briefing
paper

NSW Parliamentary
Research Service

Policies and prospects for renewable energy in New South Wales

Briefing Paper No 6/2014

by Andrew Haylen

RELATED PUBLICATIONS

- Electricity prices, demand and supply in NSW, NSW Parliamentary Research Service Briefing Paper 03/2014 by Andrew Haylen

- A tightening gas market: supply, demand and price outlook for NSW, NSW Parliamentary Research Service Briefing Paper 04/2014 by Andrew Haylen

- Wind Farms: regulatory developments in NSW, NSW Parliamentary Research Service e-brief 13/2012, by Nathan Wales and Daniel Montoya

- Key Issues in Energy, Background Paper 4/2014, by Daniel Montoya and Nathan Wales

ISSN 1325-5142

ISBN 978-0-7313-1926-8

October 2014

Policies and prospects for renewable energy in New South Wales

by

Andrew Haylen

NSW PARLIAMENTARY RESEARCH SERVICE

Gareth Griffith (BSc (Econ) (Hons), LLB (Hons), PhD),
Manager, Politics & Government/Law .... (02) 9230 2356

Daniel Montoya (BEnvSc (Hons), PhD),
Senior Research Officer, Environment/Planning .... (02) 9230 2003

Lenny Roth (BCom, LLB),
Senior Research Officer, Law.. (02) 9230 2768

Alec Bombell (BA, LLB (Hons)),
Research Officer, Law .... (02) 9230 3085

Tom Gotsis (BA, LLB, Dip Ed, Grad Dip Soc Sci)
Research Officer, Law .... (02) 9230 2906

Andrew Haylen (BResEc (Hons)),
Research Officer, Public Policy/Statistical Indicators .... (02) 9230 2484

John Wilkinson (MA, PhD),
Research Officer, Economics .... (02) 9230 2006

Should Members or their staff require further information about this publication please contact the author.

Information about Research Publications can be found on the Internet at:

http://www.parliament.nsw.gov.au/prod/parlment/publications.nsf/V3LIstRPSubject

CONTENTS

Summary i

List of abbreviations v

1. Introduction 1

2. Summary of Renewable energy in Australia 2

2.1 Renewable electricity generation 3

3. Renewable energy policy framework 5

3.1 The Renewable Energy Target 6

3.2 Carbon pricing 9

3.3 Commonwealth Direct Action Plan and Emissions Reduction Fund ... 11

3.4 The Australian Renewable Energy Agency and the Clean Energy Finance Corporation 11

3.5 Commonwealth Solar Towns program 12

3.6 NSW Renewable Energy Policy 12

4. Hydro energy 15

5. Wind energy 18

6. Solar energy 22

7. Other renewable forms of energy 27

7.1 Geothermal 27

7.2 Tidal and wave energy 30

7.3 Bioenergy 33

8. Costs of renewable energy production 35

9. Investment in renewable energy 36

9.1 Outlook for renewable energy investment 37

9.2 Renewable energy projects under development in NSW 41

10. Conclusion 43

SUMMARY

This briefing paper assesses the current state of renewable energy in New South Wales, with a particular focus on electricity generation capacity. Where possible, the paper considers the future prospects for each renewable resource in the State, in terms of electricity generation growth.

As a preliminary to this discussion, the paper provides an outline of the current policy framework in New South Wales influencing investment and the uptake of renewable energy.

This is the third of a series of four companion briefing papers on utilities. The first two related to electricity and gas; a paper on water resources is forthcoming.

Renewable energy in New South Wales

Renewable energy is energy which can be obtained from natural resources that can be constantly replenished. Of the States, New South Wales was the second highest aggregate consumer of renewable energy in 2012-13 at 80.8 PJ; an increase of 32 per cent from 2008-09.

When considered as a proportion of total energy consumption, Tasmania is by far the greatest consumer of renewable energy. New South Wales was ranked fourth at 5.1 per cent in 2012-13.

When considered by head of population, Tasmania was the greatest per capita consumer of renewable energy in 2012-13 at 94 GJ. New South Wales ranked fourth at 11 GJ in 2012-13

New South Wales was the third highest generator of renewable electricity in 2012-13, generating 12 per cent from renewable sources. Hydro is the main source of renewable electricity generation in New South Wales, followed by wind and solar. **[2.1]**

Renewable energy policy framework

The Renewable Energy Target is a Commonwealth Government scheme designed to mandate the proportion of electricity generated from selected renewable sources. An announcement by the Federal Industry Minister on 22 October 2014 suggests that the precise levels of this target are under review **[9.1.1]**

Currently, the targets are 41,000 GWh of electricity for the Large Scale Renewable Energy Target and a notional target of 4,000 GWh for the Small Scale Renewable Energy Scheme. Together, these targets are intended to represent 20 per cent of Australia's electricity usage by 2020. **[3.1]**

The Large-scale Renewable Energy Target encourages additional generation from large-scale renewable energy projects, such as wind and solar farms and hydro facilities.

The Small-scale Renewable Energy Scheme supports the installation of small-scale renewable energy generation systems (including rooftop solar PV, solar water heaters and micro wind and hydro systems).

While the details vary between the small and large scale schemes, both operate through the trade of certificates between liable entities and producers of renewable energy. **[3.1.1, 3.1.2]**

Other current Commonwealth Government renewable energy programs include the: Emissions Reduction Fund; Australian Renewable Energy Agency; Clean Energy Finance Corporation; and the Commonwealth Solar Towns Program. **[3.2, 3.3, 3.4]**

In September 2013, the NSW Government released its Renewable Energy Action Plan. This Plan supports the achievement of the national goal for 20 per cent renewable energy by 2020. **[3.5]**

The NSW Government had previously established the Solar Bonus Scheme using a subsidised feed-in tariff for small scale solar PV systems. It was to operate from 1 January 2010 to 31 December 2016. The feed-in tariff policy design used a fixed tariff rate of 60 cents per kWh for 10 kW or less of installed capacity.

This resulted in a noted acceleration in small scale solar PV system installations. The scheme was officially terminated in July 2011. Based on information provided by NSW Trade & Investment to IPART (2014) in March 2014, there are around 145,000 customers receiving subsidised feed-in tariffs under the Solar Bonus Scheme.

A number of analysts were highly critical of the scheme, including IPART (2014) which concluded that the costs contributed to higher retail electricity prices in New South Wales. **[3.6]**

Hydro Energy

Hydro is the most advanced and mature renewable energy technology. It has the advantages of low greenhouse gas emissions, low operating costs and a high ramp rate.

Hydro generating capacity in Australia coincides with the areas of highest rainfall and elevation and is mostly in New South Wales, Tasmania and Victoria. Hydroelectric power in New South Wales is sourced predominantly from generators in the Snowy Hydro scheme.

Hydro generated 69.1 per cent of renewable electricity and 8 per cent of total electricity generation in New South Wales during 2012-13.

Hydro-energy is becoming less significant in Australia’s electricity fuel mix, as growth in generation capacity is being outpaced by other fuels. Existing potential for hydroelectricity, particularly in New South Wales, has already been developed. **[4]**

Wind Energy

Wind turbines are relatively efficient and can convert around 45 per cent of the wind passing through the blades into electricity. Australia's wind energy resources are located mainly in the southern parts of the continent. The areas with the highest wind energy potential in New South Wales lie along the higher exposed parts of the Great Dividing Range and very close to the coast.

Wind generated 10.2 per cent of renewable electricity and 1.2 per cent of total electricity generation in New South Wales during 2012-13.

The largest installed wind farms in New South Wales are the Gullen Range (165 MW) and Capital Wind Farms (140 MW), although larger wind farms are under development.

The Renewable Energy Target provides an incentive to build the lowest cost renewable energy projects. This means that wind power is likely to be the main technology supported by the policy this decade. **[5]**

Solar Energy

The Australian continent has the highest solar radiation per square metre of any continent. The Port Augusta region in South Australia, north-west Victoria and central and north-west New South Wales are the regions in the National Electricity Market with high potential for solar thermal power.

Electricity generation from solar in New South Wales has increased in response to generous government subsidies to customers installing solar photovoltaic (PV) units. As a result, the vast majority of solar capacity in New South Wales is in the form of rooftop solar PV systems installed on homes and businesses.

In 2012-13, solar PV generated 10.5 per cent of all renewable electricity in New South Wales and 1.2 per cent of total electricity generation.

There are a number of larger projects being planned or under construction, including the Capital Solar Farm near Bungendore, as well as proposed solar farms near Nyngan and Broken Hill. **[6]**

Other forms of renewable energy

Australia has considerable **geothermal energy** potential. However, current drilling technology and associated costs of exploration limit extensive economic development of these resources. Future production from these systems will depend on significant advances in technology. Geothermal is therefore still an emerging industry in Australia, with most projects still at proof-of-concept or early commercial demonstration stage. **[7.1]**

Tidal energy is generated from tidal movements. Tidal power is considered a potential energy source for north-west Australia. Tidal kinetic energy on the entire Australian continental shelf at any one time, on average, is about 2.4 PJ. Tidal kinetic energy adjacent to New South Wales is estimated at 1.21 TJ, the lowest of any of the other coastal jurisdictions.

Wave energy is generated by converting the energy of ocean waves into electricity. The total wave energy on the entire Australian continental shelf at any one time, on average, is about 3.47 PJ. New South Wales has the lowest amount of wave energy when compared to the other jurisdictions. New South Wales currently has no tidal or wave energy projects in operation or in line for prospective development. **[7.2]**

Bioenergy refers to the use of renewable and organic material for power, electricity generation and direct source heat applications. Queensland has the largest bioenergy sector of any State, followed by New South Wales, with 37 plants operating during 2013. Bioenergy fuels generated 10.3 per cent of renewable electricity and 1.2 per cent of total electricity generation in New South Wales during 2012-13. **[7.3]**

Costs of renewable energy

The Asia-Pacific Renewable Energy Assessment provides an overview of the current and possible future costs of renewable electricity generation in Australia. The available levelised cost of energy estimates suggest that onshore wind, followed by biomass, is the most economic renewable electricity option in Australia. According to BREE (2012) estimates, onshore wind is about 40 per cent cheaper than offshore wind in Australia. The available estimates indicate that biomass and geothermal could be more affordable compared to solar PV and solar thermal technology. **[8]**

Investment in renewable energy

The Australian market attracted $5.2 billion of new investment in clean energy in 2013. Investment has been above $5 billion per year since 2011. Wind farms were the dominant form of new large-scale renewable energy built in 2013. According to the Clean Energy Council (2014), a total of 18 projects came online in 2013, with the remainder made up of some smaller wind projects, solar power, bioenergy and a hydro upgrade. **[9]**

Analysis by ROAM Consulting for the Clean Energy Council found that with the Renewable Energy Target operating as currently legislated, investment in large-scale clean energy generation will be $2 to $4 billion per year out to the end of the decade.

However, according to the AER (2013), renewable energy investment outside of wind energy is likely to be limited over the next few years.

With further investment scheduled in renewable technologies, the relative contribution of traditional fuel sources to the National Electricity Market is forecast to decline in the medium to longer term. However, recent changes announced by the Abbott Government to the Renewable Energy Target makes this outlook highly uncertain. **[9.1]**

LIST OF ABBREVIATIONS

ABARE	Australian Bureau of Agricultural and Resource Economics
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
ARENA	Australian Renewable Energy Agency
BREE	Bureau of Resource and Energy Economics
CEFC	Clean Energy Finance Corporation
CER	Clean Energy Regulator
CO_2	Carbon dioxide
ERF	Emissions Reduction Fund
GJ	Gigajoules (10^9 joules)
GWh	Gigawatt hours
KW	Kilowatt
KWh	Kilowatt hours
LCOE	Levelised cost of energy
LGC	Large-scale generation certificates
LRET	Large-scale Renewable Energy Target
MW	Megawatt
MWh	Megawatt hours
PJ	Petajoules (10^{15} joules)
PV	Photovoltaic
RET	Renewable energy target
SRES	Small-scale Renewable Energy Scheme
STC	Small-scale technology certificate
TJ	Terajoule (10^{12} joules)
TWh	Terawatt hours

1. INTRODUCTION

Carbon emissions have been consistently increasing and are largely the result of rising fossil fuel emissions. Electricity generation in Australia is the single largest contributor, producing 38 per cent of emissions.[1] The 2014 CSIRO State of the Climate report concluded that it was 'extremely likely that the dominant cause of recent warming is human-induced greenhouse gas emissions and not natural climate variability'.[2]

However, access to secure, reliable and competitively priced energy, including fossil fuels, underpins almost every facet of life in Australia's modern economy. As the 2012 Energy White Paper put it, 'without it, our society simply cannot function.'[3]

Renewable energy is energy which can be obtained from natural resources that can be constantly replenished. Incorporating renewable energy into the fuel mix in Australia has potential to abate carbon emissions whilst maintaining energy security for electricity, heat and transport.

Recognising this, renewable energy has taken on an increasingly important focus in the energy policies of New South Wales and Commonwealth Government (Chapter 3). These policies have resulted in a marked increase in the use of other forms of renewable energy, particularly wind (Chapter 5) and solar (Chapter 6).

Because of high production costs (Chapter 8), most renewables have only been made commercially viable through subsidies and incentives. Without them, renewables are typically not competitive with fossil fuels. They also do not have the same level of reliability to cater for both peak and off-peak demand.

Investment and advances in technology have the ability to create the necessary efficiency gains and economies of scale to change this situation (Chapter 9).

The aim of this paper is to assess the current state of renewable energy, with particular focus on electricity generation capacity in New South Wales. Where possible, the paper considers the prospects for each renewable resource in the State, focussing on the factors affecting electricity generation capacity.

As a preliminary to this discussion, the paper provides an outline of the current policy framework in New South Wales influencing investment and the uptake of renewables. This includes polices related to carbon pricing, the Renewable Energy Target and solar feed in tariffs.

[1] Australian Government, Energy White Paper 2012, October 2012, Department of Resources, Energy and Tourism, Canberra

[2] Commonwealth Scientific and Industrial Research Organisation and the Bureau of Meteorology, State of the Climate 2014, March 2014

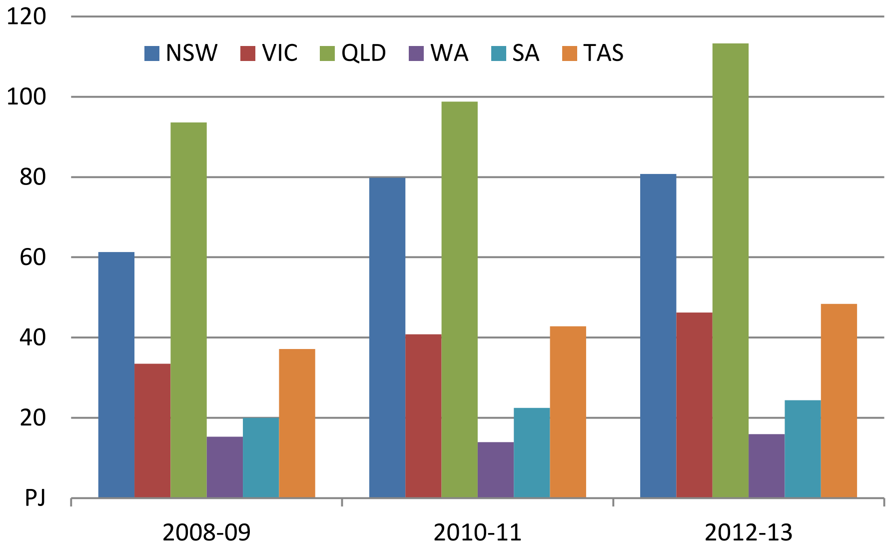
[3] Australian Government, Energy White Paper 2012, October 2012, Department of Resources, Energy and Tourism, Canberra, p.4

2. SUMMARY OF RENEWABLE ENERGY IN AUSTRALIA

Of the Australian States, New South Wales was the second highest aggregate consumer of renewable energy in 2012-13 at 80.8 PJ; an increase of 32 per cent from 2008-09 (Figure 1).

Queensland was the highest consumer of renewable energy in 2012-13 at 113 PJ, an increase of 21 per cent since 2008-09. Tasmania (48.4 PJ in 2012-13; up 31 per cent since 2008-09) and Victoria (46.2 PJ in 2012-13; up 38 per cent since 2008-09) were ranked third and fourth respectively.

Figure 1: Total renewable net energy consumption[4]

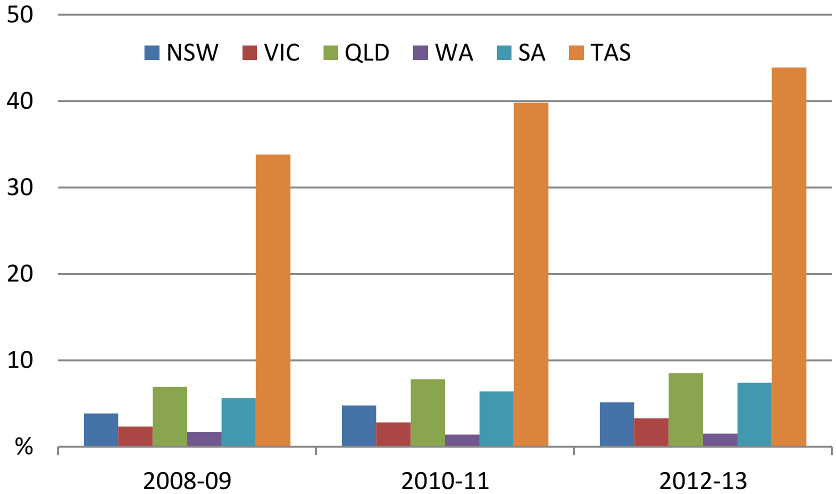


When considered as a proportion of total energy consumption, Tasmania is by far the greatest consumer of renewable energy. This is because the bulk of its electricity generation is sourced from hydro (82 per cent in 2012-13). In 2012-13, renewables accounted for 44 per cent of total net energy consumption in Tasmania, up from 34 per cent in 2008-09.

Renewables account for less than 10 per cent of net energy consumption in the other States and Territories. In fact, after Tasmania, the next highest relative consumer of renewable energy is Queensland at 8.5 per cent in 2012-13. New South Wales was ranked fourth at 5.1 per cent in 2012-13 (Figure 2).

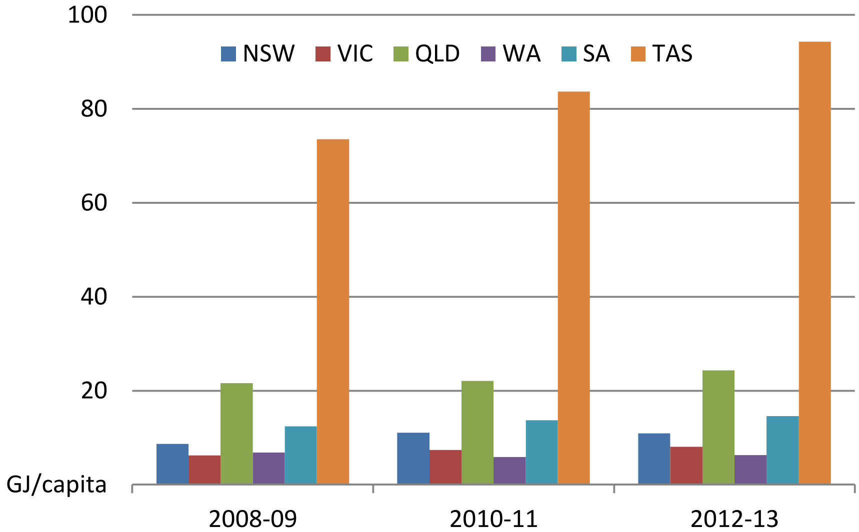
[4] BREE, 2014 Australian energy statistics data, July 2014, Table C; Total net energy consumption is the total quantity (in energy units) of primary and derived fuels consumed less the quantity of derived fuels produced.

Figure 2: Renewable net energy consumption (% of total energy consumption)[5]



When considered by head of population (Figure 3), Tasmania was the greatest consumer of renewable energy in 2012-13 at 94 gigajoules (GJ) per capita (up by 28 per cent since 2008-09). Queensland (24 GJ per capita in 2012-13) and South Australia (15 GJ in 2012-13) were ranked second and third respectively, followed by New South Wales at 11 GJ in 2012-13.

Figure 3: Net renewable energy consumption, per capita[6]



2.1 Renewable electricity generation

Hydro is the main source of renewable electricity generation in New South Wales. In 2012-13, 5651.6 GWh of electricity was generated from hydro, up 78 per cent since 2008-09. Wind and solar are the next most significant renewable

5 BREE, 2014 Australian energy statistics data, July 2014, Table C

6 BREE, 2014 Australian energy statistics data, July 2014, Table C; ABS, Australian Demographic Statistics, Mar 2014, September 2014, Cat. No. 3101.0

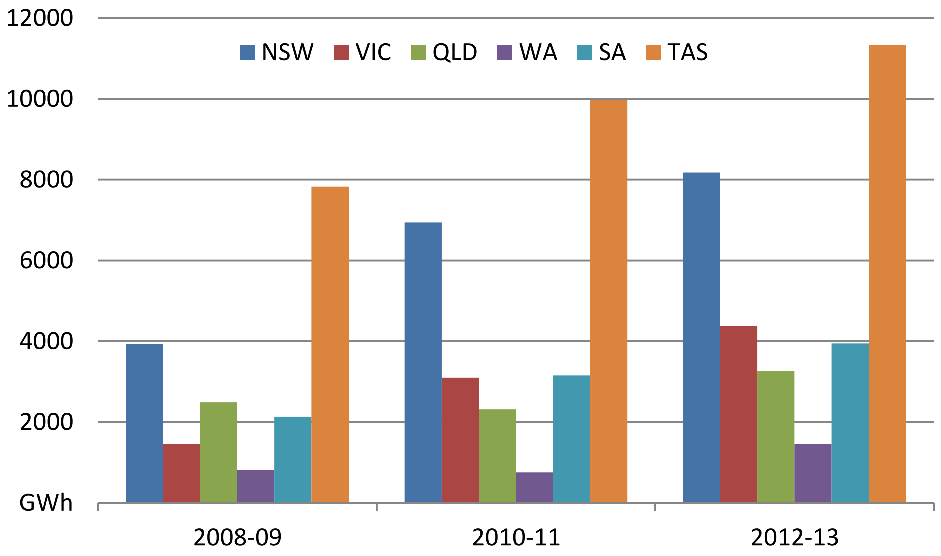
electricity sources (Table 1). Both have risen in recent years on the back of renewable energy targets and other associated climate change policies (Chapter 3).

Table 1: Renewable electricity generation in New South Wales, gigawatt hours[7]

	2008-09	2009-10	2010-11	2011-12	2012-13
Bagasse, wood	291.3	295.3	253.3	413.6	425.4
Biogas	383.4	385.8	360.0	408.7	413.4
Wind	41.3	432.5	530.1	697.6	832.6
Hydro	3 173.7	3 820.8	5 267.0	3 792.8	5 651.6
Solar PV	36.3	119.2	526.3	657.7	856.0
Total renewable	**3 926.0**	**5 053.6**	**6 936.7**	**5 970.3**	**8 179.0**

New South Wales was the second highest generator of renewable electricity in 2012-13 at 8,179 GWh (Figure 4). Tasmania generated the most renewable electricity in 2012-13 at 11,330 GWh; up 45 per cent since 2008-09. Western Australia generated the least renewable electricity in 2012-13 at 1,448 GWh.

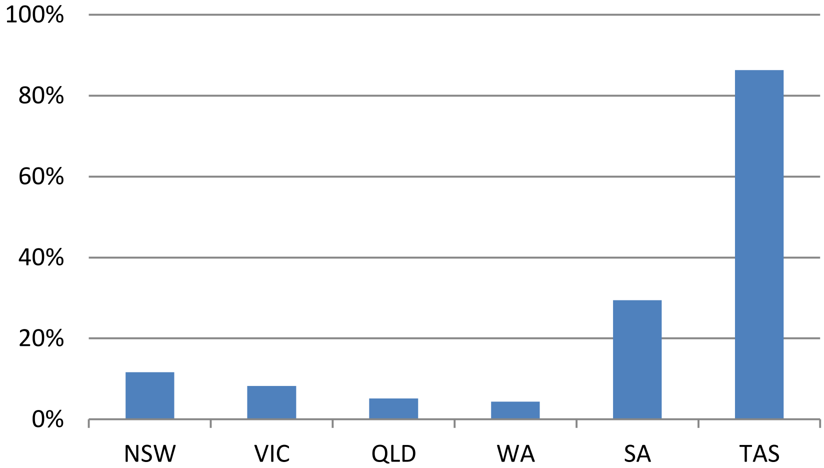
Figure 4: Electricity generation from renewable sources, by State[8]



Tasmania generated 86 per cent of its electricity from renewable sources in 2012-13, the highest of all the States (Figure 5). South Australia ranked second, generating 30 per cent of its electricity from renewables in 2012-13. New South Wales ranked third, generating 12 per cent of its electricity from renewables in 2012-13. Queensland (5.2 per cent) and Western Australia (4.4 per cent) were the worst performing States that year.

[7] BREE, 2014 Australian energy statistics data, July 2014, Table O
[8] Ibid

Figure 5: Proportion of electricity generated from renewable sources, by State, 2012-13[9]



Large-scale renewable generation capacity has increased significantly since the Mandatory Renewable Energy Target was introduced in 2001 (Table 2). Total wind capacity increased by over 3,800 MW since 2001 and predominantly in South Australia and Victoria.

Table 2: Large-scale renewable capacity installed by state and fuel source, 2001 to 2014, megawatts[10]

Eligible energy source	ACT	NSW	NT	QLD	SA	Tas	Vic	WA	Additional capacity	Power stations
Biomass	-	49	-	12	-	1	7	126	196	81
Hydro	1	32	-	16	3	26	174	-	152	105
Landfill gas	4	33	1	509	1	5	27	16	597	61
Solar	21	2	4	3	1	-	7	11	50	87
WCMG	-	29	-	130	-	-	-	-	158	7
Wind	-	454	-	12	1,473	312	1,070	488	3,809	75
Additional capacity	26	599	5	682	1,478	344	1,285	642	5,062	416

3. RENEWABLE ENERGY POLICY FRAMEWORK

This Chapter of the paper outlines the key Commonwealth and State Government policies influencing the renewable energies sector in New South Wales. As discussed later in this paper (Chapter 9.1.1), the precise levels of the Renewable Energy Target are currently under review, with the Federal Industry Minister indicating a significant shift in policy on 22 October 2014. The present discussion, however, is based on the position this is currently in place.

---

[9] BREE, 2014 Australian energy statistics data, July 2014, Table O

[10] Warburton, D., Fisher, B, In't Veld, S, and Zema, M., Renewable Energy Target Scheme Review, August 2014, Report of the Expert Panel, p.8

The information presented in this Chapter of the paper has been sourced predominantly from the Commonwealth Government Review of the Renewable Energy Target Scheme which was completed in August 2014.

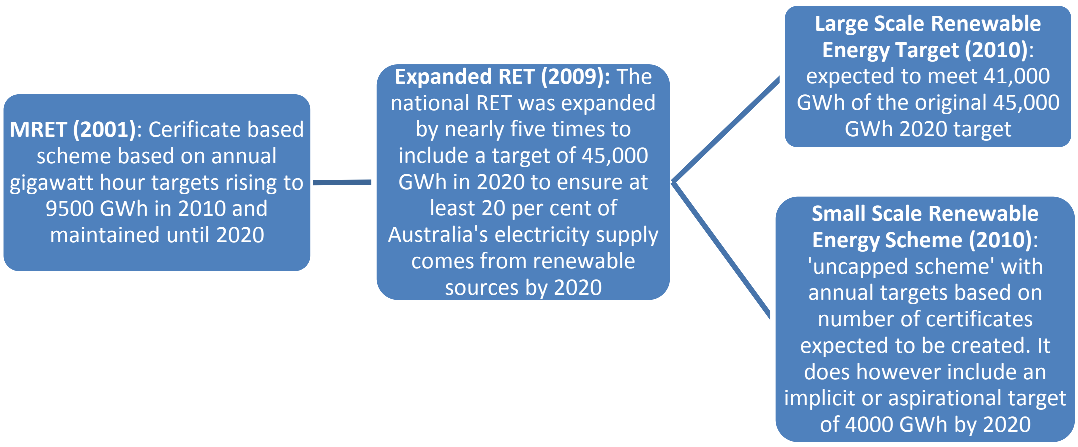
The basics of the Renewable Energy Target, in terms of the current design and administration, are discussed in this Chapter of the paper. There is ongoing debate surrounding the efficiency, costs and implementation of this scheme. These issues are beyond the scope of this paper and are not addressed at length. They are dealt with in the Commonwealth Government Review (in which specific findings and recommendations were made) and also by the Centre of International Economics in their report The Renewable Energy Target: How it works and what it costs.

3.1 The Renewable Energy Target

The Renewable Energy Target (RET) is a Commonwealth Government scheme designed to mandate the proportion of electricity generated from selected renewable sources. The aim is to reduce the emissions of greenhouse gases and to promote the development of a renewable energy industry in Australia.[11]

The RET has been operating in various forms since the Mandatory Renewable Energy Target commenced in 2001 to achieve an additional two per cent of the renewable energy mix by 2010.[12] As part of the 2010 Renewable Energy (Electricity) Act 2000 amendments, the expanded RET was split into two parts (Figure 6), the Large Scale Renewable Energy Target (Chapter 3.1.1) and the Small Scale Renewable Energy Scheme (Chapter 3.1.2).

Figure 6: Evolution of the Renewable Energy Target[13]



[11] St John, A., The Renewable Energy Target: a quick guide, May 2014, Research Paper Series, Parliamentary of Australia, Department of Parliamentary Services, p.1

[12] Warburton, D., Fisher, B, In't Veld, S, and Zema, M., Renewable Energy Target Scheme Review, August 2014, Report of the Expert Panel, p.i

[13] Adapted from: The Centre for International Economics, The Renewable Energy Target: How it works and what it costs, November 2013, Prepared for Australian Industry Greenhouse Network, Figure 3.1, p.9

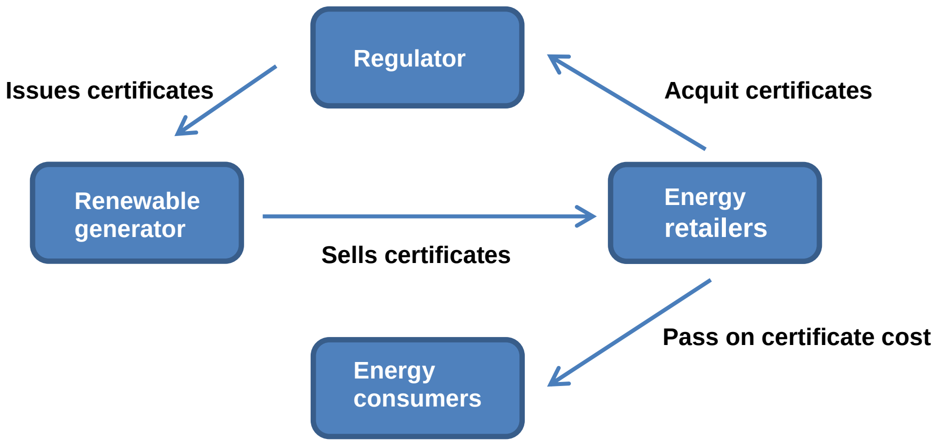
The target is expressed in the Act as a fixed amount of electricity that must be sourced from renewable generators each year. The actual targets are 41,000 GWh of electricity for the Large Scale Renewable Energy Target and a notional target of 4,000 GWh for the Small Scale Renewable Energy Scheme.

Together, these targets were meant to represent 20 per cent of Australia's electricity usage by 2020. However, demand for electricity is falling and the 45,000 GWh target is likely to account for substantially more than 20 per cent of Australia's electricity by 2020.[14]

As all electricity fed into the grid is indistinguishable, it is necessary to have an external mechanism to account for the renewable electricity purchased by liable entities.[15] As such, the RET works by allowing renewable energy producers and owners of small-scale renewable energy systems to create certificates for every megawatt hour (MWh) of renewable electricity they produce.

Liable entities (such as electricity retailers and large industrial users) are obligated to purchase certificates and surrender them to the Clean Energy Regulator each year to demonstrate compliance with the scheme (Figure 7). Liable entities have obligations to purchase renewable energy from both the large and small scale schemes.

Figure 7: The basic flow of certificates[16]



The RET is consequently a policy that effectively taxes electricity users (and in some cases non-renewable generators) in order to subsidise selected renewable producers.[17] This creates a market which provides financial

---

[14] St John, A., The Renewable Energy Target: a quick guide, May 2014, Research Paper Series, Parliamentary of Australia, Department of Parliamentary Services, p.1

[15] Ibid

[16] Adapted from: The Centre for International Economics, The Renewable Energy Target: How it works and what it costs, November 2013, Prepared for Australian Industry Greenhouse Network, Figure 2.1, p.2

[17] The Centre for International Economics, The Renewable Energy Target: How it works and what it costs, November 2013, Prepared for Australian Industry Greenhouse Network, p.1

incentives to both large-scale renewable power stations and owners of small-scale systems.[18]

3.1.1 The Large-scale Renewable Energy Target

The Large-scale Renewable Energy Target (LRET) encourages additional generation from large-scale projects, such as wind and solar farms and hydro facilities. It does so by allowing eligible renewable energy generators to create large-scale generation certificates (LGCs) for the electricity they produce. Each certificate represents one megawatt hour of renewable generation.[19]

Liable entities have an obligation to buy a certain number of these certificates. The revenue from selling these certificates supplements the revenue that renewable operators can earn by selling the electricity they generate through the normal market mechanisms.[20]

The Clean Energy Regulator administers the LRET by managing the REC Registry[21], accrediting renewable power stations and establishing the annual renewable power percentage. The amount of LGCs that a liable entity is required to surrender each year is proportionate to its liable electricity purchases. The renewable power percentage determines this proportion. Accredited power stations can trade the LGCs they create with liable entities or other certificate traders through the REC Registry.

In 2014, the renewable power percentage is 9.87 per cent. This means that liable entities must surrender enough certificates to cover 9.87 per cent of their electricity purchases.

Certificates are commonly traded through brokers on spot markets or through long-term contracts between generators and liable entities. In 2013, the volume-weighted average price for an LGC was $35.24/MWh. Should a liable entity fail to surrender enough certificates to cover their electricity purchases, they must pay a shortfall charge of $65 per megawatt-hour for each certificate not surrendered. This effectively caps the price of a LGC.[22]

3.1.2 The Small-scale Renewable Energy Scheme

The Small-scale Renewable Energy Scheme (SRES) supports the installation of small-scale renewable energy generation systems (including rooftop solar PV, solar water heaters and micro wind and hydro systems).

---

[18] Warburton, D., Fisher, B, In't Veld, S, and Zema, M., Renewable Energy Target Scheme Review, August 2014, Report of the Expert Panel, p.3

[19] Ibid

[20] St John, A., The Renewable Energy Target: a quick guide, May 2014, Research Paper Series, Parliamentary of Australia, Department of Parliamentary Services, p.2

[21] This is a secure web-based application that facilitates the creation, trade and surrender of certificates.

[22] St John, A., The Renewable Energy Target: a quick guide, May 2014, Research Paper Series, Parliamentary of Australia, Department of Parliamentary Services, p.2

The SRES is very similar to the LRET. Liable entities have an obligation to purchase small-scale technology certificates (STCs) in the same way as LGCs. The amount of STCs that must be purchased is set by the small-scale technology percentage. This is also determined by the Clean Energy Regulator, based on the number of STCs likely to be created in the next year.

Owners of eligible small-scale systems are able to obtain STCs upfront by estimating the quantity of electricity an eligible system will generate or displace over its lifetime.[23] This differs from the large-scale systems which are only awarded LGCs as they actually generate electricity. The number of certificates a system can create depends on the amount of electricity in megawatt hours:

- deemed to be generated by the small-scale solar panel, wind or hydro system, over its lifetime (up to a maximum of 15 years); or
- displaced by the solar water heater or heat pump, over the course of its lifetime of up to 10 years.

As STCs are provided upfront, this makes it possible for householders to assign their STCs to the company that installs their small scale system, in return for a lower upfront installation cost.

Owners of STCs can either exchange a financial benefit through a registered agent or sell the financial benefit through the STC Clearing House. Here, there is a government guaranteed price of $40 per certificate, which is effectively a price cap. Alternatively, STCs may be bought and sold in the open market, where the price is determined by the interaction of supply and demand.[24]

Unlike the LRET, the SRES does not have binding annual targets. For example, in 2013 the small-scale technology percentage was 19.70 per cent, for 2014 it will be 10.48 per cent. This is based on the number of certificates which are expected to be created in the next year; whereas the LRET renewable power percentage rises each year towards the legislated target.

3.2 Carbon pricing

As part of steps to reduce greenhouse gas emissions, a national carbon price was implemented by the Gillard Government from 1 July 2012. For three years, carbon was to be priced at a fixed (indexed) rate commencing at $23 and increasing to $25.40 in 2014.

From 2015, the carbon price was to be linked to the European Emissions Trading Scheme. During the 3 year period from July 2012, the amount of emissions was to be unlimited. After that the government would have capped emissions; with the cap to be determined on advice from the Climate Change

[23] Warburton, D., Fisher, B, In't Veld, S, and Zema, M., Renewable Energy Target Scheme Review, August 2014, Report of the Expert Panel, p.6

[24] Warburton, D., Fisher, B, In't Veld, S, and Zema, M., Renewable Energy Target Scheme Review, August 2014, Report of the Expert Panel

Authority. The annual cap was set with the aim of reducing Australia's total greenhouse gas emissions by 5 per cent on 2000 levels by 2020, and an 80 per cent reduction on 2000 levels by 2050. As Byrnes et. al (2013) explain: [25]

> the rationale for the carbon price [was] to support the development of an effective global response to climate change in a way that encourages investment in clean energy, while supporting jobs, competitiveness and economic growth and reducing pollution.

The legislation required that the 500 heaviest emitters purchase carbon credits per tonne of emissions. Trade exposed industries and coal fired power stations were eligible for free credits to sustain competitiveness whilst international competitors were not subject to carbon pricing. The extent of this support would have been substantial. An amount of $9.2 billion had been allocated to the 'Jobs and Competitiveness Program' to support emissions intensive trade exposed industries.[26]

Carbon pricing is no longer part of the policy framework in Australia following its abolition by the Abbott Government. The carbon tax repeal legislation received the Royal Assent on Thursday, 17 July 2014 and the bills as part of this package are now law, with effect from 1 July 2014. According to the Department of Environment (2014) repealing the carbon tax and the Clean Energy Package is designed to:[27]

- Reduce the cost of living - modelling by the Australian Treasury suggests that removing the carbon tax in 2014-15 will leave average costs of living across all households around $550 lower than they would otherwise have been in 2014-15.
- Lower retail electricity prices by around 9 per cent and retail gas prices by around 7 per cent than they would otherwise have been in 2014-15 with a $25.40 carbon tax.
- Boost Australia's economic growth, increase jobs and enhance Australia's international competitiveness by removing an unnecessary tax, which hurts businesses and families.
- Reduce annual ongoing compliance costs for around 370 liable entities by almost $90 million per annum.
- Remove over 1,000 pages of primary and subordinate legislation.

The Australian Competition and Consumer Commission will monitor and enforce reasonably expected price reductions across key sectors of the economy, particularly the electricity, gas and synthetic greenhouse gas sectors.

---

[25] Byrnes, L, Brown, C, Foster, J, and Wagner, L., Australian renewable energy policy: Barriers and challenges, 2013, Renewable Energy 60, p.716

[26] Ibid

[27] Department of the Environment, Repealing the Carbon Tax, accessed 17 October 2014

3.3 Commonwealth Direct Action Plan and the Emissions Reduction Fund

The Emissions Reduction Fund (ERF) is central to the Federal Government's Direct Action Plan, which aims to meet Australia's CO_2 emissions reduction target of five per cent below 2000 levels by 2020.

Through the ERF, the Government intends to purchase CO_2 emissions reductions at the lowest available cost and has allocated $2.55 billion over four years from 1 July 2014.

A reverse auction process[28] will be established whereby confidential bids will be submitted to the Clean Energy Regulator, specifying emission reductions at a nominated price. Auction rounds will begin in late 2014 and take place quarterly.[29]

The ERF will be designed to link the existing Carbon Farming Initiative with new projects such as industrial and commercial energy efficiency and emissions avoidance projects. The Government will only pay for emission reductions after they have been delivered and measured and where these are genuine, additional reductions.[30]

The ERF will also include a CO_2 emissions safeguard mechanism which will be designed to ensure that emissions reductions paid for by the ERF are not displaced by significant increases in CO_2 emissions elsewhere in the economy. The safeguard mechanism is scheduled to begin in July 2015.

3.4 The Australian Renewable Energy Agency and the Clean Energy Finance Corporation

The Australian Renewable Energy Agency (ARENA) was established to support the research, development and demonstration of renewable energy technologies. ARENA has two broad objectives:

- to improve the competitiveness of renewable energy technologies; and
- to increase the supply of renewable energy in Australia.

ARENA is supporting more than 200 projects, worth close to $2.5 billion, with around $1 billion of funding from ARENA.[31] These projects span the innovation chain, but most are at the research and development stage and typically have a

[28] A reverse auction is a type of auction in which the roles of buyer and seller are reversed. In an ordinary auction (also known as a forward auction), buyers compete to obtain a good or service by offering increasingly higher prices. In a reverse auction, the sellers compete to obtain business from the buyer and prices will typically decrease as the sellers undercut each other.

[29] Commonwealth of Australia, Emission Reduction Fund White Paper, 2014, p.11

[30] Warburton, D., Fisher, B, In't Veld, S, and Zema, M., Renewable Energy Target Scheme Review, August 2014, Report of the Expert Panel, p.90

[31] Australian Renewable Energy Agency, Projects, accessed 23 October 2014

value under $10 million.

The Clean Energy Finance Corporation (CEFC) was established to help overcome capital market barriers that hinder the financing and commercialisation of renewable and low emission technologies. The CEFC generally finances projects at the later stages of development, with a positive expected rate of return and the capacity to service and repay capital. It is funded through the provision of $2 billion per annum in investment funds provided by the Commonwealth Government.

The Abbott Government has introduced legislation to abolish the CEFC.[32] The Climate Change Authority (Abolition) Bill 2013 and the Clean Energy Finance Corporation (Abolition) Bill 2014 were introduced into parliament as part of the broader Carbon Tax Repeal Legislative Package. Policy responsibility for the Clean Energy Finance Corporation remains with the Treasury.

3.5 Commonwealth Solar Towns program

As part of the 2014-15 Budget, the Government committed to establish the Solar Towns program which will provide $2.1 million over three years to community groups for the uptake of solar technologies.[33]

The program will provide grants to support the installation of solar photovoltaic (PV) and solar water heater systems. It is likely that systems receiving assistance under the program would also be eligible to receive assistance under the RET.

The Panel conducting the review into the RET suggested that the Government consider the level of assistance available under the RET when designing the rules for the Solar Towns program. This is to ensure that installations under the program are additional to what would have otherwise been achieved.

3.6 NSW Renewable Energy Policy

In September 2013, the NSW Government released its Renewable Energy Action Plan. This Plan supports the achievement of the national goal for 20 per cent renewable energy by 2020.The Plan has three overarching goals:

- attract renewable energy investment;
- build community support; and
- attract and grow renewable energy expertise.

The NSW Government established a working group (chaired by the NSW Renewable Energy Advocate) to deliver 24 actions outlined in the plan. The plan will operate alongside the Energy Efficiency Action Plan, the Regional Clean Energy Program and the Energy Savings Scheme.

[32] Department of the Environment, Repealing the Carbon Tax, accessed 17 October 2014
[33] Commonwealth of Australia, Budget Measures Budget Paper No.2 2014-15, p.130

The NSW Government also announced it will supplement ARENA funding for the deployment of large-scale solar in Broken Hill and Nyngan, and will provide continued support for small-scale renewable technology including rooftop solar PV.[34]

3.6.1 Solar Bonus Scheme

In November 2009, the NSW Government announced that it would establish the Solar Bonus Scheme using a subsidised feed-in tariff for small scale solar PV systems to operate from 1 January 2010 to 31 December 2016.

The Scheme was under statutory review when 50 MW of installed capacity was achieved. The feed-in tariff policy design used a fixed tariff rate of 60 cents per kWh for 10 kW or less of installed capacity. This was comparable to other generous tariff payments on offer in other Australian jurisdictions (Table 3).

Table 3: Australian State and Territory feed-in tariff schemes[35]

State	Scheme	Rate	Duration	Max size (kW)	Model
Australian	Premium Rate (March 09–June10) incl. 6 c/kW h MRP	50.05 c/kW h	20 years	10	Gross
Capital	Closed	40.04 c/kW h		30	
Territory	Reduced Rate (July 10–June 11) incl. 6 c/kW h MRP Closed	45.70 c/kW h		30	
Northern	Alice Solar Project (January 06–May 13) incl. $5/day	51.28 c/kW h	Ongoing	30	Net
Territory	capped. Reverts to normal buyback rate on 1 June 2013				
	Domestic Buyback (July–December 12)	21.77 c/kW h	6 month	4.5	
	Domestic Buyback (January–June 13)	25.83 c/kW h	Review		
Queensland	Premium Rate (July 08–June 12) Closed	44.00 c/kW h	20 years	30	Net
	Reduced Rate (after July 12). Payments end Jul 14	8.00 c/kW h	Annual review	5	
South	Customer Group 1–3 (June 08–January 12). Max 45 kW h/day	44.00 c/kW h	20 years	10	Net
Australia	Closed	16.00 c/kW h	3 years		
	Customer Group 4 (September 11–October 13). Max 45 kW h/day.				
	incl. 9.8 c/kW h MRP (July 12–June 13); and 11.2 c/kW h MRP (July 13–June 14)				
Tasmania	Solar buyback at 1:1 retail electricity supply tariff. Aurora Energy supplier	NA	Ongoing	10	Gross
Victoria	Premium Rate (November 09–September 11) Closed	60.00 c/kW h	15 years	5	Net
	Transitional Rate (January 12–December 12) Closed	25.00 c/kW h	5 years		
	Standard Rate (December 11–December 12). 1:1 retail electricity supply tariff. Closed	NA	5 years	100	
Western Australia	Premium Rate (August 10–July 11) incl. 7 c/kW h MRP (Synergy Energy). Closed	47.00 c/kW h	10 years	5	Net
	Reduced Rate (July 11–August 11) Closed	20.00 c/kW h			
	Buyback scheme (Synergy) (September 11–Current)	8.40 c/kW h	Ongoing		
	Premium Rate (August 10–July 11) incl. 18.93 c/kW h MRP (Horizon Power). Closed	58.93 c/kW h	10 years	30	
	Buyback scheme (Horizon) (August 11–current)	10–50 c/kW h	Ongoing		

Following the announcement of the Solar Bonus Scheme in January 2010, there was a noted acceleration in small scale solar PV system installations.[36] By the end of June 2010, over 28,000 investors had installed systems with a total capacity of approximately 53 MW, triggering the mandatory statutory review.

The feed-in tariff rate was subsequently reduced to 20 cents per kWh, with new participants able to access the 60 cents per kWh rate only if they had lodged a connection application by 18 November 2010. This resulted in a significant surge in investment prior to this deadline. Continued investor activity forced the NSW government to close entry to the Scheme in April 2011. The scheme was officially terminated in July 2011. According to IPART (2012):[37]

---

[34] Warburton, D., Fisher, B, In't Veld, S, and Zema, M., Renewable Energy Target Scheme Review, August 2014, Report of the Expert Panel, p.94-95

[35] Martin, N, and Rice, J., The solar photovoltaic feed-in tariff scheme in New South Wales, Australia, July 2013, Energy Policy 61, Table 1, p.700

[36] IPART, Solar feed-in tariffs, March 2012, p. 1

[37] Ibid

> The uptake of small-scale PV units has been much greater than anticipated by Government. As a result, the costs of the subsidy schemes are also greater than expected.

Households and small businesses with solar PV units in NSW can still earn feed-in tariffs for the electricity they export to the grid. Those who are not part of the initial scheme can receive unsubsidised feed-in tariffs.

Based on information provided by NSW Trade & Investment to IPART (2014) in March 2014, there are around 145,000 customers receiving subsidised feed-in tariffs under the Solar Bonus Scheme. Around 100,000 receive unsubsidised feed-in tariffs on the competitive market.[38]

IPART (2014) determined that the benchmark range for unsubsidised solar feed-in tariffs is 4.9 to 9.3 cents per kWh with a median of 5.6 cents per kWh and the retailer contribution is 5.1 cents per kWh. The benchmark range reflects the forecast wholesale market value of solar PV electricity in the coming year at different times of the day.

The upper end of the range represents this value during the period when solar PV exports have the highest wholesale market value (between 3pm and 5pm). The lower end of the range represents this value at all other times of day.[39] The benchmark range is not binding on retailers. Like other components of electricity retailers' competitive offers, solar feed-in tariffs are not regulated by IPART. Rather, as IPART (2014) explains:

> …[the] benchmark range provides guidance on the likely value of the electricity exported by PV customers, and can assist retailers in making these decisions and customers in deciding whether to install PV units and in comparing market offers.

The basics of the Solar Bonus Scheme, in terms of its design and administration, have been discussed in this Chapter of the paper. There was widespread criticism of the Scheme in terms of its efficiency, costs and implementation. The journal article by Rice and Martin (2013) addresses such issues at length. It specifically argues that the scheme resulted in very high public costs largely because of the faulty financial modelling relied upon in the design phase of the scheme.[40]

In 2011 the Auditor-General[41] found that the total tariffs to be paid under the scheme would be between $1.05 billion and $1.75 billion. The majority of the funds in the New South Wales Climate Change Fund would be required to reimburse distribution network service providers for their tariff payments. The

---

[38] IPART, Solar feed-in tariffs: the subsidy-free value of electricity from small-scale solar PV units from 1 July 2014, June 2014, Electricity – Final Report, p.1

[39] Ibid, p.1-2

[40] Martin, N, and Rice, J., The solar photovoltaic feed-in tariff scheme in New South Wales, Australia, July 2013, Energy Policy 61, p.697

[41] New South Wales Auditor-General, Special Report: Solar Bonus Scheme, November 2011

Auditor-General was also highly critical of the planning and management of the scheme.[42]

IPART (2012) in its review of the Solar Bonus Scheme was also critical of the scheme in terms of the costs associated with the scheme and concluded that the costs contributed to higher retail electricity prices in NSW and will continue to put pressure on prices for the life of the scheme.[43]

4. HYDRO ENERGY

Hydroelectricity is generated when water from reservoirs, rivers, streams or waterfalls is channelled through turbines. The water pressure on the turbine blades causes a shaft to rotate which then drives an electrical generator, converting the motion into electrical energy. Water is typically dammed and the flow of water out of the dam is controlled to drive the turbines.[44]

According to Geoscience Australia (2014), hydro is the most advanced and mature renewable energy technology. It has the advantages of low greenhouse gas emissions, low operating costs and a high ramp rate which enables it to be used for either base or peak load electricity generation.[45]

Australia’s water resources are limited by the high variability in rainfall, evaporation rates and temperatures. Of Australia’s gross theoretical hydro energy resource (265 TWh per year), only 30 TWh per year is considered to be economically feasible capacity.[46]

Nevertheless, Australia’s network of 123 operating hydro power stations produced electricity to power the equivalent of 2.7 million homes in 2013.[47] Generating capacity coincides with the areas of highest rainfall and elevation and is mostly in New South Wales, Tasmania and Victoria (Table 4).

Table 4: Distribution of hydro power stations, by State, 2013[48]

	NSW	VIC	QLD	WA	SA	NT	TAS	ACT
Plants operating	39	33	10	2	2	0	35	2
Under development	1	0	1	0	0	0	0	0

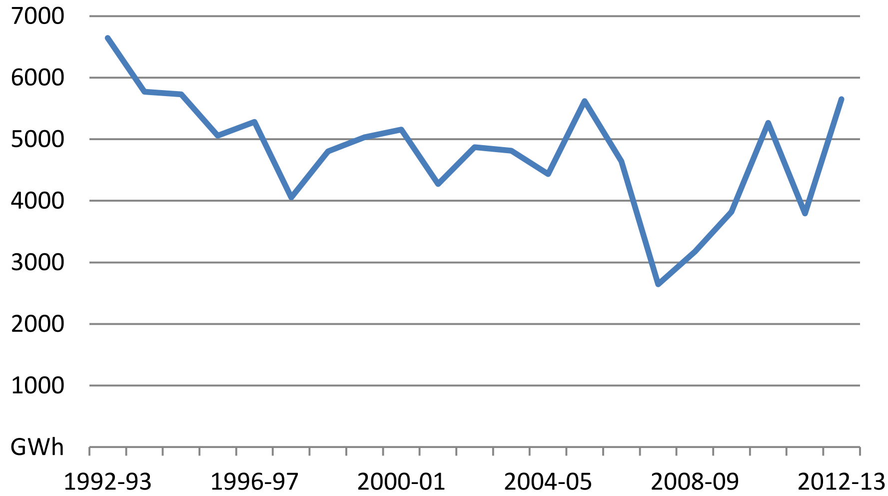
In 2012-13, hydro generated 18,270 GWh of electricity in Australia; equivalent to 56.1 per cent of renewable electricity and 7.3 per cent of total electricity generation.

---

[42] New South Wales Auditor-General, Special Report: Solar Bonus Scheme, November 2011
[43] IPART, Solar feed-in tariffs, March 2012, p. 1
[44] Geoscience Australia, Hydro Energy, accessed 24 September 2014
[45] Ibid
[46] Geoscience Australia and ABARE, Australian Energy Resource Assessment, 2010, p.232
[47] Clean Energy Council, 2013 Clean Energy Australia Report, 2014, p.41
[48] Ibid, p.42

By comparison, hydro generated 69.1 per cent of renewable electricity and 8 per cent of total electricity generation in New South Wales during 2012-13.[49] The State's hydroelectricity production is virtually unchanged from a decade or so ago (Figure 8).

Figure 8: NSW hydro-electricity production[50]



Hydroelectric power in New South Wales is sourced predominantly from generators in the Snowy Hydro scheme. With a capacity of 3800 MW, it accounts for around half of Australia's total hydroelectricity generation capacity and provides base load and peak load power to the eastern mainland grid of Australia.[51]

The Scheme collects and stores the water that would normally flow east to the coast and diverts it through trans-mountain tunnels and power stations. The water is then released into the Murray and Murrumbidgee Rivers for irrigation. The Snowy Mountains Scheme comprises sixteen major dams, seven power stations, 145 km of inter-connected trans-mountain tunnels and 80km of aqueducts.[52]

Other hydro stations, primarily operated by Sydney Water, represent a smaller proportion of generating capacity. For example a relatively small, 50 MW station operates as part of the Warragamba Dam in New South Wales (Table 5).[53]

Hydro energy is becoming less significant in New South Wales's electricity fuel mix, as growth in generation capacity is being outpaced by other fuels. For example, between 2008-09 and 2012-13, hydro electricity's contribution to renewable electricity generation declined from 81 per cent to 69 per cent.[54]

---

[49] BREE, 2014 Australian energy statistics data, July 2014, Table O
[50] BREE, 2014 Australian energy statistics data, July 2014, Table I
[51] Geoscience Australia, Hydro Energy, accessed 24 September 2014
[52] Ibid
[53] Legislative Assembly of New South Wales, The economics of energy generation, November 2012, Public Accounts Committee, Report 6/55, p.117
[54] BREE, 2014 Australian energy statistics data, July 2014, Table O

Table 5: Hydroelectricity capacity in New South Wales, as at August 2014, megawatts[55]

Power Station	Owner	Installed Capacity
Blowering	Snowy Hydro Ltd	80
Guthega	Snowy Hydro Ltd	60
Hume NSW	Green State Power Pty Ltd	29
Shoalhaven	Origin Energy Eraring Pty Ltd	240
Tumut 3	Snowy Hydro Ltd	1500
Upper Tumut	Snowy Hydro Ltd	616
Brown Mountain	Green State Power Pty Ltd	5.2
Burrendong	AGL	19
Burrinjuck	Green State Power Pty Ltd	27.2
Copeton	AGL	20
Glenbawn	AGL	5
Jindabyne	Snowy Hydro Ltd	1.1
Jounama	Snowy Hydro Ltd	14.4
Keepit	Green State Power Pty Ltd	7.2
Nymboida	Essential Energy	33.6
Oaky	Essential Energy	4.8
Pindari	AGL	5.7
The Drop	Pacific Hydro Investments Pty Ltd	2.5
Warragamba HEPS	Sydney Catchment Authority	50
Wyangala A	Hydro Power Pty Ltd	20
Wyangala B	AGL	4

Further development of hydro resources in Australia is constrained by water availability.[56] Existing potential for hydroelectricity, particularly in New South Wales, has already been developed; or in some cases, are not available for development because of environmental considerations. The National Generators Forum observed in their submission to the 2012 Legislative Assembly report on the Economic of Energy Generation:[57]

> …most major available hydroelectric resources have already been developed,

[55] AEMO, General information – generation capacity, August 2014

[56] Bahadori, A, Zahedi, G, and Zendehboudi, S., An overview of Australia's hydropower energy: Status and future prospects, January 2013, Renewable and Sustainable Energy Reviews 20, p.565-569

[57] Legislative Assembly of New South Wales, The economics of energy generation, November 2012, Public Accounts Committee, Report 6/55, p.118

> so that new opportunities are limited to upgrades of existing facilities or installations of small generating units.

Bahadori et. al (2013) noted that upgrading and improving existing large scale infrastructure is important to increasing the efficiency of hydro energy. However, they emphasised that the key area for hydroelectricity growth exists in small scale developments:[58]

> Although most of Australia's most favourable hydroelectricity sites have been developed, mini-hydroelectricity plants are potentially viable on smaller rivers and streams where large dams are not technically feasible or environmentally acceptable. They can also be retro-fitted to existing water storages. Small hydropower plants, including micro and picoplants, are increasingly seen as a viable source of power because of their lower development costs and water requirements, and their lower environmental footprint.
>
> At present mini hydro- plants account for only around 2% of installed hydrocapacity. Small scale hydroelectricity plants, are still at a relatively early stage of development in Australia, and are expected to be the main source of future growth in hydroelectricity generation.

5. WIND ENERGY

Wind energy is generated using wind turbines which extract energy from the passing air. It does so by converting kinetic energy from rotational movement via a rotor. Wind energy is primarily used for electricity generation, both onsite and for transport to the grid.[59]

Wind turbines are relatively efficient and can convert around 45 per cent of the wind passing through the blades into electricity. In comparison, New South Wales coal-fired power stations convert 29 per cent to 37 per cent of the coal into electricity, while gas plants convert 32 per cent to 50 per cent of gas processed into electricity.[60]

Australia's wind energy resources are located mainly in the southern parts of the continent. Meso-scale maps show that Australia's greatest wind potential lies in the coastal regions of western, south-western, southern and south-eastern Australia (areas shown in orange to red colours in Figure 9 where average wind speeds typically exceed 6.5 m/s).[61]

---

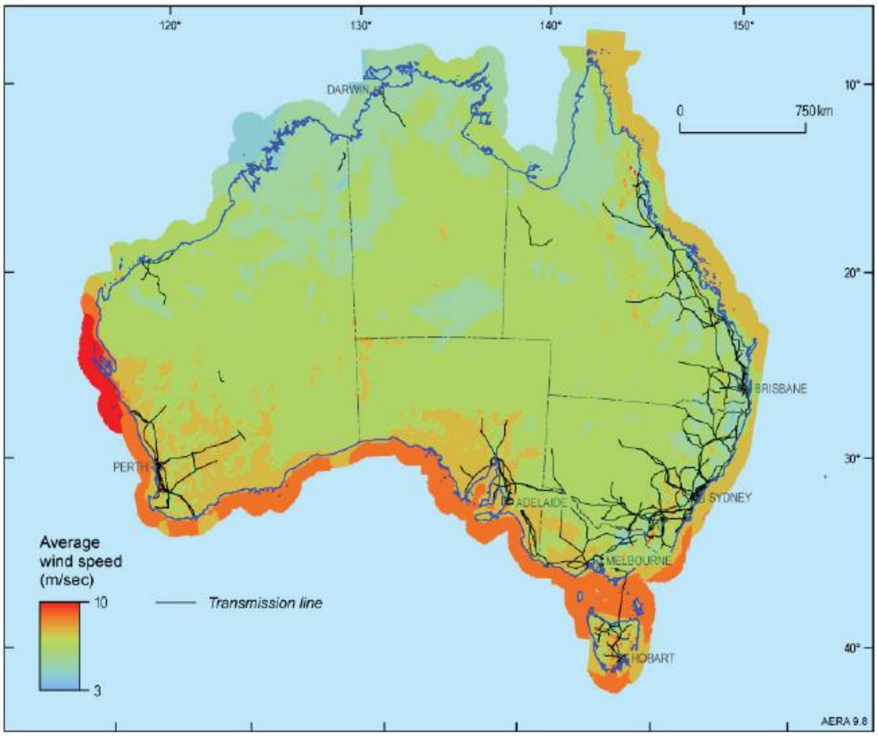
[58] Bahadori, A, Zahedi, G, and Zendehboudi, S., An overview of Australia's hydropower energy: Status and future prospects, January 2013, Renewable and Sustainable Energy Reviews 20, p.565-569

[59] Geoscience Australia, Wind Energy, accessed 24 September 2014

[60] Department of Environment, Climate Change and Water, The wind energy fact sheet, November 2010, p.3; Acil Tasman, Fuel resource, new entry and generation costs in the NEM, 2009, Final Report to AEMO

[61] Geoscience Australia and ABARE, Australian Energy Resource Assessment, 2010, p.246

Figure 9: Predicted average wind speed at a height of 80 metres[62]



The New South Wales Wind Farm Map shows that the areas with the highest wind energy potential lie along the higher exposed parts of the Great Dividing Range and very close to the coast. The best sites result from a combination of elevation, local topography and orientation to the prevailing wind.

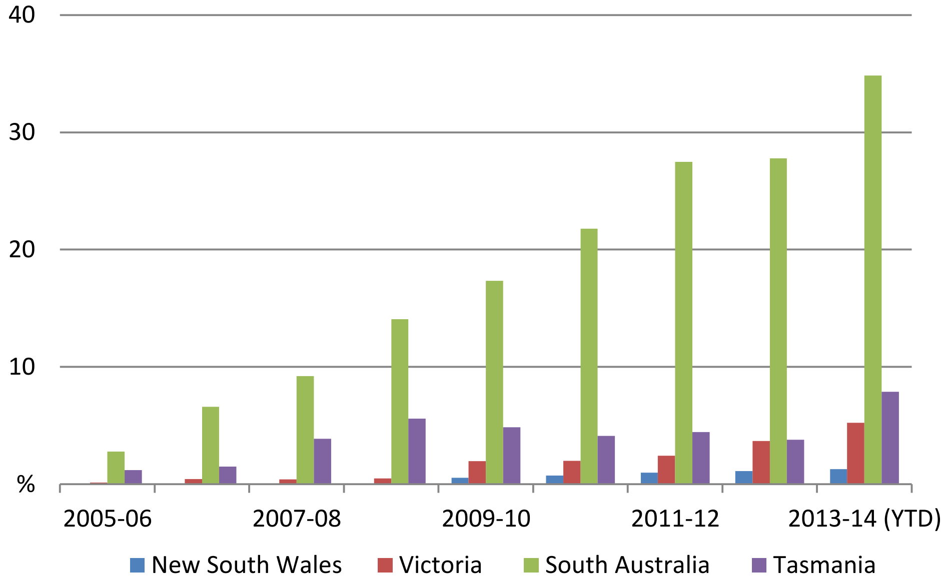
Wind generated 7,328 GWh of electricity in Australia in 2012-13; equivalent to 22.5 per cent of renewable electricity and 2.9 per cent of total electricity generation. By comparison, wind generated 10.2 per cent of renewable electricity and 1.2 per cent of total electricity generation in New South Wales during 2012-13.[63]

Wind generation has developed rapidly in South Australia (Figure 10), accounting for the largest share (28 per cent in 2012-13) of electricity generation when compared to the other Australian jurisdictions. Tasmania (8 per cent in 2012-13) and Victoria (5 per cent) have the next highest shares.

[62] Geoscience Australia and ABARE, Australian Energy Resource Assessment, 2010, Figure 9.8, p.246

[63] BREE, 2014 Australian energy statistics data, July 2014, Table O

Figure 10: Wind output as a percentage of regional output, by State[64]



Australia's 68 wind farms produced energy equivalent of more than 1.3 million average homes in 2013.[65] There were 1,639 wind turbines operating at the end of 2013, providing a combined capacity of 3,240 MW. South Australia had the most wind turbines of any State at the end of 2013, accounting for over a third (37 per cent) of the nation's wind capacity.

The AEMO reported in August 2014 that 28 wind projects were under development in New South Wales with a combined capacity of 5,089 MW (Chapter 9).

Table 6: Distribution and capacity of wind energy farms, by State, 2013[66]

	NSW	VIC	QLD	WA	SA	NT	TAS	ACT
Plants operating	9	13	2	21	16	0	7	0
Installed wind capacity (MW)	282	939	12.5	491	1205	0	310	0
Number of turbines	170	454	22	308	561	0	124	0

The majority of wind capacity installed in New South Wales takes the form of mid to large-scale projects. As Geoscience Australia and BREE (2010) describes:

> The increasingly large size of wind farms reflects the economies of scale to be gained through larger operations. Heavy utilisation of sites with high wind potential and consolidation of generating technology will significantly reduce

[64] AER, Wholesale Statistics, 2014
[65] Clean Energy Council, 2013 Clean Energy Australia Report, 2014, p.59
[66] Ibid, p.60

grid integration costs and maximise the economic gains from wind energy.

The largest currently installed wind farms are the Gullen Range (165 MW) and Capital Wind Farms (140 MW). However larger wind farms are under development in New South Wales. A 150 MW wind farm produces enough electricity to power around 60,000 to 65,000 homes, saving on average 360,000 tonnes of greenhouse gas emissions annually.[67]

Table 7: Wind capacity in New South Wales, as at August 2014, megawatts[68]

Power Station	Owner	Installed capacity
Gunning	Gunning Wind Energy Developments	46.5
Woodlawn Wind Farm	Woodlawn Wind Pty Ltd	48.3
Gullen Range	Gullen Range Wind Farm Pty Ltd	165.5
Boco Rock Wind Farm	Boco Rock Wind Farm Pty Ltd	113
Taralga	CBD Energy/Banco Santander	106.7
Blayney	Green State Power Pty Ltd	9.9
Capital Wind Farm	Renewable Power Ventures Pty Ltd	140.7
Crookwell	Green State Power Pty Ltd	4.8
Cullerin Range Wind Farm	Cullerin Range Wind Farm Pty Ltd	30
Kooragang	Ausgrid	0.6

The development of wind energy is relatively capital intensive and is estimated to comprise between 70 and 80 per cent of a project's lifetime costs.[69] This is primarily because of the high cost of turbines and grid integration infrastructure. Individual turbines can cost up to $3 million. The only variable costs are operation and maintenance costs.[70]

Economies of scale have permitted wind power to reduce the cost of delivered power by more than 80 per cent over the last 20 years. As Geoscience Australia and BREE noted (2010), there is an expectation that the cost of wind energy and associated technologies will decrease in the coming years:[71]

---

[67] Department of Environment, Climate Change and Water, The wind energy fact sheet, November 2010, p.4

[68] AEMO, General information – generation capacity, August 2014

[69] Blanco, M., The economics of wind energy, 2009, Renewable and Sustainable Energy Reviews, Vol. 13, pp. 1372–1382; Dale, L, Milborrow, D, Slark, R and Strbac, G., Total cost estimates for large-scale wind scenarios in UK, 2004, Energy Policy, Vol. 32, p. 1949–1956

[70] Geoscience Australia and ABARE, Australian Energy Resource Assessment, 2010, Chapter 9 – Wind Energy, p.250

[71] Ibid, p.251

> Lower manufacturing costs together with improvements in turbine efficiency and performance, and optimised use of wind sensing equipment are expected to decrease the cost of wind technology in the future.

Despite the high up-front capital costs, according to the Clean Energy Council (2014), wind power is currently the lowest cost type of renewable energy that can be rolled out on a large scale. The Renewable Energy Target provides an incentive to build the lowest cost renewable energy projects (Chapter 3). This means that wind power is likely to be the main technology supported by the target this decade.[72]

Stakeholders such as Pacific Hydro and Epuron (in their respective submissions to the 2012 Legislative Assembly report on the Economics of Energy Generation) suggested that there is potential for increases in the penetration of wind energy in New South Wales. In its submission, Pacific Hydro suggested that New South Wales has the potential for at least 3,000 MW of wind energy. Epuron claimed that between 20 and 30 per cent of the electricity generated in the National Electricity Market could be sourced from wind power.[73]

6. SOLAR ENERGY

Solar power is generated when sunlight is converted into electricity or used to heat air, water, or other fluids. There are two main types of solar energy technologies (Figure 11):[74]

- **Solar thermal** is the conversion of solar radiation into thermal energy which is commonly used directly, for space heating or to generate electricity using steam and turbines. Solar thermal is commonly used for hot water systems. Solar thermal electricity, known as concentrating solar power, is also designed for large scale power generation.
- **Solar photovoltaic (PV)** converts sunlight directly into electricity using photovoltaic cells. PV systems can be installed on rooftops, integrated into building designs or scaled up to megawatt scale power plants. PV systems can also be used in conjunction with concentrating mirrors or lenses for large scale centralised power. Solar PV cells are best for supplying peak demands in the middle of the day but are less effective in managing the evening peak.[75]

Solar energy is environmentally advantageous as it does not deplete natural resources, does not cause carbon dioxide emissions or generate waste

---

[72] Clean Energy Council, 2013 Clean Energy Australia Report, 2014, p.59

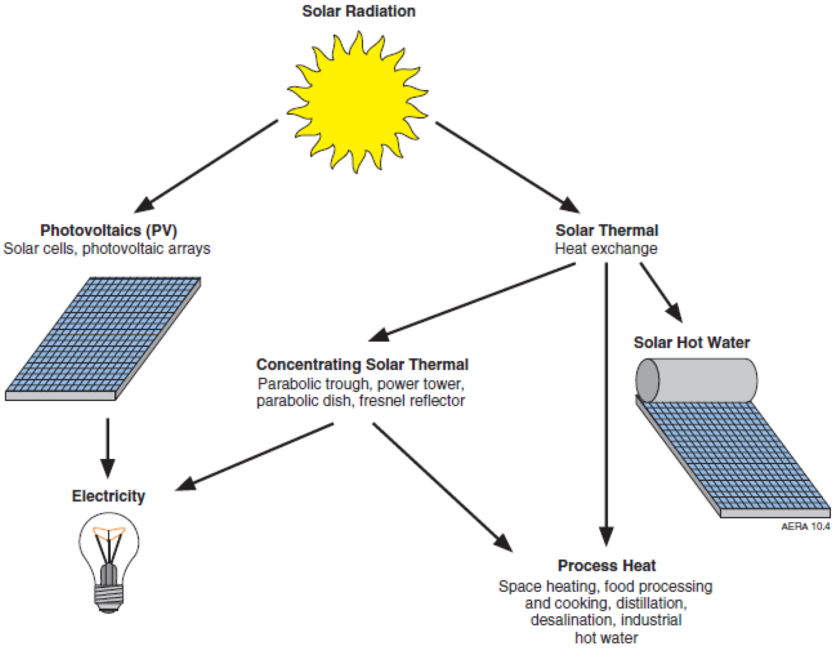
[73] Legislative Assembly of New South Wales, The economics of energy generation, November 2012, Public Accounts Committee, Report 6/55, p.120

[74] Geoscience Australia, Solar Energy, accessed 24 September 2014

[75] Bahadori, A, Nwaoha, C, Zendehboudi, S, and Zahedi, G., An overview of renewable energy potential and utilisation in Australia, February 2013, Renewable and Sustainable Energy Reviews 21, p.584

products.[76]

Figure 11: Solar energy flows[77]



The Australian continent has the highest solar radiation per square metre of any continent. However, high solar regions are typically deserts in the northwest and centre of the continent (Figure 12).

Wyld Group and MMA (2008) identified the Port Augusta region in South Australia, north-west Victoria, and central and north-west New South Wales as regions in the National Electricity Market of high potential for solar thermal power.[78] This was based on solar radiation levels, proximity to local loads and electricity costs from alternative sources.

Australia receives an average of 58 million PJ of solar radiation per year. This compares with annual national energy consumption of 4,022 PJ in 2012–13. Theoretically, then, if only 0.1 per cent of the incoming radiation could be converted into usable energy at an efficiency of 10 per cent, all of Australia's energy needs could be supplied by solar energy.[79]

It should be noted that this measurement of solar radiation is not appropriate for concentrating systems, including both solar thermal power and concentrating

[76] Bahadori, A, and Nwaoha, C., A review on solar energy utilisation in Australia, November 2012, Renewable and Sustainable Energy Reviews 18, p.2

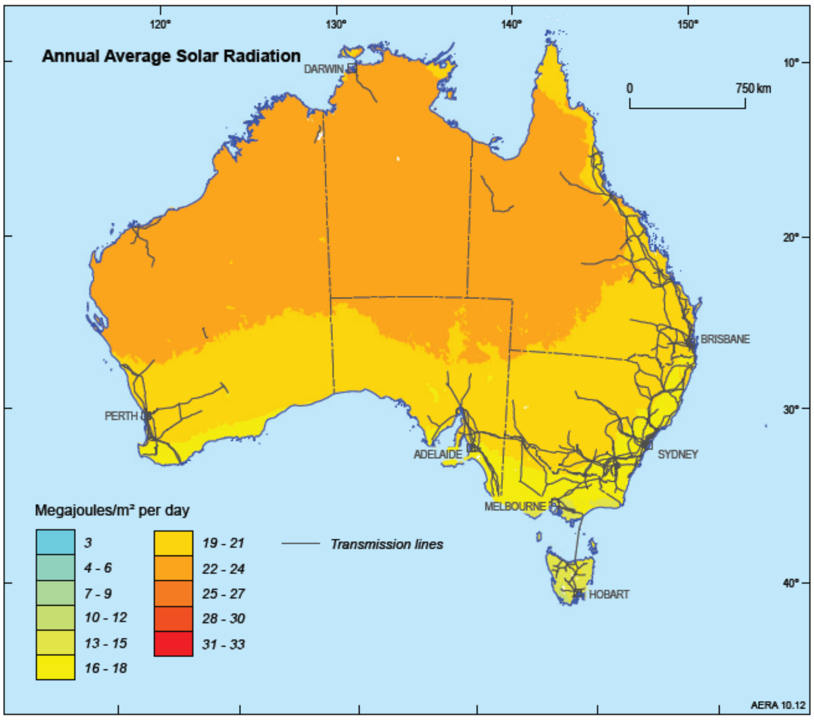
[77] Geoscience Australia and ABARE, Australian Energy Resource Assessment, 2010, Chapter 10 – Solar Energy, Figure 10.4, p.263

[78] Wyld Group and MMA, High Temperature Solar Thermal Technology Roadmap, 2008, Prepared for the NSW and Victorian Governments by Wyld Group and McLennan Magasanik Associates

[79] Geoscience Australia and ABARE, Australian Energy Resource Assessment, 2010, Chapter 10 – Solar Energy, p.268

PV. The Direct Normal Irradiance[80] is a more relevant measure of the solar resource.[81] Even with these and other restrictions on solar measurements[82], the annual radiation falling is equivalent to 2.7 million PJ, more than 500 times the annual energy demand of Australia.

Figure 12: Annual average solar radiation (MJ per square meter)



Solar energy consumption has risen at a relatively fast pace since 2005-06 across most Australian jurisdictions (Figure 13). Annual consumption for New South Wales has risen from 0.6 PJ of in 2002-03 to 3.7 PJ in 2012-13. The State is the largest consumer of solar energy, ahead of Western Australia (3.0 PJ in 2012-13), Queensland (2.4 PJ) and Victoria (2.3 PJ).

While consumption has increased, solar energy still accounts for a very small share of total energy consumption in New South Wales (0.24 per cent in 2012-13) and Australia (0.22 per cent).

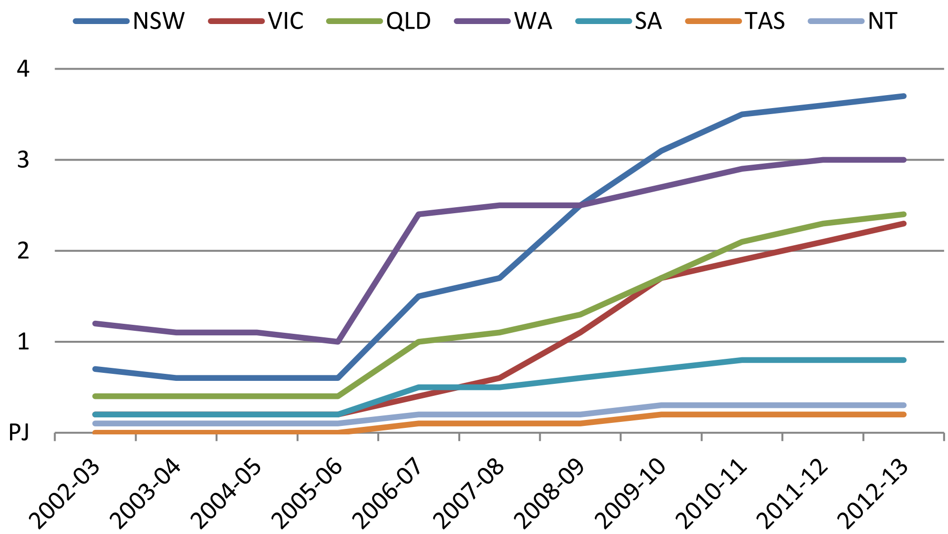
---

[80] This is the amount of solar radiation received per unit area by a surface that is always held perpendicular (or normal) to the rays that come in a straight line from the direction of the sun at its current position in the sky.

[81] For a more detailed discussion of the difference between solar radiation measurements see: Geoscience Australia and ABARE, [Australian Energy Resource Assessment], 2010, Chapter 10 – Solar Energy, p.269-270

[82] Where land with a slope of greater than 1 per cent, and land further than 25 km from existing transmission lines has been excluded to account for the viability of infrastructure connection.

Figure 13: Solar energy consumption in Australia, by State and Territory[83]



Electricity generation from solar in New South Wales increased in response to government subsidies to customers installing solar PV units. The RET Scheme provided an up-front subsidy on PV units; while the Solar Bonus Scheme provided subsidised feed-in tariffs for the electricity produced by PV units (Chapter 3).[84]

Table 8: Annual number of solar PV system installations in Australia[85]

Year installed	ACT	NSW	NT	QLD	SA	TAS	VIC	WA
2008	277	14,026	225	18,377	8,592	1,454	8,735	11,166
2009	803	14,009	215	18,283	8,573	1,452	8,429	11,157
2010	2,390	69,887	637	48,691	16,703	1,889	35,680	22,292
2011	6,944	80,115	401	95,261	63,476	2,475	60,203	51,658
2012	1,560	53,825	512	130,158	41,803	6,358	66,198	42,628
2013	2,553	36,605	986	79,581	28,247	7,552	33,666	24,050

The vast majority of solar capacity in New South Wales is in the form of rooftop solar PV systems installed on homes and businesses. Almost 1.25 million small-scale solar power systems were installed by the end of 2013 (269,700 in New South Wales). Approximately 3.1 million Australians now live or work beneath a set of solar panels.

In 2012-13, solar PV generated 3,816 GWh of electricity in Australia. This is represents 11.7 per cent of all renewable electricity and 1.5 per cent of total electricity generation in 2012-13. By comparison, solar PV generated 10.5 per

[83] BREE, 2014 Australian energy statistics data, July 2014, Table D
[84] IPART, Solar feed-in tariffs, March 2012, p. 1.
[85] Clean Energy Council, 2013 Clean Energy Australia Report, 2014, p.47

cent of all renewable electricity and 1.2 per cent of total electricity generation in New South Wales during 2012-13.[86]

Table 9: Capacity of small scale solar installations, by State, megawatts[87]

	NSW	VIC	QLD	WA	SA	NT	TAS	ACT
2013 Capacity of Solar PV Installed	141.4	137.2	308.6	76.7	147.1	5	32.4	11.7
Total Capacity of Solar PV Installations	659	559.2	1,073.8	358.9	502.4	11.5	63.6	41.5

Currently, solar PV systems are not economically viable without government subsidies. It requires between 4 and 10 years to recoup the investment outlay and 2 to 3 years to recoup the energy used in their manufacture. Advances in the techniques of manufacture are expected to bring the cost of these systems down below US$1 per installed watt; the point at which the systems become financially viable.[88] As the Australia Academy of Science (2009) noted:

> The objective of the industry is to approach 'grid parity', the point at which the costs of generation by photovoltaic systems becomes equal to the cost of power generated by other means.

According to the Clean Energy Council (2014), Australia currently has only two genuinely large-scale solar power plants.[89] Namely, the 10 MW Greenough River solar PV facility in Western Australia and a 9.3 MW solar thermal plant which was added to the Liddell coal-fired power plant in New South Wales.

The other solar generation projects operating in New South Wales are limited to small pilot projects. However, there are a number of larger projects being planned or under construction, including the Capital Solar Farm near Bungendore, as well as proposed solar farms near Nyngan and Broken Hill.[90]

Table 10: Distribution of larger-scale solar operations, by State, 2013[91]

	NSW	VIC	QLD	WA	SA	NT	TAS	ACT
Plants operating	11	7	7	8	6	10	0	0
Under development	8	0	3	0	0	0	0	2

The 102 MW Nyngan Solar Plant is the first of two large-scale solar PV projects

[86] BREE, 2014 Australian energy statistics data, July 2014, Table O
[87] Clean Energy Council, 2013 Clean Energy Australia Report, 2014, p.47
[88] Australian Academy of Science, Australia's renewable energy future, December 2009, p.12
[89] Clean Energy Council, 2013 Clean Energy Australia Report, 2014, p.51
[90] Legislative Assembly of New South Wales, The economics of energy generation, November 2012, Public Accounts Committee, Report 6/55, p.133
[91] Clean Energy Council, 2013 Clean Energy Australia Report, 2014, p.52

that AGL will deliver, with support from ARENA and the NSW Government. Construction began at Nyngan in early 2014 and it is expected to come online by mid-2015. AGL's second plant at Broken Hill is scheduled to start construction during 2014, with an expected completion date of late 2015.[92]

Table 11: Solar capacity in New South Wales, as at August 2014, megawatts[93]

Power Station	Owner	Installed Capacity
Broken Hill Solar Plant	AGL PV Solar Development	53
Moree Solar Farm	Moree Solar Farm	56
Nyngan	AGL Energy Limited	102
Capital East Solar Farm	Infigen Energy	0.13

7. OTHER RENEWABLE FORMS OF ENERGY

To date, the development of renewable forms of energy generation in Australia has focused on hydroelectricity, solar and wind energy. However, there are a number of alternative forms of energy generation which have the potential to provide significant amounts of energy, including nuclear power and various renewable sources such as bio-mass, geothermal, tidal and wave.[94]

7.1 Geothermal

Geothermal energy is heat contained within the earth and is generated by the natural decay of radiogenic elements over billions of years. It is a relatively abundant, clean and renewable natural resource.[95] As Bahadori et. al. (2013) note:[96]

> The most compelling feature of geothermal energy process is that it produces zero carbon emissions, potentially making it one of the cleanest sources of energy at our disposal. Another compelling feature is that it can create a constant 24 hour base-load power where other renewable energies are unable.

Geothermal resources range from shallow ground to hot water and rock several kilometres below the Earth's surface. It is consequently useful to distinguish between hydrothermal and other geothermal resources (Figure 14):[97]

---

[92] Clean Energy Council, 2013 Clean Energy Australia Report, 2014, p.51

[93] AEMO, General information – generation capacity, August 2014

[94] Legislative Assembly of New South Wales, The economics of energy generation, November 2012, Public Accounts Committee, Report 6/55, p.145

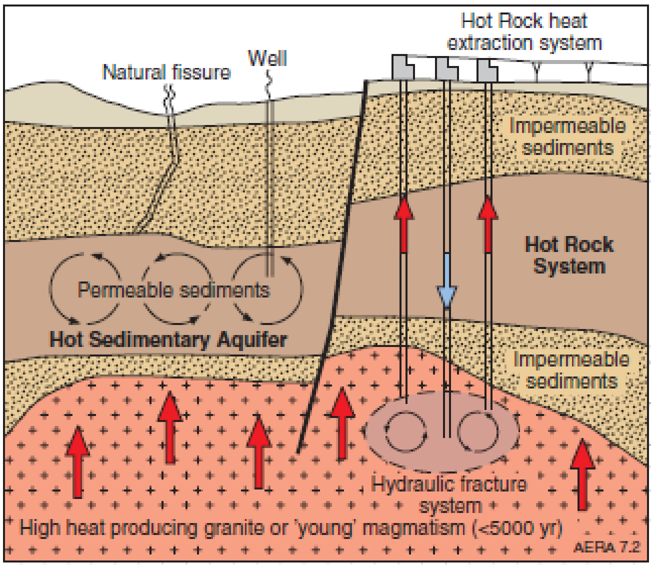
[95] Geoscience Australia and ABARE, Australian Energy Resource Assessment, 2010, p.205

[96] Bahadori, A, Zendehboudi, S, and Zahedi, G., A review of geothermal energy resources in Australia: current status and prospects, January 2013, Renewable and Sustainable Energy Reviews 21, p.29-34

[97] Geoscience Australia and ABARE, Australian Energy Resource Assessment, 2010, p.205

- **Hydrothermal resources** use naturally occurring hot water or steam circulating through permeable rock and are commonly associated with active or young volcanic systems. Australia lacks hydrothermal resources as it has no active volcanism on the mainland.
- **Hot Rock** resources (also known as enhanced geothermal systems) produce super-heated water or steam by artificially circulating fluid through the rock. The thermal energy is retained in the basement rocks and overlying strata causing elevated temperatures at relatively shallow depths.
- **Hot Sedimentary Aquifers** are found in areas where high temperatures are reached at depths shallow enough for natural porosity and permeability in sedimentary rocks to be preserved. Fluid circulation can occur without artificial enhancement.

Figure 14: Hot Rock and Hot Sedimentary Aquifer systems[98]

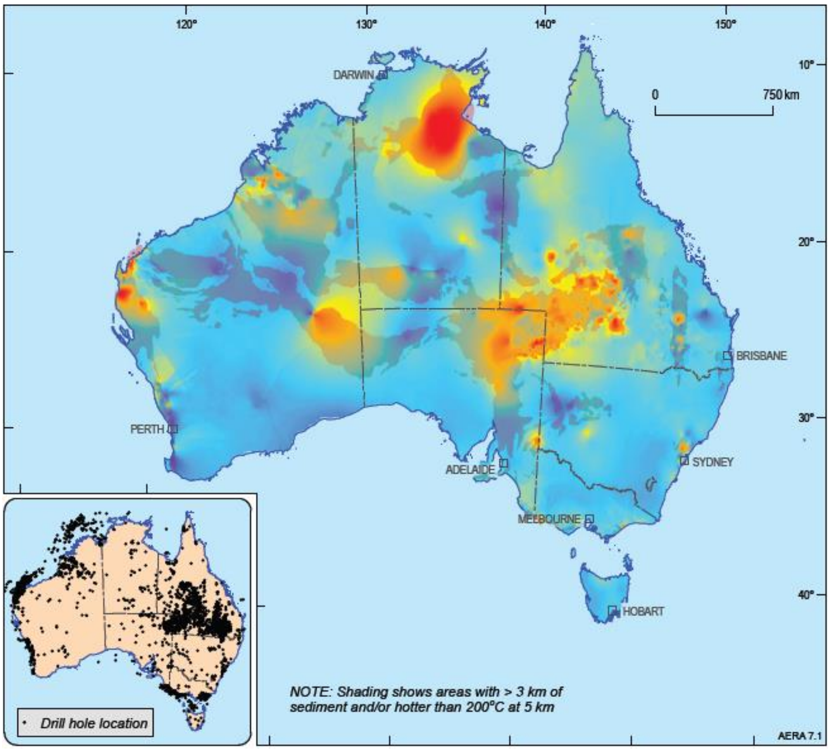


For further information related to the different types of geothermal energy, see Chapter 7 of the Australian Energy Resource Assessment.

According to Geoscience Australia and ABARE (2010), Australia has considerable **hot rock** geothermal energy potential; with extensive areas where temperatures are estimated to reach at least 200°C at around 5 km depth (Figure 15).[99] Further, Geoscience Australia and ABARE (2010) calculate that if just 1 per cent of Australia's geothermal energy with a minimum temperature of 150°C and at a maximum depth of 5 kilometres were accessible, the total resource is 190 million PJ.[100]

[98] Geoscience Australia and ABARE, Australian Energy Resource Assessment, 2010, p.205
[99] Ibid, p.203
[100] Ibid, p.213

Figure 15: Predicted temperature at 5 km depth in petroleum and water boreholes across Australia[101]



However, current drilling technology and associated costs of exploration (estimated between $15 and $20 million[102] for a site) limit extensive economic development of these resources. Future production from these systems will depend on significant advances in technology which the AEMO does not expect to be available until sometime between 2020 and 2030.[103]

There is also potential for lower temperature geothermal resources associated with naturally circulating waters in **hot sedimentary aquifers**.[104] The Great Artesian Basin, part of which is located in north-west New South Wales, is considered one of Australia's best potential sources of geothermal aquifer energy. However, as the amount of electricity likely to be produced is limited and isolated, it is only considered a viable energy source for small communities located in close proximity.[105]

[101] Geoscience Australia and ABARE, Australian Energy Resource Assessment, 2010, p.204

[102] Legislative Assembly of New South Wales, The economics of energy generation, November 2012, Public Accounts Committee, Report 6/55, p.160

[103] CSIRO Energy Transformed Flagship, AEMO 100% Renewable Energy Study, 3 September 2012, p. 8

[104] Needham, S., The potential for renewable energy to provide baseload power in Australia, 2008-09, Parliamentary of Australia, Department of Parliamentary Services, Research Paper No. 9

[105] Legislative Assembly of New South Wales, The economics of energy generation, November 2012, Public Accounts Committee, Report 6/55, p.159

For the aforementioned reasons, geothermal is still an emerging industry in Australia, with exploration being conducted in all States and the Northern Territory. However, most[106] geothermal projects are still at proof-of-concept or early commercial demonstration stage. Other than at Birdsville in Queensland,[107] Australia's reported geothermal resources are currently all sub-economic because the large-scale commercial viability has not yet been demonstrated in Australia.[108]

Table 12: Distribution of geothermal energy operations, by State, 2013[109]

	NSW	VIC	QLD	WA	SA	NT	TAS	ACT
Plants operating	0	0	1	0	2	0	0	0
Under development	0	0	0	0	1	0	0	0

In their submission to the 2012 Legislative Assembly report on the Economics of Energy Generation, the CSIRO observed that New South Wales has attractive geothermal resources located in the Hunter Valley, which are close to existing electricity infrastructure. The proximity of these resources to coal fired power stations provides the opportunity for hybrid application to pre-heat steam.

Geodynamics Limited was developing the Hunter Valley Geothermal Project, the first geothermal energy project in New South Wales. It had potential for expansion to a 200 MW plant. The project received over $10 million in NSW Government funding. However, the company reported that no field activities were planned for the immediate future.[110]

7.2 Tidal and wave energy

Tidal energy is generated from tidal movements which contain both potential energy (vertical fluctuations in sea level) and kinetic energy (horizontal motion of the water column). It can be harnessed using two main technologies:[111]

- *Tidal barrages* – are based on the rise and fall of the tides and generally enclose a large tidal basin. Water enters the basin through gates in the barrage and is released through low-head turbines to generate electricity.
- *Tidal stream generators* – free-standing structures typically built in

[106] A geothermal power plant has been in operation at Birdsville, Queensland, periodically since 1992. It uses a bore that taps water from the Great Artesian Basin at 98°C at surface to produce approximately 80 kW net.

[107] Geoscience Australia and ABARE, Australian Energy Resource Assessment, 2010, p.203

[108] Bahadori, A, Zendehboudi, S, and Zahedi, G., A review of geothermal energy resources in Australia: current status and prospects, January 2013, Renewable and Sustainable Energy Reviews 21, p.31; Department of Resources, Energy and Tourism, Australian geothermal industry development framework, December 2008

[109] Clean Energy Council, 2013 Clean Energy Australia Report, 2014, p.40

[110] Legislative Assembly of New South Wales, The economics of energy generation, November 2012, Public Accounts Committee, Report 6/55, p.161

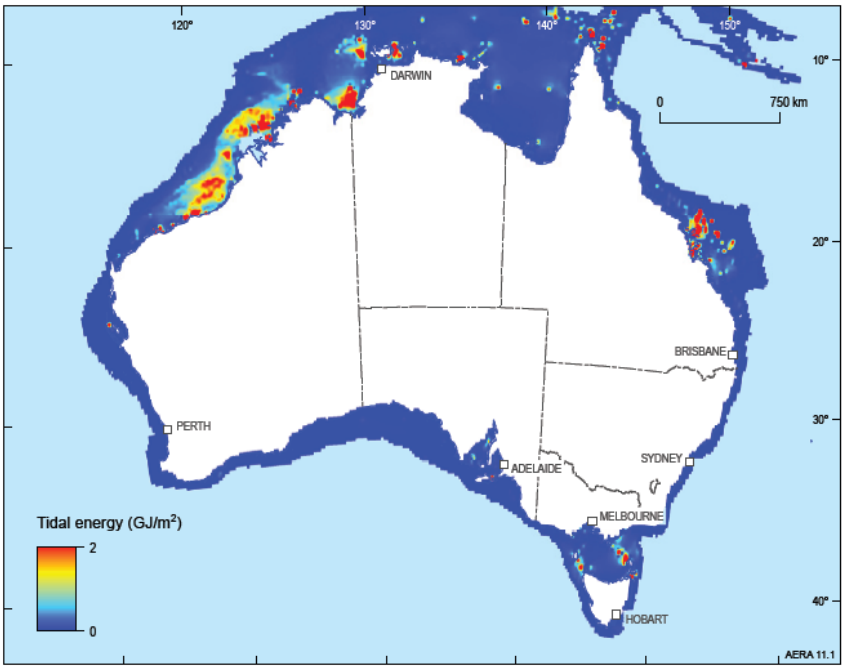
[111] Geoscience Australia, Ocean energy, accessed 24 September 2014

channels or straits to harness the kinetic energy of the tide. The turbines generate electricity from horizontally flowing tidal currents.

Tidal power is considered a potential energy source for north-west Australia where there is a large energy density due to the tide range and a large volume of water mobilised by the tide (Figure 16).

Tidal kinetic energy on the entire Australian continental shelf at any one time, on average, is about 2.4 PJ. Tidal energy is estimated 1.21 TJ for New South Wales, the lowest of any of the other coastal jurisdictions.[112]

Figure 16: Total annual tide kinetic energy (GJ per square metre) on the Australian continental shelf (less than 300 m water depth)



Tidal power is not a viable energy source for New South Wales, as the state does not have a tidal range of five metres or more, which is required for large-scale installations.[113]

The best resourced jurisdictions are Western Australia, Queensland and the Northern Territory. However, the relatively high capital costs and lengthy construction times for large tidal schemes are considered major obstacles to their growth in Australia.

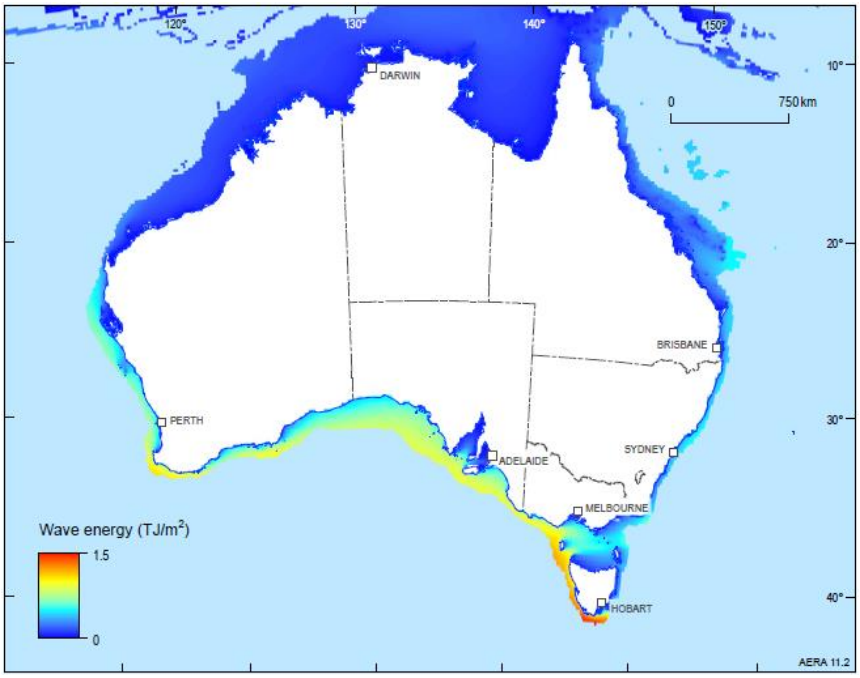
Wave energy is generated by converting the energy of ocean waves into

[112] Geoscience Australia and ABARE, Australian Energy Resource Assessment, 2010, Chapter 11 – Ocean Energy, p.291

[113] Needham, S., The potential for renewable energy to provide baseload power in Australia, Parliamentary of Australia, Department of Parliamentary Services, Research Paper no. 9, 2008–09

electricity. The total wave energy on the entire Australian continental shelf at any one time, on average, is about 3.47 PJ. New South Wales has the lowest amount of wave energy when compared to the other jurisdictions at 69 TJ.[114] The States with the best wave energy resource are Western Australia, South Australia, Victoria and Tasmania (Figure 17).

Figure 17: Total annual wave energy (Terrajoules per square metre) on the Australian continental shelf (less than 300 m water depth)



In 2013, 18 companies were actively investigating a variety of innovative marine energy projects in Australia, using tides, currents or waves to generate electricity.

Marine energy projects under development range from 250 KW trials to the Carnegie Wave Energy 5 MW commercial power plant. New South Wales currently has no tidal or wave energy projects in operation or in line for prospective development.

Table 13: Distribution of tidal and wave energy projects, by State, 2013[115]

	NSW	VIC	QLD	WA	SA	NT	TAS	ACT
Plants operating	0	0	0	1	0	0	0	0
Under development	0	4	0	3	1	1	3	0

[114] Geoscience Australia and ABARE, Australian Energy Resource Assessment, 2010, Chapter 11 – Ocean Energy, p.297
[115] Clean Energy Council, 2013 Clean Energy Australia Report, 2014, p.44

7.3 Bioenergy

Bioenergy refers to the use of renewable and organic material for power, electricity generation and direct source heat applications. Biomass[116] releases carbon dioxide and small amounts of greenhouse gases when it is converted into energy. However, carbon dioxide is absorbed during the regrowth of the restored vegetation through the photosynthesis process.[117]

Table 14: Current bioenergy resources[118]

Biomass groups	Current resources	Bioenergy	
Agricultural wastes and by-products	Livestock wastes: manure; abattoir wastes; wheat starch	P	T
Sugar cane	Bagasse; fibrous residues of sugar cane milling process; sugar and C-molasses	P	T
Energy crops	High yield, short rotation crops: sugar, starch and oil bearing crops	-	T
Forest residues	Wood from plantation forests	P	-
Wood waste	Saw mill residues	P	-
Landfill gas	Methane emitted from landfills	P	-
Sewage gas	Methane emitted from solid organic components of sewage	P	-

P = electricity and heat generation; T=transport biofuel production

Bioenergy accounted for 64 per cent renewable energy supply in Australia but only 4 per cent of total energy supply in 2012-13.[119] The majority of Australia's bioenergy is from wood, wood waste and bagasse. In 2012-13, bagasse and wood accounted for 45 per cent and 42 per cent of bioenergy use respectively. Liquid biofuels comprised the remaining 13 per cent of bioenergy use.[120]

Queensland has the largest bioenergy sector of any State, with its 43 power stations accounting for over half the country's bioenergy generation capacity. Australia's largest bioenergy plant is Sucrogen's 68 MW Pioneer Mill near Ayr in North Queensland.[121] New South Wales has the next largest bioenergy capacity of the other Australian jurisdictions, with 37 plants operating during 2013 and another 5 more in development (Table 15).

---

[116] Biomass is vegetable and animal derived organic materials, which are grown, collected or harvested for energy. Examples include wood waste, bagasse (sugar cane residues) and animal fats.

[117] Geoscience Australia, Bioenergy, Accessed 24 September 2014

[118] Geoscience Australia and ABARE, Australian Energy Resource Assessment, 2010, Chapter 12 – Bioenergy, Table 12.4, p.316

[119] BREE, 2014 Australian energy statistics data, July 2014, Table A

[120] Ibid

[121] Clean Energy Council, 2013 Clean Energy Australia Report, 2014, p.37

Table 15: Distribution of bioenergy operations, by State, 2013[122]

	NSW	VIC	QLD	WA	SA	NT	TAS	ACT
Plants operating	37	28	43	15	8	1	4	3
Under development	5	2	3	1	0	0	1	0

In 2012-13, bioenergy fuels generated 3,150 GWh of electricity in Australia. This represents 9.7 per cent of all renewable electricity and 1.6 per cent of total electricity generation. By comparison, bioenergy fuels generated 10.3 per cent of all renewable electricity and 1.2 per cent of total electricity generation in New South Wales during 2012-13.[123]

Table 16: Bioenergy electricity capacity in New South Wales, as at August 2014, megawatts[124]

Power Station	Owner	Installed Capacity	Fuel Type
Awaba	LMS Energy	1.123	Landfill Methane / Gas
Belconnen	EDL LFG ACT	1.03	Landfill Methane / Gas
Belrose	EDL LFG NSW	1.03	Landfill Methane / Gas
Broadwater	Cape Byron Power	38	Bagasse
Condong	Cape Byron Power	30	Bagasse
EarthPower Biomass Plant	EarthPower Technologies Sydney	3.9	Biomass recycled material
Eastern Creek	EDL LFG NSW	5.06	Landfill Methane / Gas
Eastern Creek 2 Gas Utilisation Facility	LMS Energy	7.861	Landfill Methane / Gas
Grange Avenue	EDL LFG NSW	1.26	Landfill Methane / Gas
Jacks Gully	EDL LFG NSW	2.3	Landfill Methane / Gas
Lucas Heights I	EDL LFG NSW	5.39	Landfill Methane / Gas
Lucas Heights II Stage 2	EDL LFG NSW	17.25	Landfill Methane / Gas
Mugga Lane	EDL LFG ACT	3.45	Landfill Methane / Gas
Stotts Creek	LMS ENERGY	0.3	Landfill Methane / Gas
Summer Hill	LMS Energy	2.246	Landfill Methane / Gas
West Nowra Landfill Gas Power Generation Facility	AGL	1	Landfill Methane / Gas
Woodlawn Bioreactor Energy Generation	Veolia Environmental Services Aust	5.325	Landfill Methane / Gas
Wyong	LMS ENERGY	2.246	Landfill Methane / Gas

[122] Clean Energy Council, 2013 Clean Energy Australia Report, 2014, p.38
[123] BREE, 2014 Australian energy statistics data, July 2014, Table O
[124] AEMO, General information – generation capacity, August 2014

Bioenergy resources are difficult to estimate due to their multiple and competing uses. There are production statistics for current commodities such as grain, sugar, pulp wood and saw logs. However, these commodities are largely committed to food, animal feed and materials markets. They could be switched to the bioenergy market in certain conditions, but this may not be the highest order use for them.[125]

According to Geoscience Australia (2014), the proportion of biomass potentially available will depend on: the value of biomass relative to competing uses; the impact of their removal; and global oil prices. The right economic conditions may result in some of the biomass potentially being used for bioenergy production. Depending on the price point, biomass may be diverted to biofuels or electricity generation if it is a higher value product.

8. COSTS OF RENEWABLE ENERGY PRODUCTION

The Asia-Pacific Renewable Energy Assessment provides an overview of the current and possible future costs of renewable electricity generation in Australia. This includes assessing any associated environmental and energy security externalities that may apply to different technology choices. As BREE (2014) explains:[126]

> Knowledge of the cost of new electricity generating technology plays an important role in determining the mix of electricity generation capacity additions that will serve growing loads in the future. Understanding technology costs also helps to determine how new electricity generation capacity competes against existing capacity, and the response of electricity generators to the imposition of environmental controls on conventional pollutants or any limitations on greenhouse gas emissions.

The Asia-Pacific Renewable Energy Assessment specifically provides levelised cost of energy (LCOE) estimates of renewable generation technologies existing within Australia. That is, the minimum cost of energy at which a generator must sell the produced electricity in order to achieve its desired economic return. It is equivalent to the long-run marginal cost of electricity because it measures the cost of producing one extra unit of electricity with a newly constructed electricity generation plant.[127]

LCOE estimates for Australian renewable electricity technologies were sourced by BREE from a number of different analysts and are presented in Figure 18. Differences in modelling assumptions by source agencies produce the wide ranging LCOEs.[128] Detailed LCOE estimates for onshore and offshore wind, solar PV, biomass, geothermal, and solar thermal electricity in Australia are available in Appendix A of the BREE (2014) report.

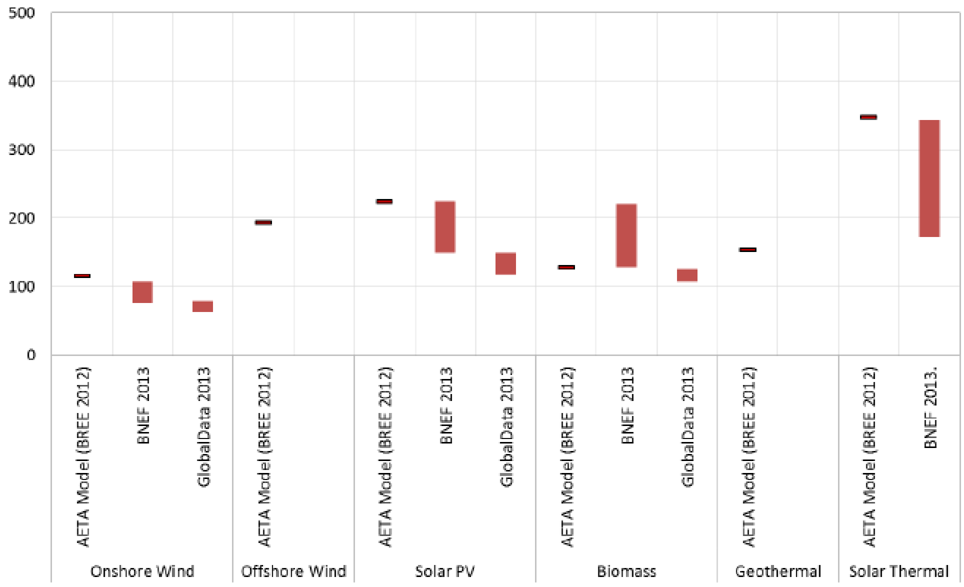
---

[125] Geoscience Australia, Bioenergy, Accessed 24 September 2014
[126] BREE, Asia-Pacific Renewable Energy Assessment, July 2014, p.3
[127] Ibid, p.55
[128] Ibid, p.66

The available LCOE estimates suggest that onshore wind, followed by biomass, is the most economic renewable electricity in Australia. According to BREE (2012) estimates, onshore wind is about 40 per cent cheaper than offshore wind in Australia. The available estimates indicate that biomass and geothermal could be more affordable as compared to solar PV and solar thermal technology.[129]

According to BNEF (2013), reductions in equipment and financing costs have driven a significant decline in the LCOE of wind and large scale solar PV since 2011. It is forecasted that the LCOE of both of these two technologies would continue to fall as manufacturing economies of scale and innovation continue to reduce costs.[130]

Figure 18: LCOE estimates for renewable energy technologies in Australia, 2013, USD/MWh



9. INVESTMENT IN RENEWABLE ENERGY

The Australian market attracted $5.2 billion of new clean energy investment in 2013. Investment has been above $5 billion per year since 2011.[131]

Investment in renewable energy can take place at a small-scale or large-scale level. With respect to small-scale investment, according to the Clean Energy Council (2014), by the end of 2013, almost 1.25 million homes and businesses had installed a solar power system. This means that approximately 3.1 million Australians lived or worked at a property with solar power.[132]

---

[129] BREE, Australian Energy Technology Assessment, 2012, Department of Industry, Australia

[130] Bloomberg New Energy Finance, Cost of energy technologies, 2013, World Energy Council Report

[131] Clean Energy Council, 2013 Clean Energy Australia Report, 2014, p.19

[132] Ibid, p.9

More than 213,200 solar power systems were installed in 2013. This was a reduction of 38 per cent on the year before, although the average system size continues to increase. The Clean Energy Council (2014) claimed changes to government incentives underpinned this decline, but also suggested that there was significant upside for the uptake of solar-energy at the household level:[133]

> While the cost of solar power systems continued to decline, the boom-bust cycle created by the alternate introduction and sudden reduction of state solar incentives meant a quieter year for the industry.
>
> Strong indications are that, with continued support through the Federal Government's Small-scale Renewable Energy Scheme and a downward trend in the cost of systems, the solar sector will move forward sustainably following a period of consolidation.

The Clean Energy Council (2014) identified a number of benefits from the increasing uptake of solar energy systems, notably the role they will have in alleviating the peak period demand pressures:[134]

> As well as helping individuals reduce their power bills, solar power is helping relieve some of the strain on the power grid on hot days when power use goes into overdrive. During a heatwave affecting Victoria and South Australia in January 2014, solar power may have been the difference that stopped the electricity market setting a new record for peak power use.

New wind farms were the dominant form of new large-scale renewable energy built in 2013. Australia's Renewable Energy Target (Chapter 3) is designed to support the lowest cost form of renewable energy that can be rolled out on a large scale; a position currently held by wind energy.

According to the Clean Energy Council (2014), a total of 18 projects came online in 2013, with the remainder made up of some smaller wind projects, solar power, bioenergy and a hydro upgrade:[135]

> AGL's 140-turbine Macarthur Wind Farm was by far the largest renewable energy plant that came online during 2013, adding 420 MW of new renewable energy capacity. Also notable was the 168 MW Musselroe Wind Farm in Tasmania, with the 55 MW Mumbida Wind Farm in WA and a 38 MW bioenergy plant built by Mackay Sugar in Queensland.

9.1 Outlook for renewable energy investment

Analysis by ROAM Consulting for the Clean Energy Council found that with the Renewable Energy Target operating as currently legislated, investment in large-scale clean energy generation will be $2 to $4 billion per year out to the end of the decade.[136] However, according to the AER (2013), renewable energy

[133] Clean Energy Council, 2013 Clean Energy Australia Report, 2014
[134] Ibid
[135] Ibid, p.11
[136] Ibid, p.20

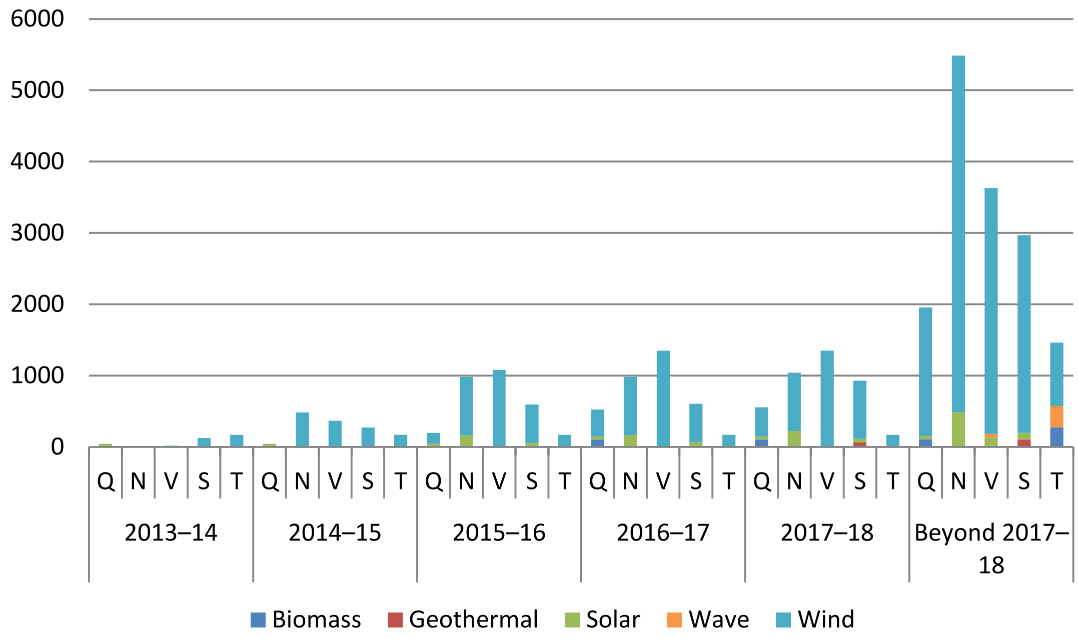
investment outside of wind energy is likely to be limited over the next few years (Figure 19).

At June 2013 the National Electricity Market had around 800 MW of committed capacity, mostly in wind generation. The six committed wind farms are roughly equal in scale and will be developed in New South Wales, Victoria and South Australia.[137]

While the bulk of proposed capacity is in wind (47 per cent) and gas powered generation (36 per cent), the proposals also include:[138]

- 740 MW of solar generation capacity in New South Wales, Victoria and South Australia.
- 350 MW of generation using wave technology for Tasmania and Victoria.
- 550 MW of geothermal generation in South Australia.

Figure 19: Major proposed renewable generation investment in Australia – as at June 2012[139]



Climate change policies, including the renewable energy target and subsidies for rooftop solar PV installations, accelerated the growth in solar PV generation capacity over the past five years.[140] The AEMO (2013) noted the role of such renewable energy policies in the changing composition of generation:

> The National Electricity Market generation fleet continues to evolve in response to government renewable energy policies. For example, the Large-scale

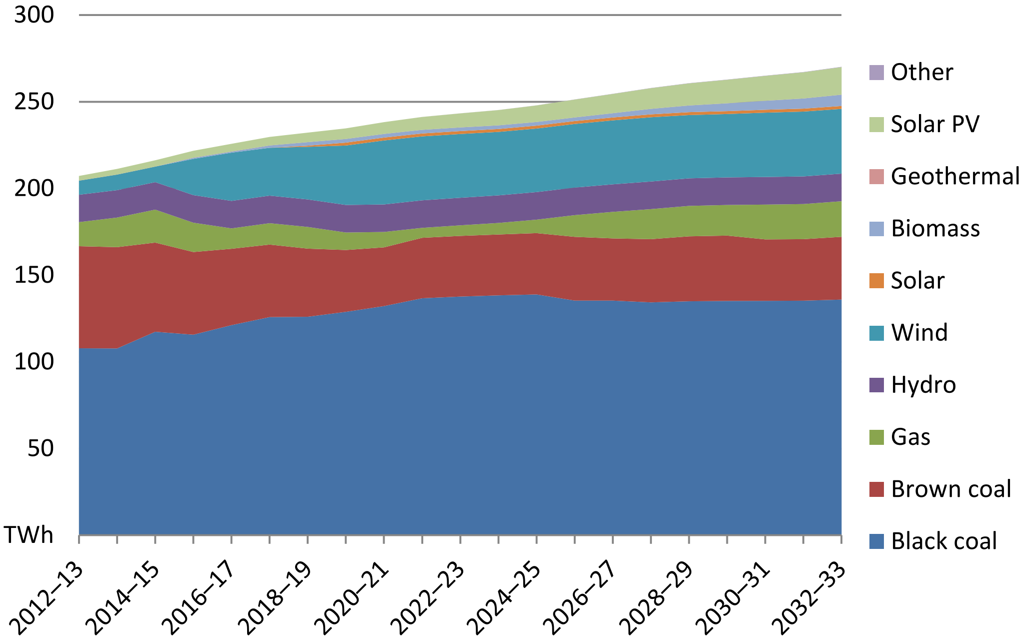
---

[137] AER, State of the Energy Market 2013, December 2013, p.48
[138] Ibid, p.49
[139] Ibid, Figure 1.29, p.49
[140] Ibid, p.25

Renewable Energy Target (LRET) continues to drive the entry of renewable generation capacity. However, demand-driven investment signals for new plant remain muted.

With investment scheduled for renewable technologies, the contribution of traditional fuel sources (such as black and brown coal) to the National Electricity Market is forecast to decline in the medium to longer term (Figure 20).

Figure 20: Forecast contribution of generation technologies to meet electricity demand[141]



9.1.1 Proposed changes to the Renewable Energy Target – October 2014

The AEMO (2013) highlighted the pivotal role future government policy will have in determining the energy mix in the National Electricity Market:[142]

> Any changes resulting from the forthcoming 2013 Federal Government election may also impact current energy policy settings and investment drivers. Potential changes may impact the future mix of generation projects, either through changed incentives for withdrawing existing plant, or a reassessment of the timing and/or technology of proposed future projects.

On 22 October 2014, Federal Industry Minister Ian Macfarlane announced at the National Press Club that the Abbott Government wanted to reduce the 20 per cent Renewable Energy Target by 2020 to what it calls ‘a real 20 per cent’. The Minister specifically proposed reducing the agreed energy target of 41,000 GWh of baseline power by 2020 to closer to 26,000 GWh. The proposal would exempt all emissions-intensive industries from the target and leave the current solar rooftops scheme untouched.

---

[141] AER, State of the Energy Market 2013, December 2013, Figure 1.8, p.25
[142] AEMO, Electricity Statement of Opportunities, 2013

The Minister argued that the lower target is needed because aggregate energy consumption has fallen from the projected amount in 2020, with the result that 41,000 GWh would amount to a 27 per cent Renewable Energy Target.[143]

Mr Macfarlane said the Coalition had only ever signed up to a 20 per cent Renewable Energy Target. He claimed the proposal would protect jobs in industries that are under pressure and provide confidence to the renewable energy industry:[144]

> If the Labor Party and the Coalition are able to negotiate an outcome then the industry can go forward confidently; if we can't it's the renewable energy that can get hurt.

This decision comes in response to the recommendations made in the Renewable Energy Target review. The review, which cost the Government more than $500,000, recommended in August that Australia's large-scale RETS either be closed to new projects or scaled back dramatically on the basis of yearly reviews.[145]

As reported in the Sydney Morning Herald, 'clean energy producers slammed the proposal as devastating for the industry because it would cost thousands of jobs and millions of dollars in investment.'[146] Many of these stakeholders argue that such changes will simply protect incumbent fossil fuel producers in the coal industry; the Federal Government, on the other hand, argues that it was a matter of 'protecting blue collar jobs in traditional energy industries.'[147]

In response to the proposed changes, Labor announced that it would negotiate with the Coalition, creating hopes a deal is possible.[148] However, it rejected initial proposed scale back, with Shadow Treasurer Chris Bowen describing the changes as 'completely unacceptable'.

If these proposed changes are realised, there will likely be significant downward revisions in the renewable energy investment outlook in New South Wales and more broadly in Australia (Chapter 9.1). Even in the interim, the uncertainty around such proposed changes is likely to undermine impending renewable energy investment decisions. There is also the possibility of implications for the price of renewable energy certificates and revaluations of renewable assets. However, the nature and extent of such implications is uncertain and dependent on the final outcome of the proposed Federal Government changes.

[143] Sydney Morning Herald, Renewable energy target cut to 'real 20 per cent', October 23, 2014
[144] The Australian, RET deal key to 'saving jobs', October 23, 2014
[145] Warburton, D., Fisher, B, In't Veld, S, and Zema, M., Renewable Energy Target Scheme Review, August 2014, Report of the Expert Panel
[146] Sydney Morning Herald, Renewable energy target cut to 'real 20 per cent', October 23, 2014
[147] Ibid
[148] The Australian, RET deal key to 'saving jobs', October 23, 2014

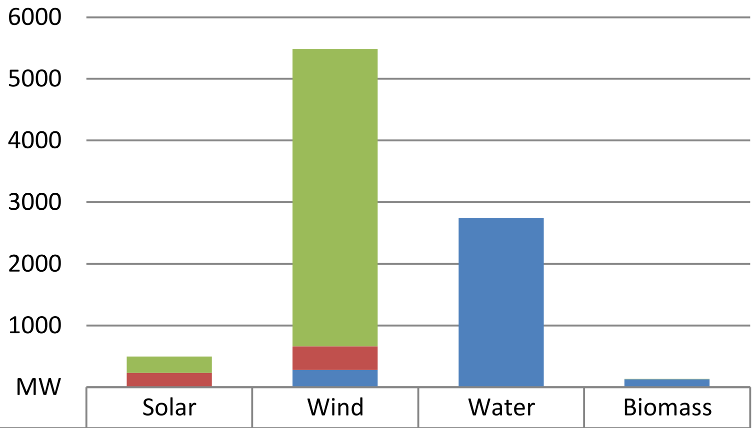
9.2 Renewable energy projects under development in New South Wales

Generation plant owners advise the AEMO about the status of generation projects currently under development in each region. Proposed projects can be at different stages of development and are categorised as follows:

- Committed projects, representing generation that is considered to be proceeding.
- Proposed projects, which are further identified as either:
  - Advanced proposals, representing generation at an intermediate stage of development, or
  - Publicly announced proposals, representing generation at an early stage of development.

Projects are categorised based on the AEMO commitment criteria, which covers site acquisition, contracts for major components, planning approval, financing, and the date set for construction. Committed projects meet all five of the commitment criteria, advanced proposals meet at least three, and publicly announced proposals meet less than three (Figure 21).

Figure 21: Existing and potential renewable energy developments in NSW[149]



	Solar	Wind	Water	Biomass
Withdrawn	0	0	0	0
Publicly announced	267	4,817	0	8
Committed	231	385	0	0
Existing	0.13	281	2745	129

Details of the specific renewable energy projects under development in New South Wales are presented in Table 17; which is sourced from the AEMO.

[149] AEMO, General information – generation capacity, August 2014

Table 17: Renewable energy projects under development in NSW, greater than 50 MW capacity[150]

Project	Owner	Fuel Type	Capacity
Bango Wind Farm	Bango Wind Farm Pty Ltd	Wind	140
Ben Lomond	AGL Energy	Wind	200
Birrema Wind Farm	Epuron Pty Ltd	Wind	75
Boco Rock Wind Farm	Boco Rock Wind Farm Pty Ltd	Wind	113
Bodangora Wind Farm	Infigen Energy	Wind	100
Broken Hill Solar Plant	AGL PV Solar Development	Solar	53
Capital 2 Wind Farm	Infigen Energy	Wind	100
Collector	Ratch Australia	Wind	175
Crookwell 2 Wind Farm	Crookwell Development Pty Ltd	Wind	92
Crookwell 3 Wind Farm	Crookwell Development Pty Ltd	Wind	58
Crudine Ridge Wind Farm	Crudine Ridge Wind Farm Pty Ltd	Wind	135
Flyers Creek Wind Farm	Infigen Energy	Wind	129
Glen Innes Wind Farm	Glen Innes WindPower Pty Ltd	Wind	100
Gullen Range	New Gullen Range Wind Farm Pty Ltd	Wind	166
Kyoto Energy Park	Pamada Pty Ltd	Wind	60
Liverpool Range Wind Farm	EPURON Pty Ltd	Wind	864
Manildra Photovoltaic Solar Farm	Infigen Energy	Solar	50
Moree Photovoltaic Solar Farm	Infigen Energy	Solar	60
Moree Solar Farm	Moree Solar Farm	Solar	56
Nyngan	AGL PV Solar Developments	Solar	102
Nyngan Photovoltaic Solar Farm	Infigen Energy	Solar	100
Paling Yards Wind Farm	Union Fenosa Wind Australia Pty Ltd	Wind	200
Rugby Wind Farm	Wind Lab Developments	Wind	166
Rye Park Wind Farm	Rye Park Wind Farm Pty Ltd	Wind	378
Sapphire Wind Farm	Sapphire Wind Farm Pty Ltd	Wind	319
Silverton Wind Farm	Silverton Wind Farm Developments Pty Ltd	Wind	250
Taralga	CBD Energy/Banco Santander	Wind	107
Uungula Wind Farm	Uungula Wind Farm Pty Ltd	Wind	623
White Rock Wind Farm	White Rock Wind Farm Pty Ltd	Wind	238
Yass Valley Wind Farm	Yass Valley Wind Farm Pty Ltd	Wind	360

[150] AEMO, General information – generation capacity, August 2014

10. CONCLUSION

The contribution of renewables to the energy mix in New South Wales has historically been limited. Until recently, the Snowy Hydro Scheme accounted for the vast majority of renewable energy in the State.

This situation changed following the expanded Commonwealth Renewable Energy Target in 2009 which mandated that 20 per cent of electricity consumption be accounted for by renewables in 2020. This policy coincided with the introduction of the Solar Bonus Scheme by the NSW Government in 2010. Subsidies and incentives from both policies underpinned the substantial growth in renewables, particularly in wind and solar energy in the period following.

While consumption has grown in the last few years, renewable energy still only accounts for less than 10 per cent of total energy consumption in New South Wales. Tasmania is the only State that exceeds this figure. There is consequently considerable scope for growth in the renewable energies sector in New South Wales.

The capacity for growth, however, is not consistent across all the forms of renewables. New South Wales, at present, has limited capacity for growth in the areas of wave, tidal and geothermal energy.

Looking ahead, the capacity for renewables expansion in New South Wales therefore lies in wind and to a lesser extent solar energy. The Renewable Energy Target, as it is currently legislated, provides an incentive to build the lowest cost renewable energy projects. This means that wind power will be the main technology supported by the target this decade. This is already being realised, with the vast majority of prospective investment in renewables directed toward wind energy.

With investment scheduled for renewable technologies, the contribution of traditional fuel sources to the National Electricity Market is forecast to decline in the medium to longer term. However, if the proposed Federal Government changes to the Renewable Energy Target are realised, the renewable energy investment outlook is likely to be more subdued than currently projected.

Ultimately, the extent of the renewables contribution is contingent upon investment and subsequent advances in technology in the coming years. Such developments will create the economies of scale required to drive down costs, thereby enabling renewables to compete with traditional fossil fuel energy sources.