AUSTRALIAN ENERGY MARKET COMMISSION

Management of negative settlement residues in the Snowy Region

Public description of modelling approach being adopted for the Southern Generators' Rule change proposal

Information Disclosure Statement

9 May 2006

Contents

Summary

The Commission proposes to use market modelling of the NEM to inform its assessment of the Southern Generators' Rule change proposal.[1] This paper sets out the analytical framework, modelling methodology and assumptions for the information of interested parties. This modelling analysis is being undertaken and the results of the modelling exercise will be included in the Commission's draft determination. No additional information on the modelling approach or assumptions will be provided prior to the release of the draft determination.

Modelling will only be one input into the Commission's decision, which will be based on the NEM Objective. The Commission will also consider the likely effect of the rule change proposal on the quality, security and reliability of supply; and have regard to principles of good economic regulatory design.

[1] The Southern Generators include: Loy Yang Marketing Management Company Pty. Ltd., Southern Hydro Pty. Ltd, International Power (Hazelwood, Synergen, Pelican Point, Loy Yang B and Valley Power), TRUenergy Pty. Ltd., NRG Flinders Pty. Ltd., and Hydro Tasmania. Their rule change proposal is available on the AEMC's website at http://www.aemc.gov.au/electricity.php?r=20051214.200416

1 Introduction

The Commission has received a number of Rule change proposals to alter the way transmission congestion related to the Snowy region is managed. These include the Southern Generators' Rule change proposal on the management of negative residues and two proposals on the Snowy region boundary — one from Macquarie Generation and the other from Snowy Hydro. In addition to these proposals, the Ministerial Council on Energy (MCE) has asked the Commission to consider the management of transmission congestion more generally. Details on these proposals and of the broader congestion management project are available in an Issues Paper that the Commission released in March 2006.[2]

The proposed Rule changes potentially give rise to complex behavioural changes in the market, and in the context of the intricate pricing setting mechanism that exists at the core of the NEM, the Commission needs a systematic and robust basis for assessing and comparing the costs and benefits of competing options. This may involve conceptual and empirical modelling. Conceptual modelling may be sufficient where the problems do not require detailed market simulation and data analysis to determine the likely effects of a change. The Commission may also conduct more detailed empirical modelling of potential market outcomes arising from the implementation of these rule change proposals.

Modelling will only be one input into the Commission's decision. The Commission will also consider the likely effect of the rule change proposal on the quality, security and reliability of supply; and have regard to principles of good economic regulatory design.

In their submissions to the AEMC, market participants and customers have expressed interest in the process and outcomes of any modelling undertaking in the context of the Rule change proposals. The Commission considers informing the market of its intended modelling approach will raise the quality of debate and provide the Commission access to better quality information to model. In addition to releasing this paper that describes the modelling approach, the Commission has also formed a Technical Reference Group, drawn from representatives from the industry, to work with the Commission to help develop and refine its modelling approach and assumptions.

The Commission proposes to use market modelling of the NEM to inform its assessment of the Southern Generators' Rule change proposal. This paper sets out the analytical framework, modelling methodology and assumptions for the information of interested parties. This modelling analysis is being undertaken and the results of the modelling exercise will be included in the Commission's draft determination. No additional information on the modelling approach or assumptions will be provided prior to the release of the draft determination.

The Commission also intends to use quantitative modelling to inform its analysis of the Macquarie Generation and Snowy Hydro proposals to modify the Snowy region boundaries. This is particularly important since the Commission is considering competing proposals, and it may not be possible to distinguish between them using a qualitative assessment of the merit and disadvantages of each proposal. This will be the first time a quantitative economic assessment of the merit of alternative boundary change proposals has been undertaken since the commencement of the NEM, and is a

2 See http://www.aemc.gov.au/electricity.php?r=20051216.172956

significant undertaking. While this note is primarily concerned with the Southern Generators' Rule change proposal, it is likely that a similar approach and similar assumptions would be employed in the analysis of the Snowy region boundary Rule changes. The Commission intends to release a similar paper providing information on the modelling approach and assumptions prior to the publication of the draft determination on these Rule changes.

2 Analytical framework

The Commission may only make the Southern Generators' Rule change proposal if it contributes to the NEM Objective. The NEM Objective will be advanced by the promotion of economic efficiency for the long term benefit of consumers of electricity. The Commission will consider the likely effects of the Southern Generators' Rule change proposal on the various dimensions of efficiency (productive, allocative and dynamic) in the context of both the operation of the spot market and the trading of electricity derivative contracts. The Commission will seek to quantify these effects and compare them to the likely outcomes – in terms of efficiency – of the operation of the spot market and the trading of electricity derivatives in the absence of the Southern Generators' Rule change.

The Commission will carry out both analytical and modelling work in quantifying these effects. The description of the modelling framework provided in this paper focuses on the approach to measure and compare the efficiency changes that would be expected with the Southern Generators' rule change and the status quo. The approach aims to measure and compare the direct changes to overall economic welfare. All other things being equal, a proposal that results in greater economic welfare – because it reduces costs most and/or results in prices being closer to costs – would be preferred to other options. The quantified changes in efficiency will then inform the Commission assessment, together with non-quantifiable considerations relevant to the NEM Objective.

The NEM Objective also requires the Commission to consider the likely effect of a rule change proposal on the quality, security and reliability of supply and the reliability, safety and security of the national electricity system.

The Commission considers that principles of good economic regulatory design are also relevant to the NEM Objective. Those principles include the propositions that regulatory interventions should be limited to circumstances of demonstrated market failure and where a case for intervention is made the intervention should be transparent, predictable and where possible address the underlying cause of the market failure. These principles appear to be relevant to considering the strengths and weaknesses of the Rules framework in the absence of the Southern Generator's Rule change proposal – a feature of which is the intervention of NEMMCO to restrict (or "clamp") northward flows in order to manage negative settlement residues.

Another aspect of the principles of good economic regulatory design is to have regard to the extent to which Participants and consumers are likely to be affected, either positively or negatively, by a proposal. This may involve identifying and, where possible, quantifying wealth transfers. Consequently, the Commission may have regard to whether a proposal involves substantial wealth transfers but limited benefits to the NEM Objective.

A further aspect of the principles of good economic regulatory design is the practicality and likely adjustment effects of the implementation of a proposal. Consequently, the

Commission may have regard to whether the implementation of a Rule change proposal is likely to involve complexity, practical difficulties or transition costs.

3 Modelling framework

As indicated above, the modelling framework is oriented towards the decision making criteria to be applied by the Commission, which are guided by the nature of the issue that the Rule change is seeking to correct and the NEM objective. In terms of the Southern Generators' Rule change proposal, the modelling framework aims to answer the following key questions:

- How do the proposals affect the **economic efficiency of dispatch?** In particular, the AEMC is interested in testing whether the economic efficiency of dispatch (i.e. savings in resource costs) is likely to be improved by the proposals, and how large this improvement is likely to be over the period of the Rule change (i.e. until the expiry of the CSP/CSC trial).

- How do the proposals affect the **firmness of IRSR units?** In particular, we are interested in testing whether IRSRs are 'firmed up' by the proposals and the implications for inter-regional trade. The functionality of the hedging market potentially has efficiency consequences.

4 Modelling approach

There are two key parts to the forward-looking modelling analysis:

- **Dispatch/price modelling** to examine market outcomes in terms of generator output and revenues and spot market prices, which involves participants being allowed to engage in strategic bidding to maximise their profitability under different market conditions. This modelling aims to test the behavioural changes resulting from implementation of the proposals and the differences in dispatch, price and revenue outcomes relative to the status quo and/or competing proposals; and

- **Risk modelling** to consider the risk management implications for market participants. In particular this aims to examine whether different proposals increase or decrease the risks of trading either by making prices more volatile and, hence, more difficult and costly to hedge, and/or by making inter-regional trading more or less valuable.

The models used to undertake each of these tasks is discussed in more detail below. Both the dispatch and the risk modelling analysis will be undertaken for three key scenarios:

- a **base case**, which reflects the existing Rules including the Chapter 8A, Part 8 derogation enabling the Tumut CSP/CSC trial. In this case NEMMCO manages counter price flows at times when there are northward flows on the Vic-Snowy interconnector by clamping and when there are southward flows on the Vic-Snowy interconnector by reorientating the constraint to Dederang. This case would be run in two ways: one, a theoretical benchmark, assuming all bids are based on Short Run Marginal Costs (SRMC); and a second assuming a degree of strategic bidding behaviour on a share of generation capacity;

- a **Southern Generators case**, which reflects the Southern Generators' Rule change proposal. In this case, NEMMCO do not clamp northward flows on the Vic-Snowy interconnector to manage counter price flows. Instead, the Snowy-NSW interconnector funds any negative settlement residues that accrue on the Vic-Snowy interconnector; and

- a **reorientation case**, which reflects the option of reorientation proposed by Snowy Hydro.[3] This involves moving the Snowy regional reference node to Dederang during times of northbound and southbound constraint. The way this is done in practice is discussed in more detail in the modelling assumptions.

5 Process

The Commission recognises the importance of ensuring that the assumptions and data sources used in the modelling are accurate as possible. To this end the Commission established an expert panel drawn from industry (the Congestion Management Technical Reference Group). The expert panel was invited to comment on the:

- questions the modelling is seeking to answer;

- the approach to the modelling task; and

- the proposed assumptions for the modelling.

The comments made by the Technical Reference Group on each of these points has been taken into account in the modelling and in this note.

The Commission has selected consultants to assist the Commission with its analysis, and models with the features described below. There are a number of commercially available models that could be used for this analysis, which have similar features. Parties interested in testing or replicating the Commission's modelling should seek independent advice.

6 Dispatch/price modelling

The dispatch/price modelling will be undertaken using a game-theoretic wholesale market model. The Commission has been advised that the dispatch model it is using incorporates a representation of the physical system and is purpose built to examine strategic behaviour in a wholesale electricity market. The Commission understands that the dispatch model contains the following features:

- a realistic treatment of plant characteristics, including for example minimum on/off times, variable operation costs, etc;

- a realistic treatment of the network and losses, including inter-regional quadratic loss curves, and constraints within and between regions;

- the ability to model systems from a single region down to full nodal pricing; and

---

3 See Snowy Hydro's two submissions on the Southern Generators' rule change proposal, available on the AEMC website at http://www.aemc.gov.au/electricity.php?r=20051214.200416.

- the capability to optimise the operation of fuel constrained plant (e.g. hydro plant), and pumped storage plant over some period of time.

In addition to the above, the dispatch model uses game theory to determine equilibrium generator bidding patterns, providing a systematic tool for assessing likely market outcomes under a broad range of assumptions. The use of game theory to determine generator bids negates the need for subjective judgements on bidding assumptions, and effectively makes generator bids an output of the model, rather than an input. This limits the need to make arbitrary assumptions on the bidding behaviour of generators, which depend on a range of factors including, fundamentally, the level of competition in the market.

The model identifies optimal and sustainable bidding behaviour strategies for generators in electricity markets using game theoretic techniques. The generator bids the model produces are the optimal set of bids for each market participant (from a wide range of bidding choices) for each set of market conditions having regard to the market rules, power system conditions and the extent of intervention. The model allows strategic players to select from a set of quantity change strategies (Cournot competition) and/or price increase strategies (Bertrand competition). In addition, the model has the capability to model portfolios of generators, both within and across regional boundaries.

Once each participant is provided with a similar set of bidding choices, there can be millions of possible bidding combinations that are tested for their sustainability. The model determines the optimal pattern of bidding by having regard to the reaction by competitors to a discrete change in bidding behaviour by each generator to increase profit (either by attempting to increase price or expand market share). Once the profit outcomes from all possible actions and reactions to these actions are determined, the model finds the equilibrium outcome based on standard game theoretic techniques. A Nash equilibrium is a point from which no generator has any incentive to deviate.

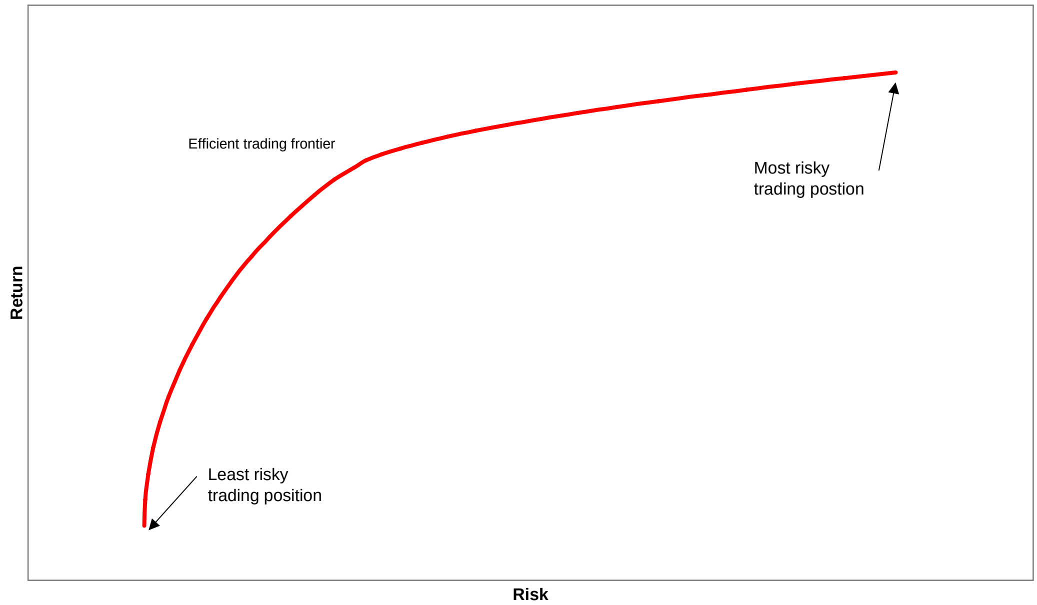
As assumptions change, so does the optimal set of bids and, hence, market price and output. This enables us to test changes in behaviour and market outcomes resulting from the Southern Generators' Rule change proposal compared to the base case and the reorientation proposed by Snowy Hydro.

7 Risk modelling

The risk analysis will be undertaken using a financial portfolio optimisation model. This financial model uses portfolio theory to determine an efficient mix of energy purchasing instruments from a suite of options (spot, physical and financial) for a range of risk levels. Each efficient combination of instruments is represented as a point on a frontier, against which other portfolios can be compared.

Portfolio theory sets out how rational investors will use diversification to optimise their portfolios, and how an asset should be priced given its risk relative to the market as a whole. More specifically, portfolio theory estimates the return of an asset as a random variable and a portfolio as a weighted combination of assets. The return of a portfolio is therefore a random variable and consequently has an expected value and a variance. Risk in this economic model is usually identified with the standard deviation of portfolio return (although other measures of risk can be used). For a given return, a rational investor would choose a less risky portfolio. In portfolio theory this relationship between risk and reward is represented by an efficient frontier (see Figure 1). The efficient frontier describes the outer edge of every possible combination of assets that could be plotted in risk-return space. Combinations of assets along this line represent portfolios for which there is lowest risk for a given level of return. Conversely, for a given amount of risk, the portfolio lying on the efficient frontier represents the combination of assets offering the best possible return. The model calculates the outer edge (frontier) of every possible combination using an advanced quadratic mixed integer programming technique.

Figure 1: A generalised efficient frontier



As assumptions change, so does the efficient frontier. This enables the impact of changes in spot price volatility and IRSR firmness on the ability of participants to efficiently hedge between regions, arising from the Southern Generators' Rule change proposal, to be compared to both the base case and the reorientation case.

8 Modelling assumptions

This Section discusses the proposed assumptions for each of the scenarios. Many of these assumptions will also be relevant in the context of the modelling for the Snowy boundary change proposals, with the notable exceptions of the regional structure, loss factors and the representation of some constraints.

8.1 Base case assumptions

8.1.1 Generation capacity

Existing and committed generation capacities for scheduled generators are taken from *NEMMCO, Statement of Opportunities for the National Electricity Market, October 2005* (Section 4.2). The portfolio structure of existing generation is based on *NEMMCO, List of Scheduled Generators and Loads, 21 February 2006* adjusted for those portfolios where dispatch rights have recently been transferred under contract or via sale.

8.1.2 Generator bids

Thermal generation short run marginal costs (SRMC) are taken from *ACIL, SRMC and LRMC of Generators in the NEM, February 2005*. SRMC for Snowy Hydro is calculated based on the SRMC of thermal plant that is displaced by the hydro generation from Snowy under a SRMC scenario (i.e. Snowy Hydro's opportunity cost).

The Commission is advised that it is not possible to allow all generators to engage in strategic bidding because of computational limitations. It is therefore necessary to make assumptions about the number and type of bidding options available to strategic players, and about the way non-strategic players are bid into the market. Snowy Hydro and major generators in each region are assumed to be strategic players. They are given options to alter the quantities they offer into the market using a number of strategies (i.e. Cournot competition). Other baseload units are bid in at SRMC for 90% of capacity. Peaking units are bid in at three times marginal cost, resulting in bids of $100-300/MWh.

8.1.3 Contract levels

The level of contract cover is likely to be an important determinant of bidding behaviour. The Commission will therefore model a number of different assumptions on contracting levels for each of the scenarios. In particular, it is assumed that Snowy Hydro contracts a share of its output at the NSW and Victorian nodes. Several cases are modelled for the split between the NSW and Victorian nodes. Snowy Hydro is assumed to buy IRSRs for the Vic-Snowy and Snowy-NSW interconnectors to cover the volume assumed to be hedged at the node in each region. Several cases are also modelled for the contract cover of major generators in each region.

8.1.4 Demand

To streamline the modelling analysis the Commission proposes to focus on a number of representative demand points (i.e. load blocks), rather than modelling each hour of the year. The time saved by modelling fewer demand points allows a larger number of strategic players and strategies to be modelled. The demand points modelled can then be weighted according to the load duration curve to find indicative results over the year.

For flows from VIC to NSW, the analysis concentrates on NSW summer peak demand points, since historical analysis shows this is when the Murray-Tumut constraint is most likely to bind. In particular, the Commission will model 20 NSW summer peak demand points, with coincident representative demand points chosen for the other regions based on the 2004/05 load profile, adjusted to match 2006/07 50% probability of exceedence forecasts from the *2005 Statement of Opportunities* (SOO). These demand points are averages of sections of the load duration curve, with varying lengths. The rest of the year is represented by 38 demand points.

A similar approach will be used to model negative residues when flows are from NSW to VIC. In this case, a number of VIC demand points will be chosen, with coincident representative demand points chosen for other regions. Demand side bids are included, with the volume taken from the SOO, at an assumed offer price of $500/MWh. No additional demand elasticity is assumed in at any given demand point.

8.1.5 Loss factors and equations

Static marginal loss factors and dynamic marginal loss factor equations are taken from a pre-release draft version of NEMMCO's document, *List of Regional Boundaries and Marginal Loss Factors for the 2006/07 Financial Year, March 2006*.

8.1.6 Constraint equations

The constraints for the Snowy region are taken from the *NEMMCO, Constraint List for the Snowy CSP/CSC trial, March 2006*. This document specifies the re-orientated constraints for the current management of southward counter price flows.

The constraint equations for all other constraints are taken from the Constraint Spreadsheet provided with the *Annual Transmission Statement (ANTS)* data attached to the NEMMCO 2005 SOO. The full list of national transmission flow path (NTFP) constraints will be included in the modelling.

8.1.7 Interconnectors

The interconnector transfer capabilities are limited by the network constraints represented in ANTS under system normal conditions. Basslink is assumed to be fully commissioned from the commencement of the modelling period, with limits of 590MW north or 300MW south, consistent with the detailed information provided with the 2005 SOO. Basslink is assumed to operate as an unregulated interconnector which is bid into the market by Hydro Tasmania, subject to limitations imposed by the Tasmanian Government Ministerial Notice.[4] MurrayLink and Directlink are assumed to be converted to regulated interconnectors and dispatched accordingly.

8.1.8 Outages

The modelling has been conducted on a system normal basis, and therefore does not include any outages, scheduled or random, again to increase the flexibility for the gaming analysis. This is consistent with the assumption that generator outages are unlikely to be scheduled during the summer months, which are the focus of the modelling analysis. Random or forced outages have been excluded from the analysis for simplicity, which may slightly overstate the potential dispatch efficiencies emerging from the results.

8.1.9 Energy constrained plant

Hydro plant is modelled to reflect energy limitations. Run of river plant is assumed to run flat across all demand periods. Other hydro plant is assumed to run to meet annual energy budgets, based on the assumption that the water is used at times it is most valuable. The modelling also incorporates pumping units (Wivenhoe, Shoalhaven and Tumut), which are assumed to have a 70% pumping efficiency and be dispatched when economic.

8.1.10 NEMMCO intervention to manage counter price flows

NEMMCO is assumed to intervene to manage counter price flows in accordance with *NEMMCO, Operating Procedure: Dispatch, Document Number SO_OP3705*. This includes reducing flows on the VIC-Snowy interconnector (i.e. 'clamping') to manage counter price flows at times of northward flows on the Vic-Snowy interconnector and re-orientation of the constraint to Dederang to manage counter price flows at times of southward flows on the Vic-Snowy interconnector.

Clamping is modelled assuming perfect foresight; that is, the interconnector limit is set to zero when there would otherwise have been negative settlement residues on the Vic-Snowy interconnector for northward flows.

8.1.11 CSP/CSC trial

The CSP/CSC trial has been implemented consistent with the Chapter 8A, Part 8 derogation. Under the arrangements transfers are made between Snowy Hydro and the

---

4 *Electricity Supply Industry Act 1995* (Tas), Ministerial Notice Under Section 36, 31 July 2005.

Snowy-NSW Inter Regional Settlement Residues (IRSRs) to reflect CSP and CSC payments. CSP payments are based on the dual (or shadow) price(s) of the relevant Snowy constraint(s), consistent with the derogation. CSC payments are modelled by allocating Snowy Hydro a 41% (550/1350) share of NSW-Snowy (i.e. southward) IRSRs at times when there is a binding constraint from Tumut to Murray.

8.2 Southern Generators case

The assumptions for the Southern Generators case are consistent with the base case, with the inclusion of sharing of IRSRs; which in turn means that clamping is not required. In the event any negative settlement residues accrue on the Vic-Snowy interconnector, for either northwards or southwards flows, these negative residues are offset by positive residues on the Snowy-NSW interconnector (after adjusting for CSP/CSC allocations).

8.3 Reorientation case

The assumptions for the reorientation case are consistent with the base case, with the exception of the removal of clamping on the Vic-Snowy interconnector. Clamping is replaced by reorientation to Dederang for the duration of the potential counter price flows. The reorientated constraints for the management of northward counter price flows are taken from *NEMMCO, Constraint List for the Snowy CSP/CSC trial, March 2006*.

9 Risk modelling assumptions

The risk modelling is based on the price duration curves and IRSRs produced by the dispatch modelling for each of the three key scenarios. In addition, for the purposes of comparison, we compare the efficient frontier for a generator hedging load across regions using Vic-Snowy and Snowy-NSW IRSRs.