The Levelised Cost of Frequency Control Ancillary Services in Australia's National Electricity Market

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Historically, Australia's National Electricity Market's (NEM) fleet of (synchronous) coal, gas and hydro generators would ensure that grid electricity was delivered at the appropriate Frequency (50Hz) through a series of 5-minute spot markets for Frequency Control Ancillary Services (FCAS). But the disorderly exit of ~5000MW of coal plant and reduction in operating duties of gas plant meant the supply of plant capable of delivering FCAS duties diminished sharply – especially in NEM regions such as South Australia. Simultaneously, rising variable solar/wind resources led to increasing demand for Frequency management duties. As a result, prices for FCAS duties went up significantly – from $1-4/MW/hour to $23-26/MW/hour.

A key question is how new investment in FCAS capable plant will be delivered, particularly utility-scale batteries which are ideally suited for FCAS duties. Investment decisions made inside utility boardrooms invariably place considerable reliance on forward market prices, or where these do not exist, price forecasts from structural models of the relevant power system. However, there is no forward price curve for FCAS markets, nor is there any systematic framework for determining equilibrium prices that might otherwise be used for investment decision-making.

In this article, we develop an approach for quantifying long run equilibrium prices in the FCAS markets, with the intended application being to guide the suitability of utility-scale battery investments under conditions of uncertainty and missing forward FCAS markets.

The principle that underpins our work is that FCAS provision has an opportunity cost given such duties are co-optimised with the NEM's spot market for electricity. We have developed a framework for assessing the underlying cost of FCAS provision – the Levelised Cost of FCAS – for a range of technologies.

We model the cost of FCAS duties from existing coal units, and from new entrant utility-scale wind, solar, and battery projects taking into account the capital, financing, and operational constraints. In the case of batteries, FCAS duties also use up the limited number of charge-discharge cycles covered under the battery warranty.

Our findings are important. Based on projections of future cost reductions in batteries, we find batteries to be the lowest cost alternative generation technology to coal for delivering FCAS. Our projections of the Levelised Cost of FCAS show that while the cost of FCAS initially rises due to increasing quantities required, unit prices are likely to decline over time as technologies move down their experience cost curve. We also find long duration batteries that currently exist in Australia's NEM will be better suited to delivering FCAS Regulation (regular adjustments to frequency), whereas short duration batteries will be better suited to FCAS Reserve duties.

Ultimately, capacity reserved for FCAS duties incur genuine opportunity costs from making headroom available or from being activated during inopportune moments. Therefore, we consider it unlikely that FCAS prices will fall to negligible levels in equilibrium. Policy makers will

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need to be mindful of allowing reserve markets to be priced appropriately – unpriced services inevitably lead to overconsumption, undersupply, or both.

It is also possible that inefficient over-investment occurs, whereby the supply of batteries temporarily well-outstrips demand for services. This would of course depress future FCAS prices, but we would suggest on a transient basis. Strong growth in battery storage will be required to manage a 100% renewable energy grid, and consequently this dynamic should drive prices back towards equilibrium.