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ELECTRICAL TRADES IN THE GREEN ECONOMY: ANALYSIS OF THE NSW ENERGY SECTOR TO 2020

2011

ELECTRICAL TRADES IN THE GREEN ECONOMY

Analysis of the NSW energy sector to 2020

Final

For the Electrical Trades Union (ETU) and the National Electrical and Communications Association (NECA), NSW and ACT Branches

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Disclaimer

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Executive Summary

The past five years has seen a significant rise in scientific, political and public policy attention paid to the issue of climate change, and it is widely recognised that the Australian electricity sector will need to undergo a structural shift away from carbon intensive electricity. There has been much speculation about the likely cost and employment implications surrounding such a transition.

The NSW and ACT branches of the Electrical Trades Union (ETU) and the National Electrical and Communications Association (NECA) commissioned the Institute for Sustainable Futures at the University of Technology Sydney to examine the effect of a transition to low carbon energy supplies on jobs in the electrical trades. Despite many studies focussing on broad employment trends, very little detail is available on how specific occupations may be affected.

The report examines the effect of a transition to low carbon electricity supplies on overall and electrical trade employment in the energy sector, defined here as electricity supply and energy efficiency, over the next decade to 2020.

Methodology

The report first presents a business as usual scenario for electricity generation in NSW, and three scenarios with progressively steeper carbon reductions. Total employment in the energy sector is projected for the four scenarios by using a series of employment multipliers, and the projected electrical generation and capacity. Only direct employment is included, namely jobs in construction, manufacturing, operations and maintenance, and fuel supply associated with electricity generation. Jobs in transmission and distribution are not included, as to a great extent these jobs will be unaffected by changes in the electricity supply source, unless there is a very significant shift to distributed generation.[1] An indicative result for energy efficiency jobs is calculated, although the associated uncertainty is even greater than for electricity supply. Indirect employment, which includes flow-on jobs that indirectly support the low carbon products and services, is not included. Numbers of indirect jobs provide little information on occupation specific impacts. Thus the job figures reported in this research are likely to be much lower than reports that also cover indirect employment.

A desk study and industry consultation was undertaken to determine the proportion of employment in each technology for electrical trades.

The energy scenarios

We constructed four scenarios for electricity consumption and supply in NSW and the ACT to cover business as usual and three progressively lower carbon futures reflecting possible policy settings. The four scenarios may be summarised as follows:

- **Scenario 1: Business as usual**. The current projections for NSW electricity consumption and generation, including current legislation such as the Commonwealth 20% Renewable Energy Target, but not including an emissions trading scheme.
- **Scenario 2: 5% Emissions Reduction.** Australia's current unconditional Commonwealth political commitment at the international level.
- **Scenario 3: 25% Emissions Reduction.** Australia's current conditional Commonwealth political commitment at the international level, if there is ambitious international action.

[1] "Distributed generation" refers to smaller scale electricity generation located close to the electricity user, as opposed to the traditional model of "centralised generation".

- **Scenario 4: 25% Emissions Reduction plus 30% Renewable.** Same as Scenario 3 with a 25% national emissions reduction, plus an increased Renewable Energy Target (RET), so that NSW achieves 30% of electricity from renewable energy by 2020[2].

Results – overall employment effects

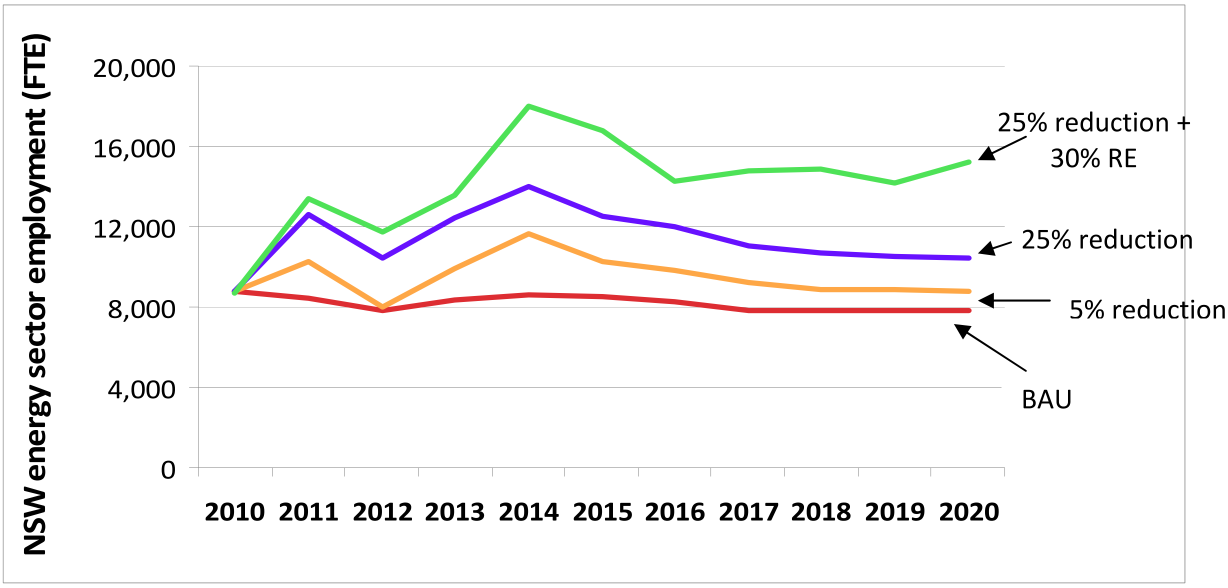
There are 8,800 jobs in the NSW energy sector at present according to these calculations. Jobs fall in the business as usual case, by about 11% by 2020, as shown in the table below. Job losses are lower in all the low carbon scenarios, and job numbers increase by 18% and 74% in the two lowest carbon scenarios, Scenario 3 and 4 respectively. There is a significant restructure in Scenario 4 (25% emissions reduction plus 30% renewable energy), with renewable energy accounting for 41% of energy sector jobs, compared to only 22% now.

Energy sector jobs here are defined as jobs in electricity generation, energy efficiency, and the coal mining associated with electricity generation, but do not include jobs associated with coal exports, nor jobs in transmission and distribution of electricity. These are not expected to be significantly affected by the energy scenarios modelled.

NSW energy sector jobs at 2010 and 2020, all scenarios, by sector

	2010 jobs (FTE)	2020 jobs (FTE)			
	All scenarios	Scenario 1: BAU	Scenario 2: 5% reduction	Scenario 3: 25% reduction	Scenario 4: 25% reduction and 30% RE
Coal	4,874	4,751	4,114	3,638	2,750
Gas	397	374	649	1,012	1,244
Renewable	2,016	1,167	1,251	1,251	6,239
Efficiency	1,500	1,500	2,773	4,517	4,981
Total	**8,787**	**7,792**	**8,787**	**10,418**	**15,214**

Total NSW employment in electricity supply and energy efficiency, 2010 to 2020



[2] Note that achieving 30% of renewable electricity in NSW is likely to require a national RET of 35% - 40%, as the present 20% RET is only anticipated to bring NSW renewable generation to 10%.

The figure above shows total NSW energy sector jobs for each scenario over the decade to 2020.

- In **Scenario 1 – Business as Usual**, energy sector jobs fall from 8,700 to 7,800 by 2012, climb back up to 8,600 in 2014, and then fall back to 7,700 by 2017 and remain there until 2020. Energy sector jobs in this analysis include electricity supply, associated jobs in fuel supply, and energy efficiency.
- Job losses in the energy sector are lower in all the carbon reduction scenarios (Scenarios 2-4).
- In **Scenario 2 - 5% emissions reduction**, energy sector jobs fluctuate between 2010 and 2014, falling from 8,800 in 2010 to 8,000 by 2012. Job numbers reach 11,700 in 2014, and then fall gradually back to present levels (8,800) by 2020.
- In **Scenario 3 - 25% emissions reduction**, energy sector jobs increase steeply to 12,600 in 2011, then drop again to 10,400 in 2011. Job numbers reach 14,000 in 2014, and then fall gradually back to 10,400 by 2020, an 18% increase from today.
- In **Scenario 4 - 25% emissions reduction and 30% renewable electricity**, energy sector jobs increase steeply to 13,400 in 2011, then drop to 11,800 in 2011. Job numbers climb to reach 18,000 in 2014, and then fall gradually back to 15,000 by 2020, a 74% increase from today.

It should be emphasised that indirect jobs are not included in these figures. US and Australian jobs studies cite total jobs (direct plus indirect jobs) as approximately 2 to 2.25 times higher than direct jobs.

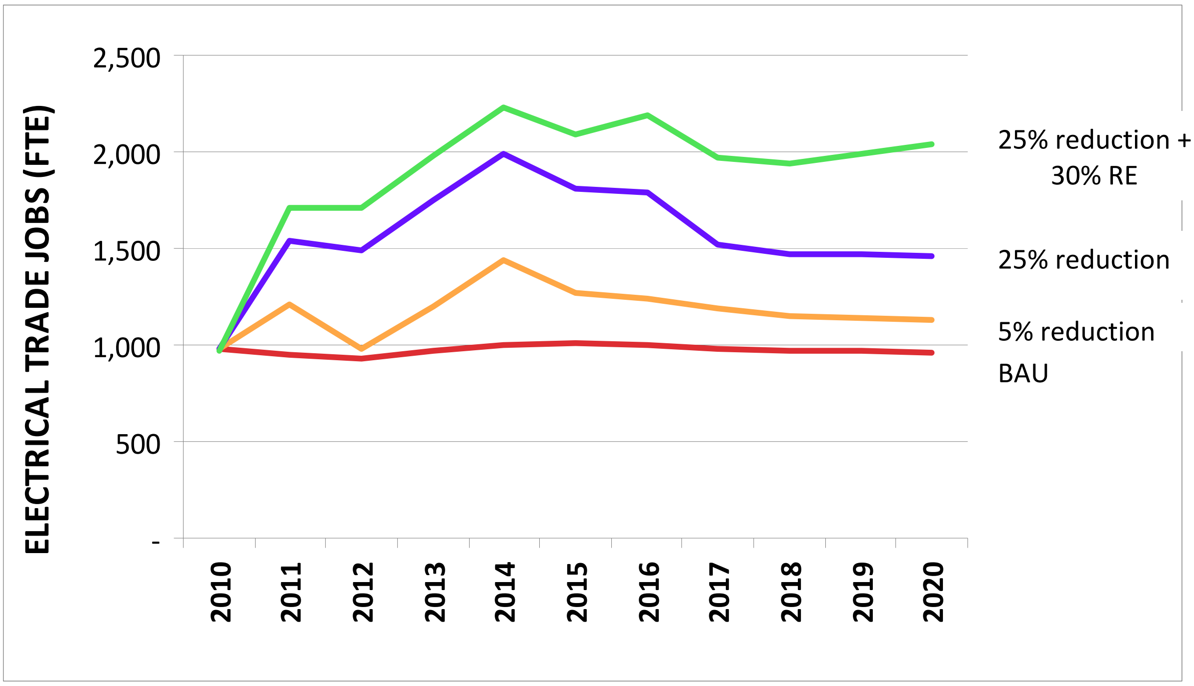
Results – electrical trades in a low carbon energy sector

- In **Scenario 1: Business as Usual**, electrical trade jobs in electricity supply, associated fuel supply, and energy efficiency stay nearly constant at just under 1,000.
- Electrical trade jobs increase in all the carbon reduction scenarios (Scenarios 2-4).
    - In **Scenario 2 - 5% emissions reduction**, electrical trade jobs fluctuate between 1,000 and 1,200 until 2012. Jobs then climb to 1,400 in 2014, before falling back to 1,100 by 2020.
    - In **Scenario 3 - 25% emissions reduction**, electrical trade jobs increase to 1,500 by 2011, then fall back slightly before climbing 1,800 in 2014. After this jobs gradually decrease to 1,500 by 2020.
    - In **Scenario 4 - 25% emissions reduction and 30% renewable electricity**, electrical jobs increase to 1,700 by 2011. Jobs climb to 2,200 in 2014, then fall back to 2,000 by 2020, more than double the numbers in 2010.

This analysis identified just fewer than 1,000 electrical trades people currently employed in the energy sector (defined as electricity supply, fuel supply, and energy efficiency). This compares to just over 35,000 electrical trades jobs in NSW at the 2006 census, so it is not a large percentage of current electrical employment.

The figure below shows the growth in electrical trades jobs in all scenarios to 2020. The overall effect on electrical trades of a transition to low carbon parallels the effect on total job numbers. Under business as usual, job numbers fall slightly by 2020, and as the energy scenarios become progressively lower carbon, job numbers increase. In the lowest carbon scenario, Scenario 4, with a 25% emission reduction and 30% renewable electricity supply, electrical trades employment doubles, and is 2,000 by 2020.

Electrical trades employment in electricity supply and energy efficiency, 2010 - 2020



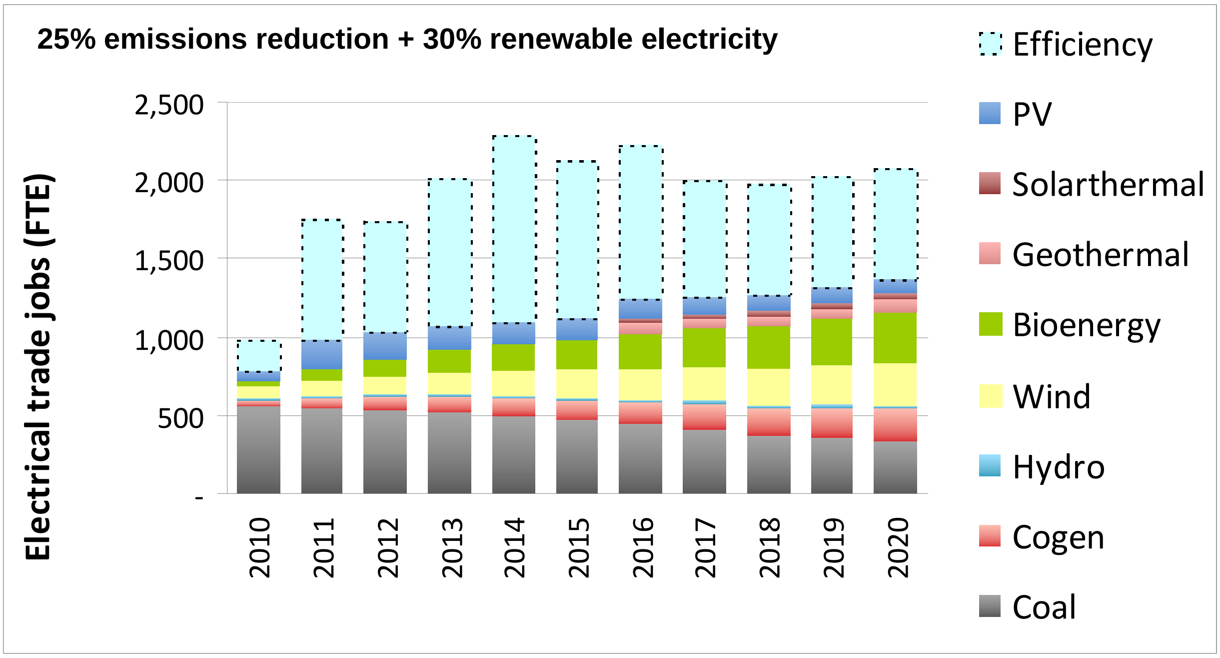
Electrical trades energy sector jobs at 2010 and 2020, by technology

	2010 jobs (FTE)	2020 jobs (FTE)			
	All scenarios	**Scenario 1: BAU**	**Scenario 2: 5% reduction**	**Scenario 3: 25% reduction**	**Scenario 4: 25% reduction and 30% RE**
Coal	556	524	451	425	337
Gas cogeneration	36	44	64	148	206
Hydro	15	18	18	18	18
Wind	77	116	116	116	272
Bioenergy	41	52	52	52	324
PV	59	17	40	40	90
Efficiency	192	192	389	660	660
Total	**976**	**963**	**1,130**	**1,458**	**2,038**

The table above shows the electrical trade employment for each technology at 2010, and then for each scenario at 2020. Note that wind energy, gas cogeneration and energy efficiency show the strongest growth promise for electrical trades in the moderate low carbon scenarios (Scenarios 2 and 3).

When the structure of the electricity sector changes are greatest, in Scenario 4 (25% carbon pollution reduction plus 30% renewable electricity), electrical employment shows a marked increase. The figure below gives a more detailed illustration of the electrical trade jobs by technology annually from 2010-2010 for Scenario 4. Coal generation falls from 57% of electricity supply employment for electrical trades to only 17% by 2020. Wind energy, and cogeneration demonstrate strong growth as was the case in Scenarios 2 and 3. However in Scenario 4 electrical trades jobs also grow strongly to 2020 in bioenergy and solar PV. As in Scenarios 2 and 3, energy efficiency shows particularly strong growth, accounting for 32% of the estimated electrical trades employment in electricity supply by 2020, up from 20% in 2010.

Electrical trades employment by technology, lowest carbon scenario, 2010 - 2020



Training needs
From a preliminary desktop analysis and industry consultation, notable gaps in continuing development (CPD) training available to electricians appear evident in the areas of:

- Large-scale commercial photovoltaic systems (including gaps in technical and project management skills).
- Wind and micro-hydro energy generation systems.
- Energy efficiency, particularly hot water systems (some topics are covered by CPD, but in limited depth).
- Energy auditing and management for commercial and residential buildings.
- Home automation.
- Several companies interviewed also stated the need for training in general OH&S and site management.

Conclusion
This research suggests that under a “business as usual” scenario, both total employment and employment in electrical trades in electricity supply and energy efficiency will decline towards 2020. However, this study finds that both total energy sector employment in NSW and jobs in electrical trades increase with progressively lower carbon energy scenarios.

In the business as usual case, NSW jobs in electrical trades fall by 7% by 2020, while in the 25% carbon reduction case (Scenario 3) we see electrical trades jobs increase by 50%. In the 25% carbon reduction with expanded renewable energy (Scenario 4, the lowest carbon scenario), we see a 110% increase in electrical trade jobs.

This analysis, based on the best currently available data, indicates that in terms of total employment the electrical trades are likely to benefit significantly from a transition to a low carbon economy. Employment growth is strongest in the scenarios showing the most significant cuts in carbon pollution. The expansion of renewable technologies brings the most significant benefits to electrical trades.

The distribution of employment within the electricity supply sector changes significantly in the low carbon scenario with enhanced renewable energy (Scenario 4). Coal generation falls from 57% of electricity supply electrical trade employment to only 17% by 2020. Wind energy, bioenergy, cogeneration, and solar PV all demonstrate strong growth for electrical trades jobs. Energy efficiency shows particularly strong growth, accounting for 34% - 45% of the estimated electrical trade employment in the low carbon scenarios (Scenarios 2-4), up from 20% in 2010.

However, in order to benefit from this potential increase in employment, the industry will need a labour force and service providers who are trained and qualified across the range of skills associated with the emerging technologies, notably renewable energy and energy efficiency. Our preliminary analysis has identified possible gaps in the continuing development training available to electricians in photovoltaic systems, wind and micro-hydro energy generation systems, Energy efficiency, Energy auditing and management for commercial and residential buildings, home automation and, possibly OH&S and site management.

Areas for further research
In order to obtain the most out of this research and to assist in building political momentum for pursuit of a low carbon future through delivery of positive employment outcomes, the team in conjunction with ETU and NECA identified the following priority areas of further research:

- Further investigation of the changing *nature* of the jobs in electrical trades the driving forces behind these changes. For example, newly available products in residential and commercial construction, which are changing the trade labour requirements on site. Focussing solely on job numbers is a good platform to establish gross trends, but risks simplifying the more complex underlying effects.

- Detailed research on specific training needs in the trades to meet the requirements of the emerging green economy, including both basic trade qualification and Continuing Professional Development (CPD) courses.

- Investigation of the potential impact of local low carbon product design and manufacturing on jobs and the balance of trade, as well as the policy implications that flow from this.

- Investigation of the actual and potential industry implications of the trend towards less qualified tradespeople installing low carbon energy technology, such has been reported in the solar PV industry in interviews conducted as part of this research.
- *Indirect* (flow-on) job implications of low-carbon future energy sector scenarios and policies (this study was restricted to quantifying *direct* jobs).
- Detailed profiling of the jobs and skills associated with energy efficiency products and services, across a broad range of private sector providers, including areas such as facilities management. This research indicated that an increasing focus on energy efficiency is likely to lead to more jobs for electricians working outside their traditional capacity (for example in energy efficiency sales and project management).

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Abbreviations

ABS	Australian Bureau of Statistics
ANZSIC	Australia and New Zealand Standard Industry Code
AQF	Australian Qualifications Framework
CMI	Construction, installation, manufacturing and development
CPRS	Carbon Pollution Reduction Scheme
GPI	Greenpeace International
EREC	European Renewable Energy Council
ETU	Electrical Trades Union
FTE	Full-Time Equivalent
GW	Gigawatts
GWh	Gigawatt hours
HVAC	Heating, Ventilation and Air Conditioning
MD	Mandatory Disclosure
MW	Megawatts
MWh	Megawatt hours
NECA	National Electrical and Communications Association
NREL	National Renewable Energy Laboratory
O&M	Operation & Maintenance
ppm	parts per million (used with reference to atmospheric carbon dioxide concentration)

1 Introduction

The past five years has seen a significant rise in scientific, political and public policy attention paid to the issue of climate change. In 2010, after the unsuccessful international efforts to secure a binding multilateral legal agreement at the Copenhagen Conference, Australia is still in the process of planning its approach to the dramatic reduction needed in national carbon dioxide emissions. It is widely recognised that the Australian electricity sector will need to undergo a large structural shift away from carbon intensive centralised coal-fired electricity generation, towards energy efficiency and low or no carbon gas or renewable generation.

There is much speculation about the likely cost and employment implications surrounding such a massive shift in the electricity sector. It is important that industry and professional groupings endeavour to understand the potential changes their industries may undergo as a result of these changes, in order to manage the transition and realise an optimal outcome.

Despite some research in recent years focussing on broad employment trends as a result of the renewable energy and other developments in the area of carbon emissions reduction, very little work has been done to analyse the occupation-specific impacts of this phenomenon at the level of and/or qualification. So while many results point to increasing job numbers overall as a result of increased renewable energy uptake,[e.g 1,3] for example, there is little detail of who those jobs are for.

In an effort to better understand the implications of a low carbon economy for jobs in the electrical trades, the NSW and ACT branches of the Electrical Trades Union (ETU) and the National Electrical and Communications Association (NECA) have commissioned the Institute for Sustainable Futures at the University of Technology, Sydney to research and compile this report.

This report analyses overall and electrical trade employment in the “energy sector”, defined in this report as electricity supply and energy efficiency, using four modelled energy scenarios to understand a range of possible low carbon futures. Note that jobs in electricity transmission and distribution are not included, as job numbers in this area are not expected to change significantly in any of the scenarios.

The proportions of electrical trades in the different electricity technology sectors and energy efficiency are needed in order to convert overall energy sector employment impacts to the effects on these trades. Industry consultation was undertaken to estimate the breakdown into electrical trades and other occupations.

A large part of the interest the ETU and NECA have in commissioning this research is to understand the skills and training implications associated with this transition to a low carbon economy, to adapt and better prepare their Continuing Professional Development (CPD) course needs to address any identified training deficiencies.

In order to achieve these multiple aims, the report adopts the following structure:

Section 2 outlines the methodology used in this research.

Section 3 explains the various low carbon scenarios to 2020 that underpin the analysis.

Section 4 gives the results for *overall* NSW electricity supply and energy efficiency jobs for the three low carbon scenarios and business as usual.

Section 5 presents results of the industry consultation, with indicative breakdowns of the occupations involved in delivering renewable energy and energy efficiency, with a specific focus on electrical trades.

Section 6 gives the current and historic employment of electrical trades in NSW, and the numbers in different industries.

Section 7 presents the electrical trades employment in NSW electricity supply and energy efficiency jobs for the three low carbon scenarios and business as usual (total job projections are converted to electrical trades employment).

Section 8 investigates existing and potential gaps in training resources to prepare electrical trades for a rapid transition to a low carbon economy.

Section 9 draws together the analysis and makes *conclusions* on the implications of a low carbon economy for electrical trades.

Section 10 contains **References** for this research while the more detailed methodological and other information underpinning this research can be found in the **Appendices**.

2 Methodology

This section briefly explains the approach taken to the various steps involved in: modelling the employment implications of the energy sector scenarios; analysis of the status and projection of electrical trade job implications; and the training needs analysis.

2.1 Overview

Total employment in the electricity sector is projected for four scenarios by using a series of employment multipliers and projected electrical generation and capacity. Only direct employment is included, namely jobs in construction, manufacturing, operations and maintenance, and fuel supply associated with electricity generation. Jobs in transmission and distribution are not included, as to a great extent these jobs will be unaffected by changes in the electricity supply source, unless there is a very significant shift to distributed generation.

An indicative result for energy efficiency jobs is calculated, although the associated uncertainty is even greater than for energy supply.

A desk study and industry consultation was undertaken to determine the proportion of employment in each technology for electrical trades.

The inputs to the total employment projections are as follows:

- ***Installed electrical capacity and generation by technology***, at yearly intervals from 2010 to 2022[a] (see *Section 3 NSW energy scenarios)*.
- ***Employment factors*** which give the number of jobs per MW for each technology in construction and manufacturing, operations and maintenance, and fuel supply. These are the key inputs to the analysis.
- ***Decline factors***, or learning adjustment rates, for each technology. These reduce the employment factors by a given percentage per year, to take account of the reduction in employment per MW as technologies mature.
- ***Local manufacturing percentages*** are used to determine the proportion of manufacturing jobs associated with each technology which occur within NSW.
- ***Energy efficiency employment:*** a baseline employment figure for energy efficiency is included from a 2009 study by the Clean Energy Council[1], which is kept constant in all scenarios. Additional efficiency employment is calculated from the reduction in electricity generation in GWh in each scenario compared to business as usual (Scenario 1). The calculation is based on a factor for employment per GWh saved relative to business as usual.

[a] Electricity supply capacities are projected to 2022 in order to calculate construction employment in 2019 and 2020.

The calculation of energy supply jobs is summarised in the equations below:

Total jobs = manufacturing jobs + construction jobs + operations and maintenance (O&M) jobs + fuel supply jobs, where:

Manufacturing jobs	=	MW installed per year	**x**	Manufacturing employment factor	**x**	decline factor $^{\text{(no.of years)}}$	**x**	% local manufacturing
Construction jobs	=	MW installed per year	**x**	Construction employment factor	**x**	decline factor $^{\text{(no.of years)}}$		
O&M jobs	=	Cumulative capacity	**x**	O&M employment factor	**x**	decline factor $^{\text{(no.of years)}}$		
Fuel supply jobs	=	Electricity generation	**x**	Fuel employment factor	**x**	decline factor $^{\text{(no.of years)}}$		

Limitations

Employment numbers are indicative only, as a large number of assumptions are required to make calculations. Quantitative data on present employment based on actual surveys is extremely difficult to obtain, so it is not possible to calibrate the methodology against time series data, or even against the current situation. However, within the limits of data availability, the figures presented are indicative of employment levels under the four scenarios.

2.2 Employment factors

Electricity sector employment is calculated by using employment factors, which give the jobs created per MW of capacity or per GWh of generation.

Only **direct** employment in development, construction, manufacturing, operations and maintenance, and fuel supply is included in this study.

Operations and maintenance (O&M) and fuel supply jobs are expressed in terms of jobs per MW and per GWh respectively, and are ongoing jobs which fluctuate with the capacity or the generation totals.

Construction, installation, manufacturing and development (CMI) are expressed in terms of job years per MW installed. Some studies (for example Kammen et al, 2004[2]), convert construction jobs to jobs per GWh over the lifetime of the facility, in order to compare the job creation potential of different technologies. While this is theoretically sound, it does not reflect physical reality, as construction employment occurs before the power station comes online, not during operation. For example, a coal plant with a forty year lifetime will create a large number of construction jobs for a ten year period before commencing generation, and a wind farm will create construction jobs for 1- 2 years prior to generation.

In this study, it is assumed that construction and manufacturing employment occurs for the five years prior to generation in the case of coal and hydro, for two years prior to generation in the case of gas, wind, bioenergy, geothermal, or solar thermal, and for one year prior to generation in the case of PV.

The employment factors are the most important inputs to employment calculations. It is difficult to obtain accurate data, as information is patchy, even for well established industries such as coal and gas generation.

Wherever possible, industry employment factors were used, or factors were calculated from employment and production data. For a discussion of the wide variation in employment factors, see *Energy sector jobs to 2030: a global analysis,* (Rutovitz and Atherton 2009).[3]

The factors presented in Table 1 are those used in this study. These factors are further adjusted to:

- Take account of the proportion of manufacturing which occurs locally by using local manufacturing percentages (see section 2.4).
- Take account of the reduction in technology costs and the corresponding fall in employment per MW by using decline factors (see section 2.3).

Table 1 Employment factors used in NSW analysis[1]

	Construction/ installation person years/ MW	**Manufacturing**	**Operations & maintenance** jobs/MW	**FUEL** jobs/ GWh	
Coal	6.2	1.5	0.2	0.04	Note 1
Gas (except cogen)	1.4	0.1	0.1	0.04	Note 2
Hydro	5.4	0.5	0.22		Note 3
Wind	2.5	12.5	0.16		Note 4
Bioenergy (and gas cogen)	2.0	0.1	0.95		Note 5
Geothermal	3.11	3.3	0.74		Note 6
Solar thermal	6	4	0.3		Note 7
PV	29	9	0.4		Note 8
Energy efficiency	2.08 jobs per GWh				Note 9

Notes

1. **Coal**
   Construction and manufacturing data is from the National Renewable Energy Laboratory (NREL) publicly available JEDI model[4], downloaded 30/4/09. Default values from the model were used for all variables.
   O&M data is for NSW power station employment (including subcontractors)[5]
   Fuel multipliers were calculated from ABS employment data[6], Australian coal use for electricity[22], and total Australian coal production[7].

2. **Gas**
   Construction, manufacturing, and O&M data is from the NREL publicly available JEDI model[4], downloaded 30/4/09, with default values used for all variables.
   Fuel multipliers were calculated from Australian Bureau of Statistics employment data[8], and gas production and consumption for electricity generation from ABARE Energy statistics[9]. Gas cogeneration is assumed to have the same construction and O&M as bioenergy, following the industry consultation for this report.

3. **Hydro**
   The employment factor for construction, installation and manufacturing is derived from the Clean Energy Council 2009 report (note that the indicator listed in Table 3.5 of the CEC report is 3.59 jobs per MW, but includes only domestic labour; this has been adjusted using the proportions of offshore and domestic labour in Chart 3.10 of the report).
   Operations and maintenance are calculated from ABS data for hydro generation employment[10], and the data for total hydro capacity from ESAA 2009 [22].

4. **Wind**
   Construction, manufacturing, and installation are from the European Wind Energy Association 2009 report[11], confirmed by industry consultation in this study. The factor for operations and maintenance is taken from the industry consultation results.

5. **Bioenergy**
   Only bioenergy for power generation is considered in this analysis (it does not include bio-fuels). Employment factors are taken from a Canadian study[12]. There is no multiplier given for fuel, as bioenergy covers everything from landfill or sewage gas to agricultural residues. For a large bioenergy contribution, which would include energy crops, this is likely to underestimate the bioenergy employment.

6. **Geothermal**
   All factors are from the US Geothermal Energy Association 2005 report[13].

7. **Solar thermal electricity**
   All factors are from the European Renewable Energy Council 2008 report[14].

8. **Solar PV**
   CMI factors are from the European Photovoltaic Industry Association 2008 report[15], and O&M factors are from Germany industry data[16]. Factors other than manufacturing are confirmed by the industry consultation.

9. **Energy efficiency**
   The factor for energy efficiency jobs additional to the base case, which contribute to reducing electricity consumption, are calculated from the factor for employment per GWh taken from the CEC 2009 report[1]. It is assumed that employment only occurs in the year the savings first appear. This factor is applied to however many GWh the low carbon scenarios save compared to business as usual.

2.3 Adjustment for learning rates – decline factors

Employment factors are adjusted to take account of the reduction in employment per unit of electrical capacity as technologies and production techniques mature. The learning rates assumed have a significant effect on the outcome of the analysis.

Industry decline values are used where available, but this is only the case for wind, solar thermal, and solar PV generation. For other technologies, the projected annual decline in cost for each technology is taken as a proxy value for the decline in employment. Cost declines will correspond to a reduction in employment, whether they result from greater efficiency in production processes, scaling up of technology, or as a direct result of more efficient working practices. Where industry decline factors are not available, they are derived from cost data for the Greenpeace

International (GPI) and the European Renewable Energy Council (EREC) Energy Revolution 2008 report[17].

Table 2, shows the decline factors from industry sources, and those derived from cost data. The decline factors from cost data for wind, PV, and solar thermal are shown for comparison but are not used in the analysis.

Table 2 Decline rates

	2010-20	Source
Coal	0.9%	GPI & EREC 2008 (cost data)[17]
Gas	0.4%	GPI & EREC 2008 (cost data) [17]
Bioenergy	1.0%	GPI & EREC 2008 (cost data) [17]
Hydro	0%	GPI & EREC 2008 (cost data) [17]
Wind	1.40%	Derived from EWEA 2009 [11]
PV	7.72%	EPIA 2008 [15]
Geothermal	2.5%	GPI & EREC 2008 (cost data) [17]
Solar thermal (electricity)	1.6%	GPI/ ESTELA 2009, page 62 [18]

2.4 Adjustment for manufacturing in the renewable energy sector

The proportion of manufacturing that occurs within NSW is estimated in order to calculate local jobs. It is assumed that 10% of manufacturing for coal, gas, and bioenergy occur within the state in all scenarios.

Table 10 shows the percentages of local manufacturing assigned to each renewable technology now and by 2020 (wind, solar PV, geothermal, and solar thermal) in each scenario. Where manufacturing proportions for the state change, it is assumed that growth is linear between 2010 and 2020.

The proportion of renewable manufacturing occurring in NSW in the expanded renewable scenario increases, reflecting the significantly higher deployment of renewable technologies.

Table 3 Proportion of renewable manufacturing in NSW by 2020 under different energy scenarios.

	All scenarios: 2010	Scenarios 1 (BAU), 2 (5% reduction) & 3 (25 % reduction): 2020	Scenario 4 (25% reduction and 30% renewable electricity): 2020
Wind	0%	0%	18% (1)
PV	20%	50% (2)	50%
Geothermal	20%	20%	30%
Solar thermal	20%	20%	30%

Note 1) This assumes tower and blade manufacturing is established in NSW.

2.5 Energy efficiency

This analysis uses the estimates for Australian employment in energy efficiency given in the Clean Energy Council 2009 report[1]. The report analysed current Australian energy efficiency policies and programs up to 2020, and estimated the associated employment. The estimates are indicative only, as the data on spending on which the employment calculations were based were themselves indicative, from the 2003 Sustainable Energy Agency of Victoria work under the National Framework for Energy Efficiency[19].

Table 4 Employment from energy efficiency in Australia, projection to 2020

Sector	Annual energy saved (2020 GWh)	Average annual capital cost ($M 2004-5)	Average annual direct installation employment (2009-20)	Job years per GWh
Residential	13,922	$1,411 m	2,253	**1.78**
Commercial	4,781	$415 m	1,708	**3.93**
Industrial	3,708	$141 m	270	**0.80**
Total	22,410	$1,967 m	4,231	**2.08**

From Clean Energy Council 2009,[1] Table 4.14

One quarter of the CEC estimate of the energy efficiency employment (a total of 4,231 jobs Australia wide) is assumed to occur in NSW. This is included in business as usual for this analysis, and in all three lower carbon scenarios. Further energy efficiency employment is calculated from the reduction in total electricity consumption in each scenario compared to the business as usual case, using the GWh employment factor from the CEC study.

The most comprehensive assessment of the energy efficiency industry is given in a 2008 study of the USA, *The Size of the U.S. Energy Efficiency Market: Generating a More Complete Picture,* by Ehrhardt-Martinez and Laitner (ACEEE 2008)[20]. This identifies the energy efficiency premium spending by sector in the US in 2004, and gives both the energy savings and the job creation. Their results are significantly different from the CEC report, and indicate both lower energy efficiency employment and lower spending for each GWh saved. The Australian results have been used in this report as the programs identified are likely to be the basis of energy efficiency improvements in the period to 2020.

In order to calculate electrical trades employment in energy efficiency, the split between residential and commercial/industrial efficiency was assumed both for the business as usual case and the additional GWh reductions. These were taken as 60% residential efficiency in the business as usual case (from Table 4 above), and 30% residential in the additional energy efficiency.

2.6 Smart grids

The relatively recent emergence of the “smart grid” concept means that there is far from a standard definition of the technological and service elements that smart grid development will actually include. Furthermore, elements are included will vary according to the desired policy purpose and will strongly influence the contribution to reducing carbon emissions. For example, a focus primarily on centralised grid control and monitoring systems may deliver improved customer service, but without a focus on enabling integration of energy efficiency and low-carbon forms of distributed generation, emission reductions will be limited. This has relevance to the determination of the smart grid elements to include as integral components of our future low carbon scenarios.

For the purposes of this report, smart grid technologies have been restricted solely to smart metering. This was considered to be a pragmatic approach based on:

- The lack of existing clarity of smart grid technologies in the Australian marketplace and their likely influence of the technology over the 2020 time horizon; and
- The relevance of these technologies to employment for electricians.

It should be noted that the energy efficiency and renewable energy components facilitated by smart grids are addressed elsewhere in the other technology categories covered by this research.

Employment was calculated for a smart meter rollout in NSW between 2012 and 2015, using the employment figures from the industry consultation for this study (refer to Section 5.4).

Small businesses were assumed to already be on some form of time-of-use metering and tariff structure or be in the process of switching over under the business as usual case by 2020. New residential customers are assumed to be installed with smart meters under the business as usual case and are therefore ignored.

2.7 Industry consultation

Industry consultation was undertaken with companies engaged in the clean energy technologies and services of interest, to provide an indication of the proportion of work electricians are engaged in for specific technologies. Additionally, information regarding skills gaps and an indication of total employment figures were elicited.

The research method employed began with desktop research. Relevant industry reports and websites were used to identify:

- The different types of companies involved in different aspects of a technology;
- Which companies were active in each field and should be consulted; and
- The likely job categories within each company or technology type.

Based on the desktop research, a set of interview questions and a consultation matrix were developed for each technology, with questions designed to ascertain job multipliers for each job type identified. This covered clarification of the job types in their company; number of MW manufactured/installed/maintained; as well as full-time equivalent employment figures or proportions for the company and associated sub-contractors. Questions were also asked regarding skills gaps and known electrical trades training programs. A sample interview template is included in Appendix A.

Criteria for selecting which companies to consult included where possible:

- Coverage across the different company types for technologies;

- Companies with an existing relationship with ISF researchers, to increase the participation rate; and
- Mature companies, with a large coverage of the sector, as they were more likely to have employment structures consistent with the industry as it develops, thus providing more accurate information for our purposes.

Table 5 gives the number of companies who were contacted to participate in the consultation for each technology, as well as the success rate. Wind companies were the most widely consulted, while biomass companies the least. The differentiation in the number of companies both contacted and interviewed can be attributed to the size of the sector, as well as the time needed to secure the interviews, which differed dramatically from company to company.

Table 5 Number of companies by technology contacted and interviewed during the industry consultation

Technology	Number of companies contacted	Number of companies interviewed
Wind	7	7
Cogeneration/ bioenergy	8	2
Energy Efficiency	6*	3
Solar PV	5	4
Smart Grid	3	1

* One of the bodies contacted was a government department, another an industry association, neither were interviewed.

The actual consultation process involved an introductory phone call and/or email to the company outlining the project brief and providing a preliminary set of questions. Short phone interviews which typically lasted between 15 and 30 minutes were undertaken, using the questions based on those outlined in the template provided in Appendix A. The interviews were not recorded, however detailed notes were taken, which were generally sent to the interviewee for confirmation and final clarifications. Where necessary, interviews were followed up to fill any information gaps that became apparent during the analysis.

Limitations

The small sample size of companies consulted means that the numbers produced from the consultation process are not statistically robust. However, given the small size of the renewable energy industry in Australia and the restricted scope of this research project, the process employed was methodologically sound and the authors believe that the results produce a reasonable indication of the current Australian renewable energy industry.

2.8 Converting overall employment numbers to electrical trades

In order to convert the overall jobs analysis to numbers for electrical trades, the percentage employment for electricians (and other occupations) was calculated for each of the technologies and sectors examined, using the data from the industry consultation and / or census data (shown in Table 16). While the sample size was too small to give definitive numbers, percentages are indicative of electrical trade employment.

2.9 Training needs

Training needs were evaluated through the combination of a desktop gap analysis focussing on existing Continuing Professional Development Courses and feedback received through the industry consultation component.

A full assessment of training provision for electricians (including TAFE and the tertiary education sector) and how this could be developed to meet the emerging skill requirements was not attempted, but could represent a valuable additional piece of future research building on the approach developed here.

2.10 Determining current and historic employment in electrical trades

Three data sources were used to analyse current and historical electrical trades employment: ETU membership data, NSW electrical licensing data (found at the NSW Department of Fair Trading website), and Australian Census data (found at the Australian Bureau of Statistics (ABS) website). Unfortunately NSW electrical licensing data does not contain individual employment figures, as individuals may hold more than one type of license and licenses may cover more than one person. Thus, Australian Census data is used, as it has the most comprehensive NSW employment statistics and provides a standard classification framework for both industry and occupations.

To determine how many people are employed as electrical tradespeople, it is first necessary to define what is meant by electrical trades. It is important to note that electrical trades occupations are distinct from the electrical industry. Thus, for the purpose of this report electrical trades are defined as encompassing the following four Australian Standard Classification of Occupation 1993 (ASCO93) unit-groups[a]:

- 4212 Automotive Electricians, who “install, maintain and repair electrical wiring and electronic components in motor vehicles” (ABS, 1997 p319)[10];
- 4311 Electricians, who “assemble, install, test and maintain electrical equipment and components, domestic and commercial electrical appliances and equipment, and service and repair lifts” (ABS, 1997, p326)[10];
- 4313 Electrical Distribution Tradespersons, who “prepare, install, repair, maintain and patrol electric power distribution networks” (ABS, 1997 p329)[10]; and
- 9918 Electrical and Telecommunications Trades Assistants, who “perform routine tasks in the installation and maintenance of electrical and telecommunications systems, usually working under close supervision” (ABS, 1997, p578)[10].

Although these four unit-groups do not completely cover ETU and NECA membership, they were chosen as the most relevant sub-unit groups that require

[a] ASCO93 unit-groups are groupings of occupations with similar skills specialisation. It is also the finest occupation classification level at which it is possible to access Census employment statistics.

electrical skills (discussed further in Section 6.3). Automotive electricians are included in electrical trades occupation break down, as there is likely to be an increase in the number of automotive electricians with the increased take-up of electric vehicles. However, due to resource limitations, electric vehicles were not included in the projection of energy sector/electrical trade jobs shown in later sections of the report.

To undertake the necessary analysis, these five occupation unit-groupings were cross tabulated with Australian and New Zealand Standard Industrial Classifications 1993 (ANZSIC 93) divisions and relevant classes[a] to produce NSW employment data tables for 1996 and 2006 by occupation and industry (Appendix C).

It should be noted that there are more recent occupation and industry classification systems, released in 2006. However, in order to do a time-series comparison with 1996 Census data, the earlier versions have primarily been used. The one exception is that the Australian and New Zealand Standard Industrial Classifications 2006 (ANZSIC 06) was used on 2006 Census data to provide a more detailed snap-shot of the electrical trades employment in the Electricity Supply sector (Figure 7) which is of particular relevance to this report.

Appendix B contains further discussion of the classifications used.

Limitations

This analysis has a number of limitations including:

- A lack of complete coverage of relevant occupations and industry classes.
- The statistics used were for employment, not full-time equivalent jobs (FTE), as such these statistics are not directly comparable with the research undertaken in subsequent sections, which is based on job multipliers (FTE per MW).
- The most recent data available is from 2006 and therefore changes in electrical trades employment in the subsequent four years were not possible to analyse.
- Limitations associated with census methodology.

Based on these limitations, this analysis should not be considered exhaustive. Nevertheless, within the scope of available data and resources a comprehensive and robust analysis has been undertaken.

[a] ANZSIC 93 divisions are the broadest level of industry classification, while ANZSIC 93 classes are the most specific level of industry classification at which it is possible to access Census employment statistics.

3 NSW energy scenarios

Australia, along with the rest of the world, is considering how best to reduce carbon emissions as part of the international effort to lessen the impacts of climate change. Australia's current commitment is a unilateral reduction of 5% below 2000 emission levels, with a commitment to increase this target to 25% if there are legally binding international agreements to reduce emissions sufficiently to stabilise carbon dioxide levels at 450 parts per million (ppm). There are calls to increase the reduction target on grounds both of climate risk and of international equity, with a global movement calling for stabilisation at 350 ppm carbon in the atmosphere rather than 450 ppm.

Whatever the specific commitments, it is likely that the next decade will see considerable change in the energy sector across Australia. The scale of the change will depend both on the outcome of political debates, and their intersection with new evidence on the rate and extent of climate change in response to increasing atmospheric carbon concentrations.

We constructed four scenarios for electricity consumption and supply in NSW[a] to cover a range of low carbon futures. These scenarios are then analysed for the potential employment effects in the NSW electricity sector. The four include a business as usual and three increasingly low carbon scenarios, and may be summarised as follows:

- **Scenario 1: Business as usual** – the TransGrid 2009 baseline scenario to 2018[21], extended to 2020 using the projected annual growth rate for 2009 – 2018.
- **Scenario 2: 5% Emissions Reduction.** Australia's current unconditional Commonwealth political commitment at the international level.
- **Scenario 3: 25% Emissions Reduction.** Australia's current conditional Commonwealth political commitment at the international level, if there is ambitious international action.
- **Scenario 4: 25% Emissions Reduction plus 30% Renewable.** Same as Scenario 3 with a 25% national emissions reduction, plus an increased Renewable Energy Target (RET), so that NSW achieves 30% of electricity from renewable energy by 2020[b].

More details of the derivation of the scenarios, including the installed capacities, are given below.

The scenarios are intended to be exemplars of the electricity supply mix under each of these policy settings, rather than predictive of what will eventuate.

Figure 1 shows the electricity generation by source in each scenario. Total electricity consumption falls as scenarios become progressively lower carbon. The amount of reduction in GWh has been characterised as 'energy efficiency', and used in calculating additional energy efficiency employment.

The modelled capacities for each type of generation in each scenario are given in Table 6.

[a] All the electricity scenarios are for NSW and the ACT, as the National Electricity Market region NSW includes the ACT.
[b] Note that achieving 30% of electricity supply from renewable energy in NSW is likely to require a national Renewable Energy Target of at least 35% - 40% if the current structure is maintained, as the present 20% RET is only anticipated to bring NSW renewable generation to 10%.

Figure 1 Electricity generation in NSW in 2010 and 2020 (all scenarios)

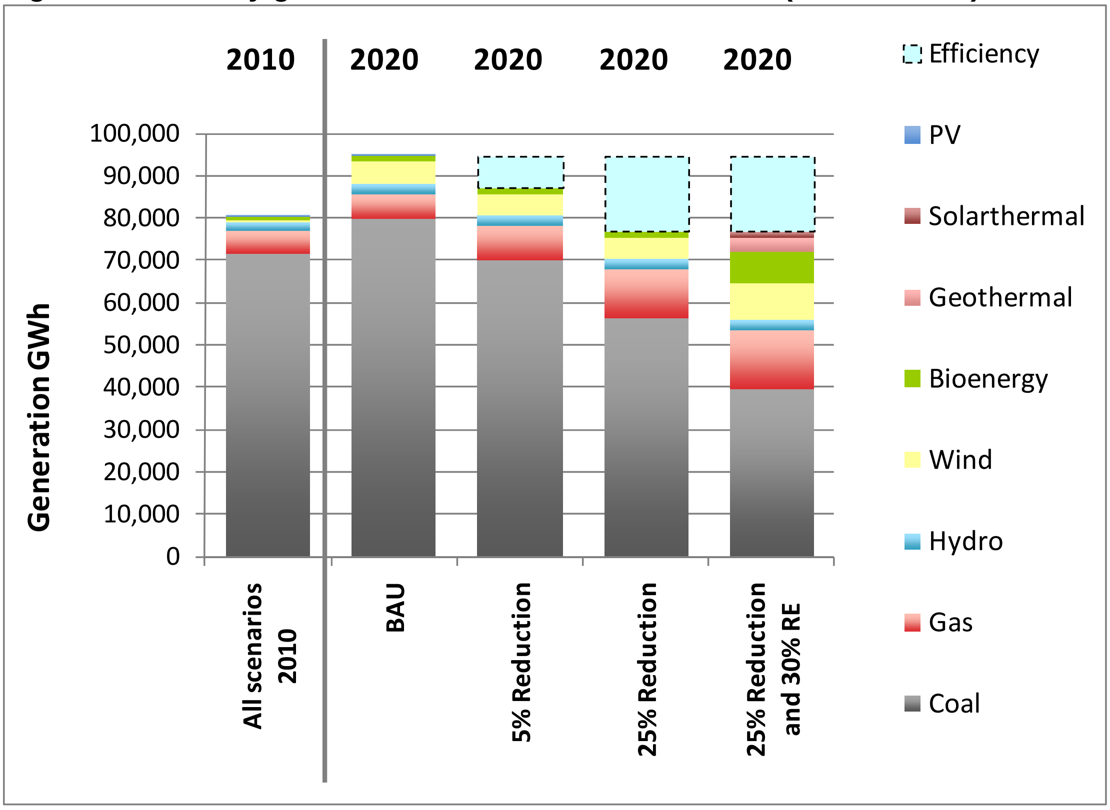


Table 6 NSW generating capacity at 2010 and 2020, all scenarios

	2010 MW	2020 MW			
	All scenarios	Scenario 1: BAU	Scenario 2: 5% reduction	Scenario 3: 25% reduction	Scenario 4: 25% reduction and 30% RE
Coal	11,730	11,730	10,000	10,000	8,230
Gas	2,217	2,305	3,000	3,000	3,000
includes cogen	*170*	220	320	670	870
Hydro	2,285	2,657	2,657	2,657	2,657
Wind	246	1,948	1,948	1,948	3,300
Bioenergy	179	289	289	289	1,400
Geothermal	-	-	-	-	750
Solar thermal	-	-	-	-	750
PV	16	50	100	100	200
Total capacity	**16,673**	**18,979**	**17,994**	**17,994**	**20,287**
NSW renewable %	**5%**	**10%**	**12%**	**12%**	**30%**

Scenario 1: Business as usual

Electricity generation is the baseline projection for generation given in the TransGrid 2009 Annual planning report, extended from 2018 to 2020 by using the projected annual growth rate for 2009 – 2018[21].

Coal fired capacity is taken from Electricity Gas Australia 2009[22], with a presumption that this will remain the same over the ten year period.

Gas and renewable capacities are taken as the sum of the projection for existing and committed scheduled capacity for NSW from the Australian Electricity Market Operator's (AEMO) website[23], and the projection for unscheduled gas generation in NSW from the 2008 report to the National Electricity Market Management Company (NEMMCO)[24]. This allows for the current national Renewable Energy Target (RET) of 20% by 2020. Snowy hydro capacity, with the exception of Murray 1 and 2, is included in NSW.

It is assumed that NSW will have a total capacity of 50 MW of PV by 2020 in the reference case, and an additional 50 MW of cogeneration.

On current projections, the 20% target will result in approximately 10% of NSW electricity generation to be from renewable energy by 2020.

Scenarios 2 & 3: 5% and 25% emissions caps

These two scenarios assume that a 5% or a 25% national economy-wide emissions target is introduced respectively. This could be implemented in the form of an emissions trading scheme such as the currently postponed Carbon Pollution Reduction Scheme (CPRS) or via other means. However, the method of achieving this reduction is not of significant consequence to the research presented in this paper.

The reference scenario was modified using changes in generation and capacity estimated from the McLennan Magasanik Associates (MMA) report to the Federal Treasury, *Detailed Results of the Modelling of the Impacts of Emissions Trading on the Electricity Markets*[25].

The overall reduction in NSW generation for the 5% and the 25% target is estimated from the national reduction in generation in the MMA results, divided by four. The impact on NSW is conservatively taken as somewhat less that the NSW share of generation, which is currently 33%. The changes in national generation are given in Figures 1.1 to 1.4 in the MMA report[25].

The changes in NSW coal generation and capacity for the 5% and 25% emissions reduction targets are estimated from Figures 4.4 and 6.5 in the MMA report, while changes in gas capacity are estimated from figures 4.7 and 6.7 in the MMA report.

Renewable generation and capacity (with the exception of PV) are unchanged from the reference case, as these are assumed to be driven by the RET. It is assumed PV capacity will increase to 100 MW by 2020 in both of these scenarios. Cogeneration is assumed to increase by 150 MW in the 5% reduction case, and by 500 MW in the 25% case.

Gas generation is calculated to meet the shortfall left by the reduction in coal generation.

Energy efficiency savings of 7,500 GWh per year below business as usual are included in the 5% case, and 17,750 GWh per year in the 25% case.

A roll out of smart meters to every household in NSW is included in Scenario 3 (25% reduction), but not in Scenario 2 (5%).

Scenario 4: 25% emissions reduction plus 30% renewable

In this scenario it is assumed that the RET is increased sufficiently so that NSW generates 30% of electricity from renewable energy. This is likely to require a national target greater than 30%, or some additional policy intervention, as modelling of the current RET indicates that NSW will reach renewable generation of approximately 10% despite the national target of 20% renewable electricity.

Renewable capacities have been increased sufficiently to achieve 30% of NSW generation. The mix of technologies is just one example of how this target could be reached. 200 MW of PV is included in this expansion.

An additional 700 MW of cogeneration is included in this scenario.

Energy efficiency savings are unchanged from the earlier 25% case, at 17,750 GWh per year.

A roll out of smart meters to every household in NSW is included in this scenario.

4 NSW energy sector jobs in a low carbon economy – results

4.1 Overview

- In **Scenario 1: Business as Usual**, energy sector jobs fall from 8,800 to 7,800 by 2012, climb back up to 8,600 in 2014, and then fall back to 7,800 by 2017 and remain there until 2020 in the business as usual case. Energy sector jobs in this analysis include electricity supply, associated jobs in fuel supply, and energy efficiency.
- Job losses in the energy sector are lower in all the carbon reduction scenarios (Scenarios 2-4).
- In **Scenario 2: 5% emissions reduction**, energy sector jobs fluctuate between 2010 and 2014, falling from 8,800 in 2010 to 8,000 by 2012. Job numbers climb to reach 11,700 in 2014, and then fall gradually back to present levels (8,700) by 2020.
- In **Scenario 3: 25% emissions reduction**, energy sector jobs increase steeply to 12,600 in 2011, then drop again to 10,400 in 2011. Job numbers climb to reach 14,000 in 2014, and then fall gradually back to 10,400 by 2020, an 18% increase from today.
- In **Scenario 4: 25% emissions reduction and 30% renewable electricity**, energy sector jobs increase steeply to 13,400 in 2011, then drop again to 11,800 in 2011. Job numbers climb again to reach 18,000 in 2014, and then fall gradually back to 15,000 by 2020, a 74% increase from today.

There are 8,800 jobs in the NSW energy sector at present according to these calculations, including jobs in energy efficiency. This includes jobs in coal mining associated with electricity generation, but does not include jobs associated with coal exports, nor jobs in transmission and distribution of electricity. These are not expected to be significantly affected by the energy scenarios modelled.

Four energy scenarios have been modelled to see the effects on jobs in this area: a business as usual scenario (Scenario 1) and three scenarios with progressively lower carbon emissions: a 5% emissions reduction(Scenario 2), a 25% emissions reduction (Scenario 3), and a 25% emissions reduction plus 30% renewable electricity scheme (Scenario 4). All the low carbon scenarios have a positive effect on job numbers, with the most significant effect from the scenario including an expansion of renewable energy. Figure 2 shows the results for 2010, which are the same for all scenarios, and for 2020. Jobs are divided according to technology.

Figure 3 shows energy sector jobs each year from 2010 until 2020, while Table 7 and

Table **8** show the results for all scenarios at 2010 and 2020 by sector and type respectively. Appendix D shows the results for each year by type.

Note again that indirect jobs are not included in these figures. US[26] and Australian[27] studies cite total jobs (direct plus indirect jobs) as approximately 2-2.25 times higher than direct jobs.

Figure 2 Total energy sector jobs in 2010 and 2020, all scenarios

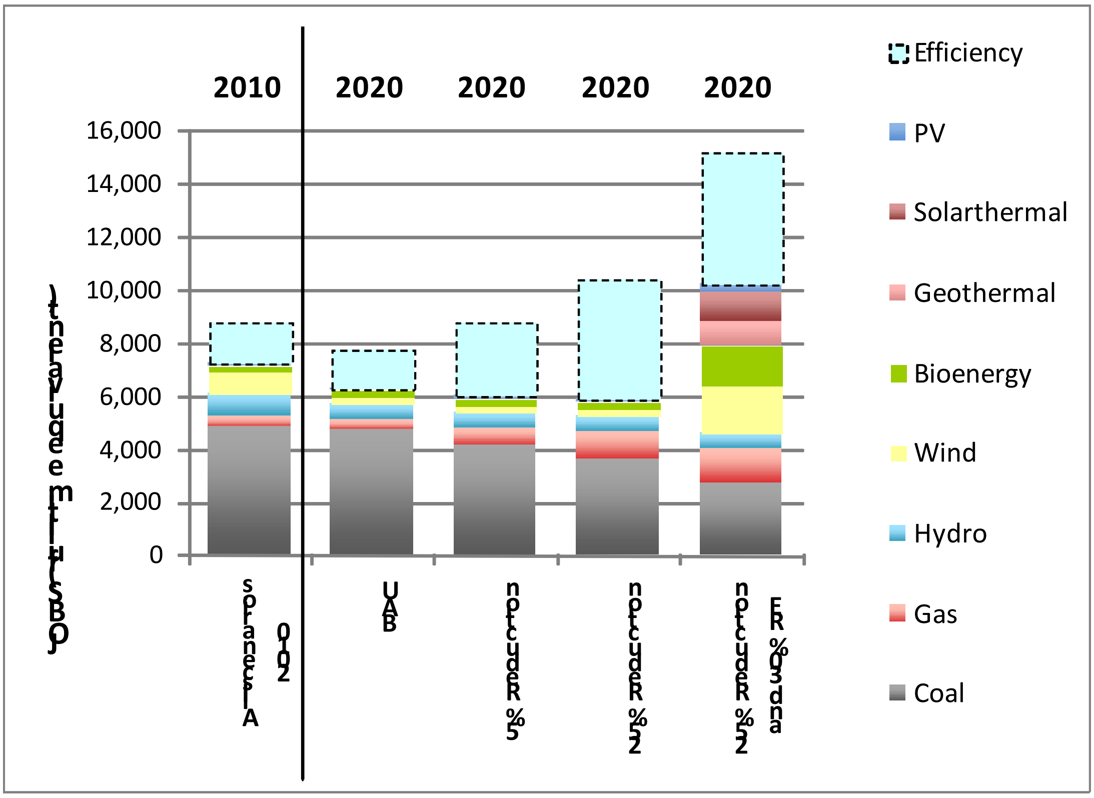


Figure 3 Total energy sector jobs for each year from 2010 to 2020, all scenarios

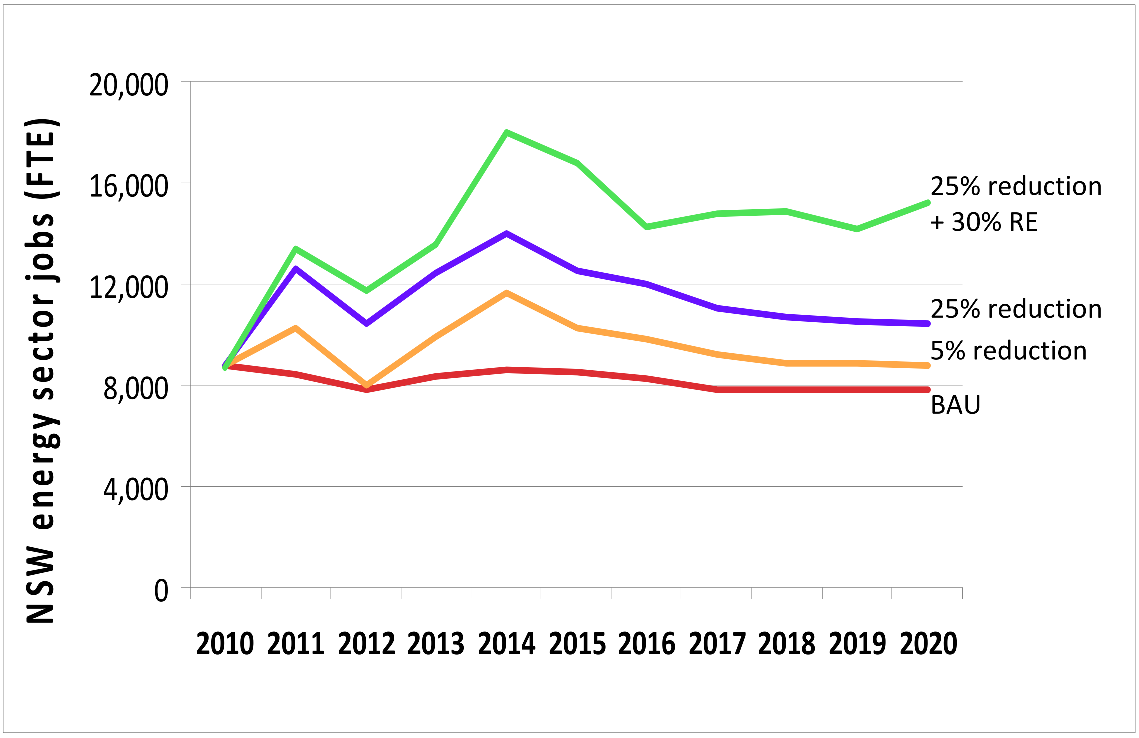


Table 7 NSW energy sector jobs at 2010 and 2020, all scenarios, by sector

	2010 jobs (FTE)	2020 jobs (FTE)			
	All scenarios	BAU	5% reduction	25% reduction	25% reduction and 30% RE
Coal	4,874	4,751	4,114	3,638	2,750
Gas	397	374	649	1,012	1,244
Renewable	2,016	1,167	1,251	1,251	6,239
Efficiency	1,500	1,500	2,773	4,517	4,981
Total	**8,787**	**7,792**	**8,787**	**10,418**	**15,214**

Table 8 NSW energy sector jobs at 2010 and 2020, all scenarios, by type

	2010 jobs (FTE)	2020 jobs (FTE)			
	All scenarios	BAU	5% reduction	25% reduction	25% reduction and 30% RE
Manufacturing	140	7	18	18	1,195
Construction & installation	1,224	47	240	262	2,318
Operations & maintenance	3,100	3,353	3,197	3,499	5,163
Fuel	2,822	2,885	2,560	2,122	1,556
Efficiency	1,500	1,500	2,773	4,517	4,981
Total	**8,787**	**7,792**	**8,787**	**10,418**	**15,214**

4.2 Results by scenario – discussion

The job results for each scenario by technology – as discussed in this section – are shown in Figure 4, below.

Scenario 1: Business as usual
Under business as usual, job numbers fall to 2012, go up again to present levels about 2015, and then fall by about 11% to 7,800 in 2020. Job numbers to 2015 are influenced by construction in the wind sector, mainly as a result of the national renewable energy target. The structure of the target means that projects have to be built early to recoup investment, so it is unlikely that any construction will take place after 2015. Most other sectors are relatively constant over the period.

Scenario 2: 5% Emissions Reduction
Under the 5% reduction, energy efficiency employment is increased as there is an overall decrease in electricity consumption from coal, which is reflected in a decrease in coal sector employment. Renewable energy employment other than solar PV remains the same as in the business as usual case, but there is a small increase in gas employment as more cogeneration is installed. Solar PV employment increases relative to the base case.

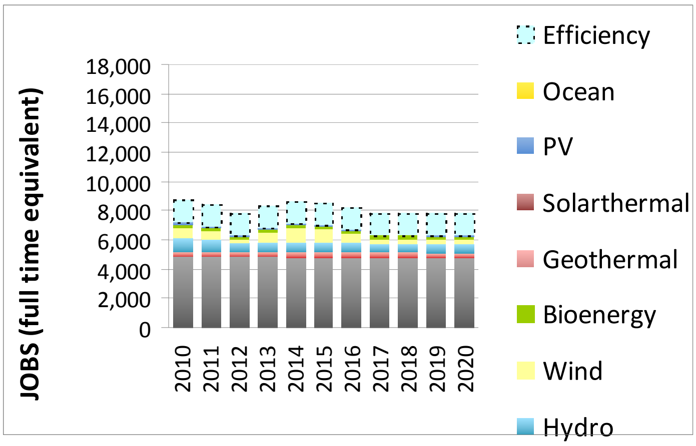
Scenario 3: 25% Emissions Reduction

Under the 25% reduction, energy efficiency employment is further increased as there is a greater decrease in electricity consumption, leading to a decrease in coal sector employment. The scenario also includes the roll out of smart meters, accounting for nearly between 200 and 400 jobs between 2013 and 2016. Renewable energy employment other than solar PV remains the same as in the business as usual case, but there is an increase in gas employment as more cogeneration is installed. Solar PV employment increases relative to the base case.

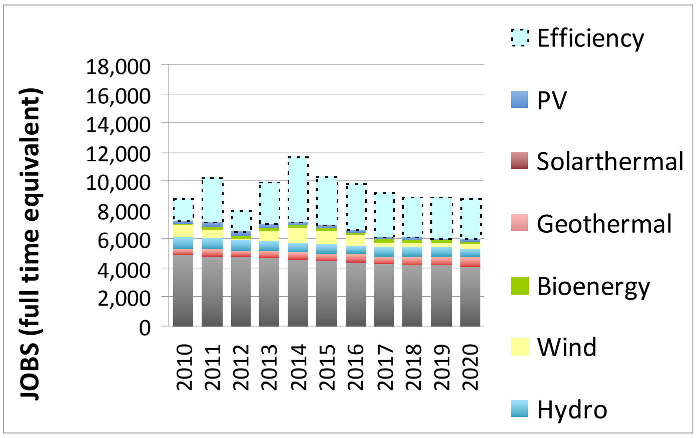
Scenario 4: 25% Emissions Reduction with an increased renewable energy target

Under the 25% reduction plus expanded renewable energy there is a very significant increase in job numbers, and the energy sector has a different structure. Coal generation is scaled back considerably, and with it employment, and renewable energy and cogeneration expand. Energy efficiency employment is also boosted. This scenario shows the strongest job growth of the four.

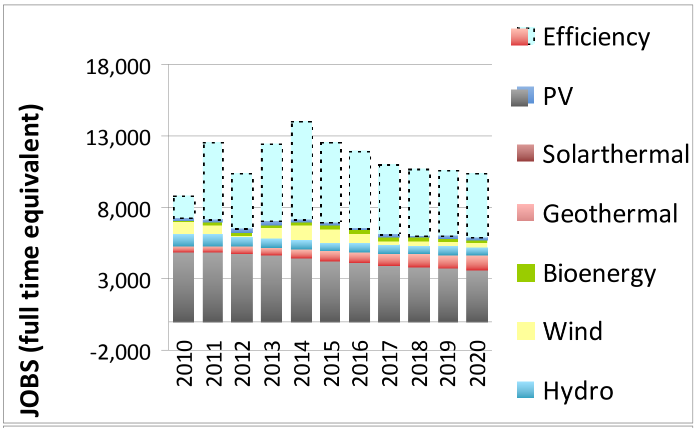
Figure 4 NSW energy sector jobs by technology 2010 – 2020 – all scenarios



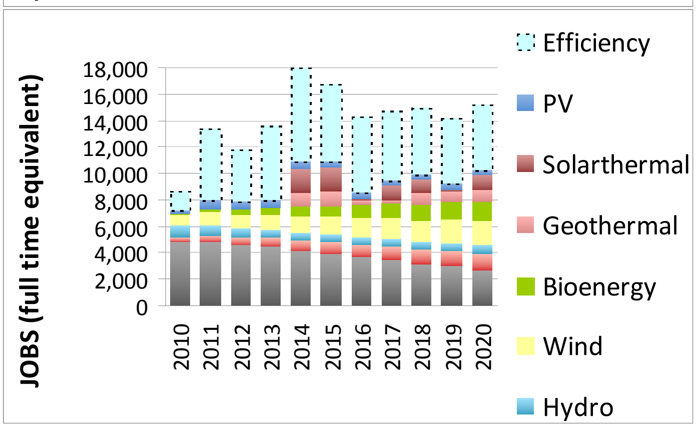
Business as usual



5% Emissions Reduction



25% Emissions Reduction



25% Emissions Reduction and 30% renewable electricity

5 Jobs and skills breakdown by technology

This section presents the results of the industry consultation component of this research, broken down by the technology groupings used for the interviews. The technology groupings covered are: solar PV; wind; energy efficiency; smart grids; cogeneration; and biogas. The latter two technologies were grouped for the purposes of this analysis due to technological similarities. The treatment of other renewable energy technologies not covered through the consultation are covered in Section 7.

The primary purpose of this section is to present and discuss the proportional job breakdowns by occupation and/or qualification, which are then applied to the industry growth projections in each of our scenarios in Section 7. Figures for "approximate work per MW" (or dollars invested in the case of energy efficiency) derived from the interviews are also presented for each technology and compared with the reference data used as the basis for the job multipliers.

5.1 Solar PV

We consulted three solar PV installation companies for this project, which accounted for 24MW of solar PV installations in 2009 alone. We also consulted a solar PV manufacturing firm. Results have been amalgamated to give indicative breakdowns for 'typical' solar PV manufacture, design and installation, and operations and maintenance in Table 9.

Table 9 Solar PV – job breakdown (consultation results)

STAGE [company type]	Job category	Employment Proportions	Approx work per MW	Reference data [(1)] work per MW
MANUFACTURING Cells and Modules	Engineers/designers	21%	3.3 job year / MW	9.32 job year / MW
	Manufacturing plant maintenance electricians	9%		
	Assembly line	55%		
	Admin, sales, finance, management	15%		
DESIGN & INSTALLATION	PV system installers	21%	30.9 job year/ MW	29.0 job year/ MW
	Electricians	33%		
	PV installation project manager/foreman	4%		
	Admin, sales and management	40%		
	Solar engineers	2%		
O&M	Admin, sales and management	96%	0.40 jobs / MW	0.40 jobs / MW
	Electrician/PV Installer	4%		

Note 1) European Photovoltaic Industry Association, 2008 [15]

This job breakdown has been used to calculate the number of electrician's jobs included in the expansion of renewable energy employment.

Indicative results are that jobs for electricians are:

- 0.3 jobs (industry consultation) or 0.8 jobs (reference data) are created per MW installed solar PV cell and module manufacturing
- 10.2 jobs (industry consultation) or 9.6 jobs (reference data) are created per MW installed in design and installation, and
- 0.02 jobs per MW are created for electricians operations and maintenance (industry consultation and reference data).

For both O&M and design and installation the job factors based on the industry consultation are very similar to the industry reference data from the European Photovoltaic Industry Association, although the manufacturing results are significantly lower. This may be because components are not included in the response. The reference data for jobs per MW is used in the jobs analysis for both overall employment and electrical trades employment as it is based on a much more established industry, while the percentage of work for electrical trades is taken from the industry consultation (this information is not available from the European data).

Overall, electricians account for 9% of the work in solar PV manufacturing, 33% of the work created in design and installation of solar PV systems, and only 4% of the work created in operations and maintenance.

5.2 Wind energy

We interviewed four wind companies for this project, which between them operate more than 1000 MW of Australian wind farms, with more than 3000 MW in development. We also consulted the two companies making wind farm towers in Australia. Towers are currently the only major wind farm components manufactured on-shore.

Results have been amalgamated to give indicative breakdowns for 'typical' wind development, construction, and operations and maintenance in Table 10. Companies vary in their structure, emphasis, and operations, so this table does not exactly reflect any one of the companies surveyed.

The breakdown of the job categories shown in Table 10, and the percentages of electricians in each category, was used to calculate indicative results for the number of electrician's jobs involved in the expansion of wind energy employment:

- 0.02 jobs are created per MW installed in tower manufacture;
- 0.15 jobs are created per MW installed in construction; and
- 0.05 jobs per MW are created for electricians in operations and maintenance.

Overall, it was found that electricians account for 5% of the work created in development and construction of wind energy projects (assuming that only towers are manufactured on-shore), and 26% of the work created in operations and maintenance.

Table 10 Wind Energy – job breakdown (consultation results)

STAGE [company type]	Job category	%	Approx work per MW	Reference data [1]
MANUFACTURING Towers (to factory gate)	Electrical	3%	0.62 job years/ MW	12.5 job years / MW all manufacturing
	Fabrication (includes welding, boilermaker, profiling, assembly)	68%		
	Blasting and painting	16%		
	Engineers	2%		
	Sales/ admin/ finance	11%		
DEVELOPMENT & DESIGN [Developer/ consultant]	Engineers/ designers/ specialist consultants		0.3 job years/ MW	2,5 job years / MW
	- Wind engineers	8%		
	- noise modelling, ecological, archaeology, traffic, social, visual assessment	33% [2]		
	- Electrical engineering	32%		
	- Mechanical/ civil engineers			
	Admin, finance, sales and management	19%		
CONSTRUCTION [Construction/ specialist construction]	Riggers/ crane operators	4%	2.2 job years / MW	
	Installation technicians (assemble and install turbines, substation, transformers, etc)	22%		
	Electrical cablers	5% [2]		
	Construction contractors (earth moving, concrete, building, roadworks, etc)	41% [2]		
	Heavy goods transport professionals	5% [2]		
	Other – warehouse, technical support	2%		
	Admin, sales and management (includes legal, HR, finance, supply chain)	22%		
O&M Specialist company	Wind technician	56%	0.16 jobs per MW	0.4 jobs per MW
	Technical support	23%		
	Site/ operations managers	15%		
	Admin, sales, mgt (includes legal, HR, etc)	7%		

Notes
1) European Wind Energy Association. 2009. Wind at Work.
2) Subcontracted labour.

The results from the industry consultation for total employment per MW for development and construction were identical to the reference data from the European Wind Energy Association.[11] The results for operations and maintenance employment are significantly lower than the EWEA data. This may be because Australian wind farms tend to be larger than their European counterparts, or it may be because of different working practices.

The manufacturing figure for Australia is only a small section of the overall manufacturing. The figure of 12.5 jobs per MW in manufacturing includes the turbine itself (7.5 jobs) and the components such as gearboxes, transformers, and cranes (5 jobs). Earlier work by the EWEA referred to 1996 Danish data indicating that towers accounted for approximately 18% of the overall manufacturing employment. While 18% would correspond to 1.35 jobs per MW, it is likely that the rapid increase in turbine size from 1 MW to 2 MW could account for the shrinking proportion of labour associated with tower manufacture. The EWEA manufacturing multiplier of 12.5 is used, but only 6% of this is taken to correspond to tower manufacture.

The Australian factor for operations and maintenance is used in this analysis.

5.3 Energy efficiency

It should be noted that defining the industries delivering “energy efficiency” products or services is not straightforward. The immature nature of the energy efficiency industry means that companies involved in energy efficiency product or service provision often do not identify themselves as dealing with energy efficiency *per se*. For example, a legitimate energy efficiency company may be involved in the manufacturing, sale and installation of energy using products, some of which include reduced operational energy use amongst their features. Companies such as this have difficulty defining what proportion of their business could legitimately be described as energy efficiency related, which then makes counting employees and associated turnover within that area of the business problematic. Further, there may be many reasons why their products are utilised, only some of which relate to energy efficiency. These difficulties notwithstanding, it is still possible to hone in on areas of relevant businesses that would likely increase through stronger uptake of energy efficiency in the NSW economy through policy or other measures.

We contacted 6 companies that class themselves as providing energy efficiency products and/or services and one industry body, which resulted in 4 interviews, of which 3 yielded usable results. The companies interviewed covered energy performance contracting and other energy management services, the manufacturing, sales and installation of energy efficiency products, and provision of electrical contracting services. Between them, these companies are responsible for delivering total annual combined energy efficiency and environmental products and services worth around $1.1 billion/yr and employ a total of 1600 people across Australia to deliver these products and services. It was not possible to reliably calculate the amount of energy savings (in GWh) delivered by these companies, or the amount of sales which relate to the “energy efficiency premium” (that is, the *additional* amount of sales beyond business as usual expenditure on their products and services).

Whilst with the small number of respondents it is difficult to generalise across the energy efficiency industry due to the large range and variation in the products and services involved, some commonalities were observed and results have been amalgamated across the range of project stages covered through our interviews to produce breakdowns by profession/ occupation for the energy efficiency industry as a whole. These figures are presented below in Table 11. As companies vary in their structure, emphasis, and operations, this table does not reflect any one of the companies surveyed.

Table 11 Energy Efficiency – job breakdown

Job category	%	Approx work per $m	Reference data[1]
Electricians	26% (7% of these in sales/mgmt/tech support)	4.6 job year per AU$m investment	3.9-4.0 job year per AU$m Investment
Electrical Apprentices	6%		
Electrical/Energy Engineers[2] (in sales, mgmt & tech support)	16%		
Other Engineers[3] (in sales, mgmt & tech support)	22%		
Other professionals (in sales, mgmt & tech support)	2%		
Mechanical tradespeople	6%		
Production Line	20%		
Admin	3%		

Notes
1) Figure from CEC 2009[1] and ACEEE 2008[20] respectively, based on 90% of commercial figure and 10% of industrial figure, to represent a comparable split to our respondents. The ACEEE data is converted from US$ using Purchasing Power Parity of 1.46[28].
2) Generally electrical engineers although some with mechanical background working on electrical issues.
3) Generally mechanical engineers.

As can be seen from Table 11, jobs for electricians, including those working directly as electricians and those with electrical qualifications working in jobs such as sales, project management and technical support were found to account for 26% of total energy efficiency jobs. Looking across company types, electricians are more strongly represented in electrical contracting, as would be expected. There appears to be significant variation in the degree to which other companies dealing in energy efficiency products and services employ electrical tradesman directly. In any case, companies that do not employ their own electricians tend to engage electrical subcontractors to a greater degree than those with in-house electricians. The sales and management roles mentioned above generally represent a career progression from the more traditional tradesperson roles.

A further 6% of jobs were found to be for electrical apprentices, primarily in electrical contracting, with a much smaller portion embedded within the other products and services companies. This brings the total electrical trade jobs to 32%.

Energy or electrical engineers made up 16% of total jobs, which may represent opportunities for career progression for electricians seeking further formal qualification at the university level. These jobs are spread fairly evenly across sales, management and technical support roles throughout the industry.

The “other engineers” category generally covers those with mechanical engineering backgrounds, and accounted for 22% of total jobs. That is, engineering roles appear to be split relatively evenly between electrical and mechanical disciplines, reflecting the importance of Heating, Ventilation and Air Conditioning (HVAC) systems to energy efficiency outcomes. Tradespeople working on HVAC systems represent 6% of total jobs. The category of “Other professionals” (2% of total) refers to degree-qualified staff primarily with non-technical backgrounds, such as business or management. Unskilled workers involved with manufacturing production lines accounted for 20% of our sample, with admin staff making up the remaining 3%.

5.4 *Smart metering*

For the consultation we contacted three Victorian electricity distribution utilities and two government offices, given Victoria's experience in large-scale smart-metering rollout. This resulted in one interview with a network utility business. From this consultation the approximate figures shown in Table 12 were derived for the occupations involved on the electricity network business side of procuring and installing smart meters.[a]

Table 12 Employment from installing smart meters

	Job years per 100,000 dwellings
Project managers	9.1
Electrical trades	36.3
Software developers	Employment of 50 people for two years per utility
TOTAL	**45.1** (excluding set up of software)

While all of the electrical trade jobs require training to AQF Certificate III level, the jobs are dominated by lineworkers, followed by 'electrical trade assistants' who complete the installation preparatory work to reduce the time required for higher paid, fully qualified and licensed electricians.

Note that the overall job implications from new smart meter installations were only assessed for those within or engaged by the distribution utility. It is anticipated that there is likely to be net unskilled job losses as a result of eliminating the need for meter reading. These services are generally outsourced by utilities and the changes in these areas are not considered as they have no net effect on electricians. Maintenance schedules for smart meters are assumed to be comparable with existing meters.

Based on the figures from Table 12, the installation of smart meters to all existing NSW and ACT residential customers (2,977,603 as at 30/6/08)[29] was calculated to create approximately 270 jobs per year for an assumed rollout period of 5 years. Approximately 215 of these are in electrical trades. Given the policy moves towards smart metering at the State level in Australia to date (that is, Victoria's current mandated roll-out and consideration by other States), such a NSW-wide rollout of smart metering with in the 2020 time horizon is considered a reasonably likely outcome. Therefore the job calculations for smart metering presented in Section 7 include smart meters in *both* of the 25% scenarios (Scenarios 2 & 3).

[a] It should be noted that the degree of confidence in the above figures is low and future work should concentrate on increasing the sample size as greater experience in smart metering exists in the marketplace.

5.5 Cogeneration & Biogas

We interviewed two cogeneration companies for this project, which between them operate 8 MW of Australian cogeneration, trigeneration, or biogas.

Results have been amalgamated to give an indicative breakdown for a 'typical' cogeneration development, shown in Table 10. The small number of companies interviewed, and the early stage of development of cogeneration in Australia means that little confidence can be placed in the overall job multipliers, and instead the reference data for bioenergy is been used as the employment factor for cogeneration. This is likely to be more accurate than the gas multiplier, as the small size of cogeneration plant is a better match with bioenergy development than with centralised gas generation.

Table 13 Cogeneration – job breakdown (consultation results)

<table>
<tr><th>STAGE</th><th>Job category</th><th>%</th><th>Approx work per MW</th><th>Reference data [1,2]</th></tr>
<tr><td rowspan="7">DEVELOPMENT/ CONSTRUCTION</td><td>Civil engineers</td><td>2%</td><td rowspan="7">5.5 job years / MW</td><td rowspan="7">Gas:
1.4 job years/ MW [1]

Bioenergy:
2.0 job years/ MW [2]</td></tr>
<tr><td>Electrical engineers</td><td>20%</td></tr>
<tr><td>Mechanical engineers</td><td>20%</td></tr>
<tr><td>Construction contractors</td><td>1%</td></tr>
<tr><td>Fitters/ plumbers</td><td>24%</td></tr>
<tr><td>Electricians</td><td>26%</td></tr>
<tr><td>Admin, sales and management (includes legal, finance, etc)</td><td>7%</td></tr>
<tr><td rowspan="5">O&M</td><td>Electrical engineers</td><td>38%</td><td rowspan="5">1.3 jobs per MW</td><td rowspan="5">Gas :
0.05 jobs/ MW [1]

Bioenergy:
0.95 jobs/ MW [2]</td></tr>
<tr><td>Mechanical engineers</td><td>19%</td></tr>
<tr><td>Electricians</td><td>21%</td></tr>
<tr><td>Fitters/ plumbers</td><td>16%</td></tr>
<tr><td>Admin, sales and management</td><td>6%</td></tr>
</table>

Notes
1) Gas data from National Renewable Energy Laboratory publicly available JEDI model[4]
2) Bioenergy data from Pembina Institute. 2002. [12]

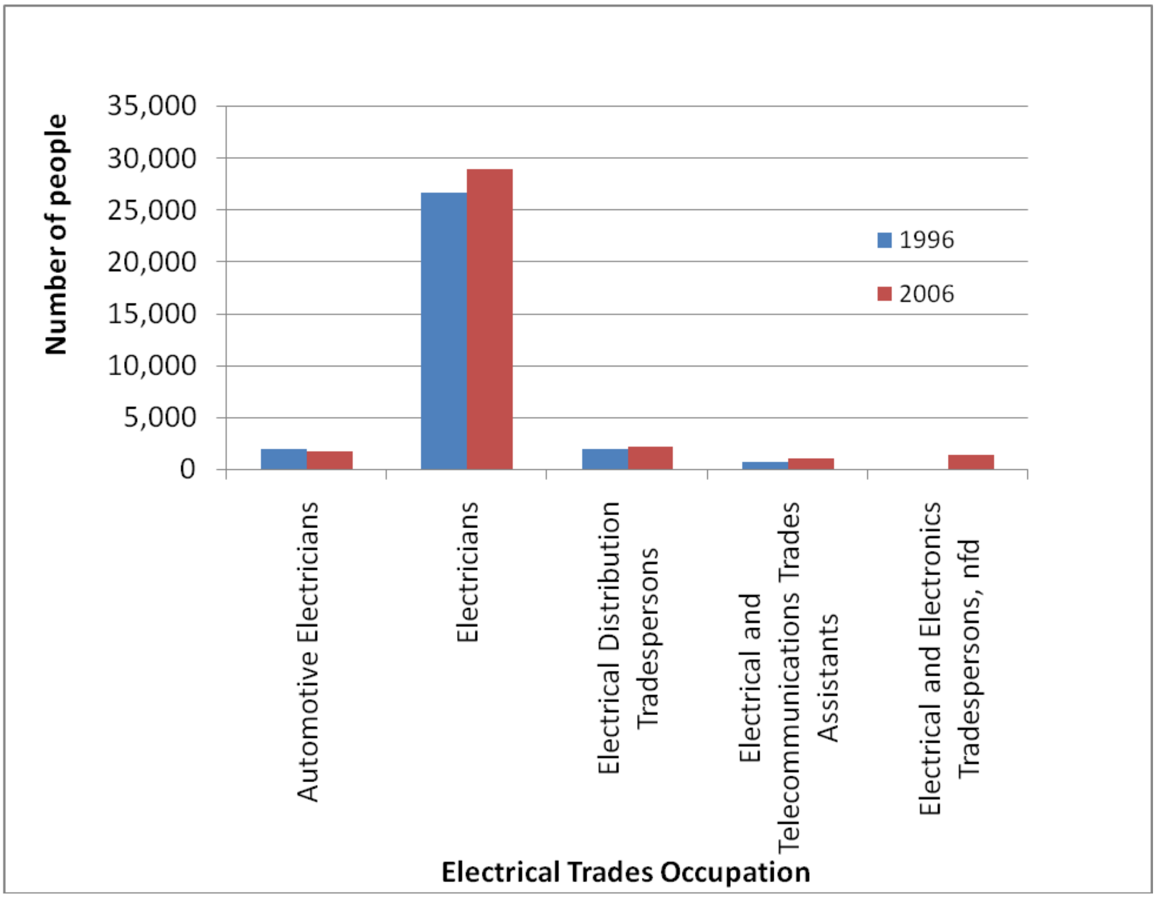
6 Electrical trades in NSW – current situation

6.1 Overview

In order to consider the effect of different energy scenarios on employment in electrical trades it is important to understand how many and in which industries people are currently employed in electrical trades in NSW, and to gain a historical perspective on job numbers. Australian 1996 and 2006 census data has been analysed to answer these questions.

In 2006, 35,275 people were employed in NSW in electrical trades, accounting for 1.2% of the NSW work force. Of those employed in electrical trades the majority (82%) are electricians (Figure 5).

Figure 5 Number of people in electrical trades in NSW in 1996 and 2006



As shown in Figure 6, the largest proportion of electrical tradespeople work in the construction industry, with 16,413 employed in 2006. This accounts for 46% of the people working in electrical trades and 8% of total employment in the NSW construction industry. Figure 6 also indicates that employment in electrical trades is fragmented across many industries. Also of note are the 4,249 electrical tradespeople working in the Electricity, Gas and Water Supply industry. While less than the total in manufacturing, electrical trades represent 18% of employment in this industry.

Figure 6 Electrical trades in NSW in 1996 and 2006 – employment by industry

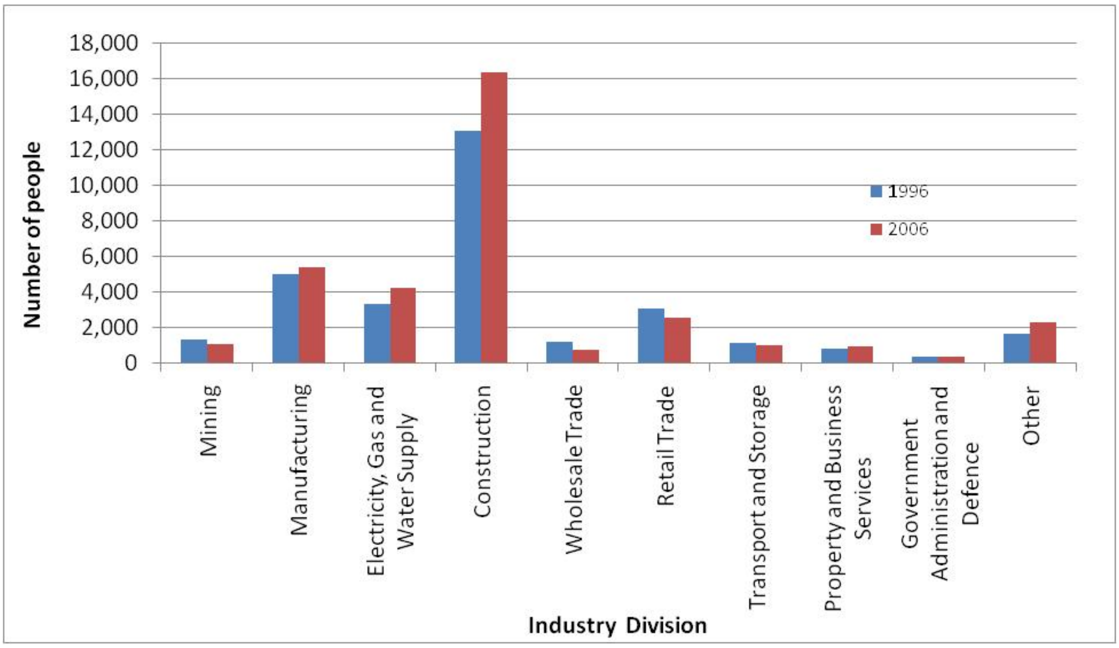


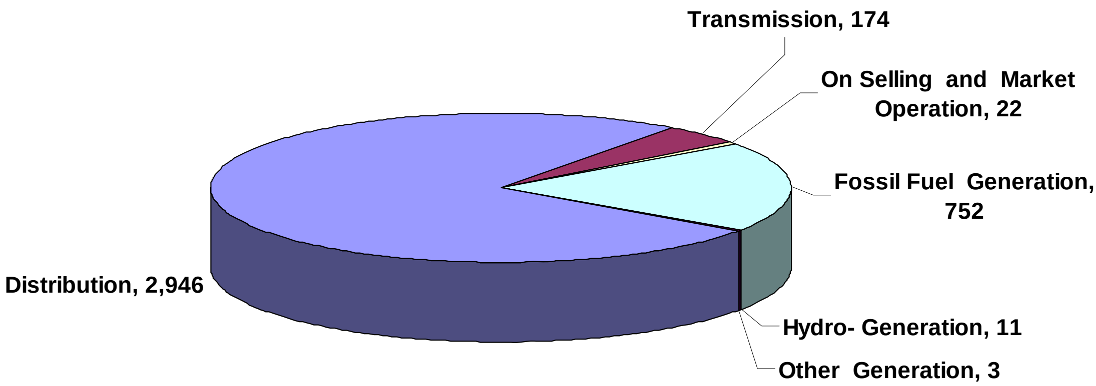
Table 14 gives a snapshot of some of the key sub-industry classes in the mining, manufacturing, electricity, gas and water supply, construction and transport industry divisions that employ electrical tradespeople. Unsurprisingly the largest numbers of electrical tradespeople are employed in Electricity Supply and Electrical Services. However, also of note are the Lift and Material Handling Equipment Manufacturing, Electrical and Equipment Manufacturing and Electrical Equipment and Appliance Manufacturing industries, as electrical tradespeople represent 25%, 17% and 31% respectively in those sub-sectors.

Table 14 Electrical trades in NSW in key industry classes in 1996 and 2006

Industry Division	Industry Class	1996	2006
Mining	Black coal mining	691	809
Manufacturing	Basic iron and steel manufacturing	746	512
	Electrical equipment and appliance manufacturing	40	237
	Electrical and equipment manufacturing	606	672
	Lifting and material handling equipment manufacturing	723	904
Electricity, Gas and Water Supply	Electricity supply	3,279	4,100
Construction	House construction	25	563
	Non-building construction	397	443
	Electrical Services	11,749	13,958
	Air conditioning and heating services	242	319
	Fire and security system services	208	280
Transport and Storage	Rail transport	787	734

Figure 7 provides a more detailed breakdown of the number of electrical trades jobs in different parts of the electricity sector in 2006[a]. The majority of electricity supply electricians are working in fossil fuel generation (752), with only 14 listed in renewable electricity. The majority (80%) of electrical tradespeople in this sector work in transmission and distribution.

Figure 7 Electrical trades jobs in the electricity Sector [b], 2006



6.2 Change from 1996 to 2006

Census data from 1996 and 2006 was analysed to provide some indication of how employment in electrical trades has changed over the period of 10 years. In 1996, there were 31,233 people employed in electrical trades. Thus, between 1996 and 2006 there was a 12.7% growth in people employed in electrical trades, a slightly slower growth rate than the total NSW workforce growth of 13.7%.

Figure 6 and Table 14 indicate that in the sectors where most electrical tradespeople are employed there was an increase in employment between 1996 and 2006. For example both the Construction and the Electricity, Gas and Water Supply industries saw 20% employment growth rates in electrical trades over this decade. This was lower than the overall construction employment growth rate of the same period of 29%, however significantly larger than the Electricity, Gas and Water Supply industry growth rate of 5.1%. However, industries such as Mining and Wholesale Trades saw significant declines in electrical trades employment in NSW between 1996 and 2006 at -20.5% and -52.5% respectively. While both of these industries more broadly saw an employment decline over this period, the electrical trades decline rates were significantly greater. These growth rates are summarised in Table 15.

It has not been possible to do a time-series comparison of electrical trades employment in the Electricity sector as shown in Figure 7 as 1996 Census data is not available in the relevant industry class classifications.

[a] Figure 6 is based on the industry sub classes for “electricity gas and waste services”, but includes the classification of ‘electricity generation’ and ‘electricity supply’ under fossil fuel generation.
[b] The data used in here is based on industry classes from the Australia New Zealand Industry Classification 2006 (ANZIC 06) and are sub-classifications of the ANZIC 06 Electricity, Gas Water and Waste Water Services industry division.

Table 15 Changes in electrical trades and total NSW employment, 1996 - 2006

	% change 1996 – 2006	
	Electrical trades	**NSW employment**
Total employment	+ 12.7%	+ 13.7%
Construction sector	+ 20%	+ 29%
Mining	**- 20%**	**- 5%**
Electricity supply	+ 25%	+ 8.3%
Iron and steel	**- 25%**	+ 23%

Since 2006, a number of events have occurred that have likely impacted NSW electrical trades employment figures. Most significant has been the economic down-turn which has particularly affected the construction sector. As such it is likely that the electrical trades employment growth rate in Electrical Services has slowed or seen a decline in real job numbers. Conversely, the uptake of residential solar PV, which requires licensed electricians for installation, supported by the Federal Government rebate introduced in 2008, may have reduced or avoided any decline in electrical trades jobs as a result of a decline in construction. However, it has not been possible within the scope of this research to test these hypotheses.

6.3 Skills and Qualification levels

The occupation statistics outlined in Section 6.2 cover people employed at different skill and qualification levels typically from supervisor to apprentice. For example the occupations covered by the Electricians grouping include:

- General Electrician
- Electrician (Special Class)
- Lift Mechanic
- Apprentice Electrician
- Apprentice Lift Mechanic
- Supervisor, Electricians

Nevertheless, ABS (1997) suggests for the groups considered in this report, with the exception of Electrical or Telecommunications Trades Assistants, the entry level requirement is an Australian Qualifications Framework (AQF) Certificate III or higher qualification. For Electrical or Telecommunications Trades Assistants, the completion of compulsory secondary education is sufficient. All occupations under the Electricians grouping must also be licensed, while other electrical tradespeople may also have licensing requirements. More information regarding the skills and tasks involved can be found in ABS (1997).

7 Electrical trades in a low carbon economy

7.1 Overview

This study examines the effect of a transition to a low carbon economy on NSW energy sector jobs by means of four scenarios, a business as usual and three scenarios with progressively steeper carbon reductions. In general, the greater the carbon reduction, the more job creation in the energy sector overall. This section looks at the effects on electrical trades. Some key findings are as follows:

- In **Scenario 1: Business as Usual**, electrical trade jobs in electricity supply, associated fuel supply, and energy efficiency stay nearly constant at just under 1,000.
- Electrical trade jobs increase in all the carbon reduction scenarios (Scenarios 2-4).
- In **Scenario 2: 5% reduction**, electrical trade jobs fluctuate between 1,000 and 1,200 until 2012. Jobs then climb to 1,400 in 2014, before falling back to 1,100 by 2020.
- In **Scenario 3: 25% reduction**, electrical trade jobs increase to 1,500 by 2011, then fall back slightly before climbing 1,800 in 2014. After this jobs gradually decrease to 1,500 by 2020.
- In **Scenario 4: 25% reduction and 30% renewable electricity**, electrical trade jobs increase to 1,700 by 2011. Jobs climb to 2,200 in 2014, then fall back to 2,000 by 2020, more than double the numbers in 2010.

This analysis identified just under 1,000 electrical trades people currently employed in the energy sector (defined as electricity supply, fuel supply, and energy efficiency). This compares to just over 35,000 electrical trades jobs in NSW at the 2006 census, so it is not a large percentage of current electrical employment. However, it is likely to include a high proportion of ETU membership, as within electricity supply there is close to 100% union membership.

The overall effect on electrical trades of a transition to low carbon parallels the effect on total job numbers. Under business as usual, job numbers fall slightly by 2020, and as the energy scenarios become progressively lower carbon, job numbers increase. In the lowest carbon scenario (Scenario 4), with a 25% emission reduction and 30% renewable electricity supply, electrical trades employment doubles to 2,000 by 2020.

Figure 8 shows the growth in electrical trades jobs in all scenarios to 2020. Business as usual total employment remains relatively constant, while all the low carbon scenarios show growth in electrical trade employment in electricity supply and energy efficiency. In the lowest carbon scenario (Scenario 4), electrical trade employment rises sharply, and is double the 2010 level in 2020.

Figure 9 shows the electrical trades employment by technology in 2010, and for each scenario in 2020. Electricity supply electrical trade jobs reduce slightly by 2020 in business as usual and both the 5% and 25% carbon reduction scenarios (Scenarios 1-3), although efficiency jobs compensate in the two lower carbon scenarios. In the lowest carbon scenario (Scenario 4), electrical jobs double overall, electricity supply jobs increase by 65%, and efficiency jobs by 300%. Coal generation and coal mining electrical trade jobs are reduced in all scenarios by 2020, most significantly in the lowest carbon scenario.

Note that the energy sector as defined here does not include electricity transmission and distribution. This area employs nearly 3,000 electrical trades people at present, but job numbers are unlikely to be significantly affected by the change to a low carbon economy, although some additional skills may be required as monitoring and control of transmission becomes even more sophisticated.

Not all of the electrical trade jobs identified will be classified as electricity supply, either in census data or by the ETU. In particular, electrical jobs in solar PV and energy efficiency are likely to be within the construction sector.

Figure 8 Electrical trades in energy sector employment, 2010 – 2020 (all scenarios)

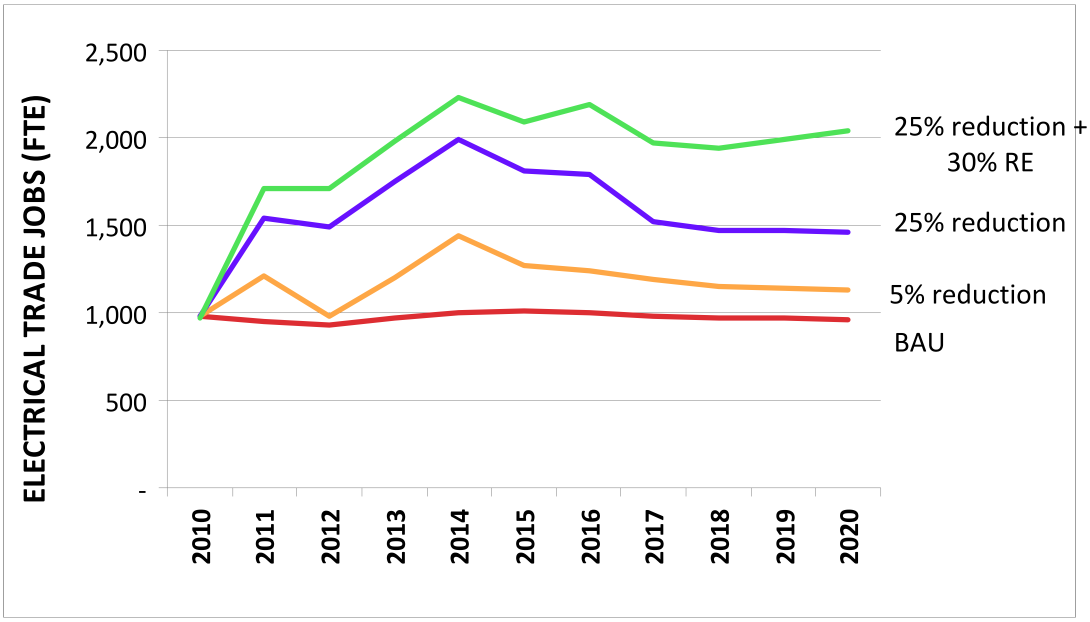
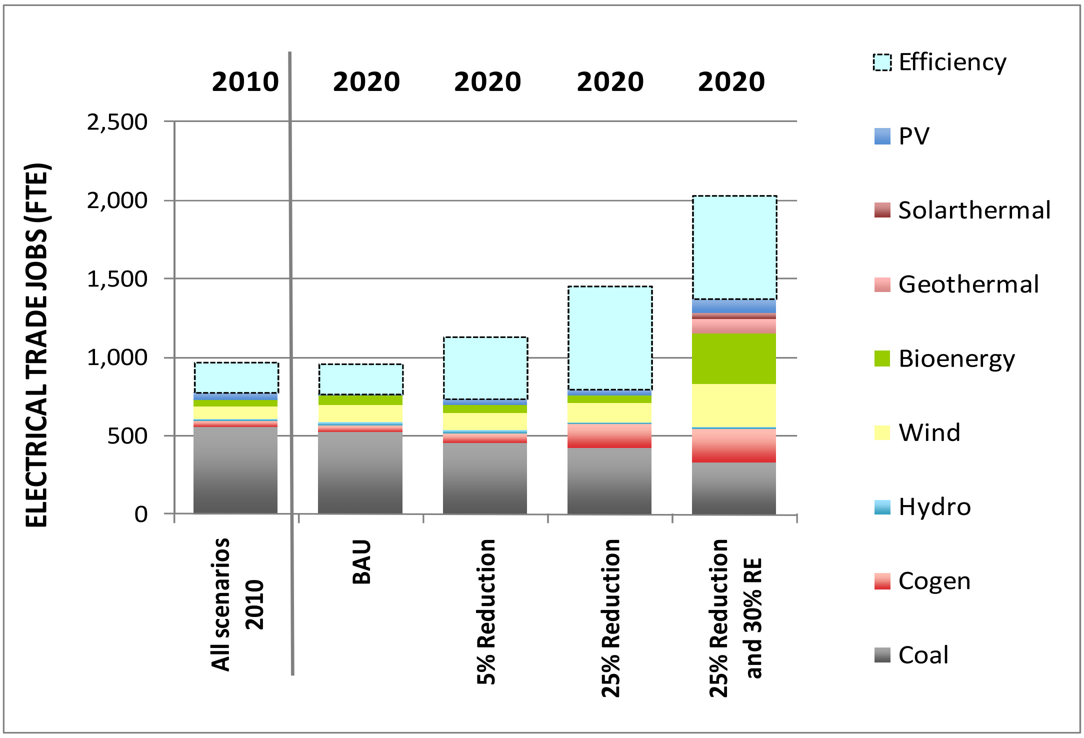


Figure 9 Electrical trades in energy sector employment, 2010 and 2020 (by technology)



7.2 Proportion of trades in each technology sector

We identified the percentage of work done by electrical trades in each of the technology sectors in the industry consultation, in order to extrapolate the modelling of overall energy sector employment. Table 1 shows percentages assigned to electrical trades, and comes from either census data or the industry consultation (see Section 5 for detailed results from the industry consultation).

While we were not able to interview bioenergy companies, the cogeneration employment breakdowns for operations and maintenance, and development and construction, are assumed to be similar to bioenergy. Both technologies are likely to have small (less than 5 MW) turbines, whether gas or solid fuel fired. In fact, one of the cogeneration companies interviewed did have biogas installations, which are included in the cogeneration data.

We have also used the cogeneration data for operations and maintenance in solar thermal and geothermal technologies, which are both based on steam turbines. No electrical trades input is calculated for construction and development, as the correspondence between this and other technologies seems too uncertain. Therefore the electrical trades figures for solar thermal and geothermal may be higher than is suggested in this analysis.

We were not able to interview sufficient companies within the scope of this project to have a high level of confidence in the results, particularly in energy efficiency. However, results are indicative of the likely trends for electrical trades.

Table 16 Percentage of electrical trades employment by energy technology

	Development, construction/ installation	Manufacturing	Operations & maintenance	Fuel	Notes
Coal generation	n/a	n/a	19%	5%	Derived from census data.
Cogeneration	26%	n/a	21%		Derived from industry consultation; includes biogas. Two companies only interviewed, including one biogas operator. .
Hydro			3%		Derived from census data.
Wind	8%	3%	43%		Derived from industry consultation.
Solar PV	26%	n/a	21%		Derived from industry consultation.
Energy efficiency	32% combined				Derived from industry consultation; covers commercial and industrial sectors only & includes apprentices. Considerable uncertainty about result as sector is so varied.

Notes: n/a = not available

7.3 Detailed results

Figure 10 shows the electrical trade energy sector employment in from 2010 to 2020 in the lowest carbon scenario, while Table 7 and

Table 8 give the results at 2010, and for all scenarios at 2020. Appendix E shows the results each year for all scenarios.

Under the low carbon scenarios electrical trade employment in coal generation and coal mining reduces over the period, and employment in renewable electricity and cogeneration increases. This trend increases in progressively lower carbon scenarios, so that employment doubles in the lowest carbon scenario, compared to a small reduction in business as usual.

In all but Scenario 4, the lowest carbon scenario, there is a significant reduction in trade employment in construction associated with electricity supply, as shown in

Table 8. This is largely a result of the current boom in renewable electricity expansion, which is likely to reduce sharply around 2013/2014 owing to the current structure of the Commonwealth Renewable Energy Target.

There is a boost to energy efficiency employment between 2012 and 2016 in both Scenario 3 and 4, the 25% emission reduction scenarios, as they both include a roll out of smart meters, creating 200 electrical jobs per year for five years.

The distribution of employment within the electricity supply sector changes significantly over the period in the low carbon scenario with enhanced renewable energy. Coal generation falls from 75% of electricity supply electrical trade employment to only 25% by 2020. Wind energy, bioenergy, cogeneration, and solar PV all demonstrate particularly strong growth. Energy efficiency shows particularly strong growth, accounting for 36% - 50% of the estimated electrical trade employment in the low carbon scenarios, up from 23% in 2010.

Figure 10 Electrical trade employment 2010 – 2020 – lowest carbon scenario (Scenario 4: 25% reduction plus expanded renewable electricity)

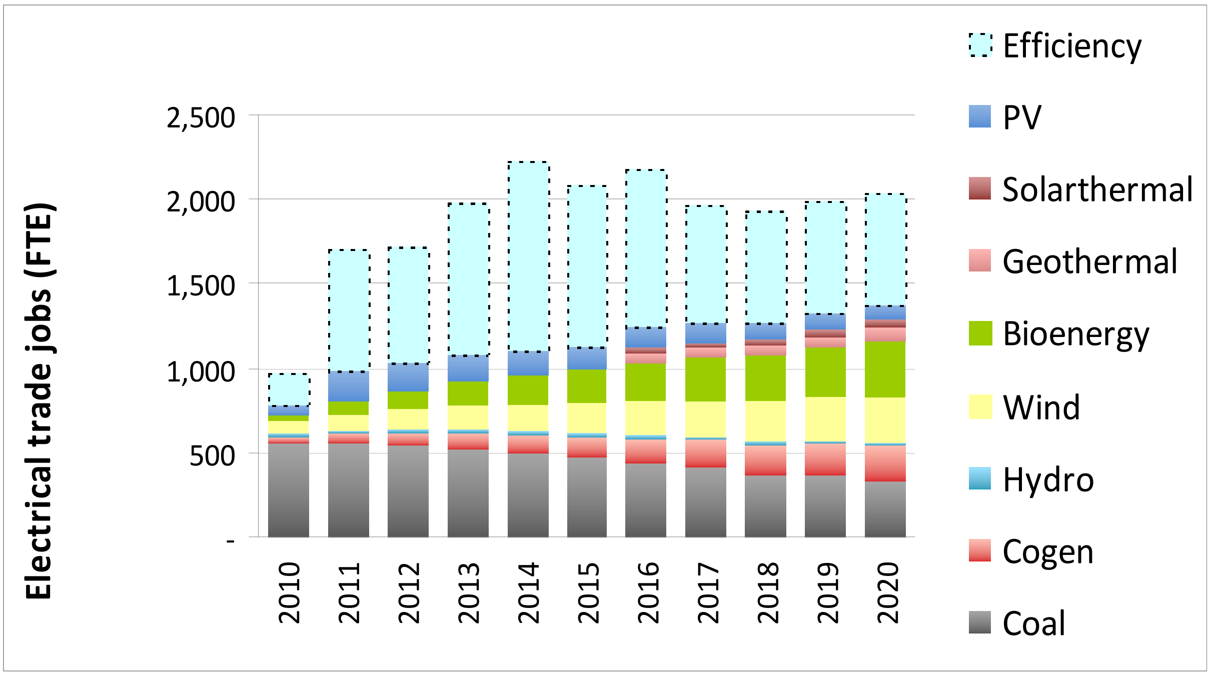


Table 17 Electrical trades energy sector jobs at 2010 and 2020, by technology

	2010 jobs (FTE)	2020 jobs (FTE)			
	All scenarios	Scenario 1: BAU	Scenario 2: 5% reduction	Scenario 3: 25% reduction	Scenario 4: 25% reduction and 30% RE
Coal	556	524	451	425	337
Gas cogeneration	36	44	64	148	206
Hydro	15	18	18	18	18
Wind	77	116	116	116	272
Bioenergy	41	52	52	52	324
PV	59	17	40	40	90
Efficiency	192	192	389	660	660
Total	**976**	**963**	**1,130**	**1,458**	**2,038**

Table 18 Electrical trades energy sector jobs at 2010 and 2020, by type

	2010 jobs (FTE)	2020 jobs (FTE)			
	All scenarios	Scenario 1: BAU	Scenario 2: 5% reduction	Scenario 3: 25% reduction	Scenario 4: 25% reduction and 30% RE
Manufacturing	1	1	2	2	25
Construction & installation	123	16	39	55	248
Operations & maintenance	512	604	569	636	1,030
Fuel	147	150	131	106	74
Efficiency	192	192	389	660	660
Total	**976**	**963**	**1,130**	**1,458**	**2,038**

8 Training needs

8.1 Current Training Gaps

From a preliminary desktop analysis and industry consultation, notable gaps in continuing development (CPD) training available to electricians appear evident in the areas of:

- Large-scale commercial photovoltaic systems (including gaps in technical and project management skills)
- Wind and micro-hydro energy generation systems
- Energy efficiency, particularly hot water systems (some topics are covered by CPD, but in limited depth)
- Energy auditing and management for commercial and residential buildings
- Home automation
- Several companies interviewed also stated the need for training in general OH&S and site management

There are a number of courses that cover domestic grid connect photovoltaic systems, while many larger renewable energy (e.g. solar PV and wind) and electrical contracting companies run training courses for electricians in-hose. Nonetheless, a skills shortage may still result due to external factors that increase demand (such as the feed in tariff recently introduced in NSW). Demand for auditing skills is also likely to increase significantly with the introduction of mandatory disclosure of building energy performance.

An observation was made that some training topics could be better differentiated in line with the different industry sectors in which electricians work. For example, some of the energy efficiency training reviewed covered a mix of topics for residential and commercial electricians, which could diminish perceived relevance or appeal if most electricians tend to work in one sector or the other.

8.2 Review of existing courses

Training in sustainable energy for electricians

The basis for the training of licensed electricians in Australia is the *Electrotechnology Training Package UEE07* developed by the Energy Utilities Industry Skills Council. Many of the units of competency in UEE07 are outside the licensing requirements for electricians and are therefore not part of the basic training. This includes those related to sustainable and renewable energy practice.

Renewable energy

There are a number of nationally recognised courses available in the area of renewable energy, particularly grid connect photovoltaic systems. Many of these are Certificate or higher level courses offered through TAFEs, but some are offered as either full or part certificate courses for qualified electricians by various Registered Training Organisations (RTOs) and are nationally recognised training. These are often based on the relevant units of competency from UEE07.

Accreditation to design and install renewable energy systems is industry regulated through the Clean Energy Council, and is not a licence.

Photovoltaics

There are several training courses offered that provide Clean Energy Council accreditation. However, these focus on smaller scale domestic installations and not larger scale commercial power generation systems.

One interviewee in the solar installation business stated that there is likely to be a skills shortage in electrician installers in 2-3 years as the PV industry grows. There may be a lack of training capacity if PV installation increases rapidly due to gross feed in tariffs or other government regulations or incentives. They see a particular skills shortage in grid connecting larger systems (more than 500kW). They are currently employing engineers from overseas with the required skills. However, they also stated that they are unaware on any training programs for electricians in their industry.

They also consider there is a lack of training in project management, particularly for larger scale projects, and people who understand ISO standards. There are units of competency in UE007 that deal specifically with project planning and management that could be used as the basis for project management training specifically related to sustainable energy.

The capacity to train an adequate number of PV accredited electricians needs to be monitored. A training gap may be for a specific course in the installations of larger scale grid connected systems.

Other renewable energy sources

There is little in the way of non-TAFE CPD courses on offer at present for wind power and micro-hydro. The market for wind power and hydro is currently for larger scale systems than PV. Small scale wind and micro-hydro are more relevant to remote stand alone systems than grid connect, and these are few in number.

One company is offering Australia's first wind farm electrical apprenticeships in conjunction with Certificate III in Electrotechnology - Electrician Apprentice (UEE30807) at RMIT to overcome skills shortages. They also provide in-house training in wind turbine technology.

EU007 does contain units of competency for wind power and micro-hydro, and these are included in the Certificate IV in Renewable Energy UEE41607. There do not appear to be any courses currently on offer that provide CPD type training in these specific skill areas.

Specific training in bio energy generation may not be as important, as many of the skills required are generation equipment related and may already be covered by other generation technology training for electricians.

Energy Efficiency

The EcoSmart Electrician, Global Green Electrician and Green Electrician courses all include elements of energy efficiency. However, as would be expected in such short courses covering a range of topics, it is not at an in-depth level for all issues. The EcoSmart Electrician course has good coverage on pumps, motors and lighting but lacks in other areas, such as water heating. For example, solar water heating is covered in a superficial way and there is only the briefest mention of heat pumps. Ideally other modules would be added to the course to cover these and other areas in more depth.

Although the detailed content of the Global Green course has not been available for review, the outline provided suggests that although about twice as long as the EcoSmart course, it is much more focused on regulatory and sustainable workplace issues. The technical content may not be in any more depth than the EcoSmart course. The two units of competency from UEE07 (UEENEEK42a and UEENEEK45A) used in the course are both concerned with sustainable workplace practice. These include efficient use of energy in the workplace, but it is not the prime focus.

NABERS and the home sustainability assessment courses also contain some material on energy efficiency, but it is not in-depth. No other generally available CPD courses were found.

There is no specific Certificate course offered in energy efficiency. UEE07 does contain some relevant units of competency (*Develop strategies for effective energy reduction in buildings* UEENEEK041B, *Design energy management controls for electrical installations in buildings* UEENEEK046A) but these are not core or stream core units in any of the other Cert IV renewable / sustainable energy related qualifications.

In anything other than a business as usual energy future for Australia, energy efficiency will play a major role, equal to or greater than any other individual form of clean energy production. It would appear that there is a gap in higher level CPD training in energy efficiency.

It may make more sense to have courses that specialise more in the residential, commercial and industrial sectors to reflect the fields that electricians tend to work in. For example, the EcoSmart course lighting module could be of relevance for all these areas, but the module on pumps and motors may not be of much relevance to someone working entirely in the single or medium density residential sector. A module on hot water systems would probably be of more benefit.

Energy auditing and management

There are a limited number of recognised courses in energy auditing and management. This will become an increasingly important issue as mandatory disclosure (MD) of the environmental performance of buildings is introduced over the next few years. MD for energy performance of commercial buildings commences in 2010 and for the residential sector in 2011 (already in place in Queensland).

One interviewee stated “there is a particular lack of people with qualification or experience in energy management” so this lack of energy auditing and management is seen as an issue by some businesses.

MD for commercial buildings will require a NABERS assessment by an accredited assessor.

The Electrical and Communications Association Queensland (ECAQ) has developed an energy auditing course aimed at leading to accreditation as a MD assessor for the residential sector. It is a pre-requisite to obtain Energy Management Institute accreditation to perform energy audits for residential, office and retail.

The EcoSmart, Global Green and Green Electrician courses all include elements of energy auditing and management. From the course materials available to view, coverage is fairly superficial and does not deal in detail how to conduct an audit. They are based on VPAU283 – *Advise on electrical energy management* and

VPAU284 – *Implement efficient electrical systems* that comprise the *Course in Electrical Energy Efficiency* (21876VIC).

The courses designed for home sustainability assessors (e.g. to support the Green Loans program) are probably too general to satisfy the needs of most electricians, but do include a session on how to conduct a residential energy assessment and a practical exercise in conducting an assessment.

There is an AQF qualification Certificate IV in Energy Management and Control UEE41007 but this does not appear to be currently offered by any training organisation.

One area that could become important is ‘home automation’. This is currently in its early stages of development with systems such as C-Bus, but will increase in popularity with the widespread use of more sophisticated mobile communication systems. Some manufacturers such as Clipsal offer their own training courses but there do not appear to be any general CPD type courses in this area at present.

It would appear that there is a gap in higher level CPD training in energy auditing and management.

9 Conclusion

Since the mid 1990s, total employment in electrical trades has grown, albeit at a slower rate than NSW employment as a whole. This growth has principally occurred in the construction and electricity supply industries, while electrical trade jobs in mining and processing industries have declined. Although note that this research only considers employment in electricity supply and energy efficiency, two sectors that will be directly affected by the transition to a low energy supply.

The research finds that under a “business as usual’ scenario, both total employment and employment in electrical trades in these sectors will decline towards 2020. However, this study demonstrates that both total energy sector employment in NSW and jobs in electrical trades increase with progressively lower carbon energy scenarios.

In the business as usual case (Scenario 1), NSW jobs in electrical trades fall by 1% by 2020, while in the 25% carbon reduction case (Scenario 3) we see 56% increase in electrical trades jobs. In Scenario 4, with 25% carbon reduction and expanded renewable energy (the lowest carbon scenario), we see a 110% increase in electrical trade jobs.

Thus despite significant uncertainties associated with the employment data, it appears clear that electrical trades have much to gain from a transition to a low carbon economy.

The job losses seen in the business as usual case are primarily the result of the reduction in current renewable energy construction employment. These could be mitigated by structuring renewable energy support policies to ensure that industry development is constant, rather than a continuation of the boom bust cycle that has been observed in Australia over the last decade.

The assessment of training needs drawn from our preliminary desktop analysis and industry consultation also identified some notable gaps in continuing development (CPD) training available to electricians in the areas of:

- Large-scale commercial photovoltaic systems (technical *and* project management skills)
- Wind and micro-hydro energy generation systems
- Energy efficiency, particularly hot water systems
- Energy auditing and management for commercial and residential buildings
- Home automation
- General OH&S and site management

Providing that the electrical trade industry is able to quickly and effectively deliver qualified and well trained service providers across the range of skills needs associated with the uptake of renewable energy and energy efficiency technologies, electrical tradespeople stand to make significant gains from opportunities presented by a low carbon “green economy”.

10 Further Research

In order to obtain the most out of this research and to assist in building political momentum for pursuit of a low carbon future through delivery of positive employment outcomes, the team in conjunction with ETU and NECA identified the following priority areas of further research:

- Further investigation of the changing *nature* of the jobs in electrical trades the driving forces behind these changes. For example, newly available products in residential and commercial construction, which are changing the trade labour requirements on site. Focussing solely on job numbers is a good platform to establish gross trends, but risks simplifying the more complex underlying effects.
- Detailed research on specific training needs in the trades to meet the requirements of the emerging green economy, including both basic trade qualification and Continuing Professional Development (CPD) courses.
- Investigation of the potential impact of local low carbon product design and manufacturing on jobs and the balance of trade, as well as the policy implications that flow from this.
- Investigation of the actual and potential industry implications of the trend towards less qualified tradespeople installing low carbon energy technology, such has been reported in the solar PV industry in interviews conducted as part of this research.
- *Indirect* (flow-on) job implications of low-carbon future energy sector scenarios and policies (this study was restricted to quantifying *direct* jobs).
- Detailed profiling of the jobs and skills associated with energy efficiency products and services, across a broad range of private sector providers, including areas such as facilities management. This research indicated that an increasing focus on energy efficiency is likely to lead to more jobs for electricians working outside their traditional capacity (for example in energy efficiency sales and project management).

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