). The social indicator of employment generation is 20% greater than average, two thirds of this is a direct sector effect and the remainder of the chain has a similar composition to the surplus indicator. The environmental indicator of greenhouse emissions is 70% above average and its composition is discussed in more detail below.

## TBL Accounts #2 and #3

The second TBL account shows that the financial indicator of export propensity is 40% below average, the social indicator of income is equal to average and the environmental indicator of water use is 80% below average. The export indicator for the sector is improving and some manufacturers report sales of 10-20 million units to a diverse range of countries including New Zealand, Japan, China, Korea and Taiwan. The third TBL account shows that import penetration is 40% below average, government revenue 30% above average and land disturbance is 95% below average.

## Structural Path Analysis and Linkages

While greenhouse emissions can be set against the long life of ceramic products, an examination of the structural path shows a number of possibilities for improvement. The direct sector effect is one half of the total and increases in process efficiency can reduce total emissions. Improved 'low thermal mass' tunnel kilns can reduce natural gas consumption by 35%, improve yearly production rates and reduce rejection rates. Other emissions come from electricity production (13%), gas mining and distribution (9%), non-metallic minerals production (4%), cement production (3%) and road transport (1%). Purchasing lower carbon content electricity could give further reductions and, depending on the size of the ceramic plant, the installation of a combined heat and power plant may enable the optimal use of several heat and electricity streams.

The sector's stimulus to its upstream suppliers is around the economy wide average with effects on sand and gravel mining, non-metallic minerals, wholesale trade, road transport and legal and accounting services. The linkages to downstream industries are around average and suggest that domestic building in particular must expand in order to dissipate any increased production from this sector. Growth in exports could also help to dissipate increased production.

## Future Trends in Sector

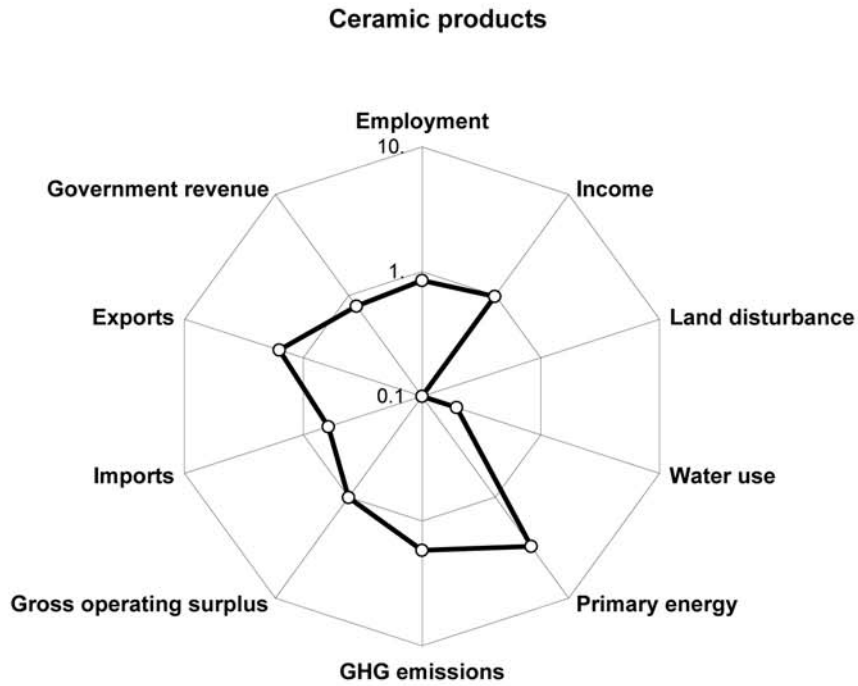
Under the base case scenario of the *Future Dilemmas* study the floor area of built infrastructure doubles by the year 2050 and the yearly requirement for clay bricks is relatively constant for the next 50 years with a slight decline towards the end. This anticipation is uncertain as it assumes that the composition of the built infrastructure will remain similar to today. If consumer preferences or building codes change, the demand for brick facades and brick structural elements may decline. For house exterior cladding, a timber framed and weather board covered home has around 200 MJ embodied energy per m<sup>2</sup>, versus a timber frame with a clay brick veneer with 560 MJ/m<sup>2</sup>. If houses last for 100 years, the energy embodied in construction is around 10% of total life cycle energy use.

## Innovation and Technical Opportunities

Brick making can use sludge from sewage plants, thus saving on virgin materials and locking up problem materials that would otherwise go to landfill. New buildings can reuse whole bricks on facades or crushed bricks in concrete and site fill. The establishment of brickworks in industrial ecology precincts close to other material and energy transactions may speed dematerialisation.

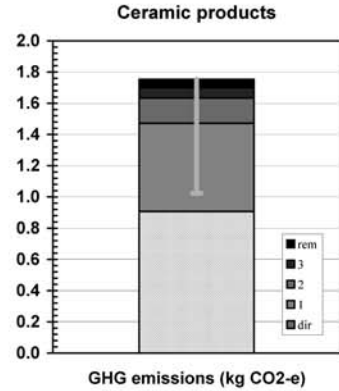
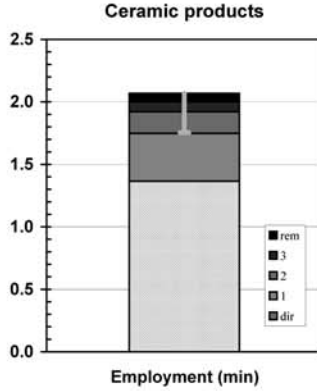
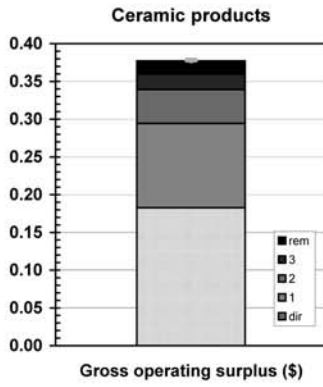
Bricks, refractory products, tiles, basins, tableware and other ceramic products

**Spider diagram**

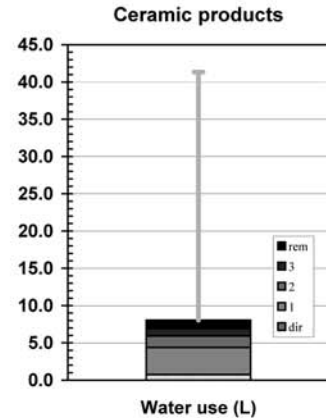
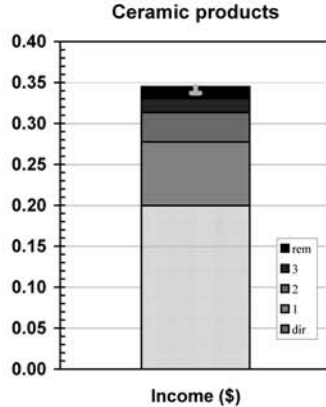
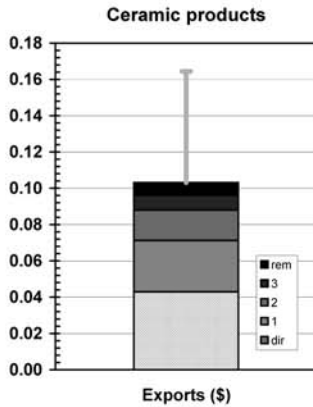


**Bar graphs**

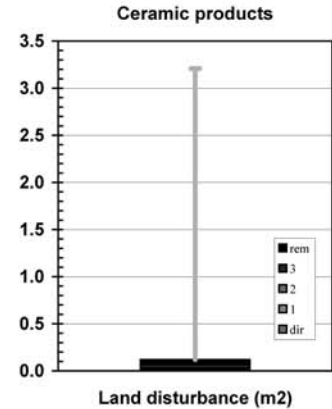
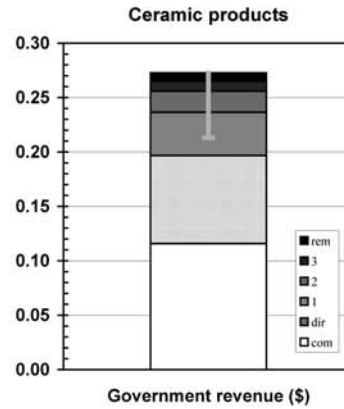
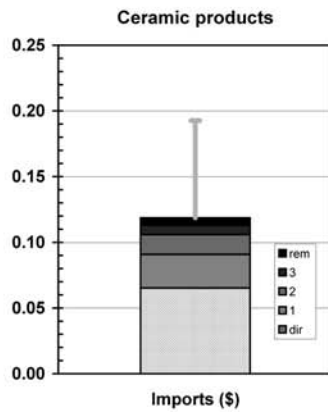
**Account #1**



**Account #2**



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 173.5	(0.07% of total)	(\$m 80.7 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 15.7	(0.01% of total)	(\$m 15.7 domestically produced)
Net changes in stocks	\$m 61.0	(3.45% of total)	(\$m 52.8 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 250.3</b>	<b>(0.05% of GNE)</b>	<b>(\$m 149.2 domestically produced)</b>
Exports	\$m 62.5	(0.07% of total)	(\$m 62.5 domestically produced)
<b>Final demand</b>	<b>\$m 312.7</b>	<b>(0.06% of GNT)</b>	<b>(\$m 211.7 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 290.9	(0.17% of total)
Gross operating surplus	\$m 266.3	(0.14% of total)
Taxes less subsidies	\$m 118.0	(0.14% of total)
<b>Sectoral GDP*</b>	<b>\$m 675.2</b>	<b>(0.15% of GDP)</b>
Imports	\$m 95.0	(0.10% of total)
<b>Primary inputs</b>	<b>\$m 770.1</b>	<b>(0.14% of GNT)</b>

\* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 266.3	(0.14%)	\$m 38.7 (0.02%)	\$m 79.9 (0.04%)
Exports (\$m)	\$m 62.5	(0.07%)	\$m 9.1 (0.01%)	\$m 21.8 (0.03%)
Imports (\$m)	\$m 95.0	(0.10%)	\$m 13.8 (0.01%)	\$m 25.1 (0.03%)
Employment (e-y)	15,938 e-y	(0.22%)	2,315 e-y (0.03%)	3,509 e-y (0.05%)
Income (\$m)*	\$m 290.9	(0.17%)	\$m 42.3 (0.02%)	\$m 73.0 (0.04%)
Government revenue (\$m)†	\$m 142.4	(0.13%)	\$m 41.6 (0.04%)	\$m 57.8 (0.05%)
GHG emissions (kt CO <sub>2</sub> -e)	1,321 kt	(0.25%)	192 kt (0.04%)	371 kt (0.07%)
Water use (ML)	1,074 ML	(0.01%)	156 ML (0.00%)	1,706 ML (0.01%)
Land disturbance (kha)	1 kha	(0.00%)	0 kha (0.00%)	3 kha (0.00%)
Primary energy (TJ)	23,189 TJ	(0.60%)	3,368 TJ (0.09%)	4,976 TJ (0.13%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.18	0.38	0.38
Exports (\$)	0.04	0.10	0.16
Imports (\$)	0.07	0.12	0.19
Employment (min)	1.36	2.07	1.75
Income (\$)	0.20	0.34	0.34
Government revenue (\$)	0.20	0.27	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.91	1.75	1.02
Water use (L)	0.74	8.06	41.32
Land disturbance (m <sup>2</sup> )	0.01	0.12	3.21
Primary energy (MJ)	15.91	23.50	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks



**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Cr	0.183	(0; 48.%)	Cr	1.36	(0; 66.%)	Cr	0.907	(0; 52.%)
Mi Cr	0.0149	(1; 4.%)	Mi Cr	0.0619	(1; 3.%)	El Cr	0.234	(1; 13.%)
Ng Cr	0.0147	(1; 3.9%)	Rd Cr	0.061	(1; 2.9%)	Ga Cr	0.0877	(1; 5.%)
Ga Cr	0.0128	(1; 3.4%)	Wt Cr	0.031	(1; 1.5%)	Mi Cr	0.0677	(1; 3.9%)
Sg Cr	0.0106	(1; 2.8%)	Ms Cr	0.0204	(1; 0.99%)	Ng Cr	0.0669	(1; 3.8%)
Rd Cr	0.0104	(1; 2.8%)	Pi Cr	0.0196	(1; 0.95%)	Ce Cr	0.0464	(1; 2.6%)
El Cr	0.00946	(1; 2.5%)	Ga Cr	0.0188	(1; 0.91%)	Rd Cr	0.0165	(1; 0.94%)
Ms Cr	0.00455	(1; 1.2%)	Sg Cr	0.0134	(1; 0.65%)	El Mi Cr	0.0155	(2; 0.89%)
Wt Cr	0.00431	(1; 1.1%)	Rt Cr	0.0134	(1; 0.65%)	Ce Mi Cr	0.0107	(2; 0.61%)
Ts Cr	0.00285	(1; 0.76%)	Ts Cr	0.0129	(1; 0.62%)	Sg Cr	0.00838	(1; 0.48%)
Cp Cr	0.00265	(1; 0.7%)	El Cr	0.0105	(1; 0.51%)	El Pi Cr	0.00714	(2; 0.41%)
Pi Cr	0.00245	(1; 0.65%)	Ho Cr	0.01	(1; 0.49%)	Bl El Cr	0.0059	(2; 0.34%)
Sg Mi Cr	0.00228	(2; 0.61%)	Fm Cr	0.0079	(1; 0.38%)	Wt Cr	0.0043	(1; 0.25%)
Cm Cr	0.00209	(1; 0.55%)	Cp Cr	0.00695	(1; 0.34%)	Ce Cp Cr	0.0041	(2; 0.23%)
St Cr	0.00193	(1; 0.51%)	Rd Mi Cr	0.00605	(2; 0.29%)	El Ng Cr	0.00355	(2; 0.2%)
Ce Cr	0.0018	(1; 0.48%)	Cm Cr	0.00577	(1; 0.28%)	Lm Mi Cr	0.00236	(2; 0.13%)
Bl El Cr	0.00151	(2; 0.4%)	Ng Cr	0.00568	(1; 0.27%)	Lm Ce Cr	0.00235	(2; 0.13%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Cr	0.0429	(0; 42.%)	Cr	0.2	(0; 58.%)	El Cr	1.29	(1; 16.%)
Mi Cr	0.00702	(1; 6.8%)	Mi Cr	0.0105	(1; 3.1%)	Mi Cr	1.14	(1; 14.%)
Sg Cr	0.00529	(1; 5.1%)	Rd Cr	0.0105	(1; 3.%)	Cr	0.737	(0; 9.1%)
Rd Cr	0.00361	(1; 3.5%)	Wt Cr	0.00666	(1; 1.9%)	Wa Cr	0.367	(1; 4.6%)
Wt Cr	0.00352	(1; 3.4%)	Pi Cr	0.00549	(1; 1.6%)	Sg Cr	0.27	(1; 3.3%)
Bl El Cr	0.00229	(2; 2.2%)	Ga Cr	0.00496	(1; 1.4%)	Ng Cr	0.131	(1; 1.6%)
Sg Mi Cr	0.00114	(2; 1.1%)	Ms Cr	0.00474	(1; 1.4%)	Wa Ms Cr	0.117	(2; 1.5%)
Ms Cr	0.000704	(1; 0.68%)	Ts Cr	0.00301	(1; 0.87%)	Bx Mi Cr	0.107	(2; 1.3%)
Lg Cr	0.000582	(1; 0.56%)	El Cr	0.00285	(1; 0.83%)	El Mi Cr	0.0858	(2; 1.1%)
Nf Cr	0.000574	(1; 0.56%)	Ng Cr	0.00247	(1; 0.72%)	Br Cr	0.0807	(1; 1.%)
Ho Cr	0.000558	(1; 0.54%)	Sg Cr	0.00226	(1; 0.66%)	Wa El Cr	0.0748	(2; 0.93%)
Oc Cr	0.00051	(1; 0.49%)	Rt Cr	0.00158	(1; 0.46%)	Ws Ho Cr	0.0731	(2; 0.91%)
At Cr	0.000507	(1; 0.49%)	Cp Cr	0.00154	(1; 0.45%)	Sg Mi Cr	0.0579	(2; 0.72%)
St Cr	0.000479	(1; 0.46%)	Ho Cr	0.00146	(1; 0.42%)	Bc Mp Ho Cr	0.0525	(3; 0.65%)
Ts Cr	0.000453	(1; 0.44%)	Cm Cr	0.00131	(1; 0.38%)	Dc Dp Ho Cr	0.0435	(3; 0.54%)
Fm Cr	0.000407	(1; 0.39%)	Fm Cr	0.00124	(1; 0.36%)	Rd Cr	0.0433	(1; 0.54%)
Pc Cr	0.000372	(1; 0.36%)	Bk Cr	0.00123	(1; 0.36%)	El Pi Cr	0.0395	(2; 0.49%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$		
Cr	0.0652	(0; 55.%)	Cr	0.0809	(0; 52.%)	Bc Mp Ho Cr	0.0145	(3; 12.%)
Sg Cr	0.00333	(1; 2.8%)	Rd Cr	0.00744	(1; 4.7%)	Cr	0.00719	(0; 6.%)
Mi Cr	0.0033	(1; 2.8%)	Mi Cr	0.00392	(1; 2.5%)	Bc Mp Rt Cr	0.00716	(3; 6.%)
Rd Cr	0.00263	(1; 2.2%)	Wt Cr	0.00311	(1; 2.%)	El Cr	0.00378	(1; 3.2%)
Ng Cr	0.00109	(1; 0.92%)	Pi Cr	0.00253	(1; 1.6%)	Wo Mp Ho Cr	0.00163	(3; 1.4%)
Ms Cr	0.00103	(1; 0.87%)	Ga Cr	0.00252	(1; 1.6%)	Rd Cr	0.00128	(1; 1.1%)
Wt Cr	0.001	(1; 0.84%)	Ms Cr	0.00225	(1; 1.4%)	Ga Cr	0.00124	(1; 1.%)
Ts Cr	0.000819	(1; 0.69%)	Ng Cr	0.00179	(1; 1.1%)	Sw Pp Cr	0.0012	(2; 1.%)
Ga Cr	0.000801	(1; 0.67%)	El Cr	0.00177	(1; 1.1%)	Ba Bm Ho Cr	0.00118	(3; 0.99%)
Pc Cr	0.00079	(1; 0.67%)	Sg Cr	0.00148	(1; 0.94%)	Wo Tx Wt Cr	0.0011	(3; 0.93%)
Oc Cr	0.000789	(1; 0.67%)	Ts Cr	0.00148	(1; 0.94%)	Bc Mp Ho Ms	0.0011	(4; 0.93%)
Pa Cr	0.00076	(1; 0.64%)	Ho Cr	0.000771	(1; 0.49%)	Bc Mp Ho Rd	0.000876	(4; 0.74%)
Sg Mi Cr	0.000715	(2; 0.6%)	Rd Mi Cr	0.000739	(2; 0.47%)	Wo Mp Rt Cr	0.000808	(3; 0.68%)
El Cr	0.000657	(1; 0.55%)	Cp Cr	0.000715	(1; 0.46%)	Bc Mp Ch Mi Cr	0.000735	(4; 0.62%)
Pi Cr	0.000632	(1; 0.53%)	Bk Cr	0.000682	(1; 0.43%)	Bc Mp Ho Mi Cr	0.000654	(4; 0.55%)
Fm Cr	0.000534	(1; 0.45%)	Cm Cr	0.000626	(1; 0.4%)	Bc Mp Ho Wt Cr	0.000637	(4; 0.54%)
Pl Cr	0.000497	(1; 0.42%)	Ot Cr	0.000527	(1; 0.34%)	Sw Wp Cr	0.000601	(2; 0.51%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.001 ±0.014	(±1.4%)
Downstream	1.086 ±0.058	(±5.3%)

# Sector 26310010: Cement (Ce)

*Cement including hydraulic and Portland, excluding adhesive or refractory*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is over five times the average while water use and land disturbance are 80% and 95% below average respectively. The social indicators of employment generation, income and government revenue are 25%, 20% and 25% below average respectively. This is a capital intensive industry in a free market economy producing a material central for economic growth and development. The extent to which it can give a more balanced TBL account is a complex topic that merits further discussion. The financial indicator of operating surplus is 20% above average, while export propensity and import penetration are 30% and 50% below average respectively. New materials and use of by-products such as fly ash and slag from other industries can reduce the greenhouse intensity of cement, and the emissions embodied in downstream built infrastructure. New cements under development may substantially reduce material and energy content.

## Sector Description

The cement sector in Australia produces approximately 7 million tonnes per annum of Portland type cements (a cement consisting predominantly of calcium silicates which reacts with water to form a hard mass) and is driven by general economic, building and construction activity with occasional spikes due to one-off factors (such as the Sydney Olympics). In the last decade the number of cement kilns has halved and production is dominated by four large and energy efficient dry process plants, each with a capacity of over one million tonnes per annum, at Gladstone (Qld), Berrima (NSW), Railton (Tas) and Birkenhead (SA). The more efficient dry process has direct energy use of 3 GJ/tonne of clinker produced, versus 6 GJ/tonne for the older wet process. Coal is the dominant energy source (50%) followed closely by natural gas (38%).

## Place of Industry in the Economy

The cement manufacturing industry ranks 118<sup>th</sup> out of 135 sectors in terms of value adding and contributes 0.06% of GDP in this analysis. It is a relatively small employer with industry sources quoting approximately 2000 people employed Australia wide. However employment is important in a regional sense since plants are generally located outside the major urban-industrial areas. The sector's small contribution to value adding needs to be assessed against the physical centrality of cement to Australia's built environment and transportation networks, and its strong linkages to both downstream recipients and upstream suppliers. The sector is responsible for less than one tenth of one percent of energy use, greenhouse emissions, water use and land disturbance. In accounting terms, the sector's greenhouse content is distributed through the value adding chain of construction.

## Strategic Overview

The integrated overview of the cement sector provided by the spider diagram shows reasonable outcomes for the financial indicators and for the environment indicators of water use and land disturbance. All social indicators are marginally below the economy wide average and the primary energy and greenhouse indicators are substantially above the average. The degree to which social and environmental indicators can be improved within an essential physical process sector, such as cement manufacture, is unclear. A cement plant is capital intensive and has a long life. Currently excess cement manufacturing capacity in Pacific Rim countries is leading to dumping of low priced cement. The import penetration and social indicators may be affected by this practice in the future.

## TBL Account #1

The financial indicator of operating surplus is 20% greater than the economy wide average with one third a direct effect and additional contributions from sand and gravel (13%), road transport (7%), natural gas (6%) and electricity (2%). The social indicator of employment is 30% below the economy wide average with one quarter a direct effect and the rest due to suppliers such as road transport (14%), sand and gravel (6%), pipelines (2%) and natural gas (2%). The greenhouse emissions indicator is five times the economy wide average with nearly three quarters a direct effect. In an overall sense, the first TBL account reveals a tension between a relatively good financial outcome based on high capital intensity (and therefore less employment) and high energy use (which generates higher greenhouse emissions per dollar of final demand).

## TBL Accounts #2 and #3

In the second TBL account, export propensity is 30% below average, while income and water use are 20% and 80% below average respectively. All of these have relatively small direct effects with most of the effect in the supply chain. For the third TBL account, import penetration and government are 50% and 25% below average respectively. Land disturbance is small, but the indirect effect of limestone mining could be locally significant. The two accounts show reasonable environmental outcomes but social indicators may merit attention.

## Structural Path Analysis and Linkages

The structural path analysis of the greenhouse chain for the cement sector shows that 72% of the emissions occur directly within the sector. Most of this is in producing clinker, a cement precursor made by heating limestone and other substances at high temperature. This suggests greenhouse reduction should focus on kiln design and operation. Indirect emissions come from the production processes of immediate suppliers to the sector including lime (4%), electricity (4%), natural gas (3%), road transport (1%) and sand and gravel (1%).

Decisions to invest in production capacity in the cement sector show very strong downstream linkages to sectors such as residential construction, concrete products, mixed concrete, non-residential construction and the water supply and sewage sector. Increases in consumer demand give a strong upstream stimulus to suppliers such as road transport, sand and gravel and wholesale trade.

## Future Trends in Sector

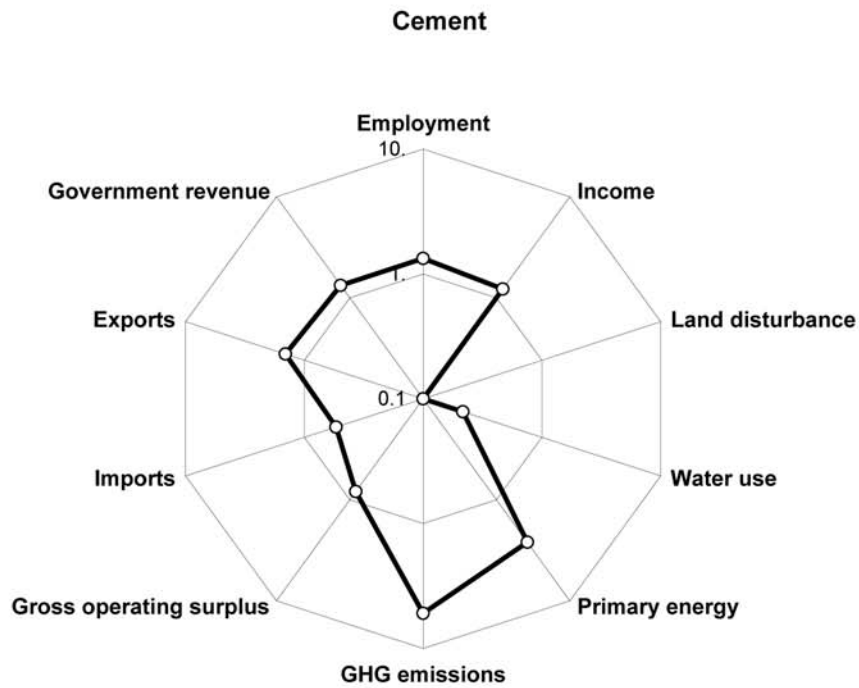
The base case scenario in the CSIRO *Future Dilemmas* study shows a small growth in cement requirements over the next 50 years, perhaps to 8-9 million tonnes per annum. The key drivers are population stabilising at 25.4 million after 2040 and assumptions for building composition similar to today. Policy innovation (eg a MAGLEV train) could vastly increase cement demand, while innovations in recycling, technology and building standards could reduce the amount of cement required per unit of construction activity. Since kilns typically last 40 years or more, the relatively new cement plants could still dominate operations, with some re-fitting, in 50 years time.

## Innovation and Technical Opportunities

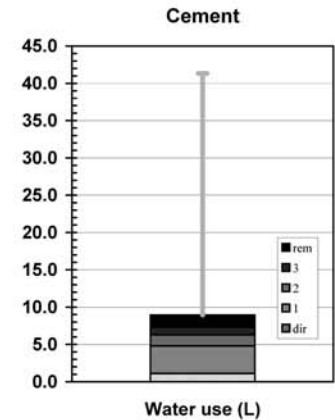
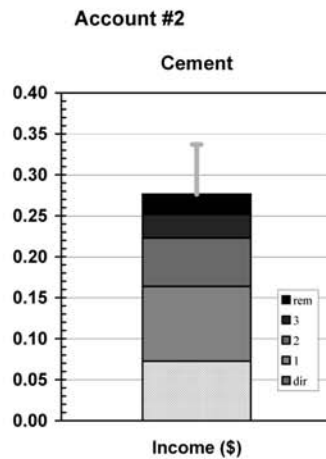
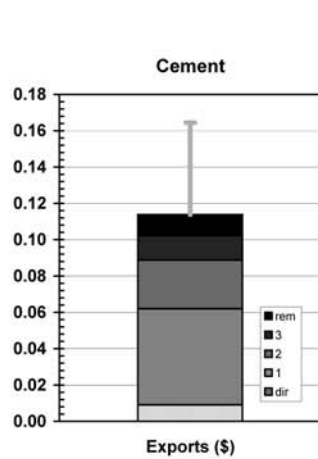
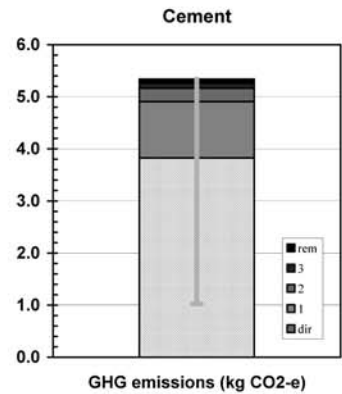
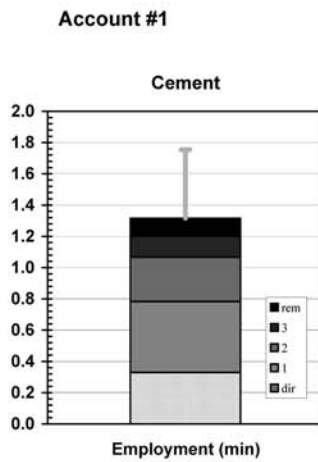
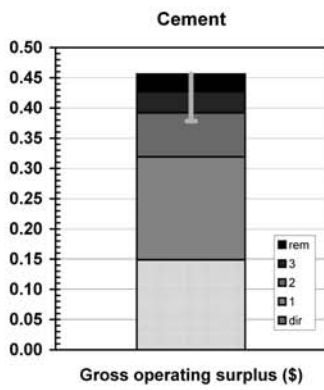
Apart from continual development of Portland-like cements for new applications and structural integrity, much current research is directed to the energy embodied in the cement making process and the resulting greenhouse emissions. The use of fly ash from coal fired electricity plants and integrated steel plants can replace up to 25% of the cement in concrete, and save nearly 10% of energy required for the final service of concrete construction. New forms of cement containing the mineral belite and calcium sulfo-aluminate have much lower energy requirements and carbon dioxide emissions, but weathering problems still need to be solved.

Cement, incl hydraulic and portland, excl adhesive or refractory

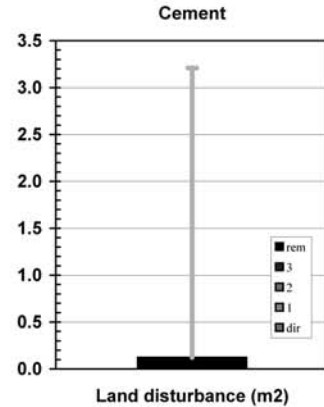
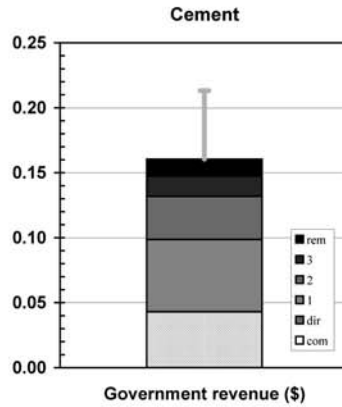
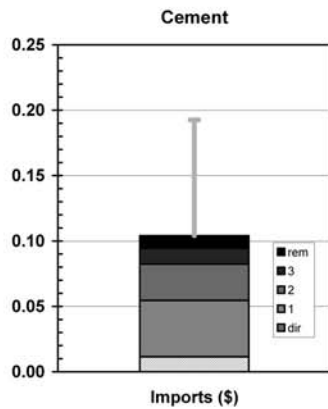
Spider diagram



Bar graphs



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 0.0		
Government final consumption	\$m 0.0		
Gross fixed capital expenditure	\$m 0.0		
Net changes in stocks	\$m 1.1	(0.06% of total)	(\$m 1.1 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 1.1</b>	<b>(0.00% of GNE)</b>	<b>(\$m 1.1 domestically produced)</b>
Exports	\$m 9.4	(0.01% of total)	(\$m 9.4 domestically produced)
<b>Final demand</b>	<b>\$m 10.6</b>	<b>(0.00% of GNT)</b>	<b>(\$m 10.5 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 75.7	(0.04% of total)
Gross operating surplus	\$m 155.3	(0.08% of total)
Taxes less subsidies	\$m 44.9	(0.05% of total)
<b>Sectoral GDP*</b>	<b>\$m 275.9</b>	<b>(0.06% of GDP)</b>
Imports	\$m 12.0	(0.01% of total)
<b>Primary inputs</b>	<b>\$m 287.9</b>	<b>(0.05% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 155.3	(0.08%)	\$m 1.6 (0.00%)	\$m 4.8 (0.00%)
Exports (\$m)	\$m 9.4	(0.01%)	\$m 0.1 (0.00%)	\$m 1.2 (0.00%)
Imports (\$m)	\$m 12.0	(0.01%)	\$m 0.1 (0.00%)	\$m 1.1 (0.00%)
Employment (e-y)	2,750 e-y	(0.04%)	28 e-y (0.00%)	111 e-y (0.00%)
Income (\$m)*	\$m 75.7	(0.04%)	\$m 0.8 (0.00%)	\$m 2.9 (0.00%)
Government revenue (\$m)†	\$m 44.9	(0.04%)	\$m 0.5 (0.00%)	\$m 1.7 (0.00%)
GHG emissions (kt CO <sub>2</sub> -e)	3,994 kt	(0.77%)	40 kt (0.01%)	56 kt (0.01%)
Water use (ML)	1,148 ML	(0.01%)	12 ML (0.00%)	94 ML (0.00%)
Land disturbance (kha)	1 kha	(0.00%)	0 kha (0.00%)	0 kha (0.00%)
Primary energy (TJ)	11,503 TJ	(0.30%)	116 TJ (0.00%)	212 TJ (0.01%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.15	0.46	0.38
Exports (\$)	0.01	0.11	0.16
Imports (\$)	0.01	0.10	0.19
Employment (min)	0.33	1.32	1.75
Income (\$)	0.07	0.28	0.34
Government revenue (\$)	0.04	0.16	0.21
GHG emissions (kg CO <sub>2</sub> -e)	3.83	5.34	1.02
Water use (L)	1.10	8.93	41.32
Land disturbance (m <sup>2</sup> )	0.01	0.12	3.21
Primary energy (MJ)	11.02	20.14	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

### Structural Paths (intensities - commodities)

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Ce	0.149	(0; 33.%)	Ce	0.329	(0; 25.%)	Ce	3.83	(0; 72.%)
Sg Ce	0.0603	(1; 13.%)	Rd Ce	0.185	(1; 14.%)	Lm Ce	0.194	(1; 3.6%)
Rd Ce	0.0315	(1; 6.9%)	Sg Ce	0.0761	(1; 5.8%)	El Ce	0.188	(1; 3.5%)
Ng Ce	0.0152	(1; 3.3%)	Pi Ce	0.0202	(1; 1.5%)	Ga Ce	0.0897	(1; 1.7%)
Ga Ce	0.0131	(1; 2.9%)	Ga Ce	0.0193	(1; 1.5%)	Ng Ce	0.0689	(1; 1.3%)
El Ce	0.0076	(1; 1.7%)	Rd Sg Ce	0.0168	(2; 1.3%)	Rd Ce	0.05	(1; 0.94%)
Rv Rd Ce	0.00296	(2; 0.65%)	Wt Ce	0.0141	(1; 1.1%)	Sg Ce	0.0475	(1; 0.89%)
Rd Sg Ce	0.00286	(2; 0.63%)	Wt Sg Ce	0.0133	(2; 1.%)	Pc Ce	0.00849	(1; 0.16%)
St Ce	0.00259	(1; 0.57%)	Rf Ce	0.0119	(1; 0.9%)	Fr Ce	0.00843	(1; 0.16%)
Pi Ce	0.00252	(1; 0.55%)	Wt Rd Ce	0.00922	(2; 0.7%)	Fo Sg Ce	0.00775	(2; 0.15%)
Cp Ce	0.00252	(1; 0.55%)	Gv Rd Ce	0.00884	(2; 0.67%)	El Pi Ce	0.00735	(2; 0.14%)
Lm Ce	0.00219	(1; 0.48%)	El Ce	0.00845	(1; 0.64%)	El Rd Ce	0.00639	(2; 0.12%)
Cm Rd Ce	0.00214	(2; 0.47%)	Rv Rd Ce	0.00791	(2; 0.6%)	Ce Lm Ce	0.00588	(2; 0.11%)
Wt Ce	0.00196	(1; 0.43%)	Ms Rd Ce	0.00684	(2; 0.52%)	Bl El Ce	0.00474	(2; 0.089%)
Br Ce	0.00191	(1; 0.42%)	Ts Ce	0.00681	(1; 0.52%)	Fo Rd Ce	0.00456	(2; 0.085%)
Oi Pc Ce	0.00185	(2; 0.41%)	Cp Ce	0.00661	(1; 0.5%)	Rd Sg Ce	0.00455	(2; 0.085%)
Wt Sg Ce	0.00185	(2; 0.4%)	Cm Rd Ce	0.00592	(2; 0.45%)	Gd Ce	0.00451	(1; 0.084%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Sg Ce	0.03	(1; 26.%)	Ce	0.0725	(0; 26.%)	Sg Ce	1.53	(1; 17.%)
Rd Ce	0.011	(1; 9.6%)	Rd Ce	0.0319	(1; 12.%)	Ce	1.1	(0; 12.%)
Ce	0.00903	(0; 7.9%)	Sg Ce	0.0128	(1; 4.6%)	El Ce	1.04	(1; 12.%)
Rf Ce	0.00244	(1; 2.1%)	Pi Ce	0.00566	(1; 2.%)	Wa Ce	0.38	(1; 4.3%)
Pc Ce	0.002	(1; 1.8%)	Ga Ce	0.00507	(1; 1.8%)	Br Ce	0.154	(1; 1.7%)
Bl El Ce	0.00184	(2; 1.6%)	Rf Ce	0.00334	(1; 1.2%)	Ng Ce	0.135	(1; 1.5%)
Wt Ce	0.0016	(1; 1.4%)	Wt Ce	0.00303	(1; 1.1%)	Rd Ce	0.132	(1; 1.5%)
Wt Sg Ce	0.00151	(2; 1.3%)	Rd Sg Ce	0.00289	(2; 1.%)	Mn Sg Ce	0.069	(2; 0.77%)
Oi Pc Ce	0.00126	(2; 1.1%)	Wt Sg Ce	0.00285	(2; 1.%)	Wa El Ce	0.0601	(2; 0.67%)
Wt Rd Ce	0.00105	(2; 0.92%)	Ng Ce	0.00254	(1; 0.92%)	El Pi Ce	0.0407	(2; 0.46%)
Rd Sg Ce	0.000996	(2; 0.88%)	El Ce	0.00229	(1; 0.83%)	Wa Ms Rd Ce	0.0393	(3; 0.44%)
Oi Fo Sg Ce	0.000754	(3; 0.66%)	Gv Rd Ce	0.00222	(2; 0.8%)	Wa Ga Ce	0.0381	(2; 0.43%)
Ma Sg Ce	0.000687	(2; 0.6%)	Wt Rd Ce	0.00198	(2; 0.72%)	El Rd Ce	0.0354	(2; 0.4%)
St Ce	0.000641	(1; 0.56%)	Ts Ce	0.00159	(1; 0.58%)	Wa Ms Ce	0.0284	(2; 0.32%)
Eq Sg Ce	0.000582	(2; 0.51%)	Ms Rd Ce	0.00159	(2; 0.58%)	Pp Pa Ce	0.0281	(2; 0.32%)
Mv Rd Ce	0.000464	(2; 0.41%)	Cp Ce	0.00147	(1; 0.53%)	Ws Ho Ce	0.0275	(2; 0.31%)
Oi Fo Rd Ce	0.000443	(3; 0.39%)	Cm Rd Ce	0.00134	(2; 0.49%)	Pa Ce	0.0267	(1; 0.3%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Sg Ce	0.0189	(1; 18.%)	Ce	0.043	(0; 27.%)	Ce	0.00749	(0; 6.1%)
Ce	0.0115	(0; 11.%)	Rd Ce	0.0226	(1; 14.%)	Bc Mp Ho Ce	0.00544	(3; 4.4%)
Rd Ce	0.00799	(1; 7.7%)	Sg Ce	0.0084	(1; 5.2%)	Rd Ce	0.00389	(1; 3.1%)
Pc Ce	0.00426	(1; 4.1%)	Pi Ce	0.0026	(1; 1.6%)	El Ce	0.00304	(1; 2.5%)
Fo Sg Ce	0.00254	(2; 2.4%)	Ga Ce	0.00258	(1; 1.6%)	Bc Mp Ho Sg	0.00273	(4; 2.2%)
Fo Rd Ce	0.00149	(2; 1.4%)	Rd Sg Ce	0.00205	(2; 1.3%)	Fr Ce	0.00271	(1; 2.2%)
Pa Ce	0.00133	(1; 1.3%)	Ng Ce	0.00184	(1; 1.1%)	Bc Mp Ho Rd	0.00266	(4; 2.2%)
Mv Rd Ce	0.00116	(2; 1.1%)	Rf Ce	0.00154	(1; 0.96%)	Rf Ce	0.00168	(1; 1.4%)
Ng Ce	0.00112	(1; 1.1%)	El Ce	0.00143	(1; 0.89%)	Sg Ce	0.00154	(1; 1.2%)
Ga Ce	0.000819	(1; 0.79%)	Wt Ce	0.00141	(1; 0.88%)	Ga Ce	0.00127	(1; 1.%)
Pc Sg Ce	0.000814	(2; 0.78%)	Wt Sg Ce	0.00133	(2; 0.83%)	Fr Sg Ce	0.00116	(2; 0.94%)
Ma Sg Ce	0.000811	(2; 0.78%)	Wt Rd Ce	0.000925	(2; 0.58%)	Sw Pp Pa Ce	0.000907	(3; 0.73%)
Rd Sg Ce	0.000726	(2; 0.7%)	Rv Rd Ce	0.000786	(2; 0.49%)	Wo Mp Ho Ce	0.000614	(3; 0.5%)
Ap Rd Ce	0.000654	(2; 0.63%)	Ts Ce	0.000785	(1; 0.49%)	Wo Tx Pa Ce	0.000565	(3; 0.46%)
Pi Ce	0.000651	(1; 0.63%)	Gv Rd Ce	0.000774	(2; 0.48%)	Ng Ce	0.000564	(1; 0.46%)
Ke Ce	0.000637	(1; 0.61%)	In Sg Ce	0.000767	(2; 0.48%)	Wo Tx Ru Rd	0.000513	(4; 0.42%)
Oc Sg Ce	0.00054	(2; 0.52%)	Ms Rd Ce	0.000756	(2; 0.47%)	Wo Tx Wt Ce	0.000502	(3; 0.41%)

### Linkages (average = 1)

	Value	C.o.V.
Upstream	1.605 ±0.033	(±2.1%)
Downstream	2.017 ±0.049	(±2.4%)

# Sector 26310020: Lime (Lm)

*Lime, incl. quick, hydrated, slaked and agricultural*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is 14 times the economy wide average, while water use and land disturbance are 80% and 95% below average respectively. The social indicators of employment generation, income and government revenue are 25%, 20% and 25% below average respectively. The financial indicators reveal that operating surplus is 20% above average, while export propensity and import penetration are 30% and 50% below average respectively. Lime is a critical input to many industrial processes but lime calcination releases 0.68 tonne of carbon dioxide for each tonne produced. Future carbon constraints may drive a change to less emission intensive materials. The impacts on agricultural applications would need to be considered as lime is also used to treat agricultural soil acidity.

## Sector Description

Limestone (Calcium Carbonate:  $\text{CaCO}_3$ ) and lime (Calcium Oxide:  $\text{CaO}$ ) are important and critical inputs into many industrial processes. Around 16 million tonnes of limestone are produced annually in Australia at over 180 locations. Up to one million tonnes are imported, mostly from Japan, while 250 000 tonnes are exported. Limestone is used for cement making (43%), lime (11%), flux in steel making (6%), agricultural soil amendment (3%), mining and construction (34%) and other uses (2%). The liming process is undertaken in lime kilns that are fired by a variety of fuels, waste and biomass. Calcium carbonate is heated to produce calcium oxide, releasing the greenhouse gas carbon dioxide. This is the sector's main environmental issue. It is difficult to operate kilns optimally because of variation in ore quality and composition and the process dynamics within the kiln. Treating soil acidity in agricultural lands requires the application of one to two tonnes per hectare of lime every five to ten years. While many agricultural soils in Australia are naturally acidic, productive legume pastures that fix nitrogen and the use of industrial nitrogen fertilisers can increase the acidification process. In 2001, it was estimated that soil acidity impacted on 50 million hectares of surface layers and 23 million hectares of subsoil layers of Australia's agricultural zone.

## Place of Industry in the Economy

The lime making sector ranks 135<sup>th</sup> out of 135 sectors in terms of value adding, and contributes 0.01% of GDP in this analysis. It is similar in value adding to the hardwood forestry and mixed fertiliser sectors. Lime is one of the truly intermediate commodities in this analysis and very little of it enters final demand as lime is passed on to other industries for value adding. The strength of the downstream linkages shows this facet. Thus it has small employment in direct terms as well as in terms of its upstream suppliers. However, it does contribute 400 employment years to downstream industries such as pulp and paper, cement manufacture, concrete making, residential building and non-residential construction. It has relatively small resource requirements in national terms as the resource use is passed through to the final commodities. In financial terms, imports and exports are more or less in balance but this is subject to yearly variations.

## Strategic Overview

The spider diagram reveals a number of significant outliers particularly for primary energy use and greenhouse gas emissions. Downstream issues for lime include the large embodiment of carbon dioxide due to the conversion process which is passed onto final products and services. Also lime used in agriculture must be physically mixed into the soil matrix before it can reduce acidification, highlighting future landscape challenges if surface soil acidity progresses deeper into the soil.

## TBL Account #1

The financial indicator of operating surplus is 20% greater than the economy wide average and one third of this is a direct sector effect, with additional contributions from limestone mining (13%), road transport (7%), natural gas (6%), cement production (3%), and electricity production (2%). The social indicator of employment generation is 25% below average and has a similar makeup to the surplus indicator. The environmental indicator of greenhouse emissions is over 14 times the economy wide average. Most of this is a direct effect of the calcination process, which releases 680 kilograms of carbon dioxide for each tonne of lime produced.

## TBL Accounts #2 and #3

The second TBL account reveals that export propensity is 30% below average, income is 20% below average, and water use is 80% below average. The third TBL account reveals that import penetration is 50% below average, government revenue is 25% below average, and land disturbance is 95% below average. All three social indicators are below average however it is difficult to envisage how these might be improved for a number of reasons. Lime production is a capital intensive process producing a bulk material that must be situated close to the industrial processes for which it is a key input. The process efficiency is tightly constrained by both the quality of the limestone ore and the quantity and type of energy input. Improving the social indicators would inevitably increase the market cost of lime which would flow on to important downstream sectors such as cement and concrete thereby increasing the cost of house building and construction.

## Structural Path Analysis and Linkages

The greenhouse emissions content of lime is an important issue particularly as it is passed onto many downstream processes and products. The structural path shows that 90% of the indicator is a direct within sector effect. Energy combustion in the kiln emits one tenth of the direct emissions with the remainder (80% of total) due to the calcination process which releases carbon dioxide from limestone. The energy use in kiln component can be improved by fuel switching, but many kilns already use natural gas which has a lower carbon content. A co-firing approach that uses wastes such as used oil, old tires or sawdust can help reduce greenhouse emissions to the extent that these inputs would otherwise generate methane and carbon dioxide in land fill. However this does not address the calcination component. The long run solution may lie in developing less greenhouse intensive cements and in re-inventing arable agriculture to reduce the rate of soil acidification. Most industrial processes which require lime have recycling or regenerating processes to limit its use.

The stimulus by the lime production sector to its upstream suppliers is 60% greater than average and impacts on sectors such as limestone mining, road freight, cement manufacture, wholesale trade, and plant and vehicle hire. Because it is such a physically essential commodity, the downstream linkages are some of the strongest in this analysis. These linkages are to sectors such as cement, concrete, pulp and paper, residential building and water supply.

## Future Trends in Sector

Under the base case scenario of the *Future Dilemmas* study the total floor space of dwellings, institutional buildings, and commercial space doubles by 2050. The construction driver for lime production will thus be maintained. Also soil acidity requiring lime amelioration will emerge as a key issue in agricultural lands over the next two decades and require large applications of lime.

## Innovation and Technical Opportunities

Given the centrality of lime to construction, purification, agriculture, and industrial processes, its life cycle use and cost may be scrutinised more even though limestone resources are not limited.



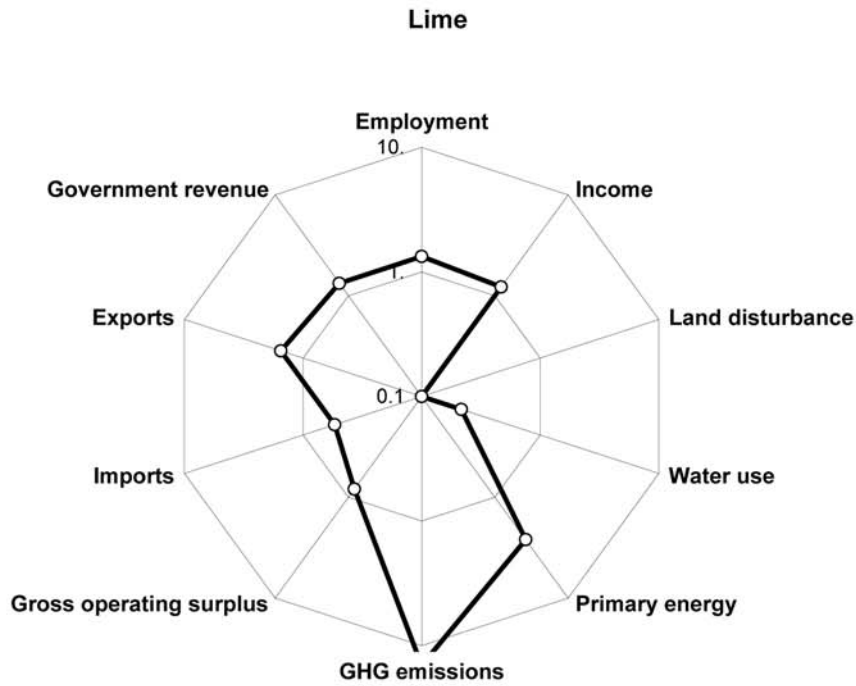
**Sector**

**Lime**

**(Lm)**

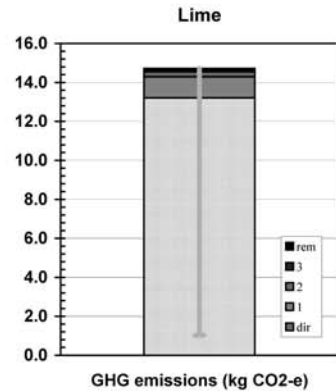
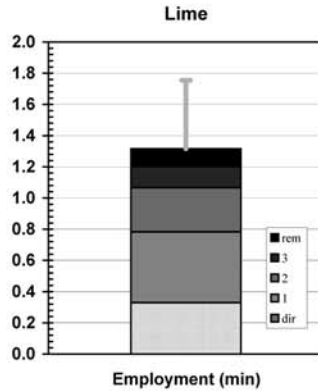
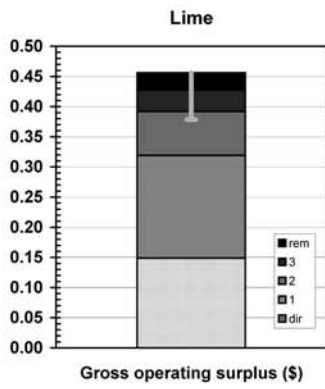
Lime, incl quick, hydrated, slaked and agricultural

**Spider diagram**

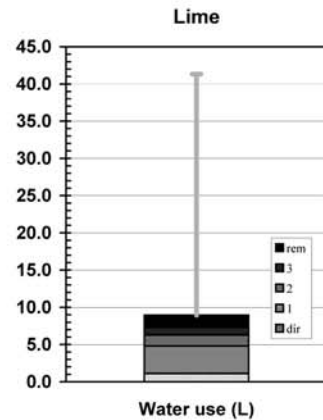
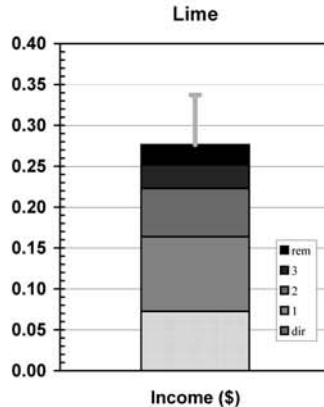
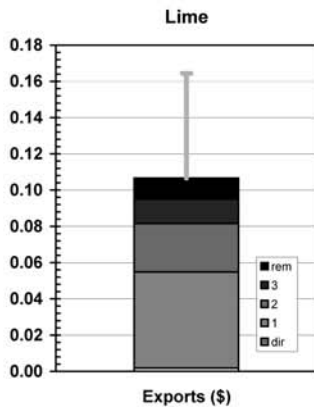


**Bar graphs**

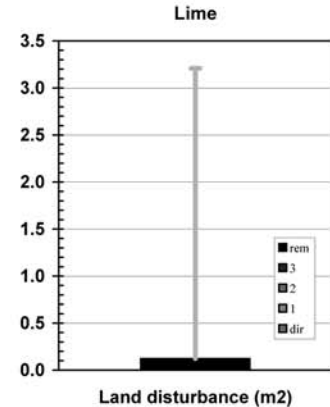
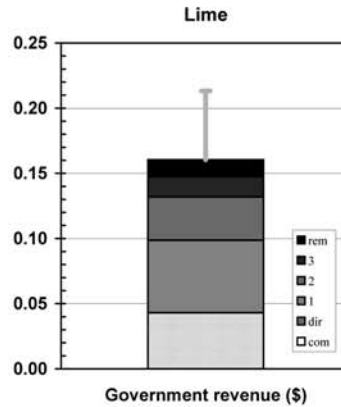
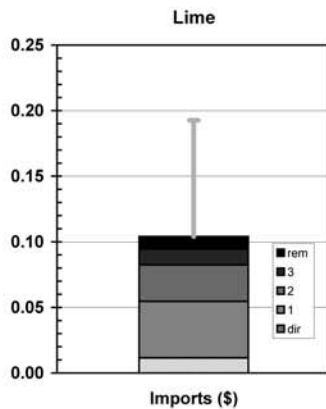
**Account #1**



**Account #2**



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 0.1	(0.00% of total)	(\$m 0.1 domestically produced)
Government final consumption	\$m 0.0		
Gross fixed capital expenditure	\$m 0.0		
Net changes in stocks	\$m 0.4	(0.02% of total)	(\$m 0.4 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 0.5</b>	<b>(0.00% of GNE)</b>	<b>(\$m 0.5 domestically produced)</b>
Exports	\$m 0.3	(0.00% of total)	(\$m 0.3 domestically produced)
<b>Final demand</b>	<b>\$m 0.8</b>	<b>(0.00% of GNT)</b>	<b>(\$m 0.8 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 11.1	(0.01% of total)
Gross operating surplus	\$m 22.8	(0.01% of total)
Taxes less subsidies	\$m 6.6	(0.01% of total)
<b>Sectoral GDP*</b>	<b>\$m 40.4</b>	<b>(0.01% of GDP)</b>
Imports	\$m 1.8	(0.00% of total)
<b>Primary inputs</b>	<b>\$m 42.2</b>	<b>(0.01% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 22.8	(0.01%)	\$m 0.1 (0.00%)	\$m 0.3 (0.00%)
Exports (\$m)	\$m 0.3	(0.00%)	\$m 0.0 (0.00%)	\$m 0.1 (0.00%)
Imports (\$m)	\$m 1.8	(0.00%)	\$m 0.0 (0.00%)	\$m 0.1 (0.00%)
Employment (e-y)	403 e-y	(0.01%)	2 e-y (0.00%)	8 e-y (0.00%)
Income (\$m)*	\$m 11.1	(0.01%)	\$m 0.1 (0.00%)	\$m 0.2 (0.00%)
Government revenue (\$m)†	\$m 6.6	(0.01%)	\$m 0.0 (0.00%)	\$m 0.1 (0.00%)
GHG emissions (kt CO <sub>2</sub> -e)	2,020 kt	(0.39%)	10 kt (0.00%)	11 kt (0.00%)
Water use (ML)	168 ML	(0.00%)	1 ML (0.00%)	7 ML (0.00%)
Land disturbance (kha)	0 kha	(0.00%)	0 kha (0.00%)	0 kha (0.00%)
Primary energy (TJ)	1,686 TJ	(0.04%)	8 TJ (0.00%)	15 TJ (0.00%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*	
	direct	total
Gross operating surplus (\$)	0.15	0.46
Exports (\$)	0.00	0.11
Imports (\$)	0.01	0.10
Employment (min)	0.33	1.32
Income (\$)	0.07	0.28
Government revenue (\$)	0.04	0.16
GHG emissions (kg CO <sub>2</sub> -e)	13.20	14.72
Water use (L)	1.10	8.93
Land disturbance (m <sup>2</sup> )	0.01	0.12
Primary energy (MJ)	11.02	20.14

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Nation-wide average
total
0.38
0.16
0.19
1.75
0.34
0.21
1.02
41.32
3.21
7.65

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Lm	0.149	(0; 33.%)	Lm	0.329	(0; 25.%)	Lm	13.2	(0; 90.%)
Sg Lm	0.0603	(1; 13.%)	Rd Lm	0.185	(1; 14.%)	Ce Lm	0.399	(1; 2.7%)
Rd Lm	0.0315	(1; 6.9%)	Sg Lm	0.0761	(1; 5.8%)	El Lm	0.188	(1; 1.3%)
Ce Lm	0.0155	(1; 3.4%)	Ce Lm	0.0343	(1; 2.6%)	Ga Lm	0.0897	(1; 0.61%)
Ng Lm	0.0152	(1; 3.3%)	Pi Lm	0.0202	(1; 1.5%)	Ng Lm	0.0689	(1; 0.47%)
Ga Lm	0.0131	(1; 2.9%)	Rd Ce Lm	0.0193	(2; 1.5%)	Rd Lm	0.05	(1; 0.34%)
El Lm	0.0076	(1; 1.7%)	Ga Lm	0.0193	(1; 1.5%)	Sg Lm	0.0475	(1; 0.32%)
Sg Ce Lm	0.00629	(2; 1.4%)	Rd Sg Lm	0.0168	(2; 1.3%)	Lm Ce Lm	0.0203	(2; 0.14%)
Rd Ce Lm	0.00329	(2; 0.72%)	Wt Lm	0.0141	(1; 1.1%)	El Ce Lm	0.0196	(2; 0.13%)
Rv Rd Lm	0.00296	(2; 0.65%)	Wt Sg Lm	0.0133	(2; 1.0%)	Ga Ce Lm	0.00936	(2; 0.064%)
Rd Sg Lm	0.00286	(2; 0.63%)	Rf Lm	0.0119	(1; 0.9%)	Pc Lm	0.00849	(1; 0.058%)
St Lm	0.00259	(1; 0.57%)	Wt Rd Lm	0.00922	(2; 0.7%)	Fr Lm	0.00843	(1; 0.057%)
Pi Lm	0.00252	(1; 0.55%)	Gv Rd Lm	0.00884	(2; 0.67%)	Fo Sg Lm	0.00775	(2; 0.053%)
Cp Lm	0.00252	(1; 0.55%)	El Lm	0.00845	(1; 0.64%)	El Pi Lm	0.00735	(2; 0.05%)
Cm Rd Lm	0.00214	(2; 0.47%)	Sg Ce Lm	0.00794	(2; 0.6%)	Ng Ce Lm	0.00719	(2; 0.049%)
Wt Lm	0.00196	(1; 0.43%)	Rv Rd Lm	0.00791	(2; 0.6%)	El Rd Lm	0.00639	(2; 0.043%)
Br Lm	0.00191	(1; 0.42%)	Ms Rd Lm	0.00684	(2; 0.52%)	Rd Ce Lm	0.00522	(2; 0.035%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Sg Lm	0.03	(1; 28.%)	Lm	0.0725	(0; 26.%)	Sg Lm	1.53	(1; 17.%)
Rd Lm	0.011	(1; 10.%)	Rd Lm	0.0319	(1; 12.%)	Lm	1.1	(0; 12.%)
Sg Ce Lm	0.00313	(2; 2.9%)	Sg Lm	0.0128	(1; 4.6%)	El Lm	1.04	(1; 12.%)
Rf Lm	0.00244	(1; 2.3%)	Ce Lm	0.00757	(1; 2.7%)	Wa Lm	0.38	(1; 4.3%)
Pc Lm	0.002	(1; 1.9%)	Pi Lm	0.00566	(1; 2.0%)	Sg Ce Lm	0.159	(2; 1.8%)
Bl El Lm	0.00184	(2; 1.7%)	Ga Lm	0.00507	(1; 1.8%)	Br Lm	0.154	(1; 1.7%)
Lm	0.00182	(0; 1.7%)	Rf Lm	0.00334	(1; 1.2%)	Ng Lm	0.135	(1; 1.5%)
Wt Lm	0.0016	(1; 1.5%)	Rd Ce Lm	0.00333	(2; 1.2%)	Rd Lm	0.132	(1; 1.5%)
Wt Sg Lm	0.00151	(2; 1.4%)	Wt Lm	0.00303	(1; 1.1%)	Ce Lm	0.115	(1; 1.3%)
Oi Pc Lm	0.00126	(2; 1.2%)	Rd Sg Lm	0.00289	(2; 1.0%)	El Ce Lm	0.109	(2; 1.2%)
Rd Ce Lm	0.00114	(2; 1.1%)	Wt Sg Lm	0.00285	(2; 1.0%)	Mn Sg Lm	0.069	(2; 0.77%)
Wt Rd Lm	0.00105	(2; 0.98%)	Ng Lm	0.00254	(1; 0.92%)	Wa El Lm	0.0601	(2; 0.67%)
Rd Sg Lm	0.000996	(2; 0.93%)	El Lm	0.00229	(1; 0.83%)	El Pi Lm	0.0407	(2; 0.46%)
Ce Lm	0.000943	(1; 0.88%)	Gv Rd Lm	0.00222	(2; 0.8%)	Wa Ce Lm	0.0396	(2; 0.44%)
Oi Fo Sg Lm	0.000754	(3; 0.71%)	Wt Rd Lm	0.00198	(2; 0.72%)	Wa Ms Rd Lm	0.0393	(3; 0.44%)
Ma Sg Lm	0.000687	(2; 0.64%)	Ts Lm	0.00159	(1; 0.58%)	Wa Ga Lm	0.0381	(2; 0.43%)
St Lm	0.000641	(1; 0.6%)	Ms Rd Lm	0.00159	(2; 0.58%)	El Rd Lm	0.0354	(2; 0.4%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Sg Lm	0.0189	(1; 18.%)	Lm	0.043	(0; 27.%)	Lm	0.00749	(0; 6.1%)
Lm	0.0115	(0; 11.%)	Rd Lm	0.0226	(1; 14.%)	Bc Mp Ho Lm	0.00544	(3; 4.4%)
Rd Lm	0.00799	(1; 7.7%)	Sg Lm	0.0084	(1; 5.2%)	Rd Lm	0.00389	(1; 3.1%)
Pc Lm	0.00426	(1; 4.1%)	Ce Lm	0.00449	(1; 2.8%)	El Lm	0.00304	(1; 2.5%)
Fo Sg Lm	0.00254	(2; 2.4%)	Pi Lm	0.0026	(1; 1.6%)	Bc Mp Ho Sg	0.00273	(4; 2.2%)
Sg Ce Lm	0.00197	(2; 1.9%)	Ga Lm	0.00258	(1; 1.6%)	Fr Lm	0.00271	(1; 2.2%)
Fo Rd Lm	0.00149	(2; 1.4%)	Rd Ce Lm	0.00236	(2; 1.5%)	Bc Mp Ho Rd	0.00266	(4; 2.2%)
Pa Lm	0.00133	(1; 1.3%)	Rd Sg Lm	0.00205	(2; 1.3%)	Rf Lm	0.00168	(1; 1.4%)
Ce Lm	0.0012	(1; 1.2%)	Ng Lm	0.00184	(1; 1.1%)	Sg Lm	0.00154	(1; 1.2%)
Mv Rd Lm	0.00116	(2; 1.1%)	Rf Lm	0.00154	(1; 0.96%)	Ga Lm	0.00127	(1; 1.0%)
Ng Lm	0.00112	(1; 1.1%)	El Lm	0.00143	(1; 0.89%)	Fr Sg Lm	0.00116	(2; 0.94%)
Rd Ce Lm	0.000834	(2; 0.8%)	Wt Lm	0.00141	(1; 0.88%)	Sw Pp Pa Lm	0.000907	(3; 0.73%)
Ga Lm	0.000819	(1; 0.79%)	Wt Sg Lm	0.00133	(2; 0.83%)	Ce Lm	0.000782	(1; 0.63%)
Pc Sg Lm	0.000814	(2; 0.78%)	Wt Rd Lm	0.000925	(2; 0.58%)	Wo Mp Ho Lm	0.000614	(3; 0.5%)
Ma Sg Lm	0.000811	(2; 0.78%)	Sg Ce Lm	0.000877	(2; 0.55%)	Bc Mp Ho Ce	0.000568	(4; 0.46%)
Rd Sg Lm	0.000726	(2; 0.7%)	Rv Rd Lm	0.000786	(2; 0.49%)	Wo Tx Pa Lm	0.000565	(3; 0.46%)
Ap Rd Lm	0.000654	(2; 0.63%)	Ts Lm	0.000785	(1; 0.49%)	Ng Lm	0.000564	(1; 0.46%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.605 ±0.033	(±2.1%)
Downstream	2.065 ±0.038	(±1.8%)

# Sector 2603: Concrete and Mortar (Cc)

*Ready mixed concrete and mortar*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is more than twice the economy wide average, while water use and land disturbance are 80% and 95% below average respectively. The social indicators of employment generation, income and government revenue are respectively 25%, 20% and 25% below average. The financial indicators show an operating surplus 20% above average, export propensity 30% below average and import penetration 50% below average. The sector is capital intensive with strong competition between a limited number of national players and reveals lower than average social indicators. This is a typical pattern for a number of basic resource sectors. Improvements in environmental performance could focus on greenhouse issues where the production chain analysis reveals 34% of emissions are direct from energy use within the sector, while 50% of emissions come from sector's suppliers such as cement manufacture, lime, electricity and gas.

## Sector Description

The current annual requirement for mixed concrete of all types varies from 45 to 55 million tonnes per year depending on the business cycle and levels of demand in different building and construction sectors. On the basis of building activity, industry sources suggest that dwellings represent 60% of activity, non-dwellings 30% and roads etc. 10% by dollar value. Financial activity does not match concrete requirements exactly but it may indicate the order of difference. In 2002, the sector had a financial turnover of \$3 billion and involved over 200 enterprises. Sector activity is strongly linked to state population number, population growth rates and construction activity, and is dominated by New South Wales (32%), Queensland (23%) and Victoria (22%).

## Place of Industry in the Economy

The concrete making sector ranks 96<sup>th</sup> out of 135 sectors in terms of value adding in the economy and contributes 0.12% to GDP in this analysis. It is a relatively small employment generator and contributes 5 000 employment years to downstream sectors, principally residential building and non-residential construction. The sector's national requirement for land disturbance, water use, energy use and greenhouse emissions are less than one tenth of one percent each. In physical terms it is difficult to imagine a modern built environment without concrete. Its linkages to upstream activities such as cement and lime production, and downstream structural sectors such as pipes and construction, suggest it provides a pivotal enabling capacity for a wide range of economic and manufacturing activity. Its low contribution to financial value adding considerably understates its physical worth.

## Strategic Overview

The integrated picture provided by the spider diagram shows the environmental indicators of greenhouse emissions and energy use as outliers, and below average performance for the three social indicators of employment generation, income and government revenue. The process and composition of cement manufacture links the sector's upstream and downstream issues. The energy and greenhouse intensity of the upstream clinker production process is progressively embodied in the final downstream construction process. There are many options for improvement such as lighter construction approaches and replacing cement with fly ash from steel making and electricity production. Less massive designs based on recycled wood and other materials are also possible.

## TBL Account #1

The financial indicator of operating surplus is 20% above the economy wide average and one third of this effect is direct. Smaller indirect effects are due to sand and gravel, road transport and natural gas production and distribution. The social indicator of employment generation is 25% below average with one fifth being a direct effect. The industry is capital intensive with strong price competition between four major suppliers and a large number of smaller firms, and thus seeks high levels of labour use efficiency. The environmental indicator of greenhouse emissions is over twice the economy wide average with one third the direct effect of energy combustion in the sector, and additional contributions from key suppliers such as cement manufacture, lime, electricity, gas and road transport.

## TBL Accounts #2 and #3

In the second TBL account, export propensity is 30% below average since the sector is basically a domestic physical activity. However some concrete majors have invested overseas so future analyses may show improvement in this indicator if financial activity is reported in Australia. The income indicator is 20% below average with only one fifth a direct effect and the rest due to the sector's supply chain. The water indicator is 80% below average with most of the effect due to the supply chain. In the third TBL account, import penetration is 50% below average, the government revenue indicator is 25% below average while the land disturbance indicator is negligible.

## Structural Path Analysis and Linkages

The concrete sector's greenhouse emissions indicator is more than twice the economy-wide average. An examination of the structural path reveals that operations within the sector contribute 34% of emissions. Immediate suppliers to the sector such as cement manufacture (17%), lime (8%), electricity (8%), natural gas (7%), road transport (2%) and sand and gravel (2%) are important, and offer opportunities for innovation and improvement back along the production chain.

Increases in consumer demand for products from the concrete sector give a strong upstream stimulus to the sector's suppliers and in particular the road transport, sand and gravel and wholesale trade sectors. Decisions to invest in the sector's capacity show a stronger than average downstream linkage to obvious sectors such as residential and non-residential construction.

## Future Trends in Sector

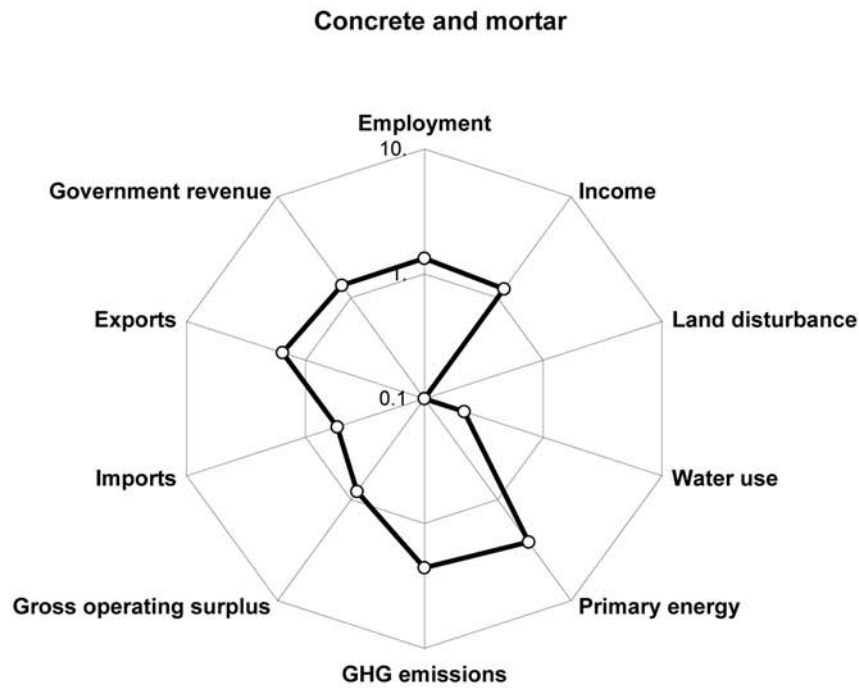
While the sector displays regular cyclical activity on top of an underlying growth trend, the base case scenario in the CSIRO *Future Dilemmas* study points to a relatively stable future as the population (and thus underlying physical requirements) stabilises past 2030. Parallel to this are construction innovations which use less material for the same structural integrity. Some industry leaders may locate activities in countries such as China, in order to facilitate continuing business expansion. A decision to substantially redesign urban Australia to reduce fossil energy use and subsequent greenhouse emissions may change this prognosis of relative stability, as will substantially higher or lower population growth rates.

## Innovation and Technical Opportunities

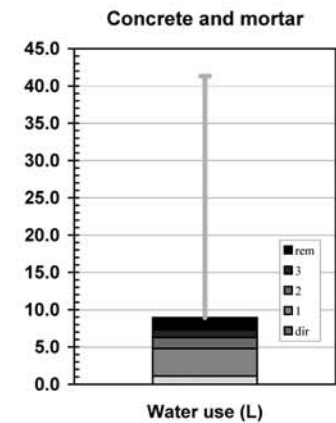
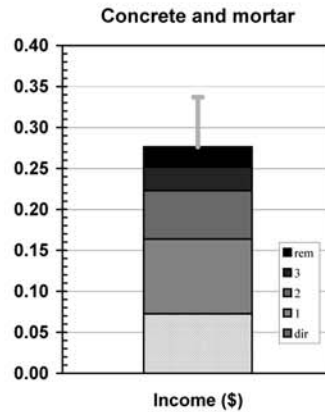
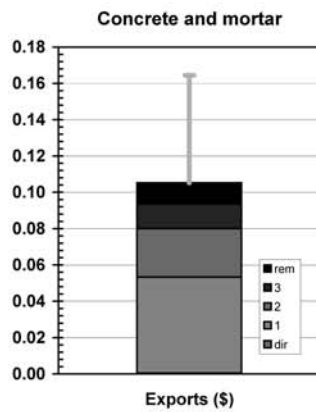
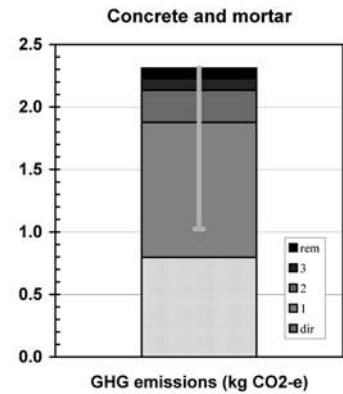
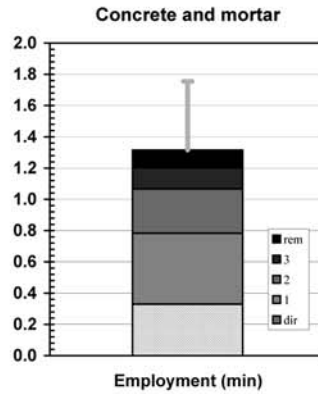
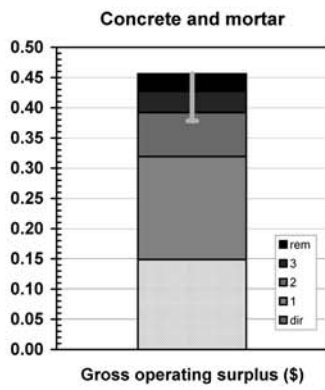
Greenhouse issues may spur innovation in the concrete sector covering the complete production chain as suggested by the structural path analysis. However greenhouse mitigation policies may also force changes in the composition of domestic housing towards lighter materials such as wood, which tend to have a lower greenhouse content for the complete life cycle of a house. Recycling of used concrete is standard industry practice in many large re-construction sites. This trend will increase as construction materials in cities have to be transported over longer distances.

Ready mixed concrete and mortar

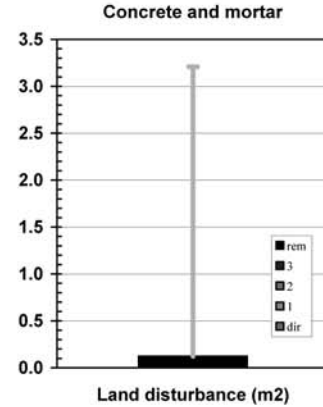
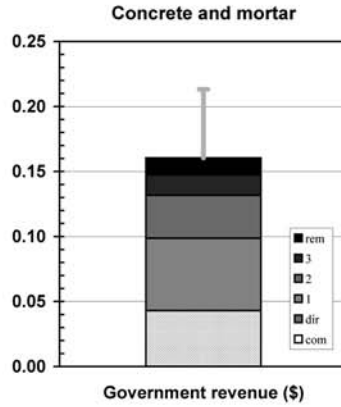
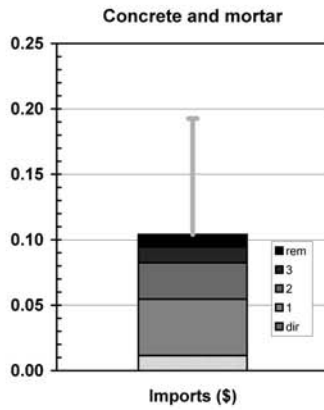
Spider diagram



Bar graphs



Account #3



National Accounts extracts

Receipts: GNT(E) - commodities

Private final consumption	\$m 1.1	(0.00% of total)	(\$m 1.1 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 11.8	(0.01% of total)	(\$m 11.8 domestically produced)
Net changes in stocks	\$m 12.8	(0.73% of total)	(\$m 12.8 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 25.8</b>	<b>(0.01% of GNE)</b>	<b>(\$m 25.8 domestically produced)</b>
Exports	\$m 0.8	(0.00% of total)	(\$m 0.8 domestically produced)
Final demand	\$m 26.5	(0.00% of GNT)	(\$m 26.5 domestically produced)

Costs: GNT(I) - industries

Wages and salaries	\$m 143.6	(0.08% of total)
Gross operating surplus	\$m 294.5	(0.15% of total)
Taxes less subsidies	\$m 85.2	(0.10% of total)
<b>Sectoral GDP*</b>	<b>\$m 523.3</b>	<b>(0.12% of GDP)</b>
Imports	\$m 22.8	(0.02% of total)
<b>Primary inputs</b>	<b>\$m 546.1</b>	<b>(0.10% of GNT)</b>

\* Sectoral gross value added + net taxes on products

TBL factors

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 294.5	(0.15%)	\$m 3.9 (0.00%)	\$m 12.1 (0.01%)
Exports (\$m)	\$m 0.8	(0.00%)	\$m 0.0 (0.00%)	\$m 2.8 (0.00%)
Imports (\$m)	\$m 22.8	(0.02%)	\$m 0.3 (0.00%)	\$m 2.8 (0.00%)
Employment (e-y)	5,216 e-y	(0.07%)	70 e-y (0.00%)	280 e-y (0.00%)
Income (\$m)*	\$m 143.6	(0.08%)	\$m 1.9 (0.00%)	\$m 7.3 (0.00%)
Government revenue (\$m)†	\$m 85.2	(0.08%)	\$m 1.1 (0.00%)	\$m 4.3 (0.00%)
GHG emissions (kt CO <sub>2</sub> -e)	1,576 kt	(0.30%)	21 kt (0.00%)	61 kt (0.01%)
Water use (ML)	2,176 ML	(0.01%)	29 ML (0.00%)	237 ML (0.00%)
Land disturbance (kha)	1 kha	(0.00%)	0 kha (0.00%)	0 kha (0.00%)
Primary energy (TJ)	21,817 TJ	(0.56%)	293 TJ (0.01%)	535 TJ (0.01%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

TBL multipliers - commodities

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.15	0.46	0.38
Exports (\$)	0.00	0.11	0.16
Imports (\$)	0.01	0.10	0.19
Employment (min)	0.33	1.32	1.75
Income (\$)	0.07	0.28	0.34
Government revenue (\$)	0.04	0.16	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.80	2.31	1.02
Water use (L)	1.10	8.93	41.32
Land disturbance (m <sup>2</sup> )	0.01	0.12	3.21
Primary energy (MJ)	11.02	20.14	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Cc	0.149	(0; 33.%)	Cc	0.329	(0; 25.%)	Cc	0.796	(0; 34.%)
Sg Cc	0.0603	(1; 13.%)	Rd Cc	0.185	(1; 14.%)	Ce Cc	0.399	(1; 17.%)
Rd Cc	0.0315	(1; 6.9%)	Sg Cc	0.0761	(1; 5.8%)	Lm Cc	0.194	(1; 8.4%)
Ce Cc	0.0155	(1; 3.4%)	Ce Cc	0.0343	(1; 2.6%)	El Cc	0.188	(1; 8.1%)
Ng Cc	0.0152	(1; 3.3%)	Pi Cc	0.0202	(1; 1.5%)	Ga Cc	0.0897	(1; 3.9%)
Ga Cc	0.0131	(1; 2.9%)	Rd Ce Cc	0.0193	(2; 1.5%)	Ng Cc	0.0689	(1; 3.%)
El Cc	0.0076	(1; 1.7%)	Ga Cc	0.0193	(1; 1.5%)	Rd Cc	0.05	(1; 2.2%)
Sg Ce Cc	0.00629	(2; 1.4%)	Rd Sg Cc	0.0168	(2; 1.3%)	Sg Cc	0.0475	(1; 2.1%)
Rd Ce Cc	0.00329	(2; 0.72%)	Wt Cc	0.0141	(1; 1.1%)	Lm Ce Cc	0.0203	(2; 0.88%)
Rv Rd Cc	0.00296	(2; 0.65%)	Wt Sg Cc	0.0133	(2; 1.%)	El Ce Cc	0.0196	(2; 0.85%)
Rd Sg Cc	0.00286	(2; 0.63%)	Rf Cc	0.0119	(1; 0.9%)	Ga Ce Cc	0.00936	(2; 0.41%)
St Cc	0.00259	(1; 0.57%)	Wt Rd Cc	0.00922	(2; 0.7%)	Pc Cc	0.00849	(1; 0.37%)
Pi Cc	0.00252	(1; 0.55%)	Gv Rd Cc	0.00884	(2; 0.67%)	Fr Cc	0.00843	(1; 0.36%)
Cp Cc	0.00252	(1; 0.55%)	El Cc	0.00845	(1; 0.64%)	Fo Sg Cc	0.00775	(2; 0.34%)
Lm Cc	0.00219	(1; 0.48%)	Sg Ce Cc	0.00794	(2; 0.6%)	El Pi Cc	0.00735	(2; 0.32%)
Cm Rd Cc	0.00214	(2; 0.47%)	Rv Rd Cc	0.00791	(2; 0.6%)	Ng Ce Cc	0.00719	(2; 0.31%)
Wt Cc	0.00196	(1; 0.43%)	Ms Rd Cc	0.00684	(2; 0.52%)	El Rd Cc	0.00639	(2; 0.28%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Sg Cc	0.03	(1; 28.%)	Cc	0.0725	(0; 26.%)	Sg Cc	1.53	(1; 17.%)
Rd Cc	0.011	(1; 10.%)	Rd Cc	0.0319	(1; 12.%)	Cc	1.1	(0; 12.%)
Sg Ce Cc	0.00313	(2; 3.%)	Sg Cc	0.0128	(1; 4.6%)	El Cc	1.04	(1; 12.%)
Rf Cc	0.00244	(1; 2.3%)	Ce Cc	0.00757	(1; 2.7%)	Wa Cc	0.38	(1; 4.3%)
Pc Cc	0.002	(1; 1.9%)	Pi Cc	0.00566	(1; 2.%)	Sg Ce Cc	0.159	(2; 1.8%)
Bl El Cc	0.00184	(2; 1.7%)	Ga Cc	0.00507	(1; 1.8%)	Br Cc	0.154	(1; 1.7%)
Wt Cc	0.0016	(1; 1.5%)	Rf Cc	0.00334	(1; 1.2%)	Ng Cc	0.135	(1; 1.5%)
Wt Sg Cc	0.00151	(2; 1.4%)	Rd Ce Cc	0.00333	(2; 1.2%)	Rd Cc	0.132	(1; 1.5%)
Oi Pc Cc	0.00126	(2; 1.2%)	Wt Cc	0.00303	(1; 1.1%)	Ce Cc	0.115	(1; 1.3%)
Rd Ce Cc	0.00114	(2; 1.1%)	Rd Sg Cc	0.00289	(2; 1.%)	El Ce Cc	0.109	(2; 1.2%)
Wt Rd Cc	0.00105	(2; 1.%)	Wt Sg Cc	0.00285	(2; 1.%)	Mn Sg Cc	0.069	(2; 0.77%)
Rd Sg Cc	0.000996	(2; 0.95%)	Ng Cc	0.00254	(1; 0.92%)	Wa El Cc	0.0601	(2; 0.67%)
Ce Cc	0.000943	(1; 0.9%)	El Cc	0.00229	(1; 0.83%)	El Pi Cc	0.0407	(2; 0.46%)
Oi Fo Sg Cc	0.000754	(3; 0.72%)	Gv Rd Cc	0.00222	(2; 0.8%)	Wa Ce Cc	0.0396	(2; 0.44%)
Ma Sg Cc	0.000687	(2; 0.65%)	Wt Rd Cc	0.00198	(2; 0.72%)	Wa Ms Rd Cc	0.0393	(3; 0.44%)
St Cc	0.000641	(1; 0.61%)	Ts Cc	0.00159	(1; 0.58%)	Wa Ga Cc	0.0381	(2; 0.43%)
Eq Sg Cc	0.000582	(2; 0.55%)	Ms Rd Cc	0.00159	(2; 0.58%)	El Rd Cc	0.0354	(2; 0.4%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Sg Cc	0.0189	(1; 18.%)	Cc	0.043	(0; 27.%)	Cc	0.00749	(0; 6.1%)
Cc	0.0115	(0; 11.%)	Rd Cc	0.0226	(1; 14.%)	Bc Mp Ho Cc	0.00544	(3; 4.4%)
Rd Cc	0.00799	(1; 7.7%)	Sg Cc	0.0084	(1; 5.2%)	Rd Cc	0.00389	(1; 3.1%)
Pc Cc	0.00426	(1; 4.1%)	Ce Cc	0.00449	(1; 2.8%)	El Cc	0.00304	(1; 2.5%)
Fo Sg Cc	0.00254	(2; 2.4%)	Pi Cc	0.0026	(1; 1.6%)	Bc Mp Ho Sg	0.00273	(4; 2.2%)
Sg Ce Cc	0.00197	(2; 1.9%)	Ga Cc	0.00258	(1; 1.6%)	Fr Cc	0.00271	(1; 2.2%)
Fo Rd Cc	0.00149	(2; 1.4%)	Rd Ce Cc	0.00236	(2; 1.5%)	Bc Mp Ho Rd	0.00266	(4; 2.2%)
Pa Cc	0.00133	(1; 1.3%)	Rd Sg Cc	0.00205	(2; 1.3%)	Rf Cc	0.00168	(1; 1.4%)
Ce Cc	0.0012	(1; 1.2%)	Ng Cc	0.00184	(1; 1.1%)	Sg Cc	0.00154	(1; 1.2%)
Mv Rd Cc	0.00116	(2; 1.1%)	Rf Cc	0.00154	(1; 0.96%)	Ga Cc	0.00127	(1; 1.%)
Ng Cc	0.00112	(1; 1.1%)	El Cc	0.00143	(1; 0.89%)	Fr Sg Cc	0.00116	(2; 0.94%)
Rd Ce Cc	0.000834	(2; 0.8%)	Wt Cc	0.00141	(1; 0.88%)	Sw Pp Pa Cc	0.000907	(3; 0.73%)
Ga Cc	0.000819	(1; 0.79%)	Wt Sg Cc	0.00133	(2; 0.83%)	Ce Cc	0.000782	(1; 0.63%)
Pc Sg Cc	0.000814	(2; 0.78%)	Wt Rd Cc	0.000925	(2; 0.58%)	Wo Mp Ho Cc	0.000614	(3; 0.5%)
Ma Sg Cc	0.000811	(2; 0.78%)	Sg Ce Cc	0.000877	(2; 0.55%)	Bc Mp Ho Ce	0.000568	(4; 0.46%)
Rd Sg Cc	0.000726	(2; 0.7%)	Rv Rd Cc	0.000786	(2; 0.49%)	Wo Tx Pa Cc	0.000565	(3; 0.46%)
Ap Rd Cc	0.000654	(2; 0.63%)	Ts Cc	0.000785	(1; 0.49%)	Ng Cc	0.000564	(1; 0.46%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.605 ±0.033	(±2.1%)
Downstream	1.179 ±0.057	(±4.8%)



# Sector 2604: Plaster and Other Concrete Products (Cp)

*Plaster board, sheet, panels, tiles; concrete pipes, bricks, blocks, boards, tiles and other concrete products*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is 5% above average, while those of water use and land disturbance are 80% and 95% below average respectively. The social indicators reveal that employment generation is 20% below average, income is 15% below average, and government revenue is 30% below average. For the financial indicators, the operating surplus is 25% above average while the export propensity and import penetration are both 40% below average. The export indicator is less pertinent due to the bulky and local nature of the product. A number of externally driven environmental issues such as soil salinity and acidification, and urban air pollution, may require design responses from the sector.

## Sector Description

This sector manufactures a wide range of plaster and concrete products including plaster board used in the internal cladding of most buildings, acoustic tiles, box culverts, concrete pipes, concrete blocks and bricks, and railway sleepers. Industry sources suggest that the yearly production of plasterboard and fibre cement is 200 million m<sup>2</sup> and concrete roof tiles is 7 million m<sup>2</sup>. Physical production information on concrete pipes and blocks is difficult to obtain. The recently completed 1420 km Alice Springs to Darwin railway required 2 million sleepers and 1 500 culverts. Water and sewage pipelines in Australia, many of them concrete, total 300 000 km. A significant proportion of this infrastructure will require replacement or refurbishment in the next decade because of its age. Financial turnover was around \$3 billion in 2002 and involved about 300 enterprises. Plaster products make up 24% of this turnover, concrete pipes and culverts 12%, and concrete blocks 64%.

## Place of Industry in the Economy

The plaster and concrete products sector ranks 66<sup>th</sup> out of 135 sectors in terms of value adding in the economy, and contributes 0.23% of GDP in this analysis. It is similar in the extent of value adding to the sectors of agricultural and mining machinery, and sheet metal products. The employment effect is relatively small with 300 employment years directly embodied in final demand, and another 300 years in the sector's upstream suppliers, giving a total of 600 employment years. However the sector contributes 11 000 employment years to downstream industries such as residential building and non-residential construction. The sector has relatively small resource requirements with less than one tenth of one percent of national water use, land disturbance, energy use and greenhouse emissions. In financial terms, imports are four times greater than exports.

## Strategic Overview

The integrated overview in the spider diagram shows a reasonable TBL report with below average performance for exports, government revenue and employment. The export indicator is less pertinent since the bulky nature of the product essentially defines it as a local product, manufactured close to sources of building demand. Downstream issues for the sector's products focus on their long term performance in environments for which they may not have been designed. Investigation of concrete pipes and their steel reinforcing may be required in many agricultural zones in Australia where soil salinity and acidification may eventually give more corrosive conditions.

## TBL Account #1

The financial indicator of operating surplus is 25% above the economy wide average and one half of this is a direct sector effect with additional contributions from sand and gravel (7%), road transport (3%) and cement manufacture (3%). The social indicator of employment generation is 10% below average with a similar composition to the surplus indicator. The environmental indicator of greenhouse emissions is 15% above average and the emissions chain is described below.

## TBL Accounts #2 and #3

The second TBL account reveals that the export propensity is 40% below average, the income indicator is equal to average and the water use indicator is 80% below average. The third TBL account reveals that import penetration is 40% below average, government revenue is 70% below average and land disturbance is 95% below average.

## Structural Path Analysis and Linkages

Several companies in this sector are part of voluntary agreements to reduce their greenhouse emissions. The structural path shows the emissions embodied in cement are the largest component making up about one third of the total, while the direct sector effect is only one twentieth of the total. Other contributors include electricity production (10%), iron and steel (3%), road transport (2%), sand and gravel (2%), lime used in cement making (2%) and garbage disposal (1%). Recycling concrete onsite and using less cement per unit of product with the same use specification is one way to further reduce greenhouse intensity. This approach is currently used to produce 'aerated lightweight' concrete products. An additional systemic way is to locate coal fired electricity generators and cement manufacturing plants together within an industrial ecology complex. This reduces transmission loss for electricity and provides waste heat from steam turbines as well as a limestone substitute in fly ash from coal. Combining these factors optimally can help reduce the greenhouse intensity of cement and its derived products. Some studies suggest this could reduce the emissions content of cement production by more than 40%.

The sector's stimulus to its upstream suppliers is 20% larger than average with effects on sectors such as road freight, sand and gravel, cement manufacture, wholesale trade, and business support. The linkages to downstream industries such as domestic building and non-residential construction are also strong and imply that the downstream industries must expand in line with this sector if any expansionary effects are to be dissipated.

## Future Trends in Sector

Under the base case scenario in the *Future Dilemmas* study which has 25 million people by 2051, there is a doubling of the total building space with domestic housing making up about 90% of the total in 2001, and around 80% in 2051. There is a relative increase in institutional and commercial buildings due to tourism, more office employment, and increasing aged care. This doubling of built space suggests that the future of this sector is reasonably assured. The broadscale environmental issues of dryland salinity, soil acidification and urban air pollution could increasingly impact on the structural integrity of pipe and block products and perhaps require a design response.

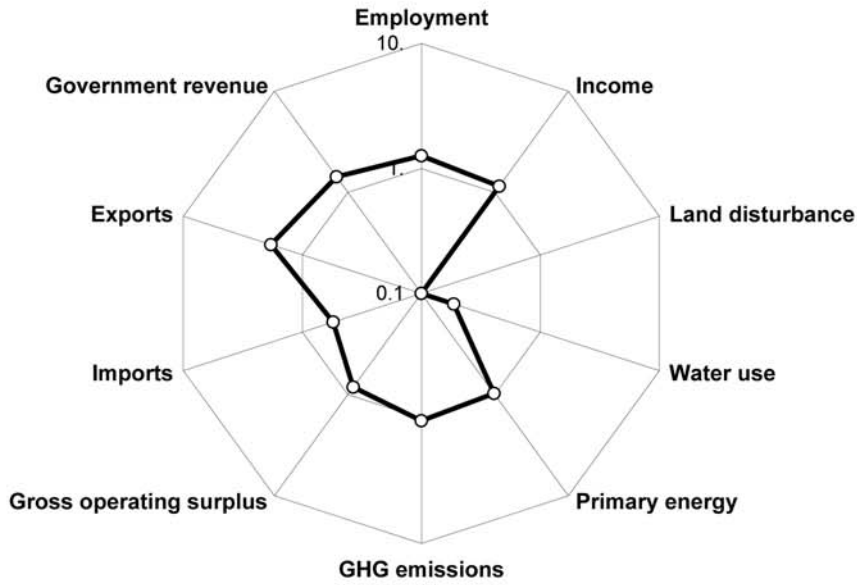
## Innovation and Technical Opportunities

Growing expectations of the structural and environmental integrity of final building products will flow back to the design and fabrication of the individual components. This sector's products are likely to become more complex and have several functions. Bricks and roofing tiles may have photovoltaic coverings. Increasing complexity of building design, fittings and functionality, may require wall and ceiling coverings that self clean, and dynamically manage noise and air quality.

Plaster board, sheet, panels, tiles; concrete pipes, bricks, blocks, boards, tiles and other concrete products

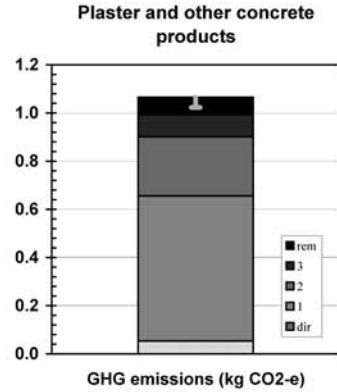
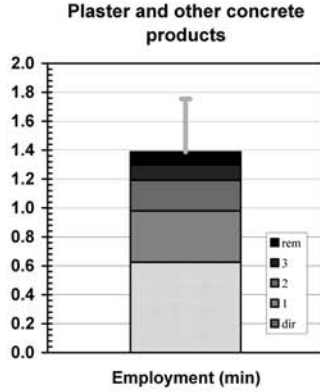
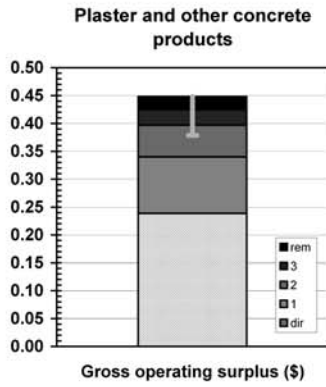
**Spider diagram**

**Plaster and other concrete products**

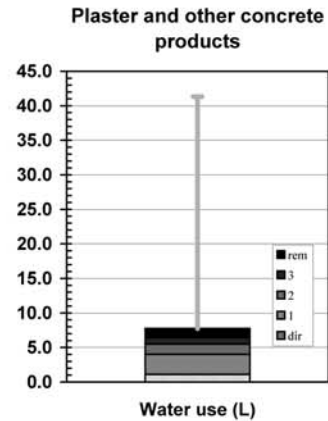
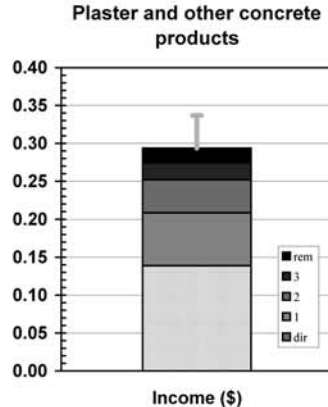
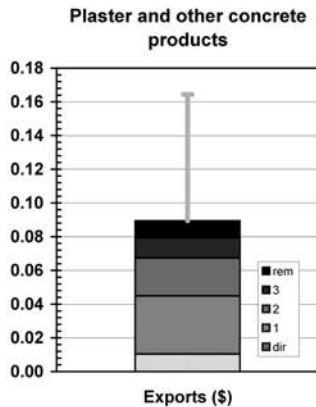


**Bar graphs**

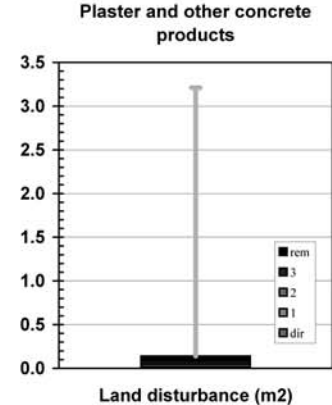
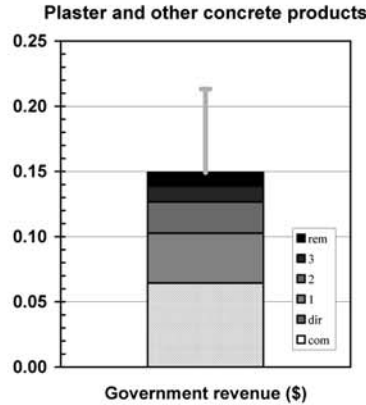
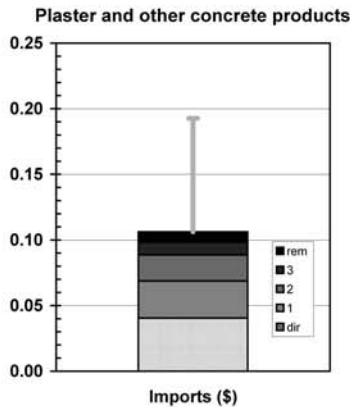
**Account #1**



**Account #2**



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 0.3	(0.00% of total)	(\$m 0.3 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 14.0	(0.01% of total)	(\$m 14.0 domestically produced)
Net changes in stocks	\$m 17.1	(0.97% of total)	(\$m 17.0 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 31.4</b>	<b>(0.01% of GNE)</b>	<b>(\$m 31.3 domestically produced)</b>
Exports	\$m 24.4	(0.03% of total)	(\$m 24.4 domestically produced)
<b>Final demand</b>	<b>\$m 55.8</b>	<b>(0.01% of GNT)</b>	<b>(\$m 55.7 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 324.9	(0.19% of total)
Gross operating surplus	\$m 558.2	(0.29% of total)
Taxes less subsidies	\$m 150.8	(0.18% of total)
<b>Sectoral GDP*</b>	<b>\$m 1,033.9</b>	<b>(0.23% of GDP)</b>
Imports	\$m 94.6	(0.10% of total)
<b>Primary inputs</b>	<b>\$m 1,128.5</b>	<b>(0.21% of GNT)</b>

\* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 558.2	(0.29%)	\$m 13.3 (0.01%)	\$m 25.0 (0.01%)
Exports (\$m)	\$m 24.4	(0.03%)	\$m 0.6 (0.00%)	\$m 5.0 (0.01%)
Imports (\$m)	\$m 94.6	(0.10%)	\$m 2.3 (0.00%)	\$m 5.9 (0.01%)
Employment (e-y)	11,731 e-y	(0.16%)	279 e-y (0.00%)	620 e-y (0.01%)
Income (\$m)*	\$m 324.9	(0.19%)	\$m 7.7 (0.00%)	\$m 16.4 (0.01%)
Government revenue (\$m)†	\$m 150.8	(0.14%)	\$m 3.6 (0.00%)	\$m 8.3 (0.01%)
GHG emissions (kt CO <sub>2</sub> -e)	125 kt	(0.02%)	3 kt (0.00%)	59 kt (0.01%)
Water use (ML)	2,574 ML	(0.01%)	61 ML (0.00%)	431 ML (0.00%)
Land disturbance (kha)	2 kha	(0.00%)	0 kha (0.00%)	1 kha (0.00%)
Primary energy (TJ)	1,717 TJ	(0.04%)	41 TJ (0.00%)	416 TJ (0.01%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.24	0.45	0.38
Exports (\$)	0.01	0.09	0.16
Imports (\$)	0.04	0.11	0.19
Employment (min)	0.63	1.39	1.75
Income (\$)	0.14	0.29	0.34
Government revenue (\$)	0.06	0.15	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.05	1.07	1.02
Water use (L)	1.10	7.74	41.32
Land disturbance (m <sup>2</sup> )	0.01	0.14	3.21
Primary energy (MJ)	0.73	7.47	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Cp	0.238	(0; 53.%)	Cp	0.625	(0; 45.%)	Ce Cp	0.37	(1; 35.%)
Sg Cp	0.0251	(1; 5.6%)	Rd Cp	0.0872	(1; 6.3%)	El Cp	0.0815	(1; 7.7%)
Rd Cp	0.0148	(1; 3.3%)	Ce Cp	0.0318	(1; 2.3%)	Cp	0.0532	(0; 5.%)
Ce Cp	0.0144	(1; 3.2%)	Sg Cp	0.0317	(1; 2.3%)	Is Cp	0.035	(1; 3.3%)
Sg Ce Cp	0.00582	(2; 1.3%)	Sm Cp	0.0265	(1; 1.9%)	Rd Cp	0.0236	(1; 2.2%)
Ms Cp	0.00418	(1; 0.93%)	Wt Cp	0.0192	(1; 1.4%)	Sg Cp	0.0198	(1; 1.9%)
Is Cp	0.00405	(1; 0.9%)	Ms Cp	0.0187	(1; 1.3%)	Lm Ce Cp	0.0188	(2; 1.8%)
El Cp	0.0033	(1; 0.73%)	Rd Ce Cp	0.0179	(2; 1.3%)	El Ce Cp	0.0182	(2; 1.7%)
Rd Ce Cp	0.00304	(2; 0.68%)	Bs Cp	0.0113	(1; 0.82%)	Gd Cp	0.0142	(1; 1.3%)
Sm Cp	0.00303	(1; 0.67%)	Eq Cp	0.00985	(1; 0.71%)	Lm Cp	0.0134	(1; 1.3%)
Wt Cp	0.00266	(1; 0.59%)	Is Cp	0.00966	(1; 0.7%)	Cc Cp	0.0129	(1; 1.2%)
St Cp	0.00257	(1; 0.57%)	Sg Ce Cp	0.00735	(2; 0.53%)	Ga Ce Cp	0.00866	(2; 0.81%)
Cc Cp	0.00242	(1; 0.54%)	Rd Sg Cp	0.00701	(2; 0.51%)	Is Sm Cp	0.00863	(2; 0.81%)
Cm Cp	0.00191	(1; 0.43%)	Os Cp	0.00648	(1; 0.47%)	Ng Ce Cp	0.00665	(2; 0.62%)
Ng Ce Cp	0.00146	(2; 0.33%)	Gd Cp	0.00563	(1; 0.41%)	Ce Cc Cp	0.00649	(2; 0.61%)
Rv Rd Cp	0.00139	(2; 0.31%)	Wt Sg Cp	0.00554	(2; 0.4%)	Sw Pp Cp	0.00569	(2; 0.53%)
Ga Ce Cp	0.00126	(2; 0.28%)	Cc Cp	0.00534	(1; 0.38%)	Pp Cp	0.00555	(1; 0.52%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Sg Cp	0.0125	(1; 14.%)	Cp	0.139	(0; 47.%)	Cp	1.1	(0; 14.%)
Cp	0.0104	(0; 12.%)	Rd Cp	0.015	(1; 5.1%)	Sg Cp	0.636	(1; 8.2%)
Rd Cp	0.00516	(1; 5.8%)	Ce Cp	0.007	(1; 2.4%)	Wa Cp	0.503	(1; 6.5%)
Is Cp	0.00309	(1; 3.5%)	Sg Cp	0.00534	(1; 1.8%)	El Cp	0.451	(1; 5.8%)
Sg Ce Cp	0.00289	(2; 3.2%)	Sm Cp	0.00457	(1; 1.6%)	Bx Cp	0.418	(1; 5.4%)
Wt Cp	0.00218	(1; 2.4%)	Ms Cp	0.00436	(1; 1.5%)	Sm Cp	0.168	(1; 2.2%)
Eq Cp	0.00176	(1; 2.%)	Wt Cp	0.00412	(1; 1.4%)	Sg Ce Cp	0.147	(2; 1.9%)
Rd Ce Cp	0.00106	(2; 1.2%)	Rd Ce Cp	0.00308	(2; 1.%)	Pp Cp	0.139	(1; 1.8%)
Sm Cp	0.000936	(1; 1.%)	Is Cp	0.0023	(1; 0.78%)	Wa Ms Cp	0.107	(2; 1.4%)
Ce Cp	0.000872	(1; 0.98%)	Os Cp	0.00181	(1; 0.62%)	Ce Cp	0.106	(1; 1.4%)
Io Is Cp	0.00084	(2; 0.94%)	Eq Cp	0.00174	(1; 0.59%)	El Ce Cp	0.1	(2; 1.3%)
Bl El Cp	0.000797	(2; 0.89%)	Gd Cp	0.00158	(1; 0.54%)	Is Cp	0.0926	(1; 1.2%)
Is Sm Cp	0.000763	(2; 0.85%)	Bs Cp	0.00139	(1; 0.47%)	Mi Cp	0.0916	(1; 1.2%)
Uo Cp	0.000695	(1; 0.78%)	Sg Ce Cp	0.00124	(2; 0.42%)	Rd Cp	0.0619	(1; 0.8%)
Ms Cp	0.000647	(1; 0.72%)	Rd Sg Cp	0.00121	(2; 0.41%)	Bx Ao Cp	0.0537	(2; 0.69%)
St Cp	0.000636	(1; 0.71%)	Cm Cp	0.0012	(1; 0.41%)	Wa Ce Cp	0.0367	(2; 0.47%)
Nf Sm Cp	0.000631	(2; 0.71%)	Wt Sg Cp	0.00119	(2; 0.4%)	Wa Bs Cp	0.0347	(2; 0.45%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Cp	0.0404	(0; 38.%)	Cp	0.0644	(0; 43.%)	Wo Tx Cp	0.0173	(2; 12.%)
Sg Cp	0.00786	(1; 7.4%)	Rd Cp	0.0106	(1; 7.1%)	Wo Tx Tp Cp	0.00812	(3; 5.8%)
Rd Cp	0.00376	(1; 3.5%)	Ce Cp	0.00416	(1; 2.8%)	Cp	0.00717	(0; 5.1%)
Sm Cp	0.00217	(1; 2.%)	Sg Cp	0.0035	(1; 2.3%)	Bc Mp Ho Cp	0.00535	(3; 3.8%)
Sg Ce Cp	0.00182	(2; 1.7%)	Rd Ce Cp	0.00218	(2; 1.5%)	Sw Pp Cp	0.00448	(2; 3.2%)
Is Cp	0.00146	(1; 1.4%)	Ms Cp	0.00207	(1; 1.4%)	Rd Cp	0.00183	(1; 1.3%)
Eq Cp	0.00116	(1; 1.1%)	Wt Cp	0.00192	(1; 1.3%)	Gd Cp	0.00134	(1; 0.95%)
Ce Cp	0.00111	(1; 1.%)	Sm Cp	0.00175	(1; 1.2%)	El Cp	0.00132	(1; 0.93%)
Fo Sg Cp	0.00106	(2; 1.%)	Is Cp	0.00106	(1; 0.71%)	Bc Mp Ho Rd	0.00125	(4; 0.89%)
Ms Cp	0.00095	(1; 0.89%)	Eq Cp	0.000861	(1; 0.58%)	Bc Mp Ch Cp	0.00117	(3; 0.83%)
Pp Cp	0.000853	(1; 0.8%)	Rd Sg Cp	0.000856	(2; 0.57%)	Bc Mp Ho Sg	0.00114	(4; 0.81%)
Rd Ce Cp	0.000771	(2; 0.73%)	Os Cp	0.000841	(1; 0.56%)	Bc Mp Ho Ms	0.00101	(4; 0.72%)
Fo Rd Cp	0.000703	(2; 0.66%)	Sg Ce Cp	0.000811	(2; 0.54%)	Bc Mp Rt Cp	0.00079	(3; 0.56%)
Wt Cp	0.000619	(1; 0.58%)	Gd Cp	0.000731	(1; 0.49%)	Fr Sw Pp Cp	0.000789	(3; 0.56%)
Mv Rd Cp	0.000548	(2; 0.52%)	Cc Cp	0.000699	(1; 0.47%)	Ce Cp	0.000723	(1; 0.51%)
Pc Ce Cp	0.000412	(2; 0.39%)	El Cp	0.000618	(1; 0.41%)	Wo Tx Wt Cp	0.000683	(3; 0.48%)
Pa Cp	0.000378	(1; 0.36%)	Cm Cp	0.000574	(1; 0.38%)	Wo Tx Kn Cp	0.000673	(3; 0.48%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.202 ±0.021	(±1.7%)
Downstream	1.266 ±0.057	(±4.5%)

# Sector 2605: Other Non-Metallic Mineral Products (Mi)

*Mineral and glass wool, abrasives and other non-metallic mineral products*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is two times the economy wide average, while water use and land disturbance are 40% and 95% below average respectively. The social indicators of employment generation and income are 5% and 10% below average respectively and government revenue is 35% below average. The financial indicator of operating surplus and export propensity are respectively 10% and 20% above average while import penetration is 40% below average. Making fibreglass insulation is energy intensive but lifetime operational energy savings can be 100-200 times the manufacturing energy.

## Sector Description

The products from this sector are dominated by glass fibre and glass wool products used mainly for building insulation and lagging of pipes for industrial machinery, some formed or worked building stone, and ground minerals that are used as coatings for abrasive material such as sand papers and grinding or cutting wheels. The manufacture of many insulating materials such as glass fibre is energy intensive. One kilogram or the coverage of one square metre has 30 MJ (10<sup>6</sup>J) of energy embodied in it, or the energy equivalent of three quarters of a litre of petrol or diesel. However in the 50 year life of a house the energy saved can be 100-200 times greater than the manufacturing energy embodied in the insulation product. The embodied energy in glass fibre insulation is midway between natural products such as cellulose (recycled newspapers), rockwool, and recycled sheep wool (2-5 MJ/kg), and petroleum based products such as polystyrene and polyester (50-60 MJ/kg). Domestic production of insulating fibre products is around 90 000 tonnes per annum with 30 000 tonnes of fibreglass batts, and 30 000 tonnes of rock wool insulation made from basalt. The financial turnover of the sector was about \$1.4 billion in 2002 and involved over 100 enterprises.

## Place of Industry in the Economy

The non-metallic mineral products sector ranks 113<sup>th</sup> out of 135 sectors in terms of value adding in the economy, and contributes 0.08% of GDP in this analysis. It is similar in value adding to the cable car and chair lift transport and the knitting mill product sectors. It is a small employer with around 800 employment years directly embodied in final demand, and another 600 years in the sector's upstream suppliers giving a total of 1 400 employment years. It also contributes 5 000 employment years to downstream industries such as residential and non-residential construction. It has small resource requirements with less than one tenth of one percent of national water use, land disturbance, energy use, and greenhouse emissions. Exports are twice the size of imports.

## Strategic Overview

The integrated overview presented in the spider diagram presents a relatively balanced TBL account with three outliers which may require more scrutiny. The social indicators of employment generation and income are equal to the economy wide average, while the government revenue indicator is below average. The financial indicators reveal a positive outcome with both the operating surplus and the export propensity above average, while import penetration is below average. The environmental indicators show that energy use and greenhouse emissions are above average, while water use is below average, and land disturbance is negligible.

## TBL Account #1

The financial indicator of operating surplus is 10% above the average and half of this is a direct effect with additional contributions from other mining (8%), road transport (4%), electricity generation (2%), plaster and cement products (3%) and wholesale trade (1%). The social indicator of employment generation is 5% below average with half of this being a direct effect and the remainder similar to the surplus indicator. The environmental indicator of greenhouse emissions is 90% above the average and is described in more detail below.

## TBL Accounts #2 and #3

The second TBL account reveals that the export propensity is 20% greater than average, the income indicator is 10% below average and the water use indicator is 40% below average. The third TBL account shows that import penetration is 40% below average, government revenue is 35% below average and land disturbance is 95% below average.

## Structural Path Analysis and Linkages

The structural path analysis suggests the potential for improvement in the greenhouse emissions indicator where half is a direct sector effect and includes nitrous oxides from the process, as well as fuel combustion. Indirect sources include electricity generation (12%), cement (8%), lime (2%), basic chemicals (1%), other mining (1%) and road transport (1%). Marginal improvements can be obtained by purchasing lower carbon electricity (eg replacing coal fired electricity with a gas turbines source) but significant reductions could be achieved through within sector processes. As discussed above, this may be possible through a transition to insulation materials with lower embodied energy in their manufacturing.

The sector's stimulus to its upstream suppliers is 15% above the economy wide average and impacts on sectors such as road transport, other mining, wholesale trade, and plaster and concrete products. The linkages to downstream industries are also stronger than average. They imply that if this industry is to expand, then there must also be expansion in sectors such as residential and non-residential construction, bricks and ceramics, wholesale trade, and the ownership of dwellings.

## Future Trends in Sector

Under the base case scenario in the *Future Dilemmas* study, which has 25 million people by 2051, there is a doubling of the total building space with domestic housing making up about 90% of the total in 2001 and around 80% in 2051. There is a relative increase in institutional and commercial buildings due to tourism, more office employment and increasing aged care. Environmentally directed policies could encourage the use of less energy and greenhouse intensive products such as rockwool over fibreglass. However these improvements are trivial relative to the large savings in whole system energy use that any suitable insulation material brings to building and industrial applications. Given the energy and greenhouse savings from adequate insulation over the full lifecycle of buildings, and the policy agenda for increasing the energy star ratings of all new buildings through procedures such as the BASIX building codes, the future of products from this sector seems assured.

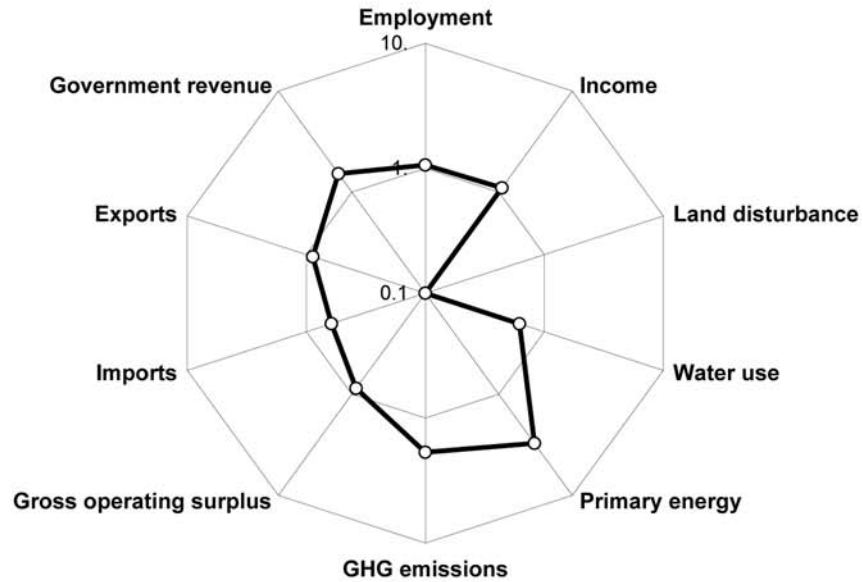
## Innovation and Technical Opportunities

The science literature suggests innovation in a number of areas. The development of new building designs and materials may make the requirement for insulation as a 'stand alone' product less important. So called 'smart buildings', with elaborate networks of sensors combined with materials that change their thermal properties and orientation on command, may enable heat storage and release in a dynamic way that optimises the comfort of the individuals daily and seasonally.

Mineral and glass wool, abrasives and other non-metallic mineral products

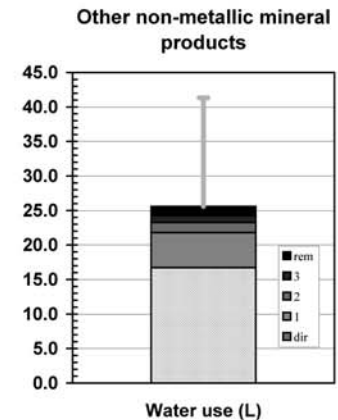
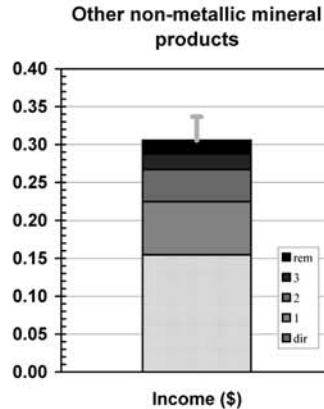
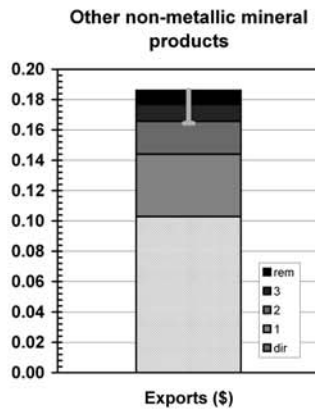
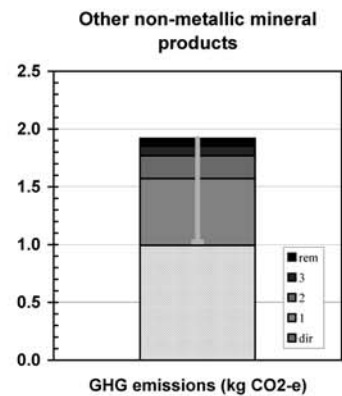
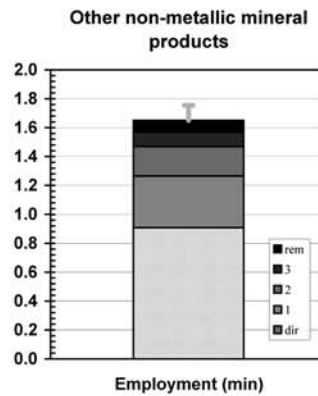
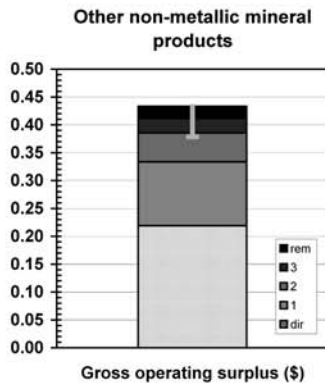
Spider diagram

Other non-metallic mineral products



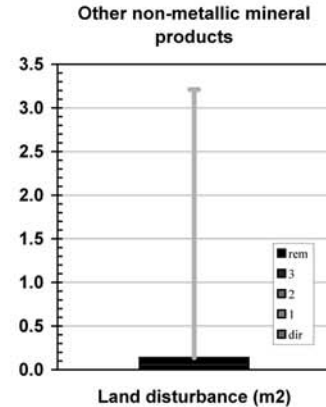
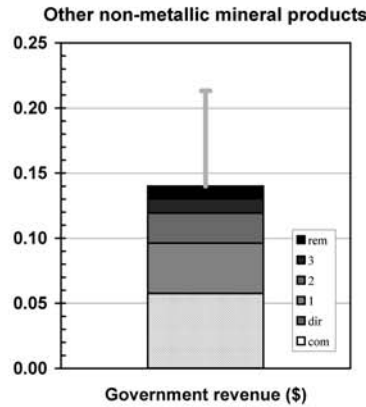
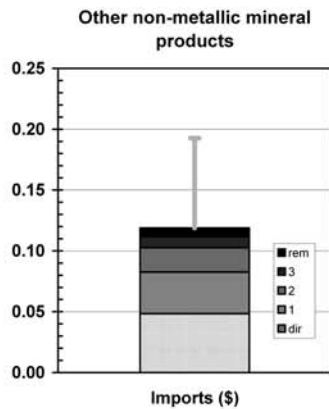
Bar graphs

Account #1





Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 0.8	(0.00% of total)	(\$m 0.8 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	
Gross fixed capital expenditure	\$m 19.8	(0.02% of total)	(\$m 19.8 domestically produced)
Net changes in stocks	\$m 0.4	(0.02% of total)	(\$m 0.5 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 21.0</b>	<b>(0.00% of GNE)</b>	<b>(\$m 21.1 domestically produced)</b>
Exports	\$m 84.3	(0.10% of total)	(\$m 84.3 domestically produced)
<b>Final demand</b>	<b>\$m 105.3</b>	<b>(0.02% of GNT)</b>	<b>(\$m 105.4 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 126.5	(0.07% of total)
Gross operating surplus	\$m 179.5	(0.09% of total)
Taxes less subsidies	\$m 47.1	(0.06% of total)
<b>Sectoral GDP*</b>	<b>\$m 353.1</b>	<b>(0.08% of GDP)</b>
Imports	\$m 39.7	(0.04% of total)
<b>Primary inputs</b>	<b>\$m 392.8</b>	<b>(0.07% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 179.5	(0.09%)	\$m 23.1 (0.01%)	\$m 45.7 (0.02%)
Exports (\$m)	\$m 84.3	(0.10%)	\$m 10.8 (0.01%)	\$m 19.6 (0.02%)
Imports (\$m)	\$m 39.7	(0.04%)	\$m 5.1 (0.01%)	\$m 12.5 (0.01%)
Employment (e-y)	5,963 e-y	(0.08%)	767 e-y (0.01%)	1,394 e-y (0.02%)
Income (\$m)*	\$m 126.5	(0.07%)	\$m 16.3 (0.01%)	\$m 32.2 (0.02%)
Government revenue (\$m)†	\$m 47.1	(0.04%)	\$m 6.1 (0.01%)	\$m 14.8 (0.01%)
GHG emissions (kt CO <sub>2</sub> -e)	813 kt	(0.16%)	105 kt (0.02%)	202 kt (0.04%)
Water use (ML)	13,700 ML	(0.07%)	1,762 ML (0.01%)	2,695 ML (0.01%)
Land disturbance (kha)	1 kha	(0.00%)	0 kha (0.00%)	1 kha (0.00%)
<b>Primary energy (TJ)</b>	<b>12,779 TJ</b>	<b>(0.33%)</b>	<b>1,644 TJ (0.04%)</b>	<b>2,471 TJ (0.06%)</b>

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.22	0.43	0.38
Exports (\$)	0.10	0.19	0.16
Imports (\$)	0.05	0.12	0.19
Employment (min)	0.91	1.65	1.75
Income (\$)	0.15	0.31	0.34
Government revenue (\$)	0.06	0.14	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.99	1.92	1.02
Water use (L)	16.72	25.58	41.32
Land disturbance (m <sup>2</sup> )	0.01	0.14	3.21
<b>Primary energy (MJ)</b>	<b>15.60</b>	<b>23.45</b>	<b>7.65</b>

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

### Structural Paths (intensities - commodities)

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Mi	0.219	(0; 51.%)	Mi	0.908	(0; 55.%)	Mi	0.993	(0; 52.%)
Sg Mi	0.0335	(1; 7.7%)	Rd Mi	0.0887	(1; 5.4%)	El Mi	0.228	(1; 12.%)
Rd Mi	0.0151	(1; 3.5%)	Sg Mi	0.0423	(1; 2.6%)	Ce Mi	0.157	(1; 8.2%)
El Mi	0.0092	(1; 2.1%)	Sm Mi	0.0326	(1; 2.%)	Lm Mi	0.0346	(1; 1.8%)
Cp Mi	0.00912	(1; 2.1%)	Wt Mi	0.0287	(1; 1.7%)	Ch Mi	0.0271	(1; 1.4%)
Ce Mi	0.00611	(1; 1.4%)	Cp Mi	0.0239	(1; 1.4%)	Sg Mi	0.0264	(1; 1.4%)
Wt Mi	0.00399	(1; 0.92%)	Ms Mi	0.0162	(1; 0.98%)	Rd Mi	0.024	(1; 1.2%)
Sm Mi	0.00371	(1; 0.86%)	Ce Mi	0.0135	(1; 0.82%)	Ga Mi	0.017	(1; 0.88%)
Ms Mi	0.00362	(1; 0.84%)	El Mi	0.0102	(1; 0.62%)	Ng Mi	0.0143	(1; 0.74%)
Ng Mi	0.00314	(1; 0.72%)	Rd Sg Mi	0.00935	(2; 0.57%)	Ce Cp Mi	0.0141	(2; 0.74%)
Cm Mi	0.00293	(1; 0.68%)	Cm Mi	0.0081	(1; 0.49%)	Is Sm Mi	0.0106	(2; 0.55%)
Sg Ce Mi	0.00248	(2; 0.57%)	Rd Ce Mi	0.00761	(2; 0.46%)	Lm Ce Mi	0.00798	(2; 0.42%)
Ga Mi	0.00247	(1; 0.57%)	Wt Sg Mi	0.00738	(2; 0.45%)	El Ce Mi	0.00773	(2; 0.4%)
Ch Mi	0.00226	(1; 0.52%)	Ho Mi	0.00665	(1; 0.4%)	Bl El Mi	0.00573	(2; 0.3%)
Lg Mi	0.00167	(1; 0.39%)	Ch Mi	0.0066	(1; 0.4%)	Fo Sg Mi	0.00431	(2; 0.22%)
Rd Sg Mi	0.00159	(2; 0.37%)	Pl Mi	0.00621	(1; 0.38%)	El Ch Mi	0.00409	(2; 0.21%)
Bx Mi	0.00151	(1; 0.35%)	Fm Sm Mi	0.00497	(2; 0.3%)	Lg Mi	0.00398	(1; 0.21%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Mi	0.103	(0; 55.%)	Mi	0.154	(0; 51.%)	Mi	16.7	(0; 65.%)
Sg Mi	0.0166	(1; 8.9%)	Rd Mi	0.0153	(1; 5.%)	Bx Mi	1.57	(1; 6.1%)
Rd Mi	0.00525	(1; 2.8%)	Sg Mi	0.00712	(1; 2.3%)	El Mi	1.26	(1; 4.9%)
Wt Mi	0.00326	(1; 1.7%)	Wt Mi	0.00616	(1; 2.%)	Sg Mi	0.849	(1; 3.3%)
Ch Mi	0.00315	(1; 1.7%)	Sm Mi	0.00561	(1; 1.8%)	Wa Mi	0.409	(1; 1.6%)
Bl El Mi	0.00222	(2; 1.2%)	Cp Mi	0.00531	(1; 1.7%)	Sm Mi	0.207	(1; 0.81%)
Lg Mi	0.00196	(1; 1.1%)	Ms Mi	0.00378	(1; 1.2%)	Wa Ms Mi	0.0932	(2; 0.36%)
Sg Ce Mi	0.00123	(2; 0.66%)	Ce Mi	0.00298	(1; 0.97%)	Ch Mi	0.0828	(1; 0.32%)
Sm Mi	0.00115	(1; 0.62%)	El Mi	0.00277	(1; 0.91%)	Wa El Mi	0.0728	(2; 0.28%)
Is Sm Mi	0.000937	(2; 0.5%)	Cm Mi	0.00184	(1; 0.6%)	Rd Mi	0.063	(1; 0.25%)
Wt Sg Mi	0.000838	(2; 0.45%)	Rd Sg Mi	0.00161	(2; 0.53%)	Sg Ce Mi	0.0627	(2; 0.25%)
Nf Sm Mi	0.000774	(2; 0.42%)	Wt Sg Mi	0.00158	(2; 0.52%)	Pp Mi	0.0516	(1; 0.2%)
Ms Mi	0.000561	(1; 0.3%)	Ch Mi	0.0014	(1; 0.46%)	Ws Ho Mi	0.0485	(2; 0.19%)
At Mi	0.000559	(1; 0.3%)	Rd Ce Mi	0.00131	(2; 0.43%)	Ce Mi	0.0452	(1; 0.18%)
Rd Sg Mi	0.000554	(2; 0.3%)	Pl Mi	0.00125	(1; 0.41%)	El Ce Mi	0.0427	(2; 0.17%)
Uo Mi	0.000535	(1; 0.29%)	Bk Mi	0.00118	(1; 0.38%)	Cp Mi	0.0421	(1; 0.16%)
Pc Mi	0.000513	(1; 0.28%)	Pi Mi	0.00117	(1; 0.38%)	Bc Mp Ch Mi	0.0391	(3; 0.15%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Mi	0.0484	(0; 41.%)	Mi	0.0575	(0; 41.%)	Bc Mp Ch Mi	0.0108	(3; 7.8%)
Sg Mi	0.0105	(1; 8.8%)	Rd Mi	0.0108	(1; 7.7%)	Bc Mp Ho Mi	0.00959	(3; 6.9%)
Rd Mi	0.00383	(1; 3.2%)	Sg Mi	0.00467	(1; 3.3%)	Mi	0.0072	(0; 5.2%)
Ch Mi	0.00316	(1; 2.7%)	Wt Mi	0.00288	(1; 2.1%)	Bc Ch Mi	0.00542	(2; 3.9%)
Sm Mi	0.00267	(1; 2.2%)	Cp Mi	0.00246	(1; 1.8%)	El Mi	0.00367	(1; 2.7%)
Cp Mi	0.00155	(1; 1.3%)	Sm Mi	0.00215	(1; 1.5%)	Wo Tx Tp Mi	0.00239	(3; 1.7%)
Fo Sg Mi	0.00141	(2; 1.2%)	Ms Mi	0.00179	(1; 1.3%)	Rd Mi	0.00186	(1; 1.3%)
Pl Mi	0.00119	(1; 1.%)	Ce Mi	0.00177	(1; 1.3%)	Sw Pp Mi	0.00166	(2; 1.2%)
Pc Mi	0.00109	(1; 0.92%)	El Mi	0.00172	(1; 1.2%)	Wo Tx Mi	0.00157	(2; 1.1%)
Wt Mi	0.000926	(1; 0.78%)	Rd Sg Mi	0.00114	(2; 0.82%)	Bc Mp Ho Sg	0.00152	(4; 1.1%)
Ms Mi	0.000824	(1; 0.69%)	Rd Ce Mi	0.000929	(2; 0.66%)	Bc Mp Ho Rd	0.00127	(4; 0.92%)
Sg Ce Mi	0.000775	(2; 0.65%)	Cm Mi	0.000878	(1; 0.63%)	Wo Mp Ch Mi	0.00122	(3; 0.88%)
Fo Rd Mi	0.000715	(2; 0.6%)	Wt Sg Mi	0.000741	(2; 0.53%)	Wo Tx Pl Mi	0.0012	(3; 0.87%)
Oc Mi	0.00067	(1; 0.56%)	Ch Mi	0.000699	(1; 0.5%)	Bc Mp Rt Mi	0.00111	(3; 0.8%)
El Mi	0.000638	(1; 0.54%)	Bk Mi	0.000649	(1; 0.46%)	Wo Mp Ho Mi	0.00108	(3; 0.78%)
Mv Rd Mi	0.000557	(2; 0.47%)	Pl Mi	0.000547	(1; 0.39%)	Bc Mp Ch Pl	0.00103	(4; 0.74%)
Fo Mi	0.000549	(1; 0.46%)	Pi Mi	0.000539	(1; 0.39%)	Wo Tx Wt Mi	0.00102	(3; 0.74%)

### Linkages (average = 1)

	Value	C.o.V.
Upstream	1.163 ±0.019	(±1.7%)
Downstream	1.378 ±0.035	(±2.5%)

# Sector 2701: Basic Iron and Steel (Is)

*Basic iron, pig iron, ingots, pipes, tubes, wire, chain, forged iron and steel*

## Short Summary

Against the metric of one dollar of final demand the environmental indicator for greenhouse emissions is nearly three times the average, while water use and land disturbance are 65% and 95% below average respectively. The social indicators show that employment generation, income and government revenue are respectively 35%, 20% and 35% below average. The financial indicator of operating surplus is 15% above average, export propensity is more than twice the average and import penetration is 25% below average. The financial indicators reflect the considerable structural adjustment and capital investment that have taken place in the industry over the last fifteen years. Reconciling positive financial indicators with less advantageous social indicators is difficult for this sector for two reasons. Firstly the industry is globalised, competing mainly on price and quality. Ability to allocate more resources to labour versus capital may be limited. Secondly the sector is a strong enabler of economic and physical activity in the downstream sectors it supplies (eg construction industries), as well as upstream sectors that supply goods and services to it. There may be potential to improve the greenhouse indicator: industry sources note that 26 GJ (10<sup>9</sup>J) are required to produce one tonne of Australian steel, well above Japan's average of 22 GJ per tonne and a potential best practice figure of 19 GJ per tonne. While electric arc furnace technology uses less direct energy, if powered by fossil fuel electricity it may not reduce total emissions below current levels.

## Sector Description

The Australian steel industry produces seven to eight million tonnes of steel annually, with about 80% manufactured in integrated steel plants using the basic oxygen process. The remainder is produced using the electric arc furnace process generally in mini-mills. These use scrap steel, are less capital intensive and operate at a smaller scale than integrated plants. Recycling is well established in Australia with 65% of available material used. Over 1.9 million tonnes of ferrous scrap are used in electric arc and basic oxygen processes annually. Iron and steel exports are two to three million tonnes per year.

## Place of Industry in the Economy

The iron and steel sector ranks 29<sup>th</sup> out of 135 sectors in terms of value adding in the economy, and contributes 0.86% of GDP in this analysis. It is similar in value adding to the water supply and newspaper publishing sectors. It is a small employment generator with a direct requirement for 6 000 employment years and another 10 000 years for the sector's suppliers, giving a total of 16 000 employment years. In addition, it contributes 34 000 employment years to downstream sectors such as residential building and non-residential construction. The sector requires 1.5% of national primary energy and emits one percent of national greenhouse gas emissions. The sector's use of water and its contribution to national land disturbance are both less than one tenth of one percent. In financial terms, exports are twice the level of imports.

## Strategic Overview

The integrated overview in the spider diagram for the iron and steel sector reveals two outliers for energy use and greenhouse emissions and below average outcomes for the three social indicators. The social indicators are difficult to change given that Australian firms compete within a global industry including locations with lower wage structures and different environmental standards.

## TBL Account #1

The financial indicator of surplus is 15% above the economy wide average with about one half a direct effect and additional contributions from iron ore mining (6%) and electricity production (2%). The social indicator of employment generation is 35% below average with a direct effect of over one third and minor contributions from wholesale trade (3%), iron ore mining (2%) and rail freight (2%). The greenhouse indicator is nearly three times the average with a direct effect of nearly two thirds. The first TBL account may indicate some areas for improvement but many issues are outside the control of sector management. The employment generation issue may reflect the globalised cost structure of the industry, and the greenhouse indicator could be attributed the basic physics and chemistry of turning iron ore into iron and then to steel products.

## TBL Accounts #2 and #3

In the second TBL account, export propensity is over twice the economy wide average with half being a direct effect. The social indicator of income is 20% below average and one third is a direct effect. The environmental indicator of water use is 65% below average, with one third a direct effect. For the third TBL account, import penetration is 25% below average, government revenue is 35% below average and land disturbance is 95% below average.

## Structural Path Analysis and Linkages

The structural paths that contribute to the greenhouse indicator show that 58% arises through direct energy use in the steel plant. Supply chain contributions include 8% for electricity, 1% each for shipping and black coal mining and less than 1% for natural gas production and iron ore mining. This suggests efforts to improve the greenhouse indicator should focus on the sector itself.

The iron and steel sector is central for the economy with strong downstream linkages to residential and non-residential construction, and structural steel products. Increase in consumer demand for the sector's products also gives relatively strong upstream linkages to plant and material hire, wholesale trade and iron ore mining.

## Future Trends in Sector

As a globally traded commodity, steel futures will be driven by the world business cycle and by industries such as shipbuilding, and construction industries in strongly growing economies such as China. Assumptions behind the base case scenario in the CSIRO *Future Dilemmas* study anticipate a domestic annual requirement for steel that grows from six to seven million tonnes per year currently, to eight to ten million tonnes per annum during the period 2020 to 2050. Concerns about the low levels of domestic value adding to many primary minerals may stimulate more steel making activity in Australia for export. Current investments into the Hismelt process at Kwinana near Perth and the hot briquetted iron plant at Port Hedland in the north west of Western Australia are evidence of this trend. However significant mineral markets are unlikely to relocate their processing.

## Innovation and Technical Opportunities

The primary energy used and greenhouse emitted per dollar of final demand appear to offer opportunities for technological innovation. Industry sources report that Australian steel uses 26 GJ per tonne, versus an industry wide average in Japan of 22 GJ per tonne and a theoretical best technology of around 19 GJ per tonne. Electric arc furnaces use 9 GJ per tonne but unless electricity is sourced from hydro (as in Brazil), the steel retains a high carbon dioxide intensity. Virgin steel is generally preferred over recycled steel for structural use. This may limit the amount of recycling in the national steel cycle. However there is considerable scope for greater use of recycled steel in other forms of construction.

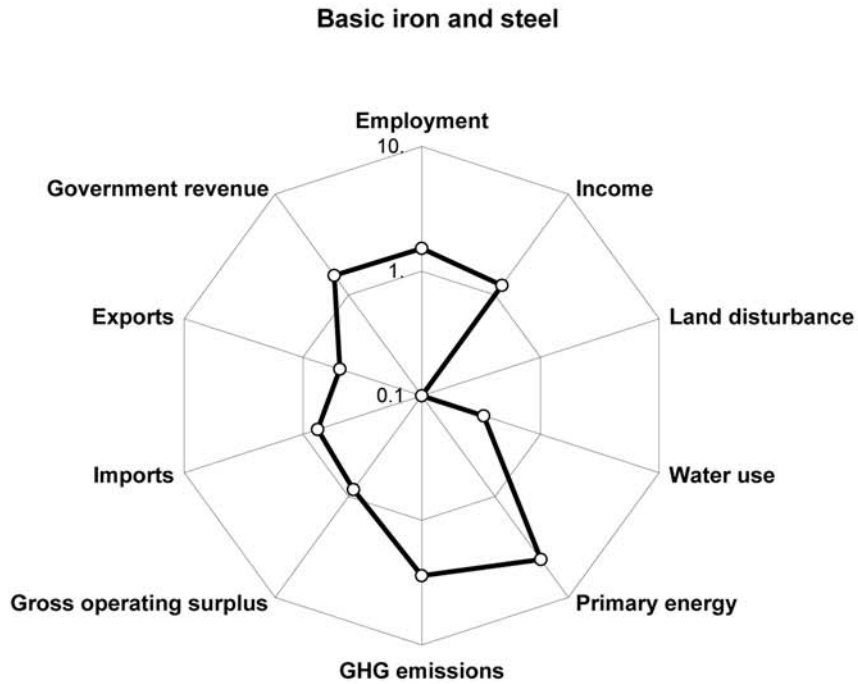
**Sector**

**Basic iron and steel**

**(Is)**

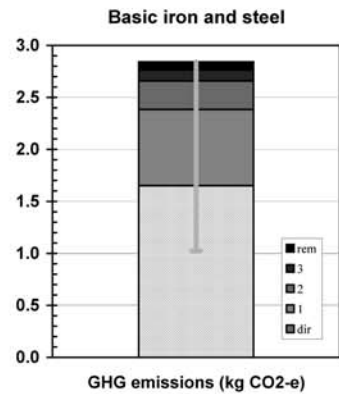
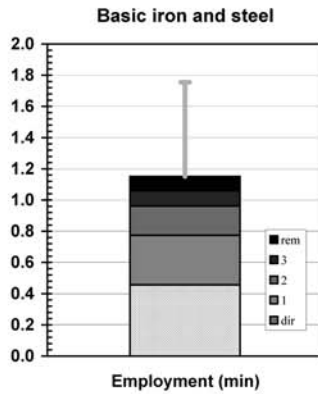
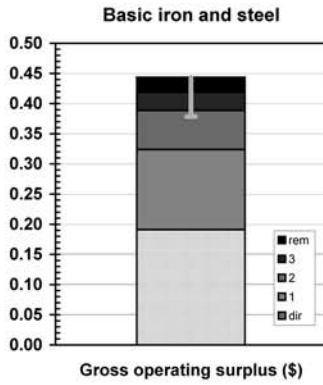
Basic iron, pig iron, sponge iron and spiegeleisen, iron and steel granules, ingots, pipes, tubes, angles, shapes, sheets, rods, bars, rails, fittings, wire, profiles, castings, chain, forged iron and steel and other basic iron and steel

Spider diagram

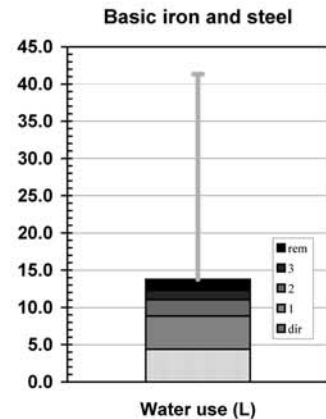
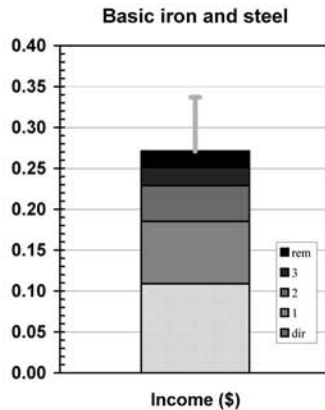
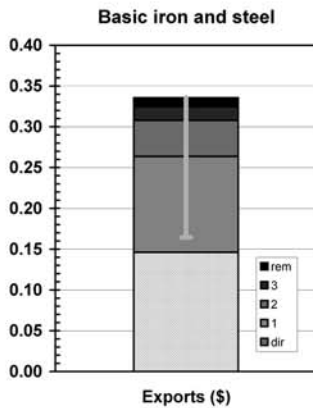


Bar graphs

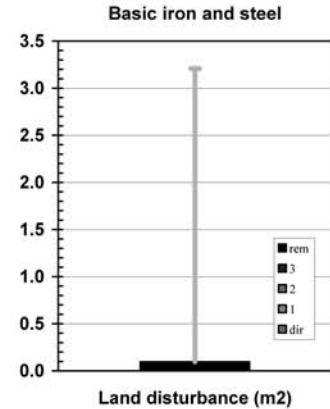
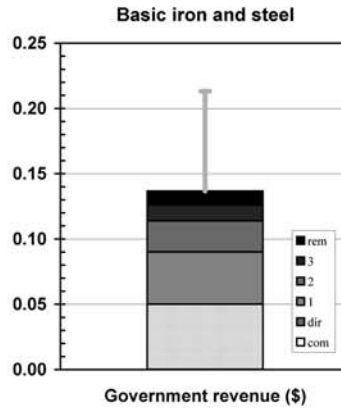
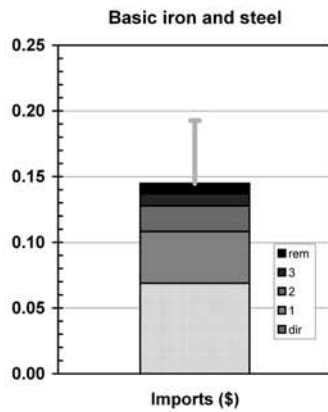
**Account #1**



**Account #2**



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 7.5	(0.00% of total)	(\$m 7.5 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 23.9	(0.02% of total)	(\$m 23.9 domestically produced)
Net changes in stocks	\$m 141.9	(8.03% of total)	(\$m 124.8 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 173.3</b>	<b>(0.04% of GNE)</b>	<b>(\$m 156.3 domestically produced)</b>
Exports	\$m 1,601.0	(1.92% of total)	(\$m 1,601.0 domestically produced)
<b>Final demand</b>	<b>\$m 1,774.3</b>	<b>(0.33% of GNT)</b>	<b>(\$m 1,757.3 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 1,192.6	(0.70% of total)
Gross operating surplus	\$m 2,094.4	(1.09% of total)
Taxes less subsidies	\$m 547.0	(0.64% of total)
<b>Sectoral GDP*</b>	<b>\$m 3,834.0</b>	<b>(0.86% of GDP)</b>
Imports	\$m 754.3	(0.77% of total)
<b>Primary inputs</b>	<b>\$m 4,588.3</b>	<b>(0.84% of GNT)</b>

\* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 2,094.4	(1.09%)	\$m 335.9 (0.18%)	\$m 779.6 (0.41%)
Exports (\$m)	\$m 1,601.0	(1.92%)	\$m 256.8 (0.31%)	\$m 590.1 (0.71%)
Imports (\$m)	\$m 754.3	(0.77%)	\$m 121.0 (0.12%)	\$m 254.6 (0.26%)
Employment (e-y)	40,063 e-y	(0.56%)	6,425 e-y (0.09%)	16,206 e-y (0.23%)
Income (\$m)*	\$m 1,192.6	(0.70%)	\$m 191.3 (0.11%)	\$m 476.4 (0.28%)
Government revenue (\$m)†	\$m 547.3	(0.51%)	\$m 88.0 (0.08%)	\$m 240.5 (0.22%)
GHG emissions (kt CO <sub>2</sub> -e)	18,093 kt	(3.49%)	2,902 kt (0.56%)	4,996 kt (0.96%)
Water use (ML)	47,942 ML	(0.23%)	7,689 ML (0.04%)	24,165 ML (0.12%)
Land disturbance (kha)	0 kha	(0.00%)	0 kha (0.00%)	17 kha (0.01%)
Primary energy (TJ)	212,339 TJ	(5.47%)	34,054 TJ (0.88%)	56,751 TJ (1.46%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*	
	direct	total
Gross operating surplus (\$)	0.19	0.44
Exports (\$)	0.15	0.34
Imports (\$)	0.07	0.14
Employment (min)	0.46	1.15
Income (\$)	0.11	0.27
Government revenue (\$)	0.05	0.14
GHG emissions (kg CO <sub>2</sub> -e)	1.65	2.84
Water use (L)	4.38	13.75
Land disturbance (m <sup>2</sup> )	0.00	0.10
Primary energy (MJ)	19.38	32.29

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Nation-wide average**

	total
Gross operating surplus (\$)	0.38
Exports (\$)	0.16
Imports (\$)	0.19
Employment (min)	1.75
Income (\$)	0.34
Government revenue (\$)	0.21
GHG emissions (kg CO <sub>2</sub> -e)	1.02
Water use (L)	41.32
Land disturbance (m <sup>2</sup> )	3.21
Primary energy (MJ)	7.65

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Is	0.191	(0; 43.%)	Is	0.456	(0; 40.%)	Is	1.65	(0; 58.%)
Io Is	0.0247	(1; 5.6%)	Wt Is	0.0317	(1; 2.8%)	El Is	0.217	(1; 7.6%)
El Is	0.00876	(1; 2.%)	Io Is	0.0185	(1; 1.6%)	Sp Is	0.026	(1; 0.91%)
Br Is	0.00539	(1; 1.2%)	Rf Is	0.0181	(1; 1.6%)	Bl Is	0.0203	(1; 0.71%)
Pd Is	0.0052	(1; 1.2%)	Rd Is	0.0177	(1; 1.5%)	Ga Is	0.0101	(1; 0.36%)
Bl Is	0.00519	(1; 1.2%)	Pd Is	0.0125	(1; 1.1%)	Io Is	0.00812	(1; 0.29%)
Wt Is	0.00441	(1; 0.99%)	El Is	0.00974	(1; 0.85%)	El Io Is	0.00758	(2; 0.27%)
Sg Is	0.00416	(1; 0.94%)	Ts Is	0.00843	(1; 0.73%)	Ng Is	0.0075	(1; 0.26%)
Rd Is	0.00301	(1; 0.68%)	Cr Is	0.00773	(1; 0.67%)	El Al Is	0.00685	(2; 0.24%)
Rf Is	0.00226	(1; 0.51%)	Bk Is	0.00757	(1; 0.66%)	El Rf Is	0.00659	(2; 0.23%)
St Is	0.002	(1; 0.45%)	Sp Is	0.00659	(1; 0.57%)	Rf Is	0.00656	(1; 0.23%)
Pt Is	0.00199	(1; 0.45%)	Fm Is	0.00613	(1; 0.53%)	Nf Is	0.00645	(1; 0.23%)
Bk Is	0.00191	(1; 0.43%)	Sg Is	0.00526	(1; 0.46%)	Bl El Is	0.00546	(2; 0.19%)
Ts Is	0.00187	(1; 0.42%)	Ot Is	0.0048	(1; 0.42%)	Ce Is	0.00538	(1; 0.19%)
Ng Is	0.00165	(1; 0.37%)	Gv Is	0.00467	(1; 0.41%)	Cr Is	0.00513	(1; 0.18%)
Sp Is	0.00162	(1; 0.37%)	Ms Is	0.00426	(1; 0.37%)	Pc Is	0.00506	(1; 0.18%)
Ga Is	0.00148	(1; 0.33%)	Pt Is	0.00399	(1; 0.35%)	Al Is	0.00496	(1; 0.17%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Is	0.146	(0; 44.%)	Is	0.109	(0; 40.%)	Is	4.38	(0; 32.%)
Io Is	0.0397	(1; 12.%)	Wt Is	0.00681	(1; 2.5%)	El Is	1.2	(1; 8.7%)
Sp Is	0.011	(1; 3.3%)	Io Is	0.00518	(1; 1.9%)	Wa Is	0.745	(1; 5.4%)
Bl Is	0.00787	(1; 2.3%)	Rf Is	0.00508	(1; 1.9%)	Io Is	0.595	(1; 4.3%)
Nf Is	0.00472	(1; 1.4%)	Pd Is	0.00469	(1; 1.7%)	Br Is	0.433	(1; 3.2%)
Rf Is	0.00371	(1; 1.1%)	Rd Is	0.00304	(1; 1.1%)	Wa Pd Is	0.142	(2; 1.%)
Wt Is	0.0036	(1; 1.1%)	El Is	0.00264	(1; 0.97%)	Sg Is	0.106	(1; 0.77%)
Al Is	0.00264	(1; 0.79%)	Ts Is	0.00197	(1; 0.73%)	Bl Is	0.105	(1; 0.77%)
Bl El Is	0.00212	(2; 0.63%)	Bk Is	0.00187	(1; 0.69%)	Mn Io Is	0.0783	(2; 0.57%)
Sg Is	0.00207	(1; 0.62%)	Sp Is	0.0016	(1; 0.59%)	Wa El Is	0.0693	(2; 0.5%)
Lg Is	0.00154	(1; 0.46%)	Ot Is	0.00135	(1; 0.5%)	Bx Ao Al Is	0.0468	(3; 0.34%)
Pc Is	0.0012	(1; 0.36%)	Gv Is	0.00117	(1; 0.43%)	El Io Is	0.0419	(2; 0.3%)
Rd Is	0.00105	(1; 0.31%)	Cr Is	0.00113	(1; 0.42%)	Nf Is	0.0402	(1; 0.29%)
Gl Nf Is	0.000858	(2; 0.26%)	Ms Is	0.00099	(1; 0.37%)	El Al Is	0.0379	(2; 0.28%)
Oi Pc Is	0.000754	(2; 0.22%)	Fm Is	0.000961	(1; 0.35%)	El Rf Is	0.0364	(2; 0.27%)
Uo Nf Is	0.000523	(2; 0.16%)	Pt Is	0.000929	(1; 0.34%)	Bl El Is	0.0283	(2; 0.21%)
St Is	0.000496	(1; 0.15%)	Br Is	0.000903	(1; 0.33%)	Wa Io Is	0.0283	(2; 0.21%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$		
Is	0.0688	(0; 48.%)	Is	0.0499	(0; 37.%)	Bc Mp Ho Is	0.00377	(3; 4.%)
Sp Is	0.00463	(1; 3.2%)	Wt Is	0.00318	(1; 2.3%)	El Is	0.0035	(1; 3.7%)
Pc Is	0.00254	(1; 1.8%)	Io Is	0.00315	(1; 2.3%)	Wo Tx Tp Is	0.00277	(3; 2.9%)
Io Is	0.00224	(1; 1.5%)	Pd Is	0.00307	(1; 2.2%)	Io Is	0.00263	(1; 2.8%)
Pt Is	0.00217	(1; 1.5%)	Rf Is	0.00233	(1; 1.7%)	Rf Is	0.00255	(1; 2.7%)
Sg Is	0.0013	(1; 0.9%)	Rd Is	0.00216	(1; 1.6%)	Bc Mp Ch Is	0.00126	(3; 1.3%)
Wt Is	0.00102	(1; 0.71%)	El Is	0.00164	(1; 1.2%)	Wo Tx Wt Is	0.00113	(3; 1.2%)
Rd Is	0.000762	(1; 0.53%)	Sp Is	0.00105	(1; 0.77%)	Bc Mp Ho Pd	0.000887	(4; 0.93%)
Pd Is	0.000749	(1; 0.52%)	Bk Is	0.00103	(1; 0.76%)	Bc Mp Ch Pt I	0.000768	(4; 0.8%)
El Is	0.000608	(1; 0.42%)	Ts Is	0.000972	(1; 0.71%)	Bl Is	0.00066	(1; 0.69%)
Rf Is	0.000584	(1; 0.4%)	In Is	0.000744	(1; 0.54%)	Bc Mp Ho Wt	0.000652	(4; 0.68%)
Nf Is	0.000567	(1; 0.39%)	Br Is	0.000655	(1; 0.48%)	Bc Ch Is	0.000634	(2; 0.66%)
Mn Io Is	0.000538	(2; 0.37%)	Bl Is	0.00063	(1; 0.46%)	Bc Mp Pd Is	0.000605	(3; 0.63%)
Ts Is	0.000537	(1; 0.37%)	Ot Is	0.000619	(1; 0.45%)	Wo Tx Is	0.000487	(2; 0.51%)
Fm Is	0.000415	(1; 0.29%)	Sg Is	0.000581	(1; 0.42%)	Bc Mp Wt Is	0.000431	(3; 0.45%)
Br Is	0.000398	(1; 0.27%)	Mn Io Is	0.000564	(2; 0.41%)	Wo Mp Ho Is	0.000426	(3; 0.45%)
Bl Is	0.000383	(1; 0.26%)	Pt Is	0.000515	(1; 0.38%)	Bc Ch Pt Is	0.000386	(3; 0.4%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.298 ±0.029	(±2.2%)
Downstream	1.771 ±0.036	(±2.0%)

# Sector 27210010: Alumina (Ao)

*Alumina from bauxite*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicators of greenhouse emissions and water use are over four times and twice the average respectively, while land disturbance is 95% below average. The social indicators reveal that employment generation is 50% below average, income is 20% below average, and government revenue is 25% below average. The financial indicators reveal that the operating surplus is 10% above the average, export propensity is nearly six times the average, and import penetration is 30% below the average. Technical opportunities to reduce the greenhouse and water intensity of alumina exist.

## Sector Description

Australian production of alumina ( $\text{Al}_2\text{O}_3$ ) represents over 30% of world production and will soon be 17.2 million tonnes per annum, with expansion plans to take the total production to 22.7 Mt/a. Two tonnes of alumina are required to make one tonne of aluminium and after domestic aluminium smelting, this leaves nearly 14 Mt/a of alumina production available for export to smelters overseas. There are six alumina refineries in Australia at Gladstone (5 Mt/a), Gove (1.8 Mt/a), Worsley (3.1 Mt/a), Wagerup (2.2 Mt/a), Pinjarra (3.2 Mt/a) and Kwinana (1.9 Mt/a). Alumina production is resource and energy intensive and one tonne requires 3 tonnes of bauxite, 180 kg of sodium hydroxide, 90 kg of lime, 10 500 litres of process water (10.5 tonnes), and nearly 18 GJ ( $10^9\text{J}$ ) of fuel energy. Some studies suggest that improved digesters and kilns can save 25% of energy requirements. Financial turnover of the sector was about \$4 billion in 2002.

## Place of Industry in the Economy

The alumina refining sector ranks 78<sup>th</sup> out of 135 sectors in terms of value adding, and contributes 0.19% of GDP in this analysis. It is similar in value adding to the natural gas production and the 'processed wool and woven fabrics' sectors. It is a moderate sized employer with 5 000 employment years directly embodied in final demand, and another 11 000 years in the sector's upstream suppliers giving a total of 16 000 employment years. In addition it contributes 1 000 employment years to downstream industries such as aluminium smelting. It has moderate resource requirements with 3.5% of national energy, 2% of greenhouse emissions, 1% of water use, and a negligible amount of land disturbance. In financial terms, exports are 15 times the size of imports.

## Strategic Overview

The integrated overview in the spider diagram reveals a number of outliers for the environmental indicators of water, energy and greenhouse emissions, and for the social areas of employment generation, income and government revenue. The below average status of the social indicators can be partly explained by the capital intensive nature of the industry, and need for it to compete in a highly competitive globalised marketplace. Upstream issues for the sector relate to the environmental impact of bauxite mining but the industry has established leading edge protocols of rehabilitation. Downstream issues relate to the energy and water signature of alumina as it is passed to the smelting sector.



## TBL Account #1

The financial indicator of operating surplus is 10% above the economy wide average and about one third of this is a direct effect with additional contributions from bauxite mining (22%), electricity generation (4%), natural gas (10%), brown coal (3%) and mining exploration (1%). The social indicator of employment generation is 50% below average and it has a similar composition to the surplus indicator. The environmental indicator of greenhouse emissions is over four times the economy wide average and the composition of the production chain is described below.

## TBL Accounts #2 and #3

The second TBL account reveals that export propensity is nearly six times the economy wide average and most of this is a direct sector effect. The social indicator of income is 20% below average and water use is nearly three times the average. The third TBL account reveals that import penetration is 30% below average, government revenue is 25% below average, and land disturbance is 95% below average.

## Structural Path Analysis and Linkages

Greenhouse emissions and water use are the key environmental issues for the sector. The greenhouse chain reveals that 75% of the effect is a direct sector one due to the steam pressure digestion of bauxite with sodium hydroxide, and the drying of alumina in kilns. Other greenhouse emissions are due to electricity generation (10%), electricity used in bauxite mining (2%), bauxite mining (2%), and gas production and supply (4%). The water chain is mostly due to the first order effect of bauxite washing to remove clay (88%), and due to water used in bauxite digestion (4%), the first stage of alumina processing.

The sector's stimulus to its upstream suppliers is 20% greater than the economy wide average and includes components such as bauxite mining, electricity supply, wholesale trade and plant and vehicle hire. With the exception of aluminium smelting, the linkages to downstream industries are very weak as the remaining linkage effects are dissipated by exports.

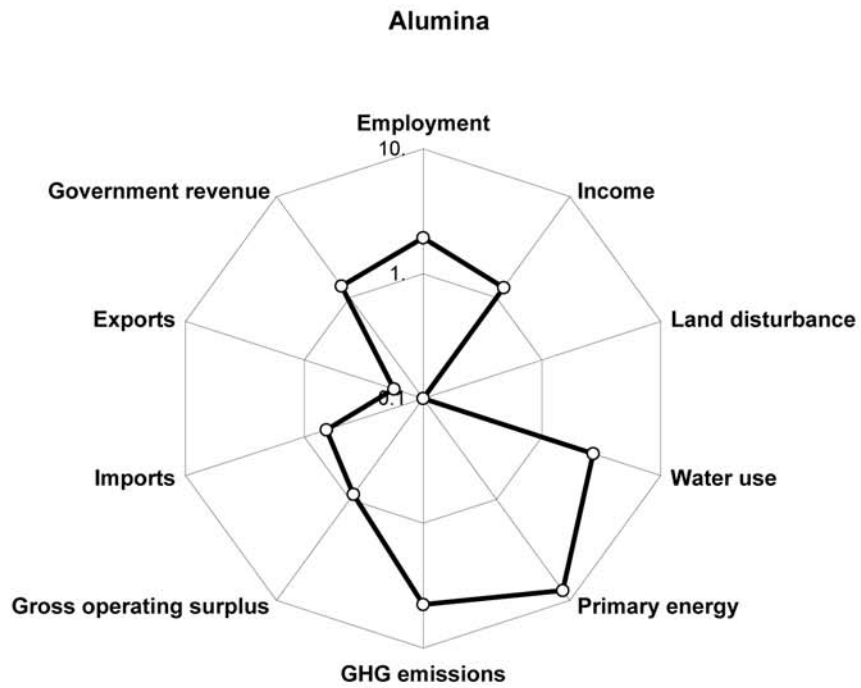
## Future Trends in Sector

The alumina sector is totally dominated by export market opportunities. The domestic consumption of alumina (as smelted aluminium) is relatively constant at 350 000 tonnes per annum of aluminium, or 700 000 tonnes of alumina. Industry sources suggest that world aluminium demand could grow at 500 000 tonnes per year requiring an additional 1 million tonnes of alumina. Current expansion of 5 million tonnes annual capacity seems to be planned within the existing domestic refining locations. Australia has nearly 15% of the proven world reserves of bauxite ore and much of this is close to existing alumina refineries. Provided that policy settings domestically or for world trade access do not change markedly, the Australian alumina sector seems to have an assured future. The lower carbon content and ease of use of natural gas is important for some refineries particularly at Gove and Gladstone, and gas pipeline extensions are currently in the final stage of project negotiation pending development. Aluminium is the third most common element on the earth and aluminium compounds form 8% of the world crust. There are many sources of aluminium, and new feedstocks and processes could revolutionise the bauxite to alumina chain described here.

## Innovation and Technical Opportunities

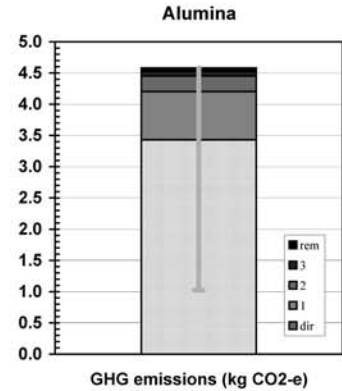
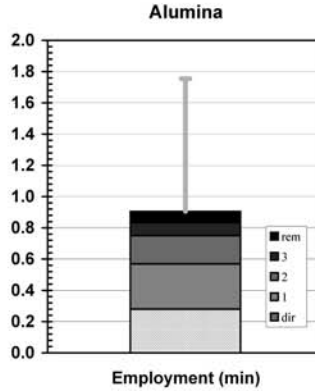
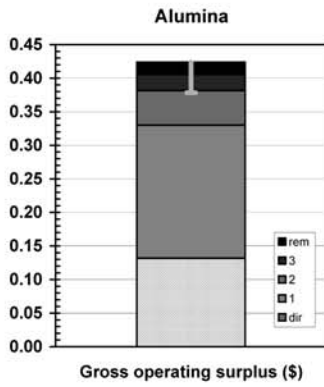
Alumina is finding many more uses than as the primary feedstock for aluminium smelting. It is used as a catalyst in many chemical reactions, as a coating in the fabrication of computer chips, as a water purifier to which polluting metals such as arsenic adsorb, or can absorb parts of flue gases, and when combined with materials such as zirconia, can be fabricated into hip joints for humans.

Spider diagram

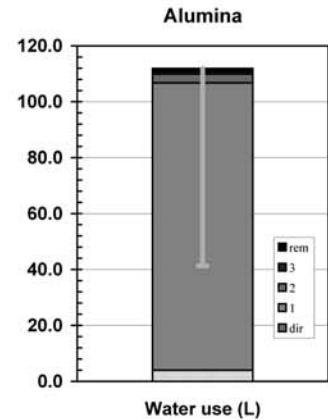
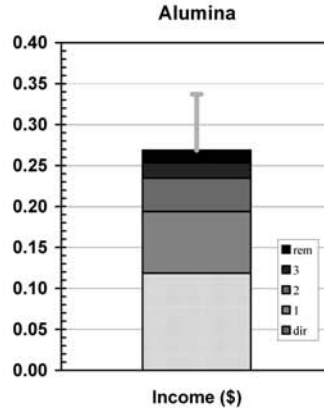
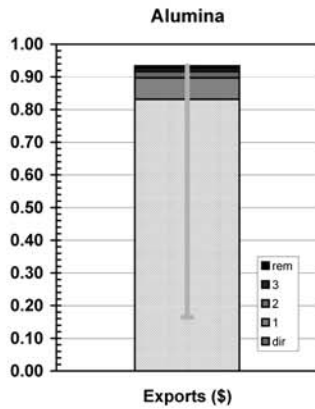


Bar graphs

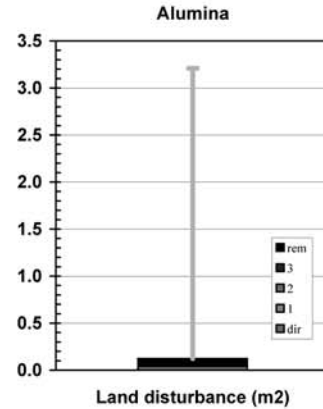
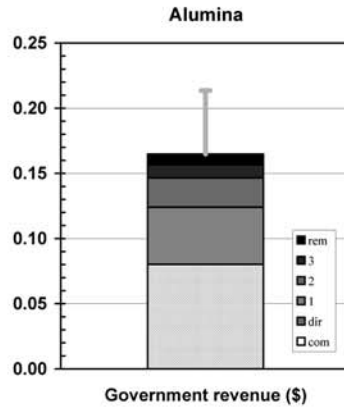
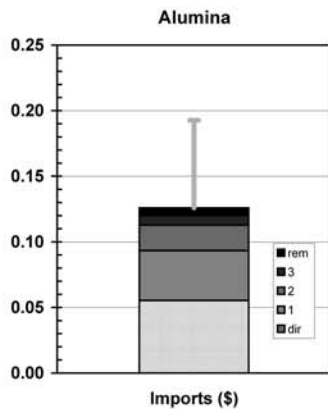
Account #1



Account #2



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 0.0		
Government final consumption	\$m 0.0		
Gross fixed capital expenditure	\$m 0.0		
Net changes in stocks	\$m 40.4	(2.28% of total)	(\$m 39.0 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 40.4</b>	<b>(0.01% of GNE)</b>	<b>(\$m 39.0 domestically produced)</b>
Exports	\$m 2,135.8	(2.56% of total)	(\$m 2,135.8 domestically produced)
<b>Final demand</b>	<b>\$m 2,176.2</b>	<b>(0.40% of GNT)</b>	<b>(\$m 2,174.8 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 304.6	(0.18% of total)
Gross operating surplus	\$m 338.3	(0.18% of total)
Taxes less subsidies	\$m 205.9	(0.24% of total)
<b>Sectoral GDP*</b>	<b>\$m 848.7</b>	<b>(0.19% of GDP)</b>
Imports	\$m 142.1	(0.15% of total)
<b>Primary inputs</b>	<b>\$m 990.8</b>	<b>(0.18% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 338.3	(0.18%)	\$m 286.4 (0.15%)	\$m 922.0 (0.48%)
Exports (\$m)	\$m 2,135.8	(2.56%)	\$m 1,808.1 (2.17%)	\$m 2,031.5 (2.44%)
Imports (\$m)	\$m 142.1	(0.15%)	\$m 120.3 (0.12%)	\$m 273.9 (0.28%)
Employment (e-y)	5,752 e-y	(0.08%)	4,869 e-y (0.07%)	15,775 e-y (0.22%)
Income (\$m)*	\$m 304.6	(0.18%)	\$m 257.9 (0.15%)	\$m 584.3 (0.34%)
Government revenue (\$m)†	\$m 205.1	(0.19%)	\$m 173.5 (0.16%)	\$m 357.7 (0.33%)
GHG emissions (kt CO <sub>2</sub> -e)	8,815 kt	(1.70%)	7,462 kt (1.44%)	9,960 kt (1.92%)
Water use (ML)	10,078 ML	(0.05%)	8,531 ML (0.04%)	243,505 ML (1.16%)
Land disturbance (kha)	0 kha	(0.00%)	0 kha (0.00%)	27 kha (0.02%)
Primary energy (TJ)	129,184 TJ	(3.33%)	109,363 TJ (2.82%)	132,837 TJ (3.42%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.13	0.42	0.38
Exports (\$)	0.83	0.93	0.16
Imports (\$)	0.06	0.13	0.19
Employment (min)	0.28	0.91	1.75
Income (\$)	0.12	0.27	0.34
Government revenue (\$)	0.08	0.16	0.21
GHG emissions (kg CO <sub>2</sub> -e)	3.43	4.58	1.02
Water use (L)	3.92	111.97	41.32
Land disturbance (m <sup>2</sup> )	0.00	0.12	3.21
Primary energy (MJ)	50.29	61.08	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

### Structural Paths (intensities - commodities)

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Ao	0.132	(0; 31.%)	Ao	0.279	(0; 31.%)	Ao	3.43	(0; 75.%)
Bx Ao	0.0951	(1; 22.%)	Bx Ao	0.0982	(1; 11.%)	El Ao	0.434	(1; 9.5%)
El Ao	0.0175	(1; 4.1%)	Ga Ao	0.0197	(1; 2.2%)	El Bx Ao	0.0936	(2; 2.%)
Ng Ao	0.0153	(1; 3.6%)	El Ao	0.0195	(1; 2.2%)	Ga Ao	0.0918	(1; 2.%)
Lg Ao	0.0146	(1; 3.4%)	Rf Ao	0.0147	(1; 1.6%)	Bx Ao	0.0718	(1; 1.6%)
Ga Ao	0.0134	(1; 3.2%)	Wt Ao	0.0143	(1; 1.6%)	Ng Ao	0.0695	(1; 1.5%)
Br Ao	0.011	(1; 2.6%)	Rd Ao	0.0124	(1; 1.4%)	Lg Ao	0.0346	(1; 0.76%)
Mn Bx Ao	0.00542	(2; 1.3%)	Wt Bx Ao	0.0115	(2; 1.3%)	Fr Bx Ao	0.0124	(2; 0.27%)
Pd Ao	0.00411	(1; 0.97%)	Mn Bx Ao	0.0114	(2; 1.3%)	Is Ao	0.0114	(1; 0.25%)
El Bx Ao	0.00378	(2; 0.89%)	Ot Ao	0.0112	(1; 1.2%)	Bl El Ao	0.0109	(2; 0.24%)
Sg Ao	0.003	(1; 0.71%)	Pd Ao	0.00987	(1; 1.1%)	Bl Ao	0.00942	(1; 0.21%)
Bl El Ao	0.0028	(2; 0.66%)	Bk Ao	0.00763	(1; 0.84%)	Fo Bx Ao	0.00786	(2; 0.17%)
Bl Ao	0.00241	(1; 0.57%)	Ts Ao	0.00727	(1; 0.8%)	Sp Ao	0.00699	(1; 0.15%)
Rd Ao	0.00211	(1; 0.5%)	Pi Ao	0.00634	(1; 0.7%)	Ce Ao	0.00691	(1; 0.15%)
Wt Ao	0.00198	(1; 0.47%)	Nb Bx Ao	0.00614	(2; 0.68%)	Ch Ao	0.00686	(1; 0.15%)
Bk Ao	0.00192	(1; 0.45%)	Ng Ao	0.00591	(1; 0.65%)	El Rf Ao	0.00537	(2; 0.12%)
Rf Ao	0.00184	(1; 0.43%)	Lg Ao	0.00562	(1; 0.62%)	Rf Ao	0.00534	(1; 0.12%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Ao	0.831	(0; 89.%)	Ao	0.119	(0; 44.%)	Bx Ao	98.6	(1; 88.%)
Bx Ao	0.0292	(1; 3.1%)	Bx Ao	0.0255	(1; 9.5%)	Ao	3.92	(0; 3.5%)
Lg Ao	0.017	(1; 1.8%)	El Ao	0.00528	(1; 2.%)	El Ao	2.4	(1; 2.1%)
Bl El Ao	0.00424	(2; 0.45%)	Ga Ao	0.0052	(1; 1.9%)	Br Ao	0.885	(1; 0.79%)
Bl Ao	0.00366	(1; 0.39%)	Rf Ao	0.00413	(1; 1.5%)	El Bx Ao	0.517	(2; 0.46%)
Rf Ao	0.00302	(1; 0.32%)	Mn Bx Ao	0.00382	(2; 1.4%)	Wa Ao	0.415	(1; 0.37%)
Sp Ao	0.00297	(1; 0.32%)	Pd Ao	0.0037	(1; 1.4%)	Mn Bx Ao	0.361	(2; 0.32%)
Wt Ao	0.00162	(1; 0.17%)	Ot Ao	0.00315	(1; 1.2%)	Wa Bx Ao	0.152	(2; 0.14%)
Sg Ao	0.00149	(1; 0.16%)	Wt Ao	0.00307	(1; 1.1%)	Wa El Ao	0.139	(2; 0.12%)
Wt Bx Ao	0.00131	(2; 0.14%)	Ng Ao	0.00256	(1; 0.95%)	Ng Ao	0.136	(1; 0.12%)
Is Ao	0.00101	(1; 0.11%)	Wt Bx Ao	0.00247	(2; 0.92%)	Wa Pd Ao	0.112	(2; 0.1%)
Bl El Bx Ao	0.000915	(3; 0.098%)	Lg Ao	0.00244	(1; 0.91%)	Sg Ao	0.076	(1; 0.068%)
Ch Ao	0.000798	(1; 0.085%)	Rd Ao	0.00214	(1; 0.8%)	Bl El Ao	0.0567	(2; 0.051%)
Oi Fo Bx Ao	0.000764	(3; 0.082%)	Bk Ao	0.00188	(1; 0.7%)	Lg Ao	0.0525	(1; 0.047%)
Rd Ao	0.000736	(1; 0.079%)	Br Ao	0.00184	(1; 0.69%)	Bl Ao	0.0489	(1; 0.044%)
Eq Bx Ao	0.000658	(2; 0.07%)	Pi Ao	0.00178	(1; 0.66%)	Wa Ga Ao	0.039	(2; 0.035%)
Ma Bx Ao	0.000498	(2; 0.053%)	Ts Ao	0.0017	(1; 0.63%)	Is Ao	0.0302	(1; 0.027%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Ao	0.0553	(0; 44.%)	Ao	0.0801	(0; 49.%)	Bx Ao	0.0233	(1; 19.%)
Bx Ao	0.0231	(1; 18.%)	Bx Ao	0.0158	(1; 9.6%)	El Ao	0.00701	(1; 5.7%)
Fo Bx Ao	0.00258	(2; 2.%)	El Ao	0.00329	(1; 2.%)	Bc Mp Ho Ao	0.00441	(3; 3.6%)
Mn Bx Ao	0.00248	(2; 2.%)	Ga Ao	0.00264	(1; 1.6%)	Fr Bx Ao	0.00398	(2; 3.3%)
Sp Ao	0.00125	(1; 0.99%)	Mn Bx Ao	0.0026	(2; 1.6%)	Bc Mp Ch Ao	0.00273	(3; 2.2%)
El Ao	0.00122	(1; 0.97%)	Pd Ao	0.00243	(1; 1.5%)	Rf Ao	0.00207	(1; 1.7%)
Ng Ao	0.00113	(1; 0.9%)	Rf Ao	0.0019	(1; 1.2%)	El Bx Ao	0.00151	(2; 1.2%)
Lg Ao	0.00107	(1; 0.85%)	Ng Ao	0.00186	(1; 1.1%)	Hw Ao	0.00139	(1; 1.1%)
Sg Ao	0.000939	(1; 0.75%)	Lg Ao	0.00177	(1; 1.1%)	Bc Ch Ao	0.00137	(2; 1.1%)
Ga Ao	0.000838	(1; 0.67%)	Rd Ao	0.00152	(1; 0.92%)	Ga Ao	0.0013	(1; 1.1%)
Br Ao	0.000812	(1; 0.64%)	Ot Ao	0.00145	(1; 0.88%)	Bc Mp Ho Bx	0.00101	(4; 0.83%)
Ch Ao	0.000799	(1; 0.63%)	Wt Ao	0.00143	(1; 0.87%)	Bc Mp Ch Bx	0.000958	(4; 0.78%)
Pd Ao	0.000592	(1; 0.47%)	Br Ao	0.00134	(1; 0.81%)	Wo Tx Bx Ao	0.000879	(3; 0.72%)
Ma Bx Ao	0.000588	(2; 0.47%)	Wt Bx Ao	0.00115	(2; 0.7%)	Fr Hw Ao	0.000844	(2; 0.69%)
Rd Ao	0.000536	(1; 0.43%)	Bk Ao	0.00104	(1; 0.63%)	Bc Mp Ho Pd	0.000701	(4; 0.57%)
Is Ao	0.000476	(1; 0.38%)	Ts Ao	0.000838	(1; 0.51%)	Bc Mp Ho Mn	0.00057	(5; 0.47%)
Rf Ao	0.000475	(1; 0.38%)	Pi Ao	0.000818	(1; 0.5%)	Ng Ao	0.000569	(1; 0.47%)

### Linkages (average = 1)

	Value	C.o.V.
Upstream	1.214 ±0.027	(±2.2%)
Downstream	0.222 ±0.016	(±7.1%)

# Sector 27220010: Aluminium (Al)

*Aluminium alloys and aluminium recovery (from alumina smelted at the same unit, and secondary)*

## Short Summary

Against a metric of one dollar of final demand, the environmental indicator of greenhouse emissions is five times the national average, while water use is equal to average, and land disturbance is 95% below average. The social indicator of employment generation is 50% below average, income is 20% below average, and government revenue is 20% below average. The financial indicators reveal that operating surplus is 15% above average, export propensity is seven times the average, and import penetration is 30% below average. New process technologies may, if proven, be able to halve the current energy intensity of production.

## Sector Description

Australia produces around 1.8 million tonnes of aluminium per year. Around 320 000 tonnes is consumed domestically and the remaining 1.5 million tonnes is exported, giving around \$4.2 billion of export income at a unit price of \$2 800 per tonne. Aluminium smelting began in 1955 at Bell Bay in Tasmania with 12 000 tonnes per annum, increasing to 142 000 tonnes currently. Other smelters include Port Henry (185 000 tonnes/annum) and Portland (345 000 t/a) in Victoria, Tomago (440 000 t/a) and Kurri Kurri (150 000 t/a) in New South Wales, and Gladstone in Queensland (490 000 t/a). Aluminium production is energy intensive (hence its description as 'frozen electricity') and requires 211 MJ (10<sup>6</sup>J) of energy per kg if produced with black coal electricity. The theoretical limit for the current process is 9% (193 MJ/kg) below the average figure, while different anodes and cathodes can decrease the average by nearly 30% (152 MJ/kg). A theoretical and untested carbothermic process claims to be able to reduce energy use to 45% (94 MJ/kg) of the current average.

## Place of Industry in the Economy

The aluminium smelting sector ranks 82<sup>nd</sup> out of 135 sectors in terms of value adding in the economy and contributes 0.17% of GDP in this analysis. It is similar in value adding to the commercial fishing and flour milling sectors. It is a relatively small employer with 4 000 employment years embodied in final demand and another 12 000 employment years in the sector's upstream suppliers giving a total of 16 000 employment years. In addition it contributes another 1 000 employment years to downstream industries. Its resource requirements include a negligible amount of land disturbance and about one half of one percent of national water use. Both energy and subsequent greenhouse gas emissions are around one fortieth of national totals, or 2.5%. This analysis treats the three components (bauxite mining, alumina, and aluminium smelting) as separate sectors. In absolute financial terms, exports are thirteen times the level of imports.

## Strategic Overview

The integrated overview provided in the spider diagram reveals a number of extended outliers for energy use and greenhouse emissions, and below average outcomes for the social indicators of employment generation, income and government revenue. Some viewpoints may criticise the sector for these, but strong economic indicators particularly for export propensity, provide some counterview. Given the concern for the structural imbalance in Australia's international trading accounts, a strong export performance from a value added commodity such as aluminium cannot be easily dismissed. Advanced processing technologies and improved product stewardship and recycling may help improve some of the indicators.

## TBL Account #1

The financial indicator of operating surplus is about 15% above the economy wide average with about one quarter of this being a direct effect. Other important contributors to the surplus include electricity production (18%), alumina production (4%), bauxite mining (3%), and black coal mining (3%). The employment generation indicator is 50% below the average with a similar composition to the surplus indicator. The greenhouse emissions indicator is five times the average and one quarter of this is a direct sector effect. The extended greenhouse chain is described below.

## TBL Accounts #2 and #3

The second TBL indicator reveals that the export propensity is seven times the economy wide average and two thirds of this is due to the commodity itself, with an additional 10% due to alumina production. The income indicator is 20% below average while the water use indicator is equal to average. The third TBL indicator shows that import penetration is 30% below average, government revenue is 20% below average and land disturbance is 95% below average.

## Structural Path Analysis and Linkages

The greenhouse chain will probably require attention and an examination of the structural path reveals that electricity production from coal accounts for 36% of total emissions, while the direct sector effect is 26%, alumina production is 9%, black coal mining is 1%, and electricity production for alumina production is 1%. A step change in the smelting process is the most logical route to reducing the greenhouse indicator. Large changes to the domestic electricity production mix are unlikely to yield enough low greenhouse electricity to run one extra smelter, given that Bell Bay in Tasmania is the only one supplied by hydro electricity. Hydro is unlikely to grow by more than 10%.

The sector's stimulus to its upstream suppliers is about 50% greater than the economy wide average and includes obvious parts of the chain such as electricity production, aluminium recycling, alumina production, bauxite mining, wholesale trade and equipment hire. The linkages to downstream industries are weak as most of the production leaks to exports.

## Future Trends in Sector

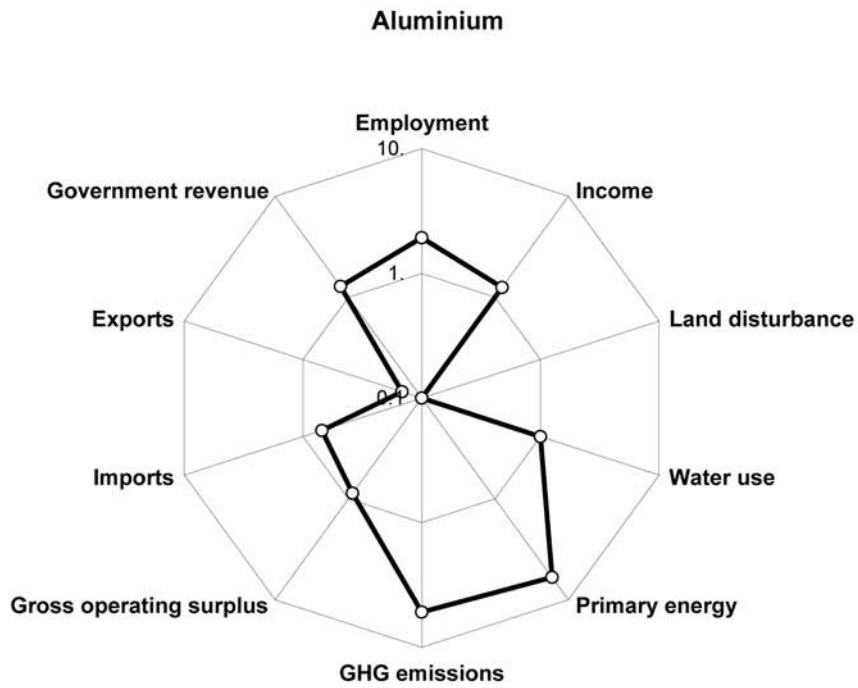
In the base case scenario of the *Future Dilemmas* study, the metal group which includes aluminium expands production by 40% over the next 50 years and thus aluminium production to 2.5 million tonnes per annum on a pro rata basis. However this projection is uncertain, as Australian aluminium is a greenhouse-intensive trade-exposed industry, and would be particularly affected by future carbon constraints. Industry sources indicate that an extra four million tonnes annual production will be added to global production in the next decade, and at least 55% will be smelted by hydro, 30% by coal fired and 15% by natural gas electricity.

## Innovation and Technical Opportunities

In addition to the process improvements already noted, the literature suggests three areas for improvement. Firstly, markedly improving recovery and recycling rates offers substantial savings in energy and greenhouse once metal has been reused several times. Some Australian data suggests that current recycling rates are around 22%. Secondly, to avoid contamination by 'tramp' metals in this process, effective collection and sorting systems are required. Thirdly, the almost endless recycling potential in the life cycle of aluminium gives it a 'cradle to cradle' stewardship advantage.

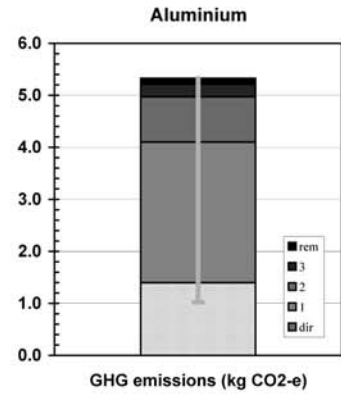
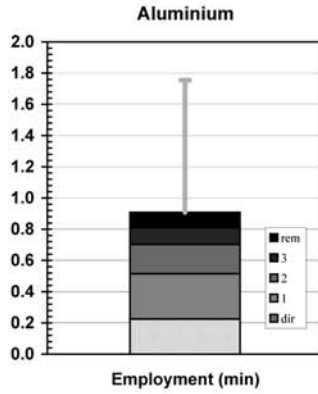
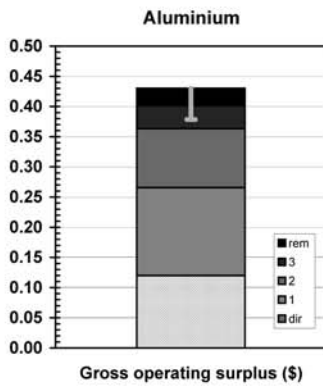
Aluminium alloys and aluminium recovery (from alumina smelted at the same unit, and secondary)

Spider diagram

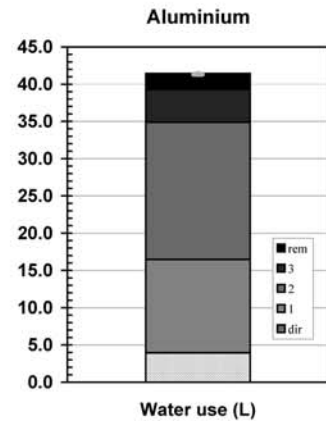
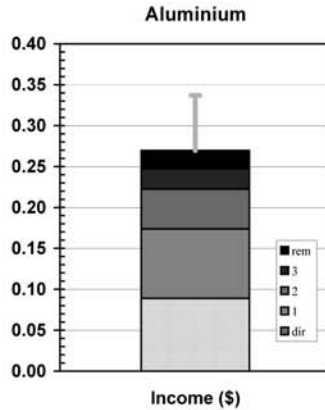
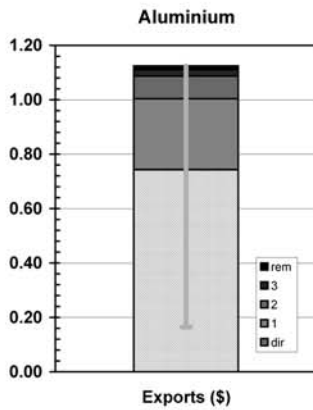


Bar graphs

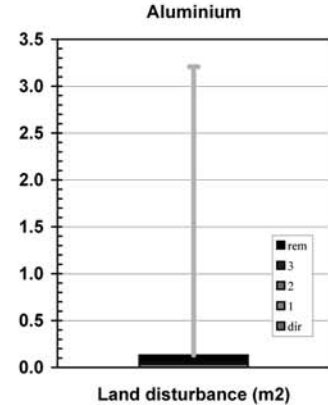
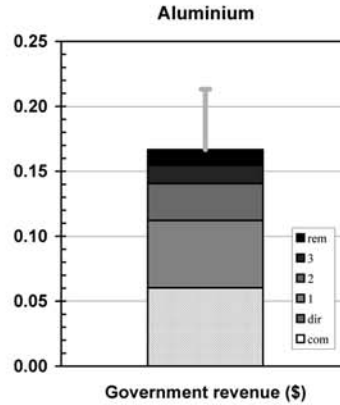
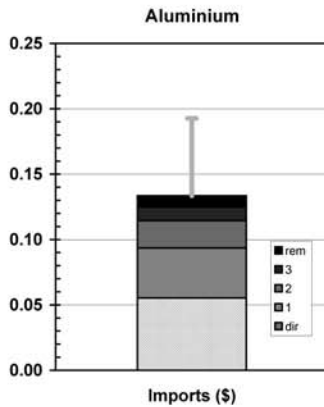
Account #1



Account #2



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 0.0		
Government final consumption	\$m 0.0		
Gross fixed capital expenditure	\$m 0.0		
Net changes in stocks	\$m 36.5	(2.07% of total)	(\$m 36.1 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 36.5</b>	<b>(0.01% of GNE)</b>	<b>(\$m 36.1 domestically produced)</b>
Exports	\$m 2,155.6	(2.59% of total)	(\$m 2,155.6 domestically produced)
<b>Final demand</b>	<b>\$m 2,192.2</b>	<b>(0.40% of GNT)</b>	<b>(\$m 2,191.8 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 257.9	(0.15% of total)
Gross operating surplus	\$m 348.1	(0.18% of total)
Taxes less subsidies	\$m 174.9	(0.20% of total)
<b>Sectoral GDP*</b>	<b>\$m 780.9</b>	<b>(0.17% of GDP)</b>
Imports	\$m 160.6	(0.16% of total)
<b>Primary inputs</b>	<b>\$m 941.5</b>	<b>(0.17% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 348.1	(0.18%)	\$m 262.7	(0.14%)
Exports (\$m)	\$m 2,155.6	(2.59%)	\$m 1,627.3	(1.95%)
Imports (\$m)	\$m 160.6	(0.16%)	\$m 121.2	(0.12%)
Employment (e-y)	5,221 e-y	(0.07%)	3,941 e-y	(0.06%)
Income (\$m)*	\$m 257.9	(0.15%)	\$m 194.7	(0.11%)
Government revenue (\$m)†	\$m 174.9	(0.16%)	\$m 132.0	(0.12%)
GHG emissions (kt CO <sub>2</sub> -e)	4,052 kt	(0.78%)	3,059 kt	(0.59%)
Water use (ML)	11,390 ML	(0.05%)	8,598 ML	(0.04%)
Land disturbance (kha)	0 kha	(0.00%)	0 kha	(0.00%)
Primary energy (TJ)	11,100 TJ	(0.29%)	8,379 TJ	(0.22%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.12	0.43	0.38
Exports (\$)	0.74	1.12	0.16
Imports (\$)	0.06	0.13	0.19
Employment (min)	0.22	0.91	1.75
Income (\$)	0.09	0.27	0.34
Government revenue (\$)	0.06	0.17	0.21
GHG emissions (kg CO <sub>2</sub> -e)	1.40	5.33	1.02
Water use (L)	3.92	41.44	41.32
Land disturbance (m <sup>2</sup> )	0.00	0.13	3.21
Primary energy (MJ)	3.82	45.83	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks



**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Al	0.12	(0; 28.%)	Al	0.224	(0; 25.%)	EI Al	1.93	(1; 36.%)
EI Al	0.0779	(1; 18.%)	EI Al	0.0866	(1; 9.5%)	Al	1.4	(0; 26.%)
Ao Al	0.0176	(1; 4.1%)	Ao Al	0.0373	(1; 4.1%)	Ao Al	0.458	(1; 8.6%)
Bx Ao Al	0.0127	(2; 3.%)	Rf Al	0.0134	(1; 1.5%)	EI Ao Al	0.0579	(2; 1.1%)
BI EI Al	0.0124	(2; 2.9%)	Bx Ao Al	0.0131	(2; 1.4%)	BI EI Al	0.0486	(2; 0.91%)
Pd Al	0.00374	(1; 0.87%)	Wt Al	0.013	(1; 1.4%)	Pc Al	0.0131	(1; 0.25%)
Oi Pc Al	0.00286	(2; 0.67%)	Rd Al	0.0113	(1; 1.2%)	EI Bx Ao Al	0.0125	(3; 0.23%)
Sg Al	0.00273	(1; 0.63%)	Ot Al	0.0102	(1; 1.1%)	Ga Ao Al	0.0123	(2; 0.23%)
EI Ao Al	0.00234	(2; 0.54%)	Pd Al	0.00898	(1; 0.99%)	Is Al	0.0104	(1; 0.19%)
Ng Ao Al	0.00204	(2; 0.48%)	Bk Al	0.00694	(1; 0.76%)	Bx Ao Al	0.00959	(2; 0.18%)
Lg Ao Al	0.00195	(2; 0.45%)	Ts Al	0.00662	(1; 0.73%)	Ng Ao Al	0.00928	(2; 0.17%)
Rd Al	0.00193	(1; 0.45%)	Pi Al	0.00577	(1; 0.64%)	Sp Al	0.00637	(1; 0.12%)
Wt Al	0.00181	(1; 0.42%)	BI EI Al	0.00479	(2; 0.53%)	Ce Al	0.00629	(1; 0.12%)
Ga Ao Al	0.00179	(2; 0.42%)	Fm Al	0.00379	(1; 0.42%)	Ch Al	0.00625	(1; 0.12%)
Bk Al	0.00175	(1; 0.41%)	Ms Al	0.0035	(1; 0.39%)	Oi Pc Al	0.00607	(2; 0.11%)
Rf Al	0.00168	(1; 0.39%)	Sg Al	0.00345	(1; 0.38%)	EI Rf Al	0.00489	(2; 0.092%)
Br Ao Al	0.00147	(2; 0.34%)	Is Al	0.00287	(1; 0.32%)	Rf Al	0.00486	(1; 0.091%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Al	0.742	(0; 66.%)	Al	0.0888	(0; 33.%)	Bx Ao Al	13.2	(2; 32.%)
Ao Al	0.111	(1; 9.9%)	EI Al	0.0234	(1; 8.7%)	EI Al	10.7	(1; 26.%)
BI EI Al	0.0188	(2; 1.7%)	Ao Al	0.0158	(1; 5.9%)	Al	3.92	(0; 9.5%)
Bx Ao Al	0.0039	(2; 0.35%)	Rf Al	0.00376	(1; 1.4%)	Wa EI Al	0.616	(2; 1.5%)
Pc Al	0.0031	(1; 0.28%)	Bx Ao Al	0.00341	(2; 1.3%)	Ao Al	0.524	(1; 1.3%)
Rf Al	0.00275	(1; 0.24%)	Pd Al	0.00337	(1; 1.3%)	Wa Al	0.378	(1; 0.91%)
Sp Al	0.0027	(1; 0.24%)	Ot Al	0.00287	(1; 1.1%)	EI Ao Al	0.32	(2; 0.77%)
Lg Ao Al	0.00227	(2; 0.2%)	Wt Al	0.00279	(1; 1.%)	BI EI Al	0.252	(2; 0.61%)
Oi Pc Al	0.00196	(2; 0.17%)	BI EI Al	0.00208	(2; 0.77%)	Br Ao Al	0.118	(2; 0.29%)
Wt Al	0.00148	(1; 0.13%)	Rd Al	0.00195	(1; 0.72%)	Br EI Al	0.104	(2; 0.25%)
Sg Al	0.00136	(1; 0.12%)	Bk Al	0.00171	(1; 0.64%)	Wa Pd Al	0.102	(2; 0.25%)
Is Al	0.000919	(1; 0.082%)	Pi Al	0.00162	(1; 0.6%)	Sg Al	0.0692	(1; 0.17%)
Ch Al	0.000726	(1; 0.065%)	Ts Al	0.00155	(1; 0.57%)	EI Bx Ao Al	0.0691	(3; 0.17%)
Rd Al	0.00067	(1; 0.06%)	Ms Al	0.000815	(1; 0.3%)	Wa Ao Al	0.0554	(2; 0.13%)
BI EI Ao Al	0.000567	(3; 0.05%)	EI Ao Al	0.000705	(2; 0.26%)	Mn Bx Ao Al	0.0482	(3; 0.12%)
Lg Al	0.000558	(1; 0.05%)	Ga Ao Al	0.000694	(2; 0.26%)	Is Al	0.0275	(1; 0.066%)
BI Ao Al	0.000488	(2; 0.043%)	Is Al	0.000685	(1; 0.25%)	EI Rf Al	0.027	(2; 0.065%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Al	0.0553	(0; 41.%)	Al	0.0602	(0; 36.%)	EI Al	0.0311	(1; 24.%)
Ao Al	0.00739	(1; 5.5%)	EI Al	0.0146	(1; 8.8%)	Bc Mp Ho Al	0.00401	(3; 3.1%)
Pc Al	0.0066	(1; 4.9%)	Ao Al	0.0107	(1; 6.4%)	Bx Ao Al	0.00311	(2; 2.4%)
EI Al	0.00541	(1; 4.%)	Pd Al	0.00221	(1; 1.3%)	Bc Mp Ch Al	0.00248	(3; 1.9%)
Bx Ao Al	0.00308	(2; 2.3%)	Bx Ao Al	0.00211	(2; 1.3%)	Rf Al	0.00189	(1; 1.4%)
Sp Al	0.00114	(1; 0.85%)	Rf Al	0.00173	(1; 1.%)	BI EI Al	0.00158	(2; 1.2%)
BI EI Al	0.000916	(2; 0.69%)	BI EI Al	0.00151	(2; 0.9%)	Hw Al	0.00126	(1; 0.96%)
Sg Al	0.000855	(1; 0.64%)	Rd Al	0.00138	(1; 0.83%)	Bc Ch Al	0.00125	(2; 0.95%)
Ch Al	0.000727	(1; 0.54%)	Ot Al	0.00132	(1; 0.79%)	Bc Mp Ho EI /	0.001	(4; 0.76%)
Pd Al	0.000539	(1; 0.4%)	Wt Al	0.0013	(1; 0.78%)	EI Ao Al	0.000936	(2; 0.71%)
Rd Al	0.000488	(1; 0.37%)	Bk Al	0.000947	(1; 0.57%)	Fr Hw Al	0.000769	(2; 0.59%)
Is Al	0.000433	(1; 0.32%)	Ts Al	0.000763	(1; 0.46%)	Bc Mp Ho Pd	0.000638	(4; 0.49%)
Rf Al	0.000433	(1; 0.32%)	Pi Al	0.000745	(1; 0.45%)	Bc Mp Ho Ao	0.000588	(4; 0.45%)
Ts Al	0.000421	(1; 0.32%)	In Al	0.000592	(1; 0.36%)	Fr Bx Ao Al	0.000531	(3; 0.4%)
Wt Al	0.00042	(1; 0.31%)	EI Ao Al	0.000439	(2; 0.26%)	Wo Tx Tp Al	0.000505	(3; 0.38%)
Fo Bx Ao Al	0.000344	(3; 0.26%)	Ms Al	0.000387	(1; 0.23%)	Wo Tx Wt Al	0.000463	(3; 0.35%)
Mn Bx Ao Al	0.000331	(3; 0.25%)	Sg Al	0.000381	(1; 0.23%)	Wo Mp Ho Al	0.000453	(3; 0.35%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.532 ±0.034	(±2.2%)
Downstream	0.406 ±0.019	(±4.6%)

# Sector Rem. 2702: Other Basic Non-Ferrous Metal Products (Nf)

*Copper, silver, lead, zinc, nickel, platinum, antimony, tungsten, molybdenum and other non-ferrous metal recovery; all basic non-ferrous metal, pipe, tube, plate, sheet, bar, strip, and wire products*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is 50% above average while water use and land disturbance are 65% and 95% below average respectively. The social indicators reveal that employment generation, income and government revenue are 55%, 40%, and 40% below average respectively. The financial indicators show that operating surplus is 20% above average, export propensity is over five times the average, and import penetration is 20% below average. Incentives which encourage stewardship and recycling could reduce persistent long term threats to ecological function from some of these metals.

## Sector Description

This sector produces both virgin base metals (copper, silver, lead and zinc) from refining of mined ores as well as from the re-smelting and purification of recycled materials. Precise production information for the base metals sector is difficult to calculate due to statistics which report the metal content of ore mined, partially concentrated, and as fully refined products. Given these caveats, it would appear that Australia currently produces around 530 000 tonnes of copper, 740 000 tonnes of lead, 600 000 tonnes of zinc, 200 000 tonnes of nickel, 700 tonnes of silver and may soon be producing 3 tonnes (100 000 oz) of platinum. Australia itself consumes over 300 000 tonnes of base metals per year, composed of 28% zinc, 54% copper, and 18% lead. In a process sense, these materials are highly recyclable and some data suggest that over 100 000 tonnes (or 30% of yearly use) are reclaimed each year. Recycling of copper, lead and zinc can respectively save 85%, 65% and 60% of energy requirements compared to the use of virgin metals. The sector had a turnover of about \$6.5 billion per year in 2002 and involved over 100 enterprises.

## Place of Industry in the Economy

The base metals sector ranks 56<sup>th</sup> out of 135 sectors in terms of value adding to the economy and contributes 0.3% of GDP in this analysis. It is similar in value adding to the basic chemicals and electronic equipment sectors. It is a moderate sized employer with 2 000 employment years directly embodied in final demand and another 20 000 years in the sector's upstream suppliers giving a total of 22 000 employment years. It has moderate resource requirements with less than three tenths of one percent of national water use and land disturbance, but two percent of national energy use and one percent of greenhouse emissions. In financial terms, exports are eight times the size of imports.

## Strategic Overview

The spider diagram has a number of prominent outliers, highlighting a number of issues. These include the environmental indicators of greenhouse emissions and energy use, and the social indicators of employment generation, income and government revenue. The sector's upstream issues relate to the environmental effect of, and the total material flows associated with, mining practices. Important downstream issues relate to the effect of some of the metals on ecosystem function once they pass threshold concentrations in urban and industrial locations. The social and environmental indicators mostly reflect the global nature of the industry. Material taxes or other policies may be used in the future to increase metal stewardship systems and recycling rates.

## TBL Account #1

The financial indicator of operating surplus is 20% above average and one third of this is a direct sector effect with additional contributions from the primary ore mining sectors such as copper (7%), uranium (7%), gold and lead (6%), silver and zinc (2%), and electricity production (1%). The social indicator of employment generation is 55% below average and one tenth of this is a direct sector effect perhaps reflecting the capital intensive nature of metal processing and refining. The environmental indicator of greenhouse emissions is 50% above average and nearly one half of this is a direct effect of fuel combusted in the sector.

## TBL Accounts #2 and #3

The second TBL account reveals that the export propensity indicator is over five times the economy wide average and one half of this is the direct sector effect with contributions from the primary mining sectors similar to the operating surplus above. The social indicator of income is 40% below average and the indicator of water use is 65% below average. The third TBL account shows that the import penetration indicator is 20% below average, the government revenue indicator is 40% below average and the land disturbance indicator is 95% below average.

## Structural Path Analysis and Linkages

An examination of the structural path for emissions shows that direct fuel combustion plus process emissions in the sector contributes 40% of the total. Electricity use in the sector contributes 8%, while electricity use in the uranium, copper and gold and lead mining sectors contributes 2% each, giving an electricity total of about 15%. Fuel combustion in the primary mining sectors contributes 3%, and natural gas mining and distribution contribute another 2%. With such a broadly based emissions chain, significant improvements may require new concentrating and refining processes.

The sector's stimulus to its upstream suppliers is 60% greater than the economy wide average with particular effects on the primary mining sectors of copper, gold and lead, and uranium and nickel as well as for property development and real estate. The linkages to downstream industries is around average and suggests that any expansion in this refining sector must also be accompanied by expansion in structural metal products, motor vehicles and electrical equipment for this effect to be dissipated.

## Future Trends in Sector

In the base case scenario of the *Future Dilemmas* study, the aggregate metal group including these metals increases its production by 50% over the next 50 years. Given a number of environmental and human health concerns about the accumulation in infrastructure and waste, and then the subsequent release of some of these metals (lead, zinc, copper), these anticipated increases in production could be uncertain. In addition, there are many opportunities for substitution such as replacing copper cables by optic fibres, and reducing the lead content but increasing the energy density in lead-acid batteries. Copper requirements may mostly come from recycled metal.

## Innovation and Technical Opportunities

Many innovations are underway in refining of the metals in this sector as well as their use in traditional bulk applications, and as minor components of new materials, process catalysts and electronic chips. While volumetric use in developed countries may decline, advanced recycling could allow management of the metals in a 'cradle to cradle' life cycle approach. The lower cost and industrial maturity of metals such as copper, lead, and zinc will maintain markets in developing countries. Lead-acid batteries for motor vehicles and telecommunication applications consume 75% globally of lead. A major breakthrough in vehicle technology could significantly affect lead demand.

**Sector**

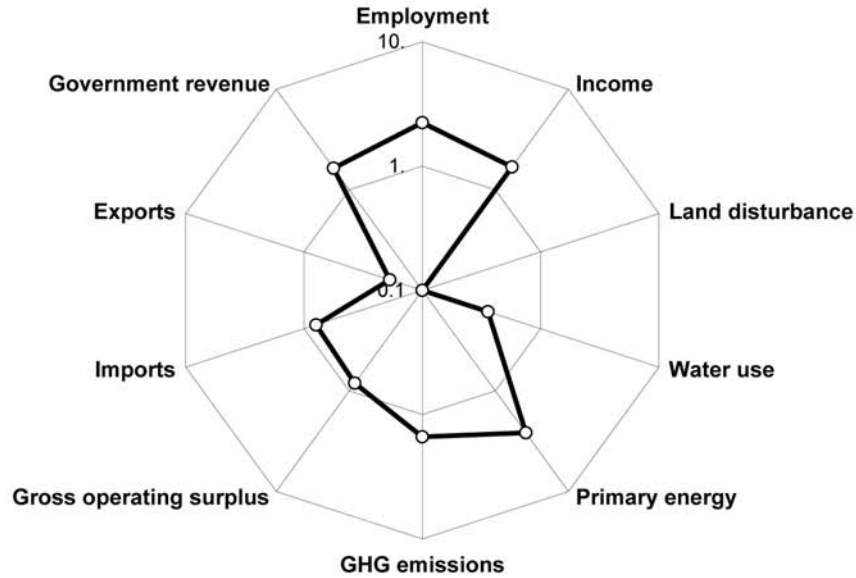
**Other basic non-ferrous metal products**

**(Nf)**

Copper, silver, lead, zinc, nickel, platinum, antimony, tungsten, molybdenum and other non-ferrous metal recovery; all basic non-ferrous metal, pipe, tube, plate, sheet, bar, strip, wire and other products

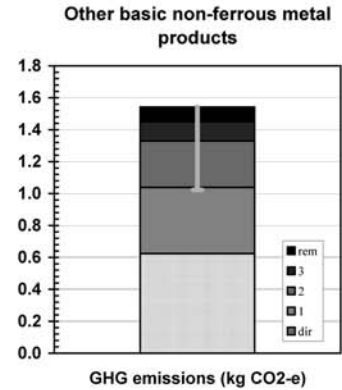
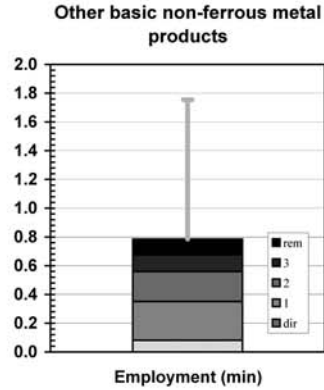
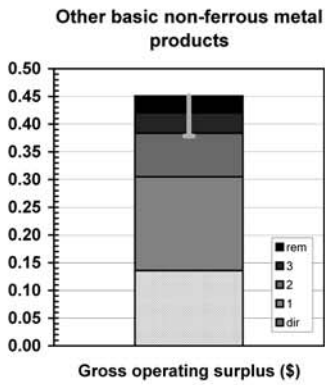
Spider diagram

**Other basic non-ferrous metal products**

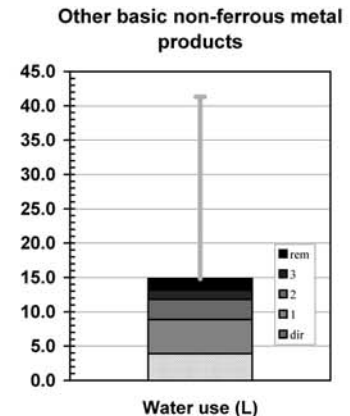
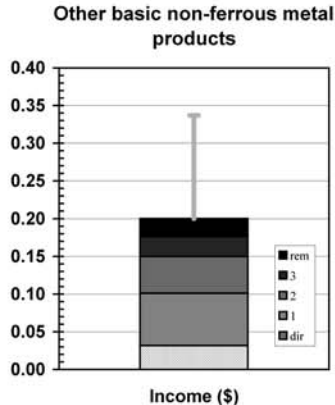
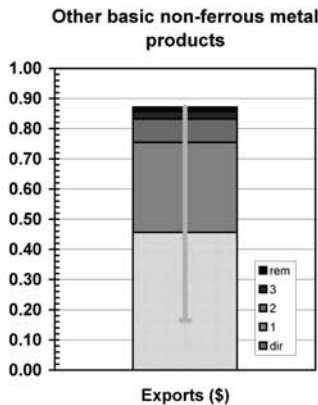


Bar graphs

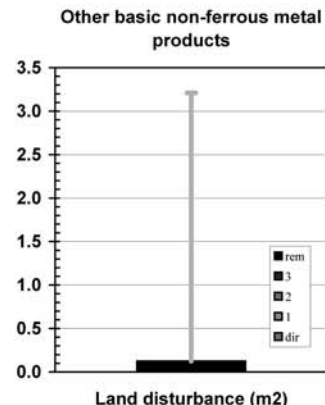
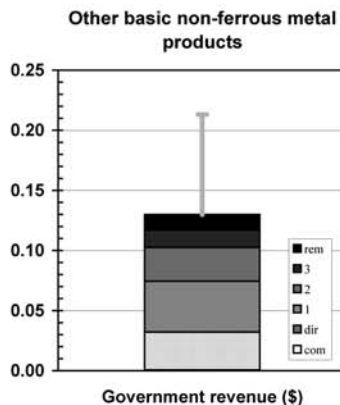
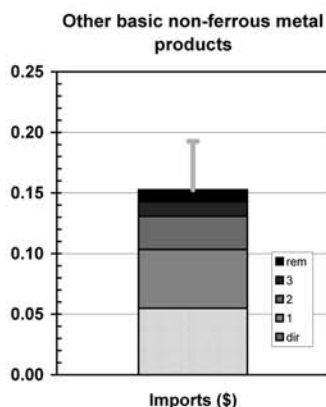
**Account #1**



**Account #2**



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 249.6	(0.09% of total)	(\$m 225.2 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 16.1	(0.02% of total)	(\$m 16.1 domestically produced)
Net changes in stocks	-\$m 27.7	-(1.57% of total)	
<b>Sectoral GNE</b>	<b>\$m 238.0</b>	<b>(0.05% of GNE)</b>	<b>(\$m 184.5 domestically produced)</b>
Exports	\$m 3,275.1	(3.93% of total)	(\$m 3,275.1 domestically produced)
<b>Final demand</b>	<b>\$m 3,513.1</b>	<b>(0.65% of GNT)</b>	<b>(\$m 3,459.6 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 227.3	(0.13% of total)
Gross operating surplus	\$m 974.3	(0.51% of total)
Taxes less subsidies	\$m 226.4	(0.26% of total)
<b>Sectoral GDP*</b>	<b>\$m 1,428.0</b>	<b>(0.32% of GDP)</b>
Imports	\$m 393.7	(0.40% of total)
<b>Primary inputs</b>	<b>\$m 1,821.7</b>	<b>(0.33% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct (% of national)	total (% of national)
Gross operating surplus (\$m)	\$m 974.3	(0.51%)	\$m 477.6 (0.25%)	\$m 1,584.8 (0.83%)
Exports (\$m)	\$m 3,275.1	(3.93%)	\$m 1,605.4 (1.93%)	\$m 3,065.1 (3.68%)
Imports (\$m)	\$m 393.7	(0.40%)	\$m 193.0 (0.20%)	\$m 536.7 (0.55%)
Employment (e-y)	4,636 e-y	(0.07%)	2,272 e-y (0.03%)	22,130 e-y (0.31%)
Income (\$m)*	\$m 227.3	(0.13%)	\$m 111.4 (0.07%)	\$m 703.7 (0.41%)
Government revenue (\$m)†	\$m 228.4	(0.21%)	\$m 113.0 (0.10%)	\$m 457.0 (0.42%)
GHG emissions (kt CO <sub>2</sub> -e)	4,477 kt	(0.86%)	2,194 kt (0.42%)	5,424 kt (1.05%)
Water use (ML)	27,918 ML	(0.13%)	13,685 ML (0.07%)	52,125 ML (0.25%)
Land disturbance (kha)	0 kha	(0.00%)	0 kha (0.00%)	44 kha (0.03%)
Primary energy (TJ)	69,534 TJ	(1.79%)	34,084 TJ (0.88%)	70,283 TJ (1.81%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.14	0.45	0.38
Exports (\$)	0.46	0.87	0.16
Imports (\$)	0.05	0.15	0.19
Employment (min)	0.08	0.79	1.75
Income (\$)	0.03	0.20	0.34
Government revenue (\$)	0.03	0.13	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.62	1.54	1.02
Water use (L)	3.89	14.82	41.32
Land disturbance (m <sup>2</sup> )	0.00	0.12	3.21
Primary energy (MJ)	9.69	19.99	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Nf	0.136	(0; 30.%)	Nf	0.0807	(0; 10.%)	Nf	0.624	(0; 40.%)
Co Nf	0.0322	(1; 7.1%)	Co Nf	0.0332	(1; 4.2%)	El Nf	0.126	(1; 8.2%)
Uo Nf	0.0309	(1; 6.9%)	Uo Nf	0.0319	(1; 4.1%)	El Co Nf	0.0316	(2; 2.1%)
Gl Nf	0.0274	(1; 6.1%)	Gl Nf	0.0283	(1; 3.6%)	El Uo Nf	0.0304	(2; 2.%)
Sz Nf	0.00755	(1; 1.7%)	Rf Nf	0.0152	(1; 1.9%)	El Gl Nf	0.027	(2; 1.7%)
El Nf	0.00509	(1; 1.1%)	Wt Nf	0.0147	(1; 1.9%)	Co Nf	0.0243	(1; 1.6%)
Pd Nf	0.00424	(1; 0.94%)	Rd Nf	0.0128	(1; 1.6%)	Uo Nf	0.0233	(1; 1.5%)
Sg Nf	0.00309	(1; 0.69%)	Ot Nf	0.0116	(1; 1.5%)	Ga Nf	0.0161	(1; 1.%)
Ng Nf	0.00268	(1; 0.6%)	Pd Nf	0.0102	(1; 1.3%)	Ng Nf	0.0122	(1; 0.79%)
Lg Nf	0.00255	(1; 0.57%)	Bk Nf	0.00787	(1; 1.%)	Is Nf	0.0118	(1; 0.76%)
Ga Nf	0.00235	(1; 0.52%)	Sz Nf	0.0078	(1; 0.99%)	Gl Nf	0.00945	(1; 0.61%)
Rd Nf	0.00218	(1; 0.48%)	Ts Nf	0.0075	(1; 0.95%)	El Sz Nf	0.00743	(2; 0.48%)
Wt Nf	0.00205	(1; 0.45%)	Pi Nf	0.00654	(1; 0.83%)	Sp Nf	0.00721	(1; 0.47%)
Bk Nf	0.00198	(1; 0.44%)	El Nf	0.00566	(1; 0.72%)	Ce Nf	0.00713	(1; 0.46%)
Rf Nf	0.0019	(1; 0.42%)	Fm Nf	0.00429	(1; 0.55%)	Ch Nf	0.00708	(1; 0.46%)
Mn Co Nf	0.00183	(2; 0.41%)	Ms Nf	0.00397	(1; 0.51%)	Lg Nf	0.00607	(1; 0.39%)
Mn Uo Nf	0.00176	(2; 0.39%)	Sg Nf	0.00391	(1; 0.5%)	Fo Nf	0.00572	(1; 0.37%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Nf	0.457	(0; 52.%)	Nf	0.0317	(0; 16.%)	Nf	3.89	(0; 26.%)
Gl Nf	0.083	(1; 9.5%)	Co Nf	0.00863	(1; 4.3%)	Uo Nf	1.62	(1; 11.%)
Uo Nf	0.0506	(1; 5.8%)	Uo Nf	0.00828	(1; 4.1%)	El Nf	0.696	(1; 4.7%)
Co Nf	0.0339	(1; 3.9%)	Gl Nf	0.00735	(1; 3.7%)	Co Nf	0.65	(1; 4.4%)
Sz Nf	0.0169	(1; 1.9%)	Rf Nf	0.00426	(1; 2.1%)	Sz Nf	0.453	(1; 3.1%)
Rf Nf	0.00311	(1; 0.36%)	Pd Nf	0.00382	(1; 1.9%)	Wa Nf	0.428	(1; 2.9%)
Sp Nf	0.00306	(1; 0.35%)	Ot Nf	0.00325	(1; 1.6%)	El Co Nf	0.175	(2; 1.2%)
Lg Nf	0.00298	(1; 0.34%)	Wt Nf	0.00316	(1; 1.6%)	El Uo Nf	0.168	(2; 1.1%)
Wt Nf	0.00167	(1; 0.19%)	Rd Nf	0.0022	(1; 1.1%)	El Gl Nf	0.149	(2; 1.%)
Sg Nf	0.00154	(1; 0.18%)	Sz Nf	0.00203	(1; 1.%)	Mn Co Nf	0.122	(2; 0.82%)
Bl El Nf	0.00123	(2; 0.14%)	Bk Nf	0.00194	(1; 0.97%)	Mn Uo Nf	0.117	(2; 0.79%)
Is Nf	0.00104	(1; 0.12%)	Pi Nf	0.00184	(1; 0.92%)	Wa Pd Nf	0.116	(2; 0.78%)
Ch Nf	0.000823	(1; 0.094%)	Ts Nf	0.00175	(1; 0.88%)	Mn Gl Nf	0.104	(2; 0.7%)
Rd Nf	0.000759	(1; 0.087%)	El Nf	0.00153	(1; 0.77%)	Sg Nf	0.0784	(1; 0.53%)
Oi Fo Nf	0.000556	(2; 0.064%)	Mn Co Nf	0.00129	(2; 0.65%)	Wa Co Nf	0.0513	(2; 0.35%)
Eq Nf	0.0005	(1; 0.057%)	Mn Uo Nf	0.00124	(2; 0.62%)	Wa Uo Nf	0.0492	(2; 0.33%)
Wt Co Nf	0.000442	(2; 0.051%)	Mn Gl Nf	0.0011	(2; 0.55%)	Wa Gl Nf	0.0437	(2; 0.29%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Nf	0.0549	(0; 36.%)	Nf	0.0316	(0; 24.%)	Uo Nf	0.00586	(1; 4.7%)
Co Nf	0.00781	(1; 5.1%)	Co Nf	0.00534	(1; 4.1%)	Gl Nf	0.00513	(1; 4.1%)
Uo Nf	0.0075	(1; 4.9%)	Uo Nf	0.00512	(1; 4.%)	Bc Mp Ho Nf	0.00455	(3; 3.6%)
Gl Nf	0.00665	(1; 4.4%)	Gl Nf	0.00455	(1; 3.5%)	Bc Mp Ch Nf	0.00281	(3; 2.3%)
Fo Nf	0.00188	(1; 1.2%)	Pd Nf	0.0025	(1; 1.9%)	Co Nf	0.00237	(1; 1.9%)
Sz Nf	0.00183	(1; 1.2%)	Rf Nf	0.00196	(1; 1.5%)	Rf Nf	0.00214	(1; 1.7%)
Sp Nf	0.00129	(1; 0.84%)	Rd Nf	0.00156	(1; 1.2%)	El Nf	0.00203	(1; 1.6%)
Sg Nf	0.000969	(1; 0.63%)	Ot Nf	0.00149	(1; 1.2%)	Hw Nf	0.00143	(1; 1.1%)
Fo Co Nf	0.000872	(2; 0.57%)	Wt Nf	0.00148	(1; 1.1%)	Bc Ch Nf	0.00141	(2; 1.1%)
Mn Co Nf	0.000839	(2; 0.55%)	Sz Nf	0.00125	(1; 0.97%)	Fr Co Nf	0.00135	(2; 1.1%)
Fo Uo Nf	0.000837	(2; 0.55%)	Bk Nf	0.00107	(1; 0.83%)	Fr Uo Nf	0.00129	(2; 1.%)
Ch Nf	0.000824	(1; 0.54%)	El Nf	0.000955	(1; 0.74%)	Sz Nf	0.00126	(1; 1.%)
Mn Uo Nf	0.000806	(2; 0.53%)	Mn Co Nf	0.000879	(2; 0.68%)	Fr Gl Nf	0.00115	(2; 0.92%)
Fo Gl Nf	0.000743	(2; 0.49%)	Ts Nf	0.000864	(1; 0.67%)	Fr Hw Nf	0.000871	(2; 0.7%)
Mn Gl Nf	0.000715	(2; 0.47%)	Mn Uo Nf	0.000844	(2; 0.65%)	Bc Mp Ho Pd	0.000723	(4; 0.58%)
Pd Nf	0.00061	(1; 0.4%)	Pi Nf	0.000844	(1; 0.65%)	Wo Tx Wt Nf	0.000524	(3; 0.42%)
Rd Nf	0.000553	(1; 0.36%)	Mn Gl Nf	0.000749	(2; 0.58%)	Wo Mp Ho Nf	0.000513	(3; 0.41%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.621 ±0.030	(±1.9%)
Downstream	1.042 ±0.025	(±2.4%)

# Sector 2703: Structural Metal Products (Sm)

*Construction steel, scaffolding, perforated plate, reinforcing steel rods and bars, welded steel mesh, frames, doors, windows and other structural metal products*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is equal to average, while water use and land disturbance are 65% and 95% below average respectively. The social indicators reveal that employment generation is 5% above average, income is equal to average, while government revenue is 30% below average. For the financial indicators, the operating surplus is 15% below average, the export propensity is 25% above average and import penetration is 15% below average. The literature suggests that after a century of restrained innovation, the construction industry is moving ahead with the possibility of introducing composite structural materials that might rival the current dominant position of steel. Domestic population growth and urban refurbishment should maintain a medium term optimistic outlook.

## Sector Description

The structural metal products sector makes a wide range of products central to modern building and construction including steel beams, scaffolding, steel rails for railways, reinforcing rods and mesh for concrete, as well as railings, door frames and stairways. Important companies in this sector include One Steel (spun off from BHP Steel in 2000) and Smorgon Steel which have contrasting operations. One Steel has access to a fully integrated iron and steel chain from iron ore mines through steel mills (1.2 million tonnes produced at its Whyalla steel mill) to a well developed distribution network. By contrast, Smorgon Steel has built its business through scrap steel recycling that is fed through electric arc mini-mills, and now produces over 900 000 tonnes per year. The financial turnover of the sector was about \$2.6 billion in 2002 and involved over 500 enterprises.

## Place of Industry in the Economy

The structural metal products sector ranks 52<sup>nd</sup> out of 135 sectors in terms of value adding in the economy, and contributes 0.37% of GDP in this analysis. It is similar in value adding to the exploration and services to mining and the sand and gravel sectors. It is a small employer with 2 000 employment years directly embodied in final demand, and another 2 000 years in the sector's upstream suppliers, giving a total of 4 000 employment years. In addition, it contributes 36 000 employment years to the final demand of downstream industries such as residential building, non-residential construction, rail transport, and ownership of dwellings. The sector has small resource requirements with less than one tenth of one percent of national water use, land disturbance, energy use, and greenhouse emissions. In absolute financial terms, imports are twice the size of exports possibly explained by specialised materials not fabricated in Australia and price differences.

## Strategic Overview

The spider diagram shows a reasonably well balanced TBL account with small outliers for primary energy use and government revenue. The upstream issues for the sector relate to energy and greenhouse gas intensity of the steel processes that supply raw materials to fabricate structural metal products. Architects who seek to design commercial buildings with a low embodied energy and greenhouse gas content currently note that they cannot access domestically made recycled steel of the correct structural requirements. Part of the issue is that the mini mills that recycle steel are fuelled in the main from higher carbon brown and black coal electricity generators.

## TBL Account #1

The financial indicator of operating surplus is 15% below the economy wide average and one third of this is a direct sector effect with additional contributions from iron and steel production (10%), nuts and bolts (4%), and non-ferrous metals (2%). The social indicator of employment generation is 5% greater than average and one half of this is a direct within sector effect with other contributors similar to the surplus indicator. The environmental indicator of greenhouse emissions is equal to average with only a minor part of the total being due to fuel combusted directly within the sector.

## TBL Accounts #2 and #3

The second TBL account reveals that export propensity is 25% greater than average, income is equal to average and water use is 65% below average. The third TBL account reveals that import penetration is 15% below average, government revenue is 30% below average and land disturbance is 95% below average. All three accounts provide a reasonable TBL outcome for the sector.

## Structural Path Analysis and Linkages

While the greenhouse emissions indicator is only 10% above average, the scrutiny given to major material industries may suggest the production chain be examined for possible improvements. The structural path for greenhouse shows that iron and steel production is the largest contributor (29%) followed by electricity production (9%), the direct sector effect (3%), non-ferrous metals (3%), and the second order chain of 'iron and steel-nuts and bolts-structural metal products' (2%).

The sector is a notable one in that the upstream and downstream linkages are 44% and 47% above the economy wide average respectively. This emphasises the material centrality of the sector to the function of the economy as a whole. The stimulus to the sector's upstream suppliers includes iron and steel production, non-ferrous metals, nuts and bolts, wholesale trade and property development. The strong downstream linkages suggest any expansion in the sector must be accompanied by expansion of the residential building, non-residential construction, rail freight transport, and ownership of buildings sectors, in order for the effect to be dissipated.

## Future Trends in Sector

Under the base case scenario in the *Future Dilemmas* study, the demand for steel products used in both domestic and commercial buildings declines by 20% by the year 2050. This outcome reflects only part of this sector's production and is uncertain, as it depends on a number of key assumptions. The first are the demographic drivers and the home ownership patterns associated with them. A move to urban densification will reinforce the declining trend, while an increase in single person households and a larger population will expand it. There is a technological style for less materially intense building designs. However this could be overturned by more massive construction with large investments of energy and materials upfront, that are compensated by very low operational energy costs. Major projects such as the Alice Springs to Darwin railway line are seen as important. However this required 144 000 tonnes of rails which is not a large part of yearly production.

## Innovation and Technical Opportunities

Several possibilities for applying industrial ecology concepts are apparent. Because blast furnace slag from integrated iron and steel works can replace significant amounts of CO<sub>2</sub> intensive limestone in cement making, there is the opportunity to reduce the total CO<sub>2</sub> budget for the core materials of concrete and structural metal by fully integrating the steel and cement production processes. Also many dusts, sludges, and slags still seen as wastes could be reincorporated in the metal and material recycling process. Composite materials that mimic human bone and connective materials may pose a challenge to structural steel in advanced construction designs and applications.



**Sector**

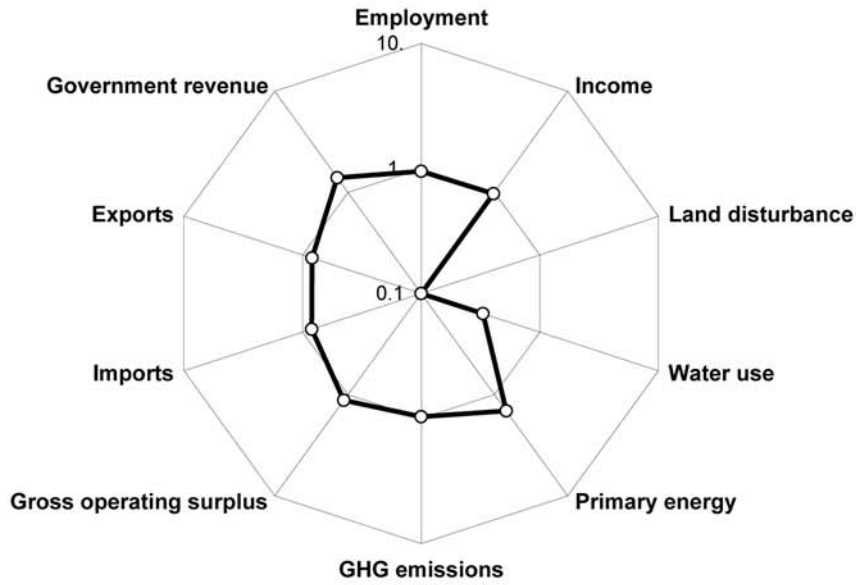
**Structural metal products**

(Sm)

Construction steel, scaffolding, perforated plate, reinforcing steel rods and bars, welded steel mesh, frames, doors, windows and other structural metal products

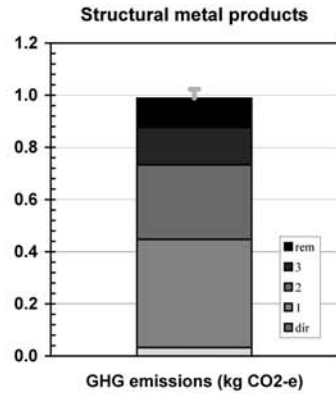
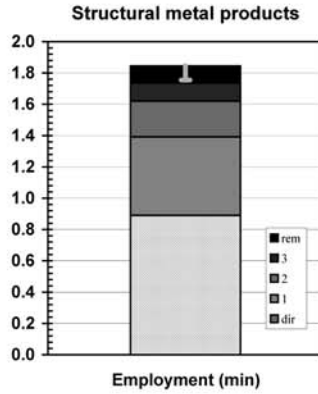
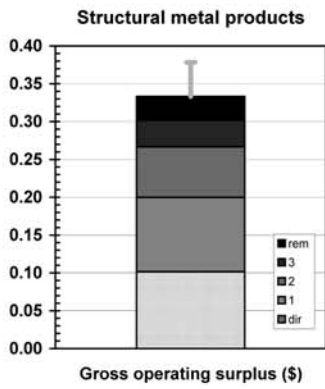
**Spider diagram**

**Structural metal products**

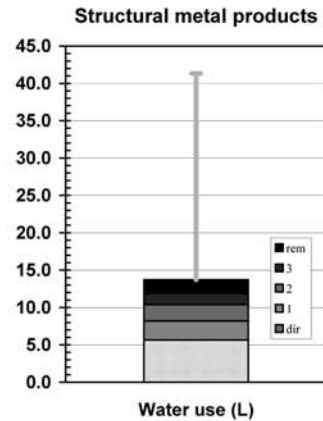
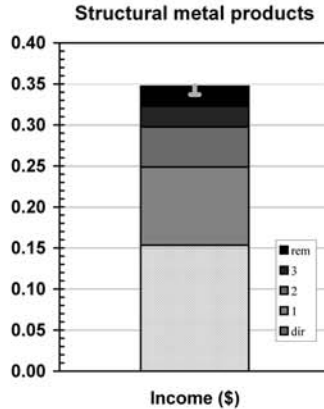
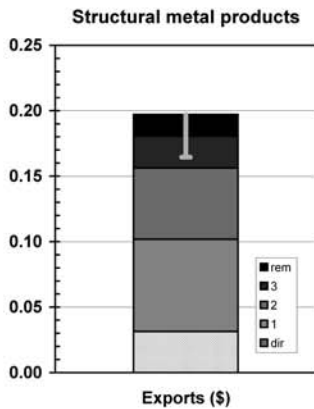


**Bar graphs**

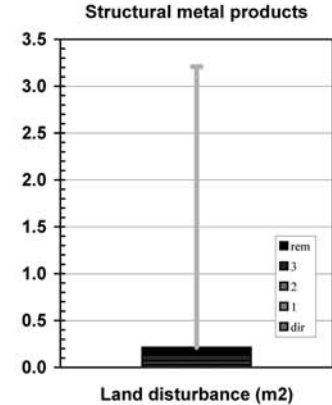
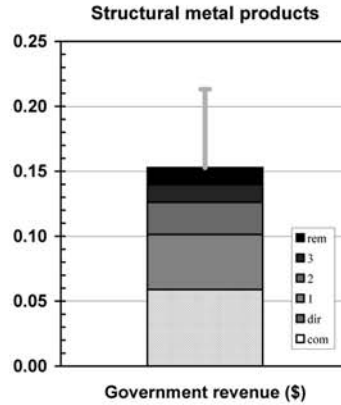
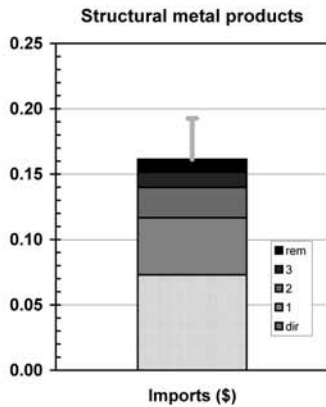
**Account #1**



**Account #2**



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 8.6	(0.00% of total)	(\$m 8.6 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 52.0	(0.05% of total)	(\$m 51.9 domestically produced)
Net changes in stocks	\$m 42.0	(2.38% of total)	(\$m 42.0 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 102.6</b>	<b>(0.02% of GNE)</b>	<b>(\$m 102.5 domestically produced)</b>
Exports	\$m 166.4	(0.20% of total)	(\$m 166.4 domestically produced)
Final demand	\$m 269.0	(0.05% of GNT)	(\$m 268.9 domestically produced)

**Costs: GNT(I) - industries**

Wages and salaries	\$m 812.7	(0.48% of total)
Gross operating surplus	\$m 538.0	(0.28% of total)
Taxes less subsidies	\$m 311.8	(0.36% of total)
<b>Sectoral GDP*</b>	<b>\$m 1,662.5</b>	<b>(0.37% of GDP)</b>
Imports	\$m 386.3	(0.40% of total)
<b>Primary inputs</b>	<b>\$m 2,048.8</b>	<b>(0.38% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct (% of national)	total (% of national)
Gross operating surplus (\$m)	\$m 538.0	(0.28%)	\$m 27.3	\$m 89.6 (0.05%)
Exports (\$m)	\$m 166.4	(0.20%)	\$m 8.4	\$m 53.0 (0.06%)
Imports (\$m)	\$m 386.3	(0.40%)	\$m 19.6	\$m 43.4 (0.04%)
Employment (e-y)	37,800 e-y	(0.53%)	1,918 e-y	3,978 e-y (0.06%)
Income (\$m)*	\$m 812.7	(0.48%)	\$m 41.2	\$m 93.4 (0.05%)
Government revenue (\$m)†	\$m 311.8	(0.29%)	\$m 15.8	\$m 41.1 (0.04%)
GHG emissions (kt CO <sub>2</sub> -e)	171 kt	(0.03%)	9 kt	266 kt (0.05%)
Water use (ML)	29,930 ML	(0.14%)	1,519 ML	3,689 ML (0.02%)
Land disturbance (kha)	12 kha	(0.01%)	1 kha	6 kha (0.00%)
Primary energy (TJ)	2,856 TJ	(0.07%)	145 TJ	2,970 TJ (0.08%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.10	0.33	0.38
Exports (\$)	0.03	0.20	0.16
Imports (\$)	0.07	0.16	0.19
Employment (min)	0.89	1.85	1.75
Income (\$)	0.15	0.35	0.34
Government revenue (\$)	0.06	0.15	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.03	0.99	1.02
Water use (L)	5.65	13.72	41.32
Land disturbance (m <sup>2</sup> )	0.02	0.21	3.21
Primary energy (MJ)	0.54	11.05	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Sm	0.102	(0; 30.%)	Sm	0.89	(0; 48.%)	Is Sm	0.289	(1; 29.%)
Is Sm	0.0335	(1; 10.%)	Fm Sm	0.136	(1; 7.4%)	El Sm	0.0453	(1; 4.6%)
Fm Sm	0.0122	(1; 3.7%)	Is Sm	0.08	(1; 4.3%)	El Is Sm	0.038	(2; 3.8%)
Nf Sm	0.0063	(1; 1.9%)	Wt Sm	0.0331	(1; 1.8%)	Sm	0.0324	(0; 3.3%)
Wt Sm	0.0046	(1; 1.4%)	Fu Sm	0.0176	(1; 0.96%)	Nf Sm	0.0289	(1; 2.9%)
Io Is Sm	0.00432	(2; 1.3%)	Rd Sm	0.0133	(1; 0.72%)	Is Fm Sm	0.0197	(2; 2.%)
St Sm	0.00343	(1; 1.%)	Gp Sm	0.0111	(1; 0.6%)	El Fm Sm	0.0104	(2; 1.%)
Gp Sm	0.00319	(1; 0.96%)	Bs Sm	0.0101	(1; 0.55%)	Gd Sm	0.00952	(1; 0.96%)
Is Fm Sm	0.00229	(2; 0.69%)	Ts Sm	0.00942	(1; 0.51%)	Gp Sm	0.00621	(1; 0.63%)
Rd Sm	0.00227	(1; 0.68%)	Ho Sm	0.00919	(1; 0.5%)	El Nf Sm	0.00584	(2; 0.59%)
Ts Sm	0.00209	(1; 0.63%)	Ms Sm	0.00756	(1; 0.41%)	Sw Ti Sm	0.00545	(2; 0.55%)
El Sm	0.00183	(1; 0.55%)	St Sm	0.0056	(1; 0.3%)	Fm Sm	0.00482	(1; 0.49%)
Cm Sm	0.00172	(1; 0.52%)	Wt Is Sm	0.00556	(2; 0.3%)	Wt Sm	0.00459	(1; 0.46%)
Ms Sm	0.00169	(1; 0.51%)	Is Fm Sm	0.00546	(2; 0.3%)	Sp Is Sm	0.00455	(2; 0.46%)
El Is Sm	0.00153	(2; 0.46%)	Os Sm	0.0052	(1; 0.28%)	Ch Sm	0.00382	(1; 0.39%)
Co Nf Sm	0.00149	(2; 0.45%)	Cm Sm	0.00477	(1; 0.26%)	El Gp Sm	0.00377	(2; 0.38%)
Uo Nf Sm	0.00143	(2; 0.43%)	Ne Sm	0.00448	(1; 0.24%)	Rd Sm	0.0036	(1; 0.36%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Sm	0.0314	(0; 16.%)	Sm	0.153	(0; 44.%)	Sm	5.65	(0; 41.%)
Is Sm	0.0256	(1; 13.%)	Fm Sm	0.0213	(1; 6.1%)	Is Sm	0.767	(1; 5.6%)
Nf Sm	0.0212	(1; 11.%)	Is Sm	0.0191	(1; 5.5%)	Wa Sm	0.306	(1; 2.2%)
Fm Sm	0.007	(1; 3.6%)	Wt Sm	0.00712	(1; 2.%)	El Sm	0.251	(1; 1.8%)
Io Is Sm	0.00696	(2; 3.5%)	Rd Sm	0.00229	(1; 0.66%)	El Is Sm	0.21	(2; 1.5%)
Gl Nf Sm	0.00385	(2; 2.%)	Fu Sm	0.00225	(1; 0.65%)	Fm Sm	0.188	(1; 1.4%)
Wt Sm	0.00376	(1; 1.9%)	Ts Sm	0.0022	(1; 0.64%)	Nf Sm	0.18	(1; 1.3%)
Uo Nf Sm	0.00235	(2; 1.2%)	Gp Sm	0.00208	(1; 0.6%)	Wa Is Sm	0.131	(2; 0.95%)
Sp Is Sm	0.00193	(2; 0.98%)	Ms Sm	0.00176	(1; 0.51%)	Io Is Sm	0.104	(2; 0.76%)
Nf Fm Sm	0.00179	(2; 0.91%)	Nf Sm	0.00147	(1; 0.42%)	Br Is Sm	0.076	(2; 0.55%)
Is Fm Sm	0.00175	(2; 0.89%)	Os Sm	0.00146	(1; 0.42%)	Uo Nf Sm	0.0753	(2; 0.55%)
Co Nf Sm	0.00157	(2; 0.8%)	St Sm	0.00143	(1; 0.41%)	Ws Ho Sm	0.067	(2; 0.49%)
Bl Is Sm	0.00138	(2; 0.7%)	Ho Sm	0.00134	(1; 0.39%)	El Fm Sm	0.0573	(2; 0.42%)
Ti Sm	0.00086	(1; 0.44%)	Is Fm Sm	0.0013	(2; 0.37%)	Wa Fm Sm	0.0536	(2; 0.39%)
St Sm	0.00085	(1; 0.43%)	Bs Sm	0.00124	(1; 0.36%)	Is Fm Sm	0.0523	(2; 0.38%)
Nf Is Sm	0.000827	(2; 0.42%)	Wt Is Sm	0.00119	(2; 0.34%)	Bc Mp Ho Sm	0.0481	(3; 0.35%)
Io Sm	0.000818	(1; 0.42%)	Cm Sm	0.00108	(1; 0.31%)	Wa Ms Sm	0.0433	(2; 0.32%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$		
Sm	0.0729	(0; 45.%)	Sm	0.0588	(0; 39.%)	Sm	0.0225	(0; 10.%)
Is Sm	0.0121	(1; 7.5%)	Is Sm	0.00875	(1; 5.7%)	Wo Tx Sm	0.02	(2; 9.3%)
Fm Sm	0.00919	(1; 5.7%)	Fm Sm	0.00743	(1; 4.9%)	Wo Tx Fu Sm	0.0134	(3; 6.2%)
Nf Sm	0.00255	(1; 1.6%)	Wt Sm	0.00333	(1; 2.2%)	Bc Mp Ho Sm	0.0133	(3; 6.2%)
Fu Sm	0.00117	(1; 0.72%)	Rd Sm	0.00163	(1; 1.1%)	Wo Tx Cl Sm	0.00615	(3; 2.9%)
Wt Sm	0.00107	(1; 0.66%)	Nf Sm	0.00146	(1; 0.96%)	Wo Tx Tp Sm	0.00492	(3; 2.3%)
Gp Sm	0.00098	(1; 0.61%)	Ts Sm	0.00109	(1; 0.71%)	Sw Ti Sm	0.00429	(2; 2.%)
Is Fm Sm	0.000823	(2; 0.51%)	Fu Sm	0.00108	(1; 0.71%)	Fm Sm	0.0021	(1; 0.98%)
Sp Is Sm	0.000812	(2; 0.5%)	Gp Sm	0.00101	(1; 0.66%)	Bc Mp Ch Sm	0.00152	(3; 0.71%)
Ne Sm	0.000637	(1; 0.39%)	Ms Sm	0.000835	(1; 0.55%)	Wo Mp Ho Sr	0.0015	(3; 0.7%)
Ts Sm	0.0006	(1; 0.37%)	St Sm	0.000763	(1; 0.5%)	Wo Tx Fm Sr	0.00131	(3; 0.61%)
Rd Sm	0.000575	(1; 0.36%)	Ho Sm	0.000706	(1; 0.46%)	Wo Tx Wt Sm	0.00118	(3; 0.55%)
Pl Sm	0.000486	(1; 0.3%)	Os Sm	0.000675	(1; 0.44%)	Bc Mp Ho Fm	0.0011	(4; 0.51%)
Pc Is Sm	0.000446	(2; 0.28%)	Pd Sm	0.00061	(1; 0.4%)	Ba Bm Ho Sm	0.00108	(3; 0.5%)
Ch Sm	0.000445	(1; 0.28%)	Is Fm Sm	0.000597	(2; 0.39%)	Gd Sm	0.000893	(1; 0.42%)
Io Is Sm	0.000393	(2; 0.24%)	Wt Is Sm	0.000558	(2; 0.37%)	Bc Ch Sm	0.000764	(2; 0.36%)
Ms Sm	0.000383	(1; 0.24%)	Io Is Sm	0.000552	(2; 0.36%)	Fr Sw Ti Sm	0.000756	(3; 0.35%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.448 ±0.030	(±2.0%)
Downstream	1.467 ±0.040	(±2.7%)

# Sector 2704: Sheet Metal Products (Sh)

*Sheet containers, cylinders, ducting, sheet sanitary ware, lids, reservoirs, vats, tanks, sheet tableware, machine guards and other sheet metal products*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is 25% greater than average, water use is 70% below average and land disturbance is 95% below average. For the social indicators, employment generation is equal to average, while income and government revenue are both 5% above average. The financial indicators reveal an operating surplus 5% higher than average, an export propensity 45% above average, and an import penetration equal to average. For many of the traditional products from this sector, plastics have gained a significant market share. Integrated full chain production approaches that emphasise reuse and reduce environmental loadings may help to maintain and expand market share for metal cans and containers.

## Sector Description

This sector makes items out of various types of metal sheet, mainly in steel and aluminium, but also includes sophisticated alloys for certain applications. Typical products include cans for beer, soft drinks and processed foods, air conditioning ducts and roof guttering, drums, gas cylinders and motor vehicle number plates. Around 600 million litres of carbonated drinks are canned in Australia and this sector's products represent about one quarter of the total, with PET plastics being the dominant packaging with minor amounts of glass. It is possible that recycling and product stewardship trends may alter the amount of sheet metal used in food and drink packaging. This also applies to drums, ducting and guttering. The sector had a financial turnover of over \$3 billion in 2002 and involved over 1 000 enterprises.

## Place of Industry in the Economy

The sheet metal products sector ranks 67<sup>th</sup> out of 135 sectors in terms of value adding and contributes 0.23% of GDP in this analysis. It is similar in value adding to the plaster and concrete products and the sawn timber and woodchips sectors. It is a small employer with 4 000 employment years directly embodied in final demand, and another 5 000 in the sector's upstream suppliers, giving a total of 9 000 employment years. In addition the sector contributes 14 000 employment years to the final demand of downstream industries such as fruit processing, soft drinks, beer and malt, and communications. The sector has relatively small resource requirements with less than one tenth of one percent of national water use and land disturbance, and around two tenths of one percent of energy use and greenhouse emissions. In financial terms imports are three times the size of exports.

## Strategic Overview

The spider diagram reveals a reasonably good TBL account for the sheet metal products sector with lower than average outcomes for the social indicators of employment generation and income and higher than average outcomes for the environmental indicators of energy use and greenhouse emissions. The many positive attributes of sheet metal products may face long term competition from plastics and even a re-emergent glass industry. Full chain life cycle analyses may help determine the sector's competitive position. The major downstream issue is the degree to which the sector's products can be continually recycled. Many products have coatings or are made of alloy formulations, some of which can frustrate closed loop recycling thus denying the same product use.

## TBL Account #1

The financial indicator of operating surplus is 5% below the economy wide average and one third of this is a direct sector effect with additional contributions from basic iron and steel (12%), freight forwarding services (3%), non-ferrous metal recovery (3%) and nuts and bolts (2%). The social indicator of employment generation is 15% below average and about one half is a direct sector effect. The environmental indicator of greenhouse emissions is 10% above average and most of this is located upstream in the production chain with the direct sector effect representing 5% of the total.

## TBL Accounts #2 and #3

The second TBL account reveals an export propensity indicator that is 40% above average, an income indicator that is 5% below average and a water indicator that is 75% below average. The third TBL account shows an import penetration indicator that is 10% below average, a government revenue indicator that is 40% above average and a land disturbance indicator 95% below average.

## Structural Path Analysis and Linkages

An examination of the structural path reveals that one third of the emissions are due to the production of iron and steel while the direct sector effect is 5% of the total. Electricity production used directly in the sector contributes 7% of the total emission in addition to electricity used in steel making (4%) and aluminium making (2%). Other contributors include non-ferrous metal recovery (4%), aluminium making (2%) and garbage disposal (1%).

The upstream and downstream linkages of this sector are greater than the economy wide average. The upstream linkages are 35% above average and affect basic iron and steel, non-ferrous metal recovery, nuts and bolts, wholesale trade, and property development and real estate. The downstream linkages are 20% above average and suggest that the soft drink, beer and malt, canned fruits, accommodation and cafes, and communications sectors must expand in order to dissipate the effect of any expansion in the sheet metal products sector. However, the plastic and glass container sectors could equally be led by expansion in these end using sectors.

## Future Trends in Sector

The base case scenario of the *Future Dilemmas* study anticipates that by 2050, food packing materials (as one index of activity in this sector) will increase by 50% compared to now. As noted earlier, the material composition of this packaging is quite uncertain. Both policy and consumer decisions may substantially disadvantage this sector depending on perceived and real issues. These include the energy and material cost of recycling, the number of reuse cycles that a virgin material can undergo before it becomes degraded in a structural or contamination sense, and the degree to which metal coatings such as zinc used in galvanising eventually leak into the biosphere, with implications for the function of ecosystems and the quality and safety of water. Some plastic containers are disadvantaged in this sense as they can only recycle to a lower grade use.

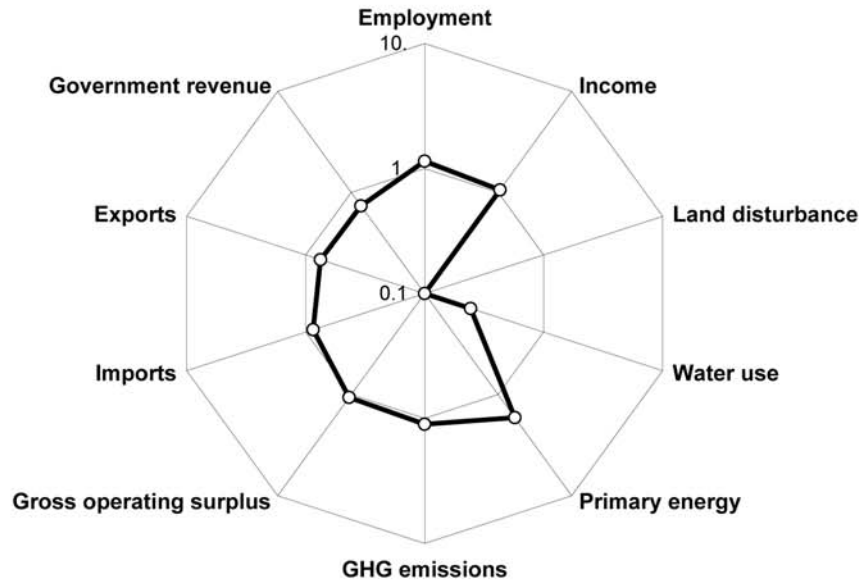
## Innovation and Technical Opportunities

The literature reveals many exciting opportunities for the materials used in this sector but also a number of tensions, particularly in regard to energy use and greenhouse emissions. Many sheet metal applications that require more strength and less weight inevitably require a mix of materials particularly using nickel, chromium and molybdenum to produce alloyed steels. Recycling of these alloys is feasible but it is not always possible to reconstitute the original specifications in the recycled product, and recycled uses are then relegated to lower grade applications. Many exciting developments are underway in the area of metal forming, which allow the production of more complicated and highly specified articles from sheet metal, without a multistage fabrication process.

Sheet containers, cylinders, ducting, sheet sanitary ware, lids, reservoirs, vats, tanks, sheet tableware, machine guards and other sheet metal products

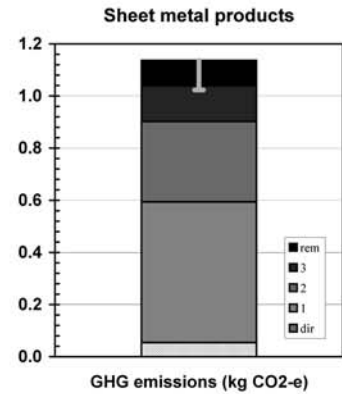
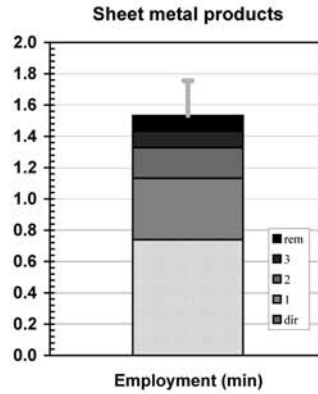
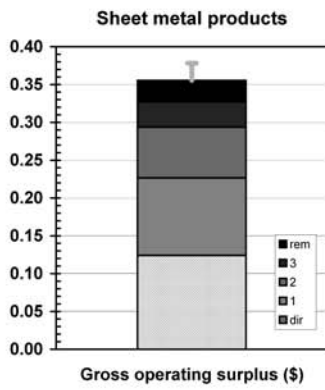
Spider diagram

Sheet metal products

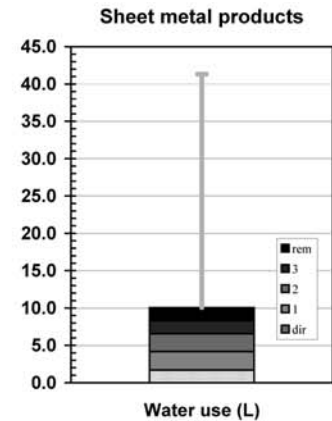
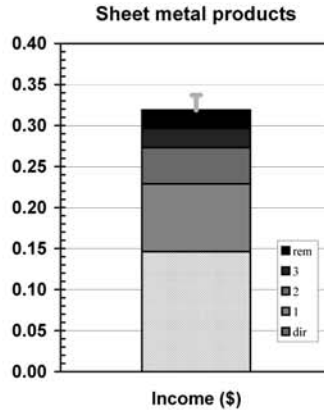
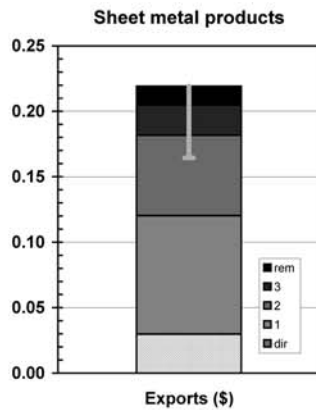


Bar graphs

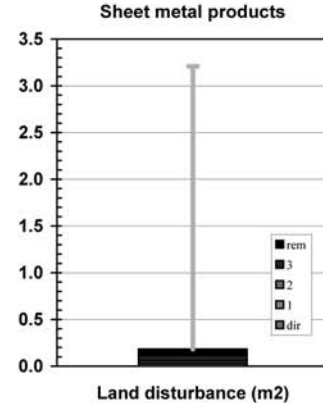
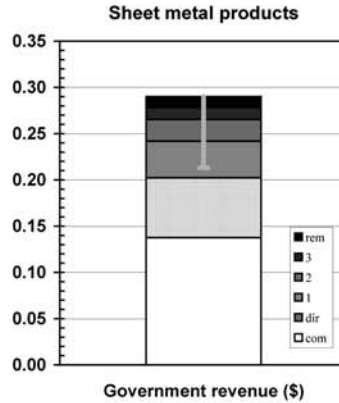
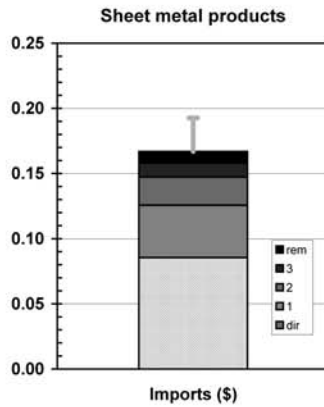
Account #1



Account #2



Account #3



National Accounts extracts

Receipts: GNT(E) - commodities

Private final consumption	\$m 183.1	(0.07% of total)	(\$m 169.1 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 502.2	(0.48% of total)	(\$m 474.6 domestically produced)
Net changes in stocks	\$m 4.6	(0.26% of total)	(\$m 3.9 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 690.0</b>	<b>(0.15% of GNE)</b>	<b>(\$m 647.7 domestically produced)</b>
Exports	\$m 90.8	(0.11% of total)	(\$m 90.8 domestically produced)
<b>Final demand</b>	<b>\$m 780.8</b>	<b>(0.14% of GNT)</b>	<b>(\$m 738.5 domestically produced)</b>

Costs: GNT(I) - industries

Wages and salaries	\$m 445.8	(0.26% of total)
Gross operating surplus	\$m 377.7	(0.20% of total)
Taxes less subsidies	\$m 196.8	(0.23% of total)
<b>Sectoral GDP*</b>	<b>\$m 1,020.3</b>	<b>(0.23% of GDP)</b>
Imports	\$m 260.5	(0.27% of total)
<b>Primary inputs</b>	<b>\$m 1,280.9</b>	<b>(0.23% of GNT)</b>

\* Sectoral gross value added + net taxes on products

TBL factors

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct (% of national)	total (% of national)
Gross operating surplus (\$m)	\$m 377.7	(0.20%)	\$m 91.5	(0.05%)
Exports (\$m)	\$m 90.8	(0.11%)	\$m 22.0	(0.03%)
Imports (\$m)	\$m 260.5	(0.27%)	\$m 63.1	(0.06%)
Employment (e-y)	18,050 e-y	(0.25%)	4,374 e-y	(0.06%)
Income (\$m)*	\$m 445.8	(0.26%)	\$m 108.0	(0.06%)
Government revenue (\$m)†	\$m 298.5	(0.28%)	\$m 149.4	(0.14%)
GHG emissions (kt CO <sub>2</sub> -e)	164 kt	(0.03%)	40 kt	(0.01%)
Water use (ML)	5,121 ML	(0.02%)	1,241 ML	(0.01%)
Land disturbance (kha)	7 kha	(0.00%)	2 kha	(0.00%)
Primary energy (TJ)	2,849 TJ	(0.07%)	690 TJ	(0.02%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

TBL multipliers - commodities

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.12	0.36	0.38
Exports (\$)	0.03	0.22	0.16
Imports (\$)	0.09	0.17	0.19
Employment (min)	0.74	1.53	1.75
Income (\$)	0.15	0.32	0.34
Government revenue (\$)	0.20	0.29	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.05	1.14	1.02
Water use (L)	1.68	10.05	41.32
Land disturbance (m <sup>2</sup> )	0.02	0.18	3.21
Primary energy (MJ)	0.93	12.89	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Sh	0.124	(0; 35.%)	Sh	0.739	(0; 48.%)	Is Sh	0.36	(1; 32.%)
Is Sh	0.0417	(1; 12.%)	Is Sh	0.0996	(1; 6.5%)	El Sh	0.0749	(1; 6.6%)
St Sh	0.00927	(1; 2.6%)	Fm Sh	0.0773	(1; 5.%)	Sh	0.0539	(0; 4.7%)
Nf Sh	0.00898	(1; 2.5%)	Wt Sh	0.0282	(1; 1.8%)	El Is Sh	0.0473	(2; 4.2%)
Fm Sh	0.00695	(1; 2.%)	Rd Sh	0.016	(1; 1.%)	Nf Sh	0.0412	(1; 3.6%)
Io Is Sh	0.00538	(2; 1.5%)	St Sh	0.0151	(1; 0.99%)	El Al Sh	0.027	(2; 2.4%)
Wt Sh	0.00392	(1; 1.1%)	Ts Sh	0.0127	(1; 0.83%)	Al Sh	0.0196	(1; 1.7%)
El Sh	0.00303	(1; 0.85%)	Bs Sh	0.0112	(1; 0.73%)	Is Fm Sh	0.0112	(2; 0.99%)
Ts Sh	0.00282	(1; 0.79%)	Ho Sh	0.0106	(1; 0.69%)	Gd Sh	0.0108	(1; 0.95%)
Rd Sh	0.00272	(1; 0.77%)	Ms Sh	0.0104	(1; 0.68%)	El Nf Sh	0.00832	(2; 0.73%)
Ms Sh	0.00232	(1; 0.65%)	Sm Sh	0.00808	(1; 0.53%)	Ch Sh	0.0068	(1; 0.6%)
Co Nf Sh	0.00213	(2; 0.6%)	Gv Sh	0.00733	(1; 0.48%)	Ao Al Sh	0.00643	(2; 0.57%)
Uo Nf Sh	0.00204	(2; 0.57%)	Wt Is Sh	0.00692	(2; 0.45%)	El Fm Sh	0.00589	(2; 0.52%)
El Is Sh	0.00191	(2; 0.54%)	Os Sh	0.0065	(1; 0.42%)	Sp Is Sh	0.00567	(2; 0.5%)
Gl Nf Sh	0.00181	(2; 0.51%)	Nf Sh	0.00533	(1; 0.35%)	Bl Is Sh	0.00443	(2; 0.39%)
Al Sh	0.00168	(1; 0.47%)	Pl Sh	0.00479	(1; 0.31%)	Rd Sh	0.00432	(1; 0.38%)
Pd Sh	0.00134	(1; 0.38%)	Rh Sh	0.00478	(1; 0.31%)	Wt Sh	0.00391	(1; 0.34%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Is Sh	0.0319	(1; 15.%)	Sh	0.146	(0; 46.%)	Sh	1.68	(0; 17.%)
Nf Sh	0.0302	(1; 14.%)	Is Sh	0.0237	(1; 7.4%)	Is Sh	0.955	(1; 9.5%)
Sh	0.0298	(0; 14.%)	Fm Sh	0.0121	(1; 3.8%)	El Sh	0.414	(1; 4.1%)
Al Sh	0.0104	(1; 4.7%)	Wt Sh	0.00605	(1; 1.9%)	Wa Sh	0.339	(1; 3.4%)
Io Is Sh	0.00866	(2; 3.9%)	St Sh	0.00386	(1; 1.2%)	El Is Sh	0.261	(2; 2.6%)
Gl Nf Sh	0.00549	(2; 2.5%)	Ts Sh	0.00297	(1; 0.93%)	Nf Sh	0.257	(1; 2.6%)
Fm Sh	0.00398	(1; 1.8%)	Rd Sh	0.00275	(1; 0.86%)	Bx Ao Al Sh	0.185	(3; 1.8%)
Uo Nf Sh	0.00334	(2; 1.5%)	Ms Sh	0.00242	(1; 0.76%)	Wa Is Sh	0.162	(2; 1.6%)
Wt Sh	0.0032	(1; 1.5%)	Nf Sh	0.00209	(1; 0.66%)	El Al Sh	0.149	(2; 1.5%)
Sp Is Sh	0.0024	(2; 1.1%)	Gv Sh	0.00184	(1; 0.58%)	Io Is Sh	0.13	(2; 1.3%)
St Sh	0.0023	(1; 1.%)	Os Sh	0.00182	(1; 0.57%)	Uo Nf Sh	0.107	(2; 1.1%)
Co Nf Sh	0.00224	(2; 1.%)	Ho Sh	0.00154	(1; 0.48%)	Fm Sh	0.107	(1; 1.1%)
Bl Is Sh	0.00172	(2; 0.78%)	Wt Is Sh	0.00149	(2; 0.47%)	Br Is Sh	0.0946	(2; 0.94%)
Ao Al Sh	0.00156	(2; 0.71%)	Sm Sh	0.00139	(1; 0.44%)	Ws Ho Sh	0.077	(2; 0.77%)
Sz Nf Sh	0.00111	(2; 0.51%)	Bs Sh	0.00138	(1; 0.43%)	Wa Ms Sh	0.0596	(2; 0.59%)
Nf Is Sh	0.00103	(2; 0.47%)	Al Sh	0.00125	(1; 0.39%)	Bc Mp Ho Sh	0.0553	(3; 0.55%)
Nf Fm Sh	0.00102	(2; 0.47%)	Pd Sh	0.00121	(1; 0.38%)	Al Sh	0.055	(1; 0.55%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Sh	0.0855	(0; 51.%)	Sh	0.0646	(0; 42.%)	Sh	0.0227	(0; 12.%)
Is Sh	0.015	(1; 9.%)	Is Sh	0.0109	(1; 7.1%)	Bc Mp Ho Sh	0.0152	(3; 8.3%)
Fm Sh	0.00523	(1; 3.1%)	Fm Sh	0.00423	(1; 2.8%)	Wo Tx Sh	0.0148	(2; 8.1%)
Nf Sh	0.00363	(1; 2.2%)	Wt Sh	0.00283	(1; 1.9%)	Wo Tx Cl Sh	0.00929	(3; 5.1%)
Pt Sh	0.00123	(1; 0.74%)	Nf Sh	0.00209	(1; 1.4%)	Wo Tx Tp Sh	0.00325	(3; 1.8%)
Sp Is Sh	0.00101	(2; 0.61%)	St Sh	0.00206	(1; 1.4%)	Wo Tx Kn Sh	0.00316	(3; 1.7%)
Pl Sh	0.000921	(1; 0.55%)	Rd Sh	0.00195	(1; 1.3%)	Bc Mp Ch Sh	0.0027	(3; 1.5%)
Wt Sh	0.00091	(1; 0.54%)	Ts Sh	0.00146	(1; 0.96%)	Wo Mp Ho Sh	0.00172	(3; 0.94%)
St Sh	0.000839	(1; 0.5%)	Ms Sh	0.00115	(1; 0.75%)	Bc Ch Sh	0.00136	(2; 0.74%)
Ts Sh	0.000808	(1; 0.48%)	Al Sh	0.000845	(1; 0.55%)	Ba Bm Ho Sh	0.00124	(3; 0.68%)
Ch Sh	0.000792	(1; 0.47%)	Os Sh	0.000844	(1; 0.55%)	El Sh	0.00121	(1; 0.66%)
Al Sh	0.000776	(1; 0.46%)	Ho Sh	0.000811	(1; 0.53%)	Fm Sh	0.00119	(1; 0.65%)
Rd Sh	0.000689	(1; 0.41%)	Pd Sh	0.000795	(1; 0.52%)	Bc Mp Rt Sh	0.00107	(3; 0.58%)
Sm Sh	0.000662	(1; 0.4%)	Wt Is Sh	0.000694	(2; 0.46%)	Wo Tx Fu Sh	0.00105	(3; 0.57%)
Pc Is Sh	0.000555	(2; 0.33%)	Io Is Sh	0.000687	(2; 0.45%)	Gd Sh	0.00101	(1; 0.55%)
Ms Sh	0.000527	(1; 0.32%)	Pd Is Sh	0.00067	(2; 0.44%)	Wo Tx Wt Sh	0.001	(3; 0.55%)
Co Nf Sh	0.000516	(2; 0.31%)	Gv Sh	0.000641	(1; 0.42%)	Wo Tx Pl Sh	0.000924	(3; 0.5%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.358 ±0.029	(±2.2%)
Downstream	1.202 ±0.018	(±1.5%)



# Sector 2705: Fabricated Metal Products (Fm)

*Hand tools, nuts, bolts, washers, nails, staples, springs, knives, blades, drills, non-ferrous fittings, plate containers, metal blinds, locks, anchors, cable, wire fabric, cutlery, munitions, boilers, non-ferrous metal fittings and other fabricated metal products and repairing*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicators of greenhouse emissions, water use, and land disturbance are 15%, 80% and 95% below average respectively. The social indicators of employment generation and income are 20% and 10% above average respectively, while government revenue is two times the economy wide average. The financial indicators of operating surplus and import penetration are 20% and 10% below average respectively while export propensity is 30% above average. Parts of the sector face intense price pressure from low wage countries in Asia. Advanced technologies such as laser welding and drilling, combined with expertise in aluminium, titanium, magnesium and nickel alloys are central to future viability.

## Sector Description

This sector produces a wide range of metal products from hand operated workshop and garden tools, cutlery, nuts, bolts, wire and springs, to ammunition, large boilers and metal storage tanks. Parts of the sector such as hand tools and metal pipe fittings face strong price competition from low wage countries in Asia, while bulky metal items such as water tanks and silos retain a distinct regional advantage. Leading edge suppliers include the Adelaide based Coherent Industrial and New South Wales based Raymax who supply and develop advanced laser-based machining and fabricating capability for the sector. The Victorian Government has embarked on a strategic plan for the sector which aims to grow exports and replace imports. The financial turnover of the sector was over \$6 billion in 2002 and involved over 3 000 enterprises. Items such as metal nuts and bolts, locks and hinges, and repairing and servicing each contribute about 10% of the turnover.

## Place of Industry in the Economy

The fabricated metal products sector ranks 46<sup>th</sup> out of 135 sectors in terms of value adding in the economy, and contributes 0.44% of GDP in this analysis. It is similar in value adding to the meat and meat products and the libraries, parks and museums sectors. It is a mid-sized employer with a direct requirement of 8 000 employment years and another 4 000 in the sector's suppliers, giving a total of 12 000 employment years. In addition, it contributes 44 000 employment years to the final demand of downstream industries such as motor vehicles and parts, non-residential and residential construction. It has relatively small resource requirements with less than two tenths of one percent of national water use, land disturbance, energy use and greenhouse emissions. In financial terms, the imports are 30% above exports but overseas competition is extending the trade imbalance.

## Strategic Overview

The spider diagram reveals excellent TBL outcomes for the sector with better than average indicators except for primary energy use and operating surplus. A number of downstream issues for the sector relate to regulated simplification of final products for some markets, to facilitate the process of re-engineering as well as recycling. Many alloys and coated metals are more difficult to recycle as the components are sometimes difficult to separate. Upstream issues relate to coating and fabrication processes which sometimes pose use and disposal issues for some of the materials used.

## TBL Account #1

The financial indicator of operating surplus is 20% below the economy wide average, and about half of this is a direct sector effect. The social indicator of employment generation is 20% greater than average and two thirds of this is a direct sector effect. The environmental indicator of greenhouse emissions is 15% below average, and less than one tenth of this is a direct effect. The first TBL account reveals a positive outlook for the sector overall. This aggregated measure hides a number of more basic products that are struggling against low cost imports, and more complex products that are competitive in domestic and export markets.

## TBL Accounts #2 and #3

The second TBL account reveals that export propensity is 30% above average, income is 10% above average, and that water use is 80% below average. The third TBL account reveals import penetration 10% below average, government revenue is two times the average and land disturbance is 95% below average. As noted above, the import penetration indicator is increasing and this trend could be reversed by increased uptake of advanced laser processes used with light metals and new alloys.

## Structural Path Analysis and Linkages

The greenhouse emissions indicator is below average and in the longer term, market advantage may accrue to production sectors with a low greenhouse embodiment. The direct sector effect is 6% with other contributions from iron and steel (24%), electricity generation (16%), copper products (3%), chemicals (2%) and garbage (1%). Iron and steel and electricity together make up 40% of emissions so improvements therein will improve this sector's performance. Redesign of basic fabrication processes could also improve the greenhouse indicator.

The sector's stimulus to its upstream suppliers is slightly above average, and impacts on steel tubes and pipes, copper products, wholesale trade, and property development and real estate. The linkages to downstream industries are 50% stronger than average. They suggest that any expansion in the sector be led by expansion in sectors such as structural metal products, motor vehicles and parts, residential construction, non-residential construction, and wholesale trade.

## Future Trends in Sector

While it does not model this sector in specific detail, the base case scenario of the *Future Dilemmas* study suggests that by 2050 activity within important downstream industries such as motor vehicles and parts will have grown by 10%, while the residential and non-residential construction sectors will be more than 40% larger than they are today. Investment in the advanced capabilities required to keep the sector at the leading edge of design and innovation will ensure that domestically manufactured items are technologically attractive and cost competitive. A number of state governments are taking active steps to embrace this type of future.

## Innovation and Technical Opportunities

The metal fabrication sector could undergo a step change in domestic activity if it prepares for the looming deficit in the transport fuel trade balance as domestic oil stocks become constrained after 2020. There are three bridging technologies prior to a full hydrogen economy. These are (natural) gas-to-liquids, coal liquefaction, and biomass-to-methanol conversion. For methanol from biomass, between 1 000 and 2 000 regional conversion plants would be required by 2050. For all three feedstocks, the enabling technologies depend on the production and fabrication of advanced steels alloyed with chromium, vanadium and molybdenum. Normal steels react with gaseous hydrogen at high pressures and temperatures and become brittle causing failure in the reaction vessels.

**Sector**

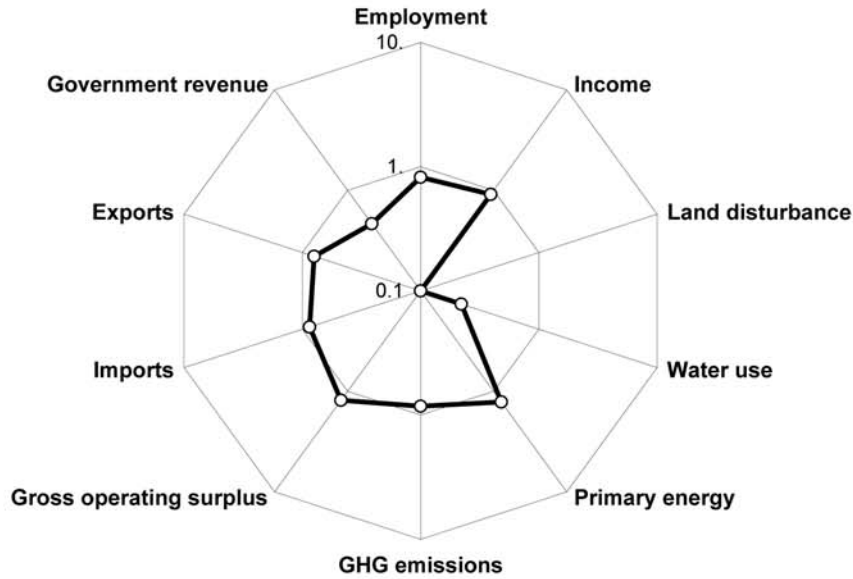
**Fabricated metal products**

**(Fm)**

Hand tools, nuts, bolts, washers, nails, staples, springs, knives, blades, drills, non-ferrous fittings, plate containers, metal blinds, locks, anchors, cable, wire fabric, cutlery, munitions, boilers, non-ferrous metal fittings and other fabricated metal products and repairing

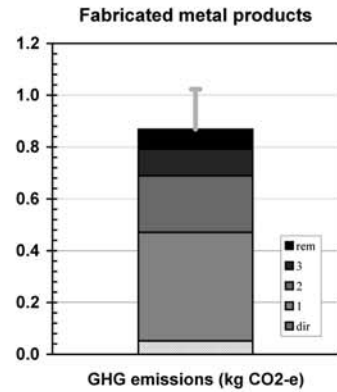
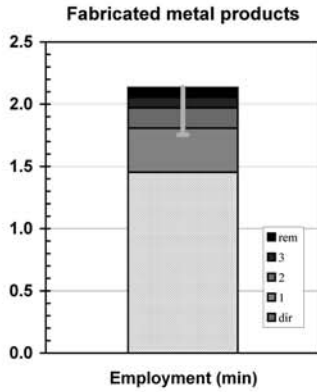
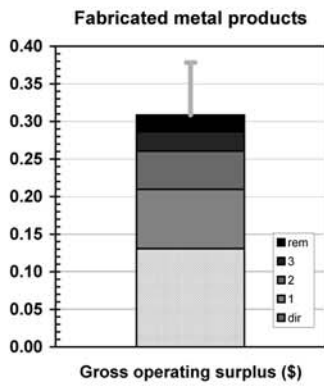
Spider diagram

**Fabricated metal products**

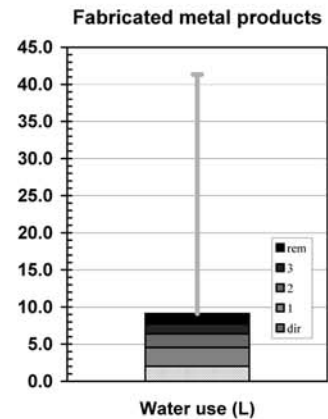
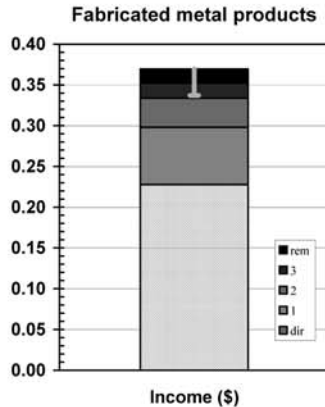
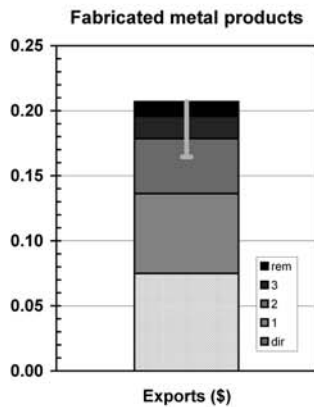


Bar graphs

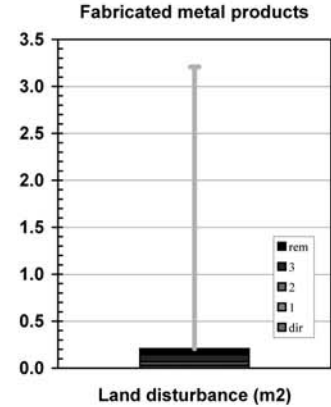
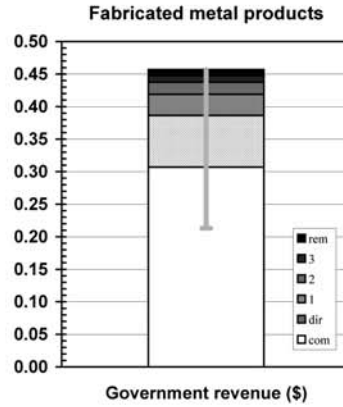
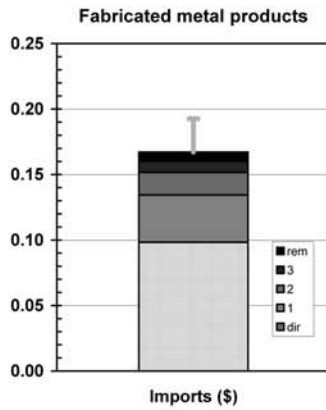
**Account #1**



**Account #2**



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 323.6	(0.12% of total)	(\$m 129.4 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 285.4	(0.27% of total)	(\$m 238.6 domestically produced)
Net changes in stocks	\$m 35.0	(1.98% of total)	(\$m 16.3 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 644.0</b>	<b>(0.14% of GNE)</b>	<b>(\$m 384.3 domestically produced)</b>
Exports	\$m 333.9	(0.40% of total)	(\$m 333.9 domestically produced)
<b>Final demand</b>	<b>\$m 977.8</b>	<b>(0.18% of GNT)</b>	<b>(\$m 718.1 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 1,015.0	(0.59% of total)
Gross operating surplus	\$m 582.4	(0.30% of total)
Taxes less subsidies	\$m 354.2	(0.41% of total)
<b>Sectoral GDP*</b>	<b>\$m 1,951.6</b>	<b>(0.44% of GDP)</b>
Imports	\$m 438.3	(0.45% of total)
<b>Primary inputs</b>	<b>\$m 2,389.9</b>	<b>(0.44% of GNT)</b>

\* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 582.4	(0.30%)	\$m 93.8 (0.05%)	\$m 221.6 (0.12%)
Exports (\$m)	\$m 333.9	(0.40%)	\$m 53.8 (0.06%)	\$m 148.6 (0.18%)
Imports (\$m)	\$m 438.3	(0.45%)	\$m 70.6 (0.07%)	\$m 120.0 (0.12%)
Employment (e-y)	51,900 e-y	(0.73%)	8,361 e-y (0.12%)	12,279 e-y (0.17%)
Income (\$m)*	\$m 1,015.0	(0.59%)	\$m 163.5 (0.10%)	\$m 265.4 (0.16%)
Government revenue (\$m)†	\$m 574.5	(0.53%)	\$m 277.4 (0.26%)	\$m 328.1 (0.30%)
GHG emissions (kt CO <sub>2</sub> -e)	230 kt	(0.04%)	37 kt (0.01%)	624 kt (0.12%)
Water use (ML)	8,954 ML	(0.04%)	1,442 ML (0.01%)	6,543 ML (0.03%)
Land disturbance (kha)	10 kha	(0.01%)	2 kha (0.00%)	15 kha (0.01%)
Primary energy (TJ)	4,014 TJ	(0.10%)	647 TJ (0.02%)	7,011 TJ (0.18%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.13	0.31	0.38
Exports (\$)	0.07	0.21	0.16
Imports (\$)	0.10	0.17	0.19
Employment (min)	1.45	2.13	1.75
Income (\$)	0.23	0.37	0.34
Government revenue (\$)	0.39	0.46	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.05	0.87	1.02
Water use (L)	2.01	9.11	41.32
Land disturbance (m <sup>2</sup> )	0.02	0.21	3.21
Primary energy (MJ)	0.90	9.76	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Fm	0.131	(0; 42.%)	Fm	1.45	(0; 68.%)	Is Fm	0.211	(1; 24.%)
Is Fm	0.0244	(1; 7.9%)	Is Fm	0.0584	(1; 2.7%)	El Fm	0.111	(1; 13.%)
Nf Fm	0.0057	(1; 1.8%)	Wt Fm	0.0279	(1; 1.3%)	Fm	0.0515	(0; 5.9%)
El Fm	0.00448	(1; 1.5%)	Sm Fm	0.0259	(1; 1.2%)	El Is Fm	0.0277	(2; 3.2%)
St Fm	0.00407	(1; 1.3%)	Rd Fm	0.0117	(1; 0.55%)	Nf Fm	0.0262	(1; 3.%)
Wt Fm	0.00388	(1; 1.3%)	Bs Fm	0.0107	(1; 0.5%)	Ch Fm	0.0134	(1; 1.5%)
Io Is Fm	0.00316	(2; 1.%)	Ms Fm	0.0106	(1; 0.5%)	Lm Fm	0.011	(1; 1.3%)
Sm Fm	0.00296	(1; 0.96%)	Hh Fm	0.00872	(1; 0.41%)	Is Sm Fm	0.00842	(2; 0.97%)
Ms Fm	0.00237	(1; 0.77%)	Ho Fm	0.00818	(1; 0.38%)	Gd Fm	0.00779	(1; 0.9%)
Rd Fm	0.00199	(1; 0.64%)	St Fm	0.00664	(1; 0.31%)	El Al Fm	0.00608	(2; 0.7%)
Cm Fm	0.00177	(1; 0.57%)	Ts Fm	0.00663	(1; 0.31%)	El Nf Fm	0.00529	(2; 0.61%)
Ts Fm	0.00147	(1; 0.48%)	Cr Fm	0.00553	(1; 0.26%)	Al Fm	0.0044	(1; 0.51%)
Co Nf Fm	0.00135	(2; 0.44%)	El Fm	0.00498	(1; 0.23%)	Wt Fm	0.00387	(1; 0.45%)
Sg Fm	0.00131	(1; 0.42%)	Cm Fm	0.00489	(1; 0.23%)	Cr Fm	0.00367	(1; 0.42%)
Uo Nf Fm	0.0013	(2; 0.42%)	Rt Fm	0.00487	(1; 0.23%)	Sp Is Fm	0.00332	(2; 0.38%)
Gl Nf Fm	0.00115	(2; 0.37%)	Os Fm	0.00476	(1; 0.22%)	Rd Fm	0.00316	(1; 0.36%)
Pt Fm	0.00113	(1; 0.37%)	Wt Is Fm	0.00406	(2; 0.19%)	Hh Fm	0.00304	(1; 0.35%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Fm	0.0749	(0; 36.%)	Fm	0.228	(0; 62.%)	Fm	2.01	(0; 22.%)
Nf Fm	0.0192	(1; 9.3%)	Is Fm	0.0139	(1; 3.8%)	El Fm	0.612	(1; 6.7%)
Is Fm	0.0187	(1; 9.%)	Wt Fm	0.006	(1; 1.6%)	Wa Fm	0.573	(1; 6.3%)
Io Is Fm	0.00508	(2; 2.5%)	Sm Fm	0.00446	(1; 1.2%)	Is Fm	0.56	(1; 6.1%)
Gl Nf Fm	0.00349	(2; 1.7%)	Ms Fm	0.00247	(1; 0.67%)	Sm Fm	0.164	(1; 1.8%)
Wt Fm	0.00317	(1; 1.5%)	Rd Fm	0.00201	(1; 0.54%)	Nf Fm	0.163	(1; 1.8%)
Al Fm	0.00234	(1; 1.1%)	St Fm	0.00169	(1; 0.46%)	El Is Fm	0.153	(2; 1.7%)
Uo Nf Fm	0.00212	(2; 1.%)	Hh Fm	0.00166	(1; 0.45%)	Wa Is Fm	0.0952	(2; 1.%)
Ch Fm	0.00156	(1; 0.76%)	Ts Fm	0.00155	(1; 0.42%)	Io Is Fm	0.0761	(2; 0.83%)
Co Nf Fm	0.00142	(2; 0.69%)	El Fm	0.00135	(1; 0.36%)	Uo Nf Fm	0.0682	(2; 0.75%)
Sp Is Fm	0.00141	(2; 0.68%)	Os Fm	0.00133	(1; 0.36%)	Wa Ms Fm	0.061	(2; 0.67%)
Bl El Fm	0.00108	(2; 0.52%)	Nf Fm	0.00133	(1; 0.36%)	Ws Ho Fm	0.0596	(2; 0.65%)
Io Fm	0.00107	(1; 0.52%)	Bs Fm	0.00131	(1; 0.36%)	Br Is Fm	0.0554	(2; 0.61%)
St Fm	0.00101	(1; 0.49%)	Ho Fm	0.00119	(1; 0.32%)	Bc Mp Ho Fm	0.0428	(3; 0.47%)
Bl Is Fm	0.00101	(2; 0.49%)	Cm Fm	0.00111	(1; 0.3%)	Bx Ao Al Fm	0.0416	(3; 0.46%)
Sm Fm	0.000914	(1; 0.44%)	Pd Fm	0.000952	(1; 0.26%)	Ch Fm	0.041	(1; 0.45%)
Is Sm Fm	0.000745	(2; 0.36%)	Wt Is Fm	0.000871	(2; 0.24%)	Dc Dp Ho Fm	0.0355	(3; 0.39%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /S)		
Fm	0.0983	(0; 59.%)	Fm	0.0795	(0; 53.%)	Fm	0.0224	(0; 11.%)
Is Fm	0.00881	(1; 5.3%)	Is Fm	0.00638	(1; 4.3%)	Wo Tx Tp Fm	0.0172	(3; 8.3%)
Nf Fm	0.0023	(1; 1.4%)	Wt Fm	0.0028	(1; 1.9%)	Wo Tx Fm	0.014	(2; 6.8%)
Sm Fm	0.00212	(1; 1.3%)	Sm Fm	0.00171	(1; 1.1%)	Bc Mp Ho Fm	0.0118	(3; 5.7%)
Hh Fm	0.0021	(1; 1.3%)	Rd Fm	0.00143	(1; 0.95%)	Bc Mp Fm	0.00803	(2; 3.9%)
Ch Fm	0.00157	(1; 0.94%)	Nf Fm	0.00133	(1; 0.88%)	Bc Mp Lp Fm	0.00725	(3; 3.5%)
Pt Fm	0.00123	(1; 0.74%)	Ms Fm	0.00117	(1; 0.78%)	Wo Tx Cl Fm	0.00625	(3; 3.%)
Wt Fm	0.000901	(1; 0.54%)	St Fm	0.000905	(1; 0.6%)	Bc Mp Ch Fm	0.00534	(3; 2.6%)
Pl Fm	0.000641	(1; 0.38%)	El Fm	0.00084	(1; 0.56%)	Wo Lp Fm	0.00377	(2; 1.8%)
Sp Is Fm	0.000593	(2; 0.35%)	Hh Fm	0.000779	(1; 0.52%)	Bc Ch Fm	0.00269	(2; 1.3%)
Pa Fm	0.000586	(1; 0.35%)	Ts Fm	0.000764	(1; 0.51%)	Bc Mp Rt Fm	0.00261	(3; 1.3%)
Pc Fm	0.000567	(1; 0.34%)	Ho Fm	0.000628	(1; 0.42%)	El Fm	0.00179	(1; 0.86%)
Tp Fm	0.000553	(1; 0.33%)	Pd Fm	0.000624	(1; 0.42%)	Wo Mp Ho Fm	0.00133	(3; 0.64%)
Ms Fm	0.000539	(1; 0.32%)	Os Fm	0.000619	(1; 0.41%)	Wo Tx Wt Fm	0.000995	(3; 0.48%)
Rd Fm	0.000504	(1; 0.3%)	Cm Fm	0.000531	(1; 0.35%)	Ba Bm Ho Fm	0.000964	(3; 0.46%)
Ee Fm	0.000454	(1; 0.27%)	Wt Is Fm	0.000407	(2; 0.27%)	Wo Mp Fm	0.000907	(2; 0.44%)
Ts Fm	0.000422	(1; 0.25%)	Io Is Fm	0.000402	(2; 0.27%)	Wo Tx Fu Fm	0.000821	(3; 0.4%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.073 ±0.020	(±1.8%)
Downstream	1.552 ±0.023	(±1.5%)

# Sector 2801: Motor Vehicles and Parts (Mv)

*Motor vehicles and parts, caravans, trailers, body panels and other transport equipment*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is 45% below average while water use and land disturbance are respectively 85% and 95% below average. The social indicators of employment generation and income are both 20% below average while government revenue is nearly three times the average. The financial indicator of operating surplus is 20% below average while export propensity and import penetration are respectively 10% and 60% above average. Imports have run at three times the level of exports for some time, despite success in developing export markets. In the absence of major policy or market interventions, the domestic demand for the sector may stabilise past 2020 as the population ages and begins to stabilise. Technological innovation in the 10-20 year timeframe may centre on new drive trains for cars and trucks such as hybrid engines and fuel cells. These innovations may cause the current TBL account to shift as manufacturing becomes more complex and energy intensive but requires less labour.

## Sector Description

Automotive industry statistics show yearly sales of around 530 000 cars and 220 000 light trucks. About 40% of passenger cars are made in Australia. Imports come from Japan (57%), Germany (14%), Korea (7%) and other (22%). Industry sources reveal that the sector is investing heavily in projects to increase exports of cars and components. Car exports were worth \$3.3 billion and components \$1.7 billion in 2001. For locally made vehicles, 109 000 were exported and 200 000 were purchased locally in 2001. Engines account for one quarter of the value of motor parts exports, the remainder is in other components. In 2002, the industry turnover was \$13.6 billion and involved over 80 enterprises.

## Place of Industry in the Economy

The motor vehicles and parts sector ranks 27<sup>th</sup> out of 135 sectors in terms of value adding in the economy, and contributes 0.94% of GDP in this analysis. The sector is a good employment generator with a direct requirement for 52 000 employment years and an additional 57 000 years in the sector's suppliers, giving a total of 109 000 employment years. In addition, the sector contributes 25 000 employment years to downstream sectors such as mechanical repairs and road transport. The sector has absolute requirements for 1.6% of national energy use and emits one percent of national greenhouse emissions. Water use is three tenths of one percent of the national total, while land disturbance is less than one tenth of one percent. In financial terms, imports are usually three times the level of exports and in the year 2001, the outcome was \$9 billion in imports versus \$3 billion in exports, a deficit of \$6 billion.

## Strategic Overview

The integrated overview in the spider diagram shows a reasonably balanced TBL account with below average performance for two financial and two social indicators. Maintaining a strategic capability in manufacturing cars and car parts is an important linkage to high-tech mass manufacturing. Downstream issues for the sector focus on the everyday use of motor vehicles which gives many negative outcomes such as health problems from vehicle emissions, motor accidents and congestion costs. Some of these issues are attributable to poor design and manufacture and thus the firms in this sector, but many effects can be sheeted home to the behaviour of individual consumers.

## TBL Account #1

The financial indicator of operating surplus is 20% below average in this analysis and may reflect the dynamics of the business cycle. The direct effect is one third with smaller contributions from iron and steel, wholesale trade and technical services. Employment generation is 20% below the economy wide average with about half a direct effect. Greenhouse emissions are 45% below average with a minor direct effect and larger contributions from iron and steel (22%) and electricity generation (11%). While it may be possible to improve the surplus and employment indicators, the diverse and globalised nature of the motor industry makes it difficult to buffer the sector against a wide range of competitive forces.

## TBL Accounts #2 and #3

In the second TBL account, the financial indicator of export propensity is 10% better above average with half a direct effect and smaller contributions from iron and steel, wholesale trade and non-ferrous metals. The income indicator is 20% below average and one third of the effect is direct. The water indicator is 80% below average with only a minor direct effect. In the third TBL account, the financial indicator of import penetration is 60% above average revealing an ongoing structural issue where imports are three times the size of exports in dollar terms. Government revenue is treble the average due to sales taxes as well as income and payroll taxes.

## Structural Path Analysis and Linkages

Since both the employment and income indicators are below the economy wide average, the structural paths may help identify options for improvement for both. About 40% of the effect is within the sector, 6% is within wholesale trade, 3% in basic iron and steel and 2% in scientific research. The remaining 50% of the effect is due to the production chain comprising many hundreds of suppliers. Thus improvement efforts should focus on the four main contributing sectors.

The sector shows relatively weak downstream linkages to motor manufacturing (the assembly industry), mechanical repairs, and road freight transport (car transporters). This is due to domestic consumption and exports, which dissipate the effect of the linkage both inside and outside the Australian economy. Increases in consumer demand give a relatively strong upstream stimulus to suppliers to the sector such as car components, wholesale trade and basic iron and steel.

## Future Trends in Sector

Under the assumptions of the CSIRO *Future Dilemmas* base case scenario (25 million people in 2050), there is a yearly requirement past 2020 for about 500 000 private cars, 140 000 fleet cars and 220 000 light trucks. The future size of the local industry will depend on its ability to increase exports and change the 40:60 ratio of locally made to imported cars. Radical changes to urban transport systems that reduce the need for personal vehicles could generate prompt changes.

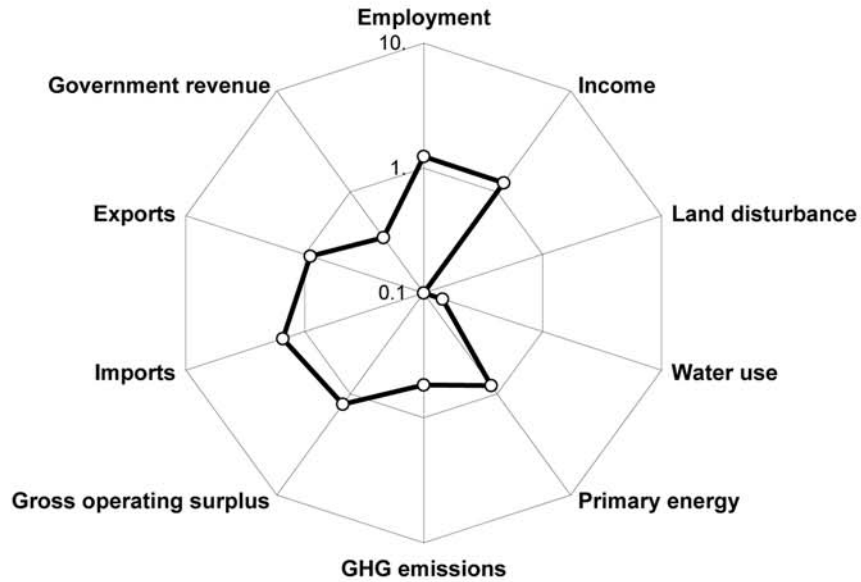
## Innovation and Technical Opportunities

Although the sector has produced advanced hybrid prototypes such the Holden ECommodore and the aXcessaustralia car, interest in the local manufacture of these vehicles seems slow to develop. Recent industry support schemes have been directed towards traditional internal combustion engine cars, and current consumers seem to favour power rather than engine efficiency and lower emissions. The rate at which air emissions in cities and carbon dioxide emissions from the full vehicle life cycle become central to consumer choice will determine technology change for this sector. New car production systems may become more energy intensive (computers, carbon fibre, light metals) as the manufacturing process becomes more sophisticated and less labour intensive. The TBL indicators presented here may change appreciably as new vehicle technologies penetrate.

Motor vehicles and parts, caravans, trailers, body panels other transport equipment

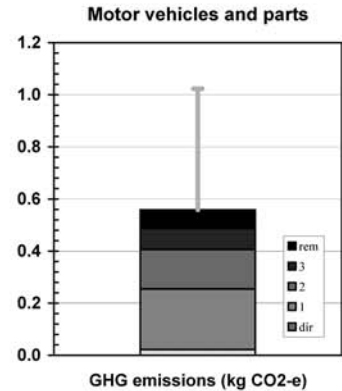
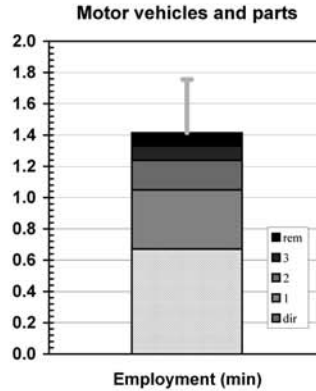
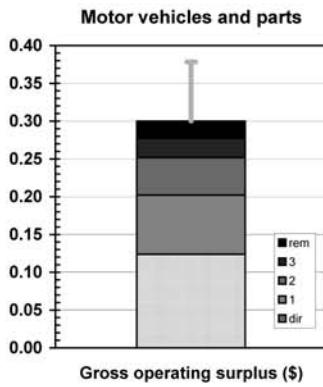
Spider diagram

Motor vehicles and parts

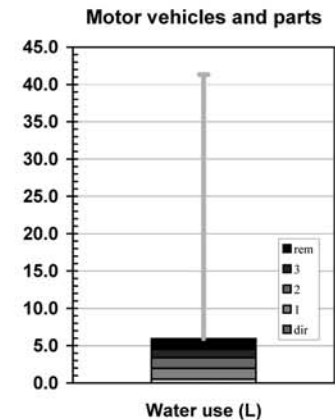
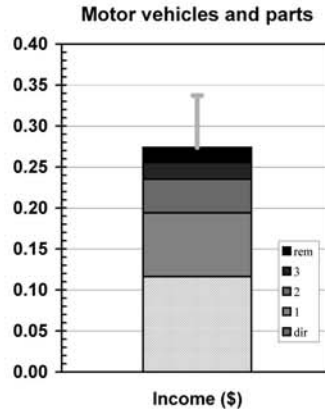
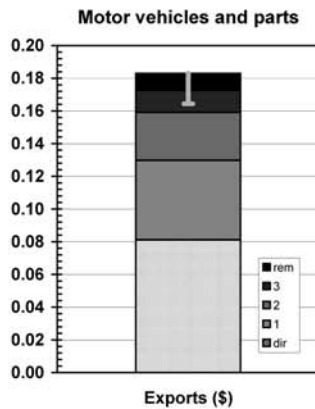


Bar graphs

Account #1

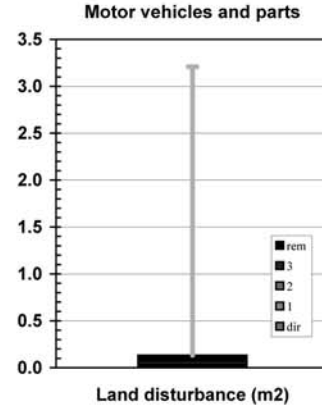
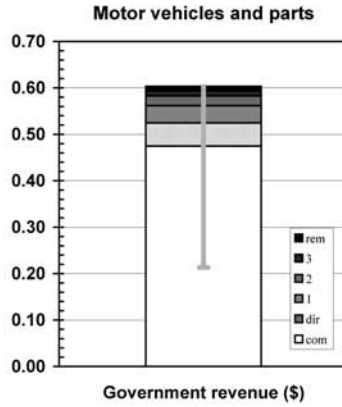
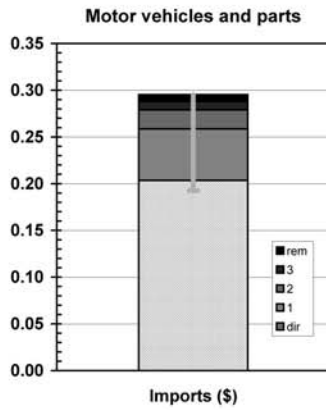


Account #2





Account #3



National Accounts extracts

Receipts: GNT(E) - commodities

Private final consumption	\$m 5,480.3	(2.07% of total)	(\$m 3,231.4 domestically produced)
Government final consumption	-\$m 0.6	(0.00% of total)	
Gross fixed capital expenditure	\$m 8,663.2	(8.27% of total)	(\$m 4,702.1 domestically produced)
Net changes in stocks	\$m 876.0	(49.56% of total)	(\$m 508.5 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 15,018.9</b>	<b>(3.27% of GNE)</b>	<b>(\$m 8,441.3 domestically produced)</b>
Exports	\$m 1,176.8	(1.41% of total)	(\$m 1,176.8 domestically produced)
Final demand	\$m 16,195.6	(2.98% of GNT)	(\$m 9,618.1 domestically produced)

Costs: GNT(I) - industries

Wages and salaries	\$m 1,685.7	(0.99% of total)
Gross operating surplus	\$m 1,794.4	(0.94% of total)
Taxes less subsidies	\$m 722.5	(0.85% of total)
<b>Sectoral GDP*</b>	<b>\$m 4,202.6</b>	<b>(0.94% of GDP)</b>
Imports	\$m 2,950.5	(3.02% of total)
<b>Primary inputs</b>	<b>\$m 7,153.1</b>	<b>(1.31% of GNT)</b>

\* Sectoral gross value added + net taxes on products

TBL factors

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 1,794.4	(0.94%)	\$m 1,189.7 (0.62%)	\$m 2,885.3 (1.50%)
Exports (\$m)	\$m 1,176.8	(1.41%)	\$m 780.2 (0.94%)	\$m 1,759.9 (2.11%)
Imports (\$m)	\$m 2,950.5	(3.02%)	\$m 1,956.3 (2.00%)	\$m 2,839.3 (2.91%)
Employment (e-y)	77,991 e-y	(1.09%)	51,710 e-y (0.73%)	109,032 e-y (1.53%)
Income (\$m)*	\$m 1,685.7	(0.99%)	\$m 1,117.7 (0.65%)	\$m 2,633.3 (1.54%)
Government revenue (\$m)†	\$m 5,287.4	(4.89%)	\$m 5,043.9 (4.67%)	\$m 5,803.2 (5.37%)
GHG emissions (kt CO <sub>2</sub> -e)	316 kt	(0.06%)	210 kt (0.04%)	5,369 kt (1.04%)
Water use (ML)	7,242 ML	(0.03%)	4,802 ML (0.02%)	57,134 ML (0.27%)
Land disturbance (kha)	14 kha	(0.01%)	9 kha (0.01%)	128 kha (0.08%)
Primary energy (TJ)	5,883 TJ	(0.15%)	3,900 TJ (0.10%)	60,925 TJ (1.57%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

TBL multipliers - commodities

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.12	0.30	0.38
Exports (\$)	0.08	0.18	0.16
Imports (\$)	0.20	0.30	0.19
Employment (min)	0.67	1.41	1.75
Income (\$)	0.12	0.27	0.34
Government revenue (\$)	0.52	0.60	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.02	0.56	1.02
Water use (L)	0.50	5.94	41.32
Land disturbance (m <sup>2</sup> )	0.01	0.13	3.21
Primary energy (MJ)	0.41	6.33	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Mv	0.124	(0; 41.%)	Mv	0.671	(0; 47.%)	Is Mv	0.122	(1; 22.%)
Is Mv	0.0141	(1; 4.7%)	Wt Mv	0.0854	(1; 6.%)	EI Mv	0.06	(1; 11.%)
Wt Mv	0.0119	(1; 4.%)	Is Mv	0.0337	(1; 2.4%)	Mv	0.0218	(0; 3.9%)
Ts Mv	0.00482	(1; 1.6%)	Ts Mv	0.0217	(1; 1.5%)	EI Is Mv	0.016	(2; 2.9%)
Pd Mv	0.00326	(1; 1.1%)	Fm Mv	0.0215	(1; 1.5%)	Wt Mv	0.0118	(1; 2.1%)
EI Mv	0.00242	(1; 0.81%)	Bs Mv	0.0098	(1; 0.69%)	Nf Mv	0.00891	(1; 1.6%)
Pt Mv	0.00241	(1; 0.8%)	Pd Mv	0.00783	(1; 0.55%)	Gd Mv	0.00702	(1; 1.3%)
St Wt Mv	0.00226	(2; 0.75%)	Ms Wt Mv	0.00771	(2; 0.55%)	Ch Mv	0.00675	(1; 1.2%)
Nf Mv	0.00194	(1; 0.65%)	Ms Mv	0.00744	(1; 0.53%)	EI Wt Mv	0.00356	(2; 0.64%)
Fm Mv	0.00194	(1; 0.65%)	Gv Mv	0.00567	(1; 0.4%)	Is Fm Mv	0.00313	(2; 0.56%)
Io Is Mv	0.00182	(2; 0.61%)	Ru Mv	0.00485	(1; 0.34%)	Ch Pt Mv	0.00235	(2; 0.42%)
St Mv	0.00179	(1; 0.6%)	Pt Mv	0.00484	(1; 0.34%)	Sp Is Mv	0.00192	(2; 0.34%)
Ms Wt Mv	0.00172	(2; 0.57%)	Rd Mv	0.00433	(1; 0.31%)	EI Nf Mv	0.0018	(2; 0.32%)
Ms Mv	0.00166	(1; 0.55%)	Os Mv	0.00431	(1; 0.3%)	At Mv	0.00168	(1; 0.3%)
Pd Wt Mv	0.00136	(2; 0.45%)	Eq Mv	0.00418	(1; 0.3%)	EI Fm Mv	0.00164	(2; 0.29%)
Bs Mv	0.000993	(1; 0.33%)	Ho Mv	0.00381	(1; 0.27%)	EI Pd Mv	0.00155	(2; 0.28%)
Ru Mv	0.000833	(1; 0.28%)	St Wt Mv	0.00369	(2; 0.26%)	BI EI Mv	0.00151	(2; 0.27%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Mv	0.0811	(0; 44.%)	Mv	0.116	(0; 42.%)	Mv	0.499	(0; 8.4%)
Is Mv	0.0108	(1; 5.9%)	Wt Mv	0.0183	(1; 6.7%)	Wa Mv	0.416	(1; 7.%)
Wt Mv	0.0097	(1; 5.3%)	Is Mv	0.00803	(1; 2.9%)	EI Mv	0.332	(1; 5.6%)
Nf Mv	0.00652	(1; 3.6%)	Ts Mv	0.00508	(1; 1.9%)	Is Mv	0.323	(1; 5.4%)
Io Is Mv	0.00293	(2; 1.6%)	Fm Mv	0.00337	(1; 1.2%)	Wa Pd Mv	0.0891	(2; 1.5%)
GI Nf Mv	0.00119	(2; 0.65%)	Pd Mv	0.00294	(1; 1.1%)	EI Is Mv	0.0884	(2; 1.5%)
Fm Mv	0.00111	(1; 0.61%)	Ms Wt Mv	0.00179	(2; 0.66%)	Wa Ts Mv	0.065	(2; 1.1%)
Sp Is Mv	0.000813	(2; 0.44%)	Ms Mv	0.00173	(1; 0.63%)	Nf Mv	0.0556	(1; 0.94%)
Ch Mv	0.000785	(1; 0.43%)	Gv Mv	0.00143	(1; 0.52%)	Wa Is Mv	0.0549	(2; 0.92%)
Ts Mv	0.000765	(1; 0.42%)	Pd Wt Mv	0.00123	(2; 0.45%)	Wt Mv	0.0478	(1; 0.8%)
Eq Mv	0.000745	(1; 0.41%)	Ru Mv	0.00123	(1; 0.45%)	Wa Ms Wt Mv	0.0442	(3; 0.74%)
Uo Nf Mv	0.000723	(2; 0.39%)	Os Mv	0.00121	(1; 0.44%)	Io Is Mv	0.0439	(2; 0.74%)
BI EI Mv	0.000586	(2; 0.32%)	Bs Mv	0.0012	(1; 0.44%)	Wa Ms Mv	0.0427	(2; 0.72%)
BI Is Mv	0.000581	(2; 0.32%)	Pt Mv	0.00113	(1; 0.41%)	Wa Pd Wt Mv	0.0373	(3; 0.63%)
St Wt Mv	0.000561	(2; 0.31%)	In Mv	0.000976	(1; 0.36%)	Dc Dp Mv	0.0342	(2; 0.58%)
At Mv	0.000535	(1; 0.29%)	St Wt Mv	0.000943	(2; 0.34%)	Br Is Mv	0.032	(2; 0.54%)
Co Nf Mv	0.000484	(2; 0.26%)	Bk Mv	0.000781	(1; 0.29%)	Wa Bs Mv	0.03	(2; 0.51%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Mv	0.203	(0; 69.%)	Mv	0.0498	(0; 39.%)	Mv	0.00952	(0; 7.1%)
Is Mv	0.00508	(1; 1.7%)	Wt Mv	0.00857	(1; 6.7%)	Wo Tx Mv	0.0095	(2; 7.1%)
Wt Mv	0.00276	(1; 0.93%)	Is Mv	0.00368	(1; 2.9%)	Bc Mp Ho Mv	0.0055	(3; 4.1%)
Pt Mv	0.00263	(1; 0.89%)	Ts Mv	0.0025	(1; 1.9%)	Wo Tx Wt Mv	0.00304	(3; 2.3%)
Ru Mv	0.00161	(1; 0.55%)	Pd Mv	0.00193	(1; 1.5%)	Bc Mp Ch Mv	0.00268	(3; 2.%)
Fm Mv	0.00146	(1; 0.49%)	Fm Mv	0.00118	(1; 0.91%)	Wo Tx Tp Mv	0.00259	(3; 1.9%)
Ts Mv	0.00138	(1; 0.47%)	In Mv	0.00105	(1; 0.82%)	Wo Tx Ru Mv	0.00227	(3; 1.7%)
Ch Mv	0.000786	(1; 0.27%)	Ms Wt Mv	0.000852	(2; 0.66%)	Wo Tx Fu Mv	0.00191	(3; 1.4%)
Nf Mv	0.000784	(1; 0.27%)	Ms Mv	0.000822	(1; 0.64%)	Bc Mp Ho Wt	0.00176	(4; 1.3%)
Eq Mv	0.000493	(1; 0.17%)	Pd Wt Mv	0.000805	(2; 0.63%)	Bc Ch Mv	0.00135	(2; 1.%)
PI Mv	0.000474	(1; 0.16%)	Ru Mv	0.000646	(1; 0.5%)	Bc Mp Wt Mv	0.00116	(3; 0.87%)
Pd Mv	0.000469	(1; 0.16%)	Pt Mv	0.000625	(1; 0.49%)	EI Mv	0.000968	(1; 0.73%)
Ee Mv	0.000422	(1; 0.14%)	Os Mv	0.00056	(1; 0.43%)	Bc Mp Ch Pt M	0.000932	(4; 0.7%)
Et Mv	0.000419	(1; 0.14%)	Rd Mv	0.000528	(1; 0.41%)	Bc Mp Rt Wt M	0.000898	(4; 0.67%)
Ms Wt Mv	0.000391	(2; 0.13%)	St Wt Mv	0.000503	(2; 0.39%)	Wo Ts Mv	0.000833	(2; 0.62%)
Ms Mv	0.000377	(1; 0.13%)	Gv Mv	0.000496	(1; 0.39%)	Wt Mv	0.000725	(1; 0.54%)
Pr Wt Mv	0.000374	(2; 0.13%)	EI Mv	0.000455	(1; 0.35%)	Wo Tx CI Mv	0.000693	(3; 0.52%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.147 ±0.023	(±2.0%)
Downstream	0.599 ±0.018	(±3.0%)

# Sector 2802: Ships and Boats (Sb)

*Ships and boats, including repairing and servicing*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicators of greenhouse emissions, water use and land disturbance are 35%, 85% and 95% below the economy wide average respectively. The social indicators reveal that employment generation is 40% below average, income is 10% below average, and government revenue is equal to average. The financial indicators reveal that operating surplus is 40% below average, export propensity is more than two times the average, and import penetration is 50% above average. The industry is strategically important given Australia's reliance on sea transport. Its future performance will depend on defence contracts and the ability to defend niche export markets in large catamarans and sophisticated pleasure craft. In common with aircraft manufacturing, investing in design skills and their integration with advanced materials science may help improve the sector's future options.

## Sector Description

Australia has a surprisingly robust and dynamic ship building industry led by iconic manufacturers of large commercial catamarans such as the Tasmanian firm Incat, and major defence shipbuilders such as Tenix (builders of 10 Anzac Class guided missile frigates) and the Australian Submarine Corporation (builders of 6 Collins Class Submarines). The defence contracts are designed to develop domestic strategic skills and stimulate local employment. Since the launch of its first high speed catamaran in 1977, Incat designs have been used to build more than 170 large aluminium catamarans worldwide, 60 of which (36%) have been built in Australia. In the year 2000, Australia exported more than 10 000 recreational boats valued at \$130 million. The import and export picture is variable depending on major commercial or defence items purchases and sales. Yearly turnover of the sector was about \$2 billion in 2002 and involved over 600 enterprises. In dollar terms, purchases of large vessels account for 70% and repairs for 10%.

## Place of Industry in the Economy

The ship and boat manufacturing sector ranks 100<sup>th</sup> out of 135 sectors in terms of value adding in the economy and contributes 0.11% of GDP in this analysis. It is similar in value adding to the adhesives, inks and polishes and the carpets and curtains sectors. It is a relatively small employer with a direct requirement of 2 000 employment years embodied in the sector's final demand and another 5 000 years in the sector's suppliers giving a total of 7 000 employment years. In addition the sector supplies another 2 000 employment years to the final demand of other sectors such as sea transport and defence. The sector has relatively small resource requirements with less than two tenths of one percent of national water use, land disturbance, energy use and greenhouse emissions. In financial terms, exports are twice imports in this analysis and this varies with the yearly imports of commercial and defence craft and the exports of pleasure craft.

## Strategic Overview

The spider diagram reveals that the social indicators of employment generation and income, and the financial indicators of operating surplus and import penetration, are all below average. Some of these indicators may be improving with the growing success of the pleasure craft industry, a lot of which is based on the Gold Coast of Queensland. Major overseas defence purchases can change the financial indicators in a particular year. Upstream issues relate to the continuity and scale of future defence orders for large boats. Downstream issues relate to energy efficient designs and emissions.

## TBL Account #1

The financial indicator of operating surplus is 40% below the economy wide average and about one fifth of this is a direct sector effect. The social indicator of employment generation is 40% below average and the environmental indicator of greenhouse emissions is 35% below average. The lower than average indicators for employment generation and greenhouse emissions are partly linked to the high levels of imports, as production of high technology equipment and the emissions therein, are undertaken in other countries. The recent purchase of new Bass Strait ferries built in Finland and Germany was based on financial, operational and safety decisions. As a result the domestic ship building industry missed the opportunity for major projects providing both profit and employment.

## TBL Accounts #2 and #3

The second TBL account shows an export propensity indicator more than two times the average, an income indicator that is 10% below average and a water use indicator that is 85% below average. The third TBL account reveals an import penetration indicator 50% above average, a government revenue indicator that is equal to average and a land disturbance indicator that is 95% below average. Since exports and imports are mostly in balance (depending on major orders) the accounts suggest that operating surplus and employment generation may be key areas for improvement.

## Structural Path Analysis and Linkages

The structural path analysis for employment generation shows that the direct sector effect is 23% of the total with contributions from nuts and bolts (8%), wholesale trade (6%), scientific and radio equipment (7%), steel tube and plate (4%), heavy machinery manufacture (3%), plywood products (2%), pumps and bearings (2%) and structural metal (1%). While employment generation will be enhanced by more ship orders, the supply chain is broadly based and may benefit from skill and design investments which can help replace imports. Major items such as engines will mostly be imported, but innovative companies such as the Sydney based DBD Marine (a revolutionary marine drive train), and the Perth based Sarich Orbital Engine Company (now included in many outboard motors), may allow some improvement in this indicator if domestic manufacturing ensues.

The sector's stimulus to its upstream suppliers is about 10% higher than the economy wide average with significant effects on steel tubes and plates, wholesale trade, scientific and radio equipment, nuts and bolts, copper metal products, and plant and vehicle hire. The linkages to downstream industries are weak with most of the effect being dissipated by domestic consumption and exports.

## Future Trends in Sector

The sector's future depends on major policy decisions for defence. The recently released 'Defence Capability Plan 2004-2014' signals that nearly \$10 billion will be spent in the next decade on amphibious support craft, fleet tender vessels, and the major item of a new 'air warfare destroyer' which will cost \$6 billion, and be built in Australia. In the commercial and pleasure markets for the past decade, Incat have delivered between three and six large catamarans per year. Only one third of these are built in Australia emphasising the need to maintain a technological and marketing edge.

## Innovation and Technical Opportunities

Commercial shipping design will be driven by increased requirements for global safety and disaster-avoidance, as well as reduced energy use and greenhouse emissions per passenger kilometre or per freight tonne kilometre. Naval vessels will be stealthier and have multi-mission capability probably with fewer more highly trained personnel. The US Navy's 'Arsenal Ship' revamps naval concepts with a large stealthy and survivable vessel packed with munitions, permanently deployed close to persistent threats with small revolving crews to maximise available skills and reduce costs.

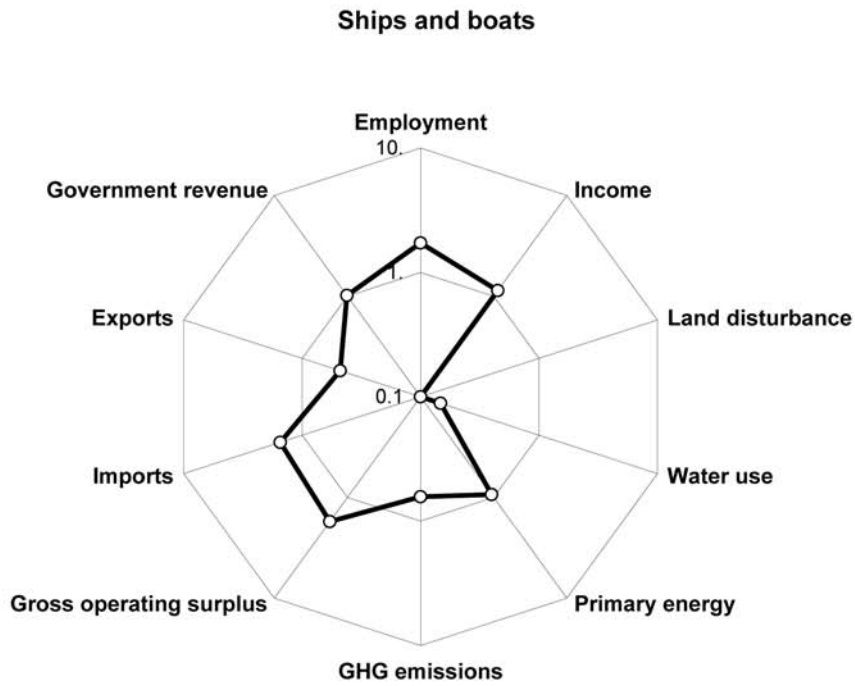
**Sector**

**Ships and boats**

(Sb)

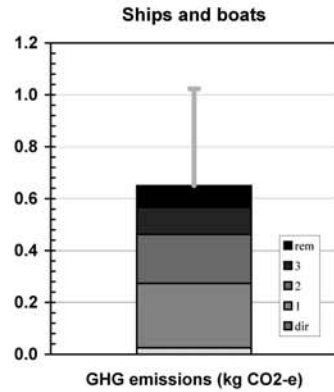
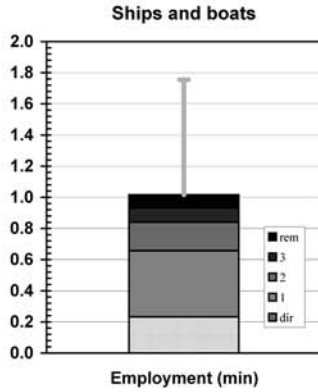
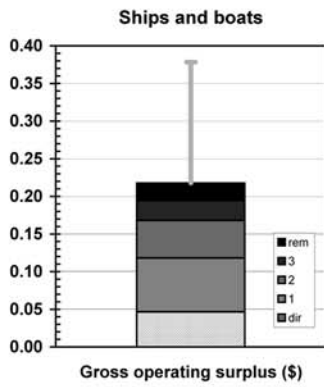
Ships and boats, incl repairing and servicing

**Spider diagram**

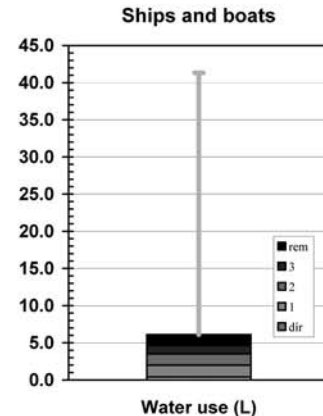
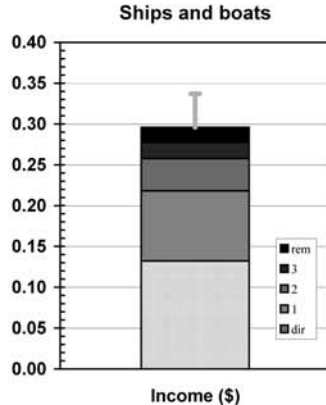
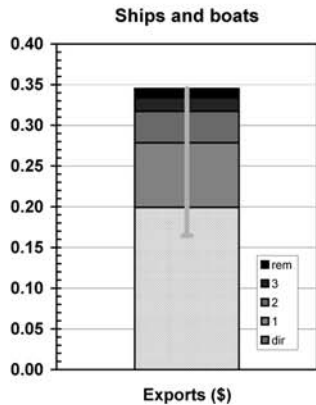


**Bar graphs**

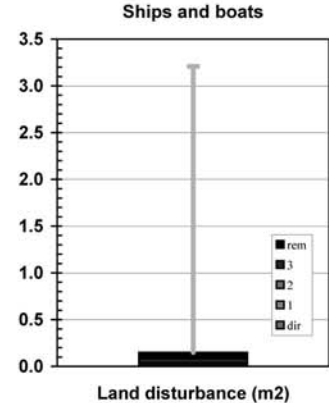
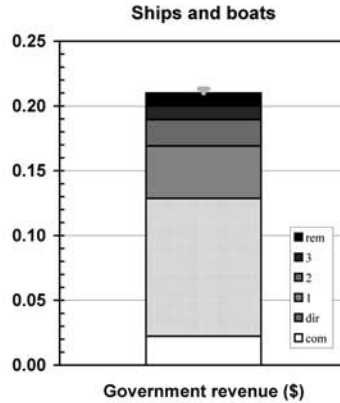
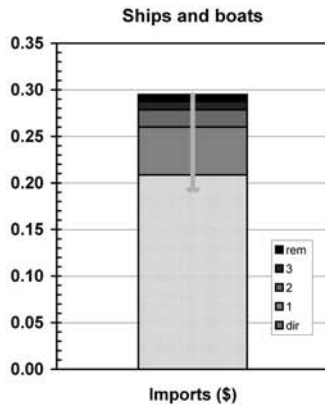
**Account #1**



**Account #2**



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 182.6	(0.07% of total)	(\$m 141.7 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 445.9	(0.43% of total)	(\$m 321.2 domestically produced)
Net changes in stocks	\$m 43.3	(2.45% of total)	(\$m 45.3 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 671.8</b>	<b>(0.15% of GNE)</b>	<b>(\$m 508.1 domestically produced)</b>
Exports	\$m 348.3	(0.42% of total)	(\$m 348.3 domestically produced)
<b>Final demand</b>	<b>\$m 1,020.1</b>	<b>(0.19% of GNT)</b>	<b>(\$m 856.4 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 231.1	(0.14% of total)
Gross operating surplus	\$m 81.3	(0.04% of total)
Taxes less subsidies	\$m 186.1	(0.22% of total)
<b>Sectoral GDP*</b>	<b>\$m 498.5</b>	<b>(0.11% of GDP)</b>
Imports	\$m 364.6	(0.37% of total)
<b>Primary inputs</b>	<b>\$m 863.0</b>	<b>(0.16% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 81.3	(0.04%)	\$m 39.8 (0.02%)	\$m 186.4 (0.10%)
Exports (\$m)	\$m 348.3	(0.42%)	\$m 170.6 (0.20%)	\$m 295.6 (0.35%)
Imports (\$m)	\$m 364.6	(0.37%)	\$m 178.5 (0.18%)	\$m 252.6 (0.26%)
Employment (e-y)	3,250 e-y	(0.05%)	1,592 e-y (0.02%)	6,970 e-y (0.10%)
Income (\$m)*	\$m 231.1	(0.14%)	\$m 113.2 (0.07%)	\$m 253.4 (0.15%)
Government revenue (\$m)†	\$m 205.1	(0.19%)	\$m 110.2 (0.10%)	\$m 179.8 (0.17%)
GHG emissions (kt CO <sub>2</sub> -e)	43 kt	(0.01%)	21 kt (0.00%)	557 kt (0.11%)
Water use (ML)	655 ML	(0.00%)	321 ML (0.00%)	5,227 ML (0.02%)
Land disturbance (kha)	2 kha	(0.00%)	1 kha (0.00%)	13 kha (0.01%)
Primary energy (TJ)	780 TJ	(0.02%)	382 TJ (0.01%)	6,139 TJ (0.16%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.05	0.22	0.38
Exports (\$)	0.20	0.35	0.16
Imports (\$)	0.21	0.29	0.19
Employment (min)	0.23	1.02	1.75
Income (\$)	0.13	0.30	0.34
Government revenue (\$)	0.13	0.21	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.02	0.65	1.02
Water use (L)	0.37	6.10	41.32
Land disturbance (m <sup>2</sup> )	0.01	0.15	3.21
Primary energy (MJ)	0.45	7.17	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Sb	0.0465	(0; 21.%)	Sb	0.232	(0; 23.%)	Is Sb	0.14	(1; 22.%)
Is Sb	0.0162	(1; 7.5%)	Fm Sb	0.0776	(1; 7.6%)	El Sb	0.0497	(1; 7.7%)
Wt Sb	0.00899	(1; 4.1%)	Oe Sb	0.0668	(1; 6.6%)	Sb	0.0248	(0; 3.8%)
Fm Sb	0.00698	(1; 3.2%)	Wt Sb	0.0647	(1; 6.4%)	Nf Sb	0.019	(1; 2.9%)
Oe Sb	0.00613	(1; 2.8%)	Is Sb	0.0388	(1; 3.8%)	El Is Sb	0.0184	(2; 2.8%)
Nf Sb	0.00413	(1; 1.9%)	Ma Sb	0.0295	(1; 2.9%)	Is Fm Sb	0.0113	(2; 1.7%)
Pt Sb	0.00392	(1; 1.8%)	Wp Sb	0.0242	(1; 2.4%)	Wt Sb	0.00897	(1; 1.4%)
Wp Sb	0.00269	(1; 1.2%)	Eq Sb	0.019	(1; 1.9%)	Is Ma Sb	0.00808	(2; 1.2%)
St Sb	0.00228	(1; 1.1%)	Sm Sb	0.011	(1; 1.1%)	El Fm Sb	0.00592	(2; 0.91%)
Ma Sb	0.00223	(1; 1.1%)	Ee Sb	0.00838	(1; 0.83%)	Sw Wp Sb	0.00443	(2; 0.68%)
Io Is Sb	0.0021	(2; 0.96%)	Pt Sb	0.00788	(1; 0.78%)	Ch Sb	0.0043	(1; 0.66%)
El Sb	0.00201	(1; 0.92%)	Wt Oe Sb	0.00704	(2; 0.69%)	Is Oe Sb	0.00423	(2; 0.65%)
Eq Sb	0.00192	(1; 0.88%)	Bs Sb	0.00649	(1; 0.64%)	Sw Ti Wp Sb	0.00395	(3; 0.61%)
St Wt Sb	0.00171	(2; 0.79%)	Rt Sb	0.006	(1; 0.59%)	El Nf Sb	0.00383	(2; 0.59%)
Ee Sb	0.00135	(1; 0.62%)	Ms Wt Sb	0.00584	(2; 0.58%)	Ch Pt Sb	0.00382	(2; 0.59%)
Is Fm Sb	0.00131	(2; 0.6%)	Rd Sb	0.00551	(1; 0.54%)	El Oe Sb	0.00371	(2; 0.57%)
Ms Wt Sb	0.0013	(2; 0.6%)	Gv Sb	0.00417	(1; 0.41%)	El Wp Sb	0.00364	(2; 0.56%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Sb	0.199	(0; 58.%)	Sb	0.132	(0; 45.%)	Sb	0.375	(0; 6.1%)
Oe Sb	0.0242	(1; 7.%)	Oe Sb	0.0153	(1; 5.2%)	Is Sb	0.372	(1; 6.1%)
Nf Sb	0.0139	(1; 4.%)	Wt Sb	0.0139	(1; 4.7%)	El Sb	0.275	(1; 4.5%)
Is Sb	0.0124	(1; 3.6%)	Fm Sb	0.0122	(1; 4.1%)	Wp Sb	0.199	(1; 3.3%)
Wt Sb	0.00735	(1; 2.1%)	Is Sb	0.00925	(1; 3.1%)	Wa Sb	0.198	(1; 3.2%)
Ma Sb	0.00433	(1; 1.3%)	Ma Sb	0.00553	(1; 1.9%)	Nf Sb	0.118	(1; 1.9%)
Fm Sb	0.004	(1; 1.2%)	Wp Sb	0.00468	(1; 1.6%)	Fm Sb	0.107	(1; 1.8%)
Eq Sb	0.00338	(1; 0.98%)	Eq Sb	0.00335	(1; 1.1%)	El Is Sb	0.102	(2; 1.7%)
Io Is Sb	0.00337	(2; 0.98%)	Sm Sb	0.00189	(1; 0.64%)	Dc Dp Sb	0.102	(2; 1.7%)
Gl Nf Sb	0.00253	(2; 0.73%)	Pt Sb	0.00183	(1; 0.62%)	Sm Sb	0.0697	(1; 1.1%)
Uo Nf Sb	0.00154	(2; 0.45%)	Ee Sb	0.00161	(1; 0.54%)	Wa Is Sb	0.0633	(2; 1.1%)
Ee Sb	0.00135	(1; 0.39%)	Wt Oe Sb	0.00151	(2; 0.51%)	Io Is Sb	0.0506	(2; 0.83%)
Nf Oe Sb	0.00116	(2; 0.34%)	Ms Wt Sb	0.00136	(2; 0.46%)	Uo Nf Sb	0.0494	(2; 0.81%)
Co Nf Sb	0.00103	(2; 0.3%)	Gv Sb	0.00105	(1; 0.35%)	Ws Sb	0.0433	(1; 0.71%)
Nf Fm Sb	0.00102	(2; 0.3%)	Bk Sb	0.000965	(1; 0.33%)	Br Is Sb	0.0368	(2; 0.6%)
Is Fm Sb	0.000998	(2; 0.29%)	Nf Sb	0.000964	(1; 0.33%)	Wt Sb	0.0362	(1; 0.59%)
Sp Is Sb	0.000937	(2; 0.27%)	St Sb	0.000952	(1; 0.32%)	Sc Cg Pt Sb	0.0354	(3; 0.58%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Sb	0.208	(0; 71.%)	Sb	0.106	(0; 57.%)	Sb	0.00963	(0; 6.4%)
Oe Sb	0.0148	(1; 5.%)	Oe Sb	0.00756	(1; 4.%)	Wo Tx Tp Sb	0.0092	(3; 6.2%)
Is Sb	0.00585	(1; 2.%)	Wt Sb	0.00649	(1; 3.5%)	Wo Tx Sb	0.00822	(2; 5.5%)
Fm Sb	0.00525	(1; 1.8%)	Fm Sb	0.00425	(1; 2.3%)	Bc Mp Ho Sb	0.00397	(3; 2.7%)
Ma Sb	0.00511	(1; 1.7%)	Is Sb	0.00424	(1; 2.3%)	Sw Wp Sb	0.00349	(2; 2.3%)
Pt Sb	0.00429	(1; 1.5%)	Ma Sb	0.00267	(1; 1.4%)	Bc Mp Rt Sb	0.00321	(3; 2.2%)
Wp Sb	0.00238	(1; 0.81%)	Wp Sb	0.00228	(1; 1.2%)	Sw Ti Wp Sb	0.00311	(3; 2.1%)
Eq Sb	0.00224	(1; 0.76%)	Eq Sb	0.00166	(1; 0.88%)	Wo Tx Wt Sb	0.0023	(3; 1.5%)
Wt Sb	0.00209	(1; 0.71%)	Pt Sb	0.00102	(1; 0.54%)	Wo Tx Oe Sb	0.00229	(3; 1.5%)
Nf Sb	0.00167	(1; 0.57%)	Nf Sb	0.00096	(1; 0.51%)	Sw Ti Sb	0.00227	(2; 1.5%)
Ee Sb	0.00132	(1; 0.45%)	Sm Sb	0.000727	(1; 0.39%)	Bc Mp Ch Sb	0.00171	(3; 1.1%)
Sm Sb	0.0009	(1; 0.31%)	Wt Oe Sb	0.000706	(2; 0.38%)	Bc Mp Ch Pt Sb	0.00152	(4; 1.1%)
Ch Sb	0.000501	(1; 0.17%)	Ee Sb	0.000703	(1; 0.37%)	Bc Mp Ho Wt	0.00133	(4; 0.89%)
Pl Oe Sb	0.0005	(2; 0.17%)	Rd Sb	0.000672	(1; 0.36%)	Fm Sb	0.0012	(1; 0.8%)
En Sb	0.000476	(1; 0.16%)	Ms Wt Sb	0.000645	(2; 0.34%)	Bc Mp Ho Oe	0.000947	(4; 0.63%)
Is Fm Sb	0.00047	(2; 0.16%)	Pd Wt Sb	0.00061	(2; 0.32%)	Bc Mp Wt Sb	0.000879	(3; 0.59%)
Ch Pt Sb	0.000444	(2; 0.15%)	In Sb	0.000545	(1; 0.29%)	Bc Ch Sb	0.000859	(2; 0.58%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.148 ±0.019	(±1.6%)
Downstream	0.575 ±0.035	(±6.1%)

# Sector 2803: Railway Equipment (Rw)

*Railway equipment, including repairing and servicing*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicators of greenhouse emissions, water use and land disturbance are 55%, 90%, and 95% below average respectively. The social indicator of employment generation is 50% below average due partly to imports, while income is 25% below average, and government revenue is equal to average. The financial indicator of operating surplus is 60% below average, the export propensity is 25% above average, while import penetration is 20% above average. Expanding rail manufacturing could be important in a strategic sense if future transport options with low embodied energy and greenhouse emissions are required for urban transit and for passengers and freight between cities on the eastern seaboard.

## Sector Description

This sector manufactures and repairs rail locomotives, rolling stock and urban tramcars. There are several major manufacturers in Australia including United Goninan, Downer EDI, and Bombardier Australia. Downer EDI manufactured 200 cars for Sydney's Millennium trains at its manufacturing plants in Cardiff and Bathurst, using specialised components from Germany, Austria, Italy, and France. It supplied locomotives and wagons for the Alice Springs to Darwin railway line and has new orders for the Queensland and Western Australian rail systems. United Goninan runs a diverse set of manufacturing and maintenance activities including iron ore trains in Western Australia, coal and sugar trains in Queensland, and it also supplies light rail vehicles to Hong Kong. Bombardier Australia is currently engaged building 38 new 'fast trains' for Victorian Rail at its Dandenong Factory. The sector's yearly turnover was about \$1.2 billion in 2002 and involved about 30 enterprises. New equipment accounts for 75% of expenditure and maintenance for 25%.

## Place of Industry in the Economy

The railway equipment manufacturing sector ranks 121<sup>st</sup> out of 135 sectors in terms of value adding in the economy, and contributes 0.06% of GDP in this analysis. It is similar in value adding to the unmilled barley and the services to forestry sectors. It is a small employer with a direct requirement of 700 employment years in delivery to final demand complemented by 2 600 employment years in the sector's upstream suppliers, giving a total of 3 000 employment years. In addition, it contributes 1 000 employment years to the delivery of other sectors such as rail freight and rail passenger transport. It has small resource demands with less than one tenth of one percent of national water use, land disturbance, energy use, and greenhouse emissions. In financial terms imports and exports are approximately equal, but this is variable and depends on major contracts.

## Strategic Overview

The integrated overview in the spider diagram reveals better than average outcomes for six of the indicators. Two social indicators of employment and income and two financial indicators of operating surplus and import penetration have below average performance. Higher than average imports, mainly of electrical equipment, motors and control units, reduce environmental indicators such as energy use and greenhouse emissions because physical transactions take place overseas. This in turn reduces the indicators of employment, income and operating surplus. Upstream issues for the sector include the national priorities for rail which will determine industry scale and profitability. Downstream issues focus on the potential advantages for urban and greenhouse emissions of a competitive and well organised rail system with high freight and passenger loadings.



## TBL Account #1

The financial indicator of operating surplus is 60% below average and about one sixth of this is a direct sector effect, with the rest due to a diffuse chain of the sector's suppliers. The social indicator of employment generation is 50% below average. This is due to several factors including the lumpy nature of major equipment orders, the capital intensive nature of the sector, and the imported components of rail machinery which are mostly specialised equipment such as diesel and electric motors, as well as control and monitoring equipment. The environmental indicator of greenhouse emissions is 55% below average due mostly to the imported components of production.

## TBL Accounts #2 and #3

The second TBL account reveals that export propensity is 25% above average, income is 25% below average and water use is 90% below average. The third TBL account reveals that import penetration is 20% above average, government revenue is equal to average and land disturbance is 95% below average. In absolute financial terms, imports and exports are within \$50 million in this analysis. This seems a reasonable way to make the most of domestic design and fabrication skills, while importing specialised components for which Australia will always lack scale, unless there are fundamental shifts of specialised manufacturing in world terms due to resource location.

## Structural Path Analysis and Linkages

The structural pathway for the operating surplus indicator reveals that the direct sector effect is 16% with additional contributions from electrical equipment (6%), wholesale trade (5%), structural metal (5%), iron and steel (5%), electricity production (1%), forwarding and storage (1%), and nuts and bolts (1%).

The sector's stimulus to its upstream suppliers is about 10% greater than the economy wide average with effects on steel pipes and sheets, structural metal, electrical equipment and wholesale trade. The linkages to downstream industries are strong, and require expansion in freight and passenger rail, pipeline transport and cable cars in order to dissipate further expansion in this sector.

## Future Trends in Sector

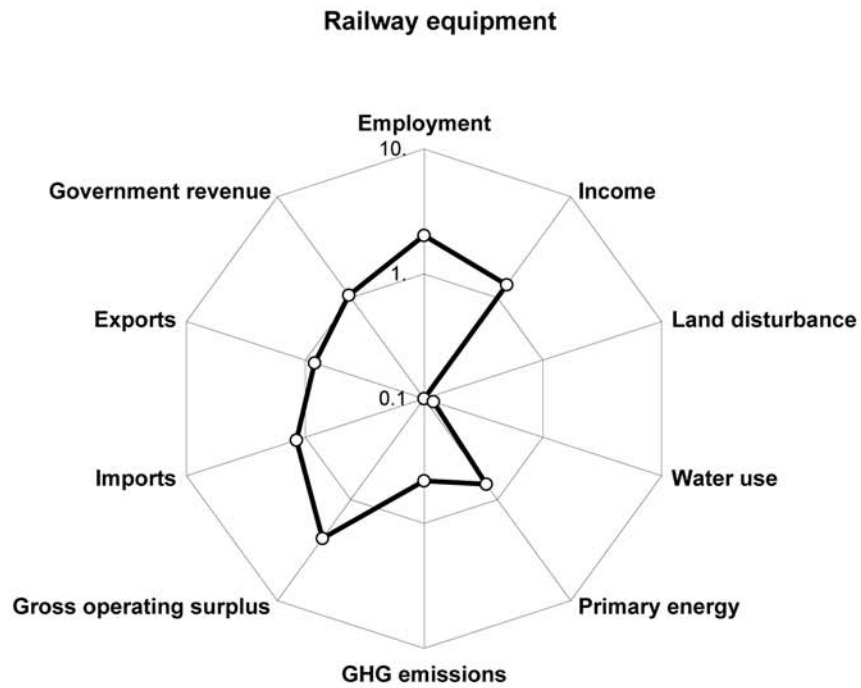
The base case scenario of the *Future Dilemmas* study anticipates that the heavy freight component of rail will increase by 150% for locomotives, and 80% for freight wagons. This is based on steadily expanding markets for Australian minerals, particularly black coal and iron ore. The agricultural component, mainly composed of grains, is more or less stable. These projections are uncertain and rely on steady economic growth in key commodity markets on the Pacific Rim, and continuing market acceptance of black coal for steam and coking applications. Both intercity rail and city rail remain similar to today, and based on the assumption that cars and buses will remain the dominant transport modes. National moves towards a radically different structure and function for capital cities and the possible implementation of a new high speed rail network will obviously change the size of the domestic rail manufacturing task, or require significant increases in imports.

## Innovation and Technical Opportunities

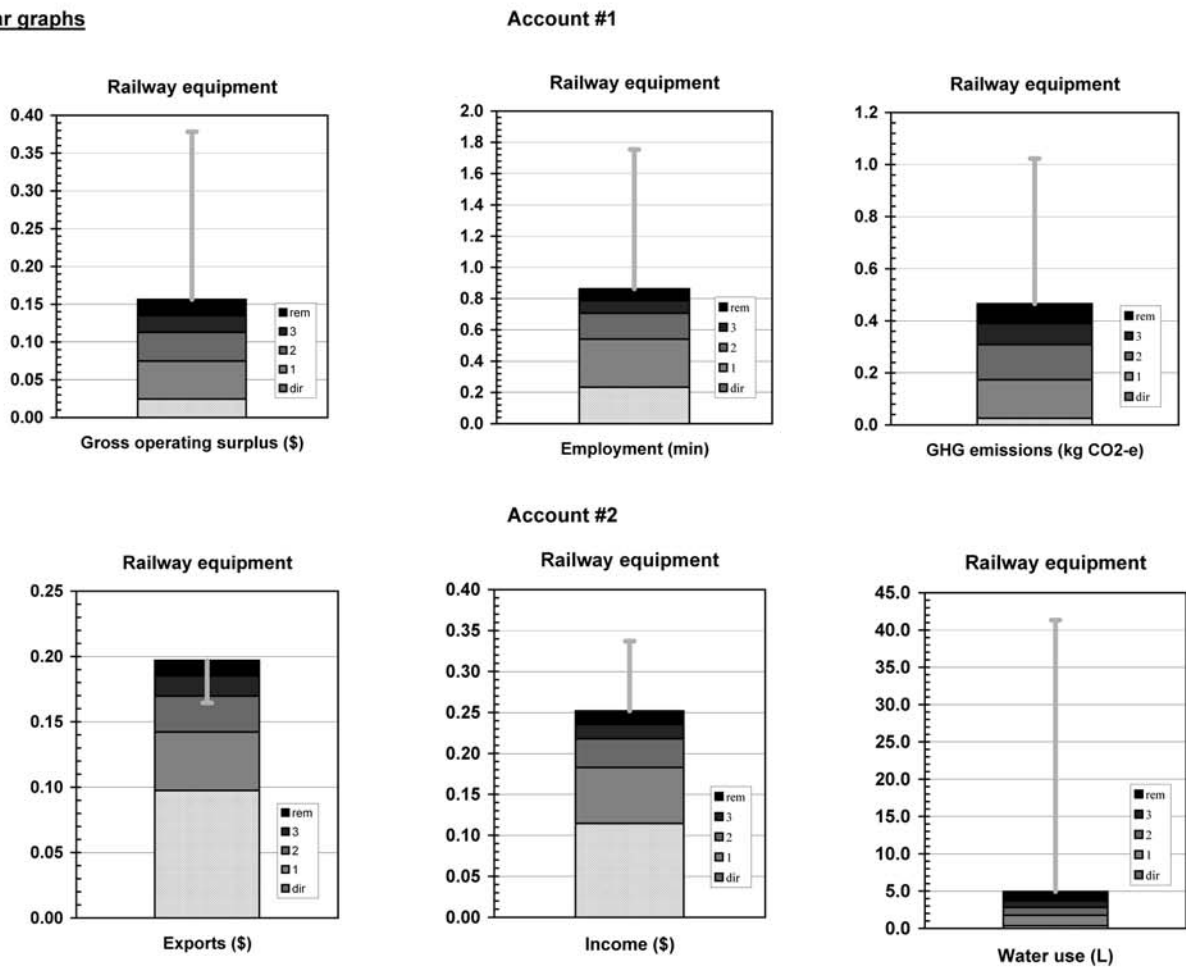
The literature suggests that innovation in railway manufacturing in the future will include the development of highly efficient diesel engines with low nitrous oxide emissions, fuel cell powered locomotives, improved crash resistance and survivability, noise reduction within cities, and the development of train-trams that seamlessly integrate longer haul transportation with street delivery of passengers. At a logistics scale, there is a requirement for seamless interconnectivity between rail passenger or rail freight and complementary modes that supply to, and deliver from, rail. To maximise both time saving and energy saving may require a radical redesign of future rail vehicles.

Railway equipment, incl repairing and servicing

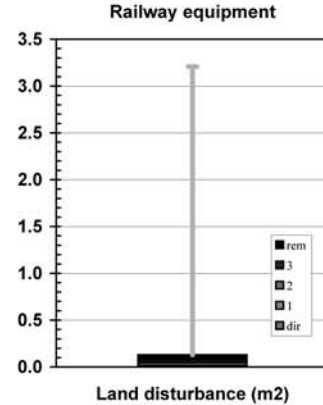
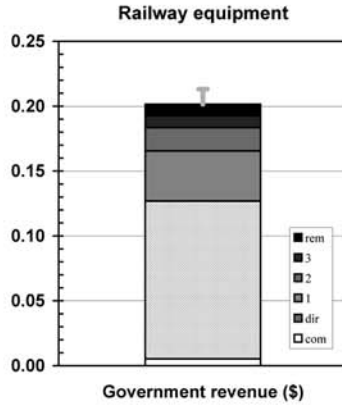
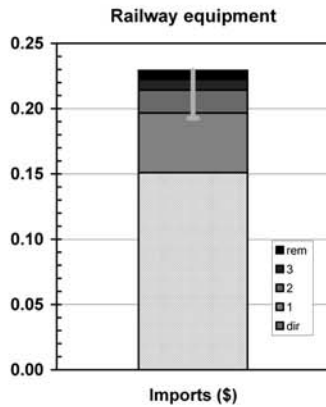
**Spider diagram**



**Bar graphs**



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 1.6	(0.00% of total)	(\$m 1.6 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 327.9	(0.31% of total)	(\$m 276.7 domestically produced)
Net changes in stocks	-\$m 93.1	(-5.27% of total)	
<b>Sectoral GNE</b>	<b>\$m 236.4</b>	<b>(0.05% of GNE)</b>	<b>(\$m 184.9 domestically produced)</b>
Exports	\$m 93.2	(0.11% of total)	(\$m 93.2 domestically produced)
Final demand	\$m 329.6	(0.06% of GNT)	(\$m 278.2 domestically produced)

**Costs: GNT(I) - industries**

Wages and salaries	\$m 109.5	(0.06% of total)
Gross operating surplus	\$m 23.4	(0.01% of total)
Taxes less subsidies	\$m 116.2	(0.14% of total)
<b>Sectoral GDP*</b>	<b>\$m 249.1</b>	<b>(0.06% of GDP)</b>
Imports	\$m 144.3	(0.15% of total)
<b>Primary inputs</b>	<b>\$m 393.5</b>	<b>(0.07% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 23.4	(0.01%)	\$m 9.1 (0.00%)	\$m 58.1 (0.03%)
Exports (\$m)	\$m 93.2	(0.11%)	\$m 36.2 (0.04%)	\$m 73.1 (0.09%)
Imports (\$m)	\$m 144.3	(0.15%)	\$m 56.1 (0.06%)	\$m 85.2 (0.09%)
Employment (e-y)	1,787 e-y	(0.03%)	694 e-y (0.01%)	2,569 e-y (0.04%)
Income (\$m)*	\$m 109.5	(0.06%)	\$m 42.5 (0.02%)	\$m 93.6 (0.05%)
Government revenue (\$m)†	\$m 118.2	(0.11%)	\$m 47.1 (0.04%)	\$m 74.9 (0.07%)
GHG emissions (kt CO <sub>2</sub> -e)	24 kt	(0.00%)	9 kt (0.00%)	173 kt (0.03%)
Water use (ML)	323 ML	(0.00%)	126 ML (0.00%)	1,837 ML (0.01%)
Land disturbance (kha)	1 kha	(0.00%)	0 kha (0.00%)	5 kha (0.00%)
Primary energy (TJ)	440 TJ	(0.01%)	171 TJ (0.00%)	1,996 TJ (0.05%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.02	0.16	0.38
Exports (\$)	0.10	0.20	0.16
Imports (\$)	0.15	0.23	0.19
Employment (min)	0.23	0.86	1.75
Income (\$)	0.11	0.25	0.34
Government revenue (\$)	0.13	0.20	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.03	0.47	1.02
Water use (L)	0.34	4.95	41.32
Land disturbance (m <sup>2</sup> )	0.01	0.13	3.21
Primary energy (MJ)	0.46	5.37	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

### Structural Paths (intensities - commodities)

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Rw	0.0245	(0; 16.%)	Rw	0.233	(0; 27.%)	Is Rw	0.0661	(1; 14.%)
Ee Rw	0.00898	(1; 5.7%)	Sm Rw	0.0725	(1; 8.4%)	El Rw	0.0533	(1; 11.%)
Wt Rw	0.00828	(1; 5.3%)	Wt Rw	0.0596	(1; 6.9%)	Rw	0.0253	(0; 5.4%)
Sm Rw	0.00827	(1; 5.3%)	Ee Rw	0.0557	(1; 6.5%)	Is Sm Rw	0.0236	(2; 5.1%)
Is Rw	0.00765	(1; 4.9%)	Is Rw	0.0183	(1; 2.1%)	El Is Rw	0.00867	(2; 1.9%)
Is Sm Rw	0.00273	(2; 1.7%)	Fm Rw	0.0175	(1; 2.%)	Wt Rw	0.00826	(1; 1.8%)
El Rw	0.00215	(1; 1.4%)	Eq Rw	0.0136	(1; 1.6%)	El Ee Rw	0.00506	(2; 1.1%)
St Wt Rw	0.00158	(2; 1.%)	Fm Sm Rw	0.0111	(2; 1.3%)	El Sm Rw	0.00369	(2; 0.79%)
Fm Rw	0.00158	(1; 1.%)	Is Sm Rw	0.00651	(2; 0.75%)	Ch Ee Rw	0.00347	(2; 0.75%)
Eq Rw	0.00138	(1; 0.88%)	Ts Rw	0.00587	(1; 0.68%)	El Is Sm Rw	0.00309	(3; 0.66%)
Ts Rw	0.0013	(1; 0.83%)	Ms Wt Rw	0.00538	(2; 0.62%)	Nf Ee Rw	0.00288	(2; 0.62%)
Ms Wt Rw	0.0012	(2; 0.77%)	Wt Ee Rw	0.00428	(2; 0.5%)	Is Ee Rw	0.0027	(2; 0.58%)
Fm Sm Rw	0.000995	(2; 0.64%)	En Rw	0.00283	(1; 0.33%)	Sm Rw	0.00264	(1; 0.57%)
Io Is Rw	0.000987	(2; 0.63%)	Wt Sm Rw	0.0027	(2; 0.31%)	Is Fm Rw	0.00255	(2; 0.55%)
Pd Wt Rw	0.00095	(2; 0.61%)	St Wt Rw	0.00258	(2; 0.3%)	Mi Rw	0.00254	(1; 0.54%)
St Rw	0.000892	(1; 0.57%)	El Rw	0.00239	(1; 0.28%)	El Wt Rw	0.00249	(2; 0.53%)
Cm Rw	0.000654	(1; 0.42%)	Mi Rw	0.00232	(1; 0.27%)	Nf Sm Rw	0.00236	(2; 0.51%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Rw	0.0975	(0; 49.%)	Rw	0.114	(0; 45.%)	Sm Rw	0.46	(1; 9.3%)
Ee Rw	0.00897	(1; 4.6%)	Wt Rw	0.0128	(1; 5.1%)	Rw	0.338	(0; 6.8%)
Wt Rw	0.00677	(1; 3.4%)	Sm Rw	0.0125	(1; 5.%)	El Rw	0.295	(1; 6.%)
Is Rw	0.00585	(1; 3.%)	Ee Rw	0.0107	(1; 4.2%)	Is Rw	0.175	(1; 3.5%)
Sm Rw	0.00256	(1; 1.3%)	Is Rw	0.00436	(1; 1.7%)	Wa Rw	0.149	(1; 3.%)
Eq Rw	0.00243	(1; 1.2%)	Fm Rw	0.00275	(1; 1.1%)	Ee Rw	0.117	(1; 2.4%)
Nf Ee Rw	0.00211	(2; 1.1%)	Eq Rw	0.0024	(1; 0.95%)	Is Sm Rw	0.0625	(2; 1.3%)
Is Sm Rw	0.00209	(2; 1.1%)	Fm Sm Rw	0.00173	(2; 0.69%)	El Is Rw	0.0479	(2; 0.97%)
Nf Sm Rw	0.00172	(2; 0.88%)	Is Sm Rw	0.00155	(2; 0.62%)	Mi Rw	0.0427	(1; 0.86%)
Io Is Rw	0.00159	(2; 0.81%)	Ts Rw	0.00137	(1; 0.55%)	Wo Tx Rw	0.0376	(2; 0.76%)
Nf Rw	0.00157	(1; 0.8%)	Ms Wt Rw	0.00125	(2; 0.5%)	Sc Cg Ee Rw	0.0338	(3; 0.68%)
En Rw	0.00151	(1; 0.77%)	Wt Ee Rw	0.000919	(2; 0.36%)	Wt Rw	0.0334	(1; 0.67%)
Fm Rw	0.000904	(1; 0.46%)	Pd Wt Rw	0.000857	(2; 0.34%)	Wa Ms Wt Rw	0.0309	(3; 0.62%)
Al Ee Rw	0.000728	(2; 0.37%)	En Rw	0.000714	(1; 0.28%)	Wa Is Rw	0.0298	(2; 0.6%)
Fm Sm Rw	0.00057	(2; 0.29%)	St Wt Rw	0.000658	(2; 0.26%)	El Ee Rw	0.028	(2; 0.57%)
Io Is Sm Rw	0.000567	(3; 0.29%)	El Rw	0.000648	(1; 0.26%)	Wa Pd Wt Rw	0.026	(3; 0.53%)
Bl El Rw	0.000521	(2; 0.26%)	Wt Sm Rw	0.00058	(2; 0.23%)	Wa Sm Rw	0.0249	(2; 0.5%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Rw	0.151	(0; 66.%)	Rw	0.122	(0; 62.%)	Wo Tx Rw	0.0279	(2; 22.%)
Ee Rw	0.00876	(1; 3.8%)	Wt Rw	0.00598	(1; 3.%)	Rw	0.0086	(0; 6.7%)
Sm Rw	0.00594	(1; 2.6%)	Sm Rw	0.00479	(1; 2.4%)	Bc Mp Ho Rw	0.00278	(3; 2.2%)
Is Rw	0.00276	(1; 1.2%)	Ee Rw	0.00467	(1; 2.4%)	Wo Tx Tp Rw	0.00249	(3; 1.9%)
Wt Rw	0.00192	(1; 0.84%)	Is Rw	0.002	(1; 1.%)	Wo Tx Wt Rw	0.00212	(3; 1.6%)
En Rw	0.00175	(1; 0.76%)	Eq Rw	0.00119	(1; 0.61%)	Sm Rw	0.00183	(1; 1.4%)
Eq Rw	0.0016	(1; 0.7%)	Fm Rw	0.00096	(1; 0.49%)	Wo Tx Sm Rw	0.00163	(3; 1.3%)
Fm Rw	0.00119	(1; 0.52%)	Is Sm Rw	0.000713	(2; 0.36%)	Bc Mp Ch Ee	0.00138	(4; 1.1%)
Is Sm Rw	0.000983	(2; 0.43%)	Ts Rw	0.000677	(1; 0.35%)	Bc Mp Ho Wt	0.00123	(4; 0.95%)
Fm Sm Rw	0.000749	(2; 0.33%)	Fm Sm Rw	0.000605	(2; 0.31%)	Wo Tx Fu Sm	0.00109	(4; 0.84%)
Ru Rw	0.00041	(1; 0.18%)	Ms Wt Rw	0.000594	(2; 0.3%)	Bc Mp Ho Sm	0.00108	(4; 0.84%)
Ch Ee Rw	0.000404	(2; 0.18%)	Pd Wt Rw	0.000562	(2; 0.29%)	El Rw	0.00086	(1; 0.67%)
Ts Rw	0.000374	(1; 0.16%)	En Rw	0.000435	(1; 0.22%)	Bc Mp Wt Rw	0.000809	(3; 0.63%)
Pt Rw	0.000326	(1; 0.14%)	Wt Ee Rw	0.00043	(2; 0.22%)	Bc Mp Ch Rw	0.000747	(3; 0.58%)
Ms Wt Rw	0.000273	(2; 0.12%)	El Rw	0.000404	(1; 0.21%)	Bc Ch Ee Rw	0.000694	(3; 0.54%)
Fo Rw	0.000271	(1; 0.12%)	St Wt Rw	0.000351	(2; 0.18%)	Bc Mp Rt Wt F	0.000627	(4; 0.49%)
Ma Rw	0.000269	(1; 0.12%)	Wt Sm Rw	0.000271	(2; 0.14%)	Ee Rw	0.000602	(1; 0.47%)

### Linkages (average = 1)

	Value	C.o.V.
Upstream	1.011 ±0.020	(±2.0%)
Downstream	1.445 ±0.032	(±2.2%)

# Sector 2804: Aircraft (Ai)

*Aircraft, including repairing and servicing*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicators of greenhouse emissions, water use and land disturbance are 75%, 90% and 95% below average respectively. Employment generation is 65% below average, income is 15% below average, while government revenue is equal to average. The financial indicators show that the operating surplus is 80% below average and both export propensity and import penetration are about twice the economy wide average. The dominance of the industry by a small number of multinational companies means that most of the sector's activity takes place offshore, giving financial and social outcomes that are below average but above average environmental outcomes. By developing advanced capability in ceramics, composites, and metal alloys on the back of natural resource endowments, Australia could be well placed to participate in the global manufacturing chain for both civil and defence aircraft.

## Sector Description

The aircraft manufacturing sector developed its capability during the second world war, and has changed from a manufacturer of whole aircraft to manufacturing parts for civil and defence aircraft (through offsets, and memoranda of understanding) as well as servicing and repairing both engines and airframes. Companies are generally overseas owned and include Boeing, British Aerospace, Hawker Pacific, and Tenix. The current turnover is around \$3 billion per year, involving around 250 enterprises and split between new aircraft purchases (60%) and servicing and repairs (40%). Purchases are lumpy and large, with new civil aircraft costing around \$300 million each, and defence purchases such as the Global Hawk unmanned surveillance aircraft costing \$1 billion. Australia intends to invest \$300 million in the US for the development of the Joint Strike Fighter on the understanding that local firms will win contracts in the design and manufacturing phase.

## Place of Industry in the Economy

The aircraft sector ranks 90<sup>th</sup> out of 135 sectors in terms of value adding in the economy and contributes 0.13% of GDP in this analysis. It is similar in value adding to the soft drinks and cordials and household appliance manufacturing sectors. It is a relatively small employer with a direct requirement of 1 000 employment years and another 1 000 in its upstream suppliers giving a total of 2 000 employment years. It also contributes 3 000 employment years to the final demand of other industries such as air transport and defence. It has small resource requirements with less than one tenth of one percent of national water use, land disturbance, energy use and greenhouse emissions. Imports are currently three times the size of exports and this is highly variable depending on purchases by airlines and defence, and the size of aircraft offset manufacturing within Australia.

## Strategic Overview

The integrated overview in the spider diagram reveals a TBL account with a number of extended outliers for the social indicators of employment generation and income, and the financial indicators of import penetration and operating surplus. The better than average outcomes for the environmental indicators reflect the high levels of imports where most manufacturing activities are conducted overseas, usually with materials that have high contents of energy and greenhouse emissions. The high import penetration is also responsible for lower than average employment, income and operating surplus indicators. Given the capital and skill intensity required for aircraft manufacture, Australia's small scale may restrict it to servicing and component manufacture.

## TBL Account #1

The financial indicator of operating surplus is 80% below average and one quarter of this is a direct sector effect. The social indicator of employment generation is 65% below average due mainly to the dominance of imported planes. The environmental indicator of greenhouse emissions is 75% below average and most of this is due to suppliers rather than fuel combustion in manufacturing activities. This first account reveals financial and social issues that are difficult to solve in a globalised aircraft industry, dominated by several large conglomerates and fierce competition.

## TBL Accounts #2 and #3

The second TBL account reveals an export propensity that is twice the economy wide average and due to component manufactures and some exports of aircraft servicing. The income indicator is 15% below average, which combines with a low employment generator (above) a result of the high level of imports. The environmental indicator of water use is well below average. The third TBL account reveals that import penetration is more than twice the average, government revenue is equal to average and land disturbance is 95% below average. The import indicator may defy substantial improvement due to the dominance of globalised prime aircraft manufacturers in the US and Europe.

## Structural Path Analysis and Linkages

The structural path analysis of the operating surplus indicator reveals that the direct sector effect is 25% of the total with further contributions from electricity (6%), wholesale trade (5%), paints (4%), nuts and bolts (4%), sheet metal (4%), technical services (4%) and communications (2%). Thus eight supplying sectors account for only one half of the surplus. In common with other complex manufacturing sectors, improving the operating surplus will be difficult. It will require action within many supplying companies in a complicated and diverse supply chain that possibly lacks scale.

The sector's stimulus to its upstream suppliers is 70% below average due to the import of whole aircraft and components that are manufactured abroad but this is balanced by some local offset manufacturing. There is some effect on sheet metal products, fabricated metal parts and wholesale trade. The linkages to downstream industries are stronger than average suggesting that the sector's expansion needs to be led by expansion in the air transport and defence industries.

## Future Trends in Sector

Industry forecasts by the European manufacturer Airbus anticipate that worldwide growth in passenger kilometres will average 4.7% annually out to 2020, giving two and one half times the current activity level by that time. They also anticipate that air freight transport will grow at 5.5% annually, giving a tripling by 2020. The base case scenario of the *Future Dilemmas* report anticipated that domestic and international air travel would triple driven by strong international inbound tourism. These futures are uncertain as recent terrorism, economic and disease shocks have shown. Depending on the nature and intensity of defence concerns out to 2050, this sector will maintain its purchases and maintenance activity. The Australian contribution to this anticipated growth in activity will have to build on a national capability in advanced materials science, and partnering with a limited number of global giants who have immense strategic and political power.

## Innovation and Technical Opportunities

The literature suggests that expanded expertise in carbon fibre composite materials (plus ceramics, titanium alloys etc.) is essential to maintaining a foothold in the next generation of defence and commercial aircraft. Complex materials give the challenge of matching design, fabrication, and assembly, so that material strength and flexibility are harmonised, and structural integrity is assured.

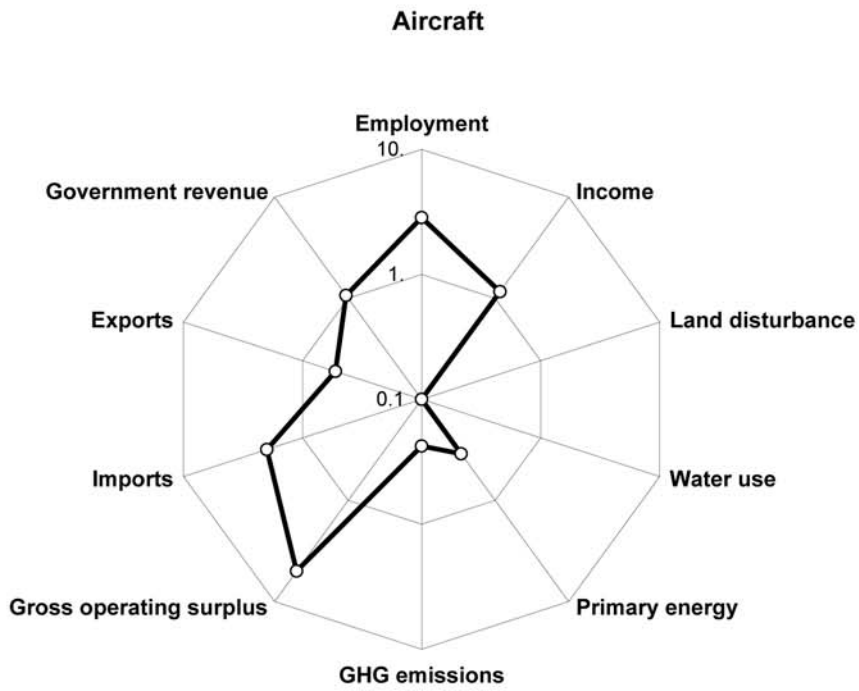
**Sector**

**Aircraft**

**(Ai)**

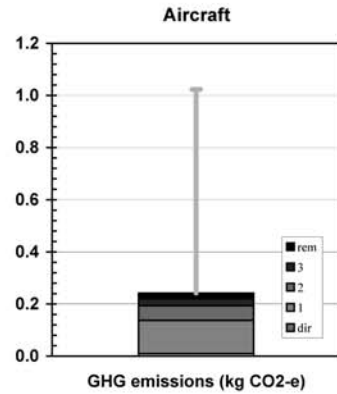
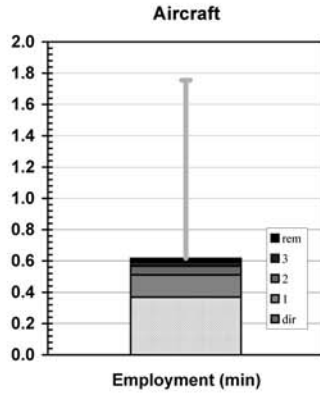
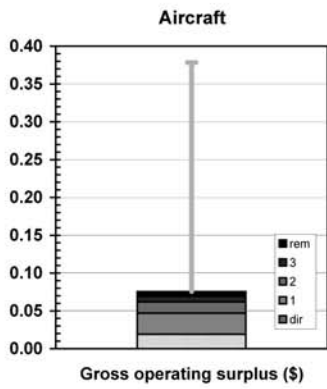
Aircraft, incl repairing and servicing

**Spider diagram**

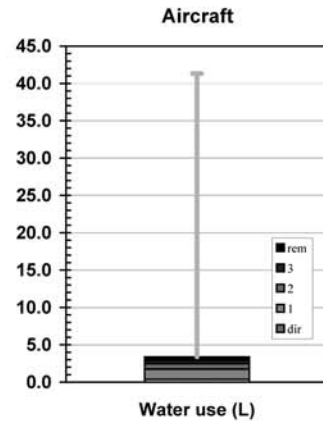
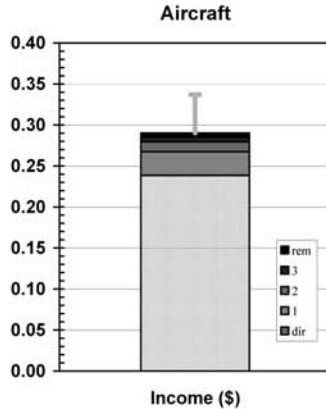
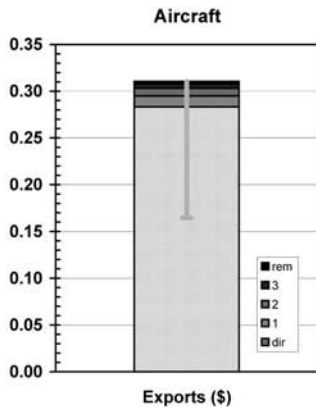


**Bar graphs**

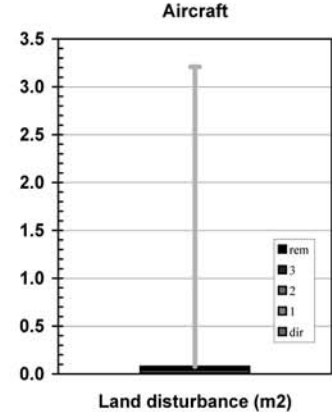
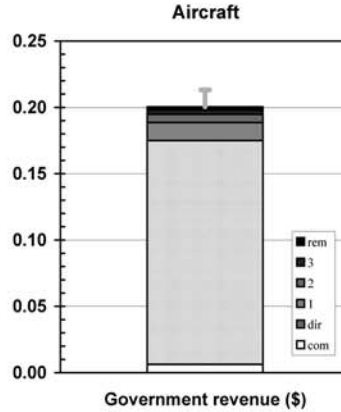
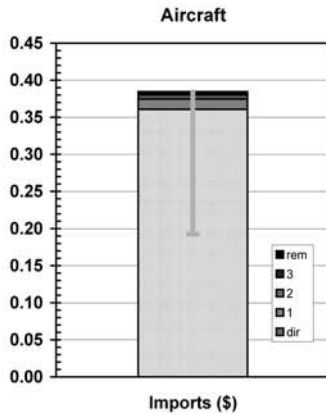
**Account #1**



**Account #2**



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 66.0	(0.02% of total)	(\$m 5.9 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 726.5	(0.69% of total)	(\$m 34.3 domestically produced)
Net changes in stocks	-\$m 64.7	-(3.66% of total)	
<b>Sectoral GNE</b>	<b>\$m 727.8</b>	<b>(0.16% of GNE)</b>	
Exports	\$m 402.0	(0.48% of total)	(\$m 402.0 domestically produced)
<b>Final demand</b>	<b>\$m 1,129.9</b>	<b>(0.21% of GNT)</b>	<b>(\$m 375.6 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 338.3	(0.20% of total)
Gross operating surplus	\$m 27.0	(0.01% of total)
Taxes less subsidies	\$m 239.6	(0.28% of total)
<b>Sectoral GDP*</b>	<b>\$m 604.9</b>	<b>(0.13% of GDP)</b>
Imports	\$m 512.0	(0.52% of total)
<b>Primary inputs</b>	<b>\$m 1,116.9</b>	<b>(0.20% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT		
	(% of national)		direct (% of national)	total (% of national)	
Gross operating surplus (\$m)	\$m 27.0	(0.01%)	\$m 8.4	(0.00%)	\$m 33.4 (0.02%)
Exports (\$m)	\$m 402.0	(0.48%)	\$m 125.2	(0.15%)	\$m 137.4 (0.16%)
Imports (\$m)	\$m 512.0	(0.52%)	\$m 159.5	(0.16%)	\$m 170.0 (0.17%)
Employment (e-y)	4,185 e-y	(0.06%)	1,303 e-y	(0.02%)	2,186 e-y (0.03%)
Income (\$m)*	\$m 338.3	(0.20%)	\$m 105.4	(0.06%)	\$m 128.3 (0.08%)
Government revenue (\$m)†	\$m 242.3	(0.22%)	\$m 77.4	(0.07%)	\$m 88.7 (0.08%)
GHG emissions (kt CO <sub>2</sub> -e)	13 kt	(0.00%)	4 kt	(0.00%)	107 kt (0.02%)
Water use (ML)	507 ML	(0.00%)	158 ML	(0.00%)	1,498 ML (0.01%)
Land disturbance (kha)	1 kha	(0.00%)	0 kha	(0.00%)	4 kha (0.00%)
Primary energy (TJ)	243 TJ	(0.01%)	76 TJ	(0.00%)	1,169 TJ (0.03%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.02	0.08	0.38
Exports (\$)	0.28	0.31	0.16
Imports (\$)	0.36	0.38	0.19
Employment (min)	0.37	0.62	1.75
Income (\$)	0.24	0.29	0.34
Government revenue (\$)	0.17	0.20	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.01	0.24	1.02
Water use (L)	0.36	3.39	41.32
Land disturbance (m <sup>2</sup> )	0.00	0.08	3.21
Primary energy (MJ)	0.17	2.64	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks



**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Ai	0.019	(0; 25.%)	Ai	0.368	(0; 60.%)	El Ai	0.103	(1; 43.%)
El Ai	0.00416	(1; 5.5%)	Fm Ai	0.0318	(1; 5.2%)	Ai	0.00892	(0; 3.7%)
Wt Ai	0.00378	(1; 5.%)	Wt Ai	0.0272	(1; 4.4%)	Is Sh Ai	0.00765	(2; 3.2%)
Pt Ai	0.00298	(1; 3.9%)	Sh Ai	0.0157	(1; 2.5%)	Gd Ai	0.00472	(1; 2.%)
Fm Ai	0.00286	(1; 3.8%)	Ts Ai	0.0117	(1; 1.9%)	Is Ai	0.00466	(1; 1.9%)
Sh Ai	0.00263	(1; 3.5%)	Bs Ai	0.00735	(1; 1.2%)	Is Fm Ai	0.00462	(2; 1.9%)
Ts Ai	0.0026	(1; 3.4%)	Pt Ai	0.006	(1; 0.97%)	Wt Ai	0.00377	(1; 1.6%)
Cm Ai	0.00156	(1; 2.1%)	El Ai	0.00463	(1; 0.75%)	Ch Pt Ai	0.0029	(2; 1.2%)
Is Sh Ai	0.000886	(2; 1.2%)	Cm Ai	0.00431	(1; 0.7%)	Bl El Ai	0.0026	(2; 1.1%)
Bs Ai	0.000745	(1; 0.99%)	Ms Ai	0.00317	(1; 0.51%)	El Fm Ai	0.00242	(2; 1.%)
Wa Ai	0.000742	(1; 0.98%)	Ps Ai	0.00276	(1; 0.45%)	At Ai	0.00188	(1; 0.78%)
St Wt Ai	0.00072	(2; 0.95%)	Ms Wt Ai	0.00245	(2; 0.4%)	El Sh Ai	0.00159	(2; 0.66%)
Ms Ai	0.000706	(1; 0.93%)	Ee Ai	0.0024	(1; 0.39%)	Mi Ai	0.00142	(1; 0.59%)
Bl El Ai	0.000664	(2; 0.88%)	Is Sh Ai	0.00211	(2; 0.34%)	Ch Ai	0.00136	(1; 0.56%)
St Ai	0.000609	(1; 0.81%)	Pr Ai	0.00193	(1; 0.31%)	Sh Ai	0.00114	(1; 0.47%)
Ms Wt Ai	0.000547	(2; 0.72%)	Gd Ai	0.00187	(1; 0.3%)	El Wt Ai	0.00113	(2; 0.47%)
Is Ai	0.000539	(1; 0.71%)	Bk Ai	0.00171	(1; 0.28%)	Fm Ai	0.00113	(1; 0.47%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Ai	0.283	(0; 91.%)	Ai	0.238	(0; 82.%)	El Ai	0.569	(1; 17.%)
Wt Ai	0.00309	(1; 0.99%)	Wt Ai	0.00584	(1; 2.%)	Wa Ai	0.545	(1; 16.%)
Fm Ai	0.00164	(1; 0.53%)	Fm Ai	0.00498	(1; 1.7%)	Ai	0.357	(0; 11.%)
Bl El Ai	0.00101	(2; 0.32%)	Sh Ai	0.00311	(1; 1.1%)	Dc Dp Ai	0.202	(2; 6.%)
Is Sh Ai	0.000677	(2; 0.22%)	Ts Ai	0.00274	(1; 0.94%)	Ws Ai	0.0459	(1; 1.4%)
Nf Sh Ai	0.000641	(2; 0.21%)	Pt Ai	0.0014	(1; 0.48%)	Fm Ai	0.0439	(1; 1.3%)
Sh Ai	0.000633	(1; 0.2%)	El Ai	0.00125	(1; 0.43%)	Sh Ai	0.0357	(1; 1.1%)
At Ai	0.000599	(1; 0.19%)	Cm Ai	0.000979	(1; 0.34%)	Wa Ts Ai	0.035	(2; 1.%)
Pt Ai	0.000492	(1; 0.16%)	Bs Ai	0.000902	(1; 0.31%)	Wa El Ai	0.0329	(2; 0.97%)
Oe Ai	0.000461	(1; 0.15%)	Ms Ai	0.000736	(1; 0.25%)	Sc Cg Pt Ai	0.0269	(3; 0.8%)
Nf Fm Ai	0.000419	(2; 0.14%)	Ms Wt Ai	0.000571	(2; 0.2%)	Wo Tx Ai	0.0255	(2; 0.75%)
Ts Ai	0.000412	(1; 0.13%)	Gd Ai	0.000523	(1; 0.18%)	Mi Ai	0.0238	(1; 0.7%)
Is Ai	0.000412	(1; 0.13%)	Is Sh Ai	0.000504	(2; 0.17%)	Wa Bs Ai	0.0225	(2; 0.66%)
Is Fm Ai	0.000409	(2; 0.13%)	Ee Ai	0.000461	(1; 0.16%)	Bc Mp Ai	0.0224	(2; 0.66%)
Ee Ai	0.000387	(1; 0.12%)	Bk Ai	0.000423	(1; 0.15%)	Is Sh Ai	0.0203	(2; 0.6%)
Ch Pt Ai	0.000338	(2; 0.11%)	Pd Wt Ai	0.000391	(2; 0.13%)	Wa Ms Ai	0.0182	(2; 0.54%)
Nf Ai	0.000329	(1; 0.11%)	Pr Ai	0.000387	(1; 0.13%)	Pt Ai	0.0172	(1; 0.51%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Ai	0.361	(0; 94.%)	Ai	0.169	(0; 87.%)	Wo Tx Ai	0.019	(2; 24.%)
Pt Ai	0.00326	(1; 0.85%)	Wt Ai	0.00273	(1; 1.4%)	Bc Mp Ai	0.00618	(2; 7.8%)
Fm Ai	0.00215	(1; 0.56%)	Fm Ai	0.00174	(1; 0.89%)	Ai	0.00437	(0; 5.5%)
Sh Ai	0.00182	(1; 0.47%)	Sh Ai	0.00137	(1; 0.71%)	Wo Tx Tp Ai	0.00214	(3; 2.7%)
Wt Ai	0.000877	(1; 0.23%)	Ts Ai	0.00135	(1; 0.69%)	El Ai	0.00166	(1; 2.1%)
Ts Ai	0.000745	(1; 0.19%)	El Ai	0.000781	(1; 0.4%)	Wo Tx Cl Ai	0.00147	(3; 1.8%)
Ee Ai	0.000378	(1; 0.098%)	Pt Ai	0.000773	(1; 0.4%)	Bc Mp Ch Pt /	0.00115	(4; 1.5%)
En Ai	0.000353	(1; 0.092%)	Cm Ai	0.000468	(1; 0.24%)	Dc Dp Ai	0.00105	(2; 1.3%)
Pr Ai	0.000345	(1; 0.09%)	Ms Ai	0.00035	(1; 0.18%)	Wo Tx Wt Ai	0.000968	(3; 1.2%)
Ch Pt Ai	0.000338	(2; 0.088%)	Ms Wt Ai	0.000271	(2; 0.14%)	Ba Bm Ai	0.000958	(2; 1.2%)
Is Sh Ai	0.000319	(2; 0.083%)	At Ai	0.000268	(1; 0.14%)	Bc Mp Ho Ai	0.000883	(3; 1.1%)
El Ai	0.000289	(1; 0.075%)	Bs Ai	0.000267	(1; 0.14%)	Wo Mp Ai	0.000697	(2; 0.88%)
Oe Ai	0.000282	(1; 0.073%)	Pd Wt Ai	0.000256	(2; 0.13%)	Bc Ch Pt Ai	0.00058	(3; 0.73%)
Cm Ai	0.000267	(1; 0.069%)	Gd Ai	0.000242	(1; 0.12%)	Bc Mp Ho Wt .	0.000559	(4; 0.7%)
Is Ai	0.000194	(1; 0.051%)	Bk Ai	0.000234	(1; 0.12%)	Bc Mp Ch Ai	0.000542	(3; 0.68%)
Is Fm Ai	0.000193	(2; 0.05%)	Is Sh Ai	0.000231	(2; 0.12%)	Fm Ai	0.000491	(1; 0.62%)
At Ai	0.000179	(1; 0.046%)	Ee Ai	0.000202	(1; 0.1%)	Sh Ai	0.000481	(1; 0.6%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	0.342 ±0.005	(±1.5%)
Downstream	1.370 ±0.056	(±4.1%)

# Sector 2805: Scientific Equipment (Oe)

*Cameras, projectors, optical fibres and cables, glasses and contact lenses, surgical and medical equipment, surveying, physical and chemical analysis, radio and radar equipment, navigational aids, remote control equipment, scientific equipment*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicators of greenhouse emissions, water use and land disturbance are 50%, 85% and 95% below average which is an excellent outcome. The social indicators reveal that employment generation is 15% below average, income is equal to average, and government revenue is nearly three times the average. The financial indicators show that operating surplus is 40% below average, export propensity is nearly three times the average and import penetration is 35% above average. Australia has several leading edge companies that export most of their production. However imports are growing faster than exports. This has led to an industry response to compete with imports and to develop key export niches.

## Sector Description

This sector includes the manufacture of photographic and optical goods, medical and surgical equipment and scientific instruments. There are many success stories that leverage off domestic scientific leadership in areas of medicine and laboratory analysis. In 1978, GBC Scientific Equipment commenced manufacturing mass spectrometers and other laboratory equipment, and now export 90% of their production to 80 countries. SSH Medical manufactures advanced equipment for the internal examination of humans and animals. Vision Systems Limited has yearly sales of about \$140 million, 85% of which are exports, with product expertise in fire control, video surveillance and medical pathology equipment. The sector relies heavily on fully imported equipment as well as basic components for assembly and fabrication into final equipment. Financial turnover of the sector was around \$5 billion in 2002 and involved over 1 000 enterprises.

## Place of Industry in the Economy

The scientific equipment sector ranks 88<sup>th</sup> out of 135 sectors in terms of value adding in the Australian economy and contributes 0.14% of GDP in this analysis. It is similar in value adding to the bricks and ceramics and the soft drinks and cordial sectors. In meeting final demand, this sector is a moderate sized employer with a direct requirement of 6 000 employment years, and with a further 5 000 years in the sector's upstream suppliers, giving a total of 11 000 employment years. In addition, it contributes 5 000 employment years in meeting the final demand of other downstream industries such as ship building, defence and health services. It has relatively low resource requirements with less than one tenth of one percent of national water use and land disturbance, and less than two tenths of one percent of energy use and greenhouse emissions. In financial terms, imports are currently three times greater than exports.

## Strategic Overview

The integrated overview depicted in the spider diagram reveals a reasonably good TBL account with two outliers for the financial indicators of import penetration and operating surplus. The environmental indicators are advantaged by a high level of imports, as a range of materially intense operations for complex components are done overseas. The social indicators are average or better implying that the intellectual sophistication of the scientific equipment sector generates positive social returns in value adding rather than simple assembly. An industry strategy plans to connect and synergise local expertise to compete better with imports and develop niche markets for exports.

## TBL Account #1

The financial indicator of operating surplus is 40% below the economy wide average, the social indicator of employment generation is 15% below average, and the environmental indicator of greenhouse emissions is 50% below average. The greenhouse indicator chain is interesting to examine. The direct effect of energy combusted within the sector is 6% while the indirect effects include steel pipes and plates (10%), electricity generation (9%), basic chemicals (5%), copper products (4%), 'chemicals-plastics-scientific equipment' (3%), wholesale trade (2%), 'electricity-aluminium-scientific equipment' (2%) and garbage disposal (2%).

## TBL Accounts #2 and #3

The second TBL account reveals an export propensity that is nearly three times the average and three quarters of which is a direct effect of the exports of finished equipment. The remaining quarter is due to the indirect effect of exports of components and services. The social indicator of income is equal to average and two thirds of this is a direct within sector effect. The environmental indicator of water use is 85% below average. The third TBL account reveals that import penetration is 35% above average, the government revenue is nearly three times the average and that land disturbance is 95% below average.

## Structural Path Analysis and Linkages

The structural path analysis of the operating surplus indicator reveals that one third of it is a direct within sector effect and the rest is due to an extended chain that includes wholesale trade (6%), steels tubes and plates (3%), plastics (3%), scientific services (3%), copper products (2%), electrical equipment (2%) and road transport (1%). Many sectors in this area of the economy suggest that combinations of high import penetration and diffuse production chains may constrain profits, and thus improving the indicator must involve action on a diverse number of fronts. Improving the import penetration indicator provides a simpler target because three quarters is due to equipment imports rather than components. By comparison, components such as plastics (3%), electronic and electrical equipment (2%), wholesale trade (1%) and basic chemicals (1%) are a relatively small part of the import challenge.

## Future Trends in Sector

While the *Future Dilemmas* study does not model the detail of this sector, there are a number of obvious drivers that suggest parts of the sector will continue to grow. As medical technology becomes more pervasive and as Australia ages from 13% over the age of 65 now, to 28% by 2060, it can be expected that medical instrumentation will increase in application range and sophistication. While medical complications of the young will stabilise or may even decrease, most projections anticipate that diseases of the older ages could increase by up to 50% or even 75%. Similarly, the increasing sophistication of the science-based manufacturing and defence industries will require fine analysis and fabrication with zero defects. It is unlikely that Australian scientific equipment manufacturing can cover all requirements. Therefore strong linkages to key areas of national competitive advantage will help maintain the trade balance of the sector more effectively.

## Innovation and Technical Opportunities

The literature, particularly in advanced chemistry where future processes will involve the precise construction of new molecules, points to high precision control and measurement equipment that is multi-functional, and can couple and uncouple elementary processes. Similarly, cellular and molecular biology points to more complexity and functionality in equipment, with increasing interdependence between biotechnology, infotechnology, nanotechnology and microelectronics. Fisheries science and even sports science require increasingly sophisticated measuring equipment.

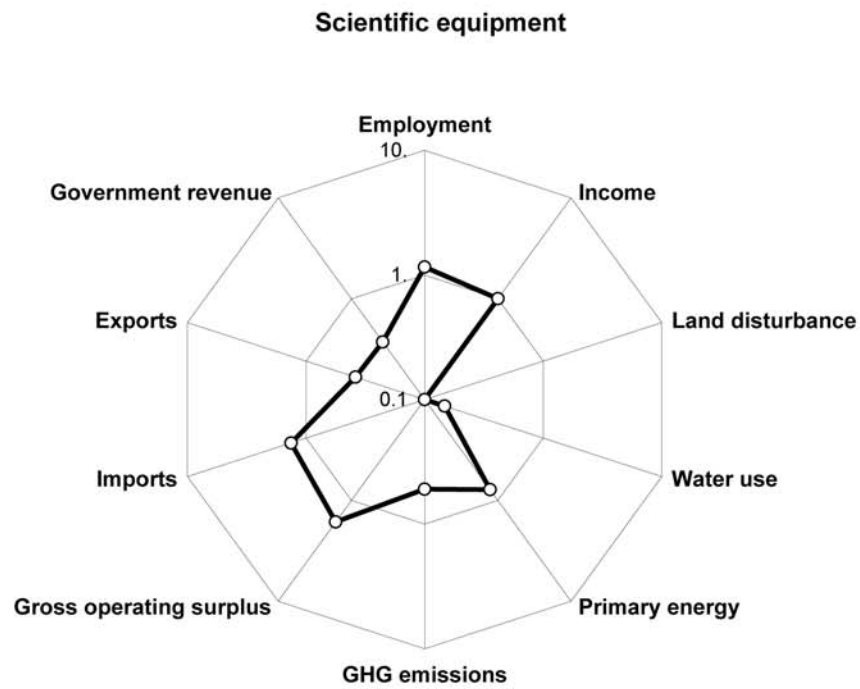
**Sector**

**Scientific equipment**

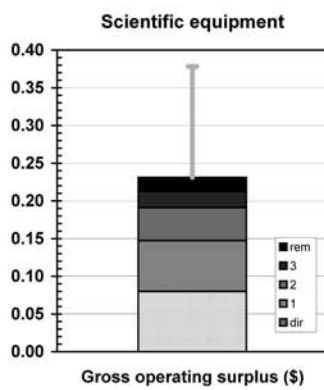
**(Oe)**

Cameras, projectors, optical fibres and cables, glasses and contact lenses, surgical and medical equipment, surveying, physical and chemical analysis, radio and radar equipment, navigational aids, remote control equipment, scientific equipment

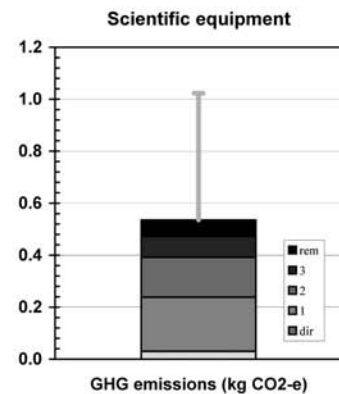
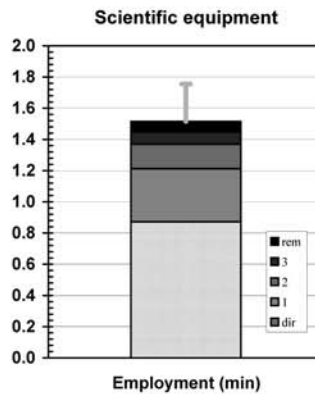
**Spider diagram**



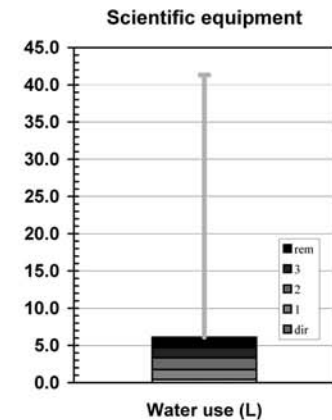
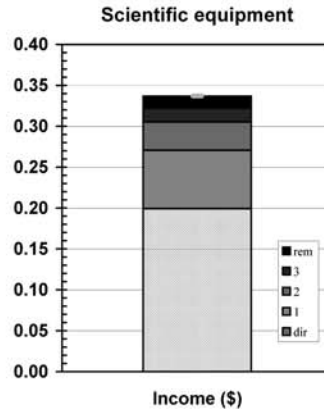
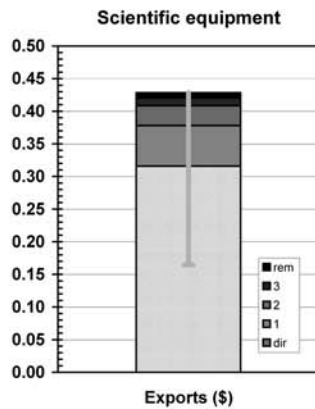
**Bar graphs**



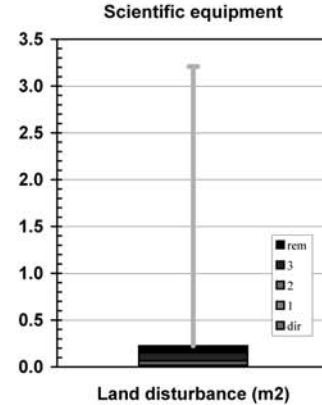
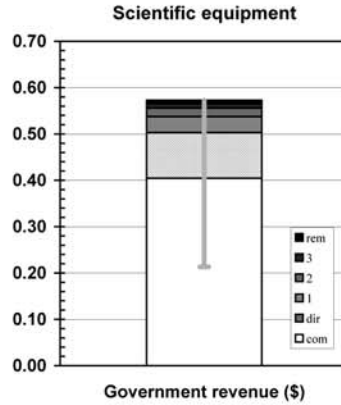
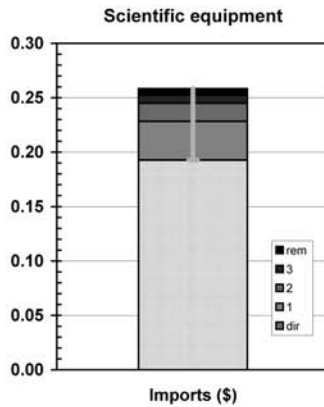
**Account #1**



**Account #2**



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 720.1	(0.27% of total)	(\$m 131.7 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 1,127.8	(1.08% of total)	(\$m 255.5 domestically produced)
Net changes in stocks	\$m 114.3	(6.47% of total)	(\$m 31.7 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 1,962.2</b>	<b>(0.43% of GNE)</b>	<b>(\$m 418.9 domestically produced)</b>
Exports	\$m 526.2	(0.63% of total)	(\$m 526.2 domestically produced)
Final demand	\$m 2,488.4	(0.46% of GNT)	(\$m 945.0 domestically produced)

**Costs: GNT(I) - industries**

Wages and salaries	\$m 332.0	(0.19% of total)
Gross operating surplus	\$m 133.2	(0.07% of total)
Taxes less subsidies	\$m 164.3	(0.19% of total)
<b>Sectoral GDP*</b>	<b>\$m 629.5</b>	<b>(0.14% of GDP)</b>
Imports	\$m 321.2	(0.33% of total)
<b>Primary inputs</b>	<b>\$m 950.8</b>	<b>(0.17% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT		
		(% of national)	direct (% of national)	total (% of national)	
Gross operating surplus (\$m)	\$m 133.2	(0.07%)	\$m 75.5	(0.04%)	\$m 218.5 (0.11%)
Exports (\$m)	\$m 526.2	(0.63%)	\$m 298.3	(0.36%)	\$m 405.1 (0.49%)
Imports (\$m)	\$m 321.2	(0.33%)	\$m 182.1	(0.19%)	\$m 244.2 (0.25%)
Employment (e-y)	11,638 e-y	(0.16%)	6,598 e-y	(0.09%)	11,480 e-y (0.16%)
Income (\$m)*	\$m 332.0	(0.19%)	\$m 188.3	(0.11%)	\$m 318.3 (0.19%)
Government revenue (\$m)†	\$m 546.3	(0.51%)	\$m 475.2	(0.44%)	\$m 541.4 (0.50%)
GHG emissions (kt CO <sub>2</sub> -e)	49 kt	(0.01%)	28 kt	(0.01%)	506 kt (0.10%)
Water use (ML)	714 ML	(0.00%)	405 ML	(0.00%)	5,772 ML (0.03%)
Land disturbance (kha)	2 kha	(0.00%)	1 kha	(0.00%)	21 kha (0.01%)
Primary energy (TJ)	822 TJ	(0.02%)	466 TJ	(0.01%)	5,657 TJ (0.15%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.08	0.23	0.38
Exports (\$)	0.32	0.43	0.16
Imports (\$)	0.19	0.26	0.19
Employment (min)	0.87	1.52	1.75
Income (\$)	0.20	0.34	0.34
Government revenue (\$)	0.50	0.57	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.03	0.54	1.02
Water use (L)	0.43	6.11	41.32
Land disturbance (m <sup>2</sup> )	0.01	0.23	3.21
Primary energy (MJ)	0.49	5.99	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Oe	0.0799	(0; 35.%)	Oe	0.871	(0; 57.%)	Is Oe	0.0551	(1; 10.%)
Wt Oe	0.0127	(1; 5.5%)	Wt Oe	0.0918	(1; 6.1%)	EI Oe	0.0483	(1; 9.%)
Is Oe	0.00638	(1; 2.8%)	PI Oe	0.0339	(1; 2.2%)	Oe	0.0294	(0; 5.5%)
PI Oe	0.00636	(1; 2.8%)	Ts Oe	0.0256	(1; 1.7%)	Ch Oe	0.024	(1; 4.5%)
Ts Oe	0.00569	(1; 2.5%)	Ee Oe	0.0213	(1; 1.4%)	Nf Oe	0.0206	(1; 3.9%)
Nf Oe	0.00449	(1; 1.9%)	Rd Oe	0.0156	(1; 1.%)	Ch PI Oe	0.0142	(2; 2.6%)
Ee Oe	0.00344	(1; 1.5%)	Is Oe	0.0152	(1; 1.%)	Wt Oe	0.0127	(1; 2.4%)
Rd Oe	0.00265	(1; 1.1%)	Bs Oe	0.0118	(1; 0.78%)	EI AI Oe	0.0118	(2; 2.2%)
St Wt Oe	0.00243	(2; 1.1%)	Ms Oe	0.0104	(1; 0.69%)	Gd Oe	0.00894	(1; 1.7%)
Ms Oe	0.00232	(1; 1.%)	Ho Oe	0.00856	(1; 0.56%)	AI Oe	0.00856	(1; 1.6%)
Cm Oe	0.00226	(1; 0.98%)	Ms Wt Oe	0.00829	(2; 0.55%)	EI PI Oe	0.00738	(2; 1.4%)
GI Oe	0.00203	(1; 0.88%)	Os Oe	0.00748	(1; 0.49%)	EI Is Oe	0.00723	(2; 1.4%)
Ch Oe	0.002	(1; 0.87%)	Fm Oe	0.00721	(1; 0.48%)	Mi Oe	0.00463	(1; 0.86%)
EI Oe	0.00195	(1; 0.85%)	Rt Oe	0.00643	(1; 0.42%)	At Oe	0.00428	(1; 0.8%)
Ms Wt Oe	0.00185	(2; 0.8%)	Cm Oe	0.00625	(1; 0.41%)	Rd Oe	0.00421	(1; 0.79%)
Pd Wt Oe	0.00146	(2; 0.63%)	Ch Oe	0.00585	(1; 0.39%)	EI Nf Oe	0.00416	(2; 0.78%)
Bs Oe	0.0012	(1; 0.52%)	En Oe	0.00559	(1; 0.37%)	EI Wt Oe	0.00383	(2; 0.71%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Oe	0.316	(0; 74.%)	Oe	0.199	(0; 59.%)	Oe	0.428	(0; 7.%)
Nf Oe	0.0151	(1; 3.5%)	Wt Oe	0.0197	(1; 5.8%)	Wa Oe	0.273	(1; 4.5%)
Wt Oe	0.0104	(1; 2.4%)	PI Oe	0.00685	(1; 2.%)	EI Oe	0.267	(1; 4.4%)
GI Oe	0.00615	(1; 1.4%)	Ts Oe	0.006	(1; 1.8%)	Is Oe	0.146	(1; 2.4%)
Is Oe	0.00488	(1; 1.1%)	Ee Oe	0.00409	(1; 1.2%)	Nf Oe	0.129	(1; 2.1%)
AI Oe	0.00455	(1; 1.1%)	Is Oe	0.00363	(1; 1.1%)	Vf PI Oe	0.084	(2; 1.4%)
Ee Oe	0.00344	(1; 0.8%)	Rd Oe	0.00268	(1; 0.8%)	Bx Ao AI Oe	0.0808	(3; 1.3%)
En Oe	0.00297	(1; 0.69%)	Ms Oe	0.00242	(1; 0.72%)	Mi Oe	0.0779	(1; 1.3%)
Ch Oe	0.00279	(1; 0.65%)	Os Oe	0.00209	(1; 0.62%)	Wa Ts Oe	0.0767	(2; 1.3%)
GI Nf Oe	0.00274	(2; 0.64%)	Ms Wt Oe	0.00193	(2; 0.57%)	Ch Oe	0.0733	(1; 1.2%)
PI Oe	0.00184	(2; 0.43%)	Bs Oe	0.00145	(1; 0.43%)	EI AI Oe	0.0654	(2; 1.1%)
Uo Nf Oe	0.00167	(2; 0.39%)	Cm Oe	0.00142	(1; 0.42%)	Ws Ho Oe	0.0624	(2; 1.%)
Ch PI Oe	0.00165	(2; 0.38%)	En Oe	0.00141	(1; 0.42%)	Wa Ms Oe	0.0596	(2; 0.98%)
At Oe	0.00136	(1; 0.32%)	Pd Wt Oe	0.00132	(2; 0.39%)	Uo Nf Oe	0.0537	(2; 0.88%)
Io Is Oe	0.00133	(2; 0.31%)	Ho Oe	0.00125	(1; 0.37%)	Wt Oe	0.0514	(1; 0.84%)
Co Nf Oe	0.00112	(2; 0.26%)	Ch Oe	0.00124	(1; 0.37%)	Wa Ms Wt Oe	0.0475	(3; 0.78%)
Rd Oe	0.000922	(1; 0.22%)	Fm Oe	0.00113	(1; 0.34%)	PI Oe	0.046	(1; 0.75%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Oe	0.193	(0; 75.%)	Oe	0.0985	(0; 58.%)	Wo Tx Oe	0.0298	(2; 13.%)
PI Oe	0.00651	(1; 2.5%)	Wt Oe	0.00921	(1; 5.5%)	Bc Mp Ho Oe	0.0123	(3; 5.5%)
En Oe	0.00345	(1; 1.3%)	PI Oe	0.00299	(1; 1.8%)	Wo Tx Tp Oe	0.0108	(3; 4.8%)
Ee Oe	0.00336	(1; 1.3%)	Ts Oe	0.00295	(1; 1.8%)	Oe	0.00996	(0; 4.4%)
Wt Oe	0.00296	(1; 1.1%)	Rd Oe	0.0019	(1; 1.1%)	Bc Mp Lp Oe	0.0099	(3; 4.4%)
Ch Oe	0.0028	(1; 1.1%)	Ee Oe	0.00179	(1; 1.1%)	Bc Mp Ch Oe	0.00955	(3; 4.2%)
Is Oe	0.0023	(1; 0.89%)	Is Oe	0.00167	(1; 0.99%)	Wo Tx PI Oe	0.00653	(3; 2.9%)
Nf Oe	0.00181	(1; 0.7%)	Ms Oe	0.00115	(1; 0.68%)	Bc Mp Ch PI C	0.00563	(4; 2.5%)
Ch PI Oe	0.00165	(2; 0.64%)	Nf Oe	0.00104	(1; 0.62%)	Wo Lp Oe	0.00514	(2; 2.3%)
Ts Oe	0.00163	(1; 0.63%)	Os Oe	0.000971	(1; 0.58%)	Bc Ch Oe	0.0048	(2; 2.1%)
Pa Oe	0.00107	(1; 0.42%)	Ms Wt Oe	0.000915	(2; 0.54%)	Bc Mp Rt Oe	0.00344	(3; 1.5%)
Rd Oe	0.000672	(1; 0.26%)	Pd Wt Oe	0.000865	(2; 0.51%)	Wo Tx Wt Oe	0.00327	(3; 1.5%)
Ms Oe	0.000527	(1; 0.2%)	En Oe	0.000857	(1; 0.51%)	Bc Ch PI Oe	0.00283	(3; 1.3%)
GI Oe	0.000493	(1; 0.19%)	Cm Oe	0.000678	(1; 0.4%)	Bc Mp Ho Wt	0.00189	(4; 0.84%)
Ru Oe	0.000491	(1; 0.19%)	Ho Oe	0.000657	(1; 0.39%)	Wo Mp Ho Oe	0.00139	(3; 0.62%)
Fm Oe	0.000488	(1; 0.19%)	Ch Oe	0.000619	(1; 0.37%)	Bc Mp Wt Oe	0.00125	(3; 0.55%)
Pr Oe	0.000449	(1; 0.17%)	At Oe	0.000609	(1; 0.36%)	Wo Mp Lp Oe	0.00112	(3; 0.5%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	0.964 ±0.015	(±1.5%)
Downstream	0.667 ±0.015	(±2.2%)

# Sector 2806: Electronic Equipment (En)

*Data processing machines, EFTPOS machines, photocopying, vending and gaming machines, telephones, radio, video and TV, mobile phones, hearing aids, alarm systems and other electronics*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicators of greenhouse emissions, water use and land disturbance are 40%, 85% and 95% below average respectively. Employment generation and income are 35% and 25% below average respectively, while government revenue is nearly two times the average. The operating surplus is 40% below average while export propensity and import penetration are each about twice the average. The global nature of the industry and the high import component reduce the social returns but also lessen domestic resource impacts. The industry has an aggressive agenda to focus on core areas of photonics, defence, automotive and medical electronics thereby reducing the import-export imbalance.

## Sector Description

This sector manufactures a wide range of electronic equipment from a mix of domestically made and imported components. Australia has a number of technically sophisticated electronic manufacturers that compete effectively on the world market. These include Codan with factories in Adelaide and Brisbane, which manufactures remote area communications equipment and exports 84% of its production to 150 countries. The core of Cochlear's competitive advantage began in 1967 when Professor Graeme Clark began basic research into multichannel cochlear implants at Melbourne University. Today the firm is a world leader and exports its Nucleus implant system to more than 70 countries. Iplex-Volante is a manufacturer of desktop and notebook computers, which specialises in a whole-of-life approach to computer services for major corporations. The yearly turnover of electronic manufacturing was about \$5 billion in 2002 and involved 1 500 enterprises.

## Place of Industry in the Economy

The manufacture of electronic equipment ranks 57<sup>th</sup> out of 135 sectors in terms of value adding in the economy, and contributes 0.30% of GDP in this analysis. It is similar in value adding to the copper, silver, lead and zinc and the plywood products sectors. The sector is a relatively small employer with a direct requirement of 9 000 employment years and another 14 000 in the sector's upstream suppliers giving a total of 23 000 employment years that are embodied in this sector's final demand. In addition, the sector supplies 9 000 employment years to downstream industries that include this sector's outputs, as intermediate inputs to their goods and services. The sector has relatively small resource requirements with less than one tenth of one percent of national water use and land disturbance, and around four tenths of one percent of energy use and greenhouse emissions. Imports are 20% greater than exports in these data but the imbalance has since widened to imports being three times exports in current trade data.

## Strategic Overview

The integrated overview in the spider diagram presents a mixed outcome with a number of outliers including the social indicators of employment and income, and the financial indicators of operating surplus and import penetration. The environmental indicators are below average because a high level of imports implies that materially intensive processes are conducted overseas. High imports also contribute to below average social and financial indicators. There are downstream issues associated with the use and disposal of sector products such as television watching and lifestyle, gaming machines and problem gamblers, and the appropriate disposal of all electronic equipment.

## TBL Account #1

The financial indicator of operating surplus is 40% below the economy wide average, with about one third of this is a direct sector effect and the rest due to a diverse production chain. The social indicator of employment generation is 35% below average and linked to the global nature of the industry and a high level of imports. The environmental indicator of greenhouse emissions is 40% below average and most of this is due to emissions embodied in electricity (44%), and components used, such steel tubes and plates, copper, plastics and basic chemicals (all together 8%). Greenhouse improvements should focus on purchasing lower carbon electricity.

## TBL Accounts #2 and #3

The second TBL account reveals that the export propensity is two times the average, income is 25% below average and water use is 85% below average. The third TBL account reveals that import penetration is nearly twice the average with three quarters being a direct effect. Government revenue is twice the average and land disturbance is 95% below average. The issues posed by high imports and low surplus are now the focus of an industry wide strategy for the next decade.

## Structural Path Analysis and Linkages

The structural path analysis for operating surplus reveals that the direct sector effect is 35% and accompanied by a diverse production chain that includes wholesale trade (9%), technical services (5%), electricity production (5%), forwarding and storage (2%), plastics (1%), electrical equipment (1%) and iron and steel (1%). Improvement will require innovation through the entire chain.

The sector's ability to stimulate its upstream suppliers is 10% below the economy wide average due to the high level of import penetration. However wholesale trade, property development, scientific and technical services and business management services are still important upstream suppliers. The linkages to downstream industries are about three quarters the average and suggest that expansion of the non-residential construction sector and the communication sector would be required to lead any expansion in the sector, although any sector with a high requirement for electronics would suffice.

## Future Trends in Sector

Under the base case scenario of the *Future Dilemmas* study, by 2050 there could be a 30% increase in the yearly requirement of aggregated classes of electronic goods loosely termed 'telecom equipment' and 'office machines' compared to today. This is a conservative estimate based on population increase (20 to 25 million), decreases in household size (2.6 to 2.3 persons), more office based jobs, and rates of machine turnover similar to the past decade. Major uncertainties lie in the technological trajectories underway in personal wireless objects and the rate of turnover of equipment (longer or shorter life, recycling and remanufacture). There are also uncertainties around the possibility of an energy discontinuity due to the availability of cheap oil after 2020.

## Innovation and Technical Opportunities

The literature suggests few firm directions and trends in the technological push in consumer electronics which is complex, unknowable and unstoppable. The key issue for Australia and the more developed world relates to the disposal, recycling and remanufacture of electronic goods many of which are now turned over in one to three year timeframes. Increasing miniaturisation often means increasing material complexity, and difficulty in re-processing and disposal, due to the component heavy metals and toxic compounds. A recent European Union study found that discards from end-of-life electronic equipment were around 20 kg per person per year suggesting that Australia already discards 400 000 tonnes annually. This presents a challenge for current designers (for recycling and remanufacture) and an opportunity for new industry development.



**Sector**

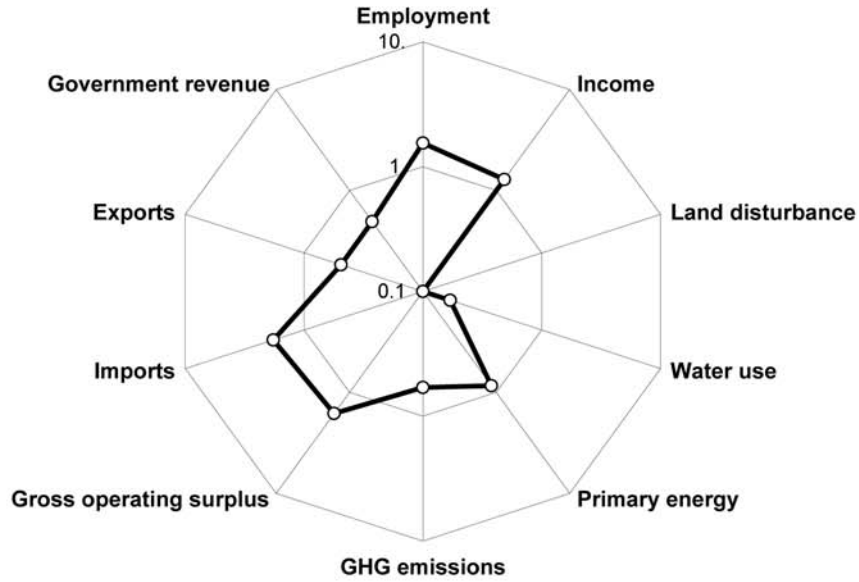
**Electronic equipment**

(En)

Data processing machines, EFTPOS machines, photocopying, vending and gaming machines, electrical telephone equipment, radio, video and TV, mobile phones, hearing aids, alarm systems and other electronic equipment

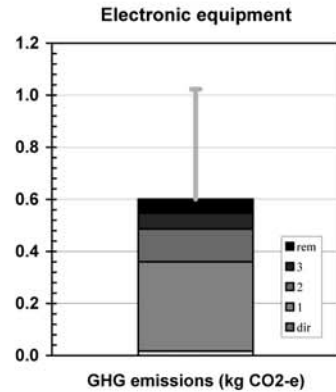
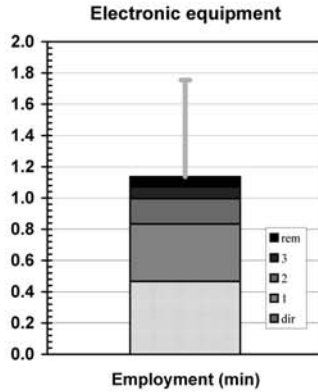
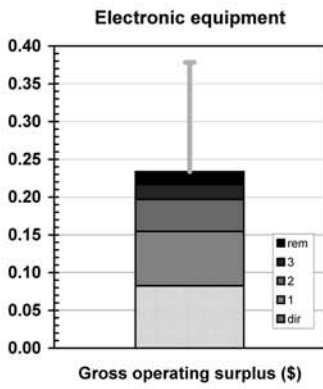
Spider diagram

**Electronic equipment**

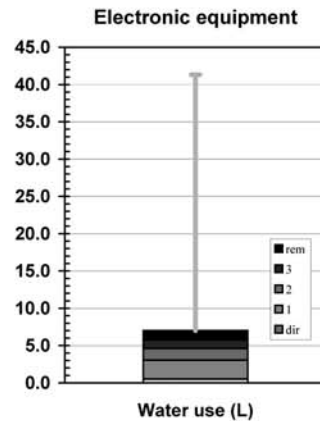
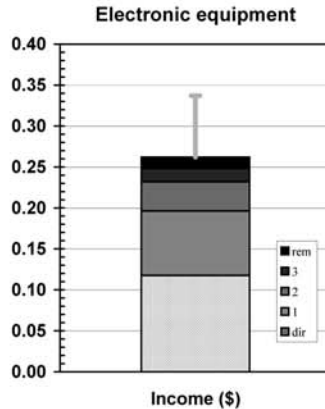
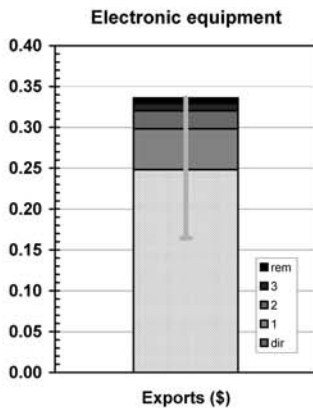


Bar graphs

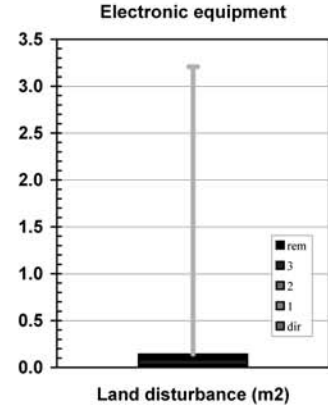
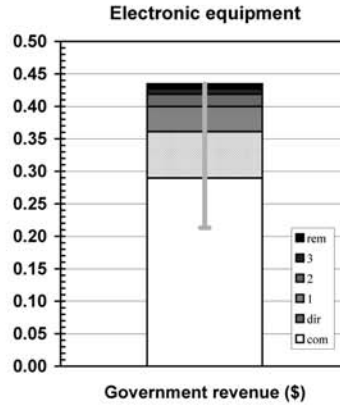
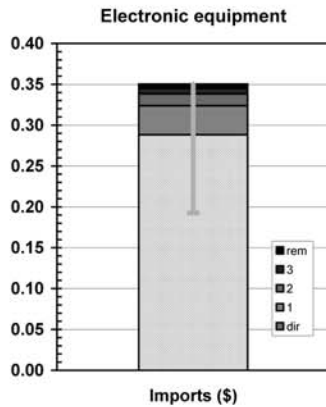
**Account #1**



**Account #2**



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 1,890.2	(0.72% of total)	(\$m 536.0 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 5,463.9	(5.22% of total)	(\$m 741.1 domestically produced)
Net changes in stocks	\$m 262.8	(14.87% of total)	
<b>Sectoral GNE</b>	<b>\$m 7,616.9</b>	<b>(1.66% of GNE)</b>	<b>(\$m 1,256.8 domestically produced)</b>
Exports	\$m 1,219.1	(1.46% of total)	(\$m 1,219.1 domestically produced)
<b>Final demand</b>	<b>\$m 8,836.0</b>	<b>(1.63% of GNT)</b>	<b>(\$m 2,475.9 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 577.5	(0.34% of total)
Gross operating surplus	\$m 405.2	(0.21% of total)
Taxes less subsidies	\$m 351.5	(0.41% of total)
<b>Sectoral GDP*</b>	<b>\$m 1,334.2</b>	<b>(0.30% of GDP)</b>
Imports	\$m 1,415.6	(1.45% of total)
<b>Primary inputs</b>	<b>\$m 2,749.8</b>	<b>(0.50% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 405.2	(0.21%)	\$m 205.9 (0.11%)	\$m 583.0 (0.30%)
Exports (\$m)	\$m 1,219.1	(1.46%)	\$m 619.4 (0.74%)	\$m 839.2 (1.01%)
Imports (\$m)	\$m 1,415.6	(1.45%)	\$m 719.2 (0.74%)	\$m 874.6 (0.90%)
Employment (e-y)	18,350 e-y	(0.26%)	9,323 e-y (0.13%)	22,721 e-y (0.32%)
Income (\$m)*	\$m 577.5	(0.34%)	\$m 293.4 (0.17%)	\$m 654.2 (0.38%)
Government revenue (\$m)†	\$m 1,074.3	(0.99%)	\$m 901.4 (0.83%)	\$m 1,085.0 (1.00%)
GHG emissions (kt CO <sub>2</sub> -e)	84 kt (0.02%)		43 kt (0.01%)	1,500 kt (0.29%)
Water use (ML)	2,441 ML (0.01%)		1,240 ML (0.01%)	17,497 ML (0.08%)
Land disturbance (kha)	5 kha (0.00%)		2 kha (0.00%)	35 kha (0.02%)
Primary energy (TJ)	1,432 TJ (0.04%)		728 TJ (0.02%)	16,408 TJ (0.42%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.08	0.23	0.38
Exports (\$)	0.25	0.34	0.16
Imports (\$)	0.29	0.35	0.19
Employment (min)	0.47	1.14	1.75
Income (\$)	0.12	0.26	0.34
Government revenue (\$)	0.36	0.43	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.02	0.60	1.02
Water use (L)	0.50	7.01	41.32
Land disturbance (m <sup>2</sup> )	0.01	0.14	3.21
Primary energy (MJ)	0.29	6.57	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
En	0.0825	(0; 35.%)	En	0.466	(0; 41.%)	EI En	0.264	(1; 44.%)
Wt En	0.0198	(1; 8.5%)	Wt En	0.143	(1; 13.%)	Is En	0.0216	(1; 3.6%)
Ts En	0.0111	(1; 4.7%)	Ts En	0.0499	(1; 4.4%)	Wt En	0.0198	(1; 3.3%)
EI En	0.0107	(1; 4.6%)	Ee En	0.0185	(1; 1.6%)	En	0.0171	(0; 2.8%)
St Wt En	0.00378	(2; 1.6%)	PI En	0.0169	(1; 1.5%)	Gd En	0.0073	(1; 1.2%)
PI En	0.00318	(1; 1.4%)	Ms Wt En	0.0129	(2; 1.1%)	Ch PI En	0.00707	(2; 1.2%)
Ee En	0.00298	(1; 1.3%)	EI En	0.0119	(1; 1.%)	Nf En	0.00705	(1; 1.2%)
Ms Wt En	0.00287	(2; 1.2%)	Bs En	0.0102	(1; 0.9%)	BI EI En	0.00666	(2; 1.1%)
Is En	0.00251	(1; 1.1%)	Ho En	0.00851	(1; 0.75%)	EI Wt En	0.00595	(2; 0.99%)
Pd Wt En	0.00228	(2; 0.97%)	Rd En	0.00624	(1; 0.55%)	At En	0.0045	(1; 0.75%)
BI EI En	0.0017	(2; 0.73%)	St Wt En	0.00617	(2; 0.54%)	EI PI En	0.00369	(2; 0.61%)
Cm En	0.00162	(1; 0.69%)	Is En	0.00598	(1; 0.53%)	EI AI En	0.0034	(2; 0.57%)
Nf En	0.00153	(1; 0.66%)	Ms En	0.0058	(1; 0.51%)	EI Is En	0.00284	(2; 0.47%)
Cm Wt En	0.00133	(2; 0.57%)	Pd Wt En	0.00547	(2; 0.48%)	EI Ts En	0.00276	(2; 0.46%)
Ms En	0.00129	(1; 0.55%)	Fm En	0.00506	(1; 0.45%)	Ch En	0.00253	(1; 0.42%)
Ne En	0.00123	(1; 0.53%)	Ed En	0.00493	(1; 0.43%)	AI En	0.00246	(1; 0.41%)
Rd En	0.00106	(1; 0.45%)	Ps En	0.00491	(1; 0.43%)	At Wt En	0.00241	(2; 0.4%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
En	0.248	(0; 74.%)	En	0.118	(0; 45.%)	EI En	1.46	(1; 21.%)
Wt En	0.0162	(1; 4.8%)	Wt En	0.0306	(1; 12.%)	Wa En	0.647	(1; 9.2%)
Nf En	0.00516	(1; 1.5%)	Ts En	0.0117	(1; 4.5%)	En	0.497	(0; 7.1%)
Ee En	0.00298	(1; 0.89%)	Ee En	0.00355	(1; 1.4%)	Wa Ts En	0.149	(2; 2.1%)
GI En	0.00297	(1; 0.88%)	PI En	0.00342	(1; 1.3%)	Sc Cg En	0.14	(2; 2.2%)
BI EI En	0.00258	(2; 0.77%)	EI En	0.00321	(1; 1.2%)	Wa EI En	0.0845	(2; 1.2%)
Is En	0.00192	(1; 0.57%)	Ms Wt En	0.003	(2; 1.1%)	Wt En	0.0799	(1; 1.1%)
Ts En	0.00176	(1; 0.52%)	Pd Wt En	0.00205	(2; 0.78%)	Wa Ms Wt En	0.0739	(3; 1.1%)
At En	0.00143	(1; 0.43%)	St Wt En	0.00158	(2; 0.6%)	Wa Pd Wt En	0.0622	(3; 0.89%)
AI En	0.00131	(1; 0.39%)	Is En	0.00143	(1; 0.54%)	Ws Ho En	0.062	(2; 0.88%)
GI Nf En	0.000938	(2; 0.28%)	Ms En	0.00135	(1; 0.51%)	Is En	0.0573	(1; 0.82%)
St Wt En	0.000937	(2; 0.28%)	Bs En	0.00126	(1; 0.48%)	Bc Mp Ho En	0.0445	(3; 0.64%)
PI En	0.00092	(1; 0.27%)	Ho En	0.00124	(1; 0.47%)	Nf En	0.044	(1; 0.63%)
Eq En	0.000838	(1; 0.25%)	Ed En	0.00122	(1; 0.47%)	Wa Wt En	0.043	(2; 0.61%)
Ch PI En	0.000822	(2; 0.24%)	Os En	0.00119	(1; 0.46%)	Vf PI En	0.0419	(2; 0.6%)
At Wt En	0.000767	(2; 0.23%)	Rd En	0.00107	(1; 0.41%)	Ee En	0.039	(1; 0.56%)
Nf Ee En	0.0007	(2; 0.21%)	Cm En	0.00102	(1; 0.39%)	Dc Dp Ho En	0.0369	(3; 0.53%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
En	0.288	(0; 82.%)	En	0.0715	(0; 49.%)	Bc Mp Ho En	0.0123	(3; 8.7%)
Wt En	0.00461	(1; 1.3%)	Wt En	0.0143	(1; 9.9%)	En	0.00981	(0; 7.%)
PI En	0.00325	(1; 0.93%)	Ts En	0.00575	(1; 4.%)	Wo Tx Tp En	0.00595	(3; 4.2%)
Ts En	0.00317	(1; 0.91%)	EI En	0.002	(1; 1.4%)	Wo Tx Wt En	0.00508	(3; 3.6%)
Ee En	0.00291	(1; 0.83%)	Ee En	0.00155	(1; 1.1%)	EI En	0.00427	(1; 3.%)
Is En	0.000902	(1; 0.26%)	PI En	0.00149	(1; 1.%)	Wo Tx PI En	0.00326	(3; 2.3%)
Ch PI En	0.000823	(2; 0.23%)	Ms Wt En	0.00142	(2; 0.98%)	Bc Mp Ho Wt E	0.00293	(4; 2.1%)
EI En	0.000741	(1; 0.21%)	Pd Wt En	0.00135	(2; 0.93%)	Bc Mp Ch PI E	0.00281	(4; 2.%)
Ms Wt En	0.000654	(2; 0.19%)	St Wt En	0.000841	(2; 0.58%)	Wo Tx CI En	0.00195	(3; 1.4%)
Pr Wt En	0.000626	(2; 0.18%)	Rd En	0.000762	(1; 0.52%)	Bc Mp Wt En	0.00194	(3; 1.4%)
Nf En	0.00062	(1; 0.18%)	Is En	0.000654	(1; 0.45%)	Wo Ts En	0.00191	(2; 1.4%)
Ne En	0.000593	(1; 0.17%)	Ho En	0.000654	(1; 0.45%)	Bc Mp Ts En	0.00157	(3; 1.1%)
Eq En	0.000554	(1; 0.16%)	At En	0.000641	(1; 0.44%)	Bc Mp Rt Wt E	0.0015	(4; 1.1%)
Pa En	0.000498	(1; 0.14%)	Ms En	0.00064	(1; 0.44%)	Wo Tx En	0.00149	(2; 1.1%)
At En	0.000427	(1; 0.12%)	Rd Wt En	0.000573	(2; 0.39%)	Bc Ch PI En	0.00141	(3; 1.%)
Pr En	0.000418	(1; 0.12%)	Os En	0.000554	(1; 0.38%)	Wo Mp Ho En	0.00139	(3; 0.98%)
St Wt En	0.000342	(2; 0.098%)	In Wt En	0.000522	(2; 0.36%)	Wt En	0.00121	(1; 0.86%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	0.941 ±0.018	(±2.0%)
Downstream	0.788 ±0.022	(±2.8%)

# Sector 2807: Household Appliances (Hh)

*Hot water systems, stoves, ovens, heaters, refrigerators, freezers, domestic air conditioning, clothes washers, dryers, sewing machines, vacuum cleaners and other household appliances*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is 10% above average, while those for water use and land disturbance are 80% and 95% below average respectively. The social indicators of employment and income are equal to average, while government revenue is 20% below average. The financial indicators reveal that operating surplus is 30% below average, export propensity is 30% above average and import penetration is 70% above average. Growth in imports is outpacing growth in exports.

## Sector Description

The household appliance sector includes all the major electrical items used to undertake the chores in a modern household. It includes items such as fridges and freezers (580 000 sold per year), clothes washers (440 000 per year), clothes dryers (180 000 per year) and dishwashers (170 000 per year) as well as hot water systems and stoves. There is considerable industry amalgamation and specialisation in the world appliance market. The long established global appliance giant Electrolux now owns the iconic brand names of Simpson, Westinghouse, Dishlex, and Kelvinator, and retains three manufacturing plants in Adelaide, Botany and Orange, as well as an 'innovation centre' in Sydney. The New Zealand company Fisher and Paykel operates separate fridge and clothes washer factories in Brisbane from which it supplies domestic and export markets. Australia has globally competitive brands such as Solahart solar hot water heaters which are exported to over 70 countries. Industry turnover was around \$2.3 billion in 2002 and involved about 200 enterprises.

## Place of Industry in the Economy

The household appliances sector ranks 91<sup>st</sup> out of 135 sectors in terms of value adding in the Australian economy and contributes 0.13% of GDP in this analysis. The sectors of aircraft manufacture and sugar cane are similar in their contribution to value adding. The sector is a relatively small employer with a direct requirement of 11 000 employment years and another 10 000 years in the sector's upstream suppliers giving a total of 21 000 employment years. In addition it supplies 3 000 employment years to downstream industries. The sector has low resource requirements with less than one tenth of one percent of national water use and land disturbance, and less than four tenths of one percent of energy use and greenhouse emissions. Imports are three times exports in financial terms, and recently imports were valued at about \$1.2 billion.

## Strategic Overview

The sector presents a reasonable TBL account with outliers for the financial indicators of operating surplus and import penetration. There appears to be a widening imbalance developing between imports and exports. Vigorous competition and the below average indicator of operating surplus may pressure the industry to move more domestic manufacturing to low wage countries. There are three important downstream issues for the industry. The first is the resource requirement for the full lifecycle use of the equipment particularly energy for all appliances, and water for washing machines. The second is that efficient manufacturing processes and expensive and complex individual components mean that consumers often find it economically more efficient to purchase new, rather than repair malfunctioning equipment. The third is that the complex composition of equipment and its components makes for difficult recycling and re-engineering.

## TBL Account #1

The financial indicator of operating surplus is 40% below the average and only one fifth of this is a direct effect with the remainder due to the production chain. The social indicator of employment is 10% below average with one half of this a direct effect. The environmental indicator of greenhouse emissions is equal to average and one third of this is due to direct fuel combustion, while emissions embodied in steel tube and plate (24%) and electricity production (5%) are other major contributors. Some appliance manufacturers purchase green power to reduce their greenhouse emissions, but may derive greater benefit purchasing steel content with low embodied greenhouse emissions.

## TBL Accounts #2 and #3

The second TBL account shows that export propensity is 25% above average, income is 5% below average and water use is 80% below average. The third TBL account shows that import penetration is 50% above average, government revenue is 15% below average and land disturbance is 95% below average. As already noted, the expanding import-export ratio may be a future issue.

## Structural Path Analysis and Linkages

At 30% below average, the operating surplus may require attention. The structural path analysis reveals that the direct effect is moderate at 21% and most of the effect is in the production chain. This includes steel pipe and sheet (10%), wholesale trade (4%), electrical equipment (3%), technical services (3%), legal and accounting (2%) and copper products (1%). Improving profitability is thus a broad challenge for the whole production chain not just the sector alone.

The sector's stimulus to its upstream suppliers is about 10% above the average and impacts particularly on steel pipe and sheet, wholesale trade and electrical equipment. The linkages to downstream industries are very weak as most of the effect is dissipated by private consumption.

## Future Trends in Sector

The base case scenario of the *Future Dilemmas* study suggests some interesting issues for this sector. If population reaches 25 million by the year 2051, an increase of 25% compared to now, the number of households could grow from 7.3 million to 10.8 million, an increase of 48%. Thus the total energy use of buildings could double over that period due to larger living areas, decreasing number of people per household and growing affluence. There is a concerted policy effort to reduce the energy and water use of domestic appliances and there are steady increases in efficiency for fridges, clothes dryers and dishwashers. There are competing pressures for clothes washers where front loaders show large efficiency increases while top loaders, which dominate the market show less improvement. Thus individual machines may steadily improve, but the target variable (total energy and water use) may outpace population growth due to non-appliance social drivers.

## Innovation and Technical Opportunities

While the manufacturing phase is important, more than 95% of the appliance life cycle impact occurs during its domestic use phase. The Japanese 'top runner' approach (where today's best model sets tomorrow's standards) will produce a cascade effect on the global appliance market during the next five years. Manufacturers and importers of major appliances and cars sold on the Japanese market have to fulfil energy efficiency targets within 5 to 10 years for the sales-weighted average of their products. The Japanese 'front runner' scheme has large fines for manufacturers and importers who do not meet the standards. The European standards for re-manufacturing, reuse and recycling will also impact on domestic appliance manufacturing. Water and energy utilities may supply and manage complete sets of household appliances to ensure resource targets are met. This could rejuvenate domestic production of suitable appliances and create vibrant export opportunities.

**Sector**

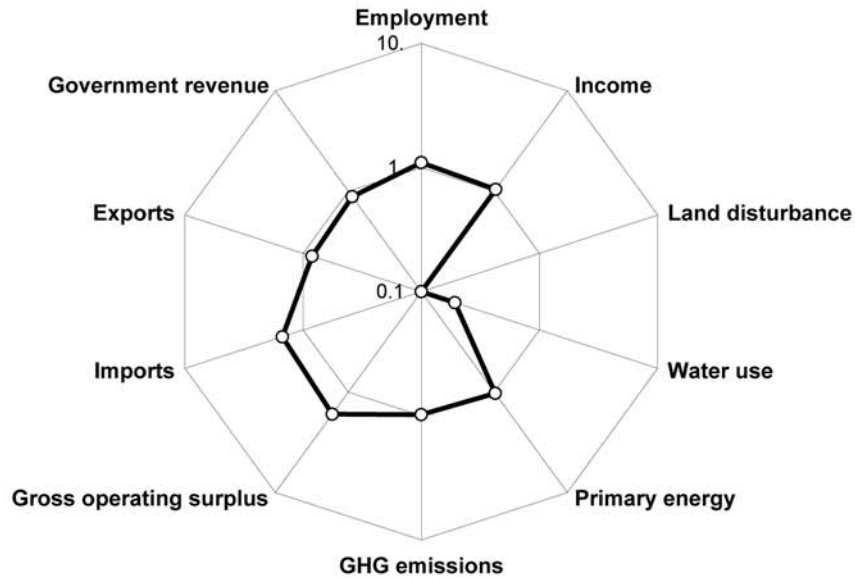
**Household appliances**

**(Hh)**

Hot water systems, stoves, ovens, heaters, refrigerators, freezers, domestic air conditioning, clothes washers, dryers, sewing machines, vacuum cleaners and other household appliances

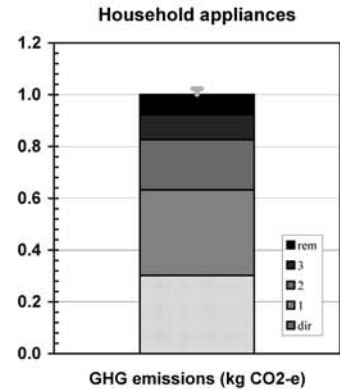
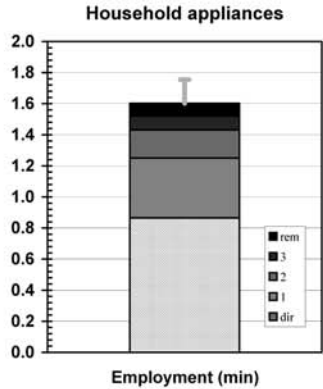
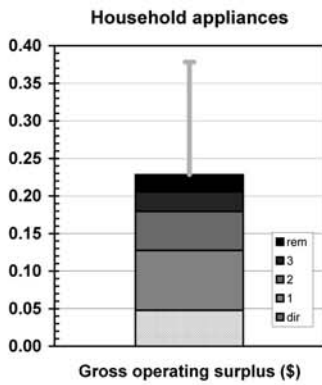
Spider diagram

**Household appliances**

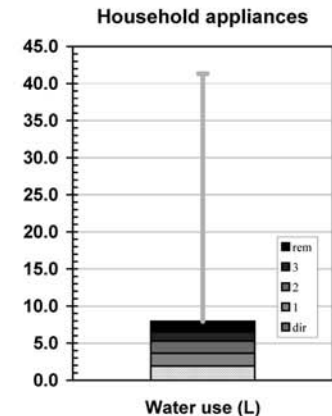
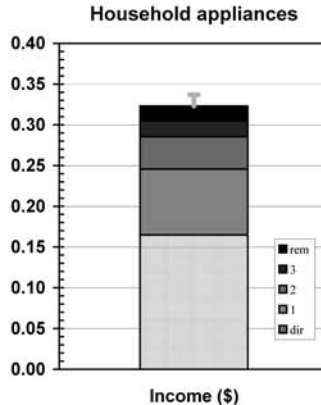
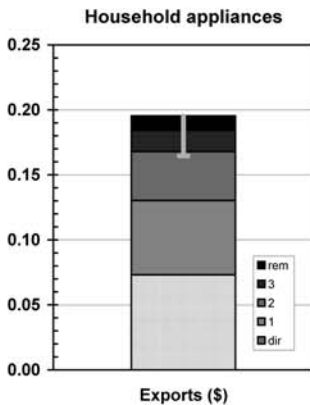


Bar graphs

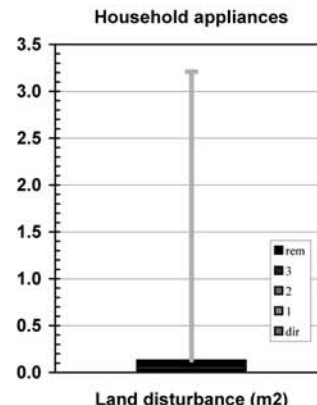
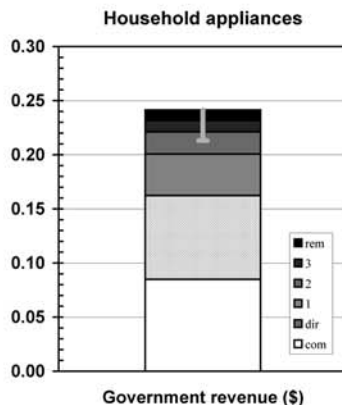
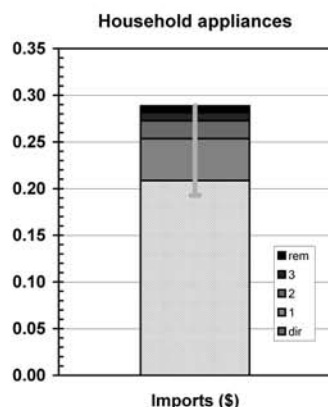
**Account #1**



**Account #2**



### Account #3



### National Accounts extracts

#### Receipts: GNT(E) - commodities

Private final consumption	\$m 1,947.9	(0.74% of total)	(\$m 1,071.0 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 551.3	(0.53% of total)	(\$m 421.1 domestically produced)
Net changes in stocks	\$m 19.6	(1.11% of total)	(\$m 13.1 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 2,518.7</b>	<b>(0.55% of GNE)</b>	<b>(\$m 1,505.2 domestically produced)</b>
Exports	\$m 150.4	(0.18% of total)	(\$m 150.4 domestically produced)
<b>Final demand</b>	<b>\$m 2,669.1</b>	<b>(0.49% of GNT)</b>	<b>(\$m 1,655.6 domestically produced)</b>

#### Costs: GNT(I) - industries

Wages and salaries	\$m 339.3	(0.20% of total)
Gross operating surplus	\$m 98.4	(0.05% of total)
Taxes less subsidies	\$m 159.2	(0.19% of total)
<b>Sectoral GDP*</b>	<b>\$m 596.9</b>	<b>(0.13% of GDP)</b>
Imports	\$m 429.5	(0.44% of total)
<b>Primary inputs</b>	<b>\$m 1,026.4</b>	<b>(0.19% of GNT)</b>

\* Sectoral gross value added + net taxes on products

### TBL factors

	in supplying industry		embodied in commodity GNT		
		(% of national)	direct	(% of national)	total (% of national)
Gross operating surplus (\$m)	\$m 98.4	(0.05%)	\$m 79.1	(0.04%)	\$m 378.3 (0.20%)
Exports (\$m)	\$m 150.4	(0.18%)	\$m 120.9	(0.15%)	\$m 323.4 (0.39%)
Imports (\$m)	\$m 429.5	(0.44%)	\$m 345.2	(0.35%)	\$m 478.0 (0.49%)
Employment (e-y)	14,273 e-y	(0.20%)	11,472 e-y	(0.16%)	21,264 e-y (0.30%)
Income (\$m)*	\$m 339.3	(0.20%)	\$m 272.7	(0.16%)	\$m 534.9 (0.31%)
Government revenue (\$m)†	\$m 299.7	(0.28%)	\$m 268.5	(0.25%)	\$m 399.7 (0.37%)
GHG emissions (kt CO <sub>2</sub> -e)	622 kt	(0.12%)	500 kt	(0.10%)	1,657 kt (0.32%)
Water use (ML)	3,915 ML	(0.02%)	3,147 ML	(0.02%)	13,173 ML (0.06%)
Land disturbance (kha)	2 kha	(0.00%)	2 kha	(0.00%)	22 kha (0.01%)
Primary energy (TJ)	371 TJ	(0.01%)	298 TJ	(0.01%)	13,041 TJ (0.34%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

### TBL multipliers - commodities

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.05	0.23	0.38
Exports (\$)	0.07	0.20	0.16
Imports (\$)	0.21	0.29	0.19
Employment (min)	0.86	1.60	1.75
Income (\$)	0.16	0.32	0.34
Government revenue (\$)	0.16	0.24	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.30	1.00	1.02
Water use (L)	1.90	7.96	41.32
Land disturbance (m <sup>2</sup> )	0.01	0.13	3.21
Primary energy (MJ)	0.18	7.88	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Hh	0.0478	(0; 21.%)	Hh	0.865	(0; 54.%)	Hh	0.302	(0; 30.%)
Is Hh	0.0236	(1; 10.%)	Wt Hh	0.0691	(1; 4.3%)	Is Hh	0.204	(1; 20.%)
Wt Hh	0.00959	(1; 4.2%)	Is Hh	0.0563	(1; 3.5%)	El Hh	0.0545	(1; 5.4%)
Ee Hh	0.00755	(1; 3.3%)	Ee Hh	0.0468	(1; 2.9%)	El Is Hh	0.0267	(2; 2.7%)
Ts Hh	0.00716	(1; 3.1%)	Ts Hh	0.0323	(1; 2.%)	Nf Hh	0.0135	(1; 1.3%)
Ms Hh	0.00345	(1; 1.5%)	Ms Hh	0.0155	(1; 0.96%)	Ch Hh	0.0109	(1; 1.1%)
Io Is Hh	0.00304	(2; 1.3%)	Sh Hh	0.0135	(1; 0.84%)	Wt Hh	0.00957	(1; 0.96%)
Nf Hh	0.00293	(1; 1.3%)	Rd Hh	0.0121	(1; 0.75%)	Gd Hh	0.00686	(1; 0.69%)
Sh Hh	0.00226	(1; 0.99%)	PI Hh	0.0114	(1; 0.71%)	Is Sh Hh	0.00655	(2; 0.65%)
El Hh	0.0022	(1; 0.96%)	Fm Hh	0.0101	(1; 0.63%)	Ch PI Hh	0.00476	(2; 0.48%)
PI Hh	0.00214	(1; 0.94%)	Bs Hh	0.00946	(1; 0.59%)	El Ee Hh	0.00425	(2; 0.42%)
Rd Hh	0.00205	(1; 0.9%)	Rt Hh	0.00846	(1; 0.53%)	At Hh	0.00346	(1; 0.35%)
St Wt Hh	0.00183	(2; 0.8%)	Ms Wt Hh	0.00623	(2; 0.39%)	Rd Hh	0.00326	(1; 0.33%)
Pt Hh	0.0017	(1; 0.74%)	Gp Hh	0.00503	(1; 0.31%)	Sp Is Hh	0.0032	(2; 0.32%)
Cm Hh	0.0015	(1; 0.66%)	Os Hh	0.00479	(1; 0.3%)	Ch Ee Hh	0.00292	(2; 0.29%)
Gp Hh	0.00144	(1; 0.63%)	Cm Hh	0.00415	(1; 0.26%)	El Wt Hh	0.00288	(2; 0.29%)
Ms Wt Hh	0.00139	(2; 0.61%)	Eq Hh	0.00403	(1; 0.25%)	Gp Hh	0.00281	(1; 0.28%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Hh	0.073	(0; 37.%)	Hh	0.165	(0; 51.%)	Hh	1.9	(0; 24.%)
Is Hh	0.018	(1; 9.2%)	Wt Hh	0.0148	(1; 4.6%)	Is Hh	0.54	(1; 6.8%)
Nf Hh	0.00984	(1; 5.%)	Is Hh	0.0134	(1; 4.2%)	Wa Hh	0.353	(1; 4.4%)
Wt Hh	0.00784	(1; 4.%)	Ee Hh	0.00898	(1; 2.8%)	El Hh	0.301	(1; 3.8%)
Ee Hh	0.00755	(1; 3.9%)	Ts Hh	0.00756	(1; 2.3%)	El Is Hh	0.148	(2; 1.9%)
Io Is Hh	0.00489	(2; 2.5%)	Ms Hh	0.00359	(1; 1.1%)	Ee Hh	0.0987	(1; 1.2%)
GI Nf Hh	0.00179	(2; 0.92%)	Sh Hh	0.00266	(1; 0.82%)	Wa Ts Hh	0.0966	(2; 1.2%)
Nf Ee Hh	0.00177	(2; 0.91%)	PI Hh	0.00231	(1; 0.71%)	Wa Is Hh	0.0918	(2; 1.2%)
Sp Is Hh	0.00136	(2; 0.7%)	Rd Hh	0.00207	(1; 0.64%)	Wa Ms Hh	0.0886	(2; 1.1%)
Ch Hh	0.00126	(1; 0.65%)	Fm Hh	0.00158	(1; 0.49%)	Nf Hh	0.0839	(1; 1.1%)
Ts Hh	0.00114	(1; 0.58%)	Ms Wt Hh	0.00145	(2; 0.45%)	Io Is Hh	0.0733	(2; 0.92%)
At Hh	0.0011	(1; 0.56%)	Os Hh	0.00134	(1; 0.42%)	Br Is Hh	0.0534	(2; 0.67%)
Uo Nf Hh	0.00109	(2; 0.56%)	Bs Hh	0.00116	(1; 0.36%)	Wt Hh	0.0386	(1; 0.49%)
Bl Is Hh	0.000971	(2; 0.5%)	Rt Hh	0.001	(1; 0.31%)	Wa Ms Wt Hh	0.0357	(3; 0.45%)
Co Nf Hh	0.000732	(2; 0.37%)	Pd Wt Hh	0.000993	(2; 0.31%)	Uo Nf Hh	0.035	(2; 0.44%)
Eq Hh	0.000718	(1; 0.37%)	Cm Hh	0.000941	(1; 0.29%)	Ch Hh	0.0331	(1; 0.42%)
Rd Hh	0.000714	(1; 0.37%)	Gp Hh	0.00094	(1; 0.29%)	Sh Hh	0.0306	(1; 0.38%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Hh	0.209	(0; 72.%)	Hh	0.0773	(0; 49.%)	Hh	0.00976	(0; 7.4%)
Is Hh	0.00849	(1; 2.9%)	Wt Hh	0.00693	(1; 4.4%)	Bc Mp Rt Hh	0.00454	(3; 3.5%)
Ee Hh	0.00736	(1; 2.6%)	Is Hh	0.00616	(1; 3.9%)	Bc Mp Ho Hh	0.00452	(3; 3.4%)
Wt Hh	0.00223	(1; 0.77%)	Ee Hh	0.00393	(1; 2.5%)	Bc Mp Ch Hh	0.00431	(3; 3.3%)
PI Hh	0.00219	(1; 0.76%)	Ts Hh	0.00372	(1; 2.4%)	Wo Tx Wt Hh	0.00246	(3; 1.9%)
Ts Hh	0.00206	(1; 0.71%)	Ms Hh	0.00171	(1; 1.1%)	Wo Tx PI Hh	0.0022	(3; 1.7%)
Pt Hh	0.00186	(1; 0.64%)	Rd Hh	0.00147	(1; 0.94%)	Bc Ch Hh	0.00217	(2; 1.7%)
Sh Hh	0.00156	(1; 0.54%)	Sh Hh	0.00118	(1; 0.75%)	Wo Tx Hh	0.00209	(2; 1.6%)
Ch Hh	0.00126	(1; 0.44%)	PI Hh	0.00101	(1; 0.64%)	Bc Mp Ch PI H	0.00189	(4; 1.4%)
Nf Hh	0.00118	(1; 0.41%)	Ms Wt Hh	0.000688	(2; 0.44%)	Wo Tx Tp Hh	0.00186	(3; 1.4%)
Pa Hh	0.000923	(1; 0.32%)	Nf Hh	0.00068	(1; 0.43%)	Wo Tx Cl Hh	0.00145	(3; 1.1%)
Ms Hh	0.000784	(1; 0.27%)	Pd Wt Hh	0.000651	(2; 0.42%)	Bc Mp Ho Wt	0.00142	(4; 1.1%)
En Hh	0.000726	(1; 0.25%)	Os Hh	0.000623	(1; 0.4%)	Wo Ts Hh	0.00124	(2; 0.94%)
Fm Hh	0.000682	(1; 0.24%)	Fm Hh	0.000551	(1; 0.35%)	Bc Mp Ch Ee	0.00116	(4; 0.88%)
Mv Hh	0.000629	(1; 0.22%)	At Hh	0.000493	(1; 0.31%)	Bc Mp Ts Hh	0.00101	(3; 0.77%)
Sp Is Hh	0.000571	(2; 0.2%)	Gp Hh	0.000454	(1; 0.29%)	Bc Mp Hh	0.000985	(2; 0.75%)
Ch PI Hh	0.000555	(2; 0.19%)	Cm Hh	0.00045	(1; 0.29%)	Bc Ch PI Hh	0.000952	(3; 0.73%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.138 ±0.020	(±1.8%)
Downstream	0.280 ±0.008	(±2.9%)



# Sector 2808: Electrical Equipment (Ee)

*Cable, wire, batteries, lights, bulbs, light fittings, transformers, electric motors, electric welding and soldering equipment, generators, relays, switches, signals, insulators and other electrical equipment*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicators of greenhouse emissions, water use and land disturbance are 30%, 80%, and 95% below average respectively. The social indicators of employment and income are 15% and 10% below average respectively while government revenue is equal to average. The financial indicator of operating surplus is 15% below average while import penetration is 15% above average and export propensity is two times the average. This sector is reasonably adept at maintaining manufacturing edge based on product innovation and well targeted add-on equipment, but import penetration is increasing.

## Sector Description

This diverse sector ranges from cable and battery manufacturers, through electrical fittings and equipment to project activities that bring together specific domestic manufacturing with the management of whole industrial plants or remote sites. At one end of the scale there are major world companies such as Pirelli Cable, Corning Cable, Siemens, and Ericsson, who blend some domestic manufacturing with local sales, installation, and maintenance. At the other end of the scale there are battery manufacturers such as Battery Energy with products focused on long life SunGel batteries designed for remote solar photovoltaic and backup systems. Survival for domestic companies probably rests on portfolios of niche innovations, and the ability to supply whole-enterprise solutions at home and abroad. The BP Solar factory at Homebush in Sydney now has the capacity to produce 35 megawatts of PV cells a year for the domestic and world markets. In 2002, the sector had a turnover of about \$6.5 billion and involved nearly 900 enterprises.

## Place of Industry in the Economy

The electrical equipment sector ranks 54<sup>th</sup> out of 135 sectors in terms of value adding in the Australian economy and contributes 0.35% of GDP in this analysis. It is similar in value adding to the sand and gravel and the basic chemicals sectors. It is a relatively small employer with a direct requirement of 8 000 employment years, and another 6 000 years in the sector's upstream suppliers, giving a total of 14 000 employment years. In addition it supplies 20 000 employment years to downstream industries. It has small resource requirements with less than one tenth of one percent of national water use and land disturbance, and around two tenths of one percent of energy use and greenhouse emissions. For this data analysis, exports approximately equal imports.

## Strategic Overview

The electrical equipment sector reveals a reasonably well balanced TBL account with slightly below average performance for the financial indicators of gross operating surplus and import penetration. The sector is similar to many high-tech manufacturing and sales sectors in that it relies heavily on both imported and domestic manufactured components and skills to deliver the full range of capability to keep up with the rapid pace of the communications revolution. Upstream issues for the sector relate to the nature of the manufacturing process and the care and disposal of toxic materials used therein. Downstream issues include the efficient energy performance of the sector's products and whether their use stimulates or reduces energy use for the electrical systems in which they are installed. The eventual disposal of electrical equipment could be an issue which can be improved by stewardship programs for metals (such as copper) or by equipment re-manufacture.

## TBL Account #1

The financial indicator of operating surplus is 15% below average and about one half of this is a direct sector effect, with indirect contributions from copper products (3%), wholesale trade (3%), technical services (2%), steel tube and plate (2%), basic chemicals (2%) and electricity production (1%). The social indicator of employment generation is 15% below average with a similar composition to the operating surplus. The environmental indicator of greenhouse emissions is 30% below average with a minor amount (2%) due to direct fuel combustion in the sector. The largest component is electricity production (12%) with other components being due to emissions embodied in the production of basic chemicals (8%), aluminium (8%), copper (7%), and steel tubes and pipes (6%). Sourcing low carbon electricity (hydro, gas turbine, green power) and using components with non-virgin (recycled) metal content could further improve the sector's greenhouse account.

## TBL Accounts #2 and #3

The second TBL account shows that the export propensity is nearly two times the economy wide average, the income indicator is 10% below average and water use is 80% below average. The third TBL account reveals that the import penetration is 15% above average, government revenue is equal to average and land disturbance is 95% below average.

## Structural Path Analysis and Linkages

Recent data indicates that the import-export balance (more or less equal in this data) is widening and thus the import penetration indicator may require attention, obviously in tandem with the export indicator. The structural path analysis reveals that most of the import effect (65%) is a direct sector effect and made up of already built components. Minor contributions are made by basic chemicals (3%), copper components (2%), wholesale trade (1%), and steel tubes and plates (1%). Improving the import penetration indicator will probably depend on the domestic sourcing of product lines.

The stimulus the sector supplies to its upstream suppliers is around the economy wide average with notable effects on basic chemicals, steel tubes and plates, copper wire and products, and wholesale trade. The linkage to downstream industries is 25% greater than average, and suggests that the domestic and non-domestic construction, and the communications sector, must also expand if expansion in the electrical equipment sector is contemplated.

## Future Trends in Sector

The technological and consumer drivers for electrical and electronic equipment suggest that the recent double digit growth will be maintained in the medium term as increased speed and bandwidth is required both for business and the home consumer market. However the base case scenario from the *Future Dilemmas* study highlights a number of cautionary issues. If population stabilises at around 25 million and the number of households at 11 million, 90% of that will have been reached by the year 2030, so growth may be limited beyond then. Of those households, 30% will be classified in age terms, as over the age of 65 years of age and possibly less open to purchasing the full range of technological and consumer opportunities.

## Innovation and Technical Opportunities

Key issues are difficult to distil apart from continually increasing bandwidth, and wireless mobility. Recycling and remanufacture will be mandated in leading markets and then spread to Australia. Markets are emerging for implanted body chips for personal health, home and vehicles. Issues could include a saturation of demand due to a glut of information. A concept of strategic ignorance may develop that avoids additional material consumption. High workplace usage of technology may lead to avoidance at home and a transition to a simpler, community-based and non-electronic lifestyle.

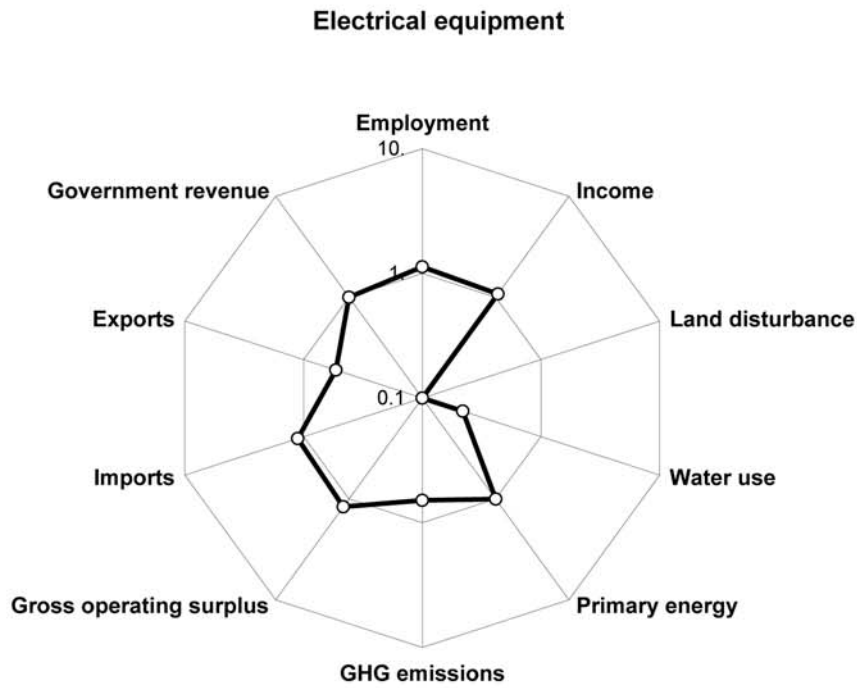
**Sector**

**Electrical equipment**

**(Ee)**

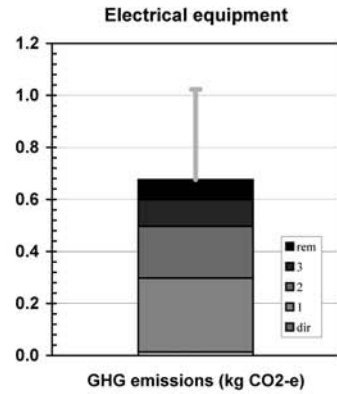
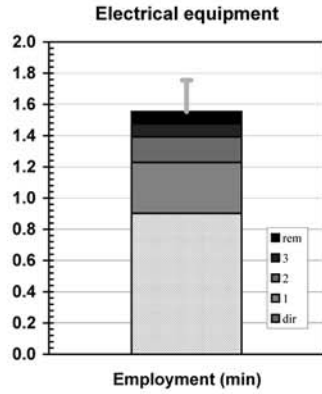
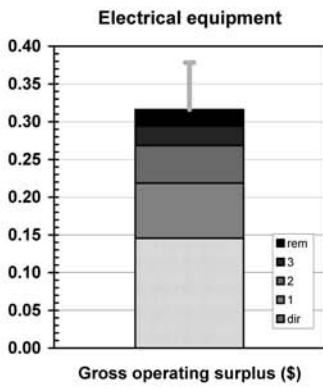
Cable, wire, batteries, lights, bulbs, light fittings, transformers, electric motors, electric welding and soldering equipment, generators, relays, switches, signals, insulators and other electrical equipment

**Spider diagram**

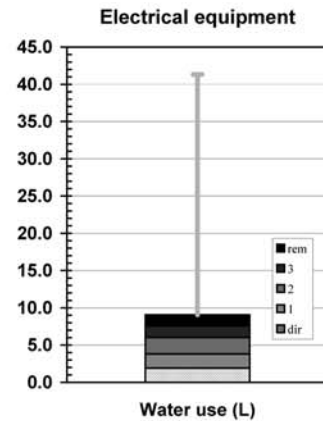
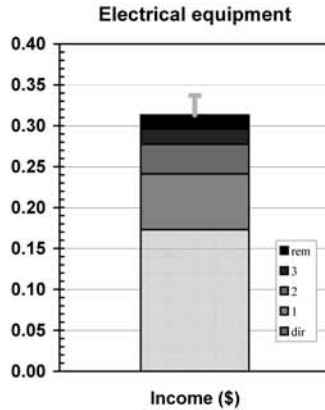
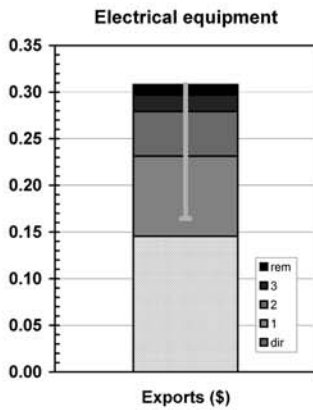


**Bar graphs**

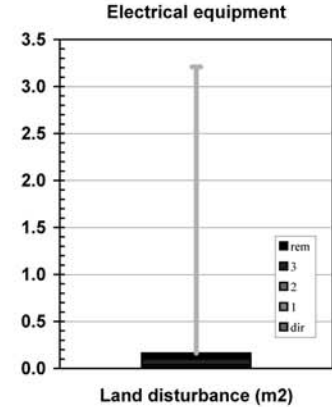
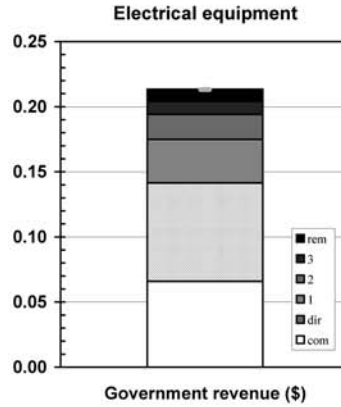
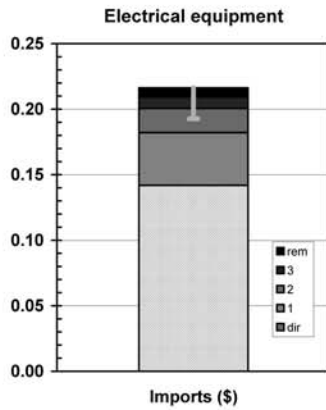
**Account #1**



**Account #2**



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 408.0	(0.15% of total)	(\$m 267.4 domestically produced)
Government final consumption	\$m 0.4	(0.00% of total)	(\$m 0.4 domestically produced)
Gross fixed capital expenditure	\$m 598.5	(0.57% of total)	(\$m 211.5 domestically produced)
Net changes in stocks	\$m 71.8	(4.06% of total)	(\$m 44.8 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 1,078.8</b>	<b>(0.23% of GNE)</b>	<b>(\$m 524.0 domestically produced)</b>
Exports	\$m 580.4	(0.70% of total)	(\$m 580.4 domestically produced)
<b>Final demand</b>	<b>\$m 1,659.2</b>	<b>(0.31% of GNT)</b>	<b>(\$m 1,104.4 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 691.0	(0.40% of total)
Gross operating surplus	\$m 581.0	(0.30% of total)
Taxes less subsidies	\$m 302.0	(0.35% of total)
<b>Sectoral GDP*</b>	<b>\$m 1,574.0</b>	<b>(0.35% of GDP)</b>
Imports	\$m 566.5	(0.58% of total)
<b>Primary inputs</b>	<b>\$m 2,140.5</b>	<b>(0.39% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 581.0	(0.30%)	\$m 160.7	\$m 349.2 (0.18%)
Exports (\$m)	\$m 580.4	(0.70%)	\$m 160.5	\$m 340.4 (0.41%)
Imports (\$m)	\$m 566.5	(0.58%)	\$m 156.7	\$m 238.9 (0.24%)
Employment (e-y)	28,865 e-y	(0.40%)	7,982 e-y	13,755 e-y (0.19%)
Income (\$m)*	\$m 691.0	(0.40%)	\$m 191.1	\$m 345.8 (0.20%)
Government revenue (\$m)†	\$m 374.7	(0.35%)	\$m 156.2	\$m 235.7 (0.22%)
GHG emissions (kt CO <sub>2</sub> -e)	52 kt	(0.01%)	14 kt	747 kt (0.14%)
Water use (ML)	7,591 ML	(0.04%)	2,099 ML	10,013 ML (0.05%)
Land disturbance (kha)	4 kha	(0.00%)	1 kha	18 kha (0.01%)
Primary energy (TJ)	897 TJ	(0.02%)	248 TJ	8,473 TJ (0.22%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.15	0.32	0.38
Exports (\$)	0.15	0.31	0.16
Imports (\$)	0.14	0.22	0.19
Employment (min)	0.90	1.55	1.75
Income (\$)	0.17	0.31	0.34
Government revenue (\$)	0.14	0.21	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.01	0.68	1.02
Water use (L)	1.90	9.07	41.32
Land disturbance (m <sup>2</sup> )	0.01	0.16	3.21
Primary energy (MJ)	0.22	7.67	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Ee	0.145	(0; 46.%)	Ee	0.902	(0; 58.%)	EI Ee	0.0819	(1; 12.%)
Nf Ee	0.0102	(1; 3.2%)	Wt Ee	0.0694	(1; 4.5%)	Ch Ee	0.0563	(1; 8.3%)
Wt Ee	0.00964	(1; 3.%)	Ts Ee	0.0247	(1; 1.6%)	Nf Ee	0.0467	(1; 6.9%)
Ts Ee	0.00548	(1; 1.7%)	Sm Ee	0.0178	(1; 1.1%)	Is Ee	0.0437	(1; 6.5%)
Is Ee	0.00506	(1; 1.6%)	Ch Ee	0.0137	(1; 0.88%)	EI AI Ee	0.0306	(2; 4.5%)
Ch Ee	0.0047	(1; 1.5%)	Is Ee	0.0121	(1; 0.78%)	AI Ee	0.0222	(1; 3.3%)
EI Ee	0.00331	(1; 1.%)	Fm Ee	0.0118	(1; 0.76%)	Ee	0.013	(0; 1.9%)
Co Nf Ee	0.00241	(2; 0.76%)	PI Ee	0.00791	(1; 0.51%)	Wt Ee	0.00962	(1; 1.4%)
Uo Nf Ee	0.00231	(2; 0.73%)	Bs Ee	0.00783	(1; 0.5%)	EI Nf Ee	0.00943	(2; 1.4%)
GI Nf Ee	0.00205	(2; 0.65%)	Rd Ee	0.00782	(1; 0.5%)	EI Ch Ee	0.00847	(2; 1.3%)
Sm Ee	0.00203	(1; 0.64%)	Ms Ee	0.00727	(1; 0.47%)	Ao AI Ee	0.00728	(2; 1.1%)
Cm Ee	0.00199	(1; 0.63%)	Ms Wt Ee	0.00626	(2; 0.4%)	Is Sm Ee	0.0058	(2; 0.86%)
AI Ee	0.0019	(1; 0.6%)	Nf Ee	0.00604	(1; 0.39%)	EI Is Ee	0.00574	(2; 0.85%)
St Wt Ee	0.00184	(2; 0.58%)	Cm Ee	0.0055	(1; 0.35%)	Gd Ee	0.00507	(1; 0.75%)
Ms Ee	0.00162	(1; 0.51%)	EI Ee	0.00368	(1; 0.24%)	At Ee	0.00369	(1; 0.55%)
PI Ee	0.00149	(1; 0.47%)	AI Ee	0.00357	(1; 0.23%)	Ch PI Ee	0.0033	(2; 0.49%)
Ms Wt Ee	0.0014	(2; 0.44%)	Eq Ee	0.00351	(1; 0.23%)	Bc Mp Ch Ee	0.00308	(3; 0.46%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Ee	0.145	(0; 47.%)	Ee	0.173	(0; 55.%)	Ee	1.9	(0; 21.%)
Nf Ee	0.0342	(1; 11.%)	Wt Ee	0.0149	(1; 4.8%)	Sc Cg Ee	0.547	(2; 6.%)
AI Ee	0.0118	(1; 3.8%)	Ts Ee	0.00578	(1; 1.8%)	EI Ee	0.453	(1; 5.%)
Wt Ee	0.00788	(1; 2.6%)	Sm Ee	0.00307	(1; 0.98%)	Wa Ee	0.293	(1; 3.2%)
Ch Ee	0.00654	(1; 2.1%)	Ch Ee	0.00291	(1; 0.93%)	Nf Ee	0.291	(1; 3.2%)
GI Nf Ee	0.00621	(2; 2.%)	Is Ee	0.00288	(1; 0.92%)	Bx Ao AI Ee	0.209	(3; 2.3%)
Is Ee	0.00387	(1; 1.3%)	Nf Ee	0.00237	(1; 0.76%)	Ch Ee	0.172	(1; 1.9%)
Uo Nf Ee	0.00379	(2; 1.2%)	Fm Ee	0.00184	(1; 0.59%)	EI AI Ee	0.169	(2; 1.9%)
Co Nf Ee	0.00254	(2; 0.82%)	Ms Ee	0.00169	(1; 0.54%)	Uo Nf Ee	0.122	(2; 1.3%)
Ao AI Ee	0.00176	(2; 0.57%)	PI Ee	0.0016	(1; 0.51%)	Is Ee	0.116	(1; 1.3%)
Sz Nf Ee	0.00126	(2; 0.41%)	Ms Wt Ee	0.00146	(2; 0.47%)	Sm Ee	0.113	(1; 1.2%)
At Ee	0.00117	(1; 0.38%)	AI Ee	0.00141	(1; 0.45%)	Bc Mp Ch Ee	0.0811	(3; 0.89%)
Io Is Ee	0.00105	(2; 0.34%)	Rd Ee	0.00134	(1; 0.43%)	Wa Ts Ee	0.0739	(2; 0.81%)
Uo Ee	0.000927	(1; 0.3%)	Cm Ee	0.00125	(1; 0.4%)	AI Ee	0.0623	(1; 0.69%)
Ts Ee	0.000869	(1; 0.28%)	Pd Wt Ee	0.000998	(2; 0.32%)	EI Nf Ee	0.0521	(2; 0.57%)
BI EI Ee	0.000801	(2; 0.26%)	EI Ee	0.000996	(1; 0.32%)	Co Nf Ee	0.0486	(2; 0.54%)
En Ee	0.000678	(1; 0.22%)	Bs Ee	0.000961	(1; 0.31%)	EI Ch Ee	0.0469	(2; 0.52%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Ee	0.142	(0; 66.%)	Ee	0.0756	(0; 51.%)	Bc Mp Ch Ee	0.0224	(3; 14.%)
Ch Ee	0.00655	(1; 3.%)	Wt Ee	0.00696	(1; 4.7%)	Bc Ch Ee	0.0112	(2; 6.9%)
Nf Ee	0.00411	(1; 1.9%)	Ts Ee	0.00285	(1; 1.9%)	Ee	0.00976	(0; 6.%)
Wt Ee	0.00224	(1; 1.%)	Nf Ee	0.00236	(1; 1.6%)	Wo Tx Tp Ee	0.00892	(3; 5.4%)
Is Ee	0.00182	(1; 0.84%)	Ch Ee	0.00145	(1; 0.98%)	Bc Mp Ho Ee	0.0033	(3; 2.%)
Ts Ee	0.00157	(1; 0.73%)	Is Ee	0.00132	(1; 0.9%)	Wo Mp Ch Ee	0.00253	(3; 1.5%)
PI Ee	0.00152	(1; 0.7%)	Sm Ee	0.00118	(1; 0.8%)	Wo Tx Wt Ee	0.00247	(3; 1.5%)
Sm Ee	0.00146	(1; 0.68%)	AI Ee	0.000957	(1; 0.65%)	Bc Mp Rt Ee	0.00181	(3; 1.1%)
AI Ee	0.000879	(1; 0.41%)	Rd Ee	0.000954	(1; 0.65%)	Wo Tx PI Ee	0.00153	(3; 0.93%)
Fm Ee	0.000796	(1; 0.37%)	Ms Ee	0.000803	(1; 0.54%)	Bc Mp Ho Wt	0.00143	(4; 0.87%)
En Ee	0.000788	(1; 0.36%)	PI Ee	0.000698	(1; 0.47%)	EI Ee	0.00132	(1; 0.81%)
Co Nf Ee	0.000584	(2; 0.27%)	Ms Wt Ee	0.000692	(2; 0.47%)	Bc Mp Ch PI E	0.00131	(4; 0.8%)
Uo Nf Ee	0.000561	(2; 0.26%)	Pd Wt Ee	0.000654	(2; 0.44%)	Wo Ch Ee	0.00111	(2; 0.68%)
Pt Ee	0.000542	(1; 0.25%)	Fm Ee	0.000643	(1; 0.44%)	Wo Ts Ee	0.000947	(2; 0.58%)
GI Nf Ee	0.000498	(2; 0.23%)	EI Ee	0.000621	(1; 0.42%)	Bc Mp Wt Ee	0.000942	(3; 0.58%)
Pr Ee	0.000496	(1; 0.23%)	Cm Ee	0.000596	(1; 0.4%)	Fr Ch Ee	0.000779	(2; 0.48%)
Eq Ee	0.000414	(1; 0.19%)	At Ee	0.000525	(1; 0.36%)	Bc Mp Ts Ee	0.000775	(3; 0.47%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.076 ±0.017	(±1.6%)
Downstream	1.235 ±0.023	(±1.9%)

# Sector 2809: Agricultural and Other Machinery (Ma)

*Lawn mowers, ploughs, seeders, planters, harvesters, threshers, haymakers, tractors, dairy machinery, excavators, loaders, bulldozers, buckets, shovels, crushers, grinders, store trucks, conveyors, hoists, cranes, elevators, material handling and other construction machinery*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicators of greenhouse emissions, water use and land disturbance are 25%, 75% and 95% below average respectively. The social indicators of employment and income are 5% below and equal to average respectively while government revenue is 10% below average. The export propensity and import penetration are 70% and 25% above average respectively, while the operating surplus is 35% below average. Australia does not have the scale or expertise to compete sector-wide with imports. However the domestic and export markets for equipment for mining and agriculture is significant, and open to innovation.

## Sector Description

This is a diverse sector with agricultural (tractors, harvesters, ploughs, milking machines) and mining equipment (bulldozers, mine trucks, conveyors) representing the major items but it also includes lawn mowers and construction machinery. Australia has about 320 000 farm type tractors and 60 000 harvesters. There are about 8 000 tractors (\$100 000 each) and around 800 combine harvesters (\$350 000 each) sold locally each year, but this depends on the pervading optimism and profit levels. Historically, Australia made tractors (Chamberlains in Western Australia), and harvesters (Sunshine Harvesters in Melbourne) but the local market could not provide the scale required to succeed. Worldwide, the tractor manufacturing market has consolidated into four major manufacturers serving major markets such as North America, where 200 000 wheeled tractors and 8 000 combines are sold each year. Periodically there are calls by industry to revive a local tractor industry suitable for Australian and developing country conditions, but to date little has happened.

## Place of Industry in the Economy

The agricultural and other machinery sector ranks 65<sup>th</sup> out of 135 sectors in terms of value adding in the economy, and contributes 0.24% of GDP in this analysis. It is similar in value adding to the dairy cattle and whole milk sector and the plaster and concrete products sector. It is a moderate sized employer with a direct requirement of 13 000 employer years, and another 10 000 years in the sector's suppliers, giving a total of 23 000 employment years. In addition, it supplies 11 000 employment years to downstream industries. Its resource requirements are small, with less than one tenth of one percent of national water use and land disturbance, and less than four tenths of one percent of energy use and greenhouse emissions. Exports are 80% of imports in financial terms.

## Strategic Overview

The integrated overview reveals a reasonable TBL report card with the financial indicators of operating surplus and import penetration both below average. Upstream issues for the sector include product design to improve operational occupational health and safety. Downstream issues include the overall energy use in a full lifecycle context, and the extent to which major equipment can be re-engineered to achieve several lives. For agricultural machinery, the local impact on issues such as soil compaction are important and the extent to which innovative and enhanced capabilities may allow questionable land use practices not previously feasible, or which increase degradation risk.

## TBL Account #1

The financial indicator of operating surplus is 35% below average and one third of this is a direct sector effect with the remainder due to an extended chain of suppliers. The social indicator of employment generation is 5% below average and two thirds of this is a direct sector effect. The environmental indicator of greenhouse emissions is 25% below average with one half of this due to iron and steel and electricity production systems, and only 2% is direct sector effect.

## TBL Accounts #2 and #3

The second TBL account reveals that export propensity is 60% above average, income is equal to average and water use is 75% below average. The third TBL account reveals that import propensity is 25% above average, government revenue is 10% below average and land disturbance is 95% below average. A high export propensity will increasingly be linked to high import penetration as specialised imported components are used in local manufacture, and while domestic manufacturing lacks the scale and expertise to produce items such as bulldozers, tractors and combine harvesters.

## Structural Path Analysis and Linkages

The operating surplus indicator may require improvement. The structural path analysis reveals an extended influence chain with a direct sector effect of 30%, iron and steel (12%), wholesale trade (5%), 'iron ore in iron and steel' (2%), technical services (2%), electricity (1%) and electrical equipment (1%). Improvements should focus initially on the sector itself. Inevitably the balance between imports and exports will be important given the size of the domestic market, and degree to which sector activity and financial returns are determined by activity in construction, agriculture and mining which in turn are driven by domestic and global business cycles and trade advantage.

The sector's stimulus of its upstream suppliers is slightly above the economy wide average with a particular effect on steel pipe and plate, wholesale trade, and property development. The linkage to downstream industries is weaker than average suggesting that any expansion of the sector needs to be led by expansion in sectors such as domestic and non-domestic construction, sand and gravel, and wholesale trade.

## Future Trends in Sector

The base case scenario of the *Future Dilemmas* study anticipates that requirements for farm machinery such as tractors will increase 25% by 2050. Mining machinery might almost triple due to steady expansions of coal and iron ore exports. Construction machinery might increase by 30% due to a diversity of drivers such as domestic population growth, inbound tourism, urban infill, high rise accommodation and the service economy. However these trends are highly uncertain, and could be overturned by changes in domestic policy, trade dynamics and technology.

## Innovation and Technical Opportunities

Three macro-trends are apparent. Greater operating complexity will mean greater complexity of manufacturing and maintenance. Secondly, there will be a progressive removal of human labour from direct machine management, making issues of human safety simpler, but those of telemetry and error control more complex. Thirdly, technological and societal progress may remove entire product lines. Precision agriculture may see entire crops grown without human oversight or hand, and allow more challenging and toxic environments to be farmed. Mining machines may have to cope with increased volumes of ore, as grades inevitably decline. Alternatively mining machines may be replaced by nano- or bio-concentrators that do the machine's work in situ, or whole-of-life stewardship of metals may replace many mining activities entirely. Construction machines may become more agile and multifunctional as stronger and lighter materials replace heavy components.

**Sector**

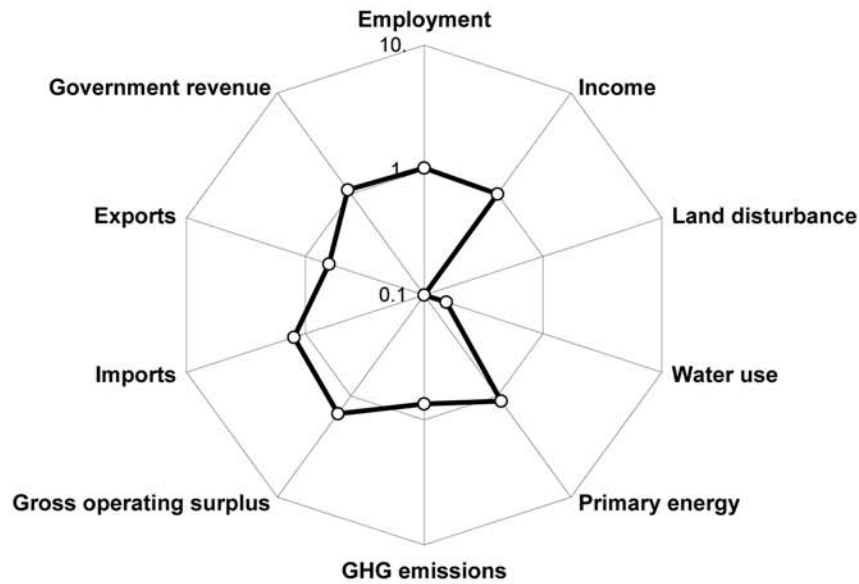
**Agricultural and other machinery**

**(Ma)**

Lawn mowers, ploughs, seeders, planters, harvesters, threshers, haymakers, tractors, dairy machinery, excavators, loaders, bulldozers, buckets, shovels, crushers, grinders, store trucks, conveyors, hoists, cranes, elevators, material handling and other agricultural, mining and construction machinery

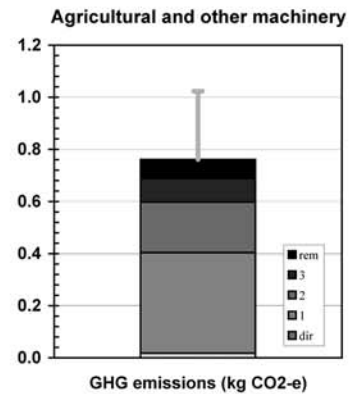
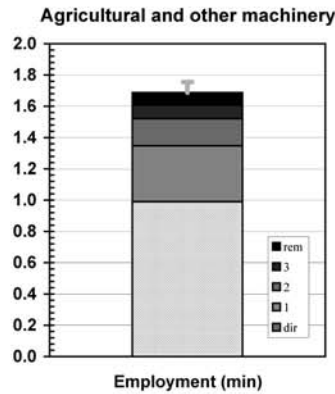
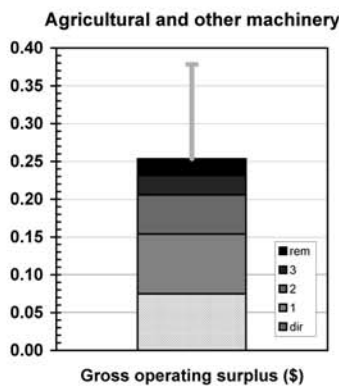
Spider diagram

**Agricultural and other machinery**

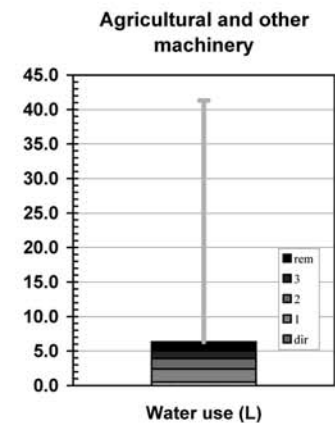
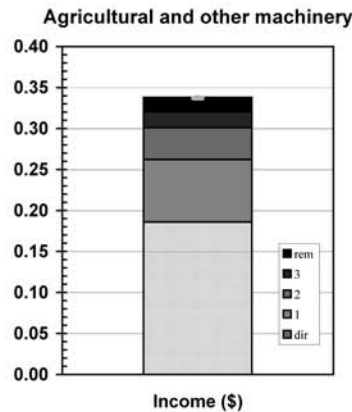
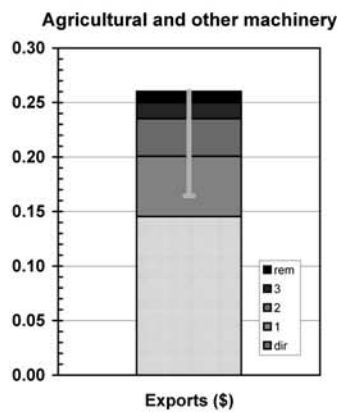


Bar graphs

**Account #1**

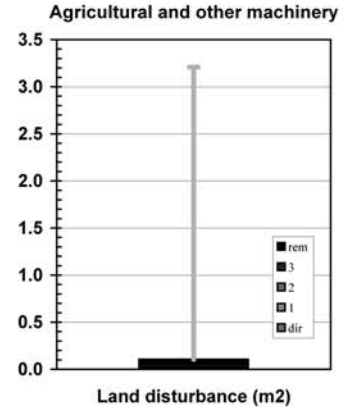
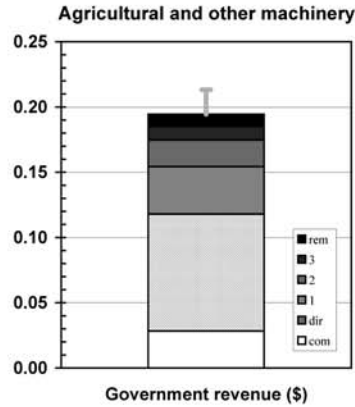
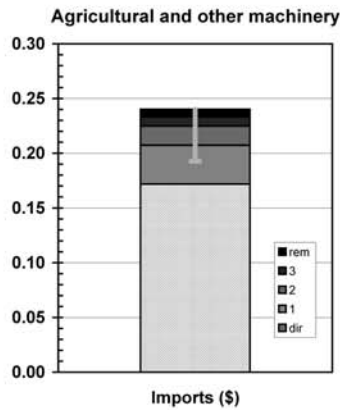


**Account #2**





Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 187.8	(0.07% of total)	(\$m 132.8 domestically produced)
Government final consumption	\$m 0.1	(0.00% of total)	(\$m 0.1 domestically produced)
Gross fixed capital expenditure	\$m 2,971.9	(2.84% of total)	(\$m 1,083.5 domestically produced)
Net changes in stocks	\$m 40.8	(2.31% of total)	(\$m 24.7 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 3,200.4</b>	<b>(0.70% of GNE)</b>	<b>(\$m 1,241.1 domestically produced)</b>
Exports	\$m 446.2	(0.54% of total)	(\$m 446.2 domestically produced)
<b>Final demand</b>	<b>\$m 3,646.6</b>	<b>(0.67% of GNT)</b>	<b>(\$m 1,687.3 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 569.9	(0.33% of total)
Gross operating surplus	\$m 229.5	(0.12% of total)
Taxes less subsidies	\$m 275.0	(0.32% of total)
<b>Sectoral GDP*</b>	<b>\$m 1,074.3</b>	<b>(0.24% of GDP)</b>
Imports	\$m 526.9	(0.54% of total)
<b>Primary inputs</b>	<b>\$m 1,601.3</b>	<b>(0.29% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 229.5	(0.12%)	\$m 126.3 (0.07%)	\$m 427.6 (0.22%)
Exports (\$m)	\$m 446.2	(0.54%)	\$m 245.5 (0.29%)	\$m 439.3 (0.53%)
Imports (\$m)	\$m 526.9	(0.54%)	\$m 289.9 (0.30%)	\$m 405.3 (0.42%)
Employment (e-y)	24,337 e-y	(0.34%)	13,389 e-y (0.19%)	22,823 e-y (0.32%)
Income (\$m)*	\$m 569.9	(0.33%)	\$m 313.5 (0.18%)	\$m 570.2 (0.33%)
Government revenue (\$m)†	\$m 322.8	(0.30%)	\$m 199.1 (0.18%)	\$m 328.2 (0.30%)
GHG emissions (kt CO <sub>2</sub> -e)	54 kt	(0.01%)	30 kt (0.01%)	1,284 kt (0.25%)
Water use (ML)	1,500 ML	(0.01%)	825 ML (0.00%)	10,704 ML (0.05%)
Land disturbance (kha)	3 kha	(0.00%)	2 kha (0.00%)	18 kha (0.01%)
Primary energy (TJ)	914 TJ	(0.02%)	503 TJ (0.01%)	14,496 TJ (0.37%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.07	0.25	0.38
Exports (\$)	0.15	0.26	0.16
Imports (\$)	0.17	0.24	0.19
Employment (min)	0.99	1.69	1.75
Income (\$)	0.19	0.34	0.34
Government revenue (\$)	0.12	0.19	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.02	0.76	1.02
Water use (L)	0.49	6.34	41.32
Land disturbance (m <sup>2</sup> )	0.01	0.11	3.21
Primary energy (MJ)	0.30	8.59	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Ma	0.0748	(0; 30.%)	Ma	0.99	(0; 59.%)	Is Ma	0.272	(1; 36.%)
Is Ma	0.0314	(1; 12.%)	Wt Ma	0.099	(1; 5.9%)	EI Ma	0.0691	(1; 9.1%)
Wt Ma	0.0138	(1; 5.4%)	Is Ma	0.075	(1; 4.4%)	EI Is Ma	0.0356	(2; 4.7%)
Io Is Ma	0.00406	(2; 1.6%)	Ee Ma	0.0169	(1; 1.%)	Ma	0.0176	(0; 2.3%)
Ts Ma	0.00373	(1; 1.5%)	Ts Ma	0.0168	(1; 0.99%)	Wt Ma	0.0137	(1; 1.8%)
EI Ma	0.00279	(1; 1.1%)	Sm Ma	0.0102	(1; 0.61%)	Nf Ma	0.00577	(1; 0.76%)
Ee Ma	0.00272	(1; 1.1%)	Fm Ma	0.00996	(1; 0.59%)	At Ma	0.00575	(1; 0.76%)
St Wt Ma	0.00262	(2; 1.%)	Bs Ma	0.00911	(1; 0.54%)	Gd Ma	0.00471	(1; 0.62%)
Cm Ma	0.00223	(1; 0.88%)	Ms Wt Ma	0.00894	(2; 0.53%)	Sp Is Ma	0.00427	(2; 0.56%)
Ms Wt Ma	0.00199	(2; 0.79%)	Rd Ma	0.00892	(1; 0.53%)	EI Wt Ma	0.00413	(2; 0.54%)
Ms Ma	0.00165	(1; 0.65%)	Mv Ma	0.00845	(1; 0.5%)	Bl Is Ma	0.00334	(2; 0.44%)
Pd Wt Ma	0.00158	(2; 0.62%)	Ms Ma	0.0074	(1; 0.44%)	Is Sm Ma	0.00333	(2; 0.44%)
Mv Ma	0.00156	(1; 0.61%)	Eq Ma	0.00627	(1; 0.37%)	Is Sh Ma	0.00287	(2; 0.38%)
Rd Ma	0.00152	(1; 0.6%)	Cm Ma	0.00617	(1; 0.37%)	Rd Ma	0.00241	(1; 0.32%)
EI Is Ma	0.00144	(2; 0.57%)	Sh Ma	0.0059	(1; 0.35%)	Cr Ma	0.00178	(1; 0.23%)
Nf Ma	0.00126	(1; 0.5%)	Wt Is Ma	0.00522	(2; 0.31%)	Bl EI Ma	0.00174	(2; 0.23%)
Sm Ma	0.00117	(1; 0.46%)	St Wt Ma	0.00428	(2; 0.25%)	At Wt Ma	0.00167	(2; 0.22%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Ma	0.145	(0; 56.%)	Ma	0.186	(0; 55.%)	Is Ma	0.72	(1; 11.%)
Is Ma	0.024	(1; 9.2%)	Wt Ma	0.0213	(1; 6.3%)	Ma	0.489	(0; 7.7%)
Wt Ma	0.0112	(1; 4.3%)	Is Ma	0.0179	(1; 5.3%)	Wa Ma	0.45	(1; 7.1%)
Io Is Ma	0.00653	(2; 2.5%)	Ts Ma	0.00393	(1; 1.2%)	EI Ma	0.382	(1; 6.%)
Nf Ma	0.00422	(1; 1.6%)	Ee Ma	0.00324	(1; 0.96%)	EI Is Ma	0.197	(2; 3.1%)
Ee Ma	0.00272	(1; 1.%)	Ms Wt Ma	0.00208	(2; 0.62%)	Wa Is Ma	0.122	(2; 1.9%)
At Ma	0.00183	(1; 0.7%)	Sm Ma	0.00176	(1; 0.52%)	Io Is Ma	0.0978	(2; 1.5%)
Sp Is Ma	0.00181	(2; 0.7%)	Ms Ma	0.00172	(1; 0.51%)	Br Is Ma	0.0713	(2; 1.1%)
Bl Is Ma	0.0013	(2; 0.5%)	Fm Ma	0.00156	(1; 0.46%)	Sm Ma	0.065	(1; 1.%)
Eq Ma	0.00112	(1; 0.43%)	Rd Ma	0.00153	(1; 0.45%)	Wt Ma	0.0554	(1; 0.87%)
Mv Ma	0.00102	(1; 0.39%)	Mv Ma	0.00146	(1; 0.43%)	Wa Ms Wt Ma	0.0513	(3; 0.81%)
Nf Is Ma	0.000776	(2; 0.3%)	Pd Wt Ma	0.00142	(2; 0.42%)	Wa Ts Ma	0.0502	(2; 0.79%)
Gl Nf Ma	0.000767	(2; 0.29%)	Cm Ma	0.0014	(1; 0.41%)	Wa Pd Wt Ma	0.0432	(3; 0.68%)
En Ma	0.000721	(1; 0.28%)	Sh Ma	0.00117	(1; 0.35%)	Wa Ms Ma	0.0424	(2; 0.67%)
Bl EI Ma	0.000676	(2; 0.26%)	Wt Is Ma	0.00112	(2; 0.33%)	Nf Ma	0.036	(1; 0.57%)
St Wt Ma	0.00065	(2; 0.25%)	Bs Ma	0.00112	(1; 0.33%)	Ee Ma	0.0356	(1; 0.56%)
Nf Ee Ma	0.00064	(2; 0.25%)	Os Ma	0.00111	(1; 0.33%)	Wa Wt Ma	0.0298	(2; 0.47%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Ma	0.172	(0; 72.%)	Ma	0.0897	(0; 54.%)	Ma	0.00974	(0; 9.2%)
Is Ma	0.0113	(1; 4.7%)	Wt Ma	0.00994	(1; 6.%)	Bc Mp Ho Ma	0.0047	(3; 4.5%)
Wt Ma	0.0032	(1; 1.3%)	Is Ma	0.00821	(1; 4.9%)	Wo Tx Wt Ma	0.00353	(3; 3.3%)
Ee Ma	0.00265	(1; 1.1%)	Ts Ma	0.00194	(1; 1.2%)	Bc Mp Ho Wt	0.00204	(4; 1.9%)
Mv Ma	0.00256	(1; 1.1%)	Ee Ma	0.00142	(1; 0.85%)	Wo Tx Tp Ma	0.00179	(3; 1.7%)
Ru Ma	0.00113	(1; 0.47%)	Rd Ma	0.00109	(1; 0.66%)	Wo Tx Ru Ma	0.00159	(3; 1.5%)
Ts Ma	0.00107	(1; 0.44%)	Ms Wt Ma	0.000988	(2; 0.59%)	Wo Tx Ma	0.00142	(2; 1.3%)
Pt Ma	0.000936	(1; 0.39%)	Pd Wt Ma	0.000933	(2; 0.56%)	Bc Mp Wt Ma	0.00134	(3; 1.3%)
Sm Ma	0.000839	(1; 0.35%)	At Ma	0.000819	(1; 0.49%)	EI Ma	0.00112	(1; 1.1%)
En Ma	0.000837	(1; 0.35%)	Ms Ma	0.000817	(1; 0.49%)	Bc Mp Rt Wt M	0.00104	(4; 0.99%)
Sp Is Ma	0.000762	(2; 0.32%)	Sm Ma	0.000677	(1; 0.41%)	Wo Tx Cl Ma	0.000935	(3; 0.89%)
Eq Ma	0.000738	(1; 0.31%)	Cm Ma	0.000669	(1; 0.4%)	Wt Ma	0.00084	(1; 0.8%)
Pl Ma	0.00069	(1; 0.29%)	Mv Ma	0.000627	(1; 0.38%)	Wo Tx Pl Ma	0.000692	(3; 0.66%)
Sh Ma	0.000682	(1; 0.28%)	St Wt Ma	0.000583	(2; 0.35%)	Wo Ts Ma	0.000644	(2; 0.61%)
Fm Ma	0.000674	(1; 0.28%)	Eq Ma	0.000548	(1; 0.33%)	At Ma	0.000624	(1; 0.59%)
At Ma	0.000545	(1; 0.23%)	Fm Ma	0.000545	(1; 0.33%)	Bc Mp Ho Is M	0.000621	(4; 0.59%)
Pr Ma	0.000522	(1; 0.22%)	EI Ma	0.000524	(1; 0.32%)	Bc Mp Ch Pl M	0.000596	(4; 0.57%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.096 ±0.024	(±2.2%)
Downstream	0.797 ±0.009	(±1.1%)

# Sector 2810: Other Machinery and Equipment (Eq)

*Pumps, bearings, air conditioning units, printing equipment, wood and metal working, powered hand tools, gas welding and cutting equipment, heat exchangers, food processing, packing, canning, bottling, labelling and other machinery and equipment*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicators of greenhouse emissions, water use and land disturbance are 40%, 85% and 95% lower than average respectively. The social indicators reveal excellent outcomes with employment generation and income 5% above and equal to average respectively while government revenue is 70% above average. The financial indicators reveal that operating surplus is 30% below average, export propensity is more than two times the average and import penetration is 10% above average. The sector has a set of globally competitive firms which service industries based on Australia's natural resource endowments in mining and agriculture. Specific metal processes may emit toxic compounds.

## Sector Description

This diverse manufacturing sector produces everything from pumps and bearings to air conditioners, heat exchangers and food processing equipment. It is globally competitive across a wide range of manufactures with exports showing a steady upwards trend over the last 20 years particularly to countries such as USA, New Zealand, Singapore, United Kingdom and Indonesia. Typical of successful firms are ANCA Pty Ltd (precision tool cutting and grinding equipment), and J. Furphy and Sons (processing equipment for dairy, wine, brewing and chemical industries) which occupy successful niches in competitive world markets. In 2002, sector turnover was around \$6 billion.

## Place of Industry in the Economy

The other manufacturing and equipment sector ranks 50<sup>th</sup> out of 135 sectors in terms of value adding to the economy and generated 0.36% of GDP in this analysis. It is similar in value adding to the furniture manufacturing sector and the exploration and services to mining sector. It is a moderate sized employer with a direct requirement of 17 000 employment years and another 8 000 years in its suppliers, giving a total of 25 000 employment years. In addition, it supplies another 20 000 employment years to downstream industries. Its resource requirements are relatively small with less than one tenth of one percent of national water use and land disturbance, and around three tenths of one percent of energy use and greenhouse emissions. Exports outweigh imports by 50%.

## Strategic Overview

The overview of the other manufacturing and equipment sector portrayed in the spider diagram shows a balanced TBL account with below average outcomes for the financial indicators of operating surplus and import penetration. The sector is characterised by both high imports and exports as specialised equipment requires components not produced in Australia. Thus import penetration may be difficult to improve in this component churn, typical of globalised trade. Current high exchange rates are assumed to disadvantage manufacturing exports and thereby the resultant profits or surplus. Upstream issues for the sector relate to the safety of the workforce in complex fabrication procedures and the use of coating materials and process compounds, some of which can produce toxic emissions. Downstream issues relate mainly to design sophistication of the equipment which determines process efficiency and thereby the overall system's environmental performance.

## TBL Account #1

The financial indicator of operating surplus is 30% below the economy wide average with about half of this due to a direct sector effect with steel tubes and sheets (9%), wholesale trade (3%) and electrical equipment (1%) also making contributions. The social indicator of employment generation is 5% above average and about two thirds of this is a direct effect. The environmental indicator of greenhouse emissions is 40% below average. Only 1% of emissions are due to fuel combusted directly within the sector, and about half are due to production of steel and the generation of electricity.

## TBL Accounts #2 and #3

The second TBL account reveals an export propensity that is more than twice the economy wide average, income that is equal to average and water use that is 85% below average. The third TBL account shows that import penetration is 10% above average (imported components), government revenue is 70% above average and land disturbance is 95% below average. While the import penetration indicator could be improved, these accounts portray the sector's good TBL outcome.

## Structural Path Analysis and Linkages

While the TBL account provides good outcomes, the indicators of operating surplus and import penetration may require further investigation. The structural path analysis shows that both indicators have a large direct component with import penetration at 72%, and surplus at 47%. Thus sector reform is obviously the first option for improvement. Steel tubes, electrical equipment, and wholesale trade contribute to both indicators, but their contributions are moderate to small.

The sector provides below average stimulus to its domestic suppliers although steel components and wholesale trade are individually significant. The sector is relatively self contained but also requires specialised imported components from outside the domestic supply chain. It also has below average linkages to downstream industries, as much of its output is dissipated by export activity.

## Future Trends in Sector

The base case scenario of the *Future Dilemmas* study, using aggregated machinery descriptions, anticipates that activity could increase from 50 to 100% by the year 2051 depending on the specific machine set. Other studies suggest that the recent successful trend in exports of 'elaborately transformed manufactures' will be continued. This relies on a wide range of domestic (innovation, investment, policy, market success) and international (globalised trade in general) drivers, and the outcomes are considered highly uncertain. A recent report suggests that Australia could evolve to an industrial structure in this area, similar to Ireland or Finland.

## Innovation and Technical Opportunities

Germany, USA, Japan and Italy lead the export of specialised machinery. Australia's scale and technological know-how may never rival these major countries. However this does not negate the opportunities related to particular manufacturing niches, possibly linked to mining, minerals, agriculture and the process of value adding in these sectors. The replacement of normal machines by micro-machines or nano-technology is a key issue for the next 20 years as is the confluence of genetic engineering, nano-technology, materials science and information technology. The current literature points to three facets that are keys to success. The first is the active participation of users in the innovation process and this requires fluent linkages with export markets. The second is that robots will not substantially replace skilled workers in high value-added machinery markets where flexibility is the key. The third is that firms on the 'edge' may out-compete and out-innovate firms at the 'core' as they begin with a clean slate and don't have to undertake market adjustment.

**Sector**

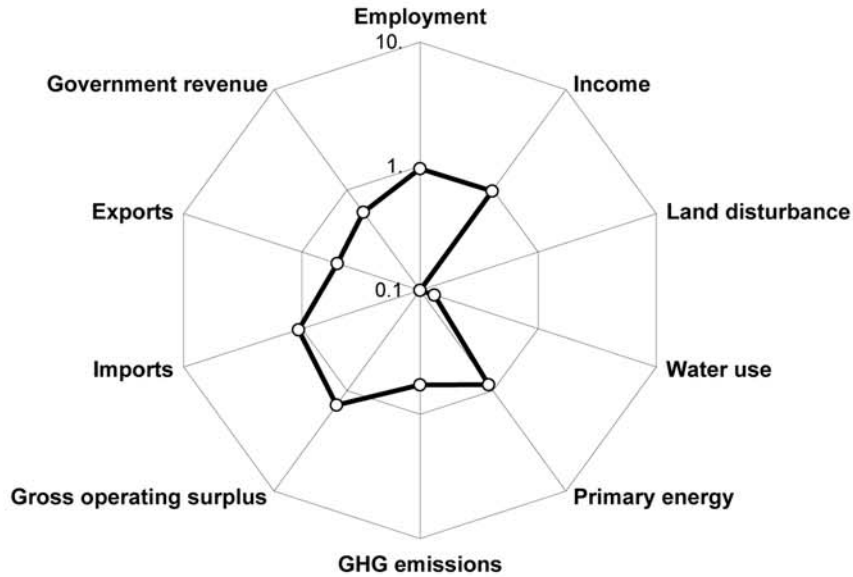
**Other machinery and equipment**

**(Eq)**

Pumps, bearings, air conditioning units, printing equipment, wood and metal working, powered hand tools, gas welding and cutting equipment, heat exchangers; food processing, packing, canning, bottling, labelling and other machinery and equipment

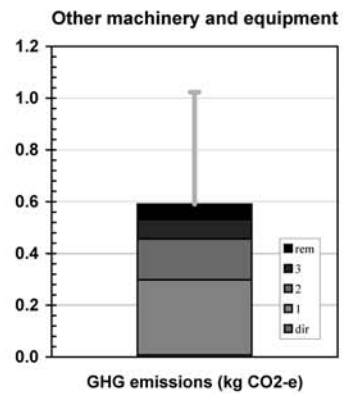
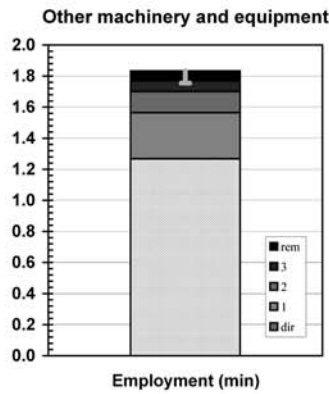
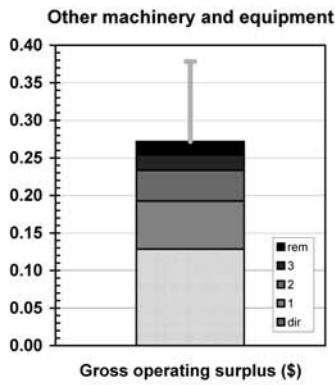
Spider diagram

**Other machinery and equipment**

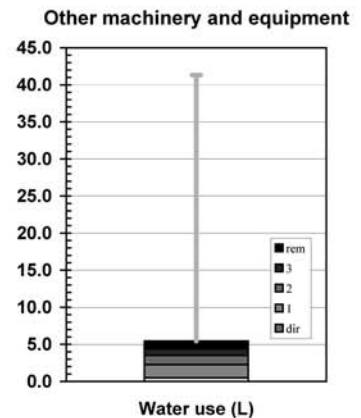
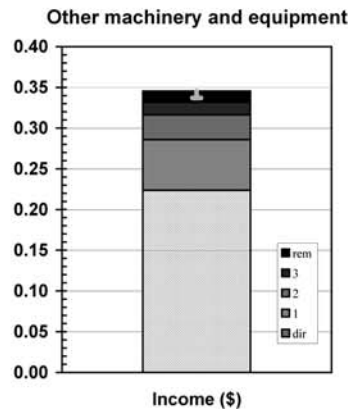
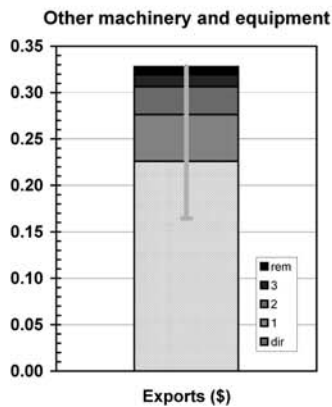


Bar graphs

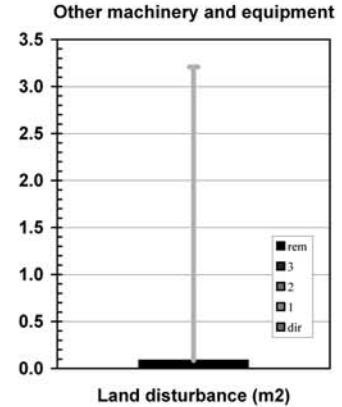
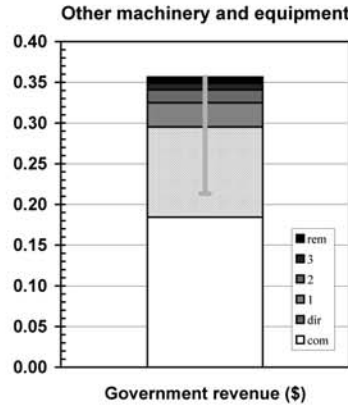
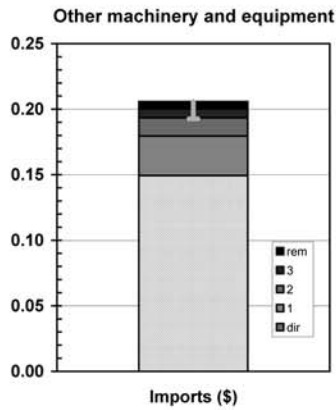
**Account #1**



**Account #2**



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 41.9	(0.02% of total)	(\$m 4.4 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 3,462.4	(3.31% of total)	(\$m 879.7 domestically produced)
Net changes in stocks	\$m 62.3	(3.52% of total)	
<b>Sectoral GNE</b>	<b>\$m 3,566.6</b>	<b>(0.78% of GNE)</b>	<b>(\$m 879.5 domestically produced)</b>
Exports	\$m 831.5	(1.00% of total)	(\$m 831.5 domestically produced)
<b>Final demand</b>	<b>\$m 4,398.1</b>	<b>(0.81% of GNT)</b>	<b>(\$m 1,711.0 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 823.1	(0.48% of total)
Gross operating surplus	\$m 472.4	(0.25% of total)
Taxes less subsidies	\$m 407.9	(0.48% of total)
<b>Sectoral GDP*</b>	<b>\$m 1,703.4</b>	<b>(0.38% of GDP)</b>
Imports	\$m 549.6	(0.56% of total)
<b>Primary inputs</b>	<b>\$m 2,253.0</b>	<b>(0.41% of GNT)</b>

\* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 472.4	(0.25%)	\$m 220.1 (0.11%)	\$m 466.5 (0.24%)
Exports (\$m)	\$m 831.5	(1.00%)	\$m 387.5 (0.46%)	\$m 563.0 (0.68%)
Imports (\$m)	\$m 549.6	(0.56%)	\$m 256.1 (0.26%)	\$m 353.1 (0.36%)
Employment (e-y)	37,375 e-y	(0.52%)	17,417 e-y (0.24%)	25,208 e-y (0.35%)
Income (\$m)*	\$m 823.1	(0.48%)	\$m 383.6 (0.22%)	\$m 592.9 (0.35%)
Government revenue (\$m)†	\$m 724.0	(0.67%)	\$m 506.2 (0.47%)	\$m 611.6 (0.57%)
GHG emissions (kt CO <sub>2</sub> -e)	27 kt	(0.01%)	13 kt (0.00%)	1,014 kt (0.20%)
Water use (ML)	1,798 ML	(0.01%)	838 ML (0.00%)	9,371 ML (0.04%)
Land disturbance (kha)	4 kha	(0.00%)	2 kha (0.00%)	15 kha (0.01%)
Primary energy (TJ)	458 TJ	(0.01%)	213 TJ (0.01%)	11,438 TJ (0.29%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.13	0.27	0.38
Exports (\$)	0.23	0.33	0.16
Imports (\$)	0.15	0.21	0.19
Employment (min)	1.27	1.83	1.75
Income (\$)	0.22	0.35	0.34
Government revenue (\$)	0.30	0.36	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.01	0.59	1.02
Water use (L)	0.49	5.46	41.32
Land disturbance (m <sup>2</sup> )	0.01	0.09	3.21
Primary energy (MJ)	0.12	6.67	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Eq	0.128	(0; 47.%)	Eq	1.27	(0; 69.%)	Is Eq	0.188	(1; 32.%)
Is Eq	0.0218	(1; 8.%)	Wt Eq	0.0599	(1; 3.3%)	El Eq	0.0673	(1; 11.%)
Wt Eq	0.00832	(1; 3.1%)	Is Eq	0.0519	(1; 2.8%)	El Is Eq	0.0247	(2; 4.2%)
Io Is Eq	0.00281	(2; 1.%)	Ee Eq	0.017	(1; 0.93%)	Nf Eq	0.0116	(1; 2.%)
Ee Eq	0.00274	(1; 1.%)	Sm Eq	0.0147	(1; 0.8%)	Wt Eq	0.0083	(1; 1.4%)
El Eq	0.00272	(1; 1.%)	Ms Eq	0.0105	(1; 0.57%)	Eq	0.00737	(0; 1.2%)
Nf Eq	0.00253	(1; 0.93%)	Bs Eq	0.00801	(1; 0.44%)	Is Sm Eq	0.00478	(2; 0.81%)
Cm Eq	0.00242	(1; 0.89%)	Fm Eq	0.00788	(1; 0.43%)	Is Sh Eq	0.00326	(2; 0.55%)
Ms Eq	0.00233	(1; 0.86%)	Ts Eq	0.00759	(1; 0.41%)	At Eq	0.00313	(1; 0.53%)
Ts Eq	0.00168	(1; 0.62%)	Sh Eq	0.0067	(1; 0.37%)	Sp Is Eq	0.00296	(2; 0.5%)
Sm Eq	0.00168	(1; 0.62%)	Cm Eq	0.00669	(1; 0.36%)	El Wt Eq	0.0025	(2; 0.42%)
St Wt Eq	0.00159	(2; 0.58%)	Ma Eq	0.00658	(1; 0.36%)	El Nf Eq	0.00234	(2; 0.4%)
Ms Wt Eq	0.00121	(2; 0.44%)	Ms Wt Eq	0.00541	(2; 0.29%)	Bl Is Eq	0.00231	(2; 0.39%)
Sh Eq	0.00112	(1; 0.41%)	Ot Eq	0.00537	(1; 0.29%)	Gd Eq	0.00206	(1; 0.35%)
El Is Eq	0.000996	(2; 0.37%)	Rd Eq	0.00435	(1; 0.24%)	El Ot Eq	0.00196	(2; 0.33%)
Pd Wt Eq	0.000955	(2; 0.35%)	Wt Is Eq	0.00361	(2; 0.2%)	Is Ma Eq	0.00181	(2; 0.31%)
Pt Eq	0.000825	(1; 0.3%)	Bk Eq	0.00325	(1; 0.18%)	Bl El Eq	0.0017	(2; 0.29%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Eq	0.226	(0; 69.%)	Eq	0.224	(0; 65.%)	Is Eq	0.498	(1; 9.1%)
Is Eq	0.0166	(1; 5.1%)	Wt Eq	0.0129	(1; 3.7%)	Eq	0.488	(0; 8.9%)
Nf Eq	0.0085	(1; 2.6%)	Is Eq	0.0124	(1; 3.6%)	Wa Eq	0.463	(1; 8.5%)
Wt Eq	0.0068	(1; 2.1%)	Ee Eq	0.00326	(1; 0.94%)	El Eq	0.372	(1; 6.8%)
Io Is Eq	0.00452	(2; 1.4%)	Sm Eq	0.00253	(1; 0.73%)	El Is Eq	0.136	(2; 2.5%)
Ee Eq	0.00274	(1; 0.83%)	Ms Eq	0.00243	(1; 0.7%)	Sm Eq	0.0932	(1; 1.7%)
Gl Nf Eq	0.00154	(2; 0.47%)	Ts Eq	0.00178	(1; 0.51%)	Wa Is Eq	0.0847	(2; 1.6%)
Sp Is Eq	0.00125	(2; 0.38%)	Cm Eq	0.00152	(1; 0.44%)	Nf Eq	0.0724	(1; 1.3%)
At Eq	0.000995	(1; 0.3%)	Ot Eq	0.00151	(1; 0.44%)	Io Is Eq	0.0677	(2; 1.2%)
Ma Eq	0.000967	(1; 0.29%)	Sh Eq	0.00133	(1; 0.38%)	Wa Ms Eq	0.06	(2; 1.1%)
Uo Nf Eq	0.000942	(2; 0.29%)	Ms Wt Eq	0.00126	(2; 0.36%)	Br Eq	0.0528	(1; 0.97%)
Bl Is Eq	0.000896	(2; 0.27%)	Ma Eq	0.00124	(1; 0.36%)	Br Is Eq	0.0493	(2; 0.9%)
Bl El Eq	0.000658	(2; 0.2%)	Fm Eq	0.00123	(1; 0.36%)	Ee Eq	0.0358	(1; 0.66%)
Nf Ee Eq	0.000644	(2; 0.2%)	Bs Eq	0.000984	(1; 0.28%)	Wt Eq	0.0335	(1; 0.61%)
Co Nf Eq	0.000631	(2; 0.19%)	Pd Wt Eq	0.000861	(2; 0.25%)	Wa Ms Wt Eq	0.031	(3; 0.57%)
Nf Is Eq	0.000537	(2; 0.16%)	El Eq	0.000818	(1; 0.24%)	Uo Nf Eq	0.0302	(2; 0.55%)
Sm Eq	0.000518	(1; 0.16%)	Bk Eq	0.000802	(1; 0.23%)	Wa Pd Wt Eq	0.0261	(3; 0.48%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Eq	0.149	(0; 73.%)	Eq	0.111	(0; 64.%)	Eq	0.00968	(0; 11.%)
Is Eq	0.00783	(1; 3.8%)	Wt Eq	0.00601	(1; 3.5%)	Bc Mp Ho Eq	0.00304	(3; 3.5%)
Ee Eq	0.00267	(1; 1.3%)	Is Eq	0.00568	(1; 3.3%)	Wo Tx Eq	0.00214	(2; 2.5%)
Wt Eq	0.00193	(1; 0.94%)	Ee Eq	0.00143	(1; 0.83%)	Wo Tx Wt Eq	0.00213	(3; 2.5%)
Sm Eq	0.0012	(1; 0.58%)	Ms Eq	0.00116	(1; 0.67%)	Wo Tx Tp Eq	0.00143	(3; 1.7%)
Ma Eq	0.00114	(1; 0.55%)	Sm Eq	0.000971	(1; 0.56%)	Bc Mp Eq	0.00123	(2; 1.4%)
Nf Eq	0.00102	(1; 0.5%)	Ts Eq	0.000875	(1; 0.51%)	Bc Mp Ho Wt	0.00123	(4; 1.4%)
Pt Eq	0.000901	(1; 0.44%)	Cm Eq	0.000725	(1; 0.42%)	Wo Tx Ru Eq	0.00115	(3; 1.3%)
Ru Eq	0.000815	(1; 0.4%)	Ot Eq	0.000693	(1; 0.4%)	El Eq	0.00109	(1; 1.3%)
Sh Eq	0.000774	(1; 0.38%)	Ms Wt Eq	0.000597	(2; 0.35%)	Bc Mp Wt Eq	0.000813	(3; 0.95%)
En Eq	0.000572	(1; 0.28%)	Ma Eq	0.000596	(1; 0.35%)	Wo Tx Cl Eq	0.000655	(3; 0.76%)
Pr Eq	0.000568	(1; 0.28%)	Nf Eq	0.000587	(1; 0.34%)	Bc Mp Rt Wt E	0.00063	(4; 0.73%)
Fm Eq	0.000533	(1; 0.26%)	Sh Eq	0.000585	(1; 0.34%)	Bc Mp Ho Ms	0.000565	(4; 0.66%)
Ms Eq	0.000531	(1; 0.26%)	Pd Wt Eq	0.000564	(2; 0.33%)	Wt Eq	0.000508	(1; 0.59%)
Sp Is Eq	0.000527	(2; 0.26%)	Rd Eq	0.000531	(1; 0.31%)	Wo Tx Pl Eq	0.000455	(3; 0.53%)
Ts Eq	0.000483	(1; 0.23%)	El Eq	0.00051	(1; 0.3%)	Bc Mp Rt Eq	0.000454	(3; 0.53%)
Pl Eq	0.000454	(1; 0.22%)	At Eq	0.000445	(1; 0.26%)	Bc Mp Ho Is E	0.00043	(4; 0.5%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	0.881 ±0.017	(±2.0%)
Downstream	0.902 ±0.014	(±1.6%)

# Sector 2901: Prefabricated Buildings (Bu)

## *Prefabricated buildings*

### Short Summary

Against the metric of one dollar of final demand, the environmental indicators of water use and land disturbance are 70% and 90% below average respectively while greenhouse emissions are equal to average. The social indicators of employment generation and income are 5% above and equal to average respectively, while government revenue is 30% below average. The financial indicators reveal an operating surplus 10% below average, export propensity 25% above average, and import penetration equal to average. Because of the 'one stop shop' nature of the sector, it could design and manufacture buildings with integrated solar thermal and solar photovoltaic cladding, and with removable tech-pods containing power, water, and waste technologies and functions. This could provide stand-alone and semi-sustainable housing decoupled from central utility grids.

### Sector Description

This sector includes the manufacture and erection of transportable homes, carports, sheds and garages mostly made of metal, but also including concrete and timber as primary construction materials. The traditional focus of the sector is in construction projects, mining camps, defence locations and the urban fringe. However it is displacing normal housing construction for reasons of lower cost, lack of local building skills, immediacy and transportability. Potentially, a large export opportunity exists both for basic housing in the Asia-Pacific region, and for more sophisticated dwellings in Japan. The sector has approximately 220 enterprises with an approximate financial turnover of \$700 million in 2002.

### Place of Industry in the Economy

The prefabricated buildings sector ranks 129<sup>th</sup> out of 135 sectors in terms of value adding in the Australian economy, and contributes 0.04% of GDP in this analysis. It is similar in value adding activity to the leather products, and the pig farming sectors. It is a small employer with a requirement of 3 000 employment years in both direct and indirect terms, giving a total of 6 000 employment years. In addition it supplies 1 000 employment years to downstream industries such as sand and gravel mining, defence and non-residential construction. The sector's resource requirements are small and represent less than one tenth of one percent of national land disturbance, water use, energy use, and greenhouse emissions. In financial terms, imports are twice the size of exports but recent trade deals will have altered this considerably.

### Strategic Overview

The spider diagram for the prefabricated buildings sector shows a reasonably balanced TBL account with less than average performance from two indicators, government revenue and primary energy use and these indicators may be difficult to improve. Extracting more government revenue from the sector could impact on employment and income indicators. Improving energy and greenhouse indicators given the steel content may be difficult due to lack of alternative materials, although sourcing recycled product might become a procurement option. There are a number of downstream issues related to environmental and social performance. The 'on demand' nature of some of the sector's products, particularly for mining and development projects in remote areas, requires robust products that can be easily connected to site services. In these situations social and environmental performance is a lesser requirement, but is an issue when buildings are transformed to clusters of permanent dwellings. This is a design challenge for the next generation of prefabricated product.



## TBL Account #1

The financial indicator of operating surplus is 10% below the economy wide average and about one third of this is a direct sector effect, with the rest due to first and second order suppliers such as iron and steel, nuts and bolts, structural metal, and wholesale trade. The social indicator of employment generation is 5% above average with one half of this being a direct sector effect. The environmental indicator of greenhouse emissions is equal to average, with about one tenth due to fuel directly combusted within the sector.

## TBL Accounts #2 and #3

The second TBL account reveals that export propensity is 25% larger than average, income is equal to average and that water use is 70% below average. The third TBL account reveals that import penetration is equal to average, government revenue is 30% below average and that land disturbance is 70% below average. It may not be feasible to improve the government revenue indicator since this is generally perceived as a basic but more affordable housing class.

## Structural Path Analysis and Linkages

Direct combustion of energy within the sector contributes 8% of greenhouse emissions. The largest component is iron and steel production (22%) along with 'electricity embodied in iron and steel' (3%), metal frames (2%) and nuts and bolts (2%). The production chain for sawn timber and plywood contains another 4%. Such an extended greenhouse chain is difficult to improve substantially. However steel sourced from recycled stock reformed by a hydro or wind-powered electric arc furnace process electricity would minimise carbon content.

The sector's stimulus to its upstream suppliers is 40% greater than the economy wide average with a larger effect on obvious sectors such as iron and steel pipe, copper pipes and sheets, mesh, nuts and bolts and wholesale trade. The linkages to downstream industries are relatively weak. If the sector were to expand, it would need to be accompanied by expansion of construction materials, residential and non-residential construction, and defence.

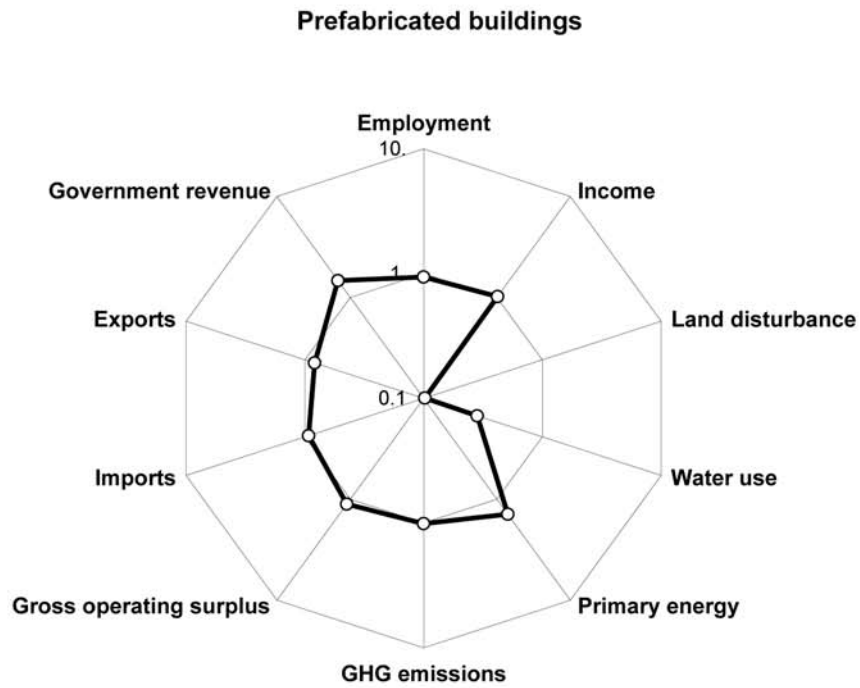
## Future Trends in Sector

National statistics are difficult to derive for this sector and the prefabricated housing part of it is very much a residual value found in the 'other' category of the national housing stocks. Currently there are around 150 000 'other' houses and the *Future Dilemmas* study anticipates this category could number around 220 000 in 2050, an increase of 46%. In the same period, the overall housing stock for 25 million people will increase by 50%. This could change markedly in the intervening five decades as cost structures and regional population pressures evolve in unforeseen directions.

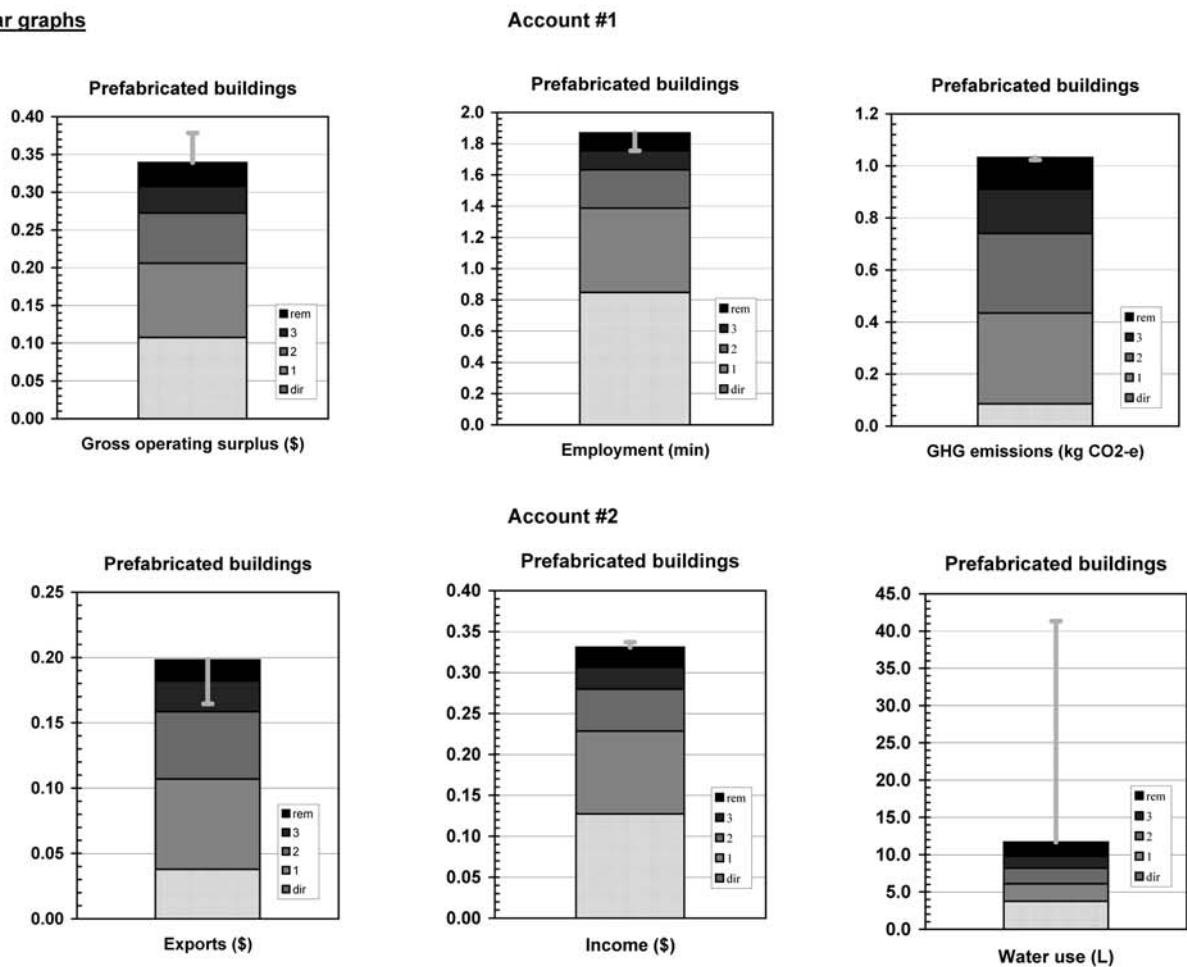
## Innovation and Technical Opportunities

In seeking an advantaged market position, this sector must track away from cheap bulk commodity designs towards habitation modules that integrate key sustainability concepts, such as full compatibility with recycling and re-engineering standards, as well as a stand alone 'energy-water -waste' capability with a short payback time. The key advantage for this sector is that all operations take place in the one shop, with possible synergies for scale and innovation, compared to normal domestic building. Many parts of the jigsaw are already mature in Australian industry, but the market has not yet perceived signals to stimulate the essential system integration, refinement, and scaling up. Domestically it remains in the 'back yard innovators' league. In 2002 near the Capitol in Washington DC, fourteen prefabricated solar homes were presented, all meeting exacting standards of energy self sufficiency, liveability, and technical performance. Their prototype cost was around \$A300 000 providing sufficient proof of practice to catalyse the next generation of prefabricators.

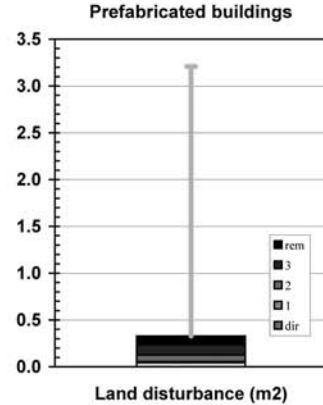
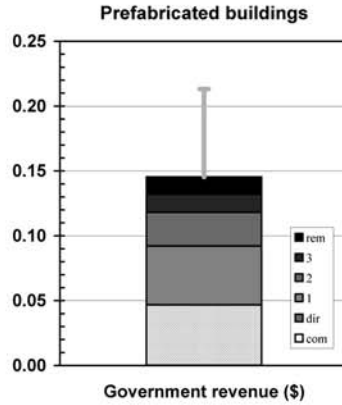
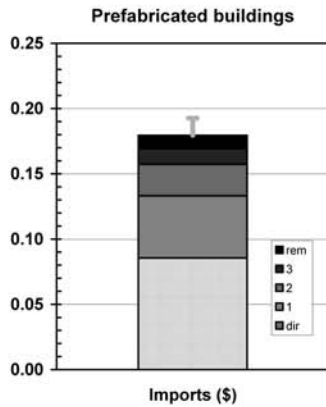
Spider diagram



Bar graphs



Account #3



National Accounts extracts

Receipts: GNT(E) - commodities

Private final consumption	\$m 1.4	(0.00% of total)	(\$m 1.4 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 394.6	(0.38% of total)	(\$m 392.5 domestically produced)
Net changes in stocks	\$m 4.5	(0.26% of total)	(\$m 4.5 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 400.5</b>	<b>(0.09% of GNE)</b>	<b>(\$m 398.4 domestically produced)</b>
Exports	\$m 22.4	(0.03% of total)	(\$m 22.4 domestically produced)
Final demand	\$m 422.9	(0.08% of GNT)	(\$m 420.8 domestically produced)

Costs: GNT(I) - industries

Wages and salaries	\$m 75.1	(0.04% of total)
Gross operating surplus	\$m 63.6	(0.03% of total)
Taxes less subsidies	\$m 27.6	(0.03% of total)
<b>Sectoral GDP*</b>	<b>\$m 166.3</b>	<b>(0.04% of GDP)</b>
Imports	\$m 50.5	(0.05% of total)
<b>Primary inputs</b>	<b>\$m 216.8</b>	<b>(0.04% of GNT)</b>

\* Sectoral gross value added + net taxes on products

TBL factors

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 63.6	(0.03%)	\$m 45.3 (0.02%)	\$m 142.8 (0.07%)
Exports (\$m)	\$m 22.4	(0.03%)	\$m 16.0 (0.02%)	\$m 83.4 (0.10%)
Imports (\$m)	\$m 50.5	(0.05%)	\$m 36.0 (0.04%)	\$m 75.5 (0.08%)
Employment (e-y)	4,013 e-y	(0.06%)	2,857 e-y (0.04%)	6,300 e-y (0.09%)
Income (\$m)*	\$m 75.1	(0.04%)	\$m 53.5 (0.03%)	\$m 139.2 (0.08%)
Government revenue (\$m)†	\$m 27.6	(0.03%)	\$m 19.7 (0.02%)	\$m 61.2 (0.06%)
GHG emissions (kt CO <sub>2</sub> -e)	51 kt	(0.01%)	36 kt (0.01%)	434 kt (0.08%)
Water use (ML)	2,217 ML	(0.01%)	1,578 ML (0.01%)	4,921 ML (0.02%)
Land disturbance (kha)	3 kha	(0.00%)	2 kha (0.00%)	14 kha (0.01%)
Primary energy (TJ)	869 TJ	(0.02%)	618 TJ (0.02%)	4,526 TJ (0.12%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

TBL multipliers - commodities

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.11	0.34	0.38
Exports (\$)	0.04	0.20	0.16
Imports (\$)	0.09	0.18	0.19
Employment (min)	0.85	1.87	1.75
Income (\$)	0.13	0.33	0.34
Government revenue (\$)	0.05	0.15	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.09	1.03	1.02
Water use (L)	3.75	11.69	41.32
Land disturbance (m <sup>2</sup> )	0.04	0.33	3.21
Primary energy (MJ)	1.47	10.75	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Bu	0.108	(0; 32.%)	Bu	0.847	(0; 45.%)	Is Bu	0.232	(1; 22.%)
Is Bu	0.0269	(1; 7.9%)	Fm Bu	0.139	(1; 7.4%)	Bu	0.0855	(0; 8.3%)
Fm Bu	0.0125	(1; 3.7%)	Sm Bu	0.0753	(1; 4.%)	Sw Ti Bu	0.0331	(2; 3.2%)
Sm Bu	0.00859	(1; 2.5%)	Is Bu	0.0641	(1; 3.4%)	El Is Bu	0.0304	(2; 3.%)
Wt Bu	0.00637	(1; 1.9%)	Wt Bu	0.0459	(1; 2.5%)	Nf Bu	0.0262	(1; 2.5%)
Nf Bu	0.0057	(1; 1.7%)	Wp Bu	0.0336	(1; 1.8%)	Is Sm Bu	0.0245	(2; 2.4%)
Ti Bu	0.00402	(1; 1.2%)	Ti Bu	0.0262	(1; 1.4%)	El Bu	0.0221	(1; 2.1%)
Wp Bu	0.00373	(1; 1.1%)	Fu Bu	0.0141	(1; 0.76%)	Is Fm Bu	0.0202	(2; 2.%)
Io Is Bu	0.00347	(2; 1.%)	Rd Bu	0.0136	(1; 0.73%)	Fr Sw Ti Bu	0.0143	(3; 1.4%)
Is Sm Bu	0.00283	(2; 0.84%)	Ts Bu	0.0118	(1; 0.63%)	El Fm Bu	0.0106	(2; 1.%)
Ts Bu	0.00261	(1; 0.77%)	Fm Sm Bu	0.0115	(2; 0.61%)	Ti Bu	0.00879	(1; 0.85%)
Is Fm Bu	0.00234	(2; 0.69%)	Ho Bu	0.00978	(1; 0.52%)	Gd Bu	0.00831	(1; 0.81%)
Rd Bu	0.00231	(1; 0.68%)	Bs Bu	0.00886	(1; 0.47%)	Ga Bu	0.00662	(1; 0.64%)
Rv Bu	0.00226	(1; 0.66%)	Gp Bu	0.0072	(1; 0.39%)	Wt Bu	0.00635	(1; 0.62%)
Gp Bu	0.00206	(1; 0.61%)	Is Sm Bu	0.00676	(2; 0.36%)	Sw Wp Bu	0.00614	(2; 0.6%)
Cm Bu	0.00192	(1; 0.57%)	Rv Bu	0.00603	(1; 0.32%)	Sw Ti Wp Bu	0.00548	(3; 0.53%)
Cp Bu	0.00187	(1; 0.55%)	Ms Bu	0.00594	(1; 0.32%)	El Nf Bu	0.00528	(2; 0.51%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Bu	0.0379	(0; 19.%)	Bu	0.127	(0; 38.%)	Bu	3.75	(0; 32.%)
Is Bu	0.0205	(1; 10.%)	Fm Bu	0.0218	(1; 6.6%)	Is Bu	0.615	(1; 5.3%)
Nf Bu	0.0191	(1; 9.7%)	Is Bu	0.0153	(1; 4.6%)	Sm Bu	0.478	(1; 4.1%)
Fm Bu	0.00716	(1; 3.6%)	Sm Bu	0.013	(1; 3.9%)	Wp Bu	0.276	(1; 2.4%)
Io Is Bu	0.00558	(2; 2.8%)	Wt Bu	0.00984	(1; 3.%)	Fm Bu	0.192	(1; 1.6%)
Ti Bu	0.00522	(1; 2.6%)	Wp Bu	0.00649	(1; 2.%)	El Is Bu	0.168	(2; 1.4%)
Wt Bu	0.00521	(1; 2.6%)	Ti Bu	0.00424	(1; 1.3%)	Wa Bu	0.166	(1; 1.4%)
GI Nf Bu	0.00348	(2; 1.8%)	Ts Bu	0.00276	(1; 0.83%)	Nf Bu	0.163	(1; 1.4%)
Sm Bu	0.00266	(1; 1.3%)	Rd Bu	0.00234	(1; 0.71%)	El Bu	0.122	(1; 1.%)
Is Sm Bu	0.00217	(2; 1.1%)	Fu Bu	0.0018	(1; 0.54%)	Wa Is Bu	0.105	(2; 0.89%)
Uo Nf Bu	0.00212	(2; 1.1%)	Fm Sm Bu	0.0018	(2; 0.54%)	Io Is Bu	0.0836	(2; 0.71%)
Nf Fm Bu	0.00183	(2; 0.92%)	Is Sm Bu	0.00161	(2; 0.49%)	Ws Ho Bu	0.0713	(2; 0.61%)
Nf Sm Bu	0.00179	(2; 0.9%)	Ho Bu	0.00143	(1; 0.43%)	Uo Nf Bu	0.0681	(2; 0.58%)
Is Fm Bu	0.00179	(2; 0.9%)	Ms Bu	0.00138	(1; 0.42%)	Is Sm Bu	0.0649	(2; 0.55%)
Sp Is Bu	0.00155	(2; 0.78%)	Gp Bu	0.00135	(1; 0.41%)	Br Is Bu	0.0609	(2; 0.52%)
Co Nf Bu	0.00142	(2; 0.72%)	Is Fm Bu	0.00133	(2; 0.4%)	El Fm Bu	0.0585	(2; 0.5%)
Bl Is Bu	0.00111	(2; 0.56%)	Nf Bu	0.00133	(1; 0.4%)	Wa Fm Bu	0.0548	(2; 0.47%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Bu	0.0855	(0; 48.%)	Bu	0.0467	(0; 32.%)	Bu	0.0442	(0; 13.%)
Is Bu	0.00967	(1; 5.4%)	Fm Bu	0.0076	(1; 5.2%)	Wo Tx Bu	0.0274	(2; 8.3%)
Fm Bu	0.0094	(1; 5.2%)	Is Bu	0.00702	(1; 4.8%)	Sw Ti Bu	0.0261	(2; 7.9%)
Sm Bu	0.00617	(1; 3.4%)	Sm Bu	0.00498	(1; 3.4%)	Wo Tx Cl Bu	0.0212	(3; 6.5%)
Wp Bu	0.0033	(1; 1.8%)	Wt Bu	0.0046	(1; 3.2%)	Bc Mp Ho Bu	0.0141	(3; 4.3%)
Nf Bu	0.0023	(1; 1.3%)	Wp Bu	0.00316	(1; 2.2%)	Wo Tx Tp Bu	0.012	(3; 3.6%)
Ti Bu	0.00204	(1; 1.1%)	Ti Bu	0.00186	(1; 1.3%)	Wo Tx Fu Bu	0.0107	(3; 3.3%)
Wt Bu	0.00148	(1; 0.82%)	Rd Bu	0.00166	(1; 1.1%)	Sw Wp Bu	0.00484	(2; 1.5%)
Pt Bu	0.0013	(1; 0.72%)	Ts Bu	0.00136	(1; 0.93%)	Fr Sw Ti Bu	0.00459	(3; 1.4%)
Is Sm Bu	0.00102	(2; 0.57%)	Nf Bu	0.00132	(1; 0.91%)	Sw Ti Wp Bu	0.00431	(3; 1.3%)
Fu Bu	0.000937	(1; 0.52%)	Fu Bu	0.000867	(1; 0.6%)	Bc Mp Rt Bu	0.0024	(3; 0.73%)
Is Fm Bu	0.000842	(2; 0.47%)	Ho Bu	0.000751	(1; 0.52%)	Hw Ti Bu	0.0023	(2; 0.7%)
PI Bu	0.000832	(1; 0.46%)	Is Sm Bu	0.00074	(2; 0.51%)	Fm Bu	0.00214	(1; 0.65%)
Fm Sm Bu	0.000777	(2; 0.43%)	Ms Bu	0.000656	(1; 0.45%)	Sm Bu	0.0019	(1; 0.58%)
Ts Bu	0.00075	(1; 0.42%)	Gp Bu	0.00065	(1; 0.45%)	Wo Tx Sm Bu	0.00169	(3; 0.51%)
Cl Bu	0.000672	(1; 0.37%)	Fm Sm Bu	0.000628	(2; 0.43%)	Wo Tx Wt Bu	0.00163	(3; 0.5%)
Sp Is Bu	0.000651	(2; 0.36%)	Is Fm Bu	0.00061	(2; 0.42%)	Wo Mp Ho Bu	0.00159	(3; 0.48%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.485 ±0.026	(±1.8%)
Downstream	0.493 ±0.008	(±1.6%)

# Sector 2902: Furniture (Fu)

*Furniture, passenger transport seats, mattresses and supports, pillows and cushions*

## Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is equal to average while water use and land disturbance are 70% and 40% below average respectively. The social indicators of employment generation, income and government revenue are 40% greater, 5% greater and 5% less than average respectively. The financial indicators of operating surplus, export propensity and import penetration are 25%, 20% and 5% less than average respectively. Furniture manufacturing reveals a reasonably balanced TBL account in an overall sense with some improvement possible in the greenhouse and export indicators. There is a trend worldwide towards the integrated life cycle costing of both buildings and their furniture driven by initiatives such as the Climate Neutral Network and its Climate Cool brand. Opportunities exist for substantial recycling and remanufacturing of large volumes of discarded furniture.

## Sector Description

The furniture manufacturing sector includes items such as wooden furniture, upholstered seats for cars, sheet metal items such as filing cabinets, mattresses, and shop and office fittings. Some analyses suggest that about 600 000 tonnes of new furniture is required per year and about 300 000 tonnes per year are discarded, indicating an opportunity for recycling and remanufacturing. Office fit-outs show an increasing trend to shorter use lives of three to five years driven by fashion as well as by building design and leasing practices. These favour low yearly rentals over full life cycle costing. Domestic manufacturing of furniture has lost ground to imports over the last decade. In the trading year 2000-01, furniture represented 1% of imports and 0.1% of exports with an imbalance of 8:1 in financial terms. Low wage manufacturers are one source of the imbalance, but superior design and branding from Italian and Scandinavian manufacturers are also significant. The sector has around 3 300 domestic enterprises and in 2002 a turnover of about \$6 billion.

## Place of Industry in the Economy

The furniture manufacturing sector ranks 49<sup>th</sup> out of 135 sectors in terms of value adding in the Australian economy, and contributes 0.38% of GDP in this analysis. It is similar in value adding to the iron ore mining and the pumps, bearings and air conditioners sectors. It has a direct employment requirement of 47 000 employment years and another 24 000 employment years in the sector's upstream suppliers, giving a total of 71 000 employment years or 1% of the national total. In addition it contributes another 7 000 jobs to downstream industries. In resource terms, it requires less than one half of one percent of national energy, water use and land disturbance. Greenhouse emissions are a little higher, at seven tenths of one percent. Imports are six times that of exports.

## Strategic Overview

The furniture manufacturing sector has a reasonably balanced TBL overview with two small outliers for gross operating surplus and export propensity. Upstream issues for the sector focus mainly on the source of raw materials such as rainforest woods, and on the labour practices used for bulk imported product. There are a number of international codes that verify forest harvesting protocols. Downstream issues relate to the reuse, recycling and re-engineering of discarded furniture products. New design protocols which emphasise 'cradle to cradle' instead of 'cradle to grave' life cycles could allow a more fluent reuse of high quality wood products and easier replacement of fabric coverings. Replacing furniture ownership with leasing could also help reduce material churn.

## TBL Account #1

The financial indicator of operating surplus is 25% below the economy wide average and about one third of this is a direct sector effect with the rest due to a large number of first order suppliers such as wholesale trade, steel tubes, sawn timber, plywood and road transport. The social indicator of employment generation is 40% above average and two thirds of this is a direct sector effect. The environmental indicator of greenhouse emissions is equal to average.

## TBL Accounts #2 and #3

The second TBL account reveals an export propensity that is 20% below average, an income indicator that is 5% above average and a water use indicator that is 70% below average. The third TBL account shows that import penetration is 5% below average, government revenue is 5% below the average and that domestic land disturbance is 40% below the average.

## Structural Path Analysis and Linkages

In a highly competitive market such as furniture manufacturing, the environmental aspect of the full production chain may be important and cause increased scrutiny of the greenhouse emissions indicator. The direct effect of energy use within the sector is relatively small at 3% of total while forest management contributes 20%. Moderate contributions are made by iron and steel production (9%), 'forestry-softwoods-sawn timber-furniture' (12%), 'wool-textiles-furniture' (5%), electricity production (5%), 'electricity-iron and steel' (1%) and wholesale trade (1%). The dominance of the forestry and wood production chain is important and could be tackled by the recycling and remanufacture of used wood components, or by the vertical integration with a forest supplier where plantings and subsequent carbon sequestration are larger than harvesting and emissions.

The sector's stimulus to its upstream suppliers is 10% greater than average with notable effects on the sectors of sawn timber, plywood, steel pipes and tubes, wholesale trade and road freight transport. There are very weak linkages to downstream industries as much of the effect is dissipated by private consumption and some exporting activities.

## Future Trends in Sector

The base case scenario of the *Future Dilemmas* study with 25 million people by 2050 anticipates a 20% increase in the yearly requirement of furniture by 2050. In addition to domestic population growth, this is driven by increases in building size (more floor space), a tripling of affluence and a large increase in inbound tourism requiring more hotels, restaurants and public spaces. These data exclude seats for cars, trucks and buses etc so the anticipated growth may be larger. A change in furniture retention time, or a marked consumer preference for second hand furniture, may alter these anticipations considerably. High value furniture will be marketed on a full life cycle basis.

## Innovation and Technical Opportunities

Faced with the current dominance of countries such as Italy in furniture exporting, and an emerging China (30 000 furniture firms with three million workers), the innovation and survival strategy route for this sector lies clearly along two axes. Low priced bulk production is not one of these. The first is to embrace environmental design as routine and develop product lines that have low energy and material contents, and are able to be fully recycled or re-engineered. These designs will integrate with and be highly preferred for greenhouse friendly houses and commercial buildings, partially decoupled from the power, water and waste grid. The second is to uniquely brand and build furniture with Australian woods, fibres, colours and textures that are attractive to affluent homemakers willing to pay premium prices. Tasmanian Wood Designs, recycled jarrah furniture (Jah Roc) and the Re-Define product lines provide seminal examples of these strategic options.

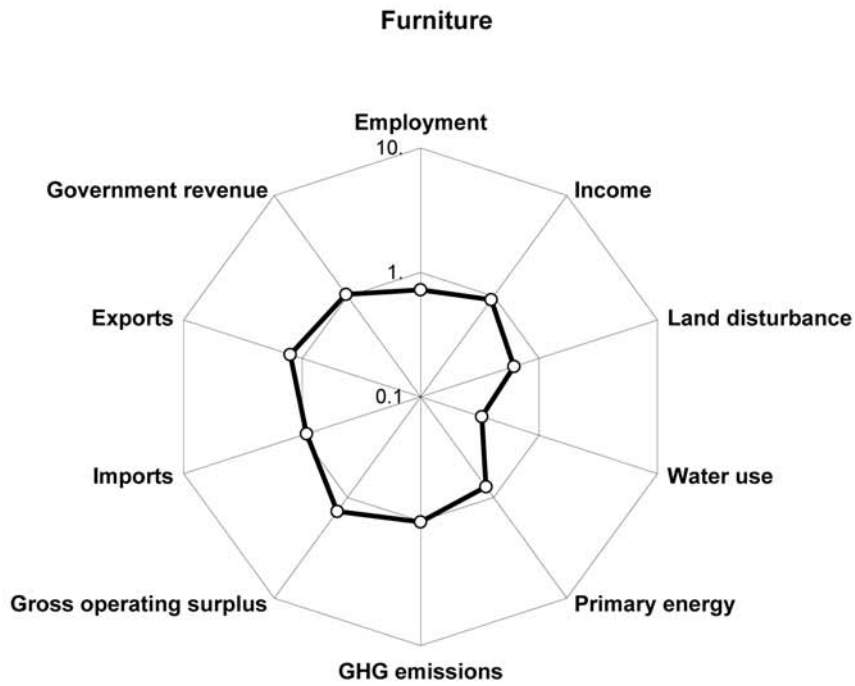
**Sector**

**Furniture**

(Fu)

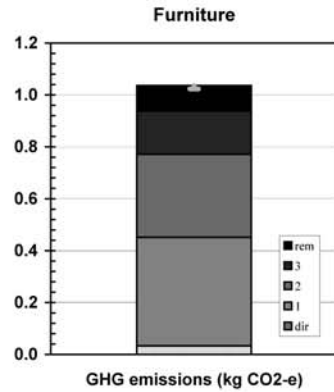
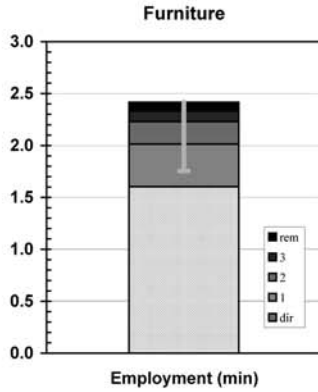
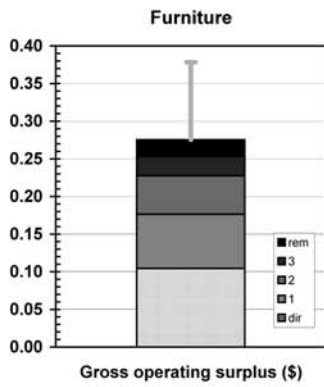
Furniture, passenger transport seats, mattresses and supports, pillows and cushions

**Spider diagram**

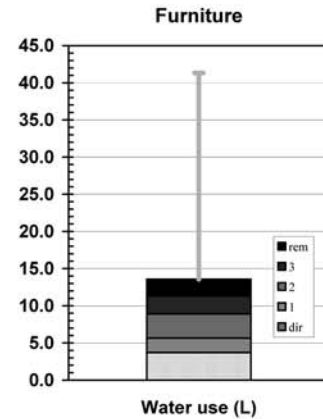
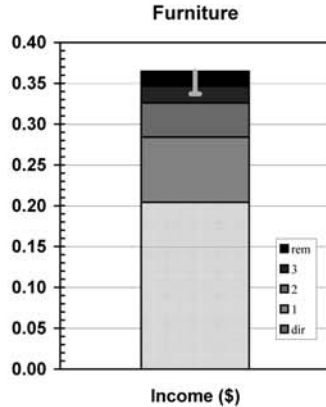
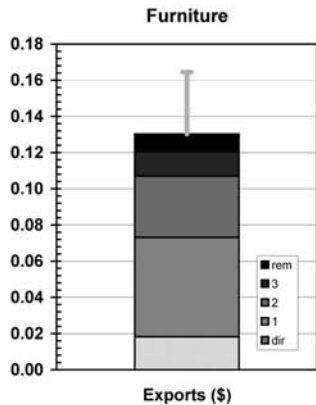


**Bar graphs**

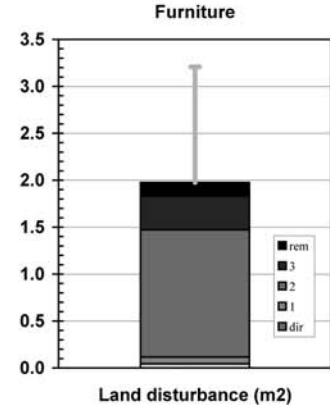
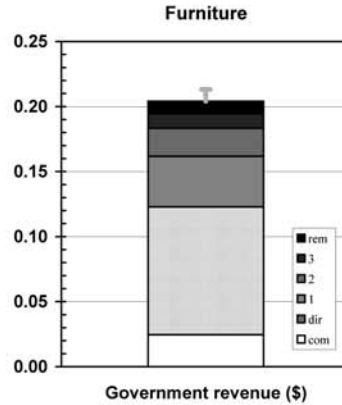
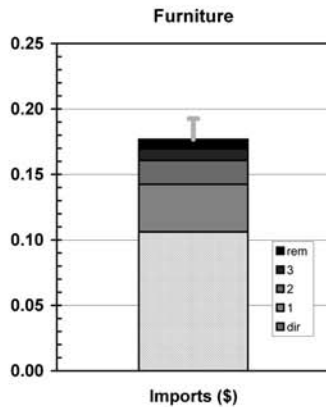
**Account #1**



**Account #2**



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 1,636.8	(0.62% of total)	(\$m 1,538.8 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 2,250.2	(2.15% of total)	(\$m 1,972.6 domestically produced)
Net changes in stocks	\$m 77.6	(4.39% of total)	(\$m 68.5 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 3,964.6</b>	<b>(0.86% of GNE)</b>	<b>(\$m 3,579.8 domestically produced)</b>
Exports	\$m 76.4	(0.09% of total)	(\$m 76.4 domestically produced)
<b>Final demand</b>	<b>\$m 4,041.0</b>	<b>(0.74% of GNT)</b>	<b>(\$m 3,656.2 domestically produced)</b>

**Costs: GNT(I) - industries**

Wages and salaries	\$m 857.8	(0.50% of total)
Gross operating surplus	\$m 438.2	(0.23% of total)
Taxes less subsidies	\$m 412.8	(0.48% of total)
<b>Sectoral GDP*</b>	<b>\$m 1,708.9</b>	<b>(0.38% of GDP)</b>
Imports	\$m 446.0	(0.46% of total)
<b>Primary inputs</b>	<b>\$m 2,154.8</b>	<b>(0.39% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT		
		(% of national)	direct	total (% of national)	
Gross operating surplus (\$m)	\$m 438.2	(0.23%)	\$m 381.4	(0.20%)	\$m 1,007.1 (0.53%)
Exports (\$m)	\$m 76.4	(0.09%)	\$m 66.5	(0.08%)	\$m 476.4 (0.57%)
Imports (\$m)	\$m 446.0	(0.46%)	\$m 388.1	(0.40%)	\$m 646.5 (0.66%)
Employment (e-y)	53,963 e-y	(0.76%)	46,966 e-y	(0.66%)	70,814 e-y (0.99%)
Income (\$m)*	\$m 857.8	(0.50%)	\$m 746.6	(0.44%)	\$m 1,333.9 (0.78%)
Government revenue (\$m)†	\$m 502.7	(0.47%)	\$m 449.2	(0.42%)	\$m 746.3 (0.69%)
GHG emissions (kt CO <sub>2</sub> -e)	137 kt	(0.03%)	119 kt	(0.02%)	3,790 kt (0.73%)
Water use (ML)	15,579 ML	(0.07%)	13,559 ML	(0.06%)	49,630 ML (0.24%)
Land disturbance (kha)	18 kha	(0.01%)	16 kha	(0.01%)	723 kha (0.44%)
Primary energy (TJ)	2,358 TJ	(0.06%)	2,052 TJ	(0.05%)	21,869 TJ (0.56%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.10	0.28	0.38
Exports (\$)	0.02	0.13	0.16
Imports (\$)	0.11	0.18	0.19
Employment (min)	1.60	2.42	1.75
Income (\$)	0.20	0.36	0.34
Government revenue (\$)	0.12	0.20	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.03	1.04	1.02
Water use (L)	3.71	13.57	41.32
Land disturbance (m <sup>2</sup> )	0.04	1.98	3.21
Primary energy (MJ)	0.56	5.98	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks



**Structural Paths (intensities - commodities)**

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Fu	0.104	(0; 38.%)	Fu	1.6	(0; 66.%)	Fr Fu	0.203	(1; 20.%)
Wt Fu	0.011	(1; 4.%)	Wt Fu	0.079	(1; 3.3%)	Is Fu	0.0911	(1; 8.8%)
Is Fu	0.0105	(1; 3.8%)	Ti Fu	0.0595	(1; 2.5%)	Sw Ti Fu	0.0752	(2; 7.3%)
Ti Fu	0.00912	(1; 3.3%)	Wp Fu	0.0577	(1; 2.4%)	Wo Tx Fu	0.0506	(2; 4.9%)
Wp Fu	0.00641	(1; 2.3%)	Is Fu	0.0252	(1; 1.%)	El Fu	0.0485	(1; 4.7%)
Rd Fu	0.0036	(1; 1.3%)	Fm Fu	0.0239	(1; 0.99%)	Fu	0.0326	(0; 3.1%)
Wo Tx Fu	0.00357	(2; 1.3%)	Rd Fu	0.0212	(1; 0.88%)	Fr Sw Ti Fu	0.0325	(3; 3.1%)
Pl Fu	0.00336	(1; 1.2%)	Pl Fu	0.0179	(1; 0.74%)	Ti Fu	0.02	(1; 1.9%)
Pt Fu	0.00272	(1; 0.99%)	Wo Tx Fu	0.0146	(2; 0.61%)	El Is Fu	0.012	(2; 1.2%)
Fm Fu	0.00215	(1; 0.78%)	Tx Fu	0.0129	(1; 0.54%)	Wt Fu	0.0109	(1; 1.1%)
St Wt Fu	0.00209	(2; 0.76%)	Bs Fu	0.0124	(1; 0.51%)	Sw Wp Fu	0.0106	(2; 1.%)
Ms Fu	0.00202	(1; 0.73%)	Ms Fu	0.00908	(1; 0.38%)	Hw Ti Fu	0.0101	(2; 0.98%)
El Fu	0.00196	(1; 0.71%)	Ti Wp Fu	0.00745	(2; 0.31%)	Fr Hw Ti Fu	0.0099	(3; 0.95%)
Cm Fu	0.00165	(1; 0.6%)	Ms Wt Fu	0.00713	(2; 0.29%)	Sw Ti Wp Fu	0.00942	(3; 0.91%)
Ms Wt Fu	0.00159	(2; 0.58%)	Sw Ti Fu	0.00597	(2; 0.25%)	El Wp Fu	0.00868	(2; 0.84%)
Nf Fu	0.00155	(1; 0.56%)	Wt Wp Fu	0.00575	(2; 0.24%)	El Ti Fu	0.00784	(2; 0.76%)
Io Is Fu	0.00136	(2; 0.49%)	Pt Fu	0.00546	(1; 0.23%)	Ch Pl Fu	0.00749	(2; 0.72%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Fu	0.0182	(0; 14.%)	Fu	0.204	(0; 56.%)	Fu	3.71	(0; 27.%)
Ti Fu	0.0119	(1; 9.1%)	Wt Fu	0.017	(1; 4.6%)	Wo Tx Fu	1.64	(2; 12.%)
Wt Fu	0.00897	(1; 6.9%)	Wp Fu	0.0112	(1; 3.1%)	Sc Cg Tx Fu	0.774	(3; 5.7%)
Is Fu	0.00806	(1; 6.2%)	Ti Fu	0.00964	(1; 2.6%)	Wp Fu	0.475	(1; 3.5%)
Tx Fu	0.00777	(1; 6.%)	Is Fu	0.006	(1; 1.6%)	Wa Fu	0.321	(1; 2.4%)
Nf Fu	0.00522	(1; 4.%)	Fm Fu	0.00375	(1; 1.%)	Sc Cg Wo Tx	0.306	(4; 2.3%)
Wo Tx Fu	0.00448	(2; 3.4%)	Rd Fu	0.00364	(1; 1.%)	El Fu	0.268	(1; 2.%)
Io Is Fu	0.00219	(2; 1.7%)	Pl Fu	0.00362	(1; 0.99%)	Is Fu	0.241	(1; 1.8%)
Wp Fu	0.00149	(1; 1.1%)	Tx Fu	0.00325	(1; 0.89%)	Tx Fu	0.123	(1; 0.91%)
Ti Wp Fu	0.00149	(2; 1.1%)	Ms Fu	0.00211	(1; 0.58%)	Bc Mp Fu	0.121	(2; 0.89%)
Lp Fu	0.00136	(1; 1.%)	Ms Wt Fu	0.00166	(2; 0.45%)	Bc Mp Lp Fu	0.117	(3; 0.86%)
Rd Fu	0.00125	(1; 0.96%)	Bs Fu	0.00153	(1; 0.42%)	Ti Fu	0.103	(1; 0.76%)
Fm Fu	0.00123	(1; 0.95%)	Pt Fu	0.00127	(1; 0.35%)	El Is Fu	0.0661	(2; 0.49%)
Pl Fu	0.000974	(1; 0.75%)	Wt Wp Fu	0.00124	(2; 0.34%)	Vf Wo Tx Fu	0.0617	(3; 0.45%)
Gl Nf Fu	0.000948	(2; 0.73%)	Ti Wp Fu	0.00121	(2; 0.33%)	Sc Cg Fu	0.0529	(2; 0.39%)
Ch Pl Fu	0.000871	(2; 0.67%)	Pd Wt Fu	0.00114	(2; 0.31%)	Wa Ms Fu	0.0521	(2; 0.38%)
Al Fu	0.00082	(1; 0.63%)	Cm Fu	0.00103	(1; 0.28%)	El Wp Fu	0.048	(2; 0.35%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Fu	0.106	(0; 60.%)	Fu	0.0983	(0; 55.%)	Wo Tx Fu	1.21	(2; 61.%)
Wp Fu	0.00568	(1; 3.2%)	Wt Fu	0.00792	(1; 4.4%)	Fr Fu	0.0652	(1; 3.3%)
Ti Fu	0.00464	(1; 2.6%)	Wp Fu	0.00543	(1; 3.%)	Sw Ti Fu	0.0592	(2; 3.%)
Is Fu	0.0038	(1; 2.1%)	Ti Fu	0.00422	(1; 2.3%)	Fu	0.0436	(0; 2.2%)
Pl Fu	0.00344	(1; 1.9%)	Is Fu	0.00275	(1; 1.5%)	Bc Mp Fu	0.0335	(2; 1.7%)
Pt Fu	0.00297	(1; 1.7%)	Rd Fu	0.00258	(1; 1.4%)	Bc Mp Lp Fu	0.0323	(3; 1.6%)
Wt Fu	0.00255	(1; 1.4%)	Tx Fu	0.00231	(1; 1.3%)	Wo Lp Fu	0.0168	(2; 0.85%)
Fm Fu	0.00162	(1; 0.92%)	Pl Fu	0.00158	(1; 0.88%)	Fr Sw Ti Fu	0.0104	(3; 0.53%)
Tx Fu	0.00119	(1; 0.67%)	Fm Fu	0.00131	(1; 0.73%)	Wo Tx Tp Fu	0.00844	(3; 0.43%)
Rd Fu	0.000913	(1; 0.52%)	Ms Fu	0.001	(1; 0.56%)	Sw Wp Fu	0.00831	(2; 0.42%)
Ch Pl Fu	0.000872	(2; 0.49%)	Ms Wt Fu	0.000787	(2; 0.44%)	Wo Tx Kn Fu	0.00811	(3; 0.41%)
Ch Fu	0.000653	(1; 0.37%)	Pd Wt Fu	0.000744	(2; 0.41%)	Wo Tx Cl Fu	0.00783	(3; 0.4%)
Nf Fu	0.000627	(1; 0.35%)	Pt Fu	0.000704	(1; 0.39%)	Sw Ti Wp Fu	0.00741	(3; 0.38%)
Ti Wp Fu	0.000582	(2; 0.33%)	Rd Ti Fu	0.000658	(2; 0.37%)	Bc Mp Ho Fu	0.00642	(3; 0.32%)
Sw Ti Fu	0.000533	(2; 0.3%)	Wt Wp Fu	0.000577	(2; 0.32%)	Hw Ti Fu	0.00522	(2; 0.26%)
Oc Fu	0.000471	(1; 0.27%)	Ti Wp Fu	0.000528	(2; 0.29%)	Wo Mp Fu	0.00378	(2; 0.19%)
Ms Fu	0.00046	(1; 0.26%)	Cm Fu	0.000494	(1; 0.27%)	Wo Mp Lp Fu	0.00365	(3; 0.18%)

**Linkages (average = 1)**

	Value	C.o.V.
Upstream	1.124 ±0.017	(±1.5%)
Downstream	0.232 ±0.004	(±1.7%)

# Sector 2903: Other Manufacturing (Om)

*Badges, coins, jewellery, sporting goods, toys, signs, brushes, pens, pencils, crayons, chalk, musical instruments and other manufacturing*

## Short Summary

Against the metric of one dollar of final demand the environmental indicators for greenhouse emissions, water use and land disturbance are 30%, 50% and 90% below the economy wide average respectively. The social indicators of employment generation, income and government revenue are all substantially above average. For the financial indicators the export propensity and import penetration are both above average while operating surplus is 35% below average. This sector is something of a residual manufacturing sector with some competitive advantage being lost to low wage countries, but other advantages being developed in items with Australian image and lifestyle.

## Sector Description

This sector is a catch-all for the Australian manufacturing industry and includes coin and jewellery manufacture, toys and sporting goods, graphic art supplies and musical instruments. It represents in some ways the decline of the manufacturing industry over the last five decades, which is paralleled in other developed economies. Areas that avoid this decline are those linked to Australia's natural resource endowments, specific national identity issues such as lifestyle and sport, or bulky low value items that are better manufactured close to major markets. Small and medium sized enterprises are particularly adept in this sector an example being Croker Oars, a manufacturer of carbon composite rowing and surfboat oars. This firm has become the second largest manufacturer of rowing oars in the world while being based in coastal NSW. The turnover of the total sector in 2002 was about \$1.5 billion per year.

## Place of Industry in the Economy

The other manufacturing sector ranks 109<sup>th</sup> out of 135 sectors in terms of value adding in the economy and contributes 0.09% of GDP in this analysis. It is similar in value adding to the bauxite, and brown coal mining sectors. It is a relatively small employer with a direct requirement of 12 000 employment years and an indirect requirement of 5 000 years in the sector's upstream suppliers giving a total of 17 000 employment years. In addition it contributes 7 000 employment years to downstream industries such as wholesale and retail trade, and non-residential construction. It has relatively small resource requirements with less than one tenth of one percent of national water use, land disturbance, energy use and greenhouse emissions. In financial terms, exports are twice the size of imports.

## Strategic Overview

The spider diagram for the other manufacturing sector reveals a reasonably well balanced set of TBL outcomes with small outliers for operating surplus and import penetration. The import penetration indicator is less of an issue since it is outweighed substantially by exports in absolute terms. Many of the imports are essential inputs to the manufacturing, fabrication and assembly process. The lower than average operating surplus may suggest a sector viability issue, or it may be a low point in a process of industry reorientation and restructuring. The downstream issues for the sector are similar to other manufacturing sectors and relate to the material churn underpinning a consumption orientated economy. Some sector products such as badges, coins and jewellery are long lived artefacts and therefore less of an issue. Others such as sporting goods and toys have relatively short lives, and could become the focus of a product stewardship system.

## TBL Account #1

The financial indicator of operating surplus is 35% below the economy wide average and only one fifth of this is a direct effect. The social indicator of employment generation is 60% above average, with three quarters of this a direct effect. The environmental indicator of greenhouse emissions is 30% below average and most of this due to the sector's upstream suppliers involved in electricity production, plastics, chemicals and steel production.

## TBL Accounts #2 and #3

The second TBL account reveals an export propensity that is over two times the economy wide average, an income indicator that is 10% above average and a water use indicator that is 50% below average. The third TBL account reveals import penetration 10% above average, government revenue three times the average and land disturbance 90% below average.

## Structural Path Analysis and Linkages

The structural chain analysis of the import penetration indicator reveals that the direct within sector effect is 60%, while other inputs such as plastics (6%), gemstones (3%), basic chemicals (2%), motor vehicles (1%), steel products (1%) and paints (1%) are relatively minor. The analysis for the operating surplus indicator shows that the direct sector effect is smaller (19%) and there are larger items in the production chain such as gemstones (7%), plastics (5%), wholesale trade (4%), steel products (3%) and banking services (2%). Improving the operating surplus will require a much broader approach than import penetration which can be more focused provided that essential inputs are available within Australia.

The stimulus provided by the sector to its upstream suppliers such as plastic products, steel tubes and pipes, and wholesale trade, is 20% greater than the economy wide average. The linkages to downstream industries are relatively weak as most effect is either dissipated by private consumption or sent to exports.

## Future Trends in Sector

Over the last 100 years the manufacturing sector's share of economic activity has varied from 12% in 1901, to a peak of 25% in the 1960s, to around 12% currently, although the absolute volume and value has increased substantially over that period in line with overall economic growth. This sector represents only a part of overall manufacturing. Major studies anticipate that lower wage but increasingly technically sophisticated countries will capture more of Australia's manufacturing requirements. The extent to which other manufacturing will remake itself through market focus, political activity and consumer power is uncertain. It is unlikely that trade will become more restricted. Possibly this sector will require substantial innovation to even survive.

## Innovation and Technical Opportunities

The innovation literature for small and medium manufacturing is extensive and promises sustained evolution as well as faddism. For this sector and in particular the sporting goods component, the linkage to sporting festivals such as the 2000 Olympic Games or 2003 Rugby World Cup provide some opportunities, although organisation and service sectors benefit more immediately than manufacturing products, which are often sourced from lower wage countries, particularly for sporting artefacts. Notable exceptions such as Croker Oars (already mentioned) and Enforcer (a specialised producer of rugby union training equipment) provide attractive examples, but perhaps with niche markets that are not large in volume. Argyle diamonds, Australian pearls and Australian opals present a significant domestic resource, but it is unclear whether the design, manufacturing and marketing skills for world markets, can dominate from such a distance.

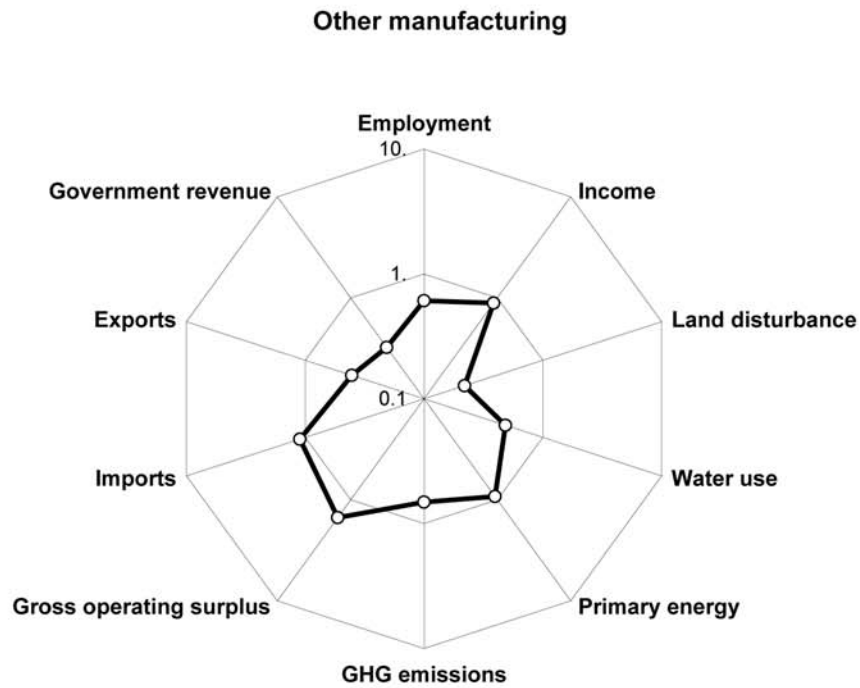
Sector

Other manufacturing

(Om)

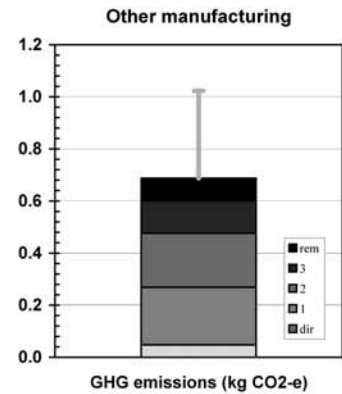
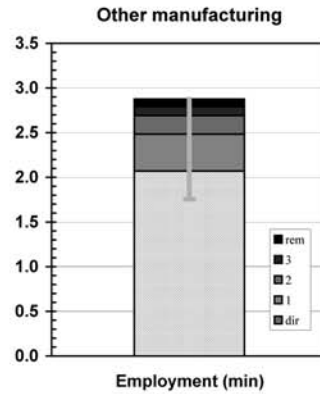
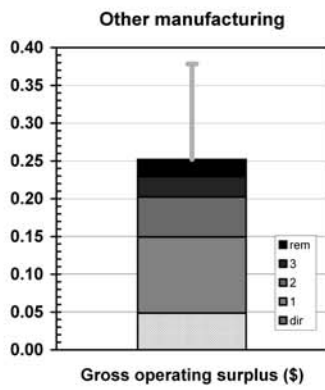
Badges, coins, jewellery, sporting goods, toys, signs, brushes, pens, pencils, crayons, chalk, musical instruments and other manufacturing

Spider diagram

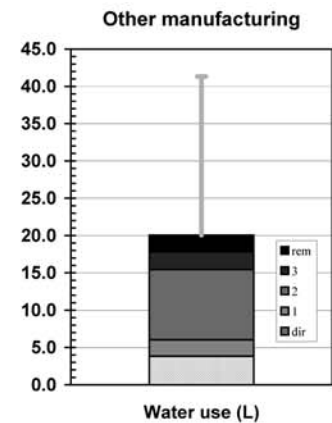
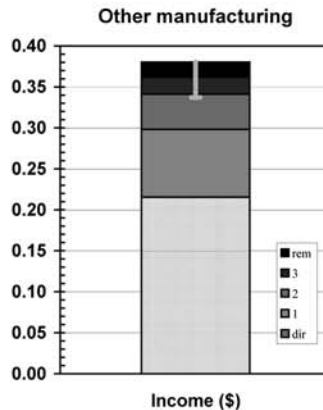
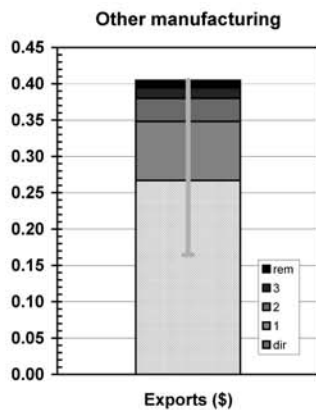


Bar graphs

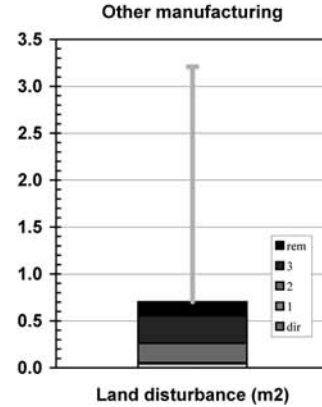
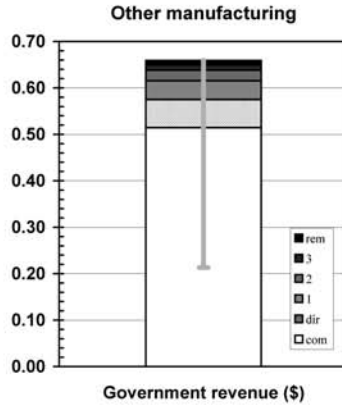
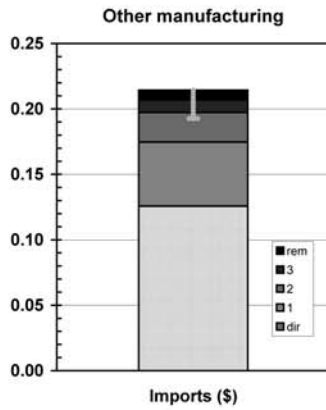
Account #1



Account #2



Account #3



**National Accounts extracts**

**Receipts: GNT(E) - commodities**

Private final consumption	\$m 1,588.7	(0.60% of total)	(\$m 409.5 domestically produced)
Government final consumption	\$m 0.0	(0.00% of total)	(\$m 0.0 domestically produced)
Gross fixed capital expenditure	\$m 18.9	(0.02% of total)	(\$m 14.8 domestically produced)
Net changes in stocks	\$m 97.7	(5.53% of total)	(\$m 0.4 domestically produced)
<b>Sectoral GNE</b>	<b>\$m 1,705.3</b>	<b>(0.37% of GNE)</b>	<b>(\$m 424.7 domestically produced)</b>
Exports	\$m 321.2	(0.39% of total)	(\$m 321.2 domestically produced)
Final demand	\$m 2,026.4	(0.37% of GNT)	(\$m 745.9 domestically produced)

**Costs: GNT(I) - industries**

Wages and salaries	\$m 259.1	(0.15% of total)
Gross operating surplus	\$m 58.5	(0.03% of total)
Taxes less subsidies	\$m 73.1	(0.09% of total)
<b>Sectoral GDP*</b>	<b>\$m 390.7</b>	<b>(0.09% of GDP)</b>
Imports	\$m 151.3	(0.15% of total)
<b>Primary inputs</b>	<b>\$m 542.0</b>	<b>(0.10% of GNT)</b>

\* Sectoral gross value added + net taxes on products

**TBL factors**

	in supplying industry		embodied in commodity GNT	
		(% of national)	direct	total (% of national)
Gross operating surplus (\$m)	\$m 58.5	(0.03%)	\$m 36.2 (0.02%)	\$m 187.9 (0.10%)
Exports (\$m)	\$m 321.2	(0.39%)	\$m 199.0 (0.24%)	\$m 302.0 (0.36%)
Imports (\$m)	\$m 151.3	(0.15%)	\$m 93.7 (0.10%)	\$m 159.9 (0.16%)
Employment (e-y)	19,963 e-y	(0.28%)	12,367 e-y (0.17%)	17,190 e-y (0.24%)
Income (\$m)*	\$m 259.1	(0.15%)	\$m 160.5 (0.09%)	\$m 283.8 (0.17%)
Government revenue (\$m)†	\$m 456.6	(0.42%)	\$m 428.8 (0.40%)	\$m 491.7 (0.45%)
GHG emissions (kt CO <sub>2</sub> -e)	57 kt	(0.01%)	35 kt (0.01%)	513 kt (0.10%)
Water use (ML)	4,619 ML	(0.02%)	2,862 ML (0.01%)	14,969 ML (0.07%)
Land disturbance (kha)	5 kha	(0.00%)	3 kha (0.00%)	52 kha (0.03%)
Primary energy (TJ)	1,006 TJ	(0.03%)	623 TJ (0.02%)	5,291 TJ (0.14%)

\*excludes income tax

† includes net commodity taxes on final demand and income tax

**TBL multipliers - commodities**

	per \$ of GNE/GNT*		Nation-wide average
	direct	total	
Gross operating surplus (\$)	0.05	0.25	0.38
Exports (\$)	0.27	0.40	0.16
Imports (\$)	0.13	0.21	0.19
Employment (min)	2.07	2.88	1.75
Income (\$)	0.22	0.38	0.34
Government revenue (\$)	0.57	0.66	0.21
GHG emissions (kg CO <sub>2</sub> -e)	0.05	0.69	1.02
Water use (L)	3.84	20.07	41.32
Land disturbance (m <sup>2</sup> )	0.04	0.70	3.21
Primary energy (MJ)	0.84	7.09	7.65

\*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

### Structural Paths (intensities - commodities)

Gross operating surplus (\$/\$)			Employment (min/\$)			GHG emissions (kg CO <sub>2</sub> -e/\$)		
Om	0.0486	(0; 19.%)	Om	2.07	(0; 72.%)	EI Om	0.0665	(1; 9.7%)
Sg Om	0.0171	(1; 6.8%)	PI Om	0.0717	(1; 2.5%)	Is Om	0.0636	(1; 9.3%)
PI Om	0.0135	(1; 5.3%)	Wt Om	0.0639	(1; 2.2%)	Om	0.0472	(0; 6.9%)
Wt Om	0.00888	(1; 3.5%)	Bk Om	0.0235	(1; 0.82%)	Ch PI Om	0.0299	(2; 4.4%)
GI Om	0.00742	(1; 2.9%)	Sg Om	0.0215	(1; 0.75%)	Bc Mp Lp Om	0.0198	(3; 2.9%)
Is Om	0.00737	(1; 2.9%)	Fm Om	0.0197	(1; 0.69%)	EI PI Om	0.0156	(2; 2.3%)
Bk Om	0.00592	(1; 2.4%)	Is Om	0.0176	(1; 0.61%)	Ch Om	0.0155	(1; 2.3%)
Cm Om	0.00307	(1; 1.2%)	Cg Om	0.0129	(1; 0.45%)	Sg Om	0.0134	(1; 2.%)
EI Om	0.00269	(1; 1.1%)	Ms Om	0.0104	(1; 0.36%)	Wt Om	0.00886	(1; 1.3%)
Ch PI Om	0.0025	(2; 0.99%)	Mv Om	0.0103	(1; 0.36%)	Nf Om	0.00846	(1; 1.2%)
St Om	0.00234	(1; 0.93%)	Sm Om	0.00996	(1; 0.35%)	EI Is Om	0.00835	(2; 1.2%)
Ms Om	0.00232	(1; 0.92%)	Lp Om	0.00876	(1; 0.3%)	EI GI Om	0.0073	(2; 1.1%)
Pt Om	0.00214	(1; 0.85%)	Bs Om	0.00866	(1; 0.3%)	Sc Cg Om	0.00709	(2; 1.%)
Sf Bk Om	0.00207	(2; 0.82%)	Rd Om	0.00864	(1; 0.3%)	EI AI Om	0.0065	(2; 0.95%)
Cg Om	0.00196	(1; 0.78%)	Cm Om	0.00848	(1; 0.29%)	Sw Ti Om	0.00616	(2; 0.9%)
Mv Om	0.00189	(1; 0.75%)	GI Om	0.00766	(1; 0.27%)	Fr Om	0.0052	(1; 0.76%)
Nf Om	0.00184	(1; 0.73%)	Ch PI Om	0.00729	(2; 0.25%)	AI Om	0.00471	(1; 0.68%)

Exports (\$/\$)			Income (\$/\$)			Water use (L/\$)		
Om	0.267	(0; 66.%)	Om	0.215	(0; 57.%)	Sc Cg Om	7.42	(2; 37.%)
GI Om	0.0225	(1; 5.5%)	PI Om	0.0145	(1; 3.8%)	Om	3.84	(0; 19.%)
Sg Om	0.00848	(1; 2.1%)	Wt Om	0.0137	(1; 3.6%)	Bc Mp Lp Om	0.522	(3; 2.6%)
Wt Om	0.00726	(1; 1.8%)	Bk Om	0.0058	(1; 1.5%)	Sg Om	0.432	(1; 2.2%)
Nf Om	0.00619	(1; 1.5%)	Is Om	0.0042	(1; 1.1%)	Wa Om	0.411	(1; 2.%)
Lp Om	0.00605	(1; 1.5%)	Sg Om	0.00363	(1; 0.95%)	EI Om	0.367	(1; 1.8%)
Is Om	0.00563	(1; 1.4%)	Fm Om	0.00309	(1; 0.81%)	Vf PI Om	0.178	(2; 0.89%)
PI Om	0.0039	(1; 0.96%)	Ms Om	0.00242	(1; 0.64%)	Is Om	0.169	(1; 0.84%)
Ch PI Om	0.00348	(2; 0.86%)	Cg Om	0.00222	(1; 0.58%)	Sc Cg Sc Cg Om	0.154	(4; 0.77%)
Cg Om	0.00346	(1; 0.85%)	GI Om	0.00199	(1; 0.52%)	Wo Tx Om	0.141	(2; 0.7%)
AI Om	0.00251	(1; 0.62%)	Cm Om	0.00193	(1; 0.51%)	Wo Lp Om	0.101	(2; 0.5%)
Ch Om	0.0018	(1; 0.45%)	Mv Om	0.00178	(1; 0.47%)	PI Om	0.0973	(1; 0.48%)
Io Is Om	0.00153	(2; 0.38%)	Sm Om	0.00172	(1; 0.45%)	Ch PI Om	0.0914	(2; 0.46%)
Mv Om	0.00124	(1; 0.31%)	Ch PI Om	0.00155	(2; 0.41%)	EI PI Om	0.0864	(2; 0.43%)
GI Nf Om	0.00112	(2; 0.28%)	Rd Om	0.00149	(1; 0.39%)	Vf Om	0.0792	(1; 0.39%)
Fm Om	0.00102	(1; 0.25%)	Ms Wt Om	0.00134	(2; 0.35%)	Sc Cg Tx Om	0.0666	(3; 0.33%)
Ti Om	0.000973	(1; 0.24%)	Lp Om	0.00118	(1; 0.31%)	Sm Om	0.0632	(1; 0.31%)

Imports (\$/\$)			Government revenue (\$/\$)			Land disturbance (m <sup>2</sup> /)\$)		
Om	0.126	(0; 59.%)	Om	0.0607	(0; 42.%)	Bc Mp Lp Om	0.144	(3; 20.%)
PI Om	0.0138	(1; 6.4%)	Wt Om	0.00641	(1; 4.4%)	Wo Tx Om	0.104	(2; 15.%)
Sg Om	0.00534	(1; 2.5%)	PI Om	0.00632	(1; 4.4%)	Wo Lp Om	0.0748	(2; 11.%)
Ch PI Om	0.00349	(2; 1.6%)	Bk Om	0.00321	(1; 2.2%)	Om	0.0435	(0; 6.2%)
Mv Om	0.00311	(1; 1.5%)	Sg Om	0.00238	(1; 1.6%)	Wo Tx Cl Om	0.0195	(3; 2.8%)
Is Om	0.00265	(1; 1.2%)	Is Om	0.00192	(1; 1.3%)	Wo Mp Lp Orr	0.0163	(3; 2.3%)
Pt Om	0.00234	(1; 1.1%)	GI Om	0.00123	(1; 0.85%)	Wo Tx PI Om	0.0138	(3; 2.%)
Wt Om	0.00206	(1; 0.96%)	Cg Om	0.00117	(1; 0.8%)	Bc Mp Ch PI Om	0.0119	(4; 1.7%)
Ch Om	0.0018	(1; 0.84%)	Ms Om	0.00115	(1; 0.79%)	Sc Cg Om	0.00975	(2; 1.4%)
GI Om	0.0018	(1; 0.84%)	Fm Om	0.00108	(1; 0.74%)	Bc Mp Ho Om	0.00879	(3; 1.2%)
Fm Om	0.00134	(1; 0.62%)	Rd Om	0.00105	(1; 0.73%)	Wo Tx Tp Om	0.00652	(3; 0.93%)
Ee Om	0.000874	(1; 0.41%)	Cm Om	0.00092	(1; 0.63%)	Bc Mp Ch Om	0.00616	(3; 0.88%)
Sm Om	0.000816	(1; 0.38%)	Ch PI Om	0.000771	(2; 0.53%)	Bc Ch PI Om	0.00598	(3; 0.85%)
Lp Om	0.000776	(1; 0.36%)	Mv Om	0.000762	(1; 0.53%)	Sw Ti Om	0.00485	(2; 0.69%)
Nf Om	0.000744	(1; 0.35%)	Sm Om	0.000658	(1; 0.45%)	Wo Tx Kn Om	0.00428	(3; 0.61%)
Fo Sg Om	0.000719	(2; 0.34%)	Ms Wt Om	0.000637	(2; 0.44%)	Bc Ch Om	0.0031	(2; 0.44%)
Pr Om	0.000684	(1; 0.32%)	Pd Wt Om	0.000602	(2; 0.42%)	Wo Tx Wt Om	0.00228	(3; 0.32%)

### Linkages (average = 1)

	Value	C.o.V.
Upstream	1.216 ±0.017	(±1.4%)
Downstream	0.611 ±0.011	(±1.8%)







