Centre of Full Employment and Equity

Policy Report

A Just Transition to a Renewable Energy Economy in the Hunter Region, Australia

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This Report was commissioned by Greenpeace Australia Pacific

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Terms of Reference

This Report is the collaboration between researchers at the Centre of Full Employment and Equity, The University of Newcastle (Bill, Mitchell and Welters) and independent consultants Geoff Evans and Jay Rutovitz.

The project was commissioned by Greenpeace Australia Pacific and the Terms of Reference were designed by Greenpeace Australia Pacific.

The researchers at the Centre of Full Employment and Equity take responsibility for Sections 3 and 5 and the input-output modelling in Section 4 (indirect employment numbers in Table 24 and discussion). Geoff Evans is fully responsible for Section 2, and Jay Rutovitz is responsible for Section 4. Joint contributions have been made in Section 1 and the conclusion, Section 6.

The specific Terms of Reference provided to the researchers at the Centre of Full Employment and Equity were

- Use input-output analysis to model the employment losses resulting from a closure of the coal-fired powered industry in the Hunter / Wyong region.
- Use data estimates of the direct jobs generated by renewable energy production (these estimates were provided by an independent consultant, Jay Rutovitz) in input-output analysis to estimate the total jobs generated by a switch to renewable energy electricity production. In undertaking this exercise the researchers were cognisant of the fact that the initial data estimates were based on occupational classifications broadly mapped into the ANZSIC structure. The resulting input-output analysis used the industries identified. A more complete study would clearly treat the renewable sector as a new entrant without existing linkages and gather new data on the exact nature and magnitude of these linkages through the input-output system.
- Develop some policy parameters to assist the Hunter region in the industrial restructuring from coal-fired power to renewable energy.

Executive Summary

This Report demonstrates that there can be major benefits to the Hunter and adjacent Wyong region if there is a shift from coal-fired power generation to a renewable energy economy. These benefits include the creation of thousands of new secure, well-paid jobs in the research, design, manufacture, installation, maintenance and export of energy efficiency and renewable energy technologies.

This Report estimates that a shift to a renewable energy economy in the Hunter / Wyong region would create between 7,500 and 14,300 new jobs - a net gain in jobs of between 3,900 and 10,700 jobs.

The lower estimate is extremely conservative, as it assumes no Australian manufacturing in wind or solar energy. If manufacturing is established in the Hunter to service the NSW renewable industries, the lower estimate is 9,400 jobs, a net gain of 7,100 jobs.

The Hunter / Wyong region could become a renewable energy hub, and in doing so revitalise the region’s manufacturing industry.

There are costs in making a shift to a renewable energy economy and that is why there needs to be a just transition to such an economy.

This Report estimates there will be 1,300 direct job losses in the phasing out of coal-fired electricity generation in the Hunter / Wyong region and 2,300 indirect job losses (a total of 3,600 jobs).

A just transition policy recognises that people and ecology are both important. It recognises that ‘business-as-usual’ and high risk technological fixes to unsustainable economic activity are not credible options for confronting climate change.

A just transition ensures that the costs of economic restructuring and the shift to sustainability do not fall on workers in targeted industries and their communities.

A just transition in the Hunter / Wyong region requires government intervention and community partnerships to create the regulatory framework, infrastructure and market incentives for the creation of well-paid, secure, healthy, satisfying environmentally-friendly jobs with particular attention to appropriately meeting the needs of affected workers and their communities.

The Report reflects the findings of other researchers, such as Diesendorf, Saddler, Teske and others, who have documented Australian energy scenarios, and identified that energy needs (including base-load power) can be met by extensive deployment of currently-existing energy efficiency, renewable energy technologies, and some supplementary gas-fired electricity generation.

The Report outlines two renewable energy scenarios for the Hunter which it uses to generate employment estimates: one that sees the Hunter as a self sufficient regional energy centre, and one that continues the Hunter’s role as a net energy exporter to the rest of NSW. The scenarios are summarised in Table 1.

1. Two scenarios for a renewable energy future for the Hunter

Scenario 1 *Hunter as a self-sufficient regional energy centre*

- This would involve 23 per cent of NSW electricity being generated within the region. This is equivalent to all local energy being supplied from local renewable energy (wind, solar, geothermal, and bioenergy) or gas co-generation. It includes electricity for the two large aluminium smelters located at Tomago and Kurri Kurri. This scenario estimates 4,700 jobs will be directly created, and the same number indirectly – a total of 9,400 jobs. Establishing the *Hunter as a Self-Sufficient Regional Energy Centre* would create a net gain of 5,800 jobs.

Scenario 2. *Hunter as a NSW energy exporting centre*

- This would involve 40 per cent of the NSW electricity being generated in the Hunter, again from a mix of renewable (wind, solar, geothermal and bioenergy) and gas co-generation. This scenario retains the Hunter and Wyong region's historic role as a major energy exporter to the rest of NSW, although on a somewhat smaller scale than this currently occurs. Under this scenario, it is estimated new industries would create 7,350 jobs directly, and 6,950 jobs indirectly, a total of 14,300 jobs. Establishing the Hunter as a NSW Energy Exporting Centre would create a net gain of 10,700 jobs.

Energy efficiency

Energy efficiency is maximised in both scenarios, keeping NSW electricity consumption stable at current levels. This compares to the business as usual (BAU) growth in electricity use of 16 per cent by 2020, which has electricity growth of 1.6 per cent per annum.

Table 1 Net employment gains from a switch to clean energy in the Hunter / Wyong region

	Renewable energy	Energy efficiency	Total Direct jobs	Total Indirect jobs	Total Jobs
<u>Employment gains</u>					
Scenario 1: Hunter as a self-sufficient regional energy centre	3,680	1,020	4,700	4,700	**9,400**
Scenario 2: Hunter as a NSW energy export centre	6,320	1,020	7,340	6,950	**14,290**
<u>Employment losses</u>					
Phase out of coal fired generation			1,300	2,340	**3,640**
<u>Net effect</u>					
Scenario 1: Hunter as a self-sufficient regional energy centre			3,400	2,360	**5,760**
Scenario 2: Hunter as a NSW energy export centre			6,040	4,610	**10,650**

Notes:

1. Employment gains are an average of low and high energy efficiency estimates for Scenario 1 and Scenario 2, and assume renewable manufacturing for all of NSW occurs within the Hunter.
2. Energy efficiency uses the average values for job creation.
3. Jobs losses in the phase out of coal-fired power generation are based on input/output analysis of ABS data, as are indirect jobs created under employment gains for the renewable energy sector.

2. Local impacts of phasing out coal-fired power generation

- An overnight closure of the coal-fired power stations would lead to 1,300 direct job losses in power stations, and an estimated additional 2,377 indirect job losses, a total of 3,637 jobs.
- Many of the jobs lost would be relatively high wage jobs so the closure of the industry would lead to some loss of consumer spending, which may spark further losses in the region.
- The phasing out of coal-fired electricity is likely to have its highest impact in the Wyong and Lake Macquarie Local Government Areas (LGAs) where Munmorah, Vales Point and Eraring power stations are located, and in Muswellbrook and Singleton LGAs where Bayswater, Liddell and Redbank are located, and where mines supplying these power stations are located.
- Some mines operate solely to provide coal for nearby power stations and therefore may be phased out as the power stations are phased out. These mines make up only a relatively small proportion of total employment in the Hunter's coal mining industry. It is likely that, in the event of a phase-out of demand from local coal-fired power generators these mines would focus production on export markets.
- It is noted that Greenpeace has called for a phasing out of coal-fired power by 2030, not an "overnight" closure of industry. The purpose of modelling the "overnight" shut-down of industry is two-fold:

  a) It provides a snapshot of the total employment 'footprint' of a specific industry via its interconnections with other industries;

  b) It identifies the scale of the transition that is required and informs the policy design. It allows governments to scale the transition to minimise the costs to the communities affected.

3. Revitalising manufacturing industry through green jobs

- Green jobs are secure, well-paid, environmentally-friendly jobs.
- Green jobs in renewable energy and energy efficiency are in manufacturing, installation, maintenance and servicing, operations, transport and delivery of goods, sales, research and design. A significant growth in these jobs would revitalise manufacturing industry in the Hunter / Wyong region.
- Skills development and training are a critical part of creating green jobs. Investment in new training programs and apprenticeships in energy efficiency and renewable energy technologies is essential to attract these industries.
- The full range of new jobs that could be created in the Hunter / Wyong region would vary according to a range of local manufacturing scenarios (see Table 2). The scenarios range from:
  - no renewable sector manufacturing in the region
  - renewable sector manufacturing for the Hunter / Wyong region only
  - renewable sector manufacturing for all of NSW.

- A local renewable energy and energy efficiency industry has potential as a new export industry, supplying technology and expertise to other regions in NSW, Australia and to global markets. The potential export industry has not been included in the analysis.
- Renewable energy and energy efficiency technologies are by their very nature decentralised, which means that jobs in these industries can be created in the many localities where appropriate natural resources (wind, geothermal, sun) are available. This report estimates that many thousands of additional renewable energy and energy efficiency jobs could be created around NSW if 100 per cent of the state's electricity is from renewable energy or gas co-generation (see Table 2).

Table 2 Total direct and indirect jobs created in renewable energy, energy efficiency and co-generation in the Hunter and NSW in a 2020 renewable energy scenario

Hunter region	RE direct jobs	EE direct jobs	Indirect jobs	Total Jobs
Scenario 1: Hunter as a self-sufficient regional energy centre Assume region generates 100 per cent of electricity for local use (23 per cent of NSW electricity)				
No Australian manufacturing in RE	2,760	690-1,340	3,500-4,000	6,950-8,100
Assumes renewable sector manufacturing for Hunter region only	2,940	690-1,340	3,700-4,200	7,300-8,500
Assumes renewable sector manufacturing for all of NSW	3,680	690-1,340	4,400-5,000	8,800-10,000
Scenario 2: Hunter as a NSW energy export centre Assumes region generates 40 per cent of NSW electricity				
No Australian manufacturing in RE	5,400	690-1,340	5,700-6,300	11,800-13,000
Assumes renewable sector manufacturing for Hunter region only	5,780	690-1,340	6,100-6,700	12,600-13,800
Assumes renewable sector manufacturing for all of NSW	6,320	690-1,340	6,700-7,200	13,700-14,900
Total NSW Employment In RE and EE Assumes 100 per cent of electricity from renewable energy or co-generation				
No Australian renewable energy manufacturing	17,100	6,150-11,920	38,000-42,900	61,400-72,000
NSW manufacture of 36 per cent of wind energy equipment, 20 per cent of Photovoltaics (PV), and 100 per cent of solar thermal	18,100	6,150-11,920	39,000-43,800	63,200-73,800

Notes:
1) Manufacturing: when onshore manufacturing is included, 100 per cent of solar thermal, 36 per cent of wind, and 20 per cent of PV manufacturing assumed to occur in Australia.
2) Solar thermal (Hunter region): 70 per cent of construction work and all of the O&M is assumed to occur outside the Hunter. Jobs are included in 'rest of NSW'.
3) Co-generation: all fuel collection and distribution employment are assumed to occur outside the Hunter. These jobs are included in 'all of NSW'.

4. Community response: a just transition to green job creation

- Coal communities, like the Hunter have for too long been taken for granted by corporations and governments as out-of-sight, out-of mind ‘cash cows’. Their local environments have been degraded by mines and dirty power stations, and local communities have been chronically disadvantaged. The incidence of linked ecosystem and human health distress is being well-documented.
- Furthermore, critics of the further expansion of the Hunter coal industry, including the region’s horse breeding, wine, crop growing and tourism industries, have argued that the cumulative local impacts of the region’s coal-fired electricity generation and large-scale coal mining, particularly open cut mining, on air quality, water quality and quantity, light pollution, noise, traffic, biodiversity and other impacts is jeopardising local ecosystem and human health, and undermines the viability of their businesses.
- Awareness of the region’s contribution to climate change, the impacts of local coal mining, and concern about the impacts of climate change are high and are powerful drivers of calls for a change in the region’s economy, and a just transition to new green jobs in a clean, renewable energy economy.

5. Green industrial restructuring

- Successful policies for regional-scale transitions to Green industry in European countries – with their potential application in coal communities would involve:
    - Clear environmental targets – greenhouse gas emission cuts of at least 40 per cent by 2020;
    - A clear decision to end investment in the affected area or industry – a statement indicating an end to investment in coal-fired power stations and new coal mines;
    - Availability of satisfactory technological alternatives to the technology being phased out – appropriate mix of renewable energy and energy efficiency technologies, and gas-fired co-generation;
    - Innovation and political leadership that promotes the diffusion of alternative technologies – a commitment to research, develop and invest in energy efficiency and renewable energy technologies, and local jobs manufacturing and installing them;
    - A market that encourages research and development investment –carbon taxes and carbon cap and emissions trading;
    - A high degree of political integration among different government sectors – between environment, energy, regional development, industry ministries and between local, state and national levels of government;
    - Compensation and income support to minimise social and regional disruption caused by change – targeting displaced workers and communities, and low-income families;
    - Establishment of Regional Development Funds to facilitate research and investment incentives for the establishment of areas.

6. A just transition for coal communities

- Governments have a critical role in fostering a just transition that protects local communities and environments during change. Government support must include:
  - Assistance for both displaced workers and for contractors;
  - Adequate notice of workplace change and closures;
  - Consultation and full engagement of relevant unions;
  - Support for innovation and partnerships for new local industries;
  - Investment in research and development and infrastructure;
  - Training for alternative employment tailored to local and individual needs and opportunities;
  - Special targeted support for older, disabled and less educated workers;
  - Relocation assistance for displaced workers;
  - Income maintenance, redundancy entitlements and retraining allowances;
  - Cheap loans and subsidies for new industries and employers;
  - Compensation and equipment buy-outs for contractors;
  - Assistance programs extended to workers employed by contractors;
  - A just transition requires investment in training programs and apprenticeships to create a highly trained 'green' workforce;
  - The introduction of a Job Guarantee.

7. Investment in clean energy

- The renewable energy scenario discussed in this report assumes that energy efficiency measures sufficient to achieve a saving of 16 per cent compared to business as usual are put into place. Renewable energy supply sufficient to meet the reduced consumption, and energy efficiency measures sufficient to achieve it, are assessed to determine the effects on employment.
- The assumed energy efficiency potential for the Hunter / Wyong region is in keeping with targets adopted elsewhere. For example, the state of Maryland in the USA has just adopted policies to reduce electricity consumption by 29 per cent compared to business as usual by 2025 and the European Union also has policies to reduce energy use by 20 per cent by 2020 (American Council for an Energy – Efficient Economy 2008, European Commission 2007).
- There are a growing number of regions where new renewable energy industry development has occurred, including in coal mining regions of Germany.
- Approximately $12 billion would need to be invested in renewable energy, co-generation and energy efficiency measures for Scenario 1 between now and 2020. This may be an over estimate, as it makes no allowance for technology cost decline over the period.

8. Green-labour alliances

- Labour unions and environmentalists are critical participants in a just transition process. Many are recognising that the massive challenge of making a just transition process in response to global warming offers scope for transforming the traditional agenda of labour unions and environmental organisations, bringing them together in campaigns targeting government development priorities.
- Green-labour alliances can inspire the broad-based community awareness and actions needed to make a just transition to renewable energy and new green jobs - collective social action on issues of ecological sustainability and related social development.

9. Policy framework to enhance the Hunter as a renewable energy hub

General considerations

- In general, the policy mix must attempt to address several basic issues, which include ensuring that:
  - There is on-going research and development to reduce the economic cost disadvantage associated with renewable energy;
  - Barriers which prevent investment in and take-up of renewable energy are reduced;
  - Market failures which hinder the development of renewable energies are reduced;
  - Human capital development keeps pace with the investment in renewable energy capital to reduce the chance of skilled labour bottlenecks inhibiting innovation and implementation; and
  - An appropriate safety net is in place to smooth the labour market transitions from fossil fuel based industries to renewable energy industries.

Research and development

- The CSIRO Energy Centre in Newcastle is a major regional resource, whose funding for renewable energy and energy efficiency research needs to be sustained as a catalyst for local industry development. The same applies for the University of Newcastle.
- A major funding boost for renewable energy and energy efficiency research and development in the Hunter region would boost the region's international reputation in these technologies and facilitate local industry development, potentially setting the region up as Australia's Renewable Energy 'Silicon Valley'.

Skill development

- Targeted initiatives in the area of renewable energy skills are desirable and would require improved Government/industry collaboration. The Hunter TAFE system is ideally placed to offer new training courses in renewable energy, with linkages into schools and potential employers. A significant boost in funding is needed to support quality teaching, to attract students and engage employers.

Overcoming scale disadvantage through export promotion

- Scale disadvantages can be overcome, in part, by adopting an export strategy. Provision of first class public infrastructure including transport systems, port capacity and communication systems is crucial in this regard.
- Further, social infrastructure in the form of community development and adequate housing and recreation is required.
- Industry clusters and skilled labour will be attracted to the Hunter if the State and Federal governments work together to ensure this infrastructure is the best available.

Safety socio-economic net

- The introduction of a Job Guarantee is essential to ensure that everyone who wants to work and is currently unable to find employment is provided with productive work by the public sector at the minimum wage.

1. Introduction

The recently released reports by the Intergovernmental Panel on Climate Change (IPCC) have provided tangible evidence of the effects of climate change in Australia, implicated human activity in such effects and highlighted the potential future environmental impacts that would be incurred in the absence of intervention (IPCC, 2007a, 2007b, 2007c).

One of the recommendations of the IPCC aimed at reducing carbon dioxide (CO_2) emissions – which account for more than 75 per cent of greenhouse gases implicated in climate change – is to decouple economic growth from the use of CO_2 emitting resources. Electricity generating sector emissions make up 25 per cent of the global total CO_2 emissions. There is an urgent need to find alternatives to carbon-intensive energy production. The science tells us that the time to act is now.

As part of the global community, Australia needs to take responsibility for the impacts of our industrial activity on the environment, despite a seeming reluctance by successive federal governments to resist the well-documented and significant influence of the carbon-intensive industries lobby, the self-styled ‘greenhouse mafia’ (Hamilton, 2007; Pearse, 2007).

People living in the Hunter and Wyong region communities are aware of the link between climate change and coal as well as the impacts that the coal industry is having on the local environment. The communities are divided on the benefits of the region’s coal mining industry. Growing numbers of residents indicate willingness to buy ‘Green’ power. Younger people in the 25-34 years age group were significantly more likely to believe that the costs of coal outweighed the benefits and that climate change will have a direct impact on their lives in the next 20 years than other age groups. (HVRF, 2007; HVRF 2008, CCRF, 2008). These shifting attitudes are driving local calls for a shift from a fossil fuel to renewable energy economy.

The coal-fired power stations of New South Wales have been described as among the world’s most polluting and inefficient by Carbon Monitoring for Action (CARMA 2007), a database containing information on the carbon emissions of over 50,000 power plants and 4,000 power companies worldwide. This database provides detailed information on carbon emissions resulting from the production of electricity. CARMA is a product of the Confronting Climate Change Initiative at the Center for Global Development, an independent and non-partisan think tank located in Washington, DC.

CARMA (2007) research indicates that Australia’s power industry is the highest polluting in the world on a per capita basis, producing more than 10 tonnes of carbon dioxide in generating power for each person per year, compared with 9 tonnes for Americans and 2 tonnes for the Chinese.

The two biggest producers of carbon dioxide in Australia are the Bayswater and Eraring power stations in the Hunter, which each produce 18.325 million tonnes of carbon dioxide a year. These rank equal 44th in terms of their carbon dioxide emissions globally, but their carbon dioxide intensity — that is carbon dioxide to power output — is comparable to many of the power stations in China, which are often criticised for being ‘dirty’ plants (CARMA, 2007; Davies and Morton, 2007).

In terms of assessing the Australian position, a major issue is the economic dependence on coal as an energy source. There are two dimensions to this dependence: (a) its use as a productive input within Australian industry; and (b) its major contribution to our export performance.

The emissions from New South Wales' coal-fired power stations are shown in Table 3. Together they emit 78 million tonnes annually.

Table 3 CO_2 Equivalent emissions from NSW coal-fired power stations

Name	Total capacity MW	Year commissioned	CO_2 E MT per year	Source for emissions data
Eraring	2640	1982/84	18.32	http://carma.org/plant/detail/12587
Bayswater	2760	1982/4	18.32	http://carma.org/plant/detail/3667
Liddell	2030	1971/73	13.15	http://carma.org/plant/detail/25185
Redbank	148	2001	1.01	http://carma.org/plant/detail/36909
Wallerawang	1000	1976/80	6.35	http://carma.org/plant/detail/48810
Vales Point	1320	1978	8.46	http://carma.org/plant/detail/47612
Mount Piper	1320	1992/93	8.46	http://carma.org/plant/detail/29573
Munmorah	600	1969	3.72	http://carma.org/plant/detail/29872
		Total CO_2 E	**77.79**	

Source: Carbon Monitoring for Action (CARMA) (2007) – Carbon Monitoring for Action, http://carma.org/plant.

Some government and industry groups with a strong vested interest argue that Australia can both maintain coal dependency and contribute to ecological and economic sustainability through the development and deployment of a suite of technological fixes known as 'clean coal' and carbon capture and storage technologies (CCS) (ACA, 2004; NSW Government, 2006; NSW Minerals Council, 2007; Williams, 2007).

These propositions have been refuted by others, who argue that 'clean coal' and carbon capture and storage technologies are high risk options, as they are of insufficient impact, and (particularly in the case of CCS) immature, expensive and unlikely to be commercialised on a scale sufficient to tackle climate change within the necessary timeframes (Diesendorf, 2006; Saddler, Riedy, and Passey 2004; Wilkenfeld *et al.*, 2007; Rochon *et al.,* 2008).

Furthermore critics of the further expansion of the Hunter coal industry, including the region's horse breeding, wine, crop growing and tourism industries, have argued that the cumulative local impacts of the region's coal-fired electricity generation and large-scale coal mining, particularly open cut mining, on air quality, water quality and quantity, light pollution, noise, traffic, biodiversity and other impacts is jeopardising local ecosystem and human health, and undermines the potential for ecological, economic and social sustainability in the longer term (Connor *et al*., 2004 Albrecht, 2000; Evans, 2005).

Despite what many would consider coal's central position in the economic wealth generation process in this country, a transition away from coal dependency to cleaner energy sources would represent a major step forward in terms of reducing Australia's climate change impact.

This Report is written from the perspective of reducing the Hunter region's direct carbon footprint by phasing out dependency on coal-fired electricity generation, and avoiding risks inherent in unproven technologies such as carbon capture and storage. It is consistent with the findings of researchers, such as Diesendorf, Saddler, Teske and others who have documented Australian energy scenarios to 2040. These researchers have identified how Australia's energy needs (including base-load power) can be met by extensive use of energy efficiency, currently-existing renewable energy technologies, and some supplementary gas-fired electricity generation (Diesendorf 2007; Saddler, Diesendorf and Denniss 2004, Teske *et al.*, 2008).

However, structural changes in any economy are not without costs and transition phases can be particularly painful. In terms of an economy that is so heavily reliant on coal-fired electricity these adverse economic effects are likely to be highly significant and cannot be ignored. Specifically, without any adjustment policies, localised pockets of mass unemployment in regions in which the coal industry is a substantial source of employment will occur. Not only will direct employment loss occur, but indirect job losses in associated industries within these areas are likely to occur, with potentially severe impacts on social cohesion within the affected areas.

This Report focuses on the Hunter and adjacent Wyong region in New South Wales (NSW) Australia, which is a region in which the coal-fired electricity generation and coal mining industry is a significant source of employment.

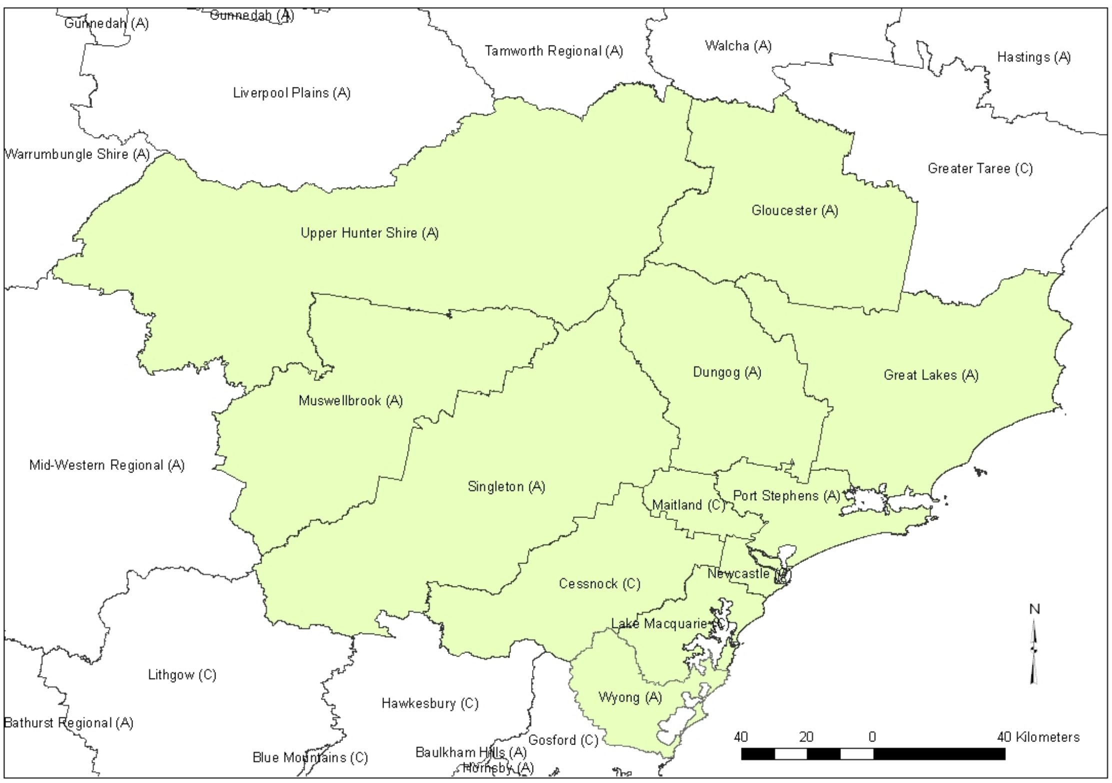
Section 2 discusses the concept of a 'just transition' to a renewable energy economy, an approach to structural change advocated by both labour unions and environmental organisations. The role of governments in facilitating the process is discussed. Section 3 examines the likely challenges of downsizing coal-fired electricity generation in the region, in terms of forecasted job losses. This discussion is informed by empirical evidence from previous large downsizing activities experienced in other countries.

Section 4 focuses on the likely opportunities that downsizing the coal-fired electricity generation industry in the Hunter / Wyong region will present with respect to new employment creation in renewable energy and energy efficiency. We analyse the opportunities the creation of an industry hub of renewable energy in the region would provide, calculating direct and indirect employment flowing from such an initiative. Section 5 proposes a general policy framework for encouraging the development of a renewable energy industry in the Hunter / Wyong region, and Section 6 concludes.

1.1 Defining the region

The Hunter Valley is located in New South Wales, Australia. It is situated 150 kilometres north of Sydney and extends 200 kilometres inland from the coast. The region can be defined in many ways, perhaps most often as the catchment of the Hunter River. However, we must stress that the Hunter Valley and its surroundings is not a statistically defined region within the Australian Standard Geographic Classification (ASGC) used by the Australian Bureau of Statistics (ABS) to disseminate their data. This means that we cannot conduct statistical analysis for a region called “Hunter Valley and its surroundings”. Instead we use the ABS defined statistical region, the Hunter Region as the basis of our statistical analysis presented (see Figure 1 below), and extend this standard definition to include also Wyong Local Government Area (LGA).

Figure 1 LGAs in the Hunter Statistical Region and Wyong, 2006



Source: ABS, 2006 Census of Population and Housing.

There are 8 coal-fired power stations in NSW, with six located in what we refer to as the Hunter / Wyong region. In the 2004/2005 financial year production in the Hunter coal mining industry yielded 95 million tons of saleable coal, worth 5.5 billion dollars. About 70 per cent of saleable coal is exported, predominantly to Asia. The remaining 30 per cent is used in domestic consumption by the electricity industry (NSWDPI, 2006). Coal for the Hunter power stations is provided from 18 coal mines in the Hunter and Newcastle coalfields.

The coal-fired power stations in New South Wales are responsible for the major part of domestic coal consumption and subsequently the emission of greenhouse gases in the state. Table 4 summarises the employment and production data for the eight coal-fired power stations located in NSW. Six of those are located in the coalfields of the Hunter region. Together these six power stations directly employ 1,300 people in the Hunter region, with the two other power stations at Wallerawang and Mt Piper making a total workforce in coal-fired power stations of 1,625 in the NSW. These jobs would be lost in the ‘shut-down of industry’ scenario we describe in Section 3.3 of this Report (in addition many jobs associated with these jobs will be lost indirectly).

While the ABS 2006 Census of Population and Housing indicates 2,785 workers are employed in the ‘electricity supply’ industry, according to 1993 ANZSIC classification – many of these workers will be employed in administrative or clerical functions outside of the coal-fired power stations themselves, and are not included in our analysis of direct job losses (or the subsequent indirect employment losses). We assume that any job loss which would result in these administrative fields from the closure of the coal-fired generation plants would be met by an equal quantum of jobs generated in the renewable energy sector.

It is important to point out that loss of coal-fired electricity generation is different from loss of coal mining. Coal-fired electricity generation will inevitably be replaced by a mix of renewable and gas generation. If renewable energy, then employment numbers will be higher, and it will be local, so this transition is likely to result in net job gain.

A phasing out of the Hunter’s coal-fired electricity generation industry will have some impact on the 18 mines supplying coal to local power stations. In the case that the mines did not redirect their supply to the export market, then job losses would be most significant in the coal mines whose sole purpose is supplying coal-fired power stations. The reality is that many mines currently providing coal for local power stations (particularly those in the Hunter coalfield) primarily produce for export markets. In the event of coal-fired power generation industry shut-down the production of those mines (and also the mines providing for domestic market) are likely to shift totally to the export market. We make this assumption in the analysis.

Table 4 Coal-fired electricity generators in NSW, 2006

Geographical breakdown	Employees	Production (GWH)
Hunter and Wyong region:		
Bayswater	320	18.5
Eraring	360	18.5
Liddell	230	14.0
Redbank	40	1.1
Munmorah	50	4.2
Vales Point	300	9.3
Total Hunter region	**1,300**	**65.6**
Elsewhere in NSW:		
Mount Piper	150	9.3
Wallerawang	175	7.0
Rest of NSW	**325**	**16.3**
Total NSW	**1,625**	**102.4**

Source: GWh derived from ESAA (2006). ABS, 2006 Census of Population and Housing and ABS, Labour Force Survey, August 2006. Note: Employment figures derived from websites. Industry spokespeople confirm that it is difficult to give precise numbers of employees, as numbers vary depending on contractors or other employee arrangements on particular sites.

2. A Just Transition to a renewable energy economy

2.1 Overview

The Intergovernmental Panel on Climate Change (IPCC), has predicted that average global temperatures could rise over the next 100 years to as high as 5.8˚C above pre-industrial average. Scenarios of the impact of an average temperature rise of even 2˚C show serious impacts on weather patterns, biodiversity, human health, economies (IPCC, 2007 a, b, c). The climate change impacts from the burning of fossil fuels, including Hunter coal, are beginning to "boomerang" back on the health of the region's social–ecological system through higher average temperatures, lower rainfall, and increased frequency and severity of bushfires and storm events (Jones and Hennessy 2000, Pittock 2003, Hennessy *et al*. 2005, CSIRO, 2007a, b). Government policy should be guided by science, rather than by political and economic expediency, no matter how challenging the transition to a clean energy economy might be.

As local and global concern about climate change grows, there are demands for the Hunter Valley to move from its non-sustainable 'Carbon Valley' present to a sustainable 'Post-Carbon Society' future. A 'Post-Carbon Society' would have reduced per capita resource usage in wealthy countries, renewable energy sources, emphasis on strong local economies rather on a global free-market, and dramatically improved environmental conditions and social equity (Heinberg, 2004).

Yet as the global warming threat grows, many Australian political leaders remain under the spell of the coal industry and the lobby groups that work on its behalf. Indeed, despite the warnings from scientists to the contrary, there is still a strong lobby that is advocating new coal-fired power stations and a massive increase in coal exports.

Tackling climate change means our dependency on coal as an export earner and as a domestic fuel must be phased out over the next decades. This will mean a huge change in the national economy, and for coal-affected regions such as the Hunter and Latrobe Valleys. The challenges associated with this change are significant, but not insurmountable. Indeed, a transition to renewable energy promises to revitalise Australian manufacturing and create thousands of new jobs in many rural, regional and urban communities, including coal communities.

The United Nations Environment Programme (UNEP), the World Health Organisation (WHO) and the International Labour Organisation (ILO) emphasise that workers affected by change have to be consulted and fully engaged in environmental, employment and economic policy development and restructuring from unsustainable to sustainable industries so their needs and experiences are fully taken into account, and their cooperation is secured (United Nations Environment Program *et. al*. 2007).

2.2 Community response: a just transition to green job creation

Coal communities, like the Hunter and Latrobe Valley, have for too long been sacrificed and taken for granted by corporations and governments as considered narrowly in terms of their ability to generate export revenue. Their local environments have been degraded by mines and dirty power stations, and local communities have been chronically disadvantaged as a result. The incidence of linked ecosystem and human health distress is well-documented (Connor *et al*. 2004).

Environmental organisations and labour unions refer to the process of economic restructuring from non-sustainable to a sustainable industry economy as a ‘just transition’.

The Canadian Labour Congress (CLC) was a pioneer in the theory and organising around the just transition concept and noted that a:

> Just transition will ensure that the costs of environmental change will be shared fairly. Failure to create a just transition means that the cost of moves to sustainability will devolve wholly onto workers in targeted industries and their communities (CLC, 2000: 4).

A just transition links ecological sustainability with issues of work, equity and social justice. A just transition process recognises the needs of both current and future generations for safe, secure and satisfying jobs.

A just transition policy recognises that people and ecology are both important. It recognises that ‘business-as-usual’ and high risk technological fixes to unsustainable economic activity are not credible. A just transition is needed to ensure that the costs of change do not fall on vulnerable workers and communities, or that failure to change falls on the world most vulnerable communities (such as those living on islands of the Pacific such as Kiribati or in other low-lying regions of the world) or on future generations.

The CLC noted that Green Job creation – well-paid, secure, healthy and satisfying jobs that protect rather than harm the environment – is the flip side of a just transition (CLC, 2000).

The Australian Council of Trade Unions (ACTU, 2007) has also noted that a just transition is needed to deal with the challenges of climate change, and this requires new partnerships of the labour movement and other sectors, including government, industry, local communities and training providers to retrain and re-skill workers into jobs in the renewable energy industry.

The ACTU policy recognises the tremendous potential of renewable energy to create additional jobs in development, installation and operation phases:

> Increasing the share of renewable energy in the total energy mix is possible without damaging existing industry and with continuing growth in high quality jobs, as the EU experience demonstrates (ACTU, 2007: 6).

2.3 Green industrial restructuring

A just transition to a renewable energy economy in coal communities, like the Hunter and Latrobe Valley, is possible. Research shows that currently-available energy efficiency and renewable energy technologies (solar, wind, geothermal, and biomass) with gas as a transitional fuel can meet energy needs in Australia, and in the developing countries of our region (Teske *et al.*, 2007, 2008; Mallon *et al.*, 2007).

A shift to renewable energy systems would create more resilient and empowered local communities. Big centralised energy infrastructure, like coal-fired power stations, require massive investment in a single piece of infrastructure. Renewables, on the other hand, are decentralised technologies located at multiple sites where solar, wind and geothermal resources are available – often in regions where investment and economic revitalisation is urgently needed and where local needs rather than global profit-seeking can rule.

Furthermore, investment in renewable energy and energy efficiency creates many more new jobs than in current fossil fuel industries per dollar invested, and they can be in many rural and regional communities, as this report will show.

Successful policies for regional-scale transitions to Green industry in European countries – with their potential application in coal communities would involve:

- Clear environmental targets – the greenhouse gas emission cuts of at least 40 per cent by 2020;
- A clear decision to end investment in the affected area or industry – a statement indicating an end to investment in coal-fired power stations and new coal mines;
- Availability of satisfactory technological alternatives to the technology being phased out – an appropriate mix of renewable energy and energy efficiency technologies;
- Innovation and political leadership that promotes the diffusion of alternative technologies – a commitment to research, develop and invest in energy efficiency and renewable energy technologies and local jobs manufacturing and installing them;
- A market that encourages research and development investment – carbon taxes and carbon cap and emissions trading;
- A high degree of political integration among different government sectors – between environment, energy, regional development, industry ministries and between local, state, national and international levels of government;
- Funding for compensation to minimise social and regional disruption caused by change – compensation and income support to displaced workers and communities, and low-income families;
- Establishment of Regional Development Funds to facilitate research and investment incentives for the establishment of areas (Binder *et. al*. 2001).
- Introduction of employment guarantees to ensure that all those who want to work and are currently unable to find work can be productively employed by the public sector adding value to their local communities and achieving independence from the welfare system.

The closure of the BHP steelworks in Newcastle in 1999 exemplified other features of a just transition process, including early notice and active government, industry, union and community partnerships. Workers were given years of prior notice of the proposed changes and packages were put in place to ensure that workers received benefits during the transition from steel making. Workers and management worked together to ensure that the two groups worked towards the same objectives and established a BHP workforce transition committee.

2.4 A just transition for coal communities

Workers in transition between jobs need redundancy entitlements, income maintenance and opportunities for retraining tailored to individual skills, needs and local opportunities.

Research shows that workers with less formal education, older or disabled workers need special targeted support (Robinson and Wilkinson 1998).

Governments have a critical role fostering a just transition that protects local communities and environments during change in many industries – fishing, mining, manufacturing, forestry, etc. The 1999 Forestry Restructuring Program of the Victorian Government provided assistance for both displaced workers and for contractors with elements fundamental to most just transition processes, including support for innovation and partnerships for new local industries, research and development and infrastructure investments. Training and alternative employment tailored to local and individual needs and opportunities was provided. Relocation assistance and support for displaced workers, including income maintenance, redundancy entitlements and retraining allowances was provided. Compensation and equipment buy-outs for contractors were offered and assistance programs were extended to workers employed by contractors (Victorian Department of Natural Resources and the Environment, 2002).

As indicated in Section 2.3, the public sector has a responsibility to introduce a buffer stock of jobs which we call a Job Guarantee. The introduction of employment guarantees would ensure that all those who want to work and are currently unable to find work can be productively employed by the public sector adding value to their local communities and achieving independence from the welfare system.

2.5 Green-labour alliances

Labour unions and environmentalists are critical participants in a just transition process. Many are recognising the massive challenge of building a sustainable society. They seek to build collaborations rather than conflict or 'business-as-usual', and in particular, to avoid a false 'jobs versus the environment' conflict.

A just transition process targeting global warming offers scope for transforming the traditional agenda of labour unions, bringing them into collaborations with environmental organisations, governments and other civil society organisations campaigns that link workplaces and communities into collective social action on issues of ecological sustainability and related social development (United Nations Environment Program *et. al.* 2007). Australian building unions' Green Bans of the 1970s pioneered transformational union-environmental activism and social movement unionism.

Many Australian labour unions have embraced the concept of social movement unionism that links the labour movement into broader political coalitions on issues of public concern. Social movement unionism engages unions in issues beyond the workplace, organising union members to work with other civil society organisations to support each other in what are seen as mutually beneficial goals (Brofenbrenner and Juravich, 1998; Reiss, 2005; Tattersall, 2005).

Australian unions have been involved in leading the highly successful Your Rights at Work, Defend Public Education and Medicare campaigns. Union – community collaborations for a just transition and Green Job Creation in response to climate change are beginning to emerge around Greening the Workplace campaigns.

Green-labour alliances can inspire the broad-based community campaigns needed to make a just transition to renewable energy and new Green jobs.

3. Challenges of downsizing the Hunter / Wyong coal-fired power generation industry

3.1 Overview

In this Section we outline the challenges and opportunities that are presented by a proposal to transform the Hunter / Wyong region into one which provides environmentally sustainable employment in renewable energy, rather than being coal dependent. The aim is to provide an evidence base for an informed and balanced discussion on the merits of this proposal.

In some parts of this Report we adopt what is known as the 'loss of the industry' or 'shut-down of industry' approach to estimate the job losses and the resulting labour market impact by assuming that all coal-fired electricity generation is closed down overnight. This is a technical construct within the context of Input-Output (IO) modelling to enable the researcher to trace the linkages between industries and produce a total employment loss (or gain) estimate.

It needs to be emphasised however that none of the environmental, farmer or resident groups that have been involved in advocacy around the Hunter's coal industry have proposed an overnight shut down of the coal-fired power generation industry.

Instead there are calls for a phasing out of the coal-fired power generations over time. For example Greenpeace, in its recently-published Australia's Energy [R]evolution (Teske *et. al.* 2008) calls for the phase-out of coal-fired power generation by 2030, with phase-out beginning with the most polluting power stations, and with appropriate support to affected workers and communities.

This approach is referred to as a 'just transition' (Evans, 2008).

The purpose of modelling the 'shut-down of industry' is two-fold:

- It provides a snapshot of the total employment 'footprint' of a specific industry via its interconnections with other industries;
- It identifies the scale of the transition that is required and informs the policy design. It allows governments to scale the transition to minimise the costs to the communities affected.

3.2 Existing theory on large scale industry downsizing

It is clear that downsizing the coal-fired power generation industry will have employment consequences in these industries directly, and will also affect jobs in other industries linked to these industries. This subsection considers empirical studies of major industry downsizing activities throughout the world to make an assessment of the extent of the 'contagion' that is likely to occur under the 'shut down of industry' scenario.

We consider the important facets of downsizing that bear on an assessment of the employment losses likely in downsizing the coal-fired electricity generation industry in the Hunter, an industry within the larger coal industry. Aspects that will be discussed in this section are employment spill-overs, wage spill-overs, spatial spill-overs (that is, migration effects), worker heterogeneity and the concept of opportunity costs.

Employment spill-overs

Black *et al.* (2005) explore the effects of the boom and bust in the coal industry in the 1970s and 1980s in the United States (US). The oil price hike in the early 1970s made coal an attractive alternative to oil as an energy resource (that is, the boom), but the subsequent decrease in oil prices, reduced the competitiveness of the coal industry relative to the oil industry (that is, the bust). This study focuses on the consequences of this process for three states in the US. The study compares ‘coal rich’ to ‘coal poor’ counties within these states both during the boom and after the bust of the coal industry. The research formed a benchmark control group upon which comparative analysis was based by including ‘coal poor’ counties. The study sought to estimate the employment spill-overs, that is, the extent to which the ‘coal bust’ impacts on employment in non-coal industries in counties where employment in the coal industry falls dramatically.

The study finds that over the period 1983 to 1989, average annual employment in the coal mining industry declined by around 8 per cent. This represents a serious downsizing of that industry.[2] The study finds evidence of employment spill-over effects such that the regional employment consequences of downsizing the coal mining industry extend beyond that sector. For example, employment in the construction and the retail trade sectors falls by 2 to 4 per cent more in ‘coal rich’ counties than in ‘coal poor’ counties. Consequently, downsizing a dominant employment sector will lead to employment losses that extend beyond the direct jobs lost in the dominant industry. However, these associated employment losses are limited to sectors which are closely related to the dominant sector (the construction and ‘retail trade’ sector).

The spill-over effects arise in two ways: (a) loss of business; and (b) loss of consumer spending. The construction industry is a contractor into the coal mining industry and directly loses business following the bust. The retail trade industry, in turn, suffers from reduced sales because the regional income base shrinks.

Wage spill-overs

Carrington (1996) investigates the labour market consequences of the Trans-Alaska Pipeline, which was built between 1974 and 1977. The discovery of significant oil reserves in Alaska in the late 1960s, spurred the US government to construct a pipeline to transport the oil. The construction of that pipeline initially led to a boom in the construction industry in Alaska, but then, once construction was completed, gave way to “bust conditions” in that industry. Employment in the Alaskan construction industry surged by 270 per cent during the boom, but slumped to its original level afterwards.

The Alaskan labour force was too small to accommodate these changes. Consequently, the majority of labourers that worked on constructing the pipeline came from outside Alaska and left Alaska once the construction was finished. Therefore, studying the local employment effects in the Alaskan construction industry is not very informative, but the study is useful for examining the wage spill-overs into other industries. To attract construction workers, the Alaskan construction company had to pay high wages, both to compensate for the arctic conditions and the time pressure under which the pipeline had to be constructed. Though it was clear from the outset that the Alaskan labour force was not deep enough to supply sufficient labourers to complete the project, the construction company had agreed to employ all Alaskans who were willing and qualified to work on the project. Consequently, the pipeline construction interfered in the Alaskan wage structure, potentially driving up wages in other sectors to retain workers. These effects are those that we term wage spill-overs.

Carrington divides the non-construction sectors into two groups: sectors that were directly affected (in terms of increased business) by the construction boom – such as mining, the various services sectors (retail trade, finance and insurance), and sectors that were not – such as manufacturing and the public sector. The sectors that were directly affected may simultaneously experience labour demand increases (increased business) and labour supply decreases (workers moving into construction). Both effects will put upward pressure on wages. The sectors that were not directly affected however can only experience wage increases through labour supply decreases.

Carrington finds that the directly affected industries, and to a lesser extent, the non-affected sectors experienced wage increases during the boom caused by the increase in earnings in the construction sector. He therefore concludes that significant wage spill-overs occur as a consequence of the major up scaling or downsizing of industries and extend beyond the sectors that instigate the dynamic.

Spatial spill-overs

Beatty and Fothergill (1995) study the massive coal mining industry downsizing in the eighties and early nineties in the UK. Employment in the coal mining industry fell from 218,800 in 1981 to 10,800 in 1994. They study the spatial decision making process of those that lost their job over a ten year period in areas in which at least 25 per cent of male employment was located in the coal mining industry in 1981.

Their research was triggered by the finding that unemployment rates in areas with at least 25 per cent job loss went up by a meagre 1.7 per cent on average, suggesting leakages in the official regional unemployment statistic. About a third of the newly unemployed migrated out of the region and therefore did not count in the regional unemployment statistics for the region they vacated. Another 20 per cent continue to reside in the affected area, but find employment outside of the region. About 30 per cent of the job losers find employment in the original region. In some cases this is partially sheltered employment provided by the government to help the affected areas. Finally there is a group of about 22 per cent who leave the labour force because there are too few job opportunities available to them (that is, they join the hidden unemployed).

The leakages caused by out-migration and commuting critically depend on the size of the investigated region. The above figures relate to so-called pit villages and are hence fairly small. Expanding the size of what constitutes the study regions by definition leads to progressively lower shares of migration and commuting. However, the size of the region is unrelated to the share of discouraged workers. Governments that employ job creation schemes to neutralise the 1.7 per cent unemployment gap, may underestimate the seriousness of the problem. If new employment is created in these areas, discouraged workers will re-enter the local labour market potentially followed by commuters and even recent migrants. Given the size of these groups, Beatty and Fothergill conclude that the unemployment rate gaps governments are facing are much higher than the official 1.7 per cent.

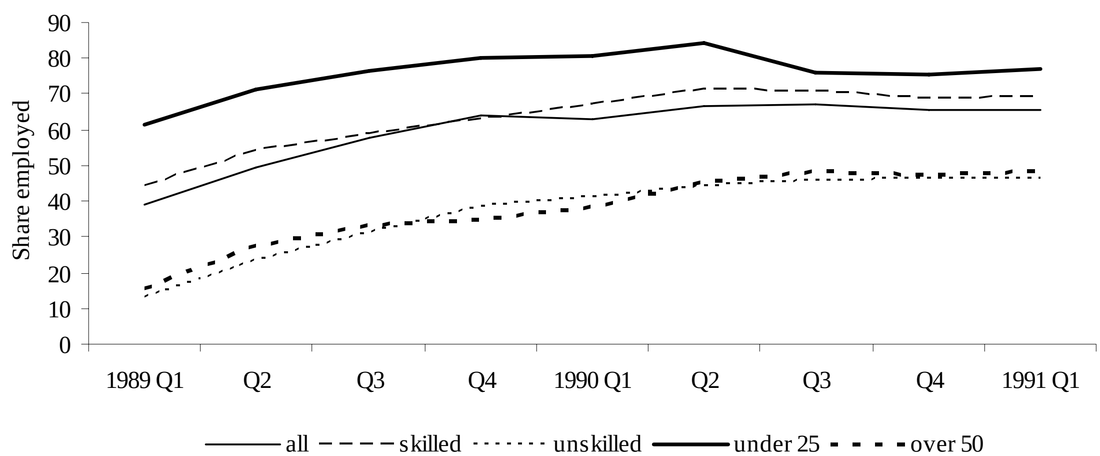
Worker heterogeneity

Hinde (1994) explores the labour market consequences of the Sunderland shipyard plant closure in the UK in 1989, which put an end to the shipbuilding industry in Sunderland. In total 2,092 workers were made redundant in the space of a few months and had to start searching for employment in an already depressed labour market. Many unemployed workers who lost their jobs in previous downsizing activities and who possessed similar skills to the ones who were made redundant in 1989 were still searching for jobs.

Hinde explores the age and educational break down of those made redundant during the closure of the shipyard in Sunderland in an attempt to determine which workers were more successful in finding new employment. Hinde exploits data which allows tracking the unemployed for a two year period following the redundancy.

Figure 2 presents some of the findings. Hinde finds that about 35 per cent of all redundant workers found employment soon after the closure of the shipyard. This share increases to about 60 per cent a year after the closure, but then levels off. The author hints at the 1990 recession as a reason why the job find rate stagnates. However, the differences within the population are stark. As expected, older and/or unskilled workers find it far more difficult to find employment than their younger and/or more skilled colleagues, clearly indicating that the economic and social burden of the shipyard closure is shared unequally.

Figure 2 Reemployment of redundant shipyard workers over time



Source: Hinde (1994).

This unequal burden also impacts on the duration of employment gained after redundancy. Hinde calculates the number of weeks of employment gained by the workers who were made redundant in 1989 and who were unemployed in the first quarter of 1991. Young and skilled unemployed workers had on average worked for about 40 weeks out of a potential 103 weeks whereas the old and unskilled unemployed workers only worked for an average 5 weeks.

Opportunity costs

Hooker and Knetter (2001) look at the closure of military bases in the period 1971-1994 in the US. They exploit data covering 57 closures, ranging from 0.05 per cent to 30 per cent job loss in the region, with a median of 2.25 per cent. Consequently, the job losses are small compared to the previous studies, but their approach deserves inclusion in this section. Hooker and Knetter determine multipliers involved in the closure which are the ratio of regional job losses to the initial job losses arising from the downsizing.

A multiplier larger than one suggests that negative spill-overs are present. Surprisingly, the authors find multiplier effects equal to unity at best, not larger than unity. This suggests that the regions examined which were hit by mild adverse shocks demonstrated a strong resilience to recover. The authors give several explanations for their findings.

First, they find higher multipliers or spill-overs if the base is an Air Force base. Air Force employment is highly skilled and hence high wage employment. The loss of that type of employment will erode the regional income base more than low wage job loss.

Second, the authors demonstrate that the multiplier is close to one if job loss concerns military personnel, but the multiplier is close to zero if job loss concerns civilian personnel. As opposed to civilian personnel, military personnel do not demonstrate a close attachment to a region and are transferred to another base once a base is closed down. Civilian personnel are typically rooted in the region and thus seek new employment in that region after the shut-down.

The extent of the damage is clearly linked to the type of employment generating activity that is undertaken at the location of the closure. In some cases, it is possible to conceive of new alternatives that are richer in employment opportunities than the existing usage but which would not have been introduced if the original industry was not closed.

3.3 Summary of literature on industry closure

Drawing the findings together, the literature suggests that when analysing the employment consequences of downsizing, employment spill-overs increase if:

- The downsizing sector constitutes a large part of the income base of a region, which could either be because the sector is large, or it pays high wages.
- Wage spill-overs could occur if the downsizing sector dominates regional wage setting. Downsizing a high wage sector, may erode wages in other sectors in the region as well.
- The existence of spatial spill-overs may soften the employment consequences of downsizing. The entrenchment of redundant workers in the region and the availability of work outside the region determine the likelihood of spatial spill-overs to function as a cushion.
- Skill levels and age impact on the length of the transition towards new employment after being made redundant.
- The opportunity costs of the downsizing activity should be taken into account in any policy regime aimed at downsizing a significant industry.

These findings are useful when estimating the employment consequences of downsizing the coal-fired power generation industry in the Hunter.

3.4 Predicted effects of downsizing the Hunter / Wyong coal-fired power generation industry

Data collated from the coal-fired power industry in the broad Hunter and Wyong region (that is, including the coal-fired power stations in the Newcastle coalfields in Wyong LGA) indicates that 1,300 workers will lose their jobs if the coal fired power industry were shut down.

We have drawn on 2001 requirement coefficients for the ‘Electricity Supply’ sector generated by ABS Input-Output tables (in doing so we make an assumption that the majority of electricity supply in the Hunter is through coal-fired power generation), to examine the flow on employment effects of the shut-down of the coal-fired power generation industry. The estimates are therefore not exact but a reasonably accurate approximation.

Table 5 shows the production loss in terms of dollars for a 100 dollar reduction in the electricity industry. The strongest impacts will occur in mining, manufacturing and in property and business services.

Table 5 Impact on production of a $100 reduction in Electricity industry output, 2001

Industry	Output loss (in dollars)
Agriculture	0.28
Mining	14.57
Manufacturing	11.73
Electricity, Gas, and Water Supply	115.57
Construction	7.95
Wholesale Trade	3.78
Retail Trade	1.94
Accommodation, Cafes and Restaurants	0.69
Transport and Storage	4.55
Communication Services	1.99
Finance and Insurance	7.43
Property and Business Services	10.29
Government Administration and Defence	0.26
Education	0.66
Health and Community Service	0.02
Cultural and Recreational Services	0.42
Personal and Other Services	0.12

Source: ABS, Input-Output Tables 2001-02.

We calculate using the Input-Output analysis indirect employment effects in Table 6, this time for closing the coal-fired power industry in the Hunter rather than the coal mining industry. Again, including indirect effects means that the overall job losses are higher than the original 1, 300 - increasing to 3,637 (of which 2,337 jobs are lost indirectly).

Table 6 Direct and indirect job loss following downsizing in electricity sector, 2006

Industry	Employment loss No's	Employment loss Per cent shares
Agriculture	13	0.2
Mining	104	1.0
Manufacturing	490	1.7
Electricity, Gas and Water Supply	1,502	37.3
Of which electricity	1,498	48.1
Construction	503	2.0
Wholesale Trade	38	0.3
Retail Trade	81	0.2
Accommodation, Cafes and Restaurants	69	0.5
Transport and Storage	160	1.5
Communication Services	58	1.7
Finance and Insurance	163	2.2
Property and Business Services	356	1.3
Government Administration and Defence	15	0.1
Education	43	0.2
Health and Community Services	1	0.0
Cultural and Recreational Services	30	0.6
Personal and Other Services	11	0.1
Total	**3,637**	**1.3**

Source: ABS, 2006 Census of Population and Housing; ABS, Labour Force Survey, August 2006; ABS, Input-Output Tables 2001-02.

The phasing out of coal-fired electricity is likely to have its highest impact in the Wyong and Lake Macquarie LGAs where Munmorah, Vales Point and Eraring power stations are located, and in Muswellbrook and Singleton LGAs where Bayswater, Liddell and Redbank are located, and where mines supplying these power stations are located.

Some mines operate solely to provide coal for nearby power stations and therefore may be phased out as the power stations are phased out. These mines make up only a relatively small proportion of total employment in the Hunter's coal mining industry.

3.5 Other labour market consequences of downsizing the industry

The lessons drawn from the international literature discussed in Section 3.2 suggest that there may be several reasons why adding the employment loss to the existing unemployment rate to derive a new 'after the shut down' unemployment rate is incorrect.

We learned that loss of business and loss of consumer spending cause employment spill-overs. The IO analysis only considers the first of these effects - loss of business. The loss of consumer demand depends on the loss of income involved in the downsizing, which is a function of the size of employment loss and the wages earned in that industry.

Table 7 Industry sector weekly wages in the Hunter Statistical Region, 2006

Industry	Over $2,000 Per cent shares	Over $1,600 Per cent shares	Over $1,300 Per cent shares
Agriculture	3	5	8
Mining	28	55	71
Manufacturing	4	9	19
Electricity, Gas and Water Supply	11	22	38
Construction	3	7	13
Wholesale Trade	4	8	15
Retail Trade	1	2	4
Accommodation, Cafes and Restaurants	1	1	2
Transport and Storage	5	11	20
Communication Services	3	8	17
Finance and Insurance	7	11	18
Property and Business Services	7	11	18
Government Administration and Defence	3	8	21
Education	2	7	28
Health and Community Services	5	8	14
Cultural and Recreational Services	2	3	5
Personal and Other Services	1	3	8
Total	**4**	**9**	**17**

Source: ABS, 2006 Census of Population and Housing.

Table 7 shows relevant estimates of industry wages in the Hunter. We present the percentage shares of employees that earn more than $2,000; $1,600; and $1,300 a week, respectively. The results clearly demonstrate that the mining industry is by far the highest income earning sector in the Hunter. The Electricity, Gas and Water supply industry (of which Electricity Supply is a sub-section) also has an above average share of workers employed in high income jobs, although the share is significantly lower than the mining sector. As a consequence of the higher income the Electricity Gas and Water Supply sector generates through above-average wages, we would estimate that the employment spill-overs arising from the loss of consumer demand would be significant if the coal-fired power generation industry were shut down.

From Section 3.2 we also know that a significant proportion of those that face job loss in the process of large scale downsizing will leave the labour force because they assess their chances of becoming re-employed as weak (the so-called hidden unemployed or discouraged job seekers). The most likely category of discouraged job seekers are those aged over 55. Table 8 gives the current age break down to sector in the Hunter.

The age break down in the Hunter electricity, gas and water industry is roughly in line with the overall age structure. Hence, a coal-fired power generation industry closure will not put a disproportionately high number of older workers who might subsequently find it hard to find re-employment onto the labour market.

Table 8 Industry sector age structure in the Hunter Statistical Region, 2006

Industry	Over 35 years Per cent shares	Over 45 years Per cent shares	Over 55 years Per cent shares
Agriculture	75	54	33
Mining	71	43	12
Manufacturing	63	37	13
Electricity, Gas and Water Supply	71	44	14
Construction	60	34	13
Wholesale Trade	64	38	13
Retail Trade	46	28	10
Accommodation, Cafes and Restaurants	40	24	9
Transport and Storage	78	52	23
Communication Services	61	36	12
Finance and Insurance	60	33	11
Property and Business Services	62	39	16
Government Administration and Defence	68	37	11
Education	76	53	17
Health and Community Services	74	47	16
Cultural and Recreational Services	56	35	15
Personal and Other Services	57	34	14
Total	**62**	**38**	**14**

Source: ABS, 2006 Census of Population and Housing.

Younger workers are more likely to search for new employment elsewhere. That elsewhere may be outside the Hunter / Wyong region meaning that these workers will either migrate to new regions or increase their commuting to take on new opportunities.

Table 9 provides an indication of the labour market impacts for the Hunter region of a closure of the coal-fired power industry. As in Table 9 it estimates the age-related unemployment rates that would result. The unemployment rate (in 2006) would increase by 1.4 per cent, assuming that none of the laid off workers or currently unemployed workers leave the labour force. Once again this also assumes the lay-off is uniformly distributed over the various age cohorts, which may be an unlikely assumption.

Table 9 Estimated Hunter unemployment rates pre- and post-downsizing, 2006, per cent

Labour Market Indicator	35-44 years	45-54 years	> 55 years	Total
	per cent	per cent	per cent	per cent
Unemployment rate, 2006	5.5	4.3	5.1	6.9
Estimated unemployment rate, after closure	7.0	5.8	6.7	8.3

Source: ABS, 2006 Census of Population and Housing.

Table 10 provides an occupational breakdown of job losses for the Hunter following the coal-power generation sectors downsizing, focusing on the commuting and migration area represented by the Sydney metropolitan region. The first two columns show that coal-fired power industry closures in the Hunter would lead to very moderate job losses concentrated in three occupational groups: Technicians and Trade Workers and Machinery Operators and Drivers. The last two columns show the occupational employment distribution post downsizing for the Hunter and Sydney. While the share of employment provided in Sydney for ‘Clerical and administrative workers’ is favourable, it is less favourable for ‘Technicians and Trade Workers’ and ‘Machinery Operators and Drivers’ than in the Hunter, which is bad news for Hunter workers in these two occupations who may lose their jobs.

Table 10 Occupational structure in the Hunter, 2006

Occupation	Job loss (No's)	Job loss Per cent shares	Post-downsizing per cent shares	
			Hunter	Sydney
Managers	339	1.1	11.3	13.5
Professionals	503	1.1	17.0	24.4
Technicians and trades workers	1,063	2.2	17.1	12.9
Community and personal service workers	65	0.3	8.6	8.2
Clerical and administrative workers	659	1.8	13.6	17.1
Sales workers	176	0.5	12.8	9.8
Machinery operators and drivers	414	1.8	8.3	6.1
Labourers	417	1.3	11.4	8.1

Source: ABS, 2006 Census of Population and Housing. The Hunter shares do not include effects of developing new industries in the Hunter.

3.6 Summary of employment loss impacts of the 'shut down industry' scenario

Drawing the findings of this subsection together, the following conclusions can be made:

- An overnight closure of the coal-fired power stations would lead to 1,300 direct job losses in power stations, and an estimated additional 2,337 indirect job losses, a total of 3,637 jobs.
- Many of the jobs lost would be relatively high wage jobs so the closure of the industry would lead to some loss of consumer spending, which may spark further losses in the region.

4. Opportunities for the Hunter / Wyong region in switching away from coal-fired generation

In this Section we estimate the size of possible alternate energy industries and their contribution to the Hunter's labour demand.

The Hunter region currently generates nearly 80 per cent of NSW electricity in 6 coal-fired power stations. The region accounts for 20 per cent of NSW electricity consumption, with the two aluminium smelters at Kurri Kurri and Tomago consuming 15 per cent of the State's electricity. Under business as usual, NSW electricity consumption is projected to increase by 27 per cent by 2020.[3]

In order to determine the scale of renewable or low emission generation needed to enable a phase out of coal-fired electricity stations, one must first answer the question: what future electricity consumption do we need to provide for?

A renewable energy scenario such as discussed in this report is driven by the need for greenhouse emissions cuts in the region of greater than 40 per cent below 1990 levels by 2020 and 90 per cent by 2050.

A 40 per cent reduction in greenhouse emissions corresponds to a reduction of 335 million tonnes compared to business as usual [4]. A recent study of the potential to reduce Australian greenhouse emissions estimated that energy efficiency in buildings and industry could save 85 million tonnes greenhouse emissions by 2020, one quarter of the required emission reduction, as well as saving $6.5 billion dollars (McKinsey, 2008a).

A similar picture is found internationally. Global energy use is expected to increase by 40 per cent by 2020 with current policy settings. A recent study estimated that investing in energy efficiency could reduce global energy growth by more than half, even by undertaking only energy efficiency with a commercially attractive rate of return (McKinsey, 2008b). The United Nations Development Program estimated that industrialized countries can become 25-35 per cent more energy efficient in the next 20 years at no net cost (Goldemberg and Johannson, 2004).

Thus a realistic scenario for replacement of coal-fired electricity generation assumes a significant deviation from business as usual growth in electricity consumption.

4.1 How much can energy efficiency reduce NSW electricity consumption?

The potential for reduction in the projected growth of NSW electricity consumption has been explored using NFFE (2003), Energetix (2004), McNichol (2004), EMET (2004) and GWA (2004).

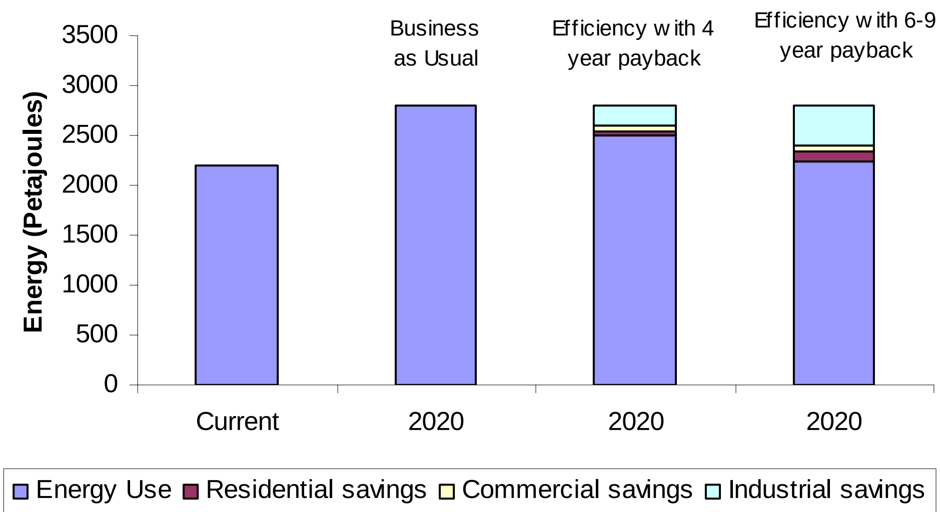
The National Framework on Energy Efficiency commissioned research in 2003 (NFFE 2003) to estimate the potential for energy efficiency in Australia. The limit is generally economic rather than technical, as studies tend to examine options that repay capital investment within a certain time period.

In the NFFE work the lower estimate includes efficiency measures that pay for themselves within 4 years, while the higher range includes measures where the combined payback is 6 years. Most other carbon abatement has a net cost rather than saving money, so setting the boundary at 6 years may not be appropriate when comparing emissions reduction options.

After the initial NFFE work more detailed studies were carried out to identify energy efficiency potential with paybacks up to 4 years in the industrial and residential sectors, and paybacks of up to 6 years in the commercial sector.

Figure 3 shows current energy use in industry and buildings, and 2020 energy use with and without energy efficiency. Implementing efficiency measures with a combined payback of 4 years would reduce business as usual energy by 13 per cent. Implementing measures with a combined payback of 6-9 years could reduce business as usual energy use by 19 per cent. This work did not include the effects of a carbon price, which would increase the economically attractive potential for energy efficiency.

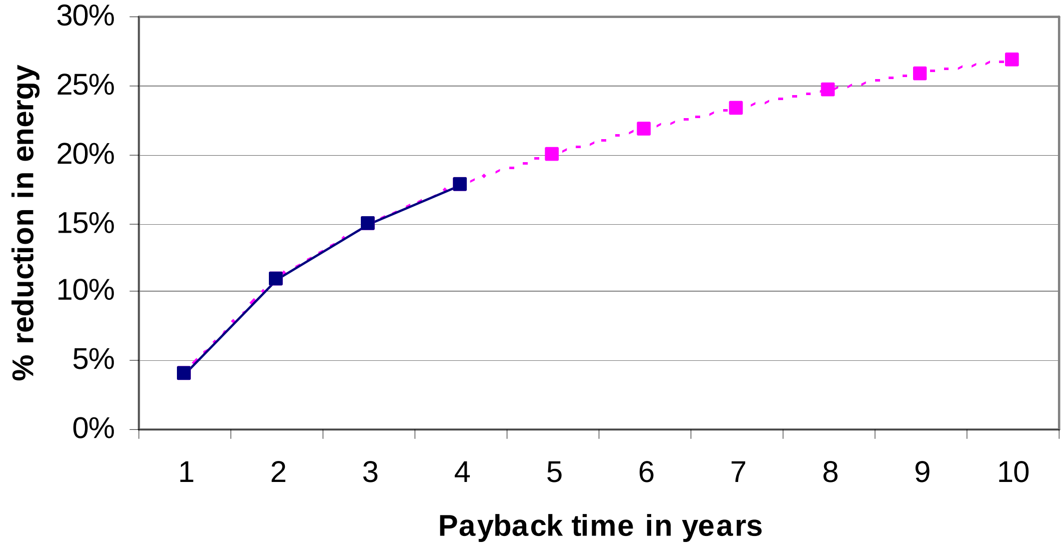
Figure 3 Estimated potential to reduce energy use in Australia



Note: Derived from NFFE (2003), Energetix (2004) McNichol (2004), EMET (2004) GWA (2004)[5]

The potential for industrial energy efficiency was derived by projecting the Energetix work, which gives a detailed breakdown of savings against payback times. The trendline is shown in Figure 4 and has an R value of 0.99. The formula has been applied to obtain a projected saving for years 5 to 10.

Figure 4 Potential reduction in industrial energy use from EE measures



N
ote: Years 1 – 4 are from Energetix (2004), with later years projected values. The regression underlying the data which was used to project the years 5-10 is y = 0.0987Ln(x) _ 0.0405. The R-squared was 0.9885.

The percentages shown in Figure 4 are gross savings, and include the energy savings under BAU which Energetix anticipates as 6.3 per cent. These are not included in the comparison with BAU (Figure 3), which uses the net saving beyond BAU of 19 per cent as the potential for reducing industrial energy use by measures with a combined payback of nine years.

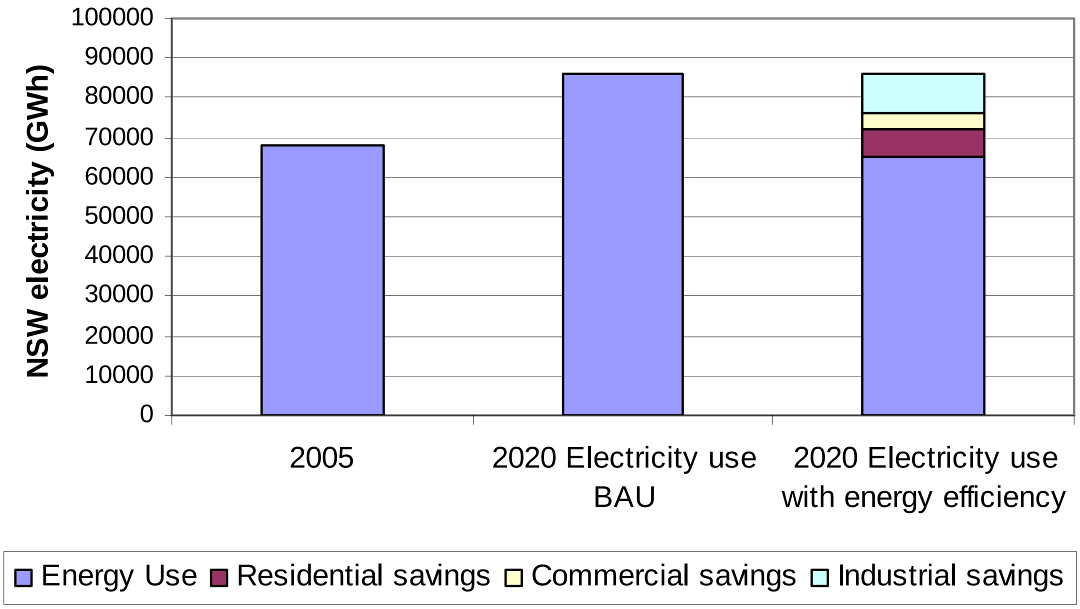
The potential for reduction in electricity use from energy efficiency in the residential and commercial sectors have been assumed to be equal to overall energy efficiency potential in these sectors for Australia.

The potential for efficiencies in industrial electricity use are derived from Energetix (2004), which details potential savings by sector and fuel type. The values for years 1 – 4 have been projected to year 9, with an R value of 0.98 (shown in Figure 4). This gives a potential reduction of 22 per cent in addition to business as usual efficiency.

Applying these potentials to projected NSW electricity use gives an overall reduction of 24 per cent compared to business as usual, and reduces electricity consumption by 4 per cent compared to 2005. This is equivalent to saving 20,700 GWh in NSW, and 4,600 GWh in the Hunter region, compared to business as usual. Current consumption, business as usual at 2020, and business as usual with energy efficiency are shown in Figure 5 and Table 11.

The two aluminium smelters in the Hunter account for 15 per cent of NSW electricity consumption, which is nearly 65 per cent of consumption in the Hunter region. Therefore action taken in aluminium smelting, is extremely important in any analysis of regional electricity supplies. The energy efficiency potential for the aluminium smelters in the Hunter region has been taken directly from Energetix (2004), rather than using a projected value. Thus savings of 13 per cent are expected in aluminium smelting relative to business as usual [6], with an expected payback of 3.8 years. This corresponds to an 8 per cent reduction in electricity use compared to current levels (see Figure 5).

Figure 5 NSW electricity consumption 2005 and 2020 with and without EE



The renewable energy scenario discussed in this report assumes that energy efficiency measures sufficiently to achieve a saving of 24 per cent compared to business as usual are put into place. Renewable energy supply sufficient to meet the reduced consumption, and energy efficiency measures sufficient to achieve it, are further assessed to determine the effects on employment.

The energy efficiency potential used is in keeping with targets adopted elsewhere. The state of Maryland in the USA has just adopted policies to reduce electricity consumption by 29 per cent compared to business as usual by 2025 (ACEEE, 2008), and the European Union to reduce energy use by 13 per cent by 2020 (European Union, 2007).

4.2 Renewable energy supply

Two electricity supply scenarios are used in this study. The projected consumption show in Table 11 is the basis for both scenarios.

Table 11 shows 2005 electricity generation and consumption in the Hunter region and NSW, and 2020 consumption under business as usual, and with a significant improvement in energy efficiency.

Table 11 Electricity consumption in NSW and the Hunter 2005 and 2020, BAU and with energy efficiency measures

	Generation	Consumption			Consumption reduction 2020 compared to			
	2005	2005	2020 BAU	2020 with EE	2020 BAU		2005 Consumption	
	GWh	GWh	GWh	GWh	%	GWh	%	GWh
NSW		67,200	85,300	64,600	24	-20,700	4	-2,600
Hunter	52,142	15,700	18,100	14,700	18 [1]	-3,300	5	-950
Hunter as % of NSW	78% [2]	23%	21%	23%				

Notes
1) Consumption for aluminium smelting is reduced by 8 per cent compared to current levels.
2) Hunter region coal generation as a percentage of NSW consumption.

Two electricity supply scenarios are given in Table 12 and Table 13, and are used to model the employment effects of a transition to renewable energy. Scenario One: *Hunter as a Self-Sufficient Regional Energy (RE) Centre* assumes that the Hunter region generates sufficient for local consumption, but that its role as the major energy exporter for the rest of NSW does not continue. This reflects the more diffuse nature of renewable energy compared to fossil fuels, and the need to locate generation equipment near resources. The large concentration of coal-fired power stations reflects the location of coal mining. It is likely that the role of the region as a major energy supplier to the whole State would change as fuel sources change.

The second scenario: *Hunter as a NSW Energy Export Centre* assumes that the Hunter region continues to generate a very significant proportion of NSW electricity supply.

In both scenarios, it is assumed that every effort is made to locate companies and jobs associated with improvements in energy efficiency and renewable energy within the Hunter, to compensate for the loss of coal-associated employment.

A regional resource assessment is beyond the scope of this Report. The following scenarios are not prescriptive; they are indicative only based on reasonable assumptions about resources within the region.

The second scenario assumes the development of concentrating solar thermal power stations would be outside the Hunter region. It is highly unlikely that the power stations would be located within the Hunter, as optimum conditions occur several hundred kilometres to the west where daily sunlight hours are significantly higher. However, location will be driven by proximity to transmission lines, so power stations are likely on both the Nyngan/ Cobar and the Narrabri/ Inverell lines.

The employment potential assumes that companies associated with manufacturing and development for these projects are locate within the region, capitalising on the presence of the National Solar Centre in Newcastle.

The two scenarios show the Hunter can continue to play an important role in NSW energy production under a transition to renewable energy, although it is very unlikely that the region could continue to supply as high a proportion of NSW electricity.

The scenarios use two emerging technologies, geothermal using hot dry rocks, and solar thermal. While solar thermal power generation is in use internationally, it has not been fully commercialised. In the event that these technologies cannot be scaled up sufficiently, gas combined cycle technology would need to be deployed as an interim measure. This would still bring a very substantial emission reduction compared to coal generation.

The aluminium industry has an important role to play, as it accounts for 65 per cent of the Hunter electricity consumption (15 per cent of NSW). As well as energy efficiency measures equivalent to the potential identified in Energetix (2004), it is assumed that aluminium smelters will install substantial levels of co-generation. This is in keeping with the information produced by the Aluminium Council:

> Alumina production facilities are the perfect co-generation partner, with 365 day 24/7 constant heat demand. Few, if any, industries “fit” better than alumina for co-generation, particularly in an Australian climate (Australian Aluminium Council, 2006).

Table 12 Scenario 1: Hunter as a Self-Sufficient Regional Energy Centre

	MW	GWh	Per cent of regional electricity	Per cent of NSW electricity
Hunter region				
Wind (note 1)	1,400	3,679	25	6
Bioenergy (note 2)	250	1,752	12	3
Geothermal(note 3)	200	1,489	10	2.3
PV – Residential(note 4)	250	329	2	0.5
PV - Business (note 5)	325	427	3	0.7
Gas Co-generation (note 6)	1,000	7,008	48	11
Total	**3,425**	**14,684**	**100**	**23**
Elsewhere in NSW				
Wind	3,500	9,198	-	14
Hydro	4,200	3,800	-	6
Bioenergy	1,300	9,110	-	14
PV	3,000	3,942	-	6
Solar thermal	2,000	6,132	-	10
Co-generation	2,500	17,520	-	27
Total	**16,500**	**49,702**		**77**
Energy efficiency (note 7)	-	-20,700	-	-

Notes
1. Assumes that 3500 MW of wind is developed elsewhere in NSW.
2. 16 per cent of identified currently available NSW bioenergy resource. (Rutovitz and Passey, 2004)
3. Assumes development of the Geodynamics sites at Muswellbrook and Bulga.
4. Assumes installation of 3kW systems on 37 per cent of houses.
5. Assumes business PV installation is 30 per cent higher in total than residential.
6. Assumes installation of gas fired co-generation at industrial sites and large users within the region, initially at aluminium smelters.
7. This is the total NSW saving compared to BAU electricity use.

Table 13 Scenario 2: Hunter as a NSW Energy Export Centre

	MW	GWh	Per cent of regional electricity	Per cent of NSW electricity
Hunter region				
Wind (note 1)	2,000	5,256	36	8
Bioenergy (note 2)	400	2,803	19	4
Geothermal(note 3)	200	1,489	10	2
PV – Residential(note 4)	467	614	4	1.0
PV - Business (note 5)	934	1,228	8	1.9
Gas Co-generation (note 6)	1,600	11,213	76	17
Solar Thermal	1,000	3,066	21	5
Total	**6,601**	**25,669**	**174**	**40**
Elsewhere in NSW				
Wind	2,900	7,621	-	12
Hydro	4,200	3,800	-	6
Bioenergy	1,200	8,410	-	13
PV	2,200	2,891	-	4
Solar thermal	1,000	3,066	-	5
Co-generation	1,900	13,315	-	21
Total	**13,400**	**39,103**		**61**
Energy efficiency (note 7)	-	-20,700	-	-

Notes
1. Assumes that 2900 MW of wind is developed elsewhere in NSW.
2. 26 per cent of identified currently available NSW bioenergy resource. (Rutovitz and Passey, 2004)
3. Assumes development of the Geodynamics sites at Muswellbrook and Bulga.
4. Assumes installation of 3kW systems on 70 per cent of houses.
5. Assumes business installs double the total capacity of residential PV.
6. Assumes installation of gas fired co-generation at industrial sites and large users within the region, initially at the aluminium smelters.
7. Assumes major development of solar thermal, although power stations would not be located within the region

4.3 Capital Investment

Approximately $12 billion would need to be invested in the capital costs of the renewable energy and co-generation and the energy efficiency measures for Scenario 1 between now and 2020 (Table 14 shows these estimates). This does not take account of technology cost decline over the period, which is likely to lead to PV in particular being considerably less expensive than shown.

Table 14 Estimated capital cost of renewable energy, co-generation and energy efficiency measures for Scenario 1 (Hunter region only)

Energy efficiency investment	**GWh savings**	**Investment** **$AUD million per GWh**	**Capital cost** **$AUD million**
Residential	590	$0.73	$429
Commercial	320	$0.39	$124
Industrial	975	$0.89	$869
Renewable energy investment	**MW installed**	**$AUD million per MW**	
Wind	1,400	$1.7	$2,380
Bioenergy	250	$2	$500
Geothermal	200	$4	$800
PV	575	$10	$5,750
Solar thermal	0	$3.5	$0
Co-generation	1,000	$1.2	$1,200
Total			**$12,052**

Note: Does not take account of technology cost decline over the period. All investment will not occur in the Hunter, as capital costs include imported technology.

4.4 The employment effects of renewable energy

But what sort of jobs are we talking about? Jobs in energy efficiency and renewable energy are potentially secure, well-paid, environmentally-friendly jobs – Green Jobs.

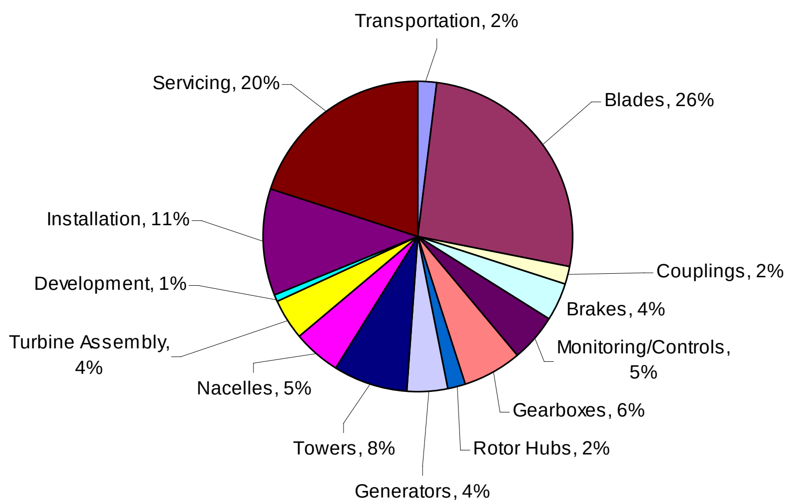
There are a wide variety of jobs available in the manufacture, installation, maintenance and servicing, transport and delivery of goods, operation, sales, and research and design of renewable energy technologies.

A local renewable energy and energy efficiency industry has potential as a new export centre, supplying technology and expertise to global markets. This potential export industry has not been included in the analysis.

Many of these jobs can utilise skills that are already in abundance in the Hunter, creating new jobs for local people. Skills development and training are a critical part of creating Green jobs through new training programs and apprenticeships.

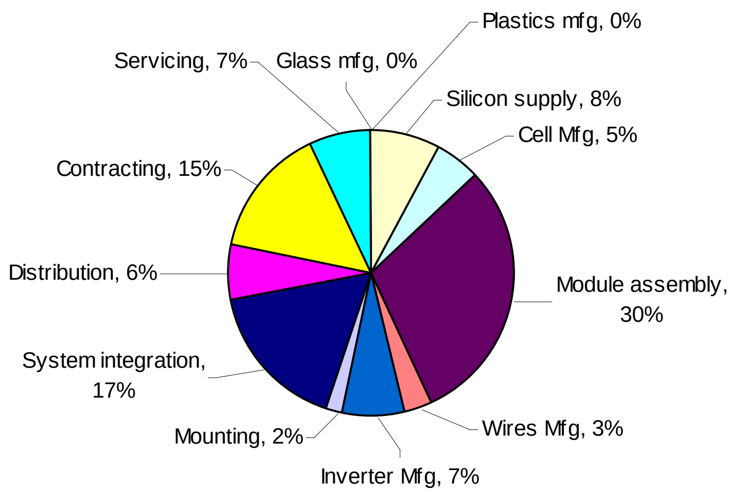
These include a range of trades and non-trades jobs, Figures 6 and 7 below give examples of the type of labour requirements involved in wind and solar photovoltaics, based on research by Singh and Fehrs (2001).

Figure 6 Labour requirements in wind by activity



Source: Singh and Fehrs, 2001

Figure 7 Labour requirements in solar photovoltaics by activity



Source: Singh and Fehrs, 2001

4.5 Employment factors for renewable energy and co-generation

How many jobs would be generated in the Hunter if there were a shift to renewable energy?

Employment factors for renewable energy are presented in numerous studies, usually in the form of jobs per MWp in operations and maintenance, and job years in installation, construction, and manufacturing per MWp installation. Some studies present job numbers per $ million investment. There is considerable variation in the actual numbers, and in the allocation of jobs to different stages of work. The results from a number of studies, and the derivation of the factors used here is presented in the following sections.

The employment factors for renewable energy and co-generation used in this report are shown in Table 15, and the employment creation from present coal-fired electricity generation in NSW.

The last column shows the numbers of jobs per GWh for each technology compared with the employment creation resulting from coal generation in NSW. The renewable technologies are considerably more employment intensive than current generation. The ratio ranges from 1.2 times as many jobs per unit of electricity for wind compared to coal generation, to 20 times as many jobs for PV generation. Globally wind energy creates approximately 1.9 times as many jobs as coal generation job per unit of electricity. However, this figure includes manufacturing, and a great deal of this will occur offshore. The employment modelling here is presented for 36 per cent of wind manufacturing occurring onshore, and for none of the wind manufacturing occurring onshore.

Co-generation creates less jobs in the Hunter region, although more jobs overall, as the fuel extraction does not take place within the Hunter.

These factors underestimate the potential increase in employment from a phase out of coal-fired electricity, as they include jobs created during construction of power stations, although this occurred some time ago.

This comparison is consistent with the general consensus that expanding a country's renewable energy sector (and contracting fossil-fuel based production) has a net positive impact on employment. For example Kammen *et al.* (2004), Bedzek (2007), MacGill *et al.* (2002), find the renewable energy sector generates more jobs than the fossil-fuel based energy sector per unit of energy delivered across a broad range of scenarios.

The factors are only for *direct* employment impacts (rather than the IO analysis employed in the previous section which includes the generation of *indirect* in addition to direct employment).

Renewable energy employment must be categorised according to the Australian and New Zealand Standard Industrial Classification (ANZSIC) classification system. This required further subdivision of 'construction, manufacturing, and installation'. As this breakdown is not available in most studies, it has been derived for this report. The ratio and derivation are given in Table 16. Manufacturing, construction and installation, operations and maintenance, and fuel supply, have been allocated to ANZSIC categories for each technology, with the allocation shown in Table 17.

Table 15 Renewable energy and co-generation employment factors used in this study

	Person years per MWp	Jobs per MWp	Person years per GWh	**Normalised to lifetime of facility** Jobs per GWh			
Energy technology	C M & I	O & M	Fuel	C M & I	O & M & fuel	**Total**	Ratio with NSW coal
PV[1]	20 (29)	1.8	0	**0.6** (0.88)	1.33	**2.21**	**20** (26)
Wind[2]	5.2 (9.4)	0.09	0	**0.08** (0.14)	0.03	**0.18**	**1.2** (1.9)
Bioenergy[3]	5.25	1.2	**-**	0.03	0.17	**0.20**	2.3
Geothermal	4	1.7	0	0.02	0.24	**0.27**	3.1
Solar thermal	8.3	0.7	0	0.09	0.20	**0.29**	3.4
Co-generation[4]	5.8	0.13	N/a	0.03	**0.02** (0.09)	**0.12**	**0.5** (1.2)
NSW coal generation[5]	8.3	0.14	0.03	0.04	0.06	**0.09**	1

Notes

1. Figures in bold are PV indicators from REN21 (2005) adjusted for 80 per cent of manufacturing occurring overseas
2. Figures in bold show wind indicators from EWEA 2003 adjusted for 64 per cent of manufacturing occurring overseas.
3. Fuel collection and processing for bioenergy is included in O & M.
4. Figure in bold for gas co-generation excludes fuel extraction and processing, as it will be outside the region..
5. NSW coal generation operation and maintenance and fuel employment calculated from current data; construction, manufacturing and installation taken from Kammen *et al* 2004.
6. PV, bioenergy, geothermal and solar thermal derived from REN21 (2005) *Renewables 2005 Global Status Report* . Wind from EWEA 2003. Co-generation from ACIL (2000).

Table 16 Assumed proportion of manufacturing in 'Construction, installation and manufacturing'

	Percentage of manufacturing	Reference
PV	40 per cent	Ratio given in BCSE 2004, page 20.
Wind	67 per cent	EWEA 2003 ratio, adjusted for 66 per cent of manufacturing occurring outside Australia.
Solar thermal	22 per cent	Ratio for solar water heating used, derived from BCSE (2006)
Bioenergy, geothermal, and co-generation	Not available	No data available, all jobs in construction, installation, and manufacturing are treated as being in construction and installation.

Note: Some technology stages have been allocated to two classifications,. For example, solar thermal manufacturing has been identified as including 75 per cent glass manufacturing and 25 per cent machinery and equipment manufacture.

Table 17 ANZIC classification of employment created in renewable energy and co-generation

	Manufacturing	**Installation**	**Operations and maintenance**	**Fuel supply**
ANZSIC employment categories	C26 Non metallic mineral product manufacturing (0.5) C27 Metal product manufacturing (0.5) C28 Machinery and equipment manufacturing	E42 Construction trade services B15 Services to mining	D36 Electricity and gas supply E42 Construction trade services L78 Business services	A01 Agriculture A03 Forestry and logging
PV	C28	E42	E42 (0.5) L78 (0.5)	-
Wind	C26 (0.5) C27 (0.5)	E42	D36	-
Bioenergy	C28	E42	E42 (0.5) D36 (0.5)	A01 (0.5) A03 (0.5)
Geothermal	C28	B15 (0.8) E42 (0.2)	D36	-
Solar thermal	C26 (0.75) C28 (0.25)	E42	E42 (0.5) D36 (0.5)	-
Co-generation	C28	E42	E42 (0.5) D36 (0.5)	B12 D26

REN21 (2005) presents employment factors from more than 15 renewable energy studies, and estimates of global employment in the renewable industry for 2005. The mid range estimates from this study have been used to derive the employment factors used in this report, with the exception of wind power and co-generation.

Kammen *et al.* (2004) review 13 independent reports/studies to develop estimates of the job creation potential of selected renewable technologies, and present job factors from 4 of these reports. The authors have attempted to standardise job numbers according to the actual electricity generation of each technology. To this effect they have used a new measure, MWa, which adjusts the nameplate capacity of generation plant according to their likely actual generation, and have assumed the lifetime and capacity factors for each technology. They have also averaged the 'person years' of employment in manufacturing and construction over the lifetime of facilities to approximate 'constant' job creation, so that they present just one figure of jobs per MWa.[7] Jobs may also be presented per GWh generated over the life of the facility.

This report uses the same methodology developed by Kammen *et al.* (2004), adjusted for Australian capacity factors, to derive employment factors from REN21 (2005), ACIL (2000), and EWEA (2003). Factors are presented as jobs per GWh over the lifetime of the facility, rather than as jobs per MWa, as GWh is a more common unit.

Table 19 summarises the reports used by Kammen *et al* (2004), and the additional reports considered here.

Table 18 compares the estimated employment factors from different studies for various renewable energy technologies. The last column shows the job creation per GWh compared to NSW coal-fired electricity generation.

In Table 18, PV1, PV2, Wind 1, Wind 2, the high and low bioenergy estimates, and the coal and gas factors are all from Kammen *et al.* with modified capacity factors. The capacity factor for PV has been set at 15 per cent rather than 21 per cent, and for wind at 30 per cent rather than 35 per cent. The lower capacity factor for wind has been used because the large expansion envisaged is likely to lead to utilisation of slightly lower wind speed sites.

PV, bioenergy, wind and geothermal are also derived using REN21 (2005), the most recent global data available, and shown as PV3, wind 3, bioenergy 3, and geothermal.

Wind 4 has been derived from the EWEA (2003), which presents projected employment for Europe broken down into manufacturing, installation and operations, and excluding employment associated with export. This indicator has been used because the data includes the breakdown between manufacturing and installation. It has been adjusted in Table 15 to include the likelihood that most manufacturing employment will occur overseas.

The latest Australian data from the 2006 Clean Energy Report (BCSE 2006) is used to derive Australian factors for comparison, and shown as Wind 5 and Bioenergy 4.

The global indicators from REN21 (2005) and EWEA (2003) are used in this report as they seem more relevant to the scale of industry development that would be needed in either energy scenario. The higher Australian factors for wind energy probably reflect the early stages of the industry in this country. In bioenergy the Australian factors are lower than the global figures, perhaps as a result of the current low representation of agricultural and forestry residues or crops (other than bagasse) in the Australian industry. This is likely to change if significant development of bioenergy occurs.

Employment data for PV and geothermal technologies were presented in the 2006 Clean Energy Report but are not presented here. Australian employment factors are several orders of magnitude higher than the global estimates, but this is not considered to reflect a long term employment creation potential. In the case of geothermal, there are currently 100 people employed and only 0.1 MW installed, but this is because there is significant research and development underway. There were 1300 people employed in the PV industry in Australia in 2004 (3.5 MW installed). However, the greater share of this employment is in the export sector, so cannot be extrapolated to expansion of the domestic market.

Factors for employment in coal fired power generation have been derived for NSW, using the employment data from Table 4. The average capacity factor has been calculated from ESAA (2006), and the tonnes per MWh from the Department of Climate Change (2008) workbook and the emissions intensity of Eraring power station given in NSW Government *Energy Direction Green Paper* (NSW Government. 2004).

Table 18 Renewable energy and co-generation employment factors with derivation and source

Energy technology	Data source	CF %	Lifetime years	Employment factors			Employment factors normalised to lifetime of facility					
				CM&I	O&M	Fuel	Jobs per MWp		Jobs per GWh			
				person years / MWp	Jobs per MWp	person years/ GWh	CM&I	O&M & fuel	CM&I	O&M & fuel	Total	Ratio with NSW coal
PV1	REPP (2001)	15	25	32	0.25	0	1.29	0.25	0.98	0.19	1.17	14
PV2	Greenpeace (2001)	15	25	30	1.0	0	1.20	1	0.91	0.76	1.67	20
PV3	REN21 (2005)	15	25	29	1.8		1.16	1.75	0.88	1.33	2.21	26
Wind 1	REPP (2001)	30	25	3.8	0.1	0	0.15	0.1	0.06	0.04	0.10	1.1
Wind 2	Greenpeace/EWEA (2003)	30	25	22	0.1	0	0.88	0.1	0.33	0.04	0.37	4.4
Wind 3	REN21 (2005)	30	25	5.6	0.15	0	0.7	0.5	0.09	0.06	0.14	1.5
Wind 4	EWEA (2003)	30	25	9.4	0.09	0	0.38	0.09	0.14	0.03	0.18	1.9
Wind 5	CEC (2006)	30	25	3.1	0.6	0	0.13	0.56	0.05	0.21	0.26	3.0
Bioenergy high	REPP (2001)	85	25	8.5	0.44	0.22	0.34	2.08	0.05	0.28	0.32	3.8
Bioenergy low	REPP (2001)	85	25	8.5	0.04	0.04	0.34	0.34	0.05	0.05	0.09	1.1
Bioenergy 3	REN21 (2005)	80	25	5.25	1.2		0.21	1.20	0.03	0.17	0.20	2.3
Bioenergy 4	CEC (2006)	80	25	3.7	0.9		0.15	0.93	0.02	0.13	0.15	1.8
Geothermal	REN21 (2005)	80	25	4	1.7	0	0.16	1.70	0.02	0.24	0.27	3.1
Solar thermal	REN21 (2005) Bedzek (2007)	40	25	8.3	0.7	0	0.33	0.7	0.09	0.20	0.29	3.4
Co-generation	ACIL (2000)	80	25	5.8	0.13	0.07	0.23	0.62	0.03	0.09	0.12	1.4
Coal	Kammen *et al.* (2004)	80	40	8.5	0.18	0.06	0.21	0.60	0.03	0.09	0.12	-
Gas	Kammen *et al.* (2004)	85	40	8.5	0.1	0.07	0.21	0.62	0.03	0.08	0.11	1.3
NSW coal generation	Calculated	63	40		0.14	0.03	-	0.32	0.03	0.06	0.09	1

Note: PV3, Wind 4, and Bioenergy 3 have been used in this study, but modified to allow for a 64 per cent of wind manufacturing employment and 80 per cent of PV manufacturing employment to occur offshore. Capacity factors and lifetimes have been added to source data in order to normalise to jobs per GWh. Solar thermal construction employment has been derived the information about Nevada 1 solar thermal plant: average employment of 400 (Bedzek 2007) and a construction time of 16 months.

Table 19 Studies used to derive renewable energy employment factors

Studies drawn on by Kammen e*t al.* (2004):	Used for factors
REPP (2001) *The work that goes into renewable energy*: Study calculates jobs in person-yrs/MW and person-yrs/$ invested. Does not take into account multiplier. Authors collected primary employment data from companies in the solar PV, wind energy and coal sectors, and used project scenario numbers for biomass energy. Includes jobs in manufacturing, transport, delivery, construction and installation, and operations and maintenance.	PV 1, Wind 1
Greenpeace (2001) *2 million jobs by 2020*: Based on employment information provided by the industry, jobs for each region have been calculated for scenario of 207GWp of installed PV by 2020. It is assumed that between 2000 and 2010, 20 jobs are created per MW during manufacture, decreasing to 10 Jobs per MW between 2010 and 2020. About 30 jobs generated per MW during installation, retailing and providing other local services between 2000 and 2010, going down to 26 jobs per MW between 2010 and 2020. For maintenance, it is assumed that after accounting for economies of scale and other efficiency gains, 1 job will be created per installed MW. Since developing world markets will play a more significant role beyond 2010, this is assumed to steadily increase up to 2 jobs per MW by 2020.	PV 2
Greenpeace/EWEA (2003) *Wind force 12: a blueprint to achieve 12 per cent of the worlds electricity from windpower by 2020*: Numbers based on 2 prior studies/surveys - Danish Wind Turbine Manufacturers Association and Danish Counties and Municipalities Research Institute (Society Value of Wind Power). This study did not specify employment from O and M, so the author's draw on the REPP figure.	Wind 2
CALPIRG (2003); BLS (2004): Analysis based on combining industry data with median values of economic models produced by others.	Coal and gas indicators except NSW.
Additional studies considered	
EWEA 2003. Wind energy: the facts. Volume 3 Industry and employment. Calculates direct and indirect employment in the European wind energy industry, divided into manufacturing, installation, and operations. A table is presented of employment from the domestic market against annual and cumulative installed MW, projected to 2010. The 2008 figures have been used to derive the employment factors in 0.	Wind 3
ACIL Consulting. 2000. Employment Indicators for Australia's Renewable Energy Industries. Gives indicators of employment following industry survey.	Co-generation (except fuel)
REN21 Renewable Energy Policy Network. 2005. Renewables 2005 Global Status Report. Summarises the status of the RE industry at the end of 2005. Data includes cumulative and incremental MW installed for each technology, and estimates of global employment split into construction and manufacturing, and operations and maintenance per MWp. The mid range figure of technology estimates have been used to derive jobs per MWp.	PV3, Bioenergy 3, Geothermal
Business Council for Sustainable Energy 2006. *Clean energy report 2006*. Data includes cumulative and incremental MW installed in each technology, and employment per technology. The figures for employment in the PV Industry do not differentiate between domestic and export, so these have not been used.	Wind 4, Bioenergy 4

4.6 Direct employment in renewable energy and co-generation – results

Three different employment levels are presented for the renewable energy sector as it could develop in the Hunter region, and are applied to both of the energy scenarios. The energy scenarios project different levels of renewable energy generation in the Hunter.

In Scenario 1: *Hunter as a Self-Sufficient Regional Energy Centre* only sufficient electricity generation is developed to meet consumption within the region.

In Scenario 2: *Hunter as a NSW Energy Export Centre*, the Hunter remains a significant energy exporter, albeit not supplying the 80 per cent it currently does.

The three employment levels are:

- *All manufacturing occurs offshore:* this assumes that all manufacturing associated with PV, wind or solar thermal occur overseas. While it is unlikely that all manufacturing would be located within Australia, it would be a lost opportunity if none was realised onshore.
- *Manufacturing related to electricity generation within the Hunter (and in the case of solar thermal, to the west of the Hunter) occurs locally.* This assumes 100 per cent of manufacturing associated with solar thermal, 36 per cent of manufacturing associated with wind power, and 20 per cent of manufacturing associated with PV occurs on shore. Local manufacture of wind turbine towers and blades would be approximately equal to 36 per cent (EWEA 2003).
- *Manufacturing is established in the Hunter to supply the RE industry statewide.* The same percentages as the previous level are used (100 per cent of manufacturing for solar thermal, 36 per cent for wind, and 20 per cent for PV), but in this case manufacturing within the Hunter supplies all the renewable generation installed in NSW.

In some cases adjustments have been made to job factors to allow for the physical realities of industry development and the Hunter region, or for the lack of more detailed information. These are summarised below.

- *Solar thermal*: power stations are unlikely to be located in the Hunter region as better conditions occur some hundreds of kilometres to the west. It has been assumed all manufacturing would be located in the Hunter, and that 30 per cent of the jobs associated with construction and installation would benefit the Hunter. All the operations and management and 70 per cent of the construction jobs are excluded from the calculations for the Hunter, and are included in the totals for ‘rest of NSW’ in Table 23.
- *Co-generation*: the job factors have been adjusted to exclude all fuel supply jobs in calculations of Hunter region employment.

Table 20 shows the employment potential for renewable energy in both scenarios, for different levels of manufacturing within the Hunter region. It also shows the employment potential for the whole state.

Table 20 Potential jobs in the Hunter in renewable energy and co-generation

Scenario 1: Hunter as a Self-Sufficient Regional Energy Centre	Capacity MWp	RE manufacturing		Construction	Operations and maintenance	Fuel supply	Total employment		
		For installation in Hunter region only	For installation in rest of NSW				No manufacturing	Manufacturing for Hunter	Manufacturing for NSW
Wind	1,400	127	317	176	124	-	301	428	745
Bioenergy	250	-	-	53	66	234	353	353	353
Geothermal	200	-	-	32	340	-	372	372	372
PV	575	53	278	399	1,006	-	1,405	1,458	1,736
Solar thermal	-	-	149	0	0	-	0	0	149
Co-generation	1,000	-	-	200	130	-	330	330	330
Total	3,425	180	744	860	1,667	234	2,761	2,941	3,685
Scenario 2*:* Hunter as a Energy Export Centre (generates 40 per cent of NSW electricity)	Capacity MWp	RE manufacturing		Construction	Operations and maintenance	Fuel supply	Total employment		
		For installation in Hunter region only	For installation in rest of NSW				No Manufacturing	Manufacturing for Hunter	Manufacturing for NSW
Wind	2,000	181	263	252	178	-	430	611	874
Bioenergy	400	-	-	84	106	374	564	564	564
Geothermal	200	-	-	32	340	-	372	372	372
PV	1,401	130	204	973	2,452	-	3,425	3,555	3,758
Solar thermal	1,000	74	74	77	-	-	77	152	226
Co-generation	1,600	-	-	320	208	-	528	528	528
Total	6,601	386	541	1,738	3,284	374	5,396	5,781	6,322

Note: Manufacturing: when manufacturing is included, it assumes 100 per cent of the manufacturing associated with solar thermal, 36 per cent of that associated with wind, and 20 per cent of that associated with PV occurs onshore. Solar thermal (Hunter region): 70 per cent of construction work and all of O&M is assumed to occur outside the Hunter. Co-generation all fuel collection and distribution employment are assumed to occur outside the Hunter.

4.7 The employment effects of energy efficiency measures

How much employment will be created in the energy efficiency industry in a renewable energy scenario?

Three studies have been used to derive the factors to calculate employment potential in the Hunter. Employment in energy efficiency tends to be spread through other sectors, including construction, manufacturing, trade services, and retailing. Employees may be only partially employed in energy efficiency work. It is therefore difficult to obtain accurate data on the employment creation potential of energy efficiency. Bedzek (2007) reviews the energy efficiency and renewable energy efficiency industries in the US, and details total sales, and numbers of employees. The direct employment has been used in this report to derive employment compared to spending on energy efficiency measures.

Table 21 Direct employment factors in the energy efficiency industry

Study	Comment	Annual investment/ sales in EE goods and services A$	Number of employees in EE sector/ programs	Jobs per $million investment/ sales in EE goods and services
Bezdek (2007) Renewable Energy and Energy Efficiency: Economic Drivers for the 21st Century	Gives total employment and sales in the energy efficiency industry in the USA for 2006.	$987,182 million	3,500,000	3.5
Wade J *et al.* (2000) National and local employment impacts of energy efficiency investment programmes.	Reviews nine programs across Europe, including all sectors. The weighted average job creation per $million is shown here.	$255 million	1,712 (calculated)	6.7
MEA (2003) Australian Sustainable Energy Survey 2002	Survey of Australian employment 2002, gives total jobs and sales per employee.	$570 million	5,800	6.6

Note: exchange rates of 1.6 A$ per Euro and A$1.07 per US$ have been used to convert from original currencies.

MEA (2003) surveyed the Australian sustainable industry in 2002 and gives the number of jobs in energy efficiency, and the average sales per employee. Wade *et al.* (2000) investigated the employment creation of nine European energy efficiency programs with a total investment value of $A255, and presents employment creation and investment for each program.

The indicators and the summary details of the studies reviewed are shown in Table 21. Two estimates are presented of employment, using the low and high factors shown here.

In order to undertake input - output analysis for energy efficiency employment, the employment potential requires allocation to standard industry classifications. This is a speculative exercise, as the activities within each sector can vary considerably. The classifications which have been used for this study are shown in Table 22.

Table 22 ANZIC classification of employment created in the energy efficiency sector

	ANZSIC category			
Energy efficiency sector	C26 Non metallic mineral product manufacturing	C28 Machinery and equipment manufacturing	E42 Construction trade services	L78 Business services
Residential (existing)	0.2	-	0.7	0.1
Residential (new build)	0.2	0.1	0.5	0.2
Commercial	0.1	0.1	0.6	0.2
Industrial	-	0.2	0.5	0.3

4.8 Energy efficiency – direct and indirect jobs

The estimated direct employment creation from energy efficiency is shown in Table 23. Between 700 and 1,300 direct jobs are created in the Hunter, with a further 6,100 – 11,900 in the rest of NSW.

The annual capital investment is the input used to determine employment levels, as the employment factors are expressed as jobs per $ million. Investment levels to achieve the 20,700 GWh reduction of electricity consumption relative to business as usual have been calculated by multiplying the Hunter (and NSW) electricity savings by the capital investment per petajoule savings in the studies of Australian energy efficiency potential. Investment is assumed to occur over an 8 year period in all cases.

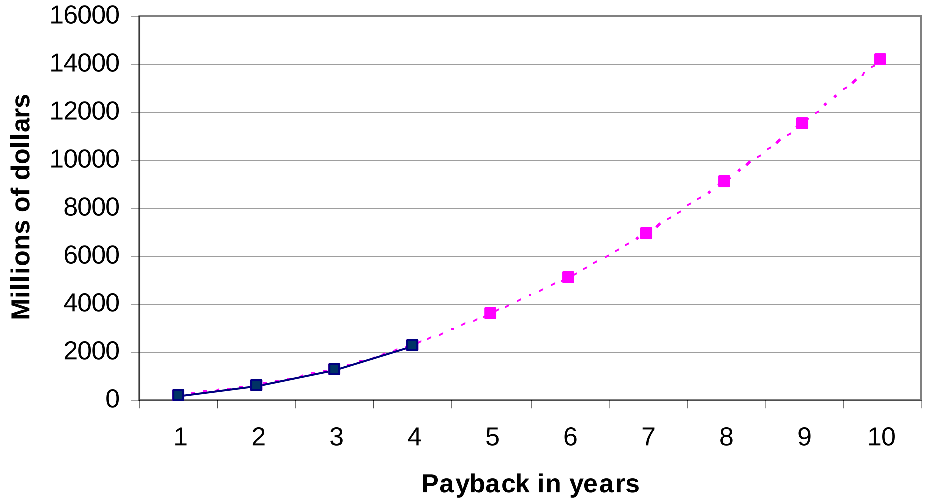
Residential investment is calculated from the high energy efficiency savings from NFFE (2003). Commercial capital investment is the weighted average of the commercial sectors presented in EMET (2004). Industrial investment is from Energetix (2004), with the costs for savings projected from 1-4 year payback measures to 9 year payback measures. Figure 8 shows the trend line for electricity savings versus payback time, and cost versus payback time. The trend lines have R values of 0.98 and 0.99 respectively.

Table 23 Direct employment in the Hunter and NSW in the energy efficiency sector in 2020, with measures achieving an overall reduction of 24 per cent (20,700 GWh) in NSW electricity consumption compared to BAU

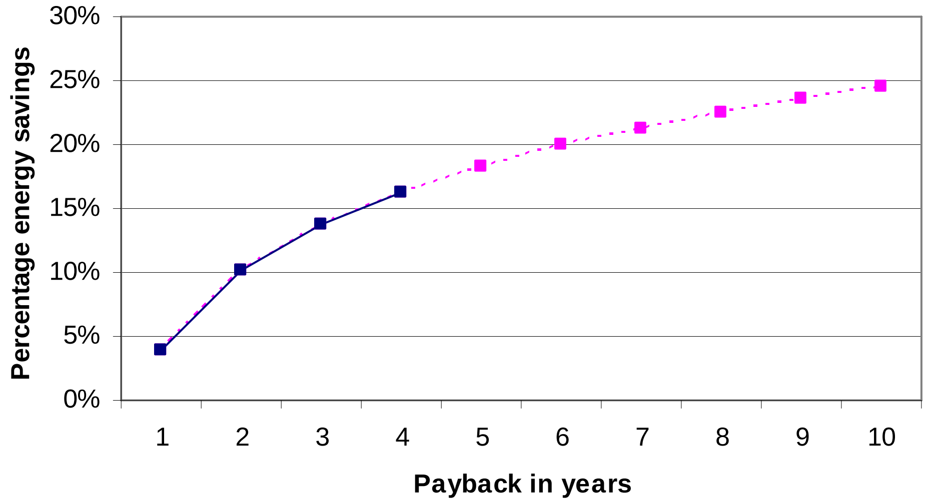
Hunter	Total capital investment $ million	Annual spending[1] $ million	Direct jobs low estimate	Direct jobs high estimate
Residential (existing housing)	$386	48	167	323
Residential (new build)	$43	5	19	36
Commercial	$124	16	54	104
Industrial	$869	109	375	727
Aluminium	$181	23	78	151
Total (Hunter region)	$16,03	$200	693	1,342
Rest of NSW				
Residential existing	$4,322	540	1,868	3,620
Residential new build	$480	60	207	402
Commercial	$1,394	174	602	1,167
Industrial	$6,431	804	2,780	5,386
Total (rest of NSW)	$12,627	$1,578	5,458	10,575
Total (All NSW)			6,151	11,917

Note 1. In all cases investment in all cases investment has been assumed to occur over 8 years.

Figure 8 Capital costs and potential for industrial electricity reduction from energy efficiency measures



(a) Costs of measures versus payback time



(b) Energy savings as a percentage of payback time

Note: Years 1 – 4 are from Energetix (2004), with later years projected values. For Figure 8a, the underlying regression model is $y = 141.81x^2$. For Figure 8b, the underlying regression model is $y = 0.0891\ln(x) + 0.396$. The estimates for years 5-10 are predicted from the respective regressions.

4.9 Total employment in energy efficiency, renewable energy and co-generation

Table 24 shows the total direct and indirect jobs created in renewable energy, energy efficiency and co-generation by the energy scenarios presented.

In Scenario 1: *Hunter as a Self-Sufficient Regional Energy Centre*, the Hunter generates electricity for use within the region only. The minimum is 3,500 direct jobs in the Hunter (23,300 in NSW) if no renewable energy manufacturing occurs on shore, and the lowest estimates for energy efficiency job creation prove correct. The maximum is 5,000 jobs created if manufacturing for the state-wide renewable energy industry is located in the Hunter, and the higher estimate for energy efficiency jobs is correct (30,000 jobs in NSW).

In Scenario 2: *Hunter as a NSW Energy Export Centre*, the Hunter region generates 40 per cent of NSW electricity. The minimum estimate is 6,100 jobs within the region, and the maximum is 7,700 jobs within the region. These numbers do not include indirect jobs.

Between 23,300 and 30,000 direct jobs are created in the whole of NSW, including the Hunter, in each scenario.

These figures have been used to perform input - output analysis so that the employment creation from renewable energy and energy efficiency can be compared with the job losses arising from phasing out coal-fired power generation in the Hunter region.

Table 24 Total direct and indirect jobs created in renewable energy, energy efficiency and co-generation in the Hunter and NSW in a 2020 renewable energy scenario

Hunter region	RE direct jobs	EE direct jobs	Indirect jobs	Total Jobs
Scenario 1: Hunter as a self-sufficient regional energy centre				
Assume region generates 100 per cent of electricity for local use (23 per cent of NSW electricity)				
No Australian manufacturing in RE	2,760	690-1,340	3,500-4,000	6,950-8,100
Assumes renewable sector manufacturing for Hunter region only	2,940	690-1,340	3,700-4,200	7,300-8,500
Assumes renewable sector manufacturing for all of NSW	3,680	690-1,340	4,400-5,000	8,800-10,000
Scenario 2: Hunter as a NSW energy export centre				
Assumes region generates 40 per cent of NSW electricity				
No Australian manufacturing in RE	5,400	690-1,340	5,700-6,300	11,800-13,000
Assumes renewable sector manufacturing for Hunter region only	5,780	690-1,340	6,100-6,700	12,600-13,800
Assumes renewable sector manufacturing for all of NSW	6,320	690-1,340	6,700-7,200	13,700-14,900
Total NSW Employment In RE and EE				
Assumes 100 per cent of electricity from renewable energy or co-generation				
No Australian manufacturing in RE	17,100	6,150-11,920	38,000-42,900	61,400-72,000
NSW manufacture of 36 per cent of wind, 20 per cent of PV, and 100 per cent of Solar thermal	18,100	6,150-11,920	39,000-43,800	63,200-73,800

Notes:
1)When onshore manufacturing is included, it assumes 100 per cent of solar thermal, 36 per cent of wind, and 20 per cent of PV.
2) Solar thermal (Hunter region): 70 per cent of construction work and all of the O&M is assumed to occur outside the Hunter. Jobs are included in ‘rest of NSW’.
3) Co-generation all fuel collection and distribution employment are assumed to occur outside the Hunter. These jobs are included in ‘all of NSW’.

We use the same input-output methodology as in Section 3 (ABS, Input-Output Tables 2001-02), but this time to calculate indirect job creation from switching to a renewable industry in the Hunter, see Table 24. Results show that indirect job flows from creating jobs in the renewable industry exceed those which result from closing down the coal fired power stations. If the whole of NSW is taken into account, job creation including indirect effects would exceed the jobs lost from a shut down of the entire coal mining sector.

In Scenario 1, where the Hunter generates electricity for use within the region only, indirect job creation ranges between 3,500 direct jobs in the Hunter (39,100 in NSW) if no renewable energy manufacturing occurs on shore, and the lowest estimates for energy efficiency job creation are valid. The maximum is 5,000 indirect jobs created if the Hunter is the site for manufacturing the whole of the NSW renewable energy industry, and the higher estimate for energy efficiency jobs is correct (44,900 jobs in NSW). Under the NSW scenario it is predicted that direct employment will result in the oil and gas sectors. These are highly productive sectors, having very large average products (ratio of GDP to employment), thus a lot of indirect employment results from each job created in this sector.

In Scenario 2, it is estimated at minimum 5,700 indirect jobs will be generated within the region, and the maximum is 7,200 indirect jobs. Thus between 38,000 and 43,800 direct jobs are created in the whole of NSW, including the Hunter, in each scenario.

The above analysis shows that developing a renewables industry in the Hunter is a viable alternative to the closure of the coal fired generation in the Hunter. Looking at the various scenarios the results suggests that for Scenario 1 and Scenario 2 direct employment creation equals indirect.

The creation of the renewable energy and energy efficiency industries will result in a minimum 6,950 direct and indirect jobs (and a maximum of 10,000 jobs) for Scenario 1: *Hunter as a Self-Sufficient Regional Energy Centre* where the Hunter generates 100 per cent of electricity use within the region (23 per cent of NSW electricity).

Looking at Scenario 2: *Hunter as a NSW Energy Export Centre* where the Hunter generates 40 per cent of NSW electricity total jobs range between 11,800 and 14,900.

Clearly the job creation potential of renewable energy for the Hunter (in both the 'Self-Sufficient Regional Energy Centre' Scenario and 'Exporting Centre' Scenario), out-weighs the losses of the coal fired power generation sector, with job losses dwarfed by the job creation potential of the new industries.

In the Hunter Region 1,300 people are currently employed in the coal-fired electricity industry, with a further 2,337 employed indirectly, a total of 3,637. This is well below the job creation within the Hunter in the new industries under both Scenarios, and even further below the job creation in renewable energy for the whole of NSW. For Scenario 1 in the Hunter (with no manufacturing) the job gain is approximately 2.5 fold the loss, and for Scenario 2 the job gain is approximately 4 fold the loss. This job creation for NSW is almost 19 times the total job loss of jobs in the coal-fired power industry, with job created estimated to be between 66,700 (average of estimates for no Australian manufacturing) and 68,500 (average of estimates for NSW manufacturing).

5. Policy framework to enhance the Hunter as a renewable energy hub

5.1 Overview

The development of an integrated policy framework to both downsize the coal-fired power industry and simultaneously develop renewable energy capacities (production and employment) in the Hunter region is beyond the scope of this report. A thorough analysis is required to ensure that an appropriate policy mix and implementation strategy is designed such that the government responsibilities are clearly demarcated and understood.

In this Section, we provide a sketch of some of the policy components that would be necessary.

In general, the policy mix must attempt to address several basis issues, which include ensuring that:

- On-going technological progress via research and development to reduce the economic cost disadvantage associated with renewable energy is put in place;
- Barriers which prevent investment in and take-up of renewable energy are reduced;
- Market failures which hinder the development of renewable energies are reduced;
- Human capital development keeps pace with the investment in renewable energy capital to reduce the chance of skilled labour bottlenecks inhibiting innovation and implementation; and
- An appropriate safety net is in place to smooth the labour market transitions from fossil fuel based industries to renewable energy industries.

The urgency for a policy response

REN21 (2006: 10) provide a reasonable summary of the current outlook:

> (a) 'Global energy demand will continue to grow … unless major conservation and efficiency programmes are undertaken'; and
>
> (b) Current energy supply is dominated by fossil based technologies.
>
> With current price expectations and reserve projections, this domination will not dramatically change in the next decades unless renewable energy technologies become more cost competitive.

However, it is clear from the latest evidence available that the policy framework must provide results in the short- to medium-term rather than wait for the cost advantages to turn definitively in favour of renewable energy which may take us into the second half of this century. REN21 (2006: 10-11) respond to the argument that renewables will enjoy unambiguous cost advantages after 2050 (based on current projections) by saying that the 'analysis of the carbon constraints imposed by associated climate change on the other hand, show that major reductions in GHG emissions will be required from around 2030 to ensure that the long-term stabilisation of GHG concentration levels is manageable.'

Market failure

When the true costs and benefits are not reflected in the final price of a good or service then under- or over-investment in various related activities can occur. Economists call these under- or over-investments – externalities – and consider they represent the failing of the market mechanism to efficiently allocate resources.

Renewable energy development suffers from notable market failures which impose barriers to entry and distortions to investment. In relation to renewable energy, these externalities impact in various ways but we can summarise their effects in two ways: (a) they unduly inflate the costs of renewable energy relative to other sources of energy by failing to include the benefits the former and the true costs of the latter; and (b) generate barriers to entry which make it hard for rational investors to choose renewable energy (see Beck and Martinot, 2004).

Governmental responsibility

Given that market failures are a significant constraint on the development of viable renewable energy solutions, the role that government has to play is crucial. A reliance on the market alone will not redress these failures. REN21 (2006: 11) recognise this and place the responsibility for fast-tracking the solution in the governmental domain. The response will 'require dedicated action by governments on policies for economic incentives, technology transfer, private sector investment, and research and development.'

There is already a broad literature available on the types of policies that might be included in a renewable energy strategy. Some countries already deploy several of these policies. Table 25 is taken from Beck and Martinot (2004: Table 1, pages 2-3) and shows the breadth of policies that economists have propose as a multi-pronged vehicle to stimulate the increased reliance on renewable energy.

Any policy framework aimed at promoting the Hunter region as a renewable energy hub would involve a mix of the type of initiatives shown in Table 25. In the remaining part of this Section we consider some of the key initiatives that might be part of an overall policy response.

5.2 Some key policy initiatives for the Hunter

The following policy initiatives should be implemented as soon as possible as part of the just transition from fossil fuel to renewable energy industries in the Hunter region.

Redressing financial barriers

While the traditional financial institutions are slowly realising that renewable energy projects are worthy of inclusion in their lending portfolios, it remains the case that one of the major constraints facing start-up industries is the lack of access to capital. This general problem is compounded in the case of renewable energy by certain particular characteristics. Beck and Martinot (2004: 4) argue that:

> Even though lower fuel and operating costs may make renewable energy cost-competitive on a life-cycle basis, higher initial capital costs can mean that renewable energy provides less installed capacity per initial dollar invested than conventional energy sources. Thus, renewable energy investments generally

> require higher amounts of financing for the same capacity. Depending on the circumstances, capital markets may demand a premium in lending rates for financing renewable energy projects because more capital is being risked up front than in conventional energy projects.

If it can be shown that the net social benefits of renewable energy are significant then a prima facie case exists for government to use its financial capacity to share in the start-up risk of the industry. The Federal government could play a major role in redressing the finance market distortion that results in an under-investment in renewable energy. For more than a decade, the Federal government has been under spending in areas such as public infrastructure, education, skills development and many other areas that generate public benefit.

At the same time they have been riding the taxation wave associated with the commodity prices boom. The result has been growing budget surpluses. These surpluses have highlighted their lack of imagination and their failure to demonstrate leadership. They should have been providing, among other things, first-class infrastructure to foster new initiatives such as renewable energy.

In recent years, to prevent this fiscal austerity and revenue surge generating ever increasing budget surpluses the Federal government has been speculating in financial markets using the surplus funds to purchase financial assets both in domestic and international markets (for example, the Futures Fund). While not supporting the initial austerity, it is clear that these funds could be better placed in a renewable energy fund and used to finance start-up companies under the usual conditions of due diligence.

Removing pricing distortions

We noted above that if the true costs and benefits are not reflected in the final price of a good or service then under- or over-investment in various related activities can occur. The existence of externalities provides a solid foundation for government intervention into the pricing system to ensure that the costs of an activity reflect the true social cost rather than the narrow private cost that the company itself incurs. Available policy tools include taxation and subsidies.

Beck and Martinot (2004: 5) argue that

> The environmental impacts of fossil fuels often result in real costs to society, in terms of human health (i.e., loss of work days, health care costs), infrastructure decay (i.e., from acid rain), declines in forests and fisheries, and perhaps ultimately, the costs associated with climate change. Dollar costs of environmental externalities are difficult to evaluate and depend on assumptions that can be subject to wide interpretation and discretion. Although environmental impacts and associated dollar costs are often included in economic comparisons between renewable and conventional energy, investors rarely include such environmental costs in the bottom line used to make decisions.

In this regard, the Federal government should include in its upcoming review of the taxation system, initiatives to ensure that damaging activities are more fully costed. The market would then respond to the changing relative costs of competing technologies and begin to divert investment funding into renewable energy industries.

Table 25 Summary of Renewable Energy Policies and Barriers

Policies	Description	Key barriers addressed
Renewable Energy Promotion Policies		
Price-setting and quantity-forcing policies	Mandates prices to be paid for renewable energy, or requires a fixed amount or share of generation to be renewable	High costs, unfavorable power pricing rules, perceived risks
Cost reduction policies	Reduces investment costs through subsidies, rebates, tax relief, loans, and grants	High costs, perceived risks
Public investments and market facilitation activities	Provides public funds for direct investments or for guarantees, information, training, etc. to facilitate investments	Transaction costs, perceived risks, lack of access to credit, information, and skills
Power grid access policies	Gives renewable energy equal or favorable treatment for access to power grids and transmission systems	Independent power producer frameworks, transmission access, inter-connection requirements
Transport Biofuels Policies		
Biofuels mandates	Mandates specific shares of transport fuel consumption from biofuels	Lack of fuel production or delivery infrastructure
Biofuel tax policies	Provides tax relief for biofuels	High costs
Emissions Reduction Policies		
Renewable energy set-asides	Allocates, or sets aside, a percentage of mandated environmental emissions reductions to be met by renewable energy	Environmental externalities
Emissions cap and trade policies	Allows renewables to receive monetary credit for local pollutant emissions reductions	Environmental externalities
Greenhouse gas mitigation policies	Allows renewables to receive monetary credit for greenhouse-gas emissions reductions	Environmental externalities
Rural Electrification Policies		
Rural electrification policy and energy service concessions	Rural electrification policy and energy service concessions	May heighten barriers of high costs, lack of fuel price risk assessment, unfavorable power pricing rules
Rural business development and microcredit	Rural business development and microcredit	May reduce barrier of inter-connection requirements, but heighten barriers of high costs, lack of fuel price risk assessment
Comparative line extension analyses	Comparative line extension analyses	May reduce barrier of subsidies, but heighten barriers of high capital costs and perceived risks

Source: Beck and Martinot (2004).

Table 25 Summary of renewable energy policies and barriers (continued)

Policies	Description	Key barriers addressed
Power Sector Restructuring Policies		
Competitive wholesale power markets	Allows competition in supplying wholesale generation to the utility network and eliminates wholesale pricing restrictions	May heighten barriers of high costs, lack of fuel price risk assessment, unfavorable power pricing rules
Self-generation by end-users	Allows end-users to generate their own electricity and either sell surplus power back to the grid or partly offset purchased power	May reduce barrier of inter-connection requirements, but heighten barriers of high costs, lack of fuel price risk assessment
Privatization and/or commercialization of utilities	Changes government-owned and operated utilities into private or commercial entities	May reduce barrier of subsidies, but heighten barriers of high capital costs and perceived risks
Unbundling of generation, transmission and distribution	Eliminates monopolies so that separate entities provide generation, transmission, and distribution	May provide greater incentives to self-generate, including with renewable energy
Competitive retail power markets	Provides competition at the retail level for power sales, including "green power" sales	May reduce barriers of high costs, lack of information, transaction costs
Distributed Generation Policies		
Net metering	Values renewable energy production at the point of end-use and allow utility networks to provide "energy storage" for small users	Unfavorable power pricing rules
Real-time pricing	Values renewable energy production at the actual cost of avoided fossil fuel generation at any given time of the day	Unfavorable power pricing rules
Capacity credit	Provides credit for the value of standing renewable energy capacity, not just energy production	Unfavorable power pricing rules
Interconnection regulations	Creates consistent and transparent rules, norms, and standards for interconnection	Interconnection requirements, transaction costs

Source: Beck and Martinot (2004).

Research and development

A major policy goal must be to reduce technology costs associated with renewable energy so that market mechanisms will push investment towards these activities. It is clear that renewable energy technologies (for example, wind-power and photovoltaic cells) have become significantly cheaper in recent years as investment in research and development has generated new production techniques and better materials. As the market begins to price these developments correctly (in part because regulation and taxation initiatives work to better "cost" fuel fossil technologies) larger multinational companies are likely to become involved in this renewable technologies which will further drive cost advantages in its favour.

Government can assist in this process by increasing the scale of research funding to universities and related institutions to conduct research and development. REN21 (2006: 3) argue that both R&D and educational initiatives are required to lower the costs of renewable energy technology.

The CSIRO Energy Centre in Newcastle is a major regional resource, whose funding for renewable energy and energy efficiency research needs to be sustained as a catalyst for local industry development. This would also apply for the University of Newcastle. The University has a long and distinguished record of conducting world-best research into coal technology which has reduced the costs of that industry significantly. A major funding boost for research and development in renewable energy and energy efficiency would boost its international reputation in these technologies and facilitate local industry development.

Skill development

Any growth strategy has to involve the development of human capital in addition to providing a suitable investment climate. The current parlous state of human capital development in Australia reflects the abandonment of an integrated skills development framework by the previous federal regime and the run-down of our principle educational and training institutions by federal and state governments. Australia suffers further from the lack of widespread private sector involvement in the skills development process.

The challenge is to revitalise our education and training institutions by increasing our investment in the training and skills of our population. Targeted initiatives in the area of renewable energy skills are desirable and would require improved Government/industry collaboration.

The destructive way in which the Technical and Further Education (TAFE) system is being forced into a competitive vocational education market while at the same time having its funding in real terms squeezed has to end. The Hunter TAFE system is ideally placed to offer new training courses in renewable energy, with linkages into schools and potential employers. A significant boost in funding is needed to support quality teaching, to attract students and engage employers.

Employment guarantees

There will be transitional pain involved in the winding down of fossil fuel industries and the promotion of the emerging renewable energy sector. While the regional stimulus to the education and training systems and the provision of enhanced public infrastructure on a local basis will provide expanding employment prospects, there will be a rise in unemployment if no further policy initiatives are introduced.

We advocate the introduction of a Job Guarantee to ease this transitional pain. Under the Job Guarantee policy, the government would continuously absorb workers displaced from private sector employment. The Job Guarantee employees would be paid the federal minimum wage and be entitled to the normal statutory entitlements of leave etc.

The costs of unemployment extend beyond the narrow concerns usually considered by orthodox economists. The rise and sustenance of mass unemployment acts as a form of social exclusion perpetrated against particular sections of the community, in general the young, the old, the poor and those lacking skills and education. The burden of unemployment is typically not shared evenly across the community.

An empirically based, experiential notion of human rights suggests that governments are violating the right to work by refusing to eliminate unemployment via appropriate policies. Unemployment is not compatible with fundamental human rights in that unemployment denies those affected access to income and hence participation in markets, it reduces the opportunity for advancement and stigmatises those affected, and violates basic concepts of membership and citizenship. Without the right to work, afflicted individuals are denied citizenship rights as surely as they were denied the right of free speech or the right to vote. As long as employment is not considered to be a human right, a portion of the community will be excluded from the effective economic participation in the community

The Job Guarantee underpins the following propositions:

- There should be a right to work
- This right should be a statutory right
- The State should bear the responsibility for implementing this right
- Access to work should not be conditional
- The right to work and a full employment policy are inexorably linked
- A full employment program, encompassing the right to work, can be implemented which also guarantees price stability.

What do we mean by the right to work? Those who wish to do so should be able to obtain paid full-time (or fractional) employment. This guarantee should be made by the State and it should be legally enforceable in much the same way as other rights. Should it be any work as designated by the State? No, those exercising their right to work should be given options as to the type of employment they wish to take up. What wage rates should they be paid? They should be paid minimum adult rates of pay and be accorded to same rights and conditions associated with full-time market employment (or pro rata) - holiday and sickness benefits, a safe workplace, protection against unfair dismissal. For how long should they be employed? Employees would remain as long as they wish while satisfying the standard conditions of employment. Those exercising this right could regard guaranteed jobs as a temporary step towards higher paid employment in the market sector.

The implications of a full employment policy are considerable. First, it would mean greater use of labour and capital resources, as mentioned the single most significant efficiency reform that could be implemented in Australia is the elimination of unemployment. The direct financial benefits to the economy would be enormous; as indicated, of the order of 10 per cent additional GDP every year. Second, it would mean fewer fluctuations in aggregate economic activity. By legislation the government would be forced to generate jobs for those who are made redundant by the private sector. Such a situation would offer greater certainty for investors in the private sector since investment decisions would be undertaken in an ongoing full employment economy. Third, the extent of exclusion, poverty and costs associated with unemployment will be significantly reduced. It would be a policy that facilitated social inclusion rather than social exclusion. Fourth, governments would have to approach other economic goals from a full employment context, not, as currently, assume a given rate of unemployment and attempt to stabilise prices or reduce the current account deficit at this unemployment rate. Full employment would be the default setting for policy. Fifth, employers would be forced to contemplate how to better utilise labour and how to raise labour productivity through investment in machinery, technology and training. There would no longer be the emphasis upon cost cutting, lower wages and static efficiency gains associated with surplus labour conditions.

The Job Guarantee is the synthesis between the right to work and a full employment policy.

Industry studies

The Productivity Commission describes itself on its WWW Home Page as

> the Australian Government's independent research and advisory body on a range of economic, social and environmental issues affecting the welfare of Australians. Its role, expressed simply, is to help governments make better policies in the long term interest of the Australian community (Productivity Commission 2008).

It is recognised that in its present guise the Productivity Commission is an orthodox economic rationalist body which has demonstrated hostility to the renewable energy industry (for example, its attitude to the MRET system). However, if there is an appropriate political commitment to renewable energy substitution then the bureaucratic machinery that supports the policy process has to be configured so that it delivers appropriate evidence-based analysis.

The global reality that massive industry restructuring is required to seriously address the climate change challenges thus requires a strategic approach in terms of industry policy. In this case, the Productivity Commission should be used to spearhead the task of understanding which industry initiatives will best serve the goals of the national innovation system within the overall environmental challenges.

Changes to the tariff structure and related industry support schemes have to be designed to encourage new investment in renewable technology which meets the environmental goals.

The decision has to be made as to whether we will be a producer or an importer of renewable energy production technologies. The policy framework needs to be informed by research to ensure investments are made which best suit our mix of human and other capital resources but still result in significant employment gains to the renewable energy sector in the Hunter.

Tripartite understandings

For a transition to be effective the policy framework must include tri-partite understandings between government (all levels), business and trade unions. The environment urgency has to be shared and an investment strategy designed which provide benefits to all.

Scale considerations

The initial scale of the renewable energy sector in the Hunter will be small. This makes it hard to achieve the same cost efficiencies that are available to larger scale producers. This problem has long been used to justify “infant industry” protection of industry.

A way of maximising the opportunities for local industry to grow in scale is to ensure there is a long-term commitment to the products being products. Government must ensure that the policy framework provides that long-term stability in the market environment facing the new players.

Scale disadvantages can be overcome, in part, by adopting an export strategy. Provision of first class public infrastructure including transport systems, port capacity and communication systems is crucial in this regard. Further, social infrastructure in the form of community development and adequate housing and recreation is required. Industry clusters and skilled labour will be attracted to the Hunter if the State and Federal governments work together to ensure this infrastructure is the best available.

6. Conclusion: When challenges and opportunities meet: a just transition

Concerns about the local environmental and social sustainability impacts of coal mining and coal-fired electricity generation, have combined with concern about climate change to focus the attention of many farmers, environmentalists, unionists and other residents of the Hunter region on the challenging issue of how to transform the region's current coal industry dependent economy to a more sustainable and climate-friendly economy.

A shift to sustainable renewable energy will have substantial benefits for the Hunter region and will make the region and Australia a leader in the global fight against the threat of climate chaos.

The shift would greatly assist the Hunter in diversifying its over-reliance on coal and revitalise the region's manufacturing industry.

The public health and environmental benefits are also substantial - such a move would involve a significant reduction in pollutants from coal plants within the region.

The Federal government has some policies which could be a powerful catalyst for change, but more needs more to be done in actively creating the regulatory and market environment for a shift to renewable energy in the urgent timeframe necessary.

Initiatives are needed that specifically target coal dependent regions such as the Hunter to assist a transition to a renewable energy economy, so the people of the region are not left behind in a carbon-constrained world. Skills development and training, income support, job guarantees, compensation, research, and infrastructure investment are all critical to a just transition. This transition will cost many millions, possibly billions of dollars, but a just transition is not an exorbitant demand: it merely addresses the need for fair treatment of coal communities, rather than welfare subsidies to coal corporations.

The Hunter region's coal-fired electricity generation industry could be phased out relatively quickly if government takes the initiative and investment is shifted to alternative clean energy technologies. The precise details of the process and timing of transforming the Hunter economy from coal dependency requires further study.

However, this report shows that the energy security can be achieved in the Hunter and NSW by investment in energy efficiency and renewable energy, with gas as an interim fuel. A switch to clean, energy-based economy in the Hunter, models what is possible across Australia and globally. A transition to a renewable energy economy will provide thousands of new Green jobs while protecting local and global environments. A just transition can ensure that the costs of change do not fall on vulnerable workers and communities, but can help achieve genuine sustainability grounded in ecological health and social justice for all.

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Endnotes

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[2] An annual decline of 8 per cent amounts to nearly 50 per cent employment reduction in the 7 year period.

[3] Business as usual is taken as the medium electricity growth scenario from the 2007 Transgrid Annual Planning Report (Transgrid. 2007), which has electricity growth of 1.6 per cent per annum.

[4] Business as usual emissions (with current policy measures) are predicted to rise by 120 per cent by 2020 from 1990 levels of 554 million tonnes (665 million tonnes). A 40 per cent reduction relative to 1990 would equal emissions of 330 million tonnes.

[5] NFFE (2003) preliminary modelling looked at 3 year and 6 year payback periods. Subsequent work (EMET 2004 and GWA 2004) looked at 4 and 6 year paybacks in the residential sector, but did not allow combined payback, so that individual measures with longer than 6 years were disallowed. EMET (2004) looked at combined 6 year paybacks for the commercial sector, and Energetix (2004) looked at combined 4 year paybacks in the industrial sector. The 4 year payback uses the later work, with the percentage applied to 2020 BAU sectoral energy use. The only deviation is that the commercial sector savings include half of the business as usual savings in the commercial energy use anticipated in EMET, as these have not occurred to date. The 6 to 9 year payback for residential and commercial energy uses the NFFE (2003) assessment for high energy efficiency potential, adjusted downwards to preserve the same ratio as between the NFFE (2003) 3 year projected savings and the later work. Industrial energy efficiency has used the Energetix (2004) savings for 1-4 year payback projected to 9 years.

[6] The business as usual growth in electricity consumption in aluminium smelting is taken as 6.1 per cent between 2005 and 2020, from ABARE (2007).

[7] MWp refers to peak megawatt capacity of a plant under consideration, which is the chief determinant of installation employment (it will be no less labour intensive to install solar in a less sunny spot, for example). However comparing employment according to MWp may be misleading, as actual generation varies considerably according to technology. Actual generation is determined by the capacity factor (CF) of the plant, where CF = (nameplate generation in MW x total hours in the year) / actual generation in MWh. A coal power plant may have a capacity factor of 80 per cent (and be closed for maintenance the other 20 per cent of the time), a residential solar array in Australia will have on average a CF of 15 per cent, while Australian wind farms have average CF of 35 per cent. MWa equals MWp multiplied by the capacity factor for that technology.