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Growing the Green Collar Economy:

Skills and labour challenges in reducing our greenhouse emissions and national environmental footprint

Report to the Dusseldorp Skills Forum

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1 INTRODUCTION AND SUMMARY OF MAIN FINDINGS

This report was commissioned by Dusseldorp Skills Forum to explore the skills, innovation and workforce dimensions of the transition to a more environmentally sustainable society, with a particular focus on the challenges involved in achieving deep cuts in greenhouse emissions.

The report draws on two very different types of national model to explore potential green collar employment futures: the CSIRO ASFF models, representing a technology based 'physical economy' approach, and the Monash University multi-regional computable general equilibrium (CGE) model, a price based 'monetary economy' approach. Section 3 of this report draws on output from these models to explore reductions of net greenhouse emissions of 60-100% by 2050 (in the CGE model) and an ambitious 'Factor 4' resource efficiency scenario (in the ASFF model).

The projections developed by these two approaches share substantial areas of agreement, despite fundamental differences in the underlying structure, constraints, and drivers of change incorporated into the models. Key results include:

- Well designed policies can substantially decouple economic growth from environmental pressure, so that living standards continue to increase at current rates (avoiding blockages that might otherwise occur), while our national environmental footprint reduces over time
- Achieving a rapid transition to sustainability would have little or no impact on national employment, with projected increases in employment of 2.5 to 3.3 million jobs over the next two decades.
- Employment in sectors with high potential environmental impacts will also grow strongly, with projected increases of more than 10% over ten years. This will add 230,000 to 340,000 new jobs – in addition to normal employment turnover – in the transport, construction, and agriculture, manufacturing and mining sectors. Employment in construction and transport sectors is projected to grow significantly faster than the national average.

But achieving the transition to a low carbon sustainable economy will require a massive mobilisation of skills and training – both to equip new workers and to enable appropriate changes in practices by the three million workers already employed in these key sectors influencing our environmental footprint. Current approaches do not appear sufficient for meeting these challenges (as discussed in Section 4).

We identify five key elements of a coherent and systematic response to the skills challenges associated with this transition (as discussed in Section 5):

- incentives and policy settings for environmental performance;
- green skills and training;
- performance assessment and accreditation to inform action;
- access to appropriate business inputs and components; and
- promotion of a stronger innovation culture.

The report concludes that the transition to a low carbon economy will require policy attention to both incentives for environmental performance, and to the skills required to deliver this performance. Substantial action will be required to ensure that the skills, education, and training required are available and ready to contribute. This will involve concerted action by government, businesses, labour, and educational and training institutions to develop and implement new approaches to green education, training and jobs. To be prepared for such challenge in both magnitude and innovation needs, Australia should strengthen its capacity for analysing and understanding the interrelationships between education and training, jobs and employment and environmental footprint by improving the scientific knowledge underpinning such understanding and by up-grading the extent and quality of information and data in the areas concerned. There is a triple-dividend of greater wellbeing, cost-saving and greater competitiveness and reduced environmental impact to be earned if measures would be taken to support the skill revolution required for a low-carbon, environmentally sound society.

2 THE NEED FOR A 'SUSTAINABILITY TRANSITION'

Australia, and the world, is at a turning point.

Two decades after sensing the need for sustainable development there is mounting evidence that urgent changes are required to ensure the integrity and sustainability of our climate, food and fresh water supplies, urban environments, and ecosystems. The OECD warns that "increasing pressures from population and economic growth … risk irreversible environmental damage within the next few decades" unless we change the way we do things, to recognise the social and economic value of the environmental systems that support us all. Time is running out. We have a short window – a few decades – to achieve the transition to sustainability [OECD 2008, MEA 2005a, 2005b, Spangenberg et al. 2002].

The relationship between economic growth and the environment has been a hotly contested issue since the early 1960s. Recent years have seen an emerging consensus around a number of important points, however. First, increases in income per person and the total value of economic activity are strongly associated with increases in various pressures on the environment. Second, changes in policy settings and institutional arrangements can moderate these pressures, acting to buffer the relationship between economic growth and the environment. Third, these changes will not occur automatically through market processes, however, and require attention and action by citizens and policy makers to guide and harness market forces in achieving sustainable development [Arrow et al 1995, Spangenberg and Lorek 2002, Hatfield-Dodds et al 2008, Sachs 2008, OECD 2008]

Human effort, ingenuity and technology underlie most of the environmental challenges of the twenty first century. Human labour, skills and knowledge underpin and drive the extraction and transformation of resources, the production of goods and services, and the generation of waste and emissions – modifying ecosystems through changes in land use (such as agriculture or urban expansion), and through the introduction of pests and pollutants.

Yet these same human resources are central to achieving social and ecological sustainability. Participation in paid work is central to social status, self-image, social integration and security. Human capital is the most valuable component of the economic wealth of nations, accounting for more than 75% of the total asset base of high income nations, and 40-60% in developing nations [Hamilton et al 2006]. Achieving full employment and minimising involuntary unemployment are thus important social and economic goals.

The Australian Government is committed to reducing greenhouse emissions by 60%, with influential voices suggesting that significantly deeper cuts could be in our national interest [Garnaut 2008]. We face a range of associated challenges in managing our water, ensuring healthy rivers and landscapes, and protecting our natural resources and unique biodiversity.

Meeting these challenges require quite dramatic changes from current trends in energy and water use, resource management, and patterns of economic activity [Australia 2020 Summit, 2008].

3 THE SCALE OF THE CHALLENGE

This report explores the scale of the challenges involved in the transition to a sustainable economy by drawing on existing national modelling of major environmental reforms.

Two very different modelling approaches are used: the CSIRO Australian Stocks and Flows Framework (ASFF), a technology focused physical model of the Australian economy; and the Monash University MMRF-Green model, a computable general equilibrium (CGE) model of the Australian economy with enhanced detail of electricity generation, other energy products, and greenhouse emissions accounting. The potential economic impacts of greenhouse emissions reductions, including on employment, have been explored by a number of other national and global CGE models, and using specific energy sector models [see EFF 2006, Grubb et al 2006]. More general Australian environment-employment interactions have also been explored by a number of authors [such as Annandale et al 2004, Diesendorf 2004, Hatfield-Dodds et al 2004, Lawn 2006].

3.1 Scenarios explored in this report

This report incorporates previously unpublished results from modelling scenarios involving deep cuts in greenhouse emissions and a more general ‘Factor 4’ physical resource efficiency scenario, with a specific focus on the employment dimensions of these scenarios.

3.1.1 CGE modelling of emissions reductions

In recent work undertaken for The Climate Institute we modelled reductions in net Australian greenhouse gas emissions of 40-100% by 2050 using the Monash CGE model. [Hatfield-Dodds et al 2007] This current report draws on two scenarios from that modelling.

The *Deep Cuts* scenario involves a 60% reduction in emissions without significant tax reform. This scenario was used for sensitivity analysis, and is a variant of the Follower scenario in The Climate Institute report [see Hatfield Dodds et al 2007 p.39].

Carbon Neutral involves a 100% reduction in net emissions and one-off tax reform to increase employment and participation. Around one third of the emissions reductions in 2040-2050 are achieved through purchase of international credits. This results in a *Carbon Neutral* scenario which has slightly higher national employment growth than in the base case (without policy action) and a more rapid reorientation of economic activity towards a low carbon economy than occurs in the *Deep Cuts* scenario.

The logic of the model assesses the production of goods and services by 52 industries across Australia’s eight states and territories for each year from 2005 to 2050. The allocation of resources across industries (including labour and capital inputs) is driven by prices, which reflect supply and demand. The national labour supply is determined by demographic factors, and national capital supply responds to rates of return. The model includes significant enhancements to account for greenhouse gases and economic responses to emissions trading or the introduction of an emissions tax.

The modelling assumes comprehensive coverage of sectors in an emissions trading system, with insulation for trade exposed energy intensive sectors. Carbon Capture and storage is assumed to be feasible, and nuclear generation is excluded from the scenarios. Permits are auctioned and revenues used to reduce personal and corporate income tax [see Table 3, Hatfield Dodds et al 2007 pp.19-20 for more details].

3.1.2 ASFF modelling of resource efficiency

A 'Factor 4' resource efficiency scenario was created in a physical flow economic model using the CSIRO ASFF approach. This is informed by a public mood for significant behaviour change, industrial ecology and sustainable business literature, which has highlighted the potential for massive improvements in resource use efficiency through the adoption of a 'Factor 4' approach. Factor 4 is simply a shorthand expression of seeking to double the value of output while halving energy and material inputs [von Weizsäcker et al. 1997].

The ASSF 'Factor 4' scenario explores the types of changes in economic structure, resource-use and economic efficiency, and employment that might be associated with ambitious policy settings designed to reduce material and energy use. The analysis focuses on exploring the drivers and potential flexibility of the physical economy in relation to material flows, waste and emissions and provides insights into the magnitudes and timing of potential changes. Like most modelling of social and economic processes, the ASFF model is designed for exploring possible scenarios; hence caution needs to be applied in interpreting outcomes as predictions.

The Factor 4 scenario involved a series of hypothetical policy strategies to reduce material and energy flows in a number of material and emission intensive sectors, including the energy sector, construction and housing, transport and mobility, food production and nutrition, and primary export industries. These changes included:

- A decisive shift from coal powered electricity to gas and renewables over the period to 2050
- Uptake of energy efficient building design incorporating solar passive living, with extensive retrofitting of the existing building stock
- A shift to more efficient transport options, including a reduction in the transport share of private vehicles for commuter travel from 85% to 60%
- Changes in eating habits to emphasise healthy fresh food, with increased fruit, vegetables and cereals and a reduction in average meat consumption
- Long term reductions in extraction and export of minerals and energy commodities (reflecting reduced world demand) from 2030

The model assesses the impacts of these policies on the broad Australian economy, including flows of employment (or labour), materials (including food and fibre, mineral resources), energy, and CO_2 emissions, and stocks of buildings, vehicles and people. The modelling uses a five year time step, and is calibrated to census years (2001, 2006 and so on). More details on the policy settings and outcomes are provided in the Appendix.

3.2 Overall economic impacts

Both modelling frameworks suggest the scenarios explored would substantially decouple economic growth and environmental pressure. Economic growth and employment continue at rates near to the base case (i.e. an Australian future that assumes significant climate change in lieu of policy action), while key environmental pressure indicators fall (such as emissions) or stabilise near to current levels (such as energy use).

3.2.1 CGE modelling of emissions reductions

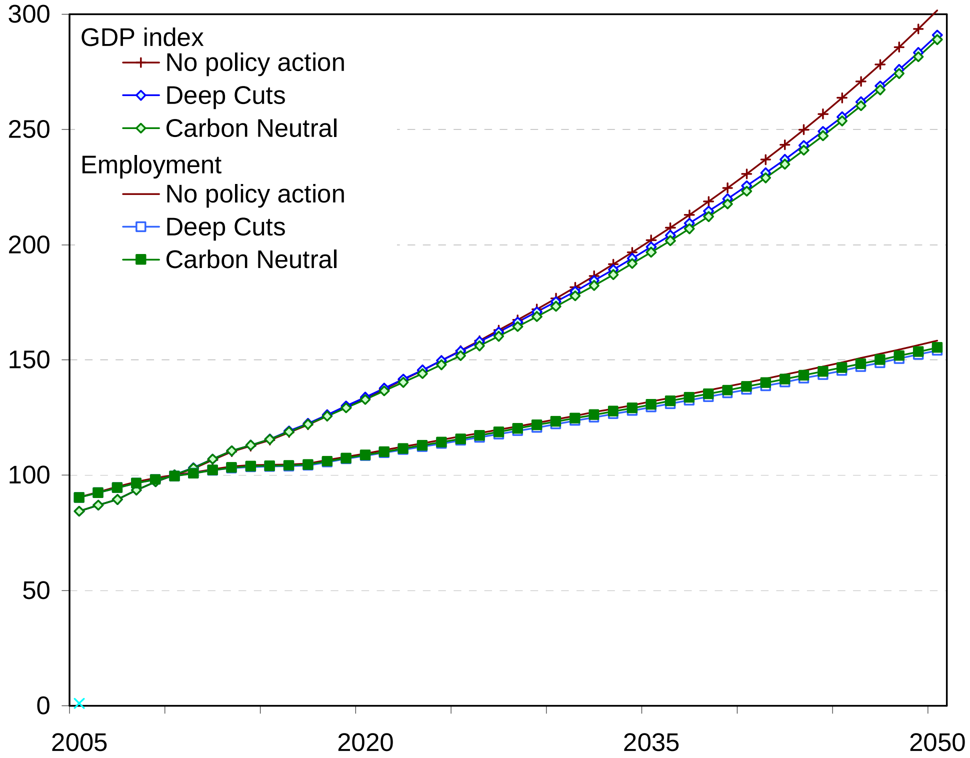
As shown in Figure 1, CGE modelling of emissions reductions suggests that an emission trading system has only modest impacts on economic growth and employment. The value of economic activity increases by 50% from 2010 to 2025 and trebles by 2050: employment increases around 15% by 2025 and 55% by 2050, in line with population growth.

These increases are lower than projected in the absence of policy action (referred to as the base case). Annual employment growth is 0.04% lower, with a cumulative employment gap of 0.1% by 2030. Annual GNP and GDP growth is projected to be 0.02-0.10 lower that it would otherwise be, resulting in a cumulative performance gap of around 2% by 2030.

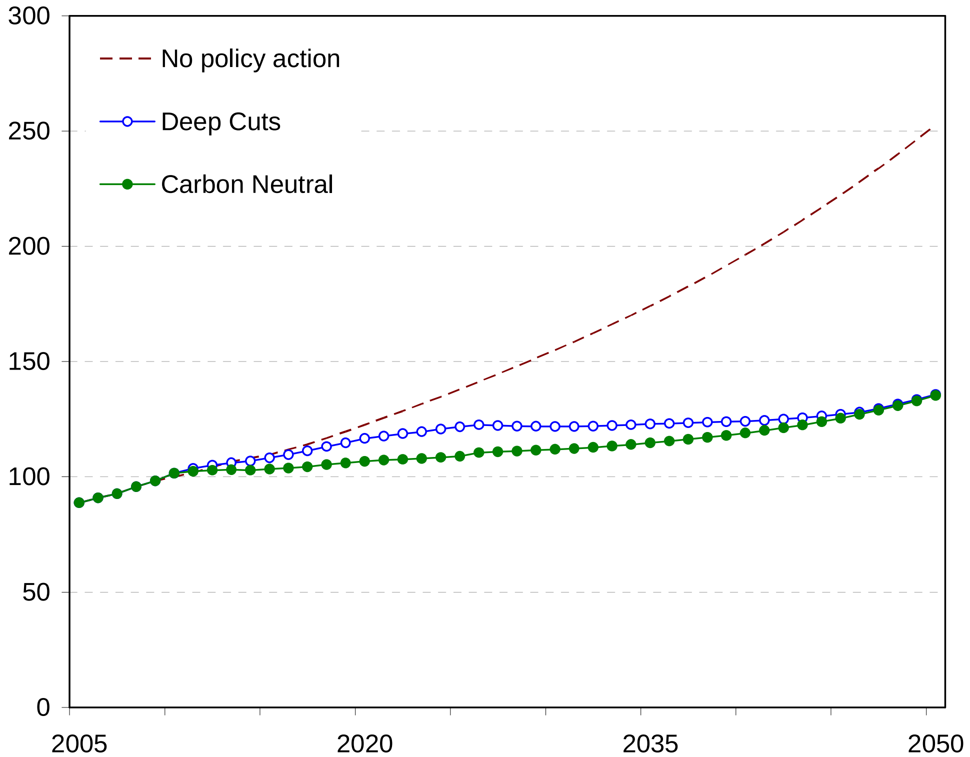
However these relatively minor economic impacts contrast with the dramatic changes in physical flows. Energy use plateaus at around 35% higher than 2010 levels, rather than rising 150% by 2050 (as shown in Figure 1). Gross greenhouse emissions (before accounting for international credits) fall by two thirds rather than doubling. The modelling thus suggests that emissions' trading is able to effectively decouple economic activity from energy use and greenhouse emissions, although these scenarios do not address other material flows, such as water use.

Figure 1 Overview of outcomes of CGE emission reduction scenarios, 2005-2050 (index 2010 = 100)
Source: Data from The Climate Institute, see Hatfield-Dodds et al 2007

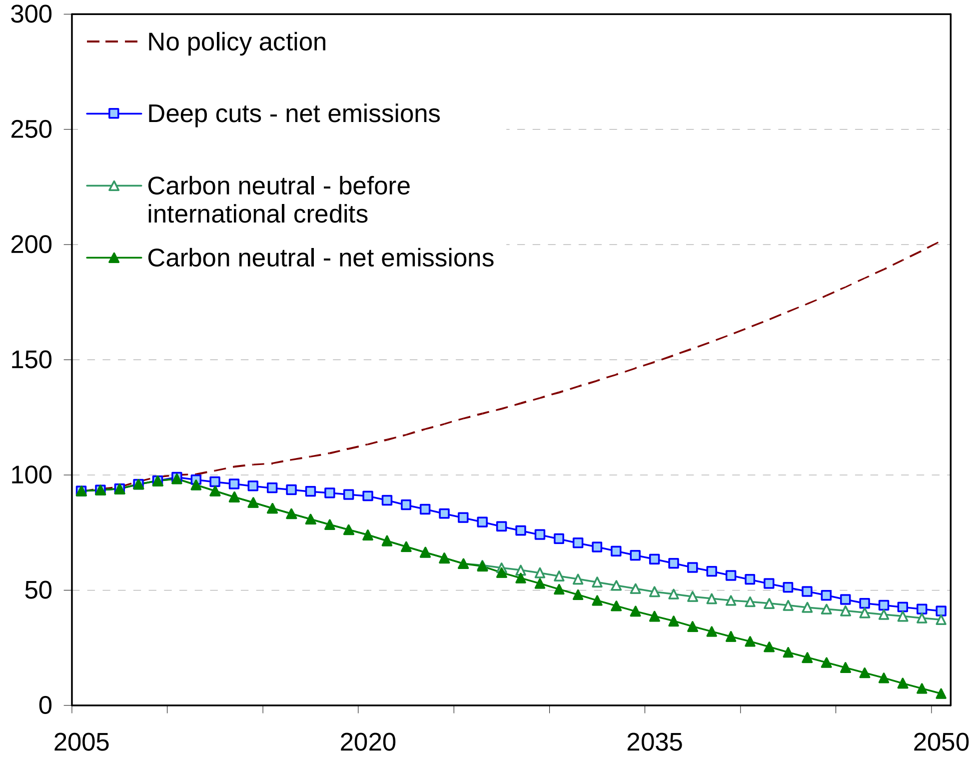
a) Economic growth and employment



(b) Final energy use



(c) Greenhouse gas emissions



3.2.2 ASFF modelling of resource efficiency

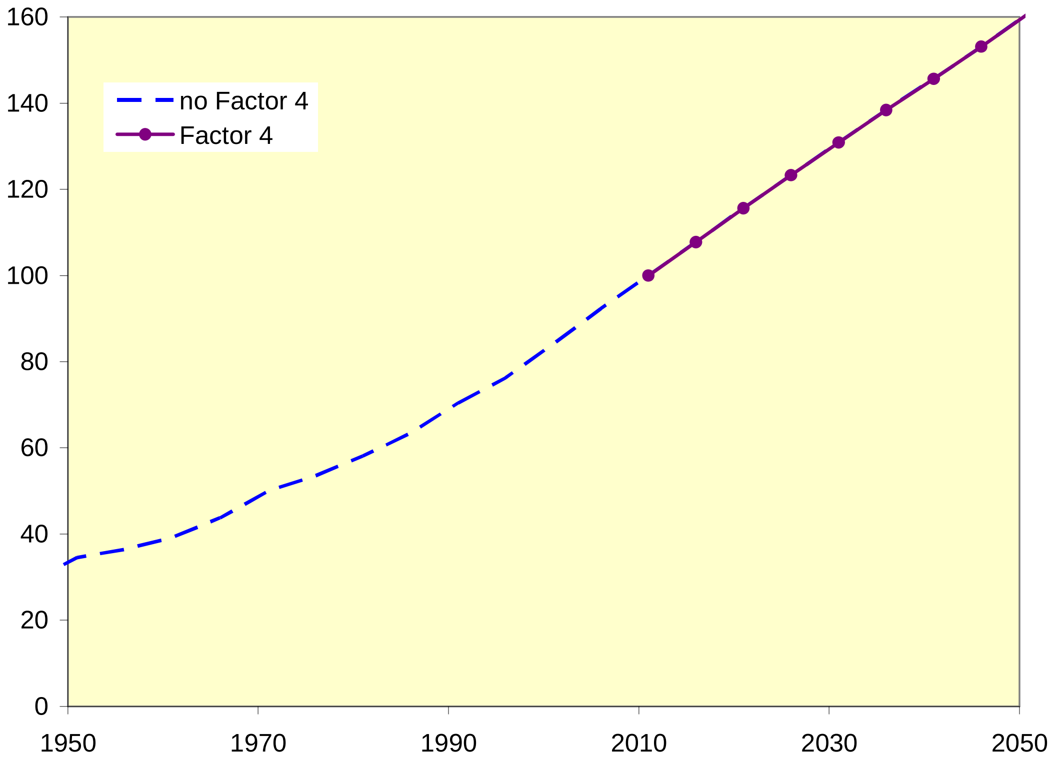
A similar story emerges from the ASFF modelling, although the richer physical detail suggests a more complex pattern of environmental pressures. The strategies modelled yield significant reductions in the material and energy flows within the domestic economy relative to a business-as-usual scenario (see Appendix). These improvements are even larger relative to the growth in the economy, indicated by either the increase in employment or proxy measures for GDP.

As shown in Figure 2, national employment grows steadily in both the Factor 4 scenario and the scenario without Factor 4 actions. By 2050 employment has risen 60% above current levels. Growth in GDP is expected to moderate after 2030 in the Factor 4 scenario, largely due to assumed changes in world demand that results in reduced demand from the mining and agricultural cropping sectors.

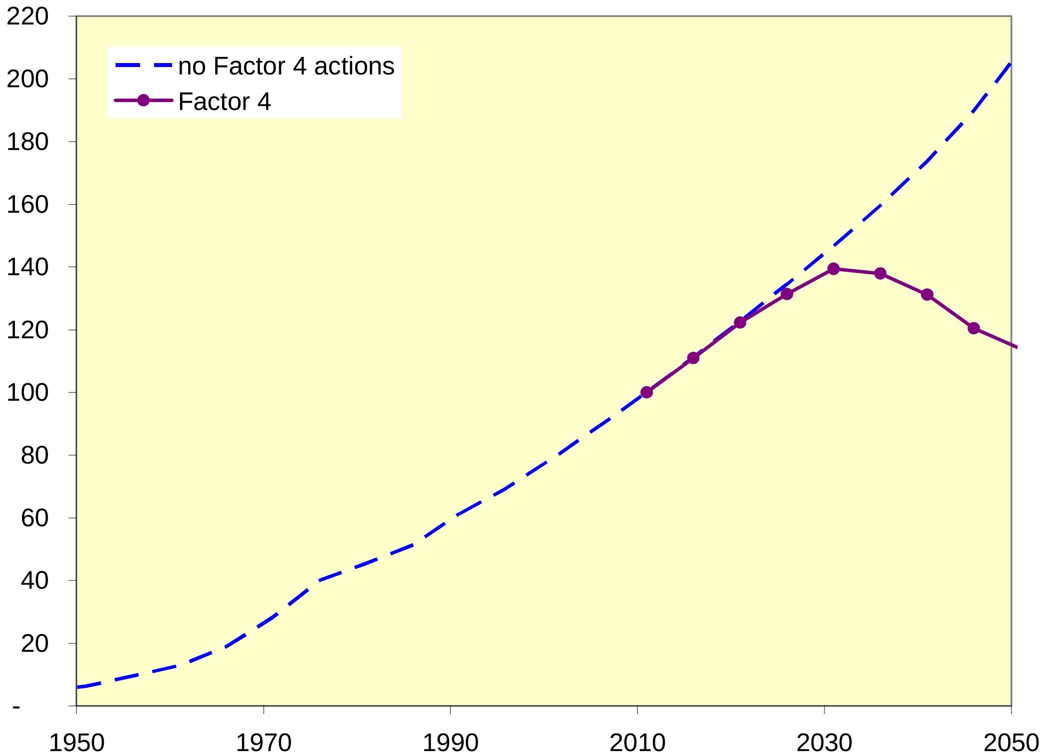
Total material flows (made up of domestic primary material production and imports) peak around 2030 and then decrease to levels some 15% above current levels. Total energy consumption decreases somewhat for about two decades, and then climbs slowly to be about 20% higher than current levels by 2050. This pattern reflects initial gains through energy efficiency (particularly in buildings) which are later outweighed by population and economic growth. Water use increases by around a third less than it would without policy action, with decreases in water use in currently developed southern water systems (particularly irrigated pasture) and growth in water use in urban areas and Northern Australia by 2050. These projections do not take full account of potential variations in water availability due to drought or climate change.

Figure 2 Overview of outcomes of ASFF Factor 4 scenario, 1950–2050
(index 2010 = 100)

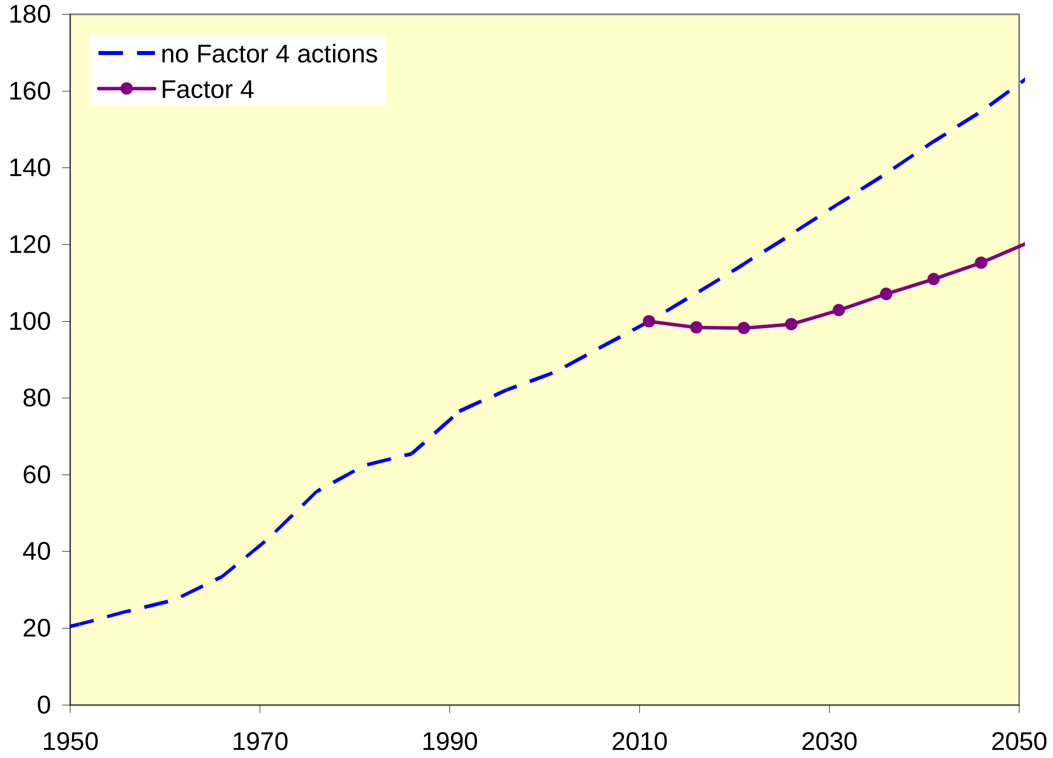
(a) Employment



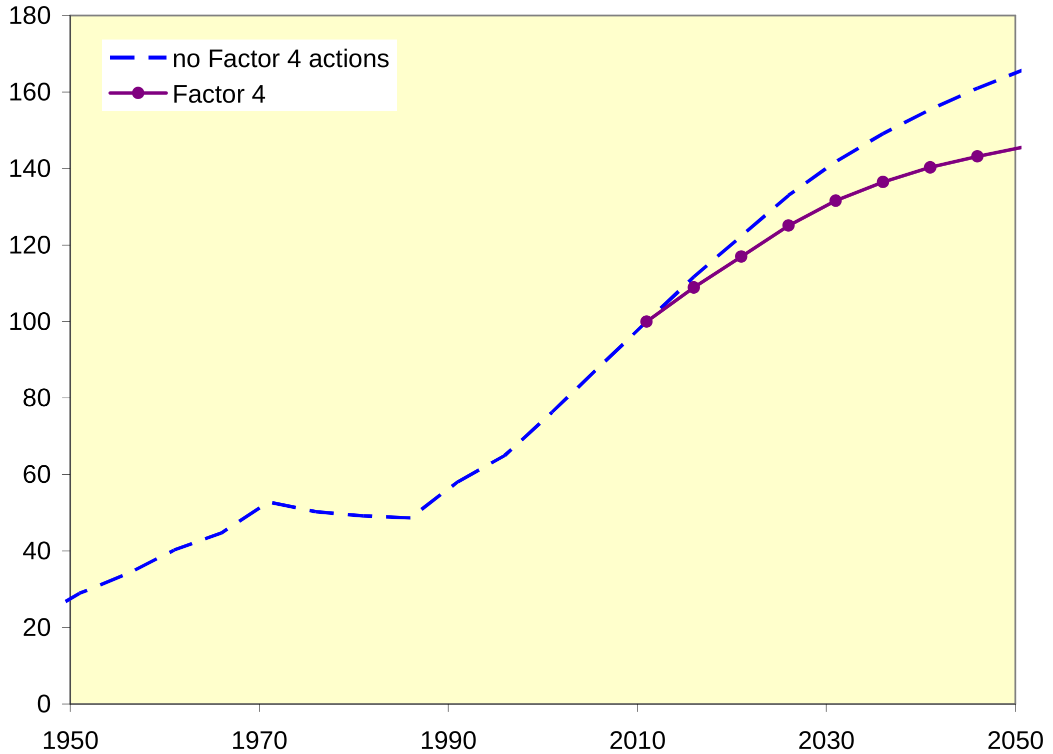
(b) Primary material inputs



(c) Energy consumption



(d) Water consumption



3.3 What this means for Australian workers

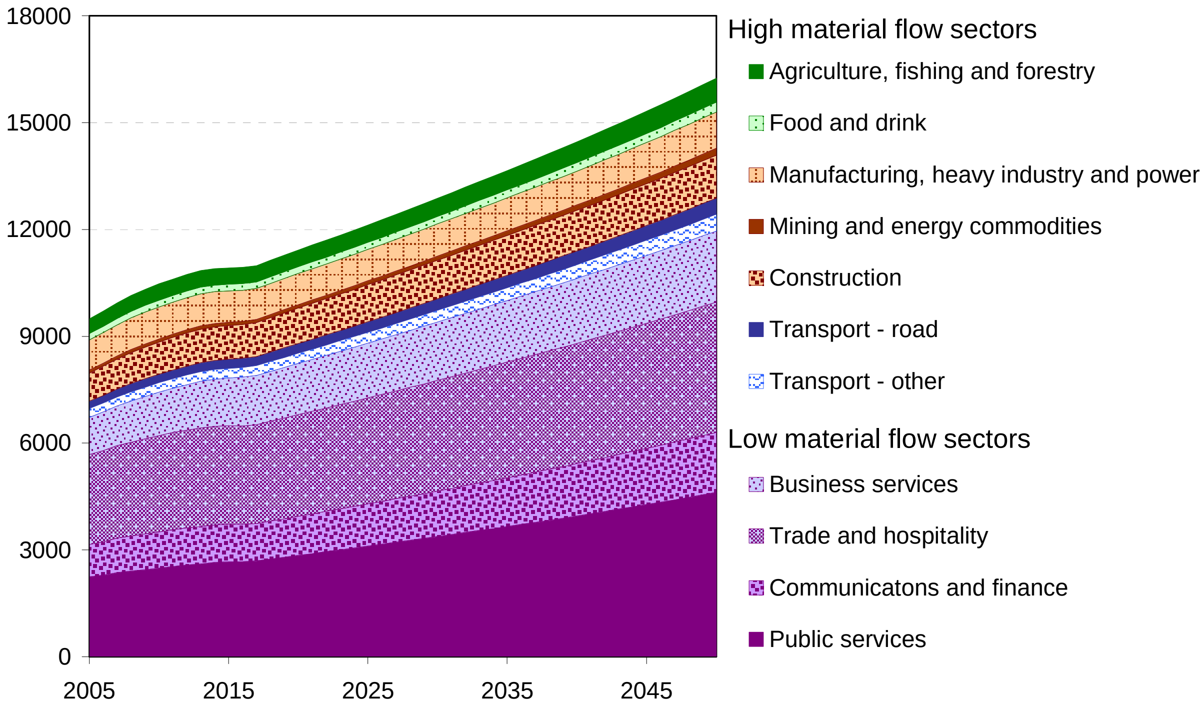
Both modelling frameworks indicate strong employment growth over coming decades. The CGE modelling is calibrated to match the second Treasury Intergenerational Report, and projects around 2.5 million jobs will be created over the twenty years to 2025. The ASFF modelling draws on high immigration scenarios, and projects employment growing by 3.3 million people over the next twenty years, and 7.5 million by 2050.

High level sector employment shares are projected to remain stable over the period, as shown in Figure 3. The analysis details the results for ten major sectors including seven or eight sectors with high potential environmental impacts and two to four service sectors involving relatively low environmental impacts. Other researchers have found that high material flow sectors – often defined as construction and housing, food and nutrition, and transport and mobility – account for nearly 70% of material extraction and energy consumption and more than 90% of land use in industrial economies such as Australia [Spangenberg and Lorek 2002]. The different underlying structures of the models make it difficult to compare across sectors with precision.

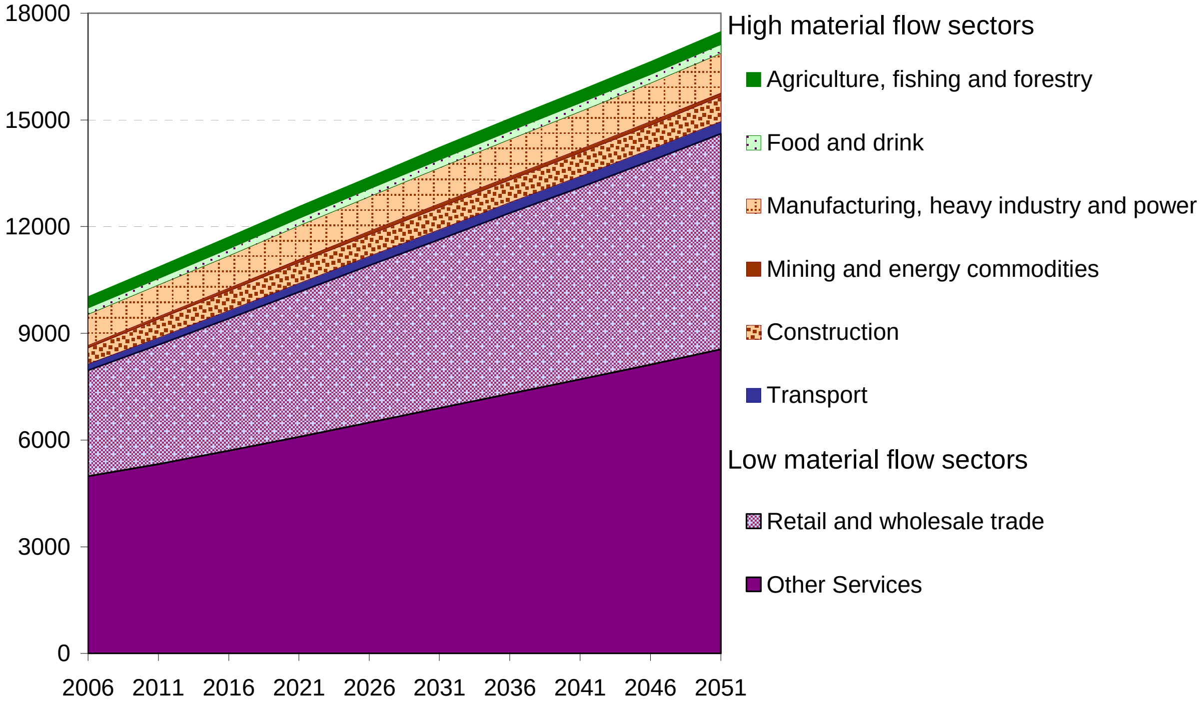
In the CGE model the high impact sectors account for 27-28% of total employment, while in ASFF they account for 18-20%. In both cases the share of employment falls slightly by 2050 (see Tables 1, 2 and 3). The high material flow sectors, as shown in the ASFF model, contribute to a large share of environmental pressure in Australia being responsible for about 90% material flows, 75% of energy use, 80% of water use and 75% of emissions.

Figure 3 Employment by major sector, 2005-2051 (in '000)

(a) CGE modelling of greenhouse emissions reductions, Carbon Neutral scenario



(b) ASFF modelling of resource efficiency, Factor 4 scenario



Source: Unpublished data from The Climate Institute (Hatfield-Dodds et al 2007) and ASFF

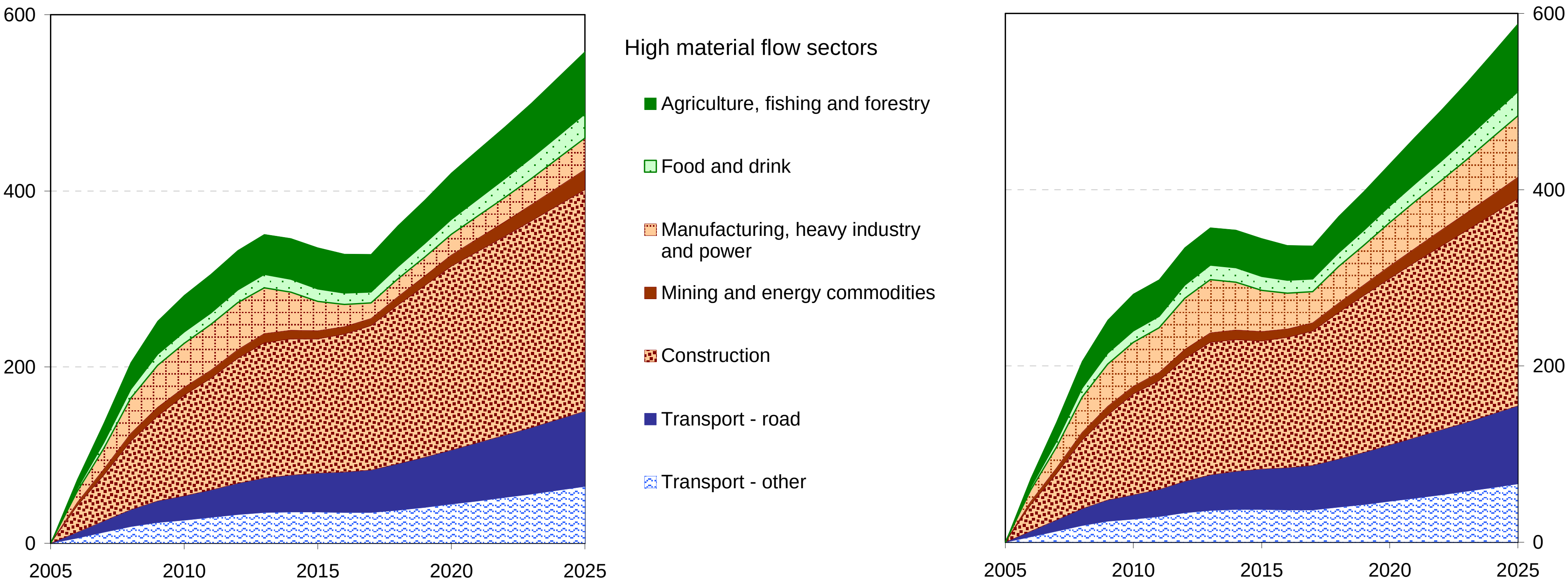
Closer examination reveals a more dynamic picture.

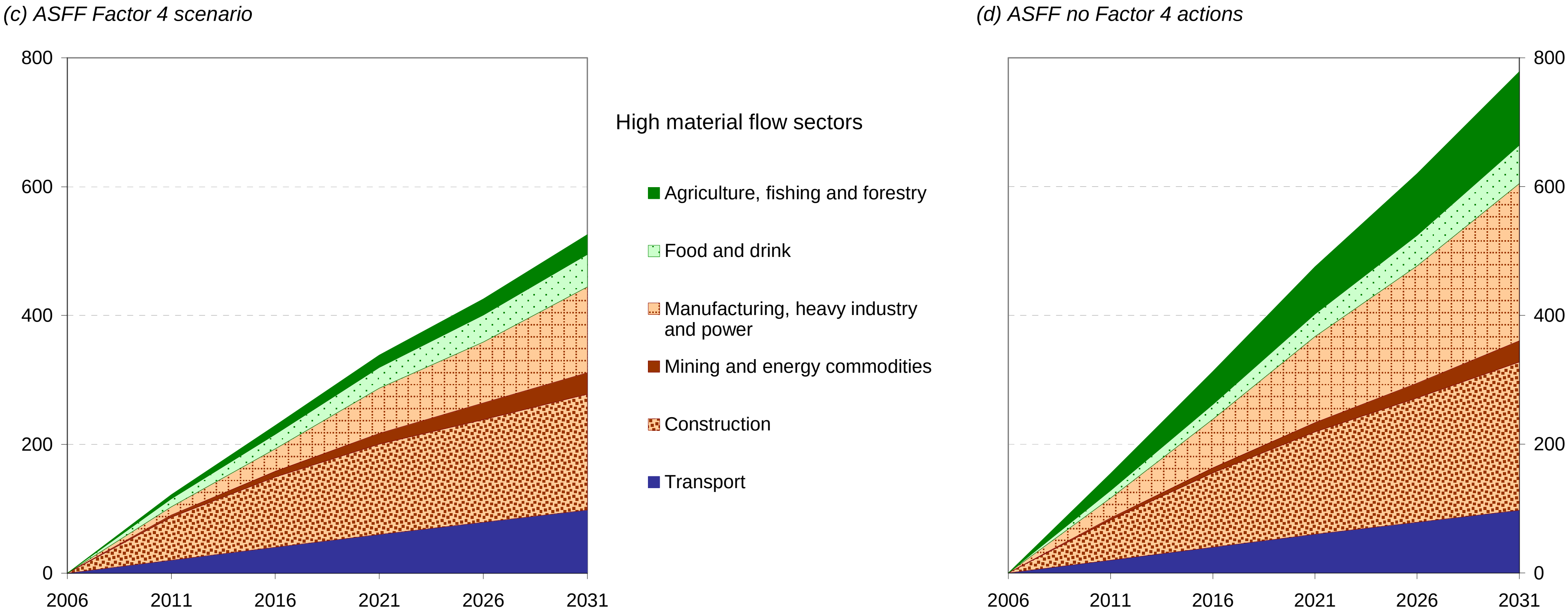
Data presented in Tables 1, 2 and 3 (below) indicates that most of the high material flow sectors grow more slowly than the national average and that all sectors experience net employment growth from current levels except heavy industry and power in the ASFF Factor 4 scenario. Figure 4 provides more detail on increases in sectoral employment.

Employment in construction and road transport sectors grows more rapidly than the national average in both modelling frameworks, with these two sectors accounting for more than half of all new employment in the high material flows sectors. The construction sector makes the largest contribution, with the CGE modelling suggesting that it accounts for 8% of total employment and 10% of national employment growth from 2005, with a projected increase of 150,000 jobs by 2015 and more than 235,000 jobs by 2025. These increases are in addition to normal labour turnover, such as associated with the retirement of existing workers.

Figure 4 Change in employment in high material flow sectors, 2005-2031 (in ‘000)

(a) CGE Deep Cuts scenario *(b) CGE Carbon Neutral scenario*





Source: Unpublished data from The Climate Institute (Hatfield-Dodds et al 2007) and ASFF

The introduction of emissions trading appears to slow the growth of the manufacturing and heavy industry sector in the CGE emissions reduction scenarios, despite the modelling providing full insulation of trade exposed energy intensive industries until 2020, and partial insulation until 2030. The CGE modelling indicates that employment in this sector contracts slightly for several years from 2010, while remaining above 2005 levels, and then begins to grow modestly. These contractions are small, even at the more detailed sub-sector level, and are likely to be smaller than annual labour turn-over. Importantly, value added for the manufacturing, heavy industry and power sector grows each year throughout this period, without any contraction, with an average growth rate of 2.5% per annum from 2010 to 2020.

The implementation of Factor 4 policies is consistent with strong employment growth in manufacturing, agriculture, food, mining and transport sectors – despite large material and energy efficiencies. Employment growth in the construction sector is more rapid in the early period than in the base case, due to the increased labour required for retrofitting. Employment in agriculture shows a slight increase in absolute numbers over the period, contrasting with the historical trend reduction. Employment in heavy industry contracts somewhat due to lower throughput of basic materials and energy. Employment in mining and energy commodities grows strongly, however, from a very low base. Employment in manufacturing is stable, contrasting with observed declines from around 1970 to 1990's, while transport enjoys employment growth along with some compositional changes (with decreases in freight and increases in public transport).

Table 1 Change in employment and sector employment shares, ASFF Factor 4 scenario, 2006-2026

	Change in Employment				Employment share	
	2006 - 2016		2006 - 2026		2006	2026
High material flow sectors						
Agriculture, fishing and forestry	14,015	4%	25,433	8%	3%	2%
Food and drink	22,422	13%	41,830	24%	2%	2%
Mining and energy commodities	9,081	82%	25,638	231%	0.1%	0.1%
Recycling	31	10%	48	15%	-	-
Manufacturing	34,578	4%	94,690	11%	9%	8%
Transport	39,896	23%	78,923	45%	2%	2%
Construction	109,145	24%	159,326	36%	4%	5%
	229,170	**11%**	**425,888**	**21%**	**20%**	**18%**
Low material flow sectors						
Business, finance, communications, hospitality and public services	718,778	14%	1,517,410	30%	50%	48%
Retail and wholesale trade	735,267	25%	1,426,214	48%	30%	33%
	1,454,045	**18%**	**2,943,625**	**37%**	**79%**	**81%**
Total	**1,683,215**	**17%**	**3,369,513**	**34%**	**100%**	**100%**

Table 2 Change in employment and sector employment shares, CGE *Deep Cuts* scenario, 2005-2025

	Change in Employment				Employment share	
	2005 – 2015		2005 – 2025		2005	2025
High potential environmental impact sectors						
Agriculture, fishing and forestry	47,000	+11%	70,600	+17%	4%	4%
Food and drink	14,100	+8%	27,600	+16%	2%	2%
Mining and energy commodities	9,500	+12%	22,800	+28%	1%	1%
Manufacturing, heavy industry and power	33,400	+4%	36,100	+4	9%	7%
Transport – road	44,100	+21%	85,200	+40%	2%	2%
Transport – other	35,200	+15%	64,500	+27%	3%	3%
Construction	152,400	+19%	251,500	+32%	8%	8%
	335,700	**+12%**	**558,300**	**+21%**	**28%**	**27%**
Low potential environmental impact sectors						
Business services	290,100	+28%	489,400	+47%	11%	13%
Communications and finance	148,000	+16%	274,400	+30%	10%	10%
Trade and hospitality	240,700	+10%	449,300	+18%	27%	24%
Public services	420,300	+19%	867,400	+39%	24%	26%
	1,099,100	**+17%**	**2,080,500**	**+31%**	**72%**	**73%**
Total	**1,434,800**	**+15%**	**2,638,800**	**+28%**	**100%**	**100%**

Source: Unpublished data from The Climate Institute for the *Deep Cuts* scenario, as described in text. See Hatfield-Dodds et al 2007.

Table 3 Change in employment and sector employment shares, CGE *Carbon Neutral* scenario, 2005-2025

	Change in Employment			
	2005 – 2015		2005 – 2025	
High potential environmental impact sectors				
Agriculture, fishing and forestry	43,000	+10%	76,900	+18%
Food and drink	15,800	+9%	27,800	+16%
Mining and energy commodities	10,500	+13%	24,300	+30%
Manufacturing, heavy industry and power	47,100	+6%	69,800	+8%
Transport – road	45,700	+22%	88,600	+42%
Transport – other	37,200	+15%	66,200	+27%
Construction	145,500	+18%	235,000	+30%
	344,800	**+12%**	**588,600**	**+21%**
Low potential environmental impact sectors				
Business services	293,500	+28%	494,000	+47%
Communications and finance	153,300	+17%	281,500	+31%
Trade and hospitality	247,400	+10%	458,400	+18%
Public services	429,300	+19%	886,600	+40%
	1,123,500	**+17%**	**2,120,500**	**+32%**
Total	**1,468,300**	**+15%**	**2,709,100**	**+29%**

Source: Unpublished data from The Climate Institute for the *Carbon Neutral* scenario, as described in text. See Hatfield-Dodds et al 2007

4 SKILLS AND INNOVATION REVIEW

Research for this project indicated that current information on green skills and workforce capabilities is very poor. No systematic and comprehensive data gathering appears to have occurred with regard to the skills and knowledge base of business leaders and work force to be necessary to make the shift to a low carbon or ‘environmentally friendly’ economy. The Australian Bureau of Statistics gathers and reports figures on employment by occupation group and industry, unemployment and labour force utilisation, but provides little insight into the availability – or scarcity – of skills and the wider supply dimensions of energy and water sensitive design and implementation across different economic sectors. There is also data available on tertiary education, vocational education and training as well as work related training. These sets of information are weakly linked and there is no systematic information gathered on curricula that would support certain skills required or workplace related training that would support sustainability approaches in key sectors.

Rising to the challenge of reducing our greenhouse emissions and wider environmental footprint will involve the rapid diffusion and mobilisation of new skills and approaches across a variety of sectors and business niches. Poor data will make this task doubly difficult. Gathering data on skill requirement and shortfalls is thus an urgent priority. This will require data collection and consultations with a wide range of industry stakeholders, including providers, customers, and third parties such as advisors, regulators and accreditation agencies. There is very little already in the existing literature that could be adapted for the purposes of this study.

4.1.1 Issues

Some of the issues that have been raised in relation to the impact that climate change is likely to have on employment in Australia are:

- what little data there are is concentrated on jobs in renewable energy, and the trades, such as construction, plumbers and electricians — there is little about transport, agriculture, innovation and/or research and development, and green accounting/standards, which are also areas of potential employment change and perhaps growth;
- skills shortages are affecting consumers’ ability to switch to more sustainable or energy efficient alternatives (for example, shortage of mechanics to convert cars from petrol to LPG, following the announcement of a consumer subsidy (NSW DET 2007 p.10), and inadequate workforce skills and training is affecting the take-up of solar energy use (NREL 2006 p.6));
- in some cases, there may be a negative feedback effect that needs to be addressed — demand for, say, solar panels may be low because it is expensive or because there is a long waiting list, or both. This may be because there are insufficient numbers of trained electricians, or it may be that there are insufficient numbers of trained electricians because demand for solar panels is low;
- the critical factor — and the one on which there appears to be the *least* information — is consumer demand for green products and services. It is necessary to develop estimates of consumer demand for solar panels, LPG conversions, etc so that the demand for green collar workers can be estimated. This is difficult to do in

the absence of government intervention aimed at addressing the negative feedback effect noted above.

4.1.2 Australian data

Our review was not able to identify comprehensive or consistent data about green collar jobs — either in Australia, and in other countries. What data there are tends to be anecdotal, and associated with particular industries, or employers. For example, there is information available on:

- green plumbers (www.greenplumbers.com.au/information/energy-saving/), with an estimated 600 green plumbers in Victoria, Queensland and Tasmania, accredited through Green Plumbers;
- growth in environmental workers in the environmental sector, based on a study commissioned by Greenskills, in Western Australia (www.greenskills.green.net.au/greenjobs/);
- plans to train and accredit 'eco-smart electricians', but no data on numbers of electricians (www.ecosmartelectricians.com.au/).
- Swinburne University of Technology developed a strategic approach to implementing sustainability into vocational education and training to build capacity of the workforce that results in behaviour change toward more sustainable business systems, business practices and business thinking (www.swinburne.edu.au/ncs)

Much of the information is oriented towards marketing specific skills or trade networks. The data is not comprehensive, is generally not well described or documented, and frequently includes claims with little supporting documentation or empirical background.

4.1.3 International best practice

There are numerous examples of policy documents, scientific reports and case studies articulating the need to recognise the underlying skills requirements for a transition to a low-carbon, environmentally friendly economy. A good example of the current state of knowledge is presented by the Green Jobs Initiative, which is a joint initiative of the United Nations Environment Programme (UNEP), the International Labour Organization (ILO) and the International Trade Union Confederation (ITUC) that has been launched to assess, analyse and promote the role of employment in climate change [UNEP 2008]. The background paper looks at energy efficient buildings, transportation, agriculture and the global food system. It does not present quantitative data but outlines policies for a green jobs strategy discussing:

- The need of government action
- A green investment strategy
- Green R&D and technology transfer
- International cooperation and aid
- Job training
- Dialogue to achieve a just transition

In its conclusions the report stresses the necessary “green” transformation of economies and the lack of information and data. The main issue identified is how efforts can best be linked to the international business community to realize the transformation to a green economy.

The UNEP background paper is supported by a comprehensive study undertaken by the Worldwatch Institute. The have issued a preliminary report on ‘Green Jobs: towards sustainable work in a low carbon economy’ supporting the UNEP, ILO, ITUC green jobs initiative with evidence [Worldwatch Institute 2007]. The study is international in scope and presents a comprehensive approach discussing energy supply alternatives, energy-efficient buildings, transportation and food and agriculture, as well as industry in more general terms. The report is framed by a section on green policies and business practices and concludes by identifying the need of a new production/consumption model enabling a fair transition. The report has a comprehensive list of references identifying examples for green jobs and skills initiatives globally.

There has been earlier work for the US economy by Bezdek and Wendling [2005] ‘Jobs Creation in the Environmental Industry in California and the United States’. The report has a broad focus on green jobs and presents data for the role of environmental industries in the US and in California. Worldwatch Institute [Renner 2000] has flagged environmental policies as a growing source of jobs by discussing the changing nature of work and the need for improving resource productivity. In this report, environmental policy is understood as a motor for creating new jobs rather than killing jobs.

While the idea of looking at the business opportunities created by environmental policies is not new, the policy debate and the need for looking at the skills and knowledge base underpinning a transition to a ‘green economy’ has been reinforced by the scientific and policy debate around climate change. The UK government Stern review suggests 25 million people working in green sector worldwide by 2050 [Stern 2007], a very low estimate in the light of our findings.

There is an indication that the issues of skills and knowledge have been taken more seriously internationally than in Australia. To give an example, EU president Jose Manuel Barroso has argued for millions of new jobs that will occur in the green sector during the presentation of the EU’s climate and energy package in January 2008. It has been acknowledged, that the ecological restructuring of our economies will be constrained by skill shortages and will be accompanied by lack of funds (World Business Council for Sustainable Development, 2008).

4.1.4 Suggested next steps

There are significant data gaps that need to be addressed before the impact of climate change on employment can be meaningfully addressed. Some of the steps that will need to be taken in order to address these data gaps and to undertake robust labour market modelling include:

- defining the types of services that are considered ‘green’ (eg, installation of solar panels, LPG conversions, grey-water systems, green accounting, energy efficiency monitoring and enforcement, etc), and then estimating the current demand for these services;

- developing a view on likely government interventions (whether in relation to training more green workers, or providing subsidies to consumers [which doesn't always work, as demonstrated with the LPG conversion subsidy]), and the impact that these will have on the demand for green services;
- speaking with industry groups (for example, Master Builders, Master Plumbers, Communications Electrical Plumbing Union [CEPU], Electrical Trades Union, etc) about the potential of these sectors to meet demand for green services.

5 NATURE OF THE RESPONSE REQUIRED

The modelling reviewed above indicates very significant increases in employment across a range of sectors that are crucial to achieving the transition to a more sustainable society and economy, characterised by rising quality of life and living standards along with a shrinking environmental footprint.

The key sectors for intervention in regards to a transition to a low carbon economy are the energy sector, construction and housing, transport and mobility and crop and livestock production and nutrition. These activities account for around 70-80% of overall resource use, emissions and environmental impact. Supporting a low carbon transition will require a fundamental change in the organisation, design and actual activities in those sectors and will depend on the right incentives to be in place as well as on the human and leadership capacity to deliver very different outcomes.

Yet these raw numbers from the modelling – the creation of at least 33,000 new jobs in manufacturing, 77,000 jobs in transport, and 145,000 jobs in construction over ten years – understate the nature and extent of the challenge.

The real challenges will lie in providing appropriate skills to these new workers while also supporting the re-skilling of the 2.9 million workers who are currently employed in these high impact sectors.

5.1 Keys to achieving a high performance - low carbon economy

We consider that a systems approach is required to address the multiple challenges involved in enhancing living standards while rapidly reducing environmental pressures. We have identified 5 'keys' to achieving a rapid transition to a genuinely sustainable society:

- incentives and policy settings for environmental performance;
- green skills and training;
- performance assessment and accreditation to inform action;
- access to appropriate business inputs and components; and
- promotion of a stronger innovation culture.

5.1.1 Improved incentives for environmental performance

Public policy settings are an important part of the institutional context of economic activity. These settings, and more general social norms and expectations, act as part of the evolutionary environment of businesses, shaping the selection pressures that reward some ideas and behaviours and penalise others. The introduction of emissions trading will create new market niches, business opportunities, and pressures for change that will continue to evolve and interact with other trends in ways that regulation or government programs would find difficult to emulate.

Emissions trading is also likely to be accompanied, over time, by other changes in policy settings, such as changes to planning and building regulations, and to corporate disclosure and accreditation standards. Key areas for enhancing incentives for environmental performance include:

- Greenhouse gas emissions (largely addressed by emission trading);
- Energy efficiency, including buildings, appliances and vehicles;
- Water use, security and pricing;
- Waste management and disposal, including point source emissions to air and water; and
- Natural resource management, including impacts on native vegetation, water quality, and dry land salinity.

New information also can have incentive effects, such as by helping to scope social and economic needs and opportunities, providing insight into current performance, or revealing hidden costs or risks associated with existing practices.

Improved policy settings and information will – if well designed – provide social and economic incentives for continued reductions in environmental pressure, while promoting improved living standards, and enhanced social and economic options.

5.1.2 Green skills and training

A flexible and efficient response to emissions trading will place a premium on currently scarce skills, in an economy that is already struggling with high employment demand and skill deficits. Demand will increase for the design and construction of energy and water efficient buildings and infrastructure, renovations and retrofits, and the installation and maintenance of efficient appliances and machinery. Restructuring of the energy system to decentralized and renewable systems will require know-how and skills not yet available. Developing alternative transport systems and changing ways in which nutrition is provided will further add to increased demand for new skills. Skill needs will include technical and trade skills, design and engineering, assessment and accreditation, reliable product and market knowledge, and supply and post-sale support.

Important green collar skills include:

- planning and design
- business leadership and entrepreneurship
- project management and procurement
- specific business management expertise (such as for architectural practice, broad acre farming, fleet management, specialist manufacturing or retail)
- trade skills (such as green plumbing, construction of energy efficient buildings, renewable energy, low input gardening)
- assessment of project requirements (such as specification of inputs, system specifications, access to finance, approvals requirements, total costs) and outcomes (such as water and energy use, efficiency, market value)
- marketing and communication

These needs will not be restricted to the construction or manufacturing sectors. Emissions trading is likely to catalyse new attention to supply chain management, building services, transport and logistics. These are core issues for many retail and wholesale businesses and niche business service providers. Attention from customers and shareholders will reinforce policy signals about efficient energy and resource use, underlining normal sound business principles, and draw new attention to the insights from ‘corporate social responsibility or ‘eco-efficiency’ into profitable business opportunities.

5.1.3 Performance assessment and accreditation

Ensuring access to trustworthy and timely information on environmental performance is crucial to the evolution of more sustainable social and economic practices.

Well structured and reliable projections of environmental performance are particularly important for decisions with long legacy effects, such as the design and construction of buildings and infrastructure, or decisions that shape the future of communities. An increasing number of decisions over coming decades will need to grapple with aspects of adapting to the direct impacts of projected changes in climate, taking account of the resilience and vulnerability of key social groups, as well as working towards reductions in national greenhouse gas emissions. Third party assessments and accreditation can provide confidence to businesses and households that they are making worthwhile investments that are consistent with their preferences and needs.

Information on actual performance is also important for monitoring outcomes and identifying options for improving performance over time. For example, data on household water use or energy intensity (per person or in relation to building size and type) could provide a useful diagnostic tool for targeting offers for efficiency audits and investments.

Performance assessment has important potential links to incentives and green skills and training. Accreditation of skills and training can be linked to employment opportunities and skill loadings. Businesses can also be accredited as being able to provide specific services, or be eligible for related benefits (such as an enhanced apprenticeship allowance for accredited green builders). The capacity to provide robust assessment of expected outcomes – such as projected energy rating for buildings – allows regulations to be framed in terms of outcomes (promoting flexibility and innovation) rather than prescriptive processes or inputs. Information also can have incentive effects, such as by helping to scope social and economic needs and business opportunities, providing insight into current performance, or revealing hidden costs or risks associated with existing practices.

5.1.4 Business inputs and supply chains

The ability for changes in practice in the building, energy, transport and nutrition sectors will depend on the availability of supply chains and intermediary goods and services at affordable costs. It will require adjustments in a number of secondary activities in order to deliver the materials and products that allow for substantial changes in the high impact sectors. For example, the availability of double glazing, of energy efficient structural materials and insulation and of heating systems supporting low energy standard will be instrumental for the adaptations aimed at in the building sector. While in an early phase prices for those materials and products might be considerably higher as those of traditional materials, economies of scale and a change in preference and practice are likely to lead to significant reduction in price over time. It also becomes obvious, that changes in the priority sectors will have impacts on all other sectors of the economy and will change procedures, range of products and the required skills.

5.1.5 Promoting a stronger innovation culture

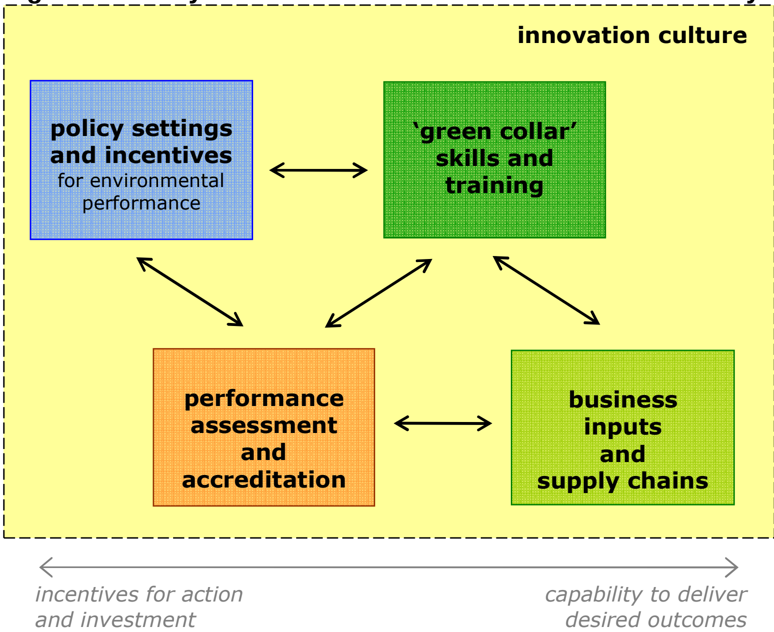
Making the transition to a low carbon and more resource efficient economy will require ingenuity and innovation across all sectors of society and the economy. Much of this is likely to occur spontaneously as a result of new incentives and information. Experience suggests that significant changes in social and economic organisation require experimentation and innovation, usually outside or at the edges of the dominant regime and associated mainstream structures. These innovative practices can be enabled by encouraging experimentation or learning activities in niches that are protected, for a period, from mainstream pressures or expectations. This strategic niche management is an important aspect of applied sustainability policy in the Netherlands. Innovation can also be supported by nurturing stronger linkages and partnerships between different types of actors within the innovation system – especially entrepreneurs, small and medium enterprises, and business oriented staff within research organisations – in order to help bring commercially relevant innovations to market. Lastly, innovation can be fostered simply by providing tangible signals that critical and imaginative thinking is valued and esteemed within organisations and in the nation as a whole. This might be achieved by initiating ‘innovation harvests’ where all employees are encouraged to make suggestions on how to improve work practices and productivity, or through initiating deliberate processes to review, evaluate and re-imagine core organisational and operational processes, or by greater public recognition of the contributions of innovators.

5.1.6 Implementing a systems approach

Each of the five keys has a necessary but not sufficient contribution to meeting the challenges of making deep cuts in greenhouse emissions, and promoting a happier and more sustainable society. This of itself raises serious policy and implementation challenges, as carriage for these different strands is divided between departments and levels of government.

We suggest that it is useful to think of the five components in terms of their role in providing incentives for action and investment and underpinning the capability required to deliver these desired outcomes. The incentives dimension draws attention to policy settings, while capability highlights skills and business inputs. Performance assessment links these two dimensions. These linkages are illustrated in Figure 7.

Figure 5 Keys to the transition to a sustainable economy



While specialisation and focus have important benefits in policy delivery, just as they do in business, extra care will need to be taken to ensure these different arms of policy effort work effectively with each other, rather than each working in isolation from – or even against – the others. For example, implementing a national retrofit program or ambitious energy efficiency and insulation improvements in public housing could make an important contribution to national emissions reductions, but would risk exacerbating green trade skill deficits if action is not also taken to boost skills and workforce capacity. But boosting trade skills alone will not be sufficient without increased attention to design, and the choices and information available to those who specify performance standards for home and building fit-outs. Many of these tensions can be resolved through established coordination processes, which deliberately seek to harness different perspectives in developing robust solutions.

The next step in achieving the transition to a high performing sustainable economy is to deliberately create linkages between the different keys. Policy frameworks can provide incentives for environmental performance based on robust independent accreditation. Land release processes could provide incentives for more sustainable subdivisions and community engagement in the design process. Training programs can be linked to supply chains so that designers and tradespeople are familiar with leading building materials and system components. Policy should provide direct support and incentives for investment in green collar skills and training (expanding the supply of these skills), as well as enhancing the demand for green products and services.

This implies that systematic attention to human skills and labour will play an important role in implementing worthwhile national action to address climate change. Human skills, passion, and ingenuity are central to each component of a coherent strategy, and to meeting the multiple challenges ahead.

5.2 Suggestions for a green collar research agenda

The scale of the challenges ahead will require research and activity across a range of fronts. Undertaking this project has suggested a number of clusters of issues for further exploration:

Skills coordination: Overcoming the skills shortages would be assisted by the development of a shared broad understanding of the types of skills required, and the likely demand for these over the periods 2010-15 and 2015-20. This would assist the task of developing appropriate training pathways, accreditation systems, and coordination with key stakeholders (such as technology providers, educators, and employer and industry groups). It would also help to provide the confidence needed by people considering whether they should acquire one or more different types of green collar skills, and help identity the specific 'skill packages' likely to be in demand. Specific research questions include:

- How might robust broad estimates of future skill requirements be developed? Who is best placed to inform these? Who should lead this process and how might it be resourced? How should this information be disseminated, and to whom? What processes would be effective for keeping these estimates up to date, ensuring that different views are reflected appropriately.
- What training pathways – including accredited training courses, changes to the curriculum of existing qualifications, apprenticeships and trade certificates, and other on the job training – are likely to be most effective? How can skills training keep pace with changes in technologies and provide the flexibility to respond to evolving market conditions?
- What are the distinctive roles and contributions of different stakeholders, including large and small businesses, education providers, industry bodies, government, and the research sector? What are the options for harnessing these distinctive strengths and achieving synergies across stakeholder contributions?

Policy opportunities: Guiding and motivating action to create a more sustainable economy will generate numerous opportunities for creating jobs, shaping business growth and enhancing Australia's future economic strengths. All change involves challenges, however. The design and management of our fresh water systems, for example, has not given enough attention to climate variability and future climate change. Reform of current arrangements is difficult. A return to wetter seasons would highlight different tensions. These opportunities and tensions raise a range of research questions:

- How can the next wave of environmental reforms learn from the past? How can we provide for review and adjustment of policy settings, which also providing the confidence required for business investment and employment creation?
- What opportunities are there for lateral approaches to stalled policy issues, such as providing financial incentives for more efficient use of scarce natural resources (such as water or petroleum fuels) while addressing legitimate concerns about access and adjustment costs? How can we ensure that policies improve living standards and enhance lifestyle options, as well as protecting our natural capital?
- How do we build momentum and broad support for long term policy changes, and implement practical strategies for developing policy over time? New approaches are needed to problems such as biodiversity conservation, increasing urban

congestion, and adaptation to climate change. Who has the capacity to support and guide the development of new options and approaches? What data and analysis is required? Who is the custodian of the long term in Australia?

Achieving synergies: Effective policy will require coordinated sets of policies that enhance both incentives for action and investment, and build our practical capacity to decouple economic growth from environmental pressure. This will involve attention to incentives, skills, information, and supply chains. But policy implementation will raise challenges and tensions as well as opportunities and synergies. Research questions to be considered will include:

- How can different arms of policy be linked to allow the co-evolution and adaptation of specific policy components? What are the opportunities for linking regulations and standards to performance assessment and accreditation arrangements? How can this foster continuous improvement of both business practices and business regulation?
- What opportunities are there for implementing outcome or objective based regulations, backed by default input or process based standards for those that wish to use them? What jurisdictions or areas of regulation provide good models of learning systems that can be applied elsewhere?
- How can policy approaches create stronger linkages between regulatory silos or across different issues? Are there risks of policy paralysis? How might these be mitigated or reduced?
- What is the role of skill based groups and institutions in facilitating the transition to a flexible and fulfilling high-wellbeing low-carbon society?

6 CONCLUSIONS

This report commissioned by Dusseldorp Skills Forum explores the skills, innovation and workforce dimensions of the transition to a more environmentally sustainable society. The report draws on two very different types of national models to explore potential green collar employment futures: the CSIRO ASFF model; and the Monash University multi-regional computable general equilibrium (CGE) model.

The projections developed by these two approaches share substantial areas of agreement, despite fundamental differences in the underlying structure, constraints, and drivers of change incorporated into the models. Key results include:

- Well designed policies can substantially decouple economic growth from environmental pressure, so that living standards continue to increase at current rates (avoiding blockages that might otherwise occur), while our national environmental footprint reduces over time
- Achieving a rapid transition to sustainability would have little or no impact on national employment, with projected increases in employment of 2.5 to 3.3 million jobs over the next two decades.
- Employment in sectors with high potential environmental impacts will also grow strongly, with projected increases of more than 10% over ten years. This will add 230,000 to 340,000 new jobs – in addition to normal employment turnover – in the transport, construction, agriculture, manufacturing and mining sectors. Employment in construction and transport sectors is projected to grow significantly faster than the national average.

But achieving the transition to a low carbon sustainable economy will require a massive mobilisation of skills and training – both to equip new workers and to enable appropriate changes in practices by the three million workers already employed in these key sectors influencing our environmental footprint. Current approaches do not appear sufficient for meeting these challenges (as discussed in Section 4).

We identify five key elements of a coherent and systematic response to the skills challenges associated with this transition (as discussed in Section 5):

- incentives and policy settings for environmental performance;
- green skills and training;
- performance assessment and accreditation to inform action;
- access to appropriate business inputs and components; and
- promotion of a stronger innovation culture.

The transition to a low carbon economy will require policy attention to both incentives for environmental performance, and to the skills required to deliver this performance. Substantial action will be required to ensure that the skills, education, training required are available and ready to contribute.

This will involve concerted action by government, businesses, labour, and educational and training institutions to develop and implement new approaches to green education, training and jobs. To be prepared for such challenge in both magnitude and innovation needs Australia should strengthen its capacity for analysing and understanding the interrelationships between education and training, jobs and employment and environmental footprint by improving the scientific knowledge underpinning such understanding and by up-grading the extent and quality of information and data in the areas concerned.

There is a triple-dividend of greater wellbeing, cost-saving and greater competitiveness and reduced environmental impact to be earned if measures would be taken to support the skill revolution required for a low-carbon, environmentally sound society.

APPENDIX 1

The Factor 4 scenario was implemented using a combination of intensive and extensive measures in the CSIRO Australian Stocks and Flows Framework (ASFF). This is a process-based simulation of the Australian economy, tracking the dynamics of major capital and resource pools, and flows associated with these stocks such as productive output, resource inputs and changes in capital (Turner and Poldy 2001; Foran and Poldy 2004; Lennox et al. 2004). Common units throughout the framework are tonnes, litres and joules. The ASFF was calibrated over 1941–1996 to reproduce many national data series of labour, trade, materials and energy use.

The ASFF and related simulations have been used in studies of the environmental implications associated with future population (Foran and Poldy 2002), agriculture (Dunlop and Turner 2004), fisheries (Lowe et al. 2003), climate change (Turner et al. 2007; Jones et al. 2005), human settlements (Lennox and Turner 2005) and water-energy systems (Kenway et al. 2008).

Modelling Factor 4 policy scenario

The Factor 4 scenario is based on the high immigration scenario in the *Futures Dilemmas* study of population impacts on the environment (Foran and Poldy 2002), which broadly matches recent population growth and immigration trends. This existing scenario was modified through the incorporation of a series of policy strategies to reduce material and energy flows in line with the logic of Factor 4 literature. These policies focused on the key material and emission intensive sectors: electricity generation, construction and housing, transport and mobility, food production and nutrition, and primary export industries.

The following changes have been modelled and tested for outcomes in material use, CO_2 emissions and changes in employment.

- In electricity production, coal-based power is phased out as existing plants age, to be replaced by wind, photovoltaic and gas-powered generation in equal proportions (of electricity delivered for otherwise unmet demand). Taking account of capacity factors and existing plants, the modelling results in more wind capacity than gas-based power, and then photovoltaic power. The modelling assumes that the gradual transformation away from coal is virtually completed by 2050.
- Construction and renovation of residential dwellings assumes the use of solar passive concepts to achieve relatively rapid material and energy efficiency improvements. Average building energy requirements per unit floor area was halved in the scenario over about two decades, assuming for example, wide-spread use of solar hot water systems, double glazing and insulated roofing and walls. This would involve a thorough refurbishment program of the extant building stock, and the large majority of new dwellings achieving greater energy savings through optimal orientation and design. New dwellings use light insulating outer structures keeping the thermal mass inside, resulting in past trends continuing over 20 years until a 50% decrease of overall mass is achieved. Building material composition has been adjusted to higher percentages of glass and wood, lower brick and concrete. Additionally, the growing trend in dwelling floor area has been

reversed incrementally to approximately 150m^2 average dwelling size by mid-century.

- Changes in urban transit implement a modal shift in commuting away from private vehicles (down from about current levels of 85% to 60% in 2050), towards the use of public transport, bicycling and walking. The efficiency of public transit in terms of passenger load is increased by about a third. Shorter commuting distances, reduced by some 30% in 2050, reflect improved urban design incorporating more distributed employment zones and improved urban mix. Growth in the share of inter-city travel by air is reversed, assuming bus and rail travel dominates (more than 70% in 20500.
- Improvements in nutrition are addressed through per capita dietary adjustments toward a higher share of fruit, vegetables and cereal-based food, and less meat, dairy, and sugar. The projections modelled are in keeping with a number of historical trends, though a 50% reduction in meat consumption represents a significant departure. We assumed that the overall annual volume of food consumed per capita falls by about 10% by 2050, i.e., back to about 1980 levels of some 1.2 tonnes per capita.
- Primary industries also undergo a gradual transformation to a stabilised use of Australia's endowed resources in mining and agriculture. Flows of materials through international trade were diminished in the Factor 4 economy. Exports of livestock products were maintained at a constant level throughout the scenario. In the mining sector, it was assumed that current mining leases are maintained and utilised for another 20 years, after which the Factor 4 transformation of the economy involves a reduction in this activity. Growth in production of major minerals and energy commodities was continued at current rates, peaking at about 2030 and subsequently decreasing to contemporary production rates in 2060.

These changes are implemented without incorporating any "rebound effect", or "take-back", where efficiencies and subsequent cost-savings can result in further economic growth and consumption. Absence of rebound is consistent with, for example, an economy operating under an imposed cap on the resource use system.

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