Bardak Ventures Pty Ltd

The Pool Prices in the National Electricity Market in 2002
or
"Are Price Spikes Good for You?"©

Summary

This paper examines the pricing performance (as measured by the Regional Pool Price (RPP)) of the National Electricity Market (NEM) in the calendar year 2002.

It looks specifically at the incidence and effect of price spikes on the average RPP and also examines the pricing performance expected if perfectly competitive market conditions existed in the NEM.

Finally, it computes the increased price of power in the NEM due to constrained operation of the interconnecting transmission links, and imputes the level of investment which could be justified if the results of the year 2002 are repeated.

It illustrates the many problems associated with the present compulsory pool/energy-only market structure applying in the NEM and presents some solutions to them.

Average Prices in the NEM for 2002

Bardak has processed the half-hourly data provided by NEMMCo for each of the major Regions (States) making up the NEM in several different ways, to extract statistics which help understand how the NEM works (or does not work).

Firstly, the annual average RPP prices for the year 2002 were:

Table 1: Annual Average Regional Pool Prices for 2002
(all in $/MWh)

	Time weighted average	Load weighted average
Queensland	47.78	52.54
New South Wales	39.76	44.50
Victoria	33.11	35.44
South Australia	35.30	38.05
NEM	**39.72**	**43.68**

These prices may usefully be compared to Bardak's estimate of the Long Run Marginal Cost of the most economical new entrant generators in each Region.[1]

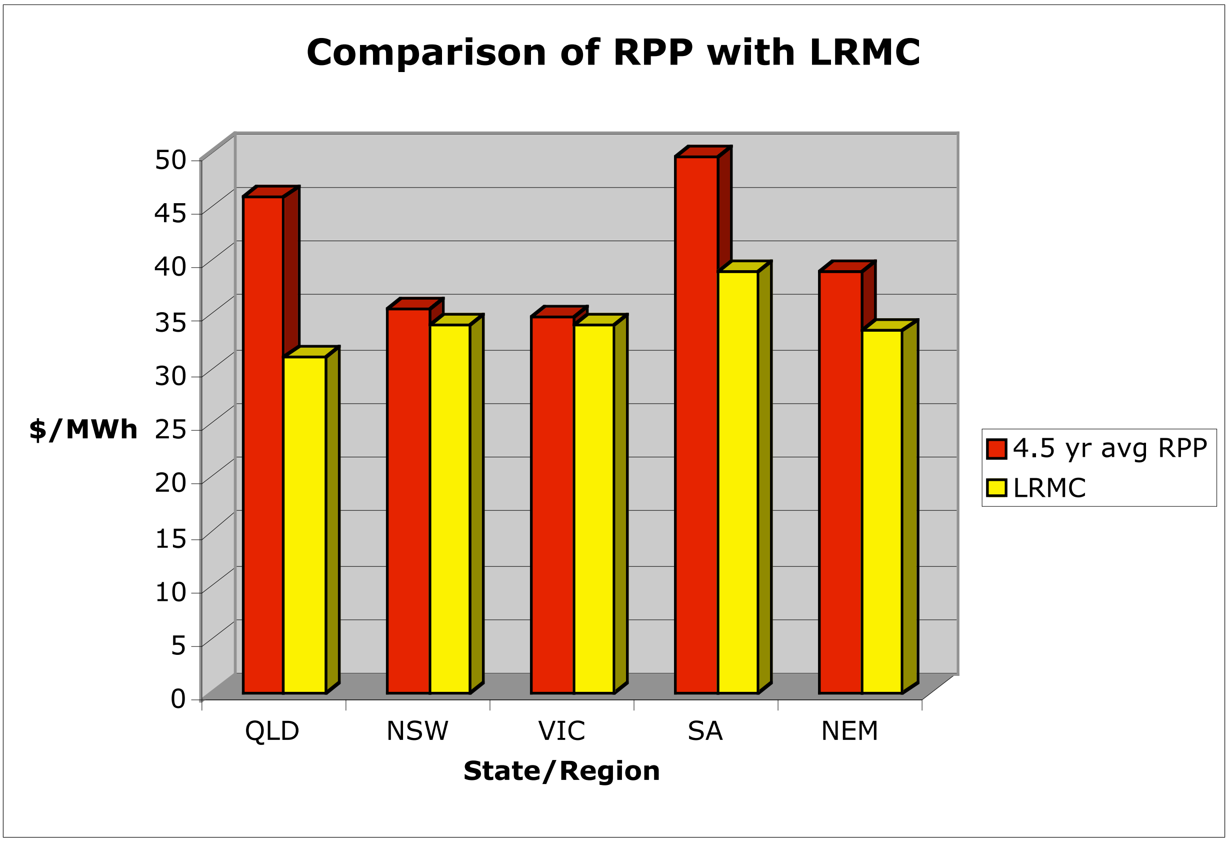
[1] Note that Bardak's estimated LRMC's match those produced by ACIL Tasman in their March draft report to NEMMCo entitled "SRMC and LRMC of Generators in the NEM".

These LRMC's are shown in Table 2.

Table 2: Estimated New Entrant LRMC's compared to RPP

	LRMC	Load weighted average
Queensland	30-32	52.54
New South Wales	33-35	44.50
Victoria	33-35	35.44
South Australia	38-40	38.05
NEM	**33.6**	**43.68**

The same information is shown in the following graph, but this time using the average RPP's for the entire 4.5 years of NEM operation (which is more appropriate when considering longer term matters):



A few observations can be made on these tables and the graph:

- there is about a 10% difference between the time-weighted and the demand-weighted RPP, with the demand-weighted price being the highest;

- there was a 48% difference between the highest cost and lowest cost Regions in 2002;
- the difference between Qld and NSW RPP's was 18%; between NSW and Vic 26%, and between SA and Vic, 7%. Significant constraints must exist between NSW and Qld and between NSW and Vic to sustain such differentials[2] ;
- since the average losses between Regions are of the order of 10%, these results illustrate the fact that the NEM is far from one unified market, and is more a series of regional markets, with significant constraints between them;
- each of the Regions experienced long term average RPP's which were above the Bardak estimate of LRMC's of new generation in each State. The differences were quite marked in the case of Qld and SA, where long term average RPP's are considerably higher than LRMC estimates.

Contract (hedging) prices are generally higher than the RPP in each Region, and generator revenue comes from a mixture of power sold at hedging prices and some at spot prices.

On the basis of these figures, generators in the NEM are being well rewarded and further price increases are not needed to encourage new investment let alone to reward past investments.

Price Spikes in the NEM in 2002

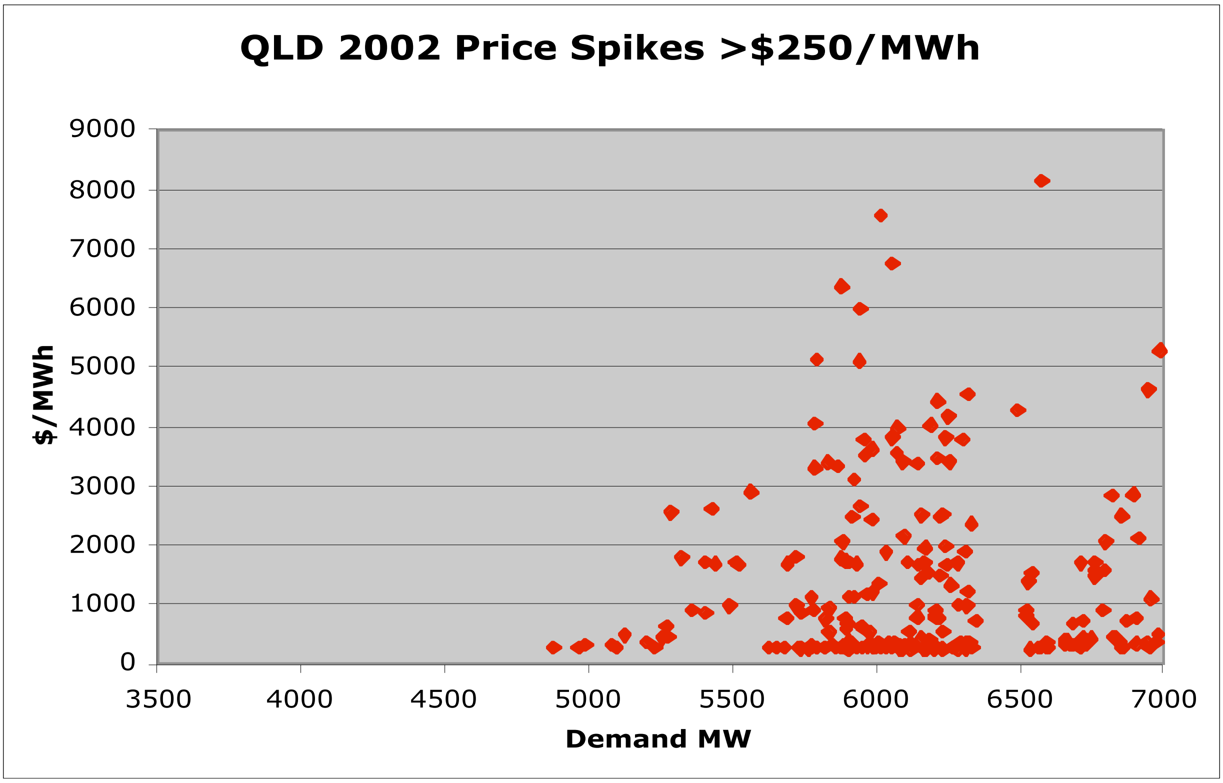
Bardak then analysed the incidence of price spikes in the NEM to determine their correlation with demand and their effect on the annual average RPP's.

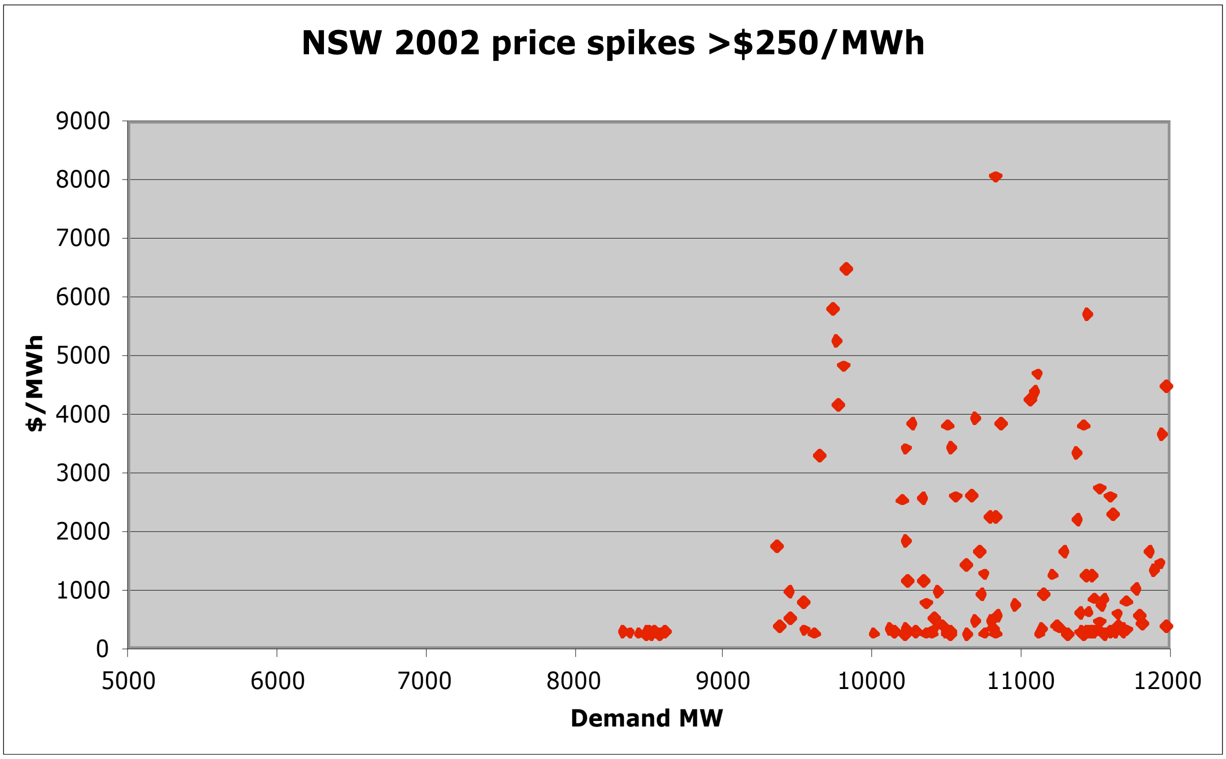
Competitive market theory tells us that, if perfectly competitive conditions applied, the highest cost seen in a spot market (before customer load starts to be shed) would be the Short Run Marginal Cost (SRMC) of the highest cost generator operating in the market. As we shall see later, this highest cost SRMC in the NEM is $250/MWh.[3] Bardak has defined a "price spike" as being any price in excess of $250/MWh in any half-hour in a year. It isolates those instances with prices in excess of those which would be experienced in a fully competitive market.

The following graphs show the incidence of price spikes, thus defined, plotted against the demand in each half hour, with the the scale of the horizontal axis adjusted so as to show the range between the minimum and maximum loads experienced during the year.

[2] The QNI interconnection was commissioned during the year and reduced the RPP differential between Qld and NSW under normal conditions, with power flowing south most of the time. The price spikes which occurred in Qld in December (when QNI was constrained) were sufficiently large to reverse the normal outcome.

[3] Based on the estimated in the ACIL Tasman report cited as Reference 1.


QLD 2002 Price Spikes >$250/MWh
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
$/MWh
3500
4000
4500
5000
5500
6000
6500
7000
Demand MW


NSW 2002 price spikes >$250/MWh
9000
8000
7000
6000
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3000
2000
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$/MWh
5000
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7000
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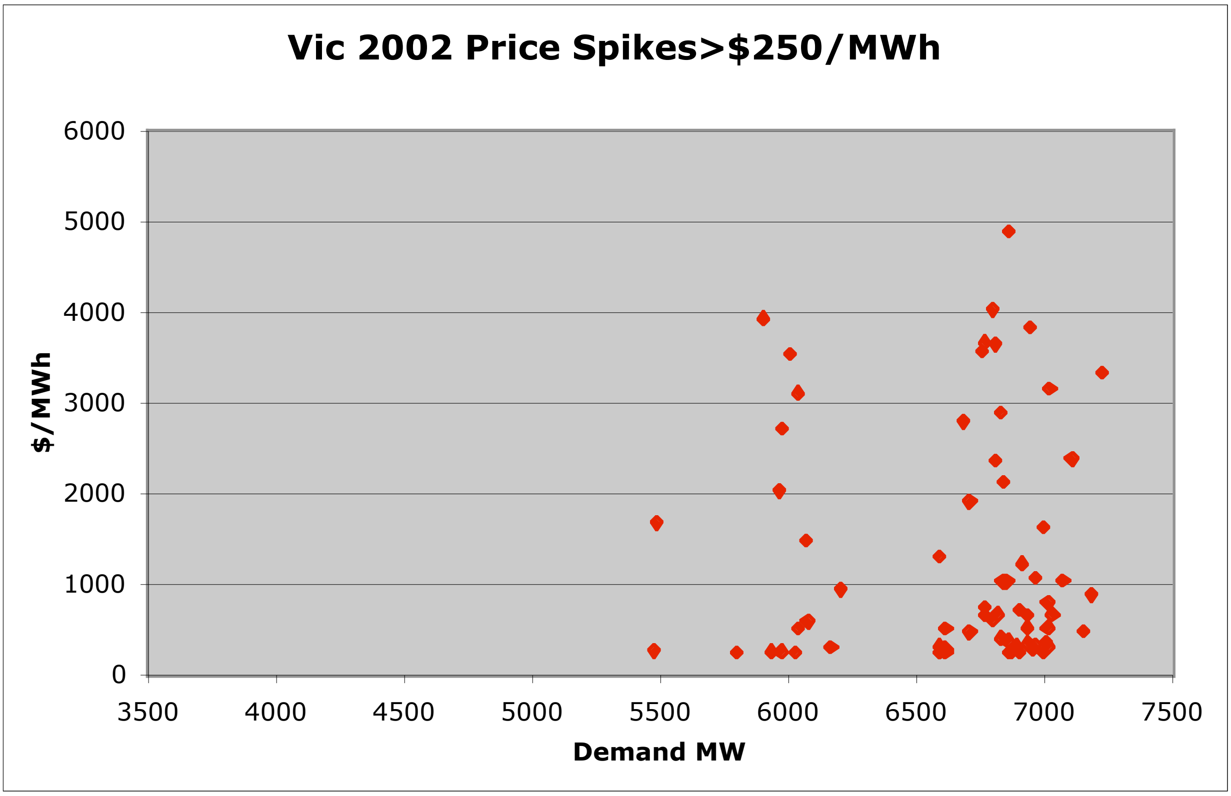
9000
10000
11000
12000
Demand MW


Vic 2002 Price Spikes>$250/MWh
$/MWh
6000
5000
4000
3000
2000
1000
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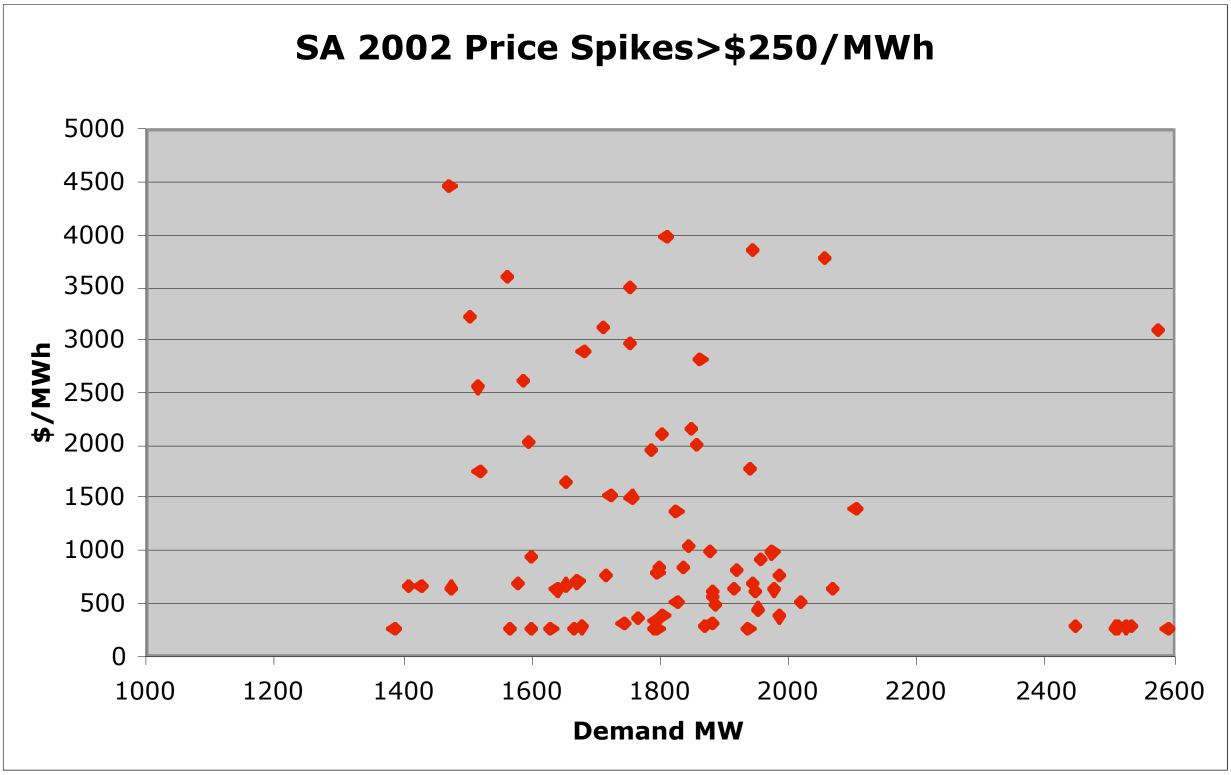
3500
4000
4500
5000
5500
6000
6500
7000
7500
Demand MW


SA 2002 Price Spikes>$250/MWh
$/MWh
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1000
1200
1400
1600
1800
2000
2200
2400
2600
Demand MW

Note in all cases, and especially in the case of South Australia, the number of price spikes which occur at demand levels which are well below the peak demand in the State. In the case of South Australia, very few price spikes occurred when loads were near the annual peak load.

Most of the price spikes are thus not related to any shortage or imminent shortage of capacity, but rather are artificially created by generators bidding and rebidding to withdraw capacity from the market — either physically, by not starting units, or economically, by bidding their capacity at very high prices. It is not unusual to see 25-30% of the capacity in a Region being bid at prices around $9,000/MWh.

The proportion of the annual revenue gained from pool prices due to price spikes is analysed in Table 3 and the following graph. Two cases are shown — one showing the proportion of annual revenue (or pool turnover) due to all price spikes above $250/MWh, and the second isolating those which occurred when demand was within 10% of the annual peak demand.

These latter cases may have some (tenuous) level of justification on the basis that shortages were possible at such high load load levels. This interpretation is very generous to the NEM, since we will show later that prices would not rise above $250/MWh in a workably competitive market.

Table 3: Proportions of Annual Pool Turnover due to Price Spikes

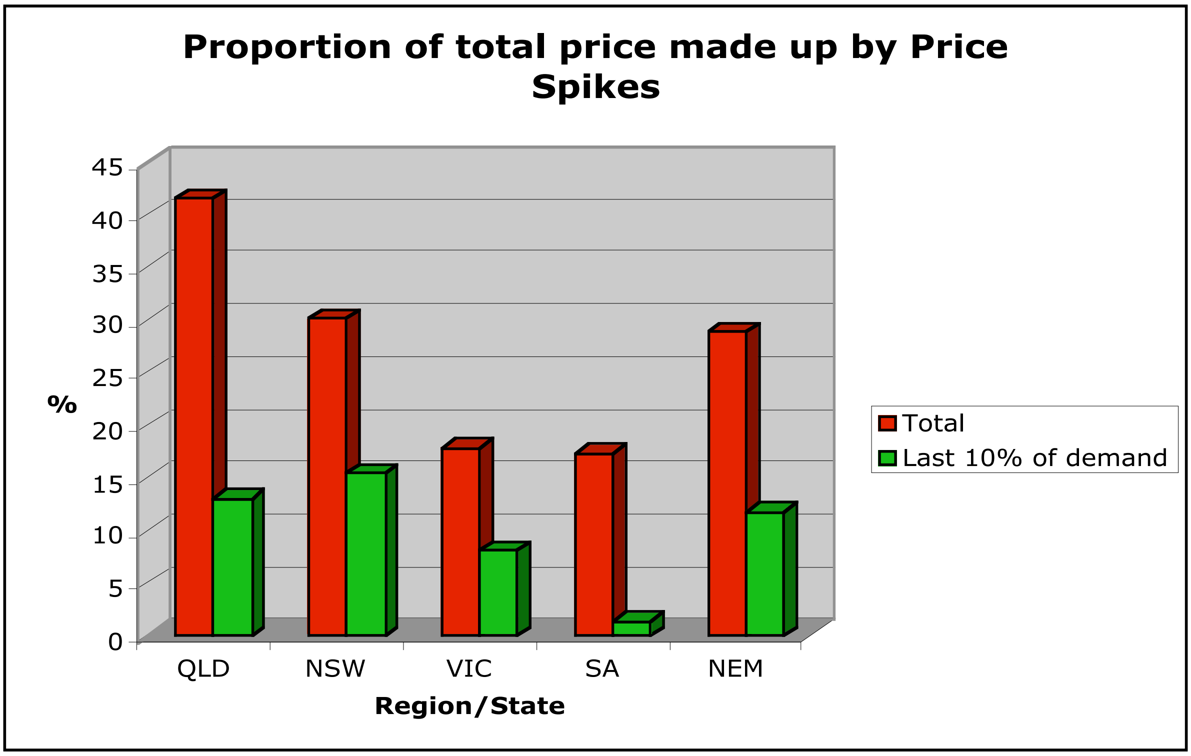
	All Price Spikes	**Spikes within 10% of peak MW**
Queensland	41.6%	13.0%
New South Wales	30.1%	15.4%
Victoria	17.8%	8.1%
South Australia	17.3%	1.3%
NEM totals	**28.4%**	**11.8%**

It can be seen that the proportion of annual revenue caused by price spikes is generally very high — ranging from 17% to 42% of total revenue and averaging 28.4% for the NEM as a whole. Even excluding price spikes when demand was within 10% of peak demand, only reduces these proportions to the range 12% to 29% and to 16.6% for the NEM as a whole.

Up to 28% of annual pool revenue is due to price spikes which are essentially artificial and quite unrelated to the supply/demand balance at the time.

This illustrates the poor job which the NEM trading system does in providing indications of the future price of electricity on which to base investment decisions. Ignoring for the moment the significant timing issue (that it is prices 3 to 5 years out which are needed — not some short term price), that such a high proportion of the average NEM pool price is unrelated to the fundamental supply/demand balance, takes away confidence that such prices can be relied upon to occur regularly in the future.

This lack of longer term forward price discovery is one of the major problems facing the NEM.



The artificial nature and the size of the unjustified price spikes also plays havoc with the parallel contract (hedging) market — making it extremely risky to operate in and driving those who do not have deep pockets to avoid taking on the risk of such illogical outcomes from the NEM trading system.[4] The hedging contract market is well known to be both illiquid and short term in focus.

Clearly there is insufficient competition in the generation sector of the NEM, since it is all too easy for generators and traders to manipulate the pool price.

There is little point in maintaining the paraphernalia of a trading system relying on intense competition to work properly, when this level of competition is not present. We need a trading system where market prices fairly reflect the conditions of supply and demand, rather than as a result of the exercise of market power by generators and traders.

The "Effective Wholesale Price" of Electricity in the NEM

The price spikes are the cause of the excessive volatility and risk associated with trading in the NEM. The direct and indirect cost of coping with this excessive volatility and risk is being shown in the pressure for retail pricing increases in Vic and SA. NSW and Qld have control systems in place which provide a high degree of protection and risk

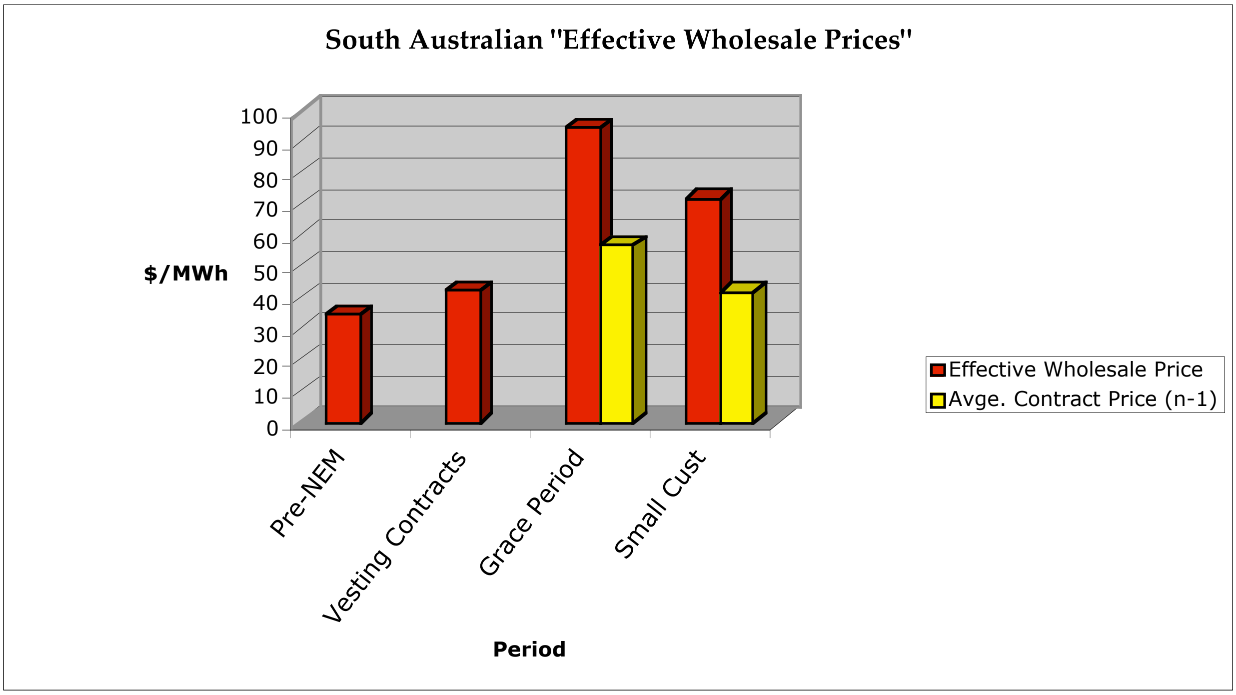
[4] See the supplementary report by KPMG to the Parer Panel Report on Energy Market Reform, dated December 2002 for details of the problems being encountered in the illiquid and short term contract/hedging market in Australia.

mitigation for the Government-owned generators and retailers in these two States.

South Australia provides the most potent example of the "layer cake" effect of additional costs associated with a retailer coping with the volatility and risk of the NEM wholesale market.

Bardak defines the "effective wholesale price" of power as consisting of all the components which a retailer or a major customer must pay to wholesale vendors. Recent work for the State regulatory agencies in both South Australia and Victoria shows that the "effective wholesale price" to smaller retail customers can add 80-100% or more to the prevailing pool or contract prices in those states.

We illustrate what we mean by "effective wholesale price" in the following two slides, both using South Australia as an example:[5]



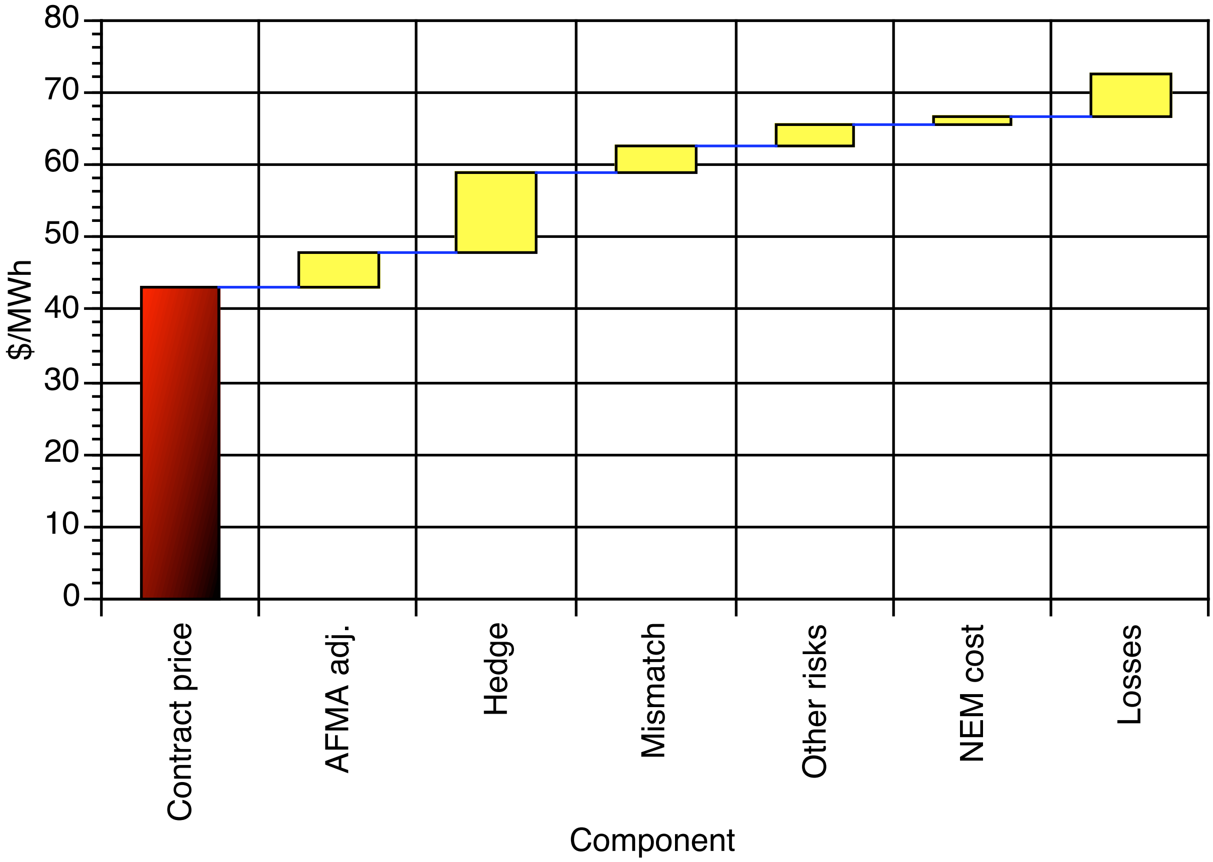
This "layer cake" effect is predominantly due to the excessive and unreasonable volatility allowed in the pool prices and the consequential need for all players in the industry — even the generators — to make multiple allowances for the risk of trading in the NEM.

Reducing the incidence of unjustified price spikes would lower average RPP's by up to 25% or so and lower or eliminate the bulk of the add-on cost components which make the "effective wholesale price" so high.

For one example, the component labeled "hedge" in the graph below would not be needed if RPP's are held below about $300/MWh.

[5] These two graphs use data sourced from various reports from ESCOSA.

Components of "Effective Wholesale Price"



Simulation of Competitive Market Outcomes

It is possible to simulate the outcome expected in the year 2002 had the NEM provided a workably competitive market. In such a market all generators would be forced by competitive pressure to bid at their SRMC and no more.

In overseas markets, the extent to which the actual pool price exceeds the price which would result from SRMC bidding, is used as a measure of the effectiveness of a market and of the extent to which generators and traders are using their market power to drive up prices. In California, for example, the Californian ISO computes the results of SRMC bidding, allows a 10-20% margin above this level, and then counts any prices above that level as exceeding reasonable competitive market outcomes.[6]

This is called their "price-cost markup index", with the markup expressed either as a $/MWh figure or as a percentage of the SRMC bidding outcome (after allowing the margin).

Bardak has replicated the Californian calculations for the NEM in 2002. We used the SRMC estimates recently published by ACIL Tasman for NEMMCo as our base, and

[6] ISO means "Independent System Operator".

developed progressive capacity vs SRMC curves for the various NEM Regions. To allow for plant availability, we reduced the capacity of each generator by 10% — reflecting the average NEM availability of about 90%. For each half-hour, the pool price was recalculated by referring to the tables which underlie the series of graphs following.

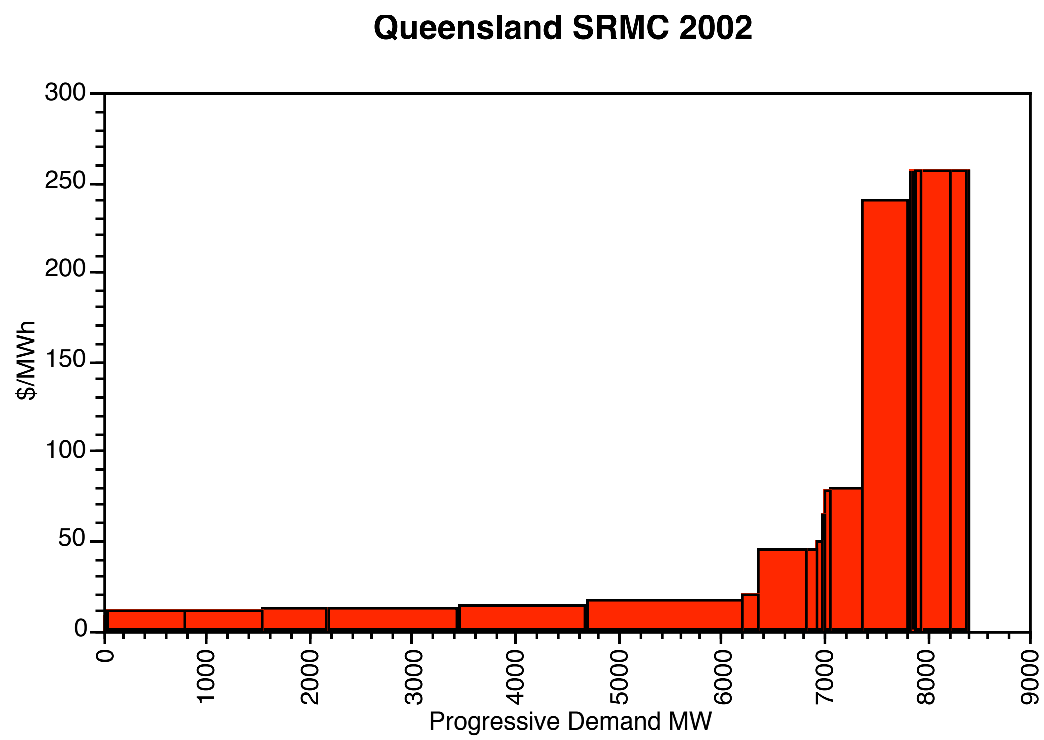
In each case, they show that much of the capacity in the NEM possesses generally low SRMC's (based on brown coal in Vic, lignite in SA and black coal in NSW and Qld). SRMC's rise to higher intermediate levels when gas plants become marginal and then rise to very high levels when oil-fired gas turbine need to be called upon.

The resulting pool prices over a year can therefore be very volatile and unstable depending on which plants are marginal producers at any time.

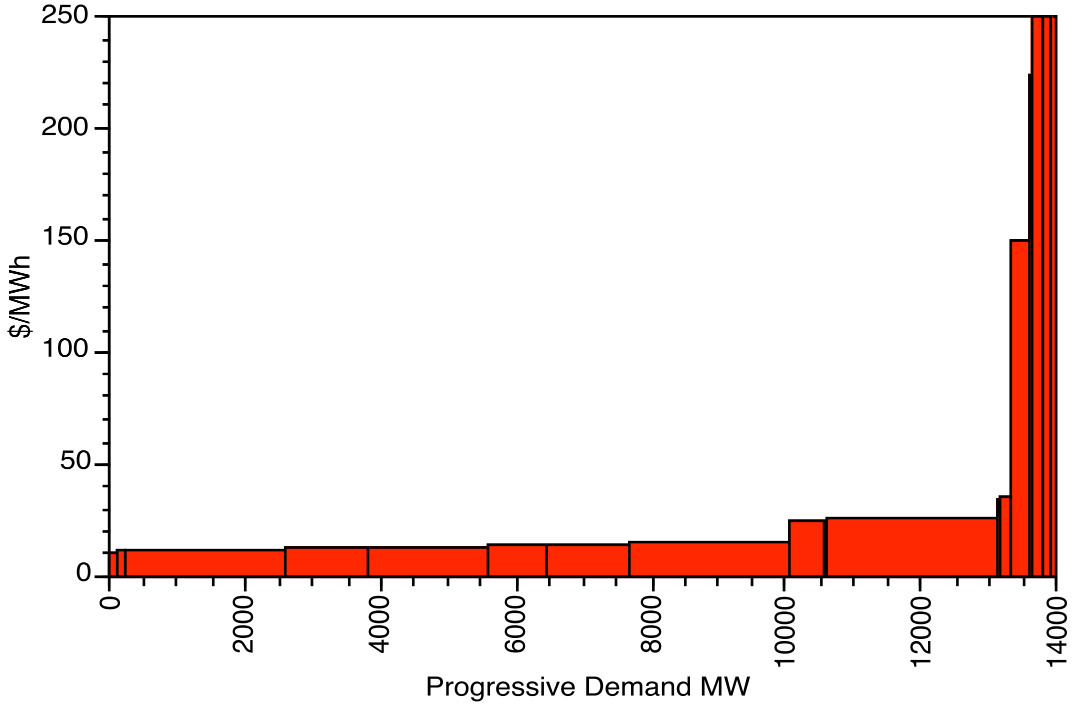
This volatility would be limited to the range of \$2/MWh to \$250/MWh were workably competitive conditions to apply in the NEM. This is in stark contrast to the present range of prices — which range from \$5/MWh to \$9,000/MWh.

Prices should not go to VoLL unless customer load is actually being shed — which never happened in 2002.

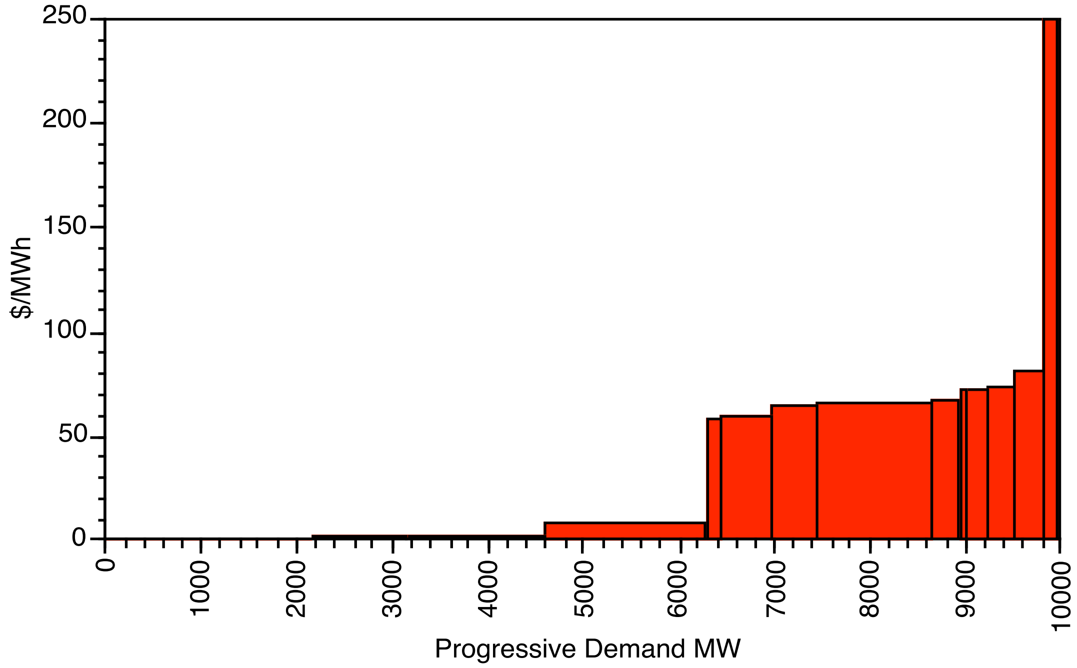
The SRMC vs progressive capacity curves used in the analysis for each of the NEM Regions are shown in the series of graphs following:

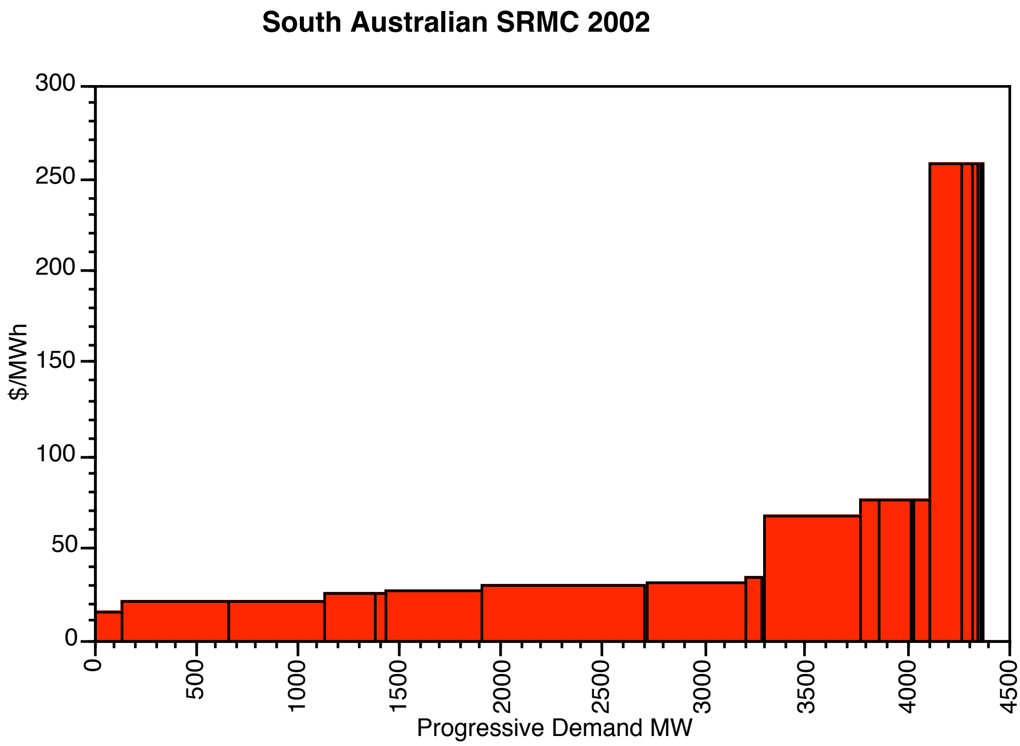


NSW SRMC 2002



Victorian SRMC 2002





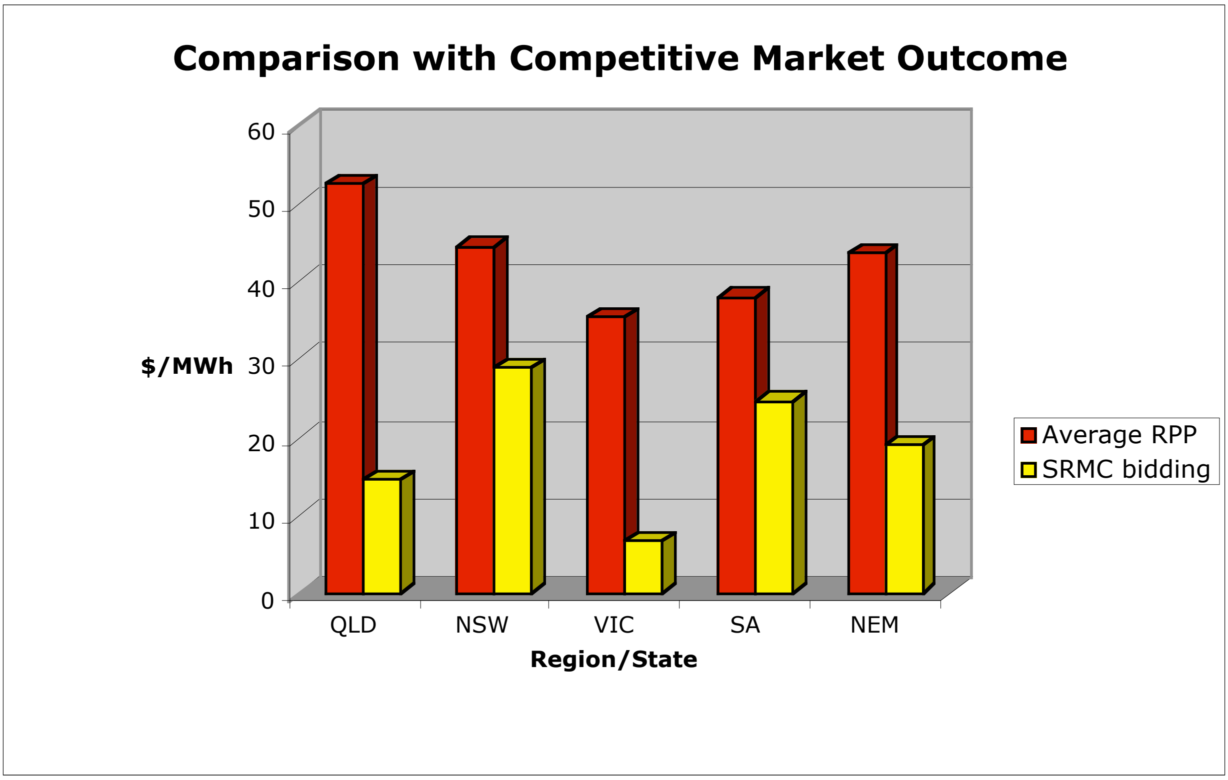
The results of the simulation of SRMC bidding and the % price-cost markup (after allowing a generous 20% margin) for the year 2002 are shown in Table 4 below.

Table 4: Result of Competitive Outcome and Price-Cost Markup Analyses

	SRMC bidding ($/MWh)	Price-Cost Markup
Queensland	14.6	67%
New South Wales	29.0	34%
Victoria	6.7	414%
South Australia	24.8	33%
NEM	**19.0**	**144%**

In all cases, the outcome is that the actual RPP is always significantly higher than the outcome of a workably competitive market, with the price-cost markups very high indeed, indicating a lack of competitive forces.

The following graphs illustrate the results tabulated in Table 4, adding a bar to show the actual RPP's in each case.

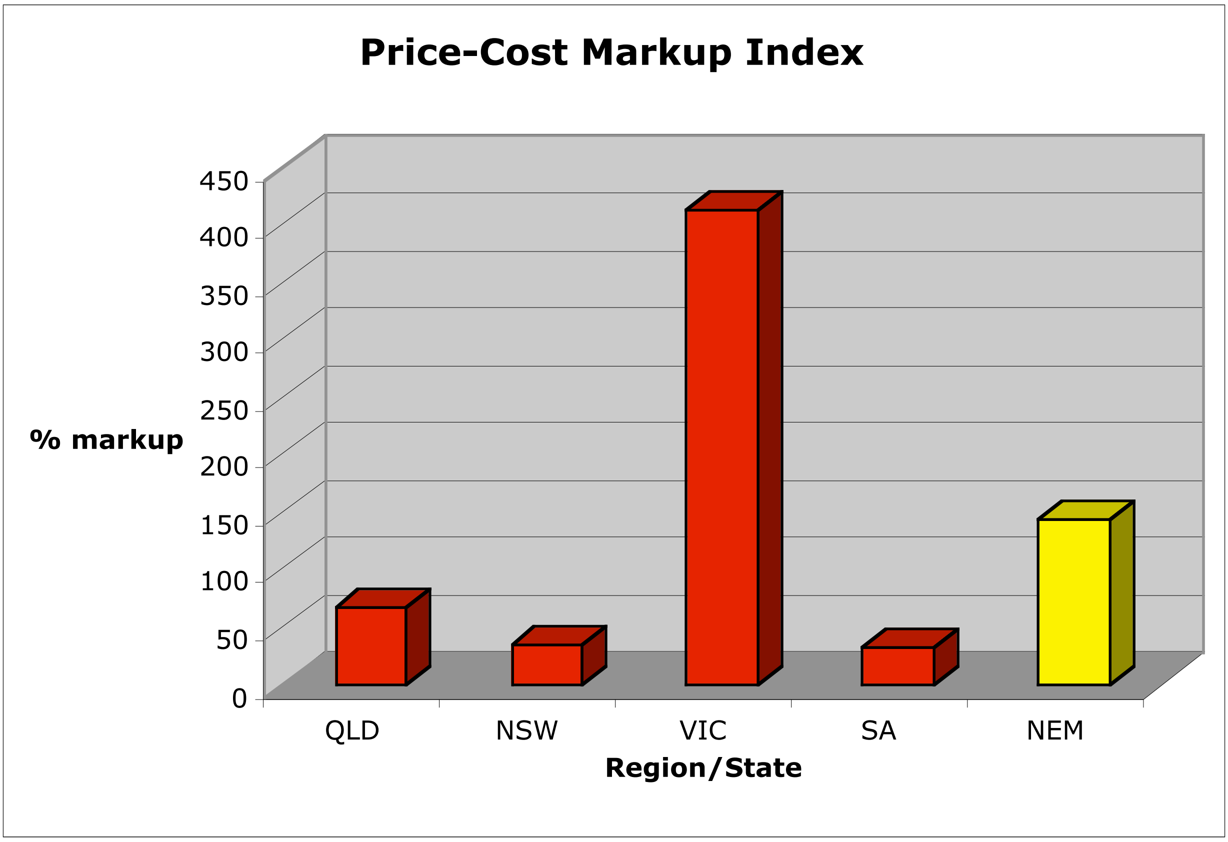


This graph illustrates one of the fundamental flaws of the NEM trading system — in that if it worked as stated and produced workably competitive market pricing outcomes, then this price would not produce enough revenue for generators to survive and to invest in new production facilities.

There is clearly the chance of unstable price outcomes for so long as the present NEM trading system is allowed to exist.

Given that a rather conservative 20% margin has already been allowed in the following graph above the SRMC bidding results, the price-cost markup for the NEM is far above those expected under workably competitive conditions.

The large range between the SRMC of the brown coal plants and the other plants in Vic make the price-cost markup of that State particularly volatile.



In Defense of the Generators

A word in defense of the NEM generators is in order here. Clearly behaving completely competitively (by offering all capacity to the market and bidding at SRMC) will not result in pool prices (and their impact on hedging prices) which are high enough to cover the fixed costs of most of the generators in the NEM.

Under the current market design therefore, generators have to bid non-competitively (i.e. bidding at prices higher than SRMC and withdrawing capacity) in order to secure price outcomes which allow them to cover their fixed costs and allow new investment to occur. This latter requirement calls for pool price outcomes around LRMC in each State.

But the freedom to withdraw capacity and to bid above SRMC is the same freedom that allows generators and traders to generate artificial price spikes and thus "game" the market. This is aggravated by the fact that bid prices can be offered as high as $10,000/MWh — despite the fact that no customer load is at risk.

This situation would not be allowed in other competitive markets around the world.

For example, as well as being opposed to compulsory pools, FERC in the USA has a cap of $US1,000/MWh ($A1,500/MWh at a 65¢ exchange rate) to catch exceptional price spikes. FERC also used a cap in California which equated to the highest SRMC on the system to bring that State's runaway prices under control since the events of 2000/01.

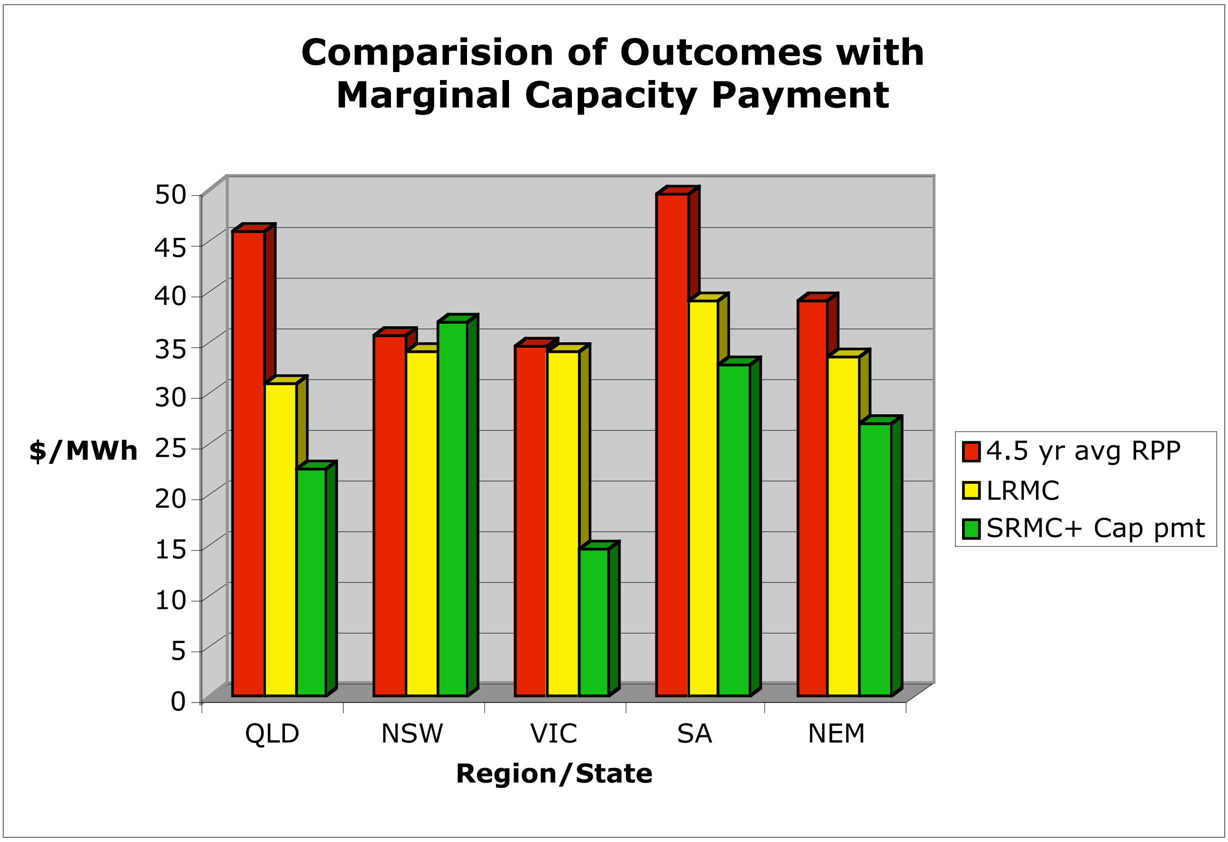
Australians did not expect that the prices in the so-called competitive National Electricity Market would be set at the whim and fancy of the generators alone — but this is the situation which has resulted.

It calls for a fundamental change in the nature of the trading system to get the incentives right on the part of both generators and retailers / major customers.

Effect of a Capacity Payment

Economic theory tells us that the LRMC and the result of SRMC bidding will only equate (under perfect competitive conditions and several other ideal conditions) if the SRMC bidding is supplemented by a marginal capacity payment. The marginal capacity payment should be the lowest marginal cost of providing a MW of peaking capacity — effectively the fixed costs of the cheapest open cycle gas turbine. Bardak estimates this marginal capacity cost as being about $8/MW/hour.[7]

The result if such a capacity payment is added to the SRMC bidding case is shown below, using the 4.5 year average NEM RPP's as a base case:



The addition of such a payment would generally equalise short run pool prices with LRMC in NSW, but not in any other State. For the NEM as a whole, it would still not make up the average price to the average LRMC.

7 See "Warring Tribes — The Story of Power Development in Australia", Revised Edition, available from www.bardak.com.au for the derivation and further explanation.

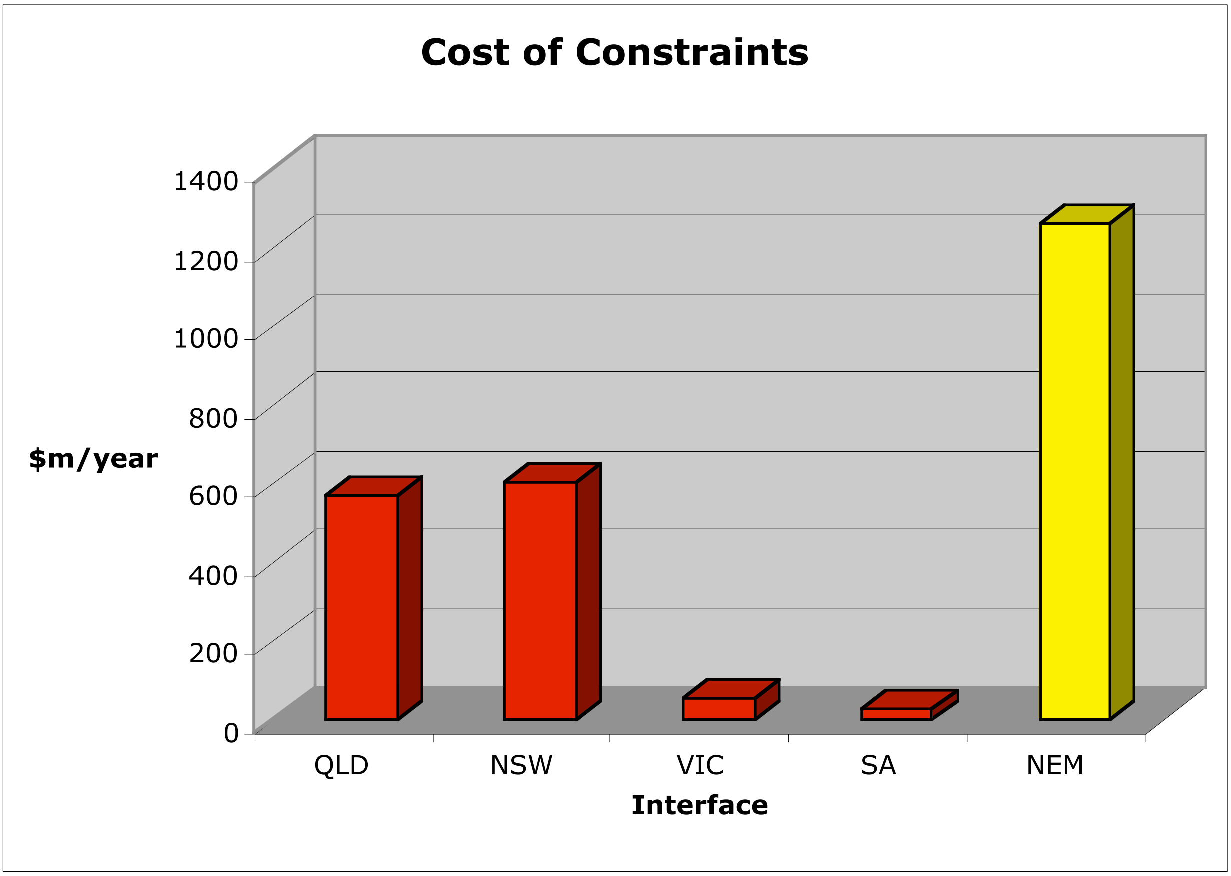
So even this short term fix, while theoretically correct and generally helpful, cannot overcome the fundamental flaws inherent the NEM trading system.

Effect of Interconnector Constraints

Bardak also analysed the half-hourly data to estimate the additional cost in the wholesale market due to differentials between the RPP's. Apart from loss effects, any time a differential appears between RPP's, it means that lower priced energy in one Region cannot find its way to a higher priced region and thus lower the RPP for that region.

We allowed 10% as an average loss factors between regions, so whenever the local RPP was greater than 110% of a neighbouring region's RPP, the lower of these two values was used. Revised annual costs were then computed for each region/State.

The result for 2002 was as shown below;



NSW and Qld suffered the greatest penalties due to constrained interconnectors, and the total annual additional cost for the year was $1,260 million.

This represents a wholesale market cost which is fully 19.4% above that which would have prevailed if the lowest RPP (after loss adjustment) was applicable.

This is the extent to which the lack of interconnection capacity in the NEM failed to produce the lowest cost outcome for the total wholesale market.

Bardak is aware of an analysis conducted by Pareto Associates which arrives at a similar figure for the year 2002, and also calculates a cumulative increased cost of $5,800 million since the NEM began operation, or an average of $1,290 million/year.[8]

These figures are quite remarkable, as such an annual amount, if continued each year, would service approximately $12,600 million of new investment in transmission interconnections. Given that the long 1000MW QLD-NSW interconnection was completed for just $340 million a year or so ago, such an amount would fund a major program of construction of interconnecting lines — perhaps adding some 30,000MW of new interconnection capacity between the States (at an assumed average cost of $400/kW).

This is far and above greater than what would be required, but ample to fund duplications of QNI, a very strong link between NSW and Vic, and stronger links from NSW and Vic into SA. In the longer term a really radical proposal worth considering is a 1400km HVDC link from the Surat Basin power plants in Southern Qld direct to SA and Vic. This would link the NEM region with the lowest LRMC to that with the highest LRMC and bring many other benefits in its wake.

But, we might add that the Regulatory Test as presently used by the ACCC prevents proponents of interconnections from claiming such cost savings as a benefit.

This anomaly needs to be rectified urgently.

At some stage, the additional capital cost would not be matched by sufficient savings in costs, but at the moment, ***the gap between where we are now and this situation is so great that a "national program" of constructing strong interconnections would be clearly justified.***

The Need to Change the Trading System

The theoretical underpinning of the design of the present NEM trading system relies upon the key assumption that there is a sufficient number of independent generators operating in the mandatory pool to deliver workably competitive outcomes.

In the NEM at present, Bardak can count only 16 independent owners of significant generation capacity — clearly not enough to sustain workably competitive conditions — especially when interconnections are often constrained. For example, the original UK pool had 38 participants the day it closed down and this level of competition was insufficient to avoid manipulation of the common pool price.

It would be nice to think that the NSW and Qld Governments would agree to disaggregate their State-owned generators into competing, separate independent power stations, free of political controls. But this is simply fanciful at the present time,

[8] Review of the ACCC Regulatory Test. Report to the National Electricity Market Advocacy Panel from Energy Users' Association of Australia and Energy Action Group, Pareto Associates, July 2003.

given the public aversion to privatisation and the potential instability inherent in the NEM (which persuades State Governments to maintain a degree of control in order to protect their consumers from unjustified prices).

Stronger interconnections will also assist, by forcing all the generators to compete in the same pool, but this will take many years to achieve.

It is extremely doubtful that, even were these developments to take place, the Australian NEM would exhibit enough competitive pressure to allow the compulsory pool to work properly.

The proper solution, and one adopted in several countries overseas, is to change the fundamental design of the NEM trading system to allow workably competitive conditions to apply with a small number of generators, supplemented by proper regulatory controls over remnant market power and adequate monitoring of market performance.

In essence, the present NEM trading system is far too prone to price manipulation and instability, causing unnecessary price spikes and volatility, both of which greatly increase the risk of operating in the NEM.

This should come as no surprise, as it has been the experience of all regions of the world that have tried to operate with a single-priced compulsory pool market. Chile and the United Kingdom were first to try the system, followed by Australia, New Zealand (partly), California, Alberta, Ontario and Brazil (partly). All bar Australia have been forced to make changes to the system to control excessive prices and/or volatility.

In the United Kingdom, the NETA[9] program replaced the original pool design with one based on bilateral, physical contracts at freely negotiated prices, supplemented by commercial power exchanges to allow the adjustment of contractual positions, and a compulsory balancing market. The latter carries only 2-3% of traded energy and is akin to the frequency control ancillary service markets in the NEM.

Since they made this change, the results have been quite spectacular. In their 2002 Annual Report, OFGEM state that:

> "NETA has performed far better against the objectives originally set than anyone could have reasonably expected. Wholesale electricity prices are now 40 per cent lower than they were when reform started and most electricity is now traded like any other commodity. The demand-side is playing an increasing part in setting prices, the trading exchanges are functioning well and liquidity is increasing."

The Chairman of OFGEM, recently summarised the UK experience in a speech given in Australia, where he said:[10]

> ".......generators formed an oligopoly, and could – and did – act to control wholesale electricity prices, something made easier by the electricity trading arrangements copied from the nationalised industry and known as the Pool.

[9] NETA stands for New Electricity Trading Arrangements.
[10] Callum McCarthy, in a speech to open an IPART Conference in July 2002.

... Today, the situation is again very different: we have broken the generators' oligopoly, so that now no company has more than 15 per cent of generating capacity. And we have changed the trading arrangements for wholesale electricity to strip them as much as possible of their special features which so clearly facilitated manipulation between generators."

Australia will have to face up to making a similar change to the NEM trading system, if we are to halt the adverse trends which this paper highlights.

The sooner we start, the better.

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