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NEM Pricing issues

Fuel costs and NEM prices

Minerals Council of Australia | December 2022

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DOCUMENT INFORMATION

Project	Fuel costs and NEM prices
Client	Minerals Council of Australia
Status	Report
Report prepared by	G.H.Thorpe
Date	December 2022

Update notes.

This version of the report adds reference to reports prepared by the Australian Energy Market Operator (August 2022) and post the publication of our initial report, a report published by the Australian Energy Regulator (published 15 December 2022). It also corrects transcription errors in data used in the calculation of SRMC within the report.

CONTENTS

1. Introduction

The Minerals Council of Australia (MCA) has requested a brief discussion of a number of matters that impact wholesale prices in the National Electricity Market (NEM) regions of Queensland (QLD) and New South Wales (NSW) with a focus on historical prices during 2022. Members of the MCA are both large fuel suppliers and significant energy consumers. The discussion is to address the contribution of fuel price and market structure, amongst other factors, to wholesale electricity prices and be supported by historical analysis of outcomes during 2022.

Executive summary

This report analyses the contribution of fuel prices and market structure, amongst other factors, to wholesale electricity prices through 2022 in the NEM.

It shows that high wholesale market prices reflected implied fuel costs that were much higher than the typical long term contract coal prices.

This observation means one or more of the following:

- Generator bids were opportunistically high given the market conditions. This conclusion is consistent with materially lower priced bids either side of the conditions of June and July 2022
- Fuel prices were not represented by typical long term contract prices. This conclusion is consistent with a tiered contract price structure coupled with consumption above lower priced tiers particularly in the critical period of May-June; and
- Generator capacity factors for the year were low and reduced the opportunity for the generators to recover full fixed and variable costs pushing the coal generators up the merit order to such a degree that their bids were structured to be more like those of peaking generators.

Further analysis, beyond the scope of this report, would be required to assess which alternative(s) best explains the observation.[1]

Any intervention in the interests of customer prices should be directed at customer bill relief. The speed of change-over in generating technology and simplicity of market mechanisms will impact outcomes over the longer term.

[1] See for example AEMO analysis (August 2022 NEM Market Suspension incident report (aemo.com.au)) and since initial publication of our report, AER analysis of 15 December (June 2022 market events report (Australian Energy Regulator (aer.gov.au))

2. How are fuel prices used by generators to create their bids[2] for dispatch in the NEM?

2.1. Background

2.1.1. Dispatch basics

Generators across the interconnected NEM are dispatched on the basis of the prices and quantities offered in their dispatch bids. The Australian Energy Market Operator (AEMO) assesses the bids from all generators in all of the five regions of the NEM each 5 minutes to identify the lowest 'cost' combination to meet demand in all regions. AEMO's assessment is undertaken within the NEMDE dispatch algorithm which also accounts for the capability of transmission network elements and requirements for essential system services needed to ensure the resultant dispatch is safe and secure.

NEMDE treats the prices in dispatch bids has variable costs but strictly speaking they are the economic value generators believe should be ascribed to incremental production from their generating units at the time. This is an important distinction that is explained below.

2.1.2. Transmission capability

Power flow on transmission lines is an outcome of dispatch of generators and is not independently scheduled in Australia – noting that one of the inputs to the NEMDE calculation is the capability of transmission.[3]

2.1.3. Spot Price

In addition to calculating requirements for dispatch from generators the NEMDE also produces a marginal price of meeting demand in region. The price in each region is the Spot Price and is used for wholesale settlement and is the price paid for all energy from produced by generators and paid by energy consumed in the respective regions after adjustment for network losses.

The Spot Price is a marginal price in that it is based on the change in cost that would occur if demand was hypothetically 1 MW higher. This creates an economically efficient incentive that values additional generator capability and additional customer demand.

Bid stack approximation

Explanation of the process to calculate Spot Price is often simplified through the concept of a bid stack. In a bid stack available generation is stacked by price until demand is met and the highest price in the stack taken to be the Spot Price. While this is a good and illustrative approximation it is not technically accurate. It cannot, for example, account for situations where the least cost outcome to meet an additional MW of demand (that is the basis of marginal pricing) may be sourced from a number of different generators dispersed across the NEM and in particular if the least cost results in rearranging which generator will be used to supply operating reserve. For this reason, Spot Price may not be equal to any particular generator but instead be a combination of generators. This situation complicates assessment of 'the price setter' and price setter reports are more completely described as units that are likely to be involved in price setting.

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2 Strictly speaking dispatch bids are offers to sell but are generally termed bids

3 The Market Network Service Provider construct allows for scheduled network flows but these are currently not being used this way

2.1.4. How do fuel prices impact Spot Price?

At its simplest each generator will offer capacity for dispatch with a price that at least covers the change in its cost if dispatched. This will be the marginal cost of supply from the perspective of the generator. As fixed costs such as repayment of capital and costs of maintenance that needs to be undertaken regardless of dispatch will not change, these costs and are not part of the marginal cost and not included in a simple cost-based dispatch bid.

The main exception to this generalisation about the structure of generator bids relates to minimum loading of generating units that the bidder wishes to keep on-line even if it does not cover dispatch costs – for example large coal units that take many hours to cycle down and then back up using high-cost fuel such as gas or oil to start their boilers. Generators will typically bid a very low price for capacity of their minimum loading before there is a need to shut down.

Dispatchable but energy limited generation facilities, typically storable hydro and increasingly battery storage, are also able to participate in the wholesale market (i.e. be dispatched by AEMO and receive payment at the Spot Price). In principle these resources will price their bids at the opportunity value of the stored energy where the price offered reflects the highest price(s) that will be displaced if the stored energy is retained for future dispatch reducing the cost of generation over time.

Fuel and maintenance costs that vary as a function of dispatch are the dominant components of a simple cost-based dispatch offer and form the variable operating and maintenance cost of the unit (VOM). Short Run Marginal Cost (SRMC) is the term applied to the sum of fuel cost and VOM cost multiplied by heat rate of the generating unit.

Using the bid stack analogy, when a generator with a dispatch bid based on its marginal cost is the highest priced generation source being dispatched by the NEMDE in a particular region, that generator's SRMC will be the Spot Price in the region (after accounting for losses to the relevant regional reference node).

Typically generators' total costs are higher than their variable costs. There are a number of ways that the market design and generators bidding behaviour can result in generators recouping the difference between variable cost and total cost over time:

- In a situation where a generator is dispatched to the maximum capacity in its bid other generators with higher SRMC will be dispatched. All generators will be paid the same price (apart from adjustment to account for loss factors) and the generator with the lower variable cost will receive a contribution to its fixed costs. The generator with the lower SRMC is then said to be infra-marginal. This is the traditional mode of operation for coal units.
- A generator prices its bids to the market higher than its SRMC and if dispatched may be the price setter.
    - Note, if another generator with an even higher priced bid is also dispatched, the price will be set by this higher priced unit and the first generator will receive the higher price, making it unnecessary to have bid above its SRMC;
    - Again, in terms of the bid stack analogy, a peaking generator that is dispatched for only a small number of hours and is the last unit dispatched has no commercial alternative but to price its bids at something approaching its annual total cost. This is to be expected and is the reason the market price cap in the NEM is as high as it is. Many commentators classify this behaviour as abuse of market power, this author does not agree for the following reason, which is relevant to any generator faced with market conditions where it cannot recover cost;[4]

[4] It is however extremely difficult to separate pricing that is related recovery of costs and actual abuse of market power.

- Pricing close to total cost in this circumstance highlights a complexity that is not obvious from the high-level discussion to this point. Contrary to much commentary Spot Market theory expects generators will bid for dispatch in a way that covers their operating cost and a component that that represents the economic value offered to consumers.[5] As a result, the price that generators can theoretically be expected to bid is related to:
  - SRMC + LoLP*VoLL
  - Where
    - SRMC is the sum of fuel cost and variable maintenance cost
    - LoLP is the probability of loss of (customer) load; and
    - VoLL is the economic value consumers place on continuity of supply
  - LoLP is a statistical parameter and is very sensitive to reserve capacity and is very low except when total supply approaches total demand and will be 1.0 when load is actually being shed. Meaning that LoLP*VoLL is negligible most of the time. But, when load shedding is imminent LoLP*Voll overshadows SRMC. As noted, when load is shed LoLP is 1.0 and Spot Price will be equal to VoLL (actually VoLL plus SRMC but markets like the NEM cap price at VoLL/MCP).

How is this relevant to consideration of price setting and market price related to fuel?

In summary:

1. In a circumstance where a generator with a low-ish fuel price achieves significant dispatch it will be marginal and be the price setter for a limited amount of time but will be infra-marginal most of the time and potentially recover its fixed and variable costs. This is the traditional situation for coal.
2. In a situation where a generator with low fuel price bids at SRMC but does not achieve sufficient dispatch volume or be infra-marginal at a sufficiently high price, it will not recover its full costs. This situation will not be sustainable and will likely prompt the generator to adopt strategy 3 or 4 below or both at different times of day or under different circumstances.
3. A generator in this situation can withdraw capacity in whole or in part. If it withdraws in part, it may do this by offering less than its full capacity which will lead to NEMDE selecting capacity of higher priced bids and setting higher Spot Price and the generator trading higher revenue per MW for lower volume. In this instance the generator will rarely be the price setter but will contribute to total capacity while it is infra-marginal.
4. Alternatively, it may submit bid prices that exceed its SRMC aiming to set price when it is marginal at a higher output level seeking a price volume trade-off where it may see less dispatch but at higher price. In the extreme this will replicate the position of traditional peaking plant. Clearly where there is an overall shortage of capacity this may be a profitable strategy. In this instance the generator will be aiming to increase the time it will be the price setter. The generator may also alternate between strategies 1,2,3 and 4 using the flexibility for shifting capacity between different price bands available in the NEM.

[5] This construction was the basis for the first market design in the UK and was also addressed in a paper prepared for the AEMC pp20-22, NERA-Report.pdf (aemc.gov.au)

Time and space limits the ability to discuss the impact of hedge contracts and complexity of generation operation at minimum output when a generator may offer prices below SRMC in order to avoid incurring higher costs for cycling on and off. While these matters change the picture, they do not change the fundamental points.[6]

What can Spot Price tell us about fuel prices?

From the discussion in the preceding sections we can see that Spot Price will be closely related to SRMC in some circumstances and not in others. For the purposes of this analysis it is useful to consider a concept of 'implied SRMC' calculated from Spot Price at times when a particular generator is setting the Spot Price by a simple division by heat rate of the particular unit. Subtracting a known/assumed VOM from the implied SRMC can deliver an implied fuel price that can then be compared with actual fuel price.

This analysis could also be extended to consider bid price at all times including when a unit is infra-marginal but as the unit will be receiving the prevailing Spot Price it is of less value and has not been considered further.

In the following we present analysis of Calendar 2022 for price setting by week and also daily time blocks.

2.2. What can be learnt from recent market outcomes?

The following charts presents analysis of 'NEM Price Setter' files available from www.aemo.com.au. for NSW and QLD.

Figure 1 charts Spot Price by month across the year. The extreme conditions of June and July are clearly evident. The Spot Price for July dropped markedly due to application of the Administered Price and suspension of the NEM when a price cap of $300/MWh applied.

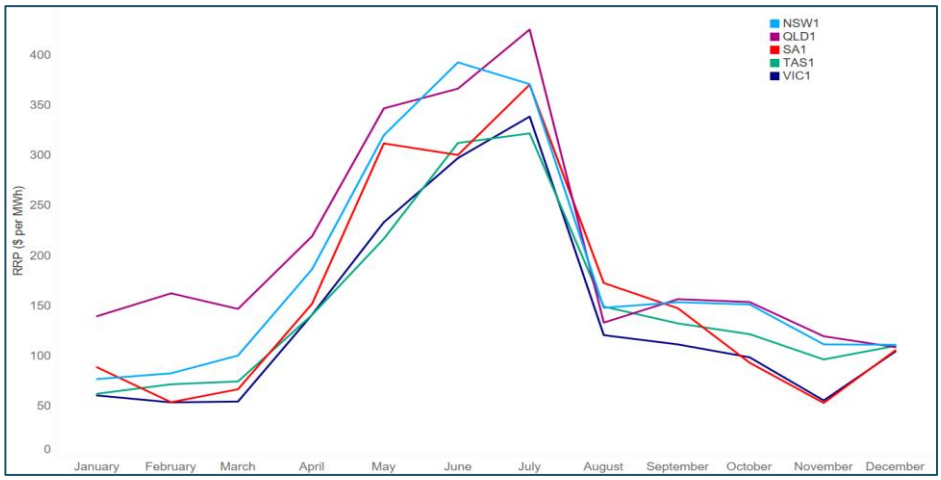


Figure 1 Average Spot Price by month

[6] As an aside the above rationale for generators with low utilisation to submit bid prices approaching their total costs is greatly ameliorated by a capacity market which typically pays for the fixed costs of a peaker removing and guaranteeing that component of revenue although other generators still rely on infra-marginal revenue but to a lesser extent

Figure 2 shows the involvement each fuel type has in setting price in NSW across the year – fuel types with no or minor involvement have been omitted for simplicity of presentation. Of significance, black coal and hydro dominate the fuel types setting price with gas being far less involved. However, this is misleading as the results in Figure 3 show.

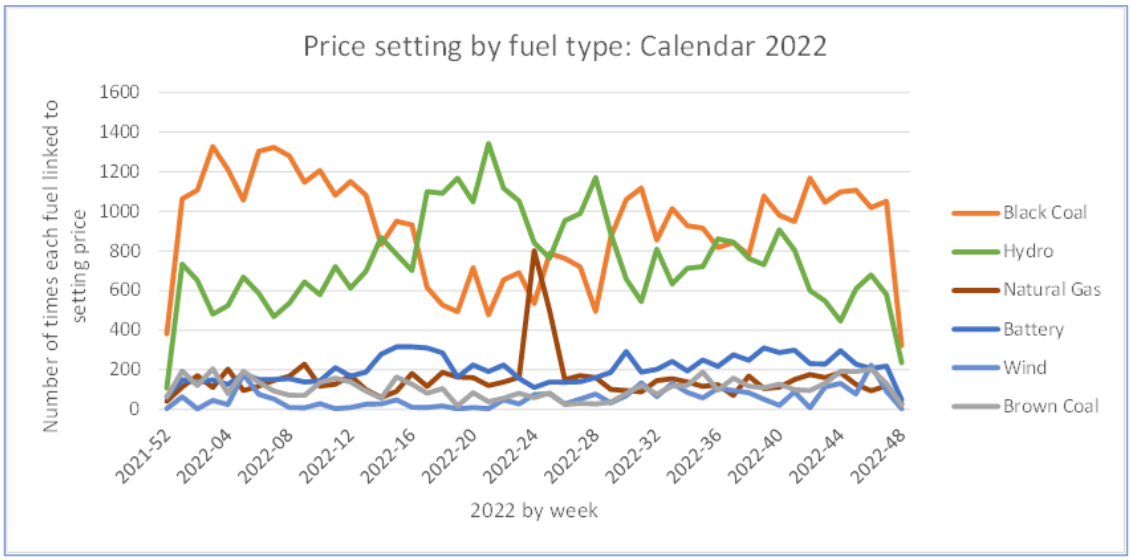


Figure 2 Count of 5 minute dispatch intervals setting Spot Price by fuel type

Figure 3 presents a view of the fuel type setting price across calendar 2022 (until the time of writing of this report) with an overlay of the price when each fuel sets price. This view shows that while gas sets price for a relatively limited percentage of the time, when it does the average price is the highest of all fuel types.

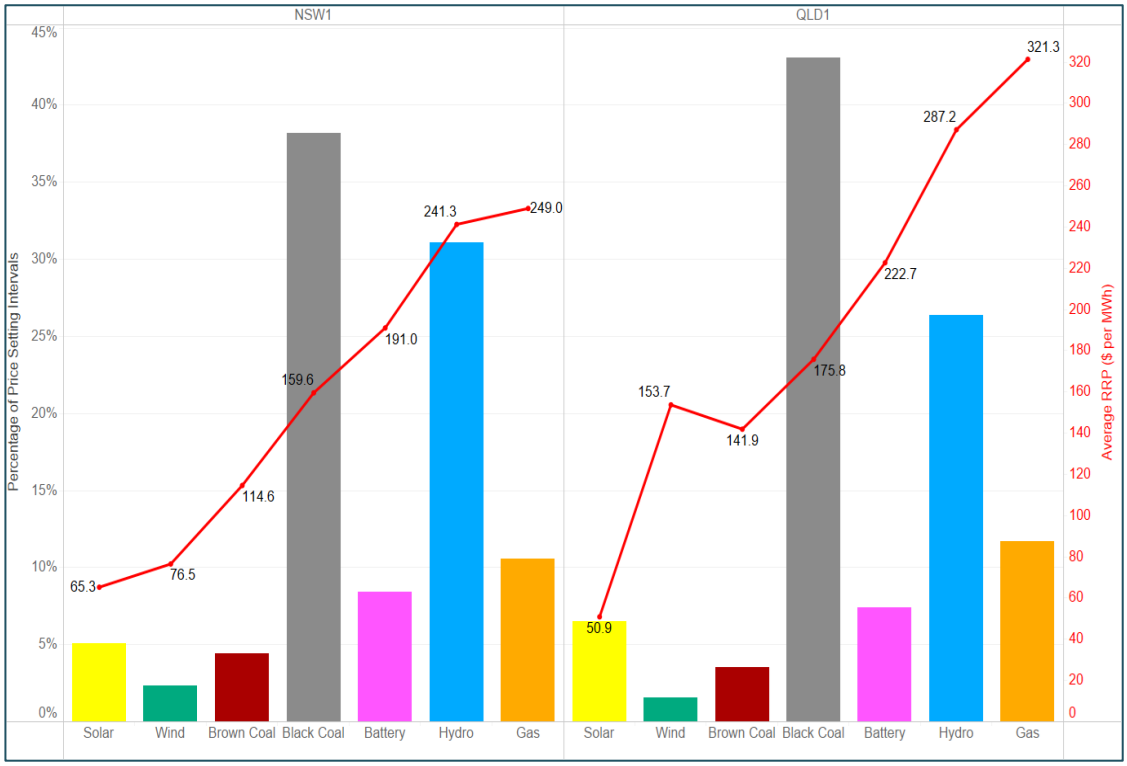


Figure 3 Price setting percentage and associate Spot Price

We understand two coal stations have been noted in public comment as potentially being heavily involved in setting high price. Figures 4 and 5 examine the frequency of price setting by Eraring in NSW and Gladstone in Queensland respectively overlaid with Spot Price when each is the station setting price. Eraring set price in NSW between 11 percent and 23 percent of the time with prices that rose from approximately $75/MWh at the start of the year and exceeded $300/MWh for the months of May, June and July. It set price for 18 percent of the time during June at a peak of just under $500/MWh dropping to $150 and most recently to under $120/MWh. Similarly, Gladstone set price for between 4 percent and 36 percent of the time with prices that rose from approximately $100/MWh and exceeded $300/MWh for the months of May, June and July with a peak of $555/MWh in July dropping to the between $234/MWh and most recently $161/MWh. As noted, prices in July will have been affected by suspension of the NEM. It is notable that thermal capacity available was well below typical levels with up to 6.6GW of capacity unavailable during June and elevated demands.[7]

7 NEM Market Suspension incident report (aemo.com.au)

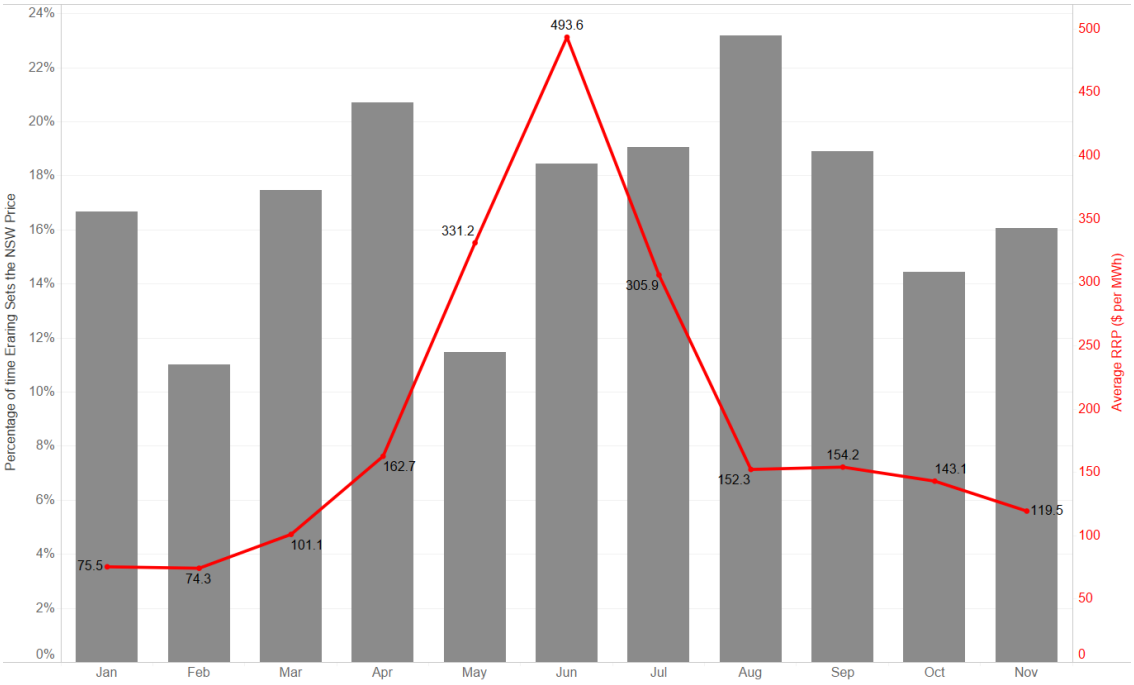


Figure 4 Frequency of Eraring as Price Setter and NSW Spot Price when this occurs

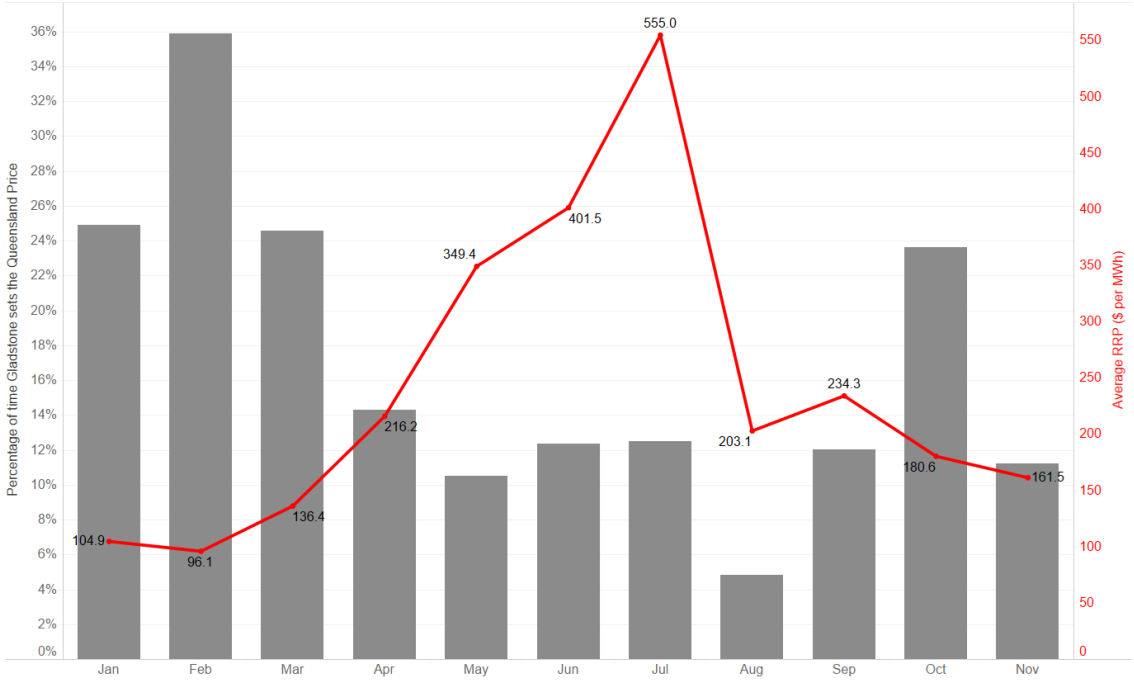


Figure 5 Frequency of Gladstone as Price Setter and QLD Spot Price when this occurs

3. SRMC calculations

This section presents the relationship between coal price and generating unit SRMC for Eraring in NSW and Gladstone in QLD, two stations which we understand have been singled out as potentially key reasons for elevating the Spot Prices in these two regions.

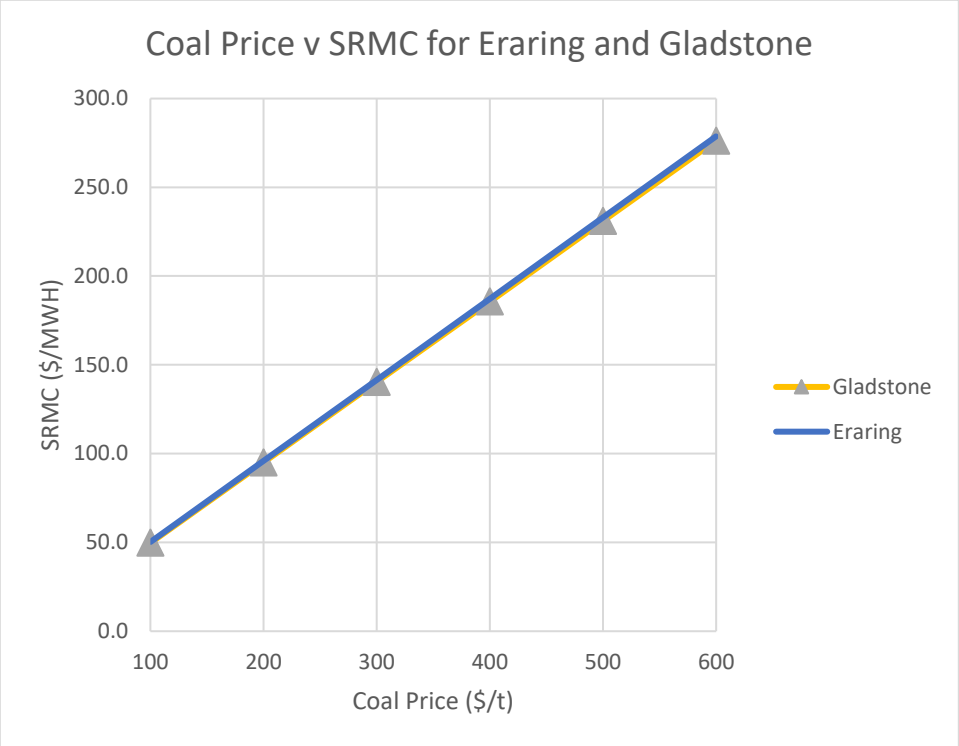
The chart provides a means to develop an understanding of the price these two generators would need to receive to cover their variable costs (SRMC) for a given price of coal and in reverse how the price in their bids at times they set the Spot Price related to their SRMC or the implied SRMC introduced earlier in this paper.

Input data assumptions for the calculations behind the chart are as follows:

Station	Coal use (GJ/MWh)	VOM ($/MWh)	Assumed Energy Value of coal (GJ/t) and kcal/kg)
Eraring	9.55	4.49	20.9 GJ/t 5000 kcal/kg
Gladstone	9.47	4.42	20.9 GJ/t 5000 kcal/kg

Source: Input assumptions and scenarios workbook, dated 30 June 2022 Available at AEMO | Current inputs, assumptions and scenarios

Using the figures in the table above for a range of coal prices results in the following relationship.



4. Conclusions

All values for peak implied fuel cost are above what can be found from a simple analysis based on expected long term coal contracts. This observation suggests one or more of the following:

- Generator bids are opportunistically high given the market conditions. This conclusion is consistent with materially lower priced bids either side of the conditions of June and July 2022
- Fuel prices were not representative of typical long term contract prices; and
- Generator capacity factors for the year were low and reduced the opportunity for the generators to recover full fixed and variable costs pushing the coal generators up the merit order to such a degree that their bids were structured to be more like those of peaking generators described above.

Further investigation beyond the scope of this report is required to assess which situation or situations best describes the conditions experienced during 2022[8]. However, it should be noted that a cap on fuel prices without considering the driving forces behind the price increases carries the risk of distortion to market mechanisms, including investment signals, supply reliability and price stability in the short, medium and long term.

5. Intervention Principles

If a decision is taken to intervene in the interests of customer prices, the following sets out a number of questions and principles for consideration.

- Choose a mechanism that fits with policy for permanent or transitory application as appropriate
- Make it simple
- As the industry transitions in accordance with policy objectives the speed of change is of critical importance to delivery of reliable and economically efficient supply in particular how quickly existing resources are withdrawn and replacements can be constructed
- Intervene as close as possible to the customer, for example provide bill relief as opposed to consumer price caps

Managing reliability and cost during rapid change and a framework for long term stability

The Australian electricity sector is changing fast, a point that is widely noted. One of the principles for intervention we have listed concerns the speed of change. While much has changed there is much more yet to be done to achieve policy objectives, especially as significant thermal stations are also approaching the end of their useful lives. Logistical limitations such as transmission to connect additional resources located away from existing transmission, labour availability and international supply chains, to note just three constraints, are impacting the speed of replacement capacity.

[8] See for example AEMO analysis August 2022 (NEM Market Suspension incident report (aemo.com.au)) and since initial publication of our report, AER analysis of 15 December (June 2022 market events report | Australian Energy Regulator (aer.gov.au))

The existing NEM structure was designed to economically displace inefficient and ageing generation through price incentives and signals. However, market outcomes over the last 5 or more years have seen generation that is approaching retirement and also generation well short of retirement displaced to the point where the economic viability of that plant is threatened and with it, reliability of supply. Mechanisms such as the Retailer Reliability Obligation (RRO) are giving some support to these units in the interests of ensuring reliability. However, the RRO is a short-term backstop mechanism and only viable on a large scale when generation plant is available to contract and currently does not manage price.

In parallel intermittent availability of most renewable resources is leading to increased financial risk and increasing reliability settings such as the market price cap. Under the current market structure, we expect this cap will need to rise considerably more until, and if, sufficient long duration storage can be developed – witness delays to Snowy 2.0 - and this may turn out to be an unworkable level of risk within the energy-only structure.

What is not clear is how reliability in the next 5 years will be assured and at what price – this is not to argue one way or the other about long-term target outcomes.

Irrespective of views on the industry's ability to change rapidly, the transition as it is currently progressing has a number of risks.

At the very least a clear market or other mechanisms that deliver enough revenue to support sufficient capacity to ensure reliability is sound policy. Looking further ahead such a mechanism should also be able to support the most cost-effective portfolio of resources that delivers the underlying policy objective(s) over time. Although the term is now contentious, any mechanism that does this outside of payment limited to dispatched energy (i.e. within an energy-only framework) is a capacity mechanism of some form, be it a physical requirement or a financial one such as the RRO is for short term threats[9]. This is somewhat different to identifying the resources that are needed to meet physical policy requirements in the absence of the cost-effective qualifier.

The RRO is an existing framework to manage short term reliability but not price. The RRO framework could however be used to ensure sufficient supply not only to manage reliability but also to ensure there is capacity to keep downward pressure on price. Enhancing the RRO with price provisions could also be considered but will not be without its difficulties but offers a way forward within an existing framework and therefore has a shorter time to implementation.

In the very short term, as noted, external energy market contracts will be in place and price will locked in. Internal contracting within vertically integrated firms which are a large part of the market could be required to be made transparent replicating the position of external contracts.

Subsidies which reduce consumer bills are also generally the most efficient means to intervene on customer behalf. If desired, subsidies can be designed to leave consumers exposed at the margin to prevailing (contract) prices leaving an efficient signal. Subsidies can also be targeted in accord with policy considerations.

9 For example, another financial capacity mechanism, is the Reliability Option design, which was also considered by the ESB.