Outline of Aurora's spatial demand forecasting methodology

Proposed demand forecasting methodology for Aurora's 44 connection points and 16 zone substations

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ACIL Tasman

Economics Policy Strategy

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Aurora Spatial Load Forecasting Methodology

Overview

- The underlying approach is to project load growth forward at each zone substation or connection point at a rate that is consistent with recent history.
- These spatial forecasts will then be aggregated together, using diversity factors, to a system level forecast (bottom-up).
- This will be compared to, and reconciled with, a forecast prepared independently at the system level (top-down).
- Spatial forecasts, in MWs will be prepared for 44 connection points and 16 zone substations (ZSS).
- Demand forecasts will be prepared for both summer (Dec-Feb) and winter (June –Aug) periods

Data issues

To produce the forecasts requires a data series that is quite specific. Data 'cleaning' would be undertaken by Aurora. In particular, Aurora will:

a) adjust for loads that have been switched (permanently) from one point to another

b) ensure that the data is reasonably free of problems like missing observations and other errors

For the purposes of the modelling ACIL Tasman will require a daily time series for the summer and winter periods for each of the connection points and zone substations, going back a minimum of five years (denoted in MWs).

ACIL Tasman will require details of any permanent transfers between substations both historically and for the forecast period. These are required to correct for any past and expected discontinuities in the dataset which if not accounted for, may result in biased forecasts. ACIL Tasman is advised that there are relatively few of these within the Aurora network.

Past details of major block loads and details of forecast block loads that will cause a discontinuity in the time series are also required.

The actual peaks will need to be adjusted by any permanent transfers and block loads before any forecasts are derived. In addition to block loads and permanent transfers and block loads, details of any demand side management (DSM) and irrigation loads which will affect the peak in each historical and also forecast period will also need to be accounted for and adjustments made to the underlying time series before any time trend regressions or growth factors are applied.

Embedded generation is another factor that will be accounted for. ACIL Tasman believes that the best approach is to include embedded generation in the original daily time series for each substation (which is used for weather correction) but to remove the contribution of embedded generation from the peak in each season before extrapolating into the forecast period.

Weather correction

ACIL Tasman will weather correct the data to the 10% and 50% Probability of Exceedence levels (POE).

Importance of weather correction in demand forecasting

The random nature of weather means that any comparison of historical electricity loads over time requires these loads to be adjusted to standardised weather conditions. Typically, actual demand is standardised to either, or both, of 10% and 50% POE. The 50% (10%) POE demand level is the annual maximum level that, on average, would be met or exceeded 50% (10%) of the time. It can be thought of as the maximum demand that would be observed or exceeded once every two (ten) years on average.

As the intent of load forecasting is to forecast maximum demand at a given POE level, any trend relationships of spatial maximum demand that are based on non-weather normalised data could be susceptible to bias, particularly if the historical data contains a number of extreme seasons. It is imperative that any demand forecasting methodology incorporate an appropriate form of weather normalisation or correction. This is true at all levels of the network, from the feeder level all the way up to the system.

ACIL Tasman approach to weather correction

ACIL Tasman's approach to weather correction involves estimating a regression model between the daily MD and a selection of weather variables from a suitable weather station, most probably maximum and minimum temperatures, but also possibly including rainfall and average wind speed.

Those substations that tend to peak in the morning will have coefficients that are weighted more towards the daily minimum, whereas those that peak in the afternoons will have a higher temperature sensitivity for the daily maximum.

The temperature sensitivities will be calculated for each year in the time series. So for example, to temperature correct five winter peaks from 2006, we will estimate five separate regressions between the daily MD and temperature/weather variables for each winter season from 2006 onwards.

There are two possibilities for applying weather correction to each connection point and zone substation. The first entails only estimating temperature sensitivities for a subset of the total number of connection points/zone substations and grouping the rest according to the customer mix and load type (ie. urban, commercial, industrial rural) and applying a temperature correction adjustment in proportion to the adjustment made for the connection point/zone substation that represents it.

The alternative approach involves calculating individual temperature sensitivities for each of the 44 connection points and 16 zone substations. The second approach, while clearly superior to the first, involves significantly more calculations for which provision has not been made in the project budget. ACIL Tasman is examining possible ways of finding efficiencies which will allow us to apply weather correction to each of the connection points and zone substations separately. This would remove a potential source of criticism of Aurora by the AER.

Before estimating the temperature sensitivity coefficients, it is important to note that we must remove weekends from the time series as these almost never correspond to seasonal peaks. In the case of summer, in addition to removing the weekends, we need to remove the Christmas/ New Year period which usually corresponds to lower demand.

The actual season peak is then adjusted along the regression line towards a long run weighted average temperature which corresponds to the 10% POE and 50% POE weighted average temperature. The weights are determined by the coefficients on the daily maximum and daily minimum temperature variables from the temperature sensitivity regressions.

Adjusting for significant block loads, permanent transfers and other factors

Before applying any form of regression analysis or growth factor to historical weather corrected peak demands, these will be adjusted for transfers to and from the zone substation as well as significant block loads that comprise a large proportion of the loads at the specific zone substation/connection point. The effects of transfers and large block loads are removed from the historical data series before any trends are fitted or growth rates are determined. These are later added back to the forecasts.

Forecasts will also be adjusted for predicted transfers and large block loads expected to arise during the forecast period.

Expected block loads will be added to the forecast only if they stand out as unusual or significant when compared to the history of the connection point/zone substation in question. If they are not unusual, the underlying trend growth estimated by fitting linear trend through the historical data will incorporate these types of loads.

One way to minimise the possible double counting of block loads is to apply a percentage threshold of 5% of the load at a given connection point/ zone substation so that only loads that are greater than 5% of the total load at a connection point/zone substation are added onto the forecast. Loads smaller than the threshold are assumed to be captured by the underlying trend in the time series.

If unusual or significant block loads are expected, their size and the likelihood that they will materialise should be estimated and the product of these two things should be added to the forecast at the appropriate time. Regard should be had to when loads like subdivisions are expected to be occupied (i.e. empty streets demand no electricity).

Size of spot loads should be estimated in terms of contribution to load at the time of ZSS/connection point peak demand. Some types of load may be at full demand when the system peaks, others may not.

The same approach should be used for expected reduction in load as a result of any demand side management projects (treated as negative loads).

We anticipate that Aurora will provide details of expected block loads and their likely size etc, as well as details of permanent transfers between substations.

In addition to adjustments for block loads and permanent transfers, it is also necessary to make adjustments for irrigation loads and the effect of any embedded generation operating at the time of peak demand for each connection point/zone substation.

The model will also make provision via an additional line item for the possibility of reduced demand arising from increased customer contributions/developer charges for new residential developments.

Developing the forecasts

Once data has been temperature/weather corrected and adjusted for large block loads and permanent transfers, demand forecasts will be produced.

The basic approach will be to extrapolate from recent history using linear time trends (over varying time frames) or applying growth rates based on historical behaviour to the most recent temperature corrected observation.

This is applied to non-coincident peak demands for each substation. Diversity factors will need to be applied to the aggregated forecasts to derive an overall system demand for each season in the forecast period.

The model will also make provision for the inclusion of a number of new connection points/zone substations during the forecast period.

Reconciliation with system level forecasts (top-down)

The forecasts will then be reconciled with an independently produced system level forecast by applying a proportional adjustment to each of the individual substations so that the sum of the coincident demands corresponds to the independent system demand forecast in each year of the forecast period.

The adjusted coincident substation forecasts will be converted back to non-coincident peaks using the same diversity factor as applied previously. The diversity factors applied during the forecast period will be related to historical behaviour, most probably an average of the last three or five years. We can also include trends in diversity factors if this is evident in the historical series.

Reconciliation with an independently produced system level forecast has the advantage of allowing the methodology to incorporate the impacts of broader macroeconomic and demographic aggregates, as well as the impacts of new policy initiatives which are better modelled at the system level. System level data is also smoother and more amenable to the fitting of econometric models which can be used to generate more accurate system level forecasts

Internal review of forecasts

ACIL Tasman recommends that the derived forecasts should be reviewed by an Aurora person with experience of the relevant ZSS/connection point. This person should make sure that the forecast 'fits' with the ZSS in question and use judgement to make adjustments where it does not. In particular, the use of old data creates a tendency for forecasts to 'miss' changes in growth rates. For example:

c) the forecasts may be too low in areas which are about to become (or have recently become) high growth areas

d) conversely, the forecasts may be too high in areas that have recently reached 'maturity'

e) growth in industrial load will likely reflect growth in Tasmania's GSP. If GSP is expected to accelerate (decelerate) over the forecast period, the forecasts will tend to under (over) estimate actual growth.

Any changes that are made through this process should be recorded with supporting evidence. These records form part of the documentation of the forecasts and should be provided with the forecasts where necessary (e.g. to the AER).