



1

ELECTRICITY GENERATION



The supply of electricity begins with generation in power stations. This chapter provides a survey of electricity generation in the National Electricity Market, a wholesale market in which generators and retailers trade electricity in eastern and southern Australia. There are six participating jurisdictions, physically linked by a transmission network—Queensland, New South Wales, the Australian Capital Territory, Victoria, South Australia and Tasmania.

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ELECTRICITY GENERATION

This chapter considers:

- > electricity generation in the National Electricity Market, including geographical distribution, types of generation technology, and the lifecycle costs and greenhouse gas emissions of different generation technologies
- > the ownership of generation infrastructure
- > new investment in generation infrastructure
- > the reliability of electricity generation in the National Electricity Market.

1.1 Electricity generation

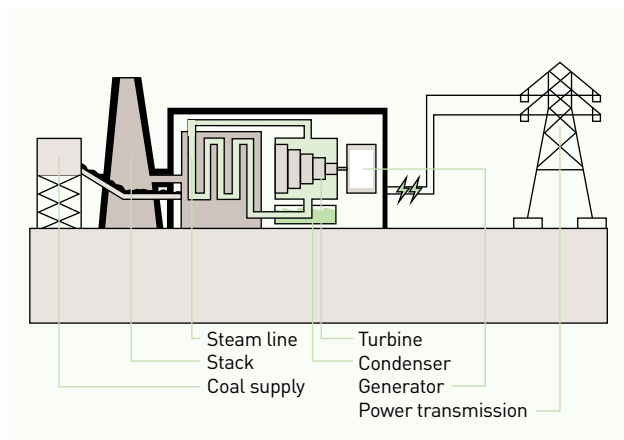
A generator creates electricity by using energy to turn a turbine, which makes large magnets spin inside coils of conducting wire. In Australia, electricity is mainly produced by burning fossil fuels, such as coal and gas, to create pressurised steam. The steam is forced through a turbine at high pressure to drive the generator. Other types of generators rely on the heat emitted through a nuclear reaction, or renewable energy sources such as the sun, wind or the flow of water to generate

electricity. Figure 1.1 illustrates four types of electricity generation commonly used in Australia—coal-fired, open cycle gas-fired, combined cycle gas-fired and hydroelectric generation.

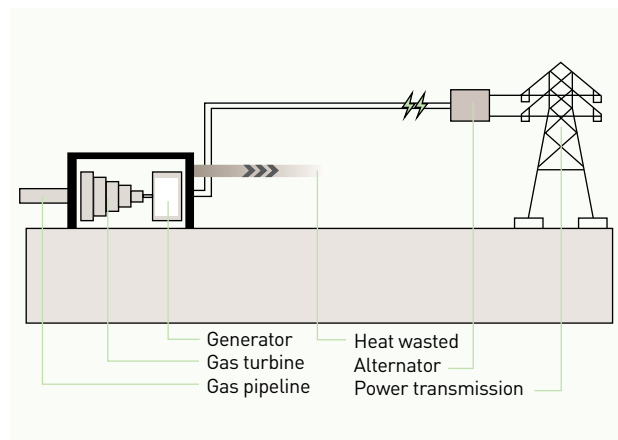
The fuels that can be used to generate electricity each have distinct characteristics. Coal-fired generation, for example, has a long start-up time (8–48 hours), while hydroelectric generation can start almost instantly. Lifecycle costs and greenhouse gas emissions also vary markedly with generator type.

Figure 1.1
Electricity generation technologies

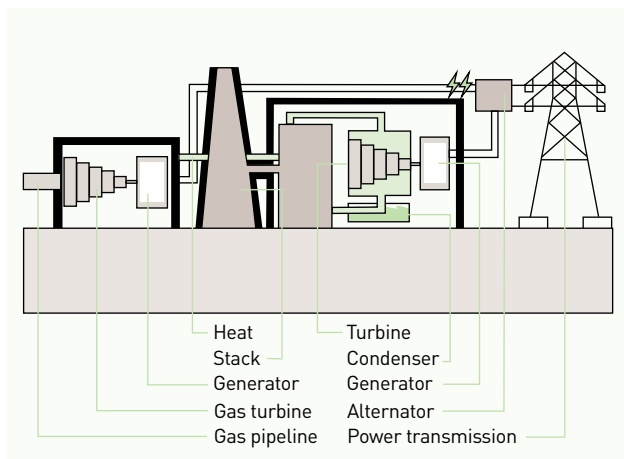
Coal-fired generation



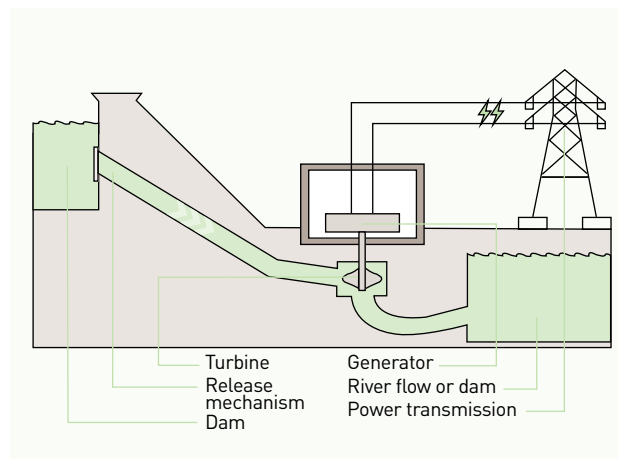
Open cycle gas-fired generation



Combined cycle gas-fired generation



Hydroelectric generation



Source: Babcock & Brown.

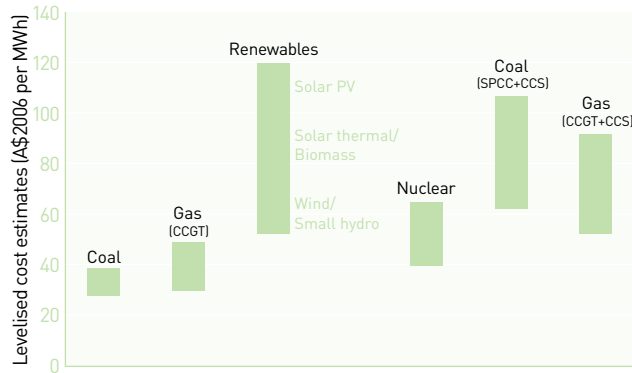
1.1.1 Lifecycle costs

Estimates of the economic lifecycle costs of different electricity generation technologies in Australia are provided in figure 1.2. To allow comparison, the costs of each generation option have been converted to a standardised cost per unit of electricity.¹

Figure 1.2 includes technologies currently in use, as well as alternatives such as nuclear energy, and fossil fuel-fired generators using carbon capture and storage (CCS) technology.² The cost estimates for CCS, which can be used to reduce greenhouse gas emissions from fossil fuel-fired generation (coal, gas and oil) technologies, are indicative only.

1 The levelised cost of electricity is the real wholesale price of electricity that recoups capital, operating and fuel costs. The present value of expenditures is divided by the electricity generated over the lifetime of the plant to produce a cost per unit of electricity (in \$ per MWh).
2 Carbon capture and storage, also known as carbon sequestration, is an approach to mitigating carbon dioxide emissions by storing the carbon dioxide. Potential storage methods include injection into underground geological formations, injection deep into the ocean, and industrial fixation in inorganic carbonates. Some industrial processes might use and store small amounts of captured carbon dioxide in manufactured products.

Figure 1.2
Lifecycle economic costs of electricity generation



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

Source: Commonwealth of Australia, *Uranium mining, processing and nuclear energy—opportunities for Australia?* Report to the Prime Minister by the Uranium Mining, Processing and Nuclear Energy Review Taskforce, December 2006.

Developing a consistent evaluation of electricity generation costs across different technologies is difficult because of variations in the size and timing of construction costs, fuel costs, operating and maintenance costs, plant utilisation and environmental regulations. Site-specific factors can also affect electricity generation costs. Figure 1.2 therefore expresses the economic costs for each technology in wide bands.

Coal and gas are the lowest cost fuel sources for electricity generation in Australia. Of the renewable technologies currently used here, wind and hydroelectric generation are cheaper over their lifecycle than biomass and solar. It is estimated that the cost of nuclear generation would fall between that for conventional and renewable generation.

1.1.2 Greenhouse gas emissions

Greenhouse gas emissions for a range of different electricity generation technologies, based on current best practice under Australian conditions, are shown in figure 1.3. The data takes account of full lifecycle emission contributions—including from the extraction of fuels—and estimates the emissions per megawatt hour (MWh) of electricity generated.

Renewable sources of electricity (hydroelectric, wind and solar) and nuclear electricity generation have the lowest greenhouse gas emissions of the generation technologies analysed. Of the fossil fuel technologies, natural gas has the lowest emissions and brown coal, the highest. Figure 1.3 does not account for CCS technologies, which could potentially reduce emissions from gas and coal-fired generators.

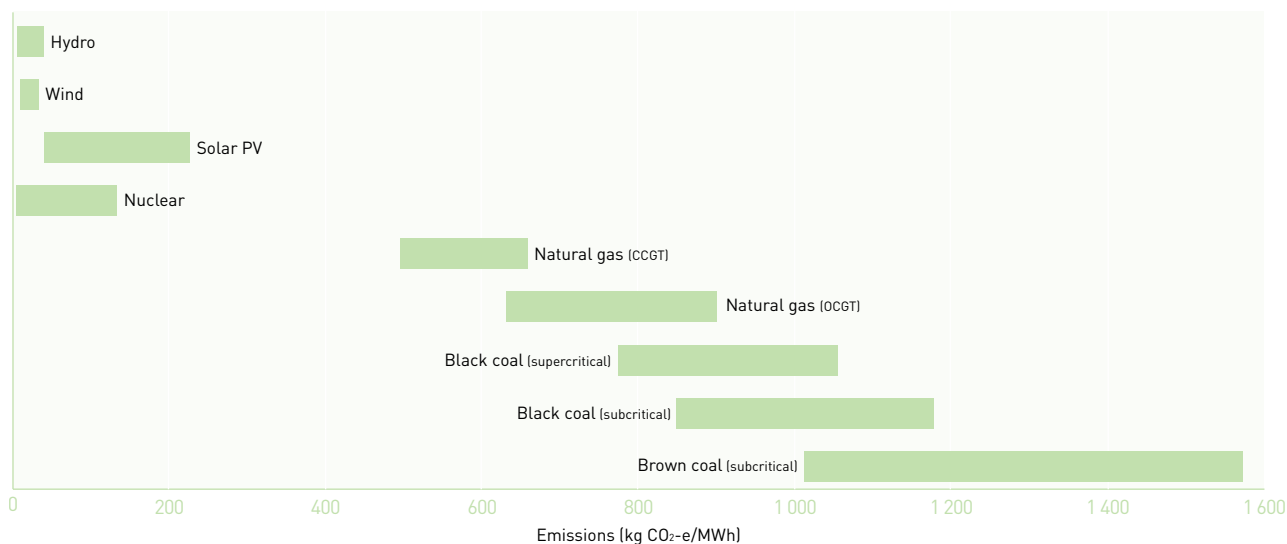
1.2 Generation in the National Electricity Market

Australia has about 244 large electricity generators (figure 1.4), of which around 190 are in the National Electricity Market (NEM) jurisdictions in eastern and southern Australia.³ The electricity produced by major generators in the NEM is sold through a central dispatch managed by the National Electricity Market Management Company (NEMMCO). Chapter 2 of this report outlines the dispatch process.

The demand for electricity is not constant, varying with time of day, day of week and ambient temperature. Demand tends to peak in summer (when hot weather drives up air conditioning loads) and winter (when cold weather increases heating requirements). A reliable power system needs sufficient capacity to meet these demand peaks. In effect, a substantial amount of capacity may be called on for only brief periods and may remain idle for most of the year.

³ This chapter has minimal coverage of Western Australia and the Northern Territory, which do not participate in the National Electricity Market. Chapter 7 provides more detailed information on the generation sectors in those jurisdictions.

Figure 1.3
Lifecycle greenhouse gas emissions from electricity generation



CCGT, combined cycle gas turbine; OCGT, open cycle gas turbine; PV, photovoltaic.

Notes:

1. The figure shows the estimated range of emissions for each technology and highlights the most likely emissions value; includes emissions from power station construction and the extraction of fuel sources.
2. kg CO₂-e/MWh refers to the quantity of greenhouse gas emissions (in kilograms, converted to a carbon dioxide equivalent) that are produced for every megawatt hour of electricity produced.

Source: Commonwealth of Australia, *Uranium mining, processing and nuclear energy—opportunities for Australia?* Report to the Prime Minister by the Uranium Mining, Processing and Nuclear Energy Review Taskforce, December 2006.

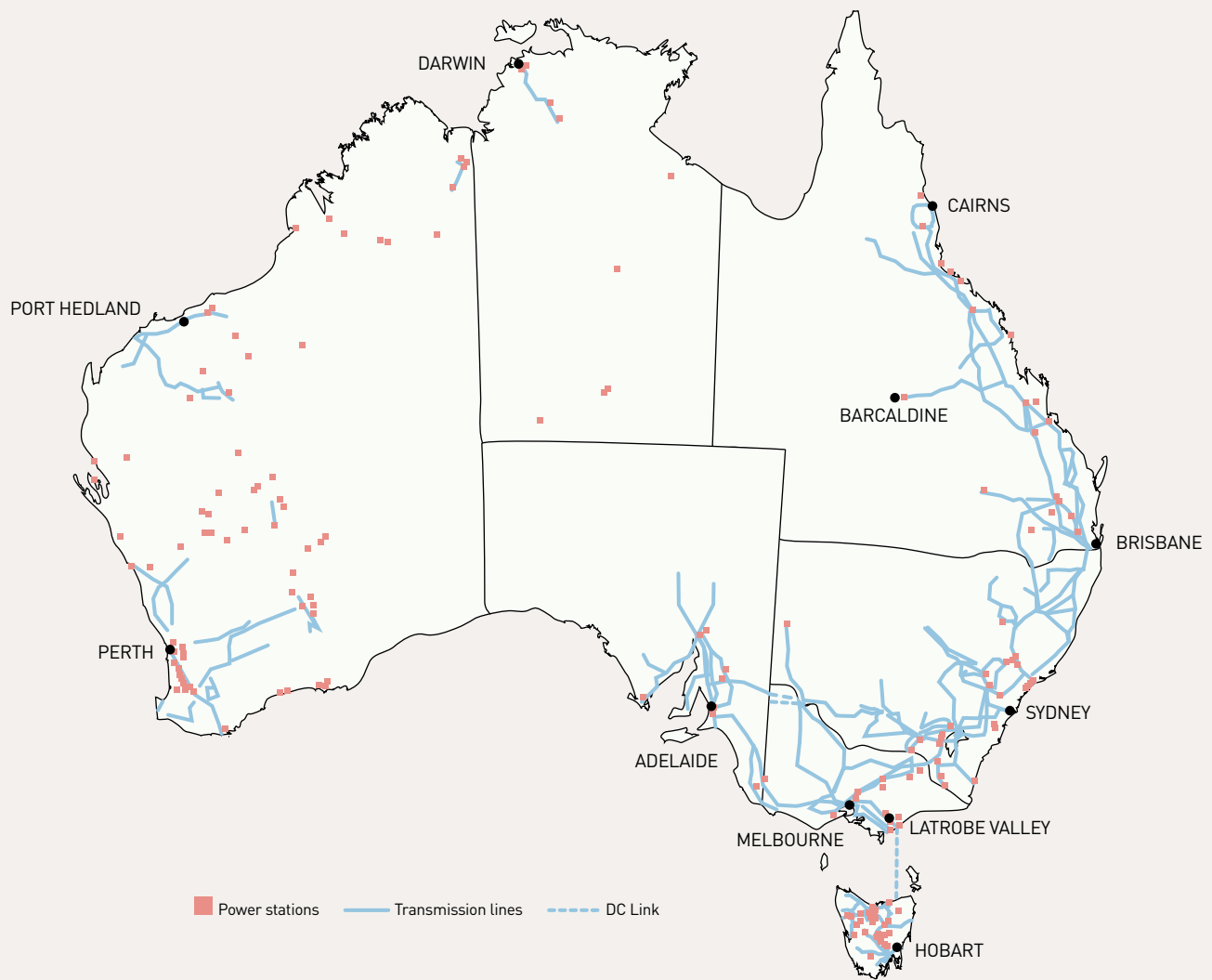
It is necessary to have a mix of generation capacity that reflects these demand patterns. The mix consists of baseload, intermediate and peaking power stations.

Baseload generators, which meet the bulk of demand, tend to have relatively low operating costs but high start-up costs, making it economical to run them continuously. *Peaking* generators have higher operating costs and are used to supplement baseload at times when prices are high. This normally occurs in periods of peak demand or when an issue such as a network outage constrains the supply of cheaper generators. While peaking generators are expensive to run, they must be capable

of a reasonably quick start-up as they may be called upon to operate at short notice. There are also *intermediate* generators, which operate more frequently than peaking plants, but not continuously.

The NEM generation sector uses a variety of fuel sources to produce electricity (figure 1.5). Black and brown coal account for around two-thirds of total generation capacity across the NEM, followed by hydroelectric generation (17 per cent) and gas-fired generation (15 per cent).

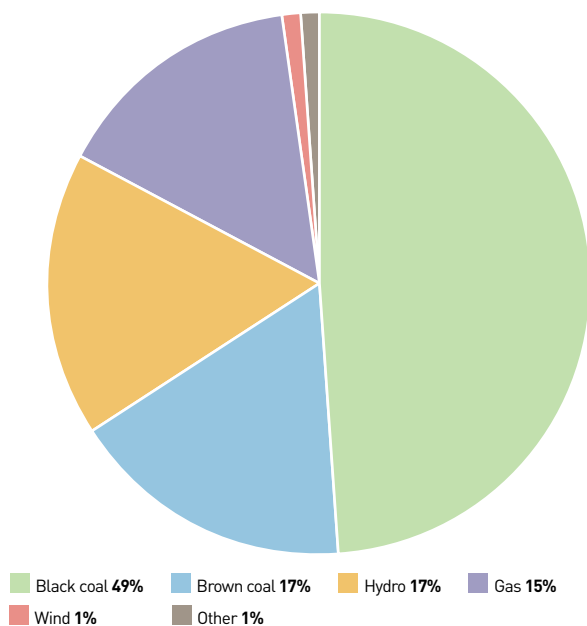
Figure 1.4
Electricity generators in Australia



Note: Locations are indicative only.

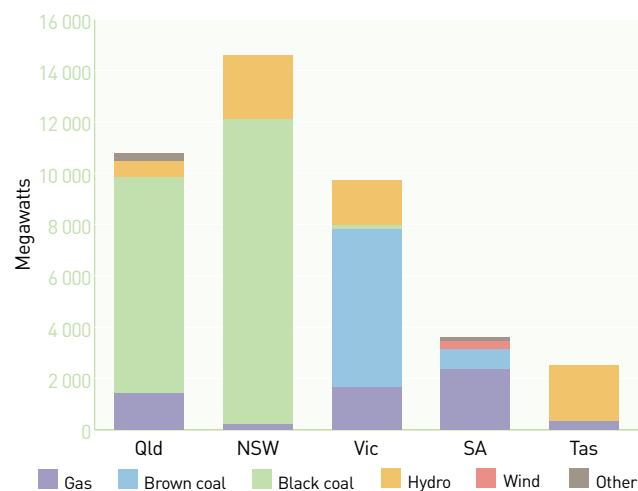
Source: ABARE, *Energy in Australia*, 2008.

Figure 1.5
Scheduled generation capacity by fuel source—
National Electricity Market, 2008



Note: Excludes power stations not managed through central dispatch
Source: NEMMCO/AER.

Figure 1.6
Scheduled generation capacity by fuel source—
regional, 2008



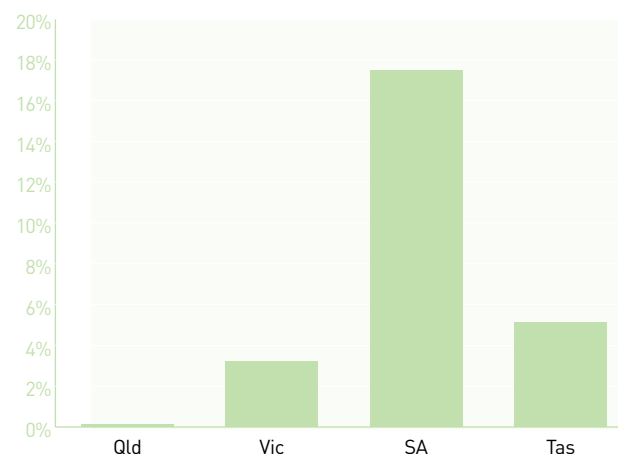
Notes:

1. Excludes power stations not managed through central dispatch.
2. New South Wales and Victoria include Snowy Hydro capacity allocated to those regions.

Source: NEMMCO/AER.

4 The former Snowy region was abolished on 1 July 2008. The area formerly covered by the Snowy region is now split between the Victoria and New South Wales regions of the NEM.

Figure 1.7
Wind generation in the National Electricity Market
as a percentage of registered capacity, 2008



Source: NEMMCO/AER.

Figure 1.6 sets out regional data on generation capacity by fuel source. Victoria's generation is mainly fuelled by brown coal, supplemented by gas-fired peaking generation. New South Wales and Queensland mainly rely on black coal, but there has been some recent investment in gas-fired generation. Victoria and New South Wales also have some hydroelectric generation, mainly owned by Snowy Hydro.⁴ Electricity generation in Western Australia, South Australia and the Northern Territory is mainly fuelled by natural gas. Tasmania relies primarily on hydroelectric generation.

Wind generation is often reported separately from other types of generation because its capacity is dependent on the weather and cannot be relied on for generation at specified times. The extent of new investment in wind generation has led the Australian Energy Market Commission (AEMC) to determine that new wind generators be classified as *semi-scheduled*, which will require them to participate in the central dispatch process. Wind generation is the equivalent of around 2.8 per cent of registered capacity in the NEM. Wind has a significantly higher share in South Australia at 17 per cent (figure 1.7).



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The pattern of generation technologies across the NEM is evolving over time. As indicated in figure 1.3, coal-fired generators produce relatively more greenhouse gas emissions than most other technologies. The Australian and state and territory governments have implemented (and are developing) initiatives to encourage the development and use of low-emission technologies.

The Australian Government has announced that it will introduce an emissions trading scheme—called the Carbon Pollution Reduction Scheme—by 2010, with a detailed design to be finalised by the end of 2008. Some Australian governments also apply targets for greenhouse gas emissions reduction, renewable energy and other low-emission generation, and provide funds for technology development.

Over time, such initiatives are likely to increase the cost competitiveness and use of low-emission technologies in the generation sector.

1.2.1 Generation ownership

Table 1.1 and figures 1.8 and 1.9 provide background on the ownership of generation businesses in Australia. Across the NEM, around two-thirds of generation capacity is government-owned or controlled.

In the 1990s, Victoria and South Australia disaggregated their generation sectors into multiple stand-alone businesses and privatised each business. Most generation capacity in these jurisdictions is now owned by International Power, AGL Energy, TRUenergy, the Great Energy Alliance Corporation (GEAC) group (in which AGL Energy holds a 32.5 per cent stake) and Snowy Hydro. Some of these businesses have invested in new generation capacity—mainly gas-fired intermediate and peaking plants—since the NEM began.

There has been a significant trend in Victoria and South Australia towards vertical integration of electricity generators with retailers. In Victoria, AGL Energy and TRUenergy are key players in both generation and retail. In South Australia, AGL Energy is both the leading generator and the leading retailer. Across Victoria and South Australia, AGL Energy and TRUenergy own around 41 per cent of registered generation capacity.⁵ In July 2007, AGL Energy and TRUenergy completed a generator swap in South Australia that moved the capacity of each business into closer alignment with their respective retail loads. International Power, which controls around 26 per cent of generation capacity in Victoria and South Australia, established a retail business (Simply Energy) in 2007 and is expanding its market share in that sector. Origin Energy is currently the only major retailer with limited generation capability, but has committed to major development projects.

New South Wales and Queensland have disaggregated their generation sectors, but retain significant government ownership. Generation capacity in New South Wales is mainly split between the state-owned Macquarie Generation, Delta Electricity and Eraring Energy. Snowy Hydro, jointly owned by the New South Wales, Victorian and Australian governments also has a significant amount of hydroelectric generation capacity. Two private sector entrants, Babcock & Brown Power and the Marubeni Corporation, each own around 1.6 per cent of the generation capacity in New South Wales. The New South Wales Government announced in June 2008 its intention to privatise much of the state's generation sector, but reversed this decision in August 2008.

5 Includes AGL Energy's 32.5 per cent stake in Loy Yang A and TRUenergy's contractual arrangement for Ecogen Energy's capacity. See table 1.1.

Table 1.1 Generation ownership in the National Electricity Market, July 2008

GENERATION BUSINESS	POWER STATIONS	CAPACITY (MW) ¹	OWNER
NEW REGIONS			
NEW SOUTH WALES AND THE AUSTRALIAN CAPITAL TERRITORY			
Macquarie Generation	Bayswater; Liddell; Hunter Valley	4834	NSW Government
Delta Electricity	Vales Point B; Mt Piper; Wallerawang C; Munmorah	4320	NSW Government
Eraring Energy	Eraring; Shoalhaven; Hume	2938	NSW Government
Snowy Hydro	Blowering; Tumut; Guthega	2006	NSW Govt (58%); Vic Govt (29%); Australian Govt (13%)
Marubeni Australia Power Services	Smithfield	160	Marubeni Corporation
Redbank Project	Redbank	145	Babcock & Brown Power
Various	Embedded and non-grid	514	Various
VICTORIA			
Snowy Hydro	Laverton North; Valley Power; Murray	2070	NSW Govt (58%); Vic Govt (29%); Australian Govt (13%)
Loy Yang Power	Loy Yang A	2050	GEAC (AGL Energy 32.5%; TEPCO 32.5%; Transfield Services 9.3%; others 25.7%)
Hazelwood Power	Hazelwood	1580	International Power (91.8%); Commonwealth Bank (8.2%)
TRUenergy Yallourn Pty Ltd	Yallourn	1420	TRUenergy (CLP Group)
IPM Australia	Loy Yang B	965	International Power (70%), Mitsui (30%)
Ecogen Energy	Newport; Jeeralang A and B	891	Industry Funds Management (Nominees) Ltd (all contracted to TRUenergy)
AGL Hydro Partnership	McKay Creek; Dartmouth; Somerton; Eildon; West Kiewa	477	AGL Energy
Alcoa	Anglesea	154	Alcoa
Energy Brix Australia	Energy Brix Complex	139	Energy Brix Australia
Babcock & Brown Power	Bairnsdale	70	Babcock & Brown Power
Eraring Energy	Hume Vic	58	NSW Government
Various	Embedded and non-grid	511	Various
SOUTH AUSTRALIA			
AGL	Torrrens Island	1260	AGL Energy
Flinders Power	Northern; Playford B; Lake Bonney	907	Babcock & Brown Power
Pelican Point Power	Pelican Point	450	International Power
Synergen	Dry Creek; Mintaro; Snuggery; Port Lincoln	269	International Power
ATCO Power	Osborne	175	ATCO (50%); Origin Energy (50%) (all contracted to Babcock & Brown Power)
TRUenergy	Hallett	151	TRUenergy (CLP Group)
Origin Energy	Quarantine; Ladbroke Grove	146	Origin Energy
AGL Hydro Partnership	Hallett	95	AGL Energy
Infratil Energy Australia	Angaston	49	Infratil
Various	Embedded and non-grid	454	Various

GENERATION BUSINESS	POWER STATIONS	CAPACITY (MW) ¹	OWNER
QUEENSLAND			
CS Energy	Callide B; Kogan Creek; Swanbank B; Swanbank E	2254	Queensland Government
Transfield	Gladstone	1680	Rio Tinto (42.1%), Transfield Services (37.5%); others 20.4%) [all contracted to Stanwell Corporation]
Stanwell Corporation	Stanwell; Kareeya; Barron Gorge; Mackay	1580	Queensland Government
Tarong Energy	Tarong; Wivenhoe	1550	Queensland Government
Callide Power Management	Callide C	900	CS Energy (50%); InterGen (50%)
Millmerran Power Management	Millmerran	860	InterGen (50%); China Huaneng Group (50%)
Braemar Power Projects Pty Limited	Braemar 1	450	Babcock & Brown Power
Tarong Energy	Tarong North	443	Queensland Government (50%); TEPCO (25%); Mitsui (25%)
Origin Energy	Mt Stuart; Roma	314	Origin Energy
Oakey Power Holdings	Oakey	276	Babcock & Brown Power (50%); ERM Group (25%); Contact Energy (25%) [all contracted to AGL Energy]
Transfield	Yabulu	232	Transfield Services Infrastructure Fund [all contracted to AGL Energy and Arrow Energy]
Transfield	Collinsville	187	Transfield Services Infrastructure Fund [all contracted to CS Energy]
Ergon Energy	Barcaldine	49	Queensland Government
Various	Embedded and non grid	1055	Various
TASMANIA			
Hydro Tasmania	Gordon; Poatina; Reece; John Butters; Tungatinah; other	2172	Tasmanian Government
Bell Bay Power (Hydro Tasmania)	Bell Bay	240	Tasmanian Government
Babcock & Brown Power	Bell Bay 3	108	Babcock & Brown Power
Various	Embedded and non-grid	42	Various
NON-NEM REGIONS			
WESTERN AUSTRALIA²			
Verve	Maju; Kwinana WPC; Pinjar; Collie; Cockburn; other	3475	Western Australian Government
Various	Independent and remote	2642	Various
NORTHERN TERRITORY²			
Power and Water Corporation	Channel Island; Ron Goodin; Berrimah; Pine Creek; Katherine; other	475	Northern Territory Government
Various	Embedded and non-grid	174	Various

GEAC, Great Energy Alliance Corporation; NEM, National Energy Market.

Fuel types: coal; gas; hydro; wind; diesel/fuel oil/multi-fuel; unspecified

Notes:

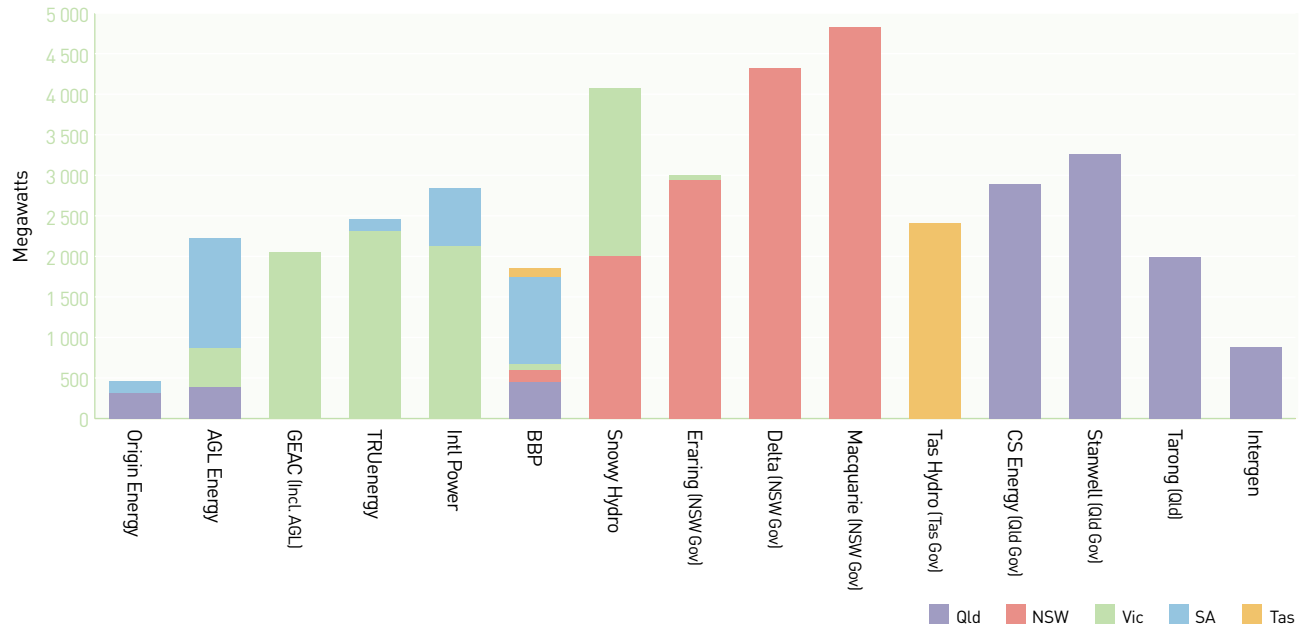
1. Capacity is total capacity for embedded, non-grid, Western Australian and Northern Territory generators; and summer capacity for other generators. An embedded generator is one that directly connects to a distribution network and does not have access to a transmission network.

2. Summary data only for Western Australia and Northern Territory. For more detailed information see chapter 7 of this report.

Data sources: NEMMCO; ESAA, *Electricity gas Australia*, 2008; other public sources.

Figure 1.8

Ownership of major power stations in the National Electricity Market—major stakeholders, 2008



BBP, Babcock & Brown Power; GEAC, Greater Energy Alliance Corporation

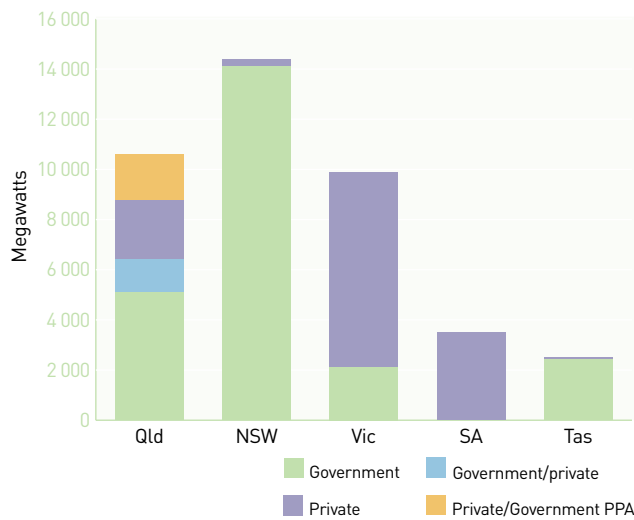
Notes:

1. Excludes power stations that are not managed through central dispatch.
2. AGL ownership excludes its 32.5 per cent stake in GEAC, which owns Loy Yang A.
3. Ecogen Energy capacity is included for TRUenergy, which has a power purchase agreement for that capacity.
4. Does not adjust ownership shares for power purchase agreements held over the capacity of some power stations.
5. Some corporate names have been shortened or abbreviated.

Source: NEMMCO/AER.

Figure 1.9

Private and public sector generation ownership by region, 2008



Notes:

1. Excludes power stations that are not managed through central dispatch.
2. Private/government PPA refers to capacity that is privately owned but contracted under power purchase agreements to government-owned corporations. PPAs are held by government-owned corporations over the Gladstone and Collinsville generators.
3. Government/private refers to joint venture arrangements between the private and government sectors. Tarong North and Callide C generators in Queensland are government/private joint ventures.
4. New South Wales and Victoria include Snowy Hydro capacity allocated to those regions.

Source: NEMMCO/AER.

In Queensland, the state-owned Tarong Energy, Stanwell Corporation and CS Energy own around 46 per cent of generation capacity.⁶ There has been considerable private investment in new capacity, including through joint ventures with state government entities—for example at Callide C and Tarong North. RioTinto, InterGen, Transfield Services Infrastructure Trust, Origin Energy and Babcock & Brown Power are among the private sector participants. Much of the privately owned capacity is contracted under power purchase agreements to state-owned wholesale energy providers.

The state-owned Hydro Tasmania owns virtually all generation capacity in Tasmania.

1.3 Investment

Investment in generation capacity is needed to meet the future growth in demand for electricity and to maintain the reliability of the power system. Investment includes the construction of new power stations and upgrades or extensions of existing power stations.

Some electricity markets (including Western Australia and most markets in the United States) use a capacity mechanism to encourage new investment in generation capacity. This may take the form of a tendering process in which capacity targets are determined by market operators and then built by the successful tenderers. Chapter 7 describes the Western Australian capacity market. By contrast, the NEM is an ‘energy only’ market in which investment is largely driven by price signals in the wholesale and forward markets for electricity (see section 1.4).

From the inception of the NEM in 1999 to July 2008, new investment added almost 6100 megawatts (MW) of generation capacity.⁷ Figure 1.10 illustrates investment in generation capacity (excluding wind generation) since the market started, while figure 1.11 illustrates annual investment in wind capacity. Figure 1.12 illustrates cumulative investment since 1999, including wind capacity.

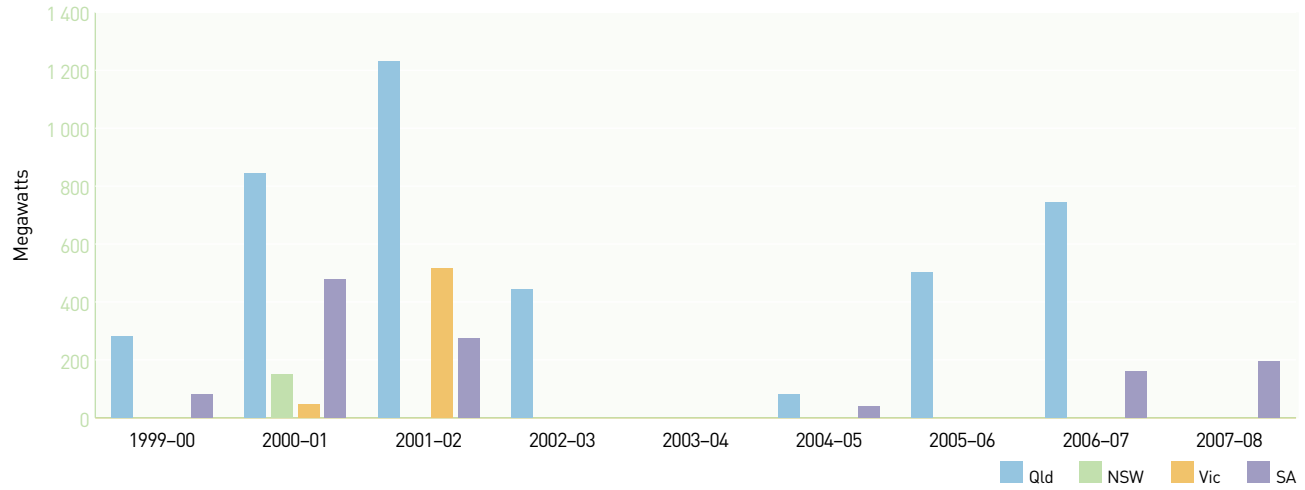
The investment profile has differed between regions. The strongest cumulative growth has been in Queensland and South Australia, with investment in both regions responding to high spot prices in the late 1990s. Queensland investment was mainly in baseload generation, whereas South Australian investment was mostly in intermediate and peaking generation. Investment in both regions has again accelerated since 2006.

There has been less investment in New South Wales and Victoria, but tight market conditions have recently led to the announcement of new generation projects in both regions. The bulk of new investment in Victoria has been in peaking capacity to meet summer demand peaks.

6 This does not include joint ventures, such as Callide C and Tarong North, or government power purchase agreements for the capacity of privately owned generators (for example, Gladstone and Collinsville).

7 Includes only power stations that are managed by NEMMCO through central dispatch. There has also been investment in generators that bypass the central dispatch process—for example, small generators, wind generators, remote generators not connected to a transmission network, and generators that produce exclusively for self-use (such as for remote mining operations).

Figure 1.10
Annual investment in new generation capacity (excluding wind)

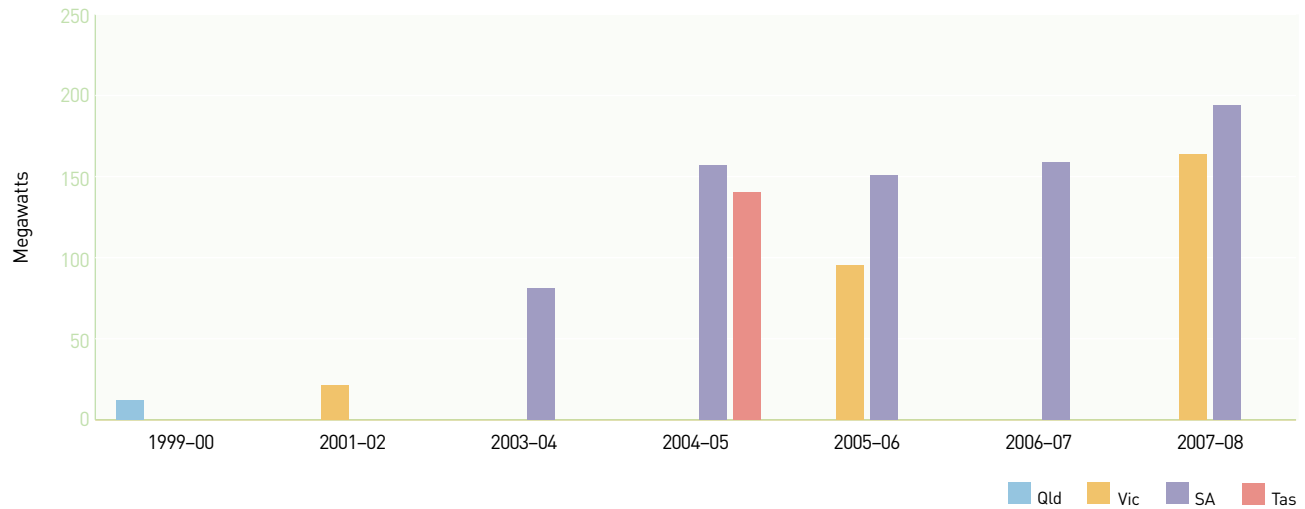


Notes:

1. These are gross investment estimates that do not account for decommissioned plant.
2. Excludes wind generation and power stations not managed through central dispatch.

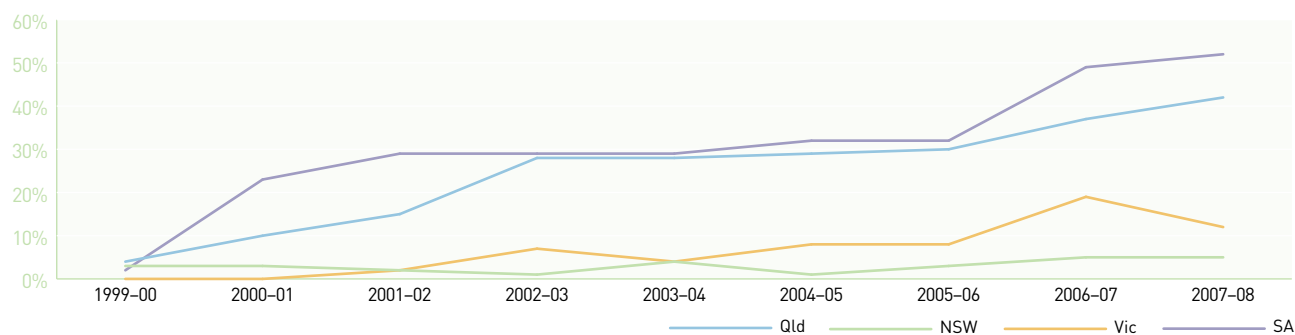
Source: NEMMCO/AER.

Figure 1.11
Annual investment in new wind generation capacity



Source: NEMMCO/AER.

Figure 1.12
Cumulative growth in net generation capacity since 1999–2000 (includes scheduled wind capacity)



Note: Growth is measured from market start in 1998–99. A decrease may reflect a reduction of capacity due to decommissioning or a change in the ratings of generation units.

Source: NEMMCO/AER.

Table 1.2 Generation investment in the National Electricity Market, January 2007–June 2008

REGION	POWER STATION	DATE COMMISSIONED	TECHNOLOGY	CAPACITY (MW)	ESTIMATED COST (\$ MILLION)	OWNER
Qld	Daandine	Feb 2007	Biomass	33	29	APA Group
Qld	Oaky Creek	Feb 2007	Biomass	15	18	Envirogen
Qld	Kogan Creek	Apr 2007	Coal	750	1200	CS Energy
NSW	Condong	Dec 2007	CCGT	30	n/a	Delta Electricity
NSW	Eraring	Jan 2008	Gas	42	n/a	Eraring
NSW	Broadwater	Feb 2008	Biomass	30	n/a	NSW Sugar Milling Cooperative
NSW	Hunter Economic Zone	Apr 2008	Diesel	29	n/a	Infratil Energy

CCGT, combined cycle gas turbine; n/a, not available.

Note: Excludes wind generation.

Sources: NEMMCO, *Statement of opportunities for the National Electricity Market*, 2007; EnergyQuest, *Energy Quarterly*, August 2008.

1.3.1 Recent and committed investment

Investment in generation capacity needs to respond dynamically to projected market requirements for electricity. Table 1.2 sets out major new generation investment that has come on line since 1 January 2007. New investment in the Kogan Creek power station (750 MW) continues a trend of strong investment growth in the Queensland generation sector. In addition, investors have recently committed to a number of generation projects and have proposed several others (tables 1.3 and 1.4). The majority of committed and

proposed projects involve gas-fired generation, reflecting the industry’s expectations in respect of government climate change policies.

Committed investment projects include those already under construction and those where developers and financiers have formally committed to construction. NEMMCO takes account of committed projects in making future projections of electricity supply and demand.

Table 1.3 Major committed generation investment in the National Electricity Market, 2008

DEVELOPER	POWER STATION	TECHNOLOGY	CAPACITY (MW)	PLANNED COMMISSIONING DATE
NEW SOUTH WALES				
Delta Electricity	Colongra	OCGT	668	2009–10
Origin Energy	Uranquinty	OCGT	640	2008–09
TRUenergy	Tallawarra	CCGT	400	2008
QUEENSLAND				
Origin Energy	Darling Downs	CCGT	630	2010
ERM Power/Arrow Energy	Braemar 2	OCGT	474	2009
Rio Tinto	Yarwun Alumina Refinery	Gas	145	2010–11
Queensland Gas Company	Condamine	CCGT	135	2009
VICTORIA				
Origin Energy	Mortlake	OCGT	550	2010–11
AGL Energy	Bogong	Hydro	140	2009
SOUTH AUSTRALIA				
Origin Energy	Quarantine	OCGT	120	2008–09
TASMANIA				
Tasmanian Government	Tamar Valley	CCGT	191	2009

CCGT, combined cycle gas turbine; OCGT, open cycle gas turbine.

Note: Excludes wind generation.

Sources: NEMMCO, *Statement of opportunities for the National Electricity Market*, 2007; EnergyQuest, *Energy Quarterly*, August 2008; company websites.

At June 2008, developers had committed to around 3900 MW of new capacity (table 1.3), of which around 45 per cent was in New South Wales. The Tallawarra and Uranquinty gas-fired power stations are major private investments in the New South Wales generation sector. TRUenergy's 400 MW Tallawarra plant is expected to become operational by summer 2008–09. Origin Energy's Uranquinty plant is expected to be able to provide 471 MW by summer 2008–09 and be fully operational (640 MW) by mid 2009.

Origin Energy has also committed to new generation capacity in other regions, including a 550 MW gas-fired power station near Mortlake in Victoria (scheduled for the summer of 2010–11) and a 630 MW gas-fired power station in the Darling Downs region of Queensland (scheduled to commence operation in early 2010). Also in Queensland, ERM Power and Arrow Energy reached financial closure in 2008 on the 474 MW Braemar 2 power station (to start in the first half of 2009).

1.3.2 Proposed projects

Proposed projects include generation capacity that is either in the early stages of development or at more advanced stages, which might include a proposed commissioning date. Such projects are not fully committed, and may be shelved in the event of a change in circumstances such as a change in demand projections or business conditions.

NEMMCO's annual Statement of Opportunities (SOO) for the NEM refers to proposed projects that are 'advanced' or publicly announced. NEMMCO does not include these projects in its supply and demand outlooks as it considers them to be too speculative. In total, the 2007 SOO referred to around 9460 MW of proposed capacity (excluding wind) in the NEM. The bulk is for New South Wales and Queensland. The significant amount of proposed capacity for New South Wales may reflect that the region is currently the highest net importer in the NEM.

Table 1.4 Major proposed generation investment in the National Electricity Market, 2008¹

DEVELOPER	POWER STATION	TECHNOLOGY	CAPACITY (MW)	PLANNED COMMISSIONING DATE
NEW SOUTH WALES				
Wambo Power Ventures	Wellington	OCGT	628	2009–10
Macquarie Generation	Tomago	OCGT	500	n/a
Eraring Energy	Eraring upgrade	Coal	360	2009
AGL Energy	Leaf's Gully	OCGT	350	2011
Delta Electricity	Marulan	OCGT	300	2011–12
Delta Electricity	Bamarang	OCGT	300	2011–12
Delta Electricity	Mt Piper expansion	Coal	180	n/a
Wambo Power Ventures	Bega	CCGT	114	2009–10
Delta Electricity	Bamarang II	CCGT	100	2011–12
Metgasco	Richmond Valley	OCGT	30	2009
QUEENSLAND				
Origin Energy	Spring Gully	CCGT	1000	2009
CS Energy	Swanbank F	CCGT	400	2012
AGL Energy	SE Qld 1 (Ipswich)	OCGT	350	2011
AGL Energy	Townsville	OCGT	350	2012
ERM Power	Braemar 2	OCGT	290	2010–11
AGL Energy	SE Qld 2 (Kogan)	OCGT	250	2012
CS Energy/AGL	Mica Creek upgrade	CCGT	70	2010
VICTORIA				
Origin Energy	Mortlake Stage 2	CCGT	450	n/a
Snowy Hydro	Laverton North conversion	CCGT	440	2012
HRL/Harbin Power	Latrobe Valley	IDGCC	400	2011–12
Snowy Hydro	Valley Power upgrade	OCGT	100	2010
Loy Yang Power	Unit 4 upgrade	Coal	25	2008
Loy Yang Power	Unit 2 upgrade	Coal	25	2009
TASMANIA				
Gunns Ltd	Bell Bay Pulp Mill	Biomass	188	2009–10

CCGT, combined cycle gas turbine; IDGCC, integrated drying and gasification combined cycle; OCGT, open cycle gas turbine; n/a, not available.

Notes:

1. Excludes wind generation.

Sources: NEMMCO, *Statement of opportunities for the National Electricity Market, 2007*, *EnergyQuest*, August 2008; various company websites.

1.3.4 Wind projects

Wind generation is reported separately in the SOO as non-scheduled generation because the capacity is dependent on the weather and cannot be relied on to generate at specified times.⁸ Wind projects can, however, play an important role in providing electricity for future demand growth. The 2007 SOO listed about 5840 MW of committed or proposed wind capacity, predominantly in South Australia, Victoria and New South Wales.

1.4 Reliability of the generation sector

Reliability refers to the continuity of electricity supply to customers. Various factors—planned and unplanned—can lead to plant outages that interrupt power supplies. These may occur in generation or in the networks that deliver power to customers. A planned outage may occur for maintenance or construction works, and can be timed for minimal impact. Unplanned outages occur when equipment failure causes the supply of electricity to be disconnected.

The AEMC Reliability Panel reports annually on the reliability of the generation sector. The panel has set a reliability standard that requires sufficient generation and bulk transmission capacity to ensure that, in the long term, no more than 0.002 per cent of customer demand in each region of the NEM is at risk of being unserved. To ensure the standard is met, NEMMCO determines the necessary spare capacity for each region that must be available (either within the region or via transmission interconnectors). These minimum reserves provide a buffer against unexpected demand spikes and generation failure. The Reliability Panel also recommends a wholesale market price cap, which is aimed at a level to stimulate sufficient investment in generation capacity to meet the reliability standard. The panel recently completed a comprehensive review of reliability settings in the NEM and recommended a number of refinements (see box 1.1).

The AEMC Reliability Panel reports performance against the reliability standards and the minimum reserve levels set by NEMMCO. In practice, generation has proved highly reliable. Reserve levels are rarely breached and generator capacity across all regions of the market is generally sufficient to meet peak demand and allow for an acceptable reserve margin. The performance of generators in maintaining reserve levels has improved since the NEM began in 1998, most notably in South Australia and Victoria. This reflects significant generation investment and improved transmission interconnection capacity between the regions.

There were only two instances of insufficient generation capacity to meet consumer demand from the commencement of the NEM to 30 June 2007. The first occurred in Victoria in early 2000, when a coincidence of industrial action, high demand and temporary loss of generating units resulted in load shedding. The second occurred in New South Wales on 1 December 2004, when a generator failed during a period of record summer demand. The restoration of load began within ten minutes. NEMMCO has published three drought reports to assess the impact of drought on reliability. For the 2006–07 period, it found there was no unserved energy due to drought.

Table 1.5 sets out the performance of the generation sector in selected states against the reliability standard. All states now operate within the standard.

Table 1.5 Unserved energy, long-term averages to 30 June 2007

STATE	UNSERVED ENERGY
New South Wales	0.00%
Victoria	0.01%
Queensland	0.00%
South Australia	0.00%

Note: Long-term average since December 1998.

Sources: AEMC Reliability Panel, *Annual Electricity Market Performance Review: Reliability and Security 2007* (and previous years).

⁸ The AEMC published a final Rule determination on 1 May 2008 that requires new intermittent generators to register under the new classification of Semi-Scheduled Generator. These generators will be required to participate in the central dispatch process. Additionally, the South Australian regulator, ESCOSA, implemented licence conditions preventing wind farms from being classified as non-scheduled. Accordingly, all wind farms commissioned in South Australia since that date are currently classified as scheduled generation. Some pre-existing South Australian wind farms also have changed classification from non-scheduled to scheduled.

1.4.1 Excluded data

The power system is operated to cope with credible (foreseeable) supply interruptions. These events can be avoided through investment in generation capacity. But some power supply interruptions are caused by events that are ‘non-credible’. Typically, such events occur simultaneously or in a chain reaction. For example, several generating units might fail or ‘trip’ at the same time, or a transmission fault might occur at the same time as a generator trips. It would not be economically efficient to operate the power system to cope with non-credible events (also called multiple contingency events). For this reason, non-credible events are excluded from reliability statistics.

Multiple contingency events caused a significant amount of unserved energy in 2006–07, including outages caused by bushfires in Victoria on 16 January 2007 and lightning storms in Tasmania on 22 February 2007. The bushfires in northern Victoria resulted in two transmission lines tripping, and the power system subsequently separating into three electrical islands. A major imbalance followed which resulted in 2490 MW of lost load. The lightning storms in Tasmania caused two 220 kV lines to trip, resulting in the power system on the west coast being islanded (disconnected from the rest of the state). A number of generating units then tripped, and the west coast transmission system eventually collapsed. The Victorian and Tasmanian incidents led to losses of consumer load but did not result in a breach of the reliability standard. The Reliability Panel noted that events such as these can seriously affect continuity of supply and that, from a consumer perspective, the effects are indistinguishable from that of reported reliability events.

1.4.2 Investment in generation and long-term reliability

The NEM combines a number of mechanisms to ensure high levels of reliability in the generation sector. In the short term, NEMMCO can manage shortfalls in reserves by directing peak generators to come on line, or by contracting for reserve capacity (which occurred for

Victoria and South Australia in February 2006). In the longer term, a reliable power supply needs sufficient investment in generation to meet the needs of customers.

Price signals

A central element in the design of the NEM is that spot prices respond to a tightening in the supply–demand balance. Wholesale prices and projections in the supply–demand balance are also factored into forward prices in the contract market (see chapter 3). Regions with potential generation shortages (which could lead to reliability issues) will therefore exhibit rising prices in the spot and contract markets. High prices may help to attract investment to the areas where it is needed, and may lead to some demand–side response if suitable metering and price signals are available to end users. For example, retailers might offer a customer financial incentives to reduce consumption at times of high system demand to ease pressure on prices.

Seasonal factors (for example, summer peaks in air conditioning loads) create a need for peaking generation to cope with periods of extreme demand. The NEM price cap of \$10 000 per MWh is necessarily high to encourage investment in peaking plant, which is expensive to run. Over the longer term, peaking plants play a critical role in ensuring there is adequate generation capacity (and therefore reliability) in the NEM. Victoria and South Australia have invested in significant peaking generation capacity, and investors have committed to new peaking plant in Queensland and New South Wales (see figure 1.6 and table 1.3).

Historical adequacy of generation to meet demand

Figure 1.13 compares total generation capacity with national peak demand since the NEM began. The chart shows actual demand and the demand forecasts published by NEMMCO two years in advance. The data indicates that the NEM has seen sufficient investment in new capacity over the past decade to keep pace with rising demand (both actual and forecast levels), and to provide a safety margin of capacity to maintain the reliability of the power system.



Box 1.1 Comprehensive reliability review

The AEMC Reliability Panel conducted a comprehensive review of the NEM reliability settings in 2007. It was the first review of its kind since the inception of the NEM. The panel reviewed the following reliability standards and parameters:

- *The NEM reliability standard*—currently set at 0.002 per cent.
- *Administered price mechanisms*—which aim to ensure the reliability standard is met, while avoiding unmanageable risks for market participants. These mechanisms are the market price cap (known as the value of lost load or VoLL), the market floor price, and a cap on financial exposure (the cumulative price threshold or CPT).
- *Intervention mechanisms*—which come into effect if price mechanisms fail. NEMMCO operates a reserve trader mechanism which allows it to enter into reserve contracts with generators to ensure that supply meets the reliability standard. When entering into such contracts, NEMMCO must give priority to facilities which would result in the least possible distortion to spot prices. NEMMCO can also intervene in the market by requiring generators to provide additional supply at the time of dispatch to ensure that minimum reserve levels are met.

The Reliability Panel found that the reliability standard has worked satisfactorily to date. Nevertheless, it noted that stakeholders had perceived future risks that may delay investment and impact on reliability over time. The risks identified by stakeholders included uncertainty in relation to greenhouse gas emission policies, government ownership of generation assets, the risk of investment by government-owned businesses being driven by non-commercial considerations, and inadequate long-term contracting.

The review considered a number of adjustments to the current reliability settings to maintain confidence in the NEM's ability to deliver long-term reliability. Specifically, the review considered:

- clarifying the reliability standard
- adjusting administered price mechanisms such as VoLL
- improving the reserve trader mechanism
- increasing the range and quality of information on reliability matters to assist the market in addressing potential energy constraints.

In terms of the reliability standard, the panel concluded that the existing standard of 0.002 per cent unserved energy is satisfactory. However, the panel considered that the measurement should more clearly specify its purpose. In this regard, a new version of the formal reliability standard will be published.

In relation to administered pricing, the Reliability Panel recommended raising VoLL in the medium term, and proposed to make a Rule change proposal to the AEMC to raise VoLL to \$12500 per MWh from 1 July 2010. The CPT would be similarly raised to \$187500 by specifying its value as fifteen times the value of VoLL.

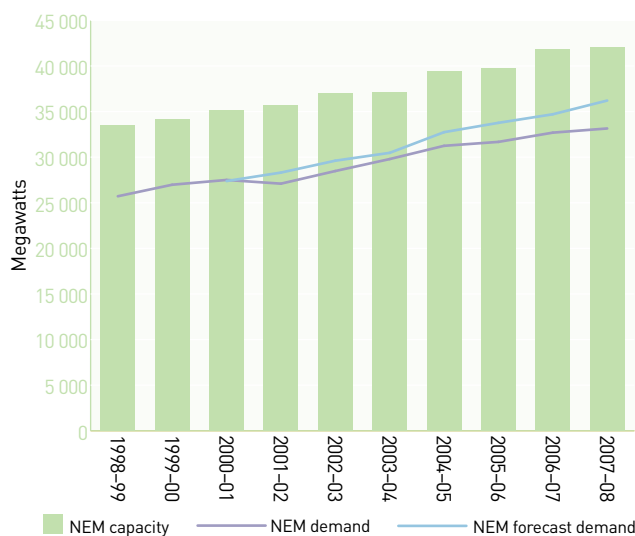
The Reliability Panel also recommended a review of the VoLL price in the context of the reliability settings every two years, with at least a two-year notification period for any proposed change. It recommended that, for the VoLL to reflect its true nature as a market price cap, it should be renamed the market price limit. The market floor price should remain unchanged at -\$1000 per MWh.

The Reliability Panel suggested that the current reserve trader mechanism be changed to a Reliability and Emergency Reserve Trader mechanism, whose operation should be reviewed as part of the regular review of reliability settings.

In terms of increasing the range and quality of information, the panel recommended a new Energy Adequacy Assessment Projection to provide information on projected response times to address energy constraints in the market that may affect reliability. The panel also recommended that, where possible, long-term contract prices such as those traded on the Sydney Futures Exchange should be published alongside spot prices to provide more balanced information about the financial exposure of market participants in extreme conditions. It considered that improved transparency would make the market more responsive to the reliability settings, particularly price mechanisms.

Further information: AEMC Reliability Panel, *Comprehensive Reliability Review, Final Report*, December 2007.

Figure 1.13
National Electricity Market peak demand and generation capacity



Notes:

1. Demand forecasts are taken two years in advance, based on a 50 per cent probability that the forecast will be exceeded (due, for example, to weather conditions) and a coincidence factor of 95 per cent.
2. NEM capacity excludes wind and power stations not managed through central dispatch.

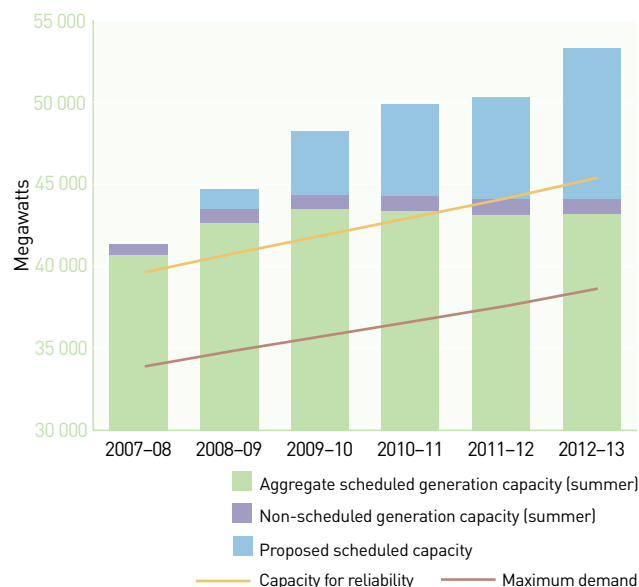
Sources: NEMMCO, *Statement of opportunities for the National Electricity Market*, various years.

Reliability outlook

The relationship between future demand and capacity determines both electricity prices and the reliability of the power system looking forward. Figure 1.14 charts forecast peak demand in the NEM against installed, committed and proposed capacity. The chart indicates the amount of capacity that NEMMCO considers would be needed to maintain reliability, given the projected rise in demand. While wind generation is not classified as installed capacity, it is included as a possible source of electricity.

Figure 1.14 indicates that current installed and committed capacity will be sufficient to meet NEMMCO's peak demand projections and reliability requirements until at least 2010-11, with a safety margin provided by wind generation.

Figure 1.14
Demand and capacity outlook to 2012-13



Notes:

1. The maximum demand forecasts for each region in the NEM are aggregated based on a 50 per cent probability of exceedence and a 95 per cent coincidence factor.
2. Reserve levels required for reliability are based on an aggregation of minimum reserve levels for each region. Accordingly, the data cannot be taken to indicate the required timing of new generation capacity within individual NEM regions.

Data source: NEMMCO, *Statement of opportunities for the National Electricity Market*, 2007.

While the uncertain nature of proposed projects means they cannot be factored into NEMMCO's reliability equations, they do provide an indicator of the market's awareness of future capacity needs. In particular, they can be seen as an indicator of the extent of competition in the market to develop electricity infrastructure. Figure 1.14 indicates the extent of proposed capacity that may need to be constructed to meet projected shortfalls beyond 2011-12. While many proposed projects may never be constructed, only a relatively small percentage would need to come to fruition to meet demand and reliability requirements into the next decade.