2 ELECTRICITY WHOLESALE MARKET


Power Station control panel. Mark Wilson

Generators in the National Electricity Market sell electricity to retailers through wholesale market arrangements in which the dynamics of supply and demand determine prices and investment. The Australian Energy Regulator monitors the market to ensure that participants comply with the National Electricity Law and National Electricity Rules.

2 ELECTRICITY WHOLESALE MARKET

This chapter considers:

- features of the National Electricity Market
- how the wholesale market operates
- the demand for electricity by region, and electricity trade between regions
- spot prices for electricity in the National Electricity Market, including price volatility, and international price comparisons

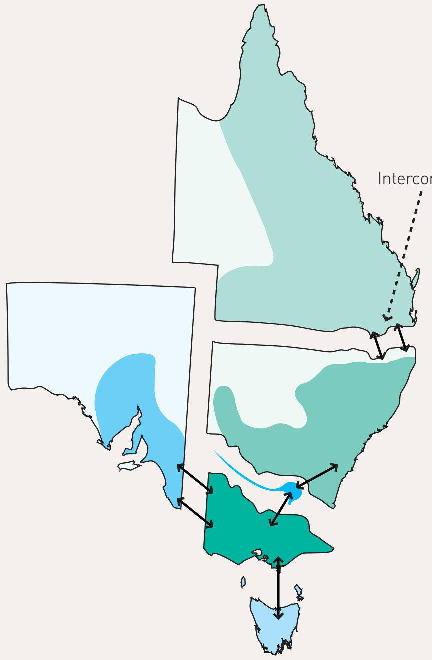
2.1 Features of the National Electricity Market

The National Electricity Market (NEM) is a wholesale market through which generators and retailers trade electricity in eastern and southern Australia. There are six participating jurisdictions—Queensland, New South Wales, the Australian Capital Territory, Victoria, South Australia and Tasmania, which are physically linked by transmission network interconnectors.

The NEM has around 260 registered generators, six state-based transmission networks (linked by cross-border interconnectors) and 13 major distribution networks that collectively supply electricity to end-use customers. In geographical span, the NEM is the largest interconnected power system in the world. It covers a distance of 4500 km, from Cairns in North Queensland to Port Lincoln in South Australia and Hobart in Tasmania. The market has six regions (figure 2.1). The Queensland, Victoria, South Australia and Tasmania regions follow state boundaries. The other regions are New South Wales and Snowy, which is located in southern New South Wales. Snowy is a major generation centre that has negligible local demand.[1]

1 The Australian Energy Market Commission released a draft determination in January 2007 proposing to abolish the Snowy region. This would involve an expansion of the New South Wales and Victorian regions.

Figure 2.1
Regions of the National Electricity Market



The shaded area represents the approximate geographical range of the interconnected network in each NEM region.

Vic | NSW | Qld | SA | Tas | Snowy

Box 2.1 Development of the National Electricity Market

Historically, governments owned and operated the electricity supply chain from generation through to retailing. There was no wholesale market because generation and retail were operated by vertically integrated state-based utilities. Typically, each jurisdiction generated its own electricity needs, with limited interstate trade.

Australian governments began to reform the electricity industry in the 1990s. The vertically integrated utilities were separated into generation, transmission, distribution and retail businesses. For the first time, generation and retail activities were exposed to competition. This created an opportunity to develop a wholesale market that extended beyond jurisdictional borders.

The Special Premiers' Conference in 1991 agreed to establish the National Grid Management Council to coordinate the development of the electricity industry in eastern and southern Australia. In early 1994 the Council of Australian Governments (COAG) developed a code of conduct for the operation of a national grid, consisting of the transmission and distribution systems in Queensland, New South Wales, the Australian Capital Territory, Victoria and South Australia. In 1996, these jurisdictions agreed to pass the National Electricity Law, which provided the legal basis to create the National Electricity Market.

During the transition to a national market, Victoria and New South Wales trialled wholesale electricity markets that used supply and demand principles to set prices. The National Electricity Market commenced operation in December 1998, with Queensland, New South Wales, Victoria, South Australia and the Australian Capital Territory as participating jurisdictions. While Queensland was part of the NEM from inception, it was not physically interconnected with the market until 2000–01 when two transmission lines (Directlink and the Queensland to New South Wales interconnector (QNI)) linked the Queensland and New South Wales networks. Tasmania joined the NEM in 2005 and was physically interconnected with the market in April 2006 with the opening of Basslink, a submarine transmission cable from Tasmania to Victoria.

Mark Wilson

Power station control room

The NEM supplies electricity to over 7.7 million residential and business customers. In 2006–07, the market generated around 206 terawatt hours[2] of electricity with a turnover of almost $13 billion (table 2.1).

Table 2.1 NEM at a glance

Participating jurisdictions	NSW, Qld, Vic, SA, ACT, Tas
NEM regions	NSW, Qld, Vic, SA, Snowy, Tas
Registered capacity	43 130 MW
Number of registered generators	263
Number of customers	7.7 million
NEM turnover 2006–07	$13 billion
Total energy generated 2006–07	206 TWh
National max winter demand 2006–07 (21 June 2007)	32 688 MW
National max summer demand 2006–07 (5 February 2007)	31 796 MW

2.2 How the National Electricity Market works

The NEM is a wholesale pool into which generators sell their electricity. The main customers are retailers, which buy electricity for resale to business and household customers. While it is also possible for an end-use customer to buy directly from the pool, few choose this option.

The market has no physical location, but is a virtual pool in which supply bids are aggregated and dispatched to meet demand. The Australian Energy Regulator (AER) monitors the market to ensure that participants comply with the National Electricity Law and the National Electricity Rules.

The design of the NEM reflects the physical characteristics of electricity. This means:

> Supply must meet demand at all times because electricity cannot be economically stored. This requires coordination to avoid imbalances that could seriously damage the power system.

> One unit of electricity cannot be distinguished from another, making it impossible to determine which generator produced which unit of electricity and which market customer consumed that unit. The use of a common trading pool addresses this issue by removing any need to trace particular generation to particular customers.

The NEM is a gross pool in which all physical delivery of electricity is managed through the pool. In contrast, a net pool or voluntary pool would allow generators to contract with market customers directly for the delivery of some electricity. Western Australia's electricity market uses a net pool arrangement (see chapter 7).

Unlike some overseas markets, the NEM does not provide additional payments to generators for capacity or availability. This characterises the NEM as an energy-only market and gives reason for a high price cap of $10 000 a MWh. Generators earn their income in the NEM from market transactions (either in the spot or ancillary services[3] markets or by trading hedge instruments in financial markets[4] outside NEM arrangements). In some jurisdictions, generators might earn income outside the wholesale market through emissions trading[5] or for the use of renewable technologies.

Market operation

The National Electricity Market Management Company (NEMMCO) coordinates a central dispatch to manage the wholesale spot market. The process instantaneously matches generator supply offers against demand in real time. NEMMCO issues instructions to each generator to produce the required quantity of electricity that will meet demand at all times at the lowest available cost, while maintaining the technical security of the power system. NEMMCO does not own physical network or generation assets.

2 One terawatt hour (TWh) is equivalent to 1000 gigawatt hours (GWh), 1 000 000 megawatt hours (MWh) and 1 000 000 000 kilowatt hours (KWh). One TWh is enough energy to light 10 billion light bulbs with a rating of 100 watts for one hour.

3 NEMMCO operates a market for a number of ancillary services. These include frequency control services that relate to electricity supply adjustments to maintain the power system frequency within the standard. Generators can bid offers to supply these services into spot markets that operate in a similar way to the wholesale energy market.

4 See chapter 3.

5 For example, the Greenhouse Gas Abatement Scheme in New South Wales and the Australian Capital Territory.

There are some generators in NEM regions that bypass the central dispatch process—for example, they might only generate intermittently (such as wind generators), may not be connected to a transmission network, and/or might produce exclusively for self-use (such as for remote mining operations).

Demand and supply forecasting

NEMMCO continuously monitors demand and capacity across the NEM and issues demand and supply forecasts to help participants respond to the market's requirements. While demand varies, industrial, commercial and household users have relatively predictable patterns, including seasonal demand peaks related to extreme temperatures. NEMMCO uses data such as historical load (demand) patterns and weather forecasts to develop demand forecasts. Similarly, it forecasts the adequacy of supply in its projected assessment of system adequacy (PASA) reports. It publishes a seven-day PASA that is updated every 30 minutes, and a two-year PASA that is updated weekly.

Central dispatch and spot prices

NEMMCO uses a sophisticated IT system to match electricity supply and demand in the most cost-effective manner that meets power system security requirements. Market supply is based on the offers of generators to produce particular quantities of electricity at various prices for each of the 30-minute trading intervals in a day. Generators must lodge offer bids ahead of each trading day. Coal-fired base load generators need to ensure their plants are kept running at all times to cover their high start-up costs, and may offer to generate some electricity at low or negative prices to ensure they are dispatched.[6] Peaking generators, on the other hand, face high operating costs and normally offer to supply electricity only when the price is high.

NEMMCO determines which generators are dispatched to satisfy demand by stacking the offer bids of all generators in ascending price order for each five-minute dispatch period. NEMMCO dispatches the cheapest generator bids first, then progressively more expensive offers until enough electricity is dispatched to satisfy demand. This results in demand being met at the lowest possible cost. In practice, the dispatch order may be modified by a number of factors, including generator ramp rates—that is, how quickly generators can adjust their level of output—and congestion in transmission networks.

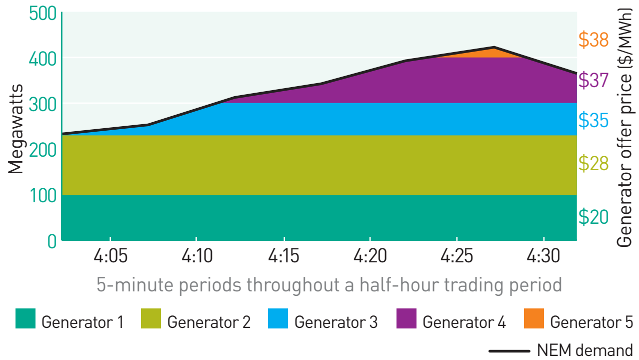
The dispatch price for a five-minute interval is the offer price of the highest (marginal) priced megawatt (MW) of generation that must be dispatched to meet demand. For example, in figure 2.2, the demand for electricity at 4.15 is about 350 MW. To meet this level of demand, the four generators offering to supply at prices up to $37 must be dispatched. The dispatch price is therefore $37. By 4.25, demand has risen to the point where a fifth generator needs to be dispatched. This higher cost generator has an offer price of $38, which drives the price up to that level. The wholesale spot price is the volume weighted average of the six dispatch prices over half an hour, and is the price that effectively brings demand into balance with supply. In figure 2.2, the spot price is about $37 a MWh. This is the price all generators receive for production during this 30-minute period and the price market customers pay for the electricity they use in that period. A separate spot price is determined for each region, taking account of physical losses in the transport of electricity over distances and transmission congestion that can sometimes isolate particular regions from the national market (section 2.4).

The price mechanism in the NEM allows spot prices to respond to a tightening in the supply-demand balance. This creates signals for demand-side responses. For example, customers may be able to adjust their consumption in response to higher prices, provided suitable metering arrangements are available (section 2.6). In the longer term, price movements also create signals for new investment (see sections 1.3, 2.5 and 2.6).

6 The minimum allowed bid price is $–1000 a MWh.

Figure 2.2

Illustrative generator offers (megawatts) at various prices



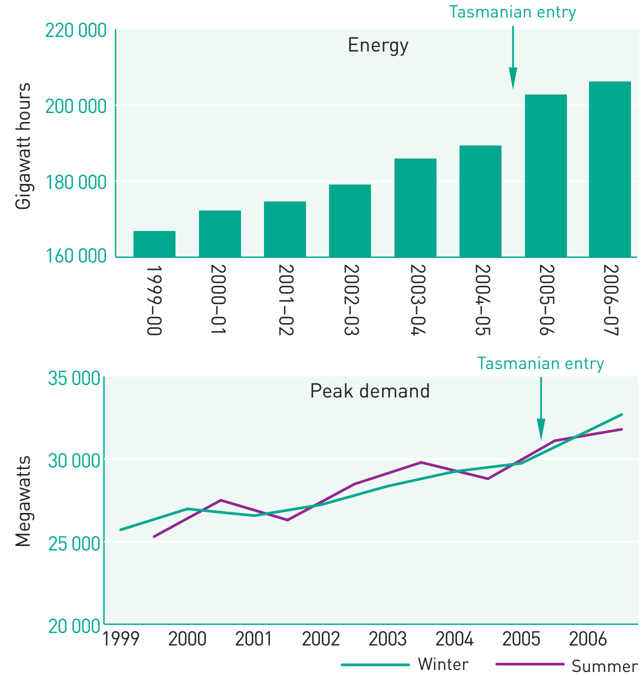
Source: NEMMCO

2.3 National Electricity Market demand and capacity

Annual electricity consumption in the NEM rose from under 170 000 GWh in 1999–2000 to over 205 000 GWh in 2006–07 (figure 2.3a). The entry of Tasmania in 2005 accounted for around 10 000 GWh. Demand levels fluctuate throughout the year, with peaks occurring in summer (for air conditioning) and winter (for heating). The peaks are closely related to temperature. Figure 2.3b shows that seasonal peaks have risen nationally from around 26 000 MW in 1999–2000 to over 31 000 MW in 2006–07. The volatility in the summer peaks reflects variations in weather conditions from year to year.

Figure 2.3a and b

NEM energy consumption and peak demand since 1999



Data source: NEMMCO

Table 2.2 sets out the demand for electricity across the NEM since 1998–99. Reflecting its population base, New South Wales has the highest demand for electricity, followed by Queensland and Victoria. Demand is considerably lower in the less populated regions of South Australia and Tasmania.

Table 2.2 Annual energy demand (terawatt hours)

	QLD	NSW	SNOWY	VIC	SA	TAS	NATIONAL
2006–07	51.4	78.6	1.3	51.5	13.4	10.2	206.4
2005–06	51.3	77.3	0.5	50.8	12.9	10	202.8
2004–05	50.3	74.8	0.6	49.8	12.9	na	189.7
2003–04	48.9	74.0	0.7	49.4	13.0	na	185.3
2002–03	46.3	71.6	0.2	48.2	13.0	na	179.3
2001–02	45.2	70.2	0.3	46.8	12.5	na	175.0
2000–01	43.0	69.4	0.3	46.9	13.0	na	172.5
1999–00	41.0	67.6	0.2	45.8	12.4	na	167.1

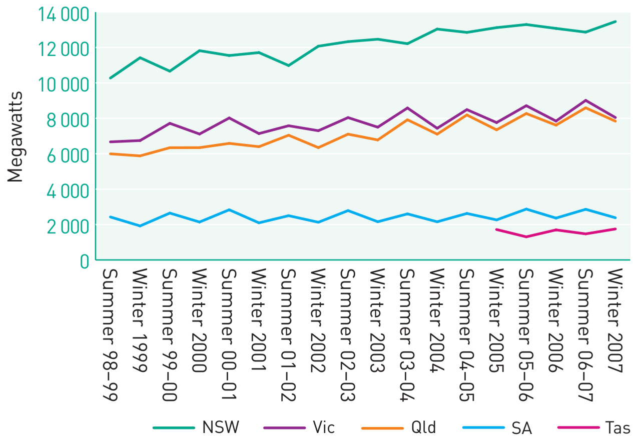
na not applicable.

Note: Tasmania entered the market on 29 May 2005.

Data source: NEMMCO

Figure 2.4

Seasonal peak demand in the NEM



Data source: NEMMCO

Figure 2.4 compares seasonal demand across the regions. Victoria, South Australia and Queensland experience high demand in summer due to air conditioning loads. Tasmania tends to experience its maximum demand in winter due to heating loads. New South Wales was traditionally winter peaking, but since the summer of 2002–03 has been alternately summer and winter peaking.

2.4 Trade between the regions

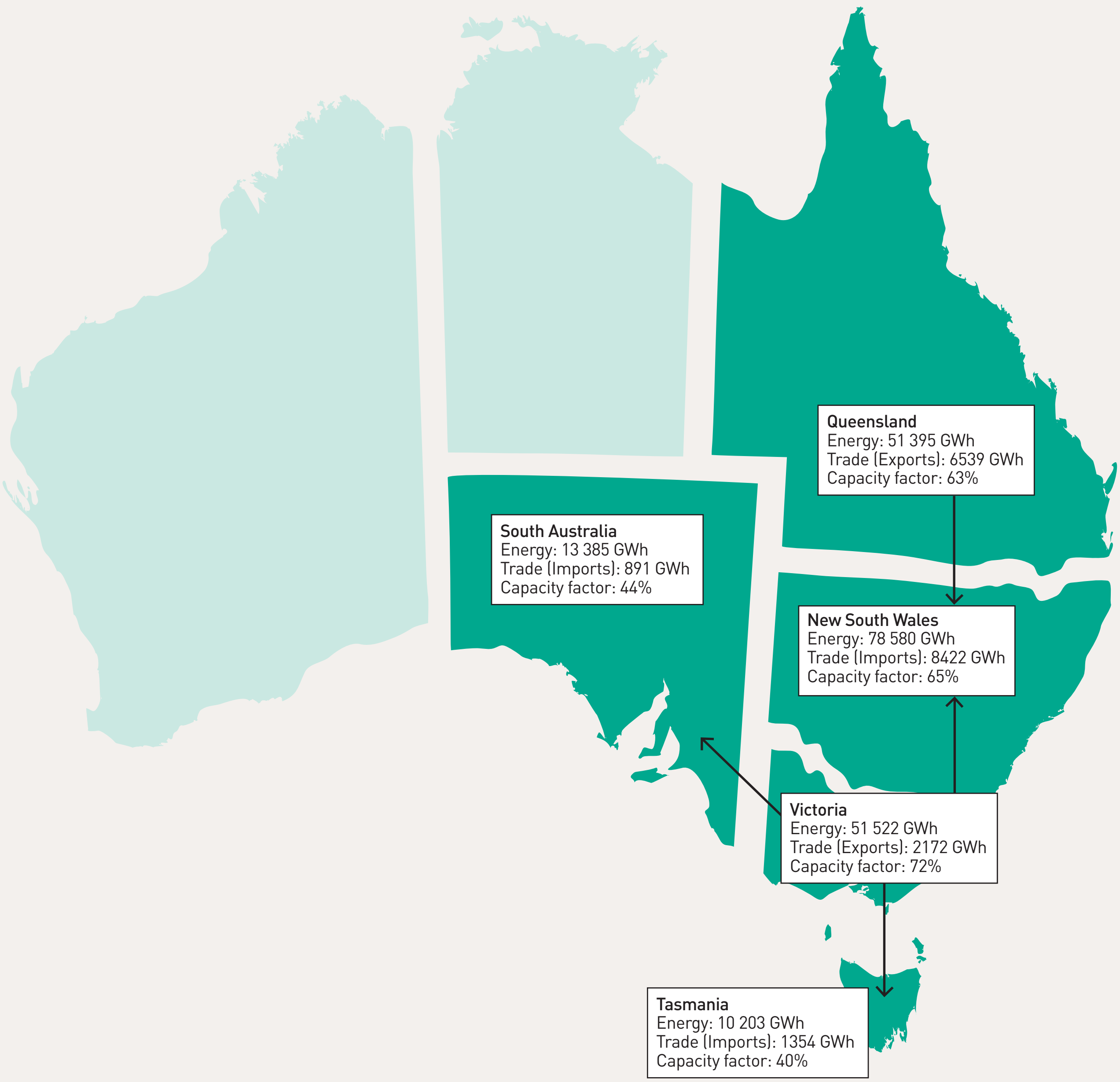
The NEM promotes efficient generator use by allowing trade in electricity between the regions. The six regions of the NEM are linked by transmission interconnectors that make trade possible. This enhances the reliability of the power system by allowing the regions to pool their reserves to manage the risk of a system failure. Trade also provides economic benefits by allowing high-cost generating regions to import from lower cost regions. For example, importing electricity from another region's base load generators may be cheaper than using local peaking generation.

Imports are especially attractive when peak demand forces up local prices. For example, a day of hot weather in South Australia might drive up electricity demand to the point where high-cost local generators are needed to satisfy demand. This can make lower cost interstate generation a competitive alternative. NEMMCO can dispatch electricity from lower cost regions and export it to South Australia (up to the technical capacity of the interconnectors).

Figure 2.5 shows annual energy (consumption) and trade between the regions in 2006–07. The figure also shows each region's generation capacity factor (the rate at which local generation capacity is used):

- New South Wales is a net importer of electricity. It relies on local base load generation due to its low cost, but has limited peaking capacity at times of high demand. This puts upward pressure on prices in peak periods, making imports a cheaper alternative.
- Victoria is a net exporter because it has substantial low-cost base load capacity. This is reflected in the region's 72 per cent capacity factor, the highest for any region. Victoria tends to import only at times of peak demand, when its regional capacity is stretched.
- Queensland's installed capacity exceeds its demand for electricity, making it a significant net exporter.
- South Australia is a net importer. The region has a high proportion of open cycle gas turbine generation, resulting in relatively high-cost generation. South Australia's peak demand exceeds its average demand by a greater margin than for any other region. This is reflected in South Australia's low generation capacity factor. Depending on prevailing market conditions, it is usually cheaper for South Australia to import electricity than to meet demand exclusively from local generation. It also has the highest proportion of wind generation, the energy output of which cannot be accurately forecast as it varies with weather conditions.
- Tasmania is currently a net importer from Victoria, although this relationship may be reversed during periods of peak demand in Victoria. Tasmania's rainfall and dam levels can affect its ability to use hydro capacity.
- The Snowy region (not shown) has little local demand and is almost exclusively an exporter of electricity to other regions. As for Tasmania, rainfall and dam levels can affect the region's ability to generate hydro-electricity.

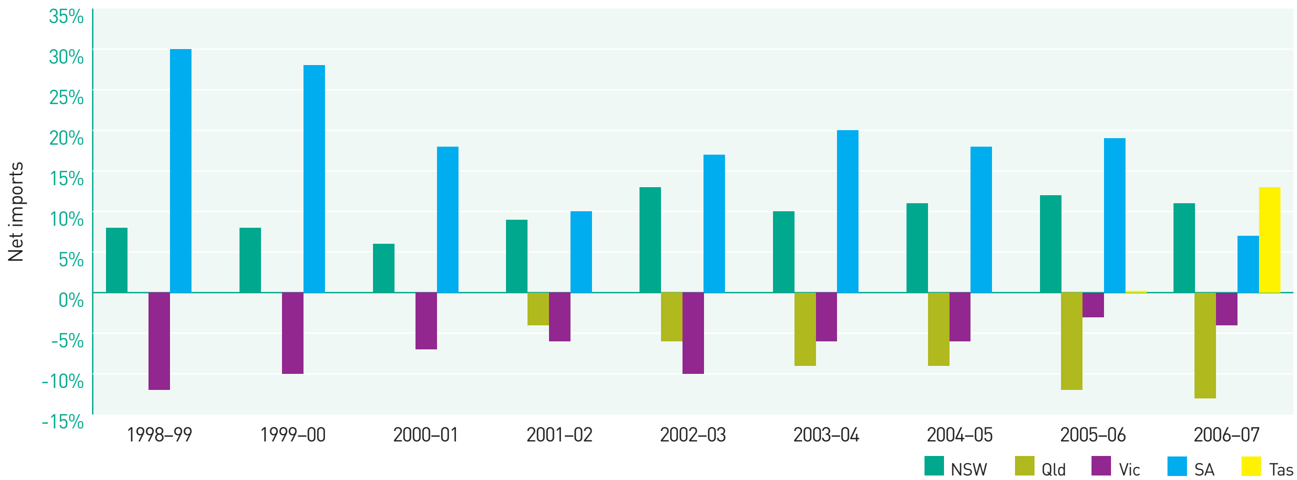
Figure 2.5
Trade flows across the NEM regions in 2006–07



Notes: 1. Energy refers to energy consumption. 2. Capacity factor refers to the proportion of local generation capacity in use. 3. The Snowy region (not shown) is located in south-eastern New South Wales. It generates around 5200 GWh of energy a year. The region's energy consumption, which is mainly for pumping purposes in its hydro generation plants, is equal to around 9 per cent of Snowy generation.

Data source: NEMMCO

Figure 2.6
Inter-regional trade as percentage of regional energy consumption



Note: The Snowy region (not shown) has little local demand and is almost exclusively an exporter to other regions.

Data source: NEMMCO

The NEM's inter-regional trade relationships are also reflected in figure 2.6, which shows the net trading position of the regions since the NEM commenced. South Australia, historically the most trade-dependent region, has reduced its reliance on imports from over 25 per cent of its annual energy consumption in the early years of the NEM to 7 per cent since 2006–07. The reduction reflects new investment in generation since 1999. New South Wales, also a net importer, has increased its reliance on imports from around 5 to 10 per cent in the early years of the NEM to over 10 per cent.

Victoria has consistently been a net exporter, although its exports as a share of consumption has fallen since 2004–05. Queensland has been a net exporter since it was interconnected with other regions of the NEM. Queensland exports as a share of its consumption has steadily risen since 2001–02 and has exceeded 10 per cent since 2005–06.

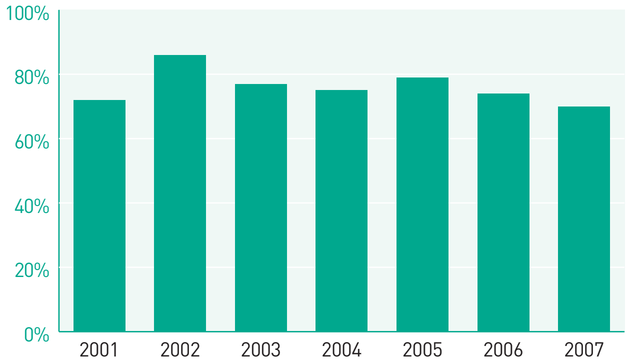
Market separation

The NEM central dispatch determines a separate spot price for each region of the NEM. In the absence of networks constraints, interstate trade brings prices across the regions towards alignment. Due to transmission losses that occur when transporting electricity over distances, it is normal to have some disparities between regional prices. More significant price separation may occur if an interconnector is congested. For example, imports may be restricted when import requirements exceed an interconnector's design limits. Similar issues may arise if the interconnector is undergoing maintenance or an unplanned outage that reduces its import capability. The availability of generation plant and the bidding behaviour of generators may also contribute to transmission congestion.

When congestion restricts a region's ability to import electricity, prices in the high-demand region may spike above prices elsewhere. For example, if low-cost Victorian electricity is constrained from flowing into South Australia on a day of high demand, more expensive South Australian generation—for example, local peaking plants—would need to be dispatched in place of imports. This would drive South Australian prices above those in Victoria.

Figure 2.7 indicates that the NEM operates as an 'integrated' market with price alignment across all regions for around 70 per cent of the time. The market is considered aligned when every interconnector in the NEM is unconstrained and electricity can flow freely between all regions. There may still be price differences between regions due to loss factors that occur in the transport of electricity.

Figure 2.7
Market alignment as a percentage of trading hours



Data source: NEMMCO

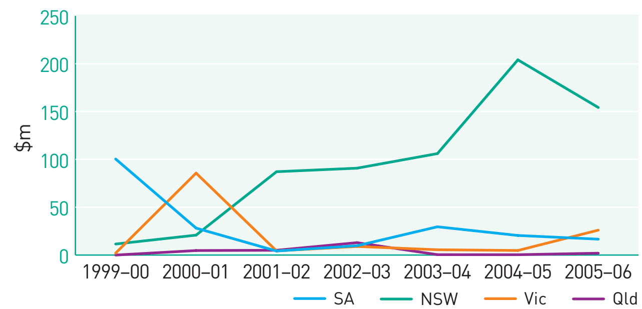
While the extent of alignment is an indicator of how effectively the market is working, it should be noted that full alignment would require significant investment to remove all possible causes of congestion. There is also some conjecture as to the benefits of addressing the issue. Preliminary AER research indicates that the economic costs of transmission congestion may be relatively modest (see section 4.7).

Settlement residues

When there is price separation between regions, electricity tends to flow from lower priced regions to higher priced regions. The exporting generators are paid at their local regional spot price, while importing customers (usually energy retailers) must pay the higher spot price in the importing region. The difference between the price paid and the price received multiplied by the amount of electricity exported is called a settlement residue. Over time, these residues accrue to the market operator, NEMMCO.

Figure 2.8 charts the annual accumulation of inter-regional settlement residues in each region. There is some volatility in the data, reflecting that a complex range of factors can contribute to price separation—for example, the availability of transmission interconnectors and generation plant, weather conditions and the bidding behaviour of generators.

Figure 2.8
Settlement residues



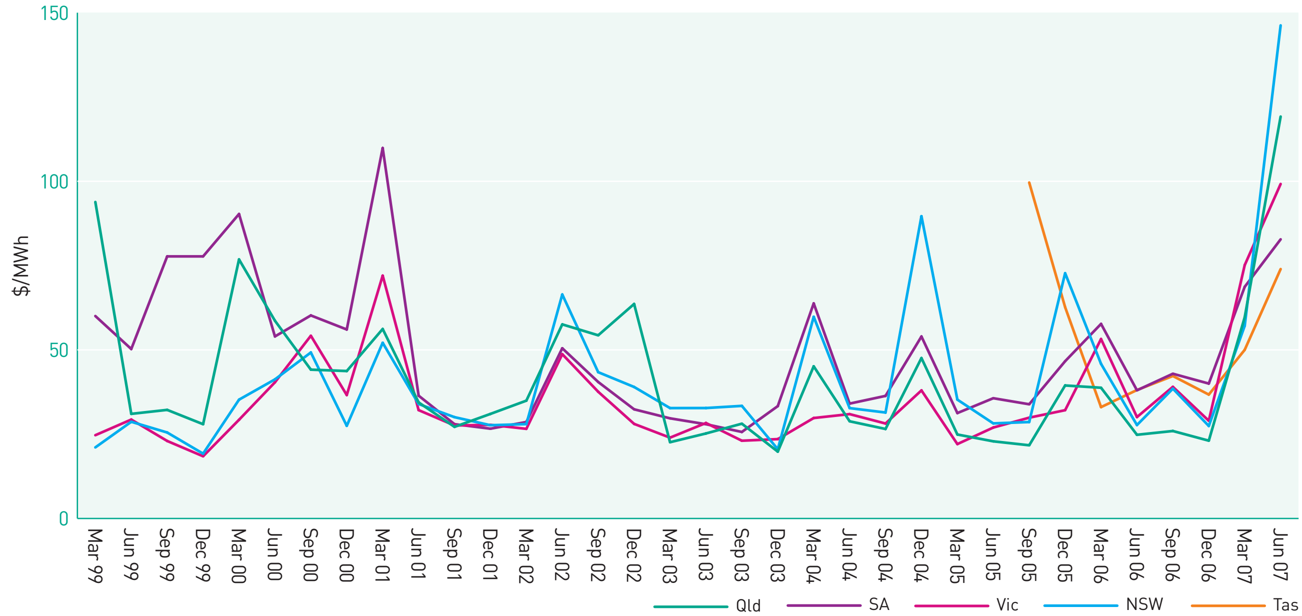
Data source: NEMMCO

New South Wales recorded settlement residues of around $100 million or more each year from 2001–02, reaching $200 million in 2004–05. This may reflect the region's status as the largest importer of electricity (in dollar terms) since the NEM commenced, making it vulnerable to price separation events. South Australia and Victoria also recorded settlement residues. As a net exporter, the Queensland region tends not to accumulate settlement residue balances. The residues resulting from exports from the Snowy region are included in the relevant importing region.

Price separation creates risks for the parties that contract across regions. NEMMCO offers a risk management instrument by holding quarterly auctions to sell the rights to future residues. An explanation of the auction process is provided in section 4.7.

Figure 2.9

Quarterly volume weighted average spot prices in the National Electricity Market



Data source: NEMMCO

2.5 National Electricity Market prices

NEMMCO's central dispatch process determines a spot price for each NEM region every 30 minutes.[7] As noted, prices can vary between regions because of losses in transportation and transmission congestion, which sometimes restricts inter-regional trade.

Figures 2.9 charts quarterly volume-weighted average prices since the NEM commenced, while table 2.3 sets out annual volume weighted prices. Figure 2.10 provides a more detailed snapshot of weekly prices since July 2005. Overall, prices tended to fall in the early years of the NEM—especially in Queensland and South Australia—following investment in new transmission and generation capacity. In the past three years, warmer summers and record peak demands have seen prices rise relative to earlier in the decade.

A variety of factors led to significantly higher prices in 2006–07. In January 2007, bushfires caused an outage of the Victoria–Snowy interconnector, causing price spikes in Victoria and South Australia. Network issues in Queensland in late January also affected prices. While wholesale prices normally ease in autumn—when demand is relatively subdued—the reverse occurred in 2007, when drought began to impact on prices. The drought constrained hydro-generating capacity in the Snowy, Tasmania and Victoria and also limited the availability of water for cooling in some coal-fired generators. In combination, these factors led to a tightening of supply and higher offer prices by generators.

These conditions were exacerbated in June 2007 by a number of generator outages, network outages and generator limitations. For example, rain and flooding in the Hunter Valley made some generation capacity unavailable for a period. Tight supply was accompanied by record electricity demand as cold winter days increased heating requirements. In combination these factors led to an extremely tight supply-demand balance during the early evening peak hours, particularly in New South Wales.

7 NEMMCO issues dispatch instructions every five minutes. The instructions tell each generator how much it needs to generate during the five-minute dispatch interval. A price is determined for each five-minute period based on generator offers, and is then averaged over 30-minute time periods ('trading intervals'). Generators are paid for each MW generated during a trading interval at the average price over the trading interval.

Table 2.3 Annual average NEM prices by region ($/MWh)

	QLD	NSW	SNOWY	VIC	SA	TAS
2006–07	57	67	38	61	59	51
2005–06	31	43	29	36	44	59
2004–05	31	46	26	29	39	
2003–04	31	37	22	27	39	
2002–03	41	37	27	30	33	
2001–02	38	38	27	33	34	
2000–01	45	41	35	49	67	
1999–2000	49	30	24	28	69	
1998–99[1]	60	25	19	27	54	

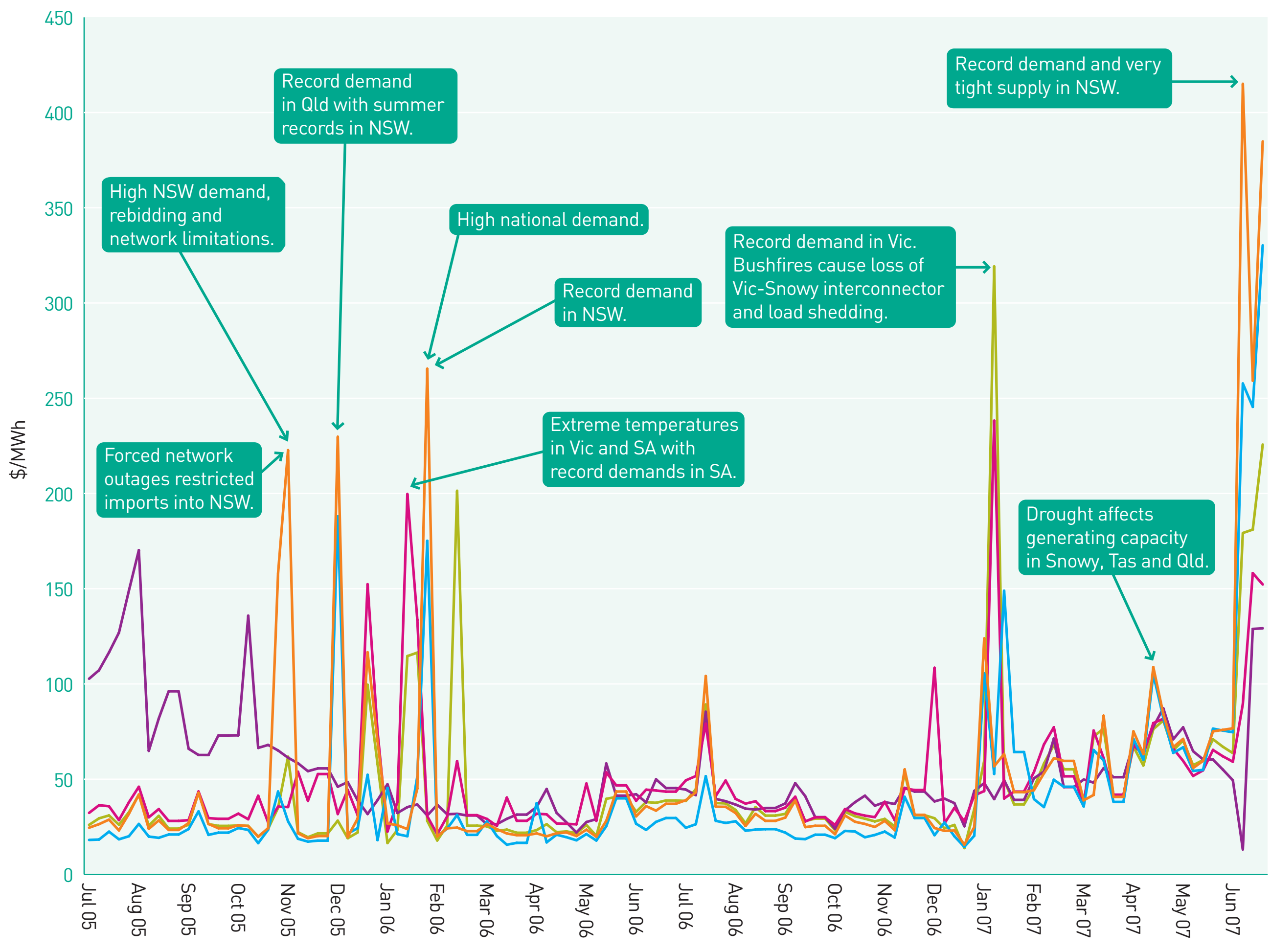
1. 6 months to 30 June 1999.
Data source: NEMMCO

These conditions led to some of the highest spot prices since the NEM commenced. In particular, spot prices exceeded $5000 a MWh on 42 occasions during June 2007 in New South Wales, Queensland and Snowy. The AER published a report on these events in July 2007, including the contributing impact of high demand, constrained supply and other factors.

Prices in the physical spot market flowed through to forward prices, which in June 2007 reached historically high levels (chapter 3). This suggests that the market is factoring in the risk of persistently tight supply for some time into the future.

The AER closely monitors the market and reports weekly on wholesale and forward market activity. It also publishes more detailed analysis of extreme price events.

Figure 2.10
NEM prices July 2005–June 2007 (weekly volume weighted averages)



Data source: NEMMCO

2.6 Price volatility

The spot prices determined every 30 minutes in the NEM reflect fluctuating supply and demand conditions. The market is sensitive to changes in these conditions, which can occur at short notice. For example, electricity demand can rise swiftly on a hot day. Similarly, an outage of a generator or transmission line can quickly increase regional spot prices. The sensitivity of the market to changing supply and demand conditions can result in considerable price volatility.

Figure 2.10 charts volume weighted spot prices on a weekly basis in the NEM from July 2005 to June 2007. As noted, there were a number of price spikes in 2006–07. Prices spiked in Victoria and South Australia in January 2007 due to bushfires that caused an outage of the Victoria-Snowy interconnector and other flow-on effects. There were also price spikes due to network issues in Queensland in late January. Extremely tight demand and supply conditions in New South Wales in June 2007 caused record prices with flow-on effects in other regions.

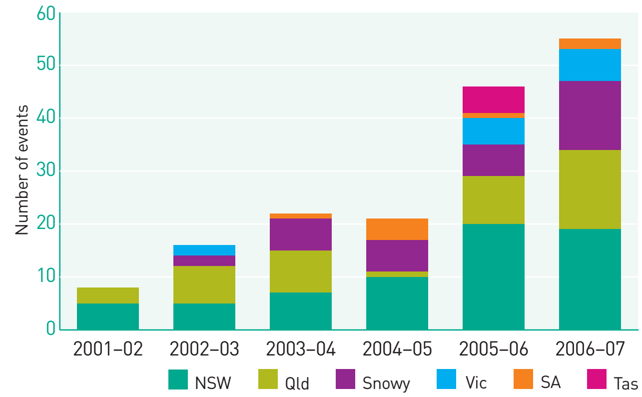
Extreme price events

As figure 2.10 is based on weekly averages, it masks more extreme spikes that can occur during a half-hour trading interval. On occasion, 30-minute spot prices approach the market cap of $10 000 a MWh. Two indicators of the incidence of extreme price events are:

> the number of 30-minute trading intervals above $5000 a MWh (figure 2.11)
> the number of 30-minute spot prices per week that are more than three times the volume weighted average price (figure 2.12).

The number of 30-minute trading intervals with prices above $5000 a MWh has increased since the NEM commenced (figure 2.11). In particular, the number of events more than doubled in 2005–06 to 46 events, and rose again in 2006–07 to 55 events. Figure 2.12 indicates that weekly spot prices above three times the volume weighted average occur most frequently in summer and winter, when peak demand is highest. The AER publishes a report on every price event above $5000 a MWh.

Figure 2.11
Number of price intervals above $5000 a MWh



Data source: NEMMCO

Many factors can cause price spikes. While the cause of a high price event is not always clear, underlying causes might include:

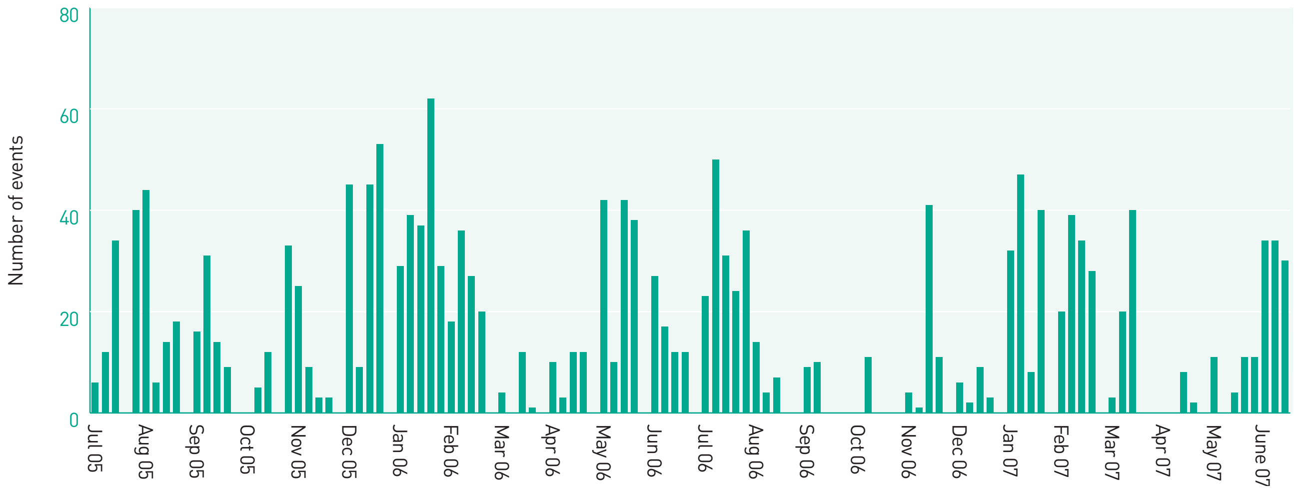
> high demand that requires the dispatch of high-cost peaking generators
> a generator outage that affects regional supply
> transmission network outages or congestion that restricts the flow of cheap imports into a region
> a lack of effective competition in certain market conditions
> a combination of factors.

To increase transparency, the AER publishes weekly reports on market outcomes. The reports highlight factors contributing to spot prices that are more than three times the volume-weighted average price for the week.

Price spikes are not uncommon in the market but can have a material impact on outcomes. If prices approach $10 000 for just two hours a year, the average price in a region may rise by 10 per cent. Generators and retailers typically hedge against this risk by taking out contractual arrangements in financial markets (see chapter 3). This can help to insulate market players from the impact of price spikes.

Figure 2.12

Weekly spot prices above three times volume-weighted average



Data source: NEMMCO

Price volatility in the NEM plays an important role in providing solutions to capacity issues. In particular, extreme prices create incentives to hedge against the associated risks. This encourages investment in peaking generation plant and contracting with customers to provide a demand-side response.

For example, summer peaks in air conditioning loads create a need for peaking generation that can come online quickly. High spot prices are needed to encourage investment in peaking plant, which is expensive to operate. Spot price activity in Victoria and South Australia has led to significant investment in peaking capacity (see figure 1.10 in chapter 1).

Demand-side management responses can also help to manage tight supply-demand conditions. This might involve a retailer offering a customer financial incentives to reduce consumption at times of high demand to ease price pressures. Effective demand-side management requires suitable metering arrangements to enable customers to manage their consumption. The Energy Reform Implementation Group noted in 2007 that demand-side management activity in the NEM was mainly confined to the large customer segment. It estimated that the extent of potential demand-side response in the NEM is around 700 MW across a range of energy-consuming industries.[8] At the small customer level, COAG agreed in 2007 to a national implementation strategy for the progressive roll out of 'smart' electricity meters to encourage demand-side response (see section 6.5.4 of this report).

8 Energy Reform Implementation Group, *Energy reform: The way forward for Australia—a report to the Council of Australian Governments*, 2007.

Box 2.2 International electricity prices

While Australian electricity prices rose in 2007, over the longer term they have been low relative to liberalised markets overseas. The principal reason is access to a low-priced fuel such as brown or black coal. Table 2.4 compares annual load-weighted wholesale prices in the NEM with selected international markets on a calendar year basis.

Comparisons across markets should be made with caution. Various factors can impact on wholesale market outcomes, including:

- market design—for example, the use or absence of a capacity market
- the stage of the investment cycle
- overcapacity that may be a legacy from previous regulatory regimes
- meteorological conditions
- fuel costs and availability
- exchange rates
- requirements under a carbon trading scheme
- regulatory intervention.

Prices in the Nord Pool (an electricity market linking Norway, Sweden, Finland and Denmark) increased significantly over the period 1999–2006. Heavily reliant on hydro-electric power, prices in this region have a strong negative correlation with rainfall levels. The sharp price increase in 2006 resulted from a combination of factors, including increased load, rising fuel costs, low reservoir levels, unavailability of nuclear plants in Sweden and the introduction of a carbon-trading scheme in Europe.

The Electric Reliability Council of Texas (ERCOT) operates a wholesale market that supplies electricity to 75 per cent of Texas. Price fluctuations in this market, as well as the Alberta market, largely reflect changes in the cost of natural gas.

Table 2.4 Average wholesale prices in selected markets ($AUD/MWh)

	NEM				INTERNATIONAL				
YEAR	NSW	QLD	SA	VIC	NORD POOL (SCANDINAVIA)	ALBERTA[1] (CANADA)	ERCOT (TEXAS)	NEMS (SINGAPORE)	PJM[2] (USA)
2006	35	28	45	38	81	95	–	111	71
2005	41	27	37	28	48	76	95	86	83
2004	53	37	47	32	49	57	61	66	60
2003	30	24	29	25	64	69	68	82	64
2002	45	52	38	35	47	52	47	–	57
2001	36	37	52	40	40	92	–	–	71
2000	39	56	65	40	20	–	–	–	53
1999	24	46	60	24	22	–	–	–	53

1. Prices for Alberta are unweighted.
2. The PJM includes a capacity market.

Nord Pool: Market between Norway, Sweden, Finland and Denmark; ERCOT: Electric Reliability Council of Texas; NEMS: National Electricity Market of Singapore; PJM: Pennsylvania–New Jersey–Maryland Pool.

Rounded annual volume weighted price comparison based on calendar year data.

Price conversions to Australian dollars based on average annual exchange rates.

Sources: Nord Pool, PJM, Electricity Market Company of Singapore, ERCOT, Alberta Electric System Operator.

The Pennsylvania–New Jersey–Maryland pool (the PJM) links generating facilities in 12 states in the USA. Coal is the major fuel source for electricity in the market (accounting for over 50 per cent of generation), with gas (28 per cent) and nuclear (19 per cent) also significant. For 1999 prices in the PJM were comparable to those in Queensland and South Australia. The market then saw a fairly steady increase in prices to 2005. Average prices moved above $80 a MWh in 2005 following a 40 to 50 per cent increase in oil and gas costs.[9]

Unlike the NEM, the PJM operates a capacity market in conjunction with the energy market. Capacity markets provide an additional source of revenue for generators and so reduce revenue requirements in the energy market. Accordingly, spot prices in the PJM would likely be higher in the absence of capacity markets. Adjusting for this difference, table 2.4 may understate the price discount in the NEM compared to the PJM.

The National Electricity Market of Singapore (NEMS) commenced operating in January 2003. With electricity generation fuelled by gas (49 per cent), fuel oils (48 per cent) and diesel (3 per cent), prices have been substantially above those experienced in the NEM.[10]

9 PJM, *2005 State of the market report*, Market Monitoring Unit, 2006.

10 Energy Market Company of Singapore, *2006 Market report of the National Electricity Market of Singapore*, 2007.