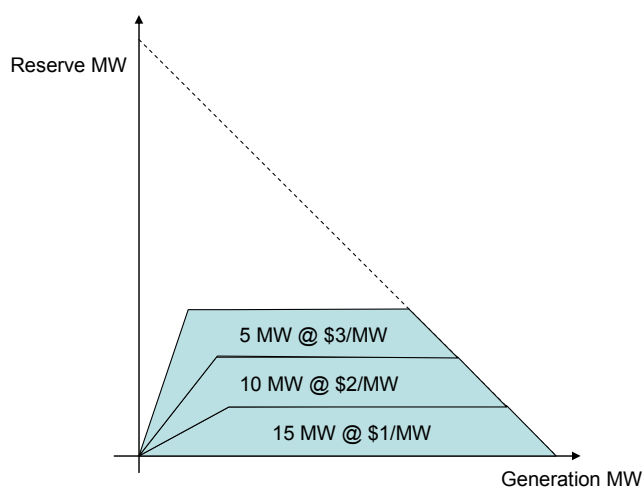


Appendix B NZ Electricity Market Overview

1. Under the New Zealand electricity market Rules, generators make half hourly energy offers up to a day ahead⁹⁰. Offers can be by station except for units that cannot synchronise and come up to minimum load within a half hour trading period. Offers specify maximum capacity, maximum up and down ramping rates, and up to 5 MW bands at increasing \$/MWh prices.
2. Generators and interruptible load providers holding contracts with the System Operator can also make half hourly offers for *fast* or *sustained* instantaneous reserves. Instantaneous reserves offers may contain up to three MW bands at increasing \$/MW prices⁹¹. Generator instantaneous reserves offers for a particular plant must be submitted by unit or station, on the same basis as energy offers. The general form of offer for generator partly loaded spinning reserve (PLSR) is depicted in stylised form⁹² in Figure 21.

Figure 21: Stylised form of generator PLSR offers



3. Each offer band specifies the MW reserve that can be provided, at the specified \$/MW price:

⁹⁰ Before 1pm, up to midnight the same day. From 1pm, to midnight the following day.

⁹¹ Offers for different instantaneous reserve categories can be considered independently, because the response time frame requirements do not overlap.

⁹² In practice, the tops of the second and third offer bands are not entirely flat. The exact form of PLSR offers is discussed in Appendix A.

- As a percentage of generated MW (the left hand slope) up to a maximum MW level.
 - Subject to an overall joint limit on capacity for both energy and reserve purposes⁹³ (the right hand slope).
4. This form of offer, known as the 'fan' or 'radial' offer form⁹⁴, is intended to enable the reserve capabilities of multi-unit stations to be represented more effectively.
 5. At two hourly intervals, using the market scheduling, pricing and dispatch (SPD) software, the System Operator prepares half hourly pre-dispatch schedules from generation and instantaneous reserves offers, and purchaser demand bids, up to midnight the following day. SPD *co-optimises* generator energy and instantaneous reserves offers, assigning offered generation capacity to energy or instantaneous reserves so as to achieve the least cost schedule given expected demand⁹⁵. The concept of co-optimisation is integral to this investigation and is the subject of a later discussion (section 4).
 6. SPD models transmission system elements and calculates nodal energy prices and separate North Island and South Island instantaneous reserves prices.
 7. From each pre-dispatch schedule, the System Operator publishes forecast energy and instantaneous reserves prices and, to each participant, their scheduled quantities of energy and instantaneous reserves. Generators are able to adjust their energy and instantaneous reserves offers until up to two hours ahead of dispatch (gate closure), after which only offered quantities are able to be revised (increased in response to System Operator emergency notices or reduced for bona fide physical reasons).
 8. In each half hour trading period, the System Operator selects the contracted frequency keeping provider in each island with the lowest offer price. i.e. frequency keeping offers are not co-optimised in SPD in the same manner as energy and instantaneous reserves offers are. The selection decision is normally made just after gate closure.
 9. Since 4 June 2008, the System Operator's selection decision has taken account of the constrained on payable to a frequency keeper should it need to be scheduled up to meet its minimum control limit. The System Operator made this change at the request of the Commission and with the agreement of frequency keeping providers. No account is taken of any constrained off payments that might be required to reduce generation below the control maximum limits, nor of the potential impacts on energy prices. Commission staff are monitoring the effect of the recent change in the

⁹³ Although the joint capacity limit in Figure 21 is shown at a slope of 45 degrees, representing a 1:1 trade-off between energy and reserve, a different slope can be applied in the market clearing software (SPD). For example, to represent a plant's short term capability, as an instantaneous reserve provider, to exceed its normal energy capacity rating.

⁹⁴ The Rules distinguish between generator PLSR and generator tail water depressed (TWD) instantaneous reserves offers. TWD offers comprise up to three horizontal bands, as for interruptible load offers, without the fan element.

⁹⁵ SPD also calculates the amount of instantaneous reserves needed in each island as a function of contingent risks.

- selection method on frequency keeping costs with a view to establishing the potential benefits of further changes.
10. Maximum and minimum control limits are applied to selected frequency keeping providers in the pre-dispatch schedule to ensure they are scheduled and dispatched within their frequency keeping range.
 11. The System Operator uses SPD to produce dispatch schedules following the same process as for pre-dispatch. SPD uses current generation levels (from SCADA) and the current set of offers to do this. Dispatch schedules are updated at 5 minute intervals (or more often if necessary – for example to return a designated frequency keeper to within its offered MW range). When it is notified of a generator outage, for the subsequent 5 minute re-dispatch schedules, the System Operator applies a constraint to SPD (reflecting the available generation)⁹⁶.
 12. The System Operator also publishes ‘real time prices’ at 5 minute intervals, and corresponding half hourly averages for each trading period. Real time prices are indicative only, for information purposes, and calculated at the end of each 5 minute period (ex post). They are calculated separately from 5 minute re-dispatch schedules. Prices in the 5 minute dispatch schedules, if published, would be ex ante 5 minute prices.
 13. The System Operator dispatches/ re-dispatches generators in accordance with 5 minute dispatch schedules⁹⁷. Generators receive dispatch instructions electronically from the System Operator’s Genco system, subject to System Operator endorsement of instructions⁹⁸. It is understood that dispatch instructions received via Genco are implemented automatically at some locations. i.e. routed directly into plant MW set point controls. However, the Rules only require generators to acknowledge instructions with 4 minutes and to use reasonable endeavours to acknowledge instructions within 3 minutes. KEMA [4] suggests that tightening up the dispatch process (removing delays and better accounting for offered ramp rates) may improve the current frequency keeping arrangements. It is unclear what the implications for the current frequency keeping arrangements might be. However, as discussed later, synchronisation of energy dispatch and AGC based frequency regulation instructions and consistent treatment of ramping rates would enhance the feasibility and effectiveness of a frequency regulation market.
 14. Generators may elect to be dispatched by station or, for hydraulically linked hydro stations, by block. i.e. offers are made by unit or station as described above but the

⁹⁶ The generator offer at the start of the trading period is used for the remainder of the trading period.

⁹⁷ In determining dispatch instructions, the System Operator uses the actual profile of demand during the previous trading period and the expected demand profile within the current trading period and the subsequent trading periods.

⁹⁸ It is understood that only instructions that have changed since the previous set of instructions were issued are sent out and that the System Operator reviews and then validates the instructions before they are sent out.

generator has the flexibility to redistribute aggregate dispatch requirements to stations within the block provided the overall requirement is met.

15. Energy and instantaneous reserves prices for each half hour are calculated ex post (by SPD) from actual demand, actual generation at the start of the trading period and the final set of energy and instantaneous reserves offers. When a generator outage occurs within a trading period, the offer which existed at the start of the trading period is used in final price calculations.
16. Generators receive the final energy price for their metered generation. Instantaneous reserves providers are paid the relevant final price for dispatched quantities. If dispatched by the System Operator, generation offered at a price higher than the final energy price⁹⁹ receives a constrained-on payment (to compensate for the difference between its offered price and the final market price). Constrained-off payments are not made, except to designated frequency keepers. Frequency keepers receive their offer price plus any constrained-on, -off payments. National half-hourly frequency keeping procurement costs are allocated to wholesale market purchasers in proportion to the amount of electricity purchased.
17. Energy, instantaneous reserves and frequency keeping settlements occur monthly.

⁹⁹ i.e. subject to a dispatch instruction from the System Operator.