Submission

No 30

INQUIRY INTO THE ECONOMICS OF ENERGY GENERATION

Organisation: National Generators Forum

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Mr Jonathan O'Dea MP
Chair
Legislative Assembly Public Accounts Committee
Parliament of New South Wales
Macquarie Street
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Dear Mr O'Dea MP

The National Generators Forum welcomes your invitation of 9 December 2011 to make a submission to the NSW Parliament Public Account Committee's Inquiry into the Economics of Energy Generation.

The NGF is the national industry association representing private and government owned electricity generators. NGF members operate all generation technologies, including coal-fired plant, gas-fired plant, hydroelectric plant and wind farms. Members have business interests in all States.

The NGF considers that the National Electricity Market has performed extremely well over the past 15 years, delivering significant benefits to residential and businesses customers in New South Wales and other NEM States. The evidence for this is highly competitive wholesale prices, outstanding levels of reliability within the bulk supply system, ongoing generation sector investment in response to changing demand patterns, and efficient investment in inter-regional transmission assets.

In addition to providing information that addresses specific parts of the Committee's terms of reference, the attached submission examines:

- how the competitive wholesale market fits within the electricity supply industry;
- how existing generators make production decisions and manage wholesale market risk;
- the key factors power plant investors take into account when considering new projects;
- future modelling of the likely demand and supply balance in New South Wales, showing adequate system reserves until well into this current decade;
- recent and likely future drivers of retail price increases, including sharply increasing monopoly network charges and the projected impact of the Federal Clean Energy Future package; and

- the cost of various policies to support particular renewable technologies.

The NGF believes the current NEM Rules and governance arrangements should provide efficient signals for new private-sector investment in projects when, where and of the technology necessary to deliver competitive prices and a reliable electricity supply.

However, as outlined in the submission, new investments involve huge financial commitments for assets with expected economic lives spanning many decades. A stable and predictable regulatory framework is therefore critical. Any investor perception of the possibility of major policy changes or government intervention to support particular projects or technologies would reduce the willingness of investors to commence the planning process. Longer term certainty and a focus on efficiency should underpin all policy initiatives.

Given the finalisation of the Federal Government's carbon pricing scheme, the NGF believes that it is an appropriate time for the NSW Government to review the cost-effectiveness of NSW carbon and energy efficiency related schemes. The NSW Greenhouse Gas Abatement Scheme should not be extended past 30 June 2012.

The NGF considers that the Government's decision to repeal Part 3A of the New South Wales planning laws may add unnecessary costs and project risks during the development approvals process for all new generation facilities.

The NGF is of the view that the planned sale of the NSW Government's generation assets will have no impact on supply reliability in New South Wales. Private participants have invested significantly in new generation projects over recent years in response to spot and contract prices. As detailed in the submission, we believe the NEM energy-only market design is the key to competitive market outcomes.

The NGF would be pleased to expand further on the commentary in this submission should the Committee hold public hearings as part of its inquiry process.

Thank you for your consideration.

Yours sincerely

David Bowker
On behalf of the NGF Executive Director

15 February 2012

Public Accounts Committee - Inquiry into the economics of energy generation

Response by the National Generators Forum

February 2012

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Executive summary

This submission sets out the response of the National Generator's Forum (NGF) to the Public Accounts Committee's inquiry into the economics of energy generation.

New South Wales generation sector

New South Wales is an integral part of the National Electricity Market (NEM), and the NEM rules and governance arrangements set the framework in which the New South Wales generation sector operates. New South Wales generators compete to sell their output in the NEM spot market, and generation investment is accordingly market-driven. While there is some scope to provide for improved price signals to consumers at times of peak demand in order to lower electricity supply costs overall, to date, the NEM has performed well in attracting new generation investment to meet increasing customer demand and supply customers reliably and at an efficient cost. New South Wales in particular has seen significant market-driven investment in gas-fired generation capacity over the last three years.

In recent years, new challenges have emerged from policy measures designed to attract alternative generation technologies. The carbon pricing scheme, which will begin operating in 2012 is expected to fundamentally change the economics and the ability to compete of coal-fired power stations in New South Wales and in other NEM regions. Serious concerns arise from the operation of the Large-scale Renewable Energy Target (LRET) scheme, which mandates the use of renewable energy technologies, and has the effect of artificially lowering wholesale market prices and thereby risks undermining future investment incentives. On current projections, the LRET will be very costly to implement (a cost that will be borne by consumers), but will nonetheless not achieve its intended target. More generally, a comparison of the various policies that have been adopted in Australia, including in New South Wales, and internationally to encourage renewable and alternative generation technologies shows that these vary very significantly in terms of the costs they impose on all parties, including market participants and consumers.

Given the existence of overlapping policies adopted at the federal and state level, and given the high cost impact of such policies on consumers, the NGF considers that there is some merit in reviewing the effectiveness of existing New South Wales environmental schemes that impact on the electricity supply industry. The NGF recommends that consideration should be given to:

- permitting the Greenhouse Gas Scheme (GGAS) to expire on 1 July this year, consistent with legislation that allows the scheme to terminate at the commencement of a national carbon pricing arrangement; and
- reviewing the rationale and effectiveness of the Energy Savings Scheme, given indications that high retail prices are already having a significant dampening effect on energy demand and the interventionist and costly nature of the scheme.

Looking forward, the challenge for governments will be to determine a policy framework that recognises the importance of market signals that underpin the operation of the NEM, and do not impose inefficient cost burdens on participants and consumers. Ongoing investment in the generation sector requires substantial capital commitments over long timeframes, and poorly designed policies can potentially undermine the incentives to undertake such investments. Longer term certainty in the governance and regulatory framework of the NEM and a focus on efficiency should therefore underpin all policy initiatives.

Comments on the terms of reference

(i) The mix of energy sources used in New South Wales

Coal-fired generation capacity accounts for around 68 per cent of New South Wales generation capacity, but more than 90 per cent of energy was generated from coal-fired power stations in 2010-11. These outcomes are a reflection of New South Wales' substantial endowment with high-quality coal reserves, which has historically enabled New South Wales customers to benefit from low-cost electricity. Going forward, the introduction of the carbon pricing scheme will reduce or eliminate that competitive advantage.

(ii) Comparison of NSW's energy mix with other jurisdictions both in Australia and overseas

A comparison of the mix of energy sources used in New South Wales with that in other Australian jurisdictions and internationally highlights significant variations in the energy mix, and the corresponding importance of domestic resource endowments. Given Australia's significant low cost coal resources, almost 80 per cent of electricity generated in Australia comes from black or brown coal. More generally, the availability (or lack thereof) of domestic fuel sources and the relative costs of different technologies play a central role in the generation mix.

Overall, differences in resource endowments may limit the value of comparisons of the generating mix between different jurisdictions and countries. An additional consideration is that generation assets have an economic life between 30 and 50 years. Very significant financial resources applied over long timeframes are therefore required to materially change the generation mix in an established ESI.

(iii) Issues relating to long term energy security in New South Wales

On current projections, there are few immediate concerns about supply security in New South Wales:

- New South Wales has sufficient existing generation capacity to meet customers' demand reliably until 2018-19;
- even on the basis of the AEMO's most recent 2011 projections (which have historically been overly conservative), no new baseload generation capacity is required in New South Wales (or the NEM more generally) until after 2020;
- there is an extensive pipeline of investment projects proposed for New South Wales, which would more than suffice to meet projected demand; and
- New South Wales is well endowed with gas and coal resources so that fuel shortages are unlikely.

Additionally, the NEM operates as an integrated market and New South Wales regularly imports and exports electricity from and to other states in Eastern Australia.

The experience in the NEM furthermore demonstrates that the planned sale to the private sector of generation assets (as proposed by the Government) will not impact on supply reliability. The NGF expects that the private sector will continue to maintain existing plant and invest in new capacity as and when required on the basis of market signals. Given the substantial expenditures required for generation investment and the associated long planning and investment horizons, however, the NGF considers it essential that the NEM be permitted to operate as designed and the overall Rules framework remain predictable and stable. Relatedly, the NGF is concerned that the planned repeal of Part 3A of the New South Wales planning laws may in future impede the timely commissioning of new generation investment.

In the longer term, an increased reliance on alternative energy generation must be balanced with the potential costs this imposes on the power system, in terms of the greater challenges to maintain system stability, and the potential impact on NEM prices. While it is likely that the market will evolve to meet these challenges, the existence of these trade-offs should nevertheless be considered in the course of policy decisions.

(iv) The potential for NSW sourcing energy interstate

New South Wales is a significant importer of electricity during peak periods when it is economical to import lower cost power from Victoria and Queensland. The NEM governance arrangements are designed to facilitate inter-regional trade, and planning studies are conducted on a regular basis to ensure that the capability of the network is such that efficient trade can take place. These responsibilities are shared by regional planning bodies and the AEMO to ensure that the overall NEM objective is achieved.

(v) The potential for, and barriers to, development of alternative forms of energy generation (e.g. tidal, geothermal) in New South Wales

Many alternative forms of energy generation require substantial upfront investments and are currently more costly than generation from wind, the most common alternative technology deployed in Australia. In order to be viable, alternative generation facilities (other than wind) will generally also need to be located in remote parts of Australia and therefore require very substantial and costly network investment. Finally, whether technologies such as generation from tidal and geothermal can be deployed in practice is unclear at this point in time. These factors inherently represent material barriers to investment in all parts of Australia. Specifically in New South Wales, the potential to deploy alternative energies (other than wind or biomass) is likely to be limited, since New South Wales has few of the geographical or environmental characteristics that are required to make such investments feasible.

(vi) Best practice in alternative energy generation in other jurisdictions

There are numerous instruments at the disposal of governments to encourage (or enforce) investment in alternative and renewable energy technologies. A common trend, both in Australia and in overseas jurisdictions, has been a tendency by governments to put in place multiple policies that often overlap in terms of the objectives they seek to achieve, and are frequently extremely costly in their implementation.

While there is little doubt that there is a central role for government in establishing a framework for reducing emissions, there are a number of principles that should underpin policies directed at the generation sector:

- policies should be ‘market-based’ in order to ensure that the costs of achieving a given target, including associated administrative and compliance burdens, can be minimised;
- governments should refrain from technology-specific regulations, from ‘picking winners’, and from applying multiple overlapping schemes, all of which are costly and undermine the environmental effectiveness of policies; and
- given the long planning horizon of investment in an ESI, policy certainty is of overriding importance to encourage market-driven investment on the basis of durable price signals.

1. Introduction

The Public Accounts Committee's terms of reference raise a number of issues that relate to the competitive context in which the New South Wales generation sector, operates. The New South Wales electricity supply industry (ESI) is integrated within the interconnected electricity system that spans Eastern Australia and makes up the National Electricity Market (NEM). The NEM is a wholesale market in which New South Wales generators compete to sell their output, but also establishes a comprehensive governance framework that applies to the electricity industry across Eastern Australia. An investigation into the economics of the New South Wales generation sector and related matters should therefore be framed within the broader context of the NEM.

This submission accordingly considers the New South Wales generation sector in its competitive context, and has been structured as follows:

- Section 2 describes the operation of the NEM, and the economics of electricity generation in that context; while
- Section 3 address each of the issues raised in the Committee's terms of reference in turn.

Additional supporting information and a list of references is presented in two appendices.

2. The electricity supply industry in New South Wales and Eastern Australia

The NEM has its origins in a number of policy initiatives taken during the 1990s with a view to creating a national competition policy and improving the performance of the ESI in Eastern Australia. In the course of implementing these policies, the ESI was reformed and restructured to reflect the overarching principle that competition should be introduced wherever possible. The network functions – electricity transmission and distribution – were considered to be natural monopolies and were established as regulated businesses. In contrast, the generation and retail functions were opened to competition.

In New South Wales, Pacific Power's electricity generation business was separated from the transmission business to create a regulated 'transmission network service provider' (TNSP) - TransGrid , and three competing generation businesses - Macquarie Generation, Delta Electricity and Eraring Energy. The twenty-five electricity distribution businesses were amalgamated into six and subsequently three businesses, and separate electricity retailers were established. The NEM finally commenced operating in New South Wales (including the ACT), Queensland, South Australia and Victoria on 13 December 1998; Tasmania entered the NEM in 2005.[1]

Today, the New South Wales electricity generation sector includes 67 power stations covering a wide range of technologies and with an installed capacity of around 17,200MW.[2] In 2010, the then government sold the generation trading rights for four state-owned power stations, referred to as the 'GenTrader' model, as well as three power station development sites(NSW Auditor General, 2011). Under the GenTrader' model, the physical power stations remain in public ownership, but the rights to control the operation of the power stations and to the revenue from the sale of their output was transferred to private sector investors. Following the recommendations of the Tamberlin inquiry, the government has announced plans to privatise the State's generators, including those subject to the GenTrader contracts, as well as other government-owned energy assets.

2.1 Generation in the National Electricity Market

The operations and governance arrangements of the NEM reflect the overarching principle that electricity generation is a competitive activity, and that the operation of and investment in power stations should be determined by market forces. The National Electricity Objective (NEO), as stated in the National Electricity Law is:

to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to –

a. price, quality, safety, reliability, and security of supply of electricity; and

b. the reliability, safety and security of the national electricity system.

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[1] The Queensland ESI did not become physically connected with the New South Wales ESI until the QNI interconnector was commissioned in 2001. The Tasmanian ESI became physically connected with the Victorian ESI in 2006 when Basslink was commissioned.

[2] Table 10 in Appendix A lists all registered existing and committed power stations in New South Wales as of January 2012.

Governance

Significant changes have been made to the NEM governance and regulatory arrangements since its inception. In the years following the establishment of the NEM, the different participating jurisdictions initially maintained separate regulations to manage the transition from a regulated to a competitive ESI. Today, and while the NEM continues to have a regional structure that follows state boundaries, a common regulatory and institutional framework underpins all aspects of the market:

- the National Electricity Rules ('the Rules'), which have the force of law under the National Electricity Law, govern the operation of the NEM;
- energy market policy is determined by the Ministerial Council on Energy (MCE) in which all member jurisdictions are represented;
- the Australian Energy Market Commission (AEMC) reports and provides policy advice to the MCE, administers and makes the Rules, and reviews NEM operations;
- the Australian Energy Regulator (AER) enforces the Rules relating to the wholesale market, and is responsible for the economic regulation of the transmission and distribution networks; and
- a single central market operator (the Australian Energy Market Operator (AEMO)) coordinates all aspects of the physical and market operations of the grid.

Market price for electricity generated

The NEM operates across the interconnected electricity system of Eastern Australia across state boundaries, so that all generators in all NEM regions compete with one another most of the time.[3] Figure 28 in Appendix B contains a map of the NEM.

At the heart of the NEM is a physical spot market (or 'pool') in which generators located in all regions of the NEM continuously compete to sell their output. The demand for electricity changes rapidly during a typical day and throughout the year, and electricity cannot be economically stored in large quantities. The AEMO therefore calls for competitive offers to supply electricity from NEM generators continuously in five-minute

[3] When electricity flows between the NEM regions are not 'constrained', the spot price for wholesale electricity differ only marginally across the NEM regions by the amount of energy 'lost' when electricity is transmitted over long distances. When there are network constraints that limit flows between regions, prices in the NEM separate between regions.

intervals.[4] In each interval, the AEMO stacks all price offers to produce electricity in ascending order, and progressively schedules generators into production to meet prevailing demand, starting with the least-cost generation option. The use of a rising price-stack for generator offers, also referred to as the 'merit order', means that power stations offering to supply electricity at lower cost (in $/MWh) are dispatched more often, while more expensive power stations are scheduled and dispatched only when the total demand for electricity is higher than the available capacity of the lower cost power stations.[5] In this way, the AEMO determines a market-clearing ($/MWh) spot price for every five minutes. Six five-minute prices are averaged every half-hour to determine the spot price for each half-hourly trading interval for each of the regions of the NEM.

Figure 1 provides an example of the corresponding price outcome over a 24 hour time frame for New South Wales. The market clearing price for each region is determined at a particular location, referred to as the 'regional reference node' (RRN). In the case of New South Wales, the RRN is located in Western Sydney. Prices at the RRN, shown on the left hand axis and plotted in red, rise from about 4AM onwards, as demand begins to increase (shown on the right hand axis and plotted in green). Prices generally increase with demand, as more expensive generators must be dispatched to meet demand. Over the two day timeframe shown here, for instance, prices ranged from as low as $14.6/MWh overnight, to up to $35.7/MWh in the late afternoon.

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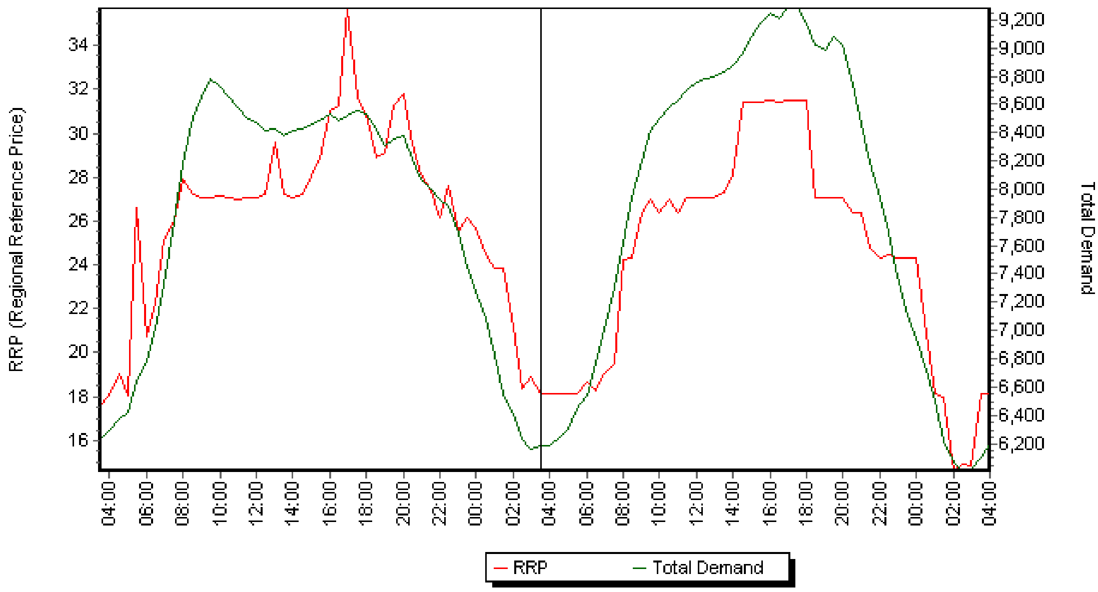
[4] This scheduling and dispatch process applies to all 'scheduled' generators with an aggregate generation capacity of at least 30MW. Because of the intermittent nature of their output, some renewable ('semi-scheduled' or 'non-scheduled') generators do not participate in the scheduling and dispatch process.

[5] There are exceptions if network constraints prevent a particular generator from exporting all of its output.

Figure 1. New South Wales 30 minute demand and price intervals for the period from 4 February 2012 to 6 February 2012



Source: Australian Energy Market Operator; http://www.aemo.com.au/data/GRAPH_30NSW1.html; accessed on 05 February 2012.

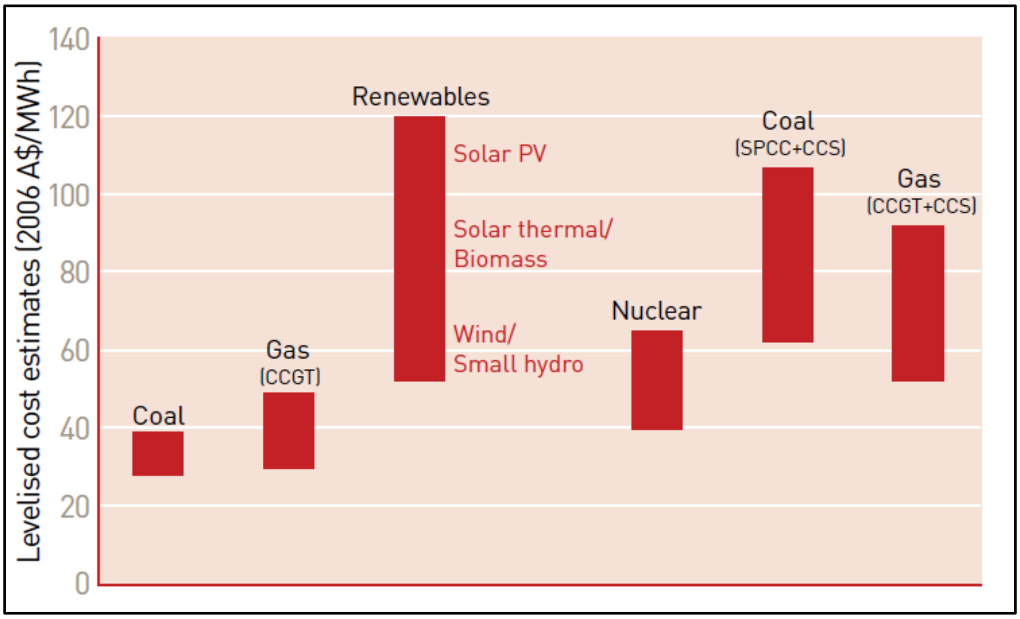
In addition to the physical spot market, the NEM encompasses forward markets for electricity, in which market participants trade in financial contracts to lock in forward prices for electricity. Because electricity cannot be stored in large quantities and supply and demand must continuously and instantaneously be matched, spot prices in the NEM (and in all other electricity wholesale markets) can be very volatile. Price volatility represents a source of financial risk to generators who may not earn sufficient revenues to cover their costs, and to retailers who may not be able to pass high prices on to customers. Market participants manage these risks by entering into financial hedge contracts that lock in firm prices for the electricity they intend to produce or buy.

Electricity market price volatility is also a key driver behind the emergence in the NEM and in many other electricity markets of vertically integrated electricity generation and retailing businesses ('gentailers'). Gentailers are able to manage wholesale price risks internally, since losses that the generation part of the business may incur if prices are low tend to be offset by gains to the retailing business from lower purchasing costs (and vice versa). Gentailers are also in a better position to underwrite the financing of long-term power station investments, particularly in the current economic environment where investors tend to be risk averse. Vertical integration in the electricity sector is therefore a reflection of the need to manage the considerable financial and other risks that arise in wholesale electricity markets.

2.2 Generation investment

Power stations can be classed into ‘conventional’ thermal plant that burn fossil fuels such as coal or gas, and ‘renewables’ that use water, solar, wind or other renewable sources of energy to generate electricity. As a general principle, all power stations in the NEM earn their revenues from sales of electricity into the market. Investment in generation is market-based; that is, new power stations are built if investors expect that the revenues that a power station can earn in the market are sufficient to recover its costs. However, power stations that use renewable energy sources are generally significantly more costly to build, so that renewable generation generally requires additional payments in order to be viable in a market context. Figure 2, for instance, which compares the lifecycle costs of different electricity generating technologies, shows that (at least at the present time) the levelised costs of renewable and other ‘clean’ technologies are significantly higher than the cost of coal and gas-fired generation. Power stations classed as ‘renewable’ therefore receive various additional payments in the NEM.

Figure 2. Lifecycle economic costs of electricity generation



Notes: CCGT refers to combined cycle gas turbine; CCS refers to carbon capture and storage (costs are indicative only); PV refers to photovoltaic; SPCC refers to supercritical pulverised coal combustion (in which steam is created at very high temperatures and pressures).

Source: Australian Energy Regulator, 2009, ‘State of the Energy Market’.

Market-based operation and investment

Thermal (gas and coal-fired) power stations generally earn their revenues from the sale of wholesale electricity in the NEM.[6] The NEM has been designed as an 'energy-only' market in which generators submit $/MWh supply offers and are paid the market price for their output. In this respect, the NEM differs from electricity wholesale markets in other countries, which incorporate payments for generation capacity or availability. Conventional NEM generators must therefore recover the upfront capital cost of their investment and their on-going running costs from electricity sales.

Table 1 shows capital and variable operating and maintenance (O&M) cost estimates for thermal generation technologies. Investment in a thermal power station involves substantial financial outlays. For instance, the capital cost of a (four unit) 2,000MW black coal-fired station can cost upward of $5 billion to more than three times that for stations that incorporate carbon capture and storage (CCS) technologies. The capital costs of gas-fired power stations tend to be significantly lower than those for coal-fired stations, but as Table 1 shows, there is an important trade-off between high upfront capital costs and low on-going operating and maintenance (O&M) costs, mainly fuel costs – coal or gas, and vice versa. At least historically, this trade-off was such that on a per MWh basis, large coal-fired stations represented a very low cost source of electricity in Australia.

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[6] Generators can additionally earn revenues from providing various support ('ancillary') services to the system operator, but in general these sales forma small part of overall revenues.

Table 1. Capital and O&M cost estimates for thermal generating technologies (no carbon price, $ 2006)

Technology	Capital cost ($ millions/MW)	Typical unit increment (MW)	Variable O&M costs ($/MWh)	Economic life (years)
Black coal (pulverised fuel)	1.948	500	1.20	40
Black coal (integrated gasification combined cycle)	3.004	500	1.50	40
Black coal (CCS)	4.348	500	2.70	40
Brown coal (pulverised fuel)	2.895	500	1.20	40
Brown coal (integrated gasification combined cycle)	3.320	500	1.50	40
Brown coal (CCS)	7.380	500	2.70	40
Gas open cycle	0.449	150	7.50	30
Gas combined cycle	0.892	200-400	4.85	30
Gas (CCS)	2.900	500	14.96	30

Source: CSIRO, Jennifer A. Hayward, Paul W. Graham and Peter K. Campbell, 2011, 'Projections of the future costs of electricity generation technologies', EP104982, February. AcilTasman, 2009, 'Fuel resource, new entry and generation costs in the NEM', Prepared for the Inter-Regional Planning Committee, April.

Given the NEM market context, investment in thermal generation in New South Wales (or in any other NEM region) depends crucially on expected future electricity wholesale market prices, as well as the profile of these prices, which in turn depends on the interplay between supply and demand. When there is substantial excess generation over demand, prices tend to be low. As demand grows over time, there is less excess generation supply, and prices begin to rise, particularly during peak periods when demand in the system may come close to reaching the limits of the existing generation capacity. Such higher prices in turn encourage new generation investment, since power stations can earn more revenues. If significant new power station investment occurs, average wholesale prices will again fall.

Optimal generation mix

While wholesale market prices are the prime driver of (conventional) generation investment in the NEM, the *type* (technology) of investment that occurs depends on nature of expected demand and the corresponding distribution of prices. As described above, and in very general terms, coal-fired plant tend to have very high capital costs but low O&M costs, while gas-fired plant have lower capital costs and relatively higher O&M costs. Beyond differences in costs, generating technologies also differ in other respects.

Gas-fired (but also certain hydroelectric plant) play an essential role in most electricity systems because they are capable of modifying or 'ramping' their output up or down very quickly in order to respond to changing patterns of electricity demand. Coal-fired stations, in contrast, require more time to adjust their output, can generally not operate unless they maintain a minimum stable level of output and also take far longer (sometimes days) to start up or shut down. More generally, generation technologies are generally classed into three categories:

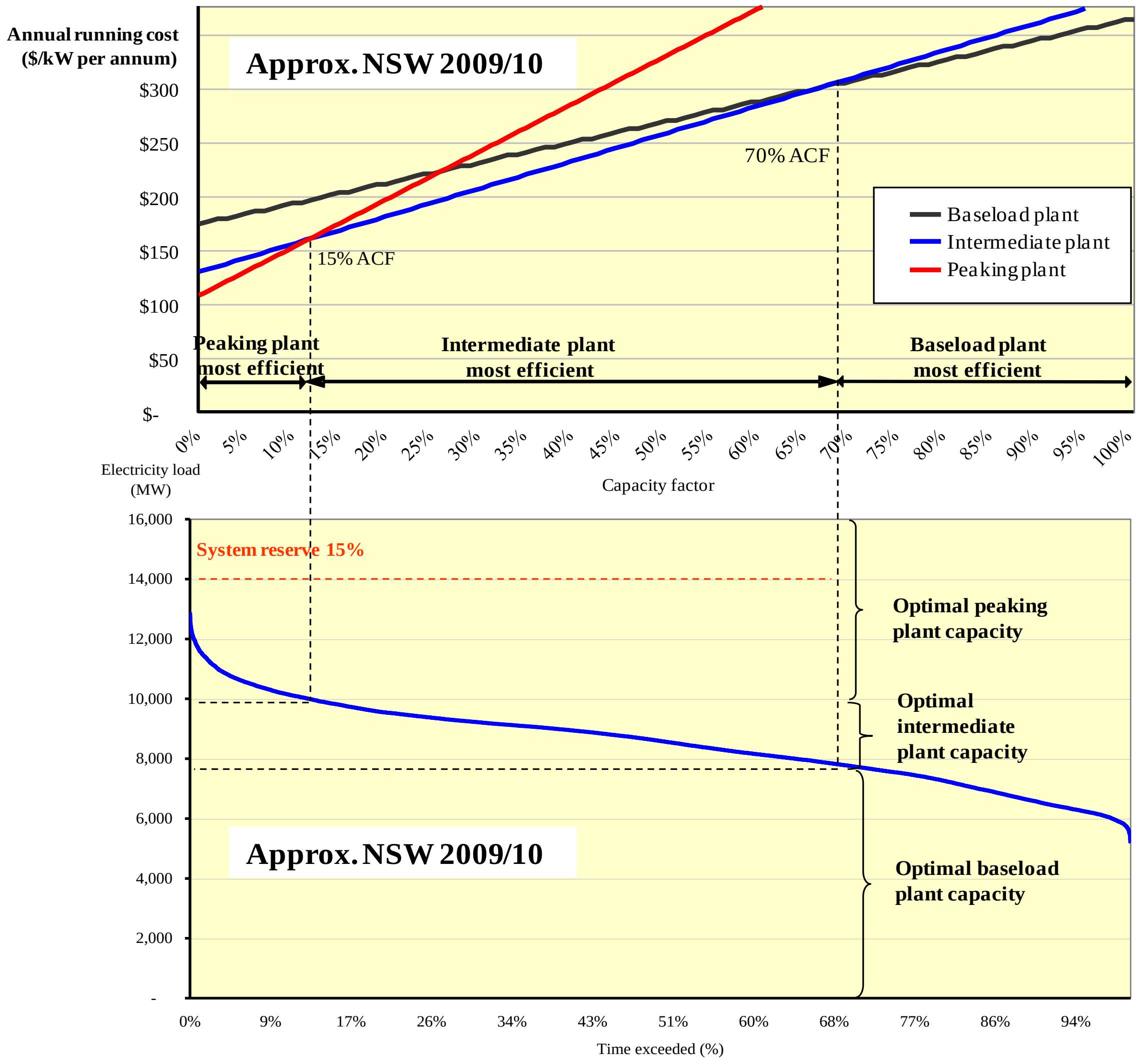
- 'Baseload' stations, which operate virtually continuously at most of their capacity to meet demand at all times (peak and off-peak) times of the day. In New South Wales coal-fired stations operate as baseload plant. The capacity factor of baseload station (broadly speaking, the extent to which they are fully utilised) is generally high.[7]
- 'Intermediate' or 'mid-merit' stations, which operate when demand increases above off-peak levels. These are typically higher cost coal- or gas-fired stations.
- 'Peaking' stations, which operate when demand is at its highest. These are typically gas or distillate-fired power stations; rapid response hydroelectric stations such as the various Snowy units are also used as peaking plant. The capacity factor of such stations can be as low as 1 per cent, although 5 to 10 per cent might be more typical.

The need for different types of power stations in any power system in order to be able to meet demand under a wide range of conditions therefore gives rise to an optimal 'generation mix', illustrated in Figure 3 below. The bottom graph in Figure 3 represents the load duration curve (LDC) for New South Wales in 2009-10. The LDC shows what percentage of hours in the year demand was at or above a particular level. For instance, aggregate demand in New South Wales was never below around 5,000 MW, and was at or above 8,000 MW around 68 per cent of the time. At low levels of demand, baseload plant is the most efficient generating option. At higher levels of demand, intermediate plant with an average capacity factor between 15 per cent and 70 per cent is the most efficient option; and at very high levels of demand, peaking plan with an average capacity of 15 per cent is the most efficient option. In an (entirely hypothetical) ideal world in which demand was entirely flat throughout the year, only low-cost baseload plant would be needed. In reality, demand varies hour-by-hour and day-by-day, so that higher cost intermediate and

[7] Formally, the capacity factor of a power station is its actual output, say, over a year, in MWh, divided by its theoretical output (its capacity multiplied by the number of hours in a year).

peaking plant are also required to operate. One implication of these technical considerations is that demand that is characterised by high peaks is very costly to meet, because it requires the installation of high-cost gas- and distillate fired power stations.

Figure 3. Optimal New South Wales generation mix



The key point to note is that the optimal plant mix in any power system is a function of the shape of the LDC and specifically how 'peaky' demand is. In a competitive wholesale market such as the NEM, market prices signal what type of capacity is required to meet demand efficiently. For instance, high prices during peak demand periods in recent years have encouraged significant new investment in gas-fired intermediate and peaking plant. Overall, pressures for greater cost reductions in the generation sector are fundamentally tied to providing customers with incentives to reduce their demand at peak times, which in turn requires less costly investment in peaking generation capacity and in associated network capacity, which is also driven by peak demand. In a deregulated electricity market such as the NEM, improved investment incentives will only arise through further reform of network regulation and in the retail sector. This is because NEM retailers represent the interface between the wholesale markets and the networks, on the one hand, and consumers, on the other. For instance, as part of the billing services they provide, New South Wales retailers currently charge customers for the electricity they have consumed and also collect network charges on behalf of TransGrid and the New South Wales distribution businesses. However, customer charges are levied on a highly averaged basis, and provide few incentives for customers to consume less electricity during peak demand periods. If retailers offered incentives to customers to respond to peak demands (and perhaps ultimately share in the network savings), demand peaks in New South Wales may be reduced, which would in turn flow through to a more efficient generation sector and result in lower average energy costs.

2.3 Renewable energy policies

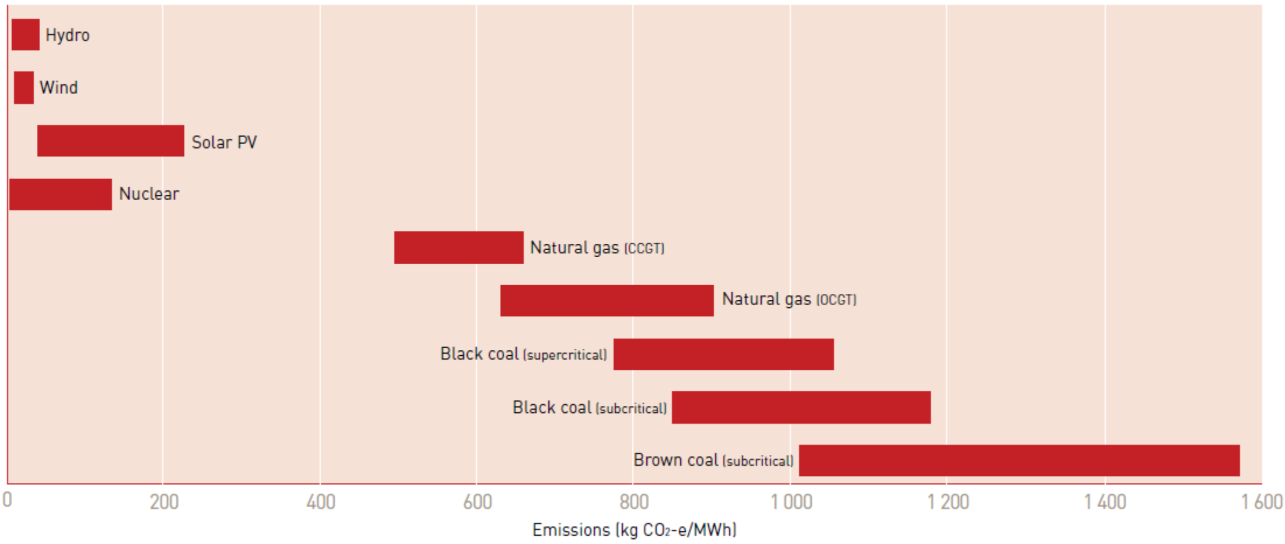
As noted above, investment in renewable generation is generally significantly more costly than is the case for conventional thermal technologies. In order to encourage the development of alternative generating technologies, both the Commonwealth and jurisdictional governments have put in place a range of climate change policies targeting the electricity sector, including the carbon pricing scheme described above.

Carbon price

In November 2011, the Federal Parliament passed legislation to establish an Australian carbon pricing scheme. The scheme will operate in two phases: a fixed price phase commencing in July 2012 with a price of \$23/tCO_{2-e} and increasing to \$25.40/tCO_{2-e} by 2014-15, followed by a floating price phase commencing in July 2015. The electricity industry will be one of the key sectors covered by the scheme.

While prices in the wholesale market remain the key drivers of investment in thermal power stations, the planned introduction of a carbon price will profoundly change the relative economics of different types of generation technologies. The carbon pricing scheme creates an explicit price for emissions and will require generators to purchase permits corresponding to their emissions, the cost of which will be priced into wholesale market price outcomes. The effect of a carbon price is to change the relative costs of generating electricity from fossil fuel-fired versus renewable plant, as well as those for different fossil fuels, for instance, coal versus natural gas. Brown and black coal-fired stations, which account for the bulk of energy produced in the NEM, are particularly emissions intensive (Figure 4). The application of a carbon price therefore reduces or eliminates the cost advantage that coal has traditionally had relative to other generation fuel sources.

Figure 4: Lifecycle greenhouse gas emissions from electricity generation



Notes: CCGT, combined cycle gas turbine; OCGT, open cycle gas turbine; PV, photovoltaic.
The figure shows the estimated range of emissions for each technology and highlights the most likely emissions value. It includes emissions from power station construction and the extraction of fuel sources.

Source: Australian Energy Regulator, 2009, 'State of the Energy Market'.

Renewable Energy Target / Large-scale Renewable Energy Target

The RET scheme was established by the Commonwealth Government to encourage investment in renewable energy generation so as to achieve a 20 per cent share of renewables in Australia's electricity supply (corresponding to 45,000 MWh) by 2020.[8] The scheme obliges electricity retailers to purchase an increasing proportion of electricity from renewable energy sources. Retailers are required to surrender Renewable Energy Certificates (RECs), corresponding to one MWh of eligible renewable energy, purchased from accredited renewable energy generators, or alternatively pay a penalty. Retailers seek to pass the cost of compliance through the competitive retail market to all customers.

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[8] The RET scheme expanded the previous Mandatory Renewable Energy Target (MRET) of 9,500 GWh of renewable energy generation by 2010.

RECs therefore provide an additional source of revenue for renewable generators for each MWh they produce.

In January 2011, the RET was split into a 'Large-scale Renewable Energy Target' (LRET) with a target of 41,000 GWh by 2020, and a 'Small-scale Renewable Energy Scheme' (SRES). RECs were correspondingly classified into Large-scale Generation Certificates (LGCs) and Small-scale Technology Certificates (STCs). The LRET created a financial incentive for large-scale renewable power stations such as wind and commercial solar, while the SRES encouraged retailers to support small scale technologies such as solar photovoltaic (PV) panels and solar hot water heaters. However, unlike the carbon pricing scheme, which is technology-neutral and incentivises market participants to select the least-cost option for reducing emissions, the LRET operates by requiring the adoption of renewable technologies, whether such technologies are cost-effective or not. The compliance costs of the LRET are correspondingly high, and are forecast to increase from around $812 million per year in 2011/12 to around $2.2 billion per year in 2020/21 (AEMC, 2011a).

Irrespective of high compliance costs, on current projections, the AEMC expects that the LRET target will not be met because of an oversupply of RECs and a lack of renewable energy projects that would be commercially viable at current low REC prices (AEMC, 2011a).[9] The AEMC has additionally raised concerns that the LRET has the effect of suppressing electricity wholesale prices in the NEM, which in turn reduces incentives to invest, particularly in gas-fired peaking capacity. In the longer term, this may result in 'unserved energy' (circumstances where electricity demand cannot be met) in a number of States over a number of years.

New South Wales renewable energy schemes

In addition to the carbon pricing scheme and the LRET, which apply to all generation facilities in Australia, a number of state-based schemes have been introduced that often operate in parallel to federal schemes. In New South Wales, these include the Greenhouse Gas Reduction Scheme (GGAS), the Energy Savings Scheme (ESS), and the feed-in tariff (FIT) scheme (IPART; 2009, 2010):

- Greenhouse Gas Reduction Scheme. The GGAS, introduced in 2003, aims to reduce greenhouse gas (GHG) emissions by requiring New South Wales electricity retailers to meet mandatory targets for reducing or offsetting GHG emissions. Retailers can reduce the average emissions intensity of the electricity they supply or use by creating or purchasing ‘abatement certificates’, whereby each certificate represents one tonne of GHG abated. Retailers can create abatement certificates in different ways, including by sourcing more electricity from renewable energy sources, through energy saving or efficiency measures, or by managing forests so as to capture and retain carbon.

- Energy Savings Scheme. The ESS, introduced in 2009, aims to create financial incentives to reduce electricity consumption by rewarding businesses who undertake projects that reduce electricity consumption or improve energy efficiency. The ESS requires electricity retailers and certain other parties to meet individual energy savings targets based on their market share. Scheme participants achieve their energy savings targets by surrendering Energy Savings Certificates (ESCs), which are created by accredited certificate providers (ACPs) when these carry out activities that save energy or increase energy efficiency.

Feed-in tariff scheme. FITs pay a guaranteed (often quite high) tariff for electricity produced with prescribed technologies such as solar PV or wind. A FIT scheme (the ‘Solar Bonus Scheme’) was introduced by the then New South Wales Government in 2009 to encourage the uptake of residential PV generating technologies. The initially very generous tariffs were reduced in October 2010; the scheme has since been closed to new applications after the 300MW of installed solar capacity under the program was reached. Overall, and while the various policies designed to encourage investment in alternative generation operate in quite different ways, they share a common feature in that they implicitly set a price on emissions. The most notable aspect of these schemes is the wide range of abatement costs that they imply. Table 2 below, which summarises estimates prepared by the Productivity Commission in 2011, for instance, suggests that the range of implied abatement costs of these schemes ranges from as low as \$4.6/$Co_{2\text{-}e}$ to more than \$1,000/$Co_{2\text{-}e}$.

Table 2: Implied carbon cost of renewable energy policies (\$2010)

Scheme	Coverage	Total cost ($ millions, 2010)	Implied emissions abatement cost ($/$co_2$-e)
Carbon pricing scheme	Australia-wide	n/a	Beginning at \$23/$tCO_{2\text{-}e}$

Scheme	Coverage	Total cost ($ millions, 2010)	Implied emissions abatement cost ($/co₂-e)
Large-scale Renewable Energy Target (LRET)[1]	Australia-wide	283 - 459	37 - 111
Small-scale Renewable Energy Scheme (SRES)[1]	Australia-wide	52 - 98	152 - 525
Solar feed-in tariffs[2]	All states/territories	149-194	431 – 1,043 (all states)
NSW Greenhouse Gas Reduction Scheme	New South Wales/ACT	2.7	4.57

Notes: [1]The ranges given reflect different assumptions about the amount of emissions abatement, the cost of RECs, and discount rates.
[2] All states. Refers to the combined effects of the SRES and state/territory FITs.
Source: Productivity Commission 2011, Carbon Emission Policies in Key Economies, Research Report, May.

Aside from the significant variations in costs across schemes, it is also apparent that many renewable energy schemes overlap in that they aim to achieve similar or identical objectives, and thereby place an increasing compliance cost burdens on energy market participants and eventually customers. The GGAS, for instance, essentially seeks to achieve the same objective as the carbon price, namely a reduction in GHG emissions. Following its review of New South Wales renewable energy policies, the Independent Pricing & Regulatory Tribunal (IPART) accordingly recommended that GGAS should be terminated following the introduction of a carbon price (IPART, 2009). IPART concluded that the continued operation of GGAS would result in an increased compliance burden on business and increased costs to the economy. The ESS similarly overlaps in important respects with federal initiatives such as the carbon pricing scheme and the LRET.

2.4 Electricity generation in the NEM – achievements to date

Table 3 provides an overview of the NEM today. The NEM can be considered one of the most successful electricity wholesale markets around the world. With few exceptions, the NEM institutions and governance arrangements have flexibly evolved to meet new challenges, to the benefit of all customers, including customers in New South Wales. As set out in the following, investment in the electricity generation sector has been ongoing so that customers have benefited from reliable and efficient electricity supply.

Table 3. National Electricity Market – key statistics

Participating jurisdictions	New South Wales, Queensland, Victoria, South Australia, Tasmania, ACT
Regions	New South Wales, Queensland, Victoria, South Australia, Tasmania
Registered generation capacity	49,100 MW
Number of registered generators	305
Customers	9 million
Turnover 2010-11	$7.4 billion
Total energy generated in 2010-11	204,000,000 MWh
Maximum winter demand 2010-11	31,240 MW
Maximum summer demand 2010-11	34,933 MW

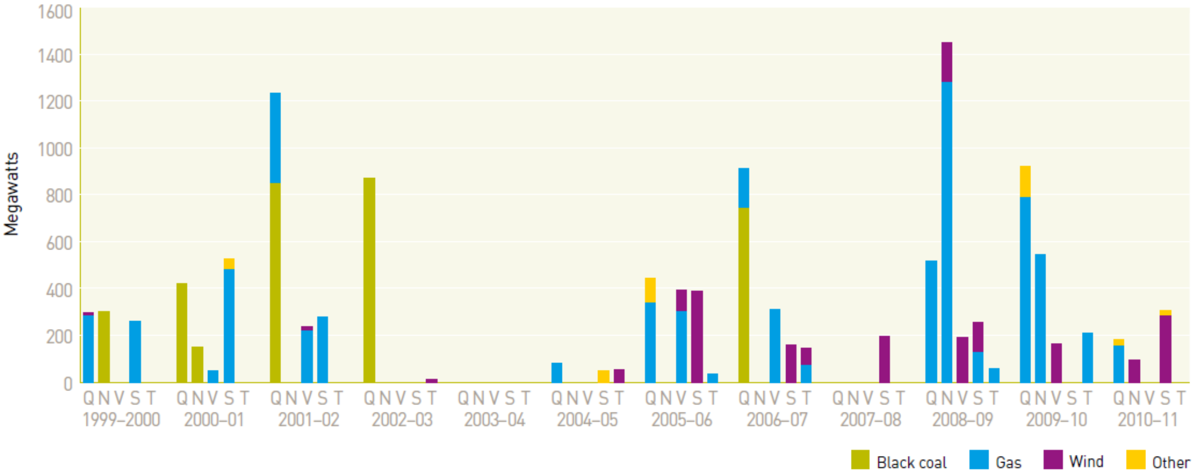
Source: Australian Energy Regulator, 2011, 'State of the Energy Market'.

Generation investment

New generation investment to meet growing demand has occurred in the NEM since its inception. The AER's most recent State of the Energy Market report (2011) highlights that from the beginning of the NEM in 1999 until June 2011, around 12,600 MW of new generation investment has occurred (Figure 5). In particular, tightening supply conditions have led to an upswing in generation investment, with over 4,700 MW of new capacity added in the three years to 30 June 2011 — predominantly gas fired generation in New South Wales and Queensland. In New South Wales, that investment has included the 667 MW Colongra plant (2009), the 664 MW Uranquinty power station (2009), and the 435 MW Tallawarra power station (2009).

Looking forward, the AER has identified over 31,000 MW of proposed generation investment in the NEM (Figure 6), most of which is projected to occur in New South Wales and Victoria. The proposals mostly rely on gas-fired and wind technologies.

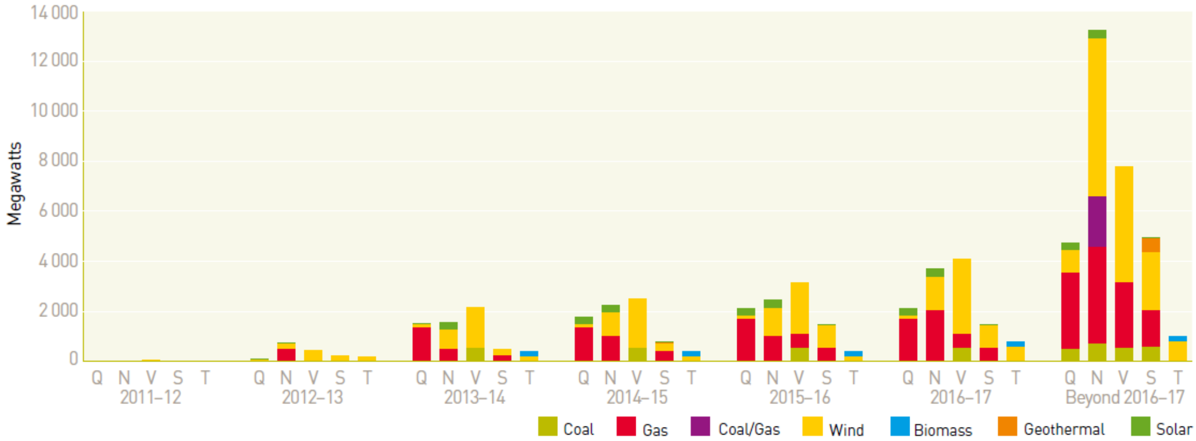
Figure 5. Annual investment in registered generation capacity



Notes: Q, Queensland; N, New South Wales; V, Victoria; S, South Australia; T, Tasmania. Data refer to gross investment estimates that do not account for decommissioned plant.

Source: Australian Energy Regulator, 2011, 'State of the Energy Market'.

Figure 6. Major proposed generation investment in the National Electricity Market, cumulative, June 2011



Notes: Q, Queensland; N, New South Wales; V, Victoria; S, South Australia; T, Tasmania. Data refer to gross investment estimates that do not account for decommissioned plant.

Source: Australian Energy Regulator, 2011, 'State of the Energy Market'.

Reliability

The NEM applies a 'reliability standard' to ensure that customers do not experience supply interruptions due to generation or transmission capacity shortages unless there are exceptional circumstances. That standard requires the integrated system to be planned so that unserved energy per year for each region must not exceed 0.002 per cent of the total energy consumed in that region. Since market start, unserved energy for the most recent ten financial years was 0 per cent for New South Wales, Queensland and Tasmania, 0.00051 per cent for South Australia, and 0.00044 per cent for Victoria (AER, 2011). These figures are well below the NEM criterion, and imply that in New South Wales, Queensland and Tasmania there were no supply interruptions at the wholesale level over the last ten years.

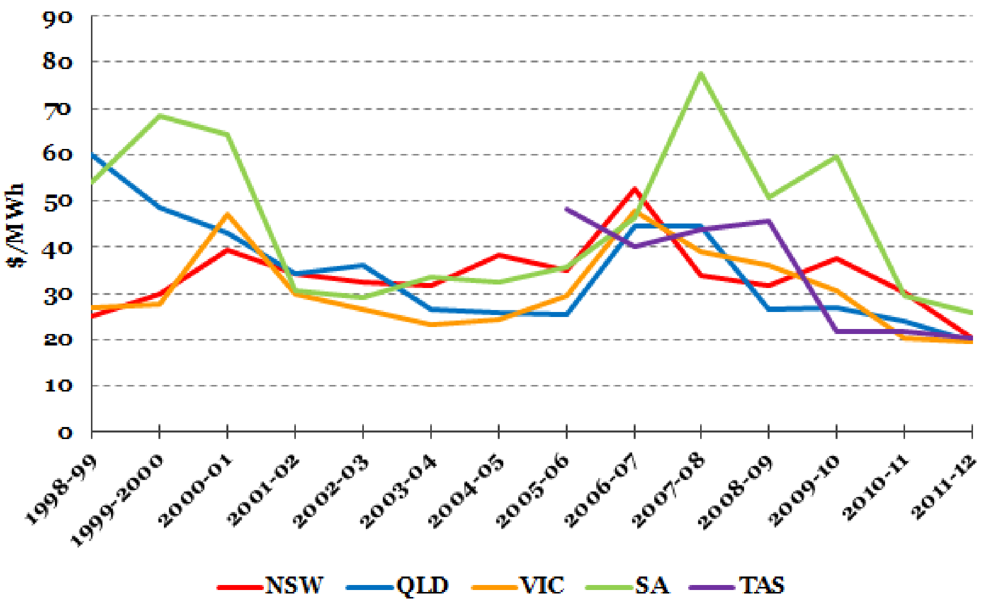
While generation and transmission supply reliability is addressed via standards that apply across the NEM, the reliability standards that apply at the local, distribution levels are currently determined by the NEM jurisdictions. In New South Wales, new licence conditions for the State distribution businesses were put in place by the then government in December 2007 (AEMC, 2011d). The new reliability criteria required the businesses to accelerate upgrades to the distribution networks to achieve improved network design planning criteria by 1 July 2014, and to meet generally decreasing outage duration and frequency standards between 2005 and 2010. Given concerns by the current New South Wales Government over the high cost impacts of raised reliability standards on customer bills, the MCE has directed the AEMC to review the new distribution reliability standards, in order to assist the Government in determining the level of reliability that most effectively balances the costs of incremental investment and ongoing maintenance with the benefits of improved reliability.

Wholesale market prices

Figure 7 considers the evolution of real wholesale market prices since the beginning of the market. With the exception of the South Australian region, prices have not increased to a material extent in real terms and have trended downwards in recent years.[10]

[10] Historically higher prices in South Australia have been the result of a number of factors, including the effects of the recent drought, very high demand peaks as a result of high summer temperatures and limited interconnector capacity so that electricity imports from Victoria to South Australia have had to be curtailed.

Figure 7. Real annual volume weighted average wholesale prices ($/MWh)



Source: Australian Energy Regulator; http://www.aer.gov.au/content/index.phtml/tag/MarketSnapshot LongTermAnalysis/fromItemId/722740; CPI deflator from the Australian Bureau of Statistics, 6401.0 Consumer Price Index, Australia, December 2011.

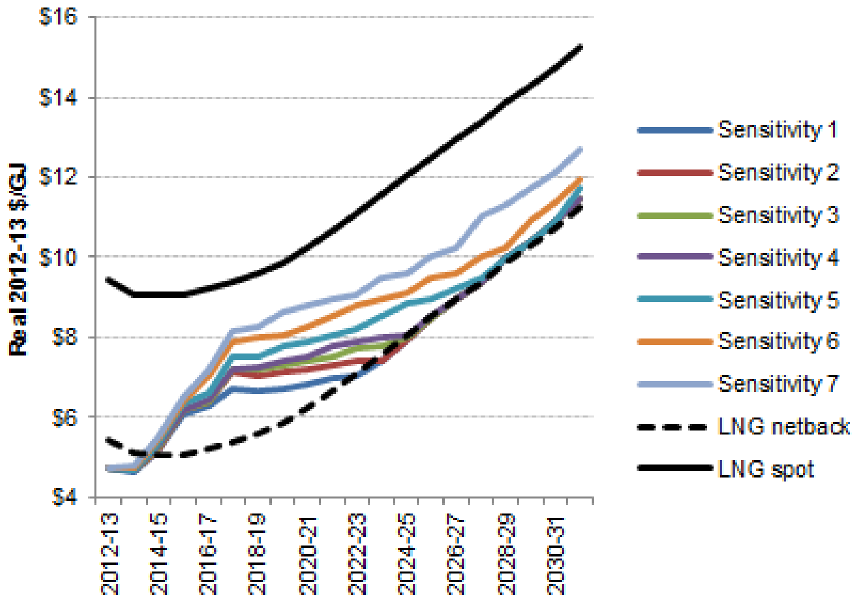
2.5 Future trends in New South Wales

Looking forward, on current projections wholesale market prices in New South Wales, and in particular retail prices will rise. These trends reflect underlying fuel costs pressures, in particular on natural gas prices, but also the impact of regulatory and policy decisions.

Trends in natural gas prices

In a competitive market such as the NEM, generator offers to supply electricity will primarily reflect their variable O&M costs, which in turn reflect underlying fuel costs. Natural gas prices in Eastern Australia, including in New South Wales, are projected to increase significantly going forward. Figure 8 shows projections of natural gas prices to 2030-31 that AEMO considers most likely for the Moomba gas hub, the representative price for the East coast market. In that (most likely) scenario, natural gas prices increase from around $3.50/GJ to $4.00/GJ to approximately $6.00/GJ to $7.5/GJ by FY2020. This trend reflects an expectation that liquefied natural gas (LNG) export facilities will come online in Queensland in late 2013, enabling gas producers to export LNG to take advantage of high international natural gas prices. As a result, domestic Australian gas prices will increase over time as natural gas prices approach export parity. In effect, and as shown in Figure 8, under most modelled sensitivities, domestic prices will track 'netback' prices (i.e. the price of natural gas overseas, net of liquefaction and transport costs).

Figure 8. Projected natural gas prices – East Coast of Australia (AEMO planning scenario, $2009-10).



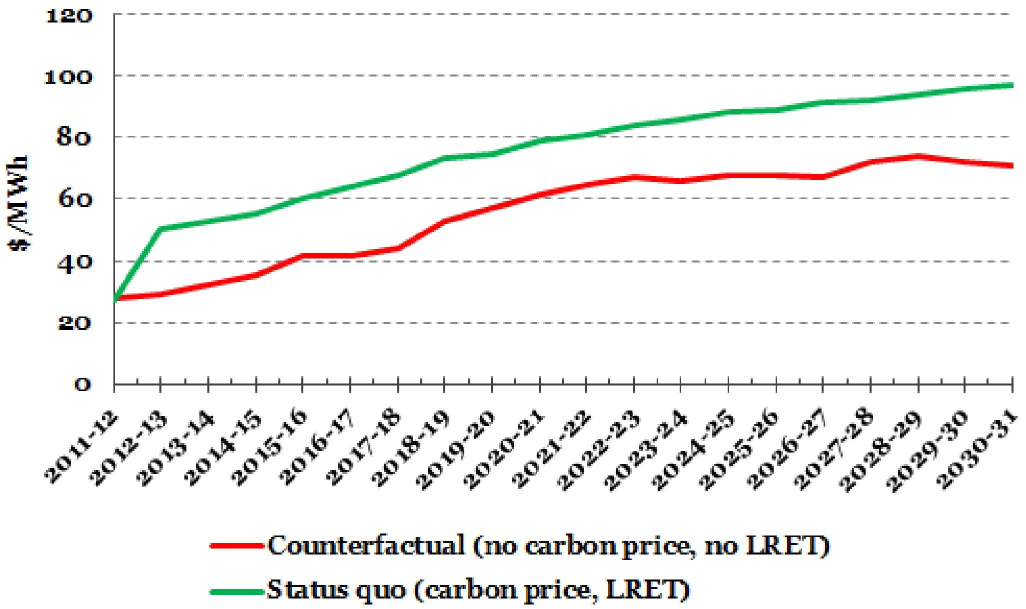
Notes: The LNG netback represents the risk-adjusted LNG price less liquefaction and pipeline tolling costs. The LNG spot price series represents the assumed Asia-Pacific LNG price FOB at Gladstone.

Source: Acil Tasman, 2011, 'Fuel cost projections, Natural gas and coal outlooks for AEMO modelling, Draft report', Prepared for WorleyParsons, December.

Greenhouse gas policies

Successive federal governments have put in place a number of GHG policies that will impact on electricity wholesale prices in the NEM and in New South Wales. Figure 9 shows the result of recent modelling undertaken on behalf of the AEMC and highlights the impact of various greenhouse gas policies on wholesale electricity prices in New South Wales. It compares wholesale market price outcomes for a scenario in which neither a carbon price nor the LRET are applied, with the status quo in which a carbon price and the LRET are applied. According to these projections, the application of a carbon price and the LRET will raise spot prices in New South Wales by on average around $19.5/MWh over the forecasting horizon.

Figure 9. Projected weighted average prices – New South Wales ($/MWh)



Source: NERA Economic Consulting and Oakley Greenwood, 2011, 'Impact of the Large-Scale Renewable Energy Target on Wholesale Market Prices and Emissions Levels' 1 July.

New South Wales retail prices

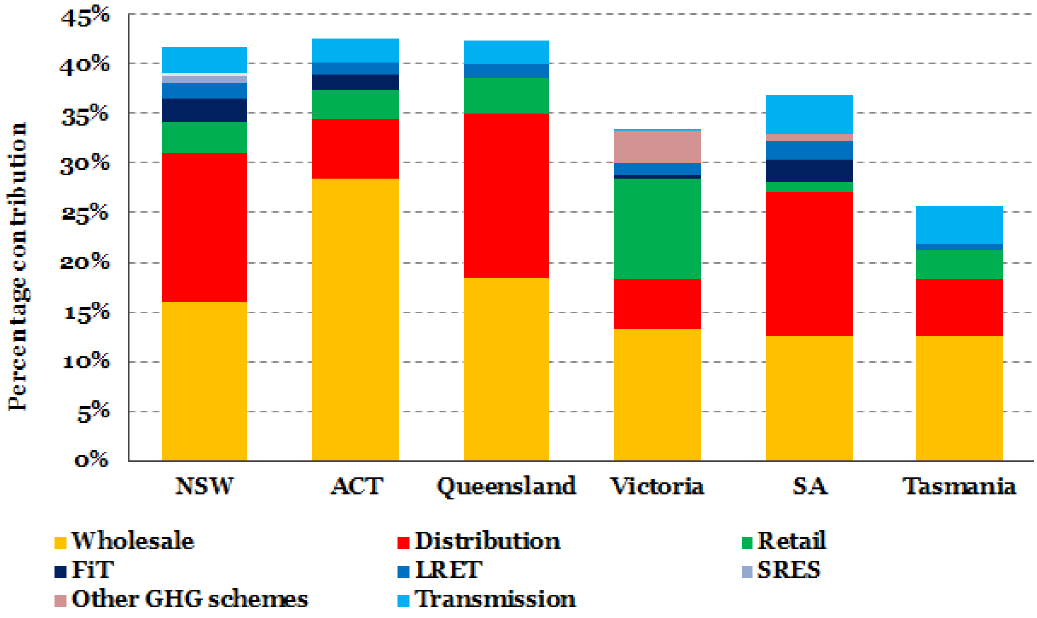
Wholesale market price increases arising as a result of greenhouse gas policies shown in Figure 9 will have only a limited impact on retail customers, since wholesale electricity costs constitute only around 20 to 30 per cent of residential electricity bills. Significant pressures on retail prices are instead expected to arise from the following factors (AEMC, 2011b):

- Increasing network costs, which account for 40 per cent to 50 per cent of electricity costs for a typical household, and represent the single largest contributing factor to retail electricity prices. Substantial increases in regulated network costs are expected in all NEM regions.
- The costs of renewable schemes (the LRET, SRES and FIT schemes). Of these:
  - the cost of the LRET was estimated to be around $35 per household per year in 2011, increasing to $48 - $68 per household per year in 2020;
  - the cost of the SRES was estimated to be around $43 per household per year in 2011, reducing to $5 - $19 per annum by 2020; and

- the cost of FIT schemes, which was estimated to be in the range of $35 to $42 per New South Wales household per year in January 2011.

Figure 10 shows the aggregate forecast percentage increase for residential electricity supplies between 2010-11 to 2013/14 across NEM regions. In New South Wales, the price of residential electricity is expected to increase from 22.75c/kWh in 2010-11 by 9.51c/kWh to 32.27c/kWh in 2013-14, corresponding to an increase of 41.8 per cent.

Figure 10. Percentage contribution of each component to future residential standing offer electricity price increase



Source: AEMC, 2011, 'Possible Future Retail Electricity Price Movements: 1 July 2011 to 30 June 2014', Final Report, 25 November.

Figure 10 shows that more than 60 per cent of the increase in New South Wales residential prices is attributable to increasing network (transmission and distribution) costs and the cost impacts of various other greenhouse gas schemes, rather than rising electricity wholesale prices. With the inclusion of a price on carbon, the wholesale energy component is expected to increase by 3.65c/kWh in nominal terms over the projection period, compared with 1.62c/kWh in the absence of a price on carbon (AEMC, 2011b). As outlined by the AEMC, the large increase in the cost of distribution and transmission services in New South Wales is a reflection of significant investment requirements on the part of TransGrid and the New South Wales distribution businesses that have been accepted by the regulator (the AER). These investment requirements are in turn a function of:

- Ongoing rapid growth in peak electricity demand, particularly in and around Sydney, as a result of the high uptake of air conditioners. This trend is resulting in an overall shift towards higher maximum demand in summer compared to winter in New South Wales. As a result, significant increases in capital works are required to ensure this projected growth in maximum demand can be met.
- Substantial asset replacement programs being undertaken by all New South Wales distribution businesses to replace ageing assets.
- New design, reliability, and performance requirements placed on New South Wales distribution businesses and that must be implemented by 2012/13.
- The cost of the Solar Bonus Scheme (corresponding to $12 per household per year), which is included in distribution costs charged to customers.

Overall, capital expenditure by New South Wales distribution businesses over the current five year regulatory period is expected to reach $14.4 billion, an increase of 80 per cent compared to the previous regulatory period.

2.6 Conclusions

New South Wales is an integral part of the NEM, and the NEM rules and governance arrangements set the framework in which the New South Wales generation sector operates. All New South Wales generators compete to sell their output in the NEM spot market. Generation investment in New South Wales is market-driven; the NEM relies on wholesale market price signals to encourage timely investment in new generation capacity. While there is some scope to provide for improved price signals to consumers in order to reduce electricity supply costs by limiting increases in peak demand, to date, the NEM has performed well in attracting new generation investment to meet increasing customer demand, and in supplying customers reliably and at an efficient cost. New South Wales in particular has seen significant market-driven investment in gas-fired generation capacity in recent years.

In recent years, new challenges for NEM participants and the market as a whole have emerged from policy measures designed to attract alternative generation technologies. The carbon pricing scheme, which will begin operating in 2012 is expected to present substantial challenges to existing coal-fired power stations in New South Wales and in other NEM regions who will find it more difficult to compete against low emissions generation alternatives. Concerns also arise from the operation of the LRET scheme, which forces certain technologies to be adopted and is therefore costly to implement and administer, a cost that will be borne by consumers. More generally, a comparison of the various policies that have been adopted to encourage alternative generation technologies shows that these vary very significantly in terms of the costs they impose on all parties, including market participants and consumers. The NGF accordingly considers that there is some merit in reviewing the effectiveness of existing New South Wales renewables schemes, given the existence of similar policies adopted at the federal level, and given the cost impact of multiple overlapping policies on consumers. Specifically, the NGF recommends that consideration should be given to:

- permitting the GGAS scheme to expire on 1 July this year, consistent with legislation that allows the scheme to terminate at the commencement of a national carbon price arrangement; and
- reviewing the rationale and effectiveness of the ESS, given that significantly increasing retail prices are already sending a strong signal to households and businesses to reduce their energy consumption, and given the interventionist and costly nature of the scheme. The recent experience in the NEM (as illustrated in the AEMO's recent revisions to its consumption forecasts, Figure 17) has demonstrated that higher electricity retail prices have proved very effective in dampening (historically) rapidly rising demand growth.

Overall, the NGF considers that the existing competitive wholesale market arrangements have supported the NEO's focus on efficient investment for the long term benefit of consumers. Looking forward, the challenge for governments will be to determine a policy framework that recognises the importance of market signals that are fundamental to the operation of the NEM, and do not impose inefficient cost burdens on participants and consumers. Ongoing investment in the generation sector requires substantial capital commitments over long timeframes, and poorly designed policies can undermine incentives to undertake such investments. Longer term certainty and a focus on efficiency should therefore underpin all policy initiatives.

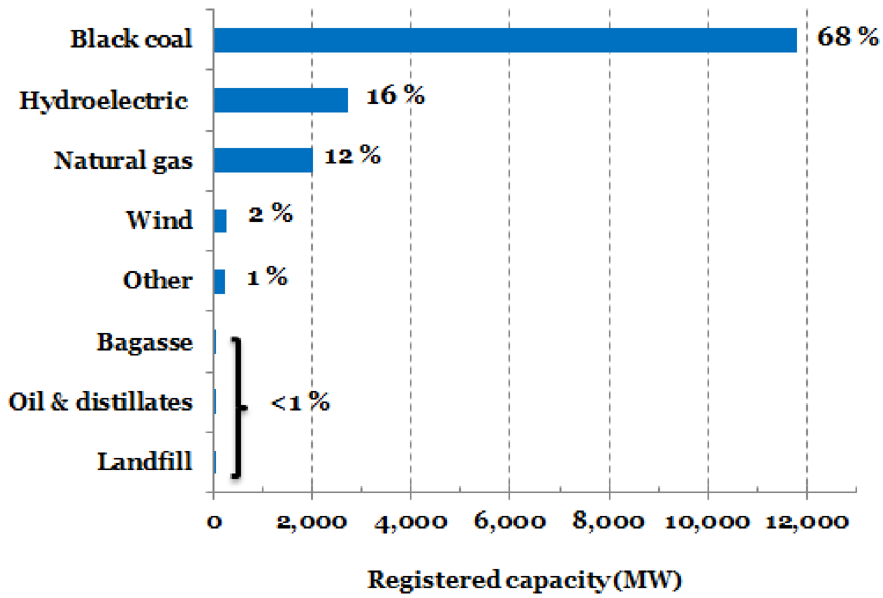
3. Comments on the terms of reference

3.1 Mix of energy sources used in New South Wales

Energy mix – capacity

Figure 11 below shows the registered capacity of existing and committed (which AEMO considers will proceed) power stations in New South Wales. The great majority of generation capacity in New South Wales is black coal capacity, reflecting the state's abundant low cost coal reserves.

Figure 11. New South Wales existing and committed generation capacity, by fuel type (2010-11)



Notes: Committed projects are projects that have entered into site acquisition, contracts for major components, planning approval, financing, and have set the date for construction.

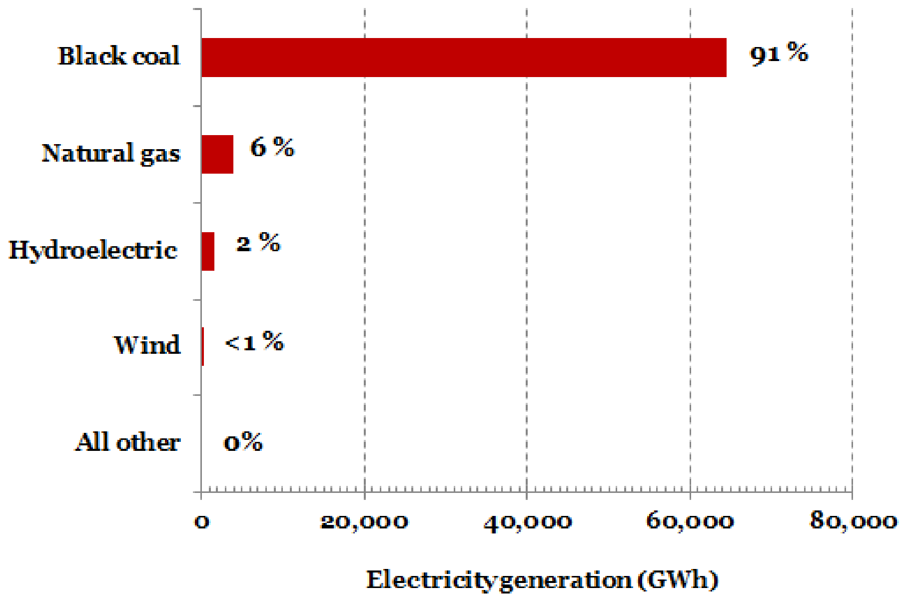
Source: Australian Energy Market Operator, 2011, 'Electricity Statement of Opportunities'.

Energy mix – electricity generated

Figure 12 compares the output generated by different types of power stations. While coal-fired generation capacity makes up for around 68 per cent of generation capacity, more than

90 per cent of energy was generated from coal-fired power stations in 2010-11. This is a reflection of the fact that coal-fired power stations in New South Wales operate virtually continuously as baseload facilities and at a high capacity factor. In contrast, only 6 per cent of energy generated came from natural gas, which accounts for 16 per cent of generation capacity.

Figure 12. New South Wales electricity generation by plant type (2010-11)



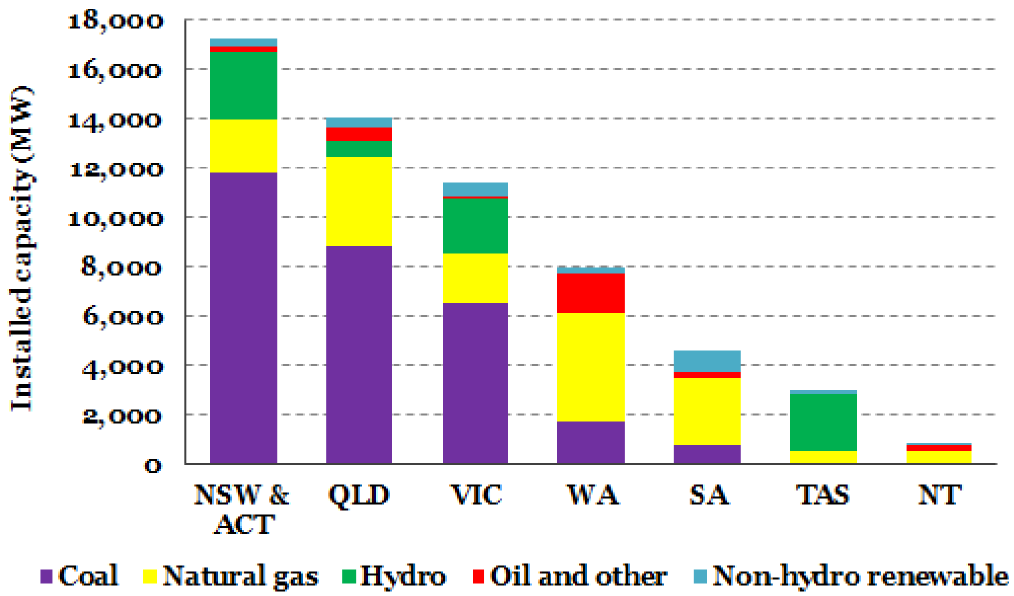
Source: ESAA, 2011, Electricity and Gas Statistics.

3.2 Comparison of New South Wales' energy mix

Energy mix comparison – Australia

Figure 13 and Figure 14 below compare installed generation capacity by fuel type with the volume of electricity generated by fuel type across Australia. Figure 13 shows that the generation mix, in terms of installed capacity, differs significantly across all Australian states/territories, reflecting different resource endowments. Both New South Wales and Queensland have major black coal reserves, with estimates of economic demonstrated black coal resources of around 400,000 PJ and 460,000 PJ, respectively, while Victoria has estimated economic demonstrated brown coal resources of substantial brown coals around 360,000 PJ. New South Wales, Queensland and Victoria correspondingly have significant amounts of (black and brown) coal-fired capacity. New South Wales and Victoria also have significant hydroelectric capacity (reflecting their shares of the Snowy Hydroelectric Scheme) as does Tasmania. South Australia has the largest amount of installed wind capacity in the NEM because of suitable wind conditions along its coastlines (see Figure 23 below).

Figure 13. Installed capacity by fuel type (MW) at 30 June 2010

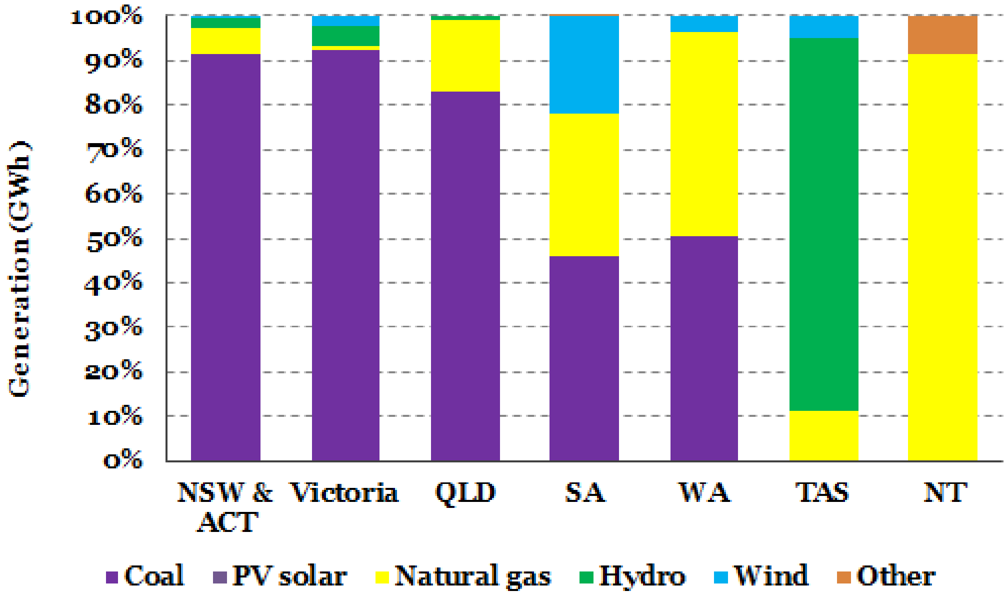


Notes: Estimates includes total principal, embedded and non-grid generation capacity. Hydro data includes pump storage plant. Natural gas capacity includes coal seam methane and coal waste methane.
Source: ESAA, 2011, Electricity and Gas Statistics.

Figure 14 shows the amount of electricity generated from various fuel sources. Figure 14 highlights that, as is the case in New South Wales, the overwhelming proportion of electricity produced in Victoria and Queensland is generated from black or brown coal resources.[11] In these states, the availability of high quality, low cost coal reserves means that coal-fired plant operate virtually continuously as baseload stations. Gas plays an important role in the Northern Territory, which has ample gas reserves and no local coal deposits. In all other states/territories, gas-fired power stations operate as mid-merit or peaking plant. Given its substantial water resources, more than 80 per cent of electricity generated in Tasmania is from hydroelectric stations.

[11] The percentage of electricity generated from black coal is 91 per cent for New South Wales and 8 per cent for Queensland, while the percentage of electricity generated from brown coal is 83 per cent for Victoria.

Figure 14. Principal electricity generation by plant type (GWh) - year ending June 2010 1



Notes: Figures exclude generation for private consumption.
Source: ESAA, 2011, Electricity and Gas Statistics.

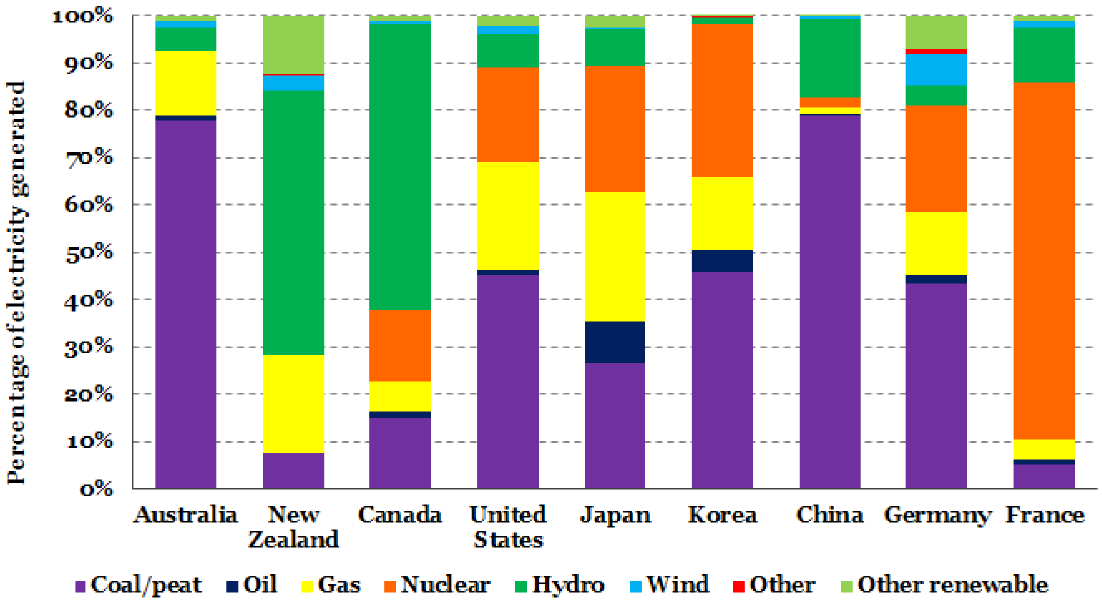
Energy mix comparison – international

Figure 15 compares the electricity generation fuel mix across a selection of OECD countries, as well as China. The comparison highlights the wide variations in the fuels used for generating electricity, which in turn reflect domestic resource endowments. For instance (Productivity Commission, 2011):

- New Zealand is rich in water and other renewable resources. More than half of its electricity generation comes from hydroelectric power stations (56 per cent), and around 16 per cent from other renewables such as geothermal and wind.
- The US electricity generation sector is predominantly a mix of coal (45 per cent), natural gas (23 per cent) and nuclear (20 per cent). Hydroelectric and renewable (wind, biofuels) generation accounted for around 7 and 4 per cent, respectively.
- Japan has few conventional or other resources; its electricity generation sector consists in relatively equal proportions of coal, gas and nuclear based generation.
- South Korea's electricity generation is dominated by coal and nuclear baseload power. LNG and oil make up a smaller proportion of the generation mix.

- Like Australia, China is rich in coal resources, and the Chinese electricity sector is dominated by coal-fired generation, which accounted for around 80 per cent of electricity generated in 2009.
- Germany has significant black and brown coal reserves (so that coal accounted for around 40 per cent of electricity generation in 2010), as well as significant nuclear capacity (23 per cent). Around 17 per cent of energy is generated from renewable technologies (mainly wind, bio-fuels and hydroelectric).

Figure 15. Comparison of electricity generation fuel mix (2010)



Notes: Data for China are for 2009. Analysis does not take account of electricity imports and exports.

Source: International Energy Agency, Electricity/Heat by Country/Region; http://www.iea.org/stats/prodresult.asp?PRODUCT=Electricity/Heat; accessed on 5 February 2012.

Conclusions

A comparison of the mix of energy sources used in New South Wales with that in other Australian jurisdictions and internationally highlights significant variations between electricity systems and the importance of domestic resource endowments. Australia as a whole, and in particular New South Wales, Victoria and Queensland, is rich in low-cost, high quality coal resources. Almost 80 per cent of electricity generated in Australia therefore comes from black or brown coal. More generally, the availability (or lack thereof) of domestic fuel sources and the relative costs of different technologies play a central role in the generation mix. For instance:

- countries, such as France, Japan and Korea with limited domestic resources have opted for nuclear generating capacity to meet their energy requirements; while
- countries with significant renewable fuel sources such as New Zealand have an inherent cost advantage in terms of producing electricity from alternative generation technologies (including from technologies such as geothermal, which are currently considered to be prohibitively expensive in Australia).

Overall, and while there is clearly a role for government to encourage alternative energy technologies, differences in resource endowments may limit the value of comparisons of the generating mix between different jurisdictions and countries. An additional consideration is that generation assets have an economic life between 30 and 50 years. Very significant financial resources applied over long timeframes are therefore required to materially change the generation mix in an established ESI.

3.3 Issues relating to long term energy security in New South Wales

This section comments on a range of matters relevant to the long term energy security in New South Wales, including the demand-supply outlook, New South Wales resource endowments and the implications of certain NEM policies.

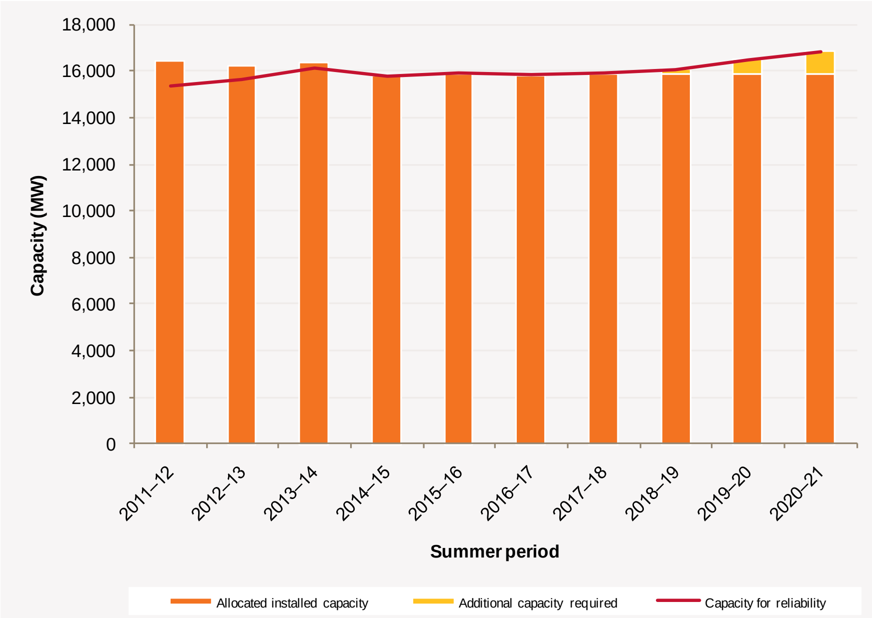
New South Wales demand – supply projections

The energy security of individual NEM regions such as New South Wales is analysed annually by the NEM system operator, the AEMO. The assessments in the 'Electricity Statement of Opportunities' (ESOO) compare expected growth in electricity demand with known power station investment projects in order to determine whether and when supply shortfalls might occur.[12] AEMO's most recent projections indicate that New South Wales does not require additional generation investment until 2018-19 when 190 MW of new generation capacity would be required (Figure 16). These projections focus on the available

[12] In addition, AEMO publishes a range of shorter-term supply demand assessments. They include the annual 'Power System Adequacy – Two Year Outlook', the quarterly 'Energy Adequacy Assessment Projections ' (EAAP), and the 'Medium-term Projected Assessment of System Adequacy' (MT PASA).

generating capacity to meet demand in summer when New South Wales electricity demand is at its highest.

Figure 16. New South Wales summer supply – demand outlook

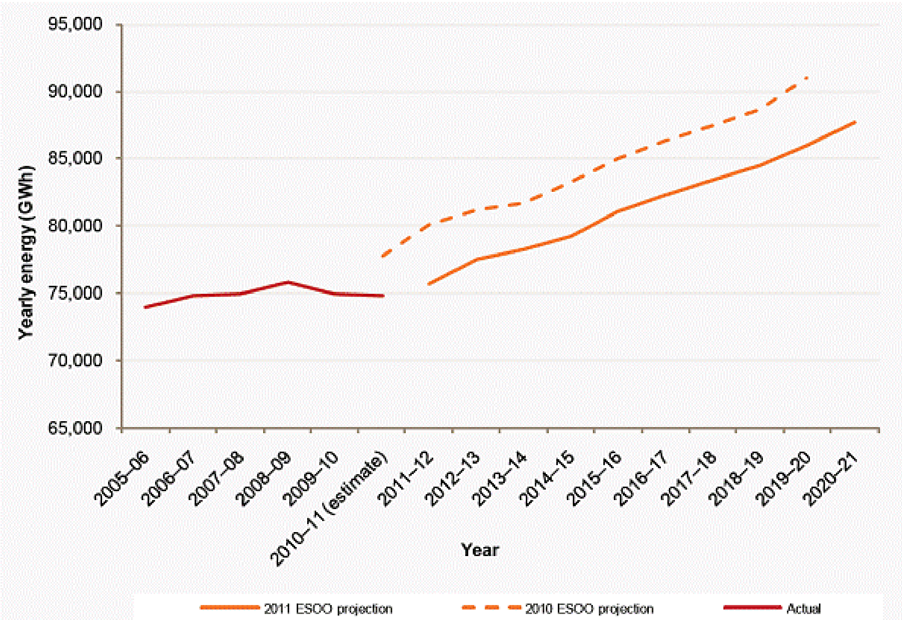


Source: Australian Energy Market Operator, 2011, Electricity Statement of Opportunities.

It should be noted, however, that even the supply-demand outlook presented in Figure 16 is likely to be overly pessimistic, in the sense that it is likely to overestimate (possibly significantly so) the need for new generation capacity in New South Wales. This is because the AEMO has historically systematically *over-forecast* demand and energy in New South Wales, and has correspondingly systematically forecast supply shortfalls that have not materialised in practice. Figure 17 below illustrates these forecasting errors with reference to the AEMO's most recent energy projections for New South Wales. It is apparent that:

- Energy consumption between 2005-06 and 2010-11 has remained virtually flat. On the face of it, this trend immediately casts doubt on the projected steep increase in consumption forecast going forward, particularly given that electricity retail prices will continue to increase rapidly.
- Between the 2010 and the 2011 forecast, the AEMO has sharply revised downwards future consumption for New South Wales. This is consistent with past (downward) forecast revisions for New South Wales.

Figure 17. Comparison of New South Wales medium growth energy projections (GWh)



Source: Australian Energy Market Operator, 2011, Electricity Statement of Opportunities.

Proposed generation investment

Table 4 below shows that there is no shortage of additional investment proposals going forward (which have not been included in Figure 16 above). The AEMO's most recent list of electricity projects currently under development in New South Wales includes 73 projects corresponding to a total announced capacity of 13,390 MW. Proposed projects, such as those shown in Table 4 do not meet all of AEMO's requirements to be considered to be 'committed', and instead include publicly announced proposals, which are at an early or intermediate stage of development. While these projects cannot be considered to be certain to proceed, as noted by the AER (2009, P.69):

While the projects means they cannot be factored into AEMO's reliability equations, they indicate the market's awareness of future capacity needs. In particular, they indicate the extent of competition in the market to develop electricity infrastructure. ... While many proposed projects may never be constructed, only a relatively small percentage would need to occur to meet demand and reliability requirements into the next decade.

Table 4. Projects under development – New South Wales (2011)

Project	Owner	Fuel type	Nameplate capacity (MW)	Planned commissioning date
Eraring (Upgrade)	Eraring Energy	Black Coal/fuel oil	60	Jan-12
Eraring (Upgrade)	Eraring Energy	Black Coal/fuel oil	60	Oct-12
Munmorah Rehabilitation	Delta Electricity	Black coal/fuel oil	700	TBA
Bayswater B	Macquarie Generation	Black coal or gas	2,000	TBA
Bamarang[a]	TRUenergy	Natural Gas	300 or 400	TBA
Dalton	AGL	Natural Gas	500	Oct-12
Kerrawawy GT	Origin Energy	Natural Gas	1,000	Jan-17
Leafs Gully	AGL Energy	Natural Gas	360	TBA
Marulan[a]	TRUenergy	Natural Gas	350 or 450	TBA
Parkes Peaking	International Power	Natural Gas	150	TBA
Tallawarra B	TRUenergy	Natural Gas	450	TBA
Wellington	ERM Power	Natural Gas	510	Sep-14
Charlestown Square Cogeneration	GPT RE	Natural Gas	3	Feb-11
Capital Solar Farm	Infigen Suntech Australia	Solar	37	Oct-12
Manildra Solar Farm	Infigen Suntech Australia	Solar	33	Jul-13
Moree Photovoltaic Solar Farm	Infigen Energy	Solar	50	Apr-16
Moree Solar Farm	BP Solar/Fotowatio Renewable Ventures/Pacific Hydroelectric	Solar	150	2013
Nyngan Photovoltaic Solar Farm	Infigen Energy	Solar	80	Feb-14
Bango	Wind Prospect CWP	Wind	150-300	TBA
Ben Lomond	AGL Energy	Wind	200	TBA
Birrema	Epuron	Wind	140	TBA
Boco Rock	Wind Prospect CWP	Wind	270	Jul-13
Bodangora	Infigen Energy	Wind	100	TBA
Capital WF 2	Infigen Energy	Wind	100	Apr-13
Carols Ridge Wind Farm	Epuron	Wind	30	TBA

Project	Owner	Fuel Type	Nameplate Capacity (MW)	Commissioning Start Date
Collector	Transfield Services	Wind	120-235	Jun-14
Conroys Gap	Origin Energy	Wind	30	Aug-16
Crookwell 2	Crookwell Development	Wind	92	Jan-14
Crookwell 3	Crookwell Development	Wind	75	Jul-14
Crudine Ridge	Wind Prospect CWP	Wind	165	TBA
Flyers Creek Wind Farm	Infigen Energy	Wind	108	Nov-14
Glen Innes	Glen Innes WindPower	Wind	62.5-75	TBA
Golspie	Wind Prospect CWP	Wind	150-300	TBA
Gullen Range Wind Farm	Gullen Range Wind Farm	Wind	183	TBA
Liverpool	Epuron	Wind	1,100	TBA
Paling Yards	Union Fenosa Wind Australia	Wind	150	Jan-16
Rye Park	Epuron	Wind	200	TBA
Sapphire Wind Farm	Wind Prospect CWP	Wind	425	TBA
Silverton	Silverton Wind Farm Developments	Wind	1,000	TBA
Taralga	RES Southern Cross	Wind	122	Sep-12
Uungula	Wind Prospect CWP	Wind	500-800	TBA
White Rock (Glen Innes)	Epuron	Wind	238	TBA
Woodlawn	Woodlawn Wind Power	Wind	48	May-11
Yass Valley Wind Farm	Origin Energy	Wind	222	Aug-16
Woodlawn Bioreactor Energy Generation	Veolia Environmental Services	Landfill Methane/Landfill Gas	TBA	Sep-11 to Aug-21
Estimated total	73		13,391 [1]	

Notes: TBA refers to 'to be announced'.

[1] Only announced capacities are included in the total. Where ranges are given, the mid-point was used.

Source: Australian Energy Market Operator, 2011, Electricity Statement of Opportunities.

New South Wales resource endowments

Longer-term, New South Wales is richly endowed with conventional fuels such as black coal and gas. Table 5 and Table 6 provide an overview of coal and gas reserves in the NEM states. New South Wales has around one third of Australia's economic demonstrated black coal resources, and has significant conventional and coal seam gas resources.

Table 5. Australian coal resources by state (PJ)

Basin	Economic demonstrated resources	Sub-economic demonstrated resources	Inferred resources
New South Wales	390,519	68,942	747,900
Queensland	462,359	20,483	343,100
Victoria	362,005	505,411	972,684
South Australia	415	91,090	242,406
Tasmania	6,032	807	0
Total	1,221,330	686,733	2,306,090

Source: Australian Energy Market Operator, 2011, Electricity Statement of Opportunities.

Table 6. Australian conventional and coal seam gas resources and reserve estimates as at 31 December 2010 (PJ)

Basin	States	Remaining proved-plus-probable	Remaining proved-plus-probable plus possible	Prospective
		Conventional gas reserves		
Adavale	Queensland	21	25	6
Bass	Victoria	266	337	182
Bowen-Surat	Queensland, New South Wales	205	351	210
Cooper-Eromanga	South Australia, Queensland	1,396	1,612	1,594
Gippsland	Victoria	5,455	7,163	3,184
Gunnedah	New South Wales	6	9	3
Otway	Victoria, South Australia	991	1,518	869
Total conventional gas reserves		8,340	11,015	6,047

Coal seam gas reserves				
Bowen-Surat	Queensland, New South Wales	33,719	52,335	43,817
Clarence-Moreton	Queensland, New South Wales	397	2,418	3,893
Galilee	Queensland	0	0	21,840
Gloucester	New South Wales	669	832	0
Gunnedah	New South Wales	1,520	2,797	50,000
Sydney	New South Wales	293	469	0
Total coal seam gas reserves		36,598	58,851	119,550

Notes: 'Remaining' gas reserves are defined as the total quantity of gas expected to be recovered from a reservoir over its remaining productive life.

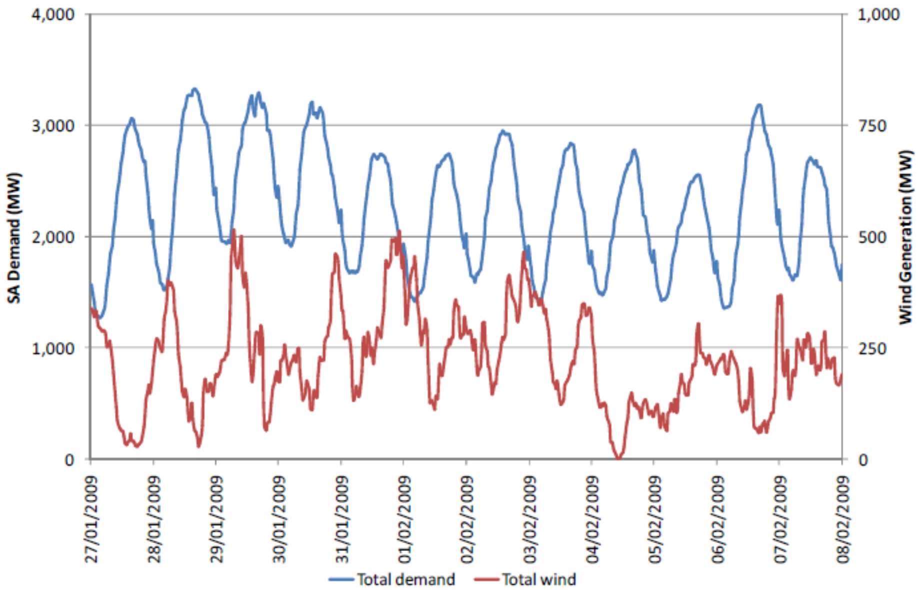
Source: Australian Energy Market Operator, 2011, Gas Statement of Opportunities.

Impact of renewables

There is no fundamental reason – in terms of either the availability of fuels or generation investment going forward – to be concerned about New South Wales's energy security. However, the large-scale introduction of renewable generation raises some specific issues, since an increase in the proportion of energy generated from renewable energy sources can weaken the stability and reliability of a power system. A key characteristic of generation from wind (and to a lesser degree from other forms of renewable energy) is that it is intermittent and therefore unpredictable. The output associated with individual wind generators, for instance, can change by as much as 50 per cent in a five-minute dispatch interval (AEMO, 2010). One consequence of this variability is that interconnectors between regions must be operated at lower limits to avoid overloads, which in turn reduce the total generation capacity available to meet demand.

More generally, the experience in a number of Australian states (for instance, in South Australia) has been that while there may be significant wind capacity, this is of relatively little value in terms of meeting demand in a reliable manner. For instance, analysis undertaken of the contribution of wind to meeting peak demand during the 2009 heat wave in South Australia suggested that output from wind generation was negatively correlated with demand, so that generation tended to be at its lowest when demand peaked and vice versa (**Error! Reference source not found.**).

Figure 18: Wind generation versus total demand (27 January 2009 - 8 February 2009)



Source: Electricity Supply Industry Planning Council, 2009. Annual Planning Report, June.

The intermittency characteristics of wind imply that relatively little generation capacity can be 'saved' by installing renewables, and that potentially significant volumes of complementary, quick response generation capacity must be maintained, as well as other network equipment installed, to be called on when renewable generation suddenly falls. The findings of the recent AEMC investigation into the longer-term effects of the LRET discussed in Section 2 also indicate that increased generation from renewables requires additional expenditures on network support services in order to maintain the overall stability of the integrated network. In addition, the AEMC has highlighted longer-term risks arising from the LRET because this scheme has the effect of suppressing electricity wholesale prices in the NEM, which in turn reduces incentives to invest, particularly in peaking capacity. This effect occurs because the revenues that renewable generators receive from RECs for every MWh they generate allows them to offer their output into the NEM at a cost of $0/MWh or even at negative offer prices. Conventional (thermal) generation cannot viably operate in circumstances where market prices are frequently zero or negative. The AEMC (2011a) therefore warns that a consequence in the longer term may be increased 'unserved energy' (circumstances where electricity demand cannot be met) in a number of States and over a number of years.

Government policies impacting on the New South Wales generation sector

Looking forward, the Government's announced plans to privatise the State's generation businesses is not expected to impact on supply reliability in New South Wales. As set out in Section 2, New South Wales has maintained high levels of supply reliability since the NEM was established, and private investors have commissioned significant new generation capacity in New South Wales and elsewhere in the NEM in a timely manner and in response to market signals. In addition, concerns about a need for additional New South Wales baseload capacity that have on occasion been expressed in the past are not warranted. Even on the basis of the AEMO's most recent projections (which have historically significantly over-forecast energy consumption in New South Wales) no new baseload capacity is required in the NEM until beyond 2020, and even then such capacity may only be required in other regions of the NEM (AEMO, 2011).

The NGF therefore expects that the private sector will continue to maintain existing plant that are cost competitive and to invest in new capacity of the size and fuel type on the basis of market signals, and that they expect will earn a return over the life of the project. There is no reason to think that the privatisation of power station assets will impact on energy reliability, provided that the NEM is allowed to operate as designed and the overall Rules framework remain predictable and stable.

The NGF notes, however, that electricity generation investments have a very long economic life of 30 to 50 years, but additionally require significant lead times of at least three years (and in many cases significantly longer) for most types of conventional thermal generation. Given lengthy lead times and planning horizons, investment in energy generation requires certainty of planning processes, including associated processes for obtaining environmental and other approvals. The NGF is therefore concerned that the Government's decision to repeal Part 3A of the New South Wales planning laws may in future create additional hurdles that may impede the timely commissioning of new generation investment.

Conclusions

On current projections, there are no reasons to be concerned about supply security in New South Wales:

- even on the basis of the AEMO's most recent 2011 projections (which have historically been overly conservative), New South Wales has sufficient existing generation capacity to meet customers' demand reliably until 2018-19, and no new baseload generation capacity is required in the NEM until after 2020;
- there is an extensive pipeline of proposed investment projects in New South Wales;
- New South Wales is well endowed with gas and coal resources so that there is little prospect of fuel shortages; and
- more generally, and as discussed in the next section, the NEM operates as an integrated market and New South Wales regularly imports and exports electricity from and to other states in Eastern Australia.

The experience in the NEM has furthermore demonstrated that the privatisation of generation assets has not impacted on supply reliability. The NGF therefore expects that the private sector will continue to maintain existing plant and invest in new capacity on the basis of market signals.

The NGF notes, however, that given the substantial expenditures required for generation investment and the associated long planning and investment horizons, it is essential that the NEM be permitted to operate as designed and the overall Rules framework remain predictable and stable. The NGF is therefore concerned that the planned repeal of Part 3A of the New South Wales planning laws may in future impede the timely commissioning of new generation investment. Additionally, and in the longer term, an increased reliance on alternative energy generation must be balanced with the potential costs this imposes on the power system, in terms of the greater challenges to maintain system stability. While it is likely that the market will evolve to meet these challenges, the existence of these trade-offs should nevertheless be considered in the course of policy decisions.

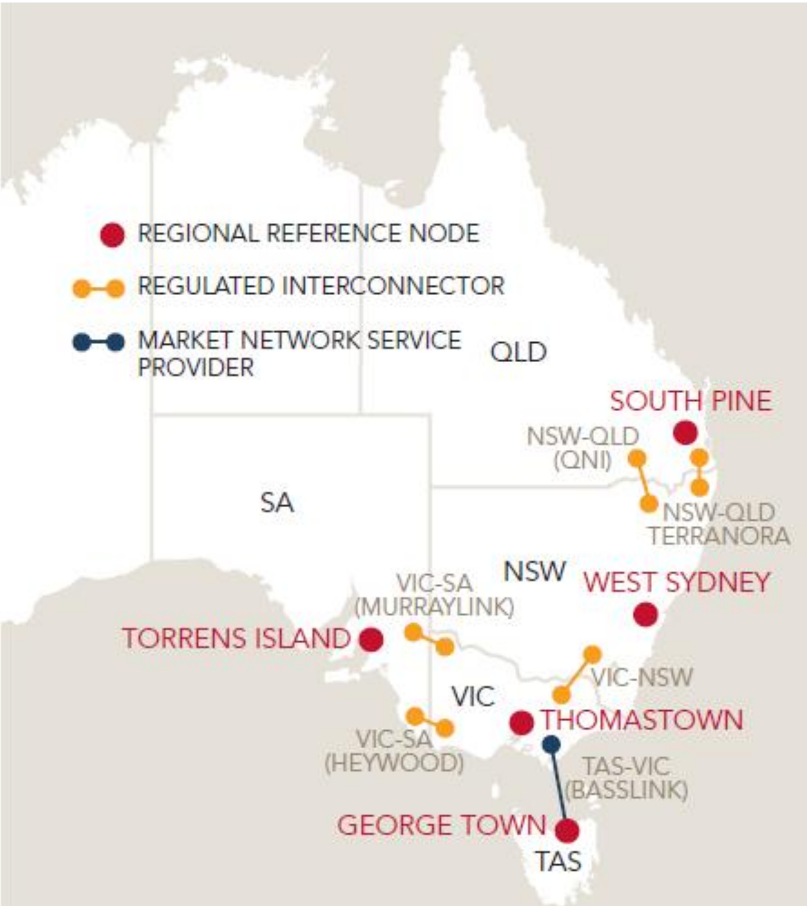
3.4 Potential for New South Wales sourcing energy interstate

This section describes trends in inter-regional trade in electricity between New South Wales and other NEM regions, as well as the governance arrangements that exist to facilitate this trade.

The NEM as an integrated network

The NEM operates across an integrated network that spans Eastern Australia, and is premised on inter-regional competition and trade. Inter-regional trade takes place across interstate interconnectors that link the NEM regions (Figure 19). The majority of NEM interconnectors are 'regulated', meaning that these assets have been found to be economically justified and passed the AER's 'regulatory test', described below. The TNSPs that own these interconnectors receive a fixed annual revenue based on the value of the asset, as determined by the regulator. Australia has one unregulated (or 'market') interconnector – Basslink, which links Tasmania with Eastern Australia. Basslink essentially earns its revenues by a process of arbitrage – purchasing energy in a lower priced region and selling it to a higher priced region.

Figure 19. Interconnectors in the NEM

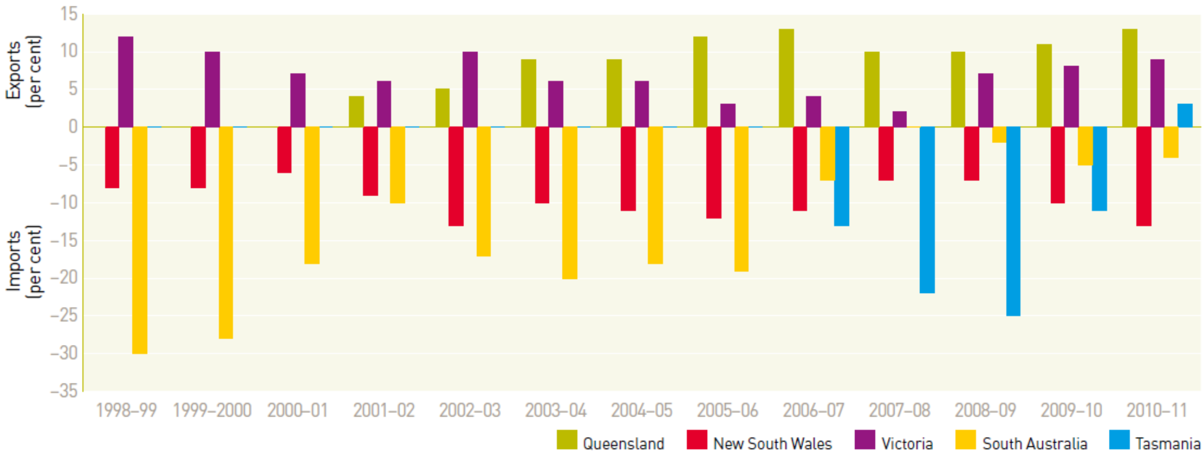


Source: Australian Energy Market Operator, 2010, 'An Introduction to Australia's National Electricity Market, July.

Trade between New South Wales and other NEM regions

Figure 20 and Table 7 describe trade between New South Wales and other NEM regions. In aggregate, New South Wales is a net importer of electricity (Figure 20). New South Wales has ample baseload generation, but has limited peaking capacity at times of high demand (AER, 2011).

Figure 20. Interregional trade as percentage of regional energy consumption



Source: Australian Energy Regulator, 2011, 'State of the Energy Market'.

While New South Wales is a net importer of electricity overall, it also exports energy to Victoria, although exports have been declining in recent years (Table 7).

Table 7. Energy transfer between regions 2006–07 to 2010–11 (GWh)

Direction	2006–07	2007–08	2008–09	2009–10	2010–11
New South Wales to Queensland	45	114	128	55	48
Queensland to New South Wales	6,538	5,421	5,038	5,750	6,494
Victoria to New South Wales	4,987	3,451	2,088	3,114	4,317
New South Wales to Victoria	3,233	4,257	1,147	1,011	558
Victoria to South Australia	1,333	697	874	1,183	1,234
South Australia to Victoria	390	702	647	565	668
Tasmania to Victoria	587	226	72	666	1,315
Victoria to Tasmania	1,961	2,520	2,642	1,798	1,103

Notes: Flows on multiple interconnectors between regions and across the former Snowy Region have been aggregated.

Source: Australian Energy Market Operator, 2011, Electricity Statement of Opportunities.

Regulatory test for transmission

The NEM governance arrangements aim to ensure that inter-regional trade occurs where this is efficient and in the interests of customers. TNSPs such as TransGrid are required to prepare Annual Planning Reports (APRs) that describe the network development plans for their respective regional transmission networks,[13] while the AEMO prepares a National Transmission Network Development Plan (NTNDP), which coordinates the APRs of the individual jurisdictions and provides a long-term vision for the development of the integrated grid. The capacity for inter-regional trade is assessed as part of this process.

The NEM Rules provide that significant transmission investment will take place (including investment in interconnectors) if it is economic to do so, that is, if it passes the 'regulatory investment test for transmission' (RIT-T). The RIT-T is intended to promote efficient transmission investment in the NEM and to ensure greater consistency, transparency and predictability in transmission investment decision making (AER, 2010). The test is applied to all significant network investments to ensure that the benefits of a project investment (for instance, in terms of cost savings from inter-regional trade or improved reliability of service outcomes for customers) warrant its costs, and that the proposed project delivers the greatest benefits from the range of choices available. As such, the RIT-T takes the form of a comprehensive economic cost benefit analysis that must be approved by the regulator following a process of review and consultation.

At the present time, TransGrid and the Queensland TNSP Powerlink are investigating the economic viability and optimum timing of upgrading the QNI interconnector (AEMC, 2011c). The upgrade would facilitate greater exports from New South Wales to Queensland during high demand periods and from Queensland to New South Wales during lower demand periods. TransGrid is also undertaking preparatory work to assess interconnector augmentation options for increased exports from New South Wales to Victoria during low demand periods.

Last resort planning power

In addition to the standard NEM planning provisions, the NEM Rules additionally confer upon the AEMC a Last Resort Planning Power (LRPP). The LRPP is an oversight power designed to ensure that efficient inter-regional transmission investment occurs where this is

[13] In South Australia and Victoria, planning is undertaken by bodies separate from TNSPs.

in the long term interests of consumers. It allows the AEMC to direct TNSPs to apply the RIT-T to a project which is likely to address any shortfall in inter-regional transmission investment. The AEMC did not exercise the LRPP in 2011 (AEMC, 2011c).

Conclusions

New South Wales is a significant importer of electricity during peak periods when it is economical to import lower cost power from Victoria and Queensland. The NEM governance arrangements are designed to facilitate inter-regional trade, and planning studies are conducted on a regular basis to ensure that the capability of the network is such that efficient trade can take place. These responsibilities are shared by regional planning bodies and the AEMO to ensure that the overall NEM objective is achieved.

3.5 Potential for, and barriers to, the development of alternative forms of energy generation in New South Wales

The NEM scheduling and dispatch processes have been modified to allow alternative generators to participate in the market (AEMO, 2010), and these arrangements apply across all NEM regions. However, as discussed in the following, the renewable 'fuel' endowments that are required to power such alternative generators vary across Australia, and New South Wales is not particularly well placed in this respect.

Economics of alternative forms of energy generation

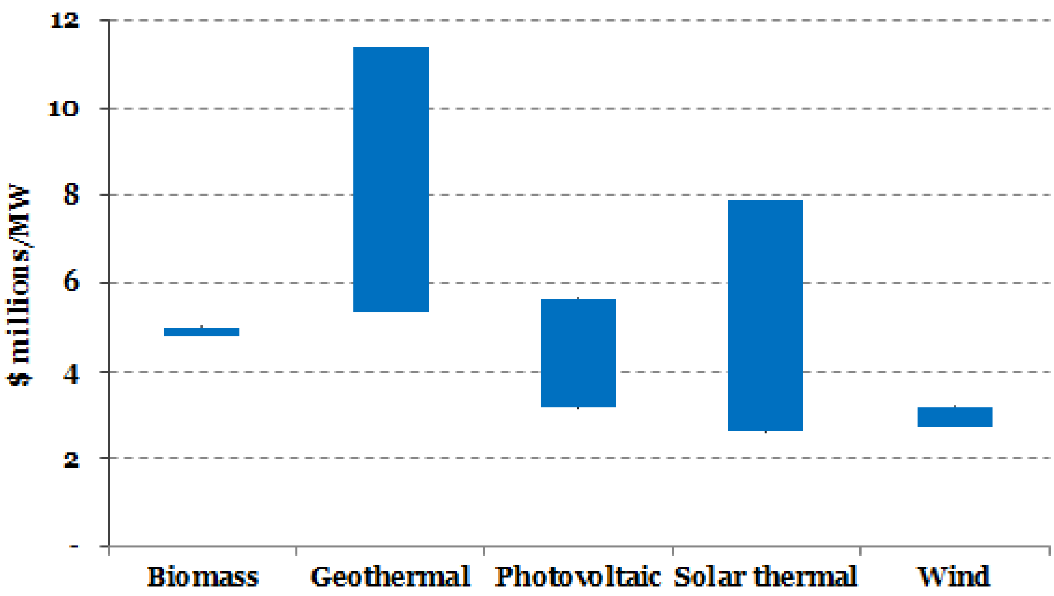
The scope for developing alternative forms of energy generation is highly site-specific, and differs across Australia. As set out in Section 0, generation investment in the NEM is market-based, and federal and state governments have introduced a number of policies to encourage investment in renewable and alternative forms of generation. However, irrespective of the type of technology used, in order for a generation investment to be viable in the NEM, a number of key conditions must be in place:

- The generation technology must be economic relative to other generating technologies (including other alternative) technologies. As Figure 21 below shows, there are material cost differences, in terms of the upfront capital costs required between alternative generation technologies.

- All power stations require a primary fuel to generate electricity, be it coal or gas for thermal power stations or sunlight, wind or below-ground heat for renewable facilities. The geographical distribution of renewable fuels differs across Australia.
- The network infrastructure must be in place to export the electricity that has been generated. The NEM's existing transmission grid has historically not been planned to connect locations suitable for alternative generation facilities with major load centres. In particular, many sites that may be suitable for alternative generation are in remote locations.[14]

Beyond the factors discussed above, other considerations also play a role. For instance, many alternative technologies have not yet been built to commercial scale in Australia, so that technological risk can be a material concern.

Figure 21. Capital cost comparison of alternative technologies



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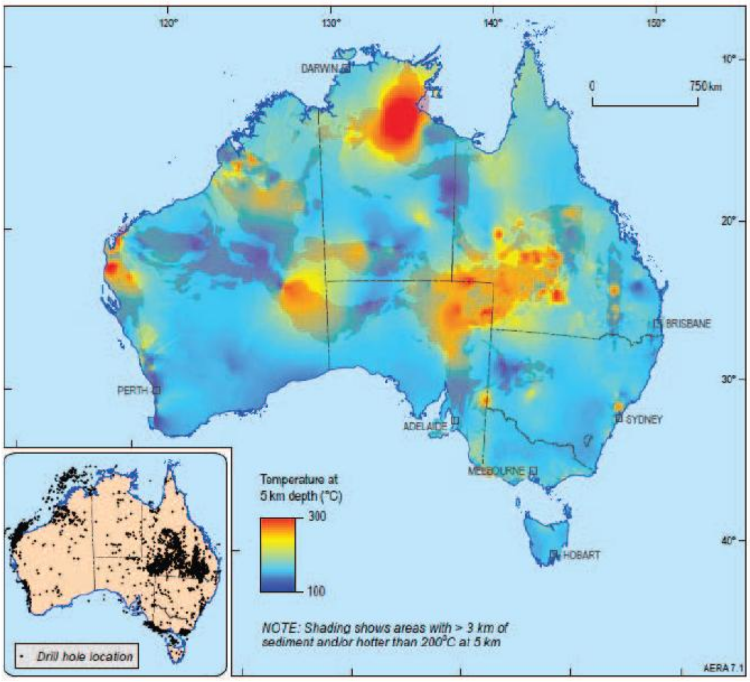
Notes: Data in the figure are independent of location.
Source: Australian Energy Market Operator, 2012, AEMO, 2012, Supply Inputs – Scenario 3.

[14] The AEMC is currently in the process of considering whether additional measures can be taken to promote network investment to connect new generation technologies. One option under consideration is the scale efficient network extensions (SENE) proposal that would promote the efficient connection of clusters of new generation.

Geothermal energy

Australia is considered to have substantial geothermal resources, mainly located in South Australia's North East and Queensland's South West (Figure 22). However, this technology is still at an early stage of development, and its commercial viability for electricity generation has not yet been demonstrated in Australia (KPMG, 2011). Electricity generation from geothermal energy in Australia is currently limited to pilot power plants producing small amounts of electricity. In addition, many geothermal resources are located at great distances from existing transmission lines and from customers.

Figure 22. Predicted temperatures at five kilometres depth

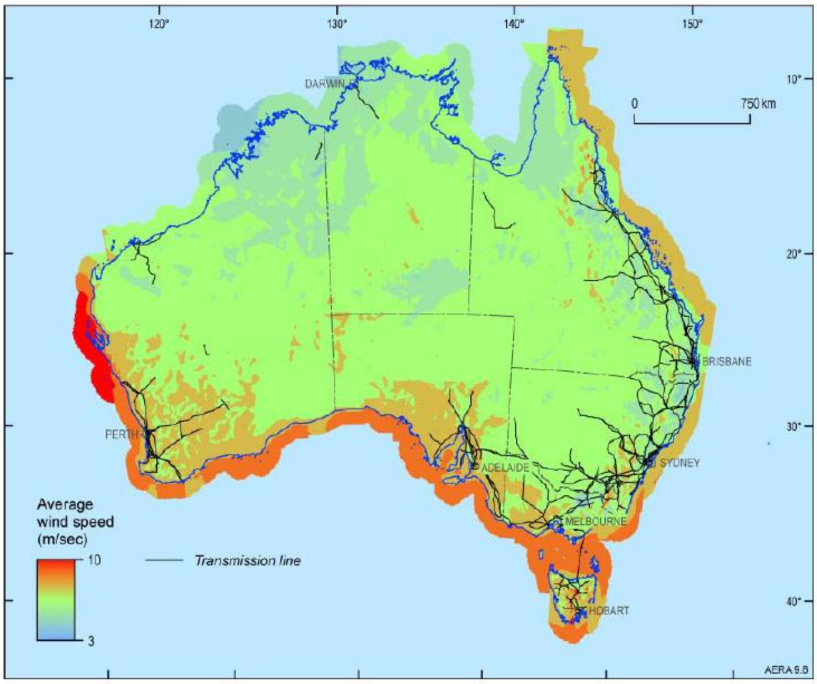


Source: Australian Energy Market Operator, 2011, Electricity Statement of Opportunities.

Wind energy

Wind generation technology is a mature technology, and one of the renewable technologies with the lowest upfront investment costs. Generating electricity from wind requires locations with high average wind speeds, which exist along Australia's south-western and southern coastlines (Figure 23). Almost half of the around 2,500MW wind capacity installed in Australia is accordingly located in South Australia.

Figure 23. Predicted average wind speed at a height of 80 metres



Source: Australian Energy Market Operator, 2011, Electricity Statement of Opportunities.

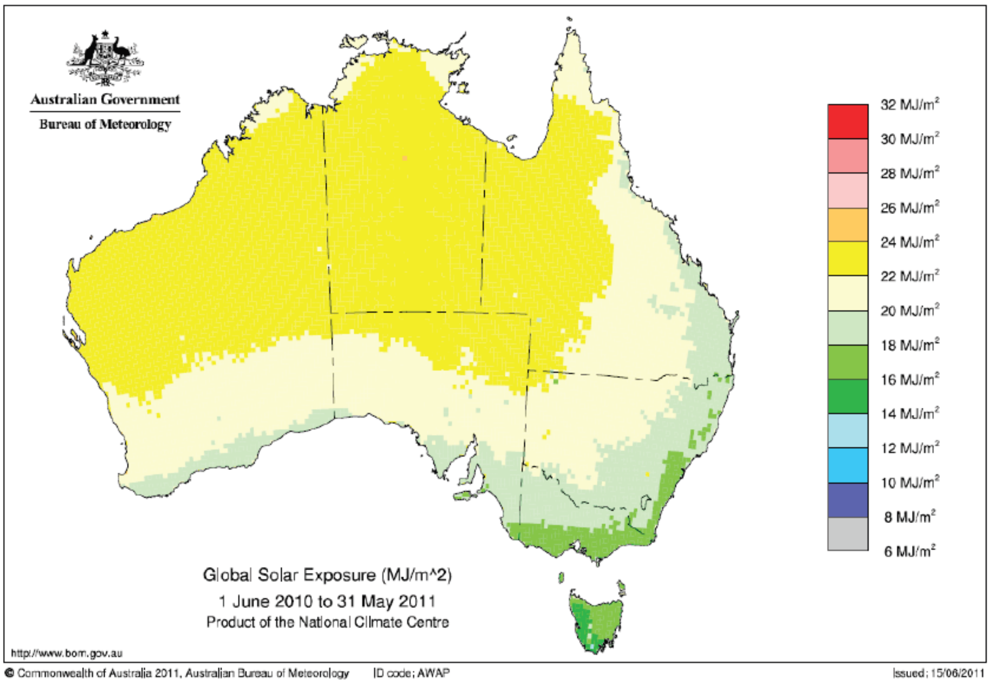
Solar energy

Australia has the highest average solar radiation per square metre of any continent in the world, but many solar energy resources are in remote locations. Figure 24 shows the annual average solar resources available across Australia. Areas with intense sunlight are mostly located in the centre of Australia and remote from the NEM transmission network.

While there are solar energy resources near grid-connected areas, the high upfront cost of solar technologies is considered the most important barrier to their installation (KPMG, 2011). Accordingly, electricity generation from solar energy in Australia is very limited, and currently almost entirely sourced from PV installations. Electricity generation from solar thermal systems is currently limited to small pilot projects.[15]

[15] Some companies are targeting commercial scale expansions of solar thermal technology across Australia building on the success of pilot projects. Macquarie Generation is in the process of expanding its solar thermal project, making it the largest in the southern hemisphere.

Figure 24. Annual average solar radiation



Source: Australian Energy Market Operator, 2011, Electricity Statement of Opportunities.

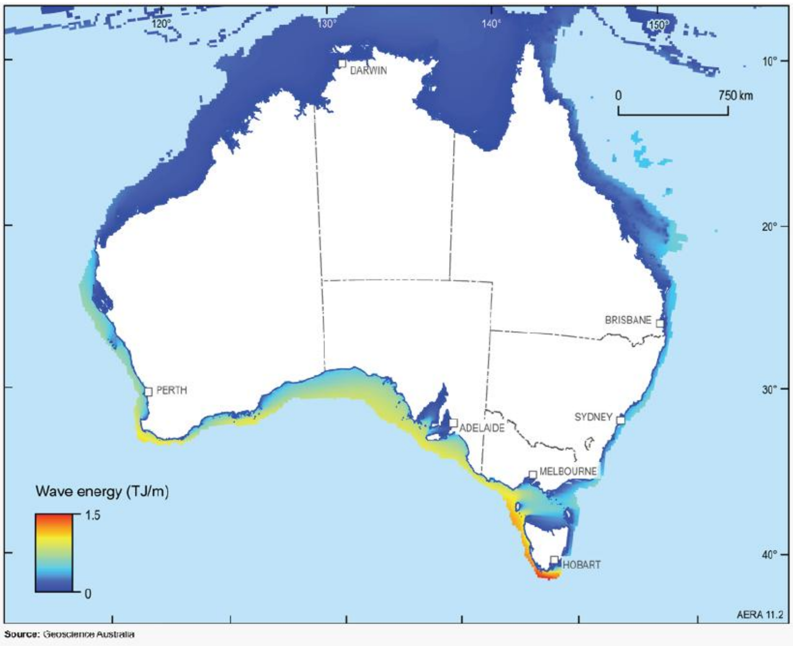
Ocean and tidal energy

Energy from the ocean (wave, tide and ocean thermal energy) is an undeveloped but potentially substantial renewable energy source. However, few such facilities are currently in operation (AEMO, 2011). In Australia:

- the southern half of the Australian continental shelf, particularly off the southern coast of Tasmania, has high quality wave energy resources (Figure 25); while
- total annual tidal energy is limited along the southern coast, but is significant along the northern coast, particularly above Western Australia and Far North Queensland (Figure 26).

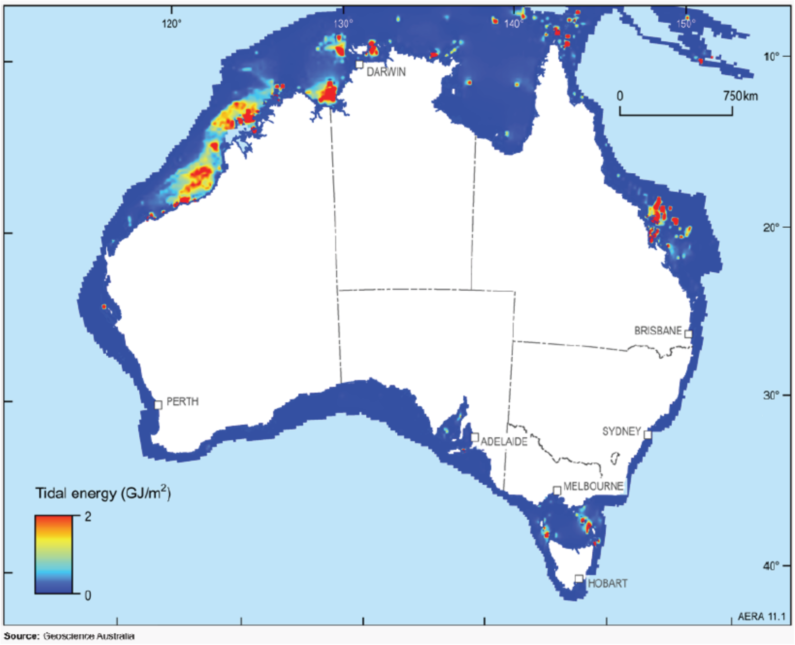
The remoteness of these locations from transmission infrastructure, as well as the high capital costs and unproven reliability of these technologies are considered major obstacles to their deployment (KPMG, 2011).

Figure 25. Total annual wave energy on the Australian continental shelf (at less than 300 meters depth)



Source: Australian Energy Market Operator, 2011, Electricity Statement of Opportunities.

Figure 26. Total annual tidal kinetic energy on the Australian continental shelf (at less than 300 metres depth)



Source: Australian Energy Market Operator, 2011, Electricity Statement of Opportunities.

Hydroelectric energy

Australia has significant water resources. There are more than 100 hydroelectric power stations in Australia, with the majority located in New South Wales, Victoria and Tasmania. However, most major available hydroelectric resources have already been developed, so that new opportunities are limited to upgrades of existing facilities or installations of small generating units (AEMO, 2011).

Biomass energy

Agriculture, forestry and food production in every NEM region produces substantial waste biomass that can be harnessed to create electricity. Biomass resources include bagasse, landfill gas, sewage gas, and various forms of agricultural and other organic waste. The majority of biomass technologies are bagasse-fired cogeneration facilities in Queensland (332MW) and New South Wales (60MW). Other biomass energy sources include landfill gas, sewage gas, and other forms of agricultural and organic wastes. The Clean Energy Council's Australian Bioenergy Roadmap identified the potential for over 10 MWh to be generated annually from biomass resources by 2020 in all parts of Australia.

Conclusions

Many alternative forms of energy generation require a substantial upfront capital investment and are currently higher cost than generation from wind, the most common alternative technology deployed in Australia. At the same time, many alternative energy technologies would need to be located in remote parts of Australia and would therefore require very substantial and costly network augmentations. Finally, at this time it is uncertain whether electricity generation technologies such as geothermal and ocean can be deployed at commercial scale. Individually and in combination, these factors represent material barriers to investment in alternative energy sources in all parts of Australia. Specifically in New South Wales, the potential to deploy alternative energies (other than wind or biomass) is likely to be particularly limited, since New South Wales has few of the geographical or environmental characteristics that are required to make such investments practically feasible.

3.6 Best practice in alternative energy generation in other jurisdictions

A great deal of research and effort has been expended by governments in recent years to encourage alternative generation, largely driven by concerns about global warming.[16] Given the very large number and complexity of these policies, it is not possible to provide a comprehensive description here, and the following therefore focuses on the broad themes that have emerged in recent years.

There are numerous instruments at the disposal of governments to encourage (or enforce) investment in alternative and renewable energy technologies, as summarised in Table 8. Examples of all of these types of policy mechanisms can be found in Australia, including the carbon pricing scheme which is a market-based scheme, regulatory schemes such as the LRET, the FITs applied in all states, direct subsidies and government expenditures, and government R&D support.

Table 8. Policy instruments to encourage take-up of alternative/renewable generation technologies

General instrument	Example
Market-based schemes (explicit carbon price)	Emissions trading scheme Carbon tax
Regulatory instruments	Renewable energy target Technology standard Fuel content mandate Other regulation
Subsidies and (other) taxes	Capital subsidy Feed-in tariff Tax rebate, credit or exemption Preferential, low-interest or guaranteed loan Other subsidy or grant Fuel or resource taxes
Direct government expenditure	Government investment — infrastructure
Support for research and development (R&D)	R&D — general and demonstration R&D — deployment and diffusion

Source: Based on Productivity Commission, 2011, 'Carbon Emission Policies in Key Economies, Research Report, May.

[16] To a lesser extent, concerns about energy self-sufficiency are also sometimes cited.

Alternative energy policies in other countries

Given the wide range of policy instruments available, comparisons of alternative generation policies between jurisdictions and countries are very difficult. In addition, policies at the federal level are often duplicated by state-based or local policies that also seek to support alternative generation technologies of one form or another. Table 9 provides a snapshot of policies adopted by a selection of countries to encourage alternative energy generation. As is the case in Australia, there are often multiple policies that often overlap in terms of the objectives they seek to achieve. In its assessment of Australian and international carbon price policies, for instance, the Productivity Commission (2011) identified approximately 230 emissions reductions policies in Australia and emphasised the correspondingly complex regulatory environment, potential for overlapping policies, as well as high administrative and compliance costs.

Table 9: Snapshot of alternative generation policies in selected countries

Country	Emissions trading scheme	Regulations	Subsidies/taxes
United States	No plans for an ETS at the Federal level. One existing and one planned ETS at the state level.	At the federal level, regulations to reduce generation emissions operate via permitting arrangements and new performance standards under the Clean Air Act (1970). Numerous state-based Renewable Portfolio Standards.	Renewable Electricity Production Tax Credit Section 1603 Treasury Grants Capital subsidies at the state level
United Kingdom	European ETS introduced in 2008	Renewables Obligation	Climate Change Levy Offshore Wind Capital Grants Scheme FIT schemes
Japan	Plans to introduce an ETS delayed to 2015.	Renewable Portfolio Standard	Project for Promoting the Local Introduction of New Energy Project for Supporting New Energy Operators New Buyback Program for Solar PV National PV Capital Subsidies, Tokyo PV Capital Subsidies Petroleum and Coal Tax

Country	Emissions trading scheme	Regulations	Subsidies/taxes
South Korea	Plans to introduce an ETS delayed to 2015	Commitment to introduce Renewable Portfolio Standards and mandatory emissions-reduction targets for large emitters (including power generators).	FITs for renewable energy; preferential loans for renewable energy; the Korea Certified Emission Reduction (KCER) scheme; and three capital subsidy programs
New Zealand	ETS introduced in 2010.	n/a	n/a
China	Announced plans for a nationwide ETS by the end of 2015.	'Large Substitute for Small' (LSS) to decommission and replace small inefficient thermal power plants.	FiTs, capital subsidies for the use of renewable energy sources (wind, solar photovoltaic and biomass)

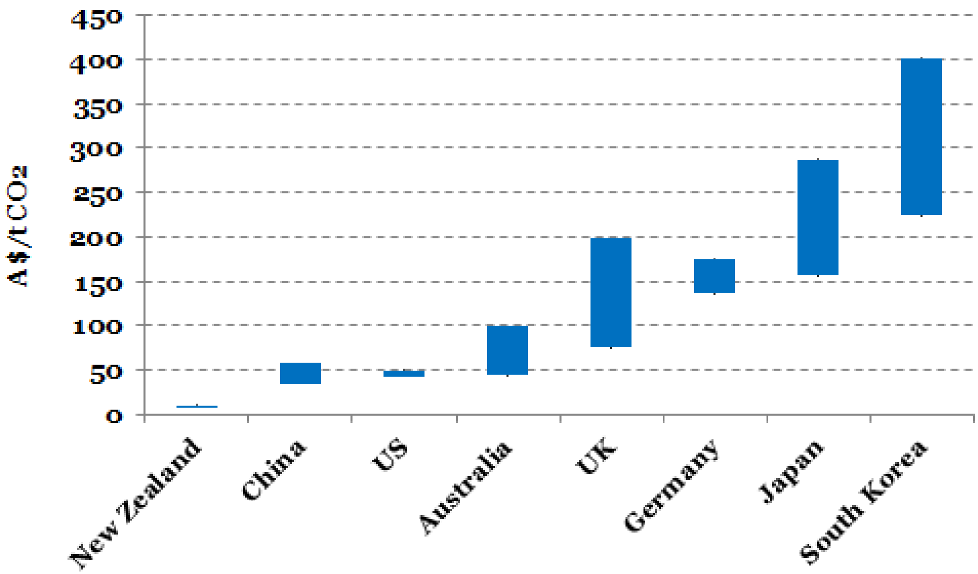
Source: Productivity Commission, 2011, 'Carbon Emission Policies in Key Economies, Research Report, May.

Costs of alternative generation policies

From a policy perspective, the effectiveness of different alternative energy policies should be assessed both in terms of their ability to achieve a given environmental objective and in terms of the costs they impose on society. Such costs take a number of forms, including the direct implementation and administration costs to government, and compliance costs, such as capital and operating expenditures incurred by the private sectors.[17] Nonetheless, the analysis undertaken by the Productivity Commission showed that the costs of measures to reduce emissions by encouraging alternative generation in the electricity industry vary very widely (Figure 27). Specifically the examples of South Korea and Japan highlight that high costs are often unrelated to the effectiveness of policies. Where renewable energy policies in Australia are concerned, the Productivity Commission came to a similar conclusion. The Commission's modelling suggests that the abatement the LRET could have been achieved at a fraction of the cost if a market-based instrument such as a carbon price had been applied instead.

[17] In addition, there are also indirect costs that are difficult or impossible to quantify, for instance if policies impact on investment or economic growth.

Figure 27. Comparison of average implicit abatement subsidies (cost per tonne of emissions abated)



Source: Productivity Commission, 2011, ‘Carbon Emission Policies in Key Economies’, Research Report, May.

Market-based versus ‘command and control’ mechanisms

Given material differences in costs between different policies intended to encourage the uptake of renewable generation, the question then arises what lessons can be drawn about the effectiveness of such policies. Broadly speaking, the consensus today is that ‘market-based’ policies that rely on price signals in some form are far more effective in terms of their environmental and cost effectiveness, as compared with regulatory or ‘command and control’ instruments.

Market-based instruments such as a tradable permits, pollution charges or taxes encourage changes in behaviour through market signals, rather than as a result of explicit directives regarding pollution control levels or methods. The Australian carbon pricing scheme is an example of such an instrument. By putting an explicit price on emissions, market-based instruments operate on the principle that the damage caused by a unit of emissions is the same no matter where it originates, and by creating a financial incentives for consumers and producers to reduce emissions where this is least-cost. The conclusion that market-based mechanisms deliver greater benefits in terms of both environmental and cost effectiveness was strongly supported by the Intergovernmental Panel on Climate Change

(2007), as well as in a number of studies undertaken by the Productivity Commission, which found that the implicit costs of market-based policies are consistently considerably lower than those of regulations and direct action policies, which are costly and largely ineffective.

More generally, and unlike regulatory mechanisms, market-based approaches provide strong and durable incentives for investment in technology research, development and deployment, and for consumers and businesses to improve energy efficiency (Gillingham et al., 2007). Energy prices play a crucial role in influencing consumption, the adoption of energy efficient technologies, and innovation. Hence a number of studies suggest that price signals that incorporate the costs of environmental externalities will encourage energy conservation, the take-up of new technologies, and are lasting drivers of energy-efficient innovation in the long term.

In contrast to market-based instruments, regulatory approaches allow consumers and producers relatively little flexibility in how environmental goals are achieved (Stavins, 2002). Regulations cannot generally achieve similar short and longer-term economic efficiency objectives as market-based instruments, since they force producers and consumers to adopt specific measures, regardless of cost. The LRET is an example of such a policy, since it prescribes a given level of investment in renewable technologies, irrespective of whether a different investment profile (for instance, a rebalancing from coal to gas) would achieve the same emissions reductions outcome at a lower cost. One important drawback of such regulatory approaches is also that they constrain the technological choices available, and may inhibit the development of other environmentally beneficial technologies.

Conclusions

Australia, like most other developed countries, has adopted a multitude of policies designed to reduce emissions by encouraging the adoption of alternative generation technologies. Many of these policies overlap in the objectives that they seek to achieve, and a number of them, including the LRET are extremely costly, a cost that will eventually be borne by consumers. More generally, the Australian history of policies targeted at the electricity sector is characterised by a willingness of governments to intervene in market processes, often with little regard for the environmental and cost effectiveness of policies, or for their longer-term impact.

While there is little doubt that there is a central role for government in putting in place a framework for reducing emissions, there are a number of principles that should underpin policies directed at the generation sector:

- policies should be ‘market-based’ in order to ensure that the costs of achieving a given target, including associated administrative and compliance burdens, can be minimised;
- governments should correspondingly refrain from putting in place technology-specific regulations, from ‘picking winners’, and from applying multiple overlapping schemes, all of which are costly and undermine the environmental effectiveness of policies; and
- given the long planning horizon of investment in an ESI, policy certainty is of overriding importance to encourage market-driven investment on the basis of durable price signals.

Appendix A. New South Wales generation sector

Table 10. Existing and committed generation capacity in New South Wales

Power Station	Registered participant/owner	Registered/ nameplate capacity (MW)	Plant Type	Fuel Type
Bayswater	Macquarie Generation	2,640	Steam Subcritical	Black Coal
Eraring	Origin Energy Electricity Limited	2,682	Steam Subcritical	Black Coal
Liddell	Macquarie Generation	2,000	Steam Subcritical	Black Coal
Mt Piper	TRUenergy	1,400	Steam Subcritical	Black Coal
Munmorah	Delta Electricity	600	Steam Subcritical	Black Coal
Vales Point B	Delta Electricity	1,320	Steam Subcritical	Black Coal
Wallerawang C	TRUenergy	1,000	Steam Subcritical	Black Coal
Redbank	Redbank Project	150	Steam Subcritical	Coal Tailings
Colongra	Delta Electricity	724	OCGT	Natural Gas
Smithfield Energy Facility	Marubeni Australia Power Services	160	CCGT	Natural Gas
Tallawarra	TRUenergy	460	CCGT	Natural Gas
Uranquinty	Origin Energy Uranquinty Power	664	OCGT	Natural Gas
Hunter Valley	Macquarie Generation	50	OCGT	Diesel
Bankstown Sports Club	Bankstown Sports Club	2	Compression Reciprocating Engine	Diesel
Broken Hill GT	Essential Energy	50	OCGT	Diesel
Eraring GT	Eraring Energy	42	OCGT	Diesel
Hunter Economic Zone	Infratil Energy Australia	29	Compression Reciprocating Engine	Diesel
Nine Network Willoughby	Nine Network	3	Compression Reciprocating Engine	Diesel
Revesby Workers	Revesby Workers	3	Compression Reciprocating	Diesel

Power Station	Registered participant/owner	Registered/ nameplate capacity (MW)	Plant Type	Fuel Type
Club	Club		Engine	
St George Leagues Club	St George Leagues Club	1	Compression Reciprocating Engine	Diesel
West Illawarra Leagues Club	Wests Illawarra Leagues Club	1	Compression Reciprocating Engine	Diesel
Western Suburbs League Club (Campbelltown)	Western Suburbs League Club (Campbelltown)	1	Compression Reciprocating Engine	Diesel
Shoalhaven	Origin Energy Electricity	240	Pumped-Storage Hydroelectric	Water
Blowering	Snowy Hydro	70	Gravity Hydroelectric	Water
Guthega	Snowy Hydro	60	Gravity Hydroelectric	Water
Hume	Eraring Energy	58	Gravity Hydroelectric	Water
Tumut 1[a]	Snowy Hydro	616	Gravity Hydroelectric	Water
Tumut 2 [a]	Snowy Hydro	-	Gravity Hydroelectric	Water
Tumut 3	Snowy Hydro	1,500	Gravity Hydroelectric	Water
Brown Mountain	Eraring Energy	5	Gravity Hydroelectric/Run of River	Water
Burrendong	AGL Energy	18	Gravity Hydroelectric	Water
Burrinjuck	Eraring Energy	27	Gravity Hydroelectric	Water
Copeton	AGL Energy	20	Gravity Hydroelectric	Water
Glenbawn	AGL Energy	5	Gravity Hydroelectric	Water
Jindabyne	Snowy Hydro Ltd.	1	Gravity Hydroelectric	Water
Jounama	Snowy Hydro Ltd.	14	Gravity Hydroelectric	Water
Keepit	Eraring Energy	7	Gravity Hydroelectric	Water
Nymboida	Essential Energy	34	Gravity Hydroelectric	Water
Oaky	Essential Energy	5	Gravity Hydroelectric	Water
Pindari	AGL Energy	6	Gravity Hydroelectric	Water
The Drop	Pacific Hydro Investments	3	Gravity Hydroelectric	Water
Warragamba	Eraring Energy	50	Gravity Hydroelectric	Water
Broadwater	Ferrier Hodgeson,	30	Steam Subcritical	Bagasse/Wood

Power Station	Registered participant/owner	Registered/ nameplate capacity (MW)	Plant Type	Fuel Type
	Sunshine Electricity joint venture in receivership			Waste
Condong	Ferrier Hodgeson, Sunshine Electricity joint venture in receivership	30	Steam Subcritical	Bagasse/Wood Waste
Awaba	LMS Generation	1	Spark Ignition Reciprocating Engine	Landfill Methane
Belconnen	EDL LFG (ACT)	1	Spark Ignition Reciprocating Engine	Landfill Methane
Eastern Creek	EDL LFG (NSW)	5	Spark Ignition Reciprocating Engine	Landfill Methane
Eastern Creek 2 Gas Utilisation Facility	LMS Generation	8	Spark Ignition Reciprocating Engine	Landfill Methane
Grange Ave	EDL LFG (NSW)	1	Spark Ignition Reciprocating Engine	Landfill Methane
Jacks Gully	EDL LFG (NSW)	2	Spark Ignition Reciprocating Engine	Landfill Methane
Lucas Heights I	EDL LFG (NSW)	5	Spark Ignition Reciprocating Engine	Landfill Methane
Lucas Heights II	EDL LFG (NSW)	11	Spark Ignition Reciprocating Engine	Landfill Methane
Mugga Lane	EDL LFG (ACT)	3	Spark Ignition Reciprocating Engine	Landfill Methane
Summer Hill	LMS Generation	2	Spark Ignition Reciprocating Engine	Landfill Methane
Woodlawn Bioreactor Energy Generation	Veolia Environmental Services (Aust)	6	Spark Ignition Reciprocating Engine	Landfill Methane
West Nowra	AGL Energy	1	Compression Reciprocating Engine	Landfill Methane
EarthPower Biomass Plant	EarthPower Technologies Sydney	4	Spark Ignition Reciprocating Engine	Municipal and Industrial Materials
Teralba	EnviroGen	4	Spark Ignition Reciprocating Engine	Waste Coal Mine Gas
Appin	EDL CSM (NSW) Pty Ltd	60	Spark Ignition Reciprocating Engine	Waste Coal Mine Gas/Natural Gas
Tower	EDL NSW (CSM)	41	Spark Ignition Reciprocating	Waste Coal Mine

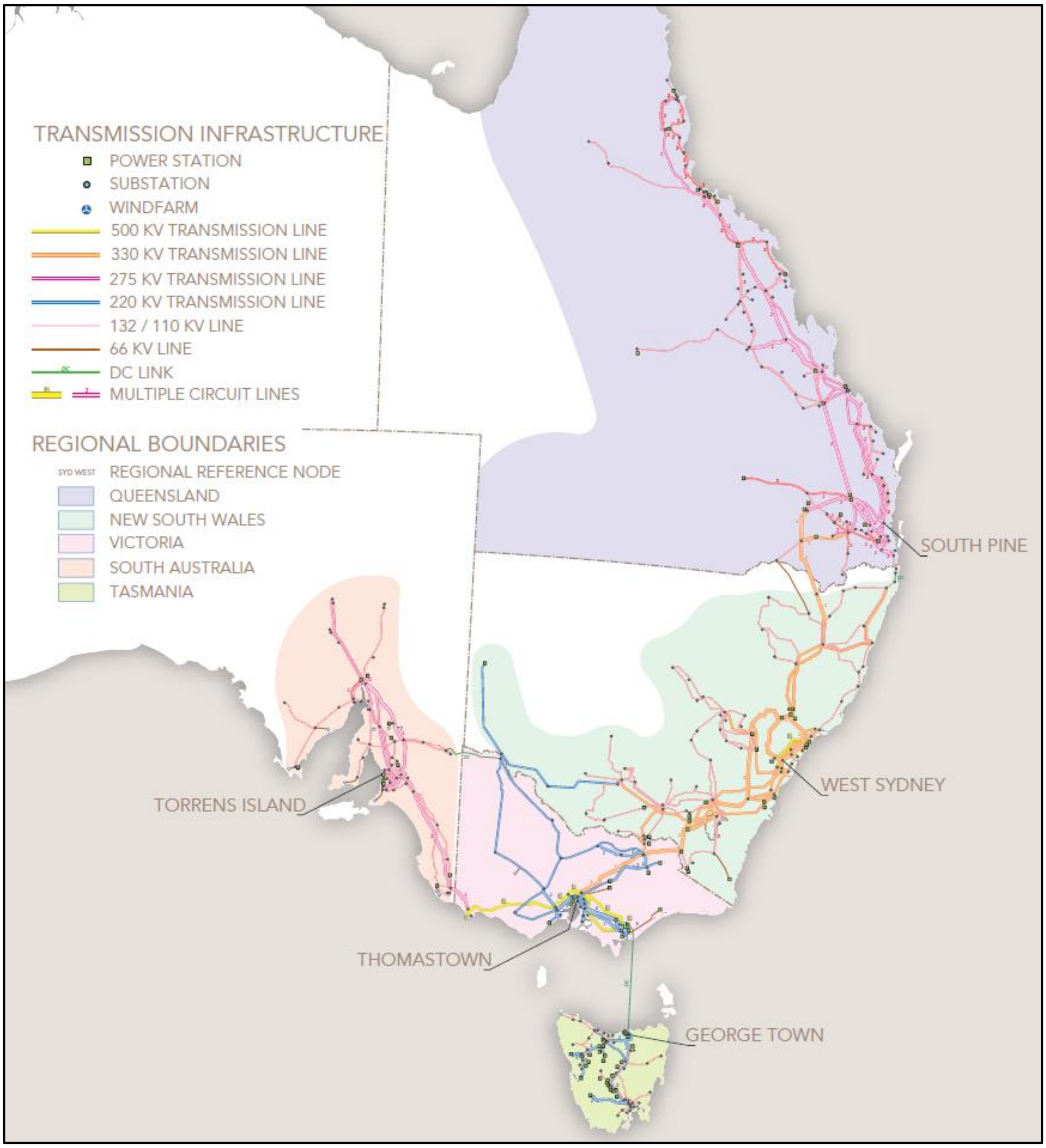
Power Station	Registered participant/owner	Registered/ nameplate capacity (MW)	Plant Type	Fuel Type
			Engine	Gas/natural gas
Gunning	Gunning Wind Energy Developments	47	Wind	Wind
Woodlawn [1]	Woodlawn Wind	48	Wind Turbine	Wind
Blayney	Eraring Energy	10	Wind	Wind
Crookwell	Eraring Energy	5	Wind	Wind
Cullerin Range	Cullerin Range Wind Farm	30	Wind	Wind
Kooragang	Ausgrid	1	Wind	Wind
Capital	Renewable Power Ventures	141	Wind	Wind

Notes: [1] Committed project. Projects are categorised as committed based on AEMO's commitment criteria, which cover site acquisition, contracts for major components, planning approval, financing, and the date set for construction. Committed projects meet all five of the commitment criteria.

Source: Australian Energy Market Operator, 2011, Electricity Statement of Opportunites.

Appendix B. Map of the National Electricity Market

Figure 28. Regions and networks in Australia's National Electricity Market



Source: Australian Energy Market Operator, 2010, 'An Introduction to Australia's National Electricity Market, July.

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