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The Evolving Australian National Electricity Market: An Assessment

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A brief history of the restructured electricity industry in eastern and southern Australia

The Special Premiers' Conference in July 1991 agreed to "establish a National Grid Management Council [NGMC] to encourage and coordinate the most efficient, economic and environmentally sound development of the electricity industry in eastern and southern Australia having regard for key national and State policy objectives" (NGMC, 1992).

In February 1994, the Council Australian Governments (COAG) agreed to develop a Code of Conduct for the operation of the National Grid (NECA, 2003a, Clause 1.2.1), where the National Grid was defined as "the sum of all connected transmission systems and distribution systems within the participating jurisdictions" (NECA, 2003a, Glossary). The participating jurisdictions were Queensland, New South Wales, South Australia and the Australian Capital Territory. Tasmania will also participate if and when the proposed cable joining it to the mainland enters service.

In 1996, the participating jurisdictions agreed to pass the National Electricity Law, "being the schedule (as amended from time to time) to an act of the parliament of South Australia entitled National Electricity (South Australia) Act 1996" (NECA, 2003a, Glossary). This provides the legal basis for the restructured industry, including the National Electricity Code and the key institutions.

The NGMC released the National Electricity Market (NEM) Code of Conduct (version 1.0) in February 1996. It has since evolved into the National Electricity Code (NEC) Version 1, which is now maintained by the National Electricity Code Administrator (NECA), a company owned by the participating jurisdictions that was created by the National Electricity Law, which also created the National Electricity Market Management Company (NEMMCO) to operate the National Electricity Market.

The original NEC and amendments to it have been subjected to the authorisation process conducted by the Australian Competition and Consumer Commission (ACCC) under the Trade Practices Act 1974. The ACCC "will also scrutinise market conduct by Code Participants through the provisions of the Trade Practices Act and will monitor prices, where necessary, through the Prices Surveillance Act 1983" (NECA, 2003a, Clause 1.2.1).

Prior to restructuring, each jurisdiction owned (in large part) the electricity supply industry within its borders. As a result, each jurisdiction determined the extent of disaggregation and privatisation of its industry. Victoria has proceeded furthest in both disaggregation and privatisation; South Australia has leased its supply industry assets on long-term leases while the electricity supply industries in New South Wales and Queensland remain in government ownership.

These outcomes have been controversial in various ways, particularly the privatisation processes in Victoria and South Australia. Also, the final report of the recent COAG energy market review concluded that "NSW needs more competing generators, and more dispersed generator ownership" (Parer et al, 2002: 21). It recommended that "the New South Wales government should further disaggregate its generation assets" (Parer et al, 2002: 50).

Each jurisdiction also decided the pace and extent of the introduction of competition for retail electricity customers and Queensland has yet to implement retail competition for residential and small commercial end-users.

This chapter assesses the performance of the NEM to date. It is argued that the restructuring process is only partially complete and that any assessment of outcomes must be viewed in this light. It is also argued that the future success of the NEM depends on achieving a satisfactory balance between competitive and cooperative processes. Key objectives should include effective, impartial and nationally consistent industry regulation, active end-user participation in ancillary service, spot energy and derivative markets and the implementation of an effective sustainability strategy.

Scope of the National Electricity Code

The NEC, which is market-oriented, sets out objectives and functions for NECA and NEMMCO and contains rules for registration as a participant, operation of the NEM, power system security, network connection and pricing, metering and administrative functions. It also contains derogations and transitional arrangements and a glossary (NECA, 2003a).

NECA is given the functions of code compliance and enforcement, dispute resolution, code development and code change. NEMMCO is given the functions of NEM operation, power system operation and security, and coordination of power system planning (NECA, 2003a, Clauses 1.5 and 1.6).

The NEC defines the following objectives for the NEM (NECA, 2003a, Clause 1.3)[1]:

- The market should be competitive;
- Customers should be able to choose which supplier (including generators and retailers) they will trade with;
- Any person wishing to do so should be able to gain access to the interconnected transmission and distribution network;
- A person wishing to enter the market should not be treated more favourably or less favourably than if that person were already participating in the market;
- A particular energy source or technology should not be treated more favourably or less favourably than another energy source or technology;
- The provisions regulating trading of electricity in the market should not treat intrastate trading more favourably or less favourably than interstate trading of electricity.

[1] It is interesting to note that neither the NEC nor the NEM have any environmental objectives, despite the original 1991 brief "to encourage and coordinate the most efficient, economic and environmentally sound development of the electricity industry". The final report of the COAG energy market review notes that:
"Government policy makers anticipated that energy market reform, and its acceleration, would lower the average greenhouse gas intensity of energy. Analysis now shows that far from achieving a 14 Mt reduction in 2010, as estimated in Australia's Second National Communication to the United Nations Framework Convention on Climate Change, energy market reform is now estimated to result in an increase of 0.1 Mt CO2-e by 2010" (Parer et al, 2002: 224).
In fact, existing brown coal power stations, with the highest climate change emission coefficients but the lowest operating costs of all fossil fuel generation, increased their market share after commencement of the NEM and it is hard to understand why this was a surprising result. The final report of the COAG energy market review recommended the introduction of "an economy wide emission trading regime" to replace a range of existing policy measures (Parer et al, 2002: 233).

Key design features of the National Electricity Market

As discussed in Outhred (2003a), "an electricity industry operates by maintaining a continuous flow of electrical energy from generators to end-use equipment. Generators, network elements and end-use equipment all contribute to this goal by operating in a mutually dependent manner." A commercial model of the industry can only represent this in an approximate manner. For example, it is not practical to make spot market intervals short enough to manage supply/demand balance in an electricity industry purely by a market mechanism alone. Nor is it possible to fully manage quality and availability of quality of supply within an electricity supply system by market mechanisms alone. Thus centrally controlled operation must be retained even in a restructured industry. NEMMCO is given the role of system operator for the National Grid as well as market operator. This is a rational choice, given the intimate relationship between the two roles. However it also means that some of the links between market and system operation are dealt with in an informal manner rather than being formally specified.

Rules for market operation

The market rules that NEMMCO implements cover bidding, dispatch, the determination of spot and ancillary service prices, settlements, market information, and conditions and procedures for market suspension (NECA, 2003a, Chapter 3). NEMMCO (2001a) provides an introduction to the NEM and describes its scope and operation. These documents should be consulted for a complete description of the market operation. A brief summary follows.

Dispatchable (that is with controllable output) generators, market network service providers (trading between market regions) and end-users (if they so wish) submit bid functions (initially one day ahead but with bid quantities that are changeable until the market interval to which they apply) into the spot energy market and ancillary service markets. Day-ahead price projections are made once initial bids have been submitted and revised on a regular basis.

The spot energy market algorithm is a linear program that sets forward-looking five-minute dispatch prices and quantity targets for all dispatchable participants. Spot prices are capped at the so-called "Value of Lost Load" (VOLL), which is currently $10 000 per MWH, with a provision to reduce the price cap if time at VOLL is prolonged. Spot market settlements are based on 30-minute average spot prices and 30-minute measured quantities.

The NEM spot market incorporates a regional representation of network losses and flow constraints and implements a hub-and-spoke approximation to nodal pricing. According to a procedure set out the NEC, market region boundaries are to be placed wherever significant network flow constraints are anticipated, although political considerations have also influenced boundary placement in practice. A regional reference node is then determined for each market region. Equations representing notional interconnectors between regional reference nodes are used to model marginal losses and constraints associated with flows between regions[2]. Network loss factors represent the effects of location on network losses within market regions. Flow constraints within market regions are not represented in the spot market.

The spot price that is paid by a buyer or paid to a seller is the regional reference price (RRP) at the relevant regional reference node (one for each market region) multiplied by the transmission and distribution loss factors that apply for the network node where the particular market participant is connected. Transmission and distribution loss factors are determined annually and represent the average effect on marginal network losses of locating a small generator or load at that node rather than at the regional reference node. Loss factors provide a price signal to generators to locate near loads and vice versa.

[2] Notional interconnectors are simplified representations of the relevant physical network elements.

The representation of marginal network losses and interconnector flow constraints in the spot market model normally results in a positive settlement residue. That is, in each spot market interval, the total amount paid by buyers (retailers or large end-users) to NEMMCO for electricity purchases normally exceeds the total amount that NEMMCO pays to sellers (generators) for electricity sales. This is particularly true when the flow on a notional interconnector is constrained in the spot market solution. The regional reference price at the receiving end can then be much higher than that at the sending end, leading to a large settlement residue unless the interconnector flow is zero because a relevant physical network element is out of service. NEMMCO conducts settlement residue auctions (SRAs), in which market participants can compete to acquire the right for a 3-month period to the directional inter-regional settlement residue associated with the notional interconnectors represented in the market model. The intent of the SRAs is to promote the efficiency of the derivative market by providing a partial hedge against the risk associated with differences between regional reference prices.

NEMMCO plays no direct role in derivative trading apart from the SRA process but it does produce "projections of system adequacy" (PASA) for seven days (Short-term PASA) and two years (Medium-term PASA), which are updated 2-hourly and weekly respectively. These compare projected generator availability with projected demand, and are intended to assist market participants to make decisions about issues such as scheduling plant maintenance. NEMMCO also produces an annual "Statement of Opportunities" (SOO), which contains ten-year forecasts of projected generator availability and projected demand. Network service providers also produce annual ten-year plans, which forecast future network constraints and propose future network developments. The intent of these forecasting processes is to assist market participants to make informed investment decisions. They can be regarded as a bridge between cooperative and competitive decision making processes. However the respective roles and accountabilities are not fully defined, nor is their relationship to the work of the Reliability Panel (see next section).

Rules for system operation

The NEC gives NEMMCO the role of "ensuring that the power system is operated in a safe, secure and reliable manner" (NEMMCO, 2001a: 24) according to power system and reliability standards set by the Reliability Panel, an entity established by the NEC and which operates under the auspices of NECA. The Reliability Panel also provides guidelines to NEMMCO for issuing directions in connection with maintaining reliability and in entering into contracts for the provision of reserves (NEMMCO, 2001a: 28).

NEMMCO carries out its operation function by means of on-going security assessments and control of key technical parameters including frequency, voltage, network loading and the capability for system re-start following a system collapse (NEMMCO, 2001a: 24). The NEC authorises NEMMCO to purchase "ancillary services" from market participants for this purpose. Despite the misleading name, ancillary services are essential to maintaining viable power system operation and manage those aspects of power system operation that are not modelled in the energy spot and derivative markets.

Ancillary services are grouped as frequency control ancillary services (FCAS), network control ancillary service (NCAS) and system restart ancillary services (SRAS). FCAS are used to control the short-term supply-demand balance as measured by power system frequency. NCAS are used primarily to control voltage levels and network power flows (NEMMCO, 2001b). NEMMCO uses eight five-minute ancillary service markets to acquire FCAS services and the others are acquired under tendering arrangements. The costs of FCAS services are partly allocated according to a "causer-pays" methodology that is based on the response of participating generators and loads to frequency deviations. Thus ancillary services are implement by a combination of centralised (cooperative) and

decentralised (competitive) processes. The centralised aspects are particularly important with respect to network services.

Regulatory arrangements

The National Electricity Law and the National Electricity Code establish industry-specific regulatory arrangements. Thus as previously indicated, NECA is responsible for administering and enforcing the NEC and the Reliability Panel is responsible for determining power system security and reliability standards.

External to the industry, the Australian Competition and Consumer Commission (ACCC) monitors market behaviour and may authorise changes to the NEC under the Trade Practices Act. Derivative trading comes under the auspices of the Australian Securities and Investment Commission.

The ACCC also has very important roles in the regulation and pricing of network services according to the principles set out in the NEC. This includes the crucial role of setting a regulatory test to determine whether a proposed network investment project can be classified as a regulated asset:

> "The regulatory test uses a cost-benefit framework so that an optimal outcome is identified and not just any option that generates a net public benefit or a positive Net Present Value (NPV). Therefore, a new interconnector or an augmentation option satisfies this test if it maximises the NPV of the market benefits having regard to a number of alternative projects, timings and market development scenarios." (ACCC, 2003a)

The interpretation of this test has proved to be controversial (McDonell, 2002) and it is currently under review (ACCC, 2003a). There are two underlying problems. First, there is great uncertainty associated with a cost benefit assessment of an appropriate timescale. Second and more fundamentally, network services are difficult to define and to separate from the services that can be provided by generators or end-users, let alone to commercialise (Outhred, 2002). The latter problem is in fact a major barrier to further progress in electricity industry restructuring generally.

The jurisdictions retain responsibility for varying regulatory roles that may include (NEMMCO, 2001a):

- Distribution network pricing according to principles set out in the NEC
- The introduction of retail competition
- Safety and environmental standards
- Distribution and retail licence conditions.

Assessing outcomes to date

It is not an easy matter to assess the outcomes of the National Electricity Market and the broader restructuring context in which it operates. That is partly because restructuring cannot be implemented as a controlled experiment. Of necessity, it takes place in a continually changing context with social, economic, environmental and technical dimensions. Therefore, there is no clear basis on which to make "before and after" comparisons. Also, outcomes such as trends in retail prices and availability and quality of supply depend on matters associated with distribution networks, retail markets and regulation that lie outside the National Electricity Market per se. Finally, electricity industry restructuring can be a prelude to privatisation, which is itself a highly controversial process.

Thus opinions vary. One the one hand Nethercote (2003) claims that restructuring is a success because average Australian electricity prices for business and residential consumers were lower in real terms in 2002 than in 1993, by 11.5% and 13% respectively. On the other hand, Spoehr (2003: 6)

claims that "privatisation of the South Australian electricity industry is likely to remain one of the most unpopular decisions ever made by a government in South Australia".

Focussing on the NEM, NECA provides quarterly reports on various aspects of market behaviour (NECA, 2003b). These reports show that after an initial transition period following market inception in December 1998, average NEM spot prices have exhibited a seasonal pattern, with high prices occurring more frequently in summer and winter peak load periods. There is a long-term converging trend in average prices in all regions, although differences still emerge from time to time. Differences between regional reference prices arise when the market representation of inter-regional flows becomes constrained, which is more likely to occur during summer and winter peak periods than at other times of year. It is worth noting that although there are clear trends in spot prices averaged over weeks or months, thirty-minute spot prices can be very volatile. Important underlying drivers are weather-related uncertainty in peak demand and uncertainty in generator and network availability at times of peak demand.

Forward contract prices for flat annual contracts as reported by NECA also show a converging trend since market inception towards "new entrant" prices in all regions. Generation investment plays an important role in preventing average spot prices rising much above the "new entrant" level, and a total of 4,400 MW of generating capacity commissioned in the first 3.5 years of market operation primarily in market regions that were relatively short of capacity (Reliability Panel, 2002). However, it seems likely that some cycling between under and over capacity will be an ongoing feature of the market and thus oscillations are likely to continue to emerge in near-term forward prices.

Outcomes with respect to network services have been mixed. As previously discussed, the application of the regulatory test for network investment has proved to be controversial and a recently completed market network service provider has applied for, and provisionally been granted, conversion to regulated status (ACCC, 2003b).

More broadly, the final report of the COAG Energy Market Review identified the following remaining deficiencies in electricity industry restructuring in Australia (Parer et al, 2002):

- Confused governance, excessive regulation and perceived conflicts of interest in States that still own important power system resources
- Insufficient generator competition in spot markets in States that have not adequately disaggregated their generation portfolios
- Flawed electricity network operation and investment and poorly defined NEM market regions where States have interfered with the boundary setting process
- Financial instrument markets that are illiquid and hampered by regulatory uncertainty and some specific State initiatives
- Insufficient competition in east-coast gas and uncertainty surrounding investment in new gas pipelines
- Ad hoc and poorly targeted climate change response.
- Some regional areas that have been disadvantaged by poor implementation of NEM market regions.

These deficiencies reflect a mixture of regulatory, structural and market design issues, illustrating the complexity of the electricity industry restructuring process.

A possible source of consolation is that much more significant deficiencies in restructuring have occurred in other countries. For example, Maze (2003), Stoft (2003), Welch et al (2003) and Wolak (2003) discuss the complexities and pitfalls of the electricity restructuring experience in the USA, while Outhred (2001) discusses the implications of the Californian experience for Australia.

One underlying issue is that a competitive model must assume that participants can deliver efficient outcomes merely by behaving as independent competitive agents. This is not the case in an electricity industry, where cooperative behaviours are also required. A key challenge in electricity restructuring is to achieve an appropriate balance of competition and cooperation, through a compatible combination of markets, centralised operation and planning and regulation. As previously mentioned, a key problem is that network services are difficult to define and separate from the services provided by generators and end-users (Outhred, 2002).

Improving the design of the National Electricity Market

Key recommendations of the COAG review are (Parer et al, 2002):

- Replace the present mixed Federal and State level regulatory structure with a National Energy Regulator (NER), with decisions by NER and NEMMCO to be reviewable by the Australian Competition Tribunal.
- Federal, Western Australia (WA) and Northern Territory (NT) governments to join the remaining governments as co-owners of NEMMCO, with the COAG Ministerial Council on Energy to be the sole provider of policy direction on electricity and gas.
- Further disaggregate and then privatise NSW and WA generation portfolios and implement explicit merger guidelines to control generator market power.
- Abolish existing financial arrangements between NSW and Queensland generators and retailers and facilitate derivative markets.
- Give NEMMCO a NEM-wide planning function, with performance incentives for network service providers (NSPs), a commercial cost-benefit test to approve regulated inter-regional augmentation and firm inter-regional financial transmission rights.
- Increase the number of NEM regions (currently five) with full nodal pricing in 7-10 years.
- Phase in 30-minute metering and retail competition for all small end-users.
- Enhance competition and network coverage in gas.
- Replace existing climate-change policies for the stationary energy sector with cross-sectoral emission trading except for energy-intensive export industries.

These will be discussed under the headings of governance and regulation, spot and derivative markets, ancillary services, network representation, demand side participation and sustainability. Outhred (2003a) contains some additional discussion.

Governance and regulation

There remain widely divergent understandings and expectations of electricity industry restructuring and privatisation (where it has occurred) within the Australian community. This is reflected in the divergent positions taken by state and federal governments. However, as the COAG review has identified, a restructured electricity industry requires a coherent policy and regulatory framework to address the important issues that competition cannot resolve. Therefore, a failure to resolve questions of governance is likely to detract from industry performance.

Industry regulation also faces challenges. Governments determine regulatory policy therefore divergent government positions and likely to lead to inconsistencies in regulatory policy. Also, the difficulty of commercialising important aspects of electricity industry operation, such as network services and accountability for availability and quality of supply (Outhred, 2002) means that regulation and centralised operation will continue to play an essential role in the restructured electricity industry.

Spot and derivative markets

Spot and derivative markets for electricity are at the heart of a restructured electricity industry. Further disaggregation of generation in NSW, as recommended by Parer et al (2002), would enhance competition but would not fully eliminate "price spikes", because of the lack of intermediate storage in the electricity industry. Likewise, abolishing the existing financial arrangements between NSW and Queensland generators and retailers would facilitate the operation of derivative markets. Unfortunately the physics of the electricity industry precludes the firm inter-regional financial transmission rights recommended by Parer et al (2002) without cross-subsidy of some kind.

Ancillary services

Ancillary services are essential to secure power system operation and form an integral part of a restructured electricity industry. There are boundary problems between ancillary services on the one hand, and spot and forward markets on the other in the National Electricity Market that should be reviewed (Outhred, 2003a). As it happens, a review of ancillary services has just commenced but its scope may be too narrow to fully address some important underlying issues (Charles River Associates, 2003).

Network representation and planning

In principle, it would be desirable to increase the detail of network representation in the spot market as recommended by Parer et al (2003). For risk management purposes, this network detail would have to be reflected in derivative markets, which implies that derivative markets should be implemented by NEMMCO, which in turn would be consistent with the model proposed in Outhred and Kaye (1996). It would also be consistent with giving NEMMCO a NEM-wide planning function.

Demand side participation

There is no doubt that demand side participation in the NEM should be enhanced and that interval metering, with measurement of key indicators of availability and quality of supply, is a necessary condition for this to occur. However, effective demand side participation also faces other barriers. Electricity energy is not the core business of end-users and responsibility for decisions is often shared between end users and other parties, such as equipment providers, building developers and owners, government authorities and financiers. Moreover, there are often group aspects of decision making, between end users that share location or use characteristics. Thus effective end-use decision-making requires an appropriate policy framework as well as efficient price signals.

Sustainability

The Australian electricity industry has large climate change impacts due to the dominance of coal as a primary energy resource. As discussed, the climate change intensity of the electricity industry has worsened due to restructuring because brown coal has increased its share of the primary energy market.

This is partly because no cost has been attributed to climate change emissions, which could be addressed by the introduction of emission permit trading as recommended in Parer et al (2002). However there are also barriers to key climate change response strategies that lie outside the market rules per se. These include improved end-use efficiency, fuel switching and greater reliance on renewable energy generation.

End-use efficiency could be enhanced by increasing support for demand-side decision makers, including end-users, equipment and appliance manufactures, urban planners and infrastructure developers. Regulatory approaches that rely on retail licence conditions are unlikely to succeed (Nolles et al, 2002, MacGill et al, 2003).

Barriers to the participation of intermittent renewable energy generators have been identified (NEMMCO, 2003) and could be addressed by a range of mechanisms (Outhred, 2003b), including more active end-user participation. There is an opportunity with the current MRET review to enhance the sustainability policy framework (Outhred and MacGill, 2003).

Conclusions

Electricity restructuring in Australia is a work in progress that may require another decade to complete. The end-point is likely to contain a mix of competitive and cooperative decision-making frameworks that are more refined than the current National Electricity Market design. The balance between cooperation and competition has yet to be resolved and it may be appropriate to internalise within NEMMCO more of the issues that have difficult boundary problems. Thus giving NEMMC carriage for NEM-wide planning functions and the operation of derivative markets would complement its present roles in ancillary service and spot markets. However, strong and impartial oversight would be needed given the dominant role that NEMMCO would then play in the industry.

Active end-user participation in ancillary service, spot and derivative markets is required and is likely to emerge over time, with a reduced role for electricity retailers. Instead, end-use facilitators should provide advisory services and organise aggregated responses.

Renewable energy generation and improved end-use efficiency will be key responses to the high levels of climate change emissions associated with the electricity industry. They could be facilitated by changes to the NEC and enhancements to the sustainability policy framework.

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