Consultation
on
UTS Preliminary Decision

Submission by Electric Power Optimization Centre

The University of Auckland

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Executive Summary

1. Confidence in the New Zealand Wholesale Electricity Market is affected by strategic offering by generators. The workable competition model that underlies the New Zealand wholesale market requires careful oversight to ensure that competition is seen to be happening.

2. Evidence for the alleged Undesirable Trading Situation has come from periods between 3 and 18 December 2019, when energy offer prices were high when hydro reservoirs were spilling. The evidence indicates efforts by South Island generators to manage HVDC flows to avoid price separation with the North Island. The Electricity Authority has stated that they do not agree with energy offers being used to manage transmission constraints in this way.

3. EPOC has conducted benchmark studies of the New Zealand Wholesale Electricity Market that indicate that observed HVDC flows are typically different from perfectly competitive counterfactual transmission flows. In 2017, for example, time-weighted South Island wholesale prices were $23/MWh higher than perfectly competitive counterfactual prices. In the same study the perfectly competitive HVDC transmission rents were about $20M compared with $4.3M computed from historical prices.

4. EPOC concludes that there is strong evidence of strategic offering by South Island generators to manage HVDC flows to avoid price separation. This evidence is not confined to December 2019.

5. If the Electricity Authority upholds the UTS decision, then they have a duty to implement more rigorous market monitoring to provide evidence of strategic offering that is less obvious than that reported in periods between 3 and 18 December 2019. This includes gathering evidence for strategic behaviour when reservoirs are not spilling, and hedge contract and retail positions affecting spot market offering behaviour, something that should not occur under perfect competition.

6. EPOC agrees with the Electricity Authority that the observed effects on electricity prices and HVDC rentals that arise from strategic offering have knock-on effects on investment in generation and transmission.

7. Strategic offering also affects the beneficiaries of transmission assets such as the HVDC: the benefits are distributed differently under perfect competition than they are when generators manage HVDC flows to avoid price separation. Careful oversight of the market is thus needed to give confidence in the newly proposed Transmission Pricing Methodology.

Section 1: Introduction

This document is a submission by The Electric Power Optimization Centre (EPOC) at the University of Auckland in response to the preliminary decision of the Electricity Authority regarding the Undesirable Trading Situation (UTSW) claim submitted on December 12, 2019, published as [1].

EPOC is an independent research group and our response to this decision is made independently of any market participant, the Electricity Authority, or the system operator. Our submission is not focused on events that occurred during the period in question. We are taking the opportunity presented by a submission to give an opinion on wholesale electricity market competition in New Zealand, and the role of the Electricity Authority in regulating this market.

EPOC takes the view that wholesale electricity markets work best when they are as close to perfectly competitive as possible. Perfect competition in markets is often claimed to be an unrealistic standard by which to judge wholesale electricity markets, to be replaced by a standard of “workable” competition. The latter standard unfortunately is difficult to measure or assess and is open to interpretation. Perfect competition, although arguably unattainable in practice, is a computable benchmark against which market participant behaviour can be assessed.

Wholesale electricity pool markets are highly structured market environments that are amenable to detailed analysis. The New Zealand market is unique in allowing public access to offer and bid data as well as access to dispatch and pricing software (vSPD) that can be used to investigate market outcomes against counterfactuals. It is also small enough to enable detailed ex-post analysis of historical events without approximating the physical system being studied. The Electricity Authority has adopted this approach in making their preliminary decision using vSPD analysis that compares observed generator behaviour with what would be expected in a perfectly competitive market.

We hope that the analytical approach followed by the Electricity Authority is an indication that they are prepared to make comparisons with perfectly competitive benchmarks in assessing the level of competition in the New Zealand wholesale electricity market. When such precise analysis is possible, it should be used.

Section 2: Perfectly competitive behaviour

In order to compare historical events with perfectly competitive counterfactuals it is worthwhile exploring what perfectly competitive outcomes should look like.

Water values

In their report [1] the Electricity Authority have indicated what perfectly competitive behaviour looks like when water levels are so high that reservoirs are spilling. In normal circumstances this can be difficult to identify because of the risk-adjusted opportunity value of stored water, a statistic that encapsulates future price expectations of the electricity generator who uses this water. When reservoirs are full and water is spilling, this opportunity value is zero, and so one would expect low offer prices.

When reservoirs are not full, the risk-adjusted opportunity value of stored water comes from expectations of future electricity prices. If markets are perfectly competitive and enough risk-hedging instruments (like contracts or swaptions) are available, then it is possible to compute the competitive risk-adjusted opportunity value of stored water for each generator using stochastic optimization algorithms such as SDDP [2]. The competitive risk-adjusted opportunity value of stored water turns out to be the value that a social planner would place on the water if she were aiming to meet demand with lowest risk-adjusted thermal fuel and shortage costs (see [3]). The solution that SDDP gives to a risk-adjusted New Zealand-wide hydrothermal optimization problem then yields perfectly competitive stored water values.

The risk-adjusted opportunity value of stored water computed using SDDP can be used to simulate perfectly competitive offers in vSPD. Instead of water being valued at 0 (the correct value when spilling) it is valued at its risk-adjusted opportunity value given reservoir levels and expectations of future inflows. This can be used as input to vSPD.

Researchers at EPOC have been conducting counterfactual experiments using the doasa implementation of SDDP and a 48-period version of vSPD that incorporates reservoirs and river flows in the Waitaki, Clutha and Waikato systems. This has been applied to a number of historical years (2008-2017) using the inflow data available on the Electricity Authority's EMI site.

The results of the counterfactual experiments carried out by EPOC depend on a number of assumptions regarding the many inputs to vSPD. In our runs we assume that these inputs are identical to those used historically except for generation and reserve offer prices. Thermal generators offer at their short-run marginal cost (computed from gas and coal costs and other variable costs), and hydro generators pay for daily use of reservoir water at its risk-adjusted opportunity value computed using doasa. Reserve is offered at zero cost.

Recent results from these experiments for 2017[1] yield similar prices to average historical North Island prices (although significant differences over time), but lower average South Island Prices than those observed historically. The competitive counterfactual model generates more energy from the Waitaki system and constrains the HVDC line more often. One can contrast the resulting counterfactual prices with historical values as shown in Figure 1 and Figure 2.

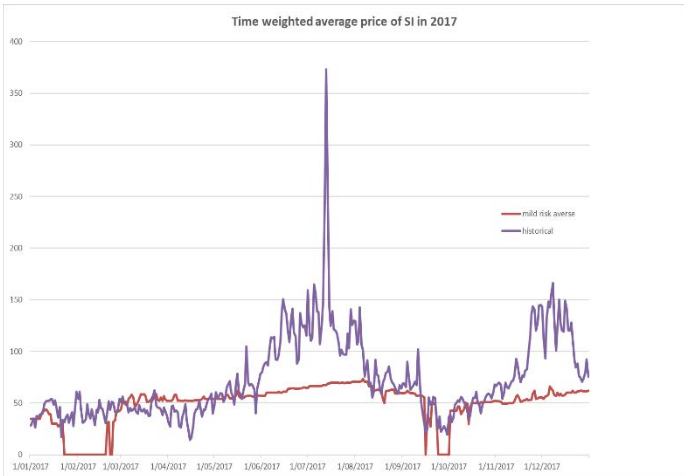

Figure 1: Historical time-weighted daily prices at Benmore (purple) compared with counterfactual prices (red). Historical prices are $23/MWh higher on average.

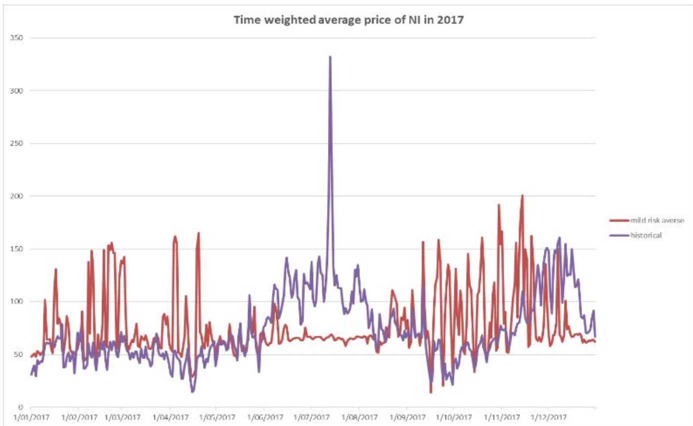

Figure 2: Historical time-weighted daily prices at Otahuhu (purple) compared with counterfactual prices (red).

Historical HVDC rentals in 2017 computed using vSPD prices were about $4.3M. The rentals from the competitive counterfactual model were approximately $20 M.

[1] 2017 is the most recent year of hydrological data maintained on the EMI site.

Portfolio effects

Generators in the wholesale market take contract positions with purchasers. Gentailers also purchase from the spot market to satisfy demand from retail customers. Both contracts and retail positions provide incentives to try and make wholesale prices lower than they would be otherwise.

In paragraph 11.27 of [1] the report states that "Contact has told us it ran TCC for portfolio reasons – generators wanting to generate at least as much as they purchase on the spot market." This appears to be a reasonable position to take. The argument is as follows. If your retail arm is purchasing Q at wholesale price p and you are generating Q at price p (assuming the same location) then this nets out and so wholesale price risk is removed. To ensure a generation level of Q, it is rational to offer the first Q units at $0/MWh.

However this is not a valid argument under perfect competition. The strategy of offering at a zero price up to Q is rational only if you believe that prices are affected by this offer. This can be seen in a simple model where we ignore the complexities of transmission, unit commitment etc. If a generator acts as if they have no effect on spot price p (i.e. perfect competition), then p is random but assumed independent of their actions. The gentailer with retail price r and retailer purchase Q then earns

$$rQ - pQ + pq - C(q), \qquad (1)$$

where C(q) is the variable cost of generating q. Recall the price p is random and is assumed to be independent of q. It then easy to see that given Q and r to maximize earnings the gentailer should choose a supply curve q(p) that maximizes R[pq(p) – C(q(p))] where R is some risk measure. This is because the last two terms in expression (1) are the only ones she can affect by choosing q. Now R[pq(p) – C(q(p))] can be maximized *at each possible value of p* by choosing q to maximize pq – C(q). Differentiating with respect to q gives p=C'(q). Thus it is optimal to offer generation at marginal cost. Moreover, the marginal cost offer has the property that it is optimal for each realization of price p, so it must be optimal irrespective of the risk attitude of the gentailer.

In summary, a risk-averse gentailer acting in perfect competition would offer energy at its marginal cost. Offering below marginal cost, ostensibly to reduce portfolio risk, is suboptimal in a perfectly competitive setting.

In contrast, a gentailer making a strategic offer would offer a supply function that lies below C'(q) for q< Q and above C'(q) for q>Q (see [5]). It is easy to find instances in the historical offer stacks of New Zealand generators that lie below marginal cost for low dispatch quantities. Some of these can be explained by constraints e.g. due to unit commitment. Other instances are evidence of strategic offering.

References

[1] Electricity Authority, The Authority's preliminary decision on claim of an undesirable trading situation, https://www.ea.govt.nz/dmsdocument/27018-preliminary-decision-2019-uts-claim.

[2] Pereira, M.V. and Pinto, L.M., (1991) Multi-stage stochastic optimization applied to energy planning. *Mathematical programming*, *52*(1-3), pp.359-375.

[3] Philpott, A.B., Ferris, M.C. and Wets, R., (2016) Equilibrium, uncertainty and risk in hydro-thermal electricity systems. *Mathematical Programming*, *157*(2), pp.483-513. (downloadable from www.epoc.org.nz.)

[4] Ferris, M.C. and Philpott, A.B., (2019) Dynamic risked equilibrium, www.epoc.org.nz

[5] Ruddell, K., Downward, A. and Philpott, A.B., (2018) Market power and forward prices. *Economics Letters*, *166*, pp.6-9. (downloadable from www.epoc.org.nz.)