CLIMATE COUNCIL

RENEWABLE ENERGY JOBS: FUTURE GROWTH IN AUSTRALIA

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Key Findings

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This report compares two scenarios for the national energy sector - business as usual renewable energy growth (34% renewable electricity in 2030) and 50% of electricity derived from renewable sources in Australia by 2030. Both scenarios show increased uptake of renewable electricity will create employment nation-wide.

› 50% Renewable Electricity (50RE) scenario in 2030 will lead to over 28,000 new jobs, nearly 50% more employment than a business as usual (BAU) scenario.

› Jobs are created in the construction, operation and maintenance of renewable energy installations, as well as in related industries.

› Across the period 2014-2030, over 80% of full-time employment created by 50RE is additional to the economy.

› Job losses in coal fired electricity generation are more than compensated for by increased employment in the renewable energy sector. However, the transition for employees in the fossil fuel sector must be planned well.

2

The net effect on jobs of 50RE is positive across Australia and each individual state: every state will experience net job growth.

› New South Wales (NSW) and Queensland will have the largest net growth in jobs, around 11,000 and 6,000 respectively.

› South Australia and NSW will experience the largest per capita jobs growth.

› Victoria will see a net gain of around 4,000 jobs by 2030.

3

Unlike other industry transitions such as in automotive manufacturing and steel smelting, which have seen many jobs move offshore, a transition to 50RE will create jobs in Australia.

› A large proportion of new jobs gained in the electricity supply sector by 2030 will stem from construction and installation activities related to renewable energy infrastructure. Many of these jobs will be additional to the economy, though location and skills may differ from those currently in demand.

› Most states will see half of all new jobs created in rooftop solar photovoltaics (PV): rooftop solar PV jobs are generally accessible, being located in areas where people already live and work.

› Utility scale renewable power in regional and remote Australia may well offer opportunities to increase employment in those regions.

› Job creation and job transition, together with infrastructure planning, would benefit from a long-term, sector-wide approach to managing the accelerated renewable electricity deployment.

1. Introduction

Climate change is happening now and must be tackled effectively.

Many consequences of climate change, driven largely by the burning of fossil fuels (coal, oil and gas) for electricity, are already evident.

Average surface temperature over the Australian continent has increased by 0.9°C since 1910. In Australia, the incidence of extreme temperatures has increased markedly over the last 50 years, while heatwaves have become hotter, are lasting longer and occur more often.

Projections of the escalating risks of climate change under a business as usual, high emissions scenario are becoming more certain and more disturbing. More extreme heat is virtually certain across the continent, and southern and eastern Australia will experience harsher fire weather. Extreme rainfall will likely become even more intense. Time in drought is expected to increase in southern Australia, with a greater frequency of severe droughts. Coastal flooding is very likely to increase as sea level rises at an increasing rate. However, there are clear solutions to the climate change challenge.

A transition to renewable energy from fossil fuels is a key strategy to tackle climate change.

Last year, nations world-wide agreed to act to limit global warming to less than two degrees Celsius (2°C). To meet this goal and to limit the impacts of climate change, the global economy will require deep reductions in greenhouse gas emissions.

In addition to reducing emissions from the electricity sector, other factors such as steep declines in the cost of wind and solar are driving record investment and capacity additions in renewable energy. As a result, more than eight million people are now employed across the globe in the renewable energy industry (REN21 2016).

With electricity generation accounting for around 40% of global greenhouse gas emissions, reducing emissions in this sector is a critical component. Australia does not face this challenge alone; however, with an electricity sector that is one of the most emissions-intensive in the world, Australia may see a greater scale of change than some other industrialised countries where the transition is already progressing. Yet as

Attaining at least 50% renewable electricity generation by 2030 is a key action to help Australia meet its share of the global commitment to tackle climate change.

one of the sunniest and windiest countries in the world, Australia has enormous potential to transition to an economy powered increasingly by renewable energy. Moreover, some states and territories, such as the Australian Capital Territory and South Australia, are already leading the way.

Australia's electricity market can move quickly from fossil fuels to renewable electricity.

Australia's electricity market is currently dominated by ageing fossil fuel-based electricity generators, with only 14.6% of electricity coming from renewable energy like solar and wind (Clean Energy Council 2016). At the same time, research suggests that Australia would need to source a minimum of 50% of its power from renewable sources by 2030 to achieve emissions reductions consistent with a 2°C pathway (ClimateWorks 2014). Decarboninising Australia's electricity sector is critical to reducing emissions in both that sector, and also enables other areas such as transport to dramatically reduce emissions. Australia can achieve over 50% of its electricity generation by 2030 through existing, available technologies and practical, cost-effective measures, with additional capacity requirements able to be met through existing identified projects (ClimateWorks 2015; IRENA 2016).

Employment over the energy transition is an important issue to explore.

The physical implications of a move towards greater renewable electricity – new generating capacity, significant investment, reduced greenhouse gas emissions – have been explored for a range of scenarios in many countries. However, employment associated with the electricity sector, and the impact of an accelerated uptake of renewables on employment in the sector, has received considerably less attention. As in other economic and technology shifts, jobs will be lost and new jobs will be created. Some jobs will be easy to replace, while others may require re-training, upskilling or relocation, or may disappear.

More electricity-sector related jobs are created through the 50% renewables scenario than in the business as usual scenario across Australia.

Change accompanying industrial transition is not new or unique to the electricity sector. However, in common with other industries, employment changes also impact directly on people and communities, for whom the whole of economy perspective may well be a secondary concern. This report explores some of the employment opportunities, and challenges, that Australia may face as the electricity sector transitions. We examine how the transition will affect the economy as a whole, but also how individuals and the communities that they are part of might be affected, and what type of measures might be taken to mitigate this.

This report focuses on the employment impact of an accelerated uptake of renewable electricity generation that sees Australia derive 50% of its electricity from renewable sources by 2030 (50RE), against a business as usual (BAU) scenario of 34% of electricity from renewable sources by 2030[1]. This report explores the employment effects that are likely to flow from this increase in renewable electricity, and corresponding decrease in the use of fossil fuelled electricity, referencing similar transitions that are underway in other sectors and countries. Based on this, this report sets out to better understand how Australia can best manage the employment implications of this transition.

There are ethical, environmental and health reasons for transitioning away from fossil fuel electricity generation. However, the focus of this report is narrowly on employment, and does not explore these wider issues. Neither does it consider the broader system effects of large-scale renewable electricity generation, or policy settings that would accompany a transition from coal and gas-fired electricity generation to renewable electricity generation. Rather, this report focuses on the comparative employment effects of accelerated renewable electricity uptake, including both the new employment generated in the renewables sector, and also the consequences for employment in both fossil fuel generators and their fuel supply streams.

At a national level, both the BAU and 50RE scenarios lead to additional employment in the electricity sector, resulting from both construction of new electricity generating infrastructure and from the operation of existing and new generating capacity. The accompanying job losses due to reduced coal fired electricity generation are more than compensated for by additional jobs created in renewables energy construction and operation. Jobs are created in both scenarios in all states, although some more than others. The BAU scenario illustrates that Australia is already moving away from coal energy to renewables.

[1] Business as usual renewable energy increases are driven by a combination of the 33,000 GWh by 2020 large-scale component of the national Renewable Energy Target, continuing rooftop solar PV deployment plus some additional wind and utility scale solar PV.

2. International and National Climate Policy

At an international level, the United Nations Framework Convention on Climate Change (UNFCCC) is the primary inter-governmental forum for international climate policy development and agreement.

The most recent Conference of the Parties to the UNFCCC held in Paris in December 2015 (COP21), was widely seen as a milestone in international climate policy. World leaders committed to work together to tackle climate change in a strong agreement that requires countries, big or small, rich or poor, to pursue efforts to limit global warming. The Paris agreement is a universal agreement involving over 190 countries around the world (including Australia) to limit the temperature increase to well below 2°C above pre-industrial levels, and to pursue efforts to limit the increase to 1.5°C. Almost all nations have submitted pledges to reduce their emissions over the next 10-15 years and have committed to continually review and strengthen their emissions reduction targets.

Analysis of the Intended Nationally Determined Contributions (INDCs) - emission reduction targets each country intends to contribute - indicates that, with *all* current INDCs being ratified *and* delivered, warming of between 2.4°-2.7°C by 2100 compared with the pre-industrial levels would be expected (Climate Action Tracker 2015). Stronger action is clearly required to tackle climate change.

While a 2°C rise in temperature above pre-industrial levels has been established as a policy target, even this level of warming may drive significant impacts. As scientific knowledge improves, it is becoming clear that risks previously considered to lie only above 2°C may occur at lower temperatures. With just 0.9°C of warming to-date, Australia has already experienced adverse consequences (CSIRO and BoM 2015). Hot days have doubled in the last 50 years (CSIRO and BoM 2012), while heatwaves have become hotter, last longer and occur more often (Perkins et al. 2012; Climate Council 2014a). Similarly, extreme fire weather has increased over the last 35 years in southeast Australia, putting people and property at risk (Johnston 2009; Climate Council 2013). Property and infrastructure across Australia has been built for previous climatic conditions, and is ill-prepared to cope with increasingly frequent and/or intense extreme weather. For instance, over $226 billion in commercial, industrial, road, rail and residential assets around Australian coasts are potentially exposed to a sea-level rise of 1.1 metres, possible by the end of the century under a high emissions scenario (DCCEE 2011; Climate Council 2014b).

As part of the COP21 agreement, Australia has committed to a 26-28% reduction in greenhouse gas emissions by 2030 (compared to 2005). This is less ambitious than emissions reductions recommended by the Climate Change Authority (CCA), which advised Australia's post- 2020 target should include: a 2025 target of a 36% reduction compared to 2005, and; further reductions of between approximately 45 to 65% below 2005 levels by 2030[2].

To achieve a 26-28% reduction in greenhouse gas emissions by 2030, the Australian government is pursuing a range of policies, including: the Renewable Energy Target to encourage the additional generation of electricity from sustainable and renewable sources (Clean Energy Regulator 2015); the Emissions Reduction Fund, to purchase abatement from a range of activities in Australia, and; the Safeguard Mechanism, which aims to limit future greenhouse gas emissions from large businesses in Australia.

Of these three pillars, the Renewable Energy Target is most clearly focused on the electricity sector. The target is split in two, with demand for large-scale renewable electricity supported by requiring retailers to source an increased share of renewable energy, which is supplied by new renewable generation assets like wind and solar farms. Small-scale generation, such as rooftop solar PV, is supported via a similar but uncapped mechanism, and this generation does not form part of the 33,000 GWh 2020 renewable electricity target.

3. Modelling Approach

This report compares employment[3] arising in Australia from development, construction and generation activities in the electricity sector in Australia under BAU and 50RE scenarios by 2030.

To achieve this, two interlinked models are used to estimate the comparative impact of accelerated uptake of renewable electricity in Australia: an electricity generation forecast model, and a sectoral employment model. Combined, these models allow employment (construction, operation and maintenance jobs) to be estimated for both the BAU and 50RE scenarios in 2030.

[2] The CCA's recommendations are based on a two-thirds chance of limiting warming to 2°C above long-term levels. For a greater chance of meeting this ambition, emission reduction targets would need to increase further.

[3] In this report, 'employment' and 'jobs' are used interchangeably to refer to employment in a particular year (or the difference in employment between two years). FTE (full time equivalent) employment typically refers to the total employment years occurring over a given period.

Electricity Model

This report uses EY's Australian electricity forecast model to forecast electricity capacity and generation in Australia to 2030 on an annual basis. This model forms the basis of both the BAU and 50RE scenarios.

Business as Usual (BAU) Generation Scenario

Under current policy settings, Australia is forecast to increase its renewable electricity generation from producing around 15% of electricity today to 34% in 2030, including large-scale hydro, wind, utility scale and rooftop photovoltaic (PV) panels, and biomass. This is the BAU scenario.

The BAU scenario shows a likely evolution of the Australian electricity network, based on current policy settings, known retirement of existing coal and gas fired generators, demand forecasts provided by the Australian Electricity Market Operator (AEMO), and other assumptions regarding future build decisions (see Annex 1 for further details). The model anticipates that in 2030, renewable electricity will contribute around 34% of total electricity demand for the National Electricity Market (the electricity grid connecting Queensland, New South Wales, Victoria, South Australia and Tasmania) plus the South West Interconnected System (the electricity grid connecting southwest Western Australia)[4].

50% Renewable Electricity (50RE) Generation Scenario

The 50RE scenario models a potential pathway for accelerated renewable energy deployment in Australia. The BAU and 50RE scenarios are identical prior to 2020; however, for the period 2020-2030 the 50RE scenario sees significantly more renewable electricity generating capacity being built and operated in Australia. To achieve this, the model increases the rate of renewable electricity new-build (wind, utility scale and rooftop PV) linearly from 2020 to 2030, scaled to deliver 50% of electricity from all renewable electricity sources in 2030[5,6].

Due to the extra electricity generation from renewables, less fossil fuel electricity generation (black and brown coal, combined cycle gas turbines and open cycle gas turbines) is required. In the 50RE scenario, coal capacity has been reduced (through plant closures) such that the remaining plant achieves the same average power output over time (capacity factor) as under the BAU scenario[7].

The 50RE scenario retains the forecasts for hydro, diesel, cogeneration and biomass that are assumed for the BAU scenario. The contributions from diesel, cogeneration and biomass were less than 2% of total generation in 2030 under the BAU scenario.

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[4] This report does not consider current or future generation in the Northern Territory or Australian Capital Territory as comparable AEMO data is not available for the territories.

[5] An increasing proportion of renewable electricity on an existing electricity network can impose additional network requirements, such balancing, frequency control and other reserve services. While the BAU scenario addresses these requirements, the network and security of supply implications of the 50RE scenario have not been investigated. It is possible that the 50RE scenario may require additional capital or operational activities, including the potential for battery storage, to ensure an equivalent level of security of supply. By excluding the employment impacts associated with any additional network service requirements under the 50RE scenario, this report takes a conservative approach of potentially underestimating the employment that would arise from these activities under the 50RE scenario.

[6] While additional policy settings would likely be required to achieve this higher rate of renewables uptake, this report is not prescriptive as what those policy settings should be. Achieving the 50RE scenario will require additional renewable electricity generation, which will have impacts on employment: this employment impact will be in proportion to the type and degree of renewables uptake, but is broadly insensitive to the policy settings used to drive the additional renewables uptake.

[7] Employment creation from decommissioning activities, whether under the BAU or 50RE scenarios, is not included in the scenarios modelled. As increased decommissioning would be anticipated under the 50RE scenario in comparison to the BAU scenario, the exclusion of decommissioning employment takes a conservative approach that potentially underestimates the additional employment that would arise from these activities under a 50RE scenario.

Employment Model

Economic activity, such as planning, building and operating electricity generators, creates employment. Some employment is long-term, some is shorter-term: some employment is directly associated with the economic activity, while some additional employment occurs indirectly in other sectors of the economy.

This report considers the economy-wide employment that flows from economic activity associated with electricity construction and generation under the BAU and 50RE scenarios, including jobs that are directly linked to the activity and those that have a less immediate connection. These different types of employment generation are referred to as Scope 1, 2 and 3 employment, described below (and illustrated using the example of a wind farm in Box 1).

Scope 1 employment refers to labour associated directly with the economic activity of a sector. For the electricity industry these jobs include employment associated with the construction, operation, maintenance and development of electricity generators, be they coal fired power stations, wind farms or solar PV plants.

Scope 2 employment results from a direct relationship between the electricity project or company and a supplier. This might include jobs associated with mining coal (for a coal fired power station) or those that are involved in producing solar PV panels. Scope 1 and 2 jobs are often referred to as direct and indirect employment, with the important distinction between the two being their relation to a product, project or business.

Scope 3 employment is the total employment that occurs along the entire supply chain of a product. Scope 3 employment includes scope 1 and 2 employment, but additionally includes all employment occurring further up the supply chain.

BOX 1: ILLUSTRATING EMPLOYMENT TYPES USING THE EXAMPLE CASE OF A WIND FARM

- **Scope 1** includes employment associated with project development, construction of access tracks, erecting wind turbines and ongoing operational employment such as site managers.
- **Scope 2** includes the manufacturers who supply turbine parts or equipment that contributes to the development and construction of the wind farm.
- **Scope 3** employment would include (for example) employment in the steel industry to produce the raw material inputs for wind turbines, together with wider employment generation[8].

[8] Economic activity in the electricity sector in Australia can also generate employment outside of Australia: examples would include employment associated with the overseas manufacture of solar PV panels for rooftop or utility-scale solar electricity systems, or steam turbines for thermal power stations which are imported into Australia. The employment analysis in this report does not include jobs created outside of Australia as a result of economic activity in the electricity sector in Australia.

BOX 1: CONTINUED

Figure 1: Wind farm employment associated with construction and manufacturing activities.

Employment Multipliers

To determine the Scope 1, 2 and 3 employment impacts for the BAU and 50RE scenarios, employment multipliers were taken from the Eora input-output model[9]. Employment multipliers were derived for operational expenditure in electricity generation and capital expenditure for new build: further refinements were carried out to derive employment multipliers for generation (GWh/y) and new build capacity (MW/y).

Employment multipliers are expressed per MW of new build capacity. However, considerably more solar PV or wind power capacity is required to produce the same amount of energy as from conventional coal or gas fired power stations. As a result, future scenarios with significant renewable electricity generation tend to be associated with significant job creation from construction.

For the construction employment multipliers, the economic activity that drives employment does not occur within a single sector only: for example, the construction of wind turbines drives economic activity across a range of different sectors. The capacity multipliers derived from the Eora model were weighted (using data from the International Renewable Energy Agency - IRENA) to reflect the contribution of different sectors to the construction of wind farms. Further, not all employment associated with wind farm construction would be generated in Australia: for example, while laying foundations and access tracks for wind turbines needs to occur locally, the wind turbine generator itself (blades and nacelle) are usually manufactured overseas. Expenditure splitting was carried out by analysing capital costs associated with technology types to distribute the total costs across the participating sectors. These sectors were also analysed in relation to the activities occurring within Australia and those occurring internationally. International employment driven by local investment (for example, manufacturing of solar PV panels, wind turbine generator blades and nacelles) has not been included in the jobs figures associated with BAU and 50RE scenarios.

[9] While the Eora model provides a highly disaggregated view of the Australian economy, it does not directly provide separate employment multipliers by electricity generating technology. To address this, additional employment data was obtained from the Department of Industry, Innovation and Science, and from IbisWorld, and used to further refine the employment multipliers obtained from Eora.

4. Australia's Electricity Market

Electricity Generation and Demand

Despite an increase in the share of renewable electricity over the past five years from 7.5% (in 2009) to 14.6% (in 2015), Australia's electricity market remains dominated by fossil fuels (Australian Government 2015a; Clean Energy Council 2016). In 2014, fossil fuels (mainly coal and natural gas) accounted for 85.4% of Australia's annual electricity generation and renewables accounted for the remainder (Clean Energy Council 2016). Black and brown coal makes up the largest proportion of Australia's energy production (Figures 2 and 3).

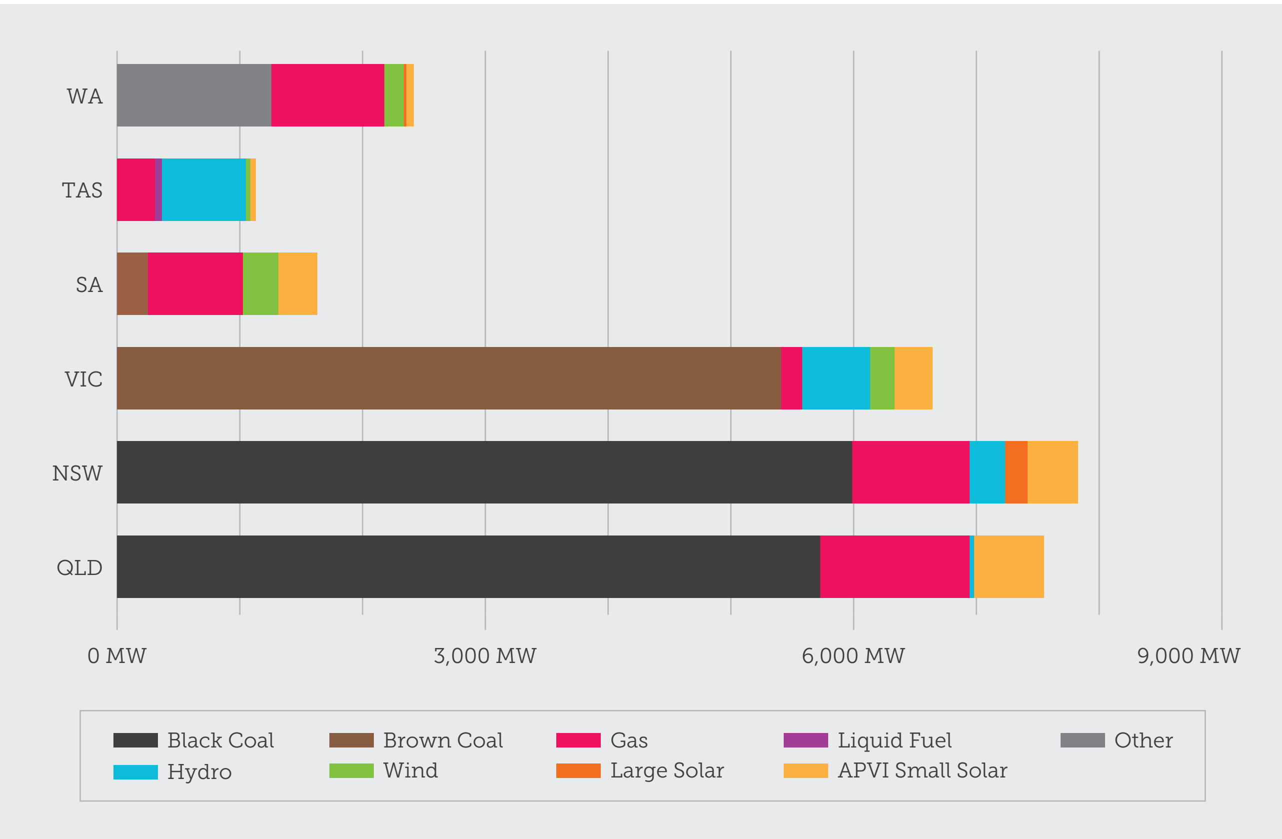


Figure 2: Australia's live electricity production by energy sources in 2014 (REneweconomy 2016).

A primary consideration for forecasting changes in the electricity market is future electricity demand, including the magnitude of peak electricity demands. Except for the period 2010 to 2013, electricity consumption in Australia has been rising (Australian Energy Regulator 2015), and is forecast to continue to rise over the next 40 years (Bureau of Resources and Energy Economics 2014). Increasing energy efficiency in businesses and households, as well as significant uptake of distributed generation technologies, such as rooftop solar PV, has impacted demand for electricity. However overall electricity demand grows due to population growth and increased industrial consumption from Queensland liquefied natural gas projects (AEMO 2015). Domestic consumption of coal-based electricity has generally decreased over the years, although in the past year consumption of black and brown coal increased (Australian Government 2016) (following the repeal of the Carbon Pricing Mechanism).

Australia currently has an excess of electricity generating capacity (McConnell 2014; AEMO 2015) - that is, it has more generating capacity than needed to meet electricity demand. AEMO's Electricity Statement of Opportunities reported surplus generating capacity of around 7,400 megawatts (MW) in the National Electricity Market by 2023-24, primarily in Victoria, New South Wales and Queensland. AEMO has subsequently revealed that the market has responded to this surplus by notifying its intent to withdraw approximately half the surplus capacity by 2022 (predominantly through the closure of coal fired power stations). This surplus capacity is partly a consequence of lower than forecast electricity consumption over recent years, and increased renewable electricity generation.

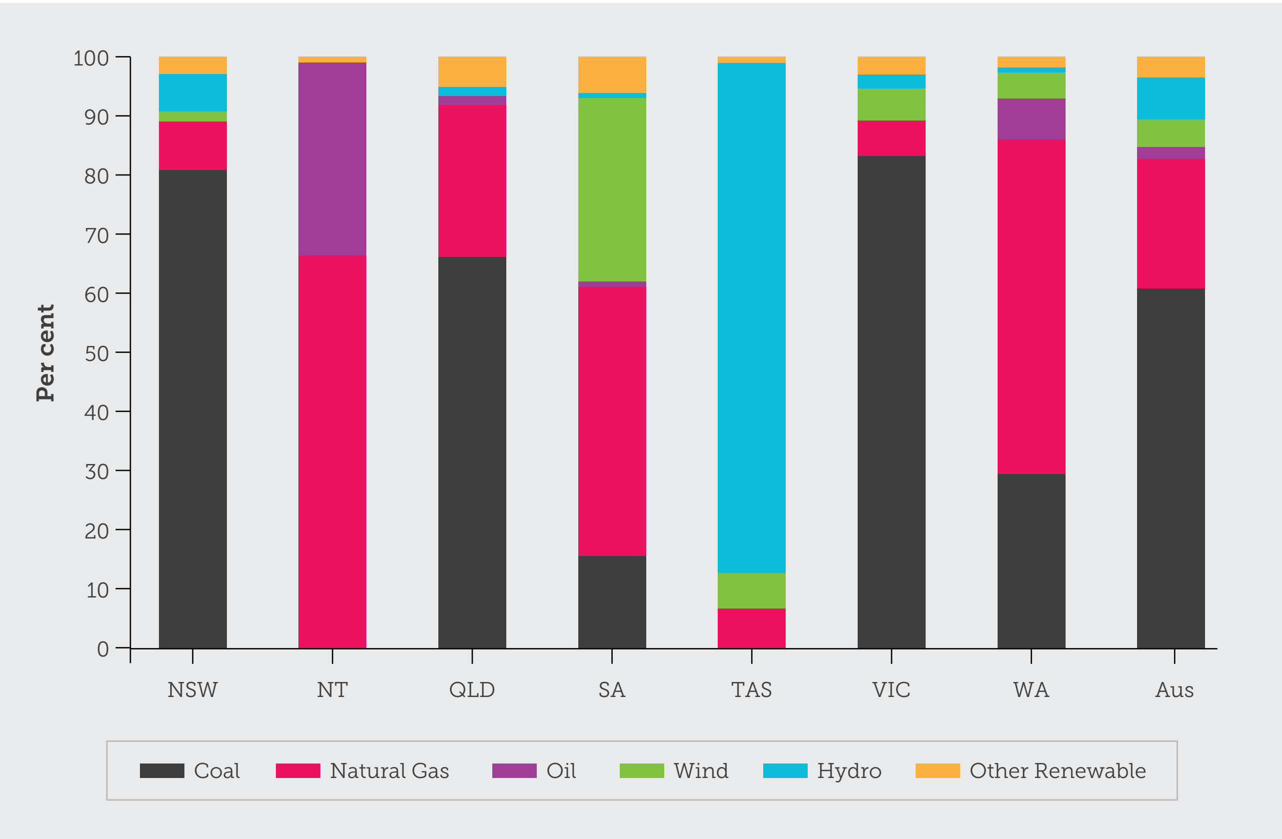


Figure 3: Electricity generation by fuel type, and by state and territory, 2013–14.
Notes: NSW includes ACT. **Source:** Department of Industry and Science (2015) Australian Energy Statistics, Table O.

Coal Fired Electricity Generation in Australia

Australia's coal fired power plants are among the oldest and least efficient in the world. The average age of Australia's coal-fired power stations is currently around 30 years, with almost all (89%) of Australia's coal power stations using older, subcritical steam technology (Caldecott et al. 2015).

Coal plant closures are already underway, driven in part by age and by system-wide excess capacity. In the past year, generation companies have announced plans to retire 3,275 MW of coal capacity before 2022. A further 1,276 MW of gas plant closures have been announced. These closures total around 7% of Australia's total generating capacity of 62,984 MW (AEMO 2015). At the same time Australia's thermal coal production and exports have continued to grow (Table 5 in Annex 4: Coal in Australia).

Australia's coal-fired power plants are among the oldest and least efficient in the world.

Renewable Energy Resources in Australia

Australia has been ranked among the top three countries in four categories for renewable energy production potential from solar and wind energy (Beyond Zero Emissions 2015: see Table 1). Australia has the potential to generate a much higher proportion of our electricity from renewable energy. Our renewable energy resources are potentially capable of providing 500 times the amount of electricity we currently use (AEMO 2013; Commonwealth of Australia 2014). However, compared to similar countries, Australia has one of the lowest levels of renewable electricity generation (ESAA 2015a). While hydro and wind currently dominate renewable electricity generation in Australia, in 2030 it is expected that solar PV (both rooftop and utility-scale) will be the major generator of renewable electricity in Australia.

Australia is a world leader in household solar PV, with double the rate of uptake (15% of households on average) compared to the next country, Belgium where about 7.5% of households have solar (ESAA 2015). High retail electricity prices, competitively priced solar panels and government incentives (such as the small-scale component of the Renewable Energy Target and state-based feed-in tariffs) have led more than 1.5 million Australian households to install solar PV panels (by March 2016) (Australian Energy Council 2016; Clean Energy Regulator 2016).

Table 1: Australia's potential to become a renewable energy "superpower" – top ten ranked nations for wind and solar energy resources (Beyond Zero Emissions 2015).

Rank	Energy production potential per square km	Energy production potential from total land area	Energy production potential from unutilised land area	Energy production potential from rural land area
1	Egypt	Russia	Russia	Australia
2	Saudi Arabia	Australia	Canada	China
3	Australia	China	Australia	United States
4	Kenya	Brazil	China	Russia
5	Zimbabwe	United States	United States	Canada
6	South Africa	Canada	Iran	Brazil
7	Malta	India	Egypt	Saudi Arabia
8	Cuba	Argentina	Argentina	Argentina
9	Israel	Saudi Arabia	Saudi Arabia	India
10	Mexico	Mexico	Brazil	Iran

5. Employment Effects from 50% Renewable Electricity

The comparative employment effects of the BAU (34% renewable electricity in 2030) and 50RE (50% renewable electricity in 2030) scenarios are explored at a national level, state level, and technology level.

National Employment Effects

At a national level, both the BAU and 50RE scenarios lead to additional employment in the electricity sector, resulting from both construction of new electricity generating infrastructure, and from the operation of existing and new generating capacity. Even with some job losses due to reduced coal fired electricity generation, these losses are more than compensated for by additional jobs created in renewables energy construction and operation.

Nationally, the net additional employment associated with the electricity sector in Australia in 2030 would be around 44% higher than in 2014 under a BAU scenario, and around 90% higher under a 50RE scenario (Figure 4).

50% renewable electricity in 2030 will lead to nearly 50% more employment from electricity generation than business as usual.

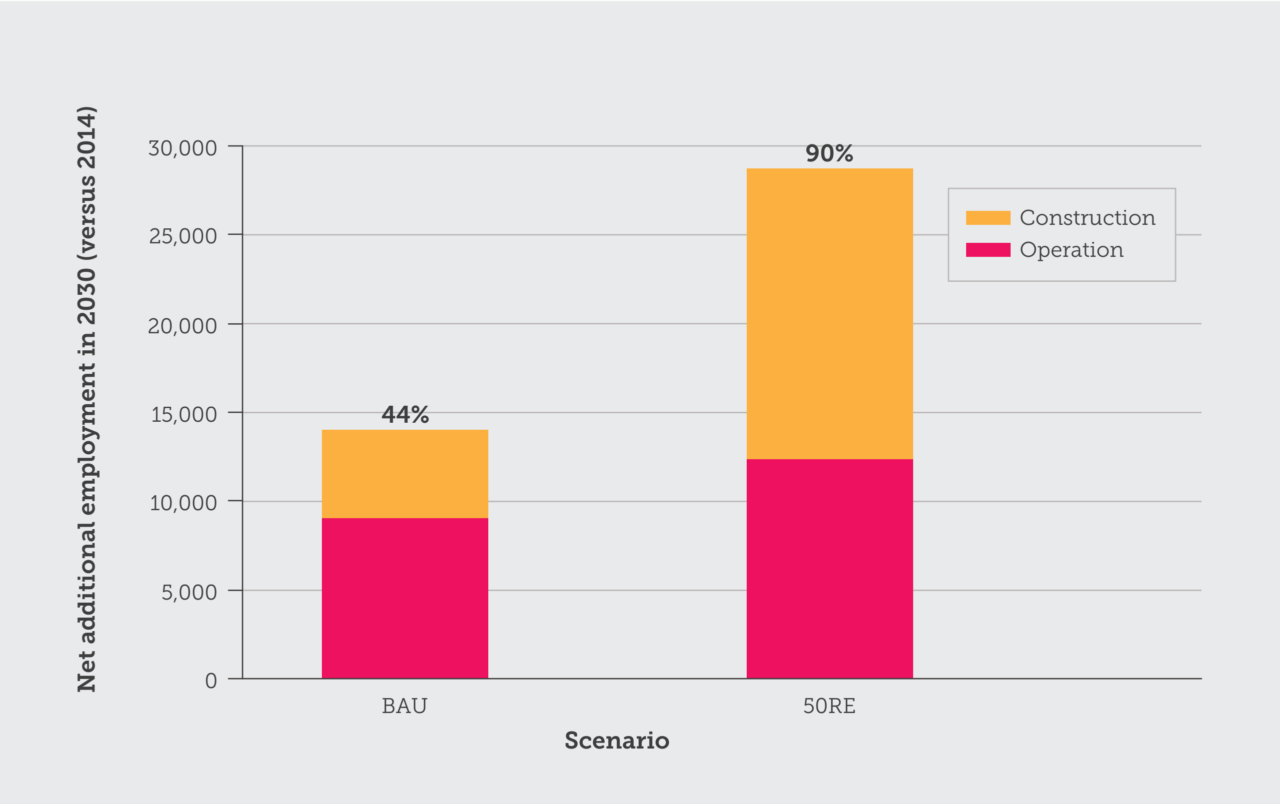


Figure 4: Net additional employment in the electricity sector in 2030 versus 2014, BAU and 50RE scenarios[10].

In both BAU and 50RE scenarios, jobs in renewable energy grow substantially.

For both BAU and 50RE scenarios, growth in electricity demand and new renewable generating capacity over the period to 2030 will drive additional employment. However, the 50RE scenario sees significantly more construction employment associated with new renewable electricity capacity than would occur under a BAU scenario. Under the BAU scenario, construction employment for wind and solar facilities peaks in 2019, and sees average levels of renewable electricity construction employment in 2028-30 about 30% **lower** than during the peak in 2019. By contrast, renewable electricity construction employment under a 50RE scenario continues to increase over the 2020s, peaking in 2029 at levels around 60% **higher** than in 2019 (the peak under BAU).

[10] Shows total additional employment in Australia in 2030 (versus 2014) arising from construction of wind power, rooftop solar PV, utility scale solar PV and new CCGT, and operation of conventional and renewable generators (excludes minor employment in operating diesel, biomass and cogeneration).

Figure 5: Wind farm construction - pouring concrete for a wind turbine foundation.

This net employment impact combines both employment creation and job losses. Under the BAU and 50RE scenarios, electricity generation from black coal and brown coal-fired power stations falls over the period 2014-2030. However these job losses are more than compensated for by increased employment in renewable electricity. In addition to construction employment associated with renewable energy, further construction employment is anticipated from new-build combined cycle gas turbine facilities[11].

In 2030, around 80% of all new jobs under the 50RE scenario are additional to the economy (versus 2014), with the balance substituting for existing jobs that were lost due to the shift away from conventional generation and towards renewables.

These results (Figure 4) are consistent with research assessing perceived economic losses and gains associated with deep decarbonisation of the Australian economy, which found "some technologies and activities decline, others expand and contribute to continued economic growth" (ClimateWorks 2014, p. 4).

[11] The employment effects of new builds accelerate under both the BAU and 50RE scenarios included in the analysis.

BAU, 50RE and Coal

There is a direct link between coal-fired electricity generation in Australia, and the Australian coal mining sector. While the national employment impacts presented above include flow-on impacts in related sectors such as coal mining, it is useful to give a sense of scale to these effects.

Under the 50RE scenario, domestic consumption of thermal coal electricity would be 22% lower in 2030 than under the BAU scenario, and 28% less than in 2014. While these reductions are significant in terms of domestic thermal electricity consumption (and Australia's emissions from coal electricity generation), the reductions represent a much smaller proportion (3.5%) of total coal production in Australia[12].

Australia would consume 22% less black coal in 2030 under a 50% renewables by 2030 scenario.

[12] Based on FY16 forecast production of thermal and metallurgical coal from the Australian Government (2016b).

State Employment Effects

Of course, Australian states vary markedly: they have different population levels, different electricity generation and demand characteristics, and different levels of renewable resource availability. The changes to electricity generation employment under BAU and 50RE scenarios will therefore be experienced differently in different states.

All Australian states experience a net increase in employment in the electricity sector in 2030 (versus 2014) under both the BAU and 50RE scenarios. Over this period:

- New South Wales and Queensland have the largest net jobs growth.
- South Australia and New South Wales have the largest per capita jobs growth.
- Victoria experiences the biggest transition in employment from coal to renewable electricity jobs.

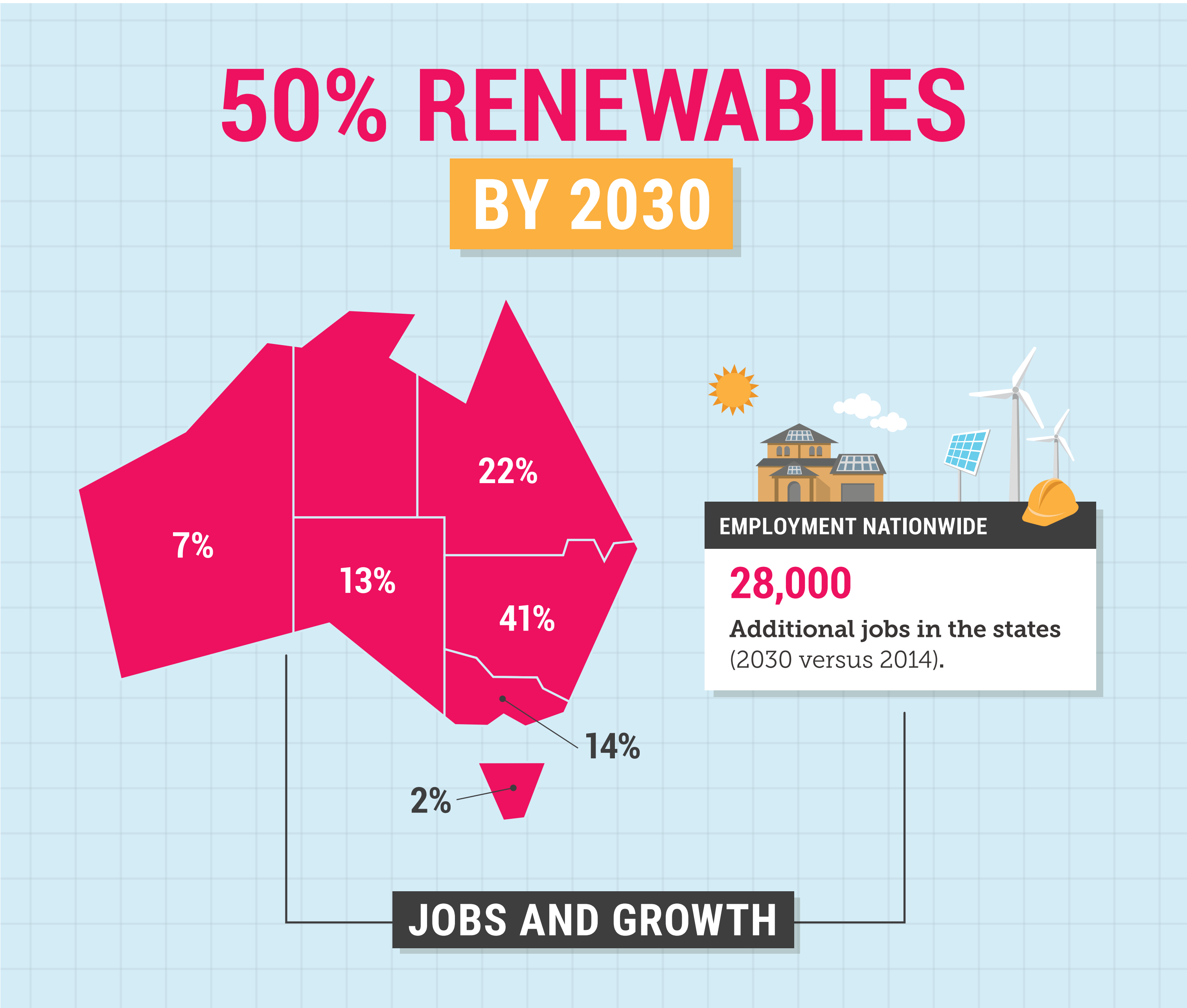
Overall, New South Wales and Queensland see more net job increases from a 50RE scenario (versus 2014) than all other states combined (Figure 6): New South Wales and Queensland are also the largest net recipients of additional jobs under a BAU scenario (not shown). Net job growth is largest for New South Wales, with a 50RE scenario seeing over 11,000 more jobs in the electricity sector in 2030 (versus 2014) (Figure 6).

All states benefit more under a 50% renewables scenario than by continuing business as usual.

On a per-capita basis, South Australia is likely to experience the greatest net growth in jobs under both the BAU and 50RE scenarios (2030 versus 2014), with New South Wales seeing the second-greatest relative impact (Figure 7).

South Australia could see around four times the number of jobs per capita compared to Victoria: this likely reflects a number of drivers, including renewable energy generation levels in SA growing from a higher base than in Victoria, a larger and potentially more cost effective renewable energy resource in SA, together with Victoria experiencing a larger proportion of job losses as brown coal electricity generation declines under the 50RE scenario (thus reducing the net employment gains of the 50RE scenario). Despite these differences, Victoria still gains more jobs in renewable energy than it loses in brown coal generation, with around 4,000 net additional jobs created in 2030 under the 50RE scenario.

Figure 6: Distribution of net *additional* jobs in 2030 under 50RE scenario (against 2014).

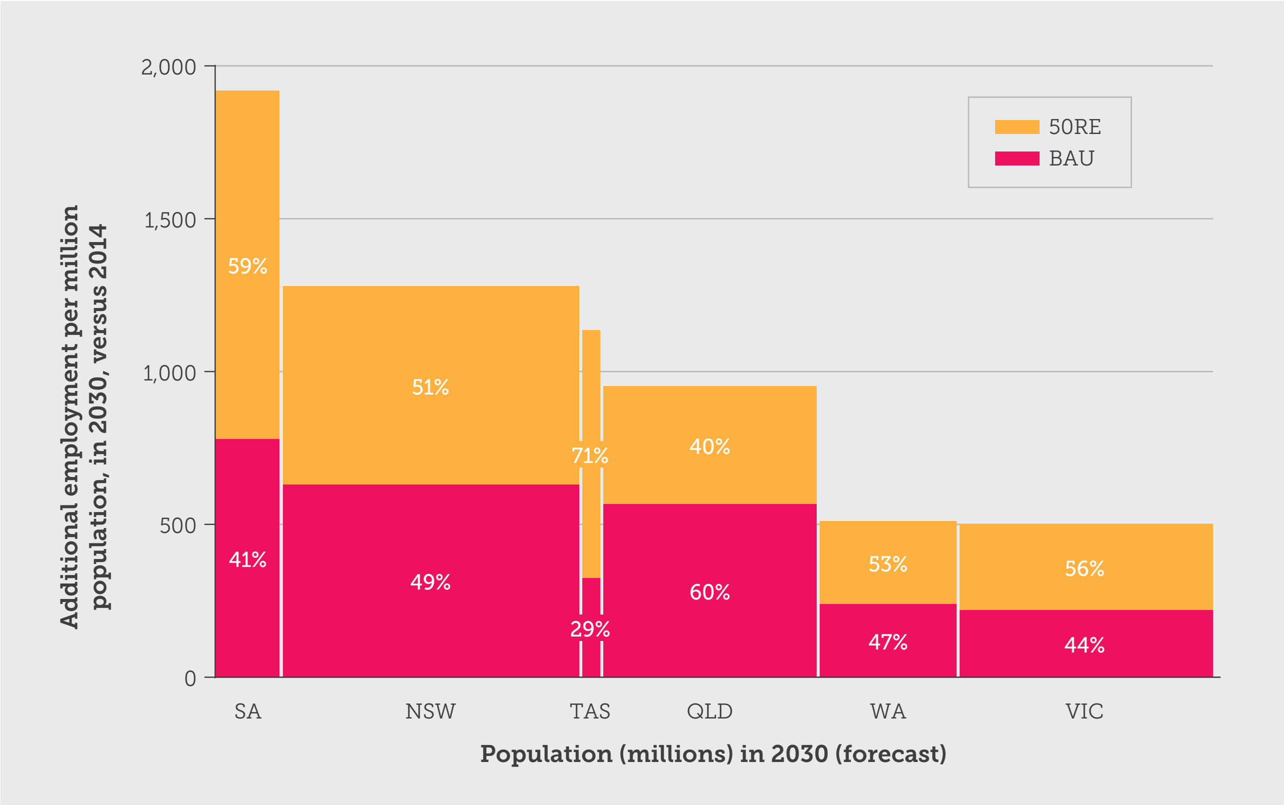


All states benefit more under 50RE than BAU in terms of job creation. South Australia benefits proportionately more than other states from a higher proportion of renewable electricity, with Tasmania and New South Wales the next most positively impacted states (Figure 7). While still benefiting overall from 50RE compared with BAU, Western Australia and Victoria see the most modest increases in employment (under either scenario as a proportion of population) compared to other states.

These factors will be significant for states when assessing policy opportunities to minimise the potential impacts experienced as coal generation declines under both BAU and 50RE scenarios.

In absolute terms, New South Wales not only has the largest net additional employment gain under the 50RE scenario, but it also loses relatively fewer jobs compared to this gain (Figure 8). Indeed, New South Wales, much like Queensland, South Australia, Tasmania and Western Australia, will be creating a substantial number of new jobs, many more than simply compensating for job losses from the reduced fossil-fuel electricity generation anticipated under both the BAU or 50RE scenarios.

Figure 7: Net additional employment per state in 2030 as a proportion of population, versus 2014 (% and employment per one million inhabitants)[13].



[13] Shows electricity sector construction and generation jobs in Australia, including employment from CCGT, as well as from wind power and solar PV construction (utility and rooftop; and generation employment from all major generating technologies). Data excludes construction employment from decommissioning. Construction job totals are the difference in average annual employment between FY14-16 and FY28-30 to remove some volatility in these figures. Population projections are drawn from ABS 2013, for June 2030, Series A.

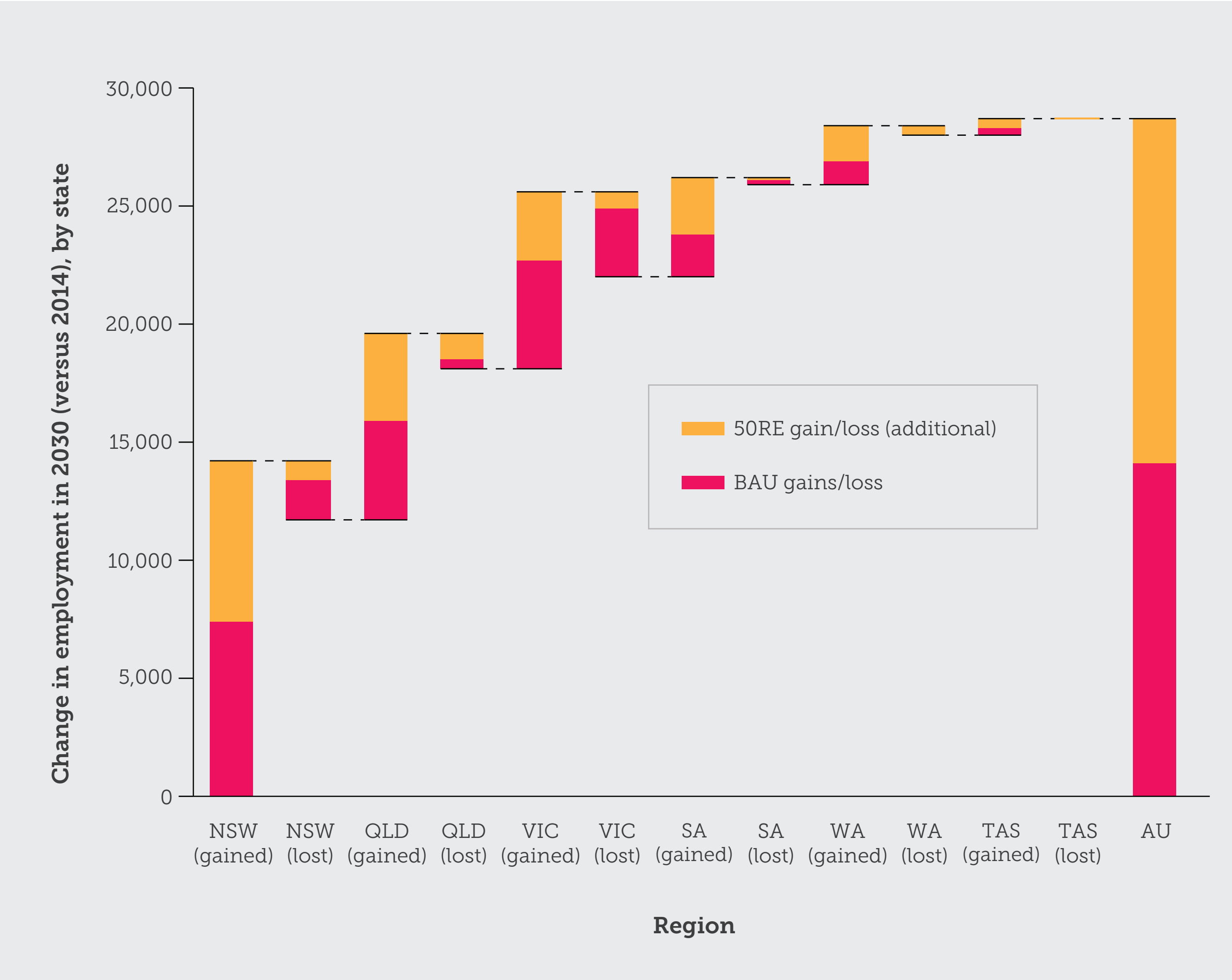


Figure 8: Jobs gained and lost in 2030 versus 2014, BAU and 50RE[14].

Victoria will see net employment increases under both BAU and 50RE scenarios. However, Victoria will experience the largest overall exchange of jobs from coal-fired electricity generation to renewable electricity generation under both the BAU and 50RE scenarios. Job losses in Victoria are expected to occur mostly in operation employment, particularly associated with reduced generation from brown coal-fired power stations. The majority of losses in Victoria are set to take place under the BAU scenario (Figure 8), with the shift to a 50RE scenario having limited further impact on employment in the brown coal generation sector in Victoria.

[14] Shows construction employment for wind, utility and rooftop solar PV and CCGT, and operation employment from all major generating technologies. Construction jobs were calculated as the difference in average annual employment between FY14-16 and FY28-30 to remove some year on year volatility in these figures. Excludes employment from decommissioning.

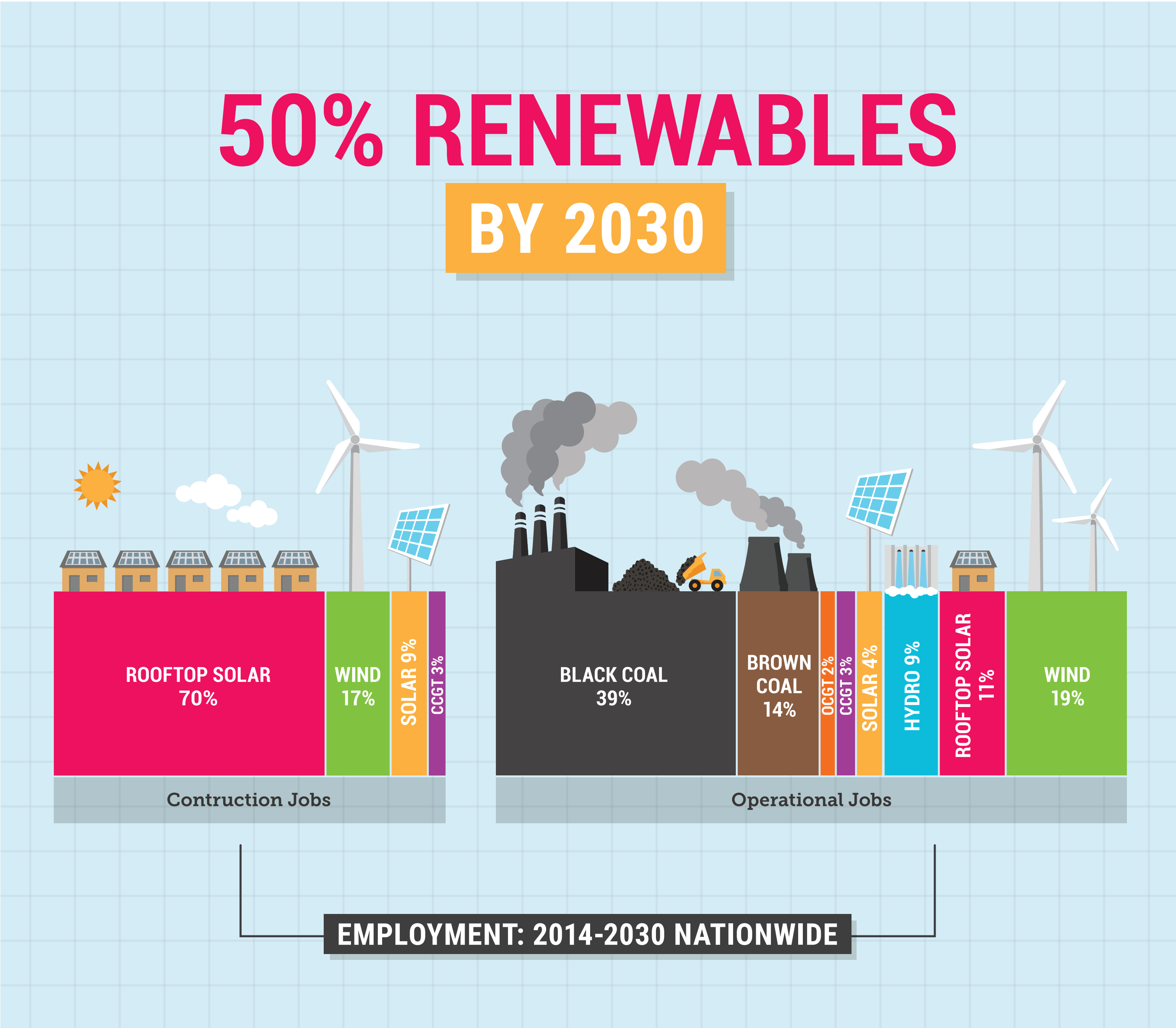


Figure 9: 50% Renewables by 2030 - employment by technology. (May not add up to 100% due to rounding).

Type of Renewable Electricity and Employment Effects

In addition to national and state employment effects, there is a third dimension to the employment effects of the BAU and 50RE scenarios: the differing impact of different renewable energy technologies on employment (Figure 9).

For the 50RE scenario, the majority of FTE jobs occurring in the electricity sector results from operations, with just over 40% of FTEs arising from construction (Figure 10)[15].

Within operations employment, brown and black coal-based electricity generation combined are responsible for just over half of all operation jobs over the 16 year period. By comparison, rooftop solar PV accounts for around 11% of operation jobs.

Wind power accounts for the second-highest proportion (19%) of generation employment, responsible for slightly more operations jobs than brown coal (14%), with gas operations jobs (open cycle gas turbine and combined cycle gas turbine) being on a similar scale to solar PV (2%, 3% and 4% of operations jobs respectively).

[15] FTE figures here relate to the total person – years of employment occurring over the period 2014-2030, not the employment in a specific year or the difference in employment between specific years.

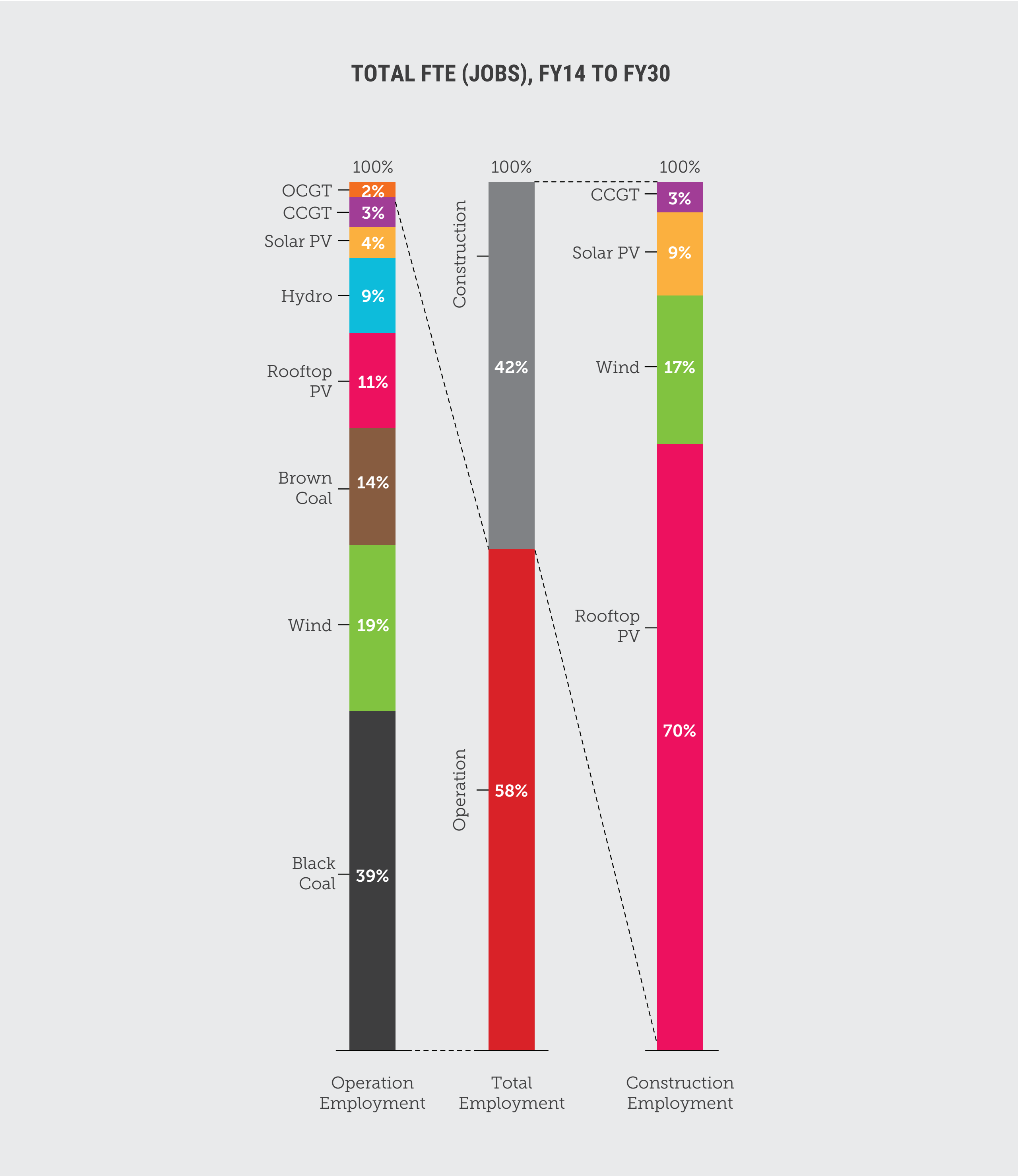


Figure 10: Total full-time employment over the scenario period 2014-2030, by activity and technology, 50RE scenario. (May not add up to 100% due to rounding).

Large-scale renewable energy projects tend to be more labour intensive during the development and construction phase than the operation of existing coal fired power stations (International Renewable Energy Agency, 2012). With most renewable energy generating capacity forecast for 2030 yet to be built, achieving a higher proportion of renewable electricity will require additional construction work to build the additional generating capacity. Further, to achieve the same long term energy output, more renewable energy capacity such as wind and solar PV is required than for coal plants.

The majority of new electricity generating capacity in the 50RE scenario and in the identified investment pipeline is for renewable energy projects, with limited additional combined cycle gas turbine capacity anticipated to 2030. As a result, most of the construction jobs in the electricity supply sector will stem from renewable electricity. Under a 50RE scenario, 97% of total construction FTEs (jobs) over the period 2014-2030 are forecast to be associated with renewable energy. By contrast, a significant proportion of full time employment from the operation of electricity generators over that period will still relate to black coal (39%), brown coal (14%) and gas (5%) (Figures 9 and 10). This has important consequences for the distribution and longevity of the jobs created through the deployment of renewable energy technologies (and reduction in fossil fuel based generation).

Figure 11 combines construction and operation employment by technology for the 50RE scenario to show the relative contribution of employment by generating technology type in each state. In this overall view, conventional generators (coal, gas and hydro) appear to be minor overall contributors to employment. This is due both to their relative generation – for example, combined cycle gas turbine generators deliver around half the electricity of utility solar PV generators in 2030 - but it is also due to employment resulting from the construction of additional renewable generating capacity in 2030.

In 2030, most states will see close to half of all jobs associated with rooftop solar PV: in Tasmania and New South Wales, the proportion is around one quarter. As rooftop solar PV is generally located in areas where people already live and work, employment generated from rooftop solar PV is likely to be accessible to people seeking employment. On the other hand, employment associated with projects in regional and remote locations (for example, wind farms and utility scale solar PV) can also be an opportunity for those communities, as in the case of the Oaklands Hill Wind Farm.

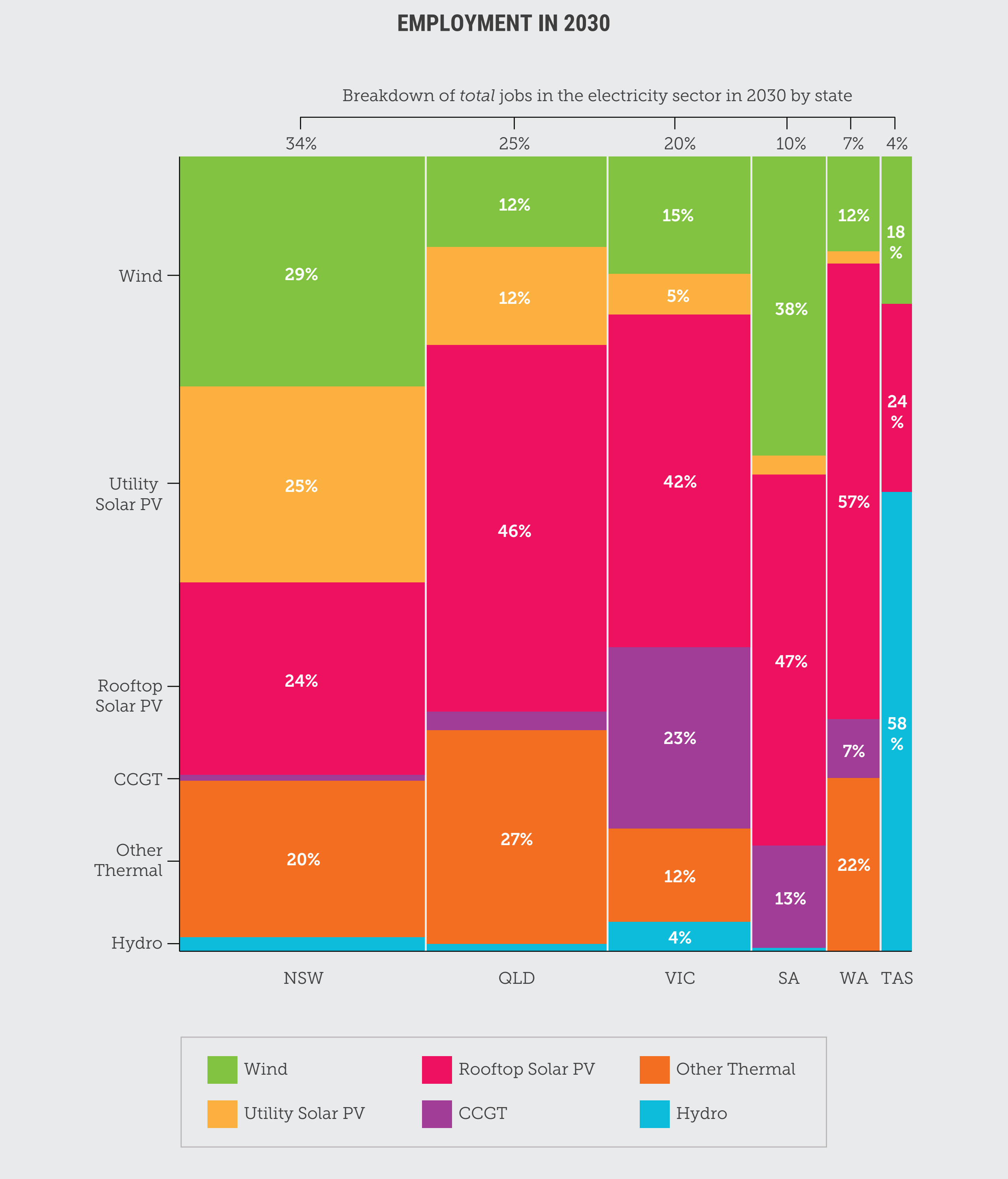


Figure 11: Breakdown of *total* jobs in electricity construction and operation in 2030 under the 50RE scenario, by state and technology[16, 17].

[16] Including construction and operation jobs from wind power, solar PV (rooftop and utility) and CCGT, and operation jobs from other thermal (black & brown coal, and OCGT) and hydro. Operational jobs for thermal generators include jobs in the fuel supply chain (coal mining and gas extraction). The diagram represents total electricity supply sector employment in 2030 under a 50RE scenario.

[17] The net increase in employment is shown in Figure 6.

Figure 12: Installing rooftop solar.

Employment from rooftop solar PV is generally accessible, being located in areas where people already live and work.

Employment Effects of Decommissioning Coal Plants

Decommissioning of conventional electricity generators can be both lengthy and expensive. For example, research has forecast that the market for coal plant decommissioning in North America and Europe will grow from $455 million in 2013 to $1.6 billion by the end of 2016 (Maize 2014). An adequate policy response will therefore need to include a cost effective plan for decommissioning coal plants in Australia as part of a broader strategy towards clean energy.

This report has taken a conservative approach to employment from decommissioning, and does not include the employment impacts of decommissioning coal-fired power stations. As a result, overall employment figures modelled for BAU and 50RE will tend to be understated, and as it is anticipated that some additional decommissioning activities and jobs would accompany the 50RE scenario.

Aside from the number of additional jobs decommissioning would create, these jobs would be focussed in areas where employment is most likely to be affected by the closure of coal-fired generators. Decommissioning jobs could form part of the post-generation employment structure, possibly smoothing the employment transition that will occur under both the BAU and 50RE scenarios. This effect is likely to be discussed on particular regions, such as Victoria’s Latrobe Valley.

6. Transitioning to a New Employment Landscape

The modelling and analysis presented here finds accelerated uptake of renewable electricity is a scenario for overall employment generation and employment transition, not reduced employment.

New renewable energy jobs associated with this transition may have similar characteristics to current electricity generation jobs, but some will differ. Similarly, while some skills may be common, this transition will likely alter the mix of skills required, potentially creating a mismatch between existing skills and the needs of new electricity employment opportunities (Cai et al. 2014).

The long-term and significant infrastructure requirements of the 50RE scenario create employment associated with the construction of renewable electricity generating capacity. Most construction employment is generated from rooftop solar PV installation, and this is neither remote nor transient. Rooftop solar PV will be built where people live and work – existing cities and towns – resulting in construction employment (and longer-term operational support) for existing population centres.

The modelling finds accelerated uptake of renewable electricity is a scenario for overall employment generation.

For utility-scale wind and solar PV generators, construction may well involve a mix of employment types, both employing locally and demanding a mobile construction force with the right set of skills to develop large-scale systems cost effectively in (sometimes) remote locations. Continuous employment, with staff moving from site to site as construction progresses, is more likely to occur for skilled labour, while semi and unskilled labour could be employed locally for each new construction project.

In addition to construction employment, new renewable generators are themselves long-term assets that require ongoing staffing. The operational phase of wind and solar PV systems can be around 25 years, a time frame that offers considerable certainty for employment. The additional renewable generating capacity foreseen in the 50RE scenario will be responsible for operational jobs long past the 2030 scenario horizon. In the case of rooftop PV, jobs associated with operation will be mainly located in existing population centres, while for more remote utility scale facilities these jobs may well diversify and increase employment opportunities in smaller rural and regional communities.

Renewable power generators are long-term assets that require ongoing staffing.

Energy Transition Translated: Real Life Effects on Communities

The discussion above has focused on the potential impacts of a 50RE scenario on employment in the electricity sector. While the whole-of-economy picture is promising, and each state stands to benefit overall from the 50RE approach, these benefits will not be uniformly distributed. Some communities will feel significant impacts of this energy transition, both positive and negative.
In this section, we review selected examples of specific projects and communities that have been part of this transition in the energy sector.

The Renewable Electricity Employment Opportunity

Increased uptake of renewable electricity will create employment: some jobs will be local and long-term, some will be remote and short-term. These different modes of employment creation, and the skills that they require, can create opportunities in both urban and rural Australia. In this section, we review selected case studies of communities caught up in this energy transition.

A Windfall for Remote Communities

Oaklands Hill is a 32 turbine wind farm in Victoria owned and operated by AGL and located in Glenthompson, Victoria (population 300). The wind farm represents significant opportunity for employment and community development, and AGL has committed to contributing to the local community for the life of the project (SKM 2012).

The Oaklands Hill Wind Farm is estimated to have generated 177 direct jobs, of which 95 are based in the region. AGL identified that a further 423 indirect jobs would be created as a result of the project (SKM 2012). However, the duration of these jobs is limited, with the majority of FTE occurring in the pre-operations stage. Four direct and seven indirect ongoing jobs for the region are estimated to be created from the project (SKM, 2012). While 11 new FTEs over the long term may appear modest, in a community of 300 people it can be a significant input to the local economy.

While the initial influx of short-term workers provides an economic boost to the local community, the more long-term job creation will help support the longer term economic viability of the community. Given these dynamics, policy makers may be able to encourage renewable energy development in specific areas to support communities that most need economic support, or to suit state development priorities, and may wish to work in collaboration with renewable electricity developers to achieve the best outcome.

Viable Employment Substitution

It might be possible to co-locate a renewable or other electricity generation facility near an existing coal fired power station to support local employment, as in the case of Leigh Creek and Port Augusta (Box 2).

BOX 2: EMPLOYMENT SUBSTITUTION IN PORT AUGUSTA, SOUTH AUSTRALIA

Alinta Energy owns a brown coal mine in Leigh Creek and two associated coal fired power stations in the vicinity of Port Augusta. As a result of significant losses (Evans 2015), it was decided to close both the mine and the power stations earlier than expected, causing the loss of approximately 438 permanent jobs in 2016 (ABC 2015). This comes at the cost of around $75 million in redundancy benefits and entitlements, as well as significant demolition and remediation costs. For the local community in Leigh Creek, the local job losses are significant, but they are also the conclusion of a long period of gradual decline. From a population of around 2,500 in 1987, only around 750 remain after successive waves of restructuring and layoffs in the mine and the coal fired power station.

Efforts are being made to minimise the employment and community impacts of this closure (Griffiths 2015), but concerns remain as to the viability of the township, due to significant potential for the loss of multiple facilities and services, including a school, hospital, medical centre and gymnasium (Booth 2015).

But Port Augusta may yet see new employment creation through proposed solar thermal or gas electricity generation projects. A local community group, 'RePower Port Augusta' has been campaigning to replace the closing coal plants with a large-scale solar thermal electricity plant. The plan, recently received an indication of support from the Federal Government, which announced that the project may qualify under the new Clean Energy Innovation Fund (The Guardian 2016).

Sundrop Farms, a tomato producer based outside of Port Augusta, is an example of a renewable energy project already driving local job creation and investment. Sundrop Farms is using solar thermal power to both heat and cool 20 hectares of greenhouses, and to produce fresh water (from desalinated sea water) for growing 15,000 tonnes of truss-tomatoes annually. The farm has a 10-year contract to provide tomatoes for Coles supermarkets, and already employs nearly 200 people. The company is considering expanding into capsicums and cucumbers in the future. This innovative approach is providing both employment and a future industry for Port Augusta, potentially reducing the employment impact of the closure of two coal-fired power plants in 2015 (The Advertiser 2015; Sundrop Farms 2015).

The remoteness of Leigh Creek, and the single focus of its economy, make it vulnerable to the type of changes arising from an energy transition. But other communities have been able to build more resilience to such a situation through economic diversity. Anglesea in Victoria is a good example.

Figure 13: Sundrop Farms Solar Thermal.

Figure 14: Anglesea coal mine and power station.

More Diverse Economic Alternatives

Anglesea is a small town in Victoria, on the Great Ocean Road. Though small, Anglesea's population exceeds Leigh Creek, at around 2,300 (ABS 2007): the town had both a mine and coal fired power station, which employed a significant portion of the population. The closure of the Anglesea coal fired power station, owned and operated by Alcoa, resulted in the loss of 85 permanent jobs (Drill 2015), but there were important distinctions between this case and Alinta in Port Augusta.

Firstly, Anglesea had other employment options: thanks to its coastal location, tourism provides substantial income and employment. And for some members of the community, the power station closure was welcomed, as parts of the Anglesea community had been campaigning for the power station to shut down due to its air pollution and associated health implications (Barker 2015). Anglesea is also relatively close to Geelong and Melbourne, which provide more potential employment opportunities.

Secondly, Anglesea's power plant did not shut down unexpectedly early. The early announcement that Anglesea power station would close gave remaining employees time to seek alternative employment, although they were unlikely to find new jobs at the same level of pay (ABC 2015).

Today's coal fired power stations do not employ large numbers of people.

The Anglesea experience suggests that long-term planning allows for adequate preparation and adaptation for transition and re-employment or, where required, reskilling and other transition strategies. Additionally, proximity to larger population centres provides a wider spectrum of alternative employment if a major community employer, such as a coal fired power station, shuts down. Finally, a more diversified economy that is not reliant on a single major employer provides greater resilience for the community. Taking these considerations into account may be helpful to policy makers in determining where to focus their support to communities in transition.

Historically, new mines and associated coal fired power stations tended to create new settlements, with whole families moving to remote areas and setting up a community. While new renewable electricity plants may offer an opportunity for the revival of existing remote communities, they may also be less likely to create new settlements. Communities located where a power station is likely to shut down may be able to reduce future economic and social impacts by planning ahead and looking at diversification options; renewables may be part of that planning for some communities.

Jobs created in renewable electricity will far exceed jobs lost in coal-based generation.

Employment Effects from the Renewable Energy Transition in Perspective

Industrial transitions and the consequential impact on employment have occurred in other sectors in Australia. In recent times, both the automotive manufacturing and steel sectors have faced significant upheaval, with the prospect (or realisation) of significant job losses.

While there are parallels between the auto and steel sectors in terms of the potential for change facing the electricity industry, there are important differences. Both the automotive and the steel industry have been greatly affected by overseas competition, and industry closure reflects a wider trend to offshoring production. Over 40,000 people are predicted to lose their jobs in the automotive industry by 2017 (Productivity Commission 2014) and more than 18,000 jobs have been eliminated at BlueScope Port Kembla alone since 1980 (Binsted 2015).

The transition from coal-based electricity to renewables is not driven by international competition, and it will not result in jobs being lost to overseas electricity producers. Transitioning from fossil fuels to renewable electricity presents opportunities for employment: in short, it represents a growth scenario for employment in Australia.

In contrast to the automotive or steel industries, the expected loss of jobs in the coal-based electricity sector will not just be compensated by jobs in renewable electricity related jobs, but additional jobs will be created.

How Germany has Managed its Electricity Sector Transition

Following the German government's decision to phase out nuclear energy by 2022, major energy companies have predicted job losses of up to 14,000 (Blau 2011). However, Germany plans to replace the use of nuclear with a greater proportion of renewable electricity (40 - 45% by 2025) in the long term (Rankin 2015; REN21 2015), and it is believed that significant employment will be generated by greater economic activity in this sector (Heinrich Boll Stiftung 2012). This aligns with our findings on employment in renewable electricity generation in Australia.

Since 2000, nuclear generated electricity in Germany has fallen from 31% to below 23%, yet unemployment has reached an all-time low compared to 1990 (Heinrich Boll Stiftung 2012). Part of the narrative criticising Germany's "Energiewende" has focused on how the fallback energy source as nuclear power is phased out has been coal. However, studies show that coal-based electricity generation has remained stable, while renewable electricity has risen steadily to surpass nuclear (Kunze & Lehman 2015). So while Germany's transition away from nuclear has maintained coal as a source of electricity, more or less at a stable level, it has also driven up additional renewable energy development. With the 2022 deadline for nuclear phase out fast approaching, the next step in meeting the Energiewende's ambitious emissions reduction targets (80-95% down from 1990 levels by 2050) has to involve decarbonisation (Agora Energiewende 2016). For Germany, one of the world's leading industrial powers, this is not expected to spell decline or painful transition and unemployment. Wind and solar energy have driven down energy prices and the combination of low electricity costs with often generous exemptions to regulations for industry and incentives to increase energy efficiency, have benefited emissions intensive industries such as steel, glass and cement. By pushing industry to embrace efficiency technologies and refocusing research and development on renewable energy technology, Germany is setting up its industry to lead in this space (HBS 2012).

Policy Considerations

While this report does not set out specific public policy recommendations to address the employment impacts of transitioning from coal-based electricity generation to renewables, recognising some of the challenges that might arise along Australia's path to becoming a lower greenhouse gas emitting country may assist policy development.

A number of countries, including Australia's major trading partners, have achieved energy transitions, whether from coal to gas or nuclear, or from oil to renewables. There are lessons to be learned from their experience, particularly in the US, Germany and the United Kingdom. Policy makers could look to the responses of these countries for lessons and guidance, not least when it comes to reconciling policy objectives that are sometimes contradictory, such as reducing greenhouse gas emissions while supporting coal-reliant communities.

Australia's climate policy, and energy policy, needs to achieve a balance between meeting our existing and future obligations to reduce greenhouse gas emissions, while addressing the impact of this shift on our economy, jobs and communities. Achieving this balance will require a long term and holistic approach for which potential considerations are outlined below.

A Long-term Approach

Policy uncertainty affects investment in renewable energy technologies and electricity generation (for example, Climate Council 2015). This is also likely to have an impact on the potential for growth in employment in renewable electricity generation and should be considered as part of the broader policy response, discussed in the final section of this report.

As with any major economic transition, a move towards renewable electricity requires adequate planning and a long term approach to reduce emissions from electricity generation, to promote investment in renewable electricity infrastructure, and to manage the closure of coal fired power stations. The expected lifespan of a coal fired power station is known, and the direct and indirect employment impacts can be estimated: a plan for winding down operations and minimising the impact of closure on employees can be made well ahead of any planned closure. There is a role both for government actors and for electricity supply companies in ensuring that negative impacts are contained, and positive impacts are maximised.

Some have advocated a greater role for the government in Australia's energy transition addressing barriers such as a lack of adequate policy frameworks, the perceived impacts on local communities and employment, and the costs associated with permanently decommissioning coal plants (ACF 2015).

At the same time, it has been argued that a comprehensive and overarching plan for a transition to more renewable electricity will ensure that carbon emission reductions are maximised, community and labour disruptions are reduced and efficient investment in renewables is promoted (ACF 2015).

Policy makers could consider working with interested parties on long term transition plans that consider environmental, economic and employment concerns and take steps to mitigate adverse effects. A successful long term transformation towards renewable electricity requires consensus and cooperation between a range of actors, such as federal and state governments, energy producers, electricity providers, investors, impacted communities, unions and workers. A formal consultation process for relevant stakeholders would facilitate this cooperation and allow for a more nuanced policy response, based on actual impacts. Appropriate planning will ensure that negative employment impacts are minimised, through the facilitation of retraining programs, investment, innovation and the rehabilitation of former coal fired power station sites are some of the options open to government.

Agora Energiewende, one of the bodies set up to help Germany transition away from nuclear power and achieve emissions reduction of 80-95% on 1990 levels by 2050, has recently put forward its "Eleven Principles for a Consensus on Coal" that set out a long-term and holistic approach to managing this transition, including seeking compromise positions between competing interests in reaching the objectives of the Energiewende (Agora Energiewende 2016). Taking this type of non-partisan, cross-sectoral approach over decades seems a promising approach to such a complex undertaking.

Market-led or Government Intervention

Just as an energy transition from coal-based electricity towards renewable electricity can be the result of market factors or government incentives, the impacts of an energy transition on employment and communities can be addressed by the private sector, or with government intervention. While these may be limited, market incentives can be introduced to encourage energy plant operators to support workers and communities after the closure of a power plant. A combination of private sector action and government support, including consideration of local economic and social conditions has been recommended (Scales 2015; Semuels 2015).

Addressing job losses is not something that can be isolated from other aspects of policy in a transition to a low carbon economy. Policy objectives can be contradictory and require collaboration between stakeholders with competing interests. An OECD study on green jobs finds that policy integration and coordination is key to meeting the challenges of creating green jobs, while ensuring that there are enough skilled people to fill these (OECD 2014). This is best achieved with the participation of all levels of government, as well as the private sector. In Victoria, the Government published the Latrobe Valley Industry and Employment Roadmap (Regional Development Victoria 2012) to tackle the effects of transitioning away from coal-based energy while supporting the regional economy - this highlights the importance of gaining the support and collaboration of actors from the Federal Government to community members.

Government is instrumental in regulating the electricity supply sector and operators according to the type of energy that they produce and use. As Australia's coal fired power stations are concentrated in specific areas, major employment impacts are likely to be felt differently according to local circumstances. Tailored and targeted management plans for winding down power plants are likely to be the most appropriate response to manage individual and community impacts, rather than allowing the market to dictate closures in line with economic fluctuations and competition. The government could influence where and when closures will occur, allowing time for and supporting community planning, retraining and innovation, as well as involving power plant operators in designing smooth transitions for stakeholders.

The US has have taken an approach that uses existing market conditions as a springboard for a strong government plan to reduce greenhouse gas emissions and assist affected communities. Environmental regulations such as the US Clean Power Plan seek to accelerate a shift towards clean energy production and curb carbon emissions, in line with international commitments (EPA 2016a). The Clean Power Plan also seeks to support the most impacted communities by incorporating local climate action frameworks and implementation guides, state incentives for renewable energy and efficiency, low income household assistance packages, tax credits, and grant programs for environmental jobs (EPA 2016b). Most importantly, each state can adopt a transition pathway that best meets its specific circumstances whilst also meeting the national emissions reduction pathway.

Tailored plans for winding down coal power plants are a better way to manage individual and community impacts than allowing the market to dictate closures.

Retraining

One of the key policy responses to support local employment through an electricity transition is likely to be offering retraining to impacted workers. As discussed earlier in this report, while the 50RE scenario would lead to more jobs across the economy, individuals and communities based around coal fired power stations will be impacted, as there may be a mismatch of skills required for employment in the two industries.

However, research suggests that the transition from coal-based electricity employment to renewable energy sectors can be relatively straightforward, and there are a range of potential solutions that could address this mismatch, through both government policy responses and industry led initiatives. In the United Kingdom (UK), for instance, there is a Renewable Training Network, co-funded by Renewable UK (the industry peak body) and the UK Government, that provides training courses for a range of roles in renewable energy industries, including management, construction and operations (Renewable UK 2016). Another example is the training provided by the Green Fund in South Africa, "to promote green jobs and decent work in the transition to a greener economy in South Africa", although this is aimed at stakeholders that are likely to oversee the implementation of programs to "green" the economy, as opposed to workers from coal-based industries who need to transition (South African Green Fund 2015). Mining company AngloAmerican has a formal process for mine closures which includes employee retraining (AngloAmerican 2013). Although the latter is not specific to coal fired power stations, similar approaches could be adapted to help the transition of employees to alternative employment, including in the renewable electricity industry.

Research suggests the transition from coal-based electricity employment to renewable energy sectors can be relatively straightforward.

Fostering Innovation and Entrepreneurship

Research undertaken on coal reliant communities in Appalachia, US revealed that a high density of coal-based employment is associated with low levels of entrepreneurship, undiversified economies, lagging economic growth, low levels of employment in other industries, and high levels of migration (Partridge et al. 2016). Research has also found that innovation, entrepreneurship and creativity are key factors for promoting diversification, economic growth and development in the region (Stephens et al. 2013). These conclusions may sound intuitive in the sense that any defined location that relies primarily on one employer or industry is less likely to promote the expansion of economic opportunities. Nevertheless, it may be worthwhile for Australian governments to consider policies that promote diversification, innovation and development in coal-reliant communities, as part of location-specific, long-term approaches to energy transition.

Coal-Reliant Communities Innovation Challenge

In the US, the National Association of Counties and the National Association of Development Organizations, with the support of the US Economic Development Administration, partnered together to support local coal-based communities to diversify and retool their economies in an effort to ensure they are resilient to the changing energy environment. Throughout 2015, three intensive workshops were held, designed to boost the innovative potential of coal-reliant counties and equip regions with the necessary skills and tools to grow and diversify their economies. Workshops were tailored to specific communities' needs and focused on the identification of immediately implementable projects (NaCo 2015). Initiatives identified included training opportunities, fostering an entrepreneurial culture, town redevelopment, and a focus on tourism and other sectors (NADO 2016).

Given the regional locations of many of our coal fired power stations, particularly in the Hunter Valley in NSW and Latrobe Valley in Victoria, Australian policy makers could consider a similar approach. Already, local communities are adopting similar initiatives, particularly those also impacted by mining downturns. Singleton, in the Hunter Valley, with support from the Federal and State government, is investing millions of dollars on projects to diversify and innovate within their local economy, including a project to upgrade the town centre to encourage tourism (Lannin 2014).

Other opportunities could also arise. This report has focused on the construction and operation jobs that would result from an accelerated renewable energy deployment scenario. Accompanying such a scenario is the potential for solar PV, wind power manufacturing and associated industries (for example, battery storage) for Australia. This would further increase employment while diversifying Australia's manufacturing base.

7. Conclusion

Accelerating the deployment of renewable electricity generation in Australia will create more employment than a business as usual pathway for the sector.

This report explores the comparative impact of 50% of electricity being generated from renewables in 2030 versus business as usual: such a scenario is likely to result in net additional employment creation in all states in Australia, arising from construction and operation. For some states, the effects are mainly positive: for others, such as Victoria, employment growth would be accompanied by a transfer of employment from existing coal fired generators to renewable power.

Annex 1: EY Modelling for BAU Scenario of Electricity Generation to 2030

Table 2 outlines the input assumptions selected for the modelling with justification for each. All assumptions outlined reference materials from the public domain, or reflect EY's own in-house views, as appropriate. All the assumptions are common to all scenarios except the rooftop PV trajectory, storage uptake, technology, capex and constraint equations, as indicated.

Under the BAU electricity model the Renewable Energy Target is a key driver of new capacity through to 2020, after which there is very limited large-scale renewable electricity construction during the early to mid-2020's, with a surge in commissioning of new renewable capacity late in the decade (to meet new demand). While this represents an economically efficient evolution, a sudden flurry of renewable energy construction activity following a long hiatus would be challenging in practice, due to the need for rapid re-skilling and acquiring specialist equipment. To address this, the construction of new renewable energy capacity over the 2020's was smoothed to provide a more even annual build rate over the 2020's.

Table 2: Overview of the key scenario assumptions.

Assumption	Source	Justification
Energy and peak demand	2015 AEMO National Electricity Forecasting Report (Medium Economic Growth) Both 10% and 50% probability of exceedance ("PoE") peak demands modelled	This trajectory reflects AEMO's central set of assumptions underlying annual peak demand and energy consumption expectations over the medium to long term.
Rooftop PV	2015 AEMO National Electricity Forecasting Report Moderate PV uptake scenario	This trajectory reflects AEMO's central view on the uptake of small-scale rooftop PV systems in line with the broader economic assumptions underlying the medium energy and peak demand expectation.
Storage	2015 AEMO National Electricity Forecasting Report supplementary material uptake	This trajectory reflects AEMO's central view on the uptake of small-scale batteries at the household level.
Renewable energy target (RET)	33,000 GWh by 2020	This is the target recently legislated in June 2015.
Generator fuel prices	EY Base Case trajectory	This trajectory reflects a significant ramp up in price for natural gas at power generators influenced by the development of liquefied natural gas ("LNG") facilities in Queensland. EY's views are broadly consistent with AEMO's central view for gas and coal fuel prices in the short to medium term.
Technology capex	CO_2CRC: Australian Power Generation Technology Report	The CO_2CRC dataset is a recent credible projection of future technology costs. The costs of renewable technologies are amended to be in line with recent exchange rate movement.
Carbon price	ElectraNet modified	See discussion in-text
Constraint equations	Base Case set of 101 constraint equations	See discussion in-text

Annex 2: Forecasting for 50RE Scenario in 2030

In creating a modified forecast that delivers 50% of electricity from renewable sources in 2030, the following changes were made to the BAU scenario. Based on the new electricity demand levels for all generators (except those unchanged – see Table 3), the original capacity factors for each generator type and year are used to determine the capacity requirement in each year. The increases in uptake for wind and solar PV (see Table 3), combined with hydro and biomass-based generation, result in 50% of electricity demand being met by renewables in 2030.

Table 3: Conversion of Base Scenario to "Industry Viable" 50% by 2030 Scenario.

Technology Type	Rationale
Wind	From FY21 to FY30 the rate of capacity deployment (using the re-profiled build profile) was increased linearly to deliver 46% more energy in FY30 over the base model
Utility solar PV	From FY21 to FY30 the rate of capacity deployment (using the re-profiled build profile) was increased linearly to deliver 46% more energy in FY30 over the base model
Rooftop PV	From FY21 to FY30 the rate of capacity deployment was increased linearly to deliver 46% more energy in FY30 over the base model
Hydro, diesel, cogeneration and biomass	These technologies are either location constrained (hydro), or of small scale in the BAU scenario that they do not have a material impact on the 2030 scenario
Thermal generation: black coal, brown coal, CCGT and OCGT	The generation from each of the fossil generators was reduced to ensure national electricity demand remains unchanged. This reduction is in proportion to the fossil generators contribution to total fossil fuel based electricity generation; thermal capacity was reduced to maintain national average capacity factors by technology type

Annex 3: Summary Table of Main Components of Australia's Climate Policy

Table 4: Components of Australian Government Climate Policy.

Policy	Description	Relation to electricity generation
Renewable Energy Target	Sets large and small scale targets for renewable energy	The large scale renewable energy target is set at 33,000 GWh by 2020 to encourage renewable energy projects in Australia. Financial incentives are used to encourage small-scale projects in households, business and communities
Emissions Reduction Fund	The fund incentivises business and community actions that are in the best interest of the environment	The program is designed to contribute to emission reductions across all sectors, including specific determinants for the electricity sector largely concerning electricity efficiency
Clean Energy Finance Corporation	The CEFC is a government body established to provide financing to operations and initiatives linked to reducing emissions	The CEFC funds a range of energy sector projects including renewable energy projects, energy efficiency projects and low emission technology
Low emission fossil fuel technology programs: › Carbon capture and storage flagship program › National low emissions coal initiative › Low emissions technology demonstration fund › Coal mining abatement technology support package	The program combines a range of actions dedicated to supporting the development of technologies to reduce emissions in Australia	These programs largely focus on developing technology to lower the emissions associated with coal based energy production and electricity generation
National Energy Productivity Plan	This plan is a government led strategy to increase Australia's energy productivity by 40% between 2015 and 2030	The NEPP is designed to support energy service providers by supporting them in managing energy costs
Australian Renewable Energy Agency	ARENA is an Australian government statutory authority in charge of administering and developing an investment plan to fund renewable energy projects throughout the development chain	The main goal of this authority is to increase the competitiveness of renewable energy in the market and to encourage increased supply in an efficient manner
Solar towns	A government program aimed at supporting the integration of small scale solar into communities	Encourages small scale solar project in communities by providing funding to install solar PPV panels and solar hot water systems to buildings

Annex 4: Coal in Australia

The majority of coal mined in Australia is exported

Australia has significant coal resources and is a major producer and exporter of coal to the world. Australia is responsible for almost a third of the global coal trade (Australian Government 2016b).

The majority of coal mined in Australia is exported overseas, and this share has increased over time. Local use of Australian coal, for example in electricity generation and local steel production, is an increasingly small percentage of production, anticipated to 12% in FY17 (Table 5; Australian Government 2016b).

Table 5: Coal production and exports.

Financial Year	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Production (Mt)	339.7	361.3	352.1	376.8	407.2	451.6	485.2	532	554.9
Exports (Mt)	261.4	292	283.3	310.6	339.1	382.6	416.2	463	485.9
Difference (Mt)	78.3	69.3	68.8	66.2	68.1	69	69	69	69
% coal produced and used locally	23	19	20	18	17	15	14	13	12

Source: Australian Government 2016b.

Employment associated with coal mined and used in Australia

Employment statistics for coal mining and electricity generation are generally available as overall figures, rather than broken down according to coal produced for export and local use (ABS 2015a). An equivalent share of jobs to percentage of coal used in Australia indicates around 6,500 jobs related to coal mined for local use in the year 2013-14 (Table 6; ABS 2015a). For comparison, renewable energy jobs for the same year totalled 12,900, almost double (ABS 2016).

Table 6: Coal mining employment.

Financial Year	2011-12	2012-13	2013-14
Total coal mining employment	45,016	43,147	43,383
% coal produced and used locally	18%	17%	15%
Employment calculated based on proportion of coal produced and used locally	8,103	7,335	6,507
Total renewable energy employment	17,000	15,300	12,900

Source: ABS 2015a, 2015b; ABS 2016; Australian Government 2016b.

List of Abbreviations

AEMO	Australian Energy Market Operator
ARENA	Australian Renewable Energy Agency
BAU	Business As Usual
CAPEX	Capital Expenditure
CCA	Climate Change Authority
CCGT	Combined Cycle Gas Turbine
COP21	Conference of Parties 21
°C	Degrees Celcius
FTE	Full Time Equivalent
GWh	Gigawatthour
INDC	Intended Nationally Determined Contribution
IRENA	International Renewable Energy Agency
MW	Megawatt
NEM	National Energy Market
OCGT	Open Cycle Gas Turbine
OPEX	Operational Expenditure
PV	Photovoltaic
RE	Renewable Electricity
50RE	50% Renewable Electricity
RET	Renewable Energy Target
UK	United Kingdom
UNFCCC	United Nations Framework Convention on Climate Change
US	United States

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