ACIL ALLEN CONSULTING

REPORT TO
ESSENTIAL SERVICES COMMISSION

22 FEBRUARY 2017

WHOLESALE ELECTRICITY SPOT PRICE

2017-18 PROJECTIONS

AN INPUT TO THE ESSENTIAL SERVICES COMMISSION'S CONSIDERATION OF THE VICTORIAN FEED-IN TARIFF

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Introduction

ACIL Allen Consulting (ACIL Allen) has been engaged by the Essential Services Commission (ESC) to provide projections of spot wholesale electricity prices for Victoria for financial year 2017-18. The projections were prepared using *PowerMark*, ACIL Allen's proprietary model of the National Electricity Market (NEM).

This report provides an overview of the approach taken to prepare the projections and the results from the modelling.

Scenario basis

The projections cover financial year 2017-18 and are undertaken for a single scenario, which represents ACIL Allen's off-the-shelf Base Case at the time of writing.

This scenario incorporates the current demand forecasts produced by the Australian Energy Market Operator (AEMO) in its 2016 National Electricity Forecasting Report (NEFR) and ACIL Allen's internal supply assumptions. The projections were prepared in November 2016 on the assumption that the aluminium smelter at Portland will continue to operate and that the Large scale Renewable Energy Target (LRET) will continue in its current form with the current target. In our view there have been no changes in the market since the modelling was conducted that would materially affect the results presented here.

Stochastic analysis

As demand and supply for electricity must be balanced in real-time, spot prices in the gross, energy-only market of the NEM can highly volatile. Spot price outcomes can range from the market price floor (-$1,000 per MWh) to the price ceiling ($14,000 per MWh at the time of writing).

As the price ceiling is much higher than average price, whether measured in time weighted or load weighted terms, individual price spike events can have a significant effect on annual average price outcomes.

There are many factors that contribute to this price volatility.[1] Key among them is the inherent uncertainty of:

— generator unavailability due to unplanned (forced) outages
— timing of high demands and peak demand variability driven by extreme weather factors (consecutive hot days in summer and cold days in winter)
— intermittent generator output (particularly wind farms).

These factors are stochastic (random) by nature and cannot be forecast deterministically.

The Base Case represents the outcomes from a single simulation. As such, it cannot characterise the full distribution of possible price outcomes. However, ACIL Allen conditions the Base Case inputs so that it approximates a median (P50) outcome.

To provide a fuller summary of potential outcomes, ACIL Allen applied Monte Carlo techniques to reveal an underlying price distribution of likely price outcomes.

The price distribution is naturally skewed to the right (high price). This reflects the fact that prices can spike to very high levels during times of generator outage coinciding with high demand periods, whereas low price events are generally bound by marginal generator costs.

[1] Note that price variation caused by stochastic factors is different to structural factors (such as explicit carbon pricing), which tends to shift the whole price distribution. Structural factors can be examined through the examination of different scenarios.

Stochastic analysis – demand traces

The timing of high demand events and the shape of the upper end of the load duration curve (how many or how few high demand periods there are) are important for price formation. ACIL Allen therefore utilises historical weather patterns to develop a range of 'synthetic' demand traces.

These 'synthetic' demand traces are derived from 41 years of historical weather data for each NEM region, sourced from the Bureau of Meteorology. Each day's historical weather data is 'mapped' to recent demand observations by finding the best matching daily temperature profile (given the month and day type) across the NEM. The best match is identified by searching for the closest least squares match between the temperature profile for that day and the temperature profile for a day in the five years 2009-10 to 2014-15 across all NEM regions simultaneously.

The produces a set of 46 'synthetic' demand traces which correspond to prevailing historical weather patterns. Each of these traces will have slight differences in terms of timing of peak events and the shape of the load duration curve. Importantly, the traces maintain the levels of correlation between NEM regions on a daily basis.

Stochastic analysis – intermittent profiles

In keeping with the 46 synthetic demand traces, ACIL Allen aligns intermittent wind generation profiles with these demand sets to preserve the correlation between wind output and demand events. For example, it is important to preserve the correlation between peak demand and the output of wind farms in South Australia and Victoria.

Stochastic analysis – peak demands

The absolute level of peak demand in each region is another stochastic factor, reflected by AEMO producing peak demand forecasts on a probabilistic basis. To account for this, ACIL Allen grows each demand trace so that the peak demand aligns randomly with a point on AEMO's distribution.

The forecast P10, P50 and P90 peak demand levels from AEMO's 2016 NEFR for each NEM region have been used to anchor the maximum and minimum peak demands from the synthetic demand traces for each year (the median is anchored to the P50). While we recognise that the P10 and P90 points do not represent the absolute extremes expected – by definition 10 per cent of occurrences occur above and 10 per cent below these levels – we lack the necessary data points.

Stochastic analysis – forced outages

PowerMark requires the availability of each generator unit as an input for each half-hour of the year. Using binomial probability theory, ACIL Allen has simulated 11 sets of forced outages, which are defined by inputs relating to the binary condition of outage (i.e. either an outage event or not an outage event) and the outage duration.

This process allows a range of outage outcomes to be produced. The most important factor in outages is coincidence – if a number of units are forced out at the same time, volatile prices usually result. The process used to simulate the outage sets allows these sorts of coincidences to be represented appropriately.

The outage scenarios are built using randomly selected sequences of events for each plant in the model which are consistent with the underlying unplanned outage rates determined for each plant.

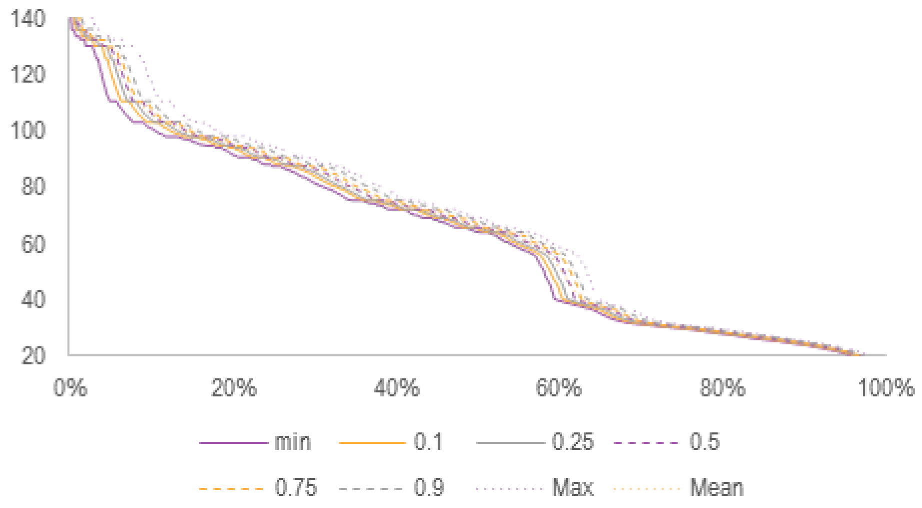
Stochastic simulations

Once the required stochastic inputs have been generated, *PowerMark* is run for each of them independently. All structural inputs – for example fuel prices, new entrant timing, retirements etc. – are held constant across these simulations. Combining the 46 synthetic demand profiles with the 11 forced outage sets results in a total of 506 simulations for each year examined.

Projection results

The projected time-weighted average spot price for Victoria for financial year 2017-18 ranges from $61.62 per MWh to $139.36 per MWh, with a mean (average) of $77.22 per MWh and a median of $72.36 per MWh. These levels are higher than corresponding projections in recent years due largely to a tightening of the balance between the supply of energy and the demand for energy in Victoria, including a change in the generation mix resulting from the planned closure of Hazelwood Power Station in 2017. Figure 1 illustrates the projected price duration curves for 2017-18.

FIGURE 1 VICTORIAN SPOT PRICE DURATION CURVES: 2017-18, SELECT PERCENTILES



SOURCE: ACIL ALLEN POWERMARK MODELLING

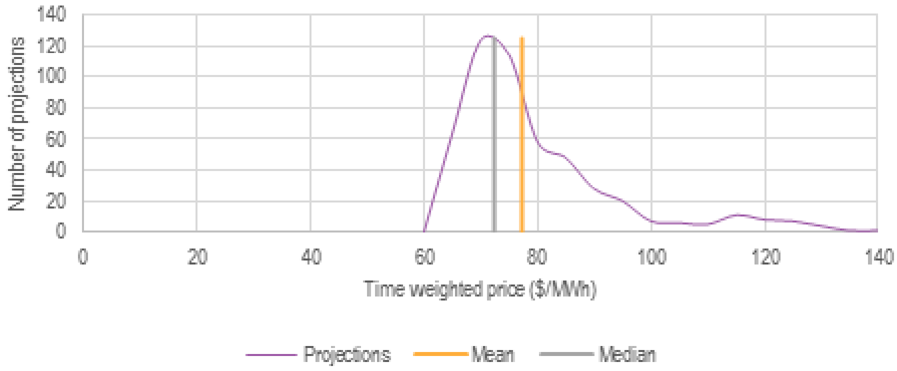
Stochastic analysis – detailed results

Each of the 506 stochastic simulations yield the same outputs that are generated for a standard single model run. This section summarises the key outcomes for Victorian wholesale spot prices for 2017-18.

Figure 2 illustrates the potential variation in annual spot price outcomes modelled for Victoria for 2017-18 achieved from varying the stochastic factors alone.

Table 1 provides summary statistics for the Victorian time-weighted annual Regional Reference Price (RRP) for 2017-18 projected from the simulations.

FIGURE 2 STOCHASTIC SIMULATION RESULTS FOR VICTORIAN RRP, 2017-18



SOURCE: ACIL ALLEN POWERMARK MODELLING

TABLE 1 SUMMARY OF STOCHASTIC OUTCOMES FOR VICTORIA TIME-WEIGHTED RRP, 2017-18

	Victorian time-weighted RRP ($ per MWh)
Maximum	**139.36**
10%	94.85
25%	82.14
Average (mean)	**77.22**
50%	**72.36**
75%	67.27
90%	64.61
Minimum	**61.62**

Note: Nominal $ per MWh

SOURCE: ACIL ALLEN POWERMARK MODELLING

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ABOUT ACIL ALLEN CONSULTING

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WE PROVIDE SENIOR ADVISORY SERVICES THAT BRING UNPARALLELED STRATEGIC THINKING AND REAL WORLD EXPERIENCE TO BEAR ON PROBLEM SOLVING AND STRATEGY FORMULATION.